

2006

BIOLOGY

Written examination 1

STUDENT NAME:

QUESTION AND ANSWER BOOK

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

Structure of book

Section	Number of questions	Number of questions to be answered	Number of marks	Suggested times (minutes)
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 23 pages, with an answer sheet for the multiple-choice questions.

Instructions

- Write your **name** in the box provided and on the multiple-choice answer sheet.
- You must answer the questions 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 or any other electronic devices into the examination.

Section A: Multiple Choice Questions

Question 1

Simple carbohydrate molecules can be written according to the formula $(\text{CH}_2\text{O})_n$. Ribose sugar is

- A. a 6-carbon simple sugar
- B. found in RNA only in the nucleus
- C. one of the structural components of DNA
- D. a pentose sugar in an RNA nucleotide

Question 2

Water is a fundamental biological molecule. Which of the following properties of water is important to it being referred to as a universal solvent?

- A. the strong attraction (cohesion) between water molecules
- B. the polarity of water molecules
- C. the high heat capacity of water
- D. the strong bonding producing surface tension

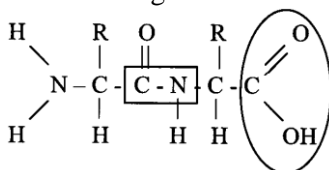
Question 3

Which of the following combinations is correct?

	<i>Name of structure</i>	<i>One of the molecules in chemical composition</i>	<i>Sub-unit of that molecule</i>	<i>Elements in that molecule</i>
A.	cell wall	cellulose	glucose	C, H, O
B.	nucleolus	DNA	nucleotide	C, H, O, N, P
C.	plasma membrane	protein	fatty acids	C, H, O, N
D.	ribosomes	RNA	nucleotide	C, H, O, N, S

Question 4

The following diagram is of two monomers linked together.



Which of the following statements is correct?

- A. This molecule is a polypeptide made up of amino acid monomers.
- B. The circled region is variable in different amino acids.
- C. The bond in the rectangular box is called a glycosidic bond.
- D. The element sulfur could be present in the R group of this molecule.

Question 5

Steroids are of important biological significance. Although, structurally, they have little in common with other lipids, they do share some important properties. Steroids

- A. are non-polar molecules that are insoluble in water
- B. are an important part of the cell membrane
- C. produce enzymes such as oestrogen and testosterone
- D. dissolve in the blood so do not affect blood flow

Information for Questions 6 and 7

DNA molecules cannot leave the nucleus however the RNA molecules can move out of the nuclear pores. A single RNA strand is formed by copying the base sequence of one of the DNA strands by complementary base pairing.

Question 6

The RNA strand formed by this process is called

- A. ribosomal-RNA
- B. nuclear-RNA
- C. messenger-RNA
- D. transfer-RNA

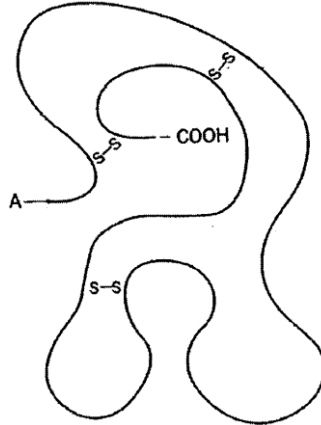
Question 7

If the percentage of bases on the strand of DNA being copied is 35% thymine, 20% guanine and 15% cytosine, the percentage of bases in the RNA that is produced in this copying process will be

- A. 15% thymine
- B. 35% guanine
- C. 15% adenine
- D. 30% uracil

Question 8

The following diagram shows the structure of a molecule of protein called lactalbumin. It consists of one polypeptide chain.



Which level of protein structure is illustrated by this diagram?

