



NACK
CENTER

Nanotechnology Applications
& Career Knowledge

WWW.NANO4ME.ORG

Ways of Introducing Nanotechnology Into Your Program

The NACK Center was established at the Pennsylvania State College of Engineering, and is funded in part by a grant from the National Science Foundation.



Hosted by MATEC NetWorks www.matecnetworks.org

Welcome to NACK's Webinar

Today's Presenters

Center for Nanotechnology Applications and Career Knowledge (NACK)



Bob Ehrmann

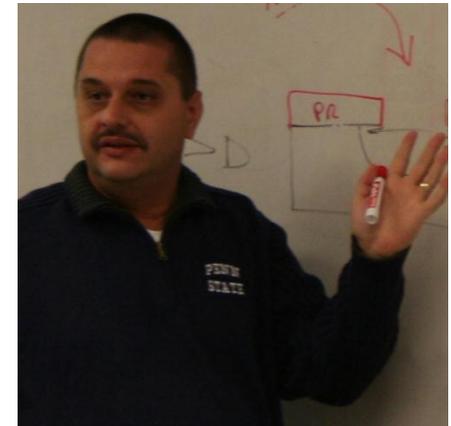
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Webinar Desired Outcomes

Participant Understanding of:

- Some projections for nanotechnology workforce needs
- Some key points for nanotechnology outreach and outreach resources
- Resources and training opportunities available to educators through NACK
- Other examples of resources that are available for the integration of nanotechnology (websites, experiments, learning modules, etc.)

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FAQ 1 – The “Why” Teach Nano Question



- Please give me some data on why I should adjust (upset??) my curriculum to include nanotechnology.
 - Is nanotechnology a real trend or just a fad?
 - Will there be jobs in industry for people who get training in nanotechnology



Why Teach Nano?

“It has been estimated that the worldwide market value of **products incorporating nanotechnology** will:

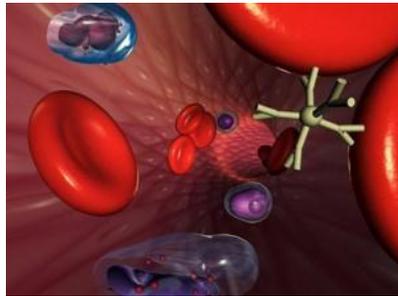
- increase by **100X** over the two decades

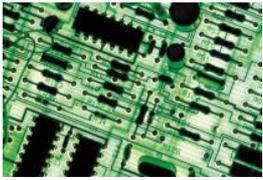


Why Teach Nano?

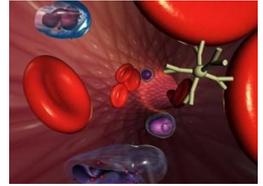
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- from about \$30 billion in 2000 to about **\$3 Trillion in 2020**





Why Teach Nano?



“It has been estimated that the worldwide market value of **products incorporating nanotechnology** will:

- increase by **100X** over the two decades
- from about \$30 billion in 2000 to about **\$3 Trillion in 2020**
-from 0.8% of GDP to **5% of GDP...**”



Mihail Roco, May 2011
Chemical Engineering Progress

Demand for Nanotechnology Workers

“.... promise of broad societal benefit from pursuing nanotechnology R&D..... where **nanotechnology plays a key role**, which would require:

- **2 million workers** with nanotechnology-related skills by 2020.

Mihail Roco
September 30, 2010



Demand for Nanotechnology Workers

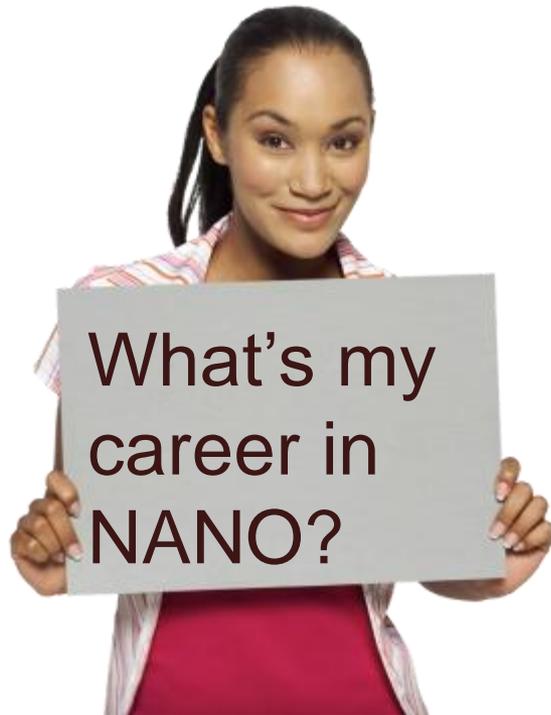
“ promise of broad societal benefit from pursuing nanotechnology R&D..... where **nanotechnology plays a key role**, which would require:



- **2 million workers** with nanotechnology-related skills by 2020.
-the rate of market increase is expected at a **25% increase per year**
- The nanotechnology markets and related **jobs** are expected to **double each three years....”**

Mihail Roco
September 30, 2010

Industries that Drive Demand



- Electronic/Semiconductor
- Biotechnology and Medical
- Pharmaceutical
- Optics/Optoelectronics
- MEMS
- Materials Design and Testing
- Food Industry/Water Purification
- Forensics
- Sales/Marketing
- University Research & Teaching
- Many More!

Job Titles for Nanotechnology Graduates

Nano in the Title ... Maybe Not??

Biological Laboratory Tech.	Laboratory Tech.	Production Scientist
Biofuels Tech.	Lithography Tech.	Quality Control Tech.
Chemical Laboratory Tech.	Materials Science Lab Tech.	Research Assistant
Cleanroom Tech.	Medical Devices Tech.	SEM Operator
Deposition Tech.	Microfabrication Tech.	SPM Operator
Device Tech.	Nanobiotech Researcher	Scientist Specialist
Equipment Maintenance Tech.	Nanoelectronics Expert	Solid State Tech.
Engineering Tech.	Nanofabrication Tech.	Test Tech.
Etch Tech.	Nanotechnologist	Thin Films Tech.
Failure Analysis Tech.	Process Tech.	Vacuum Tech.

Source - NACK Alumni Committee

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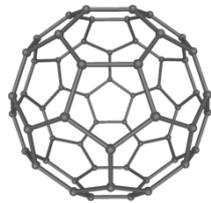
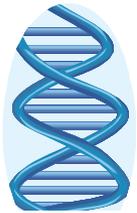
FAQ 2 – The Outreach Question

- I want to do some outreach in nanotechnology to make people aware of the impact it is having and stress some key points.
 - Where do I start?
 - What are some of the key points I should make?
 - What resources are available to me?



