

Trial Examination 2019

VCE Biology Units 3&4

Written Examination

Suggested Solutions

SECTION A – MULTIPLE-CHOICE QUESTIONS

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D
21	A	B	C	D
22	A	B	C	D
23	A	B	C	D
24	A	B	C	D
25	A	B	C	D
26	A	B	C	D
27	A	B	C	D
28	A	B	C	D
29	A	B	C	D
30	A	B	C	D
31	A	B	C	D
32	A	B	C	D
33	A	B	C	D
34	A	B	C	D
35	A	B	C	D
36	A	B	C	D
37	A	B	C	D
38	A	B	C	D
39	A	B	C	D
40	A	B	C	D

Question 1 B

The phospholipid fatty-acid tails face away from water in the phospholipid bilayer as they are non-polar/hydrophobic/lipophilic. The phosphate head is polar/hydrophilic/lipophobic and so faces the water on both sides of the membrane. If it is a plasma membrane, then the inside is referred to as intracellular and the outside is referred to as extracellular.

Question 2 C

DNA provides the blueprint to make protein. It does this by first producing mRNA through a process called transcription within the nucleus of eukaryotic cells. The mRNA then makes the protein at the ribosome through a process called translation.

Question 3 C

After transcription in eukaryotic cells, the immediate product is called pre-mRNA. RNA processing then occurs, where stabilising factors are put onto both ends of the mRNA (a cap and a tail) and short segments called introns are cleaved out. The remaining exons are joined to make a smaller (mature) mRNA.

Question 4 A

The mitochondrial matrix is the area within the inner membrane of the mitochondria. A combination of molecules would be found within this region. This could not include glucose as it is broken down in the cytosol (making **B** incorrect). tDNA does not exist (making **C** incorrect). NADPH is a hydrogen carrier during photosynthesis (making **D** incorrect). Mitochondria contain DNA and ribosomes, and therefore all types of RNA would be found so the DNA can be expressed as proteins.

Question 5 D

Enzymes are able to function at a tertiary level as well as a quaternary level (making **A** incorrect). Some enzymes have multiple active sites (such as RNA polymerase) and so are able to produce multiple products through a series of reactions. Some enzymes will hydrolyse a substrate, also producing more than one product (making **B** incorrect). Enzymes are reusable (making **C** incorrect). Enzymes do have an active site that substrates are complementary to, which enables a specific reaction to occur.

Question 6 B

Photosynthesis occurs in the chloroplast via the light-dependent reaction (A) and then the light-independent reaction (B). For the light-dependent reaction, ADP and NADP are required factors to transfer energy and hydrogen to the light-independent reaction in the form of ATP and NADPH. The area in which the light-dependent reaction occurs is within the lumen of the grana (M) and the light-independent reaction occurs in the stroma (N).

Question 7 B

The products of the light-independent reaction (B) are glucose and water. Carbon dioxide is a reactant (making **A** incorrect). Pyruvic acid and lactic acid are products of the respiration pathways (making **C** incorrect). Oxygen and water are products of the light-dependent reaction (making **D** incorrect).

Question 8 D

The isolation of area N (stroma) enables the light-independent reaction to be investigated further. It is sometimes called the dark reaction because it does not need light to occur so long as factor P is provided (ATP and NADPH).

Question 9 A

Hypotheses are usually written in the 'If something changes then something will happen' format. The element being changed is the independent variable (IV); this is pH. The element being measured as a result of the changing of the independent variable is, in this case, the time taken for the milk to coagulate. **A** is the most suitable answer because both the IV and the dependent variable (DV) are within the hypothesis.

Question 10 C

It is difficult to make comments about precision; however, trial 5 at pH 9 seems to be much higher than the other four trials at the same pH, making that measurement imprecise. Validity refers to the presence of one IV for each trial and, based on the method from the question, this is the case. The experiment was repeated; however, accuracy (the actual result) is still unknown. Logically, individual results should be averaged to reduce the impact of anomalous results.

Question 11 A

The results (shortest amount of time taken for coagulation) show a clear trend towards high enzyme activity at low pH (acidic) and so this would be appropriate for cheese-making. The +10 result at pH 11 has led to the denaturation of the rennin.

Question 12 B

Pheromones are released into the environment and so androstenone would be an intra-specific signalling molecule, not oestrogen. Gibberellic acid is a plant hormone that does not bind to synaptic membranes; neurotransmitters carry out this function. Serotonin, being a neurotransmitter, does not travel in the bloodstream. Cytokines are usually messages between white blood cells (leukocytes), and so interleukin 10 (between leukocytes) is a cytokine.

