

Biology Workshop Descriptions

Botany

Seeds - Students observe, compare, and describe the properties of seeds, fruits and vegetables. They organize their observations through sorting; they organize and analyze data from cause and effect experiments, and relate laboratory studies to natural systems.

Traveling Seeds: Millions of seeds are produced from a variety of plants. The seeds are the beginning of life for future species of the same plant. The challenge to plant survival is moving the seed to a suitable germination site. Many plants disperse the seeds through wind, water, or unique vectors (animals that carry the seeds and pollen). Some plants are unique in their means of regenerating. Through hands-on activities, students will become familiar with methods of seed dispersal.

Plant Population Studies - Students practice identifying and counting plants at our Workshop Garden using quadrants made by bending a wire hanger into the shape of a square. Later, they will travel to the study sites to collect "real" data. Students also use timed meanders to determine changing levels of biodiversity as the levee waters return to a wetland state.

Tissue Printing: Detection of Brassica Phloem Cells: When the surface of a freshly cut plant is placed on a charged membrane, whole cells, proteins and nucleic acids bind to it. This technique, known as tissue printing, is simple and yields detailed information about cell identification and biomolecule localization within cells. This workshop used a monoclonal antibody to detect *Brassica* phloem cells. Examples of *Brassica* family members include broccoli, Brussels sprouts, and cauliflower. The membrane with the tissue print was sequentially treated with the primary monoclonal antibody that is specific for *Brassica* phloem cells, followed by the enzyme linked secondary antibody and the enzyme specific substrate. Phloem cells were clearly identified as bright red.

Preparation and Fusion of Protoplasts: Protoplast isolation and fusion is utilized in plant biotechnology to obtain and culture hybrid cells. This workshop introduced students to the protocols used to obtain fused hybrid cells.

Cell Culture and Cancer Biology

Analysis and Comparison of Various Mammalian Cell Types: Students fixed and stained cells on a microscopic slide. Four different cell types provided an exciting direct microscopic comparison of different cell types. Morphological differences between normal and transformed cells were observed.

Effect of Toxic Substances on Mammalian Cells: Mammalian cells were grown in culture and are pre-exposed to a toxin such as colchicine. The effect of this treatment on cell morphology was examined by comparing treated with untreated control samples. Students examined the differences microscopically. This type of experiment has direct and practical applications in basic toxicology for the screening of suspected toxic chemicals.

Differentiation of Human Cells by Retinoic Acid: The effect of retinoic acid on cells was examined in this workshop. The concept that cells are differentiated during which unspecialized cells or tissues become specialized for a particular function was emphasized.

The Anatomy of Brain Neural Cells: This workshop demonstrated the morphology of the brain. Students were able to distinguish between astrocytes and neurons and gained an appreciation of the architecture and composition of brain cells.

Differentiation of Fat Cells: This workshop demonstrated the morphology of the brain. Students were able to distinguish between astrocytes and neurons and gained an appreciation of the architecture and composition of brain cells

Microbiology

Aspetic Technique: Handwashing Science - Students learned the mechanism of the spread of contact-based microbes using a product called Glo-Germ[®]. This experiment was reinforced by describing the history of hygiene and a few of the diseases that can be transmitted by contact.

Epidemic! - The ease with which pathogens can spread through a population is very relevant today as we cope the possibility of a flu epidemic. Using diluted acids and bases as “body fluids,” students participated in a classroom simulation of a spreading epidemic. Students then figured out who the original “carrier” was

A Microbial Detective Story - Students became field epidemiologists as they search for the source of an artificial epidemic. Our instructors hid the commonly used, non-pathogenic yeasts in workshop. Our students, knowing that yeasts produce catalase (which breaks down hydrogen peroxide into oxygen and water), sampled various locations as they attempt to track down the source of the microorganisms. This lab lends itself to an almost infinite number of variations, and helped students appreciate the work of public health officials.

