

## O Level Biology (5090)

### Unit 4: Transport in Humans and Respiration

#### Recommended Prior Knowledge

The first part of this Unit stands very much alone and can be studied in isolation, although a knowledge of the substances absorbed into the blood from the small intestine would be useful. The Respiration section of the Unit would certainly benefit from a prior knowledge of chemical molecules and of energy (see Units 2 & 3) and of active transport (Unit 1)

#### Context

Since all characteristics of living organisms are heavily dependent on the energy released during respiration, this Unit provides essential knowledge for the understanding of most of the other Units.

#### Outline

The structure and function of the heart and the circulatory system are considered together with coronary disease. The structure and function of blood and its component parts are also studied. Aerobic and anaerobic respiration are covered as well as the organs and structures involved in gaseous exchange. The Unit generates a varied assortment of practical investigations.

AO	Learning outcomes	Suggested activities and further guidance	Online resources	Other resources
7(a)	Describe the circulatory system as a system of tubes with a pump and valves to ensure one-way flow of blood.	The name of the pump (the heart) and of the three different types of blood vessel should be mentioned and. It is possible to demonstrate the one-way action of valves in the vein running along the back of the wrist or fore-arm by performing a similar procedure to the English scientist William Harvey in 1628.	William Harvey's experiment: <a href="http://www.princeton.edu/~his291/Harvey.html">http://www.princeton.edu/~his291/Harvey.html</a>	<b>Textbooks</b> Ian J Burton – Topic 9 Transport in Human Beings  M. & G. Jones – 7 Transport  Mary Jones – Unit 8 Transport in Humans
7(b)	Describe the double circulation in terms of a low pressure circulation to the lungs and a high pressure circulation to the body tissues and relate these differences to the different functions of the two circuits.	Explain that blood leaves the heart in arteries, returns in veins, and that arteries are joined to veins by capillaries. Since the lungs are close to the heart, and at the same level as the heart, the pressure needed to send blood to them is lower. Label and shade (to show oxygenated and deoxygenated blood) diagrams of the double circulation.	Double circulation animations: <a href="http://www.bbc.co.uk/schools/gcsebitesize/pe/appliedanatomy/0_anatomy_circulatorysys_rev1.shtml">http://www.bbc.co.uk/schools/gcsebitesize/pe/appliedanatomy/0_anatomy_circulatorysys_rev1.shtml</a>	

7(c)	Name the main blood vessels to and from the heart, lungs, liver and kidneys.	A simplified, labelled, demonstration diagram of only those blood vessels specified should first be explained, and then a similar unlabelled diagram might be provided for students to label.	Simplified vessel diagram: <a href="http://www.ringwoodbiology.co.uk/rotheryimages/dblcirc.gif">http://www.ringwoodbiology.co.uk/rotheryimages/dblcirc.gif</a>	
7(d)	Describe the structure and function of the heart in terms of muscular contraction and the working of valves.	A labelled demonstration diagram may be used to provide the correct terminology for the structures of the heart and to explain the heart cycle and the action of valves. Stress that both atria contract together, followed by both ventricles – rather than the right side contracting first to send blood to the lungs, followed by the left side to send blood to rest of the body. As above, an unlabelled diagram should be provided for students to label. A demonstration dissection of a heart may be carried out, although be alert to the possible sensibilities of individual students.	Circulatory system animations: <a href="http://apan.net/meetings/busan03/materials/ws/education/demos/blood-rlo/circulatorysystem.swf">http://apan.net/meetings/busan03/materials/ws/education/demos/blood-rlo/circulatorysystem.swf</a>  Heart structure diagrams: <a href="http://www.bbc.co.uk/schools/gcsebitesize/pe/appliedanatomy/0_anatomy_circulatorysys_rev2.shtml">http://www.bbc.co.uk/schools/gcsebitesize/pe/appliedanatomy/0_anatomy_circulatorysys_rev2.shtml</a>	
7(e)	Compare the structure and function of arteries, veins and capillaries.	TS drawings of of all three vessels should be supplied – together with a LS of a vein to show semi-lunar valves. Annotations on the diagrams can be used to link structure with function. Compare the nature of blood flow in each.  Ask students to use their knowledge to identify the type of blood vessel labelled A and B in the online resource and to write a paragraph to explain how their structure and functions can be compared.  Use the blood vessel animation online resource to show the flow of blood through vessels under a range of conditions. Note the action of valves in veins.	Blood vessel struc. and funct. <a href="http://www.s-cool.co.uk/gcse/biology/heart-and-circulation/blood-vessels.html">http://www.s-cool.co.uk/gcse/biology/heart-and-circulation/blood-vessels.html</a>  Artery and vein TS: <a href="http://www.bioclix.org/images/arteryvein.jpg">http://www.bioclix.org/images/arteryvein.jpg</a>  Blood vessel animations: <a href="http://www.medmovie.com/mmdatabase/MediaPlayer.aspx?ClientID=65&amp;TopicID=771">http://www.medmovie.com/mmdatabase/MediaPlayer.aspx?ClientID=65&amp;TopicID=771</a>	<b>Bioscope CD</b> TS of artery and of vein

