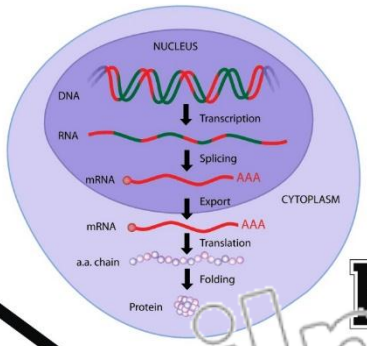


# CH# 17

# BIOTECHNOLOGY




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# 17.1 IMPORTANCE OF BIOTECHNOLOGY

## LONG QUESTIONS

**Q.1 What is meant by biotechnology? Explain the scope and importance of biotechnology. (A.B)** **(LHR 2014, GRW 2016, 17, MTN 2015)**

**OR**

**Define biotechnology and describe its importance.** **(Understanding the Concept Q.1)**

**Ans:**

**BIOTECHNOLOGY**

**Definition**

"The use of **living organisms** in processes for the **manufacture** of useful products or for **services** for **mankind** is called biotechnology".

Fermentation and other such processes, which are **based** on the **natural capabilities** of organism, are commonly considered as **old biotechnology**

**Scope and Importance:**

In recent years, biotechnology is **growing** as a **separate science**. It has attracted the attention of many intellectuals from diverse fields like:

- **Agriculture**
- **Medicine**
- **Microbiology**
- **Organic chemistry**

The **scope** for biotechnology is so **wide** that it is difficult to recognize the limits. The following are some areas of the application of biotechnology:

- **Biotechnology in the field of medicine**
- **Biotechnology in the field of food and agriculture**
- **Biotechnology and environment**

**Biotechnology in the Field of Medicine:**

In the field of **medicine**, **biotechnologists** have **synthesized**:

- **Insulin**
- **Interferon (antiviral proteins)**
- **Vaccines**
- **Antibodies**
- **Human Growth Hormone**

**Enzymes:**

Various **enzymes** are being **synthesized** for **medicinal** as well as **industrial** use.

**Gene Therapy:**

**Gene therapy** (treatment through genes) has become **important** in recent years.

**Forensic Medicine:**

**Biotechnology** also proved much beneficial in forensic medicine.

**Identification of Criminals:**

The **study of DNA** helps in the **identification of criminals**.

**Biotechnology in the Field of Food and Agriculture:**

**Food Industry:**

The following products are being produced by using **microorganisms**.

- **Fermented foods** (e.g. pickles, yogurt)
- **Malted foods** (e.g. powdered milk: a mixture of barley, wheat flour and whole milk)
- **Various vitamins**
- **Dairy products**

**Beverage Industry:**

- **Wine and beer** are produced in **beverage industry**.

**Agriculture:**

- **Biotechnology** has also **revolutionized** research activities in the area of **agriculture**.

**Transgenic Organisms:**

"The **organisms** with **modified genetic set-up** are called **transgenic organisms**".

**Transgenic Plants:**

**Transgenic plants** are being developed in which **desirable characteristics** are present. For example:

- **More yields**
- **Resistance against diseases**
- **Resistant against insects**
- **Resistant against herbicides**

**Transgenic Animals:**

- **Transgenic goats**, **chickens**, **cows** give more food and milk.
- Many animals like **mice**, **goats**, cows etc. have been made **transgenic** to get **medicines** through their **milk**, **blood** or **urine**.

**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**
- **Biodiversity conservation**

**Treatment of Sewage Water:**

**Bacterial enzymes** are used to treat **sewage water to purify**.

**Use of Microbes:**

Microbes are being developed to be used as:

- **Biopesticides**
- **Biofertilizers**
- **Biosensors**

**Other Purposes:**

**Transgenic microorganisms** are also used for:

- **Recovery of metals**
- **Cleaning of spilled oils**

**Fears of Biotechnology:**

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

# 17.1 SHORT QUESTIONS

**Q.1 Define biotechnology. (K.B)** **(GRW 2014)**

**OR**

**What is meant by biotechnology?** **(GRW 2017)**

**Ans:** Page no 242.

**Q.2 Define genetic engineering? (K.B)** **(DGK 2015, GRW 2013, 2015, 16, LHR 2017)**

**OR**

**What is genetic engineering?**

**Ans:** **GENETIC ENGINEERING**

**Definition:**

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

**Example:**

Production of transgenic living organisms is through genetic engineering.

**Q.3 What do you know about continuous fermentation process? (K.B)** **GRW 2015**

**Ans:** Page no 249.

**Q.4 When Human Genome Project was launched? (A.B)**

**Ans:** **HUMAN GENOME PROJECT**

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.

**Q.5 What are transgenic organisms? (K.B)**

**OR**

**What are the desired characteristics of transgenic plants?** **(LHR 2017)**

**Ans:** Page no 243.

**Q.6 When sheep (Dolly) was produced by genetic engineering? (K.B)**

**Ans:** **PRODUCTION OF SHEEP (DOLLY)**

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

**Q.7 What is old biotechnology? (U.B)**

**Ans:** **OLD BIOTECHNOLOGY**

Fermentation and other such process, which are based on the natural capabilities of organisms, are commonly considered as old biotechnology.

**Q.8 When genetic engineering was started? (K.B)**

**Ans:** **GENETIC ENGINEERING**

The work on genetic engineering started in 1944 when it was prove 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.

**Q.9 Write uses of microorganism in early 4000 BC. (A.B)**

**Ans.** **USES OF MICROORGANISM**

Human uses of microorganism in early 4000 BC for making:

- Wine
- Vinegar
- Cheese
- Yogurt

**Q.10 What is the other name of genetic engineering? (K.B)**

**Ans:** **OTHER NAME OF GENETIC ENGINEERING**

The other name of genetic engineering is recombinant biotechnology and it is considered as modern biotechnology.

