



National
Qualifications
2017

X707/77/02

Biology
Section 1 — Questions

TUESDAY, 23 MAY

9:00 AM – 11:30 AM

Instructions for the completion of Section 1 are given on *Page 02* of your question and answer booklet X707/77/01.

Record your answers on the answer grid on *Page 03* 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

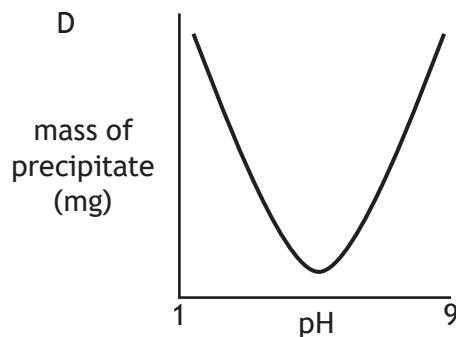
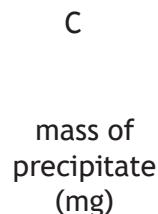
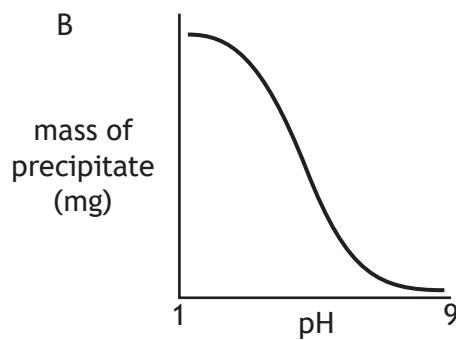
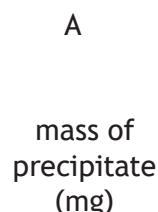
1. Trypan blue is used as a vital stain to identify viable cells when viewed in a haemocytometer.

A vital stain

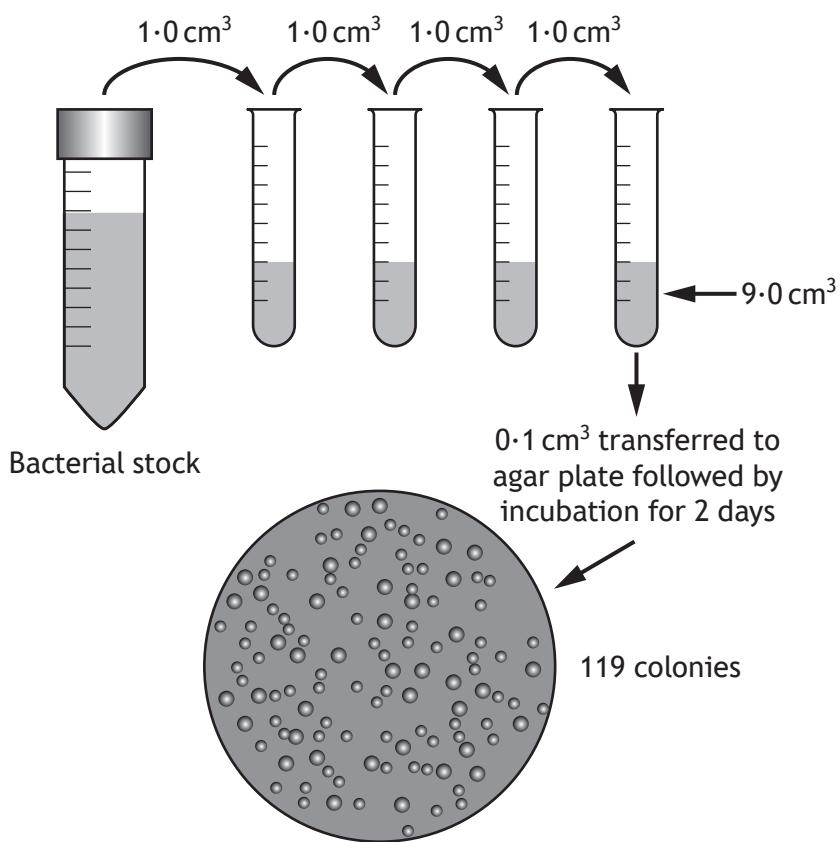
- A stains all cells
- B only stains dead cells
- C only stains living cells
- D only stains the culture medium.

2. Bovine insulin is a soluble protein with an isoelectric point of pH 5·4.

Which of the following graphs represents the level of precipitate formed as the pH of a bovine insulin solution is changed?



3. The figure shows how a scientist used serial dilution followed by plating to check the number of bacteria in a stock culture.



How many bacteria were there in 1 cm³ of the original bacterial stock?

- A 1.19×10^5
B 1.19×10^6
C 1.19×10^7
D 1.19×10^8
4. Place the following events for a sodium potassium pump into the correct sequence.
- 1 Phosphorylation
2 Potassium ions released into cell
3 Transporter protein has high affinity for sodium ions inside the cell
4 Dephosphorylation
- A 2, 1, 4, 3
B 3, 4, 2, 1
C 2, 1, 3, 4
D 3, 1, 4, 2

[Turn over

5. The binding of oxygen to haemoglobin is affected by small changes in temperature or pH.

Which of the following changes would **decrease** haemoglobin's affinity for oxygen?

- A increased temperature, decreased pH
- B increased temperature, increased pH
- C decreased temperature, decreased pH
- D decreased temperature, increased pH

6. The gene represented in the diagram codes for multiple proteins due to alternative RNA splicing.

The coding regions (exons) are labelled 1 to 10.