- A. primary
- B. secondary
- C. tertiary
- D. quaternary

Question 9

Biosensors are used to detect blood glucose concentrations in the blood. If an abnormally high level of glucose was detected in the blood it would indicate malfunctioning of the

- A. hypothalamus
- B. liver
- C. kidney
- D. pancreas

Question 10

Biosensors are used in sports training to detect blood concentrations of lactic acid. In collecting a sample from a person it would be important to

- A. have the patient lying down
- B. collect the sample early in the day
- C. have the collector wearing gloves
- D. dispose of the sample down the sink after testing

Question 11

C₄ plants like corn and sugar cane are found in desert and grassland ecosystems in warm or hot climates. They are well adapted to these hot, dry conditions as they

- A. carry out the first step of carbon fixation more rapidly
- B. complete the steps of the Calvin cycle of the light-independent reaction in cells surrounding vascular bundles deep in the leaf tissue
- C. pick up and use more carbon dioxide more efficiently and therefore have a higher rate of photosynthesis
- D. partly close their stomata for long periods during the day

Information for Questions 12 and 13

Tubes containing the same amount of catalase enzyme and the same volume of hydrogen peroxide solution of different concentrations were incubated under identical conditions of temperature. The rate of breakdown of the hydrogen peroxide substrate in each tube was plotted against the original concentration of the substrate.

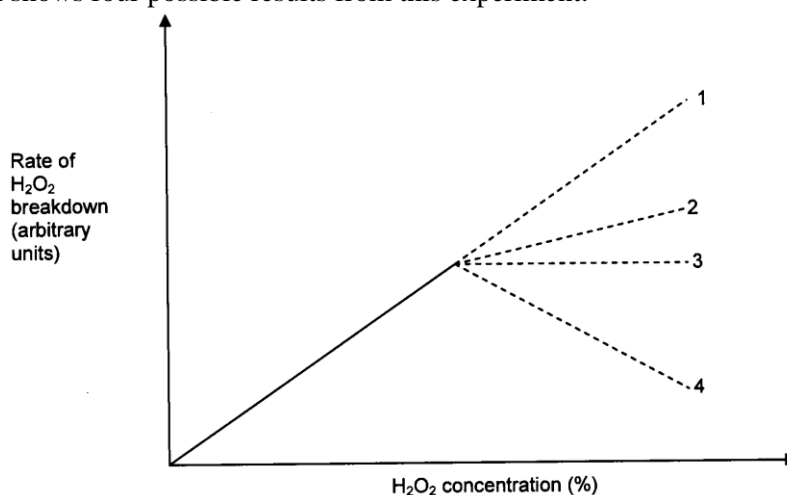
Question 12

In this experiment the experimental variable is the

- A. temperature
- B. volume of hydrogen peroxide
- C. amount of catalase enzyme
- D. concentrations of hydrogen peroxide

Question 13

The following graph shows four possible results from this experiment.



Which graph line is correct?

- A. 1
- B. 2
- C. 3
- D. 4

Question 14

A series of experiments was carried out with rattlesnakes to determine the major receptors involved in their rapid accurate strikes to catch their food (mice, rats). The following results were obtained.

- **Experiment 1** – snake in bright light with dead mouse – no strike
- **Experiment 2** – snake in dark with dead mouse pulled quickly along – no strike
- **Experiment 3** – blindfolded snake in dark with live mouse – rapid, accurate strike

These results suggest rattlesnakes detect their prey using

- A. chemoreceptors
- B. mechanoreceptors
- C. photoreceptors
- D. thermoreceptors

Information for Questions 15 and 16

Anti-diuretic hormone is an important hormone for maintaining relatively stable body fluid concentrations. As with other protein-based hormones it is water-soluble and cannot readily pass through the plasma membrane. To produce a physiological response in the cell it must use a 'second messenger mechanism'.

Question 15

Which one of the following is **not** involved in this mechanism?

- A. Specific receptors for the hormone in the cytosol.
- B. An enzyme to activate a second messenger molecule.
- C. A second messenger molecule (eg. cAMP).
- D. ATP to provide energy for the mechanism.

Question 16

The results of the physiological response caused by the hormone ADH will be

- A. the kidney tubules will be less permeable to water
- B. more water will be reabsorbed from the kidney tubules and collecting duct
- C. a larger volume of dilute urine will be produced
- D. more salt will be lost in sweating

Question 17

Influenza virus multiplies in infected cells and then spreads to other non-infected cells. Neuraminidase, a protein on the surface of the influenza virus, allows the exit of new virus particles from an infected cell.

