



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.



\* X 7 0 7 7 7 0 2 \*

**SECTION 1 — 25 marks**

**Attempt ALL questions**

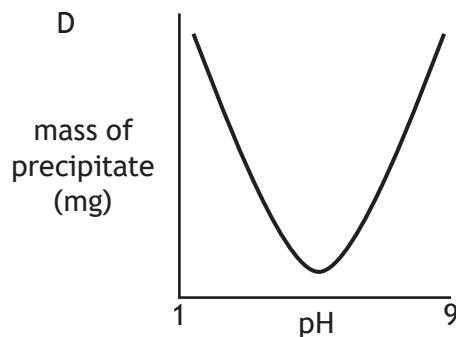
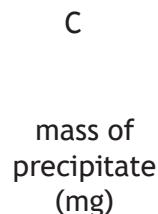
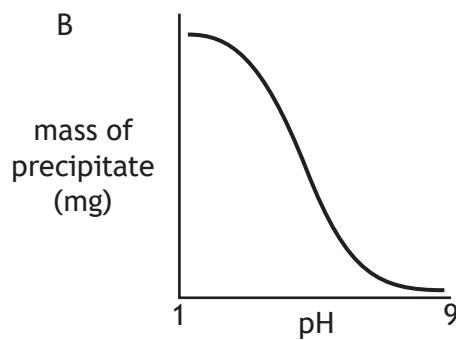
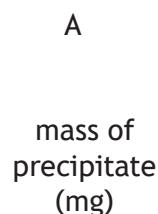
1. Trypan blue is used as a vital stain to identify viable cells when viewed in a haemocytometer.

A vital stain

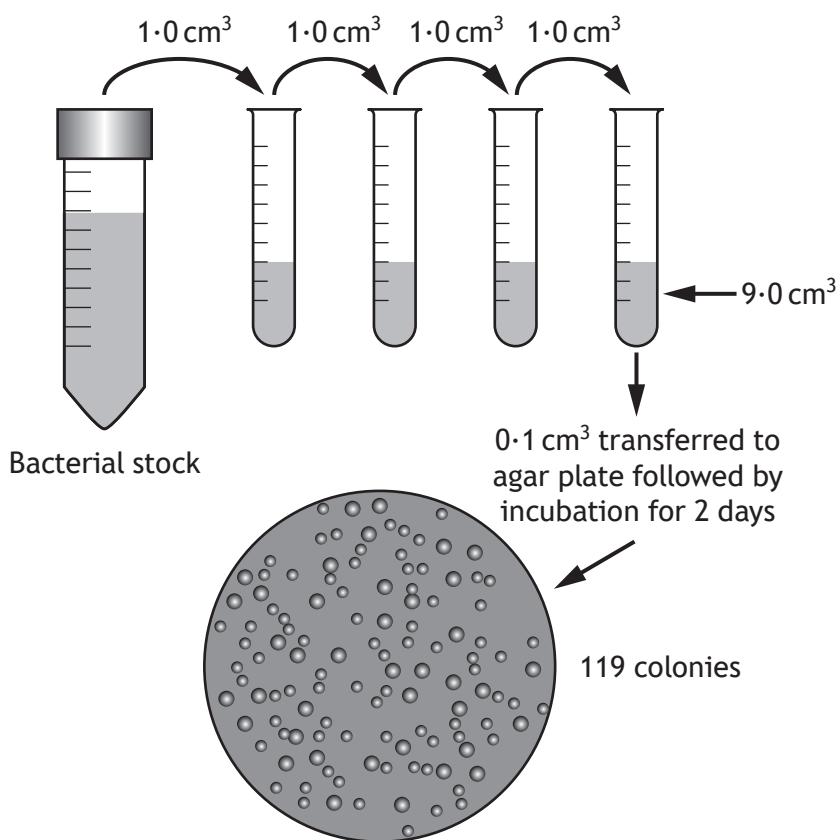
- A stains all cells
- B only stains dead cells
- C only stains living cells
- D only stains the culture medium.

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 cm<sup>3</sup> of the original bacterial stock?

- A  $1.19 \times 10^5$   
B  $1.19 \times 10^6$   
C  $1.19 \times 10^7$   
D  $1.19 \times 10^8$
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.

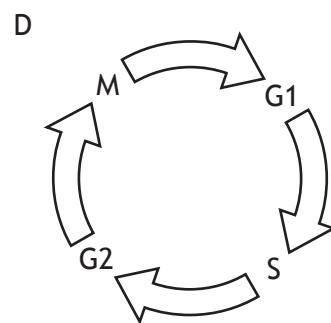
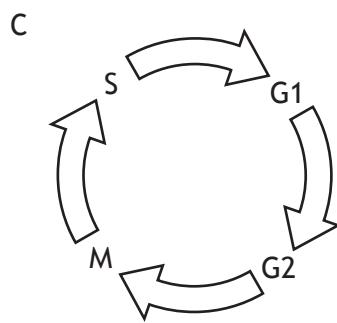
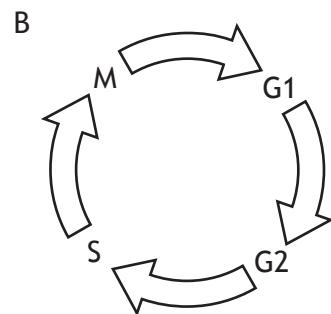
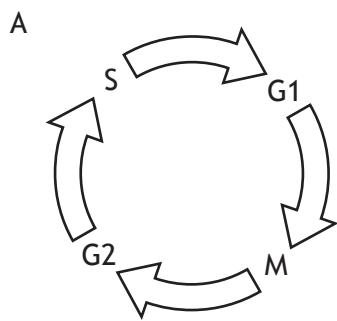
- A 3
- B 7
- C 12
- D 15

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?

