CSSA

2024

TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

MARKING GUIDELINES

Biology

Section I

20 marks
Questions 1–20 (1 mark each)

Question	Answer	Outcomes Assessed	Targeted Performance Bands
1	C	BIO12-12	2–3
2	A	BIO12-12	2–3
3	D	BIO12-13	2–3
4	B	BIO12-14	2–3
5	D	BIO12-15	3–4
6	D	BIO12-13	3–4
7	D	BIO12-12	3–4
8	A	BIO12-13, BIO12-5	3–4
9	D	BIO12-14, BIO12-5	3–4
10	A	BIO12-14	3–4
11	B	BIO12-12, BIO12-5, BIO12-6	3–5
12	C	BIO12-5, BIO12-15	3–5
13	A	BIO12-14, BIO12-2, BIO12-7	3–5
14	C	BIO12-14	3–5
15	D	BIO12-13	3–5
16	B	BIO12-12	4–6
17	C	BIO12-15, BIO12-5	4–6
18	B	BIO12-14, BIO12-4, BIO12-5	5–6
19	D	BIO12-13, BIO12-5	5–6
20	A	BIO12-15, BIO12-5, BIO12-6	5–6

Section II

80 marks
Question 21 (3 marks)
Question 21 (a) (1 mark)
Outcomes Assessed: BIO12-12
Targeted Performance Bands: 2–3

Criteria	Marks
• States ONE difference between internal fertilisation and external fertilisation	1

Sample Answer:

Internal fertilisation is the union of an egg cell with a sperm during sexual reproduction *inside* the body of a parent.

External fertilisation is when a male organism's sperm fertilises a female organism's egg outside the female's body during sexual reproduction.

Question 21 (b) (2 marks)
Outcomes Assessed: BIO12-12
Targeted Performance Bands: 2–3

Criteria	Marks
• Describes ONE advantage and ONE disadvantage between internal fertilisation and external fertilisation	2
• Describes ONE advantage OR ONE disadvantage between internal fertilisation and external fertilisation	1

Sample Answer:

Advantages may include:

- Large number of gametes being released i.e more offspring produced
- Easier to find mates as gametes can drift. (e.g in water)
- spawning can result in a greater mixture of the genes within a group, leading to higher genetic diversity and a greater chance of species survival in a hostile environment

Disadvantages may include:

- Species must produce large numbers of gametes, which requires extra energy
- Requires watery environment
- Predation of fertilised eggs may occur - no parental care

Question 22 (3 marks)
Outcomes Assessed: BIO12-14, BIO12-4
Targeted Performance Bands: 2–3

Criteria	Marks
• Explains how three methods assists in the transmission and control of malaria	3
• Explains how two methods assists in the transmission and control of malaria	2
• Explains one method assists in the transmission and control of malaria	1

Sample Answer:

Preventative measure	*How this measure assists in the control of disease*
Bed Nets	Bed nets reduces the mosquitoes' ability to bite individuals asleep in their bed. Consequently, this prevents the protozoan from entering the bloodstream of the individual and therefore prevents the transmission of Malaria.
Placing a lid on open water source	Placing a lid on an open water source reduces the risk of stagnant water, which serves as a breeding ground for mosquitoes. This action decreases the number of mosquitoes carrying the disease, thereby reducing the transmission rate.
Insecticide	Insecticides are chemicals that have been used to target and kill mosquitoes which are the vectors of Malaria. The goal of insecticides is to control the population of mosquitoes and prevent transmission to humans.

Question 23 (5 marks)
Question 23 (a) (3 marks)
Outcomes Assessed: BIO12-12, BIO12-6, BIO12-7
Targeted Performance Bands: 3–5

Criteria	Marks
• Correctly draws a punnett square using correct parent genotypes • Includes a key • States correctly the phenotypic ratio of offspring	3
• Draws a Punnett square and correctly completes the offspring genotypes • States the phenotypes of the offspring accurately for the square drawn	2
• Provides some relevant information	1

Sample Answer:

