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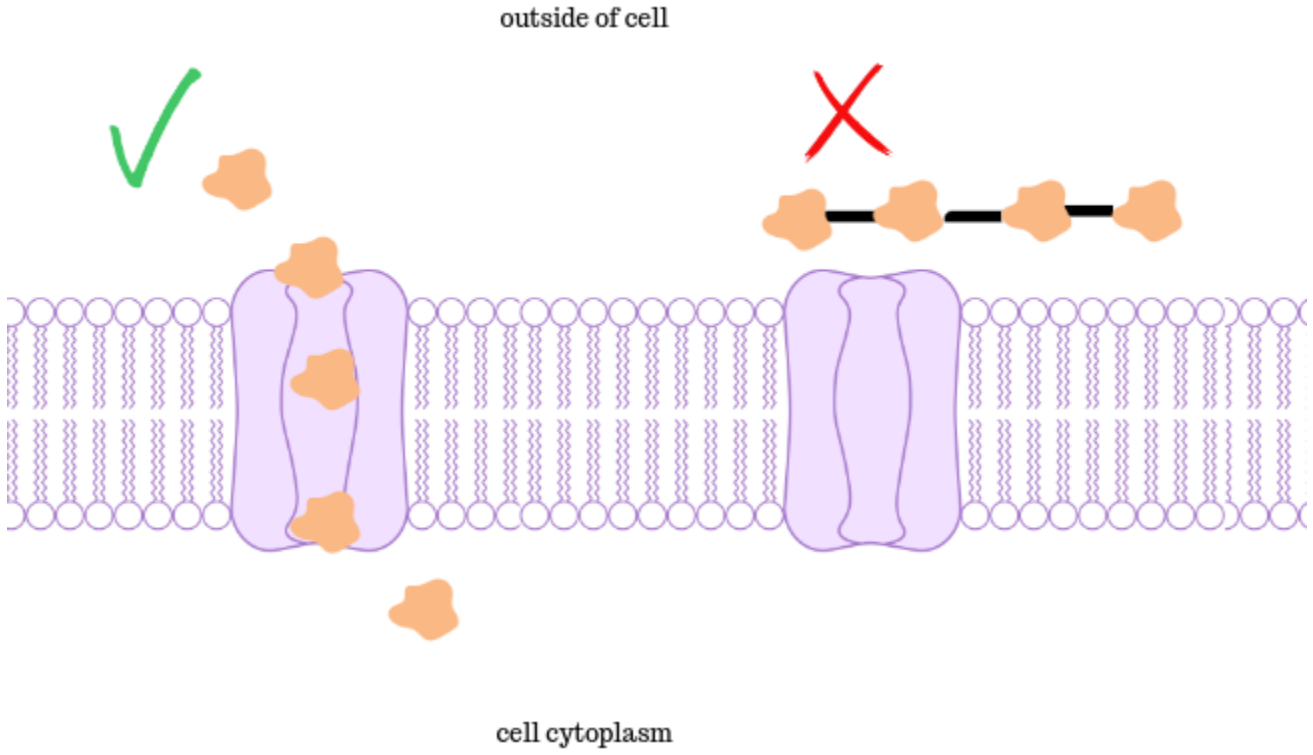
Lesson 6: Feed the Fungi

In this lesson, students will create a poster modeling an enzyme reaction on a substrate, and their description using vocabulary terms. They will also conduct a lab activity where they observe digestion of starch by fungi.

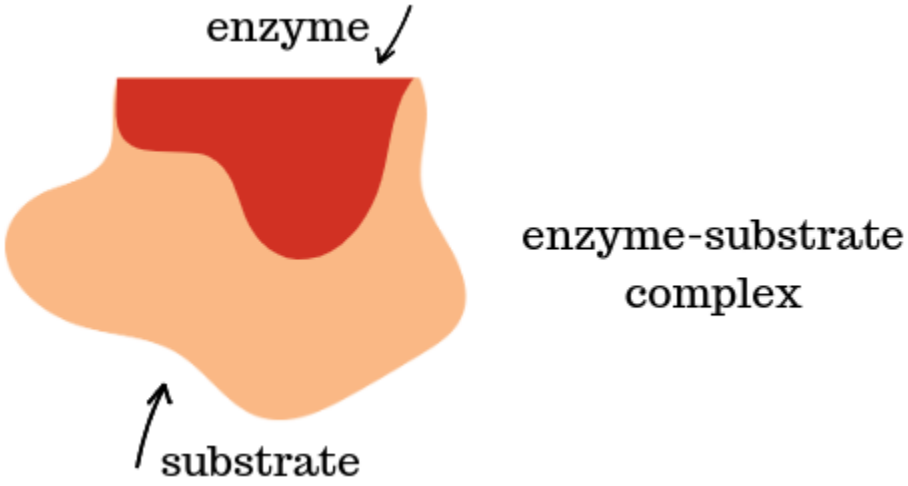
Objectives:

1. Understand how and why fungi digest food as heterotrophs.
2. Model enzyme activity on carbohydrate and protein substrates.
3. Compare digestion of fungi with humans.

