# CHAPTER 8 Biotechnology

**Students Learning Outcomes:**

**After studying this chapter, students will be able to:**

- Introduce biotechnology.
- Explain the role of yeast in the production of bread and ethanol.
- Understand that bacteria are useful in biotechnology and genetic modification.
- Describe the basic method of genetic engineering/genetic modification.
- Discuss potential advantages and risks of genetic modification.

## Subjective Type Questions

Long Questions prepared in the light of new Examination Techniques
**(Knowledge, Understanding, Application, Analytical & Conceptual)**

### 8.1 Introduction of Biotechnology

**Q.1: Define Biotechnology. Write its brief introduction.**

**Ans. Biotechnology:**

In 1919, Hungarian engineer Karl Ereky, first proposed the term "biotechnology".

"The use of living cells or organisms to create products or processes for specific purposes."

**Role of this technology:**

- The hereditary characteristics of organisms are modified.
- New organisms with desired characters are developed from a cell or a part of an organism.
- Any required substance is produced from the modified organism.

Q. Who was the leader of the research group that Cloned Dolly?
Ans. Sir Ian Wilmut is a British embryologist. He was the leader of the research group that in 1997 first produced a mammal (a lamb named Dolly) from an adult body cell.

**Modern biotechnology:** Modern biotechnology emerged after the invention of the structure and function of DNA in 1953.

**Techniques used in biotechnology:** The techniques being used in modern biotechnology include fermentation, recombinant DNA technology, cell culture, gene editing, genetic engineering and tissue culturing etc.

**Q.2: Explain the role of yeast in the production of bread and ethanol.**

**Ans. Fermentation:**

Fermentation is the process where microbes break down substances to produce useful products.

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**Importance of yeast in Fermentation:** Yeast is a microscopic fungus that plays a crucial role in both bread making and ethanol production through a process called fermentation.

> **Q. What is the oldest from of Biotechnology?**
> **Ans.** Fermentation is the oldest form of biotechnology. It is used for making bread, beer, and yogurt thousands of years ago.

### Role in Bread Making

Yeast ferments the sugars present in the dough and produces carbon dioxide ($CO_2$) gas. This gas forms bubbles in the dough, causing it to rise and become soft and airy. The alcohol produced during this process evaporates during baking.

### Role in Ethanol Production

Yeast ferments sugars from crops like sugarcane or corn to produce ethanol (alcohol) and carbon dioxide. The ethanol is then purified and used as a biofuel or in alcoholic beverages.

**Q.3: Discuss the role of bacteria in biotechnology and in genetic modification.**

**Ans. Importance of bacteria in biotechnology:**

Bacteria are essential microorganisms used in biotechnology because they are simple, fast-growing and can easily accept new genetic material. Scientists use them for producing medicines, studying genes and creating genetically modified organisms (GMOs).

### Role in Biotechnology:

- Certain Bacteria Produce important substances like antibiotics (e.g., streptomyces produces streptomycin).
- Many bacteria produce enzymes which scientists use in making cheese and detergents.
- Many bacteria produce vitamins (like vitamin B12).
- Scientists use bacteria to clean up oil spills and waste through bioremediation.
- Lactobacillus bacteria help in making yogurt and cheese by fermenting milk.

### Role in Genetic Modification:

Scientists use special structures called plasmids (small loops of DNA found in bacteria) as carriers to introduce new genes into bacterial cells. In this way, the modified bacteria start producing proteins from that foreign gene. This method is used to produce:

- Human insulin for treating diabetes
- Human growth hormones for growth disorders.
- Vaccines against diseases.

Some bacteria are also used to introduce new genes into plant cells during the creation of genetically modified crops.

## 8.2 Genetic Engineering

**Q.4: Describe genetic engineering and gene editing.**

**Ans. Genetic engineering:**

Genetic engineering is defined as a process of altering (editing) the genes of

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organisms or transferring the genes from one organism into other organism.

- In genetic engineering, special enzymes are used to cut and attach DNA at specific locations. As a result of genetic engineering, Genetically Modified Organisms (GMOs) are produced.

**Gene Editing:** Gene editing is a technique where scientists make changes in the DNA (genes) of an organisms.

- These can involve adding, removing or replacing specific parts of DNA.

**Role of gene editing:** It allows scientists to add, delete or change parts of the DNA.

- It is done to correct genetic abnormalities and to improve characteristics.

**Q.5: Describe the advantages of gene editing.**

**Ans. Advantages of Gene editing:**

(i) **Curing Genetic diseases:** Scientists are researching how gene editing can cure diseases caused by abnormal genes.

**Examples:** Sickle cell anemia (a blood disorder), cystic fibrosis (a lung disease).

**Q. Why gene editing must be done very carefully?**
**Ans.** Gene editing is done very carefully because changes made to DNA can have unexpected effects.

(ii) **Improving Crops:** Gene editing can create crops that grow faster, resist pests and diseases, and survive droughts better.

