21st Century Afterschool Science Project

Model, Guide to Incorporating Science in Afterschool and "Exploring Water Science in Afterschool" Curriculum

PART ONE: Overview

PART TWO: Curriculum Implementation

PART THREE: Lesson Overview/Guidance/Teaching Tips

PART FOUR: Resources to Support 21st CASP Curriculum

Templates

ACKNOWLEDGEMENTS

This afterschool science model, guide and curriculum was developed by *the 21st Century Afterschool Science Project (21st CASP)* partnership to enrich student learning through inquiry-based, interactive science experiences. The project was funded in its entirety with federal Elementary and Secondary Education Act, as amended by No Child Left Behind, Title IV, Part B, 21st Century Community Learning Center (21st CCLC) grant funds through a cooperative grant agreement with the New Jersey Department of Education.

The 21st Century Afterschool Science Project partnership would like to thank the following members of the 21st CASP team for researching, developing, prototyping and writing the guide and curricular materials:

- Maxie Hollingsworth Latimer, formerly Director of Afterschool Initiatives at Liberty Science Center, Jersey City, NJ
- Elizabeth Kurzawa, former Associate Director for Research and Gran Programs, Liberty Science Center, Jersey City, NJ
- Pam Lerner, Afterschool Science Specialist, New Jersey School-Age Care Coalition, Westfield, NJ

Additional thanks to Melissa Wadman, Director, Impact Evaluation at Liberty Science Center, Jersey City, NJ for synthesizing the project outcomes from individual interviews, survey and focus groups with afterschool program facilitators, students and families.

Special thanks to the following Liberty Science Center staff for their help on this project: Bryan Blaney and Bob Smith for developing the hands-on family science activities used during the pilot project and to Matthew Doering for his assistance with the research and review of materials for the curriculum and facilitator guide.

The 21st Century Afterschool Science Project partnership would also like to thank the following environmental educators whose expertise helped the Project team adapt water science experiments into a hands-on curriculum for afterschool providers:

- Claire Antonucci, New Jersey Marine Sciences Consortium
- Janice McDonnell, Institute of Marine & Coastal Sciences at Rutgers University
- Thomas M. Grothues, Rutgers University Martine Field Station at Tuckerton

We also wish to express our gratitude to the following 21st CCLC afterschool program staff who pilot-tested the curriculum activities and contributed invaluable feedback that helped shape the curriculum, training and overall model for delivering science in afterschool environments.

- Cassandra Small, Janet Poinsette and Susanne Lustberg, Janis E. Dismus Middle School, Englewood, NJ
- Pat Snyder, Maryann Brown and Pam Pelletier, Lakewood Latchkey at Oak Street School, Lakewood, NJ
- Rosalind Norrell-Nance and Dr. Jim McGinn, Atlanticare Uptown Family Center Community School, Atlantic City, NJ

We would also like to recognize the following afterschool programs for providing amazing photographs of wetlands animals.

Additionally, we would like to thank the follow staff from the Office of Educational Support Services (OESS) at the New Jersey Department of Education for their collaborative effort and guidance on this project: Haydee Y. Perez-Livingston, Extended Educational Services Unit Coordinator; and Tom Collins, Evaluation Coordinator (retired).

SPECIAL ACKNOWLEDGEMENTS

We would like to recognize and thank the following people, without whom this project would not have been possible:

- Sarah B. Cruz, former staff, New Jersey School-Age Care Coalition, Westfield, NJ for her patience and expertise in the revision of this guide.
- Susan Martz, Assistant Commissioner, Division of Learning Supports and Specialized Services, at the New Jersey Department of Education, Trenton, NJ for supporting the enhancement of quality afterschool programming through informal science education;
- Diane Genco, Executive Director, New Jersey School-Age Care Coalition, Westfield, NJ for her expertise, technical assistance and tireless promotion of afterschool;
- Jeffrey Osowski, Ph.D, former Vice President for Learning and Teaching, Liberty Science Center, Jersey City, NJ for helping to expand Liberty Science Center's role in the field of afterschool.

PART ONE: Overview

Introduction

Welcome to the 21st Century Afterschool Science Project (21st CASP).

The topic selected for the curriculum is water, a compound with wondrous properties. Water is central to life on earth, and New Jersey has an abundance of waterways, harbors and estuaries.

The curriculum consists of two units of hands-on science investigations. Unit 1 focuses on the properties of water, and Unit 2 focuses on the ecological impacts of water. The activities were designed specifically for use in Out of School Time (OST) settings for youth in grades 4 through 8.

The experiences are designed to help children probe the fundamental concepts of science and nature, to get them to see the science all around them and to put them in powerful roles as active learners.

The activities are meant to be introduced sequentially, which research suggests leads to the best student learning outcomes; however, they can be successfully completed individually or out of order according to individual program needs.

This facilitator guide was developed to prepare afterschool staff to facilitate the activities in the 21st CASP curriculum using a guided approach to encourage student inquiry. Inquiry-based questions are infused throughout the curriculum, and the curriculum includes student journals that help to promote critical thinking and problem-solving, which will support youth development as well as science learning.

The curriculum aims to help youth hone their skills of observation, documentation, formulating and refining questions, articulating ideas and reasoning, identifying and debating evidence, moving from evidence to explanation and communicating ideas and findings. Mathematical skills such as pattern recognition, data-recording and analysis, proportion, measuring and comparison were incorporated into the curricula. Literacy is integrated through guided and open discussion.Listening skills are developed during the science investigations, and writing skills are honed in the student journals.

The New Jersey Core Curriculum Content Standards (NJCCCS) were used to guide the development of the curriculum activities and learning objectives. The revised version of the guide includes information on connections to the Common Core State Standards (CCSS). The 21st CASP curriculum is a tool that enables afterschool programs to align with student learning that takes place during the school day. The Curriculum and the Facilitator’s Guide will support staff in helping to reinforce information that youth learn during the school day with inquiry-based, hands on experiences.

Background

In 2005, the New Jersey Department of Education (NJDOE), Liberty Science Center (LSC) and NJSACC: The Network for New Jersey’s Afterschool Communities held a series of meetings to discuss the benefits of science learning in OST settings, specifically in 21st Century Community Learning Center (21st CCLC) programs, which serve nearly a million youth throughout the country and 15,000 youth in New Jersey.

The 21st CASP was born from these initial meetings, with the primary goal of supporting science learning in afterschool and other OST environments. The Curriculum was designed with the understanding that the demands and expectations for OST programs, including afterschool programs, have expanded from merely providing a safe-haven and homework help to offering supplemental instruction, enrichment opportunities and physical activities.

The curriculum was developed and prototyped at Liberty Science Center's Community Science Workshop prior to dissemination to pilot sites. Additionally, the lessons were reviewed by scientists from the New Jersey Marine Sciences Consortium, the Institute of Marine & Coastal Sciences at Rutgers University and Rutgers University Marine Field Station at Tuckerton.

The 21st CASP partners then tested the model in three pilot sites to ensure that the curriculum could be replicated in afterschool programs, using available resources and attending to the practical realities facing afterschool programs. More detailed information on the Background, Initial Pilot Implementation and Evaluation can be found in Part Five of this manual.

Goals of 21st CASP

The goal of 21st CASP is to bring exciting science to the children and youth of New Jersey by expanding the capacity of afterschool programs to incorporate it. The 21st CASP seeks to enrich student learning and engagement through inquiry-based, informal science education experiences. The project emphasizes and pursues the connections between the essential components of scientific inquiry and the skills of language and mathematical literacy through a multifaceted model. The focus is on children in grades 4 - 8 and afterschool staff, including professional educators, youth workers and paraprofessionals.

The 21st CASP is designed to:

- Develop rich science experiences and curricular materials appropriate for integration into the Afterschool environment;
- Create hands-on science activities that promote language rts, math and science literacy skills for youth;
- Use a guided-inquiry approach to encourage student problem-solving and engagement;
- Demonstrate and model how to engage afterschool program staff and children in experiential science activities;
- Build the capacity of afterschool programs to make high quality, hands-on science a regular part of their offerings through training, modeling and coaching;
- Involve families in hands-on science learning using family science events as a venue to engage parents in supporting their children's learning;
- Develop curricular materials and a facilitator guide to support and sustain the integration of science experiences into afterschool programs.
- Specifically, the project model is composed of multiple components:

- An informal, hands-on science curriculum that incorporates language arts and math skills and is appropriate for the Afterschool setting;

- Use of a guided-inquiry approach to encourage student problem-solving and engagement and effective facilitation of science learning;

- Strategies for the involvement of families integral to youth's academic success.

Science Learning in Afterschool

The importance of integrating science into Afterschool is clear. According to Nicole Yohalem of the Forum for Youth Investment and Andrew Shouse of the National Research Council:

> "The potential for afterschool programs to help (youth) become scientifically engaged clearly exists. A growing number of studies and evaluations of science-focused afterschool programs show promising results in terms of youths' science knowledge, identity, interest and career trajectories. . . Lucy Friedman and Jane Quinn put it well when they stated in Ed Week, 'Afterschool programs offer an ideal setting for nurturing the potential scientist in every student... Compared to the school day, these programs' smaller groups, longer time slots and less-formal settings provide opportunities for young people to visit museums, study neighborhood environments, cultivate gardens, perform laboratory experiments and have their love of discovery awakened in countless other ways.'"

Typically, afterschool programs are less constrained by the bureaucracy of traditional school environments. They provide more opportunities for expanded and enriching activities without the burden of time constraints and test scores. Afterschool programs can often function more creatively than schools, providing more interactive learning and teaching strategies. In fact, the support needed to work with youth is sometimes more readily available in afterschool environments; for example, afterschool staff are able to develop more meaningful relationships with children and their families, often serving several children from the same family, and thus gaining a better understanding of how to serve the 'whole' child.

Science learning in afterschool environments:

- Gives girls and youth of color greater opportunities for science learning in a more supportive learning environment;

- Creates opportunities for children to see science as part of their everyday experience;

- Encourages family involvement in their child's learning;

- Provides continuity of science learning and opportunities for in-depth science learning experiences;

- Provides space, time and support for the formation of afterschool science clubs.

Science learning in Afterschool allows youth to learn essential team-building and problem-solving skills, and provides more opportunities for youth to participate in hands-on, project-based learning. Afterschool is particularly ideal for the type of informal and experiential learning that children need to balance traditional school education. In Afterschool, youth are able to learn more than just science content; indeed, they are able to research, discuss, identify and develop their own strategies for the social and environmental issues affecting their communities.

United firmly in the belief that access to intensive, comprehensive, resource-rich educational experiences is vital to removing barriers to improved educational opportunities for youth, the 21st CASP partnership moved forward to address the well-documented educational challenges that face youth in the areas of science, mathematics and technology. There is a growing body of research documenting the importance of science learning in Afterschool. Engaging children in informal science activities has been shown to be strongly correlated with the further study of science and the pursuit of science-related careers. Interactive science centers--large or small--are especially effective in fostering this mind-set and motivation among educational institutions, individuals and families. The 21st CASP aims to give youth the opportunity to explore science by investigating the biological, social and ecological significance of water in afterschool settings.

The 21st CASP partners recognize the need to find creative ways to engage youth in science learning to increase youth success rates in school and in the workforce. Afterschool programs are in a unique position to bring science to life for youth whose school-day teachers may be limited by time, large class sizes, state educational standards, resistance to new teaching strategies and discomfort with the subject or content. Effective science learning in Afterschool and other OST programs can truly support and complement structured school-day learning, particularly for youth who don't do well in traditional classroom settings. The 21st CASP focuses on collaborative efforts designed to integrate science into afterschool programs.

Expanded Learning Opportunities (ELO)

Afterschool, before-school, summer and weekend program have long been recognized as environments that offer youth a setting in which they can explore interests, participate in enrichment activities, learn and enhance skills and get support for academic learning. These setting are commonly referred to as Expanded Learning Opportunities (ELO). Programs that are held before and after school, on weekends and during the summer, and opportunities such as service learning, mentoring, internships, apprenticeships, dual enrollment in college, virtual learning and early childhood education all offer paths for young people to engage in learning in meaningful ways. While programmatic goals vary depending on the ELO, they usually relate to some combination of increased academic success, social, emotional and character development, civic engagement, wellness and nutrition, among other developmental assets.

According to The Quality Imperative: A State Guide to Achieving the Promise of Extended Learning Opportunities, ELOs provide critical support within high functioning education systems. Research demonstrates that ELOs boost academic gains, increase youth engagement, cultivate work-study habits, improve behaviors and social and emotional development, support working families and build stronger connections among families, schools and communities.[1] Additionally, researchers and afterschool practitioners have found that effective programs combine academic, enrichment, cultural and recreational activities to guide learning and engage youth. ELOs also provide youth safe, structured learning environments, thereby providing support to working families.

March 2009, National Governors Association, Center for Best Practices and Council of Chief State School Officers.

While afterschool programs are varied in their goals and purposes, all are wrestling with the need to prepare youth for the challenges of this new century, the scientific and technological revolution and achievement in school. Research has demonstrated that participation in afterschool programming has a positive impact on youth, decreasing risky behaviors and improving school success and academic achievement. Youth involved in meaningful pursuits during OST hours develop increased self-confidence and a stronger sense of community, particularly for those youth deemed "at risk." Afterschool programs are an important part of the community-based network and should be equipped to engage those with the least access to the critical fields of math, science and technology.

ELOs, including extended-day and OST programs, have tremendous potential to help youth develop the knowledge and skills needed for positive social development and academic achievement. As educational policy and attitudes change, afterschool programs must also evolve from the traditional latch-key and homework-help programs. Most 21st century-children are electronic-media savvy and possess a heightened awareness about their connection to the world community. However, because U.S. advantages in the global marketplace and in science and technology have begun to erode, our children must be better prepared to enter school and the workforce with advanced knowledge and skills. ELOs can offer experiences--particularly in science and technology--that complement and reinforce school-day learning.

Engaging Youth in Science, Math and Language Arts Literacy

The 21st CASP Curriculum was designed to engage youth in science, math and language arts literacy.

Scientific Literacy

According to the National Science Education Standards, helping youth achieve scientific literacy means equipping them with the science knowledge and skills necessary to: read, understand and discuss science; describe, predict and explain scientific phenomena; develop informed opinions and make informed decisions on science topics; find the answers to personal science questions; and evaluate the quality or validity of science information in politics and in the media (NSES, 22, 23). Science literacy involves providing youth with the tools necessary to make sense of the abundance of often conflicting science information they encounter in everyday life.

Science as an Active Process

When attempting to understand how youth learn science it is important to acknowledge that science learning is an active process. In formal education most of us have probably had the experience of being taught science through facts and formulas strictly from a textbook in a lecture format. However, learning is much more effective when youth are actively engaged and at the center of the learning. When facilitating science, it is not necessary to deliver presentations to youth, or to cover every single topic in science. It is not even necessary to have all of the answers. Youths' engagement with science needs to be both hands-on and minds-on. Science investigations should be constructed so that youth interact with both their facilitator and their peers. They should also have time to reflect about what they have observed and what additional questions they may have developed from a particular investigation. To achieve science literacy, youth should be asking questions, making observations, making predictions, exploring, experimenting, documenting and reflecting (NSES, 20).

Math Literacy

Math is an integral part of science, not an optional one. To be a good scientist, one needs to be able to understand and apply the appropriate mathematical concepts. Math should be presented to youth as a valuable tool in science inquiry. Math can be used during scientific investigations to collect information and analyze data. Using math in science may involve skills such as computation, applying equations, weighing, measuring, converting and estimating. Within a scientific context youth can practice real-world mathematical applications, see the importance of mathematics and gain a better sense of the purpose of various mathematical concepts.

Do not be anxious about using math in your afterschool science program. A major misconception is that there is only one way to solve a problem involving math – not true! As in science, there are a variety of ways to solve math problems and lots of tools to assist with the process. Use your fingers, a ruler, graph paper, objects found in nature – whatever helps your youth learn and feel comfortable with the way they absorb and retain information. You will be surprised at how much young scientists know about mathematics and will be able to share their knowledge with their peers while engaging in science activities.

Language Arts Literacy

Although language arts literacy and science seem to be separate disciplines, each is necessary for the study and practice of the other. Effective scientists are able to communicate and write fluently about science using appropriate vocabulary. They are able to communicate and defend the findings of their investigations to others. Scientists often write up the results of their studies to be published in scientific journals or books.

Just as scientists need to possess good communication skills, young scientists should also be able to communicate effectively about science both verbally and in writing. Youth should respond verbally to questions posed by the facilitator and their peers, share questions that they might have and engage in small group and whole-class discussions regarding scientific investigations. Youth should also practice describing what happened during investigations and presenting their findings. To practice written communication, youth can write down what they do and observe during investigations, as well as compose conclusion statements based on their findings.

21st Century Afterschool Science Project and Academic Standards

Using the lessons in the 21st CASP Curriculum provides the opportunity to enhance the learning that takes place during the school day through the hands-on inquiry-based activities. The lessons can be connected to academic standards used by school day educators, which in New Jersey are the Common Core State Standards (CCSS) for English Language Arts and Mathematics and the New Jersey Core Curriculum Content Standards for Science. By recognizing the connection between the activities and the academic standards, afterschool programs can be deliberate in making connections to school day learning and further support student success in the way that is unique to the ELO setting.

Academic standards are important because they describe what all youth, no matter where they live, need to know to be prepared for success in college and the workforce. They help set clear and consistent expectations for youth, parents and teachers; build child's knowledge and skills; and help set high goals for all youth.

Of course, high standards are not the only thing needed for our children's success. But standards provide an important first step — a clear roadmap for learning for teachers, parents and youth. Clearly defined goals help families and teachers work together to ensure that youth succeed. Standards help parents and teachers know when youth need extra assistance or when they need to be challenged even more. An understanding of student targets that apply during the traditional school day positions ELO programs to build on what happens during the school day and to contribute to youths' overall success.

The 21st CASP curriculum supports the CCSS, and becoming familiar with the standards for the grades that are participating in the 21st CASP lessons will help facilitators to recognize the connections between the standards and the lessons and to communicate those connections with youth, parents and school staff.

The CCSS can be found in their entirety at www.corestandards.org.

The New Jersey Core Curriculum Content Standards for Science can be found in their entirety at: www.state.nj.us/education/cccs/standards/5/index.html.

Common Core State Standards

The Common Core State Standards (CCSS) define what youth should understand and be able to do at the end of each grade level. The standards are designed to be rigorous and relevant to the real world, reflecting the knowledge and skills that our young people need to succeed academically in college-entry courses and in workforce training programs. With American youth fully prepared for the future, our communities will be best positioned to compete successfully in the global economy.

The Common Core State Standards Initiative is a state-led effort coordinated by the National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO). The standards were developed in collaboration with teachers, school administrators and other experts, to provide a clear and consistent framework to prepare our children for competition and collaboration in a global, media-saturated, rapidly changing environment. The standards are informed by the highest, most effective models from states across the country and countries around the world and provide teachers and parents with a common understanding of what youth are expected to learn. The standards were developed to:

- Align with college and work expectations;
- Be fewer, clearer and higher;
- Include rigorous content and application of knowledge through high-order skills;
- Build upon strengths and lessons from the use of current state standards;

- Be informed by other top performing countries, so that all youth are prepared to succeed in our global economy and society;
- Be research- and evidence-based.

Key Points in the CCSS for English Language Arts

Although reading, writing, speaking and listening are articulated separately in the CCSS for clarity, they are tightly interrelated.

Reading

The standards establish a "staircase" of increasing complexity in what youth must be able to read so that all youth are ready for the demands of college- and career-level reading no later than the end of high school. The standards also require the progressive development of reading comprehension so that youth advancing through the grades are able to process and understand increasingly complex written material.

Writing

The ability to write logical arguments based on substantive claims, sound reasoning and relevant evidence is a cornerstone of the writing standards, with opinion writing—a basic form of argument—beginning in the earliest grades. Both short, focused research projects (such as those commonly required in the workplace) and longer-term, in-depth research —are emphasized throughout the standards but most prominently in the writing strand since a written analysis and presentation of findings is so often critical.

Speaking and Listening

The standards require that youth gain, evaluate and present increasingly complex information, ideas and evidence through listening and speaking as well as through media.

An important focus of the speaking and listening standards is academic discussion in one-on-one, small-group and whole-class settings. Formal presentations are one important way such talk occurs, but so are the more informal discussion that takes place as youth collaborate to answer questions, build understanding and solve problems.

Language

The standards expect that youth will grow their vocabularies through a mix of conversations, direct instruction and reading. The standards will help youth determine word meanings, appreciate the nuances of words and steadily expand their repertoire of words and phrases.

The standards help prepare youth for real life experience at college and in 21st century careers. They recognize that youth must be able to use formal English in their writing and speaking but that they must also be able to make informed, skillful choices among the many ways to express themselves through language.

Vocabulary and conventions are treated in their own strand not because skills in these areas should be handled in isolation but because their use extends across reading, writing, speaking and listening.

Media and Technology

Just as media and technology are integrated in school and life in the 21st century, skills related to media use (both critical analysis and production of media) are integrated throughout the standards.

English Language Arts and Literacy Capacities

As youth advance through the grades and master the standards in reading, writing, speaking, listening and language, they are able to demonstrate with increasing success and regularity the following capacities of a literate individual:

- Demonstrate independence;
- Build strong content knowledge across a wide range of subject matter;
- Respond to the varying demands of audience, task, purpose and discipline;
- Comprehend as well as critique;
- Value evidence;
- Use technology and digital media strategically and capably;
- Gain understanding of other perspectives and cultures.

<u>Key Points in CCSS for Mathematics</u>

The mathematics standards include standards for both mathematical practice and mathematical content.

Mathematical Practices

The Standards for Mathematical Practice contain six core practices that describe the way proficient youth approach mathematics and provide a guide to what educators should seek to develop in youth. Students should:

- Attend to precision,
- Construct viable arguments and critique the reasoning of others;
- Make sense of complex problems and persevere in solving them;
- Look for structure;
- Reason abstractly and quantitatively;
- Make strategic decisions about the use of tools, including technology.

Standards for Mathematical Content

The mathematical content standards include 10 standards consisting of core concepts, core skills and a description of the student's coherent understanding. These standards focus on numbers, quantity, expressions, equations, functions, modeling, shape, coordinates, probability and statistics.

The K-5 standards provide youth with a solid foundation in whole numbers, addition, subtraction, multiplication, division, fractions and decimals—which help young youth build the foundation to successfully apply more demanding math concepts and procedures, and move into applications.

Having built a strong foundation in K-5, youth can do hands-on learning in geometry, algebra and probability and statistics. Youth who have completed 7th grade and mastered the content and skills through the 7th grade will be well-prepared for algebra in 8th grade. The middle school standards are robust and provide a coherent and rich preparation for high school mathematics.

The CCSS can be found in their entirety at www.corestandards.org.

New Jersey Core Curriculum Content Standards for Science

"Today more than ever before, science holds the key to our survival as a planet and our security and prosperity as a nation" (Obama, 2008).

Scientific literacy assumes an increasingly important role in the context of globalization. The rapid pace of technological advances, access to an unprecedented wealth of information and the pervasive impact of science and technology on day-to-day living require a depth of understanding that can be enhanced through quality science education.

In the 21st century, science education focuses on the practices of science that lead to a greater understanding of the growing body of scientific knowledge that is required of citizens in an ever changing world.

The mission of the NJCCCS for Science is to produce scientifically literate youth who possess the knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs and economic productivity.

The purpose of the standards is to provide a quality science education that fosters a population that:

- Experiences the richness and excitement of knowing about the natural world and understanding how it functions;
- Uses appropriate scientific processes and principles in making personal decisions;
- Engages intelligently in public discourse and debate about matters of scientific and technological concern;
- Applies scientific knowledge and skills to increase economic productivity.

