

THE CITIZEN SCIENCE LAB

Course Catalog

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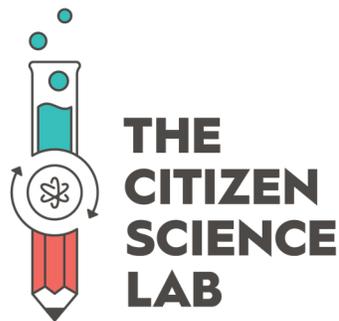
The Citizen Science Lab

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Experimental Subjects

MOLECULAR BIOLOGY & GENETICS

Learn how your genes impact how you look, feel, and live. You will learn about the structure of DNA and practice your skills as “DNA detectives” to figure out all the things DNA can really tell you.

ZOOLOGY

In zoology you will experience the awe and thrill of dissecting a fish, frog, worm, shark, or fetal pig. In the process you will learn how a heart works, why a fish floats, what makes worms so...wormy... and so much more.

MICROBIOLOGY

What bacteria is living on a doorknob, your hands, or even in your mouth? In this module, you will learn how to collect, grow, and view bacteria.

HUMAN HEALTH & PHYSIOLOGY

What does your heart do? What--and how--does it pump? How does sugar or caffeine impact heart rate? Learn all about how your body works--and how to take care of it--in this unit on Human Health & Physiology.

BOTANY

Plants are incredibly varied organisms, having evolved to live, grow, and reproduce in many unique ways. Students will study the structure and metabolic life cycles of plants, including the mechanism of photosynthesis.

AQUAPONICS 101

Learn how to install and maintain your very own aquaponics system and about human impacts on the environment, food systems, and healthy eating!

ENVIRONMENTAL SUSTAINABILITY

How do we protect the earth, the well-being of people, and a healthy economy? Explore how we can be responsible caretakers of our environment in the age of climate change.

CHEMISTRY

Solids, liquids, and gases... foam, slime, and...non-Newtonian fluids! Learn by mixing chemicals, observing reactions that change colors, temperatures, and even mix up a tasty sweet treat to snack on.

BIOCHEMISTRY

What do you get when you cross biology and chemistry? Biochemistry! In these lessons you will learn what proteins look like and what do they do in your body.

PHYSICS

Learn the secrets behind magic; our experiments will teach you the art of levitation, the science behind light, even the arts of gravity! By the end of this experiment, you will be able to showcase your skills as an amateru magician.

SPACE

Blast off into outer space with our lessons on rockets, stars, and other space-related fun. As an amateur NASA scientist you will build and launch model rockets, putting your creativity and design skills to work.



THE CITIZEN SCIENCE LAB

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MOLECULAR BIOLOGY & GENETICS



INTRODUCTION TO DNA STRUCTURE & FUNCTION THROUGH MODELING

Length: 1 Day, Time: 2 hrs

Where: Anywhere

DNA codes for messenger RNA, which in turn provides the codes for proteins: this simple process, which scientists call the central dogma of biology, lies at the center of all life on Earth. In this session, students will explore the central dogma through hands-on modeling techniques. In the process, they will be introduced to the processes of replication, transcription and translation as well as a variety of molecular techniques based on the processes.

DNA ART (KEYCHAINS)

Length: 1 Day, Time: 1 hr

Where: Anywhere

The structure of DNA is intimately bound up with its function. The famous double helix pattern allows for both easy access to the information DNA contains and ease of replication. In this session, students will explore the structure of DNA through a simple model - an origami sculpture of a DNA molecule. Then they will then create their own DNA double helix keychain!

DNA MODELING WITH CANDY

Length: 1 Day, Time: 1 hr

Where: Anywhere

Construct models of the DNA double helix using candy! Learn how DNA is constructed of matching base pairs and make a twisted ladder of sweet science.



DNA SUPERCOILING

Length: 1 Day, Time: 2 hrs

Where: Anywhere

The human genome contains a staggering amount of DNA - far more than you'd expect to fit in something as small as a cell. In this module, students will use mathematical and hands-on modeling techniques to explore the process of supercoiling, culminating with a comparison of the total length of DNA in the human body to various astronomical distances.

CANDY DNA COLOR CODE

Length: 1 Day, Time: 1.5 hrs

Where: Anywhere

In this introduction to gel electrophoresis, students will develop the skills necessary to extract "DNA" from candy and run that "DNA" on a gel. Students will learn how to properly use micropipettes and other scientific equipment as well as make an Agarose gel from scratch.

FRUIT DNA EXTRACTION

Length: 1 Day, Time: 1.5 hrs

Where: CSL only

For all the information it contains, DNA is only a molecule, far too small to see with the naked eye...or is it? In this session, students will extract DNA from various fruits, leaving it in a form that can be seen without the aid of a microscope. In the process, students will learn about the enormous length of DNA molecules and their physical properties.

DNA DETECTIVES - Advanced experiment*

Length: 1 Day, Time: 2.5 hrs

Where: CSL only

In this session students will have a chance to be CSI technicians by comparing the DNA of four suspects to the sample found at a "crime scene." In the process, they will learn a variety of common molecular biology techniques such as restriction enzyme digestion and gel electrophoresis.

**The CSL recommends Candy DNA Color Code as an introduction before this experiment, especially if your scientist(s) has not had experience with micropipettes and gels.*



IT'S ALL ABOUT YOU: GENETICS

Length: 1 Day, **Time:** 1.5 hrs

Where: Anywhere

In this experiment students will be able to learn and understand how genetics works on a broad and personal scale. Students will observe their own traits and determine if they have the dominant or the recessive version of each trait. Finally, they will be introduced to Punnett Squares to determine their very one genes and whom they got them from!