**Examples:** Virus resist varities of tomato and tobacco have been developed. Modified varities of Soybeans, corn, tomato and cotton have been produced which show resistance against herbicides.

(iii) **Producing Better Medicines:** Gene editing helps create bacteria that produce important medicines.

**For Example:** Insulin is used for diabetes.

**Q.6: Define Gene Transfer. Enlist the steps for transferring a human gene into a bacterial cell.**

**Ans. Gene transfer:** A technique in which foreign genetic material is introduced into host cell to alter their genetic makeup.

**Vectors:** Genetic engineers use special vectors to transfer genes into an organism. The most commonly used vectors to transfer genes into bacteria are plasmids and bacteriophages.

**Plasmids:** Plasmids are small, circular DNA molecules present in some bacteria.

**Bacteriophages:** These are the viruses that can enter bacteria.

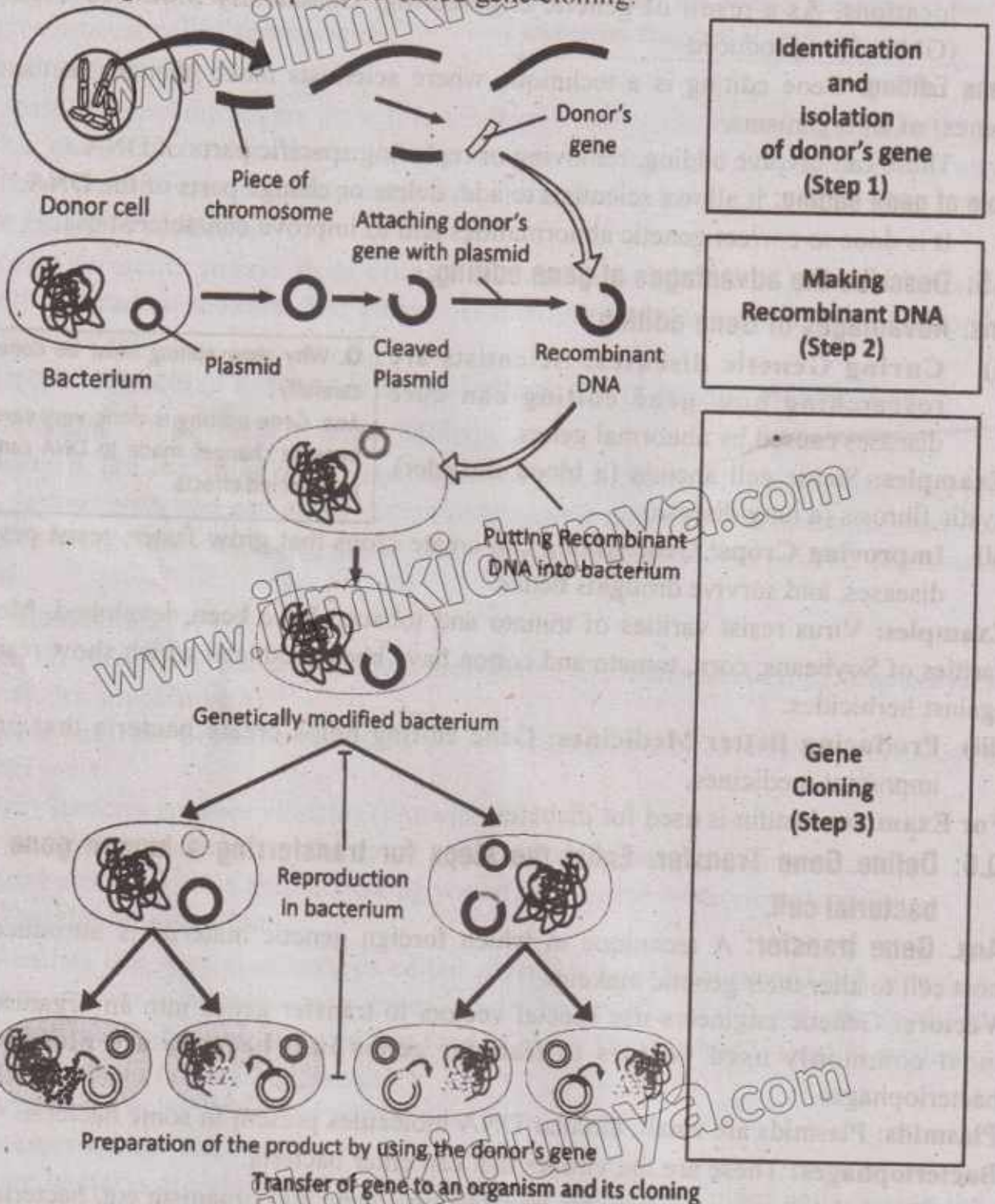
The following are the steps for transferring a gene into organism e.g. bacteria:

(i) The gene of donor organism is identified and isolated from its chromosome.