**Q.11 How biotechnology has help us in improving the environment? (U.B)** **(LHR 2017)**

**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
- Biodiversity conservation

**Q.12 What is novel protein or mini food? (K.B)** **GRW 2017**

**Ans:** Page no 258.

**Q.13 What is malted food. (K.B)** **GRW 2017**

**Ans:** Page no 243.

**Q.14 Write any two applications of Fermentation. (U.B)** **LHR 2015**

**Ans:** Page no 246.

## 17.1 MULTIPLE CHOICE QUESTIONS

**1. Human have been making use of biotechnology since the discovery of (K.B)**

(A) Farming (B) Fire extinction (C) Human production (D) Fermentation

**2. All of the following are major techniques in biotechnology, except; (K.B)**

(A) Cross pollination (B) Cross breeding (C) Fermentation (D) Pasteurization

**3. When scientists prepared human insulin? (K.B)**

(A) 1975 (B) 1976 (C) 1977 (D) 1978

**4. All are old biotechnological products, produced by using microorganisms as early as 4000 BC, except; (K.B)**

(A) Wine (B) Vinegar
(C) Cheese (D) Vaccines

**5. Human growth hormone was synthesized from? (K.B)**

(A) Fungi (B) Plants
(C) Bacteria (D) Animals

**6. Ian Wilmut was: (K.B)**

(A) Pathologist (B) Palaeontologist
(C) Embryologist (D) Physician

**7. Insulin is effective against: (A.B)**

(A) Blood pressure (B) Heart diseases
(C) Nervous disorders (D) Diabetes mellitus

**8. The use of living organisms in process for the manufacture of useful products: (K.B)**

(A) Parasitology (B) Biotechnology
(C) Pharmacology (D) Drug abuse

**9. When the work on genetic engineering was started? (K.B)** **(LHR 2015)**

(A) 1941 (B) 1942
(C) 1943 (D) 1944

**10. Human insulin was prepared from bacteria in (K.B)**

(A) 1990 (B) 1978
(C) 1970 (D) 1984

**11. The complete map of human genome was published in: (K.B)**

**(LHR 2016, GRW 2013, SWL 2014, MTN 2013)**

(A) 2000 (B) 2002
(C) 2004 (D) 2006

**12. What was the name of sheep produced by Ian Wilmut from the body cell of an adult sheep? (K.B)**

(A) Dolly (B) Nancy
(C) Ethal (D) Dhani

**13. Sheep Dolly was produced in: (K.B)**

(A) 1993 (B) 1995
(C) 1997 (D) 1999

**14. Organisms with modified genetic setup. (K.B)**

(A) Transgenic organisms (B) Simple organisms
(C) Hormone producing animals (D) Breeding animals

## 17.2 FERMENTATION

## LONG QUESTIONS

**Q.1 Define fermentation. What is carbohydrate fermentation? Explain its types. (K.B)**

**(LHR 2013, GRW 2013, 2014)**

**Ans:**

**FERMENTATION**

**Definition:**

"The **process** in which there is **incomplete oxidation-reduction** of **glucose** to release **less energy** in the form of **ATP** is called fermentation".

**Explanation:**

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 many kinds of fermentation and each kind is a **characteristic** of **microbial** group. Fermentations are classified in terms of the products formed.

One type of fermentation is **carbohydrate** fermentation.

**CARBOHYDRATE FERMENTATION**

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**.

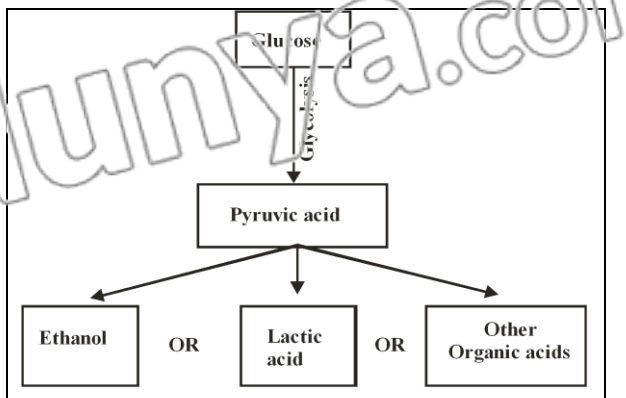



**Figure: Carbohydrate Fermentation and its Products**

**Types.**

The **two basic types** of **carbohydrate fermentation** are as follow:

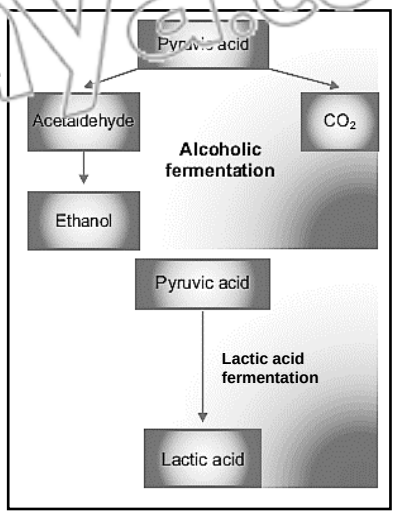
- **Alcoholic Fermentation (by yeast)**
- **Lactic Acid Fermentation (by bacteria)**

**Alcoholic Fermentation (By Yeast):**

This fermentation is **carried out** by many types of yeast such as **Saccharomyces cerevisiae**.

**Mechanism:**

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**.




**Usage:**

This process is **quite important** and is used to produce:

- **Bread**
- **Beer**
- **Wine**
- **Distilled spirits**

**Lactic Acid Fermentation (By Bacteria):**

It is **carried** out by many **bacterial species** like:

- **Streptococcus species**
- **Many Lactobacillus species**

**Mechanism:**

In this process, **pyruvic acid** is reduced to **lactic acid**.

**Usage:**

It is quite important in dairy industry where it is used for:

- **Souring milk**
- **Production of various types of cheese**

**Q.2 Describe fermentation in biotechnology. (K.B)**

**OR**

**Write a note on applications of fermentation (A.B)** **(LHR 2016)**

**Ans:** **FERMENTATION IN BIOTECHNLOGY**

**Definition:**

"In biotechnology the term "fermentation" means the **production** of any product by the **mass culture** of **micro-organisms**".

**APPLICATIONS OF FERMENTATION**

In fermentation, **maximum growth** of an organism is **obtained** for the production of **desired products** of **commercial value**. **Traditionally**, only food and beverage products were produced by using fermentation. Now many other products e.g. **industrial chemicals** are also being produced.

This can be categorized into **two groups**:

**a. Fermented Foods**

**b. Industrial Products**

**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**.

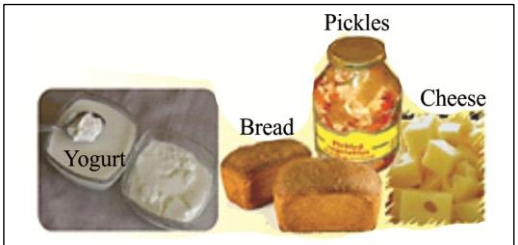



**Figure: Fermented Foods**

**Cereal Products:**

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

**Dairy Products:**

Cheese and yogurt are important **fermentation products**.

