3-5 -Hidden Kingdoms

*Curriculum Connections

Life Science

- Observe and explain how plants and animals depend on each other, and how their characteristics help them survive in different environments
- Understand how various factors can affect the life span and life cycles of various organisms
- Describe how organisms and the environment are dependent on one another

Scientific Connections And Applications

- Understand and describe examples of the importance of scientists, science, and technology and the impact they have on our lives, such as how research scientists discover new treatments for diseases

Scientific Tools and Technologies

- Use technology and tools such as magnifiers, microscopes, balances, thermometers, and computers to observe and measure objects, organisms, and phenomena

Scientific Communications

- Acquire information from observation, experimentation, print and non-print sources
- Use information gathered from experiments and other sources to explain observations and events, including actively listening for alternative interpretations and ideas

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

National Standards

Grade 3-4 – Life Science

Content Standard C:

- The characteristics of organisms
- Life cycles of organisms
- Organisms and environment

Grade 3-4 – Science and Technology

Content standard E:

- Abilities of technological design
- Understanding about science and technology
- Abilities to distinguish between natural objects and objects made by humans

Grade 3-4 – History and Nature of Science

Content Standard G:

- Science as a human endeavor

Grade 5-8 – Life Science

Content standard C:

- Structure and function in living systems
- Reproduction and heredity
- Regulation and behavior
- Populations and ecosystems

•Diversity and adaptations of organisms

Grade 5-8 – Science and Technology

Content Standard E:
• Abilities if technological design
• Understandings about science and technology

Grade 5-8 – Science in Personal and Social Perspectives

Content standard F:
- Personal health
- Populations, resources, and environments
- Natural hazards
- Risks and benefits
- Science and technology in society

Grade 5-8 – History and Nature of Science

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

3-5 Exhibits List

A Round Microbe Colony
Amoeba Moves By Flowing
Aquarium
Friendly Microbes
How Microbes Make Us Sick
How Your Body Fights Disease
Live Bacteria Grown on these Plates
Microbes with Whips – Euglena
Microbe Laboratory
Microbial Botanic Garden
Paramecium Moves with Cilia
Penicillin Alive
Phytoplankton
Refrigerator Rot
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 why a person died from stepping on a nail in 1940 and why a person wouldn't today (The discovery of penicillin)

- Create a mystery about an unseen world where creatures can either help mankind or hurt it. Find out who is a friend and who is a foe. This could be a quest like The Lord of the Rings, only this world is REAL!
- Create a mystery around creatures with no arms, no legs, no eyes…what are they and how do they survive?
- Read the Discovery of Penicillin Story and students create questions
- Demonstrate one of the Laboratory Activities with no explanation-let the questions begin
- Do one of the Laboratory Activities and facilitate a probing discussion

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

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 as-

sess what students learn.

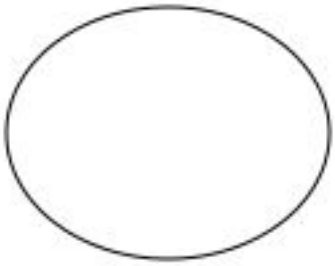
Time: (3)15-30 min. Sessions

Materials Needed:

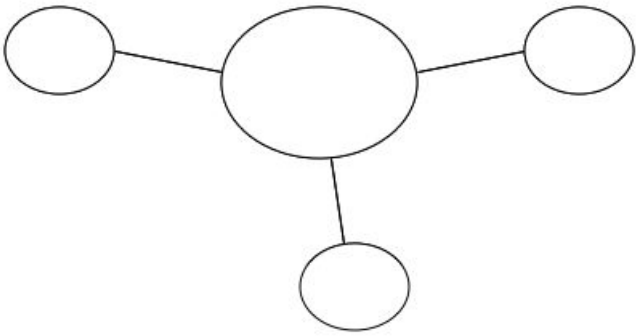
- Blank paper
- Pencils, colored markers

Procedure:

1. Begin with a center circle and write in the name of the main topic. (Students who do not write 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.

