

Nanotechnology

Teacher's Guide



Grade Level: 6–12

Curriculum Focus: Technology

Lesson Duration: 2 class periods

Program Description

Moving Atoms (5 min.) – Introduces viewers to nanoscience, which involves studying and working with matter on an ultra-small scale. *Hard Pill to Swallow* (7 min.) – Follows the journey of a pill cam as it photographs the host's small intestine. *Tiny Computers Everywhere* (5 min.) – Demonstrates the many uses of "motes" – mini computers that can network information without a jumble of lengthy cables.

Discussion Questions

- What are motes?
 - What are the benefits of mote technology?
 - What are some of the current uses of mote technology?
 - What are some of the potential uses of mote technology?
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DVD Content

This program is available in an interactive DVD format. The following information and activities are specific to the DVD version.

How to Use the DVD

The DVD starting screen has the following options:

Play Video – This plays the video from start to finish. There are no programmed stops, except by using a remote control. With a computer, depending on the particular software player, a pause button is included with the other video controls.

Video Index – Here the video is divided into sections indicated by video thumbnail icons; brief descriptions are noted for each one. Watching all parts in sequence is similar to watching the video from start to finish. To play a particular segment, press Enter on the remote for TV playback; on a computer, click once to highlight a thumbnail and read the accompanying text description and click again to start the video.

Standards Link – Selecting this option displays a single screen that lists the national academic standards the video addresses.

Teacher Resources – This screen gives the technical support number and Web site address.

Video Index

Segment 1: Moving Atoms (5 min.)

Description

A scanning tunneling microscope allows scientists to view atoms and molecules. Discover the fascinating world of nanoscience, where everything is at the cellular level.

Pre-viewing question

Q: What would be the benefit of being able to see matter at the atomic level?

A: Answers will vary.

Post-viewing question

Q: In the video segment how much magnification did it take to view the atoms on the tip of the tungsten instrument?

A: The scanning tunneling microscope magnified the tungsten tip 10 million times.

Segment 2: Hard Pill to Swallow (7 min.)

Description

For people with disorders of the small intestine, scientists have developed a camera that enables physicians to examine their patients from the inside out. Learn more about the "pill cam."

Pre-viewing question

Q: How do physicians examine people for disorders of the digestive system?

A: Answers may include a gastroscope (which is inserted in the mouth) or a colonoscope (which goes directly into the patient's colon).

Post-viewing question

Q: How does the pill cam send pictures of the patient's small intestine?

A: The pill cam sends images via radio signals that are transmitted to sensors attached to the patient's body.

Segment 3: Tiny Computers Everywhere (5 min.)

Description

Motes are minicomputers with numerous applications. Take a visit to Intel headquarters, where engineers have developed these wireless wonders.

Pre-viewing question

Q: How small do you think computers will get?

A: Answers will vary.

Post-viewing question

Q: What do the motes need in order to send information directly to the Internet?

A: The motes are able to send information directly to the Internet with a cellular signal.

Lesson Plan

Student Objectives

- Discuss and debate the ways in which nanotechnology might affect their lives.
- Discuss and debate the potential of mote technology beyond its current applications.
- Research and write a paper on the potential uses of nanotechnology and whether it would be to the benefit or to the detriment of humankind.

Materials

- *Nanotechnology* video
- Computer with Internet access
- Print and Web resources about motes and nanotechnology

Procedures

1. Before viewing the video, ask the students if they know what the prefix “nano” means. After the students have had a chance to guess the answer, inform the class that “nano” is a prefix meaning one-billionth, so a nanometer is one-billionth of a meter, or 0.000000001 meters. Nanotechnology refers to technological developments on the nanometer scale. With the help of the scanning tunneling microscope, scientists can view matter at the atomic level. Tell the students that the program they are about to see will show them various examples of nanotechnology, but they should pay special attention to the segment entitled “Tiny Computers Everywhere.”
2. After viewing the program, ask the students what they remember from the segment on mote technology. What are motes? Discuss answers from the video; motes are minicomputers that can be networked together with wireless sensors instead of a series of long cables. Where were the motes developed? (Intel Labs in Berkley, California.)
3. Ask the students to brainstorm some of the benefits of these tiny, networked computers. Record their answers. Possible answers include:
 - Inexpensive to build
 - Lightweight
 - Fit in small areas