**Cheese Formation:**

Cheese is formed when a **milk protein** is **coagulated**. This happens when the **acid produced** by lactic **acid bacteria** reacts with **milk protein**.

**Yogurt Formation:**

**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**
- **Vegetables**

**Beverage Products:**

**Beer** is produced from **cereal grains** which have been **malted**, dried and ground into find 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.

**Industrial Products:**

The following are the important industrial products produced through the process of fermentation.

| Products | Microorganisms Used | Some Uses |
|---|---|---|
| Formic Acid | Aspergillus | • **Textile dyeing**<br>• **Leather treatment** **(GRW 2013)**<br>• **Electroplating** **(DGK 2015)**<br>• Rubber manufacture |
| Ethanol | Saccharomyces | • **Used as solvent**<br>• **Production of vinegar**<br>• **Production of beverages** |
| Glycerol | Saccharomyces | • **Used as solvent**<br>• **Production of plastics**<br>• **Production of cosmetics** **(BWP 2015)**<br>• **Production of soaps**<br>• **Used in printing** **(GRW 2014)**<br>• **Used as sweetener** |
| Acrylic Acid | Bacillus | • **Used in the production of plastics** |

**Q.3 What is a fermenter? Describe types of fermentation. What are the advantages of using fermenters? (A.B)** **(LHR 2016,17 GRW 2014, DGK 2015, BWP 2015)**

**OR**

**What is fermenter? What are two types of fermentation carried out in fermenters? (A.B)** **(Understanding the Concept Q.2)**

**Ans:**

**FERMENTER**

**Definition:**

"**Fermenter** is a device that **provides optimum environment** to **microorganisms** to grow into a **biomass**, so that they can **interact with a substrate**, **forming the product**".

Fermenter constitute the heat of any industrial fermentation process.

**TYPES OF FERMENTATION**

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

- **Batch Fermentation**
- **Continuous Fermentation**

**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. 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**.

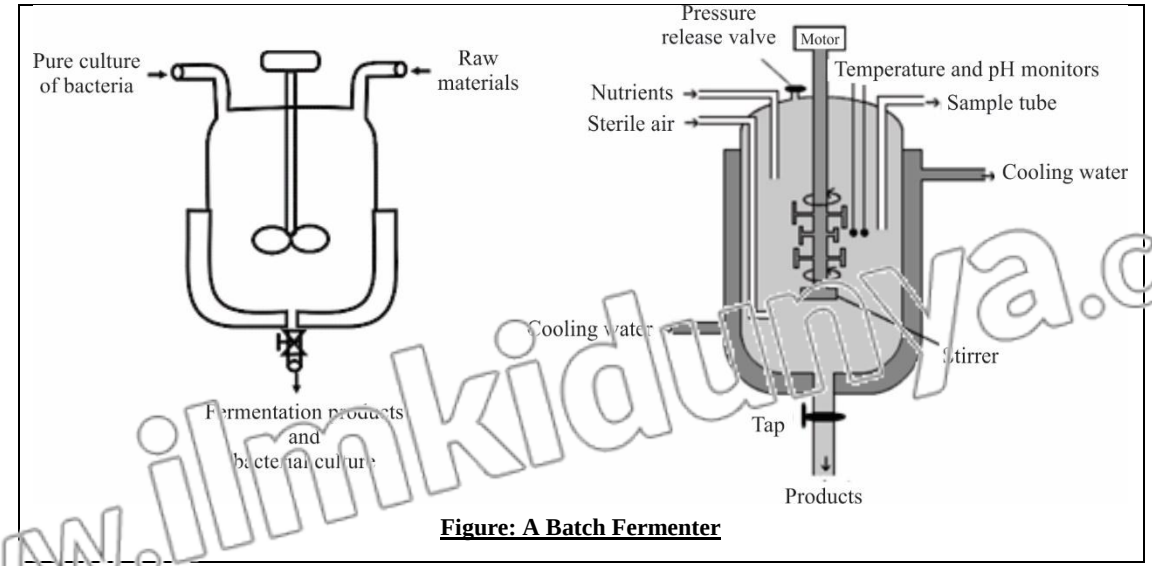



**Figure: A Batch Fermenter**

**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**.

The design and arrangements for **continuous fermentation** are more complex.

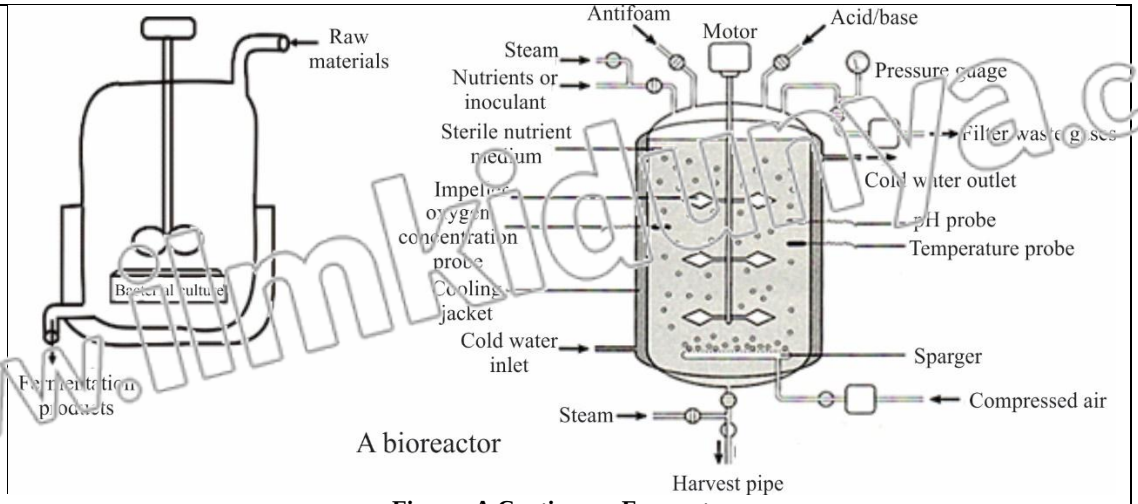



**Figure: A Continuous Fermenter**

## Advantages:

The **advantages** of using fermenters are as follows:

### Controlled Environment:

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

### Controlling Different Factors:

A fermenter **optimizes** the **growth** of the organisms by **controlling** many factors like:

- **Nutrients**
- **Oxygen**
- **Growth inhibitors**
- **pH**
- **Temperature**

### Capacity:

A fermenter may hold **several thousand liters** of the **growth medium**. So, fermenters allow the production of materials in **bulk quantities**. Massive amounts of the following products are **being produced** in fermenters:

**Figure: Fermenters Used in Food and Pharmaceutical Industry**

- **Medicines**
- **Insulin**
- **Human growth hormone**
- **Proteins**

### Inexpensive Products:

This production proves much inexpensive.