(ii) A plasmid is removed from a bacterial cell. The plasmid DNA is cut. Donor's gene is attached at the cut ends of the plasmid. The plasmid is now a combination of its original DNA and the new DNA (donor's gene). Now it is called recombinant DNA.

(iii) The recombinant DNA is transferred into a bacterial cell. When bacterial cell

reproduces to form a colony of cells, all genetically modified bacteria contain the recombinant DNA. In this way, the bacterial colony contains many copies of the donor's gene. This step is also called gene cloning.




**Q.7: Explain with examples how gene transfer is used to produce few useful substances?**

**Ans. Production of useful substances:**

(i) Human growth hormone is produced in genetically modified bacteria. It is used to treat dwarfism.

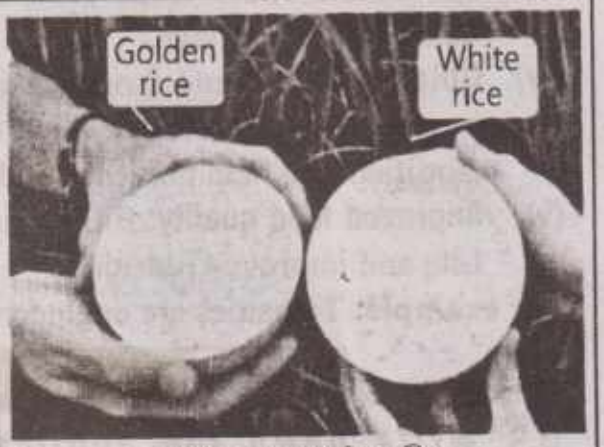
(ii) Interferon (anti-virus protein) is made in modified bacteria.

(iii) Vaccine against Hepatitis B virus has been produced from yeast through genetic modification.

**Q. How do some COVID-19 vaccines are prepared?**
**Ans.** Some COVID-19 vaccines are made by using mRNA. This mRNA carries instructions to make a harmless proteins of the corona virus, which trains the immune system to fight the real virus.

(iv) A gene from a bacterium is transferred into cotton and corn crops. The genetically modified crops then produce a natural toxin that kills insects but is safe for humans.

(v) Gene from a bacterium is transferred into rice plants. The rice produces beta-carotene, which the body converts into vitamin A. Such genetically modified rice help prevent blindness caused by vitamin A deficiency.



Golden rice & White rice

**Products made by using Gene Transfer**

| Product | Genetic Material Transferred | Organism or Technology Used | Purpose |
|---|---|---|---|
| **Insulin** | Human insulin gene | Bacteria | Treat diabetes |
| **Growth Hormone** | Human growth hormone gene | Bacteria | Treat growth disorders |
| **Interferon** | Human interferon gene | Bacteria | Treat viral infections and boost immunity |
| **Hepatitis B Vaccine** | Surface protein gene of Hepatitis B virus | Yeast cells | Protect against Hepatitis B |
| **Bt Crops** | Bt toxin gene | Cotton, Corn plants | Insect resistance |
| **Golden Rice** | Beta-carotene producing genes | Rice plants | Prevent vitamin A deficiency |

**Q.8: Explain with examples that food biotechnology has advanced agriculture.**

**Ans.** Food biotechnology has greatly improved agriculture by helping scientists develop crops that are more productive, nutritious. And resistant to diseases and pests. By using genetic engineering and modern techniques, farmers can grow better quality food with fewer losses.

(i) **Insect-resistant crops:** A gene for a bacterium is transferred into cotton and corn crops. The genetically modified crops then produce a natural toxin that kills insects

but is safe for humans.

This reduces the use of chemical pesticides and increases crop yield.

(ii) **Disease-resistant plants:** Some crops are genetically modified to resist viral or fungal diseases. This protects the plants and ensures better harvests.

(iii) **Drought-tolerant crops:** Biotechnology has helped develop plants that survive with less water. These crops grow well even in dry areas, helping formers in regions facing water shortage.

(iv) **Golden Rice:** Gene from a bacterium is transferred into rice plants. The rice produces bela-carotene, which the body converts into vitamin A. Such genetically modified rice help prevent blindness caused by vitamin A deficiency.

(v) **Improved food quality:** Biotechnology produces (SOP) with better taste, longer shelf Life and improved nutrition.

**For example:** Tomatoes are engineered to stay fresh longer.

## 8.3 Applications of Biotechnology

**Q.9: Write down the applications of biotechnology in medical field?**

**Ans. Medical Biotechnology:**

In medical field, biotechnology is helping in the following:

- Making proteins like hormones and enzymes used for treating various diseases.
- Developing vaccines to prevent viral and bacterial infections.
- Correcting defective genes responsible for genetic disorders.
- Production of targeted antibodies for disease diagnosis and treatment.
- Identifying inherited diseases and genetic conditions early.

