REVIEW ON DIFFERENT STAGES OF BIOTECHNOLOGY AND ITS APPLICATION

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Abstract:
The term biotechnology is derived from a fusion of biology and technology. True to its name, it concerns with the exploitation of biological agents or their components for generating useful products or services. The origin of biotechnology arose in ancient age. The areas of biotechnology and its scope of application will continue to broaden as science advances. This paper aimed at evaluating the origin of biotechnology from zymotechnology. Different stages of biotechnology like ancient biotechnology, classical biotechnology, modern biotechnology and their scope and application. The history of biotechnology as an industry begins in the early 19th century. Thousands of years back biotechnology was used by humankind in agriculture, food production and pharmaceuticals. Modern biotechnology came after the discovery of genetic material and its structure. After that modern biotechnology advanced very rapidly. The recent development in biotechnology have led to rapid progress in understanding the genetic basis of living organisms, and the ability to develop products and processes useful to human and animal health, food and agriculture, and industry. In agriculture, there is increasing use of biotechnology for genetic mapping and marker-assisted selection to aid more precise and rapid development of new strains by genetic engineering of improved crops and livestock. Biotechnology applications such as tissue culture and micro-propagation are being used for the rapid multiplication of disease-free planting materials.

Index Terms: Biotechnology, Zymotechnology, Agriculture, Pharmaceutical, Genetic engineering, Livestock.

I. INTRODUCTION

The area covered under biotechnology is very vast and the techniques involved are highly divergent; this has often made a precise definition of the subject rather difficult. Some standard definitions of biotechnology are reproduced below.

Biotechnology consists of "the controlled use of biological agents, such as, micro-organisms or cellular components, for beneficial use."

(U.S national Science foundation)

Biotechnology is "the integrated use of biochemistry, microbiology and engineering sciences in order to achieve technological application of the capabilities of micro-organisms, cultured tissues/cells and parts thereof."

(European federation of Biotechnology)

Biotechnology comprises the "controlled and deliberate application of simple biological agents-living or dead, cells or cell components-in technically useful operations, either of productive manufacture or as service operation."

(J.D.Bulock,1987)

"The application of biological organisms, systems or processes" constitutes biotechnology.

(British Biotechnologist)

Biotechnology may be defined as "the use of living organisms, in systems or processes for the manufacture of useful products; it may involve algae, bacteria, fungi, yeast, cells of higher plants and animals or subsystems of any of these or isolated component from living matter."

(Gibbs and Greenhalgh, 1983)

It may be seen that the different definitions of biotechnology differ in their approach, content and emphasis. But the two main features common to them all are: (1) utilization of biological entities, their components or constituents (e.g., enzymes), in such a way that (2) some product or service is generated. This product or service should, obviously enhance human welfare.

Biotechnology arose from the field of zymotechnology, which began as a search for a better understanding of industrial fermentation, particularly beer. Beer was an important industrial, and not just social, commodity. In late 19th century Germany, brewing contributed as much to the gross national product as steel, and taxes on alcohol proved to be significant sources of revenue to the government. In the 1860s, institutes and remunerative consultancies were dedicated to the technology of brewing. The most famous was the private Carlsberg Institute, founded in 1875, which employed Emil Christian Hansen, who pioneered the pure yeast process for the reliable production of consistent beer. Less well known were private consultancies that advised the brewing industry. One of these, the Zymotechnic Institute, was established in Chicago by the German-born chemist John Ewald Siebel.

The heyday and expansion of zymotechnology came in World War I in response to industrial needs to support the war. Max Delbruck grew yeast on an immense scale during the war to meet 60 percent of Germany's animal feed needs.

Compounds of another fermentation product, lactic acid, made up for a lack of hydraulic fluid, glycerol. On the Allied side the Russian chemist Chaim Weizmann used starch to eliminate Britain's shortage of acetone, a key raw material in explosives, by fermenting maize to acetone. The industrial potential of fermentation was outgrowing its traditional home in brewing, and "zymotechnology" soon gave way to "biotechnology."