Parent genotypes: grey = GG and grulla = Gg
Key
G = grey
g = cremello

	G	G
G	GG	GG
g	Gg	Gg

Phenotype ratio = Grey, cremello and grulla respectively = 2 : 0 : 2

Question 23 (b) (2 marks)
Outcomes Assessed: BIO12-12, BIO12-7
Targeted Performance Bands: 3–5

Criteria	Marks
• Correctly calculates the frequency of the g allele	2
• Provides some relevant information	1

Sample Answer:

Grey (GG) x 8 = 16 G alleles
Grulla (Gg) x 7 = 7 G alleles, 7 g alleles
Cremello (gg) x 4 = 8 g alleles

Total G alleles = 23
Total g alleles = 15

Frequency of g in herd = (15 / 38) = 0.3947 → 0.40

Question 24 (4 marks)
Outcomes Assessed: BIO12-13
Targeted Performance Bands: 3–5

Criteria	Marks
• Provides THREE total similarities AND differences between gene cloning and whole organism cloning • Identifies a relevant named example for each type of cloning	4
• Provides TWO total similarities AND/OR differences between gene cloning whole organism cloning • Identifies a relevant named example for each type of cloning	3
• Provides TWO total similarities OR differences between gene cloning whole organism cloning • Provides ONE similarity OR difference and identifies a relevant named example for each type of cloning	2
• Provides some relevant information	1

Sample Answer:

Criteria	*Gene Cloning*	*Whole Organism*
Process	A chosen gene is inserted into the plasmid of a bacteria e.g. E. Coli. The bacteria then undergoes binary fission to create identical copies of itself, creating an identical copy of the chosen inserted gene.	The nucleus of the chosen organism is removed an inserted into an unfertilised egg cell. The new cell is then placed into a surrogate mother for implantation. The developing offspring will be genetically identical to the original organism.
Result	Multiple copies of a chosen gene are created, and genetically identical.	
Genetic Similarity	Result is genetically identical to the original.	Result is genetically identical to the original.
Example	Mass production of insulin using the insulin gene.	Dolly the Sheep

Question 25 (4 marks)
Outcomes Assessed: BIO12-14, BIO12-6
Targeted Performance Bands: 3–5

Criteria	Marks
• Describes a contribution of both Pasteur and Koch and relates it to the discovery of the cause of gastric ulcers	4
• Outlines a contribution of both Pasteur and Koch and relates it to the discovery of the cause of gastric ulcers	3
• Outlines a contribution of Pasteur OR Koch and attempts to relate it to the discovery of the cause of gastric ulcers	2
• Provides some relevant information	1

Sample Answer:

H pylori can be spread from person to person due to the fact that it is a bacteria and can be found in contaminated water. This understanding can be linked to Louis Pasteur and his swan neck flask experiment. He demonstrated that it was microorganisms (such as bacteria) that can cause the spoiling of food and drink (as well as cause disease) through experimenting with microbial growth in a swan neck and straight neck flask of broth.

When Barry Marshall swallowed the cultured H. Pylori, he was conducting a version of Koch's Postulates. He found the bacteria in a number of people with the same symptoms, and then isolated that specific bacteria. When he inoculated himself, he developed the same symptoms, demonstrating the causative nature of the bacteria.

Question 26 (6 marks)
Question 26 (a) (4 marks)
Outcomes Assessed: BIO12-15, BIO12-6
Targeted Performance Bands: 3–5

Criteria	Marks
• Demonstrates an understanding of a negative feedback loop for maintain glucose levels • Explains the role of the glycogen in blood glucose regulation • Explains the impact of Cori's disease on ability to maintain blood glucose levels • Use of appropriate biological terminology throughout their answer	4
• Explains the role of glycogen in blood glucose regulation • Explains the impact of Cori's disease on ability to maintain blood glucose levels	3
• Identifies the role of glycogen in raising blood glucose	2
• Provides some relevant information	1

Sample Answer:

Cori's disease affects the body's ability to breakdown glycogen into glucose. Therefore, an individual with Cori's disease will not be able to maintain blood glucose levels. When the body detects a decrease in blood glucose levels, the pancreas releases the hormone glucagon which travels to the liver and initiates the cells of the liver breaking down stored glycogen into glucose. People with Cori's disease does not have the enzyme that facilitates the breaking down of glycogen into glucose, as a result, glycogen will remain the same and blood glucose levels will not be able to increase in response to glucagon.