Rational drug design to produce an appropriate drug to inhibit neuraminidase has involved

- A. finding the part of the virus which kept changing all the time to produce different strains
- B. determining the active site of a drug that the virus would fit into
- C. working out the molecular structure and exact shape of the active site of neuraminidase
- D. constructing a drug molecule that would fit into and stimulate the activity of neuraminidase

Information for Questions 18 and 19

In February 2006, a young fit life-saver from Israel competed in a long-distance swim from Fremantle to Rottnest Island in Western Australia. Several kilometres into the race he collapsed from hypothermia, his body temperature kept on falling rapidly and his heart stopped beating for half an hour. He was revived and miraculously recovered with very little damage to his body tissues.

Question 18

The above is an example of a

- A. stimulus-response mechanism
- B. positive feedback mechanism
- C. negative feedback mechanism
- D. co-ordinating/regulating mechanism

Question 19

Which of the following would have been occurring in his body in an attempt to reduce heat loss and increase heat again?

- A. pituitary gland detects the drop in body temperature
- B. thyroid gland produces thyroxine to increase metabolism
- C. skin arterioles dilate to reduce heat loss from the surface
- D. skeletal muscles relax to help provide insulation in cold environment

Information for Questions 20 and 21

Tapeworms are the most highly specialised parasitic flatworms. They are endoparasites in which the adults inhabit the gut of humans and the larval forms infect other mammals such as cows.

Question 20

The adaptation that greatly increases their chances of dispersal is

- A. the presence of hooks and suckers on the 'head' region for attachment to a host
- B. the long thin body made up of segments that has a large surface area for exchange
- C. each segment contains both male and female reproductive organs
- D. each segment matures into a bag of eggs after fertilisation which breaks off

Question 21

In the tapeworm life cycle the human is called the

- A. primary host
- B. principal host
- C. secondary host
- D. intermediate host

Question 22

Antibiotics, antiseptics, disinfectants, and interferon are all used to prevent the spread of or treat human disease.

In each of the following situations, which one has listed the most appropriate type of substance to use?

- A. Cleaning a graze on the skin caused by a fall on gravel.
- B. Treating an internal fungal infection.
- C. Cleaning the toilets and basins in a child-care centre.
- D. Treat a severe bacterial infection to stop the spread of bacteria to uninfected cells.

Disinfectant
Antibiotic
Antiseptic
Interferon

Question 23

Administering a live vaccine, as is used for the BCG vaccine against tuberculosis and the Sabine vaccine against poliomyelitis,

- A. is a form of acquired artificial passive immunity
- B. stimulates only the cell-mediated immune system
- C. will only give short term protection from infection
- D. involves a vaccine of live non-virulent attenuated strains of the pathogen

Question 24

Antibiotics interfere with the growth or metabolism of the pathogen in a variety of ways. Streptomycin and tetracycline both work by interfering with bacterial ribosomes. This kills the bacteria as it

- A. inhibits enzymes involved in the formation of the bacterial cell wall
- B. prevents essential exchange of materials through the protein channels of the cell membrane
- C. prevents protein synthesis especially of essential enzymes
- D. reduces transport of important proteins in and out of the cells

Question 25

The lymphatic system plays an important role in the body's immune system. Lymphocytes (a special type of white blood cell) mature in the lymphoid tissue.

Which of the following is **not** part of the lymphatic system?

- A. liver
- B. spleen
- C. thymus gland
- D. tonsils

Section B: Short Answer

Question 1

The following diagram (drawn from an electro-micrograph) shows a secretory cell from a mammary gland and its relationship to a blood capillary. The globules (A) consist of triglycerides.

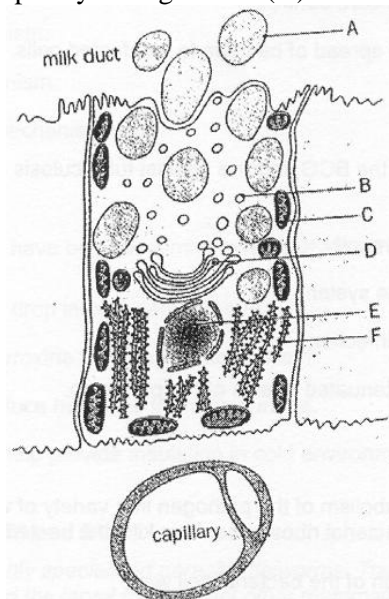


Figure 1

a. (i) What type of biomolecule are triglycerides?