Alternative RNA splicing results in an mRNA that contains exon 2 or 3, exon 4, 5 or 6 and exon 7 or 8.

Predict the total number of different proteins that can be produced from this gene.

- A 3
- B 7
- C 12
- D 15

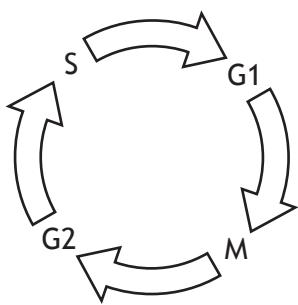
7. In an immunoassay used to detect the presence of an antigen for a disease-causing organism (pathogen), the following samples were tested.
- 1 A sample from an individual thought to be infected with the pathogen.
 - 2 A sample from an organism known to cause similar symptoms, but unrelated to the pathogen.
 - 3 A sample from the pathogen.
 - 4 A sample of purified water.

Which row in the table identifies the purpose of each sample?

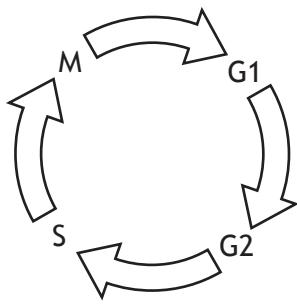
| | <i>Positive control</i> | <i>Negative control</i> | <i>Test assay</i> |
|---|-------------------------|-------------------------|-------------------|
| A | 3 | 4 | 2 |
| B | 3 | 2 | 1 |
| C | 2 | 4 | 3 |
| D | 2 | 3 | 1 |

8. Which of the following diagrams represents the sequence of phases involved in the cell cycle?

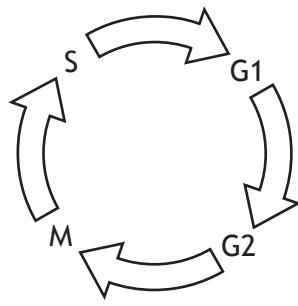
A



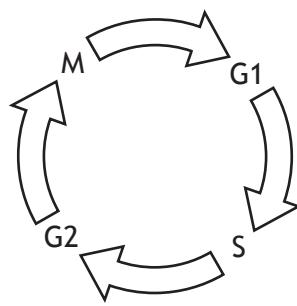
B



C

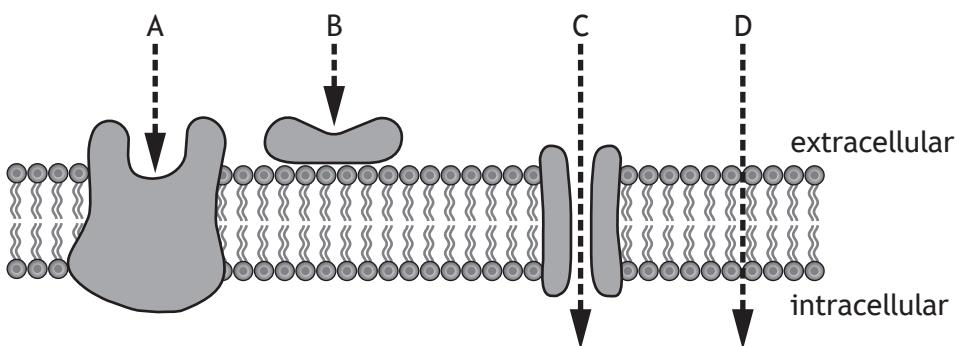


D



[Turn over

9. Which letter in the diagram represents the first stage in cell signalling for a peptide hormone molecule?



10. Red blood cells swell or shrink rapidly in response to changes in the water concentration around them. This is due to one type of water channel protein, Aquaporin 1 (AQP1).

Each red blood cell can transport a total of 1×10^{14} water molecules per second and each AQP1 channel can transport 5×10^8 water molecules per second.

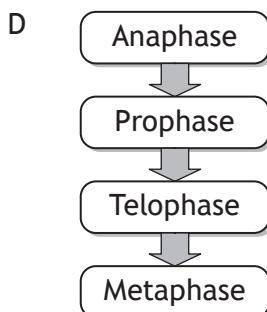
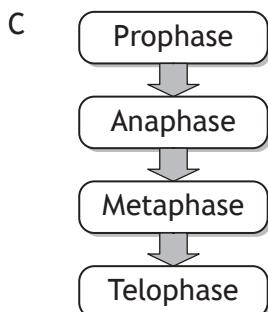
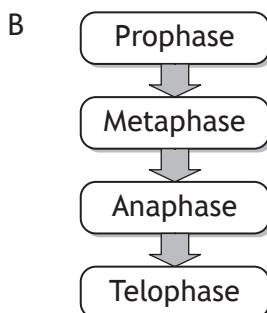
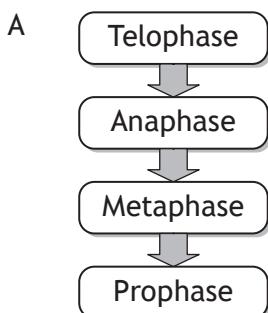
How many AQP1 channels are present in the membrane of a red blood cell?

- A 2×10^5
- B 5×10^5
- C 2×10^6
- D 5×10^6

11. Which of the following changes in the rate of the cell cycle could result in a degenerative disease?

- A A controlled increase
- B A controlled decrease
- C An uncontrolled increase
- D An uncontrolled decrease

12. Which of the following diagrams represents the sequence of stages involved in mitosis?



13. Bacteriophage M13 is a virus that can infect bacteria. When bacteria in the lab are infected with M13, it is essential to use the correct ratio of one virus particle to two bacterial cells.

