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Biological Resources for Sustainable Research

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First Edition

Editors

Dr. R.B. Tripathi

Dr. Taniya Sengupta Rathore

D. E. Nirman Kanna

Thanuj International Publishers, Tamil Nadu, India

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Preface

In a world increasingly conscious of its environmental footprint, the role of biological resources in promoting sustainable research has never been more critical. The delicate balance of our ecosystems, the preservation of biodiversity, and the sustainable use of natural resources are paramount for the health and prosperity of future generations. This book, "Biological Resources for Sustainable Research," aims to serve as a comprehensive guide for researchers, educators, policymakers, and students who are dedicated to advancing sustainable practices through the innovative use of biological resources.

"**Biological Resources for Sustainable Research**" is structured to provide a detailed exploration of the subject, integrating theoretical foundations with practical applications. The book is divided into several key sections which includes foundstion of biological resources, sustainable practices and innovations, real world applications and future directions and ethical consideration. The book various fields related to sustainable Research based on biological resources and innovations such as Entomology, Environmental Management, Medical Sciences, Biological diversity, Genetics, Reproductive Medicines, Mutagenesis, Microbial infections, Pharmacology, Microbiology, Pharmaceutical Sciences, Ethology, Forensic Entomology, Probiotics, Agricultural Microbiology, Ecosystem, Diabetes Science, Environmental Science, Microbial Biotechnology and Medicinal Plants. Weaim to foster scientific curiosity, inspire further research and contribute to the advancement of knowledge in these fields.

Our hearty acknowledgement to Thanuj International Publishers who readily accept and publish the subjects.We are also extending our heartful thanks to our authors Dr.Gopal Krishna Rathore, Prof. Ashok Kumar, Israfil Ali, Kajal Yadav, Vidyavati Gupta, Nafisha Khanam, Arti Yadav, Ranu Sahu, Prachi Tripathi, Tanisha Singh, Sahana Singh, Muskan Singh, Sheenat Chawla, Shomya Sinha, Leena Thakur,Tamanna Maji, Pritam Samanta, Taniya SahaAnkita Tiwari, Hemant Kumar, Dr. S. Uma, Theetchanya. S, Mrs. Vaheeda Rahman, and Dr.P.Shanmugasundaram, Kalpana Shruthi Chandrasekar, Parkavi Shanmugaraj, Gunamika Baskar, N. Sai prashanthi, Archana Mahakalkar, Apurva Shinde, Anuradha Jape, Parmar Bhargavkumar Manubhai, Dr. Gayatri Patel, Dr. Riteshkumar Arya, Jayashree R, Bhoomi.N. Patel, Vaidehi.S. Patel, Beulah Rose RaniP, Sheeba Rajakumari, Dr. Harini. V, Tushar Sangada, Kishan Rathod and Sucheta Karand, Dr. J. Jayannan, J. Sakthi Bama, A. Shajahan and L. Roselinrajathi, L. Roselin Rajathi, A. Shajahan and J. Sakthi Bama, Dr. P. Nithiya, Kaman.H. Patel, Kinnari.A. Prajapati and Abirami, H. for contributing the chapters and support for this work.

As you read through the chapters, I encourage you to reflect on the interconnectedness of our natural world and the pivotal role we play in preserving it. Sustainable research is not just a scientific endeavor; it is a commitment to stewardship and responsibility.

Dr.R.B.Tripathi
Dr. Taniya Sengupta Rathore
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About Editors

Dr.R.B.Tripathi is currently working as Assistant Professor in P.G.Department of Zoology, M.L.K.P.G.College, Balrampur-271201, Uttar Pradesh, India. He has been completed his Ph.D.in Zoology from Dr. R.M.L. Avadh University, Ayodhya, Uttar Pradesh, India. He has 23 years teaching experience in U.G and 19 years teaching experience in P.G classes,published19 book chapters,44 research papers in international and national reputed journals,participatedand presented papers in many international and national seminars,conferences andworkshops.He is Indian Zoologist,published by Surya Scientist Unique Researchers Yare Association, 2015. He is Associate Editor in International Journal of Advanced Research in Biological Sciences (ISSN:2348-8069), Editorial board member in International Journal of Advanced Multidisciplinary Research (ISSN:2393-8870),08 bookEditor in Recent Trends in Life Sciences Research (ISBN:978-81-947071-3-4),published by DarshanPublishers,Tamil Nadu, India,Recent Advancements and Research in Biological Sciences (ISBN:978-81-952529-1-6),Current Trends in Biological Sciences (ISBN:978-93-94638-00-6), Current Research in Life Sciences (ISBN: 978-93-94638-22-8),Recent Research in Biosciences (ISBN:978-93-94638-25-9),Current Advances in Biosciences (ISBN:978-93-94638-64-8),Advances in Pharmaceutical and Biosciences Research (ISBN:978-93-94638-87-7) and Advance Research Trends in Biology (ISBN:978-93-94638-75-4), published by Thanuj International Publishers Tamil Nadu,India.

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Biological Resources for Sustainable Research

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Sustainable Entomological research through harnessing biological resources

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Abstract

Sustainable entomological research relies on the strategic utilization of biological resources to advance scientific knowledge and promote environmental conservation. This abstract explores the multifaceted benefits of harnessing insect specimens, rearing facilities, biocontrol agents, pollinator populations, and genetic resources in entomological research. By employing ethical collection practices, sustainable rearing methods, and conservation-oriented strategies, researchers unlock new avenues of discovery while addressing pressing environmental challenges. Through interdisciplinary collaboration and adherence to ethical principles, sustainable entomological research not only enhances our understanding of insect biodiversity and ecosystem dynamics but also contributes to the preservation of global biodiversity and the promotion of ecosystem resilience. This abstract underscores the importance of responsible resource management and conservation efforts in paving the way for a more sustainable and harmonious relationship between humanity and the natural world.

Keywords: Sustainable entomological research,Rearing facilities, Biocontrol agents, Pollinator populations, Genetic resources, Environmental conservation

Introduction

Entomology, the scientific study of insects, encompasses a vast array of disciplines ranging from taxonomy and ecology to pest management and biotechnology. In recent years, the field of entomology has increasingly embraced the principles of sustainability, recognizing the urgent need to balance scientific inquiry with the conservation of insect biodiversity and ecosystem health (Tscharntke, et al. 2002). Central to this paradigm shift is the harnessing of biological resources in a manner that promotes sustainable research practices and fosters positive outcomes for both human societies and the environment) (Losey and Mace, 2006).Drawing upon interdisciplinary perspectives, ethical considerations, and case studies, we explore how the judicious utilization of biological resources can drive innovation, enhance resilience, and contribute to the long-term well-being of insect populations and their habitats.

Biological resources, including insect specimens, genetic material, and ecosystem services, serve as the cornerstone of entomological research. They provide scientists with essential tools and insights for understanding insect diversity, behaviour, and ecological interactions. Moreover, biological resources play a crucial role in addressing global challenges such as food security, disease vector control, and environmental conservation (Stork, 2018). Sustainable entomological research is guided by principles that emphasize the responsible stewardship of biological resources, the promotion of ecological integrity, and the equitable sharing of benefits among stakeholders. These principles underpin ethical collection practices, conservation-oriented research methodologies, and the integration of traditional knowledge with modern scientific approaches.Despite the growing recognition of the importance of sustainable entomological research, numerous challenges persist (Schroeder, 2005). These include habitat loss, climate change, invasive species, and the unsustainable exploitation of natural resources. However, these challenges also present opportunities for innovation, collaboration, and the development of novel solutions that harness the resilience and adaptive capacity of insect populations (Van Driesche, 1996).

Biological Collections: Preserving Biodiversity

Biological collections serve as invaluable repositories of insect specimens, providing researchers with a wealth of data for taxonomic studies, ecological research, and biodiversity assessments. These collections document the diversity of insect species and offer insights into their distribution, behaviour, and evolutionary relationships (Roberts, et al. 2017). However, the sustainability of biological collections hinges on ethical collection practices, proper specimen management, and adherence to legal regulations governing biodiversity conservation.Biological collections are vital for preserving biodiversity and advancing scientific knowledge in entomology (Thiers, 2017). Collection activities should prioritize ethical considerations, including obtaining proper permits, minimizing disturbance to natural habitats, and respecting local communities and indigenous knowledge (Suarez, et al.1995). Proper specimen management involves careful labelling, cataloguing, and storage to ensure the long-term preservation of specimens and associated data(Chapman, 2005). Digital technologies offer opportunities to enhance the accessibility and usability of biological collections through online databases, digitization initiatives, and virtual specimen repositories(Koch, et al. 2014).

Insect Rearing Facilities: Sustainable Mass Production

Insect-rearing facilities serve as vital resources for sustainable entomological research by providing a controlled environment for the mass production of insects (Des Marteaux, et al. 2020). Sustainable rearing practices prioritize the health and well-being of reared insects, ensuring that they are provided with appropriate nutrition, housing, and environmental conditions (Oonincx, et al. 2015). Sustainable rearing facilities employ strategies to minimize their environmental footprint, such as efficient waste management, energy conservation, and the use of eco-friendly rearing substrates.These facilities strive to optimize resource utilization by implementing efficient feeding protocols, minimizing water consumption, and maximizing the use of renewable resources (Mestre, et al. 2020). Many insect-rearing facilities collaborate with conservation organizations to support the conservation of endangered insect species through captive breeding and reintroduction programs. Bioprospecting involves the systematic exploration of natural resources, including insects, for the discovery of novel compounds and biological entities with potential applications in medicine, agriculture, and biotechnology (Morales-Ramos, et al. 2016). Sustainable bioprospecting entails ethical collection practices, equitable sharing of benefits with local communities, and conservation-oriented research methodologies. By harnessing the biodiversity of insects, bioprospecting holds promise for addressing pressing global challenges, such as antibiotic resistance and food security (Van Huis, et al. 2013).

Biocontrol Agents: Balancing Pest Management

Biocontrol agents, comprising parasitoids, predators, and pathogens, represent sustainable alternatives to chemical pesticides for managing insect pests in agricultural and urban environments (Koul, et al. 2007). These natural enemies offer targeted and environmentally friendly solutions that reduce reliance on synthetic chemicals while minimizing collateral damage to beneficial insects and the environment. Sustainable biocontrol strategies prioritize the conservation of natural enemies, ensure ecological compatibility, and aim for long-term pest suppression.Biocontrol agents provide effective and sustainable solutions for managing insect pests by leveraging natural ecological processes.Biocontrol reduces dependence on chemical pesticides, thereby minimizing the risks associated with pesticide use, such as environmental pollution and pesticide resistance (van Lenteren, et al. 2012). Unlike broad-spectrum pesticides, biocontrol agents specifically target pest species, minimizing harm to non-target organisms and preserving biodiversity(Gurr, et al. (2016).Sustainable biocontrol strategies focus on conserving and augmenting populations of natural enemies, such as parasitoids and predators, through habitat management and biological control releases.Biocontrol agents are selected based on their compatibility with the local environment and their ability to integrate into existing ecological systems without causing disruptions (Eilenberg, et al. 2020).

Biocontrolagents offer a sustainable approach to pest management that balances effective pest suppression with environmental stewardship. By harnessing the power of natural enemies, sustainable biocontrol strategies contribute to the conservation of biodiversity, reduce environmental risks, and promote the long-term resilience of agricultural and urban ecosystems.

Pollinator Conservation: Safeguarding Ecosystem Services

Pollinators, such as bees, butterflies, and flies, are indispensable contributors to ecosystem functioning, agricultural productivity, and global food security. Sustainable entomological research aims to conserve pollinator populations through a variety of strategies, including habitat restoration, pesticide reduction, and public awareness initiatives. By understanding the ecological requirements and threats facing pollinators, researchers can develop evidence-based conservation strategies to safeguard these vital ecosystem services.Pollinators play a critical role in the reproduction of flowering plants, facilitating fruit and seed production, maintaining plant diversity, and supporting wildlife habitat (Garibaldi, et al. 2013). Pollinators contribute to agricultural productivity by enhancing crop yields and quality, thereby ensuring food security and economic stability for farming communities (Goulson, 2013).Pollinators face numerous threats, including habitat loss and fragmentation, pesticide exposure, invasive species, climate change, and diseases, which can lead to population declines and biodiversity loss (Potts, et al. 2010)

Sustainable entomological research focuses on implementing conservation measures to mitigate threats to pollinators. These strategies include restoring pollinator habitats, adopting pollinator-friendly agricultural practices, reducing pesticide use, and raising public awareness about the importance of pollinator conservation (IPBES. 2016). Effective pollinator conservation relies on ongoing research and monitoring to assess population trends, identify key threats, and evaluate the effectiveness of conservation interventions. This research provides valuable insights for policymakers, land managers, and conservation practitioners (Winfree, et al. 2009). Pollinator conservationis essential for safeguarding ecosystem services, agricultural productivity, and global biodiversity. Sustainable entomological research plays a crucial role in developing and implementing conservation strategies that address the threats facing pollinators, thereby ensuring their long-term survival and the preservation of vital ecosystem functions.

Genetic Resources: Enhancing Resilience

Genetic resources encompass the rich tapestry of genetic diversity harboured within insect populations, serving as the foundation for their ability to adapt to changing environmental conditions and ecological challenges. Sustainable management of genetic resources is paramount, involving the conservation of wild populations, preservation of genetic diversity, and responsible utilization of genetic material for breeding and biotechnological applications. By harnessing genetic resources, researchers can enhance the resilience of insects to environmental stressors and mitigate the impacts of climate change.

Genetic diversity within insect populations provides the raw material for adaptation and evolution, enabling species to respond to environmental changes, including climate fluctuations, habitat loss, and the emergence of new pests and diseases.Sustainable management of genetic resources requires the conservation of wild insect populations and their natural habitats. Protected areas, habitat restoration projects, and captive breeding programs can help safeguard genetic diversity and prevent the loss of valuable genetic resources. Preserving genetic diversity within captive populations is essential for maintaining the long-term viability and resilience of insect species. Breeding programs should prioritize genetic diversity to avoid inbreeding depression and enhance the adaptive potential of captive populations.

The responsible utilization of genetic material involves ethical considerations, such as obtaining informed consent from stakeholders, respecting intellectual property rights, and ensuring equitable sharing of benefits derived from genetic resources. By harnessing genetic resources, researchers can develop insect strains with enhanced resilience to environmental stressors, such as temperature extremes, drought, and habitat fragmentation. These resilient populations can play a crucial role in ecosystem restoration, agricultural sustainability, and climate change adaptation efforts. The sustainable management of genetic resources is essential for enhancing the resilience of insect populations to environmental change and ensuring their long-term survival. By conserving genetic diversity, preserving wild populations, and responsibly utilizing genetic material, researchers can harness the adaptive potential of insects to address pressing ecological challenges, including climate change and habitat degradation.

Conclusion

In conclusion, the harnessing of biological resources stands as a cornerstone of sustainable entomological research, offering multifaceted benefits that extend far beyond the realms of science alone. By judiciously utilizing insect specimens, rearing facilities, biocontrol agents, pollinator populations, and genetic resources, researchers can unlock new avenues of discovery while simultaneously advancing the cause of biodiversity conservation and environmental stewardship.Biological collections emerge as invaluable repositories of insect specimens, providing researchers with a treasure trove of data for taxonomic studies, ecological research, and biodiversity assessments. However, the sustainability of these collections hinges upon ethical collection practices, proper specimen management, and adherence to legal regulations governing biodiversity conservation. Insect-rearing facilities play a pivotal role in sustainable entomological research by facilitating the mass production of insects for various purposes, including biological control, research experimentation, and industrial applications. Sustainable rearing practices prioritize the welfare of reared insects, minimize environmental impact, and optimize resource utilization, thus ensuring the long-term viability of insect populations. Biocontrol agents offer sustainable alternatives to chemical pesticides for managing insect pests, minimizing reliance on synthetic chemicals while preserving beneficial insects and environmental health. By harnessing the natural enemies of pests, sustainable biocontrol strategies emphasize conservation, ecological compatibility, and long-term pest suppression, contributing to the resilience of agricultural and urban ecosystems. Pollinator conservation emerges as a critical priority for safeguarding ecosystem services, agricultural productivity, and global biodiversity. Sustainable entomological research endeavours to conserve pollinator populations through habitat restoration, pesticide reduction, and public awareness initiatives, ensuring the continued provision of vital ecosystem services.Genetic resources represent a reservoir of genetic diversity within insect populations, underpinning their ability to adapt to changing environmental conditions and ecological challenges. Sustainable management of genetic resources involves the conservation of wild populations, preservation of genetic diversity, and responsible utilization of genetic material, enhancing the resilience of insects to environmental stressors and mitigating the impacts of climate change.In essence, by sustainably harnessing biological resources, entomological research not only advances scientific knowledge but also fosters biodiversity conservation, promotes ecosystem resilience, and addresses pressing societal challenges. Through interdisciplinary collaboration, ethical principles, and conservation-oriented practices, researchers can pave the way towards a more sustainable and harmonious relationship between humanity and the natural world.

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Sustainable Development: Principles, Goals, and Key Components in an Interconnected World

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Abstract

The chapter on sustainable development explores a paradigm of growth and progress that balances economic, social, and environmental considerations to meet the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development has emerged as a critical framework for addressing pressing global challenges, fostering resilience, and creating a more equitable and sustainable future. This chapter delves into the principles, goals, and key components of sustainable development, examining its significance in the context of our interconnected world. The chapter aims to deepen the reader's understanding of sustainable development as a holistic and dynamic framework, encouraging critical thinking and engagement with the multifaceted challenges and opportunities that define our global quest for a more sustainable and equitable world.

Key words: Environmental, Social & Economical balance, Sustainable future, Sustainable framework

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1. Introduction

Global challenges are complex, interconnected issues that transcend national borders and impact people, societies, and the planet on a worldwide scale. Addressing these challenges requires coordinated efforts, collaboration, and innovative solutions at local, national, and international levels.

Human activities, primarily the burning of fossil fuels and deforestation, contribute to the warming of the Earth's climate, resulting in extreme weather events, rising sea levels, and disruptions to ecosystems. Habitat destruction, pollution, and climate change contribute to the loss of biodiversity, leading to species extinction. Outbreaks of infectious diseases, pandemics, and inadequate healthcare systems pose threats to public health on a global scale. Factors such as climate change, population growth, and unsustainable agricultural practices contribute to insufficient food production and unequal distribution. Increasing demand, pollution, and climate change contribute to water scarcity, affecting communities, agriculture, and ecosystems. Disparities in income, education, and access to resources contribute to poverty and social inequality. Political, ethnic, and economic tensions can escalate into armed conflicts, threatening peace and stability. Environmental changes, conflicts, and economic disparities contribute to forced migration and displacement. Rapid technological advancements including automation and artificial intelligence impact employment, privacy, and societal structures.

Addressing these global challenges requires a collective and multidimensional approach, involving governments, businesses, civil society, and individuals. It emphasizes the importance of sustainable development, social justice, and responsible governance to create a more equitable and resilient world.

Sustainable development is one of the major approaches to mitigate the global issues. This chapter delves into the principles, goals, and key components of sustainable development, examining its significance in the context of our interconnected world. It explores a paradigm of growth and progress that balances economic, social, and environmental considerations to meet the needs of the present without compromising the ability of future generations to meet their own needs.

2. Definition of Sustainable Development

Sustainable development has emerged as a critical framework for addressing pressing global challenges, fostering resilience, and creating a more equitable and sustainable future.

Sustainable development is a holistic and multidimensional concept that refers to the process of meeting the needs of the present generation without compromising the ability of future generations to meet their own needs. It involves balancing economic, social, and environmental considerations to promote long-term well-being and ensure the health and resilience of the planet. Sustainable development aims to create a harmonious and equitable relationship between human societies and the natural world, recognizing the interconnectedness of economic progress, social equity, and environmental stewardship.

Sustainable development acknowledges the importance of economic growth and prosperity but emphasizes that such growth should be inclusive, fair, and compatible with environmental sustainability. It encourages responsible business practices, innovation, and the development of economic systems that promote well-being for all.

Social equity is a central pillar of sustainable development. It seeks to address issues of poverty, inequality, and social injustice, ensuring that the benefits of development are shared by all members of society. This includes promoting access to education, healthcare, and opportunities for marginalized groups.

Environmental sustainability is a core principle of sustainable development. It emphasizes the responsible use of natural resources, conservation of biodiversity, and mitigation of pollution and environmental degradation. The goal is to maintain the health of ecosystems and safeguard the planet for present and future generations.

Sustainable development recognizes the ethical responsibility to consider the needs of future generations. It emphasizes a forward-thinking approach that aims to leave a positive legacy for those who come after, ensuring that the choices made today do not compromise the well-being of future inhabitants.

Given the interconnected nature of today's world, sustainable development is a global imperative. It requires international collaboration and cooperation to address challenges that transcend national borders, such as climate change, biodiversity loss, and poverty.

Sustainable development considers the interdependencies between economic, social, and environmental factors. It discourages isolated solutions that may address one aspect while neglecting others, advocating for integrated and comprehensive strategies.

The concept gained widespread recognition following the Brundtland Commission's report in 1987, which defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Since then, sustainable development has become a guiding principle for policies, practices, and initiatives aimed at creating a more resilient, equitable, and sustainable world.

3. Historical Context of Sustainable Development

The historical context of sustainable development can be traced through significant events, reports, and milestones that have shaped the concept over the years. Some of the reports are as follows to overview the historical developments:

1. The Silent Spring (1962):

Written by Rachel Carson, "Silent Spring" highlighted the environmental impact of pesticides, particularly DDT. The book raised public awareness about the need for environmental conservation and played a role in inspiring the environmental movement of the 1960s.

2. The Club of Rome's "Limits to Growth" (1972):

This influential report was commissioned by the Club of Rome, an international think tank. The report used computer modeling to explore the consequences of exponential economic and population growth and emphasized the importance of sustainable resource use. It marked a significant step in linking economic activities with environmental concerns.

3. United Nations Conference on the Human Environment (Stockholm, 1972):

The first major international conference on environmental issues, organized by the United Nations, took place in Stockholm. It led to the creation of the United Nations Environment Programme (UNEP) and increased global awareness about the interdependence of human activities and the environment.

4. World Conservation Strategy (1980):

Developed by the International Union for Conservation of Nature (IUCN), the World Conservation Strategy emphasized the need for sustainable development that considers both environmental conservation and human well-being. It was a precursor to later sustainable development frameworks.

5. Brundtland Report (1987):

Also known as the "Our Common Future" report, this landmark publication by the World Commission on Environment and Development (WCED), chaired by Gro Harlem Brundtland, defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The report played a crucial role in popularizing the term and integrating environmental, social, and economic dimensions.

6. Earth Summit (Rio de Janeiro, 1992):

The United Nations Conference on Environment and Development (UNCED), also known as the Earth Summit, marked a significant event in the evolution of sustainable development. The summit produced Agenda 21, a comprehensive plan of action for global sustainable development, and led to the creation of the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD).

7. Millennium Development Goals (MDGs) (2000-2015):

The MDGs were a set of eight international development goals established following the Millennium Summit of the United Nations. While not exclusively focused on sustainability, they addressed issues such as poverty, gender equality, education, and healthcare, contributing to the broader sustainable development agenda.

8. Adoption of the Sustainable Development Goals (SDGs) (2015):

Building on the MDGs, the United Nations adopted the 17 Sustainable Development Goals as part of the 2030 Agenda for Sustainable Development. The SDGs cover a wide range of issues, including poverty, hunger, health, education, gender equality, clean water, and environmental sustainability. They represent a global commitment to achieving a more sustainable and equitable future by 2030.

These historical milestones reflect the evolving understanding of the interconnections between human well-being, environmental health, and economic development. The concept of sustainable development has become a guiding principle for international policies, practices, and initiatives aimed at addressing global challenges in a holistic and integrated manner.

4. Principles of Sustainable Development

The principles of sustainable development provide a framework for achieving a harmonious balance between economic, social, and environmental considerations. These principles guide decision-making, policy formulation, and actions to ensure that development meets the needs of the present without compromising the ability of future generations to meet their own needs. While there may be variations in the articulation of these principles, the following are widely recognized as fundamental to sustainable development:

1. **Interconnectedness:** Recognizes the interconnected nature of economic, social, and environmental systems. Changes or actions in one area can have ripple effects on others, emphasizing the need for integrated and holistic approaches to development.
2. **Intergenerational Equity:** Emphasizes the ethical responsibility to consider the needs of future generations. Sustainable development seeks to ensure that the choices and actions of the present do not compromise the well-being and opportunities of those who come after.
3. **Inclusivity and Social Equity:** Promotes social justice, equality, and inclusivity. Sustainable development aims to reduce disparities in access to resources, opportunities, and benefits, addressing issues of poverty, discrimination, and social exclusion.
4. **Environmental Stewardship:** Advocates for responsible and ethical management of natural resources. This involves conservation, sustainable use, and protection of ecosystems to maintain biodiversity and environmental health.
5. **Precautionary Principle:** Suggests that, in the face of uncertainty or potential risks, precautionary measures should be taken to prevent harm to the environment or human health. It emphasizes prudence in decision-making to avoid irreversible damage.
6. **Polluter Pays Principle:** Holds that those who cause pollution or environmental degradation should bear the costs associated with their actions. This principle aims to internalize environmental externalities and encourage responsible behavior.

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7. **Cultural Respect and Diversity:** Acknowledges the importance of cultural diversity and respects the values, traditions, and knowledge of different communities. Sustainable development recognizes the role of cultural heritage in shaping sustainable practices.
8. **Participatory Decision-Making:** Advocates for the active involvement of all stakeholders, including local communities, in decision-making processes. Ensures that diverse perspectives are considered, fostering transparency and accountability.
9. **Sustainable Consumption and Production:** Encourages the adoption of sustainable practices in consumption and production patterns. Involves reducing waste, promoting resource efficiency, and embracing circular economy principles.
10. **Global Responsibility:** Acknowledges that many challenges, such as climate change and biodiversity loss, are global in nature. Calls for international cooperation and collective action to address shared problems and promote global sustainability.
11. **Economic Viability:** Advocates for economic growth that is inclusive, socially just, and environmentally sustainable. Encourages the development of economic systems that prioritize long-term well-being over short-term gains.
12. **Adaptive Governance:** Recognizes the need for flexible and adaptive governance structures to respond to changing social, economic, and environmental conditions. This involves continuous learning and improvement in policy and decision-making processes.

5. Sustainable Development Goals (SDGs)

The Sustainable Development Goals (SDGs) are a set of 17 global goals adopted by all United Nations Member States in September 2015 as part of the 2030 Agenda for Sustainable Development. The SDGs serve as a universal call to action to end poverty, protect the planet, and ensure prosperity for all by 2030. These goals address a wide range of interconnected challenges, including poverty, inequality, climate change, environmental degradation, peace, and justice. The SDGs are designed to be integrated and indivisible, recognizing the interdependence of economic, social, and environmental dimensions of sustainable development. The 17 Sustainable Development Goals are:

1. **No Poverty (SDG 1):** End poverty in all its forms everywhere.
2. **Zero Hunger (SDG 2):** End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.

3. **Good Health and Well-being (SDG 3):** Ensure healthy lives and promote well-being for all at all ages.
4. **Quality Education (SDG 4):** Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
5. **Gender Equality (SDG 5):** Achieve gender equality and empower all women and girls.
6. **Clean Water and Sanitation (SDG 6):** Ensure availability and sustainable management of water and sanitation for all.
7. **Affordable and Clean Energy (SDG 7):** Ensure access to affordable, reliable, sustainable, and modern energy for all.
8. **Decent Work and Economic Growth (SDG 8):** Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.
9. **Industry, Innovation, and Infrastructure (SDG 9):** Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.
10. **Reduced Inequality (SDG 10):** Reduce inequality within and among countries.
11. **Sustainable Cities and Communities (SDG 11):** Make cities and human settlements inclusive, safe, resilient, and sustainable.
12. **Responsible Consumption and Production (SDG 12):** Ensure sustainable consumption and production patterns.
13. **Climate Action (SDG 13):** Take urgent action to combat climate change and its impacts.
14. **Life below Water (SDG 14):** Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.
15. **Life on Land (SDG 15):** Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
16. **Peace, Justice, and Strong Institutions (SDG 16):** Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels.
17. **Partnerships for the Goals (SDG 17):** Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development.

These goals are accompanied by a set of 169 targets and 230 indicators to measure progress. Governments, businesses, civil society, and individuals are encouraged to work collaboratively to achieve these goals and create a more sustainable and equitable future for all. The SDGs provide a comprehensive framework for addressing the world's most pressing challenges and promoting a vision of development that leaves no one behind.

6. Environmental Sustainability

Environmental sustainability is a principle that emphasizes responsible and balanced management of natural resources, ecosystems, and the environment to meet the needs of the present without compromising the ability of future generations to meet their own needs. It involves practices that aim to conserve biodiversity, protect ecosystems, and minimize the negative impacts of human activities on the environment.

Environmental Sustainability can be achieved by taking several initiatives such as establishing protected areas, promoting sustainable land use practices, and preventing habitat destruction, implementing resource-efficient technologies, reducing overconsumption, and adopting circular economy principles, investing in solar, wind, hydropower, and other renewable energy technologies, and reducing reliance on fossil fuels, implementing waste reduction strategies, establishing recycling programs, and promoting responsible waste disposal, transitioning to low-carbon technologies, promoting energy efficiency, and supporting international efforts to combat climate change, adopting organic farming, agro-ecological methods, and precision agriculture to minimize environmental impacts, Educational programs, public awareness campaigns, implementing green infrastructure, promoting public transportation, and integrating nature into urban spaces, implementing CSR initiatives, adopting eco-friendly production methods, and promoting transparency in supply chains.

Environmental sustainability is an integral part of the broader concept of sustainable development, recognizing the interconnectedness of environmental health, economic well-being, and social equity. Adopting environmentally sustainable practices is essential for addressing global challenges such as climate change, biodiversity loss, and pollution, and for creating a resilient and sustainable future.

7. Social Equity

Social equity refers to the fair and just distribution of resources, opportunities, and privileges within a society. It emphasizes the need to ensure that all individuals, regardless of their background, identity, or circumstances, have access to the same rights, benefits, and opportunities. Social equity aims to address historical and systemic inequalities, discrimination, and exclusion, fostering a society where everyone has the chance to reach their full potential.

Implementation of policies and practices that eliminate barriers and promote inclusivity in various sectors, enforcing anti-discrimination laws, promoting diversity and inclusion in workplaces and communities, and raising awareness about the impacts of discrimination, implementing progressive taxation, addressing wage gaps, and promoting economic policies that uplift marginalized communities, implementing policies that reduce disparities in school funding, promoting inclusive education practices, and addressing educational inequalities, addressing health disparities, improving healthcare accessibility in marginalized communities, and promoting public health initiatives, supporting community-driven development initiatives, investing in infrastructure in underserved areas, and involving communities in decision-making processes are some of the common actions must be taken for fostering social equity.

Social equity is a foundational principle of sustainable development, recognizing that true progress and well-being cannot be achieved unless all members of society are treated with fairness, dignity, and respect. Policies and initiatives that prioritize social equity contribute to building a more just and inclusive society.

8. Challenges and Critiques of Sustainable Development

While sustainable development is widely recognized as a crucial framework for addressing global challenges, promoting equity, and ensuring long-term well-being, it is not without its challenges and critiques.

Balancing economic, social, and environmental objectives can lead to conflicting interests. Economic growth may be prioritized over environmental protection, and short-term gains may overshadow long-term sustainability.

Despite the adoption of sustainable development goals, implementation at the national and local levels is often slow and inconsistent. Political, economic, and institutional barriers can hinder the effective execution of sustainable policies and practices. Achieving sustainability may require making difficult choices and trade-offs. For example, protecting a particular ecosystem may conflict with economic interests or social development goals.

Critics argue that sustainable development efforts sometimes fail to adequately address underlying issues of inequality, leaving marginalized and vulnerable populations at a disadvantage. Economic and social disparities may persist or even worsen. Some businesses and organizations engage in "green washing," presenting a false or exaggerated image of their environmental or social responsibility to appeal to environmentally conscious consumers without making substantial changes to their practices. There is a concern that an overreliance on technological solutions may divert attention from addressing root causes of environmental and social problems. Critics argue that technological advancements alone may not be sufficient without addressing systemic issues.

Achieving sustainability requires international cooperation, but geopolitical tensions and conflicting national interests can impede global collaboration on issues such as climate change, biodiversity conservation, and resource management. The tension between economic growth and environmental conservation is a persistent challenge. Some argue that prioritizing economic development may compromise environmental sustainability, while others emphasize the potential for green growth. The complexity and interconnected nature of global challenges make sustainable development a daunting task. Addressing issues such as climate change, biodiversity loss, and poverty requires comprehensive, integrated, and collaborative approaches.

Some critics argue that the prevailing culture of consumerism and overconsumption is at odds with the principles of sustainability. Efforts to promote sustainable consumption patterns may be insufficient in the face of ingrained consumer behaviors. The application of sustainable development principles may vary across cultures, and ethical considerations related to cultural diversity can pose challenges in developing universally applicable policies and practices.

The application of sustainable development principles may vary across cultures, and ethical considerations related to cultural diversity can pose challenges in developing universally applicable policies and practices.

9. Case Studies on Global Sustainable Development

The case studies demonstrate diverse approaches to sustainable development, encompassing environmental conservation, social equity, economic resilience, and community engagement. They highlight the importance of innovative solutions, collaboration, and a holistic approach to addressing the complex challenges facing societies globally. Some case studies and examples of sustainable development initiatives and projects from different parts of the world are as follows:

1. Costa Rica's Pura Vida Tourism

Costa Rica has embraced sustainable tourism through its "Pura Vida" initiative. The country promotes eco-friendly practices, conservation efforts, and community engagement in the tourism sector. Protected areas, wildlife reserves, and sustainable tourism practices contribute to both environmental conservation and community well-being.

2. Scandinavian Green Cities

Cities like Copenhagen, Denmark, and Stockholm, Sweden, are known for their commitment to sustainability. These cities prioritize renewable energy, efficient public transportation, green spaces, and bicycle infrastructure. Their urban planning focuses on reducing carbon emissions, enhancing public health, and creating livable urban environments.

3. The Circular Economy in The Netherlands

The Netherlands is a leader in adopting a circular economy model. Initiatives include recycling and repurposing waste, promoting sustainable design and production, and encouraging businesses to adopt circular practices. This approach minimizes resource consumption and waste while promoting economic growth.

4. Bhutan's Gross National Happiness Index

Bhutan's development philosophy revolves around the concept of Gross National Happiness (GNH), which prioritizes holistic well-being over GDP. Bhutan's commitment to environmental conservation, cultural preservation, and social equity has made it a unique example of sustainable and people-centric development.

5. Solar Sister in Sub-Saharan Africa

Solar Sister is a social enterprise operating in Sub-Saharan Africa that empowers women entrepreneurs to sell clean energy solutions, such as solar lamps and stoves, in their communities. This initiative addresses energy poverty, creates economic opportunities for women, and promotes sustainable energy use.

6. Masdar City, UAE

Masdar City in Abu Dhabi is a planned sustainable city that aims to be carbon-neutral and zero-waste. It integrates renewable energy sources, green building technologies, and sustainable transportation solutions. The city serves as a test bed for innovative sustainable practices.

7. The Great Green Wall in Africa

The Great Green Wall is a pan-African initiative aimed at combating desertification, land degradation, and climate change by creating a mosaic of green and productive landscapes across the Sahel region. It involves tree planting, sustainable land management, and community engagement.

8. Sustainable Agriculture in Brazil's Amazon Rainforest

The Sustainable Amazon Foundation (FAS) in Brazil works with local communities to promote sustainable agriculture practices that conserve the Amazon rainforest. Agroforestry, organic farming, and community-based initiatives contribute to biodiversity conservation and improved livelihoods.

9. Green Building - The Edge, Amsterdam

The Edge in Amsterdam is considered one of the greenest buildings globally. It incorporates sustainable design, energy-efficient technologies, and smart building management systems. The office space maximizes natural light, uses renewable energy, and employs water-saving measures.

10. Clean Water Access in Kenya - Maji Milele

Maji Milele is a project in Kenya that provides sustainable access to clean water by installing and maintaining water kiosks in rural communities. The initiative ensures a reliable water supply, promotes hygiene education, and empowers local communities.

10. Case Studies on Indian Sustainable Development

India has undertaken various sustainable development initiatives across different sectors to address environmental, social, and economic challenges. The following examples showcase India's commitment to sustainable development, addressing challenges in areas such as sanitation, renewable energy, rural development, and inclusive urban planning. These initiatives reflect a multi-faceted approach to balancing economic growth with social and environmental considerations.

1. National Rural Employment Guarantee Act (NREGA)

NREGA, introduced in 2005, guarantees 100 days of wage employment in a financial year to every rural household willing to do unskilled manual work. The program aims to enhance livelihood security in rural areas, reduce rural-urban migration, and contribute to sustainable development.

2. Clean India Mission (Swachh Bharat Abhiyan)

Launched in 2014, the Clean India Mission focuses on achieving universal sanitation and eliminating open defecation. The initiative involves building toilets, promoting proper waste management, and creating awareness about hygiene practices. It addresses public health concerns and contributes to environmental sustainability.

3. National Solar Mission (Jawaharlal Nehru National Solar Mission)

The National Solar Mission, launched in 2010, aims to promote solar energy and reduce the country's dependence on non-renewable energy sources. The initiative includes targets for increasing solar capacity, promoting research and development, and creating a conducive environment for solar energy adoption.

4. Smart Cities Mission

The Smart Cities Mission, launched in 2015, focuses on developing cities that are sustainable, inclusive, and technologically advanced. It includes projects related to urban infrastructure, transportation, waste management, and the use of technology to enhance the quality of life for residents.

5. Rural Electrification through Renewable Energy

Various programs aim to provide access to electricity in rural areas using renewable energy sources. The National Rural Electrification Program (Deen Dayal Upadhyaya Gram Jyoti Yojana) focuses on electrifying villages through solar power, minimizing environmental impact, and ensuring energy access for remote communities.

6. Van Dhan Yojana - Empowering Tribal Communities

Van Dhan Yojana focuses on empowering tribal communities by promoting sustainable livelihoods based on forest produce. The initiative involves the creation of self-help groups, value addition to forest produce, and marketing tribal products, contributing to both economic development and environmental conservation.

7. National Mission for Sustainable Agriculture (NMSA)

NMSA aims to promote sustainable agriculture practices, enhance water-use efficiency, and improve soil health. The mission includes initiatives such as watershed development, organic farming, and the adoption of climate-resilient agricultural practices.

8. Kudumbashree Mission in Kerala

Kudumbashree is a women-oriented community-based initiative in Kerala that focuses on poverty eradication and women's empowerment. The mission involves various sustainable development projects, including waste management, organic farming, and the promotion of micro-enterprises.

9. Dholera SIR - Greenfield Industrial City

Dholera Special Investment Region (SIR) is a greenfield industrial city project in Gujarat. It is designed as a sustainable city with a focus on clean and green infrastructure, renewable energy integration, and efficient urban planning to support economic growth and environmental sustainability.

11. Future Prospects of Sustainable Development

The future prospects of sustainable development are shaped by ongoing global trends, emerging challenges, and collective efforts to create a more equitable, resilient, and sustainable world. Increasing recognition of the urgent need to address climate change is driving a global shift toward sustainable and low-carbon practices. The prospect involves a green transition in various sectors, including energy, transportation, and industry, to reduce carbon emissions and promote climate resilience.

Building resilience to global challenges, including pandemics, climate-related events, and economic shocks, is likely to be a key focus. Sustainable development strategies will incorporate resilience measures to mitigate the impacts of unforeseen events. The growth of green finance and sustainable investment is anticipated. Investors are likely to prioritize businesses and projects that align with environmental, social, and governance (ESG) criteria, contributing to the financing of sustainable development initiatives. Businesses are increasingly recognizing the importance of integrating sustainability into their operations. Corporate sustainability practices, including responsible supply chain management, ethical business conduct, and environmental stewardship, are likely to become more widespread.

Continued global collaboration and partnerships between governments, businesses, non-governmental organizations (NGOs), and international institutions are essential for addressing complex global challenges. Collective action is expected to amplify the impact of sustainable development efforts. While these prospects are positive, it's important to acknowledge the challenges and uncertainties that may arise. Overcoming barriers such as policy inertia, economic interests, and geopolitical tensions will be crucial for realizing the full potential of sustainable development in the future. The commitment for building a more sustainable and resilient world, remains a shared responsibility that requires continuous collaboration and innovation.

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Valve Sparing Procedure

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Abstract

This chapter explores the evolving field of valve sparing procedures in cardiac surgery, focusing on the preservation of native heart valves whenever possible. Through a comprehensive examination, it discusses the underlying principles, surgical techniques, and clinical outcomes associated with valve sparing procedures across various cardiac pathologies. Emphasizing the significance of patient selection and surgical expertise, the chapter navigates through the intricacies of valve preservation while highlighting its superiority over conventional valve replacement approaches. From detailed surgical considerations to postoperative care protocols, this chapter offers a unique insight into valve sparing procedures, reshaping the landscape of modern cardiac surgery.

Keywords: David procedure, Yacoub Procedure, Valve Sparing Procedure, Bentall, Aortic Aneurysm, Aortic root repair.

Introduction

The composite replacement technique, initially introduced by Bentall and DeBono, has long been considered the standard treatment for addressing both ascending aorta and aortic valve pathologies. While this approach has shown remarkable outcomes, it comes with significant drawbacks, notably the necessity for lifelong anticoagulation and the potential risks associated with mechanical valves, such as thromboembolic complications[1}. Furthermore, in a considerable portion of patients, the native aortic valve remains intact. The concept of preserving the native valve in such cases has led to the development of valve-sparing aortic root procedures, including remodeling (Yacoub) and reimplantation (David) techniques[2}[3}.Aortic valve sparing procedures have been devised to maintain the integrity of the native aortic valve during surgeries for aortic root aneurysms, as well as in procedures addressing ascending aortic aneurysms accompanied by aortic insufficiency[4}. This surgical approach involves excising the aortic sinuses alongside the coronary arteries and reimplanting them, along with the aortic valve, within a cylindrical Dacron graft. It is crucial that the aortic cusps exhibit normal or minimal anatomical alterations for this procedure to be successful[5].

Types

- Yacoub Procedure (Remodeling of the aortic root)[2].
- David Procedure (Reimplantation of the aortic valve)[3].

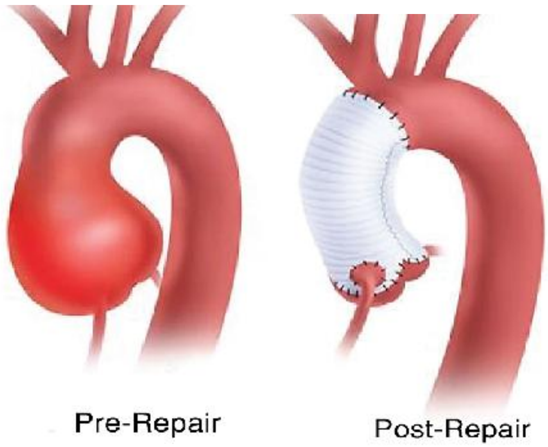

Figure 1

Yacoub procedure

The Yacoub procedure, pioneered by Dr. Yacoub in 1979, involves remodeling the aortic valve without reimplanting the aortic root. It is typically recommended for older individuals with aneurysms unrelated to genetic syndromes. Valve-related morbidity and mortality are generally lower following a valve-sparing operation compared to composite valve grafting with a mechanical prosthesis and lifelong warfarin anticoagulation, which is considered the surgical "gold standard." Preserving the native aortic valve eliminates the necessity for lifelong anticoagulation, offering patients greater freedom from medication[2][6].

Indications

The Yacoub procedure is typically indicated for patients with aortic root aneurysms, particularly those where the aortic valve is not significantly affected, and especially for individuals who are older and do not have genetic syndromes predisposing them to aneurysm development. Moreover, it is often recommended for patients who would benefit from avoiding lifelong anticoagulation therapy required with mechanical valve replacements[7}.

Procedure

1. Median sternotomy Performed,
2. Under the control of Cardiopulmonary Bypass (CPB), Through central (distal ascending aorta or proximal aortic arch) or peripheral (femoral or axillary) cannulation, arterial access is achieved.
3. Venous return is achieved usually by right atrial bicaval cannulation i.e. inserting two venous single stage cannula Via RA to Superior venacava and inferior venacava.
4. Aortic cross clamp applied
5. Cardioplegia is delivered via antegrade or retrograde route to arrest the heart and to maintain myocardial protection. SACP and RCP is used to maintain cerebral perfusion under NIRS monitoring[8}.
6. The aorta is transected just above the sinotubular junction of aorta

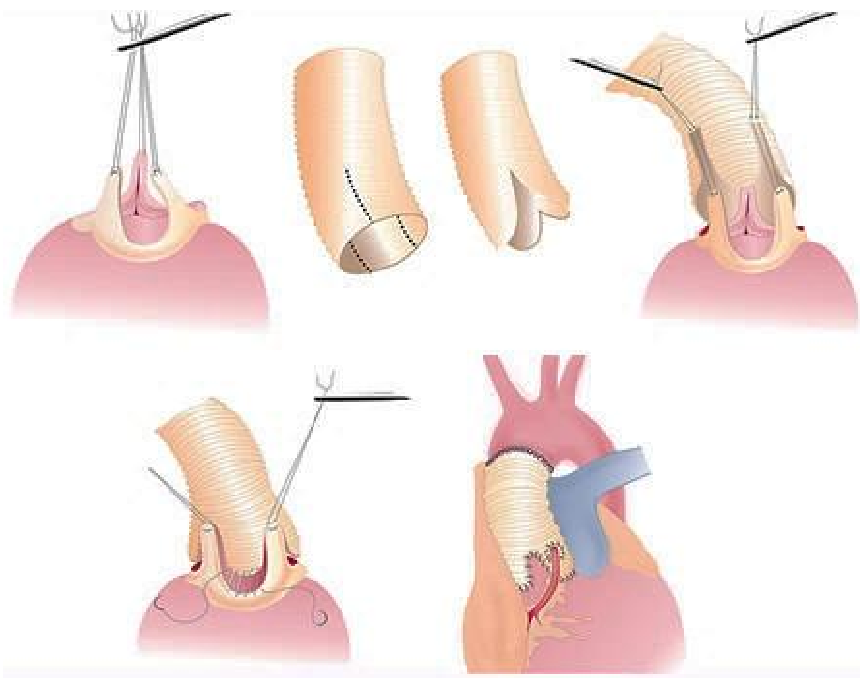

Figure 2

7. The coronary ostia are removed along with coronary buttons of tissue.
8. The remaining part of the ascending aorta is removed except for the aortic valve tissue.
9. A Dacron graft, sized to the internal aortic diameter, which is tailored to individually replace the resected sinuses.
10. The commissural pillars are resuspended within the Dacron graft so that the leaves of the graft replace each coronary sinus, and so that they are stretched upwards slightly maintaining tension on the valve leaflets.
11. The coronaries are reimplanted as buttons[9].
12. Trans Esophageal Echocardiography (TEE) is performed to ensure the normal physiology of aortic valve and ascending Aorta after the surgery.

David procedure

Dr. Tirone David pioneered the David procedure in 1995, which entails reimplanting the aortic valve along with the aortic root. This surgical approach targets patients experiencing dilatation of the sinotubular junction, expansion of the sinuses of Valsalva, and annulo-aortic ectasia. One of its key benefits is the stabilization of the annulus, potentially reducing the risk of late annular dilatation and recurrent aortic insufficiency in patients with annulo-aortic ectasia and connective tissue disorders[10].

Indications

- ✓ Dilatation of the sinotubular junction[11].
- ✓ Dilation of the sinuses of Valsalva[11].
- ✓ Annulo-aortic ectasia.[12].
- ✓ Marfan syndrome with aortic root aneurysm[13].

Procedure

1. Median sternotomy Performed,
2. Under the control of Cardiopulmonary Bypass (CPB), Through central (distal ascending aorta or proximal aortic arch) or peripheral (femoral or axillary) cannulation, arterial access is achieved.
3. Venous return is achieved usually by right atrial bicaval cannulation i.e. inserting two venous single stage cannulas Via RA to Superior venacava and inferior venacava.
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6. The aorta is transected just above the sinotubular junction of aorta
7. The coronary ostia are removed along with coronary buttons of tissue.

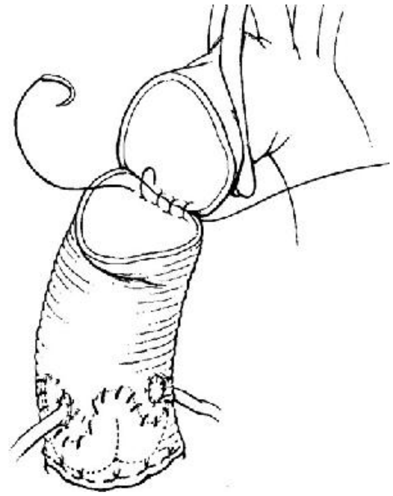


Figure 3

8. The remaining part of the ascending aorta is removed except for the aortic valve tissue.
9. Sutures will be placed under the valve and passed outside of the aortic annulus.
10. A proper Dacron graft is selected and attached to the heart with the prepared sutures.
11. The valve is then carefully positioned within the graft to eliminate leaking[12}.
12. The valve tissue is completely attached to the graft with a horizontal mattress suture technique[13}.

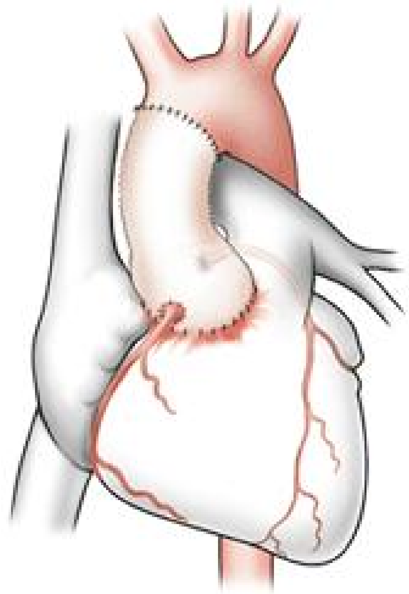


Figure 4

13. Two small holes are created in the graft for reattachment of the coronary arteries.[14].
14. The end of the graft is attached to the aortic arch[15].
15. A TEE was performed to ensure that the valve leaflets will open and close properly.

Types of david procedure

- David I - Reimplantation
- David II - Remodeling
- David III - Remodeling
- David IV - Reimplantation
- David V – Reimplantation

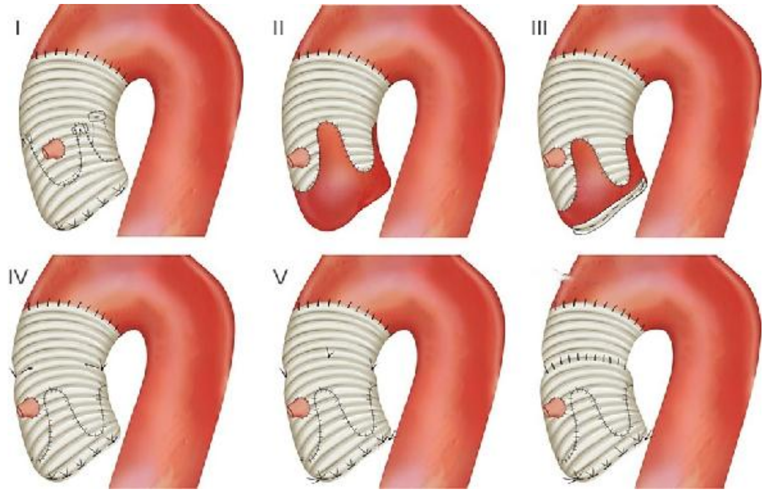
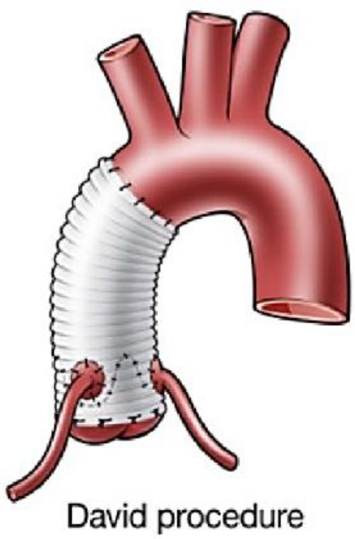


Figure 5

Figure 5 illustrates the adaptations made to the Tirone David valve-sparing aortic root replacement procedure. Types II, II, IV, and V denote enhancements and supplements to the initial type I technique, which involved a single relatively small graft. The purpose of these adjustments is to improve the physiological function of the sinus of Valsalva. This is achieved by establishing a new sinotubular junction and reducing the annulus to a greater extent than at the sinus level.



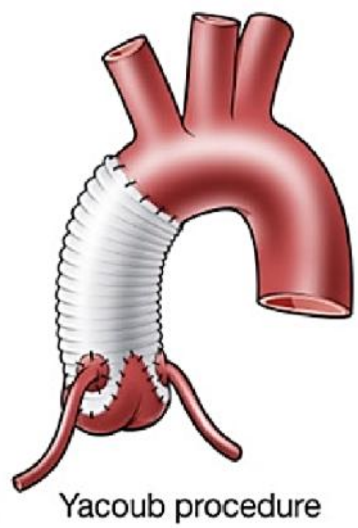


Figure 6 **Figure 7**

Prognosis

- Postoperative elective mortality is approximately 1–2% (young patients)[16}[17}.
- 10-year survival is 90–98% in David procedure[18}.
- 10-year survival is just 75% in Yacoub procedure[2}[8}.

Conclusion

In conclusion, this chapter has provided a comprehensive overview of valve sparing procedures, delving into their fundamental principles, surgical methodologies, and resultant clinical outcomes across a spectrum of cardiac pathologies. It has underscored the critical importance of meticulous patient selection and the indispensable role of surgical expertise in achieving favorable outcomes. By elucidating these key aspects, this chapter serves as a valuable resource for medical students, guiding them towards informed decision-making and optimal patient care in the realm of valve sparing procedures.

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Sustainable Bio-resource Conservation Through Ethical Collaboration

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Abstract

Biological resources are crucial for scientific exploration, covering genetic materials, ecosystems, and species diversity. They play vital roles in fields like medicine, agriculture, biotechnology, and environmental conservation. However, it's vital to use them sustainably to ensure they're available for future generations. This summary emphasizes the importance of biological resources in research, outlines challenges to their sustainability, and suggests strategies for responsible management. By conserving, harvesting sustainably, collaborating, and maintaining ethical standards, we can utilize biological resources effectively while protecting biodiversity and ecosystems. This summary stresses the need to integrate sustainability principles into research to tackle global issues and advance scientific understanding responsibly.

Keywords: Biological resources, Ethical standards, Ecosystem preservation, Sustainability principles

Introduction

In the quest for sustainable development and scientific advancement, biological resources serve as invaluable assets. These resources encompass a broad spectrum, ranging from genetic materials to ecosystems, and play a pivotal role in research across diverse fields such as medicine, agriculture, biotechnology, and environmental conservation. However, the sustainable utilization of biological resources is essential to ensure their continued availability for future generations. This chapter explores the significance of biological resources in research and strategies for their sustainable management.

Biological resources, comprising genetic materials, ecosystems, and species diversity, serve as the cornerstone of scientific inquiry across various domains including medicine, agriculture, biotechnology, and environmental conservation (Reid et al., 2018; CBD, 2020). The utilization of these resources is essential for advancing knowledge, developing innovations, and addressing pressing global challenges. However, their sustainable management is imperative to ensure their availability for future generations (McNeely et al., 2009). This introduction highlights the significance of biological resources in research, identifies challenges to their sustainability, and discusses strategies for responsible management. Biological resources offer a wealth of opportunities for scientific exploration and innovation. Genetic materials, such as DNA and proteins, provide essential insights into biological processes and serve as the foundation for developing new treatments and technologies (Venter et al., 2001). Ecosystems, ranging from forests to coral reefs, provide invaluable services such as carbon sequestration, water purification, and habitat provision, making them critical for maintaining planetary health (Millennium Ecosystem Assessment, 2005). Furthermore, species diversity not only contributes to ecosystem resilience but also offers potential sources of novel compounds and genetic traits with applications in medicine, agriculture, and biotechnology (Wilson, 1992).

Despite their importance, biological resources face numerous threats to their sustainability. Overexploitation, habitat destruction, invasive species, and climate change are among the key challenges jeopardizing the integrity of ecosystems and the viability of species populations (CBD, 2014; IPBES, 2019). Unregulated harvesting of biological resources for commercial gain often leads to depletion and irreversible damage to ecosystems (CBD, 2010). Additionally, habitat loss resulting from deforestation, urbanization, and land-use change has led to declines in species populations and the degradation of ecosystem services (FAO, 2020). Furthermore, the introduction of invasive species can disrupt native ecosystems, leading to biodiversity loss and ecological imbalance (Simberloff et al., 2013). Climate change exacerbates these threats by altering habitats, disrupting species distributions, and increasing the frequency and intensity of extreme weather events (IPCC, 2014).

Addressing these challenges requires a multi-faceted approach to sustainable resource management. Conservation efforts, including the establishment of protected areas, wildlife reserves, and gene banks, are essential for safeguarding biodiversity and preserving genetic diversity (CBD, 2011). Sustainable harvesting practices, such as quotas, regulations, and community-based management, ensure that biological resources are harvested at levels that maintain their long-term viability (Mace et al., 2014). Restoration initiatives, including reforestation, habitat rehabilitation, and ecosystem restoration projects, aim to rehabilitate degraded ecosystems and enhance the availability of biological resources (Reyers et al., 2018). Additionally, research and monitoring programs provide essential data for informed decision-making and adaptive management, enabling stakeholders to track changes in ecosystems and species populations and assess the effectiveness of conservation interventions (Sutherland et al., 2004). The sustainable utilization of biological resources is essential for advancing scientific knowledge, promoting innovation, and addressing global challenges. By implementing effective management strategies, fostering collaboration, and upholding ethical standards, we can harness the potential of biological resources while safeguarding biodiversity and ecosystem integrity. It is important to explore the critical role of biological resources in sustainable research and the importance of integrating sustainability principles into scientific practice.

Importance of biological resources in research

Biological resources provide the foundation for numerous scientific endeavours and innovations. Genetic materials, including DNA, proteins, and microorganisms, serve as essential tools for understanding biological processes, developing new medicines, and engineering novel biotechnological solutions. Agricultural research relies on biological resources to enhance crop productivity, improve livestock breeds, and develop sustainable farming practices. Furthermore, ecosystems contribute essential services such as water purification, climate regulation, and nutrient cycling, making them indispensable for environmental research and conservation efforts.

Biological resources are fundamental to scientific inquiry, playing essential roles in various fields ranging from medicine and agriculture to biotechnology and environmental conservation. Understanding their significance is crucial for advancing knowledge and addressing global challenges. DNA, proteins, and other genetic materials serve as the building blocks of life and are essential for understanding biological processes and developing new treatments and technologies (Venter et al., 2001). Ecosystems provide vital services such as carbon sequestration, water purification, and habitat provision, making them indispensable for maintaining planetary health and supporting human well-being (Millennium Ecosystem Assessment, 2005). Biodiversity contributes to ecosystem resilience and offers potential sources of novel compounds and genetic traits with applications in medicine, agriculture, and biotechnology (Wilson, 1992). Biological resources are crucial for medical research, facilitating the discovery of new drugs, vaccines, and diagnostic tools, as well as insights into disease mechanisms and treatment options (NIH, 2020). Genetic resources are essential for crop improvement, livestock breeding, and sustainable agricultural practices, ensuring food security and livelihoods for millions of people worldwide (FAO, 2021).

Biological resources serve as raw materials for biotechnological applications, including the production of biofuels, enzymes, and biopharmaceuticals, driving innovation and economic development (UNIDO, 2019). Studying biological resources helps assess ecosystem health, identify conservation priorities, and develop strategies for mitigating biodiversity loss and ecosystem degradation (CBD, 2020).

Challenges to sustainable utilization

Biological resources are vital for scientific progress and human well-being, but their sustainable utilization faces significant challenges. Understanding and addressing these challenges is crucial for ensuring the continued availability of biological resources for future generations. Unregulated harvesting or extraction of biological resources beyond their sustainable limits can lead to depletion and irreversible damage to ecosystems (CBD, 2010). Deforestation, urbanization, and land conversion degrade habitats, reducing the availability of biological resources and threatening biodiversity (FAO, 2020). The introduction of non-native species can disrupt ecosystems, outcompeting native species and altering ecological dynamics (Simberloff et al., 2013). Global warming and associated environmental changes pose significant threats to biological resources, affecting species distributions, phenology, and ecosystem functioning (IPCC, 2014). Pollution from various sources, including industrial effluents and agricultural runoff, can degrade habitats and harm species, affecting their sustainability (UNEP, 2016). Weak or absent regulatory frameworks, coupled with inadequate enforcement of existing laws, can exacerbate unsustainable practices (McNeely et al., 2009).Insufficient understanding of ecosystems, species populations, and genetic diversity hinders effective management and conservation efforts (Sutherland et al., 2004). Competing interests and conflicting priorities among stakeholders often lead to unsustainable exploitation of biological resources (Reid et al., 2018). Addressing these challenges requires coordinated efforts at local, national, and global levels, informed by scientific research, stakeholder engagement, and policy interventions. Implementing sustainable management practices, promoting conservation initiatives, and integrating ecosystem-based approaches into decision-making processes are essential steps toward ensuring the long-term viability of biological resources.

Strategies for sustainable management

Sustainable management of biological resources is crucial for ensuring their continued availability and preserving biodiversity. Various strategies have been developed to address this challenge, incorporating conservation, regulation, and community involvement. Establishing protected areas, wildlife reserves, and gene banks helps conserve biodiversity and safeguard endangered species and genetic diversity (CBD, 2011). Implementing regulations, quotas, and monitoring systems help control the harvesting and trade of biological resources, preventing overexploitation and illegal activities (McNeely et al., 2009). Involving local communities in resource management and decision-making processes promotes sustainable use and ensures that conservation efforts are aligned with local needs and priorities (Berkes, 2009). Adopting sustainable harvesting practices, such as selective logging, rotational grazing, and non-destructive collection methods, ensures that biological resources are harvested at levels that maintain their long-term viability (FAO, 2020). Rehabilitating degraded ecosystems through reforestation, habitat restoration, and species reintroduction programs enhances the availability of biological resources and promotes ecosystem resilience (Reyers et al., 2018). Researching ecosystems, species populations, and genetic diversity provides essential data for informed decision-making and adaptive management, enabling stakeholders to track changes in ecosystems and assess the effectiveness of conservation interventions (Sutherland et al., 2004). Raising awareness and providing education on the importance of biological resources and the need for sustainable management fosters a greater understanding and appreciation among stakeholders, leading to more effective conservation efforts (UNESCO, 2020). Implementing these strategies requires collaboration and coordination among governments, researchers, local communities, and stakeholders. By integrating these approaches into policies and practices, we can effectively manage biological resources sustainably and ensure their availability for future generations.

Ethical considerations

In the pursuit of sustainable research, ethical considerations are paramount. Researchers must prioritize the welfare of biological resources and adhere to ethical guidelines to ensure responsible conduct. Recognizing the intrinsic value of all living organisms and minimizing harm in research practices is essential. Researchers should strive to conduct research in ways that prioritize the well-being of biological resources and minimize any negative impacts on them (Singer, 1975). Obtaining informed consent from individuals or communities involved in research activities is crucial, particularly in studies involving human subjects or indigenous knowledge. Respecting the autonomy and rights of participants ensures that research is conducted ethically and with due regard for their well-being (Emanuel et al., 2000). Ensuring equitable sharing of benefits derived from biological resources is imperative, especially in cases involving traditional knowledge or genetic resources. Fair and transparent mechanisms for benefit sharing help promote social justice and recognize the contributions of communities to research (CBD, 2010). Maintaining transparency in research methodologies, data collection, and dissemination of findings is essential for fostering trust and accountability. Open and honest communication ensures that research outcomes are accessible and understandable to stakeholders, facilitating informed decision-making (Nosek et al., 2015).By upholding these ethical principles, researchers can conduct sustainable research that respects the rights and well-being of biological resources and contributes positively to society.These ethical considerations are vital for ensuring the responsible conduct of research and the ethical treatment of biological resources.