With food shortages spreading and resources fading, some dreamed of a new industrial solution. The Hungarian engineer, Karl Ereky coined the word "biotechnology" in Hungary during 1919 to describe a technology based on converting raw materials into a more useful product. He built a slaughterhouse for a thousand pigs and also a fattening farm with space for 50,000 pigs, raising over 100,000 pigs a year. The enterprise was enormous, becoming one of the largest and most profitable meat and fat operations in the world. In a book entitled *Biotechnologie*, Ereky further developed a theme that would be reiterated through the 20th century: biotechnology could provide solutions to societal crises, such as food and energy shortages. For Ereky, the term "biotechnology" indicated the process by which raw materials could be biologically upgraded into socially useful products.

This catchword spread quickly after the First World War, as "biotechnology" entered German dictionaries and was taken up abroad by business-hungry private consultancies as far away as the United States. In Chicago, for example, the coming of prohibition at the end of World War I encouraged biological industries to create opportunities for new fermentation products, in particular a market for nonalcoholic drinks. Emil Siebel, the son of the founder of the Zymotechnic Institute, broke away from his father's company to establish his own called the "Bureau of Biotechnology," which specifically offered expertise in fermented nonalcoholic drinks. But recent developments in molecular biology have given biotechnology new meaning, new prominence, and new potential. It is now Modern biotechnology that has captured the attention of the public. Modern biotechnology can have a dramatic effect on the world economy and society.

II. MULTIDISCIPLINARY ACTIVITY OF BIOTECHNOLOGY

Biotechnology is truly multidisciplinary in nature and it encompasses several disciplines of basis sciences and engineering. Multidisciplinary means that a number of disciplines or branches of science and related areas are included.

•The different areas are combined in such a way that a new product or process can be produced.
• Individuals with expertise in the different areas work together toward a common goal.

The science disciplines from which biotechnology draws heavily are: microbiology, chemistry, genetics, molecular biology, cell and tissue culture, and physiology. On the engineering side, it leans heavily on process, chemical and biochemical engineering since large scale cultivation of micro-organisms and cells, their downstream processing etc. are based on them.

III. BIOTECHNOLOGY AND ITS VARIOUS STAGES OF DEVELOPMENT

There are various stages in the development of biotechnology to meet the various needs of humans. Its development was basically based on observations, and applications of these observations to practical scenarios. The complexity of biotechnology is augmented due to evolution of new technologies with time, as these are based on the employment of improved technological advancements along with better understanding of various principles of life-science. If, we systemically study the developments of biotechnology up to its current stage, it can be divided into three different stages or categories: (1) Ancient Biotechnology, (2) Classical Biotechnology, and (3) Modern Biotechnology. Some important discoveries related to biotechnology have been shown in Fig.1.

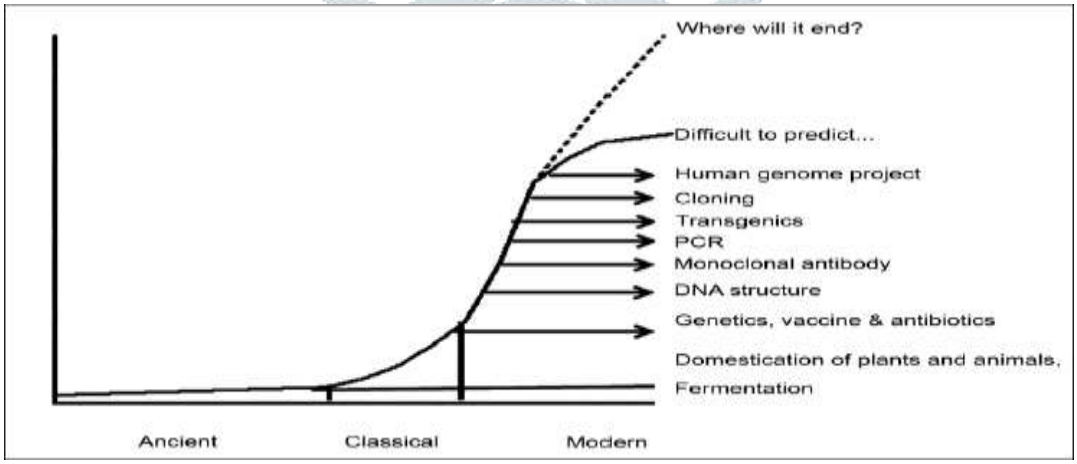

Fig .1: History of the development of biotechnology. Some of the important biotechnology discoveries have been plotted in this graph, with a possibility for its unlimited growth in the future Source: J pharm Bioallied Sc. 2011 July- sept, 3(3):321-323.

