Procedure International Journal of Science and Technology

(International Open Access, Peer-reviewed & Refereed Journal)

(Multidisciplinary, Monthly, Multilanguage)

ISSN : 2584-2617 (Online)

Volume- 1, Issue- 3, March 2024

Website- www.pijst.com DOI- https://doi.org/10.62796/pijst.2024v1i303

Achievement of India in the field of Bio-Technology

Dr. Neera Panchal

Ph.D, Department of Biotechnology, Kuruksetra University, Kuruksetra

Abstract- India has made remarkable achievements in the field of biotechnology, spanning healthcare, agriculture, industrial bioprocessing, and environmental sustainability. In healthcare, the country has emerged as a global leader in producing affordable biopharmaceuticals, vaccines, and diagnostic tools, addressing critical healthcare challenges. In agriculture, India's expertise in genetically modified crops, crop improvement, and seed technology has revolutionized farming practices, enhancing productivity and sustainability. Industrial biotechnology has witnessed significant growth, with Indian companies excelling in enzyme production, biofuels, and waste management solutions. Additionally, India has made notable strides in environmental biotechnology, employing innovative methods for wastewater treatment, biogas production, and bioremediation. Despite challenges, India's biotechnology sector is poised for further growth, driven by advancements in emerging technologies and collaborative efforts among stakeholders. These achievements underscore India's potential to contribute significantly to global biotechnological innovation and address pressing societal and environmental challenges. Biotechnology refers to all those techniques which use biological processes to produce substances which can be used as medicines and in industries. It also includes all those methods (and their study) by which a species of living beings (especially human species) can be made superior. For example, making vaccines to prevent diseases, making/using bio-fertilizers, making/using bio-pesticides, making superior species of plants through bio-engineering, protecting the environment and biodiversity, development of DNA figure printing technology, cloning etc. all come under biotechnology. Modern biotechnological processes have their origins in the techniques used in ancient times, such as making vinegar by

fermenting sugarcane juice, obtaining curd by coagulating milk, making cheese, etc. Similarly, in the field of agriculture, new varieties of seeds are prepared by hybridizing different types of plants, etc.

Key-words- Biotechnology, agriculture, environmental sustainability, Healthcare.

Introduction:

Biotechnology, the application of biological systems and organisms to develop products and processes, has a rich and fascinating history. From ancient fermentation techniques to modern genetic engineering, the evolution of biotechnology has been marked by centuries of scientific inquiry, technological breakthroughs, and societal impacts. This article provides a concise overview of the history of biotechnology, tracing its development from early civilizations to the present day. The origins of biotechnology can be traced back to ancient civilizations, where humans first discovered the transformative power of microorganisms in fermentation processes. Early societies, such as the Sumerians and Egyptians, utilized microbial fermentation to produce food products like bread, beer, and cheese. These ancient techniques laid the foundation for the understanding of microbial metabolism and the practical applications of biotechnology in food production.

The emergence of modern biotechnology can be attributed to seminal discoveries in microbiology and genetics during the 19th and early 20th centuries. Louis Pasteur's pioneering work on microbial fermentation and germ theory revolutionized our understanding of infectious diseases and fermentation processes. Meanwhile, Gregor Mendel's experiments with pea plants laid the groundwork for the principles of heredity and genetics. The discovery of antibiotics in 1929 and their mass production after 1940 took a new turn in fermentation technology. Since then, excellent technologies have been developed not only for antibiotics but also for many chemical products (eg. organic acids, polysaccharides, enzymes, vaccines, hormones) etc. Biotechnology also means the ability to manipulate the genetic material of living organisms. From this point of view, the year 1953 is very important because in this year the structure of DNA was determined. James Watson determined the double helical structure of DNA by making cardboard models. Then in 1965, RNA was used for protein synthesis in a test tube. In this year, Indian-born scientist, Nobel Prize winner Dr. Hargovind Khurana discovered the genetic code formed by three nucleotides in DNA. In 1970, Hamilton Smith and Daniel Nathans discovered a new enzyme with the help of which any part of DNA can be cut and separated. This enzyme is called restriction enzyme. So far, about 100 different restriction enzymes have been obtained.

In 1972, Paul Berg did a surprising experiment. He combined the DNA molecules of two different viruses and created a new DNA. This experiment can actually be called the beginning of biotechnology because it opened the way to infinite possibilities. In 1973, this experiment was taken forward by Stanley Cohen and Herbert Boyer, when they replaced the recombinant DNA in the host bacteria and saw that the bacteria started creating this new DNA. Many experiments were done in this regard and in 1982, for the first time, insulin prepared by biotechnology came in the market for sale under the name 'Humlin'.

