



INSIGHT

YEAR 12 Trial Exam Paper

2012

BIOLOGY

Written examination 1

STUDENT NAME:

QUESTION AND ANSWER BOOK

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>	<i>Suggested times (minutes)</i>
A	25	25	25	30
B	8	8	50	60
			Total 75	90

- Students are permitted to bring the following items into the examination: pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring sheets of paper or white-out liquid/tape into the examination.
- Calculators are not permitted in this examination.

Materials provided

- The question and answer book of 31 pages.
- An answer sheet for multiple-choice questions.

Instructions

- Write your **name** in the box provided and on the answer sheet for multiple-choice questions.
- You must answer the questions in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions in the front cover of the question and answer book.

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

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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.

One mark will be awarded for a correct answer; no marks will be awarded for an incorrect answer.

Marks are **not** deducted for incorrect answers.

Question 1

Which of the following molecules would be **least** soluble in water?

- A. nucleotide
- B. carbohydrate
- C. cholesterol
- D. amino acid

Question 2

A protein is **NOT**

- A. involved in protection against disease.
- B. a principle component of a cell membrane.
- C. associated with transport in blood.
- D. a catalyst in metabolic reactions.

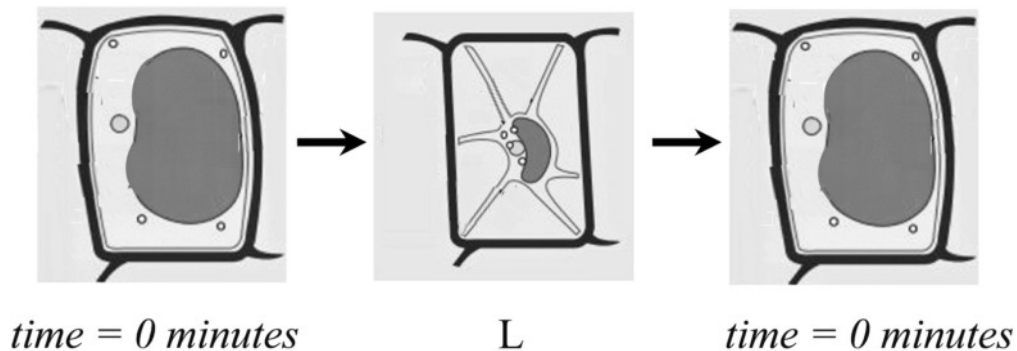
Question 3

The nuclear membrane encloses the genetic material of eukaryotes. The many nuclear pores that are embedded in the nuclear membrane allow the movement of

- A. ribosomal subunits into the nucleus.
- B. proteins out of the nucleus.
- C. mRNA out of the nucleus.
- D. DNA out of the nucleus.

The following information relates to Questions 4 and 5.

A sample of plant cells is placed in an unidentified solution and, once removed, is immediately observed by a botanist under a light microscope. The diagrams below show the observations of the botanist.



Source: Wikimedia Commons, http://en.wikipedia.org/wiki/File:Turgor_pressure_on_plant_cells_diagram.svg

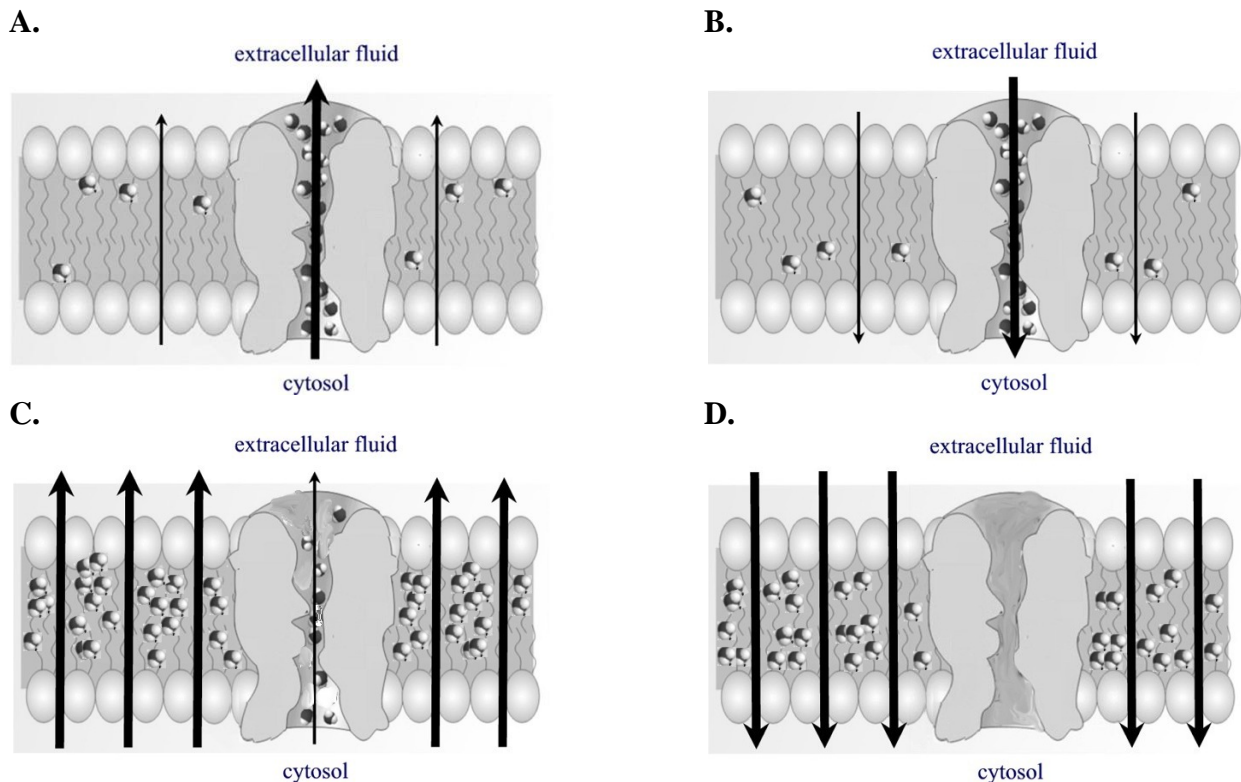
Question 4

The name of the process occurring at L is

- A. cytolysis.
- B. plasmolysis.
- C. hydrolysis.
- D. histolysis.