REEBOP ACTIVITY

Length: 1 Day, **Time:** 1 hr

Where: Anywhere

In this genetics activity, learners create imaginary creatures known as “Reebops” to explore the relationships between genes and inherited traits. Using Reebops as a model, learners investigate how hereditary information is passed from one generation to the next, and how the physical appearance of offspring is determined from the combinations of genes received from parents.

DNA FINGERPRINTING - Advanced experiment*

Length: 2 Days

Time: Day 1 = 2 hrs, Day 2 = 1 hr

Where: Anywhere

It's one thing to say that everyone's DNA is unique, but quite another to prove it for yourself. In this module, students will use techniques to harvest their own DNA from cheek cells and visualize the unique banding patterns through PCR and gel electrophoresis.

The CSL recommends Candy DNA Color Code as an introduction before this experiment, especially if your scientist(s) has not had experience with micropipettes & gels

ZOOLOGY

PREDATOR & PREY

Length: 1 Day, Time: 1.5 hrs

Where: CSL only

Some aspects of the world are impossible to experiment with-- it would be too expensive or too unethical to try. In cases like these, scientists rely on passive observation and mathematical models. In this module, students will use both methods to explore the relationship between predator and prey. Students will observe the microscopic Hydra use its tentacles to devour Daphnia, a tiny water crustacean.



DISSECTIONS

Length: 1 Day, Time: 2 hrs

Where: Anywhere

Dissections can be an integral aspect of the study of biology. In this introduction to dissection, students will build their familiarity with dissection tools and procedures, study both external and internal anatomy of the following organisms, and examine the connections between these organisms and human anatomy.

- Earthworm
- Leopard Frog
- Squid
- Gray Perch
- Fetal Pig
- Other:
 - Sheep/ pig heart, cow eye

SEA URCHIN EMBRYOLOGY

Length: 1 Day, Time: 1.5 hrs

Where: CSL only

Exploring a new world of reproduction, students will get the opportunity to observe the life cycle of a sea urchin. Students will observe how sea urchins live and survive in their aquatic environment before inseminating the urchins to understand their reproductive processes.

OWL PELLETS & PCR

Length: 1 Day, Time: 2 hrs

Where: CSL only

These hairball-like objects (owl pellets) can give us a lot of information about different owl species as well as the habitats in which they reside. In this experiment students will dissect an owl pellet, examining the bone structures it contains, to see what type of creature the owl has recently eaten. They will then take a sample of the fur and run a PCR to amplify the DNA from the prey the owl ate.



ALCOHOL TOLERANCE IN FRUIT FLIES

Length: 1 Day, Time: 1.5 hrs

Where: CSL only

In this experiment we will learn about genes, enzymes, and phenotypes by observing fruit flies. We will use fruit flies that are alcohol intolerant; since the flies cannot digest the ethanol they consume, they will die shortly after being exposed to alcohol. Students will observe the flies over a 24-hr period, which requires them to take the flies home overnight.





SEEING “EYE TO EYE” WITH MICROSCOPIC ORGANISMS

Length: 1 Day, Time: 1 hr

Where: CSL only

Protozoa occupy a somewhat strange place in taxonomy: once a catch-all category for anything that didn't fit neatly into kingdoms, the term now refers to a large group of unrelated, mostly single-celled or colony-based organisms that are nevertheless more complicated than bacteria. In this module, students will learn basic microscopy skills and use them to observe a variety of protozoa, including amoeba, euglena, and paramecium.

THE WONDERFUL WORLD OF TERMITES

Length: 1 Day, Time: 1.5 hrs

Where: CSL only

In this highly entertaining session, students will be looking at termites in two very distinct ways. Using the scientific method, students will explore the behavior of termites when they come into contact with the pheromones in ink pens.

During the second half of the session students will learn about the symbiotic relationship that occurs between termites and protozoans that live in their guts. Students will be given the opportunity to extract the protozoans from the termite gut and view them under a microscope.



MICROBIOLOGY

INTRODUCTION TO MICROBIOLOGY

Length: 2 Days, **Time:** Day 1 = 2 hrs, Day 2 = 1 hr
Where: CSL only

By some estimates there are more bacteria on the planet than there are stars in the universe; microorganisms live everywhere we can imagine and a few places we can't. In this module, students will discover the prevalence of bacteria for themselves by taking and culturing samples from their surroundings.



ASEPTIC PROTOCOL: WORKING WITH FUNGI & BACTERIA

Length: 1 Day, **Time:** 1-1.5 hrs
Where: CSL only

Students will take on the task of moving a culture from one containment to another. During this, they will learn safety protocols and sterilization techniques to reduce risk of contamination and exposure.

EXPLORING THE WILD WORLD OF MICROSCOPY

Length: 1 Day, **Time:** 2 hrs
Where: CSL only

In this module students will be introduced to the parts of a microscope and how to properly use one. After being introduced to microscope basics, students will examine prepared slides demonstrating a variety of organisms and then learn how to create their own dry and wet mount slides!

SIMPLE STAINING

Length: 1 Day, **Time:** 1.5 hrs
Where: CSL only

True to its name, the simple stain is an easy process used to view bacteria's size, shape, and arrangement. Our instructors will give your student personalized attention as we introduce the basics of bacterial analysis.

NEGATIVE STAINING

Length: 1 Day, **Time:** 1.5 hrs
Where: CSL only

Bacteria are mostly colorless so viewing them under a microscope is next to impossible unless they have been stained. Students will utilize a negative stain to view different species of bacteria. During this module, your student will learn new experimental techniques, hone their microscope skills, and take a deeper dive into the exciting world of microbiology.