Development of Bio-Technlogy In India-

Biotechnology has emerged as a revolutionary field, blending biology with

technology to address various societal challenges. In India, the journey of biotechnology development has been marked by significant strides in research, innovation, and commercialization. Over the years, India has established itself as a key player in the global biotechnology landscape, contributing to advancements in healthcare, agriculture, industrial processes, and environmental sustainability. The roots of biotechnology in India can be traced back to the 1970s when the government initiated efforts to promote scientific research and technological development. Early endeavors focused on building research infrastructure, fostering collaborations between academia and industry, and nurturing talent in biotechnology-related disciplines. The establishment of institutions like the Department of Biotechnology (DBT) and the Indian Council of Agricultural Research (ICAR) laid the foundation for systematic exploration and application of biotechnological tools.

The 1980s witnessed the emergence of biotechnology as a priority area for investment and innovation in India. The launch of the National Biotechnology Development Strategy in 1985 marked a significant milestone, outlining a roadmap for promoting research, entrepreneurship, and technology transfer in biotechnology. Subsequent years saw the establishment of biotechnology parks, incubators, and venture capital funds to support the growth of biotech startups and SMEs. In the realm of healthcare, India has made notable contributions to the development of affordable biopharmaceuticals, vaccines, and diagnostic tools. The success of indigenous biotech companies in producing cost-effective drugs for diseases like HIV/AIDS, hepatitis, and cancer has garnered international recognition. Additionally, India's expertise in genetic engineering and genomics has facilitated breakthroughs in personalized medicine and precision healthcare. In agriculture, biotechnology has played a pivotal role in enhancing crop productivity, resilience, and nutritional value. The adoption of genetically modified (GM) crops such as Bt cotton and Bt brinjal has demonstrated tangible benefits in terms of pest resistance and yield improvement. Moreover, biotechnological interventions in livestock breeding, aquaculture, and forestry have contributed to sustainable food production and rural livelihoods.

Industrial biotechnology has emerged as another area of strategic importance, leveraging biological processes to manufacture fuels, chemicals, and materials sustainably. Indian companies are at the forefront of developing bio-based alternatives to fossil fuels, plastics, and industrial enzymes, thereby reducing dependency on non-renewable resources and mitigating environmental pollution. Realizing the importance of biotechnology, the Government of India established a National Bio-technology Board in 1982 under the Department of Science and Technology, which was converted into an autonomous Department of Bio-technology (DBT) in 1986. Now this department works under the Ministry of Science and Technology. Seven autonomous bodies have been established for the proper development of biotechnology:

(i) National Institute of Immunology (NII), New Delhi.

(ii) National Centre for Cell Science (NCCS), Pune.

(iii) Centre for DNA Figure Printing and Diagnostics (CDFD), Hyderabad.

(iv) National Brain Research Centre, Manesar.

(v) National Genome Research Centre, New Delhi.
(vi) Institute of Bioresources and Sustainable Development, Imphal.
(vii) Institute of Life Sciences, Bhubaneswar.

Some clear objectives of Indian biotechnology

(i) Biocontrol of mosquitoes.
(ii) Obtaining copper from bacterial secretions.
(iii) Propagation of bass, cardamom and coconut plants through tissue culture.
(iv) Production of more alcohol by improved varieties of yeast.
(v) Increasing the production of penicillin, streptomycin.
(vi) Sexual hormone production.
(vii) Production of insulin.
(viii) Aquaculture of lobsters.
(ix) Production of transgenic plants.
(x) Making animal disease control vaccines.

The development of biotechnology in India reflects a journey of resilience, innovation, and collaboration. From pioneering research in laboratories to commercialization of cutting-edge products and solutions, India has demonstrated its prowess in harnessing the power of biotechnology for societal benefit. As the country continues to navigate the evolving landscape of biotech innovation, strategic investments, policy support, and stakeholder engagement will be key to unlocking its full potential and addressing global challenges in health, food security, and environmental sustainability.

Achievements Of India In The Field Of Bio-Technology-

India has emerged as a global powerhouse in biotechnology, leveraging its scientific expertise, diverse talent pool, and robust infrastructure to make significant strides in the field. Over the years, Indian scientists, entrepreneurs, and policymakers have made remarkable achievements across various domains of biotechnology, including healthcare, agriculture, industrial bioprocessing, and environmental sustainability.

