AH

National
Qualifications
2016

X707/77/02

Biology
Section 1 — Questions

MONDAY, 9 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.

SQA

SECTION 1 — 25 marks

Attempt ALL questions

1. An experiment was set up to measure the activity of an enzyme using a substrate that produced a coloured product. The absorbance of the coloured product was measured using a colorimeter.

   Which row in the table describes the variable being measured?

 | | discrete | continuous | qualitative | quantitative |
   |---|---|---|---|---|
   | A | ✓ | | ✓ | |
   | B | ✓ | | | ✓ |
   | C | | ✓ | ✓ | |
   | D | | ✓ | | ✓ |

2. The diagram below shows the cell types used in the production of monoclonal antibodies.
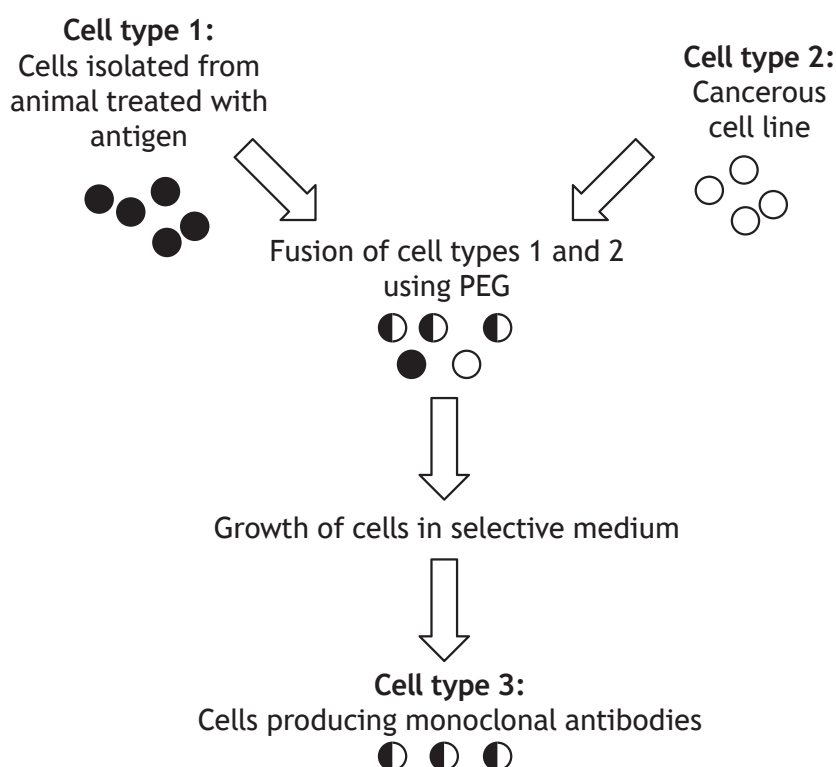
   Which row in the table identifies cell types 1, 2 and 3?

	Cell type 1	Cell type 2	Cell type 3
A	B lymphocyte	myeloma	hybridoma
B	myeloma	hybridoma	B lymphocyte
C	hybridoma	myeloma	B lymphocyte
D	myeloma	B lymphocyte	hybridoma