Question 13 B

F is an extrinsic signalling molecule that binds to an external receptor to trigger apoptosis. The 'after' diagram illustrates blebs, not blobs, and this process reduces the number of cells, whereas cancer is an increase in the number of cells. The crosses represent a caspase that cleaves the cytoskeleton, which leads to the cell breaking apart to form the blebs.

Question 14 C

A prion is a protein and does not contain nucleic acid (making **A** incorrect). A virus is non-cellular but contains either DNA or RNA as a nucleic acid (making **B** incorrect). Bacteria are not eukaryotic, they are prokaryotic (making **D** incorrect). Fungi are eukaryotic and can be single-celled (like yeast) or multicellular (like mould).

Question 15 A

In some people, chemicals that are usually harmless can cause an allergic response. The allergen (chemical) is recognised by the immune system as foreign and so it acts as an antigen to the allergy sufferer. Non-self antigens are not displayed on the surface of cells within an individual; it is self-antigens that are displayed. Transplanted cells usually have antigenic markers on their surface, which is why they are rejected. Anti-rejection drugs are required to keep the transplanted organ healthy.

Question 16 B

The neutrophils and macrophages, upon contacting an antigen, can carry out a range of functions including the secretion of cytokines. The cytokines may stimulate a fever (but not always) and they may stimulate inflammation by vasodilating blood vessels near the site of infection. To stimulate a humoral response, the antigen needs to be presented to the appropriate B cell (either directly or via an antigen-presenting cell).

Question 17 D

The milk from the mother in the first few days of feeding naturally offers short-term passive immunity to the calf. This is because the milk contains antibodies produced by the mother, conferring her resistance to pathogens that she has been in contact with. The calf will therefore be more protected against the same pathogens.

Question 18 A

The stem of the question relates to vaccination programs. The purpose of these is to make the community healthy and protected. The aim of these programs is to have 90% of the community vaccinated, which protects the unvaccinated because there is a lower chance of infected people coming in contact with them. As a result of this, the virus is less likely to come in contact with cells for reproduction (known as herd immunity).

Question 19 C

Immune deficiency diseases reduce the effect of the immune system. Multiple sclerosis is an autoimmune disease where antibodies are produced against myelin in the nervous system. Hypersensitivity is where antibodies are produced against allergens (like pollen) that lead to inflammation. Cancer usually avoids the immune system because the cells are self-cells. Human immunodeficiency virus (HIV) is an immunodeficiency disease where the virus invades T helper cells, which then lose control of the immune system.

Question 20 C

Based on the information provided, genes from the chromosome that has numbered genes translocated as a chunk (genes 3 to 5) to the chromosome originally having lettered genes. This is a form of block mutation and, as the genes are then ordered 5–4–3 rather than the original order, it is a block inversion.

Question 21 A

The diagram shows that the three new populations are smaller and two of the populations have a different gene pool compared to the original population. There is no gene flow here because three new populations have been formed with no migration between them. It is a natural phenomenon with no selection pressures leading to the altered gene pool. It is a clear example of the founder effect.

Question 22 D

Larger jaws in cichlid fish have the BMP4 gene active for longer during embryological development compared to smaller-jawed cichlid fish. Speciation has not come about due to a faster mutation rate; these were pre-existing mutations that provided the variation for particular phenotypes to be selected. It is not logical in the original ancestral population that individually sized cichlids would only breed with others of the same size. Organisms do not mutate to suit their environment; it is more logical that the variants most suited would breed in changing environments.

Question 23 C

Multicellular organisms appeared first (900 million years ago). Animals invaded land next (500 million years ago). Mammals evolved next (200 million years ago). Flowering plants were last (130 million years ago). The order is important to remember, not the times they occurred.

Question 24 D

Absolute dating is a method used to determine the actual age of a fossil. There are some methods that can be used other than radioisotopic dating including electron spin resonance. However, radioisotopic dating involves comparing the amount of a particular isotope present in a sample (fossil) compared to the amount of the same isotope in present-day samples. The isotopes decay at a known rate called the half-life, which is set for each isotope (for example, carbon-14 has a half-life of 5730 years). Sedimentary layers cannot be dated as they contain sediments of a wide variety of ages.