Nanotechnology is:

the creation of **functional** materials, devices, and systems through **control of matter** at the scale of **1 to 100 nanometers**, and the exploitation of novel properties and phenomena at the same scale.



A Nanometer is Very Small – so teaching scale is **important**

- Here is a you tube video that we use in our outreach to *drive* this point home



Museum of Science, Boston

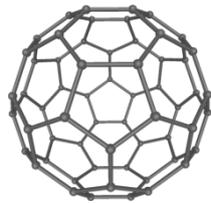
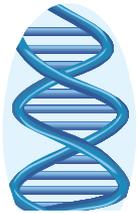
A Mini Lesson: How Small Is A Nanometer?



Museum of Science, Boston

Nanotechnology is:

the creation of **functional** materials, devices, and systems through **control of matter** at the scale of 1 to 100 nanometers, and the exploitation of **novel properties** and phenomena at the same scale.



Why is Nanotechnology Different?

- Because of their size, nano-products have **unique properties** not found at the everyday, macro scale
 - Ex:
 - Large surface to volume ratios = **high chemical reactivity**
 - Same scale as light's wavelength = **manipulate light**
 - Same scale as cells = **interaction** with **biological systems**
- Unique properties can be **tailored by adjusting the size and shape** of nanoscopic components

The Gold We Know:

- Material properties don't change with size.

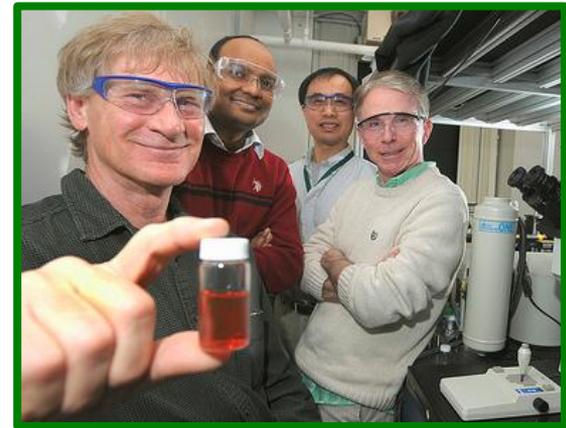
1																	2
H																	He
3	4											5	6	7	8	9	10
Li	Be											B	C	N	O	F	Ne
11	12											13	14	15	16	17	18
Na	Mg											Al	Si	P	S	Cl	Ar
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
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Ce		Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu			
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Th		Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr			



The Gold We Are Discovering:

- Material properties (e.g. optical) change with the size of the gold nanoparticle.

1																	2
H																	He
3	4											5	6	7	8	9	10
Li	Be											B	C	N	O	F	Ne
11	12											13	14	15	16	17	18
Na	Mg											Al	Si	P	S	Cl	Ar
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
87	88	89	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	--	--	--	--	--	--	--	--	--
		58	59	60	61	62	63	64	65	66	67	68	69	70	71		
		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
		90	91	92	93	94	95	96	97	98	99	100	101	102	103		
		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		



Nano Gold Behaves Differently

- Each element on the Periodic Table can give us **new capabilities** at the nanoscale
- The periodic table is now **multidimensional!**



Need Helpful Web Resources?

- The Project on Emerging Nanotechnologies has kept **track of the impact** nanotechnology has in the **economy** and **public and environmental health**
- Searchable inventory of **over 1,000 consumer products**
- Funded by *Woodrow Wilson International Center for Scholars* and *The Pew Heritage Trust*
<http://www.nanotechproject.org/inventories/consumer/>
(included in handout)

Some Videos on Nano-Applications:

- NOVA Making Stuff Series (2011):
 - Making Stuff: Stronger
 - Making Stuff: Smaller
 - Making Stuff: Cleaner
 - Making Stuff: Smarter
- Each is one hour long



<http://www.pbs.org/wgbh/nova/tech/making-stuff.html>

(included in handout)

Webinar Desired Outcomes

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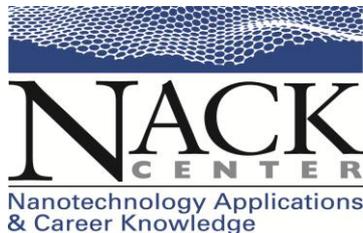
FAQ 3 – The Integrating Nanotechnology into the Classroom Question

- I want to utilize nanotechnology to teach science or integrate modular intro to micro-nanotechnology units into my classroom or curriculum.
 - How can I personally learn more about it?
 - Where can I find some good resources to utilize in my classroom?



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And Others...Can Help!!

The Portal to NACK Resources

Visit:

www.nano4me.org

The screenshot shows the Nano4Me.org website. At the top, the logo "Nano4Me.org" is displayed in a stylized font, with "4" in orange and "Me.org" in green. To the right of the logo, the text "EDUCATION & CAREERS IN NANOTECHNOLOGY" is written in a smaller, black, sans-serif font. Below the logo and text is a navigation bar with four links: "Home", "What is Nanotechnology?", "What are the Products?", and "Where are the Jobs?".

The main content area features a large green banner with the text "Take Matter Into Your Own Hands" in yellow and white. Below this text, it says "Choose a field that's changing the way we live and learn on our planet." To the right of the text is a photograph of a young man with glasses working at a computer workstation in a laboratory setting. A "WATCH VIDEO" button with a right-pointing arrow is located in the bottom right corner of the banner.

Below the banner is a section titled "The path you take could change the world:" with a list of navigation links: "Students >", "Alumni >", "Educators >", and "Industry >".

Next is an "About us:" section with links to "Nanotechnology Applications and Career Knowledge Center (NACK) Mission Statement >", "NACK resources for educators >", "NACK Staff/Contacting Us >", and "About Nano4Me >".

Below that is a "News and Links:" section with links to "Useful Links >" and "NACK Workshop News >".

The final section is "Contribute to this site:" with links to "Submit Program or Resources >" and "Submit Upcoming Workshop Info >".

On the right side of the page, there is a text block that reads: "Choose a pathway. Click on dark green states below to find 2-year degree nanotech education programs near you." Below this text is a map of the United States where states are shaded in various shades of green. A note below the map says: "Note: If you have trouble viewing the map, click [here](#) to download the latest Flash Player."

