National Qualifications 2018

X707/77/02

Biology
Section 1 — Questions

TUESDAY, 15 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.

SECTION 1 — 25 marks

Attempt ALL questions

1. Which row in the table describes properties of proteins that allow them to be separated using the techniques shown?

	Protein separation technique	
	Centrifugation	*Gel electrophoresis*
A	density	charge
B	charge	density
C	shape	charge
D	charge	shape

2. Which of the pairs of cell types are fused in order to produce monoclonal antibodies?

A T lymphocyte and myeloma

B B lymphocyte and myeloma

C T lymphocyte and hybridoma

D B lymphocyte and hybridoma

3. The three-dimensional structure of a protein is shown.

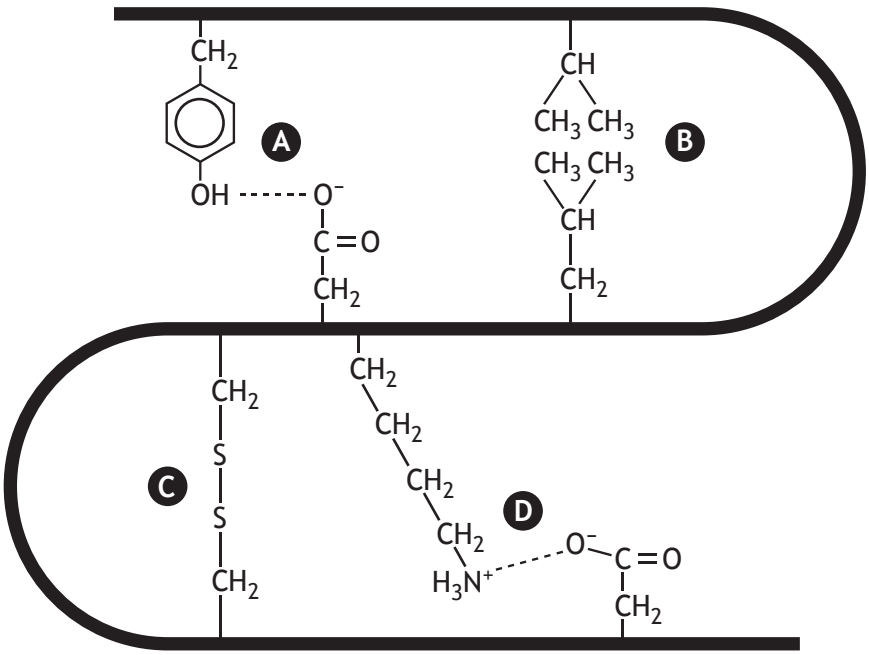
Which row in the table describes region X?

	Type of secondary structure	*Bonding that stabilises secondary structure*
A	β-sheet	peptide
B	α-helix	peptide
C	β-sheet	hydrogen
D	α-helix	hydrogen

[Turn over

4. The diagram shows some interactions between amino acid R-groups in a polypeptide chain.

Which letter shows hydrophobic interactions?



5. A student is preparing media for an experiment to investigate the effect of an inhibitor on cell growth. Flask 1 contains a control medium with no inhibitor.

The concentration of the stock inhibitor solution used to prepare the final solution is **80%.**

Flask	*Inhibitor volume* (cm^3)	*Glucose volume* (cm^3)	*FBS volume* (cm^3)	*Buffer volume* (cm^3)	*Final inhibitor concentration* (%)
1	0·00	1·00	5·00	19·00	0
2		1·00	5·00		20

What volumes of inhibitor and buffer should be added to flask 2 to give 25 cm^3 of medium with an inhibitor concentration of 20%?

A 4·75 cm^3 inhibitor + 20·25 cm^3 buffer

B 4·75 cm^3 inhibitor + 14·25 cm^3 buffer

C 6·25 cm^3 inhibitor + 18·75 cm^3 buffer

D 6·25 cm^3 inhibitor + 12·75 cm^3 buffer

6. Transcription of gene Z only occurs when its transcription factor is dephosphorylated.

The distribution of the transcription factor together with the activities of a protein kinase and protein phosphatase specific to this transcription factor are shown in the table.

Tissue	*Transcription factor present*	*Protein kinase activity*	*Protein phosphatase activity*
Muscle	–	–	+
Heart	+	+	–
Brain	+	–	+

Gene Z is transcribed in the

A brain only

B heart only

C muscle and brain only

D heart and brain only.

