There's Fungus Among Us
Fifth Grade Garden Lesson

Brief Description:
Students will learn what microbes are and why they are important for all life on earth. We will discuss useful and beneficial microbes and look at soil and yeast samples through a microscope. Students will conduct two experiments:

1) Comparing what happens when you combine yeast in a cup with water, flour and sugar, and with just water and flour. They will observe and measure which yeast mixture grows faster.
2) Students will observe what happens when you combine yeast with water and sugar in a bottle and put a balloon on top.

Objective:
Students will learn what a microbe is and why microbes are essential for life on earth. They will be able to differentiate between harmful and beneficial microbes and be able to identify yeast microbes in a microscope.

Materials:
Soil samples
Yeast
Sugar
Warm water
Flour
Clear plastic cups
Sharpie
Measuring spoons
Stirrers for mixing
Plastic bottles
Balloons

Questions to Raise:

What are microbes?
Are they good or bad?
Is soil living or non-living?

Intro:
Microbes are organisms that are too small to be seen by the human eye, but they carry the weight of all living things on their microscopic shoulders. Microbes are in the air we breathe, the ground we walk on, the food we eat—they're even inside us!

Without microbes, we couldn't eat or breathe. We couldn't digest food without them—animals couldn't, either. Without microbes, plants couldn't grow, garbage wouldn't decay and there would be a lot less oxygen to breathe. In fact, without these invisible companions, our planet wouldn't survive as we know it!

Your body is home to trillions of microbes. Run your tongue over your teeth—you're licking thousands of microbes that normally live on your teeth. Millions of them live on your tongue, too. A large part of "you" (that is, the mass of your body) is actually something else: bacteria, viruses and fungi. Isn't that a weird thought?

Microbes form the foundation of the soil food web too, helping the soil support plant life, which supports the rest of life as we know it.

It is estimated that in one teaspoon of living soil there are nearly 1 billion bacteria, up to 30 miles of fungal filaments, and up to 100,000 protozoa. The bacteria eat the simple carbohydrates the plants put out through their roots, which are then eaten by the protozoa, and then the waste from the protozoa acts as nutrition for growing plants. In addition, fungi protect plants from pathogens and harmful microbes, and create pathways in the soil that bring water and nutrients back to the plant. Both work together in decomposing organic material and making the nutrients available to the plant.

The most fertile soil is alive with organisms that work in tandem with plants, soil structure and microbial balance is continually adapting to environmental conditions and nutrient availability.

Main Types of Microbes
Fungus: Mushrooms, mold, yeast, Penicillium
Virus: Influenza, common cold, HIV
Bacteria: Strep, Staph, yogurt cultures

When you think of bacteria or fungus, do you think it's a good thing or a bad thing?

We're going to focus on fungus for today's lesson:

Fungus Among Us Activity

Procedure:

Give each group a soil sample to look at under the microscope. What do you see? Does anything look alive? Any movement?

While students look at the soil, pass out three clear cups and one plastic bottle and a balloon to each group. Label the cups A, B and C.

Prep: Give each group one small cup with 2 tablespoons of flour and 1 teaspoon of sugar and one small cup with just 2 tablespoons of flour.

Prep: Give each group a small cup with 1 teaspoon of yeast and 1 tablespoon of sugar.

1) Pour the flour and sugar mixture in Cup A. Pour the plain flour in Cup B. Add ½ teaspoon of yeast to each cup. Add ¼ cup of very warm water to each cup and mix. Compare the two cups. Use a sharpie to mark on the cups where they start. Check again in 10 minutes and put another mark how much they have grown. Which one is growing faster?
2) Pour the yeast and sugar mixture in a cup. Add ½ cup of very warm water. Mix until dissolves, then pour mixture into plastic bottle and place balloon on top.

Observations:

What is happening?

Is the flour mixture in Cup A growing more quickly than the flour mixture in Cup B? Why?

What is happening with the bottle and balloon? Why?

Results:

Cup A grows faster. Why? Yeast is a fungus and needs a supply of energy to live and grow. Sugar supplies this energy.

Why does the balloon inflate? Yeast releases energy from sugar and its byproducts are alcohol and carbon dioxide. It is this carbon dioxide gas which makes the bubbles in dough (and therefore in bread), causing the dough to rise and creates the alcohol in beer and wine (called fermentation). As the yeast feeds on the sugar, it produces carbon dioxide. With no place to go but up, this gas slowly fills the balloon. A very similar process happens as bread rises. Carbon dioxide from yeast fills thousands of balloon-like bubbles in the dough. Once the bread has baked, this is what gives the loaf its airy texture.

Vocabulary:

Microbe: Single-cell organisms so tiny that millions can fit into the eye of a needle. They are the oldest form of life on earth.

Yeast: A microscopic fungus consisting of just one cell that reproduce by budding, and are capable of converting sugar into alcohol and carbon dioxide.

Fungus: A special type of microbe that doesn't make its own food from the sun like plants, instead, it gets its food from dead and decaying plants and animals. Examples: single celled organisms like yeast and mold. As well as multicellular organisms like mushrooms. You find fungi in damp, warm places but also in the air, soil, water, on plants and in you! Most fungi aren't dangerous; most people eat fungi like mushrooms and yeast every day.

Bacteria: A microscopic living organism, usually one-celled, that can be found everywhere. They can be dangerous, such as when they cause infection, or beneficial, as in the process of fermentation (such as in beer, wine, yogurt, cheese, etc.) and that of decomposition.

Virus: A microscopic organism many times smaller than bacteria.

