

Read carefully

- 1 Check that the answer sheet provided is for **Biology Advanced Higher (Section A)**.
- 2 For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.
- 3 Check that the answer sheet you have been given has **your name, date of birth, SCN** (Scottish Candidate Number) and **Centre Name** printed on it.
Do not change any of these details.
- 4 If any of this information is wrong, tell the Invigilator immediately.
- 5 If this information is correct, **print** your name and seat number in the boxes provided.
- 6 The answer to each question is **either** A, B, C or D. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided (see sample question below).
- 7 There is **only one correct** answer to each question.
- 8 Any rough working should be done on the question paper or the rough working sheet, **not** on your answer sheet.
- 9 At the end of the exam, put the **answer sheet for Section A inside the front cover of this answer book**.

Sample Question

Which of the following molecules contains six carbon atoms?

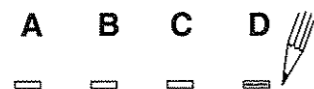
- A Glucose
- B Pyruvic acid
- C Ribulose biphosphate
- D Acetyl coenzyme A

The correct answer is **A—Glucose**. The answer **A** has been clearly marked in **pencil** with a horizontal line (see below).



Changing an answer

If you decide to change your answer, carefully erase your first answer and using your pencil, fill in the answer you want. The answer below has been changed to **D**.

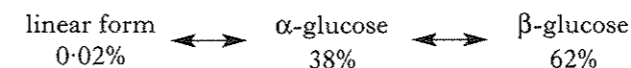


SECTION A

All questions in this section should be attempted.

Answers should be given on the separate answer sheet provided.

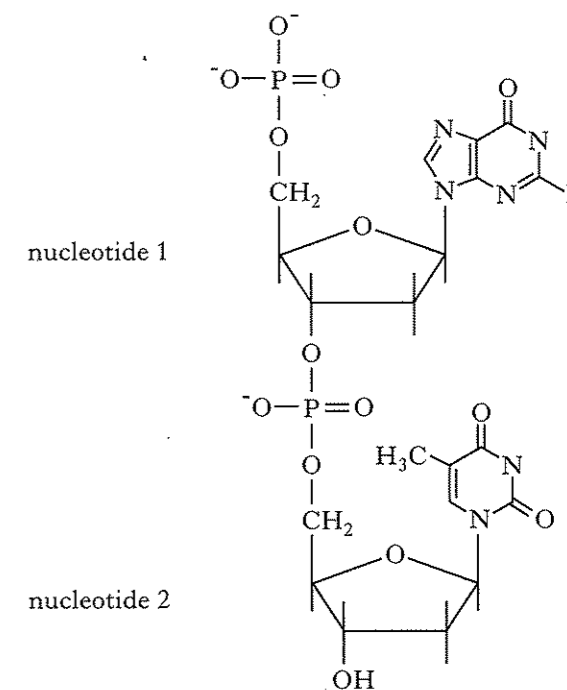
1. The presence of which of the following would indicate that a cell was from a plant?
A Plasmodesmata
B Ribosomes
C Cell wall
D Nucleoid
2. Cytokinins are used in plant tissue culture to
A promote totipotency
B promote differentiation
C produce pathogen-free plants
D fuse protoplasts.
3. In solution, glucose molecules exist in three forms. The chemical equilibrium between the forms is shown below.



Approximately how many molecules will be in the β -glucose form for every one molecule in the linear form?

- A 30
- B 300
- C 3000
- D 30 000

4. The diagram below shows the first two nucleotides in a DNA strand.



Which of the following statements about the DNA strand is correct?

Nucleotide 1 is at the

- A 3' end and has the base guanine
- B 3' end and has the base thymine
- C 5' end and has the base guanine
- D 5' end and has the base thymine.

5. At the end of each human chromosome there is a region of DNA known as the telomere that initially consists of 2000 repeats of the sequence TTAGGG. At each mitosis, 100 base pairs are lost from the telomere.

What is the minimum number of mitotic divisions that will completely remove the telomeres?

- A 60
- B 120
- C 240
- D 330

[Turn over

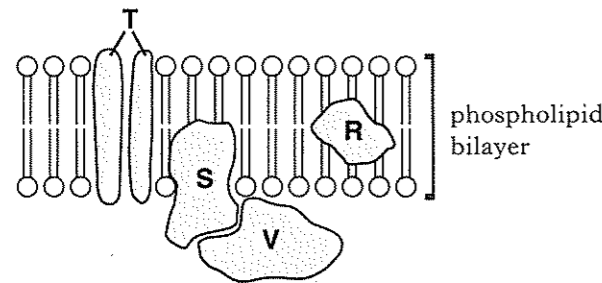
6. The percentage of adenine bases in a double strand of DNA is known. For how many of the other bases could the percentage be calculated?

A None
B One
C Two
D Three

7. During DNA replication one of the strands of DNA (the lagging strand) is replicated as a series of fragments that are then bonded together. The enzymes that make and bond the DNA fragments are

A polymerase and ligase
B ligase and kinase
C polymerase and nuclease
D kinase and nuclease.

8. The diagram below shows the arrangement of four proteins (R, S, T and V) and the phospholipid bilayer of a cell membrane.



Which of the proteins shown are integral membrane proteins?