Intent and Spirit of the Science Standards

All youth should engage in science experiences that promote the ability to ask, find or determine answers to questions derived from natural curiosity about everyday things and occurrences. The underpinning of the standards lies in the premise that science should be experienced as an active process in which inquiry is central to learning and in which youth engage in observation, inference and experimentation on an ongoing basis, rather than as an isolated a process. When engaging in inquiry, youth describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge and communicate their ideas to others in their community and around the world. They actively develop their understanding of science by identifying their assumptions, using critical and logical thinking and considering alternative explanations.

The NJCCCS are driven by two questions:

- What are the core scientific concepts and principles that all youth need to understand in the 21st century?
- What should youth be able to do in order to demonstrate understanding of these concepts and principles?

The NJCCCS for Science can be found in their entirety at:
www.state.nj.us/education/cccs/standards/5/index.html

21st Century Skills/Habits of Mind

The NJCCCS for Science are infused throughout 21st CASP, and afterschool teachers can make connections to school day standards using the NJCCCS. One of the aims of NJCCCS is to teach youth scientific processes. The goal is for youth to develop problem-solving, decision-making and inquiry skills, reflected by formulating usable questions and hypotheses, planning experiments, conducting systematic observations, interpreting and analyzing data, drawing conclusions and communicating results.

The Council of Chief State School Officers refers to the CCSS English/Language Arts Capacities and Mathematical Practices as the "Habits of Mind". The Habits of Mind are developed as the 21st CASP lessons are navigated and the youth explore the experiments. These Habits of Mind are identifiable, and afterschool teachers can recognize and assess the development of these skills. The inquiry style of the lessons enables youth to work on these skills by solving problems, learning to work as a team and using scientific processes.

The Habits of Mind that 21st CASP addresses are youths' abilities to:

- Raise questions about the world around them and be willing to seek answers through making careful observations and experimentation;
- Evaluate the strengths and weaknesses of data, claims and arguments;.
- When making decisions, evaluate conclusions, weigh evidence and recognize that not all arguments have equal merit;
- Keep records that describe observations, carefully distinguish actual observations from ideas and speculations and are understandable weeks and months later;
- Communicate experimental findings to others;
- Assess the risks and benefits associated with alternative solutions;
- Recognize that when a science investigation is replicated, very similar results are expected;
- Recognize that the results of scientific investigations are seldom exactly the same and that replication is often necessary;
- Engage in collaboration, peer review and accurate reporting of findings;
- Know that when solving a problem it is important to plan and get ideas and help from other people;
- Recognize that curiosity, skepticism, open-mindedness and honesty are attributes of scientists;.
- Explore cases that demonstrate the interdisciplinary nature of scientific enterprise.

The 21st Century Skills and Habits of Mind can be found in their entirety at: http://www.state.nj.us/education/cccs/2004/s5_science.pdf. Further information on making connections to standards will be provided in Part 3 of this manual, How to Use the Lessons: Curriculum Match Ups.

Curriculum Format Overview

This guide consists of 21 hands-on, water science lessons with an emphasis on the development of inquiry skills that will enable youth to continue their quest for knowledge. The lessons were developed and prototyped by Liberty Science Center staff at the Community Science Workshop, pilot-tested over a two-year period in three 21st CCLC afterschool programs, and reviewed by scientists from the New Jersey Marine Sciences Consortium, the Institute of Marine & Coastal Sciences at Rutgers University, and Rutgers University Marine Field Station at Tuckerton. The lessons can be found online at http://www.njsacc.org and through the New Jersey Department of Education, 21st Century Community Learning Centers website at http://www.state.nj.us/education/21cclc.

The lessons are divided into units - Unit 1: Properties of Water contains 11 lessons, and Unit 2: Aquatic Ecosystems contains 10 lessons. A student journal with corresponding lessons accompanies each unit. Each lesson is aligned with the New Jersey's academic standards. The standards and integrated skills are identified in each lesson and can be found in the appendix of this guide. The lessons are appropriate for youth from 4th through 8th grades.

Facilitator's Role

The term "facilitator" is used for any afterschool staff member who will conduct these activities with youth in the program. The facilitator(s) should review the section of this guide entitled, "Inquiry-Based Learning and Instruction" for guidance on how to create an informal learning environment that supports hands-on, experiential learning. This section also contains information on the types of questions to ask to encourage participation from youth of all abilities and educational backgrounds. The lessons in this guide are experience-focused and project-based, not chaotic and unstructured. It is important to keep in mind that these lessons are designed for the informal environment of afterschool - both in structure and tone.

Lesson Format

The lessons are broken down into themed investigations that can be lead in one session, or over several days with youth. Each investigation is divided into "parts" to help the facilitator easily navigate each lesson. Learning objectives identify the important science concepts as well as the specific and observable tasks that your youth will accomplish by the end of each lesson.

The lesson titles contain the scientific concept, such as "Cohesion", that is highlighted in the activity. The materials lists break down the supplies by parts, listing everything the facilitator will need to lead each part of the lesson. The materials include common household or office supplies, as well as other supplies which may need to be purchased from an online, craft or science supply store. A list of online and storefront retailers is provided in the appendix to help you locate and order supplies. Materials will need to be gathered and prepared in advance. Be sure to review the lessons and materials lists in advance.

Each lesson provides step-by-step instructions, as well as inquiry-based questions and prompts to help the facilitator guide youth through the activity. Procedural steps, predictions, observations, and various tips and notes for the facilitator are also placed throughout the lessons. A "Brainstorm" heading and symbol indicate that the facilitator can use a chalkboard or flipchart to record youth' responses to specific questions in this section. Vocabulary words are defined throughout the lessons, and a full glossary of these words can be found in the appendix of this guide.

Lesson Format for Unit 1 and Unit 2:

Page 1: Introduction to the science concept or theme of the lesson

Learning Objectives: What youth will learn during the lesson

Time Needed to Conduct the Investigations: estimate of the time needed to do the activity, any advance preparation for materials or procedures, and time needed for student reflection using the student journals

Group size: Recommended number of youth per group for each investigation

Vocabulary words

Page 2: Materials list

Investigation begins, including procedural steps, predictions, tips and observations

Page 3: Continuation of the Investigation

Page 4: Wrap-Up of the Investigation

Group Discussion: specific questions outlined for the facilitator

The "Why" and the "How": an explanation of the lesson results and further explanation of the science concept

Curriculum Match-Up: additional ways to enhance the lessons

References

Student Journals

The use of student journals for each lesson is critical to the full implementation of the 21st CASP model. Student journals are an excellent tool to encourage writing, documentation, diagramming and critical-thinking skills. The student journals can capture the in-depth thinking that may occur on a more subtle level for many youth and can help you identify the learning successes that are often overlooked in more traditional settings. The student journal and writing tools are included in the materials list of each lesson.

<u>Student Journal Format:</u>

- Lesson Objectives
- Questions, procedural steps, observations from the Lesson
- Space for recording ideas, responses to questions, diagrams, charts and explanations

- Wrap-Up: includes the Group Discussion and time for reflection to allow youth time to revisit the group's ideas and their own ideas about the lessons
- Curriculum Match-Up: additional activities to enhance the lessons
- Various science-related quotes and jokes throughout the journal

Family Involvement

The curriculum includes Science @Home Activities for youth to conduct at home with an adult helper, or they can be used as a part of a Family Night hosted by the Afterschool Program.

Actively engaging families in science learning in the afterschool setting can foster positive attitudes and enhance science literacy. Because parents and caregivers can unwittingly pass on their negative or ambivalent attitudes about science, it is important to provide positive science learning experiences that stimulate enthusiasm and curiosity in the whole family. Engaging youth and their families in hands-on science exploration stresses the importance of science learning and makes science careers more relevant to children and their parents.

<u>Science At Home Format:</u>

- Materials
- Investigation activity related to the Lesson completed in the afterschool program
- An Explanation to encourage youth the teach family members about lesson learned

Part TWO: Curriculum Implementation

Getting Started

Getting started with the 21st CASP curriculum are outlined below. Important factors to success of implementation of any curriculum is getting those involved excited about the potential for fun and learning and being prepared. Knowing some background about the importance of Science and it's role in everyday life is a great way to jumpstart excitement about science activity and learning. The following also includes tips on preparing space, time and materials.

Getting Staff and Youth Excited About Science

Getting staff and youth excited about science is integral to achieving true engagement and science literacy. Youth are naturally curious about the world around them. Facilitating science in Afterschool settings provides unique opportunities to capitalize on youth' enthusiasm and to tap into their interests. The less-structured and informal nature of the Afterschool environment is ideal because it offers more flexibility than a traditional classroom setting. It is important to provide youth with activities in a wide variety of science disciplines and to enable them to explore their own questions. Allowing youth to investigate what interests them increases the likelihood that they will be excited about what they are learning.

Never underestimate the power of staff enthusiasm as a way to ignite youth' excitement. Program administrators can support science learning by providing ample training opportunities for staff to gain experience and comfort-level with the new materials. In this way, you will garner their support and maintain their investment and interest in the program.

<u>Tips for Generating Excitement about Science in Afterschool:</u>

1. Be enthusiastic anytime you talk about science in afterschool!
2. Allow and encourage staff to attend 21st CASP trainings on use of the curricular materials and guide. Training will increase their comfort-level and excitement about afterschool science.
3. Offer incentives or rewards for staff who volunteer to facilitate afterschool science and for youth who sign up for afterschool science.
4. Ask local scientists from research facilities, environmental organizations, government institutions, colleges and universities, science centers or cooperative extensions to visit your afterschool program to share their own ideas and information about their work. Meeting scientists will make science more relevant and exciting, and will help eliminate any apprehensions that you or any of your co-facilitators may have about integrating science into your afterschool program. And, by sharing their personal journeys with you and the youth, you will be giving the scientific community an opportunity to be more prominent in celebrating science with the public.
5. Talk about the afterschool science program at staff meetings, parent meetings and with the youth -- often!
6. Post signs and flyers and send notices home with youth that describe the afterschool science program and what youth will gain through their participation.
7. Send emails and post information about the activities with photos on your organization's website. Your excitement is contagious and you will convey not only how fun, but how important science in afterschool is to your colleagues, families and youth.
8. Encourage all youth to participate in afterschool science -- not just high achievers or those with a clear interest in science.

Science is Everywhere: An Introduction for Afterschool Providers

Science is everywhere. As you look around, you may or may not recognize how ever-present science is in your life. You're probably sitting on a chair made of plastics, epoxies, metals and resins - a marriage of physics and chemistry largely unnoticed by the average person. Or, perhaps you used a body wash, cologne or lotion as part of your daily grooming routine? Science has a hand in each of these products - even the paper that this guide is printed on is a common example of the important and seemingly mundane role that science plays in our daily lives. Ordinary? Yes. And, extraordinary, too! Science is common, mainstream, ubiquitous, ever-present and pervasive.

We developed this guide to help afterschool and other out-of-school (OST) providers meet their goals of engaging youth in fun, educational and stimulating activities. The guide is for afterschool providers who recognize how important science learning is for youth in afterschool programs; but who may feel uncomfortable, incapable or ill-equipped to explore science in their afterschool programs. The information and materials were developed specifically for afterschool and other OST staff who have little or no background in science, or with no formal teaching experience. Users of this guide will find information about how to incorporate science in afterschool settings; engaging, interdisciplinary hands-on science activities designed for the afterschool environment; learning and teaching methods to guide you through the informal, hands-on approach uniquely fitting for afterschool and for youth of multiple learning abilities; and, additional resources and information to help afterschool staff readily approach hands-on science learning with less apprehension and anxiety.

Science is about exploration. Your understanding, comfort-level and discovery skills will improve as you and your youth explore the scientific concepts highlighted in the hands-on activities in this guide. Through these activities, your youth will discover the unique properties of water, the vital role that water plays in our lives, and how vulnerable Earth's aquatic ecosystems are to human impact. They will also gain an understanding and an appreciation for how critical water is for survival.

Accessibility lies at the heart of this guide. Our mission is to help afterschool providers make important connections for their youth by making science more accessible. We hope the information in this guide will illuminate some of the mysteries of the world and encourage you to see the world with a different set of eyes. This guide is designed to help non-science educators and afterschool providers feel comfortable with the dynamic world of science. We encourage you to use these materials as a tool to integrate science learning into your afterschool program.

We value your suggestions and invite you to share your experience using this resource. Please be sure to complete the evaluation at the end of this guide and send it to us at Liberty Science Center, 222 Jersey City Boulevard, Jersey City, NJ 07305. Your feedback will help us improve this guide over time.

What is Science?

There are many definitions for science, and almost all of those definitions identify two important themes: curiosity and exploration. As humans, we are innately curious about the history of the natural world and how the natural world works. We seek to understand and explain our natural environment through observation, investigation, and experimentation. So, in a nutshell, science is the study of the natural world.

Science is a diverse field, and there are a number of different branches of study. You may be familiar with some of the more commonly known areas such as biology, chemistry, physics, environmental science and medicine; however, there are some less well-known branches, including zoology, oceanography, neurology, seismology, and genetics. While the various branches of science examine different phenomena in the natural world, they are all interconnected and their relationship should be noted to gain a better understanding of each.

The diverse branches of science developed over time for different reasons -- primarily because different people studied different things of interest to them. Ultimately, the various branches of science became more distinct and organized as the need to examine things in different ways, and using different tools became more obvious.

A. Attitudes and Myths about Science

When you hear the word “science,” or “scientist,” what comes to mind? Is your head filled with thoughts of complicated formulas and equations? Do you imagine a person who resembles Albert Einstein? There are many myths about science which make it intimidating and inaccessible to youth and the general public. One common myth is that science knowledge is a special, superior kind of knowledge that is difficult to obtain (Halwes, 2000). In reality, science is about trying to understand the world around us, and solve the problems that we encounter every day. Scientists rely on the same curiosity, thought processes, and communication skills that are used by all people.

Another myth is that science knowledge can only be obtained by professional scientists (Halwes, 2000). Again, this is also a falsehood, as science is done by real people every day. Even an activity as ordinary as cooking involves science! Another common belief is that science knowledge is exact and always accurate (Halwes, 2000). In fact, science is always evolving and scientists are learning new things every day. Science will never be finished. And, many times scientists get things wrong! For example, at one time it was believed that the Earth was at the center of our solar system. Only later was it discovered that the planets orbit around the sun. This also illustrates the point that scientists don’t always agree with one another on a particular subject. Just turn on the television and you will see how much conflicting research there is about what constitutes a healthy diet.

B. Definition of a Scientist

What is a scientist? A scientist is a person who uses the scientific process to understand an area of science such as biology, physics or environmental science. Scientists are knowledge-seekers who observe, test theories, and try to provide explanations for what they’ve observed. Examples of scientists include geologists, paleontologists, microbiologists, botanists and physiologists. Scientists are both men and women, and individuals of many different ages, cultures, socioeconomic backgrounds, religions, ethnicities and abilities. However, there is growing concern within the scientific community with regards to the shortage of women scientists and scientists of color. By engaging youth in science in afterschool and other out-of-school time programs, it is our goal to expose them to the wide range of career possibilities in the science field, and open youth up to the possibility of pursuing science as a career.

Professionals who pursue science as a career are known as scientists. However, it is important to keep in mind that one does not need to be a professional scientist to learn, love and practice science. What’s more important are a curious mind and a willingness to explore.

C. Scientific Method

The scientific community has not formally agreed upon a format for the scientific process, and there is no magic formula to doing science, but there are generally accepted guidelines that help eliminate bias and prejudice in experiments and research.

- Science is examined through a process known as the scientific method. The scientific method involves:
- Developing questions about something that is interesting, puzzling or problematic in the natural world;

- Gathering information about those questions;
- Forming hypotheses (proposed explanations) and making predictions based on the information gathered;
- Performing experiments to test the hypotheses;
- Making observations and analyzing findings of the experiments; and,
- Making and sharing conclusions of the analysis.

Good scientists use their senses (in a safe manner) to investigate ideas and concepts. Scientists also record their observations, questions, predictions, findings and diagrams in a field journal similar to the student journals provided in this guide so they may refer back to them at a later time. Keep in mind that scientists seek answers by investigating and exploring possible solutions to questions they have about the natural world. The beauty of science is that the answers aren't needed in order to get started!

Scientific Tools

There are many different types of tools which are valuable to the scientific method. Scientific tools can be used to collect, organize and store information and analyze data. Tools help scientists work faster, more safely, with more ease, and with greater accuracy than without them. Tools used in science can range from calculators to microscopes to computers. Scientific tools do not necessarily have to be high-tech or costly, but they should make sense within the context of the scientific investigation that you are conducting. It is important for you as a facilitator to model the use of appropriate tools during scientific investigations (NSTA, 2004). Youth should be instructed on why various tools are used and how to use them properly and safely within the scientific investigation. It is also important that both you and your youth not use scientific tools such as calculators blindly, but also understand the scientific and mathematical concepts behind the tools.

D. Equity in Science

Science Equity

All youth have the right to quality science instruction. As a facilitator, it is very important for you to provide each and every student with the support they need to explore and gain scientific literacy. It is also important to be aware of your own beliefs and work to ensure that your personal biases and attitudes do not affect how you manage science in your afterschool program. Facilitators should be able to use a variety of instructional strategies to meet the differing needs and learning styles of youth. Facilitators should set high, yet realistic expectations for all youth in the afterschool program. It is also necessary to encourage the participation of all youth in science activities. Curriculum materials should be inclusive of different genders, cultures and abilities; and should also expose youth to diverse role models working in science. Assessment techniques should also be fair and equitable towards all youth. Science in afterschool presents opportunities to expose youth to a world of exiting career and educational opportunities. It is important to encourage all youth to consider pursuing one of the many diverse careers in the science field. (NSTA, 2003)

Science for All Youth

Although many youth are unfamiliar, unmotivated or intimidated by science, all youth can achieve scientific literacy, or know-how, if given the opportunity. In your afterschool program, it is necessary to create a learning environment in which all youth can learn, regardless of their gender, ability, religion, culture, ethnic background, socioeconomic status or experience with science. It is important to keep in mind that different youth may gain scientific knowledge in different ways. They may also learn at different rates and show their scientific literacy differently. Some youth may possess a greater degree of scientific understanding in one area than another. All youth should have the opportunity to participate in multiple science experiences over the years to achieve scientific literacy (NSES, 22). In addition to formal classroom education, afterschool settings are wonderful places for youth to gain additional exposure to and practice with science.

Underrepresentation of Women and Minorities in Science

STEM (Science, Technology, Engineering and Mathematics) disciplines are critical in the 21st century. Innovation in these important areas influences the global economy, standards of living and our quality of life. Historically, women and minorities have been subtly and overtly discouraged from participating in STEM educational programs and careers. Afterschool and other OST environments are in a unique position to reduce the impact of these accessibility barriers, keeping girls and youth of color in the STEM educational and workforce pipeline.

Research shows that children respond positively in learning environments that recognize and celebrate the diverse cultures and abilities of all youth. One particularly critical factor to note is that educators must <u>believe</u> that all youth can succeed. Teacher attitudes about race, gender and ability have a significant impact on overall student engagement. Research also suggests that youth achieve when learning tools including books, posters, toys and other materials reflect the diversity of the youth in the educational environment, and represent both men and women from a range of backgrounds in science careers.

The National Science Board found that American youth are among the lowest performers internationally in STEM disciplines. As the need for educated professionals in these areas increases, many critics charge that schools do not adequately prepare youth for STEM careers and that communities need to embrace strategies to change youth' competitiveness and attitudes about science and math. [1]

Having scientists with diverse experiences, thought processes, and opinions is vital to the scientific community. However, there is a significant underrepresentation of women and minorities in the sciences today. As of 2003, only 27% of employed scientists in all science and engineering occupations (at all degree levels) were women. Fourteen percent were Asian, 4.4 % were Black, 4.3 % were Hispanic, and .36% were Native American/Alaska Native (NSF, 2003). Getting more female youth and youth of color engaged in science and on the science educational and career track is an important goal; and the afterschool community can help. Afterschool science programs can expose children to the basic skills and concepts needed for the 21st century educational and workforce opportunities; provide greater exposure to STEM disciplines to K-12 youth; and expose families to science learning in a familiar and supportive setting.

In the appendix of the guide, you will find biographies of the pioneering women and minority scientists who have contributed to the diverse scientific field.

Family Involvement in Afterschool Learning

Research and anecdotal information on family involvement shows that parents who are involved in their children's education improve their parent-child relationships, have important impacts on their children's overall educational achievement, and significantly improve language skills, test scores and behavior, particularly in youth from low-income families.[2] According to Tichenor (1998), parents need to know how educational institutions and families can work together to enhance their children's leaning.

Actively engaging families in science learning in the afterschool setting can foster positive attitudes and enhance science literacy. Because parents and caregivers can unwittingly pass on their negative or ambivalent attitudes about science, it is important to provide positive science learning experiences that

---

[1] National Science Board, *Science and Engineering Indicators 2006*

[2] Henderson, A. *The Evidence Continues to Grow: Parent Involvement Improves Student Achievement--An Annotated Bibliography*. Columbia, MD: National Committee for Citizens in Education, 1987.

stimulate enthusiasm and curiosity in the whole family. Engaging youth and their families in hands-on science exploration stresses the importance of science learning and makes science careers more relevant to children and their parents.

Family involvement should be defined according to each individual afterschool program's needs; however, any level and type of family involvement should be encouraged, clearly communicated to parents and families, and supported by the program's administration.[3] Afterschool programs can engage parents and families in meaningful ways, particularly through family science programs, projects and events.

Tips for Encouraging Family Involvement

- Initiate positive and straightforward contact with parents and families using phone, email and letters home regarding their children's participation in your afterschool program. Be sensitive to language barriers and other challenges such as reading-levels or hearing abilities.

- Encourage parents and families to communicate their goals and concerns regarding their children's learning;

- Schedule regular family involvement events, including family science programs to encourage families to become more familiar with their children's afterschool program. Try to accommodate parent work schedules and meal-times.

- Ask parents and families how they would like to become involved in the afterschool program to support their children's learning.

Family science events can be a wonderful opportunity for youth and their families to experience science in a safe, fun and informal atmosphere. The event should engage families in cooperative learning, explore hands-on science activities, explain science concepts in simple terms as well as the importance of science learning, and provide ways for families to extend science learning at home.

To promote interest in your family science event, plan simple, fun activities or a project-based event (such as a river clean-up) that are not intimidating for your staff, or for the families to support. Start with a small themed program or project -- don't overwhelm your staff or your families with a large event with multiple themes. Family science events can become more sophisticated as your afterschool program gains more experience and comfort planning and conducting the events.

Reach out to parents and caregivers who may work in the STEM (science, technology, engineering and math) field. Contact science and nature centers, local colleges and universities, officials from science and environmental government agencies, museums and zoos for help planning your event.

Identify a theme to help you set clear goals for your family science event or project: do you want to clean up a local wetland, learn more about the aquatic ecosystems in your area or expose families to various ways to explore science at home? If you decide to hold an event at your afterschool program, be sure to provide multiple stations where families can explore hands-on science, "make and take" activities, written materials explaining the activities, and suggestions for continuing science learning at home.

---

[3] Cotton, K., and Savard, *W. G. Parent Involvement in Instruction, K-12: Research Synthesis.* Portland, OR: Northwest Regional Educational Laboratory, 1982. (ED 235 397).

Spread the word! Make announcements about the family science event program at staff meetings, parent meetings, during transition times at your program. Post signs and flyers throughout your organization and send home invitations with youth. Send emails and post information about the family science event on your organization's website. Invite VIPS to your event – members of your organization's board or officials from the local government. Encourage all youth from all types of families to attend the family science night. Most importantly, have fun planning and conducting your event!

Sample activities from 21st CASP Family Science events are provided in Part 4 to help you design activities which may be appropriate for families at your afterschool program. A sample flyer template to promote your afterschool program's Family Science Event is provided in the appendix of this guide.

Managing Time, Materials and Space in the Afterschool Setting

It is important to manage your time, space and materials effectively to provide the best possible experience in your afterschool science program.

A. Preparation and Time Management

Afterschool programs must manage multiple logistical issues, from student arrival to snacks to activity schedules. Consider these issues carefully as you plan to incorporate hand-on science learning into your afterschool program. Organize staff schedules to ensure that facilitators have time to review the lessons, and to organize and set up the materials needed for the activities in advance. Advance preparation will save time and enables staff to better manage the time needed to facilitate and wrap-up lessons with youth at an unhurried pace. Youth should be encouraged to help facilitators with the set up of materials.