A 0.25 cm^3 sample of an *E. coli* culture having a concentration of 8×10^8 cells per cm^3 is placed into a tube.

What volume of a bacteriophage stock having a concentration of 2×10^9 bacteriophage per cm^3 should be added to the cell sample to give a bacteriophage to bacteria ratio of 1:2?

- A 0.05 cm^3
- B 0.2 cm^3
- C 5 cm^3
- D 20 cm^3

[Turn over

14. A student planned to measure the activity of catalase by using an oxygen probe to measure oxygen production. As part of their pilot study, the student used a standard sample with an oxygen concentration of 22.00% to test the accuracy and precision of the probe.

Four readings of the standard sample were taken and the results obtained are shown in the table.

| | Reading | | | |
|--------------------------|---------|-------|-------|-------|
| | 1 | 2 | 3 | 4 |
| Oxygen concentration (%) | 20.94 | 20.93 | 20.93 | 20.94 |

The results indicate the measurements taken were

- A accurate and precise
- B accurate but not precise
- C precise but not accurate
- D neither accurate nor precise.

15. Which of the following formulae would allow relative fitness to be calculated?

- A $\frac{\text{frequency of a particular genotype after selection}}{\text{frequency of a particular genotype before selection}}$
- B $\frac{\text{frequency of a particular genotype before selection}}{\text{frequency of a particular genotype after selection}}$
- C $\frac{\text{number of surviving offspring of a particular genotype}}{\text{number of surviving offspring of other genotypes}}$
- D $\frac{\text{number of surviving offspring of other genotypes}}{\text{number of surviving offspring of a particular genotype}}$

16. Some invertebrate species can be used as indicator species to assess the level of pollution by organic waste in freshwater systems. Species within the taxa *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies) and *Trichoptera* (caddisflies) are particularly sensitive to pollution. These taxa are referred to collectively as EPT taxa.

The presence of these species can be used to assess water pollution levels by calculating an EPT index using the formula shown. The value obtained allows the water quality to be assessed using Table 1.

$$\text{EPT index} = \frac{\text{total number of EPT taxa present} \times 100}{\text{total number of taxa present}}$$

Table 1

| <i>EPT index</i> | <i>Water quality</i> |
|------------------|----------------------|
| >50% | excellent |
| 35–49% | good |
| 25–34% | moderate |
| <25% | poor |

A study sampled the invertebrate species in a stretch of river and the results are shown in Table 2.

Table 2

| <i>Taxa</i> | <i>Number of individuals</i> |
|------------------------|------------------------------|
| Striped stonefly | 6 |
| Dragonfly | 5 |
| Simulid blackfly | 9 |
| Net-spinning caddisfly | 6 |
| Bloodworm | 8 |
| Flathead mayfly | 3 |
| Damselfly | 7 |

The data suggests the water quality of this river is

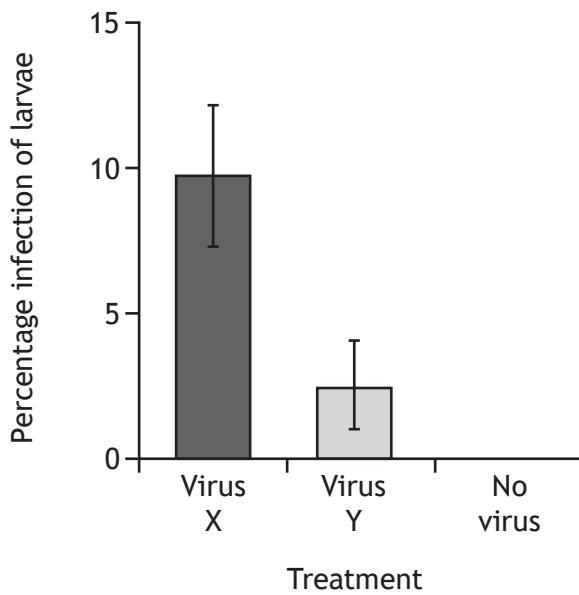
- A excellent
- B good
- C moderate
- D poor.

[Turn over

17. The smaller tea tortrix (*Adoxophyes honmai*) is a moth that is an economically important pest of tea plants in Japan. A *honmai* has a number of development stages (larvae) from egg to adult.

Viruses that infect crop pests have potential use in controlling pest populations. A study compared the infection and killing of *A honmai* by two viruses, X and Y. Mean survival time after infection for each larval stage was measured and the results are shown in the table. Uninfected larvae were then released onto tea plants that had either virus X, virus Y or no virus applied to their leaves. The percentage infection of the larvae was measured and the results are shown in the graph.

| Stage of insect development when infected | Mean survival time \pm SE (days) | |
|-------------------------------------------|------------------------------------|-------------------|
| | Virus X infection | Virus Y infection |
| 1st | 18.9 ± 0.6 | 5.8 ± 0.1 |
| 2nd | 15.2 ± 0.4 | 7.0 ± 0.1 |
| 3rd | 12.2 ± 0.2 | 7.0 ± 0.1 |
| 4th | 10.1 ± 0.2 | 8.0 ± 0.1 |
| 5th | 8.0 ± 0.1 | 6.9 ± 0.1 |



Which of the following conclusions can be drawn from this information?

- A Virus X has a higher transmission rate and is more virulent than Virus Y.
- B Virus X has a higher transmission rate and is less virulent than Virus Y.
- C Virus X has a lower transmission rate and is less virulent than Virus Y.
- D Virus X has a lower transmission rate and is more virulent than Virus Y.