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, pens or colored markers
- 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.

Science TV- Investigative Reporters

Description:
In this activity, students plan and produce a TV show featuring investigative reports on the topic. This is a cooperative learning activity that integrates language arts, science and technology. There is a significant amount of writing involved, however students who are not prolific writers can also contribute as camera people, script supervisors, directors and on-camera reporters. Students will video tape at school and at the New York Hall of Science so pre-planning is essential for this activity.

Time: (3) 45 minute sessions (writing)
(1) video shoot at school
(1) video shoot at the New York Hall of Science
(1) 45 minute session (writing)
(1) video shoot back at school
(1) 30 minute session for viewing final TV show

Materials Needed:

- Video camera
- (1) video tape per student group
- External wired microphone for camera (optional but suggested for good audio)
- TV
- Cables to run camera to TV for viewing
- Student internet access (optional for research)
- Lined paper and pencils
- Large plain paper and markers (cue cards)

Procedure:

First Session-Planning

1. Tell students they are going to plan and produce a TV show with investigative science news stories that are 4-5 minutes in length.

2. Divide the class into groups of four or five students.

3. Have students or the teacher chose a writer/script supervisor, camera person, director and on-camera reporter for each group.

4. Tell students about the various roles in the production team:
- Writer-writes groups ideas for script, makes revisions
- Cameraperson-operates camera
- Director-supervises camera person and on-camera reporter, calls for action and cuts
- Script Supervisor-makes cue cards for on-camera reporter, makes sure script is followed
- On-Camera Reporter-person who reports and appears in video

5. Tell students that everyone the group will work together to create the script.

6. Remind students of the topic of study and the trip to the New York Hall of Science.

7. Instruct students to begin to create questions around the topic for the news show. They may want to create questions for interviews with New York Hall of Science "Explainers" too.

8. Tell students to watch the local news on TV so they can observe how news reporters do their job.

Second Session-Location Scout and Scriptwriting

1. Tell students they are going to do a location scout of the location they will be shooting at the New York Hall of Science. Scouting the location will help them think of more questions and give them ideas for what to shoot on location.

2. Make prints outs of the exhibits the class will visit at the New York Hall of Science OR have students access the exhibits online themselves.

3. Once students have become familiar with the exhibits, allow time for more scriptwriting. Make sure scripts have the following components:
- Introduction to the report (name of reporter, where they are, news headline)
- Questions the investigative report will answer
- Conclusion (to be done after video shoot at New York Hall of Science, comment, opinion about answers, reporter sign-off)

Third Session- Rehearsals and Final Script

1. Remind students about the various roles in the production team:
- Writer-writes groups ideas for script, makes revisions
- Cameraperson-operates camera, responsible for video tape
- Director-supervises camera person and on-camera reporter, calls for action and cuts
- Script Supervisor-makes cue cards for on-camera reporter to read, makes sure script is followed
- On-Camera Reporter-person who reports and appears in video

2. Have groups rehearse their roles using the scripts. (Camera people can use their hands to frame shots)

3. Advise groups to make script revisions if they notice problems during rehearsal.

4. Rehearsals can be done in front of whole class or in individual groups depending on your classroom space and noise level.

5. After rehearsal have groups meet and finalize the pre-New York Hall of Science script.

Homework
Have groups give script supervisor the pre-New York Hall of Science script so they can make cue cards. (Script supervisor can ask others to help make cue cards too)

Video Shoot at School
During this session each group will shoot the introduction to their news story. Each group will have their own video tape.

Make sure each group tape is labeled. If possible you may want to have groups shoot in a quiet separate location from the others or schedule group shoots during breaks in the day. If the entire class is present during shoots, make sure the others are quiet and don't distract the shooting. After shooting make sure camera people return the group tape to the teacher for safe keeping.