Prior to each lesson, review the lesson and materials list thoroughly. Identify which supplies you need, what advance preparation is required for the lesson, how much time is needed for each part of the lesson, and places throughout each investigation where you can pause if you run out of time. Advance review and preparation will help you determine how to best facilitate each lesson, especially if you find that you need to break down the lesson and conduct it over the course of a few days instead of one day.

Each lesson in the 21st CASP Curriculum includes a breakdown of the estimated time as follows:

> Estimated Length of Time for Investigation
> ***This investigation has four parts.***
> Organize and set up materials: 10 minutes
> Introduce the lesson: 10 minutes
> Conduct the investigation: 30 – 40 minutes
> Student journaling/Group reflection: 10 minutes
> Total estimated time: 60 – 70 minutes

It is also important to allow time at the end of the lessons for youth to write in their journals and for clean-up. Youth should participate fully in the clean-up process.

Effective preparation and organization will help you successfully integrate science into your regular program offerings.

B. Materials

Review the curriculum in advance to determine which supplies you will need. You may already have many of the materials needed for some of the lessons, such as modeling clay or paperclips. Manage your program supply budget to ensure that facilitators have access to suitable science materials and tools. Good science materials don't need to be expensive or sophisticated, but they should be appropriate for the investigations that youth will be conducting.

Gather, organize, prepare and set up materials in advance. The majority of materials in these lessons require common household and office supplies that can be re-used and recycled. Some of the lessons require live plants and animals or other materials that will need to be purchased from a specialty science retailer and prepped in advance. A careful review of the curriculum will help you plan when materials should be purchased, received and prepared for the lessons. You may find yourself creating your own scientific tools using basic materials as you go through the curriculum.

Carefully consider your storage resources and needs. Use large, clear plastic food storage bags and containers to organize and store materials. Make labels with masking tape and permanent markers. Rolling carts are also useful in storing and transporting supplies and equipment if you don't have access to the same room on a regular basis in your afterschool program. Remember to involve youth in the organizing, cleaning and storing of science supplies.

C. Space

Space is also very important to the effective integration of science learning in your afterschool program. Facilitators and youth need an appropriate space in which to conduct the investigations (preferably in a room with tables where youth can work), as well as access to sinks for clean-up and for activities that require water. If your afterschool program has access to a science lab, this is the ideal place in which to facilitate the activities. If possible, it is helpful to have a room designated solely for science afterschool, where distractions and interruptions can be limited.

Safety Tips: Exploring Science in Afterschool

Afterschool science learning should be fun and safe. Safety should be a priority when incorporating science into the afterschool environment. We recommend that all youth and parents/guardians of youth sign a safety agreement before you begin science learning with youth in your program. Safety agreements are commonly used by school-day science teachers to stress the importance of safety to youth and caregivers.

The following guidelines will help foster a safe learning environment for youth and facilitators:

- Review the activities in advance to ensure that you have the correct materials and that the materials are not broken or damaged.
- Always provide adequate adult supervision – a good rule of thumb is one adult for every five to ten youth.
- Remind staff and youth to wash their hands before and after conducting any science investigation.
- Provide a first-aid kit and know your program's guidelines for handling accidents or emergency situations.
- Provide and review a student safety agreement with youth and parents/caregivers.

A student safety agreement template is provided in the appendix of this guide. We recommend that youth and their parents or guardians sign two copies of the safety agreement so they can refer to a hard copy at home. Please distribute and read the entire safety agreement aloud with youth before they take them home. Afterschool providers should keep all signed agreements on file. Youth should not be permitted to participate in science learning activities until a safety agreement is signed and returned to your afterschool program administrator, even if youth and parents/guardians have already signed a similar agreement for a school-day science class.

PART THREE: Lesson Overview/Guidance/Teaching Tips

Inquiry-Based Learning & Instruction: Exploration vs. Explanation

According to the National Science Teachers Association, scientific inquiry is "the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which youth develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world" (NSTA, 2004). There are many different levels of inquiry ranging from more open-ended student-led exploration to much more structured teacher-driven learning experiences.

Science by inquiry is a powerful tool to facilitate youth' science learning. Science by inquiry involves asking questions and using evidence to answer those questions. In scientific inquiry, youth review previous science research and then conduct investigations. During investigations, youth make observations and predictions, examine different variables and use tools to collect and analyze information. Youth then develop possible explanations for what they have investigated and communicate and defend the results of their investigations to others. Inquiry is intended to reflect the way in which scientists gather information and study our world (NSES, 23; NSTA, 2004).

Inquiry-based learning enhances content knowledge and thinking skills by leaving behind an impression on youth. Youth learn how to question, gain the mental discipline needed for critical and sequential thought, and learn the "how" and the "why" more readily than if they received a lecture or read a chapter on a particular subject.

A. Why Inquire?

1. Inquiry helps build self-confidence, motivation to learn, and collective learning among youth.

2. Inquiry creates opportunities for teachers to learn how their youth' minds work. Facilitators can apply these insights to set up appropriate learning situations and facilitate youth' pursuit of knowledge.

Some of the skills that facilitators learn when using inquiry include:

- Knowing when to provide a nudge;
- Knowing how to provide direction to each particular student;
- Knowing what not to tell youth;
- Knowing how to read student behaviors as they work through challenges;
- Knowing how to design meaningful learning situations that take specific student behaviors into consideration;
- Knowing how to help youth collaborate in solving problems together;
- Knowing when observations, hypotheses, or experiments are meaningful;
- Knowing how to tolerate ambiguity and the unknowns;
- Knowing how to use mistakes constructively;
- Knowing how to guide youth so that giving them control of their explorations does not mean losing control of the classroom.

(Adapted from the Center for Inquiry-Based Learning at Duke University)

B. Why Question?

1. Questioning is key when facilitating scientific inquiry. Through inquiry instruction, youth learn that science is about developing questions and trying to discover the answers to those questions.

2. Questioning is important because it helps access what youth already know and enables them to build on this previous knowledge.

3. Questions can get youth to think critically, reflect on and apply what they have learned and make connections between different concepts (Painter, J., 1996).

4. Questioning also provides the facilitator with feedback about youth' learning. There are many different types of questions which will lead to different kinds of scientific exploration.

When facilitating inquiry-based science, you should consider the importance of not only asking questions and encouraging youth to ask questions, but also how to answer questions and how to respond to questions posed by youth (NSTA, 2004; Painter, J. 1996).

Asking Appropriate Questions

It is important for you as the facilitator to ask a variety of different types of questions at different levels, and also teach youth to develop questions of their own. But how does one ask appropriate questions?

Different Levels of Questions

There are many different types of questions that you can pose to youth and there are many different levels of learning that can be addressed by these questions. An educational psychologist named Benjamin Bloom developed a taxonomy (an organization system) to classify how youth learn in the educational process. Bloom's Taxonomy is helpful in identifying the types of questions to ask based on the level of learning you are looking to elicit.

- Lower-order questions tap into youth' knowledge, comprehension and application of concepts that they have learned – their ability to recall information.

- Higher-order questions encourage youth to synthesize and evaluate the content of their learning. These questions help to develop youth' critical thinking and problem solving abilities, as well as their ability to develop personal opinions and judgments.

When asking questions during investigations it is helpful to contemplate what you would like youth to think about, learn and understand; and the type of skills you want them to develop. Keeping these learning objectives in mind can help guide your questioning techniques. The following chart illustrates some examples of how to apply Bloom's Taxonomy through questioning:

Types of Questions Based on Bloom's Taxonomy

Knowledge

- remembering
- memorizing
- recognizing
- recalling identification
- recalling information
- who, what, when, where, how ...?
- describe

Comprehension

- interpreting
- translating from one medium to another
- describing in one's own words
- organization and selection of facts and ideas
- retelling

Application

- problem solving
- applying information to produce a result
- use of facts, rules and principles
- how is ... an example of ...?
- how is ... related to ...?
- why is ... significant?

Analysis

- subdividing something to show how it is put together
- finding the underlying structure of a communication
- identifying motives
- separation of a whole into component parts
- what are the parts or features of ...?
- classify ... according to ...
- outline/diagram ...
- how does ... compare/contrast with ...?
- what evidence can you list for ...?

Synthesis

- creating a unique, original product that may be in verbal form or may be a physical object
- combining ideas to form a new whole
- what would you predict/infer from ...?
- what ideas can you add to ...?
- how would you create/design a new ...?
- what might happen if you combined ...?
- what solutions would you suggest for ...?

Evaluation

- making value decisions about issues
- resolving controversies or differences of opinion
- developing opinions, judgments or decisions
- do you agree that ...?
- what do you think about ...?
- what is the most important ...?
- place the following in order of priority ...

- how would you decide about ...?
- what criteria would you use to assess ...?

(Bloom et al, 1956)

Open-Ended vs. Closed-Ended Questions

Two types of questions that can be used during scientific investigations are closed-ended questions and open-ended questions. Closed-ended questions are questions that possess a limited number of possible responses for youth to select from. These would include questions such as:

- How many pennies did you use?
- Did the boat float?
- What color is the water?
- Do you agree or disagree?

Sometimes it is necessary to use closed-ended questions to move investigations along. However, once a student answers a closed-ended question there is not much left to discuss.

Open-ended questions are those that enable youth to answer questions in detail in their own words. Open-ended questions are extremely important in scientific inquiry because they get youth to think critically about science and respond in their own voices. They can also lead to many interesting discussions with youth. Some examples of open-ended questions include:

- What do you think will happen?
- What is your opinion?
- Why did you choose that tool?
- How did you conduct the experiment?
- Tell me about…

It is important to try to use open-ended questioning often throughout the investigations. These types of questions get right to the heart of what science inquiry is all about.

Follow-up or Probing Questions

Follow-up or probing questions can be used after a response to get youth to elaborate, provide more details, and clarify their response or to elicit a deeper explanation. Follow-up questions can help youth look at a problem in another way. They can also help you as the facilitator transition into new questions or content areas. Some examples of follow-up questions are:

- Why do you think that?
- How did you come up with that conclusion?
- Tell me more about…
- What do you think would happen if we tried your idea?

Assessment Questions – Are the Youth Getting It?

Questions can be an effective means of determining how well youth understand the material. Asking youth questions can help identify where youth could use additional support and where they are ready to receive additional challenges. These types of questions can assess both the progress of individual youth and of the group as a whole. Assessment questions can help you tailor the content and the pace of instruction to the needs of your youth.

These types of questions should be implemented in a sensitive manner and as a tool to enhancing teaching and learning. Examples of assessment questions include:

- What did you observe?
- What did you do during the experiment?
- Why do you think that occurred?
- What conclusions can you draw from the evidence?
- What did you learn from this investigation?
- What else you want to know?

Youth' Responses – Wait Time

When youth answer questions posed by you during curriculum instruction, there are a few considerations to keep in mind. Imagine that you have just posed a question to youth relating to the science investigation, but seem to be receiving nothing but silence and blank stares. Time for you to jump in and provide the correct answer, right? Well, maybe not. Sometimes youth require a little bit of time to digest and process what is being asked. Although the bit of silence when youth are thinking can be uncomfortable for you as the facilitator, it is important to allow them the time they need. According to NSTA (1999), youth should be provided at least 3 – 5 seconds after each question. Another potential reason for the silence is that the youth did not quite understand the question. It may be helpful to try rephrasing the question, or asking some additional questions to help guide youth.

Youth Responses' – Misconceptions vs. Preconceptions

When youth respond to your questions, sometimes they will arrive at answers that are on target and other times their answers will be off the mark. However, just because a student does not give the answer which is technically "correct" does not mean that it is not an integral part of the learning process. As youth explore the world around them, they develop theories to explain what they observe and experience. They find ways to organize and understand their environment by building schemes, structures and conceptions. Regardless of whether they are "right" or "wrong" youth' conceptions are based on their own experiences and available evidence (Worth, 2000).

When a student possesses what is typically known as a "misconception," it is often viewed negatively because the student does not know the "right" answer. However, these "misconceptions" should not be viewed in a negative light because they are simply the student's way of figuring out the world. When a student presents a "misconception" it is not appropriate to simply tell the student that s/he is wrong, because it sometimes can make it difficult for the student to move past the incorrect assumption.

"Misconceptions," more positively referred to as "preconceptions," "naïve conceptions," or "alternative conceptions," are important building blocks to learning. It is important for you as a facilitator to observe and listen carefully to student's ideas regardless of whether they are "correct" or "incorrect" and work with youth where they are having difficulty. If youth possess "preconceptions" it is helpful to ask follow up questions, have discussions with youth and provide opportunities for them to test out their ideas when possible (Worth, 2000).

Responding to Youths' Questions

Answering questions posed by youth is also an important part of the scientific inquiry process. Imagine it is your first day facilitating a new curriculum and one of your youth, whose father happens to be an environmental scientist, asks you. "How much water is on the entire planet?" Unaware of the correct answer you start to sweat as 30 pairs of inquisitive eyes bore into you. What do you do? Do you brush off the student's question? Make up an answer even if you are unsure if it is the right one? Or is there a better solution? Not knowing the answer to a question asked by a student is a fear held by many educators. In reality, scientists don't have all the answers, so why should you?

An important part of learning and of science inquiry is that youth should be aware that scientists (and adults) don't always have all the answers. Many youth feel that science is impossible for them to understand because scientists "know everything." Helping youth realize that science is not only about answers, but also about questions, may make this discipline more accessible and less intimidating. Not knowing the answer to a question is also an opportunity to explore and find out the answer together with youth. These experiences can help equip youth with the tools to conduct research and gather information independently. These skills are not only beneficial in science exploration, but in other content areas and in one's daily life.

Encouraging Youth to Develop their Own Questions

When facilitating science in your afterschool program, it is important to encourage youth to explore and develop their own questions about science. These are skills which can also be modeled by you during scientific investigations. It should be stressed to youth that there is no magic formula for every scientific investigation. Sometimes science requires "messing around" and exploring ideas and materials to get on the right track. During scientific inquiry it is important to create an environment where youth are free to explore materials (safely, of course) because exploration is an extremely valuable part of the learning process. Exploration helps to create enjoyable, risk-free learning environments where youth can make choices and find ownership in scientific investigation. In fact, many inventions, technologies and treatments for disease have been discovered by accident while scientists were exploring something else!

Evidence, Critical Thinking and Explanation

It is important that youth are able to gather evidence pertaining to science questions, think critically about that evidence and explain their conclusions. Youth should be aware that the scientific community seeks explanations which are "empirically based and logically consistent" (NSTA, 2004). The scientific community values these types of explanations because they are grounded in sound scientific methodology. During scientific investigations you should encourage youth to be "science detectives" and gather all of the evidence related to what they are studying. They then should evaluate the evidence and arrive at conclusions based on that evidence. The importance of skepticism when evaluating scientific works should be stressed to youth. Youth should also be able to explain their findings in their own words both verbally and in writing.

How to Use the Lessons

The lessons are broken down into themed investigations that can be conducted in one session or over several days with youth. Each investigation is divided into "parts" to help the facilitator easily navigate the lesson. Learning objectives identify the important science concepts as well as the specific and observable tasks that youth will accomplish by the end of each lesson.

The lesson titles contain the scientific concept, such as “Cohesion”, that is highlighted in the activity. The materials lists break down the supplies by parts, listing everything the facilitator will need to guide each part of the lesson. The materials include common household or office supplies, as well as other supplies that may need to be purchased from an online, craft or science supply store. A list of online and storefront retailers is provided in the appendix to help you locate and order supplies. Facilitators s will need to gather and prepare materials in advance, as well as reviewing the lessons and materials lists.

Each lesson provides step-by-step instructions, as well as inquiry-based questions and prompts to help the facilitator guide youth through the activity. Procedural steps, predictions, observations and various tips and notes for the facilitator are also placed throughout the lessons. A “Brainstorm” heading and symbol indicate that the facilitator may use a chalkboard or flipchart to record students’ responses to specific questions in this section. Vocabulary words are defined throughout the lessons, and a full glossary of these words can be found in the appendix of this guide.

Lesson Format for Unit 1 and Unit 2

Page 1: Introduction to the science concept or theme of the lesson
Learning Objectives: What youth will learn during the lesson
Time Needed to Conduct the Investigations: estimate of the time needed to do the activity, any advance preparation for materials or procedures and time needed for student reflection using the student journals
Group Size: Recommended number of youth per group for each investigation
Vocabulary Ventures

Page 2: Materials list
Investigation begins, including procedural steps, predictions, tips and observations

Page 3: Continuation of the Investigation

Page 4: Wrap Up of the Investigation
Group Discussion: specific questions outlined for the facilitator
The “Why” and the “How”: an explanation of the lesson results and further explanation of the science concept
Curriculum Match Up: additional ways to enhance the lessons
References

Teaching Tip: Before starting, become familiar with the lesson by completing the experiment without youth. To gain confidence, try the experiment with other staff members. As with any activity having the necessary materials and enough for everyone in the group is key to the activities’ success, so be sure to be fully prepared before starting the lesson with youth.

The Lesson: Section by Section

A) Introduction to the science concept or theme of the lesson

This section is an introduction to the science concept or theme through a description of what the youth will discover during their experiments. Reading this section can give the facilitator an idea of what to expect. The section includes questions to ask the children to engage them in thinking about the concept in relation to their own experiences as well as definitions of some of the vocabulary that is used in the lesson. Facilitators can read this introduction to the group or choose youth to read this section. The more youth do, the more they are engaged in the lessons.

B) Learning Objectives

Each lesson contains 3-4 Learning Objectives. The Learning Objectives identify what youth will be able to do during the lesson and comprehend once the lesson is complete. The Lesson Objectives are an important source of goals for the facilitator to check student comprehension. They can be used as conversation starters on each topic to gauge what youth already know. The Learning Objectives may be posted for youth to see, sent home in newsletters for families to know what youth are learning and used as an assessment for what youth learned at the completion of the lesson.

C) Vocabulary Ventures

This section lists words that may be new to youth or may already be used in the classroom during the school day. Inquiry-based facilitation allows youth to discover the meaning of these words by looking them up and identifying their use in the experiments. Youth may add new words to the list as they discover new vocabulary while working on lesson activities. Make vocabulary fun by developing games to define and identify the words on the list. Spelling the words and using them in speaking and writing can also be a part of the lesson experience.

D) Scientific Method/Experimental Process

Each lesson gives step-by-step instructions on doing the experiment or investigation. Often, youth must predict what might happen in the experiment before they begin, and they should observe what is happening as they conduct the experiment. In support of inquiry-based learning, it is useful to give the students the opportunity to experiment with materials on their own and talk with each other about what may happen or what they observe happening. Refrain from telling them what will happen.

Experiments often have multiple steps, and people may work at different paces. Keep everyone involved by facilitating the groups. Discuss what they experienced, what they think might happen next or if they changed parts of the experiment and the noted impact. If youth are struggling, encourage them to observe others working, or bring everyone away from the materials to discuss what they predict and observe as a way to include everyone in discussion and understanding.

E) Wrap Up

21st CASP provides instructions on how to summarize the activity by providing topics for a group discussion. The group discussion questions are formatted to engage the youth talking about their experiences, with the goal to get them to discover the answers and reasons behind their discoveries on their own. The wrap up also provides the answers if a group gets stuck. Each wrap up contains the “why” and the “how” of each experiment as well as more definitions and use of vocabulary words.

F) Curriculum Match Up

Every lesson contains ideas to inspire the children to discover more about the concept. These can be used for youth who finish experiments ahead of others or who need a more challenging experience. Youth will want to try many different variables and materials. All of the further experimenting and testing is a way to reinforce concepts, learning objectives and the scientific method.

G) Student Journals

Every lesson is accompanied by a student journal exercise. The student journal is a guide for youth that is aligned with the facilitator’s lesson plans. The student journals give youth an opportunity to record their thoughts and questions, write down their predictions about experiments and take notes on the process. Here, youth record data and draw pictures of what they observe.

The student journal also includes prompts for the wrap up group discussion and the curriculum match ups that can be done independently, if someone finishes an experiment early (be sure to have the materials on hand) or at home. The student journals are a fantastic tool to show student progress and keep a record of what they have experienced and learned. It is advised that the facilitator stores the journals for the youth so that they can be kept safe and referred to again in subsequent days.

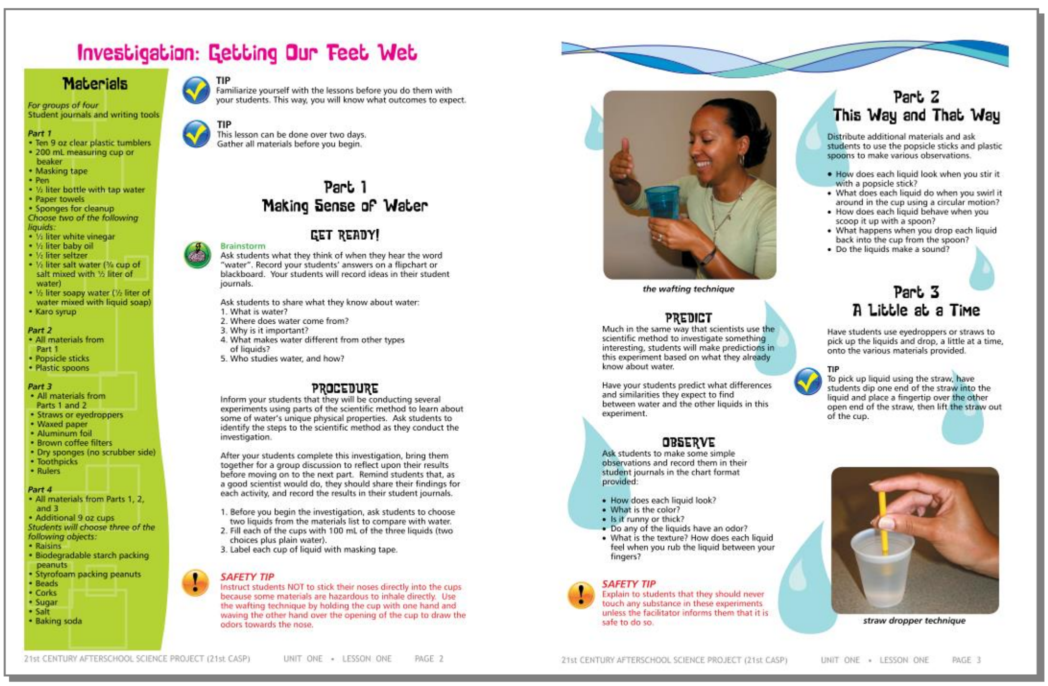
H) Family/Take Home activities: Science @ Home

A unique aspect of 21st CASP is that all of the lessons are matched with activities that can be done at home. This gives youth an opportunity to show their family members what they have learned. If a student can reteach skills and share the information they have learned, it will reinforce learning and comprehension. Further, this is an informal way to promote family involvement, and youth like it. 21st CASP is deliberate about the importance of family involvement. These take-home activities can be sent home following lessons or saved for program-hosted Family Nights. Sometimes youth may not have access to supplies at home, and the afterschool program may need to provide the materials. Be sure to include information about Science @ Home in the program newsletters so that families can be on the lookout for these activities that will come home.

Using Academic Standards to Support Lesson Objectives

Facilitators should be deliberate in making connections between afterschool and school day learning and between the 21st CASP Activities and academic standards. Understanding student targets that apply during the traditional school day positions afterschool programs to build on what happens during the school day and to contribute to overall success for youth.

Facilitators should start by becoming familiar with the academic standards for the grades that are participating in the 21st CASP activities. This will help facilitators to recognize the connections between the standards and the lessons. The deliberate connections will help facilitators in leading activities in alignment with standards' expectations through the inquiry-based process. Being familiar with standards will allow facilitators to communicate the connections between 21st CASP lessons and standards with program stakeholders.



