

CHAPTER – 1

An Introduction to Biotechnology

EXERCISES

2 Mark Questions

Q1: Define Biotechnology.

Answer: Biotechnology is the integration of biological processes and organisms with engineering principles to create products and services that improve human life.

Q2: Differentiate between traditional biotechnology and modern biotechnology.

Answer:

Traditional biotechnology: This refers to age-old practices that utilize biological processes through empirical knowledge, such as fermentation for food and beverages, or selective breeding in agriculture.

Modern biotechnology: This involves the application of scientific principles and advanced technologies like genetic engineering, recombinant DNA technology, and monoclonal antibody production to manipulate living organisms at the molecular level for new applications.

Q3: List three major branches of biotechnology.

Answer: White biotechnology: Focuses on applications in healthcare, pharmaceuticals, and diagnostics.

Red biotechnology: Deals with agricultural applications like genetically modified crops and biofertilizers.

Green biotechnology: Utilizes biological processes for environmental remediation and sustainability, such as bioremediation and biofuel production.

Q4: What are the key tools used in modern biotechnology?

Answer: Genetic engineering: Manipulating genes to alter or enhance desired traits in organisms.

Recombinant DNA technology: Combining DNA from different sources to create new genetic combinations.

Bioinformatics: Utilizing computational tools to analyze and manage biological data.

Nanobiotechnology: Combining biological molecules with nanomaterials for novel applications.

Q5: Describe two ethical concerns associated with biotechnology.

Answer:

Genetically modified organisms (GMOs): Potential risks to human health and the environment, as well as ethical concerns about modifying living organisms.

Biosecurity: Issues related to misuse of biological agents for bioterrorism or accidental release of harmful organisms.

4 Mark Questions

Q1: What do you understand by term “Biotechnology”? Explain with suitable examples.

Answer:

Biotechnology is a study of all applications of sciences. The word biotechnology is a combination of two words ‘bio’ and ‘technology’ in which bio means biological methods and processes, technology means methods , systems, and devices.

Biotechnology is a different technology which is useful for all living cells or molecules to generate useful products for the benefit of mankind. There are several

examples of biotechnology which are used to generate useful products. Biotechnology is from since a long it is practiced. The early example is fermentation technology which is to prepare bread, cheese and wine.

Q2: Give a comparative account of ancient and modern concept of biotechnology.

Answer:

Biotechnology is practiced since year's back which is used to generate useful products for benefit of mankind.

There are ancient methods of biotechnology and even modern methods of biotechnology. Greater efforts are made to utilise the traditional or ancient methods in biotechnology. Fermentation process is a ancient method which is a microbial method in which enzymatically controlled conversion of organic compounds occur. This method was practiced for years without any actual knowledge of the processes involved. In ancient method beer making bread making is included. The modern biotechnology includes identification of protein, isolation of gene for protein of interest genome. Modern biotechnology is based on the rDNA technology that has revolutionized biotechnology by allowing to scientists to cut and join DNA.

Q3: Explain the contribution of ancient biotechnology human welfare?

Answer:

Ancient biotechnology has taken root as early as in the Paleolithic era, around 10,000 years ago when early farmers began to cultivate crops such as wheat and barley. The most ancient or traditional method in biotechnology is fermentation. Fermentation was the most helpful for humans in making curd. Fermentation technology was used for production of beer, bread, cheese and wine. The relevance of traditional Indian knowledge in making dahi was indicated in few of patents found in the United States patent data base.

Q4: Discuss the role of bioinformatics in modern biotechnology research and development.

Answer:

Bioinformatics involves the use of computational tools and databases to analyze and manage biological data, such as DNA sequences, protein structures, and gene expression patterns.

It plays a crucial role in:

Genome sequencing and assembly: Reconstructing the complete DNA sequence of an organism.

Drug discovery and development: Identifying potential drug targets and designing new drugs.

Personalized medicine: Analyzing individual genetic variations to predict disease risk and tailor treatment strategies.

