

CBSE Class 12 Biology Notes Chapter 12: These notes are very important for students preparing for their CBSE Class 12 board exams in Biology. Chapter 12 focuses on biotechnology and its applications, showing how living things and biological systems can help solve real-world problems. The information is presented in a simple way making it easier for students to understand complex ideas. By studying this chapter, students will learn about the many uses of biotechnology in areas like healthcare, farming, industry and environmental protection.

CBSE Class 12 Biology Notes Chapter 12 Biotechnology and its Applications Overview

These notes have been prepared by subject experts of Physics Wallah for CBSE Class 12 Biology Chapter 12 which focuses on biotechnology and its applications. The notes break down complex topics into simpler concepts making it easier for students to grasp important ideas and understand their real-world implications.

By using these notes students can enhance their understanding of biotechnology and its significance, preparing them effectively for their board exams and future studies in this dynamic field.

CBSE Class 12 Biology Notes Chapter 12 Biotechnology and its Applications PDF

The PDF link for the CBSE Class 12 Biology Notes on Chapter 12 Biotechnology and its Applications is available below.

These notes are an essential study help for students preparing for their board exams, ensuring they have a solid grasp of the material and its practical implications.

CBSE Class 12 Biology Notes Chapter 12 Biotechnology and its Applications PDF

CBSE Class 12 Biology Notes Chapter 12 Biotechnology and its Applications

Here we have provided CBSE Class 12 Biology Notes Chapter 12 Biotechnology and its Applications-

Biotechnology and its Applications

Biotechnology focuses on the large-scale production of biopharmaceuticals and biological products using genetically modified microorganisms, fungi, plants, and animals. Its applications are diverse, encompassing therapeutics, diagnostics, genetically modified crops for agriculture, processed foods, bioremediation, waste treatment and energy production.

The three critical research areas in biotechnology include providing effective catalysts through improved organisms like microbes or pure enzymes; engineering optimal conditions to enhance the activity of these catalysts; and developing downstream processing technologies to purify proteins or organic compounds. These areas are important for advancing the field and ensuring that biotechnological processes are efficient and effective.

Biotechnological Applications in Agriculture

Biotechnological applications in agriculture can significantly enhance food production through various approaches:

1. **Agrochemical-Based Agriculture:** This traditional method utilizes chemicals such as fertilizers and pesticides to boost crop yields.
2. **Organic Agriculture:** Focused on sustainable practices, organic farming avoids synthetic chemicals and emphasizes natural growth processes.
3. **Genetically Engineered Crop-Based Agriculture:** This modern approach involves the use of genetically modified organisms (GMOs), which are plants, bacteria, fungi and animals whose genes have been altered through genetic engineering.

The Green Revolution successfully increased food production by implementing better management practices and using agrochemicals. However further increases in production using these methods have limitations. To address this GM crops are developed to have various beneficial traits, such as:

- Increased tolerance to abiotic stresses like drought and salinity.
- Reduced reliance on chemical pesticides, lowering environmental impact.
- Decreased post-harvest losses due to improved shelf life and resistance to spoilage.
- Enhanced efficiency of mineral usage, allowing plants to better absorb nutrients.
- Improved nutritional value of food, exemplified by Vitamin A-enriched rice, which addresses micronutrient deficiencies in populations reliant on rice as a staple.

Application of Biotechnology in the Production of Pest-Resistant Plants

Biotechnology plays a crucial role in developing pest-resistant plants, significantly reducing the need for chemical pesticides. One of the most notable examples is the use of **Bt toxin**, derived from the bacterium *Bacillus thuringiensis*. This bacterium produces proteins toxic to certain insects, which have been genetically cloned and expressed in various plants, creating a natural bio-pesticide. Examples of pest-resistant crops include **Bt cotton, Bt corn, rice, tomatoes, potatoes and soybeans**.