A R only
B R and S only
C R, S and T only
D R, S, T and V

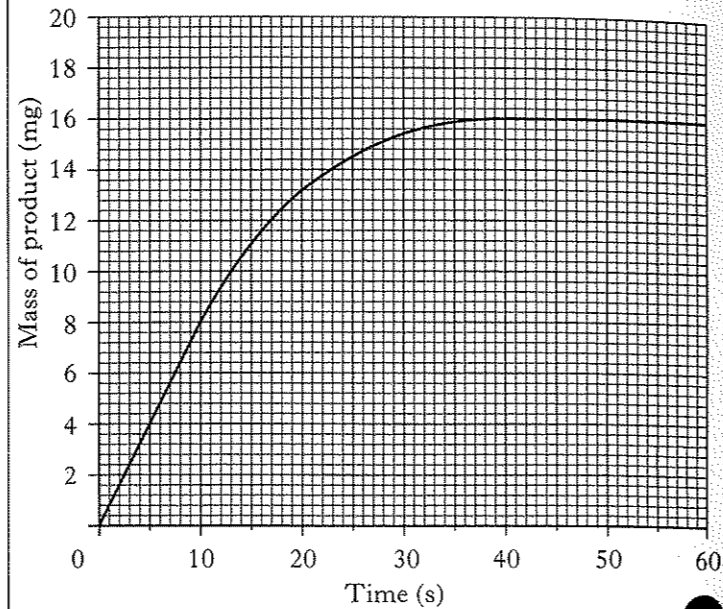
9. The mechanism of action of the sodium-potassium pump involves the following stages:

P membrane protein is phosphorylated
Q sodium ions bind to membrane protein
R sodium ions are released
S membrane protein changes conformation

The correct sequence is

A P, Q, R, S
B P, Q, S, R
C Q, P, R, S
D Q, P, S, R.

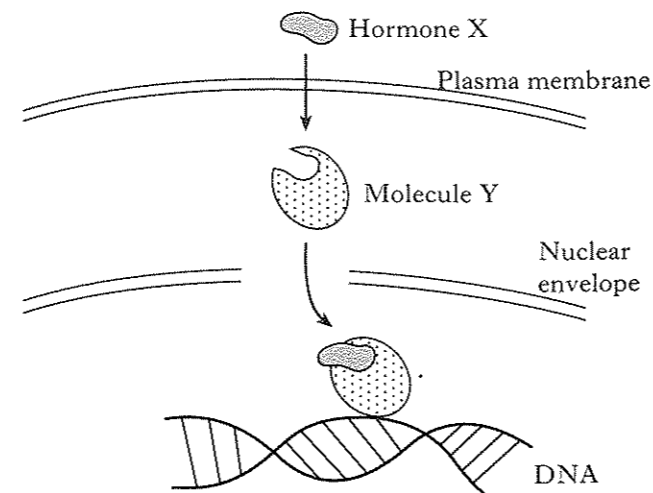
10. The graph below shows the mass of product resulting from an enzyme-controlled reaction.



What is the initial rate of reaction?

A 0.35 mg s^{-1}
B 0.8 mg s^{-1}
C 1.25 mg s^{-1}
D 3.5 mg s^{-1}

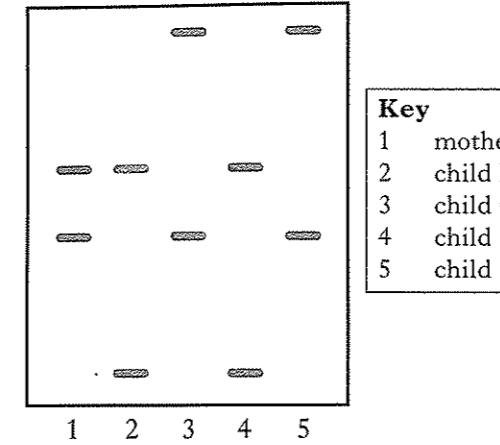
11. The diagram below illustrates the action of a signalling molecule.



Which line in the table correctly identifies molecules X and Y?

	Hormone X	Molecule Y
A	testosterone	regulatory protein
B	insulin	receptor protein
C	insulin	regulatory protein
D	testosterone	receptor protein

12. A forensic scientist is reconstructing the DNA profile of a missing person from analysis of DNA profiles of close relatives. In this case a father of four children is missing. All the children have the same biological mother and father. Results from a single locus probe DNA profile analysis for the four children and their mother are shown below.



Which of the following is likely to be the DNA profile of the missing father?



13. The table below shows mean values for net primary productivity (NPP) for four ecosystems.

Ecosystem	NPP ($\text{kJ m}^{-2} \text{ yr}^{-1}$)
Desert scrub	1400
Tropical rainforest	36 000
Temperate deciduous forest	22 000
Temperate monoculture	30 000

Which of the following factors is **not** likely to account for these differences?

A Mean annual temperature
B Annual rainfall
C Application of fertiliser
D Carbon dioxide content of air

14. Young bluegill sunfish feed on *Daphnia* (water fleas). The following table shows how low and high prey densities affect the diet of these fish.

Prey size	Low prey density			High prey density		
	small	medium	large	small	medium	large
Percentage available	33	33	34	14	30	56
Percentage eaten	32	33	35	3	40	57

From the information above, which of the following describes the feeding strategy of young bluegill sunfish at different prey density?