Question 5

Which diagram best shows the pathway of movement taken during the process at L?



**SECTION A – continued
TURN OVER**

Question 6

An example of active transport across a plasma membrane is

- A. the exchange of oxygen and carbon dioxide by a cell performing aerobic cellular respiration.
- B. the uptake of water by red blood cells when they are placed in distilled water.
- C. the transport of glucose by glucose transport protein GLUT2 in the β -cells of the pancreas.
- D. the exchange of sodium and potassium ions in the axon of a neuron when the cell is stimulated.

Question 7

Which of the following colours of light is **least** efficient in driving photosynthesis?

- A. red
- B. blue
- C. green
- D. orange

The following information relates to Questions 8 and 9.

ATP synthase is an enzyme that is found on the inner membrane of the mitochondrion. ATP synthase uses the difference in H^+ concentration on opposite sides of the inner mitochondrial membrane to produce ATP from ADP and inorganic phosphate. The H^+ concentration gradient can also be considered as a pH gradient, given that pH is a measure of H^+ concentration. Due to the electron transport chain, there is a higher concentration of H^+ on the outer side of the inner mitochondrial membrane.

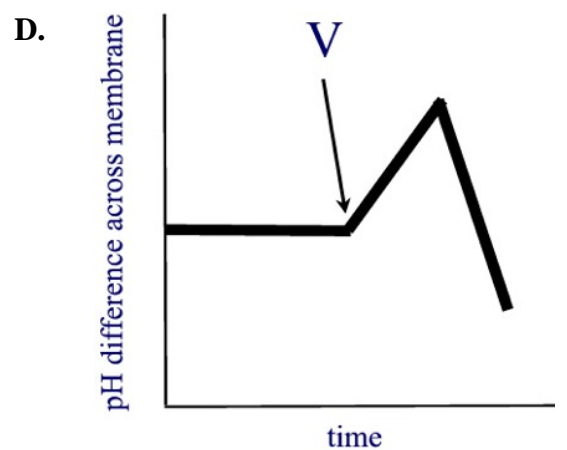
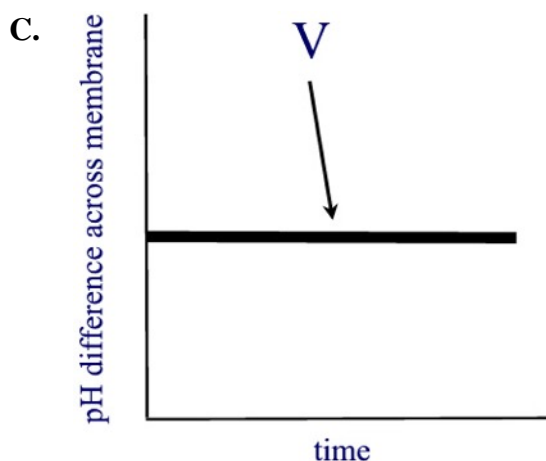
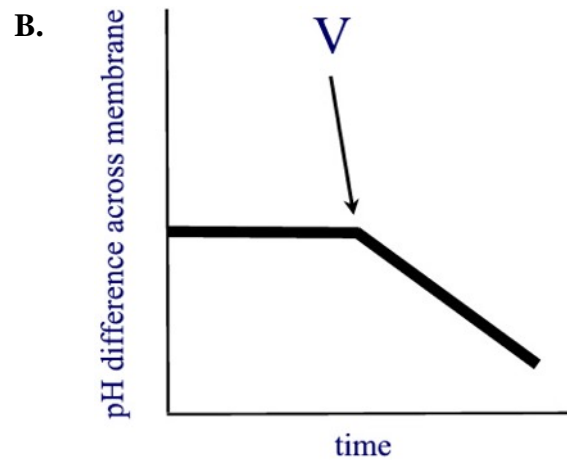
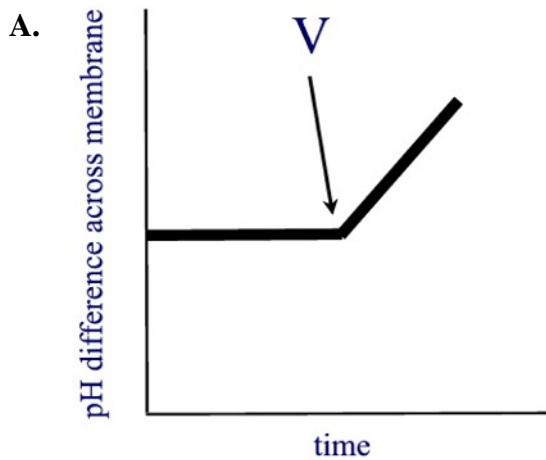
Question 8

Another name for the inner mitochondrial membrane is

- A. matrix.
- B. thylakoid.
- C. granum.
- D. cristae.

Question 9

It is possible to measure the pH difference across the inner mitochondrial membrane of a living cell. The graphs below show the pH difference over time in an actively respiring cell. A metabolic poison that inhibits the function of mitochondrial ATP synthase is added to a respiring cell at V. Which graph shows the expected effect on pH after adding the poison?



SECTION A – continued
TURN OVER

Question 10

Whether a glucose molecule undergoes fermentation or cellular respiration, a step in the metabolic pathway will always be

- A. glycolysis.
- B. the electron transport chain.
- C. the Krebs cycle.
- D. the Calvin cycle.

Question 11

Usually, cellular respiration yields 36 molecules of ATP. However, some tissues are capable of producing 38 molecules of ATP. An example of one such tissue would be found in the

- A. xylem of angiosperms.
- B. adipose depots around internal organs in humans.
- C. extracellular matrix in pig intestines.
- D. kidneys of frogs.

The following information relates to Questions 12 and 13.

Minnows are small freshwater fish of the carp family. If a minnow is injured, a substance is released from its skin and disperses in the water, inducing a response in other nearby fish.

