SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

A Gut Instinct **Grade 11 – Microbiology**

Lesson Plan

Assessment	AFL, AOL
Cross-curricular	

Big Ideas

- Groups of microorganisms have common characteristics, and these characteristics enable them to interact with other organisms in the environment

Learning Goals

- I can distinguish between eukaryotes, prokaryotes, and viruses.
- I can demonstrate how different chemical composition affects the digestion of sweeteners by yeast.
- I understand that humans live in symbiosis with bacteria, fungi, and archaea, which make up the human microbiota.
- I have learned that the gut microbiome could be influencing human health in a variety of ways.
- I know that a variety of factors including diet and antibiotic use could impact upon the gut microbiome.

Specific Expectations:

C3. demonstrate an understanding of the diversity of microorganisms and the relationships that exist between them.

C3.1 describe the anatomy and morphology of various groups of microorganisms (e.g., eukaryotes, prokaryotes, viruses)

C3.3 explain the vital roles of microorganisms in symbiotic relationships with other organisms (e.g., gut bacteria in cows digest cellulose; mycorrhizal fungi penetrate and effectively extend a plant's root system)

C3.5 describe how different viruses, bacteria, and fungi can affect host organisms, and how those effects are normally treated or prevented (e.g., hepatitis viruses can damage the liver, but vaccinations can prevent infections; streptococcus bacteria can cause respiratory infections, which are treated with antibiotics; ringworm is a fungal

Description:

In this lesson students will learn how yeast metabolizes different kinds of sweeteners. Students will also learn that a variety of factors can impact the gut microbiome, affecting human health. This lesson should be used after learning about taxonomy and the classification of cells and viruses. It may also be used after lessons on bacteria and fungi. **This lesson is intended for the college level.**

Materials

Microoganisms: Graphic Organizer (Student and Teacher)

Yeast on a Diet?

- Tablespoon for measuring
- Measuring cup (1/3 cup) (Beaker - 80ml)
- Permanent marker or tape for labeling
- Sandwich size sealable bags
- Packets of dry granular yeast (Rapid Rise) or bulk yeast
- Packets of sugar
- Packets of Sweet n' Low (saccharin
- Packets of Equal (aspartame)
- Packets of Splenda (sucralose)
- Clear, regular and diet soda (Sprite, or 7Up) - remove cap at least 24 hours prior to use
- Large (1L) graduated cylinder or other container with volume markings

The Invisible Universe of the Human Microbiome video

Safety Notes

Be careful with hot plates. Students are not to consume food in the laboratory.

Introduction

With a partner, fill in a graphic organizer, "Microorganisms" comparing Prokaryotic Organisms, Eukaryotic Organisms, and Viruses (See Link).
You may use your textbook, notes or research online. You may want to start with these videos from Khan Academy:
https://www.khanacademy.org/science/biology/structure-of-a-cell/prokaryotic-and-eukaryotic-cells/v/prokaryotic-and-eukaryotic-cells
https://www.khanacademy.org/test-prep/mcat/cells/viruses/v/virus-structure-and-classification

Action

Brewer's yeast organisms, or *Saccharomyces cerevisiae*, are unicellular fungi, and therefore, eukaryotic organisms. These organisms digest glucose for growth and reproduction.

Yeast on a diet?

In this activity, in groups of 2-3, you will be able to measure how well the yeast metabolize different kinds of sweetener: sucrose, aspartame, saccharin, and sucralose.