Conclusion

Biological resources serve as essential pillars for sustainable research and development, driving progress in diverse fields. To ensure their responsible utilization, effective management strategies, collaborative efforts, and adherence to ethical standards are paramount. By implementing measures such as conservation, sustainable harvesting, and community engagement, we can safeguard these resources for present and future generations. Collaboration among governments, researchers, communities, and stakeholders is crucial for achieving sustainable outcomes. Through collective endeavours, we can harness the potential of biological resources to address pressing global challenges, including food security, public health, and environmental degradation. Furthermore, upholding ethical principles such as respect for life, informed consent, benefit sharing, and transparency is essential in research practices involving biological resources. By integrating sustainability and ethical considerations into research endeavours, we can navigate the complexities of resource management while preserving the integrity of our planet's ecosystems. Ultimately, these concerted efforts pave the way toward a more sustainable and harmonious future, where biological resources are responsibly utilized to support human well-being and environmental resilience.

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Gene Editing: An Ethical Technique for Genetics

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Abstract

Gene editing is a powerful molecular technology that allows precise modification of DNA within living organisms. This transformative technique has gained significant attention in various fields, including medicine, agriculture, and basic research. The most widely employed gene editing tool is CRISPR-Cas9; a system derived from the bacterial immune system. The process involves designing a guide RNA that directs the Cas9 enzyme to a specific target sequence in the genome, where it induces a double-strand break. The cellular repair machinery then attempts to fix the break, leading to either error-prone non-homologous end joining (NHEJ) or precise homology-directed repair (HDR). These repair outcomes can result in gene knockout, gene correction, or insertion of desired genetic material.

Key words: - Gene Editing, Cas proteins, Gene modification, Therapy, Recombination

Table of Contents

1. Introduction

Genes are made up of DNA. Although a decade has passed since the initial use of CRISPR with mammalian cells, the first attempts at gene editing occurred in the 1980's. Subsequently, many researchers tried to develop methods to edit specific genes. Here, we review the history of genome editing and improvements in genome editing tools.

Wilhelm Johannsen coined the term gene. But French Anderson, MD, was "dubbed 'the father of gene therapy' after a team he led in 1990 cured a hereditary disease of the immune system in a 4-year-old girl." That's not quite the way it happened. Mendel's unknown factors of heredity were given the name "gene" in 1909. In 1910, the American scientist Thomas Morgan proposed that chromosomes are the carriers of Mendelian hereditary factors and that those factors segregate during the production of germ cells and recombine during sexual reproduction.

Some genes act as instructions to make molecules called proteins. However, many genes do not code for proteins. In humans, genes vary in size from a few hundred DNA bases to more than 2 million bases. Base editing is a newer genome editing approach that uses components from CRISPR systems together with other enzymes to directly install point mutations into cellular DNA or RNA without making double-stranded DNA breaks (DSBs).The term gene was introduced by Danish botanist, plant physiologist and geneticist Wilhelm Johannsen in 1909. It is inspired by the Ancient Greek: γόνος, gonos that means offspring and procreation. Used to prevent, treat, or cure certain inherited disorders, such as cystic fibrosis, alpha-1 antitrypsin deficiency, haemophilia, beta thalassemia, and sickle cell disease. They also may be used to treat cancers or infections, including HIV. Genes carry the hereditary information from one generation to the next. They control the structure and metabolism of the body. Reshuffling of genes at the time of sexual reproduction produces variations. Different linkages are produced due to crossing over of genes. Our genes carry information that gets passed from one generation to the next. For example, genes are why one child has blonde hair like their mother, while their sibling has brown hair like their father. Genes also determine why some illnesses run in families and whether babies will be male or female. They form a foetus, an egg from the mother and sperm from the father come together. The egg and sperm each have one half of a set of chromosomes. The egg and sperm together give the baby the full set of chromosomes. So, half the baby's DNA comes from the mother and half comes from the father. BEIJING — in a mostly empty co working office on the outskirts of China's capital, a scientist whose name is Etched in history is trying to stage a comeback. He announced nearly five years ago that he had created the first gene-edited babies, twin girls named Lulu and Nana. Many people regard CRISPR to have been pioneered by Jennifer Doudna & Emmanuelle Charpentier, however, the discovery of the principle of CRISPR (Clustered regularly interspaced palindromic repeats) was discovered by Francisco Mojica during his work with bacteria in the marshes of Santa Pola, when he noticed that parts.

Chinese researchers become the first to edit genes in a human embryo. June 2016: He Jiankui launches a project to edit genes in human embryos, with the goal of a live birth. Pes. Prime editing is a newly developed precise genome editing technology that enables all types of base conversion, small deletions, and insertions, as desired. Pes consists of a prime editor protein and prime editing gRNA (pegRNA).

1.1 Gene Editing

Gene editing refers to the process of making precise changes to the DNA of an organism, including microorganisms, humans, animals, plants, etc. Gene editing is a method for making specific changes to the DNA of a cell or organism. It can be used to add, remove or alter DNA in the genome (in sequences of base pairs). Human genome editing technologies can be used on germline cells (for reproduction).

Gene editing refers to the precise modification of an organism's DNA using various molecular techniques. The primary target of gene editing is to alter the specific genes within an organism's genome, we can try to add, delete, or replace genetic material. Alteration of the genetic material of a living organism by inserting, replacing, or deleting a DNA sequence, typically with the aim of improving some characteristic of a crop or farm animal or correcting a genetic disorder.

"Gene editing to date has focused on curing single point mutations such as sickle cell anaemia"

This process involves the use of molecular tools, such as CRISPR-Cas9 (Clustered Regularly Interspaced Short Palindromic Repeats and CRISPR-associated protein 9), zinc finger nucleases (ZFNs), or transcription activator-like effector nucleases (TALENs).

Genome editing is of great interest in the prevention and treatment of human diseases. Currently, genome editing is used in cells and animal models in research labs to understand diseases. Scientists are still working to determine whether this approach is safe and effective for use in people.22 Mar 2022Genome editing, also called gene editing, is an area of research seeking to modify genes of living organisms to improve our understanding of gene function and develop ways to use it to treat genetic or acquired diseases.

Gene editing has its advantages. It holds the potential to cure genetic disease and create crops resistant to drought. But scientists need to work closely with law and policy makers to ensure the technology can be used for the benefit of mankind while minimising the risks.14 Feb 2023.

Many inherited immune deficiencies have been treated (performed) successfully with gene therapy. Most commonly, blood stem cells are removed from patients, and retroviruses are used to deliver working copies of the defective genes. Gene editing is a powerful and revolutionary technology that allows scientists to make precise changes to the DNA of living organisms. The need for gene editing arises from several important factors:

- Medical Treatments
- Biotechnology
- Agricultural Fields
- Researches
- Cancer Treatment
- Conservation
- Ethical Conservation
- Infectious Diseases

1.2 History of Gene Editing

The history of gene editing is a fascinating journey that spans several decades and involves the contributions of many scientists and researchers. Here is a brief overview of key milestones in the history of gene editing.

Traditional methods: Compared to traditional genetic engineering, where genetic modifications in the host genome were always random, CRISPR-Cas based modifications are precise, predictable, inheritable, and sometimes without introducing any external gene sequence in the host-genome. Selective breeding (also called artificial selection) is the process by which humans use animal breeding and plant breeding to selectively develop particular phenotypic traits (characteristics) by choosing which typically animal or plant males and females will sexually reproduce and have offspring together.

Modern methods: Advanced genome editing methods engineered from proteins include zinc-finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs), and meganucleases. An additional method is called clustered regularly interspaced short palindromic repeats, also known as CRISPR/Cas9.

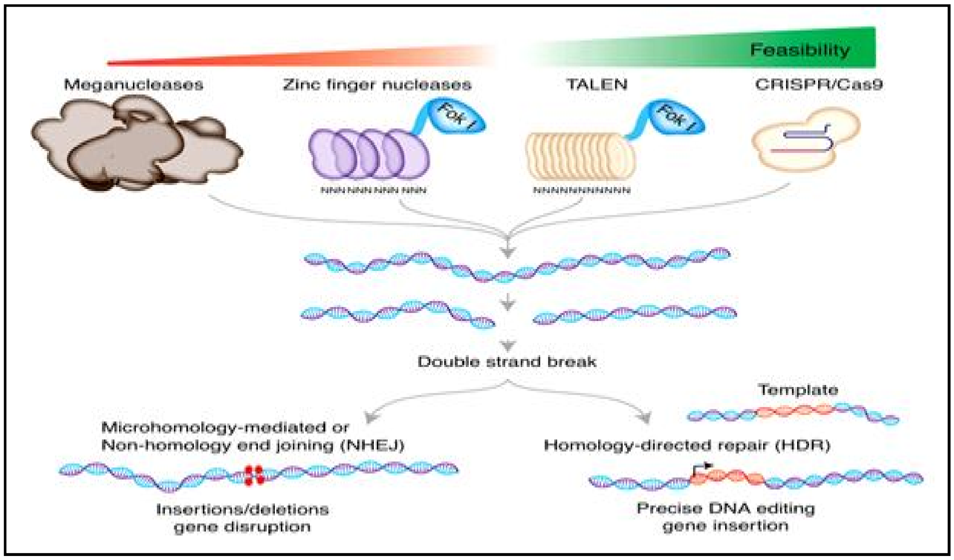

Fig 1: Modern Gene Editing Method

2. Mechanisms of Gene Editing

Gene editing is a revolutionary technology that allows scientists to modify the DNA of living organisms, including humans, with a high degree of precision. There are several techniques for gene editing, but one of the most widely used and discussed method is CRISPR-Cas9. Here's an overview of the mechanism of gene editing using CRISPR-Cas9.

This process is performed by using enzymes, particularly nucleases that have been engineered to target a specific DNA sequence, where they introduce cuts into the DNA strands, enabling the removal of existing DNA and the insertion of replacement DNA.

Gene editing refers to the intentional alteration of an organism's genes to achieve a desired result. There are several types of gene editing techniques, with each having its own set of advantages, limitations, and applications. As of my last knowledge update in January 2022, some of the prominent gene editing methods includes:

TALENs (Transcription Activator-Like Effector Nucleases)

Mechanism: They use a DNA-binding domain derived from bacteria to recognize specific DNA sequences, and an Endonuclease to cut the DNA at the targeted site.

Applications: Similar to CRISPR-Cas9, TALENs are used for gene editing in various organisms.

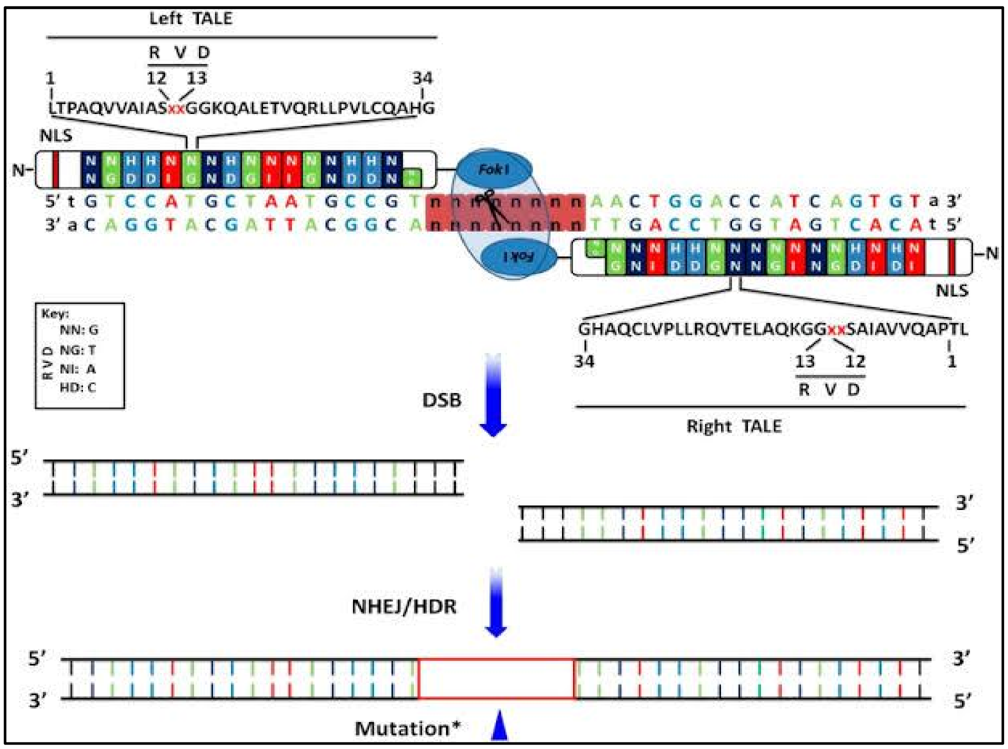

Fig 2: TALENS

ZFNs (Zinc Finger Nucleases):

Mechanism: They use zinc finger motifs for DNA binding and a nuclease to induce double-strand breaks in the DNA.

Applications: ZFNs have been used for gene editing in a range of organisms, including plants and animals.

Base Editing:

Mechanism: It involves the fusion of a catalytically impaired Cas9 enzyme with a deaminase enzyme, allowing precise single-base changes.

Applications: Base editing is used for introducing specific point mutations in the genome with high precision.

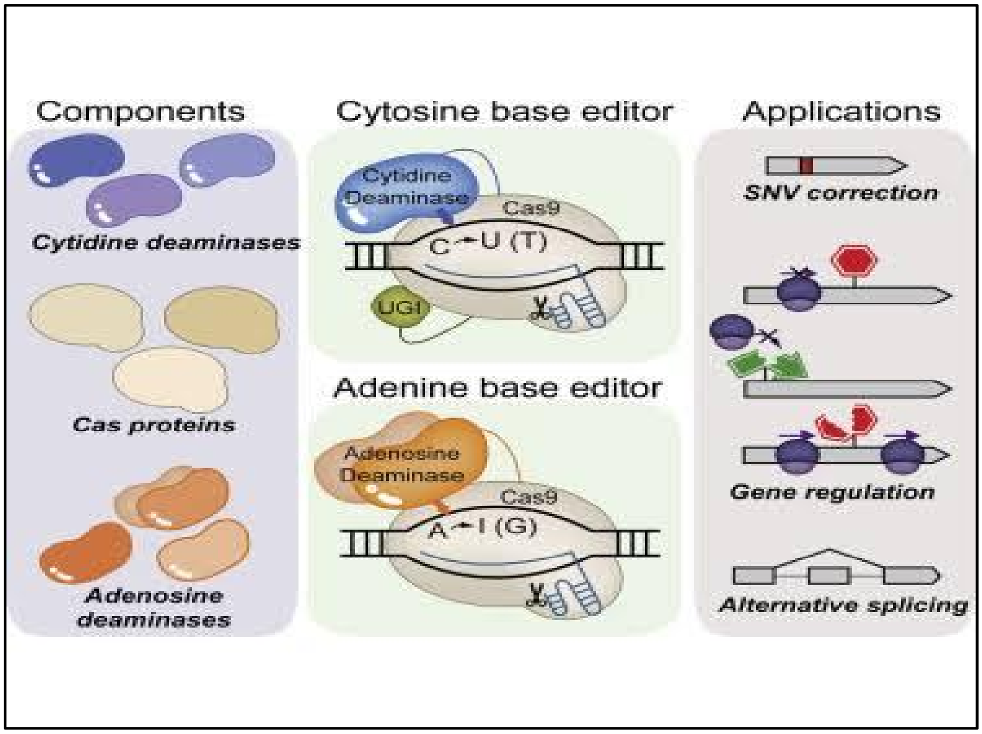

Fig 3: Base Editing

Prime Editing:

Mechanism: It utilizes a catalytically impaired Cas9 enzyme fused to an engineered reverse transcriptase to directly write new DNA sequences into the genome.

Applications: Prime editing is designed to achieve precise and targeted changes in the genome with minimal off-target effects.

These techniques continue to be refined and expanded upon, and new developments may have occurred since my last update in January 2022.

3. Applications of Gene Editing

CRISPR has many possible uses, including insert a new gene so the organism produces useful medicines; help treat genetic diseases; create tailor-made organisms to study human diseases; and help produce replacements for damaged or diseased tissues and organs.

Gene editing technologies, such as CRISPR-Cas9, have a wide range of applications across various fields. Some of the notable applications are:

1. Biomedical Research:

Functional Genomics: Gene editing helps scientists understand the function of specific genes by selectively activating, deactivating, or modifying them.

Disease Modeling: Researchers can create cellular or animal models with specific genetic mutations to study the underlying mechanisms of various diseases.

2. Therapeutic Medicine:

Gene Therapy: Correcting or replacing faulty genes to treat genetic disorders like cystic fibrosis, sickle cell anaemia, or muscular dystrophy.

Cancer Treatment: Editing immune cells to enhance their ability to target and destroy cancer cells. CRISPR is being explored for developing personalized cancer therapies.

3. Agriculture:

Crop Improvement: Developing crops with improved yield, resistance to pests and diseases, and enhanced nutritional profiles.

Livestock Improvement: Editing the genes of livestock to enhance traits such as disease resistance, growth rates, and meat quality.

4. Biotechnology:

Production of Biofuels: Optimizing microorganisms for more efficient biofuel production.

Industrial Enzyme Production: Enhancing the efficiency of microorganisms in producing enzymes used in various industrial processes.

5. Conservation:

Endangered Species Conservation: Assisting in the preservation of endangered species by addressing genetic issues such as inbreeding or susceptibility to diseases.

6. Infectious Disease Control:

Vector Control: Modifying the genes of disease-carrying vectors, such as mosquitoes, to reduce their ability to transmit diseases like malaria or Zika virus.

7. Synthetic Biology:

Creating Designer Organisms: Constructing organisms with custom-designed features for specific purposes, such as bacteria that can clean up oil spills.

8. Personalized Medicine:

Drug Development: Facilitating the development of drugs tailored to an individual's genetic makeup for more effective and personalized treatments.

9. Human Enhancement:

Enhancing Human Traits: Although ethically and socially complex, there is ongoing debate about the potential for gene editing to enhance certain human traits or capabilities.

4. Ethical consideration

A common fear is that genetically modified crops may cross-breed with any wild relatives, resulting in the spread of modified genes and the creation of invasive species. Additionally, the concern is that GMOs negatively impact ecosystems by reducing biodiversity and disrupting food webs.

Gene editing, particularly through technologies like CRISPR-Cas9, raises significant ethical considerations. Ethical considerations associated with gene editing are as follows:

Informed Consent:

Ensuring that individuals or their guardians are fully informed about the risks, benefits, and potential long-term consequences of gene editing is crucial. Informed consent becomes particularly challenging when considering germline editing, as the changes made to the genome can be passed on to future generations.

Equitable Access:

There is a risk that gene editing technologies could exacerbate existing social inequalities if they are only available to certain groups or populations. Ethical considerations include making these technologies accessible to diverse communities, ensuring that they do not exacerbate existing health disparities.

Unintended Consequences:

The potential for unintended and unforeseen consequences in the edited genome raises ethical concerns. Off-target effects or unintended alterations to non-targeted genes could have unpredictable and potentially harmful outcomes.

Germline Editing:

Editing the germline (sperm, eggs, and embryos) raises particular ethical concerns, as any changes made would be heritable. The long-term consequences and potential for unintended effects across generations need careful consideration.

Human Enhancement:

The use of gene editing for non-therapeutic purposes, such as enhancing physical or cognitive abilities, raises ethical questions about what constitutes acceptable uses of this technology and the potential for creating a “genetic elite.”

Environmental Impact:

If gene-edited organisms are released into the environment, the potential ecological consequences need to be thoroughly evaluated and ethical considerations must be taken into account to prevent unintended environmental harm.

Cultural and Religious Values:

Gene editing may raise ethical issues related to cultural or religious beliefs. Different societies and communities may have varying perspectives on the acceptability of modifying the human genome.

Regulation and Oversight:

Establishing robust regulatory frameworks and oversight mechanisms is essential to prevent misuse of gene editing technologies and to ensure that research and applications adhere to ethical standards.

Data Security and Privacy:

The handling of genetic information raises concerns about privacy and data security. Safeguarding individuals' genetic data from unauthorized access and use is crucial to maintaining trust in gene editing technologies.

Long-term Effects:

The long-term effects of gene editing are not fully understood. Ethical considerations include the responsibility to conduct thorough research to assess potential risks and benefits over time.

International Collaboration:

Ethical considerations extend globally, requiring collaboration and dialogue between nations to establish common principles and guidelines for responsible gene editing research and applications.

5. Challenges

Delivering a gene to the wrong tissue would be inefficient, and it could cause health problems for the patient. For example, improper targeting could incorporate the therapeutic gene into a patient's germline, or reproductive cells, which ultimately produce sperm and eggs.

Technical challenge

Delivering a gene to the wrong tissue would be inefficient, and it could cause health problems for the patient. For example, improper targeting could incorporate the therapeutic gene into a patient's germline, or reproductive cells, which ultimately produce sperm, etc.

Societal challenge

Germline gene therapy raises difficult ethical questions related to tampering with human nature, enhancing human traits, parental control over children, discrimination, social justice and eugenics.

6. Future prospects

Earlier this year, the United Kingdom passed the Genetic Technology (Precision Breeding) Act, which allows for the breeding of genetically modified crops as a means to address food security. 'Precision breeding' has been used in research labs for over a decade and is believed to be relatively safe, only mimicking mutations that could have naturally arisen. The new law is similar to those enacted by countries such as the US and Australia, and is one of the UK's first major deviations from the European Union, who do not yet allow this form of gene editing technology. The government are now working to ensure high quality and standards to introduce these GMOs into the food system.

The United Kingdom's fertility agency HFEA has also decided that the use of gene editing to create so-called 'three-parent babies' is 'morally permissible if it is in the future child's interests and does not add to the kinds of inequalities that already divide society.' However, the government does not view this type of editing in the same way as other germline editing techniques, and it is regulated in a distinct manner. These relaxations of the law have recently resulted in the first three-parent baby to be born in the United Kingdom, with mitochondrial DNA taken from a donor egg.

And even more recently, gene editing pioneer Feng Zhang and his team have developed what has been dubbed by some as the 'next CRISPR.' By using artificial intelligence and protein engineering, the researchers created a delivery system based off a natural bacterial characteristic that can deliver material to human cells. The work has so far shown promise in killing cancer cells, and Zhang believes the strategy addresses a bottleneck in creating effective therapies.

7. Conclusion

Gene-editing tools introduced into the body might not find their target gene within the intended cell type efficiently. The result could be little or no health benefit to the patient, or even unintended harm, such as inadvertent effects on germline cells, for which screening would be necessary.

Gene therapy is one of the areas of greatest ethical interest in genetics, but there is a great deal of speculation about the actual practicality of these technologies. Nevertheless, it seems likely that at least some forms of somatic if not germ-line gene therapies will be developed in the future. As of my last knowledge update in January 2022, gene editing represents a powerful and revolutionary tool with the potential to bring about significant advancements in various fields, including medicine, agriculture, and biotechnology. The most widely discussed and utilized gene editing technology is CRISPR-Cas9, which allows scientists to modify specific genes with unprecedented precision. However, the ethical implications of gene editing have sparked intense debates and discussions.

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The Future of Reproduction: Three- Parent Babies & Artificial Wombs

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Abstract

The concept of “three-parent babies” involves a technique known as mitochondrial replacement therapy, where genetic material from three individuals is used to create an embryo. This innovative approach aims to prevent the transmission of certain genetic disorders. On the other hand, an “artificial womb” is a fascinating technology that seeks to provide an alternative environment for gestating a fetus outside of the mother’s body. This advancement could potentially revolutionize reproductive medicine and offer new possibilities for those facing fertility challenges. Ongoing research and collaboration between scientists, healthcare professionals, and policymakers will be crucial in shaping the future of reproductive medicine.

Key words: Three-parent, genetic disorders, reproductive medicine, artificial womb, genetic material

Content

1. Introduction

About 300,000 women die from pregnancy-related problems each year, according to the World Health Organization. According to Hashem Al-Ghaili, the goal of the EctoLife artificial womb is to lessen human suffering and lower the need for C-sections. At EctoLife, couples are urged to click a button that, in one simple move, "birthes" their incubated child, in place of a mother pushing excruciatingly with her body. In addition to averting problems, the idea is made for ladies who had their uterus removed due to medical conditions such as cancer. The term "three-parent baby" describes a treatment known as mitochondrial replacement therapy, which uses three people's genetic material to prevent some inherited disorders. It entails fusing donor's healthy mitochondrial DNA with the parents' nuclear DNA. You may be thinking of "ectogenesis," which is the process of growing a fetus outside of the human body, when you say "ecto life." It's a theory related to artificial wombs that seeks to offer a substitute for conventional pregnancy. A contraption called a "artificial womb" is intended to facilitate the development and growth of embryos or fetuses outside of bodies. This technology is being studied by researchers as a potential solution to numerous reproductive issues and to enhance the outcomes of premature births.

2. Historical overview

The first three-parent children were born in the 1990s and early 2000s as a result of ooplasmic transfer, a then-novel IVF-based method (cytoplasmic transfer). Although the technique's success was regarded as miraculous, its application was contentious. It led researchers to create more advanced methods and regulatory bodies to limit the application of three-parent IVF. After a thorough evaluation, MRT was approved in the UK in 2015 with the goal of preventing genetic diseases.

The first three-parent kid created via MRT was born the following year, according to a medical scientist in the US. The surgery was done in Mexico to get around US rules. Once more, there was disagreement and enthusiasm surrounding the development.We possess certain details such as, In the UK, the first child ever generated from three genetic parents was born. By employing a procedure called mitochondrial donation treatment (MDT), medical professionals were able to avert genetic illness and produce a "three-parent baby".

One man, two ladies, and a baby

A couple from Jordan has been attempting to conceive for nearly two decades. She got pregnant ten years after they were married, but the pregnancy terminated in the first of her four miscarriages.

The couple gave birth to a girl in 2005. At that point, they learned that a genetic abnormality in the mother's mitochondria was most likely the root of their infertility issues. Leigh syndrome, which affects a developing infant's brain, muscles, and nerves, was present in their daughter at birth. She tragically passed away at the age of six. The second child of the parents lived for eight months with the same illness.The boy was born on April 6, 2016, using the contentious "three-parent baby" method. There are no symptoms of illness on him.

3. Mitochondrial DNA disorder

3.1 Mitochondrial disease and it's inheritance

Mitochondrial diseases are a group of genetic disorders that affect the mitochondria, the energy-producing structures in cells. Mutations in mitochondrial DNA or nuclear DNA can disrupt normal mitochondrial function, impacting energy production. This can lead to a wide range of symptoms affecting various organs, such as muscle weakness, neurological issues, and metabolic dysfunction. Since mitochondria play a crucial role in overall cellular health, mitochondrial diseases can have significant and varied effects on human health.

Mitochondrial DNA (mtDNA) is a circular, tiny fragment of DNA found in the cell's energy-producing mitochondria. Mothers only pass on their mtDNA to their offspring; nuclear DNA is passed down from both parents.Though the sperm's mitochondria are often wasted, the sperm provides genetic material to the egg's nucleus during fertilization. Consequently, the mitochondria in the progeny originate solely from the mother's egg. The reason for this distinct pattern of maternal inheritance is that sperm mitochondria are usually found in the tail, which is left behindafter fertilization. Since mitochondria are essential for energy production and cell metabolism, mtDNA-encoded traits are related to these activities. Mutations in the mtDNA can cause a variety of mitochondrial diseases, which can impact energy generation and perhaps result in a number of health problems.

3.2 Theory and techniques of mitochondrial replacement therapy

Mitochondrial Replacement Therapy (MRT), sometimes called mitochondrial donation, is the replacement of one or more mitochondrial cells. Disease MRT developed as a special form of in vitro fertilization where part or all of the future child and its mitochondrial DNA (mtDNA) comes from a third party. This technique is used in cases where mothers carry genes for mitochondrial diseases. The treatment is approved for use in the UK. Another application is the use of autologous mitochondria to replace damaged tissue mitochondria to restore the functional state of the tissue. It has been used In clinical trials in the United States to treat heart failure in new-borns.There are different approaches to MRI, but the two main methods are pronuclear transfer (PNT) and mother spindle transfer (MST).

1. Maternal Spindle Transfer (MST):- This technique is performed before insemination. The nucleus of the infected mother's egg is removed, leaving behind the mitochondria. The nucleus is then inserted into a donor egg that has had the nucleus removed but has intact mitochondria. This reconstructed egg is fertilized with sperm, resulting in an embryo with nuclear DNA from the parents and mitochondrial DNA from the donor. Both methods aim to create embryos without disease-causing mitochondrial mutations. The goal of MRT is to give genetically related healthy children to women suffering from mitochondrial diseases. However, MRI raises ethical issues, including the creation and destruction of embryos, the introduction of genetic modifications, and possible long-term effects on future generations. As of my last data update in January 2022, some countries have allowed limited use of MRI with strict regulations, while others have not yet approved its clinical use. It is important to stay abreast of the latest developments and ethical debates surrounding mitochondrial replacement therapy.

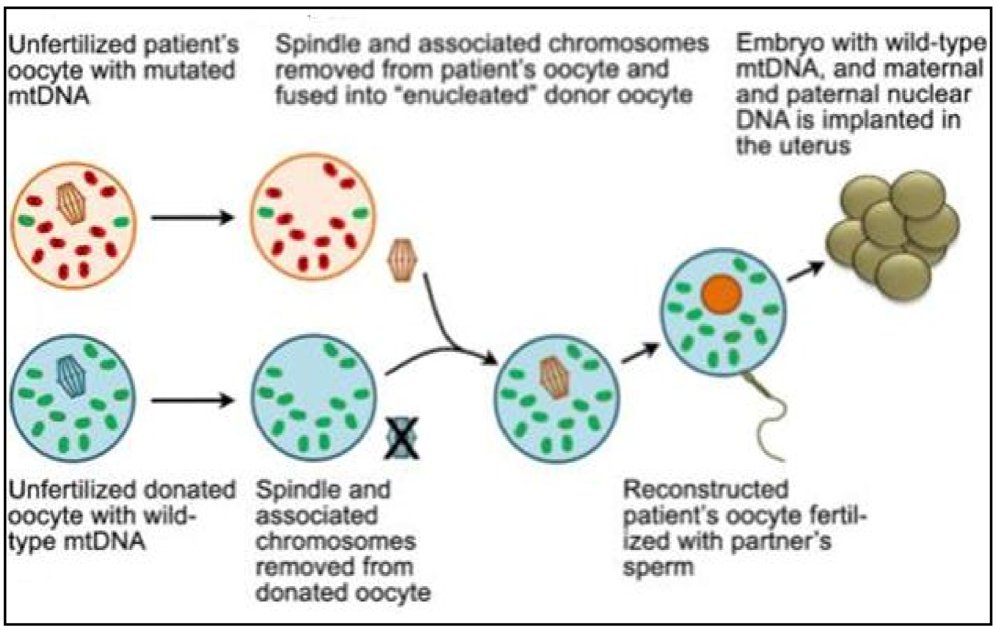

Fig1: Maternal Spindle Transfer

2. Pronuclear Transfer (PNT):-In this technique, both an oocyte provided by a woman with non-pathogenic mtDNA and the intended mother's oocyte would be fertilized with sperm in vitro, creating two zygotes. The maternal and paternal pronuclei, which contained the nDNA, would be removed from both zygotes. The intended mother's enucleated zygote, containing pathogenic mtDNA, would be discarded. The pronuclei from the intended mother's zygote would be inserted into the enucleated zygote created with the provided oocyte and the intended father's (or another man's) sperm, which would contain non-pathogenic mtDNA. The resulting embryo(s) would then be grown, tested, and transferred as detailed above for MST.

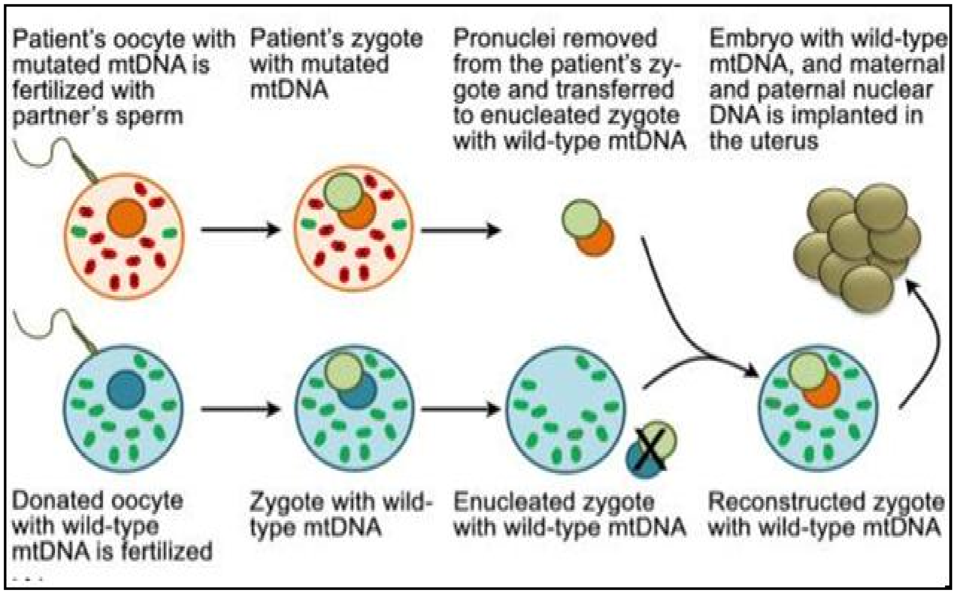

Fig 2: Pronuclear Transfer

3. Polar Body Transfer (PBT) :-There are two versions of PBT. In polar body 1 transfer (PB1T), the intended mother's first polar body, which is a by-product of oogenesis, containing her nDNA and very little mtDNA, would be transferred to an oocyte provided by a woman with non-pathogenic mtDNA from which the nDNA had been removed. The reconstructed oocyte would then be fertilized, grown, tested, and transferred as detailed above for MST. In polar body 2 transfer (PB2T), both the intended mother's oocyte and an oocyte provided by a woman with non-pathogenic mtDNA would be fertilized. The intended mother's second polar body, containing nDNA and very little mtDNA,would be transferred to the zygote of the woman who provided the

oocyte, from which the pronuclei had been removed. The resulting embryo(s) would then be grown, tested, and transferred as detailed above for MST.

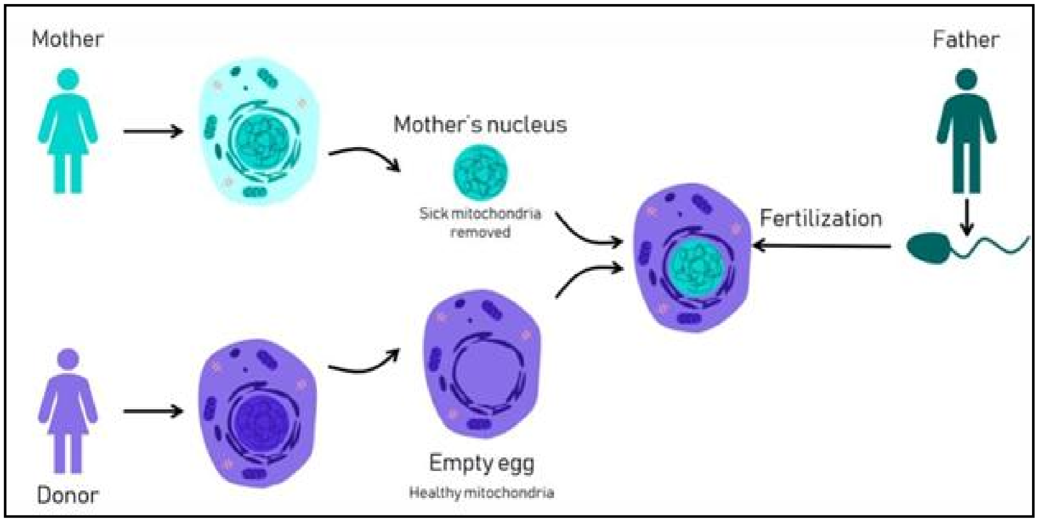

Fig 3: Mitochondrial transfer

More detailed breakdown of the process:

i. Selection of Eggs: Two eggs are required for MST – one from the intending mother (with defective mitochondria) and another from a donor (with healthy mitochondria).

ii. Removal of Nuclei: The nucleus is the compartment of the cell containing the majority of its genetic material. In both the intending mother's egg and the donor egg, the nucleus is removed.

iii. Maternal Spindle Extraction: The maternal spindle is a structure within the egg that contains the mother's genetic material. It is carefully extracted from the intending mother's egg using a delicate micromanipulation technique.

iv. Transfer of Nucleus: The nucleus from the intending mother's egg, containing the majority of the genetic material, is then transferred into the donor egg, which has had its nucleus removed. This results in a reconstructed egg with nuclear DNA from the intending mother and healthy mitochondria from the donor.

v. Fertilization and Implantation: The reconstructed egg is then fertilized with sperm in a laboratory setting. If successful, the resulting embryo carries genetic material from both parents but has mitochondria solely from the donor egg. This embryo can be implanted into the intending mother’s uterus for further development.

3.3 Ethics and Safety Concerns

Ooplasmic transfer, introduced in the mid-1990s, aimed to help women over 35 who struggled with infertility despite traditional IVF methods. But back then, there wasn’t enough data on its long-term safety or testing in animals. The health implications of mixing different mitochondrial DNA were also unknown.

In the early 2000s, studies on mitochondrial replacement in animals had mixed results. Some animals showed signs of accelerated aging or cognitive decline, while others seemed healthy. Later techniques focused on preventing mitochondrial disease transmission, but their safety and effectiveness were still uncertain.It’s important to carefully consider the safety and ethical aspects of these techniques. Ongoing research and discussions are needed to make informed decisions about their use. As for the impact on heredity, since mitochondrial DNA is passed to offspring, these techniques have the potential to influence family ancestry. Critics have raised concerns about “designer” babies, but many scientists consider that possibility to be highly unlikely.

The use of three-parent IVF is restricted due to the legal, psychological, and social ramifications for the child. In the United States, the FDA introduced special-permissions requirements in 2001, essentially banning the use of mitochondrial manipulation technologies without explicit authorization. However, in 2014, the FDA revisited the topic, considering improved technologies and new data from animal testing.In the United Kingdom, mitochondrial manipulation technologies were tested in clinical trials, and a panel concluded that their use was ethical in 2012. While germ-line alteration was initially prohibited, a proposal was introduced in 2014 to legalize the creation of three-parent babies. In early 2015, members of Parliament in the UK voted in favour of allowing it, making the country the first to have laws guiding the use of three-parent IVF.

It's Important to note that ongoing long-term studies are being conducted to assess the health of three-parent babies born using mitochondrial replacement techniques. These studies will provide valuable insights into the safety and well-being of these children. Monitoring and evaluating the outcomes are crucial to ensuring the ethical and responsible use of these technologies.

What about this method isn't so good?

- Three-parent new-borns should be closely watched for the rest of their life, according to experts, as they may be more vulnerable to cancer and premature aging.
- Future generations face considerable unknown hazards because this is unexplored area and the offspring born from this technology would have heritable genetic alterations.
- This technology comes with a number of very real risks. The most notable of these is the potential for babies to be born with developmental disabilities or die.
- Deviations may potentially cause birth abnormalities or show up later in life as higher cancer rates associated with aging.

Even if a baby's genetic disorder has been detected and their immune system has developed, there are still higher chances of problems in embryonic development when the fertilized egg is transferred to the mother's womb due to factors like maternal age, environmental conditions, or health conditions. That's why scientists have designed artificial wombs that provide all the necessary nutrition for the baby's development. It's an exciting advancement that could potentially help ensure safe and healthy development for babies. We'll learn more about it in the upcoming topics.

4. Ecto life: Artificial womb

The concept of artificial wombs is nothing short of revolutionary, with the potential to drastically medical science and brings incredible benefits to society. Imagine a future where high-advance risk pregnancies and premature births are significantly reduced, giving parents more control over their child's health. This technology also holds the promise of assisting countries facing population decline by providing an alternative form of reproduction. But that's not all! Artificial wombs offer a painless solution for mothers, eliminating labour pains and muscle contractions associated with natural childbirth.

Additionally, they can pave the way for healthier lives free from inherited genetic diseases, ensuring a brighter future for generations to come. Get ready to embark on a journey that explores the awe-inspiring possibilities of the Ecto Life Artificial Womb.

Fig 4: Ectolife

4.1 Working of Artificial womb

Artificial babies' biological bioreactor-Although artificial wombs have long been a theoretical concept, it has only been recently that the necessary knowledge and technology have combined to make them a likely reality in the near future. By giving your child the nutrition they require to grow in an environment that closely resembles their mother's womb, artificial wombs can enhance your bonding experience with your child. This allows you to spend more time interacting and developing a stronger bond with your child during their early years than you would have if they were delivered too soon or if there was another medical issue that prevented a natural birth.

A bioreactor device called an artificial womb Is made to resemble a uterus and supply oxygen, food, and other essential ingredients for foetal growth.Two central bioreactors are attached to an umbilical cord that connects each set of pods carrying future kids in these artificial wombs. Through its umbilical cord, each pod receives a nutrient-rich mixture from the first bioreactor that is similar in composition to the amniotic fluid found naturally inside mothers' uteruses. This mixture feeds the growing fetus inside each pod until full-term gestation is reached, at which point labour can start normally, or as close to it as possible. In addition, since Al manages these systems, all babies get exactly what they require without the need for human intervention. This relieves parents of the burden of ensuring that every little detail is taken care of when caring for multiple fetuses at once, which is especially important considering the amount of work that goes into planning even one pregnancy from beginning to end! In general, artificial wombs are superior to traditional childbirth methods in many ways, including enhanced parental bonding experiences because of easier access and more peace of mind that everything will go according to plan because of advanced technology operating in the background. Moreover, these settings offer the ideal circumstances required to guarantee a safe delivery when the time arrives, so there are no concerns about early deliveries.

1. The amniotic fluid in the first bioreactor supplies vital growth factors for the baby's development and shields it from injury and illness from the outside world. In an artificial womb, premature or medically complexly born new-borns can grow and develop healthily until they are ready for a normal birth.
2. The purpose of the second bioreactor is to remove any waste that the babies make while they are there. In the artificial womb's uterine environment. These premature are helped by the artificial umbilical chord. Babies expel their waste materials into this second chamber, where they are processed by a thin layer of specially designed enzymes that turn them back into nutrients like glucose, fatty acids, and amino acids—exactly like what occurs within our bodies during food digestion! With no negative effects on the health of humans or the environment, this recycling process ensures that a fetus receives all the nutrients it needs to grow up healthy within this closed system.

Artificial wombs have the potential to save countless lives over many generations by offering safe living conditions to premature infants before they are born naturally at term—something that traditional methods alone cannot do! All things considered, artificial wombs are one of modern medicine's most promising and future technologies! This innovative technology not only holds great potential for the future of neonatal care, but its application might also create whole new avenues for possibilities, like granting access to pregnancy services that would otherwise be inaccessible to women unable to conceive due to specific medical conditions.

4.2 The potential advancement of artificial intelligence in the field of robotics ovaries technology

Future advances in monitoring capabilities will be the primary benefit of Al-powered artificial wombs. The technology can track the physical traits of your unborn child and flag any potential genetic anomalies to give parents information about the health of their unborn child. Additionally, the pods feature a screen that provides you with real-time data on your unborn child's developmental progress, enabling you to track all of its milestones as it grows inside your womb. With the use of artificial intelligence (AI), premature babies may be able to develop in a controlled and perfect environment in a sophisticated artificial womb, improving their chances of survival and reducing the likelihood of issues from an early delivery. AI could change the environment for ideal growth using real-time data and medical indications, evaluating and reacting to the certain requirements from the fetus as well as the pregnant woman. Many of the risks associated with traditional delivery methods are eliminated, such as the potential for an early birth, problems resulting from infections, or other illnesses that could harm the mother or child. Furthermore, despite recent medical improvements, maternal death rates remain exceedingly high worldwide. This approach may help to reduce these rates. By increasing our understanding of foetal growth and interactions with the mother, the development of such technologies may lead to advancements in perinatal care and reproductive medicine. Therefore, expectant mothers are looking for an alternative delivery method that allows them to have greater control over their own health and peace of mind regarding the health of their unborn child before delivery will discover numerous gains from Al-powered artificial wombs. By guaranteeing that our babies enter the world safely and soundly, this cutting-edge technology has the potential to drastically alter the way we now conduct pregnancy. It combines the ability to track physical traits with strong genetic analysis capabilities.

4.3 How artificial ovaries and C-sections will become a thing of the past due to technology?

C-sections and premature births are indeed common medical procedures in modern medicine. But guess what? With the help of new and innovative technologies, these procedures may soon become a thing of the past! In the future, ultrasound waves will be used to help a fetus grow outside of the womb. This ground-breaking approach has been found to be highly effective in preventing premature deliveries and reducing the need for Cesarean sections. It also gives pregnant women more control over their healthcare decisions by allowing them to monitor their baby's growth at home. The benefits are incredible! It reduces the risks associated with premature birth and C-section surgery while giving mothers more freedom in making decisions about their pregnancies. It's truly amazing how technology can have such a positive impact on maternal healthcare outcomes worldwide.

4.4 The next generation of artificial wombs: babies created in laboratories

Future breakthroughs in medical technology and the growing recognition of the need for non-traditional delivery options will lead to an increase in the use of artificial wombs. Aiming to give premature children life support, some researchers have investigated the creation of an artificial placenta. This entails developing a tool that mimics the placenta's functions so that an infant born prematurely can continue developing outside of the womb. A well-equipped lab may hold up to maximum growth pods, popularly referred to as "artificial wombs," each of which is made to mimic the environment inside a mother's uterus.

This provides a secure environment for developing embryos outside of their mothers' bodies. Staff personnel ensure that the lab-grown new-borns receive all the food and medication they require while still in the womb by closely monitoring them. Modern labs are meticulously designed with high-precision tools like incubators and monitoring systems that give real-time information on each baby's health status during development. This ensures that the baby receives the best care possible during the entire gestation period, up until the time of natural birth, or earlier if necessary because of unique situations like preterm or high-risk pregnancycomplications. Singular buildings can hatch up to the maximum number of lab-grown infants per year, depending on their size. This makes it a viable choice for those who wish to give birth to their children in a medically safe environment but cannot afford traditional techniques. Artificial wombs have also gained popularity among fertility clinics who are trying to find ways to boost their success rates in handling challenging cases like multiple pregnancies or genetic problems. Medical professionals can lower the dangers of premature delivery by employing these facilities, where babies are kept in safe conditions until they are ready to be born, free from complications brought on by outside forces beyond our control. This method also helps parents understand what it takes to raise a healthy child from the moment of conception until they bring the child home to begin a new life together.Modern artificial womb labs around the nation would not be able to do this without the advanced technology that they have.

4.5 An app to monitor development and overall well-being for "artificial" infants

Possible importance of a monitoring app for artificial womb babies - The way parents look over and care for their unborn children has altered as a result of lab babies created in an artificial womb. Parents may now monitor their baby's development and health in real time from the comfort of their own home with the use of a smartphone app. With this technology, expectant moms can monitor vital indicators such as temperature, oxygen saturation, heart rate, breathing rate, and other vitals during their pregnancy to ensure optimal health for their unborn child. Families may observe their baby's development over time in remarkable detail by using the app's high-resolution live feeds, which allow them to see facial traits.Regular monitoring using the app may help identify developmental or medical problems early, enabling timely intervention and treatment. This technology offers an opportunity for family members who might not be able to physically attend doctor visits or ultrasounds due to distance or other reasons, in addition to giving expecting parents peace of mind by giving them direct access to what is happening inside the womb during pregnancy. They can still watch time-lapse recordings with this application, which captures every moment leading up to delivery day and helps to create lifelong memories. In general, adopting artificial womb kids is a wonderful approach to stay in touch with family members who are far away. They also provide families with previously unattainable new means of monitoring the foetus's growth throughout pregnancy. During the early stages of growth, the app could help parents monitor and care for their babies more actively, creating a sense of participation and connection. The information gathered by the app may help progress scientific studies on artificial womb technologies, infant care, and early childhood development.

Considering and overcoming obstacles:-

a) In terms of permission and privacy, ongoing surveillance presents ethical questions. Addressing these problems and defending the rights of parents and children would require precise rules and laws.
b) It would be vital for the data gathered by the app to be accurate and trustworthy. To ensure that healthcare decisions are well-informed, monitoring technologies must be accurate and reliable.
c) To prevent misunderstandings and needless interventions, healthcare practitioners and technology specialists must work together to properly evaluate the data that has been collected.

d) To guarantee that the app is accessible and simple to use, encouraging positive engagement, it is crucial to design a user-friendly interface for parents and caregivers.

e) In-depth research is required to fully comprehend the possible advantages and disadvantages of the long-term effects of artificial womb technology on the health and development of new-borns.

However, Parenting is now more accessible than ever thanks to features like real-time vital sign tracking on your phone and watch High-quality videos at anytime.

4.6 The article discusses the use of artificial womb for safe and painful delivery

It is describing an article about using artificial womb for the safe and painless delivery of a three-parent artificial development fetus, but there's a mention of "without womb." The use of artificial womb for safe and painless delivery is an intriguing concept. These synthetic devices could potentially offer a controlled and secure method for delivering infants, minimizing risks and discomfort associated with traditional childbirth. However, such technology is speculative, and real-world implementation and ethical considerations would require careful examination and consideration by the medical and scientific communities. Indeed, the use of artificial womb in delivery could have significant implications for saving premature infants. Precise control and a tailored approach provided by these synthetic devices might enhance the chances of a healthy delivery for premature babies, minimizing complications and improving overall outcomes. This, however, would necessitate rigorous research, testing, and ethical considerations to ensure the safety and efficacy of such technology in the medical field.

4.7 The potential advantages of Artificial Womb Technology

i. Premature Birth Support: - Artificial wombs could provide a controlled environment for premature infants, offering them a better chance at survival and healthy development compared to traditional incubation methods.

ii. Reduced Maternal Risks :- By transferring gestation from the mother's body to an artificial womb, potential complications associated with pregnancy, such as preeclampsia or gestational diabetes, may be minimized, leading to improved maternal health.

iii. Enhanced Foetal Monitoring: - Artificial womb technology allows for precise monitoring of foetal development, enabling healthcare professionals to closely observe and respond to any abnormalities or complications in real-time.

iv. Optimal Growth Conditions: - The controlled environment of an artificial womb can provide consistent temperature, nutrient supply, and oxygen levels, creating ideal conditions for foetal growth, potentially reducing the risk of developmental issues.
v. Solution for Infertility: - Artificial wombs may offer an alternative for couples facing infertility issues by allowing the gestation of embryos outside the mother's body, expanding options for reproductive assistance.
vi. Scientific Research Opportunities: - Artificial womb technology provides researchers with a unique platform to study foetal development in detail, advancing our understanding of prenatal conditions and potential interventions.
vii. Neonatal Care Advancements: - The technology could contribute to improvements in neonatal care by facilitating gradual transitions for preterm infants from artificial womb environments to traditional care, reducing the complications associated with abrupt changes.
viii. Increased Parental Involvement: - Artificial wombs could enable both parents to be more actively involved in the gestation process, fostering a deeper connection and involvement from the early stages of pregnancy.
ix. Mitigation of Ethical Dilemmas: - Addressing ethical concerns related to abortion and viability, artificial wombs could provide a viable alternative by offering a supportive environment for embryonic and foetal development outside the human body.
x. Emergency Situations: - In cases where maternal health is at risk or when the mother is unable to carry the pregnancy to term, artificial womb technology could serve as a life-saving intervention, ensuring the survival and health of the developing fetus.

4.8 What are the potential ethical concerns associated with artificial wombs?

There are some ethical issues regarding babies that need to be carefully considered. One of the most important issues is the question of the meaning of parenthood. With the use of this technology, traditional ideas about pregnancy and birth can become complicated. This raises questionsabout the emotional and emotional relationship between mother and child and the role of the surrogate mother.

Another concern is reproductive ability. If child births become more common, there will be a risk of pregnancy and birth turning into work. This can lead to a problem of inequality, with only those with money having access to technology, which can lead to greater inequality in child care.There are ethical considerations regarding long-term effects on the health and development of the embryo. It is important to ensure that the uterus creates a suitable environment for the development and health of the embryo.Traditions and customs may be challenged as the family context evolves. Pregnant women may provide new opportunities for same-sex couples, singles, or non-traditional families to havechildren. This will require people to adjust and accept these changes.

While babies have great potential, it is important to address ethical issues to ensure responsible and fair use of this technology.Open communication, thoughtful management, and careful consideration of the welfare of all involved are necessary to guide the ethical behaviour of infants.

4.9 Implications of artificial womb study for the future of reproduction

Baby science could change the future of birth! It may provide an alternative for those who cannot or cannot conceive. Same-sex or homosexual couples may also choose to have children. However, it is important to consider the ethical and social aspects of this technology. This is an exciting field of research full of opportunities and challenges. Embryology research, also known as in vitro development, explores the creation of external devices that can support the growth and development of embryos outside the body. This technology has the potential to change the way children are born and solve many pregnancy-related problems. Another point is that it can offer solutions to individuals or couples who have fertility problems or face medical conditions that prevent fertility. Pregnant women can provide an alternative to parenthood and give hope to those experiencing problems with pregnancy.

This technology could also have a huge impact on gender equality and LGBTQ+ rights. Parents and young people who want to have children can do this by using the artificial uterus. An effective and efficient method can be provided.However, it is important to consider the ethical and social aspects of this tool.Questions will arise about the meaning of parenthood, its ability to increase fertility, and its impact on the traditional family. Discussions should be held and policies should be developed to ensure the responsibility and ethics of human resources.

Overall, research on infants is promising for the future of reproduction, but its impact on children also needs to be carefully considered and calibrated. This is an exciting area of research that will shape how we think about parenting and family for years to come.

4.10 Recommendation for further research of IVF and three parent baby

When it comes to further research on in vitro fertilization and the children of our parents, you can review research papers and articles that discuss the latest advances and research in these fields. This resource provides detailed information about in vitro fertilization technology, its success and potential risks, and the concept of parenting our child. You can call reputable hospitals and organizations at, such as the American Society for Reproductive Medicine (ASRM) or the Human Fertilization and Embryology Association (HFEA) websites. They regularly publish advice, research and information on all aspects of reproductive technology.

Furthermore to online resources, you can also browse books written by experts in their fields. To better understand in vitro fertilization, “The IVF Revolution: A Practical Guide” by Robert Winston is a good choice. If you’re particularly interested in the idea of our parents having children, it’s worth reading “Our Parents’ Children: The Revolutionary Fertility Treatment That Gives Hope to Parents” by Susan Golombok. Please remember to approach these issues involving science, ethics and social thought with an open mind.

5. Conclusion

In conclusion, the combination of three-parent babies and artificial wombs opens up incredible possibilities for the future of reproduction and childbearing. With the potential to address genetic disorders and provide a safe and nurturing environment for premature infants, these advancements have the power to revolutionize the way we approach family planning and healthcare. By embracing these technologies responsibly and ethically, we can pave the way for a future where every child has the opportunity for a healthy and fulfilling life.

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Site- Directed Mutagenesis: Precision Unleashed

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Abstract

Site-directed mutagenesis stands as a cornerstone in genetic engineering, enabling precise modifications to DNA sequences for diverse applications. For the last three decades, site-directed mutagenesis has been utilized to describe gene and protein structure-function correlations, protein-protein interactions, protein binding domains, and enzyme active sites. In this approach, synthesized oligonucleotides are used to experimentally modify a nucleotide sequence. The most frequent method is to use an oligonucleotide that is complementary to a portion of a single-stranded DNA template but contains an internal mismatch to drive the mutation. In addition to single point mutations, this method can be used to create numerous mutations, insertions, and deletions. Because of its widespread use in disease gene characterization investigations, multiple commercial kits are now available, making this procedure rapid, simple, and dependable. Its evolution from traditional methods to cutting-edge technologies reflects the dynamic nature of molecular biology research.

Key words: Site- specific, DNA, Oligonucleotide, Mutagenesis

Table of Contents

1. Introduction

The genetic information of an organism can be changed by mutagenesis to incite desired mutation. This can occur spontaneously, as a result of exposure to a mutagen, or it can be done in a lab. Site-directed mutagenesis or oligonucleotide-directed mutagenesis is an in vitro method for inducing a specific mutation in a known sequence. It is a key technology used extensively in molecular biology and protein engineering. Site-directed mutagenesis is an effective tool for studying gene regulation and the relationship between protein structure and function because it allows researchers to construct targeted modifications to the DNA. The functional and structural roles of amino acid residues in a protein of interest can be investigated by contrasting the mutant protein with the wild-type protein.

Site-directed mutagenesis is the deliberate and targeted modification of one or more nucleotide bases in a DNA sequence. This can be accomplished using a variety of approaches, including polymerase chain reaction (PCR) amplification, restriction enzyme digestion, and oligonucleotide-mediated mutagenesis. The capacity to generate targeted mutations in genes has enormous implications for studying protein structure-function correlations, investigating disease-causing mutations, and developing proteins with improved properties. This approach has transformed the science of genetics, leading to a better understanding of gene structure, function, and regulation.

2. Site-directed mutagenesis History: The key developments and milestones

2.1 Origins of Genetic Engineering-1970’s

The groundwork for site-directed mutagenesis was laid in the early days of genetic engineering when scientists were learning to manipulate DNA.In 1971, Clyde A. Hutchison III and Marshall Edgell demonstrate that mutants can be developed using small fragments of bacteriophage ϕX174 and restriction nucleases.

In 1972, Paul Berg, Walter Gilbert, and Frederick Sanger independently developed methods for sequencing DNA, providing a foundation for understanding genetic information.

2.2 Introduction of Site directed mutagenesis-1974

Site-directed mutagenesis was achieved in 1974 in the laboratory of Charles Weissmann using a nucleotide analogue N^4-hydroxycytidine, which induces transition of GC to AT. These methods of mutagenesis, however, are limited by the kind of mutation they can achieve, and they are not as specific as later site-directed mutagenesis methods.

2.3 Introduction of Primer Extension method-1978

In 1978, Hutchison collaborated with Michael Smith developed a way of site-directed mutagenesis by using oligonucleotides in a primer extension method with DNA polymerase.

2.4 Kunkel method-1985

In 1985 Kunkel and Bebenek developed a method using the M13 phage and uracil-DNA glycosylase (UDG) to introduce site-specific mutations. This involved incorporating uracil into the DNA template, using UDG to create apurinic sites, and then repairing with a mutated primer.

2.5 Development of Overlap extension PCR method- 1989

In 1989 R M Horton and his team introduced the overlap extension PCR method. This technique involved two rounds of PCR to create a mutated DNA fragment. In the first round, two separate PCR reactions with mutagenic primers were performed, and in the second round, the products were used as templates for a final PCR.

2.6 Development of QuikChange- 1996

In 1996 the QuikChange method, developed by Stratagene (now Agilent Technologies), became a widely adopted technique. It utilized high-fidelity DNA polymerases and a pair of complementary primers carrying the desired mutation.

2.7 Development of oligonucleotide-based site-directed mutagenesis-1993

In 1993 Michael Smith for his contributions to the development of oligonucleotide-based site-directed mutagenesis with Kary B. Mullis for invention of polymerase chain reaction were awarded the Nobel Prize in Chemistry.

2.8 Emergence of the CRISPR-Cas9-Since 2013

Since 2013 onwards the CRISPR-Cas9 system emerged as a revolutionary gene editing tool. While not initially designed for site-directed mutagenesis, its precision in targeting specific DNA sequences opened new possibilities for introducing intentional mutations.

2.9 Emergence of Prime editing-2019

In 2019 Prime editing, a technology that allows precise modification of DNA without double-strand breaks, was developed in the lab of David R. Liu at the Broad Institute.

3. Classification of Site-directed mutagenesis

In vitro site-directed mutagenesis procedures are broadly classified into two types: polymerase chain reaction (PCR)-based and non-PCR-based. PCR-based site-directed mutagenesis approaches are more commonly employed than non-PCR-based methods. The basic process requires the creation of a short DNA primer (Caras et al., 1982). This synthetic primer contains the desired mutation and is complementary to the template DNA surrounding the mutation site, allowing it to hybridize with the DNA in the gene of interest (Bachman J., 2013). A mutation might be a single base change (point mutation), numerous base changes, deletion, or insertion. The single-strand primer is then extended with a DNA polymerase, which copies the remainder of the gene. The copied gene contains the altered region, which is subsequently transferred into a host cell via a vector and cloned. Finally, mutants are picked using DNA sequencing to ensure that they contain the desired mutation (Flavell et al., 1975, Liu et al., 2008).

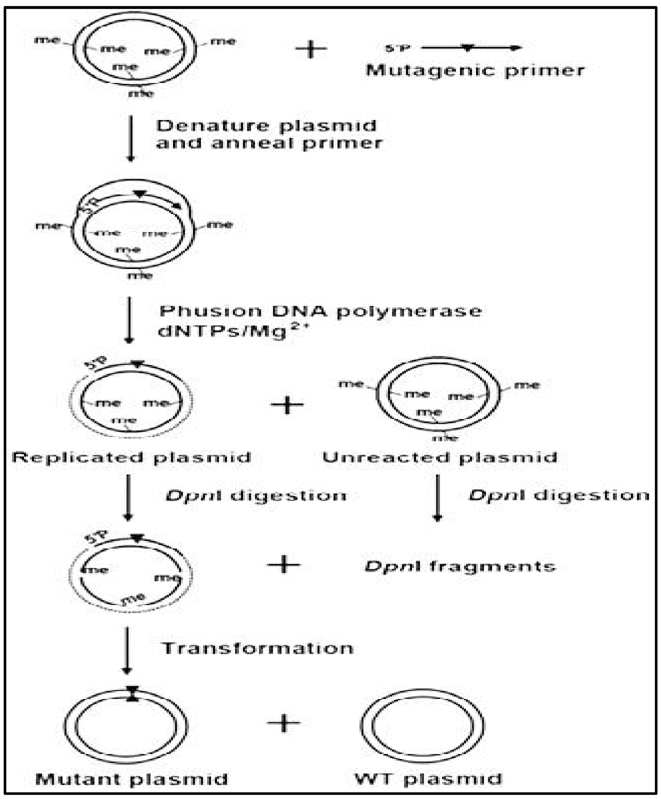
3.1 Non-PCR-based site-directed mutagenesis

3.1.1 Cassette mutagenesis

In cassette mutagenesis, a restriction fragment from the cloned DNA of interest is replaced with a restriction fragment containing the altered sequence. It is based on the existence of two restriction enzyme recognition sites flanking the DNA that would be altered. The wild-type gene's target site is deleted using restriction enzymes. A double-stranded oligonucleotide cassette containing the desired mutant sequence replaces the homologous sequence in the wild-type gene. These are relatively large-scale modifications. Nineteen amino acid changes at position 222 in the subtilisin protein sequence have been produced using this method with success.

Cassette mutagenesis is a simple approach that is quite efficient. The downsides include the need for unique restriction sites flanking the region of interest.