Ancient Biotechnology (Pre-1800)

Most of the developments in the ancient period i.e., before the year 1800, can be termed as ‘discoveries’ or ‘developments’. If we study all these developments, we can conclude that all these inventions were based on common observations about nature, which could be put to test for the betterment of human life at that point in time.

Food, clothes, and shelter are the most important basic needs of human beings irrespective of whether they lived in the ancient period or the modern period. The only factor that has changed is their types and origins. Food has been an inevitable need since the existence of man as well as for continuous existence of human beings. Early man used to eat raw meat, whenever they found a dead animal. However, during harsh weather, there was a paucity of food, hence, as per the saying, 'necessity is the mother of all inventions', which led to the domestication of food products, which is named as 'agriculture'. In ancient times, humans explored the possibilities of making food available by growing it near their shelters, so that the basic need for food could be met easily. They brought seeds of plants (mostly grains) and sowed them near to their shelters. They understood the importance of water, light, and other requirements for the optimal growth of food plants. Similar principles and needs also led them to start domestication of different wild animals, which helped them to improve their living conditions and to satisfy their hunger. The need to hunt for animal was done away with it; as now animals were available to them at closer proximity, and also they did not have to deal with the dangerous conditions of hunting. Domestication of wild animals was the beginning of observation, implications, and applications of animal breeding. Certainly, we can say that this was the initial period of evolution of farming, which led to another needs like the development of methods for food preservation and storage. They used cold caves to preserve food for long-term storage. It also made the way for the evolution of pots to store food products, in the form of leather bags, clay jars, etc.

After domestication of food crops and wild animals, man moved on to other new observations like cheese, curd, etc. Certainly, cheese can be considered as one of the first direct products (or by-product) of biotechnology, because it was prepared by adding rennet (an enzyme found in the stomach of calves) to sour milk, which is possible only by exposing milk to microbes (although this understanding was not there, at that time). Yeast is one of the oldest microbes that have been exploited by humans for their benefit. Yeast has been widely used to make bread, vinegar production, and other fermentation products, which include production of alcoholic beverages like whiskey, wine, beer, etc. Vinegar has a significant importance because of its low pH. Vinegar is capable of preventing growth of certain microbes, and therefore, vinegar can be used successfully for food preservation. The discoveries and benefits of these observations led people to work on further improvement of the process. Fermentation was a powerful tool to improve their living conditions, even though they were ignorant about the principle behind it.
One of the oldest examples of crossbreeding for the benefit of humans is mule. Mule is an offspring of a male donkey and a female horse. People started using mules for transportation, carrying loads, and farming, when there were no tractors or trucks. Mule is comparatively easier to obtain than Hinny (offspring of a male horse and a female donkey). Mule and Hinny both have a chromosome number 63, unlike horse (64) and donkey (62).

Classical Biotechnology
The second phase of evolution and development of biotechnology can be called 'Classical Biotechnology'. This phase existed from 1800 to almost the middle of the twentieth century. During this period various observations started pouring in, with scientific evidences. They were all very helpful toward solving the puzzles of biotechnology. Each and every contribution from different individuals helped to solve the puzzle and pave the path for new discoveries.

The basics for the transfer of genetic information are the core of biotechnology. This was, for the first time, deciphered in plants, i.e., *Pisum sativum*, commonly known as Pea plant. These observations were decoded by Gregor John Mendel (1822-1884), an Austrian Augustinian Monk. Mendel at that time presented "Laws of Inheritance" to the Natural Science Society in Brunn, Austria. Mendel proposed that invisible internal units of information account for observable traits, and that these 'factors' -later called as genes, which are passed from one generation to the next. However, the sad part of the story is that Mendel failed to get due recognition for his discovery for almost 34 years after his death, when other scientists like Hugo de Vries, Erich Von Tschermak, and Carl Correns validated Mendel's work in 1900. The reason why Mendel's study remained unnoticed for such a long period of time was because at the same time Charles Darwin's Theory of Evolution was so consuming that it shadowed the significance of work done by Mendel.