(ii) Of what molecules do triglycerides consist and how many of each type of molecule?

(iii) Are triglycerides polymers? Explain.

(iv) Would triglycerides be described as hydrophilic or hydrophobic? Explain.

1 + 1 + 1 + 1 = 4 marks

b. Radioactively-labelled amino acids were supplied to mammary gland secretory cells as shown in the previous diagram and they were grown in tissue culture. Later these amino acids were found in milk protein (casein) produced by the cells.

(i) Give in correct sequence the letters of those structures from Figure 1 which would show the most likely pathway taken through the cell by the amino acids after absorption.

(ii) Name the process by which the protein casein would leave the cell.

(iii) Explain the role of Structure E in determining the production of the specific protein casein and not some other protein.

1 + 1 + 2 + 1 = 5 marks

Total: 9 marks

Question 2

The following diagrams show a cell of the pondweed *Elodea* in pond water (A) and then after it had been left in a second solution (B) for 10 minutes.



Figure 2

a. (i) What conclusion can be drawn about the second solution that resulted in cell (B)?

(ii) What structure can be seen in (B) after the cell was left in this second solution that could not be seen in (A)?

1 + 1 = 2 marks

- b. In an experiment, samples of *Elodea* pondweed cells were placed in a series of salt solutions of different concentrations. After one hour the samples were examined to find the percentage of cells that looked like the cell in diagram (B). The results are given in the graph below.

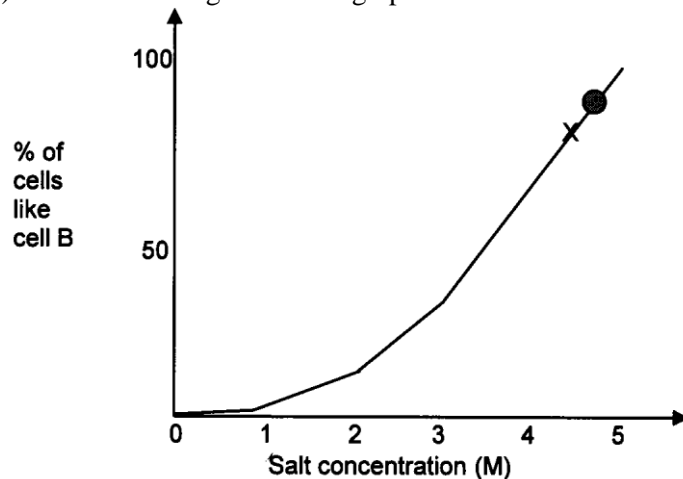


Figure 3

- (i) What term is used to describe the condition of most of the cells at point X on Figure 3?

- (ii) Explain what caused this condition.

1 + 1 = 2 marks

- c. The following diagram is taken from an electron micrograph of organelle T from Figure 2, diagram (B).

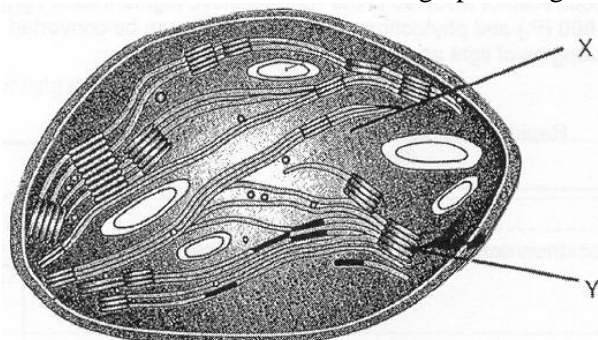


Figure 4

Complete the following table about organelle T.

