2018 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	B
2	B
3	D
4	B
5	A
6	C
7	C
8	A
9	C
10	D
11	D
12	B
13	A
14	A
15	D
16	B
17	D
18	A
19	C
20	A

Section I, Part B

Question 21 (a)

Criteria	Marks
• Identifies TWO appropriate responses in a named endotherm to a decrease in body temperature	2
• Provides some relevant information	1

Sample answer:

Shivering and vasoconstriction in humans.

Question 21 (b)

Criteria	Marks
• Outlines the role of an endotherm's nervous system in detecting and responding to temperature changes	2
• Provides some relevant information	1

Sample answer:

Changing body temperature is detected using temperature receptors in the skin and brain. A signal is sent via nerves from the receptors to the central nervous system. Nerve signals are then sent from the CNS to effectors (muscles or glands).

Question 22 (a)

Criteria	Marks
• Provides a conclusion and justification	2
• Provides some relevant information	1

Sample answer:

Microbes come from pre-existing microbes since no growth occurred in the sterile swan-necked flask.

Question 22 (b)

Criteria	Marks
• Describes the contribution of Koch to our understanding of infectious disease, including reference to the systematic identification of causative pathogens	3
• Outlines the contribution of Koch to our understanding of infectious disease	2
• Provides some relevant information	1

Sample answer:

Koch worked with microbes eg anthrax. He demonstrated the relationship between microbes and infectious disease and showed that specific microbes cause specific diseases. He developed a set of criteria to establish the cause of infectious diseases.

Question 23 (a)

Criteria	Marks
• Correctly completes the table to design a valid experiment	3
• Provides most suitable features of experimental design	2
• Provides a suitable design feature	1

Sample answer:

Dependent variable	Amount of water lost
Control	Plant kept in the dark
Variables to be kept constant	• Type of plant • Temperature

Question 23 (b)

Criteria	Marks
• Explains a mechanism for movement of material in xylem	2
• Provides some relevant information	1

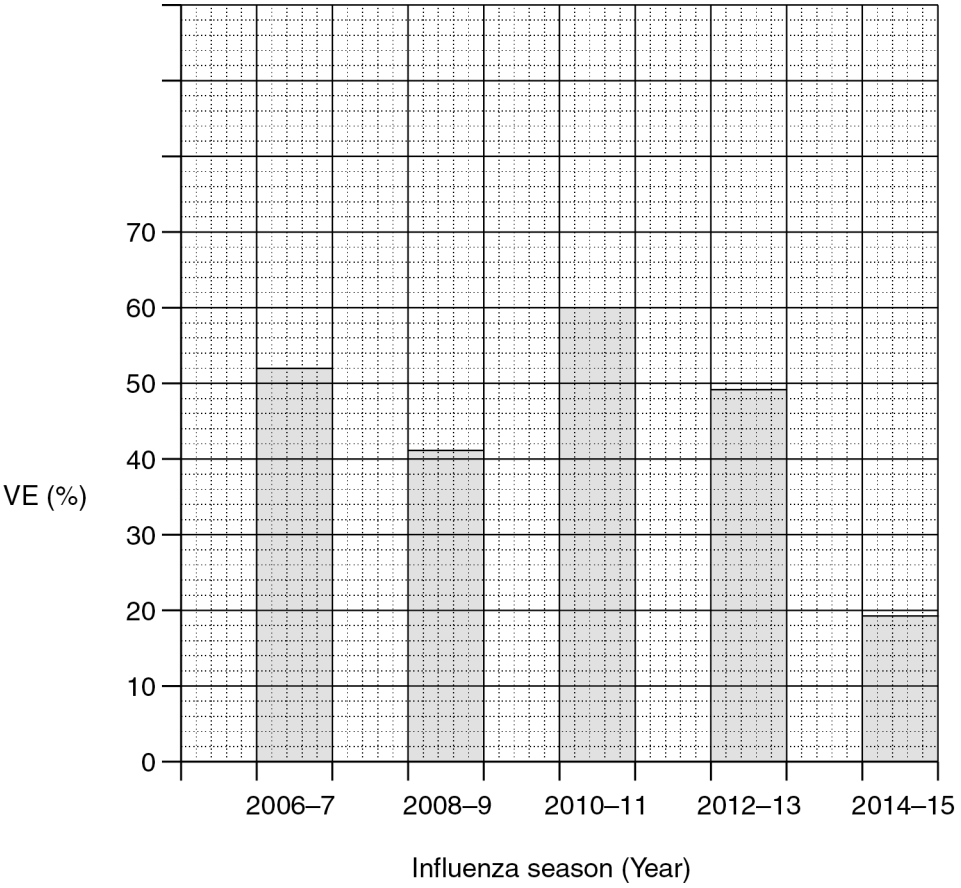
Sample answer:

Water molecules are cohesive. As water molecules evaporate the next molecules are pulled up the xylem vessel. This is one of the mechanisms that drives the movement of water from roots to leaves.

Question 24 (a)

Criteria	Marks
• Draws a column graph with: – axes labelled and scaled correctly – data plotted accurately	3
• Draws a substantially correct graph	2
• Provides some relevant information	1

Sample answer:



Question 24 (b)

Criteria	Marks
• Explains the variation in VE including reference to: – composition of vaccines – effectiveness of immune response	3
• Outlines reason(s) for variation in VE trend	2
• Provides some relevant information	1

Sample answer:

In 2014–2015 the VE was much lower than in other years. This means that the vaccine was less effective. Vaccines work by giving a person a harmless form of an antigen from a pathogen and triggering the production of antibodies that are specific to the particular antigen. If the pathogen should later mutate and its antigen change shape, then the antibodies will no longer be effective. Hence the lower VE may have been due to mutation of the virus, making the vaccine less effective.

Question 25 (a)

Criteria	Marks
• Identifies correct technology	1

Sample answer:

Arterial blood gas analysis (ABG, BGA)

Question 25 (b)

Criteria	Marks
• Analyses the data to: – identify results inside and outside the normal range – explain the link between pH and CO_2	3
• Identifies some trend(s) in the data • States relationship between pH and CO_2	2
• Provides some relevant information	1

Sample answer:

The patient's pH levels are higher than normal meaning that the blood is less acidic. This can be explained by the lower than normal levels of CO_2. As CO_2 is dissolved in solution (blood plasma) that solution becomes more acidic – so less CO_2 means lower acidity/higher pH. The patient's oxygen levels fall within the normal range.

Question 26 (a)

Criteria	Marks
• Provides similarities of and/or differences between proteins and polypeptides OR • Provides a similarity of and a difference between proteins and polypeptides	2
• Provides some relevant information	1

Sample answer:

Both proteins and polypeptides are composed of amino acids. Polypeptides, however, are single amino acid chains, whereas proteins are made up of one or more polypeptides.

Question 26 (b) (i)

Criteria	Marks
• Uses sequential steps to outline polypeptide synthesis • Relates mutation of AVP gene to change in ADH protein	3
• Outlines some aspects of polypeptide synthesis or mutation • Links mutation to change in ADH protein	2
• Provides some relevant information	1

Sample answer:

1. The base sequence of the AVP gene is altered.
2. The mRNA strand produced during transcription would not be correct.
3. At translation, incorrect amino acids would be delivered to the ribosome by tRNA.
4. An incorrect/dysfunctional/different polypeptide chain is produced.
5. The ADH protein is altered.

