

# BIOLOGY UNITS 3&4



## 2020 Practice Exam

(including fully-worked answers for every question!)

### ABOUT THIS RESOURCE

Our VCE Biology Practice Exam is written by our experienced textbook authors and VCE teachers.

- The exam consists of questions worth 120 marks, in exactly the same format as the VCE exam.
- The questions have been designed and written to simulate the experience of sitting a VCAA-style exam.
- Included is a full answer section with exemplar answers and checklists to guide students on how to produce a high-scoring answer.
- All questions are tailored to the study design updates for 2020.

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LEGAL STUDIES

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STUDENT NAME: \_\_\_\_\_

TEACHER NAME: \_\_\_\_\_

# **BIOLOGY**

## **Practice written examination**

Duration: 15 minutes reading time, 2 hrs 30 minutes writing time

### **QUESTION AND ANSWER BOOK**

#### **Structure of book**

<b>Section</b>	<b>Number of questions</b>	<b>Number of marks</b>
A	40	40
B	11	80
		Total 120

## SECTION A – Multiple-choice questions

### Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1; an incorrect answer scores 0.

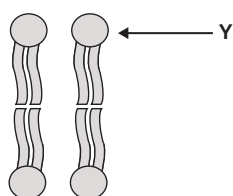
Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this question book are **not** drawn to scale.

### Question 1

The diagram represents the arrangement of a type of molecule found in the plasma membrane.



The structure labelled Y in the molecule is

- A involved in cell signalling.
- B hydrophobic.
- C cholesterol.
- D polar.

### Question 2

Which one of the following statements about passive transport is correct?

- A Facilitated diffusion, osmosis, and exocytosis are examples of passive transport.
- B Passive transport can occur down or against the concentration gradient.
- C ATP may facilitate the passive transport of certain molecules.
- D Passive transport can involve the use of protein channels.

**Question 3**

The diagram below shows four processes that transport substances from the extracellular environment into a cell.

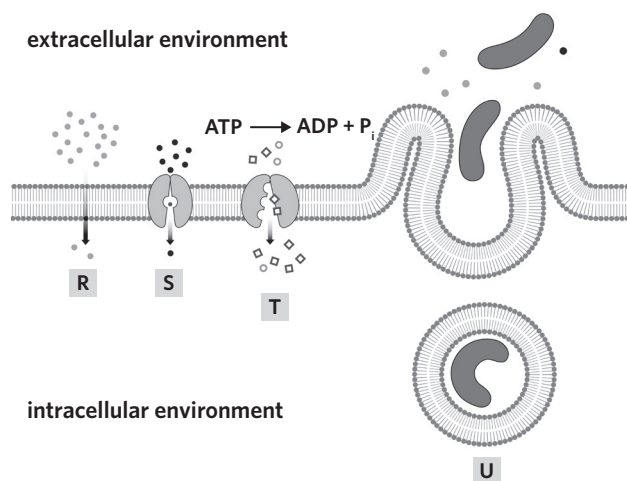


Image: Aldona Griskeviciene/Shutterstock.com

Which one of the following statements about the diagram is correct?

- A** Process T is the only process shown that requires energy.
- B** Process R shows water molecules actively moving by osmosis.
- C** Process S shows molecules moving passively by facilitated diffusion.
- D** Process U is exocytosis where large substances are moved into the cell.

**Question 4**

Proteins

- A** can function with only a primary and secondary structure.
- B** are affected by changes in pH but are not affected by changes in temperature.
- C** are synthesised in the rough endoplasmic reticulum and packaged for export by the Golgi apparatus.
- D** are synthesised from their monomers by ribosomes attached to the smooth endoplasmic reticulum.

**Question 5**

Proteins are transported to the plasma membrane for exocytosis by

- A** vesicles.
- B** ribosomes.
- C** the Golgi apparatus.
- D** the rough endoplasmic reticulum.

**Question 6**

The template strand of a particular gene is 90 nucleotide bases long and contains 40 adenine bases, 10 thymine bases, 20 cytosine bases, and 20 guanine bases. The number of adenine bases in the mRNA strand transcribed from this template would be

- A 0.
- B 10.
- C 20.
- D 40.

**Question 7**

Following transcription, pre-messenger RNA (pre-mRNA) must undergo post-transcriptional modifications before it is ready for translation.

Which row correctly matches the listed properties to their action during post-transcriptional modification of pre-mRNA?

	Introns	Exons	5' end	3' end
A	removed	remain and are joined	methyl cap added	poly-A tail added
B	removed	removed	poly-A tail added	methyl cap added
C	remain and are joined	removed	no modifications	poly-A tail added
D	removed	remain and are joined	poly-A tail added	methyl cap added

**Question 8**

Which one of the following statements about structural genes is correct?

- A A promoter region is always found downstream of structural genes that are undergoing transcription.
- B Proteins coded for by structural genes include enzymes, carrier proteins, and repressor proteins.
- C Structural genes do not make proteins that are involved in the regulation of other genes.
- D Structural genes play a large role in controlling gene expression.

**Question 9**

Ornithine decarboxylase (ODC) is an enzyme that catalyses the breakdown of ornithine into putrescine in the urea cycle.  $\alpha$ -difluoromethylornithine (DFMO) is an irreversible competitive inhibitor that inhibits the function of ODC by

- A temporarily blocking the active site of ODC.
- B increasing the rate at which putrescine is formed.
- C forming strong bonds with the active site of ODC that cannot be broken.
- D permanently binding to a site on ODC that is not the active site and causing a conformational change in the active site.

**Use the following information to answer Questions 10–12.**

Four groups of students carried out an experiment examining the effect of pH on an enzyme's rate of reaction. They used the enzyme catalase which is responsible for converting hydrogen peroxide into water and oxygen gas.

Before beginning the experiment, each group practised measuring the pH of a stock solution with a known pH of 7 to calibrate their digital pH meters.

The following results were obtained during the practice measurements.

	1st measurement	2nd measurement	3rd measurement
<b>Group 1</b>	6.8	7.0	7.2
<b>Group 2</b>	6.8	6.8	6.8
<b>Group 3</b>	6.9	7.0	7.1
<b>Group 4</b>	7.0	7.0	7.6

**Question 10**

Which one of the following statements is correct?

- A** Group 1's measurements are precise but not accurate.
- B** Group 2's measurements are accurate but not precise.
- C** Group 3's measurements are both accurate and precise.
- D** Group 4's measurements are the most accurate but the least precise.

**Question 11**

The independent variable in the experiment is

- A** pH.
- B** the amount of oxygen gas produced.
- C** the concentration of hydrogen peroxide.
- D** the accuracy and precision of the digital pH meter.

**Question 12**

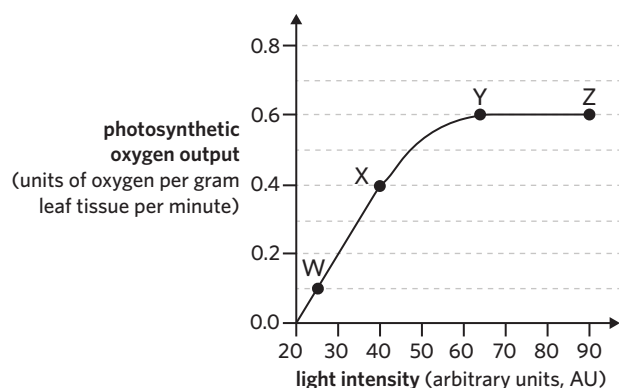
After completing the enzyme experiment, the students wanted to check the reliability of their data.

The students should

- A** alter the method to obtain qualitative and quantitative data.
- B** repeat the experiment at a higher pH to ensure the trend is correct.
- C** graph the results differently to determine if there is another trend in the data.
- D** increase the number of replicates in the experiment to see if they obtain the same data.

Use the following information to answer Questions 13–15.

An experiment was carried out to determine the photosynthetic output of oxygen in tomato leaves under changing light intensity. Temperature and carbon dioxide concentration were kept constant during the experiment. The following graph depicts the results of the experiment.



### Question 13

At point Z

- A the same rate of oxygen production as point Y was observed.
- B the rate of oxygen production is twice the rate observed at point X.
- C photosynthesis is no longer occurring as the light is too intense for the plant.
- D the rate of photosynthesis is almost ten times the rate observed at 30 AU of light.

### Question 14

Light intensity is the limiting factor of photosynthesis at point(s)

- A Z only.
- B W only.
- C Y and Z.
- D W and X.

### Question 15

Based on the information in the graph, there is enough evidence to conclude that

- A increasing the temperature at point Y will increase the rate of photosynthesis.
- B at point Z the rate of photosynthesis is equal to the rate of aerobic cellular respiration.
- C increasing the light intensity above 65 AU without changing other factors will not increase the rate of photosynthesis.
- D at points W, X, and Y, light is the limiting factor of photosynthesis, but at point Z, carbon dioxide and temperature are the limiting factors.

**Question 16**

Which one of the following processes does not involve carbon dioxide as either an input or output?

- A anaerobic cellular respiration in animals
- B aerobic cellular respiration
- C fermentation in yeasts
- D photosynthesis

**Question 17**

The rate of anaerobic cellular respiration in a human cell may decrease if the

- A temperature of the cell is lowered from 37 °C to 34 °C.
- B oxygen concentration available to the mitochondria decreases.
- C carbon dioxide concentration in the cytosol of the cell decreases.
- D rate of facilitated diffusion of glucose into the cytosol of the cell increases.

**Question 18**

Which one of the following statements about apoptosis is correct?

- A Only the intrinsic pathway involves caspase activation.
- B Cytotoxic T cells can bind to and stimulate apoptosis in infected cells.
- C Sudden changes in ion concentration can initiate apoptosis, resulting in cell lysis.
- D Cytochrome c released by the mitochondria activates an inflammatory response.

**Question 19**

Rheumatoid arthritis is an autoimmune disease where the immune system attacks the lining of joints leading to inflammation, swelling, and pain.

