Adventures in Moulds and Yeasts

Activity 2.2

GRADES
2-6; **Worksheet** 4-6

TYPE OF ACTIVITY
Experiments; worksheet

MATERIALS
See text body

VOCABULARY
chitin
fission
spores

WARNING!
Before beginning any of the following experiments, make sure due caution is given to prevent direct exposure to molds:

1. Take care in handling all specimens.
2. Make sure to always view moulds through glass or plastic.
3. Make sure nothing is eaten from the experiment.
4. Make sure hands are washed after handling the materials.
5. If you have any students with severe allergies, they may be advised to leave the class during the experiments.

OBJECTIVE
- To expand student knowledge of fungi beyond mushrooms and illustrate some of the properties of moulds and yeasts

BACKGROUND INFORMATION
Most everyone is familiar with moulds; it is what turns our bread black, makes our oranges mushy, and appears like magic on last week's yogurt. Yeast is also readily recognizable to anyone who has been in the kitchen when bread, donuts, or pizza dough are being made--and surely we all know what mushrooms are! What will come as a surprise to students though is that mushrooms, moulds, and yeasts are all members of the Kingdom Fungi. The characteristics that unite these organisms are: their food must come from an external source (unlike plants which can make their own food); they reproduce using **spores**; and they have cell walls that contain **chitin**.

Although moulds are generally inconspicuous and perceived as a nuisance, they have literally changed history for the better. In 1928 a Scottish scientist named Alexander Fleming made medical history when he discovered that the mould *Penicillium* released a chemical that prevented bacteria from growing near it. From this lemon-loving mould, the antibiotic drug Penicillin was developed. Over the last century Penicillin has saved the lives of millions of people world-wide, as well as protecting crops and farm animals from various infections. That is a lot of heroic work for a little mould!

Yeasts are no slackers either! For being nothing more than a single-celled organism, they have leavened breads and given rise to alcoholic beverages for thousands of years. They have also been celebrated for their nutritional qualities as natural sources of folic acid, niacin, riboflavin, pantothenic acid, and other B vitamins. Yeasts have the capability to go dormant in the absence of food and water, but when moisture, food, heat and oxygen are right, yeasts flourish and will grow rapidly.

In the following activities, students will become more familiar with the lifestyles of these microorganisms.

ACTIVITY 1: MUSHROOMS AND MORE

Materials:

- the best possible variety of mushroom samples. Consider: field mushrooms, shitakes, wood ears, Chinese white fungus (*Tremella*), enoki, oyster mushrooms, chanterelles, morels, blue cheese. Most of these are easily found in supermarkets or Asian markets.
- mouldy bread and/or mouldy citrus in ziploc bags (see Activity 2 for instructions)
- sampling of yeast products. Consider: bread, donuts, root beer, Brewer's yeast, nutritional yeast, Marmite/Vegemite
- an example of a plant. Consider: a head of lettuce, some carrots or beets with their tops
- Anatomical Anagrams worksheet from page 25

TEACHER INSTRUCTIONS

1. Place all the objects on a table. Ask the students to point out the item that does not belong (*the plant*). At first everything might seem edible, but guide students to thinking in terms of the biological kingdoms. Emphasize the mould on the citrus fruit rather than the fruit itself. This is a tricky question!
2. Once the outsider is identified, get the students to group the remaining items into three categories: mushrooms, moulds, and yeasts. Tell them that even though these items look very different, they do in fact have a lot in common; they are all members of the same biological kingdom.
3. Review the characteristics of the Kingdom Fungi. It may help to contrast the plants. These differences are illustrated in the text body of the activity Fungi--The Hidden Kingdom on page 8.
4. Share some information about moulds and yeasts. Remind students that mushrooms are like the fruit of a fungus and are analogous to an apple on an apple tree. It is also interesting to note that from only a small piece of mushroom stem or cap, a whole new organism can grow! This is because a mushroom is just an extension of the fungal body, which usually hides underground.
5. Next, hand out copies of the worksheet, Anatomical Anagrams, and have the students complete the worksheet. Go over the answers as a class.
6. While students are working on their worksheet, draw a simple diagram of yeast budding on the board. Point out the little "bud" and explain why it is called budding. If students get a chance to view active baker's yeast under the microscope at 400X magnification, they will mainly be viewing budding which is the fastest way to reproduce.
7. Have the students copy down the diagram on the back of their Anatomical Anagrams worksheet. Ask them if they have ever watched a person make bread or if they have done it themselves. Touch on the idea of just how fast yeast can reproduce under the right conditions. The faster they bud, the more gas they release, and the faster the bread will rise!

