Lesson Topic: - Chemical Reactions in Cellular Respiration

Students will be able to:

1. Write and explain the chemical equation for aerobic cellular respiration
2. Compare aerobic and anaerobic cellular respiration in animals

Time Required: 85 minutes

Materials Needed:

- Teacher computer with internet access
- 1 stopwatch or cell phone timer
- 2 beakers
- Phenol red indicator solution
- 1 bottle of club soda
- 2 straws
- 2 safety goggles

Teacher Preparation:

- Assign a Legends of Learning Instructional Quick Play playlist for the day(s) you will be teaching the lesson.
    - Instructional - Middle School - Chemical Reactions in Cellular Respiration
- Assign a Legends of Learning Content Review Quick Play playlist for the day(s) you will be teaching the lesson.
    - Content Review - Middle School - Chemical Reactions in Cellular Respiration
- Make a copy of the “Chemical Reactions in Cellular Respiration” handout (1 per student)

Engage (20 minutes):

1. Explain to students that the average, healthy heart beats between 60-80 beats per minute when at rest.
2. Explain to students that they can find out how fast their heart is beating by taking their pulse.
3. Tell students they will now practice finding their pulse. Tell students to place their fingers over an artery that is close to the surface of their body (such as their neck or wrist). Make sure each student is able to find their pulse.
4. Tell students to find their pulse again.
5. Students will now take their pulse. Students should be seated and at rest. Set a timer for 60 seconds and tell students when to begin counting the number of beats they feel (when you start the timer). Tell students to stop counting when the timer reaches 0.
6. Tell students to record the number of beats they felt on the “Chemical Reactions in Cellular Respiration” handout.
7. Now, ask students, “What do you expect would happen to your heart rate after two minutes of exercise?”
    a. Most students will expect their heart rate to increase.
8. Now, tell students that they will do 2 minutes of vigorous exercise. This can be jumping jacks, running in the gym, running outside, etc (as long as it is intense and

gets their heart rate up.

9. Time the students for two minutes of exercise.
10. Immediately after exercise, repeat steps 4 - 6 so students can determine their heart rate after the exercise.
11. Have students rest and sit still for 5 minutes. Repeat steps 4 - 6 to take their pulse one more time. While students are resting, ask “What do you expect your heart rate will be after 5 minutes of rest following exercise?”
    a. Some students may say their heart rate will decrease, but still be above their resting heart rate.
    b. Some students may say their heart rate will return to what it was before they did any exercise.
12. Explain to students that in this lesson they are going to learn more about *why* their hearts beat faster when they exercise.

Explore (30 minutes):

1. Have your students sign in to Legends of Learning. Instruct students to complete the Instructional playlist.
2. Assist students as needed during game play, pause playlist if you need to address content or questions to the entire class.

Explain (15 minutes):

1. Review the chemical equation for aerobic cellular respiration by writing the equation on board or using Smartboard. Have students write the equation on the “Chemical Reactions in Cellular Respiration” handout. Depending on the level of your students, the equation can be written as:
    a. **Sugar** and **oxygen** produce **carbon dioxide** and **water** and **energy**
    b. Sugar + oxygen → carbon dioxide + water + energy
    c. $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy
2. Relate student knowledge to demonstration at the beginning of class.
    a. Tell students that their bodies likely experienced aerobic respiration during their two minutes of exercise. Aerobic respiration occurs when there is plenty of oxygen available.
    b. Why do you breathe heavier during exercise than when at rest?
        i. The body needs more oxygen during exercise to provide your body fuel (energy)
        ii. The increased rate of breathing removes the carbon dioxide from your blood faster
    c. Why does your heart rate increase during exercise?
        i. An increased heart rate helps get your blood (that contains the oxygen) to get to your muscles faster
3. If time and resources allow, have two students conduct the following demonstration in front of the class:
    a. Place 10 mL of club soda (no flavors added) into a beaker and add 5-10 drops of phenol red indicator into each beaker. The solution should be a light-pink color.
    b. Explain to students that phenol red will turn from pink to clear in the presence

of carbon dioxide.

c. Have one of the two student volunteers conduct vigorous exercise for two minutes. Have the other student volunteer sit calmly for the same two minutes.
d. Provide each student volunteer a straw and a pair of safety goggles.
e. At the same time, have students blow bubbles into their own solution until it turns completely clear. Have the class observe as students blow into the beakers.
f. Ask the students, “Why did the beaker of the student who conducted exercise turn clear faster than the one who did not?”
    i. Answer: The student who conducted exercise needed more energy from their cells, which they get through cellular respiration. When they started exercising, their heart started beating faster to take oxygen to the cells and to carry away carbon dioxide from the cells that was being produced from cellular respiration. The higher rate of respiration in the student who exercised released more carbon dioxide.

Elaborate (10 minutes):

1. Explain to students that during very intense exercise, your body can’t keep up with the amount of oxygen needed for aerobic cellular respiration. This is when **anaerobic respiration** takes over.
2. Show this video that compares anaerobic respiration and aerobic respiration. (show video until 2:27 to learn about respiration in animals only)
3. Ask students “What are some of the differences between aerobic and anaerobic respiration in animals?”
    a. Aerobic respiration happens in the presence of oxygen, anaerobic respiration happens when there is no oxygen
    b. Anaerobic respiration produces less energy than aerobic respiration
    c. Anaerobic respiration produces lactic acid, aerobic respiration does not

Evaluate (10 minutes):

1. Have your students sign in to Legends of Learning. Instruct students to complete the Content Review playlist.
2. Analyze student results to determine what concepts need to be a focus for reteaching.

Additional Lesson Strategies:

- To use Legends for additional instruction, create a custom playlist with an instructional game and pre and post assessment.
- To use Legends for a quick formative assessment, create a 5-question assessment in a playlist.
- To use Legends for a student-directed experience, create a targeted freeplay playlist.
- Encourage students to play on their own at home in Legends of Learning: Awakening for a student-driven experience including avatars, battling, and quests all centered around topics they are covering in class.

Chemical Reactions in Cellular Respiration

Data Table

Resting Heart Rate (beats per minute)	Heart rate immediately after exercise (beats per minute)	Heart rate 5 minutes after exercise (beats per minute)

1. What is the chemical equation for aerobic cellular respiration?