Design of mutagenic oligonucleotides Designing the mutagenic oligonucleotide is a critical step in site-directed mutagenesis. Mutagenic oligonucleotides must have at least one base change by definition, but they can also have much more complex mutations such as insertions, deletions, and numerous replacements (Flavell et al., 1975). The minimal length of the mutagenic oligonucleotide is determined by the mutation's complexity. Oligonucleotides of approximately 25 bases can be used to perform simple single-base substitutions. More complex mutations may necessitate oligonucleotides of 80 bases or more in length.



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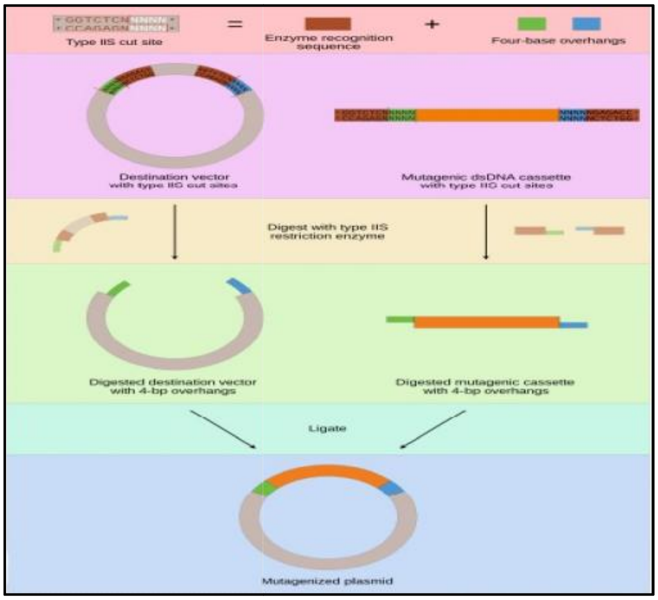
3.1.2 Primer extension mutagenesis

The simplest method of site-directed mutagenesis is primer extension mutagenesis (oligonucleotide-directed mutagenesis). The method involves DNA synthesis employing a chemically produced oligonucleotide (7-20 nucleotides long) with a base mismatch to the complementary sequence. The approach requires that the DNA to be modified be in single-stranded form. Cloning via the M13 vector yields a single-stranded form of the gene. The synthetic oligonucleotide that functions as a primer initiates DNA synthesis and is then integrated into the resulting heteroduplex molecule (Bu et al., 2013).



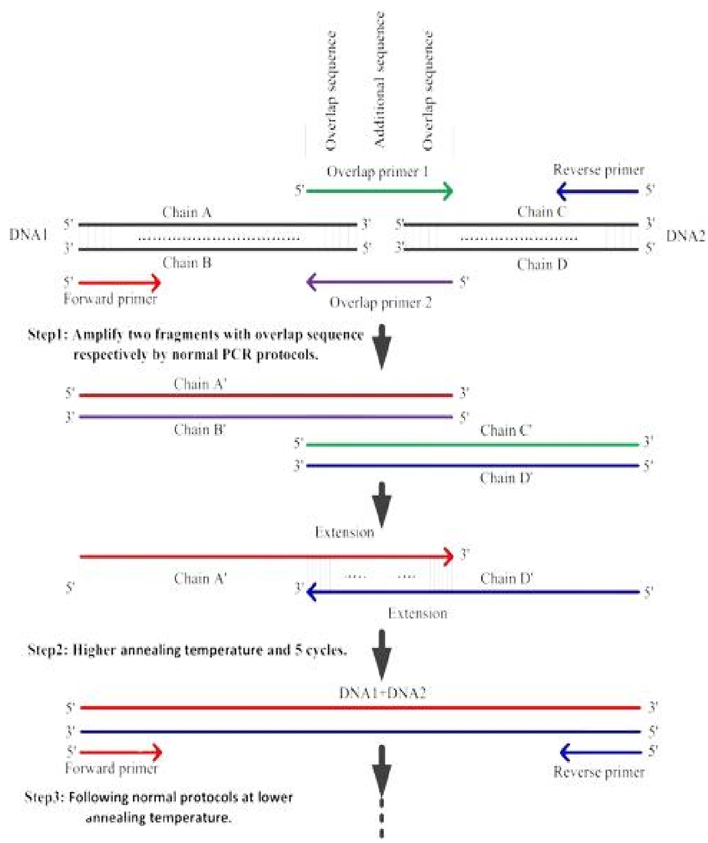
The newly generated heteroduplex is utilized for transforming cells. After introduction, DNA replication generates multiple copies of the recombinant DNA molecule **(Bu et al., 2013, Edgell et al., 1972).** Half of the resulting double-stranded molecules are copies of the original strand of DNA, while the rest are copies of the strand containing the altered sequence.

A variation on the above process uses oligonucleotides with inserted or deleted sequences. As long as stable hybrids are created with single-stranded wild-type DNA, priming of in vitro DNA synthesis can occur, eventually giving rise to clones corresponding to the inserted or deleted sequence.

3.2 PCR based site-directed mutagenesis

PCR techniques have emerged as the preferred way for producing arrays of predetermined mutations inside the gene of interest. There are many PCR-based techniques to DNA mutagenesis. PCR-mediated nucleotide alterations, deletions, and insertions can be achieved by running PCR synthesis reactions using properly selected or modified reaction components (Careyet al., 2013).

An approach for this kind of PCR mutagenesis is based on the 'mispriming' concept. Since mismatches between templates and primers are permitted under particular PCR settings, primers can be constructed with preset modifications (known as mutagenic primers) (Liu et al., 2008). Other ways take advantage of Taq DNA polymerase's inherent high error rate in the PCR procedure. Mutagenic primer PCR procedures are generally employed for introducing site-directed mutagenesis into the genes of interest, while Taq DNA polymerase or base analog PCR approaches are beneficial in inducing random and extensive mutagenesis in the target gene (Careyet al., 2013).



3.2.1 Overlap extension method

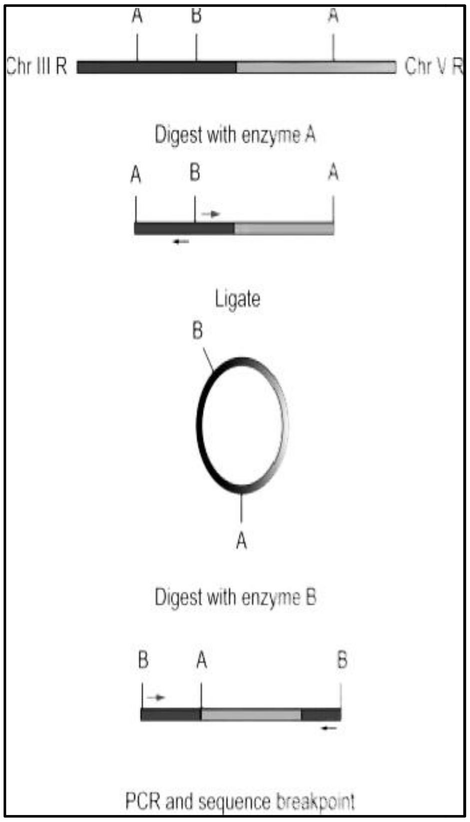
The overlap extension method is a specific technique used to introduce mutations into the core of a PCR fragment. The overlap-extension approach necessitates four oligonucleotide primers and three distinct amplification processes. Two complementary mutagenic primers cause a mutation in the target sequence of DNA, while two flanking primers amplify the mutant fragment and aid in the cloning of the PCR fragment into an appropriate vector. This technique can produce a wide range of alterations, including single base-pair modifications, deletions, and insertions (**Ho et al., 1989)**.

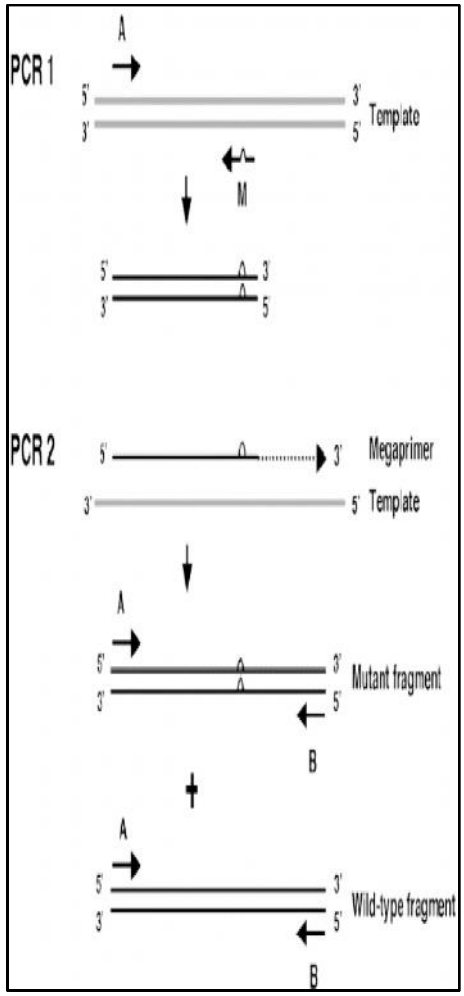
First, two independent PCR processes are initiated in parallel. One response has the "sense" mutant primer and a "anti-sense" flanking primer 3′ from the mutation site. The other response includes the anti-sense mutant primer and the sense flanking primer 5′ to the mutation site. The two amplified segments have mutations at the 5′ or 3′ terminus, respectively. In the second round of amplification, the two fragments from the previous round of PCR are purified and used as templates for amplification with only the flanking primers. Following amplification, the mutation is contained inside the target DNA segment, which is then cloned into appropriate vectors for DNA sequencing and functional analysis.

3.2.2 Megaprimer PCR

Megaprimer PCR-based site-directed mutagenesis is a technique that enhances the efficiency of introducing mutations into a DNA sequence by using a larger "megaprimer" during the PCR amplification. The megaprimer method of mutagenesis employs three oligonucleotide primers (two flaking and one megaprimer) and two cycles of PCR on a DNA template. The first PCR employs one outer primer and the middle mutagenic primer to generate a double-stranded product (the megaprimer) with the desired mutations.

The amplified result is then utilized in a second round of PCR with the wild-type template and the other flanking primer to generate a fragment that is the same length as the original target DNA and contains the desired mutation. The key to this procedure is that the amplified product from the first round of PCR serves as a primer in the second round of PCR (Sarkar et al. 1990).





3.2.3 Inverse PCR method

Inverse PCR employs only two primers to achieve the desired mutation. The main aspect of this approach is that when performing the mutation, the entire vector is amplified (Silva et al., 2023). The two primers, one of which contains the desired mutation, extend in opposing directions along the circular template DNA. Amplification produces a linear, double-stranded DNA molecule with the mutation at one end. After amplification, the ends are ligated, and the circular DNA molecule is turned into E. coli. There are other versions of this approach that improve the efficiency of mutagenesis. (Silva et al., 2023)

3.2.4 Random and Extensive Mutagenesis

In Random and Extensive Mutagenesis, mutations occur in an uneven fashion. This is a useful strategy when several mutations are required. There are two fundamental techniques to achieving these aims, both of which rely on specific applications of PCR reaction components. The first strategy employs error-prone DNA polymerases. Certain thermostable DNA polymerases, such as Taq DNA polymerase, have an intrinsic error rate due to the absence of a 3'-5' exonuclease activity. Mismatches made by the polymerase during PCR allow for the chance of mutation. The cumulative mistake rate can be significant.

The second technique is based on the degenerate base analog's ability to create base pairing with nucleotides A,C,G, and T under normal reaction circumstances. In the presence of degenerate base analog and a biased dNTP ratio, DNA polymerase randomly incorporates a significant amount of base analog into the newly manufactured DNA strand (Edelheit et al., 2009).

4. CRISPR-Cas9-based Site-directed Mutagenesis

The CRISPR-Cas9 system is employed to target a specific DNA sequence. Cas9 induces double-strand breaks, and repair mechanisms introduce mutations at the target site. The CRISPR-Cas9 system emerged as a revolutionary gene editing tool. While not initially designed for site-directed mutagenesis, its precision in targeting specific DNA sequences opened new possibilities for introducing intentional mutations.

The approach does not require a transposon insertion site, leaves no marking, and is widely used for genome editing due to its efficiency and simplicity (Biot-Pelletier et al., 2016).

5. Applications of Site-directed Mutagenesis

Site-directed mutagenesis is used to create mutations that can result in a rationally designed protein with better or unique features (protein engineering).

5.1. Investigative tools

Specific DNA mutations enable reasonable investigation of the function and characteristics of a DNA sequence or protein. Furthermore, single amino-acid alterations in proteins via site-directed mutagenesis can aid in understanding the significance of post-translational modifications. For example, altering a specific serine (phosphoacceptor) to an alanine (phospho-non-acceptor) in a substrate protein prevents the attachment of a phosphate group, allowing phosphorylation to be studied. This method was used to identify the phosphorylation of the protein CBP by the kinase HIPK2. Another comprehensive strategy is site saturation mutagenesis, which involves replacing one or more codons with all available amino acids at particular sites (Bachman J.,2013).

5.2. Commercial applications

Proteins can be altered to produce mutant forms that are optimized for a particular use. For example, typical laundry detergents may contain subtilisin, which in its wild-type form has a methionine that can be oxidized by bleach, drastically lowering the protein's activity in the process. This methionine can be substituted with alanine or other residues, making it resistant to oxidation and maintaining the protein active in the presence of bleach.

5.3. Therapeutic Applications

Further exploration of site-directed mutagenesis in therapeutic contexts, including gene therapy and personalized medicine, could lead to innovative treatments for genetic disorders and other diseases.

5.4. Agricultural improvement

Through the use of site-directed mutagenesis, agronomic qualities like yield, quality, and stress tolerance have been enhanced.

6. Conclusion

Site-directed mutagenesis has progressed from early attempts to introduce specific alterations in DNA to more complex and precise procedures. The discovery of numerous approaches has been critical in developing molecular biology, biotechnology, and our understanding of genetic information. Site-directed mutagenesis is a fundamental technology with numerous applications in genetic research and engineering. The capacity to generate targeted mutations in genes has enormous implications for studying protein structure-function correlations, investigating disease-causing mutations, and developing proteins with improved properties.

There are various ways for doing site-directed mutagenesis; however, as the cost of oligonucleotide synthesis has fallen, artificial gene synthesis is now being used as an alternative to site-directed mutagenesis. Since 2013, the CRISPR/Cas9 technology, based on a prokaryotic viral defence mechanism, has enabled genome editing, and mutagenesis may be performed in vivo with relative ease.

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Abstract

The human body is a marvel of engineering. The same body contains numerous systems that work together in a highly coordinated fashion. The world health organization (WHO) defines health as a condition of whole physical, mental, and social well-being rather than only the absence of illness or disability. The metabolic and functional efficiency of living things is also reflected in their state of health. One basic measure of life is one's health. Numerous factors can impact the well-being of a living being, encompassing not only the physical condition of the body but also the mental and emotional states. There are numerous good qualities that come with being healthy. It entails increased productivity and efficiency at work, as well as a greater comprehension of the surroundings. A healthy physique is beneficial to the economy as well as to the individual. This is due to the fact that higher productivity breeds economic prosperity in a nation with a healthy and active populace. Reduced neonatal and maternal mortality is another benefit of excellent health.

Key word- Health, common disease in humans, immunity, autoimmune disorder

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1. Introduction

The vast majority of genetic variants that impact the likelihood of disease have human origins but, the systems they affect have long-standing roots that frequently date back to evolutionary events that occurred well before humans existed. Here, we summarize how recent developments in our knowledge of the genetic architectures of diseases, along with our understanding of human evolution and deep evolutionary history, can help us understand how and why humans in contemporary situations become unwell. The frequency of numerous common and uncommon genetic illnesses varies among human populations. These variations are mostly caused by the various environmental, cultural, demographic, and genetic backgrounds of contemporary human communities. Tailoring genetic therapy to our expanding understanding of evolutionary history while taking social and environmental influences into consideration will help us realize the promise of personalized genomics and acknowledge the possibility that a person's DNA sequence can influence clinical choices. Evolving from an evolutionary perspective into the clinic will help precision medicine reach its full potential. To put it briefly, precision medicine is essentially evolutionary medicine. A state of whole emotional, mental, and physical well-being is referred to as health. The purpose of healthcare is to maintain a person's health in these vital domains.

2. Health

Being free from all illnesses and infections is the simplest definition of health. The world health organisation (who) states that being healthy involves more than just being free from illness or disease. It is a condition characterised by physical, mental, and social well-being, as well as activity and vitality. A healthy lifestyle is largely maintained by eating a balanced diet and exercising on a regular basis.

2.1 Health is influenced by a wide range of factors, including:

- Genetic Illnesses: A genetic disorder is an illness brought on by variations in a person's DNA sequence, sometimes known as mutations. Single gene, chromosomal, and complex illnesses are the three categories into which genetic disorders can be separated.
- Anxiety and Tension: Any demand made on your body or mind is considered stress. It can be brought on by any situation or incident that causes you to feel anxious or frustrated. The emotion of anxiety is fear, worry, or uneasiness. It might happen in response to stress, but it can also happen for no apparent reason at all.

- Pathogen Infection: Pathogens can affect their hosts in a number of ways. The most obvious method involves directly harming tissues or cells while they are replicating, usually by producing poisons that allow the infection to enter other tissues or escape the cells it was originally housed in.
- Eating unclean and unhealthy food: Foods that are heavy in added sugars, Trans and saturated fats, and excessive salt are frequently referred to as unhealthy foods. When ingested in excess, these might aggravate existing health concerns and cause obesity, heart disease, and other ailments.
- Avoiding physical activity: In addition to frequent exercise and other physical activities, a person should maintain good personal hygiene, eat a nutritious, balanced diet, and be physically active. The various forms of diseases and their consequences should be understood by all.

3. Diseases

An aberrant state that affects a living, healthy organism is called a disease. It is categorised as non-infectious and infectious in general.

3.1 Contagious or communicable diseases

Referred to as infectious diseases since they are mostly caused by pathogens, include bacteria, viruses, fungi, and parasites. These diseases can spread quickly from one person to another. Infectious diseases include ringworm, malaria, the common cold, TB, and the flu.

3.2 Non-infectious diseases

Also referred to as non-communicable diseases, these illnesses are not contagious and cannot spread from one individual to another. Genetic problems, poor diets, inactivity, and certain environmental variables can all contribute to the development of these diseases. Cancer ranks first among non-infectious diseases in terms of mortality.

3.3 Common diseases of human

3.3.1 Bacterial diseases:

The pathogenic bacteria that cause bacterial illnesses can take many different shapes. There include sexually transmitted illnesses, urinary tract infections, food poisoning, respiratory tract infections, and the dreaded "gastro" or skin infections.(Delong et al.,2012).

Table 1: Tabular representation of Bacterial Diseases

S.no	Bacteria	Disease caused	Symptoms	Treatment/ prevention
1.	*Vibrio cholerae*	Cholera	Diarrhea Intense thirst Muscle cramps Irritability Vomiting	Ors(oral rehydration solution) Intravenous fluid Antibiotics Zinc(in children younger than 5) Vaccine(vaxchora)
2.	*Salmonella typhi* *Salmonella paratyphi*	Typhoid	High fever Fatigue Headache Nausea Abdominal pain Diarrhea	Antibiotics Wash hands after using bathroom Typhoid conjugate vaccine Widal test
3.	*Corynebacterium diphtheriae*	Diptheria	Sore throat Difficulty breathing Nasal discharge Fever and chills Tiredness	Antibiotics Dtap vaccine(children) Tdap vaccine(adolescents and adults)
4.	*Streptococcus pneumonia* *Haemophilus influenzae*	Pneumonia	High fever (105 f) Coughing (greenish , yellow or bloody mucus) Chills Lips and nails turning blue	Pcv13(people 65 or older) Ppsv23(children more than 2 yrs of age) Antibiotics Drink plenty of fluids
5.	*Yersinia pestis*	Plague	Fever Headache and chills Abdominal pain Skin turn black Shortness of breath	Antibiotics Pcr test (polymerase chain reaction)

3.3.2 Viral diseases:

Infections brought on by viruses are called viral illnesses. Various viruses can cause a variety of ailments. The most prevalent kind of viral illness that arises from respiratory tract diseases is the common cold.

Table 2: Tabular representation of Viral Diseases

S. No	Virus	Disease caused	Symptoms	Treatment/ prevention
1.	Rhino Virus	Common Cold	Runny or Stuffy nose Sore or Scratchy throat Cough Sneezing Body-aches Headache	Antibiotics Pain relievers ; Acetamiophen (Tylenol) And Nsaids (Advil)
2.	Hepatitis a, b ,c , d and e	Viral hepatitis: Hepatitis a, b and c	Fever Fatigue Loss of appetite Nausea Vomiting Abdominal pain Dark urine	Adequate nutrition Fluid R5aking pills for 8-12 weeks Antiviral drugs
3.	Dengue Virus(Denv)	Dengue	High fever Severe headache Pain behind the eyes Muscle and joint pains Nausea Vomiting Swollen glands Rashes Fatigue	Focus is on treating the pain symptoms and no specific treatment for dengue Acetaminophen (paracetamol)

4.	Chikangunya Virus(Chikv)	Chikangunya	Joint swelling And pain Fever Headache Fatigue Rashes Nausea Red eyes	Anti-Pyretics (for fever and joint pains) Drinking plenty of fluids Paracetamol
5.	Corona virus	Coronavirus disease (covid-19)	Fever Tiredness Dry cough Aches and pains Nasal congestion Runny nose Sore throat Diarrhea Pneumonia Kidney & heart problem Organ failures	Blood plasma transfusions Anti-viral medications Breathing support Steroids (to control lung swelling) Home isolation
6.	Varicella-Zoster Virus	Chickenpox	Body aches Fever Tiredness Loss of appetite Headache	Medications: Acetaminophen(tylenol) Lukewarm bath with colloidal oatmeal or baking soda Dab calamine lotion on your itchy spots

7.	Human Immune DeficiencyVirus (HIV)	AIDS	Fever Headache Muscle aches and joint pain Rashes Sore throat and painful mouth sores Swollen lymph glands Diarrhoea Weight loss Cough Night sweats Oral yeast infection(thrush) Shingles(herpes zoster) Pneumonia	Consider pre exposure prophylaxis (prep) Use post-exposure prophylaxiz(pep)

STIs, or sexually transmitted infections, include HIV. Additionally, sharing needles, using illegal inject able drugs, and coming into contact with contaminated blood can all spread it. Additionally, it can be transferred from mother to kid during nursing or childbirth. It could take years without treatment for HIV to erode your immune system to the point where you develop AIDS.

HIV/AIDS cannot be cured, but drugs can manage the infection and stop the illness from getting worse. Worldwide aids mortality have decreased as a result of antiviral medications for HIV, and international organisations are striving to expand access to treatment and prevention programmes in nations with limited resources.

Depending on the stage of infection, HIV and aids have different symptoms.

- Primary Infection (Acute HIV): A flu-like sickness can strike certain HIV-positive individuals two to four weeks after the infection enters the body. Primary (Acute) HIV infection is the term for this sickness, which may linger for a few weeks.

Among the symptoms and indicators that could exist are: Heatstroke, joint and muscular pain, rash, mouth sores and a sore throat ,enlarges lymph nodes, primarily in the neck, diarrhea, loss of weight, coughing.

You may not even notice these symptoms because they can be so slight. However, at this moment, your bloodstream has a quite high viral load. Thus, during the primary infection stage, the infection spreads more readily than it does during the subsequent stage.

- Clinical Latent Infection (Chronic HIV): HIV is still present in the body and in white blood cells at this stage of the illness. Many people, nevertheless, might not experience any infections or symptoms at this time.

If you are on antiretroviral therapy, this stage may extend for several years (ART). Some persons experience an earlier onset of more severe disease.

- Symptomatic HIV Infection: You may experience mild infections or persistent signs and symptoms like the following when the virus multiplies and destroys your immune cells, which are the cells in your body that help fight off germs: Fatigue with fever, enlarged lymph nodes , diarrhoea, weight loss, oral thrush or yeast infection, herpes zoster or shingles, flu.

A virus is the source of HIV. It can be transmitted by sexual contact, sharing or using illegal injection equipment, coming into touch with contaminated blood, or from mother to kid through nursing or childbirth.HIV kills cd4 t cells, which are white blood cells that are essential to the body's defence against illness. Your immune system gets weaker when the number of cd4 t cells decreases.

Before HIV infection develops into aids, it can exist for years with little to no symptoms. When your cd4 t cell count is less than 200 or you have a condition that defines aids, including a major infection or malignancy, you are diagnosed with aids.

Since there is now no treatment for aids, prevention is the best course of action. Furthermore, unlike pneumonia, which is commonly the result of unintentional transmission, HIV infection is more frequently conveyed by deliberate behavioral patterns or typhoid of course, inadequate surveillance might result in infection in individuals receiving blood transfusions, newborns (from their mothers), etc. It's been said correctly to "don't die of ignorance," and ignorance may be the only acceptable explanation. The national aids control organization (NACO) and other non- governmental organizations (NGOs) in our nation work hard to raise public awareness of aids. Several initiatives have been launched by whom to stop the spread of HIV infection. Making blood (from blood banks) HIV-safe and making sure that syringes and needles are only ever thrown away in public and private clinics, the free distribution of condoms. (Mellins et al.,2011).

3.3.3 Fungal diseases:

Any disease or ailment that is caused by a fungus is considered a fungal infection. They can infect your lungs or other regions of your body, but they typically affect your skin, hair, nails, or mucous membranes. If you have compromised immune function, you are more vulnerable to fungal infections. Fungal infections are typically treated with antifungal drugs. (Janbol et al., 2019).

Table 3: Tabular representation of Fungal Diseases

S.No	Genus	Disease caused	Symptoms	Treatment/ Prevention
1.	Trichophyton	Ringworm	Scaly ring-shaped area Itchiness Bump or small sore Hair loss	Otc antifungal cream: Clotrimazole, miconazole Keep skin clean and dry Wash hands with soap and water
2.	*Candida albicans*	Vaginal yeast infection	Itchy and burning sensation in vagina or vulva Thick, white discharge with the consistency of cottage cheese Redness and swelling Buring sensation when you pee	Antifungal medications: One dose-fluconazole Topical medications to vaginal area- miconazole and terconazole

3.3.4 Protozoan diseases:

Single-celled creatures known as protozoa are occasionally responsible for illnesses. Kala azar, Amoebiasis, Malaria, and African sleeping sickness are examples of common protozoan infections. Depending on which protozoa healthcare professional suspects, diagnosing protozoan illness may require biopsies, stool testing, or blood tests. (Wiser et al., 2020).

Table 4: Tabular representation of Protozoan Diseases

S.no	Protozoan	Disease caused	Symptoms	Treatment
1.	Entamoeba	Amebiasis or Amoebic dysentery	Bloody Diarrhoea Colitis Tissue destruction Loose stools and stomach cramping Severe illness Fever	AntiAmoebic drug: Metronidazole Antibiotic: diloxanide furoate or paromomycin
2.	Trypanosoma (Tsete flies)	African sleeping sickness (African Trypanosomiasis)	Confusion Behaviour changes Sensory disturbances Poor coordination Sleep cycle disturbance	Pentamidine, intramuscular-in first stage well tolerated by patients Nifurtimox,oral-in second stage
3.	Leishmania (Sandfiles)	Kala azar or visceral leishmaniasis	Prolongs fever Weight loss Enlarged spleen and liver Anaemia Weakness	Medications: Suramin(for first stage) Melarsoprol or eflornithine(for second stage)

4.	*Plasmodium falciparum, plasmodium vivax, plasmodium Malaria, plasmodium ovale*	Malaria	Tiredness and fatigue Impaired consciousness Difficulty breathing Dark or bloody urine Abnormal bleeding	Medication: Arthemisinin Chloroquine Primaquine

The bite of an infected female Anopheles mosquito can spread the deadly disease malaria to humans. Malaria is caused by parasites of the genus plasmodium. Worldwide, malaria continues to be the primary cause of death; however, unfavourable consequences can be avoided with early detection and prompt treatment. In Africa and several Asian countries, malaria is the most prevalent disease; in the industrialised world, malaria is imported from endemic regions. (White et al., 1996, Tuteja et al., 2007).

4. Immunity

A complicated biological system with the ability to identify and tolerate things that are part of one self is called immune system. The ability of the body to fend off, defend, and repel invasive pathogens such as bacteria, viruses, and other foreign objects and poisonous substances is known as immunity. Two varieties of immunity exist:-

- Innate immunity
- Acquired immunity

4.1 Innate immunity

Innate immunity is a non-specific form of defense that exists from birth. This is accomplished by erecting several types of barriers that keep outside agents out of our bodies. There are four distinct types of barriers that comprise the innate immune system:

- Physical barriers: the primary barrier preventing microorganisms from entering our bodies is the skin. Mucus covering the gastrointestinal, urogenital, and respiratory epithelium tracts also assists in capturing microorganisms that enter our bodies.

- Physiological barriers: Saliva in the mouth, tears in the eyes, and acid in the stomach all stop the growth of microorganisms.
- Cellular barriers: our bodies' polymorphonuclear leukocytes (pmnl-neutrophils), which are specific types of leukocytes (wbc), and microbes can be phagocytosis and destroyed by tissues' macrophages, blood's natural killer (kind of lymphocytes), and monocytes.
- Cytokine barriers: Interferons are proteins secreted by virus-infected cells that shield uninfected cells from contracting new viruses. (Turvey et al.,2010)

4.2 Acquired Immunity

It is distinguished by memory. This indicates that our body initiates a reaction known as the initial response upon first coming into contact with a virus.

It has a modest level of intensity. When the same pathogen is encountered again, the secondary or anamnestic response gets stronger. This is explained by the fact that our bodies seem to remember the initial interaction.

4.3 Auto immune diorders

When the body's natural defense mechanism is unable to distinguish between its own cells and foreign ones, it can lead to autoimmune illness as the body attacks healthy cells by mistake.

One chronic (continuous) autoimmune illness is rheumatoid arthritis (RA). It differs from other forms of arthritis in that it affects the joints on both sides of your body. Pain and inflammation symptoms could be present in your fingers, hands, wrists, knees, ankles, feet and toes.

The cartilage that often serves as a "shock absorber" in your joints is harmed by unchecked inflammation. This can eventually cause joint deformation. Your bone itself erodes with time. This may result in the fusion of your joint, which is your body's attempt to shield itself from ongoing discomfort.

Rheumatoid arthritis symptoms include:

Joint pain, edoema, stiffness, and tenderness in multiple locations stiffness, particularly in the morning or after extended hours of sitting on both sides of your body, the same joints are painful and stiff Weariness (severe exhaustion) weakness and high temperature.

5. Conclusion

Being healthy is more than just avoiding being sick. It is a condition of whole mental, emotional, physical, and psychological well. Illnesses such as malaria, cholera, pneumonia, typhoid, and fungal skin infections, among many others are a primary source of distress for people. If left untreated, vector-borne illnesses like malaria, particularly those brought on by *Plasmodium falciparum*, can be lethal. Public health interventions including efficient waste disposal, purification of drinking water, control of vectors like mosquitoes, and immunization are very important in preventing these diseases in addition to personal cleanliness and hygiene. In situations where we are exposed to chemicals that cause disease, our immune system is mostly responsible for preventing these illnesses. The natural defenses that our bodies have, such as the skin, mucous membranes, antibacterial compounds found in tears, the phagocytic cells and saliva work together to prevent infections from entering our bodies. Certain antibodies (humoral immune response) and cells (cell mediated immune response) work to destroy infections if they are able to enter our body. The immune system has a memory. The immune response is faster and stronger when the same virus is encountered again. This serves as the cornerstone of defense.

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A Pilot Study on Atherogenic Index of Plasma in Predicting Cardiovascular Disorders (CVDs) Among Different Age Group of People

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Abstract

Various indices have been used for the diagnosis and prognosis of cardiovascular diseases, among which AIP is a novel marker for assessing the risk of atherogenicity and cardiometabolic health. This study was to determine the AIP and its relationship with other CVD risk factors. Cardiovascular disease (CVD) is the cause of one third of deaths worldwide and this will progress because of increasing CVD's risk factors. The most basic task of dealing with the epidemic of CVD is primary prevention of risk factors. As Atherogenic Index of Plasma (AIP) is a clear warning to predict the risk of atherosclerosis and coronary heart disease, we assessed the correlation between AIP and other important factors. The Atherogenic index of plasma (AIP) is a critical index that can be used as a stand-alone index for cardiac risk estimation. Changes in the levels of any lipid profile make the individuals more prone to get the chance of CVDs. It is defined as logarithm [log] of the ratio of plasma concentration of TG to HDL-C and is strongly correlated with CVD risks. It can act as an adjunct over the individual lipid profile. AIP is the best determinant for fractionated esterification rate of HDL-C and more useful than routine lipid parameters. It can be used as a diagnostic indicator when the other Atherogenic risk parameters appear normal. The AIP calculation estimates the values of “zone of Atherogenic risk”. This study implemented the relationship between AIP and other CVDs risks by collecting the data of ATP values of both above 40 age and below 40 agewith age between 18-80, in order to highlight that AIP rather than lipid profile is the predictor for CVDs. By performing this study, we can detect the early cases among the people and provide advices such as lifestyle changes, increased physical activity, and healthy diet, those who are in above 40 age.

Key words: Atherogenic index of plasma, AIP, Cardiovascular disease, Cardiovascular risks associated with age, Age CVDs risk factor.

Introduction

Recently developing countries are coming up against breathtaking changes in the population mostly related to health issues, among which cardiovascular diseases (CVDs) is one of the life threatening.Itis one of the biggest and largest roots of deaths occurring globally [Deaton C, et al 2011]. At the age of forty, the rate of occurrence of CVD in United States is 50% in males and 32% in females [Mensah GA, et al 2007]. They mainly consist of coronary heart disease, stroke, angina, Rheumatic heart disease, peripheral arterial disease, deep vein thrombosis etc. The adverse conditions for CVD are - dyslipidaemia, obesity, physical inactivity, smoking and poor diet [Rang HP, et al 2005].Dyslipidaemia is a condition where the increased total cholesterol, low-density lipoprotein cholesterol (LDL-C), triglycerides (TG) followed by a decreased in high-density lipoprotein cholesterol (HDL-C) is observed [Wang MC, et al 2021].These types of unfortunate situations form notable impact on a person's quality of life. When blood vessels become blocked or narrowed, the heart and other organs may not receive enough oxygen and nutrients, leading to damage and eventually death of these organs. Among all, lipid profile of plasma is a severe condition for CVD [Parinita K, et al 2012].The significance of cardiovascular disease is now a part of worldwide research which focuses in the lowering death rate and widespread of the disease. If anyone is having cardiovascular health related issue, then it is important to speak with their healthcare provider to discuss the risk factors and determine the best course of action.

There are some causes why CVDs are increasing worldwide. The major reason behind CVD is the lifestyle factors. The poor lifestyle choices such as smoking, a diet high in saturated fats and pre-manufactured foods, physical inactivity, and immoderate alcohol depletion are major risk factors for CVDs. Another factor that causes in development of CVD is the aging population. As the worldwide population ages, the spread of CVDs increases. Older people are more prone to have other conditions that increases the possibility of CVDs, such as high blood pressure and diabetes.Rapid urbanization in different parts of the world has driven to changes in diet and lifestyle that also increases the risk of CVDs. Economic development is often supported by changes in diet and lifestyle that increase the risk of CVDs. As countries become more blooming and profitable, people likely to adopt more stationary lifestyles, consuming more processed foods and engage themselves in less physical activity.

Usually, all the cholesterol are built in liver. Normally all source of cholesterol enters in human body from food-like animal-based food, milk, eggs, meat, food oil. A high amount of cholesterol in your body is a high risk for cardiovascular disease [MurtazaCassoobhoy, et al 2023]. There are four types of cholesterol present in our body- LDL (Low-density lipoprotein), HDL (High-density lipoprotein), Triglycerides and low molecular weight chylomicrons.Among these the two major types of cholesterol are – LDL (Low-density lipoprotein) or “bad” cholesterol and HDL (High-density lipoprotein) or “good” cholesterol. These are the types in which cholesterol travelled in the blood. HDL which is well known as “good cholesterol” as it carries away cholesterol to our liver to be released from our body. LDL is called “bad cholesterol” because it takes cholesterol to your arteries, where it can gather in our artery walls.

When too much amount of bad cholesterol in the body, it starts to create a problem in cardiovascular disease. It means to fatty deposition in the arteries called plaque, which can cause heart disease.The treatment of cholesterol related cardiovascular disease- eat a heart healthy diet, get regular exercise, maintain a healthy weight, be protective to manage stress, quit smoking, limit alcohol intake, treat cholesterol medications as prescribed[Erica Patino, et al 2021].

A high level of a certain types of fat (triglycerides) in the blood, known as Hypertriglyceridemia. They present in the blood to enable the bidirectional transference of adipose fat and blood glucose from the liver, and are a major component of human skin oils [Nelson D, et al 2000].

High levels of triglycerides and LDL cholesterol in the blood are both associated with an increased risk of cardiovascular disease. Triglycerides and cholesterol can interact in several ways that contribute to this risk. Additionally, both triglycerides and cholesterol can contribute to the formation of plaques in the arteries. Plaques are deposits of cholesterol, fat, and other substances that can narrow and harden the arteries, increasing the risk of heart attack and stroke.Overall, while triglycerides and cholesterol are distinct molecules, they are linked in their role in cardiovascular health, and high levels of both can contribute to an increased risk of CVDs.

After many clinical studies, it has been conveyed that the Atherogenic Index of plasma (AIP) is a clear and effective marker for detecting the probability or danger of CVDs[Dobiasova M, et al 2001].The Atherogenic

Index of Plasma (AIP) is a marker used to assess the risk of developing cardiovascular disease (CVD). The AIP is calculated by dividing the concentration of triglycerides by the concentration of high-density lipoprotein (HDL) cholesterol in the blood. A higher AIP value indicates a higher risk of CVD, as it suggests that the concentration of triglycerides in the blood is relatively high compared to the concentration of HDL cholesterol. AIP values below 0.11 are considered to be low risk, while values above 0.24 are considered high risk.

It's important to note that the interpretation of AIP values may vary depending on individual factors, such as age, sex, and overall health status. Therefore, it's always best to consult. [Kannel WB, et al 1988].Hence, we conducted a standardized and systematic review on the study of The Atherogenic index of plasma (AIP) for predicting cardiovascular diseases on age basis.

Survey of Literature

According to the review article "Plasma Atherogenic Index (AIP) as a Parameter in the Prediction of Cardiovascular Risk in Men Compared with Conventional Dyslipidaemia Indexes (Cholesterol Ratios)", it was determined whether the plasma atherogenic index is more advantageous than the conventional daily used Atherogenic indices in predicting cardiac risk. Several indices have been derived from lipid profiles to determine an index for predicting the risk of a coronary event. The plasma Atherogenic index is an actively emerging index that now meets the criteria for use as a stand-alone index for cardiac risk stratification. The article is based on a case study of 119 men aged from (43-68). This article concluded that AIP was a better index for predicting coronary artery disease compared to the most commonly used indices of atherogenicity in everyday practice [Mudhaffar SK. et al 2013].

According to Journal of Clinical lipidology (2010) "Plasma Atherogenic index" (log10 triglyceride/high-density lipoprotein 2cholesterol) predicts high blood pressure, diabetes and vascular events, it was found that the aim was to determine the association of plasma Atherogenic index (AIP), the logarithm of molar of the ratio of triglycerides to high-density lipoprotein cholesterol (TG/HDL-cholesterol) with cardio metabolic disorders was investigated in a Turkish population sample. It was conducted with 2676 middle-aged adults who were prospectively evaluated by clinical examination and laboratory tests during 7.8 years of follow-up. It was concluded that high AIP, a proxy for small LDL particle size, reflects obesity and hyperinsulinemia in men and high CRP in women. Independently predicts CHD; obesity-mediated type 2 diabetes in men and women, high blood pressure, metabolic syndrome and CAD potentially mediated by involvement in the pro-inflammatory state reflected by CRP. [A Onat, et al, 2010].

Due to genetic and environmental variables that might trigger the development and progression of atheromatous plaques, there is a high prevalence of CVD. AIP might be employed as a superior biomarker in young MI patients than other lipid indices, especially in those at high cardiovascular risk since greater AIP levels showed relationship with other CVD risk factors, and changes in these risk variables might alter AIP index.

Methodology

This study was carried out among the patients of Barasat Cancer and Research Welfare Centre. All respondents who fulfilled the inclusion criteria of no current acute illness and no known history of diabetes mellitus, hypertension, heart disease, liver disease, and renal disease were selected. The study was conducted from 2023 to April 2023.According to the clinical practice guidelines on management of dyslipidemia,hypercholesterolemia is classified as total cholesterol of more than 6.3 mmol/L, high LDL cholesterol is defined as more than 4.1 mmol/L, low HDL cholesterol is classified as less than 1 mmol/L for men and less than 1.3 mmol/L for women, and high triglyceride is defined as more than 2.3 mmol/L.[Erica Pation; et al,2021]Atherogenic index was calculated by using the following formula: log10 (TG/HDL-C) [U I Nwagha; et al,2010]. It can be classified according to the values obtained: −0.3 to 0.1 for low risk, 0.1 to 0.24 for medium, and more than 0.24 for high risk of CVD [M.Dobiasova;et al,2006].

In this study the data of Triglycerides (TG) and High-density lipoprotein (HDL-C) was obtained from the hospital. Age limit of the study was 18 years to 80 years with a mean of (mean ± S.D = 45.06 ± 14.62). The data entry and data analysis were performed by using MS Excel. Descriptive and inferential statistics were carried out based on 95% confidence interval with value less than 0.05 as significant. Statistical F test was done in to order to verify the test for the equality of the two population variances. Articles associated with the elevated levels of triglycerides and high-density lipoprotein cholesterol in predicting Cardiovascular Diseases (CVDs) was searched between 2000-2014 by collecting the resources from [PubMed], [Google scholar],[PMC free Article], [CrossRef].

Result

A total of 60 people including male and female participated in the study. The study population consisted of population aged between 18 to 80 years (mean ± S.D = **45.06 ± 14.62**). Among them 30 people have the age above or equal than 40 years age and 30 people having the age below than 40 years taken for this study. About 72% of our participants are from urban areas. The details of the respondents are presented in Table 1.

Table 1: General characteristics of the participants (n=60)

Age group = 18 to 80	
Age criteria	**n%**
Above 40 years	50% (**n_1%**)
Below 40 years	50% (**n_2%**)

In this clinical examination, the mean value of atherogenic index of plasma (AIP) level in above 40 age group of people was 0.5175 while the below 40 age group of people having the mean value of AIP was 0.3946 unit. The squared variance of AIP value in below 40 age group $(\boldsymbol{\sigma}_2)^2$ was 0.0194 while the variance of AIP value in above 40 aged people $(\boldsymbol{\sigma}_1)^2$ was 0.0523. The statistical F-test was used for hypothesis testing to check whether the variance of two samples were equal or not. In another word, F-testing was done to check whether the test is accepting the null hypothesis or rejecting it.

Table 2: Calculation of F-value between two age groups

Age criteria	**n value**	**Mean value of AIP**	**Squared variance (σ^2)**	**F-value**
Above40 years	30	0.3946	0.0523	2.695
Below40 years	30	0.5175	0.0194	

According to the F-test the calculated value of F was **2.695** [$F=(\boldsymbol{\sigma}_1)^2/(\boldsymbol{\sigma}_2)^2$]; $\boldsymbol{\sigma}_1$ represents the variance of above 40 age people and $\boldsymbol{\sigma}_2$ represents the variance of below 40 age people. Here, Null hypothesis (H_0): $(\boldsymbol{\sigma}_1)^2 = (\boldsymbol{\sigma}_2)^2$ and Alternative hypothesis (H_a): $(\boldsymbol{\sigma}_1)^2 > (\boldsymbol{\sigma}_2)^2$ The tabulated value of F at 5% significance level $f_{0.05\ (29,29)}$ = **1.85.** [Degree of freedom= $\boldsymbol{\nu}_1/\ \boldsymbol{\nu}_2$; $\boldsymbol{\nu}_1 = (n_1\text{-}1)$ & $\boldsymbol{\nu}_2=(n_2\text{-}1)$]

In this hypothesis the calculated F value is greater than the tabulated F value, so null hypothesis (H_0) is rejected as the calculated value exceeds the tabulated value at 5% level of significance (P=0.05). Hence, the result of the research supports the belief that above 40 age group people have greater AIP levels than the people having age below 40 years are more prone to be affected by the cardiovascular diseases.

Discussion

Based on the results, the values we used in this project were collected from Barasat Cancer Research and Welfare Centre, Nandagarh, Kolkata, West Bengal. A total 60 datas from the patients including both male and female were collected from this hospital. The data includes the age and gender of the patients, their residential address, triglycerides level (TG), and high-density lipoprotein level (HDL). Then the datas were filtered and devided into two groups: 50% below 40 age and 50% above 40 years. The age criteria taken for this study was 18 years to 80 years. AIP was determined by applying the established formula AIP= log(TG/HDL) for each group [Joint committee for Guides in Metrology,2008]. After determination of the AIP values the mean value of the AIPs in each group was calculated and from that mean value the standard deviation (S.D) or σ was obtained. Variance or σ^2 means the squared of standard deviation. Then the two variances were divided and F value was calculated. The calculated value of F comes out to be 2.695. Then according to the result, we determine the freedom of degree 29/29 of the whole value. According to the degree of freedom, the tabulated value of F is 1.85, which is much less than the tabulated value of F. In that case, here null hypothesis (H0) is rejected as the calculated value exceeds the tabulated value at 5% level of significance (P=0.05). Hence, the result of the research supports the belief that there is a significant difference in the variance of AIPvalues between two groups. According to the study of Atherogenic Index of Plasma (AIP) plays an important role as tumour marker in cardiovascular diseases. AIP is the most sensitive marker compared with other three atherogenic indices like Castelli's risk index-I (TC/HDL-C), Castelli' s risk index-II (LDL-C/HDL-C), and atherogenic coefficient (TC-HDL-C/HDL-C). The study shows that above 40 age group people have greater AIP levels are more prone to be affected by the cardiovascular diseases than the people having age below 40 years. AIP doesn’t only depend on the TG or HDL level but it also depends on the other parameters like BMI, visceral fat, glucose, systolic, and diastolic blood pressure. According to Flier J S, the abnormalities of blood lipids are related mainly to different dietary habits of people, lifestyle and heredity along with the other factors. Obese people seem to have an adverse pattern of plasma lipoproteins. This is manifested by low concentration of HDL cholesterol, increased LDL cholesterol concentration.Kopelman reported alteration in lipid profile associated with obesity. Dyslipidemia progressively develops with increasing abdominal fatness and body mass index. With elevated LDL concentrations as well as high concentrations of TG coronary heart disease risk rises. [Kopelman,et al 2007]. CJ Ikewuchi reported in their study that atherogenic indices are powerful indicators of the risk of heart diseases, the higher the value the higher the risk of developing cardiovascular disease & vice versa[CJ Ikewuchi,et al 2009]. Even though in this study, there were 11.67% and 86.67% for intermediate risk and high risk of AIP, respectively, the mean age was 45.06. There is a need for this age group to follow-up for especially those who had high and very high body fat percentage.

Conclusion

Our findings showed that increasing in AIP is associated with other cardiovascular diseases; therefore, change in the cardiovascular risk factors affects the AIP index. Based on the present study, by reviewing various articles, it can be concluded that, lifestyle change, performing regular exercise and healthy diet modification is recommended for every individual. In addition, AIP should be used as a regular monitoring index of cardiovascular diseases in every day practice, especially in persons with other cardiovascular risk factors. It is also associated with other major risk factors of heart disease and it is sensitive measure that can be easily calculated especially when other lipid values are within normal range.

AIP was significantly associated with cardiovascular risks after adjusting for the traditional risk factors. Therefore, it may be used as an effective mass screening method to identify patients at a high risk of cardiovascular events. This study has demonstrated that the patients aged above 40 years with higher AIP values having the high risk of developing cardiovascular diseases. Therefore, AIP can be used as a simple, economic and non-invasive marker to identify for Cardiovascular diseases.

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Traditional and Pharmacological Significance of *Datura stramonium.*

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Abstract

India is home of a diverse range of naturally occurring plant medicines with promising therapeutic activities. *Datura Stramonium* is a well-known folk remedy. *D. stramonium*, a problematic shrub with both deadly and therapeutic characteristics, has been shown to have tremendous pharmacological value and is widely used in phototherapy. Alkaloids, tannins, sugars, and proteins have all been discovered in *Datura stromonium*. In the scientific realm of Indian systems of medicine, this plant has contributed diverse pharmacological effects such as anti-asthmatic, antimicrobial, antifungal, antioxidant and analgesic effects. The current research is a one-of-a-kind review of this plant's chemical constituents and therapeutic actions.

Keywords: *Datura stramonium*, Phytochemistry, Traditional knowledge, Pharmacological activity.

Introduction

Thousands of years have passed since plants have been used for food and medicine. Herbal medicinal products and supplements have become extremely prevalent over the years, with currently 80% of people around the world depending on them for some aspect of primary health care.

Datura stramonium, also known as thorn apple or Jimson weed is a plant in the Solanaceae family.The medicinal plant *Datura stramonium* is very significant. It has long been thought to have healing properties all over the world. The leaves and seeds of this plant are used in a variety of medical conditions (Céspedes, Iturriaga, & Hormazábal 2021). Steroids, Glycosides Saponins, Phenols, Flavonoids, Alkaloids, and Tannins, are among the bioactive compounds identified in *Datura stramonium*. Its extracts from the leaves and branches have strong antifungal and antimicrobial properties (Batool, et. al, 2020).

Taxonomical Classification of*D. stramonium*

- Kingdom-Plantae
- Division - Magnoliophyta
- Class - Magnoliopsida
- Order - Solanales
- Family - Solanaceae

- Genus – Datura
- Species – *Datura stramonium* (Mukhtar, Tukur, & Bashir, 2019).

Common Names of *D.Stramonium* in Different Languages

Table-1.Common Names of *Datura stramonium.*

S.N.	Language	Common name
1.	Spanish	Daturamanzana,tapatoloache,estramonio
2.	German	Stechapfel
3.	Hindi	Dhattura,Kalahattura
4.	English	Thorn apple,jimsonweed,false castor oil
5.	Arabic	Banjtatura,nafer,thagher,tatura
6.	Chinese	Man tualuo
7.	Swedish	Violspikklubba
8.	French	Daturastramoine,pommeepineuse

Description and Distribution

D. stramonium is an herbaceous annual that reaches a height of 0.3-1.5 metres (1-5 feet). A single-stemmed plant can cover areas as large as in diameter- 3 m (9.8 ft.). This plant stems are stout and hollow, varieties in colour from green to purplish (Gaire, & Subedi 2013).The leaves of *D. stramonium* are long-petioled, smooth, oblong, dentate, bright green and 20 cm in length. The flowers are large, solitary, light purple and occur at branch bifurcations or at the end of the branch. A long, five-edged tube with a narrow, five-tipped tip makes up the calyx. With a short 5-sectioned border, the corolla is funnel-shaped and folded. There are five free stamens and one superior ovary in this flower. The fruits are densely thorny, 5 cm long, almond-sized and 4-valved envelope. The 3.5 mm long, smooth, reniform, and black seeds are numerous (Al-Snafi, 2017)

Datura stramonium is native to the Americas, but it currently grows in warm areas all over the world, including Asia, Europe, America (South and Central), and Africa.Sand flats, plains and regions up to 2,500 feet above sea level are all great places for the plant to grow. In India's sub-Himalayan tracts, such as the North-West-Himalaya, Mountains of Deccan, Kashmir, Madhya

Pradesh, West Bengal, Bihar, open Forest region of Rajasthan, Tamilnadu, Odisa, and Karnataka, it spreads as a weed in waste places and along the roadside (Soni et. al, 2012).

Traditional Importance of *D. stramonium*

D. stramonium is often used to treat hearing loss, assuage insomnia, and relieve heat on during illness. The herb was discovered in a 4,000-year-old picture, indicating that it was utilised by the Huichol Indians, together with psilocybin, to communicate with the spiritual realm. It's also utilised by the monks of Apollo in Delphi to assist people in their interpretation. *Datura stramonium* is among the greatest cures for hydrophobia, according to an American medical publication, and other medicines have superior results than this plant. Datura and hemp are combined used as cigarettes because they burns quickly. It is used by British military to treat respiratory ailments. It’s used to treat a variety of illnesses, including eye strain, vomiting, and confusion.It is often used as an anaesthetic in the fixation of bones. It is an effective medication in the treatment of asthma. And it is for this reason that the plant's leaves are used in a cigarettes or pipe.The Gujjar community in India uses the herb in a variety of ethnomedical treatments. It was taken by Ethiopian students to improve their brain and make their minds more sensitive to leaning.In Europe, the herb is also used in lotion as a witchcraft. Its seeds are used to make beer in many European nations. The plant is used in quasi practices by many Mexican tribes such as the Seri and Opata.In China, the flowering Datura plant is referred to as Yangjinhua, and it is used to treat a variety of ailments including asthma, discomfort, rheumatic, and epilepsy.In the Kashmir valley, the oil derived by grinding the leaves of *D. stramonium* is being used for skin illnesses, migraines, and dandruff, while the stalks and stems are eaten for dental and respiratory illnesses.

Phytochemistry

D. stramonium has a greater concentration of major alkaloids such as hyoscymine and scopolamine, and even some minor alkaloids. All part of the plant has the potential to be poisonous as well as healing; leaves, seed, fruit, bark, stem, root, and seed coat with the active substances expressed therapeutic effects. Because of its bioactive constituents, the plant has a strong annoying and pharmacological effects (Singh & Singh 2013).

The alkaloids atropine and scopolamine are the leading bioactive compounds in *D. stramonium.* The vegetative and generative phases of leaves and capsules, respectively, constitute the highest concentrations of alkaloid.

Alkaloids were found in higher concentrations in the younger parts of plants than in the older parts. In the generative process, the alkaloid content of leaves rapidly decreased.Scopolamine concentrations in roots were minimum (0.013 percent) during the vegetative period, then completely vanished during the generative period. Atropine is found in roots during both the vegetative (0.045%) and generative (0.056%) phases. In both levels, stems were high in atropine (0.070 percent) but low in scopolamine (0.023 percent) (Al-Snafi, 2017 & Ghani 1998).

Table.2: Bioactive compounds of DATURA STRAMONIUM and their activities.

S. No.	Compounds	Plant Part	Activities
1.	Daturanolone	Fruit and Seed	Anti-inflammatory, Muscle relaxant, Hepatoprotective, Analgesic, Antipyretic
2.	Daturadiol	Fruit and Leaves	Antidepressant, Muscle relaxant
3.	Hyoscine	leaves, Root and Seeds	Parkinson’s disease treatment, Antihelmenthic, Intoxicant, Antiasthmatic
4.	Norhyoscine	Roots	Muscle relaxation, Against stomach cramp
5.	Atropine	Seed and leaves	Anti-inflammatory, CNS depressant, Antispasmodic
6.	Hyoscimine	Whole plant	Muscle relaxation, Anticancer
7.	Hyoscyamine	Whole plant	Immunosuppressive, Anticancer
8.	Alkaloid datumetine	Leaves	Antispasmodic drug
9.	Withametelins	Flower	Cytotoxic, Anticancer, Ant-inflammatory, Antistress
10.	Withanolides	Flower	Cytotoxicity, Psoriasis treatment, Anticancer

			Immunosuppressive
11.	Baimantuoluoline A	Flower	Psoriasis exhibiting activity, immunosuppressive
12.	Beta- sitosterol	Fruit	Anticancer, anti-proliferative
13.	Fastusic acid	Seeds	Skin treatment, Analgesic
14.	Meteloidine	Flower	Chemo and Radio protection
15.	Atropinesterase	Whole plant	Gastrointestinal Secretion and Motility action
16.	3alpha,6beta-DITIGLOYLOXYTROPANE	Plant	Neuropsychiatric disorder treatment
17.	4-hydroxylubimin	Leaves	Anticancer, Antimicrobial
18.	Hygrin	Flower and Roots	Antimicrobial, Cytotoxicity
19.	1, 10-seco-withametelin B	Leaves and Flowers	Cytotoxicity
20.	2-(3,4-dimethyl-2,5- dihydro-1H-pyrrol-2-yl)-1- methylethyl pentanoate	Plant	Antimicrobial-Antifungal

Pharmacological activitities

Analgesic activity

Seed extract of *Datura stramonium* provides analgesic activity both in chronic and acute situations, according to hot plate and formalin tests. This action was most likely caused by the alkaloids in *D. stramonium* extract reacting with the opioid and muscarinic systems. Opioid receptors play a crucial role in pain alleviation (Grace, & Saleh, 1996).It's also worth highlighting the large difference between ED50 and LD50. The extract lowered pain regular dose in hot plate and formalin testing, with ED50 values of 25 and 50 mg/kg, respectively. Animals treated with *D. stramonium* seed extracts experienced significantly less immediate and chronic distress from formalin and hot plate testing (Sarangi, Ahmed, & Ghose, 2018).

Antioxidant activity:

The inhibition of lipid peroxidation technique was used to test the antioxidant function of *Datura stramonium*. The alkaloid content of the extracts ranged between 24.6 and 63.3 mg g-1. The flavonoid content of the *Datura stramonium* methalonic extract ranged between 23.15 and 63.3 mg g-1. Flavonoids are a class of polyphenic substances that have been shown to have activities such as anti-inflammatory activity, inhibition of hydrolytic oxidative enzymes, and free radical scavenging. Alkaloids and flavonoids have long been known to have antioxidant properties, and their effect on human health and medical care is significant (Bawazeer, Rauf, & Bawazeer, 2020).

Antifungal activity:

Many medicinal plants, when combined with *D. stramonium*, have antifungal properties (Grace, & Saleh, 1996). Brewed or boiled mixtures of *Azadirachat indica* (Neem), *Calotropis gigantean*, *Datura stramonium*, and cow fertilizer with methanol & water decoction (70/30 vv) of *Azadirachta indica* (Neem), *Calotropis gigantean*, and *D. stramonium* alongside fungi *Fusarium mangiferae* have an effective antifungal effect (Monira, & Munan, 2012).

Anti-Asthmatic activity:

*D. stramonium*cigratte was a strong bronchodilator for asthmatic patients with moderate airway obstruction (Kocor et. al, 1973). Atropine, scopolamine, and hyoscymine are among the phytochemicals found in the *D. stramonium* plant. Scopolamine and atropine have anticholinergic properties and are responsible for blocking the M2 receptor in submucosal gland cells and airway smooth muscles, when pregnant women were given *D. stramonium* for asthma care, the constant release of acetylcholine caused the nicotinic receptor to desensitise, resulting in foetal damage (Akbar, 2020).

Antibacterial activity

In a dose-dependent manner, *D. stramonium* extract of aerial parts in methanolshowed anti-bacterial activity against Gram's-positive bacteria. Antibacterial activity was found to be minimal or non-existent against *Escherichia coli* and *Pseudomonas aeruginosa*(Miraldi, 2001).Standard procedures were used to establish the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC). The results of the MIC and MBC tests range from 6.25 to 12.5 mg/ml.*D. stramonium*chloroform extract, has the highest antibacterial activity against *S. aureus*(ATCC 25923), whereas it has the lowest antibacterial activity against an E. coli clinical isolate (acetone extract).When compared to the other solvents employed for extraction, chloroform extracts demonstrated the highest zone of inhibition against majority of the harmful bacterial strains examined.*Vibreocholerae* and *Vibreo parahaemolyticus* strains were particularly susceptible to *D. Stramonium* as a vibriocidal. The MIC of acetone extracts of *D. stramonium* as broad-spectrum vibriocidal agents was found to be in the range of 2.5 to 15 mg/mL (Siddiqui et. al, 1986).

Anticancer activity

Human cancer cells originating from breast (MDA-MB231), head and neck (FaDu), and lung (A549) cell lines were subjected to *D. stramonium* aqueous leaf extract for 24 and 48 hours, and clonogenic cell survival as well as oxidative stress indicators were measured.Following 24 hours of exposure to the extract, MDA-MB231 and FaDu cells dramatically increased (p0.05) clonogenic cell death. A549 cells, on the other hand, were found to be resistant to cell death caused by exposure to the extract for 24 hours.During 24 hours of *D. stramonium* aqueous leaf extract treatment, MDA-MB231 showed 40% cell death, while FaDu showed 65% cell death.With some variability (p0.05), all cancer cell lines were responsive to cell death produced by *D. stramonium* aqueous leaf extract exposure after 48 hours.During 48 hours of *D. stramonium* aqueous leaf extract exposure, MDA-MB231 showed 61 percent cell death, FaDu showed 63 percent cell death, and A549 showed 22 percent cell death(Mir et. al, 2019 & Baig et. al, 2020)

Insecticidal activity

Applying ethanol solutions both from seed and leaf of *D. stramonium*, adults two spots spider mites (*Tetranychusurticae Koch*) (*Acari: Tetranychidae*) were examined in the lab for acaricidal, repellant, and larval deterrent properties. Adult spider mites were killed by leaf and seed extracts at doses of 167,250 mg/L and 145,750 mg/L after 48 hours, respectively(using the Petri leaf disc-spray tower method)(Baig et. al, 2020) .The mosquito defensive and larvicidal characteristics of ethanolic extracts of *D. stramonium* leaves were examined against *Aedes aegypti*, *Anopheles stephensi*, and *Culex quinquefasciatus*, respectively. Lethal Dose 50 (LD50) levels of *A. aegypti*86.25, *A. stephensi*-16.07,and *C. quinquefasciatus*- 6.25. The ethanolic extract of *D. stramonium* leaves provided total residence time (Mosquito repellency) of 2.73, 71.66, and 117.7 minutes against all these species at a dosage of one percent (Dharmagadda et. al, 2005).

Epilepsy

Although *D. stramonium* has not been proved to have antiepileptic activity, it was demonstrated to protect against status epilepticus if used with other medicinal plants (Gaire, & Subedi, 2013).During a practice, male rats were fed a herbal mixture containing *D. stramonium* .The rats were given a single systemic injection of lithium (3 mmol/kg) and pilocarpine (30 g/kg) to induce status epilepticus. *G. sempervirens* (Gelsemium), *S. lateriflora* (Skullcap), and *D. stramonium* extracts were given to the rats. Herbs complemented with Jimson Weed for a week after induction of status epilepticus showed no seizure during diagnosis. *D. Stramonium* may be useful as a complement to other epilepsy medications (Peredery, & Persinger 2004).

Anti-Inflammatory activity

In rats, an ethanolic extract of *D. stramonium* leaf demonstrated considerable anti-inflammatory efficacy when used to treat carrageenan-induced paw edoema.After 3 hours of oral administration of 200 mg/kg extracts, there was a 39.43 percent reduction in edoema in one experiment.When the extract was given in three-hour intervals, the highest level of activity was found.Because the extract of *Datura stramonium* prevented carrageenan-induced edoema in the first phase, which involves the release of serotonin and histamine, the inhibitory action of the extracts could be attributed in part to suppression of mast cell mediator release(Bawazeer, Rauf, & Bawazeer, 2020).

Organophosphate poisoning

D. stramonium is a therapeutic for the cholinergic symptoms of organophosphate (OP) toxicity because it contains atropine and other anticholinergic chemicals.*D. stramonium* seeds were boiled in water to make a 2 mg/mL atropine solution, which was given to male rats as a single intraperitoneal injection 5 minutes before receiving a subcutaneous injection of 25 mg/kg dichlorvos. In a rat model of severe OP poisoning, pretreatment with Datura seed extracts greatly enhanced survival (Bania et. al, 2004).

