6-8 -Hidden Kingdoms

*Curriculum Connections

Life Science

- Observe cells microscopically
- Observe and describe the ability of plants and animals to sense and respond to their environment

Scientific Connections And Applications

- Understand and describe examples of the importance of scientists, science, and technology (microscopes, SEM, penicillin) and the impact that they have on our lives
- Understand the relationship between form and function, order and organization, change and constancy
- Develop appropriate choices leading to good personal health

Scientific Tools and Technologies

- Use microscopes to observe and measure organisms
- Acquire information from observation and print sources

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

National Standards

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

6-8 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 Microbe Full of Algae - Paramecium Bursaria
A Round Microbe Colony
A Trumpet Shaped Microbe - Stentor
Amoeba Moves By Flowing
Aquarium
Beer and Bread are Made with the Help of a Microbe
Design with Diatoms
Euglena Moves with Whips
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
Microbes in the News
Microbial Botanic Garden
Paramecium Moves with Cilia
Penicillin Alive
Phytoplankton
Pink Microbes - Blepharisma
Refrigerator Rot
Reiber Glacite Models
Scanning Electron Microscope Demonstration
SEM Views of Microbes
Size and Scale of Microbes
Understanding AIDS
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 World War II American soldier died of infection in the beginning of the war and why a soldier survived that same infection by the end of the war (The Discovery of Penicillin)
- Create a mystery about whether antibacterial soap could be creating new kinds of bacteria. (antibiotic resis-

tance)
- Do one of the Laboratory Activities and facilitate questioning
- Demonstrate one of the Laboratory Activities with no explanation-let the questions begin

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

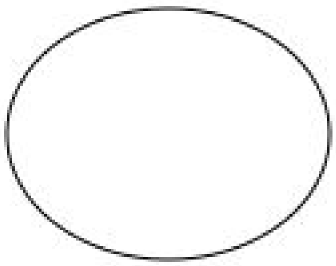
Description: Detectives will often map out related events, evidence and suspects during an investigation. This helps them get an overall picture. Students can map out their investigations with a concept map. The concept map will help you assess what students learn.

Time: (3)15-30 min. Sessions

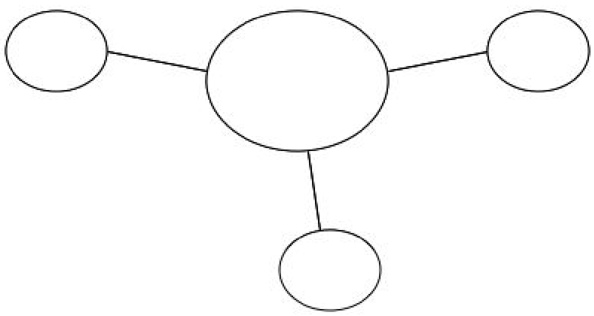
Materials Needed:
- Blank paper
- Pencils, colored markers

Procedure:

1. Begin with a center circle and write in the name of the main topic. (Students who 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.

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. 4. 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 practice observation skills and 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: (3) 45 min. Sessions

Materials Needed:
(per student pair)

- Interesting objects for student observation that will fit in a lunch bag
- Lunch bag
- Print outs of On-Site Investigation Handout

(optional suggestions)

- 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

Preparation:
Place interesting objects for observation in lunch bags to keep hidden from student view.

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. Tell students they are going to do an activity to practice their observation and describing skills.

3. Distribute materials to student pairs.

4. Tell students that the person who is holding lunch bag will now describe the object inside to the other person without naming the object or describing what it is used for. Only descriptions of what the object looks like are allowed. The other student must guess what the object is.

5. Allow student pairs to complete activity and then switch lunch bags with another student pair. Each student pair should have a new object.

6. Repeat activity.

7. Conclude activity by telling students they will need these same skills of careful observation and detailed describing to explain exhibits they investigate.

8. Conclude the session by leading a discussion about 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

9. Distribute The On-Site Investigation Handout for use at the New York Hall of Science.

10. 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-good for ESL students)
   - 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.

Note: Your class may want to make their presentations to another class or younger students as well.

Science Court- Bacteria Vs. Antibiotics

Description:
In this activity students will research and debate the controversial question:
Is antibacterial soap creating new kinds of bacteria?

Time: (4) 45 minute sessions
(1) trip to the New York Hall of Science (go in the middle of the continuum to see real microbes)

Materials Needed:
- Print out and copies of Wash Out article
- Index cards

Procedure:

First Session
1. Tell students they will be participating in a mock court session debating the question:
Is antibacterial soap creating new kinds of bacteria?

2. Tell students they will be divided into two groups to present both sides of the debate:
   - Scientists
   - Industry

3. Tell students the case will be decided by the judge (teacher) or a jury (another class).

4. Hand out the Wash Out article and have students read in class.

5. Use the remaining time to discuss the article. You can use these questions for discussion:
   - What is the problem or concern that scientists have about Triclosan?
   - Has the soap industry fooled the public?
   - What was the soap industry response to the Tufts study? Are they right?
   - What questions still need to be asked about this issue?

