

BROOKHAVEN NATIONAL LABORATORY
Office of Educational Programs

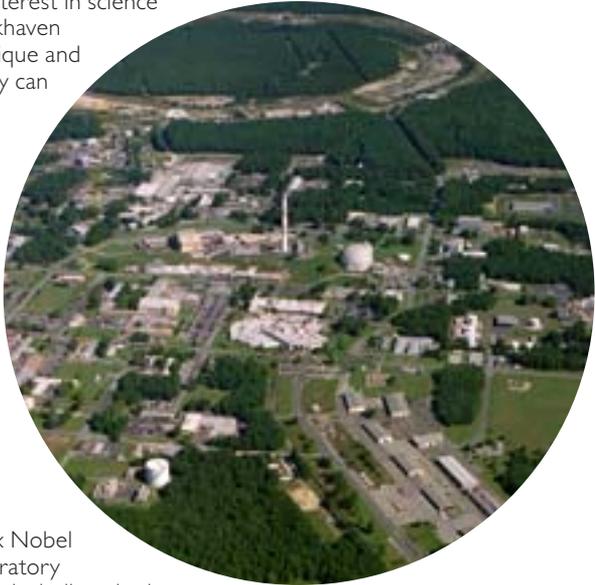
**COURSE OFFERINGS
FOR 2007/2008**



**Building the Science and Technology
Workforce of the Future**

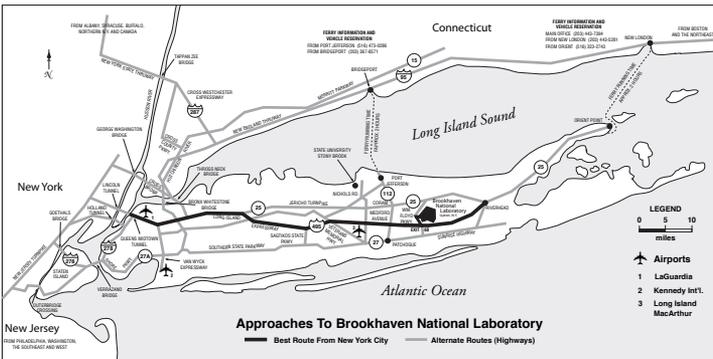
A Passion for Discovery

Motivate your students' interest in science by bringing them to Brookhaven National Laboratory, a unique and exciting setting where they can experience "Big Science". At BNL, students become scientists themselves, exploring the nature of matter and seeking conclusions based on their own data. The experience focuses on making abstract scientific concepts real as they engage in hands-on activities grounded in research done at BNL.



Established in 1947, the Laboratory is one of the Department of Energy's premiere facilities, with six Nobel Prizes awarded. The Laboratory conducts research in areas including physics, chemistry, biology, nanotechnology, nuclear medicine, computer science, and environmental science. Brookhaven is a 5,300-acre complex with some of the most powerful tools available for scientific research. Come be a scientist for the day and join in our passion for discovery.

If you can't bring your students to the Lab to experience the excitement of Brookhaven National Laboratory, let us bring it to you. Students will have the excitement of Laboratory staff bringing the world-class science of Brookhaven to the classroom in a dynamic and interactive way.



Directions: Brookhaven National Laboratory is located on William Floyd Parkway, County Road 46, 1 1/2 miles north of Exit 68 on the Long Island Expressway.

About Brookhaven National Laboratory Educational Programs

It is with great excitement and enthusiasm that we offer the programs outlined in this brochure to the Long Island educational community. Brookhaven National Laboratory's Office of Educational Programs has provided science education programs for students and teachers for many years. Our Science Learning Center has hosted thousands of elementary students per year for more than two decades. Our contests, summer internships, and many other activities motivate and inspire our youth to become science literate, and perhaps pursue a rewarding career in science or technology.

In an effort to further expand our service to our community and school districts, we now offer hands-on science programs, both on-site and off-site, for students in middle, junior, and high school. These programs, offered at cost, are designed to reinforce student understanding of scientific concepts.

We are also excited about our partnership with the Board of Cooperative Educational Services. Schools that subscribe to BOCES can access our programs in a way that supports cost recovery through New York State. Please inquire about this process when scheduling programs.

The Brookhaven National Laboratory Office of Educational Programs staff take great pride in ensuring that each and every participant in our programs has a rewarding and enriching experience.

We look forward to working with you and your students as we build the science and technology workforce of the future.