Fungi are known as saprotrophs, and secrete **digestive enzymes** from the lysosomes within the hyphae cells in order to break down and digest their food. Fungi often get their nutrients from sugars. These can be large chains of sugars known as carbohydrates, like starch, glycogen or cellulose. They could be simpler sugars like sucrose or fructose. Fungi can also get nutrients from proteins within plants or animals. These proteins digest into simpler molecules called amino acids. Whatever heterotrophs want to consume must be digested down from **polymers** (long chains of molecules) into **monomers** (the smallest units possible) in order to fit through the channels of the cell membranes. If the nutrients cannot make it inside the cells, the fungi cell cannot use it for energy. Just like if humans don't digest their food, they cannot benefit from it either.



Digestive enzymes work by binding themselves to the **substrates** (the polymer that will be broken down). Once it binds, it forms an enzyme-substrate complex that results in breaking the bonds that hold the monomers together. You can think about them as scissors, cutting the bonds and separating the long chain into subunits. Enzymes and substrates fit together like a lock-and-key, so you need the correct enzyme to break down a particular substrate.



Carbohydrate consumption

Polysaccharides are long chains of carbohydrates. Depending on how those carbohydrates are linked together, it may be a slightly different type. Starch, for example, is a **polysaccharide** that is found in the food that plants produce, like potatoes or wheat. Glycogen is also a polysaccharide, but is stored in the muscle and liver tissues of animals after they eat. *For example*, if we ate a big bowl of pasta and did not immediately use all of the energy, the rest would be stored as glycogen in our body. A third type of carbohydrate is called cellulose. This makes up the cell walls of plants, and is known commonly as fiber. Humans don't digest cellulose, but fungi can! All polysaccharides can be digested into individual molecules called **monosaccharides**.

