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| customer@rompsun.co.uk**B2.2 The challenges of size** | **Guided teaching hours:** 6 hours |
| **Chapter overview**  In this chapter, students have studied exchange and transport in organisms. They should understand the need for multicellular organisms to have specialized exchange surfaces and transport systems. They should be able to calculate surface area : volume ratios and be able to cite the alveoli and villi as two examples of increasing the surface area for exchange. Students should link this with work on di­ffusion in *B2.1 Supplying the cell*, and with respiration in *B1.3 Respiration*, and understand that exchange surfaces and transport systems are needed to provide glucose and oxygen to all cells so that they can respire. Students should appreciate the distinction between the size of an organism and the surface area : volume ratio of an organism or exchange surface. They should understand that the alveolus wall is one cell thick, and be able to distinguish between the alveolus wall and the cell wall of a plant cell.  Students have studied the circulatory system, including the double circulatory system, the functioning of the heart, and the different types of blood vessel, focusing on their structure and function. They should understand that the large network of capillaries gives them a large total cross-sectional area. They should be able to state the components of blood, and link this with specialised cells from *B2.1 Supplying the cell*.  Students have also studied plant transport systems, and should be familiar with the structure of xylem and phloem tissue, and the processes of transpiration and translocation. They should be aware that liquid water does not di­ use out of the stomata, as water evaporates within the leaf into water vapour. Again there are links with *B2.1 Supplying the cell*, which covered the root hair cell as an example of aspecialised cell and the role of active transport in transporting mineral ions into the root hair cell. | |

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| **Lesson B2.2.1 Exchange and transport** | | |  |
| **OCR GATEWAY spec link:**  B2.2a Explain the need for exchange surfaces and a transport system in multicellular organisms in terms of surface area:volume ratio. To include surface area, volume and diffusion distances.  B2.2b Describe some of the substances transported into and out of a range of organisms in terms of the requirements of those organisms. To include oxygen, carbon dioxide, water, dissolved food molecules, mineral ions, and urea.  WS1.3e Interpret observations and other data.  WS1.4d Use prefixes and powers of ten for orders of magnitude.  WS1.4e Interconvert units.  WS1.4f Use an appropriate number of significant figures in calculation.  BM2.2i Calculate surface area:volume ratios (M1c). | **Aiming for Grade 4 LOs:**   * State some examples of exchange surfaces and transport systems. * Calculate the surface area or volume of an object. Describe simple observations made during an experiment. | **Lesson Overview**  **Starters**  **Changing the surface area** (5 minutes) Use a square biscuit, and calculate the surface area of the top and bottom. Then place the biscuit into a plastic bag and crush it. Spread the crumbs out in a tray and estimate the surface area. Ask students what has happened to the surface area as the size of the structures has decreased.  **Demonstrating surface area and volume** (10 minutes) Use two wooden cubes, one small (1 cm3) and one larger, for example, 5 cm3. Ask class to help calculate the surface area. Then place the cube in a eureka can, and collect and measure the volume. These should give surface area : volume ratios close to those that could be calculated mathematically.  **Mains**  **Investigating efficient uptake by different-sized cells** (40 minutes) Students cut cubes of gelatine of different sizes, 1 cm3, 2 cm3, 5 cm3. The gel will have been stained with universal indicator before the lesson. They place these cubes into dilute hydrochloric acid for a fixed time, then remove, and slice through the middle. Students measure the depth into the cube that the colour has changed. Students create a results table, which lists the side length, surface area, volume, and surface area : volume ratio. They observe the change of colour. Questions to link to efficiency of exchange, and the need for the development of specialised exchange surfaces.  **Plenaries**  **Surface area in the gut** (10 minutes) Provide each student with a sheet of A4 and A5 paper. The A5 paper when rolled into a cylinder represents a small length of the gut. The students take the A4 paper and fold it concertina style, and then roll that up inside the tube. The students should recognise that a larger surface area caused by the foldings, which represent the villi, is present in the same length and diameter of tube. Ask students to suggest how this would increase the efficiency of uptake.  **Exchange and transport** (5 minutes) Use the interactive in which students fill in the blanks in the sentences. The paragraph describes how oxygen moves from the air into the alveoli | **Resources**  **Practical:** Investigating efficient uptake by different-sized cells  **Interactive:** Exchange and transport |
