

## DEFINING BIOTECHNOLOGY: HISTORY AND FUTURE PROSPECTS

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### ABSTRACT

This article deals with the general introduction to biotechnology, its features, its history starting from making of beer to the establishment of new discipline of biotechnology, its various types, utility and the career prospects in India and abroad. Biotechnology deals with the utilization of either the living organisms or their components for production of novel compounds at commercial level for the benefit of mankind. The founding principle of this field is genetic manipulation and maintenance of sterile conditions that enable any recombination

product to be formed. Biotechnology has emerged from zymotechnology, a discipline of science that deals with only beer fermentation. Today, biotechnology has not left even a single field of our life untouched and is finding applications in agriculture, industries, poultries, fisheries, pharmaceuticals, diagnostics, stem cell research, designer babies, 3-D printing of organs, etc. Several biotechnological companies of pharmacy, food sector and research has already established in India and abroad and with the advent of state-of-the art technology, many more are still evolving.

**KEYWORDS:** biotechnology, zymotechnology, genetic manipulation, stem cell research.

### INTRODUCTION

Common masses generally take biotechnology as a discipline having combination of biology and chemistry. Biotechnology is actually utilizing the structural and functional concepts of different types of cells and cell organelles. With the dint of this information, biotechnologists have created whole plethora of compounds availed by the humans. These compounds transcend all categories including antibiotics, alcohols, medicinal compounds, genetically modified crops, stem cell therapy, gene therapy, effective transplantation by using

monoclonal antibodies, designer babies, 3-D printing of organs, treating cancer without painful chemotherapy.

Hence, biotechnology is the science which amalgamates knowledge of living organisms and technology for modifying genes and altering the metabolic processes for producing novel compounds. It not only produces compounds but help in designing new techniques for diagnosis and treatment.

### **Features of Biotechnology**

In order to distinguish biotechnology from the rest of the discipline of science and its allied subjects, some basic features are suggested. These are.

*Genetic manipulation:* Modification is done within the gene and hence, all the changes introduced are inherited into the future generation.

*Sterile conditions are required:* Sterility is required to remove any chances of contamination in the experimental procedure.

*Commercial scale production:* Most important aspect of biotechnology is that all the experiments and techniques are carried out for the benefit of mankind. Thus, to enable their accessibility to the masses they have to be produced at industrial scale.

### **HISTORY**

Historical roots of biotechnology were established in 19<sup>th</sup> century in the discipline of zymotechnology. It is the science dealing with the better understanding of the fermentation of beer. In 1875, Emil Hansen produced consistent beer using pure cultures of yeast. Max Delbruck grew yeast on industrial scale to meet the growing demands of animal feed during world war I. On the allied side Russian chemist Weizmann produces acetone, a key raw material in explosives by fermenting maize. Subsequently, penicillin antibiotic was synthesized using fungus *Penicillium* and its strain was improved for better yield of penicillin. All these events led to the establishment of separate branch of biotechnology.

In early 20<sup>th</sup> century, Henry Wallace applied the principles of hybridization to develop new higher yielding seeds. The revolutionary incident in the history of this field is the discovery of the structure of DNA by Watson and Crick in 1953 and eventually creation of first biotechnological product in 1973. Cohen and Boyer took a piece of DNA from an African

clawed frog and inserted it into bacterium *Salmonella*. Modern biotechnology has begun with the DNA sequencing and then human genome project which has enabled researchers to perform all sorts of genetic manipulations for novel product formation.

### **Types of biotechnology**

Biotechnology can be categorized into five basic types:

1. Green biotechnology: It is applied to agricultural processes. Eg. Designing of transgenic plants and plant domestication.
2. White biotechnology: It is also known as industrial biotechnology as it includes processes applied to industries. Eg. Using enzymes for chemical production or degradation of the toxins.
3. Red biotechnology: It is applied to medical processes. Eg. producing antibiotics, gene therapy, stem cell research.
4. Blue biotechnology: This term describe marine and aquatic applications of biotechnology. Eg. Enhanced fisheries production with improved nutrients content.
5. Yellow biotechnology: It is applied to oilseeds for enhanced production of oil with better quality.

### **Utility of biotechnology**

Biotechnology finds its applications in plethora of areas. It has not only led to the creation of multiple products and transgenic plants but has also revolutionized the treatment procedure of various diseases including cancer, genetic disorders, autoimmune syndromes, infertility of the couples and many more. Following paragraphs will briefly summarize its applications in different areas.

*Genetically modified (GM) crops:* These crops are produced by introducing foreign genes into them with the aim of inserting economical traits such as more nutritious value, seedless variety, abiotic (pH, temperature, salinity, etc) and biotic (pests, pathogens, etc) stress tolerance. Eg golden rice rich in beta carotene, seedless watermelon, Bt cotton that is resistant against lepidopteron insects. Recently, in India GM mustard has been approved by GEAC (Genetic engineering approval committee) to be used on commercial basis. This is the second such crop after Bt brinjal to be approved in India since 2010.

*Environmental biotechnology* – Here, the role of biotechnologists lies in finding new organisms and genes which can be exploited to degrade xenobiotics. These are the artificial

compounds that are foreign to the ecosystem and difficult to degrade. These days wastes are converted to biofuels by using genetically engineered microbes.

*Commercial production of important biochemicals* – Whole range of primary and secondary metabolites are produced at industrial scale using biotechnological methods. Primary metabolites (enzymes, alcohols) are those compounds which are produced in organisms for their normal growth and development. Secondary metabolites (antibiotics, resins) are the compounds that are produced as byproduct of the metabolic reactions of an organism.

*Therapeutic application* – Several drugs like insulin, steroids and sugar free syrups are produced for treatment using recombinant organisms. This field is coming more in vogue in gene therapy, molecular level diagnosis, recombinant vaccines and recently treating cancer with T lymphocytes instead of chemotherapy and has proved successful.

*Organ transplantation* – Basic problem in organ transplantation is the rate of rejection by recipient individuals. This rejection rate is decreased by using monoclonal antibodies designed using the hybridoma technology. Herceptin and OKT-3 are two such commonly used antibodies for organ transplantation.

*Stem cell research* – stem cells are those cells which have the properties of renewing themselves and are able to differentiate into many types of cells. These cells can be a good source of donors for organ transplantation. These days stem cell banks have been established in almost all countries including India.

*Forensics* – biotechnological techniques of DNA fingerprinting has helped in detecting the criminals and solving the paternity issues. This technique also help in determining the evolutionary relationship of a population with other population.

*3-D printing* – Recent advancement in the field of biotechnology has created wonder as now we can perform the 3-D printing of the organs like skin, kidney, liver, etc which has solved the twin problem of organ rejection and availability of the organ for transplantation.

*Designer babies* – Money infusion along with curiosity and creativity has led to the successful development of designer babies in which a couple can decide as to what characters they wish to have in their offspring. Ethical and social issues of this application of biotechnology is beyond the point of discussion here and require great contemplation.

### Career prospects

In recent years, techniques have been developed to produce rare and medicinally valuable molecules, to change hereditary traits of plants and animals, to diagnose diseases, curing them with designed proteins or recombinant vaccines. Therefore, biotechnology has great impacts in the field of health, food, agriculture and environmental protection. India offers a huge market for the products as well as cheap manufacturing base for export.

After pursuing biotechnology, wide range of careers are available. These careers are microbiologist, forensic science, clinical researcher, agriculture sector as scientist, process developer for manufacturing of new compounds, quality control inspectors, patent inspectors, medical writer, cell biologist, gene therapist, genetic engineer in which new gene combinations are made.

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