Investigation: Getting Our Feet Wet

Materials

For groups of four
Student journals and writing tools

Part 1
- Ten 9 oz clear plastic tumblers
- 200 mL measuring cup or beaker
- Masking tape
- Pen
- ½ liter bottle with tap water
- Paper towels
- Sponges for cleanup

Choose two of the following liquids:
- ½ liter white vinegar
- ½ liter baby oil
- ½ liter seltzer
- ½ liter salt water (¾ cup of salt mixed with ½ liter of water)
- ½ liter soapy water (½ liter of water mixed with liquid soap)
- Karo syrup

Part 2
- All materials from Part 1
- Popsicle sticks
- Plastic spoons

Part 3
- All materials from Parts 1 and 2
- Straws or eyedroppers
- Waxed paper
- Aluminum foil
- Brown coffee filters
- Dry sponges (no scrubber side)
- Toothpicks
- Rulers

Part 4
- All materials from Parts 1, 2, and 3
- Additional 9 oz cups

Students will choose three of the following objects:
- Raisins
- Biodegradable starch packing peanuts
- Styrofoam packing peanuts
- Beads
- Corks
- Sugar
- Salt
- Baking soda

TIP
Familiarize yourself with the lessons before you do them with your students. This way, you will know what outcomes to expect.

TIP
This lesson can be done over two days.
Gather all materials before you begin.

Part 1
Making Sense of Water

GET READY!

Brainstorm
Ask students what they think of when they hear the word "water". Record your students' answers on a flipchart or blackboard. Your students will record ideas in their student journals.

Ask students to share what they know about water:
1. What is water?
2. Where does water come from?
3. Why is it important?
4. What makes water different from other types of liquids?
5. Who studies water, and how?

PROCEDURE

Inform your students that they will be conducting several experiments using parts of the scientific method to learn about some of water's unique physical properties. Ask students to identify the steps to the scientific method as they conduct the investigation.

After your students complete this investigation, bring them together for a group discussion to reflect upon their results before moving on to the next part. Remind students that, as a good scientist would do, they should share their findings for each activity, and record the results in their student journals.

1. Before you begin the investigation, ask students to choose two liquids from the materials list to compare with water.
2. Fill each of the cups with 100 mL of the three liquids (two choices plus plain water).
3. Label each cup of liquid with masking tape.

SAFETY TIP
Instruct students NOT to stick their noses directly into the cups because some materials are hazardous to inhale directly. Use the wafting technique by holding the cup with one hand and waving the other hand over the opening of the cup to draw the odors towards the nose.

21st CENTURY AFTERSCHOOL SCIENCE PROJECT (21st CASP) UNIT ONE • LESSON ONE PAGE 2

the wafting technique

PREDICT

Much in the same way that scientists use the scientific method to investigate something interesting, students will make predictions in this experiment based on what they already know about water.

Have your students predict what differences and similarities they expect to find between water and the other liquids in this experiment.

OBSERVE

Ask students to make some simple observations and record them in their student journals in the chart format provided:

- How does each liquid look?
- What is the color?
- Is it runny or thick?
- Do any of the liquids have an odor?
- What is the texture? How does each liquid feel when you rub the liquid between your fingers?

SAFETY TIP
Explain to students that they should never touch any substance in these experiments unless the facilitator informs them that it is safe to do so.

Part 2
This Way and That Way

Distribute additional materials and ask students to use the popsicle sticks and plastic spoons to make various observations.

- How does each liquid look when you stir it with a popsicle stick?
- What does each liquid do when you swirl it around in the cup using a circular motion?
- How does each liquid behave when you scoop it up with a spoon?
- What happens when you drop each liquid back into the cup from the spoon?
- Do the liquids make a sound?

Part 3
A Little at a Time

Have students use eyedroppers or straws to pick up the liquids and drop, a little at a time, onto the various materials provided.

TIP
To pick up liquid using the straw, have students dip one end of the straw into the liquid and place a fingertip over the other open end of the straw, then lift the straw out of the cup.

straw dropper technique

21st CENTURY AFTERSCHOOL SCIENCE PROJECT (21st CASP) UNIT ONE • LESSON ONE PAGE 3

Making the Connection: How to use Academic Standards with the 21st CASP Lessons

Locate and read the Academic Standards for the grades of the youth that are participating in the lesson. In the sample provided, we are going to work with the CCSS for English Language Arts.

Key Ideas and Details

RI.4.1. Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

RI.4.2. Determine the main idea of a text and explain how it is supported by key details; summarize the text.

RI.4.3. Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

Craft and Structure

RI.4.4. Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a *grade 4 topic or subject area*.

RI.4.5. Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in a text or part of a text.

RI.4.6. Compare and contrast a firsthand and secondhand account of the same event or topic; describe the differences in focus and the information provided.

Integration of Knowledge and Ideas

RI.4.7. Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.

RI.4.8. Explain how an author uses reasons and evidence to support particular points in a text.

RI.4.9. Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably.

Range of Reading and Level of Text Complexity

RI.4.10. By the end of year, read and comprehend informational texts, including history/social studies, science, and technical texts, in the grades 4–5 text complexity band proficiently, with scaffolding as needed at the high end of the range.

Grade 4

Read the planned Lesson, specifically the Learning Objectives. All of the Lessons in 21st CASP Learning Objectives include words such as measure, record, explore, observe, describe, demonstrate, explain, investigate and test, which are also words present in Academic Standards.

Lay the Lesson and Standards side by side to make the deliberate visual connections between Lesson Activities and Standards expectations. Look at the words in both the Standards and Lesson and look for the similarities. Identify a standard that is being addressed by the activities of the Lesson.

When planning to facilitate the lesson, look at suggestions on Inquiry Based Learning and Instruction. You will notice that the guidelines for facilitating the Lessons will help the youth meet the expectations outlined in the standards.

It can be helpful to make a chart of the Connections to standards based on lesson objectives and activities.

Lesson Objective	Activities to Meet Objective	Standard Met
• Identify the physical and chemical properties of water.	• Read aloud or have youth read Lesson Background • Youth respond to questions verbally and in writing in their journals • Facilitator engages student in answering open-ended questions based on reading and discussion	• RI 4.2 Determine the main idea of the text and explain how it is supporting by key details; summarize the text.

Considerations

It may not always be clear which Standards match to the Lessons. For example, in this Lesson, the use of the Math CCSS is not obvious. However, the Math standards could be addressed by motivating youth to explore the activities further with Curriculum Match-Ups. For this activity, match ups include creating charts and graphs, recording times and charting evaporation time. These activities are present in standards for Math.

Part FOUR: Resources to Support 21st CASP Curriculum

Tips for Encouraging Family Involvement

- *Initiate positive and straightforward contact with parents and families using phone, email and letters home regarding their children's participation in your afterschool program. Be sensitive to language barriers and other challenges such as reading-levels or hearing abilities.*

- *Encourage parents and families to communicate their goals and concerns regarding their children's learning;*

- *Schedule regular family involvement events, including family science programs to encourage families to become more familiar with their children's afterschool program. Try to accommodate parent work schedules and meal-times.*

- *Ask parents and families how they would like to become involved in the afterschool program to support their children's learning.*

Family science events can be a wonderful opportunity for youth and their families to experience science in a safe, fun and informal atmosphere. The event should engage families in cooperative learning, explore hands-on science activities, explain science concepts in simple terms as well as the importance of science learning, and provide ways for families to extend science learning at home.

To promote interest in your family science event, plan simple, fun activities or a project-based event (such as a river clean-up) that are not intimidating for your staff, or for the families to support. Start with a small themed program or project -- don't overwhelm your staff or your families with a large event with multiple themes. Family science events can become more sophisticated as your afterschool program gains more experience and comfort planning and conducting the events.

Reach out to parents and caregivers who may work in the STEM (science, technology, engineering and math) field. Contact science and nature centers, local colleges and universities, officials from science and environmental government agencies, museums and zoos for help planning your event.

Identify a theme to help you set clear goals for your family science event or project: do you want to clean up a local wetland, learn more about the aquatic ecosystems in your area or expose families to various ways to explore science at home? If you decide to hold an event at your afterschool program, be sure to provide multiple stations where families can explore hands-on science, "make and take" activities, written materials explaining the activities, and suggestions for continuing science learning at home.

Spread the word! Make announcements about the family science event program at staff meetings, parent meetings, during transition times at your program. Post signs and flyers throughout your organization and send home invitations with youth. Send emails and post information about the family science event on your organization's website. Invite VIPS to your event – members of your organization's board or officials from the local government. Encourage all youth from all types of families to attend the family science night. Most importantly, have fun planning and conducting your event!

Sample activities from 21st CASP Family Science events are provided at the end of this section to help you design activities which may be appropriate for families at your afterschool program. A sample flyer template to promote your afterschool program's Family Science Event is provided in the appendix of this guide.

Sample 21st CASP Family Science Night Activities

Unit 1: Properties of Water

Activity: *Watering Hole*
Materials: Pitcher; warm water; small plastic cups; confectioner sugar; measuring spoons; tally sheets; pens; markers or crayons
Concepts: Molecular structure of water, Surface tension
Description: Participants learn about the molecular structure of water and about the spaces between the molecules. Youth add confectioner sugar to the water and measure the change in volume. At first the volume does not change because the dissolved sugar fills in the spaces between the water molecules. Facilitator and youth discuss concepts.

Activity: *Breaking the Tension*
Materials: Pepper; dish soap; pie tins; water; pitcher
Concepts: Surface Tension
Description: Youth continue to learn about the molecular structure of water and about hydrogen bonds. Pepper is added to the water in the pie tin and youth are asked to "clean" the water by removing the pepper. Youth try to come up with creative ways of cleaning the water until a single drop of dish soap is added to the water, breaking the surface tension and forcing the pepper to the sides of the tin. The youth can now easily remove the pepper. Facilitator and youth discuss concepts.

Activity: *Water Cycle in a Bag*
Materials: Zippered plastic sandwich bags; water cycle diagram; warm water; scotch tape; pitcher
Concepts: Water Cycle
Description: Youth learn about the following parts of the water cycle: evaporation, condensation and precipitation. Youth color and label the diagram of the water cycle with assistance from the facilitator. The diagram is attached to the outside of a small zippered sandwich bag. The bag is filled with an ounce or so of warm water and sealed. The bag is then taped on a window such that the diagram is right-side-up facing the participant. The youth watch as the water cycle actually happens inside of the bag. Facilitator and youth discuss.

Activity: *Color Changing Celery*
Materials: Celery; water; food coloring; drinking glasses
Concepts: Adhesion and cohesion
Description: Youth continue to learn about adhesion and cohesion as it relates to the molecular structure of water. Youth insert a cut stalk of celery in colored water and witness the colored water rise into stalk of celery, changing its color. Facilitator and youth discuss.

Activity: *Long Distance Pour*
Materials: Pitchers and/or measuring cups; water; 9 oz - 16 oz drinking cups; food coloring; various types of string and twine
Concepts: Adhesion and cohesion
Description: Youth continue to learn about adhesion and cohesion while attempting to seemingly defy gravity. Youth pour water into a cup two feet away from a pitcher on a 45-degree angle. The do this by pouring the water along a pre-soaked string attached to the spout of the pitcher and the other end held taught on the inside rim of the cup. The water runs down the string into the cup due to the adhesive and cohesive properties of water. Facilitator and youth discuss.

Activity: *Making Rainbows*
Materials: Spray bottles; water; white butcher paper; bright flashlights
Concepts: Refraction in Water
Description: Youth learn how light is bent when it passes through water. Youth hold a strong flashlight against white butcher paper while water is misted over the beam of light. Youth witness a rainbow forming. Facilitator and youth discuss.

Activity: *Whatever Floats Your Boat*
Materials: Aluminum foil; modeling clay; large bowl or container; water; pitcher
Concepts: Buoyancy
Description: Youth learn about buoyancy by trying to make aluminum foil sink and clay float. Youth learn about density and that in order for an object/substance to float it must be less dense than water. Similarly, in order for an object/substance to sink, it must be denser than water. Youth mold each of the substances until the desired effect occurs. Facilitator and youth discuss.

Activity: *Egg Float*
Materials: Hardboiled eggs; salt; warm water; pitcher; drinking glasses
Concepts: Density and Buoyancy
Description: Youth continue to learn about buoyancy by trying to make a hardboiled egg float in warm water. Youth continue to learn about density and how it relates to mass and volume. Youth add salt to warm water in an attempt to alter the density of the water. Eventually, the water becomes denser than the egg, causing it to float. Facilitator and youth discuss.

Sample 21st CASP Family Science Night Activities

Unit 2: Aquatic Ecosystems

Activity: *The Slime that Won't Go Away*
Materials: Large aluminum pie/lasagna trays; vegetable oil; eye droppers; spoons; nylon stockings; sand; cotton balls; dish detergent
Concepts: Youth learn about the ecological impacts of oil spills and some of the techniques used to clean the spills including: vacuuming, skimming, burying, absorbing and dispersing. Youth also learn that there is no ideal way of cleaning spills and that each has consequences.
Description: Youth learn how devastating oil spills can be to the environment and how difficult they are to clean.

Activity: *Where Did All this Pollution Come from Anyway?*

Materials: Aquarium; plastic rectangular box with a large hole in the bottom; water; spray bottles; green food coloring; vegetable oil; soil; sand; aquarium pebbles; shredded paper

Concepts: Youth will demonstrate that "pollution" usually has many different sources. Using a model of a "storm drain" (i.e., the aquarium with the plastic box on top), youth add pollutants to the "street." The spray bottle allows rain to fall on the street, carrying the pollutants into the storm drain. Youth can observe how they were collectively responsible for the pollution of the water.

Description: Youth learn about the concept of non-point source pollution.

Activity: *Potable Water*

Materials: 1000 mL jar/container or 1-liter water bottle; 25 mL graduated cylinder; 10 mL graduated cylinder; eye dropper; a pitcher

Concepts: Youth learn about the concept of potable water by demonstrating how much water we can actually use. If the earth had only had 1000mL (1 liter) of water, 970mL would be saltwater, 24mL would be trapped in glaciers and in the polar icecaps, 6mL would be fresh water that is unavailable because it is trapped underground and only a single drop of water (about 0.003mL) is available for people to use.

Description: Youth learn about Earth's finite water supply and what percentage human beings can actually use.

Activity: *Water Filters*

Materials: Soil; 2-liter clear soda bottle; alum (potassium aluminum sulfate); fine sand; coarse sand; aquarium rocks; coffee filter; rubber band; measuring spoons; stirring rod/spoon; beaker or jar; pitchers; a stopwatch

Concepts: Youth will purify muddy water by passing it through a homemade water filter, by adding the aquarium rocks, course sand, fine sand and alum to an inverted soda bottle with the bottom cut off. The spout of the bottle will have a coffee filter, secured with a rubber band. The muddy water will go the purification processes of aeration, coagulation, sedimentation and filtration. Facilitators will need to discuss that the final step (i.e., disinfection) is not illustrated in this model.

Description: Youth learn how water is purified for human consumption.

Activity: *Aquifer in a Cup*

Materials: Plastic cups; modeling clay; play sand; aquarium gravel; food coloring (red); a bucket; a pitcher

Concepts: Youth create an aquifer using rocks, play sand, and clay. Water is added, which illustrates how water becomes trapped in spaces between rocks. The water is then "contaminated" using red food coloring, which shows how improperly disposed chemicals seep into aquifers, making the water unusable for people.

Description: Youth learn how to design their own personal aquifer and learn about the concept of ground water and how pollution can ruin the water supply.

Literacy Links

The following is a list of online educational, print and video resources for a variety of ages, skills, interests and abilities to help expand literacy, science, math and language arts connections for your youth. This list is designed to encourage you to incorporate the use of literature in your afterschool science program.

Websites & Online Resources

Pulse of the Planet
Check out today's two-minute sound portrait. Earth's nature, culture, and science are presented in interviews with extraordinary natural sound. From nationalgeographic.com.
http://pulseplanet.nationalgeographic.com/

Animal Diversity Web
Provides comprehensive data on all kinds of animals, from mammals to echinoderms. Features a quick search tool for finding specific animals.
http://animaldiversity.ummz.umich.edu/

BrainPOP
This site has activities and movies that make learning about health, science, and technology loads of fun! Check out BrainBuzz and today's featured movie, too.
http://www.brainpop.com/

ClassBrain.com
This site provides youth, teachers, and families with quick, manageable access to information and educational tools on the Internet. Host of "Movies in the Classroom" (http://www.moviesintheclassroom.com), a new area within the Parent & Teacher section that shows how to learn from the movies that provide scientific lessons. ClassBrain builds lesson plans based on these films. http://www.classbrain.com

Discovery Education
Provides engaging digital resources to schools and homes with the goal of making educators more effective, increasing student achievement, and connecting classrooms and families to a world of learning. Discovery Education is a division of Discovery Communications, LLC the leading global nonfiction media company.
http://school.discoveryeducation.com

Kinetic City Cyber Club
Science adventure, fun games, and more. Follow the crew on their adventures, or do some of their fun lab experiments.
http://www.kineticcity.com/

Science Essentials
Learn more about life science, physical science, and materials. Each section includes activities, interactive quizzes, and vocabulary on a variety of science topics.
http://www.channel4.com/apps26/learning/microsites/E/es...

Wonderville
Visit this cyber-town where kids can try scientific experiments, find cool science facts, download screen savers, and find out about careers in science while having fun! From the Science Alberta Foundation.
http://www.wonderville.ca/

Books

- *The Scientist in the Cribby* A. Gopnik A *et al*
- *Cloudy With a Chance of Meatballs* by Judi Barrett
- *Science Night Family Fun from A to Z* .Terrific Science Press, Steve Spangler
- *Blood, Bones, and Body Bits* by Nick Arnold
- *Come On, Rain! By* Karen Hesse
- *Teaching Science for All Children: Inquiry Lessons for Constructing Understanding (3rd Edition)* by Ralph Martin, Colleen Sexton, and Teresa Franklin
- *The Dinosaurs of Waterhouse Hawkins by* Barbara Kerley
- *Last Chance to See* by Douglas Adams and Mark Carwardine
- *It's True! Crime Doesn't Pay (It's True!)* by Beverley MacDonald and Andrew Weldon
- *Alfred Hitchcock's Ghostly Gallery by M*iscellaneous authors
- *A Medicine for Melancholy and Other Stories by* Ray Bradbury
- *Earth: Our Planet in Space* by Seymour Simon
- *The Down-to-Earth Guide to Global Warming* by Laurie David and Cambria Gordon
- *The Moon Seems to Change (Let's-Read-and-Find-Out Science 2)* by Franklyn M. Branley and Barbara & Ed Emberley
- *Dandelion: Celebrating the Magical Blossom* by Amy Wilensky
- *Eva* by Peter Dickinson
- *'Storm in the Night ("Tormenta en la noche")* by Mary Stolz
- *Heat Wave* by Helen Ketteman
- *Make It Work Plants A Creative Hands On Approach To Science (Make-It-Work!)* by Baker & haslam
- *Cam Jansen and the Mystery of the Dinosaur Bones ("Cam Jansen y el misterio de los huesos de dinosaurio")* David A. Adler
- *A Drop of Water : A Book of Science and Wonder* by Walter Adam Hibbert, Philip Steele
- *100 Things You Should Know About World Wonders* by Adam Wick
- *June 29, 1999* by David Wiesner
- *Egg-Drop Blues* by Jacqueline Turner Banks
- *The Blizzard's Robe* by Robert Sabuda
- *Things Around Us (The Process/Concept Science)* by Herbert Freestrom, Bernard Osterberger, and F. Alvin Blackman
- *The Librarian Who Measured the Earth* by Kathryn Lasky
- *Math and Science for Young Children* by Rosalind Charlesworth
- *Zathura* by Chris Van Allsburg
- *The City of Ember* by Jeanne DuPrau
- *Danny Dunn and the Swamp Monster* by Jay Williams and Raymond Abrashkin
- *Sounds All About (Stepping Into Science)* by Illa Podendorf and Darrell Wiskur
- *Motel of the Mysteries* by David Macaulay
- *Brave New World* by Aldous Huxley
- *Science Fiction, Science Fact* by Isaac Asimov
- *Popular Science Almanac for Kids* by Brainpop.com/Time Home Entertainment
- *The Microscope and What You See (The How and Why Wonder Book)* by Martin Keen and Walter Ferfuson
- *The Right Stuff* by Tom Wolfe
- *The Everything Kids' Science Experiments Book: Boil Ice, Float Water, Measure Gravity-Challenge the World Around You! (Everything Kids Series)* by Tom Robinson

- *I Wonder Why? Science Stories for Young Children [Science Stories Book One] (Curriculum Foundation Series)* by Wilbur, Gertrude Crampton and William S. Gray Beauchamp and Donn P. Crane, Studley Burroughs, Leon L. Pray and Frances Summers Miriam Story

Magazines

A report by Lesley Mandel Morrow, Ph.D., Professor and Chair of the Department of Learning and Teaching at Rutgers University's Grade School of Education, cites research demonstrating that magazines help educators improve student learning and build reading skills for youth of varying learning levels.[4]

- *Odyssey Magazine - Adventures in Science*, published by Cobblestone Publishing Company. Resources and subscription information available online at: http://www.odysseymagazine.com or at: 1-800-821-0115 / (603) 924-7209.
- *National Geographic Explorer* and *National Geographic Kids Magazine* published by the National Geographic Society. Resources and subscription information available online at: http://www.nationalgeographic.com/magazines or at: 1-800-638-4077 / (202) 857-7000.
- *Ranger Rick* magazine published by the National Wildlife Federation. Resources and subscription information available online at: http://www.nwf.org/kids or at: 1-800-588-1650.
- *YES Mag. Canada's Science Magazine for Kids*, published by Peter Piper Publishing Inc. Resources and subscription information available online at: http://www.yesmag.ca/ or by phone at: 1-888-477-5543
- *DIG* magazine published with the Archaeological Institute of America by Carus Publishing Company. Resources and subscription information available online at http://www.digonsite.com/ or at: 1-800-821-0115 / 603-924-7209.
- *Contact Kids (3-2-1 Contact),* published by the Children's Television Workshop. Resources and subscription information available online at http://www.sesameworkshop.org/aboutus/content_books.php or at: (212) 595-3456.
- *Current Science* published by Weekly Reader Corporation. Resources and subscription information available online at: http://www.weeklyreader.com/pubstore or at: 1-800-446-3355
- Dragonfly published by the National Science Teachers Association available online at: http://www.nsta.org/ or at: 1-800-722-NSTA
- Super Science Blue, Super Science Red and Science World published by Scholastic Inc. available online at: http://teacher.scholastic.com/products/classmags.htm or at:1-800-325-6149

Movies

- *October Sky (1999)*
- *Gattacca (1997)*
- *Chicken Run (2000)*
- *Finding Nemo (2003)*
- *Spirit - Stallion of the Cimarron (2002)*
- *The Wild Thornberrys (2002)*
- *The Core (2003)*
- *Harry Potter series*

[4] Morrow, Lesley Mandel and Joy Lesnick. 2001. Examining the Educational Value of Children's Magazines. *The California Reader* 34 (2): 2-9.

Academic Standards

Common Core State Standards (CCSS)

<u>New Jersey Core Curriculum Content Standards for Science</u>

Standard 5.1 (Scientific Processes): All youth will develop problem-solving, decision-making and inquiry skills, reflected by formulating usable questions and hypotheses, planning experiments, conducting systematic observations, interpreting and analyzing data, drawing conclusions and communicating results.
Unit 1 Lessons 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
Unit 2 Lessons 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Standard 5.3 (Mathematical Applications): All youth will integrate mathematics as a tool for problem solving in science, and as a means of expressing and/or modeling scientific theories.
Unit 1 Lessons 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
Unit 2 Lessons 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Standard 5.5 (Characteristics of Life): All youth will gain an understanding of the structure, characteristics and basic needs of organisms and will investigate the diversity of life.
Unit 2 Lessons 2, 3, 4, 7, 8, 9, 10

Standard 5.6 (Chemistry): All youth will gain an understanding of the structure and behavior of matter and liquids.
Unit 1 Lessons 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
Unit 2 Lessons 1, 5, 6, 7, 8, 9, 10

Standard 5.7 (Physics: All youth will gain an understanding of natural laws as they apply to motion, forces and energy transformation.
Unit 1 Lessons 3, 10, 11
Unit 2 Lessons 1, 5, 6, 7, 10

Standard 5.8 (Earth Science): All youth will gain an understanding of the structure, dynamics and geophysical systems of the Earth.
Unit 2 Lessons 1, 2, 9

Standard 5.10 (Environmental Science): All youth will develop an understanding of the environment as a system of interdependent components affected by human activity and natural phenomena.
Unit 2 Lessons 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Biographies: Diversity in Science

African American Scientists

Rebecca Cole: Born in Philadelphia, Pennsylvania in 1846, Cole was the second Black woman to graduate from medical school (1867). She joined Dr. Elizabeth Blackwell, the first white woman physician, in New York and taught hygiene and childcare to families in poor neighborhoods.