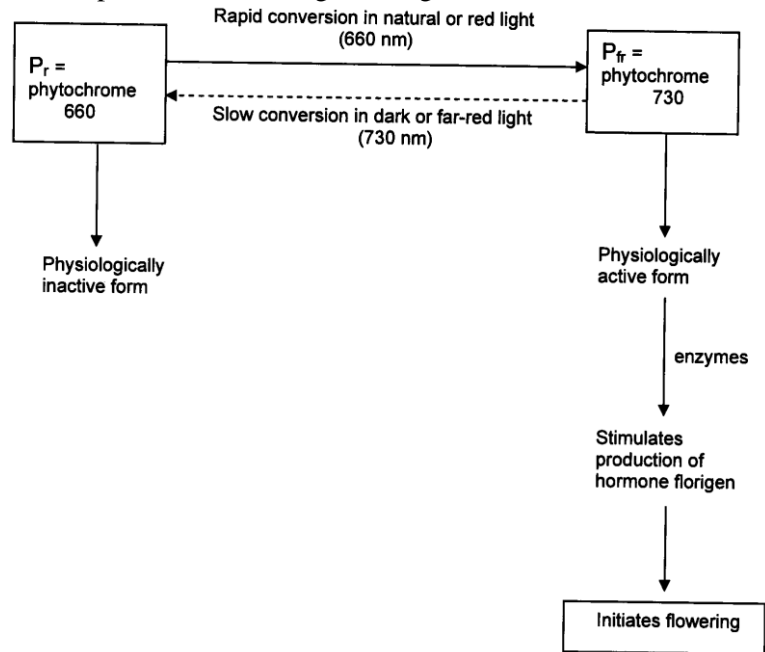
	X	Y
Name of structure		
Name of stage of photosynthesis that occurs in that structure or area		
Products or outputs of the reaction occurring in that structure or area.	(1)	(1)
	(2)	(2)
	(3)	(3)

1 + 1 + 3 = 5 marks

Total: 9 marks

Question 3

Photoperiodism is the response of a plant to the relative lengths of daylight and darkness. Flowering is affected by the period of light. The photoreceptor involved is the light-sensitive pigment called phytochrome which exists in two forms – phytochrome 660 (P_r) and phytochrome 730 (P_{fr}). They can be converted from one form to the other form in particular wavelengths of light as illustrated below.



The plant is stimulated by day length (or rather the period of uninterrupted darkness).

a. (i) What is the name for the length of light which stimulates flowering?

(ii) Where in the plant would the photoreceptor pigment be located?

1 + 1 = 2 marks

The plant measures day length by the amount of phytochrome existing in each of the two forms. Sunlight contains much more light of wavelength 660 nm than 730 nm.

b. In daylight, which form of phytochrome would predominate?

1 mark

P_{fr} is unstable and during the hours of darkness it slowly reverts back to P_r . Spinach is a long day plant.

c. (i) What conditions of light and dark would spinach need to flower?

(ii) Which form of phytochrome would spinach need to have in high concentration in order to release florigin to initiate flowering?

(iii) Spinach cannot flower in the tropics but flowers readily during summer in Southern Australia. Explain this observation.

1 + 1 + 1 = 3 marks
Total: 6 marks

Question 4

The diagram below shows the changes which take place during a process which occurs in the muscles of mammals when they are recovering from heavy exercise. The diagram is specifically designed to show changes in the energy level of the compounds involved; the higher a compound appears on the diagram the higher its energy content.

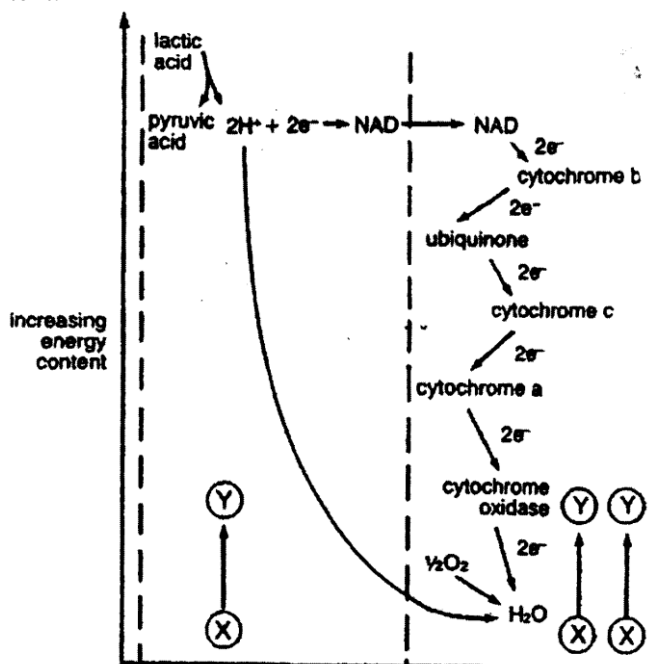


Figure 5

a. (i) What type of respiration is shown by this pathway?