Almost at the same time Robert Brown had discovered nucleus in cells, while in 1868, Fredrich Miescher, a Swiss biologist reported nuclein, a compound that consisted of nucleic acid that he extracted from pus cells i.e., white blood cells (WBC). These two discoveries became the basis of modern molecular biology, for the discovery of DNA as a genetic material, and the role of DNA in transfer of genetic information. 1n 1881, Robert Koch, a German physician described the bacterial colonies growing on potato slices (First ever solid medium). Walter Hesse, one of the co-workers in Koch's laboratory, discovered agar when he asked his wife what kept the jelly solid even at high temperature of summer. She told, it is agar agar, since then nutrient agar became the most acceptable and useful medium to obtain pure microbial cultures as well as for their identification. In 1888, Heinrich Wilhelm Gottfried Von Waldeyer-Hartz, a German scientist coined the term 'Chromosome', which is considered as an organized structure of DNA and protein present in cells or a single piece of coiled DNA containing many genes, regulatory elements, and other nucleotide sequences. Other important discoveries during this period were vaccination against small pox and rabies developed by Edward Jenner a British Physician and Louis Pasteur a French Biologist.

By this time the development and growth of biological sciences seemed to be reaching to the exponential phase. The principle of genetics in inheritance was redefined by T H Morgan, who has shown inheritance and the role of chromosomes in inheritance by using fruit flies, i.e., *Drosophila melanogaster*. This landmark work of T H Morgan was named, 'The theory of the Gene' in 1926. Before the publication of Morgan's work, in 1909, the term 'Gene' had already been coined by Wilhelm Johannsen (1857-1927), who described 'gene' as carrier of heredity. Johannsen coined the terms 'genotype' and 'phenotype'. 'Genotype' was meant to describe the genetic constitution of an organism, while 'Phenotype' was meant to describe actual organism. By this time genetics started gaining its importance, which led to the start of

Eugenic Movement in USA, in 1924. As a result of this, in 1924, the US Immigration Act was used to restrict the influx of poorly educated immigrants from Southern and Eastern Europe, on the grounds of their suspected genetic inferiority.
Almost at the same time, in Britain, Alexander Fleming a physician discovered antibiotics, when he observed that one microorganism can be used to kill another microorganism, a true representation of the 'divide and rule' policy of humans. Fleming noted that all bacteria (Staphylococci) died when a mold was growing in a petri-dish. Later he discovered 'penicillin' the antibacterial toxin from the mold *Penicillium notatum*, which could be used against many infectious diseases. Fleming wrote, *"*When I woke up just after dawn on September 28, 1928, I certainly didn't plan to revolutionize all medicine by discovering the world's first antibiotic, or bacteria killer*"*. As a matter of fact vaccines and antibiotics turned out to be the best saviors of humanity.

Modern Biotechnology
The Second World War became a major impediment in scientific discoveries. After the end of the second world war some, very crucial discoveries were reported, which paved the path for modern biotechnology and to its current status. In 1953, JD Watson and FHC Crick for the first time cleared the mysteries around the DNA as a genetic material, by giving a structural model of DNA, popularly known as, 'Double Helix Model of DNA'. This model was able to explain various phenomena related to DNA replication, and its role in inheritance. Later, Jacob and Monad had given the concept of Operon in 1961, while Kohler and Milstein in 1975, came up with the concept of cytoplasmic hybridization and produced the first ever monoclonal antibodies, which has revolutionized the diagnostics.