3. The diagram below represents a transmembrane protein. Some of the amino acids in the protein have been identified.

Membrane

Arg

Ser

Ala

Intracellular

Extracellular

Leu

Ser | Leu
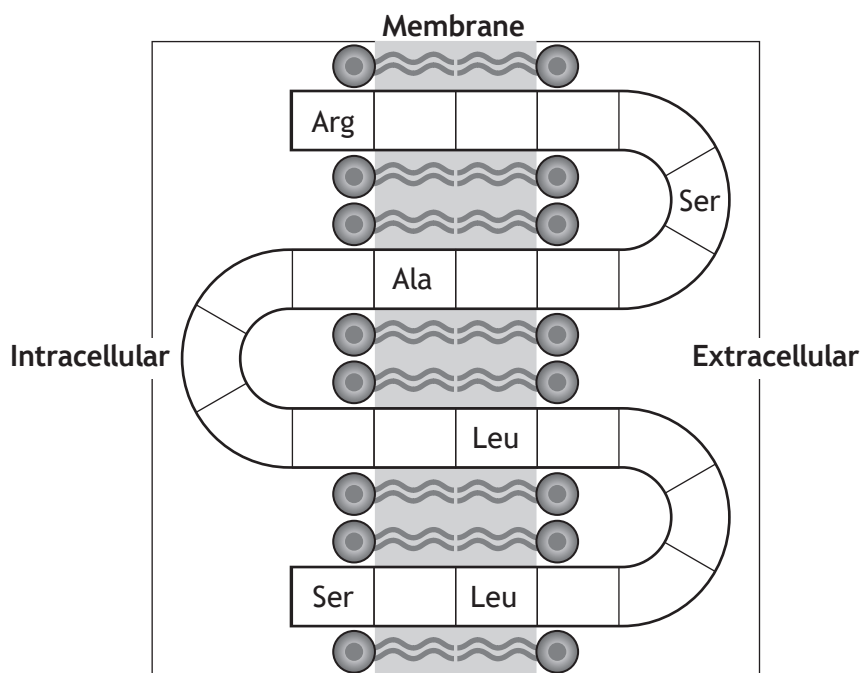
Which row in the table classifies the amino acids shown in this protein?

	Arginine (Arg)	*Alanine* (Ala)	*Leucine* (Leu)	*Serine* (Ser)
A	polar	hydrophobic	hydrophobic	polar
B	hydrophobic	polar	hydrophobic	polar
C	polar	hydrophobic	polar	hydrophobic
D	hydrophobic	polar	polar	hydrophobic

[Turn over

Questions 4 and 5 refer to the following information.

During muscle contraction, the protein myosin moves along an actin protein filament by the head of the myosin detaching from the actin, swinging forward and rebinding, as shown in the diagram.

actin

myosin

36 nm

[1 nm = 1×10^{-9} m]
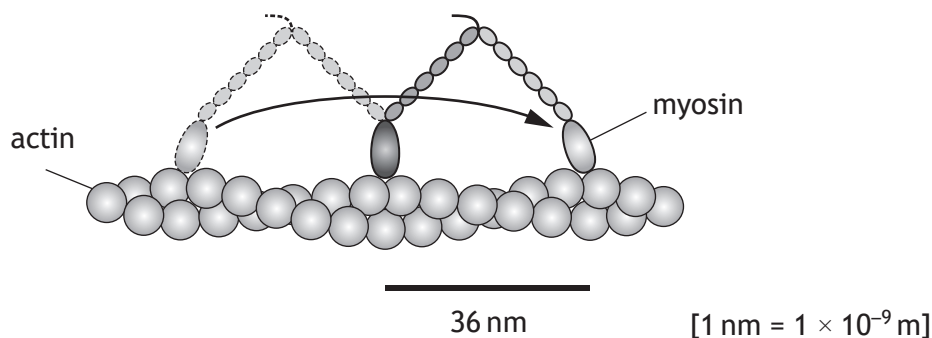
4. This reversible conformational change can be brought about by binding of ATP to the myosin head followed by hydrolysis and release of phosphate and ADP.

   The myosin head is acting as

   A a kinase

   B an ATPase

   C a proteinase

   D a phosphatase.

5. When the myosin head detaches and swings forward it moves a distance of 36 nanometres (nm).

   Myosin has been observed to move at a speed of 18×10^3 nm s^{-1}.

   How many times will the myosin head detach and swing forward in one second?

   A   50

   B   200

   C   500

   D   2000

6. In animal rod cells rhodopsin absorbs a photon of light initiating the following cell events.

   1   nerve impulse is generated
   2   sufficient product formation is triggered
   3   activation of hundreds of G-protein molecules
   4   activation of hundreds of molecules of an enzyme

   The correct order of events is

   A   4, 2, 1, 3

   B   3, 4, 2, 1

   C   4, 3, 1, 2

   D   3, 2, 4, 1.