Question 25 A

According to the graph there were six extinctions rather than four (making **B** incorrect). There were 400 families present 400 million years ago rather than 300 (making **C** incorrect). The biodiversity 500 million years ago is approximately the same as the biodiversity 200 million years ago (making **D** incorrect). From 200 million years ago to now there was an increase from about 200 families to almost 800 families, the largest increase.

Question 26 B

Both organisms have a different generic name and both developed spines from ancestors that did not have spines (the mole and platypus only have hair). For them to both develop spines independently suggests similar environmental pressures acting upon their respective ancestors. This is consistent with convergent evolution.

Question 27 A

Based on the information provided, it is likely that position 3 was the mutation in the ancestor of 1 and 2, putting these species in a different lineage to species 3 and 4 (making **C** incorrect). From there, species 3 and 4 have four mutations each, meaning that they diverged longer ago than species 1 and 2, which had fewer mutations (three and one respectively).

Question 28 B

Hominins include modern humans and all the ancestors branching from the common ancestor between chimpanzees and humans about 6 million years ago (making **A** incorrect). During that time there have been many organisms that have existed. The first feature to be seen in the line leading to modern humans was bipedalism, followed by an increase in cranial capacity. The *Australopithecines* were bipedal without a large cranial capacity and appeared before the *Homo* genus.

Question 29 A

Africa is the cradle of humanity and so mtDNA in Africans would be expected to show more diversity than mtDNA of any other indigenous group. **B** is incorrect as the South American population is much younger than the African population, so there is less time for mtDNA mutations to accumulate. **C** is incorrect because mitochondria are in both males and females (inherited from the mother). **D** is incorrect; although the Indigenous Australian and Torres Strait Islander peoples would be expected to show more mtDNA mutations than any other indigenous group out of Africa, they would show fewer differences than the Africans.

Question 30 C

The order of cultural evolution along the hominin line is evidenced by stone tools used by *Homo habilis* (2.5 million years ago), then fire mastering by *Homo erectus* (2 million years ago). *Homo neanderthalensis* (1 million years ago) are credited with the first rituals and cave paintings.

Question 31 B

A biotechnologist would use endonuclease to cut DNA and ligase to paste the DNA into a plasmid that could then be used as a vector. The polymerase is used to replicate DNA, usually in the process of PCR.

Question 32 D

When gels are run, fragments of DNA are separated by size. The smallest fragments of DNA run further in the gel compared to any other samples. In this case, man 2 has one fragment that has moved further than any other from the wells at the top of the diagram.

Question 33 A

The child should have two gene loci in common with their mother as well as their father because the child inherits one copy of each from each parent. Man 1 has two gene loci in common with the child but man 2 has no gene loci in common with the child. The mother has two gene loci in common with the child and, when combining the evidence, it seems that man 1 is the father.

Question 34 B

Stage 1 is melting or denaturation, where the hydrogen bonds holding the strands together are broken; this is done at temperatures above 90°C. Stage 2 is annealing, where primers that combine onto target sections of the DNA are added to provide an anchor point for *taq* polymerase; this is done at about 60°C. The final stage is extension, where the *taq* polymerase extends or replicates the DNA; this is done at 72°C.

Question 35 C

The DNA doubles in concentration after each cycle. An initial combination of 10 strands will make 20 strands after one cycle, 40 after two cycles, 80 after three cycles and 160 after four cycles.

Question 36 B

The more different the melting temperature of the hybrid strand is from the original non-hybrid strand, the less closely related the organisms being compared are. The evidence shows that the *H. denisovan* is more closely related to *H. sapiens*, with about –3°C melting temperature difference, followed by *H. denisovan* and *H. neanderthalensis* (–4°C) and *H. sapiens* and *H. neanderthalensis* (–6°C).

Question 37 B

The results when compared are not the same as each other. The stem of the question suggests that more than one individual from each species was tested. Results would be expected to be relatively precise but not the same. For valid comparisons to be made, multiple tests would be carried out, allowing the data to be reasonably compared.

Question 38 D

It is unfair to charge more money for antibiotics because all people should have access to them, not just the wealthy. Antibiotics are only useful against bacterial diseases, not viral diseases, and so health workers should refrain from giving prescriptions against viral diseases. More regular use of stronger antibiotics could accelerate antibiotic resistance and so should be avoided where possible. Full completion of prescriptions of antibiotics is recommended, which means the antibiotics are not inappropriately disposed of.

