Neap:

HSC Trial Examination 2007

Biology

Solutions and marking guidelines

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Section I

Part A

Answer and explanation	Syllabus content and course outcomes
Question 1 **C** It is only in the base pair sequence that each species is different. All other features of DNA are the same across every living species.	9.3.3 H9
Question 2 **D** In DNA, the base pairs are A always with T, and C always with G.	9.3.3 H9
Question 3 **A** In order for the double-stranded DNA molecule to replicate, it must first unwind. Only then can a complementary strand be formed from the original strand's template.	9.3.4 H9
Question 4 **A** Mendel kept careful records of the parents of every offspring. This enabled him to track traits from one generation to the next accurately.	9.3.2 H1, H2
Question 5 **B** According to the theory of punctuated equilibrium, there are short bursts of rapid increase in the diversity of organisms interspersed by longer periods in which little or no increase in diversity is observed.	9.3.4 H10
Question 6 **B** Structure X is a neuron. Muscles and glands are effectors. Receptors are structures that detect changes (usually found in tissues like the skin). Red blood cells are found in the blood.	9.2.1 H6
Question 7 **C** The root and older parts of the barley plant have a far greater accumulation of salt than any other part of the plant.	9.2.3 H6, H14
Question 8 **D** Amino acid chains is correct, but the best answer is three-dimensional proteins. Carbohydrates and hormones are incorrect.	9.2.3 H6
Question 9 **A** The renal artery brings unfiltered blood to the kidney. The renal vein returns filtered blood to the body. The medulla is the region where the Loop of Henle and collecting duct of the nephron are found.	9.2.3 H6
Question 10 **A** The pulmonary veins transport oxygenated blood back to the heart, so **B**, **C** and **D** are incorrect.	9.2.2 H6
Question 11 **D** The other three options are all important for the proper functioning of cells.	9.4.1 H6
Question 12 **B** Pasteur's famous experiment. Microbes couldn't enter the broth as they couldn't pass through the S-bend.	9.4.3 H6
Question 13 **A** The microbe needs to be isolated then grown in pure culture injected into a healthy host and then re-isolated and identified as the original microbe.	9.4.3 H6
Question 14 **C** Quarantine is isolation to prevent the spread of a contagious disease.	9.4.7 H5
Question 15 **B** Lung cancer, scurvy and haemophilia are not caused by pathogens.	9.4.6 H6

Part B

Sample answer	Syllabus content, course outcomes and marking guide
Question 16	
(a) The other stage of homeostasis counteracts changes from the stable state.	9.2.1 H6 • Correctly states that the other stage of homeostasis counteracts changes from the stable state 1
(b) Homeostasis is the process by which organisms maintain a relatively stable internal environment, by detecting, regulating and controlling changes from the stable state.	9.2.1 H6 • Correctly describes the process of homeostasis . . . . . 2 • Correctly states or outlines the process of homeostasis 1
Question 17	
Cause: Metabolic reactions within living cells can occur only when water is present as the solvent. Furthermore, all ions and many molecules that are vital for effective functioning of living cells are transported as an aqueous solution, in order to diffuse around the cell where required. Effect: If the concentration of water in cells should change significantly from the set narrow range, cells would not function optimally and would ultimately die.	9.2.3 H6 • Correctly explains why the concentration of water in cells should be maintained within a narrow range for optimal function, by correctly linking the cause to the effect . . 3 • Correctly states why the concentration of water in cells should be maintained within a narrow range for optimal function, by correctly describing the cause and the effect, with no link between cause and effect . . . 2 • Correctly states why the concentration of water in cells should be maintained within a narrow range for optimal function, by stating either the cause **or** the effect 1

Part B (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
Question 18	
(a) Adaptation: Large ears of the bandicoot. Cause: Metabolic reactions within living cells can occur only when temperature is in its optimal range for that cell, because enzymes within cells (necessary to catalyse metabolic reactions), only function within very narrow temperature limits. Effect: Therefore, if the temperature of cells should change significantly from the set narrow range, cells would not function optimally and would ultimately die because enzymes would become denatured. The bandicoot uses the large surface area of its ears to remove excess heat from its cells and thus regulate the temperature of its cells.	9.2.1 H6, H7 • Correctly names **one** adaptation in an Australian organism that assists in temperature regulation and correctly explains why it is important for cells to regulate temperature. Cause and effect are linked . . . . . 3 • Correctly names **one** adaptation in an Australian organism that assists in temperature regulation and correctly describes the importance for cells to regulate temperature. Cause and/or effect are/is given, but may not be linked . . . . . 2 • Correctly names **one** adaptation in an Australian organism that assists in temperature regulation. OR • Correctly describes the importance for cells to regulate temperature. Correct cause OR effect given. 1
(b) 1. Collect a thermometer or temperature sensor to determine and record the temperature of the butterfly enclosure over a 10-minute period. Data-logging technology could be used to record temperature more accurately. 2. Count and record the number of stationary and active butterflies in the enclosure. 3. Observe and record the wing orientations of the stationary and active butterflies in the enclosure over the 10-minute period. Video recording technology could also be used to observe and record wing orientations more accurately. 4. Repeat steps 1–3 above at the same time, three times a day, over six months. 5. Calculate averages to determine whether the wing orientation of stationary butterflies differs from the wing orientation of active butterflies. *(Note: It is known that the butterflies only become active when the enclosure temperature is 26–27°C. Therefore, if particular wing orientations of stationary butterflies are preferred when the temperature of the butterfly enclosure was below 26°C or above 27°C, then it could be concluded that wing orientation of stationary butterflies does assist in temperature regulation.)*	9.2.1 H11, H12, H13, H15 • Identifies the main features of the method for an appropriate investigation. • States a clear, logical method for determining whether wing orientation of stationary Australian Lurcher butterflies assists in temperature regulation. • Identifies a suitable way of minimising risks to equipment and/or humans.. . . . . 4 • Identifies some of the main features for determining whether wing orientation of stationary Australian Lurcher butterflies assists in temperature regulation.. . . . . 2–3 • Makes some correct statements relating to the method.. 1

