# BIOTECHNO ACTIVITY BOOK

*Compiled by* :

EduHeal Foundation
New Delhi

# EDUHEAL FOUNDATION

103, Taj Apartment, Ground Floor, Ring Road, Near Safdarjung Hospital, New Delhi - 29.
Ph: 011-26161014, website : www.eduhealfoundation.org, e-mail : info@eduhealfoundation.org

## Preface

Biotechno Activities book is a small step torwards encouraging school students to take up biotechnology. We at EduHeal Foundation still need lot of help and encouragement from school teachers and Principal in accomplishment of our goal. It is you who form the vital link between EduHeal Foundation and students as you can further encourage students to know about biotechnology on a day to day basics. We would also not sit idle but make efforts to increase interest :

- By publishing books like Biotechno Activities Books.
- Create awareness by conducting Nationwide Biotechnology Olympiad.
- Teacher Tranining Programme in basics of genetics and Biotechnology.
- Career Development Workshop for Students.
- Virtual Genetic Lab.
- Networking to enhance school/Govt./ Industry Interface.

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* EduSys Subject Experts
* **Mr. Ram Mohan Rao**
Former Principal Information officer,
Govt, Of India
Information Advisor to the Prime Minister
* **Prof. S.S. Mathur**
Former Prof. & Head,
Centre for Energy Studies, IIT
Delhi, Institutional Co-ordinator,
United Nations Unversity, Tokyo, Japan
Minister, Education & Culture,
Embassy of India, Washington DC, USA
* **Mr Ranglal Jamuda,** IAS
Commissioner
Kendriya Vidyalaya Sangathan,
New Delhi
* **Mr. Pervez Ali Khan**
NISCAIR, New Delhi
* **Dr. K. Sharma**, Dept. of Biotechnology,
AIIMS, Delhi
* **Dr. Saroj Mishra**
Prof. of Biotechnology, IIT, Delhi
* **Dr. A.N. Sinha**, MS, FAIS, FICS
Former Consultant Surgeon & Head,
VMMC & Safdarjung Hospital , Delhi
* **Dr. Dinkar Bakshi,** MD
Registrar, Deptt. of Paediatrics, Infirmary Hospital, Leeds,
U.K.
* **Dr. Sandeep Dham**, MD (Medicine)
Clinical Astt. Prof., SUNY Health Centre, Broklyn, New York,
USA
* **Dr Saurabh Shukla**
MD, (AIIMS) Delhi
(Presently associated with WHO Pulse Polio Programme)
* **Dr. Rajesh Kaushal**
MD (AIIMS) Delhi
* **Dr. N.K. Mendiratta**. MD, Anaesthesia, VMMC &
Safdarjung Hospital, Delhi
* **Dr. Nagendra P.** MS (Orthopedics), Bangalore Medical
College, Bangalore

* **Coordinator**, South African Agency for science and technology advancement.

For any query please contact Eduheal Foundation helpline : 09350232518

With best wishes

**Dr. Sandeep Ahlawat**
Managing Trustee
Eduheal Foundation

# CLASS - XI

# BIOTECHNOLOGY

## What is Biotechnology?

In the simplest terms, biotechnology is the use and manipulation of living things to make useful products to benefit human beings. More scientifically, it can be defined as any technique that uses living organisms, or substances from these organisms, to make or modify a product, to improve plants or animals, or to develop micro-organisms. This technology contributes to such diverse areas as food production, waste disposal, mining, industry and medicine.

**Some definitions of Biotechnology**

- The application of biological organisms, system of manufacturing and service industries.

The integrated use of biochemistry. Microbiology and engineering sciences in order to achieve technological (industrial) application capabilities of microorganisms, cultured tissue cells and parts there of.

A technology using biological phenomena for copying and manufacturing various kinds of useful substance.

The application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services.

The science of the production processes based on the action of microorganisms and their active components and of production processes involving the use of cells and tissues from higher organisms. Medical technology, agriculture and traditional crop breeding are not generally regarded as biotechnology.

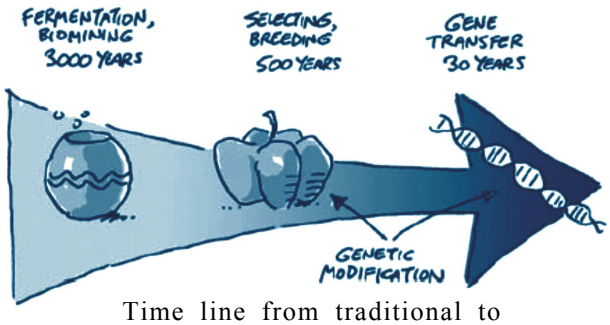
Biotechnology is really no more than a name given to a set of techniques and processes.