**Q. What has research in Pakistan achieved regarding rice varieties?**
**Ans.** Research in Pakistan has led to the development of rice varieties that are resistant to certain diseases and pests.
**Q. Which technology is used in Pakistan for the mass propagation of fruit crops?**
**Ans.** Pakistan has also advanced in using tissue culture technology for the mass propagation of high-yielding fruit crops such as mangoes and citrus.
**Q. How many disorders are estimated to be caused by errors in genes?**
**Ans.** In humans, more than 3500 disorders are due to errors in genes. Biotechnologists are trying to remove such disorders through biotechnology.

**Q.10:Explain with examples that medical biotechnology has advanced health care in diabetes and cancer.**

**Ans.** Medical biotechnology has greatly improved healthcare by using genetic engineering and modern laboratory techniques to diagnose, treat and prevent diseases more effectively.

Two major examples are diabetes and cancer:

**(i) Diabetes:**

**Production of human insulin:** Scientists transfer the human insulin gene into

**Q. What did biologists discovered from the Human Genome Project?**
**Ans.** In Human Genome Project,biologists discovered the locations of all genes in human body. They also found the characteristics controlled by each gene.

bacteria. These genetically modified bacteria start producing pure human insulin. This insulin is collected purified and give to diabetic patients.

**(ii) Cancer:**

**Production of interferon's:** Genetically engineered cells produce interferons (anti-virus and anti-cancer proteins) which help the body detect and destroy cancer cells.

**Targeted therapies:**

Biotechnology helps create medicines that target only cancer cells without harming healthy cells.

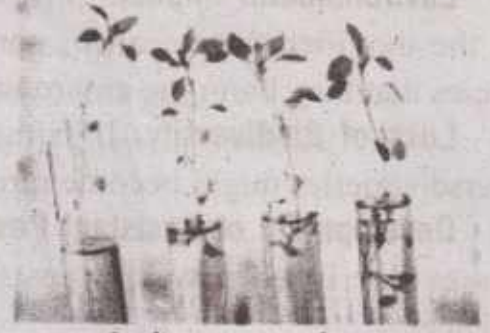
These biotechnology products have made disease management more effective, safer and more accessible for millions of patients.

**Q.11:How biotechnology is helpful in solving environment issues?**

**Ans. Bioremediation:**

Bioremediation is defined as the use of organisms such as bacteria, plants, or fungi to remove or neutralize pollutants from the environment. Genetically modified bacteria are used to break down the harmful chemicals present in waste matters and industrial discharge.

- Large number of saplings of different plants are produced through tissue culture. These saplings are planted to grow new forests in limited time.
- Modified bacteria are also used for extracting different minerals e.g., copper and uranium.
- Microbes such as bacteria, blue green algae and fungi are used to produce manure.



Saplings to grow forest

**Q.12:Write a note marine biotechnology.**

**Ans. Marine Biotechnology**

It deals with the marine organisms to develop new products, treatments, and technologies. For example:

- Genetic modifications in many fishes have led to faster growth rates.
- Compounds extracted from marine organisms (sponges, corals, and marine bacteria) are used to develop new cancer drugs, antibiotics and antiviral medicines.
- Certain marine bacteria are used to degrade oil spills, helping to clean up marine environments.
- Marine algae are cultivated in large quantities and processed into biodiesel, ethanol, and other types of renewable energy.
- Enzymes extracted from marine organisms are used in various industries. For example, an enzyme extracted from marine bacteria is used to produce high-fructose corn syrup (common sweetener in the food industry).

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**Q.13: Write down few applications of industrial biotechnology.**

**Ans.** The following are the main applications of industrial biotechnology.

- Biofuels like ethanol, biodiesel, and biogas are produced. For example, yeast is used to ferment sugars from crops (corn, sugarcane) into ethanol. This ethanol can be blended with petrol to produce a cleaner fuel.
- Biodegradable plastic (bioplastic) is produced from fermented plant starch (usually corn or sugarcane)?
- Pharmaceutical products are made through microbial fermentation and genetic engineering. For example, the production of antibiotics, such as penicillin, involves the fermentation of specific molds like "Pénicillium". Similarly, human insulin is produced through bacteria.

## 8.4 Potential Risks of Biotechnology

**Q.14: Discuss the potential risks of genetic modifications.**

**Ans.** Potential risks of genetic modifications are as follow:

**(i) Health Concerns:** Some people worry that consuming genetically modified foods could cause allergic reactions or long-term health problems. There is also concern that new genes might interact with human cells in unexpected ways.

**(ii) Environmental Impact:** GM plants can sometimes cross-pollinate with wild plants. So, the modified genes can be spread in natural ecosystems. It can lead to create such species that may harm the environment.

**(iii) Loss of Biodiversity:** If farmers mostly grow GM crops, traditional and naturally diverse varieties might become rare or extinct. This can reduce biodiversity.

**(iv) Development of Resistant Pests and Weeds:** Pests exposed repeatedly to GM crops may evolve into "powerful pests" that are no longer affected by the crop's built-in defences.

