UNIT 4: Respiration and the human transport system

Recommended Prior Knowledge: Students need to have some knowledge of energy transfer, and be able understand simple chemical equations.

Context: Respiration is a fundamental process that will be referred to in most of the subsequent units.

Outline: This Unit covers the important topic of respiration, which will be met again when the carbon cycle is dealt with in Unit 9. Gas exchange in humans, and the effects of cigarette smoke lead on from this. In animals, unlike plants, the transport system is involved in the carriage of gases between the gaseous exchange surface and the body tissues, and so coverage of this leads on naturally from a consideration of gas exchange. Some teachers, however, may prefer to deal with transport first, and then respiration; there are sound arguments for either sequence. There is considerable opportunity for practical work in the respiration topics, but it is much less easy to carry out much practical work in the transport sections.

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
II 8	Define respiration as the release of energy from food substances in all living cells.	Ensure that, right from the start, students understand that respiration is a reaction (or series of reactions) that takes place inside living cells. A very common error is to confuse it with 'breathing', and to think that it takes place only in the lungs. They should also realise that every cell respires, even plant cells.		
II 8.1	Define aerobic respiration state the equation for aerobic respiration, using either words or symbols name and describe the uses of energy in the body of humans.	Emphasise that the function of respiration is to release energy from food (usually glucose) in a form that the organism can use. Students should not state that respiration 'produces' energy! A class discussion will probably pick out a good range of uses of energy in the human body, such as muscle contraction, nerve impulses and keeping warm. It can be helpful to compare respiration with combustion - the overall equation is the same, but respiration occurs in a series of small reactions that do not suddenly release large amounts of heat energy. The energy content of a food, such as a nut, can be estimated by allowing it to heat a	Introduction to respiration http://wow.nrri.umn.edu/wow/student/photo/cellintro.html	

		known volume of water as it burns in air. (This investigation is often done using peanuts, but teachers should be very aware that an increasing number of children are allergic to peanuts. A cube of bread makes a safer alternative food to be burnt.)		
II 8.2	Define anaerobic respiration state the equation for anaerobic respiration in muscles and yeast using either words or symbols describe: its role in brewing and breadmaking the production of lactic acid in muscles during exercise compare aerobic respiration and anaerobic respiration in terms of relative amounts of energy released.	Anaerobic respiration can be investigated using a suspension of yeast in boiled, cooled water. Boiling drives off all dissolved oxygen. The carbon dioxide released can be detected by passing it through lime water or hydrogencarbonate indicator solution. Extension students may already have investigated the use of yeast in bread-making, in Unit 2 (section II 6.1). If not, this is a good opportunity for all students to investigate, for example, whether adding amylase or ascorbic acid, affects the rate at which dough rises. Anaerobic respiration in muscles will be revisited later in this Unit, when oxygen debt is considered.		
II 8.3	List the features of gaseous exchange surfaces in animals.	The idea of gaseous exchange may already have been thought about in Unit 3, in the context of the intake and loss of gases from leaves. A gaseous exchange surface can be defined as a surface across which gases pass as they enter or leave the body. For animals, oxygen enters as carbon dioxide leaves. Students should be reminded of what they know about diffusion, and then suggest features of a surface that would enable diffusion to take place as quickly as possible.		

II 8.3	State the differences in composition between inspired and expired air. Describe a test for carbon dioxide.	The differences between expired and inspired air, in terms of carbon dioxide content and water vapour content, should be investigated experimentally. Lime water or hydrogencarbonate indicator may be used to test for carbon dioxide. Students should be able to use their knowledge of gas exchange and respiration to explain these differences.		
II 8.3	Describe the effects of physical activity on rate and depth of breathing.	This should be investigated experimentally. A simple, repeatable form of exercise, such as step-ups, is the most useful for generating quantitative results. Students should use their knowledge of aerobic and anaerobic respiration to explain why breathing rate does not drop immediately to normal when exercise stops.		
II 8.3	Describe the effects of tobacco smoke and its major toxic components on the respiratory system.	Students will need some basic knowledge of the structure of the breathing system - trachea, bronchus, bronchioles and alveoli, and of ciliated and goblet cells, before thinking about how these structures are affected by tobacco smoke. They should understand that cilia become less active, and goblet cells more active, when exposed to cigarette smoke, so that mucus collects in the lungs. Bacteria are likely to breed in it, leading to bronchitis and other infections. Alveoli lose their elasticity, and coughing may damage their walls, leading to emphysema. Cancer can be triggered by exposure to many of the chemicals in tar.	The lungs - an overview of how they work http://www.lungnet.org.au/frame_learnhealth.htm Emphysema http://www.lungusa.org/site/apps/s/content.asp?c=dvLUK9O0E&B=34706&ct=67284	