Question 26 (b) (ii)

Criteria	Marks
• Identifies an effect of AVP mutation on kidney function	1

Sample answer:

Less reabsorption of water (due to malfunction of ADH)

Question 27

Criteria	Marks
• Explains how the type of nitrogenous waste relates to the volume of water excreted in terrestrial mammals and insects • Includes reference to the toxicity of different nitrogenous wastes • Provides a feature of excretion that allows for the conservation of water in terrestrial mammals and insects	4
• Links the type of nitrogenous waste to the volume of water excreted in terrestrial mammals and insects • Includes reference to the toxicity of different nitrogenous wastes • Provides a relevant feature of excretion	3
• Identifies the main nitrogenous waste in terrestrial mammals or insects • Provides a relevant feature of excretion	2
• Provides some relevant information	1

Sample answer:

In order to conserve water, terrestrial mammals concentrate their urine. Because ammonia is toxic, mammals convert ammonia to the less toxic urea which can be excreted in concentrated form.

Insects go further by producing uric acid, a substance even less toxic than urea, which can be excreted in very concentrated form with almost no water.

Terrestrial mammals may have structural adaptations such as elongated loops of Henle and collecting ducts in the kidney which result in the ability to produce highly concentrated urine.

Answers could include:

Reference to energy requirements.

Question 28 (a)

Criteria	Marks
• Defines the terms *genotype* and *phenotype*	2
• Provides some relevant information	1

Sample answer:

‘Genotype’ refers to the genes an organism inherits from its parents and ‘phenotype’ refers to the observable characteristics of an organism: how it develops, looks, reacts and behaves.

Question 28 (b)

Criteria	Marks
• Relates the interactions between survival/Darwinian fitness, genotype and phenotype in the population • Explains how the mite resistant allele is maintained in the population	4
• Relates some interactions between survival/Darwinian fitness, genotype and phenotype in the population • Outlines how the mite resistant allele is maintained in the population	3
• Provides some features of evolution in the population with reference to fur thickness/length and/or mite resistance	2
• Provides some relevant information	1

Sample answer:

The selection pressure for long, thick fur is cold climate. Thus the majority of the population carries the allele for long, thick fur.

Mite infestations change the phenotype of these individuals reducing their 'fitness' even though they still have the genes for long fur. The 'mite resistance gene' should improve the phenotype in times of mite infestations and be a survival advantage, but carrying two alleles for 'mite resistance' renders the individual infertile. Therefore, although individuals exist in the population with a phenotype suited to the environment, that is they can resist the cold with long fur that is resistant to mites, they cannot pass these genes on as they are sterile. However, the 'mite resistance allele' is co-dominant and heterozygotes will show some mite resistance, increasing their 'fitness' over those without this allele. Heterozygotes can pass the allele to their offspring and therefore keep the allele within the population.

Question 29 (a)

Criteria	Marks
• Provides main features of DNA replication	2
• Provides some relevant information	1

Sample answer:

DNA replication involves separating DNA strands and adding complementary nucleotides to each strand.

Question 29 (b)

Criteria	Marks
• Demonstrates a thorough understanding of the structure and behaviour of chromosomes in first division of meiosis and links a feature to the model • Links features of meiosis I to variation	5
• Demonstrates a sound understanding of the structure and behaviour of chromosomes in first division of meiosis and links a feature of the model • Links a feature of meiosis I to variation	4
• Describes the structure and behaviour of chromosomes during first division of meiosis • Links information provided to features of the model	3
• Outlines relevant information about structure and/or behaviour of chromosomes during first division of meiosis OR • Links information about structure or behaviour of chromosomes to the model	2
• Provides some relevant information	1

Sample answer:

The model represents homologous pairs of chromosomes as being the same size and identifies the paternal or maternal origin with different shading.

In the first division of meiosis individual chromosomes form homologous pairs. These carry the same genes but not identical alleles. When paired, crossing over occurs as genetic material is exchanged between non-sister chromatids resulting in new combinations of genetic material as shown by the shading.

The two daughter cells formed after this division have half the number of chromosomes (haploid cells), one from each homologous pair assigned at random. This increases variation in the daughter cells, as shown after the first division.

Question 30

Criteria	Marks
• Analyses the data to draw suitable conclusions • Demonstrates an extensive understanding of the development of the identification, treatment and prevention of disease • Links trends in the data to specific developments in identifying, treating and preventing disease • Synthesises information to draw a suitable conclusion/judgement about the impact of biological developments on life span • Uses precise biological terms	8
• Analyses the data to provide key trends • Demonstrates a thorough understanding of the development of the identification, treatment and prevention of disease • Links trends in the data to specific developments in identifying, treating and preventing disease • Provides a clear judgement about the impact of biological developments on life span • Uses suitable biological terms	6–7
• Provides a trend in the data • Demonstrates a sound understanding of the development of our understanding of disease • Links the data to developments in understanding disease • Uses some suitable biological terms	4–5
• Describes the data • Demonstrates some understanding of the development of our understanding of disease • Links data to understanding disease	2–3
• Provides some relevant information	1

Sample answer:

The graph shows that life span has increased for all ages over the last century. The younger the individual the greater the increase in life span. Life span at birth has increased dramatically from 48 years to 75 years. At other ages it has increased less (12 years for 20-year-olds, 10 years for 40-year-olds and the smallest increase of five years for 60-year-olds).

Being able to identify the cause of diseases such as measles, rubella and whooping cough is the result of our developing an understanding of pathogens as the cause of infectious disease through the work of Pasteur and Koch. They developed germ theory and a set of rules/postulates and culture techniques to be followed in establishing the link between a specific pathogen and disease. Knowledge of pathogens led to the development of vaccines (incorporating harmless versions of pathogens) that can be used to prevent common childhood diseases. Vaccines provide active immunity to specific pathogens. This has significantly reduced the number of deaths in young children resulting in a dramatic increase in their life expectancy.

Understanding bacterial pathogens and differences between prokaryotic and eukaryotic cells has led to the development of antibiotic treatments for pathogens such as *Staphylococcus aureus*. This means many infections can be treated instead of being life threatening. This has resulted in improved life span at all ages. However, the overuse of antibiotic treatment

resulted in bacterial resistance to many drugs and these gains may not be sustainable in the future.

The study of non-infectious diseases such as lung cancer though systematic epidemiology has resulted in being able to find the delayed link between lung cancer and smoking. Epidemiology involves careful planning and design, control groups, and the large-scale collection and analysis of data. This has led to public health campaigns that have reduced smoking rates and as a result are leading to increased life span for adults.

It is clear that biological developments have led to huge gains in expected life span in many countries. These gains are highest for the very young. However, life span around the world is variable as access to prevention and treatment is limited to those who can afford it.

Section II

Question 31 (a) (i)

Criteria	Marks
• Identifies TWO structures that refract light in the eye	2
• Identifies ONE structure that refracts light in the eye	1

Sample answer:

Cornea, lens.

