DISEASE DEFENDERS: Veterinary Medicine Path
TEACHING MATERIALS
Overview:
We hope that you and your students extend the MEDMYST adventures with the activities designed to cover related learning objectives. The activities described are intended for use both before and after students have “played” missions of MEDMYST. The files may be printed for classroom use ONLY. They consist of mini-labs that can be done with relatively little equipment or expense.

Feel free to adapt these activities to your own classroom needs. Another resource that we suggest is the National Institutes of Health (NIH) web site at http://www.nih.gov/. It contains some excellent resources and teaching materials.

If you have specific questions, please contact us.

The MEDMYST Team:
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Students practice data interpretation based on authentic data involving rabies transmission across the United States. Additionally, students analyze data to create their own inquiry based questions, as well as responding to some pre-written questions.

Activity 2 Can You See It?? ....................................................................................... page 20

Students experience the importance of careful observations and questioning as the beginning step of all scientific thinking.
Mission Briefing: Mission Synopsis

This synopsis is provided as an overview for TEACHERS. We advise teachers NOT to hand this out to the students prior to playing the adventure since much of the suspense will be eliminated.

Headquarters:
The web adventure begins at headquarters in Neuropolis. Beta, Chief Science Officer of the Reconstructors, informs the player that investigating disease outbreaks requires a team of experts. The player is then directed to the teleporters where they learn about three experts who are involved in investigating disease outbreaks. The player then chooses which of the three experts with which to train.

Veterinarian Training:
When the player chooses the veterinarian expert path, they are teleported to the vet laboratory where they learn that the vet travels to farms to take care of big animals, like horses and pigs. After learning some more information about veterinary medicine, the vet informs the player that a pig has recently died and he needs to determine the cause. The vet suspects rabies, but needs the player to help confirm his diagnosis.

In order to determine if the pig died of rabies, the player first performs a necropsy on the pig to remove the brain for analysis. The player will examine the dead pig’s brain tissue by microscopic examination to determine if the pig had rabies. The vet has already given the player a brain tissue sample from a pig that was already found to have rabies and a pig that was found to be healthy to use as controls. The player must help the vet prepare the three brain tissue samples for examination under the microscope. In order to do this, the player must correctly identify the samples as the experimental sample, positive control sample, and negative control sample. During this process, the player will have to identify the purpose of the control samples and why they need to be included in the experiment. Once the vet has stained the brain tissue samples for viewing under the microscope, the player analyzes the results and draws a conclusion about what caused the pig to die.

Experiment round-up app:
After completing the veterinarian training, the player is rewarded with a new app that is optional to play. The experiment round-up app is an arcade-style game that reinforces experiment groups, negative control groups, and positive control groups. In this game, the vet tells the player that some cows may have anthrax and she needs help rounding them up for testing. The vet needs positive control cows, negative control cows, and experimental cows rounded up, but the player must decide which cows belong to which group. The player must round up as many cows as they can in 30 seconds.
### Mission Briefing: Correlation with Standards

**National Science Education Content Standards Correlation Grades: 5-8**

<table>
<thead>
<tr>
<th>Instructional Objectives “Disease Defenders” Veterinary Medicine Path</th>
<th>Science Content Standard</th>
</tr>
</thead>
</table>
| Students will be able to recognize the role that veterinarians play in diagnosing an infectious disease in animals. | **Standard G:** Students should develop understanding of science as a human endeavor.  
**Standard G:** Students should develop understanding of the nature of science. |
| Students will be able to identify and explain the purpose of control groups in an experiment. | **Standard A:** Students should develop the abilities to do scientific inquiry. |
| Students will be able to identify and explain the purpose of experimental groups in an experiment. | **Standard A:** Students should develop the abilities to do scientific inquiry. |
| Students will be able to draw conclusions from the results of an experiment. | **Standard A:** Students should develop the abilities to do scientific inquiry. |
Mission Briefing: Vocabulary Terms

Vocabulary terms that are fundamental to understanding the concepts included in MedMyst Disease Defenders are listed below. Some of the words will be encountered while playing MedMyst Disease Defenders. They are located in the glossary of the expert menus, so you can click on them and get the definition as you play.