ENDOSPORE STAINING

Length: 1 Day, **Time:** 2 hrs
Where: CSL only

Some bacteria have protective structures called endospores that help them thrive in extreme conditions. However, because of the protective qualities of endospores, these bacteria can be difficult to stain and view. This module teaches students about these extreme bacteria and the special procedures it takes to stain them and make them visible.



GRAM STAINING

Length: 1 Day, **Time:** 2 hrs

Where: CSL only

Probably the most common and well-known differential stain, Gram staining is used to categorize bacteria based on the characteristics of their cell walls. Students will use basic microscopy techniques to observe the characteristics of a colony before and after performing their own Gram stains, and use these observations to identify the bacteria in question.

ACID-FAST STAINING

Length: 1 Day, **Time:** 2 hrs

Where: CSL only

One of several common differential stains, acid-fast staining is used to identify bacteria in the Mycobacterium family. In this module, students will use sterile techniques and live bacteria to perform their own acid-fast stains on a variety of non-pathogenic bacteria, and relate the characteristics of acid-fast bacteria to drug resistance.

STRUCTURE & FUNCTION OF MITOCHONDRIA

Length: 1 Day, **Time:** 1.5 hrs

Where: CSL only

Mitochondria are the powerhouses of the cell; energy-generating organelles that still contain many characteristics of independent organisms. In this session, students will see mitochondria in action by staining for hydrogen ions, which are used up during mitochondrial activity. The change in color as the stain is gradually removed will be easily visualized using a simple light microscope.

MICROBIAL FUEL CELL ELECTRICITY

Length: 1 Day, **Time:** 2 hrs

Where: CSL only

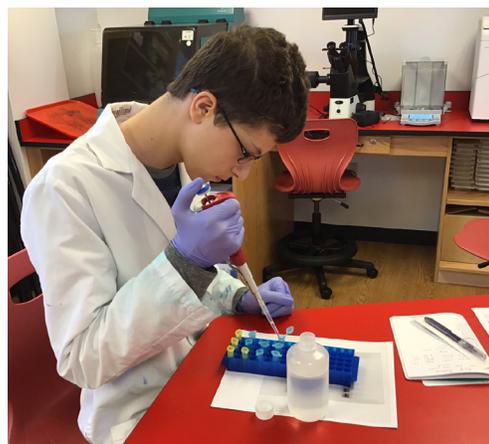
Bacteria are powerful things - and we're not using metaphors here. When harnessed correctly, a tank full of bacteria can literally generate electricity. In this module, students will learn about metabolism and the chemistry of batteries as they build - and keep-- their own bacteria-based fuel cells.

GLOW GERM ART

Length: 2 Days, **Time:** 1 hr / day

Where: CSL only

Students get a chance to create their own glowing bacterial art. Students use non-pathogenic E. coli that expresses fluorescent proteins to draw their image. Students can choose between green, yellow, blue, red, and orange fluorescent bacteria or use a combination of all five. The plates are incubated overnight and the following day students get to view their glowing bacteria art under a black light.



GROWING BACTERIOPHAGES

Length: 2 Days

Time: Day 1 = 2 hrs + overnight Incubation

Where: CSL only

A bacteriophage is a type of virus that infects bacteria. In fact, the word “bacteriophage” literally means “bacteria eater”. In this experiment we will grow and feed a colony of bacteriophages and observe how they impact bacterial growth



MICROBIOLOGY

ULTRAVIOLET BACTERIA

Where: **CSL only**

More details coming soon!

THE WONDERFUL WORLD OF YEAST

Where: **CSL only**

More details coming soon!

DETERMINING CELL GROWTH

Where: **CSL only**

More details coming soon!



BACTERIA ON OUR HANDS

Length: 2 Days, Time: *1 hr, each day*

Where: **CSL only**

In this session, students will investigate how well hand sanitizer really works on bacteria. Students begin by taking a swab of their own hands and placing it on bacterial growth media. Then students clean their hands with sanitizer and repeat the same process. Students return the next day to see how big of a difference the sanitizer actually made.

GARDEN MICROBES

Length: 2 Days

Time: *Day 1 = 2 hrs, Day 2 = 1 hr*

Where: **CSL only**

Microbes are all around us, some helpful and some harmful. In this workshop, students will learn the basics of microbes and why they are helpful to us. Plant - microbe interactions help the plant grow and acquire nutrients. Different methods of observing microbes will be discussed and students will conduct these methods on their own. In addition to this students will also pick a leaf sample and run PCR to amplify a specific piece of plant DNA. A gel will be used to visually depict the amplified DNA.

EFFECT OF TEMPERATURE ON BACTERIAL GROWTH

Length: 2 Days, Time: *1 hr / day*

Where: **CSL only**

Students will examine the effects of heat on two different types of bacteria. This will show students how some bacteria can withstand high temperatures while others cannot.



HUMAN HEALTH & PHYSIOLOGY



ANTIBIOTICS EFFECTS

Length: 2 Days, Time: 1 hr / day

Where: **CSL only**

Antibiotics are one of the biggest lifesavers in human history-- and the presence of antibiotic-resistant bacteria one of the greatest public health threats of our day. In this module, students will explore the effectiveness of antibiotics on certain bacteria.



METABOLIC TEST FOR BACTERIA

Where: **CSL only**

More details coming soon!

STUDYING OUR SENSES

Length: 1 Day, Time: 1.5-2 hrs

Where: **Anywhere**

We enjoy the flavors of the food we eat, and we identify the things we see easily, without even thinking about how we do it. But scientists have discovered that these sensory processes are amazingly complex and sophisticated. In this workshop, students will explore two types of sensory processes; how they identify flavors and how their brain interprets images.

