AS/A Level Biology 9700
Unit 9: Applications of Biology

Recommended Prior Knowledge
Students should have a good understanding of the core AS and A2 content. As will be seen from the following suggested ideas for a scheme of work, there are many areas where pupils should review their learning of the AS and A2 and make links to the applications.

Context
This section could be taught as a unit at the end of the course or could be separated and the application taught when covering the core knowledge. However, the advantage of covering it at the end of the course is that it enables pupils to draw their knowledge together to try and get a more overall picture of biology and how intricate and amazing it is that living organisms exist at all.

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. There are many ways in which this might be done, ranging from revision lessons, through overview homework, through research project and into preparation of essays, presentations, posters or other material.

- The topics, with so much attractive visual material, are well suited to highly visual presentations. A range of teaching approaches can be used and this scheme only suggests how the material may be approached. Pupils should be encouraged to take an active role in their learning and benefit enormously from group and class discussion as long as this is carefully guided and results in pupils considering the main points and arguments. As questions may be set in different and very new contexts it is important the pupils are made aware of general concepts and principles and are encouraged to apply these to different case studies or situations. When they prepare a visual presentation of a topic to their peers, this could be in the form of a poster, a video, a PowerPoint presentation, an OHP illustrated talk, and a short video clip or whatever seems appropriate. Some pupils will wish to draw their own diagrams, and others to download them from the net, and others to photocopy them from paper sources – all these approaches should be encouraged.
- Formative assessment could take the form of pupil self-marked mini tests, taking just 10 or 15 minutes for pupils to do and then mark for themselves, perhaps using questions from the LearnCIE Test Centre – 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.

An outline of what is covered in this particular unit of the scheme of work.

Sequence of teaching and learning
There are five main topics in this unit, but these should not be taught in isolation as there are many cross references to the core material but also between the five topics e.g. gene technology and biotechnology.

Some teachers prefer to teach it in the order it is presented, on the basis that pupils can follow what the learning outcomes are from a copy of the syllabus and then be encouraged to think about the cross links.

However there are also some learning outcomes, which could be linked together into one topic such as control of blood glucose, gene technology to produce human insulin and testing for glucose using biosensors.

Please evaluate these various approaches, and choose the sequence of topics that seems most appropriate for your pupils.

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
	GENERAL INFORMATION	**NCBE can provide teaching kits for DNA and biotechnology. Costs on application to NCBE.**	**The Internet is a huge resource, the web addresses given are a starting point from which other links can take pupils to other sites. However Teachers may prefer to limit pupil access because many sites do not provide additional information or may be contradictory.**	**Books which are listed in the syllabus are quoted using the titles only – however any other books suggested have the author and publisher the first time they are mentioned. Biozone books also give a list of additional resources at the end of each section which is well worth using.**
Q (b) (a) (c)	Discuss the meaning of the term biodiversity Outline the five kingdom classification to illustrate the diversity of organisms (cross reference Syllabus Section A (c) and A (g)) Discuss the reasons for the need to maintain biodiversity **Learning Activity** Pupils should participate in: Brainstorming of prior knowledge of the term biodiversity and other terms associated with it. Whole class discussion / oral question and answer leading to writing of a definition of biodiversity; spider diagram of meaning of biodiversity.	Pupils should have a good understanding of section A c, e and g; K Ecology and P Selection and Evolution. They should understand the concept of the interdependence of organisms and the need to maintain gene pools and gene diversity for the survival of organisms. Depending on the level of prior knowledge it may be advisable to have textbooks available for pupils to use to look up various definitions of biodiversity and then discuss the best one to write down. As this definition leads to considering diversity of ecosystems in a region, the number of species in each ecosystem and the genetic diversity within populations of each species and can be considered at a local, national and global level – a simple definition maybe difficult. A spider diagram may help to show the different aspects of biodiversity and their links. This also provides the chance to reinforce ecology definitions.	http://en.wikipedia.org/wiki/Biodiversity http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/artmay98/classif.html http://www.biologymad.com/master.html?http://www.biologymad.com/Classification/classification.htm http://isis.csuhayward.edu/alss/geography/mlee/envt2000/biodivf99.htm http://www.nationalgeographic.com/xpeditions/lessons/08/g68/preserve.html	Environmental Biology ch 5 & 6. Microbiology and Biotechnology ch 1 for three kingdoms. Advanced Biology ch 22 Biozone 1 Biodiversity & classification