18. Parthenogenesis is most likely to be common in environments with a

- A warm climate and low parasite density
- B warm climate and high parasite density
- C cool climate and low parasite density
- D cool climate and high parasite density.

19. Asexual reproduction is most likely to be a successful reproductive strategy in

- A wide, stable niches
- B narrow, stable niches
- C wide, unstable niches
- D narrow, unstable niches.

20. The black grouse male is larger and more brightly coloured than the female and competes with other males at leks.

Which of the following pairs of features are characteristic of this species?

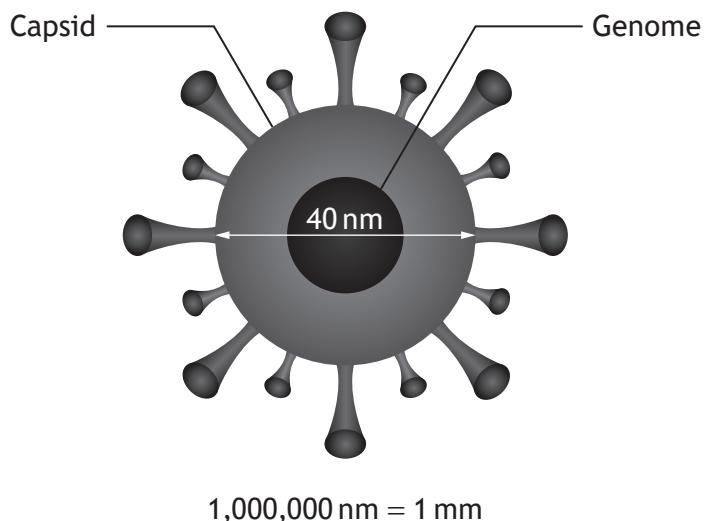
- A Monogamy and sexual dimorphism
- B Monogamy and reversed sexual dimorphism
- C Polygamy and sexual dimorphism
- D Polygamy and reversed sexual dimorphism

21. Which of the following conversions is catalysed by reverse transcriptase?

- A RNA → DNA
- B RNA → protein
- C DNA → RNA
- D DNA → protein

[Turn over

22. The figure represents the structure of a Zika virus.



Which row in the table describes the structure of a Zika virus?

| | Capsid | Genome | Diameter (m) |
|---|--------------|--------------|---------------------|
| A | Protein | Nucleic acid | 40×10^{-6} |
| B | Protein | Nucleic acid | 40×10^{-9} |
| C | Nucleic acid | Protein | 40×10^{-6} |
| D | Nucleic acid | Protein | 40×10^{-9} |

23. Schistosomiasis in humans is caused by an

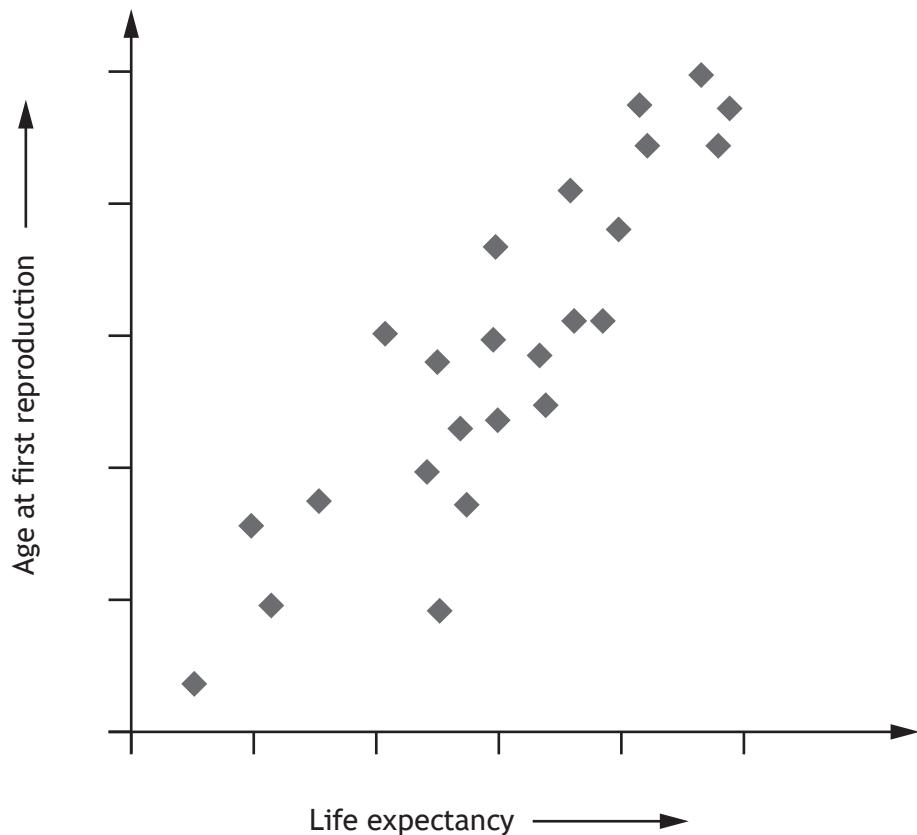
- A ectoparasitic arthropod
- B endoparasitic amoeba
- C endoparasitic nematode
- D endoparasitic platyhelminth.

24. Cholera is a disease which causes diarrhoea and is potentially fatal. It is transmitted through the consumption of food or water contaminated by the bacterium *Vibrio cholerae*. It often has a higher incidence in refugee camps than in the surrounding countryside.

