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2015 HSC Biology Marking Guidelines

Section I, Part A

Multiple-choice Answer Key

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

Section I, Part B

Question 21

Criteria	Marks
• Identifies an appropriate control measure • Relates the measure to the control of malaria	2
• Provides some information appropriate to the control of malaria	1

Sample answer:

Use of mosquito nets at night prevents mosquito bites.

Question 22

Criteria	Marks
• Relates a property of uric acid to its suitability as nitrogenous waste in insects	2
• Provides some information appropriate to the elimination of nitrogenous waste in insects	1

Sample answer:

Insects need to conserve water within their bodies and so must minimise water loss in their nitrogenous waste. Uric acid can be safely excreted in concentrated form as it has low toxicity.

Question 23 (a)

Criteria	Marks
• Identifies the process	1

Sample answer:

DNA replication

Question 23 (b)

Criteria	Marks
• Identifies TWO structural features	2
• Identifies ONE structural feature	1

Sample answer:

- Sugar-phosphate backbone
- Double helix.

Question 24 (a)

Criteria	Marks
• Provides correct reading	1

Sample answer:

97%

Question 24 (b)

Criteria	Marks
• Outlines TWO limitations of using only the data provided	2
• Provides ONE limitation of using the data provided	1

Sample answer:

- The data is provided without context eg is the person sleeping, resting or exercising when the data was collected?
- There are many other parameters of physical health: disease status, blood levels of toxic environmental substances, presence of cancers etc. There are other aspects of health eg mental health.

Question 24 (c)

Criteria	Marks
• Identifies TWO advantages of using a pulse oximeter • Names one other technology for measuring blood gases • Compares this technology to the pulse oximeter in terms of efficacy of use in the same specific setting	4
• Identifies TWO advantages of using a pulse oximeter • Names/outlines one other technology for measuring blood gases • Compares this technology to the pulse oximeter in terms of efficacy of use OR • Identifies ONE advantage of using a pulse oximeter • Names/outlines one other technology for measuring blood gases • Compares this technology to the pulse oximeter in terms of efficacy of use in the same specific setting	3
• Identifies at least ONE advantage of using a pulse oximeter in a specific setting OR • Identifies TWO advantages of using a pulse oximeter	2
• Provides some information relevant to the question	1

Sample answer:

The pulse oximeter can give you immediate and continuous data and is very portable being compact and battery operated. This makes it better than arterial blood gas determination from a blood sample that requires the sample to be analysed in a laboratory with a delayed and one-off reading. The pulse oximeter is better for an ambulance where fast and continuous data delivery in an emergency setting is required.

Question 25 (a)

Criteria	Marks
• Identifies a relevant hazard • Provides characteristics of a means of addressing the hazard	2
• Identifies a relevant hazard OR • Identifies a general safety technique relevant to the question	1

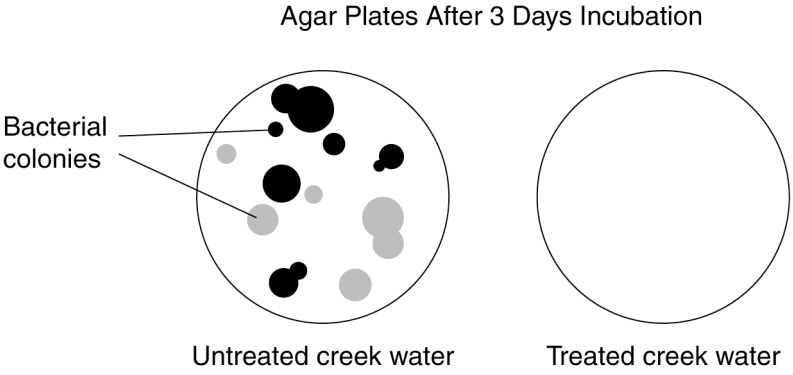
Sample answer:

The students might culture a pathogenic microbe. After the experiment they must heat the agar plates under high pressure to kill all cultured microbes before disposing of the plates.

Question 25 (b)

Criteria	Marks
• Uses clearly labelled diagrammatic form to illustrate experimental results • Results include a comparison of treated and untreated water • Provides appropriate data which support the conclusion	3
• Uses labelled diagrammatic form to illustrate experimental results • Results relate to treated and untreated water OR • Uses labelled diagrammatic form to illustrate experimental results • Results relate only to treated water • Provides data to support the conclusion	2
• Shows results appropriate to conclusion drawn	1

Sample answer:



Question 26

Criteria	Marks
• Correctly identifies a relevant tissue for a plant and an animal • Describes the structure of each tissue with correctly named features • Describes the workings of each tissue using correct scientific language • Provides corresponding structure and workings to contrast the plant and animal tissues	5
• Correctly identifies a relevant tissue for a plant and an animal • Describes the structure of each tissue with correctly named feature(s) • Describes the workings of each tissue using correct scientific language	4
• Correctly identifies a relevant tissue for a plant and an animal • Describes the structure for both organisms OR the workings of the tissue for both organisms OR • Correctly identifies a relevant tissue for a plant and an animal • Describes the structure and the workings of the tissue for either organism	3
• Correctly identifies a relevant tissue for a plant or an animal • Outlines the structure and/or the workings of the tissue	2
• Provides some relevant information	1

Sample answer:

	Plants	*Animals*
Tissue name	Phloem	Artery
Structure	A tube made from single cells joined end on end with ends of cells perforated to allow sap to flow from one cell to another	A tube made from many living muscle cells arranged in concentric layers around a hollow lumen.
Workings	Pressure flow due to active transport of sugar into tube followed by passive osmosis	Pressure flow due to pump action of the heart muscle and recoil of stretched artery

Question 27 (a)

Criteria	Marks
• Outlines TWO differences between whole blood and plasma	2
• Identifies a correct difference between whole blood and plasma	1

Sample answer:

Whole blood contains cells, plasma does not.
Plasma is a straw coloured liquid and whole blood is a thick red liquid.

Question 27 (b)

Criteria	Marks
• Identifies the features of the protocol which are relevant to effective treatment • Explains the effectiveness of the features for this disease treatment	3
• Identifies a feature of the protocol with an explanation of its effectiveness for disease treatment	2
• Provides some relevant information	1

Sample answer:

The plasma will contain antibodies for this disease because it has been taken from someone who has survived the disease. This will help to immobilise pathogen in recipients bloods stream.
Screening blood prevents the spread of Ebola and other blood-borne diseases from donor to recipient.

Question 28 (a)

Criteria	Marks
• Demonstrates an understanding of the validity of an experiment – Identifies some positive aspects of the experimental design – Identifies a variable that is not well controlled and explains why this variable would affect plant growth • Makes correct judgement on the validity of the experiment	3
• Identifies a positive and a negative aspect of the experimental design OR identifies a variable which is not controlled • Makes an appropriate judgement on the validity of an aspect of the experiment	2
• Provides some information relevant to the question	1

Sample answer:

The experiment is invalid because it does not control all variables well. As such, variables other than elevation could affect the height of the plants. Differences in plant height observed in different locations may be due to these uncontrolled variables and not elevation, or maybe not. Also, there is no reference made to the initial heights of the cuttings at planting, which may have been uncontrolled. The data cannot be used to support or refute the hypothesis.

While some variables, genotype, planting technique (watering and fertiliser), are all well controlled, there are other variables significant to plant growth that are not well controlled: exposure to prevailing wind, aspect (amount of direct sunlight on the plant).

The experiment has low validity.