Question 31 (a) (ii)

Criteria	Marks
• Provides TWO differences in visual perception	2
• Provides some relevant information	1

Sample answer:

Visual perception at A	*Visual perception at B*
High visual acuity (detail perceived)	Low visual acuity
Colour perceived	Less colour perception, mostly monochromatic vision

Question 31 (b)

Criteria	Marks
• Describes how sound is produced by the larynx • Describes the relationship between frequency of vibration and pitch • Relates changes in vocal cords to change in pitch	4
• Outlines how sound is produced by the larynx • Outlines pitch and/or frequency with reference to changes in the vocal cords	3
• Outlines pitch and/or frequency with reference to changes in the vocal cords OR • Outlines the relationship between frequency of vibration and pitch with reference to the larynx	2
• Provides some relevant information	1

Sample answer:

Sounds are produced by airflow from the lungs through the larynx. Because the length and tension of the vocal cords can be altered by the muscles of the larynx, the frequency of the vocal cord vibration can be altered and the frequency determines the pitch of the sound. High pitch, which equates to high frequency of vibration, is achieved by vocal folds that are longer, thinner, stiffer and therefore vibrate faster. Low pitch, which equates to low frequency of vibration, is achieved by vocal cords that are shorter, thicker, less stiff and therefore vibrate more slowly.

Question 31 (c) (i)

Criteria	Marks
• Outlines TWO differences in the TWO adults from the data	2
• Provides some relevant information	1

Sample answer:

Adult *B* has fewer red and green cones than adult *A*. There is much less overlap in the range of wavelengths detected by different cones in adult *B*.

Question 31 (c) (ii)

Criteria	Marks
• Explains possible differences in colour vision in the two adults • Makes reference to the data provided	3
• Outlines a difference in colour vision in the two adults with reference to the data	2
• Provides some relevant information	1

Sample answer:

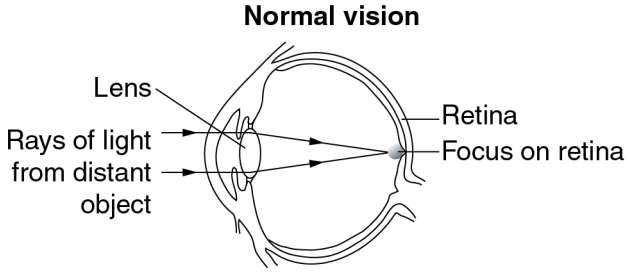
Because adult *B* has fewer red and green cones than adult *A* perception of colours in the 500–700 nm spectrum may be less vivid and less easily detected by adult *B*. This is because information from cones is carried to the brain with one nerve fibre coding for one cone, so reduced numbers of cones may produce fewer signals.

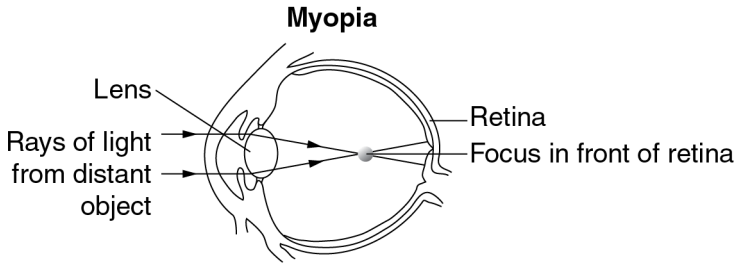
Adult *B* shows much less overlap in the range of wavelengths detected by different cones. Red and blue cones do not overlap at all, suggesting that certain hues such as purple may not be well interpreted. Above 600 nm wavelength only red cones are responding to light which would suggest that yellow and orange colours would not be detected.

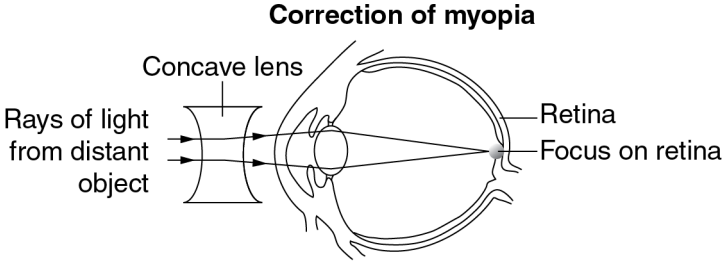
Question 31 (d)

Criteria	Marks
• Provides THREE correct clearly labelled diagrams that compare the vision of a distant object by a normal eye and a myopic eye and correction by a concave lens	5
• Provides THREE substantially correct, labelled diagrams that show vision of a distant object by a normal and a myopic eye as well as correction by a concave lens	4
• Provides a series of diagrams to illustrate vision in a normal eye and a myopic eye and/or correction	3
• Provides a relevant series of diagrams to illustrate aspects of vision	2
• Provides some relevant information	1

Sample answer:







Question 31 (e)

Criteria	Marks
• Demonstrates a thorough understanding of differences in detecting stimuli between humans and other animals • Justifies how models change in the light of new evidence • Relates animal examples to models of human sight and hearing • Demonstrates coherent and logical progression of ideas	7
• Demonstrates an understanding of the differences in detecting stimuli between humans and other animals • Makes reference to how models change in the light of new evidence • Compares animal examples to models of human sight and hearing	6
• Demonstrates an understanding of the differences between vision and hearing in humans and other animals • Relates examples to our knowledge/models of human sight and hearing	4–5
• Outlines difference(s) in sight and/or hearing between humans and other animals	2–3
• Provides some relevant information	1

Sample answer:

Our understanding of vision and hearing has been shaped by studies in humans.

A study of human vision includes detection of a limited range of the electromagnetic spectrum, 'visible light'. After recognition that birds and insects can detect UV light this range has been extended and the model of detection of light in the eye modified to include more cone types and passage of UV light into the eye in other species. Study of snakes that incorporated detection of infrared rays via heat sensitive pits into visual maps in the brain has led to revision of our understanding of how different stimuli are interpreted.

Similarly in detection of sound, humans can usually hear sounds in the range 20–20 000 Hz. Study of animals that use echolocation, such as bats and dolphins, has extended this range of detection up to more than 100 000 Hz, leading to extension of our models of hearing. Our understanding of hearing in humans includes the function of the eardrum and movement of hair cells. Study of other animals has led to extension of the use of such structures in other contexts. For example, in insects tympana on the leg or abdomen may vibrate to both detect and make sound and fish use hair cells to detect changes in surrounding water pressure.

Although vertebrate eyes are all similar in structure and function to the human eye, study of the insect eye has led to a revision of a model of animal vision. Insect eyes are made of many individual light receptors called ommatidia, all arranged with individual lens, cornea, light-collecting apparatus and photoreceptor neurons.

In conclusion, the study of humans has informed our models of sight and hearing in animals, but these models have been constantly revised as new information from other animals has come to light.

Question 32 (a) (i)

Criteria	Marks
• Identifies TWO changes occurring in an agricultural species as a result of artificial selection	2
• Provides some relevant information	1

Sample answer:

As a result of artificial selection for more productive livestock over thousands of years, modern sheep now exhibit more desirable characteristics such as reduced horns and a more muscular build compared to ancestral sheep.

Question 32 (a) (ii)

Criteria	Marks
• Outlines ONE ancient Australian Aboriginal use of biotechnology	2
• Provides some relevant information	1

Sample answer:

Eel farming and selective breeding were used by the Gunditjmara people of Victoria to ensure a consistent food supply. Artificial selection of the biggest fish for breeding further allowed a constant and reliable supply of food.

