AS Biology Syllabus 9700
Unit 5: Interrelationships

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
Students gain an understanding of what is meant by disease and what the differences are between infectious and non-infectious diseases, using named examples. Five infectious diseases of global importance - cholera, tuberculosis, malaria, measles and HIV/AIDS - are studied in some detail: cause; transmission; prevention and control, including the use of antibiotics. Smallpox is introduced in this section as knowledge and appreciation of the disease is required later in the Unit. Natural and artificial immunity 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.

I Infectious disease
- Cholera, malaria, tuberculosis (TB) and HIV/AIDS
- Antibiotics

J Immunity
- The immune system
- Vaccination

E Ecology
- Levels of ecological organisation
- Energy flow through ecosystems
- Recycling 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).
Note: *An ecosystem should be studied in relation to an area familiar to the candidates.*

AO	Learning outcomes	Suggested Teaching activities	Learning resources
I	(a) define the term disease and explain the difference between an infectious disease and non-infectious diseases (limited to sickle cell anaemia and lung cancer);	Remind students what they have learnt about cancer (e.g. lung cancer), heart disease (in relation to smoking, Unit 4) and sickle cell anaemia (Unit 3) and ask them how these diseases differ from infectious diseases with which they are familiar, such as colds. A common error is to use the term *disease* rather than *pathogen* (or named type of pathogen, or named pathogen). Encourage attention to detail e.g. ask students to explain why the statement, "transmission of a pathogen from an infected person to a non-infected person" is preferable to "the disease passes from one person to another". Ensure they know, and can confidently use, the term pathogen. **Class activities** 1. Whole class discussion / verbal question and answer leading to individual bullet points defining *infectious disease* and *pathogen*. 2. Consolidate understanding with a group effort to name some common infectious diseases and state the type of causative pathogen. Students are likely to come up with bacteria, viruses and fungi as pathogens – introduce protoctists with a few simple ideas (e.g. eukaryotic, many are unicellular, contain organisms that do not fit into other groups / kingdoms). 3. Tabulate the differences and similarities of non-infectious diseases such as sickle cell anaemia ad lung cancer with infectious diseases (such as the examples named in activity 2). 4. Class discussion about the epidemiology of different types of disease (note that *epidemiology* does not have to be defined) to consolidate understanding of the difference between infectious and non-infectious disease.	http://edis.ifas.ufl.edu/in722 useful definition of infectious disease and notes on emerging infectious diseases ***AS and A Level Biology***, p. 152 (lung cancer), p165 (infectious disease), p.235 & 236 (sickle cell anaemia), p.402 glossary (disease), and other textbooks include this topic. See also the list of definitions in the 2012 ***Cambridge International A & AS Level Biology Syllabus*** code 9700, p. 35 onwards. ***Bio Factsheet 40****: Disease and defence*

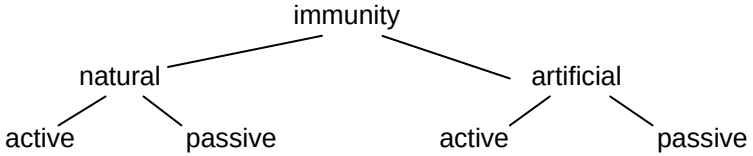
AO	Learning outcomes	Suggested Teaching activities	Learning resources
I	(b) describe the causes of the following diseases: cholera, malaria, TB, HIV/AIDS, smallpox and measles; (c) explain how cholera, measles, malaria, TB and HIV/AIDS are transmitted; (d) discuss the roles of social, economic and biological factors in the prevention and control of cholera, measles, malaria, TB and HIV/AIDS (a detailed study of the life cycle of the malarial parasite is **not** required); (e) discuss the global patterns of distribution of malaria, TB and HIV/AIDS and assess the importance of these diseases worldwide;	The facts and concepts required here are not difficult to understand. Summary sheets could be produced outlining required information for each one. Make sure that social, economic and biological factors are considered in relation to prevention and control. 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. Students should know the type and name of the causative organisms. All of these diseases are of major global importance in the 21st century and there are still no real effective control methods for any of them. Students should also be aware that some countries are better able to prevent and control a particular disease: the reasons for this should be discussed. 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. **Class activities** 1. Carry out a mix and match card exercise – name of disease, type of causative organism, name of pathogen. 2. Groups of two to five students should be encouraged to work together for an hour or two of lesson time, plus homework time. They should research information about one disease and prepare a presentation 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. 3. Make up a summary table of the key points about all the diseases. 4. Research the current situation with the diseases in the list, e.g. current outbreaks, recent disease statistics, development of vaccines, availability of treatments.	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: http://www.cdc.gov/ http://www.bbc.co.uk/news/health/ http://news.bbc.co.uk/2/hi/health/medical_notes/371580.stm http://library.med.utah.edu/WebPath/HISTHTML/EM/EM018.html EM of HIV Detailed information on the named diseases is in ***AS and A Level Biology*** (Chapter 13) and ***Essential AS Biology for OCR***, Toole and Toole, pub. Nelson Thornes, ***Revision Guide for OCR AS Biology,*** Fosbery, Gregory & Stevens, pub. Heinemann, and ***OCR AS Biology, Unit 2, Module 2802: Human Health and Disease***, Fosbery, pub. Phillip Allan Updates (out of print, but 'used' copies may be available), have short summaries.

