Advanced Higher Biology

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Hodder Gibson would like to thank SQA for use of any past exam questions that may have been used in model papers, whether amended or in original form.

National
Qualifications
MODEL PAPER 1

Biology
Section 1—Questions

Duration — 2 hours 30 minutes

Instructions for the completion of Section 1 are given on *Page two* of your question and answer booklet.

Record your answers on the answer grid on *Page three* of your question and answer booklet.

Before leaving the examination room you must give your question and answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

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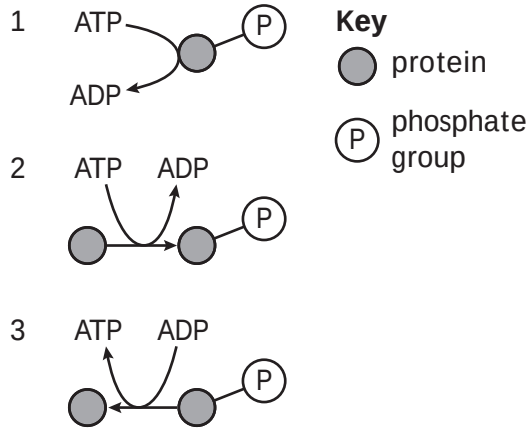
SECTION 1 — 25 marks

Attempt ALL questions

1. The diagrams below represent the general actions of enzymes involved in the transfer of phosphate groups in cells.



Which line in the table below identifies the enzymes involved in each diagram?

	Phosphatases	*ATP-ases*	*Kinases*
A	1	2	3
B	3	1	2
C	2	3	1
D	1	3	2

2. Which line in the table below describes the charges on the two components of nucleosomes?

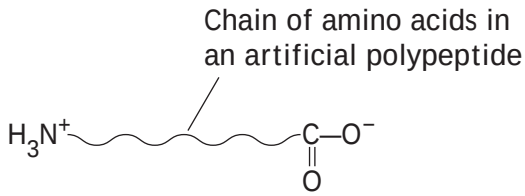
	Charge on nucleosome component	
	DNA	*Histone proteins*
A	negative	negative
B	positive	negative
C	positive	positive
D	negative	positive

3. The table below shows the charges on the R groups of four amino acids at a certain pH. An artificial polypeptide consisting of a chain of only 24 of these amino acids has the ratio 3 glycerates : 2 asparates : 2 lysines : 1 glycine and is shown in the diagram below. The charge on each chain terminus is also shown.

Table

Charge on R Group = +1	*Charge on R Group = −1*
glycerate	lysine
aspartate	glycine

Diagram



From the information given, what is the overall net charge on this polypeptide at this pH?

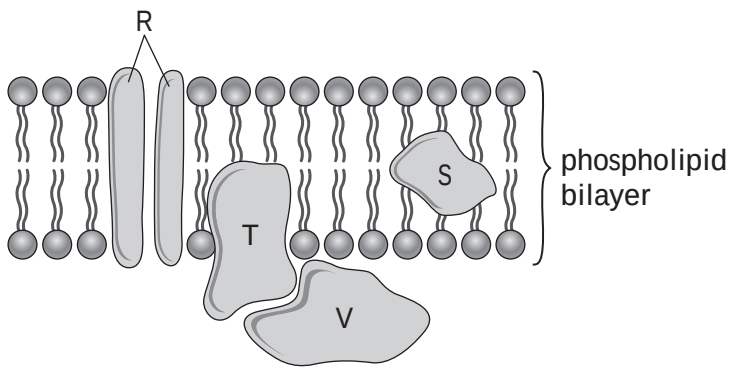
A −6

B −3

C +3

D +6

4. The diagram below shows the arrangement of four protein molecules, R, S, T and V, and the phospholipid bilayer in a fragment of cell membrane.



Which of the protein molecules shown are integral membrane proteins?

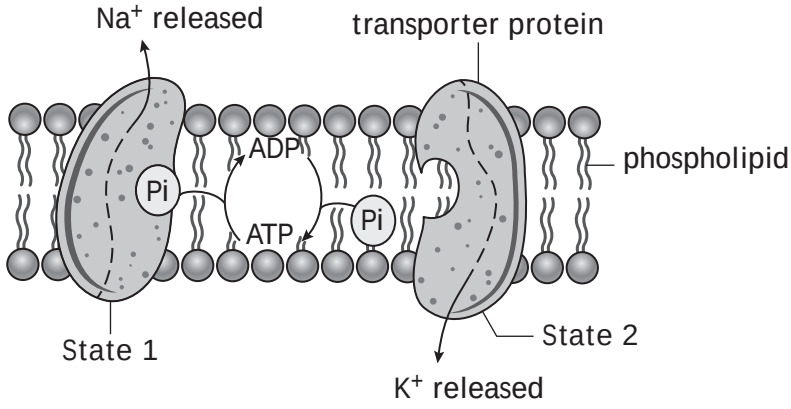
A S only

B R only

C R, S and T

D R, S, T and V

5. The diagram below shows two conformational states of molecules of the Na/K transporter protein in a cell membrane and the release of Na^+ and K^+ ions from them.



Which line in the table below identifies the affinity for Na^+ ions of each conformational state of this protein?

	State 1	*State 2*
A	low	high
B	low	low
C	high	high
D	high	low

6. Common self-heal, *Prunella vulgaris,* is a perennial plant species found in moist grassland habitats at various altitudes throughout Europe.

A transplant experiment was carried out to investigate the contribution of genes and the environment to the stem height of this species. Specimens of young apomictic plants were collected at altitudes of 1000 metres and 2000 metres and transplanted at both altitudes. The heights of the stems of the transplanted individuals were measured after a year and means calculated as shown in the table below.

Altitude from which young plants were collected (m)	*Mean height of stems* (cm)	
	Plants grown at 1000 m	*Plants grown at 2000 m*
1000	25 ± 8	19 ± 4
2000	18 ± 4	10 ± 2

Which observations could be used to justify the conclusion that variation in height is determined to some extent by the environment?

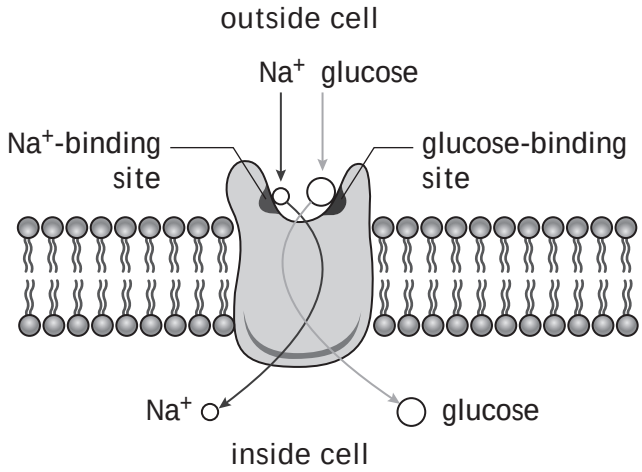
A Plants from different altitudes have similar heights when grown in different environments.

B Plants from the same altitude have different heights when grown in different environments.

C Plants from different altitudes have different heights when grown in the same environment.

D Plants from the same altitude have different heights when grown in the same environment.