Which of the following measures is **not** appropriate for reducing the incidence of cholera in refugee camps?

- A Improved vector control
- B Increased sanitation
- C Decreased population density
- D Reduced costs for cholera vaccines

25. The scatterplot shows the results obtained when life expectancy at birth was plotted against age at first reproduction for 24 species of mammals of different sizes.



Which of the following conclusions can be drawn from the data?

- A An increase in life expectancy causes an increase in the age of first reproduction.
- B An increase in the age of first reproduction causes an increase in life expectancy.
- C Larger animals have longer life expectancy.
- D Life expectancy and age at first reproduction are correlated.

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

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National
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2017

Mark

X707/77/01

Biology
Section 1 — Answer Grid
and Section 2

TUESDAY, 23 MAY

9:00 AM – 11:30 AM



* X 7 0 7 7 7 0 1 *

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

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Total marks — 90

SECTION 1 —25 marks

Attempt ALL questions.

Instructions for the completion of Section 1 are given on Page 02.

SECTION 2 —65 marks

Attempt ALL questions.

A Supplementary Sheet for Question 1 is enclosed inside the front cover of this question paper.

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 in the question paper X707/77/02.

Read these and record your answers on the answer grid on *Page 03* 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).

A B C D

| | | | |
|-----------------------|----------------------------------|-----------------------|-----------------------|
| <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input type="radio"/> |
|-----------------------|----------------------------------|-----------------------|-----------------------|

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.

A B C D

| | | | |
|-----------------------|----------------------------------|-----------------------|----------------------------------|
| <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
|-----------------------|----------------------------------|-----------------------|----------------------------------|

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:

A B C D

| | | | |
|-----------------------|----------------------------------|-----------------------|----------------------------------|
| <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
|-----------------------|----------------------------------|-----------------------|----------------------------------|

or

A B C D

| | | | |
|-----------------------|----------------------------------|----------------------------------|-----------------------|
| <input type="radio"/> | <input checked="" type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/> |
|-----------------------|----------------------------------|----------------------------------|-----------------------|



* X 7 0 7 7 7 0 1 0 2 *

SECTION 1 — Answer Grid



* O B J 2 5 A D 1 *

A B C D

| | | | | |
|----|-----------------------|-----------------------|-----------------------|-----------------------|
| 1 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 2 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 3 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 4 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 5 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 6 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 7 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 8 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 9 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 10 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 11 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 12 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 13 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 14 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 15 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 16 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 17 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 18 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
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| 21 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 22 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 23 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 24 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 25 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |



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* X 7 0 7 7 7 0 1 0 4 *



* X 7 0 7 7 7 0 1 0 5 *

SECTION 2 — 65 marks**Attempt ALL questions****It should be noted that question 11 contains a choice**

1. Read through the Supplementary Sheet for Question 1 before attempting this question.

- (a) Refer to Figure 2 in the Supplementary Sheet for Question 1.

Describe the trend shown in Figure 2.

1

- (b) Describe the action of caspases in cell destruction.

1

- (c) Refer to Figure 3 in the Supplementary Sheet for Question 1.

- (i) Explain how the data supports the conclusion that the intrinsic pathway for apoptosis is triggered by the extract.

2

- (ii) Describe what the three negative values in Figure 3 indicate about the level of apoptosis in these treatments.

1



* X 7 0 7 7 7 0 1 0 6 *

1. (continued)

(d) Refer to Figures 4A and 4B in the Supplementary Sheet for Question 1.

- (i) Calculate the percentage increase in the number of cells with 400 units of DNA in the cells treated with extract compared to the control cells.

Space for calculation

1

- (ii) It was concluded that the extract initiated cell cycle arrest at a checkpoint after DNA replication but prior to cell division in these cells.

Explain how the data in Figures 4A and 4B support this hypothesis.

2

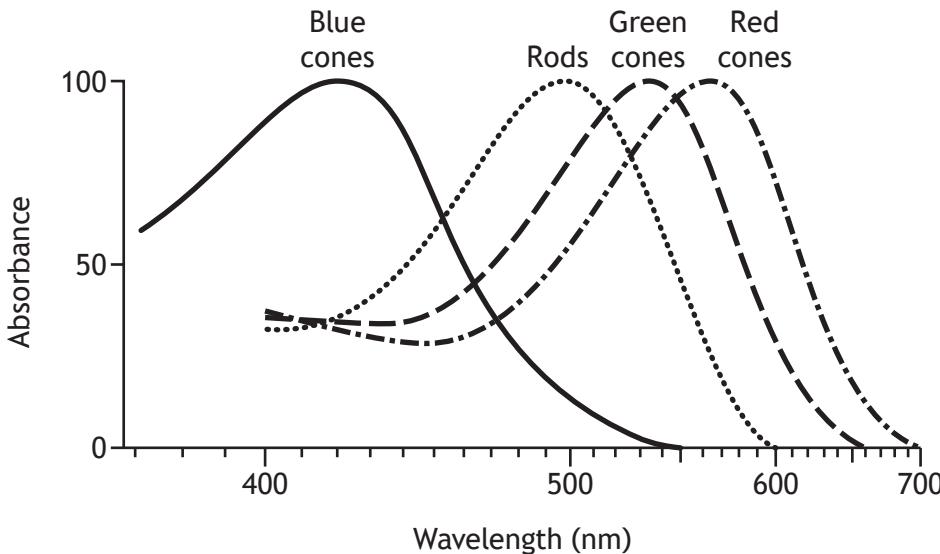
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* X 7 0 7 7 7 0 1 0 7 *

2. The light sensitive layer at the back of the human eye is called the retina. It is able to detect light due to the presence of photoreceptor cells called cones and rods. There are three types of cone cells (blue, green and red) which are sensitive to different wavelengths of light as shown in Figure 1. Different wavelengths of light are perceived as different colours.