Introductory Level Modules

- Series of **thought-provoking** nanotechnology presentations
- In-depth material for **students and workers of all knowledge levels.**
- Designed to be used in **workshops, courses, and overview lectures**
- **Introduce nanotechnology** and its **applications.**
- Can be integrated into **secondary and post-secondary** curriculum as well as for **nanotechnology outreach**

Nano4Me.org EDUCATION & CAREERS IN NANOTECHNOLOGY

Access NACK Resources | Nano4me.org | Login | Join Now | Logout | Contact

You Are Here: Home » Introductory Level Modules

Introductory Level Modules



These introductory level modules are a series of thought-provoking nanotechnology presentations filled with in-depth material for students and workers of all knowledge levels. These modules are designed to be used in workshops, courses, and overview lectures to introduce nanotechnology and its applications.

Throughout these modules, you will find words and terms printed in the color blue. These words and terms are defined in the glossary, which can be viewed by clicking [here](#).

NOTE: You must be a registered user to download the following modules. If you are not a registered user, click [here](#) to subscribe. Registration is free!

Module 1: Nanotechnology: What Is It, and Why Is It So "BIG" Now?

Description: This module gives an overview of nanotechnology, what the word "nanotechnology" means, and where it comes from. It also explores the differences between the macro-scale, micro-scale, and nano-scale. Finally, this module explores how old nanotechnology is with a brief history and concludes with why nanotechnology is so popular today.

[Download Module 1 Now](#) [Download Supplemental Materials for Module 1](#)

NOTE: It is recommended that you download the supplemental materials along with the module so that the links to the multimedia files in the PowerPoint file function. If you have any issues with the links to the multimedia files, please contact us.

Module 2: A Brief History of Nanotechnology

Description: This module explores the history of nanotechnology: from Romans using gold and silver nanoparticles in their glasswork 2,000 years ago to modern day where nanoparticles are being used in cancer treatments.

[Download Module 2 Now](#)

Module 3: A Snapshot of Nanotechnology Today

Description: This module gives a snapshot of nanotechnology today including the worldwide investment in nanotechnology, workforce demands, and some examples of nanotechnology being used to enhance consumer products.

[Download Module 3 Now](#)

Module 4: The Uniqueness of the Nano-scale

Description: This module covers the unique attributes of the nano-scale and some examples of these unique attributes, including small size, high surface to volume ratio, surface forces in relation to bulk forces, quantum mechanical effects, and wave properties of light.

[Download Module 4 Now](#)

Module 5: How Do We "See" Things at the Nano-scale: An Introduction to Characterization Techniques

Description: This module provides an introduction to characterization techniques including transmission electron microscopy, scanning electron microscopy, x-ray spectroscopy, scanning probe microscopy tools, and quantum mechanical tunneling.

[Download Module 5 Now](#) [Download Supplemental Materials for Module 5](#)

NOTE: It is recommended that you download the supplemental materials along with the module so that the links to the multimedia files in the PowerPoint file function. If you have any issues with the links to the multimedia files, please contact us.

Module 6: How Do You Make Things So Small: An Introduction to Nanofabrication

Description: This module provides an introduction to nanofabrication including what is made through nanofabrication, how nanofabrication is directed, and the various processes involved in nanofabrication: top-down, bottom-up, and hybrid.

[Download Module 6 Now](#)

Module 7: How Do You Build Things So Small: Top-Down Nanofabrication

Description: This module gives an in-depth exploration of the process of top-down nanofabrication including the basic steps: deposition, pattern transfer, etching, and materials modification.

[Download Module 7 Now](#)

Module 8: How Do You Build Things So Small: Bottom-Up Nanofabrication

Description: This module gives an in-depth exploration of the process of bottom-up nanofabrication including the basic steps: building-block fabrication and self-assembly.

[Download Module 8 Now](#)

Module 9: Nanotechnology, Biology, and Medicine

Description: This module provides various examples of the impact of nanotechnology on biology and medicine. Biology topics include intra-cellular machinery and cancer cell structure. Medicine topics include disease intervention, drug delivery, and disease detection.

[Download Module 9 Now](#) [Download Supplemental Materials for Module 9](#)

NOTE: It is recommended that you download the supplemental materials along with the module so that the links to the multimedia files in the PowerPoint file function. If you have any issues with the links to the multimedia files, please contact us.

Module 10: Nanotechnology: Impact on Microelectronics

Description: This module explores the impact of nanotechnology on the field of microelectronics, the latest innovations, alternatives to nano-scale microelectronics, nanoelectronics, and moltronics.

[Download Module 10 Now](#)

Want Some More Nano Overview Information?



The screenshot shows the Nano.gov website header. On the left is the Nano.gov logo, a stylized atom with a red arrow pointing to it from the word "Try" on the left. To the right of the logo is the text "Nano.gov" in large yellow letters, with "National Nanotechnology Initiative" below it. Further right is the tagline "Leading to a revolution in technology and industry that benefits society". Below the header is a navigation menu with five main categories: "Nanotechnology 101", "Nanotechnology and You", "About the NNI", "Collaborations and Funding", and "Publications and Resources". To the right of these are three smaller links: "Education", "Newsroom", and "Events".

Try

Teacher Resources

One of the great strengths of nanoscience can also pose tough choices for teachers. Nanotechnology does not fall under one just discipline such as physics, biology, chemistry, materials science, or engineering, but all these and others. In science, technology, engineering, and math (STEM) education circles, there is an ongoing debate about nanotechnology education: Should it have its own individual curriculum? Or should nanotechnology be woven into the many scientific—and social—disciplines comprising its many elements?

This section won't settle that argument, but it does provide a wide variety of resources to help teachers who are making nanotechnology a part of their lesson plans.

Classroom Resources

- [National Center for Learning and Teaching \(NCLT\)](#) is dedicated to developing and offering nanotechnology-specific instructional modules, professional development, and a network of educator communities related to learning and teaching about the nanoscale. The website offers multiple resources across educational levels.
- [NanoEd Resource Portal](#) at Northwestern University is a rich resource for nanotechnology curriculum development and lesson plans, as well as video simulations and links for games, research, events, and news related to nanotechnology education.
- [Materials World Modules](#) offers for purchase a series of interdisciplinary teaching modules assembled by Northwestern University on nanoscience and materials topics—including composites, ceramics, concrete, biosensors, biodegradable materials, smart sensors, polymers, food packaging, and sports materials—and supports a virtual community of module users. The modules are designed for use in middle and high school science, technology, and math classes; they have been used by more than 9,000 students in schools nationwide.



Related Resources

You can find additional, useful resources for teachers on the [K-12 page](#).

