

YEAR 12 *Trial Exam Paper*

2020

BIOLOGY

Written examination

Reading time: 15 minutes

Writing time: 2 hours 30 minutes

STUDENT NAME:

QUESTION AND ANSWER BOOK

Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	40	40	40
B	11	11	80
			Total 120

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.
- No calculator is allowed in this examination.

Materials supplied

- Question and answer book of 43 pages
- Answer sheet for multiple-choice questions

Instructions

- Write your **name** in the box provided above and on the multiple-choice answer sheet.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- All written responses must be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

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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 book are **not** drawn to scale.

Question 1

An experiment was conducted to observe osmosis using salt solutions and cylinders of potato. The following data was collected.

Initial length of potato cylinder (mm)	Final length of potato cylinder (mm)
40	36

Which one of the following explains the observed change in the length of the potato cylinder?

	Direction of water movement	Reason for water movement
A.	Water diffused out of the potato cells.	The salt solution was hypertonic compared with the cytosol.
B.	Water diffused into the potato cells.	The salt solution was hypertonic compared with the cytosol.
C.	Water diffused out of the potato cells.	The salt solution was hypotonic compared with the cytosol.
D.	Water diffused into the potato cells.	The salt solution was hypotonic compared with the cytosol.

Question 2

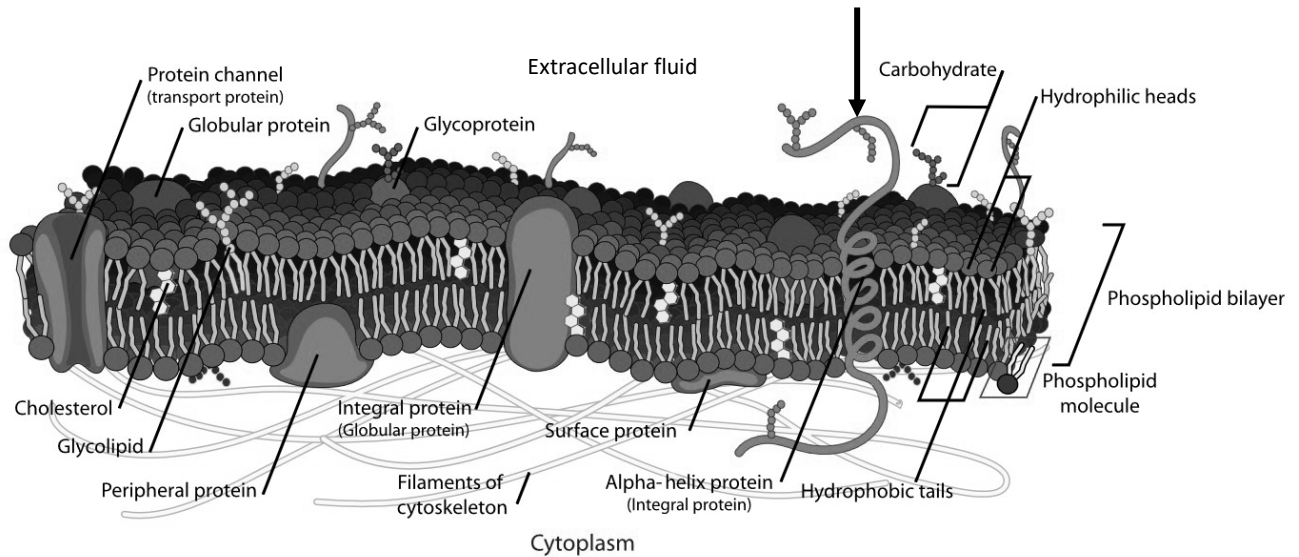
An experiment was conducted to determine the effect of pH and temperature on the action of human salivary amylase, an enzyme that breaks down starch into simple sugars. Four different test tubes, A, B, C and D, were used. The table below shows the conditions in each test tube.

In which of the test tubes would starch be broken down the fastest?

	pH	Temperature (°C)
A.	5	27
B.	7	27
C.	9	37
D.	7	37

Use the following information to answer Questions 3 and 4.

The diagram below represents the plasma membrane of an animal cell.



Source: Image by [Clker-Free-Vector-Images](https://pixabay.com/users/Clker-Free-Vector-Images-3736/?utm_source=link-attribution&utm_medium=referral&utm_campaign=image&utm_content=41522) from [Pixabay](https://pixabay.com/?utm_source=link-attribution&utm_medium=referral&utm_campaign=image&utm_content=41522)

Question 3

The diagram shows a range of proteins, including protein channels, peripheral proteins, glycoproteins, surface proteins and integral proteins.

It would be reasonable to assume that

- these proteins represent the entire proteome for this cell.
- the three-dimensional structure of each type of protein differs from all of the other types.
- all of these proteins were produced due to the expression of the same master gene.
- the functional diversity of the proteins is caused by the position that they occupy in the plasma membrane.

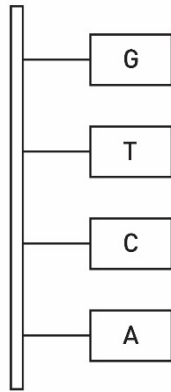
Question 4

The level of hierarchy in the integral protein indicated by the arrow is

- primary.
- secondary.
- tertiary.
- quaternary.

Question 5

The diagram below shows a short section of DNA with four bases identified.

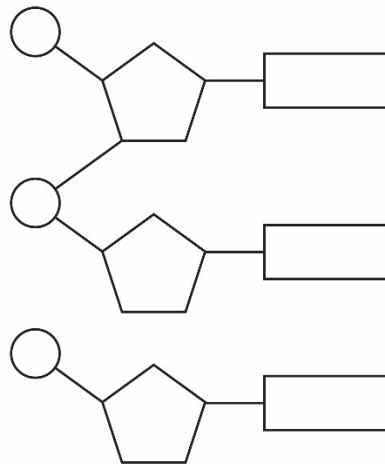


If this section of DNA were to be transcribed, the sequence of the strand produced would be

- A. GTCA.
- B. GUCA.
- C. CAGT.
- D. CAGU.

Question 6

The diagram below represents a nucleotide that is about to be joined onto two nucleotides which are bound together.



When the third nucleotide binds to the growing chain,

- A. ATP energy will be released.
- B. a polypeptide will be produced.
- C. a molecule of water will be released.
- D. the ribosome facilitating the reaction will release the polymer.

Question 7

Human enzymes stop functioning in temperatures above 50 °C.

This occurs because

- A. high temperatures alter the structure of the substrate.
- B. the shape of the active site of the enzyme will be altered.
- C. high temperatures damage cells, preventing them from secreting enzymes.
- D. substrate molecules have too much kinetic energy for the enzyme to bind to.

Question 8

The initial product of transcription is a primary transcript of RNA. This is followed by RNA processing, which results in the production of a mature mRNA molecule.

Which one of the following occurs during RNA processing?

- A. Splicing of mRNA fragments occurs in the cytosol.
- B. A polyA tail is joined to the end of the mRNA molecule.
- C. Exons are spliced together and introns are retained in the mRNA.
- D. The nucleotide sequences of the primary transcript and the mature mRNA are identical.

Question 9

A student is drawing a diagram of the *lac* operon system showing the effect of a repressor protein.

The repressor protein should be shown to be bound to the operon at the

- A. inducer.
- B. activator.
- C. operator.
- D. promoter.

Question 10

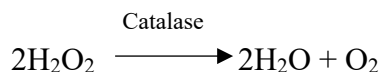
NADPH is an example of a coenzyme that has loaded and unloaded forms.

