Curriculum Units by Fellows of the National Initiative
2017 Volume IV: Chemistry of Cooking

Food Preservation: From Edible School Garden to Science Table

Curriculum Unit 17.04.03, published September 2017
by James Matthew Churilla

"Mr. Churilla! How come we don't pickle pickles? I love pickles!" Ja'lynn asked (one morning at the start of Science class).

"Well Ja'lynn, I'm not sure we have enough time to make pickles in Science."

"Sure, we do!" she exclaimed. "We can reuse the leftover pickle juice like I do at home."

"Tell me more."

"When I go to Giant Eagle with my mom, I ask her to buy me some small cucumbers. When I get home, I wash and peel them."

"Wait! Why do you peel them? Don't you like the skin?"

"Yes," she replied, "but the skin is too tough to chew and they must put some kind of wax on them. I just like the inside part."

"Ok. Then what do you do?"

"I cut them up into circles, plop them into the pickle juice, put the lid on the jar and put it in the back of the fridge for about a week so the cucumbers can soak up the juice."

"Sounds delicious Ja'lynn, but wouldn't it be cheaper to just buy them instead"

"They're expensive and I like making them because I know what I put in them. You'll see, Mr. Churilla. I'll bring some in for you to taste and you can judge yourself."

This conversation was the start of the unit I am writing on Food Preservation: From Edible School Garden to Science Table.

Introduction

Preservation of food has a long history among cultures that saved large quantities of food, that could not be consumed within a few days. I see my students as the junk food generation. Consuming mass amounts of processed foods, chips, and the little powdered donuts served at school for breakfast. These will play a not-so important role in their growing bodies. I have always supported fresh vegetables and fruits grown in the school garden. Introducing them to the preservation of foods may spark a taste for dried apples from the school tree or cucumbers from the garden, fermented in a tasty spicy brine. In this unit students, will be able to disseminate the practice of preserving foods.

Background

As a Science Specialist at Pittsburgh Miller PreK-5, located in Pittsburgh's Hill District, my school is an African-Centered Academy, teaching and promoting the history and culture of people of African descent. Pittsburgh Miller PreK-5 creates a culture of excellence through high expectations and accountability for all students where failure is not an option. My student-centered approach to science is designed to provide every student with a gratifying yet rigorous school experience, while utilizing the five E's of Science: Engage, Explore, Explain, Elaborate, Evaluate and the eight Next Generation of Science and Engineering practices: Asking questions and defining problems, Developing and using models, Planning and carrying out investigations, Analyzing and interpreting data, Using mathematics and computational thinking, Constructing explanations and designing solutions, Engaging in argument from evidence, and Obtaining, evaluating and communicating information. I provide a quality comprehensive science education in which I believe all students can learn. I use both traditional and innovative teaching and learning methods to draw from each student, his or her unique gifts of knowledge and understanding. My teaching is equipped with creative and innovative teaching methods to enhance my students' science experience. I deliberately and intentionally ensure that my students of color feel connected to their culture and heritage.

African Centered Education

Dr. Molefi Asante, the founding father of Afrocentric education defines Afrocentric education as giving the African child ownership of knowledge in the classroom, not made to feel like a renter of information. Dr. Asante states, "Afrocentric education locates the child in his or her own intellectual and historical space and radiates to other spheres of knowledge." It validates the child's experiences and builds new knowledge linking the two together. African-Centered Education places people of African origin in control and at the center of their lives and their study. The child is placed and grounded at the center and all cultural groups are respected. African-centered education prepares students from conception to ancestry to live and serve the community, transmitting knowledge, skills, values, and attitudes for the betterment of humanity.[1]

African Centered Education's philosophy is to foster an understanding and willingness to be guided by those principles that characterize a righteous and just person. Moral wisdom is the service of social and human good. The object is to restore and enrich righteousness through the practice of unity, self-determination, purpose, truth, justice, harmony, righteousness, reciprocity, order and balance. The trouble of one is the trouble of all.[2]

Culturally Relevant Pedagogy

Culturally relevant teaching uses the culture of the student to maintain it and to transcend the stereotypes of their culture. These stereotypes are brought forth, by not seeing one's history, culture, or background represented in a textbook or curriculum or by seeing that history, culture, and background distorted.[3] Specifically, culturally relevant teaching is a pedagogy the empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes.[4]

Rationale

Why is food preservation important to students at Pittsburgh Miller? It promotes healthy eating habits and physical activity. Daily, students will come to school with a supply of junk food, i.e. hot Cheetos and soda pop bought from the corner convenient store. America has promoted healthy eating and exercise over the last eight years with First Lady, Michelle Obama's "Let's Move" program. To help promote and teach this program, our school garden has taken on a new face in the school community over the last four years. Students are celebrating growing vegetables from seed to harvest. Students are finding the value and importance of physical activity. They find great pleasure being outside and working together in a cooperative physical environment. In the Life Science curriculum, students learn about ecosystems. The school garden is a place for my students to understand and care for an ecosystem in which they live in. They see their impact on their community by composting and mulching, by using rainwater to water plants, by maintaining weed and pest control. These processes and practices encourage an environmental ethic that will guide Miller students toward becoming environmental stewards of the Hill community. They take great pride in working together to sow, grow, care, and maintain their garden every year. The young garden caretakers are saddened that the bounty of their harvest lasts for a short time. During the fall and winter months, the children will learn processes and applications that will preserve fresh foods from the garden. Preservation of their harvest will ensure the choice and likelihood that they will enjoy the produce planted. Therefore, food preservation will be infused into the Life Sciences in grades 2 and 3..

Content

Preservation of Food

Preservation of food has played an important role in many cultures around the world. This made it possible for people to travel great distances to explore unknown places. Taking their portable food provisions with them meant they would not starve. As people settled in new lands, they searched for ways to preserve life by preserving foods. What they found through observations and trial and error was a variety of ways to use the natural chemicals around them to develop different ways of preserving foods through different processes. Many cultures developed methods to preserve surpluses of foods within the climate that they lived in by utilizing smoking, and drying. In regions of the world where winter months meant starvation and the limited supply of fresh foods, people dried their food in the air, kept cool in caves, and cured meats by smoking them. Eventually, with the discovery of salt, they pickled and fermented fish, meats and vegetables. As cultures harnessed the power of the sun's heat and long winter months, salts, and eventually sugars and spices, vinegars and alcohols transformed the way cultures ate and influenced their culture and lifestyles.

