Archaeology

Fifth/Sixth Grade

Unit Rationale:
This unit will focus on scientific archaeology. Students will learn how archaeologists investigate ancient people by studying artifacts.

Session One
Focus On: Welcome to Science Club for Girls
The girls will be introduced to the structure and rules of clubs. They will learn what archaeologists do and how archaeology is distinct from other fields that study the past.

Session Two
Focus On: Digging Trash and Dating
This session will focus on two main activities of archaeologists—dating artifacts and interpreting ancient trash. The girls will perform dendochronology, or dating with tree rings. They will analyze modern trash to learn about the people who made it.

Session Three
Focus On: Bones and Stones
Students will learn what bones are made of and how fossils form. They will make trace fossils and turn solid bones into rubbery bones.

Session Four
Focus On: Fossils Footprints
Archaeologists can calculate the height of ancient peoples based on fossil footprints. Students will develop a formula for estimating height based on their own footprints.

Session Five
Focus On: Ancient Diets
Students will learn how archaeologists reconstruct ancient diets. The girls will test the marks that different foods leave on teeth or tools and they will dissect owl pellets.

Session Six
Focus On: Inka *khipu*
The girls will construct *khipu*, knotted ropes used to encode information by the Inka civilization.

Session Seven
Focus On: Rope Bridges and Mummies
Students will reinvent two technologies of ancient peoples: Inka rope bridges and Egyptian mummies.

Session Eight
Focus On: Mummy Wrap-up and Science Fest prep

Session One
Focus On: Welcome to Science Club for Girls

About This Session: The first half of this session will introduce girls to the structure and rules of clubs. Mentor scientists, junior mentors, and students will introduce themselves. The girls will make posters that distinguish the fields of archaeology, paleontology, geology, and history.

The girls will:

1. Create rules and expectations for club.
2. Distinguish between the materials and time periods studied by archaeologists, paleontologists, geologists, and historians.

Materials Needed for Session:

Activity One: Welcome to Science Club for Girls		
Per Club	**Per Group**	**Per Girl**
Club Expectation Poster		
Whiteboard Markers		
Activity Two: Introduction to Archaeology		
Per Club	**Per Group (4 girls)**	**Per Girl**
	Oak tag	
	Glue sticks	
	Scissors	
	Pictures or magazine clippings of things studied by geologists, paleontologists, archaeologists, and historians	

To do before Science Club begins:

- Be sure that someone from Science Club for Girls (Site Coordinator or you) notifies any nearby school personnel of what you will be doing. Sometimes, the crayons can give off a little smoke or smell, and you don't want anyone thinking there is an emergency.
- Find out from your Site Coordinator what additional first-day activities will be occurring at your site. (All-club assembly? Name game? Etc.) This will vary from site to site.
- Discuss with your mentoring team who will be responsible for what portions of the session and prepare in advance of clubs.
- For Activity 2 you will need a collection of magazine or internet pictures of things studied by the fields of geology, paleontology, archaeology, and history. Make sure that each group has a different assortment of pictures and 3-4 pictures for each field. Possible pictures could be: **geology-** rocks, minerals, river, mountain, volcano, ocean, the Earth, desert; **paleontology**- any bones, dinosaurs; **archaeology**- pottery, bones, pyramids, stone tools, mummies, beads; **history**- castle, books, kings, battle scene, car**.**

Question of the Day:

What is archaeology? What do archaeologists study?

Activity One: Setting the Tone (15 minutes)

Set the tone and create rules together that all the girls agree to follow.

1) Get the girls' attention and make sure they are clearly focusing on you. Explain to them that before they can do any science experiments, they must all agree to follow the three rules of Science Club. Introduce the **Code of Conduct. These are the 3 expectations that Science Club for Girls expects all participants to follow.** Guide the girls to create more specific rules and write these under each code of conduct. Ask the girls probing questions like, "Why do you think this is a rule we've made?" Or "What do we mean when we say to be safe in Science Club for Girls?" The girls will offer very directive and obedient rules like, "No touching dangerous materials." Or "Don't talk when the teacher is talking." Think of ways to consolidate these so that you don't end up with a long list of "do's and don'ts." Add these to the Code of Conduct so that the girls have a voice in the rules as well.

Be sure the girls are calmly sitting in a circle or at desks. Ask the Junior Mentors to sit with the girls as well. They may have a tendency to sit separate from the girls and sit with each other, but get them mixed in right away.

2) Once done, ask the girls to put their "thumbs up" to signify that they agree to follow the rules. You can also have all the girls sign the rules sheet. Whatever you do, be sure that you have all the girls physically show that they can agree to follow the rules. You'll need this as back up as the sessions go on!

3) At this point, explain to the girls the consequence of *not* following a rule. KNOW THE SCFG DISCIPLINE POLICY. Make sure they know that not following rules can result in a call home, being taken out of Science Club and that it also makes the club less fun because they might not be able to do all of the fun projects if people were to act up. This is not used to scare the girls, but rather, a strict (and strictly enforced) discipline policy is a regular part of an afterschool program due to the nature of kids' energy after 7 hours of school. It's like showing them the boundaries of a box. Free to roam anywhere within the box, but always knowing where the boundaries are set.

4) Now, explain to the girls the benefit of following the rules. (Best to have a reward policy already decided among co-Mentors.)

A great way to continue to involve the girls is to ask them, "What happens when rules aren't followed? What happens when the rules *are* followed?" "Do groups have more or less fun when rules are followed?"

☑ Watch the clock. Be aware of the time since it is your first day.

5) Now, clearly go over the basic routine of the club. This involves:

- Where they meet each day there is SCFG. (Cafeteria? Classroom? Gym?)

- What they are to do when entering the classroom (Sit on the rug? at a table? sit in a circle? some tables off limits? Get their journals from the bin?)
- How you will show that you are ready to begin. (Hands-up? Peace signs in the air? Clapping rhythm?)
- Recite the pledge (required for Clubs Grades K-3)
- Review how the club will end each session for reflection time (return to sitting on rug, back to tables? All areas cleaned up?)

Your Pledge can be found on the back of the Code of Conduct or in the Volunteer Handbook.

Make sure the girls hear the routine that you and your co-Mentor have agreed upon so they can begin to follow it.

6) Before moving on, spend a few minutes introducing your Junior Mentors to the girls as well. Be sure the girls know:

- The Junior Mentors' names
- The Junior Mentors will be helping everyone in the club
- If the JMs ask the girls to do something, the girls should listen and do it
- That the JMs are a part of the club too!

7) Lastly, before moving to the next activity, make sure the girls understand a few things that are important to know over the course of the semester:

- Their science/topic for the semester that all projects will relate to.
- The type of scientist they are (Physicists, Biologists, Chemists, Engineers, etc.)
- At the end of the semester, the entire site will have a Science Fest and each club will teach others about what they learned. ➔This is a major point even for kindergarteners to grasp. Your girls should be reminded throughout the sessions that they will teach and lead others including parents.

Activity Two: Introduction to Archaeology

Age-Appropriate Vocabulary:

1) **Artifact**- an object made by humans
2) **Context**- the place where an artifact was left by past people and found by archaeologists
3) **Conservation**- preserving ancient remains for the future

Introduction to Activity:

Discuss what the girls already know or think about archaeology. Distinguish archaeology from other fields that study the past. The goal of this introduction is to clear up any misconceptions the girls may have about archaeology as well as to get them excited about studying the field this semester!

