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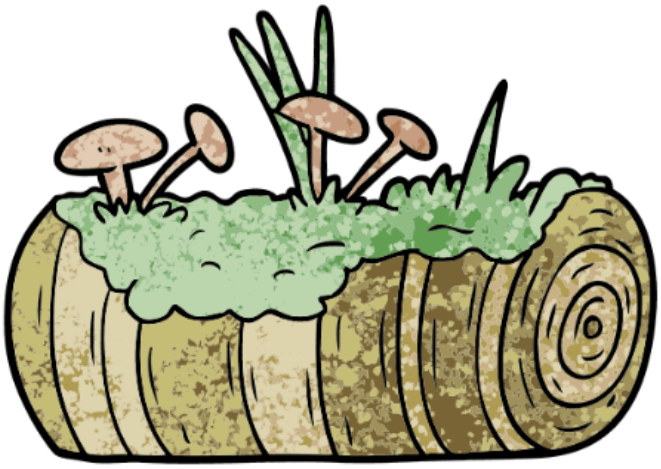
Lesson 7: Cellular respiration in fungi

Objectives:

1. Organize steps of cellular respiration through the use of a graphic organizer
2. Modify your own cellular respiration experiment.
3. Practice systems thinking within the topic of cell respiration.



Introduction

Why do we need to eat? Why do fungi need to eat? What's the point? You may have heard the famous phrase from biology class: The mitochondria is the powerhouse of the cell! In this lesson you will see just how powerful mitochondria really are.

Cellular respiration is a process that takes place in every single living cell. It is the way in which cells turn food into a usable energy source, called adenosine triphosphate (ATP). If you skip lunch, you start to feel pretty tired by the end of the day, and are running low on ATP. This is because your body's source of energy comes from digesting food and converting it into ATP.

How does this process work?

Cellular respiration comes in two forms: aerobic and anaerobic respiration. Aerobic respiration occurs when the organism has plenty of access to oxygen, while anaerobic respiration occurs when the organism is running low on oxygen. If you have ever ran for a long period of time, you may remember not being able to catch your breath fast enough. At this time your cells may use anaerobic respiration because you're not breathing in enough oxygen!

In this lesson we will focus on aerobic respiration, since it occurs more frequently. Take a look at the image below. Notice that the chemical reaction for cellular respiration is actually the opposite of photosynthesis! Instead of creating food like plants do in their chloroplasts, mitochondria use the food to convert into ATP. Then carbon dioxide and water are created as byproducts. When we exhale carbon dioxide in our breath, we are actually getting rid of the carbon dioxide that was created in each of our individual cells!

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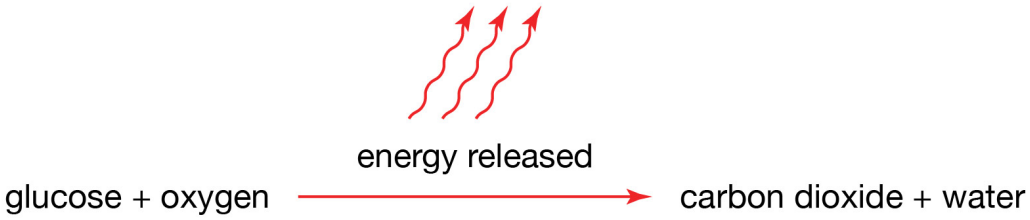
The release of energy during cellular respiration



$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$$

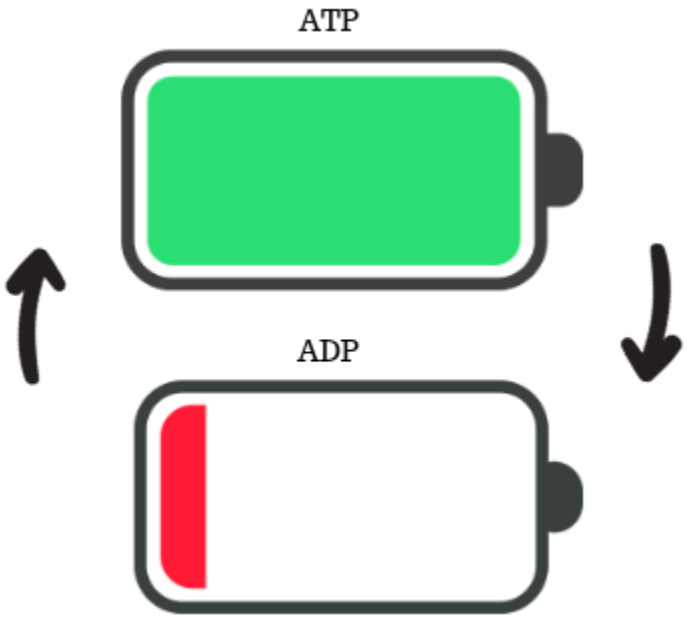
What's happening inside of the cell to produce ATP?

