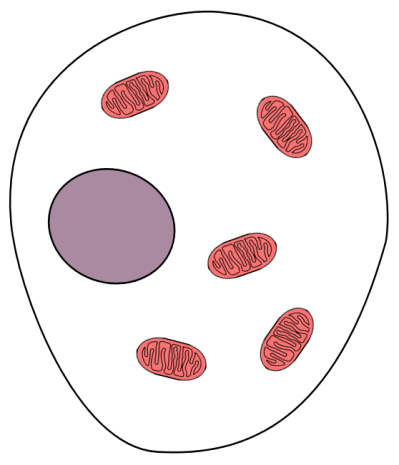
**How many mitochondria?**



cytoplasm

nucleus

mitochondria

cell membrane

Human cells contain structures called mitochondria.

A heart muscle cell and a skin cell are two different types of cell.

1. Which type of cell do you think would contain the most mitochondria?

|  |  |
| --- | --- |
| **A** | A heart muscle cell would contain the most mitochondria. |
| **B** | A skin cell would contain the most mitochondria. |
| **C** | They would both contain the same number of mitochondria. |

1. How would you explain your answer to question 1?

|  |  |
| --- | --- |
| **A** | All animal cells have the same structure. |
| **B** | It can absorb more glucose for cellular respiration. |
| **C** | It can absorb more oxygen for cellular respiration. |
| **D** | It needs more energy from cellular respiration. |

*Biology > Big idea BCL: The cellular basis of life > Topic BCL3: Biochemistry > Key concept BCL3.2: Cellular respiration*

|  |
| --- |
| **Diagnostic question** |
| **How many mitochondria?** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Energy for life processes is provided by a chemical process called cellular respiration inside all living cells, which uses glucose (from food) as fuel. |
| Observable learning outcome: | Link living animals’ and plants’ need for oxygen and the presence of mitochondria in their cells to aerobic respiration. |
| Question type: | Two-tier multiple choice |
| Key words: | mitochondria, cellular respiration |

**What does the research say?**

Dreyfus and Jungwirth (1988; 1989) note that most children will never see cells functioning, so the *living* (functional) cell remains an abstract idea even if they have become familiar with the structures of cells through light microscopy and pictures. They found that many 16-year-olds struggled to explain how cells carry out life processes.

Learning about cellular respiration will be most effective if it helps students make connections between concepts with which they are already familiar (Seymour and Longden, 1991). By the time they come to learn in detail about cellular respiration in the later stages of the 11-14 age range, students will have already learnt about mitochondria as part of the animal and plant cell models. They need to be able to link the presence of mitochondria in cells to their role in aerobic cellular respiration.

However, linking concepts in this way may be challenging for students, as they often lack experience in establishing meaningful connections between concepts – particularly at different levels of biological organisation, such as cellular explanations for phenomena observed at the organism level (Songer and Mintzes, 1994; Ummels et al., 2015). A study by Anderson and Sheldon (1990) found that even university students in the US did not connect food, oxygen, carbon dioxide and energy in a coherent conception of cellular respiration.

Clément (2007) notes that animal (and plant) cell structure is often taught using highly standardised diagrams, which can introduce or reinforce the misunderstanding that all cells have the same shape and structures (matching the archetypal depictions); Clément found this misunderstanding persisting in students up to undergraduate level.

Two-tier multiple choice questions have commonly been used in the research to probe students’ understanding of cellular respiration (e.g. Haslam and Treagust, 1987; Svandova, 2014).

**Ways to use this question**

Students should complete the questions individually. This could be a pencil and paper exercise, or you could use the presentation with an electronic voting system or mini white boards.

*Differentiation*

You may choose to read the questions to the class, so that everyone can focus on the science. In some situations it may be more appropriate for a teaching assistant to read for one or two students.

**Expected answers**

1. **A** – A heart muscle cell would contain the most mitochondria.
2. **D** – It needs more energy from cellular respiration.

Although a third tier of multiple choice options is not provided, students could be asked to explain their reasoning. For example, for the correct combination of **1A** and **2D**, they could explain that a heart muscle cell needs more energy because the heart is always beating so heart muscle contracts many times per minute. For a wrong combination, for example **1B** (“A skin cell would contain the most mitochondria”) and **2C** (“It can absorb more oxygen for cellular respiration”), they might attribute this to the cell being on the surface or outside of the body (which suggests that do not appreciate that the circulatory system delivers oxygen to cells, rather than the oxygen being absorbed directly from the air outside the body).

**How to respond - what next?**

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs. Responses often work best when the activities involve paired or small group discussions, which encourage social construction of new ideas (meaning making) through dialogue.

If students have misunderstandings about how mitochondria are related to cell processes such as cellular respiration, key concept BCL1.2 *Cells and cell structures* provides diagnostic questions and response activities to further probe and develop understanding – particularly the response activity called “Match game! Substance-structure-process”.

**Acknowledgments**

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Images: mitochondria – adapted by UYSEG from Wikimedia Commons/Nevit; all other parts – UYSEG

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