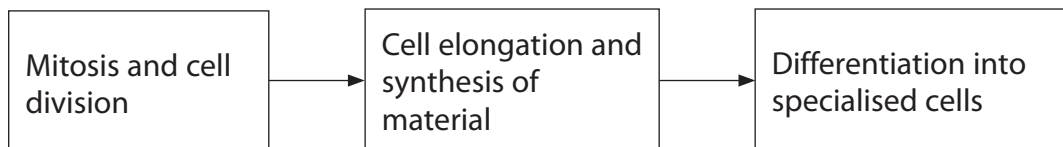


Answer ALL questions.

Some questions must be answered with a cross . If you change your mind about an answer, put a line through the box and then mark your new answer with a cross .

- 1 Plant growth involves mitosis, cell division and cell differentiation and is influenced by environmental factors such as temperature.

(a) The diagram below shows the stages in the growth of a root in a plant seedling.



- (i) Place a cross in the box next to the correct sequence of stages in mitosis.

(1)

- A** Metaphase, anaphase, prophase, telophase
- B** Prophase, anaphase, metaphase, telophase
- C** Prophase, metaphase, anaphase, telophase
- D** Telophase, metaphase, anaphase, prophase

- (ii) Place a cross in the box next to the material that would be synthesised to form the cell wall of the seedlings.

(1)

- A** Cellulose
- B** Cholesterol
- C** Glycogen
- D** Thrombin

- (iii) Place a cross in the box next to the tissue that would form the vessels in a root, following differentiation.

(1)

- A** Chorion
- B** Endothelium
- C** Sclerenchyma
- D** Xylem

- (b) A student carried out an investigation into the effect of temperature on the growth of plant seedlings. The two species that she chose for the study were sea plantain, *Plantago maritima* and bog sedge, *Kobresia simpliciuscula*.

Sets of seeds from each of these species of plant were germinated at 18 °C. As soon as they germinated, the seedlings were placed in three temperature-controlled rooms at 10 °C, 14 °C and 18 °C. They were allowed to grow for 50 days. Samples of seedlings were taken at 5-day intervals and their mean dry masses were recorded.

The results of this investigation are shown in the tables below.

Table 1 – Sea plantain

Day	Mean dry mass / mg		
	10 °C	14 °C	18 °C
5	2	2	2
10	3	4	6
15	4	6	12
20	7	12	20
25	10	19	34
30	13	25	47
35	17	31	85
40	20	40	109
45	24	55	164
50	28	80	210

Table 2 – Bog sedge

Day	Mean dry mass / mg		
	10 °C	14 °C	18 °C
5	1	1	1
10	1	1	1
15	1	2	2
20	1	2	2
25	2	2	3
30	2	3	5
35	2	4	8
40	3	5	12
45	4	6	16
50	5	7	22

- (i) Suggest how these results could be displayed in order to compare the effect of temperature on the growth of seedlings of these two species.

(3)

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- (ii) Suggest why all of the seeds were germinated at 18 °C before being placed in the temperature-controlled rooms.

(2)

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(iii) Use the data in the tables to suggest which of the two species is better adapted for growth at a wide range of latitudes (distance from the equator). Give reasons for your choice.

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(Total for Question 1 = 12 marks)

Question 2 & 3: N/A

4 Muscle contraction in mammals involves two fibrous proteins, actin and myosin. These slide over each other to reduce the length of the muscle.

(a) State **two** differences between fibrous proteins, such as actin and myosin, and globular proteins, such as enzymes.

(2)

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(b) During the first few hours after the death of a mammal, the muscles undergo a characteristic contraction known as rigor mortis.

(i) Place a cross in the box next to the factor that might influence the rate of progress of rigor mortis in a muscle immediately after death.

(1)

- A** Degree of decomposition of the muscle
- B** Oxygen concentration of the atmosphere
- C** Presence of drugs in the body
- D** Presence of egg laying insects

(ii) Suggest **two** environmental factors that influence the rate of progress of rigor mortis in a muscle immediately after death.

