

Trial Examination 2017

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 D

A typical phospholipid contains a glycerol that holds two fatty acids and one phosphate. The resultant structure is both water-soluble (the phosphate part) and water-insoluble (the fatty acid part). The glycerol provides the capacity for the other three components to be connected together.

Question 2 C

Endergonic processes are energy-requiring. They are sometimes referred to as anabolic. Energy-requiring transport includes bulk transport (endocytosis and exocytosis). Active transport also requires energy to move chemicals across a membrane against a concentration gradient.

Question 3 D

When amino acids are joined together to make a protein, it is referred to as an endergonic reaction, as well as a condensation reaction. When they are joined, water is given off as part of the reaction. Hydrolysis reactions are the opposite.

Question 4 A

Translation occurs at the ribosome. This involves the reading of mRNA by tRNA anticodons binding to the codons. The ribosomal structure is protein as well as rRNA (which is manufactured in the nucleolus).

Question 5 A

There are twenty amino acids and sixty-four different anticodons, and so more than one anticodon can provide a blueprint for the same amino acid. This is referred to as the degeneracy (or redundancy) of the code.

Question 6 B

The question is asking for a DNA sequence, so responses **A** and **C** are incorrect. The first amino acid is isoleucine, which has the anticodons UAA, UAG and UAU. The respective codons are AUU, AUC and AUA, which are part of the mRNA blueprint. The complementary template DNA would be TAA, TAG and TAT. So the first three nucleotides of the template would be TAG (eliminating response **D**).

Question 7 B

Activation of the *lac* operon requires lactose to be available, which binds to a repressor bound to the operator (not promoter). This prevents transcription. Once transcription occurs, lactase is produced which digests the lactose.

Question 8 D

NADH is involved as a hydrogen carrier in respiration and NADP is involved as a hydrogen carrier during photosynthesis (making responses **A** and **B** incorrect). ATP is an energy carrier formed from the binding of inorganic phosphate and ADP during various stages of respiration (making response **C** incorrect).

Question 9 B

Metabolic reactions, such as the one illustrated in the question, have a substrate (phenylalanine) that forms a product (tyrosine) in the presence of an enzyme (phenylalanine hydroxylase). The substrate and enzyme do not have the same shape; they are complementary to each other. Biological catalysts are enzymes which are protein.

Question 10 C

If the concentration of a substrate is increased in a well-controlled experiment, the temperature, pH and enzyme concentration should remain the same. As the substrate concentration increases, the reaction rate will increase until all of the enzyme active sites are occupied all the time. The rate of reaction will level at a maximum rate.

Question 11 C

The diagram shows that product D inhibits e_1 which converts A into B. This is also called feedback inhibition. Within a metabolic pathway there would be no survival advantage for the reaction to be irreversible, otherwise the reaction could not be controlled (making responses **A** and **B** incorrect). All three enzymes need to be present for the reaction to proceed. If D had a complementary shape to the active site of e_1 , or the same shape as A, then as D increases, the action of e_1 would slow down as a result of the reversible competitive inhibition.

Question 12 D

There are a variety of signalling molecules to be considered. Cytokines are secreted from some cells of the immune system, stimulating responses like inflammation and fever. They are not animal hormones, which are chemicals secreted into the bloodstream acting on target cells distant from their secretion. Some animal hormones are hydrophilic (insulin) and some are hydrophobic (testosterone). Plant hormones act like animal hormones by being transported through vascular tissue, but neurotransmitters are secreted into synapses for axons.

Question 13 C

Pheromones are signalling molecules secreted by an individual into their external environment. These chemicals can move through the external environment by diffusion (water or air). They have a complementary shape to external receptors on other members of the same species, which can lead to a change in behaviour (for example, reproductive behaviour).

Question 14 B

Apoptosis is both externally and internally controlled. If a cell is 'worn out', then internal stress signals (mitochondrial stress) cause caspase to degrade the cell cytoskeleton (apoptosis). If a cell is in the wrong place (as in this case), external signalling molecules bind to receptors, and via signal transduction, activate caspase to degrade the cell cytoskeleton.

Question 15 B

This question is recognising that Alzheimer's disease is a type of apoptosis and that cancer is a type of cell replacement. In this case, the rate of cell replacement in cancer is greater than apoptosis.

Question 16 A

'Anti' means against. An antigen is any molecule or chemical that, when in the body, induces an immune response against it. An antigen does not need to be a protein (but usually is). Antigens could be a chemical ingested (like an allergen) or they could be on the surface of pathogens. Depending on the type of response required, antibodies are not always made, and not always made in the same proportions.