Education

For Students K-12

★ [Teacher Resources](#)

[Higher Education Programs](#)
[Workforce and Training](#)

Want a Nano Intro Course or Nano - Modules?

- Visit [Nano-Link](#)
- Primary mission: Provide **topical, nanoscience content** in an **easy to integrate modularized format** for high school, college educators, and industry.
- Modules:
 - Require 3 to 5 hours of class time
 - **Inclusive package of activities, experiments, background information slides, questions** and other related material.
- Tailor the modules to meet needs of your classroom.



Want to Integrate into Nano Into Your Science Curriculum?

Try 

MREL

Mid-continent Research for Education and Learning

Delivering research and practical guidance to educators

Physical Science

Investigating Static Forces in Nature: The Mystery of the Gecko

Lesson 1
Lesson 2
Lesson 3
Lesson 4

Lesson 5
Lesson 6
Lesson 7
Lesson 8

NanoLeap

Entire Compilation—Lessons 1-8

+ [Physical Science Student Journals](#) (PDF 1.5 Mb)

+ [Physical Science Teacher Guides](#) (PDF, 2 Mb)

Preface

The *NanoLeap* project represents an approach for teachers to introduce the exciting world of nanoscale science and technology to their classes by integrating interdisciplinary research with traditional science concepts.

+ [Preface, Learning Objectives, Standards, & Big Ideas](#) (PDF 150 Kb)

+ [Materials Sheet](#) (PDF, 109 Kb)



Lesson 1: How Can a Gecko Walk on the Ceiling?

Students will:

- Make observations and interpretations of how the gecko's foot interacts with surfaces
- Formulate possible adhesive methods that might be considered for further investigations

+ [Teacher Guide](#) (PDF, 68 Kb)

+ [PowerPoint](#) (PPT, 373 Kb)

+ [Student Journal](#) (Word, 3 Mb)

+ [Tricky Feet](#) (WMV, 5.8 Mb)

+ [NanoSize Me](#) (QT, 4.7 Mb)



Lesson 2: What Do We Mean When We Speak About Surfaces in Contact?

Students will:

- Compare the amount of surface contact (real contact) to total unit area (apparent contact) at the macro level
- Understand that different textures of surfaces have different contact ratios

+ [Teacher Guide](#) (PDF, 55 Kb)

+ [PowerPoint](#) (PPT, 1.2 Mb)

+ [Student Journal](#) (Word, 4.6 Mb)



Chemistry

Nanoscale Materials and Their Properties

Unit 1
Unit 2

Poster Assessment
Unit 3

NanoLeap

Preface

The *NanoLeap* project represents an approach for teachers to introduce the exciting world of nanoscale science and technology to their classes by integrating interdisciplinary research with traditional science concepts.

+ [Preface](#) (PDF 31 Kb)

+ [Teacher Resource Guide](#) (PDF 414 Kb)

+ [Student Handbook Student Version](#) (Word Doc 4 Mb)

+ [Student Handbook Teacher Version](#) (PDF 818 Kb)

+ [National Science Education Standards Addressed](#) (PDF 31 Kb)

+ [Materials Sheet](#) (PopUp)



Unit 1: What is it?

Students will:

- Define nanoscience as the study of the fundamental principles of structures having at least one dimension lying roughly between 1 and 100 nanometers.
- Explain the importance of nanoscience research and technology.
- Evaluate the ethical considerations associated with nanoscience research and nanotechnology.
- Recognize the interdisciplinary nature of nanoscience.
- Identify the requirements of nanoscience and nanotechnology.

Lesson 1.1: What is Nanoscience?

+ [Teacher Guide](#) (PDF, 37 Kb)

+ [PowerPoint](#) (PPT, 463 Kb)

Lesson 1.2: What Makes Nanoscience So Different?

+ [Teacher Guide](#) (PDF, 90 Kb)

+ [PowerPoint](#) (PPT, 678 Kb)

Lesson 1.3: What Makes Nanoscience So Important?

+ [Teacher Guide](#) (PDF, 114 Kb)

+ [PowerPoint](#) (PPT, 535 Kb)



Want More Curriculum Integration?

Try



National Nanotechnology Infrastructure Network

NNIN Education Portal

Jump to: [Featured Topics](#) [Featured Activities](#)

- K-12 Students
- K-12 Teachers
- Undergrads
- Graduates & Professionals
- Community
- [All Technology Articles](#)

NNIN Site Activities

What's going on in NNIN Education [more info >](#)

NNIN REU Program

Our Network-wide summer undergraduate internship program in Nanotechnology [more info >](#)

Related NNIN Sites

- [NNIN Social and Ethical Issues Portal](#)
- [Main NNIN Site](#)
- [NNIN Education Coordinator Contact](#)

Nanotechnology

Learn all about the world of very small structures
Brought to you by the **National Nanotechnology Infrastructure Network**

Elementary students will find our Children's Science Magazine, Nanooze, most interesting. Other links on this page are primarily directed to teachers, the public, and upper level students. [more info >](#)

Featured NNIN Education Topics

Additional topics available under categories at left

- Nanotechnology Products**
Nanotechnology Products you can buy [more info >](#)
- Nanotechnology Careers**
Exciting Science and Engineering Careers [more info >](#)
- Nanostructures in Nature**
Natural Nanotechnology [more info >](#)
- Multimedia**
Training and seminars for professionals & graduates [more info >](#)
- Seeing Nanostructures**
How do we "see" nanostructures [more info >](#)
- How Big?**
Just how big (or small) are nanostructures [more info >](#)

[Back to the Top](#)

Want to integrate MEMS Technology? Kits?

Try →



The screenshot shows the SCME-NM.ORG website. The header includes the logo and navigation menu. The main content area is titled 'Kits for the Classroom' and lists 11 different MEMS technology kits available for educational use. A red arrow points from the word 'Try' to the website.