Question 32 (b)

Criteria	Marks
• Identifies and describes a specific example of animal biotechnology • Explains an advantage and a disadvantage of EITHER the product OR process associated with the animal biotechnology	4
• Identifies a specific example of animal biotechnology • Attempts to explain an advantage and a disadvantage of EITHER the product OR process associated with the animal biotechnology	3
• Identifies a biotechnology • Outlines an advantage OR disadvantage of the product OR process associated with the biotechnology	2
• Provides some relevant information	1

Sample answer:

A vaccine for Infectious Bursal Disease (IBD) in chickens has been developed using recombinant DNA technology.

Traditional vaccines have problems including the ability to regain disease-causing capacity. They are also expensive to produce and keep active. The recombinant vaccine is cheaper to produce because the cloning of recombinant bacterial cells allows the proteins' mass production. Because they are protein-based, rather than live/attenuated, they do not mutate and regain virulence.

However, recombinant vaccines may not be as effective as live vaccines at inducing immunity in chickens when compared with live vaccines and often require booster immunisations to maintain the chickens' antibody production. Recombinant vaccines based only on one viral protein may not offer full immune protection from the more virulent strains of viral IBD.

Answers could include:

- Monoclonal antibodies
- Cloning
- Aquaculture
- Transgenics

Question 32 (c) (i)

Criteria	Marks
• Outlines the polymerase chain reaction and links to amplifying DNA	2
• Provides some relevant information	1

Sample answer:

The three steps of PCR are: denaturation, annealing and extension. During denaturation DNA is heated and the complementary strands separated. After this, the mixture is cooled. During annealing, primers bind to sections of each separate DNA strand. Polymerase catalyses the complementary bonding of free nucleotides along the template DNA strands. The process is then repeated multiple times to reproduce (amplify) DNA.

Question 32 (c) (ii)

Criteria	Marks
• Relates plasmid genes being intact or cut to expression/non-expression • Explains how a non-recombinant bacterial host could be distinguished from a recombinant-carrying bacterial host using the stimulus provided	3
• Outlines how a non-recombinant host could be distinguished from a recombinant host	2
• Provides some relevant information	1

Sample answer:

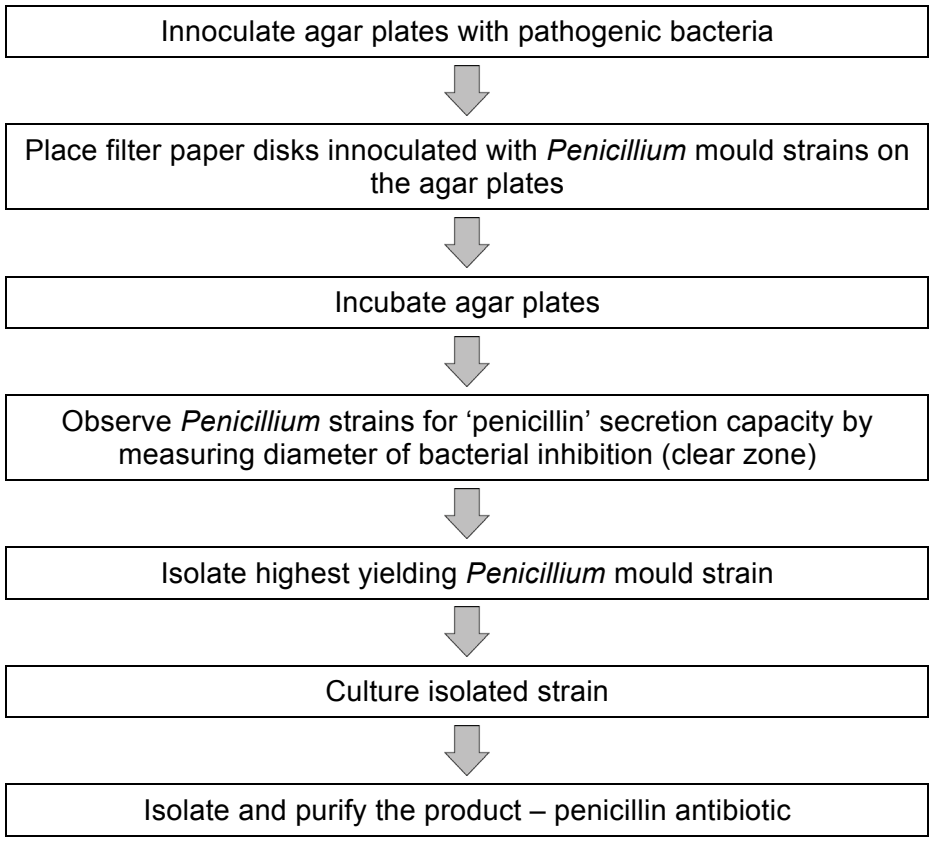
Genes produce necessary proteins when they are fully intact. If a gene has been 'broken' to allow for the insertion of another gene, it will not be functional. To identify which bacteria have been transformed with recombinant plasmids (as opposed to normal plasmids), the bacteria should be grown on nutrient agar plates, which also contain the antibiotic Ampicillin. Both bacteria containing a non-recombinant plasmid will grow because gene *A* is intact and expresses resistance to Ampicillin. If gene *B* is intact (non-recombinant) they will also appear yellow in colour. But bacteria containing the desired recombinant plasmid will not be yellow in colour because the desired gene *X* has been spliced into the middle of gene *B* which is unable to be expressed to produce the yellow substance.

Question 32 (d)

Criteria	Marks
• Constructs a clear flow chart demonstrating sequential steps to form a product • Identifies a specific example of strain isolation • Includes major steps in a strain isolation method	5
• Constructs a clear flow chart demonstrating sequential steps to form a product • Includes a specific example of strain isolation • Includes most steps in the strain isolation method	4
• Constructs a flow chart to summarise some of the steps in a strain isolation method	3
• Provides a feature of strain isolation method	2
• Provides some relevant information	1

Sample answer:

Strain isolation to identify high yielding *Penicillium sp*



Question 32 (e)

Criteria	Marks
• Describes advances in cell chemistry • Relates advances in cell chemistry to modern applications in biotechnology • Provides relevant examples that illustrate the relationship between cell chemistry and modern uses of biotechnology • Demonstrates coherence and logical progression of ideas	7
• Outlines advances in cell chemistry • Relates advances in cell chemistry to modern applications in biotechnology • Provides relevant examples to illustrate links between cell chemistry and modern uses of biotechnology	6
• Outlines advances in cell chemistry • Links advances in cell chemistry to modern applications in biotechnology • Provides a relevant example to illustrate the link between cell chemistry and modern uses of biotechnology	4–5
• Outlines advances in cell chemistry AND/OR a modern use of biotechnology	2–3
• Provides relevant information	1

Sample answer:

Developments in the understanding of enzyme activity and polypeptide synthesis have significantly modernised uses of biotechnology throughout the 20th century.

Increased knowledge of enzyme function and their role as biological catalysts in metabolic reactions has enabled microbes to be exploited for industrial fermentation purposes. The knowledge that individual enzymes are sensitive with respect to conditions such as temperature and pH has made it possible to identify, culture and mass-produce microbes with desirable enzyme function under certain conditions. For example, during modern beer production, different yeast strains are used for top (14–23°C) and bottom (6–12°C) fermentation, according to the optimum temperature for the activity of their enzymes.