The role of NADPH is to transport

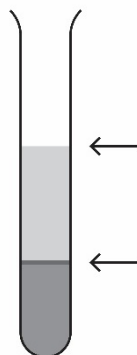
- A. electrons to the mitochondrial cristae.
- B. electrons and a proton from the grana to the stroma.
- C. and release the energy required for the photolysis of water.
- D. and release the energy required for the Krebs cycle.

Question 11

Catalase is an enzyme that facilitates the breakdown of hydrogen peroxide into water and oxygen gas, as in the following equation.



Four students conducted an experiment in which they measured the activity of the enzyme by using a ruler to measure the difference between the top of the peroxide solution and the top of the oxygen bubbles produced (these two points are indicated by the two arrows shown in the diagram below). Each of the students used identical equipment and chemicals under identical conditions.



The measurement obtained by each of the students is shown below. A statement from the conclusion written by each of the students has been provided.

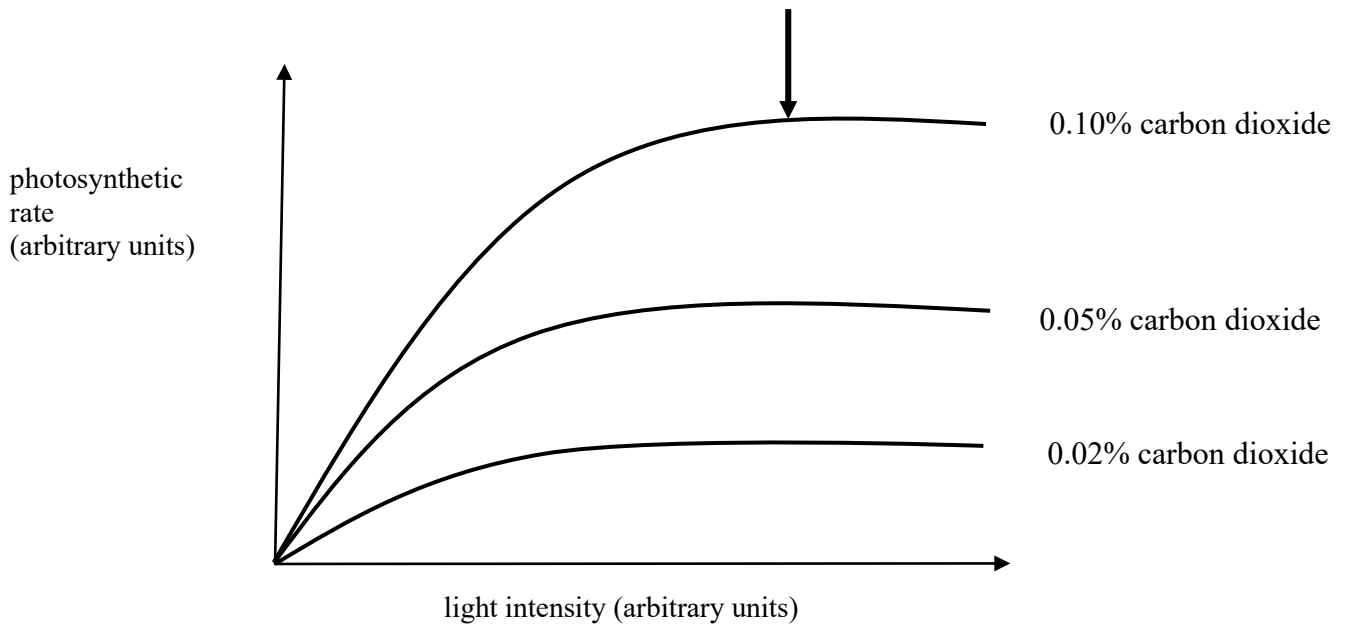
Student	Measurement (cm)
Boris	8.1
Francine	8.1
Kushal	8.0
Nina	7.4

Which student demonstrated a correct understanding of the results?

- A. Boris stated that the results were not reliable and that the experiment should be repeated.
- B. Francine stated that the results were not valid because all students should have used the same test tube instead of using different test tubes.
- C. Kushal stated that the results were not accurate because each student was of a different height and saw the points differently.
- D. Nina stated that the results were not precise because each of the values was a one-off finding.

Question 12

The graph below shows the effect that changing light intensity had on the photosynthetic rate at three different carbon dioxide concentrations. In each experiment the temperature was kept at 25 °C.



Consider the point indicated by the arrow.

What is the limiting factor for the photosynthetic rate at this point?

- A. light intensity
- B. surface area of the leaf
- C. environmental temperature
- D. carbon dioxide concentration

Question 13

Mitochondria and chloroplasts are both thought to have a bacterial origin.

This is based on the fact that both

- A. release energy via the electron transport chain.
- B. contain ribosomes that carry out protein synthesis.
- C. use carrier molecules to transport electrons from one area of the organelle to another.
- D. are structurally organised to maximise the surface area available for chemical reactions to occur.

Question 14

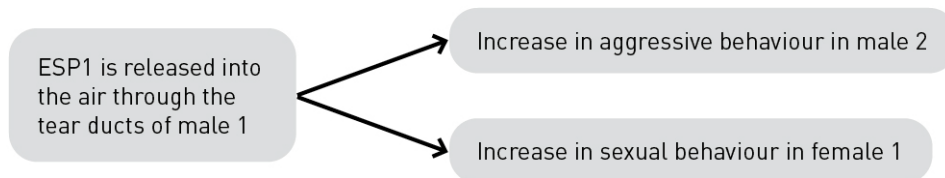
Cortisol, also known as the fight-or-flight response hormone, is a steroid that is released into the bloodstream by the adrenal gland.

Target cells are able to respond to cortisol because

- A. they have specific receptors for cortisol in their cytosol.
- B. they contain DNA to which the hormone binds, initiating translation.
- C. they have receptors for cortisol on the external surface of the plasma membrane.
- D. cortisol binds to ribosomes and causes them to produce proteins that trigger a cellular response.

Question 15

A study was conducted to determine the effect of the chemical ESP1 in mice. The diagram below shows the effect of this chemical, which is released through the tear ducts of male mice.

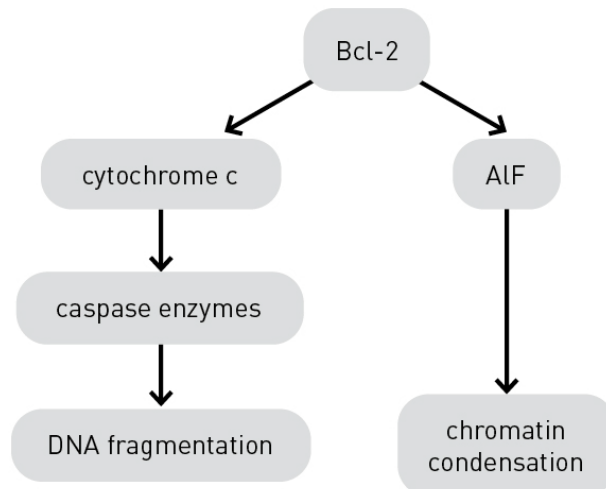


Based on the information provided, which one of the following statements is correct?

- A. ESP1 must act by entering the bloodstream of male and female mice.
- B. ESP1 can only affect other mice if they are in the same cage as male 1.
- C. This is an example of a pheromone that triggers responses in members of the same species.
- D. This is an example of a hormone that binds to different receptors in males and females.

Question 16

The diagram below shows a summary of some of the events and chemicals associated with apoptosis.



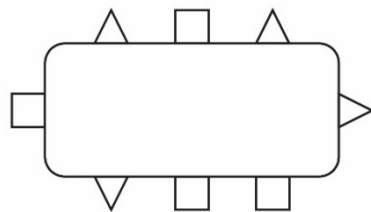
B-cell lymphoma-extra large protein (Bcl-xL) is a transmembrane protein located in mitochondria. Bcl-xL prevents the release of cytochrome c into the cytosol.