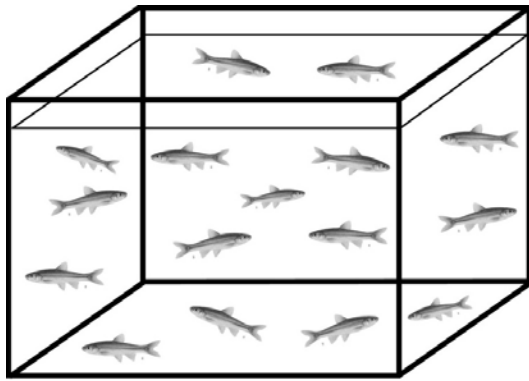
Question 12

The substance released from the skin of the minnow is a

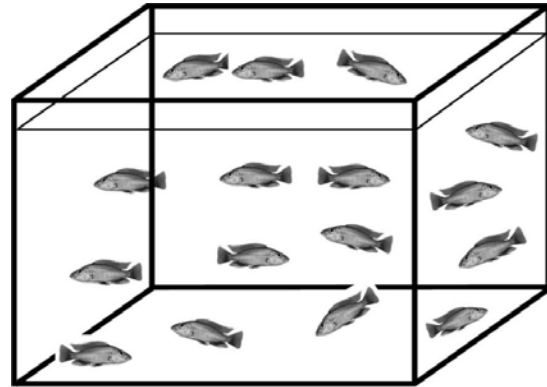
- A. neurohormone.
- B. neurotransmitter.
- C. pheromone.
- D. hormone.

Question 13

In a class experiment students were required to observe the effects of introducing Substance M, a chemical released from the skin of minnows, into two experimental groups, one with minnows (Aquarium A) and the other with cichlids (Aquarium B). Before the experiment began, the students were asked to observe the fish in Aquarium A and Aquarium B, and to make predictions about what they expected to see in each aquarium once Substance M was released into the water.



Aquarium A (minnows)



Aquarium B (cichlids)

Which student's predictions are correct?

		Aquarium A	Aquarium B
A.	Student A	Minnows will respond by grouping tightly together at a point as far away as possible from Substance M.	Cichlids will not respond to the introduction of Substance M. They will continue to show the same behaviour.
B.	Student B	Minnows will not respond to the introduction of Substance M. They will continue to show the same behaviour.	Cichlids will respond by grouping tightly together at a point as far away as possible from Substance M.
C.	Student C	Minnows will respond by grouping tightly together and swimming directly towards Substance M.	Cichlids will not respond to the introduction of Substance M. They will continue to show the same behaviour.
D.	Student D	Minnows will not respond to the introduction of Substance M. They will continue to show the same behaviour.	Cichlids will respond by grouping tightly together and swimming directly towards Substance M.

Question 14

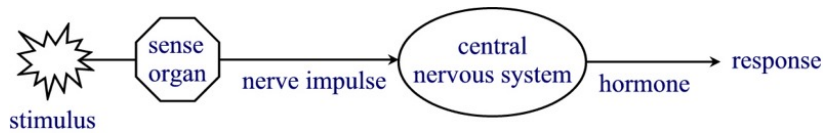
Broadly speaking, every aspect of plant growth and development is under hormonal control. A single plant hormone is capable of initiating a range of cellular and developmental processes, and multiple hormones can influence a single process. Which of the following is a known interaction between a growth hormone and a plant?

- A. ethylene – retards leaf abscission
- B. cytokinin – stimulates seed germination
- C. gibberellin – retards seed development
- D. auxin – promotes leaf abscission

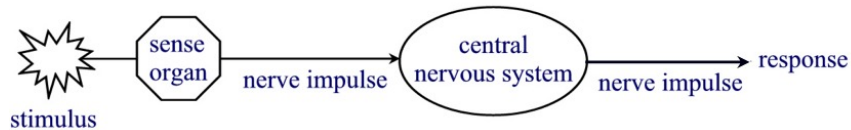
Question 15

After a sumptuous meal, Louis experiences a rise in his blood glucose level, which stabilises after around five hours. A model of this event is best represented by

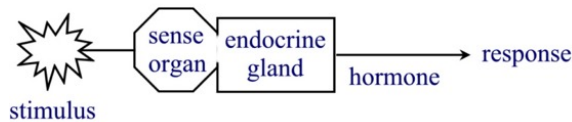
A.



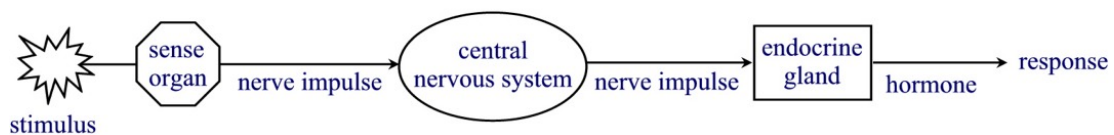
B.



C.



D.

**Question 16**

The blinking action of eyelids is essential to moisten the eye, wash away debris and provide a smooth surface for optimal focusing. When a nerve signal reaches the axon terminal at the junction between the neuron and the orbicularis oculi muscle, which helps to close the eyelid, the next action in the pathway would involve

- A. the neurotransmitter binding to a receptor molecule on the muscle cell membrane.
- B. an enzyme being released to deactivate the neurotransmitter.
- C. the release of a neurotransmitter from the neuron.
- D. the contraction of the muscle cell.

Question 17

A traveller returning from overseas was thought to have contracted an infection caused by a non-cellular agent. Such agents could include

- A. fungi.
- B. bacteria.
- C. yeasts.
- D. prions.

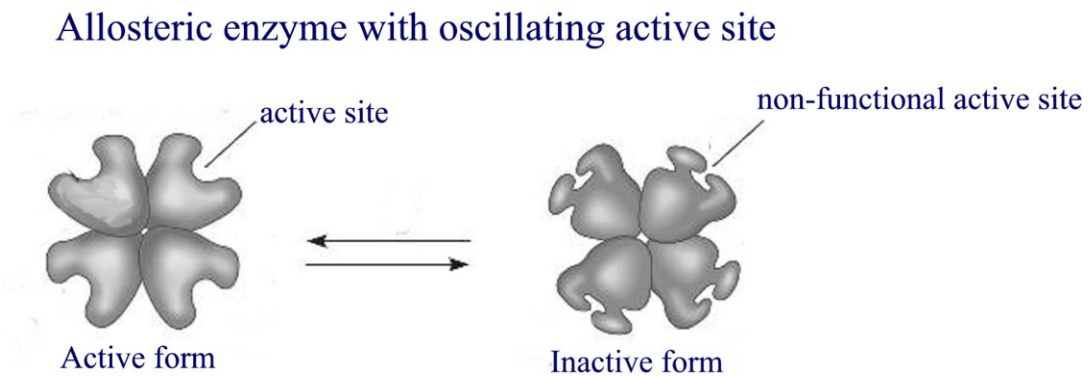
Question 18

Anoxic habitats, such as the muddy bottom of a river, are usually hosts to primitive living organisms that respire anaerobically. Anaerobic respiration is a process that

- A. mammals can sustain only over a short period of time.
- B. produces carbon dioxide and water in yeasts.
- C. occurs in reptiles, and produces ethanol and water.
- D. requires oxygen to proceed.