7. The diagram below shows a glucose and sodium ion (Na^+) symport in the membrane of a cell from the lining of the human small intestine.



Which line in the table below represents the relative concentrations of glucose and sodium ions (Na^+) on the two sides of the plasma membrane?

	Sodium ions (Na^+)		*Glucose*	
	Outside cell	*Inside cell*	*Outside cell*	*Inside cell*
A	high	low	low	high
B	high	low	high	low
C	low	high	low	high
D	low	high	high	low

8. Some stages of muscle contraction are listed below.

1 Phosphate ion released from myosin head

2 ATP binds to myosin head and causes it to detach from actin filament

3 Myosin head swings forward and attaches to actin filament

4 Myosin head drags along actin filament

In which sequence do these stages occur as contraction progresses?

A 2, 1, 3, 4

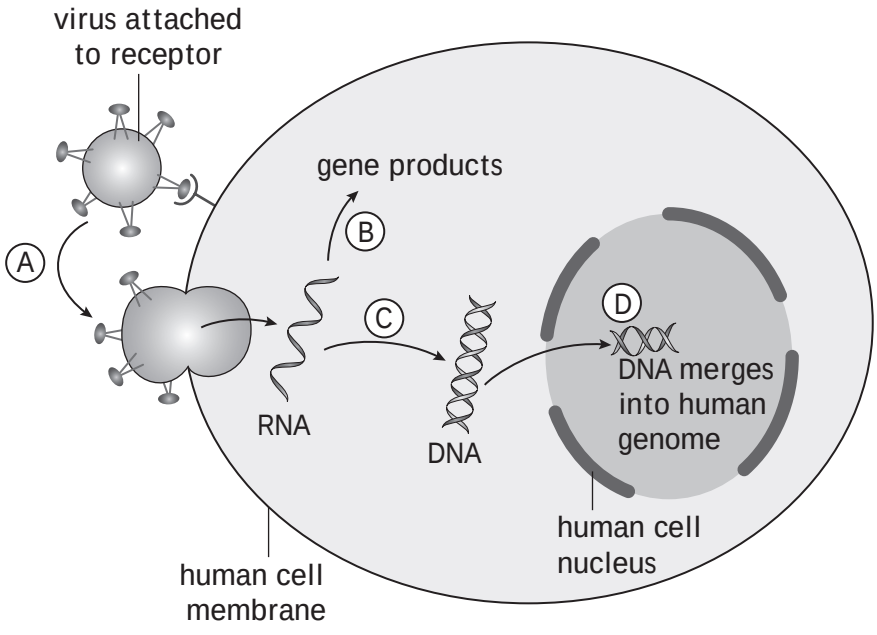
B 2, 3, 1, 4

C 3, 2, 1, 4

D 3, 2, 4, 1

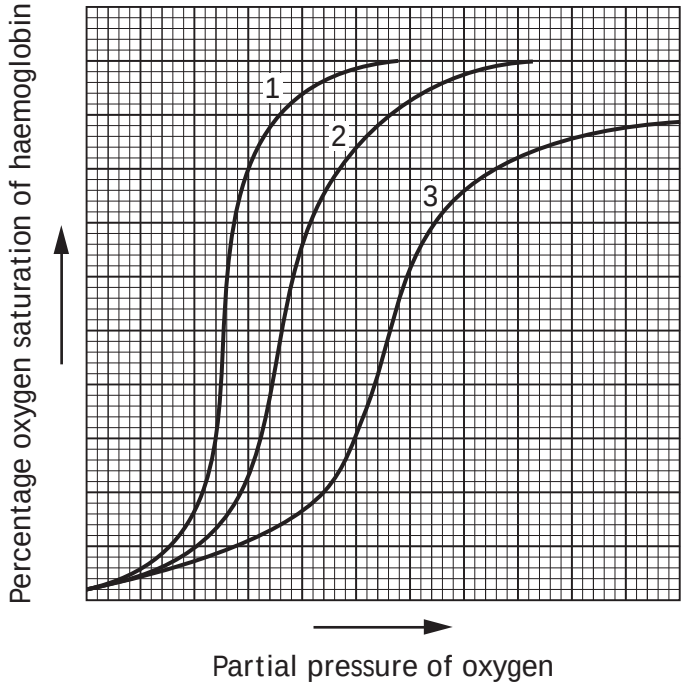
9. Zidovudine is an anti-viral drug which can be used in the treatment of HIV 1 infections in humans. It inhibits the action of reverse transcriptase during the life cycle of the virus.

At which stage in the life cycle would zidovudine be most effective?



10. Temperature influences the binding and release of oxygen molecules by haemoglobin.

The graph below shows the percentage oxygen saturation of haemoglobin at three different temperatures: 34ºC, 37ºC and 42ºC.



10. (continued)

Which line in the table below identifies these temperatures?

	Graph 1	*Graph 2*	*Graph 3*
A	34ºC	37ºC	42ºC
B	37ºC	42ºC	34ºC
C	34ºC	42ºC	37ºC
D	42ºC	37ºC	34ºC

11. Which line in the table below describes the steroid hormone thyroxine and its effect on genes that increase metabolic rate?

	Type of signal molecule	*Location of receptor molecule binding*	*Effect on transcription*
A	hydrophobic	nucleus	removes inhibition
B	hydrophilic	membrane	inhibits
C	hydrophobic	nucleus	inhibits
D	hydrophilic	membrane	removes inhibition

12. Which of the following situations would be expected to increase the rate of evolution?

A having a longer generation time

B living in a cooler environment

C reducing selection pressure

D transferring genes horizontally

13. In birds, **females** are heterogametic. The gene for feather-barring in domestic chickens is sex-linked. The allele for barred feathers is dominant to the allele for non-barred feathers.

Which ratio of offspring would be expected if a non-barred male was crossed with a barred female?

A 1 barred female : 1 barred male

B 1 non-barred male : 1 non-barred female

C 1 barred male : 1 non-barred female

D 1 non-barred male : 1 barred female

14. The Lincoln Index N = MC/R is used to estimate the size (N) of certain animal populations during field investigations. A sample of the population is captured and marked (M). After an appropriate time, a second sample is captured (C) and any recaptured individuals are counted (R).

The list below shows possible assumptions and precautions related to the method used.

1. All individuals have an equal chance of being captured.
2. Immigration and emigration occur at equal rates.
3. The sampling methods used are kept the same.

Which items in the list must be **true** for a valid and reliable population estimate?