Instructions:

1) Ask the girls if they know what archaeology is. See if they are familiar with any famous sites, people, or times such as the Egyptian pyramids, the Romans, or the Ice Age. Some of the girls may have visited archaeology sites or museum exhibits.
2) After finding out what the girls already know, clarify the following points:

   a) Archaeologists study *artifacts* (human made objects) to answer questions about people in the past. They usually find the artifacts underground and the lower they dig, the older the artifacts.

   b) Archaeology is a meticulous science, not high-adventure treasure hunting. Archaeologists do not take artifacts from their original *context* (the place where an artifact was left by past people and found by archaeologists) without careful documentation. Because you can only dig up artifacts once, archaeologists must write down everything about the excavation process so that people in the future can study it again. No one should dig up artifacts without a team of archaeologists. We dig up artifacts to learn about people in the past, not to find treasure. *Conservation* means taking care of the artifacts so that they last for people to see and study in the future.

3) Distinguish between geology, paleontology, history, and archaeology. Each group explores the past, but with different focuses, evidence, and time scales. Geologists use rocks to study the history of the Earth, from its beginning billions of years before humans. They try to explain how features of the Earth like mountains, rivers, and deserts were formed. Paleontologists study fossil bones of past creatures, including dinosaurs. Archaeologists also study bones, but only from times and places where people lived. Archaeologists also study artifacts and ancient buildings or monuments. Historians study more recent time by reading written documents.

4) Pass out a piece of oak tag paper (11x17) to each group. Tell them to make four columns (landscape) and draw an arrow along the bottom of the page showing the direction of time. They should label the columns: geology, paleontology, archaeology, and history in the order of the time periods each studies. Give each group an envelope full of pictures and have them glue the pictures into the proper column based on which field would study them. If a picture could be studied by two fields (eg: a bone could be studied by paleontologists or archaeologists) have them glue it on the border between columns.

Reflection:

Please ask the following questions. If you have time, discuss these questions further before the girls write in their journal.

- What do archaeologists study?
- How did you decide which pictures belonged to each category?

Session Two
Focus On: Digging Trash and Dating

About This Session: The girls will perform two main activities of archaeologists—dating objects and interpreting ancient trash. They will learn how archaeologists can date materials with tree rings. In Activity 2, students will investigate modern trash to learn what the objects can say about the people who used them.

The girls will:

1. Determine the age of a tree stump, house, and barn by the dating method of dendochronology, or tree-ring counting.
2. Infer what people were doing based on a collection of their trash.

Materials Needed for Session:

Activity One: Dendochronology		
Per Club	**Per Group (1-5 depending on number of tree stumps)**	**Per Girl**
	Slide of tree stump	The Stump worksheet
	Tracing paper	Ring pattern for tree core, barn, and house
	Sharpie	Scissors
Activity Two: Modern Trash		
Per Club	**Per Group**	**Per Girl**
	Grocery bag of modern trash from a specific room	Archaeological Thinking worksheet
Activity Three: Puzzle Pieces		
Per Club	**Per Group**	**Per Girl**
		Puzzle Pieces worksheet

To do before Science Club begins:

- Put together bags of modern trash from different rooms such as the kitchen, bathroom, and office. There should be one bag for each room and group of 3-4 girls. Break some of the objects so that they are more difficult to identity. Use sanitary trash or give the girls gloves.
- There will probably not be enough time for Activity Three, but this can be done at home. You can review the answers the next week and give the girls prizes or recognition for completing it.

Question of the Day:

How do archaeologists use artifacts to learn about past people?

Activity One: Dendochronology

Age-Appropriate Vocabulary:

1) **Dendochronology**- a method of dating materials by counting tree-rings

Introduction to Activity: The girls will learn one way that archaeologists know how old things are. Wooden artifacts and structures can be dated by dendochronology, or determining age based on tree-rings. Students will use pictures of tree cores to date a barn and house.

Instructions:

1) Explain that archaeologists need to know how old bones, artifacts, and monuments are. They use different methods of dating depending on the material and age. Wooden materials as old as 9000 years can be dated by *dendochronology*, the science of counting tree-rings to determine age. Ask the girls if they know anything about tree rings and the age of trees.

2) Pass out tree stump slices (one per girl if available, or one per small group). Ask if they know anything about the rings. Explain that trees get a new ring every year so by counting the rings you can tell how old a tree is. Each year a tree's ring has two parts. A wide, light colored part forms during spring/summer and a think, dark part forms during fall/winter. The rings will vary in width depending on weather differences from year to year. For instance, more rainfall and a longer spring will produce a wider light ring. Trees growing in the same area will have the same pattern of rings because they all experience the same weather conditions.

3) Have the girls complete the questions on "The Stump" worksheet, using their tree cores. They can label the rings with a sharpie if it helps.

4) Archaeologists match ring patterns to determine the age of wooden materials. They use a tree core of known age and match it to a wooden artifact of unknown age. To do the matching they make diagrams with a line in the place of every tree ring and then they align the diagrams. Have the girls place tracing paper over their stumps and mark a line at each ring, to make a horizontal diagram of rings (see examples belong).

5) Tell the girls to imagine that they found an ancient barn and house and want to determine their ages. They have sample of the wood from both structures and need to determine the age by comparing the ring pattern to that of a tree core. The tree died in 1985, so the last ring on the tree core represents the year 1985. Compare the tree core pattern to the barn and house pattern to determine the age of the structures.

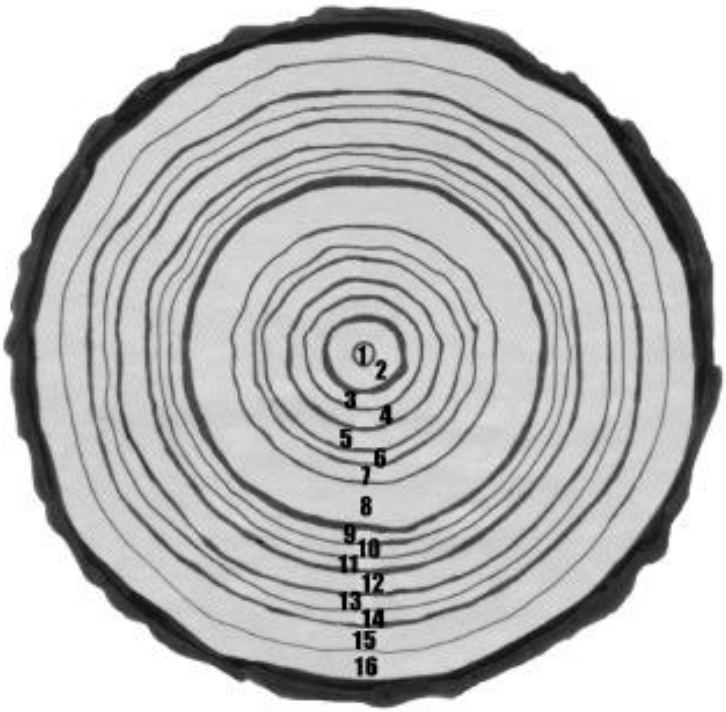
6) Pass out the ring patterns of the tree, barn, and house. The girls will have to cut out the patterns and line them up. The house and barn will start somewhere along the tree core. The start of the overlap is the age of the structure. They will have to count back rings to the start of the overlap to determine the age of the structures. They should conclude that the barn was built in 1664 and the house was built in 1655 (note: the tree

core will not extend back far enough for the house, but the house overlaps with the barn, which overlaps with the tree core. The girls will have to make a sequence of all three patterns to determine the age).