Question 28 (b)

Criteria	Marks
• Uses elevation in first column • Lists correct elevations in numerical order • Columns contain appropriate headings and units	2
• Uses elevation in first column • Lists elevations in numerical order OR columns contain appropriate headings OR • Lists elevations in numerical order • Uses elevation in first column OR columns contain appropriate headings	1

Sample answer:

Elevation (10^2 m)	Plant Height (m)
1.2	10
1.4	15
1.6	7
1.9	12
2.2	4

Question 29

Criteria	Marks
• Describes a reproductive technique used in plant breeding • Describes a reproductive technique used in animal breeding • Provides arguments that these techniques limit genetic diversity • Provides an argument that these techniques do not limit genetic diversity	6
• Outlines a reproductive technique used in plant breeding and one used in animal breeding OR outlines one technique and identifies the other • Provides arguments that these techniques limit genetic diversity AND/OR provides an argument that these techniques do not limit genetic diversity	4–5
• Identifies a reproductive technique used in plant breeding AND/OR one used in animal breeding • Provides an argument that this technique limits genetic diversity AND/OR provides an argument that this technique does not limit genetic diversity	2–3
• Provides some information relevant to the question	1

Sample answer:

Artificial pollination is the transfer of pollen from the anther of one plant to the stigma of another. Artificial insemination is the collection of semen and its delivery into the reproductive system of a female, using equipment.

Both techniques can be used to increase the number of offspring that can be generated by one parent and therefore can result in decreased genetic diversity in the population. Other individuals in the population do not contribute to the next generation. For example semen from the same bull can be used to impregnate hundreds of cows, or pollen from one male flower is more likely to be transferred to a female flower.

However the reproductive techniques can both overcome geographical barriers and therefore allow genes to be spread more widely across the world. These techniques could increase genetic diversity by allowing interbreeding between geographically separated organisms, and generating new hybrids.

Answers could include:

Banks of sperm and pollen can be created to preserve endangered genes and allow them to be more prevalent in subsequent generations. This helps to prevent the loss of genetic diversity.

Question 30 (a)

Criteria	Marks
• Provides correct bird varieties	1

Sample answer:

Varieties *Z* and *Y*

Question 30 (b) (i)

Criteria	Marks
• Identifies all the population changes in section ①: fall of *Y*, rise of *Z* and plateau of *Z* • Explains the population changes in terms of natural selection	2
• Identifies a change in each population in section ① OR • Explains population changes in either *Z* or *Y* in terms of natural selection	1

Sample answer:

In Section 1 Variety *Z* is naturally selected as its numbers grow over time. The numbers of Variety *Z* plateau off as it reaches the limits of resources the environment can provide. Variety *Y* is not naturally selected as it is not suited to the environment and becomes extinct as its numbers fall over time to zero.

Question 30 (b) (ii)

Criteria	Marks
• Provides evidence for variety *X* being generated by mutation • Provides evidence for competition between varieties *X* and *Z* • Provides evidence for variety *Z* continuing as a minority variety in the species because it does not compete as well OR provides evidence for growth of the population of variety *X* stopping due to natural selection	4
• Provides some evidence for variety *X* being generated • Provides evidence for competition between varieties *X* and *Z* • Provides evidence for variety *Z* continuing as a minority variety in the species because it does not compete as well OR provides evidence for growth of the population of variety *X* stopping	3
• Provides a natural selection argument for the rise of variety *X* and fall of variety *Z*	2
• Provides some information relevant to the question	1

Sample answer:

In Section 2 Variety *X* develops, likely from mutation: a slowly growing population starting from zero.

Variety *Z* faces competition from variety *X*: the numbers of variety *Z* quickly fall as the numbers of variety *X* quickly grow.

Variety *Z* population remains at low levels due to the difficulty of competing for resources with variety *X*, yet they do not become extinct but become a minority variety in the species. The numbers of variety *X* plateau off at a lower level than variety *Z* as it reaches the limits of resources the environment can provide as some variety *Z* survive to use some of these resources.

Question 31

Criteria	Marks
• Identifies the relevant medical condition • Explains how the treatments are very different from each other • Describes biological knowledge relevant to the development of renal dialysis • Analyses a feature of renal dialysis as an innovation based on the identified biological knowledge • Describes biological knowledge relevant to the development of successful organ transplantation • Analyses features of organ transplantation as innovations based on the identified biological knowledge	8
• Identifies the relevant medical condition • Explains how the treatments are very different from each other • Describes biological knowledge relevant to the development of renal dialysis • Describes biological knowledge relevant to the development of successful organ transplantation	6–7
• Identifies the relevant medical condition • Explains how the treatments are very different from each other • Outlines biological knowledge relevant to the development of renal dialysis • Outlines biological knowledge relevant to the development of successful organ transplantation	4–5
• Identifies the relevant medical condition OR identifies how the treatments are different from each other • Identifies biological knowledge relevant to the development of either treatment	2–3
• Provides some information relevant to the question	1

Sample answer:

Medical condition

Both renal dialysis and kidney transplants can be used to treat kidney failure.

Different treatments

They are different treatments in that renal dialysis cleans the blood of the wastes outside the body by passing it through a machine, while a kidney transplant removes the damaged organ and replaces it with a new functional organ removed from a healthy person.

Renal dialysis: new application of biological knowledge

Diffusion is the movement of substances from regions of high concentration to regions of low concentration. Diffusion can happen across a semi-permeable membrane.

The new application of this knowledge in the design of a dialysis machine is to pass the blood through narrow tubing, which is permeable to urea. The dialysing solution surrounding the tubing is replenished to maintain a steep concentration gradient for the urea to be passed out of the blood by diffusion.

Kidney transplant: new application of biological knowledge

Knowledge of the immune system helped in the understanding of organ rejection in organ transplantation. Cell markers on donated organs are read by the specific immune system (B and T cells), which attacks the organ. Also, the switching off of the immune system by suppressor T cells stops the immune system after an infection has been removed.

The new application of this knowledge is immune suppressor drugs, developed to prevent the immune system from rejecting donated organs. Recipients use the drugs for their lifetime after receiving a donated organ.

Section II

Question 32 (a) (i)

Criteria	Marks
• Provides appropriate numerical value with correct sign and appropriate unit	2
• Provides appropriate numerical value	1

Sample answer:

–70 mV

Question 32 (a) (ii)

Criteria	Marks
• Explains that threshold potential not achieved (or stimulus is too weak during refractory period) • Makes reference to data in graph	2
• Provides that threshold potential not achieved (or stimulus is too weak) OR • Makes reference to data in graph	1

Sample answer:

If the stimulus is not intense enough, the threshold potential (–60 mV) is not achieved and an action potential is not set up.

Question 32 (b)

Criteria	Marks
• Provides features of detection of different wavelengths by two or more named animals – identifies in broad terms the ranges of each – describes how this results in a difference in vision – links to perceiving the same environment differently	4
• Provides features of detection of different wavelengths by two or more named animals – describes how this results in a difference in vision OR identifies range of vision in only one animal – links to their environment	3
• Provides features of ONE animal and links to its environment OR • Provides features of detection of different wavelengths by two animals	2
• Provides some relevant information about vision in animals	1

Sample answer:

Snakes are able to detect a range of the EM spectrum that includes infrared radiation as well as visible light. This enables them to detect endotherms for prey in the environment in the dark. Animals which do not detect infrared radiation, for example some insects, would not see the prey in the dark environment. Other predators without infrared receptivity will only see their prey in the light and may need to see the animal move in order to detect it.

Answers could include:

Insects can detect the visible part of the EM spectrum as well as ultraviolet light. Insects can see tracking lines on the petals of flowers that reflect ultraviolet radiation from the sun that cannot be seen by mammals. Mammals can only see the visible light wavelength spectrum and can therefore see the overall colour of the petals.