SPICY INHIBITORS

Length: 2 Days, Time: 1 hr / day

Where: **CSL only**

Spices were once tremendously valuable commodities--not just for their taste, but also for their ability to keep foods from spoiling. In this module, students will test the antibiotic properties of a number of common spices, learning about bacterial culturing and aseptic technique in the process.

BACTERIAL TRANSFORMATION

Length: 2 Days

Time: Day 1 = 1 hr, Day 2 = 30 mins

Where: **CSL only**

While we usually think of genetic engineering as the stuff of science fiction, or at least cutting-edge research, in simple organisms it's surprisingly easy. In this module, students will create their own glowing bacteria through the true gene transfer of a plasmid coding for a fluorescent protein. In the process, they will learn about bacterial culturing, aseptic technique, and horizontal gene transfer.

BLOOD TYPING

Length: 1 Day, Time: 1.5

Where: **Anywhere**

Not all blood is alike! Differences in blood can in fact mean life-or-death in cases of blood transfusions and even pregnancies! Students will learn how blood works, how to find an individual's blood type, and how blood type is determined by genetics and heredity. We will then discover how blood typing can be used to solve mysteries.



HUMAN HEALTH & PHYSIOLOGY



SKELETAL SYSTEM

Length: 1 Day, Time: 1 hr

Where: Anywhere

Every single person has a skeleton made up of many bones. These bones give your body structure, let you move in many ways, protect your internal organs, and so much more. How many do bones you have? Do babies have more or less bones? Learn how our skeletons are organized and how they change as we grow.

REGULATION OF HEART RATE

Length: 1 Day, Time: 1.5 hrs

Where: CSL only

Each time the heart beats blood is pumped into the arteries. As blood surges into the arteries during a heartbeat, each artery stretches and bulges. This is called a pulse. In this workshop, students will learn how the heart operates and then will design a method to test how stimuli affect heart rate. Also, will create their own model of how the heart pumps.



LIGHTS, CAMERA...ACTION POTENTIAL

Length: 1 Day, Time: 1.5 hrs

Where: -

In this workshop, students will set up a model to simulate how a neuron processes information. The model will include such items as peas, beans and construction paper. Students will also be asked a series of questions to allow them to think deeper into the idea of neurons and how they affect different conditions such as epilepsy.

(SHEEP) HEART DISSECTION

Length: 1 Day, Time: 2 hrs

Where: CSL only

See the "ZOOLOGY: Dissection" activity for more details.



DAPHNIA AND HEART RATE

Length: 1 Day, Time: 2 hrs

Where: CSL only

The process of drug discovery-- the journey from chemical to medicine--is a long one. One of the first steps is testing the effects of the chosen chemical in a simple model organism. Students will experience this first hand by treating daphnia-- water fleas-- with a variety of common drugs and making qualitative and quantitative observations of the effects. In the process, they'll learn important concepts such as dose response and critical level.

BOTANY

PLANT DIVERSITY

Length: 1 Day, Time: 2 hrs

Where: Anywhere

Plants are all around us and are involved in our daily life, whether that is the grass we walk on or the fruit we eat. Students will get to learn about different types of plants and how they grow and reproduce. This knowledge will be obtained through observation and dissection of the plants. They also will get the opportunity to ask questions while exploring the world right outside their window.

PHOTOSYNTHESIS

Length: 1 Day, Time: 1.5-2 hrs

Where: Anywhere

The process of photosynthesis occurs in a series of enzyme-mediated steps that capture light energy to build energy-rich carbohydrates. In this experiment, students will use two methods to determine how much oxygen and carbon dioxide are needed in this process. Through experimentation, students will be able to understand concepts such as cell structure and function, enzymatic activity and energy storage and use.



FLOWER DISSECTION

Length: 1 Day, Time: 1.5 hrs

Where: Anywhere

During this experiment, students will delve into the structures of common flowers. They will examine the structure of the blossom, identifying the role of each component part in the plant's growth and/or reproduction along the way.

STRUCTURE OF PLANTS

Length: 1 Day, Time: 2 hrs

Where: Anywhere

In this module, students will explore the structure of plants, from the macro level down to the plant cells themselves. In the process, they will learn how to use a variety of conventional and fluorescent stains.



PLANT PCR - Advanced experiment*

Length: 1 Day, Time: 1.5 hrs

Where: CSL only

Students will start by learning the process of PCR and its importance. They will learn how to use the tools needed to complete this process. Then they will be able to obtain DNA from plants that are part of everyday life. This DNA will then be used to complete PCR, which amplifies the amount of DNA collected. This process is used to compare different gene sequences among plants.

This experiment is recommended for "CSL All-Star Scientists" who are already familiar with experimental equipment use & techniques



AQUAPONICS 101

INTRO TO AQUAPONICS

Length: 1 Day, Time: 1.5 hr

Where: -

Did you know that you can grow food indoors using only fish-waste as fertilizer? Students will explore the basics of aquaponic growing and build an aquaponics system for their classroom/program site. After constructing the system and filling the aquarium (all supplies and equipment provided on loan), students will discover the microscopic player essential to all aquaponics: bacteria.



ECOSYSTEM MODELING

Length: 1 Day, Time: 1.5 hr

Where: -

What makes an ecosystem? Students will identify biotic/abiotic factors and the concept of symbiosis in both natural and artificial ecosystems. Then students will plant seeds and introduce fish into their own aquaponics tank ("artificial ecosystem").