Rheumatoid arthritis is caused by

- A an adaptive immune response involving cytotoxic T cells and antibodies attacking the joint lining.
- B the release of histamine by mast cells resulting in severe inflammation.
- C the initiation of necrosis in the joint lining by complement proteins.
- D a bacterial infection around the joint lining.

**Question 20**

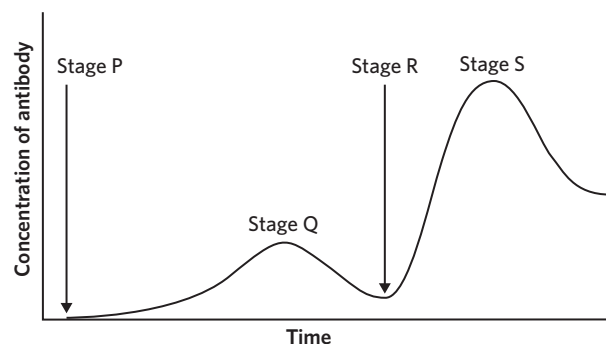
Which of the following statements describing the lymphatic system is correct?

- A Clonal selection and expansion primarily occur in lymph nodes.
- B Antigen-presenting cells are only found in the lymphatic system.
- C The thymus is an organ of the lymphatic system where B cells mature.
- D The bone marrow is a tissue of the lymphatic system where T cells mature.



**Use the following information to answer Questions 21 and 22.**

The following diagram represents the vaccination of an individual for hepatitis B.



### Question 21

Which of the following statements correctly describes the stages depicted in the diagram?

- A** Antibodies complementary to the hepatitis B virus exist before Stage P.
- B** There are no complementary helper T cells to the hepatitis B virus before Stage P.
- C** The concentration of antibodies at Stage S is greater than Stage Q due to the presence of more T lymphocytes.
- D** After Stage S, while some memory cells remain in the system until reactivation others undergo apoptosis to conserve energy.

### Question 22

The hepatitis B vaccine

- A** contains a virulent strain of the virus.
- B** only stimulates cell-mediated immunity.
- C** contains antibodies that are injected into the bloodstream.
- D** interacts with both the innate and adaptive immune responses.

**Question 23**

The prostate is a gland found in the male reproductive system. Prostate cancer represents the second most frequent type of tumour in men worldwide. The *BRCA1* and *BRCA2* genes that have been linked to breast cancer have also been linked to an increased risk of prostate cancer.

A section of the normal *BRCA2* gene and a section of a mutated *BRCA2* gene are shown below.

<i>BRCA2</i> normal	TGACCTTGAGGCCAGAAAGTTTGA
<i>BRCA2</i> mutated	TGACCGAGGCCAGAAAGTTTGA

The mutation that has occurred in the mutated *BRCA2* gene is an example of a

- A** missense substitution mutation.
- B** silent substitution mutation.
- C** frameshift mutation.
- D** block mutation.

**Question 24**

Breast cancer and stomach cancer are often treated with a monoclonal antibody called trastuzumab. In particular, it targets a receptor called HER2 which is found on the surface of cancerous cells.

Trastuzumab would

- A** attract immune cells towards the cancer cells with interferons.
- B** have two identical complementary sites to the HER2 receptor.
- C** be produced by plasma B cells inside the human body.
- D** induce necrosis in cancer cells.

**Question 25**

The immune system of babies is underdeveloped and susceptible to infection. Fortunately, they can acquire antibodies from their mother during embryonic development through the umbilical cord and through breast milk after they are born.

This form of immunity is known as

- A** artificial passive immunity.
- B** natural passive immunity.
- C** artificial active immunity.
- D** natural active immunity.

**Use the following information to answer Questions 26 and 27.**

Zika fever is a viral disease. It is most commonly transferred from one person to another by the *Aedes* species of mosquito. It can also be spread through blood transfusions and through sexual transmission. The Zika virus is injected into a person when an infected mosquito bites them. The virus then enters the bloodstream and may cause fever, rash, joint pain, red eyes, and can lead to developmental defects in foetuses when pregnant women are infected.

**Question 26**

Using the information given, it can be concluded that

- A all individuals bitten by an infected mosquito will develop symptoms.
- B Zika fever is most dangerous to people who need blood transfusions.
- C the Zika virus is a prokaryote.
- D foetuses act as a host.

**Question 27**

Based on the information provided, which of the following would not be an effective method of stopping the spread of Zika fever?

- A culling of mosquitoes
- B using nets to cover a person while they sleep
- C compulsory wearing of face masks by infected individuals
- D scanning donated blood to test for the presence of the virus

**Use the following information to answer Questions 28 and 29.**

Biologists studied many species of the fruit fly, *Drosophila*, living on the Hawaiian islands. The species vary widely in appearance, behaviour, and habitat. The diversity of *Drosophila* can be explained by the successive colonisation of newly formed islands by a small number of individuals 'island-hopping' from the neighbouring westerly island.

**Question 28**

Within each species of *Drosophila* there is a low level of genetic diversity. This is an example of

- A founder effect.
- B bottleneck effect.
- C artificial selection.
- D allopatric speciation.

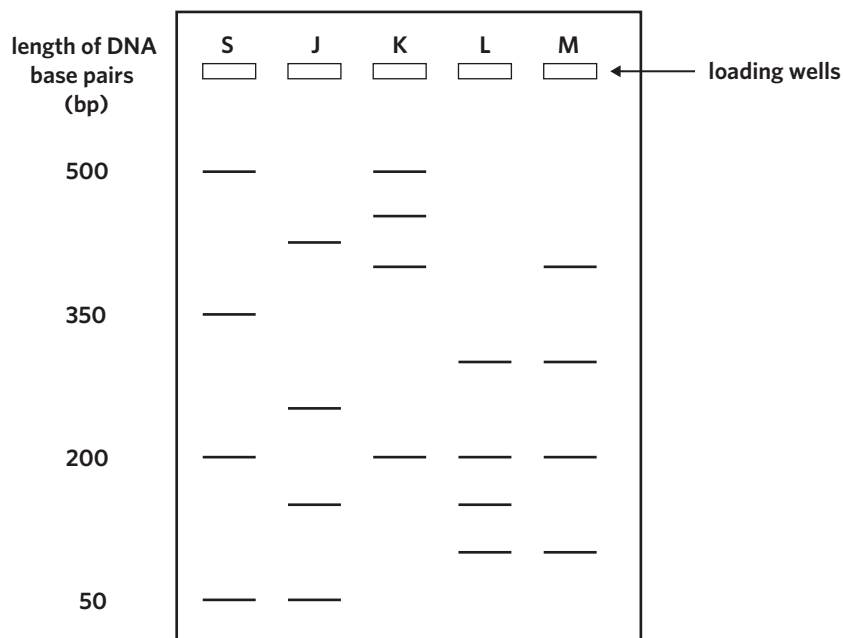
**Question 29**

The low level of genetic diversity means that individual species of *Drosophila*

- A have a high mutation rate.
- B will be very susceptible to infectious diseases.
- C will show a low frequency of genetic disorders.
- D have a high chance of survival when encountering environmental change.

**Use the following information to answer Questions 30–32.**

Genetic testing can be used to test for the allele for Huntington’s disease (HD). The onset of HD predominantly occurs in adulthood. Four individual family members were tested for the HD allele. The diagram below shows the electrophoresis gel results of a test for the presence of the allele. Individuals L and M have been diagnosed with the disease. A standard ladder (S) has also been included.



**Question 30**

Which other individual/s is/are likely to suffer from HD now or in the future?

- A S
- B J
- C K
- D S and K

**Question 31**

Which lane represents a sample that was loaded with DNA fragments of four different lengths: 100 bp, 200 bp, 300 bp, and 400 bp?

- A J
- B K
- C L
- D M

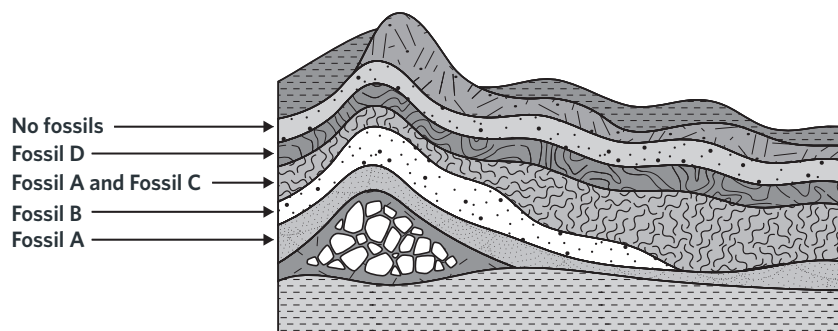
**Question 32**

Which lane contains the band that is closest to the positive electrode?

- A J
- B K
- C L
- D M

Use the following information to answer Questions 33 and 34.

The fossils present in different rock strata in a particular location are shown in the diagram.



### Question 33

From the diagram above, it can be concluded that

- A Fossil B is older than Fossil A.
- B the species represented by Fossils A and B existed at the same time.
- C the species represented by Fossil D existed for the longest period of time.
- D because there are no fossils in the topmost layer, all the species are extinct.

### Question 34

Fossil C features no organic material and shows the outline of the organism. The actual body of the organism is thought to have decomposed.

This type of fossil is best described as

- A a trace fossil.
- B preserved remains.
- C an impression fossil.
- D a permineralised fossil.

**Use the following information to answer Questions 35 and 36.**

In 2013, about 1 500 fossil bones of a hominin species were found in a cave in South Africa. From these bones, scientists have managed to construct almost a complete skeleton. The fossil bones have some features in common with those of the genus *Australopithecus*; however, they have enough similarities to the genus *Homo* that scientists have classified the fossil skeleton as belonging to a new species, *Homo naledi*.

**Question 35**

In order for the fossil skeleton to be classified in the genus *Homo* and not in the genus *Australopithecus*, which of the following features would have been present?