7. The effect of changing the concentration of extracellular potassium ions on the function of sodium potassium pumps was investigated.

Starting with an extracellular solution containing no potassium ions, as the concentration of potassium ions is increased the pumps would be expected to

A pump out potassium ions at a faster rate

B stay in their phosphorylated conformation for longer

C pump in sodium ions at a faster rate

D hydrolyse ATP at a faster rate.

[Turn over

8. A sample of 10^6 cells was found to contain 0·4 mg protein. Actin comprises 4·5% of the total protein. 42 g of actin contains $6{\cdot}02 \times 10^{20}$ molecules.

$1\text{ g} = 1000\text{ mg}$

The number of actin molecules **per cell** is

A $2{\cdot}58 \times 10^8$

B $2{\cdot}58 \times 10^{10}$

C $2{\cdot}58 \times 10^{11}$

D $2{\cdot}58 \times 10^{14}$

9. An outcome of the activation of a cell's thyroid hormone receptors by thyroxine is

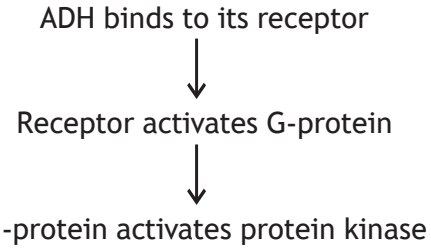
A decreased production of Na/KATPase

B increased production of Na/KATPase

C decreased metabolic rate

D opening of ligand-gated ion channels.

10. The flow diagram shows part of the ADH signal transduction pathway in a collecting duct cell.



Which row in the table shows how this pathway would be altered in an individual with diabetes insipidus?

	Concentration of inactive G-proteins	*Phosphorylation of proteins*
A	decreased	decreased
B	decreased	increased
C	increased	decreased
D	increased	increased

11. Which row in the table describes the states of the proteins p53 and Rb that would increase the rate of cell division?

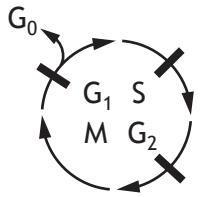
	Protein	
	p53	*Rb*
A	activated	phosphorylated
B	inhibited	phosphorylated
C	activated	dephosphorylated
D	inhibited	dephosphorylated

[Turn over

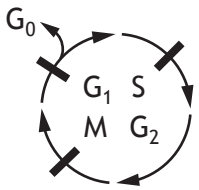
12. Which diagram shows the correct positions of the cell cycle checkpoints?

Checkpoint is represented by ▌

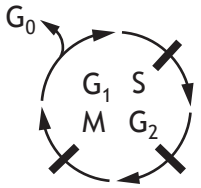
A



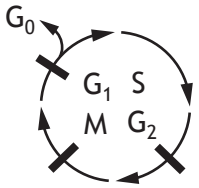
B



C



D



13. In a study of transmission of the rabies virus by vampire bats, the density of bat colonies was estimated using mark and recapture techniques.

The total population estimate is given by (MC)/R where the first sample captured is M, the second sample captured is C and the number recaptured is R.

One colony was estimated to have a bat population of 440 following the capture of a second sample of 64 bats, of which 8 were marked.