ACTIVITY 2: MOLD GARDEN

Materials:

- bread. Consider a variety: organic whole wheat, "Wonderbread", sourdough, rye, etc.
- variety of foods both organic and containing preservatives. Consider: cheeses, fruits, salad, meats
- items from living origins. Consider: fabric scraps, leather, paper, wood
- items from non-living origins. Consider: plastic utensils, wire, old batteries...
- traditional preservatives: salt, vinegar, sugar
- large jars or transparent plastic containers
- water sprayer
- plastic wrap

TEACHER INSTRUCTIONS

1. Begin with a brief discussion about spores. Explain that mould spores are everywhere and, in fact, most of the flecks we see when sunlight enters the room are actually spores. Remind students that unlike seeds, spores need to land on a suitable food source in order to germinate; seeds carry a "packed lunch" with them but spores do not.
2. Ask students if they have ever seen bread go mouldy. When did this happen? Why do they think it happened?
3. Refer them to the diagram of the mould on their worksheet. Explain that when moist bread is left of a table, it becomes a very inviting meal to spores. Spores will land on the bread and germinate into hyphae and form a mycelium. Then some of the hyphae extend upwards and form spore cases at tips of each upright hyphae. When spores are ripe, walls of spore cases split and the spores are released into the air and the cycle begins again.
4. Tell the students you are going to make a series of mould gardens to discover where moulds will grow-- in other words, their habitat.
5. For each mould garden, students will need to write a hypothesis comparing the likelihood of mould growth. There are so many variants for "themed" gardens. For example, in a "bread garden", students could predict which types of bread would develop mould the fastest. Have students read the labels and look for preservatives that may retard mould growth. There could also be two alternative bread gardens to compare to a control; one in which the bread was misted with vinegar instead of water and another misted with salt water.
6. To prepare the items for gardening, gently mist them with water and leave them exposed for 30 minutes.
7. Place them in the jar or plastic container and cover with plastic wrap; poke a few small holes for air circulation.
8. Put the containers in a warm, dark place and observe after a few days. Have the students record their initial observations. DO NOT open the containers once mould has started to grow.
9. Continue to observe the gardens every few days.
10. Some of the conclusions that students should draw is that mould grows best on moist foods such as soft fruits. Salt and vinegar should inhibit or delay mould growth. Mould also has the potential to grow on things that are made from materials that were once alive. It is highly unlikely mould will form on any plastics in the time frame of the experiment.
11. Discuss with the class things they can do to minimize the chance of mould invading their favourite foods. You can talk about refrigeration and putting lids on things to prevent air circulation. You may also want to talk about the use of salt and vinegar to make pickles as a way of traditionally preserving vegetables and meats/fish and sugar in the preserving of fruit as jam.

EXTENSIONS

1. Place a few dead flies in a jar with some stream water and wait 3 weeks. Students will observe that insects can also be a food source for fungi.
2. Start a compost in an aquarium. Not only will moulds grow, but the whole family of decomposers will come out to play!

ACTIVITY 3: YEASTS GONE WILD!

Part 1 Materials:

- 3 balloons
- 3 empty pop bottles (500mL)
- electrical tape
- funnel

- sugar
- dry baker's yeast (quick rise is good!)
- a warm place, tub with warm water or heating pad
- a thermometer

TEACHER INSTRUCTIONS

1. Remind students briefly about the release of gases during budding. If you capture these gases, you can blow up a balloon BUT you need to give yeast the right conditions in order to do so. (*happy yeast will blow bubbles!*)
2. Mix together 1-1/2 cups warm water, 3 Tbsp sugar and 3 Tbsp dry yeast and using a funnel, pour the mixture into 3 pop bottles.
3. Blow up the balloons a few times to create some "give" in them; then place a balloon over the mouth of the bottles and seal it with electrical tape.
4. Put one bottle in a warm place such as on a heating pad on a low setting or in a warm water bath with the target temperature between 24-30 degrees Celsius.
5. Leave another bottle at room temperature and place the third one in a cool place.
6. Have students make predictions about which yeast will be happiest and which balloon will blow up the fastest.
7. Discuss your observations. What does this say about the conditions yeast needs to multiply? Ask your students if they have ever seen anyone make bread. Where do they put the bread to rise? A warm place or a cool place?

