POWER OF SMALL
NANOTECHNOLOGY
VIEWERS GUIDE

Watching You Watching Me – Privacy
Clean, Green, and Unseen – Environment
Forever Young – Health
Nanotechnology: The Power of Small Viewers Guide

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DEAR VIEWER,

Nanotechnology – that’s a new word in my vocabulary and with it comes a realization that a scientific transformation is occurring – a transformation whose influence will probably rival the combined effects that electricity, antibiotics, and computers have had on our lives. This transformation takes place in the world of the infinitely small – where construction happens, atom-by-atom and molecule-by-molecule. It brings together the scientific disciplines of biology, engineering, chemistry, and physics, where researchers are offering us unprecedented understanding and control over the fundamental building blocks of all physical things, both animate and inanimate.

But along with the potential benefits of nano-science come difficult ethical, legal, medical, business, environmental, and social dilemmas. Who determines what the risks of nano-materials are? Who decides what risk levels are acceptable given the potential benefits? How do we balance societal interests with the individual’s right to privacy? We are using nano-technological devices for medical treatment; should we also use those devices to enhance human characteristics? How do we deal with unequal access to nano-technological “tools” for testing and treatment? Should nano-materials be regulated separately/differently from macro-materials? Who provides ‘insurance’ – financial, cleanup, remediation, etc – in case a mishap does occur? What is the ethical role for business and academic labs? In sum, how do we harness the extraordinary potential benefits of nanotechnology while ensuring that its power doesn’t produce disturbing consequences?

Nanotechnology: The Power of Small, a three-part Fred Friendly Seminars series for PBS, will engage the American public in a critically needed dialogue about the complex implications of this rapidly advancing field. The television broadcast is just the beginning. With a comprehensive national outreach effort, Nanotechnology: The Power of Small will serve as a catalyst to extend this dialogue into communities as a first step in building awareness around these emerging issues. The campaign is reaching out to health care and legal professionals, business people, environmentalists, educators, students, legislators and community leaders. This Discussion Guide and the resources located on our Web site www.powerofsmall.org will help you join in through your group discussions and activities.

The challenging choices presented by nanotechnology affect everyone. All of us need to deal with these issues, and we look forward to your participation in the conversation.

Ruth Friendly

ABOUT THE FRED FRIENDLY SEMINARS
For over 20 years, the Fred Friendly Seminars, winner of major broadcasting awards, have probed a broad spectrum of knotty ethical, legal, and public policy issues using their distinctive Socratic dialogue format. Within this format, prominent Seminar participants ranging from Supreme Court Justices to former Presidents, scientists, journalists, legislators, and CEOs are drawn into a situation that brings the issues down to a human scale. There is no room for rhetoric as the moderator moves these participants though a hypothetical story line, encouraging them to struggle with dilemmas drawn from real life. As panelists debate the issues, the viewers are drawn into the drama and likewise find themselves wrestling with the problems in all their complexity.
Introduction to The Power of Small and Directions for Use

This Viewers’ Discussion Guide is a toolbox that provides several instruments to initiate critical deliberation about the issues surrounding nanotechnology. It can be used before, during, and after viewing the Nanotechnology: The Power of Small programs.

From the tools provided, select those that best fit the audience you are working with and your intended goal.

This guide contains:

• A Nanotechnology in Our Lives survey
• Role-plays to engage participants in scenarios that wrestle with the personal and societal implications of the science of nanotechnology
• Questions to promote discussion before and after viewing the programs
• Suggestions and resources to help extend the discussion and explore issues that arise after watching the programs

For each tool, you will find a description of its purpose and directions for its use in the pages that follow.
The Science of Nanotechnology
by Prof. Joel Moore University of California, Berkeley

What is nanotechnology?
Every user of a computer or mobile phone has witnessed how shrinking the size of components has allowed for new device uses: a single palm-sized device connected to the Internet can serve as a library, movie screen, telephone, and camera. Nanotechnology drives this shrinking process. Nanotechnology refers to technologies made possible by components whose size is measured in nanometers (1 nanometer = 1 billionth of a meter). One nanometer is only about 20 times larger than the size of a typical atom or about 80,000 times smaller than the width of a human hair.

The physical behavior of many substances becomes quite different at the nanometer scale (“nanoscale”). There are even new forms of familiar substances that appear once their size is reduced to this small scale. For example, there are two familiar forms of the element carbon: graphite, used in the lead of a pencil, and diamond. However, a new form appears at the nanoscale. Carbon nanotubes, first discovered in the 1980s, are tiny cylinders made from pure carbon that are only a few nanometers in diameter. Their properties are entirely different from graphite and diamonds. They exhibit extraordinary strength, conduct heat, and have unique electrical properties. Many of the most scientifically exciting developments in nanotechnology involve exploiting new materials such as carbon nanotubes, and exploring new behaviors displayed by familiar materials when they are made very, very small.

