Nanotechnology Takes Off Educator Guide

A resource for using QUEST video in the classroom

Watch it online http://www.kqed.org/quest/television/view/189 |10:14 minutes

QUEST SUBJECTS

Life Science Biology, Health, Environment

Earth Science Geology, Weather, Astronomy

Physical Science **Physics**, **Chemistry**, Engineering

CA SCIENCE STANDARDS

Grade 5

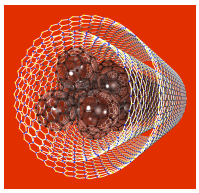
Physical Sciences
1. Elements and their combinations account for all the varied types of matter in the world. (a, b, c)

Grade 8

Structure of Matter
3. Each of the more than 100 elements of matter has distinct properties and a distinct atomic structure. All forms of matter are composed of one or more of the elements. (a, b, c)

PROGRAM NOTES

A nanotech boom in the Bay Area has begun, but what will it bring? From Lawrence Berkeley National Labs to Silicon Valley, researchers are manipulating particles at the atomic level, ushering in potential cures for cancer, clothes that don't stain and solar panels as thin as a sheet of paper.



In this segment you will find…

- an explanation of the term nanotechnology.
- examples of nanotechnology studies being conducted in the Bay Area.

TOPIC BACKGROUND

Atoms are the basic building blocks that make up what is called matter. These building blocks are arranged in a variety of ways to create everything from bugs to balloons, cars to stars, aardvarks to orchids, atmosphere to oceans—and, of course, you.

Scientists have discovered 90 naturally occurring kinds of atoms and have been able to synthesize about 25 more in the lab. They have long been able to combine these atoms in ways that create new and interesting chemical reactions and materials like medicines or synthetic fabrics. Recently, they have begun to manipulate atoms one at a time, or molecule by molecule, in a field called nanotechnology.

Nanotechnology is the science of building materials and devices from single atoms and molecules. This emerging interdisciplinary science combines chemistry, engineering, biochemistry and materials science. It's big—on a really small scale.

How small? "Nano" comes from the Greek word for "dwarf," which gives you a clue. One nanometer is one billionth (1,000,000,000) of a meter. Compare that to a human hair, which is about 80,000 to 100,000 nanometers thick, or a twisting DNA molecule 4 nanometers thick. The smell of freshly baked pizza happens on the nanometer scale, too. The scent molecules of that pizza's aroma are less than a nanometer in diameter.

Scientists have discovered that materials on an atomic and molecular scale behave very differently and have unique characteristics that differ from those of larger objects. In much the same way that magnets have positive and negative poles that are attracted to each other, the atoms and molecules of these nanoscale materials stick together because of charges that attract or shapes that fit together. The unique properties of these atoms let scientists create products like stain-resistant and wrinkle-free pants or sunscreen that blocks ultraviolet light.

Scientists predict that every aspect of our economy and lives will be affected by nanotechnology. Its biggest impact may be in the fields of computers, where nanochips could store trillions of bits of information; medicine, where nanorobots could be programmed to perform surgery or rearrange the atoms of your body; and the environment, where nanotechnology devices could remove contaminants in the atmosphere or oceans.

Media Enhance Education

Video and audio can be powerful tools for meaningful learning. It all depends on you, the educator. The key to using media effectively is preparation. Make the most of learning opportunities by encouraging students to become active viewers and listeners. Pick and choose from the suggested questions and activities to offer an engaging media experience.

Questioning

Oftentimes, teachers and students become frustrated during a media segment when students can't find the answers to a long list of questions. Provide a limited number of questions or topics for students. This focuses their attention during a media segment, helps to keep them engaged and generally results in higher quality answers. QUEST Ed. has provided a number of options for focus questions ranging from fact based to opinions, as well as "big picture" ideas.

PRE-VIEWING

- What is the smallest object you can see with your naked eye?
- What's the smallest unit of measurement you can think of?
- What tools do scientists use to look at object smaller than the naked eye?

VIEWING FOCUS

NOTE: You may choose to watch the television segment twice with your students: once to elicit emotional responses and get an overview of the topic and again to focus on facts and draw out opinions.

- Record any facts you find interesting while you watch.
- Give an example of a nanomotor that occurs in nature.
- What does a photovoltaic cell do?
- Why is it important for scientists like Jeff Grossman and Paul Alivisatos to continue to do research in the field of nanotechnology?
- What areas are really exciting frontiers for this new kind of technology?

POST-VIEWING

Links to activities mentioned here can be found on the following page.

- **Review** students' answers to the Viewing Focus Questions.
- **Measure** various objects and watch the video **Powers of Ten** (Charles and Ray Eames) http://www.powersof10.com
- **Imagine** you are a character in **Honey, I Shrunk the Kids**. Write a story describing the world you would encounter if everything was nanometer scale.
- **Read** about Berkeley's decision to regulate nanotechnology and write an article outlining your opinion on the matter.
- **Learn** more about size, scale and the metric system. Practice measuring objects and converting their units (lesson from National Nanotechnology Infrastructure Network).

A human hair is about 80,000 nanometers thick!
A moth's eye has a hexagonal shape and is a few hundred nanometers tall.
A comma in a newspaper is half a million nanometers.