Question 26 (b) (2 marks)
Outcomes Assessed: BIO12-15, BIO12-6
Targeted Performance Bands: 3–5

Criteria	Marks
• Correctly provides characteristics and features of a possible treatment/and or management for Cori's disease	2
• Provides some relevant information	1

Sample Answer:

Some possible answers could include. Other plausible answers may be accepted:

- Individuals could undergo gene therapy by having a gene inserted that when expressed would create a functional enzyme to break down the glycogen.
- People with this condition may be able to manage it by following a special diet. This diet would include complex carbohydrates and protein, eaten in small meals throughout the day (every 3-4 hours). They would also need to monitor their blood sugar levels regularly.

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Question 27 (6 marks)
Outcomes Assessed: BIO12-13
Targeted Performance Bands: 4–5

Criteria	Marks
• Correctly describes the changes that have occurred for mutations X, Y and Z. • Makes a value judgement on the impact of each mutation on the production of glutathione, demonstrating a THOROUGH understanding of mutations of coding and non-coding DNA	6
• Correctly outlines the changes that have occurred for mutations X, Y and Z. • Makes a judgement on each mutation on the production of glutathione, demonstrating a THOROUGH understanding of mutations of coding and non-coding DNA	5
• Correctly outlines the change that has occurred for at least two of the mutations. • Makes a judgement on at least two mutations on the production of glutathione demonstrating a SOUND understanding of mutations of coding and non-coding DNA	4
• Correctly identifies the change that has occurred for at least two of the mutations. • Attempts to make a judgement on at least one mutations on the production of glutathione demonstrating a SOUND understanding of mutations of coding and non-coding DNA	3
• Describes some of the changes that have occurred in the mutations provided	2
• Provides some relevant information	1

Sample Answer:

Mutations X, Y and Z may all have differing impacts on the final production of the glutathione polypeptide.

Mutation X may have a significant impact on the polypeptide. It involves the substitution of the 7th base 'A' into an 'T'. This will turn the triplet sequence TGG into AGG. If this codes for a different amino acid, the second amino acid in the polypeptide chain will be different, which may cause a less functional or even non-functional polypeptide. This will depend on how the final shape of the polypeptide is altered by the new amino acid.

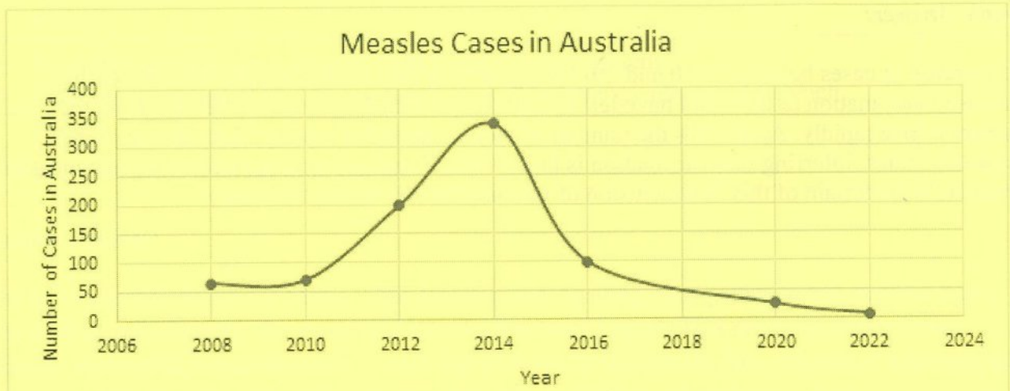
Mutation Y will likely have no impact on the polypeptide. This is due to it being on the non-coding region of the DNA. This means that whilst the 3rd base 'G' has been substituted for a 'C', the change will not be transcribed when the complementary mRNA molecule is formed, and thus will have no effect on the mRNA sequence that will leave the nucleus to be translated. This means the amino acid sequence will remain the same.

