BOSTES | BOARD OF STUDIES TEACHING & EDUCATIONAL STANDARDS NSW

2014 HSC Biology
Marking Guidelines

Section I, Part A

Multiple-choice Answer Key

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

Section I, Part B

Question 21 (a)

Criteria	Marks
• Provides the correct name of the process	1

Sample answer:

Phagocytosis

Question 21 (b)

Criteria	Marks
• Identifies one adaptive feature of inflammation • Relates feature to immune response	2
• Identifies one adaptive feature of inflammation	1

Sample answer:

Increased blood flow into the site of infection brings more antibodies white blood cells to engulf the pathogen.

Question 22 (a)

Criteria	Marks
• Identifies TWO appropriate personal hygiene practices • Clearly relates each practice to reduction of transmission of pathogens	4
• Identifies ONE personal hygiene practice and clearly relates this practice to the reduction of transmission of pathogens • Identifies ONE appropriate cleanliness practice	3
• Identifies ONE appropriate cleanliness practice and relates it to the reduction of transmission of pathogens OR • Identifies TWO appropriate personal hygiene practices	2
• Identifies ONE appropriate cleanliness practice	1

Sample answer:

Washing hands after going to toilet removes pathogens from skin so they cannot get into the body.

Placing hand over mouth when coughing stops spread of water droplets which can carry pathogens.

Question 22 (b)

Criteria	Marks
• Classifies disease correctly • Provides appropriate justification	2
• Provides some relevant information	1

Sample answer:

The disease is non-infectious. It is not caused by a pathogen so it cannot be transmitted from person to person.

Question 23 (a)

Criteria	Marks
• Writes a valid procedure which demonstrates a clear understanding of sample size, collection of appropriate data, variables kept constant and a control in the context of the aim of the experiment	4
• Demonstrates a clear understanding of collection of some data, a variable kept constant and a control in the context of the aim of the experiment • Identifies variables kept constant OR appropriate sample size	3
• Provides some appropriate features of a controlled experiment relevant to the aim	2
• Provides a feature of a controlled experiment relevant to the aim	1

Sample answer:

1. Obtain 50 plants of the same species infected with the same species of rust
2. Following instructions on the fungicide pack, treat 25 plants with the fungicide and leave the other 25 plants untreated
3. Keep all the plants in the same conditions eg ambient temperature
4. After the time advised on the pack, examine each plant for number and size of orange-brown patches
5. Record results in an appropriate table

Question 23 (b)

Criteria	Marks
• Identifies a suitable method for assessing reliability of the experiment	1

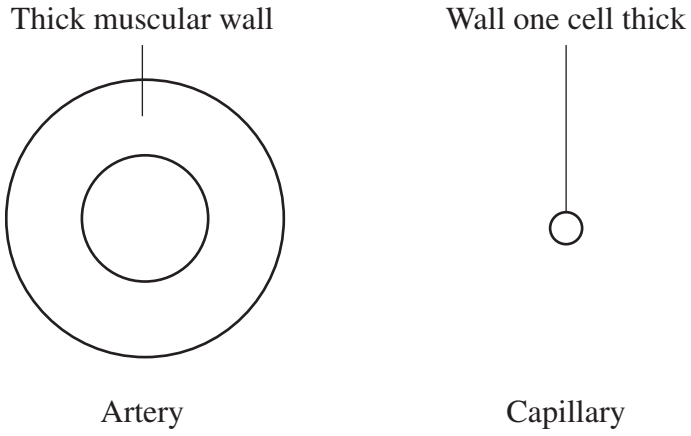
Sample answer:

Compare results of repeat runs and/or check for similarities/consistency.

Question 24 (a)

Criteria	Marks
• Provides appropriately labelled diagrams which correctly distinguish the structures of artery and capillary	2
• Provides appropriate diagrams for an artery and a capillary OR • Provides an appropriately labelled diagram of an artery or a capillary OR • Provides difference in writing without using diagrams	1

Sample answer:



Question 24 (b)

Criteria	Marks
• Relates one structure to a correct function of a capillary	2
• Identifies a correct function of a capillary	1

Sample answer:

Having a wall that is one cell thick allows diffusion of small molecules through the capillary wall to allow substances in and out of the bloodstream.

Question 25 (a)

Criteria	Marks
• Names a correct historical development in the understanding of malaria • Identifies a resulting prevention strategy	2
• Names a correct historical development in the understanding of malaria OR • Identifies a prevention strategy for malaria	1

Sample answer:

Malaria was discovered to be transmitted by mosquitoes. A prevention strategy that came from this discovery was the use of mosquito netting over people at night, when mosquitoes are active, to prevent mosquito bites.

Question 25 (b)

Criteria	Marks
• Demonstrates thorough knowledge of the specific immune response in malaria • Demonstrates thorough knowledge of the mechanism of a vaccine in rendering immunity to the individual • Relates use of vaccine to reduced spread of malaria • Relates use of the vaccine to reduction in occurrence and/or possible eradication of the disease in a population	4
• Demonstrates sound knowledge of the specific immune response • Demonstrates sound knowledge of the mechanism of a vaccine in rendering immunity to the individual • Relates the use of the vaccine to reduction in occurrence or spread of a disease	3
• Demonstrates some knowledge of the mechanism of a vaccine in rendering immunity to the individual OR • Relates the use of vaccines to reduce the occurrence or spread of a disease	2
• Provides some relevant information about the immune response and/or vaccination	1

Sample answer:

A vaccine against malaria would produce memory B cells/memory T cells. When a malarial plasmodium is encountered these cells will quickly immobilise the pathogen and kill it. If all individuals in a population are vaccinated the plasmodium will not be able to complete its life cycle leading to reduction in occurrences and transmission of the disease.

Question 25 (b)

Criteria	Marks
• Demonstrates thorough knowledge of the specific immune response in malaria • Demonstrates thorough knowledge of the mechanism of a vaccine in rendering immunity to the individual • Relates use of vaccine to reduced transmission of a pathogen • Relates use of the vaccine to reduction in occurrence and/or possible eradication of the disease in a population	4
• Demonstrates sound knowledge of the specific immune response in malaria • Demonstrates sound knowledge of the mechanism of a vaccine in rendering immunity to the individual • Relates the use of the vaccine to reduction in occurrence and/or possible eradication of the disease in a population	3
• Demonstrates some knowledge of malaria • Demonstrates some knowledge of the mechanism of a vaccine in rendering immunity to the individual OR • Relates the use of vaccines to reduce the transmission of a pathogen	2
• Provides some relevant information	1

Sample answer:

A vaccine against malaria would produce memory B cells and memory T cells. When a malarial plasmodium is encountered these cells will quickly immobilise the pathogen and kill it. If all individuals in a population are vaccinated the plasma-division will not be able to complete its life cycle leading to reduction in occurrences and transmission of the disease.

Question 26

Criteria	Marks
• Demonstrates thorough understanding of convergent evolution • Provides an appropriate example of unrelated organisms in similar environments • Demonstrates thorough understanding of the mechanism of natural selection under similar selection pressures • Demonstrates thorough understanding of role of isolation (genetic and/or physical) on evolution	5
• Demonstrates sound understanding of convergent evolution • Provides an appropriate example of unrelated organisms in similar environments • Demonstrates sound understanding of natural selection and/or isolation to explain the example	4
• Provides some understanding of convergent evolution • Provides an appropriate example OR demonstrates some understanding of natural selection or isolation	3
• Demonstrates some understanding of natural selection or isolation • Provides an appropriate example OR • Provides good understanding of natural selection or isolation on speciation	2
• Provides some relevant information about evolution	1

Sample answer:

Convergent evolution occurs when two species, which are not close in evolutionary terms, evolve similar characteristics by natural selection in similar environments. The organisms cannot interbreed to share any new DNA generated by mutation. They are genetically isolated from each other. Yet they develop similar characteristics.

Natural selection occurs when some variants in a population live longer and produce more offspring than other variants because they are suited to the environment. Their adaptive characteristics are passed on to their offspring.

After many generations the traits of those variants are common in the population.

Dolphins and sharks demonstrate convergent evolution. The dolphin is a mammal and the shark is a fish. They inhabit the marine environment which imposes the same selection pressures on both types of organism. Both groups exhibit streamlined body shape and possess fins for propulsion and stability. These features are adaptive for movement in a highly viscous environment.