Pasteur's Experiment - Prior to the 17th century, it was generally believed that living things could arise from nonliving materials, a process called “spontaneous generation”. Using an S-shaped flask of his own design, Louis Pasteur was able to disprove this “theory” once and for all. In this brilliant lab, developed by teacher Patricia Herzberg, students recreated Pasteur's famous experiment, putting the scientific method into practice, and determining if Pasteur's experiment was valid.

Cell Biology Basics - When students begin a unit in Life Science in school, they often are confronted with facts about cells; what they are, what is inside of them, how they reproduce, and the two basic types - animal and plant. What they most often do not receive is enough first-hand experience viewing living, working cells to relate what they have studied with what they have seen and know to be true. The students' environment is full of such cells, which can readily be seen and examined, with the light microscope. This workshop introduced our students to the design and use of the light microscope, and demonstrated cellular biology staining techniques.

Food Safety - What captures the interest of students? FOOD! Yes, food can be used to engage students in inquiry-based science — *really!* The Food and Drug Administration (FDA) in collaboration with the National Science Teachers Association (NSTA) have created **Science and Our Food Supply**, an innovative, interactive supplementary curriculum for use in middle level and high school science classes. An advisory board of experienced teachers just like you developed and tested the materials. These activities provided students with challenging hands-on, minds-on microbiology activities that link food science and food safety to students' everyday lives. Students learned basic to advanced microbiology techniques necessary for them to develop their own science fair projects.

Microbes and You - The workshop begins with a brief introduction to the origins and characteristics of bacteria, followed by activities and discussions that involve the students directly with common practices performed by microbiologists in their labs daily. The students reviewed the scientific method, learned about bio-safety, collected samples, streaked plates, analyzed and identified different types of bacteria, and even explored the cause and effect relationship associated with epidemiology. This workshop required two days for completion – one for the students to streak their plates, and another for them to read the incubated plates and discuss the results. We also introduce the role of microbiologists in the modern workforce.

Lesson in Decomposition – Life in the Rotting Log - When dead matter decomposes it does not disappear, but is recycled through living things and the physical environment. (The atoms are recycled.) Students learned that when dead matter decomposes it breaks down into its basic elements, some of which are nutrients. The nutrients from dead matter are put back into the surrounding physical environment (soil, water, air) by decomposers.

Soil Microbes - In this follow-up workshop to Lessons In Decomposition, students learn that millions of microorganisms live in a handful of soil and these microorganisms, some too small to see with the naked eye, eat organic matter such as grass clippings, fallen plant leaves, and algae. In doing so, they reduce dead organic matter on Earth's surface and release nutrients from

the decomposing organic matter for living plants to use. Microbiological techniques learned include: aseptic technique, plate streaking, and Gram Staining.

Spicy Inhibitors - For centuries, spices have been used to preserve foods. Marco Polo's trip to China was partly to locate a source of spices. Some spices contain natural inhibitors to food spoilage microbes. Students grow 5 food spoilage microbes on black pepper, cloves, and chili powder agars and observe the inhibition of some of the microbes. Application to food spoilage prevention and the history of the spice trade is discussed.

Spicy Inhibitors – Identifying Bacteria - Hans Christian Gram was originally looking for a stain for all bacteria to make them more easily visible in a microscope field. In the process of looking for a universal stain, he stumbled upon a fundamental difference between two distantly related groups of bacteria - those that retained the stain (Gram-positive) and those that did not (Gram-negative). Thus, today the Gram stain is one of the first steps in identifying an unknown bacterial culture. Gram reaction is important in medicine because some antibiotics are effective against only Gram-negative bacteria (e.g. erythromycin) and some against only Gram-positive ones (e.g. penicillin, actinomycin). This workshop incorporates a number of laboratory techniques, including the use of microscope, Gram's Stain, and a basic understanding of bacteria morphology.

