Science Unit: Biology Inquiry

Lesson 1: *Decomposition*

Lesson Summary

Students observe the results when drinks (milk, apple juice and soda) and breads (with short and long shelf lives) are allowed to decay in the classroom, contained in petri dishes and baggies, under various conditions. The changes during decomposition are followed closely, and ideal conditions for mould growth are determined.

School Year:	2016/2017
Developed for:	Britannia Elementary School, Vancouver School District
Developed by:	Ingrid Sulston (scientist); Kevin Dwyer and Pascal Spino (teachers)
Grade level:	Presented to grades 4-6; appropriate for 2-7 with age appropriate modifications
Duration of lesson:	This lesson needs to be spread over three (or possibly two) weeks, to allow time for mould growth. Lesson A is set up (half hour); Lesson B is an initial observation (half hour) which may be merged with Lesson C if there is a lot of growth; Lesson C is a final observation and mould study (at least one hour).
Notes:	Following Lesson 2, and observation of milk curdling when spoiling, students can perform a controlled milk curdling experiment to make their own cheese.

Objectives

a) Practice accurate observation and record keeping of multiple samples over several weeks.

b) Understand that food spoilage and decomposition is the growth of living things on the food, such as bacteria and mould.

c) Learn to use a microscope to observe mould closely.

d) Appreciate mould as a living thing that, like us, thrives in conditions suited for its survival.

Background Information

Students are universally grossed out by the appearance of mould on food, as they have learned that mouldy food is bad for us. This lesson looks at food spoilage and decomposition from another perspective: bacteria and mould are living things, just like us, and will grow wherever they are able in order to survive.

Mould grows best in warm and damp conditions, on a substrate that provides it with nutrients, and in the absence of anti-fungal agents such as food preservatives. Mould finds new places to grow by releasing spores, which are tough capsules that can survive hot, cold and dry conditions. Once a spore settles on a substrate suitable for colony growth, it germinates and grows into branching hyphae, long threads which spread over and through the substrate.

Once established, some of the hyphae grow upwards, and form clusters of new spores at their tips. The ripening spores give a mould colony its characteristic colour. The new spores blow away to spread the mould to other substrates.

Vocabulary

bacteria	Microscopic single-celled organisms with a simple cell structure. Bacteria are found in diverse environments, including extremes of temperature, pressure and acidity. Bacteria live inside other living things, including our own body.
mould	Mould is a kind of Fungi (other Fungi are mushrooms and yeasts) and is important in the decomposition and recycling of dead organic matter.
hyphae	Long, branching filament structure of mould (and other Fungi), which grows over and through a substrate. A mass of interconnected hyphae are called a "mycelium".
spore	Spherical single cell of mould (also other Fungi, plants, algae, bacteria), containing genetic material, for reproduction and dispersal. Spores are tough and can survive extreme conditions. Mould spores are often dark colours to protect the DNA inside from damage by UV radiation.
mould colony	A visible cluster of mould, generally round, and of varied colour depending on the mould species. Usually derived from one spore which landed in the centre of the colony, and gave rise to a network of hyphae (mycelium).

Materials

- slices of bread with different shelf lives e.g. fresh bread with one day shelf life; supermarket bread with 10 day shelf life
- optional: fridge
- trays and a place to store the bread/liquids for 3 weeks where they will not be disturbed
- sandwich baggies
- drinks e.g. milk, fresh apple juice, sprite or other light coloured soda
- worksheets
- spray bottle of water
- petri dishes or other shallow dishes with transparent lids
- if possible: microscopes, 20X or higher magnification
- dark cloth to wrap baggies in

In the Classroom

Introductory Discussion

Introduce the lesson with discussion on what happens to food if it is left out too long, naming the kinds of living things that grow on decomposing food, including bacteria and mould. Lead the discussion in the direction of decomposition from the point of view of the mould or bacteria - they are living things like us and need certain conditions for their survival. Tell the students that they will be setting up a series of food and drinks to figure out the conditions that moulds and bacteria prefer to grow in. They will be recording the changes they observe over two weeks.

Processes of science that the students will focus on: close observation, accurate recording of observations, designing experiments, collecting and recording data, inferring, hypothesis testing, predicting, concluding.

Safety Guidelines

Many people are allergic to mould spores, so the bread should be kept in the baggies throughout the experiment. If the mould is hard to see under the microscope through the baggie, part of the mouldy bread can be transferred to a petri dish with a lid in a well ventilated area.

Decomposition Activity

Lesson A:

Set-up the Decomposition experiment:

1. Setting up the drinks: Provide the students with petri dishes, three or more per table group, and help them to pour milk, fresh apple juice, sprite (or other soda) into them. Ask them to place a lid on each, number the dishes, then document the contents of each dish in their data table.
2. Setting up the breads: Provide students with breads of different shelf lives, a spray bottle of water, baggies and pieces of dark cloth. They can choose different conditions for bread decomposition. Discuss the importance of including different treatments of one variable, to determine how the chosen variable affects decomposition. Student groups can later share data to observe other variables.
3. Place samples in a place that they will be undisturbed for a week.

