2017 HSC Biology
Marking Guidelines

IMPORTANT: This resource was developed to support a previous version of the syllabus. It may contain content that differs from the current syllabus.

Section I, Part A

Multiple-choice Answer Key

Question	Answer
1	C
2	D
3	D
4	A
5	B
6	C
7	A
8	C
9	A
10	B
11	C
12	B
13	D
14	C
15	D
16	B
17	A
18	C
19	A
20	D

Section I, Part B

Question 21

Criteria	Marks
• Gives correct name for each component	2
• Provides some relevant information	1

Sample answer:

A = Enzyme
B = Substrate

Question 22 (a)

Criteria	Marks
• Names TWO appropriate diseases and a cause for each	2
• Provides some relevant information	1

Sample answer:

Type of disease	*Name of disease*	*Cause of disease*
Infectious disease	Malaria	Plasmodium
Non-infectious disease	Scurvy	Lack of vitamin C

Question 22 (b)

Criteria	Marks
• Relates two appropriate and different methods to the reduction of the risk of infection	4
• Outlines two appropriate and different methods to reduce the risk of infection OR • Identifies two methods to reduce the risk of infection and correctly explains one of the methods	3
• Outlines one method to reduce the risk of infection OR • Identifies two methods to reduce the risk of infection	2
• Provides some relevant information	1

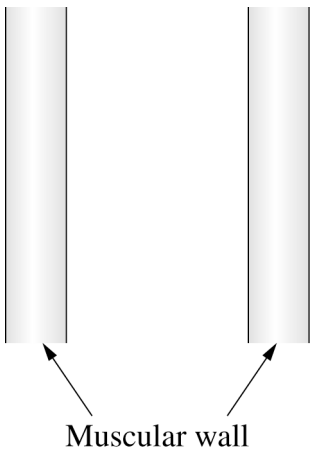
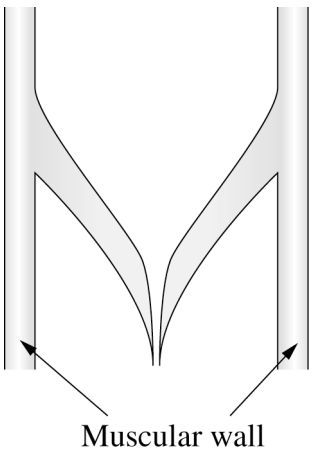
Sample answer:

Two methods that are used to treat drinking water are filtration and chlorination. Filtration reduces the risk of infection as the pathogens are removed, since they are not able to pass through the filter. The addition of chlorine reduces the risk of infection as it kills the pathogens, so they cannot cause disease.

Question 23

Criteria	Marks
• Identifies both vessels correctly • Identifies an appropriate structural feature of each vessel • Explains how each structural feature enables the vessel to carry out its function	5
• Identifies both vessels correctly • Relates an identified structural feature of one of the vessels to its function OR • Identifies the vessels as an artery and a vein • Relates an identified structural feature of each of the vessels to its function	4
• Identifies both vessels correctly • Provides a structural feature of at least one OR • Identifies one vessel as either an artery or a vein • Relates an identified structural feature to the function of that vessel	3
• Identifies both vessels correctly OR • Identifies one vessel and a structural feature OR • Relates a structural feature of one vessel to the function	2
• Provides some relevant information	1

Sample answer:

Diagram of vessel		
Name the vessel	Artery	Vein
Explain how ONE structural feature of the vessel enables it to carry out its function	Arteries have thick muscular walls in order to withstand the high pressure at which blood is pumped from the heart.	Veins have valves to prevent the backflow of blood due to the low pressure once the blood has passed the capillaries.

Question 24 (a) (i)

Criteria	Marks
• Provides correct genotype	1

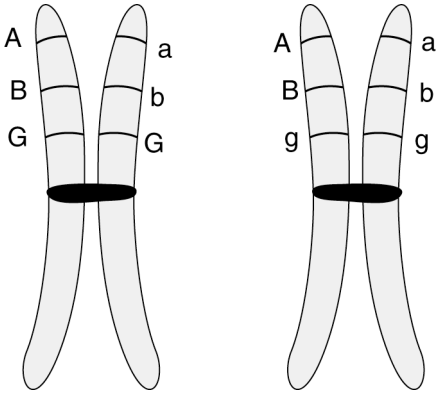
Sample answer:

Aa Bb Gg

Question 24 (a) (ii)

Criteria	Marks
• Provides correct sequence of alleles	1

Sample answer:



Question 24 (b)

Criteria	Marks
• Relates independent assortment to variation of offspring	2
• Provides some relevant information	1

Sample answer:

Independent assortment is the random alignment of homologous chromosomes during meiosis. This increases the number of possible combinations of chromosomes. Therefore, it increases the genetic variation of the offspring.