Germ: Term for a microbe that causes disease.

Aerobic: Require oxygen to grow.

Aneraobic: Do not need oxygen to grow.

Symbiotic: Refers to the close association between two or more organisms of different species that live together. The relationship is not necessarily beneficial to both. Parasites, for example, have a symbiotic relationship with their hosts, but only the parasite benefits. The association of algae and fungi in lichens and of bacteria living in the intestines or on the skin of animals are forms of beneficial symbiosis.

Mycorrhizal fungi: A fungus that has a symbiotic relationship with the roots of certain plants.

Spores: Spores are the single-celled reproductive unit of non-flowering plants, bacteria, fungi, and algae. Basically, spores are the babies, except they didn't need a mom and a dad.

Supporting Info:

A good smelling soil indicates the presence of beneficial aerobic bacteria in balance with the rest of the soil's organisms. If the soil has an offensive or alcoholic scent, the soil might have inadequate drainage or be compacted in a way that encourages anaerobic (stinky) bacteria.

Most vegetables prefer bacterially dominated soil, and an alkaline pH (around 7) best supports bacteria in their ability to turn nitrogen into a nitrite form that the plant can use.

The word "mycorrhiza" (plural: mycorrhizae or mycorrhizas) comes from the Greek language and literally means "fungus roots." You may not know it, but mycorrhizal fungi are a crucial part of the health of 95% of the plants growing throughout the world. In fact, they've been helping plants grow for millions of years! Mycorrhizal fungi are tiny, harmless critters that attach themselves to plant roots and actually help plants to make use of water and organic nutrients in the soil. They live on the roots of roughly 95% of all earth's plant species. In exchange for what they provide the plant, the plant offers the fungi a meal of sugars (fixed carbon) produced by the photosynthesis process.

Benefits of Mycorrhizal Fungi: Mycorrhizal fungi populate the area around a plant's roots and form very thin filaments, adding to the length and efficiency of a plant's roots. This is like having a second set of roots for the plants. Thus, plants, trees, and shrubs with a well established mycorrhizal fungal root systems are better able to survive droughts and transplant shock. They also absorb more nutrients from the soil. Plants with mycorrhizal fungi can survive better in their non-native environments, or that is to say, environments that don't necessarily reflect the ideal environments for their survival, such as urban areas and home gardens. Mycorrhizal fungi also boost a plant's immune system, making them resistant to soil-borne pathogens. In addition, they help to keep parasitic nematodes away. A lack of mycorrhizal fungi can create problems with trees, shrubs and plants when they are growing in our gardens. Unfortunately, our day to day gardening tasks can negatively affect these delicate mycorrhizal fungi. For example, the use of chemical fertilizers, tilling, and hoeing can disrupt or even destroy the mycorrhizal fungi found in your soil. Additionally, many of the plants we purchase and grow in the garden lack the necessary mycorrhizal fungi growing on their roots when we plant them. Furthermore, our home garden soils may lack enough mycorrhizal fungi to truly benefit our plants.

Fungi have been on earth for millions and millions of years. They are not a plant even though they can look like plants, nor are they an animal – fungi are actually a really ancient type of vegetable!

There are, experts think, over 1 million different species of fungi on earth to day! In a single teaspoon of earth, you could find about 120,000 fungi. You probably see fungi of some sort or other every day. The most common fungi are mushrooms and truffles (yum!), yeast that is made to make bread or molds, and mildew which are useful but not so pleasant.

Although some fungi have many cells, they cannot make their own food like plants do as they do not have chlorophyll (plants use chlorophyll to make food from the light of the sun). Fungi are parasites and grow on plants, animals, humans, dead and decaying organic matter, anywhere, in fact, where it is warm and damp! They get their food by making enzymes that digest food from the surface they are growing on and absorbing the digested nutrients through their cell walls. Fungi mainly absorb water and digest sugars and starches which they use to grow.

Fungi have adapted to many different environments and can be found in the air, in the ground, in water, on plants, on you! All of these places provide the nutrients, warmth and moisture fungi need. Some fungi have adapted to grow in the desert where water is scarce, in very cold parts of the world and in fresh or seawater where there is too much or the wrong kind of water. Fungi have been around so long, they have adapted to grow almost anywhere.

Fungi, along with bacteria, are one of the best decomposers of organic material. Without them, dead plants and animals would just hang around and the nutrients from the dead material would not return to the ground. Other plants, animals and micro-organisms that rely on that food would also die and the delicate balance of the ecosystem would be lost.

Fungi are pretty simple structures really. Mushrooms, toadstools, puff balls and the hard fungus you see growing like plates on the sides of trees, all have the same structure. They grow in bunches of *filaments* (which look like sewing thread) called *hyphae*, although you cannot always see this. The hyphae grow together to form *mycelium* which can form a *fruiting body* which is the part of the mushroom you can see.

Fungi can't move about, they stay where they grow, so how do they make more fungi? Underneath the fruiting body of the mushroom, the bit you can see that looks like an umbrella, there are rows of 'gills'. In these gills, tiny microscopic *spores* are produced. Spores are the seeds for the next generation of fungi and they are carried to new places by the wind and rain. When the spores come into contact with the right growing conditions – generally somewhere there is food, moisture and warmth - they *germinate* (start to grow) and break through the surface and grow.

Did you know…?

The largest known organism on earth is a mushroom! This 'humongous fungus' is 3.5 miles wide and lives mostly underground in Oregon, USA. It is thought to be over 2,4000 years old!