Bt Cotton is a prominent case, where *Bacillus thuringiensis* produces proteins that target specific insects such as lepidopterans (e.g., moths) and coleopterans (e.g., beetles). The bacterium forms crystals containing inactive protoxins. When an insect ingests these protoxins, the alkaline pH of its gut activates the toxins, which then bind to the midgut epithelial cells, creating pores that lead to cell swelling, lysis, and ultimately, the insect's death. The relevant genes in *B. thuringiensis* responsible for producing these toxins are known as the **cry genes**. For example, *cryIAb* and *cryIIAb* specifically control cotton bollworms, while *cryIAb* targets corn borers.

Another significant advancement in pest resistance is the application of **RNA interference (RNAi)** technology, particularly for controlling nematodes like *Meloidogyne incognita*, which damage tobacco plant roots and reduce yield. RNAi is a natural cellular defense mechanism present in all eukaryotic organisms, allowing for the silencing of specific mRNA to prevent protein translation. By introducing nematode-specific genes into host plants using *Agrobacterium* vectors, scientists can create transgenic plants that express interfering RNA. This results in the inability of nematodes to survive in these genetically modified plants, thus protecting crops and enhancing yields.

Through these innovative applications, biotechnology significantly contributes to sustainable agricultural practices by producing pest-resistant plants that help reduce pesticide usage while ensuring higher crop yields.

Biotechnological Applications in Medicine

Biotechnology, particularly through recombinant DNA (rDNA) technology, has profoundly transformed the healthcare sector by enabling the mass production of safe and effective therapeutic drugs. Currently, around **30 recombinant therapeutics** have been approved for human use globally, with **12 of these** available in India. This advancement has made significant strides in treating various diseases, including diabetes and genetic disorders.

Genetically Engineered Insulin

For individuals with adult-onset diabetes, regular insulin administration is crucial for managing blood sugar levels. Historically, insulin was derived from the pancreases of slaughtered cattle and pigs. However, this method often led to allergic reactions due to the foreign proteins present in animal-derived insulin. Modern biotechnology has revolutionized this process by allowing insulin to be produced from bacteria, specifically *E. coli*.

In this process, the insulin hormone consists of two polypeptide chains **Chain A and Chain B** linked by disulfide bridges. In humans, insulin is initially synthesized as a prohormone, which includes an additional segment called the **C peptide** that is absent in mature insulin. The key challenge in producing insulin via rDNA technology was to ensure it assembled into its mature form. In 1983, the American company **Eli Lilly** successfully synthesized two DNA sequences corresponding to the A and B chains of human insulin. These sequences were introduced into plasmids of *E. coli*, allowing the bacteria to produce the respective chains. After extraction,

Chains A and B were combined through the formation of disulfide bonds to yield functional human insulin.

Gene Therapy

Gene therapy represents a groundbreaking approach to correcting genetic defects in individuals with hereditary diseases. This technique involves delivering a normal gene into a person's cells and tissues to compensate for a non-functional gene. The first successful clinical gene therapy was conducted in **1990** on a 4-year-old girl suffering from **adenosine deaminase (ADA) deficiency**, a condition caused by the absence of the ADA gene crucial for immune system function.

In gene therapy, lymphocytes (a type of white blood cell) are extracted from the patient's blood and cultured outside the body. A functional ADA complementary DNA (cDNA) is introduced into these lymphocytes before they are reintroduced into the patient. Although this method requires periodic infusions of genetically engineered lymphocytes, a more permanent solution involves introducing the functional ADA gene into bone marrow cells at early embryonic stages. This could provide a lasting cure for ADA deficiency, demonstrating the potential of gene therapy in treating genetic disorders.

Molecular Diagnosis

Molecular diagnosis has revolutionized the way diseases are detected, especially when compared to conventional methods like serum or urine analysis. Traditional diagnostic techniques often fail to detect pathogens or viruses early enough, leading to delayed treatment. To overcome these limitations, several advanced methods have been developed for earlier and more accurate diagnosis of infectious diseases and genetic disorders.