**(v) Ethical Issues:** Many people feel that it is morally wrong to alter the natural genes of living organisms.

# Objective Type Questions

## Additional MCQ's

Multiple Choice Questions prepared in the light of new Examination Techniques
**(Knowledge, Understanding, Application, Analytical & Conceptual)**

## 8.1 Introduction of Biotechnology

1. **Who is credited for first proposing the term "biotechnology" in 1919?**
   (a) Sir Ian Wilmut (b) Karl Ereky (c) James Watson (d) Francis Crick
2. **What major scientific breakthrough in 1953 paved the way for modern biotechnology?**
   (a) The cloning of Dolly sheep (b) The invention of the microscope

(c) The discovery of structure and function of DNA.
(d) The first successful use of fermentation in bread making.

3. **Which techniques are used in modern biotechnology?**
(a) Fermentation (b) Recombinant DNA technology
(c) Gene editing (d) All of these

4. **Sir Ian Wilmut is famous in the field of biotechnology for:**
(a) Discovering yeast
(b) Leading the team that produced Dolly sheep from an adult body cell.
(c) Inventing the process of ethanol production
(d) Proposing the term "biotechnology"

5. **Yeast plays a crucial role in:**
(a) Bread making (b) Ethanol Production
(c) Both a and b (d) None of these

6. **During the bread-making process, what causes the dough to rise and become soft?**
(a) Ethanol (b) Water (c) Carbon dioxide (d) Oxygen

7. **In the production of ethanol for biofules, yeast ferments sugars found in crops such as:**
(a) Wheat and barley (b) Sugarcane or corn
(c) Potatoes and rice (d) Soybeans and Oats

8. **Yeasts ferments sugars from crops like sugarcane or corn to produce**
(a) Ethanol (b) Carbon dioxide (c) Oxygen (d) Both a and b

9. **Essential tools in biotechnology are:**
(a) Viruses (b) Bacteria
(c) Fungi (d) Microorganisms

10. **Bacteria are used by the scientists for:**
(a) Producing medicines (b) Studying genes
(c) Creating (GMOs) (d) All of these

11. **Scientists use bacteria to clean up oil spills and waste through a process called.**
(a) Biofertilization (b) Bioaccumulation (c) Bioremediation (d) Biopesticides

12. **Which bacteria helps in making yogurt and cheese?**
(a) Streptomyces (b) Lactobacillus (c) Staphylococcus (d) Escherichia coli

13. **The special structures used to introduce new genes into bacterial cells:**
(a) Bacteriophage (b) Plasmids (c) Injections (d) Pills

14. **Human insulin is used for:**
(a) Cancer (b) Diabetes (c) Kidney failure (d) Pneumonia

15. **The oldest form of biotechnology is:**
(a) Cloning (b) Genetic engineering
(c) Gene editing (d) Fermentation

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16. **The process of altering (editing) the genes of organisms or transferring the genes from one organism into other organism is called:**
(a) Cloning (b) Genetic engineering
(c) Fermentation (d) Gene editing

17. **Gene editing involves:**
(a) Adding of DNA segment (b) Removing of DNA segment
(c) Replacing of DNA segment (d) All of these

18. **Which diseases can be cured by gene editing?**
(a) Anaemia (b) Cystic fibrosis (c) Malaria (d) Both a and b

19. **Which two vectors are most commonly used for transferring genes into bacteria?**
(a) Insulin and Growth Hormone (b) Plasmids and Bacteriophages
(c) Yeast and cotton (d) mRNA and Beta-carotene

20. **A small-circular DNA molecules present in some bacteria as:**
(a) Plasmid (b) Bacteriophage (c) Hormone (d) Vaccine

21. **When a donor gene is attached to the cut ends of a plasmid, the resulting combination is called:**
(a) Isolated DNA (b) Recombinant DNA
(c) Interferon (d) Bacteriophage DNA

22. **Which substance is produced in modified bacteria to help treat patients with dwarfism?**
(a) Insulin (b) Interferon
(c) Human growth hormone (d) Hepatitis B vaccine

23. **Human Insulin Gene was transferred into:**
(a) Algae (b) Virus (c) Bacteria (d) Yeast

24. **Interferon is a:**
(a) Anti-virus protein (b) Anti-bacterial protein
(c) Insect-killing (d) mRNA vaccines

25. **Which organism is used to produce human insulin through gene transfer?**
(a) Yeast cells (b) Rice Plants (c) Bacteria (d) Corn Plants

26. **The purpose of producing human growth hormone via biotechnology is to treat:**
(a) Diabetes (b) Growth disorders
(c) Viral Infections (d) Vitamin deficiency

27. **Which product is used to treat viral infections and boost immunity?**
(a) Insulin (b) Interferon (c) Bt toxin (d) Beta-carotene

28. **The primary purpose of Golden Rice is to prevent:**
(a) Diabetes (b) Vitamin deficiency
(c) Insect attacks (d) viral infection