| **Aiming for Grade 6 LOs:**   * Describe the features of an efficient exchange surface. * Calculate the surface area : volume ratio. * Interpret observations and data made during an experiment. |
| **Aiming for Grade 8 LOs:**   * Explain why multicellular organisms require adapted exchange surfaces. * Compare the relationship between the surface area : volume ratio and the size of an organism or cell. * Interpret observations and data obtained during an experiment, identifying patterns and drawing conclusions. |

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| **Lesson B2.2.2** **Circulatory system** | | |  |
| **OCR GATEWAY spec link:**  B2.2c Describe the human circulatory system. To include the relationship with the gaseous exchange system, the need for a double circulatory system in mammals, and the arrangement of vessels.  B2.2d Explain how the structure of the heart and the blood vessels are adapted to their functions. To include the structure of the mammalian heart with reference to valves, chambers, cardiac muscle, and the structure of blood vessels with reference to thickness of walls, diameter of lumen, presence of valves.  WS1.4a Use scientific vocabulary, terminology, and definitions. | **Aiming for Grade 4 LOs:**   * State the function of the circulatory system. * Name the different types of blood vessels found in a circulatory system. * Use familiar vocabulary to some effect to describe the circulatory system. | **Lesson Overview**  **Starters**  **Parts of the circulatory system** (10 minutes) Issue sets of nine cards to pairs of students. The students have to sort the cards into three sets. Each set contains the name of a component of a circulatory system, the human/mammal example, and the function.  Cards:  Pump, heart, causes the blood to move, tubes, blood vessels, takes the fluid to and from the organs, fluid, blood, contains substances and is moved around the body.  **Circulation role play** (5 minutes) The teacher plays the part of the heart. At the opposite side of the class will be a group of about six students who are muscle cells. A second group of students act as blood. The teacher directs the students to walk clockwise around the room, from teacher to the muscle and back. Introduce the idea of circulation. Repeat, but this time students hold up cards with the name artery, capillary, and vein at the correct position.  **Main**  **Exploring circulation** (40 minutes) Divide the class into groups of eight, and subdivide these groups into pairs. Within the group of eight, each pair is given the task to research a section of the circulatory system. (15 minutes)   1. What happens in the right side of the heart (no details of heart are needed), focusing on the veins in and arteries out? 2. What happens in the lungs? 3. What happens in the left side of the heart? 4. What happens in the tissues, including details of the capillaries?   The groups of eight then reform and pool their information around a diagram of the human circulatory system. (10 minutes) Then give each student their own diagram of the human circulatory system. Students annotate their diagrams to cover the points they have learnt, including the following: the function of the circulatory system, how blood circulates, different types of blood vessels, oxygenated and deoxygenated blood. (20 minutes)  **Plenaries**  **Features of blood vessels** (5 minutes) Use the interactive in which students drag and drop descriptions about blood vessels into the correct blood vessel category.  **Discovering circulation** (10 minutes) Show the class an image of one of Harvey’s classic experiments providing evidence for the circulation of the blood. Give a brief description of what Harvey did, and ask students to explain what has happened. You can demonstrate this using a blood vessel in your hand/arm (no need to use a tourniquet). | **Resources**  **Activity:** Exploring circulation  **Interactive:** Features of blood vessels |
| **Aiming for Grade 6 LOs:**   * Describe the structure of the double circulatory system. * Describe the structure of the blood vessels. * Use vocabulary appropriate to purpose and effect to describe the structure of the circulatory system. |