- A large teeth
- B a c-shaped spine
- C a relatively large cranial capacity
- D the presence of a large sagittal crest

**Question 36**

As a result of bipedal locomotion, which of the following features would you expect to find in the newly classified *Homo* fossil?

- A a less protruding big toe
- B a bowl-shaped pelvis
- C opposable thumbs
- D a low foot arch

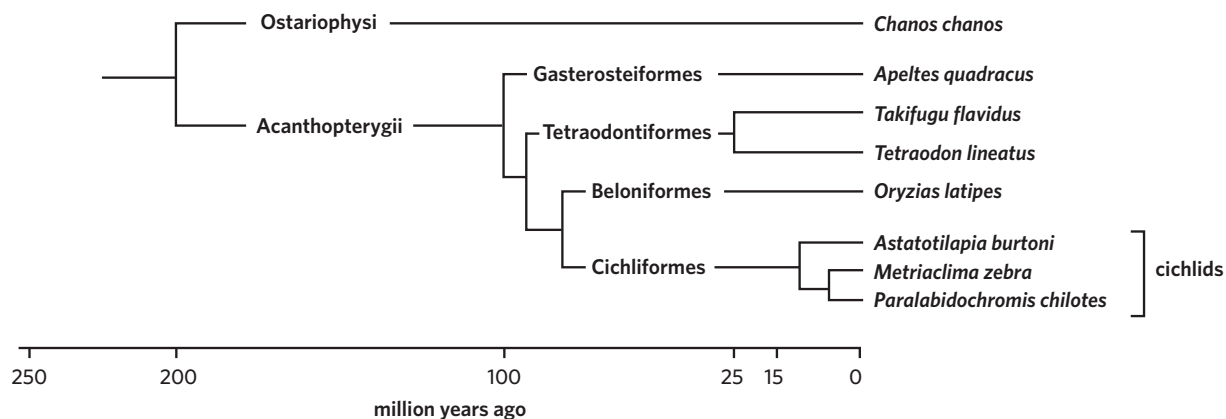
**Question 37**

Which group of characteristics best reflects the trends in hominin evolution from the *Australopithecus* species to the *Homo* species?

- A increasingly opposable big toe, increasing heel size, increasingly funnel-shaped rib cage, decreasing arm to leg ratio
- B increasingly flat face, more central foramen magnum, increasingly barrel-shaped rib cage, decreasing arm to leg ratio
- C increasingly flat face, less central foramen magnum, increasingly barrel-shaped rib cage, decreasing arm to leg ratio
- D decreasingly flat face, more central foramen magnum, increasingly barrel-shaped rib cage, increasingly bowl-shaped pelvis

**Question 38**

Consider the following phylogenetic tree, which summarises the evolutionary relationships between certain fish species.



Which of the following statements is correct?

- A *T. flavidus* and *T. lineatus* diverged 100 million years ago.
- B *C. chanos* does not share a common ancestor with cichlids.
- C *O. latipes* is more closely related to *P. chilotes* than it is *T. flavidus*.
- D *M. zebra* and *P. chilotes* diverged from a common ancestor approximately 15 million years ago.

**Question 39**

Restriction enzymes

- A join two DNA fragments together by forming phosphodiester bonds between the two fragments.
- B act as molecular scissors, cutting DNA molecules at specific nucleotide sequences.
- C separate two DNA strands during transcription so that a copy can be made.
- D are involved in protein synthesis.

**Question 40**

A molecular biologist performed the procedure outlined in the flowchart below.

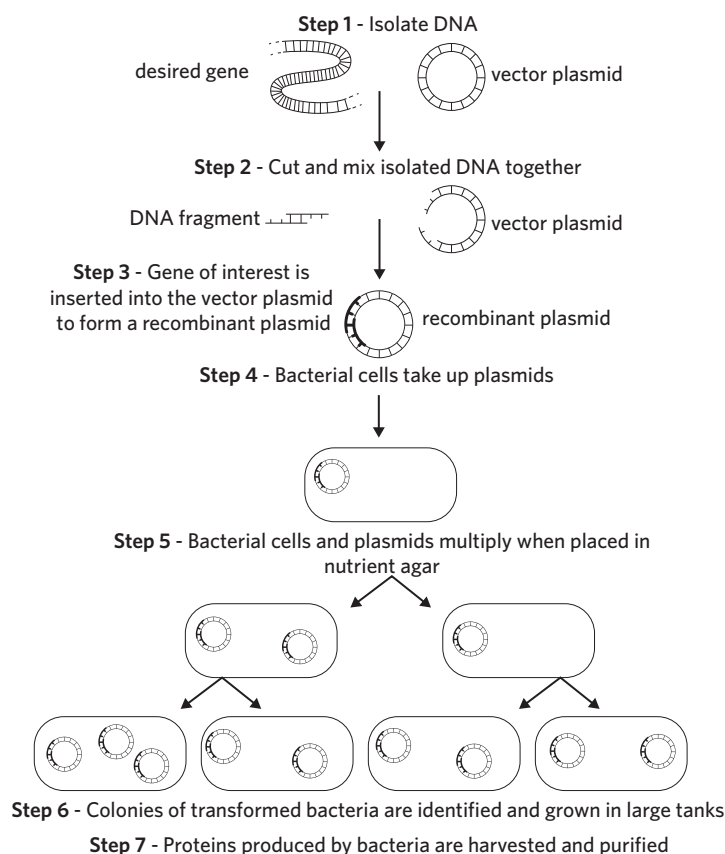


Image: adapted from P Ladiges, B Evans, R Saint and B Knox, *Biology: An Australian Focus*, 3rd edition, McGraw Hill Australia, NSW, 2008, p. 273

Which one of the following is a correct statement about the procedure outlined above?

- A** In Step 2, the same restriction enzyme is used to cut both the desired gene and vector plasmid.
- B** In Step 3, polymerase enzymes are required to establish a recombinant plasmid.
- C** In Step 4, all bacteria in the colony will take up the plasmid.
- D** In Step 5, bacterial colonies are undergoing PCR.



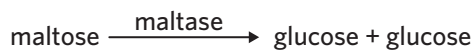
**SECTION B****Instructions for Section B**

Answer **all** questions in the spaces provided. Write using blue or black pen.

Unless otherwise indicated, the diagrams in this question book are **not** drawn to scale.

**Question 1** (6 MARKS)

Maltase is an enzyme that catalyses the breakdown of maltose into glucose as shown.



The coding information in the DNA molecule for maltase is initially transferred to mRNA before the strand undergoes translation to produce the protein.

**a** Describe how mRNA is synthesised from a DNA strand.

3 MARKS

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**b i** Apart from temperature and pH, identify two other variables that can be altered to increase the rate of production of glucose.

2 MARKS

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**ii** Scientists created a new drug that acts as a reversible competitive inhibitor of maltase. What does this suggest about the structure of the drug?

1 MARK

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**Question 2** (9 MARKS)

The mitochondrion and chloroplast are membrane-bound organelles that are the site of aerobic cellular respiration and photosynthesis respectively.

- a** Photosynthesis can be broken down into two stages, the light-dependent and light-independent stage. Identify two molecules that are outputs of the light-dependent stage and inputs of the light-independent stage.

2 MARKS

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- b** The following three-dimensional diagram depicts the internal structure of a mitochondrion.

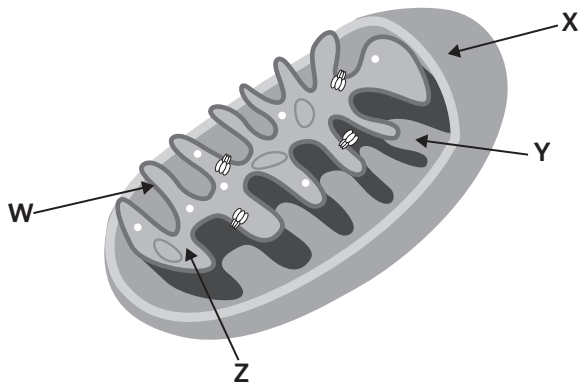


Image: Alila Medical Media/Shutterstock.com

- i** Which letter represents the matrix?

1 MARK

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- ii** The electron transport chain takes place at W. Identify the structure represented by W.

1 MARK

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- c** A number of factors influence the rate of aerobic cellular respiration. Explain the relationship between temperature and the rate of aerobic cellular respiration in humans.

3 MARKS

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- d** It is commonly understood that chloroplasts and mitochondria used to live as single-celled organisms. Provide two pieces of evidence to support this theory.

2 MARKS

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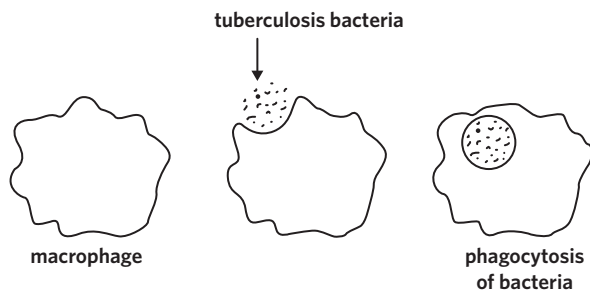
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**Question 3** (10 MARKS)

Tuberculosis is a disease caused by the bacterium *Mycobacterium tuberculosis*. It is usually transmitted between individuals by airborne droplets and mainly affects the lungs. Once inside the lungs, the bacterium is phagocytosed by macrophages, however it is able to evade destruction within the macrophage and can continue to replicate.



- a** Describe how macrophages typically digest pathogenic material once it has been engulfed. 1 MARK

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- b** Tuberculosis is often contracted by individuals infected with the human immunodeficiency virus (HIV).

Explain whether an individual infected with HIV can effectively defend against tuberculosis. 3 MARKS

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- c** While macrophages are largely incapable of stimulating an immune response, the ability of dendritic cells to migrate towards lymph nodes has been reported to be critical in initiating a targeted immune response against tuberculosis.