Question 19

The activity of an enzyme can be regulated by molecules known as allosteric activators and inhibitors, which bind to a site on the enzyme. As a result, the shape of the enzyme and the functioning of the active site change. When the function of a protein at one site is affected by the binding of a regulatory molecule at another site, enzyme activity can either be inhibited or stimulated. This process is known as allosteric regulation. The diagram below shows the oscillation that occurs between the active and inactive forms of an enzyme.



Source: College of DuPage: Principles of Biological Science BIO1151, 2010

It would be true to say that

- A. there is only one active site in the stabilised active form of the enzyme.
- B. allosteric enzymes are constructed from two or more subunits, each with their own active site.
- C. if an enzyme is inhibited by an allosteric inhibitor, it cannot become active again.
- D. allosteric activators work effectively to stabilise the inactive form of the enzyme.

SECTION A – continued
TURN OVER

Question 20

A student performed an experiment in which she added an enzyme to a solution in which the substrate and products were in equilibrium. What is she likely to observe?

- A. an increase in the temperature of the solution
- B. the formation of more products
- C. the formation of more substrate
- D. nothing would happen; the solution is at equilibrium.

Question 21

An autoimmune disease occurs when the body produces antibodies against substances and tissues that are normally present. An example of an autoimmune disease is

- A. pernicious anaemia.
- B. tuberculosis.
- C. type 2 diabetes.
- D. malaria.

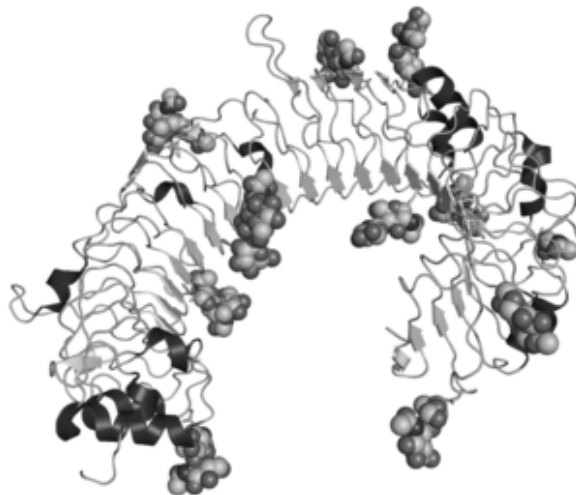
Question 22

Inflammasomes are clusters of proteins found inside certain cells. Inflammasomes respond to stresses, such as infection or injury, by releasing immune cell signalling proteins called cytokines. Inflammasomes are a component of the non-specific immune system, along with

- A. macrophages.
- B. lymphocytes.
- C. cytotoxic T cells.
- D. plasma cells.

The following information relates to Questions 23 and 24.

An adjuvant is a substance that has been added to a vaccine to help stimulate the immune system and make the vaccine more effective. Many microbial compounds function as adjuvants by stimulating Toll-like receptors (TLRs). An example of a TLR is shown in the image below.



Source: Wikimedia Commons, http://en.wikipedia.org/wiki/File:TLR3_structure.png

Question 23

From the image, it can be deduced that a TLR is a

- A. triglyceride.
- B. protein.
- C. nucleic acid.
- D. disaccharide.

Question 24

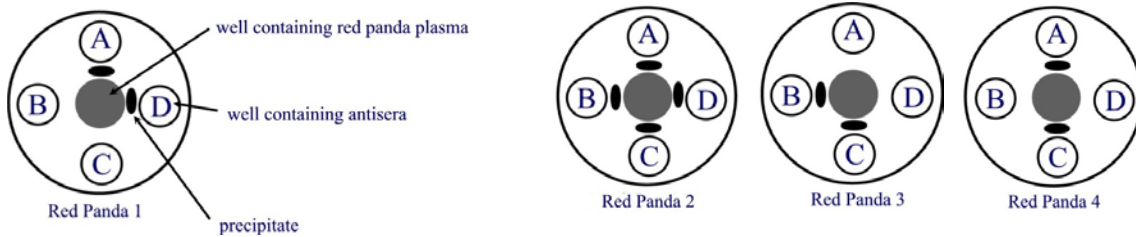
TLRs occur in vertebrates and invertebrates,

- A. and act as catalytic receptors.
- B. and play a significant role in the phagocytosis of microorganisms.
- C. and recognise microbes before they have breached physical barriers, such as the skin or intestinal tract mucosa.
- D. and are found spanning membranes.

SECTION A – continued
TURN OVER

Question 25

Researchers conducted an observation of four different proteins in four different red pandas. A sample of plasma from each panda was placed in the centre of an agar plate. Four different antisera were placed in wells located around the central well of each plate. If there was a reaction between a protein and its antiserum, a visible precipitate would form on the agar plate. The results of the observation are shown in the diagrams below. From the results, which observation is correct?



- A. All four red pandas share at least one common protein.
- B. All four red pandas share at least two proteins with one other red panda.
- C. The plasma of red panda 2 contains at least four different proteins.
- D. Each protein is found in at least three red pandas.

END OF SECTION A

END OF SECTION A

SECTION B – Short-answer questions

Instructions for Section B

Answer this section in **pen**.

Answer **all** questions in the spaces provided.

