

## O Level Biology (5090)

### Unit 9: The Continuity of Life – Inheritance and Evolution

#### Recommended Prior Knowledge

The major part of this Unit stands alone. Helpful, but not essential, would be a knowledge of cell structure, enzymes, nutrition and excretion and bacteria.

#### Context

The general thread of reproduction continues to run through this Unit from Unit 8. Genetic inheritance leading on to variation and finally to evolution is considered.

#### Outline

The importance of DNA is considered along with simple inheritance. A study of variation leads to an explanation of evolution. The Unit ends with DNA function and genetic engineering.

AO	Learning outcomes	Suggested activities and further guidance	Online resources	Other resources
17(a)	Describe the difference between continuous and discontinuous variation and give examples of each.	<p>Body weight and height are standard examples of continuous variation, as are blood groups and sex of discontinuous variation.</p> <p>Students may collect data concerning these characteristics amongst their peers and draw graphs to compare the distributions. Graphs should be drawn of the distributions shown by the two types of variation.</p> <p>Graphs may be annotated to indicate the influence of genes and/or environment on each type of variation.</p>	<p>Types of variation:  <a href="http://www.bbc.co.uk/schools/ks3bitesize/science/organisms_behaviour_health/variation_classification/revise3.shtml">http://www.bbc.co.uk/schools/ks3bitesize/science/organisms_behaviour_health/variation_classification/revise3.shtml</a></p> <p>Causes of variation:  <a href="http://www.bbc.co.uk/schools/ks3bitesize/science/organisms_behaviour_health/variation_classification/revise4.shtml">http://www.bbc.co.uk/schools/ks3bitesize/science/organisms_behaviour_health/variation_classification/revise4.shtml</a></p>	<p><b>Textbooks</b></p> <p>Ian J. Burton – Topic 22 Inheritance</p> <p>M. &amp; G. Jones – 12 Inheritance and evolution</p> <p>Mary Jones – Unit 20 Inheritance</p>
17(b)	State that a chromosome includes a long molecule of DNA.	<p>Detail of DNA structure is <b>not</b> required beyond a description as two long strands cross-linked by a succession of paired molecules called bases.</p> <p>Students may use the suggested online activity on genome structure, following which they may write a written summary of the levels of organisation found in the genome.</p>	<p>Chromosome structure:  <a href="http://www.johnkyrk.com/chromosomestructure.html">http://www.johnkyrk.com/chromosomestructure.html</a></p> <p>Genome organisation:  <a href="http://genome.wellcome.ac.uk/interactive/zoom/index.html">http://genome.wellcome.ac.uk/interactive/zoom/index.html</a></p>	

17(c)	State that DNA is divided up into sections called genes.	<p>Explain that, as a consequence, each gene comprises its own particular sequence of linked bases.</p> <p>Students may include this concept in their response to the suggested activity in 17(b) and may use the suggested online resource covering genetic terminology as consolidation.</p>	<p>Genetic terminology:  <a href="http://www.siskiyous.edu/class/bio1/genetics/genetic_terms_v2.html">http://www.siskiyous.edu/class/bio1/genetics/genetic_terms_v2.html</a></p>	
17(d)	Explain that genes may be copied and passed on to the next generation.	<p>Explain that when a cell divides its nucleus first makes an exact copy of each strand of DNA (and therefore also of each gene). The original passes into the nucleus of one cell and its copy passes into the other. In this way, the same genes are passed from generation to generation.</p> <p>Cross reference with resources and activities used in 16(a) and (c) of Unit 8.</p>	See suggested online resources for learning outcomes 16(a) and (c) of Unit 8.	
17(e)	Define a gene as a unit of inheritance and distinguish clearly between the terms gene and allele.	<p>Each gene represents one piece of information – instructions for a certain characteristic - passed from parent to offspring. Alleles are different varieties of the same gene.</p> <p>A possible link to 17(q) may be made at this time.</p>	<p>Alleles and complete dominance:  <a href="http://www.bbc.co.uk/schools/gcsebitesize/science/21c/genetics/genesinheritencerev5.shtml">http://www.bbc.co.uk/schools/gcsebitesize/science/21c/genetics/genesinheritencerev5.shtml</a></p>	
17(f)	Describe complete dominance using the terms dominant, recessive, phenotype and genotype.	These terms follow naturally from a consideration of genes and alleles above and are better explained alongside their use in 17(i) when genetic crosses are presented.	See suggested resource listed above.	
17(g)	Describe mutation as a change in the structure of a gene (sickle cell anaemia) or in the chromosome number (47 in Down's syndrome instead of 46).	<p>Genes are subject to mutations leading to a change in phenotype. Whilst most changes are very small and barely noticeable, others have a more marked effect. Students should link this change in gene structure to 17(d) and (q) and to the subsequent phenotypic outcome.</p> <p>Students may be shown the Down's karyotype, asked to identify how this is different from that expected and to suggest mechanisms for how the mutation arises.</p>	<p>Down's syndrome:  <a href="http://kidshealth.org/parent/medical/genetic/down_syndrome.html#">http://kidshealth.org/parent/medical/genetic/down_syndrome.html#</a></p> <p>Down's karyotype:  <a href="https://www.msu.edu/course/isb/202/ebermay/2004/drivers/downs1.jpg">https://www.msu.edu/course/isb/202/ebermay/2004/drivers/downs1.jpg</a></p>	