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29. **"Surface protein gene of Hepatitis B virus" is transferred into yeast cells to create:**
(a) Growth hormones (b) Bt crops
(c) Hepatitis B vaccine (d) Golden rice

## 8.3 Applications of Biotechnology

30. **Which of the following is NOT a goal of food biotechnology?**
(a) Developing virus-resistant crops (b) Developing drought-resistance crops
(c) Developing pest-resistant crops
(d) Creating synthetic meat in laboratories

31. **Enzymes extracted from certain microbes are primarily used for?**
(a) Textile production (b) Production of alcohol
(c) Plastic manufacturing (d) Paper recycling

32. **Biotechnologists use proteins like hormones and enzymes to:**
(a) Sterlize medical equipment (b) Treat various diseases
(c) Create artificial limbs (d) Increase the shelf life

33. **There are how many disorders in humans due to errors in genes?**
(a) 1000 (b) 1500 (c) 2500 (d) 3500

34. **Biologists discovered the locations of all genes in human body by using:**
(a) Genetic engineering (b) Gene editing
(c) Gene therapy (d) Human Genome Project

35. **Which process utilizes microorganisms to degrade or detoxify environmental pollutants in soil or groundwater?**
(a) Bioaugmentation (b) Bioremediation
(c) Biomining (d) Biopharming

36. **Compounds extracted from marine organisms are used to develop:**
(a) Cancer drugs (b) Antibiotics (c) Antiviral medicines (d) All of these

37. **Which biofules are produced in industrial biotechnology?**
(a) Ethanol (b) Biodiesel (c) Biogas (d) All of these

38. **Pharmaceutical products are made through:**
(a) Bacterial fermentation (b) Microbial fermentation
(c) Fungal fermentation (d) Viral fermentation

### Answers

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (b) | 2. | (c) | 3. | (d) | 4. | (b) | 5. | (c) | 6. | (c) | 7. | (b) |
| 8. | (d) | 9. | (b) | 10. | (d) | 11. | (c) | 12. | (b) | 13. | (b) | 14. | (b) |
| 15. | (d) | 16. | (b) | 17. | (d) | 18. | (d) | 19. | (b) | 20. | (a) | 21. | (b) |
| 22. | (c) | 23. | (c) | 24. | (a) | 25. | (c) | 26. | (b) | 27. | (b) | 28. | (b) |
| 29. | (c) | 30. | (d) | 31. | (b) | 32. | (b) | 33. | (d) | 34. | (d) | 35. | (b) |
| 36. | (d) | 37. | (d) | 38. | (b) | | | | | | | | |

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# Additional Short Questions

Short Answer Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)

## 8.1 Introduction to Biotechnology

**1. Define biotechnology according to Karl Ereky.**

**Ans.** In 1919, Hungarian engineer Karl Ereky first proposed the term biotechnology. It may be defined as:
"The use of living cells or organisms to create products or processes for specific purposes."

**2. Which techniques are used in modern biotechnology?**

**Ans.** The techniques used in modern biotechnology include fermentation, recombinant DNA technology, cell culture, gene editing, genetic engineering and tissue culturing etc.

**3. Define fermentation. Write down its uses in biotechnology?**

**Ans. Fermentation:** Fermentation is the process where microbes break down substances to produce useful products.

**4. Discuss the role of yeast in making bread.**

**Ans.** Yeasts ferments the sugars present in the dough and produces carbon dioxide ($CO_2$) gas. This gas forms bubbles in the dough, causing it to rise and become soft and airy. The alcohol produced during this process evaporates during baking.

**5. How bacteria acts as essential tools in biotechnology?**

**Ans.** Bacteria acts as essential tools in biotechnology because they are simple, fast growing and can easily accept new genetic material. Scientists use them for producing medicines, studying genes and creating genetically modified organisms (GMOs).

**6. How bacteria are helpful in biotechnology?**

**Ans.** Bacteria are helpful in biotechnology as:

- Bacteria produce important substances like antibiotics.
- Bacteria produce enzymes which scientists use in making cheese and detergents.
- Many bacteria use vitamins (like vitamin B12).
- Lactobacillus bacteria help in making yogurt and cheese by fermenting milk.

**7. List three medical products that modified bacteria can produce.**

**Ans.** 1. Human insulin for treating diabetes.
2. Human growth hormones for growth disorders.
3. Vaccines against diseases.

## 8.2 Genetic Engineering

**8. What is gene editing and what is the primary purpose of this technique?**

**Ans. Gene editing:** Gene editing is a technique where scientists make changes in the DNA (genes) of an organism.

**Purpose of gene editing:** It allows scientists to add, delete or change parts of the

DNA to correct genetic abnormalities and to improve characteristics.

**9. Discuss any two applications of gene editing.**

**Ans. (i) Curing genetic diseases:** Scientists are researching how gene editing can cure diseases caused by abnormal genes such as sickle cell anaemia and cystic fibrosis.