Fermentation – Making Homemade Ginger Ale: Fermentation has been used by mankind for thousands of years for raising bread, fermenting wine and brewing beer. The products of the fermentation of sugar by baker's yeast *Saccharomyces cerevisiae* (a fungus) are ethyl alcohol and carbon dioxide. During our workshop we will study the chemical reactions involved in glycolysis and fermentation. Carbon dioxide causes bread to rise and gives effervescent drinks their bubbles. This action of yeast on sugar is used to 'carbonate' beverages, as in the addition of bubbles to champagne). We will set up a fermentation in a closed system and capture the generated carbon dioxide to carbonate our home made ginger ale.

Pond Water Tour – Using microscopes, students will explore the different types of protozoa, and their microhabitats. Students will learn how to prepare wet mounts for microscopic examination; how to prepare hay infusions and cultured protozoa; how to stain specimens.

Vaccination Readiness- In this workshop, a simulated ELISA test is used to determine the degree of immunity from individuals that are unimmunized, recently immunized, distantly immunized, or distantly immunized with a recent booster. The results will demonstrate the concepts of vaccination and immunologic memory.

Molecular Biology

Micropipeting Basics: Pipetting is a critical skill necessary for the accuracy that is essential in scientific experiments. This workshop demonstrated the use of micropipets as students prepare various dye mixtures and deliver their mixture to the Pipet Card™. Additionally, students practiced their new pipetting skills as they loaded their samples on an agarose gel.

Strawberry DNA Spooling: Have you ever wondered what a forensic scientist has to do to analyze DNA evidence? DNA (the building blocks of life) is present in the cells of all living organisms. In forensic science DNA is usually extracted from human cells to identify unknown parentage, crime scene suspects, missing victims and to investigate genetic diseases. Since 1985, "DNA fingerprinting" has been used in legal cases around the world to link suspects to the scene of a crime. Students were able to extract DNA from fruit to see what it looks and feels like. This is similar to what a scientist has to do before they can then use the information contained in this DNA to solve crimes, although they don't use the same protocol.

DNA Report Card: The importance of DNA manipulation is a major news item as is evident by the enormous media attention devoted to the subject. In order to work with and study DNA, you must first isolate it from the source. Students actually precipitated their own DNA from solution! The first step involved swabbing cheek cells and then adding various chemicals to lyse the cells. Next, the DNA was precipitated from solution by an alcohol overlay. Finally, the DNA was stained

with safe methylene and transferred to the DNA Report Card™. Students had a permanent record of their DNA for safekeeping.

Principles of DNA Sequencing: DNA sequencing is used to determine the primary structure of DNA. This information is essential for understanding the structure and function of genes. This experiment is a dry lab that explains DNA sequencing and analysis. Actual autoradiograms from DNA sequencing experiments were provided for identification of mutated nucleotides.

Mitochondrial DNA Fingerprinting: amplification of DNA for Fingerprinting: In this workshop, PCR was performed on a hair (not from the victim) obtained from a murder scene. The instructor ran this DNA sample on a gel and compared the preamplified DNA from two possible suspects to determine whether either suspect was present at the crime scene.

Molecular Biology/Biotechnology

We are in the process of Beta-testing the eight core experiments developed by Boston University below:

Off To The Races - What molecule will be first to the finish line? To study highly purified materials and molecules that are similar in size and electric charge, scientists use gel electrophoresis. This is a technique also used to separate DNA for genetic testing, determine susceptibility to disease, and conduct DNA fingerprinting to solve crimes. In this experiment, students make, pour and load their own gel with six food coloring samples. The smaller the molecule and the more negative its charge, the closer it gets to the finish line. By determining where it finishes its "race", scientists can make a determination about the identity of the molecule.

The Art of Forgery - In this experiment, students become forensic scientists using DNA fingerprinting to determine which of four similar paintings is a masterpiece that recently was stolen from an art museum. Students perform gel electrophoresis on paint samples from the artwork and compare them to a paint sample similar to the original masterpiece. By making, pouring, and loading their own gel, students can observe the rate at which colors migrate through the gel and compare them to the original paint sample to determine which three paintings are forgeries.