Question 32 (c)

Criteria	Marks
• Provides reasons for diversity of receptors in humans in relation to a range of stimuli • Provides features of TWO relevant types of receptors • Outlines the brain region involved for each receptor type	4
• Provides TWO types of receptors and their stimuli • Outlines the brain region involved for each receptor type named	3
• Identifies a type of receptor and identifies the brain region involved	2
• Identifies a receptor or brain region	1

Sample answer:

Humans are able to detect stimuli using several senses. Not all changes in the environment are from a single source and therefore humans have a range of receptor types. Each receptor is specific to a particular stimulus. Once activated these receptors send signals to the appropriate specific regions of the brain along sensory neurons. This leads to the detection and processing of a range of stimuli in the environment.

Photoreceptors in the retina of the eye detect light and relay information to the visual cortex of the cerebrum via the optic nerve.

Hair cells in the Organ of Corti in the ear detect different frequencies of sound and transmit this information via the auditory nerve to the hearing centre of the brain where it is interpreted.

Question 32 (d) (i)

Criteria	Marks
• Correctly predicts the relative volume in each ear • Provides a correct reason for the difference	2
• Predicts the relative volume in each ear	1

Sample answer:

If the wavelength of the sound is shorter than the length of the head, the ear closer to the source of the sound will detect a louder volume than the ear further away from the source of the sound. This is because the head blocks the path of the sound waves to the ear further away from the sound source.

Question 32 (d) (ii)

Criteria	Marks
• Correctly determines frequency is greater than 1400 Hz • Provides relevant steps – converts cm to m – interpolates on graph (Figure 2) – uses the relationship in Figure 1, $\lambda < \ell$ – uses Figure 2 to determine the range	4
• Makes ONE error in determining frequency range and provides the relevant steps OR • Correctly articulates some relevant steps using data from figures 1 and 2 and correctly determines the frequency range	3
• Correctly articulates some relevant steps OR • Determines correct frequency range without providing the relevant steps	2
• Provides some information relevant to the question	1

Sample answer:

Step 1: $\ell = 25$ cm $= 0.25$ m

Step 2: Using Figure 2, when $\lambda = 0.25$ $\lambda \Rightarrow$ frequency = 1400 Hz

Step 3: Using Figure 1, $\lambda < \ell$

$\therefore \lambda < 0.25$

Step 4: Using Figure 2, frequency > 1400 Hz

Question 32 (e)

Criteria	Marks
• Demonstrates a thorough understanding of accommodation • Identifies a problem in visual accommodation • Explains a solution to the accommodation problem using scientific knowledge • Describes a benefit to society of using the solution to solve the problem in accommodation • Identifies a problem in hearing • Explains the solution to the hearing problem using scientific knowledge • Describes a benefit to society of applying the solution to the problem in hearing	7
• Demonstrates a sound understanding of accommodation • Identifies a problem in visual accommodation • Describes a solution to the accommodation problem using scientific knowledge • Identifies a benefit to society or the individual of using the solution • Identifies a problem in hearing • Describes a solution to the hearing problem using scientific knowledge • Identifies a benefit to society or the individual of using the solution	6
• Demonstrates an understanding of accommodation • Identifies a problem in visual accommodation • Outlines a solution to the accommodation problem using scientific knowledge • Identifies a benefit to society or the individual of using the solution • Identifies a problem in hearing • Outlines a solution to the hearing problem using scientific knowledge • Identifies a benefit to society or the individual of using the solution	5
• Identifies a problem in vision • Identifies a solution to the problem in vision • Identifies a benefit of using the solution to solve the problem in vision • Identifies a problem in hearing • Identifies a solution to the problem in hearing • Identifies a benefit of applying the solution to the problem in hearing	4
• Identifies a problem in vision AND • Identifies a solution to the problem in vision AND • Identifies a benefit of using the solution to solve the problem in vision OR • Identifies a problem in hearing AND • Identifies a solution to the problem in hearing AND • Identifies a benefit of applying the solution to the problem in hearing	3
• Identifies a problem in vision • Identifies a solution to the problem in vision OR identifies a benefit of	2

using the solution to the problem in vision OR • Identifies a problem in hearing • Identifies a solution to the problem in hearing OR identifies a benefit of applying the solution	
• Provides any information relevant to the question	1

Sample answer:

Problems with hearing and vision pose a problem for society because they limit a person's ability to function normally in jobs or at home.

Such problems limit the ability of people to communicate, which can cause personal distress and limit their capacity to contribute to society. By overcoming these problems, both individuals and society benefit. When these problems are solved, people can continue to make an economic contribution. Additionally, they will not need carers, which may be costly to the public.

<u>One problem in hearing: limited transmission of sound through the ear</u>

Deafness can be due to failure of sound waves to produce vibrations in the tympanic membrane because of inadequate transmission through the ear canal. The mechanical energy of the vibration is transferred to the cochlea where it is transformed into action potentials that are transmitted into the cerebrum to allow sound to be perceived. A hearing aid works by amplifying the sound waves within the ear canal, increasing the energy being transmitted through the ear. In order to develop this technology, scientists relied on their understanding of the role of the eardrum and the science of electronics, which enabled them to produce a small amplifier.

<u>One problem in accommodation: myopia</u>

Accommodation is the change of the shape of the lens to focus on near or far objects. Without accommodation problems sharp images of objects at any distance can be focused on the retina.

One problem with accommodation arises when the lens cannot focus a clear image on the retina due to an elongated eyeball. Light rays converge in front of the retina. No clear image of distant objects is seen. This is called myopia.

The solution is to use another lens (concave) outside the eye to cause the light rays to bend before they move into the lens of the eye. This allows the light rays to converge on the retina allowing the person to see sharp images of distant objects.

Question 33 (a) (i)

Criteria	Marks
• Correctly identifies both products	2
• Correctly identifies one product	1

Sample answer:

Carbon dioxide and alcohol (ethanol)

Question 33 (a) (ii)

Criteria	Marks
• Provides characteristics and features of a relevant change to the fermentation process	2
• Provides some information relevant to the question	1

Sample answer:

The conditions changed from anaerobic conditions to conditions with high levels of oxygen. This was achieved by continuous aeration during the fermentation process.

Question 33 (b)

Criteria	Marks
• Identifies the release of DNA from cells as a step AND specifies the chemical(s) and conditions used to achieve this • Identifies the separation of DNA as a step AND specifies the chemical, conditions and techniques used to achieve this	4
• Recalls a detailed procedure for the extraction of DNA from a cellular source without reference to cell breakdown or isolation of DNA OR • Identifies one step used to release DNA from cells stating its purpose • Identifies one step used to separate the DNA from a cell suspension stating its purpose	3
• Identifies a chemical and a condition used in either the release of DNA from cells or separation of DNA from the cell	2
• Provide some information relevant to the question	1

Sample answer:

- Getting DNA out of cell
  Combine pulped cellular material with detergent in a clean beaker of water. Add salt and stir for several minutes.

- Isolating the DNA
  Gently pour chilled ethanol into the cellular mixture in a clean test tube creating a bi-layer. Use forceps to wind threads onto a stirring rod.

Question 33 (c)

Criteria	Marks
• Demonstrates a thorough understanding of biotechnology • Explains the process of domestication of species for agriculture • Describes the specific traits selected for an identified domesticated plant or animal used in agriculture • Relates the processes of domestication to aspects of biotechnology	4
• Demonstrates an understanding of biotechnology • Describes the process of domestication of species for agriculture • Describes a specific improved characteristic in the domesticated species OR • Demonstrates a thorough understanding of biotechnology • Describes the process of domestication of species for agriculture • Relates the process of domestication to aspects of biotechnology	3
• Outlines the process of domestication of species and identifies a specific improved characteristic in the domesticated species OR • Demonstrates an understanding of biotechnology and identifies a specific improved characteristic in the domesticated species OR • Demonstrates a thorough understanding of biotechnology and explains the process of domestication of species for agriculture	2
• Provides some information relevant to the question	1

Sample answer:

Biotechnology is the use of biological processes, organisms or systems to manufacture useful products to improve the quality of human life.