A 1 only
B 1 and 3 only
C 2 and 3 only
D 1, 2 and 3

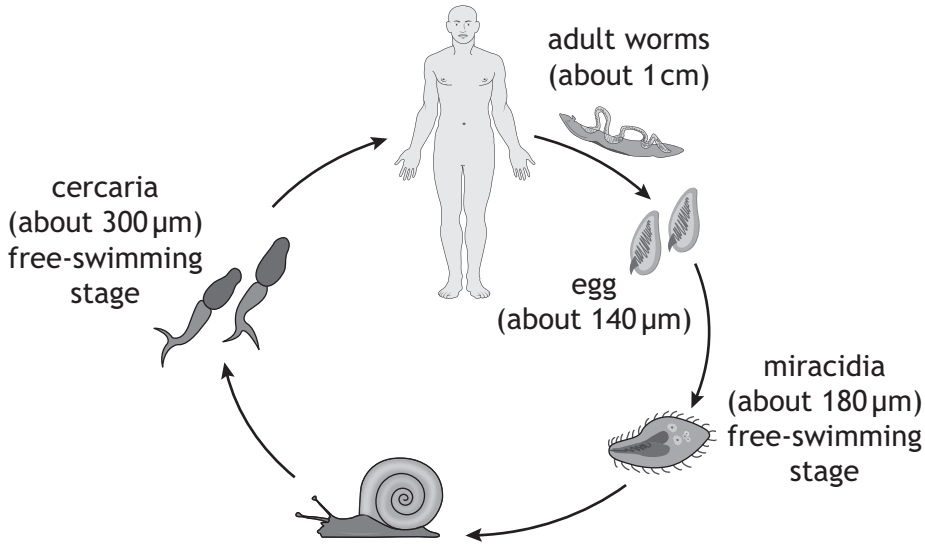
15. All viruses consist of a protein coat surrounding

A DNA or RNA
B DNA and RNA
C DNA only
D RNA only.

16. Which of the following is **not** a source of DNA during horizontal gene transfer in bacteria?

A gametes
B viruses
C plasmids
D bacterial chromosomes

17. The diagram below shows the life cycle of a parasitic worm that causes schistosomiasis in humans.



Which line in the table below shows the roles of the various species in the life cycle of this parasite?

	Definitive host	*Intermediate host*	*Vector species involved?*
A	snail	human	yes
B	human	snail	yes
C	human	snail	no
D	snail	human	no

18. Which of the following features of a parasite may be considered a part of its extended phenotype?

A virulence

B rapid antigen change

C high genetic variability

D alteration of host behaviour

19. The parental investment strategy of a species can be classified as K-selected or r-selected.

Which line in the table below describes the characteristics of K-selected species compared to r-selected species?

	K-selected compared to r-selected	
	Number of offspring	*Size of offspring produced*
A	larger	larger
B	larger	smaller
C	smaller	larger
D	smaller	smaller

20. The red-necked phalarope, *Phalaropus lobatus*, is a ground-nesting wading bird. The females have brighter plumage than the males, and the males carry out much of the egg incubation.

This situation is described as

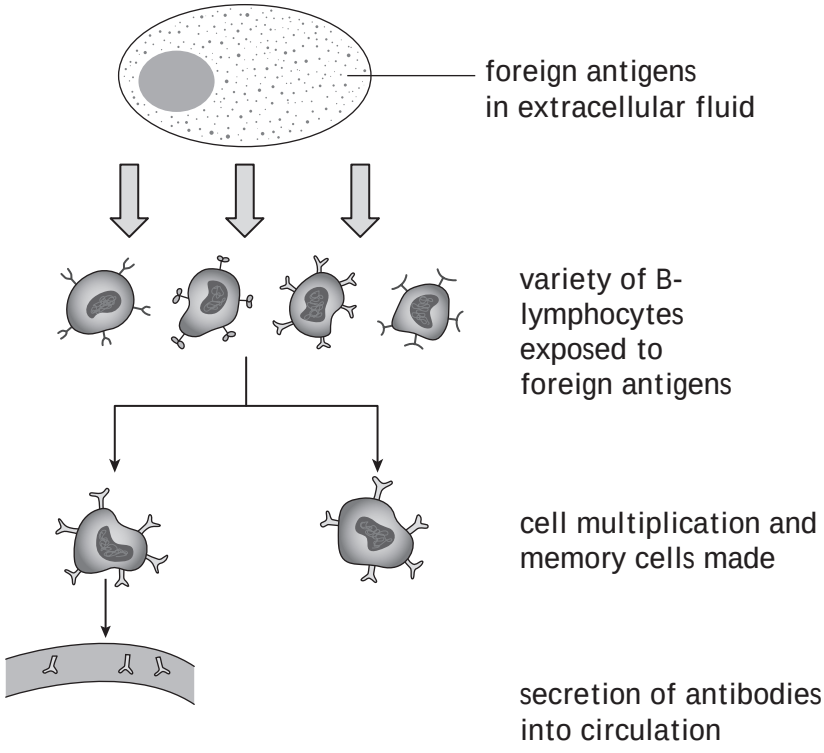
A satellite male strategy

B reversed sexual dimorphism

C lekking behaviour

D parthenogenesis.

21. The diagram below shows a response by B-lymphocytes to foreign antigens.



Which of the following identifies this cellular response?

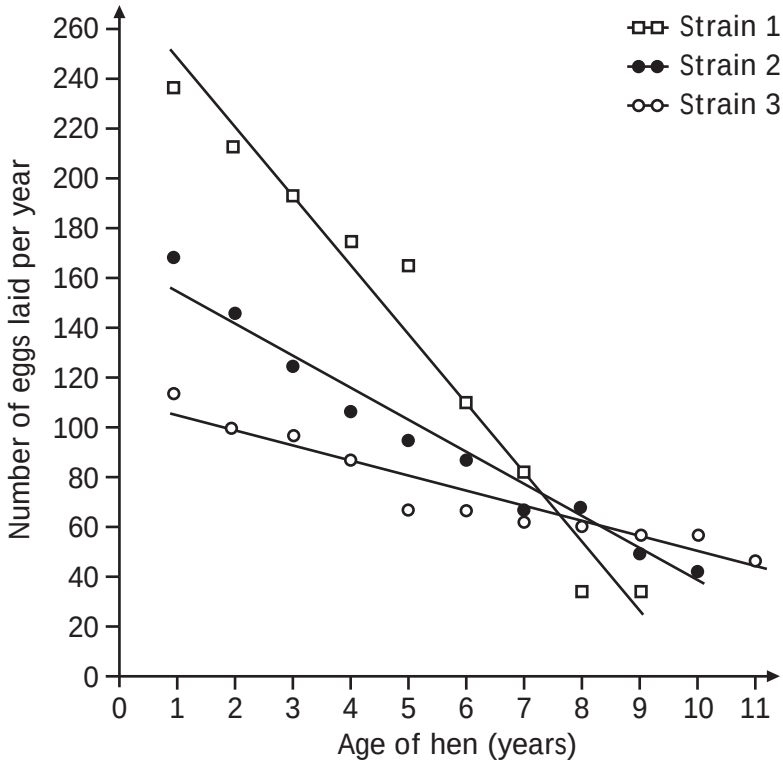
A apoptosis

B phagocytosis

C inflammation

D clonal selection

22. The graph below shows how the egg-laying rate of three different strains of white leghorn hen varies with their age.



Which of the following conclusions **can** be supported from the information shown?