Charles Henry Turner: (1867-1923) A native of Cincinnati, Ohio, Turner received a B.S. (1891) and M.S. (1892) from the University of Cincinnati and a Ph.D. (1907) from the University of Chicago. A noted authority on the behavior of insects, he was the first researcher to prove that insects can hear.

Roger Arliner Young (1889-1964) overcame racial and gender barriers to become the first African American woman to be awarded a Ph.D. in zoology, which she earned from the University of Pennsylvania in 1940. Her scientific contributions, resulting largely from research she performed at the Marine Biological Laboratory in Woods Hole, Massachusetts, include improved understanding of the structures that control salt concentration in the paramecium, as well as the effects of radiation on sea urchin eggs.

Lewis Howard Latimer: Born in Chelsea, Massachusetts in 1848, Latimer learned mechanical drawing while working for a Boston patent attorney. He later invented an electric lamp and a carbon filament for light bulbs (patented 1881, 1882). Latimer was the only African American member of Thomas Edison's engineering laboratory.

Frederick McKinley Jones: Jones was born in Cincinnati, Ohio in 1892. An experienced mechanic, he invented a self-starting gas engine and a series of devices for movie projectors. More importantly, he invented the first automatic refrigeration system for long-haul trucks (1935). Jones was awarded more than 40 patents in the field of refrigeration.

Dr. Daniel Hale Williams: Dr. Williams was born in Pennsylvania in 1856 and attended medical school in Chicago, where he received his M.D. in 1883. He founded the Provident Hospital in Chicago in 1891, and he performed the first successful open heart surgery in 1893.

Dr. Charles Richard Drew: Born in Washington, D.C. in 1904, Drew earned advanced degrees in medicine and surgery from McGill University in Montreal, Quebec, in 1933 and from Columbia University in 1940. He is particularly noted for his research in blood plasma and for setting up the first blood bank. Dr. Drew's project was the model for the Red Cross' system of blood banks, of which he became the first director. In 1950, Dr. Drew died after a serious car accident in which he needed blood, but was refused treatment at a hospital because he was Black.

Shirley A. Jackson: born on August 5, 1946, in Washington, D.C. Her father spurred her interest in science by helping her with projects for her science classes. Jackson began classes at MIT, one of fewer than twenty African American youth and the only one studying theoretical physics. While a student, she did volunteer work at Boston City Hospital and tutored youth at the Roxbury YMCA. She earned her Bachelor's degree in 1968. In 1985, Governor Thomas Kean appointed her to the New Jersey Commission on Science and Technology. Later, Governor James Florio awarded her the Thomas Alva Edison Science Award for her contributions to physics and for the promotion of science. Jackson is an active voice in the scientific field where her aim has been to actively promote women in science. From 1976 to 1991 Dr. Jackson was appointed as Professor of Physics at Rutgers University. In 1995, she was appointed head of the Nuclear Regulatory Commission by President Bill Clinton.

Willie Hobbs Moore: (1934 – 1994) The first African American woman to earn a Ph.D. in Physics (University of Michigan, Ann Arbor 1972) on vibrational analysis of secondary chlorides. While at Michigan, Moore worked for Datamax Corporation. She has also held engineering positions at Bendix Aerospace Systems, Barnes Engineering, and Sensor Dynamics where she was responsible for the theoretical analysis.

Marie Maynard Daly: was the first African American woman to earn a Ph.D. in chemistry, receiving her degree from Columbia University in 1948. Daly served as an instructor in Physical Science at Howard University between 1947 and 1948. From 1951 to 1955, she was a research assistant at the Rockefeller Institute. During her career, Daly served as an investigator for the American Heart Association (1958–1963) and cancer scientist for the Health Research Council of New York (1962–1972). Much of Daly's research focused on nucleic acids.

Mae Jemison: In 1977, Mae Jemison earned a B.S. degree in chemical engineering from Stanford University, having received a scholarship there at the age of 16. She then attended medical school and received a Doctor of Medicine degree from Cornell University in 1981. Following medical school, Jemison served as a Peace Corps medical officer in West Africa. In 1985, she began attending graduate classes in engineering and applied to the National Aeronautics and Space Administration (NASA) for admission to the astronaut program. In 1993, Jemison resigned from NASA and founded the Jemison Group, which focuses on integrating “science and technology into daily life.”

Dorothy V. McClendon: For 24 years, Dorothy V. McClendon has been a professional microbiologist. She received a B.S. degree in biology in 1948 from Tennessee A&I State University. McClendon’s studies on microorganisms led her to research in the U.S. Army. At present, she coordinates microbial research for the U.S. Army Tank Automotive Command (TACOM) in Warren, MI. As a microbiologist, she develops methods to prevent microorganisms from contaminating fuel and deteriorating military storage material. Currently, McClendon is developing a fungicide to protect storage materials and not harm the people who use them.

Percy Julian: (1899 – 1975) Percy Lavon Julian was born in Montgomery, Alabama. He graduated from DePauw University in 1920 first in his class with Phi Beta Kappa honors. He became a chemistry instructor at Fisk University, but in 1923, received an Austin Fellowship in Chemistry and went to Harvard to complete his master’s degree. He traveled to Austria to obtain his PhD in chemistry from the University of Vienna in 1931. He returned to DePauw to continue his research. His original interest was investigating plant products, especially traditional medicinal plants such as the African calabar bean. In 1935, with Josef Pikl, he first synthesized from this plant a chemical called physostigmine which could treat the blinding disease of glaucoma by reducing pressure inside the eyeball. He left academia to become lab director at Glidden Company. During World War II, Julian developed foam from soy protein that could put out oil and gas fires; it was quickly adopted by the military. In 1948, the Mayo Clinic announced the discovery of a compound that relieved rheumatoid arthritis. It was cortisone, which was very difficult to come by. Julian and his team created a synthetic cortisone substitute, a less expensive but effective alternative to natural cortisone. Julian held more than 100 chemical patents. He founded The Julian Laboratories, Inc., with labs in the U.S. and Mexico and another chemical plant in Guatemala.

Latino American Scientists

Dr. Luz Miranda-Martinez: received a Bachelor’s and Master’s in physics from the University of Puerto Rico and then decided to pursue a Ph.D. at M.I.T. because she liked the thought of being her own boss. Having a Ph.D. provides a scientist with a certain amount of independence and freedom, including the ability to decide the direction of your research. Now, as an associate professor in the Department of Materials, Science and Engineering at the University of Maryland, College Park, she teaches undergraduate classes while continuing her research in liquid crystals and supervising youth who are undergoing research training. The use of liquid crystals is expanding in many directions including their use in Global Positioning System (GPS) maps. These GPS systems come equipped in many newer, high-end cars. Furthermore, the Air Force is developing liquid crystal visors for their pilots in order to make flying more efficient.

Dr. Inés Cifuentes: a seismologist who works for the Carnegie Institution of Washington, majored in physics with an emphasis in astronomy at Swarthmore College in Pennsylvania, where she was the only woman in the department. However, in her senior year, she realized that it would be difficult to pursue astronomy in Latin America. She wanted to balance my love of science with my passion for political work. She started her graduate work at Stanford University in geophysics. After receiving her master's degree, she was employed by the U.S. Geological Survey doing field research in Guatemala and Nicaragua where she was setting up portable seismographs in rural areas. As it turned out, there was an earthquake while she was there, and because she could speak Spanish, she was able to explain to villagers what we were doing. Suddenly, it felt like she could do science research in Latin America and help people at the same time. She realized that in order to do really interesting and beneficial scientific work, she needed to get a Ph.D., because that advanced degree would give her the independence and means to create her own projects. She enrolled in the Ph.D. program in seismology at Columbia University in New York City where she became very interested in studying the Chilean Earthquake of 1960. At 9.5 on the Richter scale, it is the largest ever-recorded earthquake. It lasted for almost five minutes and created tidal waves as far away as Hawaii!

Dr. Scottie Henderson: was born in 1968 to a Navajo father and a Mexican mother. She grew up in Española, New Mexico, a town filled with Pueblo Indians, Latinos, and Anglos. Even though Española is a diverse town, Native Americans were always treated a little differently. Native Americans weren't expected to achieve, and as a result, many Indians in the area didn't finish school. Without realizing it, Scottie began to see herself the way others saw her. When her mother saw that she was leaning towards staying home after high school, she encouraged Scottie to attend Northern New Mexico Community College. Eventually she moved on to UCSC where she received her B.S. in Marine Biology, and then to the University of Washington where she earned her Ph.D. in Zoology. She is currently at the University of Arizona in the entomology department where she is studying another invertebrate called the pink bollworm, a pest of cotton crops.

Franklin R. Chang-Díaz: Astronaut & Scientist, Costa Rican American, born 1950 in San Jose, Costa Rica. Raised in a poor family in Costa Rica, he studied hard to become a scientist and a U.S. citizen. Chang-Díaz was the first Hispanic person to enter the space program, becoming an astronaut in 1981. He is a veteran of six space missions and has spent nearly 1,300 hours in space. Chang-Díaz moved to the United States when he was in high school, and got a doctorate in applied plasma physics from MIT in 1977. He eventually achieved his dream of becoming an astronaut, entering space for the first time aboard Columbia in January 1986. He was the first Costa Rican astronaut, and, as of 2004, he was one of only two astronauts to have served on seven space missions. Chang-Díaz is also the director of the Advanced Space Propulsion Laboratory at NASA's Johnson Space Center, where he has been developing a plasma rocket.

Ellen Ochoa: Astronaut, Mexican American, Born in1958, Ochoa was the first Hispanic woman to become an astronaut. A veteran of two space flights, she first flew in space on the shuttle *Discovery* in 1993. Sally Ride, the first woman astronaut in the U.S., was one of her role models. Ochoa is not only an astronaut but also an inventor, holding three patents. When she is in space, she says that she loves "looking out the window at the Earth."

Severo Ochoa: (1905–1993) Nobel Prize Winner in Medicine and Physiology. Severo Ochoa won the Nobel Prize in 1959 for medicine. He received the prize for his discovery of the process that would allow humans to create RNA in a test tube — a vital life substance that makes cells work and grow. This knowledge can be useful in understanding many things about the body, like why some cells stay healthy while tumors grow in others.

Antonia C. Novello: a Doctor and former United States Surgeon General. She was born in Puerto Rico in 1944. In 1990, Novello became the first Hispanic person — and first woman — to be appointed as Surgeon General, the chief doctor in the United States. As a child, she had a chronic illness that hurt her digestion, causing her great suffering. She never forgot that experience. As surgeon general, Novello campaigned for better care for children. She also paid special attention to the problems of alcoholism, smoking, AIDS, and violence.

Carlos Juan Finlay: (1833–1915) Physician/Epidemiologist, Cuban American. Finlay solved the mystery of what caused yellow fever. This deadly disease had no known cure just over 100 years ago and killed thousands of people. In 1881, he discovered that mosquitoes spread yellow fever, but he could not prove it. Other scientists did not believe him. They made fun of him, calling him the mosquito man. Eventually, because of the work of Finlay and Walter Reed, another important physician, scientists were able to develop a vaccine using diseased mosquitoes and conquer this disease.

Luis Alvarez: (1911 – 1988) Luis Alvarez was a physicist with wide ranging interests. At the University of Chicago, he took a class called Advanced Experimental Physics: Light, and later claimed, "It was love at first sight." He graduated in 1932 and stayed at Chicago for his graduate work. Alvarez's colleagues sometimes called him the "prize wild idea man" because of the huge range of his activities. He did all kinds of research into the atomic nucleus, light, electrons, radar, and so forth. In 1943 he was part of the Manhattan Project in Los Alamos and developed a detonating device for the atomic bomb. He was on board the bomber *Enola Gay* when it dropped the bomb on Hiroshima. Alvarez was shocked and sickened by what he saw, but because the war ended so soon afterwards, he never expressed doubts about the bomb's use. In fact, he was one of few scientists who had worked on the bomb who felt the U.S. should continue weapons development and make a hydrogen bomb. He continued to do varied work in high-energy physics, and in 1968, received the Nobel Prize. In 1965 Alvarez took his physics expertise on an archeological expedition. A U.S.-Egyptian team was trying to find hidden chambers in the Giza pyramid in Egypt by using subatomic particles to calculate the pyramid's density. They didn't find any chambers, but this began Alvarez's work with his son Walter, a geology professor at Berkeley. Together they developed a theory in 1980 that a giant asteroid striking Earth had killed off the dinosaurs around 65 million years ago. They had strong geologic evidence, but the theory is still being debated. *Radio distance and direction indicator*—Alvarez was awarded the Nobel Prize for Physics in 1968. He helped design a ground-controlled radar system for aircraft landings and with his son developed the meteorite theory of dinosaur extinction.

Miriam Rodón-Naveira, Ph.D.: Dr. Rodón-Naveira was born in San Juan, Puerto Rico. She attended high school in Puerto Rico and continued her education at Georgetown University in Washington D.C. where she received her undergraduate degree in Psychology and her Ph.D. in Biology-Aquatic Microbial Ecology. Dr. Rodón-Naveira began her career with NASA in December 2000 as an Earth Science Remote Sensing Scientist. There she was responsible for coordinating and conducting research to enhance collaboration between Directorates within DFRC, NASA Ames Research Center (Moffett Field, California), universities, Indian tribes and other governments and international entities; all in support of the integrated use of remote sensing instruments. Dr. Rodón-Naveira's professional accomplishments began with the US Environmental Protection Agency, where she served from 1990 to 2000. From 1990 to 1994 she worked as Biologist, Project Officer, and Environmental Research Scientist. In 1995, she became the first woman minority Branch Chief within the National Exposure Research Laboratory (NERL); and three years later, the first Hispanic woman to hold the Deputy Directorship for the Environmental Sciences Division (ESD) within the NERL.

Carlos Noriega: was born October 8, in Lima, Peru. Astronaut Carlos Noriega had a distinguished career as a Marine Corps pilot before venturing millions of miles beyond planet Earth. A mission specialist and computer scientist, Lieutenant Colonel Noriega has visited Mir and helped to assemble the International Space Station.

Mario Molina: was born March 19, 1943 in Mexico City, Mexico. At the University of California at Berkeley in 1973, Molina and Sherwood Rowland began researching chlorofluorocarbons (CFCs), then widely used in refrigerators, spray cans, and cleaning solvents. They discovered that the release of CFCs could destroy the ozone layer in the stratosphere, allowing more ultraviolet light to get through to Earth and potentially increasing the rate of skin cancer. Their efforts led to CFC production being banned in most countries, and they received the 1995 Nobel Prize in Chemistry.

Baruj Benacerraf: born October 29, 1920 in Venezuela. Benacerraf is an American immunologist whose contributions to an understanding of the mechanisms and genetic basis of the immune response and especially of its role in certain diseases known as the autoimmune diseases brought him a share of the 1980 Nobel Prize for Physiology or Medicine. From the age of five until the outbreak of World War II Benacerraf lived in Paris. In 1940 he entered Columbia University and graduated in 1942. He became a naturalized U.S. citizen in 1943, while a student at the Medical College of Virginia. After receiving his M.D. in 1945 and interning at Queens General Hospital in New York City, he served in the US Army in 1946-48. After a year of research at Columbia and six years at the Hôpital Broussais in Paris, he joined the faculty of New York University School of Medicine in 1956, advancing to professor of pathology in 1960. In 1968-70 he was chief of the immunologic laboratory of the National Institute of Allergy and Infectious Diseases, National Institutes of Health. From 1970 he held the Fabyan chair of comparative pathology at Harvard.

César Milstein: (1927- 2002), Argentina, Immunologist. César Milstein shared the Nobel Prize in 1980 for "pioneering contributions to the theory and techniques of immunology, which were said to lay the basis for advances in medical areas such as cancer treatment and the detection of acquired immune deficiency syndrome (AIDS). In work with his co-laureate Georges J. F. Koehler, Milstein developed the techniques for producing monoclonal antibodies, antibodies with a specific affinity for certain sites in the body that might find diseased cells but leave healthy cells intact.

Women Scientists

Olive Ann Beech: Aircraft Manufacturer (1920-1986)
Olive Ann Beech confounded Beech Aircraft and worked alongside her husband, Walter, during the 1930's and 1940's. After his death, she became President and CEO of the company, and transformed the company into a multimillion-dollar, international aerospace corporation.

S. Josephine Baker: Health Researcher (1873 - 1945)
Baker went to the Women's Medical College in New York City to earn her MD. She took a part-time job with the Department of Public health as a public school health inspector where she rose in the ranks to create and run the Bureau of Child Hygiene. She helped track down "typhoid Mary" (Mary Mallon). She was one of the first doctors to recognize how important being held is to a child's health. She perfected the application of sliver nitrate eye drops to infants, now a standard procedure to prevent eye infections in newborns. She was the first woman to be assistant surgeon general in the United States. She was also the first woman representative to the League of Nations - Health Committee representative for the United States.

Elizabeth Blackwell: Physician (1821 - 1910)
Blackwell received the first medical degree granted to a women in the United States from Geneva College in NY in 1849. She started out as a teacher but sought a medical degree. She applied to

numerous medical schools but was turned down by all until Geneva College accepted her "by accident." As Blackwell worked through her training and began a series of lectures on hygiene, where she came in contact with women who had the influence to get her started. In 1853 she opened a dispensary in a tenement district of New York City which later became the New York Infirmary for Women and Children in 1868. It closed in 1899. The Civil War halted her efforts to expand the Infirmary to include a medical college and a nursing school.

Bessie and Sadie Delaney: (Sadie: 1889-1999, Bessie: 1891-1995): home economics (Sadie) and Dentist (Bessie)

Known as the Delaney sisters, Sadie became a home economics teacher and Bessie became a dentist in the early 20th century in Harlem, New York City. In the early part of the 20th century many people suffered from diseases such as scurvy and rickets which were results from vitamin shortages. Home economics strived to teach people the basics of proper nutrition along with other household systems designed to improve peoples lives. Both sisters graduated from Columbia University and were active into their 100's. Bessie died in her sleep on September 25, 1995; Sadie in 1999, Their oral history was recorded into the book "Having Our Say" and was adapted into a play which was produced on Broadway.

Alice Fletcher: Anthropologist (1838 - 1923)

Alice Cunningham Fletcher was an ethnologist who became a special agent for the US Indian Bureau, and eventually a research fellow at the Peabody Museum, Cambridge, Massachusetts. She had studied archaeology at the Peabody, starting rather late in her life - in the late 1870's. In 1881 she arranged to live with and study the Omaha Indians of Nebraska. In 1889 she moved to the Nez Percé Reservation in Lapwai, Idaho. She brought the scientific rigor of archaeology to the study of ethnology. She served as vice-president of the American Association for the Advancement of Science (1896), president of the Anthropological Society of Washington (1903), president of the American Folk-Lore Society (1905) and founding member of the American Anthropological Association (1902). She was the first ethnologist ever to produce a complete description of a Plains Indian ceremony.

Rosalind Elsie Franklin: Chemist (1920 - 1957)

Rosalind Franklin received her degree in Chemistry in 1951 from Cambridge University. It was while working as a research associate for James Randall at King's College that she was the first to recognize the helix shape of DNA. Her work was passed on to James Watson and Francis Crick, who along with Maurice Wilkins, a coworker of Rosalind's, shared the Nobel Prize in Physiology and Medicine for the discovery of the double helix. Her work, along with that of others, was built into Watson and Crick's detailed description of DNA. She has never received official credit for her contribution to the discovery. She also contributed much to studies of coal and plant viruses. She died at the age of 37 from cancer.

Kate Gleason: Engineer (1865 - 1933)

Gleason did not have any thorough training in engineering although she did attend Cornell University as a 'special student' in 1884 to study mechanical arts. She also attended the Sibley College of Engraving and the Mechanics Institute (which is now the Rochester Inst. of Technology) part time while she was at Cornell. Gleason began her career at her father's machine-tool factory where she propelled it into the leading U.S. producer of gear-cutting machinery prior to World War I. During World War I the president of the First National Bank of Rochester resigned to join the military. So from 1917 to 1919 she served as its president, becoming the first woman to be the president of a national bank. During that time she began to promote the large-scale development of low-cost housing and set to work on projects related to this. In 1918 she became the first women elected to the American Society of Mechanical Engineers. It was through her reputation in the housing construction field and the machine-tool business that this came about. She also served as the society's representative to the World Power Conference in Germany in 1930.

Lady Augusta Ada Byron Lovelace: Computer programmer (1815-1851)
She is considered the first computer programmer. She was the daughter of Lord Byron, the English poet. One of her patrons was Sir Charles Babbage, the inventor of the first mechanical computer. She wrote the "code" to run the machine. To honor her memory, the US Navy named one of its computer languages ADA.

Barbara McClintock: Geneticist (1902 - 1992)
Barbara McClintock showed that genes could transpose within chromosomes; that they could move around (the so-called "jumping genes"). This was done through the investigation of maize (corn) genetics through careful hybridization. Her work with genetics came only twenty-one years after the rediscovery of Mendel's principles of heredity, at a time when acceptance of those general principles was not wide-spread. Thus her work, which to some now seems to have been ignored when it first appeared, was simply too advanced for many to comprehend at the time. She also traced the evolutionary history of domesticated maize to determine the genetic ancestor of the grass we now call corn.

Resources (Local, Online and Print)

The following resources will further help you to enrich hands-on science learning in your afterschool program and to make science more accessible and interesting to a wide range of youth of varying skill levels and educational backgrounds. To plan an educational program for your afterschool, extended-day or summer program contact the organizations directly.

If your program is not located in the State of New Jersey, contact your local land-grant college or university, or your state's environmental agency.