The number of bats captured initially, marked and released was

A 32

B 55

C 110

D 128

14. Which of the following describes the purpose of a randomised block design?

A Controlling for confounding variables

B Ranking sample data

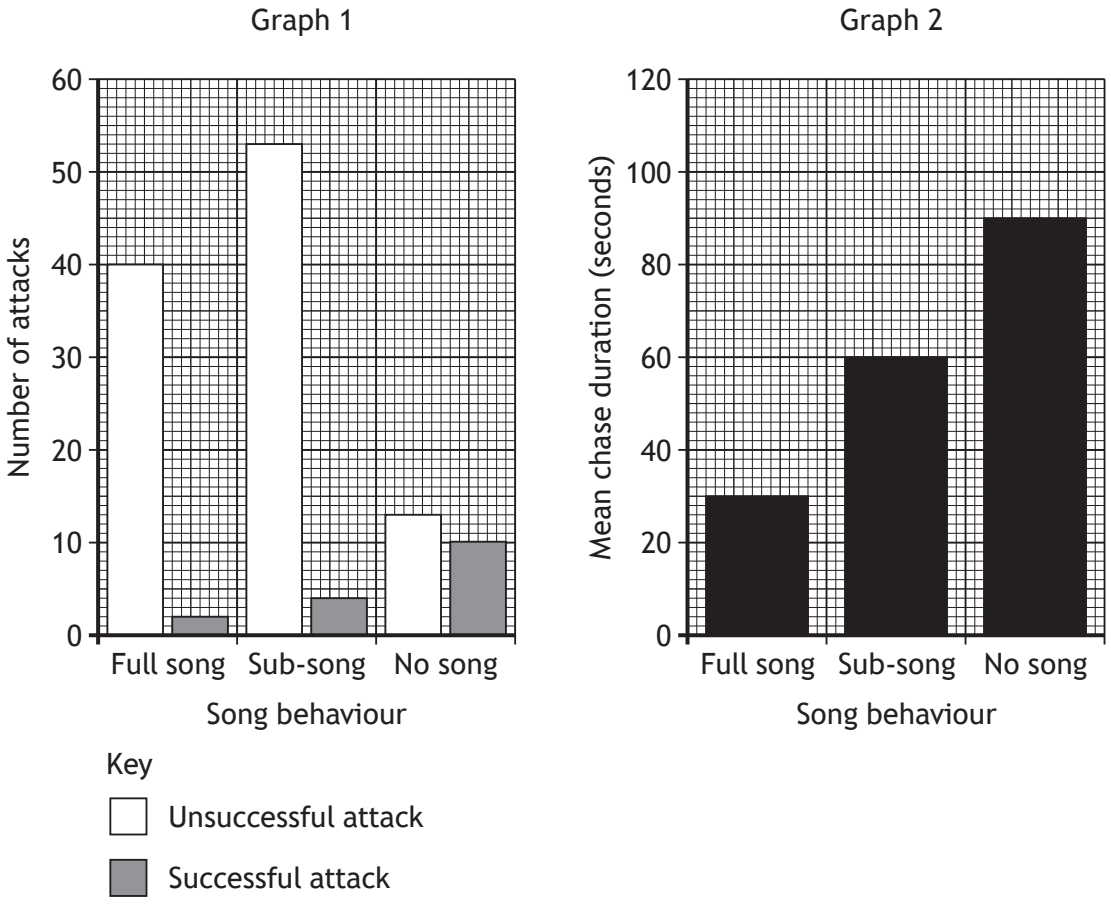
C Ensuring that sampling is representative

D Monitoring the dependent variable

15. Merlins are small birds of prey which chase and capture skylarks. The effect of skylark song on hunting by merlins was studied.

Graph 1 shows the number of successful and unsuccessful attacks on skylarks showing different singing behaviours.

Graph 2 shows how the different singing behaviours affected the mean duration of chases by merlins attacking skylarks.



Which of the following generalisations about skylark singing behaviour is valid?

A No song decreases the number of attacks by merlins and the time they will chase.

B No song increases the success of attacks by merlins and the time they will chase.

C No song increases the number of attacks by merlins and the time they will chase.

D No song decreases the success of attacks by merlins and the time they will chase.

[Turn over

16. Humans and many other primates have opposable thumbs. In the giant panda, a modified wrist bone forms a false 'thumb' which is used along with the five digits to manipulate bamboo.

The list shows processes related to evolution.

1 Convergent evolution

2 Divergent evolution

3 Natural selection

Evolution of the thumbs of primates and the false 'thumbs' of giant pandas has involved

A 1 only

B 2 only

C 1 and 3 only

D 2 and 3 only.

17. Which statement includes representatives of all three domains of life?

A Insects can be vectors for bacterial infections in plants.