Based on the information provided, the action of Bcl-xL

- A. inhibits apoptosis because caspase activation is prevented.
- B. inhibits apoptosis because the secretion of Bcl-2 will increase.
- C. stimulates apoptosis because it triggers the condensation of chromosomes.
- D. stimulates apoptosis because it facilitates initiation of apoptosis via the mitochondrial pathway.

Question 17

The diagram below shows a bacterium and the shape of some proteins located on its external surface.



Consider the diagram.

Which one of the following statements is correct?

- A. The bacterium can produce a second antigen after the first is detected.
- B. The different surface proteins are the result of the expression of different structural genes.
- C. The presence of two surface antigens enables the bacterium to evade specific immune responses.
- D. A person could produce three different antibodies, all of which would be specific for the bacterium.

Question 18

Antidiuretic hormone (ADH) is produced in the hypothalamus and released into the bloodstream from the pituitary gland. The table below shows the responses of some of the tissues that are exposed to ADH.

Liver	Kidneys	Small intestine	Heart
no response	collecting tubules become more permeable to water	no response	no response

Consider the information provided.

The most likely reason for these results is that the kidneys

- A. are able to filter ADH out of the bloodstream.
- B. contain the only cells with a receptor for ADH.
- C. must have secreted an enzyme that activates ADH.
- D. are responsible for breaking down ADH, thereby preventing it from reaching and affecting cells in other tissues.

Question 19

The Sydney funnel-web spider is highly venomous and can cause death in as little as 15 minutes. However, no deaths have been recorded since 1981, partly because organisations such as the Australian Reptile Park milk the funnel-web spider's venom.

Which one of the following correctly describes a use for this milked venom?

- A. The venom is injected into bite victims.
- B. The venom is injected into animals to create spider venom antigens.
- C. The venom is used to agglutinate and remove the venom from bite victims.
- D. The venom is used to produce antibodies against the spider venom toxin, which are then provided to bite victims.

Question 20

A child is vaccinated against diphtheria.

Which one of the following correctly describes the result of the vaccination?

- A. active immunity with memory cells produced
- B. passive immunity with memory cells produced
- C. active immunity with no memory cells produced
- D. passive immunity with no memory cells produced

Question 21

Glycolysis is an anaerobic process that occurs in the cytoplasm of eukaryotic and prokaryotic cells.

The net yield of glycolysis is

- A. 2 lactic acid.
- B. 2 ethanol and 2 carbon dioxide.
- C. 2 ATP, 2 pyruvate and 2 NADH.
- D. 4 ATP, 1 pyruvate and 2 NADH.

Question 22

Consider the information below showing the changes in allele frequency in a population of mice over 10 generations. A pack of foxes moved into this area after the second generation.

Key A = light brown fur

a = black fur

Mice that are homozygous (AA) will have light brown fur.

Mice that are heterozygous (Aa) will have light brown fur.

Mice that are homozygous (aa) will have black fur.

First generation		Fifth generation		Tenth generation	
AA	aa	AA	AA	AA	AA
AA	aa	AA	Aa	AA	AA
AA	aa	AA	Aa	AA	AA
AA	aa	AA	aa	AA	Aa
Aa	aa	AA	aa	AA	Aa

Based on the data provided, it would be correct to conclude that

- A. the mice are acclimatising to the presence of the foxes.
- B. the allele for black fur has been eliminated from the population.
- C. the trait of having light brown fur has provided a selective advantage.
- D. individuals with the aa genotype had a selective advantage after the first generation.

Question 23

A molecular clock is an example of a technique that is used to determine the degree of relatedness between species.

An example of a molecular clock is

- A. mitochondrial DNA, which accumulates mutations at a known rate.
- B. the genetic instructions that initiate replication of DNA molecules.
- C. a gene that is only located on the X chromosome in mammals.
- D. a specialised form of RNA that is used to compare the degree of similarity between different species.

Question 24

Fossilised dinosaur faeces are also known as coprolite. By studying these fossils, scientists can find out what the dinosaurs might have eaten.

These fossils are referred to as

- A. trace fossils.
- B. indicator fossils.
- C. true form fossils.
- D. preserved remains.

Question 25

Allopatric speciation occurs as a result of natural selection over time.

Which one of the following events is **not** part of this evolutionary process?

- A. Exposure to constantly changing novel environments leads to acclimatisation in a population.
- B. Geographically isolated populations gradually evolve different adaptations in response to novel environments.
- C. Genetic and phenotypic changes will occur in subpopulations that are geographically isolated for many generations.
- D. Reproductive isolation eventually occurs as a result of the accumulation of genetic changes associated with different populations adapting to novel environments.

Question 26

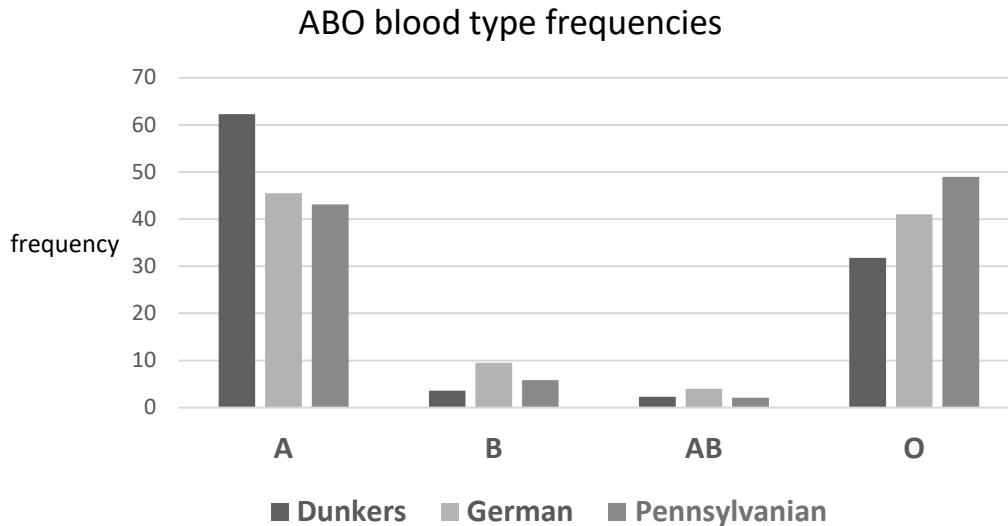
The La Brea Tar Pits are located in Los Angeles and contain the fossilised remains of many different species of organisms. These fossils are estimated to be between 10 000 and 50 000 years old. One of the problems with these fossils is that the bones are completely permeated with tar, displacing the carbon-14. The churning action of the tar has mixed remains together, rather than enabling them to settle.

In these circumstances, scientists would find it difficult to

- A. carry out relative dating only.
- B. carry out absolute dating only.
- C. carry out both relative dating and absolute dating.
- D. determine the number of species initially present.

Question 27

The Dunkers are the descendants of a group of 50 families who emigrated from Germany to Pennsylvania in the United States early in the 18th century. The Dunkers tend to intermarry between related families. A study was performed in which the frequencies of blood types in the modern populations of Dunkers was compared with that of the modern German population and the modern population of non-Dunkers who live in Pennsylvania. The results are shown in the graph below.



The difference in the frequencies of type A and type O blood are considered to be significant.

Using your knowledge and the information in the graph, which one of the following is the most likely cause of the difference in frequencies?

- A. There is a selective disadvantage in having type AB and type B blood.
- B. The Dunker population has inherited type O blood from the Pennsylvanian population.
- C. The Dunker population is completely unrelated to the modern German population.
- D. The ancestors of the Dunker population had significantly different frequencies of type A and type O blood than the ancestors of the modern German population.

