

CHAPTER # 17
BIOTECHNOLOGY

Q1. Define biotechnology and describe its importance.**Ans: Biotechnology:**

The use of living organisms in systems or processes for the manufacture of useful products or for services for humankind.

Old Biotechnology:

Although the term biotechnology is new, the discipline itself is very old. Fermentation and other such processes, which are based on the natural capabilities of organisms, are commonly considered as old biotechnology.

Modern Biotechnology:

Genetic engineering i.e. the artificial synthesis, modification, removal addition and repair of the genetic material (DNA) is considered as modern biotechnology.

Scope and Importance of Biotechnology:

The following are some areas of the application of biotechnology.

i. Biotechnology in the field of Medicine:

In the field of medicine, biotechnologists synthesized insulin and interferon (antiviral proteins) from bacteria and released for sale. A large number of vaccines and antibodies, human growth hormone and other medicines have also been produced. Various enzymes are being synthesized for medicinal as well as industrial use. Gene therapy (treatment through genes) has become important in recent years. Biotechnology also proved much beneficial in forensic medicine. The study of DNA helps in the identification of criminals.

ii. Biotechnology in the field of Food and Agriculture:

Fermented foods (e.g. pickles, yogurt), malted foods (e.g. powdered milk, a mixture of barley, wheat flour and whole milk), various vitamins and dairy products are produced by using microorganisms. Wine and beer are produced

in beverage industry, Biotechnology has also revolutionized research activities in the area of agriculture

Transgenic:

Transgenic (organisms with modified genetic set-up) plants are being developed, in which desirable characteristics are present e.g. more yields and resistance against diseases, insects and herbicides. Transgenic goats, chickens' cows give more food and milk etc. Many animals like mice, goats, cows etc. have been made transgenic to get medicines through their milk, blood or urine

iii. Biotechnology and Environment:

Biotechnology is also being used for dealing with environmental issues, like pollution control, development of renewable sources for energy restoration of degraded lands and biodiversity conservation. Bacterial enzymes are used to treat sewage water to purify. Microbes are being developed to be used as biopesticides biofertilizers, biosensors etc. Such transgenic microorganisms are also used for the recovery of metals, cleaning of spilled oils and for many other purposes.

Q2. Write a note on Genetic engineering.

Ans: Genetic engineering:

The artificial synthesis, modification, removal, addition and repair of the genetic material (DNA) is considered as modern biotechnology It is done to alter the characteristics of organisms. The work on genetic engineering started in 1944 when it was proved that DNA carries the genetic information. Scientists isolated the enzymes of DNA synthesis and then prepared DNA outside cells

In 1970s, they were able to cut and paste the DNA of organisms In 1978 scientists prepared human insulin by inserting the insulin gene in bacteria Human growth hormone was also synthesized in bacteria

In 1990, the **Human Genome Project** was launched to map all the genes in human cell. The complete map of human genome was published in 2002

Interesting Information

Human began using microorganisms as early as 4000 BC for making wine vinegar cheese, yogurt etc. Some of these processes have become a part of every home that we may even hesitate to refer them as biotechnology

Interesting Information

In Scotland, in 1997, an embryologist Ian Wilmut produced a sheep (Dolly) from the body cell of an adult sheep.

Q3. Give an example how biotechnology is helping for better environment.

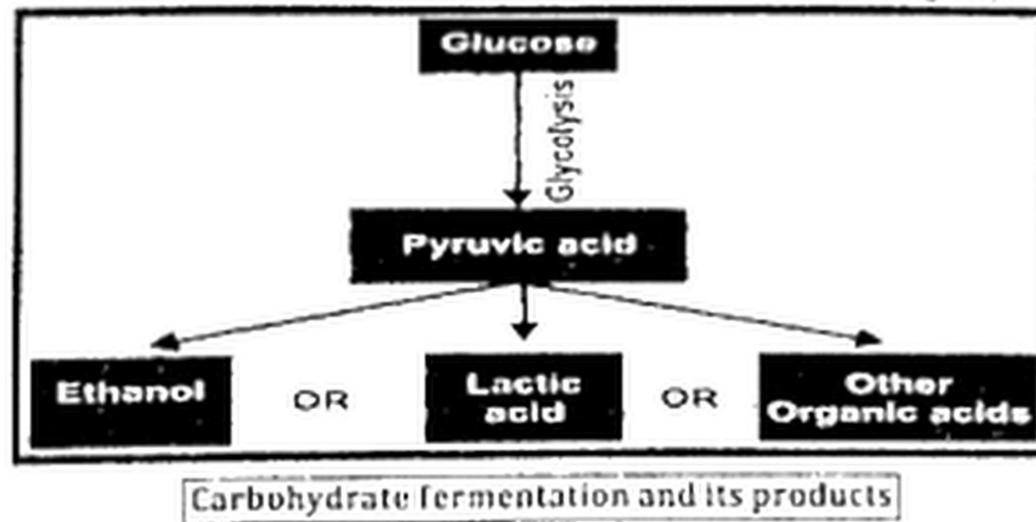
Ans: See Q #4 from Exercise (Short Questions)

Q4. Briefly explain the process of fermentation:

Ans: Fermentation:

The process in which there is incomplete oxidation-reduction of the organic substrate (glucose)

In 1857 Pasteur convinced the scientific community that all fermentations are the results of microbial activity He showed that fermentation is always accompanied by the development of microorganisms. There are fermentation and each kind is a characteristic of particular microbial group



Fermentations are classified in terms of the products formed. The initial steps of carbohydrate fermentation are identical to those of respiration. The process begins with glycolysis, in which the glucose molecule is broken into two molecules of pyruvic acid. Different microorganisms proceed the further reactions in different ways. It results in the formation of various products from pyruvic acid.