SCME-NM.ORG
NSF ATE Regional Center

Home News Educational Materials Partners SCME Events Job Links About Us Safety

Main Menu

- [Educational Materials](#)
- [Videos](#)
- [Publications and Presentations](#)
- [What's New on Site?](#)
- [Synergy Project](#)
- [WEB Links](#)
- [Matt's Corner](#)
- [SCME Calendar](#)
- [MTTC Events](#)
- [Jim's Corner](#)
 - [Industry Relations](#)
- [Fab Notes](#)
- [SCME Tech Corner](#)
- [Workshop News](#)

Partner News

- [Read all the News Flashes!](#)
- [SIPI News](#)
- [CNM News](#)
- [NW Vista College News](#)
- [UNM MTTC Cleanroom](#)

Who's Online

We have 32 guests online

For Administrators

- [Administrator](#)

SCME Home » [Educational Materials](#) » Kits for the Classroom

Newsflash: Turn your cell phone camera into a microscope – the folks at University of California at Davis figured this out – we will try this to image small stuff in our classrooms – never know, a kit may come out of this! Check out each of the links:

- [Researchers Turn iPhone Into 350x Microscope on the Cheap](#)
- [Turning The iPhone Into A 350x Medical Microscope For Under \\$50](#)
- [Cell-Phone-Based Platform for Biomedical Device Development and Education Applications](#)

[Downloads Home](#) [Search Document](#)

Kits for the Classroom

This category contains information about the SCME kits that are available to instructors who are planning to incorporate MEMS Technology into their classroom and are looking for exciting, thought-provoking activities.

1. Anisotropic Etch Activity and Kit
2. Crystallography Activities and Kits
3. GeneChip Model Activity and Kit (available Fall, 2011)
4. Dynamic Cantilever Activity and Kit
5. Lift-Off Activity and Kit
6. LIGA Micromachining Activities and Kit (available Fall, 2011)
7. MEMS: Making Micro Machines DVD Kit
8. MEMS Innovators Activity and Kit
9. Pressure Sensor Model Activity Kit
10. Pressure Sensor Process Activity and Kit
11. Rainbow Wafer Activity and Kit

To order a kit, please complete the [SCME Kit Order Form](#).

Files may not download with Internet Explorer – use Mozilla Firefox browser (free).

Files

Some Helpful Web Resources

- National Nanotechnology Institute (NNI): www.nano.gov
- Nano-Link: <http://www.nano-link.org/>
- NNIN.org education portal – RET lessons and more:
http://www.nnin.org/nnin_k12teachers.html
- Mid-continent Research for Education and Learning McREL:
<http://www.mcrel.org/NanoLeap/>
- SCME: http://scme-nm.net/scme_2009/index.php?option=com_docman&Itemid=53
- NCLT - Materials World Modules:
<http://www.materialsworldmodules.org/>
- University of Wisconsin – Madison – MRSEC:
<http://mrsec.wisc.edu/Edetc/modules/index.html>
- NanoHUB: <http://nanohub.org/education/nanocurriculum/>
- Molecular Workbench – <http://mw.concord.org/modeler/>
- NanoProfessor: www.nanoprofessor.net



- *Others ???*  Refer to your handout!

Faculty Development: Educator Workshops



Professional Development Opportunities

- NISE Net / Nano Days
- UCLA
- SCME Workshops & Webinars
- Nano-Link / U Minn Workshop
- SHINE – N.Seattle CC
- Ohio State (NSEC)
- Exploratorium
- NACK

NACK Introductory Educator Workshops:



Workshop Desired Outcomes – Participant Understanding of:

- The Uniqueness of Nano-scale Materials
- How Nanotechnology is Impacting us Today
- Why Teaching Nanotechnology is Important
- Basic Nanofabrication Processing Techniques
- Nano-scale Characterization Techniques
- Basics of Clean Room Protocol
- Exposure to Some Nanotechnology Research Applications
- Educational and Career Opportunities in Nanotechnology

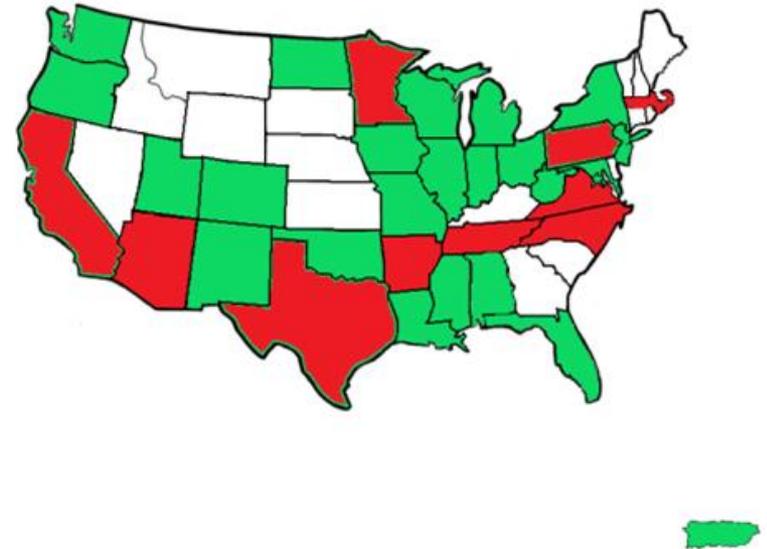
Educator Workshops

Attendees to Date:

- 983 Educators
- 34 States, DC, and Puerto Rico

2012 NACK Introductory Educator Workshop Schedule

- May 1-3
- Nov 13-15



Want to Learn More.....

but can't get of Dodge???



Try
Webinars!

NACK Webinar Series



- Live monthly webinars
- Hosted by MATEC NetWorks
- Engage **and** Educate
- FREE to attend
- Recordings and slides available

Stay informed. Find resources across the country.

Access NACK RESOURCES	Attend WORKSHOPS	Remote ACCESS	Recruit STUDENTS	Attend WEBINARS
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Webinars

The NACK center offers a live webinar, hosted by MATEC NetWorks, every month to engage and educate those of you that are interested in learning more about nanotechnology related topics. If you have an idea for a webinar please [contact us](#).

To view archived webinars please visit the links below:

Upcoming Webinars

- + [Ways of Introducing Nanotechnology Into Your Program](#)
January 27, 2012
- + [How is Nanotechnology Changing the Electronics Industry?](#)
February 24, 2012
- + [Building a Nanotechnology Workforce](#)
March 30, 2012
- + [Nanotechnology and Materials](#)
April 27, 2012
- + [How Safe is Nanotechnology in Our Lives?](#)
May 24, 2012

Micro Nano Tech (MNT) 2012 Conference

- Produced by 5 NSF Advanced Technology Education (ATE) Centers:
 - MATEC – Arizona
 - NACK – Pennsylvania
 - Nano-Link – Minnesota
 - NEATEC – New York
 - SCME – New Mexico
- Build and foster nanotechnology communities across the country



MNT 2012 Conference – Who Attends?

Educators/Administrators who **have**,
will, or **plan to** implement nano
programs and/or coursework into their
curriculum.

Join us!

