Q1.

(a)   Describe **and** explain the relationship between surface area to volume ratio of the human body and metabolic rate.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

The table below shows the height and mass of two adults.

Person	Height / cm	Mass / kg
A	181	90.90
B	149	62.62

The surface area of a person is estimated using the following formula:

$$\text{Surface area in m}^2 = \sqrt{\frac{\text{height in cm} \times \text{mass in kg}}{3600}}$$

The volume of a person is estimated using the following formula:

$$\text{Volume in m}^3 = \frac{\text{mass in kg}}{1010}$$

(b) Using suitable calculations, deduce which person has the smaller surface area to volume ratio.

Show your working **and** complete the sentence below.

Give your answer to 3 significant figures.

Person _____ has the smaller surface area to volume ratio which =

_____

(3)

(c) Which is **not** a possible explanation for the difference in surface area to volume ratio between person **A** and person **B**?

Tick (✓) **one** box.

Person **A** and person **B** have different body shapes. ☐

Person **A** has a higher mass than person **B**. ☐

Person **A** is taller than person **B**. ☐

(1)

(d) Name **two** structural features of the gills of a fish that increase their surface area.

1 _____

_____

2 _____

_____

(1)
(Total 8 marks)

Q2.

Write an essay on the mechanisms and importance of transport within organisms.

(Total 25 marks)

Q3.

A student investigated the effect of changing surface area on the rate of diffusion of a solution into the centre of agar blocks.

She used agar coloured by an indicator. The indicator is pink at pH > 8 and colourless at pH 8 and pH < 8

She cut blocks in different shapes as shown in the figure below.

C

4 cm

4 cm

4 cm

D

2 cm

2 cm

16 cm
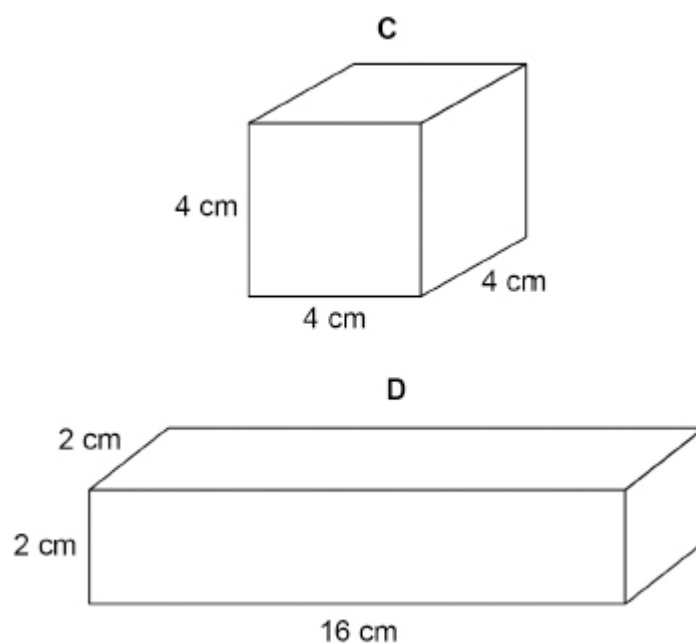
(a)   Complete **Table 1** to show the surface area and the surface area to volume ratio for the two shapes.

Table 1

Shape	Surface area / cm²	Volume / cm³	Surface area to volume ratio
C	_____	64	_____ : 1
D	_____	64	_____ : 1

(2)

(b)   The student put the blocks into an acidic solution.

The acidic solution caused the blocks to gradually turn from pink to colourless.

She recorded the time taken for the blocks to turn completely colourless. She repeated this three times.

Table 2 shows the student's results.

Table 2

Shape	Time for block to turn colourless / s				Mean time for block to turn colourless / s
	Block 1	Block 2	Block 3	Block 4	
C	3490	1200	3540	3530	_____
D	1680	1500	1590	1610	1595

After collecting the data, the student noticed that shape **C**, block 2 was damaged.

Calculate the mean for shape **C**.

(1)

(c)   Suggest what the student should have done when she saw that shape **C**, block 2 was damaged.

_____

_____

_____

(1)

(d)   State **three** variables the student controlled in order to obtain valid results.

1 _____

2 _____

3 _____

(2)

(e)   Describe how gas exchange occurs in single-celled organisms **and** explain
why this method cannot be used by large, multicellular organisms.