Question 17 C

The innate immune response is always the same regardless of prior exposure. Lymphocytes are activated to form a specific response against a specific antigen and involve B and T cells, which include plasma cells, cytotoxic cells and helper cells. A macrophage has the capacity to recognise antigens (non-self) on the surface of pathogens or diseased cells, and signal the rest of the immune system to respond accordingly. It does not promote the immune system to generate more macrophages.

Question 18 B

The lymphatic system is a one-way system that starts at the cells, moves through lymph nodes and ends at a vein near the heart. The way lymph is transported is via a series of one-way valves along the lymphatic ducts. For that to occur, the valves need to be angled to allow flow towards the heart.

Question 19 D

Active immunity is either a T cell response (cell-mediated), a B cell response (humoral) or a combination of both. When a T cell response is initiated, the naive T cell clones and differentiates into cells such as helper, cytotoxic and memory T cells. When a B cell response is initiated, the naive B cell clones and differentiates into cells such as plasma and memory B cells.

Question 20 D

Breastfed babies obtain antibodies from the mother through the breast milk. This confers short-term immunity against pathogens the mother has been in recent contact with. As a result, the baby is less likely to get sick, as illustrated by the information in the stem of the question. The immunity is passive and natural.

Question 21 A

Mutations are changes in DNA. Block mutations impact on chunks of chromosomes and aneuploidy involves whole chromosomes. Sometimes mutations affect genes, which may or may not impact on the amino acid sequence due to the redundancy in the code. A point mutation affects a single amino acid as it is one changed nucleotide, which affects one codon. A frameshift mutation (addition or deletion) affects every codon downstream and so will significantly change the amino acid sequence.

Question 22 D

Migration enables organisms to move from place to place. If organisms of the same species move from one population to another, and successfully breed with members of the new population, alleles from one population have been transferred into a different population. This is referred to as gene flow. The founder effect, as the name implies, is when small groups move into a new area. The bottleneck effect, as the word 'bottleneck' implies, is when a large population almost disappears and a new population emerges from the small numbers. Both of these are referred to as genetic drift.

Question 23 A

The gene pool is defined as the sum of all the alleles in a particular population, which can be mathematically determined (Hardy–Weinberg principle). Change in gene pools can be defined as evolution. The environment does not change a gene pool, but individuals who are at an advantage may contribute to a change in the gene pool over time. This is natural selection and occurs over many generations. Mutations may change the DNA but usually places the individual at a disadvantage. Artificial selection is when a particular individual with desired features is chosen generation after generation and so the gene pool would change more rapidly than natural selection.

Question 24 C

Natural selection follows a set of rules involving the selection of a particular variant in a changing environment, which then contributes more to the gene pool. Mutations do not occur in a population so that individuals will be more suited; there must be a pre-existing mutation. It is unlikely that birds with larger wings specifically migrated to the area; it is more likely that migratory birds would have variation for this particular phenotype. Fifty years should be a reasonable amount of time to measure a change in phenotype. Climate change has been around for that period of time and the generation time of birds could be yearly.

Question 25 D

When a group of organisms are classified as a particular species, they are able to breed truly or gene flow will still occur through intermediates. So for speciation to have occurred, the organisms would not be able to successfully breed. With allopatric speciation, a population is geographically isolated into two distinct populations that, over time, evolve into distinct groups due to different selection pressures within each environment. Over time, the populations become so different they no longer recognise each other for reproductive purposes when they inhabit the same area.

Question 26 B

The correct order is:

1. the emergence of prokaryotic cells (simple organisms like archaeobacterial were the first to evolve – about 3.5 billion years ago)
2. the formation of multicellular organisms (once single-celled eukaryotes emerged there was a survival advantage to those that clustered together – about 600 million years ago)
3. the emergence of vertebrates in the oceans (a backbone was an advantage over other animals in the ocean – about 500 million years ago)
4. the movement of animals onto land (insects were the first to colonise the land following the plants – about 450 million years ago; the vertebrates followed later)
5. flowering plants appear (plants evolved on the land with flowering plants being the top of the evolutionary tree – about 125 million years ago)

Question 27 A

When all the sequences are compared to each other in a table, differences can be noted.