Toxicity and Side effects

The plant's extracts are potentially hazardous, and inadvertent consumption can induce agitation and death. The hallucinogenic qualities of *Datura stramonium* have been described since the beginning of time (Chandan et. al,2020).Atropine (dl-hyoscyamine) and scopolamine (i-hyoscine) are tropane alkaloids (Monira, & Munan, 2012). Atropine and scopolamine are neurological depressants that work by affecting dopamine transporters sites (Smahi, & Noufel, 2020).There have been numerous reports of people attempting suicide by ingesting or chewing Datura. Due to the extreme presence of harmful tropane alkaloids, it is a particularly toxic plant.Soldiers in the area of Jamestown (Virginia) ate this herb in salad in 1676 and caused the death of the plant's toxicity, earning the plant the term Jimson weed.The herb has a highly bitter flavour, and animals don't consume it very often. However, if food resources are scarce, horses, cattle,goats and sheep will eat it and become poisoned. In fatal cases, the body temperature rises to dangerously high levels, which can lead to unconsciousness and eventually death. Anxiousness, tremors, tenesmos, excitability, rumen atony, anorexia, bloating and even mortality in the most severe cases are all signs of toxicity. Cattle, humans, horses, sheep, pigs, mules, and chickens are all poisoned by the plant. The medical uses of *D. stramonium* are limited. Humans eat Datura seeds on a regular basis, whether by accident or on purpose.

Conclusion

This quick analysis covers the phyto-chemistry and pharmacology of *Datura stramonium.* More activity testing and structural relationship studies are needed to better understand its multiple applications. The information presented in this review chapter will aid in the promotion of research aimed at the discovery and development of new agents for medical and agricultural applications based on natural products derived from plants.

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Role of Microbes in Sustainable Development Goals (SDGs)

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Introduction

Microbes are defined as single-celled organisms that are invisible to the naked eye.The term “microbes” is used to describe several different life forms with different sizes and characteristics. It includes bacteria, archaea, algae, fungi, protozoa, and viruses. **Microbiology**, the field is concerned with the study of microorganisms, their structure, function, and their classification. Microbes know no borders, and are adept at adapting, surviving and thriving in extreme and constantly changing environments. While a fraction of microbes is pathogenic, the majority are beneficial or neutral and essential for life. ASM leadership hosted a virtual panel during the United Nations General Assembly (UNGA) Science Summit discussing the role and contribution of science to the attainment of the United Nations Sustainable Development Goals (SDGs). The SDGs include 17 interconnecting global objectives identified by the UN as a "blueprint to achieve a better and more sustainable future for all" by 2030. This chapter discuss about, how the microbes contribute as a sustainable resource towards the sustainable development goals. Microbiology, the scientific discipline of microbes, their effects and practical uses has insightful influence on our day-to-day living. We present how microbiology and microbiologists could increase the scorecard and accelerate these global goals. Microbiology has a direct link to achieving SDGs addressing food security, health and wellbeing, clean energy, environmental degradation and climate change. A non-classical growing relationship exists between microbiology and other SDGs such as peace, justice, gender equality, decent work and economic growth. The pledge of ‘Leave No One Behind’ will fast track progress and microbiology is in a better position to make this work.

Zero Hunger

Agriculture is the backbone of mostly all developing economies, contributing to the whole economy of such nations and determining the general standard of life to a greater extent of 50% and so of the population. Soil productivity is a significant factor for success of agricultural production rather than soil fertility. Status of nutrients existing in the soil and its physical ability determines the fecundity of soil. The intensive agricultural technologies, which ensured a "green revolution" in the middle of the twentieth century, had an unpredictably high biological expenditure, contributing to worldwide pollution, bad climate change, and loss of biodiversity.

Microbes are integral in food production. Some soil microbes aid in plant growth via their role in soil protection and fertilization, while others are destroyers of food (spoilage), crops and livestock, and still others are direct producers of food through **fermentation**. Microbes play roles in agriculture and food production that can impact crop health and potentially increase yield to help feed a growing global population, yet we must also be cautious of the large energy and environmental inputs required by many agricultural practices. To achieve changes, researchers need to obtain scientific knowledge to promote the activities of microbes in the soil to reduce the use of energy intensive chemicals like fertilizer; utilize microbes to help plants restore soil carbon; increase carbon storage by microbes on land and water; an the major goals for food and agricultural research include: 1.) improving the efficiency of food and agricultural systems; 2) increasing the sustainability of agriculture; and 3) increasing the resiliency of agricultural systems to adapt to rapid changes and extreme conditions.

Those goals derive from key research challenges identified by the community, which include the following: • increasing nutrient use efficiency in crop production systems; • reducing soil loss and degradation; • mobilizing genetic diversity for crop improvement; • optimizing water use in agriculture; • improving food animal genetics; • developing precision livestock production systems; • early and rapid detecting and prevention of plant and animal diseases; • early and rapid detection of foodborne pathogens; and • reducing food loss and waste throughout the supply chain,and engineer microbes to reduce the negative impacts of agricultural inputs.

Bio-fertilizer

Plants nutrients are essential for the production of crops and healthy food for the world's ever increasing population. Soil management strategies today are mainly dependent on inorganic chemical-based fertilizers, which cause a serious threat to human health and the environment. Bio-fertilizer has been identified as an alternative for increasing soil fertility and crop production in sustainable farming. The exploitation of beneficial microbes as bio-fertilizers has become of paramount importance in agricultural sector due to their potential role in food safety and sustainable crop production. Bio-fertilizer can be an important component of integrated nutrients management. Microorganisms that are commonly used as bio-fertilizer components include;

1. Nitrogen fixers
2. Potassium and Phosphorus solubilizers,
3. Growth promoting rhizobacteria (PGPRs),
4. Endo and Ecto mycorrhizal fungi,
5. Cyanobacteria and other useful microscopic organisms.

The use of bio-fertilizers leads to improved nutrients and water uptake, plant growth and plant tolerance to abiotic and biotic factors. These potential biological fertilizers would play a key role in productivity and sustainability of soil and also in protecting the environment as eco-friendly and cost effective inputs for the farmers.

Health and Wellbeing

As seen with the ongoing pandemic, infectious diseases caused by viruses, bacteria, fungi and other microbes continue to plague humanity. Those living in countries with limited resources and limited access to medical care suffer the most from neglected tropical diseases like malaria and Ebola. On the other hand, a third of the drugs we use, including numerous antibiotics (penicillin), cholesterol lowering and anticancer drugs, are made by microbes. Microbes are also factories for new drugs made by recombinant DNA technology and the source of proteins used in vaccines and numerous therapies. Gut microbes are key components of health as they assist in food digestion and are even responsible for the production of some of the vitamins that are essential for our health.The European Union sponsored '*My New Gut'* project, which ended in 2018, provided scientific evidences that gut microbiota influences metabolic health. How microbiology products such as probiotics support good health is attracting the attention of the general population. Bacterial-mediated therapy has been reported to increase specificity and improve the outcome of cancer and tumourtherapy. The understanding that microbes underpin health and diseases of communicable and non-communicable origin gives further tasks to microbiologists in addressing SDG.

Role of Microbes in Industries

Microbes are essential for many industries, especiall in Food industries andPharmaceutical industries.

Food industries

Different useful species of bacteria are used for synthesis of compounds such as lactic acid bacteria (LAB) are used to produce cheese, yoghurt, kefir and kimchi. These bacteria are involved so much to other food products. The budding yeast Saccharomyces is used to make bread, beer, cider and wine. Acetic acid bacteria (AAB) are used in traditional manufacturing of vinegar. These bacteria playing significant role in food products, cosmetics at low cost and high rate of production.Food quality is important, but safety is also a matter of equal concerns:

- Recently a microchip has been designed and fabricated for detection and identification of food pathogens.

- PCR based method for detection of adulteration in turmeric and Chilli powder has been developed.

Other areas of research where microbes contribute in producing healthy and nutritious foods e.g. algal and fungal protein. *Spirulina*, button and oyster mushrooms are already cultivated on large scale. Other beneficial mushrooms; *Lentinulaedodes* (Shiitake), *Calocybeindica* (Milk mushroom), *Cordycepssinensis* (Insect mushroom, Kirajali), which are pharmaceutically more desirable but their cultivation needs more R&D. Recently in our country a protocol has been developed for *L.edodes* cultivation using rice straw as substrate.

Pharmaceutical industries

Bacteria are used to create multiple antibiotics such as streptomycin from the bacteria streptococcus. Another important role in pharmaceuticals is the use of microbes for the medically important studies, such as bacteriorhodopsin. *Escherichia coli* is used for commercial preparation of riboflavin and vitamin K. *E. coli* is also used to produce D-amino acids such as D-p-hydroxyphenylglycine, an important intermediate for synthesis of the antibiotic amoxicillin.

Escherichia coli are used for commercial preparation of riboflavin and vitamin K. These are involved in nutritional supplementation used to treat the deficiency of different diseases either due to vitamins and minerals which are required for proper growth in small quantities and regulate the body processes.

This bacterial also lives in intestine of human when it active, it damages the digestive tract and causes the diarrhea and other problems associated with digestive system. E.coli as useful for manufacturing of chemical compounds while on the other hand also causes problems.

Microbes are also used in pharmaceutical industries for synthesis of chemical drugs, chemical compounds and other compounds. It also leads to discovery of cell mechanisms allows pharmacists to discover antimicrobial drugs that would prevent an escalating number of communicable diseases. It also insures the drug therapies target the opportunistic microbes without harming its human host. Bacteria also playing important role in manufacturing of different hormones thus helpful to control the lethal diseases. The most important principle used for preparation of hormones using is the genetic engineering. Bacterial cells are transformed and used in production of commercially important products. Examples include production of human insulin that is used to treat diabetes and human growth hormone also called somatotrophin used to treat pituitary dwarfism.

Medically important microbes showing agonist as well as antagonist interactions when they enter into enter into the human body. Sometime they provide benefit while on the other hand, they have different harmful effects. Different microorganisms found in the human oral cavity are called as the oral microflora, oral microbiota or oral microbiome. The oral microbiome includes the species of actinobacteria, bacteroidetes, chlamydiae, chloroflexi, euryarchaeota, firmicutes, fusobacteria, proteobacteria, spirochaetes, streptococcus, synergistetes and tenericutes. For example, interaction between Streptococcus gordonii and Actinomyces naeslundii are both agonist and antagonist in nature. Both these microbes are involved in biofilm production.

Clean Water and Sanitation

Bacteria and drinking water are not two things that usually go together very well, but according to a new study, certain species of microbes may help remove trace minerals such as zinc, selenium and even arsenic from your drinking water in the future. The water is the main route and source to intake the zinc directly. If they found zinc in excessive amount of the permissible levels according to procedures of drinking water given by WHO, USEPA. Several deaths due to high concentration of zinc toxicity to human. There is a need of solid waste management in major human settlements so that dangerous chemicals are not pollute the water bodies.Using x-ray experiments, the researchers discovered that the bacteria formed mineral deposits from the water that surrounds them, binding them in the form of tiny spheres. In this particular case, the bacteria bound zinc and sulfate, and they did it so effectively that the zinc concentration in the spheres became a million times higher than that in the surrounding water. Indeed, the spheres consisted almost entirely of zinc sulfide. This ability makes the tiny life-forms potentially very useful in the process of water treatment. They could be used to remove zinc, selenium and even arsenic traces from contaminated water, as in the mining tunnel, or even from drinking water supplies.

Microbes can reduce pollution in water and thus improve water quality. some microorganisms have a beneficial impact on our water sources such as those that can break down oil or other dangerous toxins.

Bioremediation

Bioremediation using bacterial species can include using Pseudomonas species which are potent bacteria that are capable of degrading hydrocarbons from petrol and diesel, thereby reducing the impact of oil spills. Pseudomonas alcaligenes is capable of breaking down polycyclic aromatic hydrocarbons while Pseudomonas mendocina and Pseudomonas putida can remove toluene. Pseudomonas veronii can degrade large number of aromatic organic compounds. These oil-based compounds are eaten up by the bacteria as they utilize them as substrates for carrying out metabolism. These microorganisms occur in abundance in water bodies and soil and are effective in cleansing oil spills.

Innovation and Infrastructure

As discussed, there is tremendous benefit to harnessing the power of microbes to convert renewable resources into electricity, fuels and chemicals. Advances in genomics have paved the way for a “green bioeconomy” based on these abilities. Deploying microbes for a green bioeconomy will require advances in genomics, systems and synthetic biology, computational sciences, machine learning and tech analysis. Such a future may increase productivity and quality of products from agriculture and spawn a circular economy that recycles abundant materials.

Affordable clean energy

Energy as a dominant contributor to climate change needs to be reversed. In total, 3 billion people still depend on unsustainable sources – wood, coal, charcoal or animal waste for cooking or heating. Increasing the share of renewable energy in the global mix is one of the targets that appeal to microbiology most. Only 17.5% of total final energy consumption comes from renewable energy. Waste and agricultural substrates such as rice bran, rice paddy and microbes have been employed in the production of third-generation bio-fuel such as bio-ethanol, bio-diesel, bio-gases and bio-electricity. Exoelectrogens, micro-organisms with the ability to transfer electrons extracellularly, are being researched in the development of microbial fuel cells (MFCs). MFCs are a bio-electrochemical system that holds potential in the production of sustainable energy. MFC borders around employing microbial catabolic activity directly to generate electricity from degraded organic matter. Because of the low-energy output with MFCs from a single microbe, a cocktail of microbes is used for producing higher-voltage-output.Shewanella strains, the best studied electrogens are currently being explored in bio-electricity, including powering a future NASA space mission.

Climate Action

Microbes, the 'unseen majority' play a role in climate change notwithstanding – microbes in climate-change response. The consensus statement published by 34 microbiologists across nine countries warned that micro-organisms play a central role and of global importance in the biology of climate change. Microbes play key roles in the generation of some greenhouse gases as well as in carbon sequestration. The American Academy of Microbiology is making the role of microbes in climate change a major focus of its efforts. The Earth's soil is the largest terrestrial reservoir of carbon, containing 3 times the amount of carbon that is in the entire atmosphere and 4 times as much as all the vegetation on Earth. Agricultural practices can build soil carbon, which has 2 important outcomes: carbon enriches and stabilizes soil making it more suitable for crop production and is sequestered from the environment where it would otherwise end up polluting the atmosphere as greenhouse gases. Investment in microbial systems can lower greenhouse gas emissions and renewable resources into low-carbon and low-cost electricity, fuels, chemicals and materials.

Climate change is one of the key issues that frequently affects the root activity, photosynthesis, functioning, and general morphology of the plant specimens plus their interactions. Alteration in the type of weather not only affects the prospective crop yield, but it may also alter the activities of pests and pathogens (Bhattacharyya et al. 2016). The microbial world is the major unexplored pool of biodiversity on earth. Bacteria, fungi, algae, protozoa, actinomycetes, and the infectious agents such as viruses are the things within the enormous resources of activities of microbial diversity (Andreote et al. 2014)

Life on Landand Life in Water

Microbes are critical contributors to both the health and disease of ecosystems and thus are essential components for life below water and on land. One gram of soil contains as many bacteria as there are people on Earth. Soil bacteria promote the health of our crops by increasing drought tolerance, protecting plants from disease and providing nutrients necessary for growth. Attention to the microbial sciences can help to stop land degradation and the loss of biodiversity in water, soil, land and air.

Forest loss is slowing down, and more financial assistance is flowing towards bio-diversity, however bio-diversity is still occurring at an alarming rate. More so, about 74% of the poor are directly affected by land degradation, and 23 hectares is lost every minute due to drought and desertification (UN, 2019). On bio-diversity, the United Nations recognized that micro-organisms and invertebrates are key to ecosystem services, but their contributions are still poorly understood and rarely acknowledged (UN, 2019). The world's forests are built by symbiotic relationship between trees and micro-organisms. The kinds of dominant root-associated microbial symbionts (fungi and bacteria) in a forest will determine access to nutrients, sequester carbon, and resilience in the face of climate change.

Ocean and sea cover 70% of our planet and we rely on them for energy, food and water. However, these precious resources have been damaged by humans. Microbiology as a discipline that has lots of interaction with seas and oceans can reduce marine pollution, protect and restore the ecosystem, reduce ocean acidification, increase the economic benefits from sustainable use of marine resources – aquaculture and increase scientific knowledge for ocean health. The ocean absorbed about 30% of the anthropogenic CO2, and this result to ocean acidification. Ocean acidification will impact on the growth, development, calcification, survival and abundance of a range of species, from algae to fish. Acidification is adding pressure on global food security as sustainable fisheries and aquaculture will be difficult to attain under this acidic condition. Coral-reef degradation could be mitigated by manipulation of coral-associated prokaryotes. For instance, specific taxa that can degrade oil can by inoculated, conferring health to corals and better water quality.

Aqua Culturing

With the rapid growth of aquaculture industry, the requirement of aquaculture feeds has also increased. In fact, the availability of ingredients for aquaculture feeds has become limited in the aquaculture industry. Furthermore, the increase in traditional fish meal production may increase economic and environmental concerns. Thus, alternative feed sources are needed and this has attracted great efforts in both research and applications; among this, micro-organisms are considered as promising candidates for aquaculture feed. In contrast, some beneficial bacteria can provide micronutrients such as vitamins, fatty acids and essential amino acids in addition to macronutrients to support the healthy growth of aquatic animals. In addition, bacteria may also regulate the host digestion process by producing extracellular enzymes.

Computational biology and bioinformatics

Computational biology and bioinformatics is an interdisciplinary field that develops and applies computational methods to analyse large collections of biological data, such as genetic sequences, cell populations or protein samples, to make new predictions or discover new biology.

Bioinformatics: Research, development, or application of computational tools and approaches for expanding the use of biological, medical, behavioral or health data, including those to acquire, store, organize, archive, analyze, or visualize such data.

Computational genomics is the study of the genomes of cells and organisms. The Human Genome Project is one example of computational genomics. This project looks to sequence the entire human genome into a set of data. Once fully implemented, this could allow for doctors to analyze the genome of an individual patient. This opens the possibility of personalized medicine, prescribing treatments based on an individual's pre-existing genetic patterns. Researchers are looking to sequence the genomes of animals, plants, bacteria, and all other types of life.

One of the main ways that genomes are compared is by sequence homology. Homology is the study of biological structures and nucleotide sequences in different organisms that come from a common ancestor. Research suggests that between 80 and 90% of genes in newly sequenced prokaryotic genomes can be identified this way.

Conclusion

Majority of the biomass and biodiversity of life on the earth are accounted by microbes, and so far about 10% of the earth’s microbial diversity has been characterized. They play a significant role in biogeochemical cycles and extend various ecosystem services. Many microorganisms are rich and serve as untapped reservoirs of metabolic products and, hence, they are potentially important for scientific, industrial and economic purposes. The uninterrupted availability of such microbes for modern scientific security and their ultimate utilization for academia and industry are of paramount importance. Despite countless facts about the role of microorganisms in the biosphere, they have largely been ignored by conservation efforts and never considered part of conservation biology and thus leave number of questions unanswered. Notwithstanding, there are many factors including climate change and habitat destruction affect microbial structure and diversity calls for a consistent environmental ethics for parallel support and protection of microbes and their long-term conservation. It is needless to mention that microbial resources play important roles in developing bio-economy. However, long-term success in conservation strategies requires thorough understanding of basic biology of microorganisms and their application through state-of-the-art modern tools leading to longer viability and unaltered genome of microbes. In this regard, specialized training and laboratory infrastructures are required to be extendedfor significant contributions in protection and successful conservation of microbial gene pool in repositories and natural habitats. Therefore, conservation biologists now are bound to realize that the microbial system on which our livelihoods depend is at a risk of extinction, and this requires serious attention to ensure their sustainability in nature for continuous biogeochemical processes, diversity and abundance. In this way, we are becoming more concerned with the broader aspects of microbial conservation.

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Phycocyanin: A Potential Functional Food and Potential Therapeutic Application

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Abstract

Major health issues seen globally include cancer and other conditions like diabetes, autoimmune illnesses, and inflammation. To improve public health, it is therefore imperative to find a therapeutic target molecule for the treatment of these illnesses. Along with other algal species, cyanobacterial species are occasionally systematized in C-Phycocyanin (C-PC), an essential pigment that yields light. In addition to having many uses in the biotechnology and pharmaceutical industries, it also offers anti-inflammatory, anti-cancer, antioxidant, and increased immune system qualities, as well as liver and kidney protective capabilities. One possible molecular mode of action for C-PC's anticancer efficacy is to inhibit the advancement of the cell cycle, which in turn causes apoptosis and autophagy in cancer cells.

Introduction

With its high efficiency and low toxicity, phycocyanin extracted from marine creatures can be utilized as a functional food. Phycocyanin has been discovered to possess pharmacological benefits that protect the liver and kidneys, as well as anti-oxidative, anti-inflammatory, anti-cancer, and immune-enhancing properties. As a result, phycocyanin has seen significant advancement and use as a possible medication, and it is currently a hot topic in the field of drug research. This book chapter gives a detailed review of how phycocyanin is used for pharmacological actions.

Phycocyanin:

Natural goods have gained importance in the chemical prevention and treatment of illnesses in recent decades. Marine natural compounds have strong anti-cancer properties and few harmful side effects, leading to increased production and use of marine natural products. One of the most significant sources of innovative lead compounds for serious illnesses is phytocyanin, extracted and refined from seaweeds. Phycocyanin, a deep blue color found in various species like Aphanizomenon sp., Spirulina sp., Phormidium sp., Lyngbya sp., Synechocystis sp., and Synechococcus sp., belongs to the phycobiliprotein (PBP) family and can be categorized into three categories: phycoerythrin, phycocyanin, and allophycocyanin. Phycocyanin is a photosynthetic assistant protein that efficiently captures light energy. It is part of the phycobilisome, a supramolecular protein complex that collects and transmits light energy in photosynthesis. Phycobiliprotein acts as an antenna molecule in algae photosynthesis, efficiently delivering light to chlorophyll-containing reaction centers.

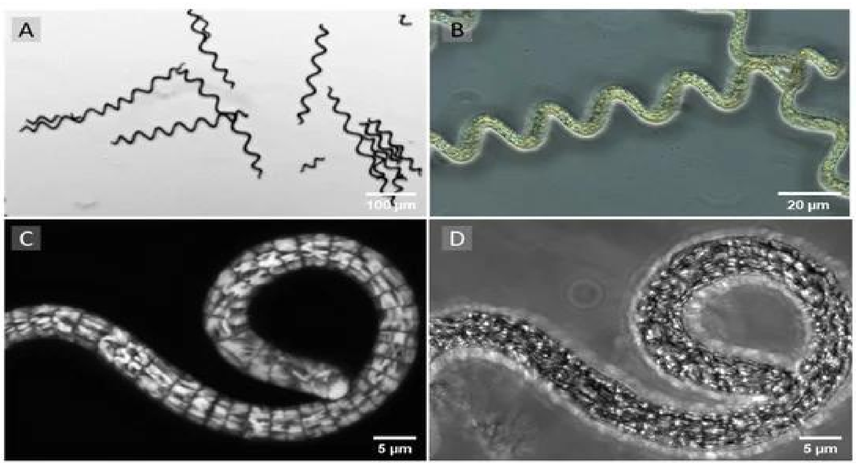

Figure 1. (A, B) Representative phase contrast images of unfixed *Arthrospira platensis* (*AP*). (C) Orthogonal projection of a three-dimensional laser scanning microscopy image stack (47 single images) of *AP*. Label-free laser scanning microscopy of an unfixed sample. The sample was exited at a 555 nm wavelength. Emissions were detected between 650 nm and 700 nm. (D) Transmitted mode image of the same position. Images were taken at 100-fold primary magnification with an axio observer. Z1/7 (Carl Zeiss Microscopy, Jena, Germany).

Phycocyanin in the treatment of cancer: `

Phycocyanin is known for its anti-tumor activity, anti-proliferation, and pro-apoptotic effects on various cancer cell lines in vitro. It has been demonstrated to be bioactive in several cancer types, including lung, ovarian, colon, prostate, histiocytic tumor, and breast cancer. Lung cancer, a common health threat, is divided into small cell lung cancer (SCLC) and non-small cell lung cancer (NSCLC), which account for over 85% of all lung carcinoma cases.

Several studies have reported the inhibiting effect of phycocyanin on NSCLC, including Li et al.'s finding that phycocyanin could inhibit the growth of NSCLC A549 cells in vivo and in vitro and a synergistic anti-tumor effect with all-trans retinoic acid. However, the anti-lung cancer mechanism of phycocyanin remains unclear. This study investigated the growth inhibitory effects and underlying mechanism of phycocyanin in three human NSCLC cell lines, NCI-H1299, LTEP-A2, and NCI-H460. The results provide a theoretical foundation for the treatment of NSCLC and the development and utilization of phycocyanin. Phycocyanin is also found to cross the blood-brain barrier, serving as an essential therapy to treat brain tumors.

Antioxidant properties of phycocyanin:

Phycocyanin, a compound found in plants, has been shown to have antioxidant properties. It can help prevent oxidative stress, which is linked to various health issues such as atherosclerosis, NASH, and aging. Phycocyanin can also help in displacing fluoride, facilitating antioxidant formation, and reversing sodium fluoride-induced thyroid changes. Studies have shown that supplementing with Phycocyanin can improve antioxidant status in both vivo and in vitro. For instance, a daily supplement of 8 grams of Phycocyanin (SP) can significantly decrease plasma levels of MDA, a biomarker of oxidative stress, in diabetic patients and healthy elderly Korean subjects. Phycocyanin also inhibits the production of alkoxyl radicals, prevents DNA damage, and scavenges hydroxyl and peroxyl radicals. It can also protect against cupric chloride-induced lipid oxidation in human plasma samples. Phycocyanin may also inhibit atherosclerosis by activating heme oxygenase-1.

Anti-diabetic property of phycocyanin:

Phycocyanin (PC) can block the α-amylase and α-glucosidase enzymes, which may help treat type-2 diabetes. Studies on the molecular interactions between PC and these enzymes are, however, uncommon. According to this study, PC inhibits these enzymes by attaching itself to the active site and interfering with the binding of substrate to the enzyme. PC is a promising candidate for natural medicinal compounds with antidiabetic properties since it is essential in establishing the connection within the cavity of active sites. According to in vitro inhibitory activity studies, PC inhibited human salivary amylase at a rate of 51.13% on average. Tests for storage stability revealed that PC when utilized as functional molecules, can maintain bioactivity. This study could help understand the molecular mechanisms of PC's interaction with carbohydrate-metabolism enzymes and contribute to its full use as an antidiabetic drug or therapeutic agent. Further confirmation on diabetic subjects is essential for providing potential therapeutic benefits.

Use of c-phycocyanin combined with other drugs:

● **Combination with Piroxicam:** A classic nonsteroidal anti-inflammatory medication used to treat rheumatism and rheumatoid arthritis is piroxicam. When piroxicam and C-PC are combined, they can prevent tumor progression in rat colon carcinogenesis caused by 1,2-dimethylhydrazine dihydrochloride. This combination also increases tumor inhibition rate when compared to single drug treatment and decreases drug toxicity and side effects.

● **Combination with All-Trans Retinoic Acid (ATRA):** In addition to inducing tumor cell differentiation and apoptosis, ATRA is frequently utilized to treat skin conditions. Li et al. looked into the anticancer effects of C-PC and ATRA on A549 lung cancer cells both in vitro and in vivo. Their findings demonstrated that the combination was superior to the use of a single medication, that ATRA dosage was significantly lowered, and that there were no overtly harmful side effects.

● **Combination with Topotecan (TPT):** Topoisomerase I inhibitors, such as TPT, are effective against almost all solid tumors. Research on the impact of TPT and C-PC on prostate cancer revealed that the combination of 10% TPT and C-PC has a significantly bigger effect than TPT at a normal dosage; this is explained by the rise in ROS and caspase-3/caspase-9 expression, which suggests that this combination has promising antitumor application prospects.

● **Combination with Doxorubicin (DOX):** With several uses, DOX is an antitumor antibiotic that prevents the synthesis of DNA and RNA. The effects of DOX in combination with C-PC on the hepatocellular carcinoma cell line HepG2 wereinvestigated by Nishanth et al. and Roy et al. The combined impact outperforms the single drug treatment in terms of antitumor effects and hazardous side effects, according to the results. These results show that the use of C-PC in combination with other anticancer medications has clear benefits over the use of these medications alone, although more research has to be done on these combinations.

Future researches:

Future research with phycocyanin in the field of pharmacy may focus on elucidating its precise mechanisms of action at the molecular level to better understand its therapeutic potential. Additionally, studies could explore novel delivery systems to enhance their bioavailability and target specific tissues or cells of interest. Investigating potential synergistic effects with other pharmaceutical agents or natural compounds could lead to the development of combination therapies for various health conditions. Furthermore, clinical trials are needed to evaluate the safety and efficacy of phycocyanin-based treatments in humans, paving the way for its integration into mainstream pharmacotherapy. Lastly, exploring sustainable and scalable methods for the production of phycocyanin could facilitate its widespread availability and affordability, making it more accessible for pharmaceutical applications.

Conclusion

Powdered deep blue algae from the sea is called C-PC. In addition to being a kind of protein, C-PC is also a great natural edible pigment, food ingredient, cosmetic, and health product. Although C-PC has been used in some fields and exhibits several physiological and pharmacological activities (such as immune regulation, antitumor, antioxidation, and anti-inflammation) without causing toxicity or harm, many related applied products, particularly in the medical field, have not yet received widespread research and application. Researchers need to plan and carry out their investigations with even more rigor to fully implement C-PC.

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Transcatheter Aortic Valve Implantation (TAVI)

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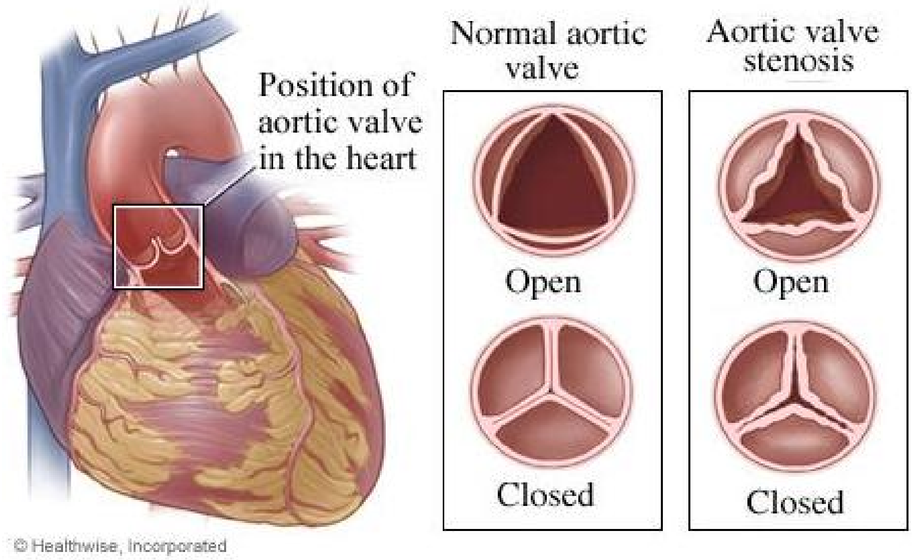
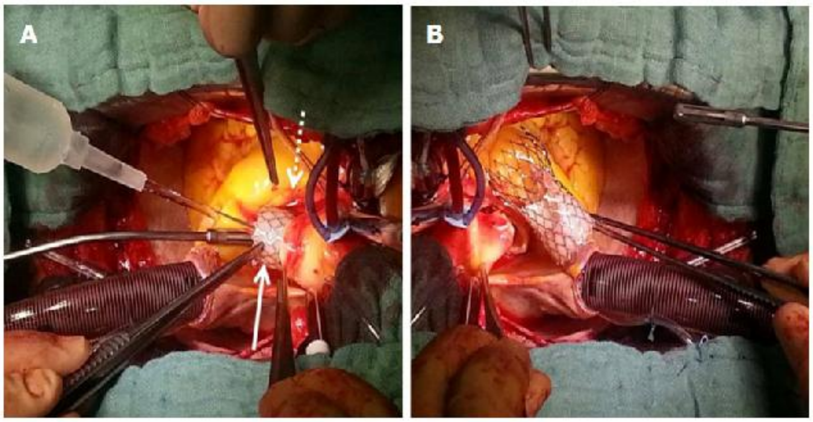
Abstract

The aortic valve is the exit point for blood being pumped out of the heart to the rest of the body. If the aortic valve becomes damaged, usually due to calcification, this can result in what is known as “aortic stenosis” or narrowing. Narrowing of the aortic valve limits the amount of oxygenated blood reaching vital organs, particularly when the body is working harder. In cases of severe aortic stenosis, it is necessary to replace the aortic valve with a prosthetic valve. In the past, aortic valve replacement would require open-heart surgery to access the heart and aortic valve. New surgical techniques have been developed to allow for a less invasive approach. Now it is possible to implant a prosthetic valve inside the native heart valve via a procedure called “TAVI or Transcatheter aortic valve implantation”. This new technique allows the surgeon to gain access to the heart without opening the chest. This kind of surgery is considered suitable for patients with high risk of complications from the open procedure. In this review, we had explained about the procedure, the risk factors and the benefits of this procedure.



Introduction

- Aortic valve stenosis or aortic stenosis is a type of valvular heart disease. The valve between the left ventricle and the aorta is narrowed and doesn't open fully. This reduces or blocks blood flow from the heart to the aorta and to the rest of the body.Treatment of aortic stenosis depends on the severity of the condition. Without treatment, severe aortic valve stenosis can lead to death
- The major treatment done for aortic valve stenosis is replacement of the aortic valve through an open heart surgery and replace it with mechanical or biological valve (extracted from cow, pig or human heart tissues).
- Transcatheter aortic valve implantation (TAVI) is otherwise known as Transcatheter aortic valve replacement (TAVR) is a minimal invasive procedure in replacing the aortic valve without a open chest surgery.



A: An intraoperative view of migrated CoreValve prosthesis (solid arrow) through aortic incision at the level of sino-tubular junction (dotted arrow). The surgical field is flushed with cold saline solution to soften the rigid nitinol struts of the prosthetic aortic valve for smooth extraction through aortotomy; B: An intraoperative view of migrated Medtronic-CoreValve prosthesis removed from ascending aorta.

Indications of TAVI

Indications for aortic valve replacement (surgical or transcatheter) are as follows:

1. Severe high-gradient Aortic stenosis with symptoms.
2. Asymptomatic patients with severe Aortic stenosis and Left Ventricular Ejection Fraction < 50%.
3. Severe Aortic stenosis when undergoing other cardiac surgery.
4. Asymptomatic severe Aortic Stenosis and low surgical risk.

TAVR is approved for the following:

1. Low to prohibitive surgical risk patients with severe Aortic Stenosis.
2. Valve-in-valve procedures for failed prior bioprosthetic valves.

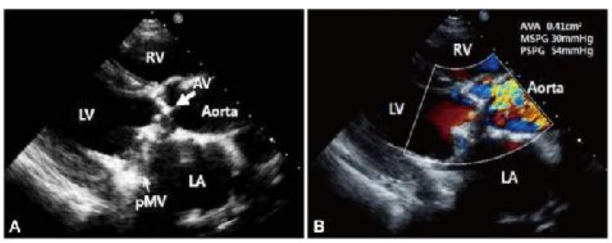
Contraindications of TAVI

- ✓ Congenital unicuspid, bicuspid or noncalcified valve.
- ✓ Hypertrophic cardiomyopathy.
- ✓ Short distance between the annulus and coronary ostium.
- ✓ Left ventricular ejection fraction less than 20%.
- ✓ Severe pulmonary hypertension with right ventricular dysfunction.

- ✓ Echocardiographic evidence of intracardiac mass.
- ✓ Thrombus or vegetation.
- ✓ Native aortic annulus smaller than 18 or larger than 25 mm.
- ✓ Severe mitral regurgitation.
- ✓ End-stage renal disease.

Preparation

- ➢ An professional heart team evaluates patients and puts them through evaluation and pre-procedural testing to determine suitability of the patient before undergoing a TAVR.
- ➢ The heart team consists of cardiologists, cardiothoracic surgeons and anesthesiologists.
- ➢ In addition to transthoracic echocardiography, transesophageal echocardiography is often utilized for better visualization of aortic valve anatomy.
- ➢ Computed tomography angiography (CTA) of the chest, abdomen, and pelvis are also performed for accurate measurement of the aortic annulus for determination of valve size.
- ➢ CTA is also essential for visualization of the vascular anatomy and determination of the approach to be taken.
- ➢ Left heart catheterization is commonly done prior to TAVR to provide invasive hemodynamic measurements as well as rule out any coexisting cornary artery disease (CAD) that may be contributing to symptoms or may need revascularization before determination of either surgical or transcatheter approach.



Transthoracic echocardiography

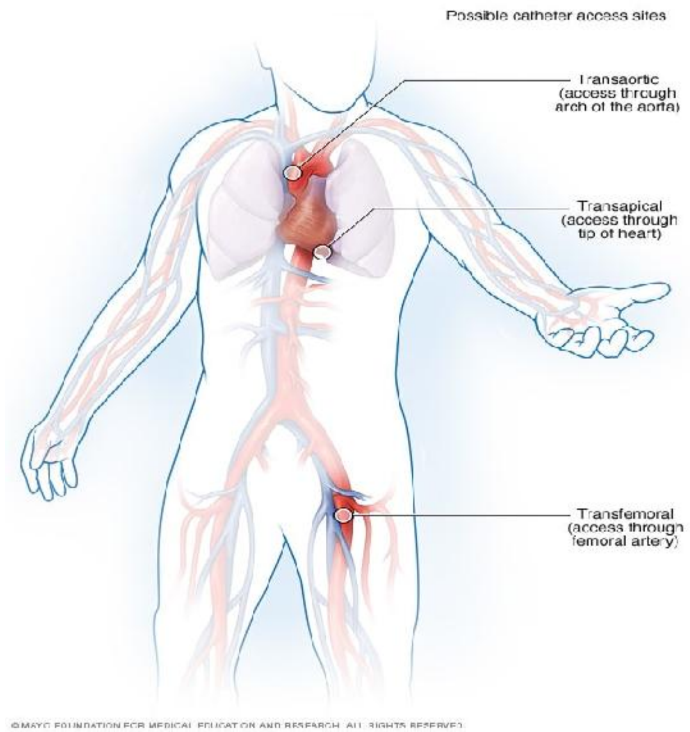
Procedure

Before the procedure

- ∗ An IV line is administrated into the forearm or hand.
- ∗ Sedatives are given through the IV.

* Medicines to prevent blood clots and infection also may be given through the IV.

During the procedure



- During transcatheter aortic valve replacement (TAVR), a cardiac surgeon replaces a damaged aortic valve made with cow or pig heart tissue.
- The cow or pig valve is called a biological tissue valve. Sometimes, surgeons place a biological tissue valve into an existing one that no longer works.
- TAVR uses small surgery cuts and a flexible, hollow tube called a catheter to reach the heart.
- It is not as same as open-heart surgery to replace the aortic valve. That surgery requires a long cut down the chest.
- During TAVR, a surgeon inserts a catheter into a blood vessel, usually in the groin or chest area.
- Surgeon guides the catheter to the location of the aortic valve in the heart using X-ray or other imaging tools as a guide.

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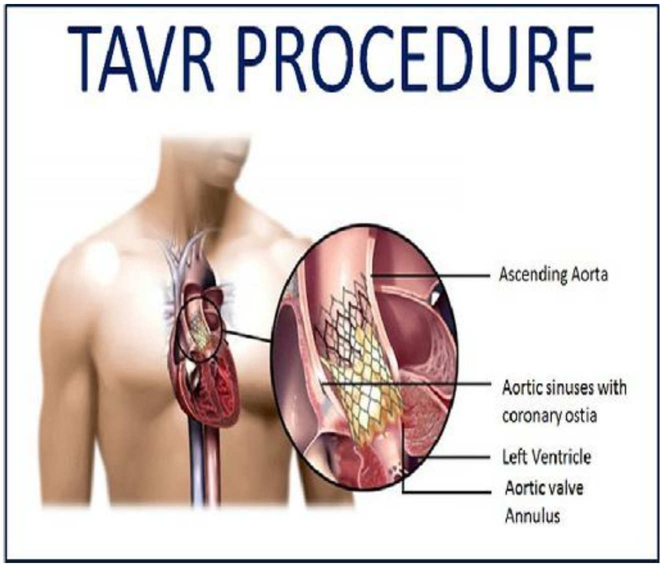
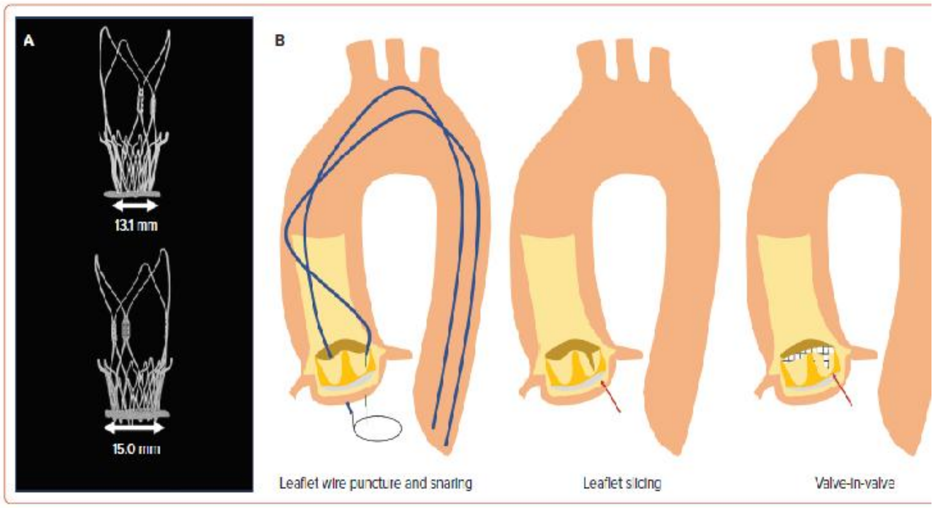
- Surgeon guides a biologic tissue valve through the catheter and places it in the area of the aortic valve.
- A balloon on the catheter tip expands to press the new aortic valve into place.
- Some replacement valves expand without the use of a balloon.
- Surgeon removes the catheter once the new valve is placed securely in position.
- During TAVR, blood pressure, heart rate and rhythm, and breathing are constantly checked.



After the procedure

- Patient is shifted to intensive care unit (ICU) for keen observation after the procedure.
- The duration of hospitalization depends on the severity and outcome of the procedure (varies from patient to patient).
- Before discharging from the hospital, health care team provides with a complete treatment and precautional guidance about wound care , and medications to avoid complications.
- Warning signs of infection include fever, increased pain and redness, swelling, draining or oozing at the catheter site.



A: Micro-CT analysis of ACURATE neo device (Boston Scientific) used for the valve-in-valve procedure showing difference of expansion before (13.1 mm) and after (15.0 mm) valve fracturing; B: Sche explanation of the BASILICA technique. BASILICA = bioprosthetic aortic scallop intentional laceration to prevent iatrogenic coronary artery obstruction.

Several medicines may be prescribed after TAVR, including:

- **Blood thinners, also called anticoagulants.** This medicine helps in preventing blood clots.The duration of the medicine is based on the severity of the procedure .
- **Antibiotics.** These medicines treat and prevent bacterial infections. Bacteria can infect the artificial heart valve.
- Regular checkups and imaging tests are needed after TAVR to make sure the new valve is working properly.

Symptoms to be checked after procedure:

- Dizziness or light-headedness.
- Swelling of the ankles.
- Sudden weight gain.
- Extreme tiredness with activity.
- Swelling, redness, tenderness or other signs of infection at the catheter site.
- Chest pain, pressure or tightness
- Severe, sudden shortness of breath.
- Fainting.

Risk Factors

- An irregular heart rhythm.
- Bleeding, bruising, damage, or an infection where the catheter tube is put into the body (in upper leg or chest)
- Blood clots and strokes

Rarer risks of TAVI include:

- A heart attack during the procedure
- Kidney problems for the first few days
- Endocarditis – where the inner lining of heart chambers and valves becomes infected

Benefits

- Increased survival when compared with medical therapy for non-operative patients.
- Minimally invasive advantages compared with the open surgical approach for high-risk patients.
- No sternotomy scar, and faster post operative recovery,
- Transapical approach allowing direct access to the heart, especially for patients with severe peripheral vascular disease, which limits access through the groin vessels.

Conclusion

It is a matter of weighing these risks against the benefits. This analysis will be different for each patient, taking into account both the individual risk profile as well as the potential for an improved quality of life. TAVI is currently used only in elderly and high-risk patients whose risk profile prohibits them to undergo surgical aortic valve replacement. In this review we concluded the procedure involved, indications, contraindications, complications and advantages of TAVI.

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Learning from animal communication

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Abstract

Communication is an important part of human as well as animal's life. Communication is the contact between two individuals of a species. In nature, communication is observed in various species like how an animal sends signals to attract the partner as well as how an animal sends warning signals to its group to protect themselves from predators. This is called animal communication. It comes under animal behavior, where the patterns of animal communication are studied. Although humans use different languages to communicate with each other. Animals communicate through different sounds such as birds which use chirping and some bird species use songs. There are different methods of animal communication which animals use.

Visual and acoustic communication methods are used. Visual signals are active during the day where they use different types of body language such as the waggle dance of honey bees which is used to communicate the location of honey to other bees. Acoustic signaling is the method where the sounds play the major role. Some animals use chemical, tactile communication also. Animal communication can be observed at natural habitats as well as zoological parks etc. It is very important to study animal communication to understand animal behavior and for the conservation of biodiversity. Artificial intelligence can be used to decode the language used by animals.

Key words: animals, communication, biodiversity, signaling, artificial intelligence, visual signals, acoustic signaling

Introduction

It is very important to have relationships with others to live. Communication is the process which is an important key to make relationships as well as living.

Communication Correspondence is essential to the presence and endurance of people as well concerning an association. It is a course of making and sharing thoughts, data, sees, realities, sentiments from one spot, individual or gathering to another. Communication is essential for management's directing function. A supervisor might be profoundly qualified and gifted however in the event that he doesn't have great relational abilities, all his capacity becomes unessential. To get the work done right, a manager must effectively communicate his instructions to his subordinates. Recommended Recordings Sorting of businesses Play How to get started with a business Play Communication in Action Interchanges is a persistent cycle that mostly includes three components viz. source, message, and collector. The components associated with the correspondence cycle are made sense of beneath exhaustively:

1. Communicator

The message is created by the sender or communicator and sent to the recipient. He is the point of origin and initiates communication.

2. Information

It is the idea, information, viewpoint, fact, feeling, etc. that the sender generates with the intention of further communicating. Explore additional Topics under Directing. Presentation, Meaning, Significance and Standards of Coordinating Components of Bearing Incentives Leadership

3. Conveying

produced by the source is encoded emblematically like words, pictures, motions, and so forth before it is being conveyed.

4. Form of communication

- It is how the encoded message is sent. The message can be delivered verbally or in written form. Telephone, the internet, the mail, fax, and e-mail are all forms of communication. The decision of medium is chosen by the shipper. Get familiar with Kinds of Correspondence here exhaustively.

5. Analyze

It is the method involved with changing over the images encoded by the shipper. The receiver receives the message after it has been decoded.

6. Recipient

He is the individual who is toward the end in the chain and for whom the message was sent by the shipper. When the recipient gets the message and comprehends it in a legitimate viewpoint and acts as per the message, really at that time the motivation behind correspondence is fruitful.

7. Comments

When the beneficiary affirms to the shipper that he has gotten the message and perceived it, the course of correspondence is finished.

8. Obstacles in communication

It refers to any obstacle that the sender, message, or both encounter during the communication process. Poor understanding of the message as a result of prejudice or inappropriate gestures, for instance, a poor telephone connection, incorrect encoding and decoding, an inattentive receiver, etc. communication (Source: businessjargons)

Communication styles

1. Formal Communication

The organizational chart specifies the official channels through which formal communications are conducted. It might happen between an unrivaled and a subordinate, a subordinate and a predominant or among similar unit representatives or supervisors. These conversations, which can be verbal or written, are typically recorded and kept in the office. Formal correspondence might be additionally named Vertical correspondence and Flat correspondence. Vertical Correspondence As the name suggests, formal channels are used for vertical communications that flow upwards or downwards. Up correspondence alludes to the progression of correspondence from a subordinate to an unrivaled while descending correspondence streams from a better than a subordinate. Application for award of leave, accommodation of an advancement report, demand for credits and so on are a portion of the instances of up correspondence. Sending notice to representatives to go to a gathering, designating work to the subordinates, illuminating them about the organization strategies, and so forth are a few instances of descending correspondence. Communication from above Level or parallel correspondence happens between one division and another. For instance, a creation supervisor might contact the money director to examine the conveyance of unrefined substance or its buy. Formal communication networks include the following: Single chain: In this kind of network, communication flows through a single chain from each superior to his subordinate. Wheel: In this organization, all subordinates under one predominant impart through him as it were. They are not permitted to talk among themselves. Roundabout: In this sort of organization, the correspondence moves all around. Every individual can speak with his connecting two people as it were. In this network, everyone has free access to one another's communications. There is no limitation. Transformed V: In this sort of organization, a subordinate is permitted to speak with his nearby predominant as well as his unrivaled prevalent moreover. Be that as it may, in the last option case, just appointed correspondence happens.

2. Informal Communication

Any correspondence that happens without following the conventional channels of correspondence is supposed to be casual correspondence. Casual correspondence is frequently alluded to as the 'grapevine' as it spreads all through the association and this way and that with practically no respect to the degrees of power. Casual correspondence spreads quickly, frequently gets twisted and recognizing the wellspring of such communication is extremely challenging. It also spreads rumors that are false. Individuals' way of behaving is frequently impacted by reports and casual conversations which in some cases might hamper the workplace. However, due to the rapid transmission of information, these channels may occasionally be helpful to the manager. Casual channels are additionally involved by the administrators to communicate data to know the responses of his/her subordinates.

Channels of communication

The channels through which employees of a company interact and communicate with one another are called communication channels. Without the appropriate correspondence channel, it is extremely challenging for representatives to line up with the business targets and objectives, as well as drive advancement and progress in the work environment. In addition to formal and informal communication channels, various business organizations use a variety of channels. They are as per the following: Channels for digital communication – To reach and draw in their staff, most firms utilize computerized correspondence stages. They incorporate various web-based apparatuses that representatives use to keep in contact with each other and keep awake to date on corporate news and advancements. This type of correspondence channel is believed to be the best of all. A couple of models are web-based entertainment, intranets, representative cooperation programming, project board instruments, criticism programming, and so on. channels of face-to-face communication – Even though electronic means of communication are becoming more common, face-to-face communication is still extremely important in the workplace. It is as yet vital since numerous circumstances require nonverbal correspondence (non-verbal communication, signals, signs, looks, and so forth.). Composed correspondence channels -

Inside partnerships, this d. Notwithstanding, literary correspondence is as yet required while conveying basic approaches, letters, reminders, manuals, notification, and declarations to representatives. Yet, for outside interchanges with the clients, retailers, wholesalers and others, composed correspondence is as yet the best. A couple of models are messages, live visit, instant messages, websites, pamphlets, composed records, and so on. Communication Models

The correspondence cycle is separated into three standard models: straight, intelligent, and conditional. They are useful because they make the basic structure of communication easier to understand and can help us understand it visually as well as verbally. In particular, they recognize the numerous correspondence pieces and go about as a type of a guide to make sense of how various segments of the correspondence cycle are interconnected. Straight Model - A message is encrypted and sent to the recipient through a channel in this model by a sender. The receiver deciphers the message. During the course of the communication, there might be obstacles or background noise. In a perspective of communication that is more dynamic, interactional models follow two channels. In the wake of getting the message, the collector encodes and communicates a reaction to the first source, who has now turned into the recipient. A telephone call is a common illustration of this model. Value-based Model - Since messages can be sent back and forth simultaneously in the Transactional Model, both the receiver and the sender can fulfill the same functions simultaneously. Individuals create shared significance in a more powerful cycle in the value-based model. To make normal significance, there should be some cross-over in domains of involvement. As such, on the off chance that individuals are to impart by any stretch of the imagination, communicators should share in any event some level of social, phonetic, or natural shared characteristic. Verbal Correspondence Vocal correspondence is joined by hear-able signs created by a vibrating organ, like the larynx in vertebrates' throats. The process by which speakers convey their feelings through nonverbal aspects of their speech and listeners interpret the speaker's emotional state is known as vocal communication. This contains parts of the voice like sound, stress, volume, speed, and complement impedance. We utilize vocal correspondence to successfully approach our message more. This type of correspondence, as well as voice elements, for example, stops and center pressure, are utilized to construct a design that permits the audience to follow your message. Sound - Inflection characterizes how the pitch of your voice increments and falls during a discourse. A shift or variety in pitch can affect the significance of what we say. Stress - Focusing is the most common way of underscoring a word or explanation to point out it.The interruption permits the speaker to assemble their contemplations prior to putting forward the last case. This permits the crowd to keep awake with you while likewise giving them an opportunity to handle what you recently expressed. When there is focus tension, the listener's attention is drawn to a specific word or phrase. To clarify, emphasize, or demonstrate the difference, focus stress is used. Pace - Speed is the rate at which you talk. The speed may be quick, slow, or moderate, and it can vacillate all through. It is claimed that in order to keep the audience's attention, the pace changes, sometimes picking up speed and then slowing down, depending on the situation and the significance of the context. Nonverbal Correspondence The process of conveying meaning without the use of written or spoken language is known as non-vocal communication.

Non-verbal correspondence alludes to any correspondence between at least two individuals that includes the utilization of looks, hand movements, non-verbal communication, stances, and motions. These non-vocal prompts can give bits of knowledge, beneficial data, and importance notwithstanding spoken correspondence. Non-vocal components like implicit images, signs, and motions toward express importance are instances of verbal correspondence. Non-vocal components like non-verbal communication, motions, facial feelings, and eye to eye connection are instances of nonverbal correspondence. Signals Signals are developments that are utilized to communicate to others one's needs, wants, and sentiments. A form of expressive communication is signaling. The essential objective of signs is to change a solitary ecological viewpoint to stand out and convey meaning. Signs have a place with no particular language, in spite of the fact that they are tracked down in essentially every district of the world. The essential qualification between a sign and a sign is that a sign, (for example, traffic signals or a cop's identification) has inborn implications, yet a sign (like a shout for help) is just a method through which outward implications can be planned. Symbols Any device that can be used to create an abstraction has been defined as a symbol. A symbol is a visual representation of an event, activity, thing, person, or location that can be used to convey information about that event, activity, thing, person, or location.

Animal communication:

The ability to communicate effectively with other humans is essential to the life of all animals. Whether we are studying how moths attract mates, moths communicate information about nearby predators, or chimpanzees maintain their position in dominance hierarchies, communication systems are

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involved. Here I give an introduction to the types of communication signals animals use and the functions they perform.

Animal communication is classically defined as that which occurs when "...an action or signal of one organism [sender] is detected and changes the likely behavior pattern of another organism [receiver]. Adapts to both actors" (Wilson 1975). produced by female Fotino. This is clearly a case where the sender benefits and the receiver does not. Alternatively, in fringe-lipped bats, Trachops cirrhosus, and stilt frogs, Physalaemus pustulosus, the recipient is the only player who benefits from the interaction. Male frogs call to attract females to their location; although the signal is intended for females to receive, eavesdropping long-lipped bats detect calls and use this information to locate and capture frogs (Ryan et al. 1982). Despite these examples, there are many cases where both the sender and the receiver benefit from the exchange of information. The sages beautifully describe this type of "real communication"; During the mating season, males produce eyebrows, which are energetically expensive, and females use this honest information about male quality to select individuals with which to mate (Vehrencamp et al. 1989).

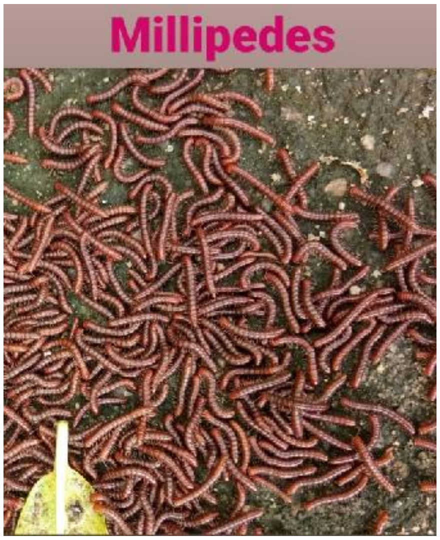

Fig 1 Communication among members of one species

Signalling:

Animals use different sensory channels or forms of signaling to communicate. Visual cues are very effective in animals that are active during the day. Some visual cues are persistent advertisements; for example, the bright red epaulettes of male red-winged warblers Agelaius phoeniceus, which are always exposed, are important in territorial defense. When researchers experimentally blackened epaulettes, other males penetrated males much more (Smith 1972). Alternatively, the individual actively produces some visual signals only under appropriate conditions. Male green anoles, Anolis carolinensis, nod and extend a brightly colored throat fan (veno) to signal territorial ownership.

Acoustic communication is also very rich in nature, probably because sound can be adapted to very different environmental conditions and behavioral situations. Sounds can vary considerably in amplitude, duration and frequency structure, all of which affect how far the sound travels in the environment and how easily the receiver can locate the transmitter. For example, many passerines send pure-voice alarm calls that make location difficult, while the same species produce more complex broadband co-attractor songs that allow the species to easily locate the transmitter (Marler 1955). A particularly specialized form of acoustic communication is seen in bats and whales that use high-frequency sounds to detect and locate prey. After the sound is emitted, the returning echo is detected and processed, allowing the animal to finally create a picture of its environment and make very accurate estimates of the prey's location.

Fig 2 Birds make sounds to communicate

Compared to visual and acoustic methods, chemical signals travel much more slowly through the medium because they must propagate from the point of production. However, these signals can be transmitted over long distances and slowly disappear after they are created. In many species of moths, females provide chemical signals and males track the location of the female. The researchers sought to determine the role of visual and chemical signaling in the silkworm Bombyx mori by giving males a choice between a female in a transparent airtight box and filter paper soaked in chemicals produced by a sexually receptive female. Males were always attracted to the source of the chemical signal and did not respond to the sight of an isolated female (Schneider 1974;

Chemical communication also plays an important role in the lives of other animals, some of which have a special vomeronasal organ that is used only to detect chemical signals. For example, male Asian elephants, Elaphus maximus, use the vomeronasal organ to process chemical signals from the female's urine and detect whether she is sexually receptive (Rasmussen et al. 1982).

Sensitive signals, where there is physical contact between the sender and the receiver, can only be sent over very short distances. Sensitive communication is often very important in establishing and maintaining a relationship between social animals. For example, chimpanzees that regularly groom other individuals are rewarded with greater cooperation and food sharing (de Waal 1989).

For aquatic animals living in murky waters, electronic signaling is an ideal form of communication. Several species of mormyrid fish produce species-specific electrical pulses that are primarily used to locate prey by electrolocation, but which allow partners to distinguish conspecifics from heterospecies. Foraging sharks have the ability to detect electrical signals using specialized electroreceptor cells in the head region that are used to pick up weak bioelectric predator fields (von der Emde 1998).

Quorum sensing: It is a process by which bacteria communicate with each other with the help of chemicals. It is a cell to cell communication process which involves paracrine signaling.

AI in animal communication:

Portable sensors and artificial intelligence helps to understand animal communication and signals produced by animals. It also helps to talk back with the animals.

Conclusion

Animal communication helps in understanding animal behavior and evolutionary processes and to understand speciation over the world. As well as it helps in wildlife conservation and animal conservation and utilizing artificial intelligence to decode animal communication.

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Forensic Entomology: - Flies lead to Criminal investigation

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Introduction

Within the specialty field of forensic science, entomology uses insects to gather crucial evidence for judicial investigations. Because insects colonize decaying remains in a predictable way, they are useful tools for figuring out the post-mortem interval (PMI), figuring out whether a body has been transported, and even figuring out what toxicological materials are in a body. The basic ideas of forensic entomology, its uses in criminal investigations, and the methods used to study insects will all be covered in this chapter.

The foundation of forensic entomology is the idea that insects infest dead bodies in a predictable order. The process of colonization starts soon after death and moves through phases as various insect species live on and eat the remains.

The kinds of insects found on a body and their stage of development can reveal important details about the cause of death. For instance, the initial colonization of the body, which usually happens minutes to hours after death, might be indicated by the presence of several species of blow flies and their larvae, such as Calliphoridae. Other insect species, such beetles (Coleoptera) and mites (Acari), may proliferate as the decomposition process progresses, indicating the advanced phases of decomposition.

Environmental elements that can affect insect activity and development rates, such as temperature, humidity, and sunlight exposure, are also taken into account by forensic entomologists. Forensic entomologists can improve their estimations of the PMI and give investigators useful information by taking these aspects into account.

Forensic entomology not only estimates the PMI but also sheds light on other case details. Since the insect species and developmental stages found on the body may differ from those at the discovery site, the existence of insect evidence, for instance, might assist in determining whether a body has been transported. Furthermore, based on the geographic distribution of bug species, evidence from insects can be utilized to determine the origins of a body.

All things considered, forensic entomology is a potent instrument in the field of forensic science, giving detectives important data that can aid in the investigation of crimes and ensure that victims and their families receive justice.

This chapter examines the various roles that insects play in forensic investigations, from estimating the time of death to identifying geographical origins and analyzing toxicological substances. Understanding the biology and behaviour of these insects is essential for forensic entomologists to accurately interpret insect evidence and provide valuable insights to law enforcement agencies and legal professionals. Insects are ubiquitous in forensic entomology, playing a pivotal role in providing crucial investigative leads in legal investigations involving decomposing remains.

Life cycle of Forensically Important Flies: -

The Calliphoridae (blow flies) and Sarcophagidae (meat flies) families are particularly important in forensic entomology because of their quick reactivity to rotting bodies. These insects are frequently the first to arrive at a body, drawn by chemical cues such as volatile organic compounds emitted during decomposition or visual cues such as color and motion.

Blow flies, members of the Calliphoridae family, are usually the first insects to occupy a body, often within minutes to hours of death. They are drawn to the body by scents like cadaverine and putrescine, which are produced during the early stages of decomposition. Female blow flies lay eggs (oviposit) on or near their bodies, which hatch into larvae (maggots) after a few hours.

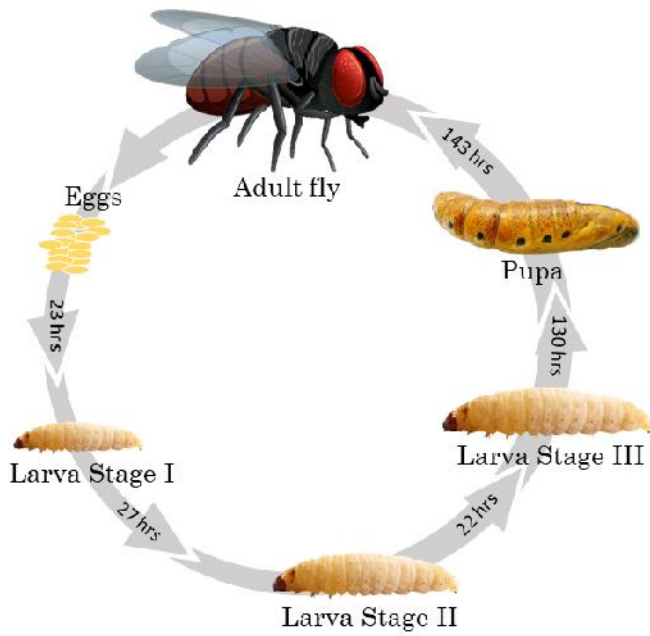

Figure 1: Life cycle of Blow fly.