MICROBES AND ALGAE

Length: 1 Day, Time: 2 hr

Where: -

Your aquarium is now teeming with tiny, microscopic life-- nitrosomonas and nitrobacter, nitrogen-oxidizing prokaryotic bacteria-- and likely algae of many kinds. Students will hone their microscope skills by taking water and algae samples and examining them under a microscope to observe the characteristics of the organisms they observe.



BIOGEOCHEMICAL CYCLES

Length: 1 Day, Time: 1.5 hr

Where: -

Dive into the complex world of bio-geo-chemical-cycles: in other words: the flow of matter and energy through living and nonliving forms. Students will track the movement of nitrogen through their aquaponics system by testing concentrations of ammonia, nitrite, and nitrate (as well as pH) in the aquarium, graphing their results and creating a schedule for weekly water quality testing.

ENVIRONMENTAL SUSTAINABILITY



3 PS' OF SUSTAINABILITY

Length: 1 Day, Time: 1 hr

Where: -

What exactly does sustainability mean? Students will explore the United Nations Sustainable Development Goals as a framework for understanding sustainability as the integration of planet, people, and prosperity. After reviewing key vocabulary, students will complete an activity on climate change that focuses on differentiating between facts, theories, observations, and hypotheses.

CARBON FOOTPRINT

Length: 1 Day, Time: 1.5 hr

Where: -

We know greenhouse gases are driving global climate change. But what are greenhouse gases and how do they get into our atmosphere? Students will model the carbon cycle throughout Earth's history through an interactive simulation activity. Then they will explore the concept of carbon footprints, examining the environmental impact of their own lifestyle.

This experiment should be paired with Human Population Growth.

RENEWABLE & NON-RENEWABLE ENERGY SOURCES

Length: 1 Day, Time: 1 hr

Where: -

We know greenhouse gases are driving global climate change. But what are greenhouse gases and how do they get into our atmosphere? Students will model the carbon cycle throughout Earth's history through an interactive simulation activity. Then they will explore the concept of carbon footprints, examining the environmental impact of their own lifestyle. This session should be paired with the session: Human Population Growth.

HUMAN POPULATION GROWTH

Length: 1 Day, Time: 1 hr

Where: -

7.7 billion. The number of people living on Earth has never before been so high. In this session, students will use graphs to model population levels over time, predicting future trends. Students will then explore population growth in the context of global climate change, using discussion and debate to relate population growth to carbon footprints.

This experiment should be paired with Carbon Footprint.

URBAN AGRICULTURE

Length: 1 Day, Time: 1 hr

Where: -

This introductory primer on urban farming teaches students the basics before they get out and get their hands dirty. Students will map the inputs and outputs of a city farm, using an online simulation to track soil health, water availability, and crop production. Together, they will analyze the benefits and challenges of city farming versus conventional agriculture.

CONVENTIONAL & SUSTAINABLE AGRICULTURE

Length: 1 Day, Time: 1.5 hr

Where: -

How does your meal reach your plate? Well, it depends on where--and how--each menu item was grown. Students will trace their meal from "farm to fork" discussing how agricultural practices can impact the environment either positively or negatively. This lesson includes a taste-testing activity to sample conventionally and sustainably grown produce.



CHEMISTRY

pH: JUST THE BASICS

Length: 1 Day, Time: 1 hr

Where: Anywhere

Just because we use vegetables in the kitchen doesn't mean we can't also use them in an experiment! Students will utilize red cabbage to create solutions for testing various pH levels. After the experiment, students will have created a rainbow of colors and built their understanding of acidic and basic solutions.



DENSITY: SINKING & FLOATING SOLIDS

Length: 1 Day, Time: 1.5 hrs

Where: Anywhere

This experiment investigates the idea of density in relation to sinking and floating in water. Students will discover it is not the weight of an object, but its density compared to the density of water, that determines whether an object will sink or float. This concept is then applied to other liquids and how their comparative density affects their interaction with water.

POLARITY & SURFACE TENSION

Length: 1 Day, Time: 1.5 hrs

Where: Anywhere

Throughout this experiment, students will be able to explain, on the molecular level, what makes a water molecule polar or nonpolar. The polarity of water actually allows it to have interesting and unique characteristics, which are also explored in this experiment. Surface tension will be investigated to help students understand polarity further.

THERMAL ENERGY (FLAME & SPECIFIC HEAT TESTS)

Length: 1 Day, Time: 1.5 hrs

Where: -

It's a rule as old as time: Energy can neither be created nor destroyed. So where does that energy go? This experiment will demonstrate to students that energy has to go somewhere - not be lost forever. In the first part of the experiment, students will complete a Specific Heat Test, observing that the heat energy of their specific metal is absorbed by the water in their calorimeter. They will then calculate the specific heat of their metal. Secondly, students will complete a Flame Test to demonstrate the ground state electron configuration as well as the electromagnetic energy that is given off when an object falls back to the ground state. Different metals will be tested to observe the different colors given off when falling back to the ground state.

SOLUTIONS & MIXTURES: EXOTHERMIC, ENDOTHERMIC & CHEMICAL CHANGE

Length: 1 Day, Time: 2 hrs

Where: Anywhere

In the first part of this experiment students will complete various experiments to distinguish between a solution, a suspension, and a colloid. Students will classify each solution/mixture type based on the characteristics of each--some obvious and others more nuanced. In the second part of this experiment students will explore exothermic, endothermic, and chemical changes of mixtures. Students will be able to learn and distinguish whether or not a chemical reaction is endothermic or exothermic. Additionally, they will observe changes in temperature and classify whether the reaction taking place is chemical or physical.