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
	Group research of one kingdom to find the main identifying features and produce a side of A4 to illustrate these with pictures of organisms which show these features. Groups would then present these to the class and they could be copied for everyone. Group discussion of the need to maintain biodiversity, could be for their particular kingdom at the local, national and global level. Then the need to maintain biodiversity across all kingdoms making up different ecosystems, revising ideas from ecology and the terminology applied to organisms. Identifying ideas across many areas of biology including maintenance of gene pools, preservation of genetic diversity, as well as the applications of the use of gene technology, new uses of e.g. plants in the tropical rainforest for medicines, discovery of new species, which may have uses in the future, as well as aesthetic and spiritual benefits.	Using textbooks/internet pupils should research the identifying features of the five kingdoms and produce a presentation to illustrate the features and examples of organisms, which show these features. During this research students should revise knowledge of the prokaryotes and take the opportunity to compare with eukaryotes and that 4 kingdoms are therefore made up of eukaryotes. This also provides the opportunity to revise similarities and differences between animal and plant cells at the light microscope and electron microscope level. The main features of viruses should be considered to show the difficulty of classification. (link to S (d)) The pupils should be encouraged to think widely across all areas of biology and uses of living organisms as well as the aesthetic value of animals e.g. dolphins to help autistic children and the awe of the vast range of living organisms and their unusual appearances and methods of survival. Extension work could be carried out to compare different classification methods or finding an unusual plant or animal, which has a use for humans. Or the funniest animal or plant. How removal of one species affects the survival of the other organisms in an ecosystem including humans could be considered.	http://www.davidsuzuki.org/Forests/Biodiversity/Importance.asp	

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
Q (d) (e)	Describe the reasons why one named species has become endangered, and use this information in the context of other endangered species. discuss methods of protecting endangered species including the roles of zoos, botanic gardens, conserved areas (national parks) and seed banks. **Learning Activity** Pupils should participate in: – Revising terminology – what is a species and what does endangered mean – what are the criteria used to place a plant or animal onto the endangered list. – Present the reasons for a specific organism being endangered. – Class discussion to compile a summary of the reasons and the methods for protecting species. – Applying this knowledge to a given case study.	Pupils should be encouraged to consider a range of different organisms, which are on the endangered list both plant and animal. An exercise to classify the organisms on the list into their kingdom would provide the opportunity to review knowledge gained from a, b and c. This might best be done by giving pupils a specific organism to research and to bring along their own presentation to the class, including where applicable protection of the species in a zoo/botanic garden/ conserved area/seed bank. From the presentations a summary list of the main reasons why an organism may find itself endangered should be compiled. How zoos, botanic gardens, conserved areas and seed banks can help to protect the endangered species could be linked to their own country. The pupils could then be given another case study of an endangered species and asked to discuss the main reasons for this organism becoming endangered and the best method for protecting it using the information provided.	http://www.worldwildlife.org/endangered/ http://www.endangeredspecie.com/ Suggest Teachers look for information about their own country's zoos, botanic gardens etc. Kew Gardens and London or Chester Zoo in the UK also have web sites.	*Environmental Biology ch 6* *Applications of Genetics ch3*

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
R (a)	describe the steps involved in the production of bacteria capable of synthesising human insulin: • Identifying the human insulin gene • Isolating mRNA and making cDNA using reverse transcriptase • Cloning the DNA using DNA polymerase • Inserting the DNA into a plasmid vector using restriction enzymes and DNA ligase • Inserting the plasmid vector into the host bacterium • Identifying the genetically modified bacteria using antibiotic resistance genes • Cloning the bacteria and harvesting the human insulin **Learning Activity** Pupils should participate in: – a review of knowledge of the importance of insulin and its control of blood sugar, structure of a prokaryotic cell, structure of DNA, RNA and a gene and control of protein synthesis – order the steps in the production of insulin using gene technology and use these to label diagrams of each step. – underline or write in colours the use of the different enzymes used in the process. – discuss the advantages of treating diabetics with human	Pupils should have a good understanding of section N n , section A c and g, section C and section F. Using class discussion/oral question and answer review previous knowledge and write up main points e.g. what is a gene? Order the steps in protein synthesis using cards with the main steps for pupils to sort. Label a diagram of E.coli the main bacterium used in production of insulin especially the plasmid – what is a plasmid? What is a vector? What is an antibiotic? What does cloning mean? Use a set of cards with a single step on each for the pupils to try and put in to an order. This could be done individually, then by pairs and then in small groups followed by a class discussion to get the correct order. It is important that pupils use their prior knowledge of protein synthesis and that the human gene codes for insulin which is a protein released by the bacterium as a waste product. Diagrams on p76 Biology 1 could be used for pupils to label however the stage of identifying the genetically modified bacteria using antibiotic resistance genes has been omitted – this therefore needs to be added and some explanation of how the antibiotic resistance genes help select the modified bacteria included. Pupils may need to be told that insulin was obtained from slaughtered pigs and cows by extracting insulin	http://www.littletree.com.au/dna.htm Shows how human insulin is produced. http://www.2aida.org/aida/index.shtml Simulation where variables which affect diabetics can be changed to show changes in blood glucose level http://www.webshowcase.net/diabetes/screen4_1.html Has a good links and list to other sites. http://www.iddtinternational.org/ International site human versus animal insulin http://www.gene-watch.org/genewatch/articles/16-6romano.html	Biology 1 p75. Advanced Biology ch 5 Biozone 2 provides a good summary in Microbiology & Biotechnology section
(b)				

