UNIT 5 Interrelationships

Timing This unit comprises approximately 20% of the learning material in AS Biology, and about 10% of the learning material in a complete Biology A Level learning programme.

Recommended Prior Knowledge Students should have a good understanding of cell structure and protein structure. If blood has previously been studied, knowledge of white blood cells will be helpful, but this is not essential as it will be covered within this Unit.

Context Previous Units have looked at living organisms on the molecular and cellular scale, before moving on to organs and systems. This Unit begins to touch on the biology of whole organisms, beginning with the interactions between pathogens and their hosts and then considering interactions between organisms within ecosystems.

Outline Four infectious diseases of global importance - cholera, malaria, tuberculosis and HIV/AIDS - are studied in some detail, and illustrate how such diseases are caused, transmitted and prevented or controlled, including the use of antibiotics. The immune response is studied, including the structure and function of antibodies. Some of the wider relationships that exist between organisms are looked at, concentrating on energy flow and the cycling of nitrogen. There are good opportunities within this Unit for students to develop their skills in data analysis, particularly with respect to disease statistics. Although this Unit provides somewhat fewer opportunities for practical work than others in the AS course, it is very important that all such opportunities be taken up. Try to ensure that each student works alone and under time pressure on some occasions, as this will help to prepare for the practical examination(s).
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Reinforcement and formative assessment It is recommended that, towards the end of the time allocated to the unit, time be taken to permit reinforcement of the learning that has occurred. This might take the form of structured revision and questions, perhaps making use of online question banks such as http://www.learncie.org.uk/ or http://exam.net/public/misc/pub_home.asp .

Formative assessment could take the form of student self-marked minitests, taking just 10 or 15 minutes for students to do and then mark for themselves, perhaps using questions from the banks above – discussing the correct answers as a whole class. At the end of the unit, there should be a much larger formative assessment test, using appropriate past-examination and similar style questions, taking a lesson to do, and a lesson to provide feedback after marking by the teacher., taking a lesson to do, and a lesson to provide feedback after marking by the teacher.

	Learning Outcomes	**Suggested Teaching Activities**	**Online Resources**	**Other resources**
I(a)	explain what is meant by an *infectious disease* **Learning activities** Whole class discussion / verbal question and answer leading to individual bullet points defining ‘infectious disease’ and ‘pathogen'	Remind students what they have learnt about cancer and heart disease (in relation to smoking) and ask them how these diseases differ from infectious diseases with which they will be familiar, such as colds. Ensure they know and can confidently use the term 'pathogen'.	http://edis.ifas.ufl.edu/BODY_UW099 interesting definition of infectious disease in the context of the wildlife of Florida USA.	*Biofactsheet 40: Disease and defence.* *Biology*, Jones, Fosbery , Taylor and Gregory and other textbooks include this topic

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
I(b) (c) (d) (e)	For 1, cholera, 2, malaria, 3 TB and 4 HIV/AIDS Describe the causes of 1-4 Explain how 1-4 are transmitted and assess their global importance Discuss the role of social, economic and biological factors in the prevention and control of 1-4 Discuss the global distribution patterns of 2 and 3 **Learning activities** – groups of two to five students should be encouraged to work together for an hour or two of lesson time, plus homework for a week or two. They should prepare a presentation about one of the diseases for their peers. If there are too many groups, split the aspects of one or more of the diseases between two or more groups. The presentation could be in the form of a poster, a video, a PowerPoint presentation, an OHP illustrated talk… – make up a summary table of the key points about all the diseases	Ensure students understand that the *cause* of an infectious disease is a pathogen - for example, the cause of malaria is *Plasmodium*, not being bitten by a mosquito. The facts and concepts required here are not difficult to understand, and you might like to ask different groups of students to research information on one disease and then report back to the rest of the class. Summary sheets could then be produced outlining required information for each one. Make sure that social, economic and biological factors are considered in relation to prevention and control. All of these diseases are of major global importance in the 21st century, and we still do not have effective control methods for any of them. Encourage students to use up-to-date sources of information (newspapers, radio or TV news reports, web sites) to find out about where these diseases are currently prevalent and how this affects people in different parts of the world.	http://www.who.int/ The World Health Organisation web site - perhaps the best starting point, as it has fact sheets for each disease, up-to-date information about outbreaks all over the world, and links to many other relevant sites. http://www.biology4all.com/resources_library/details.asp?ResourceID=36 A downloadable PowerPoint presentation on the causes, effects and control measures for malaria. Web sites giving up–to-date information / statistics on infectious diseases are: www.cdc.gov www.phls.co.uk www.news.bbc.co.uk	*The Heinemann Revision Guide for OCR AS Biology has short summaries of this information.* *Biology*, Jones, Fosbery , Taylor and Gregory and other textbooks include this topic