Question 27 (a)

Criteria	Marks
• Provides a valid cause for the rise in CO_2	1

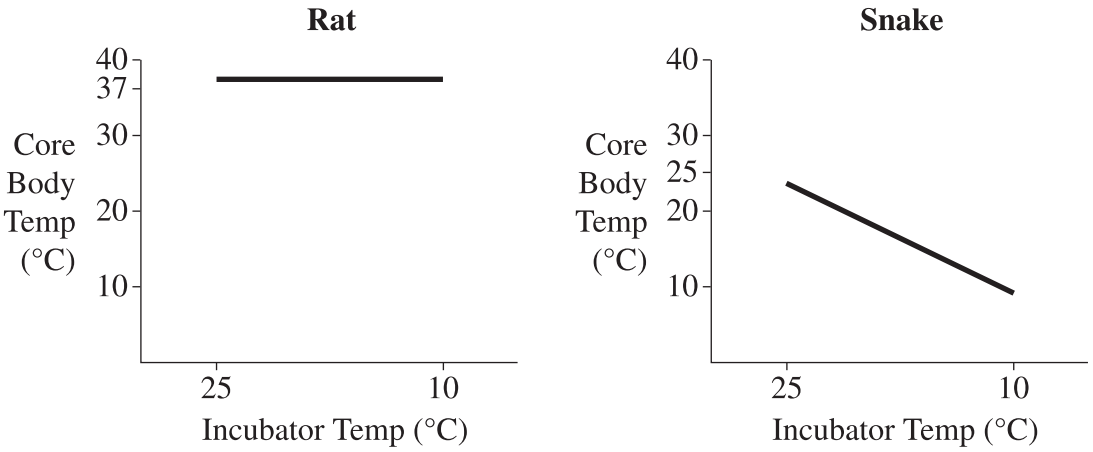
Sample answer:

CO_2 is a waste product of cellular respiration.
OR
CO_2 was released into the air by the animals

Question 27 (b)

Criteria	Marks
• Sketches both lines showing the correct starting points and the correct trends	3
• Shows the correct starting and finishing points for each graph • Shows the correct trend in one graph OR • Shows the correct trend in each graph OR • Shows the correct starting and finishing points and trend for one graph	2
• Shows the correct trend in one graph OR • Shows the correct starting or finishing point for one graph	1

Sample answer:



Question 27 (c)

Criteria	Marks
• Predicts two physiological or behavioural observations in the rat • Provides a clear explanation linked to increasing body heat or reducing body heat loss in the context of EACH observation	3
• Predicts two physiological or behavioural observations in the rat • Provides a clear explanation linked to increasing body heat or reducing body heat loss in the context of ONE observation OR • Predicts two physiological or behavioural observations in the rat • Provides a generic explanation of each observation	2
• Predicts observation(s)	1

Sample answer:

Predicted observation	*Explanation*
Rat increases food intake	The rat uses cellular respiration to generate body heat which requires glucose contained in food
Carbon dioxide levels rise at an increasing rate	The rat continues to increase the rate of production of body heat. The by-product of these reactions is carbon dioxide.

Question 28 (a)

Criteria	Marks
• Identifies that the average is calculated not using Trial 4 result • Justifies the deliberate exclusion of the Trial 4 result from the average calculation	2
• Engages appropriately with the data at 300 bubbles of CO_2	1

Sample answer:

Before averaging the data at 300 bubbles of CO_2, the outlier (311 seconds) was removed. This was necessary as it is significantly different to other values for time taken to curdle at that CO_2 volume.

Question 28 (b)

Criteria	Marks
• Relates increase in CO_2 to decrease in pH and an increase in enzyme activity • Relates observable changes in the activity of this enzyme to optimal pH of an enzyme • Observes rate of increase of enzyme activity slows down for the larger volumes of CO_2	4
• Relates increase in CO_2 to decrease in pH and an increase in enzyme activity • Relates enzyme activity over a limited pH range/optimal pH	3
• Identifies a trend from the results table • Relates the bubbling of CO_2 to a change in pH	2
• Identifies a trend from the results table OR • Relates the bubbling of CO_2 to a change in pH	1

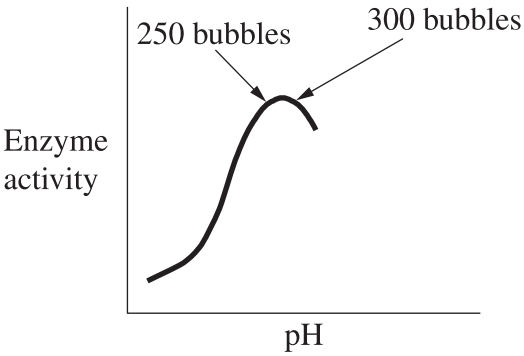
Sample answer:

One trend observable in the results is that as bubbles of CO_2 in the milk samples increase, the time taken to curdle decreases. This means that the concentration of CO_2 increases activity of the enzyme.

After 200 bubbles of CO_2 have been added the rate of increase of enzyme activity decreases with addition of further CO_2. As CO_2 is added to a solution it becomes more and more acidic.

The slower increase of enzyme activity after 250 bubbles of CO_2 is due to the enzyme being close to its optimum pH where the enzyme activity graph flattens off at the peak of the curve.

The graph below shows that enzyme activity is similar at 250 bubbles and at 300 bubbles of CO_2.



Question 29

Criteria	Marks
• Makes an appropriate assessment of whether offspring produced is a clone of the female on the basis of whether they are genetically identical • Clearly explains the relationship between the structure and behaviour of chromosomes during meiosis and the production of unique gametes (includes crossing over and independent assortment) • Explains the role of gametes and their combination in sexual reproduction to produce a unique genetic combination in each fertilisation • Links explanation to stimulus	5
• Makes an appropriate assessment of whether offspring produced is a clone of the female on the basis of whether they are genetically identical • Provides suitable explanations of the variability of the products of meiosis in gamete production (includes crossing over and independent assortment) OR explains the relationship between the structure and behaviour of chromosomes during meiosis and the production of unique gametes (includes crossing over or independent assortment) • Explains the role of gametes and their combination in sexual reproduction to produce a unique genetic combination in each fertilisation • Links explanation to stimulus	4
• Makes an appropriate assessment of whether offspring produced is a clone of the female • Provides relevant statement regarding the variability of the products of meiosis in gamete production • Refers to the combination of gametes in sexual reproduction to produce a unique genetic combination in each fertilisation	3
• Provides correct statements about cloning and/or sexual reproduction OR • Makes an appropriate assessment of whether offspring produced is a clone of the female on the basis of whether they are genetically identical	2
• Provides some relevant information about cloning or sexual reproduction	1

Sample answer:

The offspring would not be a clone of the female because the offspring and the female would not be genetically identical.

The offspring was produced using two ova. The nuclei of the two ova are different to each other and to the nuclei in the female's body cells. The ova were produced by meiosis of a body cell of the female.

During meiosis the processes of independent assortment of chromosomes and crossing over occur. In crossing over, segments of DNA swap positions on homologous chromosomes so new gene combinations are possible. Independent assortment results in different sorting of chromatids into ova. This results in genetically unique ova.

If these two genetically unique ova fuse there will be a new unique combination of genetic information in the offspring that is not identical to that of the female who produced the ova (eggs).

Question 30

Criteria	Marks
• Demonstrates thorough knowledge of the sequence of landmark developments in the understanding of inheritance, with reference to the work of three scientists • Relates the technology used by each scientist to the development of their ideas • Provides clear explanations offered by each scientist relevant to the questions explored • Provides appropriate examples of verification or modification of the work of previous scientists	8
• Demonstrates thorough knowledge of the sequence of landmark developments in the scientific understanding of inheritance, with reference to the work of some scientists • Relates the technology used by the scientists to the development of their ideas • Provides explanations offered by each scientist relevant to the questions explored • Provides some example(s) of verification or modification of the work of previous scientists	6–7
• Demonstrates some knowledge of the sequence of landmark developments in the scientific understanding of inheritance • Demonstrates some knowledge of some technologies or experimental techniques used by scientist(s) relevant to the question explored • Identifies explanations offered by some named scientist(s)	4–5
• Demonstrates some knowledge of a landmark development in the understanding of inheritance • Identifies a technology or experimental techniques used by the scientist(s) • Identifies explanation offered by the scientist(s)	2–3
• Provides some information relevant to the question	1

Sample answer:

Gregor Mendel explored the inheritance of traits in pea plants using artificial pollination. He crossed pure breeding plants to produce the F_1 generation. He explored whether the F_1 plants had lost the recessive hereditary information from one of their parents by allowing them to self-pollinate and produce offspring.

Gregor Mendel hypothesised that plants possess two inheritable factors for every trait; that these factors separated in gamete formation; that the two factors were restored after fertilisation; and that some factors dominated others.