Part B (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
Question 19	
(a) pulse oximeter OR arterial blood gas (ABG) analyser	9.2.2 H3 • Correctly states the name of a current piece of technology that allows measurement of oxygen saturation in the blood. 1
(b) Pulse oximeters may be used • for monitoring oxygenation and pulse rates throughout anaesthesia and sedation, e.g. for procedures such as endoscopy; • during mechanical ventilation in intensive care; or • as a guide for weaning from ventilation and also to help assess whether a patient's oxygen therapy is adequate. Cause: During the conditions described above, patients need monitoring to ensure their blood oxygen saturation is always above 95%. Effect: If blood oxygen saturation falls below 95%, a patient would become hypoxic (deficiency of oxygen reaching the body tissues) and cyanotic (bluish discolouration of the skin). This could lead to brain damage and death as respiration could not occur in the body's cells.	9.2.2 H3, H4, H6 • Correctly describes the conditions under which this technology is used. AND • Correctly explains the conditions under which this technology is used (linking cause to effect) . . . . . 4 • Correctly describes at least one condition under which this technology is used. AND • Correctly explains the conditions under which this technology is used (linking cause to effect) . . . . . 3 • Correctly describes at least one condition under which this technology is used. AND • Correctly states the cause or the effect of using this technology . . . . . 2 • Correctly describes at least one condition under which this technology is used. OR • Correctly states the cause or the effect of using this technology 1

Part B (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
Question 20	
(a) The genotype is the alleles present in an individual for a given gene (e.g. *Aa* or *AA*), and the phenotype is the observable traits of gene expression, (e.g. blue eyes or brown eyes).	9.3.2 H9, H13 • Defines both terms correctly and clearly . 2 • Provides a correct definition for one term only. 1
(b) An individual is homozygous for a genetic trait if only one type of allele is present (e.g. *AA* or *aa*), whereas an individual is heterozygous for a genetic trait if more than one allele is present (e.g. *Aa*).	9.3.2 H9, H13 • Defines both terms correctly and clearly . 2 • Provides a correct definition for one term only. 1
Question 21	
(a) The most direct way to accomplish this would be to mate a true-bred (homozygous) brown mouse with a true-bred (homozygous) black mouse. Such true-bred mice could be obtained by repeated inbreeding of brown and black strains.	9.3.3 H6, H9 • Correctly identifies that the two mice should be homozygous (true-bred). AND • Correctly identifies that the two mice should each exhibit the expression of one of the alleles in question. . . . . 2 • Correctly identifies that the two mice should be homozygous (true-bred). OR • Correctly identifies that the two mice should each exhibit the expression of one of the alleles in question. 1
(b) When true-bred brown and black mice are crossed, the offspring should all be heterozygous. If the offspring are either all brown or black, then it is a case of simple dominance. The phenotype of the offspring is the dominant allele and the colour absent from the offspring is the recessive allele. However, if the phenotype shows both brown and black colour within single individuals of the offspring, there is co-dominance.	9.3.3 H6, H9 • Describes how to identify the outcome of a case of simple dominance. AND • Describes how to identify which allele is dominant and which is recessive. AND • Describes how to identify a case of co-dominance. . . . . 3 • Any two of the above . . . . . 2 • Any one of the above 1

Part B (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
Question 22	
(a) For example: the peppered moth (*Biston betularia*)	9.3.1 H4, H10, H14 • Correctly identifies a species that has changed as a result of changes in its environment. 1
(b) For example: During the Industrial Revolution, an increase in pollution in the peppered moth's environment led to a decrease in the number of lichens on trees and an increase in sooty deposits on the trees. This led to a change in the moth's environment from a light-coloured background to a dark-coloured background.	9.3.1 H4, H10, H14 • Outlines more than one factor or a chain of factors in the environment that caused changes in the species named in part (a) . 2 • Outlines one factor in the environment that caused changes in the species named in part (a) 1
(c) For example: The changes to the peppered moth provide evidence for evolutionary theory by providing a clear example of natural selection in action. As the moth's environment changed from light to dark, the proportion of the population that possessed the dark-colouration increased dramatically from a very small proportion to a majority of the population. These changes in the population occurred because the moth's predators were able to prey upon the light-coloured morphs more easily, thus applying selection pressure against the light-coloured moths. However, it is important to note that no new material was introduced to the moth's genome. The dark-coloured morphs had always been present in the population, but only in small numbers.	9.3.1 H4, H10, H14 • Describes changes in the species over time. AND • Recognises changes in the population as an example of natural selection. AND • Relates changes in the population to evolutionary theory. . . . . 4 • Describes changes in the species over time. AND • Relates the changes to evolutionary theory.3 • Describes changes in the species over time. OR • States changes in the species. AND • Relates changes to evolutionary theory.. . 2 • States changes in the species over time. . 1
Question 23	
For example: The techniques involved in cloning can greatly alter the genetic composition of a population. In cloning, a donor organism's genome is copied into a host individual's cell, usually an egg cell. A process similar to this was used to clone Dolly the sheep in 1996. If widespread in use, these techniques can lead to a population consisting of individuals with the same genetic composition. This may provide some benefits if individuals with desirable traits are selected for cloning. However, problems may arise in that the population may be susceptible to disease or infection by pathogens.	9.3.5 H4, H7, H10 • Provides features of a current reproductive technique. AND • Relates features to the genetic composition of a population. AND • Gives at least one example. . . . . 3 • Any two of the the above . . . . . 2 • Any one of the above 1

Part B (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
Question 24	
All three spread disease, so by practising cleanliness in these areas we limit the spread of pathogens.	9.4.2 H6 • Recognises that all three cause disease. AND • Recognises that maintaining cleanliness stops the spread of disease. 2
	• Recognises that all three cause disease. OR • Recognises that maintaining cleanliness stops the spread of disease 1
Question 25	
• 18 BC – Malaria initially thought to be caused by bad air. • 1820 AD – Quinine used to prevent disease. • 1880 – Laveran observed malarial parasite. • 1898 – Grassi named *Anopheles* mosquito as the carrier of malarial parasite. • 1897 – Ross discovered *Plasmodium* was the protozoan that caused malaria. • 1940 – Chloroquine, the first synthetic anti-malarial drug, used.	9.4.3 H3, H5 • Includes at least four of the list items. AND • Includes a timeline showing dates. 3
	• Includes two or three of the list items. AND • Includes a timeline showing dates. 2
	• Gives some relevant information in no apparent sequence 1