	Low prey density	High prey density
A	non-selective	non-selective
B	non-selective	selective
C	selective	non-selective
D	selective	selective

15. Which line in the table may be correctly applied to detritivores?

	Mode of nutrition	Effect on humus production
A	saprotrophic	increased
B	saprotrophic	decreased
C	heterotrophic	increased
D	heterotrophic	decreased

16. In the nitrogen cycle, which process converts ammonium ions into a form that can be assimilated by producers?

A Nitrification
B Denitrification
C Ammonification
D Nitrogen fixation

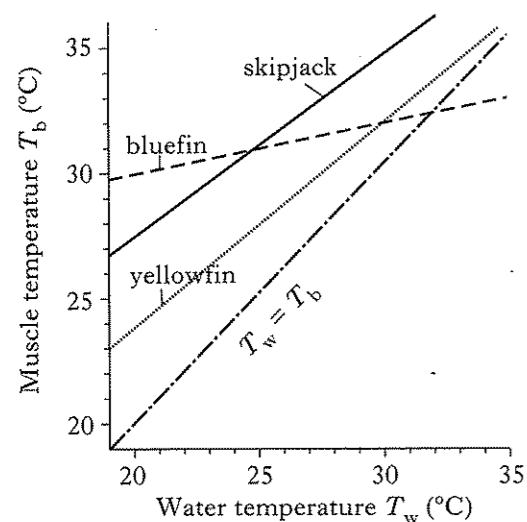
17. Several grassland plots were fenced to exclude voles, which feed mainly on annual grasses. The table below shows information about plants in fenced and unfenced plots after two years.

	Relative biomass (units)		Number of plant species	
	Fenced plots	Unfenced plots	Fenced plots	Unfenced plots
Annual grasses	120	40	6	6
Other plants	40	80	12	24

Which line of the table below best summarises the effects of excluding voles?

	Productivity of plant community	Diversity of plant community
A	increased	increased
B	decreased	increased
C	increased	decreased
D	decreased	decreased

18. The graph below shows the relationship between water temperature and muscle temperature for three species of tuna. Tuna are poikilothermic fish but have some ability to thermoregulate.



At which environmental temperature would the best thermoregulator have the same muscle temperature as a perfect thermoconformer?

- A 24°C
- B 29°C
- C 30°C
- D 32°C

19. Diagram A shows three burrowing animals which live at different depths on Scottish beaches. They are eaten by various wading birds such as those illustrated in Diagram B.

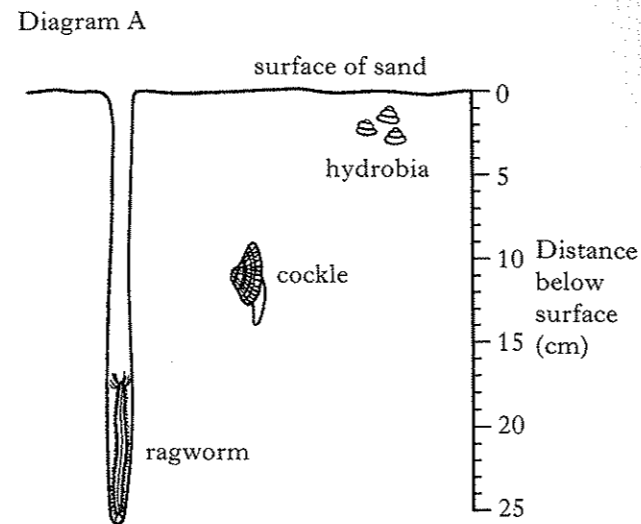
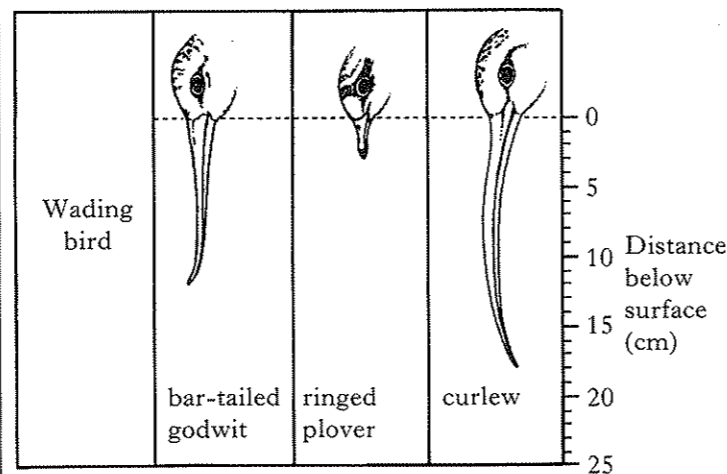