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
I (f)	outline the role of antibiotics in the treatment of infectious diseases **Learning activities** – whole class discussion / verbal question and answer and brief written questions about o for which diseases antibiotics are applicable o how that should used and the dangers of not finishing the course, and prophylactic administration to farm animals (in terms of development of resistance to antibiotic in bacteria) o antibiotics killing bacteria or stopping their growth, e.g. as inhibitors of specific enzymes of prokaryotes e.g. penicillin and an enzyme involved in cell wall synthesis in bacteria – carry out a simple microbiology practical in which antibiotic discs or other sources of antibiotic are placed onto a Petri dish with nutrient agar after inoculation to form a 'lawn' of non-hazardous bacteria (e.g. *Bacillus subtilis*)	The use of antibiotics for the treatment of TB will have been dealt with in the previous section. Now the general principles of the use of antibiotics for the treatment of bacterial infections can be discussed, ensuring that students understand that they are of no use against viruses. The importance of completing a course of antibiotics should be stressed, in relation to the development of resistance in bacteria. (A common source of confusion here is that students may think that the 'resistance' to the antibiotic develops in people, not in bacteria. Another common error is to confuse 'resistance' with 'immunity'. – another potential application of 'error-free learning' in which facts are met only correctly matched, and no guessing is permitted)	http://www.bbc.co.uk/education/asguru/generalstudies/sciencetechnology/18antibiotics/antibiotics06/antibiotics06.shtml Short text and diagrams about bacteria and antibiotics.	Both *Practical Advanced Biology*, King et al and *Comprehensive Practical Biology*, Siddiqui, have protocols for investigating the effects of antibiotics on bacterial growth. *Biofactsheet 100: Antibiotics and antibiotic resistance.* *Biology*, Jones, Fosbery , Taylor and Gregory and other textbooks include this topic

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
J(a) (b)	recognise phagocytes and lymphocytes under the light microscope; describe the origin, maturation and mode of action of phagocytes **Learning activities** – examine, identify, compare and contrast phagocytes and lymphocytes on microscope slides, the CIE Bioscope and photomicrographs from books and the web – annotate diagrams of monocytes (macrophages) and neutrophil phagocytes with brief key points on their origin, maturation and mode of action	Students should already be able to recognise these cells from their earlier work on blood; it could be revised here. Describing their mode of action is an opportunity to revise work on endocytosis. It would be helpful for students to know about both monocytes (macrophages) and neutrophils.	http://education.vetmed.vt.edu/Curriculum/VM8054/Labs/Lab6/Lab6.htm Nice material including photomicrographs (uses term granulocyte for phagocyte) CIE Bioscope Lots of University Department and microscope manufacturer websites have wide collections of photomicrographs that students will find interesting e.g. http://micro.magnet.fsu.edu/index.html	*Practical Advanced Biology*, King et al, and *Comprehensive Practical Biology*, Siddiqui, both have practicals involving phagocytes and lymphocytes. Siddiqui also contains colour micrographs. *Biology*, Jones, Fosbery , Taylor and Gregory and other textbooks include this topic

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
J(c) (d)	explain the meaning of the term *immune response*; distinguish between B- and T-lymphocytes in their mode of action in fighting infection and describe their origin and functions **Learning activities** – make a brief bullet-pointed specific definition of the terms *immune response*, antigen and antibody – summarise (3 bullet points each) the origin of B- and T-lymphocytes using information from books and the web – use flow diagrams to show how specific clones of B-lymphocytes respond to specific antigens by dividing and differentiating to produce i) plasma cells that make protein (humoral) antibodies ii) memory cells that give faster, stronger secondary response – use flow diagrams to show how specific clones of T- lymphocytes respond to specific antigens by dividing and differentiating to produce i) T- killer cells with antibodies on their cell surface membrane ii) T- helper cells that	Discuss with students how the relatively non-specific response of phagocytes to infection differs from the specific response of B- and T-lymphocytes. Flow diagrams are helpful in describing how both B- and T-lymphocytes react to their specific antigen. Try not to introduce too much complexity here. You can make links back to earlier work on HIV/AIDS.	http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/B/B_and_Tcells.html lots of information and illustrations http://www.merck.com/mrkshared/mmanual_home2/sec16/ch183/ch183c.jsp useful summary http://www.accessexcellence.org/AB/GG/antibodies.html illustrated information about antibodies and immunity	*Biology*, Jones, Fosbery. Taylor and Gregory, provides a straightforward treatment of this topic at the appropriate level.

