K-2: Hidden Kingdoms

Curriculum Connections

Developing and understanding scientific inquiry
Students need access to material, organisms and experiences to further develop skills to ask scientific questions and think about the world around them. Students develop a broader vocabulary through investigative experiences.

Life Sciences

The 5 Senses
- Students explore microbes using their sense of sight

Physical Health
- Some diseases are caused by germs
- Some bacteria are helpful

Diversity of Life
- Living things have certain characteristics to help them survive in their environment
- All living things have the same basic needs for survival---food, water, air and shelter

** Based on the New York State Elementary Science Core Curriculum and the New York City New Standards™*

National Standards

Content Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about inquiry

Content Standard C: Life Science
- The characteristics of organisms
- Life cycles of organisms
- Organisms and environments

Content Standard E: Science and Technology
- Abilities of technological design
- Understanding about science and technology
- Abilities to distinguish between natural objects and objects made by humans

Content Standard F: Science in Personal and Social Perspectives
- Personal health
- Characteristics and changes in populations
- Types of resources
- Changes in environments
- Science and technology in local challenges

Content Standard G: History and Nature of Science
- Science as a human endeavor

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K-2 Exhibits List

A Big Mouth Microbe - Bursaria Truncatella
A Bristly Microbe – Euplotes
A Cigar Shaped Microbe – Spirostomum
A Long Nosed Microbe – Dileptus
A Microbe that Flows – Amoeba
A Trumpet Shaped Microbe – Stentor
Amoeba Moves By Flowing
Aquarium
Beer and Bread are Made with the Help of a Microbe
Euglena Moves with Whips
Eye of the Needle
Friendly Microbes
How Microbes Make Us Sick
How Your Body Fights Disease
Is this Microbe Familiar - Paramecium Caudatum
Live Bacteria Grown on these Plates
Magi-Cam
Microbes In Your Nose
Microbe Laboratory
Microbes with Whips – Euglena
Paramecium Moves with Cilia
Pink Microbes – Blepharisma
Refrigerator Rot
Reiber Glacite Models
Scanning Electron Microscope Demonstration
SEM Views of Microbes
Size and Scale of Microbes
Video Microscope Demonstration
World's Smallest Sea Shell - the Foram

Guide Theme

The theme of these guides are based on popular crime and detective show investigations on TV; a mystery unfolds, questions are asked, evidence is gathered, conclusions are drawn. This process is similar to what scientists go through with the inquiry method. For more details see About the Guides.

Begin the Investigation At School

A mystery unfolds, questions are asked...
There are several ways you can introduce the topic and start the investigation. Here are some ideas that will help students start thinking about the topic and generate questions:

- Create a mystery around the idea of a Hidden Kingdom, a kingdom they are about to discover, but cannot see with their naked eye
- Create a mystery around "what made the nose run?"
- Demonstrate one of the Laboratory Activities with no explanation-let the questions begin
- Do one of the Laboratory Activities and facilitate a probing discussion
- Create a mystery around what happens when things "decay" - without explaining the concept of "decay", place an apple core in a small glass fish tank with soil and let the investigation begin.

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Prepare for Investigation at the New York Hall of Science
Once students have generated questions around the topic tell them they are going to continue the investigation at the New York Hall of Science.

At this point you may want to begin one of the Continuum Activities. These activities have the following features:

- Vary in length and depth
- Provide continuity and purpose for the visit
- Provide a way of assessing student understanding

Orientation and Planning: If you do nothing else, do this!
Here are five reasons to conduct student orientation and planning before going on a field trip:

1. Students focus on exploring and investigation versus the novelty of the location
2. Students don't have to worry about logistics like restrooms, schedule, eating etc.
3. Students who understand the plan and purpose of the visit are more likely to stay focused
4. Students who have clear goals for their visit are less likely to race from one exhibit to another with little understanding
5. Students who get involved in the planning of the visit, take ownership and are less likely to misbehave

Read more about the Orientation and Planning Process

Investigation at the New York Hall of Science

Evidence is gathered...
Okay. The class has arrived at the next phase of the investigation. The students have questions and seek answers. Everyone knows what exhibits they should visit and why. Everyone knows the schedule for the day. Students have materials to record findings or work on a Continuum Activity if required.

If all of the above is true, congratulations on a successful Orientation and Planning.

If you are curious about what teachers can do on site, we've put together a little piece called Teacher Role.

