BOSTES | BOARD OF STUDIES TEACHING & EDUCATIONAL STANDARDS NSW

2016 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	A
2	C
3	A
4	D
5	D
6	D
7	B
8	D
9	B
10	A
11	C
12	C
13	B
14	C
15	B
16	D
17	B
18	D
19	A
20	C

Section I, Part B

Question 21

Criteria	Marks
• Provides TWO benefits of artificial blood	2
• Provides ONE benefit of blood/blood products	1

Sample answer:

It does not need to be refrigerated.
It does not require cross-matching.

Question 22

Criteria	Marks
• Identifies an Australian ectotherm • Correctly describes its response to a decrease in ambient temperature	2
• Identifies an Australian ectotherm OR • Outlines a response to a decrease in ambient temperature	1

Sample answer:

The Eastern Brown Snake will bask in the sun when the ambient temperature falls.

Question 23 (a)

Criteria	Marks
• Provides a reason why the concentration of water in the cells should be maintained within a narrow range • Relates reason to optimal cell function	2
• Provides some relevant information	1

Sample answer:

Concentration of water in cells is maintained to regulate concentrations of solutes in cells. This provides appropriate substrate concentrations for metabolic function.

Question 23 (b)

Criteria	Marks
• Correctly completes the table	3
• Provides two correct effects	2
• Provides one correct effect	1

Sample answer:

Variable	*Effect*
Urine volume	Increase
ADH secretion	Decrease
Salt concentration in blood	Decrease

Question 24

Criteria	Marks
• Names an infectious disease • Describes a relevant host response • Links the response to defence adaptation	3
• Names an infectious disease • Provides relevant information about a defence adaptation	2
• Provides some relevant information	1

Sample answer:

Chickenpox is an infectious disease that triggers an immune response when a person is infected. Specific B and T cells will be activated and reproduce in large numbers to destroy the pathogen. Therefore the host survives.

Question 25 (a)

Criteria	Marks
• Relates the size of viruses to a limitation of light microscopes	2
• Provides some relevant information	1

Sample answer:

Light microscopes were not powerful enough to see the viruses which are very small in size.

Question 25 (b)

Criteria	Marks
• Relates Koch's postulates to establishing the cause of rabies	4
• Relates some of Koch's postulates to establishing the cause of rabies OR • Relates Koch's postulates to establishing the cause of a disease	3
• Provides relevant information about the use of microorganism identification and/or culture in establishing the cause of a disease	2
• Provides some relevant information	1

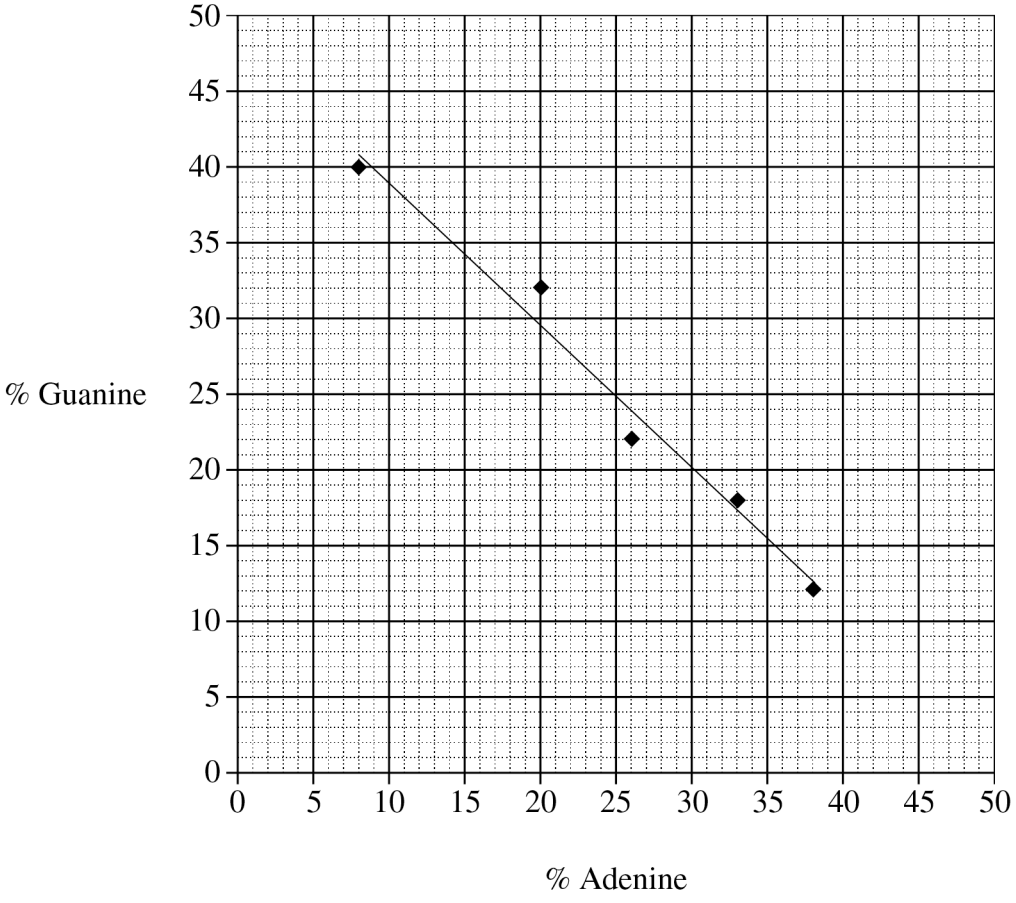
Sample answer:

Any number of microorganisms in the dog saliva may be causing rabies. Pasteur needed to identify the particular microorganism he suspected caused the disease and culture it. The microorganism had to be introduced into a healthy animal – if the animal developed rabies and the same microorganism was identified in the saliva then Pasteur could conclude that the particular microorganism caused rabies.

Question 26 (a)

Criteria	Marks
• Scales axes correctly • Plots data correctly • Draws a suitable line of best fit	3
• Scales axes correctly • Plots most points correctly OR draws a suitable line of best fit	2
• Scales axes correctly OR plots most points correctly OR draws a suitable line of best fit	1

Sample answer:



Question 26 (b)

Criteria	Marks
• Identifies a correct relationship	1

Sample answer:

As the % of Adenine increases, the % of Guanine decreases.

Question 26 (c)

Criteria	Marks
• Identifies the amount of A = T and G = C • Explains A and T and G and C should = 100% • Relates increase of one nitrogenous base in the data to a decrease in another shown by the data	3
• Demonstrates some understanding of the relationship	2
• Provides relevant information about bases in DNA	1

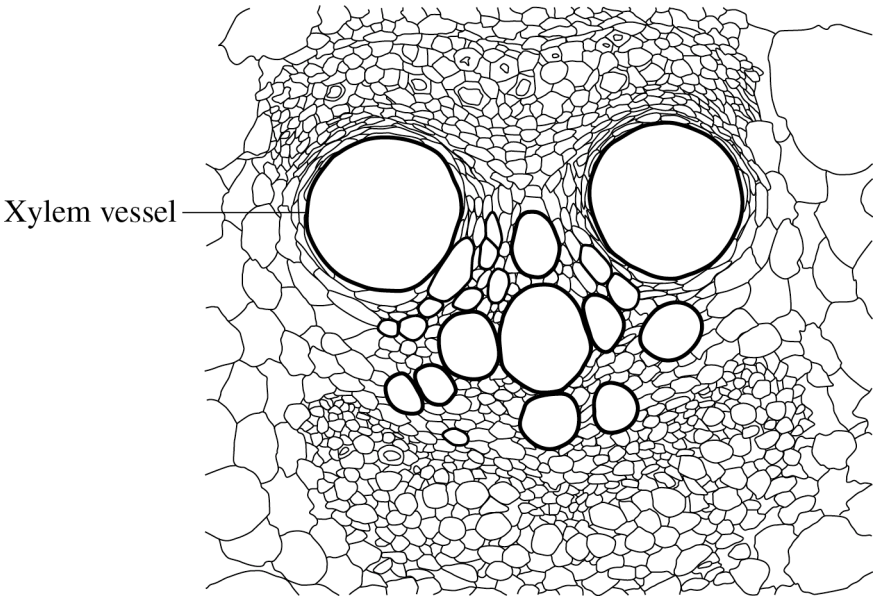
Sample answer:

The percentage of A = T and the percentage of G = C due to the base pairing rule. This means as A goes up, T will also go up because A = T and A + T + C + G should equal 100%. Therefore as A increases, the amount of G should decrease as there is a smaller proportion available.