Biotechnology is the use of living organisms and their components in agriculture, food and other industrial processes.

Biotechnology - the deciphering and use of biological knowledge.

## History of Biotechnology.

Biotechnology has been around for a long time, dating back 3000 years with the fermentation process using yeast to make bread, beer and wine. As it has developed over the past centuries, biotechnology has passed through three clear generations or phases. The first involved the use of organisms to produce food, such as bread, wine, cheese and other fermented foods, and industrial products such as mining with micro-organisms. This was followed by a second wave of innovation, using organisms and cells to produce new products such as antibiotics, enzymes and vitamins. This enabled the more effective use of the original, traditional techniques such as fermenting, which is now done on a large scale enabling the efficient industrial production by micro-organisms of pure enzymes, additives and other valuable compounds for food. Penicillin production is one of the results of this generation that has benefited the entire world. The mainstay of this second generation was the careful selection and breeding of organisms for specific purposes.




Time line from traditional to conventional to modern biotech

In the last 30 years, the third generation known as modern biotechnology or Genetic Modification (GM) has emerged. This is the further development of techniques previously used, but which are now more precise and effective, so enabling further benefit for human kind. GM techniques are applicable for plants, animals and microbes, but currently the greatest efforts are being undertaken in health care and crop production.

**Sub-fields of biotechnology**

**Red biotechnology** is biotechnology applied to medical processes. Some examples are the designing of organisms to produce , and the engineering of genetic cures to cure diseases through genomic manipulation.

**White biotechnology**, also known as **grey biotechnology**, is biotechnology applied to industrial processes. An example is the designing of an organism to produce a useful chemical. White biotechnology tends to consume less in resources than traditional processes when used to produce industrial goods.

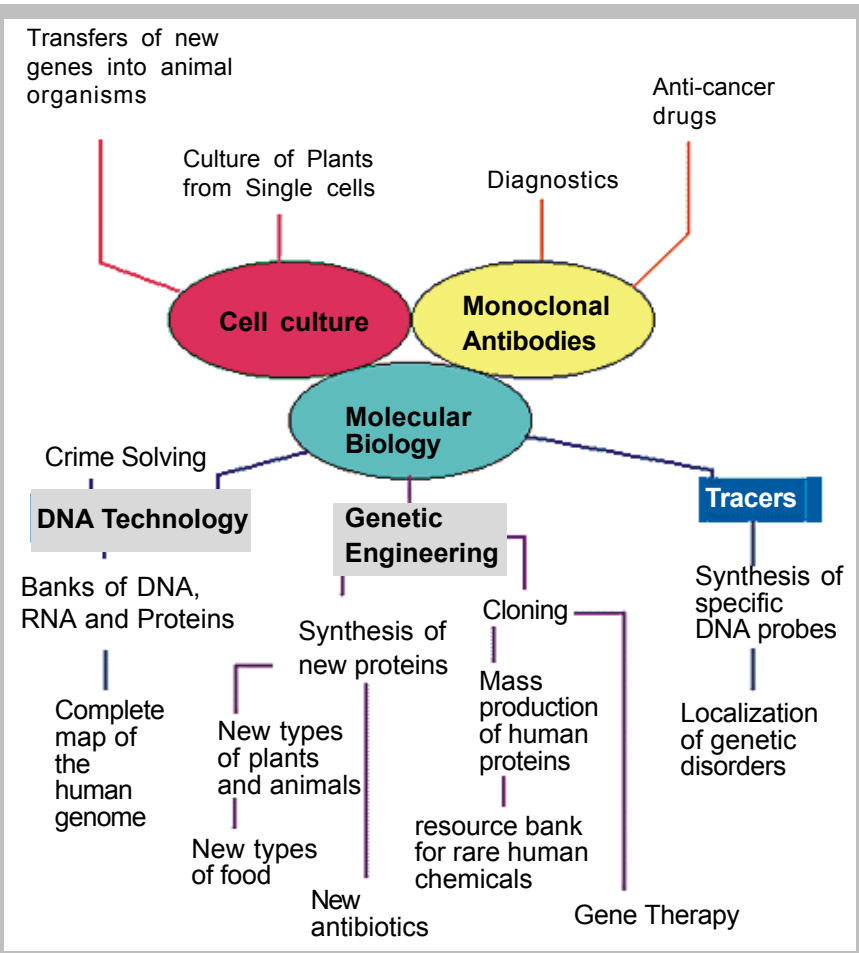
**Green biotechnology** is biotechnology applied to processes. An example is the designing of transgenic plants to grow under specific environmental conditions or in the presence (or absence) of certain agricultural chemicals. One hope is that green biotechnology might produce more environmentally friendly solutions than traditional industrial agriculture. An example of this is the engineering of a plant to express a, thereby eliminating the need for external application of pesticides. An example of this would be Bt corn. Whether or not green biotechnology products such as this are ultimately more environmentally friendly is a topic of considerable debate.