17(h)	Name radiation and chemicals as factors that may increase the rate of mutation.	<p>Mutagens can have the effect of altering the molecular structure of a gene and thus altering the way in which the gene works. This may be linked to 17(g) and in turn to 17(d) and (q).</p> <p>Students may produce a 'spider diagram' to show the two radiation and chemicals as mutagens and extend this to show examples of each and how they may be encountered in the environment.</p>		
17(i)	Predict the results of simple crosses with expected ratios of 3:1 and 1:1, using the terms homozygous, heterozygous, F <sub>1</sub> generation and F <sub>2</sub> generation.	<p>Students should be encouraged to draw full genetic diagrams to show these crosses. The diagrams should be annotated and include reference to parents and gametes. Such diagrams demonstrate that the same phenotype may have different genotypes.</p> <p>Students may use the suggested online learning activity to understand the terminology and process of a monohybrid genetics cross. This may be followed by attempting a series of teacher-set and assessed problems covering similar scenarios.</p> <p>Cross reference should be made to the terminology introduced in 17(e) and (f).</p>	<p>Monohybrid inheritance animation and activity:  <a href="http://www.siskiyous.edu/class/bio1/genetics/monohybrid_v2.html">http://www.siskiyous.edu/class/bio1/genetics/monohybrid_v2.html</a></p>	
17(j)	Explain why observed ratios often differ from expected ratios, especially when there are small numbers of progeny.	<p>It should be stressed that the ratios predicted in 17(j) are statistical and are obtained only from large samples.</p> <p>Students may use the suggested online resource to view observed and statistical data from Mendel's experiments and be asked to comment on any differences observed.</p>	<p>Observed and expected ratios in Mendel's experiments:  <a href="http://www.siskiyous.edu/class/bio1/genetics/three_to_one_ratio.html">http://www.siskiyous.edu/class/bio1/genetics/three_to_one_ratio.html</a></p>	
17(k)	Explain codominance by reference to the inheritance of the ABO blood group phenotypes (A, B, AB, O, gene alleles I <sup>A</sup> , I <sup>B</sup> and I <sup>O</sup> ).	<p>Students will observe that there can be more than two alleles of the same gene.</p> <p>A full genetics diagram may be provided as a worked example, following which students may attempt similar problems to assess their understanding.</p>		

17(l)	Describe the determination of sex in humans (XX and XY chromosomes).	<p>It will be necessary to point out that the sex inheritance is the result of the inheritance of chromosomes, not of genes.</p> <p>Students may use the suggested online or text book resources, following which they may draw a full genetics diagram to show the inheritance of sex.</p> <p>Pupils may be asked to produce a written explanation, using correct terminology, of why the probability of <b>male:female</b> is 1:1 and of which parent determines a child's sex.</p>	<p>Inheritance of sex:  <a href="http://www.bbc.co.uk/schools/gcsebitesize/science/21c/genetics/genesinheritencerev3.shtml">http://www.bbc.co.uk/schools/gcsebitesize/science/21c/genetics/genesinheritencerev3.shtml</a></p>	
17(m)	Describe variation and state that competition leads to differential survival of organisms, and reproduction by those organisms best fitted to the environment.	<p>Variation is a random process which happens to leave some members at a survival advantage over other organisms in a particular environment. It does not occur 'in order to adapt to the environment' as students often believe. Organisms which survive then reproduce and at least some of their offspring inherit this advantage.</p> <p>Students may use the suggested online and textbook resources to write a numbered list of 'generic' points outlining the process of natural selection. Students may then be presented with previously unseen specific examples of where the process occurs and asked to apply their list of generic points.</p> <p>Students may use the suggested online activity to demonstrate natural selection in the classic example of the peppered moth.</p>	<p>Natural selection process:  <a href="http://evolution.berkeley.edu/evolutionary_library/article/0_0_0/evo_25">http://evolution.berkeley.edu/evolutionary_library/article/0_0_0/evo_25</a></p> <p>Peppered moth simulation:  <a href="http://www6.district125.k12.il.us/~nfischer/Moth/">http://www6.district125.k12.il.us/~nfischer/Moth/</a></p>	
17(n)	Assess the importance of natural selection as a possible mechanism for evolution.	Survival of the better-adapted organisms, each showing variations, some of which are advantageous, generation after generation, leads to evolutionary change in the species. Students may cross reference this principle to the evolution of antibiotic resistant bacteria from 13(b) in Unit 6.	<p>Example of antibiotic resistant bacteria:  <a href="http://www.windows2universe.org/cool_stuff/tour_evolution_9.html">http://www.windows2universe.org/cool_stuff/tour_evolution_9.html</a></p>	