Suggest how dendritic cells could initiate an adaptive immune response against tuberculosis. 2 MARKS

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- d** Occasionally, tuberculosis can remain dormant for many years inside macrophages before symptoms arise. During this period, the tuberculosis bacterium does not actively replicate. However, once it becomes active, it can cause disease and disrupt the normal functioning of the body. One mechanism of the disease involves the overstimulation of the immune system through a cytokine storm, which leads to the production of an excessive quantity of cytokines.

Describe the effects of a cytokine storm on the immune system.

2 MARKS

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- e** Rifampicin is a broad-spectrum antibiotic often used to target many different strains of bacteria, regardless of whether they are pathogenic or not. It does this by targeting bacterial RNA polymerase, and is often used to treat tuberculosis.

Explain why individuals are more susceptible to bacterial infection after consuming antibiotics such as rifampicin.

2 MARKS

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**Question 4** (4 MARKS)

In Victoria, the ‘no jab, no play’ policy requires children to be fully vaccinated unless they have a medical exemption in order to enrol in childcare or kindergarten. This is so that herd immunity can be maintained.

- a** Describe the purpose of herd immunity. 1 MARK

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- b** An example of a reasonable medical exemption includes the presence of an allergic reaction to a particular vaccine.

- i** Outline the process of an individual developing an allergy upon first exposure to an allergen. 2 MARKS

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- ii** Explain whether allergies can be categorised as a disease. 1 MARK

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**Question 5** (4 MARKS)

Populations of the lizard species *Anolis sagrei* are found on the many islands of the Bahamas. There is natural variation between the phenotypes of individuals within each population.

- a** In 2004, a hurricane killed many *A. sagrei* lizards on one of the islands of the Bahamas. Over the next three years, the scientists measured the genetic diversity within the population and found there was lower genetic diversity.

Explain the reasons for the lower genetic diversity of the *A. sagrei* lizards on the island being studied compared with the population on an unaffected island.

2 MARKS

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- b** Describe the effect of having reduced genetic diversity for a species.

2 MARKS

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**Question 6** (9 MARKS)

The *CFTR* gene is responsible for the production of the cystic fibrosis transmembrane conductance regulator protein. This protein is responsible for moving chloride ions down their concentration gradient. This flow of chloride ions in and out of cells is important for the production of normal, thin mucus in the airways.

- a** Identify which type of transport chloride ions take through the membrane.

1 MARK

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- b** Explain the role of mucosal secretions in the first line of defence that protects the respiratory tract from pathogens.

2 MARKS

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Cystic fibrosis is a genetic disease caused by mutations that lead to the malfunctioning of the CFTR protein. Shown below is a small section of the mRNA nucleotide sequence found in an individual without the mutation.

5'	AUC	AUC	UUU	GGC	GUU	3'
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The codon table can be used to determine amino acids coded for by a nucleotide sequence.

1st position (5' end) ↓	2nd position				3rd position (3' end) ↓
	U	C	A	G	
U	phe	ser	tyr	cys	U
	phe	ser	tyr	cys	C
	leu	ser	STOP	STOP	A
	leu	ser	STOP	trp	G
C	leu	pro	his	arg	U
	leu	pro	his	arg	C
	leu	pro	gln	arg	A
	leu	pro	gln	arg	G
A	ile	thr	asn	ser	U
	ile	thr	asn	ser	C
	ile	thr	lys	arg	A
	met	thr	lys	arg	G
G	val	ala	asp	gly	U
	val	ala	asp	gly	C
	val	ala	glu	gly	A
	val	ala	glu	gly	G

- c** Use the section of mRNA provided and the codon table above to complete the table below.

2 MARKS

Translated sequence	
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- d** A common cause of cystic fibrosis is a deletion of three nucleotides, CUU, from the RNA sequence above.

**i** How would this alter the amino acids coded for in this sequence?

1 MARK

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**ii** Explain if this mutation is a frameshift mutation.

2 MARKS

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- e** In people without cystic fibrosis, the *CFTR* gene shows tight, tissue-specific regulation of expression. For example, in the intestinal epithelium there is a strong gradient of expression from the proximal to distal intestine.

Describe the role of the promoter region in gene expression.

1 MARK

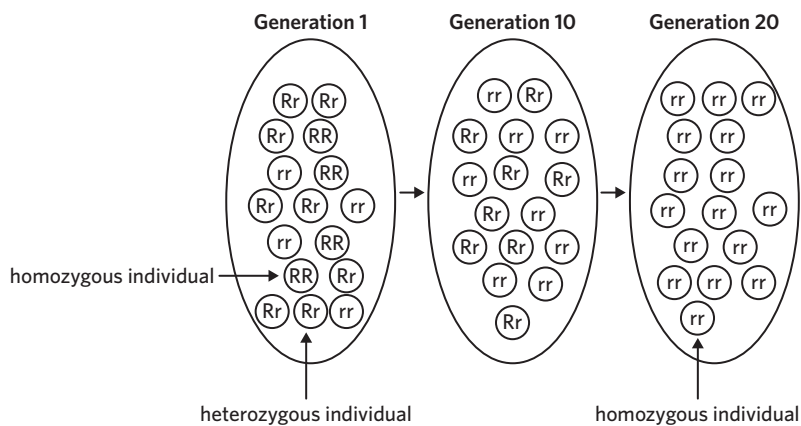
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**Question 7** (6 MARKS)

Consider the diagram below showing the gene pool of a population over 20 generations.



- a** Using the information above, explain how natural selection can lead to the differences in genotypes seen in this population over time.

3 MARKS

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- b** Scientists later discovered a different population of organisms on the other side of a mountain range. When they compared the gene pools of the two populations, they found that the newly discovered population had a gene pool similar to Generation 1 of the initial population shown above. They hypothesised that this second population was a separate species that shared a common ancestor with the original population they studied.

Name and describe the type of speciation that has taken place between the two populations.

3 MARKS

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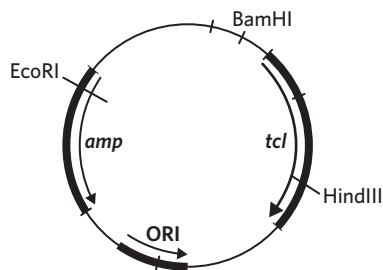


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**Question 8** (9 MARKS)

The *INS* gene encodes proteins that are essential for proper insulin production. When this gene is silenced, it often leads to type I diabetes. Scientists treat type I diabetes through synthetic insulin produced by bacteria that have the human insulin gene inserted into their genomes via bacterial transformation. To transform bacteria, a recombinant plasmid must be created.

A particular bacterial plasmid contains recognition sites for the sticky-end restriction enzymes EcoRI, HindIII, and BamHI, along with two antibiotic-resistant genes, ampicillin resistance (*amp*) and tetracycline resistance (*tcl*), and an origin of replication (ORI). The diagram below shows the positions of these recognition sites and antibiotic-resistant genes as well as the position of the origin of replication within this plasmid.



- a** Before the bacterial transformation process can begin, scientists must amplify the *INS* gene. The DNA amplification mixture was made up of the specific gene segment, a supply of four nucleotide bases, *Taq* polymerase, and DNA primers.

**i** Complete the table below and state the relevant temperatures for each step of PCR.

1 MARK

Step	Temperature (°C)
1	
2	
3	

**ii** Explain the role temperature has in each step.

3 MARKS

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- b** The scientists decided to use EcoRI to cut the bacterial plasmid and the *INS* gene. Explain why EcoRI is used for both the plasmid and *INS* gene.

1 MARK

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- c** Explain whether the transformed bacteria could be described as both a genetically modified organism and a transgenic organism.

2 MARKS

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- d** After the scientists had carried out the steps required to make plasmids with the inserted human gene, these plasmids were mixed with a culture of bacteria. This mixture was treated so that these plasmids would move into the bacterial cells. Not all bacteria took up these plasmids.

Explain how scientists use antibiotics to identify which of the bacterial cells have been successfully transformed with plasmids carrying the human gene.

2 MARKS

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**Question 9** (4 MARKS)

Between 2014–2016, an outbreak of Ebola virus disease (EVD) occurred in Guinea, Liberia, and Sierra Leone in West Africa. There were 28 616 reported cases of EVD in these countries and 11 310 deaths from EVD. It was found that humans may contract the Ebola virus from infected animals or from an infected person.



**a** Explain whether this is an example of a pandemic or an epidemic.

1 MARK

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**b** Identify one social or economic factor that could increase the transmission rate of the Ebola virus.

1 MARK

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**c** Human to animal transmission can occur from close contacts with infected animals like bats, chimpanzees, and antelopes, including the handling and preparation of meat prior to consumption.

Describe two different approaches, other than vaccination, that government health officials could implement to reduce the spread of Ebola virus.

2 MARKS

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**Question 10** (6 MARKS)**Denny: Meet Our Hybrid Relative**

In 2012, a team of Russian archeologists discovered a hominin bone fragment at the Denisova Cave in the Altai Mountains of Siberia, Russia. The bone was dated to 90 000 years old and was estimated to have belonged to a 13-year-old, who scientists named Denisova 11 ('Denny'). The bone was ground down into a fine powder before the DNA was extracted and the genome sequenced. To determine which hominin group Denny originated from, the scientists compared particular fragments of the genome with matched alleles from both a Neanderthal genome and a Denisovan genome. At these sites, it was found that 38.6% of Denny's alleles matched the Neanderthal genome, while 42.3% matched the Denisovan genome.

The discovery of Denny is often cited as conclusive evidence that disproves the idea that the hominin species evolved linearly from *Homo erectus*. According to this theory, the evolution of modern humans can be traced sequentially species-by-species from our primitive ancestors all the way through to modern humans.