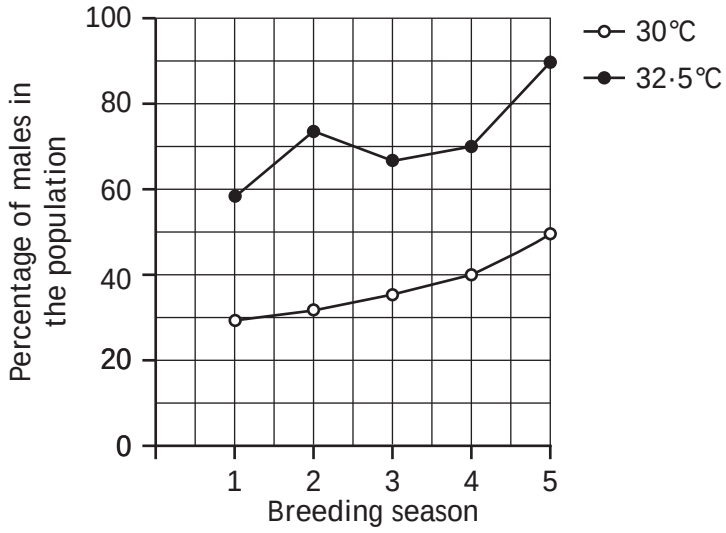
A Older hens have a higher egg-laying rate than younger hens.

B Egg-laying rate decreases faster with age in hens that lay more eggs early in life.

C The number of eggs laid throughout life is approximately equal in all three strains.

D Egg-laying rate in later life is independent of egg-laying rate in earlier years.

23. Eggs of leopard geckos kept in breeding cages were collected and incubated at two temperatures over five breeding seasons. When each new gecko hatched, its gender was noted. The graph below shows how gender in the gecko population varied at each temperature.



How many females would be present in a population of 500 geckos after four seasons at 32·5°C?

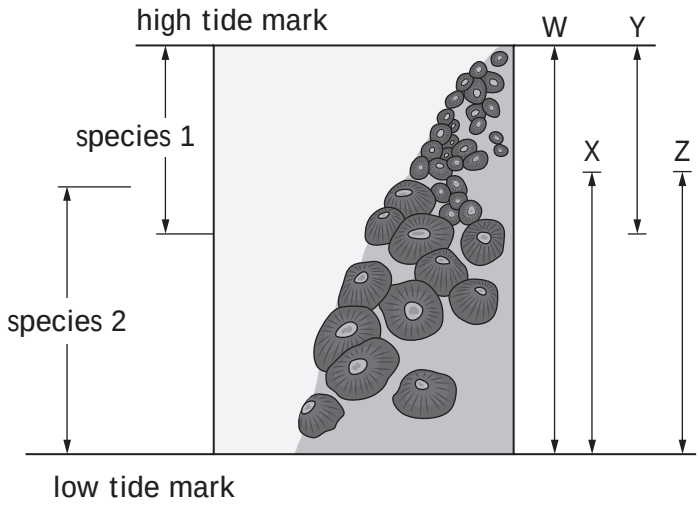
A 150

B 200

C 300

D 350

24. The diagram below represents the distribution of two species of barnacle on a rocky shore. The fundamental and realised niches of the two species are shown by the vertical lines W, X, Y and Z.



The realised niche of species 2 is shown by line Z.

Which line in the table below identifies the other niches illustrated?

	Fundamental niche of species 1	*Fundamental niche of species 2*	*Realised niche of species 1*
A	W	Y	X
B	Y	X	W
C	W	X	Y
D	X	W	Y

25. In terms of selection, fitness can be describes as absolute or relative.

Absolute fitness is the ratio of

A surviving offspring of one phenotype compared to other phenotypes

B frequencies of a particular genotype in one generation compared to the next

C surviving offspring of one genotype compared to other genotypes

D frequencies of a particular phenotype in one generation compared to the next.

[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2 OF YOUR QUESTION AND ANSWER BOOKLET]

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National Qualifications MODEL PAPER 1

Mark

Biology
Section 1 — Answer Grid and Section 2

Duration — 2 hours 30 minutes

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth

Day | Month | Year

Scottish candidate number

Total marks — 90

SECTION 1 — 25 marks

Attempt ALL questions.

Instructions for completion of Section 1 are given on *Page two.*

SECTION 2 — 65 marks

Attempt ALL questions.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. You should score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not you may lose all the marks for this paper.

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SECTION 1—25 marks

The questions for Section 1 are contained on *Page 45*—Questions.
Read these and record your answers on the answer grid on *Page 63* opposite.
Use **blue** or **black** ink. Do NOT use gel pens or pencil.

1. The answer to each question is **either** A, B, C or D. Decide what your answer is, then fill in the appropriate bubble (see sample question below).

2. There is **only one correct** answer to each question.

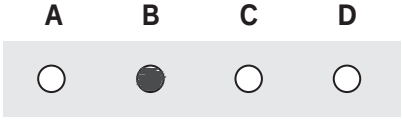
3. Any rough working should be done on the additional space for answers and rough work at the end of this booklet.

Sample Question

The thigh bone is called the

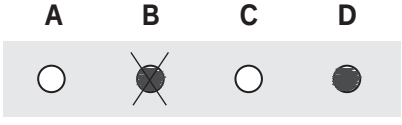
A humerus
B femur
C tibia
D fibula.

The correct answer is **B**—femur. The answer **B** bubble has been clearly filled in (see below).

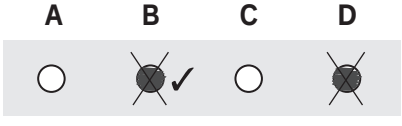


Changing an answer

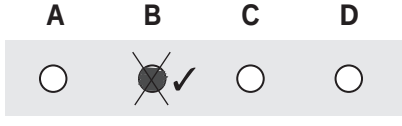
If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.



If you then decide to change back to an answer you have already scored out, put a tick (✓) to the **right** of the answer you want, as shown below:



or



SECTION 1 — Answer Grid

	A	B	C	D
1	○	○	○	○
2	○	○	○	○
3	○	○	○	○
4	○	○	○	○
5	○	○	○	○
6	○	○	○	○
7	○	○	○	○
8	○	○	○	○
9	○	○	○	○
10	○	○	○	○
11	○	○	○	○
12	○	○	○	○
13	○	○	○	○
14	○	○	○	○
15	○	○	○	○
16	○	○	○	○
17	○	○	○	○
18	○	○	○	○
19	○	○	○	○
20	○	○	○	○
21	○	○	○	○
22	○	○	○	○
23	○	○	○	○
24	○	○	○	○
25	○	○	○	○

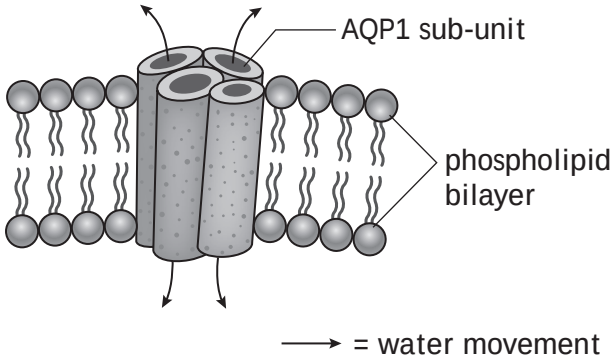
SECTION 2 — 65 marks

Attempt ALL questions

It should be noted that question 11 contains a choice.

1. Aquaporin 1 (AQP1) is a membrane protein which channels the movement of water molecules. AQP1 has four sub-units, each of which acts as a water channel, as shown in **Figure 1** below.

Figure 1: A fragment of membrane containing AQP1



Red blood cells were prepared by allowing them to take up water molecules labelled with a radioactive isotope of hydrogen. The membranes of some of these prepared cells were then phosphorylated to deactivate their membrane AQP1s. Some were left untreated.