An increased scientific understanding of DNA structure, polypeptide synthesis and gene expression has enabled the production of complementary DNA through reverse transcription. An example of the use of such knowledge is the synthesis of insulin genes for use in recombinant DNA technology. The mRNA produced in pancreas cells has already been edited to remove 'junk DNA' (introns). The mRNA can be separated from the cells and reverse transcriptase can be used to produce cDNA. This can then be amplified through PCR to produce many copies of insulin cDNA. This is then spliced into bacterial plasmids to allow mass cloning of the gene for either insulin production or gene cloning purposes.

Modern uses of biotechnology have emerged due to an increased understanding of cell chemistry. This knowledge has revolutionised many areas of society including medicine and food production.

Answers could include:

Industrial fermentation – expansion of production of glycerol, lactic acid, citric acid and/or yeast biomass; biotransformation technologies to produce cortisone and/or sex hormones.

Question 33 (a) (i)

Criteria	Marks
• Provides TWO differences in the chromosomes of haploid and diploid cells	2
• Provides a difference in the chromosome of haploid and diploid cells	1

Sample answer:

Haploid cells have half the chromosome number of diploid cells.
Haploid cells have one of each pair of chromosomes found in diploid cells.

Question 33 (a) (ii)

Criteria	Marks
• Provides differences in the inheritance patterns	2
• Provides some relevant information	1

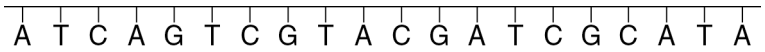
Sample answer:

Linked	*Unlinked*
Close / inherited together	Independent assortment
Offspring phenotypic ratio 3 : 1	Offspring phenotypic ratio 9 : 3 : 3 : 1

Question 33 (b)

Criteria	Marks
• Demonstrates an understanding of both types of mutation using the sequence provided • Contrasts the effect of each mutation on the polypeptide produced	4
• Demonstrates an understanding of both types of mutation using a specific sequence • Refers to polypeptide produced	3
• Outlines both types of mutation OR • Demonstrates an understanding of one type of mutation and its effect on the polypeptide produced	2
• Provides some relevant information	1

Sample answer:



Codons initially read as ATC, AGT, CGT, ACG, ATC, GCA.

A frameshift mutation could remove or insert one or more bases, leading to all codons after this point being altered.

Eg delete T (2nd from left)

Will now read ACA, GTC, GTA, CGA, TCG, CAT.

This would result in all amino acids being incorrectly coded for, resulting in a different polypeptide.

In contrast, a base mutation replaces just one base in 1 codon. One amino acid may be coded incorrectly. However, the rest of the amino acids in the polypeptide will remain correct.

Question 33 (c) (i)

Criteria	Marks
• Outlines TWO trends	2
• Provides some relevant information	1

Sample answer:

People with Lynch syndrome have an increased risk of developing every type of cancer compared to the general population.

The graph shows Lynch syndrome sufferers have the greatest difference in risk for colon and endometrial cancer compared to the general population.

Question 33 (c) (ii)

Criteria	Marks
• Analyses information to provide a detailed explanation of the disease pattern in the family	3
• Explains the disease pattern in the family	2
• Provides some relevant information	1

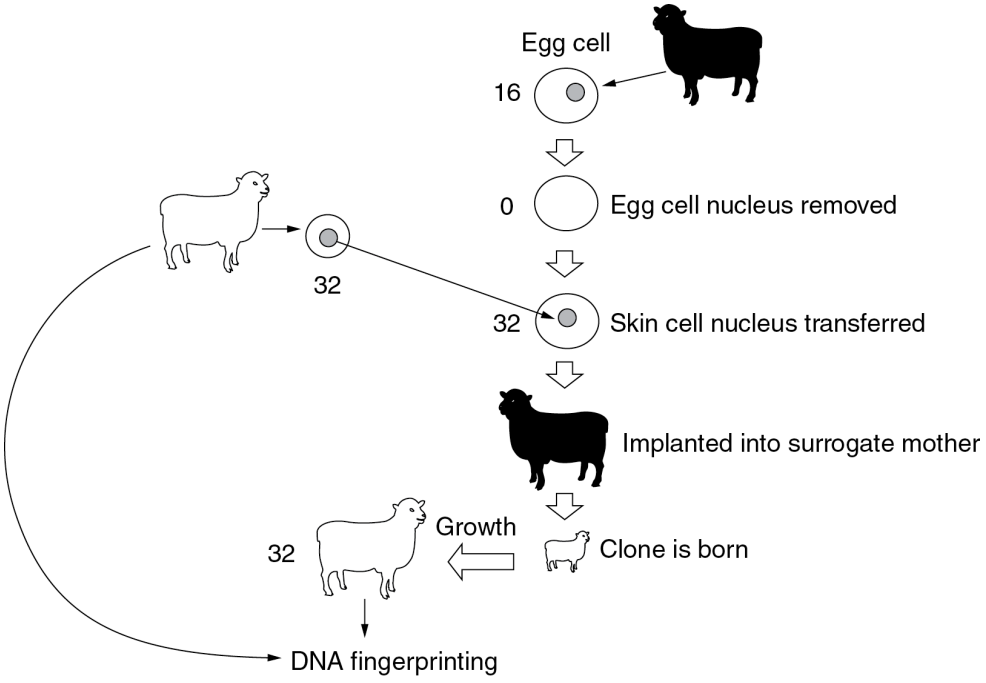
Sample answer:

People with Lynch syndrome have faulty DNA repair enzymes. Therefore they may not be able to repair random mutations leading to increased risk of cancer. The faulty allele is dominant, however, cancer may not develop. People inherit the allele that increases the risk of cancer eg individual colon dx 37 is likely to have the dominant allele and even though her mother does not show evidence for it, the allele may be present.

Question 33 (d)

Criteria	Marks
• Constructs a clear flow chart that includes the key steps in animal cloning and suitable method of verification • Includes chromosome number at each step	5
• Constructs a clear flow chart that includes most of the steps in animal cloning • Includes chromosome number at each step • Provides a suitable method of verification	4
• Constructs a clear flow chart that includes some suitable steps in animal cloning • Attempt to provide a suitable method of verification	3
• Provides some steps in animal cloning	2
• Provides relevant information	1

Sample answer:



Question 33 (e)

Criteria	Marks
• Demonstrates a thorough knowledge of genes and genetic manipulation • Relates an understanding of genes, mutations and developments in gene technologies to the production and use of mouse models • Demonstrates coherence and logical progression of ideas	7
• Demonstrates a sound knowledge of genes and genetic manipulation • Links an understanding of genes, mutations and developments in gene technologies to the production and use of mouse models	6
• Demonstrates a sound knowledge of genes and genetic manipulation • Links an understanding of developments in gene technologies to the production and/or use of mouse models	4–5
• Demonstrates some knowledge of genes and gene technologies AND/OR • Links an understanding of gene technologies to the use of mouse models	2–3
• Provides some relevant information	1

Sample answer:

Our knowledge of mutations and their effect on cell function was developed by Beadle and Tatum with experiments on bread mould showing that particular genes code for particular polypeptides. This has led to an increased understanding of the effect of mutation eg muscular dystrophy (MD) on human health.

The search for mutations that caused diseases led to the development of the HGP. It aimed to establish the sequence of the human genome and the identification and the location of all of the genes. Thus scientists could identify the MD gene and cut it out of the human genome and insert it into bacterial plasmids using DNA recombinant technology and thus producing multiple copies. Without identifying the location and size of the genes in the HGP this process of genetic engineering to produce transgenic species would not be possible.