Question 28

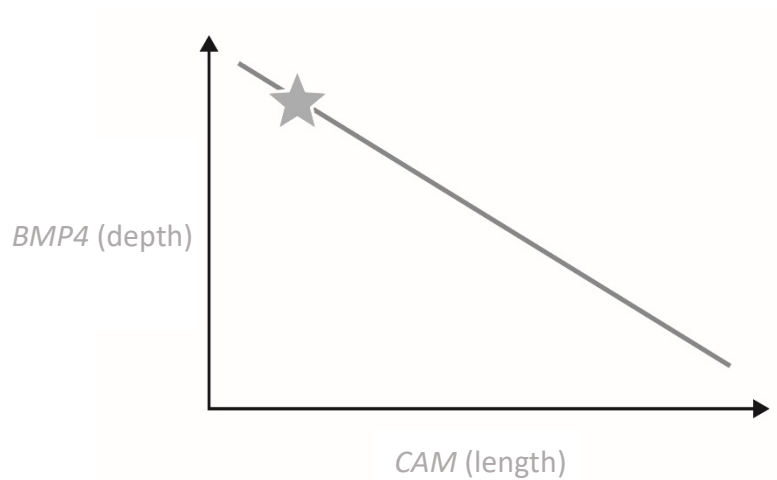
Non-disjunction is an event that can occur during meiosis. During meiosis, a pair of chromosomes sometimes fail to separate. One of the conditions caused by non-disjunction is Klinefelter syndrome, where an individual has two X chromosomes and one Y chromosome.

This condition is an example of

- A. polyploidy.
- B. aneuploidy.
- C. duplication.
- D. translocation.

Question 29

The *BMP4* and *CAM* genes are responsible for the depth and length of the beaks of Darwin's finches. The position of the star on the graph below relates to a species of finch called *Geospiza magnirostris*.



Based on the information supplied, the beak of *G. magnirostris* would be

- A. long and deep.
- B. short and deep.
- C. long and shallow.
- D. short and shallow.

Question 30

Research was conducted in which the genomes and proteins from many different species of reptiles and birds were compared with each other. The evidence suggested that the greatest degree of similarity was between crocodiles and turtles.

Which one of the following conclusions can be reached?

- A. Both types of species have stopped evolving.
- B. The proteome for both types of species must be identical.
- C. The two types of species share a recent common ancestor.
- D. Both types of species must have the same number of chromosomes.

Question 31

Australian marsupials are an example of the outcomes of adaptive radiation. Many species have been determined to have descended from a common ancestor. These include:

- Tasmanian tigers and Tasmanian devils
- possums and sugar gliders
- kangaroos and wallabies.

Which one of the following events would cause the highest rate of adaptive radiation?

- A. New species migrate into a region.
- B. Individuals migrate from one population to another.
- C. The size of a population decreases after a natural disaster.
- D. A species colonises a new area with many niches available.

Question 32

The following steps occur during gene cloning.

Step 1: The gene for human insulin production is isolated using restriction enzymes.

Step 2: A bacterial plasmid is cut open using restriction enzymes.

Step 3: The human gene is inserted into the plasmid.

Step 4: DNA ligase is used to seal the plasmid.

Step 5: The plasmid is taken up by a bacterium.

In which steps it is necessary for sticky ends to be produced?

- A. steps 1 and 2
- B. steps 3 and 4
- C. steps 3, 4 and 5
- D. steps 1, 2 and 3

Question 33

Paleoanthropologists study the origins and development of early humans. The following features might be observed in the fossils of primates.

- I the bone structure of the pelvis
- II the position of the foramen magnum
- III the parabolic shape of the jaw
- IV a divergent big toe.

Which of these would a paleoanthropologist use to determine if a primate was bipedal?

- A. I only
- B. I and II
- C. II and IV
- D. I, II and III

Question 34

Homo sapiens moved into Europe approximately 32 000 years ago. Initially, it was believed that all members of *Homo neanderthalensis* were replaced and wiped out very quickly, but there is now evidence that *H. sapiens* coexisted with *H. neanderthalensis* for at least 5000 years before the Neanderthals disappeared. This is supported by discoveries relating to cultural evolution for both species in the same location.

Consider the information provided.

Which one of the following is an example of suitable evidence?

- A. finding animal remains that are 28 000 years old
- B. finding charcoal carbon dated as being 29 000 years old
- C. finding cave paintings produced by members of both species
- D. finding tools produced by Neanderthals carbon dated as being 27 000 years old

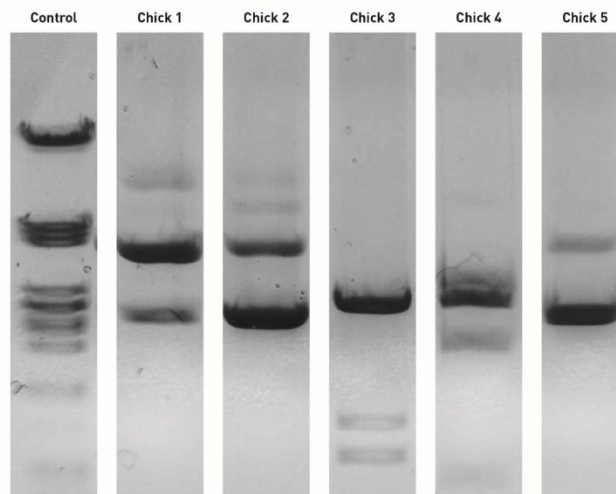
Use the following information to answer Questions 35 and 36.

In 2006, scientists were investigating genes that affect organ development in embryonic chickens. One of the scientists noticed that one of the embryos had developed teeth.

Chickens have a gene called *talpid*² that activates a gene called *shh*. The *shh* gene is essential for tooth production. Normally, *shh* is active in tissues on the sides of the beak. However, this embryo had a mutated version of *talpid*² that caused the *shh* gene to be active in the centre of the beak, resulting in the formation of teeth. The mutated form of the gene was found to be longer than the normal form of the gene.

Question 35

Samples were taken from five embryo chicks. DNA was extracted and electrophoresis was performed. The image below shows the gel that was produced.



Source: 'Gel electrophoresis' by user Mnolf, available at https://commons.wikimedia.org/wiki/File:Gel_electrophoresis_2.jpg under a Creative Commons Attribution-Share Alike 3.0 license. This image has been altered. Full terms at <https://creativecommons.org/licenses/by-sa/3.0/deed.en>

Based on the information in the image, which one of the chicks would have been expected to develop teeth?

- A. chick 4 only
- B. chicks 3 and 4
- C. chicks 1, 2 and 3
- D. chicks 1, 2 and 5

Question 36

The mutated form of the *talpid*² gene was inserted into the genome of other embryonic chickens and it was established that they also developed teeth.

The most appropriate way to describe these chickens is that they are

- A. transgenic.
- B. recombinant.
- C. artificially selected.
- D. genetically modified.

Question 37

Human epidermal growth factor receptor 2 (HER2) has been found to promote the growth of cancer cells in aggressive forms of breast cancer. Kadcyla is one of the drugs used in the treatment of breast cancer. Kadcyla contains small quantities of a chemotherapy drug linked to a monoclonal antibody that is specific for HER2.

This approach is seen as superior to standard chemotherapy treatment because

- A. patients only need to take one drug instead of many.
- B. the antibody binds to and neutralises HER2.
- C. the chemotherapy drug is delivered directly to the cancer cells.
- D. patients taking Kadcyla are not exposed to radioactive chemicals.

Question 38

Rational drug design is a technique that began in the 1960s.

The main goal of rational drug design is to

- A. produce antiviral drugs because antibiotics are ineffective against viruses.
- B. produce therapeutic drugs that will bind to specific target molecules.
- C. study the structure of surface proteins so that they can be synthesised.
- D. produce drugs that enable scientists to identify pathogens that cause specific diseases.