Treated and untreated cells were bathed in isotonic and hypertonic solutions and the average rates of water movement through their membranes were measured. The results are shown in **Table 1** below.

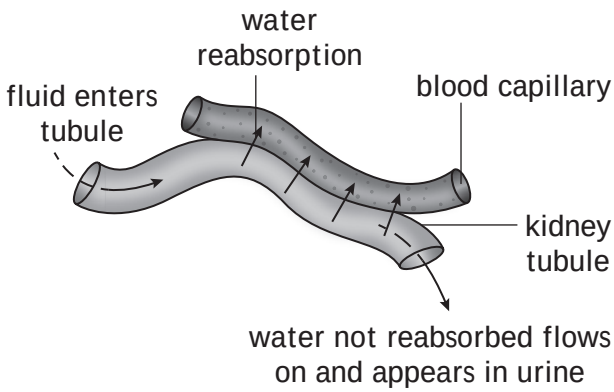
Table 1: Rate of water movement across membranes

Bathing solution	*Average rate of water movement through membranes (units)*	
	Cells with active AQP1	*Cells with deactivated AQP1*
Isotonic with cell contents	3·5	1·4
Hypertonic to cell contents	28·0	2·2

1. (continued)

Figure 2 represents part of a kidney tubule from a mouse. Cells with AQP1 are found in the walls of this part of the tubule and the blood capillaries associated with it. About 70% of water in the fluid entering the tubule is reabsorbed into the blood as it passes through this region. Water which is not reabsorbed passes through the tubule and appears in the urine.

Figure 2: Representation of part of a kidney tubule from a mouse



Presence of aquaporins in the kidney tubule cells is determined by the allele **N**. Mice with genotype **nn** have no aquaporins in their kidney tubule cells. In a study of the importance of aquaporins in the kidney function, mice of different genotypes were selected as shown.

Group 1	genotype	**NN**	aquaporins present
Group 2	genotype	**Nn**	heterozygous
Group 3	genotype	**nn**	aquaporins absent

Average body masses of the mice and the average solute concentration of their urine were measured before and after a period without water. The results are shown in **Figure 3** and **Figure 4** below.

Figure 3: % change in average body mass over a period without water

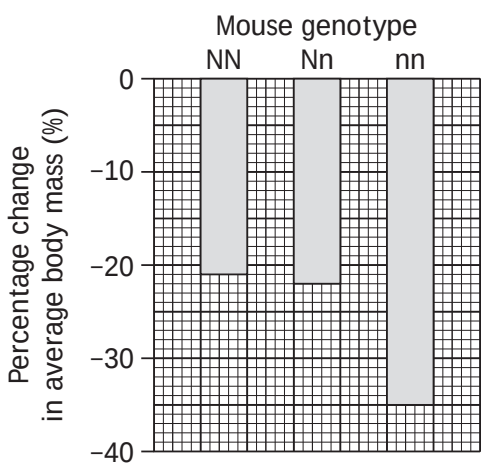
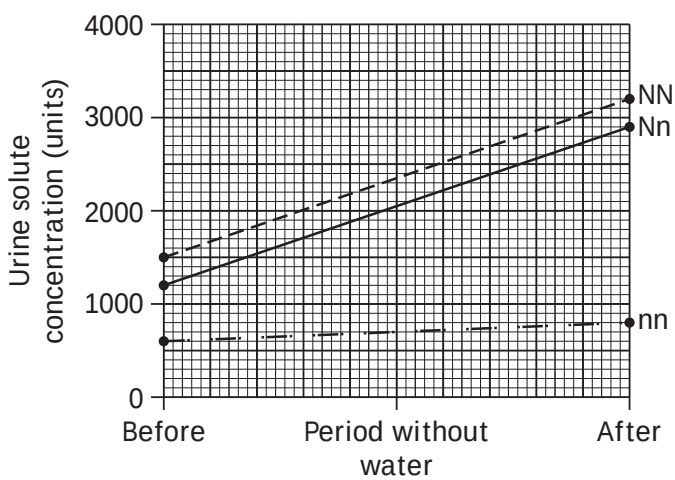


Figure 4: Urine solute concentration before and after a period without water



1. (continued)

(a) (i) Give the term used for proteins such as AQP1 which are embedded into a phospholipid membrane, as shown in **Figure 1**. **1**

(ii) With reference to AQP1, describe what is meant by the quaternary structure of a protein. **1**

(b) Explain why water labelled with radioactive hydrogen was used in this experiment. **1**

(c) (i) Use data in **Table 1** to draw conclusions about:

1 how activating AQP1 affects water flow across membranes; **1**

2 how the water concentration gradient, as well as the activity of AQP1, affects the rate of water flow across membranes. **1**

(ii) Predict the effect of osmosis on the average masses of the cells after immersion in the isotonic solution. **1**

(d) (i) Using information from **Figure 4**, explain the percentage of body mass lost by mice in Group 3 compared with those in Group 1 shown in Figure 3. **2**

(ii) Use the data in **Figures 3 and 4** to show that the heterozygous mice in Group 2 have enough AQP1 to make them capable of maintaining a steady water concentration in their blood. **2**

2. In a procedure to purify an enzyme, a tissue sample was taken through a number of stages.

The table below describes the purification stages and shows the total mass of protein present and the enzyme activity in the sample following each stage in the purification procedure.

Stage	*Description of purification stage*	*Total protein (mg)*	*Enzyme activity (units)*
1	Liquidise tissue sample	10000	2000000
2	Precipitation by salts	3000	1500000
3	Separation by iso-electric point	500	500000
4	Affinity chromatography	30	42000

(a) (i) Calculate the percentage of the protein which had been removed from the liquidised tissue by the end of Stage 4. **1**

Space for calculation

_____ %

(ii) Enzyme purity in a sample can be calculated using the formula below.

$$\textit{enzyme purity} = \frac{\textit{enzyme activity}}{\textit{total protein}}$$

Use the formula to calculate the number of times by which enzyme purity had been increased between the liquidised sample and the end of Stage 4. **1**

Space for calculation

_____ times

(b) Explain how separation by iso-electric point, as in Stage 2, occurs. **2**

_____

_____

_____

(c) In affinity chromatography at Stage 4, a ligand specific to the enzyme being purified was bonded to agarose beads packed into a column.