Question 26

• Antibiotics are chemicals that act selectively to kill the pathogen and not the host by interfering with or destroying the cells of the microorganism. • They are ineffective against other pathogens, e.g. viruses. • Initially the TB bacteria would have had some natural resistance by chance and some survived the treatment with antibiotics. • The surviving TB bacteria reproduced. • The surviving TB bacteria passed on their favourable characteristic (resistance to the antibiotic). • Over time the resistant TB became more common in the population. • Without an antibiotic to treat TB, very ill people will have no ability to fight the disease themselves (e.g. AIDS patients). • Judgement – imperative to develop new antibiotics so as to have a way of combating the disease.	9.4.3 H4, H8 • Correctly identifies what an antibiotic is and how it works. AND • Correctly identifies how antibiotic resistance occurs. AND • Outlines the risks if there were no antibiotics available to treat people. AND • Assesses the situation. . . . . 7–8 • Correctly identifies what an antibiotic is and how it works. AND • Correctly identifies how antibiotic resistance occurs. AND • Outlines the risks if there were no antibiotics available to treat people. . . . . 5–6 • Correctly identifies what an antibiotic is and how it works. AND • Outlines the risks if there were no antibiotics available to treat people. . . . . 3–4 • Correctly identifies what an antibiotic is and how it works. OR • Outlines the risks if there were no antibiotics available to treat people. 1–2

Part B (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
Question 27	
• Use a sterilised swab to collect sample from chicken stored at 65°C for one hour and transfer to sterilised nutrient agar plate. • Use a sterilised swab to collect sample from chicken stored at 30°C for one hour and transfer to sterilised nutrient agar plate. • Use a sterilised swab to collect sample of sterilised water and transfer to agar plate. • Incubate both plates at the same temperature (e.g. 30°C) for the same (and a suitable) period of time. • Repeat the experiment a number of times and average the results. • Do not open the plates as they could contain bacteria that are harmful to humans.	9.4.2 H11 • Recognises that valid experiments need to have a control set-up. AND • Recognises that a reliable experiment needs to be repeated. AND • Designs a suitable method to test the shopkeeper's idea. AND • Recognises the importance of safety in the design of the experiment. . . . . 4 • Any three of the above. . . . . 3 • Any two of the above. . . . . 2 • Any one of the above. 1
Question 28	
(a) For example, intact skin or mucous membranes.	9.4.5 H6 • Correctly states one of the first-line barriers. 1
(b) If an antigen passes through the first and second lines of defence, then the third line (B and T cells) will be sensitised.	9.4.5 H6 • Correctly identifies that barriers have been passed and that now the immune response needs to act. 1
(c) Cause: An antigen has entered the body which sensitises the T cells and B cells. Effect: T cells differentiate into helper T cells and killer T cells. Killer T cells act directly on the antigen to perforate its cell wall and cause cell lysis. Helper T cells release chemicals (e.g. interleukin or lymphokines), or help cause differentiation of B cells into plasma cells (via cell contact) to release antibodies which when in contact with an antigen form an antigen/antibody complex which renders the antigen harmless.	9.4.5 H6 • Recognises that antigens stimulate B and T cells. AND • Correctly describes the mechanism for interaction between B and T cells. AND • Correctly describes the differentiation of T cells. AND • Correctly describes the differentiation of B cells. . . . . 4 • Any three of the above . . . . . 3 • Any two of the above . . . . . 2 • Any one of the above 1

Section II

Question 29 Communication

		Sample answer	Syllabus content, course outcomes and marking guide
(a)	(i)	Any two of: The lens bends light onto the retina to focus the image. The iris allows light to pass through the eye by controlling the size of the pupil. The cornea initially bends light entering the eye. The retina contains photoreceptors for vision.	9.5.2 H6 • Gives any two structures of the eye, with the appropriate functions. . . . . 2 • Gives one structure of the eye, with the appropriate function. 1
	(ii)	This is due to binocular vision where the eyes have slightly different but overlapping views. The image into each eye will be at a different distance from each fovea. The two images sent to the brain are composed, giving depth perception.	9.5.3 H6 • States that binocular vision is responsible for depth perception. AND • Mentions the overlap of the eyes. AND • States that two images go to the brain . . . 3 • Any two of the above. . . . . 2 • Any one of the above 1
(b)	(i)	We used a lamb's brain (or another suitable model of a mammalian brain) and viewed the external area with reference to notes/texts/the internet, which allowed us to distinguish each area of the brain. We distinguished the three areas of the brain and identified how they are different. We located the areas of speech, sight and sound perception. The experiment was reliable, because it was repeated within our class. The experiment was valid, because the procedure answered the aim. The experiment was safe, as we took care with the scalpels so as to not cut ourselves.	9.5.7 H11 • Includes an appropriate description of the experiment. AND • Mentions the validity of the experiment. AND • Mentions the reliability of the experiment. AND • Mentions a safety precaution . . . . . 5 • Gives a good description of the experiment. AND • Includes two of the other points above. . . 4 • Gives a brief description of the experiment. AND • Includes two of the other points above . . 3 • Gives a brief description of the experiment. AND • Includes one of the other points above . . 2 • Includes one relevant part of the procedure. 1
	(ii)	We observed the folded nature of the cerebrum. This increases the internal surface area of the brain. This means that many more nerve connections are possible, as this is the structure involved in thinking, reasoning and sense perception.	9.5.7 H11 • Gives the correct answer. 1