**(ii) Improving Crops:** Gene editing can create crops that grow faster, resist pests and diseases and survive droughts better.

**10. Differentiate between plasmid and bacteriophage.**

**Ans. Plasmid:** Plasmids are small circular DNA molecules present in some bacteria.

**Bacteriophages:** Bacteriophages are the viruses that can enter bacteria.

**11. Write down any two examples (applications) of gene transfer.**

**Ans.** Examples of gene transfer are:

(i) The human insulin gene is transferred into a bacterium. The modified bacteria produce insulin, which is collected for treating diabetes patients.

(ii) Vaccine against Hepatitis B virus has been produced from yeast through genetic modifications.

**12. How golden rice are produced?**

**Ans.** Gene from a bacterium is transferred into rice plants. The rice produces beta-carotene which the body convert into vitamin A. Such genetically modified rice help prevent blindness caused by vitamin A deficiency.

## 8.3 Applications of Biotechnology

**13. Mention two ways biotechnology has improved crops.**

**Ans.** Biotechnology has improved crops by:

(i) Developing varities that are resistant to viruses, pests and drought.

(ii) Creating crops that grow faster than natural varities.

**14. Write two medical applications of biotechnology.**

**Ans.** In medical field biotechnology is helping in:

(i) Developing vaccine to prevent viral and bacterial infections.

(ii) Correcting defective genes responsible for genetic disorders.

**15. Define bioremediation.**

**Ans.** Bioremediation is defined as the use of organisms such as bacteria, plants and fungi to remove or neutralize pollutants from the environment.

**16. Write down two applications of marine biotechnology.**

**Ans.** Applications of marine biotechnology are as follows:

(i) Compounds extracted from marine organisms are used to develop new cancer drugs, antibiotics and antiviral medicines.

(ii) Marine algae are cultivated in large quantities and processed into biodiesel, ethanol and other types of renewable energy.

**17. State two industrial applications of biotechnology.**

**Ans.** Industrial applications of biotechnology are as follow:

(i) Biofules pike ethanol, biodiesel and biogas are produced. For example yeast is used to ferment sugars from crops into ethanol. This ethanol can be blended with petrol to produce a cleaner fuel.

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(ii) Biodegradable plastic (bioplastic) is produced from fermented plant starch (usually corn as sugarcane).

**18. Discuss any two potential risks of biotechnology.**

**Ans.** The potential risks of biotechnology are as follows:

**Health concerns:** Some people worry that consuming genetically modified foods could cause allergic reactions or long-term health problems. This is also concern that new genes might interact with human cells in unexpected ways.

**Loss of Biodiversity:** If farmers mostly grow GM Crops, traditional and naturally diverse varities might become rare or extinct. This can reduce biodiversity.

## Exercise Questions (Solved)

**A. Select the correct answers for the following questions.**

**1. Why are bacteria commonly used in genetic engineering for producing products?**

(a) They naturally produces the required products
(b) They grow quickly and accept human genes
(c) They resist all infections
(d) They have a human-like immune system

**2. In genetic engineering, the first step is:**

(a) Inserting DNA into the organism (b) Cutting the desired gene from DNA
(c) Growing the modified organism (d) Making proteins from the gene

**3. Which of these is often used as a vector in genetic engineering?**

(a) Virus (b) Fungi (c) Yeast (d) Blood cell

**4. In genetic engineering, the desired gene is usually inserted into a bacterium by using:**

(a) Protein (b) Another bacterium (c) Vector (d) Enzyme

**5. In genetic engineering, after inserting the gene, the host cell is allowed to:**

(a) Mutate randomly (b) Die naturally
(c) Multiply and express the gene (d) Produce waste

**6. In genetic engineering, "recombinant DNA" means:**

(a) Natural DNA (b) DNA copied by mistake
(c) DNAjoined from two sources (d) DNA destroyed by enzymes

**7. A gene for toxin production is inserted into a plant for:**

(a) Reducing water need (b) Increasing vitamin content
(c) Resisting insect attacks (d) Speeding up flowering

**8. Genetically modified bacteria produce the following products, except:**

(a) Hepatitis B vaccine (b) Growth hormone
(c) Insulin (d) Interferon

**9. Which biotechnology products help against viral infections?**

(a) Antibiotics (b) Vaccines (c) Clotting factors (d) Growth hormone

**10. Golden rice is a genetically modified plant to increase:**

(a) Protein (b) Vitamin A (c)Iron (d) Calcium

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**Answers**

| | | | | |
|---|---|---|---|---|
| 1. (b) | 2. (b) | 3. (a) | 4. (c) | 5. (c) |
| 6. (c) | 7. (c) | 8. (a) | 9. (b) | 10. (b) |

## B. Write short answers.

**1. What is the relation between biotechnology and genetic engineering?**

**Ans. Biotechnology:** Biotechnology is the use of living cells or organisms to create products or processes for specific purposes.