Question 24 (c)

Criteria	Marks
• States that isolation results in the segregation of the gene pool • Relates the segregation of gene pools to speciation	3
• Provides features of isolation • Makes reference to change in species	2
• Provides some relevant information	1

Sample answer:

When two groups of the same species become isolated from each other, the two groups are not able to reproduce together and therefore there is no mixing of the genes between the two groups. This means that variations and mutations that occur in one group are not necessarily found in the other group. Therefore, over long periods of time, the two populations become different species.

Question 25

Criteria	Marks
• Compares the salt concentration of the external environment and the internal environment of each fish • Explains the difference in the concentration of urine for each organism	4
• Compares the salt concentration of the external environment and the internal environment of each fish • Relates the concentration of urine for one organism to its environment OR • States the urine concentration of each fish • Relates the concentration of urine for one organism to its environment	3
• States the urine concentration for each fish OR • Compares the salt concentration of the external environment and the internal environment of each fish	2
• Provides some relevant information	1

Sample answer:

Marine fish live in an environment which has a higher salt concentration than the concentration inside their cells. This causes them to lose too much water through osmosis. To maintain their internal environment they release very concentrated but small amounts of urine.

Freshwater fish live in an environment which has a lower salt concentration than the concentration inside their cells. This causes too much water to move into their cells through osmosis. To maintain their internal environment they produce large quantities of dilute urine.

Question 26 (a)

Criteria	Marks
• Identifies the independent variable	1

Sample answer:

Substrate concentration.

Question 26 (b)

Criteria	Marks
• Identifies both trends • Relates both trends to enzyme activity	3
• Relates one trend to enzyme activity	2
• Provides some relevant information	1

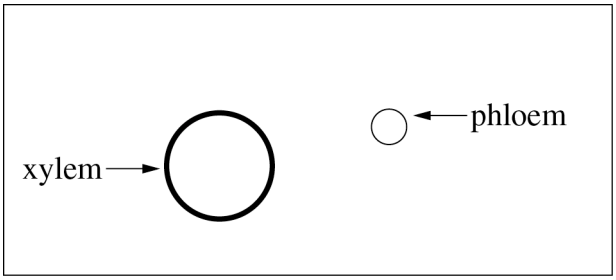
Sample answer:

As the substrate concentration increases, the rate of reaction will increase because more enzyme is available to catalyse the reaction. At higher substrate concentrations the rate of reaction will plateau because no more enzyme is available to catalyse the reaction.

Question 27 (a)

Criteria	Marks
• Draws labelled diagrams distinguishing between transverse sections of xylem and phloem vessels	2
• Provides some relevant information	1

Sample answer:



Question 27 (b)

Criteria	Marks
• Identifies that sugars move through the phloem • Provides characteristics and features of the process involved	3
• Sketches in general terms the process involved in the transport of sugar through the phloem	2
• Provides some relevant information	1

Sample answer:

Sugars produced in the leaves are transported into the phloem by active transport. Water from the xylem then follows by osmosis, which increases the pressure in the phloem. This creates a pressure gradient in the phloem allowing the sugar to move up or down the plant. At the sink, sugars are removed actively.

Question 28

Criteria	Marks
• Identifies the inherited characteristic and relates the genetic analysis to the pedigree chart	3
• Identifies one feature of the characteristic with reference to the pedigree chart	2
• Provides some relevant information	1

Sample answer:

The condition is recessive because III-1 has the condition but neither of the parents have the condition. The condition is sex linked because I-2 does not have the recessive allele and therefore the genotype of I-2 is X^AY. If I-2 was autosomal AA then it would not be possible for II-3 and II-5 to have the condition.

Question 29

Criteria	Marks
• Identifies a disease • Provides characteristics and features of a relevant treatment strategy and a prevention strategy • Supports the change in emphasis from treatment to prevention	5
• Identifies a disease • Provides characteristics and features of a relevant treatment strategy and a prevention strategy • Describes a disadvantage of treatment or an advantage of prevention	4
• Identifies a disease • Provides characteristics and features of a relevant treatment strategy or a prevention strategy • Provides a disadvantage of treatment and/or an advantage of prevention	3
• Identifies a disease • Identifies a relevant treatment or preventative strategy OR • Identifies a disease • Provides an impact on the individual/society	2
• Provides some relevant information	1

Sample answer:

Antibiotics are used to treat diphtheria. However, the misuse of antibiotics has led to problems such as antibiotic resistance. The shift has been to prevent diphtheria using vaccinations rather than treating it after the person has been infected.

With vaccination the immune system is activated and the pathogen is destroyed before the symptoms occur. The use of the diphtheria vaccination would reduce our dependence on antibiotics. This would reduce the monetary and social cost to society.

Question 30 (a)

Criteria	Marks
• Identifies one type of T cell • States the role of the named T cell in immune response	2
• Provides some relevant information	1

Sample answer:

Killer T cells act on the infected cell to destroy it.