AO	Learning outcomes	Suggested Teaching activities	Learning resources
I	(f) outline the role of antibiotics in the treatment of infectious diseases;	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 (and fungal) 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 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: learning facts and correctly matching facts, with no guessing permitted). **Class activities** 1. Research using textbooks / the web to make written notes about • the diseases for which antibiotics are applicable • the correct use of antibiotics and the dangers of not finishing the course • prophylactic administration to farm animals (in terms of development of resistance to antibiotic in bacteria) • modes of antibiotic action (including understanding the terms *bactericidal* and *bacteriostatic*) 2. Carry out a simple microbiology practical in which filter paper discs impregnated with different antibiotics (e.g. Mast rings), or the same antibiotic of different concentrations, are placed onto a Petri dish with nutrient agar after inoculation with non-hazardous bacteria (e.g. *Bacillus subtilis*). Zones of inhibition created around the discs on the lawn of bacteria formed can be measured and compared to determine the efficacy of each antibiotic (or antibiotic concentration). 3. Research the action of a named antibiotic and how bacteria are resistant, linking back to knowledge of genes, enzymes and cell structure and function e.g. penicillin and penicillinase.	http://www.hpa.org.uk/Topics/InfectiousDiseases/InfectionsAZ/AntimicrobialResistance/ short text and the latest information about antibiotic resistance http://www.tufts.edu/med/apua/Miscellaneous/mechanisms.html Alliance for the Prudent Use of Antibiotics website A search for ‘zones of inhibition bacterial lawn’ on Google images (or similar) reveals a range of visual results. ***AS and A Level Biology*** (Chapter 13, p 177) and other textbooks include this topic. Both ***Practical Advanced Biology*** and ***Comprehensive Practical Biology*** have protocols for investigating the effects of antibiotics on bacterial growth. ***Bio Factsheet 100****: Antibiotics and antibiotic resistance.* ***Bio Factsheet 71:*** *The control of bacteria* Has a short section about antibiotics and their use.

AO	Learning outcomes	Suggested Teaching activities	Learning resources
J	(a) recognise phagocytes and lymphocytes under the light microscope; (b) state the origin and describe the mode of action of phagocytes;	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. **Class activities** 1. Examine, identify, compare and contrast phagocytes and lymphocytes on microscope slides, Bioscope and photomicrographs from books and the web. 2. Annotate diagrams of monocytes (macrophages) and neutrophil phagocytes with brief key points on their origin, maturation and mode of action. 3. Sequence and label diagrams showing events occurring during phagocytosis.	http://education.vetmed.vt.edu/Curriculum/VM054/Labs/Lab6/Lab6.htm nice material including photomicrographs (uses term granulocyte for phagocyte) 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 http://library.med.utah.edu/WebPath/HISTHTML/EM/EM001.html EM of neutrophil http://library.med.utah.edu/WebPath/HISTHTML/EM/EM002.html EM of lymphocyte http://highered.mcgraw-hill.com/sites/0072507470/student_view0/chapter3/animation__phagocytosis.html animation, with commentary, of phagocytosis Bioscope. ***AS and A Level Biology*** (Chapter 14, pp.181-183) and other textbooks include this topic. ***Practical Advanced Biology*** and ***Comprehensive Practical Biology*** both have practicals involving phagocytes and lymphocytes. The latter also contains colour micrographs.