Mutation Z will have a significantly large impact on the polypeptide. This is due to a 'T' being inserted into the 7th base, changing the TGG triplet to TAG. This will result in a different amino acid for this triplet. However, due to it being an addition mutation, it will create a frameshift, where every triplet from that base onwards will be shifted by one position. This will result in every amino acid from this section onwards likely being incorrect, causing a significantly faulty polypeptide chain.

Question 28 (8 marks)
Question 28 (a) (4 marks)
Outcomes Assessed: BIO12-4
Targeted Performance Bands: 3–5

Criteria	Marks
• Correct axis labels (year on the X axis, number of cases on the Y axis) • Appropriate scales on each axis (even scales, use of 75% or more of the grid) • Points accurately plotted • Appropriate curved line of best fit drawn	4
• As above with one error or omission	3
• As above with 2-3 errors or omissions	2
• Attempt made with at least one component of graph correct	1

Sample Answer:



Question 28 (b) (1 mark)
Outcomes Assessed: BIO12-4
Targeted Performance Bands: 3–5

Criteria	Marks
Correct number of cases based on student's graph	1

Sample Answer:

Refer to student graph

Question 28 (c) (3 marks)
Outcomes Assessed: BIO12-4, BIO12-14
Targeted Performance Bands: 3–5

Criteria	Marks
• Specific references made to the graph to in relation to both increases and decreases in cases AND • Explanation shows cause and effect relationship between a higher vaccination rate and fewer cases AND lower vaccination rate and fewer cases • At least one limitation in data addressed (e.g data missing for odd numbered years)	3
• Specific references made to the graph to in relation to both increases and decreases in cases OR • Explanation shows cause and effect relationship between a higher vaccination rate and fewer cases OR lower vaccination rate and fewer cases	2
• Provides some relevant information	1

Sample Answer:

The increase in cases between 2010 and 2014 suggests that the vaccination rate was decreasing. Decreased vaccination rates would have left children unprotected against measles allowing the case numbers to rise rapidly. After 2014 the number of measle cases fell rapidly likely due to higher vaccination rates, inferring that vaccination is highly effective at protecting children against measles. However, to be certain of this, the inclusion of vaccination rate data is necessary.

Question 29 (6 marks)
Outcomes Assessed: BIO12-15, BIO12-7
Targeted Performance Bands: 5–6

Criteria	Marks
• Identifies and describes a suitable technology for each patient with reference to the stimulus material • Explains advantages and disadvantages of each technology identified for each patient • Makes a judgement about the suitability of each of the named devices for each patient	6
• Identifies and describes a suitable technology for each patient • Describes advantages and disadvantages of each technology identified for each patient • Makes a judgement about the suitability of each of the named devices for each patient	4–5
• Identifies and outlines a suitable technology for each patient • Outlines advantages OR disadvantages of each technology identified for each patient	2–3
• Provides some relevant information	1

Sample Answer:

The most suitable device for Mario is the Hearing Aid. Hearing Aids gather sound, convert it to electrical signals, amplify the signal and convert it to sound again. This device would be more suitable because he misunderstands speech due to noisy environments. The purpose of a hearing aid is to make sound louder and audible for a person who is suffering from hearing loss.

Advantages of Hearing Aids:

- Relatively cheaper
- Allows people to communicate better in a social environment
- Improved hearing range for people with hearing loss.
- No surgery required
- Increased safety and awareness
- Improved emotional wellbeing

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Disadvantages of Hearing Aids:

- Hearing aids can be somewhat expensive to buy and mainly depending on the patient's economic status.
- Hearing aids can be uncomfortable to wear. Some wearers can become self- conscious or have concerns
- The voice of the person using the device may seem a lot louder to them than usual.
- Hearing aid users may get feedback from their device such as a whistling noise.
- Hearing aids may give the patient some difficulty in distinguishing between people and sounds within a room or area.

The most suitable device for Angelique is the cochlear implant. The **cochlear implant** on the other hand electrically stimulates the nerves of the cochlea, meaning it does not depend on residual hearing and can assist people even with inner ear problems. This technology is implanted in the inner ear while its headset and speech processor are worn externally. **Sound waves are picked up by the microphone and converted into an electrical code by the speech processor. This code is sent by cable to the headset, transmitted to the implant which then transforms this into electrical pulses. Electrochemical messages are sent to the brain where they are decoded.** The cochlear implant assists profoundly deaf persons such as Angelique, having more power than the hearing aid; this can also assist patients with inner ear damage, particularly damaged hair cells in the cochlea.