Group Materials:

- Tablespoon for measuring
- Measuring cup (1/3 cup) (Beaker - 80ml)
- Permanent marker or tape for labeling
- Sandwich size sealable bags
- Packets of dry granular yeast (Rapid Rise) or bulk yeast
- Packets of sugar
- Packets of Sweet n' Low (saccharin)
- Packets of Equal (aspartame)
- Packets of Splenda (sucralose)
- Clear, regular and diet soda (Sprite, or 7Up) - remove cap at least 24 hours prior to use
- Large (1L) graduated cylinder or other container with volume markings

Instructions

1. In 6 different sealable bags, measure out 1/3 cup warm water and 1 tablespoon of yeast.
2. Add 1 tablespoon of either: sugar, aspartame (Equal), saccharin (Sweet n' Low), sucralose (Splenda), clear pop, or diet pop to a bag.
3. Mix ingredients well and seal the bag, trapping as little air as possible.
4. Place your bags on a warming plate set on low. You may notice some of the bags beginning to expand as the yeast produce a gas. What gas do you think this is? Which type of sweetener do you think will have the greatest expansion? The least?
5. Once the bags have stopped expanding (~20 minutes), fill the graduated cylinder to around 50 mL and submerge each bag into the water individually (using a pencil or other small stirring stick) to determine the volume difference between bags.

Discussion

A. Rank the different sweeteners in terms of the most expanded bag to the least expanded bag.
B. Is there a link between which bags expanded the most and how many calories are listed for one tablespoon of the sweetener?
C. For an animal that must seek its food, why is it important for foods that taste sweet to have calories? If the foods did not have calories, why would this be a disadvantage for the animal?

When yeast digests glucose, they produce CO_2, alcohol, and energy for the organism in a process called fermentation. The amount of CO_2 produced is correlated to the amount of food the yeast metabolizes. Aspartame, sucralose, and saccharin are organic compounds that do not have any calories.

Adapted from "Microbial Discovery Activity, Taste Test: Can Microbes Tell the Difference?"

Consolidation/Extension

As shown in the activity above, different types of sweetener are metabolized in different ways by microorganisms. Your body is covered in ***bacteria***, ***fungi***, and ***archaea***, from the top of your skin, to the inside of your mouth, into your internal organs such as your gastrointestinal (GI) tract. The microorganisms in the GI tract are called the "gut microbiota" and the environment they live in, the "gut microbiome".

It is thought that eating high volumes of foods high in simple sugars or high in artificial sweeteners as are often common in a Western diet may affect or "condition" your microbiome, leading to an excess of certain microorganisms and a lack of others, and perhaps be linked to greater rates of obesity and diabetes.

Watch this video by to learn about the microorganisms that cover you and how they contribute to your metabolism, immunity, nutrition, and overall physiology.

The Invisible Universe of the Human Microbiome
https://www.youtube.com/watch?v=5DTrENdWvvM

Your gut microorganisms may even affect your brain! Research in mice shows that anxiety, learning and memory, appetite and satiety, and mood may all be affected by the bacteria, protozoa, and viruses making up the gut microbiome.

This community colonizing your body also makes the treatment of a variety of diseases possible with little to no invasive procedures through ***Microbe Based Therapeutics***.

First there are preventative measures: foods containing ***Prebiotics*** (e.g. dandelion greens, garlic, leeks, oatmeal, banana) and ***Probiotics*** (e.g. yoghurt, kombucha, sauerkraut) are becoming increasingly popular as they may promote the growth of beneficial microorganisms in the gut. Secondly, there are specific therapeutic ***Faecal Microbial Transplants*** from healthy individuals being studied in attempts to introduce a healthy microbial colony to replace unhealthy gut microbiota or correct imbalances in a patient's microbiome.

We still know very little about the gut microbiota. The development and application of fast and low-cost DNA sequencing methods has been revolutionary. From a sample of gut microbes, all of the DNA is extracted and sequenced to try to learn what microbes are in there, what genes they have, and what they do. The microbes' genes make up a second genome, or set of genetic information, for us. Scientists are not only discovering new species of bacteria, but the new large scale studies are working towards establishing the baseline of a healthy gut microbiota.

Activity
Use the simulation Your Microbial Friend
http://learn.genetics.utah.edu/content/microbiome/friends/ to learn where in the body microbes act.
List one benefit to the organism from each category:

- Nutrition
- Immunity
- Protection from infection
- Maintenance of protective barriers
- Organ development