7. In multicellular organisms, only target cells respond to a specific signal because

    A   signalling molecules only come into contact with target cells

    B   only target cells have receptor molecules for the signalling molecule

    C   non-target cells do not respond when the signalling molecule binds to its receptor

    D   receptor molecules in non-target cells do not change conformation when the signalling molecule binds.

8. The hormone thyroxine is

    A   hydrophobic and unable to pass through the cell membrane

    B   hydrophilic and unable to pass through the cell membrane

    C   hydrophobic and able to pass through the cell membrane

    D   hydrophilic and able to pass through the cell membrane.

9. Biological molecules move over short distances by diffusion. The time taken for diffusion can be calculated using the equation below.

$$t = \frac{x^2}{2D}$$

t = time taken (seconds)
x = distance travelled by the diffusing molecule (cm)
D = diffusion co-efficient (cm^2 per second)

Acetylcholine is a neurotransmitter with a diffusion co-efficient of 4×10^{-6} cm^2 per second. The gap across the synapse is 5×10^{-6} cm wide.

How many seconds would it take acetylcholine to cross the synapse?

    A   1·250

    B $6·250 \times 10^{-6}$

    C $3·125 \times 10^{-6}$

    D $1·600 \times 10^{-6}$

10. Type 1 diabetes is caused by

    A   excessive production of insulin

    B   loss of insulin receptor function

    C   failure of GLUT4 to respond to insulin binding

    D   insufficient production of insulin.

[Turn over

11. An enzyme-controlled reaction is taking place in optimum conditions in the presence of a large surplus of substrate.

Conditions can be altered by

1   increasing the temperature
2   adding a positive modulator
3   increasing enzyme concentration
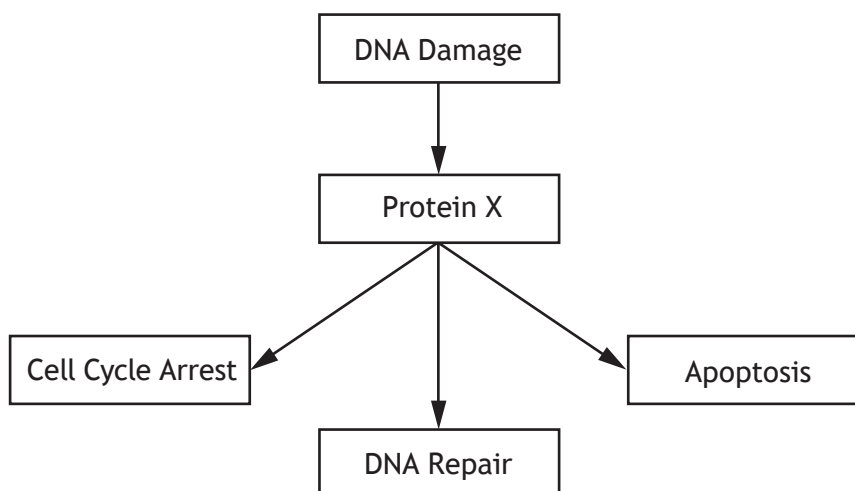4   increasing substrate concentration.

Product yield would be increased by

A   1 and 2

B   2 and 3

C   2 and 4

D   3 and 4.

12. At which phase of the cell cycle is the retinoblastoma protein phosphorylated allowing progression to the next phase of the cycle?