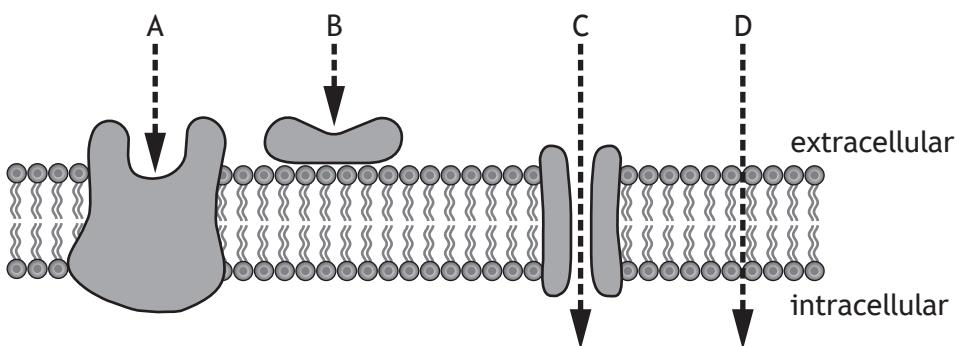
	<i>Positive control</i>	<i>Negative control</i>	<i>Test assay</i>
A	3	4	2
B	3	2	1
C	2	4	3
D	2	3	1

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



[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  $1 \times 10^{14}$  water molecules per second and each AQP1 channel can transport  $5 \times 10^8$  water molecules per second.

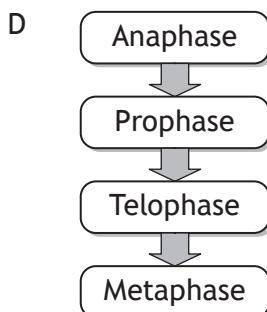
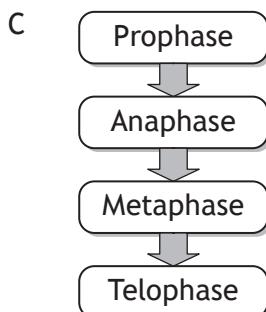
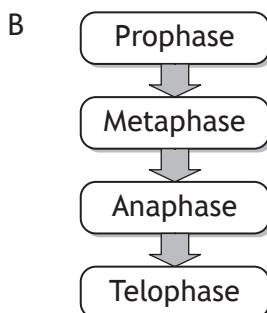
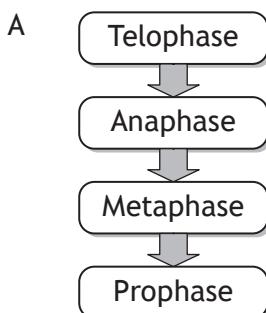
How many AQP1 channels are present in the membrane of a red blood cell?

- A  $2 \times 10^5$
- B  $5 \times 10^5$
- C  $2 \times 10^6$
- D  $5 \times 10^6$

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  $0.25 \text{ cm}^3$  sample of an *E. coli* culture having a concentration of  $8 \times 10^8$  cells per  $\text{cm}^3$  is placed into a tube.

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

- A  $0.05 \text{ cm}^3$
- B  $0.2 \text{ cm}^3$
- C  $5 \text{ cm}^3$
- D  $20 \text{ cm}^3$

[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

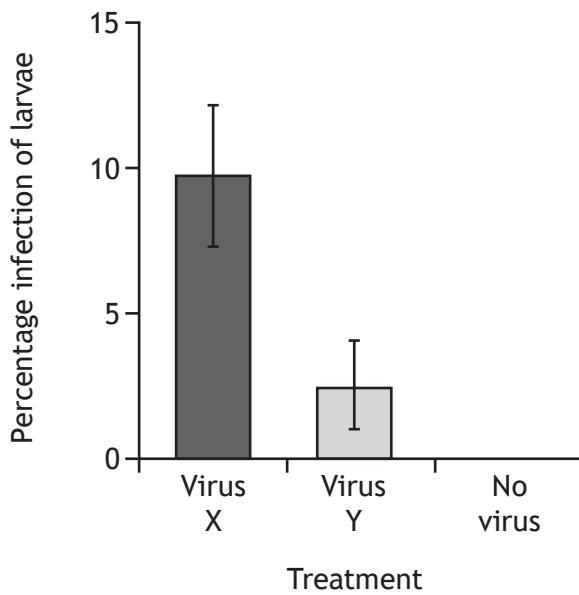
- A excellent
- B good
- C moderate
- D poor.