Veterinarian:

**Experimental sample or group** – The experimental sample or group is the one in which we introduce the independent variable that we are testing.

**Hypothesis** – An educated guess that predicts what might happen. A hypothesis is written as a statement and describes how changing the independent variable will affect the dependent variable.

**Necropsy** – A thorough examination and dissection of a dead animal’s body to determine the cause of death.

**Negative control** – A standard for comparison. This group is purposefully left untreated to show what a negative result should look like.

**Personal protective equipment** – Clothing, gloves, or a face mask that is worn to create a barrier between you and infectious materials.

**Positive control** – A standard for comparison. In this group, the disease that is being investigated is purposefully introduced to show what a positive result should look like.

**Rabies** – A disease that affects the brain and is caused by the rabies virus. The virus is typically passed through the saliva from animal to animal, but can be passed from animals to people.

**Veterinary medicine** – A branch of medicine that deals with the diagnosis and treatment of disease in animals.
Teacher Directions: Ask students to fill in the answers in the answer column as they proceed through the mission.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>_______ should always be worn in the necropsy suite.</td>
<td>Personal Protective Equipment (PPE)</td>
</tr>
<tr>
<td>What is the vet’s hypothesis?</td>
<td>If the dead pig had rabies, then the rabies virus will be in the brain.</td>
</tr>
<tr>
<td>Which brain tissue sample serves as the positive control sample?</td>
<td>The rabies brain tissue.</td>
</tr>
<tr>
<td>Which brain tissue sample serves as the negative control sample?</td>
<td>The healthy brain tissue.</td>
</tr>
<tr>
<td>Which two brain tissue samples look very similar under the microscope after staining?</td>
<td>The experimental sample and the positive control sample.</td>
</tr>
<tr>
<td>Was the vet’s hypothesis supported or rejected by the results?</td>
<td>Supported</td>
</tr>
<tr>
<td>The brain tissue staining confirmed that the pig died from _______.</td>
<td>Rabies</td>
</tr>
</tbody>
</table>
**Mission Log: Student Activity Sheet**

**Veterinarian Training**  
Name ___________________ Date ______ Period ___

**Directions:** Record your observations by finding the answer that correctly matches each question. Write down the answers as you proceed through the mission.

<table>
<thead>
<tr>
<th>Question</th>
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</tr>
</thead>
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</table>
Activity 1: And the Data Says...

This activity gives students practice reading authentic data in graphic forms, as well as using that data to answer questions and generate their own questions.

Background:
Dating back to the 12th century B.C. in Mesopotamia, rabies is one of the oldest known zoonotic diseases! Rabies is a fatal disease that is caused by a virus and transmitted through the bite of an infected animal. The virus attacks and multiplies in muscle cells at the site of the animal bite and then moves from the muscle cells to nerve cells. Once the virus attacks nerve cells, it can travel from nerve cell to nerve cell all the way to the brain where it can produce encephalitis, or brain inflammation. However, the disease can be treated with a series of anti-rabies shots if given immediately after exposure.

Rabies only affects warm blooded animals, particularly skunks, bats, cats, dogs, cattle, and horses. To prevent rabies, pets should always be vaccinated on a regular schedule by your veterinarian. People are only given the rabies vaccine for prevention if they are at a high risk of contracting rabies, such as veterinarians, animal handlers, and rabies laboratory workers. Currently, some wild animals have been vaccinated with an oral vaccine which has been particularly effective in ridding the red fox population of rabies. The NARMP (North American Rabies Management Plan) is a group connecting the US, Canada, and Mexico to oversee this type of vaccination so it is not left entirely up to the various states. There are measures that can be taken to protect you and your animals from rabies, such as avoiding any contact with wild and stray animals.