Transgenic mice are created by inserting the MD gene into the mouse genome. This allows the crossing of the species barrier incorporating the human gene into the mouse genome. The mouse can then be cloned and the population will contain this MD gene. This allows the MD mutation to be expressed in the mouse which provides a useful model for the study of characteristics and potential treatments of the disease.

By using the mouse model, scientists could see the effect of the gene for MD in mice and then look for potential ways of treating the disease by such measures as gene therapy or medical research. This may allow scientists to insert a gene into a patient's cells instead of using drugs or surgery.

Question 34 (a) (i)

Criteria	Marks
• Identifies both dating methods	2
• Identifies a dating method	1

Sample answer:

Absolute dating method – radiometric dating.
Relative dating method – superposition.

Question 34 (a) (ii)

Criteria	Marks
• Outlines a limitation using an appropriate example	2
• Provides some relevant information	1

Sample answer:

The use of different technologies might give different dates eg radioactive dating of material from campsites gives the date for colonisation of Australia at 40 000 years ago, while thermoluminescence data puts the date at 50–60 000 years.

Question 34 (b)

Criteria	Marks
• Demonstrates an understanding of polymorphism using TWO examples • Explains the evolutionary significance of polymorphism in relation to the examples	4
• Describes TWO examples of polymorphism • Describes an evolutionary advantage of an example	3
• Identifies TWO examples of polymorphism and identifies an evolutionary advantage of each OR • Describes ONE example of polymorphism and describes an evolutionary advantage	2
• Provides some relevant information	1

Sample answer:

Polymorphism refers to a discrete variation (genetic) in a population living in a particular environment.

Humans can possess one of three types of haemoglobin (Hb) -HbA, HbS, or HbA+S. In malarial regions, having HbA+S is a survival advantage as it offers greater resistance to malaria. This results in higher rates of sickle cell alleles HbA+S in these populations.

Lactose-tolerance and lactose intolerance is another example of polymorphism. In populations where the diet might consist of high levels of dairy foods, having the lactose-tolerance allele would be an advantage as it allows for these foods to be consumed without suffering symptoms, providing a survival advantage.

The significance of both examples is that gene frequencies are changed as a result of environmental pressures.

Question 34 (c) (i)

Criteria	Marks
• Describes a trend from each graph	2
• Provides some relevant information	1

Sample answer:

There has been a slight upward trend in body weight over three million years with a bigger range of body weights in *Australopithecus* compared to *H.sapiens*. Brain capacity has increased much more rapidly and especially in the last 1 million years, with *H.habilis* having a 1000 mL capacity compared to the 1500–2000 mL capacity in *H.sapiens*

Question 34 (c) (ii)

Criteria	Marks
• States a conclusion about the relationships between the data and provides points for and/or against the validity of the conclusion	3
• States a conclusion about the relationships between the data • Provides a point for/or against the validity of the conclusion	2
• Provides some relevant information	1

Sample answer:

A conclusion could be that brain volume has increased rapidly in the last million years while body weight has remained relatively constant. This conclusion is valid as it is supported by the data as body weight 1 mya was around 60 kgs as it is now, while brain volume has increased from 1000 mL to 2000 mL. However, the conclusion is not valid as it is not clear if the body weight and brain volume are from the same individuals as the points on the graph do not match up.

Question 34 (d)

Criteria	Marks
• Constructs a correct dichotomous key that demonstrates a logical sequence of steps that can be used to classify and distinguish the four groups using appropriate criteria	5
• Constructs a dichotomous key that demonstrates a clear sequence of steps that can be used to classify most groups using appropriate criteria	4
• Constructs a dichotomous key using some appropriate distinguishing features	3
• Attempts to construct a dichotomous key using some relevant distinguishing features OR • Provides some distinguishing features of the groups	2
• Provides some relevant information	1

Sample answer:

1a	Moist rhinarium	Prosimians
1b	No moist rhinarium	Go to 2
2a	Nostrils wide apart/face out	New-world monkeys
2b	Nostrils close/face down	Go to 3
3a	Brachiate or knuckle-walk	Apes
3b	Quadrupedal	Old-world monkeys

Question 34 (e)

Criteria	Marks
• Provides a justification through analysis of changing models of human evolution • Relates work of ONE named scientist to changing models • Relates advances in technology to changing models • Demonstrates coherence and logical progression of ideas	7
• Provides a sound analysis of changing models of human evolution • Relates work of ONE named scientist to changing models • Relates advances in technology to changing models	6
• Demonstrates an understanding of human evolution • Relates examples of scientist(s) and technology to our knowledge/models of human evolution	4–5
• Outlines the work of a scientist in relation to human evolution AND/OR • Outlines an advance in a technology in relation to human evolution	2–3
• Provides some relevant information	1

Sample answer:

One scientist whose work has been significant in helping show possible pathways of human evolution is Raymond Dart who worked on a fossil skull (the Taung child) in the 1920s. By identifying both ape-like features (tooth size and cranial capacity) and human-like features (position of foramen magnum suggesting upright, bipedal posture), this led to the idea that this new species – *Australopithecus afarensis* – could be an intermediate species, showing an evolutionary link between apes and humans. It also challenged the prevailing evolutionary view at the time – that intelligence developed in apes who then later walked upright. *A.afarensis* appears to have walked upright while increased intelligence came later.

Technological advances have allowed scientists to access more information to help understand human evolution. The use of mitochondrial DNA (mtDNA) as a molecular clock has been important in providing scientists with information about relationships between humans and other related species such as the Neanderthals. The technology is based on the idea that DNA mutates at a relatively constant rate and so by comparing differences in mtDNA it is possible to establish similarities and differences between species. The greater the similarity the more closely related the species are. This technology has revealed that Neanderthals and modern humans did not interbreed, as was previously believed by many scientists, but co-existed until Neanderthals became extinct.

DNA–DNA Hybridisation is a technique where the double-stranded DNA from different species is heated to separate the strands and the single strands then recombine as the temperature is lowered. The amount of recombining can be measured as a percentage – the greater the amount of recombination, the greater the similarity in the DNA, suggesting a closer evolutionary relationship. Recombination levels of 96% or more are usual in organisms from the same species. Data for chimpanzees shows a 97.6% similarity with human DNA which would suggest that chimpanzees, which are currently placed in a different genus to humans, may be incorrectly classified and are much more closely related to humans in evolution than their classification might indicate. Future classification systems might need to be changed to reflect this data.

The information above shows that models of human evolution and classification have been constantly undergoing change as new information comes to light. These changes will continue to occur to accommodate new discoveries, both through new technologies and as more fossil discoveries are made.

Question 35 (a) (i)

Criteria	Marks
• Identifies TWO relevant isotopes	2
• Identifies a relevant isotope	1

Sample answer:

Carbon 14 (^{14}C), Oxygen 18 (^{18}O)

Question 35 (a) (ii)

Criteria	Marks
• Describes the location and main structural features of thylakoids	2
• Provides TWO features of thylakoids	1

Sample answer:

Thylakoids are located inside chloroplasts arranged in layers called grana. Thylakoids are flattened hollow disks made up of membranes that have chlorophyll dissolved in the lipid bilayers.