While Denny's discovery has helped scientists confirm one aspect of hominin evolution, they are still piecing together clues to understand how and when *Homo sapiens* became so widespread. Analysis of modern human genomes reveals that present-day Africans have more genetic variation than humans from other continents. This supports the Out of Africa hypothesis, which suggests that early *Homo sapiens* lived solely in Africa and spread out across the world later in time, forming new populations. The genetic diversity of these populations was impacted by the founder effect. The Out of Africa hypothesis is also supported by the fact that the oldest known *Homo sapiens* fossil was found on the African continent.

- a** Given that Denny had approximately equal amounts of Neanderthal and Denisovan ancestry, what conclusion were the scientists able to draw about their parentage?

1 MARK

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- b** Describe why the discovery of Denny contradicts the validity of the linear evolution of modern humans theory.

1 MARK

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- c The multiregional hypothesis proposes that an ancestor of modern humans such as *Homo erectus* became widespread across the globe first and evolved into *Homo sapiens* independently in several different human populations.

Complete the following table by identifying two pieces of evidence in the text that dispute the multiregional hypothesis. Justify how each piece of evidence can be used to reject the multiregional hypothesis.

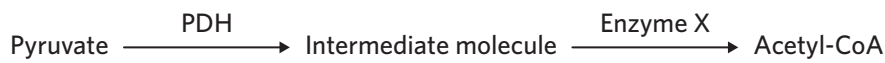
2 MARKS

Evidence	Justification
1. _____ _____ _____	_____ _____ _____
2. _____ _____ _____	_____ _____ _____

**Question 11** (13 MARKS)

Nadine wanted to investigate the effect of enzyme inhibition on cellular respiration.

Pyruvate dehydrogenase (PDH) is an enzyme required to convert pyruvate to acetyl-CoA, an input of the Krebs cycle. It catalyses the breakdown of pyruvate into an intermediate molecule that can then go on to become acetyl-CoA.



Nadine knew that NADH was a reversible inhibitor for PDH, but did not know whether it was a competitive or non-competitive inhibitor. She designed an experiment to test which type of inhibitor NADH was using the following method.

1. Collect three beakers.
2. Label each beaker sample A, B, and C.
3. Measure 10 mL of a 0.1 M NADH solution using a measuring cylinder, then add it to sample A. Repeat for sample B and C.
4. Using a clean measuring cylinder, measure 50 mL of a 0.2 M pyruvate solution, then add this to sample A.
5. Repeat step 4 for sample B and C, except for sample B pour 50 mL of a 0.4 M pyruvate solution and for sample C pour 50 mL of a 0.1 M pyruvate solution.
6. Pipette 2 mL of PDH solution and 2 mL of Enzyme X into all three beakers.
7. Test for the initial concentration of acetyl-CoA.
8. Leave all beakers uncovered for 20 minutes at 37 °C.
9. After 20 minutes, test for the concentration of acetyl-CoA.

Nadine's results are shown in the table below.

	Concentration of acetyl-CoA (M)	
	Initial	20 minutes
<b>Sample A</b>	0.00	0.02
<b>Sample B</b>	0.00	0.02
<b>Sample C</b>	0.00	0.02

- a** State the independent and the dependent variable in this experiment.

2 MARKS

Independent variable \_\_\_\_\_

Dependent variable \_\_\_\_\_

- b** List two variables that would need to be controlled to ensure the experiment produced valid results.

2 MARKS

1. \_\_\_\_\_

2. \_\_\_\_\_

- c After completing the experiment, Nadine decided she could improve her experimental design by adding another beaker that contained the following:
- 50 mL of 0.1 M pyruvate solution
  - 2 mL of PDH solution
  - 2 mL of Enzyme X solution

The results from this beaker are shown below.

	Concentration of acetyl-CoA (M)	
	Initial	20 minutes
Sample D	0.00	0.30

Explain how this additional beaker would improve her experimental design.

2 MARKS

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- d With reference to the type of inhibition and its location of binding, what conclusions do you think Nadine can draw from her investigation? You should refer to evidence collected from Nadine's experiment in your response.

2 MARKS

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From her first experiment, she knew NADH inhibits the conversion of pyruvate to acetyl-CoA, leading to an accumulation of pyruvate, which promotes anaerobic cellular respiration. In a second experiment, Nadine wanted to measure how NADH concentration affects the rate of anaerobic respiration in yeast. She set up three test tubes, unsealed, with the contents listed in the table below.

Test tube	Contents of test tube
1	10 mL of 3% glucose solution 5 mL solution containing yeast 10 mL of 5% NADH
2	10 mL of 3% glucose solution 5 mL solution containing yeast 10 mL of 2% NADH
3	10 mL of 3% glucose solution 5 mL solution containing yeast 10 mL of distilled water

Nadine wanted to measure the rate of fermentation. She knows that in yeast, the outputs of anaerobic cellular respiration are carbon dioxide and ethanol. She chooses to measure the concentration of ethanol rather than carbon dioxide.

- e** State the hypothesis that Nadine was testing. 1 MARK
- 
- f** Explain why it is more valid to measure the concentration of ethanol rather than carbon dioxide. 2 MARKS
- 
- 
- g** What results would disprove the hypothesis of Nadine's experiment? 2 MARKS
- 
- 

**END OF QUESTION BOOK**

# How to check your answers

## CHECKLISTS AND EXEMPLAR ANSWERS

This answer section includes exemplar responses with checklists to help students work towards a full mark answer. These checklists and answers are similarly structured to the ones found in our textbooks.

### Exemplar answers

Exemplar answers provide an example of how a student could respond to get full marks.

The depth of the answer is derived from the task word, the number of marks, and analysis of examiners' reports from previous VCAA examinations.

The answers are written in full sentences to model strong literacy and aid learning, although students may distill their responses into briefer phrases or dot points and still receive full marks.

### Other acceptable responses

Sometimes, there is more than one way to get full marks. Where applicable, Edrolo points students in the right direction by briefly listing some alternative correct responses.

### Checklists

Checklists break answers down into the smallest components required to get full marks. This is especially important when questions might be worth two marks, but you actually need to include two ideas plus a key term or expression.

In the example below, the VCAA examiner's report for similar questions clearly states that students would not receive full marks without using comparative language. So, this is included as a checklist item. If students prefer writing answers as brief dot points, the checklist can be used to ensure they have still provided a complete and correct answer.

When used with Edrolo's digital platform, students can use the checklist to self-mark short answer questions, and teachers can view this data to track class progress.

#### Question 1 (2 MARKS)

Scientists were trying to classify a recently discovered fossil skull into the appropriate genus. The fossil bones had some features in common with those of the genus *Australopithecus*, however, they also had similarities to the genus *Homo*.

What are two features that would classify the fossil skull in the genus *Australopithecus* and not the genus *Homo*?

**Exemplar responses** show students what a full mark answer could look like

If their answer is different to the exemplar, **other acceptable responses** help students know if they are on the right track

1 [The skull would have a heavier brow ridge and relatively small brain case.]

Other acceptable responses include:

- A more sloped face.
- A less parabolic jaw (U-shaped jaw).
- A less central foramen magnum.
- Larger teeth.
- No chin.
- More prognathic/protruding jaw.

✓ ✗ I have stated two features that are characteristic of *Australopithecus* but absent in *Homo*.<sup>1</sup>

✓ ✗ I have used comparative language such as: heavier.

**Checklist items** can help students identify 'hidden' marks or develop skills that make their responses more coherent

**Numbers** help students identify which part of the exemplar relates to which checklist item

## Bonus questions

Underneath some exemplar answers, there is a coloured box that contains an exam-style question and its corresponding exemplar answer and checklist. These extra questions are from Edrolo's Year 12 Biology textbook, which contains hundreds of exam-style questions, answers, and checklists. The bonus question aims to provide students with an example of a different type of question they may be asked on the same topic.

### WANT MORE?

Here's another question to show the theory from a different perspective:

- Study design dot point: the location of anaerobic cellular respiration, its inputs, and the difference in outputs between animals and yeasts including ATP yield
- Related Edrolo textbook lesson: 7C - Page 229

#### Question 14a

The smoke produced during a house fire is usually more dangerous than the fire itself. Two of the many toxic chemicals in the smoke from a house fire are carbon monoxide and hydrogen cyanide. Carbon monoxide molecules bind to haemoglobin molecules in the blood, which reduces the blood's capacity to transport oxygen. This causes a significant reduction in oxygen supply to the cells of the body. Symptoms of carbon monoxide poisoning include dizziness, drowsiness, and nausea.

Name and describe the process by which a cell produces ATP in the absence of oxygen, with reference to the product/s.  
(2 MARKS)

#### Answer

[Anaerobic cellular respiration,<sup>1</sup>][which produces two ATP per glucose molecule.<sup>2</sup>][Glucose is broken down into pyruvate which then reacts further to form lactic acid in animals or ethanol and carbon dioxide in yeast, bacteria, and plants.<sup>3</sup>]

✓ ✗ I have named the process that produces ATP in the absence of oxygen.<sup>1</sup>

✓ ✗ I have described the process with reference to ATP yield.<sup>2</sup>

✓ ✗ I have described the process with reference to the product/s.<sup>3</sup>

## SECTION A – ANSWERS

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

## SECTION B – ANSWERS

- 1 a** [RNA polymerase binds to the promoter region of the DNA strand<sup>1</sup>] [and the DNA double helix unwinds.<sup>2</sup>] [RNA polymerase then moves along and reads the template strand.<sup>3</sup>] [As it moves, it uses RNA nucleotides that are complementary to the DNA template to form an mRNA strand.<sup>4</sup>] [Transcription ends when RNA polymerase reaches a termination sequence.<sup>5</sup>] [The pre-mRNA strand then undergoes post-transcriptional modifications, including removal of introns and addition of the poly-A-tail and 5' methyl cap, before it is ready for translation.<sup>6</sup>]

☒ ☐ I have identified that RNA polymerase binds to the promoter region to begin transcription.<sup>1</sup>

☒ ☐ I have stated that the DNA unwinds.<sup>2</sup>

☒ ☐ I have described how RNA reads the template DNA strand.<sup>3</sup>

☒ ☐ I have described how RNA polymerase uses complementary nucleotides.<sup>4</sup>

☒ ☐ I have stated that transcription ends at a termination sequence.<sup>5</sup>

☒ ☐ I have explained that the mRNA strand undergoes post-transcriptional modifications.<sup>6</sup>

☒ ☐ I have used key biological terminology such as: RNA polymerase, promoter region, double helix, template strand, complementary nucleotides, mRNA, termination sequence, post-transcriptional modifications.