Advantages of the cochlear implant:

- Ability to participate in a variety of social activities
- Quality of life is improved
- Able to engage more fully in the workplace and professional career
- Greater independence
- Enhanced social relationships

Disadvantages of the cochlear implant:

- Surgery and the cost of a cochlear implant may be somewhat expensive depending on the patient's economic status.
- The device as a whole can be uncomfortable.
- A person who has not developed speech will be at a far greater disadvantage then a patient who becomes deaf at a later date in their life.
- Sound in noisy areas can be somewhat hard to distinguish.
- Sound can be unclear.
- Full hearing potential is not reached with a cochlear implant.
- Overall, both devices will not restore normal hearing.

Question 30 (15 marks)
Question 30 (a) (1 mark)
Outcomes Assessed: BIO12-13
Targeted Performance Bands: 2–3

Criteria	Marks
• Correctly identifies a mutation as a change in the DNA base sequence	1

Sample Answer:

A mutation is a change in the base sequence of DNA

Question 30 (b) (4 marks)
Outcomes Assessed: BIO12-12, BIO12-13
Targeted Performance Bands: 3–5

Criteria	Marks
• Demonstrates thorough understanding of the consequence of SCN1A gene mutation by explaining impact on protein synthesis and the production of faulty Nav1.1 protein • Identifies consequence of abnormal functioning of sodium channels • Identifies that two normal chromosomes are required for production of normal sodium channels • Identifies that each chromosome contributes half the number of sodium channels	4
• the consequence of SCN1A gene mutation by outlining impact on protein synthesis and production of faulty Nav1.1 protein • Identifies that two normal chromosomes are required for production of normal sodium channels AND • Identifies consequence of abnormal functioning of sodium channels OR • Identifies that each chromosome contributes half the number of sodium channels	3
• Explains how SCN1A gene mutation results in changes to mRNA and/or amino acids in protein synthesis • Identifies that two normal chromosomes are required for production of normal sodium channel OR • Identifies that each chromosome contributes half the number of sodium channels OR • Identifies consequence of abnormal functioning of sodium channels	2
• Provides some relevant information	1

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Sample Answer:

Dravet syndrome is caused by a mutation of the SCN1A gene on one of Chromosome 2. Normal SCN1A genes are needed on both chromosomes to allow for normal sodium channels. This is because expression of genes from both chromosomes are required for a full complement of Nav1.1 proteins. Both SCN1A genes on both chromosomes (maternal and paternal chromosome #2) produce mRNA during transcription. If one of the SCN1A gene is faulty as a result of mutation then during translation at the ribosomes the wrong amino acids will be added by the tRNA resulting in a non-functional protein. A mutation on one of the SCN1A genes of either chromosome of the homologous pairs results in half of the sodium channels not working correctly. The faulty Nav1.1 protein produced inhibits the sodium channel from working causing poor communication between cells resulting in seizures.

Question 30 (c) (5 marks)
Outcomes Assessed: BIO12-12, BIO12-13
Targeted Performance Bands: 4–6

Criteria	Marks
• Defines nonsense mutation • Explains impact of nonsense mutation on polypeptide synthesis • Explains how genetically altered tRNA can be used to correct nonsense mutation • Links replacement of stop codon with altered tRNA to correct amino acid sequence • Links correct amino acid to polypeptide synthesis and production of functional protein	5
• Defines nonsense mutation • Outlines impact of nonsense mutation on polypeptide synthesis • Explains how genetically altered tRNA can be used to correct nonsense mutation • Links replacement of stop codon with altered tRNA for correct amino acid sequence OR • Links correct amino acid to polypeptide synthesis and production of functional protein	4
• Defines nonsense mutation • Outlines impact of nonsense mutation on polypeptide synthesis OR • Outlines how genetically altered tRNA can be used to correct nonsense mutation • Links replacement of stop codon with altered tRNA for correct amino acid sequence OR • Links correct amino acid to production of functional protein	3
• Identifies nonsense mutation as a stop codon • Identifies impact of nonsense mutation on polypeptide synthesis OR • Identifies how genetically altered tRNA can be used to correct nonsense mutation OR • Links replacement of stop codon with altered tRNA for correct amino acid OR • Links correct amino acid to production of functional protein	2
• Provides some relevant information	1