From: *Intrigue of the Past: North Carolina's First Peoples.* Lesson 2.4: Tree-Ring Dating. http://rla.unc.edu/lessons/Menu/title.htm

The Stump

Name:



This tree was cut 3 years ago. Write that year:

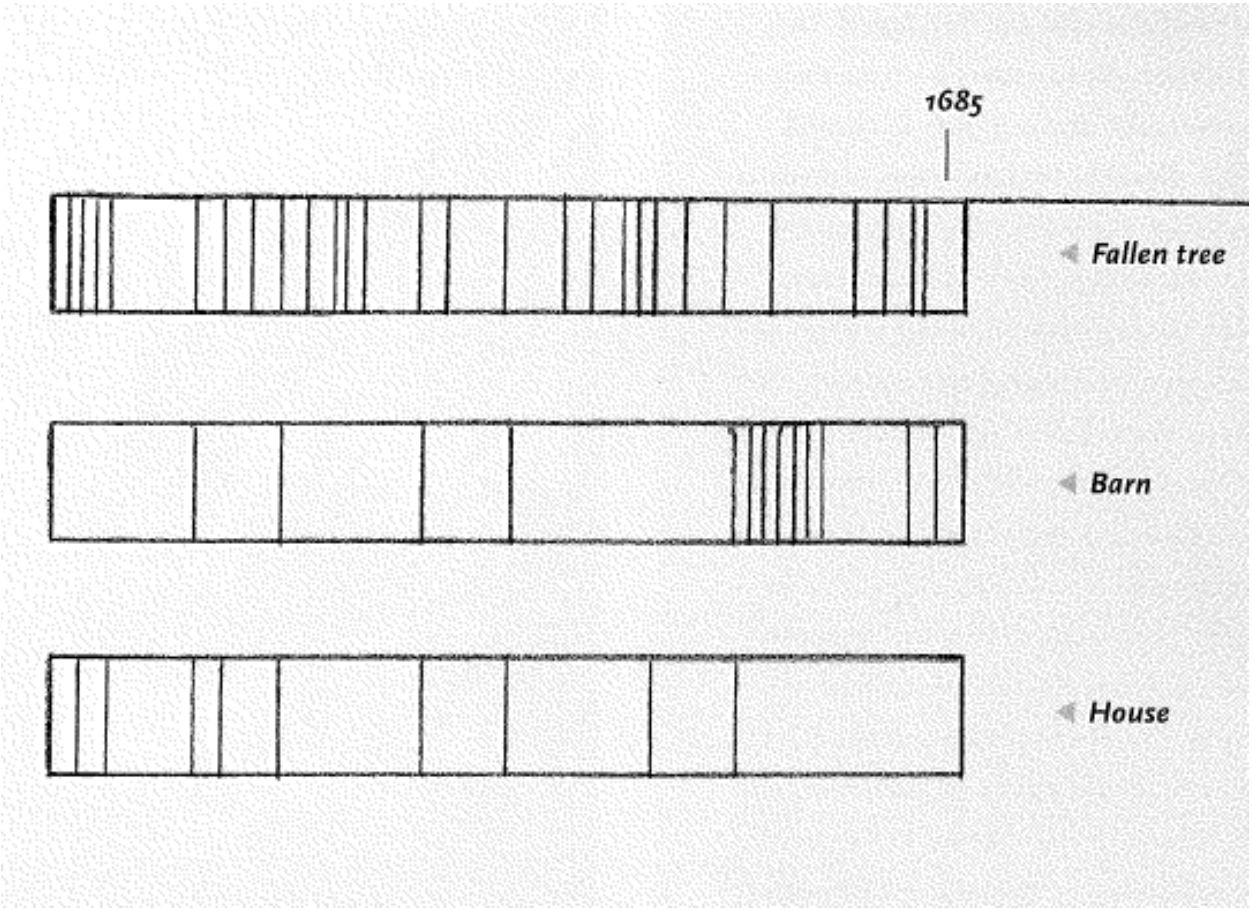
How old was the tree?

What year did the tree start growing?

Find the ring that grew the year you were born. Was it a wet or dry year?

In what year of growth was there the least rainfall?

In what year of growth was there the most rainfall?



From: Panchyk, Richard. *Archaeology for Kids: Uncovering the Mysteries of Our Past*. Chicago Review Press, Incorporated. Chicago. 2001: pg 113

Activity Two: Trash Collectors

Age-Appropriate Vocabulary:

1) **Assemblage**- a collection of artifacts found together

Introduction to Activity: Archaeologists rarely find exquisite art and artifacts. They mostly collect ancient trash! You will pretend to be archaeologists from the future interpreting artifacts from the present year. You have just dug up a typical house. Different types of artifacts were found in different spaces or rooms in the house. Based on the artifacts we will determine what happened in that space. The artifacts look like trash because they are trash! Archaeologists mostly dig trash because that is what people leave laying around when they move or abandon a house.

From "Lesson One: Archaeological Thinking" from ***Art to Zoo*** *Decoding the Past: The Work of Archaeologists*. November/December 1995. Smithsonian Institution.

Instructions:

1) Divide the girls into 4 groups and provide each group with a bag of artifacts found in a different place in the house. Give each girl a copy of the worksheet Archaeological Thinking.
2) Ask the girls to open the bags and examine each artifact. They should record what each object is made of and how it may have been used on the worksheet. The JMs and Mentor Scientists can provide hints with difficult objects.
3) After the girls have identified the objects, tell them to think about the *assemblage*, or collection of artifacts found together. Ask them to hypothesize where these objects were found and what people did there. What can they say about the people who made the trash? Were the people old, young, male, female, students, business people? Some objects may offer specific identification like an addressed envelope or a dated newspaper.
4) Conclude the activity by having each group share their assemblage with the class. Each girl can present an artifact and someone can explain where they think they assemblage is from.

ARCHAEOLOGICAL THINKING

Object	What it is made of	What it is used for	Sketch

Activity Three: Puzzle Pieces

Introduction to Activity: Archaeologists discovered more artifacts from the present time. They drew diagrams of the objects and wrote descriptions. The girls will use these field notes to identify the function of the artifacts. You probably will not have time for this activity, but the girls can do the worksheets at home.

From "Lesson Three: Puzzle Pieces" from ***Art to Zoo*** *Decoding the Past: The Work of Archaeologists*. November/December 1995. Smithsonian Institution.

Instructions:

1) Give each girl a copy of the worksheet Puzzle Pieces. Explain that the drawings only show pieces of artifacts because archaeologists usually only find pieces of larger objects. It is rare to find an unbroken, full artifact.
2) Ask the girls to complete the worksheet (be aware that they may not have seen Object 2—a floppy disk—or Object 6—a cassette tape—before!).
3) Discuss what they think each artifact is and what features from the drawing or descriptions led them to their conclusion. If you can bring in examples of the real objects it might help!
4) The answers to the worksheet are below:
   Object 1: Television remote control
   Object 2: Floppy disk
   Object 3: Door key
   Object 4: Fragment of a fork
   Object 5: Base of a light bulb
   Object 6: Portion of a cassette tape
   Object 7: Telephone/Ethernet plug
   Object 8: prong to an electrical cord

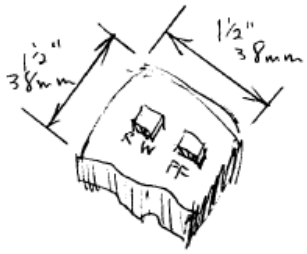
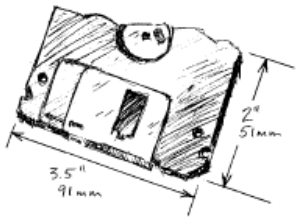
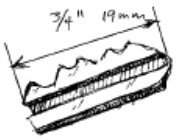
Science Club for Girls

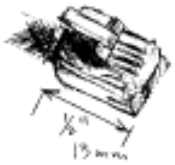
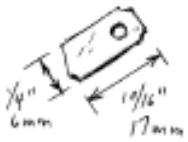
TAKE-HOME PAGE
Puzzle Pieces

To the teacher
- Duplicate this page for students.
- Use with Lesson Plan Step 3.

Publication of *Art to Zoo* is made possible through the generous support of the Pacific Mutual Foundation.

Directions: Imagine you are an archaeologist in the future. Because you are an expert on objects from the late twentieth and early twenty-first centuries, you have been asked to identify several artifacts found in a recent excavation. Compare the sketch of each object to examples you have in your own "collections" at home or at school.