- 1 b i** [The rate of glucose production can be increased by increasing the concentration of the substrate maltose,<sup>1</sup>] [or by increasing the concentration of the enzyme maltase.<sup>2</sup>]

☒ ☐ I have stated that increasing substrate concentration would increase the rate of glucose production.<sup>1</sup>

☒ ☐ I have stated that increasing enzyme concentration would also increase the rate of glucose production.<sup>2</sup>

- 1 b ii** [The drug must have a shape that is complementary to the active site of maltase, and as such is likely to be similar in shape to maltose.<sup>1</sup>]

☒ ☐ I have explained that the structure of the drug must be complementary to the active site of maltase.<sup>1</sup>

☒ ☐ I have used key biological terminology such as: complementary, active site, maltase.

- 2 a** [NADPH and ATP.<sup>1</sup>]

☒ ☐ I have identified that NADPH and ATP are the two molecules that are outputs of the light-dependent stage and inputs of the light-independent stage.<sup>1</sup>

- 2 b i** [Z.<sup>1</sup>]

☒ ☐ I have stated Z.<sup>1</sup>

**2 b ii** [Cristae.<sup>1</sup>]

Other acceptable responses include:

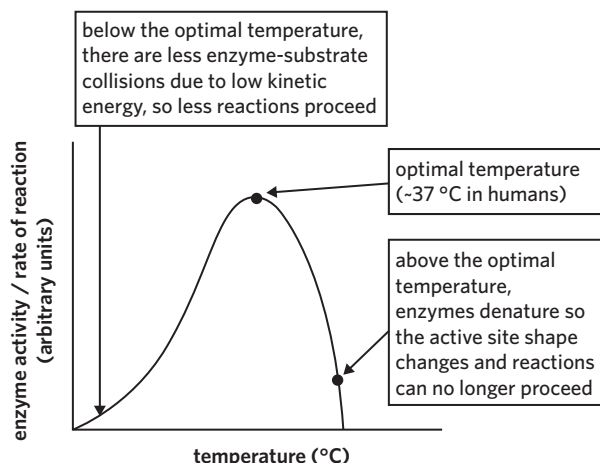
- The inner membrane of the mitochondrion.

✓ ✗ I have stated cristae.<sup>1</sup>

**2 c** [The rate of aerobic cellular respiration is greatest when the temperature aligns with the optimal temperature of the enzymes within the mitochondria, which is around 37 °C in humans.<sup>1</sup>][Below the optimal temperature, the respiration rate is slower<sup>2</sup>][due to the decreased kinetic energy of molecules, which in turn causes less frequent substrate–enzyme collisions and less enzymatic reactions.<sup>3</sup>][Above the optimal temperature, the enzymes begin to denature, causing the active site to change shape and<sup>4</sup>][significantly reducing the respiration rate.<sup>5</sup>]

Other acceptable responses include:

- Annotated graph such as:



✓ ✗ I have explained that the greatest rate of aerobic cellular respiration aligns with the optimal temperature of the enzymes within the mitochondria.<sup>1</sup>

✓ ✗ I have stated that below the optimal temperature the rate is slower.<sup>2</sup>

✓ ✗ I have described the problems that arise below the optimal temperatures.<sup>3</sup>

✓ ✗ I have described the problems that arise above the optimal temperature.<sup>4</sup>

✓ ✗ I have stated that above the optimal temperature the rate is slower.<sup>5</sup>

✓ ✗ I have used key biological terminology such as: denature, enzyme, substrate, optimal.

**2 d** [Both mitochondria and chloroplasts have their own circular DNA which is not enclosed in a nuclear membrane,<sup>1</sup>][and both replicate through binary fission, which are characteristics similar to bacteria.<sup>2</sup>]

Other acceptable responses include:

- Both have a double membrane which is similar to gram-negative bacteria.
- Both have their own ribosomes similar to bacterial ribosomes.
- Both can produce proteins independently from the cell due to the presence of their own DNA and ribosomes.
- Both contain transport proteins called porins in their outer membrane.
- Chloroplasts are a similar size to bacteria.

✓ ✗ I have provided one piece of evidence that both chloroplasts and mitochondria used to live as single-celled organisms.<sup>1</sup>

✓ ✗ I have provided a second piece of evidence.<sup>2</sup>

**3 a** [Normally, lysosomes inside macrophages fuse with vesicles containing pathogenic material, introducing lysozymes into the vesicle that destroy the pathogen.<sup>1</sup>]

✓ ✗ I have described how pathogens are normally destroyed in macrophages.<sup>1</sup>

✓ ✗ I have used key biological terminology such as: lysosome, lysozyme, vesicle.

- 3 b** [An individual infected with HIV cannot effectively defend against tuberculosis as HIV destroys T helper cells,<sup>1</sup>] [which are responsible for activating the adaptive immune response by primarily interacting with antigen-presenting cells.<sup>2</sup>] [Therefore, an individual infected with HIV cannot carry out the clonal expansion of specific B cells or the activation of specific cytotoxic T cells.<sup>3</sup>]

Other acceptable responses include:

- T helper cells secrete cytokines that stimulate the immune system, activating macrophages, phagocytes, and the clonal expansion of lymphocytes.

☒ ☐ I have identified that HIV destroys T helper cells, so the individual cannot effectively defend against tuberculosis.<sup>1</sup>

☒ ☐ I have described the function of T helper cells.<sup>2</sup>

☒ ☐ I have explained how the loss of function of T helper cells impairs the immune system.<sup>3</sup>

☒ ☐ I have used key biological terminology such as: T helper cell, clonal expansion, B cell, cytotoxic T cell, adaptive immune response.

- 3 c** [After phagocytosing tuberculosis bacteria, dendritic cells may be able to process and present tuberculosis antigens on their MHC I and MHC II markers.<sup>1</sup>] [After, their MHC I marker can interact with cytotoxic T cells and their MHC II marker can interact with helper T cells, initiating the adaptive immune response against tuberculosis.<sup>2</sup>]

☒ ☐ I have identified that tuberculosis antigens may be presented on the MHC I and II markers.<sup>1</sup>

☒ ☐ I have described how the presentation of antigens can initiate the adaptive immune response.<sup>2</sup>

☒ ☐ I have used key biological terminology such as: MHC I, MHC II, antigen, T cell, adaptive immune response.

- 3 d** [Cytokines are signalling molecules typically released by the immune system involved in the activation of immune cells as well as the inflammatory response.<sup>1</sup>] [Therefore, a cytokine storm would result in excessive numbers of immune cells being activated.<sup>2</sup>]

☒ ☐ I have described the function of cytokines.<sup>1</sup>

☒ ☐ I have described how cytokines would affect the immune system.<sup>2</sup>

☒ ☐ I have used key biological terminology such as: signalling molecule, inflammatory response.

- 3 e** [Broad-spectrum antibiotics such as rifampicin can destroy normal flora,<sup>1</sup>] [which consists of non-pathogenic bacteria that help prevent the growth of pathogenic bacteria through competition for space and resources. Individuals can be more susceptible to pathogenic bacterial infections due to the loss of this competition.<sup>2</sup>]

☒ ☐ I have identified that broad-spectrum antibiotics can destroy normal flora.<sup>1</sup>

☒ ☐ I have explained how the loss of normal flora can make individuals more susceptible to bacterial infections.<sup>2</sup>

☒ ☐ I have used key biological terminology such as: pathogenic, flora.

- 4 a** [The purpose of herd immunity is to protect vulnerable individuals such as the elderly, the immunocompromised, or those with allergic reactions to vaccinations who can't be vaccinated from preventable diseases.<sup>1</sup>]

☒ ☐ I have described the purpose of herd immunity.<sup>1</sup>

- 4 b i** [The development of an allergy begins with exposure of the immune system to the allergen,<sup>1</sup>] [after which an inappropriate humoral immune response<sup>2</sup>] [is activated which produces IgE antibodies against the allergen.<sup>3</sup>] [After, these antibodies bind to mast cells, sensitising the body to the allergen.<sup>4</sup>]

☒ ☐ I have stated that the body is exposed to the allergen.<sup>1</sup>

☒ ☐ I have identified that an inappropriate humoral immune response is activated.<sup>2</sup>

☒ ☐ I have stated that antibodies are produced against the allergen.<sup>3</sup>

☒ ☐ I have identified the process of sensitisation.<sup>4</sup>

☒ ☐ I have used key biological terminology such as: IgE antibody, humoral response, mast cell.

**WANT MORE?****Here's another question to show the theory from a different perspective:**

- Study design dot point: the deficiencies and malfunctions of the immune system as a cause of human diseases including autoimmune diseases (illustrated by multiple sclerosis), immune deficiency diseases (illustrated by HIV), and allergic reactions (illustrated by reactions to pollen).
- Related Edrolo textbook lesson: 10B – Page 363

**Question 10a**

In people with hay fever the inhalation of pollen causes an allergic reaction to take place. One of the primary symptoms of hay fever is a runny nose.