MNT 2012 - May 7-9, 2012 @ NACK

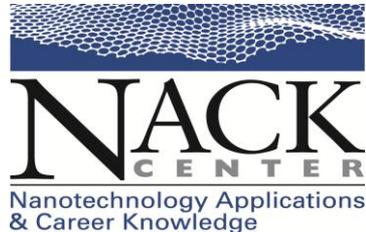
FAQ 4: The Starting a Nano Program Question

- I'm ready to jump in with both feet and begin integrating a full program in nanotechnology
 - Where do I start?
 - What resources are available to me?



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Can Help!!

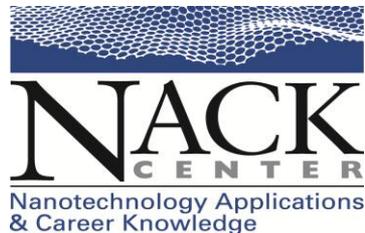
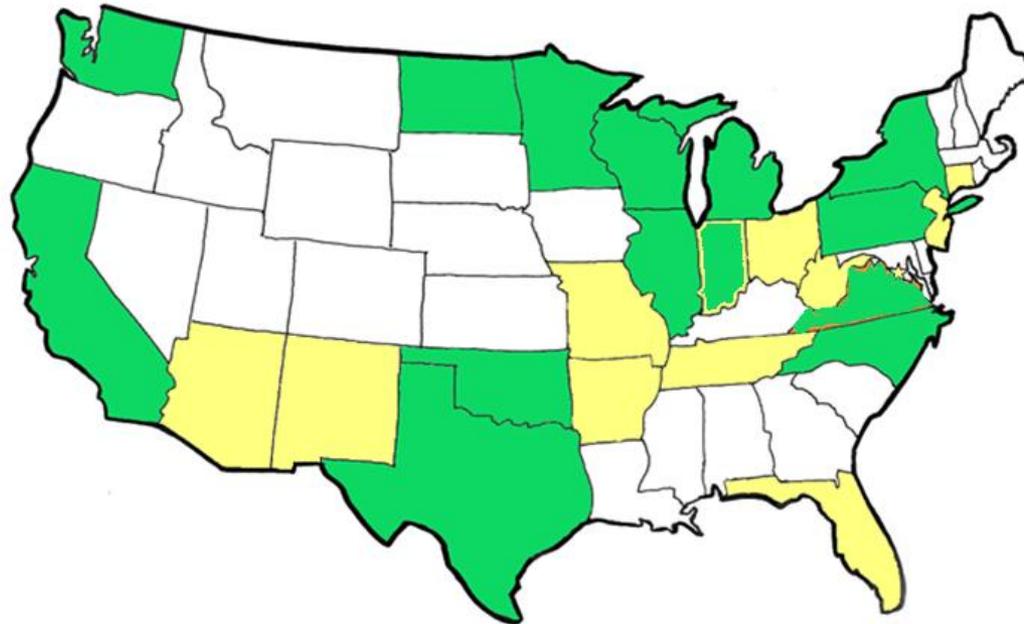
The Mission of NACK is to enable Nanotechnology Education at:

- 2-year Community & Technical Colleges
- 4-year Universities and Colleges in Partnership with Community & Technical Colleges

The NMT Partnership
Discover a Nanofabrication Manufacturing Technology program near you, and prepare yourself for a career with cutting-edge technology and great starting salaries.

A Associate Degree Program Available **B** Baccalaureate Degree Program Available **U** Penn State, University Park (Certificate, Baccalaureate, Capstone Semester)

Nanotechnology Associate Degree Programs 2011 PLUS Works In Progress



Summary of Skill Sets Taught in the 6 Nanotechnology Courses

Basic Nanotechnology EHS Awareness

- Basics of Chemical and Material Properties—Role of Scale
- Chemical and Materials Handling, Storage, and Disposal
- Nanotechnology Health, Safety, and Environmental issues

Nanotechnology Equipment and Processing Foundation Skills

- Chemical Hoods and Glove Boxes: Use and Maintenance
- Cleanrooms: Use and Maintenance
- Pumps, Flow Control Systems, Scrubbers, Sensors: Use and Maintenance
- Vacuum Systems: Use and Maintenance
- Plasma Generating Systems: Use and Maintenance
- Furnaces, Ovens, and Rapid Thermal Annealing Equipment: Use and Maintenance
- Chemical Facilities and Maintenance
- Contamination Control
- Process Integration
- Introduction to Statistical Process Control

Nanotechnology Patterning

- Optical, e-beam, and Ion Beam Lithography
- Stamping and Imprinting Lithography
- Chemical techniques; e.g., Block co-polymer and SAMs

Nanotechnology Fabrication

- Top-down Fabrication
 - Reactive Ion, Sputter, and Wet Etching
 - Chemical Vapor and Physical Vapor Deposition Systems
 - Ion Beam, Plasma, and Chemical Materials Modification
 - Nanoparticles: Etching and Grinding Approaches
- Bottom-up Fabrication
 - Chemical, Physical, and Biological Self-Assembly
 - Nanoparticles: Colloidal Chemistry
 - Nanoparticles: Plasma Approaches
 - Nanoparticles: Chemical Vapor Deposition Approaches

Nanotechnology Characterization

- Optical Microscopy
- Scanning Probe Microscopy
 - Atomic Force Microscopy
- Electron Microscopy
 - Scanning Electron Microscopy (SEM and FE-SEM)
 - Transmission Electron Microscopy (TEM and FE-TEM)
- Chemical Characterization
 - X-ray (EDS)
 - Secondary Ion Mass Spectroscopy
 - Auger Electron Spectroscopy
 - Fourier Transform Infrared Spectroscopy
- Electrical Characterization
 - Current-Voltage Measurements
 - Capacitance Measurements
 - Opto-electronic Device Measurements
- Physical Characterization
 - Spectrophotometer
 - Profilometer
 - X-ray Diffraction

Nanotechnology Professional Skills

- Team Building
- Problem Solving
- Project Organization and Planning
- Research Skills
- Assessing Cost of Ownership
- Presentation Skills
- Technical Reporting and Documentation
- Handling and Generating Intellectual Property

The Portal to NACK Resources

Visit:

www.nano4me.org

The screenshot shows the Nano4Me.org website homepage. At the top, the logo "Nano4Me.org" is displayed in a stylized font, with "4" in orange and "Me.org" in green. To the right of the logo, the text "EDUCATION & CAREERS IN NANOTECHNOLOGY" is written in a smaller, black, sans-serif font. Below the logo and text is a navigation bar with four links: "Home", "What is Nanotechnology?", "What are the Products?", and "Where are the Jobs?".