Sample Answers:

5 marks:
Nonsense mutations are mutations that prematurely end the translation process by adding a stop instruction in the mRNA during transcription. Nonsense mutation in the SCN1A gene will produce a stop codon signal on the mRNA strand. This will produce a shorter polypeptide as translation of the remaining mRNA is not allowed to continue at the ribosome. This will produce a non-functional protein as the entire correct amino acid sequence (polypeptide chain) is not present.

A genetically altered tRNA will have an anticodon that has been designed to fit at the stop instruction location but instead of stopping the amino acid sequence it adds the corrected amino acid. This removes the stop signal and allows the polypeptide synthesis to continue. This will produce the correct length of polypeptide chain with the correct amino acid sequence for a functional protein of the Nav1.1 sodium channel.

4 marks:
Nonsense mutations are mutations that prematurely end the translation process by adding a stop instruction in the mRNA during transcription. Nonsense mutation in the SCN1A gene will produce a stop codon signal on the mRNA strand. This will produce a shorter polypeptide as translation of the remaining mRNA is not allowed to continue at the ribosome. This will produce a not functional protein as the entire correct amino acid sequence (polypeptide chain) is not present.

A genetically altered tRNA may bypasses the stop signal and allowing the polypeptide to continue. This will produce the correct length of polypeptide chain with the correct amino acid sequence for a functional protein of the Nav1.1 sodium channel.

Question 30 (d) (5 marks)
Outcomes Assessed: BIO12-12, BIO12-13
Targeted Performance Bands: 5–6

Criteria	Marks
• Explains concentration gradients of both potassium and sodium ions when neuron is at rest (resting potential) • Describes potassium and sodium ion channels and their behaviour during an action potential • Explains movement of sodium ions during depolarisation and links to membrane potential • Explains movement of potassium ions during repolarisation and links to membrane potential	5
• Explains concentration gradients of both potassium and sodium ions when neuron is at rest (resting potential) • Describes potassium and sodium ion channels and their behaviour during an action potential • Describes movement of sodium ions during depolarisation and links to membrane potential • Describes movement of potassium ions during repolarisation and links to membrane potential	4
• Describes concentration gradients of both potassium and sodium ions when neuron is at rest (resting potential) • Describes potassium and sodium ion channels and their behaviour during an action potential • Outlines the movement of sodium ions during depolarisation and links to membrane potential • Outlines the movement of potassium ions during repolarisation and links to membrane potential OR • Describes movement of sodium ions during depolarisation and links to membrane potential OR • Describes movement of potassium ions during repolarisation and links to membrane potential	3
• Outlines concentration gradients of potassium OR sodium ions when neuron is at rest (resting potential) • Describes potassium OR sodium ion channels and their behaviour during an action potential OR • Outlines potassium AND sodium ion channels and their behaviour during an action potential AND • Outlines movement of sodium ions during depolarisation OR • Outlines movement of potassium ions during repolarisation	2
• Provides some relevant information	1

Sample Answer:

When a neuron is at rest there is a higher concentration of sodium ions outside the cell compared to the concentration of ions inside the cytoplasm. The opposite is true for potassium ions where there is a greater concentration of potassium ions inside than outside the cell. This creates an electro chemical gradient.

Ions like sodium and potassium cannot move across membranes unless they move through an ion channel. When a neuron receives a stimulus the sodium channels open allowing sodium ions to move into the cell. If the stimulus is strong enough sodium ions will move into the cell push the resting potential to its threshold membrane potential. At this point all sodium channels will open and sodium ions flood in (depolarisation). As the membrane potential reaches positive values sodium channels start shutting down stopping the flow of sodium into the cell. At this point potassium channels open and potassium ions flow out of the cell due to their concentration gradient which makes the membrane less positive (repolarisation).