Question 27 (a)

Criteria	Marks
• Correctly labels a xylem vessel	1

Sample answer:



Question 27 (b)

Criteria	Marks
• Identifies cause of wilting • Relates water transport in plants to xylem vessel function • Provides a possible effect of thin xylem vessel walls on the xylem function	3
• Relates water transport in plants to xylem vessel function • Demonstrates some understanding of the mechanism of wilting	2
• Provides some relevant information	1

Sample answer:

Leaves wilt when they lose water. Xylem tissue is responsible for water transport from roots to leaves. If xylem vessels collapse due to their thinner walls, the xylem vessels may not be able to transport water efficiently.

Question 28 (a)

Criteria	Marks
• Explains TWO advantages of bacteriophage treatment over antibiotic treatment for bacterial infections	4
• Explains ONE advantage of bacteriophage treatment over antibiotic treatment for bacterial infections • Identifies another advantage of bacteriophage treatment over antibiotic treatment	3
• Outlines an advantage of bacteriophage treatment over antibiotic treatment OR • Identifies TWO advantages of bacteriophage treatment	2
• Provides some relevant information	1

Sample answer:

Antibiotics are reduced in their effectiveness as bacterial pathogens have developed resistance to them due to natural selection. Bacteriophages are capable of mutation and may therefore evolve phenotypes that remain pathogenic to the mutated bacteria. Antibiotics usually act on more than one type of bacteria, and may therefore kill useful bacteria as well as pathogens, whereas bacteriophages only target the pathogen.

Question 28 (b)

Criteria	Marks
• Describes a possible disadvantage of the use of bacteriophage treatments	2
• Identifies a disadvantage of the use of bacteriophage treatment OR provides some relevant information about bacteriophages	1

Sample answer:

As bacteriophages can mutate there is a risk that they will be able to infect and damage human cells or a non-target bacteria, causing disease.

Question 29 (a)

Criteria	Marks
• Describes TWO experimental techniques relating to the flower structure • Relates these techniques to Mendel's success	3
• Describes TWO experimental techniques relating to flower structure OR • Describes ONE experimental technique relating to flower structure and relates it to Mendel's success	2
• Provides some relevant information	1

Sample answer:

He removed stamens from flowers in order to avoid self-pollination and therefore controlled the parents that were crossed.

He used a brush to transfer pollen from the anther/stamen of one plant to the stigma of another. These processes ensured he controlled which parental plants were crossed.

Question 29 (b)

Criteria	Marks
• Relates Mendel's experimental results to our knowledge of dominance and either segregation OR independent assortment	4
• Outlines Mendel's experimental results in terms of dominance or segregation or independent assortment	3
• State Mendel's ideas about dominance or segregation or independent assortment OR • Outlines one of Mendel's experimental results	2
• Provides some relevant information	1

Sample answer:

Mendel demonstrated that traits were controlled by two factors, that these factors did not blend, so either one was expressed or the other. These pairs of factors controlling different traits segregated during reproduction and did so independently of others.

His results allowed us to understand the dominant/recessive relationship between pairs of genes and the independent assortment of chromosomes.

Question 30

Criteria	Marks
• Describes features of vaccination and quarantine programs in the prevention of disease • Explains the effectiveness of the combined use of the programs	5
• Describes features of vaccination and quarantine programs in the prevention of disease • Outlines the effectiveness of the combined use of the programs	4
• Provides information relevant to the effectiveness of vaccination and quarantine programs	3
• Outlines a feature of vaccination or quarantine	2
• Provides some relevant information	1

Sample answer:

Quarantine is useful in the prevention of disease because it prevents animals being exposed to the pathogen. Vaccination is useful because it prepares the animal's immune system to respond to the pathogen meaning disease does not develop. However, quarantine doesn't provide any immunity against the disease, so if animals are exposed to the pathogen they can develop disease. Vaccination will prevent infection but immunity takes time to develop, so animals may be infected before the vaccine has an effect.

Neither strategy alone is guaranteed to prevent the disease. The most effective strategy to prevent the disease would be to use a combination of vaccination and quarantine simultaneously.

Question 31

Criteria	Marks
• Identifies and explains the differences between Species A and Species B • Explains the adaptive advantage of haemoglobin • Describes the effect of DNA mutation on the production of haemoglobin • Provides an explanation of the mechanisms of divergent evolution by natural selection for Species A and/or Species B • Links the data to the role of haemoglobin AND to the theory of evolution	8
• Identifies and explains the differences between Species A and Species B • Explains the adaptive advantage of haemoglobin • Provides an explanation of the mechanisms of divergent evolution by natural selection • Links the data to the role of haemoglobin AND to the theory of evolution	7
• Identifies and explains the differences between Species A and Species B • Outlines the adaptive advantage of haemoglobin • Describes the mechanisms of divergent evolution by natural selection • Links the data to the role of haemoglobin AND/OR to the theory of evolution	6
• Identifies the differences between Species A and Species B • Outlines the adaptive advantage of haemoglobin • Describes a mechanism of evolution by natural selection • Links the data to the role of haemoglobin OR to the theory of evolution	5
• Identifies a difference between Species A and Species B • Outlines the adaptive advantage of haemoglobin • Outlines a mechanism of evolution	4
• Identifies a difference between Species A and Species B • Outlines a role of haemoglobin • Identifies a mechanism of evolution	3
• Identifies a feature of evolution • Identifies a role of haemoglobin OR identifies a difference between Species A and Species B	2
• Provides relevant information	1

Sample answer:

Haemoglobin is a protein that provides a mechanism for efficient transport of oxygen around the body. It increases the amount of oxygen that can be carried in the blood stream as one single haem unit is able to carry four oxygen molecules. Species A and Species B have different haemoglobin structures that are able to reach 100% saturation at differing partial pressures of oxygen.

Species A and B are likely to have diverged from a common ancestor because of differing environmental pressures resulting in two different species. Within the ancestral population there was variation. In this case, a mutation resulted in haemoglobin that is able to reach 100% saturation at a lower partial pressure of oxygen. When members of the ancestral species moved to a higher altitude the ability of their haemoglobin to reach saturation at a

lower pO_2 gave them a survival advantage. These individuals were more likely to reproduce and pass on their favourable genes. For individuals living at lower altitudes, there is no survival advantage to being able to reach 100% saturation at lower pO_2 which means this trait was not selected for. Over time, due to the isolation at a higher altitude a new species has evolved.