ENERGY & CHEMICAL BONDING

Length: 1 Day, Time: 1.5 hrs

Where: Anywhere

This experiment introduces students to different subatomic particles that enable chemical bonding. During this session, students will learn to draw models of the covalent bonds between basic atoms such as oxygen and hydrogen. Students will also be introduced to the idea of ionic bonding and how this process occurs.

DISSOLVING: LIQUIDS, GASES & TEMPERATURE

Length: 1 Day, Time: 1.5 hrs

Where: Anywhere

A continuation of the Dissolving Solids experiment, this session investigates if temperature has an effect on the rate of dissolution. Students will experiment with solubility of liquids and gases. Lastly, students will be able to identify if a dissolution reaction is endothermic or exothermic through experimentation.

CHANGING STATES

Length: 1 Day, Time: 1.5 hrs

Where: Anywhere

In this experiment students will begin to understand how molecules change from a solid to liquid to gas and then back again. There will be many different methods to learn this idea of gas change, each reflecting a specific function: evaporation, condensation, freezing, and melting.



CHEMICAL REACTIONS

Length: 1 Day, Time: 1.5 hrs

Where: -

Students will gain an understanding of chemical reactions through experimentation with household items. They will be introduced to atoms and the idea that matter is never destroyed or created, but simply changed. Finally, students will be able to explain that the bonds between atoms in the reactants are broken, the atoms are rearranged, and new bonds between the atoms are formed to make the products.



MATTER, MOLECULES & MOVEMENT

Length: 1 Day, Time: 1.5 hrs

Where: Anywhere

This experiment begins at a very elementary level understanding of what matter and molecules are. Students will investigate water as being made up of molecules and understand what that means. Finally, students will experiment with temperatures effect on molecules and make their very own basic thermometer.

DIFFUSION & OSMOSIS

Length: 1 Day, Time: 1.5-2 hrs

Where: Anywhere

The movement of solutes and water across cellular membranes is essential to all life. Cells must maintain their internal environments and control solute movement using complex processes. These concepts can be illustrated using both model systems and living cells. Students will investigate transpiration in plants in order to understand the concepts of osmosis and water potential.

CHEMISTRY

MAKING A MIRROR

Length: 1 Day, Time: 1 hr

Where: Anywhere with good ventilation

Mirror, mirror on the wall, who's the fairest scientist of all? In this experiment students will turn a test tube into a mirror. Students will make the Tollens Reagent and see how the mixture of different reagents causes a chemical reaction and visible change.

DETERMINING CHEMICAL UNKNOWNNS

Length: 1 Day, Time: 1.5 hrs

Where: -

Sometimes you know what you're working with and sometimes you have to find out. In this experiment, students will perform experiments on unknown chemicals in hopes of revealing key reactions and clues. It will be up to the students to help determine the exact chemical formulas and save the unknown chemicals from being thrown away.

EDIBLE CHEMISTRY

THE SCIENCE OF CANDY MAKING

Length: 1 Day, Time: 2 hrs

Where: Anywhere

No one ever said that chemistry had to be boring. What happens in your oven is just as much a chemical reaction as what happens in a test tube. In this module, students will learn about melting points and crystallization while making delicious sweet treats.

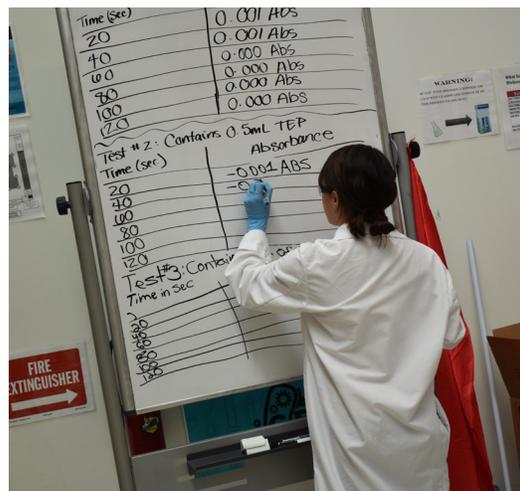
Site should ideally have access to a refrigerator to speed up chocolate cooling process.

ROCK CANDY

Length: 1 Day, Time: 1-1.5 hrs

Where: -

What's a better experiment than one you can eat afterwards! Students will learn about crystals and saturated solutions as they create their own rock candy from scratch. Why make one piece when you could make three; students will also test different sugars to see which ones produce the best candy.



GOBSTOPPER SCIENCE

Length: 1 Day, Time: 45 min - 1 hr

Where: -

Who doesn't enjoy eating colorful candy and watching their tongues change color? But what is really going on as you eat that candy? In this experiment, students will dissolve gobstoppers and make predictions as to why this colorful change happens.



CHEMICAL ARTS

TIE-DYE CHROMATOGRAPHY

Length: 1 Day, **Time:** 30 mins

Where: Anywhere

Vibrant colors and patterns naturally captivate our attention. We are reimagining the common experimental technique of chromatography, to become something fun and beautiful.



PURE CRYSTAL ART

Length: 2 Days, **Time:** 30 mins / day

Where: -

Some children use pencils to create art. Some children use paint to create art. Our students use crystals. Let your student's creativity flow as they grow crystals and create something truly beautiful and unique. Crystallization is used in chemistry experiments to create a pure substance; your student will use it to create pure art.

THE WORLD OF GEODES

Length: 1 Day, **Time:** 1.5 hrs

Where: -

Geodes seem like normal rocks on the outside, but on the inside they offer treasure trove of crystals waiting to be discovered. How did those crystals get inside that rock anyways? And how can we make them ourselves? We'll share the answers to those questions and teach you the ins and outs of crystals in the process.

