

**Paper II
Biology**

Question 1

- a. As you age, cartilage between the joints of two bones wear out.

Describe the effect this could have on the joints.

[1]

- b. State **two** differences in structure between RNA and DNA.

[2]

- c. Explain how phloem transports sugars from source to sink in plants.

[2]

- d. Explain why a shortage of oxygen in muscle cells results in reduced ATP production during prolonged exercise.

[2]

- e. How would damage to the myelin sheath of a neuron affect the transmission of nerve impulses?

[2]

- f. State the name of the reaction that forms a glycosidic bond between two monosaccharides.

[1]

Question 2

- a. The fig. 2.1 shows a loop of Henle with osmolarity values.

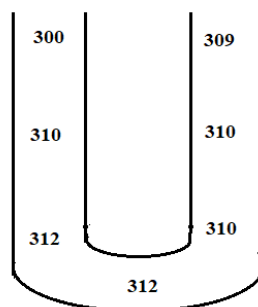


Fig. 2.1

- i. Explain how the values of osmolarity in the loop of Henle affect the urine volume.

[1]

- ii. What effect does less ADH secretion have on blood volume?

[1]

b.

- i. Explain how the Casparian strip in the root endodermis regulates the movement of water and mineral ions into the xylem.

[1]

- ii. Name **and** describe **one** adaptation of xerophytic plants.

[1]

- c. In a photosynthesis experiment, a student investigated effect of red, blue and yellow light on the rate of production of O₂ and obtained the data in **Table 2.1**.

Table 2.1

Light	Distance between light source and plant (cm)	Number of O ₂ bubbles produced every minute		
		1 min	2 min	3 min
Red	10	13	10	7
Blue	15	10	7	4
Yellow	20	4	3	2

- i. Calculate the rate of oxygen production in the first minute with blue light.
Give your answer in bubbles per second.

[1]

- ii. State any **ONE** change you would make in the experiment to draw a more valid comparison of O₂ production by different types of light.

[1]

- d. A scientist synthesizes simple organic molecules from inorganic gases under conditions similar to the early Earth.

i. Identify the phase of the origin of life represented by this process.

[1]

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Explain why this process is considered an important step in the origin of life.

[1]

- e. Two students have derived phylogenetic trees A and B of three different groups as shown in the fig.2.2.

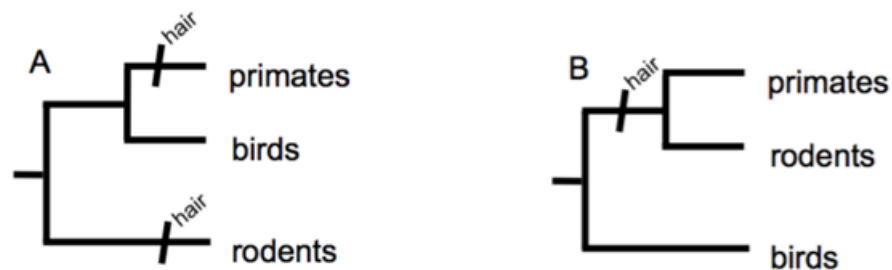


Fig.2.2

Which **one** of the two phylogenetic trees is correct?

Use **Fig. 2.2** to help explain your answer.

[1]

- f. During cell division, a mutation occurs that damages the centromere of a chromosome.

Give **one** way this would affect mitosis.

[1]

Question 3

a. **Fig.3.1** shows an evolutionary timeline.

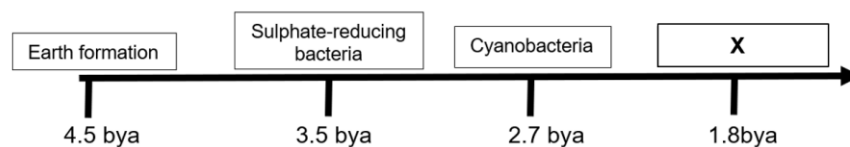


Fig. 3.1

I. Identify the type of organism represented by **X**.

[1]

II. Suggest how the evolution of cyanobacteria has affected the energy mechanism of **X**

[2]

b. A nucleotide is found to contain a phosphate group, a nitrogenous base, and a pentose sugar lacking one oxygen atom compared to another similar nucleotide.

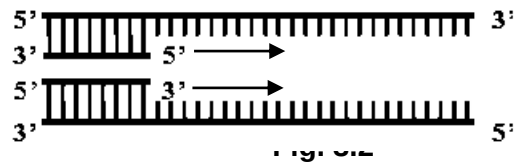
[1]

Identify the type of nucleic acid it belongs to.

c. Which strand of DNA is copied by the mRNA during transcription?