| **Aiming for Grade 8 LOs:**   * Explain the need for a double circulatory system in mammals. * Explain the link between the structure and function of the different types of blood vessels. * Use a wide range of well-selected and precise vocabulary to enhance impact when explaining the functioning of the circulatory system. |

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| **Lesson B2.2.3 Heart and blood** | | |  |
| **OCR GATEWAY spec link:**  B2.2d Explain how the structure of the heart and the blood vessels are adapted to their functions. To include the structure of the mammalian heart with reference to valves, chambers, cardiac muscle; and the structure of blood vessels with reference to thickness of walls, diameter of lumen, presence of valves.  B2.2e Explain how red blood cells and plasma are adapted to their transport functions in the blood.  WS1.4a Use scientific vocabulary, terminology, and definitions. | **Aiming for Grade 4 LOs:**   * Identify the components of the blood. * Identify the main structures in the heart. * State the names of the major parts of the heart and blood. | **Lesson Overview**  **Starters**  **What can you see in blood?** (5 minutes) Show an image of a blood smear, either by projecting it onto a screen directly from a microscope or from the internet. Ask students to identify the types of cell they can see, and their names. Ask the name of the liquid the cells are suspended in.  **Functions of the blood** (10 minutes) Write a series of questions on cards and place them in envelopes. Divide the class into groups, and give each group a complete set of the questions. Give them 4–5 minutes to discuss the questions and suggest answers. Then ask groups to offer their answers. Discuss feedback.  Questions:   1. Why does the blood need to be a liquid? 2. Why does the blood contain different components? 3. Why should the plasma be a good solvent? 4. What is haemoglobin for?   **Mains**  **The blood** (15 minutes) Tell students that red blood cells and plasma are involved in transport. Students model a red blood cell out of modelling clay and discuss how it is adapted to transport oxygen efficiently (large surface area, small size, contains haemoglobin). Quickly describe plasma as a liquid able to carry soluble substances. Create a table, linking the adaptations of plasma and red blood cells to their functions.  **Heart dissection** (25 minutes) This can be done as a demonstration or grouped practical. Students should draw a simplified and labelled diagram of the heart from viewing the dissection. Students who do not wish to be involved with the practical due to religious or moral objections can complete the questions on the corresponding Student Book spread then complete the Bump up your grade worksheet to understand the role of valves in controlling the direction of the blood flow in the heart. The information for this should come from the teacher-led dissection.  **Plenaries**  **Functions of the parts of the heart** (5 minutes) Use the interactive to get students to label a diagram of the heart and then match up blood vessels to the correct function.  **Cardiology ward** (10 minutes) Divide the class into groups of six. Each group splits into pairs that quickly research one of three heart conditions. They explain to the rest of the group what the condition is and how it affects the basic functioning of the heart. Suggested conditions: heart attack, hole in the heart, and valve failure. | **Resources**  **Practical:** Sheep heart dissection  **Interactive:** Heart and blood |
| **Aiming for Grade 6 LOs:**   * Describe the functions of the main components of the blood. * Describe the flow of blood through the heart. * Use the correct names of the parts of the heart and blood when describing their function. |
| **Aiming for Grade 8 LOs:**   * Explain the adaptations of the red blood cell that enable it to carry out its function. * Explain how the thickness of the chambers of the heart are related to their function. * Use an appropriate range of scientific vocabulary and terminology when explaining the functions of the blood and heart. |

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| **Lesson B2.2.4 Plant transport systems** | | |  |
| **OCR GATEWAY spec link:**  B2.2g Describe the processes of transpiration and translocation. To include the structure and function of the stomata.  B2.2h Explain how the structure of the xylem and phloem are adapted to their functions in the plant.  WS1.4a Use scientific vocabulary, terminology, and definitions. | **Aiming for Grade 4 LOs:**   * State the function of xylem. * State the function of phloem. * Label diagrams using simple sentence structure and familiar vocabulary. | **Lesson Overview**  **Starters**  **Demonstrate uptake of water** (10 minutes) Have prepared a cutting of celery or a Busy Lizzy, standing in coloured water. Demonstrate the set-up of this experiment, then remove the prepared sample, and cut the stem a little way up to show that the coloured dye has moved into the stem – but only in the vascular bundles. Name the cell types involved and the process shown. Then remind students about photosynthesis and ask them how sugars would be transported to the roots. Name the phloem and the process.  **Features of xylem and phloem** (5 minutes) Use the interactive in which students type in answers to complete sentences about xylem and phloem, and then sort statements into whether they describe xylem or phloem.  **Mains**  **Movement through the xylem** (20 minutes) Supply students with celery sticks that have been left overnight in ink. They cut the sticks to see how the dye has stained the xylem walls. Students then answer a series of questions on the structure and function of xylem that review knowledge of specialised cells, and draw an annotated diagram of xylem tissue.  **Transport in the phloem** (20 minutes) Show the class a video that shows how sap is tapped from trees in order to make maple syrup. Discuss with the class where the sugars in the tree trunk (stem) come from and how they are transported, or translocated, in the phloem. Ask students to explain how phloem cells are adapted for their function and to draw an annotated diagram of phloem tissue.  **Plenaries**  **Plant transport game** (10 minutes) Divide the class in half. Select a student from one half who names a feature about the structure or distribution of xylem or phloem that helps it function. They select a student from the other team to give a reason why the feature helps. If the second student gets the answer correct they can then ask the next question. And so on.  **Four words** (5 minutes) Issue mini white boards. Ask a series of questions to which there are only four possible answers, xylem, phloem, transpiration, or translocation. Students write the answer to each question on the white board. | **Resources**  **Interactive:** Plant transport systems  **Practical:** Movement through the xylem |
| **Aiming for Grade 6 LOs:**   * Describe the function and distribution of xylem tissue. * Describe the function and distribution of phloem tissue. * Annotate diagrams using varied sentence types and appropriate scientific vocabulary. |
| **Aiming for Grade 8 LOs:**   * Explain how the structure and distribution of xylem tissue is related to its function. * Explain how the structure and distribution of phloem tissue is related to its * function. * Annotate diagrams using a wide range of sentence types, including precise and appropriate scientific vocabulary. |

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| **Lesson B2.2.5 Transpiration stream** | | |  |
| **OCR GATEWAY spec link:**  B2.2f Explain how water and mineral ions are taken up by plants, relating the structure of the root hair cells to their function.  B2.2g Describe the processes of transpiration and translocation. To include  the structure and function of the stomata.  WS1.3f Present reasoned explanations. | **Aiming for Grade 4 LOs:**   * State what is meant by transpiration. * State the location of most stomata in a plant. * Describe the observations made during each experiment. | **Lesson Overview**  **Starters**  **Balloon stoma** (5 minutes) Inflate two long, thin balloons (but do not knot them), to represent guard cells. Place a length of sticky tape along one edge. The two taped edges should be lined up as the inner edge of the stoma. Blow a small amount of extra air into both balloons – they will curve, causing the stoma to open. Demonstrate this as explaining the situation in the leaf.  **Cells for the job** (10 minutes) Give each group in the class an outline drawing of a root hair cell (and possibly a xylem cell). Ask them to add labels to the diagram to suggest how the cell is adapted and what it does.  **Mains**  **Weight potometer** (15 minutes) Follow a suitable method to set up a weight potometer. Use a potometer with a plant and one without a plant as the control. Record the initial weight of each set-up. Students predict the outcome. Either have results from a previously set-up experiment, or collect the results at the start of the next lesson. Questions focus on uptake by roots and transport of water through the plant, and connect to previous lessons.  **Investigating stomata** (25 minutes) Demonstrate how you can carry out an epidermal peel to view stomata under the microscope. Ask students  to discuss in small groups what you could investigate about the stomata using this method and how they would do so. Examples include comparing the number of stomata on different types of plant, different leaves on one plant, and different areas of the leaf. Discuss the use of sampling to study different leaves and different areas on the leaf. Students then carry out the practical in small groups. They count the number of stomata in several fields of view before calculating a mean and writing a conclusion.  **Plenaries**  **Taking a cutting** (10 minutes) Demonstrate taking a cutting from a plant like a geranium. Emphasise that the plant has lost its roots. Then, break off the lower leaves and place the cutting into wet soil. Ask students to explain the importance or significance of each of these points.  **Transpiration stream** (5 minutes) Use the interactive to place a series of statements, which give the sequence of events in the transpiration stream, into the correct order. | **Resources**  **Practical:** Investigating stomata  **Interactive:** Transpiration stream |