AO	Learning outcomes	Suggested Teaching activities	Learning resources
G	(c) describe the modes of action of B-lymphocytes and T-lymphocytes; (d) explain the meaning of the term *immune response*, making reference to the terms antigen, self and non-self;	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. **Class activities** 1. Make a brief bullet-pointed definition of each of the terms: *immune response, antigen* (referring also to self and non-self and *antibody*. 2. Summarise (3 bullet points each) the origin of B- and T-lymphocytes using information from books and the web. 3. 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 antibodies (humoral response) – primary immune response (ii) memory cells that give faster, stronger secondary (immune) response. 4. Draw the immune response curve, y axis concentration of antibody, x axis, time, and annotate to show links to the primary and secondary response. 5. Use flow diagrams to show how specific T- lymphocytes respond to specific (non-self) antigens by dividing and differentiating to produce (i) T- killer cells with antibodies on their cell surface membrane (ii) T- helper cells that strengthen the B-lymphocyte response, (iii) memory cells that give faster, stronger secondary response	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 http://www.cellsalive.com/antibody.htm notes and a simple animation http://library.med.utah.edu/WebPath/HEMEHTML/HEMEIDX.html bone marrow and blood cells images http://www.bu.edu/histology/p/21001ooa.htm excellent plasma cell electron micrograph ***AS and A Level Biology*** provides a straightforward treatment of this topic at the appropriate level (Chapter 14, pp.182-188). Many terms are in the list of definitions in the 2012 ***Cambridge International A & AS Level Biology Syllabus*** code 9700, p. 35 onwards.

AO	Learning outcomes	Suggested Teaching activities	Learning resources
J	(f) relate the molecular structure of antibodies to their functions;	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. Students should understand that the variable regions in different antibodies have different sequences of amino acids and how this leads to the specificity of antibodies. Take care over potential confusion between *antibodies* and *antibiotics* – apply error-free learning, giving only correct matches and avoiding incorrect guesses. **Class activities** 1. Explain with annotated diagrams / bullet points, how primary, secondary, tertiary and quaternary structure of proteins are shown by IgG immunoglobulin, using diagrams from books and web-based research. 2. Draw a labelled, annotated diagram linking the structure of an antibody to its function. 2. 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 .	http://www.accessexcellence.org/RC/VL/GG/antibody_molecule.php 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 ***AS and A Level Biology***, Chapter 14, p.185, has a simple diagram of an antibody molecule and a computer-generated model.

AO	Learning outcomes	Suggested Teaching activities	Learning resources
J	(e) explain the role of memory cells in long-term immunity; (g) distinguish between *active* and *passive*, *natural* and *artificial immunity* and explain how *vaccination* can control disease	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, by linking back to J(c)(d), passive immunity is short-lived whilst active immunity tends to be more long-lasting and how vaccination can provide immunity to avoid the spread of disease. Refer to, and explain, the term *herd immunity*. **Class activities** 1. Make up bullet point definitions of the terms *active immunity*, *passive immunity* 2. Give a brief written explanation why active immunity produces memory cells and passive does not. 3. Give examples of each of *natural* (passive and active) *immunity*, *artificial* (passive and active) *immunity* to make clear the contrasts between them. 4. Draw and annotate the immune response curve (see activity 4. for G(d)) or add labels and annotations in a different colour to show how vaccines act to give immunity. 5. Draw out a summary chart: e.g.  **or** immunity divided into active and passive, each divided into natural and artificial. Leave enough room to add features and examples to show the differences between the categories.	http://www.biology.arizona.edu/immunology/tutorials/immunology/09t.html information about the origin and role of memory cells http://student.ccbcmd.edu/courses/bio141/lecguide/unit5/humoral/activepassive/activepassive.html information and definitions http://www.spmsd.co.uk/upload/public/Files/11/PrinciplesOfVaccination_uk11465.pdf PowerPoint – some relevant slides at an appropriate level, useful as a teacher reference resource ***AS and A Level Biology***, Chapter 14, pp.188-190, and other textbooks include this topic. Table 14.2 is a summary of features of active and passive immunity. ***Bio Factsheet 99****: Vaccines* ***Bio Factsheet 71:*** *The control of bacteria* Has a short section about vaccination.