[1]

- d. During DNA replication, the primers mistakenly attached to template DNA strands as shown below in **Fig. 3.2**.



- i. Redraw the diagram and show the correct attachment of primers to template DNA strands.

Use arrows to show the direction of synthesis of new DNA.

[1]

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- ii. A cell nucleus divides incorrectly. The homologous chromosomes do not separate during Anaphase I.

Describe how this affects the chromosome number in the gametes.

[1]

- e. Compare the processes of natural selection and artificial selection.

[2]

- f. Define allopatric speciation.

[1]

Question 4

- a. A health official claims that:

“Vaccination alone is enough to completely prevent the spread of infectious diseases such as tuberculosis, cholera, and hepatitis B.”

Evaluate the statement made by the health official.

[2]

- b. A DNA strand has the sequence:

5' ATGCGTTATCGGGAGTAG 3'.

A mutation changes the sequence to:

5' ATGAGGTATGGGGAGTAG 3'.

		Second letter					
		U	C	A	G		
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA } Stop UAG } Stop	UGU } Cys UGC } UGA } Stop UGG } Trp	U C A G	
	C	CUU } CUC } CUA } Leu CUG }	CCU } CCC } CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } CGA } Arg CGG }	U C A G	
	A	AUU } AUC } Ile AUA } AUG } Met	ACU } ACC } ACA } Thr ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G	
	G	GUU } GUC } Val GUA } GUG }	GCU } GCC } GCA } Ala GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } GGA } GGG }	U C A G	

Fig. 4.1

Use Fig. 4.1 to answer the following questions.

- i. Explain the effect this mutation will have on the amino acid sequence **and** give the name for this feature of the genetic code.

[2]

- ii. How do the 5' cap and the 3' poly-A tail work together to enhance mRNA stability? [1]

- c. Explain why mutation in DNA is permanent while mutation in mRNA is temporary. [2]

- d. The diagram shows two beetle populations occupying different ecological regions.

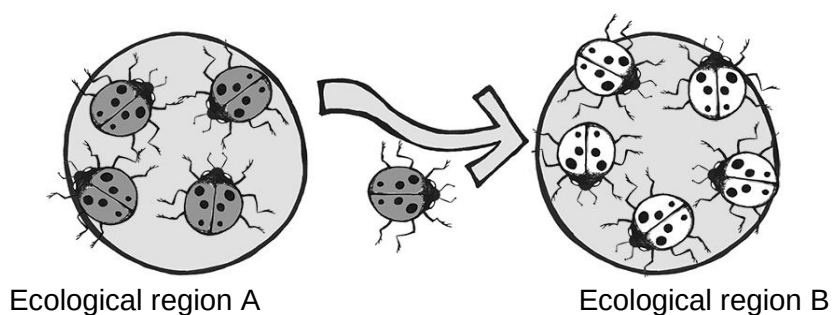


Fig. 4.2

- i. Beetles from population **A** can move to ecological region **B**.
 Beetles from population **B** cannot move to ecological region **A**.
 Explain which population will thrive in the future due to natural selection? [1]

- ii. State **ONE** limitation of Darwin's theory of natural selection. [1]

Question 5

- a. The fig. 5.1 shows the ultrastructure of a skeletal muscle.

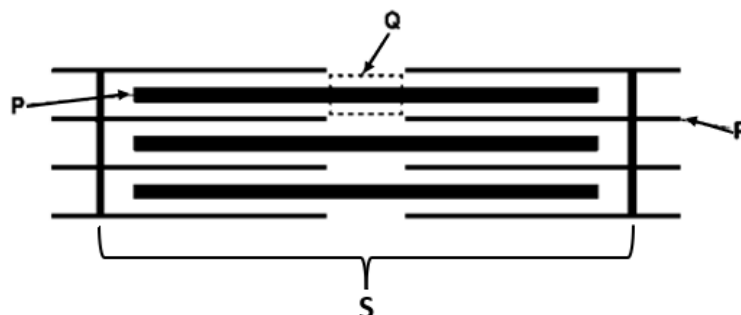


Fig. 5.1

- i. State how muscle contraction affects the length of structure S.

[1]

- ii. State which structure remains stationary during muscle contraction.

[1]

- b. The fig. 5.2 shows a section of the stomach wall.