People often ask whether nanotechnology should be classified as chemistry, biology, or physics. Nanotechnology is described as “interdisciplinary” because methods from many different disciplines can be used to create nanostructures and nanoparticles (structures and particles of nanoscale dimensions). Chemists synthesize large, complicated molecules from smaller ones or from individual atoms, while physicists can create nanostructures by patterning or “etching” a larger material using lasers or even X-rays. Biologists can use some of the same tricks that natural organisms use to create functional biomolecules. For example, Prof. J. Keasling of UC Berkeley and Lawrence Berkeley National Laboratory has developed a synthetic biology toolkit in order to synthesize important biological substances that are produced by natural organisms in tiny amounts. One such substance is artemisinin, an effective treatment for malaria that was previously too expensive for wide use.

Nanotechnology, like any other new technology, also has the potential for accidental or deliberate misuse. Nanotechnology will lead to further miniaturization of computers, cameras, and other electronic devices, which will require laws that strike a careful balance between privacy and public interest. Similar privacy protections may be needed once improved medical tests using nanotechnology make it possible to detect many diseases of genetic origin before any symptoms appear. Nanotechnology may allow new strategies to repair environmental damage, but oversight is required to ensure that nanotechnology does not produce its own negative effects on the environment. The Power of Small programs and website are designed to help prepare interested viewers to deal with these and other challenging questions raised by nanotechnology.
Why is nanotechnology important?
It is difficult to predict which technological advances will have far-reaching consequences, but there are at least three reasons to believe that nanotechnology is likely to be a fruitful realm worth pursuing.

First, nanoscale science brings together research in chemistry, physics, and biology to create a wealth of new materials with new properties. Nanostructures can be made either by chemical means starting from molecules or by physical means starting from bulk materials.

Second, most key biological molecules (proteins and DNA, for example) function at the nanoscale. This means that biological processes can be used to create nanoparticles and nanostructures, and that nanoparticles or nanostructures made by other means can have strong interaction with biological molecules.

The third simple reason for the importance of nanotechnology is that nanotechnology is the "end of the road", as far as miniaturization goes, for the foreseeable future. Nanotechnology appears to be the best hope to continue the dramatic increases in electronic technology to which we have become accustomed, and since there is no obvious route beyond nanotechnology, considerable effort will go into maximizing the gains from it. The good news is that there are many new properties of matter at the nanoscale that nanotechnologists are only beginning to take advantage of.

Current Work in Nanotechnology
Privacy/Security
By creating smaller cameras, audio recorders, and chemical sensors, nanotechnology will change the boundary between the public and private spheres. Closed-circuit television is already used in shopping malls and on trains in order to deter crime; in the future, electronic recording in public spaces may become more the rule than the exception. Chemical sensing will be introduced for uses such as determining when produce begins to rot, but could also be used to test whether a driver or employee has had one drink too many. Biometric sensing is coming into wider use by immigration services, and in a few years every entrant to an ordinary apartment building could be scanned to verify his or her identity. Many of these applications are currently limited by the cost and size of sensing devices and of transmitters to relay the information gathered, but this is changing rapidly. As an example of how nanotechnology may change how information is gathered relatively soon, DARPA (Defense Advanced Research Project Agency) is supporting research on "smart dust", tiny sensors that can be scattered over a battlefield to track enemy soldiers and relay information to a central location. This could easily lead to civilian applications as well.

Environment
Nanotechnology has the potential to impact the environment in many different ways: positively, by allowing more efficient energy use or creating new methods for environmental cleanup, or negatively, if biologically active nanoparticles enter the environment without appropriate supervision. One reason why nanotechnology is especially useful for cleaning up some environmental contaminants is that nanoparticles are small enough to flow through microscopic groundwater channels but highly reactive and able to break down dangerous substances like the organic solvents in dry cleaning fluid. While our understanding of chemical impacts on the environment has advanced significantly over the past few decades, nanotechnology raises some specific health challenges because many nanoparticles are of roughly the same size as substances known to be dangerous when inhaled in quantity.
Health
Nanotechnology is likely to change several areas of medicine dramatically: two examples are rapid testing for many genetic disorders from a single drop of blood and continuous monitoring of bodily function and drug levels from implanted nanosensors. These technologies will force many more people and their doctors to face difficult questions about the proper limits of medical diagnosis and treatment. The nanotechnology methods that underlie rapid testing of portions of an individual’s genome (for early identification of genetic diseases) are an interesting fusion of molecular biology with physics and electrical engineering: as a small amount of liquid flows through a DNA microarray, pieces of DNA in the liquid bind to molecules trapped on the microarray surface, producing an electronic signal that can be amplified and read by a computer. Future microarrays may use carbon nanotubes to increase the number of DNA sequences that can be tested in a single device.
Nanotechnology in Our Lives Survey

This survey can be used to elicit participants’ current familiarity with the use of nanotechnology in products found in our daily lives. When administered individually or to a group as a whole, the survey sparks discussion and prompts participants to think about the nature and pervasiveness of nanotechnology-influenced products.

Materials

Copies of the Nanotechnology in Our Lives survey

Decide if you will pass out one survey to each participant, to pairs, or use one for the whole group and make the appropriate number of photocopies. The survey follows on Page 10.