6. Write down student questions

Second Session
1. Divide class into two groups; industry and scientists.

2. Review student questions from the first session.

3. Have students decide which questions each group would ask to research their case.

4. Have groups copy the questions they want to answer to present their case.

5. Discuss research sources where students can prepare for their case. (Library, internet)

6. Assign research for homework.

7. Tell students they will prepare their case in the next session.

Third Session
1. Have students divide into their groups and discuss their research findings.

2. Have student groups choose a 2-3 representatives to present their case in court.

3. Have student groups choose 2-3 writers who will make index cards for the representatives.

4. Tell students they will have 125 minutes to present their group’s case.

5. Student groups spend the remainder of the time preparing their case for the court session.

Fourth Session

1. Court is in session.

2. Set up the room so that representatives from each student group can present their case.

3. Allow each group 15 minutes to present their case.

4. Allow 10 minutes for the other class jury to deliberate on who presented their case the best.

5. If another class jury is not available spend 10 minutes discussing who presented their case the best with the entire class. The teacher acts as judge and makes a final ruling.

Print Out

Wash Out

Mary Ann Hellinghausen

Triclosan—an antibacterial agent found in products as diverse as dish soap, shampoo, toothpaste, and body washes—has permeated the retail market since being introduced into consumer products in 1995. Today it's hard to find a hand soap in your grocery store aisle not containing triclosan or some other antimicrobial germ fighter.

Widespread Use

Triclosan's pervasiveness prompted geneticists at Tufts University School of Medicine in Boston to investigate whether its widespread use could generate a strain of resistant bacteria, causing it to lose its effectiveness.

"The potential is there for a problem because of the dramatic increase in its use," said Stuart Levy, MD, director of the Center for Adaptation Genetics and Drug Resistance at Tufts, where the study on triclosan was conducted. "[Nurses] need to realize there's another force out there going on in our homes that could compromise what's going on in hospitals."

The study, published in the Aug. 6 edition of the scientific journal Nature, found—in tests on E. coli bacterium—that triclosan targets a specific bacterial gene. Although researchers have not yet found resistant bacteria that are the product of triclosan exposure, the discovery that the compound targets a specific genetic site means the potential for developing a resistant bacterial strain is much higher, the study's authors conclude.

Levy said triclosan and other antimicrobials have valid uses in clinical areas, but cautioned against their indiscriminate use. Antimicrobials guard against many forms of infection, including bacterial infections. Antibacterials guard against only bacterial infections.

Use of antimicrobials needs to be monitored, said Linda Doyle, RN, an infection control consultant in Oxnard. "I do have some concerns that the more we use it, it could cause some problems along the way," she said. "Infection control people have to be alert and look for changes in organisms in their own facilities." Doyle recommended nurses be vigilant about following handwashing guidelines with regular soap and have access to antimicrobials when needed. "We have to be prudent in our use," she said.

The national Centers for Disease Control and Prevention (CDC) in Atlanta says vigorous handwashing in warm water with plain soap for at least 10 seconds is sufficient in most cases, even for healthcare workers. CDC guidelines recommend using antimicrobial soaps when caring for newborns, patients in high-risk units, and severely immunocompromised patients.

Marketing Ploy?

Fran Slater, MBA, RN, manager of the infection control department at The Methodist Hospital in Houston and president of the Association for Professionals in Infection Control and Epidemiology (APIC) in Washington, agreed there is reason to worry about the widespread use of antimicrobials. "It's a concern to us from the standpoint that the [soap] industry uses the characteristics of these products as a marketing ploy,'' Slater said.

A statement from APIC says, “These products are marketed to the consumer with the implication that their use will lower the risk of infection. We are concerned that the public may develop a false sense of security and may not be aware of the continued need for valid hygienic practices (such as frequent handwashing).”

APIC asked 11 companies that market products containing antimicrobials for information on the efficacy of such products for consumers, but received no industry response. “There is no proven infection-prevention benefit in the use of these products,” APIC states. “APIC does not advocate the use of antimicrobial household products which are marketed with the implication of preventing infections.”

At The Methodist Hospital, clinicians use antimicrobial soaps in critical care and surgical units, but not on regular nursing floors, Slater said. “We don’t want to overload the environment with antimicrobial agents—it’s a matter of being prudent,” she said.

She recommends that nurses not use antimicrobials routinely— “only when you absolutely have to,” she said.

Industry Standpoint

The Tufts study drew criticism from the soap industry as lacking “real world” value.

“These were laboratory-engineered bacteria,” said Elizabeth Moore, spokesperson for Procter & Gamble Co., which uses triclosan in Dawn and Joy dish-washing soaps. “These were not real world conditions. In the real world [germs] have to compete with a host of other organisms. We’re really not worried about [triclosan use] leading to superbugs or resistant germs.”

A spokesperson for the New York-based Soap and Detergent Association (SDA), which represents 140 North American manufacturers of cleaning products, said those containing triclosan have been used for more than 30 years and have never been shown to promote antibiotic resistance.