Understanding biological processes: Modeling and simulating cellular functions, identifying gene interactions.

Bioinformatics has revolutionized biotechnology research by speeding up data analysis, enabling large-scale comparisons, and providing valuable insights for further experimentation and development.

7 Mark Questions

Q1: Elaborate on the role of biotechnology with respect to the following:

Answer:

Biopharmaceutical production- In biotechnology pharmaceutical industry has very big role. The pharma industry comprises mainly vaccine manufacturing and its export in large quantities at international level. Biopharma company in the country which contributes to a large no. Of products related to pharmaceutical and other products.

Gene therapy and applications- Gene therapy is the technology which is used for the treatment of diseases caused by gene defects. The gene defects such as cystic fibrosis, thalassemia, Parkinson's disease etc. are cured by gene therapy. In gene therapy there is requirement of delivery of particular gene which is required to patient as a drug to treat the disease.

Abiotic stress resistance in crops- Abiotic stress resistance crops have resistance against chilling has been introduced into tobacco plants by introducing gene from glycerol-1-phosphate acyltransferase enzyme from Arabidopsis.

Crops with insect resistance- Crops with insect resistance can cause loss to the farmer. It results in devastating the financial loss of farmers and may lead to starvation in developing countries. Spraying chemical on crops lead to potential health hazards and also pollute the environment.

Environmental protection and conservation Biotechnological techniques and tools are also helpful for environmental protection. Biotechnological applications may also be helpful in the process of cleaning up the hazardous substances the environment by converting them into non-toxic or less toxic compounds.

Q2: Explain the significance of biotechnology in addressing global challenges like food security, climate change, and energy scarcity. Provide specific examples of how biotechnology is being used to tackle these issues.

Answer:

Food security: Developing drought-resistant and pest-resistant crops through genetic engineering can increase agricultural yields and reduce reliance on chemical fertilizers and pesticides. For example, Golden Rice enriched with Vitamin A combats malnutrition in developing countries.

Climate change: Microorganisms can be used for bioremediation of polluted soil and water, reducing greenhouse gas emissions. Additionally, biofuels derived from renewable sources like biomass offer a cleaner alternative to fossil fuels.

Energy scarcity: Biotechnology plays a role in developing efficient biofuels from algae and other bioresources, contributing to energy independence and sustainability. Research on microbial fuel cells also holds promise for generating electricity from organic waste.

Q3: Critically analyze the potential benefits and risks associated with the use of genetically modified organisms (GMOs) in agriculture. Discuss the regulatory frameworks and public perception surrounding GMOs.

Answer:

Benefits:

Increased crop yields and food security.

Reduced use of pesticides and herbicides.

Improved nutritional content of food.

Resistance to pests and diseases.

Risks:

Unforeseen consequences for human health and the environment.

Potential for gene transfer to wild relatives.

Increased dependence on large agribusinesses and loss of biodiversity.

Regulatory frameworks: Strict regulations aim to ensure the safety of GMOs through risk assessment and labeling requirements.

Public perception: Public opinion on GMOs varies widely, with concerns about safety, ethical implications, and corporate control influencing consumer choices. Open dialogue and scientific evidence-based decision making are crucial in addressing public concerns and shaping responsible GMO use.

Q4: Compare and contrast the approaches of traditional biotechnology and modern biotechnology in achieving desired outcomes. Provide specific examples.

Answer:**Traditional biotechnology:**

- Relies on empirical knowledge and natural processes like fermentation, selective breeding, and hybridization.
- Examples: Production of yogurt and cheese through bacterial fermentation, development of new crop varieties through cross-breeding.

- Advantages: Low-tech, often inexpensive, long history of safe use.
- Disadvantages: Time-consuming, limited control over outcomes, unpredictable variations.

Modern biotechnology:

- Utilizes advanced scientific techniques like genetic engineering, recombinant DNA technology, and bioinformatics.
- Examples: Production of insulin using recombinant bacteria, development of pest-resistant crops through gene editing.
- Advantages: Precise control over genetic modifications, faster development, potential for novel applications.
- Disadvantages: Requires sophisticated technology and expertise, higher costs, ethical concerns.