Sutton used microscopes and staining techniques to explore the behaviour of chromosomes in meiosis, fertilisation and embryonic development. He saw pairs of chromosomes separating during cell division (meiosis), and saw the pairs of chromosomes restored after fertilisation. He related their observations of chromosomes to Mendel's ideas on the behaviours of factors

in inheritance (that numbers of factors halved in gamete formation and restored after fertilisation), concluding that Mendel's factors were genes on chromosomes.
Beadle and Tatum used X-rays to subject mould to radiation. They showed that some of the mutant mould would not grow on basic medium and required the addition of a specific amino acid. They formulated the concept that one gene led to the production of a specific enzyme. Their results build on the work of Mendel and Sutton in that they showed that genes, on chromosomes, were responsible for the production of proteins and therefore traits.

Section II

Question 31 (a) (i)

Criteria	Marks
• Correctly identifies the structure	1

Sample answer:

Neurone or nerve cell ('Nerve' not accepted)

Question 31 (a) (ii)

Criteria	Marks
• Indicates the main features of the steps between the stimulus and the response, in correct sequence • Refers to the central nervous system or components of the central nervous system	3
• Identifies in correct sequence some steps between the stimulus and the response	2
• Identifies a component in the pathway OR • Provides a definition of stimulus and/or response	1

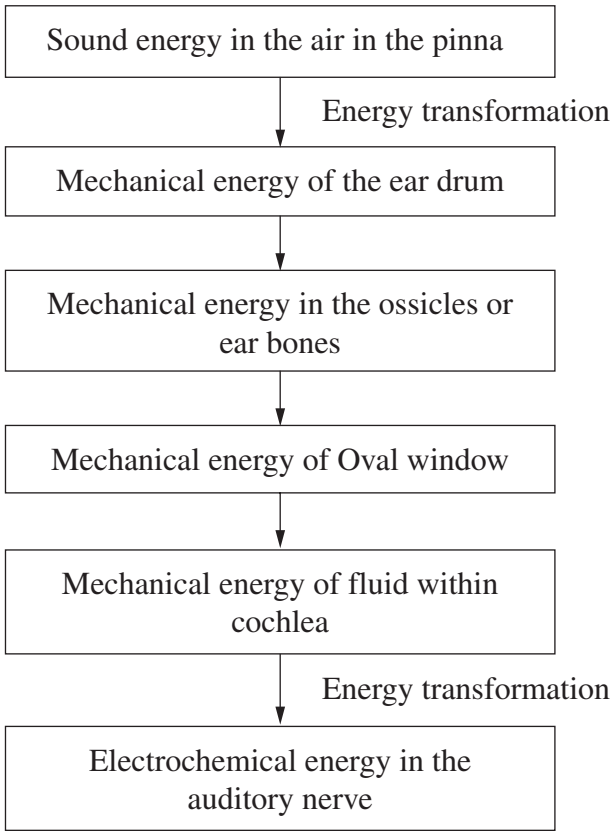
Sample answer:

1. Stimulus activates receptor
2. Receptor sends message to the brain
3. The brain sends a message to the effector organ resulting in a response

Question 31 (b)

Criteria	Marks
• Provides sequential steps linked by arrows where each step follows logically, from the preceding step, in terms of structure of the ear • Identifies type of energy at each step • Identifies locations of energy transformations within the ear	4
• Provides steps linked by arrows where most of the steps follow logically in terms of structure of the ear • Identifies type of energy at most of the steps • Identifies a location of an energy transformation within the ear	3
• Provides ordered steps where some of the steps follow logically in terms of structure of the ear • Identifies a location of an energy transformation within the ear	2
• Provides some correct information on the sound pathway in the ear	1

Sample answer:



Question 31 (c)

Criteria	Marks
• Clearly identifies the two types of photoreceptor • Provides differences between photoreceptor cells based on common criteria • Relates differences observed to different features of human vision	4
• Identifies the two types of photoreceptor • Provides differences between photoreceptor cells based on at least one common criterion • Relates differences observed to different features of human vision	3
• Identifies the two types of photoreceptor • Provides specific features of the photoreceptors • Relates a feature of each photoreceptor to human vision	2
• Provides some information about photoreceptors	1

Sample answer:

The two types of photoreceptors are rods and cones. Having both receptors allows the eye to function in a range of different conditions.

	Rods	*Cones*
Optimal light conditions	Low light levels allowing vision at dusk	High light levels; vision is possible in strong daylight
Colour or black and white perception?	Black and white due to rhodopsin pigments in cells	Colour vision – photopsin pigments Can perceive a range of colours

Question 31 (d) (i)

Criteria	Marks
• Describes the relationship between the position of the eyes on the side of the head and the size of overlapping field • Describes the relationship between the position of the eyes on the side of the head and the overall field of view	2
• Describes the relationship between the position of the eyes and size of overlapping field OR • Describes the relationship between the position of the eyes and the overall field of view OR • Identifies for an animal the relationship between the position of its eyes and the extent of the fields of view	1

Sample answer:

When the eyes are on the side of the skull and/or further apart on the skull then:
(i) the size of the overlapping field decreases
(ii) the total/overall field of view increases.

Question 31 (d) (ii)

Criteria	Marks
• Explains how loss of one eye results in loss of depth perception and reduced visual field • Relates how both changes in vision reduce the chance of survival in a specific context	4
• Explains how the loss of one eye results in loss of depth perception or reduced visual field, and outlines the other effect • Relates how a change in vision reduces the chance of survival in a specific context	3
• Outlines that the loss of one eye results in loss of depth perception and reduced visual field, and links to reduced chance of survival OR • Explains how the loss of one eye results in loss of depth perception or reduced visual field, and links to reduced chance of survival	2
• Identify that the loss of one eye results in loss of depth perception or reduced visual field	1

Sample answer:

If the monkey lost an eye then the size of the visual field on the animal would be significantly reduced. For example if it lost its right eye, the visual field would be reduced to A + (A+B) from A+(A+B) + B.

The monkey would be able to see much less of the environment around it. This might mean it could not keep a good look out for predators and therefore might die early in life.

The loss of an eye would mean there would be no part of the visual field where two eyes are looking at the same part of the environment at the same time.

This means that the monkey would have no depth perception. This may adversely affect its movements in the environment, not having a complete 3D view of the environment. It might not be able to collect food or prey upon other animals for food or protect itself with the same ease.

Question 31 (e)

Criteria	Marks
• Demonstrates thorough understanding of the versatility of sound as a communication mechanism • Demonstrates thorough understanding of the production and detection of sound, using appropriate examples (intraspecies and interspecies) • Links the successful transfer of sound signals to their wavelength/frequency and purpose	7
• Demonstrates an understanding of the versatility of sound as a communication mechanism • Demonstrates an understanding of the production and detection of sound, using appropriate examples. (intraspecies and/or interspecies) • Links the successful transfer of sound signals to their purpose or wavelength/frequency	5–6
• Outlines feature/s of sound as a communication mechanism • Outlines the production and/or detection of sound, using at least one example • Links the transfer of sound signals to their purpose or wavelength or frequency	3–4
• Provides some information relevant to the question	1–2

Sample answer:

Sound is a wave created by vibrations and can travel through the air as well as through liquids and solids. It allows communication between animals that are not in line of sight, and at night when there is no light. Messages can vary in frequency and loudness. Patterns of sounds can also increase the vocabulary of the message.

Transfer of signals involves both the successful production and detection of the specific signals. The successful transfer relies on the match of the signal (frequency range) to the structures of the sound detector in the recipient animal.

The cicada produces sound by vibrating the tymbal membrane. Other cicadas detect this sound using patches of their exoskeleton called tympanum, which resonate to sounds produced by the tymbal. These sounds allow cicadas to attract mates in a short mating season. This is an example of communication between animals of the same species.

Insectivorous bats use echolocation using ultra high frequency sound to detect their prey. The sound signal reflects off the prey and is detected by the bats whose hearing frequency range includes high frequency sounds that they produce. Some moths can detect those high frequency sounds and so avoid predation by the bats, by moving away from these sounds. This is an example of communication between species.

Question 32 (a) (i)

Criteria	Marks
• Names the process	1

Sample answer:

Translation

Question 32 (a) (ii)

Criteria	Marks
• Indicates the main features of the steps that lead to a specific shape from a polypeptide chain • Relates the difference between a polypeptide chain and a protein in terms of multiple chains linking together • Relates protein to enzyme • Relates shape of the enzyme to a fit with the substrate it acts on, this being the function of the enzyme	3
• Identifies some of the steps in the formation of a protein from a polypeptide chain • Relates these processes to the development of the shape of the protein • States that enzymes are proteins	2
• Identifies a step in the formation of a protein from a polypeptide chain OR • Understands one aspect of a functional enzyme OR • Identifies at least one aspect of a polypeptide	1

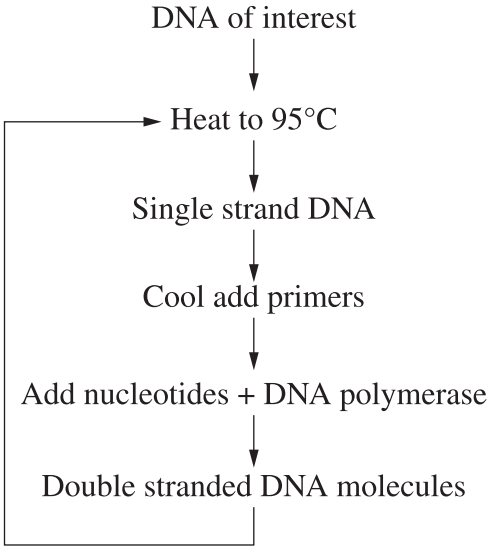
Sample answer:

The polypeptide chain folds up into a specific three-dimensional shape. Folded chains can then link together in a specific way. These processes shape the protein or enzyme. The shape of the enzyme defines the substrate it will act on. Acting on a specific substrate is the function of the enzyme.