## 17.2 SHORT QUESTIONS

**Q.1 How biotechnology has helped us in improving the environment? (A.B) LHR 2017**

**Ans: Page no**

**Q.2 What is continuous fermentation? (U.B) LHR 2016**

**Ans:** Page no 249.

**Q.3 Name organisms which are involved in alcoholic fermentation and lactic acid fermentation. (K.B) (GRW 2016)**

**Ans:** Page no 247

**Q.4 Draw a flow chart of carbohydrate fermentation and its products. (A.B)**

**Ans:** Page no 246.

**Q.5 What are the advantages of fermented foods? (K.B)**

**Ans:**

**ADVANTAGES OF FERMENTED FOODS**

Fermentation often makes the food:

- More nutritious
- More digestible
- Tastier
- Preserve the food
- Lowering the need for refrigeration

**Q.6 What cereal products are produced by fermentation? (K.B) (LHR 2015)**

**Ans:** Page no 248.

**Q.7 What are fermented dairy products? (K.B) (LHR 2013, BWP 2014)**

**OR**

**How cheese and yogurt will formed?**

**Ans:** Page no 248.

**Q.8 Which beverage products produced by fermentations? (A.B)**

**Ans:** Page no 247.

**Q.9 Define fermenter. Give its types. (K.B) (LHR 2014, GRW 2016, BWP 2014, 2015, MTN 2015)**

**Ans:** Page no 249.

**Q.10 Write down the advantages of using fermenter. (U.B)**

**Ans:** Page no 250.

**Q.11 How fermentation is used to preserve vegetables? (A.B)**

**Ans:**

**PRESERVATION VEGETABLES**

Fermentation is usually used along with salt and acid to preserve like:

- Pickle
- Fruits
- Vegetables

**Q.12 What is continuous fermentation? (K.B) (LHR 2016)**

**Ans:** Page no 249

**Q.13 Write down the uses of glycerol (A.B) (GRW 2016)**

**Ans:** Page no 248.

**Q.14 Write names of any two industrial produced through the process of fermentation**

**Q.15 Write names of any two industrial produced through the process of fermentation (A.B) GRW 201**

**Ans:** Page no 248.

**Q.16 Write a note on alcoholic fermentation (K.B) (LHR 2016)**

**Ans:** Page no 247.

## 17.2 MULTIPLE CHOICE QUESTIONS

**1. Fermentation is the result of microbial activity was proved by (K.B)**
(A) R. Koch (B) A. Fleming
(C) L. Pasteur (D) J. Watson

**2. Alcoholic fermentation is carried out by (A.B)**
(A) Saccharomyces cerevisiae (B) Lactobacillus bulgaricus
(C) Streptococcus thermophilus (D) Escherichia coli

**3. Acetaldehyde is converted to ethanol by (U.B)**
(A) Oxidation (B) Carboxylation
(C) Reduction (D) dehydration

**4. During anaerobic respiration pyruvic acid is reduced to (U.B)**
(A) $CO_2 + H_2O$ (B) Lactic acid
(C) Ethanol (D) Both B & C

**5. Pasteur convinced the scientific community that all fermentations are the results of microbial activity in: (K.B)**
(A) 1851 (B) 1853
(C) 1855 (D) 1857

**6. To preserve fruits, vegetables and pickles, we add: (A.B)** **(LHR 2014)**
(A) Water and yogurt (B) Salt and acid
(C) Flour and salt (D) Onion and garlic

**7. Microorganisms used in the manufacture of formic acid: (K.B)**
(A) Aspergillus (B) Saccharomyces
(C) Bacillus (D) Virus

**8. Microorganisms used in the manufacture of ethanol: (K.B)**
(A) Aspergillus (B) Saccharomyces
(C) Bacillus (D) Rhizopus

**9. Microorganisms used in the manufacture of glycerol: (A.B)**
(A) Aspergillus (B) Saccharomyces
(C) Bacillus (D) Spirogyra

**10. Microorganisms used in the manufacture of acrylic acid: (A.B)**
(A) Aspergillus (B) Saccharomyces
(C) Bacillus (D) Volvox

**11. Chemical used as sweetener: (K.B)**
(A) Formic acid (B) Ethanol
(C) Glycerol (D) Acrylic acid

**12. Chemical used in leather treatment: (K.B)**
(A) Formic acid (B) Ethanol
(C) Glycerol (D) Acrylic acid

**13. Yogurt is made from milk by different lactic acid: (A.B)**
(A) Yeast (B) Bacteria
(C) Fungi (D) Algae

**14. Fermentation is usually used, along with _____ and acid to preserve pickle, fruits and vegetables. (A.B)** **(LHR 2014)**

(A) Carbonic feed (B) Salt
(C) Lime (D) Oil

**15. Fermentation makes food (U.B)**

(A) More Nutritious & digestible (B) More Tastier & preserve able
(C) Lowering the need for refrigeration (D) All of these

**16. Cheese is formed by milk (A.B)**

(A) Fat emulsification (B) Proteins coagulation
(C) Carbohydrate hydrolysis (D) Demineralization

**17. In glycolysis, the glucose molecule is broken down into two molecules of: (U.B)** **(GRW 2014, SWL 2015)**

(A) Acetic acid (B) Lactic acid
(C) Pyruvic acid (D) Formic acid

**18. When milk protein is coagulated, what is formed? (A.B)**

(A) Yogurt (B) Cheese
(C) Alcohol (D) Wine

**19. Which product is used in the production of soap? (K.B)** **(GRW 2017)**

(A) Glycerol (B) Formic acid
(C) Sulphuric acid (D) Acrylic acid

**20. Alcoholic fermentation is processed by: (U.B)** **(LHR 2016)**

(A) Virus (B) Bacteria
(C) Fungi (D) Algae

## 17.3 GENETIC ENGINEERING

### LONG QUESTIONS

**Q.1 What is genetic engineering? What are its objectives? (A.B)** **(GRW 2017, BWP 2014, MTN 2015)**

**Ans:**

**GENETIC ENGINEERING**

**Definition:**

"**Genetic engineering** or **recombinant DNA technology** involves the **artificial synthesis**, **modification**, **removal**, **addition** and **repair** of the **genetic material (DNA)**".