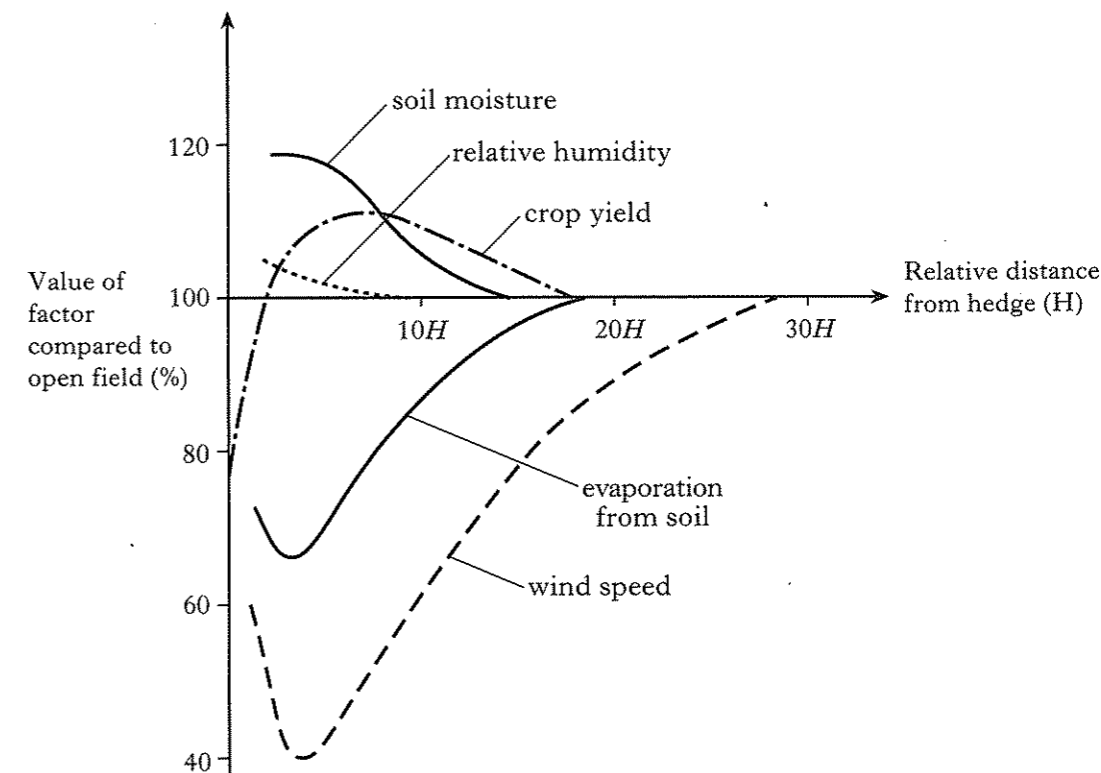
Diagram B



Which of the following is a consequence of the different length of the waders' beaks?

- A Competitive exclusion
- B Resource partitioning
- C Exploitation competition
- D Fundamental niche modification

20. The information below shows how several factors are affected by the presence of a hedge. Comparisons can be made with hedges of any height (H). At different distances from the hedge, the value of each factor is calculated as a percentage of its value in an open field. Relative distance from hedge is the distance in metres as a multiple of the hedge height H.



Which of the following is **not** likely to be responsible for an increase in crop yield 30 metres away from a 3 metre high hedge?

- A Decreased evaporation from the soil
- B Increased soil moisture
- C Decreased wind speed
- D Increased relative humidity

21. Which line in the table correctly describes ecological niches?

	Fundamental niche	Realised niche	Reason for difference
A	Resources a species actually uses	Resources a species potentially can use	Interspecific competition
B	Resources a species actually uses	Resources a species potentially can use	Intraspecific competition
C	Resources a species potentially can use	Resources a species actually uses	Interspecific competition
D	Resources a species potentially can use	Resources a species actually uses	Intraspecific competition

22. The giant bullfrog of southern Africa lives in an environment where hot and dry conditions can occur at any time of the year. To survive these conditions the frogs become dormant.

Which combination of terms applies to this type of dormancy?

- A Predictive and aestivation
- B Predictive and hibernation
- C Consequential and aestivation
- D Consequential and hibernation

23. Which of the following gases is **both** a greenhouse gas and acidic?

- A Carbon dioxide
- B Ozone
- C CFC
- D Methane

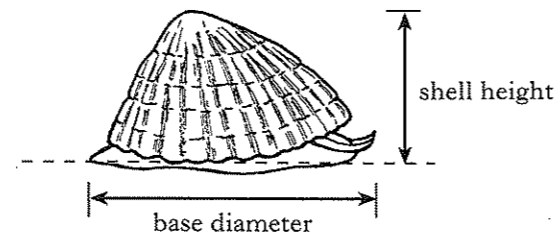
24. A large accumulation of algae was observed in a canal that had been polluted by inorganic fertilisers washed in from surrounding fields. The biochemical oxygen demand (BOD) of the water then began to increase.

This could be explained by

- A a decrease in photosynthesis by the algae
- B reduced respiration by the algae
- C decreased solubility of oxygen
- D decomposition of the algae.

25. Limpets are invertebrates which attach themselves firmly to rocks on seashores when the tide goes out. Limpet shape seems to be influenced by the degree of exposure to waves the animals experience in their specific locations. On exposed shores, the shells have a “flatter” shape than on sheltered shores because they are less likely to be dislodged by wave action.

Limpet “flatness” was determined on four shores by measuring the heights and diameters of limpets as shown below.



The results are shown in the table.

	Shore			
	A	B	C	D
Mean limpet height (mm)	24	23	20	25
Mean limpet diameter (mm)	40	49	37	50

Which shore is likely to be the most exposed?

[Turn over for Section B on Page ten

[END OF SECTION A]

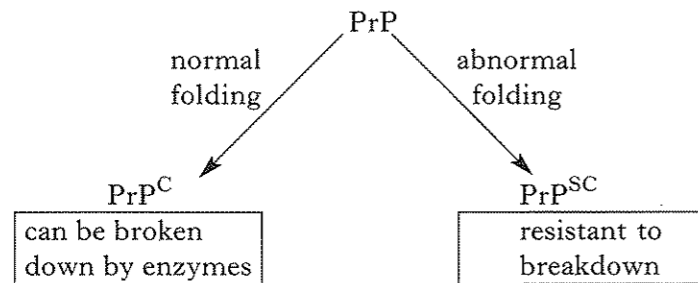
Candidates are reminded that the answer sheet **MUST** be returned **INSIDE** the front cover of the answer book.