The Mystery of the Crooked Cell - Sickle Cell Anemia is a genetically inherited disease that affects the hemoglobin molecule of red blood cells. The hemoglobin molecule is comprised of four polypeptide chains. The most common type of hemoglobin, hemoglobin A, consists of two alpha chains and two beta chains. In sickle cell anemia, a single amino acid substitution in the beta chain from glutamate to valine that causes the molecule to form insoluble chains when the oxygen concentration in the blood is low. These insoluble chains distort the cell, giving it the characteristic sickle shape. Sickle Cell Anemia is a co-dominant trait diagnosed through gel electrophoresis. In this activity, students will use their knowledge of sickle cell anemia and gel electrophoresis to diagnose an unknown patient sample.

A Twist of Lyme -In a case that strikes close to home for residents in Connecticut, students utilize ELISAs (Enzyme-Linked ImmunoSorbent Assays) to detect the tick-borne illness called Lyme disease. Shortly after infection by *Borrelia burgdorferi*, the spiral-shaped bacterium responsible for the collection of symptoms know as Lyme disease, humans produce antibodies. The ELISA test uses specific antigens found on the surface of the bacterium to detect the presence of antibodies. If antibodies are detected, the student medical experts diagnose the patient with Lyme disease. Lyme disease was first observed in Connecticut in the early 1970s when an unusually large number of children in and around Lyme, CT were diagnosed with juvenile rheumatoid arthritis. In 1975, Yale University researchers discovered *Borrelia burgdorferi* was responsible. Since then, more than 170,000 cases have been diagnosed nationwide. In 2002, 23763 cases were reported to the CDC with 95% of them found in Connecticut, Delaware,

Rhode Island, Maine, Maryland, Massachusetts, Minnesota, New Jersey, New Hampshire, New York, Pennsylvania and Wisconsin.

Case of the Crown Jewels - In 1985, the first forensic use of DNA occurred in England. Scotland Yard was looking for the murders of two young girls in the English Midlands. Every male between the ages of 13 and 34 (almost 4000 men) living in the nearby villages was required to donate a blood sample for analysis. They were able to identify a man by the name of Colin Pitchfork as responsible for the murders.

DNA fingerprinting, known also as DNA restriction analysis, is a technique with wide ranging applications in medicine, research, and forensics. In this activity, students will use DNA restriction analysis to analyze evidence for a fictional crime scene. **Lighting the Magic Lantern** - Science is literally illuminated for students in this experiment where they learn about genetic transformation, which is the insertion of a gene or genes into an organism. Genetic transformation plays an important role in providing therapeutic proteins for humans and animals. It is also used to develop pest-, frost- and drought-resistant plants and even for bioremediation. Students use biotechnology techniques to insert the gene for Green Fluorescent Protein, which naturally occurs in jellyfish, into the bacterium *E. coli*. By viewing the *E. coli* under an ultraviolet lamp, students can determine that the genetic transformation was successful and track the expression of the foreign gene by watching the bacteria glow.

Cheek to Cheek Revealed - "Cheek To Cheek" is an experiment designed for advanced biology classes targeting students interested in a career in bioscience. For the experiment students will extract DNA from buccal (cheek) cells and amplify it using polymerase chain reaction technique. Students then run their DNA samples through gel electrophoresis and determine how many repeats they have for D1S80, a VNTR (variable number tandem repeat) on chromosome 1. Students then graph the class distribution of D1S80 and compare it to the U.S. Population distribution of D1S80. D1S80 is a genetic marker used for DNA profiling internationally.

Soil Science

The Nitrogen Cycle: Through hands-on activities students will learn how soil bacteria play in providing nitrogen for plant growth via the **nitrogen cycle**.

Soil Microbiology: This workshop will address students' tendency to consider only the most obvious causes of an effect. It helps students to see that non-obvious microbes are the primary decomposers, that things don't "fall apart" on their own, and that detritivores that we can see, such as earthworms and sow bugs, are responsible for only a small percentage of decomposition. Students will learn how to isolate and identify soil microorganisms.