**Explanation:**

**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:

**Gene Therapy:**

Isolation of a **particular gene** or part of a gene for **various purposes** such as **gene therapy**

**RNA and Proteins:**

**Production** of particular **RNA** and protein molecules

**Production of Enzyme:**

**Improvement** in the production of **enzymes**, **drugs** and **commercially important organic chemicals**

**Plant Varieties:**

**Production** of **varieties** of plants having particular **desirable characteristics**

**Treatment Purposes:**

Treatment of **genetic defects** in higher **organisms**

**Q.2 Describe achievements of genetic engineering. (A.B)** **(BWP 2014, DGK 2015)**

**OR**

**Describe the achievements of genetic engineering in medicine, agriculture and environment. (A.B)** **(Understanding the Concept Q.3)**

**Ans:** **ACHIEVEMENTS OF GENETIC ENGINEERING**

Various achievements of genetic engineering are as follows

**Preparation of Insulin:**

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

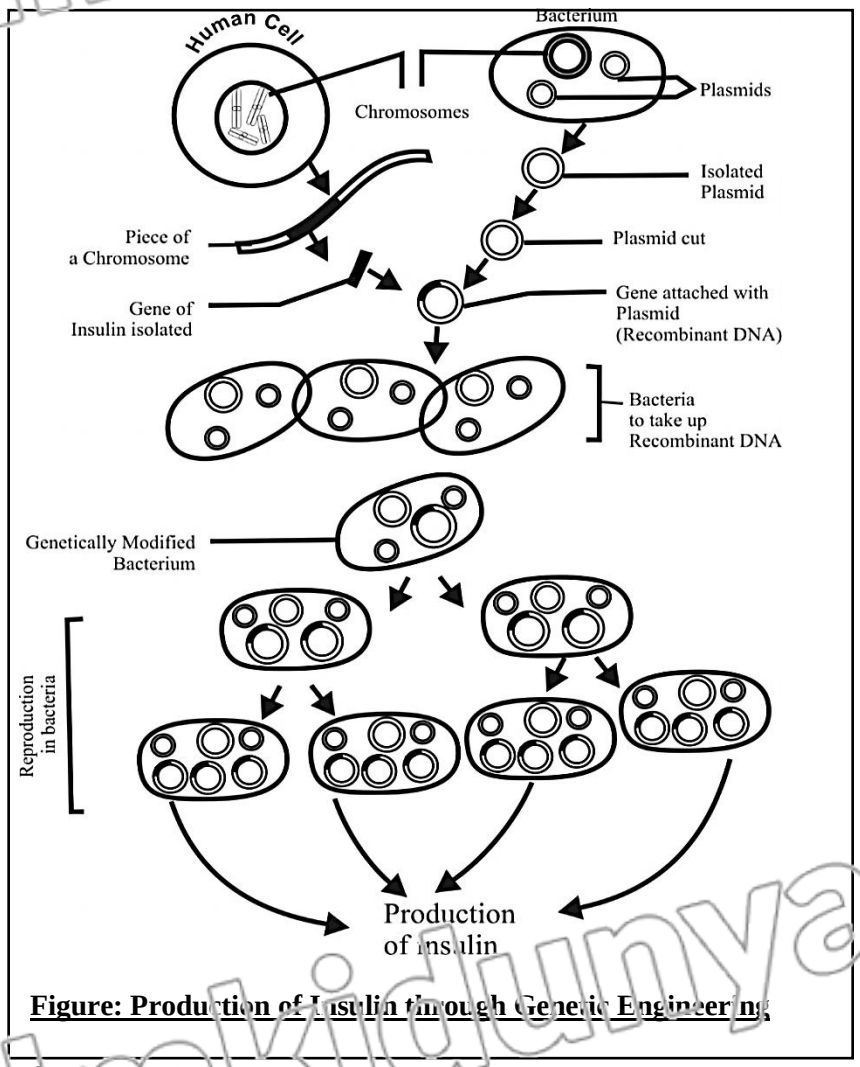



**Figure: Production of Insulin through Genetic Engineering**

**Preparation of Human Growth Hormone:**

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

**Preparation of Thymosin:**

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

**Preparation of Beta-endorphin:**

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

**Preparation of Vaccines:**

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**.

**Preparation of 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.

**Preparation of Urokinase:**

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

**Elimination of Inherited Diseases:**

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

**Cure of 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.

**Nitrogen Fixation:**

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


**Figure: Some Medicine Produced by Genetic Engineers**

**Q.3 Describe basic steps of genetic engineering. (K.B)** **(LHR 2017, DGK 2014, SWL 2015)**
**(Understanding the Concept Q.4)**

**OR**

**What basic steps a genetic engineer adopts during the manipulation of genes? (K.B)**

**Ans:**

**BASIC STEPS OF GENETIC ENGINEERING**

**Definition:**

"Genetic engineering or recombinant DNA technology involves the artificial synthesis, modification, removal, addition and repair of the genetic material (DNA)".

**BASIC STEPS OF GENETIC ENGINEERING**

The following basic steps are involved in genetic engineering:

1. **Isolation of the Gene of Interest:**

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

2. **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** (Joining enzymes). The vector DNA and the attached gene of interest are collectively called **recombinant DNA**.

**3. Transfer of Recombinant DNA:**
**Recombinant DNA** is **transferred to the target** host. In this way, **host organism** is transformed into a genetically modified organism **(GMO)**.

**4. 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.

**5. Expression of the Gene.**
The GMO **contains** the gene of interest and manufactures the desired product, which is isolated from **culture medium**.