AO	Learning outcomes	Suggested Teaching activities	Learning resources
J	(h) discuss the reasons why vaccination has eradicated smallpox but not measles, TB, malaria, sickle cell anaemia or cholera;	This is quite a wide-ranging issue and it could be useful for students to research information using the internet following a class discussion; this is very topical and new information and data are constantly emerging. It may help for students to carry out activity 1 first and use the list to see how the other diseases compare and why they have not been successfully eradicated. Students should understand that sickle cell is a disease that is a genetic disease that is inherited and not an infectious disease. **Class activities** 1. Make up a bullet pointed list of the reasons why smallpox was eradicated. 2. Research (in books and on the web) into the role of vaccination in control of diseases from the list in the learning outcome, and then make up a comparison, perhaps in table or other form to make clear the similarities and differences. 3. Research current programmes: e.g. to use vaccination to eradicate polio and to develop vaccines for malaria and HIV/AIDS.	http://www.who.int/topics/vaccines/en/ the WHO web site has a large amount of information about vaccination in different parts of the world http://www.s-cool.co.uk/alevel/biology/immunity/problems-with-vaccines.html problems with vaccines – covers the listed diseases http://www.who.int/infectious-disease-report/2000/preface.htm specific information about the lack of effective vaccines, links to antibiotics and infectious diseases from AS http://www.fordham.edu/halsall/mod/1798jenner-vacc.html background: Edward Jenner - three original publications which will take time to read but will be of interest to students interested in the history of science http://www.iavi.org/ the web site of International AIDS Vaccine Research provides up-to-date news about progress in the development of a vaccine for HIV/AIDS – background information for students ***AS and A Level Biology***, Chapter 14, pp.190-193, and other textbooks include this topic. Sickle cell disease is covered on pp.226-227 and pp.235-236.

AO	Learning outcomes	Suggested Teaching activities	Learning resources
K	(a) define the terms *habitat, niche, population, community* and *ecosystem* and state examples of each; (b) explain the terms *producer*, *consumer* and *trophic level* in the context of food chains and food webs;	This will be revision for most students, but not all will have a full understanding of ecological terms and concepts. A brainstorming exercise will indicate how much can be recalled from GCSE. AS Level examination scripts show evidence of misconceptions, so it is worth spending time on this topic. Students should visit an ecosystem (if travel is a problem, then any suitable area populated by plants and animals, 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. Students should understand that trophic level, producer and consumer are concerned with the flow of energy through the ecosystem. The terms *herbivore* and *carnivore* (for consumers) often occurs in textbooks, as do the terms *autotrophic* and *heterotrophic*. Students will benefit from being able to use these terms confidently in the correct context, or understand these terms if they come across them. **Class activities** 1. Using the definitions in the syllabus and endorsed text book, write definitions of the listed terms. Add specific examples from the practical investigation. 2. 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. 3. Make brief written explanations of how niches are different to habitats and ecosystems, and how populations and communities are different. 4. Construct a food web (from research) labelling trophic levels and feeding types. Different groups of students could construct food webs for different habitats and then compare what they find.	http://www.purchon.com/ecology/definitions.htm information about the meanings of ecological terms http://www.ecologydictionary.org/ students can type in ecological terms and view different definitions from different organisations – emphasise that these should only be used to increase understanding and are not to be learned Google, images,' food webs' returns some interesting examples of food webs for teachers to use in making their own resources to promote learning ***AS and A Level Biology***, Chapter 7, pp.89-91, and the glossary (beginning on p.399), as well as other textbooks, include this topic. See also the definitions beginning on p. 35 of the ***2012 Cambridge International A & AS Level Biology Syllabus, code 9700***. ***Practical Advanced Biology*** and ***Comprehensive Practical Biology***, contain a number of ecology practicals, which could be adapted if necessary for the particular habitat chosen for study. ***Bio Factsheet 182:*** *Disrupting Food Chains and Webs*