By this time it seemed like the world's scientific community had almost all the basic tools available to them for their applications, along with majority of basic concepts had been elucidated, which has fast forwarded the path for important scientific discoveries. Dr. Hargobind Khorana was able to synthesize the DNA in test tube, while Kary Banks Mullis added value to Khorana's discovery by amplifying DNA in a test tube, thousand times more than the original amount of DNA. Using this technological advancement, other scientists were able to insert a foreign DNA into another host and were even able to monitor the transfer of a foreign DNA into the next generation. The advent of HIV / AIDS as a deadly disease has helped tremendously to improve various tools employed by life-scientist for discoveries and applications in various aspects of day-to-day life. In the mean time Ian Wilmut an Irish scientist was successful to clone an adult animal, using sheep as model, and he named the cloned sheep as 'Dolly'. Craig Venter, in 2000, was able to sequence the human genome; the first publically available genome is from JD Watson and Craig Venter, himself. These discoveries have unlimited implications and applications. In 2010, Craig Venter has been successful in demonstrating that a synthetic genome could replicate autonomously. Should that be considered as a new possibility for creating life in a test tube, which could be planned and designed by human being using a pen, pencil, computer, and bioinformatics as tools? In future, can we produce life as per our imagination and whims?

Biotechnology has brought humanity to this level of comfort; the next question is where will it take us? Biotechnology has both beneficial and destructive potentials. It is, we who should decide how to use this technology to help humanity rather than to destroy it.

IV. SCOPE OF BIOTECHNOLOGY

Bio- technology has scope in the fields of agriculture and animal Husbandry, molecular medicine, forensic science, microbial Genetics, environmental Sciences etc.

Agriculture and animal husbandry
The scope of bio- technological applications in Agriculture and Animal Husbandry is concerned with- the development of disease and pest resistant varieties of plants and animals; the production of food containing high nutrient value; the production of vaccines and the development of drought resistant crop varieties.

Molecular medicine
This field of Bio- technology incorporates- disease diagnosis through cultural and different biotechnological methods and through Gene Therapy (cure of diseases through improvement and modification of genes.

Forensic science
This science relates to the identification of criminals and researches pertaining to crime. This field of bio- technology incorporates- the DNA- matching tests; the establishment of genetic relationships; DNA-mapping; DNA- Fingerprinting and Genetic Analysis etc.

Microbial genetics
This field of bio- technology incorporates- Study of microorganisms and their genetic make up; the study of genetic behaviour and possibilities of genetic alterations; recombination etc. The microbial Genetics is also concerned with the study of bio- weapons; bio-wars and bio- fuels.

Environmental science
This field of bio- technology incorporates- studies pertaining to the detection of microorganisms causing health hazards; environmental pollutions and the monitoring of environmental problems concerned with the living world.

V. APPLICATIONS OF BIOTECHNOLOGY

The application of bio- technology can be categorized as Specific Applications and General Applications.

Genetic engineering

The experiments of Stanley Cohen and Herbert Boyer (1973) pertaining to the removal of specific gene from a bacterium and the insertion of the same gene into another bacterium, marks the beginning of the Recombinant DNA- technology which is also called as the Genetic Engineering. In their experiments, the "restriction enzymes" were used for cutting the segments of DNA. The Enzymes are specific proteins which can speed up biochemical processes without being altered in the chemical reactions.

The science of changing the pattern of development and behaviour of an organism by making alterations in its genes is called as genetic engineering. The organisms produced by altering their genetic make up through DNA recombinant technology or through genetic engineering are called as Genetically Modified Organisms or GMOs. In agriculture, GM-crops are also being produced through genetic engineering. The food produced from genetically modified crops is called as GM- food.

The genetically engineered organism in which a foreign gene has been introduced to obtain desired results is called as a Transgenic Organism. Such an organism may be a plant, an animal, bacteria or fungi. These organisms are developed by injecting a foreign gene into the embryo or the fertilized egg of an organism.

.Through genetic engineering the alterations in the genetic make up of an organism can be done successfully.
. Genetic engineering can be employed in increasing food production from plants and animals,
. It is applied in the diagnosis of diseases and improvements in the medical treatment.

Plant tissue culture

The technique of growing plant tissues on artificial nutrient medium under laboratory conditions, so as to produce new plants, is called as plant tissue culture. These may be the Meristem Culture, Embryo Culture and Anther Culture and so on.

