Short Questions

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

Ans: Fermentation:

Fermentation is the process in which there is incomplete oxidation-reduction of glucose Fermentation has been in the knowledge of man since centuries, but it was believed that it is purely a chemical process.

Fermentation in Biotechnology:

In beginning the meaning of fermentation process was the use of microorganisms for the production of foods (cheese, yogurt, fermented pickles and sausages, soy sauce) beverages (beers wines) and spirits biotechnology the term "fermentation" means the production of any product by the mass culture of microorganisms.

2. Name any two industrial products made by fermentation. Also describe their uses in the industry.

Ans: Industrial Products:

Products	Microorganisms used	Some uses
Formic acid	Aspergillus	Used in textile dyeing leather treatment, electroplating rubber manufacture

Ethanol	Saccharomyces	Used as solvent used in the production of vinegar and beverages
Glycerol	Saccharomyces	Used as solvent used in the production of plastics, cosmetics and soaps used in printing used as sweetener
Acrylic acid	Bacillus	Used in the production of plastics

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

Ans: Products of carbohydrate fermentation:

i. Alcoholic Fermentation (by yeast)
ii. Lactic Acid Fermentation (by bacteria

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

Ans: 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 purity. 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.

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

Ans: Recombinant DNA is transferred to the target host in this way, host organism is transformed into a genetically modified organism (GMO)

The GMO are provided suitable culture medium for growth to give as much copies of the gene of interest as needed.

The GMO contains the gene of interest and manufactures the desired product which is isolated from culture medium.

UNDERSTANDING THE CONCEPT

1. 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 (0.9 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.

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

Ans: Fermenter:

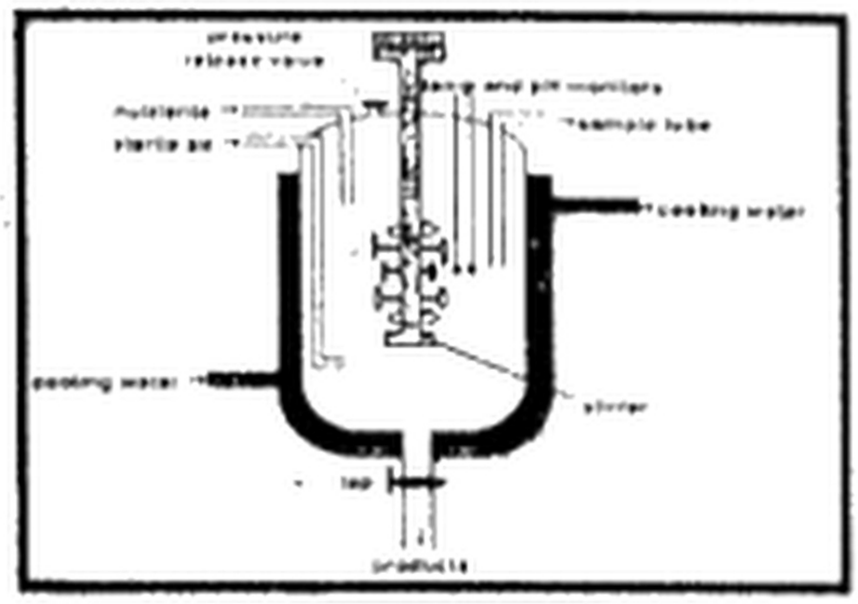
A device that provides optimum environment in which organisms can grow to produce biomass and to form the product is called fermenter.

Types of fermentation carried out in fermenters:

Fermentation is carried out in fermenters, in the following two ways

i. Batch Fermentation:

In this process, the tank of fermenter is filled with the raw materials to be fermented. The temperature and pH for microbial fermentation is properly adjusted, and nutritive supplements are added.