(2)

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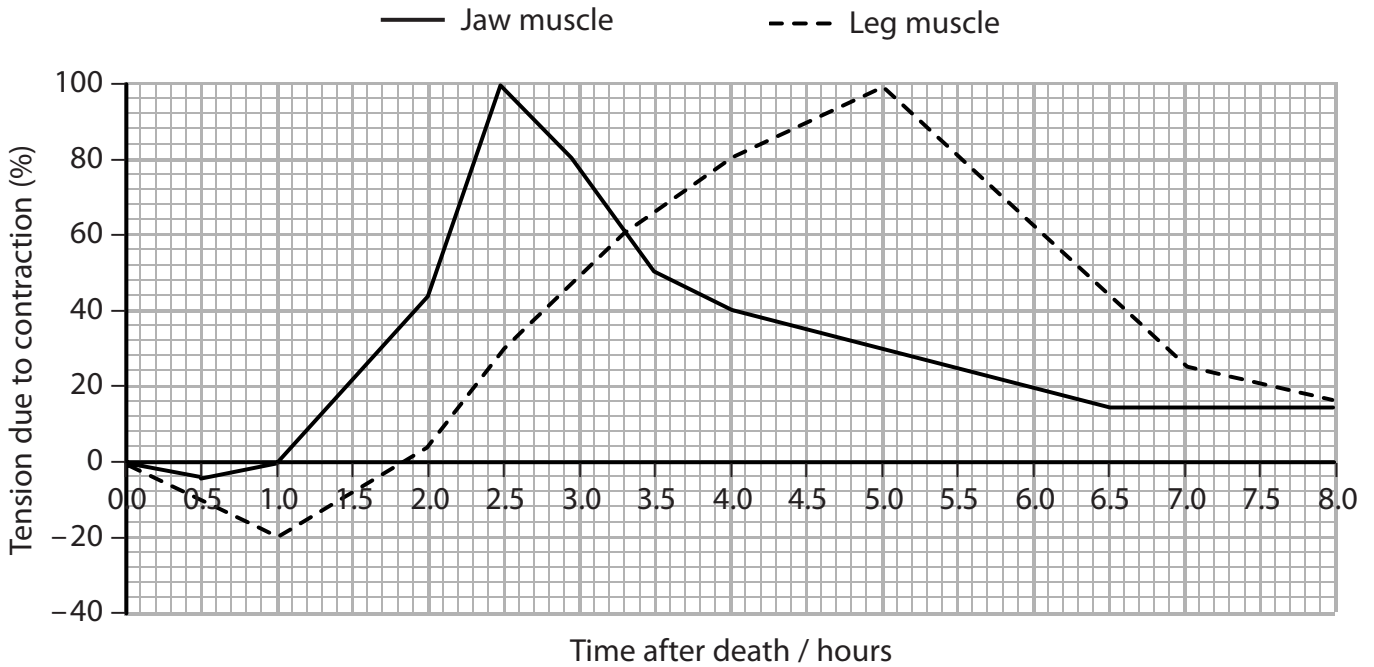
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(c) In an investigation of rigor mortis in rats, the tension due to contraction was measured in leg muscles and jaw muscles at intervals of 30 minutes after death. The tension was recorded as a percentage of the normal full contraction of each muscle in the live animal.

The graph below shows the results of this investigation.



Using the data in the graph, suggest why a forensic scientist would need to consider rigor mortis in several muscles of a body when estimating the time of death.

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(Total for Question 4 = 9 marks)

5 The skin has an important role in protecting the body from infection by pathogenic bacteria. Human skin has a community of microorganisms, called the skin flora, living on it. Most of these microorganisms are harmless bacteria that feed on dead skin cells and secretions.

(a) (i) State **two** ways in which the skin flora can help to protect a person from infection by pathogenic bacteria.

(2)

1

2

(ii) Place a cross next to the part of the skin that forms a physical barrier against infection by pathogenic bacteria.

(1)

A Epidermis

B Erector pili

C Malpighian layer

D Sebaceous gland

(b) Influenza (flu) is caused by a virus.

Sometimes antibiotics are used as part of the treatment for a person with influenza.

Suggest why antibiotics may be used as part of the treatment for influenza.

(2)

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(c) The overuse of antibiotics is causing concern.
 The table below shows the number of prescriptions for antibiotics per 10 000 population in the USA, given during treatment for influenza, from 2000 to 2006.

Year	Number of prescriptions per 10 000 population
2000	226
2002	164
2004	172
2006	142

(i) Calculate the overall percentage reduction in the number of prescriptions per 10 000 population in the USA from 2000 to 2006.
 Show your working.

(2)

Answer %

(ii) The target set by health authorities in the USA for the number of prescriptions per 10 000 population by 2012 is 128, an overall reduction of 43.4% since 2000.

Suggest whether this target will be achieved.
 Give an explanation for your answer.

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(iii) Suggest why health authorities in the USA are encouraging the reduction in the number of prescriptions of antibiotics.