Question 30 (b)

Criteria	Marks
• Relates a benefit and a limitation of suppressing the immune system to the organ transplant patient	4
• Describes a limitation of suppressing the immune system	3
• Outlines a benefit and a limitation of suppressing the immune system OR • Describes either a benefit or a limitation of suppressing the immune system	2
• Provides some relevant information	1

Sample answer:

The immune system of organ transplant patients needs to be suppressed because the donated organ would be seen as a foreign object by the recipient's immune system. This means that the donated organ would be attacked by the recipient's immune system. Therefore, the immune system of the recipient is suppressed to allow the donated organ to survive. However, the suppression of the immune system means that the recipient is more susceptible to infections which will not be seen as foreign and so will not be attacked/rejected.

Question 31

Criteria	Marks
• Explains that the work of Beadle and Tatum led to the 'one gene one polypeptide/protein' hypothesis • Describes what a transgenic species is and gives an example • Describes the production of a transgenic species • Explains the relationship between the 'one gene one polypeptide/protein' hypothesis and the production of a transgenic species • Makes a relevant judgement about the importance of the work	8
• Explains that the work of Beadle and Tatum led to the 'one gene one polypeptide/protein' hypothesis • Describes what a transgenic species is and gives an example • Describes the production of a transgenic species • Outlines a link between the work of Beadle and Tatum and the production of transgenic species • Includes a judgement about the importance of the work	6–7
• Describes the work of Beadle and Tatum and the production of a transgenic species • May provide a link between the work of Beadle and Tatum and the production of transgenic species	4–5
• Outlines the work of Beadle and Tatum and/or a transgenic species	2–3
• Provides some relevant information	1

Sample answer:

The work of Beadle and Tatum was very important to our ability to produce transgenic species, such as Bt cotton. Beadle and Tatum used *Neurospora crassa* to show that when they mutated a single gene they knocked out the function of a single protein. This led them to propose their 'one gene one protein' hypothesis. The recognition that a single protein, and hence the phenotype conferred by that protein, is determined by a single gene is very important in the production of transgenic species.

A transgenic species, such as Bt cotton, is a species whose genome has been altered by the insertion of a gene from another species that gives the species a new and favourable characteristic. In Bt cotton, the gene for the Bt toxin is transferred from the bacteria to the cotton genome allowing the cotton to produce the toxin, which kills insects which normally attack the cotton. Beadle and Tatum's hypothesis that a single gene encodes a single protein allowed other scientists to develop methods to identify and isolate genes and insert them into unrelated species to give them a specific characteristic.

Section II

Question 32 (a) (i)

Criteria	Marks
• Names a receptor and its stimulus	2
• Provides some relevant information	1

Sample answer:

Photoreceptor – detects light

Question 32 (a) (ii)

Criteria	Marks
• Provides a relationship between the wavelength, frequency and pitch of a sound	2
• Provides some relevant information	1

Sample answer:

The shorter the wavelength, the higher the frequency and the higher the pitch of the sound.

Question 32 (b)

Criteria	Marks
• Provides characteristics of lens shape to focus on both near and far objects • Provides how the lens shape changes	3
• Provides characteristics of lens shape to focus on both near and far objects	2
• Provides some relevant information	1

Sample answer:

The shape of the lens is controlled by the ciliary muscle. When focusing on distant objects the ciliary muscles are relaxed and the tension in the attachments keep the lens elongated. When focusing on near objects the ciliary muscle contracts and the lens becomes less elongated (thicker) placing the focus of the object on the retina.

Question 32 (c) (i)

Criteria	Marks
• States the location and function of rhodopsin	2
• Provides some relevant information	1

Sample answer:

Rhodopsin is found in rod cells in the retina and its function is to absorb light.

Question 32 (c) (ii)

Criteria	Marks
• Demonstrates some understanding of how the distribution and function of rods and cones differ	4
• Demonstrates some understanding of the distribution and function of rods and cones	3
• Demonstrates some understanding of the distribution or function of rods and cones OR • Demonstrates some understanding of the distribution and function of rods or cones	2
• Provides some relevant information	1

Sample answer:

Rods are suitable for night vision but unable to discriminate between colours. Cone cells function in bright light and provide colour vision.

The number of cones increases towards the fovea (central part of the retina) whereas the rods are less dense towards the fovea.

Question 32 (d) (i)

Criteria	Marks
• Identifies that *Signal 1* does not reach threshold potential • Relates threshold potential to action potential	2
• Provides some relevant information	1

Sample answer:

Signal 1 does not reach the threshold potential and so does not lead to an action potential.

Question 32 (d) (ii)

Criteria	Marks
• Provides the steps and channels involved in changing the potential of the membrane • Relates the opening of the channels to changes in the potential of the membrane with reference to the graph	3
• Provides the steps involved in changing the potential of the membrane • Relates the changes in the potential of the membrane with reference to the graph OR • Identifies that channels or ion movement are involved in changing the potential of the membrane • Relates the opening of channels or the movement of ions to the changes in the potential of the membrane	2
• Provides some relevant information	1

Sample answer:

The membrane has a resting potential of –90 mV. With *Signal 2*, a strong enough stimulus opens sodium channels that allow sodium ions to enter and increase the membrane potential beyond the threshold. The cell voltage increases to +30 mV at which stage the potassium channels open allowing the potassium ions to leave the cell which brings the membrane back to the resting potential.