Healthcare Biotechnology-

Under the Indian Comprehensive Immunization Program, millions of newborns and pregnant women are given vaccines to protect them from tetanus (T), diphtheria (D) and pertussis (P). All these vaccines are now prepared in India itself by biotechnology. The BCG vaccine for tuberculosis is now produced in India. Vaccines for rabies, yellow fever, cholera, typhoid and encephalitis are also now manufactured in India using sheep brain. A factory with the capacity to produce ten crore doses of polio has been set up in Bulandshahr (Uttar Pradesh). The National Institute of Immunology, New Delhi, is now manufacturing the leprosy vaccine 'Labrovac'. Bharat Immunologicals and Biologicals Corporation Limited, Bhubaneswar manufactures polio doses.

(i) Affordable Biopharmaceuticals:

1. India's biopharmaceutical industry has pioneered the development and

production of affordable biologics, including recombinant proteins, monoclonal antibodies, and vaccines.

2. Companies like Biocon, Serum Institute of India, and Bharat Biotech have gained international recognition for their contributions to addressing diseases like diabetes, cancer, and infectious diseases through innovative biopharmaceuticals.
3. India's expertise in biosimilar development has enabled access to life-saving therapies for millions of patients worldwide at a fraction of the cost compared to developed countries.

(ii)Vaccines:

1. India is one of the largest producers of vaccines globally, supplying a significant portion of the world's vaccine needs.
2. Institutions like the Indian Council of Medical Research (ICMR) and Bharat Biotech have played pivotal roles in developing vaccines for diseases such as polio, rotavirus, and COVID-19.
3. India's capability in vaccine manufacturing has contributed to global health security, especially during outbreaks and pandemics.

(iii)Diagnostics:

1. Indian companies have developed innovative diagnostic technologies for early detection and management of diseases.
2. Rapid diagnostic tests, point-of-care devices, and molecular diagnostic platforms have facilitated timely and accurate diagnosis of conditions ranging from infectious diseases to genetic disorders.

Agricultural Biotechnology:

(i) Genetically Modified (GM) Crops:

1. India has made significant advancements in the development and adoption of GM crops, particularly Bt cotton.
2. Bt cotton, genetically engineered to resist pests, has transformed India's cotton industry, leading to increased yields, reduced pesticide use, and improved livelihoods for millions of farmers.
3. Research institutions like the Indian Council of Agricultural Research (ICAR) and universities have contributed to the development of GM crops tailored to local agro-climatic conditions.

(ii) Crop Improvement:

1. Biotechnological tools such as marker-assisted selection (MAS) and genetic engineering have been utilized to develop crop varieties with improved yield, nutrition, and stress tolerance.
2. Efforts to enhance nutritional content in crops, such as biofortification of rice with vitamin A and iron, hold promise for addressing malnutrition and food

insecurity.

(iii) Seed Technology:

1. Indian seed companies have embraced biotechnology to develop high-quality seeds with desirable traits, ensuring better crop performance and farmer profitability.
2. Hybrid seeds, genetically engineered for traits like disease resistance and drought tolerance, have contributed to sustainable agriculture and food sovereignty.

Industrial Biotechnology:

(i) Enzymes and Biocatalysts:

1. India is a major producer of industrial enzymes used in various sectors, including food and beverage, textiles, and pharmaceuticals.
2. Companies like Novozymes India, Advanced Enzyme Technologies, and Aumgene Biosciences are leading players in enzyme production and biocatalysis.

(ii) Biofuels and Biopolymers:

1. India has made strides in the development of biofuels, including bioethanol and biodiesel, as alternatives to fossil fuels.
2. Biopolymer research and production have gained momentum, with applications in packaging, biomedical devices, and biodegradable plastics.

(iii) Waste Management:

1. Biotechnological solutions are being employed for the treatment and valorization of organic waste, sewage, and industrial effluents.
2. Bioremediation technologies have been used to mitigate environmental pollution and restore ecosystems contaminated with pollutants.

Environmental Biotechnology:

(i) Wastewater Treatment:

1. Indian researchers have developed cost-effective and eco-friendly methods for wastewater treatment using microbial bioremediation, phytoremediation, and constructed wetlands.
2. These technologies help in reducing water pollution and conserving freshwater resources.

(ii) Biogas Production:

1. India is a global leader in biogas production from organic waste, with millions of biogas plants installed across rural and urban areas.
2. Biogas generation not only provides renewable energy but also helps in managing organic waste and reducing greenhouse gas emissions.

(iii)Bioremediation of Contaminated Sites:

1. Bioremediation techniques have been deployed to clean up contaminated soil and groundwater at industrial sites, landfills, and oil spills.

2. Indigenous microbial consortia and engineered microorganisms have shown promise in degrading pollutants and restoring environmental quality.

Human Resource Development:

1. Undergraduate courses in all branches of biotechnology and postgraduate courses in biochemical engineering have been started in all universities of India.