Bacteria

The basic idea of preservation is handling and keeping food in such a way that the food maintains the quality of its texture, flavor, and color while avoiding spoilage and bacterial growth that can cause sickness and even death. Bacteria, one of the most common agents of food infection, are single-celled microorganisms that are too small to be seen with the human eye. Microbes live, die, and reproduce, and like all living creatures, they depend on certain conditions to survive and thrive.[5] For growth to occur within food, microorganisms require the temperature between 40°F and 140°F, which is called the danger zone, for bacteria to grow rapidly. Time, more than two hours in the danger zone, can cause spoilage. Water, high moisture content is helpful. Fresh fruits and vegetables have the highest moisture content. Oxygen, most microorganisms need oxygen to grow and multiply, but a few are anaerobic and do not. Acidity and pH Level, foods that have a low level of acidity (or a high pH level) provide an ideal environment, since most microorganisms grow best around 7.0 pH and not many will grow below 4.0 pH. Examples of higher pH foods include meat, seafood, milk, and corn. Examples of low pH foods include citrus fruits, sauerkraut, tomatoes, and pineapples. Nutrient Content, microorganisms need protein, starch, sugars, fats, and other compounds to grow. Typically, high-protein foods are better for bacterial growth.[6] As far as food is concerned, microorganisms can show themselves as harmless, harmful and beneficial. Microorganisms that thrive on moist, warm, aerated foods are often pathogenic, but not all microorganisms that live in and on food are lethal to us. Basically, everything we touch, breathe, or ingest contains some form of microorganism. On the other hand, some microorganisms will cause great harm when ingested. Examples are: *Clostridium Botulinum*, *E. coli*, *Salmonella*, and *Norovirus*.[7] To prevent ingesting these harmful microorganisms, we need to be educated on the safety of hand washing, the identification of food pathogens that are associated with foodborne illness, food handling, and methods on how to preserve foods in a safe way for later consumption.

The Safety of Handwashing

Keeping hands clean is one of the most important steps we can take to avoid getting sick and spreading germs to others. Many diseases and conditions are spread by not washing hands with soap and clean, running water. Where can germs come from and how can we prevent them? Let's define two important words that will be discussed in detail further on in this unit.

1. Microbes are all tiny living organisms that may or may not cause disease.
2. Germs, or pathogens, are types of microbes that can cause disease.

Did you know, germs like *Salmonella*, *E. coli*, and *Norovirus*, survive and grow in feces/(poop) from animals and even people? These kinds of germs can get onto hands after people use the toilet, but also in less obvious ways, like after handling raw meats that have invisible amounts of animal poop on them. A single gram of human feces which is about the weight of a paper clip can contain one trillion germs.[8] Germs can also get onto hands if people touch any object that has germs on it because someone coughed or sneezed on it or was touched by some other contaminated object. When these germs get onto hands and are not washed off, they can be passed from person to person and make people sick.

Handwashing with soap removes germs from hands. This helps prevent infections because people frequently touch their eyes, nose, and mouth without even realizing it. Germs can get into the body through the eyes, nose and mouth and make us sick. Germs from unwashed hands can get into foods and drinks while people prepare or consume them. Germs can multiply in some types of foods or drinks, under certain conditions, and make people sick. Germs from unwashed hands can be transferred to other objects, like clothes, table tops, or utensils, and then transferred to another person's hands. Removing germs through handwashing helps prevent diarrhea and respiratory infections and may even help prevent skin and eye infections.[9]

Handwashing is the most important thing you can do to prevent the spread of foodborne bacteria.

It may seem silly to think that you need to learn how to wash your hands. However, a proper hand washing method can make the difference between safe science room and a potentially deadly one. This is because harmful bacteria are so easy to spread by hand. The Center for Disease Control and Prevention (CDC), recommends cleaning hands in a specific way to avoid getting sick and spreading germs to others.

How to Wash Your Hands the Correct Way According to the CDC.

First, wet your hands with clean, running, warm or cold water, and apply soap. Using soap to wash hands is more effective than using water alone because the surfactants in soap, function by breaking down the interface between water, oils and dirt, and germs.[10] Soaps were the earliest surfactants and are obtained from fats which are known as tri-glycerides because they are esters formed by the tri-hydric alcohol, propane-1,2,3-triol (glycerol), with long chain carboxylic acids (fatty acids). Second, lather your hands by rubbing them together with soap. Be sure to lather the backs of your hands, between your fingers, and under your nails. By lathering and scrubbing your hands you create friction, which helps lift dirt, grease, and microbes from skin. Microbes are present on all surfaces of your hand, and a high concentration of microbes under your nails. When washing, the whole hand should be scrubbed.Third, Scrub your hands for at least twenty seconds. By doing so, you are reducing the numbers of microbes on your hands, removing more germs from your hands than washing for shorter periods. Remember to sing the ABC song from beginning to the end, twice. Next, rinse your hands well under clean, running water. Soap and friction help lift dirt, grease, and microbes, including disease causing germs from skin so they can then be rinsed off your hands. Rinsing the soap away with running water rather than standing water decreases your risk of recontamination. Last, dry your hands using a clean towel or air dry them. Germs can be transferred quickly to and from wet hands. So, your hands should be dried after washing.

The Safety of the Science Lab

Cleaning Before Food Preparation

To prepare for food preparation in the science lab, wash your hands for 20 seconds with soap and warm running water. Then clean and sanitize your food preparation workspace. Make sure you wash, rinse, sanitize, and air dry all bowls, cutting boards, knives, pots, pans, and other utensils. Use only a knife dedicated to food preparation for that purpose. Try to avoid bare hand contact with food. Use disposable gloves. The garbage cans you use during preparation should be lined with a plastic bag and have a lid on it. Remember to store food, food containers, paper products, and utensils away from your food prep area. This is very important; be mindful of student allergies to certain ingredients (e.g. peanuts or wheat) when preparing food. Safety of the students comes first when cooking food with a heat source. Establish a clear "safety zone" around your table.

