



ACHIEVERS IAS ACADEMY

Science and technology: Biotechnology – Scope and applications.

GS Paper 3: Science and technology – Awareness in the fields of IT, space, computers, robotics, nano-technology, bio-technology and issues relating to intellectual property rights.

Biotechnology is the broad area of biology involving living systems and organisms to develop or make products, or "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use". Depending on the tools and applications, it often overlaps with the related fields of molecular biology, bio-engineering, biomedical engineering, bio manufacturing, molecular engineering, etc.

Introduction

Biotechnology is defined as the 'application of scientific and engineering principles to the processing of material by biological agents to provide goods and services'. The Spinks Report (1980) defined biotechnology as 'the application of biological organisms, systems or processes to the manufacturing and service industries'. United States Congress's Office of Technology Assessment defined biotechnology as 'any technique that used living organisms to make or modify a product, to improve plants or animals or to develop microorganisms for specific uses'.

Scope of biotechnology

Biotechnology can be applied in developing various vaccines, medicines and diagnostics, improving energy production and conservation and increasing productivity. As the knowledge in the life – sciences has exploded during the last two decades, the central application fields of biotechnology include pharmaceutical industry, medicine, farming, nutrition and environmental technology as well as the techniques i.e. genetic engineering, cell culture techniques, cultivation of microorganisms.

Biotechnology is the applied science and has made advances in two major areas, viz., molecular biology and production of industrially important bio-chemical. The scientists are now diverting themselves toward biotechnological companies; this has caused the development of many biotechnological industries. In USA alone more than 225 companies have been established and successfully working, like Biogen, Cetus, Geneatech, Hybritech, etc. In world, USA, Japan, and many countries of Europe are leaders in biotechnological researchers encouraged by industrialists.

Applications of biotechnology

Biotechnology in medicine

Biotechnology products for therapeutic use include a very diverse range of products. Some products are intended to mimic the human counterpart, whereas others are intended to differ from the human counterpart and may be analogues, chemically modified (e.g., pegylated) or novel products (e.g., single chain or fragment antibody products, gene transfer vectors, tissue-engineered products).

Biotechnology-derived pharmaceuticals may be derived from a variety of expression systems such as Escherichia coli, yeast, mammalian, insect or plant cells, transgenic animals or other organisms. The expressed protein or gene may have the identical amino acid or nucleotide sequence as the human endogenous form, or may be intentionally different in sequence to confer some technical advantage such as an optimized pharmacokinetic or pharmacodynamics profile.

Bioprocess engineering
Beverage industry
Stem cell techniques
Immuno-technologies
Genetic engineering
Tissue culture
Enzyme engineering
Biosensor
Bioremediation
Photosynthetic efficiency

SCOPE OF BIOTECHNOLOGY IN INDIA

Gene therapy

The diseases for which scientists are making serious attempts to control through gene therapy are severe combined immunodeficiency (SCID) disease, Duchenne muscular dystrophy and cystic fibrosis. These disorders are mainly due to single gene defects. Cancer, cardiovascular diseases, diabetes, hypertension, arthritis, sickle cell anaemia, etc. are complex genetic disorders.

Industrial applications

The industrial application of molecular biotechnology is often subdivided, so that we speak of red, green, gray or white biotechnology. This distinction relates to the use of the technology in the medical field (in human and animal medicine), agriculture, the environment and industry. Some companies also apply knowledge deriving from molecular

biotechnology in areas that cut across these distinctions (e.g., in red and green biotechnology, sequencing services).

Red Biotechnology

Within the field of red biotechnology, which deals with applications in human and animal medicine, there are various further distinctions that can be made: biopharmaceutical drug development, drug delivery cell and gene therapies, tissue engineering/regenerative medicine, pharmacogenomics (personalized medicine), system biology, and diagnosis using molecular medicine.

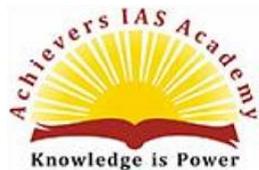
Color code	Name	Field
Red	Red Biotechnology	Medical Biotechnology
Green	Green Biotechnology	Agriculture Biotechnology
White	White Biotechnology	Industrial Biotechnology
Grey	Grey Biotechnology	Environmental Biotechnology
Blue	Blue Biotechnology	Marine Biotechnology

Drugs development

Closed linked to the development of therapeutic agents are the means of achieving their targeted delivery to their site of action. These drug delivery systems are mainly used for drugs whose physical and chemical characteristics make them insufficiently stable in reaching their site of action intact. They can also be used to transport drugs in a targeted way to particular sites of action (tissue specific targeting), or to overcome biological barriers such as the intestinal wall or the blood-brain barrier.

Green Biotechnology

Green biotechnology is the application of biotechnology processes in agriculture and food production. The main dominant forces in green biotechnology today are agro giants with a world-wide area of operation such as BASF, Bayer Crop-Science, Monsanto and Syngenta.



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They are concentrating considerable attention on molecular plant biotechnology, which is seen as a future growth factor in agro-industry. The traditional pesticide market, on the other hand has been stagnating for years.

Livestock Breeding

Modern biotechnology is being employed commercially to introduce novel performance features in productive livestock. The transgenic specimens then display for example different wool characteristics for sheep, or improved milk characteristics in cattle.

Transgenic Plants

The main emphasis in modern plant biotechnology is the production of transgenic plants. Transgenic plants are plants that have been genetically engineered, a breeding approach that uses recombinant DNA techniques to create plants with new characteristics. They are identified as a class of genetically modified organism (GMO).

SCOPE AND ONGOING R & D IN BIOTECHNOLOGY

- Automated bio-screening for therapeutic agents.
- Bio-processing alkenes to valuable oxides and glycols.
- Developing immobilized cell and enzyme systems for chemical process industries.
- Engineering of a series of organisms for specific industrial use.
- Genetical improvement of microorganisms for production of pharmaceutical products.
- Human gene therapy.
- Large-scale production of fructose from inexpensive forms of glucose.
- Manufacturing ethanol by continuous fermentation.
- Microbiological based production of human insulin and interferon's.
- Microbiologically up-gradation of hydrocarbons.
- Production and development of vaccine to prevent calibacillosis.
- Production of bio-pesticide and bio-fertilizers.
- Production of diagnostic kits for toxoplasmosis identification.
- Production of monoclonal antibodies for organ transplant tissue typing.
- Production of photo-synthetically efficient plants
- Production of xanthan gum in oil fields for recovery of crude mineral oils.



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Questions

1. What are genetically modified crops? Enumerate the ecological benefits of GM crops.
2. Biotechnology can most efficiently tackle India's hunger crisis by paving way for sustainable agriculture akin to green revolution in the past. Critically Examine.
3. India is now a leading destination for clinical trials, contract research and manufacturing activities owing to the growth in the bio-services sector. How can India take a giant leap in the biotechnology industry to emerge as a global key player?