Sincerely,
Ken White

Manager, Office of Educational Programs
Brookhaven National Laboratory
www.bnl.gov/education



Scheduling a Program

1. Identify courses of interest and the approximate dates you would like to attend them.
2. Call the Office of Educational Programs at 631-344-4495.
3. Schedule dates, courses, and locations.
4. Identify method of payment – schools with BOCES agreements may be processed differently. This should be discussed at the time of scheduling.
5. A confirmation letter, pre-arrival information, and workshop protocols will be sent to the teacher.
6. Invoice will be sent upon program completion.
7. Rescheduling and Cancellations:
Programs may be rescheduled with no less than one week's notice. Cancellations may be made up to one week in advance with no charge. Cancellations made with less than one week's notice will be invoiced in full. Weather related cancellations will be rescheduled.



Brookhaven National Laboratory

On-site Course Offerings for 2007/2008

The programs listed below are all available at Brookhaven National Laboratory. Some of the programs may also be offered at the school. The programs are listed in a suggested sequence. Detailed descriptions are provided on subsequent pages. All programs may be scheduled, or additional information obtained, by contacting the BNL Office of Educational Programs at 631-344-4495.

MIDDLE SCHOOL			
MS001	Make Your Own Cell Model	1 hour	\$200
MS002	DNA Extraction	1 hour	\$200
MS003	Gene Transfer and Genetic Engineering	1 hour	\$200
MS004	Protein Extraction and Purification	2 hours	\$400
MS005	Virus!	1 hour	\$200
MS006	A "Corny" Experience With Mendel's Law of Heredity	1 hour	\$200
MS007	Protein Structural Biology in 3-D: The Shape of Things to Come	1 hour	\$200
MS008	Find Jake the Snake: Use GPS and Radiotelemetry to Track, Map, and Monitor Animal Behavior	2 hours	\$400
MS009	Nanotechnology – Little Things Bring Big Change	1 hour	\$200

HIGH SCHOOL

BIOLOGY

HS001	DNA Analysis: Cutting DNA with Enzymes (AP Lab)	3 hours	\$600
HS002	Gene Transfer and Genetic Engineering (AP Lab)	3 hours	\$600

CHEMISTRY

HS005	The Citric Acid Process of Remediation	Two part, see below	
HS005A	Activity 1-Determine the Effect of Citric Acid Concentration On the Extraction Efficiency of Iron From Soil	2 hours	\$400
HS005B	Activity 2-Remediation of Iron-containing Extract by Biodegradation	2 hours	\$400
HS006	Toxic Metal Removal by Zeolites	3 hours	\$600

MIDDLE SCHOOL

Make Your Own Cell Model

Course No. MS001	Duration: 1 hour	Maximum Students: 30	\$200
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This program introduces students to cells, the building blocks of all life, in a memorable hands-on way. Participants will learn about the two different classes of cells — Prokaryotic (cells that lack a nucleus) and Eukaryotic (cells that have a nucleus) — and then explore the cellular diversity in living organisms including microbial cells, plants cells, and animal cells. After observing their own human cells under a microscope, students produce their own model of a cell.

DNA Extraction

Course No. MS002	Duration: 1 hour	Maximum Students: 30	\$200
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DNA is the molecule that carries the genetic blueprint of all living cells. All life is related through this molecule: humans, whales, plants, and even single-celled organisms such as *E. coli*. Students will learn about the structure and nature of this “elegant” molecule by extracting it from cells, and then collect it by a technique called “DNA Spooling”. Seeing real DNA enables students to better grasp the basic concepts of molecules and their own genetic code.

Gene Transfer and Genetic Engineering

Course No. MS003	Duration: 1 hour	Maximum Students: 30	\$200
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Students are introduced to the history of transformation: the uptake and expression of foreign DNA by a living cell. From Griffith’s famous transformation experiment in 1928, to today’s aquarium Glofish™, students will see how gene transfer technology continues to expand. Using a jellyfish gene that codes for a Green Fluorescent Protein, students will transform a harmless laboratory strain of *E. coli*. The students observe success when the bacteria they culture express the green fluorescent jellyfish trait! Today, applications of gene transfer include making human insulin for the treatment of diabetes and engineering plants that are resistant to insect pests.

Protein Extraction and Purification

Course No. MS004	Duration: 1 hour	Maximum Students: 30	\$400
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Learn how scientists use BNL’s National Synchrotron Light Source to understand protein structure and function. During this workshop, students will learn how to extract and purify the jellyfish Green Fluorescent Protein (GFP) by hydrophobic interaction chromatography (HIC). Students will also learn the techniques of protein crystallization, which is critical to determining a protein’s structure. The student workshop will conclude with an introduction to online resources for viewing the 3-D crystal structure of GFP and other proteins.

Virus!