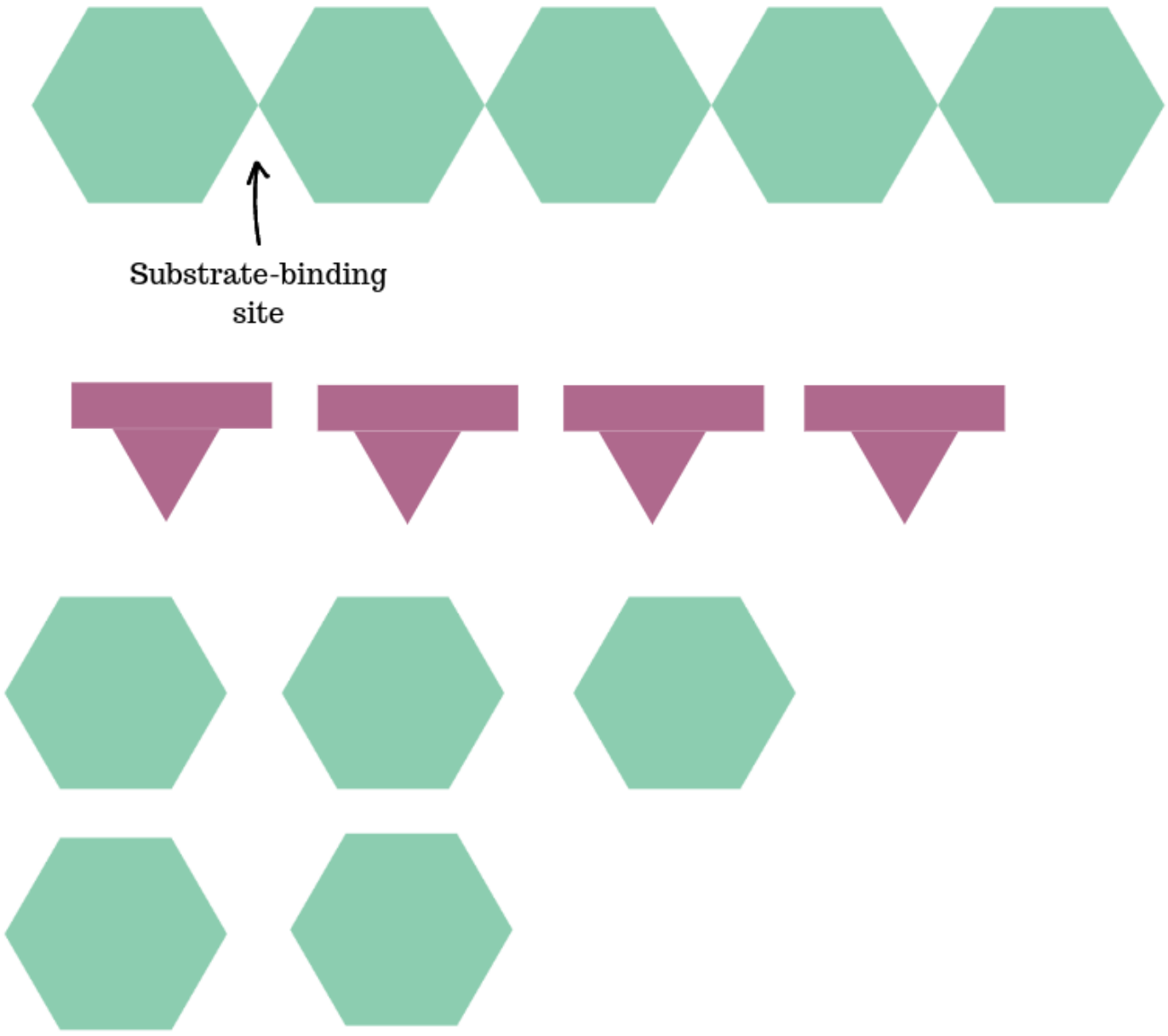
Protein consumption

Another type of polymer is a polypeptide, which is another term for protein. Protein can be produced by plants, such as in nuts or grains, or they are produced by animal muscles, such as eating a chicken thigh. Protein will break down into individual amino acids.

Enzyme	Substrate (Polymer)	Product (Monomer)
Amylase	Polysaccharide	**glucose**
Amylase	Polysaccharide	**glucose**
Protease	Polypeptide	**amino acids**

Cellulase	Polysaccharide	**glucose**

1. **Choose one of the digestive reactions from the table above.** Cut out the shapes provided below, and use them to represent the reaction that took place. Paste them onto a larger sheet of paper. Underneath the reaction, write a sentence describing in as much detail as you can, what is occurring. Label the following on your reaction with as many terms as you can: enzyme, substrate, polymer, monomer, product, polypeptide, polysaccharide, monosaccharides.



2. Reflect on your poster:

a. What do fungi eat?
b. Why do fungi need to digest their food with nutrients, like us?
c. Humans do not have the enzyme “cellulase” in our digestive system like fungi do. What do you predict would happen if a person ate cellulose?

3. Lab activity: Observe the digestion of starch by mycelium.

Starch is a complex carbohydrate made up of many glucose molecules linked together. Potassium iodide (KI), on the other hand, is a chemical compound that contains iodine. When potassium iodide comes into contact with starch, a chemical reaction occurs and the potassium iodide appears as a dark bluish-black color. This change in color can be observed visually and is used to indicate the presence of starch. If there is no starch present, KI will appear light brown.

Materials:

- Flour or starch of any type.
- Living mycelium
- Petri dishes
- Teaspoon or lab stir stick/spoon
- Pipette or droppers
- Gloves
- 70% isopropyl alcohol
- Labeling tape or wax marking pencil

Pre-lab:

a. Take a small piece of cracker or bread and place in a petri dish or other container. Add a drop of KI on top. What color change do you observe? Why?

b. Make a prediction about what color you expect to see when you place drops of KI over the mycelium and flour mixed together. What do you think may occur as the mycelium starts to digest the starch and convert it to glucose?

Procedure:

a. Sterilize your workspace by spraying 70% isopropyl alcohol on the table surface.
b. Wear gloves.
c. Obtain enough living mycelium material to fit in a petri dish.
d. Spread the material over the inside of the petri dish.
e. Add 1 teaspoon of flour and mix all together.
f. Ensure there is some moisture in the petri dish. If it is dry, add some drops of water.
g. Place a couple drops of KI over your growing mycelium. What do you observe?
h. Take a picture of the color you observe.
i. Put the top on your petri dish.
j. Label the petri dish with your group's name.

k. Wait until your next class to view results

l. Take a picture of the new colors you observe.

Post-lab:

What did you observe take place?

How can you explain these observations using your knowledge of starch polymers and glucose monomers?