7(f)	Investigate and state the effect of physical activity on pulse rate.	Students should locate an artery (e.g. at their wrist or at the side of the neck) and count and record the rate of the pulse at rest. The number of beats per 15 sec should be recorded and multiplied by 4 to give beats per minute. Students should work in pairs – one as the researcher and one as the subject, who takes two minutes brisk exercise. Immediately afterwards, the researcher takes the pulse rate for 15 sec every minute until the rate returns to normal. Graphs may be drawn of rate (beats per minute) against time. Data for the whole class may be pooled if they all perform exactly the same exercise and the investigation used as an opportunity to discuss control of variables.		
7(g)	Describe coronary heart disease in terms of the occlusion of coronary arteries and state the possible causes (diet, stress and smoking) and preventive measures.	<p>This outcome links with Unit 3. Saturated fats and cholesterol should be mentioned as being constituents of atheroma. The need for exercise should be stressed – as well as other precautions, especially if there is a family history of heart disease.</p> <p>Students may write a commentary to the suggested online resource to list the steps in development of atheroma. A list of the possible causes and preventative measures, in the form of a table, may accompany the diagram.</p>	<p>CHD site including animation:  <a href="http://hcd2.bupa.co.uk/factsheets/html/coronary_heart_disease.html">http://hcd2.bupa.co.uk/factsheets/html/coronary_heart_disease.html</a></p>	
7(h)	Identify red and white blood cells as seen under the light microscope on prepared slides, and in diagrams and photomicrographs.	Students should note the paler colour of red blood cells towards their centres, the different comparative sizes and numbers of red and white cells, and that there are different types of white cell (their different names are not required). Note that the colours of the cells are as seen after staining and are not their natural colours.	<p>Blood cell photomicrograph:  <a href="http://www.fazaclo.com/Images/red_white_blood_cells.jpg">http://www.fazaclo.com/Images/red_white_blood_cells.jpg</a></p>	<p><b>Bioscope CD</b> Human Blood</p>
7(i)	List the components of blood as red blood cells, white blood cells, platelets and plasma.		<p>Constituents of blood:  <a href="http://www.pennmedicine.org/health_info/images/19432.jpg">http://www.pennmedicine.org/health_info/images/19432.jpg</a></p>	

7(j)	<p>State the functions of blood:</p> <p>red blood cells – haemoglobin and oxygen transport;</p> <p>white blood cells – phagocytosis, antibody formation and tissue rejection;</p> <p>platelets – fibrinogen to fibrin, causing clotting;</p> <p>plasma – transport of blood cells, ions, soluble food substances, hormones, carbon dioxide, urea, vitamins and plasma proteins.</p>	<p>Prepare a table to show the name and functions of each type of blood cell. The table may be extended to show a diagram of cells seen in 7(h) above.</p> <p>The ability of haemoglobin to absorb and to release oxygen should be mentioned. Link to 5(d) in Unit 3.</p> <p>Students may write a commentary to the animations. Invite suggestions about why transplants are likely to be more successful between closely related people.</p> <p>Fibrinogen should be introduced as a plasma protein. The role of the clotting process and formation of a scab in preventing entry of pathogens should be included. Students may watch the suggested online animation and write an accompanying commentary.</p>	<p>Action of white blood cells:  <a href="http://www.bbc.co.uk/schools/gcsebitesize/science/aqa/human/defendingagainstinfectionrev4.shtml">http://www.bbc.co.uk/schools/gcsebitesize/science/aqa/human/defendingagainstinfectionrev4.shtml</a></p> <p>Phagocytosis animation:  <a href="http://www.edumedia-sciences.com/en/a82-phagocytosis">http://www.edumedia-sciences.com/en/a82-phagocytosis</a></p> <p>Blood clotting animation:  <a href="http://www.footprints-science.co.uk/flash/blood.swf">http://www.footprints-science.co.uk/flash/blood.swf</a></p>	
7(k)	Describe the transfer of materials between capillaries and tissue fluid.	Capillaries may be thought of as 'leaky', but their walls will not allow large molecules to pass. Plasma proteins are too large to do so, as are blood cells with the exception of some WBCs which are able to change shape to squeeze through and reach a site of infection. This description will allow students to differentiate between plasma and tissue fluid. Stress the two-way movement of materials – with metabolic products able to pass from cells into capillaries. Cross-reference 5(p) in Unit 3 and 8(k) in Unit 4.		
8(a)	Define respiration as the release of energy from food substances in all living cells.	It is essential at this stage to differentiate between breathing and respiration. It should be made clear that respiration is a chemical reaction occurring in all living cells with the sole purpose of releasing energy. Also stress that energy is not 'needed' for respiration and that respiration does NOT 'create' or 'produce' energy. Note that the definition allows for respiratory substrates other than glucose, although glucose is the only one required by the syllabus.	<p>Aerobic and anaerobic respiration:  <a href="http://www.s-cool.co.uk/gcse/biology/respiration.html">http://www.s-cool.co.uk/gcse/biology/respiration.html</a></p> <p>Note: this resource is relevant to many of the subsequent learning outcomes in this Unit.</p>	<p><b>Textbooks</b></p> <p>Mary Jones – Unit 9 Respiration</p> <p>Ian J. Burton – Topic 10 Respiration</p> <p>M. &amp; G. Jones – 6 Respiration</p>

