**“Where’s My ATP?” Aerobic Versus Anaerobic Respiration**

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In this lesson, students explore aerobic and anaerobic respiration through the study of Olympic sprinters and marathon runners. This lesson is designed for students in Grade 12 biology courses, and it aligns with the unit on metabolic processes. By participating in this lesson, students will learn to explain the differences between aerobic and anaerobic respiration and describe how sprinters and marathon runners rely on different cellular processes for ATP production. Students are expected to have prior knowledge about the function of mitochondria and the reactants and products of cellular respiration. However, students may know less about the exact steps involved in respiration (Ontario, 2008, p. 65, 80-81).

**Lesson Structure**

 The lesson begins with a minds-on activity where students examine [images](https://docs.google.com/presentation/d/1ejzxZQT6-Lgn0VIZau5dflp6OWuSPd9m8o2DqSp9gdQ/edit?usp=sharing) of the gold medal winners of the 100m and marathon events at the Tokyo 2020 Olympic Games. Students come up with three questions they have about the images, share their questions with a partner, and work in pairs to brainstorm possible answers. After 5-10 minutes, the teacher invites students to share their questions with the class. The teacher can use student conversations to assess their thinking and inquiry skills, or they can keep a copy of students’ questions as a diagnostic assessment for learning (Ontario, 2010).

Based on the minds-on activity, the students and teacher co-create four open-ended research questions that relate to Olympic sprinters and marathon runners. At least one of these questions should address the energy sources used by both groups. Once the research questions are finalized, the class divides into four teams. Each team chooses one question to answer.

The main activity begins once each team has chosen a research question. Students conduct independent research and develop a five-minute presentation using a medium of their choice (e.g., podcast, poster, slide deck). While the students are working, the teacher helps the teams collaborate and makes notes about students’ comprehension. It is important for the teacher to consider that students may demonstrate their knowledge more through groupwork than through the presentation of their products. After the teams have designed their products, they present their work to the class. The teacher models descriptive feedback for each group and asks students to give descriptive feedback to their peers. Students’ presentations can serve as a formative assessment for learning or an assessment of learning (Ontario, 2010).

 At the end of the lesson, students consolidate their learning by participating in a flash card game. The teacher hands out one [flash card](https://docs.google.com/presentation/d/1dJoXYhQSeJu3iFTr3V2NNBnZMqOKRT3GiaZqGk9N1Mg/edit?usp=sharing) to each student and keeps the first flash card in the sequence. Each flash card has an answer at the top and a question about cellular respiration on the bottom. The answer and the question do not match. The game starts when the teacher reads out the question on their flash card. The student who has the answer on their flash card reads it out loud. The student then asks the question on the bottom of their flash card. The student who has the answer to that question reads it out loud, and the cycle repeats until the teacher reads out the final answer. At the end of the round, each student passes their card to the person on their right. The teacher times the students to see how quickly they can make it through a second round. The quality of students’ participation in the game may indicate their understanding of aerobic and anaerobic respiration.

**Safety Guidelines**

 Students are not required to use materials that pose a significant risk to their safety. If students choose to create physical products (e.g., posters made from Bristol board), the teacher can remind them to handle scissors with care and hold papers away from where they are cutting.

**Professional Suggestions**

 This lesson uses student-led research to facilitate a high level of engagement amongst students in a Grade 12 biology course. After the students establish a foundation of knowledge on respiration, they design products which they present to their peers. These aspects of the lesson align with a pedagogical approach to science education that encourages students to assume the roles of scientists. Students who participate in learning experiences such as these are more likely to internalize that they can “do science” (Aschbacher et al., 2010).

 The teacher applies differentiated instruction by giving students choice throughout the learning process. For example, each team of students chooses to research a slightly different topic based on the research questions they formulate. Students also choose the types of products they present to the class. Student choice plays an important role in this lesson because it motivates students to participate in the ways that best suit their needs and interests (Ontario, 2013; Tomlinson, 2004). A student-centred approach also helps students realize that they can use science to investigate issues that are personally meaningful to them (Pedretti & Bellomo, 2015).

It may not be feasible for students to complete this lesson in one 75-minute class. The teacher can extend the lesson over two classes to give students ample time to develop their research questions, engage in peer teaching, and learn the flash card game. A central purpose of science education is to engage students in critical and creative thinking, regardless of their intent to pursue careers in science (Ontario, 2008). Thus, it is important for the teacher to plan flexible time in each lesson to accommodate for the time demands of high-level thinking.

 The following three recommendations are intended to help the teacher facilitate an effective lesson. First, when students formulate their research questions, the teacher is advised to facilitate student participation by asking probing questions and ensuring that each research question is written in student-friendly language. Second, it is recommended that the teacher praises students for participating to encourage other students to contribute to the discussion. Finally, to prevent students from focusing peer feedback on the aesthetic elements of each product, the teacher can co-create success criteria with students and ask them to provide feedback that relates specifically to these criteria (McTighe, 2018).

**References**

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