Domestication of species for agriculture was achieved by selective breeding (a biological process) of organisms to achieve favourable traits in offspring (useful product). Organisms with unfavourable traits were culled. In general terms this increased farm yields and reduced hunger within human populations (quality of life).

For example artificial selection of wild grasses (organisms) for non-brittle seed heads allowed for larger crop yields. Seeds were not lost from the plant during harvesting. Selection of plants with larger seeds also increased the food value of each grain harvested. These two new traits made the now domesticated grasses (wheats) useful and abundant food products.

Question 33 (d) (i)

Criteria	Marks
• Explains a benefit of using lactic acid fermentation in the production of cheese OR • Identifies benefits of using lactic acid fermentation in the production of cheese	2
• Provide some relevant information about the better production of cheese	1

Sample answer:

The fermentation of dairy products, eg using lactic acid to make cheese, prolongs the usability of the dairy product by lowering the pH and water availability, preventing unwanted bacterial growth as well as giving desired characteristics to the cheese such as flavour and texture.

Question 33 (d) (ii)

Criteria	Marks
• Makes an appropriate judgement about the students' conclusion using the data provided from both experiments • Explains appropriate data to support that 25°C produces the greatest conversion of lactose to lactic acid at pH 5 • Explains appropriate data to support that pH 5 produces the greatest conversion of lactose to lactic acid at 25°C	4
• Makes a judgement about the students' conclusion using the data • Identifies some data to support their judgement from experiment 1 and experiment 2 OR • Identifies optimum temperature with a justification with reference to data from experiment 1 • Identifies optimum pH with a justification with reference to data from experiment 2	3
• Identifies optimum temperature with a justification with reference to data from experiment 1 OR • Identifies optimum pH with a justification with reference to data from experiment 2	2
• Provides some information relevant to the question	1

Sample answer:

The conversion of lactose to lactic acid occurs due to the metabolism of the added bacteria. As lactose decreases, lactic acid increases in concentration in the substrate.

The students' conclusion was incorrect in that the data were not contradictory. In experiment 1, 25°C shows the greatest conversion of lactose to lactic acid. This was a total of 2.3% after 60 hours, whereas both 2°C and 35°C had less lactic acid produced with a total of 0.6% and 1.3% conversion to lactic acid respectively. Having identified 25°C as their optimum temperature, the pH experiment was conducted at this temperature – increasing the validity of the 2nd experiment.

In experiment 2, the lactose concentration (substrate) is lowest for pH 5. The other pH runs were higher. This means that more substrate was converted at pH 5. This value increases the validity of experiment 1.

Their data are not contradictory because both show that the conversion of lactose to lactic acid occurs optimally at 25°C and at pH 5.

Question 33 (e)

Criteria	Marks
• Demonstrates a thorough understanding of DNA technology • Identifies a medical condition which can be solved with a DNA/medical technology • Describes the scientific knowledge behind this named technology • Explains a benefit to society of using the technology in this medical setting • Describes a forensic setting in which a DNA technology can be used to solve a problem • Describes the scientific knowledge behind this named technology • Explains the benefits to society of using the technology in this forensic setting	7
• Demonstrates a sound understanding of DNA technology • Identifies a medical condition which can be solved with a DNA/medical technology • Describes the scientific knowledge behind this named technology • Identifies a benefit to society or an individual of using the technology in this medical setting • Describes a forensic setting in which a DNA technology can be used to solve a problem • Describes the scientific knowledge behind this named technology • Identifies a benefit to society or an individual of using the technology in this forensic setting	5–6
• Demonstrates some understanding of DNA technology AND • Identifies a medical condition which can be solved with a DNA/medical technology • Describes the scientific knowledge behind this technology • Identifies a benefit of using the technology in this medical setting OR • Describes a forensic setting in which a DNA technology can be used to solve a problem • Describes the scientific knowledge behind this technology • Identifies a benefit of using the technology in this forensic setting	3–4
• Identifies a medical condition which can be solved with a DNA/medical technology • Outlines the scientific knowledge behind this technology • Identifies a benefit OR • Identifies a forensic setting in which a DNA technology can be used to solve a problem • Outlines the scientific knowledge behind this technology • Identifies a benefit	2

OR • Identifies a medical AND a forensic setting which can be solved with a DNA/medical technology • Identifies a benefit	
• Provides information relevant to the question	1

Sample answer:

DNA technologies: Manipulation of DNA for useful purposes

Examples

Medicine

The treatment of diabetics with mass-produced insulin. This insulin is produced using genetic engineering and large-scale fermentation.

Forensics

DNA fingerprinting can be used to compare genetic samples gathered from crime scene and suspects. In this way police can both eliminate suspects and confirm criminals.

Science behind the technologies

Medicine

Normal genes for insulin are isolated from cells of a healthy individual using restriction enzymes. These genes are spliced into bacterial DNA using DNA ligase, and the hybrid bacteria are mass cultured to produce insulin.

Forensics

Restriction enzymes are used to cut gene sequences from crime scene samples. They are loaded onto gel electrophoresis equipment, along with the same genes from other samples. The genes traverse the gel at different rates providing a pattern of bands. Matching bands between samples can prove they are from the same source.

Solving problems of benefits to society

Medicine

A cheap and safe treatment for diabetics allows them to fully participate in society and in the workplace.

Forensics

This prevents innocent people from being wrongly incarcerated and allows them to participate fully in society. It also allows some crimes to be solved which were previously unsolved.

Question 34 (a) (i)

Criteria	Marks
• Identify B as Haploid or a gamete	1

Sample answer:

Haploid

Question 34 (a) (ii)

Criteria	Marks
• Identifies that mutation in somatic cell (A) only affects that organism • Identifies that mutation in gamete (B) can be passed on to all cells of the offspring • Identifies that gamete mutation would become more prevalent in the population/species	3
• Identifies that mutation in somatic cell (A) only affects that organism • Identifies that mutation in gamete (B) can be passed on to all cells of the offspring	2
• Shows some relevant information	1

Sample answer:

A mutation in cell A would just affect that one cell in one individual, not changing the species.

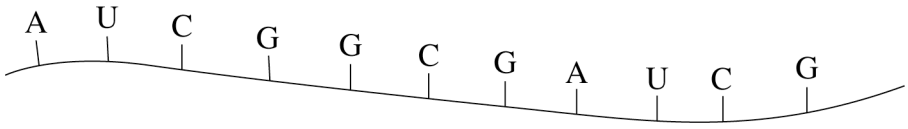
Cell B is a gamete. It could possibly be passed on to subsequent generations. Thus this mutation could become a feature within the population of that species.