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
	insulin produced by gene technology and explain how these are advantages to the diabetic and to society.	from their pancreases and then encouraged to list how this might have resulted in problems of supply and demand, rejection by humans, side effects so that they can relate these to advantages of human insulin. They should be encouraged to think more widely to cost of production, does not result in harm to animals therefore more ethical. However there is an organisation which is made up of diabetics who have suffered bad side effects from human insulin and have gone back to taking pig insulin. This could provide a good discussion point about evidence or lack of it when it is not in the best interests of drug companies.		

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
R(c) (d)	explain why promoters need to be transferred along with desired genes in gene technology **Learning Activity** Pupils should participate in: – revising/learning the importance of promoters on DNA to inform the RNA of the DNA strand to be transcribed, which part of the DNA strand is being transcribed and the first nucleotide of the gene. – Review production of insulin by gene technology and that therefore promoters need to be transferred with the human gene if it is going to be able to transcribe the DNA during protein/insulin synthesis. – Discuss the use of antibiotic resistance genes and what problems these might create. – Research why and how genes for enzymes that produce fluorescent or easily stained substances are now used as markers in gene technology.	Pupils may have covered the idea of promoters when studying protein synthesis as these are base sequences of DNA which allows the RNA to recognise which of the DNA strands is the template, which part of this DNA strand has to be transcribed and where the first nucleotide of the gene to be transcribed is located. However pupils need to revise this idea and link it to the importance in gene technology that these promoters need to be transferred with the desired gene as gene technology relies on the selected gene being able to control protein synthesis in the host, therefore the transcription onto mRNA from the DNA. The card sort exercise could be used to revise the process of insulin production and then discuss where the promoters should be included. Pupils could be given information about genes, which code for enzymes that produce fluorescent or easily stained substances and asked where these would be used in gene technology, then move on to why these would have advantages over antibiotic resistance genes being used.	http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/P/Promoter.html A good general introduction with useful analogies and links to other points of interest for the more able.	*Advanced Biology ch 5*

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
R (e) (f)	describe the benefits and hazards of gene technology, with reference to specific examples. discuss the social and ethical implications of gene technology. **Learning Activity** Pupils should participate in: – class discussion of benefits and hazards and research specific examples – this information could then be used to complete a table to summarise the information – group discussion after first understanding the difference between social and ethical implications. Followed by class discussion to complete a table or a spider diagram to summarise the main points.	It is important that pupils understand the terms and know the difference between social and ethical. Class discussion of benefits and hazards should enable a table to be completed along with brief specific examples. It is important with the social and ethical implications that pupils give specific examples e.g. 'animal rights supporters would be in favour' is not enough - why would they find this more ethically acceptable.	A search in e.g. Google of benefits of gene technology yields many web addresses for different countries and areas – pupils could be given one of these to read and summarise the main points with arguments for the hazards.	*Advanced Biology Ch5.* *Biozone 2* *Clegg C.J. (2000) Introduction to Advanced Biology (John Murray, www.johnmurray.co.uk) ISBN0719576717 ch 6* *Microbiology & Biotechnology ch 4 p 63*
R (g)	Outline the principles of electrophoresis as used in • Genetic fingerprinting • DNA sequencing **Learning Activity** Pupils should participate in: – if possible in carrying out electrophoresis using DNA – given information and results of electrophoresis pupils could act out what happens to different sequences by being given cards showing where they have travelled to.	Use of kits to carry out electrophoresis to gene sequence. Drama activity to form human gel electrophoresis results. Different groups could make up the bands on a gel electrophoresis for a victim, specimen taken from her clothing and any number of suspects depending on the class size. Only one of the groups would match the specimen.	http://www.life.uiuc.edu/molbio/geldigest/electro.html#run this is a cyberlab and takes pupils through the process using pictures and notes. http://www.koshlandscience.org/exhibitdna/crim01.jsp# Interactive from museum requires loading of flash reader but this can be done from the site. http://www.pbs.org/wgbh/nova/sheppard/analyze.html DNA electrophoresis and	Advanced Biology ch 5. Biozone 2 Applications of Genetics ch *5*