Rotting Log Decomposition Chamber: The activities in this workshop will introduce students to the cyclic causal pattern involved in decay. Students will build the ideal habitat for creatures such as crickets, earthworms, millipedes, snails, slugs, beetles, and bacteria, fungi, and actinomycetes.

Earthworm Dissection: Students will work in groups of four to conduct experiments related to the behaviors and adaptations that earthworms have developed for survival in the environment. Students will create their own ecosystems with sand, soil, live earthworms, and real plants in a 2-litre pop bottle. Everyone will also learn the components of soil. Students will learn how to culture soil microbes.

Vermicomposting: Students will work in groups of four to conduct experiments related to the behaviors and adaptations that earthworms have developed for survival in the environment. Students will create their own ecosystems with sand, soil, live earthworms, and real plants in a 2-litre pop bottle. Everyone will also learn the components of soil. Students will learn how to culture soil microbes.

Taxonomy

Sorting By Attribute - Our young scientists will practice sorting and classifying in this activity that uses a variety of easily found objects: caps, fabric scraps, plastic or foam shapes, marbles. Scientists classify and sort objects and phenomena to help analyze commonalities and differences and increase understanding. For example, zoologists and biologists classified animals by form and traits (e.g. – hot or cold-blooded). Today, scientists use DNA analysis (specifically, mitochondrial DNA) and other methods to create “trees of life” that illustrate interrelations amongst species. Object classification requires active decision-making and observation skills. As with other skills, ability increases with practice. Providing multiple opportunities to sort and classify varieties of objects will help students become more comfortable with the process.

Latin Jeopardy - Students are first given an overview of how the science of taxonomy evolved. That is, how and why did scientists develop the current system of binomial nomenclature. After this brief discussion, students are asked to classify seashells using a classification system of their own design. For example, one group might categorize shells according to the size, texture, and color; other groups might describe shells by weight and acoustical properties. Students are then asked to “name” their shells. Students are given Latin name cards, which were used to translate their “common” shell names into Latin “scientific” names. In this way they become familiar with Latin roots, prefixes and suffixes. Lastly, students compete in Latin Jeopardy Game Show.

Dissection Question - Students will compare and contrast the structures of marine invertebrates and vertebrates.

Zoology and Ecosystems

Animal Tracking - Our Animal Tracking Workshop will help people become familiar with animal tracks and sign. The workshop will include recognition, identification and interpretation of signs of critters that are rarely seen.

Amphibians - Students will learn about sound, osmosis, fluid dynamics, fresh water ecology, bone; amphibian muscle structure, evolution and anatomy.

Owl Pellets - This hands-on experiment allows students to investigate the food web, identify animal skeletons, and practice dissecting skills. Each student will dissect an owl pellet and classify the remains using a bone-sorting chart.

Sky Hunters – An introduction to Raptor Biology – Have you ever wondered what makes a raptor different from other birds? This introduction to the basic biology of birds of prey provides an overview of how these birds fit into their environment (backyards and neighborhoods) and why they are important to us. Besides being excellent barometers of the health of their environment, birds have an amazing power to inspire people and motivate action. Students will be introduced to two different live, non-releasable, species of raptors: a diurnal (daytime) hunter and a nocturnal (nighttime) hunter. Information will be provided on physical description, adaptations, habitat use, nesting and rearing of young. These birds are ambassadors for the wild, enriching their lives with daily lessons on the balance needed in nature.

Bird Beak Adaptations - Children will be given the opportunity to experiment using tools that are similar to various birds' beaks to accomplish the challenge of picking up different types of food. They will learn about the shapes, sizes, and operations of bird beaks and how they are adapted to their environments.

Penguins - Students will learn about buoyancy, heat capacity, fluid dynamics, ocean ecology, and bird anatomy. Students will know that different animals inhabit different environments and have external features that help them thrive in different kinds of places.