**Genetic engineering:** Genetic engineering is the process of altering (editing) the genes of organisms or transferring the genes from one organism into the other organism.

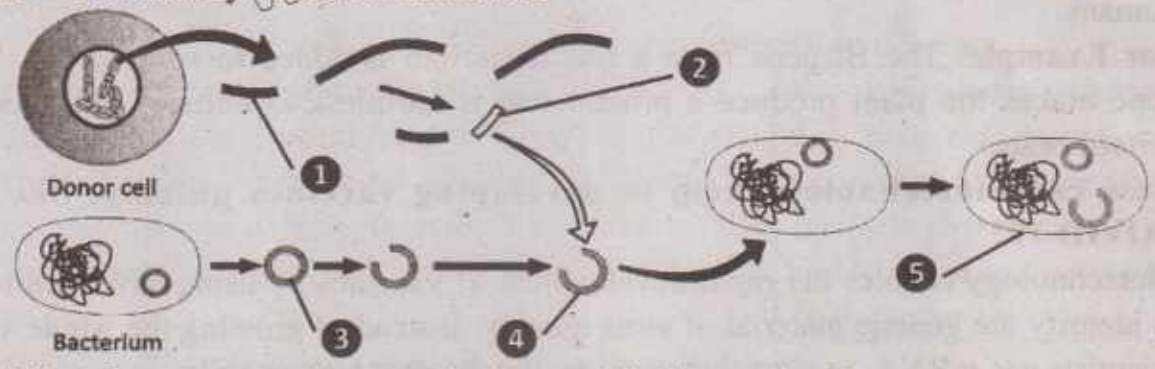
**Relation:** Biotechnology is a broad field that uses living organisms for useful purposes. Genetic engineering is a specific field of biotechnology that involves directly modifying DNA.

**2. What is a plasmid? Why biologists use plasmids in genetic engineering?**

**Ans. Plasmid:** Plasmids are small, circular DNA molecules present in some bacteria. Biologists use them as "carriers" or "vectors" to introduce new genes in bacterial cells.

**3. The following diagram shows how a gene is transferred to bacterial cell. Identify the structures labelled as 1 to 5.**

**Ans.** 1. Gene of interest
2. Donor's gene
3. Plasmid
4. Recombinant DNA
5. Genetically Modified baeterium




**4. What do you mean by genetically modified organism?**

**Ans.** Genetically modified organism whose DNA has been altered in a way that does not occur naturally by mating and natural recombination.

As a result of genetic engineering, Genetically Modified Organisms are produced.

**5. List two types of medical products that can be produced using genetic engineering.**

**Ans.** Two type of medical products that can be produced using genetic engineering are:

(i) **Human Insulin:** Used for the treatment of diabetes.

(ii) **Human Growth Hormone:** Used for treating growth disorders.

**6. List two ways by which genetic engineering may improve crops.**

**Ans.** The ways by which genetic engineering may improve crops are a:

(i) **Increasing growth rate:** Genetic engineering is used to create crops that grow

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faster than natural varities.

(ii) **Enhancing Resistance:** It allows scientists to develop crops that are more resistant to pests, viruses and environmental stressors.

## C. Write answers in detail.

**1. Explain with examples that food biotechnology has advanced agriculture.**

**Ans.** For answer See Q's 8

**2. Explain with examples that medical biotechnology has advanced healthcare in diabetes and cancer.**

**Ans.** For answer See Q's 10

**3. Explain the role of yeast in the production of bread and ethanol.**

**Ans.** For answer See Q's 2

**4. Enlist the steps for transferring a human gene into a bacterial cell.**

**Ans.** For answer See Q's 6

**5. Describe the advantages of gene editing.**

**Ans.** For answer See Q's 5

**6. Discuss the potential risks of genetic modification.**

**Ans.** For answer See Q's 14

## D. Inquisitive questions:

**1. How can inserting a gene into a plant make it pest-resistant?**

**Ans.** Inserting a gene into the plant's DNA allows the plant to produce substances that are harmful to produce substances that are harmful to certain insects but not for humans.

**For Example:** The Bt gene from a soil bacterium is added to some crops. This gene makes the plant produce a protein that is harmless to humans but toxic to certain pests.

**2. How can biotechnology help in developing vaccines quickly, like for COVID-19?**

**Ans.** Biotechnology enables the rapid development of vaccines by using advanced tools to identify the genetic material of virus quickly. Instead of growing the whole virus scientists use mRNA to carry instructions directly into human cells.

**For example:** In COVID-19 scientists use mRNA technology, where a small piece of virus's genetic code was needed to trigger immunity.

**3. Why is it important to carefully study the effects of genetically modified foods on health?**

**Ans.** It is crucial to study these foods carefully because the processes of gene editing involves making precise changes of an organisms DNA. Which can sometimes lead to unexpected or unintended effects. Scientists must ensure that the modifications do not create new allergens, toxins or reduce the nutritional value, ensuring they are safe for human consumption and the environment.

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