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
		Extra work could encourage pupils to assess the social and ethical implications of genetic fingerprinting to apply ideas from R f to different situations.	fingerprinting exercise to identify a culprit. http://en.wikipedia.org/wiki/Genetic_fingerprinting	
R (h) (i) (j)	Describe the causes and outline the symptoms of cystic fibrosis (CF) as an example of a recessive genetic condition (reference should be made to CFTR protein, issues related to CF will need to be handled with sensitivity); Describe the progress towards successful gene therapy for CF; Discuss the roles of genetic screening for genetic conditions and the need for genetic counselling. **Learning Activity** Pupils should participate in: – A review of knowledge on cell membrane structure and passage of ions and water across membranes. – Link to the problem for sufferers of CF – summarise main causes and symptoms. – Review knowledge of genetic crosses and apply these to show inheritance of the recessive allele resulting in CF. – Research and summarise progress towards successful gene therapy – In groups research and discuss the use of genetic screening for genetic conditions and why	This topic needs careful handling. It does give the opportunity to use knowledge from section D, section O and revisit R (a) to compare with gene therapy, which uses some of the same techniques. Class discussion/oral question and answer or an incomplete worksheet for revision of main points. An information sheet to illustrate the problem could be used from which pupils could summarise main causes and symptoms and be encouraged to imagine the difficulties of living with the problem and why in the past so many children died. This provides an excellent opportunity to revise genetic diagrams by giving pupils various case studies to use the information to produce the genetic diagrams. If time this could be set up as a debate with different groups representing different parties e.g. parents of a child with CF, an adult with CF who wants to start a family, an insurance company representative, an employer etc.	http://www.nlm.nih.gov/medlineplus/cysticfibrosis.html Excellent for providing a wealth of web links to various other sites for information. http://www.ygyh.org/cf/whatisit.htm http://www.cfgenetherapy.org.uk/genetherapy.htm http://mnarayan.bol.ucla.edu/Genetherapy.html	Advanced Biology ch 5 Introduction to Advanced Biology ch 6 Applications of Genetics genetic screening p 62 Biozone 2 covers genetic screening and gene therapy for diabetes as another example.

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
	genetic counselling is needed – from class discussion produce a summary diagram showing uses for specific conditions, benefits and consequences and the ethical and social issues which arise.			
S (a)	Outline the use of micro-organisms in the extraction of heavy metals from low grade ores **Learning Activity** Pupils should participate in: – brainstorming what is meant by biotechnology to write down a definition – review their knowledge of micro-organisms main groups and any named examples and their uses to produce a concept map – research the use of micro-organisms in extracting copper and uranium and if possible gold from low grade ores- – to produce a summary diagram.	This section uses knowledge from Q (a), F, I (f), C and J. Class or group brainstorming to obtain a definition of biotechnology. Revise knowledge of prokaryotes and protoctista and produce either group concept maps or a class concept map depending on pupil's familiarity with the method. Internet search could be used here or textbooks.	http://www.bioteach.ubc.ca/Bioengineering/microbialmining/ Provides clear notes and pictures of processes. http://www.prophetau.com/sciencelinks.htm useful links	Microbiology and Biotechnology Biozone 2 Microbiology & Biotechnology section

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
S (b) (c)	Explain what is meant by the terms batch culture and continuous culture. Compare the advantages and disadvantages of batch and continuous culture with reference to the production of secondary metabolites (e.g. penicillin), enzymes (e.g. protease) and biomass (e.g. mycoprotein). **Learning Activity** Pupils should participate in: – using information provided to explain the terms batch and continuous culture – -in group discussion compare the advantages and disadvantages of the two methods for production of secondary metabolites e.g. penicillin, enzymes e.g. protease and biomass e.g. mycoprotein completing a table to summarise the ideas.	Pupils could be given worksheets describing these two techniques and asked to consider what is meant by the two terms. Pupils should be encouraged to identify the requirements needed for micro-organisms to grow in culture and could be asked to draw the pattern of growth which would be observed in the two methods and what limits growth. Pupils need to know that the product is released by the micro-organism in the case of secondary metabolites and enzymes but biomass is the growth of the micro-organism, which is harvested.	http://chemeng.mcmaster.ca/courses/che3bk3/Lecture%2012%20-%20Oct%208.pdf Is a powerpoint lecture the first 4/5 sides are worth using it then becomes very mathematical! http://www.rpi.edu/dept/chem-eng/Biotech-Environ/Contin/working.htm This gives batch and continuous information and a graph to show effects of changing inlet substrate flow. Useful for more able pupils to investigate.	Microbiology & Biotechnology Biozone 2 Microbiology & Biotechnology Introduction to Advanced Biology ch 15

