

2021 PSBR 7th & 8th Grade Essay Contest
First Place

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Discoveries and inventions in the field of biomedical sciences have heralded our world into a new age. We have conquered diseases and conditions in humans and animals with the discovery of antibiotics, medical devices, and vaccines. Encapsulating numerous subdisciplines, biomedical research can be defined as “the investigation into materials and sources to find new information or reach new conclusions about the prevention and treatment of diseases that cause illnesses and death in people and animals”.^{1,2} Depending on the type of investigation, biomedical research can be classified into three types: basic, applied, and clinical.

Basic research increases our understanding and provides new information about a subject in the field of biomedical sciences. An example of basic research is ‘how does the SARS-CoV-2 virus enter a human cell?’ The research will contribute to the efforts of developing therapeutics against the virus, but it will not directly lead to a cure.

Applied biomedical research involves developing a therapeutic or a prophylactic medicine and relies on basic research to obtain information. An example of applied research is finding a cure for sickle cell anemia. Until recently, there was no cure. However, new research in the field of gene editing (CRISPR) has led to the promise of a treatment to fix the disorder.³

Clinical research involves conducting trials in animals and humans to test the effects, safety and efficacy of new medicines or treatments. Prior to conducting human clinical trials, safety and efficacy data is obtained from cell lines and animal trials. In the United States, 97% of pre-clinical animal trials typically use rodents, fish, or birds obtained from reputed suppliers, including the USDA and other governmental agencies.⁴

In most cases, basic and applied research uses *in vitro* testing, while clinical trials use *in vivo* testing. *In vitro* testing involves studies done outside the body, while *in vivo* testing involves studies done inside the body. Scientists try to use *in vitro* testing whenever possible. In recent times, computerized simulations and models have provided an alternate avenue to *in vitro* and *in vivo* testing. The models predict what can happen in an experiment without the need to conduct an actual experiment.

Whenever *in vivo* testing must be conducted, scientists use animal models. Animal models are selected based on the required similarities needed to simulate humans. These similarities include similar organs, genetic composition, or similar response to diseases. However, not all animal models share similarities with humans. For example, chickens and ducks are not good models for conducting COVID-19 vaccine animal trials because they are not susceptible to infection with SARS-CoV-2 virus.⁵

Animal trials conducted in the United States must meet the requirements set by the Laboratory Welfare Act. Prior to beginning their research, scientists must obtain approval from

an Institutional Animal Care and Use Committee (IACUC). An IACUC application involves documenting the source of animals and protocols in place to avoid causing the animals undue pain.

Human clinical trials are conducted in three phases, with each phase designed to answer certain questions. Human clinical trials are only conducted with volunteers and the trial must be approved by an Institutional Review Board (IRB). A key ethical component of human trials is providing the volunteers with an informed consent form, where all the facts, benefits, and risks associated with the trial are documented. Only after the volunteers agree to participate in the study, they are included in the trials.

An alternative to human trials, epidemiological research involves observing the prevalence of a disease in a population and finding the factors that makes the population resistant or susceptible to a disease. Epidemiological research does not involve the use of animals.

Over a century, the global human life expectancy has increased from around 30 years to over 70 years, primarily due to the inventions of biomedical research.⁶ However, solutions to many human and animal ailments still need to be invented. Emerging diseases, orphan diseases (diseases that affect fewer than 200,000 people nationwide)⁷, genetic disorders, and other diseases continue to inflict suffering.

Over the span of history, biomedical research has replaced the days of disease and mass death with good health and long life. With new inventions and discoveries, biomedical research will continue to lead our society to a healthier future.

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