SECTION B

All questions in this section should be attempted.
All answers must be written clearly and legibly in ink.

1. Bovine spongiform encephalopathy (BSE) and variant Creutzfeldt-Jakob disease (vCJD) are examples of fatal brain disease that can pass from one species to another. The nature of the infectious agent is as yet unidentified but, in both diseases, a protein known as PrP^{SC} accumulates in brain tissue.

It has been shown that PrP^{SC} is an altered form of the normal membrane protein PrP^C. Both molecules have the same primary structure (PrP) but they differ in how the PrP protein folds. Molecules of PrP^{SC} have a lower proportion of α -helix and a higher proportion of β -sheets. Proteins are normally broken down after a certain length of time by intracellular enzymes. However, the increased β -sheet content makes PrP^{SC} more resistant to enzymatic breakdown, which leads to its accumulation.



A substance capable of breaking β -sheets (β -breaker) was tested to find out if it could make PrP^{SC} more susceptible to the intracellular enzymes. PrP^{SC} samples from mice and humans were each incubated for 48 hours with different concentrations of β -breaker and the percentage of PrP^{SC} remaining after digestion was determined. The results are shown in the Figure. The error bars in the Figure indicate the degree of variation between replicates.

In the same study, mouse PrP^{SC} was further analysed to determine if any change in the proportions of α -helix and β -sheet had occurred. The results are shown in Table 1.

In a second study, mice were treated with infectious material containing (i) PrP^{SC} and (ii) a 1 : 1 mixture of PrP^{SC} and β -breaker. Quantities of PrP^{SC} were equivalent in both treatments. Table 2 shows the mean time to onset of symptoms of brain disease in the two groups. Different concentrations of PrP^{SC} were prepared by diluting stock solutions.

Question 1 (continued)

Figure: The effect of β -breaker on mouse and human PrP^{SC}.

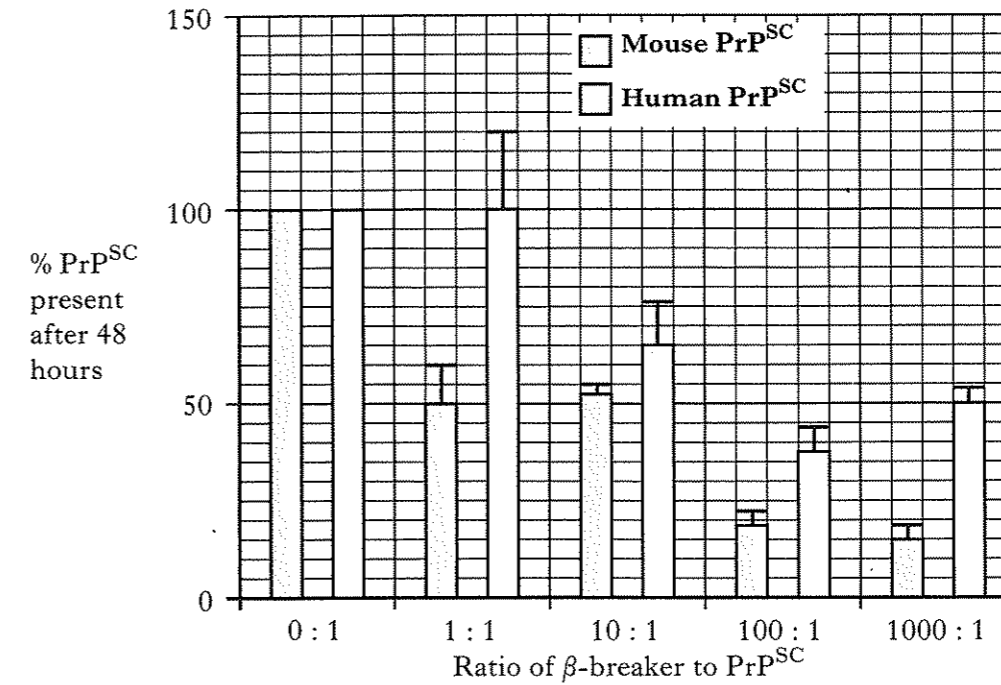


Table 1: Proportions of secondary structure in mouse PrP^{SC} before and after 48 hours incubation with β -breaker.

Secondary structure	Proportions of secondary structure (%)	
	Before incubation	After incubation
α -helix	18	27
β -sheet	36	9

Table 2: Time to onset of symptoms for mice treated with PrP^{SC} with and without β -breaker.

