Q1.

(a) A scientist investigated the hydrolysis of starch.
He added amylase to a suspension of starch and measured the concentration of maltose in the reaction mixture at regular intervals.

A quantitative Benedict's test produces a colour whose intensity depends on the concentration of reducing sugar in a solution. A colorimeter can be used to measure the intensity of this colour.

The scientist used quantitative Benedict's tests to produce a calibration curve of colorimeter reading against concentration of maltose.

Describe how the scientist would have produced the calibration curve and used it to obtain the results in the graph.

Do **not** include details of how to perform a Benedict's test in your answer.

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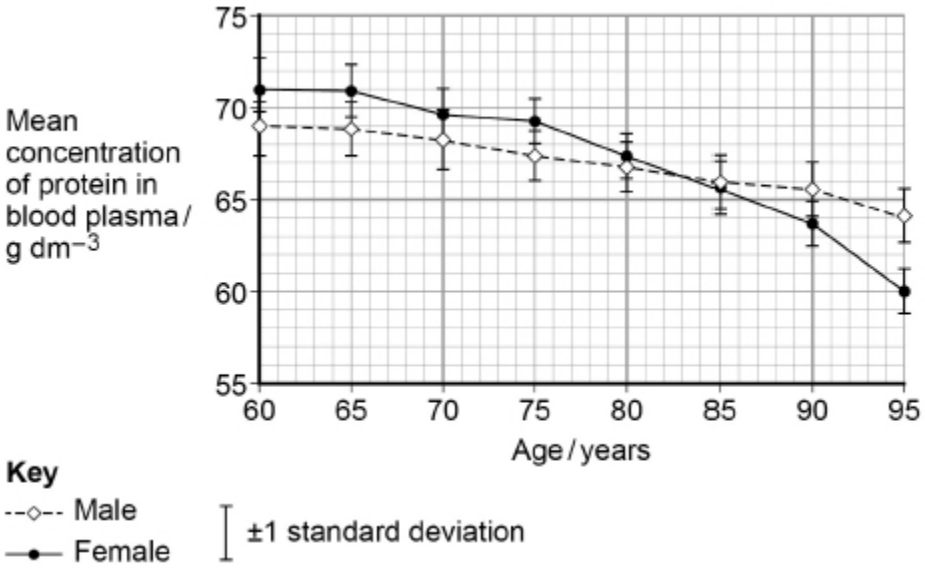
(3)

(b) Scientists investigated how the concentration of protein in blood plasma changes in people between the ages of 60 and 95.

The graph shows the scientists' results. The bars show ±1 standard deviation.



The scientists measured the absorption of each sample of blood plasma using a colorimeter. They used a calibration curve to find the concentration of protein in samples of blood plasma.

Describe how the scientists could obtain data to produce a calibration curve and how they would use the calibration curve to find the concentration of protein in a sample of blood plasma.

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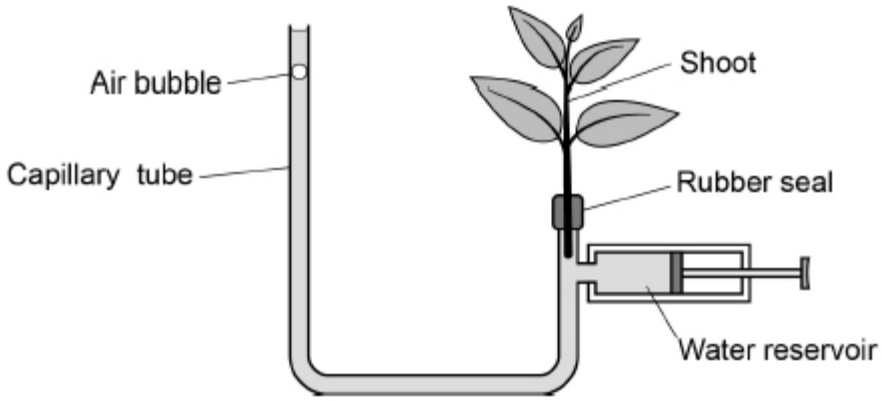
(3)
(Total 6 marks)

Q2.

A student used a potometer to measure the movement of water through the shoot of a plant. The potometer is shown in **Figure 1**. As water is lost from the shoot, it is replaced by water from the capillary tube.

Figure 1



(a) In one experiment, the air bubble moved 7.5 mm in 15 minutes. The diameter of the capillary tube was 1.0 mm.

Calculate the rate of water uptake by the shoot in this experiment.

Give your answer in mm^3 per hour. Show your working. (The area of a circle is found using the formula, area = πr^2)

_____ $mm^3\ hour^{-1}$

(2)

(b) The student wanted to determine the rate of water loss per mm^2 of surface area of the leaves of the shoot in **Figure 1**.

Outline a method she could have used to find this rate. You should assume that all water loss from the shoot is from the leaves.

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(3)

(c) The rate of water movement through a shoot in a potometer may not be the same as the rate of water movement through the shoot of a whole plant.

Suggest **one** reason why.

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(1)
(Total 6 marks)

Q3.