Local

Rutgers Institute of Marine and Coastal Sciences, New Brunswick, NJ
Provides outreach and education to a variety of audiences, including K-12 educators, youth, local/state government, families, and resource users through *The C.O.O.L. Classroom* (http://www.coolclassroom.org/home.html) and through the Jacques Cousteau National Estuarine Research Reserve.
More info at: http://marine.rutgers.edu/index.html

Brigantine Division of the Edwin B. Forsythe National Wildlife Refuge, Ocean County, NJ
Established to protect tidal wetland and shallow bay habitat for migratory water birds. Offer self-guided trails and orientation to the Refuge.
More info at: http://www.fws.gov/refuges/profiles/index.cfm?id=52510

Cape May Point State Park Nature Center, Cape May Point, NJ
Site on the New Jersey Coastal Heritage Trail with an environmental center that houses a classroom for interpretive programs and a museum on the area's natural and historic features. Virtual tours are also available.
More info at: http://www.state.nj.us/dep/parksandforests/parks/capemay.html

Great Swamp National Wildlife Refuge, Basking Ridge, NJ
Offers foot access trails and tours arranged through the Friends of the Great Swamp National Wildlife Refuge Group.
More info at: http://www.fws.gov/northeast/greatswamp/

New Jersey Marine Sciences Consortium, Sandy Hook Field Station, Ft. Hancock, NJ
Offers marine and environmental science education workshops and coastal field trips for families and groups.
More info at: http://www.njmsc.org

New Jersey Pinelands Commission, New Lisbon, NJ
Offers volunteer speakers on aquatic ecology and a downloadable water curriculum guide.
More info at: http://www.state.nj.us/pinelands/edu/curriculum/

Jacques Cousteau National Estuary Research Reserve, Tuckerton, NJ
Offers professional development in the classroom and in the field related to New Jersey's marine and coastal habitats.
More info at: http://www.jcnerr.org/

The Wetlands Institute, Stone Harbor, NJ
Provides coastal research and education programs and internships.
More info at: http://www.wetlandsinstitute.org

Liberty State Park Environmental Center, Jersey City, NJ
Open year-round and features exhibits focusing on the natural history and ecology of the Hudson River Estuary and offers programs for school and community groups and the general public. The center also offers a variety of Professional Development Workshops for formal and informal educators.
More info at: http://www.state.nj.us/dep/parksandforests/parks/liberty_state_park/liberty_education.html

New York State Department of Environmental Conservation, Dutchess County, NY
Offers teacher and student workshops on the Hudson River Estuary, field trips to their interpretive center and free lesson plan downloads.
More info at: http://www.dec.ny.gov/education/66.html

Cattus Island County Park, Toms River, NJ
Birding, boardwalk through wetlands, conservation area, environmental education site, nature trails, picnic area and scenic overlooks.
More info at: http://www.occis.com/cis/parks/cattusislandpark/

New Jersey Science Teachers Association (NJSTA)
A local organization whose primary goal is the advancement of science education in New Jersey. NJSTA holds an annual conference featuring a catalog of workshops led by science educators from around the state.
More info at: http://www.njsc-online.com/

National Science Resources

Environmental Working Group
Offers *The National Tap Water Database*, a great source of test results on water quality from anywhere in the country.
More info at: http://www.ewg.org/tapwater/yourwater/

The Groundwater Foundation
Focuses on education for action: understanding that pollution prevention is the most effective, cost efficient way to protect groundwater.
More info at: http://www.groundwater.org

National Science Teachers Association (NSTA)
NSTA publishes books and journals for science teachers from kindergarten through college. They hold four annual conferences on science education: three regional events in the fall and a national gathering in the spring. NSTA provide ways for science teachers to connect with one another. They educate and lobby Congress and the public on issues affecting science literacy and a well-educated workforce.
More info at: http://www.nsta.org

Terrific Science
Offers several resources for parents and caregivers to become and stay involved in their children's science education.
More info at: http://www.terrificscience.org

General Afterschool Resources

21st Century Community Learning Centers (21st CCLC)
The 21st Century Community Learning Center is a federally funded program supported by the New Jersey Department of Education for before-school, afterschool or summer programs in New Jersey.
More info at: http://www.state.nj.us/education/21cclc

Harvard Graduate School of Education
This free resource offers an online publication of several Afterschool evaluations.
More info at:
http://www.gse.harvard.edu/hfrp/projects/afterschool/resources/index.html#issues

Educational Equity Center at AED
EEC is a national non-profit organization that promotes bias-free learning through innovative programs and materials. Their mission is to decrease discrimination based on gender, race/ethnicity, disability, and level of family income.
More info at: http://www.edequity.org/

Southwest Educational Development Laboratory
SEDL provides tools, models, assistance and training to help state and local practitioners develop high-quality, balanced programming to engage youth and to improve afterschool learning.
More info at: http://www.sedl.org/afterschool/toolkits/index.html

Science Afterschool webpage
This website contains summaries of STEM curriculum that is available for use by after-school providers and links to other pages which list curriculum. These are primarily products that are specifically adapted for use in after-school settings.
More info at: http://scienceafterschool.wikispaces.com/Curriculum+Resources

Exploratorium
A hands-on museum of science, art, and human perception in San Francisco. Website provides interactive online exhibits and exhibitions for educators.
More info at:
http://www.exploratorium.edu/explore/handson.html

National Afterschool Association
The NAA holds an annual conference featuring a catalog of workshops on useful topics and issues relevant to afterschool programs.
More info at: http://www.naaweb.org/

Afterschool Alliance
A source of information for news in the afterschool community. This website provides advice on beginning a private afterschool program and helpful links and a periodical email newsletter are available.
More info at: http://www.afterschoolalliance.org/

Learning Support
Offers several useful tools to afterschool providers free-of-charge. A few examples include ice-breaking techniques, team-building activities, lesson plans, document sharing, and discussion forums. A great tool for provider-networking. Learning Support also currently offers one online professional development course on aligning afterschool programming to Core Curriculum Standards.
More info at: http://www.learningsupport.org/

Printed Resources

Beyond the Bell: Linkages Video, North Central Regional Educational Laboratory. Offers a video featuring two elementary and two middle schools that implement and benefit from a related school-day and afterschool curriculum. "The video can be used as a resource for facilitating discussions on starting an after-school program. A companion training guide accompanies the video." $19.95
More info at: http://www.learningpt.org/beyond/linkage/about.htm

Cost Worksheet for Out-of-School Time and Community School Initiatives, Martin H. Blank and Barbara Hanson Langford. Offers a worksheet to help facilitators estimate cost of operating or expanding their programs.
More info at: http://76.12.61.196/publications/costworksheet.pdf

Afterschool Action Kit, Afterschool Alliance offers a kit that explains what afterschool programs can and should do for young people and how to locate or even start one. Available in Spanish. No Charge
More info at: http://www.afterschoolalliance.org/documents/AfterschoolActionBookletEnglish.pdf

Quality Time After School: What Instructors Can Do to Enhance Learning
Public/Private Ventures. This 64-page book compiles results from 400 interviews with participants and instructors from five Philadelphia-based Beacon Centers. The book also lays out a "road map" for leaders in the afterschool community. Free download.
More info at: http://www.ppv.org/ppv/youth/youth_publications.asp?section_id=8#pub213/

Building Successful Partnerships: A Guide for Developing Parent and Family Involvement Programs, National PTA.
A resource to help build parent and community involvement in your afterschool program. Text is based on interviews with PTA leaders, teachers, and principals. $18.95
More info at: http://www.pta.org/

Glossary

Adaptation: changes in the form or behavior of organisms in response to conditions in their environment.

Adhesion: the property of sticking together or the joining of surfaces of different composition

Aquatic: growing or living in water.

Atom: the smallest component of an element having the chemical properties of the element.

Attraction: A force that pulls two objects together.

Buoyancy: The force that pushes upward on an object submerged in a liquid allowing it to stay afloat.

Capillary Action: The movement of a liquid within a material caused by the attraction of liquid molecules to the molecules of the material.

Capillary: A hollow tube with a very small internal diameter.

Chemical property: property used to characterize materials in reactions that change their identity depending on the arrangements of atoms in a molecule.

Cohesion: The force of attraction that holds together molecules of a substance

Concave: To curve inward.

Control: A standard of comparison for checking or verifying the results of an experiment. In an experiment to test the effectiveness of a new drug, for example, one group of subjects (the control group) receives an inactive substance or placebo, while a comparison group receives the drug being tested.

Converge: To move together toward a central point.

Convex: To curve outward.

Density: How much matter is packed into a certain amount of space. Density is calculated as the measure of mass per unit of volume (D = m/v).

Displacement: When water is pushed out of the way (moves from one place to another) when an object is placed into water.

Distort: To twist or change the shape or view of an object.

Elastic: Flexible, pliable, springy, or stretchy.

Field Journal: A collection of writing usually in a binder or tablet that consists of written observations, essays, or other composition made by a scientist about research.

Force: A push or a pull on an object that results in a change in its speed, direction or shape.

Gravity: The natural attraction that draws objects at its surface towards Earth.

Hydrogen Bonding: attractive force between Hydrogen and some other element, namely in water molecules.

Hydrogen: The lightest and most abundant element in the universe, normally consisting of one proton and one electron.

Hypothesis: An idea about the solution to a scientific problem, observation or phenomena based on knowledge and research. Hypotheses can be tested by further investigation.

Lens: a molded piece of glass, plastic or other transparent material with opposite surfaces -- at least one of which is curved -- that allows light rays to bend and form an image.

Liquid: One of the four common states of matter. Liquids are made of molecules that can move about in a substance but are bound loosely together by attractive forces. Liquids have no fixed shape, and therefore take on the shape of any container.

Magnify: To increase the size or volume an object or image of an object.

Matter: Anything that has mass and occupies space. Matter exists as a solid, liquid, gas, or plasma.

Mass: The amount of stuff (matter) contained in a physical space or body.

Meniscus: The curved top of a liquid in a tube.

Molecule: The smallest unit of a substance that can exist and still retain the physical and chemical properties of that substance.

Observations: the act of viewing or noting a fact or occurrence or phenomena for scientific purpose.

Oxygen: A gas that makes up 21% of Earth's atmosphere (the air we breathe). Humans breathe oxygen and our bodies use it to fuel chemical reactions that give our bodies energy.

Physical Properties: Any property characteristic used to describe matter and the way it interacts with other types of matter.

Physics: The study of matter and energy and their interactions.

Prediction: a statement about the future or the outcome.

Properties: A basic or essential attribute shared by all members of a class. Not used to describe living things.

Reflection: The process of throwing or bending back (light, for example) from a surface.

Refraction: The bending or turning of light as it passes through one surface into another.

Scientific Method: The basis for scientific inquiry. The scientific method follows a series of steps: (1) identify a problem you would like to solve; (2) formulate a hypothesis; (3) test the hypothesis (4) collect and analyze the data; (5) make and share your conclusions.

Scientist: a person having advanced knowledge of one or more sciences, and who uses the scientific method.

Sphere: Round in shape and sometimes hollow, for example: a soccer ball. A three-dimensional (having height, width and depth) object or surface having all of its points the same distance from a given point.

Submerge: To place or sink an object below the surface (of a liquid).

Surface Area: The total area (sum) of the flat surfaces of an object. Area is usually calculated by multiplying length X width.

Surface Tension: The attraction of molecules to each other on a liquid's surface which produces an effect within the surface layer of a liquid that causes that layer to behave like an elastic sheet.
Teddy Bear Molecule: A reference to the idea that the diagram of a water molecule resembles the head of a teddy bear. The large oxygen atom can be thought of as the teddy bear face, while the two smaller hydrogen atoms can be thought of as its ears.

Variable: The things that have an effect on an experiment. There are three kinds of variables: an independent variable is the variable you purposely change. The dependent variable is the variable that is being observed, which changes in response to the independent variable. A controlled variable is <u>not</u> changed in an experiment.

Viscosity: The measurement of resistance to flow in a liquid. The higher the viscosity the more resistance it has to flow.

Volume: The amount of space that matter occupies.

Water: A clear, colorless, odorless, and tasteless liquid. A water molecule is comprised of two Hydrogen atoms and one Oxygen atom (H_20). Water has a freezing point of 32 degrees Fahrenheit (0 degrees Celsius) and a boiling point of 212 degrees Fahrenheit (100 degrees Celsius). Water is essential for most plant and animal life and the most widely used of all solvents.

Materials List

UNIT ONE MATERIALS

Lesson One: Water & the Scientific Method Recommended for groups of four

Part 1
Ten 9 oz clear plastic tumblers
200 ml measuring cup or beaker
Masking tape
Pen
½ liter bottle with tap water
Paper towels
Sponges for cleanup
½ liter white vinegar
½ liter baby oil
½ liter seltzer
½ liter salt water (¾ cup of salt mixed with ½ liter of water)
½ liter soapy water (½ liter of water mixed with liquid soap)
Karo syrup

Part 2
All materials from Part 1
Popsicle sticks
Plastic spoons

Part 3
All materials from Parts 1 and 2
Straws or eyedroppers
Waxed paper
Aluminum foil
Brown coffee filters
Dry sponges (no scrubber side)
Toothpicks
Rulers

Part 4
All materials from Parts 1, 2, and 3
Additional 9 oz cups
Raisins
Biodegradable starch packing peanuts
Styrofoam packing peanuts
Beads
Corks
Sugar
Salt
Baking soda

Lesson Two: Cohesion Recommended for groups of two

Build a Water Molecule
Different types of marshmallows: multi-colored or large and small
Toothpicks

INVESTIGATION ONE: DROPS ON A PENNY

Part 1
9 oz cup
Eyedropper or straw
Paper towel
Penny
Sponges for clean-up

Part 2
Assortment of new, old, shiny, dirty and discolored pennies
Two ½ liter water bottles filled with tap water
Other liquids to serve as variables: Soapy water, salt water, white vinegar, Karo syrup, baby oil, isopropyl alcohol, seltzer water
Waxed paper
Paper towel
Aluminum foil
Wood block or cardboard

INVESTIGATION TWO: Filled to the Brim

Part 1
½ liter water bottle
9 oz clear hard plastic tumbler
Boxes of small metal paperclips, 100 - 150
Paper towels
Sponges for clean-up

Part 2
12 oz clear plastic cup
3 oz paper cup
Boxes of large metal paperclips
Boxes of plastic-coated paperclips
Bags of marbles
Hundreds of pennies
Different liquids

Lesson Three: Water Illusions Recommended for groups of two to four

Part 1:
Clear glass jar or beaker of water (holds 600 mL)
Pencil

Part 2:
Clear glass jar or beaker of water (holds 125 mL)
Sticker about 1-inch in length and width

INVESTIGATION ONE

Part 1
10 inch #22 gauge bare wire
Nails of different sizes (5mm, 7mm, 9mm)
Small jar or beaker of water (125 ml)

Part 2
Magazine or newspaper clipping

Lesson Four: Adhesion Recommended for groups of 3 or 4

Part 1 Note: fabric samples / swatches should all be the same size (suggested 4 x 4)
Cotton fabric
Nylon fabric
Polyester fabric
Linen fabric
Twill fabric
Wool fabric
Magnifying lenses

Part 2
½ liter bottle filled with tap water
Tongs
1000 ml jar or soda bottle with the lid cut off
Pan balance
Sponges for clean-up

Lesson Five: Adhesion II Recommended for groups of 3 or 4

Part 1:
½ liter water bottle with tap water
Plastic tablecloths
Two 16 oz plastic cups (label one cup ‘A’ and the other cup ‘B’)
Scissors
White cotton string
Measuring tape
Masking tape
Sponges

Part 2:
Additional white cotton string
Part 3:
Fishing line
Thick clothesline
Twine
Thread
Yarn
Wax-coated string

Part 4:
Additional long lengths of white cotton string

Lesson Six: Surface Tension Recommended for groups of two

Picture of a water strider from facilitator guide appendix

Part 1
½ liter water bottle filled with tap water
Pie tins or 16 oz clear plastic cups with a wide brim
Paperclips of varying sizes
Plastic fork
Magnifying lenses
Sponges for clean-up

Part 2
Liquid dish detergent

Lesson 7: Surface Tension II Recommended for groups of two

INVESTIGATION ONE

Part 1
½ liter water bottle
Pie tin
Index cards
Boat template (See Template in Facilitator Guide appendix)
Ruler
Scissors
Liquid dish detergent
Sponges for clean-up

Part 2
Construction paper
Aluminum foil
Wax paper
Cardboard
Brown paper sack
Printer / Copy paper
Sandpaper
Wrapping paper

INVESTIGATION TWO

Part 1
½ liter water bottle
9 oz clear plastic Solo cup
Ground black pepper
Liquid dish detergent
Sponges for clean-up

Part 2
Different types of soap (dish detergent, bar soap, liquid hand soap)
Electric teapot (to make hot water)
Bottles filled with other liquids (salty, soapy, hot and cold water, white vinegar, Karo syrup, mineral oil, isopropyl alcohol, seltzer water)

Lesson 8: Capillary Action Recommended for groups of three or four

Part 1
½ liter water bottle of tap water
200 ml beakers or measuring cups to hold plants
Fresh celery stalks with leaves, cut to the same length
Fresh white carnations with leaves, cut to the same length
Red or blue food coloring
Sponges for clean-up
Clock or Watch
Calendar

Part 2
Rulers
Magnifying lenses
Other types of plants with leaves
Bottles of other liquids (Salty water, soapy water, cold water, hot water, white vinegar, Karo syrup, baby oil, isopropyl alcohol, seltzer water)

Lesson Nine: Capillary Action II Recommended for groups of three or four

Part 1
½ liter water bottle
Flower template (See Facilitator Guide Appendix)
Pie tins
Notebook paper
Scissors
Food coloring
Sponges for clean-up

Part 2
Bottles of other liquids (Salty water, soapy water, cold water, hot water, white vinegar, Karo syrup, baby oil, isopropyl alcohol, seltzer water)
Various kinds of paper

Lesson Ten: Buoyancy & Density Recommended for groups of three

Marbles (15 per group)
Medium to large (shoebox-sized or larger) plastic container with a wide open top, filled with water
½ stick of clay (from a 1lb. package)
Small airtight jar or bottle (like a baby food jar or a ½ liter water bottle with cap)
Pan balance or scale

Lesson Eleven: Buoyancy & Displacement Recommended for groups of two or three

Part 1
Medium to large (shoebox size or larger) plastic container with a wide, open top filled with water
½ stick of modeling clay per student (from a 1 lb. box of clay)

Part 2
Paperclips (one box per group)

Part 3
Marbles (one bag per group)

UNIT TWO MATERIALS

Student Journal

Many of the materials and organisms for Unit 2 can be purchased online from the following companies: http://www.kelvin.com/ or http://www.radioshack.com for batteries, alligator clips, wires and other small circuitry equipment; *Live plants and organisms should be ordered 2 - 3 weeks in advance from Carolina Biological (http://www.carolina.com), Science Kit & Boreal Labs (http://www.sciencekit.com) or Delta Education (http://www.deltaeducation.com/). Seeds can also be purchased from these companies or from a plant supply store such as Metropolitan Plant Exchange or Hanover Floral Supply. Pet supply retailers such as Petco will sell guppies and will occasionally have elodea in-store and online. Drs. Foster and Smith (http://www.drsfostersmith.com) and other pet supply retailers will sell brine shrimp cysts, aquaria supplies, sand, etc. The Container Store, Dollar Stores, home improvement stores such as Ace, Home Depot or Lowes, and Target carry many of the other supplies needed for Unit 2 (shoe box containers, tongs, etc.)

Lesson One: Water Cycle For groups of three or four

Part 1
Glass jar with lid (mayonnaise jar or Petri dish), or Pyrex bowl and large plate to cover the bowl
Hot water
2 cups of ice
food coloring (dark red or dark blue)

Part 2
Can of aerosol spray
Lid

INVESTIGATION ONE

Small plastic container
Clear lid to cover the container, plastic wrap or a large re-sealable storage bag
1 - 1½ cups potting soil
Lima beans or sunflower seeds
½ liter bottle of water
Ruler
Marker
Masking tape
Small to medium-sized box to secure projects
Thermometers (optional)

Lesson Two: What's in the Water? For the entire group of youth

Part One
Flipchart or chalkboard
4 - 5 pictures of an aquatic ecosystem (see facilitator guide appendix)

Part Two
Shoebox or plastic bag
30 index cards, nametags or 2 X 2 squares of paper, each labeled with an abiotic and a biotic element from an aquatic ecosystem (see lesson chart on page 3 for suggestions)
Ball of yarn or string
Clock or watch with a minute hand

Lesson Three: Freshwater Ecosystems For groups of three or four

*Live plant and animal organisms should be ordered 2 - 3 weeks in advance from Carolina Biological (http://www.carolina.com) , Science Kit & Boreal Labs (http://www.sciencekit.com) or Delta Education (http://www.deltaeducation.com/)

Dip net
Dechlorinated or spring water
Large aquarium containing guppies, snails, Elodea and Duckweed
Small containers for offspring
Hammer
Nail

Part 1, Setting the Stage
Colorless, rinsed 2-liter soda bottle (label removed)
Colorless, rinsed 2-liter soda bottle with air holes poked in the bottom (label removed)
Dechlorinated tap or spring water
Markers
Scissors
Masking tape
Sand (rinsed with plain water)
3 Elodea plants
A scoop of duckweed
Thermometers

Part 2, Adding Some Key Players
2 water snails in a 16 oz clear plastic cup of dechlorinated water
2 guppies in a 16 oz clear plastic cup of dechlorinated water
Fish food

Part 3, Watch What Happens
Magnifying lenses
Thermometers

Lesson Four: Marine Ecosystems For groups of three

*Live plant and animal organisms should be ordered 2 - 3 weeks in advance from Carolina Biological (http://www.carolina.com) , Science Kit & Boreal Labs (http://www.sciencekit.com) or Delta Education (http://www.deltaeducation.com/), Drs. Foster and Smith (http://www.drsfostersmith.com) for brine shrimp, aquarium sand, etc.

Part 1, Salty Shrimp
Brine shrimp eggs (cysts)
Paper
Magnifying lenses
3, 500 ml clear containers (beakers, jars, plastic cups, or measuring cups) rinsed
Dechlorinated or spring water
Graduated cylinders
Instant ocean sea salt or aquarium salt
Measuring spoons
Markers
Masking tape
Thermometer

Part 2, Brine Shrimp Life Cycle
Magnifying lenses
Baker's yeast
Small dip net
Flashlight
Spoon
Petri dish
Microscope

Part 3, What If?
3, 500 ml clear containers (beakers, jars, plastic cups, or measuring cups),rinsed
Brine shrimp eggs (cysts)
Dechlorinated or spring water
Graduated cylinders
Rock salt
Measuring spoons
Markers
Masking tape
Thermometer
Magnifying lenses
Baker's yeast
Small dip net
Spoon
Petri dish
Microscope

Lesson Five: Water Body Salinities I For groups of four

Preparation
3, 1000 ml graduated cylinders or 2-liter soda bottles
Distilled water
Kosher salt
Pan balance
Roll of insulated wire
Wire stripper

Part 1
Large map of the bodies of water in NJ (see appendix)
Individual outline maps of NJ (see appendix)
Colored pencils

Part 2
250 ml (1 cup) of water samples #1, #2 & #3
3, 16 oz plastic cups
9-volt battery
Small light bulb or buzzer with 2 insulated wires attached
Masking tape or alligator clips
1, 12-inch length of insulated wire (ends stripped)
2 popsicle or craft sticks
Aluminum foil

Part 3
60 ml (1/4 cup) of water samples #1, #2 & #3
3, 9 oz plastic cups
Permanent marker

Lesson Six: Water Body Salinities II For groups of four

Preparation
3, 1000 ml graduated cylinders or 2-liter soda bottles
Distilled water
Kosher salt
Balance

Part 1
Plasticine or clay
Drinking straw, clear
Ruler
Permanent marker
Tap water
4, 16 oz clear plastic cups
Small nails or steel shot to fit inside straw
375 ml (1 ½ cups) of water samples #1, #2 & #3
Paper towels
Optional, Hydrometer Lab Kit from sciencekit.com

Part 2
250 ml (1/2 cup) of water samples #1, #2 &#3
Plastic ice cube tray
Freezer
Thermometers
Real hydrometer, optional

Lesson Seven: Estuaries For groups of three

Part 1, Salt and Water
9 oz clear cup
Measuring spoons
Kosher salt or sea salt, 2 tablespoons
Magnifying lens or microscope
Microscope slide or clear plate
Plastic stirrer or spoon
½ liter bottle of water
Eyedropper, medicine dropper or straw cut in half

Part 2, Make a Salt Wedge Estuary
Large clear plastic tub or Pyrex baking dish, (9 x 13)
Ruler
Tap water, 1 liter (room temperature)
½ liter bottle of saltwater solution (½ liter of water & 6 tablespoons of salt)
Food coloring (blue, red or green)
Paper cup, 3 oz or 5 oz
Small marbles, stones or pebbles
Pencil or pen with a pointed tip or other object with a sharp point
Book or wooden block, at least 1-inch in width

Part 3, Plant Dehydration
Salt
5, Elodea or other freshwater plant or fresh celery (all cut the same length)
Magnifying lens
Ruler (cm)
4, 1000 mL graduated cylinders or 1-liter clear plastic bottles
4 test tubes or small jars
Permanent marker
Masking tape
Dechlorinated tap or spring water
Measuring spoons

Lesson Eight: Wetlands, For groups of two to four

ADDENDUM

Part 1
Small aluminum foil pan or food storage container
1 lb. Plasticine or Crayola clay (enough to cover bottom of the pan)
Cellulose sponge with no scrub side (cut to fit the width of the pan if needed)
½ liter bottle of water or spray bottle of water
Ruler (cm)
Cup of potting soil
Toothpicks or small craft (popsicle) sticks
Permanent marker

Part 2
Photos or pictures of different wetland habitats (see facilitator guide appendix)
Photos or pictures of different wetland plants and animals (see facilitator guide appendix)

Lesson Nine: Water Quality, For groups of two or three

Part 1
4, 3 - 5 oz clear plastic cups or 50 mL test tubes
7 oz distilled water (approximately 13.5 tablespoons)
2 oz lemon juice (approximately 3.5 tablespoons)
Baking soda solution (1 teaspoon of baking soda / 3.5 tablespoons of water)
3.5 tablespoons vinegar
pH wide range test tablets*
pH color chart*

*LaMotte Tapwater Test Kit or Water Pollution Detection Kit can be ordered from http://www.sciencekit.com, or the Aquarium Pharmaceuticals Dry Tab Master Test Kit can be ordered from http://www.petsrru.com

Part 2
3 plastic-coated plates or Petri dishes
24 corn seeds, radish seeds or lima beans
Vinegar solution (1 cup vinegar / 1 cup water)
Baking soda solution (1 cup of baking soda / 1 cup of water)
1-liter water sample (rainwater, tap water or water from a local pond or lake)
Paper towel sheets (cut to fit the plates)
1-gallon clear plastic storage bags
Ruler (cm)
Permanent marker

Lesson Ten: Water Treatment, For groups of three or four

Part 1
16 oz cup of dirty water sample (mix 1 ½ cups of potting soil with 2 liters of water in a clear 2-liter soda bottle or other container)
Measuring spoons and cups
1 coffee filter
1 rubber band
1 table
Cotton fabric or cheesecloth
Funnels
Paper towels
Screen remnants
Nylon stockings
Plastic containers of various sizes

Part 2
Materials from Part 1
2-liter dirty water sample
2-liter colorless plastic soda bottle with its cap (or cork that fits tightly into the neck)
2, 2-liter colorless plastic soda bottles, one with its bottom cut off and one with the top cut off
1 large container or measuring bowl to hold a 2-liter bottle
2 tablespoons of alum spice powder

Part 3
Materials from Parts 1 and 2
2-liter colorless plastic soda bottle with the bottom cut off
One unused coffee filter
One rubber band
One 2-liter colorless plastic soda bottle with the bottom cut off
1 ½ cups fine sand (white play sand or beach sand)
1 ½ cups coarse sand (multi-purpose sand)
1 cup small pebbles (washed, natural color aquarium rocks work best)
2 liters of clean tap water

Online and Storefront Retailers for Curriculum Supplies

21st CASP purchased materials for the water curriculum from the following online and storefront retailers during the two-year pilot project. You can find many of the curriculum supplies from local grocers and other retailers in your area. The online retailers will deliver materials directly to your afterschool program if someone is there to receive the package (may include catalog shopping.)