Procedure

Before viewing the program – Participants take the survey

*Note:* Text in *bold italics* represents questions to pose to the group. These questions will serve to elicit the participants’ current ideas about nanotechnology and start discussion.

1. Begin by asking the group, *What is nanotechnology?*
2. Prompt participants to discuss this question with a person sitting near them. Allow pairs to discuss their responses for 2-3 minutes.
3. Ask for volunteers to share their ideas with the group. This will likely raise more questions. It is okay at this point to end with more questions than answers, as watching the program will provide answers to some of the questions. Record these questions in a place where they are visible to the group, such as on a chalkboard, whiteboard, or piece of chart paper.
4. Pass out a Nanotechnology In Our Lives Survey to each participant.
5. Direct participants to work individually, in pairs, or as a group to complete the survey.
6. With the group discuss how participants answered the survey. Record any new questions that arise.

*Note:* Each product on the list is a category of products currently available in the United States that was manufactured as the result of nanotechnology-derived processes or materials. It is important to note that this is not true for every product in the category. For example, not all sunscreens are created with nanotechnology-derived materials. But some sunscreens are. It is recommended that you do not disclose this before viewing the program. Instead, return to the survey after viewing the program(s) so that participants will have evidence to revisit their survey answers.
After viewing the Program—Participants revisit the survey
1. Prompt participants to return to the Nanotechnology In Our Lives Survey.
2. Ask, Now that you have viewed the program, do you still agree with your responses?
3. The correct response on the survey is that each product category can be circled. Clarify if necessary that, for example, not all cotton sheets or kitchen paints are made from nanotechnology-derived processes and materials – but there are specific brands on the market that are. Encourage participants to search the Internet for examples of products. Suggested resources are listed below.
4. Ask the group, Which products would you feel comfortable using? Why or why not? Provide time for them to share their responses with the group. Summarize the group’s thoughts and concerns.

Resources
To read about and search a list of consumer products created using nanotechnology engineered materials and processes visit the resources listed below.

- Nanotechnology Consumer Products Inventory
developed by The Project on Emerging Nanotechnologies at http://www.nanotechproject.org/inventories/consumer/

- Real World Applications of Nanotechnology
by the Nanotechnology Infrastructure network www.nnin.org/nnin_nanoproducts.html
Nanotechnology In Our Lives Survey

Directions
Below are lists of types of products you may encounter every day. In each of the categories below, circle the products that are created with or somehow incorporate the use of nanotechnology.

Home and Garden
- Cotton sheets
- Guitar strings
- Plastic bags and food containers
- Luggage
- Stain-resistant clothing
- Suntan and face lotions
- Waterproof jackets
- Non-stick bake ware
- Spray air sanitizer
- Car wax
- Floor cleaner
- Antibacterial watches
- Kitchen and bath paint

Electronics
- Flash memory stick
- Air purifier
- MP3 player chips
- Hearing aids
- Computer processors
- Wireless computer mouse
- Antibacterial cell phones

Health and Fitness
- Golf clubs
- Tennis racquets
- Baseball bats
- Sunscreen
- Toothpaste

Food and Beverages
- Canola oil
- Vitamin spray
- Slimming chocolate shake
- Nutritional supplement capsules
Nanotechnology Scenario Role-Plays

The pages that follow contain a role-play specific to each of the three programs in the Nanotechnology: The Power of Small series. These role-plays are an opportunity for participants to dive into a scenario and explore the issues and tensions related to the use of nanotechnology as they are raised in the programs. Role playing prior to watching the program and again after viewing will allow participants to explore whether their thinking changes after viewing Nanotechnology: The Power of Small.

Materials

For each participant
1 Roll Play Scenario Sheet
1 of four Role Cards

Note: Select the scenario sheet and role cards for the specific program being viewed. All sheets and card templates are on pages immediately following this section.

Advanced Preparation

Participants will work in groups of four during this role-play exercise. Photocopy and cut out the appropriate number of role cards based on the number of participants.

Procedure

Before viewing the program
1. Divide participants into small groups of four.
2. Pass out a Scenario Sheet to each participant. Read the scenario on the sheet aloud to the group.
3. Hand out one of four role cards to each group member.
4. Ask each person to read the description on his or her role card.
5. Ask the group, What is your role’s reaction to the scenario? Direct participants to write their reaction individually from the point of view of their role on their Role Play Scenario Sheet.
6. Ask each group member to introduce their role to their fellow group members and then to act out a conversation among their roles about the scenario and questions presented on the sheet.
7. Hold a group discussion to summarize what was discussed in the role-play by asking the whole group, What issues and question arose as you acted through the role-play? Ask for volunteers to share their questions, concerns, and comments with the group.
8. Explain that they will return to this role-play after viewing the program to explore how or if their thinking has changed.