- No need for large amounts of cable
 - Needs power from only a small battery
4. Discuss some of the potential drawbacks, if any, of mote technology. Would there be a downside to having a network of tiny computers that could be placed just about anywhere? Possible answers include privacy issues if the computers were fitted with cameras or audio equipment, how the network might be affected if the batteries ran out on one of the units, and the fragility of these tiny computers.
 5. Review with the class how scientists currently utilize mote technology. What are some of the current uses of mote technology? Discuss answers from the video, such as determining the ideal environmental conditions for redwood trees and measuring the effect of traffic, wind, and earthquakes on San Francisco's Golden Gate Bridge.
 6. Ask students to consider the future of motes and nanotechnology. What are some of the potential uses of mote technology? Discuss answers from the video, such as monitors in newly constructed houses to detect cracks, leaks, or malfunctioning heating and air conditioning units. What other possible uses of mote technology can you think of?
 7. Have the students research motes and nanotechnology using print and Web resources. Ask them to consider the potential uses for minicomputers and how they can benefit humankind, but also have them consider the potential ethical concerns of such revolutionary technology. Will nanotechnology make the world a better place? Is there potential that nanotechnology could lengthen our lives or at least enhance the quality of our lives? What could possibly go wrong? For example, scientists are concerned that self-replicating living matter could replicate uncontrollably. Additionally, how many people would want to live in a world where there were minicomputers everywhere? The following Web sites contain pertinent information:
 - Nanotechnology (Wikipedia)
http://en.wikipedia.org/wiki/Nanotechnology#Definitions_and_History
 - Intro to Nanotech
www.mos.org/cst/article/3410/1.html
 - Research: Intel Mote
www.intel.com/research/exploratory/motes.htm
 - Center for Nanotechnology
<http://ipt.arc.nasa.gov/>
 8. When students have completed their initial research, ask them to summarize their opinions in a two-page report. Have them defend their position by making at least three interesting, relevant points.

Assessment

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

- 3 points: Students were highly engaged in class discussions; produced a complete paper, including all of the requested information; accurately defended their position by making three interesting, relevant points.
- 2 points: Students participated in class discussions; produced an adequate paper including most of the requested information; satisfactorily defended their position by making two relevant points.
- 1 point: Students participated minimally in class discussions; created an incomplete paper with little or none of the requested information; did not defend their position or make any interesting, relevant points.

Vocabulary

accelerometer

Definition: An instrument for measuring acceleration or for detecting and measuring vibrations

Context: The accelerometers on San Francisco's Golden Gate Bridge will measure the effect of earthquakes on the bridge's construction.

hardwired

Definition: Having permanent electrical connections

Context: A hardwired phone is better than a portable phone when the power goes out.

network

Definition: A system of computers, terminals, and databases connected by communications lines

Context: When the computer network went down, people in the office were unable to get any work done.

precision

Definition: Adapted for extremely accurate measurement or operation

Context: Today's high precision seismographs can gather much more information on earthquakes than the devices used 100 years ago.

processor

Definition: The part of a computer system that operates on data

Context: A computer's processor is also called a Central Processing Unit, or CPU.

router

Definition: A device that forwards packets of data messages along networks

Context: The motes transfer information back and forth like a router.

Academic Standards

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>

This program addresses the following national standards:

- Science – Nature of Science: Understands the scientific enterprise
- Science – Physical Sciences: Understands the sources and properties of energy; Understands forces and motion
- Technology: Knows the characteristics and uses of computer hardware and operating systems; Knows the characteristics and uses of computer software programs; Understands the nature of technological design; Understands the relationship among science, technology, society, and the individual; Understands the nature and operation of systems; Understands the nature and uses of different forms of technology

National Academy of Sciences

The National Academy of Sciences provides guidelines for teaching science in grades K–12 to promote scientific literacy. To view the standards visit this Web site:

<http://books.nap.edu/html/nses/html/overview.html#content>

This lesson plan addresses the following national standards:

- Science and technology: Abilities of technological design; Understandings about science and technology
- Physical science: Transfer of energy; Motions and forces
- Science in personal and social perspective: Science and technology in society
- History and nature of science: Science as a human endeavor; Nature of science

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>

Credit

Robyn Kurth, freelance writer