8(b)	Define aerobic respiration as the release of a relatively large amount of energy by the breakdown of food substances in the presence of oxygen.	Students should realise that during this process the glucose is completely broken down to its constituent molecules, releasing all of the energy absorbed in building the molecule.		
8(c)	State the equation (in words or symbols) for aerobic respiration.	In Unit 2 students have learnt the equation for photosynthesis and that the process is the reverse of respiration. Again, a word equation is acceptable, but if symbols are used the equation must balance (it is acceptable to add '+ energy released' on the right hand side).		
8(d)	Name and state the uses of energy in the body of humans: muscle contraction, protein synthesis, cell division, active transport, growth, the passage of nerve impulses and the maintenance of a constant body temperature.	<p>This outcome allows for the introduction of the concept of energy being required to build large molecules other than glucose or starch. Two further types of energy are also introduced – heat energy and electrical energy, to add to light and chemical energy so far considered in Unit 2.</p> <p>Students may produce a 'spider diagram' to state the uses of energy and may illustrate their diagram with hand-drawn or printed pictures and/or further annotations.</p>		
8(e)	Define anaerobic respiration as the release of a relatively small amount of energy by the breakdown of food substances in the absence of oxygen.	This is likely to be a new concept for students. It may be explained that in the absence of oxygen, the respiratory substrate is not completely broken down into its constituent molecules. Some chemical energy therefore remains in the molecules produced in the reaction, leaving less to be released than in aerobic respiration.		
8(f)	State the equation (in words or symbols) for anaerobic respiration in humans and in yeast.	Two forms of anaerobic respiration are relevant to the syllabus. Both should be given with a clear explanation that one form is encountered in fermentation (Unit 6) and the other in muscle action. Word equations are likely to be more easily accessible to students at this level.		