LESSON PLANS / ACTIVITIES

Nanozone for Teachers Lawrence Hall of Science
http://www.nanozone.org/teachers.htm
- Try these activities before and after visiting the exhibit.

National Nanotechnology Infrastructure Network
http://www.nnin.org/nnin_edu.html
- Curriculum materials feature activity units on size and scale, a measurement unit and fun nanotechnology things you can buy at the store.

WEB SITES

Nanozone Lawrence Hall of Science
http://www.nanozone.org/
- "Nanozone" is both a Web site and an exhibition at UC Berkeley's Lawrence Hall of Science. The exhibition introduces basic nanoscale and state-of-the-art nanotechnology science to an 8- to 14-year-old audience.

Nanotech Kids
http://www.nanonet.go.jp/english/kids/
- A Web site produced by the National Institute for Materials Science (NIMS), Japan's sole Independent Administrative Institution (IAI) specializing in materials science, has student-friendly animations (subtitled in English) and games explaining nanotechnology.

Nanooze
http://www.nanooze.org/
- This science news magazine for students features plenty of articles and activities on nanotechnology.

ARTICLES / READING

"Tiny Is Beautiful: Translating 'Nano' into Practical" (2/22/05)
http://www.nytimes.com/2005/02/22/science/22nano.html?pagewanted=1&ei=5090&en=4ea37d77d2651a3f&ex=1266814800&partner=rssuserland
- **New York Times** article explaining some practical applications of nanoparticles

"Berkeley to Be First City to Regulate Nanotechnology" (12/11/06)
http://www.sfgate.com/cgi-bin/article.cgi?f=/n/a/2006/12/11/financial/f160106S61.DTL
- **San Francisco Chronicle** article detailing Berkeley's plans to monitor nanotechnology activity

Look for the **indicating resources from QUEST partner organizations**

QUEST QUAD

FIELD NOTES

Go outside and ...

- Observe plants and animals that have developed special features at the nanoscale level, such as a moth's eyes or butterfly wing patterns.
- Look for products used around the house that were developed through nanotechnology.

FIELD TRIP

Visit ...

- "Nanozone" at Lawrence Hall of Science
  http://www.lhs.berkeley.edu/exhibits/nanotechnology.html

Developed by Lawrence Hall of Science, this permanent exhibit is one of the first anywhere to explore cutting-edge nanotech developments, and introduce the scientists on the nanotech frontier.

- Measure yourself in nanometers.
- Hear the childhood experiences of nanotechnology scientists.
- Identify common objects under a high-powered microscope.
- Solve "The Case of the Green Milk."

FIELD RESEARCH

Find out more about...

- Careers in nanotechnology
  - Visit the "Who Works on It" section of http://www.nanozone.org/ and http://www.nnin.org/edunews_2.html

FIELD TEST

Experiment with...

- Nanotechnology measurements
  - Measure yourself using the nanotech ruler at http://www.nanozone.org/.
- Converting inches, feet and miles into nanometers
  - Use the nanoconverter at http://www.nanozone.org/.

VISIT OUR PARTNERS

The Bay Institute
www.bay.org

California Academy of Sciences
www.calacademy.org

Chabot Space and Science Center
www.chabotspace.org

East Bay Regional Park District
www.ebparks.org

Exploratorium
www.exploratorium.edu

Girl Scouts of Northern California
www.girlscoutsnorcal.org

Golden Gate National Parks Conservancy
www.parksconservancy.org

The J. David Gladstone Institutes
www.gladstone.ucsf.edu

Lawrence Berkeley National Laboratory
www.lbl.gov

Lawrence Hall of Science
www.lawrencehallofscience.org

Monterey Bay Aquarium
www.mbayaq.org

Monterey Bay Aquarium Research Institute
www.mbari.org

Oakland Zoo
www.oaklandzoo.org

The Tech Museum of Innovation
www.thetech.org

UC Berkeley Natural History Museums
http://bnhm.berkeley.edu/

U.S. Geological Survey
www.usgs.gov

MORE EDUCATIONAL RESOURCES FOR USING QUEST MULTIMEDIA TO ENHANCE 21st CENTURY SKILLS IN TEACHING AND LEARNING

Why Use Multimedia in Science Education?
http://www.kqed.org/quest/downloads/QUESTWhyMedia.pdf

- Read about the importance of using multimedia in the 21st century science classroom.

How to Use Science Media for Teaching and Learning
http://www.kqed.org/quest/downloads/QUESTMediaTips.pdf

- A collection of tips, activities and handouts to actively engage students with multimedia.

Science Multimedia Analysis
http://www.kqed.org/quest/downloads/QUESTMediaAnalysis.pdf

- Give your students the tools to recognize the purposes and messages of science multimedia.

Create Online Science Hikes with Google Maps
http://www.kqed.org/quest/files/download/52/QUEST_ExplorationCreation.pdf

- Do you like the science hike Explorations on the QUEST site? Use this place-based educational guide to create similar science-based maps with youth.

OTHER WAYS TO PARTICIPATE IN QUEST

LOG ON

www.kqed.org/quest

LISTEN

KQED 88.5 FM San Francisco &
89.3 FM Sacramento
Mondays at 6:30am and 8:30am

WATCH

KQED Channel 9
Tuesdays at 7:30pm

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