Part 2 Materials:

- variety of natural and artificial sweeteners. Consider: honey, maple syrup, molasses, fruit juice, corn syrup, brown sugar, Splenda, aspartame
- beakers, jars or glasses to correspond to number of sweeteners
- masking tape to label jars
- dry baker's yeast
- a warm place, tub with warm water or heating pad to target 24-30 degrees Celsius
- a thermometer to check ambient temperature
- rulers

TEACHER INSTRUCTIONS

1. Tell students that you will be conducting an experiment to discover yeast's favourite foods. Imagine they are gourmet chefs serving up delicacies to their yeasty patrons. The way they will be able to tell if the yeast is enjoying their meal is by the amount of foam that forms on top of the liquid.
2. Add 1 Tbsp of sweetener and 1 Tbsp of dry yeast to 1/2 cup of warm water. Stir thoroughly. Leave one jar without any sweetener at all.
3. Label the jars.
4. Record the class predictions about what food source the yeast will prefer.
5. After 15 minutes and 30 minutes, measure the amount of foam that has formed.
6. Explain why the yeast did not grow in the jar without sweetener (*no food, no reproduction*). How is this different from plants? (*plants don't need an external food source as they make their own*) Then explain that the yeast did not like the artificial sweeteners because they do not have very much energy in them (which is why people on diets sometimes use them).

Part 3 Materials:
- dry baker's yeast
- a banana

TEACHER INSTRUCTIONS

1. Slice the banana in half lengthwise.
2. Put some dry yeast on one half and nothing on the other.
3. Have the students predict what they think will happen to the banana after a few days.
4. Cover the banana slices.
5. Observe after a few days. The yeast will have gobbled up a lot of the banana as food.
6. Have the students draw the banana slices and compare their prediction to the results.
7. Dispose of the bananas when finished observations. Do not eat!

DISCUSSION

1. Review what yeast need to survive (*food, water, warmth, oxygen*) and compare this to what we need to survive.
2. Given the right conditions, some yeast are able to reproduce at rates that approach exponential growth. See handout "Exponential, My Dear Watson". Instruct students to draw two new yeast cells (for each previous single one) every 30 minutes. It may be helpful to use a stack of pennies (or nickels, or buttons) to help keep track of the yeast replication. For example, start with **one** penny (yeast cell) at 9:00am. One yeast cell buds and becomes two yeast cells so at 9:30am, there are **two** pennies. At 10am, have the students stack a penny onto each of the previous pennies. There should now be a total of **four** cells. Have students count and right down the number of pennies at each time slot before stacking more pennies and moving on. You will need a minimum of 64 pennies per student (or pair of students) to complete the activity.
3. You may want to do the activity together as a demonstration if it seems too complicated for your class. The purpose of the activity is to illustrate the magnitude of yeast reproduction.

Answer key:

9:00 - **1** cell**;** 9:30 - **2** cells; 10:00 - **4** cells; 10:30 - **8** cells; 11:00 - **16** cells; 11:30 - **32** cells; 12:00 - **64** cells

EXTENSIONS

1. As a complement to any of these yeast activities, students could view yeast under the microscope. If you have access to a microscope, set the magnification to 400X. Prepare a wet mount from a solution of yeast in warm water and sugar. Students will be able to observe phenomenal growth right under their eyes! Note that baker's yeast reproduces by budding.
2. Yeasts have a very high nutritional value. Research the role of folic acid, niacin, riboflavin, pantothenic acid, B1, 6, 12 in the body.
3. You could bring in some samples and talk about sourdough bread. Sourdough was the main bread made in Northern California during the California Gold Rush, and it remains a major part of the culture of San Francisco. The bread became so common that sourdough became a general nickname for the gold prospectors. Sourdough "captures" wild yeast and causes the dough to rise.

Exponential, My Dear Watson! 2.2

Directions

Yeast cells are able to reproduce very quickly. Imagine that you had a pet yeast cell and that you fed her a lot of sugar before leaving for school at 9:00am. If she budded a new yeast cell every 30 minutes, and each of her "buds" did the same, how many cells would there be when you arrived home for lunch at noon? (Be prepared to expect a really big party!)