After Viewing the Program
1. Direct participants to return to their Scenario Sheet and read the response they wrote before viewing the program. Ask them to write an additional response, noting if new questions have arisen and how their thinking might have expanded or changed since writing their initial response.
2. Working in their small groups, participants should act out a conversation about the scenario as they play their role, this time adding in new questions and thoughts from the new perspective of their role.
3. Ask the entire group, Did your thinking change after viewing the program? Did your role change in any way? If so, how so? Ask for volunteers to share their questions, comments, and reactions with the group.
Role-Play Scenario Sheet for Nanotechnology: The Power of Small “Watching Me, Watching You”

Directions
You will be given a role card. Read the scenario that follows in the box below from the perspective of the role you are given. How would you respond to the question posed at the end? Write your response in the space provided below.

Amanda and the “know-it-all” necklace
Amanda has an opportunity. She can participate in a program in which she will wear a necklace that contains a radio-frequency identification (RFID) tag made possible through new advances in nanotechnology. She found this chance to earn a little bit of money at the local mall. There was an information booth next to one of the entrances advertising the opportunity to participate in a tracking program. A marketing firm asked her and a group of other shoppers to wear an RFID enabled necklace for one year. In return, she will be given a debit card with money that can be redeemed at the completion of each month. The RFID necklace will register where she travels in the mall, what stores she visits, and will record which items she approaches and ultimately buys. While in certain stores, Amanda’s cell phone will be sent advertisements, coupons, and information about products based on the information tracked by the RFID necklace.

Do you think Amanda should participate in the program? Why or why not?

Response:
Role Cards Nanotechnology:
The Power of Small “Watching Me, Watching You”

Directions
This sheet contains a total of four role cards. Photocopy the number of sheets necessary and cut each sheet into four cards. Hand out one role card to each participant.

Parent 1
You and your partner have one teenage daughter, Amanda. You are a high school science teacher. You enjoy reading about current technological innovations and bringing them into your classes. You have found Amanda to be a trust-worthy daughter. Recently you and your partner had a heated debate with Amanda because she wants to get a job. You and your partner want her to use her free time for schoolwork. This discussion ended in frustration with the three of you disagreeing about whether Amanda should get a job.

Parent 2
You and your partner have one teenage daughter, Amanda. You work in the technology industry as a web programmer. As Amanda’s parent, you want to encourage Amanda’s independence but also ensure that you know her whereabouts, so you have set up a system where she checks in with you or your partner on a regular basis. The company you work for collects and analyzes internet use patterns for a research and development firm. Companies hire you to help them design websites that help promote and sell products.

Amanda
You are an independent high school student who works hard in school and likes to spend your weekends with friends. Your parents would prefer you not to have a job while in high school. They think you should spend your time studying. You, on the other hand, would like to have a job since you already earn good grades and would like to start earning spending money.

Amanda’s Aunt/Uncle
You are a civil rights lawyer. You spent extensive time working on “Right to Privacy” cases during the 1960s. While you are curious about the ways in which nanotechnology will improve the collection and storage of information, you are skeptical about the ways in which the United States protects what you consider to be “private” consumer information. You are also skeptical of private organizations that collect personal information.
Role-Play Scenario Sheet for Nanotechnology: The Power of Small, “Forever Young”

Directions
You will be given a role card. Read the scenario that follows in the box below from the perspective of the role you are given. How would you respond to the question posed at the end? Write your response in the space provided below.

The Opportunity of a Lifetime
It is ten years from now and through advances in nanotechnology and medicine there is a treatment available that enables a person to live to the age of one hundred and twenty. In order for the treatment to work, it must be administered to children under the age of ten. In this scenario, two parents visit the doctor to talk about the possibility of their child receiving this treatment.

Would you agree to the treatment? Would you agree to it for your child?

Response:
Role Cards for Nanotechnology:
*The Power of Small “Forever Young”*

**Directions**
This sheet contains a total of four role cards. Plan on grouping participants in small groups of four. Photocopy the amount of sheets necessary and cut each sheet into four cards. Hand out one role card to each participant.

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**Parent 1**
You are a nurse who works in the pediatric ward of a local hospital. You have a ten-year old child who is healthy and happy. You recently heard about a new medical treatment that has entered clinical trials. The treatment is derived from nano-technology based medicine that enables people to live until they reach an age of one hundred and twenty, but it must be administered before you are 12 years old. You are excited about the opportunities this new treatment might offer your child. You can easily imagine being able to live longer and enjoy amazing experiences not possible during the current average lifetime. You can’t imagine who wouldn’t want their child to have a longer prosperous life.

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**Parent 2**
You are a medical lawyer. The majority of cases you defend are doctors who are being sued for medical malpractice. You have a ten-year old child who is happy and healthy. Recently your partner, who is a pediatric nurse, heard about a clinical trial for a new nanotechnology-derived treatment that if given now, would provide your child with the opportunity to live until the age of one-hundred and twenty. You are really intrigued. On one hand this would give your child the opportunity to do so much. But on the other hand, you wonder what types of tests have been conducted on this new treatment. Have patients who have received the treatment been followed until they are one hundred and twenty? You have many questions for the doctor.