Disinfecting

The CDC recommends a disinfection solution made by adding 1 part sodium hypochlorite, NaClO / (common household bleach), to 9 parts of water. This solution will disinfect cutting boards, sinks, counters, knives, etc. The CDC also recommends an alternative to bleach, using soap and warm water.[11]

Foodborne Pathogens

The U.S. Public Health Service has identified the following microorganisms as being the biggest culprits of foodborne illness, either because of the severity of the sickness or the number of cases of illness they cause.[12]

1. *Campylobacteriosis* is an infectious disease caused by bacteria of the genus *Campylobacter.* Most people who become ill with campylobacteriosis get diarrhea, cramping, abdominal pain, and fever within two to five days after exposure to the organism. The diarrhea may be bloody and can be accompanied by nausea and vomiting. The illness typically lasts about one week. Sources include: raw and undercooked poultry and other meat, raw milk and untreated water.
2. *Botulism* is a rare but serious illness caused by a toxin that attacks the body's nerves and causes difficulty breathing, muscle paralysis, and even death. This toxin is made by *Clostridium botulinum* and sometimes *Clostridium butyricum* and*Clostridium baratii*bacteria. These bacteria can be spread by food and sometimes by other means. The bacteria that make botulinum toxin are found naturally in many places, but it's rare for them to make people sick. These bacteria make spores, which act like protective coatings. Spores help the bacteria survive in the environment, even in extreme conditions. The spores usually do not cause people to become sick, even when they're eaten. But under certain conditions, these spores can grow and make one of the most lethal toxins known. The conditions in which the spores can grow and make toxin are: low to no oxygen (anaerobic) environment, low acid, low sugar, low salt, a certain temperature range, and a certain amount of water. Sources include: improperly home-canned, preserved, or fermented foods, and these can provide the right conditions for spores to grow and make *botulinum* toxin. Improperly prepared home-canned foods such as honey should not be fed to children less than 12 months old.
3. *Escherichia coli*(abbreviated as *E. coli*) are a large and diverse group of bacteria. Although most strains of *E. coli*are harmless, others can make you sick. Some kinds of *E. coli* can cause diarrhea, while others cause urinary tract infections, respiratory illness and pneumonia, and other illnesses. Still other kinds of *E. coli* are used as markers for water contamination. You might hear about *E. coli* being found in drinking water, which are not themselves harmful, but indicate the water is contaminated. Sources include: beef, especially undercooked or raw hamburger, produce, raw milk, and unpasteurized juices and ciders.

4. *Norovirus* is a very contagious virus that can infect anyone. You can get it from an infected person, contaminated food or water, or by touching contaminated surfaces. The virus causes your stomach or intestines or both to get inflamed. This leads you to have stomach pain, nausea, and diarrhea and vomiting. These symptoms can be serious for some people, especially young children and older adults. Sources include: any food contaminated by someone who is infected with this virus.
5. *Salmonella* is a bacterium that makes people sick. It was discovered by an American scientist named Dr. Daniel Elmer Salmon. It has been known to cause great illness for over 125 years. The illness people get from *Salmonella* infection is called *salmonellosis*. Most people infected with *Salmonella* develop diarrhea, fever, and abdominal cramps between 12 and 72 hours after infection. The illness usually lasts 4 to 7 days, and most individuals recover without treatment. The *Salmonella* infection may spread from the intestines to the bloodstream, and then to other body sites. In these cases, *Salmonella* can cause death unless the person is treated promptly with antibiotics. The elderly, infants, and those with impaired immune systems are more likely to have a severe case of the illness. Sources include: raw and undercooked eggs, undercooked poultry and meat, fresh fruits and vegetables, and unpasteurized dairy products.
6. *Listeriosis* is a serious infection caused by the germ *Listeria monocytogenes*. People usually become ill with *listeriosis* after eating contaminated food.The disease primarily affects pregnant women, newborns, older adults, and people with weakened immune systems. It’s rare for people in other groups to get sick with *Listeria*infection. *Listeriosis* is usually a mild illness for pregnant women, but it causes severe disease in the fetus or newborn baby. Some people with *Listeria* infections, most commonly adults 65 years and older and people with weakened immune systems, develop severe infections of the bloodstream (causing sepsis) or brain (causing meningitis or encephalitis). *Listeria* infections can sometimes affect other parts of the body, including bones, joints, and sites in the chest and abdomen. Sources include: unpasteurized dairy products, including soft cheeses, sliced deli meats, smoked fish, hot dogs, paté, and deli-prepared salads including egg, ham, seafood, and chicken.

Methods of Food Preservations

Drying

Dehydrating (another word for drying) is one of the oldest methods of food preservation. Early Egyptians dried fruits and vegetables, eventually, leading to dried fish and meats. With the power of the sun, early Egyptians knew that fresh fruits and vegetables contain a lot of water. When they set out fruits and vegetables into the extreme heat of the sun to dry they discovered that the heat from the sun, mixed with the air caused them to swell.[13] After time, the fruits and vegetables had changed color, shape, and texture, but the taste from natural sugars intensified because of less water content. What happened was, when fruits and vegetables were placed in a hot environment (sun) heat transferred from the hot air to the flesh and water inside the food. Heat caused the energy of the water molecule to increase. When the energy of the water molecules reached a certain level, they changed from a liquid (water) to gas (water vapor). This changing phase is called evaporation. In fresh fruits and vegetables there lies a lot a water, about 90%. To be considered a properly dried fruit, it must only contain about 20%. Dried vegetables are even less, about 10%.[14] This is important, because having very low water after drying, they become protected against microorganisms, like mold. Without water, microorganisms cannot grow and spoil fruits and vegetables. Why is this important? Eating dried fruits and vegetables can help keep us healthy and happy. Fresh fruit and vegetables are rich in vitamins, nutrients, and flavor which are retained when dried. Fruits picked at their prime have the highest natural sugar content and best nutritional value. For the best quality product, choose only fresh, ripe, unblemished fruits. Vegetables have a low acid and sugar content that makes them more subject to spoilage, and tend to have far shorter shelf life than dried fruits.

Dehydrator

The dehydrator with separated trays will be the essential tool in the science lab for drying; use one with a clear top so students can see the transformation. Most dehydrators can be found online.

Cleaning

Fruits and vegetables will need a good cleaning to insure a safe product in the end. They should be placed in a colander, washed under running water, using a fruit/vegetable brush to scrub away any dirt. When cleaned, they are to remain in the colander to drain.

Fruit Preparation

Wash fruit thoroughly and remove any imperfections. Remove skins (if desired), stems, and stones. Cut the fruit in half or slice in 1/4" to 1/2" circles or slices. Some fruits have a natural protective wax coating such as figs, prunes, grapes, blueberries, cranberries, etc. If you want to dry these fruits whole, dip into boiling water for 1 to 2 minutes (amount of time needed depends on thickness and toughness of skin) to speed dehydration. This makes the skin more porous by removing the natural wax coating and speeds up drying time. Small lines appear on fruit skin allowing moisture to escape but may be too fine to be visible. Many fruits can be dried in halves with the pits removed. If drying with skins on, make sure to dry skin side down to prevent juice and pulp from dripping down through trays. If fruit has been artificially waxed, it should be peeled to remove wax. Pre-treatment isn't necessary for most fruit. Fruits are simply sliced and dried. However, some fruits tend to oxidize more than others. Oxidation causes browning of cut food surfaces when fruit is dried. This causes a loss in flavor and vitamins A and C. Pre-treatment minimizes oxidation. Apples, pears, peaches and apricots are better when pre-treated before drying. To pretreat, place cut fruit in a holding solution of ascorbic acid, $C_6H_8O_6$, (vitamin C) to reduce browning during preparation. Do not keep cut fruit in a holding solution for more than an hour.