**See additional Rabies FAQ questions at the end of the teacher guide.**

Learning Objective:
Students practice data interpretation based on authentic data involving rabies transmission across the United States. Additionally, students analyze data to create their own inquiry based questions, as well as respond to some pre-written questions.

Materials:

For each group of 2-3:
- A copy of the two pages showing the 4 distribution pictograph maps (with yellow dots). One set of two pages per group will work. It is best NOT to copy back to back so they can analyze all of the data at one time. Color copies are needed to be able to accurately interpret them.
- A copy of the line graph (Cases of rabies in wild animals in the United States)
  One page per group will work. Color copies are needed to be able to accurately interpret it.
- Mission Debriefing: Student Activity Guide—Questions (use one copy per group)
Procedure:
1. Divide the class into groups of two or three. Distribute the color copies of the line graph for each group.
2. Ask the students to analyze the graph independently for a minute or two mentally noting questions they have or observations they make. (This is a key step since often, there is not enough “think” time for students to attempt to make sense of data. Plus, this is where their questions will start forming in their own minds. Too often, we start explaining before they can attempt to make sense of the graphic data.)
3. Next, have students generate questions they notice from their graph observations. One person can record the group’s questions on the front of the “Mission Debriefing: Student Activity Guide—Questions” page, Part A. An example line graph question might be, “Why did the rabies cases in raccoons peak so high in 1993?” Allow about 3-5 minutes for this graph.
4. Distribute the two pages of color copies of the 4 distribution pictograph maps (with yellow dots). Repeat step 2 above (think time) and step 3 above (group question generating). Example questions from these graphic maps might be, “Why is the east coast where so many raccoons with rabies seem to be located?” or, “Why do some states have no cases reported?” Allow 5-7 minutes for these graphs. They should try to generate 10 or more questions within their group.
5. Have each group choose their two best questions to share with the class. You can attempt to answer any question the group feels they might be able to answer. Later, students could have the option to search out answers on the computer or at home. It is not always necessary to answer all of the generated questions for successful learning to have occurred. Giving them opportunity to generate inquiry questions and interpret data are two important skills.
6. The teacher generated questions can be copied on the back side of the Student Activity Guide or on a separate page. Again, a recorder can write responses for the whole group. Encourage each person to give input. Note: Groups matched to ability may allow less confident students to still participate.
7. The group’s completed page can serve as an assessment option.
8. Web sites of helpful rabies information are as follows:
   http://www.cdc.gov/rabiesandkids/
   http://www.cdc.gov/rabies/
   http://www.worldrabiesday.org/
   http://www.who.int/rabies/en/

General FAQ regarding rabies:

Is Rabies a new disease?
No. It has been mentioned since the times of the Greeks and Romans.

What causes rabies?
A virus belonging to the rhabdovirus group; it infects and destroys nerve cells.

How do you catch rabies?
Usually, by being bitten by a rabid animal or by having infected saliva come in contact with open cuts or mucous membrane surfaces.
If a dog that was chasing a raccoon got bit, can he get rabies even though he has had all of his shots?

Probably not, but sometimes health authorities require the dog to be isolated for a while to make sure.

Are rabies shots painful?

Not anymore. Old vaccines had to be injected into the abdomen, but new vaccines and immunoglobulins are no more painful than any other vaccine injection.

Why is rabies so deadly?

The problem is that rabies treatments are effective only if begun very soon after exposure, before the virus has moved to the nervous system. The immune system generally cannot fight pathogens in the nervous system. No test can easily tell if a person has been infected until symptoms appear, and then it is too late. Sometimes people consider a bite not serious enough to report, and so they are not treated soon enough.

If rabies is so deadly, why do only one or two people a year die of it in the US?

Effective dog control and vaccination programs have removed a common link connecting humans to wild animals via dogs. There is still some issue because cats, which are known to wander more, are not usually immunized.