## 17.3 SHORT QUESTIONS

**Q.1 Define glycolysis. (K.B)** **LHR -2017**
**Ans:** Page no 246.

**Q.2 Define genetic engineering. (K.B)** **LHR -2017**
**Ans:** Page no 253.

**Q.3 Write two benefits of the use of fermenter. (K.B)** **GRW -2015**
**Ans** Page no 249.

**Q.4 Write two objectives of genetic engineering. (U.B)**
**Ans:** Page no 253.

**Q.5 Define Vector. (K.B)** **(GRW 2015)**

**OR**

**What is vector in genetic engineering?** **(LHR 2016)**
**Ans:** Page no .

**Q.6 Name the bacterium which is used to prepare human growth hormone. (K.B)**
**Ans:** Page no 254.

**Q.7 Write use of hormone thymosin. (A.B)** **(DGK 2015)**
**Ans:** Page no 254.

**Q.8 What is beta-endorphin? (A.B)** **(DGK 2015, LHR 2016)**

**OR**

**What is the function of beta-endorphin?**
**Ans:** Page no 254.

**Q.9 What are Interferon's? (K.B)** **(LHR 2015, SWL 2015)**
**Ans:** Page no 255.

**Q.10 Write the use of enzyme urokinase? (A.B)** **(LHR 2015, SWL 2015)**
**Ans:** Page no 255.

**Q.11 Name the diseases which can be cured by genetic engineering. (K.B)** **(LHR 2015)**
**Ans:** Page no 276.

**Q.12 What is recombinant DNA? (K.B)** **(LHR 2017)**
**Ans:** Page no 255.

**Q.13 What is meant by gene therapy? (K.B)** **(LHR 2016)**
**Ans:** Page no 241.

**Q.14 Describe any two achievements of genetic engineering. (K.B)** **(GRW 2017)**
**Ans:** Page no 254.

## 17.3 MULTIPLE CHOICE QUESTIONS

**1. Gene of interest is excised by (A.B)**
(A) Restriction endonuclease (B) Exonuclease
(C) Ligase (D) nuclease

**2. Recombinant DNA is (U.B)**
(A) Gene of interest + Donor genome (B) Host DNA + Plasmid
(C) Vector DNA + Plasmid (D) Vector DNA + Gene of interest

**3. Which of the following can be used as biotechnological vector (A.B)**
(A) Plasmid (B) Bacteriophage
(C) Virus (D) Either of these

**4. An antiviral protein is: (K.B)** **(DGK 2014)**
(A) Insulin (B) Thymosin
(C) HGH (D) Interferon

**5. Insulin is a: (K.B)**
(A) Hormone (B) Antiseptic
(C) Antifungal (D) Sedative

**6. The enzymes that are used to cut the identified gene from the DNA of donor organism: (A.B)** **(LHR 2013)**
(A) Restriction endonucleases (B) Ligases
(C) Lipases (D) Amylases

**7. Diabetes is cured by: (K.B)**
(A) Human Growth Hormone (B) Insulin
(C) Glucagon (D) Parathormone

**8. A painkiller produced by brain: (U.B)** **(BWP 2014)**
(A) Thymosin (B) Beta-endorphin
(C) Insulin (D) Human Growth Hormone

**9. Beta endorphin, a pain killer, is produced by (A.B)**
(A) Liver (B) Kidney
(C) Brain (D) Pancreas

**10. How many sheep brains are required to produce 5 mg human growth hormone:(K.B)**
(A) 10,000 (B) 1,000
(C) 100,000 (D) 500,000

**11. Genetic engineers have developed plants that can fix _____ directly from the atmosphere such plants need less fertilizers. (K.B)**
(A) Carbon (B) Nitrogen
(C) Nitrous oxide (D) Carbon

**12. Interferon was produced in the genetically modified microorganisms, for first time in: (K.B)**
(A) 1981 (B) 1982
(C) 1980 (D) 1992

**13. E.coli bacterium was created that was capable of synthesizing the human growth hormone in: (K.B)**
(A) 1975 (B) 1976
(C) 1977 (D) 1981

**14. _____ are used to cut the identified gene from the total DNA of donor organism. (K.B)**
(A) Ligase (B) Endonucleases
(C) Restriction endonucleases (D) Urokinase

**15. Genetic engineering technique can also be used to cure: (A.B)**
(A) Blood pressure diseases (B) Blood diseases
(C) Respiratory disease (D) Heart diseases

**16. The enzyme which are used to dissolve blood clots is: (U.B)** **(GRW 2017)**
(A) Beta-endorphin (B) Thymosin
(C) Urokinase (D) Interferon

**17. The hormone which many prove effective against brain and lung cancer which is produced by genetically modified organism. (U.B)** **(GRW 2016)**
(A) Insulin (B) Thymosin
(C) Ligase (D) Urokinase

## 17.4 SINGLE-CELL PROTEIN

### LONG QUESTIONS

**Q.1 Write a note on single-cell protein. (K.B)** **(GRW 2015)**

**OR**

**What is single-cell proteins describe their importance. (K.B)** **(Understanding the Concept Q.5)**

**Ans:**

**SINGLE-CELL PROTEIN**

**Definition:**

**"**The **process** in which the **protein content extracted** from pure or **mixed cultures** of algae, yeasts, fungi or bacteria, is called **single-cell protein (SCP)**".

**Explanation:**

- It is known as **single-cell protein** because the microorganisms are used as producers are **unicellular** or **filamentous individuals**.
- The **microorganisms** are **grown** in fermenters where they **produce** a **high yield** of **protein**.
- This technique was introduced by Prof. **Scrimshow of Massachusetts Institute** of **Technology**.

**Substrates:**

For the **production** of single-cell proteins, the **microorganisms** are grown in fermenters.
These microorganisms **utilize** a **variety of substrates** like:

- **Agricultural wastes**
- **Industrial wastes**
- **Natural gas like methane**

**Growth of Microorganisms:**

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**.

**Need of (SCP):**

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).** 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.

**Substitute Food:**

Scientist and food technologists believe that **single-cell proteins** will **substitute** the other **protein-rich foods** in human and animal feeds.

**ADVANTAGES**

All scientists recognize the **significance** of the production of single-cell proteins.

**High Yield of Protein:**

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.

**High Vitamin Contents:**

When single-cell proteins are **produced** by **using yeasts**, the **products** also contain high **vitamin content**.

**Industrial Wastes:**

In the production of single- cell proteins, **industrial wastes** are used as **raw materials** for microorganisms. It helps in **controlling pollution**.

**Essential Amino Acids:**

The **use** of single-cell proteins has **good prospects** in future because they contain all **essential amino acids**.

**Seasonal Variations:**

The **production** of single-cell proteins is **independent** of **seasonal variations**.

**Limited Land Area:**

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

## 17.4 SHORT QUESTIONS

**Q.1 Define single-cell protein. (K.B)** **(GRW 2013, 16, DGK 2014, SWL 2015, LHR 2016)**

**OR**

**What is meant by single-cell protein?** **(LHR 2016)**

**Ans:** Page no 258.

**Q.2 What is mini food? (K.B)**

**Ans:** Page no 258.

**Q.3 What is the contribution of Prof. Scrimshow? (K.B)**

**Ans:**

**CONTRIBUTION OF PROF. SCRIMSHOW**

The concept of single-cell protein (SCP) was introduced by Prof. Scrimshow of Massachusetts Institute of Technology.