Finish the Investigation Back at School

Conclusions are drawn...
There are several ways you can complete the investigation. Some require less time than others. Here are some ideas:

- Student or group oral or written reports on investigation questions and answers
- Student or group illustrations of visit with answers to questions or mystery
- Do one of the Laboratory Activities
- Complete the Continuum Activity

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Continuum Activities

Continuum Activities are designed to carry through the entire investigation. Some activities require less time than others.

Investigation Map

Description: Detectives will often map out related events, evidence and suspects during an investigation. This helps them get an overall picture. Students can map out their investigations with a concept map. The concept map will help you assess what students learn.

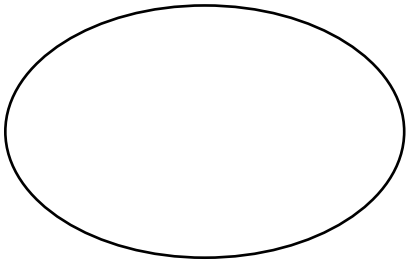
Time: (3)15-30 min. Sessions

Materials Needed:

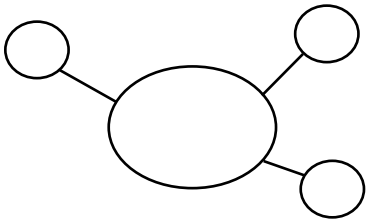
- Blank paper
- Pencils, crayons

Procedure:

1. Begin with a center circle and write in the name of the main topic. (Students who have difficulty with writing can have an adult assist or draw a representation of the main topic)



2. As students generate questions about the topic, they can add offshoot circles. They can also add circles for facts they know about prior to the visit to the New York Hall of Science.



3. When students return from their investigation at the New York Hall of Science they add additional circles of information. Their final map should reflect everything they know about the topic. Teachers can easily assess what is learned based on how the map develops.

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Investigation Journals

Description: Investigation journals provide a way for students to record their questions and findings throughout the investigation.

Time: (3)15-30 min. Sessions

Materials Needed:

- Blank or lined paper
- Pencils or crayons
- On-Site Investigation Handout (print out from this web site and make copies)
- Zip-lock bags (for on-site handout only)
- Soft yarn or thick soft string (for on-site handout only)

Procedure:

1. Ask students if they have ever seen a detective take notes when trying to solve a mystery. Tell students that as "science detectives" they too will make a record of the mystery.
2. Have students begin their journal or report with questions that are generated when they Start the Investigation at School.
3. Students who do not have writing skills can make a large question mark and draw representations of their questions. If an experiment or demonstration is done, non-writing students can sketch what they observe.
4. Older students with writing skills can list their own and other students questions in their journal.
5. We strongly advise students not bring journals to the New York Hall of Science where they can get lost. We have provided an On-Site Investigation Handout that can be copied if students want to record observations or make sketches.
6. When students return from their investigation at the New York Hall of Science have them write answers to questions or draw what they observed.

Become an Explainer

Description: Student science detectives investigate one exhibit with the goal of being able to explain it when they return to the classroom. Students can choose a variety of methods to explain and make presentations.

Time: (1) 15 min. Session (right before going on Field Trip)
(2) 45 min. Sessions (for in-class presentations)

Materials Needed:

- Interesting object (used for student observation)

(optional suggestions)

- Variety of craft materials (string, paints, glue, tape, colored paper, scissors, etc)
- Variety of clean, household recyclables (meat trays, cardboard tubes, aluminum foil, plastic wrap)
- Any other odds and ends students can construct with
- Poster board or paper
- Markers, crayons

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Procedure:

First Session

1. Tell students as "science detectives" they will investigating exhibits at the New York Hall of Science and will choose one exhibit to explain to the class when they return. (students can work in groups or individually)
2. Help students prepare for careful observation of exhibits by showing them an interesting object. (make sure all students can see object)
3. Now ask students to verbally describe what they see. Encourage details.
4. After students have described the object in great detail, tell them they will need to use these same observation skills when they are investigating their chosen exhibit.
5. Go to the New York Hall of Science. (encourage observation and verbal descriptions)

Second Session

1. Upon return to class from the trip, tell students they will spend time preparing to explain one of the exhibits they saw.
2. Here are some suggestions for student presentations:
    - Verbal explanation (with or without picture)
    - Group or individual poster showing how an exhibit worked
    - Group or individual model using materials to represent exhibit (materials can be used to substitute and represent real materials from exhibit— ex. Clear plastic wrap simulates glass, cardboard tube becomes a rocket etc.)

