Q1.
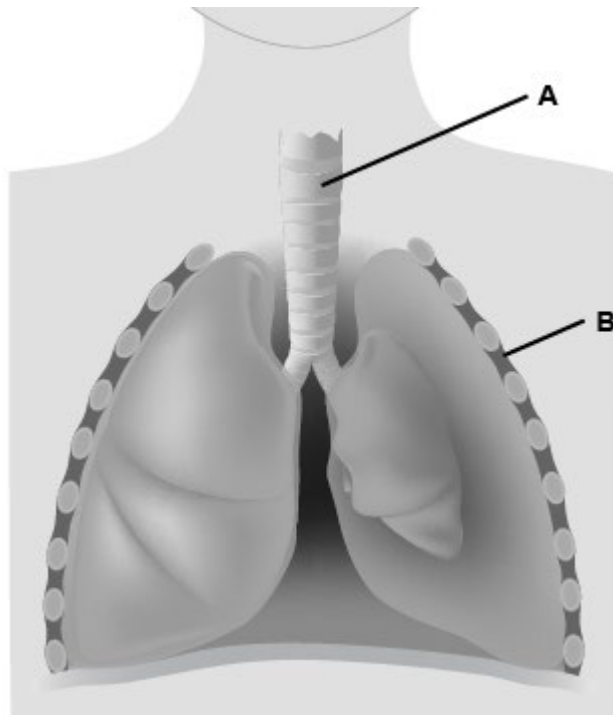
(a) **Figure 1** shows a diagram of the human gas exchange system.

Figure 1

Structure **B** is muscle. The volume of the thorax is increased when structure **B** contracts.
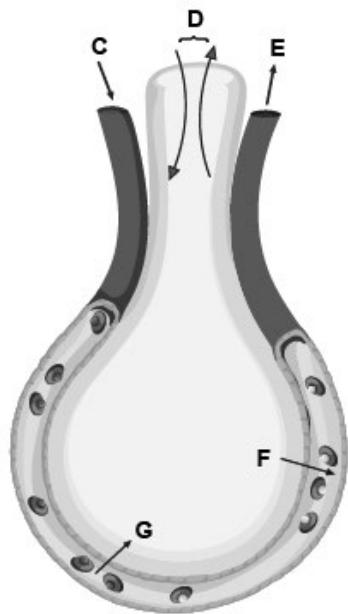
Name the structures labelled **A** and **B**.

A _____

B _____

(2)

(b) **Figure 2** is a diagram of an alveolus and a blood vessel associated with the alveolus.

The direction of the movement of substances is shown by the arrows labelled **C**, **D**, **E**, **F** and **G**.

Figure 2

Complete the table below by writing the correct letter, **C**, **D**, **E**, **F** or **G**, in the box next to each statement. You may use each letter once, more than once or not at all.

Box	Statement
	represents the diffusion of oxygen
	represents the transport of a gas mixture
	represents blood moving at the highest pressure

(2)

(c) Describe and explain **one** adaptation of a **single** alveolus for gas exchange.

_____

_____

_____

_____

(2)
(Total 6 marks)

Q2.

(a)   Describe how we breathe in.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(b)   A scientist prepared alveolar tissue to view using an optical microscope. The scientist cut very thin slices of the alveolar tissue.

Explain why the scientist used very thin slices of alveolar tissue with the optical microscope.

_____

_____

_____

_____

_____

_____
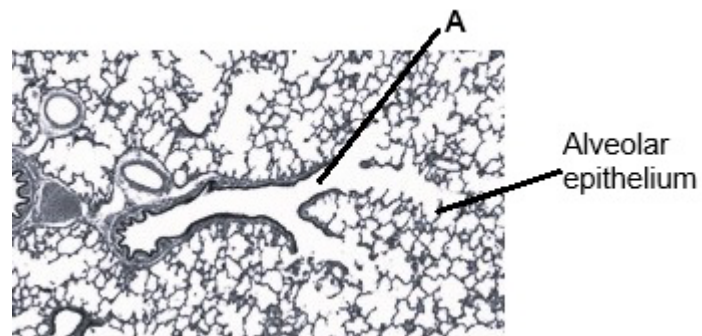
(2)

(c)   The figure below is an image of the lung tissue observed using an optical microscope.