Key Techniques in Molecular Diagnosis

1. **Recombinant DNA Technology:** This technique allows for the manipulation and analysis of DNA, facilitating the identification of specific genetic sequences associated with diseases. It enables the production of DNA probes that can hybridize with complementary sequences in samples, aiding in the detection of pathogens or mutations.
2. **Polymerase Chain Reaction (PCR):** PCR is a powerful method that amplifies small quantities of nucleic acids, allowing for the detection of low concentrations of bacteria and viruses. This technique is particularly valuable for identifying pathogens before symptoms manifest, as it can amplify specific DNA or RNA sequences even when they are present in minute amounts. PCR is routinely used in oncology to detect mutations in cancer-related genes and is crucial for diagnosing HIV in suspected AIDS patients.
3. **Enzyme Linked Immuno-sorbent Assay (ELISA):** ELISA is based on the principle of antigen-antibody interactions. It can detect the presence of pathogens by identifying antigens (such as proteins or glycoproteins) or antibodies generated in response to

infections. This method is highly sensitive and widely used for screening various infections, including HIV, hepatitis, and other viral diseases.

Applications and Advantages

The use of PCR allows for the early detection of pathogens, often before clinical symptoms become evident, which is crucial for effective treatment. Furthermore, genetic disorders can be diagnosed at an early stage, enabling timely interventions.

Transgenic Animals

Transgenic animals are those whose DNA has been modified to include and express foreign genes. These genetically altered animals—such as mice, rats, rabbits, pigs, sheep, cows, and fish—serve various purposes in research and biotechnology. Here are some common reasons for the development of transgenic animals:

Applications of Transgenic Animals

1. **Normal Physiology and Development:** Transgenic animals are used to study gene regulation and its effects on normal body functions. By introducing foreign genes, researchers can observe how these genes influence physiological processes and developmental pathways.
2. **Study of Disease:** Transgenic models are created to better understand how specific genes contribute to diseases such as cancer, cystic fibrosis, and Alzheimer's disease. These models help in investigating disease mechanisms and testing potential treatments.
3. **Biological Products:** Certain transgenic animals are engineered to produce valuable biological products. For instance, the introduction of a specific gene can enable animals to produce human proteins like alpha-1-antitrypsin, which is used in treating conditions such as emphysema. Rosie, the first transgenic cow, produced milk enriched with human protein (alpha-lactalbumin).
4. **Vaccine Safety:** Transgenic mice are often used in vaccine testing to assess safety before human trials. The polio vaccine, for example, was initially tested on transgenic mice to evaluate its safety profile.
5. **Chemical Safety Testing:** Transgenic animals can be engineered to be more sensitive to toxic substances. This enhances the ability to test chemicals' safety quickly and effectively, providing results faster than traditional methods.

Ethical Considerations

The development and use of transgenic animals raise various ethical issues. In India, the Genetic Engineering Approval Committee (GEAC) has been established to oversee GM research's validity and the safety of introducing genetically modified organisms (GMOs) for public use.

Biopatents: A patent grants the inventor exclusive rights to prevent others from commercially using their invention. This includes biological entities and products derived from biological resources.

Biopiracy: This term refers to the unauthorized use of bio-resources by multinational companies without compensatory payment to the originating countries or communities. For instance, in 1997, an American company obtained patent rights on Basmati rice, claiming it as a new variety despite it being derived from Indian farmer varieties. Similar attempts have been made to patent traditional herbal medicines like turmeric and neem, raising concerns about the exploitation of indigenous knowledge and resources.

Benefits of CBSE Class 12 Biology Notes Chapter 12

- **Comprehensive Understanding:** The notes provide a thorough overview of biotechnology, including its principles, techniques and applications. This helps students grasp complex concepts in a simplified manner.
- **Clarity on Key Topics:** By breaking down important topics like genetic engineering, molecular diagnosis and transgenic organisms, the notes clarify important processes and terms, aiding in better retention.
- **Preparation for Exams:** These notes are an effective study guide, helping students review crucial content quickly and efficiently which is important for board exam preparation.
- **Real-World Applications:** The notes highlight the practical applications of biotechnology in fields like medicine, agriculture and environmental science, showing students the relevance of their studies in real-life scenarios.