The main content area features a large green banner with the text "Take Matter Into Your Own Hands" in yellow and white. Below this text, it says "Choose a field that's changing the way we live and learn on our planet." To the right of the text is a photograph of a young man with glasses working at a computer workstation in a laboratory setting. A "WATCH VIDEO" button with a right-pointing arrow is located in the bottom right corner of the banner.

Below the banner is a section titled "The path you take could change the world:". This section contains a vertical list of navigation links: "Students >", "Alumni >", "Educators >", and "Industry >".

Below the navigation links is a section titled "About us:". This section contains several links: "Nanotechnology Applications and Career Knowledge Center (NACK) Mission Statement >", "NACK resources for educators >", "NACK Staff/Contacting Us >", and "About Nano4Me >".

Below the "About us" section is a section titled "News and Links:". This section contains two links: "Useful Links >" and "NACK Workshop News >".

Below the "News and Links" section is a section titled "Contribute to this site:". This section contains two links: "Submit Program or Resources >" and "Submit Upcoming Workshop Info >".

On the right side of the page, there is a map of the United States. The map is color-coded with various shades of green, representing different states. A note below the map reads: "Note: If you have trouble viewing the map, click [here](#) to download the latest Flash Player."

NACK Educator Resources

- Post Secondary Resources
- Educator Workshops
- Webinars
- Remote Access to Tools
- K-12 Resources
- Interactive Multimedia

The path you take could change the world:

- Students >
- Alumni >
- Educators >**
- Industry >

About us:

- Nanotechnology Applications and Career Knowledge Center (NACK) Mission Statement >
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Contribute to this site:

- Submit Program or Resources >
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Stay informed. Find resources across the country.

Access NACK RESOURCES Attend WORKSHOPS Remote ACCESS Recruit STUDENTS Attend WEBINARS

The NACK commitment

The NACK Center is committed to supporting development of two-year degree programs in micro- and nanotechnology across the country by offering academic and educational resources.

CLICK HERE TO ACCESS RESOURCES

View/Download

(or click on the individual resource links below)

Post-Secondary Resources

Introductory Level Modules: A series of thought-provoking nanotechnology PowerPoint presentations filled with in-depth material surveying where nanotechnology came from, why it is so unique, how it is practiced, and what it can do.

Undergraduate Level Course Notes: Packaged as six courses, each containing multiple modules. Each module can be rearranged to create new courses. Suitable for two-year degree programs, for certificate programs, and for freshman-sophomore use in four-year degree programs.

Undergraduate Level Laboratories: These are a set of six lab packages corresponding to the set of six course notes. Labs can be rearranged to accommodate new course arrangements. Suitable for two-year degree programs, for certificate programs, and for freshman-sophomore use in four-year degree programs.

Remote Access: A collection of characterization equipment that may be remotely controlled through the Internet.

K-12 Resources

Introductory Level Modules: A series of thought-provoking nanotechnology PowerPoint presentations filled with in-depth material surveying where nanotechnology came from, why it is so unique, how it is practiced, and what it can do.

Introductory Level Activities: Interactive nano-enabled products used to expand the imaginations of K-12 students with current applications benefiting from nanotechnology.

Multimedia: A collection of interactive multimedia in nanotechnology. These resources are suitable for a variety of levels and subject areas.

High School Level Nanotech Academy Activities: A collection of informal activities created for a 1-3 day nanotechnology camp available to those interested in creating similar events or to supplement the classroom experience.

High School Level Experiments: A collection of experiments and activities that introduce nanotechnology concepts and applications to many levels; includes, but is not limited to, nanoparticle synthesis for bacterial inhibition, micro- and nanofluidic device fabrication with common materials, micro- and nanoencapsulation, and nanowire sensor applications.

Professional Development

Workshops: NACK offers a series of workshops for educators and administrators who are interested in exploring the world of nanotechnology and the impact it is having on their lives and will have on the careers of their students. These workshops range from learning introductory nanotechnology basics to learning how to most effectively utilize NACK nanotechnology resources within their institutions.

Remote Access to Tools: NACK brings cutting-edge technology and instrumentation into your classroom, laboratory, and industry site by offering remote access to nanotechnology characterization instruments.

Student Recruitment: NACK offers assistance in the development and refinement of strategies to promote education and career opportunities in nanotechnology.

Webinars: NACK offers periodic live webinars to engage and educate those of you that are interested in learning more about nanotechnology related topics. NACK webinars are archived for new or refresher nanotechnology educator professional development.

Undergraduate Level Course Material for 6 NACK Courses

- Classroom presentation material
 - Arranged in modular units
 - Videotaped lectures are now available
- Hands-on labs for the courses

The screenshot shows the Nano4Me.org website interface. At the top, the logo "Nano4Me.org" is displayed in a stylized font, with "EDUCATION & CAREERS IN NANOTECHNOLOGY" written below it. A navigation bar contains links for "Access NACK Resources", "Nano4me.org", "Login", "Join Now", "Logout", and "Contact". Below the navigation bar, a breadcrumb trail reads "You Are Here: Home > Undergraduate Level Course - Classroom Presentations". The main heading is "Undergraduate Level Course - Classroom Presentations". To the right of the heading are icons for a document, a printer, and an email. Below the heading, a green text box states: "You must log in to download the following modules and materials." Two buttons are provided: "Create a Free User Account" and "Registered User Login". A note below the buttons says: "Once logged in, click on the item you would like to download." The page lists six course modules, each with a title and a brief description:

- ESC 211: Materials, Safety, & Equipment Overview for Nanotechnology**
This course provides an overview of the materials, safety and equipment issues encountered in the practice of "top down" and "bottom up" nanofabrication. It focuses on safety, environmental and health issues in equipment operation and materials handling as well as on cleanroom protocol. Topics to be covered include: cleanroom operation, OSHA lab standard safety training, health issues, Biosafety Levels (BSL) guidelines, and environmental concerns.
- ESC 212: Basic Nanotechnology Processes**
This course is the hands-on introduction to the processing involved in "top down", "bottom up", and hybrid nanofabrication. The majority of the course details a step-by-step description of the equipment, facilities processes and process flow needed to fabricate devices and structures. This hands-on exposure covers basic nanofabrication processes including colloidal chemistry, self-assembly, catalyzed nanoparticle growth, lithography, wet and dry etching, physical vapor deposition, and chemical vapor deposition.
- ESC 213: Materials in Nanotechnology**
This course is an in-depth, hands-on exposure to materials fabrication approaches used in nanofabrication. Students learn that these processes can be guided by chemical or physical means or by some combination of these. Hands-on exposure will include self-assembly; colloidal chemistry; atmosphere, low-pressure and plasma enhanced chemical vapor deposition; sputtering; thermal and electron beam evaporation; nebulization and spin-on techniques.
- ESC 214: Patterning for Nanotechnology**
This course is a hands-on treatment of all aspects of advanced pattern transfer and pattern transfer equipment including probe techniques; stamping and embossing; e-beam; and optical contact and stepper systems. The course is divided into five major sections: pattern generation processes; photolithography; particle beam lithographic techniques; probe pattern generation; and embossing lithography, step-and-flash, stamp lithography, and self assembled lithography.
- ESC 215: Materials Modification in Nanotechnology**
This course will cover in detail the processing techniques and specialty hardware used in modifying properties in nanofabrication. Material modification steps to be covered will include etching, functionalization, alloying, stress control and doping. Avoiding unintentional materials modification will also be covered as well as hands-on materials modification and subsequent characterization.
- ESC 216: Characterization, Testing of Nanotechnology Structures & Materials**
This course examines a variety of techniques and measurements essential for testing and for controlling material fabrication and final device performance. Characterization includes electrical, optical, physical, and chemical approaches. The characterization experience will include hands-on use of tools such as the Atomic Force Microscope (AFM), Scanning Electron Microscope (SEM), fluorescence microscopes, and fourier transform infrared spectroscopy.

Undergraduate Level Resources: Presentations

Undergraduate Level Classroom Presentation Materials



ESC 211: Materials, Safety, and Equipment Overview for Nanotechnology

Unit Title	PDF File	PowerPoint File	Videotaped Lectures		
1. Safety and Environmental Concerns	Download	Download	Lecture 1	Lecture 2	
2. Vacuum Function, Operation and Systems	Download	Download	Lecture 1	Lecture 2	
3. Materials Overview	Download	Download	Lecture 1	Lecture 2	Lecture 3
			Lecture 4	Lecture 5	Lecture 6
4. General Processing Concerns, Contamination, and Damage	Download	Download	Lecture		
5. Basic Characterization Tools	Download	Download	Lecture 1	Lecture 2	

Laboratory Activities Available for Download:

ESC 211 Laboratories

[ESC 211 Lab Overview](#)

[Lab 1: EHS: Chemical & Materials Overview](#)

[Lab 2: EHS: Equipment Safety Awareness](#)

[Lab 3: Vacuum Equipment Simulation Lab with EquipSim](#)

[Lab 4: Vacuum Equipment Components & Systems Part 1](#)

[Lab 5: Vacuum Equipment Components & Systems Part 2](#)

[Lab 6: Introduction to Metrology & Characterization](#)

- All labs have an overview to introduce you to the core objectives
- Include sample questions to quiz students

Faculty Development: Educator Workshops



Nanotechnology Course Resources I & II

Workshops (Series of 2):

Workshop Desired Outcomes – Participant Understanding of:

- Background information on NACK course and laboratory material development.
- Strategies for delivery of NACK course material
- Strategies for delivery of NACK laboratory material
- Understanding of equipment needs and costs needed for first class hands-on nanotechnology education
- Understanding of various modes available for teaching nanotechnology hands-on courses (on-site, remote, hybrid)
- Next steps plans for back home course/program development and continuous improvement of existing nanotechnology education offerings

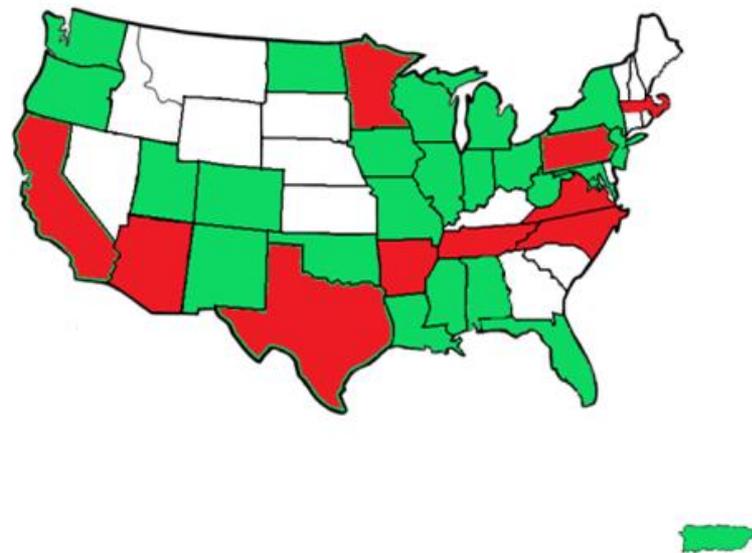
Educator Workshops

Attendees to Date:

- 983 Educators
- 34 States, DC, and Puerto Rico

2012 NACK Course Resource Workshop Schedule

- Apr 16-19 & Sep 17-20
Nanotechnology Course Resources I
(Safety, Processing, & Materials)
- Aug 13-16 & Oct 1-4
Nanotechnology Course Resources II
(Patterning, Characterization, & Applications)



Webinar Desired Outcomes

Participant Understanding of:

- Some projections for nanotechnology workforce needs
- Some key points for nanotechnology outreach and outreach resources
- Resources and training opportunities available to educators through NACK
- Other examples of resources that are available for the integration of nanotechnology (websites, experiments, learning modules, etc.)

Webinar Desired Outcomes

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- Some key points for nanotechnology outreach and outreach resources
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How Can We Better Serve You?

Whether you are joining us live or watching the recorded version of this webinar, please take 1 minute to provide your feedback and suggestions.

<http://questionpro.com/t/ABkVkZLohu>

Webinar Recordings

To access this recording, slides and handout visit

www.matecnetworks.org

Keyword Search:

“NACK Webinar Ways of Introducing Nano ”

Certificate of Participation

If you attended the live version of this
1.5 hour webinar and would like a
certificate of participation, please email:

sbarger@enr.psu.edu

Upcoming NACK Events – 2012

February 24:

Webinar

How is Nanotechnology
Changing the Electronics
Industry?

March 30:

Webinar

Building a Nanotechnology
Workforce

April 16-19:

Workshop

Nanotechnology Course
Resource I: Safety, Processes,
and Materials

May 1-3:

Workshop

Hands-on Introduction to
Nanotechnology for Educators

Visit www.nano4me.org for more details
about these and other upcoming webinars and workshops.

Thank you for attending the
NACK Center webinar

Ways of Introducing Nanotechnology Into Your Program