Question 34 (b)

Criteria	Marks
• Clearly describes structure of both mRNA and tRNA • Provides link between the tRNA anticodon (or equivalent) and a specific amino acid • Clearly describes the interaction between mRNA and tRNA • Identifies the linkage of amino acids on adjacent tRNAs • Outlines the benefit of models in the comprehension of complex processes	4
• Outlines the structure of both mRNA and tRNA • Provides link between the tRNA anticodon (or equivalent) and a specific amino acid. • Outlines the interaction between mRNA and tRNA AND • Identifies the linkage of amino acids on adjacent tRNAs OR • Outlines the benefit of models in the comprehension of complex processes	3
• Identifies the structure of mRNA or tRNA AND • Identifies the interaction between mRNA and tRNA OR • Identifies the use of models to comprehend complex ideas	2
• Provides some information relevant to the question	1

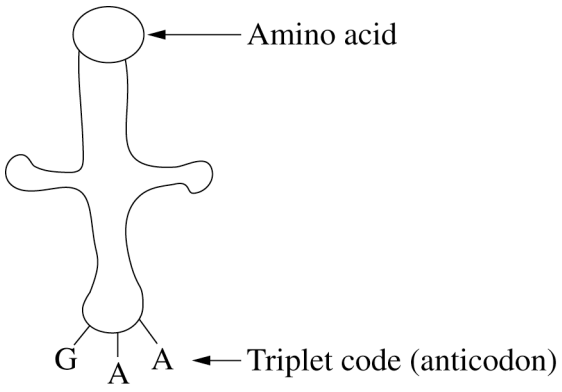
Sample answer:

mRNA – single strand RNA with nitrogenous bases exposed



tRNA – curved molecule of RNA. 3 nitrogenous bases exposed (anticodon) on one end of the molecule and a matching amino acid carried on the opposite end. [ie the amino acid carried on one end of tRNA is determined by the anticodon]

Sample answer (continued):



The anticodon on the tRNA pairs with a triplet code on the mRNA (codon) and the amino acids carried by the tRNA are then placed in order according to their codon-anticodon matching. The amino acids on adjacent tRNA molecules lined up on mRNA then form peptide bonds. Thus the structure of mRNA [sequence of bases] and tRNA offer a clear mechanism explaining how a sequence of amino acids is built. This model allows us to visualise this complex process.

Question 34 (c)

Criteria	Marks
• Provides relevant information on ideas on the action of genes • Links each idea to a correct identified feature of embryonic development	4
• Provides relevant information on an idea on the action of genes • Links the idea to a correct identified feature of embryonic development	3
• Provides relevant information on an idea on the action of genes	2
• Provides some information relevant to the question	1

Sample answer:

When genes are expressed they can produce proteins, which form part of the cell as a structural protein or an enzyme, or transcription factor that switches on another specific gene.

This explains how the embryo follows a step-by-step developmental pathway as each gene is switched on in a specific sequence and the embryo changes form in a specific order.

Some genes (master genes or hox genes) act to switch on the development of major body parts or segments. The transcription factors they produce switch on a sequence of genes called a gene cascade to build a complex body part like a limb. If the wrong master gene is stimulated the wrong body part will develop in a place in the embryo.

Question 34 (d) (i)

Criteria	Marks
• Calculates percentage of recombinants	2
• Use data from experiment 1 OR • Shows a correct method of calculating percentage recombinants	1

Sample answer:

$$\%\ \text{recombinants} = \frac{6}{60} \times 100$$

$$= 10\%$$

Question 34 (d) (ii)

Criteria	Marks
• Correctly reads from the reference graph the distance for gene loci B from E • Compares the distances between B and A from E • Makes a correct judgement on the conclusion of the student	2
• Makes a correct judgement of the conclusion based on qualitative analysis	1

Sample answer:

Reading from the graph, the distance between B and E is 17.5 map units
Therefore the distance between A and E (10) is less than the distance between B and E (17.5)
The student's conclusion is correct.

Question 34 (d) (iii)

Criteria	Marks
• States and justifies the need of results from cross breeding experiment to work out the distance between the gene loci A and B	2
• States the need of results to find the distance between gene loci A and B	1

Sample answer:

You would need to do another cross breeding experiment and use the results to work out the distance between the gene loci A and B because this data is not known.

Answer could include:

The cross breeding experiment should be AaBb × aabb.

Question 34 (e)

Criteria	Marks
• Demonstrates a thorough understanding of DNA technology • Outlines both a medical condition and a forensic setting which can be solved with a DNA technology • Describes the scientific knowledge behind both named technologies • Explains a benefit to society of using this technology in each of medical and forensic settings	7
• Demonstrates a sound understanding of DNA technology • Outlines both a medical condition and a forensic setting which can be solved with a DNA technology • Describes the scientific knowledge behind both named technologies • Outlines a benefit to society of using this technology in each of the medical and forensic settings	6
• Demonstrates a sound understanding of DNA technology • Identifies both a medical condition and a forensic setting which can be solved with a DNA technology AND • Outlines the scientific knowledge behind both named technologies • Identifies a benefit to society of using this technology in each of the medical and forensic settings OR • Identifies the scientific knowledge behind both named technologies • Outlines a benefit to society or the individual of using this technology in each of the medical and forensic settings	5
• Identifies a medical condition which can be solved with a DNA technology • Outlines the scientific knowledge behind this technology • Outlines a benefit to the individual of using this technology in this medical setting OR • Identifies a forensic setting which can be solved with a DNA technology • Outlines the scientific knowledge behind this technology • Outlines a benefit to the individual of using this technology in this forensic setting OR • Identifies a medical condition and a forensic setting which can be solved with a DNA technology • Identifies scientific knowledge behind both technologies • Identifies a benefit to the individual of using each of these technologies	4
• Identifies a medical condition OR a forensic setting which can be solved with a DNA technology • Identifies the relevant DNA technology OR relevant scientific knowledge • Identifies a benefit of this technology OR	3

• Identifies a medical condition OR a forensic setting which can be solved with a DNA technology • Outlines a relevant technology OR outlines a benefit to the individual of a relevant technology	
• Identifies a medical condition OR a forensic setting which can be solved with a DNA technology • Identifies a relevant technology OR identifies a benefit of this technology	2
• Provides information relevant to the question	1

Sample answer:

DNA technologies:

Manipulation of DNA for useful purposes

Examples:

Medicine

The genome of cystic fibrosis sufferers contains a defective gene which causes the build up of mucous in the lungs. Gene therapy introduces the normal gene into the epithelial cells of lungs through a modified 'flu virus using a nasal spray.

Forensics

In forensics, DNA fingerprinting can be used to compare genetic samples gathered from crime scenes and suspects. In this way police can both eliminate suspects and confirm criminals.

Science behind the technologies:

Medicine

Sections of DNA can be identified as genes that code for the production of proteins. These genes can be removed, using restriction enzymes, and inserted, using ligases, into viruses. The virus infects the lung cells and joins its genetic information (containing the normal gene) with that in the lung cells.

Forensics

Multiple copies of genes are made through PCR. These genes are compared to genes from other sources through gel electrophoresis. Similar banding patterns on gel electrophoresis for genes from the same locus suggest the genes are from the same source, particularly if a number of gene locii are tested.

Problems in society:

Medicine

CF individuals traditionally required daily physiotherapy and find it difficult to fully participate in jobs. High mortality meant early losses of people before they could contribute to society. This treatment is of benefit to society as the CF sufferers can be more productive members of society and less costly for the health system.

Forensics

Difficulty in finding evidence to decide guilt or innocence with accuracy in the criminal justice system: some guilty people go free and are dangerous to other members of society, some innocent people wrongly incarcerated and their talents and economic power are lost to society. Forensic evidence has a high degree of accuracy.

Question 35 (a) (i)

Criteria	Marks
• Correctly identifies tails in Figures 1 and 2	2
• Correctly describes tail in Figure 1 OR • Correctly describes tail in Figure 2	1

Sample answer:

Fig 1 – prehensile

Fig 2 – non prehensile

Question 35 (a) (ii)

Criteria	Marks
• Provides a reason to classify both baboons and spider monkeys into the same phylum • Provides a reason to classify baboons and spider monkeys into separate genus	2
• Provides a reason to classify both baboons and spider monkeys into the same phylum OR • Provides a reason to classify baboons and spider monkeys into separate genus OR • Provides relevant information about the hierarchical classification system	1

Sample answer:

In a hierarchical classification system, classification will be identical in higher levels, not necessarily the same in the lower levels.