	Red kangaroo	Antilopine kangaroo	Eastern grey kangaroo	Western grey kangaroo
Red kangaroo		3	1	4
Antilopine kangaroo	3		2	1
Eastern grey kangaroo	1	2		3
Western grey kangaroo	4	1	3	

As amino acid sequences are coded for by DNA; the more differences in the amino acid order, the more differences would be expected in the DNA. So the red and western grey kangaroos would be expected to have the most distant common ancestor. The red and eastern grey kangaroos would be expected to have the most recent common ancestor.

Question 28 C

When different organisms are exposed to similar environmental pressures they can undergo convergent evolution, where similar phenotypes are selected for. This is the case with the Northern flying squirrel and the flying phalanger.

Question 29 D

A half-life means that it takes a certain amount of time for half of a known isotope to decay in a given sample of material. In this case, the half-life of uranium-235 is 0.7 billion years. Slightly over three half-lives would have elapsed for a 2.2 billion-year-old rock (1 g → 0.5 g → 0.25 g → 0.125 g).

Question 30 D

Fossilisation is an extremely unlikely event; however, many organisms that once existed died in an environment that led to them being preserved. When organisms die, they usually decay quickly, leaving nothing behind as evidence. A typical environment where there is a good chance of fossilisation would occur when organisms die in (or fall into) water; for example, a lake. The bottom of the lake is cold (slowing decomposition), still (keeping the fossil together), the organism is rapidly buried (avoiding scavengers) and under high pressure (allowing sedimentary layers to form).

Question 31 A

If the BMP4 gene controls the development of Darwin's finches, it would be expected to be active for longer in finches with larger beaks (longer and thicker). Each of these phenotypes would have more beak protein and thus the genes controlling this should be active for longer.

Question 32 D

Students should know all these organisms are primates and thus all have opposable fifth digits (as well as forward-facing eyes). All of the organisms apart from baboons are hominoids (great apes). Humans are the only hominin.

Question 33 A

This question links the cultural change with the appropriate hominin. *Homo erectus* were the first hominins to be associated with the development of fire; however, they did not ritualistically bury their dead. A judgement call cannot be made about *Homo denisovan* because only a few fossil fragments have been discovered and so evidence of their culture cannot be determined yet. Many stone tools were found with *Homo habilis*, associating them with their use.

Question 34 B

PCR involves the cycling of three processes that leads to the amplification of specific sections of DNA. Initially a temperature of over 94°C is applied to denature the DNA (break the hydrogen bonds). The mixture is cooled to a temperature of 54°C to allow primers to anneal to specific sections along the denatured DNA. The temperature is then raised to 72°C to allow the efficient functioning of *Taq* polymerase in the replication process. The cycle is repeated many times (30 cycles) so that large quantities of DNA are generated.

Question 35 A

With DNA technology, restriction enzymes are used (also called endonucleases) to cut DNA in specific recognition sites. Occasionally DNA needs to be reconnected (pasted) and ligase enzymes are used to form a covalent bond between nucleotides. Polymerase connects free nucleotides onto a single-stranded DNA template.

Question 36 C

A non-competitive inhibitor will bind to a place away from the active site of the enzyme. The triangle is the substrate in this case, and the circle would be the drug. **A** and **B** cannot be correct because if the substrate and drug have the same shape, the drug by definition would be competitive. If the drug had the same shape as the active site (not complementary) it would not be able to bind.

Question 37 C

The public should be aware of when it would be appropriate to use antibiotics. They do not kill a virus and so are useless against the flu. Generally, a small dose would be preferable because a high dose may be unnecessary. A patient would need to show symptoms of bacterial disease to be prescribed antibiotics, rather than be prescribed them if they are going to potentially be exposed to bacteria.

Question 38 D

This question relates to how experimenters process data. An average of the trials conducted at each temperature would need to be calculated and then the average divided by 20.

Question 39 A

The data presented at the end would be best represented as a line graph because the possible results of temperatures between those that were measured can be predicted. Bar graphs and pie charts cannot be used in the same fashion. A logarithmic graph would not be useful in this case as the scale used can easily fit using normal numerals.

Question 40 B

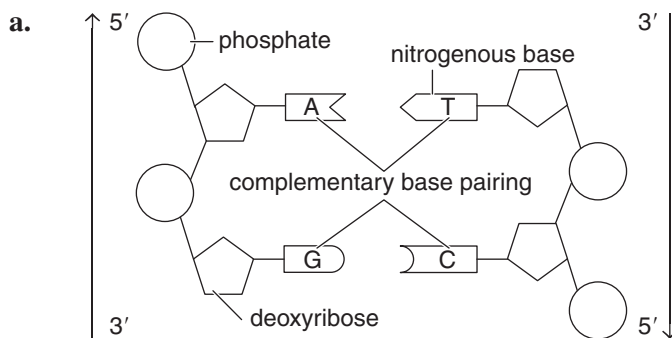
Outliers are discrepant results that are very different to the others that have been gained. There does not seem to be any significant outliers at all. Changing the method would not be advised as the controlled conditions should remain the same. Repeating the experiment with another trial may be useful; however, to analyse the data completing more trials with different temperatures would generate data that would be more reliable.