Identify the tube labelled **A**.

A _____

The scientist used a ruler to measure the diameter of some of the alveoli.

The table below shows the scientist's results.

Alveolus diameter / mm								
Alveolus diameter / mm	4	2	5	1	2	3	5	2

(1)

(d)   The magnification of the image in the figure above is × 40

Use this information and the table above to calculate the mean diameter, in μm, of the alveoli.

Show your working.

Answer _____ μm

(2)

(e)   Give the uncertainty associated with taking a measurement using a ruler with 1 mm graduations.

Calculate the percentage error for a measurement using the ruler of 4 mm

Uncertainty ± _____ mm

Percentage error _____

(2)
(Total 10 marks)

Q3.

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 / mm^2
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)

Q4.

(a)   Carbon monoxide (CO) is released during incomplete combustion of fossil fuels.

The graph below shows the dissociation curve for oxyhaemoglobin when:

- **not** exposed to CO
- exposed to CO such that 50% of the oxygen binding sites are occupied by CO (50% COHb).
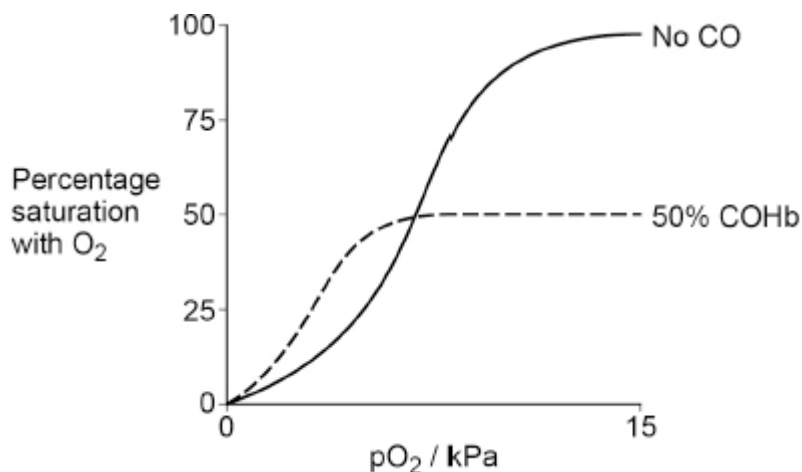
Using the graph above, what can you conclude about how exposure to CO affects the loading and unloading of oxygen by haemoglobin?

Explain your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(b) The World Health Organisation (WHO) suggests that to avoid long-term health effects, COHb concentrations should be kept below 2.5%.

WHO recommends that people should not be exposed to:

- air with > 10 mg m^{-3} CO for more than 8 hours
- air with > 30 mg m^{-3} CO for more than 1 hour.

Scientists have used a mathematical model to calculate the exposure to carbon monoxide that would result in 2.5% COHb in both adults and children.

The table shows the scientists' results.

Exposure duration at rest / hours	CO concentration in the air / mg m^{-3} resulting in 2.5% COHb	
	Child	Adult
1	31.2	40.2
8	9.6	10.6

The scientists suggest that the WHO recommendations for carbon monoxide concentrations resulting in 2.5% COHb should be reduced.

Evaluate the scientists' conclusion.

_____

_____

_____

_____

_____

_____

_____

_____

(3)
(Total 6 marks)

Q5.

(a) Describe how the structure of the insect gas exchange system:

- provides cells with sufficient oxygen
- limits water loss.

Explain your answers.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(b) Describe how humans breathe in and out.