Section II

Question 32 (a) (i)

Criteria	Marks
• Names the appropriate part of the body	1

Sample answer:

Larynx

Question 32 (a) (ii)

Criteria	Marks
• Outlines that vocal cords vibrate to produce sound • Relates tension in the vocal cords to changes in the frequency of the sound	2
• Outlines that vocal cords vibrate to produce sound OR • Relates tension in the vocal cords to changes in the frequency of the sound	1

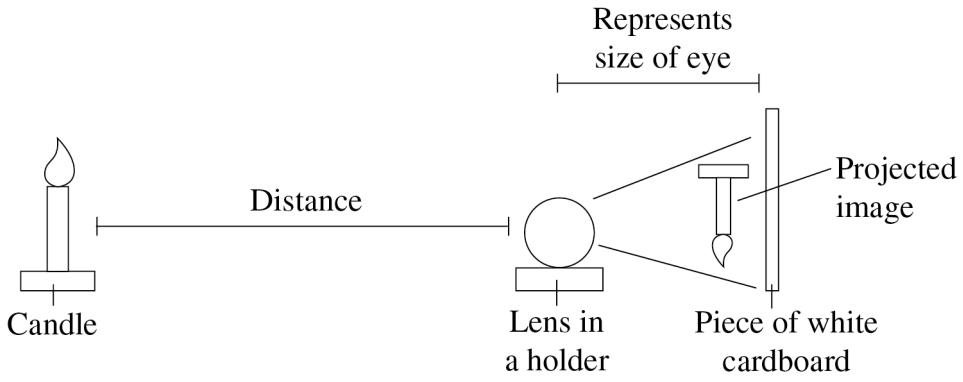
Sample answer:

Passage of air from the lungs causes vocal cords to vibrate to produce sound. The tension of the vocal cords can be varied to produce sounds of different frequencies.

Question 32 (b)

Criteria	Marks
• Demonstrates a thorough understanding of accommodation – Describes how lens shape is varied in the experiment – Describes how light from different distances is modelled – Relates the data collected to lens shape changing in accommodation	5
• Demonstrates a good understanding of accommodation – Describes how lens shape is varied in the experiment – Attempts to describe how light from different distances is modelled – Attempts to relate the data collected to lens shape changing in accommodation	4
• Outlines the experiment • Outlines how lens shape is varied • Identifies data collected as a result of changes to lens shape	3
• Outlines how lens shape is varied • Identifies a result of changes to lens shape OR identifies corresponding features of eye function	2
• Provides relevant information	1

Sample answer:



In the experiment the lens represented the lens in the human eye. The cardboard represented the retina and the candle was used to represent an object being viewed.

When a thick lens was used, the distance between the candle and the lens was small. This represents a person looking at an object close to them; the light needs to be converged to a higher degree to allow a clear image to be projected on the retina.

When a thin lens was used the candle needed to be moved much further away to gain a clear image.

Swapping the fat lens for the thin lens models the process of accommodation – altering lens thickness to allow focus on nearby and distant objects. Measuring the candle distance allowed a visual understanding of accommodation.

Question 32 (c) (i)

Criteria	Marks
• Describes the processes underlying the change in membrane potential allowing information transfer	2
• Provides some relevant information	1

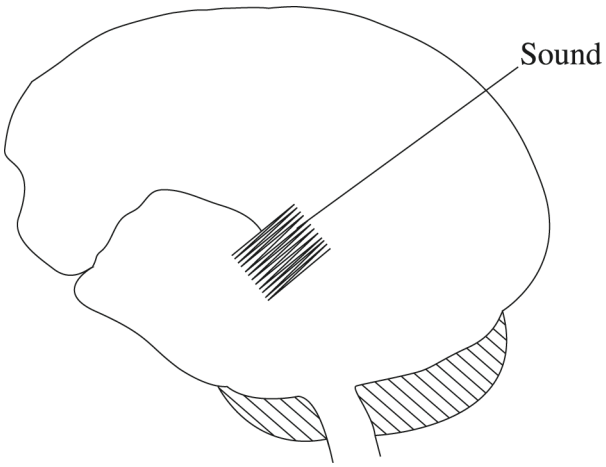
Sample answer:

Opening of membrane channels allows the movement of ions through the cell membrane. This temporarily changes the electrical charge inside the neurone from negative to positive, allowing information to be transferred along the neurone.

Question 32 (c) (ii)

Criteria	Marks
• Sketches a brain • Correctly identifies the region for perception of sound	2
• Sketches a brain OR • Correctly identifies the region for perception of sound	1

Sample answer:



Question 32 (d) (i)

Criteria	Marks
• Correctly describes the energy transformations occurring at the three locations	2
• Provides some relevant information	1

Sample answer:

1. Light energy is converted to electrical energy
2. Electrical energy is converted to sound energy
3. Sound energy is converted to electrochemical energy

Question 32 (d) (ii)

Criteria	Marks
• Names a relevant technology • Describes similarity(ies) and difference(s) to the eyeborg in terms of impact on users	4
• Names a relevant technology • Outlines an impact of the technology on users • Outlines similarity(ies) or difference(s) between the technology and the eyeborg	3
• Names a relevant technology • Identifies a similarity or difference	2
• Provides some relevant information	1

Sample answer:

Technology = contact lenses

Similarity to eyeborg

- Both require the user to wear an external device which must be removed, causing inconvenience

Difference to eyeborg

- The eyeborg does not allow the user to see colour, only perceive it while contact lenses allow the user to see ‘normally’ which increases their productivity.

Question 32 (e)

Criteria	Marks
• Identifies appropriate wave form for each of visual and auditory communication • Identifies the body organ and the specific component of that body organ in both visual and auditory communication • Describes the variation in receptors/receptor stimulation in the relevant body organ in both visual and auditory communication • Refers to the variation of incoming signals in visual and auditory communication • Relates the response of receptors to differing incoming signals to the detection of waves of differing frequencies in visual and auditory communication • Identifies that nerves from the brain and the brain centres are involved in perception of the frequency of the signal in visual and auditory communication	7
• Identifies appropriate wave form for each of visual and auditory communication • Identifies the body organ and the specific component of that body organ relevant to this context in both visual and auditory communication • Outline the variation in receptors in the relevant body organ in both visual and auditory communication • Refers to the variation of incoming signals in visual and auditory communication • Relates the response of receptors to differing incoming signals to the detection of waves of differing frequencies in visual and auditory communication	6
• Identifies appropriate wave form for each of visual and auditory communication • Identifies the body organ and the specific component of that body organ relevant to this context in both visual and auditory communication • Outlines the variation in receptors in the relevant body organ in visual and/or auditory communication • Relates the response of receptors to differing incoming signals to the detection of waves of differing frequencies in visual and/or auditory communication	5
• Identifies appropriate wave form for each of visual and auditory communication • Identifies the body organ and the specific component of that body organ relevant to this context in both visual and auditory communication • Outlines the response of receptors in the relevant body organ in visual and/or auditory communication	4
• Identifies appropriate wave form for each of visual and auditory communication • Identifies the body organ and the specific component of that body organ relevant to this context in both visual and auditory communication • Identifies the response of receptors in the relevant body organ in visual and/or auditory communication	3

• Identifies appropriate wave form for each of visual and/or auditory communication • Identifies the body organ and the specific component of that body organ relevant to this context in visual or auditory communication OR identifies a response of receptors to visual and/or auditory communication	2
• Provides some information relevant to the question	1

Sample answer:

Criteria	*Visual Communication*	*Auditory Communication*
Stimuli	Light waves of different frequency	Sound waves of different frequency
Organ	Eye	Ear
Organ component and receptor cells	Retina: photoreceptor cells called cones and rods.	Cochlea: hair cells in the organ of Corti.
Variation in receptor cells	Three types of cone cells are tuned to different light frequencies: red, blue and green. The three types of cones are evenly distributed in the fovea so colour can be correctly perceived from any part of the object being viewed. Rod cells contain only one type of light sensitive pigment. They are most sensitive to light and dark changes, shape and movement.	Hair cells of various lengths are distributed along the organ of Corti at different distances along its length.
Variation of incoming signals	Incoming light can be composed of a mixture of frequencies, and each frequency in the mix can be of a unique intensity. A typical human eye will respond to wavelengths from about 380 to 780nm.	Incoming sound can be composed of a mixture of frequencies. A healthy young person can hear sound frequencies from approximately 20 to 20,000 hertz.
Response to different stimuli	Depending on the frequency and intensity of the light signal, differing numbers of the three types of cone cells are stimulated to send signals down the optic nerve to the visual centre of the brain from any part of the retina. The effect of differing numbers of each type of cone cell firing allows for a range of different colours to be detected.	Sound signals of different frequencies make the basilar membrane in the cochlea vibrate in different modes. This membrane hits on the hair cells at different locations along the organ of Corti and stimulates them to send signals down the auditory nerve to the hearing centre of the brain (temporal lobe). Signals from individual hair cells along the auditory nerve to the hearing centre of the brain allow the perception of different frequencies by the brain.

Question 33 (a) (i)

Criteria	Marks
• Names the correct process	1

Sample answer:

Transcription

Question 33 (a) (ii)

Criteria	Marks
• Relates movement of mRNA to protein synthesis and location of ribosome	2
• Provides some relevant information	1

Sample answer:

Protein synthesis occurs at a ribosome (found in the cytoplasm). Transfer RNA (in the cytoplasm) carry amino acids needed for translation.

Question 33 (b)

Criteria	Marks
• Explains the importance of monitoring reaction conditions • Makes reference to data collected • Demonstrates a clear understanding of rate of reaction • Relates to an application of a specific biotechnology	5
• Describes the importance of monitoring reaction conditions • Makes reference to data collected • Demonstrates some understanding of rate of reaction • Relates to a biotechnology	4
• Outlines reaction conditions • Makes reference to data collected • Relates to a biotechnology	3
• Outlines reaction conditions • Makes reference to data collected	2
• Provides relevant information	1

Sample answer:

The experiment involved using fresh potato cores, which contained the enzyme hydrogen peroxidase. These cores were placed in test tubes of hydrogen peroxide solution (of the same concentration), and the test tubes placed into water baths of various temperatures (2°C, 8°C, 30°C, 50°C, 80°C), which contained a thermometer to observe the temperature.

The enzyme reaction in the test tube was:

Hydrogen peroxide $\longrightarrow$ water + oxygen

After 5 minutes reaction time the height of a column of oxygen bubbles collecting in each test tube was taken as a measure of the rate of the reaction. The faster reaction produced a largest column of bubbles in the first 5 minutes. The 30°C run produced the larger column of bubbles. At higher and very low temperatures only a very small column of bubbles.

The bubbling in the optimum temperature tube slowed after 15 minutes, presumably because the substrate concentration had fallen due to the reaction proceeding.

This helped to understand that conditions for enzymatic reactions in bread making must be managed for a fast rate of production of the fermentation product.

The process must be monitored to maintain optimal conditions for the enzyme to work at its fastest rate. The degree of bubbling could be monitored to determine the optimal enzyme rate. If it is a batch process, the enzyme function may cease after all the substrate is converted.

Glucose → Ethanol + carbon dioxide

Question 33 (c) (i)

Criteria	Marks
• Identifies that PCR amplifies DNA • Provides a reason for amplification in this context	2
• Provides some relevant information	1

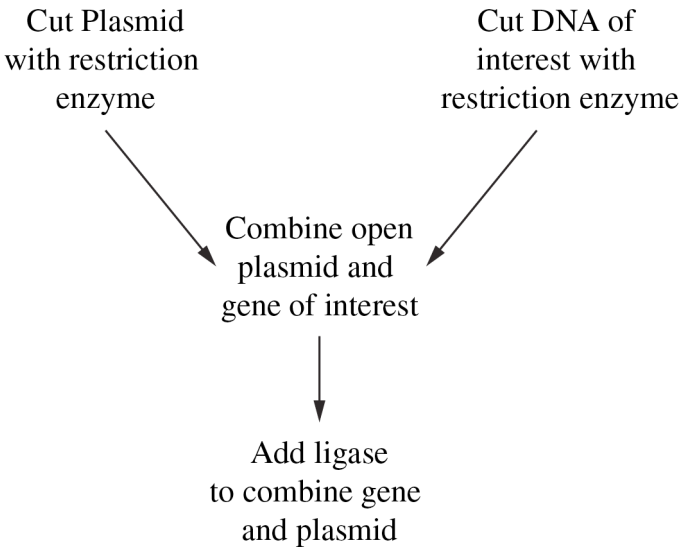
Sample answer:

PCR produces large numbers of copies of target DNA, which increases the chances of success of biotechnology applications.

Question 33 (c) (ii)

Criteria	Marks
• Provides a flowchart • Provides main steps in recombinant DNA formation	2
• Provides some relevant information	1

Sample answer:



Question 33 (d) (i)

Criteria	Marks
• States a benefit • Provides a reason for strain isolation	2
• Provides some relevant information	1

Sample answer:

Strain isolation involves identifying a target organism and growing it in pure culture by selecting a colony and transferring organisms to a culture medium. This ensures that only the desired strain is utilised in biotechnology. Ability to isolate specific strains of bacteria has led to the development of antibiotics.

Question 33 (d) (ii)

Criteria	Marks
• Explains the function of restriction enzymes • Describes applications that rely on restriction enzymes • Makes a judgement	4
• Identifies the function of restriction enzymes • Describes an application that relies on restriction enzymes	3
• Identifies the role of restriction enzymes • Provides an application that relies on restriction enzymes	2
• Provides some relevant information	1

Sample answer:

Restriction enzymes are naturally occurring enzymes that cut DNA at particular base sequences. Specific restriction enzymes cut specific sequences and leave ‘sticky’ ends. Understanding their function has led to the ability to manipulate genes as DNA is cut at a particular location. This has led to being able to cut plasmid and other DNA leaving matching DNA sticky ends. As a result genetic transformation of species such as bacteria that produce insulin has become possible. It has also become possible to mass-produce genes that can be used in gene therapy. The discovery of restriction enzymes was a crucial step in the development of recombinant DNA technologies for biotechnology applications.

Question 33 (e)

Criteria	Marks
• Defines artificial selection and animal cloning • Compares the processes to achieve artificial selection and animal cloning • Provides arguments against the claim that the biotechnologies are similar • Provides arguments for and against each process being aimed at improving characteristics • Makes an overall judgement about the statement	7
• Defines artificial selection and animal cloning • Compares the processes to achieve artificial selection and animal cloning • Provides arguments for and against each process being aimed at improving characteristics • Provides arguments against the claim that technologies are similar OR makes a judgement about the statement	6
• Defines artificial selection and animal cloning • Compares the processes to achieve artificial selection and animal cloning • Provides arguments for and against each process being aimed at improving characteristics OR provides arguments against the claim that technologies are similar	5
• Outlines artificial selection and animal cloning • Provides arguments for and against each process being aimed at improving characteristics OR provides arguments against the claim that technologies are similar	4
• Outlines artificial selection and animal cloning • Provides an argument for and against each process being aimed at improving characteristics OR provides an argument against the claim that technologies are similar	3
• Outlines artificial selection and/or animal cloning • Provides an argument against the claim that the technologies are similar OR • Provides an argument for or against a process being aimed at improving characteristics	2
• Provides some relevant information	1

Sample answer:

Artificial selection is the process of humans choosing organisms in a captive population for interbreeding to produce the next generation, at the exclusion of natural means of mate selection for that population. These choices of organisms are based on selection for desirable characteristics or characteristics to combine together for the next generation.