Vegetable Preparation

Wash vegetables thoroughly and remove any blemishes. Peel, trim, core, and/or slice vegetables. Most vegetables must be blanched, either steaming over boiling water or in microwave oven to slow enzyme action which will continue during drying and storage. Blanching softens cell structure, allowing moisture to escape more easily and allows vegetables to dehydrate faster. Using a pot with a tight-fitting lid and a steaming rack, bring about 1 inch of water to a brisk boil and drop in sliced vegetables. Cover and steam until vegetables are heated completely through, but not cooked. This is usually about 1/3 of the time required to cook vegetables. Vegetables should still be crunchy. Drain in a steamer rack and place immediately on dryer trays.

Vegetables are dried until they are crisp, tough, or brittle. Package into airtight containers immediately after drying to prevent absorption of moisture from air. The usual drying temperature for vegetables is 130°F to 145°F.

Fermentation and Pickling

Fermentation is one of the oldest and simplest means of preserving food.[15] There is no need to cook, no heat is wasted, all that is needed are a holding vessel, salt, and a weight to hold the food in its natural juices.

Fermentation occurs when certain harmless microbes, with limited presence of air, will grow and inhibit the growth of other unwanted microbes that may cause spoilage and disease. Organisms known as yeast consume sugars and convert them to alcohol, carbon dioxide, and lactic acid over the course of several weeks.[16] Pickling on the other hand, is preserving foods in acetic acid, CH_3COOH / (vinegar), or other acids. Vinegar is produced from starches or sugars fermented into alcohol and the alcohol is oxidized to lactic acid, $C_3H_6O_3$ / (milk acid).[17]

Sauerkraut

Sauerkraut involves anaerobic bacteria, which is why the shredded cabbage and salt need to be packed in a water lock container. At this stage, the surrounding environment is not acidic, just cabbage. The bacteria, mostly *Leuconostoc* species, produce carbon dioxide (replacing the oxygen in the jar) and lactic acid, which is a natural byproduct of anaerobic respiration. Eventually, the conditions within the jar become too acidic for these bacteria to survive and they die out, replaced with bacteria that can better handle the acidic conditions such as *Lactobacillus* species. The *lactobacillus* further ferment any sugars remaining in the cabbage, using anaerobic respiration. This produces more lactic acid, until the sauerkraut reaches a pH of about 3. These bacteria are inhibited by high salt concentrations (so most sauerkraut contains around 2-3% salt) and low temperatures, which is why the fermenting jars should be left at room temperature rather than in the fridge. At pH 3 the *lactobacillus* stop fermenting and the sauerkraut can be stored until needed.[18]

Science Sauerkraut in a Fermentation Crock

A fermentation crock (glass and plastic) is highly recommended for a visual examination of the process of the transformation, as it has a built-in water lock to create an anaerobic fermenting environment. Glass fermentation crocks are available on-line.

Preparation

You will need about 2-3 large heads (6-8 pounds) of green cabbage. Cabbage will be cut into quarters and sliced about 1/8 inch thin. Stuff shredded cabbage in the fermentation crock pressed down firmly and add 6 tablespoons of canning/pickling salt. Other types of salts may have anti-caking ingredients in them. This may make the brine cloudy but, harmless. Make sure to leave about ¾ of an inch of headspace between the cabbage and the rim of the crock. Add the weight on top to suppress the cabbage and place water in the rim of the crock and place lid on top. Place the crock in an area of the science lab where it can be seen. If, after 24 hours, the brine does not cover all the cabbage, add some filtered water and a pinch of salt. Once the desired pH 3 level has been reached, transfer to airtight jars with lids and refrigerate until ready to serve.[19]

Testing pH Levels in Sauerkraut

Paper pH testing strips, also known as litmus paper, change color when put into the substance being tested. The resulting color indicates the pH of the substance, correlating to the manufacturer’s label. When you use the pH strips to test the pH of sauerkraut, it is necessary to take a teaspoon of the sauerkraut, and the sauerkraut juice and puree them together for testing. You can’t simply put a test strip into the sauerkraut without blending first. It will not give you an accurate pH reading.

Sugar Preservation

Like salt, sugar makes the fruit inhospitable to microbes. It dissolves, binds up water molecules, and draws moisture out of living cells, thus crippling them.[20] The key to creating fruit preserves is pectin.[21] Pectin keeps things together, it's a naturally occurring carbohydrate with thickening and gelling properties. When fruit is cut up and heated to near boil, the pectin chains are shaken loose from the cell walls and dissolve into the released cell fluids and any added water.

Recipe for Strawberry Preserves

You will need 4 cups of mashed ripe strawberries, 4 cups of granulated sugar, and 1 tablespoon of citric acid. Wash fruit thoroughly and remove any imperfections. First, mix sugar and berries in a bowl and let sit at room temperature for about 1 hour. After 1 hour, transfer to a pot and add the citric acid and bring to a full rolling boil for 7 minutes, stirring constantly. Then, pour into 8 pre-sterilized half-pint jars, leaving ¼" headspace. Process in a boiling-water bath for 10 minutes. The preserves may be kept for one year in a cool, dark area.