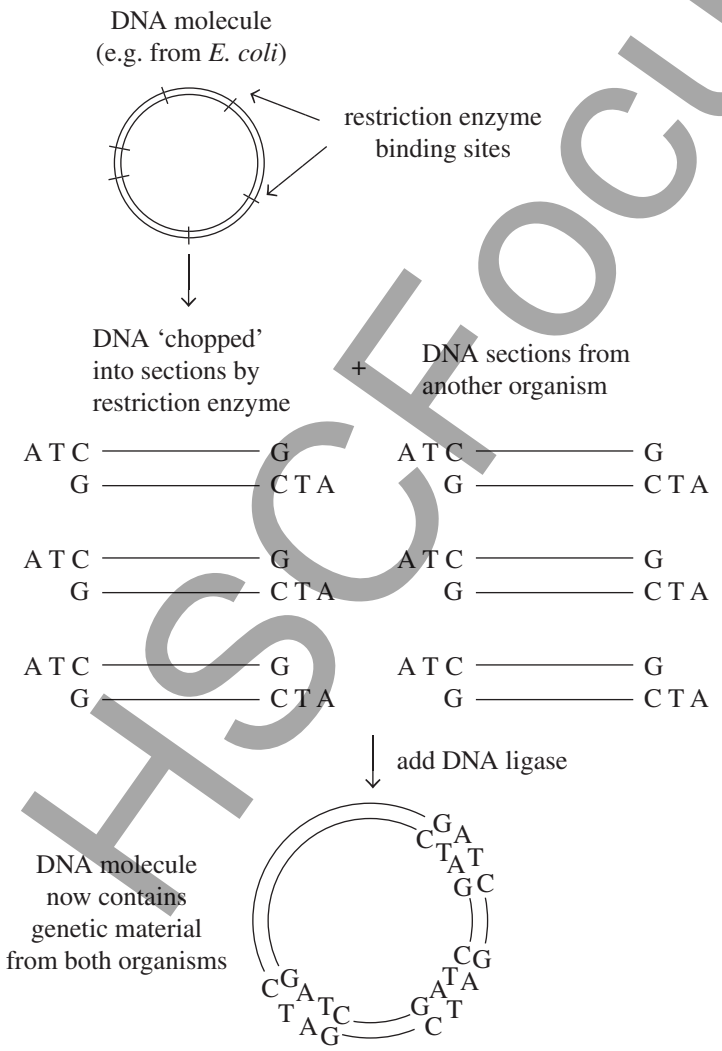
Question 29 Communication (Continued)

	Sample answer	Syllabus content, course outcomes and marking guide
(c)	Hearing aids amplify sound, then the sound waves still travel through the normal auditory pathway. Hearing aids are used when the normal pathway is functioning, but when age or industrial deafness has affected areas outside the middle ear. Hearing aids can be used at any age, are relatively cheap and are available in lots of different varieties. Cochlear implants use a speech processor and an implant to electrically stimulate nerves of the cochlea. Cochlear implants are useful when the middle ear ossicles have been affected and can therefore be bypassed with the implant. Cochlear implants are most effective when inserted at a very young age and are very expensive. Both have provided assistance for people with hearing difficulties, allowing them to be able to be independent.	9.5.6 H3, H4 • Gives a detailed description of hearing aids and cochlear implants and makes a judgement. . . . . 6–7 • Gives a description of hearing aids and cochlear implants and makes a judgement. . . . . 4–5 • Gives a description of hearing aids and cochlear implants. . . . . 2–3 • Gives some brief information about hearing aids or cochlear implants 1
(d) (i)	bat	9.5.6 H6 • Gives the correct answer 1
(ii)	pinna → ear canal → eardrum → ear ossicles → oval window → fluid of cochlea → hair cells → auditory nerve → brain	9.5.6 H6 • Gives correct answer in a flow chart . . . . 2 • Gives the correct answer with no flow chart 1
(iii)	Hair cells vibrate on the organ of Corti, transmitting impulses to the auditory nerve. The hair cells closest to the oval window detect high-frequency sounds (20 000 Hz) and those furthest from the oval window detect low-frequency sounds (20 Hz).	9.5.6 H6 • Mentions the hair cells vibrating on the organ of Corti. AND • Correctly identifies where high-frequency sounds are detected. AND • Correctly identifies where low-frequency sounds are detected. AND • Mentions information being sent to the auditory nerve. . . . . 4 • Any three of the above . . . . . 3 • Any two of the above . . . . . 2 • Any one of the above 1

Question 30 Biotechnology

		Sample answer	Syllabus content, course outcomes and marking guide
(a)	(i)	Biotechnology is a process or product that was developed using another living organism to meet human needs.	9.6.2 H13 • Gives a definition which is linked to the adaptation of the general definition (this indicates true understanding). 1
	(ii)	For example: Carbon dioxide was made by using yeast. The aim was to make bread using the fermentation of yeast. First, yeast organisms were placed in a bread mix and this was left for several hours at room temperature. Then the bread was cooked. When the mix was at room temperature, the yeast converted sugar to carbon dioxide and alcohol. The carbon dioxide expanded and moved out of the bread as it cooked. This left spaces which make the bread lighter and more easily eaten. Conclusion: The yeast helped meet a need.	9.6.2 H12 • States the aim of the experiment. AND • Accurately describes the method. AND • Draws a valid conclusion. . . . . 4 • States the aim of the experiment. AND • Makes some attempt at describing the method. AND • Makes some attempt at drawing a conclusion. . . . . 3 • States the aim of the experiment. AND • Makes some attempt at describing the method. . . . . 2 • Makes some attempt at describing the method. 1
(b)	(i)	More corn cobs in the 2007 crop are longer than in the 1998 crop. The total number of the sweet corn cobs in the crop has not increased over the last nine years. Cob length has not increased beyond 34 cm over the last nine years. *Note: This is a 'back yard' experiment with small samples. Statistical analysis was not carried out.*	9.6.1 H14 • Mentions that more corn cobs are now longer. AND • Mentions that the total number of cobs has not changed. AND • Mentions that the maximum length is not above 34 cm. . . . . 2 • Mentions that more corn cobs are now longer. 1
	(ii)	artificial selection	9.6.1 H13 • Names the correct practice. 1
	(iii)	Two factors can govern the length of corn cobs: the environment (controlled here) and genetics. Mr. Jones harvested the seed from the cobs that were longest and the next season he only planted seed that came from the longest cobs. Mr. Jones repeated this process for nine years. By artificially selecting breeding stock with long cobs, he eventually increased the average length of the sweet corn cobs in his crop.	9.6.1 H13 • Includes the selection of seeds from long cobs. AND • Mentions repetition. AND • Gives a summary of the process, including the result. . . . . 3 • Any two of the above. . . . . 2 • Any one of the above. 1

Question 30 Biotechnology (Continued)