Cloning is the production of genetically identical individuals. In animal cloning a nucleus of the animal to be cloned is transferred into a de-nucleated egg. The now diploid egg begins the process of embryonic development and is implanted into a surrogate mother.

These technologies are not similar in process. Artificial selection requires no high tech lab equipment, rather the means to subdue and manipulate the activities of whole organisms using fenced paddocks and barns. Animal cloning requires technology to remove eggs from the surrogate and to remove the nucleus from those egg cells. It also requires technology to transfer a nucleus into a denucleated egg. Implanting the embryo into the surrogate mother requires even more technology.

While selective breeding is focused on developing improved characteristics in farm animals, animal cloning is focused not on improving the next generation but having it remain the same.

While artificial selection has achieved improvements in farm animal populations, sometimes increased yields can have adverse effects on the organism eg legs which cannot support the body weight. Ironically cloned animals do not have identical life experiences as their 'parent' eg many have experienced shorter lives than their 'parent'.

Overall the statement is not true.

Question 34 (a) (i)

Criteria	Marks
• Correctly names the process	1

Sample answer:

Whole organism cloning/animal cloning/cloning.

Question 34 (a) (ii)

Criteria	Marks
• Provides TWO valid reasons	2
• Provides ONE valid reason	1

Sample answer:

This allows only chromosomes from the animal to be cloned to be present in the resulting offspring. Ensures diploid offspring.

Question 34 (b)

Criteria	Marks
• Names an agricultural species • Defines selective breeding • Outlines at least TWO steps in the series resulting in identified successive varieties in the species • Relates changing phenotype to changing genotype	5
• Names an agricultural species • Defines selective breeding • Outlines at least ONE step in the series resulting in identified successive varieties in the species • Refers to changing phenotype and changing genotype	4
• Names an agricultural species • Defines selective breeding • Outlines at least ONE step in the series resulting in identified successive varieties in the species OR • Names an agricultural species • Defines selective breeding • Refers to changing phenotype and changing genotype	3
• Outlines selective breeding in terms of its effect on a species	2
• Provides some relevant information	1

Sample answer:

Modern day wheat is the product of many years of selective breeding. Selective breeding is the process by which farmers select parents with favourable characteristics in order to produce desirable characteristics in offspring.

Thousands of years ago early farmers selected grasses with favourable characteristics and crossed them to produce offspring with larger yields. In the 1800s William Farrer crossed varieties of wheat that were rust resistant with those that were drought tolerant. Over many years, this has resulted in wheat with high yields, resistance to fungal infections and drought tolerance.

The characteristics of rust resistance and drought tolerance are genetically determined. Selective breeding has resulted in the genes responsible becoming more common in the population. In the process of selective breeding wheat has gone from being diploid to being hexaploid, and this has increased vigour.

Question 34 (c) (i)

Criteria	Marks
• Provides TWO suitable examples of multiple alleles	2
• Provides ONE suitable example of multiple alleles	1

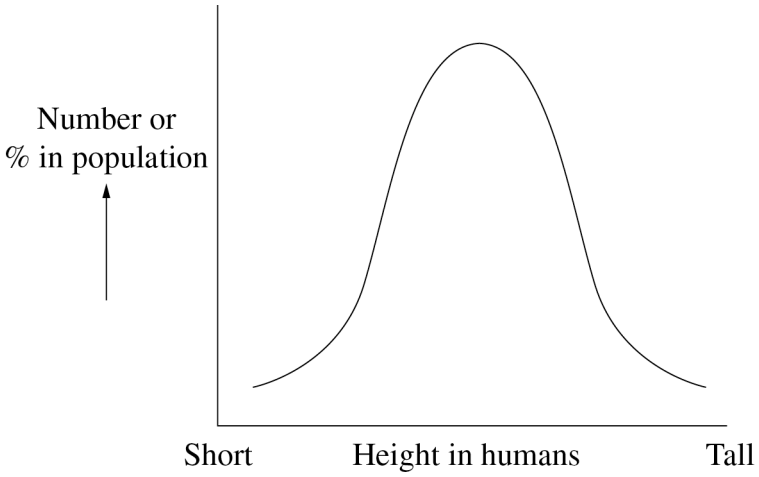
Sample answer:

The human population has three alleles for ABO blood group (I^A. I^B, i). Drosophila have more than 10 alleles for eye colour.

Question 34 (c) (ii)

Criteria	Marks
• Sketches a suitable graph showing variation • Includes named example of a polygenic trait • Correctly labels axes	2
• Provides some relevant information	1

Sample answer:



Question 34 (d) (i)

Criteria	Marks
• Provides relevant example • Provides key features of gene cloning	2
• Provides example OR • Provides some information about gene cloning	1

Sample answer:

Gene cloning is the process in which identical copies of a gene are produced. An example is the production of copies of the gene coding for insulin that can be inserted into bacteria that will then produce insulin.

Question 34 (d) (ii)

Criteria	Marks
• Describes mutations • Links an understanding of mutation to technologies • Provides a suitable judgement	4
• Describes mutations • Links an understanding of mutation to technologies OR • Describes mutations • Links understanding of mutation to a technology • Provides suitable judgement	3
• Outlines mutations and a technology	2
• Provides relevant information	1

Sample answer:

Mutation is a change in the DNA of an organism.

For example, understanding that cystic fibrosis can be caused by a mutation of the CFTR gene on chromosome 17 has led to the ability to screen for this mutation. For example, Fluorescent In Situ Hybridisation can now be used to detect the presence of the mutation in individuals.

The understanding of the nature of genetic mutations led to the improved DNA sequencing technologies employed in the Human Genome Project.

Knowledge of DNA and mutations has been the driving force behind the development of new technologies.

Question 34 (e)

Criteria	Marks
• Describes the structure and function of genes and proteins • Explains in detail the effect of genes on proteins • Explains in detail the effect of proteins on genes • Provides a suitable judgement	7
• Describes the structure and function of genes and proteins • Explains the effect of genes on proteins • Explains the effect of proteins on genes • Provides a suitable judgement	6
• Describes the structure and function of genes and proteins • Explains the effect of genes on proteins • Explains the effect of proteins on genes	5
• Outlines the structure and/or function of genes and proteins • Outlines the effect of genes on proteins • Outlines the effect of proteins on genes	4
• Outlines the structure and/or function of genes or proteins • Outlines the effect of genes on proteins OR outlines the effect of proteins on genes	3
• Provides relevant information about genes or proteins	2
• Provides some relevant information	1

Sample answer:

Genes are lengths of DNA. The building blocks of DNA are four different types of nucleotides with the bases adenine, thymine, cytosine and guanine. Within the DNA triplets of bases form codons that represent the genetic code for the production of a polypeptide. Genes provide the template for the production of mRNA which carries a copy of the genetic information to the ribosomes.