Describe the sequence of events that would result in a runny nose in a sufferer of hay fever upon inhalation of pollen. (4 MARKS)

**Answer**

[Firstly, the airways of the hay fever sufferer would have previously been exposed to pollen,<sup>1</sup>] [and their B cells would have inappropriately responded to it by producing large amounts of IgE.<sup>2</sup>] [These IgE antibodies would have bound to mast cells.<sup>3</sup>] [Later, when inhaled again, pollen would have reacted with the IgE antibodies on the surface of mast cells, causing them to degranulate and release histamine.<sup>4</sup>] [This histamine would cause increased mucus secretion in the sufferer's airways, which would be experienced by them as a runny nose.<sup>5</sup>]

- ☒ ☐ I have stated that prior exposure to pollen would have taken place.<sup>1</sup>
- ☒ ☐ I have stated B cells would have produced IgE.<sup>2</sup>
- ☒ ☐ I have explained that IgE binds to mast cells.<sup>3</sup>
- ☒ ☐ I have explained that histamine is released upon re-exposure to the allergen.<sup>4</sup>
- ☒ ☐ I have related the release of histamine to the development of a runny nose.<sup>5</sup>
- ☒ ☐ I have answered in a logical and sequential manner.
- ☒ ☐ I have signposted steps in my response by using terms such as: firstly, later.
- ☒ ☐ I have used key biological terminology such as: B cells, IgE antibodies, mast cells, degranulate, histamine.

- 4 b ii** [Because allergies impair the normal functioning of the body, they can be categorised as a disease.<sup>1</sup>]

☒ ☐ I have explained how allergies can be categorised as a disease.<sup>1</sup>

- 5 a** [The lower genetic diversity was due to the bottleneck effect.<sup>1</sup>] [The hurricane would have randomly decreased the population size and decreased the gene pool.<sup>2</sup>]

☒ ☐ I have stated that the bottleneck effect is responsible.<sup>1</sup>

☒ ☐ I have explained how the bottleneck effect reduces genetic diversity.<sup>2</sup>

- 5 b** [Reduced genetic diversity has negative effects on a population.<sup>1</sup>] [It increases the risk of inbreeding, which can increase the amount of deleterious recessive alleles in the gene pool.<sup>2</sup>] [It also lowers the adaptive potential of the population.<sup>3</sup>]

☒ ☐ I have stated that reduced genetic diversity has negative effects on the population.<sup>1</sup>

☒ ☐ I have stated that reduced genetic diversity increases the risk of inbreeding.<sup>2</sup>

☒ ☐ I have stated that reduced genetic diversity lowers the adaptive potential of a population.<sup>3</sup>

☒ ☐ I have used key biological terminology such as: inbreeding, deleterious recessive alleles, adaptive potential.

- 6 a** [Facilitated diffusion.<sup>1</sup>]

☒ ☐ I have identified facilitated diffusion as the type of transport.<sup>1</sup>

- 6 b** [Mucous is a sticky physical barrier that traps pathogens,<sup>1</sup>][allowing cilia to sweep them away from the respiratory tract and into the digestive system to be destroyed.<sup>2</sup>]

☒ ☐ I have identified that mucous is a physical barrier that traps organisms.<sup>1</sup>

☒ ☐ I have explained how cilia contribute to the destructions of pathogens.<sup>2</sup>

☒ ☐ I have used key biological terminology such as: physical barrier, cilia, digestive system.

- 6 c**

Translated sequence	Ile – Ile– Phe – Gly – Val
---------------------	----------------------------

☒ ☐ I have translated the sequence correctly.

- 6 d i** [The three-nucleotide deletion would cause the removal of a Phe amino acid.<sup>1</sup>]

☒ ☐ I have identified that Phe is removed.<sup>1</sup>

- 6 d ii** [It is not a frameshift mutation.<sup>1</sup>][The reading frame of the DNA is not affected as three nucleotides were removed.<sup>2</sup>][This means future amino acids are not affected.<sup>3</sup>]

☒ ☐ I have stated it is not a frameshift mutation.<sup>1</sup>

☒ ☐ I have explained why it is not a frameshift mutation.<sup>2</sup>

☒ ☐ I have explained that there is no effect to future amino acids.<sup>3</sup>

☒ ☐ I have used key biological terminology such as: reading frame.

- 6 e** [The promoter region is the site that RNA polymerase and transcription factors bind to initiate transcription.<sup>1</sup>]

☒ ☐ I have identified the role of the promoter region.<sup>1</sup>

- 7 a** [Variation existed between individuals in Generation 1.<sup>1</sup>][A selective pressure was applied to the population that favoured the phenotype produced by the rr genotype.<sup>2</sup>][This trait is heritable.<sup>3</sup>][As a result, rr individuals tended to survive and reproduce, passing on their advantageous feature<sup>4</sup>][and the corresponding rr genotype.<sup>5</sup>]

☒ ☐ I have stated that variation within the population existed.<sup>1</sup>

☒ ☐ I have stated a selective pressure was applied that favoured the phenotype of rr individuals.<sup>2</sup>

☒ ☐ I have stated the trait is heritable.<sup>3</sup>

☒ ☐ I have stated individuals with this phenotype/genotype were more likely to reproduce.<sup>4</sup>

☒ ☐ I have stated this would increase the frequency of the rr genotype.<sup>5</sup>

- 7 b** [Allopatric speciation has taken place.<sup>1</sup>][In allopatric speciation, populations of the same species become isolated by a geographic barrier.<sup>2</sup>][Over time, the isolated population is exposed to different selection pressures<sup>3</sup>][and accumulate sufficient differences to the original population so that they form a new species and can no longer mate and produce fertile offspring.<sup>4</sup>]

☒ ☐ I have stated that allopatric speciation has occurred.<sup>1</sup>

☒ ☐ I have stated that allopatric speciation involves a geographic barrier.<sup>2</sup>

☒ ☐ I have stated that different selection pressures act on separate populations.<sup>3</sup>

☒ ☐ I have stated that these pressures result in the two populations accumulating differences that result in the formation of a new species.<sup>4</sup>



**8 a i**

Step	Temperature (°C)
1	94
2	55
3	72

☒ ☐ I have stated the temperature of step 1 is 90 °C–95 °C.

☒ ☐ I have stated the temperature of step 2 is 50 °C–55 °C.

☒ ☐ I have stated the temperature of step 3 is exactly 72 °C.

**8 a ii** [For step 1, the temperature needs to be approximately 94 °C to denature the DNA and separate them into single strands.<sup>1</sup>] [The temperature is then lowered to approximately 55 °C so that the DNA primers can attach to the single-stranded DNA molecules.<sup>2</sup>] [Finally, the temperature is raised to 72 °C as at this temperature the activity of the *Taq* polymerase enzyme is optimal.<sup>3</sup>]

☒ ☐ I have explained why the temperature is required for step 1.<sup>1</sup>

☒ ☐ I have explained why the temperature is required for step 2.<sup>2</sup>

☒ ☐ I have explained why the temperature is required for step 3.<sup>3</sup>

☒ ☐ I have used key biological terminology such as: denature, DNA primers, *Taq* polymerase, optimal.

**8 b** [The same restriction enzyme should be used on both sets of DNA to create complementary overhanging nucleotides and increase the chance of successful bonding.<sup>1</sup>]

☒ ☐ I have explained why the same restriction enzyme should be used.<sup>1</sup>

☒ ☐ I have used key biological terminology such as: complementary overhanging nucleotides.

**8 c** [Transformed bacteria are genetically modified organisms because their genetic material has been altered.<sup>1</sup>] [They are also transgenic organisms because they contain genetic material from a different species.<sup>2</sup>]

☒ ☐ I have explained that transformed bacteria are GMOs.<sup>1</sup>

☒ ☐ I have explained that transformed bacteria are TGOs.<sup>2</sup>

**8 d** [The transformed bacteria should be grown on agar containing tetracycline.<sup>1</sup>] [Those bacteria that will grow on agar containing tetracycline have the plasmid with the human *INS* gene included (and the tetracycline-resistance gene).<sup>2</sup>] [Whereas, if plasmid is not taken up, those bacteria are killed by tetracycline.<sup>3</sup>]

☒ ☐ I have stated the transformed bacteria should grow on tetracycline agar.<sup>1</sup>

☒ ☐ I have explained that transformed bacteria will grow on this agar.<sup>2</sup>

☒ ☐ I have explained that untransformed bacteria will not grow on this agar.<sup>3</sup>

☒ ☐ I have specified the antibiotic as tetracycline.

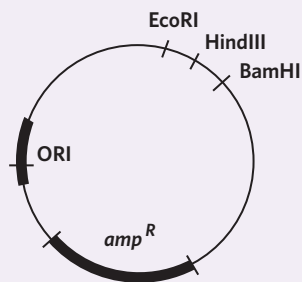
☒ ☐ I have used key biological terminology such as: transformed, agar, tetracycline-resistant.

**WANT MORE?****Here's another question to show the theory from a different perspective:**

- Study design dot point: the use of recombinant plasmids as vectors to transform bacterial cells.
- Related Edrolo textbook lesson: 15D – Page 592

**Question 15ei**

Chymosin is an enzyme used to manufacture cheese. Found in rennet, chymosin is traditionally extracted from the fourth stomach of newborn calves. Because of the difficulties in sourcing chymosin, scientists engineered a non-pathogenic strain of recombinant *E. coli* that can generate large quantities of chymosin in a laboratory. Currently, about 60-90% of hard cheese in the USA and UK is made with genetically engineered chymosin. The *E. coli* plasmid contains recognition sites for the restriction enzymes EcoRI, HindIII, and BamHI, along with the gene for ampicillin resistance (*amp<sup>R</sup>*) and an origin of replication (ORI). The diagram shows the positions of these recognition sites and ampicillin-resistance gene as well as the position of the origin of replication within this plasmid.