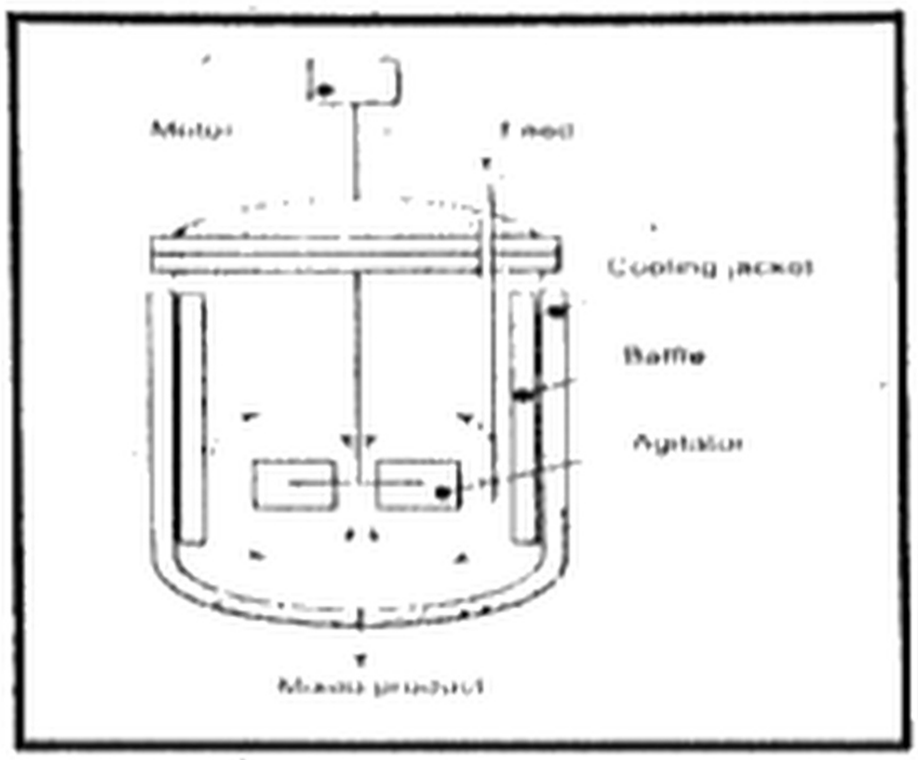


A batch fermenter

All the material is steam sterilized. The pure culture of microorganisms is added to fermenter from a separate vessel. Fermentation proceeds and after the proper time the contents of fermenter are taken out Fermenter is cleaned and the process is repeated. Thus, fermentation is a discontinuous process divided into batches.

ii. Continuous Fermentation:

In this process, the substrate is added to fermenter continuously at a fixed rate. This maintains the microorganisms in growth phase. Fermentation products are taken out continuously (Fig. 17.4).



A continuous fermenter

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

Ans: Achievements of Genetic Engineering in Medicine:

Various achievements of genetic engineering are as follows

Human insulin:

Human insulin gene was transferred into bacteria. The genetically modified bacteria became able to synthesize insulin. Diabetics are now receiving this insulin.

Human growth hormone:

In 1977 an E coli bacterium was created that was capable of synthesizing the human growth hormone.

Hormone Thymosin:

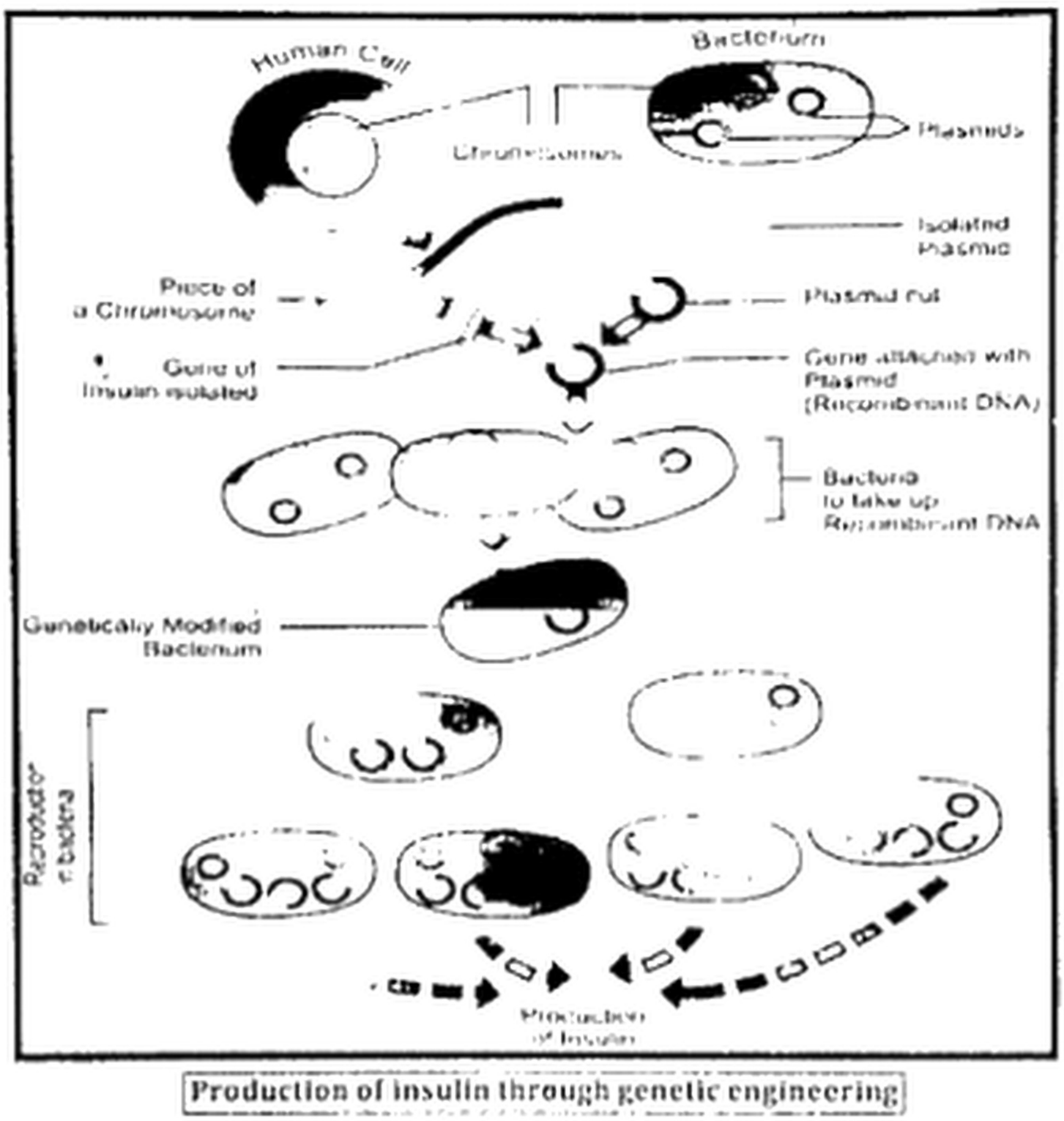
The hormone thymosin which may prove effective against brain and lung cancer has been produced by genetically modified microorganisms.