**Bioinformatics** is an interdisciplinary field which addresses biological problems using computational techniques. The field is also often referred to as computational biology. It plays a key role in various areas like functional genomics, structural genomics, and proteomics amongst others, and forms a key component in biotechnology and pharmaceutical sector.

The term **blue biotechnology** has also been used to describe the marine and aquatic applications of biotechnology, but its use is relatively rare.

**Applications of Modern Biotechnology include :**

- **Insect, fungal and virus tolerance** – by planting pest resistant crops less chemicals (pesticides) are used, lowering production costs and reducing the impact on the environment. Examples include potato, maize, cotton and tomato.
- **Stress tolerance** – increasing the tolerance of crops to extreme stresses such as drought, salt and frost could enable resource poor farmers to produce food in areas where it is most needed.
- **Herbicide tolerance** – when such crops are planted, more environmentally friendly broad-spectrum herbicides can be used. Examples include rice, cotton and beet;
- **Enhanced food value and nutrition** – such as changing oil profiles in oilseed crops, and developing vitamin enriched staple crops such as rice, wheat and corn. Research is also focusing on reducing allergens, and enriching crops with protein.
- **Higher yields and greater crop stability** – this increases crop production per unit of land.
- **Control and minimise post harvest losses** – this reduces the substantial losses after harvesting, and improves the shelf life of fruits and vegetables, such as tomato, contributing to a higher overall crop yield.




Monoclonal antibodies are new tools to detect and localize specific biological molecules. In principle, monoclonal antibodies can be made against any macromolecule and used to locate, purify or even potentially destroy a molecule as for example with anticancer drugs.

Molecular biology is useful in many fields. DNA technology is utilized in solving crimes. It also allows searchers to produce banks of DNA, RNA and proteins, while mapping the human genome. Tracers are used to synthesize specific DNA or RNA probes, essential to localizing sequences involved in genetic disorders.

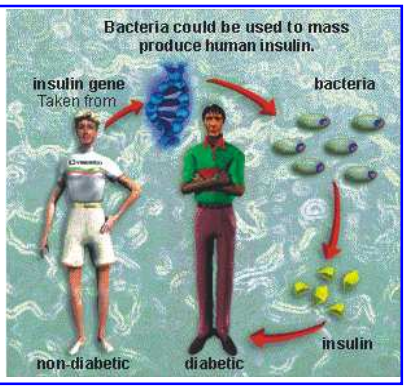
With genetic engineering, new proteins are synthesized. They can be introduced into plants or animal genomes, producing a new type of disease resistant plants, capable of living in inhospitable environments (i.e. temperature and water extremes,...). When introduced into bacteria, these proteins have also produced new antibiotics and useful drugs.

Techniques of cloning generate large quantities of pure human proteins, which are used to treat diseases like diabetes. In the future, a resource bank for rare human proteins or other molecules is a possibility. For instance, DNA sequences which are modified to correct a mutation, to increase the production of a specific protein or to produce a new type of protein can be stored . This technique will be probably play a key role in gene therapy.

- **Reduce the loss of top soil and biodiversity** – by promoting low tillage production especially in marginal areas that are not ideal for agriculture;
- **Development of improved livestock vaccines** – for major diseases affecting productivity, diagnostic tools for disease detection and pedigree verification;
- **Impact on small-scale farmers** – with potentially large yield impacts and significant financial returns despite higher initial seed costs.

**Human or pig**

The cloning of the human insulin gene (which diabetics lack) was made possible using a bacterium which enables vast quantities of human insulin to be produced at low cost. Prior to 1983, insulin was extracted from pigs and purified for diabetics to use, which was both more costly and less safe. Today, a large number of life saving drugs are pro-duced in a similar way, such as human growth hormone and fac-tor VIII which is a blood clotting protein lacking in haemophiliacs.




**What Are The Benefits of Biotechnology ?**

Modern biotechnology can make an important contribution to the national priorities of a country in a number of areas:

♦ **Enhanced Food Security**

The promise of biotechnology in food production is its capacity to improve the quality and quantity of plants and animals quickly and effectively.