Question 35 (b)

Criteria	Marks
• Describes the functions of photosystems I and II • Describes a difference in the functions • Relates functions to light-independent reactions	4
• Outlines functions of photosystems I and II • Outlines a difference in functions of photosystems I and II • Attempts to relate functions to light-independent reactions	3
• Outlines functions of photosystems I and II OR • Outlines a difference in functions of photosystems I and II	2
• Provides relevant information	1

Sample answer:

Photosystem II traps light energy to cause the oxidation of water (photolysis results in electrons, protons and oxygen). As electrons are excited and then passed down the electron transport chain this provides the energy for pumping protons into thylakoid disk spaces and the synthesis of ATP through chemiosmosis.

The electrons are passed to photosystem I where they are raised to a much higher energy level by the absorption of light. Photosystem I generates a strong reducing agent, reducing NADP+ to NADPH.

The function of photosystem II is to provide electrons and trap energy to generate ATP while photosystem I is responsible for producing NADPH that transports electrons to the Calvin cycle. Both ATP and NADPH are essential for the Calvin cycle and therefore both PSI and PSII are needed.

Question 35 (c) (i)

Criteria	Marks
• Outlines a suitable method for measuring the rate of photosynthesis	2
• Provides some relevant information	1

Sample answer:

Oxygen produced by photosynthesis in pondweed can be collected and measured. The rate can be determined by measuring the amount of oxygen produced in a period of time.

Question 35 (c) (ii)

Criteria	Marks
• Analyses the data to draw suitable conclusions about the effect of light, temperature and CO_2 concentration on the rate of photosynthesis shown in the data • Justifies conclusions using data from the graph	3
• Analyses the data to draw two suitable conclusions about the effect of light, temperature or CO_2 concentration on the rate of photosynthesis • Refers to data from the graph OR • Analyses the data to draw suitable conclusions about the effect of light, temperature and CO_2 concentration on the rate of photosynthesis	2
• Provides some relevant information	1

Sample answer:

As light intensity increases so does the rate of photosynthesis until a maximum rate is reached and a stable rate/plateau follows after which increasing light does not increase the rate of photosynthesis. This general trend still occurs when CO_2 or temperature are increased.

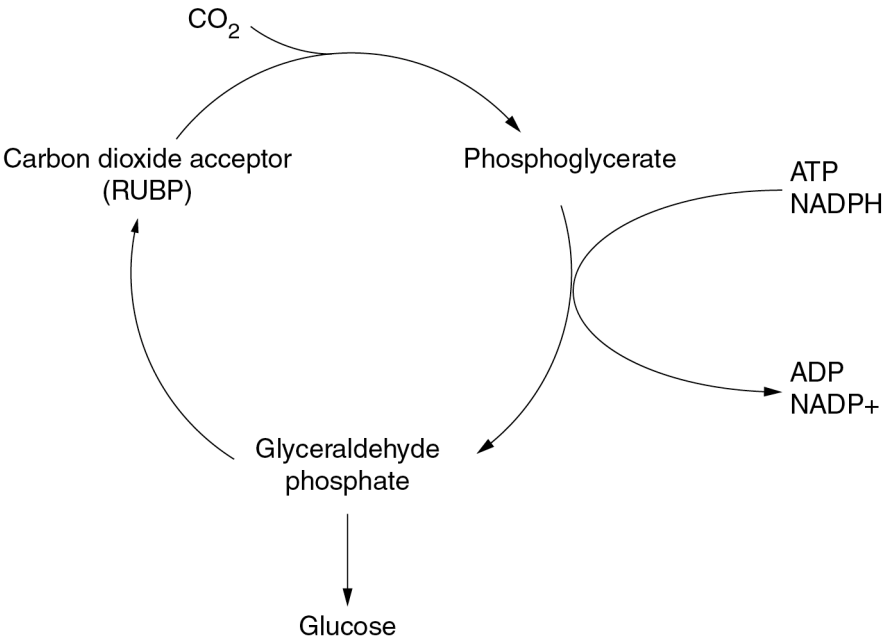
Increasing the temperature from 15°C to 25°C results in an increase in the rate of photosynthesis at all light intensities. The plateau is reached at a similar light intensity for both temperatures.

Increasing CO_2 concentration from 0.04 to 0.4% increases the rate of photosynthesis dramatically and it is higher at all light intensities. A plateau, indicating the maximum rate, is still reached, however, this occurs at much higher light intensities. The increased CO_2 has a much larger effect than the increase in temperature shown.

Question 35 (d)

Criteria	Marks
• Constructs a flow chart that includes a cycle • Includes main steps, intermediates and relationship between ATP and NADPH • Products include regeneration of carbon dioxide acceptor and carbohydrate	5
• Constructs a clear flow chart • Provides key processes and products • Includes reference to ATP and NADPH	4
• Constructs a suitable flow chart that includes three relevant features	3
• Provides two features of light-independent reactions	2
• Provides relevant information	1

Sample answer:



Question 35 (e)

Criteria	Marks
• Demonstrates an understanding of the provisional nature of science • Demonstrates a thorough understanding of the historical progression of theories about photosynthesis • Provides suitable examples, including evidence provided by the work of Engelmann • Relates progression of ideas of photosynthesis to the development of new technologies/methods and evidence • Demonstrates coherence and logical progression of ideas	7
• Demonstrates an understanding of the provisional nature of science • Demonstrates an understanding of the historical progression of theories about photosynthesis • Provides suitable examples, including evidence provided by the work of Engelmann • Relates progression of ideas of photosynthesis to the development of new technologies/methods and evidence	6
• Demonstrates an understanding of changing theories about photosynthesis • Provides suitable examples, including some evidence provided by the work of Engelmann • Relates progression of ideas of photosynthesis to the development of new technologies/methods and evidence	5
• Demonstrates an understanding of changing theories about photosynthesis • Provides suitable examples, including some evidence provided by the work of a specific scientist • Links progression of ideas of photosynthesis to the development of new technologies/methods and evidence	4
• Describes some aspects of the historical progression of our theories about photosynthesis • Outlines the work/evidence produced by a relevant scientist/technology	3
• Outlines some aspects of the development of theories about photosynthesis	2
• Provides relevant information	1

Sample answer:

Scientific explanations are provisional in nature; they are based on current evidence and accepted for a time but may be changed as new evidence becomes available. New evidence often arises as a result of new methods and technologies.

Early evidence for photosynthesis gathered by von Helmut showed that soil was not primarily responsible for a plant's mass change as it grows. Later observations by Hale showed changes in the air when plants were grown in a closed environment. Priestly then provided specific evidence that plants 'restore air' when growing them in enclosed environments for a few weeks as a candle was able to be relit. This theory was refined by Ingen-Housz in the late 19th century when performed over controlled experiments with plants to demonstrate that the 'purification of air' (photosynthesis) took only hours, not days and required the presence of both light and green parts of plants. This refined the theory significantly.

The development of high quality microscopes in the 19th century led to new evidence about which specific organelles and what type of light were involved in photosynthesis. Engelman used a specially modified microscope to shine light of different wavelengths onto *Spirogyra* and then observed the growth of aerobic bacteria. He was able to demonstrate that the bacteria grew best near the chloroplast in the presence of red or blue light (due to oxygen being produced there). This led to the modification of photosynthetic theory in terms of which wavelengths of light were involved and also showed that chloroplasts were responsible for photosynthesis.