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**Ten-year-old child**
You are a fourth-grader who has many friends both at school and at home. You spend your weekends playing on the street with your friends. You like to read comic books and play simulation games. Last week your mom came home from work and told you about a new treatment that allows people to live until the age of one hundred and twenty. Since she told you, you’ve been daydreaming about what it would be like. You imagine how cool it would be to have more time to do all of the fun things you’d like to do like go surfing, and buy a really cool house and a car. Your grandmother recently died and it really scared you. If this treatment delayed the time you would die, that would be cool too because you don’t want to die.
Pediatrician
You are in academic medicine and have been working with a team of researchers to develop a new therapy enabled by nanotechnology. It will allow the people who receive it to live until they are one hundred and twenty. You are very excited because the treatment has recently entered the final phase of clinical trials. This treatment, however, must be administered to children under the age of twelve in order for it to lengthen their life span to the age of one hundred and twenty reliably. The early human trials of the treatment have followed the children who received it into their forties. They have experienced some social side effects. They mature at a much slower rate and therefore find that their friends move faster than they do through school and in social situations. You are anxious to recruit participants into the trial.
Role-Play Scenario Sheet for Nanotechnology: The Power of Small “Clean, Green and Unseen”

Directions
You will be given a role card. Read the scenario that follows in the box below from the perspective of the role you are given. How would you respond to the question posed at the end? Write your response in the space provided below.

Solar Synergies Comes to Town
Sunnyville is an economically depressed town. Many businesses and manufacturing plants that once called Sunnyville home closed down long ago. There are not many jobs in Sunnyville. Solar Synergies is thinking of locating their new manufacturing plant and corporate headquarters in Sunnyville and is looking for tax incentives. Solar Synergies is an innovative company that is the first in the United States to manufacture solar cells using materials and processes derived from nanotechnology. There is controversy brewing in Sunnyville. Some residents want the company to come to town to spur economic growth and create jobs. Others are concerned that the environmental impact of the new technology has not yet been explored. Using a new technology without knowing its environmental impact can be risky. Especially if the widespread affects on water, soil, and air or not well documented.

Would you vote to allow Solar Synergies to build a plant in Sunnyville?

Response:
Role Cards Nanotechnology: The Power of Small “Clean, Green and Unseen”

Directions
This sheet contains a total of four role cards. Photocopy the number of sheets necessary and cut each sheet into four cards. Hand out one role card to each participant.

Automobile Mechanic
You trained as a mechanic years ago. You were really good at your job but unfortunately, when the super-store opened in town the garage you worked at closed down because it couldn’t compete. You went to the super-store garage to see about employment opportunities, but they said you were over-trained and wouldn’t hire you. You’ve been unemployed for several months. When you heard about the possibility of Solar Synergies opening you began to hope that you might get employment at the plant.

Major of Sunnyville
As mayor you want to support new business and the growth of the Sunnyville economy, and for this reason you are excited about Solar Synergies’ proposed purchase of land to build a plant in Sunnyville. You also know that if the town board doesn’t approve the tax breaks that they are requesting quickly, Solar Synergies will look to purchase land in a different Town.

Environmental agent
You work for the Sunnyville local environmental agency. You are trained to conduct water, soil, and air testing and are very familiar with pollution regulations. You are cautious about Solar Synergies because the company has not released information about the process used to make solar cells. You know from the history of industrial plants in the United States and emerging technology that often information about the toxicity of manufacturing processes is not known until harm has already been done to air, water, and soil resources.

Homeowner
You bought a house in Sunnyville ten years ago when the housing market was on the rise. More recently, because so many businesses have closed in Sunnyville, house prices have dropped. No one wants to buy a home in Sunnyville because there are no jobs. You were excited to hear about the possible Solar Synergies deal, thinking that it might kick-start the economy of the town, but at the same time you would like it to happen in an environmentally responsible way. If the water and soil become toxic because of something the Solar Synergy plant emits, your property value will plummet and the area will not be safe to live in.
Nanotechnology:
The Power of Small “Watching Me, Watching You”
Program Viewing Guide

Synopsis of “Watching You, Watching Me”
In this program the moderator, John Hockenberry, asks panelists to place themselves in scenarios in which they consider the personal and societal implications of nanotechnology-enabled devices in their lives. In the first scenario two brothers are asked to consider the implantation of a nanotechnology-enabled chip into their father. Next, panelists discuss Amanda’s participation in a program that asks her to wear an RFID tag to collect information about her consumer habits for a marketing research firm. Panelists consider the pros and cons of living in a community that has cameras on every corner, or of having an individual carry a nano-ID that would provide personal information every time public transit is used. Who will keep and have access to this information? How will the information be used? The potential benefits and drawbacks are raised as panelists explore the scenarios from the viewpoint of different stakeholders.

Before Viewing
Visit the privacy section of the website www.powerofsmall.org so that you can
• Preview the background and expertise of each panelist involved in the discussions by clicking on the “Meet Panelists” button above the video clips.
• Listen to short, informative audio productions on nanotechnology from Earth and Sky Radio by clicking on the “Listen to Nano Radio” button” above the video clips.

Viewing the Program
Cue the program to the beginning of the episode, The Power of Small—Watching Me, Watching You at http://www.powerofsmall.org/topicpages/health.php or on DVD.