Course No. MS005	Duration: 1 hour	Maximum Students: 30	\$200
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Often referred to as “hijackers of cells”, viruses ask the question: what is life? The fact that viruses contain the smallest genomes has made them an ideal model for studying genetics since the 1940s. Much of what we know about how genes work comes from our understanding of viruses. Brookhaven National Laboratory has contributed greatly to this knowledge through its work on the bacteria virus T7. Today, the biotechnology industry uses a genetic “switch” from this virus to express foreign proteins in bacteria on an industrial scale. In this lab, students will infect a harmless laboratory strain of *E. coli* with T7. Students identify where infections have occurred by observing clear areas in bacterial growth, called plaques, on petri dishes. Using T7 as a model, students will also learn about different viruses such as HIV, influenza, and SARS.

A “Corny” Experience With Mendel’s Law of Heredity

Course No. MS006	Duration: 1 hour	Maximum Students: 30	\$200
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Students learn about the 19th century monk Gregor Mendel and his critical observations of how physical traits are passed down to the next generation. Today these rules of heredity are simply known as Mendel’s Laws. Students will apply Mendel’s Laws to determine the genotype (gene type) and phenotype (physical trait type) of unknown “parents” using a kernel color trait from an ear of corn. Students will then learn about the British geneticist, Reginald Punnett, and the tool he developed to predict genotype and phenotype frequencies of offspring. Using this tool, called the “Punnett Square”, students predict offspring genotypes and phenotypes from several crosses of corn. Students conclude by studying their own inherited traits that follow Mendel’s Laws.

Protein Structural Biology in 3-D: The Shape of Things to Come

Course No. MS007	Duration: 1 hour	Maximum Students: 30	\$200
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Proteins are one of the key products of the genetic code. In addition to being responsible for our physical traits, proteins also play a critical role in a wide range of human disease, from sickle cell to cancer. The National Synchrotron Light Source at Brookhaven National Laboratory allows scientists to gain insight into the structure of these important proteins. Come learn about the differences in the human genetic code and how scientists use their knowledge of protein shape to develop more effective medical treatments. Students will use the same scientific databases as BNL scientists to examine and compare the structures of DNA and proteins. With our state-of-the-art 3-D theater, students will view and generate models of proteins to explore the relationship between protein structure and protein function. Students will compare the protein structures of various fluorescent proteins to examine how the shape affects the function.

Find Jake the Snake: Use GPS and Radiotelemetry to Track, Map, and Monitor Animal Behavior

Course No. MS007	Duration: 2 hours	Maximum Students: 30	\$400
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Biologists are interested in animal behavior patterns such as range of travel, habitat, and other related factors. One way to assess behavior is through the radio tracking of animals and the use of global positioning systems and mapping. Students will learn about GPS and mapping techniques, locate radio transmitters, take GPS readings, and integrate their findings to reach conclusions about animal behavior.

Nanotechnology – Little Things Bring Big Change

Course No. MS009	Duration: 2 hours	Maximum Students: 30	\$400
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Nanotechnology will revolutionize society much the way computers have. Students will learn about nanotechnology, the use of tools such as a scanning transmission electron microscope, and futuristic opportunities that nanotechnology presents. The program will include student analysis of real electron diffraction patterns to identify carbon nanotube structures.

HIGH SCHOOL

BIOLOGY

DNA Analysis: Cutting DNA with Enzymes (AP Lab)

Course No. HS001	Duration: 3 hours	Maximum Students: 30	\$600
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Students learn about the discovery of enzymes, called Restriction Enzymes, which cut (or “digest”) DNA molecules in a precise and predictable manner. Today, scientists use these enzymes on DNA with the same precision that surgeons use a scalpel on a patient. Cutting and pasting DNA from different organisms is the basis of the “recombinant DNA” revolution in the study of biology and the rapidly expanding field of Biotechnology. In this lab, students use the tools of recombinant DNA research. Students digest DNA from two harmless viruses that infect bacteria. Using a technique called agarose gel electrophoresis, the students analyze the DNA digestion patterns to decipher the identity of an unknown bacterial virus. DNA cutting patterns are used by the students as a “DNA fingerprint” to identify their unknown virus.

Gene Transfer and Genetic Engineering

Course No. HS002	Duration: 3 hours	Maximum Students: 30	\$600
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Students are introduced to the history of transformation: the uptake and expression of foreign DNA by a living cell. From Griffith’s famous transformation experiment in 1928, to today’s aquarium Glofish™, students will see how gene transfer technology continues to expand. Using a jellyfish gene that codes for a Green Fluorescent Protein, students will transform a harmless laboratory strain of *E. coli*. The students observe success when the bacteria they culture express the green fluorescent jellyfish trait! Today, applications of gene transfer include making human insulin for the treatment of diabetes and engineering plants that are resistant to insect pests.



