Step 8 Innovations and applications

Here is a review of the main concepts of this step!

1 How biotechnology improves our lives

Biotechnology utilizes living organisms to develop products and solutions that benefit human health and society. Originally coined in 1919, the field encompasses a wide range of applications beyond genetic engineering, including agriculture, medicine, food processing, energy production, and forensics. Significant milestones include the development of antibiotics during World War II and the commercialization of genetically engineered insulin in the 1980s. Today, biotechnology continues to advance with applications in DNA fingerprinting for forensics and the production of pest-resistant crops, demonstrating its diverse and significant impact across various industries.

2 Genetic engineering

Genetic engineering, also known as genetic modification, involves artificially altering an organism's genome to introduce new traits or functions. This process utilizes recombinant DNA (rdna) technology to create genetically modified organisms (GMOS). Initially developed in the 1970s with bacteria and mice, genetic engineering significantly expanded with the completion of the Human Genome Project in 2003, which mapped all human genes.

Applications of genetic engineering include biotechnologically produced drugs, gene therapy for curing genetic disorders, and innovations in agriculture and animal breeding. Despite its benefits, genetic engineering is contentious due to ethical concerns raised by various groups regarding moral implications and potential risks. However, it has also enabled significant advancements such as the development of safe and effective vaccines against diseases like SARS-COV-2 in 2021, demonstrating its potential to address global health challenges. Governments regulate genetic engineering through legislation to manage its ethical and practical implications.

3 Cloning

Technology is used to generate embryonic stem cells, crucial for studying human development and treating various diseases by replacing or repairing damaged tissues and organs. Reproductive cloning, achieved through Somatic Cell Nuclear Transfer (SCNT), involves transferring the nucleus of a somatic cell from an adult animal into an egg cell devoid of its nucleus. This process allows the egg cell to develop into an embryo, which is then implanted into a surrogate female host and develops into a genetically identical animal, known as a clone. Reproductive cloning holds potential for advancing medicine, agriculture, and conservation efforts, but it is costly, inefficient, and associated with health risks in cloned animals such as abnormal birth sizes, organ complications, and increased susceptibility to infections and tumors.

4 Agritech

Agritech, or agricultural biotechnology, encompasses processes and tools used to manipulate the genetic makeup of organisms involved in food production. Biotechnology in agriculture aims to enhance crop quality, yield size, and resilience to environmental stresses like drought and pests. Genetic modifications also reduce dependence on agrochemicals by introducing traits such as herbicide and pesticide resistance in crops like soybean, maize, rapeseed, and cotton. Despite benefits like increased productivity, GMO crops face scrutiny for potential long-term environmental impacts and risks to biodiversity. Different global regions adopt varying regulatory approaches, with the EU maintaining stringent rules while the US has more lenient regulations. This diversity reflects ongoing debates over the advantages and disadvantages of GMO crops in food production and environmental mamagement.

5 Biotechnology and health

Medical biotechnology uses living cells and biological materials to create new medicines and tools that help treat and prevent human diseases. Researchers in this field work in labs at universities and companies. In labs, scientists do experiments to study diseases, while in companies, biotechnologists focus on solving medical problems to make new drugs and treatments.

One important part of medical biotechnology is biopharmaceuticals. These are different from regular medicines because they come from biological sources like proteins and cells. Biopharmaceuticals target specific parts of diseases in the body, which helps treat illnesses like arthritis, hepatitis, and cancer. They also include insulin made through genetic technology to treat diabetes.

Scientists are also using genetic research to find cures for diseases like Parkinson's and Alzheimer's. Medical biotechnology is growing because more people need new medicines, especially as populations age.

6 Regenerative medicine

Regenerative medicine focuses on tissue engineering and uses cells, materials, and biochemical factors to enhance or replace biological tissues. It aims to improve life for an aging population by creating new organs like livers and kidneys. Challenges include ensuring new tissues get enough blood supply to function properly inside the body. Tissue engineering has already succeeded in clinical use for bone grafts and reconstructing skull and facial bones. At Oxford University, scientists have developed synthetic tissues that mimic nervous system signaling using light. This innovative technology combines 3D printing and complex chemistry to create tiny synthetic cells capable of biological activities, controlled by light.