AO	Learning outcomes	Suggested Teaching activities	Learning resources
K	(c) explain how energy losses occur along food chains and discuss the efficiency of energy transfer between trophic levels;	Most students will be familiar with this concept. Ensure 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 (egestion) and urine (excretion), can be used by decomposers. Saprobiotic bacteria and fungi should be introduced at this stage as a link and introduction to (d). Raise knowledge and skills to AS level by giving students 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. Discuss the ways that energy is lost (i) between the sun and producer and (ii) between striking the plant and being, incorporated into sugar / converted into chemical energy. **Class activities** 1. 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). 2. Construct a Sanky diagram for energy flow through one link of the food chain. Draw out one link of the food chain, wider arrow (representing energy ingested), narrowing as side arrows leave, labelled with the energy loss (e.g. respiration, egestion, inedible parts, excretion,death - to decomposers - etc) and ending as a much narrower arrow: energy available to next trophic level. 3. Make calculations: (i) percentage efficiency of energy transfer between gross productivity (input) and net productivity (output as growth). (ii) add up energy losses in various components (e.g. faeces, respiration), subtract from gross productivity to work out missing energy losses.	http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/F/FoodChains.html various aspects of energy flow through food chains and productivity are considered, including a summary of Odum's survey of Silver Springs. http://gonzo.cbl.umces.edu/documents/nutrients/EcolMod%20178_43-49.pdf more complex article, but useful for students to see reproductions of the Silver Springs original figures http://jan.ucc.nau.edu/~doetqp-p/courses/env470/Lectures/lec38/Lec38.htm includes energy flow through a saltmarsh http://www.globalchange.umich.edu/globalchange1/current/lectures/kling/energyflow/energyflow.html a comprehensive site, including comparison of different ecosystems Google, images, 'energy trophic levels' gives a range of images of food webs and chains, some of which have energy flow figures on. ***AS and A Level Biology***, Chapter 7, pp. 92-93, and other textbooks include this topic. ***Bio Factsheet 16****: Flow of energy through ecosystems*

AO	Learning outcomes	Suggested Teaching activities	Learning resources
K	(d) describe how nitrogen is cycled within an ecosystem, including the roles of microorganisms;	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. By verbal question and answer, or small group discussion, ask students to build up a list of the biological compounds which contain nitrogen. Once they realise that they include DNA, RNA, ATP and proteins, they will appreciate the importance of nitrogen to living organisms. Rather than presenting students with a complete diagram all at once, try building up a flow diagram of the cycle on the board or using an OHP or interactive white board. Tackle first the most familiar parts of the N cycle, such as the flow of nitrogen from plants to animals to decomposers. Students with a reasonably strong chemistry background should understand that nitrogen fixation is a reduction reaction, dentrification is reduction of nitrate, 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), carry out denitrification (as a respiratory process in, anoxic / anaerobic, conditions) and decompose (to obtain amino acids for growth). **Class activities** 1. Whole class discussion / verbal question and answer based around the completed diagram of the nitrogen cycle. 2. Transformation of diagrammatic presentations of the nitrogen cycle into a series of brief bullet points. 3. Gap filling exercises of various versions of a nitrogen cycle. 4. Look at the root nodules of a locally available legume and squash and stain with methylene blue to see bacteroids.	Google, images, ‘nitrogen cycle’ produces a range of useful images. http://www.biotopics.co.uk/eco/cycles.html simple diagram with questions http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/N/NitrogenCycle.html has a more detailed overview for extension http://bcs.whfreeman.com/thelifewire9e/default.asp#542578__591740__ a short animation giving an overview A large colour poster illustrating the nitrogen cycle is available from the Biotechnology and Biological Sciences Research Council (BBSRC) http://www.school-portal.co.uk/GroupDownloadFile.asp?GroupId=485036&ResourceId=3170997 form to complete for free resources ***AS and A Level Biology***, Chapter 7, pp. 94-97, and other textbooks include this topic. ***Bio Factsheet 18****: The nitrogen cycle* ***Bio Factsheet 90****: Answering questions on nutrient cycles* (one section on the nitrogen cycle) ***Bio Factsheet 177****: Nitrogen Fixation*