Question 39 D

There is no way that a pathogen that kills all individuals who contract it (100% mortality) very quickly (in 1 day) could spread worldwide and cause a pandemic (making **A** incorrect). A low mortality (<1%) with a long incubation period (10 days) would spread worldwide but not cause as much concern as another with an equal incubation period but much higher mortality (>50%).

Question 40 A

Relenza is an antiviral medication used to treat influenza. It binds to the neuroaminidase (not the haemagglutinin) part of the virus and prevents its exit from the cells that are infected. It is not a supplement to a vaccine but is a useful treatment if taken in environments where influenza is present.

SECTION B

Question 1 (5 marks)

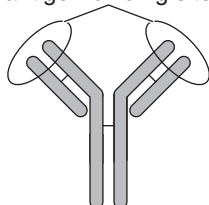
a. C – rough endoplasmic reticulum OR ribosome 1 mark

b. C, D and E 1 mark

Note: All three in order are required for the mark.

c. i. antibody 1 mark

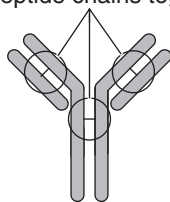
ii. antigen-binding site



1 mark

Note: Both sites are required for the mark.

iii. disulfide bonds holding four polypeptide chains together



1 mark

Note: All three bonds are required for the mark.

Question 2 (6 marks)

a. i. The function of the transcription factor is to bind to the RNA polymerase that then changes shape, enabling it to bind to the operator region of the gene. 1 mark

ii. Having the appropriate 'body form' that HOX genes are involved in regulating is a distinct survival advantage. Any change/mutation in these genes is likely to be removed from the gene pool. 1 mark

b. i. HOX genes A, C and D (the white colour of the arms and legs illustrates that gene 1 is most active) 1 mark

ii. genes 3 and 5 (the shading means HOX A, B and D are active, and two of these HOX genes suppress structural genes 3 and 5) 1 mark

c. The effects are different due to different combinations and repressions of a different combination of structural genes (HOX A activates 1, 2, 3, 4, 6 and 8, and suppresses 5 and 7, while HOX B activates 1, 2, 3, 4, 5 and 6, and suppresses 7 and 8). 1 mark

The transcription factor has a different shape, leading to a different combination of activation and repression of structural genes. 1 mark

Question 3 (5 marks)

a. CTC AAC GGT CAC TTT AAG CTG 1 mark

b. Reverse transcriptase converts the RNA from the virus into DNA, which eventually results in double-stranded DNA. The DNA can then make protein for the capsid by expressing the genes along the DNA. 1 mark

The DNA can also make more RNA that can be encapsulated by the capsid, thus making more virus particles. 1 mark

c.

Original strand of RNA	GAG UUG CCA GUG AAA UUC GAC
tRNA anticodons	CUC AAC GGU CAC UUU AAG CUG
Amino acids	glu – leu – pro – glu – lys – phe – asp

2 marks

1 mark for correct RNA strand.

1 mark for correct anticodons.

Question 4 (8 marks)

a. i. The air temperature is a control to ensure that this factor is not influencing the changed temperature inside the two thermoses. 1 mark

ii. the temperature of the thermoses (°C) 1 mark

iii. 1.5 hours 1 mark

b. The temperature increases by about 3°C and then levels out because cellular respiration is occurring within the yeast as it feeds on the glucose; temperature is a product of this reaction. 1 mark

The temperature plateaus as the rate of respiration is limited by other factors such as the concentration of oxygen or the number of yeast cells. 1 mark

c. i. Yeast with glucose has a 3°C increase in temperature and yeast with Equal has a 1.5°C increase in temperature. A lower rate of respiration with the same amount of substrate (glucose or Equal) means it could be used as a dietary supplement. 1 mark

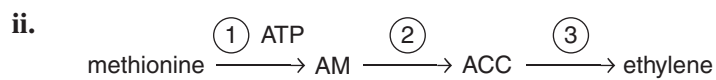
ii. Any two of:

- The experiment was not repeated and so it is not known if anomalous results were obtained.
- The pH of the solutions was not taken into account and should have been a controlled variable.
- There may have been anaerobic respiration occurring during the experiment.
- The effect of glucose/Equal on anaerobic respiration may be different, and so differing amounts of ethanol may have been present in each flask.

2 marks

Question 5 (7 marks)

- a. i. The methionine cycle is an anabolic reaction because ATP is an input. Anabolic reactions require energy for them to proceed. 1 mark



1 mark

Note: All requirements needed for the mark.