Members of the Sarcophagidae family, which includes flesh flies, are another class of insects frequently discovered on decaying bodies. Similar to blow flies, flesh flies are drawn to dead bodies due to the smells of decay and can be useful in determining how long someone has been dead. Larvae of flesh flies are indicators of the advanced phases of decomposition because they feed on decaying tissue.

Both blow flies and flesh flies go through predictable developmental phases known as instars, which can be used to estimate the age of the larvae and, by extension, the time since colonization. By investigating the presence and development of these insects on a body, forensic entomologists can assist investigators in establishing timelines and reconstructing events around a death.

Factors affecting the growth rate of insects: -

Temperature, humidity, and sunshine exposure can all have an impact on insect colonization and succession. By considering these criteria, forensic entomologists can improve their estimates of the PMI and provide useful information to investigators.

Temperature:

Temperature affects how blow fly larvae develop, with higher temperatures typically causing them to grow more quickly. Forensic entomologists can determine the least amount of time after death by examining the developmental stage of blow fly larvae found on a body. This information is vital for investigators.

Sun exposure:

Fly oviposition is strongly influenced by temperature and generally doesn’t occur below 10° C unless the substrate temperature has been influenced by solar radiation. Bodies found in direct sunlight will be warmer heating up more rapidly and decomposing faster, they will lose biomass more rapidly than bodies in shade and progress through decomposition stages faster.

Elements affecting the insect activity and decomposition rate: -

Location:

Indoor vs outdoor: Some often believe that insect won’t colonize remains inside a building. However, insect will colonize remains indoors as easily as outdoors. The succession will be limited by the species that can and will enter a dwelling and on how the dwelling is sealed.

Urban vs rural: some insect species are found in both urban and rural areas yet others are very specific to one or the other. This can be useful in forensic analysis as certain species of blow flies found on remains have been moved from an urban to rural environment or vice versa.

Burial: Burial of the remains is a very commonly chosen method by the killer. Buried remains are still colonized by the insects but burial influences the time required for insects to reach the remains, the sequence of colonization of the species involved and the rate of decomposition.

Scavenging:

Scavengers other than insects are attracted to remains and can remove large quantities of flesh. This can have a major effect on the decomposition rate and consequent insect colonization. Scavengers are common on remain acting as opportunistic predators of insects, they may remove blow fly larvae.

Presence or absence of clothing:

Majority of human victims are completely or partially clothed. Clothing can be expected to have an effect on insect colonization on corpses as it affects the temperature and humidity of the remains. Most 1st instar larvae require liquid protein for survival, clothing become saturated with decompositional fluids and provides site for oviposition than naked portion resulting in faster decomposition.

Submerged in water:

Similar stages of decomposition also take place in water but an additional stage i.e. floating decay stage was noticed. In this stage other aquatic insects, invertebrates and terrestrial insect species colonize the body. The PMI estimation will depend on the temperature of water.

Drug Consumption:

Type of drugs that had been consumed by the body before dying, may be recovered by analyzing the insect life cycle.

Post-mortem interval (PMI) estimation: -

Estimating the post-mortem interval (PMI) using insect colonization involves several steps, including the collection and preservation of insect evidence and the analysis of insect development stages. Here's an overview of the process:

Insect Collection: Insects are collected from the body and the surrounding area using standard entomological tools such as forceps, aspirators, and sticky traps. Care must be taken to collect both adult insects and their immature stages (eggs, larvae, pupae) as they provide valuable information about the PMI.

Preservation: Collected insects are preserved in containers filled with a preservative such as ethanol or isopropyl alcohol. Proper labelling of the containers is essential to ensure that the collection site and other relevant information are recorde

Insect Identification: Insects are identified to species level, preferably by an entomologist specializing in forensic entomology. This step is crucial as different insect species have different developmental timelines and colonization behaviours.

Developmental Stage Determination: The developmental stage of each insect specimen is determined.

-For larvae, this involves identifying the instar (developmental stage) based on size and morphology.

-For adults, the age can be estimated based on wing wear and other physical characteristics.

Temperature Data Collection: Ambient temperature data from the location where the body was found are collected. This information is crucial as temperature influences insect development rates.

PMI Calculation: The PMI is calculated using the accumulated degree hours (ADH) or accumulated degree days (ADD) method. This method involves calculating the total heat energy (in degrees Celsius or Fahrenheit) accumulated over time, using the formula: $ADH = \sum(T_i - T_{min})$, where T_i is the temperature at time i, and T_{min} is the minimum temperature threshold for insect development. This calculation provides an estimate of the time since insect colonization began, which can then be used to estimate the PMI.

It's important to note that estimating the PMI using insect evidence is not always straightforward, as factors such as environmental conditions, body size, and insect species composition can influence the rate of insect development. Additionally, insect evidence is most reliable for estimating the PMI within the first few weeks after death, after which other methods may be required. Overall, the succession of insects on a dead body is a complex process that follows a predictable pattern. By understanding this process and the role of different insect species, forensic entomologists can contribute valuable information to legal investigations.

Application of Molecular biology techniques for forensically important fly identification

Determining the postmortem interval (PMI) is the primary responsibility of forensic entomology. Morphological identification was important in the field of age estimation and PMI, but it might be challenging to utilize when identifying juvenile stages or when the material is damaged. Regardless of life stage or specimen completeness, molecular identification can be a more accurate method of identifying forensically significant insects than morphological and histological investigation. Furthermore, new insights into species identification, growth and development, and PMI estimation are provided by omics technology, high-throughput analysis techniques, and bioinformatics. Over the past 20 years, molecular data has been used to identify forensic insects. A new method in forensic entomology for identifying immature individuals is gene expression analysis and examination of the developing transcriptome.

Entomological evidences not only useful in human death investigation but also in human and animal neglected cases. Molecular biology methods in forensic entomology provides important information to identify victim, suspect and insect species. As fly larvae directly feed on corpse, their larval stage can be used for PMI. DNA barcoading can be used to identify fly species from egg, larva and adults.Traditionaly fly identification can be carry out by larval or adult morphological key characters for which the larvae are reared to adult. But this took several weeks and if proper environmental conditions are not maintained the larvae may not develop properly or die. However the larval stage of flies looks similar morphologically so at this stage identification may be difficult or impossible. So in this scenario molecular techniques shown potential to identify species.

Fly DNA Barcoding Protocol

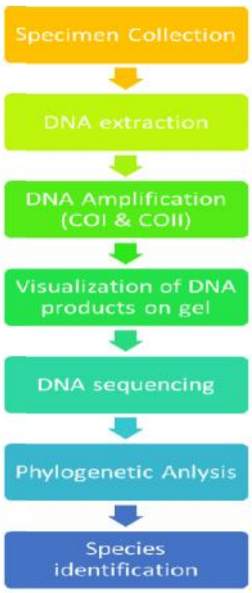

Fig: Flowchart of DNA Barcoding

Forensic entomology can provide insights on PMI however there are still some limitations. Seasonal variation, variation in timing of oviposition, etc.Microbial communities are considered as important tool in detecting PMI.

Microbial communities of every body and each organ is different and change with time upon death. Study of microbes found in internal organs and cavities upon death highlights the potential to estimatePMI. Thanactomicrobiome and study of microbial metabolites can act as indicators in PMI studies.

Realtime fluorescence quantitative PCR and high throughput sequencing technologies has emerged as promising tools in identifying microbial communities of spoilage flora. Microbial markers, microbial associations and their effect on different parts of the body are considered as future tools in identification tasks in forensics.

Microbes produce diverse volqtile compounds. Microbes associated with cadavers cause decomposition of body and release indole, cadaverine, putrescine and are sensed by insects who find it as a signal for food rich environment. Insects get attracted by the volatile metabolites released by microbial decomposition and deposit their eggs, microbial volatiles produced during decomposition can lead insect succession during cadavar decomposition. Entomology and Microbiology together can bridge ecological and forensic context further that can be validated using high-throughput techniques and instrumental analysis.

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Future Applications of Probiotics for Targeted Immune Potentiation (TIP)

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Abstract

Probiotics represent a very promising option for targeted immune enhancement (TIP) and therapeutic interventions in a wide range of health conditions. This review examines the ways in which probiotics can be used to improve immune responses and achieve particular health outcomes. Probiotics influence the intestinal immune system in a complex way by controlling cytokine production, activating regulatory T cells, and inducing the production of IgA antibodies to maintain homeostasis. Its ability to alter the intestinal microbiota, strengthen immune defenses, and prevent the onset of diseases has been highlighted by recent advances. Through the complex communication pathways of the gut-lung and gut-brain axes, probiotics show efficacy in reducing gastrointestinal disorders, fighting respiratory infections, and addressing mental health conditions. New technologies, such as genetically modified yeast strains and bacterial cancer therapy platforms, provide targeted therapeutic approaches. However, to fully exploit the clinical utility of probiotics, further research and scientific collaborations are needed to address issues such as strain-specific effects and interindividual variability. In summary, probiotics have the potential to revolutionize immune modulation and disease management strategies in personalized medicine.

Keywords: Probiotics, Immune modulation, Gut microbiota, Therapeutic interventions, Targeted immune potentiation.

Introduction

Probiotics, known for their benefits for gut health and overall well-being, are gaining attention for their targeted immunity-boosting (TIP) potential. This chapter discusses potential future applications of probiotics to improve immune responses in relation to particular health outcomes. The intestinal immune system, consisting of anatomical barriers such as the epithelium and lamina propria, as well as structures such as Peyer's patches, plays an important role in immune function. To maintain immune balance, probiotics work with intestinal immune cells to control cytokine production and the activation of regulatory T cells. The therapeutic potential of probiotics in gastrointestinal disorders is highlighted by the association of intestinal microbiota dysbiosis with inflammatory diseases(Yan et al., 2011). LAB strains have antibacterial properties and immunomodulatory effects and clinical studies show promising results of the diet in regulating the intestinal microbiota. Interactions between the microbiome and the immune system extend beyond the gut and offer opportunities for therapeutic interventions in a variety of conditions. Intestinal dysbiosis disrupts the gut-lung axis, affecting respiratory health and exacerbating respiratory viral infections. Probiotics reduce the risk of respiratory infections by working with intestinal immune cells to regulate antiviral pathways. Additionally, probiotics may improve mental health disorders via the gut-brain axis by modifying the stress response and mood regulation. New techniques, such as genetically modified yeast strains and bacterial cancer therapy platforms, provide targeted therapeutic solutions. For effective clinical translation, challenges such as strain-specific effects and individual variability require further research and collaboration.

1. Understanding Probiotics and Immune Modulation

Anatomical barriers such as the epithelium and lamina propria, as well as gut-associated lymphoid tissue (GALT), which includes structures such as Peyer's patches, are part of the intestinal immune system. A component of mucosal-associated lymphoid tissue (MALT), GALT, contains large numbers of T and B cells required to initiate immune responses(*Frontiers | Publisher of Peer-Reviewed Articles in Open Access Journals*, n.d.). GALT dendritic cells (DCs) capture antigens to activate T cells, triggering an immune response. Most IgA-producing B cells are found in the intestine. These cells are essential for mucosal immunity by neutralizing harmful substances and preventing them from binding to intestinal cells. To protect against pathogens, innate immunity provides the first line of defense, while adaptive immunity provides specific responses. The intestinal mucosa, covered in antimicrobial peptides and protective mucus, collaborates with immune cells to produce immune responses. By aiding digestion, producing essential nutrients and maintaining intestinal integrity, the intestinal microbiota, composed of beneficial bacteria, supports the health of the host. Furthermore, commensal bacteria regulate the immune system by promoting immune homeostasis and differentiating beneficial microbes from harmful pathogens. The activation of macrophages, the stimulation of IgA production and the inhibition of the release of proinflammatory cytokines are some of the mechanisms of immunomodulation of the intestinal microbiota (Mazziotta et al., 2023).

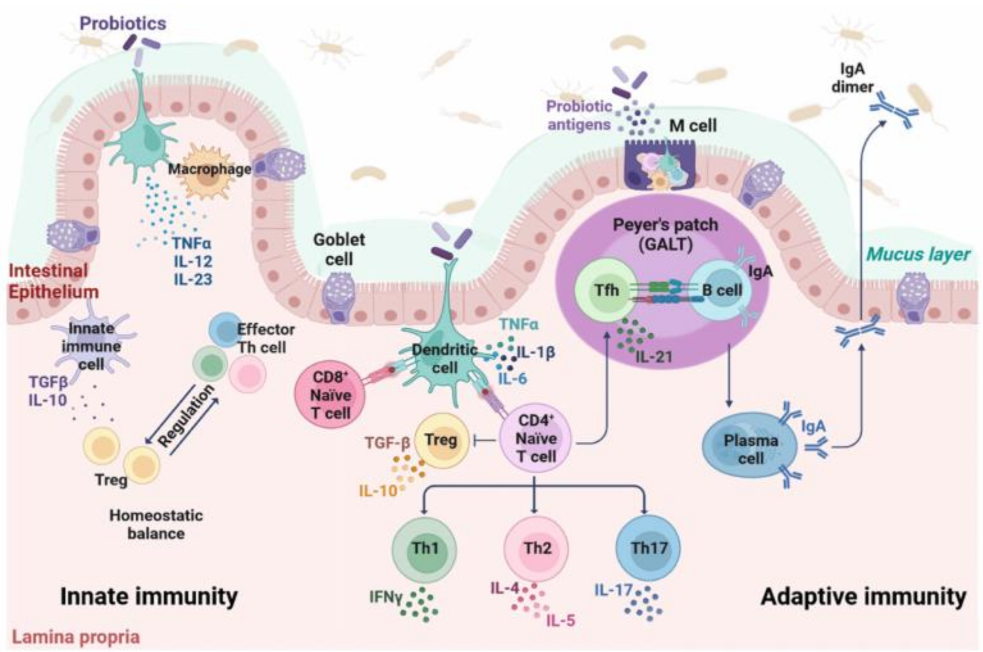

Figure 1. Immune cells in the gut are influenced by probiotics. By interacting with cells such as dendritic cells, macrophages, and B and T lymphocytes, probiotics alter innate and adaptive immune responses. Most often they interact with cells on the surface of the intestinal barrier, which is formed by the epithelium and lamina propria. Goblet cells secrete a mucous layer that separates the gut microbiota from the gut epithelium. Probiotic bacteria adhere to intestinal epithelial cells and activate pattern recognition receptors (PRRs) when consumed. As a result of this activation, the production of cytokines occurs, which in turn activate regulatory T cells (Tregs). By suppressing exaggerated immune responses, Treg cells help maintain balance in the gut. Probiotics can also cause B cells to produce IgA antibodies, which help control bacterial adhesion to intestinal tissue(Mazziotta et al., 2023).

By strengthening mucosal and systemic immunity, probiotic bacteria regulate the immune system. They cause the secretion of IgA antibodies into the intestinal lumen, which reduces the ability of pathogenic microorganisms to colonize the body. Probiotics also prevent the adhesion and proliferation of pathogens by altering the viscoelastic properties of mucus. Furthermore, these microorganisms help beneficial commensal flora to colonize the intestine and regulate the activity of immune cells. Furthermore, probiotics improve the immunity of older people and improve the effectiveness of vaccines, especially against rotavirus. Various probiotic components, including proteins and non-protein compounds, interact with immune cells in important ways, thereby altering immune responses. However, to fully understand their effects on human health, further explanation of these interactions is needed(Mazziotta et al., 2023). The gut microbiota plays an important role in the formation and regulation of the mucosal immune system, and dysbiosis is responsible for the emergence of a variety of inflammatory diseases. Experimental evidence, especially in germ-free mouse models, highlights the crucial role of the gut microbiota in the growth and function of mucosa-associated lymphoid tissues and systemic immune responses. The increase in metabolic disorders is due to current dietary practices, making it necessary to investigate the therapeutic potential of modifying the intestinal microbiota-immune system axis to treat these conditions. Probiotics, alone or in combination, have emerged as promising interventions in gastrointestinal disorders, including diarrhea and inflammatory bowel disease. Studies have demonstrated the ability of probiotics to mitigate inflammatory responses, preserve the integrity of the intestinal barrier, and suppress the colonization of pathogens, thus offering avenues for therapeutic intervention in such disorders(Begum et al., 2021).The intestinal immune system, composed of epithelial barriers, lamina propria, and gut-associated lymphoid tissue (GALT), is essential for immune functioning(*World Nutrition Journal*, n.d.). IgA-producing B cells neutralize harmful agents, while GALT dendritic cells activate T cells. Probiotics stimulate the production of cytokines and the activation of regulatory T cells to maintain immune balance. Furthermore, they promote the synthesis of IgA antibodies, which regulate bacterial adhesion. Probiotics strengthen systemic and mucosal immunity, alter mucosal mucus characteristics, and influence the activity of intestinal immune cells. The therapeutic potential of probiotics in gastrointestinal disorders is highlighted by the association of intestinal microbiota dysbiosis with inflammatory diseases. This is because probiotics reduce inflammation and maintain the integrity of the intestinal barrier.

2. Emerging Trends in Probiotic Research for TIP

Clinical intervention studies investigating the influence of diet on gut microbiota modulation are limited, but recent research has highlighted the potential of specific dietary approaches. For instance, diets low in fermentable oligosaccharides, disaccharides, monosaccharides, and polyols have been shown to increase the abundance of *Akkermansia muciniphila* and butyrate-producing *Clostridium cluster* XIVa while reducing levels of *Ruminococcus torques* in individuals with Crohn's disease. Similarly, high-fiber diets have been found to promote the growth of short-chain fatty acid (SCFA) producers in the gut and improve glucose metabolism in patients with type 2 diabetes mellitus (T2DM). However, individual responses to postprandial glycemic stimuli remain variable and are influenced by factors such as gut microbial composition, fasting blood glucose levels, and body mass indices, necessitating personalized dietary interventions. Additionally, dietary interventions involving flaxseed mucilage have demonstrated alterations in gut microbiota composition and improved insulin sensitivity in obese individuals(*National Center for Biotechnology Information*, n.d.). Furthermore, dietary nucleic acids have been shown to modulate infant gut microbiota, underscoring the role of diet in shaping microbial communities from an early age(Daliri et al., 2020). LAB strains with antibacterial properties, particularly Lactobacillus plantarum, were screened in plant environments. Selected strains exhibited potent antagonistic activity against pathogens and demonstrated robust tolerance to gastrointestinal conditions, adhesion to intestinal cells, and potential biofilm formation for gut colonization. Antibiotic susceptibility profiles were consistent with those of other lactobacilli, meeting safety standards. Cell-free supernatants (CFS) from L. plantarum strains displayed immunomodulatory effects on macrophages, suggesting potential therapeutic applications in inflammation management. Further investigation is warranted to elucidate the specific components and signaling pathways involved in these immunoregulatory effects. This research contributes to the understanding of probiotic selection criteria and the potential of L. plantarum as a functional food ingredient for promoting gut health and modulating immune responses(Rocchetti et al., 2023). The gut microbiome's association with health in older individuals suggests a potential avenue for promoting healthy aging through microbiome modulation. Various interventions, including probiotics, prebiotics, synbiotics, and dietary adjustments, can be employed to target the gut microbiota. While animal models have been extensively utilized, this review primarily focuses on intervention studies conducted on human subjects. A comprehensive search yielded 23 pertinent studies, predominantly investigating alterations in gut microbiota composition, metabolic biomarkers, and cognitive function among older adults. Probiotic-containing strains such as Lactobacillus and Bifidobacterium exhibit promising outcomes in enhancing immune function, cognitive performance, and bone health. Prebiotic interventions, encompassing oligosaccharides and dietary fibers, demonstrate bifidogenic effects but may not consistently translate into measurable improvements in health outcomes. Synbiotic formulations, combining probiotics and prebiotics, have shown efficacy in ameliorating metabolic parameters in older individuals with metabolic syndrome. Nonetheless, further research is warranted to delineate optimal intervention strategies, including formulation, dosage, and long-term effects of microbiome-targeted interventions in the elderly population(Lim & Nam, 2023). Aberrant interactions between the host's immune system and the microbiome in genetically susceptible individuals may contribute to the etiology of complex immune-mediated disorders. These conditions encompass a spectrum of diseases, including inflammatory bowel disease (IBD), systemic autoimmune diseases, cardiometabolic disorders, and cancer. While the microbiome-immunity axis has been implicated in the pathophysiology of various ailments, further elucidation through human studies is imperative to delineate its precise mechanistic involvement(*Nature*, n.d.). Notably, establishing a causal relationship between microbiome alterations and immune dysregulation in many human disorders remains an ongoing challenge, In the context of inflammatory bowel disease (IBD), comprising Crohn’s disease (CD) and ulcerative colitis, dysbiosis characterized by diminished microbial diversity and altered taxonomic composition is a prominent feature contributing to disease onset and progression(*The University of Groningen Research Portal*, n.d.). Disruptions in the integrity of the gut barrier, as well as genetic variants such as NOD2 and ATG16L1 mutations, exacerbate intestinal inflammation by perturbing immune responses and barrier function, Rheumatoid arthritis (RA), an autoimmune condition primarily affecting the joints, demonstrates associations with specific microbiome signatures, particularly alterations in microbial taxa abundance. Microbiome-derived metabolites are implicated in modulating immune pathways relevant to RA pathogenesis. Dysbiotic microbiota from RA patients can incite inflammatory responses and arthritic manifestations in animal models with genetic predisposition, Cardiometabolic diseases, typified by chronic low-grade inflammation, involve intricate interactions between the microbiome and host immunity. Perturbations in the gut microbiome composition and function can propagate metabolic inflammation via various mechanisms, including immune cell activation and metabolite-mediated signaling pathways. These alterations may contribute to the pathogenesis of metabolic disorders, encompassing conditions such as diabetes mellitus, obesity, atherosclerosis, and non-alcoholic fatty liver disease (NAFLD), Interactions between the gut microbiota and the immune system also exert significant influence on cancer immune surveillance and response to immunotherapy. Specific microbial taxa within the tumor microenvironment can modulate immune cell activity, impacting tumor growth and treatment outcomes. Exploring the intricate interplay between the microbiome and cancer immunity holds promise for advancing therapeutic strategies in oncology(Zheng et al., 2020).

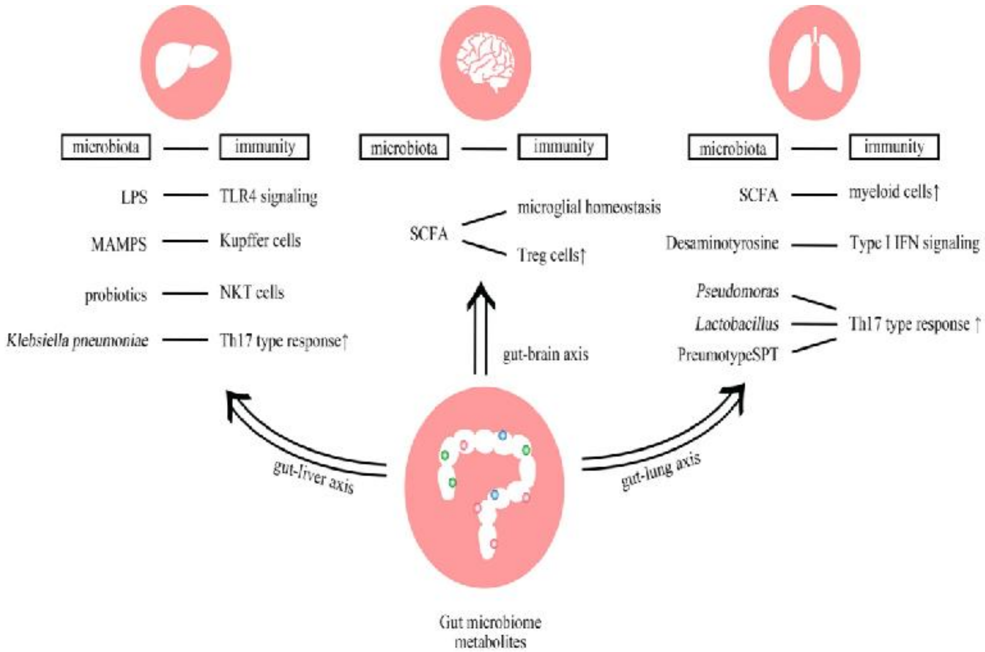

Figure 2. Microbiome-immunity interplay extends beyond the gut to extra-intestinal organs. Gut microbiota and metabolites traverse the bloodstream to organs like the liver, brain, and lung, eliciting site-specific immune responses. In the liver, bacterial components such as lipopolysaccharides activate Toll-like receptor 4 (TLR4), inducing inflammation and modulating Kupffer cell function. Certain probiotics activate hepatic natural killer T (NKT) cells. Pathobionts like Klebsiella pneumoniae provoke Th17 responses in the liver. In the central nervous system (CNS), microbiome-derived short-chain fatty acids (SCFAs) regulate microglial homeostasis and bolster regulatory T cell activity to counter CNS autoimmunity. In the lung, SCFAs influence myeloid cells and shape pulmonary immunological dynamics. Lung-resident microbes like Pseudomonas and Lactobacillus enhance Th17 responses. Additionally, metabolites from bacteria like *Clostridium orbiscindens* modulate type I interferon (IFN) signaling pathways(Zheng et al., 2020).

Despite the efficacy of biologics in managing psoriasis, the precise immunological triggers remain uncertain. The gut-skin connection is gaining attention due to gut microbiome dysbiosis potentially contributing to autoimmune diseases. Our study aims to clarify gut microbiome differences in psoriasis patients in Hong Kong, focusing on taxonomic, functional, and network levels. We found significant variations in gut microbiome profiles between psoriasis patients and controls, particularly in the Firmicutes/Bacteroidetes ratio and specific genera abundance. Notably, *Blautia wexlerae* was enriched in psoriasis patients, while *Parabacteroides distasonis* increased in controls, suggesting potential key roles. Functional analysis revealed alterations in short-chain fatty acid (SCFA) biosynthesis and degradation pathways, known for immune modulation. Co-occurrence network analysis highlighted gut dysbiosis in psoriasis and partial restoration with probiotics. The machine learning-derived gut dysbiosis index showed promise in monitoring dysbiosis and treatment response. These findings underscore gut microbiome involvement in psoriasis and suggest probiotics as a potential therapeutic avenue(Choy et al., 2023). Clinical studies on diet and gut microbiota are limited but promising. Low-FODMAP diets increase beneficial bacteria and reduce harmful ones in Crohn's disease. High-fiber diets improve glucose metabolism in type 2 diabetes. Dietary interventions with flaxseed mucilage enhance insulin sensitivity in obesity. LAB strains like Lactobacillus plantarum have antibacterial properties and immunomodulatory effects, showing potential for inflammation therapy. Diet-based interventions may promote healthy aging and address immune disorders like inflammatory bowel disease (IBD), rheumatoid arthritis (RA), cardiometabolic diseases, and cancer. Microbiome-immunity interactions extend beyond the gut to affect liver, CNS, and lung immunity. Despite progress, more research is needed to understand mechanisms and therapeutic implications.

3. Applications of Probiotics in Disease Prevention and Management

Gut dysbiosis, or an imbalance in gut bacteria, can lead to inflammatory conditions not only in the gut but also in the respiratory tract, causing diseases like asthma, allergies, and COPD. The gut and lungs are connected through the gut-lung axis, allowing immune cells to travel between them. Changes in gut bacteria can affect immune responses in the lungs. Metabolites produced by gut bacteria, like short-chain fatty acids (SCFAs), can also influence immune balance in both the gut and lungs. These metabolites can move from the gut to the lungs and trigger immune responses there(*Frontiers | Publisher of Peer-Reviewed Articles in Open Access Journals*, n.d.). Similarly, lung inflammation can impact gut bacteria. Viral respiratory infections are a major global health concern, and disruptions in gut bacteria can worsen immune responses to such infections. Gut bacteria help regulate the body's defense against viruses by affecting signaling pathways involved in antiviral responses. Probiotics, beneficial bacteria found in certain foods and supplements, can modulate the immune system and reduce the risk of respiratory infections by interacting with receptors on immune cells in the gut. They can activate immune cells that defend against viruses, such as natural killer cells. Studies suggest that probiotics may help prevent respiratory infections caused by bacteria and viruses, including those like the novel coronavirus and influenza virus(Mazziotta et al., 2023).

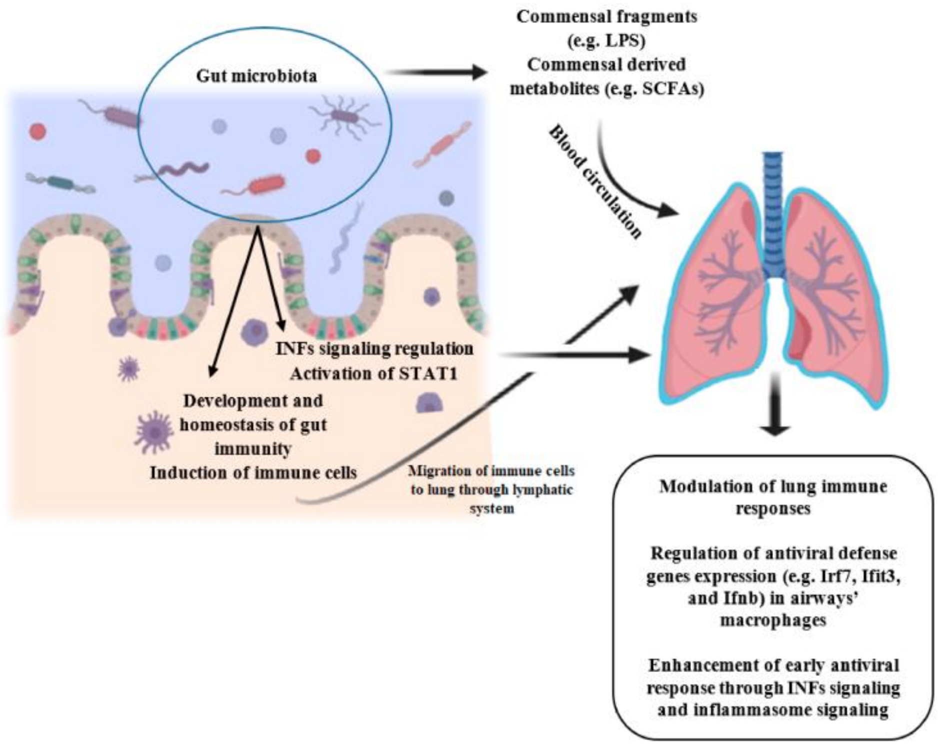

Figure 3. The gut microbiota plays a significant role in preventing viral respiratory infections. Fragments and metabolites derived from commensal bacteria migrate to the lungs through the systemic circulation, where they serve as signaling molecules, eliciting immune responses. Additionally, activated immune cells can migrate from the gut to the lungs via the lymphatic system. Moreover, gut bacteria regulate the activation of STAT1 and interferon (IFN) signaling pathways, which are crucial for the induction of antiviral defense genes before infection and for mediating immune resistance against viral pathogens. These include interferons (IFNs), which play a key role in the body's defense against viruses(Shahbazi et al., 2020).

Recent research has elucidated the significant role of the gut microbiota in modulating human brain function through bidirectional communication known as the gut-brain axis. Probiotics, a subset termed psychobiotics, are investigated for their potential in maintaining mental health. They influence various aspects of brain function, including stress response, neuronal circuits, and mood regulation. This gut-brain axis involves intricate interactions among the central, autonomic, and enteric nervous systems, immune system, and endocrine system. Probiotics have been shown in animal studies and clinical trials to mitigate stress-induced responses and alleviate psychological distress, thereby suggesting their therapeutic potential in managing mental health disorders(Hori et al., 2020). Probiotics exhibit potential efficacy in ameliorating symptoms associated with depression, as evidenced by reductions in depression scores observed in various clinical trials following probiotic supplementation. However, the evidence regarding their impact on anxiety symptoms remains inconclusive, with limited data available. Notably, probiotics do not seem to exert significant effects on symptoms related to schizophrenia. The challenges inherent in probiotic research encompass small sample sizes, methodological heterogeneity, and the variable effects of different probiotic strains. Despite these challenges, probiotics offer promise as adjunctive therapies for select psychiatric disorders, particularly depression. Further investigation is warranted to elucidate their efficacy and refine treatment protocols(Mörkl et al., 2020). Gut dysbiosis disrupts the gut-lung axis, impacting respiratory health by influencing immune responses and metabolite production. Short-chain fatty acids (SCFAs) from gut bacteria modulate immune balance in both the gut and lungs. Viral respiratory infections are exacerbated by alterations in gut bacteria, compromising antiviral immune defenses. Probiotics interact with gut immune cells, enhancing defenses against viruses such as COVID-19 and influenza by regulating antiviral pathways. Furthermore, probiotics, known as psychobiotics, may ameliorate mental health disorders by modulating stress response and mood regulation via the gut-brain axis. While they show promise in reducing depression symptoms, their efficacy in treating anxiety and schizophrenia remains uncertain due to research limitations such as small sample sizes and strain variability. Further investigation is warranted to elucidate their therapeutic potential in psychiatric disorders.

4. Future Perspectives and Challenges

Engineered yeast strains have been developed to respond to extracellular ATP (eATP) in the inflamed gastrointestinal tract by secreting apyrase, an enzyme that hydrolyzes eATP to adenosine. This enzymatic conversion reduces pro-inflammatory eATP levels and promotes the generation of immunosuppressive adenosine, thereby attenuating intestinal inflammation and fibrosis while restoring a balanced gut microbiome. The engineered yeasts harbor a self-tunable gene circuit, controlled by the P2Y2 purinergic receptor and its downstream signaling pathways, which enables them to specifically sense and respond to eATP fluctuations in a time- and location-dependent manner. By enhancing the sensitivity of the human P2Y2 receptor to physiological eATP levels through directed evolution, the anti-inflammatory response of the engineered yeasts has been optimized. This therapeutic platform can be further refined to incorporate multiple regulatory mechanisms and respond to various environmental cues, thereby enhancing its efficacy and safety(Scott et al., 2021a). Through the integration of this engineered gene circuit into the yeast genome, the risk of horizontal gene transfer has been minimized, and biocontainment has been maintained in accordance with regulatory guidelines for live biotherapeutic organisms. This work represents a significant advancement in the fields of directed evolution and synthetic biology for the development of self-tunable anti-inflammatory probiotics. Furthermore, the engineered yeasts described herein hold promise as a targeted therapeutic approach for intestinal inflammation and other inflammatory conditions affecting extraintestinal tissues, such as graft-versus-host disease and irradiation-induced fibrosisClick or tap here to enter text.(Scott et al., 2021b). The Bacterial Cancer Therapy (BCT) platform employs genetically modified strains of Escherichia coli Nissle (EcN) to deliver cytotoxic proteins selectively to tumor cells. These EcN variants are engineered with a bacterial vector, protein payload, and protein-expressing system tailored for targeted tumor delivery. Through metabolic engineering techniques, EcN exhibits notable proficiency in colonizing colorectal tumors, demonstrating minimal sensitivity to diverse administration routes. The engineered strain, EcNe, exhibits specific adhesion to cancer cells and displays a predilection for tumor tissue colonization, resulting in restrained tumor proliferation. The protein payload, hemolysin E (HlyE), is secreted by EcNe and manifests potent cytotoxicity against malignant cells. Engineered EcNe strains proficiently synthesize and dispense HlyE to tumor sites, culminating in considerable tumor regression. Additionally, EcNe/HlyE administration elicits negligible acute infection and exerts regulatory effects on immune responses(Chiang & Huang, 2021). The integration of probiotics into standard therapy for H. pylori infection enhances eradication efficacy while mitigating adverse reactions, such as diarrhea and nausea. However, the effectiveness of probiotics may vary depending on the specific microbial strain(s) used, necessitating further investigation through randomized multicenter studies. Probiotic monotherapy demonstrates promising eradication rates, offering a potential alternative when antibiotic therapy proves ineffective. Probiotics afford flexibility in treatment duration and exhibit a favorable safety profile compared to antibiotics. Various approaches to probiotic therapy include pre-, co-, and post-eradication strategies, each with distinct benefits. Autoprobiotics represent a novel avenue with potential, although their efficacy and safety require validation through randomized placebo-controlled multicenter trials. Overall, probiotics serve as adjunctive therapy to antibiotics for H. pylori eradication, offering an alternative for select patient populations. Identifying the optimal probiotic strains for individual patients is paramount to optimizing treatment outcomes(Baryshnikova et al., 2023). The intricate interaction between the gut microbiota and heart failure presents a promising avenue for innovative therapeutic interventions. Probiotics, by modulating gut microbiota composition, have the potential to mitigate inflammation, oxidative stress, and metabolic dysregulation, all of which contribute to the progression of heart failure(*MDPI - Publisher of Open Access Journals*, n.d.). However, translating these scientific insights into clinical practice faces numerous challenges, including strain-specific effects of probiotics, individual variability in gut microbiota, determination of optimal dosages, and assessment of long-term safety. Advanced technologies such as metagenomics and metabolomics offer opportunities to elucidate the underlying mechanisms of probiotic action and guide personalized interventions. Collaborative efforts among researchers, clinicians, regulatory agencies, and industry stakeholders are essential for translating the potential of probiotics into effective clinical strategies for heart failure management(Petruzziello et al., 2024). Engineered yeast strains respond to gastrointestinal inflammation by secreting apyrase, reducing pro-inflammatory ATP levels, and promoting immunosuppressive adenosine generation. These yeasts feature a self-tunable gene circuit controlled by the P2Y2 receptor, enabling specific sensing and response to ATP fluctuations. Through directed evolution, human P2Y2 receptor sensitivity to physiological ATP levels is optimized, enhancing anti-inflammatory effects. This platform can integrate multiple regulatory mechanisms and respond to diverse cues, minimizing the risks of horizontal gene transfer. The Bacterial Cancer Therapy (BCT) platform employs genetically modified Escherichia coli Nissle (EcN) to selectively deliver cytotoxic proteins to tumor cells, inducing tumor regression with minimal side effects. Probiotics integrated into H. pylori infection therapy enhance eradication efficacy and reduce adverse reactions. Probiotics also show promise in heart failure management by modulating gut microbiota composition to mitigate inflammation and metabolic dysregulation. However, challenges such as strain-specific effects and individual variability necessitate further investigation and collaborative efforts for effective clinical translation.

Conclusion

Probiotics have garnered attention for their potential in targeted immune potentiation (TIP), leveraging their interactions with the gut microbiota and host immunity to modulate immune responses. Their mechanisms of action involve modulation of cytokine production, activation of T regulatory cells, and promotion of mucosal and systemic immunity through IgA antibody production. These immunomodulatory effects contribute to maintaining immune homeostasis and protecting against inflammatory diseases. Recent advancements in probiotic research have introduced innovative strategies, such as engineered yeast strains and bacterial cancer therapy platforms, that offer targeted therapeutic interventions with minimal adverse effects. Engineered yeasts respond to gastrointestinal inflammation by secreting anti-inflammatory agents, while genetically modified bacteria selectively target tumor cells, inducing tumor regression. These developments hold promise for personalized medicine and novel treatment modalities in inflammatory and neoplastic disorders. However, the translation of probiotic research findings into clinical applications faces challenges such as strain-specific effects, individual variability, and the need for standardized protocols. To overcome these challenges and fully realize the therapeutic potential of probiotics in disease prevention and treatment, researchers, clinicians, regulatory agencies and industry stakeholders need to work together.

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Obesity Paradox in Myocardial Infarction

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Introduction

In our research, we are investigating a phenomenon known as the "obesity paradox" in patients who have suffered a heart attack, medically termed myocardial infarction (MI), and undergone treatment known as percutaneous coronary intervention (PCI). While obesity is conventionally regarded as a risk factor for heart issues, certain studies propose that overweight or obese individuals might experience better outcomes following a heart attack compared to those with lower body weight.

To explore this phenomenon further, we are not solely relying on the conventional measure of obesity, body mass index (BMI), which has its limitations. Instead, we are employing a more advanced method called bioimpedance analysis (BIA) to assess fat mass percentage. By employing this method, we aim to achieve a clearer understanding of how both obesity and fat distribution correlate with the incidence of further cardiovascular events in these patients.

Obesity paradox

The obesity paradox refers to the discovery in certain studies of a lower mortality rate among overweight individuals or those within specific subpopulations. This paradox has been noted in individuals with cardiovascular disease and cancer.

OBESITY→ Abnormal or excessive fat accumulation that presents a risk to health

PARADOX→ A statement that seems to go against common sense but may still be true.

Types

- Normal weight obese
- Metabolically obese normal weight
- Metabolically healthy obese
- Metabolically unhealthy obese

Causes

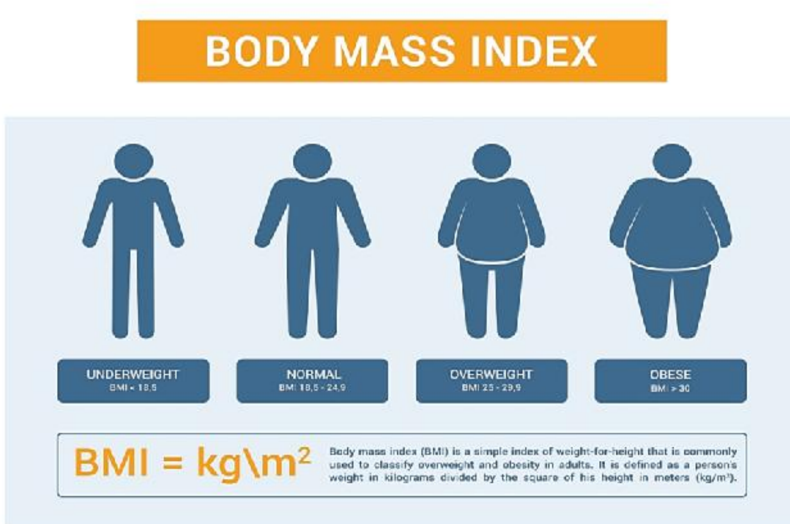
- Lack of physical activity
- Unhealthy diet
- Low fiber diet
- Extreme amount stress
- Genetics and Environment

Significance

- Type 2 Diabetes Mellitus
- Coronary Artery disease
- Cerebrovascular Accident
- Tumor
- Joint Problems,like osteoarthritis.
- Sleep Apnea
- Hypertension
- Fatty Liver Disease: non-alcoholic fatty liver disease.
- Mental Health problems

Body Mass Index (BMI)

Obesity is defined as an excess fat mass (FM) that impairs health,which is most commonly defined by determination of a body mass index



Formula: BMI = weight (kg) / height (m^2)

BMI Ranges

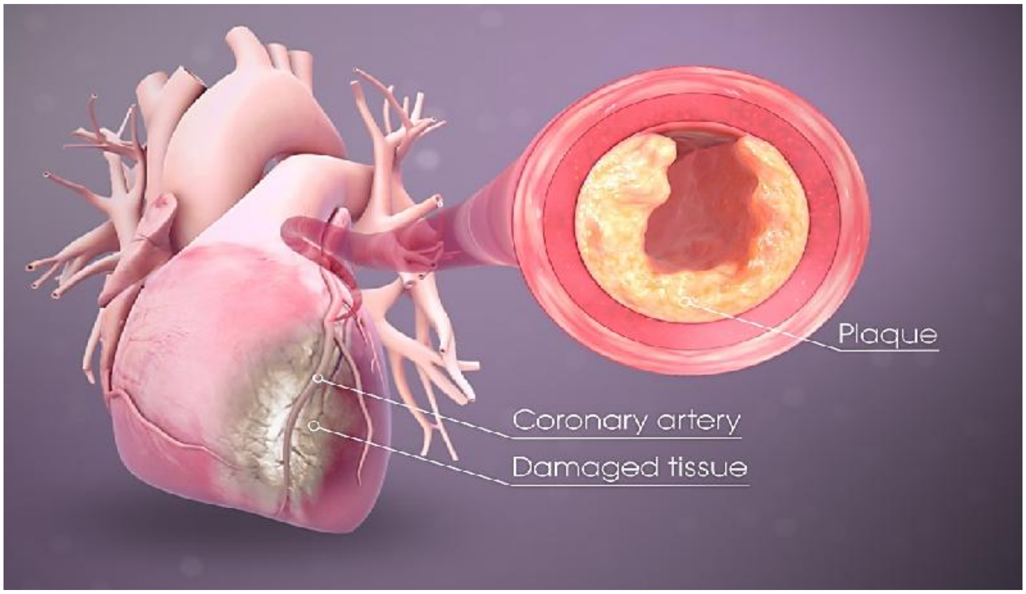
- **Class I**: BMI 30–34.9.
- **Class II**: BMI 35–39.9.
- **Class III**: BMI ≥ 40.

Waist-to-Hip Ratio (WHR)

Risk Level	WHR Range (Women)	WHR Range (Men)
Low	0.80 or lower	0.95 or lower
Moderate	0.81–0.85	0.96–1.0
High	0.86 or higher	1.0 or higher

Myocardial infraction

A myocardial infarction (MI), commonly known as a heart attack, happens when blood flow decreases or halts in one of the coronary arteries of the heart. This interruption results in tissue death (infarction) in the heart muscle. A blood clot forms at the site of rupture, completely obstructing the artery.



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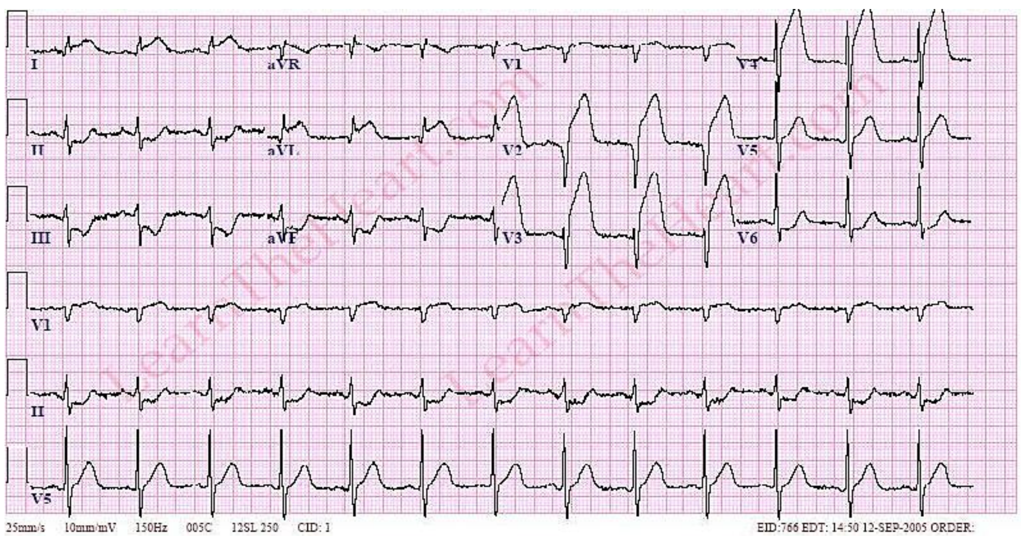


Types of Mi

- ST Segment Elevation Myocardial Infarction (STEMI)
- Non-ST Segment Elevation Myocardial Infarction (NSTEMI)
- Coronary Spasm or Unstable Angina
- Type 1 Myocardial Infarction
- Type 2 Myocardial Infarction

Symptoms and Signs

- Chest pain or discomfort.
- Radiation travel to the shoulder, arm, back, neck, or jaw.
- Imagine a tight band squeezing your chest
- Shortness of breath,
- Nausea, feeling faint, cold sweats,
- loss of consciousness.

Risk Factors

- High blood pressure,
- Smoking, Excessive alcohol intake.
- Diabetes,
- Lack of exercise, Poor diet.
- Obesity,
- High blood cholesterol,

Pathophysiology

Atherosclerosis
↓
Plaque Buildup
↓
Plaque Rupture
↓
Blood Clot Formation
↓
Reduced Blood Flow
↓
Ischemia (Oxygen Shortage)
↓
Cellular Injury
↓
Cardiac Enzymes Released
↓
Chest Pain, Shortness of Breath

Treatment

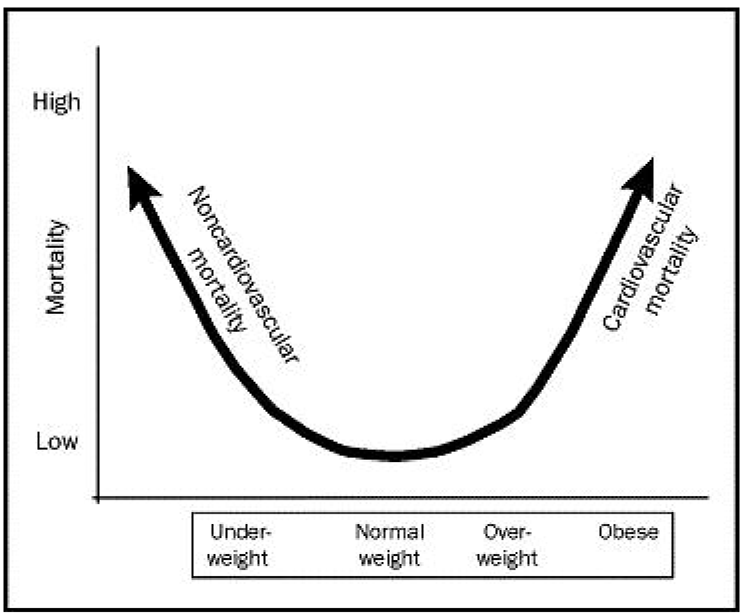
- ACE Inhibitors
- Beta blockers
- Calcium channel blockers
- Nitrates
- Angiotensin 2^{nd} receptor blockers
- Anti-Platelet agent like Aspirin and clopidogrel

Obesity paradox in mi ptients

The term "obesity paradox" describes an intriguing finding: studies have indicated that, in certain subpopulations, overweight or obese individuals fare better than others, particularly concerning cardiovascular diseases, despite obesity being a significant risk factor for numerous health conditions.

Definition:

- The obesity paradox casts doubt on accepted knowledge by indicating that, in some clinical situations, a higher body mass index (BMI) may be protective.
- It's critical to understand that this paradox has only been seen in particular situations and is not relevant everywhere.



Types of obesity paradox:

- Cardiovascular Disease (CVD): Research has shown that people with CVD, including MI, who are overweight or obese had reduced death rates.
- Cancer: Some cancer populations have shown similar surprising findings.

Causes and mechanisms:

- **Survival Bias**: Obese individuals who survive to participate in studies may represent a resilient subgroup.
- **Reverse Causation**: Chronic illness may lead to weight loss, making normal-weight patients appear sicker.
- **Metabolic Reserves**: Excess adipose tissue might provide energy reserves during illness.
- **Inflammation and Immune Response**: Adipose tissue influences immune function and inflammation.
- **Hemodynamic Effects**: Increased body mass may buffer against hemodynamic stress
- **Nutritional Reserves**: Obese patients may have better nutritional reserves.

Significance:

- The paradox challenges our understanding of obesity's impact on health outcomes.
- It underscores the complexity of obesity-related health risks.
    - Challenging Assumptions:
    - Clinical Implications:
    - Complexity of Health Factors:
    - Patient Counseling:
    - Scientific Curiosity:

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Pathophysiology

- **Adipose Tissue**: Adipose tissue is not merely inert; it secretes hormones and cytokines affecting metabolism and inflammation.
- **Insulin Resistance**: Obesity often leads to insulin resistance, which may influence outcomes.
- **Cardiac Function**: Obesity affects cardiac structure and function.

Signs and symptoms

- Chest Pain or Discomfort: Most commonly, patients experience chest pain or pressure. However, in obese individuals, this sensation may differ due to altered chest wall compliance.
- Radiating Pain: Pain may radiate to the left arm, neck, jaw, or back.
- Shortness of Breath: Difficulty breathing, especially during exertion.
- Sweating: Profuse sweating, often described as cold and clammy.
- Nausea and Vomiting: Some patients feel nauseous or vomit during an MI.
- Fatigue: Unexplained fatigue or weakness. Comorbidities:
- Diabetes: Obesity increases the risk of developing type 2 diabetes.
- Hypertension (High Blood Pressure): Obese individuals are more likely to have elevated blood pressure.
- Dyslipidemia: Abnormal lipid levels (high cholesterol or triglycerides) are common in obesity.

Management and treatment:

- **Individualized Approach**:
    - **Why**: People differ, so their treatment should too!
    - **How**: Consider their overall health, other conditions they have (comorbidities), and individual risk factors.
- **Weight Management**:
    - **Why**: Weight impacts health outcomes.
    - **How**: Gradual, sustainable weight loss—no crash diets!

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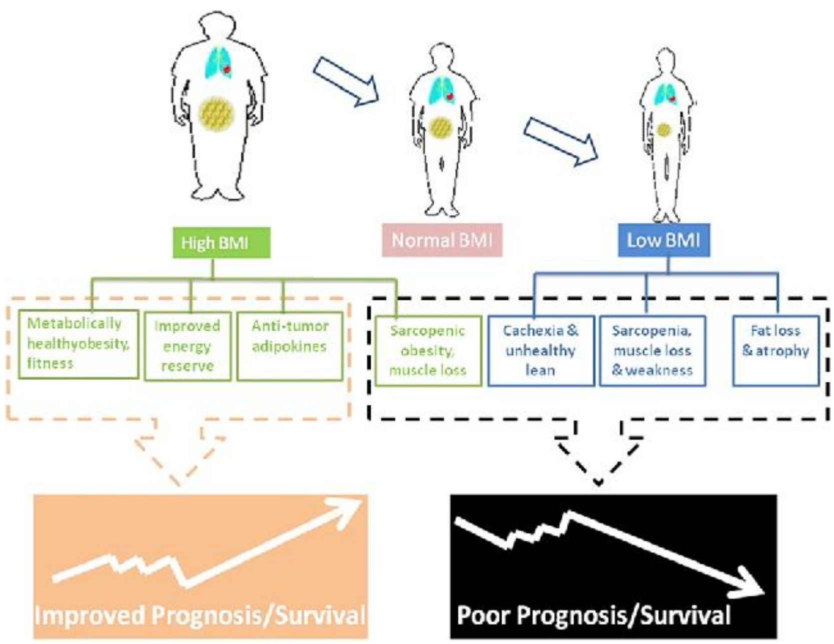
- **Physical Activity**:
  - **Why**: Exercise is like magic for health!
  - **How**: Regular walks, dancing, sports—whatever gets them moving.
- **Nutrition**:
  - **Why?** Food fuels our bodies.
  - **How?** Balanced diet—fruits, veggies, whole grains, lean proteins.
- **Cardiovascular Risk Reduction**:
  - **Why**: Heart health matters!
  - **How**: Manage blood pressure, cholesterol, and blood sugar.
- **Medications**:
  - **Why**: Sometimes pills help.
  - **How**: Doctors decide which meds fit the situation.
- **Behavioral Interventions**:
  - **Why**: Habits matter—good ones lead to better health.
  - **How**: Counseling, motivation, and positive reinforcement.

Prevalence



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1. **Good News**: Overweight and Class I obesity have **lower overall death rates**.

2.**Catch**: Mainly due to fewer non-heart-related deaths.

3.**Watch Out**: Severe obesity (Class III) still risky for heart issues

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Exploring *Actinomycetes* 'Role in sustainable Agriculture'

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History of Actinomycetes:

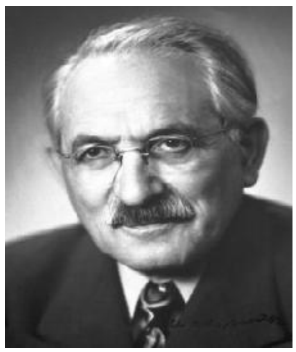

Figure 1 Selman A. Waksman (Nobelprize.org)

Between 1914 and 1939, Selman A. Waksman diligently worked on isolating soil bacteria and fungi capable of producing antibiotics for tuberculosis. In 1939, researchers at the University of California identified a specific type of fungi, actinomycetes, which inhibited bacterial growth. the antibiotic produced by actinomycetes slowed down bacterial growth significantly.[1]. In 1940, he successfully isolated actinomycin, which showed effectiveness against tb. however, a significant drawback was discovered: this antibiotic is toxic to both humans and animals if ingested[2]. Since then, various antibiotics have been developed from actinomycetes. Selman Abraham Waksman (July 22, 1888 – August 16, 1973) was a Biochemist and Microbiologist known for his research on soil-dwelling organisms' decomposition. while he didn't personally discover streptomycin and several other antibiotics from actinomycetes, his work laid the foundation for these breakthroughs.[3].

Characteristics of Actinomycetes:

Classification	
Domain	Bacteria
Phylum	Actinobacteria
Class	Actinobacteria
Order	Actinomycetales
Family	Actinomycetaceae

Streptomyces is the largest genus of Actinobacteria, belongs to genus of the family Streptomycetaceae[4][5]. From them only 500 species of Streptomyces bacteria are isolated. *Actinomycetes* are also called thread or ray bacteria[6]. As with the Other Actinobacteria, Streptomycetes are gram-positive, which form branched filamentous hyphae having resemblance with fungal hyphae, filaments contain mumaric acid. But their hyphal diameter is approximately 1-2µm, whereas in fungi it is 5 to 10 µm[7]. Uncommonly used streptomycin this word came from STREPTOMYCES[8]. *Actinomycetes* are commonly found in soil and marine environment. Micromorphology they are classified based on aerial mycelium, substrate mycelium, spore chain morphology and spore surface. Mycelium is the vegetative part of fungus. Aerial mycelium observed upper layer of medium and it grows upward and outward from the surface of a base of organism where the generation of spore are in continue process. Substrate mycelium remain contact with the substrate [9]. *Actinomycetes*spp. are able to stimulate lung macrophage reactions, which can lead to inflammation and tissue injury[9]. *Actinomycete*s spores are formed either by subdivision of existing hyphae by fragmentation or swelling or by endogenous spore formation. The hyphae that subdivide into spores can be sheathless or have a sheath, after fragmentation partly remains in spore form. This leads to three types of spores: arthrospores (subdivision of sheathed hypha), aleuriospores (subdivision of sheathless hypha), and endospores[10]. The significance of the differences in the spore structure is not known, but these differences are expected to cause differences in the survival and airborne behavior of these spores [11][12]. Cultural characteristic based on colony consistency, aerial mass color, reverse side pigment, soluble pigment and melanoid pigment[13][14].

Difference between Actinomycetes and Bacteria:

Actinomycetes	Bacteria
*Actinomycetes*are filamentous bacteria	A large group of microorganisms with a murine cell wall and no membrane-bound organelles.
Gram positive	Gram positive and gram negative also.
Facultative anaerobe	Aerobes, anaerobes and facultative anaerobe
Actinomycetes colonies leathery and form fungus-like branched networks of hyphae	Bacteria to form slimy colonies called biofilms
*Actinomycetes*have earthy smell	Bacteria make a lot of different types of smells
*Actinomycetes*are non-motile, non-capsulated and non-acid-fast	Bacteria are motile, capsulated and some bacteria are acid fast
*Actinomycetes*are slow grower 6-7 days for growth	Bacteria are fast grower within 24-48hrs
High G+C contain in their genetic material	Different contain of A+T and G+C in their genetic material
Grow in hyphae form	Grow in colony form

Distribution and mode of nutrition in *Actinomycetes*:

Soil *Actinomycetes* thrive within a temperature range of 32 C to 36 C, a pH range of 5.5 to 8.0, and a NaCl concentration of 0% to 0.5%. They struggle to survive in extreme soil conditions such as high salt levels or low moisture but are known to support plant growth [10]. On the other hand, marine *Actinomycetes*prefer a temperature of 37 C for optimal growth, with some species capable of growing at 40 C[15]. They exhibit minimal growth in saline environments, requiring a minimum of 3% W/V NaCl. Interestingly, even marine *Actinomycetes*without salt display a reduced growth rate due to their Na+ ion membrane transport system, which is essential for maintaining a high intracellular potassium concentration necessary for activating various enzymes. Regarding pH levels, they exhibit maximum activity at a pH of 3.5, which is acidic, but their activity decreases at lower pH values[16][17].

Life cycle of actinomycetes:

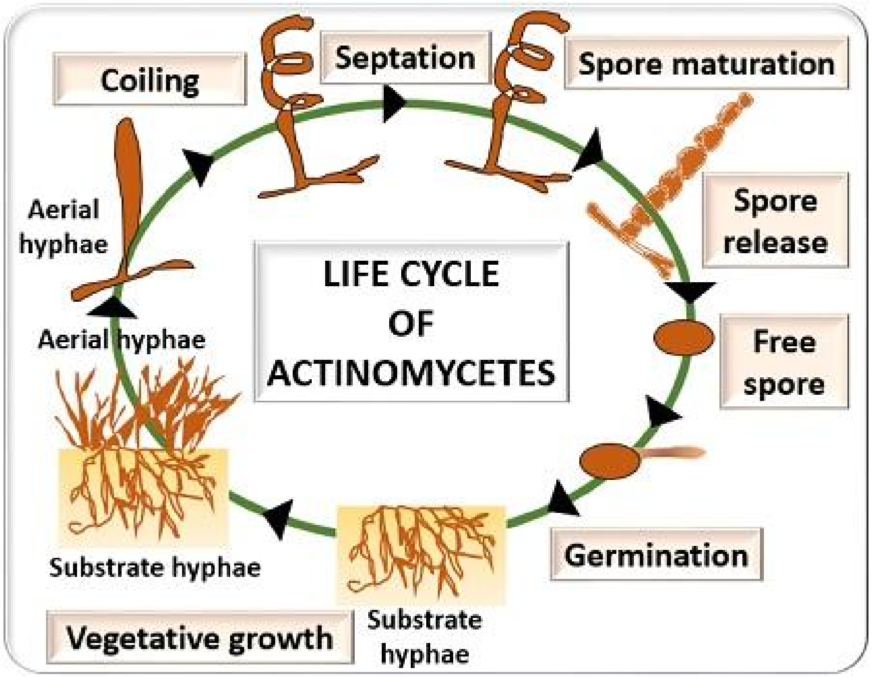

Figure 2 Reproduction in actinomycetes (biologyreader.com)

Actinomycetes life cycle include following steps:

Step 1.) Germination: The spores of *Actinomycetes* remain free in the environment as a "**Free spore**". During unfavorable condition spore are in dormant stage of germination when they provide favorable condition spores are germinates and form a "**Germ tube**".

Step 2.) Vegetative Growth: The germ tube promotes growth of hyphae in form of aerial hyphae which grows upward and outward from the surface and substrate hyphae remain contact with the substrate

Step 3.) Coiling: during unfavorable condition in environment, aerial hyphae change its structure in coiled shape.

Step 4.) Septation: in vegetative hyphae formation of septa in septation stage

Step 5.) Spore maturation: after septation hyphae is mature and they form chain of spores. Thus forms by fragmentation or swelling of the hyphae.

Step 6.) Release of spore: During the unfavourable condition, the spores get separated from the vegetative hyphae and are free in the environment [18][19][10].