Preservation Tools of the Trade

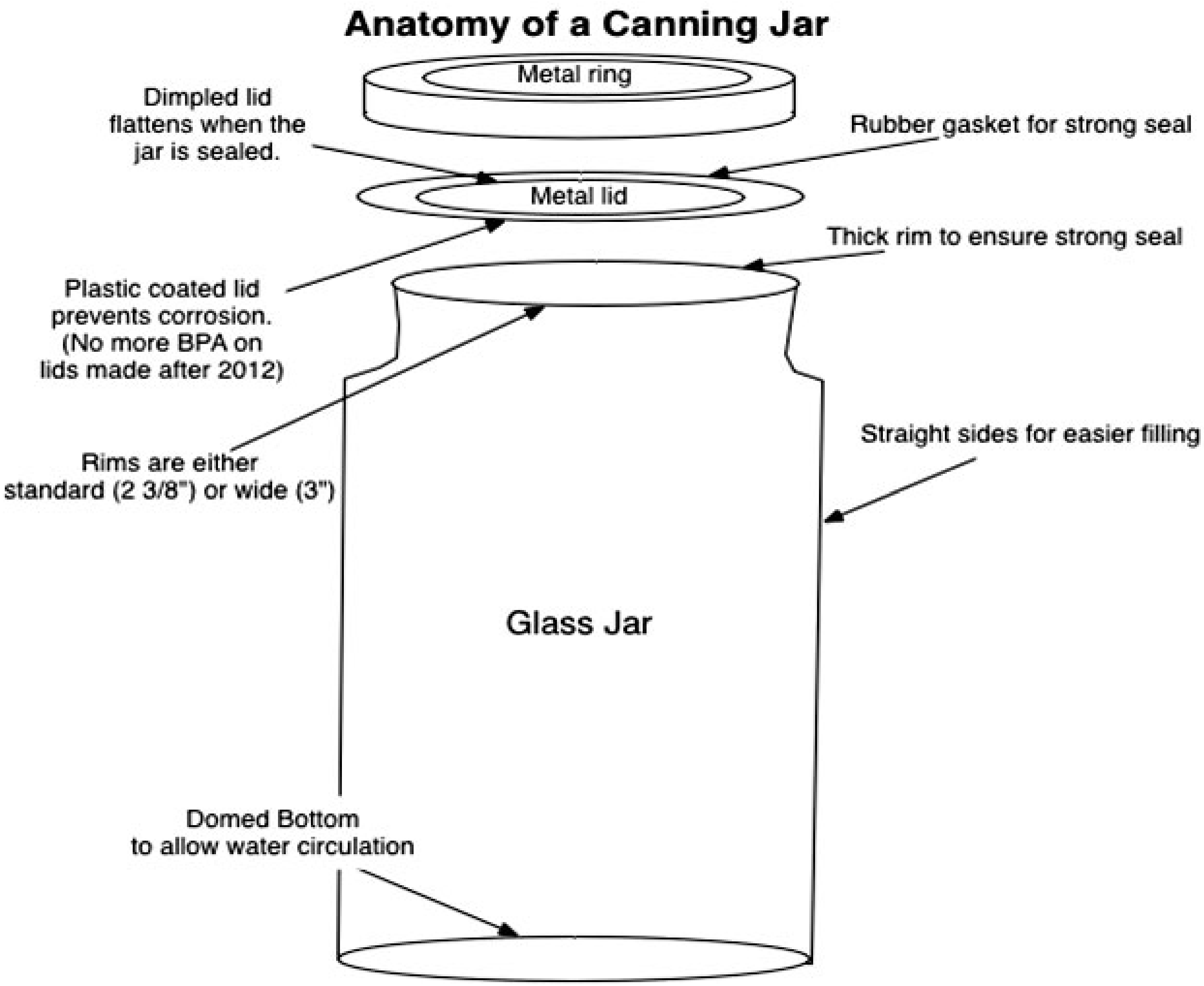
Utensils for Canning

The following canning-specific tools may be purchased on-line: Jar lifter, magnetic wand, jar funnel, and a combination ruler/spatula. These also can be purchased on-line: Induction cooktop with induction cookware, measuring spoons, ladles, ruler, measuring cups, kitchen towels, timer, pot holders, colander, large sieve, 4 and 8 cup glass liquid measures.

Boiling-water canning

For the purpose, of this unit, I recommend The Ball® freshTECH Electric Water-Bath Canning System. This tabletop water canner is perfect for the science lab. A boiling-water canner is simply a very large pot with a rack on the bottom and a lid on the top. Jars are submerged in simmering water for a specified time. They then are heated to a temperature of 212^0 F; this method is used mainly for fruits, pickles, salsa, and other high-acid foods.[22]

The Anatomy of a Canning Jar



Addi. "Anatomy of a Canning Jar." [23]

Nicolas Appert

The Father of modern day canning, Appert was a professional chef and confectioner. He became obsessed with ways of preserving different foods. 18th century Paris gave way to preserved foods that lacked taste and the unpleasantness of food with no aroma, bad juices, the stiffness of food fibers making them inedible. Salt, gave foods a sourness making them too tough and unable to digest. Appert spend ten years experimenting with different sized champagne bottles that he filled with fruits, vegetables, and meats and placed them in a bath of hot water. Appert stated that the function of nutrition, for it to be preserved, it must be subjected to heat, until all air is ridden from the bottle. He wrote the details of his process consisted principally of:

> 1st. In enclosing in bottles the substances to be preserved.
>
> 2d, In corking the bottles with the utmost care; for it is chiefly on the cooking that the success of the process depends.

3d. In submitting these inclosed substances to the action of boiling water in a water-bath (Balneum Mariae), for a greater or less length of time, according to their nature, and in the manner pointed out with respect to each several kind of substance.

4th, In withdrawing the bottles from the water-bath at the period described.[24]

Endnotes

1. Asante, Molefi Kete. "Afrocentric Curriculum." 28
2. Ibid. 31
3. Ladson-Billings, Gloria. *The Dream-Keepers: Successful Teachers of African American Children*. 19
4. Ibid. 20
5. McGee, Harold. *On Food and Cooking: The Science and Lore of the Kitchen*. 26
6. Ibid. 27
7. "Food Safety.".
8. Ibid
9. "Handwashing: Clean Hands Save Lives."
10. Ibid
11. Greene, Janet, Hertzberg, Ruth, and Vaughan, Beatrice. *Putting Food By*. 25
12. "Foodborne Pathogens"
13. "Reshafim.org."
14. McGee, Harold. *On Food and Cooking: The Science and Lore of the Kitchen*. 291
15. Ibid
16. Shepard, Sue. *Pickled, Potted, and Canned: How the Art and Science of Food Preserving Changed the World*. 125
17. Ibid
18. "Sauerkraut: Bacteria Making Food."
19. "Make Sauerkraut: Fermented Foods for Health."
20. *McGee, Harold. On Food and Cooking: The Science and Lore of the Kitchen*. 269
21. *McGee, Harold. On Food and Cooking: The Science and Lore of the Kitchen.* 296
22. "Fresh Preserving, Shop Ball Mason Jars and Home Canning."
23. Addi. "Anatomy of a Canning Jar."
24. Appert, Nicolas. *The Art of Preserving: All Kinds of Animal and Vegetable Substances for Several Years.* 9-10

Bibliography for Teachers

Addi. "Anatomy of a Canning Jar." Digital image. Relocavor. May 30, 2014. Accessed

August 13, 2017. https://relocavor.files.wordpress.com/2014/05/canning-jar-anatomy.gif. Image details the parts of a canning jar.