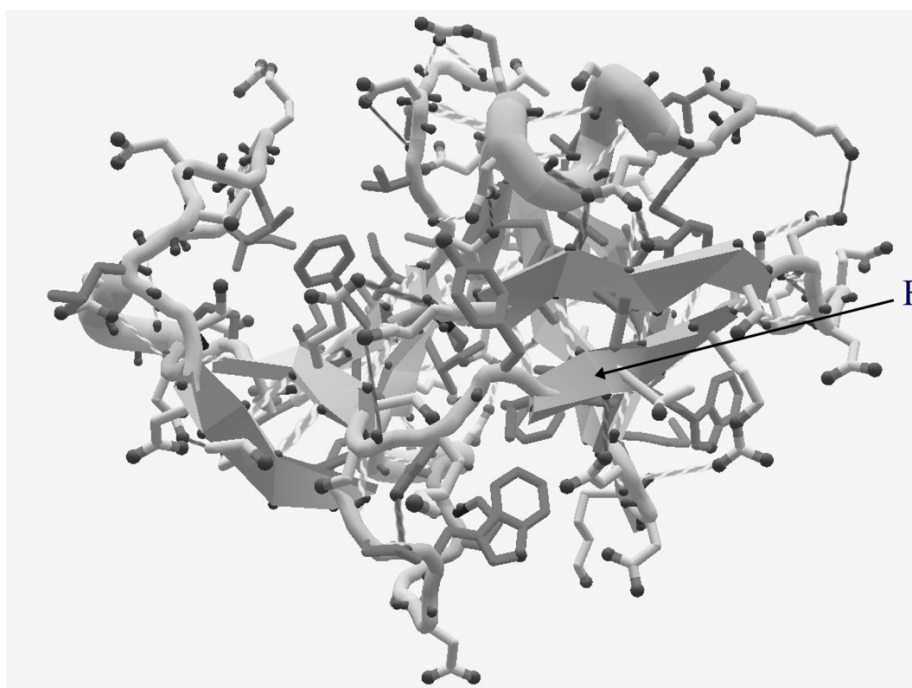
Question 1

The Mason-Pfizer monkey virus (M-PMV) is a lentivirus (a member of the retrovirus family). It is similar to the human immunodeficiency virus (HIV) and causes acquired immunodeficiency syndrome (AIDS) in monkeys and apes.

- a. Identify one characteristic of a retrovirus.

1 mark

'Foldit' is an online game that allows players to collaborate and compete in predicting the structure of protein molecules. In September 2011, online gamers solved the crystal structure of the M-PMV retroviral protease (PR), the protein whose configuration had stumped scientists for more than a decade. The diagram below shows the crystal structure of the Mason-Pfizer monkey virus (M-PMV) retroviral protease.

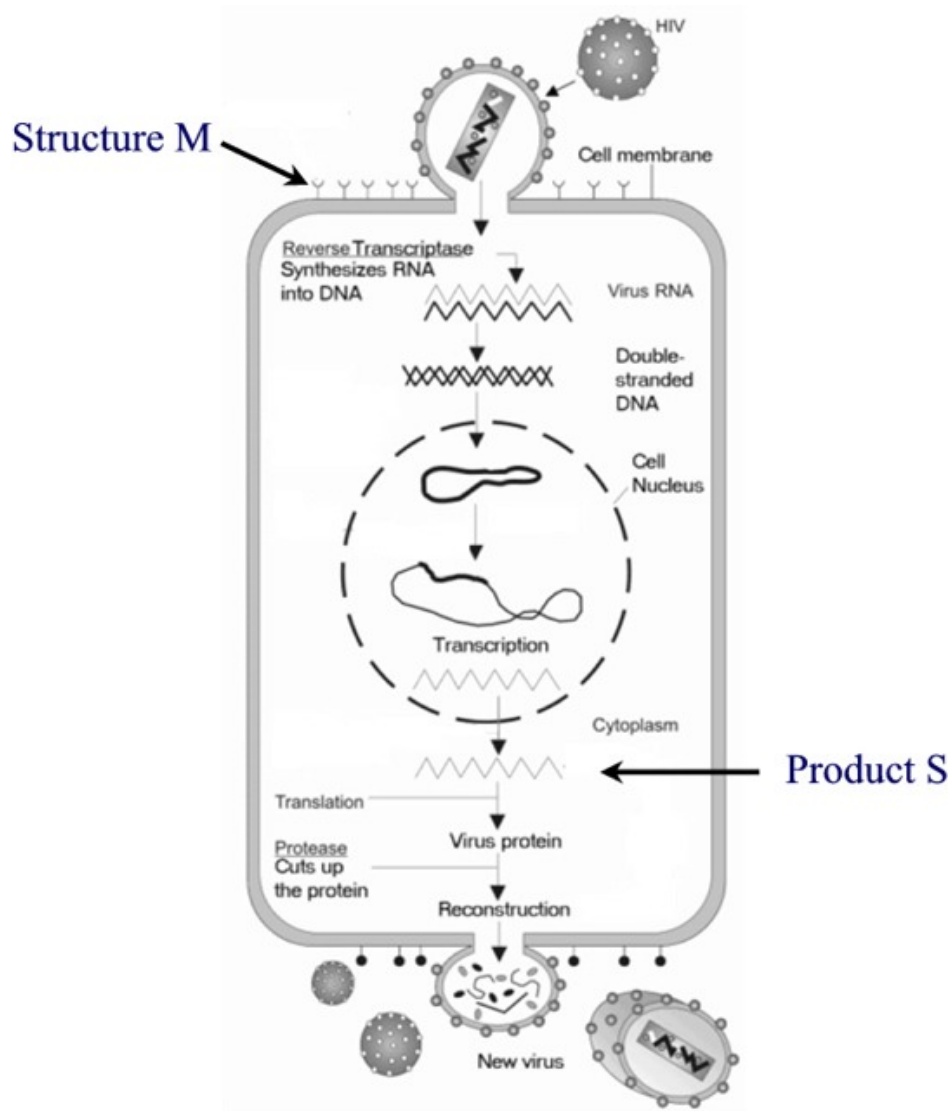


Source: David Baker, Washington University

- b. What is the name given to the type of secondary protein structure labelled **F**?

1 mark

SECTION B – Question 1 – continued
TURN OVER



Source: Wikimedia Commons,

http://upload.wikimedia.org/wikipedia/commons/thumb/3/35/HIV_gross_cycle_only.png/300px-HIV_gross_cycle_only.png

- c. In the diagram above, what is the name given to structure **M**?