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(Total for Question 5 = 12 marks)

- 6 Osteocalcin is a structural protein found in the bones of mammals. The sequence of the amino acids in osteocalcin can be determined using mass spectrometry.

The sequences of the first 20 amino acids in the primary structure of osteocalcin from the bones of humans and some apes are shown in the table below. Each amino acid is represented by a capital letter.

Mammal	Amino acid number																			
	1				5					10					15					20
Human	Y	L	Y	Q	W	L	G	A	P	V	P	Y	P	D	P	L	E	P	R	R
Chimpanzee	Y	L	Y	Q	W	L	G	A	P	V	P	Y	P	D	P	L	E	P	R	R
Orang utan	Y	L	Y	Q	W	L	G	A	P	V	P	Y	P	D	P	L	E	P	K	R
Gorilla	Y	L	Y	Q	W	L	G	A	O	V	P	Y	P	D	P	L	E	P	K	R

- (a) Place a cross next to the most appropriate answer that completes each of the following statements about these sequences of amino acids.

- (i) The number of nucleotides in the gene for osteocalcin production used for each of these sequences is (1)

- A 20
 B 40
 C 60
 D 80

- (ii) The type of bond that links the amino acids in the primary structure of osteocalcin is (1)

- A disulphide
 B hydrogen
 C ionic
 D peptide

- (iii) The structure in which the amino acids in the primary structure of osteocalcin would be linked together is a (1)

- A centriole
 B lysosome
 C nucleolus
 D ribosome

(b) (i) Using the data in the table, suggest with reasons what conclusions scientists might make about the ancestral relationships of humans and apes.

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(ii) Suggest how DNA analysis could give further evidence for their conclusions.

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(iii) Describe how gel electrophoresis can be used to analyse DNA.

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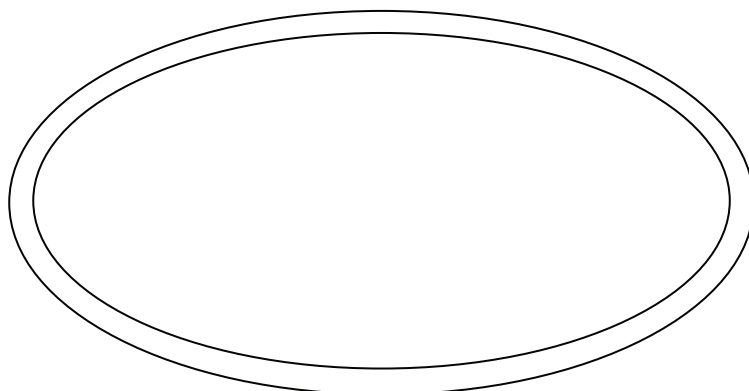
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(Total for Question 6 = 12 marks)

7 In seaweeds that are found on shores around Britain, photosynthesis occurs during the time that they are submerged at high tide. Seaweeds found near the top of the shore are submerged for short periods in shallow water. Seaweeds found lower down the shore are submerged for longer periods in deeper water.

(a) The diagram below shows the double-membrane envelope of a chloroplast.



(i) Complete the diagram to show the structures involved in the light-dependent reactions of photosynthesis. Label these structures.

(2)

(ii) The table below shows two statements taken from a student's essay about the light-dependent reactions of photosynthesis. Complete the following table by placing a tick (✓) in the correct column next to each statement to show whether it is true or false.

(2)

Statement	True	False
Electrons in chlorophyll are excited as light energy is absorbed		
The energy absorbed by chlorophyll is used to generate ADP and NADP		

(iii) Explain how oxygen is produced during the light-dependent reactions of photosynthesis.

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- (b) As light penetrates deeper water, red, orange and yellow wavelengths are absorbed by the seawater, whereas in shallow water most wavelengths penetrate.

The table below shows the relative rates of photosynthesis in a green seaweed, *Ulva lactuca*, and a red seaweed, *Schizymenia dubyi*, at different wavelengths of light.

The relative rates of photosynthesis are compared with the rate in light with a wavelength of 660 nm (red).

Seaweed	Relative rate of photosynthesis / arbitrary units		
	430 nm (blue)	540 nm (green)	660 nm (red)
<i>Ulva lactuca</i>	0.94	0.17	1.0
<i>Schizymenia dubyi</i>	0.38	3.40	1.0

- (i) Using the data in the table, suggest where each of these two seaweeds is most likely to be found on a seashore. Place a tick (✓) in the most appropriate box in each column.

(2)

Position on shore	<i>Ulva lactuca</i>	<i>Schizymenia dubyi</i>
Top of the shore		
Middle of the shore		
Lower down the shore		
All regions		

- (ii) Give reasons for your answers.