Question 32 (b)

Criteria	Marks
• Provides sequential steps linked by arrows where each step follows logically, from the preceding step, in terms of PCR for DNA amplification • Clearly identifies conditions for each step • Clearly demonstrates chain reaction (repeat steps)	4
• Provides steps where most of the steps follow logically in terms of PCR for DNA amplification • Identifies conditions for most steps	3
• Provides ordered steps where some of the steps follow logically in terms of PCR • Identifies conditions for some steps	2
• Provides some correct information on manipulation of DNA	1

Sample answer:



Question 32 (c)

Criteria	Marks
• Demonstrates clearly one difference and one similarity between a traditional biotechnology and a biotransformational biotechnology	4
• Provides an example of each biotechnology • Identifies one difference or one similarity between the biotechnologies	3
• Provides relevant information about a biotechnology	2
• Names a relevant biotechnology	1

Sample answer:

A similarity between a traditional biotechnology and a biotransformational biotechnology is that both use micro-organisms to change feedstock chemicals into different forms by intracellular enzyme catalysed reactions.

They are different in that in traditional biotechnology the whole process of chemical change happens within the microorganism. In biotransformational biotechnology only some steps happen within the microorganism. Other steps are performed in the laboratory by artificial synthesis.

Question 32 (d) (i)

Criteria	Marks
• Identifies *Thiobacillus novellus* • Gives reasons for this choice with reference to appropriate data from the table	2
• Identifies *Thiobacillus novellus* • Gives a reason that relates to success in this context	1

Sample answer:

Thiobacillus novellus because it has a high plasmid uptake efficiency and so will be easily used in genetic engineering contexts.

Thiobacillus novellus has an optimum pH and pH range closer to that of blood than the other bacteria in the table.

Question 32 (d) (ii)

Criteria	Marks
• Describes the process for isolating the two species, including: – sterile agar prepared at pH 2.5 and pH 7.0 – mixture of strains streaked on both types of agar plates – details of appropriate sterile technique	4
• Describes the process, including: – sterile agar prepared at pH 2.5 and/or pH 7.0 – mixture of strains streaked on agar plates – details of appropriate sterile techniques	3
• Identifies: – mixture of strains streaked on agar plates – features of relevant sterile techniques used OR • Outlines the separation of bacterial strains at pH 2.5 and/or pH7.0	2
• Provides some information on the growth of bacteria	1

Sample answer:

Make two batches of agar plates: one batch with a pH of 2.5, one batch with a pH of 7.0.

Flame an inoculating loop in a Bunsen flame. Cool by touching on sterile agar. Touch the loop onto the mixture of bacterial strains.

Streak the pH 2.5 with the loop, while holding the lid of the plate just ajar to prevent airborne bacteria entering.

Re-flame and cool the loop and repeat to streak a plate at pH 7.0.

Incubate the plates until colonies begin to form.

Do not streak some pH 2.5 plates and some pH 7.0 plates to compare with the streaked plates to ensure that agar was sterile originally and that sterile techniques employed were working.

Question 32 (e)

Criteria	Marks
• Describes thoroughly specific biotechnology • Describes the known good outcomes of identified applications of their chosen biotechnology for society and/or the environment • Describes the known harm of identified applications of their chosen biotechnology for society and/or the environment • Makes a judgement of known good vs known harm for their biotechnology • Describes some doubts about risks that need further proof of lack of significance provided by the proposer(s) • Relates the discussion to the given ethical framework	7
• Describes specific biotechnology • Identifies a known good outcome of an application of their chosen biotechnology for society and/or the environment • Identifies a known harm of an application of their chosen biotechnology for society and/or the environment • Describes some doubts about risks that need to have some further proof of lack of significance • Relates to the given ethical framework and/or makes a judgement about their biotechnology	5–6
• Describes specific biotechnology • Identifies a known good outcome of an application of their chosen biotechnology for society and/or the environment • Identifies a known harm of an application of their chosen biotechnology for society and/or the environment • Describes some doubts about risks that need to have some further proof of lack of significance OR • Identifies a biotechnology • Sketches in general terms the benefits of their chosen biotechnology • Sketches in general terms the possible harms/risks of their chosen biotechnology on society and/or environment • Makes a supported ethical judgement about their biotechnology and/or relates to the given framework	3–4
• Provides some information relevant to the question	1–2

Sample answer:

GMOs are genetically modified organisms, ie they contain genes from another species of animal or plant. The genes that have been inserted into them provide for useful traits in the context of agriculture or animal husbandry.

The useful trait might mean that the GMO can be used for the good of society. An example of this is the insertion of a fish gene for antifreeze that has been inserted into strawberries to prevent the fruit from being affected by frost. This would increase farm productivity, make more food available and reduce the price of strawberries. However, does the inserted gene affect the other genes in the strawberry genome to change the food value of the strawberries in ways adverse to society?

Roundup-ready soybeans have a gene for tolerance to toxic weed killer inserted into their genomes. When used in agriculture, the farmer aerial sprays Roundup over the crops. This increases the toxic chemicals in the environment and the soybeans sold to the public might contain toxic residues of Roundup. These toxins can drift into natural ecosystems and biologically magnify in food chains. Does this harm outweigh the increases in farm productivity?

In the above cases the potential adverse effects should be studied and compared to the positive effects of increased farm productivity in order to decide the balance of good over harm. (Utilitarian ethics)

The proposers of the use of GMOs (chemical companies which profit from this) must be obligated to prove that the harm is not significant. For example, they must be able to prove that the genetic drift of GMO genes to non-GMO farms by insect cross-pollination does not occur. They should prove that residues of Roundup in crops are low or safe for human consumption. (The Precautionary Principle)

Since there is little evidence put forward to justify the safety of their use, I think that a valid case for the ethical use of GMOs has not been developed.

Question 33 (a) (i)

Criteria	Marks
• Correctly identifies component as a nucleotide	1

Sample answer:

Nucleotide

Question 33 (a) (ii)

Criteria	Marks
• Sketches in general terms activities of enzymes that can remove and replace damaged bases and nucleotides OR • Identifies that DNA codes for repair enzymes and sketches in general terms some activity of these enzymes	3
• Identifies activities that remove and replace DNA OR • Identifies activities of an enzyme that remove or replace DNA OR • Identifies that DNA codes for enzymes and provides the function of one type of enzyme	2
• Provides some relevant information about DNA repair	1

Sample answer:

DNA may be damaged through a variety of processes. Repair mechanisms rely on a range of different enzymes that are coded for by DNA. These enzymes have a range of functions such as:

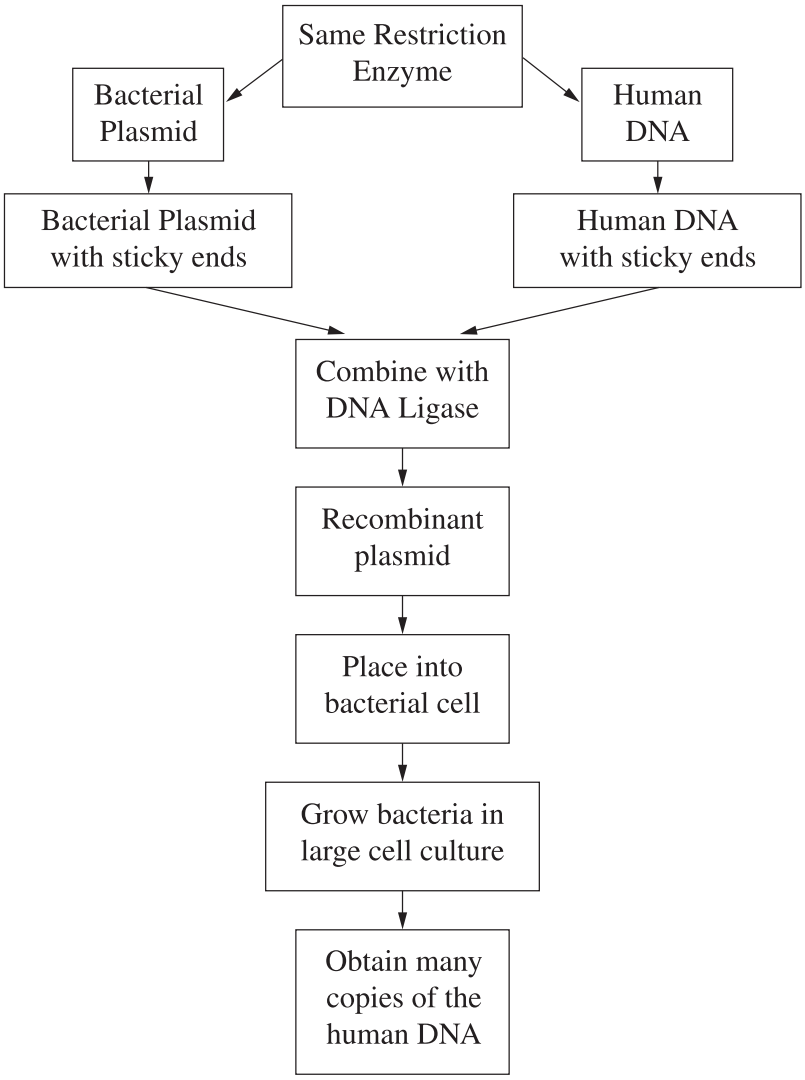
- base excision followed by deoxyribose and phosphate excision and the insertion of a replacement nucleotide via ligase
- nucleotide excisions and covalent bonding of multiple replacement nucleotides via ligases.

Question 33 (b)

Criteria	Marks
• Provides sequential steps linked by arrows where each step follows logically, from the preceding step, in terms of gene cloning • Steps with named enzymes in correct sequence • Gives correct product at completion of process	4
• Provides steps linked by arrows where most of the steps follow logically, in terms of gene cloning • A step with correctly named enzyme • Gives correct product at completion of process	3
• Provides steps linked by arrows where some of the steps follow logically in terms of gene cloning	2
• Provides some correct information on cloning	1

Sample answer:

Cloning the human insulin gene in *E.coli.*



Question 33 (c)

Assess the use of blood groups and highly variable genes for paternity testing.

Criteria	Marks
• Describes use of highly variable genes in paternity testing • Describes use of blood groups in paternity testing • Makes an appropriate judgement about the validity for each technology for paternity testing with supporting arguments	4
• Describes use of highly variable genes in paternity testing • Describes the use of blood groups in paternity testing OR • Describes one of the technologies used in paternity testing • Identifies a feature of the other technology • Makes an appropriate judgement for the described technology	3
• Describes one technology for paternity testing • Makes an appropriate judgement for the technology for paternity testing OR • Outlines the use of both technologies for paternity testing	2
• Provides some relevant information	1

Sample answer:

Highly variable genes are the repeat sequence of junk DNA found at defined locii in the human genome. Individuals vary in the number of repeat sequences for each allele at any one locus. Ten variable genes are isolated from the offspring and potential parent and are compared (using electrophoresis).

If the suspected father and the child share the same variable genes at the same locii and the mother does not, then the suspected father is almost certainly the child's father.

Using blood groups can give negative answers with clarity, eg a type O man could not be the father of a type AB child if the mother was type A. However if the man was type B he might be the father of the child, but not certainly. Another individual who is type B could also be the father, as type B is common.

The fact that blood groups are not as varied as the highly variable genes makes the blood group technologies less useful in paternity testing.

Question 33 (d) (i)

Criteria	Marks
• Provides relevant information from the table to explain how the same protein can be produced from different gene sequences	2
• Provides some relevant information from the table to verify the statement in the question	1

Sample answer:

DNA sequence is made up of a series of triplets (groups of three bases) that provide information for specific amino acids. There is more than 1 triplet that codes for a particular amino acid, so different codes can produce the same protein. For example in Species 2 the third base in the first triplet is different but still codes for the same amino acid, hence the protein produced is the same.

Question 33 (d) (ii)

Criteria	Marks
• Demonstrates a thorough understanding of genetic evidence for common ancestry in terms of similar genes and identical gene product • Demonstrates a thorough understanding of the genetic evidence required to determine evolutionary proximity in terms of number of mutations/percentage genetic difference as a measure of divergence • Explains a limitation and a strength of using the data shown for the matter under investigation	4
• Provides a limitation or a strength of the presented data for the matter under investigation • Demonstrates some understanding of genetic evidence for common ancestry in terms of similar genes and identical gene product	3
• Identifies a limitation or strength of the presented data for the matter under investigation OR • Demonstrates some understanding of genetic evidence for evolutionary relationships in terms of similar genes and identical gene product	2
• Some correct information pertaining to the data or the matter under investigation	1

Sample answer:

Strength of Data Use for Deducing Evolutionary Relationships

Despite having different amino acid sequences, the proteins produced by these genes are the same. Therefore any of these genes' products would initiate eye development in any of the species listed.

This provides strong evidence of close ancestry of all these organisms. Their common ancestor possessed an eye control gene not dissimilar to these, in amino acid sequence.

OR

Since the average rate of mutation is known, the number of mutations between organisms can be used as a measure of time since divergence from a common ancestor. The data on % genetic similarity in the eye control gene shows that Species 2 (85% genetic similarity) would be more closely related to the mouse than Species 4 (71.66% genetic similarity), because it must have diverged more recently.

Limitation of Data Use for Deducing Evolutionary Relationships

The data presented relates to one gene only, not the entire genome of the five species being compared. With the entire genome of the each organism taken into account, % genetic similarity figures might be different from that of the eye control gene. Hence the predictions of evolutionary relationships might be different.

OR

Back mutations can be masked in modern amino acid sequences, and so the estimated total number of changes to amino acid sequences over time would be in error. This would affect predictions of evolutionary relationships.

Question 33 (e)

Criteria	Marks
• Demonstrates understanding of homologous pairs of chromosomes controlling a trait, eg sex chromosomes in human females • Describes thoroughly the use of recombinant DNA technologies required to get the XIST gene into the genome of human cells • Demonstrates a thorough understanding of trisomy and its implications for human health • Explains the implications of the use of XIST gene to avoid trisomy in the human genome into the future	7
• Outlines that homologous pairs of chromosomes control traits, eg sex chromosomes in human females • Describes the use of recombinant DNA technologies required to get the XIST gene into the genome of human cells • Demonstrates an understanding of trisomy (in general terms) • Identifies the significance of the use of XIST gene to avoid trisomy	5–6
• Outlines that homologous pairs of chromosomes control traits, eg sex chromosomes in human females • Identifies a recombinant DNA technology(ies) required or classification as gene therapy to get the XIST gene into the genome of human cells • Demonstrates an understanding of trisomy (in general terms)	3–4
• Provides some information about genetics or gene technology relevant to the question	1–2

Sample answer:

During embryonic development, genes are switched on and off. The XIST gene switches off one whole chromosome in an homologous pair (one of the two X chromosomes in the cells of a normal human female). This is a normal function in the genomes of every human female, apparently.

Recombinant DNA technology using restriction enzymes can be used to remove the XIST gene which can be inserted into another chromosome. Within this technology, scientists can also use PCR gene amplification technologies to make many copies of this gene, and gene splicing technologies to introduce this gene into other parts of the human genome. The introduced XIST gene presumably silences the chromosomes it is spliced into.

Trisomy is a condition in which an individual has three chromosomes instead of an homologous pair. Down syndrome is an example of this, and is a serious disease involving many adverse phenotypic symptoms for the sufferer including shorter life span. Trisomy is a serious mutation and can occur in a range of chromosome pairs in the human genome and can cause many diseases.

The last experiment mentioned is attempting to use the XIST gene to silence one of the three chromosomes causing a trisomy. If successful the individual would have a normal phenotype, quality of life and lifespan. This is a completely new form of gene therapy and would be important to medicine in reducing the incidence of the phenotypes of trisomies like Down syndrome in the population.

Question 34 (a) (i)

Criteria	Marks
• States one feature that is used to classify humans as *Homo*	1

Sample answer:

Upright stance/parabolic jaw shape

Question 34 (a) (ii)

Criteria	Marks
• Sketches in general terms the difficulties of interpreting the data from fossils	3
• Identifies the difficulties of interpreting data	2
• Provides some relevant information	1

Sample answer:

Conflicting dates based on different technologies: carbon dating would give a low reliability age for fossil species older than 50,000 years.

Paucity of the fossil record: eg some species only recently evolved, rare rate of fossil formation generally, so few fossils of these species.

Different interpretations of the same evidence: eg objects around skeleton might suggest afterlife belief, but might not.