PrP ^{SC} concentration (relative to stock solution)	Time to onset of symptoms (days)	
	PrP ^{SC}	PrP ^{SC} + β -breaker
1×10^{-2}	129	143
1×10^{-3}	145	159
1×10^{-4}	173	185

[Question 1 continues on Page twelve]

Question 1 (continued)

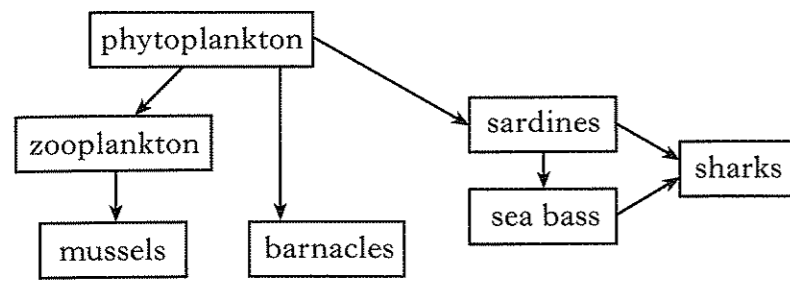
- (a) PrP^C and PrP^{SC} are both glycoproteins.
- (i) Apart from a polypeptide, what is the other chemical component of glycoprotein? 1
 - (ii) State the function of cell membrane glycoproteins. 1
- (b) (i) PrP^C and PrP^{SC} have the same primary structure. Why should they be expected to fold in an identical way? 1
- (ii) Hydrogen bonds are important in the development of secondary structure of proteins.
Name **two** other types of interactions involved in protein folding. 1
- (c) Refer to the data in the Figure.
- (i) What evidence is there to suggest that the experimenters tested only one sample in each of the controls? 1
 - (ii) Draw **two** conclusions about the effect of β -breaker on human and mouse PrP^{SC}. 2
- (d) Refer to the information in Table 1.
- (i) Explain why the PrP^{SC} protein should be more susceptible to breakdown by intracellular enzymes after incubation. 2
 - (ii) What additional information about PrP^{SC} would be required to establish if β -breaker has caused the PrP^{SC} to become fully susceptible to breakdown? 1
 - (iii) Which type of enzyme would break down PrP? 1
- (e) Refer to the information in Table 2.
- (i) At what concentration of PrP^{SC} does the β -breaker have the greatest effect? 1
 - (ii) What is the effect of changing the concentration of PrP^{SC} on the onset of brain disease in mice? 1
- (f) Taking all the data into consideration, suggest **two** modifications to the treatments in the second study that may delay the onset of symptoms further. 2

(15)

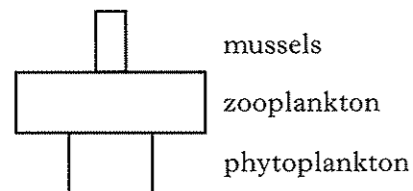
[Questions 2, 3 and 4 are on fold-out Page thirteen]

5. The diagram shows a food web in a marine ecosystem and the vertical distribution of the organisms involved.

Marks



- (a) Explain why phytoplankton are only found in the surface waters. 2
- (b) Within this food web there is variation in the number of trophic levels for the different food chains. Explain why a food chain rarely contains more than four trophic levels. 1
- (c) The diagram below shows a pyramid of biomass for the trophic levels involving phytoplankton, zooplankton and mussels in a sample from the ecosystem.

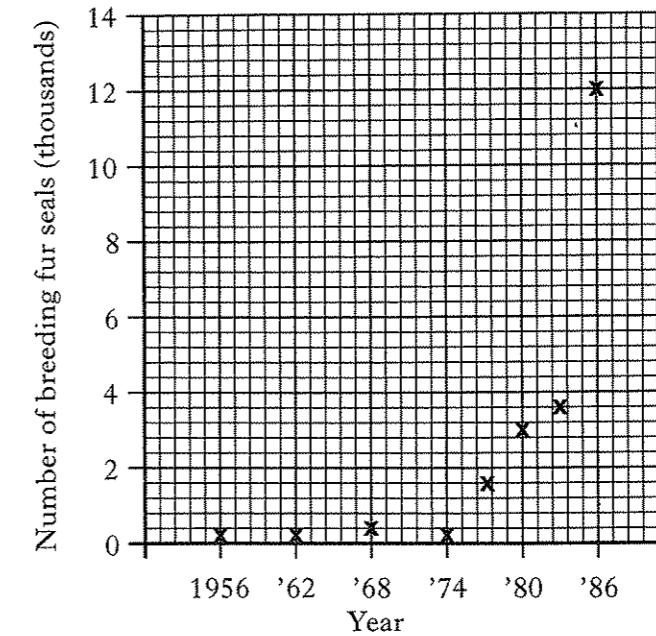


Describe how a pyramid of productivity would differ from the pyramid of biomass shown. Give one reason for the difference. 2

(5)