| **Aiming for Grade 6 LOs:**   * Describe the transpiration stream. * Describe the structure of a stoma. * Explain the observations made during each experiment. |
| **Aiming for Grade 8 LOs:**   * Explain the mechanisms by which water is moved through the plant. * Explain how stomata control water loss from leaves. * Relate the findings of both experiments to one another, to explain how water is lost from the plant. |

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| **Lesson B2.2.6 Factors affecting transpirations** | | |  |
| **OCR GATEWAY spec link:**  B2.2i Explain the effect of a variety of environmental factors on the rate of water uptake by a plant. To include light intensity, air movement, and temperature.  B2.2j Describe how a simple potometer can be used to investigate factors that affect the rate of water uptake.  WS1.2c Apply a knowledge of a range of techniques, instruments, apparatus, and materials to select those appropriate to the experiment.  WS1.2e Evaluate methods, and suggest possible improvements and further investigations.  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.  WS1.3g Evaluate data in terms of accuracy, precision, repeatability, and reproducibility.  WS2a Carry out experiments.  WS2b Make and record observations and measurements using a range of apparatus and methods.  BM2.2ii Use simple compound measures, such as rate (M1a, M1c).  BM2.2iii Carry out rate calculations (M1a, M1c).  BM2.2iv Plot, draw, and interpret appropriate graphs (M4a, M4b, M4c, M4d). | **Aiming for Grade 4 LOs:**   * State the factors that affect the rate of transpiration. * State what a potometer measures. * State a limitation found with the method. | **Lesson Overview**  **Starters**  **Affecting the rate** (10 minutes) Provide the student groups with a set of six cards with terms written on them (sunny day, dull day, windy day, still day, warm day, and cold day). Students sort the cards into two groups, showing which conditions would produce rapid transpiration and which would lead to slow transpiration. Name the three factors.  **Environments** (5 minutes) Hold up a card with the title of a type of environment (for example, desert, sand dune, woodland, school field, tropical rainforest). Ask students to say which environment has the fastest/slowest rate of transpiration. Ask them to state the factor that leads them to their decision.  **Mains**  **Factors affecting transpiration** (40 minutes) Explain to students thatthe rate of evaporation increases as the temperature increases, humidity decreases, and air flow increases. Demonstrate how a mass potometer and a moving bubble potometer can be used to measure the uptake of water by the plant. Discuss how leaving the equipment in different conditions would affect the rate of water uptake and why. Mention why light intensity increases rate of transpiration (it does not affect evaporation). Ask students to draw diagrams of the equipment and to describe briefly how they work. Students then make a prediction and plan a fair test to investigate one of the factors that affects the movement of water through a plant by transpiration.  **Plenaries**  **Evaluating the potometer** (10 minutes) Show an image of the potometer set-up on the board. Ask students to list any limitations they found with the experiment. Ask them to explain why they found this to be a limitation. Did it affect the results?  **Factors affecting transpiration** (5 minutes) Use the interactive in which students link statements about transpiration with the correct explanation. | **Resources**  **Activity:** Factors affecting transpiration  **Interactive:** Factors affecting transpiration |
| **Aiming for Grade 6 LOs:**   * Describe the relationship between a given factor and the rate of transpiration. * Describe how to use a potometer. * Discuss a range of limitations with this method, which might affect the results. |
| **Aiming for Grade 8 LOs:**   * Explain how environmental factors affect the rate of transpiration. * Explain how to calculate the rate of transpiration using a potometer. * Discuss a range of limitations with this method, which might affect the results, suggesting a series of improvements. |