Question 32 (e)

Criteria	Marks
• Demonstrates a thorough understanding of the structure and function of the human ear • Describes examples of technologies that assist hearing • Links the use of technologies to the understanding of the human ear • Makes an appropriate judgement of how our understanding of the path of a soundwave has led to the development of technologies • Includes correct use of biological terms	7
• Demonstrates a sound understanding of the structure and function of the human ear • Outlines at least one example of a technology that assists hearing • Links the use of a technology to the understanding of the human ear • Makes a judgement of how our understanding of the detection of sound and the human ear has led to the development of technologies	5–6
• Demonstrates some understanding of the structure and function of the human ear • Attempts to link the use of a technology to the understanding of the human ear • Identifies an example of a technology that assists hearing	3–4
• Demonstrates a limited understanding of the structure and/or function of the human ear • Identifies an example of a technology used to assist hearing	2
• Provides some relevant information	1

Sample answer:

Hearing is a multi-step process involving collecting and focusing the sound (external ear), transferring the sound to vibrations in the tympanic membrane, amplifying this vibration through the ossicles, and then separating high and low frequencies to different neurons in the cochlea where they convert the vibrations into electrical signals in the auditory nerve to send to the brain.

This knowledge has been very important for the development of technologies to assist those with failing hearing. For example, where the tympanic membrane has been broken, it can be repaired or the sound amplified using a hearing aid. A hearing aid can also reduce background noise by filtering. This helps to separate frequencies in the organ of Corti and the cochlea (hair cells). The bionic ear is a cochlear implant which bypasses many of the initial steps in hearing and transfers sound waves via the implant into electrical signals that directly stimulate the auditory nerve, allowing relatively normal hearing.

Question 33 (a) (i)

Criteria	Marks
• Names two relevant biotechnologies	2
• Provides some relevant information	1

Sample answer:

Fermentation and seed collection

Question 33 (a) (ii)

Criteria	Marks
• Provides two benefits resulting from artificial selection in relation to a specific organism	2
• Provides some relevant information	1

Sample answer:

Wheat was bred to improve flour quality and to shorten its growing period to match climatic conditions.

Question 33 (b)

Criteria	Marks
• Describes the steps required in the formation of recombinant DNA	3
• Describes steps required to produce transgenic species	2
• Provides some relevant information	1

Sample answer:

Identify the desired gene in an organism (that will produce a protein) that will benefit the target organism.

The section of DNA responsible is extracted using restriction enzymes. A plasmid is also cut using the same restriction enzymes and mixed with the target DNA. Ligase is added to join the two pieces together.

Question 33 (c) (i)

Criteria	Marks
• Provides features that indicate differences between DNA and RNA	2
• Provides some relevant information	1

Sample answer:

In DNA there is a double strand of nucleotides linked together forming a twisted helix. There are 4 types of nitrogen bases in DNA: A, T and G, C.

RNA is a single strand of nucleotides linked together. There are 4 types of bases in RNA, but the base uracil substitutes for thymine.

Question 33 (c) (ii)

Criteria	Marks
• Identifies two types of RNA • Describes the role of each type in protein synthesis	4
• Identifies two types of RNA • Provides the role of one of the types of RNA in protein synthesis	3
• Identifies two types of RNA OR • Provides some information about one type of RNA in protein synthesis	2
• Provides some relevant information	1

Sample answer:

Two types of RNA are mRNA and tRNA. The code contained in the DNA molecule is copied into a mRNA molecule. The mRNA molecule is then able to move out of the nucleus and into the cytoplasm where it binds with a ribosome. In the ribosome, tRNA, which carries specific amino acids, interacts with the mRNA by binding with the complementary triplet codon on the mRNA molecule. In this way, successive amino acids bind to each other to produce a polypeptide.

Question 33 (d) (i)

Criteria	Marks
• Relates the use of biotechnology to crossing the species barrier	2
• Provides some relevant information	1

Sample answer:

The organisms are from different genera so genetic material is not usually transferred between them. The desired genetic material is cut out from the bacteria and inserted into the yeast genome.

Question 33 (d) (ii)

Criteria	Marks
• Provides a reason why one of the strains is more suitable to use, with reference to information from the graph • Links the reason to an advantage for commercial operation	3
• Identifies the strain more suited • Provides a reason why the strain chosen is preferred, based on information from the graph	2
• Provides some relevant information	1

Sample answer:

Strain *B* would be the better strain to use. Strain *B* has a higher rate of ethanol production than Strain *A*. The graph shows that Strain *B* consistently produced significantly more ethanol than Strain *A* produced. This means the strain is more efficient and, for the production of commercial quantities, more ethanol will be produced within a given time frame.