Ribosomes translate the mRNA codons into a chain of amino acids called a polypeptide, the primary structure of a protein. This polypeptide folds into a secondary and tertiary structure determined by the properties of the amino acids present in the chain. Several tertiary structures may combine to form a quaternary protein structure such as haemoglobin.

If the nucleotide sequence of a gene changes this may or may not change the polypeptide/ protein that it codes for as there are various codons that code for each amino acid.

The sequence and types of amino acids determine the function of a protein. This is because the amino acids determine the shape and the chemical properties of a protein. Both the shape and the chemical properties of proteins determine their function. For example enzymes are globular proteins with an active site that has specific physical and chemical properties determined by the amino acids present.

Proteins can interact with DNA and promote or inhibit the expression of genes. In this way a protein produced as a result of a gene may influence the transcription of other genes. One example of this is a gene cascade where the protein product of a gene results in a cascade of effects on a series of other genes that control the development of a limb in mammals.

While proteins have some influence on genes, genes are a more powerful influence on proteins and therefore evolution.

Question 35 (a) (i)

Criteria	Marks
• Correctly names the dating technique	1

Sample answer:

Relative dating.

Question 35 (a) (ii)

Criteria	Marks
• Identifies an appropriate dating technique • Describe how this dating technique could be used to compare ages of the fossils in the location	2
• Identifies an appropriate dating technique OR • States the need to compare the ages of the fossils	1

Sample answer:

Absolute dating could be used to determine the actual age of the fossil in each strata. The actual age of the fossil is determined, for example using carbon dating. The ages can then be compared.

Question 35 (b)

Criteria	Marks
• Identifies the relative number of amino acid changes in the protein • Provides relevant alternative data type • Discusses evolutionary relationships based on both data sets • Describes how reliability is improved by the use of both data sets	5
• Identifies the relative number of amino acid changes in the protein • Provides relevant alternative data type • Outlines evolutionary relationships based on both data sets • Describes how reliability is improved by the use of both data sets	4
• Identifies an amino acid change • Provides relevant alternative data type • Outlines evolutionary relationships based on both data sets • Outlines how reliability is improved by the use of both data sets	3
• Identifies the need for an alternative data type • Outlines how reliability is improved by the use of both data sets OR • Outlines evolutionary relationships based on data sets	2
• Provides some relevant information	1

Sample answer:

The amino acid data set shows that chimpanzees and humans have identical amino acids in this protein. Gorillas show one amino acid difference, new world monkeys show three amino acid differences and prosimians show four amino acid differences. On the basis of this data, it can be assessed that chimpanzees and humans are identical, followed by gorillas then new world monkeys and then prosimians.

Feature	*Humans*	*Chimpanzees*	*Gorillas*	*New world monkeys*	*Prosimians*
Position of foramen magnum	At the base of the skull	Almost at base of skull	Almost at the base of the skull	Between the back and base of the skull	Back of the skull
Tail	No	No	No	Yes	Yes
Relative size of brain	Largest	Second largest	Third largest	Second smallest	Smallest

The morphological characteristics outlined in the table would rank the organisms in evolutionary proximity as chimpanzees most closely related to humans but different species, followed by gorillas then new world monkeys and then prosimians. Both data sets correlate and therefore the estimates of evolutionary proximity to humans can be considered to be more reliable.

Question 35 (c) (i)

Criteria	Marks
• Identifies TWO relevant features of homologous chromosomes	2
• Identifies relevant information	1

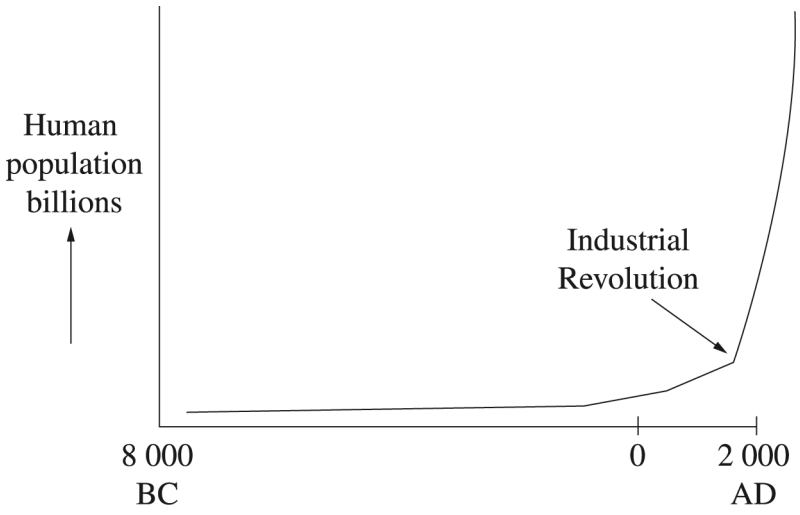
Sample answer:

The position of centromeres and the banding patterns present.

Question 35 (c) (ii)

Criteria	Marks
• Sketches suitable graph depicting human population growth trend over 10 000 years • Shows a relevant data point • Correctly labels axes	2
• Attempts to graph an appropriate trend	1

Sample answer:



Question 35 (d) (i)

Criteria	Marks
• Describes a key difference between fossils classified as genus Australopithecus or as genus Homo	2
• Provides some relevant information	1

Sample answer:

For a fossil to be classified genus *Homo*, it should indicate an upright stance and not stooped, as this would indicate genus Australopithecus.

Question 35 (d) (ii)

Criteria	Marks
• Identifies DNA sequence comparison between the fossil, *Australopithecus* and *Homo* species • Identifies that DNA in each organism is sequenced • Describes the data analysis of results of DNA sequencing for the problem to be solved	4
• Identifies that DNA in each organism is sequenced • Describes the data analysis of the results of DNA sequencing for the problem to be solved OR • Identifies DNA sequence comparison between the fossil, *Australopithecus* and *Homo* species • Describes the data analysis of the results of DNA sequencing for the problem to be solved OR • Identifies that DNA in each organism is sequenced • Identifies DNA sequence comparison between the fossil, *Australopithecus* and *Homo* species	3
• Identifies DNA comparison between the fossil, *Australopithecus* and *Homo* species	2
• Provides relevant information	1

Sample answer:

Mitochondrial DNA sequences of the fossil and a modern *Homo* species (eg *Homo sapiens*) could be compared to determine time since a common ancestor. If the time since a common ancestor is less than 2 MYA the fossil is likely to be of the *Homo* genus. If it is greater than 2MYA since a common ancestor it is likely that this fossil is either *Australopithecus* or another species.

Question 35 (e)

Criteria	Marks
• Describes biological evolution and cultural development using hominid examples • Explains in detail the influence of biological evolution on cultural development • Explains in detail the influence of cultural development on biological evolution • Provides a suitable judgement	7
• Describes biological evolution and cultural development • Explains the influence of biological evolution on cultural development • Explains the influence of cultural development on biological evolution • Provides a suitable judgement	6
• Describes biological evolution and cultural development • Explains the influence of biological evolution on cultural development • Explains the influence of cultural development on biological evolution OR • Describes biological evolution and cultural development • Describes the influence of biological evolution on cultural development • Describes the influence of cultural development on biological evolution • Provides a suitable judgement	5
• Outlines biological evolution and/or cultural development • Outlines the influence of biological evolution on cultural development OR outlines the influence of cultural development on biological evolution	3–4
• Provides some information about biological evolution and cultural development	2
• Provides some relevant information	1

Sample answer:

Biological evolution is the development of morphological characteristics due to mutation and natural selection. Genes for these new characteristics are passed to offspring during sexual reproduction. For example, precision grip is a characteristic of hominids that is controlled by genes for fine motor control of the hand. It was naturally selected as it allowed for more precise manipulation of objects. As a result, *Homo habilis* was the first tool user in human evolution, being capable of the precision grip.