Science Kit / Boreal Laboratories: sells materials for biology, chemistry, earth science, physics and forensics. Includes online and catalog shopping.
http://sciencekit.com/

Doctors Foster and Smith: sells aquarium supplies, small live organisms and eggs, tropical fish supplies and fish tank supplies, pet supplies including dog supplies, cat supplies, products for horses, birds, small pets, reptiles, and pet medicines from their pharmacy.
http://www.drsfostersmith.com/

American Science & Surplus: offers science kits, educational toys, school supplies, arts and crafts items, hobby tools, scales, lab glass, house wares and hard-to-find items.
http://www.sciplus.com

Carolina Biological: sells science supplies and live organisms for educators.
http://www.carolina.com

Sargent-Welch: offers products for science educators of all science disciplines and levels.
http://www.sargentwelch.com

Arbor Scientific: provides educators, parents and caregivers, and youth with science products for teaching physics, physical science, and chemistry.
http://www.arborsci.com

Delta Education: provides inquiry-based, research driven, hands-on science curriculum, kits, live plants and organisms, and other educational programs and materials.
http://www.delta-education.com

Oriental Trading Company: carries an assortment of value-priced products and supplies.
http://www.orientaltrading.com

Steve Spangler: offers science-related supplies, videos, toys and games for children and educators.
http://www.stevespanglerscience.com

Kelvin: has products, activities and kits designed to assist educators and motivate youth through hands-on activities. http://www.kelvin.com/

Petco and Petsmart: These stores offer pet accessories, products & services
http://www.petco.com
http://www.petsmart.com

Office Max, Office Depot & Staples: Office supply stores, furniture, electronics, ink and toner, copy paper and computers.
http://www.officemax.com
http://www.officedepot.com
http://www.staples.com

The Container Store: Features storage and organization products. Offers space-planning. http://www.containerstore.com

Michaels: Operates specialty retail stores which provide an assortment of general crafts, home decor items, picture framing materials and services, art and hobby. http://www.michaels.com

A.C. Moore: Operates arts and crafts superstores throughout the Eastern United States http://www.acmoore.com

Jerry's Artist Outlet: accepts phone orders with a credit card for art supplies. http://www.jerrysartistoutlet.com

Student Safety Agreement Template

Safety is a priority in the afterschool science (workshop/lab/environment). The following guidelines will help foster a safe learning environment for youth and facilitators. **Please read the entire contract before you sign**. Youth will not be allowed to participate in hands-on science activities until their safety contracts are signed and returned to the (name of your afterschool program).

1. Never eat, chew gum or while doing these investigations.
2. Never taste any of the materials that you will be handling in these investigations.
3. Follow all instructions carefully. If you do not understand a direction or part of a procedure, ask the instructor before you continue.
4. Don't touch any equipment or other materials until you are told to do so.
5. Keep hands away from your face, eyes, mouth and skin while using investigation materials. Wash your hands with soap and water after doing all experiments.
6. Clean (with detergent), rinse, and wipe dry all work surfaces (including the sink) and equipment at the end of the experiment. Return all equipment clean and in working order to the proper storage area.
7. When transferring materials from one container to another, hold the containers over a table or sink.
8. Never remove chemicals or other materials from the room.
9. Carry glass tubes in a vertical (straight up) position to prevent damage and injury.
10. Never handle broken glass with your bare hands. Use a brush and dustpan to clean up broken glass.
11. When removing an electrical plug from its socket, grasp the plug, not the electrical cord. Hands must be dry before touching an electrical switch, plug or outlet.
12. Examine glassware and other containers before each use. Never use chipped, cracked or dirty containers.
13. Notify your instructor immediately if you find damaged equipment or materials. Look for cracks, chips, frayed cords, exposed wires, and loose connections. Do not use damaged electrical equipment.
14. If you do not know how to use a piece of equipment, ask the instructor for help.
15. Do not place hot glassware in cold water -- it may shatter.
16. Allow heated metals and glass to cool before use. Use tongs or heat-protective gloves if necessary.
17. Never look into a container that is being heated.
18. Do not place hot equipment directly on the desk. Always use an insulating pad. Allow plenty of time for hot equipment or tools to cool before touching them.
19. Use a wafting motion of the hand to check odors or fumes.
20. Never force rubber stoppers into glassware.
21. Know where the fire extinguisher, eyewash, shower, and exits are located.
22. Report all injuries to the instructor immediately.

I, ______________________________________ (student's name) have read and agree to follow all of the safety rules stated in this contract. I realize that I must obey these rules to insure my own safety, and that of my fellow youth and facilitators. I will cooperate with my instructor and fellow youth to maintain a safe learning environment. I will also closely follow instructions provided by the facilitator. I understand that if I violate this safety contract, I may be removed from the afterschool science activity.

____________________________________ ______________________________

Student Signature Date

____________________________________ ______________________________

Parent / Guardian Signature Date

Family Science Event Flyer Template

(*Name of Your Afterschool Program*) invites you and your family to attend **Family Science Night** to be held (*Date, Location, Address and Time*).

Come and experience science in a safe and fun environment!

This event is FREE for the whole family!

Special activities include: *(examples)*

- Traveling Science demonstrations provided by Liberty Science Center
- Hands-on water science activities that you can do with your children
- Presentation on the Hudson River Estuary by scientists from the Rutgers Institute for Marine and Coastal Sciences
- Make and take crafts and other hands-on activities for all family members

A free, healthy dinner will be provided during the evening.

For more information, contact (Name of Contact, title and phone number and alternate phone number and email address, if available)

Bring the family and explore the world of science!

TEMPLATES continued

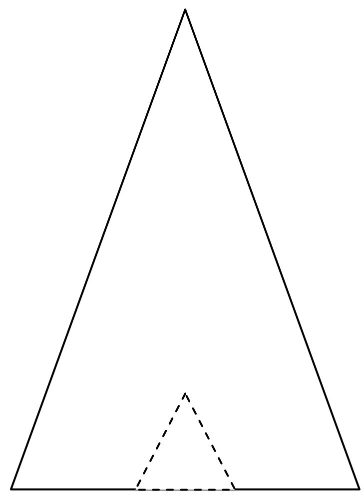
Unit 1, Lesson 6, Surface Tension I
Water Strider Photo

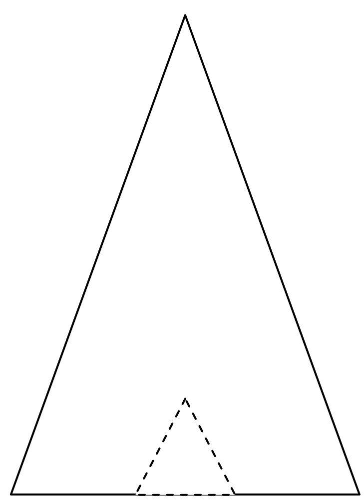
Water Striders *(Aquarius sp.)* using surface tension when mating (courtesy Wikimedia)

TEMPLATES

Unit 1, Lesson 7, Below the Surface: Surface Tension
Investigation #1: Floating Along Template

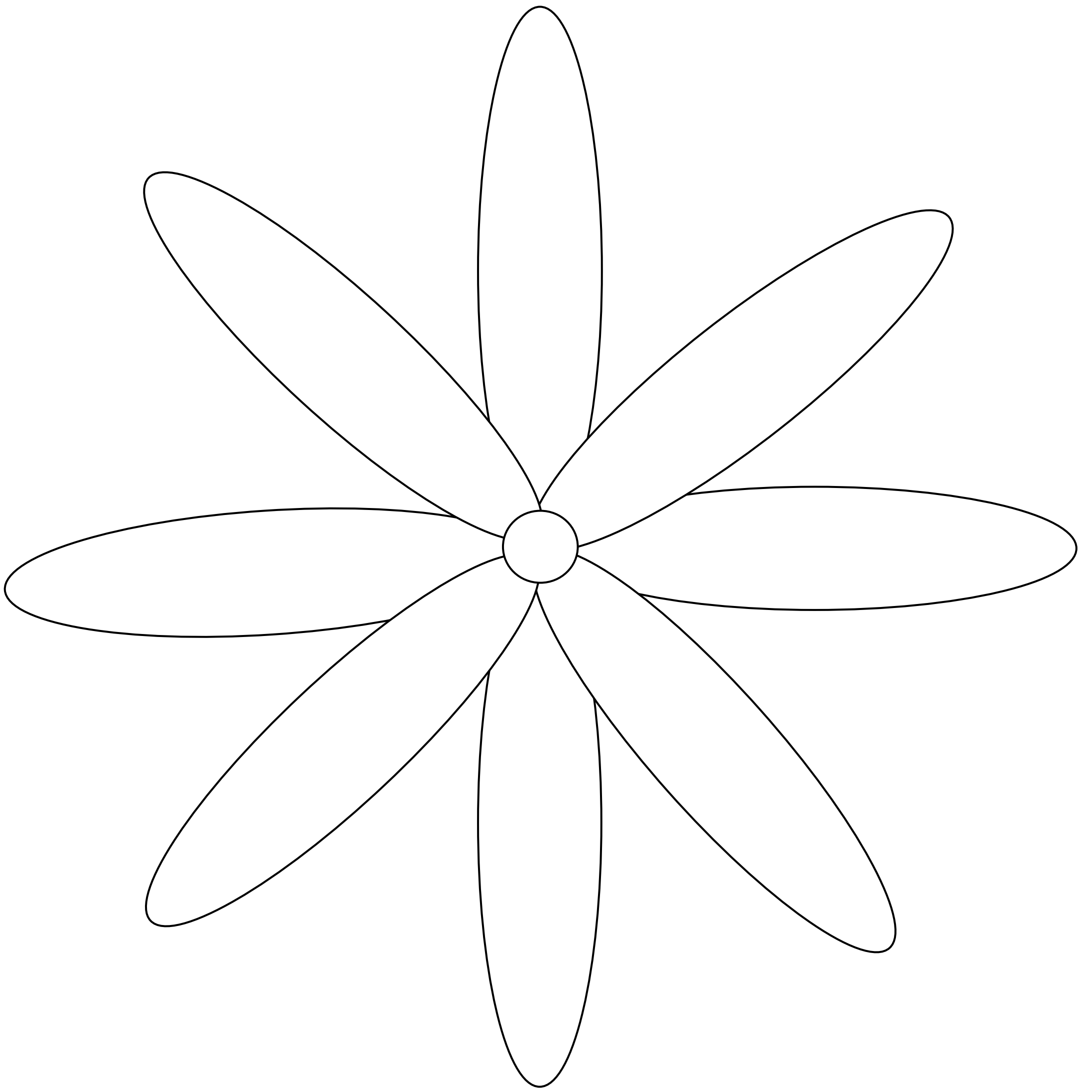
2 ½ X 1 ½ inches





TEMPLATES

Unit 1, Lesson 9, Moving On Up: Capillary Action II
Investigation #1: Paper Blooms Template

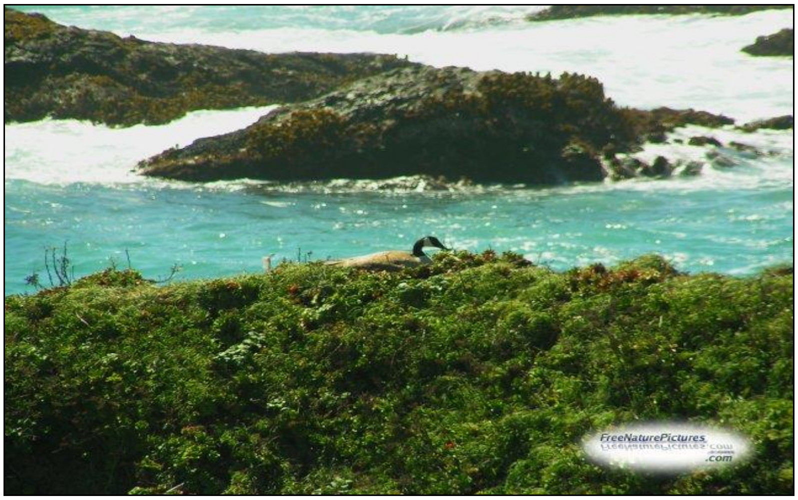


TEMPLATES

Unit 2, Lesson 2, What's in the Water? Biotic & Abiotic Elements in Aquatic Ecosystems
Part 1: Biotic and Abiotic Identification, Photos of Aquatic Ecosystems

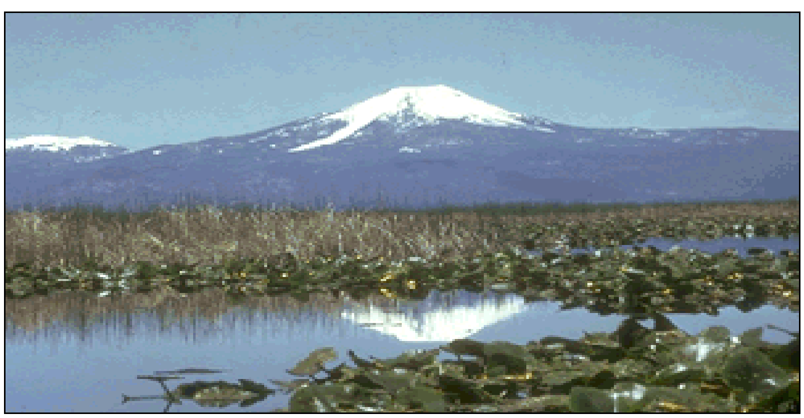
Large river (courtesy of USFWS)

Freshwater marsh (courtesy of USGS)



Goose on a cliff of low brush overlooking the ocean
(courtesy of Free Nature Pictures)

Wood pylons and aluminum can in a stream
(courtesy of Free Nature Pictures)



River basin (courtesy of USFWS)

Saltwater cliffs (courtesy of Free Nature Pictures)

Frog swimming in a creek (courtesy of Free Nature Pictures)

Seagulls entering the stream on a beach
(courtesy of Free Nature Pictures)

Sea turtle on the rocky beach
(courtesy of Free Nature Pictures)

TEMPLATES continued

Unit 2, Lesson 5, Water Body Salinities I
Part 1, Oceans, Rivers & Estuaries
New Jersey Outline Template

Unit 2, Lesson 7 Addendum
Wetlands Plants and Animals / Wetland Types

Plants of Aquatic Wetlands
Duckweed has many rounded leaves that float on the water. Duckweed leaves are small and serve as food for water birds and beavers. Cattails are the most common wetland plants. They grow more than eight feet tall on stiff stems. Cattails have flower spikes shaped like hot dogs. Muskrats, beavers and geese eat cattails. Birds nest among the cattails. Muskrats use this plant to build their homes. Early Americans used cattail stems to weave baskets and bedding. Cattail spikes could be torches when soaked in oil. Cattails were once used to insulate gloves and shoes, and cattail pollen is used to make flour.

Plants of the Bogs
Peat moss has a unique structure that allows it to hold 15 times as much water as the weight of the plant. Because of its ability to hold water, peat moss can survive during long dry periods.

Plants of Forested Wetlands
The forest wetland is full of Venus flytrap plants. This carnivorous plant has pointed hairy leaves that trap insects for food. Venus flytraps are becoming endangered because people dig them up to sell for a profit. Willow trees grow in forested wetland. Their roots trap sand and other sediment, preventing erosion and helping other trees grow in the wetland. Some of the trees that grow in swamps form a set of roots above the soil surface or above the water that allows them to get oxygen to the lower roots.

Plants of Emergent Wetlands
Purple loosestrife grows faster than any other wetland plant. It is a non-native and invasive plant that thrives in freshwater wetlands, crowding out native plants. Yellow iris is another invasive plant. Native Americans used Iris flowers as perfume and Iris leaves to make ropes and snares to trap elk for food. Iris is poisonous to humans, but it can be used to make a paste to stop swelling.

Plants of Shrub/Scrub Wetlands
Blackberry shrubs can grow roots from the branches if the branch is resting in a wet area. Blackberry thorns protect small animals hiding in the branches. Birds and bears eat blackberries. Birds and insects are protected in the cover of willow. Rats, birds and rabbits eat willow twigs. Willow trees also grow in shrub/scrub wetlands. Its branches are flexible and can be used to make baskets, twine, dye and furniture. Native Americans chewed willow bark for pain relief since it contains a chemical similar to aspirin.

Plants of Saltwater Marshes
Saltwater marsh plants include salt marsh grass and spartina. These plants have special glands that allow them to eliminate excess salt that they take in from the water and soil.

Insects of the Wetlands
Wetland insects include mosquitoes, water striders, dragonflies and mayflies. Mayfly larvae and adults serve as a food source for fish and amphibians. Water striders use a property of water called *surface tension* to walk on water. The surface of water acts likes a skin to help water striders and pond skaters. Pond skaters have specialized, paddle like legs that enable the insect to “skate” on the surface of the water.

Types of Wetlands Found in New Jersey

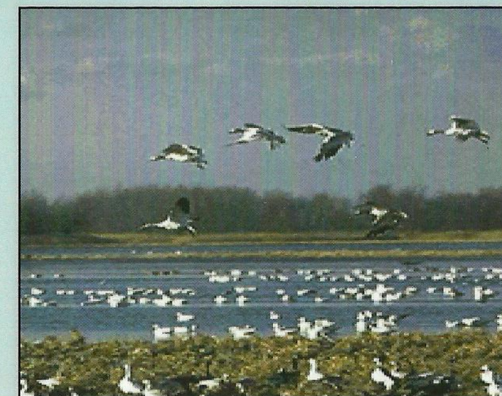
The Great Swamp Refuge is located in Morris County, New Jersey. The refuge holds 7,600 acres of varied wetland habitats, serving as a breeding, nesting and feeding ground for birds, foxes, deer, muskrats, turtles, fish, frogs, wildflowers and plants.

Aquatic beds are found near the edges of lakes or stream and are dominated by plants that generally grow on or below the surface of the water. Water lily, duckweed and pondweed grow in aquatic beds three to six feet deep. Waterfowl such as ducks and herons feed and rest in aquatic beds because they offer food and protection. Fish spawn (deposit their eggs) and feed in aquatic beds.

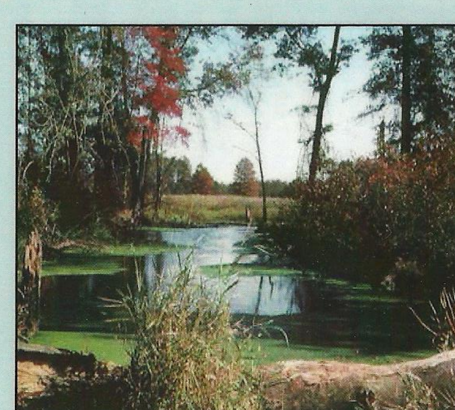
Emerging wetlands are found next to lakes and streams. They are home to green plants that produce flowers and fruit. Plants in emerging wetlands have soft stems, roots that are submerged in the water or wet soil, and leaves that are above the water or wet soil.

Bogs are covered by thick carpets of moss, lichen and peat (dead plant material). The water in bogs is low in oxygen, highly acidic and usually cold. Almost all of the water found in bogs comes from precipitation (rain and snow). Plants and animals that live in bogs have adapted to the low nutrient levels and acidic waters. Carnivorous (meat-eating) plants such as Venus flytraps eat insects because the water and soil in bogs lack the minerals and other nutrients needed for survival. Cranberries are harvested from bogs in New Jersey.


Bog (courtesy EPA)


Aquatic Bed Wetland (courtesy USFWS)


Willow tree *Salix babylonica*(courtesy Wikimedia)

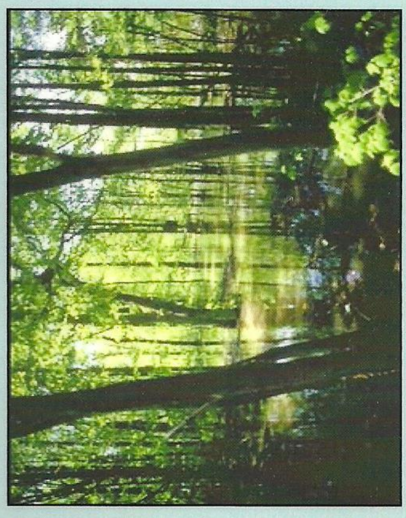

Great Swamp (courtesy of USFWS)

Fens have slow moving water that rinses acid from the soil. Minerals and nutrients drain into fens from surrounding soils and from groundwater. Fens are covered by grasses, rushes, sedges and wildflowers—mostly vascular plants with specialized tissues that transport water and minerals. These plants provide food and shelter for other aquatic organisms. Fens provide shelter to insects such as mosquitoes; amphibians such as the Eastern tiger salamander; birds, and mammals such as shrews, voles and muskrats.

