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| **B1.2 What happens in cells?** | **Guided teaching hours:** 4 hours |
| **Chapter overview**  In this chapter students have studied DNA as the molecule that caries the information that determines an organism’s characteristics. They should understand that DNA is arranged into sections called genes, and that each gene codes for a specific protein.  Students should be able to describe the structure of DNA as a polymer made of two strands that form a double helix. They should know that DNA is made from four different nucleotides that are each made of a sugar, a phosphate group, and one of four different bases. Students should be able to describe complementary base pairing between the four bases and know that it holds the two strands of DNA together. Higher-tier GCSE Biology students have studied how the information stored on DNA is transcribed and translated into proteins.  Students have studied enzymes, and should be able to state their functions as well as the factors that affect enzyme-controlled reactions. They should be able to describe the mechanism of enzyme action using the lock and key hypothesis, and understand the importance of the active site for specificity. Students should understand that the rates of enzyme-controlled reactions are affected by many factors, including temperature, pH, substrate concentration, and enzyme concentration. They should be able to explain how changes in these factors affect the rate of a reaction. Students should be able to describe what happens when an enzyme is denatured. | |

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| **Lesson B1.2.1 DNA** | | |  |
| **OCR GATEWAY spec link:**  B1.2a Describe DNA as a polymer.  B1.2b Describe DNA as being made up of two strands forming a double helix.  B1.2c Describe that DNA is made from four different nucleotides; each nucleotide consisting of a common sugar and phosphate group with one of four different bases attached to the sugar. To include the pairs of complementary bases.  **H**  WS1.4a Use scientific vocabulary, terminology, and definitions.  WS2a Carry out experiments with due regard to the correct manipulation of apparatus, the accuracy of measurements, and health and safety considerations, and following written instructions. | **Aiming for Grade 4 LOs:**   * Describe the structure of DNA. * State the role of DNA. * Use the correct apparatus to follow a method with help. | **Lesson Overview**  **Starters**  **True or false?** (5 minutes) Show a newspaper headline or film clip of a TV news item describing the importance of DNA in current medical issues. Briefly discuss the story and its relevance. Students have a red (false) and green (true) card. The teacher then makes a number of statements and the students vote true or false. The statements cover:  • The structure of DNA.  • The role of DNA.  • The location of DNA.  **What is DNA?** (5 minutes) Students complete the interactive by matching the following words to the correct definitions: gene, chromosome, DNA bases, and nucleotides. Students then select true or false in a series of statements.  **Mains**  **Extracting DNA from kiwi fruits** (40 minutes) Follow a practical method for the extraction of DNA from a kiwi fruit or similar. The practical sheet guides students in reviewing the procedure they have just carried out, including justifying some of its stages.  **Plenaries**  **Human DNA** (5 minutes) Issue each student a sheet of paper with a letter (A, T, C, or G). Ask them to make an appropriate pairing, and then link the pairs together to build a DNA molecule.  **Describing DNA** (5 minutes) Students work in pairs. Each pair sit back to back. Student one is issued with an image of a nucleotide or DNA molecule (see the Student Book, Figures 3 and 4). Student 2 has a pen and paper. Student 1 then describes the structure of either the nucleotide or DNA and student 2 has to draw the molecule. Student 2 reveals the result and they discuss the actual structure. | **Resources**  Interactive: DNA  Practical: Extracting DNA from kiwi fruits |
| **Aiming for Grade 6 LOs:**   * Describe the structure of the nucleotide as the building block of DNA. * Describe the role of a gene. * Use a method to carry out an experiment appropriately and independently, having due regard for the correct manipulation of apparatus. |
| **Aiming for Grade 8 LOs:**   * Explain what is meant by complementary base pairing. * Explain the relationship between DNA, genes, and chromosomes. * Use a method to carry out an experiment appropriately and independently, with due regard to the correct manipulation of apparatus and the accuracy of measurements. |

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| **Lesson B1.2.2 Transcription and translation** | | |  |