Since *phylum* is above *order* in the classification system, these two animals in the same order will be in the same phylum.

Genus is below *order* in the classification system, so these animals are not necessarily in the same genus.

Question 35 (b)

Criteria	Marks
• Demonstrates an understanding of the theory of regional continuity • Describes one piece of evidence for the theory • Provides in detail why this evidence supports the theory • Describes one piece of evidence against the theory • Provides in detail why this evidence refutes the theory	4
• Identifies one piece of evidence for AND one against the theory • Provides why this evidence supports/refutes the theory OR • Describes the theory of regional continuity • Describes evidence for OR against the theory • Provides why this evidence supports or refutes the theory	3
• Identifies one piece of evidence for OR against the theory • Provides why this supports or refutes the theory	2
• Provides some information relevant to the question	1

Sample answer:

The theory of regional continuity poses that *H.erectus* left Africa 1.0 million years ago and spread to Europe and Asia. Then parallel evolution combined with some gene flow between populations caused the separate emergences of *H.sapiens* in a range of locations over multiple continents.

Evidence for:

Peking Man is a fossil found in China dated to 750,000 years ago with a combination of features of *H.erectus and H.sapiens.* It suggests interbreeding between these groups, or that Peking Man is a transitional form in the development of *H.sapiens* from *H.erectus.*

Evidence against:

The mtDNA in modern African people contains greater variety than modern Chinese people, for example. This suggests that Africa is the source of migrations for human evolution and each isolated population of *H. sapiens* in the rest of the world contains a small portion of the genetic diversity of the African source population.

Question 35 (c)

Criteria	Marks
• Demonstrates thorough knowledge of differences in cultural development of *Australopithecus* and *Homo neanderthalensis* • Correctly distinguishes the cranial capacities for both hominins • Thoroughly relates size of brain capacity to the development of culture in both species	4
• Demonstrates knowledge of differences in cultural development of *Australopithecus* and *Homo neanderthalensis* • Correctly distinguishes the cranial capacities for both hominins • Relates size of brain capacity to the development of culture in both species	3
• Demonstrates some knowledge of differences in cultural development of *Australopithecus* and/or *Homo neanderthalensis* OR • Relates size of brain capacity to the development of culture	2
• Provides some information relevant to the question	1

Sample answer:

	Australopithecus	*Homo neanderthalensis*
Identified differences	No tools No use of fire No shelters or clothing Lived in small groups Scavenged meat No language	Stone tools Bone tools Use of fire Built shelters / clothing from animal skins Lived in larger groups Hunted large prey in groups Language
Cranial capacity (cm^3)	400	1500

Cranial capacity is related to the development of culture. Higher brain capacity helping to remember and link observations allows for innovation. The development of language allows complex ideas to be shared and cooperative ventures attempted. Language also assists in the development of technologies in the process of articulating and linking concrete as well as abstract ideas.

Homo neanderthalensis had much higher cranial capacity, which allowed them to make huge progress in cultural development compared to *Australopithecus* who had much lower cranial capacity.

Question 35 (d) (i)

Criteria	Marks
• Correctly distinguishes between relative dating and absolute dating	2
• Correctly outlines relative dating OR • Correctly outlines absolute dating	1

Sample answer:

Relative dating is able to tell you if one fossil is older or younger than the other. Absolute dating can provide a quantitative value for the age of individual fossils.

Question 35 (d) (ii)

Criteria	Marks
• Correctly analyses relative positions of formerly horizontal strata now folded strata in Figure 1 • Correctly deduces relative ages of fossils using principle of Superposition and radiometric data • Accurately compares ages in Figure 1 and Figure 2 • Makes a judgement about the conclusion	4
• Deduces relative ages of fossils in Figure 1 using principle of Superposition • Correctly deduces the relative ages of fossils in Figure 2 in relation to radiometric data • Compares deduced ages in Figure 1 and Figure 2	3
• Deduces relative ages of fossils in Figure 1 using principle of Superposition OR • Correctly uses radiometric data in Figure 2 to deduce relative ages of fossil formation	2
• Provides some information relevant to the question	1

Sample answer:

In Figure 1 the strata that contains fossil A is below the strata that contains fossil B. Fossil B is located lower than Fossil A. This has occurred because the landscape was folded pushing up some of the strata containing fossil A and pushing down the strata containing fossil B. Therefore fossil A is older of the two. Fossil C is younger because it is located in a higher strata than the other two fossils.

In Figure 2, fossil A is shown to have an age of four half-lives of C14, fossil B three half-lives and fossil C one half-life. So fossil A is the oldest and fossil C is much younger.

Therefore the students' conclusion is incorrect.

Question 35 (e)

Criteria	Marks
• Identifies problems in obtaining useful information on the evolutionary relationships between humans and other primates other than using genetic evidence • Describes in depth DNA-DNA hybridisation technology • Explains how the difference between hybrid DNA and original DNA in terms of adhesions and separation can be used as a measure of the similarity in structure of the DNA • Describes in depth karyotype technology • Explains how examination of the karyotype can be used to distinguish between species • Explains how the data from each technology can be analysed to determine the evolutionary relationships between the two species • Explains reasons for society's interest in the matter	7
• Describes DNA-DNA hybridisation technology • Explains how the difference between hybrid DNA and original DNA in terms of adhesions and/or separation can be used as a measure of the similarity in structure of the DNA • Describes karyotype technology • Explains how examination of the karyotype can be used to distinguish between the two species • Explains how the data from each technology can be analysed to determine the evolutionary relationships • Provides a reasons for society's interest in the matter	5–6
• Describes DNA-DNA hybridisation technology OR karyotype technology • Explains how examination of the technology can be used to distinguish between the two species • Provides a reason for society's interest in the matter OR explains how the data from the technology can be used to determine the evolutionary relationships between species	3–4
• Outlines DNA-DNA hybridisation technology or karyotype technology • Explains how examination of the data produced can be used to differentiate between species OR provides a reason for society's interest in the matter	2
• Provides some information relevant to the question	1

Sample answer:

Using comparative morphologies is very limited in determining relationships between humans and other primates. Sometimes morphologies seem very different, yet the changes or modifications required to achieve those differences might be small in number or simple.

Using genetic evidence gives a better picture, but how do you compare the DNA of one species to another? Chromosomes are not visible in most cells, and DNA is a fine thread-like material difficult to manipulate.

Scientists have developed procedures to overcome those obstacles.

DNA-DNA Hybridisation can be used to show how genetically similar two species are. DNA from a human and a chimpanzee (other primate) can be tested for melting point. Then it can be melted into single strands. The single strands are combined into hybrid DNA, in which some hydrogen bonding between base pairs does not happen because they are not complementary. The lower the hybrid DNA M.P. is compared to the original DNA is a measure of how similar the original DNA was. When the DNA is similar the two species are seen to be close in evolutionary terms.

Karyotype Analysis involves using a chemical to kill a cell during cell division when the chromosomes can be seen individually. Photos are taken and the chromosome pictures arranged in pairs of increasing size. This picture of all the chromosomes in the genome is a karyotype. Comparing the number, size, shape and banding pattern of chromosomes allows scientists to observe differences between species. The fewer differences between the karyotypes, the closer the species are in evolutionary terms.

People are interested to study our closest living relatives, as it helps us to understand where we have come from. It helps us to understand ourselves as a species when we can identify our closest living relatives and see our unique or common features and behaviours. We can understand how the primate group of organisms came to be what it is today.