First, a glucose molecule (or other monomer) will travel through the cell's plasma membrane into the cytoplasm. Here the glucose molecule will undergo a process called glycolysis, where enzymes are used to break the glucose molecule into two smaller molecules, called pyruvates. Through this reaction, *a small amount* of ATP is produced. Then, each pyruvate molecule travels into the mitochondria, where it enters a process called the Krebs cycle (sometimes called the Citric Acid cycle).

In the mitochondria, each pyruvate will enter the Krebs cycle which is a complex process powered by several enzymes (enzymes don't just digest food you know!). Oxygen will also enter the mitochondria (from the air that we breathe) and be used in the series of reactions. As pyruvate molecules are

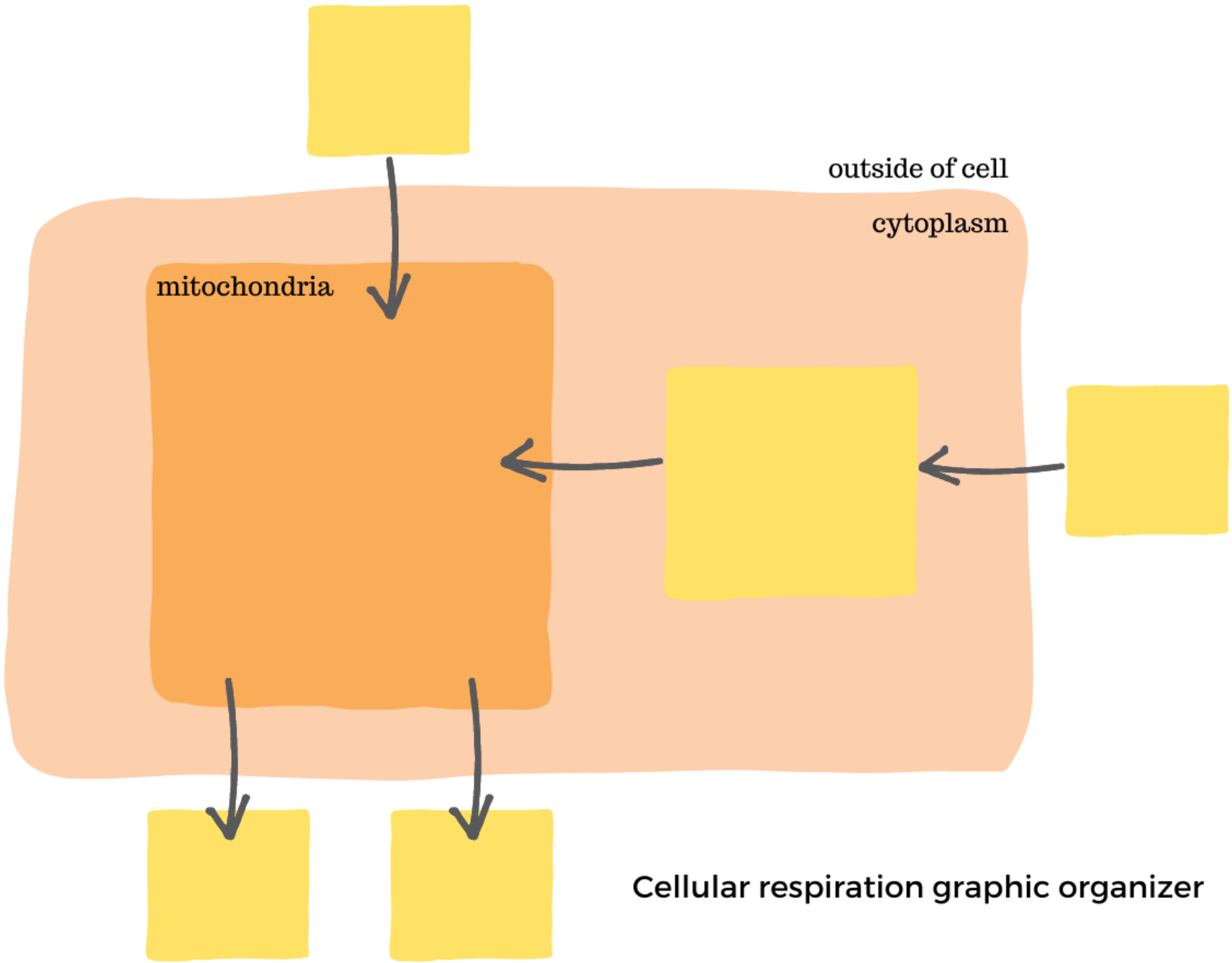
broken down further in the cycle, ATP is released. For every pyruvate that enters the Krebs cycle, *a large amount* of ATP is produced.