Figure 1



- (a) (i) In cone cells, the light sensitive molecule retinal combines with a membrane protein to form photoreceptor proteins.

Name this membrane protein.

1

-
- (ii) One percent of human males do not have functional red cone cells, a colour vision deficiency called *protanopia*.

Affected individuals would perceive a red object reflecting light of a wavelength of 670 nm as black.

Use Figure 1 to explain this observation.

1



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MARKS

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2. (continued)

- (b) Rod cells are more sensitive than cone cells at low light intensities.

State how this sensitivity is achieved.

1

- (c) Most birds have four types of cone cells.

Name the additional wavelength range to which these organisms are sensitive.

1

[Turn over



* X 7 0 7 7 7 0 1 0 9 *

3. Cortisol is a hydrophobic signalling molecule, produced by the human adrenal gland, that affects a number of different tissues in response to stress. It has a role in increasing blood sugar levels, in suppressing the immune system, and in promoting the metabolism of fats, proteins, and carbohydrates.

- (a) (i) Cortisol is a steroid hormone.

Describe the mechanism by which this type of signalling molecule causes an effect within the target cell.

2

- (ii) Suggest a way in which cortisol might have different effects in different tissues.

1

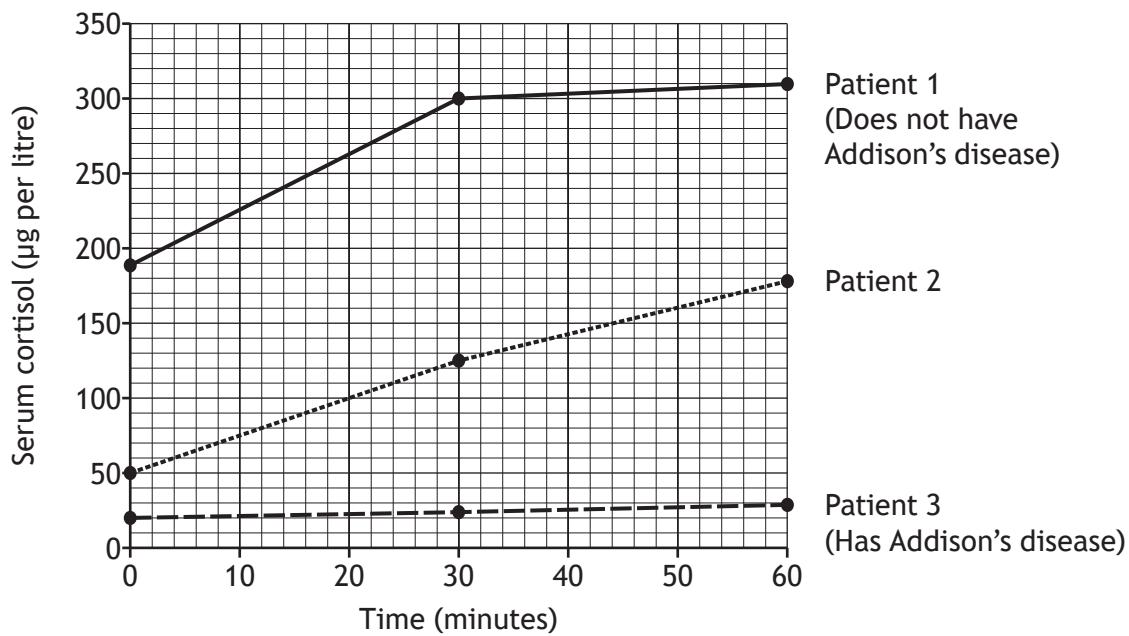


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3. (continued)

- (b) Addison's disease is a disorder in which the adrenal glands do not produce sufficient cortisol. One test for this disease is to give the patient an injection of a hormone called ACTH, which stimulates the adrenal gland to release cortisol. In a healthy person, cortisol levels should rise by at least 70 µg per litre after 30 minutes and 110 µg per litre after 60 minutes.

The graph shows the results of this test on three patients who were investigated for Addison's disease.



State the diagnosis that would be appropriate for Patient 2, using data to justify your answer.