1 mark

- d. What process is occurring in the nucleus of the cell?

1 mark

There are two families of nitrogenous bases found in DNA and RNA. They are shown in the table below.

Purines	Pyrimidines
adenine, guanine	cytosine, thymine, uracil

e. What nitrogenous bases would be found in Product S?

1 mark

Retroviral proteases play a critical role in the maturation and proliferation of HIV.

f. How could understanding the exact structure of the retroviral protease assist in the development of antiretroviral drugs that can fight HIV?

3 marks

Total 8 marks

**SECTION B – END OF QUESTION 1
TURN OVER**

Question 2

Plants are subject to attack by plant-eating animals (herbivores). Plants are capable of defending themselves against herbivores through the use of mechanical defences.

- a.** Identify one mechanical defence against a herbivore. Explain how this defence protects the plant.

Mechanical defence: _____

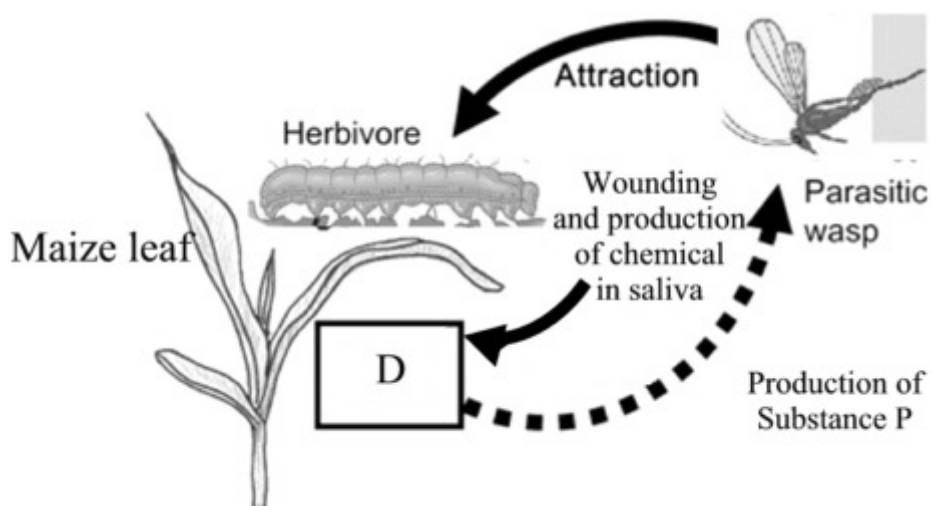
1 mark

The jack bean (*Canavalia ensiformis*) produces an amino acid called canavavine. Canavavine closely resembles arginine, one of the 20 amino acids that organisms incorporate into their proteins. If an insect eats a plant that has produced canavavine it will die.

- b.** Explain why the insect dies after eating the plant.

2 marks

Plants are also known to 'recruit' predatory animals as a defensive response. Consider the following diagram.



- c. Identify and explain the process occurring at **D**.

Process: _____

2 marks

- d. i. What is the general name given to Substance **P**?

1 mark

- d. ii. Suggest how the wasp might assist in the defence of the maize plant.

2 marks

Total 8 marks

**SECTION B – END OF QUESTION 2
 TURN OVER**

Question 3

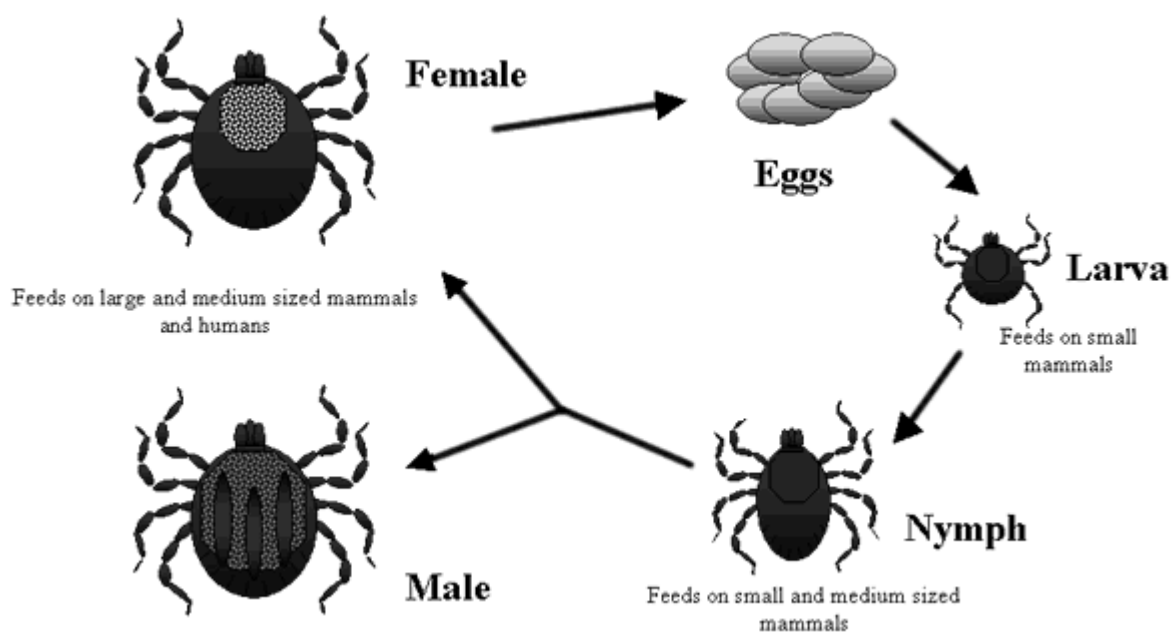
Lyme disease is a condition caused by species of bacteria from the genus *Borrelia* and is one of the most common tick-borne diseases in the northern hemisphere. *Borrelia* is transmitted to humans through the bite of infected ticks, one of which is classified in the genus *Ixodes scapularis*. The table below identifies the geographical areas in which three species of *Borrelia* are found.

Species	Location
<i>Borrelia burgdorferi sensu strict</i>	United States
<i>Borrelia afzelii</i>	Europe
<i>Borrelia garinii</i>	Europe

- a. Identify the vector associated with Lyme disease.