Question 39

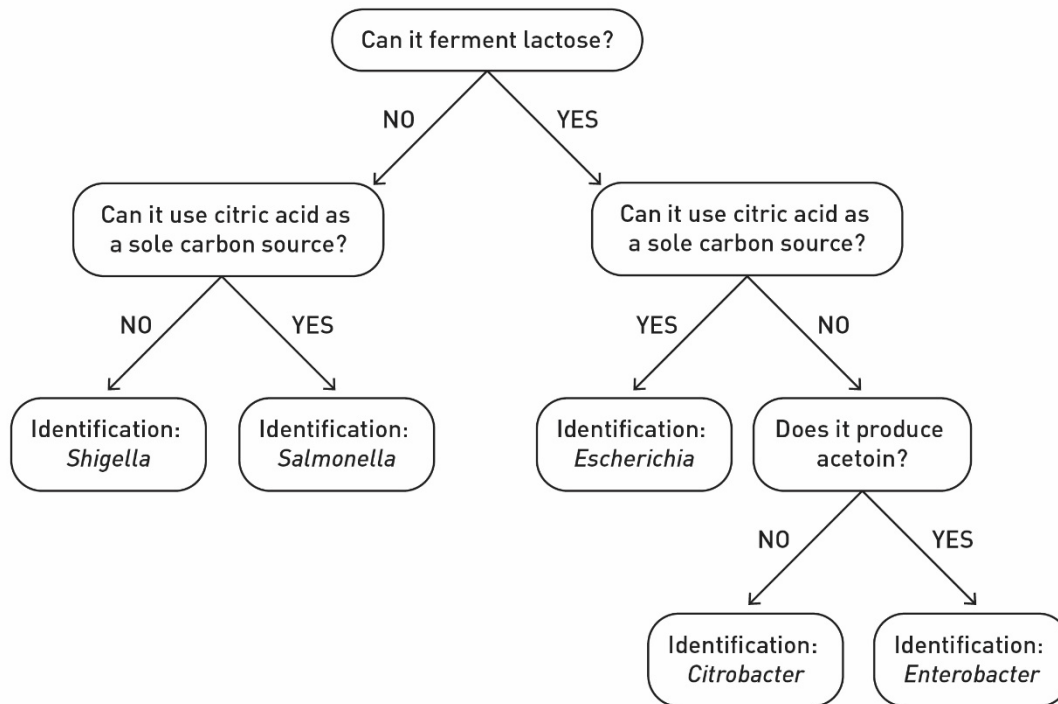
Strategies to deal with the emergence of new diseases have been grouped into broad categories.

Which broad category would ‘developing tools for identifying and understanding how the emerging pathogens cause infectious diseases’ fit into?

- A. prevention and control
- B. carrying out and applying research
- C. providing training and infrastructure
- D. improving surveillance and response

Question 40

Biochemical tests are performed to identify different species of bacteria. The flow chart below shows a series of these tests and identifies five different species of bacteria.



A species of bacteria is unable to ferment lactose, is able to use citric acid as a sole carbon source and does not produce acetoin.

Based on the results of these tests, the bacteria has to be

- A. *Shigella*
- B. *Salmonella*
- C. *Escherichia*
- D. *Citrobacter*

**END OF SECTION A
TURN OVER**

SECTION B

Instructions for Section B

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

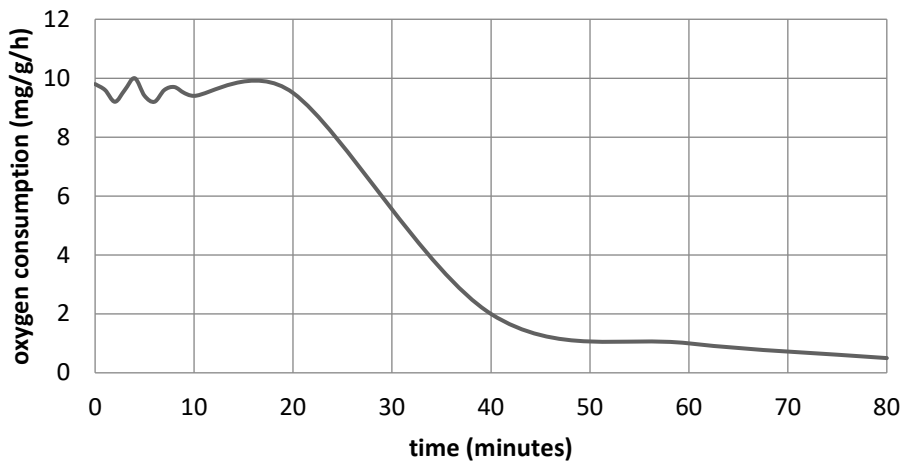
Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1 (8 marks)

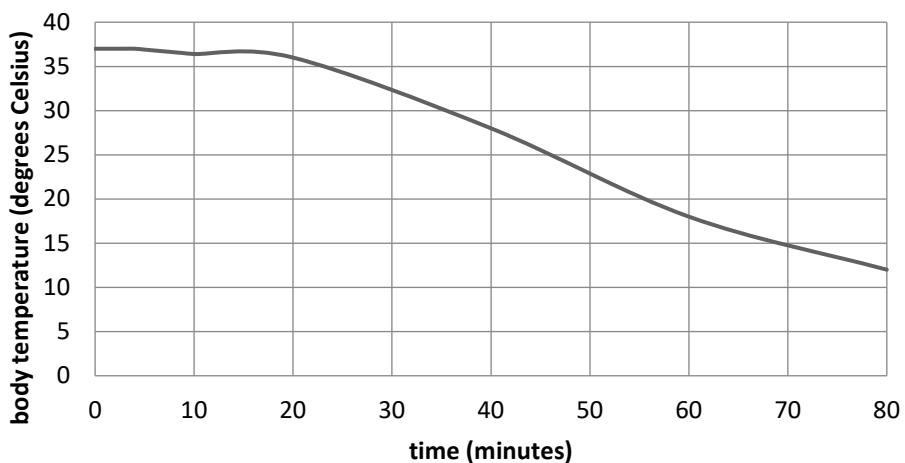
Hummingbirds have the fastest metabolism of all living organisms, eating up to three times their own mass per day.

The two graphs below show the change in oxygen consumption over time and the corresponding change in temperature in a hummingbird.

Oxygen consumption over time



Temperature over time



- a.** Identify what happens to a hummingbird's body temperature as oxygen consumption decreases. Explain why this occurs.

2 marks

Hummingbirds are unable to meet their energy requirements when resting or asleep, so when they need to rest they experience a condition called 'torpor'. During this time, their heart rate slows from 500 beats per minute to less than 50 beats per minute, and they may also stop breathing.

- b.** Consider the graph 'oxygen consumption over time' on page 20.

Using the data to support your answer, describe at what point the hummingbird would have begun to go into torpor.