		Sample answer	Syllabus content, course outcomes and marking guide
(c)	(i)	Changing either the microorganism or the substrate that the organism acts on can result in a variety of different products. For example, when yeasts ferment sugar in the presence of sulfite, the yeast produces glycerol instead of carbon dioxide and ethanol. Glycerol can now be cheaply manufactured in large quantities. It is used in explosives, textiles, paints, foods and pharmaceuticals.	9.6.3 H13 • Describes the process (simply naming the process is not sufficient). AND • Explains how the change has improved production . . . . . 2 • Any one of the above. 1
	(ii)	For example: Human insulin can now be synthesised by bacteria in large quantities, so more diabetics can use it. This has replaced the need for porcine or ovine insulin. Human insulin is preferable to animal-derived insulin which can cause side-effects such as inflammation. OR The use of animal by-products is unacceptable to some people on ethical grounds.	9.6.6 H3 • Correctly describes the technology. AND • Correctly describes the benefit of the technology. . . . . 2 • Any one of the above. 1
	(iii)		9.6.5 H9 • Shows restriction enzymes cutting DNA leaving sticky ends. AND • Shows ligase joining pieces of DNA together at sticky ends. AND • Indicates that scientists can use these two enzymes to cut out genes and place them into other DNA. . . . . 3 • Any two of the above. . . . . 2 • Any one of the above. 1

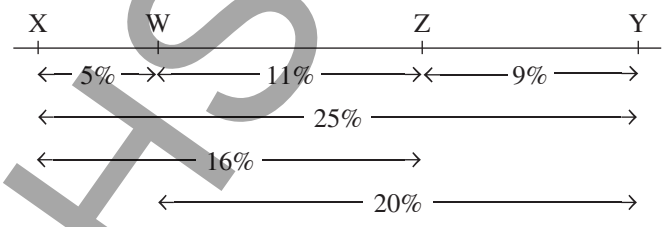
Question 30 Biotechnology (Continued)

	Sample answer	Syllabus content, course outcomes and marking guide
(d)	For example: Genetically modified organisms (GMOs) are those that have received foreign DNA (genetic material) into their genome. Bt cotton has had a gene that produces a pesticide inserted into its genome. When an insect eats the leaves of Bt cotton it dies. The transfer of genetic material from one species to another may be a problem because • the gene may have a secondary effect which may be detrimental to the organism. If the Bt gene caused infertility in the cotton plant, the cotton would not flower and the crop would not be economical; and • through cross-fertilisation, the gene may be passed into a new species where it is not wanted or it has detrimental secondary effects. If the Bt gene were passed on to plant pests through cross-pollination, natural control of the plant pests by insect populations might be reduced. The long term effects have usually been thoroughly investigated before the release of the GMO. • Before scientist release a GMO, many generations of the GMOs have been grown to investigate if the gene has secondary effects. • Scientists are developing ways of preventing the transfer of recombinant DNA from one species to another, such as introducing a male sterility gene into genetically modified organisms or limiting opportunities for cross-pollination and breeding between GMOs and non-GMOs. GMOs usually have benefits to humans such as increased yield/quality or reduction in the time and cost of production. At a time when thousands are dying of starvation, it is humanitarian to produce more food, more quickly. GMOs may hold the answer to problems like this. I believe we must use these biotechnologies.	9.6.7 H4 • Describes the process of the biotechnology with an example, supports the argument using two pieces of evidence, refutes the argument using two pieces of evidence and concludes the answer with final assessment statement. . . . . 6–7 • Describes the process of the biotechnology with an example, supports the argument using one piece of evidence, refutes the argument using one piece of evidence and concludes the answer with final assessment statement. . . . . 4–5 • Briefly describes the process of the biotechnology with an example. AND • Supports the argument using one piece of evidence. OR • Refutes the argument using one piece of evidence. OR • Concludes the answer with final assessment statement. . . . . 2–3 • Briefly describes the process of the biotechnology with an example. 1

Question 31 Genetics – The Code Broken?

		Sample answer	Syllabus content, course outcomes and marking guide
(a)	(i)	Germ line mutations have the potential to affect changes within the species (evolutionary change), since they will be passed on to the next generation. Somatic mutations, in most cases, do not result in species change as they will only affect the individual organism.	9.7.6 H9 • Provides features of germ line mutations and somatic mutations to distinguish between the two types of mutation. . . . . 2 • Provides features of either germ line mutations or somatic mutations. 1
	(ii)	Base addition and base substitution are two different types of mutation that can occur in DNA. Both involve the change of only a single nucleotide, but their effects can be vastly different. In base addition, an extra nucleotide is added to the DNA sequence, resulting in all base triplets beyond the mutation to be misread by one location. This is called a frameshift mutation and results in a dysfunctional polypeptide if the mutation is early in the reading sequence. Conversely, base substitution involves an incorrect nucleotide to be inserted into a location in the DNA sequence. This only affects the base triplet in which the mutation occurred and may have no net resultant effect in the polypeptide (due to built-in redundancies in the codes for amino acids).	9.7.6 H9 • Names two types of mutation. AND • Provides features of effects of each type of mutation. . . . . 3 • Names two types of mutation. AND • Provides features of effects of one type of mutation only. . . . . 2 • Names two types of mutation. 1
(b)	(i)	I constructed a DNA model using toothpicks to join together pink marshmallows (sugar), white marshmallows (phosphate) and jelly beans (bases). The marshmallows were joined together to construct the DNA backbone of sugar-phosphate and the jelly beans were added in the middle of the structure to form the base pairs. The jelly beans were also colour coded: red for adenine, green for thymine, yellow for guanine and purple for cytosine. Together, this was assembled into a three-dimensional model, including a full twist of the double helix. From this model, it was possible to visualise the overall structure of the DNA molecule, and to gain a better understanding of features such as the base pairing of A–T and C–G. However, as it was a simple model, it was also limiting, since the actual complexity of the molecular arrangement (especially of the bases) is much greater.	9.7.1 H9, H11, H12 • Provides detailed features of procedures used in DNA model. AND • States more than one feature of the findings obtained.. . . . . 5 • Provides features of procedures used in DNA model. AND • States more than one feature of the findings obtained.. . . . . 4 • Provides features of procedures used in DNA model. AND • States one feature of the findings obtained.3 • Provides features of procedures used in DNA model. AND • States a feature of the findings obtained. OR • States some features of the procedure used2 • States some features of the procedure used. OR • States a feature of the findings obtained.. 1