8(g)	Describe the effect of lactic acid production in muscles during exercise.	<p>Ask students to raise their arm and to open and close their fist in quick succession for as long as possible. The resulting discomfort is a result of lactic acid build up in the muscles. Whilst discussing the concept with students, sufficient time will elapse for the discomfort to subside – a result of the lactic acid being broken down into harmful carbon dioxide and water. Use the stimulus photo of a runner with muscle cramp to elucidate ideas.</p> <p>This can be related to the build-up of lactic acid during exercise. Cramp often strikes after exercise has finished - a result of the circulation not being able to remove the lactic acid quickly enough from the muscles - refer to 7(k).</p>	<p>Marathon runner stimulus photo:  <a href="http://gobblegreen.com/blog/wp-content/uploads/2009/08/runner-with-muscle-cramp-by-cesareb.jpg">http://gobblegreen.com/blog/wp-content/uploads/2009/08/runner-with-muscle-cramp-by-cesareb.jpg</a></p>	
8(h)	Know the percentages of gases in atmospheric air and investigate and state the differences between inspired and expired air.	<p>A table of differences – with approximate percentages – should be given. Students may use this data to plot pie charts of gas composition and to produce written explanations of the similarities and differences apparent.</p> <p>The table above should be supported by a practical investigation of the comparative amounts of CO<sub>2</sub> and water vapour in air, and of differences in temperature.</p> <p>Students may breathe out through limewater indicator to show presence of CO<sub>2</sub> in exhaled air. The demonstration may be extended to the ‘huff-puff’ apparatus to show more CO<sub>2</sub> is present in exhaled than inhaled air.</p> <p>Breathing into a test-tube of water at laboratory temperature for several minutes (to demonstrate temperature of expired air) and onto dried cobalt chloride paper (to show presence of moisture) may be suitable investigations depending on ambient temperature and humidity.</p>	<p>Composition of air table:  <a href="http://www.yteach.co.uk/page.php/resources/view_all?id=diaphragm_expiration_hemoglobin_inspiration_pleura_respiratory_system_lungs_t_page_22">http://www.yteach.co.uk/page.php/resources/view_all?id=diaphragm_expiration_hemoglobin_inspiration_pleura_respiratory_system_lungs_t_page_22</a></p> <p>Huff-puff apparatus:  <a href="http://www.chemistrydaily.com/chemistry/upload/6/68/Huff_%27n%27puff_equipment.png">http://www.chemistrydaily.com/chemistry/upload/6/68/Huff_%27n%27puff_equipment.png</a></p>	

8(i)	Investigate and state the effect of physical activity on rate and depth of breathing.	<p>Students will be aware that they breathe more deeply after exercise. This knowledge should be supported with an illustrative graph (which would also show the change in rate of breathing). A spirometer, if available, may be used to generate such a graph both before and after exercise.</p> <p>Working in pairs, with one student as the subject, breathing rates before and after exercise may be measured (using the 'count for 15 sec then multiply by 4' method – repeated for 10 minutes after the exercise). Graphs may be drawn of the results and compared with those obtained in 7(f) above.</p>	<p>Spirometer trace before and after exercise:  <a href="http://www.brianmac.co.uk/spiro2.gif">http://www.brianmac.co.uk/spiro2.gif</a></p>	
8(j)	Identify on diagrams and name the larynx, trachea, bronchi, bronchioles, alveoli and associated capillaries.	A labelled OHP transparency of the contents of the thorax could be shown and described to the students. Include only the labels specified (plus the diaphragm, ribs and intercostals muscles covered later). Supply students with an unlabelled version for them to label.	<p>Thorax labelled diagram:  <a href="http://www.homebusinessandfamilylife.com/images/respiratory_system.gif">http://www.homebusinessandfamilylife.com/images/respiratory_system.gif</a></p>	
8(k)	State the characteristics of, and describe the role of, the exchange surface of the alveoli in gas exchange.	Draw attention to the small size, large number and large surface area of the alveoli. The thinness of the alveoli walls, their moist coating and the short distance between the air and the extensive networks of capillaries should also be included.	<p>Gas exchange animation:  <a href="http://www.bbc.co.uk/schools/gcsebitesize/pe/appliedanatomy/1_anatomy_respiratorysys_rev3.shtml">http://www.bbc.co.uk/schools/gcsebitesize/pe/appliedanatomy/1_anatomy_respiratorysys_rev3.shtml</a></p>	<b>Bioscope CD</b> Lung (showing alveoli)
8(l)	Describe the role of cilia, diaphragm, ribs and intercostal muscles in breathing.	<p>Ensure that students do not believe cilia to be hairs that filter the passing air.</p> <p>Consider the mechanism by which these components result in altering the volume and pressure in the thorax.</p> <p>Balloons attached to a glass tube in an air-tight bell jar with a rubber sheet stretched across its base demonstrate the principles involved. Invite students to list ways in which the demonstration does not accurately reflect the process of breathing. Pupils may construct similar models.</p>	<p>Inhalation and exhalation:  <a href="http://www.bbc.co.uk/schools/gcsebitesize/pe/appliedanatomy/1_anatomy_respiratorysys_rev1.shtml">http://www.bbc.co.uk/schools/gcsebitesize/pe/appliedanatomy/1_anatomy_respiratorysys_rev1.shtml</a></p> <p>Pupil-constructed model:  <a href="http://www.practicalbiology.org/reas/advanced/cells-to-systems/ventilation-systems/modelling-the-human-ventilation-system,119,EXP.html">http://www.practicalbiology.org/reas/advanced/cells-to-systems/ventilation-systems/modelling-the-human-ventilation-system,119,EXP.html</a></p>	