- b. i. Ethylene is a hydrophilic (non-protein) signalling molecule because it binds to cell surface receptors. 1 mark

- ii. Once ethylene binds to a receptor, a series of second messengers will be activated within the cell. 1 mark

The final response would be the activation of the cellular respiration reaction, which produces carbon dioxide and provides the energy to ripen the fruit. 1 mark

- c. The asRNA would be complementary to the mRNA coding for enzyme 2, thus preventing the production of enzyme 2. 1 mark

ACC is not produced and ethylene is not produced. Less ethylene leads to less stimulation of fruit ripening. 1 mark

Question 6 (7 marks)

a.

	Specific barrier	Description
Physical barrier	unbroken skin	prevents entry of pathogens such as malaria into the bloodstream
Chemical barrier	stomach acidity	reduces the incidence of gastro infections by destroying the pathogen

4 marks

*1 mark per cell of the table correctly filled in.**Note: Other answers would be acceptable, such as mucus production in the lungs as a chemical barrier.*

- b. Companies could keep citronellal, geranyl acetate and limonene levels constant and then change the level of geraniol. 1 mark

They could also expose groups of humans in a controlled environment to the various mixtures of citronella oil. 1 mark

Lower levels (than 11%) are less effective in the citronella oil as an insect repellent and higher levels (than 13%) are more sensitive on human skin. 1 mark

Question 7 (10 marks)**a.**

Cell	Type of immune cell	Specific role played
1	B memory cell	Upon subsequent exposures to gluten, B memory cells clone and differentiate into plasma cells to make antibodies against the gluten antigen.
2	T helper cell	Antigenic receptors on T helper cells bind to other cells (plasma, memory) to control their action.

4 marks

*1 mark per cell of the table correctly filled in.**Note: Other cells would be acceptable, such as T memory cells or T cytotoxic cells.*

- b. i.** It was used as a control, where individuals were given a vaccine that did not contain gluten to see the effect of the small gluten vaccines (in the experimental group) on desensitising the bodies response.

1 mark

ii. Any three of:

- All 116 individuals in the trial would have to suffer coeliac disease.
- The level of immune response to gluten should be similar in all individuals in the trial.
- The general health status of all individuals should be similar.
- The diet of all individuals should be the same.
- The vaccines (experimental or placebo) should be administered at the same time, as well as the same number of times.

2 marks

Note: 1 mark is to be awarded for only one correct controlled factor.

- c.** A therapeutic vaccine is used to treat an already existing disease like coeliac disease, whereas a preventative vaccine protects against the potential to contract a disease like influenza.

1 mark

With a therapeutic vaccine, regular injections are required to desensitise the body's response to gluten, whereas a preventative vaccine only requires one injection to stimulate the immune response.

1 mark

The therapeutic vaccine Nexvax 2 produces antibodies and memory cells against gluten and the preventative vaccine Fluvax produces antibodies and memory cells against influenza.

OR

The regular injections of Nexvax 2 leave very large amounts of memory cells, so the body will not respond against small amounts of gluten. The one injection of Fluvax leaves a reasonable amount of memory cells, so the body will respond against influenza.

1 mark

Question 8 (9 marks)

- a. To place the giant wombat in this time frame, no fossils could be dated earlier than 1.6 million years or later than 46 000 years. 1 mark
- b. Radioisotopic dating, in this case carbon dating, determines how much carbon-14 is present in the fossil compared to how much would have been present if the organism lived today. 1 mark
- With a 54 000-year-old fossil, nine half-lives have elapsed with carbon-14 ($9 \times 6000 = 54\,000$). For example, if there were 100 units of carbon-14 initially, there would be 0.2 units of carbon-14 in the fossil today. 1 mark
- c. i. *Diprotodon* is more closely related to wombats because they have a more recent common ancestor compared to the koala. 1 mark
- ii. DNA hybridisation is a technique that compares particular gene loci between different organisms. The more closely related they are, the more nucleotides they have in common and therefore the melting temperature of the hybrid strands would be closer to the original melting temperature. 1 mark
- The melting temperature for the hybridised *Diprotodon*–wombat strand would be higher compared to the *Diprotodon*–koala strand. 1 mark
- d. The event that occurred would have been (allopatric) speciation. 1 mark
- An original population with genetic variation was geographically divided into two separate groups and each group was subjected to different selection pressures. 1 mark
- Over time, different phenotypes were selected for in the different environments, and the wombat and the *Wynyardiidae* appeared. 1 mark