Appert, Nicolas. *The Art of Preserving: All Kinds of Animal and Vegetable Substances for Several Years.* London, England: East-India

Company, 1812. The first book of preserving for the future.

Asante, Molefi Kete. "Afrocentric Curriculum." Educational Leadership 49, no. 4 (December 1991): 28-31. Accessed July 13, 2017. http://www.ascd.org/publications/educational-leadership/dec91/vol49/num04/toc.aspx. Article that provides insight to the teaching of African American students.

"Foodborne pathogens." Fight Bac! Accessed July 05, 2017. http://www.fightbac.org/food-poisoning/foodborne-pathogens/. Identified microorganisms by the U.S. Public Health Service.

"Food Safety." Centers for Disease Control and Prevention. October 05, 2016. Accessed July 09, 2017. https://www.cdc.gov/foodsafety/index.html. Background information on foodborne/germs.

"Fresh Preserving, Shop Ball® Mason Jars & Home Canning." Fresh Preserving, Shop Ball® Mason Jars & Home Canning. Accessed July 19, 2017. http://www.freshpreserving.com/. Background information from Ball® on step by step fresh preserving.

Greene, Janet, Hertzberg, Ruth, and Vaughan, Beatrice. *Putting Food By*.5th ed. Edited by Stephen Schmidt. New York, NY: Penguin Group, 2010. Instructions on the best ways for canning, pickling, drying, curing, and preserving.

"Handwashing: Clean Hands Save Lives." Centers for Disease Control and Prevention. January 27, 2016. Accessed July 11, 2017. https://www.cdc.gov/handwashing/index.html. Steps for teaching the science behind hand washing.

Ladson-Billings, Gloria. *The Dream-Keepers: Successful Teachers of African American Children.* San Francisco: Jossey-Bass, 2009. Ladson-Billings challenges us to envision intellectually rigorous and culturally relevant classrooms that have the power to improve the lives of not just African American students, but all children.

"Make Sauerkraut: Fermented Foods for Health." Make Sauerkraut: Fermented Foods for Health. Accessed July 17, 2017. https://www.makesauerkraut.com/. The Who, What, Where, When, Why and How to make sauerkraut.

McGee, Harold. *On Food and Cooking: The Science and Lore of the Kitchen*. New York: Scribner, 2004. This is the go to book which food lovers and professional chefs worldwide turn for an understanding of where our foods come from, what exactly they are made of, and how cooking transform them into something new and delicious.

Miller, Jan, ed. *Better Homes and Gardens: Complete Canning Guide*. New York, NY: Houghton Mifflin Harcourt, 2015. Provides all the information and inspiration you need to stock your pantry with home-canned food. Offers the safest, simplest, and the most up to date methods to ensure safety and success in home canning.

"Reshafim.org." Reshafim.org. Accessed July 18, 2017. http://www.reshafim.org/. Topics include fruit and vegetables, with early Egyptian influence.

"Sauerkraut: bacteria making food." Scientific American Blog Network. Accessed July 22, 2017. https://blogs.scientificamerican.com/lab-rat/the-science-of-sauerkraut-bacterial-fermentation-yum/. Science Blog

Shepard, Sue. *Pickled, Potted, and Canned: How the Art and Science of Food Preserving Changed the World.* New York: Simon & Schuster Paperbacks, 2006. Pickled, Potted, and Canned gives us fascinating insights into the histories, cultures, and ingenuity of people inventing new ways to pickle, pot, and can.

Bibliography for Students

Barrett, Judi, and Ron Barrett. *Cloudy with a Chance of Meatballs*. Boston, MA: National Braille Press, 1978. A Children's Classic from the 70's. One of my favorites.

Barrett, Judi, and Ron Barrett. *Pickles to Pittsburgh: The Sequel to Cloudy with a Chance of Meatballs*. New York: Aladdin Paperbacks, 2000. As the title says, The Sequel to Cloudy with a Chance of Meatballs.

Cobb, Vicki, and Peter J. Lippman. *Science Experiments You Can Eat*. Philadelphia: Lippincott, 1994. Your kitchen will be transformed into a laboratory as you make startling discoveries about how cabbage can detect acid, how bacteria makes yogurt and much more.

DAmico, Joan, Karen Eich. Drummond, and Tina Cash-Walsh. *The Science Chef: 100 Fun Food Experiments and Recipes for Kids*. New York: J. Wiley, 1995. With *The Science Chef,* you'll learn loads of basic science by doing fun, easy to perform cooking projects. You also get to eat the results when you're finished.

Eamer, Claire, and Marie-Eve Tremblay. *Inside Your Insides: A Guide to the Microbes that Call You Home*. Toronto, Ontario: Kids Can Press, 2016. Great colored pencil art work describing Microbes.

Littlefield, Cindy, and Joanne Schmaltz. *Tianas Cookbook: Recipes for Kids*. New York, NY: Disney Press, 2009. In *The Princess and the Frog,* Tiana is such a good cook that she opens her own restaurant. Now kids can make their own versions of her dishes with these simple step by step recipes.

Miller, Jan, ed. *Better Homes and Gardens: Complete Canning Guide*. New York, NY: Houghton Mifflin Harcourt, 2015. Provides all the information and inspiration you need to stock your pantry with home-canned food. Offers the safest, simplest, and the most up to date methods to ensure safety and success in home canning.

Taylor-Butler, Christine. *Food Safety*. New York, NY: Children's Press, 2008. Chapter book on food safety. Super pictures.

Verdick, Elizabeth, and Marieka Heinlen. *Germs Are Not for Sharing.* Minneapolis, MN: Free Spirit Pub., 2011. Cute book for teachers to read to students.

Zappy, Erica. *Curious George Discovers Germs.* Boston: Houghton Mifflin Harcourt, 2015. When George comes down with a cold, he learns all about germs so that he can figure out how to get better, stay healthy, and prevent germs from spreading.

Classroom Activities

Lesson Plan #1

Science Notebooks in the Elementary Classroom. It Makes Sense!

Written for Elementary Science Grades 2-5

50 Minute Lab Period

Objectives

1. Using writing as a process for discovery and synthesis of inquiry.
2. Modeling many enduring functions of scientists; recording information and data, creating experimental diagrams, forming associations and connections to other learning, and asking thoughtful questions.
3. Improving your ability to organize ideas and information to provide a study reference for each unit, as well as a resource to consult for review prior to tests.

Science and Engineering Practices:

1. Asking questions and defining problems.
2. Developing and using models.
3. Planning and carrying out investigations.
4. Analyzing data.
5. Using mathematics and computational thinking.
6. Constructing explanations and designing solutions.
7. Engaging in argument from evidence.
8. Obtaining, evaluating, and communicating information.