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Question 31 (7 marks)
Outcomes Assessed: BIO12-13
Targeted Performance Bands: 2–6

Criteria	Marks
• Demonstrates an extensive understanding of genetic technologies and their use in agriculture • Provides features for AND against the use of genetic technologies in agriculture with reference to ethical considerations • Makes a suitable judgement • Uses appropriate scientific terminology • Provides examples to support answer	7
• Demonstrates a thorough understanding of genetic technologies and their use in agriculture • Provides features for AND/OR against the use of genetic technologies in agriculture with reference to ethical considerations • Makes a suitable judgement • Uses appropriate scientific terminology • Provides examples to support answer	6
• Demonstrates a sound understanding of genetic technologies and their use in agriculture • Provides features for AND/OR against the use of genetic technologies in agriculture with reference to ethical considerations • Attempts to make a judgement • Provides at least one example to support answer	5
• Demonstrates some understanding of genetic technologies and their use in agriculture • Provides features for AND/OR against the use of genetic technologies in agriculture • Provides at least one example to support answer	4
• Demonstrates basic understanding of genetic technology and its use in agriculture OR • Provides features for AND/OR against the use of genetic technologies in agriculture	3
• Outlines some relevant features of a genetic technology OR • Identifies a relevant benefit OR limitation of a genetic technology	2
• Provides some relevant information	1

Sample Answer:

Genetic technology refers to the targeted transfer of genes between organisms or the manipulation of genes within an organism to create Genetically Modified Organisms, or GMOs. If a new gene from another species is introduced to an organism, it is called a transgenic organism.

There are numerous benefits of using genetic technologies in agriculture, such as:

- Increasing the yield of crops- crops are able to be engineered to have advantageous features, such as pest or disease resistance or increased drought tolerance. This leads to higher yields and ultimately can lead to enhanced food security. An example of this is Bt Cotton, which has been genetically engineered to produce a toxin that is harmful to pests such as bollworm, that eat it.
- Increased nutritional content- crops are able to be engineered to produce nutrient-rich crops. For example, 'Golden Rice' has been genetically engineered to produce beta-carotene (a Vitamin A precursor) to assist in combating Vitamin A deficiencies.
- Improved environmental impact- Farmers can grow crops without the need for pesticides which can be harmful to the environment (such as Bt Cotton) or can reduce the crops lost due to adverse conditions. For example, maize has been genetically modified to have improved its drought tolerance which has greatly increased yield further enhancing food security.

Our knowledge and application of genetic technologies is developing constantly as our scientific knowledge increases. Despite the numerous benefits, there are limitations and ethical concerns that must be taken into consideration:

- There are environmental concerns if say the genetically modified organism was to escape into the wild population, it may pose a threat to the ecosystem or reduce biodiversity. A crop such as Bt Cotton could produce toxins that also harm the non-target species having unintended consequences on the delicate food webs.
- Although our understanding and knowledge has greatly increased over time, there is still concern over the long-term effects on both the environment and on human health.

However, since genetic technologies also have the potential to improve yield (and thus food security) and nutritional content of crops for developing nations; can create climate-resilient crops to cope with the risks associated with climate change and could have the potential to conserve biodiversity by growing endangered plants, overall increased scientific knowledge has the potential to greatly improve the way that genetic technologies are being utilised in agriculture.

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Question 32 (6 marks)
Question 32 (a) (2 marks)
Outcomes Assessed: BIO12-12, BIO12-5
Targeted Performance Bands: 2–6

Criteria	Marks
• Identifies that the chromosomes are homologous • Provides a suitable reason	2
• Provides some relevant information	1

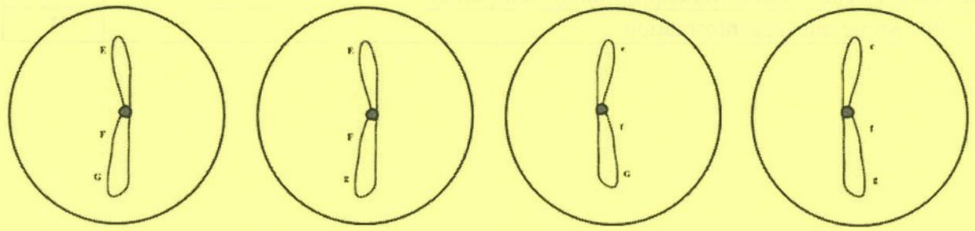
Sample Answer:

The chromosomes should be labelled as homologous. This is because the chromosomes have an identical arrangement of genes (even though the alleles are different) and homologs pair during meiosis.

