**Flames**

air from the room

exhaled air

jar

candle

sand



Your teacher is going to place burning candles into two jars of air.

* One jar contains air from the room.
* The other jar contains exhaled air (air that has been breathed out by a person).

**Predict**

What will happen to the candle in each jar?

**Explain**

Explain why you think this will happen.

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| Your teacher will now place the candles in the jars. |

**Observe**

Watch what happens to the candles in the jars.

**Explain**

Was your prediction correct?

If not, how would you explain what you observed?

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

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| **Response activity** |
| **Flames** |

**Overview**

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| 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: | Describe aerobic cellular respiration using a simple model of the process, including what it uses as fuel (glucose plus oxygen) and what it makes as waste products (carbon dioxide and water). |
| Activity type: | Practical PEOE (predict-explain-observe-explain) |
| Key words: | cellular respiration, gas exchange system |

This activity challenges students to apply their understanding of a simple model of cellular respiration by applying it to predict how cellular respiration in humans changes the composition of air. It helps develop students’ understanding through prediction, explanation, observation and group discussion, and can be used in response to the following diagnostic questions:

* Diagnostic question: A simple model of aerobic cellular respiration
* Diagnostic question: Making gas (Part 1)

**What does the research say?**

While most children at age 11 are aware that humans need air to survive, some think that air is breathed into the lungs (or, less commonly, just into the head) and is then breathed out unchanged. A related but contrasting misconception has also been reported, in which children think that inhaled air is all oxygen while exhaled air is all carbon dioxide (Yip, 1998; García-Barros, Martínez-Losada and Garrido, 2011; Allen, 2014).

Inhaled air is approximately 78% nitrogen, 21% oxygen and 0.04% carbon dioxide; it also contains water vapour, other gases and particulates. Not all of the oxygen is absorbed into the blood. Exhaled air contains the same amount of nitrogen, approximately 17% oxygen and ten times more (4%) carbon dioxide.

Students should be able to apply their understanding of a simple model of aerobic cellular respiration to explain the decrease in oxygen and increase in carbon dioxide in exhaled air. At ages 11-14, a simple model of the inputs and outputs of the process may be good enough to enable them to do this. (Note, however, that the use of a word or symbol equation has been avoided in the BEST 11-14 resources, as it may reinforce the misunderstanding that photosynthesis is a single reaction.)

Aerobic

cellular

respiration

energy

water

glucose from carbohydrate food

oxygen

carbon dioxide

The EEF *Improving Secondary Science* guidance report advocates explicitly teaching pupils about models to help them develop a deeper understanding of scientific concepts (Holman and Yeomans, 2018).

**Ways to use this activity**

This activity takes the form of a predict-explain-observe-explain (PEOE) activity, which allows students to apply what they know to make predictions, and to build explanations for what they have predicted and what they observe.

Students should complete this activity in pairs or small groups, with time allowed for each group to engage in discussion to agree their predictions and explanations. It is through the discussions that students can check and develop their understanding. If students in any group cannot agree, you may be able to direct them with some careful questioning.

To begin, each group should discuss the activity and use their scientific understanding, firstly to predict *what* they think will happen, and then to explain *why* they think it will happen.

Students now carry out the practical, or watch a demonstration. You will need to decide whether it is better for each group to carry out the practical and risk some unexpected observations, or to demonstrate the activity so that everyone observes the same thing.

After the practical each group should be given the opportunity to change, or improve their explanation in light of their observations. A good way to review your students’ thinking might be through a structured class discussion. You could ask several groups for their explanations and put these on the whiteboard. Then ask other groups to suggest which explanation is the best and why, the through careful questioning work up a clear ‘class explanation’.

A useful follow up is for individual students to then write down explanations in their own words – without reference to the class explanation on the board (i.e. cover it up).

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as a scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

*Extension activity*

Lime water

* What will happen when **atmospheric air** is bubbled through lime water?

The lime water should not change, provided the experiment is not continued for too long, as there is insufficient carbon dioxide in atmospheric air to turn lime water milky.

* What will happen when **exhaled air** is bubbled through lime water?

The lime water should turn milky due to the increased amount of carbon dioxide (a waste product of aerobic cellular respiration) that is present in exhaled air.

**Equipment**

For demonstration to the class:

* two candles
* two tall glass jars
* tray containing sand

**Expected answers**

Students should predict and explain that:

* both of the candles will burn for some time inside the jars, because the air inside both jars contains oxygen
* both of the flames will eventually go out because all of the oxygen in the jars has been used up (combusted)
* the candle in the jar containing exhaled air will go out first, because there is less oxygen in exhaled air (because some of the oxygen was absorbed into the blood while the air was in the lungs, to be used as a fuel for cellular respiration).

**Acknowledgments**

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Images: UYSEG

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