Q1.

Courtship behaviour in the frog species, *Xenopus laevis*, involves male frogs calling to:

- attract sexually active females – these are advertisement calls
- start and continue mating – these are mating calls
- signal when a male is not sexually active – these are rasping calls.

Scientists investigated frog courtship behaviour by feeding a population of sexually active male frogs a diet containing the hormone EE2. The scientists also fed a separate control population of sexually active male frogs a diet without EE2.

They determined the percentage of males making advertisement calls or rasping calls in each population.

Table 1 shows their results.

Table 1

Population	Percentage of males making:	
	Advertisement calls	**Rasping calls**
Males fed EE2	94.0	4.0
Males not fed EE2 (control)	97.0	0.5

(a) There were 800 males in the control population.

Each male made one type of call.

Use this information and **Table 1** to calculate the number of males making mating calls in the control population.

Answer _____ males

(1)

(b)   Suggest **one** change the scientists could make to both frog populations to increase the number of mating calls.

_____

_____

_____

(1)

(c)   The scientists also investigated the effect on **female** frog courtship behaviour of feeding EE2 to male frogs.

Table 2 shows their results.

Table 2

Population	Median time females spent in courtship / s
Males fed EE2	8
Males not fed EE2 (control)	16

EE2 is contained in human contraceptive pills. Some EE2 is released in human urine and collects in sewage. Untreated sewage pollutes the water in frog habitats.

Suggest and explain the effect EE2 pollution in frog habitats will have on frog breeding.

Use information from **Table 1** and **Table 2** in your answer.

Effect on frog breeding   _____

Explanation   _____

_____

_____

_____

_____

_____

_____

(4)
(Total 6 marks)

Q2.

Scientists dissected gills from several species of fish. They recorded:

- the mass of the whole fish
- the total number of gill filaments
- the mean length of one filament
- the mean number of lamellae per mm
- the mean surface area of one lamella.

(a) It was not possible for the scientists to measure the length of every filament and the surface area of every lamella.

Suggest how they collected data to give a reliable mean for these variables.

_____

_____

_____

_____

_____

(2)

(b) From these measurements, the scientists calculated the total surface area of the gas exchange surface on the gills of each fish species.

Calculate the total surface area of the gills of a fish with the following measurements:

- total number of gill filaments = 595
- mean length of one filament = 2.86 mm
- mean number of lamellae per mm = 16
- mean surface area of one lamella = 0.66 mm^2

Give your answer in mm^2 **and** to an appropriate number of significant figures.

Show your working.

_____ mm^2

(2)

(c) **Table 1** shows the scientists' data for two species of fish.

Table 1

Fish species	Mean fish mass / g	Mean total surface area of the gills / mm²
Opsanus tau	305	46 100
Trachurus trachurus	250	252 500

One of these fish spends most of its time not moving, waiting to catch passing prey. The other species is very active, hunting mobile prey.

Suggest which of the species in **Table 1** is the very active fish species.

Explain your answer.

Very active fish species _____

Explanation _____

_____

_____

_____

(2)

(d) Complete **Table 2** to show the phylogenetic classification for these two species.

Table 2

Taxon	*Opsanus tau*	*Trachurus trachurus*
		Animalia
	Chordata	
Class	Actinopterygii	Actinopterygii
	Batrachoidiformes	Carangiformes
Family	Batrachoididae	Carangidae
Genus		
Species	*tau*	*trachurus*

(2)

(Total 8 marks)

Q3.

(a)   Define genome and proteome.

Genome   _____

_____

_____

Proteome   _____

_____

_____

(2)

The classification system used in the early 20th century grouped different species of bacteria according to the position and shape of flagella on bacterial cells and by the number of flagella per cell. These were observed using an optical microscope.
Each species of bacterium has a characteristic cell shape and arrangement of flagella. These characteristics may be shared with other species within a genus. Flagella are fragile, difficult to stain and may extend from the cell at any angle.

(b)   Consider the accuracy and limitations of the early classification of bacteria using the arrangement of flagella.

_____

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_____

(3)

(c)   Suggest why several bacterial species have been renamed in recent years.

_____

_____

_____

(1)

(d)   The figure below shows an image from an optical microscope of a single bacterial cell.

This bacterial cell is 2.3 µm long (excluding the flagellum).