Question 33 (e)

Criteria	Marks
• Describes an industrial fermentation process • Relates the implications of knowledge of biochemistry to the industrial fermentation process • Makes a well-supported judgement about the impact on society of the fermentation process, as an application of cell biochemistry • Includes correct use of biological terms	7
• Describes an industrial fermentation process • Relates the implications of knowledge of biochemistry to the industrial fermentation process • Makes a judgement about the impact on society of the fermentation process as an application of cell biochemistry	5–6
• Outlines an industrial fermentation process • Outlines a benefit to society • Links knowledge of biochemistry to an industrial fermentation process/product	3–4
• Identifies an industrial fermentation process used by society	2
• Provides some relevant information	1

Sample answer:

An understanding of glycolysis and the subsequent reaction pathways that cells use to release energy from sugars or other organic molecules allowed scientists to determine the different products that can result from fermentation using different microorganisms.

One application of this resulted in the industrial fermentation of citric acid. Until the early 1900s almost all citric acid was extracted from lemon juice. It was expensive and demand well exceeded supply. A species of yeast, *Aspergillus niger*, was found that produced and accumulated high yields of citric acid. Citric acid is produced by this method worldwide.

In this way, our understanding of cell biochemistry had a large positive impact on society as citric acid is widely used as a food additive to enhance flavour and as a preservative to extend the shelf life of food.

Question 34 (a) (i)

Criteria	Marks
• Identifies X and Y	2
• Provides some relevant information	1

Sample answer:

X – phosphate group
Y – sugar group

Question 34 (a) (ii)

Criteria	Marks
• Distinguishes Z in DNA and RNA	2
• Provides some relevant information	1

Sample answer:

Z in DNA is thymine (T) whereas in RNA, it is uracil (U).

Question 34 (b)

Criteria	Marks
• Sketches in general terms the use of highly variable genes in DNA fingerprinting	3
• Shows some understanding of highly variable genes and DNA fingerprinting	2
• Provides some relevant information	1

Sample answer:

Highly variable genes are sequences of DNA that display significant differences between individuals. It is these sequences of DNA that are used for comparison in the DNA fingerprinting process.

Question 34 (c) (i)

Criteria	Marks
• Provides features of the effect of germ line mutations on species	2
• Provides some relevant information	1

Sample answer:

Germ line mutations are passed on to the offspring, increasing variation in the species.

Question 34 (c) (ii)

Criteria	Marks
• Indicates an understanding of transposable genetic elements • Describes how these elements operate and their effect • Relates the impact on the genome	4
• Indicates an understanding of transposable genetic elements • Sketches in general terms how these elements operate • States the impact of these elements	3
• Sketches in general terms how transposable genetic elements operate • States the impact of these elements	2
• Provides some relevant information	1

Sample answer:

Transposable genetic elements are sections of DNA that can move around among chromosomes. As they move, these elements may carry sections of neighbouring genes. This disrupts the normal base sequence of those genes as well as at the site of insertion. This causes mutations in the chromosomes and alters the genetic make-up of the individual.

Question 34 (d) (i)

Criteria	Marks
• Identifies genotype and phenotype of both parents	2
• Provides some relevant information	1

Sample answer:

Both parents are RrTt and are tall and have red flowers.

Question 34 (d) (ii)

Criteria	Marks
• States the phenotypic ratio for both cases • Relates the difference in ratios to independent assortment	3
• States the phenotypic ratio for both cases	2
• Provides some relevant information	1

Sample answer:

If the genes are on separate chromosomes the ratio of the phenotypes is 9 : 3 : 3 : 1. This occurs due to independent assortment. The phenotypic ratio would be 3:1 if the genes RT and rt were on the same chromosome as they are linked.

Question 34 (e)

Criteria	Marks
• Links at least one outcome of the HGP to named technologies • Describes the technologies and a benefit to society of each, using specific examples • Includes correct use of biological terms	7
• Links an outcome of the HGP to named technologies • Outlines the technologies and a benefit to society of each, using an example	5–6
• Identifies a technology linked to the HGP • Identifies a benefit to society of that technology	3–4
• Identifies a relevant technology • Identifies a feature of the HGP OR identifies a benefit to society of the technology	2
• Provides some relevant information	1

Sample answer:

HGP has allowed us to determine the position of genes and has led to the development of technologies such as gene therapy used to treat people with cystic fibrosis. A healthy CFTR gene is isolated and inserted into the lungs of the patient using a viral vector. This gene is then expressed and produces the normal protein required for preventing the build-up of mucous in the lungs. This has improved the quality of life and increased the life expectancy of individuals with CF.

HGP provides the sequence of bases in genes. Genetic mutations are the result of a change in the sequence of bases in genes. When a genetic mutation in an individual's genome is identified it is possible to construct lengths of DNA with the correct base sequence thus correcting the mutation. This segment of DNA can then be used in recombinant DNA technology to produce effective amounts of the missing protein that can be used to counteract the symptoms of the disease eg artificial production of insulin to maintain required supplies for diabetics.

This benefits society by reducing medical costs, not having to use animal sources of insulin and enabling suffers to contribute to society.

Question 35 (a) (i)

Criteria	Marks
• Provides two features that classify humans as primates	2
• Provides some relevant information	1

Answers could include:

Forward facing eyes
Grasping hands with long fingers

Question 35 (a) (ii)

Criteria	Marks
• Sketches in general terms one feature in hominids that can be used to distinguish them from other primates	2
• Provides some relevant information	1

Sample answer:

Hominids do not possess a tail, whereas primates do.