Contrasting Studies

Two recent studies by hospital infection control researchers showed triclosan-based wash products controlled and reversed outbreaks of resistant bacteria infections in hospitals. One showed the use of Bacti-Stat—containing 0.3 percent triclosan—eradicated an outbreak of methicillin-resistant Staphylococcus aureus (MRSA) in a neonatal nursery. An Australian study showed that triclosan body washes were effective in reducing the impact of MRSA in acute care facilities.

“Hospitals are areas where antibiotic resistance is closely monitored,” said Janet Donohue, SDA spokesperson. “Triclosan has been used in hospitals for years with no evidence that antibiotic resistance is an issue.”

The Food and Drug Administration said research is continuing into triclosan’s use. “The jury’s still out,” said FDA spokesperson Stephanie Bernier. “It is an issue that we are looking into, but we don’t see it as a major health problem.”

Source: http://www.nurseweek.com/features/98-10/soap.html

Note: According to the U.S. Centers for Disease Control, antibiotic-resistant bacteria kill more than 40,000 North Americans a year.

For more information:
How do microbes “learn” to defeat antibiotics?
http://whyfiles.org/038badbugs/mechanism.html

Print Out

The Discovery of Penicillin

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

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 activity that shows yeast in action without the need to make bread. Yeast is made of living cells and is a fungus just like mushrooms even though it looks different from a mushroom. 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:
(per student group)

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

Procedure:
1. Tell students they are going to work with live microbes and see how they breathe.

2. Distribute yeast to student groups.

3. Have students open up yeast packages and examine the contents.

4. Ask students to verbalize what they observe. (nothing is happening with the yeast in it's dry state, so comments will be limited)

5. Tell students that they will now activate the yeast to make it breath.

6. Distribute the other materials to student groups.

7. Tell students to blow up the balloon a few times and let the air out to loosen it up.

8. Instruct students to warm up the glass of the bottle by pouring some warm water into the bottle and swirling it around. Pour the water out.

9. Now ask students to dump the yeast into the bottle.

10. Have students add 1 teaspoon of sugar to the bottle and swirl it around.

11. Have students add 1/2 cup of warm water to the bottle and swirl the contents around.

12. Now have students 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.

13. Have students place the bottle in a large bowl with warm water.

14. Have students watch what happens. (the balloon should start inflating)

15. Tell students that yeast is made of living cells and is a fungus just like mushrooms even though it looks different from a mushroom. 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.

Adapted from Kid Wizard

Growing Mold

Description:

In this experiment students grow mold using four 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
- (4) 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
   - 4 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 four different kind of mold growing conditions they could test or simply tell students they will grow mold in 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.

Microbe Survival Tests

Description:
Students create their own experiments to test conditions where microbes survive best. Teams write experiment proposals that include a hypothesis, prediction, materials needed and procedure. This is a cooperative learning activity.

Time: (4) 45 minute sessions
Observation and data recording over time

Materials Needed:
- Ziploc® storage bags or clear glass jars with lids (baby food, jelly jars etc)
- Microbe medium for growth (bread, aged cheese, agar)
- Microbes (yeast is most common)
- Small thermometers (to fit in jars or bags)
- Microscope or hand lens (optional)
- Other experiment materials as listed by students in experiment proposal

Procedure:

First Session
1. Divide class into groups of 4-5 students each.

2. Tell students they will be designing an experiment to test what conditions microbes survive in best.

3. As a class or in groups determine what conditions will be tested. Some ideas are:
- Temperature (hot, medium and cold)
- Light (darkness, sunlight, ambient light)

- Moisture (dry, damp, wet)
- Additives (dirty paper towel, dirty sponge, anti-bacterial wipe)

4. Show students materials that will be provided.

5. Tell students that if they require additional materials for their experiments they must have them approved by the teacher. Acquiring additional materials can be done by students or teacher.

6. Spend the remainder of the time having groups work together to develop their experiment.

Second Session
This session is dedicated to experiment development. The teacher can circulate during this time and facilitate any questions that arise from students. Teachers are encouraged to let students work through experiment design problems and solutions. Group can share experiment designs with other groups as is often done in real scientific research. Groups should hand in proposals and have them approved before conducting their experiments.

Third Session
This session is devoted to student groups setting up their experiments and data recording. Team members from each group can be assigned tasks such as gathering and setting up equipment and data recorders.

Fourth Session
This session is conducted after the experiments have concluded. The teacher leads a question and answer discussion so students can share results. Here are some examples of questions teachers can ask:

- Did any microbes not grow at all?
- Did some microbes take longer to become visible?
- Which microbes grew the fastest?
- What appears to be the ideal conditions for yeast microbes?
- Where would those conditions be found on Earth?
- What are the worst conditions for yeast microbe growth?
- Where would those conditions be found on Earth?

Experiment adapted from National Science Foundation, Polar Connections, Activity B1.2.
Source: http://www.nsf.gov/nstw/teach/nstw98/english/actb/spores1.htm

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