Video Shoot at the New York Hall of Science

1. Make the shooting schedule for the day.

2. Allow 15-20 minutes for groups to shoot in their location.

3. Choose a central location for production groups to meet the adult who will have the video camera and group tapes.

4. Make sure production groups stay together at the New York Hall of Science and Chaperones know the schedule for the day.

5. If students plan to interview a staff "Explainer", locate the Explainer in the area before shooting and ask for their assistance and cooperation for the shoot.

6. After shooting make sure camera people return the group tape to the adult for safe keeping.

Conclusion Script Back at School

1. Production groups will need to write the conclusion to their video script after their New York Hall of Science video shoot.

2. The conclusion should include a summary or opinion of the overall story as well as the reporter sign off.

3. Allow production groups to review their video footage (if necessary) so they can form opinions or summaries.

4. Have script supervisors and others in the group make up the final cue cards and conduct short rehearsals.

Video Shoot at School

During this session each group will shoot the conclusion to their news story. If possible you may want to have groups shoot in a quiet separate location from the others or schedule group shoots during breaks in the day. If the entire class is present during shoots, make sure the others are quiet and don't distract the shooting. After shooting make sure camera people return the group tape to the teacher for safe keeping.

View the Show

Hook up the camera to the TV and run the group tapes from the beginning. Enjoy the show.

Become an Explainer

Description: Students 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) 30 min. Session
(2) 45 min. Sessions (for in-class presentations)

Materials Needed:

- Interesting objects (used for student observation)
- Print outs of On-Site Investigation Handout

(optional suggestions)

- Variety of craft materials Variety of craft materials (pipe cleaners, popsicle sticks, straws, string, paints)
- 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, colored pencils

Procedure:

First Session

1. Tell students as they will be 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 distributing interesting objects.

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. Lead a discussion on what students can do at the New York Hall of Science to help explain and record what they see. Ideas include:

- Sketching
- Writing
- Using exhibit pictures on this web site
- Photography

6. Distribute The On-Site Investigation Handout (if needed) for use at the New York Hall of Science.

7. Go to the New York Hall of Science.

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)
- Labeled diagram
- 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.

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?

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 although yeast looks different from 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.

Growing Mold

Description:
In this experiment students grow mold using two variables. Students will observe and record results over time. This is a cooperative learning activity.

Time: (1) 45 minute session
Observation over several days

Materials Needed:

- (1) lemon per 4 students
- (1) orange per 4 students
- (1) tomato per 4 students
- (1) slice of bread per 4 students
- (2) large zip-lock bags per 4 students
- (1) permanent marker per 4 students
- Science Journals (lined or blank paper)
- The Discovery of Penicillin Story (optional)

Preparation:

- Cut the lemons, oranges, tomatoes and bread slices in half.
- Store cut food in large sip-lock bags until ready for use

Procedure:

1. Read The Discovery of Penicillin story to give students a context for the experiment. (optional step)

2. Display sliced foods in bags in student accessible area.

3. Divide the class into groups of four.

4. Have the students or teacher choose a “Collector” from each group (the Collector is responsible for collecting materials for the group)

5. Tell Collectors to get the following materials for their group:
- 2 lemon halves
- 2 orange halves
- 2 tomato halves
- 2 bread slice halves
- 2 large zip-lock bags
- 1 permanent marker

6. Tell students they will be conducting an experiment to discover what conditions grow mold best and how mold grows on different foods.

7. Have students place food in the two zip-lock bags. Each bag should have a piece of lemon, orange, tomato and bread.

8. Ask students what different kind of mold growing conditions they could test or simply tell students they will grow mold in two of the following conditions:
- Light versus dark area
- Warm versus cold area

9. Have student groups label their bags and place in testing areas.

10. Next, have students set-up their observation recording journal. Each recording page in the journal should have the following information:
- Date of observation
- Testing Area (cold, dark, light, warm etc)
- Test Subject Reports (written or drawing)

-Lemon
-Orange
-Tomato
-Bread

- Predictions (students may have predictions based on observations)

11. To conclude the session, conduct a brief discussion about student predictions. Here are some sample questions:
- What testing area do you think will grow mold best?
- Which food do you think will grow mold first?
- Which food will grow the most mold?