**Q.4 What are the advantages of single-cell protein? (A.B)**

**Ans:** Page no 259.

**Q.5 Name microorganisms which are used in single-cell protein. (K.B)**

**Ans:** Page no 258.

**Q.6 How the microorganisms produce cell protein? (A.B)** **(LHR 2017)**

**Ans:** Page no 258.

## 17.4 MULTIPLE CHOICE QUESTIONS

**1. How much yeast is required to produce 250 tons of protein in one day? (K.B)**

(A) 20 kg (B) 30 kg

(C) 40 kg (D) 50 kg

**2. The technique of single-cell protein was introduced by: (K.B)**

(A) Prof. Robert (B) Prof. Hudgson

(C) Prof. Scrimshow (D) Prof. Hook

**3. How much protein (dry weight) per acre per year is produced by algae grown in ponds? (K.B)**

(A) 20 tons (B) 25 tons

(C) 30 tons (D) 35 tons

**4. Microorganism grow very vigorously and produce a high yield of protein. The protein content produced by microorganism is: (K.B)**

(A) Novel protein (B) Mini food

(C) Single cell protein (D) All of these

**5. It is known as single-cell protein because the microorganism used as producers are: (U.B)**

(A) Unicellular (B) Filamentous individual

(C) Algae (D) Both A and B

**6. Single cell protein can be obtained from: (K.B)** **(LHR 2017)**

(A) Insect (B) Cow

(C) Bird (D) Algae

# ANSWER KEY

## MULTIPLE CHOICE QUESTIONS

## 17.1 IMPORTANCE OF BIOTECHNOLOGY

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | A | **2** | D | **3** | D | **4** | D | **5** | C | **6** | C |
| **7** | D | **8** | B | **9** | D | **10** | B | **11** | B | **12** | A |
| **13** | C | **14** | A | | | | | | | | |

## 17.2 FERMENTATION

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | C | **2** | A | **3** | C | **4** | D | **5** | D | **6** | B | **7** | A |
| **8** | B | **9** | B | **10** | C | **11** | C | **12** | A | **13** | B | 14 | B |
| **15** | D | **16** | B | **17** | C | **18** | B | **19** | A | **20** | C | | |

## 17.3 GENETIC ENGINEERING

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | A | **2** | D | **3** | D | **4** | D | **5** | A | **6** | A | **7** | B |
| **8** | B | **9** | C | **10** | D | **11** | B | **12** | C | **13** | C | **14** | C |
| **15** | B | **16** | C | **17** | B | | | | | | | | |

## 17.4 SINGLE CELL PROTEIN

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | D | **2** | C | **3** | A | **4** | D | **5** | D | **6** | D |

# REVIEW QUESTIONS

## MULTIPLE CHOICE QUESTIONS

**1. Find the correct match for the fermentation product and the organism involved. (K.B)**

(a) Formic acid – Saccharomyces (b) Ethanol - Saccharomyces

(c) Ethanol - Aspergillus (d) Glycerol - Aspergillus

**2. Which one is NOT an objective of genetic engineering? (U.B)**

(a) Production of cheese and yogurt by lactic acid bacteria

(b) Isolation of a particular gene or part of a gene

(c) Production of RNA and protein molecules

(d) Correction of genetic defects in higher organisms

**3. Which of these is an antiviral protein? (K.B)**

(a) Urokinase (b) Thymosin

(c) Insulin (d) Interferon

**4. The first step in genetic engineering is; (K.B)**

(a) Growth of the genetically modified organism

(b) Transfer of the Recombinant DNA into the host organism

(c) Isolation of the gene of interest

(d) lnsertion of a gene into a vector

## ANSWER KEY

| 1 | b | 2 | a | 3 | d | 4 | c |
|---|---|---|---|---|---|---|---|

## SHORT QUESTIONS

**1. How would you define fermentation with reference to biotechnology? (U.B)**

**Ans:**

**FERMENTATION**

**Definition:**

"In biotechnology the term "fermentation" means the production of any product by the mass culture of micro-organisms".

**2. Name any two industrial products made by fermentation. Also describe their uses in industry. (K.B)** **(GRW 2016)**

**Ans:**

**INDUSTRIAL PRODUCTS**

The industrial products made by fermentation are as follows:

| Industrial Products | Some Uses |
|---|---|
| Formic acid | • Textile dyeing<br>• Leather treatment<br>• Electroplating<br>• Rubber manufacture |
| Ethanol | • Used as solvent<br>• Production of vinegar<br>• Production of beverages. |

**3. What are the products of the two types of carbohydrates fermentation? (K.B)**

**Ans:** **CARBOHYDRATES FERMENTATION**

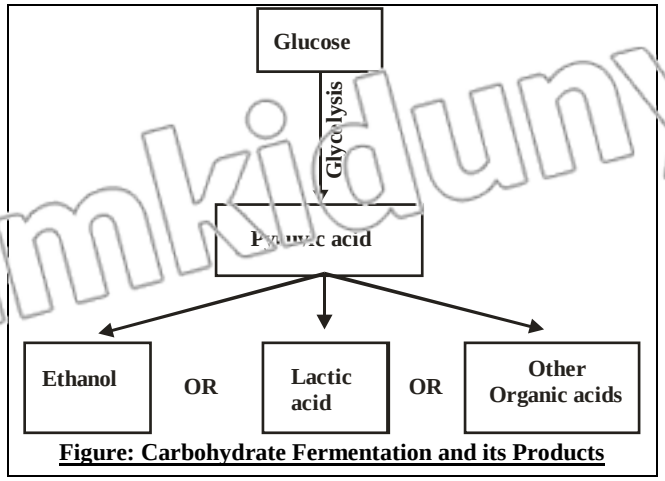



**Figure: Carbohydrate Fermentation and its Products**

**4. Give an example how biotechnology is helping for the better environment. (K.B)**

**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
- Biodiversity conservation

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

**Ans:** **GMO**

**Definition:**

"The organism in which DNA (gene) from some other organism has been transferred is called Genetically Modified Organism (GMO)".

**Example:**

Bacterium with human insulin gene is an example of Genetically Modified Organism (GMO).