If rabies is so deadly, why don’t the wild animals carrying it just die out instead of spreading it to new areas?

The effects of rabies vary depending on the type of animal. Mice, for example, typically develop the disease with a few days after infection, whereas raccoons and some other wildlife species may carry the virus for years without developing symptoms. So, it can be spread. In most species, there is time that passes between the bite and the symptoms so the disease can easily spread further.

Key point to remember and communicate to students:

The data in the graphs shows the number of animals tested. This means animals that have been submitted for testing due to suspicion by people or animals that have been caught and tested as a result of state rabies surveillance measures. In reality, there are a lot more animals out there that are positive, but never caught or seen by people.


Explain more about the skunk variant?

“Variant” means a rabies virus that has adapted to a specific host in a geographically discrete region, but it can jump hosts or species. There are many different rabies variants that are antigenically and genetically distinct from each other. (Note: In asking an expert, she stated that the skunk variant started being listed separately just to show in the data that the virus had a different origin.)

Why did the raccoon cases get so high in 1993?

In 1993 raccoon rabies cases were really high because there was a raccoon rabies epizootic (epidemic) occurring. High population density among raccoons and translocation from previous epizootics may have contributed to the increase. Raccoons also have a greater tendency than skunks, bats, or foxes to live in close proximity to humans, which leads to more cases being reported.

Why do different animals spike at different times?
The spikes correspond to epizootics and these can occur in different species depending on that species population density and migration patterns. The proportion of rabid species reported can also depend on how close in proximity they are living to humans. The type of rabies virus variant infecting the animals can also influence the epizootic—some are a stronger strain than others.

Distribution Pictograph map (with yellow dots) questions and responses:

**Why are there so many more rabid bat cases in Texas?**
Texas is home to the largest bat colony in North America in an urban area (Austin Texas/Congress Avenue Bridge). Surveillance in bats compared to other states may also be higher in Texas because the bat population is so high.

**Why are there very few species affected in the northwest?**
There is a lower human population in parts of the northwest and therefore less contact with sick animals. Also, there aren’t very many animals tested in that region, except for bats.

**Are the cases of rabies related to geographic areas of water?**
They are not related to geographic areas of water, but geographic boundaries such as bodies of water and mountains, restricts animal movements, which slows the spread of the rabies virus.

**Do the 2008 graphs vary much from earlier years of graphs?**
Rabies surveillance data through 2005 shows only small increases and decreases in the number of rabies positive animals. Also, in previous years some states and counties did not submit rabies testing data, so this information was not included in those graphs. Going back further to 1993 or 1998, there are much higher numbers for raccoons compared to the 2008 graphs. Basically, anytime there was an epizootic there is a large number of positive rabies cases and then a decrease each year after the peak of the epizootic. Also, changes in cases by county and state vary through the years, but they all look small except for epizootic years.

**How is the decision made to test species for rabies? Who guides that process—federal government, state government, other people?**
Rabies testing is done ultimately for the purpose of protecting human health. Fewer rabies cases in animals means less chance that humans will contract rabies from a positive animal. Public health is primarily a local government issue, and then proceeds up to the state level (case in point is quarantine law, in which 50 states have 50 different laws). The CDC has to be invited by a state official during an outbreak such as rabies (unless it is a bioterror event or national security threat, in which case the FBI has precedence). Animal health issues are considered a federal responsibility, and are handled by the USDA. Things get confusing for zoonoses, when both people and animals are involved! What is key is the idea of One Medicine, One Health. “One Health is the collaborative efforts of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals, plants and our environment.” In a perfect world, doctors, veterinarians, public health officials, and a cadre of biologists, government officials, medical personnel, researchers, etc. work together to help solve infectious disease problems such as rabies. Of course the world is not perfect, but there are very dedicated people who are trying to work together to solve these important veterinary and public health issues.
What % of rabies cases occur in wild animals?
93% of the cases are in wild animals.