SECTION B

Question 1 (7 marks)

- a. mRNA is the nucleic acid that is translated into protein (aquaporin) at the ribosome. 1 mark
- b. quaternary 1 mark
- c. Some cells may have the function of moving large quantities of water and so need high levels of aquaporin to move the water. 1 mark
 Most cells are usually only exposed to small changes in solute levels and so water moving across the phospholipid layer is all that is required to retain the balance. 1 mark
- d. i. The hypotonic solution is low in solutes and so the cells would be expected to gain water by osmosis in both experimental set-ups. 1 mark
 ii. The cells treated with aquaporin mRNA at 2.5 minutes stopped gaining volume (or slowed down). 1 mark
 The cells internally may have become isotonic to the outside environment. 1 mark

Question 2 (6 marks)



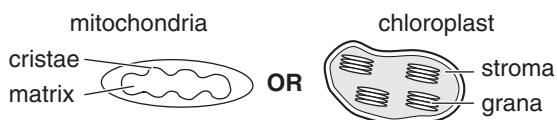
3 marks

- 1 mark for drawing correctly labelled nucleotide structure (phosphate, deoxyribose and nitrogenous base).*
- 1 mark for drawing correctly labelled antiparallel structure (or nucleotides on opposite strands upside down to each other, or showing 3' to 5' for one strand and 5' to 3' for the other).*
- 1 mark for correct complementary base pairing (A to T and G to C; must show the four nucleotides).*

- b. stage 1: transcription 1 mark
- stage 2: RNA processing 1 mark
- stage 3: translation 1 mark

Question 3 (5 marks)

a. the mitochondria and the chloroplast 1 mark

b. 

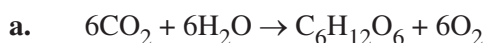
2 marks

Note: Diagram should be accurate for at least the two structures evident in either diagram and both should be included for the full marks.

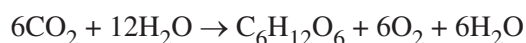
c. Any two of:

- Both organelles have two membranes (as a result of being endocytosed).
- Both organelles contain circular DNA (like bacterial DNA).
- Both organelles contain ribosomes (the same size as bacterial ribosomes).
- Both organelles are small (about the size of bacteria).

2 marks

Question 4 (6 marks)

OR



2 marks

1 mark for balanced inputs.

1 mark for balanced outputs.

Note: Either equation is appropriate.

b. i. the colour of light the chloroplasts were exposed to 1 mark

ii. blue and red 1 mark

Note: Both colours are required for full marks.

iii. Light provides the energy to split water, convert NADP into NADPH, and form ATP. 1 mark

More light energy leads to more of the products of the light-dependent reaction (LDR) which are available for the light-independent reaction (LIDR), and therefore leads to a faster rate of photosynthesis. 1 mark

Question 5 (6 marks)

a. ABA is hydrophilic (water-soluble) as it binds to surface receptors, meaning it cannot move through the hydrophobic (water-insoluble) phospholipid bilayer. 1 mark

Note: Do not accept ABA is a protein as there is no evidence of this (it is an acid and proteins are not called acids).

- b. i.** After reception, a series of second messengers are activated that leads to the opening of a gated potassium channel, which may involve the activation of enzymes, genes or signal amplification to produce the specific response. 1 mark
- ii.** The loss of potassium ions would make the guard cells more hypotonic to the outside environment. 1 mark
Water moves from the cytosol to the external environment, leading to less turgidity (closing the stomata). 1 mark
- c.** The more surface receptors there are, the greater the number of hormone/receptor complexes are possible. 1 mark
Guard cells are more sensitive to an environment with reduced water conditions, such as a dry habitat. 1 mark

Question 6 (9 marks)