**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).

## UNDERSTANDING THE CONCEPT

**1. Define biotechnology and describe its importance. (U.B)**

**Ans:** See LQ.1 (Topic 17.1)

**2. What is a fermenter? What are the two types of fermentation carried out in fermenters? (K.B)**

**Ans:** See LQ.3 (Topic 17.2)

**3. Describe the achievements of genetic engineering in medicine, agriculture and environment. (A.B)**

**Ans:** See LQ.2 (Topic 17.3)

**4. What basic steps a genetic engineer adopts during the manipulation of genes? (A.B)**

**Ans:** See LQ.3 (Topic 17.3)

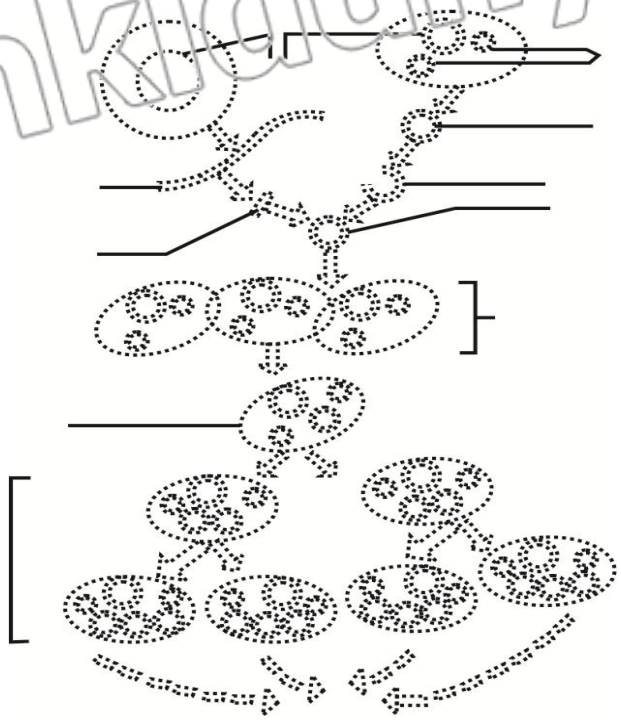
**5. What are single-cell proteins? Describe their importance. (A.B)**

**Ans:** See LQ.1 (Topic 17.4)

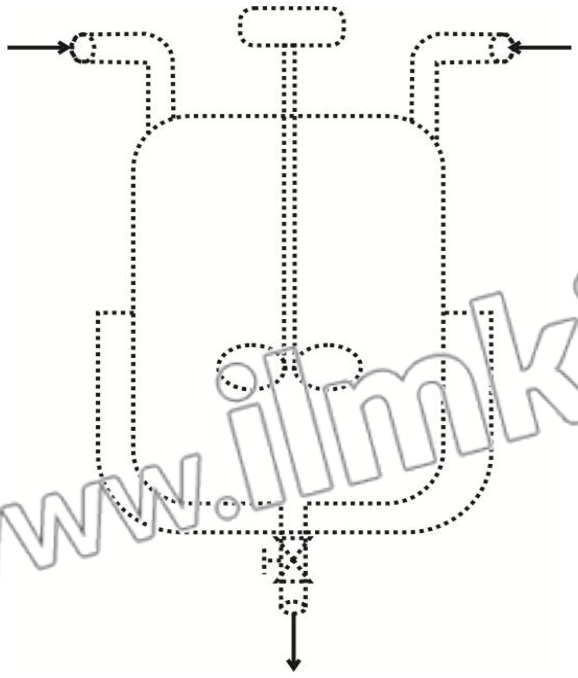
# ASSIGNMENT

## PRACTICE DIAGRAM AND LABEL

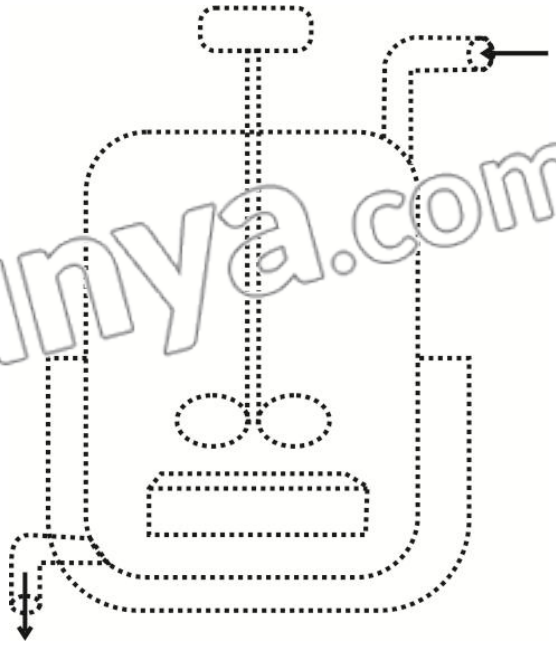
**PRODUCTION OF INSULIN THROUGH GENETIC ENGINEERING**



**BATCH FERMENTER**



**CONTTINUOUS FERMETER**



CUT HERE

## SELF TEST

**Time: 40 min** **Marks: 25**

**Q.1 Four possible answers A, B, C and D to each question are given, mark the correct answer. (6×1=6)**

**1. Insulin is effective against: (K.B)**

**(A)** Blood pressure **(B)** Heart diseases

**(C)** Nervous disorders **(D)** Diabetes mellitus

**2. Sheep Dolly was produced in: (K.B)**

**(A)** 1993 **(B)** 1995

**(C)** 1997 **(D)** 1999

**3. Microorganisms used in the manufacture of glycerol: (K.B)**

**(A)** Aspergillus **(B)** Saccharomyces

**(C)** Bacillus **(D)** Spirogyra

**4. A painkiller produced by brain: (A.B)**

**(A)** Thymosin **(B)** Beta-endorphin

**(C)** Insulin **(D)** Human growth hormone

**5. The technique of single-cell protein was introduced by: (K.B)**

**(A)** Prof. Robert **(B)** Prof. Hudgson

**(C)** Prof. Scrimshow **(D)** Prof. Hook

**6. How much protein (dry weight) per acre per year is produced by algae grown in ponds? (A.B)**

**(A)** 20 tons **(B)** 25 tons

**(C)** 30 tons **(D)** 35 tons

**Q.2 Give short answers to following questions. (5×2=10)**

**(i)** What is advantage of single-cell protein? **(A.B)**

**(ii)** What are mini food? **(K.B)**

**(iii)** What are beta-endorphin? **(K.B)**

**(iv)** Define fermenter? Give its types n ames. **(K.B)**

**(v)** What is human genome project? **(K.B)**

**Q.3 Answer the following questions in detail. (5+4=9)**

**(a)** What is a fermenter? Describe types of fermentation. What are the advantages of using fermenters? **(A.B)**

**(b)** What is genetic engineering? What are its objectives? **(A.B)**

**NOTE:** Parents or guardians can conduct this test in their supervision in order to check the skill of students.