♦ **Improved Health Care**

In addition to improved health through enhancing the nutritional quality of foods, there are many other uses of modern biotechnology that can further enhance human health:

- *Inexpensive medicine production* – Modern biotechnology is enabling the production of higher quality drugs at a lower cost;
- "*Biopharming*" – Crops are now being tested as possible delivery systems for pharmaceuticals, such as banana which could one day contain various vaccines;
- *Human Genome Project* – this research will one day enable genetic diseases to be understood, diagnosed and perhaps cured;
- *Gene Therapy* – medicines are being developed to target specific cells in the human body;
- *HIV/AIDS* – The production of vaccines for clinical trials is underway and if successful, the companies undertaking the research could produce the vaccine in large amounts at low cost so they are affordable;
- *Forensics and Diagnostics* – also known as genetic fingerprinting, these techniques could provide invaluable evidence in bringing criminals to justice.

**Environmental sustainability**

In addition to reducing the amount of toxic chemical pesticides that are released into the environment though built in resistance to pests, herbicide resistance means that more environmentally friendly broad-spectrum herbicides can be used to eliminate competing weeds. More novel contributions GM can make towards sustainable development include:

- *Waste management: "Biomaterials"* – biodegradable plastics are being developed using a micro-organism that degrades polyethylene plastics;
- *Bioremediation* – the use of microorganisms such as bacteria to remove environmental and often poisonous pollutants from soil and water. Waste cleaning organisms, mainly plants, could be grown at treatment plants and contaminated areas.

**Industrial Development Processes**

Current GM research is opening up future possibilities which could significantly contribute to national economies, and promote new global collaborations, such as:

- Engineering traditional food crops to become valuable industrial crops – e.g. canola is being used to produce high value industrial oil;
- Improved/additional characteristics for processing – such as potatoes that absorb less oil, and fruits with a longer shelf life, such as tomato;
- Transforming raw materials – useful enzymes are now mass produced at low cost and high quality for various industries;
- *Biomining* – this is the inexpensive extraction of precious metals from low-grade ores using microbes. Plants are also being developed to mine precious metals, for example Brassica, which concentrate gold from the soil in their leaves.

**What are the problems and risks of Biotechnology?**

With all new technologies, there are risks and elements of unpredictability and modern biotechnology is no exception. There are a number of areas of concern associated with GM that must be taken into consideration by decision makers:

**Food safety**

Areas of concern include the potential detrimental effect of toxins, allergies, dangers of nutritional changes and antibiotic resistance, and unexpected effects. Foods safety issues have been extensively investigated and the consensus is that there is no greater risk of these effects from eating GM foods than from traditionally bred crop varieties. Before marketing, any GM food product has to be exhaustively tested by the developer and independently evaluated for safety by food scientists for all the above mentioned risks. These food safety assessments are decided nationally, but must be consistent with international standards.


**Environmental impact**

Impact assessments are carried out on all GMOs worldwide

prior to commercialisation and all GMOs are monitored after approval. Several long-term environmental impact studies are currently being conducted in many countries but to date, no negative impacts have been found. The specific areas of concern all relate to the potential impact of GM crops on other organisms in the same or near by environment, such as:

- *Non-target organisms:* built in resistance to pests may adversely affect other, non-target organisms;
- *Agro-biodiversity:* the affect of modern biotechnology on local biodiversity found on farms. GM crops are considered no more of a threat than traditionally bred varieties, which have contributed to genetic erosion of biodiversity. However, this risk remains, but is minimised when considered against the alternative of converting natural habitats to agriculture;
- *Invasive species:* GM, whether through traditional breeding, natural changes or modern biotechnology can potentially change an organism to be an invasive species, which is something that spreads widely in its non-native environment.

Either the GM species could become invasive (i.e. a weed) or it could breed with a wild or weedy relative and so produce invasive offspring. Invasiveness of all GM plants, animals and microbes is assessed before decisions are made;

- *Gene Flow:* The concern is that the inserted gene(s) could be passed into other species. Genes do flow or move between species, and the impact of such movement is always assessed before decisions are made.

**Socioeconomic concerns**

These concerns are not specific to GM, but are the same for any new technology, including:

- *Access to affordable seed and sustainable development for poor communities* – there is a fear of multinational companies controlling food production in developing countries;
- *Globalisation, trade issues, income inequality and Intellectual Property Rights (IPRs)* – any technology should be available for development and used to benefit the local markets and farmers. A further concern is that increased yields of commodity crops will cause the price to drop, which could be detrimental to the farmer, but good news for the consumer;
- *Dietary preferences* – the use of animal genes in plants has implications for vegetarians and some religious groups;
- *Ethics* – the choice of the consumer to eat GM or not and whether it is morally, personally acceptable to transfer genes from species to species in this manner. The ethics of using GM crops should be compared to the ethics of not using the technology;
- *Problems associated with replanting seed* – privately developed seed must be bought each year. There is also the risk that farmers who have not paid for GM seed will have their crops affected through pollen movement;
- *Development of resistance* – built in resistance could favour the development of resistance within the pest population, as is the case with all pest control systems;