CHEMISTRY

The Citric Acid Process of Remediation

Course No. HS005 | This course is a two part program; see Activities 1 and 2 below:

In these labs, students and teachers learn about a molecular technique developed at BNL for the remediation of soils and wastes contaminated with toxic metals. Using iron as a model for toxic metal contamination, students follow a simple two-step procedure to remove and recover the metallic "contaminant". The two steps can be summarized as (i) extraction and (ii) biodegradation or photodegradation. Citric acid, a naturally occurring organic complexing agent, is used by the workshop participants in the first activity to extract iron (a surrogate for toxic metals) from soil by forming a soluble iron-citrate complex. Other metals may also be extracted by this step. The iron-citrate extract in activity two is subjected to biodegradation in a microbial "bioreactor" which results in bioprecipitation of the iron that is then recovered in a concentrated form.

Activity 1

Determine the Effect of Citric Acid Concentration On the Extraction Efficiency of Iron From Soil

Course No. HS005A	Duration: 2 hours	2 hours	\$400
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Soil is added to plastic centrifuge bottles containing 250 ml 0.05 M, 0.1 M, or 0.2 M citric acid solution. The bottles are placed on a wrist-action shaker to extract the iron. The extract is allowed to settle and is then filtered by students to separate the extract from the soil. The extract is collected and the pH is determined. Students use the o-phenanthroline method to analyze the concentration of ferrous and ferric iron. The students compare the extent of iron extracted in solution with the citrate concentration

Activity 2

Remediation of Iron-containing Extract by Biodegradation

Course No. HS005B	Duration: 2 hours	Maximum Students: 30	\$400
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The iron extract obtained from Activity 1 is subjected to bacterial activity to metabolize the citrate and precipitate the iron. Students determine the concentration of citric acid using an enzyme assay kit while total iron is determined using the o-phenanthroline method. Students determine the rate of citrate metabolism and iron precipitation by plotting the data using a computer graphics program. A parallel experiment is performed using a synthetically prepared iron citrate complex.

Toxic Metal Removal by Zeolites

Course No. HS006	Duration: 3 hours	Maximum Students: 30	\$600
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Zeolites are common minerals in the earth's crust. They are made of crystals that take many different shapes, sizes, and internal structures. Zeolites play an important role in the scavenging of toxic metals and radionuclides from waste water. The zeolites provide an effective trap for removing hazardous ions (charged particles, either positive or negative) from solutions and preventing them from being released again. At Brookhaven National Laboratory, geologists, chemists, and physicists are searching the earth for new materials and trying to discover new techniques to improve the process of ion exchange in zeolites. This exercise uses calcium and iron ions as surrogates for toxic substances. Since the basic chemical processes and reaction mechanisms are the same for calcium and iron, these ideas and principles replicate processes used for elements of environmental concern such as cesium, cadmium, and lead.

Other BNL Programs and Contests

See www.bnl.gov/education for details

■ K–8 Programs

Science Learning Center Programs (at BNL or at school and libraries)

– see www.bnl.gov/slc

Open Space Stewardship Program (OSSP)

NYS Science and Technology Entry Program (6–8)



■ High School Programs

Open Space Stewardship Program (OSSP)

Community Summer Science Program

High School Research Program

Minority High School Apprenticeship Program

NYS Liberty Partnership Program

NYS Science and Technology Entry Program



■ Undergraduate/Graduate Programs



DOE Science Undergraduate Laboratory Internship Program (SULI)

DOE Community College Institute (CCI)

DOE Faculty and Student Teams (FaST)

DOE Pre-Service Teacher Program (PST)
(Graduate level available)

Brookhaven College Mini-semester Program

NYS Collegiate Science and Technology Entry Program Mini-Course

ACS Nuclear Chemistry Summer School

Graduate Research Internship Program

■ Teacher/University Faculty Programs

DOE Academies Creating
Teacher Scientists
Open Space Stewardship Program
– GREEN Institute
DOE Faculty and Student Team
Program
K-12 Teacher Workshops



■ Contests

Elementary School Science Fair
Middle School Science Bowl and Fuel Cell Car
Challenge
MAGLEV Contest – Middle School
High School Science Bowl
Model Bridge Building Contest – High School
Science and Society Essay Contest – High School



General Information

Brookhaven National Laboratory
Office of Educational Programs
Bldg. 438, 14 Brookhaven Avenue
P.O. Box 5000
Upton, NY 11973-5000

PHONE (631) 344-4503
FAX (631) 344-5832
EMAIL oeep@bnl.gov

Contact the Office of Educational
Programs for customized teacher
training programs



Brookhaven National Laboratory
Office of Educational Programs
Bldg. 438, 14 Brookhaven Avenue
P.O. Box 5000
Upton, NY 11973-5000