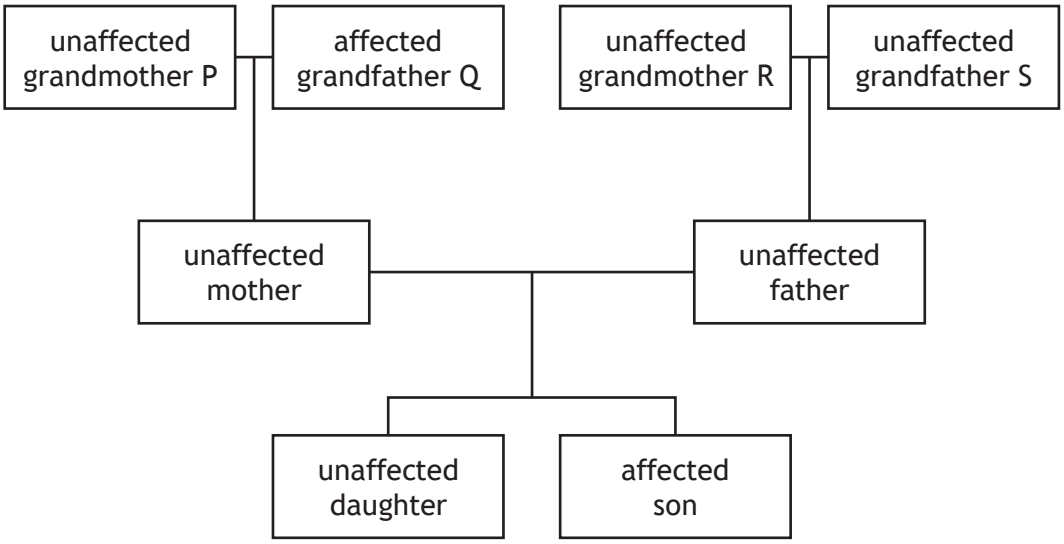
B Photoreceptor proteins are found in archaea, plants and animals.

C Scientists have cloned genes from archaea that can be expressed in *Escherichia coli*.

D Diseases in potato crops can be caused by the transmission of viruses by nematodes.

18. Haemophilia A is a sex-linked condition that slows blood clotting. The allele for normal clotting (X^H) is dominant to the allele for haemophilia A (X^h).

The diagram gives information about the inheritance of haemophilia A in one family.



From the information given, which of the statements is true?

A The genotype of grandmother P must be X^HX^h but the genotype of grandmother R cannot be determined.

B The genotype of neither grandmother can be determined.

C The genotype of both the unaffected mother and her daughter must be X^HX^h.

D The genotype of neither the mother or her daughter can be determined.

[Turn over

19. Red deer in Scotland have no natural predators. Control of the growth of a population to prevent it from outstripping resources is achieved by annual culling. The number killed annually must be greater than the *recruitment* (annual population increase due to births). Since birth rates vary, computer models are used to generate three estimates for recruitment based on birth rates of 30%, 35% and 40%. The number of red deer culled annually is recorded in different areas.

The table shows cull totals for one year in four areas, along with estimated recruitment at each birth rate.

Area	*Cull total*	*Estimated recruitment based on birth rate*		
		30%	*35%*	*40%*
North Ross	2654	2151	2557	2963
East Loch Ericht	887	897	1066	1234
Breadalbane	3026	1396	1659	1922
Knoydart	1082	1079	1283	1487

If the true birth rate is 35%, the area(s) in which the cull is sufficient to prevent population growth would be

A North Ross, East Loch Ericht, Breadalbane and Knoydart

B North Ross, Breadalbane and Knoydart only

C North Ross and Breadalbane only

D Breadalbane only.

20. Many species display some characteristics that are typical of r-selection and some that are typical of K-selection.

Which of the following species displays **only** K-selected characteristics?

A Leatherback turtles: lay up to nine large clutches of eggs per breeding season; hatchlings receive no parental care; small proportion survives to reach sexual maturity.

B Arctic terns: usually lay two eggs per clutch; adults are aggressive in defence of their young; more than 50% of offspring live to 30 years of age.

C English oak trees: slow-growing; do not produce seeds until at least 40 years of age; mature trees produce many thousands of seeds annually but only a small proportion germinate.

D Common dandelions: readily colonise disturbed ground; grow rapidly; flower several times a year; produce many seeds per flower head.

21. During the ritualised courtship in peafowl, *Pavo muticus*, the male spreads and shakes his tail feathers to attract a female before stepping back and bowing. This is followed by loud mating calls.

This type of fixed action pattern response can be a result of

A honest signals

B imprinting

C male-male rivalry

D species-specific sign stimuli.

22. An *in vivo* study involves observations made in

A the natural habitat of an animal

B a living cell culture in the laboratory

C a living organism

D extracts prepared from living tissues.

[Turn over

23. Eggs of the parasitic liver fluke *Leucochloridium paradoxum* are found on vegetation and can be eaten by marsh snails, *Succinea putris*. Inside snails, eggs develop into larvae which move to the ends of their tentacles. The tentacles become swollen and brightly coloured, resembling striped caterpillars. Infected snails become more active during daylight when predatory birds mistake the abnormal tentacles for caterpillars and eat them. The larvae within the tentacles complete their life cycle within the birds' bodies. Eggs are passed out of the birds in faeces.

