The Real Bionic Man: Teacher’s Guide

Grade Level: 9-12  Curriculum Focus: Technology  Lesson Duration: Two class periods

Program Description

Are bionic men and women in our future? In places like Utah's Bionic Valley, scientists are developing incredibly sophisticated artificial body parts: hearing devices implanted in the cochlea and eyes that transmit electric signals to the visual cortex. This video explores the field of science-fiction-turned-science-fact and shows how some inventions are already helping people with disabilities.

Onscreen Questions and Activities

Segment 1, The Real Bionic Man, Part One

- How does a cochlear implant work? *(The cochlear implant, or bionic ear, works by transforming sound into electric signals that travel through a wire directly into the cochlea.)*
- What two different approaches are scientists currently taking to develop a bionic eye? *(Scientists are developing a bionic eye by using video cameras that either send electric signals directly to the visual cortex of the brain or stimulate the retina of the eye.)*
- Discuss the criteria you think should be used to determine who receives a bionic implant.
- Consider what will happen to the demand for bionic implants when they work better than the human parts they replace.
- Activity: Use the Internet and other resources to research the development of bionics over the last century. Then make a time line to illustrate your findings.

Segment 2, The Real Bionic Man, Part Two

- What superhuman capacity does the most advanced artificial arm possess? *(The most advanced artificial arm currently in development has a 360-degree rotating wrist.)*
- What is one of the major obstacles to developing tissue-engineered human organs for transplant? *(Growing tissue-engineered organs would require a very complex scaffold to direct the growth of several different types of tissues simultaneously.)*
- Discuss the ethical implications of tissue engineering and bionic implants. If both were an option, which would you prefer and why?
Activity: Choose a specific part of the body and research all the functions it normally performs. Then design a bionic replacement that will perform equally well. Be sure not to leave out any critical functions.

Lesson Plan

Student Objectives

Students will understand:

- Scientists have been working for years on sophisticated artificial human parts, including technologically superior artificial limbs, hearing devices implanted in the cochlea, and eyes that transmit electric signals to the visual cortex.
- Their work is already being used to help people with disabilities.
- In an artificial human part, each device functions in place of an actual biological structure.

Materials

- The Real Bionic Man video and VCR, or DVD and DVD player
- Research materials on the human eye and brain
- Research materials on Professor Richard Norman’s work to restore sight by stimulating the brain
- Computer with Internet access

Procedures

1. Initiate a class discussion about what your students know about cyborgs and recent work of scientists who are creating sophisticated bionic human parts to help people with disabilities. For example, scientists have been working for years on sophisticated artificial human parts, including technologically superior artificial limbs, hearing devices implanted in the cochlea, and eyes that transmit electric signals to the visual cortex.
2. Review what you learned about the work of Professor Richard Norman, the scientist in the video who is attempting to restore sight by stimulating the brain in a normal fashion. Explain that Norman is using a video camera, microchips, and a microelectrode array to send signals to the visual cortex of the brain.
3. Tell students that each device used in Norman’s bionic “eye” corresponds to an actual biological structure in the human eye or brain.
4. Challenge students to use research materials to determine the biological structure(s) that correspond to the following devices:
   - Video camera
   - Microchips
• Microelectrode array

5. Students should draw a clearly labeled diagram of each device and another diagram of the biological structure to which the device corresponds. Each pair of diagrams (device and corresponding biological structure) should be accompanied by a short explanation of the function of the device and structure.

Discussion Questions

1. What technological advances must occur before bionic implants can become a reality?
2. Materials technology is very much a part of the development of bionic parts. What space-age materials are depicted in the video?
3. Bionic enhancement will give rise to many ethical issues, such as the factors used in determining who receives the implants. What other issues might arise?
4. Which mechanism of enhancement is preferable—electromechanical (e.g., bionic eyes, prosthesis) or biological (e.g., genetically engineered replacement tissue)? Why?
5. Why is implantation of bionic components so important?
6. Development of bionic humans might require redefinition of the term handicapped. Would a separate category of enhanced individuals be appropriate?

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

• 3 points: Student correctly pairs artificial devices and biological structures; all six diagrams provided; all diagrams accurate and clearly labeled; explanations of functions correct and clearly stated.
• 2 points: Student correctly pairs artificial devices and biological structures; all six diagrams provided; most diagrams accurate and clearly labeled; explanations of functions correct, but lacking in clarity.
• 1 point: Student does not correctly pair artificial devices and biological structures; some diagrams missing; some diagrams inaccurate, not labeled correctly, or not labeled at all; some explanations inaccurate.

Vocabulary

actuators

Definition: Devices that put an object into motion.

Context: There isn't space for all of the man-made actuators that we would like to install to move every joint of an artificial limb.
carbon fiber

*Definition:* A technologically advanced material that has the properties of high strength and lightweight.

*Context:* The artificial leg is made of carbon fiber, weighs only four-and-a-half pounds, and has 10 speeds and a shock absorber.

cyborg

*Definition:* A composite being in which living and artificial components are combined.

*Context:* By definition he is a cyborg—a man-machine hybrid.

laser

*Definition:* Light Amplification by Stimulated Emission of Radiation. A device that converts incident electromagnetic radiation of mixed frequencies to discrete frequencies of highly amplified and coherent visible radiation.

*Context:* The TV signal will not go directly to the brain but will be sent by a laser into the eye.

microchip

*Definition:* An electronic circuit that consists of components of very small size.

*Context:* Their plan is to link a video camera to a microchip embedded in the visual cortex.

prosthesis

*Definition:* An artificial replacement for a missing body part.

*Context:* The artificial leg’s socket, where the machine and man come together, is the most important part of the whole prosthesis.

**Academic Standards**

**National Academy of Sciences**

The National Science Education Standards provide guidelines for teaching science as well as a coherent vision of what it means to be scientifically literate for students in grades K-12. To view the standards, visit [http://books.nap.edu](http://books.nap.edu).

This lesson plan addresses the following science standards:

- Science, Technology, and Society

**Mid-continent Research for Education and Learning (McREL)**

McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education addresses 14 content areas. To view the standards and benchmarks, visit [http://www.mcrel.org/compendium/browse.asp](http://www.mcrel.org/compendium/browse.asp).

This lesson plan addresses the following national standards:

- Science—Physical Science: Understands the sources and properties of energy.
• Science—Nature of Science: Understands the nature of scientific knowledge.
• Technology: Understands the nature of technological design.
• Technology: Understands the relationships among science, technology, society, and the individual.

Support Materials
Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

•  http://school.discovery.com/teachingtools/teachingtools.html