Introduction:

Keeping a science notebook encourages students to record and reflect on inquiry-based observations, activities, investigations, and experiments. Science notebooks are also an excellent way for students to communicate their understanding of science concepts, and for teachers to provide students with feedback.

A science notebook is a strategy for students to record and reflect on inquiry-based observations, activities, investigations, and experiments to increase their understanding of science instruction. Students will use them to communicate their understanding of science concepts to their peers, and for teachers to provide students with feedback on their learning. Student scientists record their observations, ideas, drawings, and other illustrations such as charts, tables, models, and graphs, along with their questions, ideas, and reflections in a running record of their thinking. The same as a scientist would do in a lab.

As a science teacher, I individualize the science notebook organization to the grade level, student interests, abilities, and needs. Here is the makeup of the science notebook that I use.

Materials: composition book or single subject, spiral notebook. I prefer the composition over the spiral because sheets will not be easily torn out. Pencils, pens, markers and crayons. Heavy duty drawing paper or card stock cut to the size of the composition book and stick glue.

Procedures:

Setting up the science notebook.

1. Pass out the blank drawing paper or cardstock. Students write their name, group number, if you use groups and homeroom class at the top. Allow students to draw a science related cover. They can color it and glue this to the front of their composition book.
2. Inside the first page will be divided into three columns. Each column is titled as date, activity, and page number.
3. Skip to the next page on the right and guide students to write the numbers 1-10 on the front of the pages only; starting at the top right corner. This helps to organize students to complete page by page.

4. Headings such as focus questions, hypotheses, objectives, reflections are printed at the top of each page as they investigate science objectives.
5. Tables, measurements, conversions, equations, formulas, facts, etc. are always added to the sequence order of the pages. Best practice is to have those with the activity itself.
6. Glossary: Alphabetical list of new vocabulary and definitions. This is the last 14 pages in their notebook. I fold the pages ahead of time for the students and walk them through the organization of science vocabulary. The first page will be titled Science Vocabulary and Definitions. The front side of the paper, the letters of the alphabet will be listed at the top. A on one side of the column and B on the other side. Continuing until X and Z are completed.
7. Create a word/definition wall with words learned to add to glossary. Students can write the definitions, create drawings, diagrams, models, charts, graphs, and so on to understand the word.
8. I keep all science notebooks in a dish pan for easy access and distribution.

Lesson #2

How Well Do You Wash?

Written for Elementary Science Grades 2-5

50 Minute Lab Period

Objectives:

1. Understand the impact of germs and bacteria on their health.
2. Conduct an experiment to test their hypothesis.
3. Calculate the percentage of germs on hands before and after hand cleaning methods.
4. Analyze class results to determine the best method of cleaning hands before and after food preparation and consumption.
5. Recognize the importance of maintaining food safety in the Science lab and at home.

PA Science Standards:

4.4.3.A. Identify Pennsylvania crops that provide food for the table.

4.4.4.A. Describe the journey of local and global agricultural commodities from production to consumption.

4.4.8.A. Identify and describe how food safety issues have impacted food consumption.

Science and Engineering Practices:

1. Asking questions and defining problems.
2. Developing and using models.
3. Planning and carrying out investigations.
4. Analyzing data.
5. Using mathematics and computational thinking.
6. Constructing explanations and designing solutions.
7. Engaging in argument from evidence.
8. Obtaining, evaluating, and communicating information.

Vocabulary: Germs, Bacteria

Materials: Lab sheet, Fluorescent yellow hi-lighter, UV flashlight, Glo-Germ Gel, "Wet Ones" Antibacterial hand wipes, Liquid soap, Hand Sanitizer Gel, and Access to a sink with running water.

Introduction:

1. Have students look at their hands. Ask students, "What have you touched today?"

Then ask students, "Are your hands really clean?"

Procedures:

1. Read: *Germs Are Not for Sharing*, by: Elizabeth Verdick. (Grade 2)
2. Read: *Food Safety,* Chapter 3, by: Christine Taylor-Butler (Grades 3-5)
3. Discuss Germs and Bacteria, write student responses on chart paper.
4. Ask students, "What happens if we have germs on our hands and then eat food with our hands?" Then ask, "how can we protect ourselves?"
5. Inform students of the four different types of hand cleaning methods. (Antibacterial hand wipes, Hand Sanitizer Gel, Plain Warm Water, and Liquid Soap with Warm Water.)
6. Have students predict which method they believe will be the most effective at removing germs and bacteria from their hands.
7. Discuss the way to show percentages on their lab sheet.
8. Students, with the help of the teacher, add 1 drop of Glo-Germ lotion to their palm and have them rub the lotion over the front and of their hands and between their fingers and nails.
9. Darken the room and shine the UV flashlight on each student's hands.
10. Students observe their hands, then use the fluorescent yellow highlighter to mark where the germs "Glowed" on their hands lab sheet.
11. Determine the percentage on your hands covered with Glo-Germ percent on the lab sheet.
12. Assign each group of four students one of the following cleaning methods:
13. Wipe hands with Antibacterial Hand Wipes for 20 seconds.
14. Wipe hands with Hand Sanitizer Gel for 20 seconds.
15. Wipe hands with Plain Warm Water for 20 seconds.
16. Wipe hands with Liquid Soap with Warm Water for 20 seconds.
17. When treatment methods have been completed, darken the room again and shine the UV flashlight on each student's hands.
18. Students observe their hands, then use the fluorescent yellow hi-lighter to mark where the germs remained on their hands lab sheet.
19. Determine the percentage on your hands still covered with Glo-Germ percent on the lab sheet.
20. Do the Math – Subtract percentage before treatment from after treatment to determine percentage removed. Record on your lab sheet.
21. Collect results and students present their findings to the class in word form.

How Well Do You Wash?

Scientists   Day ______ Date ___/___/____

Group Leader ____________________ Reporter ____________________

Materials Manager #1 ___________________ Materials Manager #2 __________________

How Well Do You Wash?

Are your hands really clean?

Good hand washing can control the spread of germs and bacteria, which can cause illness.

How well are you doing at washing your hands?

Your task is to test one of four different hand cleaning methods. You will determine the most effective hand cleaning method.