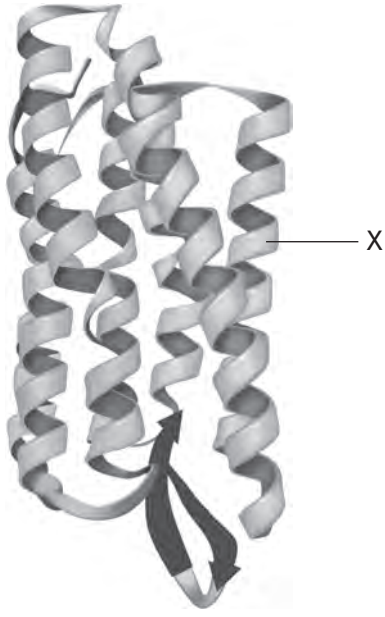
Describe how this method can improve the purity of the enzyme. **2**

_____

_____

_____

3. The diagram below represents part of a molecule of bacteriorhodopsin, a protein found in *Archaea*.



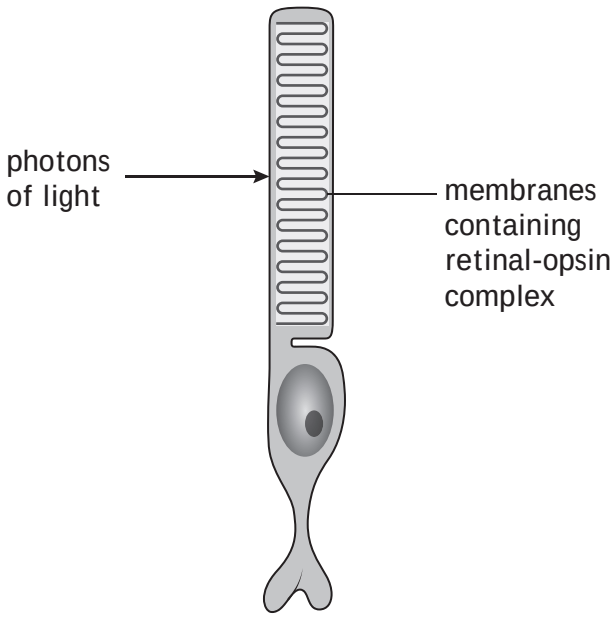
(a) The ribbons in the diagram represent the primary and secondary structures of the protein.

(i) Describe what is meant by the primary structure of a protein. **1**

(ii) Name the secondary structural feature shown at X in the diagram and describe how this feature is formed from the primary structure of the protein. **2**

(b) Describe how bacteriorhodopsin generates a potential difference across membranes. **2**

4. Rod cells and cone cells are photoreceptors in the retinas of vertebrate eyes which are sensitive to photons of light. The diagram below shows a rod cell containing membranes rich in a retinal-opsin complex.



(a) Name the retinal-opsin complex found in vertebrate rod cells. **1**

(b) The retinal opsin complex activates hundreds of G-protein molecules and so provides amplification in the system.

(i) Describe the role of activated G-protein molecules. **1**

(ii) State why amplification is an advantage to vertebrates. **1**

(c) Describe how the photoreceptor proteins of cone cells differ from those of rod cells. **1**

(d) Explain why the variety of photoreceptor proteins in cone cells provides an advantage to vertebrates. **1**

5. Insulin is a peptide hormone involved in the regulation of blood glucose in humans.

(a) Describe how insulin is involved in the uptake of glucose into target cells. **2**

(b) (i) Adiponectin is a signalling molecule thought to increase the sensitivity of cells to insulin.

In a clinical study, the concentration of adiponectin in the blood of patients with Type 2 diabetes was compared to non-diabetics. The results are shown in **Table 1** below.

Table 1

Patient Group	*Average concentration of adiponectin in blood plasma* ($\mu g\,cm^{-3}$)
Type 2 diabetic	6·6 ± 0·4
Non-diabetic	7·9 ± 0·5

Explain how the results in **Table 1** relate to the characteristics of Type 2 diabetes. **2**

5. (b) (continued)

(ii) **Table 2** below shows results of another clinical study in which increases in adiponectin concentration were determined in individuals at risk of developing Type 2 diabetes who received treatment.

Table 2

Treatment	*Average increase in concentration of adiponectin in blood plasma* ($\mu g\,cm^{-3}$)
Drug treatment	0·83 ± 0·05
Lifestyle changes	0·23 ± 0·05
Control (no treatment)	0·10 ± 0·05

Compare the results of drug treatment to lifestyle changes in terms of their effectiveness in increasing adiponectin concentration. **1**

(iii) Both studies used human volunteers.

1 Give **one** ethical issue which should be considered when using human volunteers. **1**

2 Explain why large numbers of volunteers are required to produce reliable results upon which valid conclusions may be based. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

6. Describe the role of genetic drift in the evolution of new species. **4**

7. Feather mites of the order *Sarcoptiformes* (**Figure 1**) are parasites of many birds. The mites feed on oil produced by the birds' oil glands. Oil is applied to feathers during preening times in the mornings and evenings and empties the oil gland. Birds unable to oil their feathers efficiently use more energy maintaining body temperature.

A field investigation into the relationship between mite infection and the breeding success of crested tits (*Parus cristatus*) (**Figure 2**), a species given special protection in Scotland, was carried out.

Figure 1: Feather mite

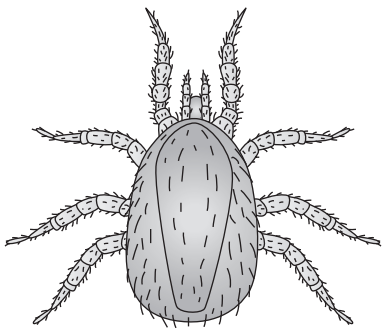


Figure 2: Crested tit

Crested tit nests were located using a systematic search method at a woodland study site and a number of those located were sampled at random. The parent birds from the sample were caught and the following measurements made:

- number of feather mites present
- size of the oil gland.

The nests were monitored and the following data collected:

- number of eggs laid
- number of chicks hatched
- number of chicks which survived to leave the nest.

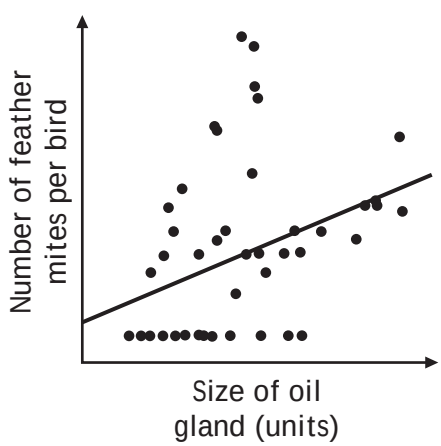
The breeding success rate was calculated as the percentage of eggs laid from which chicks survived to leave the nest.

The results are shown in the table and graph below.

Table

Number of feather mites on parent birds	*Breeding success rate (%)*
0	86
2	100
5	64
10	82
14	70
15	85
170	42

Graph



7. (continued)

(a) Suggest the reasons for the following:

(i) a systematic search was carried out to locate the crested tit nests; **1**

(ii) a random sample of the nests located was used in the study. **1**

(b) Give a null hypothesis appropriate to the investigation. **1**

(c) How does the data support the conclusion that feather mite infections reduce breeding success in crested tits? **1**

(d) (i) Describe the relationship between size of oil gland and number of feather mites per bird. **1**

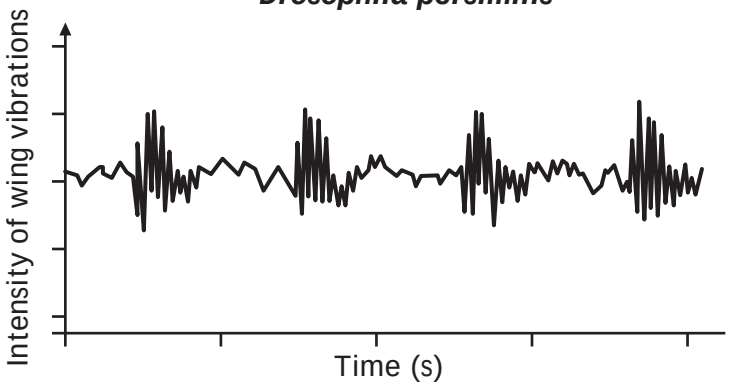
(ii) Suggest **one** precaution which should be taken to ensure that the oil gland measurements could be validly compared. **1**