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
S(d)	describe, for penicillin as an example of an antibiotic: • the mode of action on bacteria and why it does not affect viruses • causes and effects of antibiotic resistance **Learning Activity** Pupils should participate in: – researching how penicillin affects bacteria and summarising mode of action – group discussion of why penicillin does not affect viruses revising knowledge of viruses to produce summary. – researching causes and effects of antibiotic resistance and class discussion to summarise problems associated with antibiotic resistance	The study of penicillin could be separated from the different sections to consider its culture as a secondary metabolite, its mode of action on bacteria and why it does not affect viruses and the causes and effects of antibiotic resistance. (Link to use of genes resulting in antibiotic resistance and their use in gene technology to isolate genetically modified bacteria). Class question and answer can be used to review knowledge of bacteria structure and features of viruses. Antibiotic resistance should enable pupils to revise gene mutation and that this produces new protein/enzyme synthesis to control change to bacteria structure so resistant to effects of antibiotic.	http://science.howstuffworks.com/question88.htm http://www.fda.gov/fdac/features/795_antibio.html	Introduction to Advanced Biology ch 15 Vellacott & Side (2002) Understanding Advanced Human Biology (Hodder & Stoughton) ISBN 0340679115 ch 30 Biology 1 ch 15 Biozone 2 Preventing and treating disease

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
S(e) (f)	immobilise an enzyme in alginate and compare the ease of recovering the enzyme and ease of purification of the product compared to the same enzyme that has not been immobilised. explain the principles of operation of dip sticks containing glucose oxidase and peroxidase enzymes, and biosensors that can be used for quantitative measurement of glucose **Learning Activity** Pupils should participate in: – an investigation into making immobilised enzymes and comparing its action with the enzyme when it is not immobilised – group discussion to summarise the differences in the patterns of graphs which would be obtained for changing temperature, pH, substrate concentration and inhibitors. – class discussion to compare graphs and to draw an agreed set with notes to explain why they are similar or different from the enzyme when not immobilised. – write a summary or draw a poster of advantages of immobilising enzymes to include the ease of purifying the product as well as the examples of uses of immobilised enzymes and how	Pupils should be encouraged to research uses of immobilised enzymes using the Internet/textbooks. This section reviews knowledge of enzymes section C and uses of cell membranes and organelles where enzymes are attached This technique can be used to practice design modification to investigate changing a variable so that pupils think about the variables which they are unable to control; how they would control the other variables, how they would change the variable under investigation to obtain a good range of results e.g. at least 5; what they would measure to show the effect of the change; the importance of repeat/replicate measurements to test reliability of the investigation. The pupils could be given data to practice line graph drawing and then asked to discuss how the patterns would be different for enzymes not immobilised.	http://www.rpi.edu/dept/chem-eng/Biotech-Environ/IMMOB/Immob.htm introduction to immobilisation and different methods. Plus good links to bioreactors. http://www.lsbu.ac.uk/biology/enztech/ very good book online for enzymes and immobilised enzymes. http://www.ncbe.reading.ac.uk/NCBE/PROTOCOLS/PRACBIOTECH/glucose.html One of a booklet of practicals which can be downloaded from the NCBE web site. This one is on home made glucose detection strips.	Practical Advanced Biology Effect of bead size Microbiology and Biotechnology ch 6 Introduction to Advanced Biology ch 4 Understanding Advanced Human Biology ch 7

	they work e.g. dip sticks containing glucose oxidase and peroxidase enzymes and biosensors that can be used for quantitative measurement of glucose.			