| **OCR GATEWAY spec link:**  B1.2d Recall a simple description of protein synthesis. To include the unzipping of the DNA molecule around the gene, copying to mRNA in nucleus (transcription), (translation) of the nucleotide sequence, in the cytoplasm.  B1.2e Explain simply how the structure of DNA affects the proteins made in  protein synthesis. To include triplet code and its use to determine amino acidorder. | **Aiming for Grade 6 LOs:**   * Compare the difference in structure between mRNA and DNA. * Describe the process of protein synthesis; to include transcription and translation. * Summarise and evaluate with accuracy and clear understanding. | **Lesson Overview**  **Starters**  **Central dogma sequence game** (10 minutes) Students work in groups of three. Issue each group with a series of six cards each with a statement describing a step in the process of protein synthesis. Students are given 2–3 minutes to put the statements in the correct order.  **Transcription and translation** (5 minutes) Students use the interactive to select the bases found in mRNA and then to sort statements about DNA and mRNA.  **Main**  **Protein synthesis marketplace**  **Stage 1 Becoming experts** (15 minutes) Split the class into groups of three. Supply each group with one of three information cards, a large sheet of paper (flip chart paper), and pens. Students have 20 minutes to become experts on the information on their card. To do this, they read the card and make drawings to illustrate the information from the card, but you should limit the number of words the groups can use. Then, collect in the cards.  The cards describe:  • The structure of DNA and mRNA.  • The process of transcription.  • The process of translation.  **Stage 2 Gathering information** (10 minutes) One member of each group stays in place and acts as a teacher, using the drawings their group has made. The other two move to separate groups, and learn about the other two topics.  **Stage 3 Sharing learning** (15 minutes) Students return to their home group and share the information learnt with the other team members. Each student should have learnt about the entire process of protein synthesis.  **Plenaries**  **DNA to protein** (5 minutes) Students fill in the gaps to complete a paragraph about how DNA and protein are connected.  **Making mRNA** (10 minutes) Issue students with two sheets of different coloured A4 paper. Ask them to make simple paper strip models to illustrate how mRNA is made in the nucleus. | **Resources**  **Interactive:** Transcription and translation  **Activity:**  Protein synthesis marketplace  **Interactive:**  DNA to protein |
| **Aiming for Grade 8 Los:**   * Distinguish between the roles of mRNA and DNA in the process of protein synthesis. * Explain how the base sequence in the DNA molecule determines the amino acid sequence in the protein. * Summarise and critically evaluate with detailed and perceptive understanding. |

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| **Lesson B1.2.3 Enzymes** | | |  |
| **OCR GATEWAY spec link:**  B1.2g Explain the mechanism of enzyme action. To include the role of enzymes in metabolism, the role of the active site, enzyme specificity (lock and key hypothesis), and factors affecting the rate of enzyme-controlled reactions (pH, temperature, substrate, and enzyme concentration). | **Aiming for Grade 4 LOs:**   * State what an enzyme is. * Describe simply how an enzyme works. * Describe how an enzyme works by communicating simply and with some clarity for the audience. | **Lesson Overview**  **Starters**  **Mystery agents** (10 minutes) Tell students that we produce a toxic waste in cells called hydrogen peroxide, which must be removed. Carry out a simple demonstration to show what happens to the waste substance. Take three test tubes with hydrogen peroxide (about 5 cm3 at 1.8 mol dm−3). Add a small piece of liver to one test tube; it will fizz rapidly. To the second, add a piece of potato; there will be the same response, but less dramatic. Finally, add something non-living, for example, a marble. The key features to draw out from the students are:  • The process occurs in living tissues and it is speeded up by an enzyme.  • It is rapid.  • It is a chemical reaction.  Introduce enzymes as the vital component.  **Nuts and bolts** (5 minutes) Use one spanner, and a nut and bolt combination. Demonstrate that the spanner can be used to take apart the nuts and bolts. Referring to learning from Key Stage 3, draw an analogy to enzyme structure, the active site, substrate, and simple enzyme function.  **Mains**  **How does an enzyme work?** (40 minutes) Students produce a cartoon to explain how an enzyme works. This could be achieved by providing the students with a storyboard template or, alternatively, they could produce a stop-motion cartoon by photographing modelling clay models or drawings. Students could use tablets, phones or cameras. The cartoon should include text and images, as well as the definition of an enzyme.  **Plenaries**  **Metabolism** (5 minutes) Provide a simple list of enzyme systems, for example, enzymes involved in breaking starch into sugars, or enzymes responsible for building sugars from carbon dioxide and water. Ask students to identify where these systems operate, the name of the life process they are involved in, and what would happen if the organism did not have the enzymes.  **Use of enzymes** (10 minutes) Students complete an interactive activity where they complete a series of paragraphs summarising the key points of enzymes. They then identify true and false statements about enzymes. | **Resources**  **Activity:** Storyboard template  **Interactive:** Enzymes |