Object	Description	What is it?
	**Object 1** Fragment of black plastic object with two rubber buttons. The writing below the buttons is difficult to read. The letters "FW" and "RW" are visible under two of the buttons.	
	**Object 2** Fragment of gray plastic and shiny metal. Square in shape with movable metal piece near bottom. Portion of a circular metal piece at the top of the object.	
	**Object 3** Fragment of highly polished, silvery metal. Several different notches along the top edge. Deep groove in side of object.	
	**Object 4** Metal object with two long prongs. The prongs have sharp points.	

Object	Description	What is it?
	**Object 5** Intact rounded object with grooves and black ceramic case. Glass fragments attached to object. Glass fragments may have been part of a larger glass globe.	
	**Object 6** Plastic spool with a long, thin, brown plastic strip wound around it. The spool has six notches and a groove to attach it to the end of the plastic strip.	
	**Object 7** Small, square, clear plastic object. Bendable plastic strip attached to object at one end. Gray cable with four colored wires (yellow, black, green, and red) attached to other end of object. Wires visible as they lead into the square, clear plastic.	
	**Object 8** Small, shiny, metal object with round hole in the side of one end. Two of these objects were located near each other.	

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Reflection:

Please ask the following questions. If you have time, discuss these questions further before the girls write in their journal

- Why is it important to know how old things are in archaeology?
- Why do archaeologists look at ancient trash?

Next Week:

Tell the girls that if they have any fossils at home they can bring them next week to share.

Session Three
Focus On: Bones and Stones

About This Session: Bones are made of rock-like mineral and soft organic material. When bones become all mineral, they become fossils. Bones can also become all organic, and then they become soft and rubbery. Students will make fossils and rubbery bones in this lesson.

The girls will:

1. Make trace fossils.
2. Dissolve the mineral component of bones to isolate the organic portion.

Materials Needed for Session:

Activity One: Fossil Making		
Per Club	**Per Group**	**Per Girl**
	Plaster of Paris	Plasticene modeling clay (enough to cover base of bowl at least 3 cm thick)
	Water	Disposable bowl
	Container for mixing above Petroleum Jelly	Shell, leaf, or something to imprint as a fossil
Activity Two: Rubber Bones		
Per Club	**Per Group**	**Per Girl**
	Vinegar (enough to fill glass jars of each girl)	Chicken bone Glass jar with lid Litmus paper

To do before Science Club begins:

- If the JM or Mentor Scientists have any fossils at home they should bring them in to share. You should also ask the girls the week before if they have any fossils to share.

Question of the Day: What are bones made of? How do fossils form?

Activity One: Fossil Making

Age-Appropriate Vocabulary:

1) **Fossil**- a rock that takes on the shape of something that was once alive like a bone or leaf
2) **Trace fossil**- a fossil of an impression left by a creature like a footprint

Introduction to Activity:

Bones are made of hard rock-like mineral and soft *organic* material. *Organic* materials are made of cells and only found in living creatures. The mineral part of bone is a rock, mostly made of Calcium. When organisms die most of their bodies decompose. However, sometimes bones become all mineral and loose the organic portion. When a bone becomes all rock, it is a *fossil* and preserves forever (or at least for billions of years).

Bones turn into fossils, but fossils can also form from the impression an organism makes in mud or other soft sediment. This is called a *trace fossil*. There are trace fossils of leaves, soft creatures without bones, and footprints. We will make trace fossils.

Instructions:

1) Explain to the girls that fossils are rare. In nature organisms usually decompose and disappear because other animals eat their remains. First carnivores eat the big parts, then bacteria eat what is left. However, if a plant or animal dies and is quickly buried, the soft parts will turn to rock known as a fossil. If an organism makes an impression like footprints in mud, which is quickly buried, a fossil will also form of that shape. This is how geologists, paleontologists, and archaeologists know about creatures that lived millions and billions of years ago.
2) Give each student and bowl and have them cover the inner base with at least 3 cm of modeling clay. As they are doing this, prepare the plaster of Paris. The directions will probably say to add 2 parts plaster to 1 part water, but this is too much water. Start with the plaster and gradually mix in water until the paste is the consistency of cake batter.
3) Each student should imprint an organism like a shell or a leaf into the modeling clay. They should then cover the clay surface with a thin layer of petroleum jelly without erasing the impression. Pour plaster of Paris over the imprint so it is covered to about 3 cm thickness.
4) The fossils may dry by the end of clubs if girls work quickly. If they are dry (they will be rock solid), peel the plaster away from the clay and bowl. The plaster is the trace fossil. If the fossils are not dry by the end of clubs, save them for next week.

Activity Two: Rubbery Bones

Introduction to Activity:
Fossils form when the organic part of a bone disappears and only the mineral remains. The opposite can happen as well. If bones are exposed to acid, the mineral will dissolve and only the soft organics will remain, so the bones will be rubbery. Soft, organic bones will not preserve for long. However, archaeologists need to make organic bones in order to do tests like carbon dating or DNA analysis. The mineral portion gets in the way of these tests. Students will dissolve the mineral of chicken bones to isolate the organic portion.

Instructions:

1) Give each girl a chicken bone and jar.
2) Instruct students to feel how hard the bone is and note this observation in their journals.

3) Next they should put the bone in the jar and fill it nearly to the top with vinegar. Explain that vinegar is a weak acid. Bones are exposed to acid in nature through acid rain. In laboratories scientists expose bones to stronger acids, which dissolve the mineral faster. It will take about a week for vinegar to dissolve the bones. Litmus paper is a way to test how strong an acid is. They should dip a piece into the vinegar and record the acid strength in their journals. They can tape the Litmus paper in their journals as well.
4) Put the lids on and leave the bones until next week.

Reflection:

Please ask the following questions. If you have time, discuss these questions further before the girls write in their journal.

- Why are fossils rare?
- Why do archaeologists study fossils?
- What do you predict will happen to the bones in vinegar and why? What would happen if we used a stronger acid?

Session Four
Focus On: Fossil Footprints

About This Session: Archaeologists can estimate the height of ancient people based on fossil footprints. The girls will do this by painting their feet, striding across paper, and developing a formula that relates stride length to height.

The girls will:

1. Learn about pre-human bipeds.
2. Develop a formula that relates stride length to height in order to estimate the height of ancient people based on fossil footprints.

Materials Needed for Session:

Activity One: Bones and Stones Part II		
Per Club	**Per Group**	**Per Girl**
		Jar with chicken bone prepared from last week
		Journal
Activity Two: Footprints		
Per Club	**Per Group (2 girls)**	**Per Girl**
Roll of paper large enough to walk on	Measuring tape with cm	Paper, pencil
Tray of washable paint	Calculator	
Tray of warm soapy water Tray of warm water Towels		

To do before Science Club begins:

- In Activity 2 the girls will walk 5-6 steps on paper with painted feet. Before club or during Activity 1 fill the bottom of a disposable aluminum tray with washable paint. Unroll paper long enough for 6 steps. At the end have a washing station of trays of warm soapy water and warm plain water and then drying towels. If there are enough supplies you can have more than one walkway.

Question of the Day: *What can fossil footprints tell us?*

Activity One: Bones and Stones Part II

Introduction to Activity:
The mineral component of the chicken bones from last week should be dissolved, leaving a rubbery organic bone.

Instructions:

1) Redistribute the jars of vinegar soaked chicken bones. Instruct the girls to remove the bones and observe how they have changed. This activity can be done with all students at the beginning of clubs, or run by JMs as other students are doing the footprint activity.