Question 34 (b)

Criteria	Marks
• Provides sequential steps linked, where each step follows logically from the preceding step, in terms of a dichotomous key about these primates • Provides observable features of animals correct in their contexts • Identifies all animals at the end branch points of the key	4
• Provides steps linked, where most of the steps follow logically in terms of a key about these primates • Provides observable features of animals mostly correct in their contexts • Identifies most animals in the question in the key	3
• Provides some steps linked, where some of the steps follow logically in terms of a key about primates OR • Provides distinguishing observable features of animals mostly correct in their contexts	2
• Provides a distinguishing observable feature of one animal OR • Provides correct features of a dichotomous key	1

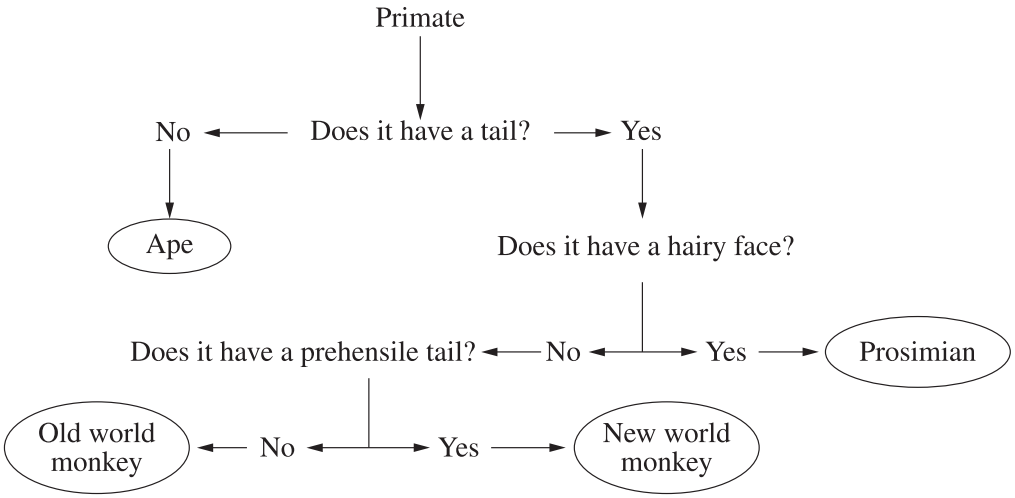
Sample answer:

Dichotomous Key

1. Has a tail ..... go to 2
   Does not have a tail..... Ape
2. Has a hairy face..... Prosimian
   Has a naked face..... go to 3
3. Has a prehensile tail..... New world monkey
   No prehensile tail..... Old world monkey

OR

Classification tree



Question 34 (c)

Criteria	Marks
• Demonstrates sound knowledge of applications which have arisen from the Human Genome Project • Relates applications of HGP to possible future trends in human evolution in terms of changes to gene frequencies or equivalent	4
• Demonstrates some knowledge of applications which arise from the Human Genome Project • Relates applications of HGP to possible future trends in human evolution	3
• Describes an application which has arisen as a consequence of HGP	2
• Provides some correct information about HGP	1

Sample answer:

The Human Genome Project has succeeded in mapping genes and identifying base sequences of the entire genome. Precise locations of disease-causing genes have been worked out, as well as their specific base sequences.

Genetic screening allows people to find out whether they hold defective genes and hence whether they are at risk of a genetic disease, even before symptoms appear. Modification of lifestyle could help to prolong life and increase the chances of the individual producing offspring. This could increase the frequency of the defective gene in the population.

Medicines (pharmaceuticals) can be designed to prevent expression of defective DNA using base sequence recognition chemistry. This would mean that holders of a defective gene would not experience a defective genotype and might live long lives and reproduce. The defective gene could become more common in the humans species as a consequence.

Question 34 (d) (i)

Criteria	Marks
• Describes the two general trends shown in the graph	2
• Describes a general trend OR • Compares two equivalent data points from each line	1

Sample answer:

- Average skin pigmentation decreases with distance from the equator
- At any particular distance from the equator, people in the northern hemisphere will have less pigmentation than people in the southern hemisphere

Question 34 (d) (ii)

Criteria	Marks
• Demonstrates understanding of polymorphism • Identifies an appropriate example of polymorphism • Describes selective pressures in the environment • Relates the adaptive advantage of variants in this phenotype to those selective pressures	4
• Identifies an appropriate example of polymorphism • Describes selective pressures appropriate to the example in the environment • Relates the adaptive advantage of variants in this phenotype to those selective pressures OR • Demonstrates understanding of polymorphism • Identifies an appropriate example of polymorphism • Describes selective pressures in the environment	3
• Outlines an appropriate feature of polymorphism OR • Describes how selective pressures in the environment have resulted in variation in the population	2
• Gives some relevant information about polymorphism OR • Describes the evolutionary significance of changes in skin colour with latitude	1

Sample answer:

Polymorphism is the occurrence of several different phenotypes in a population as a result of more than one form of the gene controlling that trait. These variations in phenotype can provide an adaptive advantage for organisms to different selection pressures in different environments.

Sickle-cell anaemia is an example. It is a genetic disease caused by a mutation in the gene for haemoglobin. The normal gene and the defective gene are co-dominant.

In heterozygous individuals, some red blood cells are sickled and some are normal. The oxygen-carrying capacity, though impaired, is not as adversely affected as in homozygous individuals.

Malaria is a potentially fatal disease in which the pathogen conducts part of its life cycle within the red blood cells of the host. Sickle cells in blood do not provide this habitat for the pathogen.

In tropical habitats where communities are prone to malaria, this heterozygous condition confers an adaptive advantage by providing protection against malaria and adequate oxygen transport.

Question 34 (e)

Criteria	Marks
• Demonstrates a sound understanding of relevant technologies • Describes the results generated by the relevant technologies • Relates the use of technologies and results to the deductions on hominin history • Identifies significant new ideas on hominin history • Describes fully how existing theories on hominin evolution could be modified as a consequence	7
• Demonstrates some understanding of relevant technologies • Describes the results generated by the technologies • Relates the use of technologies and results to the deductions on hominin history • Describes how existing theories on hominin evolution could be modified as a consequence	5–6
• Identifies a relevant technology and the use of the results it generates • Makes reference to ideas on hominin evolution OR • Identifies the significance of this new fossil find and describes how one existing theory could be modified as a consequence • Makes reference to a technology	3–4
• Provides some information about a relevant technology or an existing theory on hominin evolution	1–2

Sample answer:

Use of technologies and the results they generate

(i) Age of the Denisovan fossils
The fossil bone is intact, so radiocarbon dating is appropriate. Scientists would look at the ratio of carbon 14 to carbon 12 and compare it to the same ratio in living species. Using published half-life of carbon 12 they can calculate how many half-lives have elapsed. Approximately six half-lives would have elapsed for the radioisotopes in the Russian fossils for a 41, 000 age estimate.

(ii) Migration of Denisovans out of Africa
They would use a mt-DNA molecular clock, knowing the rate of mutation of mt-DNA. They could quantify the difference between mt-DNA from the Russian fossils and the Spanish fossils. Comparing this to a known rate of mitochondrial DNA mutation they can see how much time has elapsed between Spanish fossil forms and Russian fossil forms. This gives an indication of the dates of migration, and the rates of migration. They could work backwards to estimate time leaving Africa.

New ideas on hominin history deduced
A new form of hominin (Denisovan) has now been discovered, descended from a separate migration out of Africa (600,000 years ago), later than the *Homo erectus* migration (1.4 million years ago), but earlier than *Homo sapien* migrations (80,000 years ago). This hominin was very successful, being of a large population and moving over great distances in a long history on the planet.

This hominin interbred with other hominins including our own species *Homo sapiens* (likely 60,000 – 80,000 years ago) and Neanderthals possibly at a much earlier date.

Modify existing theories
(i) The former scientific thinking was the original Out of Africa hypothesis in which *Homo erectus* migrated out of Africa approximately 1.4 million years ago and diverged into other forms like Neanderthals or Peking Man. Once *Homo sapiens* left Africa approximately 60,000 years ago they displaced other hominins they encountered and so dominated the planet.

This new evidence requires the Out of Africa hypothesis to be modified to recognise significant interbreeding between hominins after the migration of *Homo sapiens* out of Africa. It also requires the acceptance of a new variety of hominin that was a contemporary of Neanderthals and which predates *Homo sapien*.

(ii) This evidence is further evidence against the multi-regional theory of human evolution. This evidence further supports the Out of Africa hypothesis.