Question 35 (b)

Criteria	Marks
• Provides characteristics and features of DNA-DNA hybridisation • Relates the result of hybridisation to the evolutionary relationship between the two primates	3
• Provides characteristics and features of DNA-DNA hybridisation OR • Relates the result of hybridisation to the evolutionary relationship between the two primates	2
• Provides some relevant information	1

Sample answer:

DNA-DNA hybridisation is a technique in which the DNA of two primate species can be compared by allowing them to anneal together. The more similar the sequence of the two DNA molecules, the stronger the bond between them and consequently the greater the energy that is needed to separate them.

Question 35 (c) (i)

Criteria	Marks
• Provides the distinguishing feature polymorphism and clinical gradations	2
• Provides some relevant information	1

Sample answer:

Polymorphism refers to distinct forms of genetically determined characteristics whereas clinal gradation refers to the gradual change in the gene frequency in a population.

Question 35 (c) (ii)

Criteria	Marks
• Provides examples of polymorphism • Relates how the polymorphisms enable humans to survive in their environment	4
• Provides examples of polymorphism • Outlines how the polymorphism(s) enable humans to survive	3
• Provides an example of a polymorphic trait • Outlines how the polymorphic trait enables humans to survive OR • Provides examples of polymorphic traits	2
• Provides some relevant information	1

Sample answer:

Humans in tropical countries produce higher levels of melanin, which protects them from UV damage from the sun reducing the number of deaths from skin cancer. Humans in tropical countries who have the gene for sickle cell anaemia will be protected from malaria in regions where it is endemic reducing the death toll from malaria.

Question 35 (d) (i)

Criteria	Marks
• Identifies the difference in the changes of the cranial capacity for each genus over time	2
• Provides some relevant information	1

Sample answer:

The increase in the cranial capacity of the genus *Australopithecus* was relatively small (from 300 mL to 500 mL) over time compared to the greater increase in the cranial capacity of the genus *Homo* (from approximately 550 mL to 1400 mL).

Question 35 (d) (ii)

Criteria	Marks
• Contrasts the locations in which fossils of both genus are found • Identifies the difference in cranial size between the two genera • Links the greater cranial size of the genera to patterns of migration	3
• Outlines the distribution of where fossils of both genus are found • Identifies the difference in the cranial size between the two genera	2
• Provides some relevant information	1

Sample answer:

Fossils of genus *Homo* were found throughout Africa, Asia and Europe. In contrast, the fossils of the genus *Australopithecus* were mostly found in Africa. The greater cranial capacity of the fossils of genus *Homo* compared to those of genus *Australopithecus* means that genus *Homo* had larger brains, which may have` allowed them to construct shelters. This may have enabled genus *Homo* to migrate out of Africa.

Question 35 (e)

Criteria	Marks
• Describes modern technologies affecting human evolution • Describes the impact technologies have on the genome • Draws out and relates the implications of the effect(s) on the genome to the subsequent impact on human evolution • Includes correct use of biological terms	7
• Outlines modern technologies affecting human evolution • Outlines how the technologies affect the genome • Links the effect(s) on the genome to the impact on human evolution	5–6
• Outlines a modern technology affecting human evolution • Outlines how the technology affects the genome • Identifies an effect on human evolution OR • Outlines modern technologies affecting human evolution • Outlines how the technologies affect the genome or human evolution	3–4
• Identifies a modern technology affecting human evolution • States how the technology affects the human population	2
• Provides some relevant information	1

Sample answer:

The sequencing of the human genome as a result of the HGP could help us identify mutations that are the cause of non-infectious diseases such as cystic fibrosis and breast cancer. Using this knowledge it would be possible to use genetic engineering to alter the genome by employing gene therapy to add, delete or modify genetic information. Treatment of previously fatal (or life limiting) diseases will mean that these flawed genes can be passed on to offspring, thus increasing the frequency of these genes in the population and resulting in more individuals who are reliant on these treatments. This can reduce the genetic strength of the population and cause problems of the technologies to produce the treatment fail.

The ability to screen embryos and select for healthy offspring who will not possess genes that will predispose them to identified cancers, will reduce the frequency of the defective gene in the gene pool. This will alter the path of human evolution, reducing the incidence of this particular cancer, since the defective gene will not be passed on.

Question 36 (a) (i)

Criteria	Marks
• States two reasons for studying photosynthesis	2
• Provides some relevant information	1

Sample answer:

Studying photosynthesis leads to an understanding of how oxygen is produced as well as how raw materials can be produced for a range of human needs.

Question 36 (a) (ii)

Criteria	Marks
• Names products of photosynthesis with their respective functions	2
• Provides some relevant information	1

Sample answer:

Oxygen is used for respiration.
Sugar is used as a fuel for respiration.