Activity Two: Footprints

Age-Appropriate Vocabulary:

1) **Stride**- distance from the heel of the back foot to the toe of the front foot while walking
2) **Primate**- group of animals that includes humans, apes, and monkeys
3) **Biped**- an animal that walks on two legs most of the time

Introduction to Activity:

Most fossils are from before the time that archaeologists study. However, archaeologists are very interested in fossils of *primates* (group of animals that includes humans, apes, and monkeys) from about 10 million to 50,000 years ago, the period of human evolution. Humans and apes are like cousins. They have the same ancestors, or the same great-great-great-great-great… great-great grandparents. In the period 10 million to 50,000 years ago some primates began looking and acting more like humans and less like apes. The three main differences between humans and other apes are that humans have bigger brains, make tools, and walk on two legs as *bipeds*.

Archaeologists know that pre-humans were *bipeds* at least 4 million years ago because they have found fossil footprints. The most famous early footprints were found by Mary Leakey, one of the first female archaeologists. She found fossil footprints in Laetoli, Kenya made by Australopithecines, a group of pre-human primates that lived 4-2 million years ago in Africa.

The footprints told Mary Leakey more than the fact that Australopithecines were bipeds. She was also able to calculate about how tall the Australopithecines were based on their *stride* (distance from the heel of the back foot to the toe of the front foot when walking). The girls will use the same technique as Leakey to calculate height from footprints.

From: Panchyk, Richard. *Archaeology for Kids: Uncovering the Mysteries of Our Past*. Chicago Review Press, Incorporated. Chicago. 2001: pg 17

Instructions:

1) Have the girls partner up to measure and record their heights in cm.
2) Unroll paper long enough for 5-6 steps.
3) Have a girl remove shoes and socks, step into paint, and walk the length of the paper with normal steps. At the end of the paper have a JM or Mentor assist washing the girl's feet.
4) Repeat the exercise so that everyone's footprints are recorded. Multiple girls can go at the same time, but there should be a JM or Mentor at the beginning and end of each walkway to help with painting and cleaning of the girls' feet.

5) The girls should measure the distance of their strides in cm, from the heel of the back foot to the toe of the next. They should add the length of all strides and divide the total by the number of strides to get the average stride length.
6) Each girl should divide her height by her average stride length to get a magic number.
7) The girls should trade footprints, measure the stride length, and multiply by their magic number. Did they get the correct height? Explain that it is not an exact science, but human bodies have similar proportions between body parts. This is a good way to estimate height from just footprints.

Reflection:

Please ask the following questions. If you have time, discuss these questions further before the girls write in their journal.

- What can fossil footprints tell us about ancient primates?
- Did you get the correct height using your magic number on someone else's footprints? Why or why not?

Session Five

Focus On: Ancient Diets

About This Session:

The girls will:

1. Identify the marks that different foods make on a surface to detect ancient food use from tools or teeth.
2. Dissect owl pellets to determine what the owl ate.

Materials Needed for Session:

Activity One: Microwear		
Per Club	**Per Group**	**Per Girl**
	Block of florist foam imprinted by walnuts (about 6x2x2)	Smooth block of florist foam (about 6x2x2")
	Separate plates of walnuts (unshelled), granola, sunflower seeds, and pine needles	
Activity Two: Owl Pellets		
Per Club	**Per Group**	**Per Girl**
Glue	Bone chart	Owl pellet
		Dissection stick (wooden skewer) Paper
		Gloves (optional)

To do before Science Club begins:

- Softly grind a few blocks of florist foam on walnuts so that they leave an imprint on the blocks.

Question of the Day: How do archaeologists determine what people in the past were eating?

Activity One: Microwear

Age-Appropriate Vocabulary:

1) **Microwear-** microscopic marks made by food on teeth or tools

Introduction to Activity: A big question in archaeology is what different people were eating at different times. Archaeologists look at many forms of evidence to answer this question. Sometimes they find food remains like animal bones or seeds in ancient garbage. Some drinks like hot chocolate and wine leave chemicals on the inside of their containers. Another way archaeologists reconstruct diets is from *microwear*, or tiny marks made on tools and teeth by food. When you eat, foods leave microscopic pits and scratches on your teeth. The same thing happens when tools are used to cut or grind food. Different foods leave different marks so by looking at the *microwear* on teeth and tools archaeologists can guess what people were eating and cooking. We will test different foods to determine what made the microwear patterns on an artifact.

Instructions:

1) Explain that foods make tiny pits and scratches on teeth and tools (*microwear*). The marks on teeth are microscopic and disappear after about 5 days as new ones are made with every meal. By looking at the marks, a specialist can make inferences about a person's diet over the past 5 days. Archaeologists looking at ancient teeth see the marks made about 5 days before the person or animal's death. Similar marks appear on the tools used to cut and grind food, but these marks are often large enough to see with your eyes.
2) Show the girls images of microwear (below) and explain what foods made them. Have the girls describe the differences between marks made by grasses (long scratches) and marks made by seeds/nuts (pits). Point out that humans have a mixed diet so we see all kinds of marks on human teeth.
3) Pass around the block that you impressed with walnuts and ask the girls what kind of food they think made this mark. They should pretend this is an artifact found in the kitchen space of an ancient home.
4) Give each girl a block of florist foam. At each table put walnuts, granola, pine needles, and sunflower seeds on separate plates.
5) Tell the girls to grind different sides of their florist foam block on different plates of food. They should pretend to make chewing/grinding motions to mimic teeth or food processing tools (like a mortar and pestle or knife).
6) Ask the girls to determine which food made the mark on the unknown block based on their experimental blocks.

Activity Two: Owl Pellet Dissection

Age-Appropriate Vocabulary:

1) **Coprolite**- fossil poop
2) **Owl Pellet**- owl puke (regurgitated indigestible remains of an owl's food)

Introduction to Activity:
Another way that archaeologists determine ancient diets is by looking at *coprolites*, which are fossilized poop. It's not gross because feces turn into hard rocks after a long time. Archaeologists can dissect coprolites and look for tiny food remains like seeds and bones. We're not going to dissect coprolites, but something similar: *owl pellets*. When owls eat they swallow their mice and other rodents whole. They digest the soft parts and then throw up the waste like fur, bones, and feathers. The vomit is in little round packages called *owl pellets*. We are going to dissect owl pellets to see what the owls last ate. The girls will be able to identify specific bones using a bone chart.

It's best if each girl has her own owl pellet, but if there are not enough they can work in groups of 2-3. The kits usually come with dissection tools and a bone identification guide, but if not provide copies of the guide below and wooden skewers.