Question 31 Genetics – The Code Broken? (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
(ii) From this model, it was easy to see the arrangement of the base sequence in triplets (each of which codes for one amino acid) and how the sequence of triplets can be arranged within a single region of DNA to make one gene.	9.7.1 H9, H11, H12 • Provides a feature of gene structure related to the DNA molecule. 1
(c) The Human Genome Project (HGP) began in 1990 with the aim of sequencing the DNA of the human genome. By 2000, the first rough draft of this sequence was complete. Scientists had developed sophisticated analytical equipment that automated the process of reading the base sequence of the DNA, speeding up the entire process and diminishing error rates. The HGP was a major undertaking, often referred to as 'big science', as laboratories in some 18 different countries all contributed to the task at great cost and investment. Using the data from the HGP will inevitably further the causes of modern medicine. Doctors and researchers will be able to find and identify disease-causing and dysfunctional genes within the human genome, be able to detect these at an early age and remedy the situation even before a patient has exhibited any symptoms. In addition, understanding the genetic causes of some diseases may aid directly in their treatment, or even their diagnosis. There exists, however, the possibility of exploiting the knowledge generated by the HGP for unethical reasons. It is not difficult to imagine a scenario where individuals are excluded from certain jobs and lifestyles based only on the early identification of a predisposition to a certain disease. On balance, it appears that the benefits to mankind will far outweigh any potential risks if the right checks and balances are implemented to regulate the use of the knowledge gained from the HGP.	9.7.4 H1, H3, H4, H5, H9 • Describes features of the Human Genome Project. AND • Provides a clear link between the Human Genome Project and modern medicine. AND • Gives a clear judgement of the value of the Human Genome Project based on criteria given in the answer. . . . . 6–7 • Describes features of the Human Genome Project. AND • Provides a clear link between the Human Genome Project and modern medicine. AND • Makes some attempt to provide a judgement. (Criteria may/may not be present.) . . . 4–5 • Describes features of the Human Genome Project. AND • Makes some attempt to provide a link between the Human Genome Project and modern medicine with limited success. 2–3 • States features of the Human Genome Project. 1
(d) (i) The percentages are a direct indication of the distance between the genes on the chromosome. A 1% recombination rate is equal to one centimorgan's distance on the chromosome.	9.7.3 H4, H9, H14 • Identifies that the percentages are related to the distances between the genes. 1
(ii) Sample answer:  	9.7.3 H4, H9, H14 • States the correct order of the genes. AND • Gives results as a chromosome map, with distances correctly marked out between the genes. . . . . 2 • States the correct order of the genes. 1

Question 31 Genetics – The Code Broken? (Continued)

	Sample answer	Syllabus content, course outcomes and marking guide
(iii)	By mapping the different genes in different organisms, it is possible to infer a degree of relatedness based on the degree of similarity in their chromosome maps. If, for instance, it is found that on chromosome 1 of three different species a sequence of genes A, B, C and D are all found in the same order, with the same functions and the same distance apart on the chromosome, it is possible to draw the conclusion that this gene sequence implies a degree of relatedness among the three different species. When viewed across the entire genome, these maps can provide an indication of how closely related different species are. Species' relationships can also be investigated by examining chromosome number, but several species belonging to the same family or even genus may possess different numbers of chromosomes (e.g. *Drosophila* fruit fly). At first glance, this may indicate that the organisms are not directly related. However, inspection of chromosome maps often reveal that the difference in chromosome number can be explained by the fusion of non-homologous chromosomes in one or more of the species in the past, as evidenced by the presence of similar/same genes at various locations across the organisms' genomes. However, chromosome maps alone are not sufficient in determining the relatedness of two species. Rather, it is only one tool among several that can be used. To rely only on chromosome maps may lead to distorted perceptions of how closely related two species are when other factors are not considered. If chimpanzees were found to have a gene sequence very similar to one identified in starfish, it does not necessarily mean that the two organisms are closely related. Therefore, used in conjunction with other indicators and tools, it is possible to use chromosome maps to determine the degree of relatedness among different species.	9.7.3 H4, H9, H14 • Describes features of chromosome mapping in relation to an example. AND • Provides issues and points for and against using chromosome maps in identifying relationships between species. . . . . 4 • Describes features of chromosome mapping. AND • Provides an issue and points for OR against using chromosome maps. . . . . 3 • States features of chromosome mapping OR an example of chromosome mapping. AND • Provides an issue OR a point for using chromosome maps OR a point against using chromosome maps. . . . . 2 • States a feature of chromosome maps. OR • States an example. 1

Question 32 The Human Story

		Sample answer	Syllabus content, course outcomes and marking guide
(a)	(i)	Chordates: possesses a notochord and a dorsal nerve tube. Mammals: hair or fur, mammary glands, four types of teeth, diaphragm, cerebrum and cerebellum, four-chambered heart, endothermic. Primates: opposable thumb, flattened nails, fingerprints.	9.8.1 H10, H13, H14 • States two features from two of the following groups: chordates, mammals, primates. • Identifies data sources. • Explains the validity of data sources. . . . 3
			• States two features from two of the following groups: chordates, mammals, primates. • Identifies data sources. 2
			• States one feature from the following groups: chordates, mammals, primates. OR • Identifies data sources 1
	(ii)	Hominid features: arms shorter than legs, thumb opposing all digits in hand only, larger brain, bipedal. The hominid family is separate to the ape family (pongins). Hominine family features: four fingers and opposable thumb on hand, collarbone, menstrual cycle, single uterus, breeding groups with elaborate maternal care, poor sense of smell, well-developed stereoscopic colour vision, no tactile hairs on nose, slow growth rate, i.e. includes gorillas, apes and humans with the hominid features now described the hominin tribe. Hominin is more likely, due to close genetic relationships between members of this family.	9.8.1 H2, H10, H11, H12 • Lists two features of hominins. • Lists two features of hominids. • Compares family relationships. 2
			• Lists one feature of hominins. OR • Lists one feature of hominids. OR • Explains family relationships. 1

Question 32 The Human Story (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
(b) (i)	9.8.5 H10, H13, H14 • Gives a table with appropriate column and row headings. • Compares humans and apes, including any four of the features shown 5