	strengthen the B- Lymphocyte response, iii) memory cells that give faster, stronger secondary response			

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
J(f)	relate the molecular structure of antibodies to their functions **Learning activities** – explain with annotated diagrams / bullet points, how primary, secondary, tertiary and quaternary structure of proteins are shown by IgG immunoglobulin, using diagrams from book and web-based research – show, using a diagram or series of diagrams or written explanations, how IgG immunoglobulin interacts with specific antigens, and why it does not interact with other materials such as the organisms own proteins, or different antigens with which other IgG immunoglobulins interact	This topic provides an opportunity to revise protein structure. There is no need for students to know about all the different types of antibodies, but they should understand the basic structure of an immunoglobulin (e.g. IgG) and how these molecules interact with antigens. Take care over potential confusion between *antibodies* and *antibiotics* – apply 'error-free learning', giving only correct matches and avoiding incorrect guesses.	http://www.accessexcellence.org/AB/GG/antiBD_mol.html shows an antibody molecule http://www.biology.arizona.edu/immunology/tutorials/antibody/structure.html illustrates the interactions between antibodies and antigens http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/A/AntigenReceptors.html detailed extension material	*Biology*, Jones, Fosbery , Taylor and Gregory and other textbooks include this topic

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
J(e) (g)	explain the role of memory cells in long-term immunity; distinguish between *active* and *passive*, *natural* and *artificial immunity* and explain how *vaccination* can control disease **Learning activities** – link back to J(c)(d) and forward to J(h) – make up bullet point definitions of the terms *active immunity*, *passive immunity*, – give a brief written explanation why active immunity produces memory cells and passive does not – give example of each of *natural* (passive and active) *immunity*, *artificial* (passive and active) *immunity* to make clear the contrasts between them	If students understand how B- and T-lymphocytes react to exposure to antigen, then this topic is not difficult to understand. They should be aware that both B- and T-lymphocytes produce memory cells. Specific examples of each type of immunity will help understanding. Students should know why passive immunity is short-lived whilst active immunity tends to be more long-lasting.	http://www.biology.arizona.edu/immunology/tutorials/immunology/09t.html information about the origin and role of memory cells http://www.cat.cc.md.us/courses/bio141/lecguide/unit3/humoral/activepassive/artificial/artificial.html information and definitions	*Biofactsheet 99: Vaccines.* *Biology*, Jones, Fosbery , Taylor and Gregory and other textbooks include this topic

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
J(h)	discuss the reasons why vaccination has eradicated smallpox but not measles, TB, malaria or cholera **Learning activities** – research (in books and on the web) into the role of vaccination in control of diseases from the list in the outcome, and then make up a comparison, perhaps in table or other form to make clear the similarities and differences	This is quite a wide-ranging issue and it could be useful for students to research information using the internet; this is very topical and new information and data are constantly emerging	http://www.who.int/ The WHO web site has a large amount of information about vaccination in different parts of the world. http://www.iavi.org/ The web site of International AIDS Vaccine Research - up-to-date news about progress in the development of a vaccine for AIDS. http://hopkins-id.edu/tb_hiv/tbhiv_12.html optimistic view by vaccine producer http://www.who.int/infectious-disease-report/2000/preface.htm specific information about the lack of effective vaccines	*Biology*, Jones, Fosbery , Taylor and Gregory and other textbooks include this topic