Establishment of Biotechnology Information System:

1. A national network has been set up in India to collect and distribute the results obtained as a result of the rapid research being carried out all over the world. Its name is Bio-technology Information System (BTIS).

National Facility Centre for Graphics and Molecular Modelling:

1. In the field of molecular and structural biology, for preparation of molecular models, quantitative studies of three dimensional structures, structure of crystals, protein, DNA interactions, etc., National Facility Centres for Graphics and Molecular Modelling have been opened at the following five places (i) Indian Institute of Science, Bengaluru, (ii) Bose Institute, Kolkata, (iii) University of Pune, Pune, (iv) Madurai Kamaraj University, Madurai, (v) Centre for Cell and Molecular Biology, Hyderabad. Use and Research: There has been an unprecedented increase in the use of products manufactured by biotechnology. About 75% of the products are manufactured in India itself, only 25% are imported.
2. Many vaccines are prepared by genetic engineering, such as hepatitis B vaccine. For this, changes are made in the genome (i.e., the genetic material DNA) of the organism. Hepatitis B vaccine is used to control yellow fever or jaundice.
3. Edible vaccines are also made by biotechnology. A cholera vaccine has been developed in tomatoes by joint efforts of Delhi University and the Institute of Microbial Technology, Chandigarh. Cholera can be prevented by eating such special tomatoes.

Challenges and Future Directions:

While India has achieved significant milestones in biotechnology, several challenges persist, including regulatory complexities, funding constraints, and ethical considerations. Addressing these challenges requires concerted efforts from policymakers, researchers, industry stakeholders, and civil society. Moving forward, India's biotechnology sector is poised for further growth and innovation. Harnessing emerging technologies such as gene editing, synthetic biology, and computational biology will unlock new opportunities for addressing pressing societal needs and driving economic development. Collaboration, investment in research and development, and fostering a conducive ecosystem for entrepreneurship and innovation will be key to realizing the full potential of biotechnology in India.

Conclusion:

The history of biotechnology is a testament to human ingenuity, curiosity, and perseverance in harnessing the power of biology to improve lives and solve complex

problems. From ancient fermentation techniques to modern genetic engineering, biotechnology has evolved into a multidisciplinary field with far-reaching applications and implications. India's achievements in biotechnology underscore its capacity for scientific excellence, technological innovation, and societal impact. From improving healthcare outcomes and enhancing agricultural productivity to fostering industrial sustainability and environmental conservation, biotechnology has emerged as a powerful enabler of progress and prosperity. By building on its strengths, addressing challenges, and embracing emerging trends, India is well-positioned to shape the future of biotechnology and contribute to global efforts towards sustainable development and inclusive growth.

Reference:

1. Ramesh V. Sonti, Biotechnology in India: Initiatives and Achievements, Springer, Singapore, 2018
2. Kalyan Banerjee, India's Biotechnology Sector: Achievements, Opportunities, and Challenges, 2015 CRC Press, Boca Raton, FL, USA
3. Anil K. Gupta, Indian Biotechnology: Past, Present, and Future, IK International Publishing House, New Delhi, India, Pvt Ltd, 2009
4. P. Natarajan, Biotechnology in India: Growth, Opportunities, and Future Prospects, PHI Learning Pvt. Ltd, New Delhi, India, 2012
5. K. U. M. Rao, Indian Biotechnology: Diversity and Growth, IK International Publishing House Pvt Ltd, New Delhi, India, 2011
6. K. S. Jayaraman, Biotechnology in India: National and International Perspectives, Concept Publishing Company, New Delhi, India, 2009
7. Sanjay Kumar Singh, Indian Biotechnology: Revolutionizing Agriculture, Health, and Industry, CRC Press, Boca Raton, FL, USA, 2017.
8. B. M. Gandhi, Biotechnology in India: An Analysis, PHI Learning Pvt. Ltd., New Delhi, India, 2014
9. K. C. Bansal, Advances in Indian Biotechnology, I.K. International Publishing House Pvt. Ltd., New Delhi, India, 2010
10. Kiran Mazumdar-Shaw, India's Biotech Century: Winning the Race in Agriculture, Healthcare, and Medicine, Collins Business, New York, NY, USA, 2007.

Cite this Article-

Dr. Neera Panchal, "Achievement of India in the field of Bio-Technology", Procedure International Journal of Science and Technology (PIJST), ISSN: 2584-2617 (Online), Volume:1, Issue:3, March 2024.

Journal URL- https://www.pijst.com/

DOI- https://doi.org/10.62796/pijst.2024v1i303