Question 36 (a) (i)

Criteria	Marks
• Provides an appropriate label	1

Sample answer:

Chlorophyll molecules (chloroplasts not accepted)

Question 36 (a) (ii)

Criteria	Marks
• Identifies different action spectra for each photosystem • Explains the summative nature of energy provided to electrons in successive photosystems • Relates the systems to efficiency of the light reaction	3
• Identifies different action spectra for each photosystem OR explains the summative nature of energy provided to electrons in successive photosystems • Relates the systems to efficiency of the light reaction	2
• Provides some information relevant to the question	1

Sample answer:

Photosystem I is activated by light at the red and violet parts of the spectrum. Photosystem II is activated by light at the blue and orange parts of the spectrum. By acting together a larger component of the incident white light is used and photosynthesis is more efficient. The excited electrons pass from one photosystem to another. Excited electrons are energised by the other photosystem, in this way a higher energy level for excited electrons is made possible and reactions of the light reaction can happen eg reducing NADP+.

Question 36 (b)

Criteria	Marks
• Describes Blackman and Mathgel's experiments, varying temperature regularly for different fixed temperatures • Describes results of Blackman and Mathgel's experiments in terms of rates of photosynthesis reaction as light is increased at each temperature • Explains the common low rate of photosynthesis for all experiments at low light intensities in terms of the slow rate of the light dependent reaction • Explains higher plateauing for higher temperature runs at higher light intensity in terms of lack of bottlenecks	4
• Outlines Blackman and Mathgel's experiments, varying temperature regularly for different fixed temperatures • Outlines results of Blackman and Mathgel's experiments in terms of rates of photosynthesis reaction as light is increased at each temperature • Explains the common low rate of photosynthesis for all experiments at low light intensities in terms of the slow rate of the light dependent reaction OR explains higher plateauing for higher temperature runs at higher light intensity in terms of lack of bottlenecks	3
• Identifies Blackman and Mathgel's experiments, varying temperature regularly for different fixed temperatures • Identifies results of Blackman and Mathgel's experiments in terms of rates of photosynthesis reaction as light is increased at each temperature	2
• Provides some information relevant to the question	1

Sample answer:

At low light levels, the rate of photosynthesis for all experiments no matter the temperature had low rates of photosynthesis. The light was the limiting factor, and the light dependent reaction must be happening at a slow rate.

As light is initially increased, the rate of photosynthesis for all experiments no matter the temperature gradually increased at the same rate. Again the light is the limiting factor, and the light dependent reaction speeds up at the same rate for each experiment as light is gradually increased.

As light intensity is further increased, the rate of photosynthesis in each experiment plateaus. The value for the rate of photosynthesis at each plateau was higher for experiments conducted at higher temperatures. This suggests that there is another factor limiting rate of reaction, that is temperature. Even if the rate of the light reaction may be occurring faster at higher light intensities there is a bottleneck for the temperature dependent reaction if the temperature is low.

Question 36 (c)

Criteria	Marks
• Provides correct location for each reaction (light and dark) within the chloroplast • Correctly describe a relevant feature at each location • Relates the features to each reaction (light and dark)	4
• Provides correct location for each reaction (light or dark) within the chloroplast • Correctly outlines a relevant feature at either location • Relates the feature to a reaction (light or dark)	3
• Provides correct location for each reaction (light or dark) within the chloroplast • Correctly identifies a relevant feature at each location is	2
• Provides some information relevant to the question	1

Sample answer:

The light reaction happens on the thylakoid membranes of the chloroplast. The thylakoid membranes have chlorophyll molecules embedded in them as well as receiver molecules of the electron transport chain. When light strikes this membrane it is harnessed by the chlorophyll molecules and excited electrons sent along the electron transport chain.

The dark reaction happens within the chloroplast in a fluid stroma that fills the organelle and surrounds the thylakoid sacs. The stroma contains the enzymes for the dark reaction and can accept the ATP and NADPH from the thylakoid sacs.

Question 36 (d) (i)

Criteria	Marks
• Outlines physical actions • Identifies chemical solvent	2
• Provides some relevant information	1

Sample answer:

Leaf is crushed using a mortar and pestle while covered in a solvent like methylated spirits.

Question 36 (d) (ii)

Criteria	Marks
• Makes a judgement on the students' conclusion based on criteria • Identifies variable controlled: solvent • Demonstrates pigments have risen the same proportion of the distance of the solvent front • Identifies pigment colours in new plant the same as for chlorophylls a and b	4
• Makes a judgement on the students' conclusion based on criteria • Provides reasons to support their judgement with reference to the data	3
• Identifies data relevant to the students' conclusion	2
• Provides some information relevant to the question	1

Sample answer:

The students are wrong to conclude that the new plant has a unique pigment system.

The pigment system of the new plant is chlorophyll a and chlorophyll b because:

(i) Pigments have climbed the same proportion of the solvent front (same solvent) distance in each experiment

$$\frac{9.1}{10.7} = 0.85 = \frac{4.25}{5.0}$$ chlorophyll a

$$\frac{6.2}{10.7} = 0.58 = \frac{2.89}{5.0}$$ chlorophyll b

(ii) The colours for the two pigments of the new plant are similar as for chlorophyll a and b. Dark and light shades may be due to different relative amounts of each pigment.

Question 36 (e)

Criteria	Marks
• Describes why the study of photosynthesis was limited prior to the development of radioactive tracers • Describes the science which explains any radioactive tracer and its use • Names relevant radioactive tracers relevant to the study of photosynthesis • Describes how the tracers are used in the study of photosynthesis • Describes the new information on photosynthesis which was provided by the use of tracers • Explains why society benefits from this new information	7
• Outlines why the study of photosynthesis was limited prior to the development of radioactive tracers • Describes the science which explains any radioactive tracer and its use • Names relevant radioactive tracers relevant to the study of photosynthesis • Describes how the tracers are used in the study of photosynthesis • Describes the new information on photosynthesis which was provided by the use of tracers • Identifies why society benefits from this new information	5–6
• Outlines the science which explains any radioactive tracer and its use • Names relevant radioactive tracers relevant to the study of photosynthesis • Outlines how a tracer is used in the study of photosynthesis • Identifies the new information on photosynthesis which was provided by the use of the tracer • Identifies why society benefits from this new information	3–4
• Names a relevant radioactive tracer relevant to the study of photosynthesis • Outlines the new information on photosynthesis which was provided by the use of the tracer	2
• Provides some information relevant to the question	1

Sample answer:

It is difficult to study the biochemical pathways of photosynthesis. It is hard to see what happens to the reactants in a chemical reaction inside a plant. Science has developed ways to tag atoms of the reactants and follow their pathway in the complex reactions of photosynthesis within the plant.

Radioactive atoms release radiation that can be seen by technologies like X-ray film, geiger counters etc. Radioactive tracers are molecules which contain radioactive atoms, and which can be readily taken up by a living thing like a plant. The pathway of a radioactive substance through the living thing can be followed, as can the biochemical pathways that the molecule/atom is involved in using other technologies like chromatography.

$C^{14}O_2$ and H_2O^{18} are both radioactive tracers that can be used to study photosynthesis.

If plants are surrounded by $C^{14}O_2(g)$ the radioactivity is soon seen in starch granules in the leaves of the plant. This shows that the starch is formed from the CO_2 in the air, and is

composed of carbon atoms from the air. None of the C^{14} in the $C^{14}O_2(g)$ taken in by the plant is lost.

If plants are watered with $H_2O^{18}(l)$ the radioactivity is seen in the O_2 that the plant releases into the air around the plant and not in molecules constructed by photosynthesis contained within the leaf. Therefore in photosynthesis the water is split and the oxygen released into the atmosphere, the H incorporated into the plant within intermediate molecules in a biochemical pathway, and then finally into a starch molecule.