Working With Each Segment
1. Cue the first video segment.
2. Show the video segment.
3. Pose the end-of-segment questions to the viewing group. Several questions are provided for each segment. Based on the group you are working with and the time you have available, decide if you will ask all of the questions or select key questions from the list.

You may ask the question in a number of ways. Two suggested methods are to direct the group to
a. Turn to your partner and discuss the question or statement. After 2-3 minutes of discussion, ask volunteers to report their thoughts and discussion to the whole group.
b. Use the questions to generate group discussion.
End-of-segment questions

Segment One – “It’s 10 P.M. Do you know where Dad is?”

- Pose the question to the group, Would you tag dad?
  Encourage discussion among partners and then ask participants to share their ideas with the group.
- Ask the group, How does nanotechnology enable RFID devices? Ask for responses based on information in the segment. See the information provided in the side-bar for guidance.

Segment Two – “Amanda’s so-called privacy”

- Pose the question to the group, Should Amanda sell her secrets?
- In the second segment one of the panelists states, “It’s never just a technology issue, it is how it challenges our values, sense of self, privacy, and family.” Do you agree with this statement? Did anything from the segment change your view?

Segment Three –“The all-knowing train station”

- Pose the question to the group, Would you carry a nano-ID?
- Ask the group, How do computers enable this nano-ID system? Refer to the sidebar for information that can be used to answer this question.
- In the third segment a panelist states, “Is the right to privacy more important than the right to safety?” Ask the group to express their views.

Segment Four – “The world is watching, oh behave”

- Pose the question to the group, Would you support nano-enhanced surveillance in your community?
- In the fourth segment the statement is made, “Can technology protect information as well as make it more accessible?” Ask the group to comment on this statement.
- Which community would you want to live in – the one with abundant surveillance or the one without?

Segment Five – “We’re the government and we’re here to help”

- Pose the question, Under what circumstances do you think the government should have access to information collected by nanotechnology-enabled devices?
- In the fifth segment the moderator closes by saying to the panel, “In the nanotechnology world, it is a race, between technology and the norms, moralities, and values that you describe.” Describe what you think this means based on the discussion in the program. Where does the need for privacy outweigh the need for security in your view?

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Nanotechnology-enabled Devices

Radio-frequency identification (RFID) devices require a small antenna to broadcast the radio signal and also an electronic subsystem to create the signal. Nanotechnology enables both these components to be shrunk. For example, researchers at UC Berkeley and Lawrence Berkeley National Laboratory recently created the world’s smallest radio antenna from a single carbon nanotube, a cylinder of carbon atoms about 10,000 times thinner than a human hair. Actually the mechanical motion of the nanotube can also substitute for some of the electronic components of a conventional radio!
Extend the Discussion

• Visit the website www.powerofsmall.org where you can register your vote for issues relating to this episode.
• Find experts to answer the questions the group has raised.
• Search for newspaper articles and magazines that talk about current events as they relate to nanotechnology and applications that might enhance security and/or impinge on privacy.
Nanotechnology: The Power of Small – Forever Young Program
Viewing Guide

Synopsis of “Forever Young”
In this episode the panel of experts considers ways in which medicine and health may be influenced by new developments in nanotechnology. From the development of digital implants to track even the smallest change in a person’s health, to the long-term enhancement of life, panelists consider how these advances may affect societies. Who will and who should benefit from nanotechnology derived health programs? How might these methods change the face of medicine? Where does the line exist between health improvement and gratuitous enhancement?

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  • Preview the background and expertise of each panelist involved in the discussions by clicking on the “Meet Panelists” button above the video clips.
  • Listen to short, informative audio productions on nanotechnology from Earth and Sky Radio by clicking on the listen to “Nano Radio” button above the video clips.

Viewing the Program
Cue the program to the beginning of the episode, The Power of Small—“Forever Young” at http://www.powerofsmall.org/topicpages/health.php or on DVD.

Working with each Segment
1. Cue the first video segment.
2. Show the video segment.
3. Pose the end-of-segment questions to the viewing group. Several questions are provided for each segment. Based on the group you are working with and the time you have available decide if you will ask all of the questions or select key questions from the list.

You may ask questions in a number of ways. Two suggested methods are to direct the group to
a. Turn to your partner and discuss the question or statement. After 2-3 minutes of discussion, ask volunteers to report their thoughts and discussion to the whole group.
b. Use the questions to generate whole group discussion.
End-of-segment questions

Video Segment One – “A Night in the Museum”
- Ask the group to, Turn to a person sitting near you and brainstorm a list of things nanotechnology may influence in the next twenty-five years. Provide time for pairs to come up with a list. Then ask for volunteers to share their list with the group.
- Ask the group, Do you think future museums will feature the problems or promise of nanotechnology? Should a museum feature both? Why or why not? Encourage discussion among partners and then ask participants to share their ideas with the group.

Video Segment Two – “The Digital Doctor”
- How does nanotechnology make a Digital Doctor possible? Use the information provided in the side-bar to guide viewer’s answers to this question.
- Pose the question to the group, What benefits might result from the use of a Digital Doctor? What concerns or drawbacks might result from using a Digital Doctor?
- Pose the question to viewers, Would you want a Digital Doctor? Why or why not?