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
K(a) (b)	define the terms *habitat, niche, population, community* and *ecosystem* and state examples of each; explain the terms *producer*, *consumer* and *trophic level* in the context of food chains and food webs; **Learning activities** – investigate by visiting and making observations, an ecosystem to find examples of producers, consumers & trophic levels within food chains and webs, and to exemplify the meanings of habitat, niche, population, community and ecosystem – make written definitions of the terms, with specific examples from the practical investigation above – make brief written explanations how niches are different to habitats and ecosystems, and how populations and communities are different	This will be revision for most candidates, but it should not be taken for granted that students have understood ecological terms and concepts first time around. AS Level examination scripts show lots of evidence of misconceptions, and that many students find this much more difficult than might appear to be the case. Students should visit an ecosystem (if you cannot go far, then even a grassy area within or near to school or college grounds will be rewarding) to discuss and revise the use of these terms and concepts in the context of a particular ecosystem. Ask students to write down definitions of each term, and to give a specific example from this particular ecosystem to illustrate each one.	http://www.colchsfc.ac.uk/biology/newsite/brian/ecodef.html brief definitions of ecological terms http://www.purchon.com/ecology/definitions.htm fuller information about the meanings of ecological terms Google, images, food webs returns some interesting examples of food webs for teachers to use in making their own resources to promote learning	*Practical Advanced Biology*, King et al, and *Comprehensive Practical Biology*, Siddiqui, contain a number of ecology practicals, which could be adapted if necessary for the particular habitat you are able to study. *Biology*, Jones, Fosbery , Taylor and Gregory and other textbooks include this topic

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
K(c)	explain how energy losses occur along food chains and discuss the efficiency of energy transfer between trophic levels; **Learning activities** – review and build on understanding of energy flow by considering energy losses from pyramids of energy (which actually show productivity) and energy flow through food chains and webs found in books and on the web, including the forms of energy involved (light, chemical, heat) – make calculations of the percentage efficiency of energy transfer between gross productivity (input) and net productivity (output as growth) – add up energy losses in various components (e.g. faeces, respiration), subtract from gross productivity to work out missing energy losses	Here again most students will already be familiar with this concept. Make sure that they understand that respiration results in complete energy loss to the ecosystem. Energy used in growth / production is the only energy available to the next trophic level by eating the organism. Students will need to realise that some energy lost by death, or in faeces and urine can be used by decomposers Raise their knowledge and skills to AS level by giving them numerical data and asking them to calculate efficiency of energy transfer between two trophic levels. Discuss the form in which the energy exists as it is passed from one organism to another, and as it is lost to the environment.	http://zooplankton.lsu.edu/web_2008/energy_flow_web/energy_flow.htm various aspects of energy flow and productivity considered http://jan.ucc.nau.edu/~doetqp-p/courses/env470/Lectures/lec38/Lec38.htm includes energy flow through a saltmarsh Google, images, energy trophic levels gives a range of images of food webs and chains, some of which have energy flow figures on	*Biofactsheet 16: Flow of energy through ecosystems* *Biology*, Jones, Fosbery , Taylor and Gregory and other textbooks include this topic

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
K(d)	describe how nitrogen is cycled within an ecosystem, including the roles of microorganisms **Learning activities** Whole class discussion / verbal question and answer based around a staged presentation of the nitrogen cycle Transformation of diagrammatic presentations of the nitrogen cycle into a series of brief bullet points	Students will already know a simple nitrogen cycle, but it should not be assumed that they have remembered it, or understood it correctly first time around. Rather than presenting them with a complete diagram all at once, try building up a flow diagram of the cycle with them, on the board or using an OHP or interactive white board. Students with a reasonably strong chemistry background should understand that nitrogen fixation is a reduction reaction, while nitrification is a series of oxidation reactions. They should know the names of the main bacteria involved in this cycle, including *Rhizobium*, *Nitrosomonas* and *Nitrobacter*. They should be able to understand the reasons why microorganisms fix nitrogen (for their own independent supply of amino acids), carry out nitrification (to release energy for chemosynthesis), denitrification (to release oxygen for use in respiration in anoxic conditions)	Google, images, nitrogen cycle produces a range of useful images http://www.geog.ouc.bc.ca/physgeog/contents/9s.html is a brief summary http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/N/NitrogenCycle.html has a more detailed overview for extension	A large colour poster illustrating the nitrogen cycle is available from the bbsrc at c/o ADMS Mailing Centre Ltd, Athena Avenue, Elgin Drive Estate, Swindon SN2 6EJ, England. *Biofactsheet 18: The nitrogen cycle* *Biology*, Jones, Fosbery , Taylor and Gregory and other textbooks include this topic