1 mark

The life cycle of *Ixodes scapularis* is shown in the diagram below.



Source: Centre for Disease Control and Prevention

- b. i. Identify the stages in the life of *I. scapularis*.

1 mark

Borrelia inhabits the digestive tract of *I. scapularis*. Lyme disease is transmitted to humans from a tick bite.

- b. ii.** Explain how the disease can be transmitted through the tick bite.

1 mark

The western fence lizard (*Sceloporus occidentalis*) is found in California, a southern state on the west coast of the United States. Research on the role of the western fence lizard in the occurrence of Lyme disease has produced divergent results.

Result A: Lyme disease is reduced when western fence lizards are found in an area.

Result B: Lyme disease is reduced when western fence lizards are removed from an area.

- c.** What might be a possible explanation for result **A**?

2 marks

Total 5 marks

**SECTION B – END OF QUESTION 3
TURN OVER**

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Question 4

Chloroplasts were taken from the leaves of a maize plant and a bean plant and examined under a microscope. The maize plant was grown under normal diurnal illumination. The bean plant was grown for 14 days in the dark and then transferred to continuous illumination.



Plant A



Plant B

- a. Explain which plant is most likely to be the maize plant.

2 marks

The production of ATP in photosynthesis is dependent on the existence of a pH gradient across the thylakoid membrane. A group of chloroplasts from the maize plant was placed in a solution with all the necessary components to perform ATP synthesis. A solution (Solution K) that makes membranes permeable to hydrogen ions was also added to the solution. This is shown in the diagram below.

- b. What reaction of photosynthesis occurs on the thylakoid membrane?

1 mark

- c. Explain what is likely to happen to the rate of ATP synthesis following the addition of solution K.

2 marks

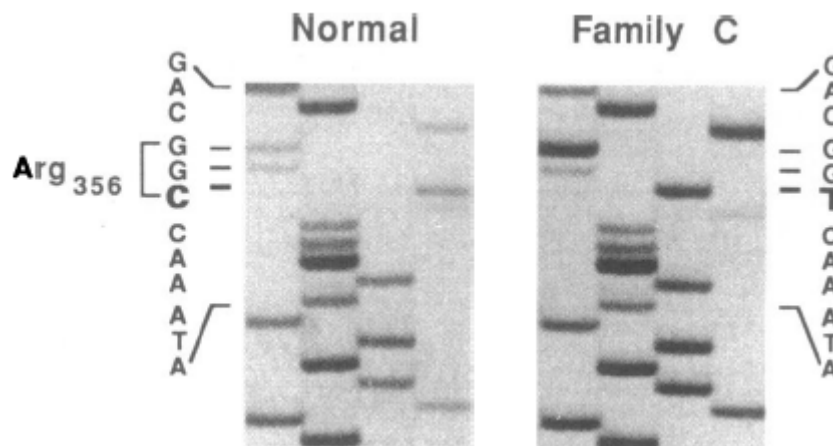
Total 5 marks

**SECTION B – END OF QUESTION 4
TURN OVER**

Question 5

The enzyme, alpha galactosidase A (alpha-A), is normally responsible for the breakdown of the fatty substance, globotriaosylceramide (GL-3). Faulty production of alpha-A results in Fabry disease, in which abnormal deposits of GL-3 accumulate in blood vessel walls throughout the body. Fabry disease can be caused by a range of genetic mutations.

The images below show a comparison of template DNA sequences for individuals from two families.



Source: Harold Bernstein, University of California, San Francisco

- a. What is the difference in nucleotide sequence for the normal case and the individual in family C?

1 mark

The table below shows the genetic code.

		Second Letter				
		T	C	A	G	
First Letter	T	TTT } Phe TTC } TTA } Leu TTG }	TCT } TCC } Ser TCA } TCG }	TAT } Tyr TAC } TAA Stop TAG Stop	TGT } Cys TGC } TGA Stop TGG Trp	T C A G
	C	CTT } CTC } Leu CTA } CTG }	CCT } CCC } Pro CCA } CCG }	CAT } His CAC } CAA } Gln CAG }	CGT } CGC } Arg CGA } CGG }	T C A G
	A	ATT } ATC } Ile ATA } ATG Met	ACT } ACC } Thr ACA } ACG }	AAT } Asn AAC } AAA } Lys AAG }	AGT } Ser AGC } AGA } Arg AGG }	T C A G
	G	GTT } GTC } Val GTA } GTG }	GCT } GCC } Ala GCA } GCG }	GAT } Asp GAC } GAA } Glu GAG }	GGT } GGC } Gly GGA } GGG }	T C A G

- b. i.** What is the amino acid sequence for the individual in family C?

1 mark

- b. ii.** Use the available information to explain how changing a single amino acid in a polypeptide chain may adversely affect the function of that specific protein.

2 marks

Currently, enzyme replacement therapy (ERT) is used to treat individuals with Fabry disease. However, ERT requires a complicated and expensive process to purify and replace the damaged alpha-A enzyme, and it must be performed by a medical professional. Researchers are considering an alternative strategy called pharmacological chaperone (PC) therapy, which uses smaller molecules, taken orally, to ensure that the correct enzyme proteins are produced.

c. What advantages could PC have over ERT?

2 marks

Total 6 marks

Question 6

Exosomes are small vesicles secreted by most cell types, including B lymphocytes and dendritic cells, and measure around 150 nm in diameter. They are formed within the cell in compartments known as multivesicular endosomes (MVE), which take up parts of the cytoplasm and its contents.

- a. What is the outer layer of an exosome vesicle made of?

1 mark

Exosomes contain cell-specific proteins, lipids and mRNA. It has been shown that B lymphocytes secrete measurable numbers of exosomes only when stimulated by the binding of a cell-surface receptor.

- b. Identify one possible role of an exosome and explain your reasoning.

2 marks

The proteins released by exosomes differ from the proteins contained in the vesicles released by apoptotic cells. Apoptotic vesicles contain a number of nuclear, cytosolic and endoplasmic reticulum-derived proteins, all of which are cellular components that have been broken down.

- c. Outline the three steps that are likely to occur in apoptosis after cellular proteins are broken down into their components.