Question 9 (7 marks)

- a. Out of Africa: Only one branch of the ancestral humans leaving Africa led to modern humans. Any group of non-African modern humans have less genetic diversity than African modern humans, meaning they appeared more recently (less time for variation to accumulate). 1 mark
- Multiregional: Modern humans left Africa and stayed as one species. Gene flow between the populations retained the integrity of modern humans as a single species. 1 mark
- b. Gene flow between populations would allow alleles within one population to move into a population where it did not exist. This occurs due to breeding between members of each different population. 1 mark
- The gene pool, which is the frequency of alleles within a population, will become more diverse (or increase) as a result of gene flow. 1 mark
- c. A genetic bottleneck occurs when a large population is reduced to a small number. The remaining individuals have a reduced genetic variety or the gene pool is smaller. 1 mark
- Individuals that breed have less genetic variety compared to before the genetic bottleneck, and so the larger population that emerged 70 000 years ago will have a smaller gene pool. 1 mark

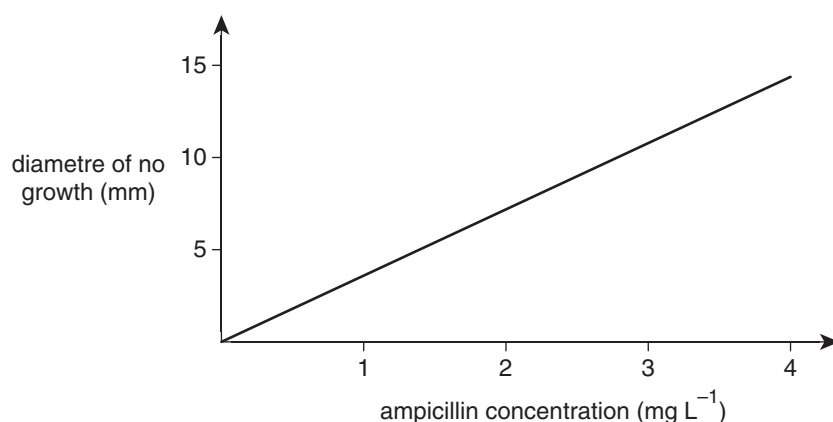
- d. 'Multiregional evolution within Africa' means that several populations of modern humans emerged in that area due to gene flow. The passage describes substantial gene flow between modern humans and other hominins within Africa before moving out of Africa. This evidence supports the view, because there may have been variation in the phenotypes of the modern human groups leaving Africa. 1 mark

Question 10 (8 marks)

- a. a circular strand of DNA found in bacteria 1 mark
- b. The plasmid and the gene of interest need to be isolated and cloned. 1 mark
A restriction enzyme is used to cut the plasmid (once) and the gene of interest (twice) on either side of the gene section to be transferred, liberating the sticky ends. 1 mark
The gene of interest and the plasmid are mixed together with DNA ligase. The presence of complementary sticky ends ensure that the gene of interest and the plasmid are spliced together. 1 mark
- c. The plasmid will not enter every bacterium when mixed together, leaving some bacteria with the recombinant plasmid and some bacteria without the recombinant plasmid. 1 mark
The mixture of bacteria is spread onto an agar plate containing an antibiotic. The transformed bacteria will grow in the presence of the antibiotic and the non-transformed bacteria will not. 1 mark
- d. The modified plant is a GMO because its genome has been artificially altered. 1 mark
If the gene of interest is from the same species of plant then it is a GMO but not transgenic, and if the gene of interest is not from the same species of plant then it is a GMO as well as transgenic. 1 mark

Question 11 (8 marks)

- a. As the concentration of ampicillin increases, the circle of no bacterial growth will increase. 1 mark
- b. The ampicillin has diffused from the ampicillin disc and prevented the growth of *Streptococci* bacteria in the region where there are no bacteria growing. 1 mark
- c. average diameter of no bacterial growth (mm) 1 mark
- d.



2 marks

1 mark for correct graph shape.
1 mark for correct scale and labelling,

- e. the data set gained at an ampicillin concentration of 1 mg L^{-1} , because the circles of no growth of bacteria are very similar to each other 1 mark
- f. The hypothesis is supported. 1 mark
- As the ampicillin increases from 0 mg L^{-1} to 3 mg L^{-1} , the diameter of no bacterial growth increased from 0 mm to X mm. The growth then plateaus out at this level with increasing ampicillin. 1 mark