Monoclonal antibody

The specialized types of protein molecules produced in the laboratory are called as monoclonal antibodies. These are produced naturally in our bodies when any bacteria or virus invades it. Monoclonal antibodies are produced in our blood and protect us from different types of diseases. These bodies are used in identifying different types of cells. These are also employed in many diagnostic tests for bacteria and viruses. The experiments on using monoclonal antibodies for fighting against cancer are also going on across the world.

The genetic engineers have engineered the bacterial species E. coli to synthesize a specific protein called as Interferon. These proteins are produced naturally by body cells to oppose viral infections. The biologically synthesized interferon has been tested and found successful.

Synthesis of enzymes

The Proteinaceous chemical substances of biological origin that accelerate biochemical reactions without undergoing any change are called as enzymes. The term "enzyme" was coined by William Kuhne in 1867 on the basis of his studies on yeast. Specific enzymes can be synthesized through the application of bio- technology. These enzymes are used in various processes like removal of stains, softening of fabrics, preparation of digestible foods, processing of meat and, even the treatment of cancer.

Synthesis of biodegradable plastics

Bio- technology is currently employed in the synthesis of plastic which is biodegradable i.e. unlike other plastics; this plastic can be broken down into simpler substances by microorganisms.

The biodegradable plastic is made from lactic acid which is produced at the time of bacterial fermentation of plant materials like discarded stalks of corn. In the process, molecules of Lactic Acid are chemically grouped to form the biodegradable plastic. In fact, the biodegradable plastic is a material which has most of the properties of plastic except the property of being non- biodegradable.

Blood substitute

Today the number of people needing blood transfusion is increasing due to frequent accidents and diseases. In view of these facts, biotechnologists are trying to synthesize artificial blood through bio- technology. The biotechnologists like Mary L. Nucci and Abraham Abuchowski (1998) are likely to get success in their experiments in this regard.

Bio- technology and mining

Different types of bacteria are being currently employed in the extraction of different metals like copper, zinc, lead and other metals. These bacteria act on the metallic compounds available inside the earth and help in the isolation of respective metals.

Bio- technology and blood clotting protein

Bio- technology has many types of dramatic applications in the field of medicine. It has produced Factor- VIII (1986), which is a blood clotting protein and which is not produced in haemophilic persons. Under these conditions the haemophilic people are always at the risk of bleeding to death. In the process of synthesis of Factor VIII, the human genes having codes of production of blood clotting protein are transplanted into the haemophilic person. The factor VIII is being produced commercially since 1992.

Cloning

The bio- technology of production of cells or organisms that are originally derived from a single original cell or organism by asexual method under laboratory conditions is called as cloning. The copies of organisms produced during cloning have identical genetic make up and are known as clones. We can define a clone as an individual cell or organism which has been grown by a single body cell and which is genetically identical to its parent cell.

During 1950s, scientists cloned frogs and by 1980s they cloned mice. During 1996, Ian Wilmot and his team of researchers achieved success for the first time in cloning an adult sheep. They named the clone as Dolly. Scientists at Texas A & M University in College Station produced the first cloned cat on Dec. 22, 2001 through the Nuclear Transfer Technique. They named the clone – **cc** or the carbon copy. It is hoped that scientists may one day become successful in cloning extinct animals also.

Applications in food and beverage industry

A number of food products are produced on industrial scale through the fermentation technology. Some of those products are wine, idlis, yoghurt, cheese, mycoproteins, bread etc. Besides this bio- technology helps in the production of different vitamins, amino acids and vinegar etc.

Application in Pharmaceuticals

Modification of microorganisms, animals and plants so as to get maximum yield of medicinally useful substances is called as pharmaceutical bio- technology. Some important examples are being given below-

(I) Production of human insulin from non- human sources.
(ii) Production of Interferon, Cytokines, Steroids and human growth hormones.
(iii)Gene-therapy for prevention and control of diseases.
(iv) Development of vaccines and antibodies.