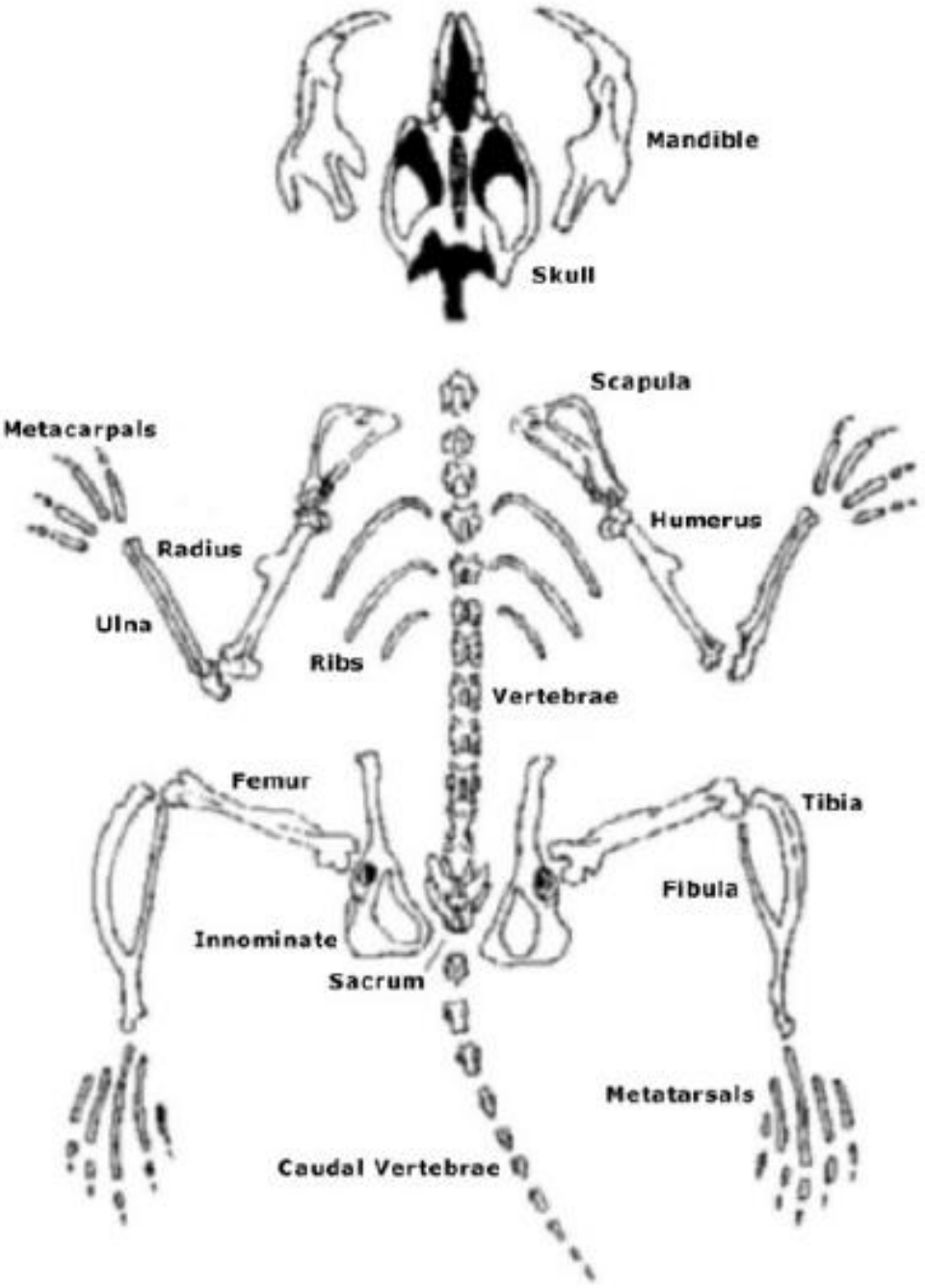
Instructions:

1) Explain to the girls that the owl pellets have been sanitized so they are safe to touch. If they are still worried they can wear gloves.
2) Give each girl a dissection stick (wooden skewers work well) and an owl pellet. The girls may need to share owl pellets if there are not enough. Tell them to carefully break the pellet apart and separate out the bones.
3) They should try to put the bones together to make an animal, using the identification guides provided in the owl pellet kits.
4) Have the girls determine what the owl last ate and glue down the bones onto a sheet of paper. They should label the identified bones.

Reflection:

Please ask the following questions. If you have time, discuss these questions further before the girls write in their journal.

- How did you figure out which food marked up the unknown block?
- What did your owl last eat?



Owl Puke

http://www.hometrainingtools.com/article.asp?ai=1244&bhcd2=1271352201

Session Six
Focus On: Inka *khipu*

About This Session: The girls will construct *khipu*, systems of knotted rope used to code information by the Inka people in ancient South America.

The girls will:

1. Learn who the Inka were and how they stored information in knotted rope.
2. Construct and read *khipu* that encodes a 3-item grocery list.

Materials Needed for Session:

Activity One: *Khipu* codes		
Per Club	**Per Group**	**Per Girl**
Pictures of *khipu* and sample		3 x 1 meter yarn (different colors) 1 x 1.5 meter length
Map of ancient civilizations		Shopping list

To do before Science Club begins:

- Cut different colors of yarn into 1 meter strands so that you have at least 3 per student. Cut a dull color of yarn into 1.5 meter strands, enough for 1 per student. Also make a stock of pendant cords to distribute if the girls are running out of time making pendants and need to move onto knot tying and coding.

Question of the Day: How can you store or code information without writing?

Activity One: *Khipu* codes

Age-Appropriate Vocabulary:

1) **Inka**- a people and civilization that lived in the Andes Mountains region of South America from about 1400 AD until the Spanish arrived and conquered them in 1532
2) ***khipu*-** a system of cords and knots that the Inka used to code information instead of writing
3) **civilization**- a large group of people organized by a government with traits like writing, monuments, long distance trade, science and math, a class system, etc

Introduction to Activity: Each girl will create a *khipu* that codes information.

Instructions:

1) The Inka were ancient people with an empire in South America that covered present day Peru and parts of Ecuador, Bolivia, Chile, and Argentina. They made many incredible monuments and artifacts including the famous site of Machu Picchu, a palace in the

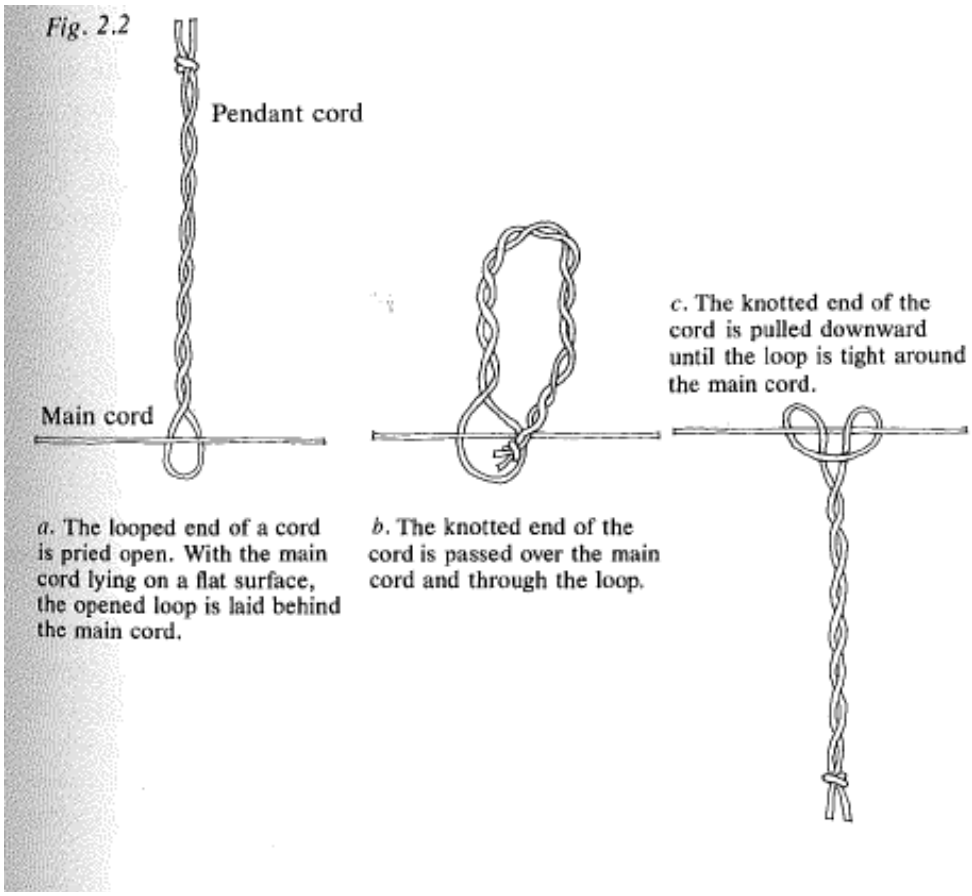
mountains (Share a map of the Inka empire and a picture of Machu Picchu). The Inka ruled this territory from about 1400 AD until they were conquered by the newly arrived Spanish in 1532 AD.