Step 1: _____

Step 2: _____

Step 3: _____

3 marks

Total 6 marks

**SECTION B – END OF QUESTION 6
TURN OVER**

Question 7

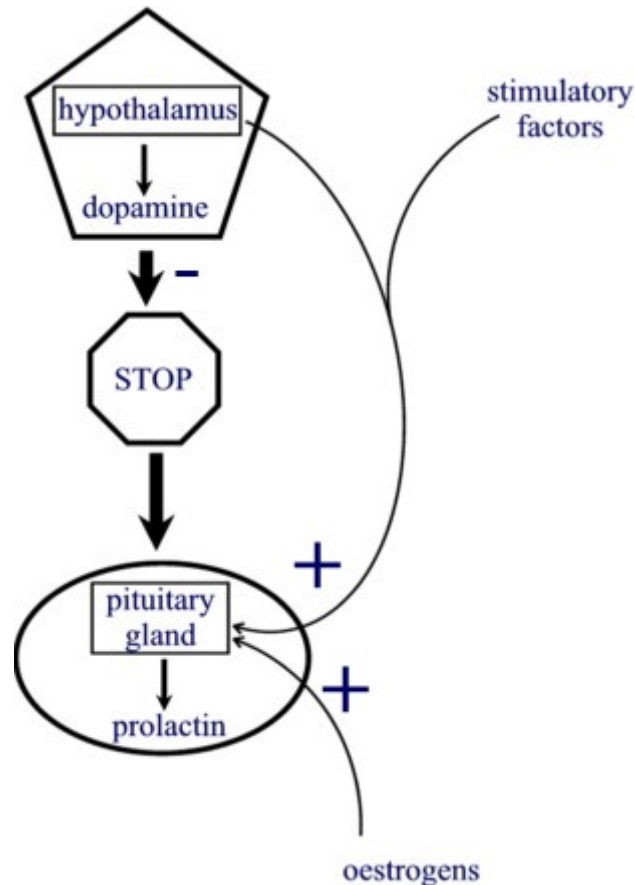
Parkinson's disease (PD) is a degenerative condition that affects the central nervous system in humans. In its early stages, it is characterised by movement-related symptoms, such as shaking, rigidity and slowness of movement, and then progresses to cognitive and behavioural problems, and commonly dementia. PD is caused by the death of dopamine-producing cells in the midbrain; the reason for cell death is unknown.

After synthesis, dopamine is packaged into vesicles, which are then released into the synapse in response to a presynaptic action potential.

- a. What is the function of dopamine?

1 mark

Dopamine is also released into the bloodstream by neurons in the hypothalamus and binds to receptors on lactotrophs. Lactotrophs are cells in the anterior pituitary that produce prolactin. The diagram below outlines the control of prolactin production.



- b. Explain what class of endocrine molecule dopamine would be acting as.

2 marks

In mammals, young are nourished postnatally with milk that is produced by the mammary glands. In response to changes in oestrogens and suckling by the newborn, the hypothalamus releases thyrotropin-releasing hormone (TRH), which sends a signal to the pituitary gland. In response, prolactin is secreted and the mammary glands are stimulated to release milk.

- c. Explain what kind of feedback is associated with lactation.

2 marks

Total 5 marks

**SECTION B – END OF QUESTION 7
TURN OVER**

Question 8

Pertussis (whooping cough) is a highly contagious condition caused by the many strains of the bacterium *Bordetella pertussis*. From 1880 to the 1940s, the incidence of pertussis was recorded in the hundreds of thousands. After the 1940s, the incidence declined almost completely until the early 1990s.

- a. What is most likely to have caused such a significant decline in the incidence of pertussis from 1940 to late 1980?

1 mark

A child with pertussis has spasms of coughing, with a characteristic whoop upon inhalation. However, this is less common in older children and adults. Some of the tests that can be used to confirm a diagnosis of pertussis include

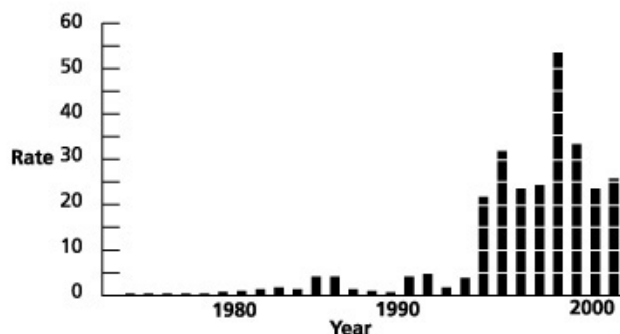
- bacterial culture
- serological testing to detect rises in immunoglobulin IgA or IgG antigens
- lymphocyte count.

After a two-week course of broad-spectrum antibiotics, a woman who still has a persistent cough visits a medical clinic. Concerned that she might have whooping cough, the doctor decides to perform a series of serological tests to detect the levels of IgA and IgG antibodies specific to *B. pertussis* antigens.

- b. Explain why the doctor chooses serological testing over the other tests available.

3 marks

Currently in Australia, epidemics of pertussis occur every three to four years. The following graph shows the rates of pertussis in Australia from 1970–2000.



Australia's pertussis rate (per 100,000 population)

Up until the late 1990s, children were given a broad-acting whole-cell vaccine. However, concerns over the potential side effects resulted in the development of a more targeted acellular vaccine. The acellular vaccine contains a pertussis toxin that has either been inactivated or genetically detoxified.

	Whole cell vaccine	Acellular vaccine
Period of use	prior and up to 1997	after 1997
number of different antigens against pertussis	hundreds	3-5

More than 200 samples of the bacterium collected over the past 40 years in Australia were compared with samples from Japan, Canada, the United States and Finland. An analysis showed that the vaccine currently in use is effective against some of the strains circulating in Australia. However, it may no longer offer protection against two strains, MT27 and MT70.

- c. Identify two possible explanations for the dramatic rise in the incidence of pertussis in vaccinated Australians since the mid-1990s.

Explanation 1: _____

Explanation 2: _____

2 marks

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Researchers have analysed particular sequences in the DNA of strains of *B. pertussis* that make the three to five antigens. Strains MT27 and MT70 have different gene sequences.

- d.** What is the likely outcome of strains MT27 and MT70 having different gene sequences?

1 mark

Total 7 marks

END OF SECTION B

END OF QUESTION AND ANSWER BOOK