Question 35 (a) (i)

Criteria	Marks
• Gives name of a relevant scientist	1

Answer could include:

One of Van Helmont, Hales, Priestley, Ingen-Housz, Senebier, Saussure

Question 35 (a) (ii)

Criteria	Marks
• Provides the main features of a 17th or 18th century experiment and its findings • Provides how the findings informed a conclusion	3
• Provides some features of an experiment • Provides a conclusion for the experiment	2
• Provides some relevant information	1

Sample answer:

Data collected
Saussure grew plants in a closed system and collected quantitative data:

- Initial and final mass of the soil
- Initial and final mass of the plant
- Mass of water added to the plant
- The mass of the carbon dioxide absorbed by the plant.

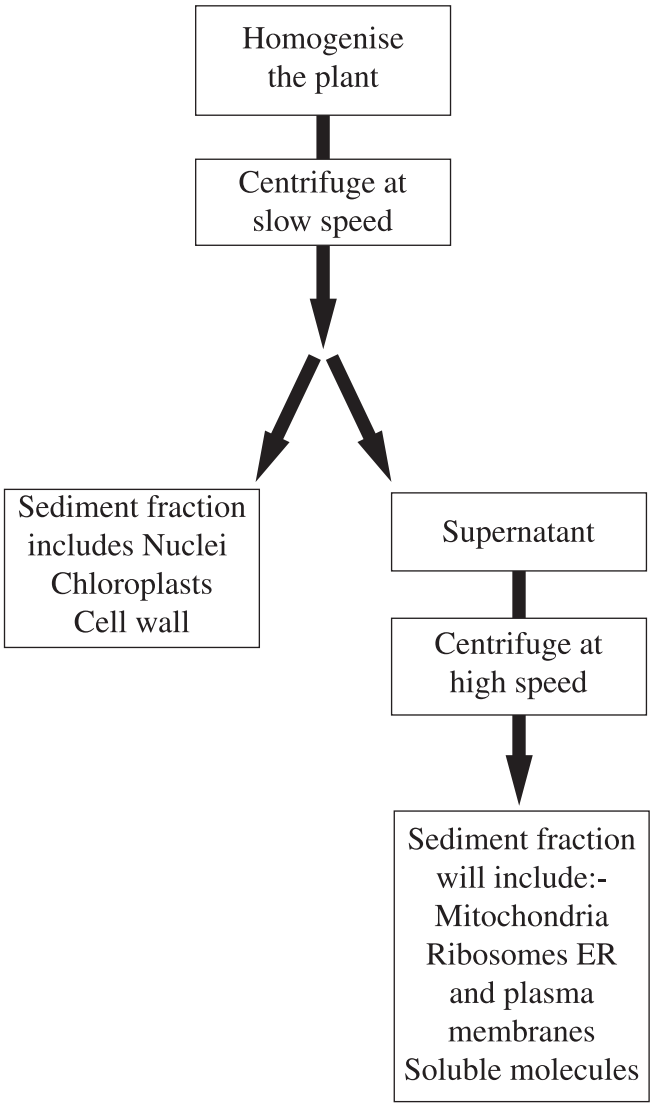
Data Analysis
The mass increase of the plant was larger than the combined mass of CO_2 absorbed and the minerals taken from the soil.

Conclusion
The plant's increase in weight could not be solely due to uptake of carbon dioxide from the air or minerals from the soil. Water uptake and incorporation into the plant also contributed to the mass gained by the plant.

Question 35 (b)

Criteria	Marks
• Provides sequential steps linked by arrows where each step follows logically, from the preceding step, in terms of preparation of plant cell fractions • Identifies correct processes and conditions • Identifies correct products at each stage	4
• Provides sequential steps where most of the steps follow logically in terms of preparation of plant cell fractions • Identifies some correct processes and conditions • Identifies some cell components at correct stage of process	3
• Provides steps where some of the steps follow logically in terms of plant cell break-up and separation • Identifies some correct processes OR cell components	2
• Provides some correct information on cell components	1

Sample answer:



Question 35 (c)

Criteria	Marks
• Demonstrates an in-depth knowledge of the design of Calvin's experiments • Relates exact timing of the pulse of radioactive carbon dioxide and the timing of killing the algal cells to the observation of sequential products of the reaction • Relates procedures to identify organic molecules in chromatography including comparison to standard chromatographs • Describes use of radioactive tags on carbon dioxide molecules made visible by X-ray film after the chromatography	4
• Demonstrates some knowledge of the design of Calvin's experiments • Provides links between some features of Calvin's experiments and the success of his experiments	3
• Demonstrates some knowledge of Calvin's experiments • Provides a link between a feature of Calvin's experiments and the success of his experiments	2
• Provides some information on Calvin's experiments	1

Sample answer:

The experiments carried out by Calvin exposed a unicellular algae to a pulse of radioactive carbon dioxide $^{14}CO_2$.

Samples of the algae at various time intervals were placed into boiling alcohol to kill the cells, denature the enzymes and to stop the metabolic pathway at different stages.

Each timed collected sample was broken up and then separated into separate metabolites using paper chromatography.

Placing the chromatogram over a sheet of X-ray film identified those lines on the chromatogram that contained metabolites containing the ^{14}C. The components were identified by comparison to control chromatograms of known organic substances.

Early metabolites in carbon fixation would be found tagged with ^{14}C in the earliest chromatograms. Later metabolites in carbon fixation would be found tagged with ^{14}C in the samples of the algae in later chromatograms.

In this way Calvin was able to identify each sequential molecule in the biochemical pathway in the light-independent reaction.

Question 35 (d) (i)

Criteria	Marks
• Provides the formula for each radioactive tracer used, with each radioactive tracer clearly linked to the correct experiment	2
• Provides the formula for one radioactive tracer, with the radioactive tracer clearly linked to the correct experiment	1

Sample answer:

Experiment 1 $H_2{}^{18}O$

Experiment 2 $C^{18}O_2$

Question 35 (d) (ii)

Criteria	Marks
• Makes reference to specific numbers in the result table for each of Experiment 1 and Experiment 2 • Identifies appropriate relationships between the data in the table and the mechanism of the reaction of photosynthesis for each experiment	4
• Gives an explanation for the results of Experiment 1 and Experiment 2 in terms of the mechanism of the photosynthesis reaction	3
• Gives some information about the mechanism of the photosynthesis reaction • Outlines the use of radioactive tracers in the study of photosynthesis	2
• Gives some information about the mechanism of the photosynthesis reaction or the use radioactive tracers in the study of photosynthesis relevant to the question	1

Sample answer:

Ratio of ^{18}O to ^{16}O is high in reactant H_2O (0.900) and high in product O_2 (0.857) in Experiment 1 because the oxygen released in photosynthesis comes from the reactant water molecule. The water is split in the light reaction releasing oxygen into the air.

$$2H_2{}^{18}O \longrightarrow {}^{18}O_2 + \text{combined hydrogen (glucose)}$$

The oxygen–18 in the carbon dioxide (0.850) in Experiment 2 goes into the glucose molecule, which is another product of photosynthesis, not into the oxygen product (0.003 which is effectively zero).

$$C^{18}O_2 \longrightarrow C^{18}{}_6H_{12}O_6 + \text{combined oxygen (water)}$$

Question 35 (e)

Criteria	Marks
• Identifies the main ideas presented in the text • Explains the ideas using knowledge of the mechanism of the photosynthesis reaction • Demonstrates thorough knowledge of photosynthesis at the molecular, intra-organelle, photosystem and enzyme/co-enzyme level • Relates knowledge of photosynthesis to problem-solving in the development of high efficiency renewable energy technologies with implications for society and the environment	7
• Identifies most of the main ideas presented in the text • Explains the ideas using knowledge of the mechanism of the photosynthesis reaction • Demonstrates a good knowledge of photosynthesis at the molecular level • Relates knowledge of photosynthesis to problem-solving for society and the environment	5–6
• Identifies some ideas presented in the text • Explains the ideas using knowledge of photosynthesis OR • Identifies some ideas presented in the text • Relates knowledge of photosynthesis to problem-solving for society and the environment	3–4
• Provides some features of photosynthesis OR • Identifies one social implication of the ideas presented in the text	1–2

Sample answer:

Chemical bottlenecks waste captured light energy as heat

(i) Downstream electron transfer less efficient

ATP synthesis in photosystem I occurs as excited electrons are passed from protein to protein in the electron transport chain. For the energy of the electron to be effectively captured, ADP and P must be available to make ATP. If this is not the case the small quanta of energy from each movement of the electrons between embedded proteins will not be captured into ATP and will be lost as heat.

ATP synthesis at the end of photosystem II relies on the diffusion of H+ ions from the stroma to an enzyme in the thylakoid membrane (ATP synthase). Enzyme catalysed reactions can be slow and depend on substrate concentration and temperature. This could be a bottleneck.

(ii) Downstream carbon fixation less efficient

The Calvin cycle of reactions happens in the stroma where dissolved enzymes catalyse a cycle of reactions. Co-enzymes ATP and NADPH from the light reaction must diffuse through the stroma and find the appropriate enzyme and substrate to act on. These enzyme-catalysed reactions can be affected by concentration of reactants.