Types of Carbohydrates Fermentation:

The two basic types of carbohydrate fermentation are

i. Alcoholic Fermentation (by yeast):

This fermentation is carried out by many types of yeast such as *Saccharomyces cerevisiae*. This process is quite important and is used to produce bread, beer, wine and distilled spirits. In this process, carbon dioxide is removed from pyruvic acid. The product i.e. acetaldehyde is then reduced to ethanol. The carbon dioxide produced during this fermentation causes the rise of the bread.

ii. Lactic Acid Fermentation (by bacteria):

In this process, pyruvic acid is reduced to lactic acid. It is carried out by many bacteria e.g. *Streptococcus* and many *Lactobacillus* species. It is quite important in dairy industry where it is used for souring milk and also for production of various types of cheese.

Interesting Information

Fears are also being expressed about the advances in biotechnology terms of release of harmful organisms developed through recombinant DNA technology.

Q5. What are the products of the two types of carbohydrate fermentation?

Ans: See Q# 3 from Exercise (Short Questions)

Q6. How would you define fermentation with reference to biotechnology?

Ans: See Q # 1 from Exercise (Short Questions)

Q7. Describe the applications of fermentation in the field of fermented foods.

Ans: Applications of fermentation in fermented foods:

Fermentation often makes the food more nutritious more digestible and tastier It also tends to preserve the food, lowering the need for refrigeration. The following groups are included in the fermented foods.

Cereal products:

Bread is the commonest type of fermented cereal product. Wheat dough fermented by *S. cerevisiae* along with some lactic acid bacteria

ii. Dairy products:

Cheese and yogurt are important fermentation products Cheese is formed when a milk protein is coagulated this happens when the acid produced by lactic acid bacteria reacts with milk protein. Yogurt is made from milk by different lactic acid bacteria.

Fruit and vegetable products:

Fermentation is usually used, along with salt and acid, to preserve pickle, fruits and vegetables

iv. Beverage Products:

Beer is produced from cereal grains which have been malted, dried and ground into fine powder. Fermentation of the powder is done by yeast. This process breaks the glucose present in powder into pyruvic acid and then into ethanol. Grapes can be directly fermented by yeasts to wine.

Q8. Name any two Industrial products made by fermentation. Also describe their uses in the industry.

Ans: See Q#2 from Exercise (Short Questions),

Q9. What is a fermenter? What are the two types of fermentation carried out in fermenters?

Ans: See Q#2 from Exercise (Understanding the Concept)

Q10. What are the Advantages of using Fermenters.

Ans: Advantages of using Fermenters:

For each biotechnological process, the environment provided to the organisms must be monitored and controlled. Such a controlled environment is provided by fermenters.

A fermenter optimizes the growth of the organisms by controlling many factors like nutrients, oxygen, growth inhibitors, pH and temperature.

A fermenter may hold several thousand litres of the growth medium. So, fermenters allow the production of materials in bulk quantities.

Massive amounts of medicines, insulin, human growth hormone and other proteins are being produced in fermenters and this production proves much inexpensive.

Interesting Information

The design and arrangements for continuous fermentation are more complex

Interesting Information

In fact fermenter constitutes the heart of any industrial fermentation process.

Q11. Give introduction and objectives of genetic engineering.

Ans: Introduction of Genetic Engineering:

Genetic engineering or recombinant DNA technology involves the artificial synthesis, modification, removal, addition and repair of the genetic material (DNA). Genetic engineering developed in the mid-1970s when it became possible to cut DNA and to transfer particular pieces of DNA from one type of organism into another. As a result, the characteristics of the host organism could be changed. If host organism is a microorganism, such as a bacterium, the transferred DNA is multiplied many times as the microorganism multiplies. Consequently, it is possible to obtain millions of copies of a specific DNA inside a bacterial cell.

Objectives of Genetic Engineering:

The important objectives of genetic engineering are as follows

- i. Isolation of a particular gene or part of a gene for various purposes such as gene therapy

- ii. Production of particular RNA and protein molecules
- iii. Improvement in the production of enzymes, drugs and commercially important organic chemicals
- iv. Production of varieties of plants having particular desirable characteristics
- v. Treatment of genetic defects in higher organisms

Q12. What basic steps a genetic engineer adopts during the manipulation of genes?

Ans: See Q # 4 from Exercise (Understanding the Concept)

Q13. In biotechnology, what is meant by Genetically Modified Organism (GMO)? How is it made?

Ans: See Q # 5 from Exercise (Short Questions)

Q14. Describe the achievements of genetic engineering in medicine, agriculture and environment.

Ans: See Q# 3 from Exercise (Understanding the Concept)

Interesting Information

Before genetic engineering, 500,000 sheep brains were required to produce 5 mg human growth hormone

Q15. What are single cell proteins? Describe their importance.

Ans: See Q# 5 from Exercise (Understanding the Concept)

Interesting Information

It is known as single cell protein because the microorganisms used as production are unicellular individuals.

Interesting Information

SCP is gaining popularity day by day because it requires limited land area for production.