(ii) Where in the mammalian muscle cells would this process be occurring?

(iii) What is the name given to this stage of respiration?

1 + 1 + 1 = 3 marks

b. Compound Y is a high energy compound needed for the mammalian muscle cells activities and functioning. Write an equation that would show the reaction $X \rightarrow Y$ in detail.

1 mark

c. The two reactions shown (pyruvic acid \rightarrow water and $X \rightarrow Y$) are often called 'coupled reactions'. Explain what this means using appropriate terms for the type of each reaction in terms of its energy input or output.

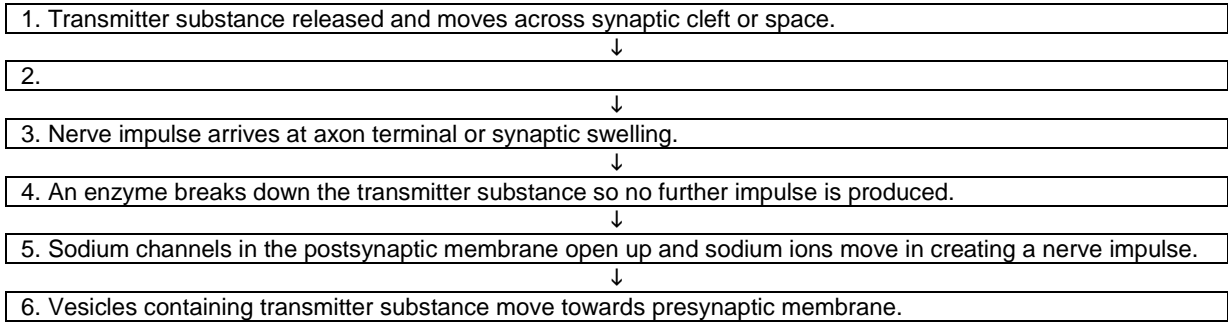
2 marks

d. The cytochromes involved in this process are iron-containing proteins. The poison cyanide, specifically inhibits cytochrome c oxidase. Using your knowledge and this information, explain why cyanide poison causes death.

1 mark
Total: 7 marks

Question 5

The flowchart below shows some of the events which occur at a synapse at a neuromuscular junction but they are not in order and one event is missing.



a. Put the events 1 to 6 on the diagram in the correct sequence.

_____ → _____ → _____ → _____ → _____ → _____

1 mark

b. Acetylcholine is a transmitter substance, called a neurotransmitter, which acts as a signalling molecule to activate specific target cells.

(i) If acetylcholine was the transmitter substance in the flow chart example, what would be the target cells?

(ii) By what process would acetylcholine cross the synaptic cleft?

(iii) Box 2 in the flow chart was empty. Complete this missing box in the space below by briefly explaining how acetylcholine activates the target cells.

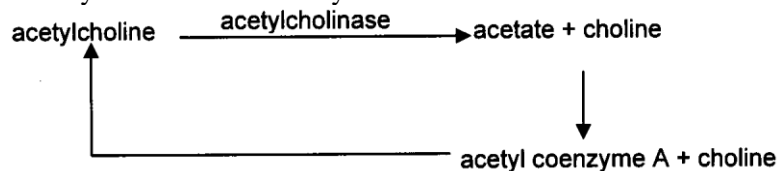
1 + 1 + 1 = 3 marks

Molecules of the drug curare are very similar in shape to those of acetylcholine.

c. Using this information and the explanation in the box above, explain why doctors can use the drug curare to stop muscles contracting during a surgical operation.

1 mark

The enzyme which breaks down acetylcholine is called acetylcholinase and it is present in the synaptic cleft. This splits acetylcholine into acetate and choline. The choline is taken up by the presynaptic cell and combined with acetyl coenzyme A to reform acetylcholine. This can be summarised –



d. (i) Suggest two factors that would affect the rate at which acetylcholine is broken down.