This energy in the form of ATP is a byproduct of the reactions that are breaking down the glucose and pyruvate. After ATP is produced, the energy can be used to power all cellular functions. Once the ATP has been used up, it gets recycled back into a form called adenosine diphosphate (ADP). The ADP molecules can then be converted to ATP once more when more glucose enters the cell. ATP can be thought of as a 'charged battery' while ADP is akin to a "used up battery".



1. **Cellular Respiration Graphic Organizer**

Read the informational text above closely. Then use textual clues to organize as many details as you can into the graphic organizer.



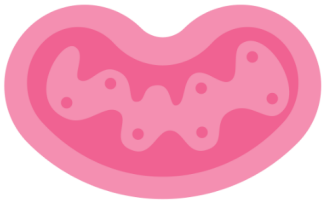
Cellular respiration graphic organizer

2. **Systems thinking:** Using your graphic organizer, make predictions about the following. Be sure to add a justification for your thinking.

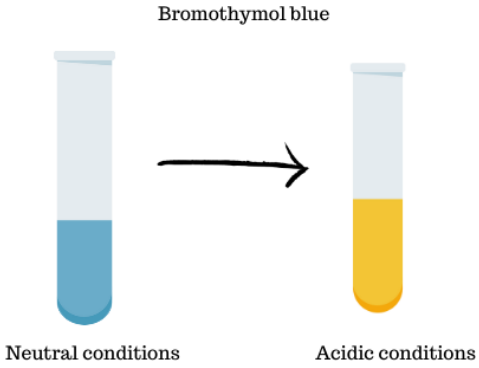
How might the production of ATP be affected if…..

- The cell did not receive glucose?
- There was a defect in the enzymes that promote glycolysis?
- The cell's mitochondria was destroyed?
- The cell did not receive oxygen?
- There was a defect in the recycling of ATP?

3. **Experiment:** Observe the cellular respiration of growing mycelium.



In this experiment, we will be able to observe cellular respiration taking place in an enclosed environment containing living mycelium. As the mycelium undergoes respiration, it will produce carbon dioxide. But how can we measure how much carbon dioxide is in the enclosed environment?



A chemical called bromothymol blue can help with that. This chemical changes color when it comes into contact with carbon dioxide in solution. This color change happens because when carbon dioxide mixes with water, it forms carbonic acid. This carbonic acid makes the water more acidic, and causes the bromothymol blue to change color. When bromothymol blue is mixed with water, it is initially either a blue or a green color. When carbonic acid forms, it will turn yellow. This color shift indicates that carbon dioxide is present.

<u>Materials per group:</u>

- Bromothymol blue solution (prepared by your instructor)
- 1 shallow container that is wide enough to fit 2 petri dishes inside
- Plastic wrap
- Masking tape
- 2 petri dishes (the tops will not be used)
- Sample of living mycelium
- Pipette or droppers
- Gloves
- 70% isopropyl alcohol

- Labeling tape or wax marking pencil

Procedure:

a. Sterilize your workspace by spraying 70% isopropyl alcohol on the table surface.
b. Wear gloves.
c. Place two petri dishes into the shallow container.
d. In one small petri dish or beaker, place some living mycelium. Do not put a top on the petri dish.
e. In the other small petri dish, use a pipette to fill about halfway with bromothymol blue solution. Do not put a top on the petri dish.
f. Take a picture of the set up, making sure to document the color of the bromothymol blue solution.
g. Label your group's names onto your container wherever convenient.
h. Cover the container with plastic wrap. Use tape to create an enclosed environment. Keep the plastic wrap taut so that you can easily view the petri dishes inside.

------ Wait one or two classes to view your results -------

i. Remove the plastic wrap and carefully throw it away.
j. Observe and document the color of the bromothymol blue solution.
k. Sterilize the mycelium by spraying 70% isopropyl alcohol into the petri dish.
l. Follow your teacher's instructions for discarding your materials.
m. After all materials are discarded, wipe down your workspace with 70% isopropyl alcohol.

Modify your apparatus! What happens if you.....

- Changed the temperature of the water?
- Changed the type of sugar? (glucose, fructose, sucrose, starch)
- Change the quantity of sugar? Of yeast?

GIY material kenaf or hemp hurd.

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Students test cellular respiration with their growing mycelium.
Add more instructions to the respiration experiment, with visuals.
Can add the option to use phenolphthalein as a CO2 detector, instead of the alternative yeast and balloon experiment. (place open test tube of phenolphthalein indicator solution within a sealed chamber with mycelium, take photos to see the color change. Need to test this for issues).