Not all the *E. coli* will take up the recombinant plasmids. To test which bacteria are transformed, the scientists set up four Petri dishes:

Plate A	Nutrient agar + <i>E. coli</i> not exposed to plasmids
Plate B	Nutrient agar + ampicillin + <i>E. coli</i> not exposed to plasmids
Plate C	Nutrient agar + <i>E. coli</i> exposed to plasmids + heat shocked
Plate D	Nutrient agar + ampicillin + <i>E. coli</i> exposed to plasmids + heat shocked

The Petri dishes were incubated overnight at 37 °C. The scientists found bacterial growth on plates A, C, and D but no growth on plate B. Explain the scientists' results for each Petri dish, including whether any results were unexpected. (4 MARKS)

**Answer**

[The bacterial growth in plate A would form a lawn as the bacteria in this plate are untransformed bacteria, which readily grow on nutrient agar.<sup>1</sup>] [There would be no growth on plate B. These bacteria have not been transformed and are not ampicillin-resistant, therefore they are unable to grow on ampicillin-containing nutrient agar.<sup>2</sup>] [The bacterial growth in plate C would form a lawn. Both transformed and untransformed bacteria would be able to grow since this plate contains only nutrient agar.<sup>3</sup>] [The bacteria in plate D would form colonies. Bacteria in these colonies have been transformed and contain the ampicillin-resistance gene and so will still be able to grow on ampicillin-containing agar. Untransformed bacteria would not survive since they do not contain the ampicillin-resistance gene.<sup>4</sup>] [None of these results were unexpected.<sup>5</sup>]

☒ ☐ I have explained that all bacteria are able to grow on nutrient agar.<sup>1</sup>

☒ ☐ I have explained that untransformed bacteria are not able to grow on ampicillin-containing agar.<sup>2</sup>

☒ ☐ I have explained that all bacteria are able to grow on nutrient agar.<sup>3</sup>

☒ ☐ I have explained that transformed bacteria are able to grow on ampicillin-containing agar.<sup>4</sup>

☒ ☐ I have identified that none of the results were unexpected.<sup>5</sup>

☒ ☐ I have used key biological terminology such as: lawn, colony, transformed.

9 a [Epidemic,<sup>1</sup>][as the disease has not spread over an extensive geographic area.<sup>2</sup>]

✓ ✗ I have stated it is an epidemic.<sup>1</sup>

✓ ✗ I have explained why it is not a pandemic.<sup>2</sup>

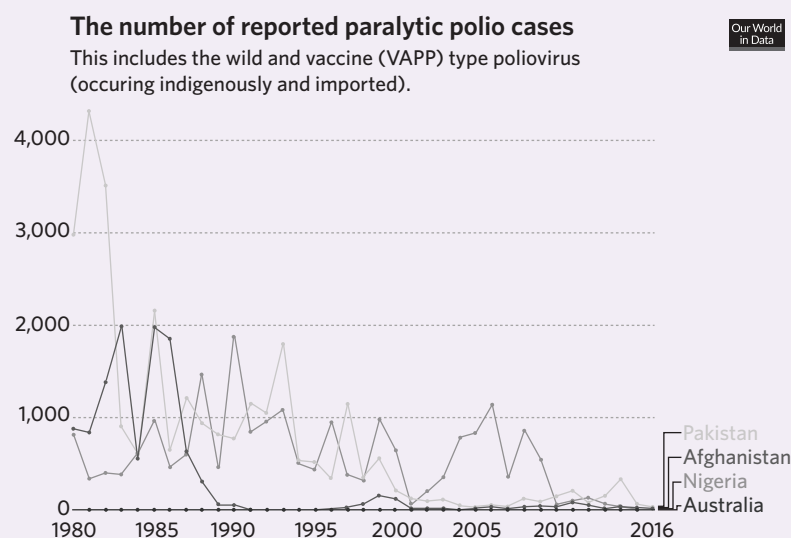
### WANT MORE?

Here's another question to show the theory from a different perspective:

- Study design dot point: strategies that deal with the emergence of new diseases in a globally connected world, including the distinction between epidemics and pandemics, the use of scientific knowledge to identify the pathogen, and the types of treatments.
- Related Edrolo textbook lesson: Chapter 16 Review – Page 662

#### Question 18bii

Polio used to be one of the most widespread and severe viral diseases. 1 in 200 individuals infected with polio develop irreversible paralysis which commonly results in death. The graph shows the number of reported paralytic polio cases in several countries since the 1980s.



Does this graph suggest that there may have been a polio pandemic between the years of 1990 and 1995?

Explain your response. (2 MARKS)

#### Answer

[No,<sup>1</sup>][because there isn't a sudden or unusual increase in the occurrence of polio in this time period in the given regions.<sup>2</sup>]

✓ ✗ I have stated if the graph supports the occurrence of a pandemic.<sup>1</sup>

✓ ✗ I have justified my answer.<sup>2</sup>

✓ ✗ I have not referred to the geographic distribution of polio in my answer.

9 b [Lack of education about the transmission of disease.<sup>1</sup>]

Other acceptable responses include:

- Decreased access to resources that improve sanitation and hygiene.
- Intimate communities or shared housing resulting in many close contacts with infected people.
- Lack of facilities in which to isolate infected individuals.

✓ ✗ I have stated one social or economic factor that could increase the transmission rate.<sup>1</sup>

- 9 c [Government officials could lead education campaigns for correct handling and cooking of meat,<sup>1</sup>] [and quarantine infected people.<sup>2</sup>]

Other acceptable responses include:

- Funding to improve hygiene resources and practices.
- Inspect and fumigate cargo entering new countries.

☒ ☐ I have stated one approach government officials can take.<sup>1</sup>

☒ ☐ I have stated another approach government officials can take.<sup>2</sup>

- 10 a [Scientists were able to infer that one of her parents is neanderthalian and the other is denosovian.<sup>1</sup>]

☒ ☐ I have identified the conclusion that was drawn.<sup>1</sup>

- 10 b [Denny disproves this theory, as its genome suggests that it is the offspring of a Denisovan and Neanderthal, meaning that these two species interbred and two separate hominin species contributed to each others' DNA and evolution.<sup>1</sup>]

☒ ☐ I have stated that Denny disproves this because it is the offspring of two different hominin species.<sup>1</sup>

10 c	Evidence	Justification
	1. Modern African <i>Homo sapiens</i> populations have a higher genetic diversity than other populations from different continents.	This suggests that modern human populations outside of Africa were founded by a small population of <i>Homo sapiens</i> with less genetic diversity than the larger group that remained within Africa.
	2. The oldest <i>Homo sapiens</i> fossils are found in Africa.	This suggests that <i>Homo sapiens</i> likely evolved on the African continent before migrating to other regions.

☒ ☐ I have stated a piece of evidence and justified how it refutes the multiregional hypothesis.

☒ ☐ I have stated a second piece of evidence and justified how it refutes the multiregional hypothesis.

- 11 a [Independent variable: pyruvate concentration.<sup>1</sup>]  
[Dependent variable: concentration of acetyl-CoA.<sup>2</sup>]

☒ ☐ I have stated the independent variable.<sup>1</sup>

☒ ☐ I have stated the dependent variable.<sup>2</sup>

- 11 b [1. Volume of PDH and Enzyme X added into each beaker is the same.<sup>1</sup>]  
[2. Volume of NADH solution added into each beaker is the same.<sup>2</sup>]

Other acceptable responses include:

- The temperature of all samples is the same.
- The pH of all samples is the same.
- The concentration of PDH and Enzyme X/NADH added into each beaker is the same.

☒ ☐ I have stated one controlled variable.<sup>1</sup>

☒ ☐ I have stated a second controlled variable.<sup>2</sup>

- 11 c [The additional beaker will act as a control.<sup>1</sup>] [This will allow Nadine to form meaningful comparisons with the experimental groups as it determines the amount of acetyl-CoA formed without any inhibitor present,<sup>2</sup>] [and informs her if factors besides the independent variable are affecting the results.<sup>3</sup>]

☒ ☐ I have stated the beaker will act as a control.<sup>1</sup>

☒ ☐ I have explained this enables meaningful comparisons to be made with the experimental groups.<sup>2</sup>

☒ ☐ I have stated that the additional beaker informs scientists if uncontrolled factors are affecting the results.<sup>3</sup>

- 11 d** [NADH is a non-competitive inhibitor to PDH.<sup>1</sup>] [This means it would bind to the allosteric site and cause a conformational change to PDH's active site, preventing substrates from binding.<sup>2</sup>] [This is supported by the finding that increased amounts of substrate present in the solution didn't increase the amount of product made.<sup>3</sup>]

☒ ☐ I have stated it is a non-competitive inhibitor.<sup>1</sup>

☒ ☐ I have explained where NADH would bind to PDH.<sup>2</sup>

☒ ☐ I have justified my response by referring to the results.<sup>3</sup>

☒ ☐ I have used key biological terminology such as: non-competitive inhibitor, allosteric site, conformational change.

- 11 e** [When NADH is present, the concentration of ethanol will increase.<sup>1</sup>]

☒ ☐ I have stated Nadine's hypothesis.<sup>1</sup>

- 11 f** [Carbon dioxide is an output of both aerobic and anaerobic cellular respiration in yeast,<sup>1</sup>] [whereas, ethanol is exclusively produced through fermentation.<sup>2</sup>]

☒ ☐ I have stated why measuring carbon dioxide is not appropriate.<sup>1</sup>

☒ ☐ I have stated why measuring ethanol is appropriate.<sup>2</sup>

- 11 g** [The hypothesis would be refuted if test tubes 1 or 2 had lower ethanol concentrations than test tube 3<sup>1</sup>] [as tubes with NADH present (i.e. tubes 1 and 2) should produce less acetyl-CoA, forcing the yeast cells to undergo fermentation which leads to to greater production of ethanol.<sup>2</sup>]

Other acceptable responses:

- The hypothesis would be rejected if there was no difference in ethanol concentration between the test tubes.
- The hypothesis would be rejected if the concentration of ethanol was not lowest in test tube 3, followed by test tube 2, then test tube 1.

☒ ☐ I have stated what would refute the hypothesis.<sup>1</sup>

☒ ☐ I have explained why it refutes the hypothesis.<sup>2</sup>