Optional: edible rock candy fondant geode for an additional \$5 per student

BATH BOMB SCIENCE

Length: 1 Day, **Time:** 2 hrs

Where: CSL only

A simple pleasure in life is dipping into a nice, warm bath and plopping a fizzy bath bomb in to soften the waters. It turns out the science behind this simple pleasure is not so simple! These relaxing crafts have quite a bit of chemistry behind them. Students will learn about acids and bases, chemical reactions, and will get to make their own custom bath bombs!

SOAPY SCIENCE

Length: 1 Day, **Time:** 1.5 hrs

Where: Anywhere

Did you know that scientifically speaking soap is considered a salt? That's because it's the product of the combination of an acid and base. There is quite a bit of chemistry behind this common household item. Students will learn about each component of soap and the science behind the chemical reaction while they make their own natural soap from scratch.

Experiment requires a microwave & soap must set in molds for 24 hours prior to removing.

INVESTIGATING OOBLECK

Length: 1 Day, **Time:** 1 hr

Where: Anywhere

What object is able to act like a solid and liquid at the same time? Oobleck, that's what! Dr. Seuss was the man to name this non-Newtonian fluid with a high potential for fun. This module discusses states and properties of matter through a hands-on experiment that challenges the laws of physics.

THE SCIENCE OF SLIME

Length: 1 Day, **Time:** 1.5 hrs

Where: Anywhere

Slime is the original fun science experiment, but not many people talk about what's going on at a molecular level. Students will be taught how to use proper experimental techniques while carrying out this entertaining chemical reaction. Investigating oobleck



CHEMISTRY - CHEMICAL ARTS



COLOR CHROMATOGRAPHY

Length: 1 Day, Time: 1 hr

Where: -

Most mixtures and solutions we see look like they are made up of one uniform substance, but we know that's not true. Is there a way to see all the solutions that make up the mixture? Yes! During this experiment students will use chromatography to separate a mixture and see the unique solutions that form it.



BIOCHEMISTRY - Advanced experiments*

These experiments are recommended for “CSL All-Star Scientists” who are already familiar with experimental laboratory equipment use & techniques

INTRODUCTION TO BIOCHEMISTRY & VITAMIN C CONCENTRATION

Length: 1 Day, Time: 1.5 hrs
Where: CSL only

Even before you get to the level of cells and DNA, life depends on specialized organic molecules - proteins, carbohydrates, fats, and more. In this module, a wide variety of chemical assays will be utilized to learn about these molecules; students will analyze foods for starch, sugar, lipids, protein, and amino acids; observe the enzyme mechanisms of digestion; and perform chromatography separation. Vitamin C is vital for human health - without it, we develop scurvy. In this module, students will also test a variety of foods for their presence and concentration of vitamin C.

PHYSICAL PROPERTIES OF PROTEINS

Length: 1 Day, Time: 2 hrs
Where: CSL only

Proteins are a critically important part of organic life, so it's no surprise that there are a variety of techniques for working with them. In this module, students will learn a number of methods for working with proteins, including precipitation, fractionation, and denaturation.



STARCH, PROTEIN & LIPIDS INVESTIGATION

Length: 1 Day, Time: 1.5-2 hrs
Where: CSL only

Students will complete a series of tests and comparisons of starch and proteins in this workshop. They will begin by being introduced to what starch and proteins are and how they are represented molecularly. Then students will test different samples to see if starch or proteins are present in them.



PROTEIN BIOASSAY ELISA EXPERIMENTS

Length: 2 Days, Time: 1 hr/day
Where: CSL only

Immunoassays are one of the most powerful analytical tools in molecular biology. In this module, students will learn how to conduct an ELISA assay, using antibodies to probe for the presence of environmental hazards.



BIOCHEMISTRY - Advanced experiments*

These experiments are recommended for “CSL All-Star Scientists” who are already familiar with experimental equipment use & techniques

TURNIP PEROXIDASE REACTIONS

Length: 1 Day, Time: 1.5 hrs

Where: CSL only

What exactly is a redox reaction? Students will learn that Reduction - Oxidation Reaction describe all chemical reaction where the atoms have changed their oxidation number (simply the exchange of electrons). Enzymes are also very important for these reactions to take place and this experiment will demonstrate this as well. The interaction of enzymes will be discussed and how they specifically relate to this experiment as well as the bigger picture. Students will then learn how to use a spectrophotometer to read the levels of specific proteins and enzymes from their turnip.



ENZYMES AND DIGESTION

Length: 1 Day, Time: 1.5 hrs

Where: CSL only

The food you eat contains many different types of molecules, including sugars. In order for our bodies to digest these large molecules we need enzymes to help break them down. In this workshop, students will further understand how enzymes and sugars interact through activities and experimentation.



PHYSICS

PAINT WITH THE FORCE OF GRAVITY

Where: Anywhere

Gravity, the force that ties humanity to the Earth, is crucial in our understanding of the universe. Students participating in this experiment will not only have the opportunity to study gravity, but will use logic and creativity to see the effects of gravity in everyday life as they create their own watercolor paintings.

EGG DROP

Where: Anywhere

This classic experiment simulates how objects are affected by the forces of gravity and how certain measures can be taken to protect against damage. In this experiment, students will experience how engineers and physicists problem solve as they design a support structure to protect an egg. At the end, students will test their design by dropping their egg and observing whether their design was effective.

DANCING SLIME

Where: Anywhere

Enter the novel study of Cymatics: the world of sound. In this experiment, students will have the opportunity to not only understand sound waves, but also work with circuits and sound systems to make slime dance. This experiment introduces the fundamental concepts of waves and fluid mechanics with the help of a ripple tank.