_____

_____

_____

_____

_____

_____

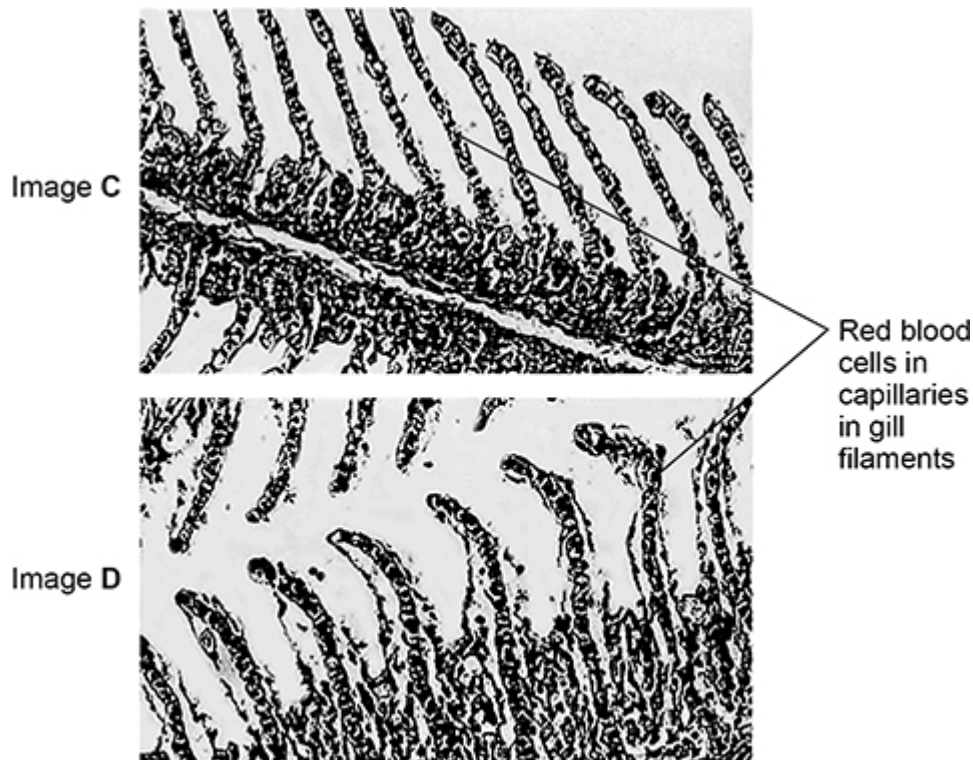_____

_____

_____

(5)
(Total 10 marks)

Q6.

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 / µm²	Volume / µm³	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 _____

_____

_____

_____
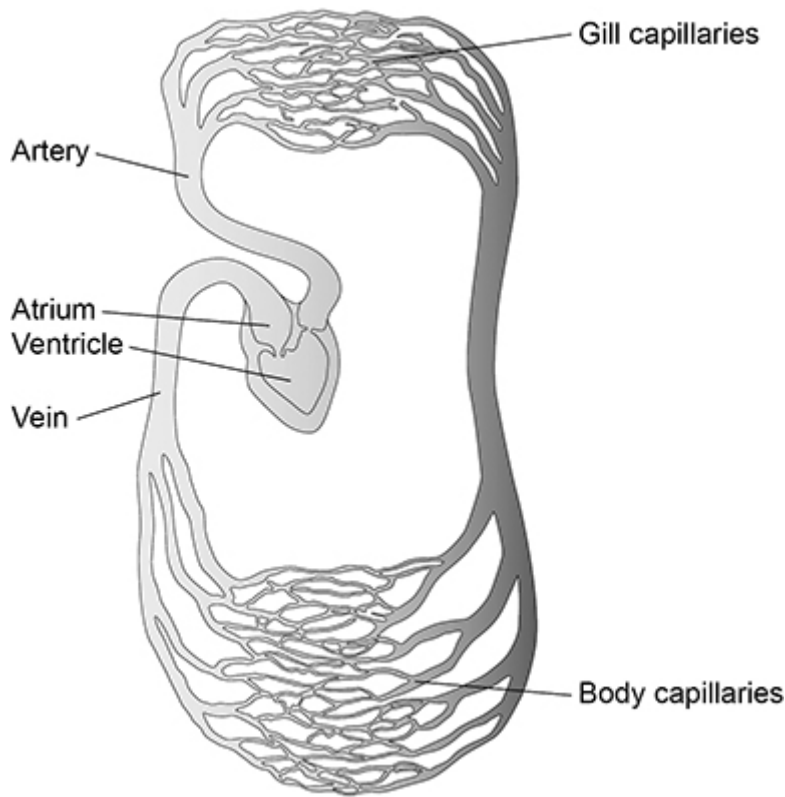
_____

_____

(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)