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Prisha H.

Charles F. Patton Middle School
Kennett Square, PA

One of my most vivid memories is that of seeing a beloved family member admitted in the critical care unit of a hospital due to a diagnosis of Diabetic Coma. I recall seeing her hooked to multiple tubes, one of which was delivering her life saving insulin directly into her vein. With the help of insulin, her condition improved dramatically despite this life-threatening disease. I couldn't help but think that without the help of biomedical research, the miracle drug, insulin wouldn't have been researched and used so widely to save lives in diabetics as it is today.

So, what exactly is biomedical research? It is an area of science that includes investigation of causes of disease through detailed experimentation. It is designed to identify methods of prevention against illnesses and help scientists produce medical treatments for them. Animals are used to test these medications to verify the safety before using it on humans. Some examples of biomedical research methods include basic research, applied research, clinical research, In vitro, ex vivo, and In vivo. Basic research is the first step in biomedical research. In this research, scientists acquire the building blocks, or fundamental knowledge for later research. Applied research is where scientists apply this knowledge to conduct specific experiments and procedures on animals to solve a biomedical problem. Clinical research is the study of humans and animals that determine if a new treatment or medical procedure is effective. In vitro research translates to "in the glass" research. This means bacterial, cell, tissue, and organ cultures done in the lab. Ex vivo research translates to "out of the living" research. This refers to experimentation on living cells and tissues done outside the animal's body. Finally, in vivo research is "in the living" research, which means the experimentation is done in an animal's body. There is a newer area of research called Translational research which brings biomedical research into human use. In addition to animal research, computer models and cell tissue studies are also being used to discover novel ways of solving complex health problems. But computer simulations/computer models cannot mimic all the complexities of our bodies which is why we need animals for research purposes.

One may ask how and which animals help in biomedical research? The most common animals used in research are lab rodents. We also use them because they are small, easy to handle, inexpensive, and produce many offspring in a short period of time. Mice, and other rodents such as rats and hamsters, make up over 90% of the animals used in biomedical research. Dogs, cats, rabbits, sheep, pigs, fish, birds, and nonhuman primates make up less than 10% of the research animals used. Although these animals look entirely different compared to humans, the opposite is true for their body systems that work similar to humans. Moreover, their DNA structure is about 80 percent similar to that of humans. For this reason, the use of animals in some types of research is essential to the development of new and effective

methods for diagnosing and treating diseases that affect humans such as cystic fibrosis, cardiovascular diseases (including heart by-pass and other life-saving surgeries), HIV/AIDS, arthritis, spinal cord injury, Parkinson's and Alzheimer's (stem cell treatments), muscular dystrophy and diabetes (gene therapy) and organ transplantation (kidney, heart, lung, or liver transplant). Many of these animals have also been used in significant research. For example, use of lab mice was critical to finding new molecularly targeted cancer medicines especially in breast cancer, the measles vaccine, and most recently the COVID-19 vaccine that has saved innumerable lives. Biomedical researchers use the 3 R's when handling animals- reduction, refinement and replacement of animals and procedures (as in using computer models). But wait, biomedical research benefits animals too! Vaccines against parvo, rabies virus, antibiotics, and other approaches developed during biomedical research are now commonly used in veterinary medicine to cure animal diseases. There are federal and bioethical regulations and principles on which they rely on.

In conclusion, advances made in biomedical research have not only helped adults and children with finding many treatments and cures for disease but also benefited animal life and safety making it a necessary tool for survival of mankind.

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