(in)VISIBLE WAVES

Where: Anywhere

This experiment introduces the fundamental concepts of waves and fluid mechanics, with the help of a ripple tank. Students will be able to simulate waves and learn how to use experiment equipment to test ideas under different constraints.



THE ART OF LEVITATION...AND MAKING SPARKS FLY

Where: Anywhere

Levitation, a phenomenon found in science fiction and myths, is actually possible! Students in this lab will learn about the imbalance of electrons also known as static electricity, and how we can use static electricity to make common objects levitate. Students will also make sparks fly using an electrically charged balloon and a comb.

MAGNETIC MAGIC

Where: Anywhere

Although dropping a magnet through a metal tube does not seem like a noteworthy act, you may find yourself quite surprised. In this experiment, students will explore magnetic and electric fields and witness unexpected occurrences that arise when they come into contact with one another. Students will also explore ferrofluids, liquids that display both fluid and magnetic properties. Students will learn how magnetic fluids react when introduced to a magnetic field, and gain an understanding of nanoparticles.

STEAMING ENGINE

Where: Anywhere

Although steam engines are an outdated form of transportation, the science behind them is very useful in understanding modern day engines. Students will use a tea light and copper tubing to create their steam engine all while discussing concepts of thermal physics.

PHYSICS

MAKE YOUR OWN KALEIDOSCOPE

Where: **Anywhere**

A simple kaleidoscope can provide deep and meaningful insight into the concepts of reflection and refraction. In this experiment, young scientists will be able to explore the world of light through the eyes of a hand-made kaleidoscope.



LED LANDSCAPE

Where: **Anywhere**

Although street art is a form of creative expression, it can sometimes be seen as a nuisance. Inventors have created the concept of LED street art lights. Students will mix circuitry with magnetism to create LED light magnets which can be used to create glowing LED mosaics.

QUANTUM ENCRYPTION

“While quantum encryption seems like a scary topic, your students will have the opportunity to visually create the effects of quantum encryption using low-powered lasers and light blockers (polarizers). Students will be able to send and receive messages using a laser light and decryption key.”



SPACE

LUNAR LANDER

Where: **Anywhere**

Think of all the power required to propel a spacecraft to the moon... and the technology required to stop it once it arrives. Students will engineer a shock-absorption system out of homemade springs and marshmallow-cushioning to ensure a safe landing that doesn't damage their "aircraft" or astronaut "passengers".

PLANETARY PASTA ROVER

Time: *2.5 hrs*

Where: **Anywhere**

Imagine designing a vehicle to travel across the surface of Mars; it must cross rocky, treacherous, and unpredictable terrain. Students will construct their own vehicle, a "pasta rover" while staying within their project budget as they "buy" component pieces from the pasta "market". Once they have completed their rover, students will test its speed and stability down a model track.

GALAXY IN A JAR

Where: **Anywhere**

Solar System, Galaxy, Universe...such realities are immense and difficult to grasp. Students will create their own model galaxy in a jar to take home and remind them of the Milky Way: the galaxy that is home to our solar system.

BALLOON-POWERED NANOROVER

Where: **Anywhere**

Even in the vast regions of outer space, astronomers use tiny rovers to explore surfaces such as moons and asteroids. In this session, students will build their own balloon-powered nanorover using common materials while trying to minimize "costs" and weight in their construction.

STRAW (/SLINGSHOT) ROCKETS

Where: **Anywhere**

Students will design their first rocket, using just paper and tape, and launch it into "orbit" with a drinking straw. During this activity, students will practice the engineering/design process by troubleshooting their design as they pilot their rocket on the test launch-pad.



POP ROCKETS

Where: **Anywhere**

The aerodynamics of a rocket can determine its ability to fly to great heights. Students will design their own model rockets out of paper and test their flight-readiness. Students can take their learning to a higher level using homemade altitude trackers--and a little geometry-- to calculate the peak height of their launch.

LUNAR LANDING SWINGING TRAY

Where: **Anywhere**

In this session, students will explore the gravitational and centripetal forces that are essential to the orbits of planets and asteroids.



SPACE

ALKA-ROCKETS

Where: **Anywhere**

Who doesn't love a little fizzling action? In this session, students will harness the power of Alka-Seltzer tablets to fuel the launch of their own "Alka-Rocket". Students can experiment with how timing and water temperature influence rates of reaction and the power they can produce.

GLITTER GALAXY SLIME

Where: **Anywhere**

Have you enjoyed reaching astronomical heights through your construction of rockets and rovers? Take a step back and get crafty by creating your own galaxy-inspired slime using common household materials.

SPACE LAUNCH SIMULATOR

Where: **Anywhere**

Massive power is needed to launch rockets into earth's orbit. NASA's Space Launch System is designed to do just that. In this introductory lesson, students will engineer a balloon-powered launch mechanism and test its weight capacity.

MAKE YOUR OWN COMET

Where: **Anywhere**

If you have ever wanted to see what a comet looks like up close, this is the session for you! Students will make their own comet using dry ice and some common household items in order to explore the environments found on these awesome hunks of mass.



DRY ICE ROCKETS

Where: **Anywhere**

Students will be exploring the world of rockets. They will be designing their own rockets out of cardboard, construction paper, and other commonly found items. Then the students will try and use different fuel sources to see which will launch their rocket the furthest. These fuels include: dry ice and water, Alka-Seltzer and water, and baking soda and vinegar. These fuel sources will help teach the students about gas expansion and pressure.