These graphs don’t include domestic animals. What is the % of rabies cases associated with them?
Cats are 4.3% of the cases, dogs are 1.1%, and cattle are 0.9%.

Why is Hawaii not included on the map?
Hawaii is the only state in the U.S. without rabies. They require a 6 month quarantine for any mammal brought into the state in an effort to keep the area free from rabies.

Why are pigs not included on the map?
It is very rare for a pig to get rabies.

Extension Activities:

Language Arts or Science: Students can seek answers to the questions they generated by researching more about rabies through online or research materials.

Health, Science, or Social Studies: Students can explore local rabies issues by searching the Centers for Disease control site data for information specific to their state or accessing data from their state’s Division of Wildlife web site. Explore where outbreaks are located and examine possible causes for rabies spread in certain locations.

Health: Research the effectiveness of rabies prevention measures used in animals and how this has affected the number of rabies cases in humans.

Language Arts: “Old Yeller” by Fred Gipson

Standards:
National Science Education Standards, Grades 5-8
• Science Content Standard A: All students should develop abilities necessary to do science.
• Science Content Standard F: All students should develop an understanding of science in personal and social perspectives.

Web Sites:
http://www.cdc.gov/rabiesandkids/
http://www.cdc.gov/rabies/
http://www.worldrabiesday.org/
http://www.who.int/rabies/en/
Part A: Student Generated Questions about the graph(s):
Each group will create their own questions on this side of the page.

Part B: Teacher Generated Questions and Group Responses:
(Note: These questions are found on the back side of the Student Activity Guide handout.)

1. **Line Graph:** Which species seems to have shown the greatest increase in numbers over the years? Use data to explain.
   Raccoons seemed to have increased the most rapidly with very few cases in 1958 and increasing to around 6,000 cases in 1993. By 2008, the cases had decreased to approximately 3,000.

2. **Line Graph:** Have any of the species remained the same or decreased since 1958? Only bat numbers seem to have decreased since 1958.

3. **Line Graph:** What is unique about the skunk species? What do you think a variant might be?
   The skunk graph line breaks apart around 1978 and two variants (different origins of the virus) are graphed separately. Note: One variant tends to be found more in the north and the other in the south.

4. **Distribution Pictograph map (yellow dots):** How are numbers of rabid raccoons, bats, foxes, and skunks indicated on these maps?
   Various sizes of yellow circles indicate the numbers of species that were rabid. The larger the dot, the greater the number. Using the key to interpret the size of the yellow dots gives a specific indication of the numbers of rabid animals.
1. Distribution Pictograph map (yellow dots): How are the numbers of individuals from a species who were tested indicated on this map? Four different shades of grayscale colors, from light gray to black, indicate the number of species that were tested. Using the key gives you indicators of the number range.

Distribution Pictograph map (yellow dots): Rabid raccoons, foxes, and skunks seem to be more heavily distributed along the eastern coast. Do you think the cases between the species are linked somehow? Explain. Yes, probably. When a wild animal has rabies, it acts in an abnormal fashion and might be aggressive to many other species. So, in that way the disease could spread within a species and to other species. Where rabies cases start increasing, it makes sense that cases in other species in the wild which interact with that species might increase also. Additionally, these species are all terrestrial and their ranges might overlap, increasing potential contacts.

2. Distribution Pictograph map (yellow dots): Why might maps that show topographical details (elevation, water distribution, etc.) or a map showing human population densities be helpful in analyzing this data? Maps that show water distribution or elevation factors might show the most desirable habitat locations for species that need certain resources. If animal populations are higher in those areas, we could use our maps to see if there was a connection with disease frequency also. Human population density maps could show us if disease occurrences seem to be increased in urban areas or outlying areas.
Mission Debriefing: Student Activity Sheet
And The Data Says...