Third Session (optional)
Use this time for students to make their class presentations if they made posters, drawings or models.

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Laboratory Activities

Laboratory Activities are designed for the classroom and generally require simple materials. These activities can be done before or after a visit to the New York Hall of Science. To help students use higher-level thinking and generate questions, facilitate discussion with these types of questions:

- What do you notice here?
- Tell me about this.
- What do you see?
- Why do you suppose this happens?
- What can you conclude from the evidence?

Make Your Own Microbe

Description: Students plan and construct an imaginary microbe using available materials. The goal is for students to identify basic physical characteristics in microbes. This can be a before and after activity as students make revisions after they have been to the exhibition.

Time: (1) 15 min. Session (before the trip)
(2) 45 min. Sessions (for in-class construction and presentations)

Materials Needed:

- Variety of craft materials (string, paints, glue, tape, colored paper, scissors, etc)
- Variety of clean, household recyclables (meat trays, cardboard tubes, aluminum foil, plastic wrap)
- Any other odds and ends students can construct with

Procedure:

1. Have students imagine the Hidden Kingdom with creatures called microbes.
2. Tell students they will construct an imaginary microbe using available materials.
3. Before constructing have students think about the physical characteristics of their microbe and be able to answer the following questions:
    - How does it move?
    - How does it eat?
    - Where does it live?
4. Tell students they are going to the New York Hall of Science to see the Hidden Kingdom and REAL Microbes.
5. Tell students they can make adjustments to their imaginary microbes after seeing the real microbes.
6. Upon return from the New York Hall of Science, allow time for students to make changes to their microbes and present their finished microbe to the class. Have students answer these questions when presenting:
    - What are some characteristics that your microbe had compared to the real ones you saw at the Hall?
    - How does it move?
    - How does it eat?
    - Where does it live?

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Move Like a Microbe

Description: This short activity that can be done before and after a visit to the Hidden Kingdoms exhibition. Students are encouraged to imagine microbe movement, observe real microbes and then incorporate their observations into new microbe movements. Older children may be asked to identify the name of the microbe they are representing.

Time: (2) 15 minute sessions (before and after visit)

Materials Needed:

- Eyes to observe
- Bodies to move
- Crumpled green tissue paper (optional)

Procedure:

1. Tell students they are going to visit the Hidden Kingdom at the New York Hall of Science and see creatures that are invisible to the naked eye.
2. Tell students that these creatures do not have arms or legs.
3. Ask students to imagine how these creatures would move and tell them to begin to move in a way they imagine.
4. Stop the student movement when you feel enough time has passed.
5. Tell students they are going to see the REAL creatures and they may move in a way they imagined or not.
6. Tell students they are going to discover the mystery of how these creatures move without arms and legs and they will need to use their eyes to pay careful attention to how they move.
7. Go to the New York Hall of Science and visit Hidden Kingdoms.
8. Soon after your visit, ask students if they recall the name of the creatures in Hidden Kingdoms. (microbes).
9. Now ask students to move like a microbe based on what they observed.
10. As an option you may throw crumpled green tissue paper on the floor and tell them it represents food.
11. The moving student microbes can collect food as they near it to simulate a microbe eating.
12. You may want to conclude the activity with a discussion about the visit or student drawings of their observations.

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The Life and Death of Bread

Description: Yeast microbes bring bread to life and mold microbes bring about its death. Make bread and see how microbes can be both helpful and harmful. This activity can be a teacher demonstration or group activity. Yeast is made of living cells and is a fungus like mushrooms even though they look very different. Yeast is activated when added to warm water and sugar. The yeast feeds on the sugar and as it feeds, it breathes out carbon dioxide which make the bread dough rise. Bread mold is made up of a variety of microbes. Mold will form on bread because there are mold spores present even when the bread is fresh. The mold spores grow into mold over time and under favorable conditions.