Isolation of *Actinomycetes*:

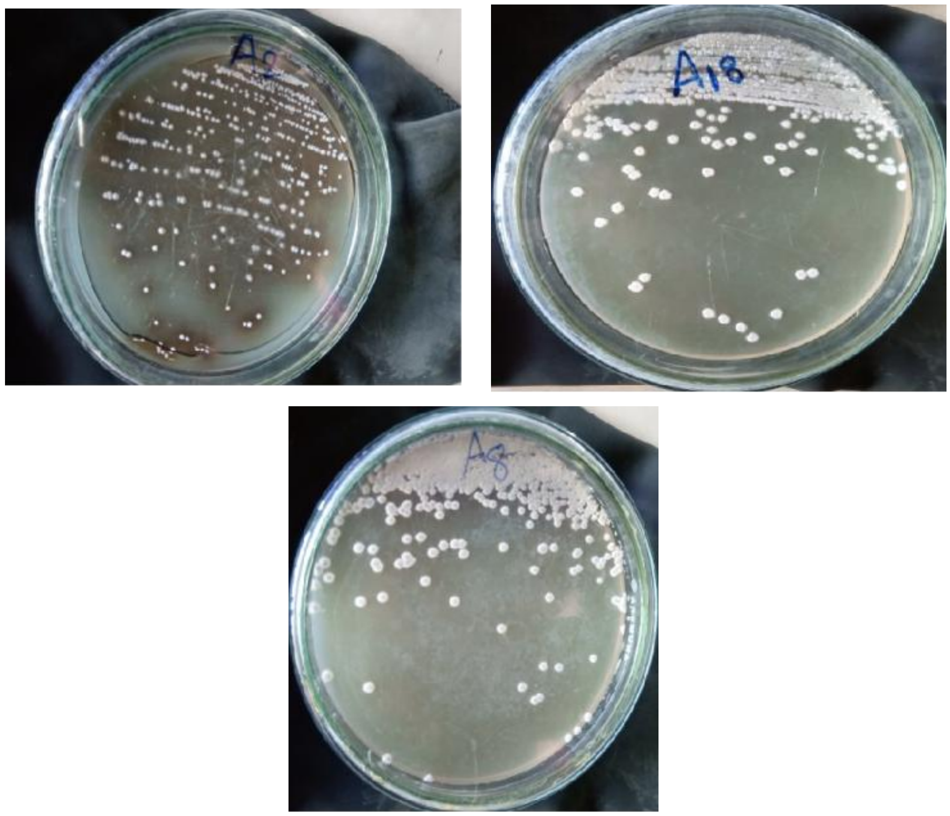

Figure 3 Isolation of soil Actinomycetes (Bhoomi N Patel) Muis Microbiology laboratory Ganpat University Kherva Gujarat India

Isolation of *Actinomycetes* by using different types of media:

Sr.no	Types of media	Main source	Application
1.)	Starch casein agar (SC)	Starch and Casein as carbon and nitrogen source	saccharolytic marine bacteria and mostly *Actinomycete*s
2.)	Luria Bertani agar (M1)	Tryptone as nitrogen source	Prokaryotic bacteria
3.)	Starch nitrate agar (SN)	Starch as carbon source	*Actinomycetes*
4.)	Actinomycetes isolation agar	sodium caseinate as nitrogen source	*Actinomycetes*
5.)	Glucose soyabean agar	Glucose	Aerobic *Actinomycete*s
6.)	Actinomyces Agar	Beef heart infusion, solids and Tryptose	Anerobic *Actinomycete*s

Before isolation of *Actinomycete*s, soil samples was heated for 1hr. at 121 C. For streaking make serial dilutions upto 10^{-6} carried out. For membrane filtration pre treated soil samples were sprinkle on membrane filters after 4day incubation membrane were removed from filter.direct inoculation in culture media which involved application of 2-3 mg of soil. Characterizations of *Actinomycete*s were done by cultural characteristics, morphological characteristics and biochemical characteristics of isolates. Isolation of *Actinomycete*sby using direct inoculation, serial dilution and membrane filtration were also significantly different [20].

Isolation of Saprophytic *Actinomycete*s. In studying saprophytic *Actinomycete*s cannot tolerate an acid medium. Acid-sugar media which support the growth of yeasts and molds there for this medium is not used for *Actinomycete*s. Sugar which is present in medium and due to sugar fastidious bacteria are easily utilized this medium and their over growth suppresses the *Actinomycete*s. Very small amount of nutrition is required for growth of *Actinomycete*s so, avoid growth of bacteria which are not able to grow at low nutrition level. Capek's solution agar used for isolation of saprophytic *Actinomycete*s. This medium will not allow to grow other bacteria and those that do are not spread [17][21].

Genetic material in *Actinomycetes*:

Genetic material as a DNA, consist of helical structure with sugar and phosphate backbone attached through adenine, thymine, guanine and cytosine (A+T have 2bonds and G+C have 3bonds). Comparative study of actinomycetes genetic material with bacterial genetic material resulted in *Actinomycete*scontain high 60%-78% G+C ratio compare to bacterial genetic material. Due to their high G+C ratio survive in extreme environment [21][22].

Economics important of actinomycetes:

Actinomycetes have huge application in production of different types of antibiotics like tetracycline, chloramphenicol, neomycin, amphotericin, novobiocin etc [23]. They have capacity to digest complex compounds like cellulose, hemicellulose, carbohydrates, chitin etc. thus *Actinomycete*ssp. Play important role in bioremediation [24]. Use in regulation of plant growth which produces phytohormones also produces certain bioactive compounds and extracellular enzymes. These compounds promote direct plant growth and protect against phytopathogens and pests by producing indole 3-acetic acid, solubilize phosphate and siderophore [21]. application of enzymes in different fields like which is produced by *Actinomycete*s.

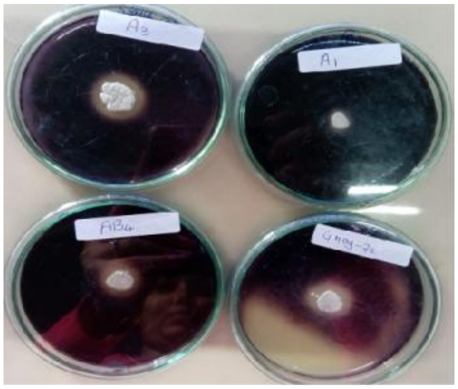

Figure 4 Amylase producing Actinomycetes (Bhoomi N Patel Muis Microbiology laboratory Ganpat University Kherva Gujarat)

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Figure 5 Pectinase producing Actinomycetes (Bhoomi N Patel Muis Microbiology laboratory Ganpat University Kherva Gujarat)

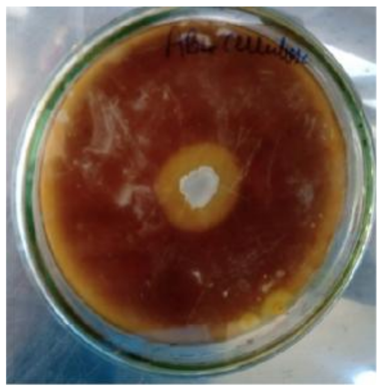

Figure 6 Cellulase producing Actinomycetes (Bhoomi N Patel Muis Microbiology laboratory Ganpat University Kherva Gujarat)

Microorganisms found in biofertilizers are responsible for these attributes. While various microorganisms are suitable for biofertilizer formulation, *Actinomycete*sst and out due to their unique characteristics. Unlike bacteria and fungi, *Actinomycete*splay a crucial role in the soil ecosystem, benefiting not only industries but also agriculture[25]. They are seen as promising candidates for biofertilizer production because they have the ability to produce a diverse array of secondary metabolic compounds and substances with antibacterial, antifungal, and antagonistic properties[26]. Using *Actinomycete*s to enhance soil fertility and plant growth is an appealing method for creating sustainable agricultural systems because of their efficiency, environmentally friendly nature, and cost-effectiveness.

Traditional agriculture has played a vital role in boosting crop yields and meeting the food demands of a rapidly expanding global population. However, the extensive application of fertilizers and agrochemicals has raised significant environmental and health issues. Organic farming is emerging as a viable alternative to conventional farming methods. This approach advocates for the use of natural substances and biofertilizers instead of synthetic chemicals to enhance plant growth, productivity, and resilience to stress. Furthermore, natural compounds and biofertilizers have the potential to synthesize nanoparticles, potentially reducing the reliance on synthetic fertilizers [27].

Contribution in Maintaining Soil Fertility

Production of Lytic Enzymes

Actinomycetes are known for secreting numerous lytic enzymes as part of their biocontrol mechanisms. These enzymes work by breaking down cell wall materials, thus combating pathogens[28]. For instance, the damping-off disease caused by Pythium aphanidermatum in cucumber seedlings can be countered by several strains of *Actinomycete*s such as *Actinoplanes phillippinensis*, *Microbispora rosea*, *Micromonospora chalcea*, and *Streptomyces griseoloalbus*. These actinobacterial strains produce significant amounts of β-glucanases that can disrupt the fungal pathogen's hyphae. Additionally, some strains release inhibitory metabolites, while others can parasitize the pathogens' oospores[29][30].

Sr.no	Enzymes	Applications
1.)	Cellulase	softening of garments, and removal of excess dye from the fabrics and textile wet processing
2.)	Pectinase	clarification, extraction, and stabilization of fruit juices
3.)	Amylase	Paper industry, food industry and textile industry
4.)	Chitinase	Biochemical industries, treatment of chitinous waste and for mosquito control
5.)	Catalase	Food and detergents industries
6.)	Lipase	food, detergent, pharmaceutical, leather, textile, cosmetic, and paper industries

Nitrogen Fixation

Actinomycetes play a significant role in nitrogen fixation in both legumes and non-legumes, even without nodules forming[31] [2,17]. This makes them highly influential in regulating nitrogen availability and movement within the air, soil, and plant systems. Additionally, *Actinomycete*scan impact plant processes like photosynthesis, as well as carbon and nitrogen metabolism. For example, research has shown that *Actinomycete*s*coelicolor* HHFA2 can boost the content of photosynthetic pigments and improve foliar growth parameters in onions, as demonstrated in pot and field experiments [4].

Phosphate Solubilization

Phosphorus is crucial for plant growth and development, yet much remains unavailable in soil, leading to low phosphorus-use efficiency. Microbial solubilization of phosphorus, especially by *Actinomycetes* like *Streptomyces*, offers an eco-friendly alternative to chemical fertilizers. *Streptomyces* species have been found capable of solubilizing various phosphorus sources, including tricalcium phosphate, aiding in plant nutrition. Studies show *Streptomyces* strains can produce significant phosphorus amounts, with some outperforming other phosphorus-solubilizing bacteria. This microbial strategy not only benefits plant health but also reduces environmental impact and promotes sustainable agriculture[32].

Potassium Solubilization

Another crucial element vital for plant growth is potassium. Plants typically absorb potassium ions, which are essential for regulating stomatal pores' opening and closing[33]. Besides reducing stress in plants, potassium aids in detoxifying plants by neutralizing the harmful effects of reactive oxygen species[34]. Its involvement in respiratory chain activities and metabolic processes is also well-documented. Potassium deficiency can render plants susceptible to various pathogens and pest infestations. The decline in potassium levels, along with other essential macro nutrients, is a common issue due to intensive crop production methods and the use of high-yielding crop varieties[35].

An environmentally friendly approach to address depleted potassium levels and restore soil fertility is through an integrated nutrient management system that utilizes potassium-solubilizing microbes. These microbes employ several mechanisms such as exchange and complexation reactions, organic acid production followed by acidolysis, and chelation to facilitate potassium availability. Several *Streptomyces* species, like *Streptomyces* sp. KNC-2 and

Streptomyces sp. TNC-1, have been identified for their effective potassium-solubilizing abilities.

Siderophores production

Siderophores are compounds synthesized by various soil microorganisms, utilizing chelation processes to support their biological functions. These molecules, characterized by their extracellular fluorescent pigmentation, exhibit a strong affinity for iron (III), are water-soluble, and typically have a low molecular weight ranging from 500 to 1000 Da [36]. They are notably produced by a diverse range of microorganisms thriving in environments with limited iron availability. Siderophores function as specific chelating agents for ferric ions, converting them to the ionic form (Fe^{2+}), which is readily assimilated by microorganisms [10]. Upon formation of the Fe^{3+}-siderophore complex, cell membrane receptors recognize these compounds, aiding in their cellular uptake. Inside the cell, Fe^{3+} ions undergo reduction to Fe^{2+}, thereby becoming accessible for various biological processes. Eventually, the siderophore is released again. *Actinobacteria* stands out as one of the primary producers of siderophores among microorganisms.

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Pigeon's role in (*Columba livia*) Ecological enrichment

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Abstract

The rock pigeon is the world's oldest domesticated bird. Pigeons have held historical importance to humans as food, pets, holy animals, and messengers. Due to their homing ability, pigeons have been used to deliver messages, including during the world wars. Pigeons play diverse and vital roles in ecosystems. In rural and urban ecosystems, pigeons fulfil several important ecological roles.As primary consumers, they form a significant part of the food chain, supporting substantial predation by various urban predators. While they themselves are preyed upon by birds of prey such as falcons and hawks, pigeons also serve as essential seed dispersers, aiding in the growth and spread of various plant species by consuming fruits and seeds. Additionally, their occasional consumption of nectar-rich flowers allows them to contribute to pollination, albeit to a lesser extent compared to specialized pollinators. Overall, pigeons act as urban and rural keystone species, influencing trophic levels as both primary consumers and prey for urban raptors.

Keywords: Feral pigeons, Ecosystem, Seed dispersal, Pollination

Introduction

The domestic pigeon, *Columba livia*, likely descended from the rock dove, known for nesting and roosting on natural rock formations like cliffs, gorges, and caves. Feral pigeons found in urban areas are descendants of escaped domesticated birds, utilizing human-made structures' ledges akin to how rock doves use natural rock formations. These feral pigeons form groups ranging from pairs to large, loosely organized flocks for feeding and roosting.

Despite their communal behavior, pigeons are territorial creatures, fiercely defending their roosting and nesting spaces. During breeding seasons, pairs are typically monogamous, with males separating females from the rest of the flock.

Primarily seed eaters, domestic pigeons also consume a variety of grains, fruits, berries, vegetation, and small invertebrates like snails. With over 200 distinct breeds, some bred for racing or exhibition purposes, certain traits in pigeons may lead to welfare concerns. Hence, careful consideration is necessary when selecting breeds for laboratory use. Throughout history, pigeons have held significance for humans as sources of food, companionship, sacred animals, and messengers. Today, they remain crucial in laboratory research, particularly in fields such as endocrinology and genetics.

Ecological role of birds

Birds indeed hold immense importance in ecosystems due to their diverse ecological roles: Many bird species, such as hummingbirds and certain songbirds, play essential roles in pollinating flowers. As they feed on nectar, pollen sticks to their bodies and is transferred from flower to flower, facilitating the reproduction of flowering plants and the production of seeds and fruits. Birds consume a variety of seeds and fruits as part of their diet. Through their movements and droppings, birds help disperse seeds to new locations, aiding in the colonization of plant species and promoting biodiversity across different habitats. Birds, particularly scavengers like vultures and crows, play vital roles in recycling nutrients within ecosystems. By consuming carrion and organic matter, these birds help break down dead organisms and return nutrients to the soil, contributing to soil fertility and ecosystem health.Some bird species, such as insect-eating birds like swallows and warblers, help control insect populations by preying on pests that can damage crops and vegetation. Their predation helps maintain ecological balance and reduce the need for chemical pesticides. Birds form mutualistic relationships with plants, particularly those that rely on bird pollination or seed dispersal. In exchange for nectar, birds assist in pollination, ensuring the reproductive success of flowering plants. Overall, birds play multifaceted roles in ecosystems, contributing to the functioning and resilience of natural systems. Understanding and conserving bird populations are crucial for maintaining biodiversity and ecosystem health.

Most common birds in Tamilnadu

Tamil Nadu has over 2,000 species of fauna, including a rich wildlife due to its favorable climate, vegetation, and diverse relief features. Tamil Nadu boasts a rich and varied landscape encompassing hills, coasts, forests, and wetlands, offering diverse habitats for a plethora of bird species. The following are most common birds found in the region, each renowned for its vibrant plumage, distinctive behaviors, and specialized adaptations to thrive in the varied environments of Tamil Nadu.

- House crow
- Common myna
- Large-billed crow
- Rose-ringed parakeet
- Rock pigeon
- Asian koel
- Common tailorbird
- Red-vented Bulbul.

Feral Pigeons

From ancient times, pigeons have been emblematic of peace, love, and purity, drawing tourists to many renowned locations. Pigeons possess remarkable intelligence, often compared to the Raven, a renowned symbol of intelligence in the avian world. Their visual acuity surpasses that of humans, enabling them to perceive details that escape our notice. Pigeons demonstrate cognitive abilities such as numerical recognition, distinguishing numbers from one to nine. Moreover, they exhibit a remarkable aptitude for recognizing human faces and interpreting facial expressions, especially in individuals with whom they have developed a relationship. This cognitive prowess highlights the complexity of pigeon cognition and their remarkable capacity for social interaction with humans.

Typically found in urban areas, these pigeons, known as 'Feral pigeons,' freely roam cities, establishing nests wherever space permits.

Pigeons role in ecological enrichment

Pigeons not only add to the natural beauty but also play a crucial role in balancing the urban ecosystem. While their growing numbers may pose challenges, managing their population can help maintain environmental equilibrium.

1. Pigeons' Role in Waste Cleanup:

Pigeons aid in cleaning up urban areas by consuming seeds, nuts, vermin, and insects, which often accumulate in garbage. Their scavenging behavior contributes to swift waste disposal. Firstly, pigeons aid in waste cleanup by consuming various organic materials found in urban areas. Their diet includes seeds, grains, fruits, and insects, which are commonly found in discarded food scraps and other organic waste. By foraging on the streets and in public spaces, pigeons help prevent the accumulation of organic matter, reducing the potential for pest infestations and foul odors associated with decaying waste.

Moreover, pigeons contribute to waste cleanup through their natural behaviors, such as pecking and scratching at surfaces. This behavior helps to dislodge and break down organic debris, facilitating its decomposition and eventual assimilation into the environment. Additionally, pigeons' droppings, or guano, contain valuable nutrients such as nitrogen, phosphorus, and potassium. When deposited on surfaces, these nutrients contribute to soil fertility, promoting the growth of vegetation and facilitating the decomposition of organic matter.

2.Insect Control:

By preying on vermin and insects attracted to trash, pigeons help prevent the spread of pests and the associated mess, reducing the risk of zoonotic diseases. Although pigeons primarily feed on seeds, grains, and vegetation, they also consume small invertebrates like insects, particularly when they are readily available. In urban areas where food sources may be limited, pigeons may supplement their diet with insects found in parks, gardens, and other green spaces.

3. Pigeons Impact Habitat Formation

Pigeons play a role in shaping and altering habitats through their nesting behaviors. They construct simple nests using twigs, leaves, and various materials in diverse locations such as cliffs, ledges, buildings, bridges, and trees. As nesting materials and droppings accumulate over time, they transform the physical attributes of nesting sites, forming microhabitats that can benefit other bird species and wildlife.

4.Pigeons' Role in Nutrient Circulation within Ecosystems

Pigeons play a vital role in ecosystem nutrient cycling through their feeding and nesting activities. Their droppings, known as guano, are rich in essential nutrients like nitrogen, phosphorus, and potassium. When deposited in the environment, pigeon guano serves as a valuable fertilizer, enriching soil fertility and stimulating plant growth. In natural habitats, accumulations of pigeon guano act as significant nutrient reservoirs, benefiting soil microorganisms, plants, and various other organisms, thereby contributing to the overall health and productivity of ecosystems. When pigeons pass away and fall to the ground, they become food for various insects, including ants. They're busy creating countless tiny tunnels in the soil, which serve as pathways for water, nutrients, and oxygen to reach deeper into the earth. Interestingly, in the absence of oxygen, roots can rot and perish. So, in an unexpected twist, the carcass of the pigeon plays a role in sustaining plant life. Ants transport numerous small meat fragments into their tunnels, inadvertently aiding in the nourishment of plants above ground.

5. Seed Dispersal:

Pigeons play a vital role in ecosystem maintenance by dispersing seeds, promoting the growth of vegetation in various locations. This facilitates the proliferation of trees, contributing to biodiversity conservation efforts. Pigeons play a crucial role as seed dispersers for numerous plant species, especially those bearing fleshy fruits. As pigeons ingest these fruits, the seeds largely remain intact through their digestive system and are subsequently excreted in their feces. This mechanism aids in the dispersal of seeds away from the parent plants, allowing them to germinate and thrive in new locations. By facilitating the establishment of new individuals, pigeon-mediated seed dispersal promotes genetic diversity within plant populations, contributing to the resilience and sustainability of ecosystems.

6. Role of Pigeon in Pollination

Though pigeons aren't specialized pollinators like bees or butterflies, they can inadvertently aid in pollination when they visit nectar-producing flowers. While feeding on nectar or pollen, pigeons may inadvertently transfer pollen between flowers, facilitating cross-pollination and promoting genetic diversity within plant populations. While their contribution to pollination may be less pronounced compared to other animal pollinators, pigeons can still play a role in the reproductive success of certain plant species.

7. Economic Significance:

Pigeons have been historically valued for their role as a food source and tourist attraction. Tourists often favour destinations with abundant pigeons for their scenic beauty, enhancing the economic appeal of such areas. Additionally, their waste-cleaning behavior reduces local cleaning costs and provides a nutritious food source for urban residents, thereby bolstering public health and the urban economy.

8. Supporting Predatory Animals:

Pigeons serve as prey for both humans and other predatory animals, maintaining a balanced ecosystem and supporting the natural food chain. Pigeons fulfill an important role as prey for a diverse array of predators, including birds of prey like hawks, falcons, and owls, as well as mammals such as foxes and raccoons, and reptiles like snakes. Being a readily accessible food source, pigeons contribute significantly to supporting the populations of predator species. Their presence in the food chain helps maintain the balance and functioning of ecosystems by providing sustenance for various predators, thereby contributing to the complexity and stability of food webs.

9. Religious and Cultural Importance:

Pigeons hold symbolic significance in various religious traditions, representing purity and harmony. Pigeons have been esteemed by humans for millennia, playing significant roles in culture, history, and society. Descended from wild rock doves, domesticated pigeons have served various purposes, including messenger duties, racing competitions, and as ornamental pets. Pigeon racing boasts a rich tradition and continues to be a beloved pastime in many nations.

Furthermore, pigeons hold revered status as symbols of peace, freedom, and spirituality across diverse cultures and religions. For instance, the dove symbolizes peace and reconciliation in Christianity, Judaism, and Islam, drawing from narratives such as Noah's Ark and the dove bearing an olive branch.They are often revered in many religious sites hosting flocks of pigeons as a symbol of compassion and connection to the divine.

Conclusion

In conclusion, pigeons fulfil crucial ecological roles as seed dispersers, prey for predators, contributors to nutrient cycling, creators of habitat, potential pollinators, and bearers of cultural and historical significance. Despite being sometimes disregarded as urban pests, pigeons play integral parts in maintaining ecosystem functionality and resilience. Their deep intertwining with human culture and society underscores their importance beyond mere urban inhabitants.

Overall, pigeons play integral roles in both urban and rural ecosystems by facilitating seed dispersal, influencing trophic dynamics, contributing to nutrient cycling, modifying habitats, and aiding in pest control. Understanding and conserving these ecological functions are essential for maintaining the biodiversity and sustainability of rural environments.

By acknowledging and valuing the ecological contributions of pigeons, we can cultivate greater awareness and spur conservation efforts to safeguard these remarkable birds and the ecosystems they inhabit. Recognizing pigeons' multifaceted roles fosters a deeper understanding of urban biodiversity and promotes harmonious coexistence between humans and wildlife. This scenario underscores a fundamental principle of nature: everything within the biosphere operates in harmony with one another, except perhaps for Homo sapiens. It's a reminder of the interconnectedness of all living things and the vital roles they play in sustaining ecosystems.

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Diabetes in youngsters - An emerging threat of the era

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Abstract

The rising prevalence of diabetes among young individuals presents a significant public health concern globally. This paper delves into the intricate factors contributing to this emergent phenomenon, encompassing genetic predispositions, lifestyle choices, and socio-economic influences. Drawing upon contemporary epidemiological data, the study delineates the escalating incidence of diabetes in youth cohorts and its ramifications on long-term health outcomes. Moreover, it discusses preventative measures and interventions aimed at alleviating the burden of diabetes in young populations, stressing the importance of early identification, education, and lifestyle adjustments. Through a thorough examination of the multifaceted nature of this issue, this article aims to foster awareness and advocate for proactive strategies to tackle the burgeoning challenge of diabetes in today's youth.

Keywords: diabetes in youngsters, causes, other types of diabetes, complications, diabetic Ketoacidosis with treatment, risk factors, HbA1c, awareness, management.

Introduction

What is diabetes? A Diabetes is a condition that happens when your blood sugar {glucose} is too high. It develops when your pancreas doesn’t make enough insulin or your body isn’t responding to the effects of insulin properly. Source of glucose mainly comes from carbohydrates for example: when glucose present in your bloodstream it needs a vehicle to reach its destination {vehicle is insulin} a hormone. If your pancreas isn’t making enough insulin or your body not properly using it; glucose builds up in your bloodstream causing high blood sugar {hyperglycemia}.

Types of diabetes

- ✓ **Type 1 diabetes:** This type is an autoimmune disease in which your immune system attacks and destroys insulin producing cells in your pancreas upto 10% of people who have diabetes. It is usually diagnosed in children and young adults.

- ✓ **Type 2 diabetes:** In this type your body doesn't make enough insulin or your body cells don't respond normally to the insulin {insulin resistance}. This is the most common type of diabetes. It usually affects adults.

Diabetes in youngsters

Diabetes is no longer constricted to age. The dreaded condition is now taking alarming proportions in youth. There are more than 72 million adults in India with diabetes and worldwide it has afflicted more than 422 million people.

Reasons for rising type 2 diabetes in children

- While type 2 diabetes is frequent among adults and the elderly, obesity and unhealthy eating habits have caused it to become a common illness amongst youngsters. Many blame it on genetics, however lack of physical activity and belly fat are leading causes of increasing number of children and teens with type 2 diabetes.
- The national diabetes statistics report 2020 states that around 2,10,000 children and teenagers under the ageof 20 years in the United States have diagnosed diabetes.Type 1 diabetes is much more common in young people than type 2 diabetes .However the rates of both types in young people are increasing .In 2014-2015 doctors diagnosed type 1 diabetes in around 18,291 young people aged 10-19 years and type 2 diabetes in around 5758 young people . The national institute of health{NIH} reports that each year rates of type 1 diabetes are rising by 1.8% and rates of type 2 diabetes are rising by 4.8%. Young people who develop diabetes have higher risk of health challenges and problems throughout their life.

Reasons behind the cause of diabetes in children and teens

People can develop type 1 diabetes at any age from childhood to adulthood but the average age of diagnosis is 13 years. At estimated 85% of all type 1 diagnoses take place in people aged under 20 years, where type 2 is less common in young children but the rates of type 2 diabetes are increasing along with increase in childhood obesity.

Causes of diabetes in teens and children

- Type 1 due to the attack of auto immune cells which affect or destroy the beta cells of pancreas which produces insulin

- Type 2 due to overweight, obesity, physical inactivity, insulin resistance, genes and family history, heart and blood vessel diseases.

Risk factors

Type 2 diabetes occurs more commonly in adults. In fact it is used to be called adult - onset diabetes. But the increasing number of children with obesity has led to more cases of type 2 diabetes in younger people

- Obesity
- Lack of physical activity
- Dietary intake of food {irregular}
- Irregular sleep pattern
- Junk food/oily foods.

Type 2 diabetes in children is often associated with metabolic syndrome and polycystic ovarian syndrome

Metabolic syndrome

Certain conditions occur with obesity, they are associated with insulin resistance and can increase the risk of diabetes- leads to heart disease and stroke

- High blood pressure
- low levels of HDL{high density lipoprotein} The good cholesterol
- High triglycerides
- High blood sugar level
- Large waist size

Polycysytic ovarian syndrome

It affects young females after puberty. PCOS is caused by an imbalance of hormones, resulting in signs such as weight gain, irregular menstrual periods, excess face and body hair, people with PCOS often have problems with metabolism that can result in insulin resistance and ultimately end up in type 2 diabetes mellitus.

Symptoms

- ✓ Increased thirst
- ✓ Frequent urination
- ✓ Increased hunger
- ✓ Fatigue
- ✓ Blurry vision
- ✓ Darkened areas of skin

- ✓ Unintended weight loss.{although this is less common in children with type 2 diabetes than in children with type 2 diabetes}
- ✓ Frequent infection.

Complications

- × High cholesterol
- × Heart and blood vessel diseases
- × Stroke
- × Nerve damage
- × Kidney disease
- × Eye disease, including blindness.

Diabetic ketoacidosis

It is a serious complication of diabetes. This condition develops when the body can't produce enough insulin, without enough insulin body begins to break down fat as fuel this causes a buildup acidin the blood stream called ketones, if left untreated the buildup can lead to diabetic ketoacidosis

Symptoms include thirsty, frequent urination, stomach pain, tired, shortness of breath, fruity scented breath and confused.

Lab diagnosis

- ➢ Fasting blood sugar level
- ➢ Postprandial blood sugar level
- ➢ Random blood sugar level
- ➢ Renal function test
- ➢ HbA1c { glycosylated hemoglobin}
- ➢ CBG { capillary blood sugar level}

Normal values

- ✓ FBS: 80-100MG/DL
- ✓ PPBS: 170-200MG/DL
- ✓ RBS:110-140MG/DL
- ✓ HbA1c< 5%
- ✓ RFT:
- ✓ urea: 15-40
- ✓ Creatinine: 0.5-1.4

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Exploring Nature's Toolbox: Harnessing Biological Resources for Sustainable Botanical Research

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Abstract

Nature's toolbox contains a variety of biological materials that hold great promise for long-term botanical research. From the huge diversity of plant species to the complicated symbiotic connections between plants and microorganisms, every aspect of the natural world offers chances for research and invention. Researchers discover important molecules with therapeutic characteristics by studying medicinal plants, whereas bioinspiration from nature's designs drives technological and engineering advancements. Genetic resources, such as crop wild cousins and traditional varieties, form the basis of resilient agricultural systems, while conservation biotechnology provides hope for the rescue and recovery of endangered plant species. Sustainable botanical research involves a comprehensive strategy that considers ecosystems, recognizes plant relationships, and proper uses biological resources. By integrating knowledge from diverse disciplines and embracing principles of equity and environmental management, researchers can unlock the full potential of nature's toolbox to address pressing environmental challenges and create a brighter, more sustainable future for all.

Introduction

Nature provides a breath taking richness of resources and wonders just waiting to be discovered and used for the benefit of humanity. Within the broad span of botanical research, scientists have begun on an exploration adventure, focusing their attention on the incredible biodiversity that surrounds us. From the vast trees of ancient forests to the small organisms hidden beneath the earth's surface, nature provides a diverse array of biological resources that have the potential to offer long-lasting solutions to several of our pressing concerns. In this chapter, we will take a journey into the fascinating world of nature's toolbox, where we will uncover the mysteries of the natural world and discover the untapped potential it holds for developing botanical research and encouraging sustainability. The attractiveness of nature's wealth originates from its diversity, which includes an incredible variety of plant species, habitats, and genetic resources. Each organism in the intricate fabric of life serves a distinct role, contributing to the delicate balance of ecosystems and delivering crucial services that are required for our planet to flourish. From the stately sequoias of California to the bright coral reefs of the tropics, biodiversity is the foundation of life on Earth, maintaining ecosystems, supporting livelihoods, and enriching our lives in numerous ways[1]. The field of botany affords a unique opportunity to investigate the intricate and complex tapestry of plant life, revealing the hidden treasures of the plant kingdom and unraveling its vast and diverse tapestry. Through scientific inquiry, we are able to gain valuable insights into the delicate processes that govern plant growth, development, and adaptation to various environments. The study of botany is a comprehensive and interdisciplinary field, encompassing a broad range of subjects that span from the molecular level of genes and proteins to the ecological level of interactions and feedback loops[2]. Botanical research is based on a deep understanding of life's connectivity and interdependence of all living beings. As we explore the mysteries of plant biology, we get a better understanding of the deep links that plants have with their environment, the complicated web of interactions that supports ecosystems, and the immense impact that human activities have on nature. In an era dominated by environmental issues such as climate change, habitat loss, pollution and biodiversity decrease, the need for sustainable solutions has never been more pressing[3]. Fortunately, nature provides a plethora of tools and inspiration to help us in our journey toward sustainability. From the medicinal characteristics of plants used in traditional medicine to the renewable energy potential of biomass-derived biofuels, botanical study holds the key to unlocking a better future for future generations. By leveraging nature's toolkit, we can develop novel solutions to address critical concerns, conserve biodiversity, and establish resilient ecosystems that can withstand the test of time[4].

The Diversity of Plant Species

Before delving into the discussion of specific tools. It is crucial to recognize the remarkable variety of plant species. Approximately 390,000 plant species are present on Earth. Each displaying unique adaptations and biochemical characteristics[5].Over millions of years, plants have evolved to thrive in a variety of environments, from towering sequoias to fragile mosses. As researchers, our job is to discover their secrets and use them to our advantage. The huge diversity of plant species provides a rich reservoir of genetic resources that hold immense potential for addressing a wide range of societal challenges.For example, plants have been a source of inspiration for the development of novel medicines, with many pharmaceuticals derived from plant chemicals[6]. Furthermore, plants play asignificant role in delivering ecosystem services including carbon sequestration, soil stabilization, and water purification, which are critical for the health and stability of our planet's ecosystems[7]. Furthermore, the diversity of plant species allows for innovation in agriculture, forestry, and biotechnology. By researching the genetic diversity within and among plant species, researchers can uncover qualities of interest such as disease resistance, drought tolerance, and nutritional content, which can be incorporated into crop breeding programs to generate more resilient and productive varieties[8].

Medicinal Plants: Healing Beyond Borders

Medicinal plants have been humanity's companions from time immemorial, providing cures for a wide range of diseases across nations and traditions. The usefulness of therapeutic plants has been proven and celebrated by everyone from traditional healers to modern scientists. Among the numerous botanical treasures, two outstanding examples demonstrate the tremendous impact of plant-derived compound on human health: taxol from the Pacific yew tree (*Taxus brevifolia*) and artemisinin from sweet wormwood (*Artemisia annua*)[9][10]. Taxol, obtained from the bark of the Pacific yew tree, demonstrates the power of nature's medicine. Its discovery revolutionized cancer treatment, providing hope and healing to millions of people fighting various forms of the disease. Similarly, artemisinin, derived from sweet wormwood, emerged as a powerful weapon against malaria, saving many lives and changing techniques for battling this terrible disease[9][10]. However, the significance of therapeutic plants goes far beyond these outstanding instances. Traditional healers around the world have traditionally depended on a vast range of plant species to treat a variety of health problems. From herbal teas to poultices, plant treatments are an important element of cultural legacy and medical practice[11]. In the field of modern medicine, continual study is revealing the therapeutic potential of medicinal plants, resulting in the development of new drugs and treatment options. Aside from their medicinal properties, these plants play important ecological functions in their habitats, helping to conserve biodiversity and provide services. Understanding their ecological relevance and conservation demands is crucial to assuring their continuous availability for future generations[12]. Our research focuses on discovering new pharmaceuticals by examining medicinal plants, while simultaneously considering their ecological functions and the interdependence of human health and environmental sustainability. This holistic approach emphasizes the need to maintain biodiversity and supporting sustainable behaviors to protect our natural heritage and improve global health[13].

Bioinspiration: Learning from Nature's Designs

Nature is the ultimate innovator, with a wealth of clever concepts and solutions refined over millions of years of evolution. From the delicate patterns on a butterfly's wings to the sleek shape of a dolphin's body, species all across the natural world have created designs that unable them to not just survive but thrive in their habitats. This abundance of biological ingenuity has sparked a burgeoning field known as biomimicry, which attempts to duplicate and adapt nature's answers to address human problems while also improving technology, engineering, and design. One of the most well-known examples of biomimicry is the development of Velcro, a ubiquitous fastening device inspired by the adhesive characteristics of burdock seed.In the 1940s, Swiss engineer George de Mestral was inspired to design Velcro by witnessing how burdock seeds stuck themselves to his clothing and his dog's fur on a hike in the Swiss Alps[14]. Velcro was invented to resemble the tiny hooks on the surface of burdock seeds, altering the way we fasten and secure objects in everyday life. In botanical study, biomimicry provides numerous chances to gain inspiration from the innovative designs and methods used by plants. One such example is the water-repellent surface of the lotus leaf, which has inspired the development of self-cleaning materials for agricultural and architectural uses. The lotus leaf's peculiar microstructure, which is covered in microscopic wax crystals, repels water and keeps dirt and debris from sticking to its surface. Researchers have attempted to duplicate this self-cleaning mechanism in synthetic materials, producing surfaces that are resistant to fouling and easy to clean[15]. Biomimicry shows great promise in the development of creative solutions to improve crop productivity and resilience. Researchers can develop more effective and sustainable agricultural systems by understanding plant techniques for capturing sunlight, conserving water, and resisting pests and diseases. For example, biomimetic materials inspired by the structure of plant leaves could increase the efficiency of solar panels by improving light capture and minimizing energy waste due to reflection and heat dissipation[16]. Biomimicry can help architects and designers create structures that are not only visually beautiful but also practical and sustainable. By researching the efficient structural designs of plants such as bamboo and the resilience of tree roots, architects and engineers can produce buildings that are lightweight, flexible, and resistant to environmental pressures such as wind, earthquakes, and temperature swings[17]. As our comprehension of nature's designs grows, so does our ability to use them for the benefit of humanity. By integrating biomimicry ideas in botanical research and beyond, we can find new solutions to some of society's most pressing concerns, such as sustainable agriculture and renewable energy, as well as resilient infrastructure and environmental conservation.

Genetic Resources: Seeds of Tomorrow

Plant genetic diversity provides the cornerstone for adaptation and resilience in agricultural systems, providing a pool of traits that allow crops to thrive in a variety of habitats while overcoming difficulties such as pests, diseases, and climate change. This genetic diversity is protected through seed banks and conservation efforts around the world, ensuring that future generations have access to a vast range of crops. Seed banks play an important role in protecting plant genetic resources by storing seeds and other plant materials collected from various habitats around the world. These archives protect genetic material from extinction and give researchers, breeders, and farmers access to a diverse set of genetic varieties for crop development and breeding programs. Seed banks contribute to food security and agricultural resilience in the face of environmental instability by preserving diversified seed stocks[18]. Wild Crop varieties, or the wild ancestors and closely related species of cultivated crops, are a very significant source of genetic diversity. These wild crop varieties frequently live in isolated and difficult environments, where they have evolved unique adaptations to their surroundings. These adaptations include features like disease resistance, drought tolerance, and extreme temperature tolerance, which can be transferred to cultivated crops through breeding programs. Seed banks collect and preserve seeds and other plant materials from crop wild relatives to ensure that rich genetic resources are saved for future use in crop improvement initiatives[19]. Wild crop varieties play an essential role in crop breeding and genetic development. Many of the characteristics that contribute to the resilience and productivity of modern crop varieties can be traced back to their wildvarieties. For example, the wild progenitors of wheat and rice have contributed essential genetic material for breeding operations aimed at generating varieties with better production potential, disease resistance, and environmental stress tolerance[20]. In addition to wild crop varieties, traditional crop types and landraces play an important role in preserving genetic diversity in agriculture. Farmers have been cultivating these locally adapted varieties for many years, and they frequently have distinct characteristics that are best suited to certain growing conditions. By saving ancient crop types and landraces, seed banks help to preserve cultural heritage and ensure that vital genetic diversity is not lost when contemporary crop kinds become increasingly prevalent[21].Plant genetic resources are tomorrow's seeds, providing the key to sustainable agriculture and food security in a changing world. Seed banks and conservation efforts serve an important role in preserving genetic variety, ensuring that future generations have access to a vast range of crops with unique features and adaptations. By gathering and storing genetic resources from wild crop varieties, historic varieties, and landraces, we may improve agricultural systems' resilience and productivity, thereby safeguarding our food supply for future generations.

Microbes: Silent Partners in Botanical Health

Beneath the soil's surface is a secret world teeming with microbial life, where a varied array of bacteria, fungi, and other microorganisms perform critical roles in supporting plant ecosystem health and vitality. Among these microbial occupants, mycorrhizal fungi and endophytes stand out as quiet collaborators in botanical health and productivity. These microorganisms provide a variety of benefits to plants through symbiotic partnerships, ranging from improved nutrient uptake to the production of bioactive chemicals with potential medical and pest control applications. Mycorrhizal fungi are found in soils all over the world and create symbiotic relationships with the roots of most plant species, including agricultural crops and native vegetation. These fungi colonize the root system, developing specialized structures known as mycorrhizae that act as conduits for the exchange of nutrients between the fungus and the plant. In exchange for sugars produced by photosynthesis, mycorrhizal fungi improve the plant's ability to absorb water and nutrients from the soil, particularly phosphorus and nitrogen[22]. This mutually beneficial connection not only increases plant health and vigor, but it also helps soil fertility and ecosystem resilience. Researchers are increasingly recognizing mycorrhizal fungi's ability to promote soil health and crop output, particularly in sustainable agriculture. Farmers can enhance nutrient uptake, reduce fertilizer requirements, and improve drought and disease resistance in crops by inoculating them with beneficial mycorrhizal fungi[23]. Furthermore, mycorrhizal fungi have an important function in soil aggregation and structure, enhancing soil water retention and minimizing erosion, so helping to soil conservation and sustainability[24]. In addition to mycorrhizal fungi, endophytic bacteria are an intriguing category of plant-associated microorganisms with important implications for botanical health and human well-being. Endophytes are microorganisms that infiltrate plants' interior tissues but do not cause illness. These microbial occupants have co-evolved with their plant hosts, producing complicated partnerships that benefit both sides[25]. Endophytes produce a wide range of bioactive substances, such as antibiotics, antifungals, and insecticides, which help to protect their host plants from infections and pests. Researchers are particularly interested in these bioactive chemicals due to their potential applications in medicine, agriculture, and biotechnology. Endophytic fungi isolated from medicinal plants have produced promising leads for the creation of new medicines with antibacterial, anticancer, and immunomodulatory activities[26]. Similarly, endophytic bacteria capable of producing chemicals with insecticidal action show promise for the development of ecologically benign pest control treatments for agriculture[27]. Microbes play an important role as silent collaborators in improving plant health and productivity. Mycorrhizal fungi improve nutrient uptake and soil fertility, while endophytes produce bioactive chemicals with potential applications in medicine and pest management. These microbial inhabitants contribute to the resilience and vitality of plant ecosystems.

Conservation Biotechnology: Rescuing Endangered Species

In response to the increasing extinction rates and habitat degradation, conservation biotechnology has proven to be a powerful tool in the preservation of the world's biodiversity. Among the numerous applications of biotechnology in conservation, the rescue and recovery of endangered plant species stands out as a critical effort. Conservation biotechnology, which employs novel techniques such as micropropagation and cryopreservation, provides hope for the survival of endangered plant species, assuring their persistence for future generations. Micropropagation, also known as tissue culture or in vitro propagation, has transformed the cultivation of rare and endangered plant species. This method involves the aseptic cultivation of plant cells, tissues, or organs in a nutrient-rich media under controlled environmental conditions. By culturing tiny fragments of plant tissue, such as shoot tips or nodal segments, in laboratory settings, researchers can rapidly produce large numbers of genetically identical plantlets[28]. Micropropagation has various benefits for endangered species conservation, including the ability to propagate plants year-round, regardless of seasonal limits, and the potential to produce huge numbers of individuals from limited starting materials. The use of micropropagation in the conservation of endangered plant species has produced outstanding results. For example, the *Florida torreya* (*Torreya taxifolia*), a critically endangered conifer native to the southeastern United States, has been successfully grown via micropropagation techniques. Likewise, micropropagation has been employed to reproduce endangered orchid species, such as the lady's slipper orchid (*Cypripedium calceolus*), which are threatened by habitat degradation and overexploitation[29]. Cryopreservation is another useful method in the conservation biotechnologist's toolbox for maintaining the genetic diversity of threatened plant species. This approach includes storing seeds, embryos, or tissues at ultra-low temperatures, often below -190°C, to retain their viability for long periods [30]. Cryopreserving plant material allows conservationists to construct "frozen archives" of genetic variation, protecting endangered species from extinction due to habitat loss, climate change, or catastrophic occurrences. Cryopreservation has been used effectively on a wide variety of plant species, including endangered and commercially essential crops. For example, the Millennium Seed Bank at the Royal Botanic Gardens, Kew, has one of the world's largest collections of cryopreserved seeds, with over two billion seeds from more than 190 nations[31]. This precious resource serves as a genetic reservoir for global plant conservation and restoration initiatives, providing hope for the survival of threatened plant species. Conservation biotechnology offers a ray of hope for the rescue and recovery of endangered plant species. Conservationists can grow rare plants in controlled circumstances using techniques like micropropagation and cryopreservation, preserving their genetic variety for future generations. By combining traditional conservation efforts with cutting-edge technology, we can protect biodiversity and assure the survival of threatened plant species in an ever-changing environment.

Conclusion

As exploration into nature's mysteries deepens, the significance of sustainable botanical study becomes clearer. This quest necessitates a collaborative and holistic strategy that values ecosystems, comprehends plant relationships, and uses biological resources sustainably. Implementing these principles can help create a greener, healthier planet and a more sustainable future for future generations. Sustainable botanical research is fundamentally interdisciplinary, drawing on concepts from domains including ecology, genetics, biotechnology, and conservation biology. By combining information from several fields, researchers can obtain a deeper understanding of the complex interactions between plants and their environments, leading to novel solutions for critical environmental concerns. Ecosystems must be respected in order to conduct sustained botanical research. Ecosystems are complex webs of interrelated relationships, with each organism playing a distinct function in ensuring balance and stability. Researchers that study ecosystems with humility and reverence might gain vital insights into the dynamics of plant communities, influencing conservation initiatives and minimizing the effects of human activities on natural habitats. Understanding plant interactions is an important component of sustainable botanical study. Plants communicate and cooperate with one another via a variety of methods, providing potential to increase agricultural output, rehabilitate degraded landscapes, and boost ecological resilience. The long-term viability of botanical research depends on the responsible use of biological resources. Plants include a richness of genetic diversity and biochemical riches that show potential for tackling global concerns. To avoid overexploitation and protect future generations' access, these resources must be exploited in accordance with values of equity, justice, and environmental stewardship. In continuing to explore nature's toolbox, keep in mind that humility, curiosity, and respect for the natural world will guide us. By embracing collaboration, creativity, and ethical stewardship, the full potential of botanical science can be realized, creating a brighter, more sustainable future for everybody.

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ECG Basics

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Introduction

Electrocardiogram (ECG) is the graphic record of the electrical potentials produced by cardiac conduction. ECG provides an evidence to support a diagnosis and in sometimes it is crucial for patient management also.

Recording a ECG

The electrical signal from the heart is detected at the surface of the body via the electrodes, which are joined to the ECG recorder by wires. One electrode is attached to each limb and 6 in front of the chest. The ECG recorder compares the electrical activity from different electrodes, and the recording obtained is called a "lead"

Figure 1 - Conventional ECG Machine

Figure 2 - Modern ECG Machine

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Leads & Placements

The 6 standard lead which are recorded from the electrodes attached to the limbs look the heart from vertical plane.

1) Leads I , aVL look at the left lateral surface of heart
2) Lead II, III, aVF at the inferior surface
3) Lead aVR looks at the right atrium

The 6 chest leads (V1 – V6) look the heart in a horizontal plane.

1) V1 & V2 corresponds to the right ventricle
2) V3 & V4 corresponds to the inter ventricular septum & anterior wall of LV
3) V5 & V6 corresponds to the lateral wall of LV.

Table 1: View of the Heart & Leads

VIEW OF THE HEART	LEADS
Inferior	II,III,aVF
Lateral	I,aVL,aVR,V5,V6
Anterior	V3,V4
Septal	V1,V2

Placement of the leads

A) Limb leads:

The 6 standard lead which are recorded from the electrodes attached to the limbs looks the heart from vertical plane.

Bipolar leads I , II , III

- ➢ Electrodes that form these signals are located on limbs.

Augment leads avR, avL, avF (unipolar)

- ➢ The same 3 leads that form the standard leads also form these 3 unipolar leads
- ➢ They are unipolar in that, they measure the electrical potential at one point with respect to a null point.
- ➢ They use a central terminal as their negative pole which is a combination of inputs from other 2 limb electrodes

b) Chest leads:

1) V1 – 4th intercostal space in right sternal border
2) V2 – 4th intercostal space in left sternal border
3) V3 – equidistant between V2 & V4
4) V4 – 5th intercostal space in left mid clavicular line. All subsequent leads (V5 – V6) are kept in a same horizontal plane as V4.
5) V5 – anterior axillary line
6) V6 – mid axillary line

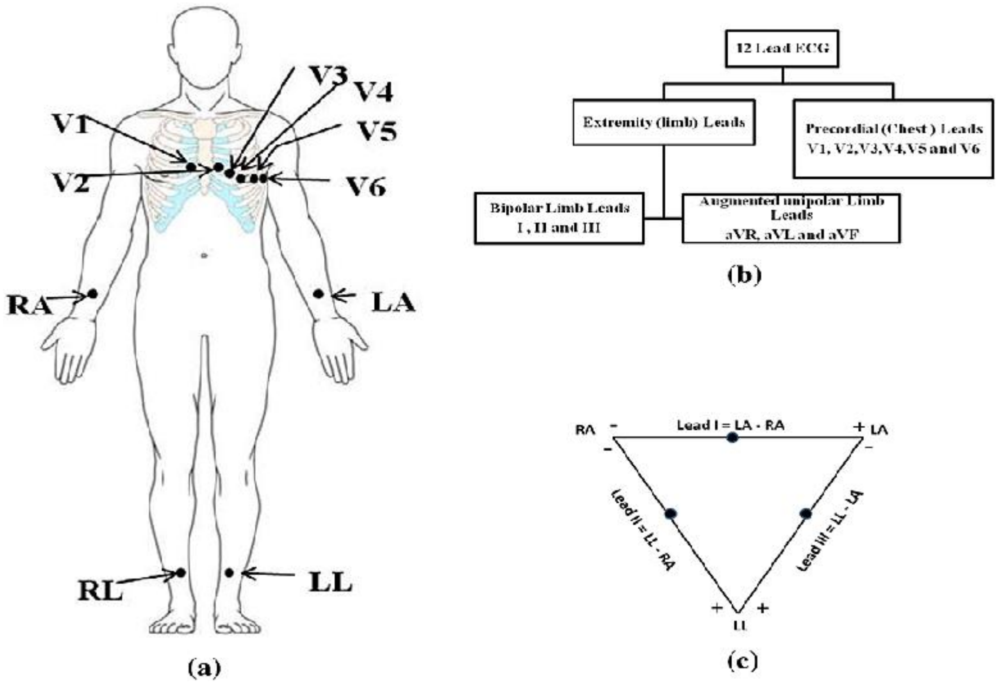

Figure 3: Placement of Leads & Einthoven Triangle

ECG Waves - Times & Speed

ECG machine records the electrical activity by drawing a trace on a moving paper. ECG machine runs at a standard rate of 25mm/s and uses paper with standard sized squares. Each large square (5mm) represents 0.2 sec i.e., 200ms. Therefore there are 5 large squares per second & 300 per minute.

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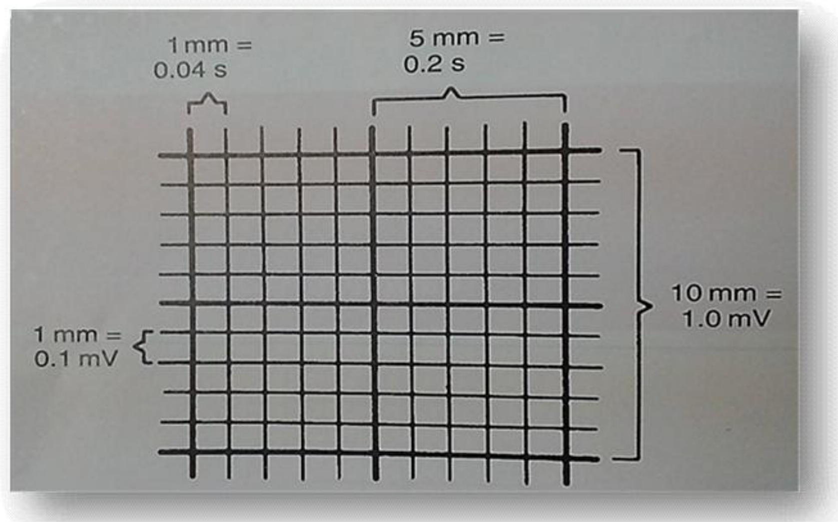


ECG – Normal waves, intervals & segments

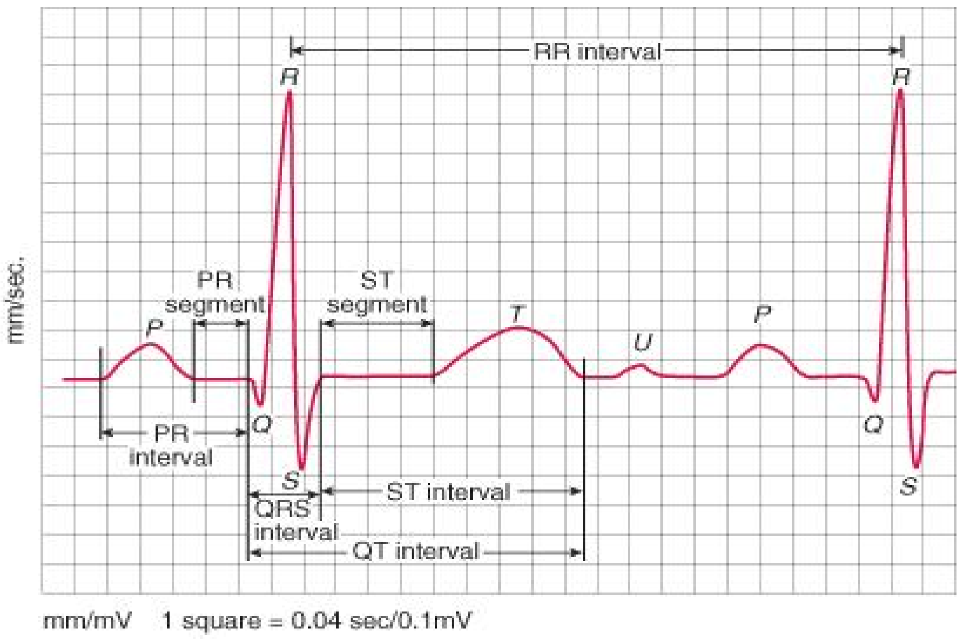


Figure 4 - Waves, Intervals & Segments in ECG

1) P wave – it is the first positive deflection of ECG, which is small, smooth & rounded. The initial portion is due to RA depolarization & late portion is due to LA depolarization .

Normal duration of P wave is < 120ms

2) PR interval – measured from beginning of P wave to beginning of QRS. It is the time taken for excitation to spread from SA node, through the atrial muscle & AV node down the bundle of His and into the ventricular musculature.

Normal PR interval is 120 – 200ms

3) QRS - due to ventricular depolarization

It is measured from onset of Q wave to the end of S wave.

Normal duration is < 120ms

4) T wave – it is the deflection produced by ventricular repolarization & coincides with the closure of semi-lunar valves. It is usually asymmetrical.

5) QT INTERVAL – measured from the onset of Q wave to the end of T wave. It measures the total duration of ventricular depolarization and repolarization which corresponds to the duration of ventricular action potential.

6) ST SEGMENT - measured from the end of S wave to the beginning of T wave. The point at which QRS ends and ST begins is the J point.

7) U wave – it follows T wave. It is best seen in V2 &V3 and it is due to slow repolarization of purkinje fibres.

Interpretation of ECG

Every ECG has to be systematically observed for the following.

1) Rate
2) Rhythm
3) Axis
4) P wave morphology
5) PR interval
6) QRS morphology
7) ST segment morphology
8) T wave morphology
9) U wave (if present)
10) QT interval (or QTc)

Rate

In a ECG, heart rate usually implies ventricular rate which means the number of QRS complexes in a minute.

How to calculate the rate in ECG?

If the rhythm is regular:

Count the number of large squares in between two R-R interval in any lead. Dividing 300 by the number of large squares that have been counted gives the ventricular rate.

OR

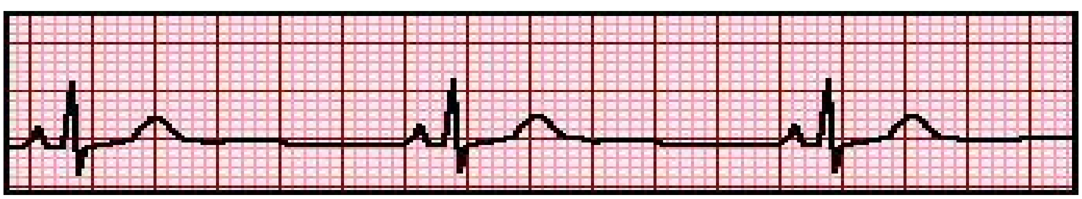
Count the number of small squares in between two R-R intervals in any lead. Dividing 1500 by number of small squares that have been counted gives the heart rate.

Ventricular rate = 1500÷number of small squares in between two R-R interval

OR

300 ÷number of large squares in between two R-R interval

Number of Big Boxes	Rate
1	300
2	150
3	100
4	75
5	60
6	50



If the rhythm is irregular:

The above method cannot be applied if the rhythm is irregular. Instead six second method is used.

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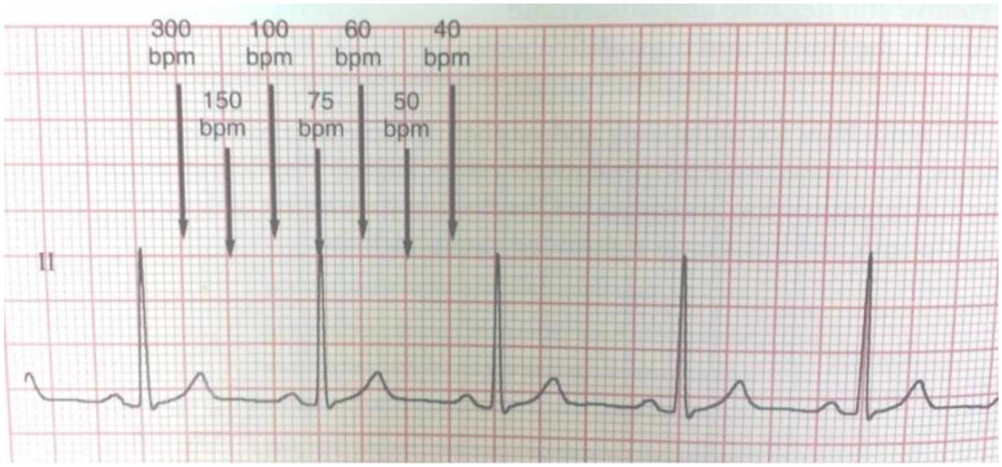
1) In this method, just count the number of QRS complexes for 6 seconds.
2) We already know that, 5 large squares in an ECG corresponds to 1 second
3) Therefore count the QRS complexes in 30 large squares which is equal to 6 seconds
4) Multiply the result by 10, this gives the approximate heart rate for 1minute.

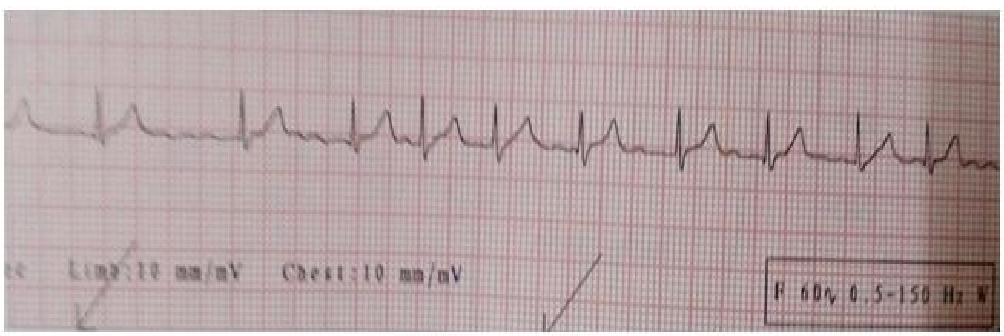
Example 1:



The above ECG has a regular rhythm. There are 4 large boxes in between two R-R interval. 300 divided by 4 = 75.

Therefore the approximate rate is 75/min.

Example 2



The above ECG has a irregular rhythm. Count the number of QRS complexes for 6 seconds & multiply by 10 to get the approximate rate per minute.

Rhythm

How to know the rhythm is sinus?

- Pacemaking impulses arise from SA node and are transmitted to ventricles via AV node & Bundle of His - Purkinje system. This results in a regular , narrow complex heart rhythm of 60 – 100 per minute.
- To be a sinus rhythm, each QRS complexes should be preceded by a P wave, PR interval should remain constant .
- Sinus Rhythm:
  - Originating from SA node
  - P wave before every QRS
  - P wave in same direction as QRS

Rhythm disturbance – Atrial Fibrillation

It is a supraventricular arrhythmia characterized by an atrial rate of around 400 per minute & replacement of P waves by fibrillatory F waves, with a irregularly irregular ventricular rate

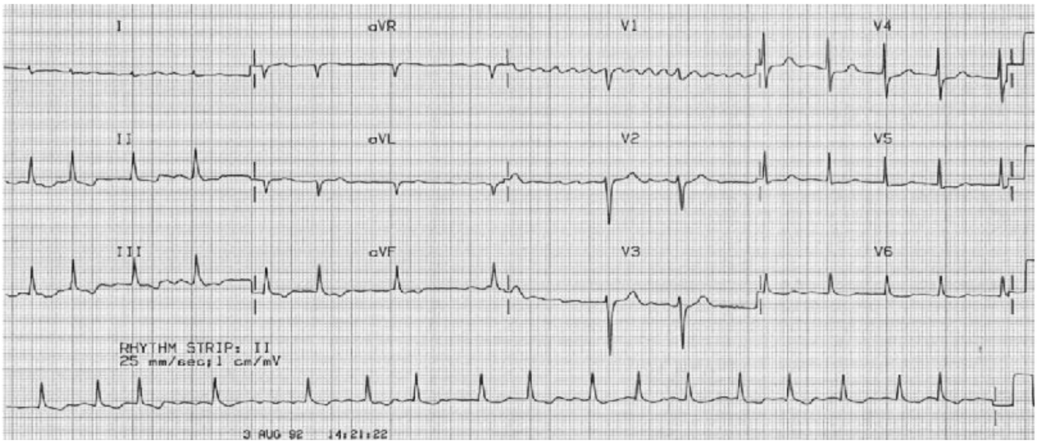
Causes of Atrial Fibrillation:

- Ischemic heart disease
- Valvular heart diseases (mitral stenosis & regurgitation)
- Thyrotoxicosis
- Cardiomyopathies

Criteria

- Fibrillatory F waves replaces the normal P waves
- Atrial rate of around 400 – 600 with a ventricular rate of 100 – 160 per minute.
- Varying R – R interval
- Narrow QRS complexes

Example:



The ECG shows, coarse fibrillatory waves in V1 with irregular ventricular response & narrow QRS complexes.

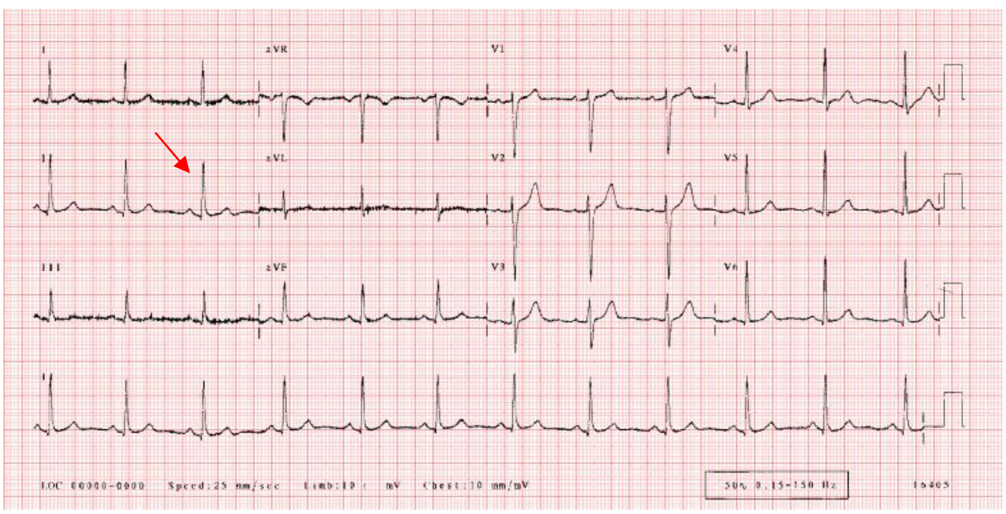
Axis

STEP 1 - WHICH LEAD HAS THE TALLEST POSITIVE QRS COMPLEX ?