Beta-endorphin:

Beta-endorphin, a pain killer produced by the brain, has also been produced by genetic engineering techniques.

Vaccine:

Genetic engineers produced a safe vaccine against the foot and mouth disease (a viral disease in cattle, goats and deer). Similarly, many vaccines have been produced against human diseases such as hepatitis B.



Production of insulin through genetic engineering

Interferons:

Interferons are anti-viral proteins produced by cells infected with viruses in 1980, interferon was produced in the genetically modified microorganisms for the first time

Urokinase:

The enzyme urokinase which is used to dissolve blood clots has been produced by genetically modified microorganisms

Hemophilia:

Now it has become possible to modify the genes in the human egg cell. This can lead to the elimination of inherited diseases like hemophilia

To cure blood diseases:

Genetic engineering techniques can also be used to cure blood diseases like thalassemia and sickle-cell anemia, which result from defects in single genes. Normal genes could be transferred into the bone marrow

Achievements of Genetic Engineering in Agriculture:

Fix nitrogen:

Genetic engineers have developed plants that can fix nitrogen directly from the atmosphere. Such plants need less fertilizers

Achievements of Genetic Engineering in Environment:

Genetic engineering 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

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

Ans: Basic Steps in Genetic Engineering:

All the above-mentioned objectives can be obtained by some basic methodologies such as

i. Isolation of the gene of interest:

In the first step the genetic engineer identifies the gene of interest in a donor organism Special enzyme, called restriction endonucleases, are used to cut the identified gene from the total DNA of donor organism

ii. Insertion of the gene into a vector:

A vector is selected for the transfer of the isolated gene of interest to the host cell. The vector may be a plasmid (the extra-chromosomal DNA present in many bacteria) or a bacteriophage. The gene of interest is attached with the vector DNA by using endonuclease (breaking enzymes) and ligase Coining enzymes). The vector DNA and the attached gene of interest are collectively called recombinant DNA.

iii. Transfer of recombinant DNA into host organism:

Recombinant DNA is transferred to the target host in this way host organism is transformed into a genetically modified organism (GMO)

iv. Growth of the GMO:

The GMO are provided suitable culture medium for growth to give as much copies of the gene of interest as needed

v. Expression of the gene:

The GMO contains the gene of interest and manufactures the desired product, which is isolated from culture medium

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

Ans: Single-Cell Protein:

The protein content extracted from pure or mixed cultures of algae yeasts, fungi or bacteria, the micro-organisms are grown in fermenters where they produce a high yield of protein

Importance of Single-Cell Protein:

a. Single-Cell Protein (SCP) refers to the protein content extracted from pure or mixed cultures of algae yeasts, fungi or bacteria. For the production of single-cell proteins, the microorganisms are grown in fermenters. These microorganisms utilize a variety of substrate like agricultural wastes, industrial wastes natural gas like methane etc. Microorganisms grow very vigorously and produce a high yield of protein. The protein content produced by microorganisms is also known as novel protein or minifood.

b. Due to over-population, the world is facing the problem of food shortage. In future, the conventional agricultural methods might not be able to provide a sufficient supply of food (especially proteins)

c. For a better management of food shortage problems in humans and domestic animals), the use of microbes as the producers of single-cell proteins has been successful on experimental basis. This technique was introduced by Prof. Scrimshow of Massachusetts Institute of Technology Scientist and food technologists believe that single-cell proteins will substitute the other protein-rich foods in human and animal feeds.

d. All scientists recognize the significance of the production of single-cell proteins. The microorganisms grow very vigorously and produce a high yield. It has been calculated that 50 kilogram of yeast produces about 250 tons of protein within 24 hours. Algae grown in ponds produce 20 tons (dry weight) of protein per acre/year. This yield of protein is 10-15 times higher than soybeans and 20-50 times higher than corn. When single-cell proteins are produced by using yeasts, the products also contain high vitamin content.

e. In the production of single-cell proteins, industrial wastes are used as raw materials for microorganisms. It helps in controlling pollution. The use of single-cell proteins has good prospects in future because they contain all essential amino acids. Moreover, the production of single-cell proteins is independent of seasonal variations.