Cultural development is the development of patterns of behaviour that are passed on from generation to generation through copying and learning. New culture is generated through innovative thinking. For example, the development of tools and the refinement of those tools from *Homo habilis* to *Homo sapiens* was a function of each generation of hominid improving on previously developed skills and passing these on to the next generation. However, tool use would not have developed without the biological development of precision grip.

The development of the larynx and its voice production potential (biological evolution) enabled a language system to develop between hominid groups (cultural development). This allowed synchronised hunting in cooperative groups.

Cultural developments such as modern medicine have allowed humans to live longer lives and to survive to a reproductive age despite defective genes in their genome. This has caused an increase in the frequency of defective genes in the population (biological evolution). While they each influence each other, biological evolution is more likely to drive cultural development.

Question 36 (a) (i)

Criteria	Marks
• Names the organelle	1

Sample answer:

Chloroplast

Question 36 (a) (ii)

Criteria	Marks
• Identifies TWO features of the location that link to requirements for the Calvin cycle	2
• Provides some relevant information	1

Sample answer:

The Calvin cycle takes place in the location X where there are enzymes to catalyse all the steps in the reaction, and the fluid stroma surrounds and makes contact with the grana which produce metabolites for the Calvin cycle.

Question 36 (b)

Criteria	Marks
• Explains the transformation of light energy into stored chemical energy • Explains the use of ATP in the light-independent reactions • Relates high energy phosphate bonds to energy storage • Directly or indirectly identifies the reaction between ADP and P • Refers to the use of ATP in all cellular metabolic processes	5
• Describes the transformation of light energy into stored chemical energy • Relates high energy phosphate bonds to energy storage • Directly or indirectly identifies the reaction between ADP and P • Refers to the use of ATP in cellular metabolic processes	4
• Outlines the transformation of light energy into stored chemical energy • Identifies the energy capture–release reaction between ADP and P • Refers to the use of ATP in cellular metabolic processes	3
• States that light energy is transformed into stored chemical energy • Identifies ATP or its uses	2
• Provides some relevant information	1

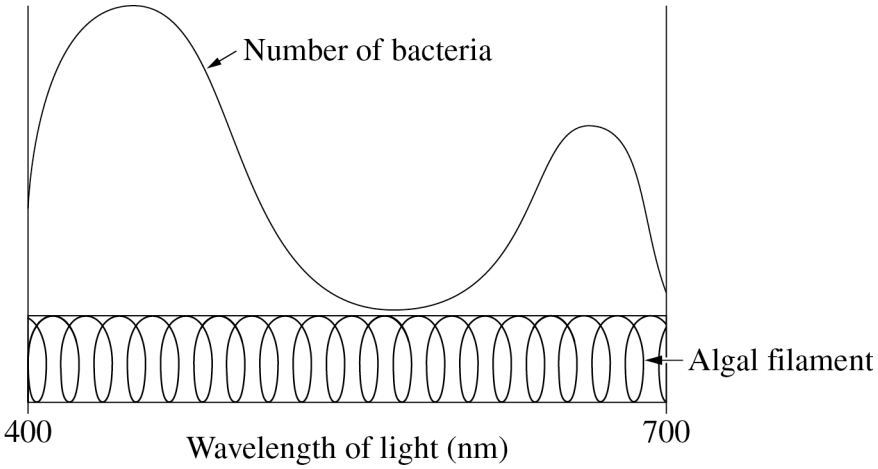
Sample answer:

Light energy is used to excite electrons, which results in the active transport of hydrogen ions and the photophosphorylation of ADP to ATP. The energy is stored in the high-energy phosphordiester bond that joins a phosphate group to ADP. The ATP produced in the light-dependent reactions may be utilised in the light-independent reactions in order to store energy in the bonds of glucose. ATP is also used as an energy source for nearly all metabolic processes. When ATP is utilised it returns to ADP and P.

Question 36 (c)

Criteria	Marks
• Provides a diagram which shows – Algal filament present and labelled – Appropriate range of values for wavelength of light arranged linearly – Aerobic bacteria present and labelled – Aerobic bacteria correctly distributed across the wavelengths	4
• Provides a diagram which shows – Algal filament present and labelled – Correct list of colours across the visible spectrum – Bacteria present and labelled – Bacteria correctly distributed across the wavelengths	3
• Shows bacteria clustering at either end of the diagram • Shows correct list of colours across the visible spectrum OR shows algal filament present and labelled	2
• Provides some information relevant to the question	1

Sample answer:



Question 36 (d) (i)

Criteria	Marks
• Identifies a similarity and a difference in corresponding processes • Identifies a similarity and a difference in corresponding products	4
• Identifies a similarity and a difference in corresponding processes • Identifies a similarity OR a difference in corresponding products	3
• Identifies a similarity OR a difference in corresponding processes • Identifies a similarity OR a difference in corresponding products	2
• Provides some relevant information	1

Sample answer:

	Plant leaf	*Artificial leaf*
Processes	Uses sunlight to excite electrons in a chlorophyll molecule to split water and generate oxygen, ATP and hydrogen attached to a coenzyme	Uses sunlight in a solar cell to make electricity to split water into hydrogen and oxygen
	A second step combines the hydrogen with carbon dioxide to form the glucose molecule	There is no second step
Products	glucose	hydrogen
	oxygen	oxygen

Question 36 (d) (ii)

Criteria	Marks
• Provides why artificial photosynthesis would be beneficial	2
• Provides some relevant information	1

Sample answer:

Artificial photosynthesis can be used to produce the renewable resource Hydrogen gas. This is less damaging than clearing land to grow biofuel crops such as corn. As fossil fuels decline, research into alternative, renewable energy sources is important.

Question 36 (e)

Criteria	Marks
• Describes the experiment of a scientist who studied changes in the environment around a plant • Describes the experiment of a scientist who studied changes in the internal environment of a plant • Describes each scientist's contribution to the understanding of photosynthesis • Makes a suitable judgement	7
• Describes the experiment of a scientist who studied changes in the environment around a plant • Describes the experiment of a scientist who studied changes in the internal environment of a plant • Identifies each scientist's contribution to the understanding of photosynthesis • Makes a suitable judgement	5–6
• Identifies the experiment of a scientist who studied changes in the environment around a plant • Identifies the experiment of a scientist who studied changes in the internal environment of a plant • Identifies each scientist's contribution to the understanding of photosynthesis	4
• Identifies the experiment of a scientist who studied changes in the internal OR external environment of a plant • Identifies the scientist's contribution to the understanding of photosynthesis OR • Identifies two relevant scientists • Gives an outline of their work and their contribution to the understanding of photosynthesis	3
• Identifies two relevant scientists • Gives an outline of their work OR • Gives a description of the work of one scientist	2
• Provides some relevant information	1

Sample answer:

In 1774 Joseph Priestley made observations about changes to the air around a living plant. He observed a candle would burn longer within a bell jar of air if a plant were included under the bell jar. He deduced that the burning of the candle was using up something in the air and thus had a limited burning time in a fixed volume of air. He further deduced the plant was reversing that change and restoring the air to allow the candle to burn longer.