II 8.3	Describe the role of ribs, internal and external intercostals muscles and diaphragm in ventilation of the lungs.	Students often find this topic difficult, and it is a good idea to use a model of some kind to illustrate how increasing the volume of the thorax leads to a reduction in pressure. The 'balloons in a bell jar' model shows this effectively.		
II 7.2.1	Describe: The gross structure and function of the heart. The double circulatory system The effect of exercise on heart beat	Diagrams of the heart, showing both external and internal structure, need to be known. Ensure that students realise that both sides of the heart beat together. The direction of blood flow through the heart, the separation of oxygenated and deoxygenated blood, and the functions of the valves should be understood. It is recommended that the idea of a double circulatory system, in which blood passes twice through the heart during one complete circuit of the body, is covered here, as this helps to make sense of the structure and function of the heart. The effect of exercise on heart beat relates closely to the effects of physical activity on rate and depth of breathing, dealt with earlier in this Unit.	Structure of your heart http://www.wehealnewyork.org/services/cardiology/structure.html Animation of heart beat http://web.ukonline.co.uk/webwise/spinneret/circuln/ancad.htm	
II 7.2.1	List the likely causes of hear attack (diet, smoking, stress), and preventative measures.	Students may already have some ideas about factors that increase the likelihood of suffering from heart disease, and class discussion will probably bring out most of the major influences. A person's genes are also thought to play a major role in this.		
II 7.2.2	Describe the structure and functions of arteries, veins and capillaries. Explain how structure & function are related in arteries, veins and capillaries.	Transparencies or microscope slides of sections through an artery and a vein can be used to help students to understand the differences between them. They should be able to explain the differences in terms of the high, pulsing blood pressure in arteries, and the much lower pressure and smoother flow in veins. Emphasise that arteries do not pump blood.		

II 7.2.3	Identify blood cells as seen under a light microscope, describe: the components of blood the functions of blood, including clotting (no details of clotting required) the transfer of materials between capillaries and tissue fluid	Again, students should see transparencies or microscope slides of stained blood samples, and be able to distinguish red cells, white cells and platelets. They should understand that red cells transport oxygen and also carbon dioxide, and know that they contain haemoglobin. Links can be made back to Unit 2, and the need for iron in the diet. This is a good place to discuss the adaptations of red blood cells to their functions, if this has not already been covered in Unit 1. White cells, on the other hand, protect the body from invading pathogens. No detail of this is required by Core students. Clotting should be mentioned, as a mechanism to prevent loss of blood and entry of pathogens, but Core students need no detail at all of how it takes place, other than that platelets are involved. Tissue fluid can be thought of simply as plasma that has leaked out of capillaries. Diffusion can be revised, and students should be able to use their knowledge of respiration to suggest substances that move from blood to tissues and vice versa.		
II 7.2.3	Describe the process of clotting (fibrinogen to fibrin only).	Extension students need to understand that fibrinogen is a soluble protein, which is converted to the insoluble fibrin when a blood vessel is damaged. Calcium is required for this, so links can be made back to Unit 2.		
II 7.2.3	Describe the immune system in terms of antibody production, tissue rejection and phagocytosis.	A relatively simple approach to this complex topic is required. Some white blood cells are phagocytes, and the process of phagocytosis should be understood. Lymphocytes, however,		

		secrete antibodies (which are proteins) in response to contact with their particular antigen, which may be an invading pathogen or a foreign tissue that has been transplanted. Students may be interested to learn how immunity to a disease can be conferred by vaccination. This topic also links with kidney transplants, covered in Unit 5.		
II 7.2.3	Describe the function of the lymphatic system in circulation of body fluids and the production of lymphocytes.	This is another potentially difficult topic, which should be dealt with simply. Tissue fluid (dealt with earlier in this Unit) drains into lymph vessels, which carry it slowly back to the main circulatory system through vessels with valves. It is worth pointing out that lacteals, dealt with in Unit 2, are part of the lymphatic system.		