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| **B1.3 Respiration** | **Guided teaching hours:** 3 hours |
| **Chapter overview**  In this chapter, students have been introduced to the idea of metabolic rate and how organic molecules are needed by the body as a source of energy. Building on  B1.2 *What happens in cells?*, they have looked at carbohydrates, proteins, and lipids, and their synthesis and breakdown.  Respiration is one of the most important processes in living cells. Students have studied aerobic respiration and written equations to represent this process. They have looked at mitochondria as the site of respiration, and considered examples of living processes that use the energy released by respiration. They should have studied aerobic respiration as an exothermic process, and be able to compare rates of respiration using this concept. They should also have investigated the effect of exercise on the heart rate and breathing rate, and considered how this is linked to respiration.  Building on this study of aerobic respiration, students have gone on to study anaerobic respiration, first in mammalian muscles. They should understand the importance of this process in muscle fatigue and the oxygen debt. Second, they should appreciate that anaerobic respiration occurs in yeast cells and some plant cells, as the process of fermentation. Finally they should be able to compare aerobic and anaerobic respiration.  Students should appreciate the link between the process of respiration *releasing* energy and the various processes in living things that *require* energy. They shouldlink their knowledge of enzymes from B1.2 *What happens in cells?* to their studies of respiration. | |

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| **Lesson B1.3.1 Carbohydrates, proteins, and lipids** | | |  |
| **OCR GATEWAY spec link:**  B1.3d Explain the importance of sugars in the synthesis and breakdown of carbohydrates. To include use of the terms monomer and polymer.  B1.3e Explain the importance of amino acids in the synthesis and breakdown of proteins. To include the use of the terms monomer and polymer.  B1.3f Explain the importance of fatty acids and glycerol in the synthesis and breakdown of lipids. | **Aiming for Grade 4 LOs:**   * Describe the components of carbohydrates, proteins, and lipids. * State what is meant by metabolic rate. * Use scientific vocabulary, terminology, and definitions, with limited accuracy in spelling, punctuation, and grammar. | **Lesson Overview**  **Starters**  **Transformations** (10 minutes) Issue small cubes made of about 20 lego blocks. Ask students to transform the cube into a pyramid, allowing 2 minutes only. Discuss quickly how they achieved this, by taking the cube apart and rebuilding a pyramid. Then show students a protein drink. Ask why people drink these (to build muscle). Then ask them how that might be achieved, linking it to the lego exercise.  **Being active** (5 minutes) Ask a student to jog on the spot for about a minute. Measure the forehead temperature before and after the exercise using a thermometer strip. Use an image of a lazy cartoon character doing nothing, and discuss why the temperature of the active person would be higher. Where does the heat come from? What could you predict about the number of reactions in the muscles of the active person compared with the inactive person? Finally, link metabolic rate to the rate of reactions inside cells.  **Mains**  **Metabolism** (15 minutes) Show a random series of metabolic reactions that can be grouped. (Show reactions suggested here only – not the groups). Such as:  • Digestion: Starch is broken down into sugars, protein is broken down into amino acids, etc.  • Synthesis: Glucose is built up into glycogen, glucose is built from carbon dioxide and water, etc.  • Respiration: Glucose is broken down to release lactic acid, glucose is broken down into carbon dioxide and water, etc.  Students study the reactions and form groups of reactions that are similar. Discuss what the reactions represent. Define metabolism, and outline the relationship between metabolic rate, activity levels, and food intake.  **Carbohydrates, fats, and proteins** (25 minutes) Issue a series of cards with facts about the features of biological molecules. The cards include information on:  • the building blocks of carbohydrates, lipids, and proteins (i.e. sugars,  fatty acids, glycerol, and amino acids)  • how they are joined together  • their uses in the body  • the enzymes used to break them down.  Students sort them and put the information into a table. Then lead a discussion to point out that fats, proteins and some carbohydrates are examples of polymers. They are made up of substances with much smaller molecules, called monomers.  **Plenaries**  **Biochemical facts** (5 minutes) Use the interactive by linking lines between the biochemical groups to either their building blocks or the function of the group.  **Building models** (10 minutes) Provide students with paper or molymodels and ask them to build starch from sugar blocks or proteins from amino acid blocks. | **Resources**  **Simple interactive:**  Biochemical facts |
| **Aiming for Grade 6 LOs:**   * Explain how carbohydrates, proteins, and lipids are synthesised and broken down. * Describe the relationship between metabolic rate, activity levels, and food intake. * Use scientific vocabulary, terminology, and definitions accurately with occasional errors in spelling, punctuation, and grammar. |
| **Aiming for Grade 8 LOs:**   * Distinguish between monomers and polymers in biological molecules. * Explain that metabolic reactions can be divided into different groups. * Use scientific vocabulary, terminology, and definitions accurately and error-free in spelling, punctuation, and grammar. |

