

Technology and Living Systems

When you think about the term *technology*, you probably think of a cell phone or a tablet computer. **Technology** is the application of scientific knowledge for practical purposes. Technology does include advanced machines, such as computers and robotic equipment. It also includes simpler items you may not have thought of, such as sunglasses, scissors, and pencils.



Collaborate Discuss with a partner three technologies that you used as you prepared for school today.

Technology and the Human Body

Over the course of human history, advancements in science and technology arose through the process of engineering. **Bioengineering** applies the concepts of engineering to living things. Through bioengineering and scientific advancements, **biotechnology** has developed that allows people to live longer, healthier lives.

Analyzing Benefits, Risks, and Costs

Every new technology has benefits, risks, and costs. Bioengineers must analyze these tradeoffs when considering how new or improved technologies can impact living systems. Decisions must be made about whether a new technology's benefits outweigh the associated costs and risks. Benefits are the favorable effects of the solution, while the costs and risks are the unfavorable effects. A cost might include the impact on the environment. A risk could be the side effects from using a medical device. Engineers must balance the benefits, risks, and costs of each design solution.

FIGURE 2: A cochlear implant sends audio signals to the brain.



For example, cochlear implants increase the hearing ability for people with damaged inner ears. In a normal ear, the pinna (the ear's outer portion) funnels sound waves into the auditory canal. The sound waves then hit the eardrum, causing it to vibrate. These vibrations are then amplified by the middle ear. Hair cells in the cochlea convert the waves into impulses that are transmitted to the brain by the auditory nerve.

A cochlear implant, shown in Figure 2, has a microphone and speech processor, which pick up sounds from the environment. A transmitter and stimulator convert signals from the processor into electrical signals. An electrode array implanted into the cochlea collects the electrical signals and sends them to the auditory nerve.



Analyze How does a cochlear implant's process of transmitting sound to the brain mimic the process used by the ear?

Scientists and engineers continue to modify technology to meet the needs and demands of society. This often involves increasing the benefits of technology while reducing the costs and risks. For the cochlear implant, engineers could increase the benefits by improving the speech recognition ability. They also may work with scientists to decrease the likelihood of infection, reducing the risk. Engineers may find new materials that reduce the cost on the environment and reduce the cost of the implant. A replacement for precious metals in computers could reduce the environmental impact from mining and make an implant less expensive.

Research and Development

Scientists ask questions to learn more about a phenomenon, and engineers design solutions to problems related to that phenomenon. This back-and-forth between scientists and engineers is part of a process known as research and development. The studies and testing performed during this process often lead to the development and improvement of technologies.

Explain How are technology and life sciences related in the field of bioengineering?

In the case of the cochlear implant, scientists asked questions to learn more about the phenomena of hearing. Scientists might have asked, “How do the ear and brain interact to detect sound?” or “Which structures are affected in patients with hearing loss?” Engineers designed the cochlear implant using information on the mechanics of hearing that arose from scientific research.

Technology and Society

Technology has greatly influenced society, and society has influenced progress in technology. New technologies change our lifestyles, diets, and living spaces. Likewise, as social trends, economic forces, and cultural values change, new technologies emerge that support these changes. These new technologies also may propel society toward new changes in culture, health, and the environment.

Consider the advances in emergency medical treatment and technology. Prior to the 1950s, many ambulances were simply a way to deliver a patient to the hospital. Ambulances only had enough room for a patient in the back, so no medical care could be given during transport. Changes in societal expectations led to vehicles with enough room for emergency responders to work on patients, as well as new technologies to save lives. Modern ambulances continue to undergo design changes as new medical needs arise.

FIGURE 3: With technological improvements, emergency response time is faster.



Science as a Human Endeavor How have improvements in emergency medical technology changed our society?

All new technologies come with risks and costs to people and society, no matter how great the benefits. For example, many vaccines are refrigerated, allowing them to remain effective for longer periods of time. Refrigeration is rare in some parts of the world, though, making it difficult for people to access these vaccines. Refrigerants also add to the greenhouse gas effect. In response, some researchers are turning their attention to producing vaccines that do not require refrigeration.



Engineering

Clean Drinking Water

FIGURE 4: Societies around the world gain access to clean drinking water through new engineering designs, such as improved devices to transport water and new wells.



Many people in the world do not have access to clean drinking water. They must walk miles to and from wells to bring water to their homes. Once they carry the water home, it often needs to be filtered to avoid water-borne diseases, such as cholera. In response, bioengineers developed better water filtration systems in wells, making the water cleaner and safer. Engineers also developed devices to make it easier to transport water over long distances, as shown in the left image in Figure 4. Getting water can be a full day's work and is often the job of women and young girls. By decreasing the time spent focusing on water, women and girls have more time to devote to other tasks, such as education.



Collaborate If you were asked to design a device to transport water, such as the rollers shown in Figure 4, what societal, cultural, and environmental impacts would you need to consider?

In some cases, by solving one problem, advances in technology can cause new social and economic problems. Medical technology has enabled many humans to live longer lives. In some countries, longer life spans mean that the proportion of older individuals continues to grow, and more resources are needed to support these people.

The environment also is a concern when it comes to new technologies. Disposable medical supplies make it possible to use sterile equipment on each new patient. Once used, though, the material needs to be disposed of properly to prevent biohazardous waste from potentially affecting others.



Explain During the next 50 years, what biotechnology would you like to see developed or improved? Describe the potential benefits, risks, and costs of the technology and how it would impact society.