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
S(g) (h)	Outline the hybridoma method for the production of a monoclonal antibody. Evaluate the use of monoclonal antibodies compared to conventional methods for diagnosis and treatment of disease, and testing for pregnancy **Learning Activity** Pupils should participate in: – reviewing knowledge of immunity by question and answer – producing an outline by writing/diagram of how monoclonal antibodies are produced by the hybridoma method – research the conventional methods and the uses of monoclonal antibodies for diagnosis and treatment of disease and testing for pregnancy – group discussion to evaluate the conventional methods versus use of monoclonal antibodies – class discussion to produce a summary of the evaluation	This enables pupils to review knowledge of section J on immunity. Question and answer session should review prior knowledge so that pupils are clear about what antibodies are and β lymphocytes and β plasma cells and that cancer cells divide uncontrollably, prior to writing an outline/producing a diagram of how monoclonal antibodies are produced by the hybridoma method. Below are some uses of monoclonal antibodies, as students will need to start here to find out what the traditional methods for diagnosis and treatment were before moving on to how this compares with treatment using monoclonal antibodies. Use: I. Diagnostics-- • Home pregnancy-test kits • Ovulation-Predicting kits • Detecting • Allergies • Anemia • Hepatitis II. Therapeutics to treat • Rejection of organ transplants • Septic shock • Cancer • Toxins	http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/M/Monoclonals.html A clear description of production of monoclonal antibodies with related links. http://www.bio.davidson.edu/Courses/molbio/MolStudents/01rakarnik/mab.html http://en.wikipedia.org/wiki/Monoclonal_antibody http://chemistry.about.com/od/chemistryfaqs/f/pregnancytest.htm http://www.hhmi.org/biointeractive/immunology/vlab.html	Microbiology & Biotechnology ch 5 Advanced Biology ch 21

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
		• Blood clots • Bacterial infections • Arthritis Pupils may need help to understand the term evaluation as identifying the advantages and disadvantages of each method, the consideration of costs per patient and the ethics of using animals and the various opinions expressed by groups, then producing a summary incorporating the various opinions and the scientific evidence. Pupils need to be aware that they may be asked to use the same evaluation techniques in a different situation using information provided.		

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
T(a) (b) (c) (d)	describe and explain the structural features of a named, wind pollinated plant compare the outcomes of self-pollination and cross-pollination in terms of genetic variation describe the structure of the fruit in maize and explain the function of the endosperm explain the significance of the grains of cereal crops in the human diet **Learning Activity** Pupils should participate in: – question and answers to review knowledge of flowering plant reproduction and complete sheets with main points of life cycle and flower structure – practical observation of wind-pollinated flowers and drawing and labelling annotated drawings of named examples of wind-pollinated flowers. – group discussion to produce diagrams to illustrate genetic variation as a result of self-pollination and cross-pollination to include meiosis and fusion of gametes (male nucleus of pollen and female nucleus in ovule). – dissecting a maize fruit and drawing and labelling its structure	Pupils may need to review knowledge of flowering plant reproduction e.g. a life cycle and then review the labelling and function of flower structure e.g. by starting with a diagram of an insect pollinated flower and then practically comparing this with examples of wind-pollinated flowers from their locality. Pupils could observe using the light microscope wind-pollinated pollen. Pupils may need reminding briefly of how pollen needs to germinate in order to fertilise the ovules to form the seed contained within the fruit. The class should discuss self-pollination and cross-pollination and review their knowledge of variation from meiosis, giving rise to variation in pollen and ovules and therefore some variation even with self-pollination but that variation increases with cross-pollination between two flowers from different plants but of the same species -why? Maize fruit are hard so may need to be softened in water before dissection, pupils could discuss why the seeds are hard and what the advantage is e.g. prevents enzyme activity. Pupils could review knowledge of human diet and then research the importance of cereal grains as high fibre in their diet and prevention of heart disease and bowel cancer. However this needs to be balanced against some people's autoimmune reaction to gluten.	http://en.wikipedia.org/wiki/Maize http://gos.sbc.edu/m/mcclintockfig3.html http://gograins.grdc.com.au/pdf/heart_disease.pdf makes link between diet and reduction in heart disease http://www.nationmaster.com/encyclopedia/Cereal general information on cereals. There are also web sites which recommend gluten free diets and therefore the consumption of only some cereals because of the effects on the autoimmune system.	Growth, Development & Reproduction ch 3