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| **Lesson B1.3.2 Aerobic respiration** | | |  |
| **OCR GATEWAY spec link:**  B1.3a Describe cellular respiration as a universal chemical process, continuously occurring, that supplies ATP in all living cells.  B1.3b Describe cellular respiration as an exothermic reaction.  WS1.2a Use scientific theories and explanations to develop hypotheses. | **Aiming for Grade 4 LOs:**   * State the word equation for respiration. * State that respiration transfers energy. * Plot a graph of data from experiments. | **Lesson Overview**  **Starters**  **Aerobic respiration introduction** (5 minutes) Use the interactive, which shows a drawing of a cell. Students drag and drop the raw materials for respiration, and the products produced, into the correct places. Students also complete the balanced equation for aerobic respiration.  **Energy in food** (10 minutes) Demonstrate burning a food, such as sugar or custard powder. Do this by sprinkling it into a Bunsen flame. Students may have seen this before, so ask the students to explain what has happened and why. Build the names of the key reactants and products (glucose, oxygen, carbon dioxide, and water) into the discussion. Then link to the ideas of energy stores in food being the source of energy for the body.  **Main**  **Respiration of peas** (5 minutes) Demonstrate the respiration of peas inside a thermos flask to the class. Use two flasks, one with living, respiring peas, and one with dead peas. Explain that respiration transfers energy to the surroundings, resulting in a temperature rise in the surroundings.  **Question sheet** (35 minutes) Provide students with a worksheet containing data from a similar experiment.  The sheet has data from three experiments:  • living, respiring peas, which have been washed in disinfectant  • living, respiring peas, which are unwashed and thus contain bacteria  • boiled (dead, non-respiring) peas.  Students plot the three lines on a graph and answer questions about respiration (including the balanced symbol equation for aerobic respiration), the production of ATP, and the transfer of energy to the surroundings by heating (including the term exothermic). Return to the demonstration to observe any change in temperature.  **Plenaries**  **Energy tally for different organisms** (5 minutes) Provide students with the images of about six different organisms, for example, athlete, physical worker, earthworm, plant, sedentary person, and arctic explorer.  Ask students to list what the organisms might need energy for. Try to estimate the relative amount of energy each will transfer in a typical day.  **Minute cartoons** (10 minutes) Divide the class into pairs. Issue each pair with an envelope containing cards. Each one has a word related to the transfer of energy in the body, such as body temperature, movement, growth, and so on. One student reads the card and, without talking, does a drawing to illustrate the word. Allow 1 minute for each word. The other student guesses the word. | **Resources**  **Simple interactive:**  Aerobic respiration  **Calculations sheet:**  Graphing respiration |
| **Aiming for Grade 6 LOs:**   * State the chemical equation for respiration. * Describe the process of aerobic respiration as an exothermic reaction. * Plot an appropriate line graph of two variables from experimental data. |
| **Aiming for Grade 8 LOs:**   * Discuss the use by the body of the energy transferred in respiration. * Explain how ATP is produced during aerobic respiration. * Plot an appropriate accurate line graph of two variables from experimental data, and interpret the data to draw conclusions. |

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| **Lesson B1.3.3 Anaerobic respiration** | | |  |
| **OCR GATEWAY spec link:**  B1.3c Compare the processes of aerobic respiration and anaerobic respiration.  To include in plants, fungi, and animals, and the different conditions, substrates, products, and relative yields of ATP.  WS1.2c Apply a knowledge of a range of techniques, instruments, apparatus, and materials to select those appropriate to the experiment. | **Aiming for Grade 4 LOs:**   * State the word equation for anaerobic respiration. * State that there are different types of anaerobic respiration in different organisms. * Use the correct apparatus to follow a method with help. | **Lesson Overview**  **Starters**  **Why do we get a stitch?** (5 minutes) Show a cartoon of a runner demonstrating pain from a stitch or cramp. Pose the question ‘Why have I got cramp?’ Either open this to discussion or put a few possible comments on the  cartoon to prompt debate, such as:  • the muscles are making lactic acid  • the muscles are over-stretched  • the muscles are tired.  **Making alcohol** (10 minutes) Start with images of making alcohol for example, beer-making or wine-making, or show demijohns and describe the functions of the jar. Ask students if they can explain how alcohol is made: what are the raw materials? Lead discussion to yeasts. Ask questions such as: What is the name of the process that makes the alcohol? What is the starting substance? Where does the starting material come from?  **Mains**  **Investigating fermentation in yeast** (30 minutes) Provide students with a method for the fermentation of yeast to make alcohol and carbon dioxide. They accurately measure out the volumes of the starting substances, and add them to the apparatus. Students then observe the carbon dioxide turning lime water milky.  **Comparing anaerobic and aerobic respiration** (10 minutes) Students use the student book to note down three differences between anaerobic and aerobic respiration, including the word equations and symbol equation for aerobic respiration. Students should also include reference to the relative yields of ATP. Students should also note the meaning of the term ‘oxygen debt’.  **Plenaries**  **Respiration definitions** (5 minutes) Tackle the interactive activity in which students match words and phrases to their definitions.  **Respiration and athletics** (10 minutes) Show the class a short film clip of a 200 m or 400 m sprint race. Ask questions such as:  • How does the runner feel at the end of the race?  • Why does he or she feel like this?  • What substance has been produced in the runner’s muscles? | **Resources**  **Practical sheet:**  Anaerobic  respiration |
| **Aiming for Grade 6 LOs:**   * State a chemical equation for anaerobic respiration. * Describe the different processes of anaerobic respiration and where they occur. * Use a method to carry out an experiment appropriately and independently, giving due regard to the correct manipulation of apparatus. |
| **Aiming for Grade 8 LOs:**   * Compare the processes of aerobic and anaerobic respiration in terms of energy yield. * Explain the consequences of anaerobic respiration in muscles in terms of oxygen debt. * Use a method to carry out an experiment appropriately and independently, giving due regard to the correct manipulation of apparatus and the accuracy of measurements. |