Calculate the magnification of this image.

Show your working.

Magnification ×   _____

(2)

(Total 8 marks)

Q4.

(a)   Describe how organisms are grouped in a phylogenetic classification system.

_____

_____

_____

_____

(2)

Table 1 shows some of the taxa in the phylogenetic classification of a rhinoceros species.

Table 1

Taxon name	Scientific name
Class	Mammalia
Order	Perissodactyla
Family	Rhinocerotidae
Genus	*Rhinoceros*
Species	*unicornis*

The figure below shows the relationship between the taxa in the classification of two rhinoceros species: *Rhinoceros unicornis* and *Dicerorhinus sumatrensis*.
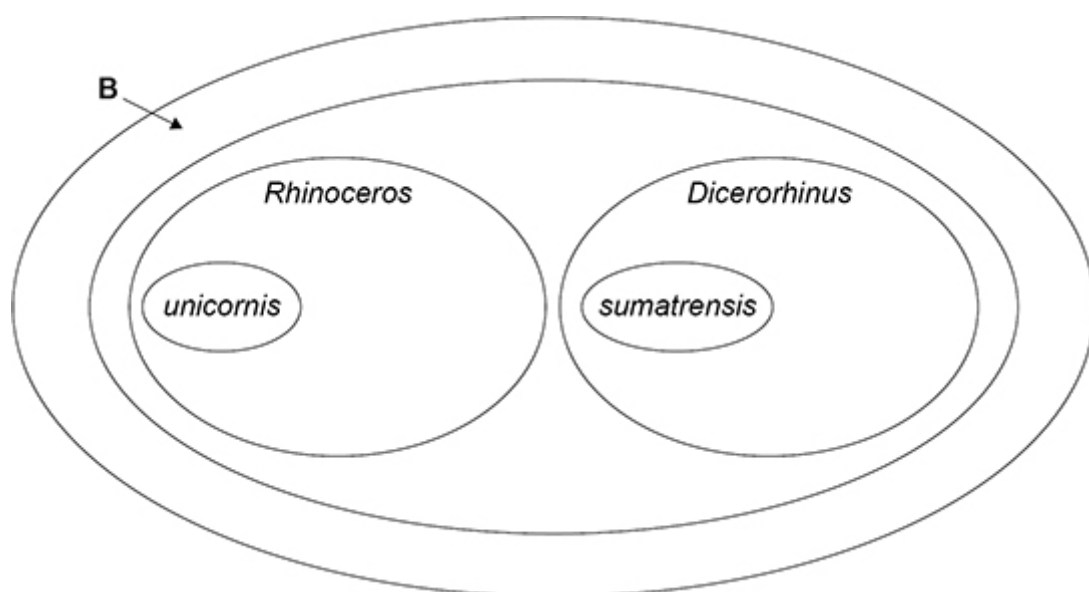
(b) Use information in **Table 1** to give the **scientific** name of the taxon labelled **B** in the figure above.

_____

(1)

(c) Draw an oval on the figure above to show the species *Rhinoceros sondaicus*.

(1)

Scientists investigated a phylogenetic relationship between individuals of five species of rhinoceros.

The scientists:

•   determined the DNA base sequence of the *cyt b* gene of each rhinoceros
•   compared each *cyt b* DNA base sequence with that of **one** Indian rhinoceros (called the reference rhinoceros)
•   calculated the percentage difference between each *cyt b* DNA base sequence and that of the reference rhinoceros.

Table 2 shows their results.

Table 2

Investigated species of rhinoceros	Percentage difference in DNA base sequences compared with the reference Indian rhinoceros
Indian	2
Javan	5
Sumatran	13
White	14
Black	14

(d)   What can you conclude about the likely phylogenetic relationships between these species? Evaluate your conclusion.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(e)   A scientist obtained a rhinoceros horn confiscated from poachers and wanted to identify the species of rhinoceros that was killed for its horn.

He used the procedure described in part (d) and calculated the difference in *cyt b* DNA as 14%.

What can you conclude from this result? Explain your answer.

Suggest a change to the procedure that will more precisely identify the rhinoceros species that provided the horn.

Conclusion and explanation   _____

_____

_____

_____

Suggested change to the procedure   _____

_____

_____

_____

(2)
(Total 10 marks)