Variable	Sample or Sample Treatment
type of bread	• short shelf life - local bakery bread with one day shelf life, sealed in a baggie • medium shelf life - supermarket bread with 3 or 4 day shelf life, sealed in a baggie • long shelf life - supermarket bread with ~10 day shelf life, sealed in a baggie
moisture level	• low moisture - leave baggie wide open or cut a hole in the baggie • medium moisture - seal baggie with bread inside • high moisture - mist bread with water before sealing inside baggie
light level	• light - bread sealed in baggie left near light from a window • dark - bread sealed in baggie wrapped in dark cloth or put in a dark box
temperature	• room temperature - bread sealed in baggie left at room temperature • cool temperature - bread sealed in baggie and put in a fridge (note that this cannot be combined with light treatment, as a fridge is dark)

Lesson B:

(one week later): Document decomposition process

1. If there has been a lot of mould growth, likely because of higher classroom temperatures, the teacher can elect to move directly to Lesson C. If the mould colonies are small (1cm diameter or less), an additional week is recommended to grow more impressive colours and colony sizes.

2. Ask students to look closely at their drinks and bread set up the week before, and document any changes on their worksheet. They should notice changes in texture, colour and smell. For safe smelling of a sample that might have unpleasant odours, teach students how to waft air from above the sample towards their nose (rather than sniffing the sample directly). If they find mould, they can record the number and colour of the colonies. They should leave the samples in their baggie/keep the petri dish lid on, to avoid possibly unsafe ingestion of mould spores.

3. Short discussion on what kinds of living things are starting to grow on the samples.

   Breads: Use a show of hands to find out what samples mould is growing on. It is likely that with high moisture levels more mould will grow. It is likely that the long shelf life bread will have little, if any, mould growth. Note that results will vary, depending on the samples used and the classroom conditions. Discuss what a mould is and that the sample it is found on is a favourable place for it to grow.

   Liquids: Mould colonies may be growing on the fresh apple juice, but are unlikely on the sprite. The milk will be clumped ("curdled") and stinky. Discuss that bacteria is present in milk and that at room temperature, they have grown and multiplied. The change in the milk is mostly due to a harmless bacteria called *Lactobacillus*, that is present in milk (it is not destroyed by pasteurization), and as it grows it releases (lactic) acid. Acid interacts with milk proteins to make them clump. (Some harmful bacterial spores also survive pasteurization, which is why milk should be kept in the fridge, and should not be consumed if the milk is spoiled.)

   

   Milk curdling due to Lactobacillus growth is directly related to how cheese curds are made and the cheesemaking process. Pair the spoiled milk observation with a lesson on making Cheese (REFERENCE to Lesson 2: Cheese).

Lesson C:
(one more week later): Document decomposition process; observe mould closely

1. If there is a lot of mould growth on a bread and odours are penetrating the baggie, add an additional baggie over the first.
2. Students record further changes to their drinks and liquids on their worksheets.
3. Discuss the class results, in terms of conditions that moulds thrive in. A consolidated table of class results can help with discussion, though it can be complex with the many possible variables. If results across groups are compared, be sure to compare results with only one variable changed between them.

   Liquids: The soda likely did not encourage any mould growth. Read out the soda ingredients, and point out that it does not contain many nutrients (apart from sugar) which mould needs for growth. Fresh apple juice is likely had some mould growth, and the ingredients of apple pulp contain many nutrients as well as sugar, which encourage mould growth. Boxed apple juice that is sold at room temperature may yield different results. The milk may have already been discussed in Lesson B but it can be discussed again - it rapidly spoiled from bacterial growth, but given time, mould would likely have grown in the milk too. Milk provides a host of nutrients for growth of bacteria and mould.

Breads: The breads will be variable in how much mould grows on them, depending on the conditions.

- Shelf life: Bread with a longer shelf life will generally have less mould growing on it. Read out the ingredients to challenge students to figure out why it may stay fresh longer. Preservatives such as calcium propionate and sorbic acid are added to long shelf-life breads. They inhibit mould and bacterial growth.
- Moisture level: Bread out of a bag turns dry very quickly and does not allow any mould growth. Bread enclosed in a bag grows mould as the bread contains some moisture. Bread that is misted with water before putting in a bag will grow a lot of mould. Conclude that mould grows better in a moist environment.
- Light level: Some moulds grow better in the dark vs the light, though this is not universal.
- Temperature: Mould would be expected to grow faster in warmer conditions. This is why we put food in the fridge to slow down decomposition and the spoiling of foods.

4. Use microscopes to look closely at mould, challenging students to find the long thread-like hyphae and the dark-coloured spore heads. If the mould structure is not clearly visible through the baggie, transfer a piece of the mouldy bread into a petri dish with a lid, making sure to do the transfer in a well ventilated area away from students (to avoid any allergy responses). Mould growing on the surface of apple juice is likely to have retained its three-dimensional colony shape, and can provide a good sample for hyphae and spore head observation.
5. Identify common bread moulds from their colour: *Rhizopus* (black bread mould) has black spores; *Neurospora* (red bread mould) has red-brown spores; *Penicillium* has blue-green spores in the centre of the colony with a white ring surrounding the colony.
6. Discuss how mould grows. Long, wispy hyphae (often light coloured) spread out from where a mould spore landed. The hyphae grow over and through the bread/drink. Once the mould colony has reached a certain size, coloured spores grow at the top of vertical hyphae.
7. Watch a video of mould growth in slow motion, to show the hyphae growth, followed by spore formation and darkening (beautiful example in Ref. 1).

References

<https://www.youtube.com/watch?v=JsQHWj2RfXg>

Time lapse video of mould growth by Lomonosov Moscow State University, Department of Soil Science. Accessed May 26th 2017.