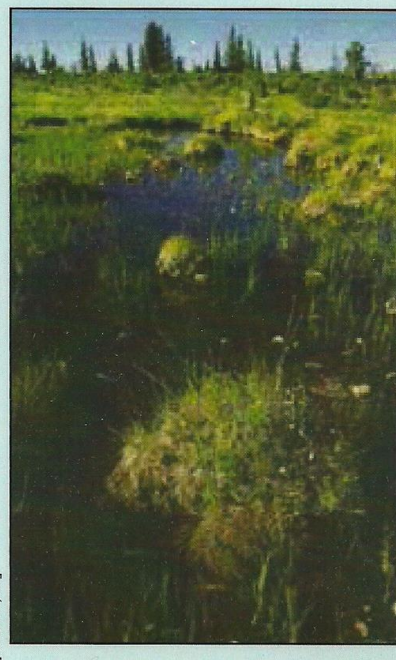
Marsh wetlands usually have shallow, standing water throughout the year. Marshes are often "riparian", meaning they form a transition or buffer zone between water and land. Marshes contain lots of nutrients for plants and animals, but the water and soil found in marshes are "anaerobic" or lacking oxygen. Marsh plants adapt to the low levels of oxygen by drawing air through hollow spaces from their leaves to their roots and to the soil around their roots. There are several types of marshes, including freshwater and saltwater. Saltwater marshes can be found at the edges of estuaries (where freshwater flows into the ocean). Saltwater marsh plants have adjusted to growing in salty, waterlogged soil and can excrete excess salt from specialized cells in their stems, roots and leaves. Cattails, rice, crabs, shrimp, tadpoles and insect larvae can all be found in marshlands.

Forested wetlands or swamps are covered by large trees and woody plants more than twenty feet tall. Swamps have water-saturated soils during the growing season and standing water during other times of the year. Both evergreen trees (having foliage that stays green throughout the year, such as the Eastern white pine) and deciduous trees (having leaves that fall off or shed seasonally, such as the Willow oak) grow in swamps. Few green plants grow in forested wetlands because of the acidic soil and lack of oxygen. Swamps also contain a layer of rotting plants called "peat".

Scrub/shrub wetlands are densely populated by small trees and bushes that are less than 20 feet in height. These wetlands are often found in estuarine areas and are flooded with shallow, standing water for extended periods during the growing season. Their thick vegetation protects small birds and amphibians from larger prey. Scrub/shrub wetlands are important breeding areas for amphibians because of the absence of predator fish. Pussy willow, dogwood and elderberry are typical shrubs found in this type of wetland. Wood ducks, song birds, herons, muskrats and deer can also be found in scrub/shrub wetlands.

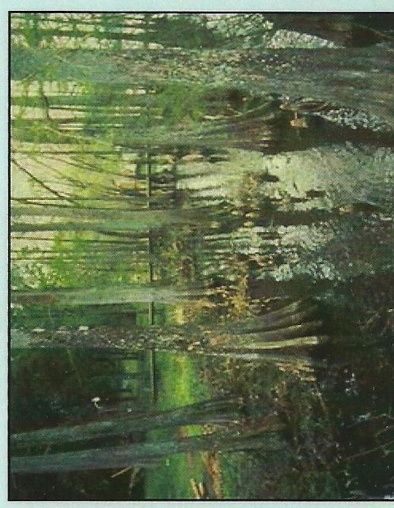


Wetlands Marsh (courtesy USFWS)



Fen (courtesy EPA)

Scrub/Shrub Wetland in an Estuarine Ecosystem (courtesy NOAA CSC)



Forested Wetland (USDA CFWR)

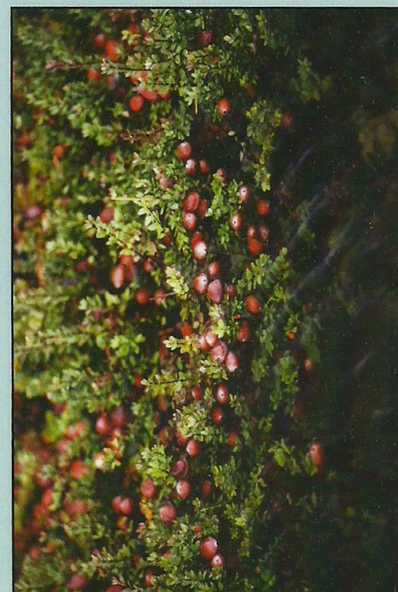
Cranberries are red berries used in foods and in herbal products. Cranberries are a unique fruit. They can grow and survive only in acid peat soil, an adequate fresh water supply, and a growing season that extends from April to November. Cranberries grow on low-lying vines in bogs or marshes layered with sand, peat, gravel and clay. *Cape Cod Cranberry Growers' Association*

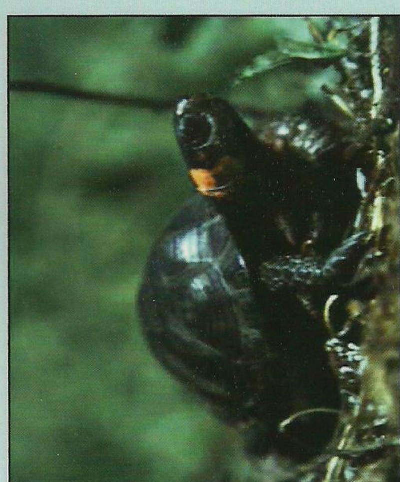
Blackberry grows in relatively open, disturbed, and moist sites such as shrub/scrub wetlands. Blackberry shrubs grow quickly and tolerate poor soil. Blackberry bushes are often called brambles, from a word that means prickly. The plants have stiff, sharp prickles along the stems and midrib of leaves. White-tailed Deer, Eastern Cottontail, and Beaver eat the leaves and stems of the blackberry shrub. The shrub also provides great cover and protection for birds and small animals. Many plants often grow closely together to form a thicket. Several species of birds nest in blackberry shrubs. Birds and other animals eat blackberries and spread the seeds through their droppings. *Community Mapping Network*

Cattails or bulrushes are wetland plants, typically 1 to 3 meters tall, with spongy, strap-like leaves and starchy, creeping stems. Cattails grow along lake margins and in marshes, often in dense colonies, and are sometimes considered a weed in managed wetlands. The plant's root systems help prevent erosion, and the plants themselves are often home to many insects, birds and amphibians. The disintegrating heads are used by some birds to line their nests. The downy material was also used by Native Americans as tinder for starting fires.

The **bog turtle** is found in the eastern United States in colonies from New York and Massachusetts south to southern Tennessee and Georgia. This is a semi-aquatic species, preferring habitats with cool, shallow, slow-moving water, deep soft mucky soils, and herbaceous vegetation. Bog turtles live in shallow, spring-fed fen, sphagnum bogs and swamps, marshy meadows and pastures generally dominated by sedges or sphagnum moss with soft, muddy bottoms, slow-flowing water and open canopies. Like other cold-blooded or ectothermic species, they require habitats with regular solar penetration for basking and nesting. The bog turtle is one of the smallest North American turtles with the adult shell measuring 3 to 4 ½ inches in length. It has a large, bright orange, yellow or red blotch on each side of its head. When danger threatens, the turtle burrows rapidly into the mucky bottom. They beetles, insect larvae, snails, seeds and millipedes. *U.S. Fish and Wildlife Service*


Blackberry Shrub (courtesy Wikimedia Commons)


Cranberry in a Bog (courtesy USDA Agricultural Research Service)


Bog Turtle *Glyptemys muhlenbergii* (courtesy USFWS)


Cattail (courtesy of Derek Jensen)

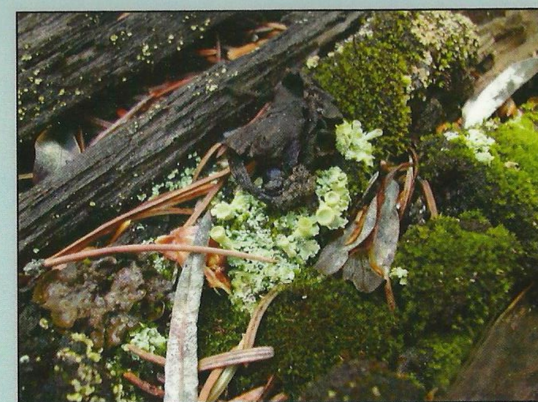
The **pitcher plant** is a carnivorous, or meat-eating, plant. Carnivorous plants have adapted to living in low-nutrient environments by developing features to attract, trap, kill, digest prey and absorb nutrients. They eat invertebrates and occasionally small frogs and mammals. The most common habitat for pitcher plants is in bogs and fens, where nutrient concentrations are low but water and sunshine are seasonally abundant. Most plants absorb nitrogen from the soil through their roots; but carnivorous plants absorb nitrogen from their animal prey through their leaves that are specially modified as traps. Pitcher plants use "pitfall" traps with leaves folded into deep, slippery pools filled with digestive enzymes. *The Botanical Society of America*

Mosses are small, low-lying, soft plants that grow 1–10 cm tall. They usually grow close together in clumps or mats in moist, shady areas. They do not have flowers or seeds, and their simple leaves cover thin wiry stems. Mosses are non-vascular plants. Unlike flowering plants, they do not have special channels to transfer nutrients up the stalk. Moss plants do not possess true roots. Instead, mosses get their nutrients and moisture from the air. Because of this they prefer damp places and have adapted to dealing with long dry periods. Mosses use spores to reproduce. Sphagnum peat-mosses are large mosses that form extensive acidic bogs in peat swamps. The leaves of peat-mosses have large dead cells alternating with living photosynthetic cells. These dead cells help to store water. Because of its water-holding capacity, peat moss is added to soil to improve its water-holding capacity and has been used as an absorbing material for oil spills. The Eskimo used peat moss to curb diaper rash. *College of Natural Sciences & Mathematics, University of Massachusetts Amherst*

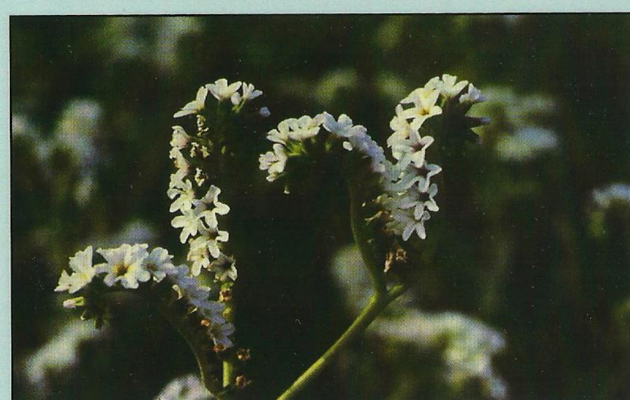
Herbaceous angiosperms (flowering plants) are the dominant and most familiar group of land plants. They have true roots, stems, leaves and flowers. They also have seeds. Angiosperm means "seed born in a vessel". These plants are more highly evolved that the algae, mosses, fungi and ferns. Their advanced structures allow angiosperms to thrive on land. They have roots that hold the plant in place and take in needed minerals and water. They have stems that hold the plants up and move nutrients and water through the plant. Angiosperms are the primary food source for animals and provide oxygen to breathe. *Monroe County Women's Disability Network*

Mosquitoes are two-winged insects. Female mosquitoes have mouth parts that form a long proboscis for piercing the skin of mammals, birds and sometimes reptiles and amphibians to suck their blood. The mosquito proboscis is serrated. The females need protein to produce and lay their eggs, while male mosquito diets consist of nectar and fruit juice. The females lay their eggs in water and the larvae and pupae live entirely in water. When the pupae change into adults, they leave the water and become flying land insects. Mosquitoes lay their eggs on the surface of woodland pools, tidal floodwaters, freshwater swamps, standing water or containers of collecting water.

Mosquito *Aedes sollicitans* (CDC)



Mossy log *Sphagnum apiculatum* (courtesy of Free Nature Pictures)



Herbaceous angiosperm (courtesy USDA NRCS)

Pitcher Plant *Sarracenia oreophila*(courtesy USGS)

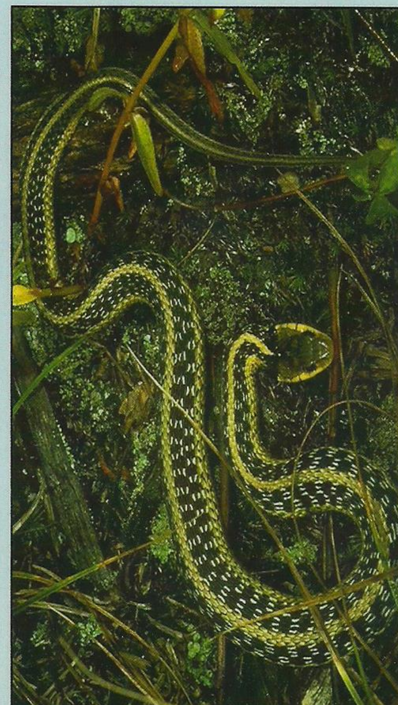
Eastern garter snakes live in moist fields, forests, meadows and marshes. They are non-venomous and feed on small fish, frogs, toads, salamanders, earthworms, tadpoles, mice, bird eggs, slugs, crayfish, leeches, insects and other small snakes. They grow between 14 and 48 inches in length and have narrow heads and bodies. They range in color from light brown to black with two alternating rows of black spots. Eastern garter snakes have black lines on their lip scales. They also have three long stripes, usually with a yellow dorsal stripe. The lateral stripes are cream to yellow and are located on the second and third scale rows. There can also be a row of black spots below the lateral stripes.

American black ducks are large ducks found in wooded ponds, salt marshes and estuaries. The American black duck is chocolate brown with bright white feathers on their underwings. They have a lighter brown neck and head, red legs and feet. Males have a flat, broad yellow bill, while females have a darker olive bill. The American black duck feeds mainly on aquatic plants, but will also forage near the shore for seeds and insects. They float high in the water and are strong fliers. Their legs are placed more towards the center of their bodies. Nests are built close to the water, often on the ground and lined with soft plant material.

Spotted Salamanders are amphibians—vertebrates that begin the first part of their lives under water (breathing with gills) and the rest of their lives on land (breathing with lungs). Amphibians are ectothermic—they warm themselves by obtaining heat from the environment. Salamanders have soft, moist skin covering their long bodies and tails. Salamanders must return to the water to mate and lay their eggs. Females lay a milky egg mass about four inches long and attach the eggs to sticks or plant stems submerged in water. During the rainy season and early summer, spotted salamanders can be found in wetland vernal ponds formed from melted snow and heavy spring rains. Spotted salamanders eat insects, worms, snails, and small fish. Their skin is bluish-black or dark gray, and they have two rows of round yellow or orange spots down their backs. Their bellies are slate gray.

Red-spotted newts are amphibians that live near fens, marshes and emergent wetlands. Newts have long and slender bodies and a flattened tail. In its larval stage, this newt is called a *red eft* because of its bright reddish-orange color. After reaching maturity, this newt's skin will turn olive, and its sides will acquire red spots that are surrounded by black.

American Black Duck *Anas rubripes* (USFWS)



Eastern Garter Snake *Thamnophis sirtalis sirtalis* (NPS)

Red-spotted Newt *Notophthalmus viridescens* (Paul Hurtado)

Spotted Salamander *Ambystoma maculatum* (USDOT)

Spring peepers are small tree frogs that live near marshes, ponds, streams, or vernal pools (water that forms in large pools in the spring, but dries up in the summer). Like all amphibians, spring peepers must lay their eggs in water. Like many salamanders, spring peepers are nocturnal—highly active at night. They grow less than an inch and a half in length and can be tan, gray or dark brown with a dark *"X"* on their backs. Spring Peepers also have large toe pads to grip plants when they climb.

Muskrats are large rodents that live in aquatic environments throughout New Jersey watersheds, swamps, lakes and marshes. They prefer to make their home in aquatic habitats where the water level remains fairly stable, preferably at a depth of four to six feet. The muskrat's thick, glossy pelt (skin with fur) is dense and waterproof. It has a rudder-like, scaly tail to help it easily move backwards and forward in water. Muskrat's have partially webbed hind feet that make it a strong swimmer and diver. Muskrats are generally herbivores, eating plants such as cattails, water lilies, sedges and rushes; but they may also feed on fish, crayfish, frogs and freshwater clams. Muskrats have strong lungs and can swim underwater for up to 17 minutes before surfacing to take a breath.

Fiddler crabs live near water on the mud or sand. They dig burrows during high tides that can reach a foot deep. These burrows are often linked to other tunnels and have more than one entrance to provide fiddler crabs with escape route from predators like fish, raccoons and aquatic birds. Male fiddler crabs have one large front claw and one small one, while females and young fiddlers have two small claws. The male fiddler crab uses the large claw to wrestle other males, to mark his territory and to attract a mate. The small claw is used to gather food. Fiddlers roll a ball of mud and use it to plug the hole of their burrow during high tides. The ball of mud traps a tiny pocket of air inside for them to breathe. All crabs have gills, which they must keep moist in order to breathe, so they stay near water at all times. Fiddler crabs grow between one and two inches and may be tan, blue-green, turquoise, black, yellow, or orange in color. Fiddler crabs eat algae, microbes, fungus and other decaying detritus. Some scientists believe that fiddler crabs help preserve wetland habitats because they aerate (expose to air) the soil and prevent anaerobic conditions as they forage for food and burrow in the sand.

Banded sunfish live in heavily vegetated areas of bogs, lakes and streams with sandy or muddy bottoms. Its body is lined by six or seven dark vertical stripes on its body. The banded sunfish has rounded pectoral (front side) fins, a gill cover spot that is larger than its eye, and an arched line on the side of its body that ends just before its tail. It has an olive-colored body sprinkled with iridescent gold, green and purple markings. Banded sunfish feed mostly on aquatic insect larvae, scuds and other small crustaceans. They grow two to four inches in length and live up to four years. Spawning can occur from early spring into summer. The female lays eggs in a small, round nest built by the male.

Banded Sunfish, *Enneacanthus obesus* (USGS)

Muskrat, *Ondatra zibethicus* (USFWS)

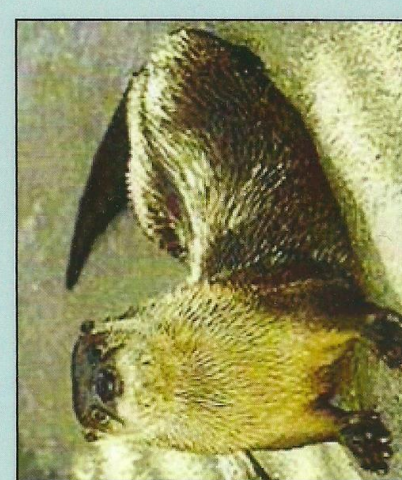
Fiddler Crab, *Uca pugnax* (NOAA)

Spring Peeper *Pseudacris crucifer* (NPS)

River otters are expert swimmers and divers. They can stay underwater for up to two minutes. They have specially built ears and diamond-shaped noses with a valve-like skin that closes when the otter swims underwater. Otters have webbed and clawed feet that are useful for running on land and swimming. They can run up to 15–l8mph. River otters are three to four feet long and weigh 15 to 25 pounds. Their colorful coats range from nearly black to reddish or grayish brown on their backs. Their belly is silvery or grayish brown. The throat and cheeks are silvery to yellowish gray. Otters eat fish, crustaceans, and other aquatic invertebrates and they have few natural enemies, especially in water. On land, young otters are vulnerable to a variety of predators such as the fox, wolf and raptors.

An **osprey** is a raptor (bird of prey). Raptors are at the top of their food chain and prey on smaller animals. The osprey has special adaptations to hunt fish but will occasionally eat rodents, birds, small vertebrates and crustaceans. The adult is blackish-brown on top of its body and white below. Ospreys range in size from 21 to 25 inches long with a wingspan of 59 to 67 inches. They are the only raptor that will plunge into the water for food. Ospreys will hover 30–100 feet above the water looking for fish. When a fish is spotted, the osprey dives feet first into the water. The osprey's method of catching prey calls for some adaptations not found in land hawks. The osprey's feathers are slightly oily to limit water absorption. Its leg shank is scaled, not feathered, with short, dense feathers on the thighs. The pads of the toes are covered with small spikes for grasping slippery fish. The osprey also has a reversible outer toe that can either be at the front of the foot or moved to the back to carry fish. They build nests close to water near the tops of trees. The nest is built of sticks and lined with grasses, seaweed, moss, lichens, bark and mud.

Osprey *Pandion haliaetus* (USGS)



River Otter *Lutra Canadensis* (USFWS)

References

American Association for the Advancement of Science. *Benchmarks for Science Literacy*; Oxford University: New York, 1993.

The American Heritage Dictionary of the English Language (Fourth Edition) Houghton Mifflin Company, 2003.

Association for Women in Mathematics, Box 178, Wellesley College, Wellesley, MA 02181.

Bainbridge, W.L. and Lasley, II., T.J. Columbus Dispatch. July 2002. "Poverty, Not Race, Holds Back Urban Youth."

Bloom, B. et al. (1956). *Taxonomy of the cognitive domain.* Retrieved March, 2006 from http://honolulu.hawaii.edu/intranet/committees/FacDevCom/guidebk/teachtip/questype.htm

Burke, R.J. and Mattis, M.C. Women and Minorities in Science, Technology, Engineering and Mathematics: Upping the Numbers Edward Elgar Publishing Inc. Northhampton, MA. September 2007

E.I. DuPont de Nemours and Company. (2003). General science safety checklist. Retrieved March 2006, from http://www.sciencenewsforkids.org/pages/safetyzone.asp

EQUALS, Lawrence Hall of Science, University of California, Berkeley, CA.

Halwes, T. (2000). Dispelling some common myths about science. Retrieved May, 2007 from http://www.dharma-haven.org/science/dispelling-myth-magical-science.htm

Math/Science Network, 2727 College Avenue, Berkeley, CA 94705.

National Research Council. (1999). National Science Education Standards. (7th ed.). Washington D.C.: National Academy Press

National Research Council. (1996) *National Science Education Standards*; Washington D.C.: National Academy.

National Science Foundation. (2003). Employed scientists and engineers, by occupation, highest degree level, race/ethnicity and sex: 2003. Retrieved May 2007, from http://www.nsf.gov/statistics/wmpd/pdf/tabh-7.pdf

National Science Teachers Association. (1999). Challenging Myths: Questioning common myths about science education. The science teacher, April, 41-53. [Newsletter] Retrieved March 2006 from http://science.nsta.org/enewsletter/2004-02/tst9904_40.pdf

National Science Teachers Association. (2004). NSTA position statement: Scientific Inquiry. Retrieved March 2006, from www.nsta.org/positionstatement&psid=37

National Science Teachers Association. (2004). NSTA position Statement: Gender equity in science education. Retrieved March 2006, from http://www.nsta.org/positionstatement&psid=43

National Women's History Project, P. O. Box 3716, Santa Rosa, CA 95402.

Painter, J. (1996). Questioning techniques for gifted youth. Retrieved March 2006, from www.nexus.edu.au/teachstud/gat/painter.htm

Saskatchewan Education. (1990). Assessment ideas for the elementary science classroom. In Science: A Curriculum Guide for the Elementary Level. Retrieved March 2006, from http://www.sasked.gov.sk.ca/curr_inst/iru/bibs/elemsci/index.html

Youth' and teachers' conceptions of the nature of science: A review of the research (p 331-359) Published Online: 18 Aug 2006. Norman G. Lederman. Journal of Research in Science Teaching 1963-1995.

"Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future." National Academy of Sciences, 10/05.

Tichenor, M. (1998). Preservice teachers' attitudes toward parent involvement: Implications for teacher education. The Teacher Educator, 33(4), 248–259.

USDA, NRCS. 2007. The PLANTS Database (http://plants.usda.gov, November 2006). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

William & Wilma Follette @ USDA-NRCS PLANTS Database / USDA NRCS. 1992. Western wetland flora: Field office guide to plant species. West Region, Sacramento.

Women's Educational Equity Act Publishing Center, Education Development Center, 55 Chapel Street, Newton, MA 02160.

Women's Resource Center, University of California, Berkeley, CA 94720.

Worth, K. (2000). The power of children's thinking. In Foundations: A monograph for professionals in science, mathematics, and technology education. Inquiry: Thoughts, views, and strategies for the K-5 classroom. (pp. 25-32). Arlington, VA: National Science Foundation. Retrieved March 2006, from http://www.nsf.gov/pubs/2000/nsf99148/ch_4.htm.