Which items on the list represent part of the extended phenotype of the parasite?

1 Prey selection by birds

2 Modification of snail tentacles

3 Changed activity of snails

4 Feeding method of snails

A 1 and 2 only

B 1 and 3 only

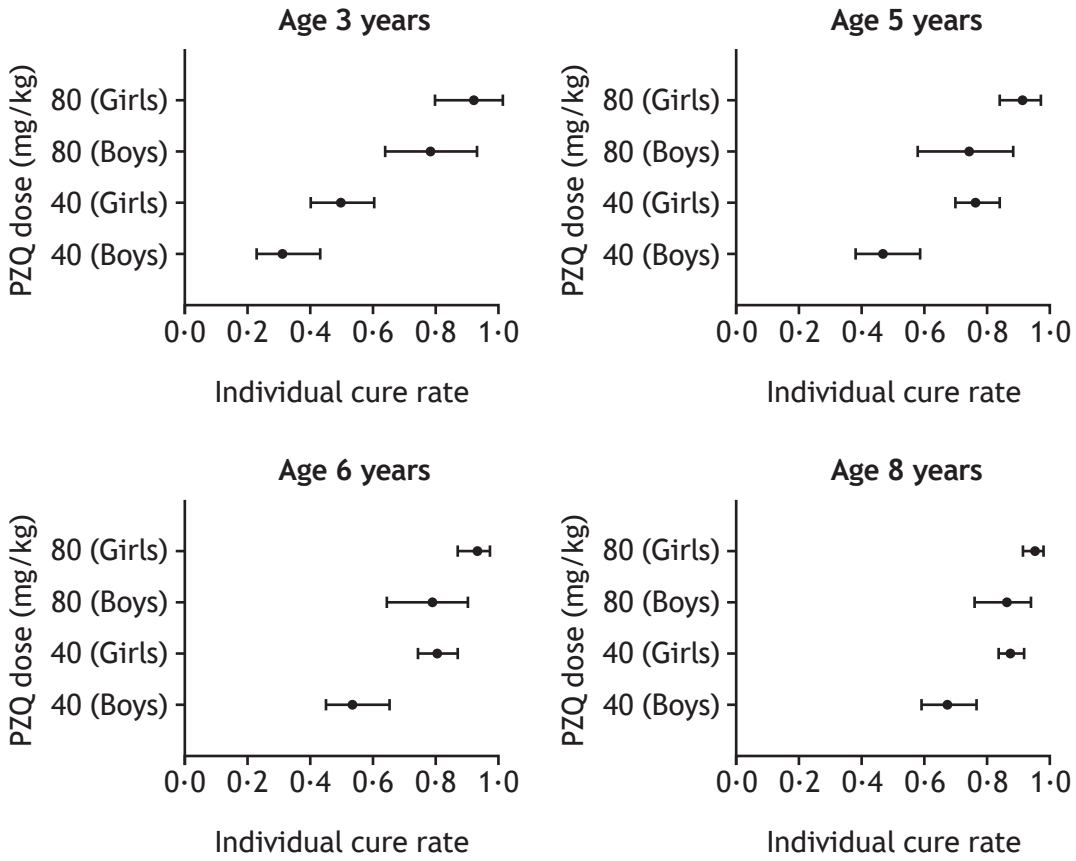
C 2 and 3 only

D 3 and 4 only

24. Which row in the table identifies white blood cells capable of long term survival as a part of immunological memory in mammals?

	Type of white blood cell			
	B lymphocytes	*T lymphocytes*	*Phagocytes*	*Natural killers*
A		✓		✓
B	✓		✓	
C			✓	✓
D	✓	✓		

25. The graphs show data derived from a study investigating the effectiveness of the drug praziquantel (PZQ) on Ugandan children with symptoms of schistosomiasis.



At what age does the data suggest that children would receive most benefit by increasing the dose of the drug?

A 3 years

B 5 years

C 6 years

D 8 years

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

ACKNOWLEDGEMENTS

Question 3 – Image of Ribbon representation of Cry3Aa toxin structure, adapted from Figure 1, is reprinted by permission of Springer Customer Service Centre GmbH: Springer Nature, Cellular and Molecular Life Sciences, “Signalling versus punching hole: how do Bacillus thuringiensis toxins kill insect midgut cells” by M. Soberón, S. S. Gill, A. Bravo, © 2009.