- a.** An epidemic is a localised disease outbreak and a pandemic is when there are many epidemics with respect to the same disease around the world. 1 mark
- b.** A virus has two main components:
• a protein shell (capsid), and 1 mark
• a nucleic acid core (not RNA and DNA). 1 mark
- c.** The number of people who died from the swine flu was 0.5% of those who contracted it, whereas the other two flus recorded had six times the mortality (Spanish flu) and 100 times the mortality (bird flu) respectively. 1 mark
- d. i.** swine flu vaccine 1 mark
This will provide long-lasting immunity against the disease rather than relief, which is not needed 1 mark
- ii.** Relenza 1 mark
The patient needs relief to stop the flu from continuing to reproduce within the body. 1 mark

Question 7 (8 marks)

- a.** The allergen combines with a naive B cell which clones and differentiates into plasma cells that produce antibodies against the allergen (sensitising). 1 mark
The antibodies combine with receptors on the surface of mast cells as a faster response against the allergen with future exposures. 1 mark
- b.** Second and third exposures to the antigen leave more mast cells with the antibody against the allergen on their surface. 1 mark
Upon exposure, the mast cells release histamines into their direct environment, leading to inflammation. There are more mast cells, more histamine and a greater inflammatory response (hypersensitivity), which is what anaphylaxis is. 1 mark
- c.** There were more airborne allergens (or fragments of allergens) in the air, which meant people had a greater chance to inhale a higher proportion of allergens. This led to more humans responding against the pollen in an allergic-type reaction (asthma). 1 mark

- d. i.** A drug could bind to the receptor site of a repressor protein upstream from the ADAM33 gene preventing it from being expressed in an environment of the allergen. 1 mark
- ii.** *For example (any two of):*
- What side effects are there?
 - How much does it cost?
 - How long do I need to take it for?
- 2 marks
- Note: There are other possibilities.*

Question 8 (7 marks)

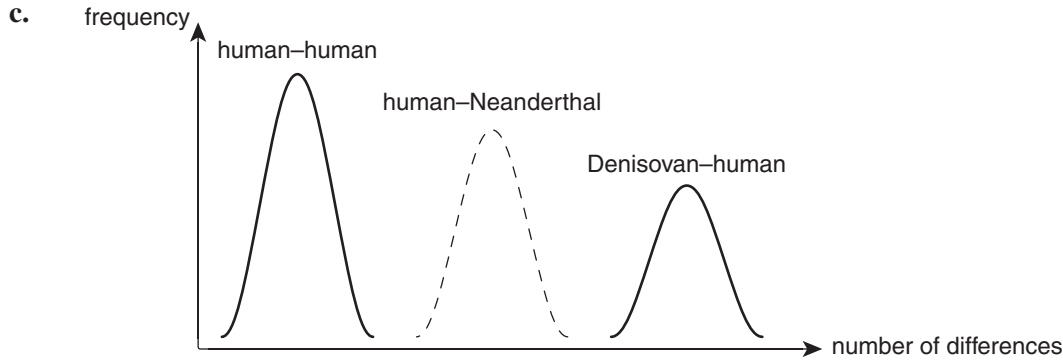
- a.** not more than 68 million years ago and not less than 66 million years ago 1 mark
- b.** The Tasmanian devil and the numbat are more closely related. 1 mark
Their most recent common ancestor is about 35 million years ago, compared to about 60 million years ago for the southern marsupial mole and the greater bilby. 1 mark
- c.** Finding a fossil that displays evidence of both organisms and is dated using radioisotopic methods would show when they existed 1 mark
1 mark
- OR**
- Using mitochondrial DNA technology to compare the mtDNA of both species by working out the mutation rate of mtDNA and the number of differences in their mtDNA, a time of divergence can be estimated. 1 mark
1 mark
- d.** divergent evolution (or adaptive radiation) 1 mark
Existing populations split (this occurred on a number of occasions) and each population is placed into different environments which favours different phenotypes, and through natural selection many new species eventually form. 1 mark

Question 9 (8 marks)

- a.** Much evidence exists to support the two coexisting species about 40 000 years ago. One finger bone is not enough supporting evidence to support the theory that more than two species coexisted. 1 mark
- b. i.** Mitochondrial DNA is useful to use for hybridisation studies because it only shows variation due to mutation, and can be compared to it, which enables predictions of relatedness to be established. 1 mark
Nuclear DNA shows variation due to mutation, but the DNA is then exposed to the rules of meiosis, which promotes more variation (crossing over, independent assortment), thus making it less desirable to be used to determine relatedness accurately. 1 mark
- ii.** the mother and the three children (not the father) 1 mark
The mitochondria is passed along the maternal line, so the mother's mitochondria is passed to all of her children. 1 mark

- iii. Certain sections of DNA from two sources are heated separately to break the hydrogen bonds between the double helix (but retaining the polynucleotide strands). The DNA from the two sources is then mixed together. 1 mark

Some of the single strands from the two sources will anneal and the degree of similarity can be measured by determining the temperature required to denature the hybrid DNA. The lower the temperature, the less related they are. 1 mark



1 mark

Note: The graph should be drawn between the two existing peaks because they should display less differences than the Denisovan-human data but probably (height-wise) somewhere between the two existing peaks (there was more Neanderthal DNA to work with).