Question 36 (b)

Criteria	Marks
• Provides characteristics and features of a valid experiment	3
• Provides some features of a valid experiment	2
• Provides some relevant information	1

Sample answer:

Individual plants were weighed and then planted in containers containing a weighed amount of dry soil. All variables were controlled, eg same amount of water and light. After two weeks of growth, the plant and the soil were separated. The final weights of the plant and the dried soil were determined and compared to the initial values.

Question 36 (c) (i)

Criteria	Marks
• Provides features of a radioisotope	2
• Provides some relevant information	1

Sample answer:

Radioisotopes are those isotopes that are unstable (because of the different number of neutrons in the nucleus) and emit radiation.

Question 36 (c) (ii)

Criteria	Marks
• Names two relevant tracers and relates how they can be used to follow the biochemical pathways photosynthesis	4
• Names two relevant tracers and outlines how they can be used to follow photosynthesis	3
• Provides a feature of the use of one named tracer in plants to follow photosynthesis	2
• Provides some relevant information	1

Sample answer:

C-14 can be fed into plants as carbon dioxide. The plant takes up the C-14 as it would normally take in CO_2. After time, the starch in the leaves can be shown to contain C-14.

O-18, which can be incorporated into water or used as a source of CO_2, can be used to show that oxygen released during photosynthesis comes from the oxidation of water.

Question 36 (d) (i)

Criteria	Marks
• Identifies the wavelength ranges	2
• Provides some relevant information	1

Sample answer:

390–500 nm and 600–690 nm

Question 36 (d) (ii)

Criteria	Marks
• Identifies a difference in the breadth of peaks • Relates the difference to the range of pigments and their different wavelengths	3
• Identifies a difference in the breadth of peaks • Relates the difference to the range of pigments	2
• Provides some relevant information	1

Sample answer:

The peaks of the action spectrum are broader than the peaks of the absorption of chlorophyll *a*. This is because the action spectrum shows the absorption spectrum of all the pigments contained in the plant. Each pigment will peak at a different wavelength therefore creating a broader peak in the action spectrum.

Question 36 (e)

Criteria	Marks
• Describes structures in the chloroplast that can be observed using the electron microscope • Describes the function of at least two different structures in the chloroplast • Draws out and relates the implications of the effect of the development of the electron microscope on our understanding of chloroplast structure and function • Includes correct use of biological terms	7
• Describes structures in the chloroplast that can be observed using the electron microscope • Outlines the function of at least two different structures in the chloroplast • Relates the effect of the development of the electron microscope to our understanding of chloroplast structure and function	5–6
• Outlines structures in the chloroplast that can be observed using the electron microscope • Outlines the function of a structure in the chloroplast • Links the development of electron microscope and understanding of chloroplast structure and function	3–4
• Names structures in the chloroplast that can be observed using the electron microscope OR • Outlines the function of one structure in the chloroplast	2
• Provides some relevant information	1

Sample answer:

Using light microscopes, chloroplasts could be viewed but their internal structure was not seen until the development of the electron microscope which had higher magnification and resolution.

When the internal structure could be viewed, various structures could be identified eg grana, stroma and thylakoids and the role of each structure in the process of photosynthesis studied.

The chloroplast is made up of flattened hollow discs called thylakoids, which are arranged in stacks called grana. The stacking of the layers into grana increases stability and surface area for the capture of light. The membranes of these thylakoids contain chlorophyll and are the site for the light-dependent reactions of photosynthesis.

The space outside the thylakoid is called the stroma, which is an aqueous fluid present within the inner membrane of the chloroplast. It contains DNA, ribosomes, lipid droplets and starch granules. The Calvin cycle takes place in the stroma of chloroplast.

The functions described above would not have been linked to the internal structures of the chloroplast without the development of an electron microscope.

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Mapping Grid

Section I
Part A

Question	Marks	Content	Syllabus outcomes
1	1	9.2.1.2.4	H6
2	1	9.2.1.2.6	H6
3	1	9.4.5.1	H1
4	1	9.4.5.2.1	H10
5	1	9.3.1.2.2	H10
6	1	9.4.4.2.4	H6
7	1	9.2.3.3.2	H3
8	1	9.2.2.3.1, 14.1h	H6, H14
9	1	9.1.11.2b	H2, H11, H14
10	1	9.1.12.4b	H12
11	1	9.1.5.2.2, 9.4.5.2.2	H6
12	1	9.3.2.2.4, 9.3.2.3.2, 14.3c	H6, H14
13	1	9.3.3.2.3, 9.3.4.2.1, 14.1a	H9, H14
14	1	9.4.3.2.2	H6
15	1	9.3.3.2.6, 9.3.3.3.2, 12.3c	H6, H9, H12
16	1	9.2.3.2.5	H6
17	1	9.3.4.3.5, 9.3.3.2.3	H1, H9
18	1	9.2.2.3.2, 12.4c	H12
19	1	9.3.3.2.4, 9.3.3.3.1	H9
20	1	9.2.1.3.1, 9.2.1.2.1, 12.3c, 14.1a	H12, H14