Feature	*Great ape*	*Human*
length of the juvenile stage	juvenile stage: from 7 to 8 years of age	juvenile stage: from 15–18 years of age
development and use of tools	simple tools, not essential to survival	highly sophisticated tools used to make other tools tools essential to survival
communication systems	wide repertoire of facial expressions; noises used to assert dominance, but no speech	speech, language, facial expression and body posture
development and size of the group	one dominant male; stable family group; several females and young adults; territorial; brief sexual encounters	monogamous; prolonged sexual relationships; stable family groups
care of the young	infant carried until 2.5–3 years of age	infancy up to 6 years of age

	• Gives a table with appropriate column and row headings. • Compares humans and apes, including any three of the features shown. 4
	• Gives a table with appropriate column and row headings. • Compares humans and apes, including any two of the features shown. 3
	• Gives a table with appropriate column and row headings. • Compares humans and apes, including any one of the features shown. 2
	• Gives a table with appropriate column and row headings. OR • Compares humans and apes, including any one of the features shown. 1
(ii) For example: The longer juvenile stage in humans allows older generations to pass on their accumulated wisdom and knowledge to the young, thus improving survival.	9.8.5 H10, H13, H14 • Assesses the evolutionary significance of any one of the features described in (b)(i).1

Question 32 The Human Story (Continued)

	Sample answer	Syllabus content, course outcomes and marking guide

(c)	Some of the benefits of modern medicine include vaccination against disease, balanced diet, surgical organ replacement and antibiotic treatment for bacterial infections.
	Genetic engineering has led to gene therapy for treating diseases, and stem cells for replacing organs.
	Human ancestors survived because they were genetically fit. The factors being discussed have changed the way in which evolution should eliminate weaker members of the species.
	Positive influences on evolution
	• Increased population mobility has mixed genes from different races causing more variation in the phenotype improving chances of survival;
	• Improved medicine has eliminated some diseases and kept many others under control. This has provided longer lifespans and improved rates of reproduction;
	• Improvements in genetic engineering have led to replacement organs becoming less likely to be rejected by the immune system, and cures for inherited diseases.
	Negative influences on evolution
	• The mixing of genes from improved population mobility have made organ and blood matching more difficult. This affects survival of very ill people with failing organs.
	• Improved medicine has allowed people who would normally have died to survive and live longer. This puts more strain on scarce resources such as water and food, causing survival problems for poorer people.
	• Improved genetic engineering has led to the possibility of cloning people. Less variation in a species reduces survival rates.
		9.6.1 H1, H10, H13, H14
		• Assesses three effects and gives two examples from **each** of the following.
		  • the effect of modern medicine on human evolution;
		  • the effect of genetic engineering on human evolution;
		  • the effect of increased population mobility on human evolution. 7
		• Assesses three effects and gives a total of five examples. 6
		• Assesses three effects and gives a total of four examples. 5
		• Assesses two effects and gives a total of three examples. 4
		• Describes two effects and gives one example.
		OR
		• Describes one effect and gives two examples. 3
		• Describes or gives two examples. 2
		• Describes one effect or gives one example 1

(d) (i)	The 'out of Africa' hypothesis suggests that there were two waves of human migration from Africa, *Homo erectus* and later *Homo sapiens*. The 'multi-regional' hypothesis suggests that humans evolved all over the world at the same time from different groups of *Homo erectus* (the first wave of migrants form Africa).	9.8.3 H10, H13, H14 • Identifies the main difference between the two hypotheses. 1
(ii)	The 'multi-regional' hypothesis claims that different racial groups support the idea of multiple evolutionary events. However the 'out of Africa' hypothesis is more likely. Dating of human remains in various places around the world suggests that the older the fossil remains the closer they are found to Africa, with fossils becoming progressively younger away from Africa.	9.8.3 H10, H13, H14 • Describes evidence of the patterns of human migration. • Outlines two or more reasons why one hypothesis is most likely . . . . . 2 • Describes evidence of the patterns of humans migration. OR • Describes evidence that supports one hypothesis 1

Question 32 The Human Story (Continued)

	Sample answer	Syllabus content, course outcomes and marking guide
(iii)	Studies of mitochondrial DNA (mDNA) have shown greater diversity in the mDNA in modern African people. All mDNA tested in peoples around the world have been shown to be subsets of the African genome. This suggests that the parent genome is the African set, thus supporting the 'out of Africa' hypothesis.	9.8.2, 9.8.3 H1, H2, H4, H12, H14 • Describes evolutionary processes which lead to the development of new species. • Describes how mitochondrial DNA differs in different regions. • Describes the significance of the differences in mitochondrial DNA. 4
		• Describes evolutionary processes which lead to the development of new species. • Describes how mitochondrial DNA differs in different regions. 3
		• Describes evolutionary processes which lead to the development of new species. • Describes mitochondrial DNA. 2
		• Describes evolutionary processes which lead to the development of new species. OR • Describes mitochondrial DNA. 1

Question 33 Biochemistry

		Sample answer	Syllabus content, course outcomes and marking guide
(a)	(i)	Blackman and Mathgel stated that when light was unlimited, a light-dependent reaction was proceeding (step 1). At the same time, a non-light dependent reaction (dependent on carbon dioxide concentration) was proceeding at a faster rate (step 2).	9.2.3 H6 • Correctly states both steps . . . . . 2 • Correctly states one step 1
	(ii)	Robert von Mayer discovered the law of conservation of energy. By studying earlier investigations (e.g. Ingen-Housz's demonstration of the importance of sunlight for oxygen production in plants) and using his newly found law, he was able to state that plants trap light energy and convert it into chemical energy. This led him to the development of the equation $CO_2 + H_2O \rightarrow O_2 + CH_2O$ (CH_2O represents organic matter containing chemical energy.)	9.2.2 H6 • Mentions von Mayer's law of conservation of energy. AND • Gives one example of an earlier investigation. AND • Includes the equation that von Mayer developed. . . . . 3 • Any two of the above. . . . . 2 • Any one of the above. 1

Question 33 Biochemistry (Continued)