17(o)	Describe the role of artificial selection in the production of economically important plants and animals.	<p>When humans select organisms with characteristics which are commercially desirable and breed from them, variation can again enhance the selected characteristic – especially when repeated over many generations.</p> <p>Students may use the suggested online resource to select one example of where this principle is used to research in further detail – including details of the feature(s) selected for and the commercial reasons for doing so.</p>	<p>Artificial selection:  <a href="http://www.s-cool.co.uk/gcse/biology/genetic-crosses/selective-breeding-crosses.html">http://www.s-cool.co.uk/gcse/biology/genetic-crosses/selective-breeding-crosses.html</a></p>	
17(p)	Explain that DNA controls the production of proteins.	The linking of amino acids to form a protein in the cells of a body is determined by DNA. The exact amino acids and their particular sequence in each different protein are controlled by one specific gene. Cross reference should be made to 17(e) and (g) in this unit and to 5(s) in Unit 3.		
17(q)	State that each gene controls the production of one protein.			
17(r)	Explain that genes may be transferred between cells (reference should be made to transfer between organisms of the same or different species).	<p>The following transfers may be included:</p> <ul style="list-style-type: none"> <li>i. Human to human in the case of treatment for cystic fibrosis.</li> <li>ii. Human to bacterium (insulin production).</li> <li>iii. Transfer to plant species (in the production of genetically modified crops).</li> </ul> <p>Students may be divided into groups and each asked to research one specific example of gene transfer. Students may share the results of their research in a variety of formats. Each example would include the gene origin, gene destination, method of transfer and the nature of the benefit(s) gained.</p>	<p>Human gene therapy:  <a href="http://www.cfgenetherapy.org.uk/gene_therapy/gene_therapy1.htm">http://www.cfgenetherapy.org.uk/gene_therapy/gene_therapy1.htm</a></p> <p>GM crop production animation:  <a href="http://www.cfs.gov.hk/english/programme/programme_gmf/programme_gmf_er_res2.html#">http://www.cfs.gov.hk/english/programme/programme_gmf/programme_gmf_er_res2.html#</a></p> <p>Examples of GM crops:  <a href="http://www.bionetonline.org/english/content/ff_cont3.htm">http://www.bionetonline.org/english/content/ff_cont3.htm</a></p>	

17(s)	Explain that the gene that controls the production of human insulin can be inserted into bacterial DNA.	The insulin gene can be identified and, with the aid of enzymes, isolated from the strand of DNA in the nucleus of a cell from a healthy person. Enzymes are again used to attach it to the DNA of a bacterium. This example will form one aspect included in the task set in 17(r) above.	Production of human insulin: <a href="http://www.abpischools.org.uk/resources/coResourceImport/modules/hormones/en-flash/geneticeng.cfm">http://www.abpischools.org.uk/resources/coResourceImport/modules/hormones/en-flash/geneticeng.cfm</a>	
17(t)	Understand that such genetically engineered bacteria can be used to produce human insulin on a commercial scale.	Culture and extraction of the insulin commercially produced should be explained similarly to that for single cell protein and penicillin in 14(e) of Unit 6.		
17(u)	Discuss potential advantages and dangers of genetic engineering.	Students may use the suggested online resource to prepare one side of the argument in readiness for class debate arguing the pros and cons of genetically engineered food.  The need for development of an overall balanced argument may be stressed by asking each student, following the class debate, to write for the argument opposing their original position.	Balanced arguments for and against GM foods: <a href="http://www.csa.com/discoveryguides/gmfood/overview.php">http://www.csa.com/discoveryguides/gmfood/overview.php</a>	