2 marks

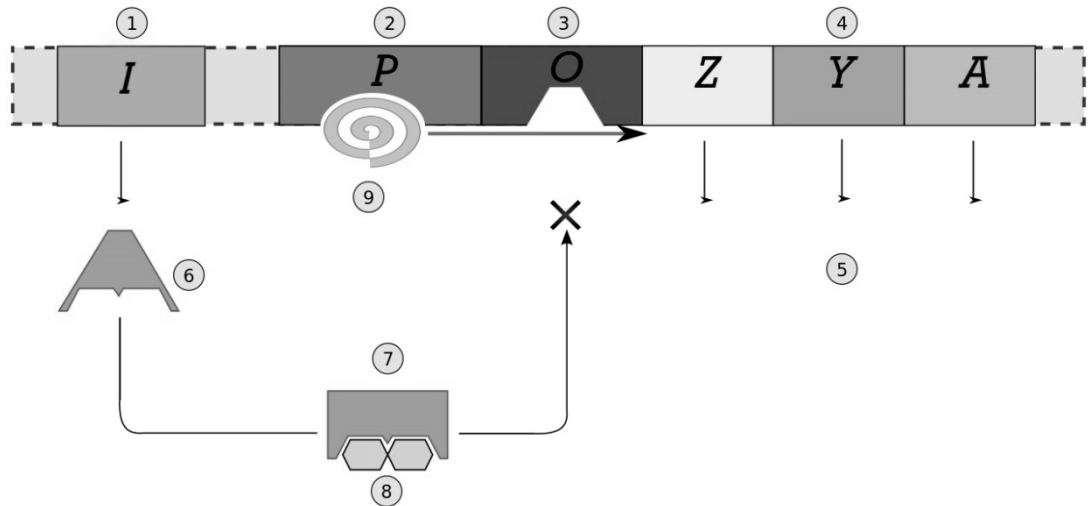
- c.** Identify two factors that will affect the hummingbird's rate of cellular respiration when it goes into torpor. Identify what will happen to the rate of cellular respiration and explain why this change will occur.

4 marks

Question 2 (6 marks)

Bacteria prefer to obtain energy by metabolising glucose, however, if lactose is present, then a bacterium is able to express the genes that code for enzymes that enable the bacterium to metabolise lactose. These genes are referred to as the *lac* operon. The diagram below represents the *lac* operon.

- *LacZ* codes for the enzyme β -galactosidase.
- *LacY* codes for the enzyme β -galactoside permease.
- *LacA* codes for the enzyme β -galactoside transacetylase.



Source: 'Operon presence lactose numeros' by User NicolasGrandjean available at https://commons.wikimedia.org/wiki/File:Operon_presence_lactose_numeros.svg under a Creative Commons Attribution-Share Alike 3.0 license. Full terms at <https://creativecommons.org/licenses/by-sa/3.0/deed.en>

a. Identify the two conditions that are necessary to trigger the expression of the *lac* operon genes.

1 mark

- b.** Explain how the sections of the diagram labelled 6, 7 and 8 play an essential role in regulating the expression of the *lac* operon.

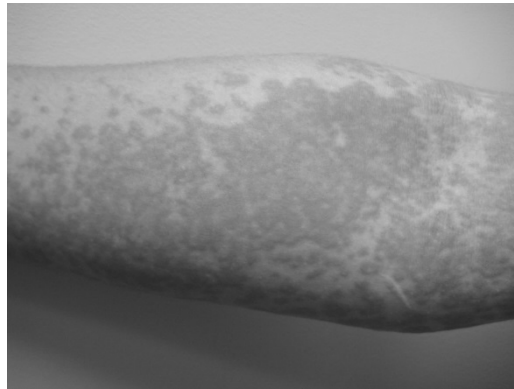
2 marks

- c.** Using the information provided, identify an example of a structural gene and a regulatory gene. Describe the functional difference between these types of genes.

3 marks

Question 3 (8 marks)

A 12-year-old boy recently developed symptoms including constant sneezing, watery eyes and a rash, such as the one shown in the image below. He was diagnosed as having an allergic response to an unknown substance.



Source: 'Emminor2010' by User James Heilman, MD available at <https://en.wikipedia.org/wiki/Hives#/media/File:EMminor2010.JPG> under a Creative Commons Attribution-Share Alike 3.0 license. Full terms at <https://creativecommons.org/licenses/by-sa/3.0/deed.en>

The boy was sent to have a scratch test, which involves pricking the skin and inserting a small amount of an allergen into the skin. These allergens can include a common allergen, such as peanuts, as well as samples from household substances, such as soap and washing powder. When an allergen is applied to the skin it causes a swollen mark, called a weal. The diameter of the weal is an indication of the degree of response to the allergen. Any diameter over 8 mm is a positive result.

The table below shows the results of the boy's scratch test.

Substance	histamine	soap	dust	garlic	shampoo	cat fur	washing powder	dog fur
Weal size (mm)	12	1	5	1	3	4	2	15

- a. Why is the substance that causes an allergic response referred to as an allergen rather than an antigen?

1 mark

- b.** People are not allergic to histamine, although it is usually included in scratch tests. This boy's response to histamine is normal.

Identify a reason for including histamine in the scratch test.

1 mark

- c.** The family had acquired a puppy and a kitten about three weeks before the child began showing symptoms. The parents want to know why the boy did not show symptoms immediately after these pets were brought into the house.

Create a detailed flow chart to explain how allergic reactions occur and why the allergic reaction did not occur sooner.

4 marks

- d.** Identify a chemical that is used to treat this condition. Explain why this chemical would be prescribed.

2 marks

Question 4 (7 marks)

Australia has a standard vaccination schedule that lists all of the vaccinations required for young children and the age at which these vaccinations should occur. The majority of vaccines are provided before a child reaches the age of 18 months.

The table below shows the list of vaccines required at 2 months and 4 months.

2 months	4 months
Hepatitis B Diphtheria Tetanus Acellular pertussis (whooping cough) Haemophilus influenza type B Polio Pneumococcal Rotavirus	Hepatitis B Diphtheria Tetanus Acellular pertussis (whooping cough) Haemophilus influenza type B Polio Pneumococcal Rotavirus

Source: <https://www.health.gov.au/health-topics/immunisation/immunisation-throughout-life/national-immunisation-program-schedule>

The table below shows how some of these diseases are spread.

Disease	whooping cough	polio	tetanus	haemophilus influenza
Method of transmission	airborne droplets	faecal–oral route	spores enter the body through a wound	airborne droplets

In 2009, an American man won a lawsuit against a drug maker, claiming that he had contracted polio 30 years earlier from the vaccine that had been given to his infant daughter. This vaccine was a live vaccine and it is claimed that he became infected after changing her nappy.

- a.** Using the information provided, identify one action that the man could have taken so that he would not have become infected.

Why might this action have prevented him from becoming infected?

2 marks

- b.** The Australian standard calls for an inactivated vaccine against polio. This means that it contains viral particles rather than live viruses.

Explain why inactivated vaccines provide immunity against viruses such as the polio virus.

1 mark

- c.** Assess the similarity of the vaccines provided at 2 months and 4 months.

What might be the purpose of this similarity?

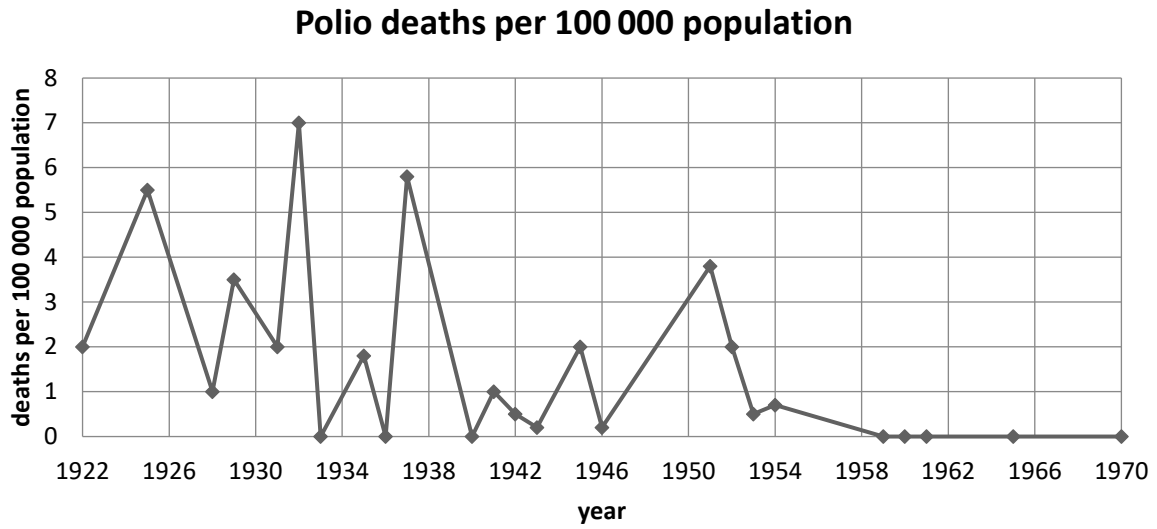
1 mark

- d.** The last known case of polio in Australia was in 2012, after an affected individual entered the country. An assessment to determine the risk of transmission was carried out and it was found that the risk of transmission was extremely low.