This knowledge is of benefit to society because we need to find ways of reducing the carbon in the atmosphere because of excess use of fossil fuel combustion and its resultant climate change. We can understand that land clearing with its removal of photosynthetic species will exacerbate the build up of carbon in the atmosphere because of the loss of photosynthesis it causes.

Society is also concerned about the need to generate oxygen in the context of massive amounts of fossil fuel combustion also removing oxygen from the atmosphere. Understanding that plants release oxygen in photosynthesis is part of the offsets for fossil fuel use in re-forestation projects as the carbon is locked up in the plant and oxygen is released into the atmosphere.

2015 HSC Biology
Mapping Grid

Section I
Part A

Question	Marks	Content	Syllabus outcomes
1	1	9.3.4.2.7	H10
2	1	9.3.2.2.5	H6
3	1	9.2.3.2.9	H6
4	1	9.4.1.2.2, 9.4.4.2.4	H6
5	1	9.2.1.2.1	H6, H13, H13.1(e)
6	1	9.2.1.3.1	H6
7	1	9.2.1.3.2	H6
8	1	9.2.1.2.8, 9.2.1.3.3	H6
9	1	9.2.2.3.2, 9.4.3.2.2, 12.3	H12
10	1	9.3.1.2.2	H6
11	1	9.3.4.2.5	H10
12	1	9.4.7.2.2, 9.4.7.3.3, 12.3(c)	H12
13	1	9.4.7.3.2	H8
14	1	9.3.4.2.2	H4
15	1	9.3.3.3.2, 9.3.3.2.8	H9
16	1	9.4.3.2.1, 9.4.6	H2
17	1	9.4.5.2.2, 9.4.5.2.1	H6
18	1	9.2.1.3.1, 13.1(a)	H13
19	1	9.4.5.2.3, 14.1(a)	H6, H8, H14
20	1	9.4.4.3.1, 14.1(a)	H14, H8, H6, H14

Section I
Part B

Question	Marks	Content	Syllabus outcomes
21	2	9.4.3.3.2	H8
22	2	9.2.3.3.5	H6
23 (a)	1	9.3.4.2.1	H9
23 (b)	2	9.3.3.2.3	H9
24 (a)	1	9.2.2.3.3, 11.1(d)	H6. H11
24 (b)	2	9.4.1.2.1, 14.1(b)	H2, H14
24 (c)	4	9.2.2.3.3, 11.3(c)	H11
25 (a)	2	9.4.2.3.1, 12.1(b)	H11
25 (b)	3	9.4.2.3.1, 13.1(e)	H13
26	5	9.2.2.2.6	H6
27 (a)	2	9.2.2.3.4	H4
27 (b)	3	9.2.2.3.4, 9.4.5.2.1	H2, H3, H4, H14.1(g)

Question	Marks	Content	Syllabus outcomes
28 (a)	3	9.3.3.3.3, 9.1	H14
28 (b)	2	9.3.3.3.3, 9.1	H13
29	6	9.3.5.2.3, 9.3.5.2.1	H7
30 (a)	1	9.1.12.3 (c)	H12.3(c)
30 (b) (i)	2	9.3.1.2.1, 9.3.1.3.1	H7, H14.1(a)
30 (b) (ii)	4	9.3.1.2.1, 9.3.1.3.1, 12.3(c), 14.1(a), 14.3(c)	H7, H12, H14.1(a)
31	8	9.2.3.3.2, 9.2.3.2.4, 9.4.5.2.4, 9.4.4.2.3, 9.4.4.2.2	H3, H4, H6

Section II

Question	Marks	Content	Syllabus outcomes
Question 32		**Communication**	
(a) (i)	2	9.5.7.3.3, 12.3(c)	H6, H12
(a) (ii)	2	9.5.7.2.3, 9.5.7.3.3, 14.1(f), 14.1(g)	H6, H14
(b)	4	9.5.2.2.2, 9.5.4.3.1, 9.5.4.3.2	H7
(c)	4	9.5.1.2.1, 9.5.1.1.1, 9.5.7.1.1, 9.5.7.3.2	H6
(d) (i)	2	9.5.6.2.6, 12.4 (b), 14.1(b)	H12, H14
(d) (ii)	4	9.5.6.2.6, 9.5.5.3.1, 12.3(c), 12.3(d), 14.1(b), 14.1(f), 14.2(b)	H12, H14
(e)	7	9.5.3.2.5, 9.5.3.3.3, 9.5.6.3.3	H4, H13
Question 33		**Biotechnology**	
(a) (i)	2	9.6.2.2.1, 9.6.2.3.1	H6
(a) (ii)	2	9.6.3.2.1, 9.6.3.3.1, 9.6.3.3.2	H1, H6
(b)	4	9.6.5.3.1, 11.2(c), 11.2(d), 11.3(a), 11.3(c)	H6, H11
(c)	4	9.6.5.2.1, 9.6.5.2.2, 9.6.5.3.2, 9.6.5.3.3	H3, H6
(d) (i)	2	9.6.2.2.1, 9.6.3.3.1	H6
(d) (ii)	4	9.6.2.2.1, 9.6.4.3.1, 12.4(c), 12.4(d)	H14
(e)	7	9.6.5.2.1, 9.6.5.2.2, 9.6.5.3.1, 9.6.5.3.2, 9.6.5.3.3, 9.6.5.3.4, 9.6.7.3.1, 9.6.6.2.1, 9.6.6.2.2, 9.6.6.2.3, 9.6.6.2.4, 9.6.6.3.1	H4
Question 34		**Genetics: The Code Broken?**	
(a) (i)	1	9.7.3.2.1	H9
(a) (ii)	3	9.7.6.2.4	H9
(b)	4	9.7.1.2.1, 9.7.1.3.2, 13.1(e)	H9
(c)	4	9.7.8.2.2, 9.7.8.2.3, 9.7.8.2.4, 9.7.6.2.1	H1
(d) (i)	2	9.7.3.2.3, 9.7.3.2.4, 14.3c	H9, H14
(d) (ii)	2	9.7.3.2.2, 9.7.3.2.3, 9.7.3.2.4, 9.7.3.3.1, 14.1(a), 14.1(b), 14.1(c), 14.1(e), 14.1(f), 14.1(g)	H2, H14
(d) (iii)	2	9.7.3.2.2, 9.7.3.2.3, 9.7.3.2.4, 9.7.3.3.1, 14.1(a), 14.1(b), 14.1(c), 14.1(e), 14.1(f), 14.1(g)	H2, H14
(e)	7	9.7.2.2.4, 9.7.2.3.1, 9.7.5, 9.7.7, 9.7.6.3.1	H4

Question	Marks	Content	Syllabus outcomes
Question 35		**The Human Story**	
(a) (i)	2	9.8.1.2.6	H7
(a) (ii)	2	9.8.4.2.4	H7, H14
(b)	4	9.8.1.3.3	H1
(c)	4	9.8.3.2.2, 9.8.5.2.1	H2
(d) (i)	2	9.8.2.2.3	H2
(d) (ii)	4	9.8.2.2.4	H2, H4
(e)	7	9.8.6.1, 9.8.6.1.2.1, 9.8.6.1.3.1, 9.8.6.1.3.2	H10
Question 36		**Biochemistry**	
(a) (i)	1	9.9.4.2.2	H6
(a) (ii)	3	9.9.4.2.5	H6
(b)	4	9.9.2.3.3	H6, H14, H14.1 (c)
(c)	4	9.9.8.3.2	H2, H13, H13.1 (a)
(d) (i)	2	9.9.3.3.4	H12, H13
(d) (ii)	4	9.9.3.3.4, 9.9.3.3.3	H14, H14.1 (b)
(e)	7	9.9.1, 9.9.1.2.1, 9.9.1.3.2	H4, H7, H8