Animal Senses: Animals use their senses everyday to find food, stay safe and even to find a boyfriend or girlfriend! Sometimes animals use different body parts for their senses, for example

the snake uses its tongue to smell the air. The Animal Senses workshop is an opportunity for your students to explore how animals rely on their senses to survive.

Insect Adaptations: Insects are everywhere in the world around us. Insects live in more different kinds of places than any other group of animals. They live in deserts, in forests, on tops of mountains, in rainforests, in water, in caves, and even in frozen places like Antarctica. They live in books and in clothes, under tree bark, in pools of petroleum, and even inside other animals. They come in many sizes, shapes, and colors. Through our fun, hands-on activities students will learn:

- Insect bodies are divided into three parts: the head, the thorax, and the abdomen.
- Most insects have compound eyes that are made up of hundreds of tiny lenses.
- There are four kinds of insect mouths: chewing (like a grasshopper), piercing (like a mosquito), sucking (like a butterfly), and sponging (like a fly).
- Insects do not have regular ears. Sounds are really just vibrations in the air. Most insects detect sounds by hairs on their bodies that can pick up these vibrations. Some insects use their antennae to pick up vibrations.

Camouflage: Camouflage comes from the French word *camouflager*, which means to "blind or veil". Some insects and animals use camouflage as an effective way to protect themselves from natural enemies. Birds, bats, moles, frogs and other animals consider some insects to be a very tasty treat. Insects protect themselves in many ways. One of these ways is by disguising themselves so that they blend into their surroundings. Some caterpillars and walking stick insects are camouflaged to look like twigs. Some insects are patterned to look like the background where they live. They may look like the bark of a tree, the leaves of a plant, some even look like soil! This week our students will pick a habitat and design a butterfly or moth that will display camouflage or mimicry in that habitat.

Silkworms – Students study some of the diversity of forms in insects. They observe and compare the differences in life cycles and behaviors of insects.

Spiders - This workshop will help students to appreciate the place spiders have in the world and will lessen the fear of spiders caused by misunderstandings. There are more than 30,000 different types of spiders known to scientists! Most of them are very tiny animals that help people by eating insects. Spiders are not insects. Students will learn the physical differences between insects and arachnids and also study other distinct characteristics of spiders. Students will know different spiders inhabit different environments and have external features that help them thrive in different kinds of places. Students investigate how spiders perceive the world. Students learn to differentiate among different scents; and learn to interpret shapes from the sense of touch.

Squid Dissection: Students will learn basic dissection techniques as they do a step-by-step exploration of the interior and exterior of the squid. They will also learn about a squid's habitat, life cycle, and its place in the food chain.

Shark Dissection - Compare bony fish anatomy to the anatomy of a shark during dissections, a slimy hands-on experience.

Whales: We will bring whales to life with hands-on projects like using tuning forks and water bags to understand echolocation; and looking at bubbles and vortices using tornado tubes to understand how whales eat using their baleen. If your child has an interest in whales this is one workshop you won't want to miss.

Bats - Students are treated to a special presentation by the "Bat Lady", Ms. Monique Smith Lee! Ms. Lee, a biologist from the California Bat Conservation Fund, visits hundreds of schools, libraries, museums, and community centers to teach approximately 40,000 children, and their teachers and care givers, the truth about bats and their benefits to the human population. Her presentation consisted of a short lecture, accompanied by a slide show. Best of all, she brought a variety of live bats that could be seen and enjoyed up close!!

Wolves - Students will learn the social behavior, physiology, and anatomy of wolves. They will also learn how to identify animals from their teeth.

What is Life? Living vs. Non-Living - Students will know how to observe and describe similarities and differences in the appearance and behavior of plants and of animals (e.g., seed-bearing plants, birds, fish, insects, etc.).

Them Bones - Students will learn how bones and muscles work together to provide a structural framework.

Zena The Cow Warrior - What do you get when you mix students, a teacher and a pile of bleached bones? You get Zena, Warrior Cow. (1.5 hour workshop)