STEP 2 - IF LEAD I or II or aVF SHOWS TALLEST POSITIVE

QRS ⟶ Normal Axis

Example:



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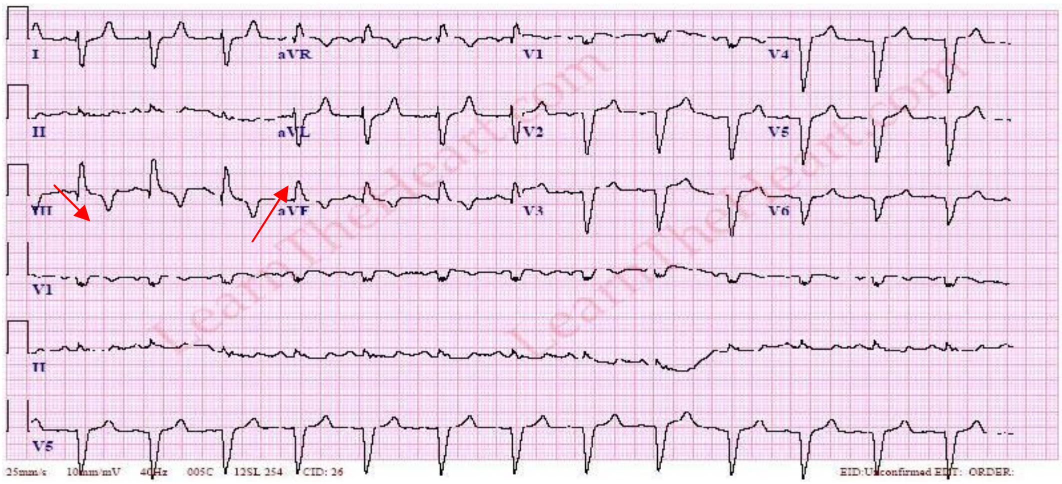
STEP 3 - IF THESE LEADS DON'T SHOW THE TALLEST POSITIVE QRS, CHECK LEAD III or aVL

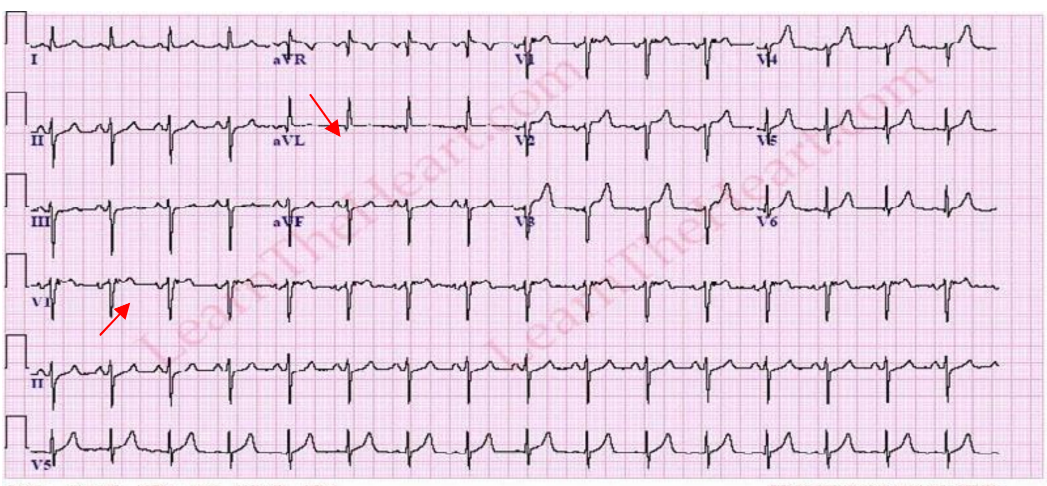
STEP 4 - IF LEAD III SHOWS THE TALLEST POSITIVE QRS COMPLEX AND aVL SHOWS NEGATIVE QRS ⟶ RIGHT AXIS

Example:



STEP 5 - IF AVL SHOWS THE TALLEST POSITIVE QRS AND LEAD III SHOWS NEGATIVE QRS ⟶ LEFT AXIS

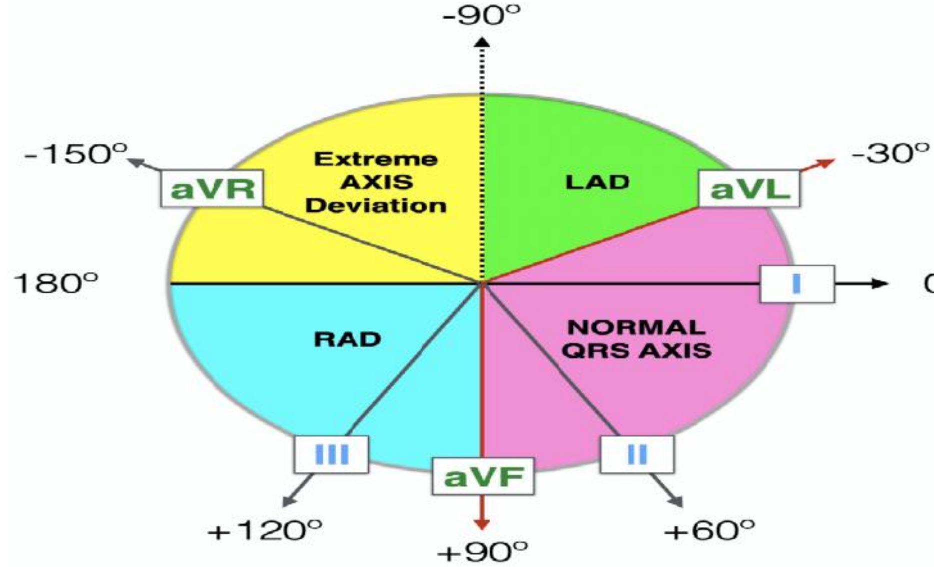
Example:



STEP 6 - IF NONE OF THESE LEADS SHOW THE TALLEST POSITIVE QRS & LEAD AVR SHOWS POSITIVE QRS COMPLEX ⟶ INDETERMINATE AXIS

Axis Deviation - Lead I & aVF

- Right Axis Deviation - Right Reaches
- Left Axis Deviation - Left Leaves



P Wave morphology

The normal P-wave:

- Has a smooth contour
- Is monophasic in lead II
- Is biphasic in lead V1

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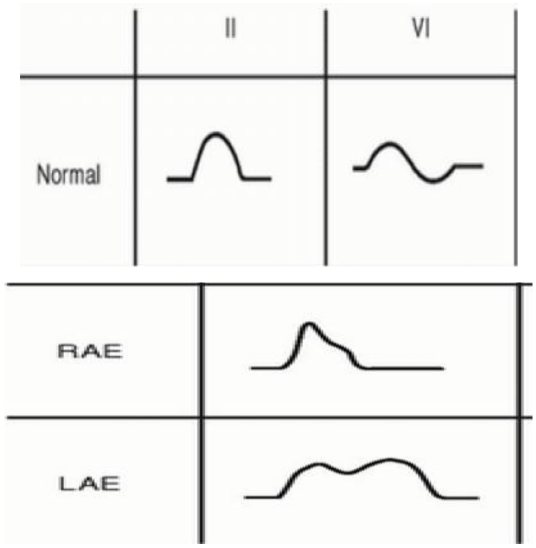

CHAMBER ENLARGEMENT/HYPERTROPHY

LEFT ATRIAL ENLARGEMENT

Causes :

1) Mitral valvular diseases (both MS & MR)
2) Cardiomyopathies

ECG Criteria

The following changes occurs in P wave(P MITRALE)

1) Notched or double peaked (M shaped), broad P waves
2) Duration of P wave is increased (2.5 mm)
3) Deep and wide negative deflection of biphasic P wave in V1
4) Left axis deviation of P wave

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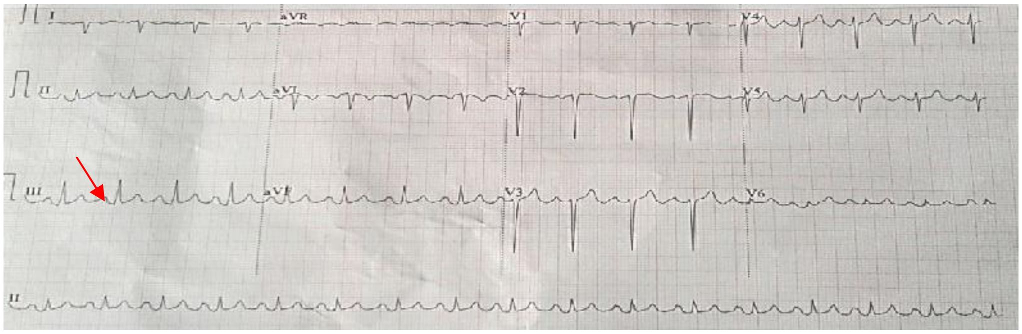
Example:

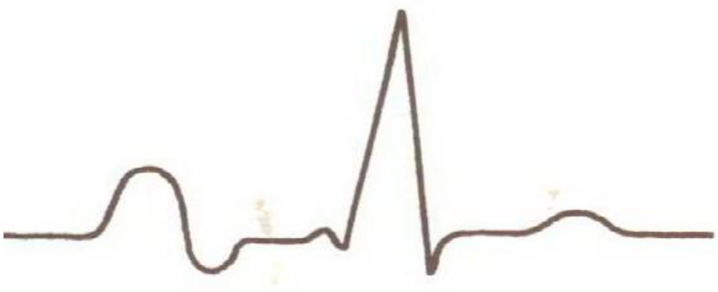


The above ECG shows wide P waves in LEAD II (P MITRALE)

RIGHT ATRIAL ENLARGEMENT

CAUSES:

1) Corpulmonale
2) Pulmonary hypertension
3) Pulmonary stenosis
4) Pulmonary embolism



ECG Criteria:

1) Tall and peaked P wave (> 2.5mm) in leads II, III & AVF (P PULMONALE)
2) Right axis deviation of P wave

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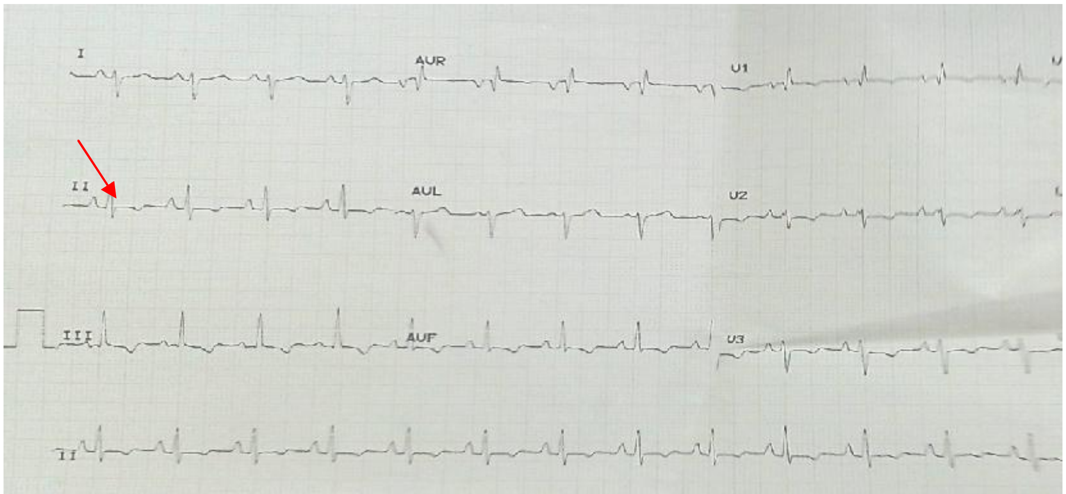
Example:



The above ECG shows tall P waves (P pulmonale)

Left ventricular hypertrophy

Causes:

1) Aortic stenosis
2) Systemic hypertension
3) Aortic regurgitation
4) Hypertrophic cardiomyopathy
5) Coarctation of aorta

ECG criteria :

1) R wave in V5 or V6 > 27mm
2) R wave in V5V6 + S wave in V1 > 35mm
3) Left axis deviation
4) ST – T changes : ST segment depression with concavity upwards.
5) T wave in V5 / V6 may be inverted

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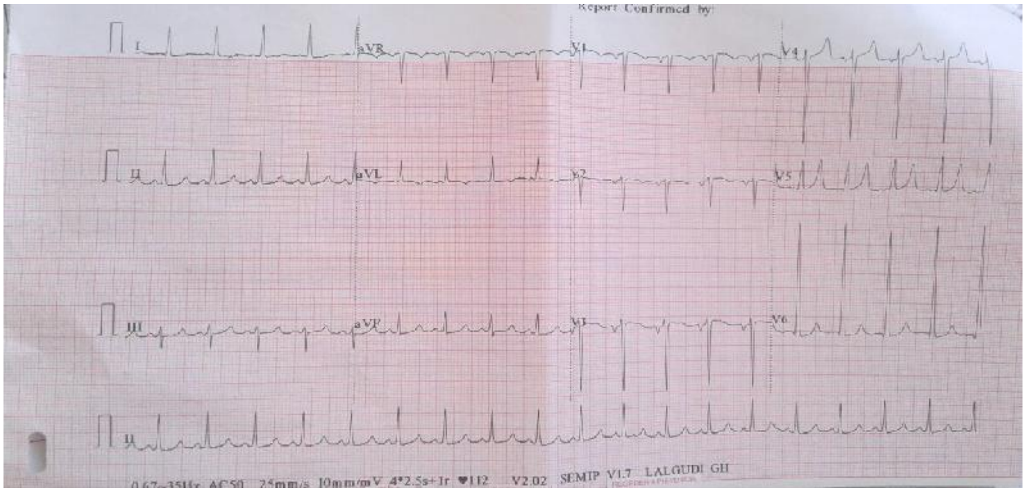
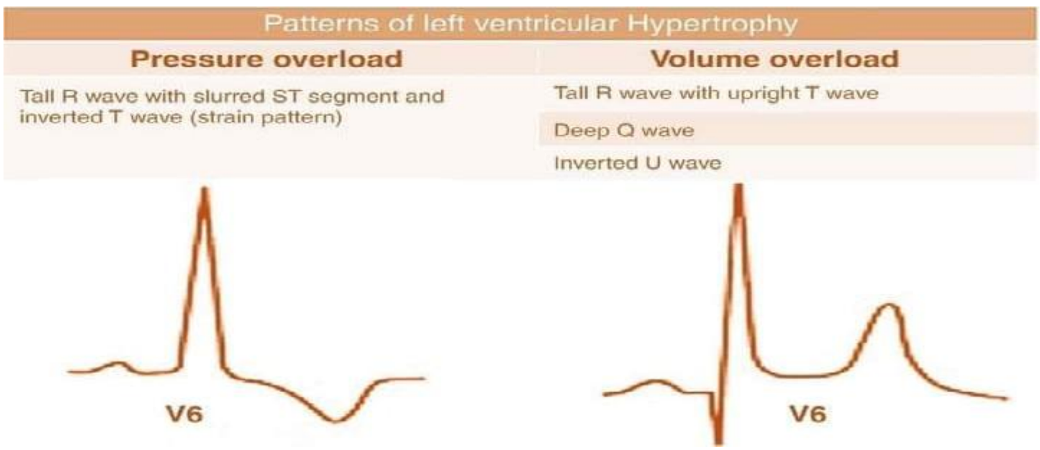
Example:



The above ECG shows R wave in V6 + S wave in V1 > 35 mm s/o LVH

LVH Patterns:



Right ventricular hypertrophy

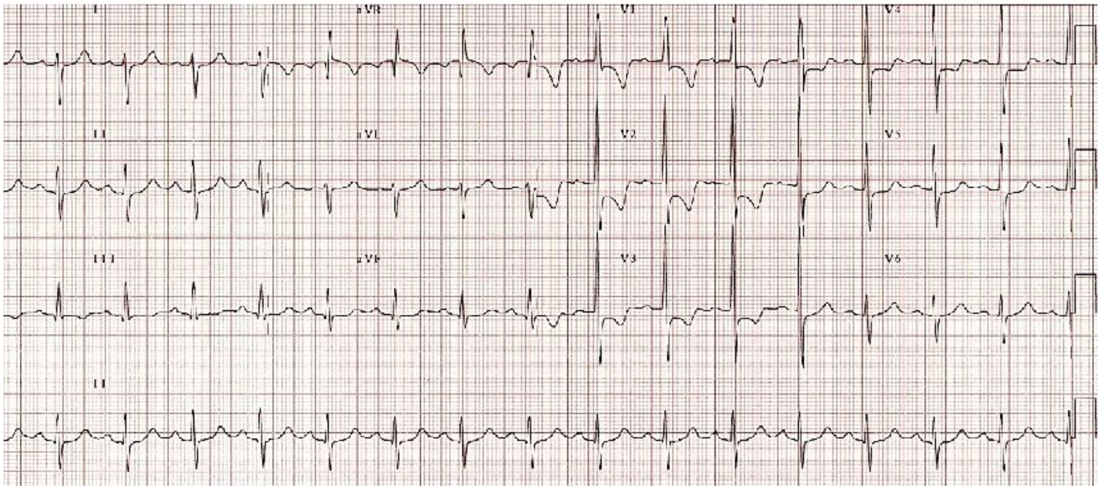
Causes:

1) Pulmonary hypertension
2) Chronic pulmonary diseases
3) Congenital heart diseases – TOF, Eisenmenger's, pulmonary stenosis
4) Acute pulmonary embolism

Criteria:

1) Tall R wave in V1 & V2 (R:S ratio > 1)
2) Corresponding to R wave in V1, there will be large S waves in V5 & V6
3) Right axis deviation

Example:



The ECG shows dominant R wave in V1 & V2 with dominant S wave in V5 & V6

PR INTERVAL - ATRIOVENTRICULAR BLOCKS

AV block is a disturbance in conduction of sinus impulses via the specialized conduction system(AV node & Bundle of His)

TYPES:

- 1st degree AV block
- 2nd degree AV block ---MOBITZ Type 1 & Type 2
- 3rd degree AV block

FIRST DEGREE AV BLOCK

CAUSES :

1) Vagal stimulation
2) Drugs – digitalis, beta blockers, Calcium Channel Blockers

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3) Coronary artery disease
4) Hyperkalemia
5) Myocarditis

ECG CRITERIA:

1) The rhythm remains regular. i.e., P-P & R-R interval remains constant
2) Every P wave will be followed by QRS complex. There is no dropped beat
3) The P-R interval is consistently prolonged beyond the upper limit of normal. i.e., > 200ms. This prolongation indicates a delay in conduction from SA node to AV node.

EXAMPLE:

SECOND DEGREE AV BLOCK

Here, some sinus impulses are conducted to the ventricles & some are blocked. Therefore 2nd degree AV block manifest with regularly occurring P wave , some of which are not followed by QRS complexes. It can be classified into 2 types (MOBITZ type 1 & MOBITZ type2).

CAUSES:

1) Coronary artery disease (esp. inferior wall MI)
2) Digitalis toxicity
3) Infiltrative heart disease

MOBITZ TYPE 1(WENCKEBACH) - CRITERIA:

1) There is a Progressive prolongation of PR interval in a cyclical manner, until one P wave is blocked i.e., not followed by QRS (dropped beat)
2) As the PR interval gets longer, the R-R interval gets shorter until a P wave is dropped.

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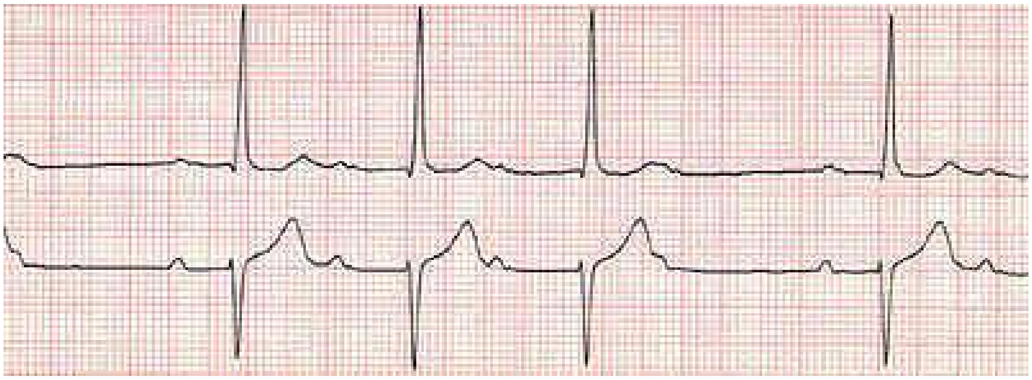
EXAMPLE:

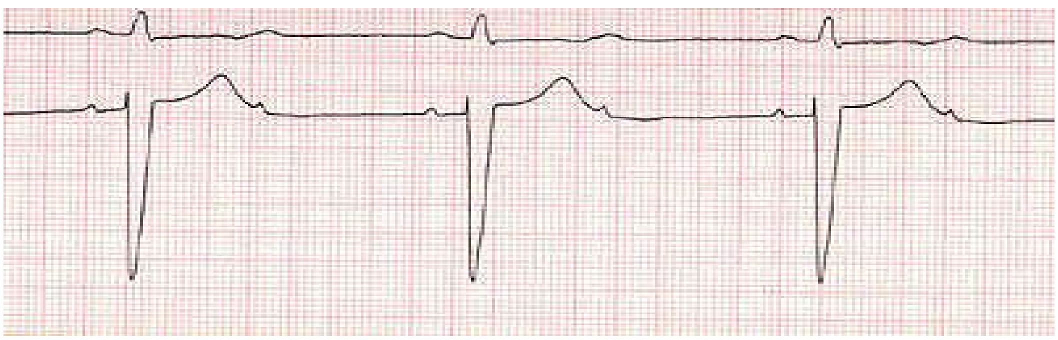


MOBITZ TYPE II – CRITERIA:

Here PR interval of all conducted beats remain constant/fixed. But there is associated dropped beats in between. i.e., some beats are conducted & some beats are blocked in a variable or fixed fashion.

1) PR interval is constant & fixed
2) PP intervals will be constant
3) RR interval is variable because of the intermittent dropped beat

EXAMPLE:



THIRD DEGREE AV BLOCK (COMPLETE HEART BLOCK)

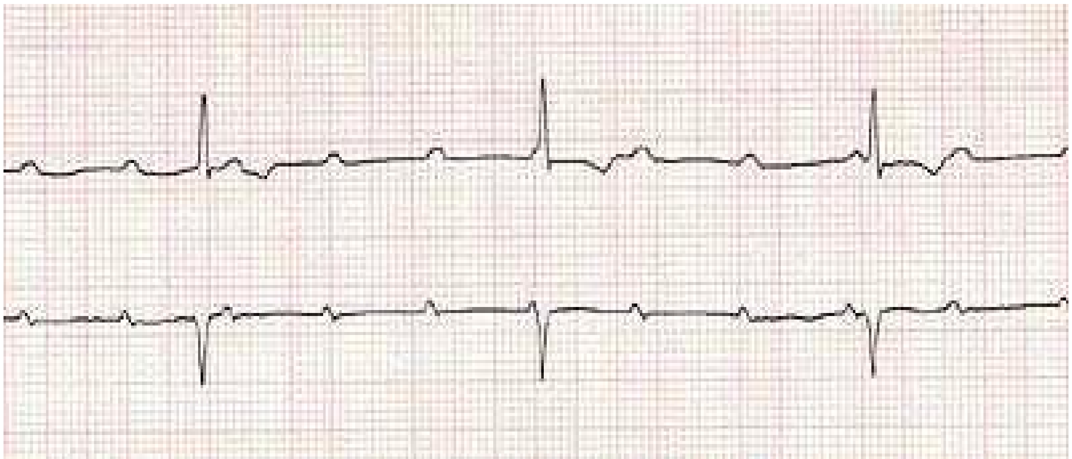
CAUSES:

1) Drugs – digitalis, beta blockers, CCB’s
2) Excessive vagal tone
3) Acute myocardial infarction
4) Myocarditis
5) Amyloid heart diseases

ECG CRITERIA:

1) PP intervals are constant
2) RR intervals are also constant
3) Atrial & ventricular rates are different
4) No relationship between P & QRS

EXAMPLE:



QRS morphology

Bundle branch block

Wide QRS complex with more than 3 box

Right Bundle branch block(RBBB)

•RSR pattern or rabbit ear pattern in V1

•Broad and slurred S wave in leads V6

Left Bundle branch block(LBBB)

•Deep and broad S wave in V1 with no R wave

•Broad slurred R wave or RR′ pattern without a Q wave in leads V6

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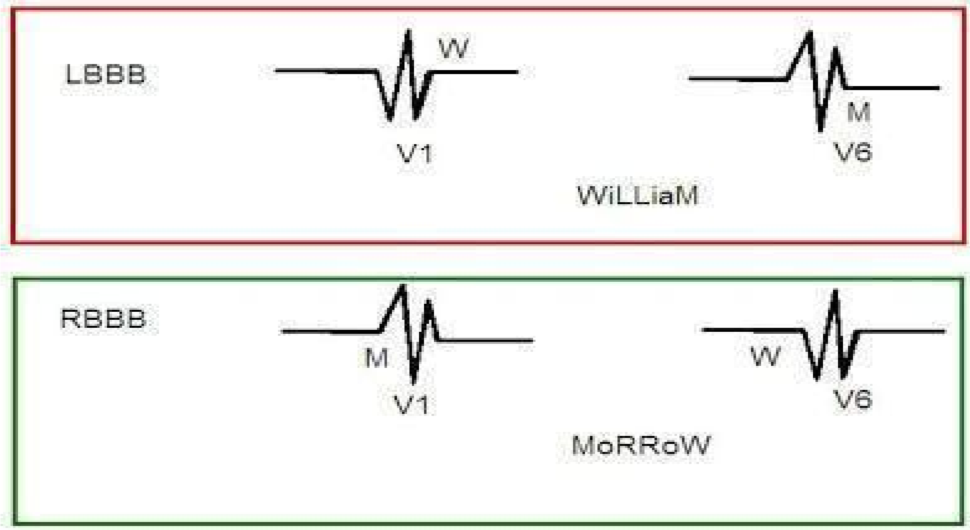


ABNORMALITIES OF ST SEGMENT

MYOCARDIAL INFARCTION

It occurs due to necrosis of heart muscle secondary to deficient blood supply over a critical length of time or due to sudden complte occlusion of coronary arteries.

The infarction process evolves in 3 stages or phases:

1) Hyperacute phase
2) Fully evolved phase
3) Chronic established phase

On the basis of ECG, there are two main types of MI :

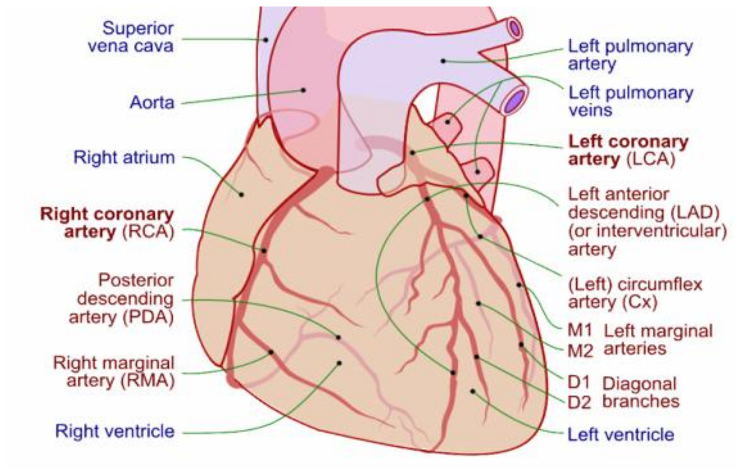
• ST segment Elevation Myocardial Infarction (STEMI) - major coronary artery complete obstruction

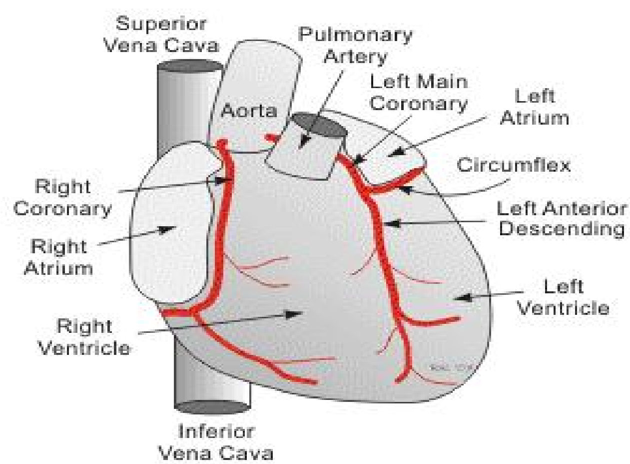
• ST segment Elevation Myocardial Infarction (NSTEMI) - Complete occlusion of a minor vessel or partial occlusion of a major coronary vessel

Corresponding walls in Myocardial Infarction:

I Lateral	aVR	V1 Septal	V4 Anterior
II Inferior	aVL Lateral	V2 Septal	V5 Lateral
III Inferior	aVF Inferior	V3 Anterior	V6 Lateral

CORONARY CIRCULATION:





Localisation of Myocardial Infarction:

Location of MI	Leads Affected	Vessel Involved	ECG Changes
Anterior wall	V_2 to V_4	• Left Anterior Descending artery (LAD) - Diagonal branch	• Poor R-wave progression • ST-segment elevation • T-wave inversion
Septal wall	V_1 and V_2	• Left Anterior Descending artery (LAD) - Septal branch	• R wave disappears • ST-segment rises • T-wave inverts
Lateral wall	I, aV_L, V_5, V_6	• Left Coronary Artery (LCA) - Circumflex branch	• ST-segment elevation
Inferior wall	II, III, aV_F	• Right coronary artery (RCA) - Posterior descending branch	• T-wave inversion • ST-segment elevation
Posterior wall	V_1 to V_4	• Left Coronary Artery (LCA) - Circumflex branch • Right Coronary Artery (RCA) - Posterior descending branch	• Tall R waves • ST-segment depression • Upright T waves

Anatomic Location	ECG Leads	ECG Findings
Anterior	V_2-V_4 II, III, aVF	ST Elevation $\geq$ 2 mm Reciprocal depression (only in 33%)
Inferior	II, III, aVF aVL	ST Elevation $\geq$ 1 mm Reciprocal depression (in ~ 80 %)
Right ventricle	V_4R V_1-V_3	ST Elevation diagnostic ST Elevation indicative
Lateral	I, aVL, V_5, V_6	ST Elevation $\geq$ 2 mm (in precordial leads)
Posterior	V_1, V_2 V_8, V_9 when used	Reciprocal depression ONLY ST Elevation $\geq$ 2 mm

*Adapted from: Reference 12

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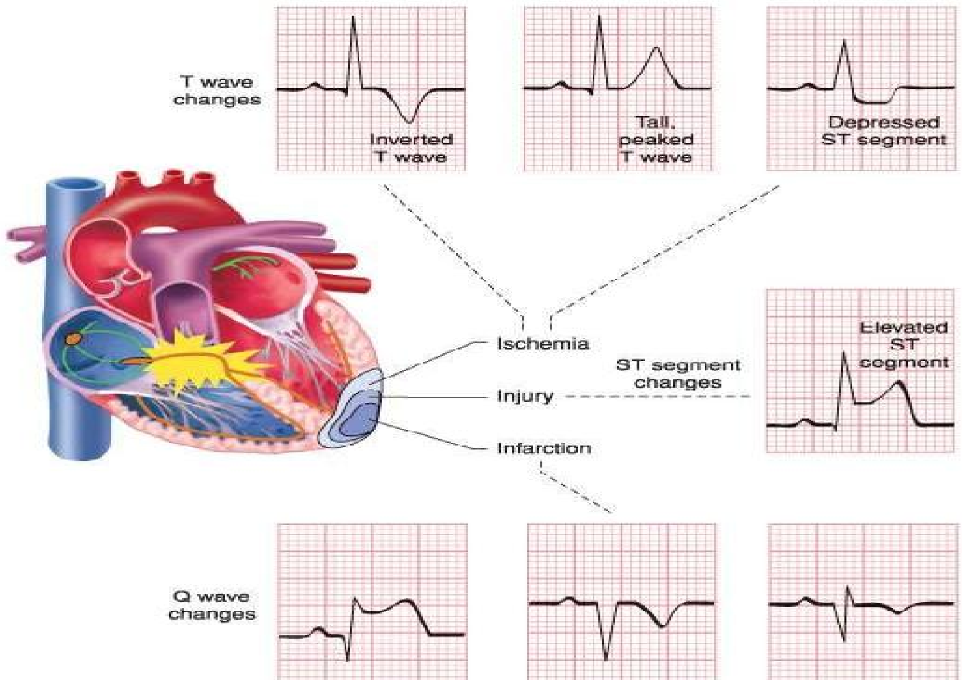
ECG FEATURES OF MYOCARDIAL INFARCTION:

Earliest changes seen in STEMI

- ST-segment inversion/elevation
- Progressive loss of R wave .
- Development of Q wave .
- Resolution of ST-segment
- T-wave



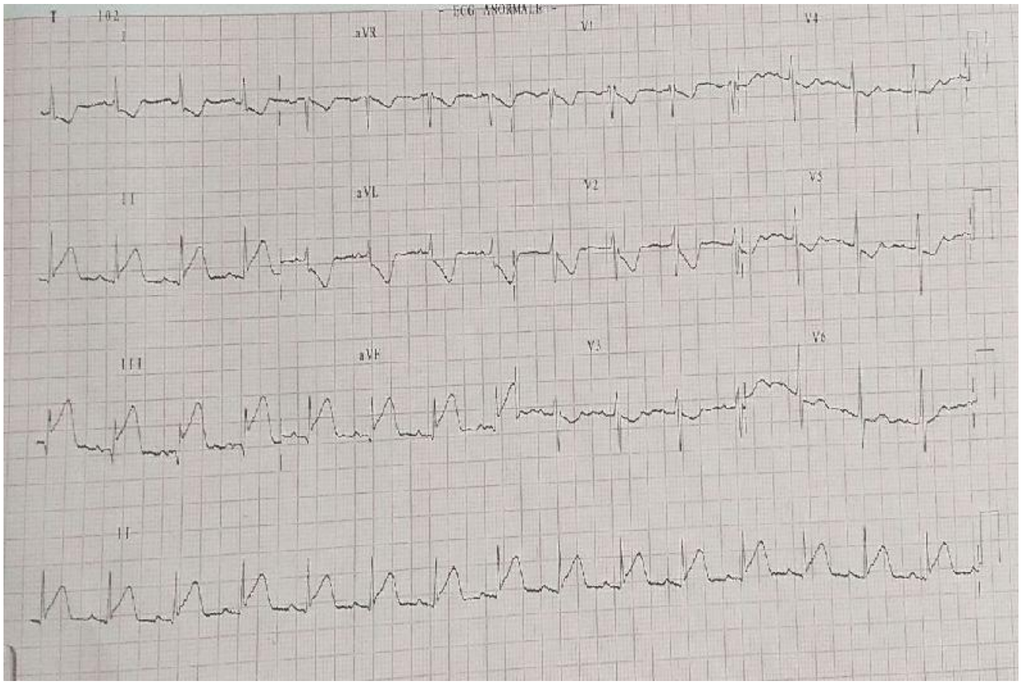
Earliest changes seen in NSTEMI

- ST-segment depression
- T-wave changes
- Loss of R-wave
- Absence of Q-wave

GENERAL ECG FEATURES IN MYOCARDIAL INFARCTION

1) Increased amplitude of R wave
2) Slope elevation of ST segment
3) Tall & wide T waves

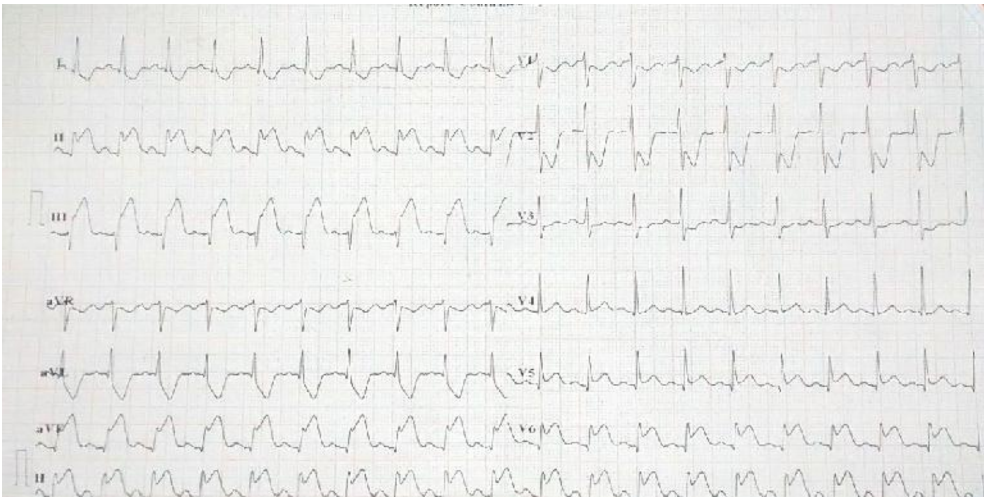
EXAMPLE 1



The above ECG shows ST elevation in lead II, III, avF suggestive of INFERIOR WALL MI.

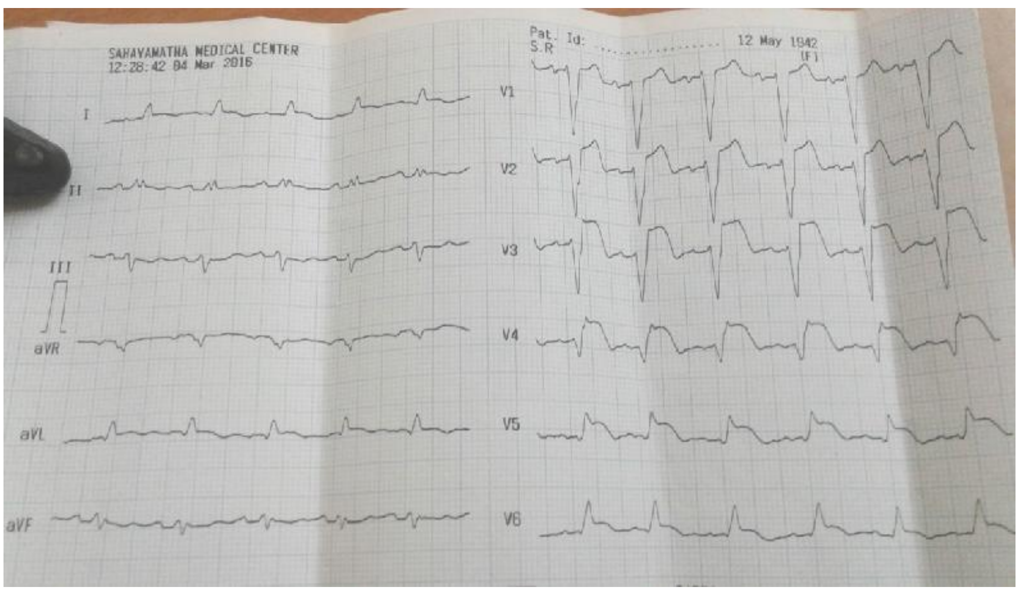
There is also reciprocal ST depression in leads V1 to V5

EXAMPLE 2



The ECG shows ST elevation in II, III, avF and also in leads V5, V6 suggestive of INFEROLATERAL MI.

EXAMPLE 3



The ECG shows ST elevation in V1 to V6 suggestive of extensive antero lateral MI.

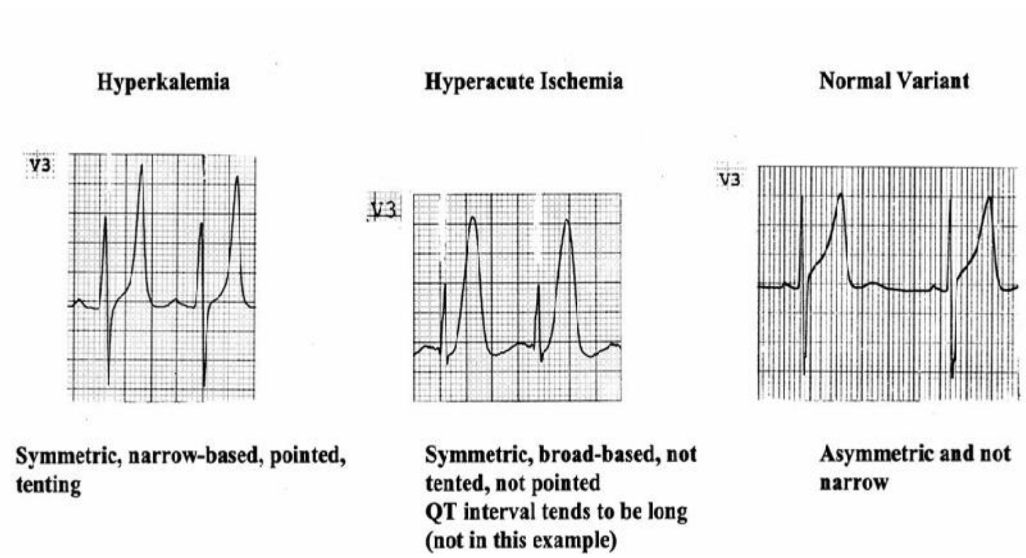
CAUSES OF ST SEGMENT ELEVATION

1) MYOCARDIAL INFARCTION
2) VENTRICULAR ANEURYSMS
3) PRINZEMETAL ANGINA
4) HYPERKALEMIA
5) EARLY REPOLARIZATION SYNDROME

T WAVE MORPHOLOGY

- T WAVES GOES WITH QRS IN AMPLITUDE AND DIRECTION
- NORMAL T WAVE AMPLITUDE - NOT MORE THAN 40% AND NOT LESS THAN 20% OF PRECEDING QRS
- >40% OF QRS- TALL T- ISCHEMIA, HYPERKALEMIA
- LESS THAN 20% OF QRS LOW VOLTAGE T- HYPOKALEMIA, NON SPECIFIC T CHANGE

CAUSES OF TALL T WAVES:



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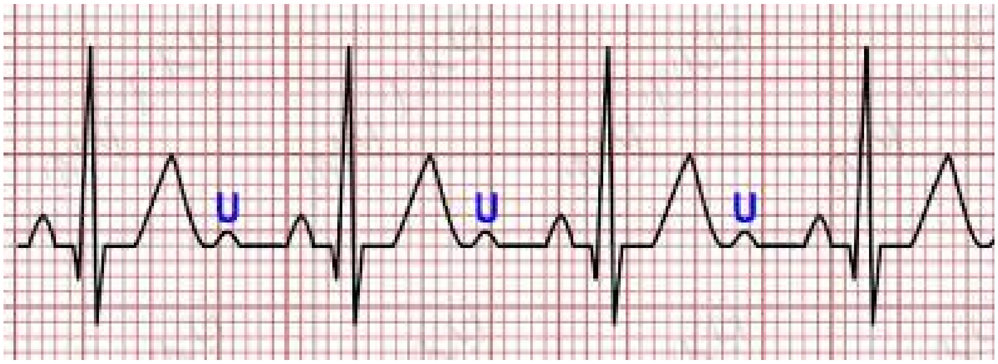
U WAVE

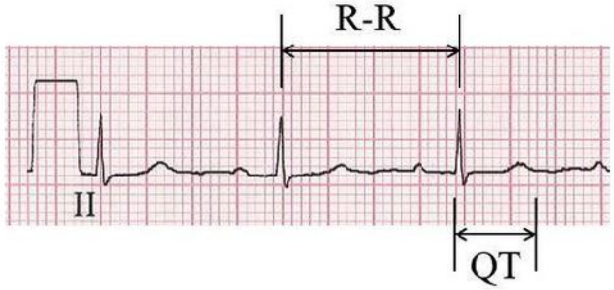
- U wave is a small deflection immediately following the T wave, usually in the same direction as the T wave
- Best seen in leads V2 & V3
- They are thought to be due to repolarisation of atrial septum
- Prominent U wavews can be a sign of Hypokalemia & Hyperthyroidism



QT INTERVAL

- BOTH DE AND REPOLARISATIONS
- SHOULD BE CORRECTED TO HEART RATE:QTC
- LONG QT - BRADYCARDIA
- SHORT QT - TACHYCARDIA
- LONG QTC (440 ms in MEN,460 ms in FEMALE) -CONGENITAL, DRUGS
- SHORT QTC DIGOXIN, HYPERCALCEMIA

BAZETT Formula to calculate corrected QT interval(QTC)



$$QTc = \frac{QT}{\sqrt{R\text{-}R}}$$

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Exploring the Pharmacological Potentials of *Cassia auriculata*: "A Comprehensive Review"

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Abstract

Cassia auriculata, a medicinal plant rich in bioactive compounds, has garnered attention for its diverse pharmacological properties. This review summarizes its antioxidant, anti-inflammatory, antimicrobial, antidiabetic, hepatoprotective, and hypolipidemic effects. *Cassia auriculata* shows promise in managing metabolic disorders like diabetes and dyslipidemia by enhancing insulin sensitivity and modulating lipid metabolism. Its hepatoprotective actions mitigate liver damage induced by toxins and oxidative stress. Moreover, its antimicrobial activity highlights its potential in combating infectious diseases. Overall, *Cassia auriculata* emerges as a promising candidate for the development of novel therapeutics.

Key words: *C.auriculata*, Anti diabatic, Anti microbial and antioxidant

Introduction

Cassia auriculata Linn, commonly known as Tanners Senna, is indigenous to the hot deciduous forests of India and holds a revered status in Ayurveda and Siddha medicine systems. Its bark acts as an astringent, while leaves and fruits serve as anthelminthics. The root is utilized for ailments like tumors, skin diseases, and asthma, whereas leaves are recommended for ulcers, diarrhea, and leprosy. Additionally, its flowers are employed in treating urinary discharge, diabetes, and dysentery Rupeshkumar *et al.*, 2014. *C. auriculata* is a key ingredient in "kalpa herbal tea," favored by those with diabetes mellitus, constipation, and urinary tract issues. Another diabetes remedy is "avaraipanchagachoornam," a blend of dried and powdered plant parts used for eye ailments, conjunctivitis, and urinary infections. Notably, the plant exhibits antipyretic, hepatoprotective, antioxidative, and antimicrobial properties. Its flowers are integral to formulations like "Diasulin," recognized for its antidiabetic effects. Moreover, the dried flower bud powder serves as a diabetic-friendly tea substitute and is believed to enhance complexion (Nille and Reddy 2015).

Scientific classification

Kingdom:	Plantae
Clade:	Tracheophytes
Clade:	Angiosperms
Clade:	Eudicots
Clade:	Rosids
Order:	Fabales
Family:	Fabaceae
Subfamily:	Caesalpinioideae
Genus:	*Cassio*
Species:	***C. auriculata***

Morphology:

The leaves of *C. auriculata* are arranged alternately and are stipulate, with paripinnate compound structures. They are densely packed, with a slender, pubescent rachis measuring 8.8-12.5 cm in length. Each leaflet pair is accompanied by an erect linear gland, with 16-24 leaflets that are oval-oblong, obtuse at both ends, and slightly overlapping. Stipules are notably large, reniform-rotund, and persistently present (Salma et al., 2020).The bright yellow, large flowers of *C. auriculata* are irregular and bisexual, with glabrous pedicels measuring 2.5 cm long. Racemes are few-flowered, short, and erect, typically forming a prominent terminal inflorescence. Sepals are distinct, imbricate, and membranous, with two outer sepals larger than the inner ones. Petals, numbering five, are free, crisped along the margin, and bright yellow veined with orange. The ovary is superior and unilocular, with marginal ovules. Fruits of *C. auriculata* are short legumes, oblong, and tipped with a long style base. They are flat, thin, papery, undulately crimpled, and pilose, typically pale brown in color. Each fruit contains 12-20 seeds, each within its separate cavity (Nagalakshm *et al*., 2022).

Medicinal uses:

The flowers of *Cassia auriculata* are utilized in various medicinal practices. In Kancheepuram district of Tamil Nadu, a mixture of dried flower powder and goat milk is orally consumed to prevent spermatorrhea and white discharge. Additionally, tribal communities in Andhra Pradesh incorporate the flowers into their diet. A combination of *Cassia auriculata* flowers, Enicostemaaxillare plant parts, and *Cuminum cyminum* fruits is administered to cattle to prevent heat-related ailments.Various parts of the plant are employed for medicinal purposes, such as treating urinary discharges, tumors, skin diseases, and asthma. The bark powder is used for dental applications, while decoctions are utilized for chronic dysentery, skin disorders, and body odor. Cassia auriculata finds wide application in alleviating rheumatism, conjunctivitis, and diabetes. It has been reported to possess ulcer-healing, leprosy-fighting, and liver disease-treating properties.Moreover, research has highlighted its antidiabetic, hypolipidemic, antioxidant, hepatoprotective, and antipyretic effects. Notably, extracts from both flowers and leaves exhibit antipyretic activity (Prasathkumar *et al*., 2021 and Uppugalla *et al.*, 2014).

Pharmacological Activities:

1. Anti-microbial Activity: A study by P.K. Nithiyanandham et al., 2018 evaluated the antimicrobial effect of *Cassia auriculata* coated modal and cotton fabric, demonstrating effective antibacterial action, particularly in modal fabric, which outperformed cotton fabric with antibacterial treatment.

2. Anti-diabetic Activity: Gayathri Nambirajan et al., 2018 assessed the antidiabetic activity of bud and flower extracts of Cassia auriculata L. The study found that bud ethanol extract showed promising effects in managing diabetes in rats induced with streptozotocin, potentially more effectively than flower ethanol extract.

3. Anti-cancer Activity: Anitha Rajagopal et al., 2022 discovered that extracts of Cassia auriculata Linn. induced apoptosis and cell cycle arrest in A549 lung cancer cell lines, suggesting potential anticancer properties attributed to flavonoid compounds.

4. Anti-bacterial Activity: Nabil Al-Zaqri et al., 2019 investigated the antibacterial activity of nickel oxide nanoparticles biosynthesized using aqueous floral extract from Senna auriculata, highlighting its potential in combating environmental and human health hazards.

5. Laxative Activity: Muhammad Akram et al., 2022 explored the laxative properties of Cassia auriculata, suggesting its efficacy in managing constipation based on various in vivo and in vitro models.

6. Anti-fungal Activity: T. S. Bhuvaneswari et al., 2019 studied silver nanoparticles synthesized using Cassia auriculata leaf extract and their antifungal efficacy, demonstrating potential antibacterial properties against various strains.

7. Anti-viral Activity: P. Sugapriya Menaga et al., 2019 investigated the potential antiviral activity of bioactive compounds from Cassia auriculata flower extract against dengue virus's Ns2b-Ns3 protease, suggesting their potential as antiviral medications.

8. Anti-obese Activity: Rajendran Vijayakumar et al., 2017 discovered that a floral extract from Cassia auriculata reduced hyperlipidemia in rats by regulating cholesterol metabolism in the liver, indicating its potential as an anti-hyperlipidemic agent.

9. Anti-inflammatory Activity: Anitha Rajagopal et al. 2022 evaluated Cassia auriculata's anti-inflammatory properties, showing robust activity in both ethyl acetate and ethanol fractions, supporting its traditional use in treating infections and inflammation.

Conclusion

In conclusion, the pharmacological exploration of *Cassia auriculata* reveals a rich array of therapeutic potentials. The plant exhibits diverse activities such as antimicrobial, anti-diabetic, anti-cancer, anti-inflammatory, laxative, anti-fungal, anti-viral, and anti-obese effects, as evidenced by numerous research studies. These findings highlight the plant's significance in traditional medicine systems and its potential for novel therapeutic applications in modern healthcare.

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Environment pollution control and eco-friendly consequence of Spirulina (*Spirulina platensis*)

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Abstract

Protection of our environment is one of our major tasks and a natural way of caring for self and for our future generations. There are several factors that would help reduce the impact of our environment. Blue green algae spirulina can serve as a convenient and eco-friendly algae, replacing chemical coagulants, to effectually remove pollution from the aquatic environment. *S. platensis* is a type of blue-green microalgae that is utilized for the purpose of eliminating pollutants, including heavy metals, organic compounds, and other contaminants, from aquatic environments. Prominence is made on bioremediation using *Spirulina platensis*. It also discusses possibilities of using Spirulina grown on the manure and waste water as a food supplement, animal fodder, or source of bioremediation and bioactive compounds.

Key words: Blue green algae, Spirulina, Pollution, Environment

Introduction

Environmental pollutants, including heavy metals, pesticides, gases such as NH_3 and H_2S, and organic compounds, pose significant risks to aquatic organisms, particularly fish. Fish are commonly used to assess aquatic ecosystem health due to the bioaccumulation of pollutants in the food chain, leading to adverse effects and mortality in aquatic systems. Additionally, fish themselves contribute to water contamination through metabolic waste products, with ammonia being a major nitrogenous waste that is toxic even in trace amounts. This study focuses on investigating the effects of ammonia on the survival and behavior of *Labeo rohita*, considering variations in body size. Understanding safe ammonia levels in water is crucial for effective water quality management.

Pollution as a Global Environment Problem

Pollution is a pervasive global issue that impacts the quality of life for communities worldwide. Despite initiatives to manage environmental contamination, limited political will has hindered administrative processes. Pollution disrupts ecosystems, threatens biodiversity, and endangers human health, particularly through industrial activities, vehicle emissions, and mining. Previous efforts to control pollution have been ineffective due to low commitment from participating countries. Toxic waste poses a global threat to natural resources and society, necessitating community awareness and political will to address the issue.

Pollution and Children Health

Pollution, present in various forms such as air, water, soil, and chemicals, poses significant health risks globally. Children, particularly in low- and middle-income countries, are disproportionately affected by environmental pollution, leading to respiratory and gastrointestinal disorders. The exact impact of pollution on pediatric health remains underestimated, necessitating better understanding and public health initiatives to mitigate its effects, especially for vulnerable populations.

Spirulina for Environmental Remediation

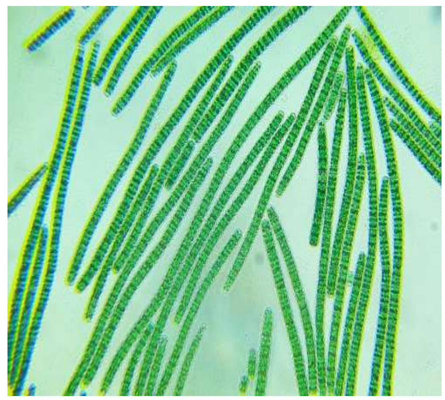
Spirulina, a blue-green algae, shows promise for phytoremediation of polluted waters. It can be cultivated using various organic substrates and wastewater, exhibiting rapid biomass growth and unique chemical properties. Spirulina's rich protein and peptide content enable it to immobilize heavy metals and metabolites of organic pollutants, facilitating water remediation. Additionally, Spirulina serves as a nutritional supplement in aquaculture, enhancing fish growth and health while detoxifying harmful substances such as ammonia and heavy metals.

Environmental Factors Influencing Spirulina Growth

The growth of *Spirulina platensis*, crucial for mass cultivation, is influenced by environmental factors such as temperature, pH, light, salinity, and nutrients. Optimal temperature ranges between 30-35°C, with deviations leading to bleaching of cultures. pH levels of 9-11 are conducive to Spirulina growth, regulating nutrient solubility in the culture medium. Water quality, affecting nutrient solubility and heavy metal accumulation, also plays a vital role in Spirulina mass production.

In conclusion, addressing environmental pollution requires concerted efforts at the local, national, and international levels, incorporating scientific research, community engagement, and policy interventions. Strategies such as phytoremediation using organisms like Spirulina offer sustainable solutions to mitigate pollution's adverse effects on ecosystems and human health.

Taxonomic position of *Spirulina platensis* (Spirulina)



Scientific classification	
Domain:	**Bacteria**
Phylum:	**Cyanobacteria**
Class:	**Cyanophyceae**
Order:	**Spirulinales**
Family:	**Spirulinaceae**
Genus:	***Spirulina***

Spirulina, a multicellular, blue-green filamentous algae native to alkaline lakes and mineral-rich water bodies, has long been recognized as a dietary supplement for communities residing in such regions. Its popularity in the dietary industry stems from its ease of cultivation, harvesting, and

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processing, coupled with its high content of essential micro and macro nutrients. Among algae species, Spirulina holds particular significance as a super food due to its exceptional protein content, valuable vitamins, and pigments like phycocyanin.

The therapeutic usage of Spirulina

The therapeutic implications of Spirulina are substantial, especially for malnourished children, particularly those under five years old. Its protein constituents and Vitamin-B complex offer significant nutritional benefits, addressing deficiencies and providing essential nutrients. Spirulina's rich beta carotene content aids in overcoming eye diseases caused by Vitamin A deficiency, serving as a vital dietary source for preventing such ailments in children. Moreover, Spirulina's high concentration of essential amino acids, gamma-linoleic acid (GLA), and essential fatty acids contribute to hormonal balance and overall health.

In the treatment of conditions like kwashiorkor, a protein-deficiency disease prevalent in infants and children, Spirulina protein proves to be highly efficient and effective compared to traditional protein sources like milk powder. Its nutritional and therapeutic value make Spirulina a staple in diets aimed at addressing malnutrition and promoting overall health.

Conclusion

In conclusion, Spirulina demonstrates remarkable potential in effectively remedying polluted aquatic environments and artificially contaminated water. This review lays the groundwork for developing phytoremediation technologies utilizing Spirulina, leveraging its cultivation conditions and growth factors. Spirulina cultivation in wastewater holds promise for addressing global environmental pollution, producing value-added products, and even generating green electricity, thereby fostering a sustainable circular bio economy. The rising recognition of Spirulina as a healthful food source underscores its immense health and therapeutic benefits.

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Biodiversity

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Introduction

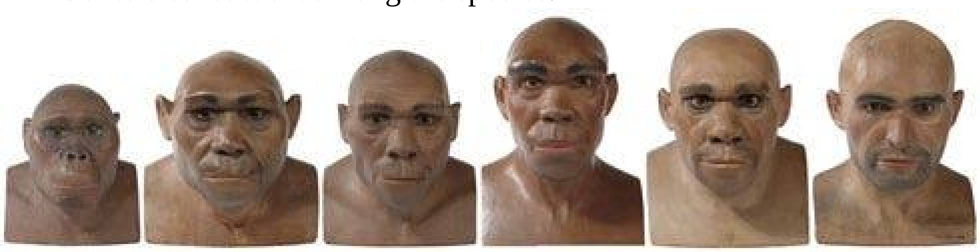
Biodiversity is defined as the variation among living organism. Diverse ecosystems are important for the health of the planet and our survival as humans. Biodiversity can be classified in to three levels based on the variation among Genes, Species and their Ecosystem. Biodiversity can be measured at various level including genetic, species, community, and ecosystem.

Types of Biodiversity are

1. Genetic Biodiversity
2. Species Biodiversity
3. Ecosystem Biodiversity

Genetic biodiversity

Variation among the genetic resources of the organism are called as genetic variation. Each and organism differ from each other based on its genetic constituents. Example. Human rays the Variation shows based on the Genetic constituent among the species.



Species Biodiversity

Variation found among the species in particular ecosystem. Variety of different species found in the particular area are called Species Biodiversity.

Eg. *Solanum* is the genus. *Solanum nigurm*, *Solanum trilobatum*, *Solanum tuberosum* are the variation different species of the same genus of *Solanum*.



Diversity is highest when all the species present are equally more in the given area. There are two constituents of species diversity:

Simpson's Diversity index:

The Simpson diversity index is used to calculate a measure of diversity taking into account the number of taxa as well as the abundance. The Simpson index gives more weight to common or dominant species which means a few rare species with only a few representatives will not affect the diversity of the sample. Simpson’s Index is a calculation done by ecologists that is a measure of diversity which takes into account both richness and evenness of species.

$$\mathbf{D = p n_i (n_i-1) / p N (N-1)}$$

n = the total number of organisms of a particular species
N = the total number of organisms of all species

Community 1			
Species	$\mathbf{n_i}$	$\mathbf{n_i-1}$	$\mathbf{n_i (n_i-1)}$
A	10	9	90
B	9	8	72
C	11	10	110
D	10	9	90
E	8	7	56
F	12	11	132
G	10	9	90
H	11	10	110
I	10	9	90
J	9	8	72
Total	**N=100**		$\mathbf{p n_i (n_i-1)=912}$

$$D = \Sigma n_i (n_i-1) / \Sigma N (N-1)$$
$$=912 / 100 \times (100-1)$$
$$=912 / 100 \times (99)$$
$$=0.09$$

Similarly various community can be calculated

Community	Simpson index D	Level of diversity
1	0.09	extremely high diversity
2	0.52	moderate diversity
3	0.38	high diversity
4	0.9	extremely low diversity

Index for the level of biodiversity

1	no diversity
0.9	extremely low diversity
0.8	very low diversity
0.7	low diversity
0.6	moderate-low diversity
0.5	moderate diversity
0.4	moderate-high diversity
0.3	high diversity
0.2	very high diversity
0.1	extremely high diversity
0	infinite diversity

Species richness:

Number of different species present in an ecosystem. Tropical areas have greater species richness as the environment is conducive for a large number of species because of its favorable environment of most of the plant and animal species.

Species richness is a measure of the number of different kinds of organisms present in a particular area.This is a simple count of the species in a community.Each species contributes one count to the total regardless of whether the species population is 1 or 1 million.

Species Richness for Two Flower Communities

Community	Species Richness
1	3
2	3

Species evenness:

Species Evenness is a measure of the relative abundance of the different species making up the richness of an area. If the number of individuals within a species is fairly constant across communities, it is said to have a high evenness and if the number of individuals varies from species to species, it is said to have low evenness. High evenness leads to greater specific diversity.
Species evenness can be calculated as:

$$\text{Relative abundance} = \frac{\text{Number of individuals of a species}}{\text{Total number of individuals}}$$

Flower Species Counts from Two Communities

Flower Species	Numbers of individuals	
	Community 1	Community 2
Daisy	300	20
Dandelion	335	49
Buttercup	365	931
Total	1000	1000

Species Evenness of Two Communities

Flower Species	Numbers of individuals	
	Community 1	Community 2
Daisy	0.30	0.02
Dandelion	0.34	0.05
Buttercup	0.36	0.93
Total	1	1

Shannon- weighner index

Shannon- weighner index or Shannon- Weighner diversity index is used to measure the evenness of species in a community. The term "evenness" simply refers to how similar the abundances of different species are in the community. It is denoted as H, this index is calculated as:

$$H = -\Sigma pi\ x ln(pi)$$

where:

Σ: A Greek symbol that means "sum"

ln: Natural log

pi: relative abundance of species /The proportion of the entire community made up of species i

The higher the value of H, the higher the diversity of species in a particular community. The lower the value of H, the lower the diversity. A value of H = 0 indicates a community that only has one species.

Species	Frequency	pi=Frequency(f)/ Σf	pi	Natural log In (pi)	pi x In (pi)
A	35	35/120	0.29	-1.23	-0.3567
B	42	42/120	0.35	-1.04	-0.364
C	23	23/120	0.19	-1.66	-0.3154
D	20	20/120	0.16	-1.83	-0.2928
Total Σf	120			Σpi x ln(pi)	-1.3289

$H = -\Sigma pi\ X\ ln(pi)$

$H=-(-1.3289)$

$H=1.3289$

Shannon Equitability Index:

$E_H = H / ln(S)$

For this example, there are S = 4 total species, so see can calculate this index to be:

$E_H = 1.3289 / ln(4)$

$E_H = 1.3289/1.6094$

Shannon Equitability Index (E_H) =0.8257

Thus the result shows very least number of species and it is highly polluted area.

