

2024 NJABR Middle School Essay Contest

2nd Place

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The Lifeblood of Medicine

Biomedical Research stands as the cornerstone of modern medicine, a tireless pursuit of knowledge aimed at understanding, preventing, and treating diseases. Through meticulous experimentation and collaboration, biomedical researchers strive to unravel the complexities of living organisms and the underlying mechanisms of disease (MDIS, 2023).

The biomedical research process can be broadly divided into three major categories: basic, clinical and applied research (Bridging). First, basic research focuses on gaining fundamental knowledge and building the groundwork for future advancements. Second, clinical research can be defined as studies which involve trials of potential drugs or therapies in cell culture and animal models. Third, applied research involves regulatory agencies which review the data and methods from the clinical research trials to ensure safety and approve the new treatment for public use (Duijnhoven et al., 2013).

Animal models play a critical role in biomedical research, particularly in acting as bridges between the controlled environment of cell cultures and the complex ecosystems of human disease (Barré-Sinoussi, 2015). Potential medications and therapies can be tested on animal models before trials on humans, and can also be used to develop surgical techniques and understand human biology.

Many animals, particularly mammals like rodents and primates, share similar organ systems, cellular processes, and basic biological functions with humans. Animals and humans share many genetic similarities as well, particularly allowing researchers to mimic human diseases caused by genetic mutations (The Role). Despite the similarities of human and animal models, there are also major differences that researchers take into account. For example, drugs that are safe and effective in animals can have unknown and unintended consequences on humans. Due to biological differences, treatments and medications that seem to show promise in animal models may not translate directly to humans (Problems 2024).

In biomedical research, varieties of animal sources and species are used, each of them with different advantages and applications. Some species of animal models are bred in designated laboratory facilities, while other species are supplied by commercial enterprises (Animal Testing). The majority of model species are rodents, followed by zebra-fish, non-human primates and other mammals. Rodents are most commonly used because of their small size and ease of breeding, relatively short lifespans, and well understood biological information (Bryda, 2013).

Animal research is framed by a complex set of regulations designed to ensure the ethical and humane treatment of animals in laboratory environments. Federal policies such as the Animal Welfare Act (AWA) and the Public Health Service Policy (PHS) help to govern the treatment of animals in biomedical research. In addition, certain legal associations such as the Institutional Animal Care and Use Committee (IACUC) and the US Department of Agriculture (USDA) enforce these regulations upon laboratories conducting biomedical research.

As scientific understanding and technology progress, researchers are developing alternatives to animal models to increase accuracy and raise ethical standards. “In silico” methods can use sophisticated digital programming to predict how medications might interact with organ systems and diseases (Digisamaksh, 2023). “In vitro” tests using 3D tissue cultures and organ-chip technology can provide miniature, functional models of complex organs or tissues, creating a more human-relevant model for biomedical research (Vuksanaj, 2024). In addition to “in silico” and “in vitro” methods, researchers can also use technologies like MRI and PET scans to study the human anatomy and physiology “in vivo” with no harm to the participant (Rosenbloom, 2008).

Epidemiological studies can be described as the detective workhouse of public health, (Frérot et al., 2018). These studies outline who is getting sick, what diseases are occurring, where diseases are happening, and when and why these diseases occur. For example, epidemiological research was crucial in the identification of the Covid-19 pandemic (Bayly et al., 2024). Overall, epidemiological studies are foundational to evidence-based public health procedures.

The ethics of human experimentation in biomedical research encompasses an imperative need for the safety and well-being of its research participants. A few important principles include informed consent, risk-benefit ratio, justice, confidentiality and consideration of vulnerable populations (Office, 2022).

Biomedical research boasts a remarkable track record, transforming the landscape of human health (Science 2021). A few significant triumphs include the Eradication of Smallpox, the Control of Infectious Diseases, and Antibiotics and Antiviral Treatments. Advancements in immunosuppressive medications and surgical techniques have increased transplant success rates and patient survival (DL, K).

The future of biomedicine is brimming with possibilities and offers exciting avenues for tackling complex diseases and improving healthcare. By continuing to invest in research and fostering collaboration, we can unlock the doors to a healthier future for generations to come.

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