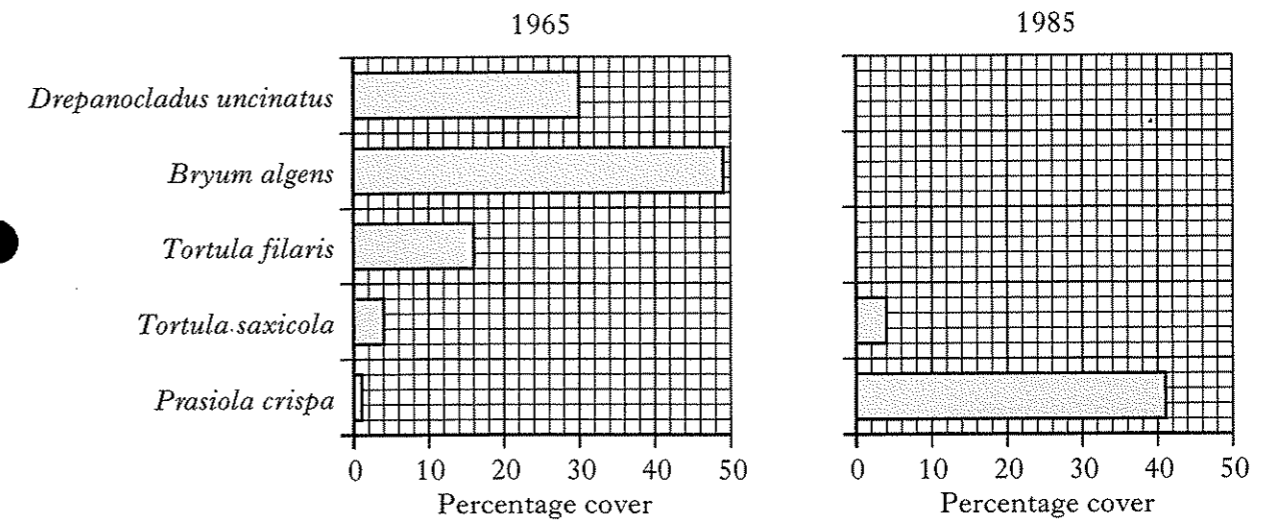
6. Fur seals spend most of their lives feeding in Antarctic seas. During the short summer they come ashore to breed. Marks

(a) The figure below shows the number of fur seals breeding on Signy Island from 1956 to 1986.



Calculate the mean annual growth rate of the seal population over the period 1980 to 1986. 1

- (b) Permanent quadrats were established to investigate the effect of seals on ground cover plants. The charts show the mean percentage cover of a number of plants in the permanent quadrats in 1965 and in 1985.



- (i) What proportion of ground cover has been lost? 1
- (ii) Suggest an explanation for the disappearance of some ground cover plant species. 2
- (iii) Suggest a possible reason for the increase in percentage cover by *Prasiola crispa* during the period of the study. 1
- (c) Fur seals are homeothermic. Explain how this feature allows the species to survive the large temperature differences between sea and land in the Antarctic. 1

(6)

	<i>Marks</i>
7. Answer either A or B.	
A. Give an account of ecosystem change under the following headings:	
(i) main features of a primary autogenic succession;	9
(ii) effects of human activity.	6
OR	(15)
B. Discuss positive/negative (+/-) interactions between species under the following headings:	
(i) grazing;	4
(ii) parasitism;	5
(iii) defence against predation.	6
	(15)

[END OF SECTION B]

7. Answer **either** A or B.

A. Give an account of ecosystem change under the following headings:

- (i) main features of a primary autogenic succession; 9
- (ii) effects of human activity. 6

(15)

OR

B. Discuss positive/negative (+/-) interactions between species under the following headings:

- (i) grazing; 4
- (ii) parasitism; 5
- (iii) defence against predation. 6

(15)

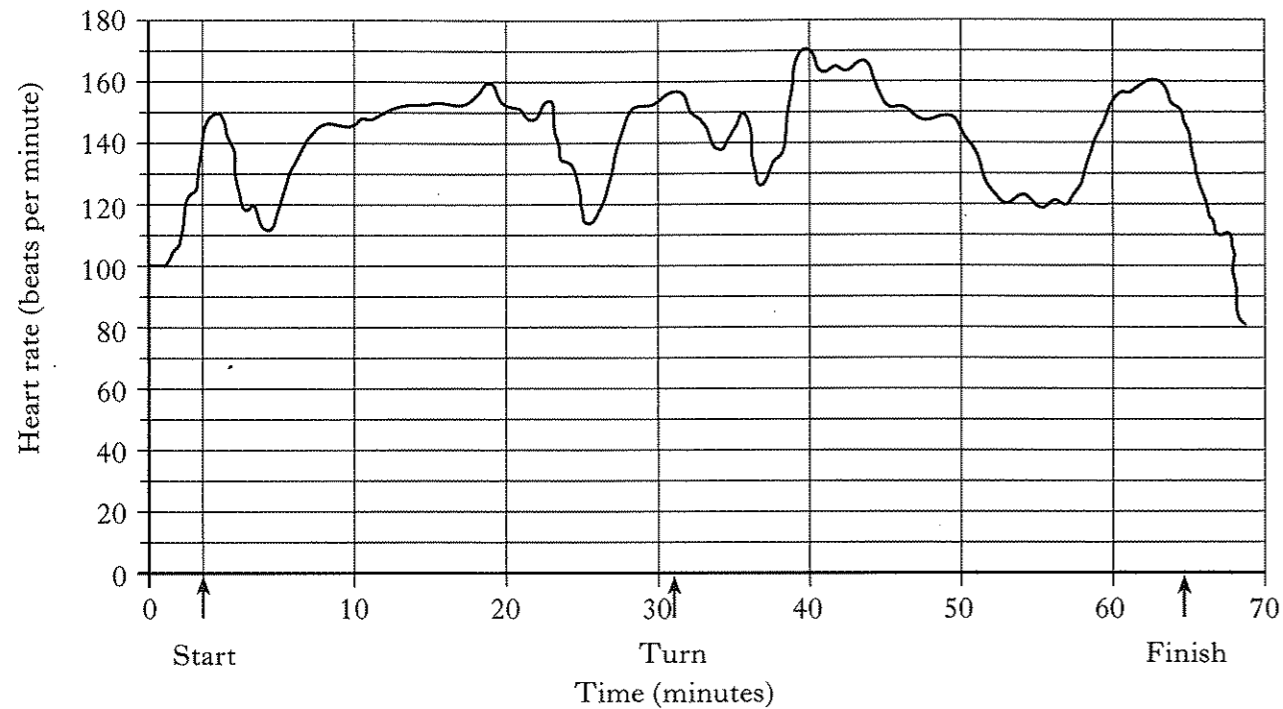
[END OF SECTION B]