(e) Identify **one** precaution the investigators should take when working with protected species during their breeding cycle. **1**

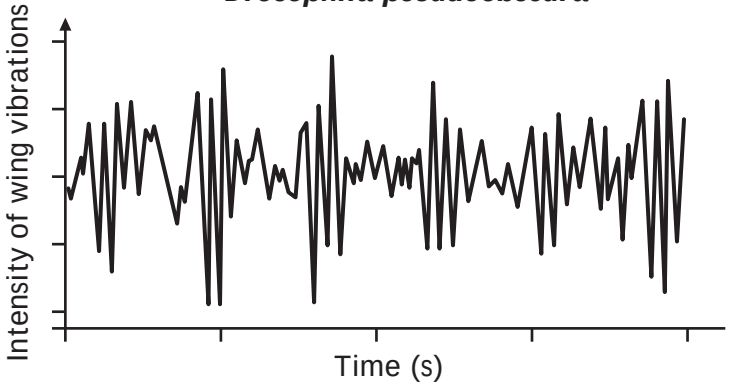
8. The songs produced by male fruit flies of the genus *Drosophila* are important courtship stimuli. Song is produced by repeated groups of rapid wing vibrations which form distinctive patterns.

The graphs below represent the recorded courtship songs of two closely related species, *Drosophila persimilis* and *Drosophila pseudoobscura*. The two species have similar distributions in western North America.

Drosophila persimilis



Drosophila pseudoobscura



(a) Compare the intensities and frequencies of the wing vibrations of the two species. **1**

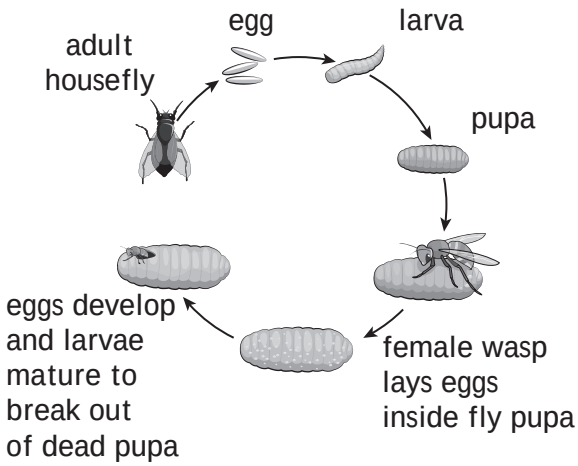
8. (continued)

(b) Females of each species discriminate against males which are not of their own species, but males of each species will court females of either species.

(i) Explain the importance of courtship songs to **female** *Drosophila* in terms of the theory of sexual investment. **1**

(ii) Explain how the courtship songs of **male** *Drosophila* may have evolved in terms of sexual selection. **2**

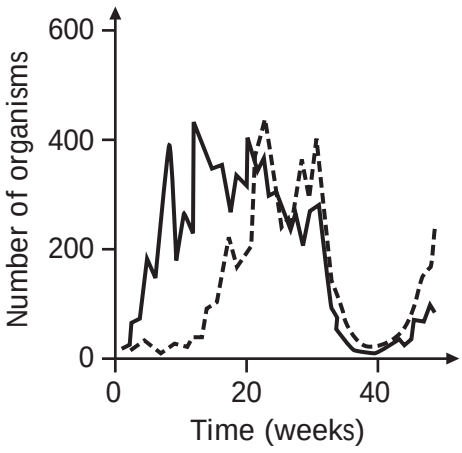
9. Female parasitic wasps, *Nasonia vitripennis*, lay their eggs inside the pupae of houseflies, *Musca domestica*. The wasp eggs hatch into larvae that consume the housefly pupae, as shown in the diagram below.



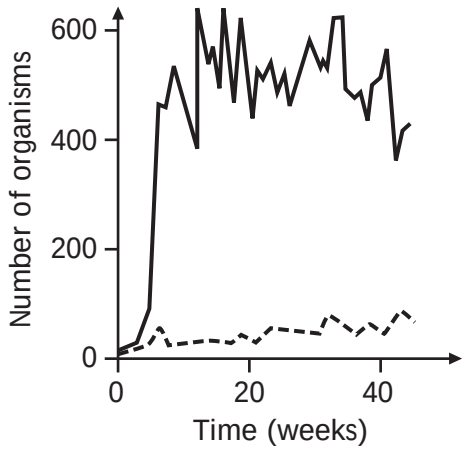
In a study to investigate the evolutionary response of the host to the parasite, two containers were set up with housefly populations. **Container A** had a housefly population with no previous exposure to the parasite and **Container B** had a housefly population which had been exposed to wasp parasitism for a period of three years prior to the study.

The graphs below show how the populations of each species in the containers changed over a 40-week period.

Container A



Container B



— Housefly --- Parasitic wasp

9. (continued)

(a) (i) Describe how the results support the general conclusion that housefly populations can develop resistance to wasp parasitism. **1**

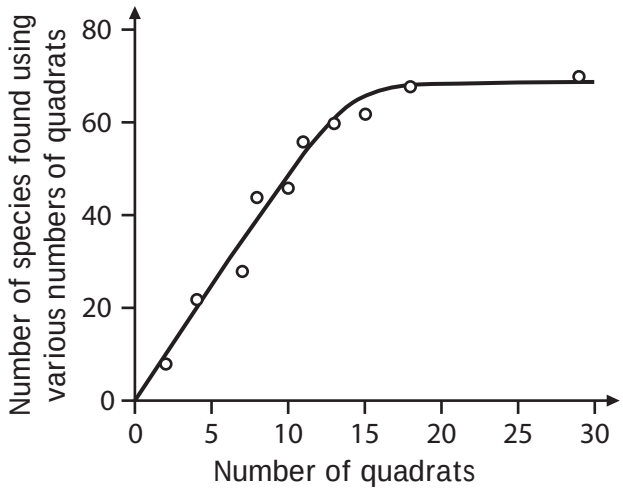
(ii) Explain how resistance to wasp parasites may have evolved. **2**

(b) The response of the houseflies is an example of co-evolution.

(i) Define the term co-evolution. **1**

(ii) Using the Red Queen hypothesis, predict the population changes in **Container B** if it were left undisturbed over a further period of time. **1**

10. A study was planned which aimed to estimate the number of species of mosses and liverworts in a damp woodland area in northern Scotland. As a pilot to the study, preliminary sampling was carried out using different numbers of randomly placed quadrats and the results are shown on the graph below.



(a) Use information from the graph to explain why each of the following numbers of quadrat would **not** be appropriate for the main survey.

(i) 10 quadrats **1**

(ii) 25 quadrats **1**

(b) Mosses and liverworts are bryophytes.