Modified the expression of chlorophyll-b genes in algal cells

The main chlorophyll molecule responsive to light is chlorophyll-a. Ancillary pigments like chlorophyll-b are tuned to light of different frequency and can collect extra light to excite electrons and channel them towards chlorophyll-a.

If these chlorophyll-b molecules were modified to be ineffective, less light energy would be transferred to electrons and more light energy would be transmitted to deeply located algae cells. This would make larger algal cultures photosynthesise more efficiently.

Implications for Society and the Environment

The use of micro-algal cells is a renewable energy technology which manipulates the efficiency of photosynthesis in large industrial scale cultures.

Human society faces an energy constraint as some traditional sources of energy dwindle (oil and natural gas), and with concerns with the carbon emissions from the burning of other traditional fuels like coal. Society needs more energy not less as third world countries progress to first world standards of living.

Being renewable this technology takes in carbon dioxide from the air in the photosynthesis of the algal cells, and returns the carbon dioxide to the air as the products of this technology are burned to release energy. The carbon is cycled, there is no net increase in the carbon in the atmosphere.

Reducing carbon emissions into the atmosphere is good for the environment: reduction of average temperature rise, prevention of melt of ice caps, reduction of habitat loss and species loss.

Answers could include:

Photosynthetic cells very efficiently capture light energy

This process is efficient because chlorophylls are excellent light absorbers because they possess delocalised electrons, which are sensitive to light. These electrons are easily excited by light of the right wavelength.

Two photosystems each tuned to a different wavelength, and linked by excited electron flow, allow electrons to be excited to very high energy levels in photosystem II.

Biology

2014 HSC Examination Mapping Grid

Section I
Part A

Question	Marks	Content	Syllabus outcomes
1	1	9.3.4.2.5	H7
2	1	9.2.3.2.5	H6
3	1	9.2.3.2.9	H6
4	1	9.2.3.3.4, 9.2.3.3.5	H6
5	1	9.4.2.2.2	H8
6	1	9.2.3.2.3	H6
7	1	9.3.1.3.1, 9.3.1.2.3	H10
8	1	9.2.2.3.6, 9.2.2.2.6	H6
9	1	12.4.b, 9.2.2.3.6	H12
10	1	9.3.3.2.6, 9.3.2.2.5	H9
11	1	9.4.3.2.3, 9.4.3.3.4	H7, H10
12	1	9.4.3.3.1, 14.2c, 11.2b, 12.3c	H11, H12, H14
13	1	14.1g, 14.3c	H14
14	1	9.2.2.2.6	H6, H14
15	1	9.3.3.2.6, 9.3.3.2.7	H9
16	1	9.3.5.2.2, 9.3.5.3.2	H7, H9
17	1	9.4.1.2.2, 9.4.5.2.1	H6
18	1	9.4.4.2.2, 9.4.5.2.1, 9.4.5.2.3, 12.3.c, 14.1a, 14.1d	H6, H12, H14
19	1	9.3.3.3.3, 14.1g, 14.1d, 14.1a	H9, H14
20	1	9.3.3.2.9, 14.3c	H9, H14

Section I
Part B

Question	Marks	Content	Syllabus outcomes
21 (a)	1	9.4.4.2.4	H6
21 (b)	2	9.4.4.1, 9.4.4.2.4	H6
22 (a)	4	9.4.2.2.1, 9.4.6.2.2	H4
22 (b)	2	9.4.2.2.2	H3
23 (a)	4	9.4.7.3.1, 11.2.a, 11.2.b, 11.2.c	H11
23 (b)	1	11.2d	H11
24 (a)	2	9.2.2.2.3, 13.1.(e)	H6, H13
24 (b)	2	9.2.2.2.3	H6
25 (a)	2	9.4.3.3.2	H1
25 (b)	4	9.4.5.2.3, 9.4.5.3.1, 9.4.3.3.2	H3, H6
26	5	9.3.1.2.3	H1, H9, H10

Question	Marks	Content	Syllabus outcomes
27 (a)	1	9.2.2.2.5, 14.1d	H6, H14
27 (b)	3	9.2.1.8, 9.2.1.3.3, 13.1(f)	H6, H13
27 (c)	3	9.2.1.2.8, 9.2.1.3.3.1(d), 14.1(b)	H6, H14
28 (a)	2	12.4(c), 12.4(e)	H12
28 (b)	4	9.2.1.2.2, 9.2.1.3.1, 9.2.2.3.1, 14.1(a), (d), (g)	H3, H14
29	5	9.3.5.2.1, 9.3.5.3.1, 9.3.3.2.4, 9.3.3.2.5, 9.3.3.3.1, 14.1(d), 14.3(c)	H2, H9, H6, H14
30	8	9.3.2.2.1, 9.3.2.2.2, 9.3.2.2.3, 9.3.3.2.1, 9.3.3.2.7, 9.3.4.3.3, 14.1(h)	H1, H2, H14

Section II

Question	Marks	Content	Syllabus outcomes
Question 31		**Communication**	
(a)(i)	1	9.5.7.2.1	H6
(a)(ii)	3	9.5.1.2.2	H6
(b)	4	9.5.6.2.2, 9.5.6.2.4, 13.1(e)	H6, H13
(c)	4	9.5.4.2.1, 9.5.4.2.2, 9.5.4.2.4	H6
(d)(i)	2	9.5.3.2.6, 12.3(c), 14.1(a)	H2, H12, H14
(d)(ii)	4	9.5.3.2.6, 12.3(b), 12.3(c), 14.1(a), 14.1(d)	H6, H12, H14
(e)	7	9.5.5.2.1, 9.5.5.3.2, 9.5.6.2.1, 9.5.6.3.2, 9.5.5.2.2, 14.3(c), 14.3(d)	H2, H14
Question 32		**Biotechnology**	
(a)(i)	1	9.6.4.2.1	H6
(a)(ii)	3	9.6.4.2.1	H6
(b)	4	9.6.5.2.2, 13.1(e)	H4, H1, H13
(c)	4	9.6.3.2.4	H1, H3
(d)(i)	2	12.3(c)	H2, H3, H12
(d)(ii)	4	9.6.3.2.3, 12.3(c), 14.1(a), 14.1(d)	H2, H3, H12, H14
(e)	7	9.6.7.2.1, 9.6.7.3.1, 9.6.7.2.2, 9.6.6.3.1, 14.3(c), 14.3(d)	H4, H6, H8, H7, H14

Question 33		**Genetics: The Code Broken?**	
(a)(i)	1	9.7.1.3.1, 12.3(c)	H12
(a)(ii)	3	9.7.6.2.2	H6
(b)	4	9.7.7.2.2, 9.7.7.2.3, 13.1(e)	H6, H13
(c)	4	9.7.2.2.4, 9.7.2.3.1, 13.1(e)	H1, H3, H13
(d)(i)	2	9.7.1.2.1, 9.7.1.3.2, 12.3(c), 14.1(b)	H6, H12, H14
(d)(ii)	4	9.7.8.3.1, 9.7.8.2.1	H9, H6
(e)	7	9.7.6.2.1, 9.7.4.2.3, 9.7.8.1.1, 14.3(c), 14.3(d)	H6, H9, H10, H14
Question 34		**The Human Story**	
(a)(i)	1	9.8.1.3.1	H6
(a)(ii)	3	9.8.2.2.5	H6
(b)	4	9.8.1.3.2, 13.1(e)	H6, H13
(c)	4	9.8.6.3.2, 9.8.6.1	H9, H10
(d)(i)	2	12.3(c), 14.1(a)	H12, H14
(d)(ii)	4	9.8.4.2.2, 9.8.4.3.1, 12.3(c), 14.1(g)	H10, H12, H14
(e)	7	9.8.2.2.6, 9.8.2.3.2, 9.8.2.3.3, 14.3(c), 14.3(d)	H1, H2, H9, H14
Question 35		**Biochemistry**	
(a)(i)	1	9.9.2.2.1	H1
(a)(ii)	3	9.9.2.2.1	H2
(b)	4	9.9.3.2.2, 9.9.3.2.3, 13.1(e)	H13
(c)	4	9.9.6.2.2, 9.9.6.2.4	H2
(d)(i)	2	9.9.5.1, 12.3(c), 13.1(d)	H12, H13
(d)(ii)	4	9.9.5.3.1, 9.9.5.2.4, 14.1(a), (d), (g)	H6, H14
(e)	7	9.9.1.2.1, 9.9.1.3.2, 9.9.5.3.2, 9.9.4.2.3, 9.9.4.2.4, 9.9.4.2.5, 9.9.4.2.6, 9.9.8.3.2, 14.3(c), 14.3(d)	H4, H14