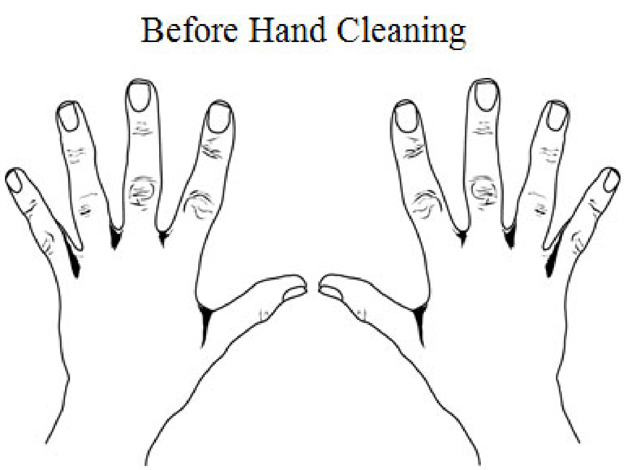
Problem (What question do you want to answer?)

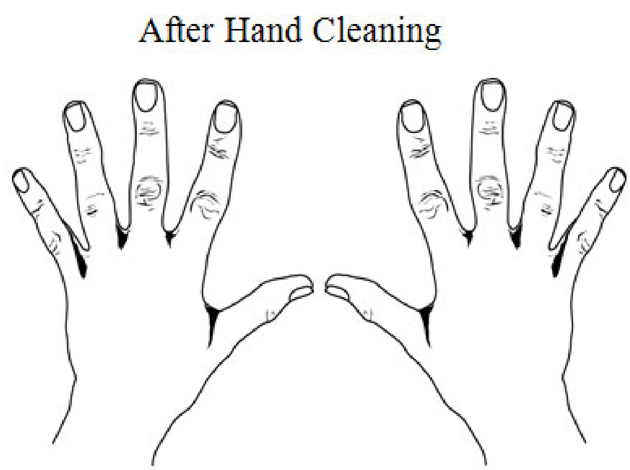
Materials (What do you need to do your experiment?)

Hypothesis (What do you think will happen?)

Procedure (What steps must you follow to do the experiment?)

Observations (What do you see happen during the experiment?)





Hand Cleaning Method	*% covered **before** hand cleaning*	*% covered **after** hand cleaning*	*% removed*	*Class Average % removed*
Antibacterial Hand Wipes, 20 seconds				
Hand Sanitizer, 20 seconds				
Plain Warm Water, 20 seconds				
Liquid Soap with Warm Water, 20 seconds				

Conclusion (What did you learn/discover from the experiment?

Lesson Plan #3

How to Check the pH Level in Sauerkraut?

Written for the Elementary Science Grade 2-5

50 Minute Lab Period

Objectives:

1. Students will investigate the pH of sauerkraut.
2. Students will design and carry out the investigation of sauerkraut pH and visually illustrate the steps.
3. Students will be able to observe the color changes produced by pH indicator in solution of sauerkraut and juice.

PA Science Standards:

4.4.3.A. Identify Pennsylvania crops that provide food for the table.

4.4.4.A. Describe the journey of local and global agricultural commodities from production to consumption.

4.4.8.A. Identify and describe how food safety issues have impacted food consumption.

Science and Engineering Practices:

1. Asking questions and defining problems.
2. Developing and using models.
3. Planning and carrying out investigations.
4. Analyzing data.
5. Using mathematics and computational thinking.
6. Constructing explanations and designing solutions.
7. Engaging in argument from evidence.
8. Obtaining, evaluating, and communicating information.

Vocabulary: Written on chart paper.

Acid-substance that has a pH less than 7.

Base-substance that has a pH greater than 7.

Indicator-compound that changes color depending on the pH of the solution it is in

pH-measure of the acidity or basicity of a substance, a pH of less than 7 is acidic (lower number = more acidic) and a pH of greater than 7 is basic, in general the scale goes from 1 (very acidic) to 14 (very basic)

Materials: Safety goggles, pH test paper, clean trays, teaspoon, small blender, food safety gloves.

Procedure:

1. Discuss with students that pH indicators are compounds that display different colors in different pH

conditions. Briefly review pH, acids and bases, and pH indicators.

2. Work with students to design a valid investigation like the one outlined in this lesson plan to determine the pH of sauerkraut.
3. Work with students to develop questions to investigate. Ensure that students outline the steps of their procedure carefully. Some good leading questions include the following:
4. How do we determine what the pH of a sauerkraut?
5. Can we make some predictions about the materials that we are going to test?
6. A general procedure that could be used is as follows:
7. Students place a clean tray in their group.
8. Students can take samples of the sauerkraut and juice to puree.
9. Students can test the pH and use the chart that comes with the indicator to determine the pH of sauerkraut.
10. Have the students illustrate their observations from this experiment.
11. Students can determine approximate pH values from the color chart provided with the commercial pH indicator and use this information to determine which solutions are acidic (pH < 7), which are basic (pH > 7) and which are neutral (pH = 7).
12. Students can draw conclusions about the acidity of certain types of solutions (cleaners, foods, drinks) and their uses.
13. After the students have finished their investigation, they may present their findings to their classmates and compare their results with those of their classmates.

How to Check the pH Level in Sauerkraut?

Scientists   Day ______ Date ___/___/____

Group Leader ____________________ Reporter ____________________

Materials Manager #1 __________________ Materials Manager #2 _________________

Student Hypothesis or Question:

Materials:

Safety Precautions:

Procedure: What are the steps?

Wear Safety Goggles for all lab work.

____

Illustrate your steps.

Observation of the pH paper:

Conclusion:

Appendix

Implementing District Standards

Connecting Food Preservation: From Edible School Garden to Science Table lessons to Pennsylvania Academic Standards for Environment and Ecology and the Common Core State Standards

The Common Core State Standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in life. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy. Pennsylvania Department of Education has not adopted Common Core Standards for Science.

Pennsylvania Science Standards for Environment and Ecology. The follow is acceptable for my unit.

4.4.4.A. Describe the journey of local/global agricultural commodities from production to consumption.

4.4.4.B. Describe how humans rely on the food and fiber system.

4.4.3.B. Explain how agriculture meets the basic needs of humans.

4.4.3.C. Use scientific inquiry to investigate what animals and plants need to grow.

4.4.4.D. Identify how technology affects the development of civilizations through agricultural production.

Next Generation Science Standards also has appropriate standards that meet my unit's needs.

2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

5-PS1-2. Develop a model to describe that matter is made of Particles too small to be seen.

5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Food Preservation: From Edible School Garden to Science Table lessons embrace the idea of preparing young students to be ready for the real world. Part of the world they are inheriting is a world with a food system that is threatening both our personal health and the health of the natural environment. My intention for this unit was to inspire students like *Ja'lynn* to use food and our current food system as a topic in the preservation of food.

Footnote: http://static.pdesas.org/content/documents/academic_standards_for_environment_and_ecology.pdf