Application of bio- technology in agriculture

Tissue culture, cloning and hybridization are important bio- technologies that are being developed in agriculture today. Tissue culture is important for the propagation of high yielding varieties of plants for agriculture and floriculture. Hybridization is the technique of combining properties of two plants or animals to produce one better hybrid plant or animal. Though this process frequently occurs in nature, the adoption of this technology has supported the agriculture to produce more food to feed growing population in many countries. Similarly, hybridization technology has supported animal husbandry to produce more milk and meat.

The application of bio- technology in agriculture can make it more sustainable. The introduction of bio-fertilizers in soil can improve its composition besides making it fertile in a natural way. Similarly, the introduction of bio-pesticides can control pests through natural ways without contaminating the natural environment. The development of disease resistant and pest resistant crop varieties through bio- technological methods has further supported the agriculture.

Scientists are continuously experimenting for the improvement of crop plants like potato, tomato, cabbage and other vegetables and fruits as well as other crop plants like sugarcane, wheat, maize etc. to obtain better yield. Some new crop varieties like Triticale (a man made cereal) have also been developed to add nutrients in our food and increase food production.

Application of bio- technology in Pollution Control

The natural tendency of microorganisms can be exploited through bio- technology for solving the problem of wastes in the environment. The crop residues and animal waste are used in making manure by the activity of aerobic and anaerobic bacteria. The bacterial species *Pseudomonas aeruginosa* has been developed to eat away the oil spilled on the sea surface. Solid wastes like crop residues can be put inside a biogas digester to produce biogas, a most suitable source of rural energy.

In nature, green plants control atmospheric carbon dioxide by utilizing it in photosynthesis. Hence, plantation of more and more fast growing trees may be an important bio- technological method of controlling carbon dioxide level of atmosphere. Plants fix carbon dioxide by the help of specific enzyme Ribulose- bi- phosphate Carboxilase. The function of this enzyme is controlled genetically. Hence, scientists are trying to manipulate this enzyme to increase the rate of photosynthesis for greater reduction of atmospheric carbon dioxide level.

Application of bio- technology in waste water treatment

The treatment of waste water comprises three major steps- the Primary treatment, the Secondary treatment and tertiary. The primary treatment comprises many sub- steps like sedimentation, chemical coagulation and precipitation. These sub-steps remove most of the physical impurities or pollutants. The secondary treatment comprises biological process involving bio- technology of employing bacteria, fungi, algae etc. for the breaking down of complex pollutants. In this process, the effluent is passed through a microbial slime layer. The microbes present in this layer break down the organic and nitrogenous waste liberating carbon dioxide and nitrogen dioxide.

Application of bio- technology in the degradation of pesticides

Different species of bacteria and fungi tend to degrade pesticides. These microorganisms can be genetically manipulated to degrade more and more of them. Some species of bacteria like Pseudomonas sp., Flavobacterium, Azotobacter, E. coli and Acromobacter tend to degrade different pesticides. It has been reported that a mixture of Phanerocheate (a fungus) and enzyme peroxidase in suitable proportion can degrade DDT.

Bioremediation
The application of biotic agents like microorganisms in the correction and recovery of environmental damage is called as bioremediation. The removal of oil spilled on sea water by the help of bacteria is one example of bioremediation.

Industrial applications of bio- technology
Bio- technology is currently being applied in many areas of industry like the production of stain remover, detergents, bread, biotech-polyester, vitamins; stone washed jeans, bleached paper etc. Here are some examples-

(i) Detergents containing protease enzyme can remove stains of proteinaceous nature both on fabrics and lenses,
(ii) Detergents containing lipase enzyme can remove stains of oil and grease, and those containing amylase can remove starch grains stuck with fabrics. Now a day, polyesters are being synthesized from corn starch feed stock through the application of bio- technology. The enzyme cellulase is used for fading of jeans.

VI. CONCLUSION
Although the term biotechnology is of recent origin the discipline itself is very old. Man began employing micro organism as early as as 5000 BC for making wine, vinegar, curd, levened bread etc. Biotechnology has rapidly emerged as an area of activity having a marked realized as well as potential impact on virtually all domain of human welfare, ranging from food processing, protecting the environment, to human health. As a result, it now play a very important role in employment, production and productivity, trade and economy, human health and the quality of human life throughout the world. It was observed that the areas and scope of application will continue to broaden as science advances.

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