Video Segment Three – “George and the Digital Doctor”
- Pose the question to the group, How can the digital doctor help in this scenario? How might its use be controversial?
- Ask the group, Would you spy on your child using a nanotechnology-devised device?

Video Segment Four – “Flying Safer with JetGreen”
- Pose the question to the group, Should airline pilots sacrifice their privacy for your safety?
- What issues surround the use of this type of testing? Encourage discussion among partners and then ask participants to share their ideas with the group.

Video Segment Five – “Electronic Enlightenment”
- When do you think such an implant should be used? Do you think there should be limits on when such an implant is used?
- Pose the question to the group; Would you want an implant to make you happier? Encourage discussion among partners and then ask participants to share their ideas with the class.

Nanotechnology-enabled Digital Doctors
Nanotechnology is fueling advances in preventative medicine by assisting the construction of materials and devices that dramatically increase the sensitivity of disease detection. Many traditional laboratory blood tests rely on the detection of a biological marker for a disease, such as prostate specific antigen, or PSA, for prostate cancer. By monitoring small changes in the conductivity of a nanowire, 5,000 times thinner than a human hair, and coated with antibodies and nucleotides that latch onto these specific markers, scientists have created a testing system a million times more sensitive than traditional methods. An array of these specially prepared nanowires, combined with new developments in nano-sized monitors and transmitters, could potentially lead to a robust, implantable medical device that could continually monitor a person’s body for a change, indicating early that there is a potential danger.
Video Segment Six – “Will You Still Feed Me When I’m 164?”
• Pose the question to the group for discussion, Would you get a treatment that would allow you to live longer? Why or why not?
• Imagine a time when nanotechnology-derived medical treatments allow people to live longer. How might society or our world be different if people elected to get this treatment?

Video Segment Seven – “If Not You, Then How About Your Kid?”
• Ask the group, Would you choose to extend your child’s life if you thought it was safe?
• In what ways would having a longer life spans change the life of a child?
• In this segment one of the speaker states, “Nanotechnology has the power to change the fabric of society.” Ask the group to discuss examples of this described in the program.

Video Segment Eight – “When Only the Rich Survive”
• Who should have access to nano-enabled medicines and therapies?
• Should the ability to pay give access to therapies unavailable to the less fortunate?
  Discuss viewer’s answers with the group.
• In what ways might access to an age-extending therapy change society based on what was discussed in the program?

Video Segment Nine – “The Final Words”
• John Hockenberry wraps up this session stating, “We began this discussion thinking that nanotechnology was about something really small and at the very least we can agree that there is nothing small about the issues raised by this new technology.” Discuss with the group what aspects of the program that support this statement. What other issues will it be important for you and for society to consider?

Extend the Discussion
• Visit the website www.powerofsmall.org where you can register your vote for issues relating to this episode.
• Find experts to answer the questions the group has raised. Pick a date to report back to the group and share the information you have collected.
• Search for newspaper articles and magazines that talk about current events as they relate to nanotechnology and it’s applications in human health.
Nanotechnology: The Power of Small – Clean, Green, and Unseen
Program Viewing Guide

Synopsis of “Clean, Green, and Unseen”
Solar Synergies, a new solar panel company, is coming to the town of Sunnyville. Watch as panel members debate the economic and environmental impact of this big move. As members of the town government they must vote to approve the move, but is there enough information to make a judgment? How much information should the company be required to provide to the community, and how much risk should the community be asked to take on if the environmental risk is unknown? Watch as panelists discuss these and other issues as they explore the connections between emerging nanotechnology and the environment.

Before Viewing
Visit the website www.powerofsmall.org so that you can
• Preview the background and expertise of each panelist involved in the discussions
• Listen to short, informative audio productions on nanotechnology from Earth and Sky Radio by clicking on the listen to “Nano Radio” button above the video clips.

Viewing the Program
Cue the program to the beginning of the episode, The Power of Small—Environment at http://www.powerofsmall.org/topicpages/environment.php or on DVD.

Working with each Segment
1. Cue the first video segment.
2. Show the video segment.
3. Pose the end-of-segment questions to the viewing group. Several questions are provided for each segment. Based on the group you are working with and the time you have available decide if you will ask all of the questions or select key questions from the list.

You may ask the questions in a number of ways. Two suggested methods are to direct the group to
a. Turn to your partner and discuss the question or statement. After 2-3 minutes of discussion, ask volunteers to report their thoughts and discussion to the whole group.
b. Use the questions to generate whole group discussion.
End-of-segment questions

Video Segment One – “A Ray of Hope in Sunnyville”
- Pose the question to the group, What information would you want to know before Solar Synergy opens in Sunnyville?
- Would you want Solar Synergy in YOUR backyard? Why? Why not?

Video Segment Two – “Town Council Must Now Decide”
- Would you vote to allow Solar Synergies to come to Sunnyville?
- Do you agree with the town council vote? Why? Why not?