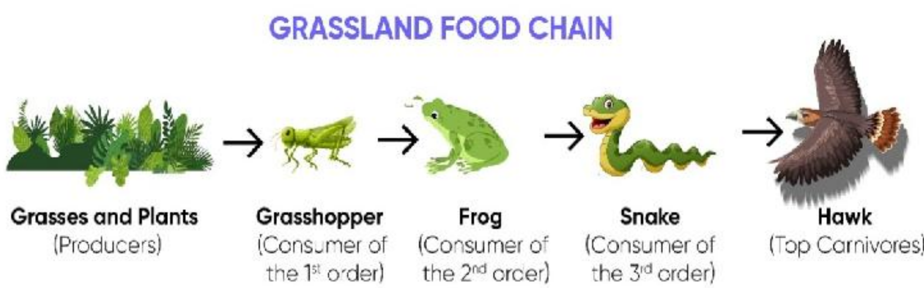
Diversity level	Shannon Wiener index	Pollution level
High	3.0–4.5	Slight
Moderate	2.0–3.0	Light
Less	1.0–2.0	Moderate
Very less	0.0–1.0	Heavy pollution

Ecological Biodiversity

Variation among the species based on the ecosystem where they live. Ecological biodiversity refers to the variations in the plant and animal species living together and connected by food chains and food webs. Based on the Ecosystem each and every species adopted their characters

Example

In aquatic ecosystem, plant and animal can live in the water. Plant has air chamber for buoyancy and also have some special characters. Likewise, aquatic animal like fishes have fins to swim and gills for aquatic respiration.



The three indices of diversity are – i) Alpha, ii) Beta, and iii) Gamma diversity:

i) Alpha Diversity:

Alpha diversity is calculated by counting the number of species found in the ecosystem. It is calculated by counting the number of taxa (typically species) present in a given region, community, or ecosystem. Alpha diversity refers to the variety of species found in each forest or grassland area. For Example In Forest Ecosystem, 21 different species found in Region A

ii) Beta diversity:

Beta diversity measures the change in diversity of species from one environment to another. In simpler terms, it calculates the number of species that are not the same in two different environments. It is the number of unique species to each environment that is used to calculate species diversity between two nearby ecosystems.This concept of beta diversity dates back to the work of Whittaker (1960), which coined this term to define the amount of variation in species composition among sampling units (or communities, assemblages, plots, relevés, sites, quadrats, etc.)

For example:

Comparison of species diversity between two region A & B

Species	**Region A**	**Region B**
Eagle	1	1
Zebra	-	1
Vulture	1	1
wolf	1	1
Fox	4	1
Hyena	1	1
Lion	2	1
Tiger	1	1

Deer	3	1
Elephant	2	1
Owl	1	1
Donkey	1	1
Cheetah	1	-
Butterfly	1	-
Monkey	2	1
Tortoise	1	-
Dove	1	1
Giraffe	1	1
Total species	**25**	**15**
Total No. of individual species	**S1=17**	**S2=15**

Total No. of individual species found in Region A S1= 17
Total No. of individual species found in Region B S2= 15
Total no. of common species = 14

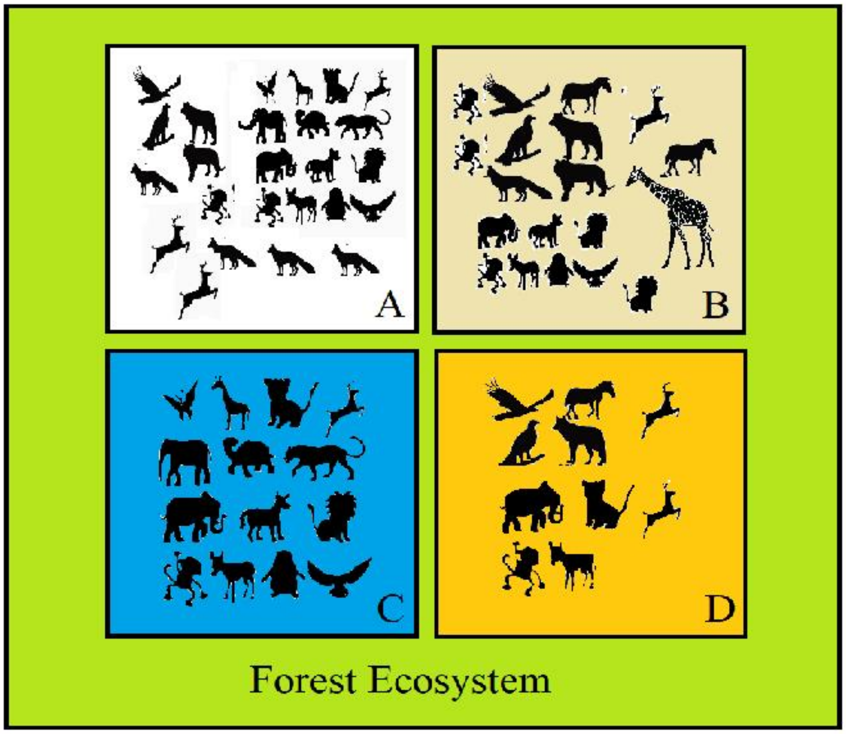
S1= Total number of species in the first environment.

S2= Total number of species in the second environment.

C= Total number of common species

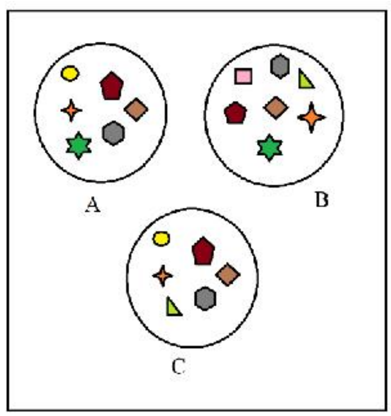
$\beta = (S1-C) + (S2-C)$
$\beta = (17-14) + (15-14)$
$\beta = 3 + 1$
$\beta = 4$

The beta diversity of the two environments is 4. That is, there are four species which are either only in environment one or only in environment two.



iii) Gamma diversity:

It refers to the habitat variety over the whole landscape or geographical area. Gamma biodiversity is the total species diversity present in a geographical area. It measures the total diversity of all the ecosystems in an area. In the given figure, gamma biodiversity is 8 i.e. the total number of species found all the area (A, B & C) of an ecosystem.



Importance of Biodiversity:

The living organisms on earth are of great diversity, living in diverse habitats and possessing diverse qualities and are vital to human existence providing food, shelter, clothing's, medicines etc.

The biodiversity has the following importance:

1. Productive values:

Biodiversity produces a number of products harvested from nature and sold in commercial markets. Indirectly it provides economic benefits to people which include water quality soil protection, equalization of climate, environmental monitoring, scientific research, recreation etc.

2. Consumptive value:

The consumptive value can be assigned to goods such as fuel woods, leaves, forest products etc. which may be consumed locally and do not figure in national and international market.

3. Social value:

The loss of biodiversity directly influences the social life of the country possibly through influencing ecosystem functions (energy flow and biogeochemical cycle). This be easily understood by observing detrimental effects of global warming and acid rain which cause an unfavorable alteration in logical processes.

4. Aesthetic value:

Aesthetic values such as refreshing fragrance of the flowers, taste of berries, softness of mossed, melodious songs of birds, etc. compel the human beings to preserve them. The earth's natural beauty with its colour and hues, thick forest, and graceful beasts has inspired the human beings from their date of birth to take necessary steps for its maintenance. Similarly botanical and zoological gardens are the means of biodiversity conservation and are of aesthetic values.

5. Legal values:

Since earth is homeland of all living organisms, all have equal right to coexist on the surface of earth with all benefits. Unless some legal value is attached to biodiversity, it will not be possible to protect the rapid extinction of species.

6. Ethical value:

Biodiversity must be seen in the light of holding ethical value. Since man is the most intelligent amongst the living organisms, it should be prime responsibility and moral obligation of man to preserve and conserve other organisms which will directly or indirectly favour the existence of the man.

7. Ecological value:

Biodiversity holds great ecological value because it is indispensable to maintain the ecological balance. Any disturbance in the delicately fabricated ecological balance maintained by different organisms, will lead to severe problems, which may threaten the survival of human beings.

8. Economic value:

Biodiversity has great economic value because economic development depends upon efficient and economic management of biotic resources.

In the day to day life, human beings are maintaining their lifestyle at the sacrifice of surrounding species which come from diversity of plants and animals struggling for their existence.

So, it is highly essential for the human beings to take care of their surrounding species and make optimum use of their service, for better economic development. Thus, it is rightly told, survival of the man depends upon the survival of the biosphere.

Uses of Biodiversity:

Biodiversity has the following uses for the development humanity:

(i) It provides food of all types.

(ii) It provides fibers, sources for the preparation of clothes.

(iii) It provides different types of oil seeds for the preparation of oils.

(iv) It provides new varieties of rice, potato etc. through the process of hybridization.

(v) It provides different drugs and medicines which are based on different plant products.

(vi) It is very essential for natural pest control, maintenance of population of various species, pollination by insects and birds, nutrient cycling, conservation and purification of water, formation of soil etc. All these services together are valued 16.54 trillion dollars per year.

Threats to Biodiversity:

Biodiversity is considered as a reservoir of resources to be used for the manufacture of food, medicine, industrial products, etc. But with an increased demand of rapid population growth, biodiversity is gradually depleting. A number of plants" and ani-mal species have already become extinct and many are endan- gered.

The different factors responsible for causing threat to biodiversity are as follows:

1. Habitat destruction:

The primary cause of loss of biodiversity is habitat loss or destruction which is resulted due to the large industrial and commercial activities associated with agriculture, irrigation, construction of dams, mining, fishing etc.

2. Habitat fragmentation:

With increased population, the habitats are fragmented into pieces by roads, fields, canals, power lines, towns etc. The isolated fragment of habitats restricts the potential of species for dispersal and colonization. In addition, the habitat fragmentation also brings about microclimatic changes in light, temperature, wind etc.

3. Pollution:

The most dreaded factor inducing loss of biodiversity is environmental pollution which include air pollution, Water pollution, industrial pollution, pollution due to chemical Pastes, pesticides radioactive materials etc.

4. Over exploitation:

The natural resources are over exploited to meet growing rural poverty, intensive technological growth and globalization of economy. All these factors together may be responsible for the extinction of a number of species.

5. Introduction of exotic species:

The introduction of exotic species are due to:

(i) horticulture

(ii) agriculture;

(iii) European colonisation and

(iv) accidental transport.

It is seen that some exotic species may kill or eat the native species thereby causing its **extinction.**

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6. Diseases:

Since the animals are more vulnerable to infection, the anthropological activities may increase the incidence of diseases in wild species, leading to their extinction.

7. Shifting or Jhum cultivation:

The shifting or Jhum cultivation by poor tribal people greatly affects the forest structure which is a store house of biodiversity.

8. Poaching of wild life:

A number of wildlife species are becoming extinct due to poaching and hunting.

Conservation of Biodiversity:

Biodiversity is being depleted by the loss of habitat, fragmentation of habitat, over exploitation of resources, human sponsored ecosystems, climatic changes, pollution invasive exotic spices, diseases, shifting cultivation, poaching of wild life etc.

Since the human beings are enjoying all the benefits from biodiversity, they should take proper care for the preservation of biodiversity in all its form and good health for the future generation i.e., the human being should prevent the degradation and destruction of the habitats thereby maintaining the biodiversity at its optimum level.

Conservation of biodiversity is protection, upliftment and scientific management of biodiversity so as to maintain it at its threshold level and derive sustainable benefits for the present and future generation. In other words, conservation of bio-diversity is the proper management of the biosphere by human beings in such a way that it gives maximum benefits for the present generation and also develops its potential so as to meet the needs of the future generations.

Mainly the conservation of biodiversity has three basic objectives:

(a) To maintain essential ecological processes and life supporting systems.

(b) To preserve the diversity of species.

(c) To make sustainable utilization of species and ecosystems.

Strategies for Conservation of Biodiversity:

The following strategies should be undertaken in order to con- serve biodiversity:

(1) All the possible varieties (old or new) of food, forage and timber plants, livestock, agriculture animals and microbes should be conserved.

(2) All the economically important organisms in protected areas should be identified and conserved.

(3) Critical habitats for each species should be identified and safeguarded.

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(4) Priority should be given to preserve unique ecosystems.

(5) There should be sustainable utilization of resources.

(6) International trade in wild life should be highly regulated.

(7) The poaching and hunting of wildlife should be prevented as far as practicable.

(8) Care should be taken for the development of reserves and protected areas.

(9) Efforts should be made to reduce the level of pollutants in the environment.

(10) Public awareness should be created regarding biodiversity and its importance for the living organisms.

(11) Priority should be given in wildlife conservation programme to endangered species over vulnerable species and to vulnerable species over rare species.

(12) The habitats of migratory birds should be protected by bilateral and multilateral agreement.

(13) The over exploitation of useful products of wild life should be prevented.

(14) The useful animals, plants and their wild relatives should be protected both in their natural habitat (in-situ) and in zoological botanical gardens (ex-situ)

(15) Efforts should be made for setting up of National parks and wild life sanctuaries to safeguard the genetic diversity and their continuing evolution.

(16) Environmental laws should be strictly followed.

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"Actinomycetes: Origins, Recognition and their Role in Sustainable Research"

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Abstract

The genus *Streptomyces* is particularly renowned for its prolific production of antibiotics. These bacteria also exhibit potential in bioremediation due to their capacity to degrade complex polymers and pollutants. Research into actinomycetes continues to uncover new species and bioactive metabolites, highlighting their significance in both natural ecosystems and biotechnological applications.Predominantly found in soil, they play a vital role in decomposing organic matter, thus contributing to nutrient cycling and maintaining soil health. The genus *Streptomyces* stands out for its prolific antibiotic production, which has been pivotal in medical and pharmaceutical advancements. In addition to their medical significance, *Actinomycetes* have potential applications in bioremediation due to their ability to degrade complex organic pollutants. Ongoing research continues to discover new species and novel bioactive substances from *Actinomycetes*, underscoring their importance in both ecological functions and biotechnological innovations. Their multifaceted roles and contributions make *Actinomycetes* a critical subject of study in microbiology and biotechnology.The genus *Streptomyces* is the most well-known among actinomycetes, primarily due to its prolific production of antibiotics such as streptomycin, tetracycline, and erythromycin, which have had a significant impact on medical science by treating various

bacterial infections. Beyond their medical applications, *Actinomycetes* are also valuable in agriculture, where they are used to develop natural pesticides and enhance plant growth through their symbiotic relationships with plants. In addition to their contributions to medicine and agriculture, *Actinomycetes* exhibit potential in bioremediation. They possess the capability to degrade a wide range of complex organic pollutants, including pesticides, herbicides, and industrial chemicals, thereby aiding in the cleanup of contaminated environments. Research into actinomycetes is ongoing, with scientists continually discovering new species and bioactive compounds that could have future applications in various fields. Their genetic diversity and metabolic versatility make them an important focus of study in microbiology and biotechnology. *Actinomycetes'* ability to adapt to different environments and produce novel compounds underscores their significance in natural ecosystems and their potential for innovation in scientific research and industrial applications.

Introduction of *Actinomycetes*

Actinomycetes that thrive in aerobic conditions, forming branching filaments and asexual spores. They share a morphological resemblance to fungi, likely due to their adaptation to similar environments. Research on the germination process of *Actinomycetes* spores has primarily focused on the *Streptomyces* genus, particularly in understanding their endospore formation. These endospores exhibit similarities in behavior to *Bacillus* spores, as they develop a new wall layer within the spore cortex during germination, expanding to create the wall of the germ tube.

Extensive research has focused on the ultrastructural changes during fungal spore germination, from an already existing wall layer in the dormant spore. However, conflicting results exist, with closely related species sometimes falling into different categories, possibly due to variations in fixatives used during studies. For instance, potassium permanganate may yield different results compared to osmium tetroxide or aldehydes. Additionally, hydration during specimen preparation can induce significant changes in spore wall layers. When cultivated on agar, *Actinomycetes* form a complex network of branched hyphae that extend across both the upper and lower surfaces of the agar medium. The hyphae observed on the surface of the agar are referred to as aerial hyphae, while those beneath the surface are referred to as substrate hyphae [1].

Septa typically divide hyphae into elongated cells, usually 20 mm or longer, each containing numerous bacterial chromosomes (nucleoids). These elongated cells make up the aerial hyphae, which grow above the substrate and reproduce through asexual means. The majority of *Actinomycetes* are immotile, although if motility is observed, it is usually limited to flagellated spores.

Cell Wall Composition

Actinomycetes generally possess a Gram-positive cell envelope that consists of a plasma membrane and a dense peptidoglycan layer. However, within the Corynebacteriales order, there's an exceptional case where a distinct outer membrane has emerged, likely through convergent evolution. This outer envelope includes a peptidoglycan layer modified by an arabinogalactan layer, which serves as a platform for attaching mycolic acids. Mycolic acids are exceptionally long fatty acids, containing around Hundread carbon atoms per molecule, and are thought to be a significant component of the outer membrane, alongside other lipids like trehalosedimycolate, also called the cord factor.

Certain bacteria belonging to the Corynebacteriales order are known pathogens in humans and animals, with Mycobacterium tuberculosis being a notable example. Studies have identified specific receptors in hosts that recognize molecular patterns on the surface of these pathogens, highlighting the importance of comprehending the structure and composition of Actinobacteria's cell envelopes. emphasizing their significant differences.

Isolation of *Actinomycetes*

Actinomycetes can be gathered using various techniques that depend on different origins and cultivation media. Samples are obtained from various ecological environments, and further analysis techniques used [2].

SOURCE	MEDIA
FROM SOIL:	
Forest Soil	➢ Starch-casein medium
Humus Layer of Forest Soil	➢ Humic acid-vitamin agar ➢ Starch casein nitrate agar(SCS) ➢ Hair hydrolysate vitamin agar(HHVA) ➢ Bennet"s agar(BA)
Corn Field, Cow Barn yard, Forest	➢ Arginine-glycerol salt(AGS)medium ➢ Chitin medium ➢ Modified Benedict"s medium ➢ Soybean meal-glucose medium ➢ Czapek"s agar medium ➢ Glycerol-asparaginate agar 2 ➢ Glucose-asparagine medium
Lake Soil	➢ Chitin agar
Soil	➢ Coal-vitamin agar
Antartic Soil	➢ Mineral salt(MS) medium
Mitidja plain (Algeria)	➢ Yeast extract-malt extract agar
Marine Soil	➢ Starch casein nitrate(SCN) agar medium
FROM WATER:	
Stream Sediments & Lake muds	➢ Chitin agar media
	➢ M3 agar medium
	➢ Benett"s medium
Marine Sediments	➢ Starch-casein agar
	➢ Asparagine agar
	➢ Glycerol-glycine agar
Marine Sediments(South China)	➢ AIM medium
FROM OTHER SOURCES:	
FROM ROOT & STEM SAMPLES OF FOUR PLANTS:	➢ Starch yeast casein agar(SYCA),Actinomycetes Isolation agar (AIA), Humic Acid vitamin gellan gum (HVG),Tap water yeast extract agar (TWYE), Coal –vitamin agar (CVA)
Mangroove Sediments	Asparagine-glucose agar medium

Table 1 Isolation of Actinomycetes

Identification

Different methods for identifying *Actinomycetes* are outlined briefly below:

Molecular Approach: One of the most effective methods for taxonomy involves studying nucleic acids, as they provide direct information about genes or gene products, allowing for meaningful comparisons and data analysis. Molecular biology, encompassing both classification and identification, traces its roots back to early protein hybridization studies but has gained significant traction with the advent of protein sequencing techniques. Phyletic studies based on 16S rDNA sequences are becoming increasingly important in bacterial and *Actinomycetes* research. These sequences create a phyletic tree that not only helps in understanding *Actinomycetes'* evolution but also serves as a basis for identification [3].

The amplified DNA fragments are sequenced directly using a DNA sequencer to determine the base order within the sample. This sequencing data is then analyzed using phyletic analysis methods to identify the organism. However, it's important to note that 16S rDNA analysis typically provides identification up to the genus level only.

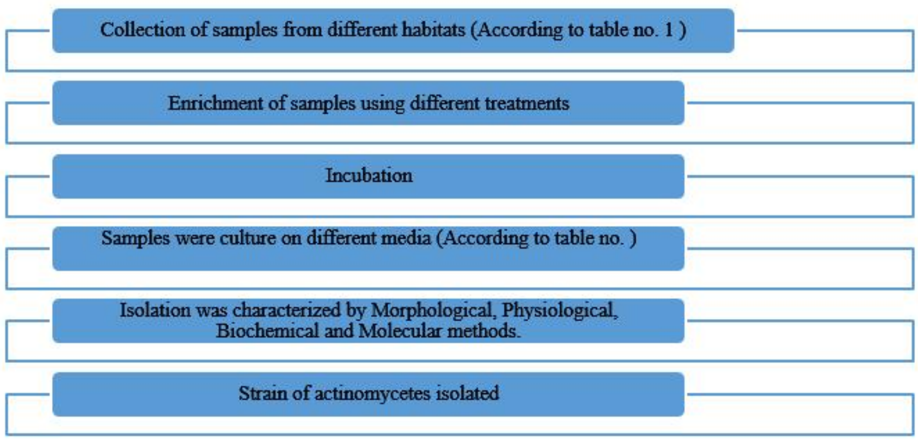

Figure 2 Procedure for isolation of Actinomycetes

Chemotaxonomical Approach

Chemotaxonomy involves studying chemical variations in organisms, which is then used for classification and identification. This approach is particularly valuable in distinguishing different composition of the cytomembrane could be a useful tool for distinguishing various types of actinomycetes, as certain chemical components become significant in taxonomy when meeting specific criteria. Within a taxonomic group, homologous features are expected to be consistent among strains, while noticeable differences are anticipated between taxa to enable differentiation. One crucial shared cell-wall property between gram-positive bacteria and actinomycetes is the presence of Diaminopimelic Acid (DAP) isomers. Peptidoglycan, responsible for forming the characteristic wall envelope in most bacteria, involves the amino acid 2,6-Diaminopimelic Acid (DAP). The systematic significance largely revolves around this amino acid with two amino groups, with its identification generally sufficient for characterization purposes.

Bacteria usually exhibit either the LL-form or the meso-form isomer of DAP, primarily localized within the peptidoglycan structure[4].

Classical Approach

- Traditional classification techniques rely on physiological, morphological, and biochemical traits. The established method described in BMDB is notably effective in identifying *streptomycetes*. These characteristics have long been fundamental to *Streptomycetes* taxonomy and are particularly valuable for routine identification purposes. The key traits discussed are as follows:
- Physiological Characteristics: Includes traits related to metabolic activities, growth requirements, and physiological behaviors under different conditions.
- Morphological Characteristics: Refers to observable features like colony morphology, spore formation, color, shape, and size of cells or structures.
- Biochemical Characteristics: Involves biochemical tests to assess enzyme activities, metabolic pathways, utilization of specific substrates, and production of characteristic compounds.

These traditional methods provide a reliable framework for identifying *streptomycetes* based on a range of observable and measurable traits [5].

1. Aerial Mass Color

The hue of the fully developed sporulating aerial mycelium is documented through a simple approach, typically denoted by descriptors like White, Grey, Red, Green, Blue, and Violet. When the aerial mass color falls within a range between two colors, both colors are noted. Similarly, if an aerial mass displays intermediate tones, both relevant color categories are recorded.

2. Melanoid Pigments

Strains are classified according to their ability to produce melanoid pigments, which may vary from light-green brown to brown-black or a clear brown hue, occasionally displaying pigment variations influenced by other colors when cultivated on the medium. These strains are divided into two categories: melanoid pigment producers (+) or non-producers (-).

3. Reverse Side Pigments

Strains were divided into two categories based on their capability to generate specific pigments beneath the colony. These categories are termed as unique pigment producers (+) and those that either lack unique pigment production or do not produce any pigments at all (-). If a color with reduced intensity, such as yellowish, olive, or yellowish-brown, is detected, it falls into the latter group (-).

4. Soluble Pigments

The strains are sorted into two groups depending on their ability to generate soluble pigments distinct from melanin. These groups are defined as pigment producers (+) and non-producers (-). The color produced, which could be orange, red, green, violet, blue, or yellow, is also noted during this classification process.

5. Spore Chain Morphology

In terms of spore chain characteristics, strains are categorized into "sections." Within the *Streptomyces* genus, as outlined by Shirling and Gottlieb in 1966, there are three sections: Rectiflexibiles (RF), Retinaculiaperti (RA), and Spirales (S). If a strain forms two distinct types of spore chains, both types are recorded, denoted as a combination (e.g., SRA).

6. Reproductive Structure Surface

To study spore morphology and surface features, utilizing a scanning electron microscope is essential. Alternatively, cross-sectioned cultures prepared for examination using a light microscope can also fulfill this objective.

Numerical Taxonomic Approach

Numerical taxonomy involves evaluating various strains based on a broad range of characteristics to group them based on shared features. After classification, specific traits unique to clusters or predictive traits are chosen for identification purposes. Additionally, clusters were identified at similarity levels ranging from 59.6% to 64.6%. This demonstrates the utility of numerical taxonomy in providing a robust framework for Streptomyces taxonomy and species identification.

Enzyme production from *Actinomycetes*

Marine *Actinomycetes* display notable variations in physiological, biochemical, and molecular traits compared to their terrestrial counterparts. They possess unique metabolic pathways and are renowned for their production of diverse biologically active enzymes. *Actinomycetes* are also recognized as cellulose producers, with cellulases being essential hydrolytic enzymes that break down cellulose and related cello-oligosaccharide derivatives. Furthermore, actinomycetes are prolific producers of lipases, which find extensive use in detergent industries, food processing, oleochemicals, diagnostics, pharmaceuticals, and other industrial applications. Their ability to secrete a diverse array of extracellular hydrolytic enzymes makes them vital in various fields. *Actinomycetes* are commonly isolated from natural sources, plant tissues, and rhizospheric soil, and their biological functions often vary depending on their isolation sources [6].

Notably, *Actinomycetes*, particularly *Streptomycetes*, are notable sources of microbial alkaline proteases used in manufacturing. They are also recognized for their production of L-asparaginase, an enzyme with therapeutic applications in treating certain human cancers like acute lymphoblastic leukemia. *Actinomycetes* sourced from various environments, including Thai medicinal plants' rhizosphere soil, hold promise for producing novel secondary metabolites with potential medicinal benefits.

Additionally, *Actinomycetes* are known to produce enzymes such as catalase, chitinase, and urease, further expanding their potential industrial and medical applications [7].

Applications of *Actinomycetes*

Ecological Importance

Actinomycetes are plentiful in soil and play a crucial role in breaking down resilient carbohydrates like chitin and cellulose. They contribute to the earthy scent of freshly tilled soil. Many *Actinomycetes* and other *Actinobacteria* are recognized for their ability to degrade hazardous substances, making them valuable in bioremediation efforts. They demonstrate remarkable adaptation to harsh conditions and can thrive in challenging environments. Some species can withstand high temperatures (>50°C) and play a vital role in the composting process [8][9].

Figure 3 Actinomycetes application

Human Health Importance

Antibiotics

Actinomycetes are prolific in their production of a wide range of antibiotics, which are highly esteemed and extensively utilized. These antibiotics encompass well-known names such as Amphotericin, nystatin, chloramphenicol, gentamicin, erythromycin, vancomycin, tetracycline, novobiocin, neomycin, and other antibiotics are used in medical treatments. Tetracycline and erythromycin are frequently prescribed for these conditions. Vancomycin stands out for its effectiveness against dangerous pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA) by attacking bacterial cell walls, especially crucial due to these pathogens' resistance to multiple drugs. Rifamycins are essential in combatting leprosy and tuberculosis as they target bacterial RNA polymerase. Amphotericin is unique in its action against fungal membranes. Notably, these antibiotics typically exhibit minimal impact on human cells, leading to reduced side effects [6][5].

Volatile Organic Compounds (VOCs)

The earthy scent emanating from freshly disturbed soil originates from geosmin, a volatile organic compound synthesized by *Actinomycetes*. Geosmin is also created by specific cyanobacteria and can contribute an earthy taste to drinking water. Certain fungi also produce geosmin, which can lend a similar earthy flavor to wine made from grapes affected by mold. Generally, people find the smell of geosmin in soil enjoyable. However, there is ongoing research investigating whether exposure to geosmin may be associated with symptoms related to indoor air quality. Currently, the available data is limited, and no definitive conclusions can be drawn. Nonetheless, in the future, collecting samples that can detect these organisms may be recommended for further study [9].

Actinomycetes as Antifungals

Urauchimycins, members of the antimycin class, are well-known antifungals that function by impeding electron flow within the mitochondrial respiratory chain. Studies have revealed that *Streptomyces* isolated from the integuments of attine ants produce antimycins, specifically antimycins A1–A4, with about 50% of *Streptomyces actinobacteria* isolated from various Acromyrmex ant species found to produce these compounds. This class of compounds likely plays a significant role in the symbiotic relationship between attine ants and microbes. Another antifungal substance frequently found in *Streptomyces* linked to attine ants is candicidin[10].

Infections

Actinomycetes, commonly found in the oral cavities of humans, typically exist as commensal members. However, they can lead to severe infections if they penetrate tissues through breaks in the oral mucosa. Although this disease is becoming less common globally, it remains prevalent in the USA, especially among individuals with compromised immunity. Nocardia species may also play a role in these infections [11], [12].

Hypersensitivity pneumonitis (HP)

Thermophilic*Actinomycetes* are a significant contributor to hypersensitivity pneumonitis (HP), particularly in cases of Farmer's lung disease, a subtype of HP resulting from exposure to hay contaminated with these microorganisms. The infested hay emits substantial quantities of airborne spores, especially when farmers, notably dairy farmers, handle stored hay during the colder months of winter and early spring. These fungi, known for causing hay spoilage, are also frequently present in soil and have been identified in various environments such as, clothes dryers and other places where cellulose, and moisture come together [13].

Actinomycetes as source of Agroactive compounds

The increased reliance on synthetic agrochemicals to meet the rising food demands has raised concerns about environmental and health hazards. These chemicals not only pose risks to non-target organisms, including humans, but also raise societal and scientific concerns globally regarding their continued use. The residual toxicity of these xenobiotics has led to higher incidences of cancer, hormonal and immunological disorders, allergies, and adverse effects on reproductive abilities. Due to these residual toxicities, there has been a shift in pest management strategies. The focus now is on suppressing pest populations to sub-economic and sub-lethal levels rather than completely eradicating them, as was previously practiced. With the increasing demand for organically grown food, there is a growing exploration of suitable, non-hazardous, and innovative alternatives. Crop protection groups are currently grappling with a range of complex questions when designing pesticides. These include considerations such as the form the crop protection agent should take to prevent harm to users, its water solubility, ease of application, effectiveness in controlling pests at low concentrations, and its environmental impact [14].

Actinomycetes as plant growth promoting Agents

Plant growth-promoting bacteria (PGPB) are commonly utilized microorganisms in inoculant formulations, particularly those found in the rhizospheric zone of plants known as plant growth-promoting rhizobacteria (PGPR; reference 50). The interaction between plants and plant-growth-promoting Actinomycetes (PGPA) has been extensively researched. Typically, PGPA with potential for use in microbial inoculants can positively influence host plants through two primary mechanisms: regulating phytohormones (such as auxins, gibberellins, cytokinins, and producing 1-aminocyclopropane-1-carboxylate (ACC) deaminase) and enhancing nutrient accessibility, which includes biological nitrogen fixation, phosphate solubilization, and siderophore production [3][15].

Actinomycetes in Biocorrosion

Metal corrosion is an electrochemical interaction occurring between a metal and its surroundings, with microorganisms thought to have a notable impact. The corrosion rates experienced by various metals vary based on environmental conditions and metal characteristics. Well-researched bacteria involved in biocorrosion include anaerobic sulfate-reducing bacteria (SRB), methanogens, acid-producing bacteria, aerobic iron respirers, and manganese oxidizers. Microbial biofilms contribute to biocorrosion by altering factors such as pH, pressure, oxygen concentrations, and nutrient availability at the interface between the metal and its surroundings [16]. Consequently, biofilms can manipulate conditions at metal surfaces, either accelerating or inhibiting corrosion [17][18]. *Streptomyces lunalinharesii Strain 235* exhibits promising capabilities in suppressing bacteria associated with biocorrosion phenomena [19].

Actinomycetes in Bioremediation

Actinomycetes, a significant group within soil microbial communities, possess diverse metabolic capabilities and growth traits that render them effective for bioremediation purposes. They play a proactive role in eliminating toxic heavy metals of foreign origin, as evidenced in laboratory setups and soil environments, employing either individual *Actinomycetes* strains or their collective consortia. Their remarkable adaptability can be harnessed for environmental improvement. The utilization of both *Actinomycetes* cells and their byproducts holds promise in various bioremediation applications [20]. In recent years, there has been a rise in environmentally friendly approaches leveraging microbial species to remediate polluted environments. *Actinomycetes*, in particular, have showcased their potential in degrading contaminants. These bacteria are widely distributed across aquatic and terrestrial ecosystems, playing vital roles such as breaking down complex polymers, recycling compounds, and generating bioactive substances. Consequently, employing *Actinomycetes* for environmental cleanup presents an appealing option within biotechnology. One method to achieve this is through bioaugmentation, a sustainable technique where targeted microorganisms are introduced to significantly enhance the degradation capabilities of contaminated sites [21].

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A Comprehensive Review on Therapeutic Properties of *Azima tetracantha* Linn - a Traditional Medicinal Plant

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Abstract

Plants play a crucial role in the daily lives of human beings. Ethnobotany refers to the interactions and connections between people and plants. Across the globe, plants are utilized as valuable sources of food, medicine, dyes, and timber. Traditional healers and indigenous medical systems, such as Ayurveda, Siddha, and Unani, rely on numerous plant species to treat various ailments in both humans and livestock. The therapeutic potential of plants lies in the presence of secondary metabolites like alkaloids, terpenes, and polyphenolic compounds. *Azima tetracantha* Lam., a small shrub armed with quadrangular branches, belongs to the Salvadoraceae family. This review compiles available data on the ethnomedicinal uses, phytochemistry, and pharmacological activities of *A. tetracantha*. Phytochemical investigations have revealed the presence of compounds such as friedelin, euphanol, gallic acid, genstisic acid, cinnamate, ferulic acid, azimine, azcarpine, and carpaine in this plant. Extensive research has been conducted to gather information on the traditional uses, phytochemicals, and pharmacological activities exhibited by *A. tetracantha*. The literature indicates that this plant is highly versatile in its traditional applications, serving as a remedy for various illnesses and disorders in both humans and animals. It is employed in the treatment of asthma, cold, cough, rheumatism, diabetes, dysentery, fever, toothache, dog bite, snake bite, and liver diseases.The plant has been proven through experimentation to possess pharmacological properties like analgesic, antiasthmatic, antidiarrheal, antiepileptic, antiulcer, antiasthmatic, antidiarrheal, antimicrobial, antioxidant, anti-inflammatory, antipyretic, antivenom, cytotoxic, diuretic, hepatoprotective, nephroprotective, and insecticidal activities. Antimicrobial, antioxidant, and insecticidal properties have been observed in nanoparticles produced from *A. tetracantha*. The reported pharmacological effects of the plant support its traditional use in the treatment of numerous diseases and disorders

Keywords: *Azima tetracantha*, ethnobotany, pharmacological activities, phytochemistry, secondary metabolites, traditional uses

Introduction

Natural sources have provided medicinal agents for centuries, leading to the discovery of numerous new drugs. Traditional medicine remains crucial for around 80% of the population in developing countries, thanks to its cultural acceptability and minimal side effects. Interestingly, even in today's world, around 80% of the population in developing countries heavily relies on traditional medicines for their overall well-being and disease prevention. Herbal remedies, which constitute approximately 75-80% of the global population's inspiration, are particularly favored in these countries due to their cultural acceptance, compatibility with the human body, and minimal side effects. However, there has been a significant increase in the utilization of medicinal plants-based remedies in developed countries in recent decades. Recognizing the potential, the World Health Organization (WHO) actively promotes the evaluation of plants for their effectiveness against human illnesses and the development of safe modern drugs.

Azima tetracantha Lam. (Family: Salvadoraceae) locally known as "Mulsangu", is a rambling spinous shrub flowering throughout the year found in Peninsular India, West Bengal, Orissa, African Countries and extends through Arabia to tropical Asia. The common names of the plant are Uppimullu, Mulchangan, Needle bush, Yasanku and Kundali in Ayurvedic medicine. The leaves of the plant are elliptical in shape and are rigid, pale green colored. The flowers are small, greenish white (or) yellow colored, unisexual in axillary fascicles. The berries are white in color; usually oneseeded and edible.*A. tetracantha* root bark is used in muscular rheumatism, while the leaf juice is used for treating tooth and ear ache. In East Africa the powdered roots of *Azima tetracantha* Lam. are applied directly to snake bites and an infusion is taken orally as a treatment. In India and Sri Lanka the root, root bark and leaves are added to food as a remedy for rheumatism. It is planted as live fences in Bangalore (India). In Malaysia pickled leaves are used as an appetizer and against colds. The plant is promoted as an ornamental in the United States (Hebbar *et al*., 2004; Mohamed Al-Fatimi *et al*., 2007; Vikneshwaran *et al*., 2008; Ignacimuthu *et al*., 2008).

Figure 1: Medicinal plant *Azima tetracantha* Lam

Scientific classification of *Azima tetracantha* Lam.

Kingdom : Plantae,

Phylum : Tracheophyta,

Class : Magnoliopsida,

Order : Capparales,

Family : Salvadoraceae,

Genus : Azima

Species : tetracantha

Binomial name: *Azima tetracantha*Lam.

Vernacular names

Tamil	: Kandagachangu, Sangu, Mulsangu
English	: Bee sting bush, Fire thorn, Needle bush
Sanskrit	: Kundali
Malayalam	: Ishanku
Hindi	: Kamai

Macroscopical characters of *Azima tetracantha* Lam

Azima tetracantha		**Character**
Leaf structures	Nature	Decussately opposite
	Shape	Blade elliptical-oblong to ovate-oblong or orbicular
	Dimensions	1.5-5.5cmx0.5-4.5cm
	Stipules	Absent/rudimentary
	Leaf margin	Simple and entire
	Leaf apex	Mucronate
	Leaf base	Pinnately veined with one pair of lateral veins
Flowers structures	Petals shape	Linear oblong to oblong
	Length	2-4mm
	Lobes	Triangular
	Male flower	Stamens inserted at the base
	Female flowers	Staminoids and superior ovary
Fruit Structures	Nature	Globose berry
	Dimension	0.5-1cm diameter

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Microscopical characters of *Azima tetracantha* Lam

Azima tetracantha		Character
Leaf Structures	Transverse section	Dorsiventralnature
	Midrib	Flatandhemispherical
	Cuticle	Thin,rectangularandprominent
	Vascularbundle	Singleandabaxialareshapedphloem
	Sclerenchyma	Absent
	Trichomes	230mm thick
	Abaxialepidermis	Stomatiferrous
	Epidermaltissues	Stomata and epidermal cells
	Stomata	Anisocytic
	Petiole(basal and upperpart)	1.5µm diameter, circular
Stem structures	Youngstem	1.5mm thick, consists of a distinct continuous epidermis, cortex, vascular Cylinder and pith
	Epidermalcells	Squarishor rectangular
	Cuticle	Thick
	Stomata	Frequently seen
	Cortex	150mm width, consists of chlorenchyma and parenchyma
	Pith	Wide, homogenous and parenchymatous
	Vascularcylinder	29 discrete vascular bundles
	Periderm	No deep fissures and contains homogenous Phellan cells
	Pseudocortex	Inner to the periderm,is a wide Parenchymatous zone
	Secondaryphloem	It consists of collapsed and non-collapsed phloem

Phytochemical Screening of *Azima tetracantha* Lam.

Phytochemicals are naturally occurring chemical compounds found in plants. The plant *A. tetracantha* has been found to have a diverse range of phytochemicals distributed throughout its various parts. Researchers have utilized techniques like standard phytochemical tests, gas chromatography-mass spectrometry (MS), High-performance liquid chromatography, liquid chromatography–MS, as well as other chromatographic methods, along with spectral analyses such as nuclear magnetic resonance and infrared, to identify the chemicals or phytochemical groups present in different plant parts.

The leaves of *Azima tetracantha* were subjected to phytochemical screening using an aqueous extract, which confirmed the presence of terpenoids, alkaloids, saponins, tannins, phenolic compounds, flavonoids, and steroids (Natarajan *et al*., 2014). Additionally, the preliminary phytochemical analysis of ethanolic leaf extracts of *Azima tetracantha* indicated the presence of carbohydrates, glycosides, alkaloids, and saponins (Kumarasamy Raja *et al*., 2011, Arsia and Begum, 2013).

Daulatabad and Desai, 1991 observed that the seed oil of *A. tetracantha* have ricinoleic acid and cyclopropenoid fatty acids along with normal fatty acids.Bennett *et al*., 2006 reported that *A. tetracantha* roots and seeds exhibit high concentrations of N-methoxy-3-indolylmethyl-glucosinolate, while the stems and young leaves show lower levels of this compound. The roots also contain N-hydroxy-3-indolymethyl-glucosinolate, and all plant parts contain neoascorbigen. The seeds contain a diverse mix of 26 flavonoids, mainly as glycosides and acyl-glycosides, with some aglycones present. Additionally, the alkaloids azimine, azcarpine, and carpaine were detected in all tissues.

In 2016, Gayathri *et al*. discovered a triterpenoid compound named friedelin in the hexane fraction of methanol extract from the leaves of *A. tetracantha*. Meanwhile, Kavitha and Sandhiya, in the same year, isolated euphol, a triterpene compound, from the chloroform extract of the same plant's leaves using column chromatography. Additionally, Gayathri *et al*. conducted a study in 2012 to evaluate the nutritional composition of *A. tetracantha* leaves, revealing high levels of potassium and manganese, along with significant amounts of carbohydrates, proteins, and lipids. Moreover, the leaves exhibited a higher content of Vitamin C compared to Vitamin E.

The chemical composition of *Azima tetracantha* Lam was analyzed using Thin Layer Chromatography (TLC), which identified the presence of alkaloids, flavonoids, and sterols. The results of this analysis revealed the existence of 77 phytoconstituents. However, there is limited information available regarding the chemical composition of *A. tetracantha*. Additionally, it has been reported that the leaves of *A. tetracantha* contain triterpenoids (Venkat and Prasad *et al*., 1978); isorhamnetin-3-rutinoside (Williams and Nagarajan, 1987; Daulatabad *et al*., 1991). Fatty acids, namely ricinoleic acid and cyclopropenoid acid were isolated from the seed oil of *A. tetracantha* (Daulatabad *et al*., 1991). Friedelin, lupeol, glutinol and beta sitosterol were isolated from leaves of *A. tetracantha* (Hepsibha *et al*., 2010). Vitamin E, phytol and squalene were also observed in leaf extracts of *A. tetracantha* by HPTLC analysis (Nargis *et al*., 2009).

Seeds contain a complex mixture of 26 flavonoids predominantly as neoascorbinogen, glucosinolates, glycosides and acyl-glycosides. 3-indolylmethylglucosinolate was observed in seed, root, young leaves, stem and thorns of *A. tetracantha*. N-hydroxy-3-indolylmethyl glucosinolate observed in roots; N-methoxy-3-indolylmethyl glucosinolate was observed in seed, root, stem, thorns, old and young leaves of *A. tetracantha*; neoascorbinogen present in roots, stem, thorns, old and young leaves. Dimeric piperidine alkaloids azimine, azcarpine and carpaine were present in seed, root, stem, thorns, old and young leaves of *A. tetracantha* (Rall *et al*., 1967; Bennett *et al*., 2004).

Thirty compounds were identified in the methanolic extracts of leaves of *Azima tetracantha*by GC-MS analysis. The prevailing compounds were Tetradecanoic acid - Myristic acid, Pentadecanoic acid, 9, 12-Octadecadienoic acid (Z, Z)- cis-1-(+)-Ascorbicacid 2,6-dihexadecanoate, Heptadecanoic acid, Oleic acid- 9-octadecenoic acid (Z), Octadecanoic acid, methyl, Cis-Eicosadienoic acid and Hexadecanoic acid (Murugaiah *et al*., 2015).

Ethnomedicinal uses of *A. tetracantha*

*A. tetracantha*is a versatile plant with respect to its extensive use for the treatment of human as well as veterinary illnesses. Studies have shown that various parts of the plant, in particular leaf and root, have been used for the preparation of formulations that have been used in traditional medicine. Chitravadivu *et al*., 2009 has pointed that the root of *A. tetracantha*is used by herbal vendors in South India as a component in the herbal formulation called Pilavaikkalimbu which is applied externally on the tumors.

Traditional usage of *Azima tetracantha* is widespread among the adivasis (tribal) people. Leaves are used by many herbal medicinal practitioners of Dharwad district of Karnataka in southern India in the treatment of ear and tooth ache (Hebbar *et al.*, 2004) and vomiting (Vikneshwaran *et al*, 2008). Subramanyan Ragupathy *et al*., (2008) have reported that the Malasars of the Velliangiri hills use many plants to treat wounds, cold, cough, fever, body pain which includes *Azima tetracantha*.

Subramanyam Ragupathy and Steven Newmaster (2009) have reported that Irulas of the Kodiakkarai Reserve Forest (KRF) used leaves to treat fever. *Azima tetracantha* fruits are eaten as food by tribal people of Andhrapradesh (Reddy *et al.*, 2007) and the root bark for rheumatism along with Dichrostachys cineraria (Murthy *et al*., 2008). Paliyar tribals in Theni district of Tamil Nadu, India were using *Azima tetracantha* Lam. root paste to treat external wounds (Ignacimuthu *et al*., 2008). Mohamed Al-Fatimi *et al*., (2007) reported that *Azima tetracantha* fruits were used for rheumatism and cough in Yemeni traditional medicine.

Sivaraj and Leo, 2016 emphasized that the plant is utilized for respiratory illness including pulmonary tuberculosis in Siddha system of medicine.Also, Kumarasamy, 2016 reported that the root of *A. tetracantha*is a component in a Siddha polyherbal formulation Parangichakkai Choornam which is used to treat several ailments. In addition, Andriamparany*et al*., 2014 noted thatthe leaves of *A. tetracantha*are used traditionally for medicinal purposes by rural households in the Mahafaly region of semi-arid SW-Madagascar

National Biodiversity Authority of India has included *Azima tetracantha* as a traded medicinal plant under the trade name of "KANTA-GUR-KAMAI, KANTANGUR, and KUNDALI" and it has confirmed the usage in Ayurveda, Folk, Siddha, Tibetan and Unani system of medicine (Kannaiyan, 2007). There are records from Sanskrit manuscripts and also many anecdotal reports of its use in Ayurvedic medicine (Bennet *et al.*, 2004).

Biological activities of *A. tetracantha*

The plant *A. tetracantha*is shown to exhibit a wide range of biological activities such as antimicrobial, hepatoprotective, anti-arthritic, nephroprotective, antiulcer, hypolipidemic, antioxidant, analgesic, anti-inflammatory, antipyretic, diuretic, antiepileptic, and antivenom activity. A brief description on the biological activities displayed by various parts of the plant is shown below.

Anti-arthritic Activity

Sridharan *et al*., 2008 screened for ethanolic extract obtained from whole plant of *A. tetracantha*for antiarthritic activity by Freund's complete adjuvant (FCA)-induced arthritis method. The extract was shown to possess anti-arthritic activity. It was observed that the Rheumatoid factor and C-reactive protein levels were decreased when compared with FCA group.

Antiasthmatic Activity

In a study, Hepsibha *et al*., 2015 screened the potential of various solvent extracts of *A. tetracantha* leaf to inhibit mast cell degranulation. The extracts significantly inhibited mast cell degranulation in a dose-dependent manner. Comparatively, methanol extract produced significant inhibition of mast cell degranulation when compared to ethyl acetate and petroleum ether extracts. It is inferred that the extracts possess mast cell-stabilizing effect which can be useful in developing drugs with anti-allergic potential.

Hirapara *et al*., 2012 evaluated the effects of methanolic extract of *Azima tetracantha* Lam. (MEAT) for the management of asthma. In their study, MEAT at doses of 200 and 400 mg/kg i.p. was evaluated for management of asthma using Histamine induced bronchospasm in guinea pig. The results obtained from the study reveals that treatment with 200 mg/kg and 400 mg/kg MEAT significant increase in pre convulsive time (PCT) which was induced by histamine. So they concluded that MEAT may be used in asthma due to significant increase in pre convulsive time in guinea pigs.

Anticancer Activity

Kim *et al*., 2022 reported that the methanol extract of *A. tetracantha* showed significant anticancer potential against the two gastric cancer cell lines, AGS and Kato-III. The *A. tetracantha*-extract-mediated increase in BAX expression levels in both Kato-III and AGS cancer cells was higher than the increase obtained for BCL2 mRNA levels, leading to an increase in the BAX/BCL2 mRNA ratio. The cytochrome c release from damaged mitochondrial membrane was also found to be increased in those cancer cells exposed to different doses of *A. tetracantha* methanol extract; in addition, the cellular reactive oxygen species levels were also found to be upregulated in these cells. Malayil *et al*., 2021 reported that the methanol extract of *A. tetracantha* leaves have higher polyphenol content and also shown to have promising antioxidant and anti-inflammatory activity. Apart from that, the anti-proliferative activities of the extract have also been observed in breast cancer cells; the intrinsic pathway-mediated apoptosis seems to be the possible mechanism of anti-proliferative activity by *A. tetracantha*.

Begum *et al*., 2009 determined *in vivo* anticancer activity of ethanolic extract of leaves of *A. tetracantha*on Ehrlich ascites carcinoma in mice. It was shown that the oral administration of extract increased the survival time and reduced the solid tumor volume, viable tumor cells count, and increased the non-viable tumor cells count. Veni and Pushpanathan, 2014 evaluated cytotoxic activity of various solvent extracts of *A. tetracantha*leaves against *Artemia salina* and *A. fransiscana*. All extracts were effective in causing dose-dependent mortality of the nauplii of both *Artemia* species. Among extracts, chloroform extracts exhibited stronger cytotoxic effect with LC50 value of 187.6 μg/ml.

In a study, Gopalakrishnan *et al*., 2015 screened methanolic extract of *A. tetracantha*leaves for cytotoxic activity against cancer cell line HeLa and normal cell line HPL by MTT assay. The extract was shown to exhibit cytotoxicity against HeLa cell line (IC50 value of <100 μg/ml). The extract was shown to be less toxic to HPL. Sundaresan *et al*., 2016 screened anticancer activity of hexane and ethanolic extract of stem and leaf of *A. tetracantha*against MCF-7 cell line. The extracts exhibited concentration-dependent inhibitory activity against cell lines. Ethanolic extract from leaf was shown to exhibit cytotoxicity even at nanogram range.

Antidiarrheal Activity

Antonisamy *et al*., 2015 evaluated that the anti-diarrhoeal activity of friedelin isolated from leaves of *Azima tetracantha* Lam by using castor oil-induced diarrhoea, gastrointestinal motility test, magnesium sulphate-induced diarrhea and castor oil-induced enteropooling in rats. Friedelin (20 mg/kg) showed significant reduction of intestinal transit and gastric emptying which were similar to the anti- motility activity as known compound atropine (0.1 mg/kg). Friedelin (20 mg/kg) also exerted significant anti-enteropooling effects, against castor oil-induced enteropooling in rats. The defaecation frequencies and the faecal droppings wetness were significantly reduced. Additionally, friedelin (20 mg/kg) revealed significant inhibition (89.64%) of castor oil-induced diarrhea.Begum *et al*., 2013 evaluated antidiarrheal activity of aqueous extract of *A. tetracantha*by castor oil-induced diarrhea and castor oil-induced enteropooling in rats. The extract was shown to cause significant protection against castor oil-induced diarrhea and castor oil-induced enteropooling at concentration 100 mg/kg.

Antiepileptic Activity

Manikandaselvi*et al*., 2012 reported that the leaf extract of *A. tetracantha*for nephroprotective activity in ferrous sulphate ingested rat model. Drug induced rise in biochemical parameters such as urea, GGT and creatinine where declined after treating with leaf extract as that of control. Eerike *et al*.,2016evaluated antiepileptic activity of ethanol extract of root of *A.*

*tetracantha*by maximal electroshock and pentylenetetrazole-induced seizures in mice. In maximal electroshock model, the extract caused reduction in the duration of hind limb extension and showed marked seizure protection. In pentylenetetrazole-induced seizure model, the extract caused delay in the onset of clonic phase and prevented death in 50% of animals in the group treated with 500 mg/kg extract.

Anti-inflammatory Activity

The anti-inflammatory activity of *A. tetracantha*leaf powder was assayed in male albino rats using carrageenan-induced rat paw edema (to study acute inflammation) and cotton pellet granuloma (to study chronic inflammation) methods by Ismail *et al*.,1997 It was observed that the crude drug exhibited maximum activity at a dose of 1000 mg/kg. In the cotton pellet granuloma assay, the drug was shown to suppress the transudative, exudative, and proliferative components of chronic inflammation. In addition, the drug was able to lower the lipid peroxide content of exudate and liver, γ-glutamyl transpeptidase activity in the exudate of cotton pellet granuloma. Sridharan *et al*., 2008 screened for ethanolic extract obtained from whole plant of *A. tetracantha*for anti-inflammatory activity by carrageenan-induced paw edema method. The extract at 250–500 mg/kg dose suppressed the paw edema significantly at 3–4 hrs.

Antimicrobial Activity

Shankar *et al*., 2019 investigated that the chloroform, acetone, ethanol and aqueous extracts of *Azima tetracantha* for the presence of phytochemicals and potential antimicrobial efficacy against a few bacterial pathogens such as *Escherichia coli*, *Bacillus cereus*, *Staphylococcus aureus*, *Enterococcus* sp and *Klebsiella* sp by using agar well diffusion method. Ethanol extract of *Azima tetracantha* showed considerably moderate activity against all the microorganisms tested.Abirami *et al*., 2016 investigated that *Azima tetracantha* leaves extract mediated gold nanoparticles were most effective against bacterial pathogens *Aeromonas liquefaciens, Enterococcus fecalis, Micrococcus luteus, Salmonella typhimurium* and fungal pathogens *Candida albicans, Cryptococcus sp, Microsporum canis, Trichophyton rubrum*. This revealed that gold nanoparticles could provide a safer alternative to conventional antimicrobial agents.

Compounds, namely, alkaloids, flavonoids, and sterols, isolated from leaves of *A. tetracantha*, were shown to exhibit inhibitory activity against a panel of Gram-positive and Gram-negative bacteria. It was observed that sterols exhibited marked antibacterial activity when compared to alkaloids and flavonoids[Gowthami *et al*., 2012]. The study of Natarajan *et al*., [2014] evaluated the antimicrobial potential of aqueous extract prepared from the leaves of *A. tetracantha*by disk diffusion assay and showed the potential of extract to inhibit reference strains of bacteria and fungi and clinical isolates of bacteria and fungi (from diabetic foot infection).

Hema *et al*., 2012 reported that the antimicrobial activities of five solvent extracts (ethanol, methanol, acetone, chloroform and distilled water) were tested against seven clinical pathogens such as *Staphylococcus aureus* (Pus), *Klebsiella* sp. (Sputum), *Escherichia coli* (Urine), *Pseudomonas* sp. (Pus), *Enterococci* sp. (Urine), *Serratia* sp. (Sputum) and *Proteus* sp. (Sputum). Among the five solvents tested, ethanolic extracts of *Azima tetracantha* showed higher significant activity against the pathogenic organisms such as *Proteus* sp., *Serratia* sp., *Pseudomonas* sp. followed by *Escherichia* coli, *Staphylococcus aureus* and *Klebsiella* sp.

Duraipandiyan *et al*. 2006 reported that *Azima tetracantha* has been used to treat many diseases. Hexane, ethyl acetate and methanol extracts were tested against fungi. Hexane extract showed some activity against tested fungi. Regalakshmi *et al*., 2017 examined the antimicrobial effects of chloroform and methanol extracts from the leaves of *A. tetracantha*. Their findings revealed that both extracts exhibited antimicrobial activity against Gram-positive and Gram-negative bacteria, as well as three *Aspergillus* spp. Notably, the methanol extract demonstrated a higher level of antimicrobial activity compared to the chloroform extract.Nazzaro *et al*., 2021 reported that the antiseptic properties of MeOH of the leaf of *Azima tetracantha* against bacterial pathogens ie., *Staphylococcus aureus, Bacillus cereus, Bacillus subtilis, Escherichia coli, Klebsiella pneumonia* and *Salmonella typhi*. The MeOH extract of *Azima tetracantha* showed considerably better activity against all the microorganisms tested

Antioxidant Activity

Nazzaro *et al*., 2021 reported that the antioxidant activity of MeOH leaf extract of *Azima tetracantha* by DPPH free-radical-scavenging ability. The highest concentration of MeOH extract was found at 150 µg/mL (63.50%), which was followed by 50 µg/mL (22.11%) as sample inhibition values, and the highest concentration of standard was 50 µg/mL (68.35%) and the lowest was 50 µg/mL (26.50%). Ekbote *et al*., 2010 studied the effect of oral administration of chloroform and ethanol extract of *A. tetracantha*leaf on the activity of enzymatic and non-enzymatic antioxidant defenses in animals challenged with CCl4. The extract administration resulted in clear elevation in the antioxidant defense system. An increase in the level of GSH, total thiols and catalase was observed in extract treated animals. A significant reduction in the level of MDA was observed in ethanol extract treated group of animals.

The study of Muthuswamy *et al*., 2012 was carried out to investigate antiradical activity of methanol and ethyl acetate extracts of leaves of *A. tetracantha*. Overall, methanol extract was effective in scavenging 2,2-diphenyl-1-picrylhydrazyl radicals, superoxide radicals, and hydroxyl radicals. Both extracts scavenged radicals dose dependently. Gayathri *et al*., 2014 investigated the antioxidant properties of methanolic extract derived from *A. tetracantha* leaves by analyzing total antioxidant capacity, ABTS scavenging, hydrogen peroxide scavenging, and hydroxyl radical scavenging activity. The study showed that the extract exhibited scavenging of radicals in a manner that depended on its concentration. Moreover, a positive correlation was observed between the scavenging activity and the total phenolic content of the methanol extract.

Antipyretic Activity

Begum *et al*., [2010] evaluated antipyretic activity of leaf extract of *A. tetracantha*using Brewer's yeast-induced pyrexia. Treatment with leaf extract at a dose of 100 and 200 mg/kg decreased the rectal temperature of the rats in dose-dependent manner. At the dose of 200 mg/kg, the extract caused significant lowering of body temperature up to 4 h after its administration.

Antiquorum Sensing Activity

In a study conducted by Tilton *et al*., 2014, the potential antiquorum-sensing effects of hexane, ethyl acetate, and ethanol extracts from *A. tetracantha* leaves were examined. The research specifically looked at the inhibition of violacein production in *Chromobacterium violaceum*. The findings revealed that the hexane and ethyl acetate extracts exhibited antiquorum-sensing properties, while the ethanol extract did not demonstrate the same capability.

Antiulcer Activity

The antiulcer activity of the ethanolic extract from *A. tetracantha* leaves was assessed in a study conducted by Muthusamy *et al*., 2009. The researchers utilized aspirin and pylorus ligation, as well as cold restraint stress-induced ulcer models to evaluate the extract's efficacy. The 90% alcoholic precipitate of gastric juice was analyzed for various biochemical parameters, and histopathological sections were examined. The results indicated that the extract, at concentrations of 200 and 400 mg/kg, demonstrated a dose-dependent protective effect similar to that of the standard drugs ranitidine and omeprazole.

Antivenom Activity

Janardhan *et al*., 2014 investigated the antivenom activity of different solvent extracts of *A. tetracantha* leaves by assessing their ability to inhibit venom enzymes from *Bungarus caeruleus* and *Vipera russelli* venoms. The study highlighted that the ethyl acetate extract showed a substantial inhibitory effect on enzymes like phosphomonoesterase, phosphodiesterase, phospholipase A2, and acetylcholinesterase.

Analgesic Activity

The analgesic activity of the leaves of *A. tetracantha* was investigated by Nandgude *et al*., 2007 using the hot plate method in mice. The benzene, chloroform, and aqueous extracts of the leaves were tested, and all three extracts exhibited notable analgesic potential. The analgesic activity was observed at a dose of 100 mg/kg body weight and was comparable to that of morphine sulfate. Similarly, Begum and Anand, 2010 conducted a study on the analgesic activity of the ethanolic extract of the leaves using the hot plate method in mice. The extract demonstrated significant analgesic activity at 120 seconds, which was comparable to the standard drug Pentazocine.

Diuretic Activity

In 2011, Kumarasamyraja *et al*. conducted an investigation into the diuretic effects of the methanolic extract derived from *A. tetracantha* leaves in albino rats. The results indicated a direct correlation between the concentration of the extract and the increase in urine output, demonstrating a dose-dependent diuretic activity.

Hepatoprotective Activity

The hepatoprotective activity of chloroform and ethanol extracts derived from *A. tetracantha* leaves was examined by Ekbote *et al*., 2010 using a rat model with CCl_4-induced hepatotoxicity. The study revealed that the oral administration of these extracts for a duration of 12 days effectively restored the serum enzyme levels to normal. The histopathology analysis of the treated animals also provided supporting evidence for the hepatoprotective activity. In summary, the ethanolic extract displayed a significant hepatoprotective activity.

The investigation carried out by Sowmya and Nagarajan, 2014 uncovered the hepatoprotective properties of *A. tetracantha* leaf powder against liver toxicity induced by ferrous sulfate in albino rats. In a separate experiment, Prakash *et al*., 2015 evaluated the hepatoprotective activity of the aqueous extract of *A. tetracantha* leaf on isolated hepatocytes treated with CCl4 under in vitro conditions. The inclusion of the extract in the medium demonstrated enhanced survival of hepatocytes, as evidenced by an increase in cell viability with escalating extract concentration. Additionally, the extract treatment resulted in a significant restoration of the levels of GOT, GPT, and alkaline phosphatase.

Insecticidal Activity

The research conducted by Manimegalai and Velavan, 2015 focused on assessing the larvicidal potential of various concentrations of aqueous extract obtained from *A. tetracantha* leaves on 4th instar larvae of Anopheles stephensi. The findings demonstrated a concentration-specific mortality effect on the larvae. Remarkably, after 96 hours, a mortality rate of 100% was observed at an extract concentration of 8%.

Nephroprotective Activity

The antinephrotoxic potential of *A. tetracantha* leaf powder was examined by Manikandaselvi *et al*., 2012 using a ferrous sulfate-induced renal injury model in rats. The study revealed that ferrous sulfate caused an elevation in electrolyte levels and kidney markers. However, the administration of the leaf powder effectively restored the levels of potassium, chloride, bicarbonate, creatinine, urea, and CGT. These results indicate that the plant exhibits significant nephroprotective potential.In a study conducted by Konda *et al*. in 2016, the ethanolic extract of *A. tetracantha* root was tested on Wistar albino rats with glycerol-induced acute renal failure. The results indicated a notable enhancement in biochemical parameters and histopathological changes in rats treated with the root extract, as opposed to those in the glycerol-treated group. A substantial protective effect was particularly evident at a dosage of 500 mg/kg.

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