Names of group members:

____________________________________
____________________________________
____________________________________
____________________________________

Date ________ Period _____

Part A: Student Generated Questions about the graph(s):
Part B: Teacher Generated Questions and Group Responses:

Please respond with complete sentences.

1. Line Graph: Which species seems to have shown the greatest increase in numbers over the years? Use data to explain.

2. Line Graph: Have any of the species remained the same or decreased since 1958?

3. Line Graph: What is unique about the skunk species? What do you think a variant might be?

4. Distribution Pictograph map (yellow dots): How are numbers of rabid raccoons, bats, foxes, and skunks indicated on these maps?

5. Distribution Pictograph map (yellow dots): How are the numbers of individuals from a species who were tested indicated on this map?

6. Distribution Pictograph map (yellow dots): Rabid raccoons, foxes, and skunks seem to be more heavily distributed along the eastern coast. Do you think the cases between the species are linked somehow? Explain.

7. Distribution Pictograph map (yellow dots): Why might maps that show topographical details (elevation, water distribution, etc.) or maps showing human population densities be helpful in analyzing this data?
Rabies in Wild Animals, 1958-2008

- Raccoons
- Skunks
- Skunk Variant
- Bats
- Foxes

Cases

Year

Rabid raccoons reported in the United States during 2008.

Rabid bats reported in the United States during 2008.
Rabid skunks reported in the United States during 2008.

Rabid foxes reported in the United States during 2008.
Mission Debriefing: Teacher Guide

Activity 2: Can You See It?

This activity gives students practice with simple inquiry questions based on careful observations—the beginning step of all scientific thinking.

Background:
One of the most fundamental characteristics of a scientist is curiosity which can lead to careful observations. Most scientists, regardless of discipline, constantly question the world around them. Why is the sky blue? What happens if I mix these two ingredients? How do people move? Will bacteria grow if the air is heated? How can this disease be cured? These types of questions and the search for their answers form the basis of all science.

In this activity, students will learn to ask questions about items that they probably take for granted—pencils, leaves, fingers, hair, light bulbs, and so forth. Then they will use their creative thinking to follow up and ask even more probing questions.

Learning Objective
Students experience the importance of careful observations and questioning as the beginning step of all scientific thinking.

Materials:
For each group of 3-4:
- Familiar objects such as: a pen, a piece of hair, a leaf, light bulb, etc.
- Paper and pen or pencil for each student

Procedure
1. Divide the class into groups of three or four. Give each group an object to examine.
2. Ask the students to study the object closely and to think of at least twenty questions about the object. For example, if students are looking at a pencil, possible questions might include “Why does a pencil have six straight sides?”, “What is the black material inside the pencil?”, “Where does the material come from?”, and “How is it placed inside the pencil?” Have each student independently write his or her questions on a piece of paper. You may want to remind students that there are no “right answers” to this exercise—instead, they should write down any question that comes to mind. Some students may come up with twenty; others may struggle to get that many. The point is to get their minds free to observe, think, and question.
3. After students have completed their questions, ask the students in the group to compare their lists. Working together, the students should choose one or two questions from the lists that particularly interest them.
4. Then they should brainstorm to come up with secondary questions that might help
them answer the primary question or questions they chose. For example, suppose students choose the question “Why does a pencil have six straight sides?” as their primary question. Secondary questions might include “What would happen if the pencil had five sides or four sides?”, “What would happen if a pencil had rounded sides?”, “What would happen if the pencil were a cube instead of a cylinder?”, or “How would the pencil be sharpened if it were another shape?” Again, encourage students to be as creative as possible with their questions.

5. Have students brainstorm a possible answer for each secondary question.

6. Have each group select two primary and secondary questions and answers to share with the rest of the class.

Follow Up Questions

**Note to teacher:** If time permits, hand these questions to each group to discuss for a few minutes before having a classroom discussion. Or, do questions 1 and 2 as a classroom group and have the small groups discuss questions 3 and 4. Question 3 could be completed on butcher paper or dry erase boards to share with the class, or it could be used as a group assessment to hand in.