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(Total for Question 7 = 12 marks)

8 Human immunodeficiency virus (HIV) causes the condition known as acquired immunodeficiency syndrome (AIDS) in humans.

(a) Complete the following table by placing a tick (✓) in the correct column next to each statement to show whether it is true or false.

(3)

Statement	True	False
HIV infects b-lymphocytes in the human immune system		
The genetic material in HIV is a form of RNA		
The enzyme, reverse transcriptase, is used by HIV		

(b) Following infection by HIV, the genetic material will be copied as the virus reproduces. A single virus reproduces at a very fast rate giving rise to billions of viruses in just one day.

During reproduction of HIV, many genetic mutations are produced. This means that many new strains of HIV can develop quickly within an infected person.

(i) Explain what is meant by the term **genetic mutation**.

(2)

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- (ii) Suggest why effective treatment of HIV in human populations will require the continual development of a mixture of many new drugs.

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(Total for Question 8 = 9 marks)

- 9 Florence (Flo-Jo) Griffith-Joyner's world record of 10.49 seconds for the 100 m women's sprint in 1988 is unbeaten.



In this short time, a sprinter such as Flo-Jo could not deliver enough oxygen to her muscles to maintain aerobic respiration.

- * (a) Describe how a sprinter is able to release sufficient energy for the 100 m sprint without having enough oxygen available for her muscles.

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(b) (i) Lactate (lactic acid) can build up in the muscles of a sprinter.
Suggest why the build-up of lactate may prevent any further increase in speed.

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(ii) Explain the fate of lactate following a sprint.

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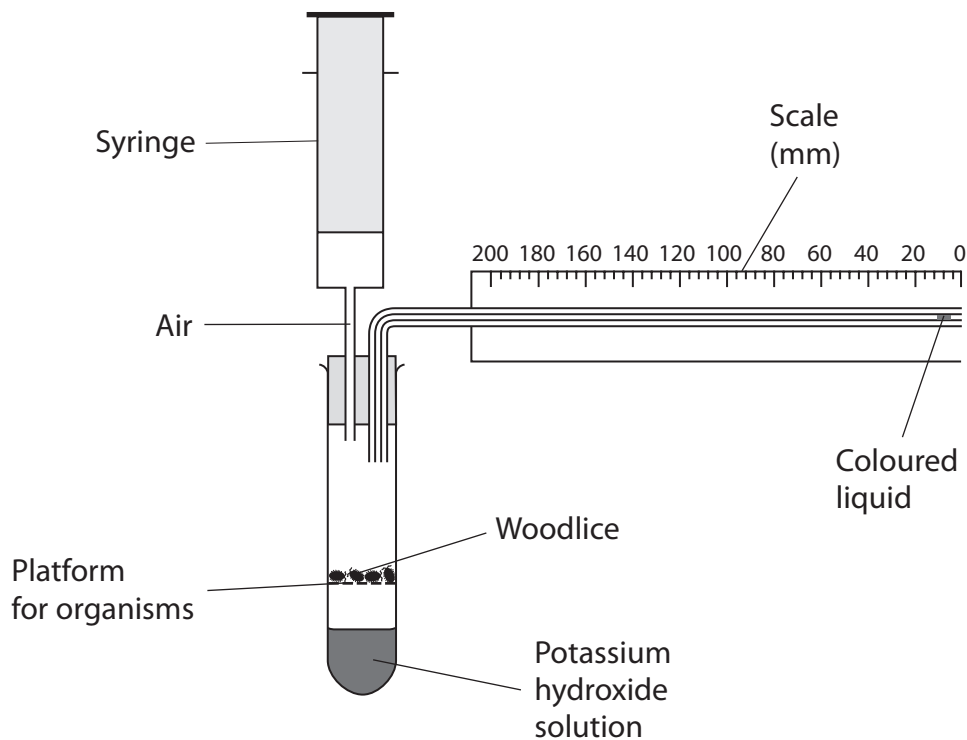
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(Total for Question 9 = 12 marks)

10 The apparatus shown in the diagram below can be used to measure the rate of respiration of small animals such as woodlice.



(a) (i) Potassium hydroxide solution absorbs carbon dioxide.
Suggest a reason for absorbing carbon dioxide in this apparatus.

(1)

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(ii) Suggest what the syringe is used for in this apparatus.

(2)

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*(b) Describe how this apparatus could be used to find the mean rate of respiration of woodlice.

(6)

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(Total for Question 10 = 9 marks)