Identify the type of immunity that reduced the risk in this situation.

1 mark

The graph below shows the number of polio deaths in Australia per 100 000 population from 1922 to 1970.



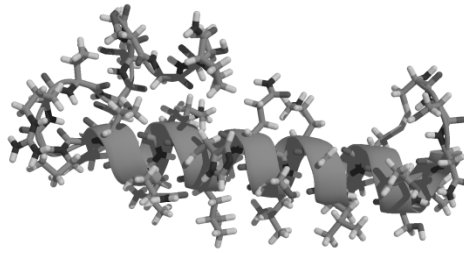
e. Consider the information provided.

Identify the trend in the rate of deaths from 1954 to 1970. Give a reason to explain why this trend occurred.

2 marks

Question 5 (6 marks)

Calcitonin is an example of a signalling molecule produced by humans. It is a peptide hormone consisting of 32 amino acids.



Calcitonin is released into the bloodstream by the thyroid gland. One of the functions of the kidneys is to prevent the loss of calcium in urine. Calcitonin binds to cells in the tubule of the kidneys and inhibits the ability of the body to reabsorb calcium ions.

- a. Briefly describe what happens during the process of gene expression responsible for the synthesis of calcitonin.

2 marks

Process	What happens during this process

- b. Identify how calcitonin is secreted by thyroid gland cells.

1 mark

- c. The stimulus-response model is used to identify and explain cellular responses to signalling molecules.

Explain each of the three stages of the stimulus-response model as it applies to the action of calcitonin.

3 marks

Stage	What happens during this stage

Question 6 (8 marks)

The cardinal, *Cardinalis cardinalis*, is a small bird located in North and South America. These birds are noted for their red feathers, distinctive crest and face mask. In 2018, a yellow cardinal was sighted in Alabama.

The cardinal birds get their distinctive red colouring by converting yellow chemicals (carotenoids) in their food into red chemicals (ketocarotenoids) in their feathers. This transformation is carried out by an enzyme called a ketolase, and takes place mostly in the skin and liver.



Source: <https://pixabay.com/photos/cardinal-bird-red-holly-berries-2872966/>

- a. Draw a diagram showing the role of ketolase in the biochemical pathway that causes cardinal birds to develop red feathers.

1 mark

The synthesis of ketolase is governed by the expression of the gene *CYP2J19*. This gene is necessary in the skin and liver for a bird to show red colouration. Samples from the eyes, liver and skin were obtained from three birds. These samples were tested for the presence of the *CYP2J19* gene, with the presence of the gene being indicated by the presence of a band in the gel.

	Bird 1 Eyes	Bird 1 Liver	Bird 1 Skin	Bird 2 Eye	Bird 2 Liver	Bird 2 Skin	Bird 3 Eye	Bird 3 Liver	Bird 3 Skin

_____	_____			_____	_____	_____	_____	_____	

- b. Which of the birds tested for the *CYP2J19* gene would display the standard red colouration of the cardinal bird? Use the data to justify your answer.

2 marks

The yellow colour of the cardinal bird may be due to environmental stress or a poor diet. If this is the case, then once the health of the bird improves it will lose its yellow feathers the next time it moults and it will regrow red feathers. If the bird remains yellow, then the colouration is more likely to have been caused by a mutation of the *CYP2J19* gene.

The table below summarises the genetic code.

		Second letter				
		U	C	A	G	
First letter	U	UUU] phe UUC] UUA] leu UUG]	UCU] UCC] ser UCA] UCG]	UAU] tyr UAC] UAA STOP UAG STOP	UGU] cys UGC] UGA STOP UGG trp	U C A G
	C	CUU] CUC] leu CUA] CUG]	CCU] CCC] pro CCA] CCG]	CAU] his CAC] CAA] CAG] gln	CGU] CGC] arg CGA] CGG]	U C A G
	A	AUU] AUC] ile AUA] AUG met	ACU] ACC] thr ACA] ACG]	AAU] asn AAC] AAA] AAG] lys	AGU] ser AGC] AGA] arg AGG]	U C A G
	G	GUU] GUC] val GUA] GUG]	GCU] GCC] ala GCA] GCG]	GAU] asp GAC] GAA] GAG] glu	GGU] GGC] gly GGA] GGG]	U C A G

Sections of the *CYP2J19* gene were compared. Sample 1 is from a bird with red colouration. Sample 2 is from a bird with yellow colouration.

Sample 1	TAC GTA GCG GAT TCA CAG GCT
Sample 2	TAC GTA GCG AAT TCA CAG GCT

- c. Using the information provided, explain the yellow colouration of the bird in Sample 2. Justify your answer.

2 marks

- d. Canaries were discovered in the 14th century. Initially, the canaries were a dull green colour, but they were bred for a variety of colours ranging from black to bright yellow. Yellow canaries have a lineage back to some canaries that were pale yellow.

Identify the process that resulted in the bright yellow canaries. Explain how this was accomplished.

2 marks

- e. People also wanted to have red canaries but were unable to breed them. In the 1920s canary breeders turned to a closely related species, the red siskin. They mated canaries with siskins, selected offspring with red feathers and only a few siskin traits and bred them back with canaries. After many generations, the result was the red factor canary, which looks like a canary but has red feathers. This strain is viable and able to breed with any other canaries as well as with siskins.

A scientist is quoted as saying, ‘the canary thus became the first animal that was purposely genetically modified by moving the genes from another species into it.’

Do you agree with this statement? Provide a justification for your answer.

1 mark

Question 7 (8 marks)

Thermophis baileyi (Bailey's snake), also called the Tibetan hot-spring snake, is a species that is only found living high in the mountains in Tibet at altitudes above 4000 metres. Another high-altitude snake, *Thermophis zhaoermii*, has been discovered living in the Sichuan province of China. These two species are separated by the Tibetan Plateau.

Although the surrounding environment is cold, these species of snake survive by living near thermal hot springs. After extensive analysis, it was determined that the closest relatives of the *Thermophis* genus of snakes were found to be the tropical snakes living in South America. It is believed that the common ancestor of the *Thermophis* snakes and the South American snakes lived in Asia about 30 million years ago when the Bering land bridge connected Asia and North America.

In the past, analysis of evolutionary relationships between different species of snake were based on details such as the shape, position and number of scales on the head, back and belly. However, modern advances in molecular biology have led to different means of determining the relatedness between different species.



- a. What term is applied to the physical features, such as scales, that are used to determine relatedness between species?

1 mark

- b. Give an example of an advance in molecular biology that is used to determine relatedness between species. Explain how the technique that you identified is used to determine the degree of relatedness between different species.

2 marks

- c. Explain how the Bailey’s snake developed into a species that is different from the South American snakes.

3 marks

- d. The *Thermophis* genus of snakes remains difficult to classify. One of the reasons for this is that they have no close living relatives.

Give **one** reason to explain why snakes of the *Thermophis* genus have no close living relatives.

1 mark

- e. The *Thermophis* genus of snakes have unique adaptations that enable them to survive by living near hot springs. The South American snakes do not have these adaptations.