1. _____
2. _____

- (ii) What is the reaction called that involves combining of several substrates, as with choline and acetyl coenzyme A, to produce a product?

2 + 1 = 3 marks

Neurotransmitters are just one type of signalling molecule. Other signalling molecules are **hormones**, such as thyroxine or adrenaline, and **pheromones**, such as sexual attractants released by female animals to attract males for mating.

- e. Give **one** difference between these three types of signalling molecules by comparing the way they travel to their target cells.

1 mark

Total: 9 marks

Question 6

Tetanus is an infectious disease causing acute muscle contractions, particularly of the jaw and neck (often called lock jaw). The symptoms are produced by the powerful poison or toxin of soil bacteria called *Clostridium tetani*. The bacteria exist as spores in soil and animal faeces and develop only in damaged tissue without oxygen such as a skin wound.

- a. Describe one structural feature that distinguishes the tetanus pathogen from

- (i) a prion causing Mad Cow disease.

- (ii) a blood fluke (flatworm) causing schistosoma or bilharzia.

1 + 1 = 2 marks

- b. A farmer planting a potato crop in a paddock had an accident and received a deep cut to his leg from the digger of the tractor. Within 24 hours he showed signs of infection.

- (i) Suggest one observation that would indicate that non-specific immunity had been activated.

- (ii) Explain how this response would be beneficial.

1 + 1 = 2 marks

- c. The farmer had foolishly never been immunised against tetanus. After cleaning and stitching the wound what two immediate treatments would the doctor carry out and why is this necessary?

1. _____

2. _____

1 + 1 = 2 marks

The following graph shows the level of his blood factors over the next two months from the time of the treatment.

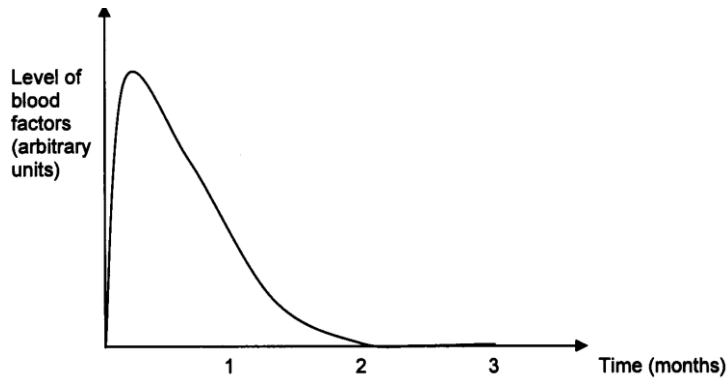


Figure 6

d. (i) What factors would have been measured in his blood?

(ii) Explain what has happened to these factors over the two months.

1 + 1 = 2 marks

A graph of the level of these blood factors over the next 10 years from two months after the accident showed the following pattern.

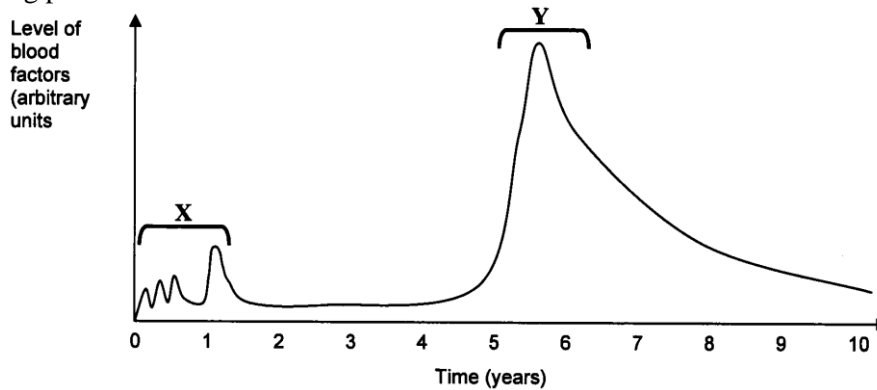


Figure 7

e. What conclusion can be drawn about what happened during

(i) period X?

(ii) period Y?

1 + 1 = 2 marks

Total: 10 marks