Section I
Part B

Question	Marks	Content	Syllabus outcomes
21	2	9.2.1.2.1	H6
22 (a)	2	9.4.3.2.2, 9.4.6.2.2	H6, H8
22 (b)	4	9.4.2.3.2	H6, H8
23	5	9.2.2.2.3	H6
24 (a) (i)	1	9.3.3.2.4, 9.3.3.3.1, 14.1f	H9, H14
24 (a) (ii)	1	9.3.3.2.4, 9.3.3.3.1, 14.1f, 12.3c	H9
24 (b)	2	9.3.3.3.1, 9.3.3.2.4	H9, H10
24 (c)	3	9.3.4, 9.3.1.2.3	H9, H10
25	4	9.2.3.3.4	H6
26 (a)	1	9.2.3.1, 12.3c, 11.2a	H2, H11, H12
26 (b)	3	9.2.1.2.1, 9.2.1.2.3, 9.2.1.3.1, 9.1.1.4.1a	H6, H14

Question	Marks	Content	Syllabus outcomes
27 (a)	2	9.2.2.3.6	H13
27 (b)	3	9.2.2.2.6	H6
28	3	9.3.3.2.6, 9.3.3.2.7, 9.3.3.3.2, 12.3c	H9, H12
29	5	9.4.7.3, 9.4.7.2.1/2, 14.3d	H3, H8, H14
30 (a)	2	9.4.5.2.2	H3, H6
30 (b)	4	9.4.5.2.2	H3, H6
31	8	9.3, 9.3.4.3.2, 9.3.5.2.2	H1, H3, H9

Section II

Question	Marks	Content	Syllabus outcomes
Question 32		**Communication**	
(a) (i)	2	9.5.1.2.2	H6
(a) (ii)	2	9.5.5.2.2, 9.5.5.3.1	H6
(b)	3	9.5.3.2.3, 9.5.3.3.2	H6
(c) (i)	2	9.5.4.2.3	H6
(c) (ii)	4	9.5.4.2.2	H6
(d) (i)	2	9.5.7.2.2, 9.5.7.2.3, 9.5.7.3.3, 12.3c, 14.1a	H6, H12, H14
(d) (ii)	3	9.5.7.2.2, 9.5.7.2.3, 9.5.7.3.3, 12.3c, 14.1a	H6, H12, H14
(e)	7	9.5, 9.5.6.2.2, 9.5.6.2.4, 9.5.6.3.3	H3, H6, H13
Question 33		**Biotechnology**	
(a) (i)	2	9.6.1.2.1	H8
(a) (ii)	2	9.6.1.2.3	H7
(b)	3	9.6.5.2.1, 9.6.5.2.2, 9.6.5.3.2	H6
(c) (i)	2	9.6.4.2.1	H9
(c) (ii)	4	9.6.4.2.1	H9
(d) (i)	2	9.6.5.2.2, 12.3c	H3, H9, H12
(d) (ii)	3	9.6.4.3.1, 14.1a, g	H3, H13, H14
(e)	7	9.6.3.3.1	H3, H6, H13

Question 34		**Genetics: The Code Broken?**	
(a) (i)	2	9.7.1.3.1, 12.3c	H9, H12
(a) (ii)	2	9.7.1.1.1	H9
(b)	3	9.7.2.2.4	H3, H4
(c) (i)	2	9.7.6.2.4	H6
(c) (ii)	4	9.7.6.2.3	H6, H9
(d) (i)	2	9.7.3.2.2	H9
(d) (ii)	3	9.7.3.3.1	H9
(e)	7	9.7.4.2.1, 9.7.2.2.4, 9.7.4, 9.7.5	H3, H5, H13
Question 35		**The Human Story**	
(a) (i)	2	9.8.1.2.3	H1, H7
(a) (ii)	2	9.8.1.3.1, 9.8.1.2.3	H1
(b)	3	9.8.2.2.6, 9.8.2.3.2	H3, H4, H10, H11
(c) (i)	2	9.8.4.2.2	H1, H2
(c) (ii)	4	9.8.4.3.1	H1, H10
(d) (i)	2	9.8.3.2.1, 9.8.3.2.2, 9.8.3.3.1	H13
(d) (ii)	3	9.8.3.2.1, 9.8.3.2.2, 9.8.3.3.1	H1, H2
(e)	7	9.8.6.2.1, 9.8.6.3.1, 9.8.6.3.2	H4, H6, H13
Question 36		**Biochemistry**	
(a) (i)	2	9.9.1.2.1	H3
(a) (ii)	2	9.9.1.3.1	H6
(b)	3	9.9.2.2.1, 9.9.2.3.1, 11.2c, 14.1c	H2, H11, H14
(c) (i)	2	9.9.5.2.1	H6
(c) (ii)	4	9.9.5.2.1	H2
(d) (i)	2	9.9.3.2.4, 9.9.3.3.4, 12.3c	H6, H12
(d) (ii)	3	9.9.3.2.4, 9.9.3.3.4	H6, H14
(e)	7	9.8.8.1, 9.8.8.2.1, 9.8.8.2.3	H1, H2, H4, H13