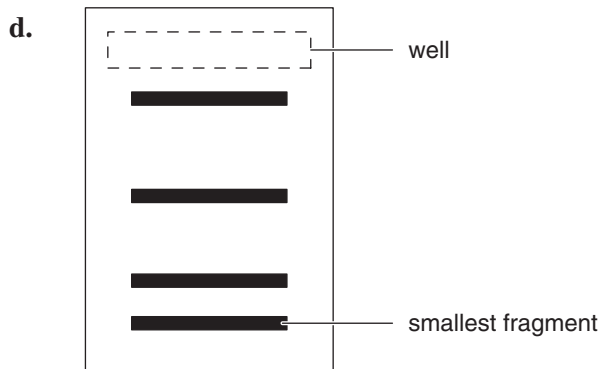
Question 10 (8 marks)

- a. to amplify specific (or target) sections of DNA 1 mark
- b. The sickle cell gene has one nucleotide that is different compared to the normal gene. This leads to a single amino acid being different in the resultant haemoglobin protein. 1 mark
- c. sickle cell allele: _____ X _____
 normal allele: _____ X _____

2 marks

*1 mark for the correct number of cutting sites for each allele.
 1 mark for generating different-sized fragments for each allele.*

Note: Each allele must produce fragments of differing size, and the normal allele needs two cutting sites while the sickle cell allele needs one cutting site. There may be some variability in where the cutting sites are located and the diagram above is a guide.



2 marks

*1 mark for a profile with four bands.
 1 mark for labelling the smallest fragment.*

e. *Any one of (advantages):*

- individual has knowledge of a genetic condition
- individual can take preventative measures to ensure health
- lower anxiety for individual if they receive negative results
- individual can give knowledge to other family members with genetic potential

1 mark

Any one of (disadvantages):

- discrimination
- may lead to depression/anxiety having knowledge of genetic status
- insurance may be compromised

1 mark

Question 11 (10 marks)

a. i. When mixed together, the BGH gene and the cut plasmid will have a chance of being joined together due to having complementary sticky ends.

1 mark

ii. Ligase joins recombinant fragments of DNA, in this case BGH and the plasmid. It does this by forming covalent bonds between the nucleotides along each polynucleotide strand.

1 mark

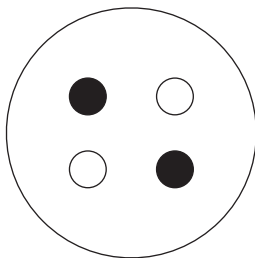
b.

Type of treated bacteria	Control culture plate	Culture plate treated with ampicillin
plasmid not taken up	yes	no
plasmid without the BGH gene taken up	yes	yes
plasmid with the BGH gene taken up	yes	yes

2 marks

1 mark for each correct column.

c.



1 mark

Note: Two black and two white colonies anywhere on the plate are required for full marks.

- d.** When the BGH gene and cut plasmid are mixed, there are a variety of other possible recombinant outcomes.

For example (any one of):

- Two (or more) BGH genes may join together on the plasmid.
- The BGH gene may connect together at both ends, forming a small, circular DNA strand.
- Two plasmids may combine, forming a larger, circular DNA strand.

1 mark

Note: There are other possibilities.

- e. i.** Work with a large sample of milk-drinking humans of similar age, health, ethnicity and location. Divide them into two equally sized groups. 1 mark

One group consumes milk that is natural and the other group consumes milk from a cow given the rBGH. Continue this for a long period of time (say six months). 1 mark

Compare the two groups in terms of health status, and if there is a significant difference in the health status of the trial group, then this could justify the banning of the use of rBGH. 1 mark

- ii.** There are many benefits for humans, otherwise using rBGH would be pointless.

Any one of:

- Farmer profits will increase as their milk yield per cow will increase.
- Biotechnologists will profit, sustaining an industry for them.
- There is greater access to milk for many.

1 mark