A   G1

B   S

C   G2

D   M

13. The diagram below shows possible outcomes for a cell following DNA damage. Protein X is involved in all three outcomes.
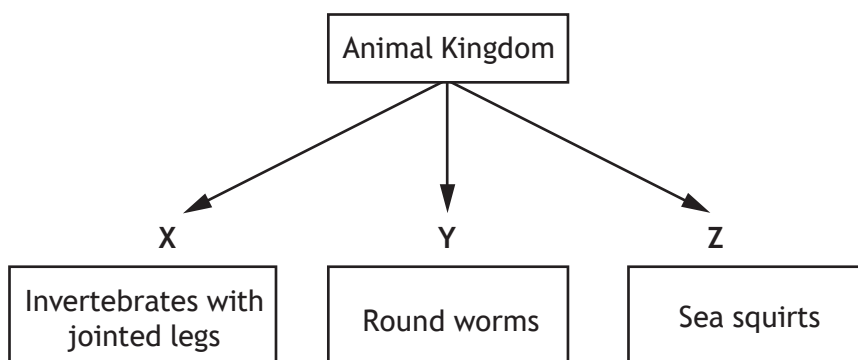
```
         ┌──────────────┐
         │  DNA Damage  │
         └──────────────┘
                │
                ▼
         ┌──────────────┐
         │  Protein X   │
         └──────────────┘
          ╱     │      ╲
         ╱      ▼       ╲
┌───────────┐ ┌──────────┐ ┌───────────┐
│ Cell Cycle│ │DNA Repair│ │ Apoptosis │
│  Arrest   │ │          │ │           │
└───────────┘ └──────────┘ └───────────┘
```

Protein X is

A   Rb

B   p53

C   Cdk

D   caspase.

14. Two reagents used in testing for the presence of carbohydrates are iodine solution, which turns blue-black in the presence of starch, and Benedict's solution, which turns brick red in the presence of maltose.

In an investigation of the breakdown of starch into maltose by the enzyme amylase, which of the following would be a positive control?

A   Maltose alone turns Benedict's solution brick red.

B   Starch treated with amylase turns Benedict's solution brick red.

C   Starch alone tested with Benedict's solution remains blue.

D   Starch treated with amylase does not change the colour of iodine solution.