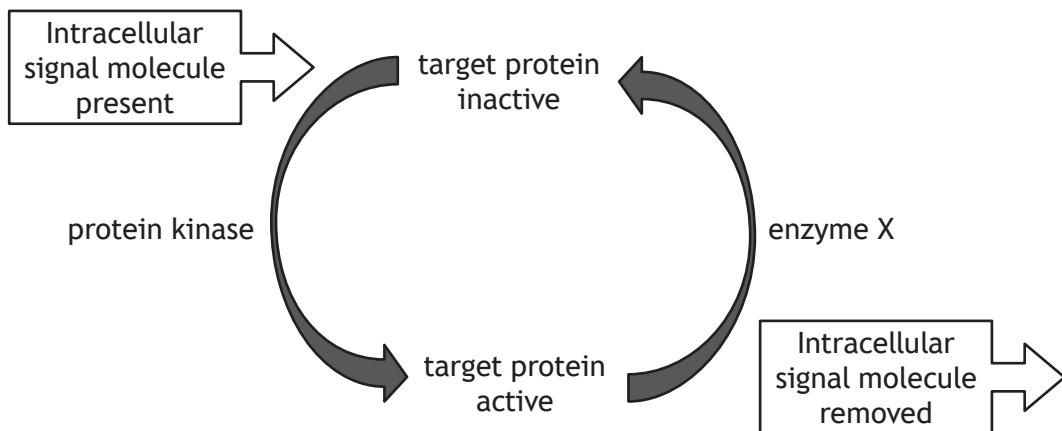
1

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* X 7 0 7 7 7 0 1 1 1 *

4. The diagram shows how two types of enzyme can be involved in controlling the activity of a protein in response to the presence of a signalling molecule within the cell (intracellular signal molecule). Intracellular signalling molecules are often produced as a result of extracellular signals received by cell-surface receptors.



- (a) (i) Explain how the action of protein kinase can switch a target protein from inactive to active.

1

- (ii) Name the type of enzyme represented by enzyme X.

1

- (iii) Explain the importance of the system being able to return the target protein to its inactive state.

1



* X 7 0 7 7 7 0 1 1 2 *

4. (continued)

(b) Protein kinase A (PKA) is an enzyme that is involved in this type of signalling. To test the hypothesis that PKA is found in a variety of cell types, cell extracts were prepared from different cell types and the proteins in the extracts separated by electrophoresis in a gel. The proteins were blotted onto a solid support and an antibody recognising PKA (anti-PKA antibody) was used to detect the presence of PKA.

- (i) Describe how protein electrophoresis is used to separate proteins.

1

- (ii) Explain how the anti-PKA antibody would be used to detect the presence of PKA.

2

[Turn over



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5. The water vole (*Arvicola amphibius*) was common in Scotland but has declined markedly in recent years due to habitat loss and predation by American mink (*Neovison vison*).

A survey was carried out to estimate the population of water voles on a Scottish river system by counting the number of latrines (droppings sites) on a river bank at the water's edge. Water vole latrines are created as part of a territorial behaviour where a water vole will revisit the same site over and over again to deposit its droppings.



Water vole



American mink

- (a) Suggest one reason why counting latrines is an appropriate indirect sampling technique for water voles.

1

- (b) The survey team worked on a total of 518 km, using survey sites of 500 m at 5 km intervals along the river system. The number of latrines per kilometre of waterways was counted.

1

Name the type of sampling used.



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5. (continued)

- (c) All surveys were conducted in June, July and August of the same year. There was heavy rainfall for three days in August. Any survey site too deep to walk into was omitted. The remains of one water vole that had been preyed upon were discovered at one survey site. Of the 92 sites sampled, only one site showed any latrines.

Identify one aspect of the experimental design that shows:

- (i) High reliability;

1

- (ii) Low reliability.

1

- (d) It was concluded that the water vole population on this river had become extremely low due to predation by American mink.

Give two reasons why this may **not** be a valid conclusion.

2

1 _____

2 _____

[Turn over



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6. The mechanism of sex determination is not the same for all species.

- (a) In most mammals the sex of the organism is determined by its genotype.

Describe how genetic control determines the phenotype of maleness in mammals.

1

- (b) In some reptile species the sex of offspring is environmentally rather than genetically controlled.

Describe how an environmental factor can influence the sex ratio of offspring in such species.

1

- (c) Diabetes insipidus is a condition characterised by the production of an excessive volume of dilute urine. An hereditary form of the disease in humans is the result of an X-linked mutation in the gene coding for the receptor for the hormone ADH. The mutated allele (X^a) is recessive to the normal allele (X^A).

- (i) Explain why males are more likely to be affected by diabetes insipidus than females.

1

- (ii) Explain why carrier females are usually not affected by diabetes insipidus even though they carry a mutated copy of the gene.

2



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MARKS

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6. (c) (continued)

- (iii) A man who is not affected by diabetes insipidus has a partner who is a carrier.

State the proportion of their sons that would be predicted to have the condition.

Space for working

1

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7. Students observed a group of California sea lions (*Zalophus californianus*) that were situated on a rocky outcrop off the coast of California. During each observation period, ten sea lions were observed for six minutes each. The sea lions were watched from a distance using binoculars. The checklist was used as a reference when recording the behaviours observed.



California sea lion

| <i>Behaviour</i> | <i>Description of behaviour</i> |
|--------------------------|-------------------------------------------------------|
| grooming | Licking, smoothing self with tongue, scratching |
| observing | Sitting up on flippers looking around |
| resting | Lying down with some head raising, barking or yawning |
| movement, aggressive | Barking, aggressive charging or chasing |
| movement, non-aggressive | Moving for better position on rock |
| other | Behaviours not specified above |

- (a) State the term used for a behavioural checklist of this kind.

1

-
- (b) As they observed the sea lions the students noted the time at which each new behaviour started.

Describe how the data could be used to construct a time budget.

1



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7. (continued)

- (c) One student noted, "Sometimes the sea lions tried to annoy each other."

Explain why anthropomorphic statements such as this should be avoided in behavioural studies.

1

- (d) Observing the sea lions from a distance made distinguishing some details of behaviour difficult.

Suggest an improvement to the method, other than direct observation, that would reduce this source of error.

1

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8. "So sex exists to keep parasites at bay." (Lane, 2009)

With reference to the Red Queen hypothesis, discuss the importance of sexual reproduction in defence against parasites.