Priestley later described a gas (oxygen) used up from air in combustion of the candle, yet released by plants. Adding oxygen to the outside air mixture can be termed a chemical transformation of air done by plants. This led to the understanding that photosynthesis produces oxygen.

Data collected inside the plant

The experiments by Calvin in the 1940s involved an illuminated flattened glass vessel, wide but thin, containing microscopic algae in solution. The algae were given a pulse of radioactive carbon dioxide ($^{14}CO_2$), injected into a stream of air into the vessel.

Samples of *Chlorella* were then released at intervals (3, 5, 10 seconds and then 15 second periods) into boiling alcohol to kill the algae and stop the progress of biochemical reactions containing the $^{14}CO_2$.

Compounds that the radioactive carbon had reached at a particular moment were determined by two-dimensional paper chromatography and autoradiography after the chlorella cells were broken up. New chemicals formed were deduced with the same results with chromatography of standard chemicals. For example, phosphoglycerate was identified as the first metabolite in the carbon cycle that was then changed into the glyceraldehyde phosphate.

In this way the series of chemical transformations of carbon compounds in the light-independent reactions of photosynthesis could be followed.

The work of scientists studying both the external and internal environments was essential in developing our understanding of photosynthesis.

2016 HSC Biology
Mapping Grid

Section I
Part A

Question	Marks	Content	Syllabus outcomes
1	1	9.2.1.2.1, 12.3(c)	H6, H12
2	1	9.4.4.3.1, 9.4.2.2.3	H6
3	1	9.3.3.2.1	H1
4	1	9.3.4.3.2	H2
5	1	9.2.1.3.1, 14.1(f)	H6, H14
6	1	9.2.1.2. 1	H6
7	1	9.2.3.2.6, 14.1(g)	H6, H14
8	1	9.3.2.3.1, 14.3(c)	H9, H14
9	1	9.2.3.2.4	H6
10	1	9.3.3.2.3, 12.3(c)	H9, H12
11	1	9.4.5.2.1	H6
12	1	9.2.1.2.9, 14.1(g)	H8, H14
13	1	9.3.3.2.4, 9.3.3.3.1	H9
14	1	9.3.2.2.5	H9
15	1	9.4.3.2.2, 14.1(a)	H7, H14
16	1	9.2.2.2.6	H8
17	1	9.2.2.2.3	H6
18	1	9.3.5.2.3	H7, H10
19	1	9.4.4.2.2	H5, H6
20	1	9.4.5.2.3, 9.4.5.2.2	H6

Section I
Part B

Question	Marks	Content	Syllabus outcomes
21	2	9.2.2.3.5	H3, H6
22	2	9.2.1.3.3	H6
23 (a)	2	9.2.3.2.1	H6
23 (b)	3	9.2.3.2.7	H6
24	3	9.4.4.2.4	H6
25 (a)	2	9.4.3, 9.4.3.2.2	H3, H8
(b)	4	9.4.3, 9.4.3.2.1	H3, H8
26 (a)	3	13.1(g)	H13
26 (b)	1	9.3.3.2.3, 14.1(a)	H9, H14
26 (c)	3	9.3.3.2.3, 12.4(c), 14.1(b), (g), (h)	H9, H12, H14
27 (a)	1	9.2.2.3.6	H6, H14
27 (b)	3	9.2.2.2.6, 9.2.3.3.7	H6, H10

Question	Marks	Content	Syllabus outcomes
28 (a)	4	9.4.3.3.4, 9.4.3.2.3	H3, H10
28 (b)	2	9.4.3.2.3	H10
29 (a)	3	9.3.2.2.1, 9.3.2.2.2, 9.3.5.2.1	H1, H2
29 (b)	4	9.3.2, 14.1(h), 14.3(c)	H2, H14
30	5	9.4.5.3.1, 9.4.7.2.1,9.4.7.3.2, 14.2, 14.3	H4, H14
31	8	9.2.2.2.2, 9.2.2.2.5, 9.3.1.2.1, 14.1(a), (g), (h), 9.3.1.2.3, 9.3.1.3.2, 9.3.3.2.9, 9.3.4.1	H6, H10, H14

Section II

Question	Marks	Content	Syllabus outcomes
Question 32		**Communication**	
(a) (i)	1	9.5.5.2.3, 12.3(c)	H6, H12
(a) (ii)	2	9.5.5.2.3, 9.5.5.2.2	H6
(b)	5	9.5.3.2.3, 9.5.3.3.1, 14.3	H6, H14
(c) (i)	2	9.5.7.2.2	H6
(c) (ii)	2	9.5.7.3.2, 9.5.7.2.4, 13.1(e)	H13
(d) (i)	2	9.5.6.2.4, 9.5.6.3.3, 12.3(c)	H3, H12
(d) (ii)	4	9.5.3.3.3, 9.5.3.2.5, 9.5.6.3.3, 14.1(g), (h)	H3, H14
(e)	7	9.5.4.2.1, 9.5.4.2.4, 9.5.7.2.4, 9.5.6.2.5	H6
Question 33		**Biotechnology**	
(a) (i)	1	9.6.4.2.1, 12.3(c)	H6, H12
(a) (ii)	2	9.6.4.2.1	H6
(b)	5	9.6.4.3.1, 9.6.2, 14.3(c)	H6, H14
(c) (i)	2	9.6.5.2.2	H4
(c) (ii)	2	9.6.5.3.2, 13.1(e)	H13
(d) (i)	2	9.6.3.2.2, 9.6.3.2.3	H6
(d) (ii)	4	9.6.5, 9.6.6	H3, H6
(e)	7	9.6.1.2.2, 9.6.1.2.3, 9.6.7.2.2	H10
Question 34		**Genetics: The Code Broken?**	
(a) (i)	1	9.7.7.2.3, 12.3(c)	H9, H12
(a) (ii)	2	9.7.7.3.2	H9
(b)	5	9.7.7.3.1	H10
(c) (i)	2	9.7.2.2.1	H6
(c) (ii)	2	9.7.2.2.3, 13.1(e), 9.7.2.3.2	H13
(d) (i)	2	9.7.7.2.2	H6
(d) (ii)	4	9.7.6	H3, H9
(e)	7	9.7.6, 9.7.1, 9.7.8	H9
Question 35		**The Human Story**	
(a) (i)	1	9.8.2.2.4, 12.3(c)	H3, H12

Question	Marks	Content	Syllabus outcomes
(a) (ii)	2	9.8.2.2.3	H3
(b)	5	9.8.2.2.6, 9.8.1.2.6, 14.1(a), (b), 12.3(c)	H9, H12, H14
(c) (i)	2	9.8.2.3.1	H1
(c) (ii)	2	9.8.6.3.1, 13.1(f)	H13
(d) (i)	2	9.8.3.2.2	H10
(d) (ii)	4	9.8.2.2.6	H9
(e)	7	9.8.5, 9.8.6.2.1	H10
Question 36		**Biochemistry**	
(a) (i)	1	9.9.8.2.1	H6
(a) (ii)	2	9.9.8.2.4, 9.9.8.3.2	H6
(b)	5	9.9.7.3.1, 14.1(g), 9.9.7.2.1, 9.9.7.2.2, 9.9.7.2.3	H6, H14
(c)	4	9.9.3.2.4, 13.1(e)	H6, H13
(d) (i)	4	9.9.1.2.1, 9.9.4.2.3	H6
(d) (ii)	2	9.9.1.2.1	H3
(e)	7	9.9.2, 9.9.3, 9.9.4, 9.9.5, 9.9.6	H2, H6