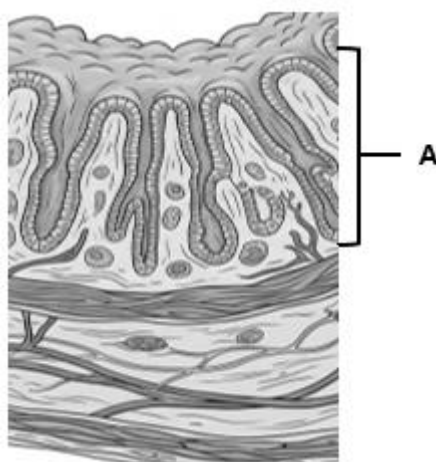


Fig. 5.2

- i. Suggest why digestion is affected when structure A is damaged by a peptic ulcer.

[1]

- ii. Use a label and label line to identify a muscular layer. [1]

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- c. The **Fig. 5.3** shows the transmission of nerve impulses from the pre-synaptic neuron to the post-synaptic neuron.

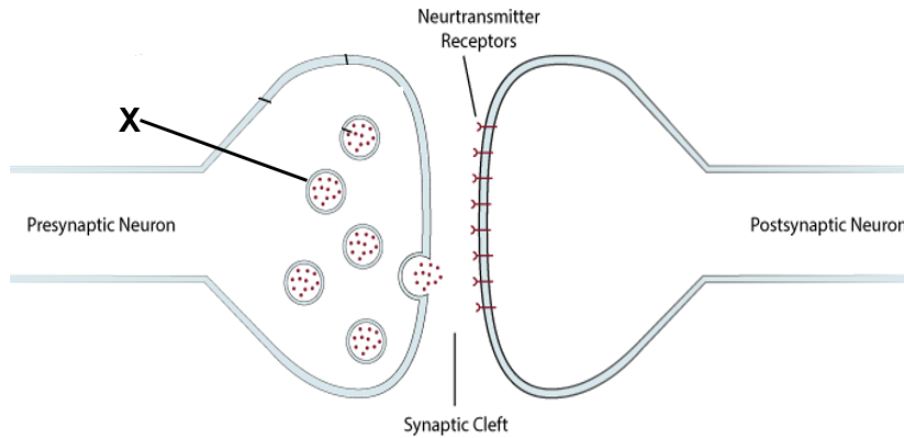


Fig. 5.3

- i. Identify the organelle labelled part X on Fig. 5.3 and explain its role in depolarizing the postsynaptic neuron. [2]

- ii. Explain why nerve impulse transmission is unidirectional. [1]

- d. State **one** reason why a 680 nm wavelength of light is effective for the Calvin cycle. [1]

- e. “A doctor suggests that the patient's motor cortex is damaged.” The doctor examined the patient using three types of tests as given in the **Table 5.1**.

Table 5.1

Types of tests	Response
Asked to raise the right arm	Unable to raise the arm
Asked to squeeze the doctor's hand	Weak grip
Pinprick on hand	Withdraws hand immediately

Evaluate the statement using the information provided in the table.

[2]

Question 6

- a. The fig. 6.1 shows a CRISPR Cas9 complex.

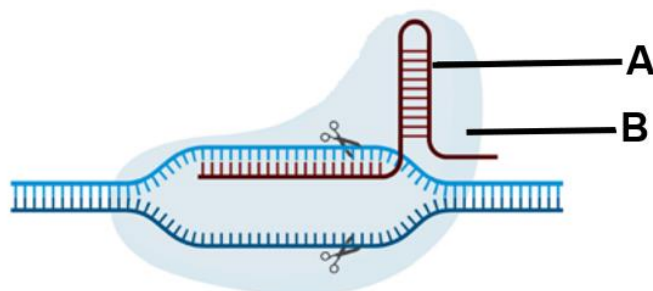


Fig. 6.1

- i. Identify parts A **and** B.

[1]

- ii. State the function of part A.

[1]

b. Study the **Table 6.1** that shows the amino acid sequence of four different species.