5

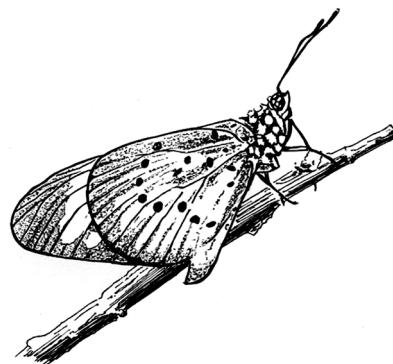


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9. *Acraea encedon* is a butterfly found in tropical Africa.



Females of this species can be one of two types: either producing broods that are entirely female or producing broods that have males and females in an approximate 1:1 sex ratio. One hypothesis proposed to explain the all-female broods was that bacteria inherited from the mother kill male embryos only.

- (a) Explain how antibiotics that kill bacteria could be used in a controlled trial to test this hypothesis.

2

- (b) Research has shown that the rapid evolution of male-killing bacteria from non-male-killing strains has been enabled by horizontal gene transfer.

Explain what is meant by “horizontal gene transfer”.

1



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9. (continued)

- (c) Some populations of the butterfly are extremely female-biased with over 90% being infected with this bacterium. These females form lekking swarms at landmarks. This has been described as *sex-role-reversal*. Butterfly populations that are not female-biased do not have lekking swarms.

Suggest the purpose of the lekking swarms and explain why they are only found in female-biased populations of the butterfly.

2

- (d) Other sex-role-reversed mating systems are usually associated with males investing more than females in offspring, but this is not the case with *A. encedon*.

Suggest **one** way in which males might demonstrate greater reproductive investment than females in a sex-role-reversed mating system.

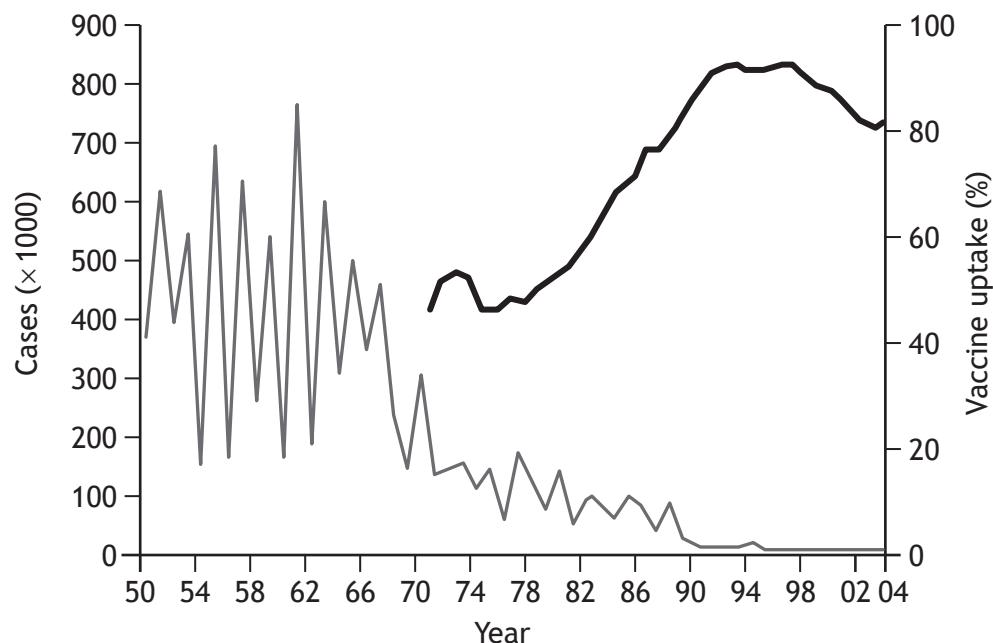
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10. The graph shows the number of measles notifications (reported cases) since 1950 and vaccination rates since 1970.



Key:

— Measles notification ($\times 1000$)

— Vaccine uptake (%)

- (a) State the term used to describe the study of data concerned with the outbreak and spread of infectious disease.

- (b) Describe the pattern of measles notifications prior to the introduction of vaccination.

- (c) Describe the correlation suggested by the graph.



10. (continued)

- (d) The MMR vaccine was introduced in 1988 to combat the infectious viral diseases of measles, mumps and rubella. In 1998, a report, published in a peer reviewed medical journal, claimed to establish a link between the MMR vaccine and the disorder known as autism.

(i) Explain what is meant by the term “peer reviewed”.

1

- (ii) Although criticised heavily and eventually discredited, this research led to a considerable reduction in the number of children being vaccinated. In some areas, such as Swansea in South Wales, vaccination rates fell as low as 67·5%. Over the same period, a huge increase in the number of measles notifications occurred in that area.

Account for the spread of measles in the Swansea epidemic.

1

- (iii) Explain how the events in Swansea confirm that the graph not only shows correlation but also shows causation.

1

- (e) The World Health Organisation (WHO) recommends 95% of children should be immunised (vaccinated) against measles in order to protect all.

State the term used to describe this WHO threshold.

1

[Turn over for next question



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11. Answer either A or B in the space below and on Page 27.

A Discuss the role of amino acid R-groups in:

- (i) the determination of tertiary structure of proteins; 3
- (ii) influencing the location of proteins within cells. 6

OR

B Discuss cell membranes under the following headings:

- (i) the phospholipid bilayer as a selective barrier; 2
- (ii) types of transport proteins and their functions. 7



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SPACE FOR ANSWER FOR QUESTION 11

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