[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	$18.9 \pm 0.6$	$5.8 \pm 0.1$
2nd	$15.2 \pm 0.4$	$7.0 \pm 0.1$
3rd	$12.2 \pm 0.2$	$7.0 \pm 0.1$
4th	$10.1 \pm 0.2$	$8.0 \pm 0.1$
5th	$8.0 \pm 0.1$	$6.9 \pm 0.1$



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?

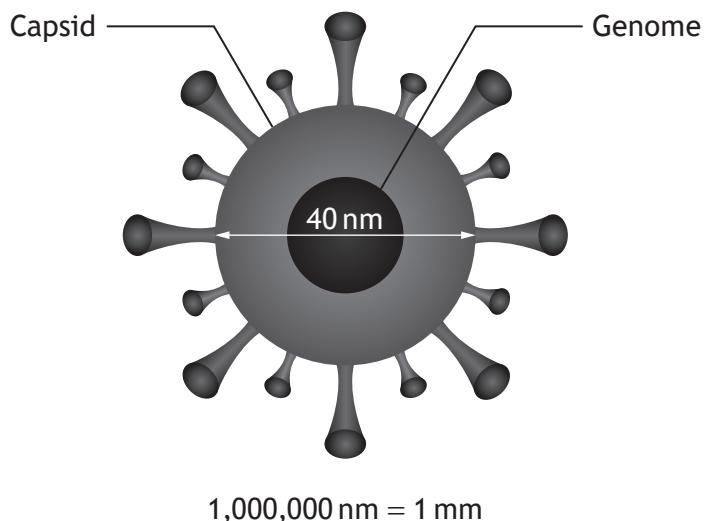
- A Monogamy and sexual dimorphism
- B Monogamy and reversed sexual dimorphism
- C Polygamy and sexual dimorphism
- D Polygamy and reversed sexual dimorphism

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	$40 \times 10^{-6}$
B	Protein	Nucleic acid	$40 \times 10^{-9}$
C	Nucleic acid	Protein	$40 \times 10^{-6}$
D	Nucleic acid	Protein	$40 \times 10^{-9}$

23. Schistosomiasis in humans is caused by an

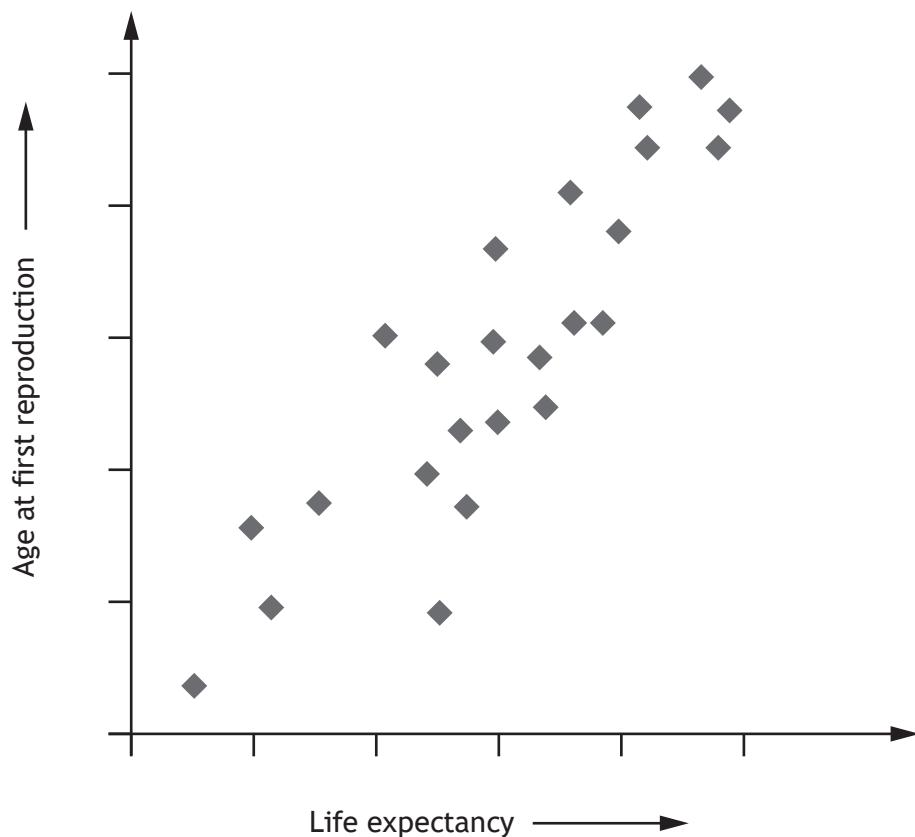
- A ectoparasitic arthropod
- B endoparasitic amoeba
- C endoparasitic nematode
- D endoparasitic platyhelminth.

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.]

**[BLANK PAGE]**

**DO NOT WRITE ON THIS PAGE**

[BLANK PAGE]

**DO NOT WRITE ON THIS PAGE**

[BLANK PAGE]

DO NOT WRITE ON THIS PAGE