[Turn over

15. The diagram below shows some phyla in the animal kingdom.

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                    ┌─────────────────┐
                    │ Animal Kingdom  │
                    └─────────────────┘
                   ╱          │          ╲
                  ╱           │           ╲
                 X            Y            Z
        ┌──────────────┐ ┌──────────┐ ┌──────────┐
        │Invertebrates │ │Round worms│ │Sea squirts│
        │with jointed  │ │           │ │           │
        │legs          │ │           │ │           │
        └──────────────┘ └──────────┘ └──────────┘
```

Which row in the table identifies the phyla X, Y and Z?

	Phylum		
	X	Y	Z
A	Chordata	Nematoda	Arthropoda
B	Arthropoda	Nematoda	Chordata
C	Nematoda	Arthropoda	Chordata
D	Arthropoda	Chordata	Nematoda

16. Which of the following descriptions of animal behaviour avoids the use of anthropomorphism?

A   In some primate species, alpha males often bully lower-ranking animals.

B   In late summer, worker bees like to visit heather flowers.

C   The grin on the chimpanzee's face showed that it was amused by the gesture.

D   The male moth is attracted to the female by the scent molecules that she emits.

17. A population of chafer beetles were damaging the tees and greens of a golf course. Results from a mark and recapture study suggested a population size that was too small to account for the extent of the damage caused.

One possible reason for this is that the

A   white paint used to mark the beetles washed off some of them before the recapture

B   white paint used to mark the beetles made them more visible to predators than unmarked beetles

C   total number of beetles in the recaptured sample was less than the number first captured and marked

D   marked beetles did not have enough time, after release, to spread out and mix with the rest of the population.

18. Ellis-van Creveld syndrome is a rare genetic condition. It is much more common in an isolated population in North America, which was founded by a small number of individuals, than in the general population.

The most likely explanation for this is

A natural selection

B sexual selection

C random mutation

D genetic drift.

19. The frequency of a given allele in a population is a measure of how common that allele is as a proportion of the total number of copies of all alleles at a specific locus. For a locus with one dominant allele (A) and one recessive allele (a), the frequency of the dominant allele (p) and the frequency of the recessive allele (q) can be used to calculate the genetic variation of a population using the equations below.

$$p + q = 1$$

p = frequency of A allele
q = frequency of a allele

$$p^2 + 2pq + q^2 = 1$$

p^2 = frequency of homozygous (AA) individuals
q^2 = frequency of homozygous (aa) individuals
$2pq$ = frequency of heterozygous (Aa) individuals

If the allele frequency of the recessive allele is 0·7, the proportion of individuals that would be heterozygous is

A 0·09

B 0·21

C 0·42

D 0·49.

20. In the fruit fly *Drosophila melanogaster* the gene for eye colour is sex-linked. The allele for red eye (R) is dominant to the allele for white eye (r).

A cross between two flies produced the offspring shown in the table below.

Sex of offspring	Number with white eyes	Number with red eyes
female	23	22
male	21	22

The genotypes of the parents in this cross were

A X^rX^r and X^RY

B X^RX^r and X^rY

C X^RX^r and X^RY

D X^RX^R and X^rY.

21. Which row in the table best describes r-selected species?

	Number of offspring	Offspring survival rate	Parental care
A	many	low	little
B	few	high	extensive
C	many	high	extensive
D	few	low	little

22. Shags and cormorants both belong to the genus *Phalacrocorax*. They look very similar and nest near each other on the same cliffs. The table below shows the main components of each bird's diet.

Prey	Percentage composition of diet	
	Shag (Phalacrocorax aristotelis)	Cormorant (Phalacrocorax carbo)
sand eels	33	0
sprats	49	1
flatfish	1	26
shrimps	2	33
gobies	4	17
other fish	4	18

The data in the table show

A   competitive exclusion

B   competition within each species

C   resource partitioning

D   the fundamental niche of each species.

[Turn over

23. A species of parasitic wasp (*Nasonia vitripennis*) lays its eggs in the larvae of flies where the eggs develop. This species displays a behaviour called "*superparasitism*" where, following the laying of eggs by one wasp, a second wasp may superparasitise the same host by also laying its eggs.

Researchers investigated the effects of superparasitism on the brood size and sex ratio of offspring in this species. Results were compared to a control that had been parasitised only once. Researchers were able to distinguish between the offspring of the first and second wasp.

Results are shown in the table below.

Offspring	*Degree of parasitism*		
	Superparasitism		*Single parasitism control*
	Wasp 1	*Wasp 2*	
brood size	18 ± 3	17 ± 4	20 ± 2
percentage of males	7 ± 2	22 ± 4	6 ± 1

The following statements refer to the data in the table.

1 Superparasitism significantly increased the percentage of males produced by both wasp 1 and wasp 2.

2 Superparasitism significantly increased the percentage of males produced by wasp 2 only.

3 Superparasitism had no significant effect on brood size.

4 Superparasitism significantly decreased the brood size produced by wasps 1 and 2.

Which of these statements are valid conclusions supported by the data?

A   1 and 3

B   1 and 4

C   2 and 3

D   2 and 4

24. The statements below describe events that occur following the engulfing of a pathogen by a phagocyte of the mammalian immune system.

    P   long term survival of lymphocytes
    Q   antigen presentation to lymphocytes
    R   antibody production by lymphocytes
    S   clonal selection of B lymphocytes

The correct sequence in which these events occur is

A   Q, R, S, P

B   R, Q, P, S

C   S, Q, P, R

D   Q, S, R, P.

25. Florida scrubjays have evolved a co-operative breeding system in which helper birds assist breeding pairs in raising young. The table below compares the effect of helpers on the breeding success of birds that are either experienced or inexperienced breeders.

Breeding experience of breeding pairs	Average number of offspring reared	
	Without helpers	With helpers
inexperienced	1·24	2·20
experienced	1·80	2·38

Helpers increase the average number of offspring reared by inexperienced breeding pairs compared to experienced breeding pairs by

A   19%

B   23%

C   45%

D   60%.

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

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