

Role of Biotechnology Revolution in Genetic Engineering Transformed Drug Development

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DESCRIPTION

The field of drug discovery has been at the forefront of medical advancements, revolutionizing the treatment of diseases and improving the quality of human life. From ancient herbal remedies to sophisticated biotechnological methods, drug discovery has come a long way. The interest for finding effective remedies dates back thousands of years. Early civilizations relied on herbal medicine, utilizing plants and natural substances to treat various ailments. The ancient Egyptians, Greeks, and Chinese were pioneers in documenting their medicinal knowledge, which laid the groundwork for drug discovery as we know it today. The 19th and 20th centuries marked a turning point in drug discovery. The isolation of active compounds from plants and the development of chemical synthesis techniques opened new avenues for researchers. The discovery of aspirin, the first synthetic drug, in the late 1800s, became a milestone in medical history, inspiring scientists to delve deeper into the world of pharmacology. With advancements in molecular biology and genetics, the focus of drug discovery shifted to a more targeted approach. Understanding the biological mechanisms behind diseases allowed researchers to identify specific molecular targets for drug intervention. This led to the development of highly effective drugs that could selectively act on disease-causing molecules, minimizing side effects and enhancing therapeutic outcomes. As technology progressed, high-throughput screening emerged as a powerful tool in drug discovery. This method involves testing thousands of compounds against specific biological targets in a short period. Automated systems and robotics made it possible to analyze vast chemical libraries, accelerating the process of identifying potential drug candidates. Combinatorial chemistry further expedited drug discovery by generating large libraries of diverse chemical compounds. These libraries provided a plethora of molecules to test against various targets, increasing the chances of finding potent drugs. Rational drug design comple-

mented combinatorial chemistry by employing computational tools to predict the interaction between drugs and targets. This approach significantly reduced the trial and error process and guided researchers in designing more effective and selective drugs. The advent of biotechnology brought about a new era in drug discovery. Recombinant DNA technology allowed the production of therapeutic proteins, such as insulin and growth hormones, on a large scale. Monoclonal antibodies, produced through hybridoma technology, proved invaluable in treating cancer and autoimmune diseases. The completion of the Human Genome Project ushered in a new era of genomics-driven drug discovery. Understanding the genetic basis of diseases enabled researchers to identify disease-associated genes and proteins as potential drug targets. Additionally, personalized medicine emerged as a significant approach, treatments to an individual's unique genetic makeup for better efficacy and safety. While modern drug discovery has heavily relied on synthetic compounds, natural products continue to play a vital role in medicine. Ethnobotany, the study of traditional plant-based remedies used by indigenous communities, has unveiled a rich source of bioactive compounds. By collaborating with local communities, scientists have discovered leads for new drugs in nature's pharmacy. Despite the remarkable progress in drug discovery, researchers face several challenges. Drug development is a costly and time-consuming process, with many potential candidates failing during preclinical and clinical trials. Safety concerns, lack of efficacy, and unexpected side effects are common obstacles that must be overcome. As technology continues to advance, drug discovery is set to undergo further transformation. Artificial intelligence and machine learning algorithms are becoming integral to drug design, enabling researchers to predict drug-target interactions more accurately. Organ-on-a-chip technology and 3D bioprinting offer new opportunities to study drug effects in a more physiologically relevant context.