12. Observe mold growth over time and have students record their observations in their science journals.

13. Wrap-up the experiment by reviewing predictions or sharing results.

Print Resources

The Discovery of Penicillin Story

Penicillin was the first antibiotic that was successfully used in treating bacterial infections. Before its development, many people suffered and died from bacterial infections that are no longer considered dangerous today. For instance, just hurting yourself on a nail could eventually lead to death.

In 1928, Alexander Fleming was working at St. Mary's Hospital in London. He was researching agents that could be used to combat bacterial infections. One serious infection at that time was caused by staphylococci bacteria.

Once, when Fleming went on vacation, he left his culture plates unwashed. When he came back a few weeks later, he noticed that something had "grown" on one of the culture plates. It was mould, and the staphylococci were not growing around it! Apparently, the mould was secreting a substance, which prevented these harmful bacteria from growing. Fleming named the substance "Penicillin" after the mould, "Penicillium notatum," that was found on the culture plate. He later did some experiments with penicillin, but was not able to purify it, and did not really realize its potential for treatment against infections.

In one of the reports Fleming wrote on penicillin, he described the substance as very unstable. This was probably one of the factors that sparked the interest of a brilliant chemist, Ernest Chain, some ten years later. Chain, who was working with Howard Florey in Oxford, had started an investigation on antibacterial substances. Chain suggested, and Florey agreed, that they should take a closer look at penicillin.

To acquire enough penicillin for the treatment of even a few mice, technical inventions were needed. Up to this point, trays, tins and bottles were used in growing the mould for the production of penicillin. But Norman Heatley made several technical inventions that made it possible to produce penicillin on a larger scale. After many tests, Heatley discovered that ordinary bedpans, which were borrowed from the Radcliff Infirmary, were the most efficient containers for growing penicillin!

In May 1940, the team had been able to produce enough penicillin to test on infected animals for the first time. Here, streptococci, another kind of bacteria, which can be harmful to humans, were used. Eight mice were infected with a deadly dose of 110 million bacteria each. One hour later, four of them were injected with penicillin and four mice were left without treatment.

Heatley watched and waited. In the late afternoon the four mice that hadn't been injected with penicillin started to show signs of illness and soon after midnight they started to die. At 3:30 in the morning all the untreated mice were dead.

The four mice treated with penicillin remained fine! When Howard Florey heard of the result the next day he exclaimed, "It looks like a miracle!" Since Howard Florey was a man known never to exaggerate, his words really showed what he felt about it.

The mice experiment had undoubtedly been a great success, but to treat a human being, the amount of penicillin needed was about 3,000 times greater. Therefore, the team had to be very creative in producing all the needed penicillin. Heatley designed a container resembling a bedpan out of ceramic, which was more suited to their needs. 400 stackable containers were made where penicillin was grown.

Although the first patient treated with penicillin died due to a shortage of supply, further tests showed that the use of penicillin was successful for treating humans as well.

In July 1941, Florey and Heatley flew to the USA from Britain on a mission to convince the medical industry to start penicillin production. Florey, as usual, was very determined, and after several meetings, the project finally got started. One compelling reason was the attack on Pearl Harbor, after which the American government started encouraging medical companies to cooperate and speed up the production of penicillin. At the end of World War II, there was enough penicillin to treat all the wounded soldiers in the Allied Forces.

Source: http://www.nobel.se/medicine/educational/penicillin/readmore.html

Book List

Microbiology
Grillone, Lisa & Gennaro, Joseph. **Small Worlds Close Up**. Crown Publishers, Inc., 1978.
Keen, Martin. **The How and Why Wonder Book of the Microscope and What You See.** Wonder Books, 1961.
Sabin, Francene. **Microbes and Bacteria**. Troll Associates, 1985.

Microscopes
Stwertka, Eve and Albert. **Microscope.** Julian Messner, 1988.