Time: (1) 30 minute session
Observe changes over time

Materials Needed:

- 2 cups warm water (110 degrees F/45 degrees C)
- 2/3 cup white sugar
- 1 1/2 tablespoons active dry yeast
- 1 1/2 teaspoons salt
- 1/4 cup vegetable oil
- 6 cups bread flour
- (2) 9x5 inch loaf pans
- large mixing bowl
- cloth (size fits over mixing bowl)
- plastic wrap
- plate (size fits a slice of bread)

Procedure:

1. In a large bowl, dissolve the sugar in warm water, and then stir in yeast. Allow to proof until yeast resembles a creamy foam.
2. Mix salt and oil into the yeast.
3. Mix in flour one cup at a time.
4. Knead dough on a lightly floured surface until smooth.
5. Place in a well oiled bowl, and turn dough to coat.
6. Cover with a damp cloth.
7. Allow to rise until doubled in bulk, about 1 hour. (students can observe the rise over time)
8. Teacher brings bread dough home and bakes bread
9. Punch dough down. Knead for a few minutes, and divide in half. Shape into loaves, and place into two well oiled 9x5 inch loaf pans. Allow to rise for 30 minutes, or until dough has risen 1 inch above pans.
10. Bake at 350 degrees F (175 degrees C) for 30 minutes.
11. Return to class with baked bread (have a bread snack if you like)
12. Save one slice of bread for mold observation
13. Take slice of bread and wipe it across the floor (to gather microbes)
14. Place dirty bread slice on plate and cover with plastic wrap
15. Over time watch the mold consume the bread

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Yeast-It's Alive!

Description:
This is a simple demonstration that shows yeast in action without the need to make bread. Yeast is made of living cells and is a fungus just like mushrooms. Yeast is activated when added to warm water and sugar. The yeast feeds on the sugar and as it feeds, it breathes out carbon dioxide.

Time: 30 minutes

Materials Needed:

- glass bottle
- 1 package of dried yeast
- 1 teaspoon
- measuring cup
- sugar
- warm water
- large bowl
- balloon
- rubber band

Procedure:

1. Blow up the balloon a few times and let the air out.
2. Warm up the glass by pouring some warm water into the glass jar and swirling it around. Pour the water out.
3. Dump the yeast into the bottle.
4. Add 1 teaspoon of sugar to the bottle. Swirl.
5. Add 1/2 cup of warm water to the bottle. Swirl the contents around.
6. Cover the neck of the bottle with the balloon. Use a rubber band to hold the balloon in place over the neck of the bottle.
7. Fill a large bowl with warm water. Stand the balloon covered bottle in the warm water.
8. Watch what happens.

How Germs Make Us Sick

Description: In this short activity, students experience how germs can spread from one person to another through simple handshakes. Students also learn the importance of washing hands to help them stay healthy.

Time: 15-20 minutes

Materials Needed:

- 1 box of red colored jello or colored chalk powder
- cotton balls
- small container of water
- access to soap and water
- Book- Germs Make Me Sick by Melvin Berger

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Procedure:

1. Read Germs Make Me Sick as an introduction or as a follow up.
2. Brainstorm ideas about why we get sick.
3. Split class into two groups---Group One will be patients (which includes the teacher) and Group Two will be doctors. 4. The two groups line up side by side facing each other.
5. Each doctor is given a damp cotton ball.
6. Instruct the students that the jello/chalk will act as our "germs" for the experiment.
7. Start by putting a small amount of jello or chalk powder in your palm and shake the next patients hand. Then instruct the patient to shake the next patients hand and so on until all the patients have some powder on their palm.
8. Then instruct the doctors to clean the hands of the patient in front of them.
9. Inspect the cotton balls which should all have taken on the color of the powder.
10. Discuss what happened and what they learned---Germs can spread from one person to another.
11. Discuss what we could do to stay healthy and have students wash their hands to get rid of germs that could make them sick.
12. Inform students that most microbes are not harmful, and many are helpful. There are many microbes in you that keep you healthy, you wouldn't want to kill them. Washing with soap and water would not remove them from your body.

Book List

Books you can use throughout the investigation are:

Microbiology

Anderson, Lucia. *The Smallest Life Around Us*. New York, Crown Publishers, Inc., 1978.
Cobb, Vicki. *Lots of Rot*. J.B. Lippincott, 1981.
Cole, Joanna. *The Magic School Bus: In a Pickle – Microbes*. Scholastic, Inc., 1997.
Simon, Seymour. *Hidden Worlds: Pictures of the Invisible.* William Morrow & Co., 1983.

Microscopes

Kumin, Maxine, *The Microscope.* Harper & Row, 1984.
Wilkin, Fred. *Microscopes and Telescopes.* Chicago, Children's Press, 1983.

Germs

Berger, Melvin. *Germs Make Me Sick!* Harper & Row, 1985.
Scholastic. *Magic School Bus: Inside Ralphie*. Scholastic, 1995. (Video)