SECTION C (continued)

Marks

Physiology, Health and Exercise

1. The figure below shows the printout from the heart rate monitor of a 30 year old cyclist completing a time trial. The time trial is a race against the clock over a distance of 36 km on an out-and-back course where all the competitors start and finish at the same place returning from the half way point by the reverse route.



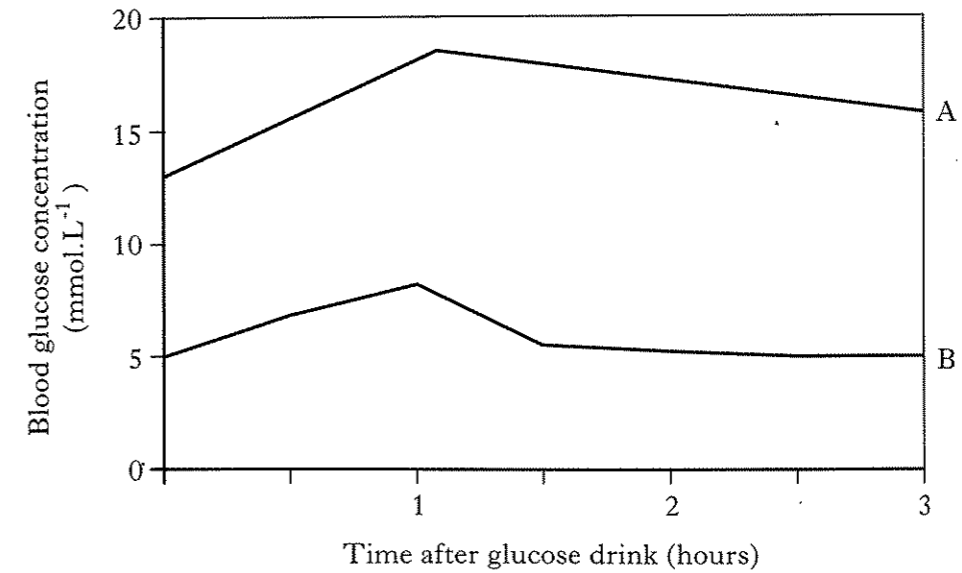
- (a) What changes to the distribution of blood would have occurred in the cyclist's body as he began the race?
- (b) The cyclist is a trained athlete. How would the structure of his heart differ from that of an untrained individual?
- (c) What **two** pieces of evidence from the figure suggest that the cyclist "warmed up" before the race?
- (d) An estimate of maximal heart rate, in beats per minute, can be determined by subtracting the person's age in years from 220. What is the highest percentage of this cyclist's maximal heart rate reached during the race?
- (e) After the race the cyclist said, "I was feeling really good on the way out but my legs felt like lead on the way back". Suggest **two** reasons for the difference between the out and return journeys.
- (f) Give **two** differences in the results that would be expected if an untrained person was monitored while cycling the same course.

1
1
2
1
2
2
(9)

Physiology, Health and Exercise (continued)

Marks

2. The following figure shows the results of a glucose tolerance test for two subjects A and B. Each fasted for a period of twelve hours and was then given 50 g glucose in a 150 cm³ drink. Blood glucose levels were then monitored for 3 hours.

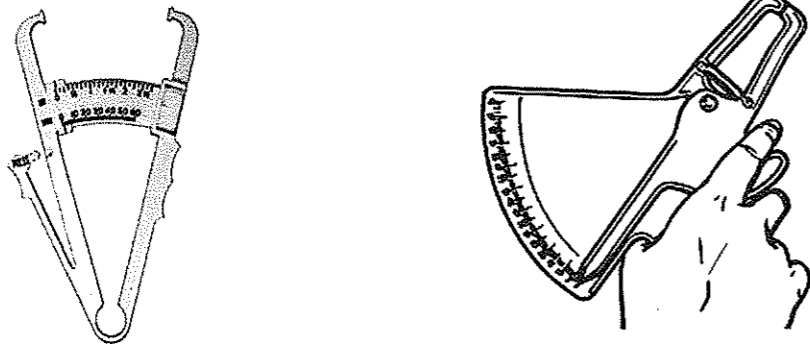


- (a) Subject B has normal control of blood glucose. Give **two** pieces of evidence from the data that suggest subject A is diabetic.
- (b) Give **two** effects of insulin that would give rise to the response shown after one hour in subject B.

2
1
(3)

[Turn over for Questions 3 and 4 on Page twenty four

3. The illustration below shows calipers used to estimate percentage body fat.



- (a) What does the device measure?
- (b) Explain how the procedure for using the calipers provides a valid estimate of percentage body fat.
- (c) Name **two** alternative methods of estimating percentage body fat.

1

2

1

(4)

4. Describe how some of the factors that contribute to cardiovascular disease can be modified to reduce the risk.

(4)

(20)

[END OF QUESTION PAPER]

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