Answers to key points regarding the questions are listed in red.

1. When you compared your list of questions with others in the group, did all the lists have the same types of questions? What could account for the similarities and differences between the lists?
   
   Students should find that the questions vary from person to person. Similarities result from the fact they are viewing the same object; differences arise when each person “sees” different things in their observations.

2. Why do you think you were asked to create a list of secondary questions? What is the purpose of the secondary questions?
   
   Secondary questions were intended to help students ask deeper questions based on their initial observations. In scientific thinking, initial observations lead to the development of creating a testable question and hypothesis so the purpose is to see that connection.

3. Think about one question from your list that you would like to answer. What steps could you take to answer that question?
   
   Answers will vary but should lead students to developing an experimental plan or research plan.

4. The physicist Albert Einstein wrote “The most beautiful thing we can experience is the mysterious. It is the source of all true art and science.” What do you think he might have meant? How does this thought connect to this activity?
   
   Answers will vary but hopefully students can see the wonder in the world around us that leads us to questions. Scientific thinking starts there and then builds upon that to develop experimentation that ultimately leads to answers.
Extension Activities
Students can choose their own objects to observe or repeat this activity at home with an object of their own choice.

Standards
**National Science Education Standards, Grades 5-8**
- *Science Content Standard A*: All students should develop abilities necessary to do science.

Web sites
Mission Debriefing: Student Activity Sheet

Can You See It?

Name __________________________ Date ________ Period ____

Background
One of the most fundamental characteristics of a scientist is curiosity which can lead to careful observations. Most scientists, regardless of discipline, constantly question the world around them. Why is the sky blue? What happens if I mix these two ingredients? How do people move? Will bacteria grow if the air is heated? How can this disease be cured? These types of questions and the search for their answers form the basis of all science.

In this activity, you will learn to ask questions about items you probably take for granted—pencils, leaves, fingers, hair, light bulbs, and so forth. Then you will use your creative thinking to follow up and ask even more probing questions.

Learning Objective
In this activity, you will experience the importance of careful observations and questioning as the beginning step of all scientific thinking.

Materials
For each group of 3-4:
- Familiar objects such as: a pen, a piece of hair, a leaf, light bulb, etc.
- Paper and pen or pencil for each student

Procedure
1. Divide the class into groups of three or four. Give each group an object to examine.
2. Study the object closely and think of at least twenty questions about the object. For example, if you are looking at a pencil, possible questions might include “Why does a pencil have six straight sides?”, “What is the black material inside the pencil?”, “Where does the material come from?”, and “How is it placed inside the pencil?” Each student will independently write his or her questions on a piece of paper.
3. After you have completed your questions, compare your lists to others in your group by reading them out loud.
4. Working together, choose one or two questions from the lists that particularly interest your group. Then, brainstorm secondary questions that might help you answer the primary question or questions you chose. For example, suppose you chose the question “Why does a pencil have six straight sides?” as your primary question. Secondary questions might include “What would happen if the pencil had five sides or four sides?”, “What would happen if a pencil had rounded sides?”, “What would happen if the pencil were a cube instead of a cylinder?”, or “How would the pencil be sharpened if it were another shape?” Be as creative as possible with your questions.
5. As a group, brainstorm a possible answer for each secondary question.
6. Select two primary and secondary questions and answers to share with the class.
Follow Up Questions

1. When you compared your list of questions with others in the group, did all the lists have the same types of questions? What could account for the similarities and differences between the lists?

2. Why do you think you were asked to create a list of secondary questions? What is the purpose of the secondary questions?

3. Think about one question from your list that you would like to answer. What steps could you take to answer that question?

4. The physicist Albert Einstein wrote “The most beautiful thing we can experience is the mysterious. It is the source of all true art and science.” What do you think he might have meant? How does this thought connect to this activity?