In the 20th century the capacity to use and trace radioisotopes allowed for experiments that gathered much new evidence about the process of photosynthesis. This included the work of Ruben that confirmed that the source of oxygen produced by photosynthesis was water and that radioactive carbon could be used to track chemical transformations of CO_2. This led to Calvin's experiments using his 'lollipop' apparatus and chromatography that resulted in evidence for the steps involved in the light-independent reactions, now known as the Calvin Cycle.

The history of our understanding of photosynthesis clearly demonstrates that scientific theories are provisional in nature and constantly challenged and modified as new evidence becomes available.

2018 HSC Biology
Mapping Grid

Section I
Part A

Question	Marks	Content	Syllabus outcomes
1	1	9.2.1.2.8	H6
2	1	9.2.2.2.1	H6
3	1	9.4.4.2.4	H6
4	1	9.4.1.2.2	H9
5	1	9.3.4.2.7	H10
6	1	9.3.4.3.2, 9.3.4.2.5	H9
7	1	9.2.3.3.1	H6
8	1	9.4.3.2.2	H6
9	1	9.2.3.2.9; 9.2.3.3.7	H6
10	1	9.3.5.2.1	H7, H10
11	1	9.4.7.2.1, 9.4.7.3.1	H8
12	1	9.2.1.2.8; 14.1a,b, 9.2.1.2.7	H6, H14
13	1	9.3.1.2.3	H10
14	1	9.3.2.3.1; 9.1.14.1a,d, 9.3.3.3.2, 9.3.2.2.6	H9, H14
15	1	9.2.3.2.6	H6
16	1	9.4.5.2.2	H6
17	1	9.4.3.3.2; 12.3c, 14.1f	H6, H12, H14
18	1	9.2.2.3.2; 12.4b; 14.2b; 14.3c	H12, H14
19	1	9.3.2.3.1; 9.3.2.3.2; 9.3.3.3.2; 14.1a,b	H9, H14
20	1	9.2.1.2.4; 9.2.3.2.8; 14.1a,b, 12.3c	H6, H12, H14

Section I
Part B

Question	Marks	Content	Syllabus outcomes
21 (a)	2	9.2.1.2.8, 9.2.1.2.5	H6
21 (b)	2	9.2.1.2.6	H6
22 (a)	2	9.4.3.2.1; 9.4.3.3.1	H2
22 (b)	3	9.4.3, 9.4.3.2.1	H2
23 (a)	3	9.1.11.2a, b, c, 9.2.2.2.6	H11
23 (b)	2	9.2.2.2.6	H6
24 (a)	3	9.1.13.1f, g	H6, H13
24 (b)	3	9.1.14.1g; 9.4.5.2.3	H6, H14
25 (a)	1	9.2.2.3.3	H1, H6
25 (b)	3	9.1.14.1d; 9.2.2.3.1; 9.2.1.2.2	H6, H14
26 (a)	2	9.3.4.2.3	H6
26 (b) (i)	3	9.3.4.2.2; 9.3.4.2.4	H6, H9

Question	Marks	Content	Syllabus outcomes
26 (b) (ii)	1	9.3.4.3.3, 9.2.3.2.7	H6
27	4	9.2.3.3.5	H6
28 (a)	2	9.3.2.2.6; 9.3.3.2.8	H7, H10
28 (b)	4	9.3.3.2.8; 9.3.3.2.9; 9.3.2.2.4; 9.3.1.2.1; 9.3.1.2.3; 9.3.1.3.1, 9.3.4.2.6	H7, H10
29 (a)	2	9.3.3.2.3; 9.3.4.2.1	H9
29 (b)	5	9.3.3.2.4; 9.3.3.2.5; 9.3.3.3.1	H9
30	8	9.4.2; 9.4.3; 9.4.5; 14.1 a, b, c, d, g, 14.3d	H1, H4, H8, H14

Section II

Question	Marks	Content	Syllabus outcomes
Question 31		**Communication**	
(a) (i)	2	9.5.3.2.2	H6
(a) (ii)	2	9.5.4.2.2	H6, H14
(b)	4	9.5.5.2.3	H6
(c) (i)	2	9.1.14.1a, 9.5.4.2.4	H14
(c) (ii)	3	9.1.14.1a, b, c, d, 9.5.4.2.1–5, 9.5.7.2.5	H6, H14
(d)	5	9.5.3, 9.1.13.1e	H6, H13
(e)	7	9.5.1.2.2; 9.5.2.2.2; 9.5.2.3.2; 9.5.4.3.1; 9.5.4.3.2; 9.5.5.3.2; 9.5.6.2.1; 9.5.6.3.2	H1, H2, H6
Question 32		**Biotechnology**	
(a) (i)	2	9.6.1.2.3; 9.6.1.3.1	H7, H8
(a) (ii)	2	9.6.1.3.2	H7, H8
(b)	4	9.6.6.3.1; 9.6.6.2.3	H3, H8
(c) (i)	2	9.6.5.2.2; 9.6.5.3.4	H6
(c) (ii)	3	9.6.5.2.2; 9.6.5.2.1; 9.1.14.1d, f, g; 9.1.14.3b, c, d	H6, H14
(d)	5	9.1.13.1e; 9.6.3.2.2; 9.6.3.2.3	H6, H13
(e)	7	9.6.2; 9.6.3; 9.6.4; 9.6.5; 9.6.6	H2, H6
Question 33		**Genetics: The Code Broken?**	
(a) (i)	2	9.7.3.2.1	H9
(a) (ii)	2	9.7.3.2.2; 9.7.3.2.3	H9
(b)	4	9.7.6.2.1.	H6
(c) (i)	2	9.1.14.1a,b, c, d; 9.7.6.3.1	H10, H14
(c) (ii)	3	9.1.14.1a,b, c, d; 9.7.6.3.1	H14
(d)	5	9.7.7.3.2; 9.1.13.1e	H6, H13
(e)	7	9.7.4; 9.7.6; 9.7.7.2.2; 9.7.7.2.3	H2
Question 34		**The Human Story**	
(a) (i)	2	9.8.2.2.3	H1
(a) (ii)	2	9.8.2.2.5	H14
(b)	4	9.8.4.2.2	H6

Question	Marks	Content	Syllabus outcomes
(c) (i)	2	9.1.14.1 a, b, c d; 9.8.3.2.2	H14
(c) (ii)	3	9.1.14.1b; 9.8.3.2.2	H14
(d)	5	9.1.13.1e; 9.8.1.2.6	H13
(e)	7	9.8.2.2.6; 9.8.2.3.2; 9.8.2.3.3; 9.8.3.3.2; 9.8.6.3.3	H2
Question 35		**Biochemistry**	
(a) (i)	2	9.9.5; 9.9.5.3.1	H6
(a) (ii)	2	9.9.8, 9.9.9.8.3.2	H6
(b)	4	9.9.4; 9.9.4.2.5	H1, H6
(c) (i)	2	9.9.3.3.1, 9.1, 9.1.14.1a,b and c	H6, H14
(c) (ii)	3	9.9.4.2.3; 9.9.4.2.6; 9.9.6.2.3; 9.9.7.1.1; 9.1.14.1 a, b and c	H6, H14
(d)	5	9.1.13.1e; 9.9.6.2.3	H13
(e)	7	9.9.2; 9.9.3.21; 9.9.3.2.4; 9.9.3.3.3; 9.9.4.2.1; 9.9.4.2.2; 9.9.5.2.4; 9.9.5.3.1; 9.9.6	H2