Give **one** plausible reason to explain why this has occurred.

1 mark

Question 8 (6 marks)

During the course of excavations between 2010 and 2015, remains of a hominin species were found on Luzon Island in the Philippines. These included seven teeth, two hand bones, three foot bones and one thigh bone. These bones are thought to have belonged to two adults and one child.

The bones from this species, named *Homo luzonensis*, have been dated as being between 50 000 and 67 000 years old. This puts these individuals in Asia at a time when *Homo sapiens* and *Homo neanderthalensis* were colonising Europe and just beginning to extend into Asia.

The fossils have been referred to as having an unexpected mix of both ancient and modern hominin traits. As an example, the feet resemble those of *Australopithecines*, a genus of hominin from Africa dating approximately three million years ago.

- a. Identify a structural difference between the foot structure of *H. luzonensis* and *H. sapiens*. Discuss a specific functional difference that members of *H. luzonensis* would have had compared to *H. sapiens*.

2 marks

- b. Information about this new species was released in April 2019.

How do discoveries such as finding the bones of *H. luzonensis* affect our understanding of the human fossil record?

1 mark

A deer bone that has stone tool cut marks was found in the same layer of sediment as the foot bones from *H. luzonensis*.

- c. Identify the significance of the hominin fossils and the butchered deer bone being found in the same layer of sediment.

1 mark

- d. What type of evolution is demonstrated by the presence of the deer bone?

1 mark

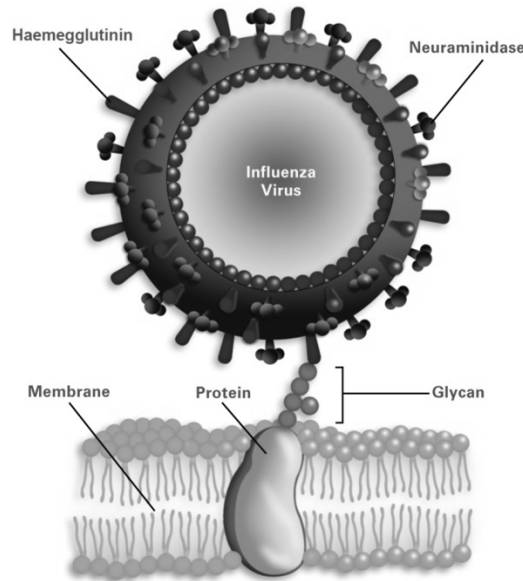
- e. Upon reconstruction, it was determined that *H. luzonensis* would have been less than 1.2 metres tall. One hypothesis is that, instead of being a new species, the fossils were from a member of *H. sapiens* who had dwarfism.

Suggest **one** piece of evidence that could be used to refute this hypothesis.

1 mark

Question 9 (7 marks)

Neuraminidase is an enzyme located on the surface of a range of viruses including some that cause influenza. Neuraminidase enables the release of viruses from infected host cells. Relenza is a drug that has been designed to target neuraminidase.



a. Identify the term applied to the development of therapeutic drugs such as Relenza. 1 mark

b. Discuss the role and therapeutic benefit of Relenza. 2 marks

c. People who had the symptoms of influenza used to be prescribed antibiotics. Discuss the biological effectiveness of treating viral influenza with an antibiotic. Give a reason to support your answer. 2 marks

- d.** Some antibacterial drugs were designed to target the nucleic acids in bacterial ribosomes. An identified side effect of these drugs was that people became slightly ill and fatigued as a result of taking them.

Give **one** plausible reason why mitochondrial ribosomes may be affected by these drugs and explain why drugs targeting bacterial ribosomes could have caused the symptoms identified.

2 marks

Question 10 (7 marks)**Wollemi pines are dinosaur trees**

There's a tree that once covered the whole of Australia, then dwindled to a dozen examples, and is now spread around the world. We call it the Wollemi pine (*Wollemia nobilis*), but you could call it the dinosaur tree.

Fossil evidence indicates that between 200 million and 100 million years ago, Wollemi pine was present across all of Australia. A dryer, more flammable continent is likely to have driven the tree to near extinction over the millennia, leaving just a very small remnant of the Wollemi in a secluded deep gully not far from Sydney.

And there these trees remained, hidden, until they were discovered by a canyoning national park worker in 1994.

The reaction to the discovery of this tree, thought to have disappeared 100 million years ago and only known through its fossils, was spectacular.

...

There was a great sigh of relief when it was discovered that trees could be successfully cloned.

...

In 2006, just over a decade after the original discovery, huge numbers of cloned Wollemi pine seedlings were released from the official nursery in Queensland.

...

A potential issue with clonal reproduction is the lack of genetic diversity, which could make the pines susceptible to further environmental changes or pests. However, many trees are maturing and producing viable seeds, and there is certainly diversity in the phenology with some Wollemi of the same age producing female cones, some male cones (and some both).

Source: 'Wollemi pines are dinosaur trees' by Cris Brack, available at The Conversation, <https://theconversation.com/wollemi-pines-are-dinosaur-trees-98160>

- a.** Is it correct to state that the extreme decrease in the number of Wollemi pine trees is an example of a mass extinction? Include an explanation of what a mass extinction event is and provide a reason to support your answer.

2 marks

- b.** Identify an absolute dating technique that could have been used to determine the age of the Wollemi pine tree fossils.

1 mark

- c. Describe a specific disadvantage of cloning the Wollemi pine.

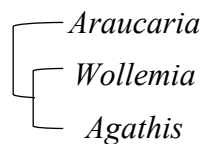
1 mark

- d. There are a range of ethical issues associated with cloning. However, many of these are not applied to cloning plants.

Explain why the idea of cloning an entire plant is generally accepted while cloning an entire human is not.

2 marks

- e. The Wollemi pine shares characteristics with *Araucaria* and *Agathis* species. Analysis of a range of nucleic acids including material from ribosomes, chloroplasts and mitochondria was conducted and used to construct the following phylogenetic tree.



Identify a conclusion that could be drawn based on the information in the phylogenetic tree.

1 mark

Question 11 (9 marks)

Leaves exposed to light carry out photosynthesis. A student performed an experiment in which they placed some elodea into a test tube containing water. This test tube was placed into a water bath that was kept at 25 °C.

The experiment was carried out in a dark room in which the only light source was a lamp. The light intensity was varied by changing the distance between the lamp and the plant.

The student counted the number of bubbles the plant produced under each condition over a period of one minute and recorded the information. This is shown in the table below.

Distance between lamp and plant (cm)	Number of oxygen bubbles per minute
10	28
20	15
30	10
40	3
50	1

- a. Describe the relationship between light intensity and the rate at which oxygen is produced.

1 mark

- b. In performing this experiment, the student has made an assumption about the bubbles. Identify the assumption. Why would they have made this assumption?

2 marks

- c. Suggest why the student used the water bath in this experiment.

1 mark

- d. The student was concerned about the precision of their results. They spoke with another student who advised them that the precision of the results could not be determined.

Explain the term 'precise'. Give **one** reason to show if the second student is correct.

2 marks

As a result of the conversation, the student decided to repeat the experiment in the same manner as before. The results are shown in the table below.

Distance between lamp and plant (cm)	Experiment 1: Number of oxygen bubbles per minute	Experiment 2: Number of oxygen bubbles per minute	Experiment 3: Number of oxygen bubbles per minute
10	28	27	20
20	21	20	29
30	14	15	14
40	6	6	6
50	2	1	2

- e. Upon analysing the data, the student realised that they must have made an error in the third experiment.

Identify the type of error that was made by the student and **one** source of error that may account for the results that they recorded.

2 marks

- f. Identify an action that the student could carry out to determine whether they had made an error or not.

1 mark

END OF QUESTION AND ANSWER BOOK