| **Aiming for Grade 6 LOs:**   * Describe the structure of an enzyme. * Explain how an enzyme works. * Illustrate how an enzyme works by communicating effectively, sustaining the audience’s interest. |
| **Aiming for Grade 8 LOs:**   * Explain what is meant by enzyme specificity. * Explain in detail how an enzyme interacts with its substrate to catalyse a reaction. * Interpret how an enzyme works by communicating, with impact and influence. |

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| **Lesson B1.2.4 Enzyme reactions** | | |  |
| **OCR GATEWAY spec link:**  B1.2f Describe experiments that can be used to investigate enzymatic reactions.  B1.2g Explain the mechanism of enzyme action, to include the role of enzymes in metabolism, the role of the active site, enzyme specificity (lock and key hypothesis), and factors affecting the rate of enzyme-controlled reactions (pH, temperature, substrate, and enzyme concentration).  WS1.1h Evaluate risks both in practical science and the wider societal context.  WS1.2b Plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data, or explore phenomena.  WS1.2c Apply a knowledge of a range of techniques, instruments, apparatus, and materials to select those appropriate to the experiment.  WS1.3a Present observations and other data using appropriate methods.  WS1.3b Translate data from one form to another.  WS1.3c Carry out and represent mathematical and statistical analysis.  WS1.3d Represent distributions of results and make estimations of uncertainty.  WS1.3e Interpret observations and other data.  WS1.3f Present reasoned explanations, including relating data to hypotheses.  WS2a Carry out experiments.  WS2b Make and record observations and measurements using a range of apparatus and methods.  BM1.2i Carry out rate calculations for chemical reactions (M1a, M1c).  BM1.2ii Understand and use simple compound measures, such as the rate of a reaction (M1a, M1c). | **Aiming for Grade 4 LOs:**   * State the factors that affect enzyme-controlled reactions. State what is meant by denaturation. Record observations from an experimental procedure, using a range of apparatus. | **Lesson Overview**  **Starters**  **Factors affecting enzyme reactions** (5 minutes) Ask students to suggest factors that might affect enzyme reactions. Then use the interactive to decide what factors affect enzyme action and answer questions about a graph.  **Hot and cold** (5 minutes) Reuse the mystery agents idea from the previous lesson. This time have the hydrogen peroxide prepared by placing one tube in ice and one in warm water. Add a cube of liver to each, and ask the students what the difference is. Ask them to suggest a relationship between temperature and the rate of enzyme-controlled reactions.  **Mains**  **Investigating the effect of temperature on enzyme reactions**  (40 minutes) Students plan an experiment to investigate how pH or temperature affect the rate of amylase activity. Students should be guide to choose a suitable range for the independent variable and to use control variables. Students use their data to plot a line graph and answer questions in order to draw conclusions from the data and evaluate the method.  Students should swap data with a group that investigated the other variable from them.  Students plot a graph of rate on the *y-*axis against temperature on the *x-*axis. Include a series of questions to encourage students to describe and explain the action of temperature on the enzyme action.  SAFETY: Avoid enzyme dust when preparing solutions.  **Plenaries**  **Mystery agents yet again** (5 minutes) Return to the second starter. To a final tube of peroxide add some boiled liver. Nothing happens. Ask students to explain what might have happened to the enzyme.  **Explaining the graphs** (5 minutes) Divide the class into pairs. Give each group one of four sketch graphs showing the effect of different factors on the rate of enzyme reaction (temperature, pH, substrate concentration, and enzyme concentration); only the axes are labelled. Students annotate the graph they have been given to explain what is happening at the key points on the graph. | **Resources**  **Interactive:** Enzyme reactions  **Practical:** Factors that affect the rate of enzyme controlled reactions |
| **Aiming for Grade 6 LOs:**   * Describe the effect of a factor on the rate of an enzyme-controlled reaction. * Describe what happens when an enzyme is denatured. * Record measurements from an experimental procedure, and plot a simple graph having been given the axes. |
| **Aiming for Grade 8 LOs:**   * Explain how different factors affect the rate of an enzyme-controlled reaction. * Explain how denaturation affects the rate of an enzyme-controlled reaction. * Record accurate measurements from an experimental procedure, plotting an accurate rate graph. |