		Sample answer	Syllabus content, course outcomes and marking guide
(b)	(i)	Step 1 Approximately 5 grams of finely chopped spinach was placed in a test tube and covered with 5 mL of ethanol. The spinach was carefully mashed in the solvent using a glass rod, making sure all of the chopped pieces were submerged. The test tube was tightly stoppered and the spinach allowed to soak for 30 minutes in a dark place. Step 2 The green solution was placed into another test tube. Light was shone through the solution and the spectrum observed with a spectrophotometer. The spectrum viewed when light passed through the chlorophyll was compared with the spectrum of light only. Step 3 A Pasteur pipette was used to drop the chlorophyll extract about 2 cm from the end of a strip of chromatography paper. Each drop was allowed to dry before adding another, until a well-coloured spot was achieved. Step 4 A small amount of ethanol (about 1.5 cm) was placed into the bottom of a gas jar. The chromatography paper was then suspended over a glass rod into the gas jar so that it just barely touched the solvent. It was placed in the dark and left until the solvent had moved up the chromatography paper to approximately 3 cm from the top. Result 1 When light was shone through chlorophyll extract, black bands were observed in the red and blue sections of the spectrum, showing that the extract had absorbed light in the red and blue sections. Result 2 On the chromatogram were distinct green and yellow bands. The green band is a mixture of chlorophyll *a* and chlorophyll *b* and the yellow band is made up of carotenoids.	9.3.9 H6, H11, H12, H14 • Correctly describes all four steps. AND • Correctly describes both results. . . . . 5 • Correctly describes three of the four steps. AND • Correctly describes both results. OR • Correctly describes all four steps. AND • Correctly describes one result. . . . . 4 • Correctly describes one or two of the four steps. AND • Correctly describes both results. OR • Correctly describes three of the four steps. AND • Correctly describes one result. OR • Correctly describes all four steps. AND • Does not describe the results. . . . . 3 • Does not describe any of the steps. AND • Correctly describes both results. OR • Correctly describes one or two of the four steps. AND • Correctly describes one result. OR • Correctly describes three of the four results. AND • Does not describe the results. . . . . 2 • Correctly describes on or two of the four steps. AND • Does not describe the results. OR • Does not describe any of the steps. AND • Correctly describes one of the results. . . . 1

Question 33 Biochemistry (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
(ii) The action spectrum of photosynthesis does not match that determined by Englemann for chlorophyll. It shows more activity in the areas where chlorophyll reflects light: the wavelengths corresponding to green, yellow and orange light. The significance of other pigments, such as the yellow and orange carotenoids is that they absorb light in these other wavelengths and pass the energy on to chlorophyll. These accessory pigments allow the plant to absorb a broader range of wavelengths than chlorophyll alone and explain why the action spectra of chlorophyll and photosynthesis do not match exactly.	9.3.4, 9.3.5, 9.3.9 H6, H14 • Gives the correct answer 1
(c) Point 1 In the late 19th century, chloroplasts were proposed as the site of photosynthesis and the main features of plant photosynthesis were known (i.e. that plants use light energy to make carbohydrates from carbon dioxide and water). Point 2 The structure of the chloroplast at this stage was only known in relation to how it was viewed under the light microscope (i.e. a disc-shaped organelle containing chlorophyll). The resolution of a light microscope is not high enough. Point 3 By the middle of the 20th century there was an understanding of the biochemistry of photosynthesis (i.e. that there were two stages (a light and a dark) and that oxygen was produced from water in the light stage and carbon dioxide was used to make glucose in the second stage). Point 4 In 1931 Ruska built the first transmission microscope and in 1965 the first scanning electron microscope was developed. As a result, the structure of the chloroplast (photographed by Gaffron and Wahl in 1980–1990) could now be seen to be made up of grana which were stacks of thykaloid membranes, and a soluble non-membranous part between was called stroma. The electron microscope has a much greater resolving power (× 200 000). Point 5 The importance of the development of the electron microscope was that the detail of the chloroplast could be observed and a link could be made between chloroplast anatomy and biochemistry. The advent of the electron microscope meant the picture was more complete. Point 6 We now know that light absorption and the conversion of light energy into chemical energy occurs in the thylakoids and that the Calvin cycle occurs in the stroma.	9.2.1, 9.3.1, 9.8.1 H1, H3, H6, H14 • Gives an answer which covers points 1, 2, 3, 4, 5 and 6.. . . . . 7 • Gives an answer which covers points 5 and 6, as well as three of the other four points . . . . . 6 • Gives an answer which covers points 5 and 6, as well as two of the other four points . . . . . 5 • Gives an answer which covers points 5 and 6, as well as one of the other four points . . . . . 4 • Gives an answer which does not cover points 5 and 6, but which covers three of the other points. . . . . 3 • Gives an answer which covers any two points.. . . . . 2 • Gives an answer which covers one point. 1

Question 33 Biochemistry (Continued)

		Sample answer	Syllabus content, course outcomes and marking guide
(d)	(i)	Van Niel's hypothesis was that water was the source of the oxygen given out in photosynthesis.	9.4.1 H6 • Correctly identifies the hypothesis. 1
	(ii)	Hill and Scarisbruck concluded that when isolated chloroplasts were supplied with light, they did not produce oxygen. When electron acceptors such as potassium ferricyanide were added, then oxygen was produced. Ruben concluded that the ^{18}O was found in the oxygen gas produced by the plant and none in the glucose formed.	9.5.4 H6 • Correctly describes the conclusion drawn by Hill and Scarisbruck, and the conclusion drawn by Ruben. . . . . 2 • Correctly describes the conclusion drawn by Hill and Scarisbruck only. OR • Correctly describes the conclusion drawn by Ruben only. 1
	(iii)	The conclusion drawn by Hill and Scarisbruck and the conclusion drawn by Ruben changed the thinking about photosynthesis in three ways. 1. Previously it was believed that carbon dioxide was the source of the oxygen produced during photosynthesis. It is now known that water is the source. 2. These experiments showed the importance of using isotopes to trace chemical pathways in plants. 3. These experiments led to research on electron acceptors and the discovery that the four electrons from photo system 1 associate with the $4H^+$ from H_2O and are carried to the dark reaction as NADPH and H^+.	9.5.4 H6, H14 • Gives an answer which includes all three points.. . . . . 4 • Gives an answer which includes point 1, and either point 2 or point 3.. . . . . 3 • Gives an answer which includes point 1 only . . . . . 2 • Gives an answer which includes point 2 only. OR • Gives an answer which includes point 3 only. 1