2) The Inka are considered one of the great ancient civilizations. A *civilization* is a large culture organized by a government, with most (but not always all) of the following characteristics:
    a) large cities, smaller villages, and rural areas
    b) writing
    c) large monuments (pyramids, temples, palaces, large statues)
    d) money
    e) trade with other cultures
    f) science and math
    g) calendar
    h) system of weights and measurement
    i) agriculture and domesticated animals
    j) art (sculpture, painting, dance, music)
    k) class system (rich people and poor people, leaders and commoners)
    l) religion
    m) laws, taxes, government
    n) roads and transportation
    o) a name and symbols for the civilization like flags, special colors
    p) games and sports

    Other ancient civilizations include Egypt, Mesopotamia, the Maya, and the Aztecs (show map).
3) One thing unique about the Inka, compared to other civilizations, is that they did NOT have writing. Instead the Inka used *khipu*, a system of cords and knots that coded information. Writing is just one way to store and record information. The Inka solved the problem of storing information in a different way—in coded rope.
4) Show pictures of real *khipu* and a sample *khipu*. Explain that *khipu* consisted of one main cord with pendant cords hanging down. The pendants represented different things, such as bags of grain, peppers, people, or houses. Different colors were used to represent different things. The pendant cords had knots tied in them to represent the number of that thing. The Inka used a number system just like us, a system of 10 digits, including zero. The Inka tied single knots to represent digits 1-9 and then left a space to separate units, tens, hundreds, thousands, etc. (see pictures below). They left a blank space to represent a zero in any of these places.
5) *Khipu* could get very complicated with pendants coming off of other pendants, color mixtures, and different types of knots used. We are going to make basic *khipu* that record grocery lists. Each girl will have to decide how to symbolize different items by colors of yarn. However, they should be able to read the numbers represented by anyone's *khipu*.
6) Demonstrate how to make a cord: fold a ~1.5 meter length of yarn in half. Have one person hold the folded end while the partner twists the open ends in the same direction. When the cord is adequately twisted bring the folded and open ends to meet: the cord should twist together. Tie the loose end together and keep an open loop at the other end (see illustration). Pendants are made the same way, but should be a bit shorter, ~1

meter length. Attach pendants to the main cord by looping the tails through the loops. Knots are tied in the pendant cords.

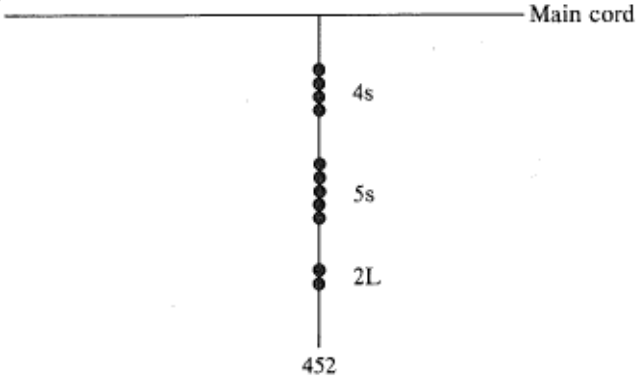
7) Have the girls make a main cord out of a bland color (black, gray, white), ~1.5 meters in length. They should work in partners (because it takes two people to twist), but everyone should make their own *khipu*.
8) Distribute grocery lists. Allow students to decide how to code the list and symbolize items. They should choose string colors for pendants in order to encode this list.
9) Help the girls construct *khipus* that code their lists. Different colored yarn should symbolize different items and the knots should represent the number of items. If there is time, they can develop ways to store the additional parenthetical information (by tying pendants onto pendants, tying different kinds of knots, etc).



Figures from *Mathematics of the Incas: Code of the Quipu*, Asher and Asher 1981

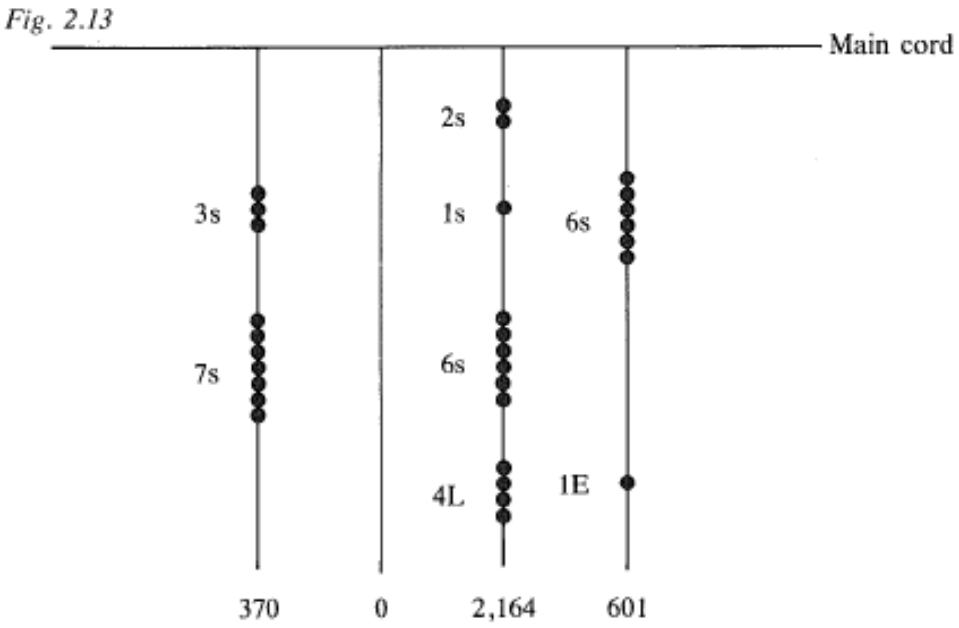
This strand represents the number 452. Higher place values are at the top of the pendant. Units are the lowest value.

Fig. 2.12



The following *khipu* shows an example of how zero is denoted by itself and as a place value.

Fig. 2.13



Reflection:

Please ask the following questions. If you have time, discuss these questions further before the girls write in their journal.

- Why did the *Inka* use *khipu*?
- Can you think of other ways to store information without writing?

SHOPPING LISTS (Provide one per girl)

LIST 1: 24 French fries (with ketchup), 1012 pickles, 3 sardines (canned)

LIST 2: 12 eggs (Free range), 106 M&Ms (peanut), 3 lbs chocolate

LIST 3: 8 chicken (Free range), 252 fish, 103 bananas (ripe)

LIST 4: 28 sardines (canned), 162 potatoes, 1032 M&Ms (plain)

LIST 5: 6 cookies (chocolate chip), 522 chips (sour cream and onion), 2302 brussels sprouts

LIST 6: 305 chicken nuggets (with ketchup), 63 chickens, 1012 eggs (brown)

LIST 7: 62 ice cream cones (sugar), 3 bottles chocolate syrup (Hershey's), 104 cherries

Session Seven
Focus On: Rope Bridges and Mummies

About This Session: Ancient and traditional peoples of the Andes, including the Inka, built bridges of twisted grass to cross canyon rivers. The ancient Egyptians spent thousands of years perfecting the procedure for mummy making. You will reinvent and perfect both of these technologies in one hour!

The girls will:

1. Mummify an apple with different salt mixtures to determine which recipe makes the best mummy.
2. Determine how to make the strongest suspension bridge of newspaper strips.