Question 32 (b) (4 marks)
Outcomes Assessed: BIO12-12, BIO12-6
Targeted Performance Bands: 2–6

Criteria	Marks
• Correctly labels ALL of the alleles on each haploid gamete • Demonstrates a thorough understanding of how crossing over involves the exchange of genetic material between homologous chromosomes and links this to increase in genetic diversity in offspring • Explains the importance of crossing over for the evolution or adaptation of a population	4
• Correctly labels MOST of the alleles on each haploid gamete. • Demonstrates a sound understanding of how crossing over involves the exchange of genetic material between homologous chromosomes AND • Links this to increase in genetic diversity in offspring OR • Explains the importance of crossing over for the evolution or adaptation of a population	3
• Demonstrates a limited knowledge of the process of crossing over and its significance OR • Correctly labels the different alleles on each haploid gamete	2
• Provides some relevant information	1

Sample Answer:



i ii iii iv

The process in part (a) is crossing over, which involves the exchange of genetic material between homologous chromosomes.

This significantly contributes to the genetic diversity of the offspring, as it creates new combinations of alleles in the gametes, where each gamete is unique (as shown in the diagram above).

This creates varied genotypes in offspring, which is significant as it provides the variation required for evolution by natural selection. For example, if a population was faced with environmental change, some individuals with a specific combination of alleles may have an advantage over others, leading to adaptation and evolution of the population over time.

Question 33 (7 marks)
Outcomes Assessed: BIO12-14, BIO12-15, BIO12-2
Targeted Performance Bands: 2–6

Criteria	Marks
Extensive comparison of CAR T cells and naturally occurring T cells • Comparison includes at least one similarity AND difference • At least TWO types of naturally occurring T cells compared with CAR T • Both infectious and non-infectious diseases must be addressed • At least 4 points of comparison provided	7
• Extensive comparison as above but with minor error or omission	6
Thorough comparison of CAR T cells and naturally occurring T cells • Comparison includes at least one similarity AND difference • Both infectious and non-infectious diseases must be addressed • At least 3 points of comparison provided	5
Sound comparison of CAR T cells and naturally occurring T cells • Comparison includes similarities OR differences • Both infectious and non-infectious diseases must be addressed • At least 3 points of comparison provided	4
• Comparison includes similarity OR difference • Infectious OR non-infectious diseases addressed • At least 1 point of comparison provided	3
• Provides at least ONE correct and relevant piece of information relating to CAR T cells AND ONE correct and relevant piece of information relating to naturally occurring T cells (even if not appropriately compared)	2
• Provides some relevant information	1

Sample Answer:

Similarities include but are not limited to:

- CAR T cells are similar to cytotoxic T cells in that they both bind to and kill other cells.
- CAR T cells and cytotoxic T cells both recognise their target cells by antigens that are present on the target cell.
- CAR T cells and cytotoxic T cells can both target cancerous cells.

Differences include but are not limited to:

- The target cells of CAR T cells are only cancer cells, however cytotoxic T cells also target cells that have been infected with a pathogen.
- CAR T cells are produced using genetic engineering and cloned in a laboratory, whereas the body naturally clones T cells upon recognition of an antigen.
- CAR T cells can only target and kill cancerous cells, they do not act as helper T cells. In natural T cell production, helper T cells are also cloned, which release cytokines to activate other specific immune cells.
- Naturally occurring T cells include memory T cells which remain in circulation to provide long-term immunity against a pathogen. CAR T cells do not remain in the body long term, so millions must be made in the lab.
- The body naturally produces Suppressor T cells after a pathogen has been eradicated from the body to prevent the body from being in constant T cell production. CAR T cells do not play such a role.

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