_____

_____

_____

_____

_____
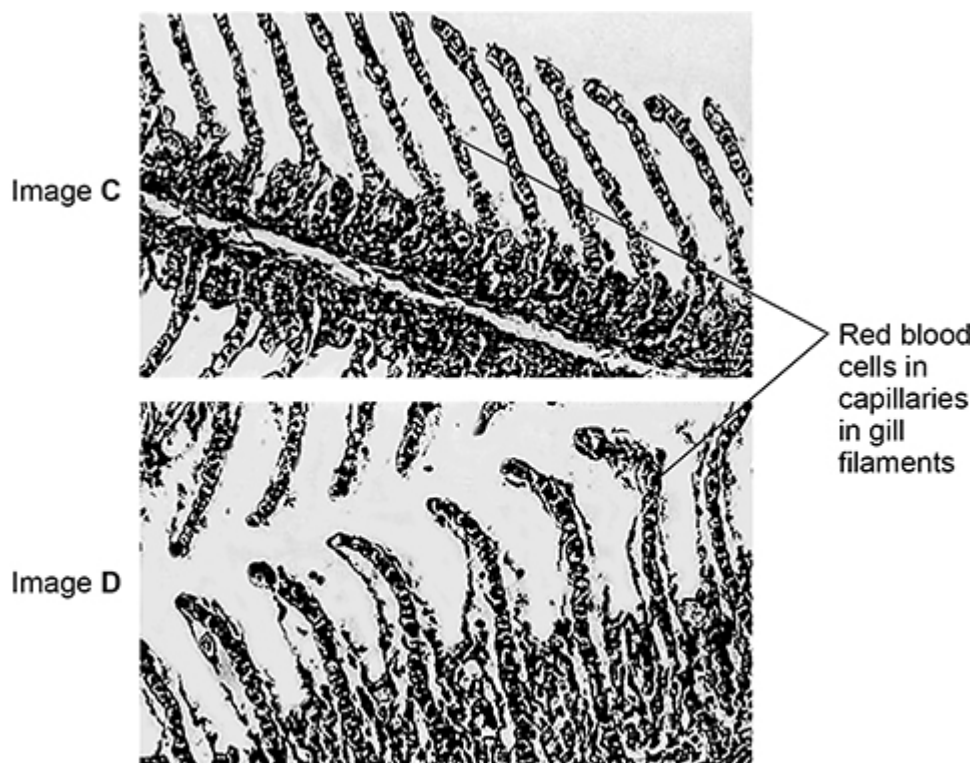
_____

_____

_____

_____

(3)
(Total 9 marks)

Q4.

Figure 1 shows images of gills from two fish as seen through an optical microscope.

Image **C** shows gills from a fish with healthy gills.

Image **D** shows gills from a fish with damaged gills.

Figure 1

Magnification × 160

(a) To observe the fish gills with the optical microscope, the scientists used **two** different stains. The first stain binds to DNA; the second stain binds to the red blood cells.

Explain why a second stain would be needed to stain the red blood cells. Suggest which molecule the stain could bind to in the red blood cells.

Explanation _____

_____

_____

Molecule _____

(2)

(b) Using **Figure 1**, the scientists calculated the surface area to volume ratios for each gill filament in these two fish. Some of their results are shown in **Table 1**.

Complete **Table 1**. State your calculated volume and surface area:volume ratio to 2 significant figures.

Table 1

Fish gill	Surface area / μm^2	Volume / μm^3	Surface area:volume ratio
Healthy	7.4×10^3	2.3×10^4	_____
Damaged	1.1×10^4	_____	0.13:1

(2)

(c) The damage to the gills causes uncontrolled cell division in the cells around the capillaries in the gill filaments.

Other than surface area:volume ratio, describe **one** way this uncontrolled cell division changes the gills, as shown in **Figure 1**.

Explain how this difference would affect gas exchange.

Difference _____
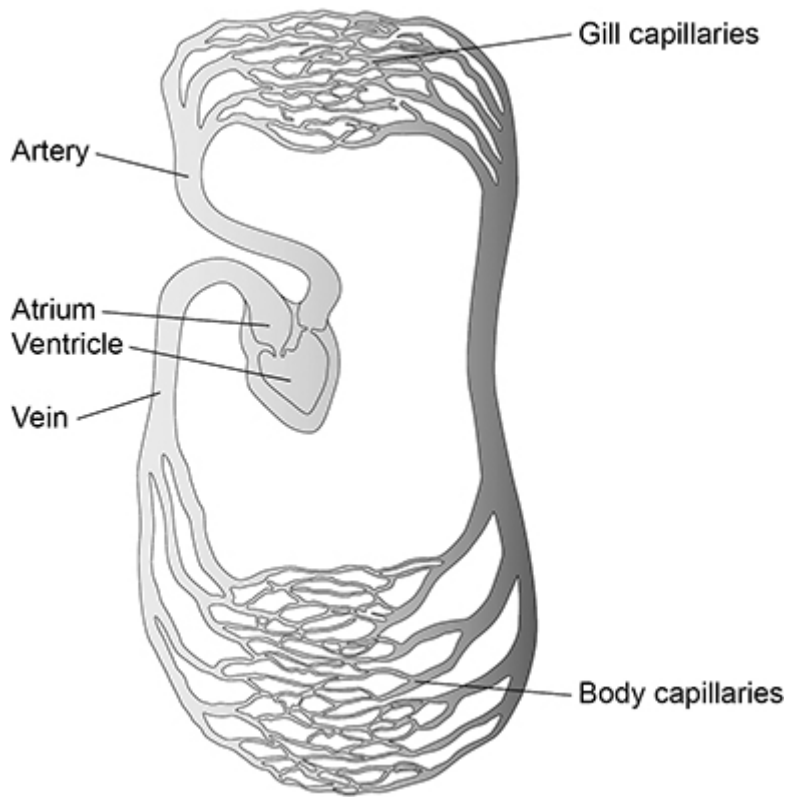
_____

_____

Explanation _____

_____

_____

_____

_____

_____

(3)

Figure 2 shows the general pattern of blood circulation in fish.

Figure 2

(d)   Use **Figure 2** to complete **Table 2** to show **two** differences between the circulation of blood in fish and the circulation of blood in a mammal.

Table 2

Difference	Circulation of blood in fish	Circulation of blood in mammal
1		
2		

(2)

(Total 9 marks)