Materials Needed for Session:

Activity One: Mummy Making		
Per Club	**Per Group**	**Per Girl**
Kitchen scale	2 cups Epsom salt	Data sheet
	2 cups table salt	Pencil/pen
	2 cups baking soda	
	8 paper cups	
	8 apple slices	
	Marker to label cups	
	Measuring cup	
Activity Two: Rope Bridges		
Per Club	**Per Group (4 girls)**	**Per Girl**
Hole puncher	Newspaper strips (5 cm wide)	Pencil, paper
	4 paper clips	
	Paper cup	
	Scissors Tape Weights (washers, coins) Two chairs	

To do before Science Club begins:

- This is a good week to divide the girls in half. Have one group work on Activity 1 while the others works on Activity 2. The JMs can lead one activity, while the Mentor Scientists the other.
- At the mummy station cut apples into 16 slices, so that there are 8 slices per group. The slices should be as close to the same size as possible so that the weights are fairly equal.
- If mentors have a laptop available, download the Nova video about rope bridges in the Andes. You need to download it in advance because the schools do not have wifi. The download is free, but the website will ask you to make a login with your organization or

school association:
http://www.teachersdomain.org/resource/eng06.sci.engin.materials.incabridge/

Question of the Day: *How did ancient people make mummies and rope bridges? Why were these inventions important for the Egyptians and Inka?*

Activity One: Mummy Making

Age-Appropriate Vocabulary:

1) **Desiccant**- a substance that dries things by removing water
2) **Control**- something in an experiment that you do not change to use for comparison with your experimental items

Introduction to Activity:
Archaeologists have found mummies from many times and cultures. Sometimes people made mummies intentionally and sometimes they are made accidentally by nature. The Egyptians made the most famous mummies by drying dead bodies with natron, a type of salt. We will experiment with different salt mixtures to see which makes the best apple mummy.

From: Science Kids at Home: Mummy Experiment
http://www.sciencekidsathome.com/science_experiments/mummy_experiment.html

Instructions:

1) To make a mummy, Egyptian morticians would remove many of the organs and store them in canopic jars, special jars with Gods' heads as the tops. They removed the brain with a hook through the nose. Next they would pack the stomach area with natron immerse the entire body in natron for about 40 days. After, the body was washed, repacked with natron and spices, and wrapped in bandages.
2) Egyptians mummies are just one type of many. Show the girls pictures of different kinds of mummies: a naturally desiccated mummy, a bog mummy, a frozen mummy, and Egyptian mummies. Explain that a mummy is a dead body that becomes dried out so that the soft parts preserve. Usually the soft parts of dead bodies rot away like decaying logs or leaves and only bones remain (and the bones eventually turn to fossils). However in special conditions, when there is no oxygen around or it is very dry, the soft parts will preserve. The Egyptians made sure this happened by special mummification procedures. They believed that people needed their bodies for the after-life. Egyptians began making mummies around 3500 BC, but it took them until 1500 BC to perfect the process. They had to experiment with different recipes and procedures. Just like the Egyptian morticians, we will test different salt recipes to see which makes the best mummy—but we will use apples instead of bodies.
3) Explain that salt is a *desiccant* or a substance that removes water from things. Apples are mostly water. When they are exposed to a desiccant they dry out and loose weight. We will weigh the apples, immerse them in different types of salt, and weigh them again

next week. The salt mixture that caused the apple to loose the most weight was the best recipe!

4) Have the girls fill out the data sheet below, recording the apple number, salt mixture, and weight before (they should leave "weight after" blank until next week).
5) Have a girl weigh an apple slice, place it in cup 1, and cover it with ½ cup baking soda.
6) Other girls should take turns repeating Step 5 with the following mixtures:
   - ½ cup Epsom salts
   - ½ cup table salt
   - 50:50 mixture Epsom salts and table salt
   - 50:50 mixture table salt and baking soda
   - 50:50 mixture baking soda and Epsom salts
   - mixture of 1/3 baking soda, 1/3 Epsom salts, 1/3 table salt
7) Lastly have a girl weigh an apple into a cup with no salt. Explain that this is the *control*, or something in an experiment that you do nothing to, to see what would happen naturally.
8) Store the cups on a shelf out of direct sunlight until next week.

Mummy Experiment Data

Apple number	Salt mixture	Weight before	Weight After	Weight loss

Activity Two: Inka bridges

Introduction to Activity:
Last week we twisted rope to make *khipu* that the Inka used to store information instead of writing. The Inka used twisted rope for another important invention: suspension bridges to cross canyon rivers. The Inka empire was in the Andes Mountains. Rather than climbing up and down every canyon, the Inka built foot bridges out of twisted grass. People of the Andes Mountains make bridges this way today! The girls will suspend weights from newspaper strips to determine the best form of support.

From Nova Teachers, "Hang in There!" *Secrets of Lost Empires I—Inca*

Instructions:

1) Show the Nova video Grass Bridge, in which traditional Peruvians construct a suspension bridge from twisted grass. http://www.teachersdomain.org/resource/eng06.sci.engin.materials.incabridge/
2) Students will construct suspension cables out of newspaper strips and determine how to support the heaviest load.
3) First they should build the load tester: Unfold paper clips into S shapes. Punch three evenly spaced holes around the top of a paper cup and slip the paper clips through. Place the fourth paper clip through the others to make a hanger (see diagram).
4) Place two chairs about 2 ft apart. Tape a newspaper strip to the top of each chair so that it sags slightly. Hook the load tester onto the middle and test how much weight (how many washers, coins) the strip can hold until it breaks.

5) Students should make a data sheet that describes the suspension (e.g.: one unaltered newspaper strip) and the load supported (e.g.: 4 quarters).
6) Now experiment with ways to support a heavier load, using the Inka rope bridge for ideas. Let the girls come up with ways, but guide them to twist the strips, like the Inka did. For each method invented, they should describe it on the chart and record the weight supported.

Reflection

Please ask the following questions. If you have time, discuss these questions further before the girls write in their journal.

- What different ways can mummies form?
- Why did Egyptians make mummies?
- Which bridge design was able to support the most weight? The least? Why?

Session Eight
Focus On: Mummy Wrap-up and Science Fest preparation

About This Session: Before club, the civilizations made last week will be buried. Each group will dig up another group's civilization and infer what the people were like based on the buried remains.

The girls will:

1. Weigh the mummy apples from last week and discuss which salt mixture worked best.
2. Prepare a poster for Science Fest.

Materials Needed for Session:

Activity One: Wrap-up of mummy experiment		
Per Club	**Per Group**	**Per Girl**
Kitchen scale		Data sheet from last week
	Toothbrush	Paper, pencil
Activity Two: Science Fest preparation		
Per Club	**Per Group**	**Per Girl**
Poster board		Hieroglyphic decipherment sheet
Markers		

Activity One: Wrap-Up of Mummy Experiment

Introduction to Activity:
The girls will reweigh the apples from last week to see which salt mixture was the best desiccant.

Instructions:

1) Ask the girls to summarize the mummy experiment from last week (especially if anyone was absent the previous week). Ask them what we have to do to finish the experiment this week.
2) Have the girls take turns brushing the salt off an apple slice and weighing it.
3) Explain that we need to figure out which apple lost the most weight or water. We will subtract "weight after" from "weight before."
4) Have the girls perform this calculation and decide which salt mixture worked best. Did both groups get the same result?

Activity Two: Science fest Preparation

Introduction to Activity:
The club must decide which activity to share at Science Fest and make a poster highlighting the semester's activities. They can use Egyptian hieroglyphs to write text on the poster.

Ancient Egyptian was one of the first written languages. The Egyptians began using hieroglyphic writing around 3200 BC, but knowledge of the system was forgotten for many thousands of years after the Egyptian Empire. In the 1800s the ancient script was finally deciphered by a Frenchman, Jean-François Champollion, who used the Rosetta Stone—a stone inscription with the same text in Ancient Egyptian hieroglyphs and Ancient Greek.

Hieroglyphs use some symbols that mean entire words and other symbols that mean sounds, like in our alphabet. The Egyptians also had signs for sounds like "sh" and "ch." Signs for letters in our alphabet and these sounds are on the handout below.

From: PBS, “Egypt’s Golden Empire,” http://www.pbs.org/empires/egypt/index.html

Reflection:

Please ask the following questions. If you have time, discuss these questions further before the girls write in their journal.

- Why did the apples lose weight? What happened to the control apple?