Table 6.1

Species	Amino acid sequence
Gorilla	Arg-Lys-Ala-Pro
Horse	Arg-Lys-His-Lys
Sparrow	Ala-Val-Pro-Meth
Zebra	Arg-Lys-His-Pro

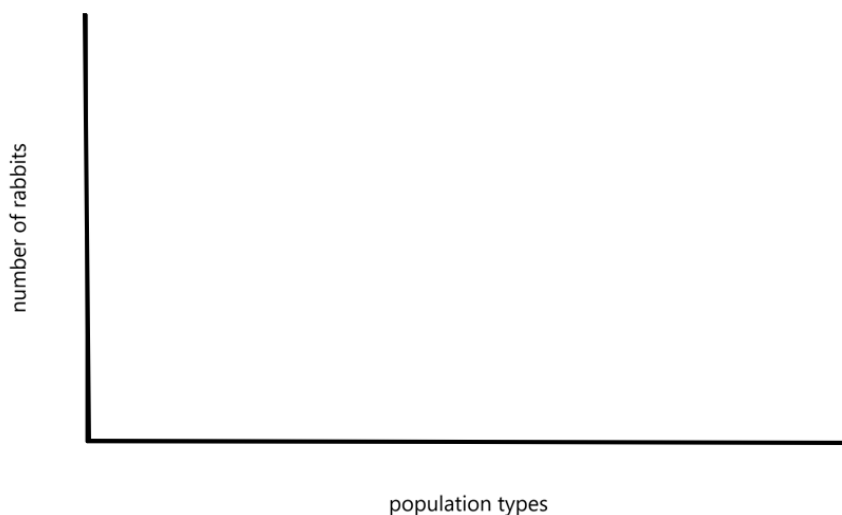
Represent the relationship between the four species on **Table 6.1** with a cladogram.

[2]

- c. A population of rabbits originally has thick fur. Over many generations, the climate becomes warmer. Rabbits with thinner fur are better adapted to the new environment and produce more offspring.

Based on the scenario, draw a graph with two curved lines; one to represent the population number of rabbits with thicker fur, **and** one to represent the population number of rabbits with thinner fur. Draw a key for your graph.

[3]



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- d. A population of 10,000 humans has:

- 6840 individuals with the blood type AA
- 2860 individuals with blood type AB
- 300 individuals with the blood type BB.

- i. Calculate the frequency of genotype BB in this population.

[1]

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- ii. The next generation contains 25,000 individuals.
Using your answer from **6(d)(i)**, calculate how many individuals would have blood type BB.
Assume the population is in Hardy-Weinberg equilibrium.
Allele frequency: $p + q = 1$
Genotype frequency: $p^2 + 2pq + q^2 = 1$

[2]

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- e. **Fig. 6.2** shows the electron transport chain (ETC) on the inner mitochondrial membrane.

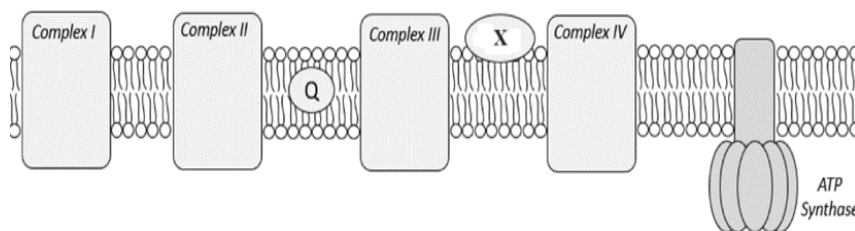


Fig. 6.2

- i. Name a compound that donates electron to complex I. [1]

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- ii. Identify structure X. [1]

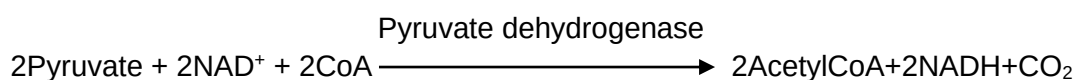
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- f. State **one** negative consequence of gene therapy on the cells or body of a patient. [1]

Question 7

- a. Explain how DNA fingerprinting can contribute to the conservation effort of species. [1]

- b. The equation represents oxidative decarboxylation.



A reduction in pyruvate dehydrogenase reduces the concentration of the products shown in the equation.

State **two** other effects that a reduction in pyruvate dehydrogenase would have on the body.

[2]

- c. Two patients have different kidney problems as shown in the table 7.1.

Table 7.1

Patient	Observation
A	Proteins detected in urine
B	Glucose detected in urine

Compare the nephron processes affected in patients A and B.

[2]

- d. A conservation programme introduces individuals from another population to increase genetic diversity. After five years, heterozygosity has increased significantly.
- i. Evaluate how this conservation strategy affects genetic variation and the Hardy – Weinberg assumptions. [2]

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- ii. A glacier separates a population of wolves into two isolated groups. After 15,000 years, the glacier melts, but the two groups no longer interbreed.
Evaluate how geographical isolation contributed to the formation of two species. [2]

- e. State **one** significance of the highly coiled structure of a DNA molecule. [1]