Fill in the Blanks

1. The integration of biological processes and organisms with engineering principles to create products and services that improve human life is known as _____.

Answer: Biotechnology

2. The age-old practices that utilize biological processes through empirical knowledge are referred to as _____ biotechnology.

Answer: Traditional

3. Modern biotechnology involves the application of scientific principles and advanced technologies like _____ and _____ to manipulate living organisms at the molecular level.

Answer: Genetic engineering, Recombinant DNA technology

4. The three major branches of biotechnology are _____ biotechnology, _____ biotechnology, and _____ biotechnology.

Answer: White, Red, Green

5. _____ is the process of manipulating genes to alter or enhance desired traits in organisms.

Answer: Genetic engineering

Multiple Choice Questions

1. Which of the following is NOT a major branch of biotechnology?

- (a) White biotechnology
- (b) Blue biotechnology
- (c) Red biotechnology
- (d) Green biotechnology

Answer: (b) Blue biotechnology

2. The key tool used in traditional biotechnology that relies on empirical knowledge is:

- (a) Genetic engineering
- (b) Recombinant DNA technology
- (c) Selective breeding
- (d) Bioinformatics

Answer: (c) Selective breeding

3. An ethical concern associated with genetically modified organisms (GMOs) is:

- (a) Increased crop yields

- (b) Reduced pesticide use
- (c) Unforeseen ecological consequences
- (d) Enhanced nutritional content

Answer: (c) Unforeseen ecological consequences

4. The discovery that revolutionized antibiotic therapy was made by:

- (a) Rosalind Franklin
- (b) Frederick Sanger
- (c) Alexander Fleming
- (d) Watson and Crick

Answer: (c) Alexander Fleming

5. The technology that combines DNA from different sources to create new genetic combinations is called:

- (a) Gene editing
- (b) Recombinant DNA technology
- (c) Bioremediation
- (d) Bioinformatics

Answer: (b) Recombinant DNA technology

6. Which of the following is NOT a potential application of modern biotechnology in medicine?

- (a) Development of personalized medicine

(b) Gene therapy for genetic diseases

(c) Production of vaccines

(d) Creation of artificial food

Answer: (d) Creation of artificial food

7. The field that utilizes computational tools to analyze and manage biological data is:

(a) Nanotechnology

(b) Bioinformatics

(c) Bioengineering

(d) Proteomics

Answer: (b) Bioinformatics

8. One of the challenges associated with biosecurity is the risk of:

(a) Accidental release of harmful organisms

(b) Overdependence on fossil fuels

(c) Loss of biodiversity

(d) Ethical concerns about human genetic engineering

Answer: (a) Accidental release of harmful organisms

SUMMARY:

Biotechnology isn't just science fiction; it's blending biology and engineering to make life better! Think medicines, super crops, and even cleaning up the environment – that's biotech's power.

White biotech tackles healthcare, from vaccines to personalized medicine. Red biotech focuses on agriculture, boosting crops and fighting pests. Green biotech champions sustainability, using microbes to clean up messes and create biofuels.

But how does it work? Genetic engineering and DNA mixing are like tiny Lego sets for building new biological wonders. And just like a computer needs software, bioinformatics crunches the data to make sense of it all.

This field has a rich history, from the discovery of penicillin to the mapping of our human blueprint. Today, it's all about CRISPR gene editing and creating sustainable solutions.

But hold on, there are wrinkles. Genetically modified foods raise concerns, and protecting biological resources and knowledge is crucial. We need to use this power wisely!

The future of biotech is bright. Imagine custom-made medicines, cleaner energy, and materials inspired by nature itself. But remember, with great power comes responsibility. Let's use biotechnology for the good of everyone, not just a few.

So, delve into the fascinating world of biotechnology and discover its potential to shape a healthier, greener tomorrow!