Video Segment Three – “Admiral Chicken Comes Back to Roost”
- Who would benefit from the reopening of Admiral Chicken?
- What risks are involved?
- Pose the question to the group, Would you be more willing to pay more for chicken that uses nanopackaging to avoid the risk of Salmonella poisoning?

Video Segment Four – “Good Life Chicken”
- Pose the question to the group, Would you eat Good Life chicken if you knew it contained special nanoparticles that reduce the amount of fat you absorb? Conduct a group vote. Discuss the group’s ideas.

Video Segment Five – “Clean Up or Leave”
- Pose the question to the group, What are the benefits and drawbacks of using nanotechnology-derived clean up methods?
- Dan Kammen, one of the panelists, comments that the scenario in this segment using nanoparticles to clean up toxic dumping is very different than the solar cell technology discussed in Video Segment One. In what ways are the two scenarios different?
- Would you vote in favor of or against running the pilot clean up project? Encourage discussion among pairs of participants and then ask participants to share their ideas with the group.

Video Segment Six – “Don’t Rub it In”
- Ask the group, Would you use sunscreen that contains nanoparticles?
- As a consumer, would you like to see products containing nanoparticles labeled as such?
- What products would you be willing to buy and use if you knew they contained nanoparticles?

Nanotechnology-clean water?

Nanotechnology has the potential to provide valuable methods to help quench the world’s growing demand for clean water. Water remediation, the removal of pollution or contaminants, is an expensive and time-consuming operation that is in high demand. Antimicrobial nanoparticles like silver and titanium dioxide can be used in combination with ultraviolet light found naturally in sunlight to remove potentially harmful bacteria, viruses and fungi during the water treatment process. The nanoparticles act as catalysts that aid the destruction of key structural components of the biological contaminants through oxidation. This method would save the use of large amounts of chemicals, fuel and electricity required by currently used methods, all of which have an impact on the environment. However, the long-term effects of silver and titanium dioxide nanoparticles on the environment and human health are currently unknown.
Video Segment Seven – “Looking to a Nano Future”

• Ask pairs of viewers to discuss the following questions;
  
  Twenty years from now, how do you think nanotechnology will be a part of our lives?

• What opportunities do you think nanotechnology might create?

Extend the Discussion

• Visit the website www.powerofsmall.org where you can register your vote for issues relating to this episode.

• Find experts to answer the questions the group has raised. Pick a date to report back to the group and share the information you have collected.

• Search for newspaper articles and magazines that talk about current events as they relate to nanotechnology’s environmental and energy applications.
Critical Consumer Cards

The critical consumer card is a tool designed to fit in a pocket or wallet that contains questions to prompt critical thought about an issue, question, or scenario. The cards were designed for use with the Nanotechnology: The Power of Small programs but can be used in a variety of ways. Prompt a group to use them once after watching the entire program, or frequently throughout an episode. Use the card as frequently as possible. You never know, maybe people will store them in their wallets and start using them on a regular basis!

Materials

For each participant
1 Critical Consumer card

Photocopy and cut out a card for each participant. If possible laminate the cards so that they can be stored in pockets and wallets for frequent use.

Procedure

1. Hand out a critical consumer card to each participant. Read the questions out loud with the group. Explain that the questions are designed to help a person think critically about a product or scenario. They can also help clarify what additional information needs to be identified in order to make an informed decision about a product or scenario. Point out that not every question applies to every situation. They will need to determine this when working with the questions.
2. Choose a scenario from the programs to evaluate. You might want to look at the use of nano particles in the Admiral Chicken Packaging discussed in the “Clean, Green, and Unseen”, or the health treatment that will expand a person’s life-span to one hundred and twenty years in the “Forever Young”.
3. With the group summarize the details of the scenario.
4. In small groups, prompt participants to answer the critical consumer questions about the scenario you are evaluating.
5. Ask for volunteers to share a summary of their discussion with the whole group.
6. Ask, What big questions arise from this?
7. As a group discuss ways to go about finding information and answers to the questions.
8. Ask the group to reflect upon their use of the critical consumer questions. What critical consumer questions did you have the most trouble answering while watching this segment? Why do you think this was the case?
Critical Consumer Question Cards

Directions: Photocopy and cut out one card for each participant.

<table>
<thead>
<tr>
<th>Critical Consumer Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who does this affect?</td>
</tr>
<tr>
<td>• Positively?</td>
</tr>
<tr>
<td>• Negatively?</td>
</tr>
<tr>
<td>• What are the short-term implications?</td>
</tr>
<tr>
<td>• What are the long-term implications?</td>
</tr>
<tr>
<td>Is it safe?</td>
</tr>
<tr>
<td>• For me? For others?</td>
</tr>
<tr>
<td>• For the environment?</td>
</tr>
<tr>
<td>What information is being used to make this decision?</td>
</tr>
<tr>
<td>What questions do I have about this?</td>
</tr>
<tr>
<td>• What information am I missing?</td>
</tr>
<tr>
<td>• Where can I go to find this information?</td>
</tr>
</tbody>
</table>