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
	• researching the function of the endosperm in the maize fruit • researching the significance of the grains of cereal crops in the human diet			
T(e) (f) (h)	explain how the structure of the leaves of C4 plants such as maize or sorghum are adapted for high rates of carbon fixation at high temperatures in terms of • the high optimum temperatures of the enzymes involved • the spatial separation of initial carbon fixation from the light-dependent stage (biochemical details of the C4 pathway are not required) explain how sorghum is adapted to survive in arid environments outline the following examples of crop improvement; • inbreeding and hybridisation in producing vigorous, uniform maize **Learning Activity** Pupils should participate in: – reviewing knowledge of photosynthesis and Carbon fixation with leaf structure. – comparing C3 and C4 leaf structure – Group discussion to consider how C4 enzymes may be affected by temperature.	Pupils need to be familiar with section M, C, O and P. Pupils will need to review knowledge of C3 photosynthesis in order to access C4 and need to be clear about photorespiration before considering the adaptations of the leaf cell structure. This will enable them to review knowledge of dicotyledonous leaf structure to compare with C4 maize leaf structure. Pupils could review this by using cards with the main stages of photosynthesis written on separate cards, with sites of the reactions to order/arrange to explain how photosynthesis occurs. This could then be discussed introducing the idea of photorespiration and the adaptation of C4 plants to remove photorespiration by having a different arrangement of cells in their leaves. If possible the use of light microscopes and TS of the different leaves could be used for making annotated drawings to compare the leaves. Pupils could be given graphs of the rate of photosynthesis with changing temperature and asked to sketch in the graph for a C4 plant. This should stimulate the discussion of the effect of higher temperatures on C3 enzymes versus C4 enzymes. This might also lead to an extension of considering the effects of global warming on C4 plants.	http://maize.agron.iastate.edu/general.html http://en.wikipedia.org/wiki/Maize http://en.wikipedia.org/wiki/Sorghum http://www.icrisat.org/text/coolstuff/crops/gcrops2.html	Advanced Biology ch 8

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
	– research sorghums' ability to grow in arid conditions and summarise these. – research improving maize by inbreeding and hybridisation.	Pupils need to be clear about the terms adaptation, inbreeding and hybridisation. The web addresses provide information about maize and sorghum. From these sites there are many links to other sites including simulations of the effect on crop yield of different variables, which might be used by pupils to investigate changing a variable to gain data, which could be analysed, and conclusions drawn. The web sites also give useful information on inbreeding and hybridisation for improving maize.		

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
T(g) (h)	explain how rice is adapted to grow with the roots submerged in water in terms of tolerance to ethanol and presence of aerenchyma outline the following examples of crop improvement: • genetic manipulation to enhance the vitamin A concentration in rice • hybridisation leading to polyploidy in wheat **Learning Activity** Pupils should participate in: – discussing the problems for root growth when submerged in water and summarise these using a diagram - research how rice is adapted to overcome these problems especially build up of ethanol and lack of oxygen supply - observe aerenchyma using a light microscope and slides of rice - review knowledge of gene manipulation and research how vitamin A can be enhanced in rice using this method. - researching to describe how hybridisation of wheat has lead to polyploidy	This section provides the opportunity to review and use knowledge of sections G, d, e and R and F. Pupils need to understand what adaptation means and link the structural adaptation to the reason why this helps rice to survive in the environment. For extension work there is a web address which is suggesting that farmers can increase their yield of rice by changing the way they grow it and not submerging it in water until the reproductive phase and then only with 1 – 2 cm. Of water. Pupils might use this for research to discuss the different methods of growing or information of both methods of management provided to pupils to scan read and isolate facts and evidence (maybe by underlining them in different colours) and then either summarise these or use them as the basis for arguing for one method or the other as in a debate. Gene manipulation to enhance vitamin A in rice provides the opportunity to review knowledge of gene technology and link this to protein synthesis. The web has information on the rice genome and how it might be manipulated in all sorts of ways to improve the diet of populations for whom it is their staple nutrition. A search on the Internet for wheat will produce a large number of sites from which pupils should select one which clearly shows the hybridisation and how polyploidy has resulted. They could be asked to discuss how mitosis, meiosis and protein synthesis may be affected by polyploidy.	http://en.wikipedia.org/wiki/Rice http://www.riceromp.com/teachers/lessonContent.cfm?pId=147 Student information on structure and life cycle of rice http://en.wikipedia.org/wiki/Golden_rice http://www.irri.org/publications/annual/pdfs/ar2001/datta.pdf Information on vitamin A and rice http://en.wikipedia.org/wiki/Special:Search?search=wheat+polyploidy&fulltext=Search It uses wikipedia and is the search page for wheat polyploidy – click on links. http://www-saps.plantsci.cam.ac.uk/worksheets/activ/prac4.htm extension activity on root growth – could be adapted to investigate rice root growth in oxygenated and deoxygenated conditions	
U (a)	describe the histology of mammalian ovary and testis	Pupils need to review knowledge of sections A and E.	http://images.google.co.uk/images?q=human+ovary&hl=e	For testis Bioscope CD UCLES.