Give **two** other major divisions used to classify the plant kingdom. **2**

MARKS | DO NOT WRITE IN THIS MARGIN

11. Answer **either A or B** in the space below.

A Describe the events of meiosis and how they lead to variation in gametes. **8**

OR

B Describe the basis of sex determination and how the sex of an organism might change during life. **8**

Space for answer

[END OF MODEL PAPER]

MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

MARKS | DO NOT WRITE IN THIS MARGIN

ADVANCED HIGHER FOR CfE BIOLOGY MODEL PAPER 1

Section 1

Question	Response	Mark
1.	B	1
2.	D	1
3.	D	1
4.	C	1
5.	A	1
6.	B	1
7.	A	1
8.	B	1
9.	C	1
10.	A	1
11.	A	1
12.	D	1
13.	C	1
14.	D	1
15.	A	1
16.	A	1
17.	C	1
18.	D	1
19.	C	1
20.	B	1
21.	D	1
22.	B	1
23.	A	1
24.	C	1
25.	B	1

Section 2

Question			Expected response	Max mark
1.	(a)	(i)	Transmembrane protein	**1**
		(ii)	Four connected polypeptide sub-units	**1**
	(b)		To allow specific water molecules to be traced	**1**
	(c)	(i) 1	Rate of water molecule flow across the membrane increased when the AQP1 was activated	**1**
		(i) 2	Increase in rate of water molecule flow was **greater** when the concentration gradient was increased	**1**
		(ii)	There would be no net change in the mass of cells in isotonic solution	**1**
	(d)	(i)	Group 3 mice lose more water in their urine (than Group 1) **(1)** Because they do not have aquaporins (in their kidney tubule membranes) to reabsorb it **(1)**	**2**
		(ii)	Group 2 mice lose about the same body mass as Group 1 after a period without water **(1)** And the change in concentration of their urine (over the period) is about the same **(1)**	**2**
2.	(a)	(i)	99.7%	**1**
		(ii)	7 times	**1**
	(b)		When proteins (in solution) are brought to their isoelectric point, they have an overall neutral charge **(1)** and precipitate out of solution **(1)**	**2**
	(c)		Enzyme binds to the ligand and becomes trapped in the stationary phase/on the agarose **(1)** The stationary phase/ agarose can then be washed and the (purified) enzyme released from entrapment/eluted **(1)**	**2**

Question			Expected response	Max mark
3.	(a)	(i)	The sequence of amino acids in the polypeptide chain	**1**
		(ii)	Alpha/α helix **(1)** Formed through H bonding between amino acids (in the polypeptide) **(1)**	**2**
	(b)		Rhodopsin molecules absorb light energy **(1)** And use it to pump protons/H^+ across the membrane **(1)**	**2**
4.	(a)		Rhodopsin	**1**
	(b)	(i)	G-protein molecules activate (hundreds of) enzyme molecules	**1**
		(ii)	Allows animal to see in low light intensities/dim light	**1**
	(c)		Different forms of opsin (combine with retinal)	**1**
	(d)		Animals are sensitive to different colours/ wavelengths of light/can see in colour	**1**
5.	(a)		The binding of insulin to specific cell receptor molecules **(1)** triggers the recruitment of glucose transporter molecules/GLUTs to the membranes of fat and muscle cells **(1)**	**2**
	(b)	(i)	Diabetics have lower adiponectin levels so their cells not so sensitive to insulin **(1)** Lowered sensitivity to insulin makes cells less able to convert blood glucose to glycogen **(1)**	**2**
		(ii)	Lifestyle changes gave increased adiponectin levels **(1)** Drug treatment gave greater increases in adiponectin **(1)**	**1**
		(iii) 1	The potential effect of the treatments on the health of the individual volunteers	**1**
		(iii) 2	Eliminate effects of variation between individuals **OR** Produce more reliable data	**1**
6.			1. Evolution is the change over time in the frequency of alleles in the gene pool of a population 2. Genetic drift is a random process 3. Named examples of random processes from: colonisation/ establishment of new populations/the founder effect; survivors of an environmental event/a volcanic eruption/an earthquake/a tsunami 4. A second named example 5. Genetic drift is more important in small populations (than large ones) 6. Alleles are more likely to be (completely) lost from the gene pool of a small population **[Any 4 for 1 mark each]**	**4**
7.	(a)	(i)	More likely to reveal nest sites than a random search	**1**
		(ii)	To minimise the effects of bias which may affect a non-random sample	**1**
	(b)		That feather mite infection does not affect the reproductive success of crested tits	**1**
	(c)		As the number of feather mites increases, the breeding success of birds is reduced	**1**
	(d)	(i)	As the size of the oil gland increases, the number of feather mites increases	**1**
		(ii)	Ensure that the measurements of oil gland size were made at the same time of day	**1**

Question			Expected response	Max mark
	(e)		Obtain correct licences **OR** ensure that as few individuals as possible are disturbed **OR** ensure that study sites are kept confidential **OR** do pilot studies to quantify the effect of disturbance on breeding success	**1**
8.	(a)		Intensity of *D. persimilis* is less than that of *D. pseudoobscura* (or converse) **AND** High intensity bursts are less frequent in *D. persimilis* (or converse)	**1**
	(b)	(i)	Females invest more than males in reproduction so it is more important to them to have successful mating	**1**
		(ii)	Those with the best/most attractive songs get most matings and produce most offspring **(1)** Song characteristics passed on to offspring **(1)**	**2**
9.	(a)	(i)	The population with no previous exposure to wasps was reduced when wasps were abundant but those with previous exposure increased their population in spite of the presence of wasps	**1**
		(ii)	A few already resistant flies survive the effects of parasitism and are able to breed **(1)** The resistant flies pass on their resistance to offspring and the incidence of resistance increases **(1)**	**2**
	(b)	(i)	Co-evolution occurs in pairs of species that interact frequently/closely	**1**
		(ii)	The wasp would evolve ways of overcoming the resistance and the population of flies would drop again	**1**

Question			Expected response	Max mark
10.	(a)	(i)	10 quadrats fail to show the number of species present in the area	**1**
		(ii)	25 quadrats waste resources because 20 is enough to show the same number of species in the area	**1**
	(b)		Ferns Conifers Flowering plants **[Any 2 for 1 mark each]**	**2**
11.	A		1. Meiosis occurs in diploid gamete mother cells 2. There are two phases: meiosis I and meiosis II 3. In meiosis I, homologous chromosomes pair 4. The paired chromosomes undergo crossing over at chiasmata 5. DNA is exchanged and recombination occurs 6. Homologous pairs are separated 7. In meiosis II, sister chromatids are separated 8. Haploid gametes form **[Any 5 for 1 mark each]** 9. In meiosis I, homologous chromosomes separate independently 10. And irrespective of their maternal and paternal origin 11. Chiasmata formation is random 12. New combinations of alleles on linked chromosome are formed **[Any 3 for 1 mark each]**	**8**

Question			Expected response	Max mark
	B		1. Genetic factors can determine sex 2. In live-bearing mammals sex chromosomes are involved 3. In mammals XX determines female/ homogametic sex 4. In mammals XY determines male/ heterogametic sex 5. The Y chromosome contains a gene/ SRY which causes maleness 6. XY males lack the homologous alleles on their Y chromosome 7. In Drosophila the XY chromosome system is also involved 8. Environmental factors can determine sex **[Any 5 for 1 mark each]** 9. Sex can change within an individual as a result of size/age 10. Competition 11. Parasitic infection 12. Some species are hermaphroditic/have both sexes present in one individual **[Any 3 for 1 mark each]**	**8**