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
(b)	outline gametogenesis in a male and female human as a process involving mitosis, growth, meiosis and maturation **Learning Activity** Pupils should participate in: – using the light microscope and slides of ovary and testis to observe histology and draw annotated drawings. – reviewing knowledge of mitosis and meiosis linked to diploid and haploid numbers. – using research and card sort exercise working in groups to arrange cards in order. After class discussion to establish correct order – copy the information using colours to show mitosis and meiosis. – repeat exercise with other gametogenesis. – discuss the similarities and differences between the two – return to drawings of ovary and testis to link gametogenesis to where the stages occur.	Pupils need to observe the histology of ovary and testis using light microscopes and link this to gametogenesis. Pupils could be given cards with separate stages of gametogenesis and asked to research and sort the cards into order. Class discussion can then establish the correct sequence and pupils copy this using colours to highlight where mitosis and meiosis occur. The exercise can be repeated for the other gametogenesis. Pupils should then be encouraged to consider where cells are diploid and haploid and could include this information for humans on their diagrams. Extension work could use a case study for a different mammal with a different diploid number to review learning.	n&btnG=Search+Images This is a search of Google images for ovary and produces a range of diagrams and suitable images. A similar search for testis could also be carried out. http://wps.prenhall.com/esm_freeman_biosci_1/0,6452,501052-,00.html The links, each to a nice flash animation of oogenesis, spermatogenesis and a comparison of the two.	Growth, Development & Reproduction ch 4 Biozone 2 Reproduction & Development

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
U (c) (d) (e)	explain the role of hormones in maintenance of the human menstrual cycle, and link this to changes in the ovary and uterus during the cycle. Outline the biological basis of the effect of oestrogen/progesterone contraceptive pills Discuss and evaluate the biological, social and ethical implications of the use of contraception **Learning Activity** Pupils should participate in: – reviewing knowledge of hormones and endocrine organs – sorting and ordering cards showing the menstrual cycle and how the hormones control it and the changes to the ovary and uterus then summarising this using annotated diagrams and colours to show the hormones. – using the same colours used for each hormone on a graph to show the changes in the levels of the hormones during a cycle – discuss the changes to this graph for shorter/longer cycles, pregnancy and change which might result in infertility. - research and outline how the different hormone contraceptive pills prevent pregnancy these could be added to the normal	Pupils need to review section N control in terms of hormones. Pupils need to be clear of the menstrual cycle and how the hormones control the changes. Pupils should also discuss graphs showing the changing levels of the hormones and discuss how these may be different e.g. for longer/shorter menstrual cycles, what changes in the hormones might result in infertility. Leading on to pupils outlining the effect of the different contraceptive pills depending on their hormone content. For discussing and evaluating pupils need to be clear about considering different views and evidence to support or not the use of contraception generally and what are biological, social and ethical implications. A suggestion would be to divide into groups who consider one of biological, social or ethical implications starting with what these mean and then relating this to contraception generally and specifically hormones in pills. Groups could then feedback to a class discussion and produce a summary of the main arguments for each area.	http://www.biologymad.com/master.html?http://www.biologymad.com/Hormones/Hormones.htm http://www.crlp.org/ww_iss_contracept.html International law on reproductive rights – useful for discussion. http://www.contraceptiononline.org/slides/slide01.cfm?tk=10 Range of powerpoint slides some of which could form the basis of consideration of the issues involved in contraception being successful within a population. http://hcd2.bupa.co.uk/fact_sheets/html/hormonal_contraception.html General information.	Growth, Development & Reproduction ch 4 Biozone 2 Reproduction & Development

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
	diagram of the menstrual cycle to show what happens and add on to the graphs the effect of the hormones. - In a group discuss and summarise the main points to evaluate the implications of the use of contraception generally on biological, social and ethical grounds. - Contribute to class discussion and summarise main points arising from discussion.			
U (f)	outline the technique of in-vitro fertilisation (IVF) and discuss its ethical implications. **Learning Activity** Pupils should participate in: – researching IVF to produce a side of A4 with annotated diagrams of the procedure. – share their version with others – contribute to class discussion of the ethical implications to produce a summary.	Pupils could share their version with others to discuss which gives the best presentation, different pupils will find different presentations easier or harder to understand, this is useful for them to identify their own way of learning as being different from the way others learn. Pupils need clear guidance on what ethical means and that the implications need to be specific not vague.	http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/I/I.html Very useful for IVF and other sources acts like an encyclopaedia with search facility. Go through and click on In Vitro Fertilization (IVF) http://en.wikipedia.org/wiki/In_vitro_fertilization	Growth, Development & Reproduction ch 4 Advanced Biology ch 17