(a) A student used a dilution series to investigate the number of cells present in a liquid culture of bacteria.

Describe how he made a 1 in 10 dilution and then used **this** to make a 1 in 1000 dilution of the original liquid culture of bacteria.

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(3)

(b) Using an optical microscope, the student determined there were 15 cells in 0.004 mm^3 of the 1 in 1000 dilution of the culture.

Calculate the number of cells in 1 cm^3 of undiluted liquid culture.

Answer = _____ Number of cells

(2)

(c) The student looked at cells in the 1 in 10 dilution during his preliminary work. He decided **not** to use this dilution to determine the number of cells in the undiluted liquid culture.

Suggest an explanation for the student's decision.

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(2)

(d). Describe two aseptic techniques that should be used when working safely with bacteria.

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(2)

(Total 9 marks)

Q4.

(a) A student investigated the distribution of stomata on leaves from two species of plant. She removed small pieces from the lower surface of the leaves of each plant species. She mounted these pieces on separate microscope slides. She then counted the number of stomata in several parts of the epidermis on each piece of leaf tissue using an optical microscope.

(i) Suggest appropriate units the student should use to compare the distribution of stomata on leaves.

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(1)

(ii) The pieces of leaf tissue examined were very thin.

Explain why this was important.

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(2)

(iii) Give **two** reasons why it was important that the student counted the number of stomata in several parts of each piece of leaf tissue.

1. _____

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2. _____

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(2)

(b) Stomata are found mainly on the underside of leaves of dicotyledonous plants.
A student painted a layer of nail varnish on the lower epidermis of a leaf.
She peeled off the dry layer of nail varnish and placed it on a microscope slide. The student was able to see the impressions of the stomata on the varnish using an optical microscope.
She then determined the mean diameter of the stomata.

(i) Describe how the student could use an eyepiece graticule to determine the mean diameter of stomata.

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(3)

(c) Describe how you could make a temporary mount of a piece of plant tissue to observe the position of starch grains in the cells when using an optical (light) microscope.

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(4)
(Total 12 marks)

Q5.

(a) **Figure 1** shows a photograph of part of a mitochondrion from a mouse liver cell taken using a transmission electron microscope at × 62 800 magnification.

Figure 1

Produce a scientific drawing of the mitochondrion in **Figure 2** in the box below.

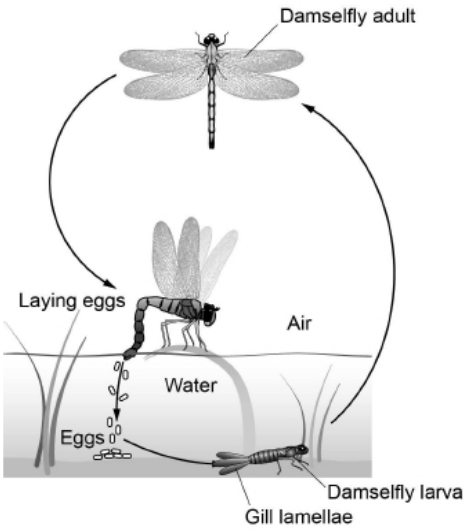
Label the following parts of the mitochondrion on your drawing.

- Matrix
- Crista

(4)

(b) **Figure 2** shows the stages of development of an insect called a damselfly.

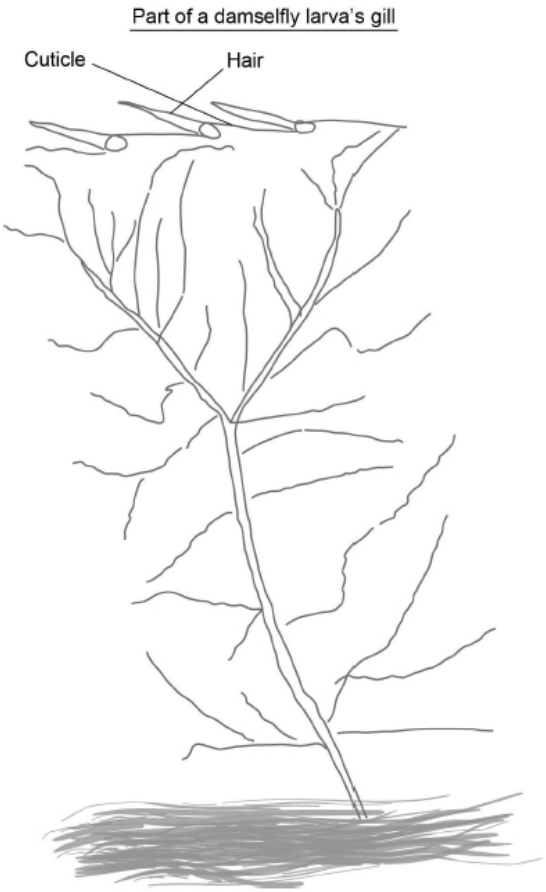
Figure 2



A student used an optical microscope to observe part of a damselfly larva gill.

Figure 3 shows the drawing the student produced.

Figure 3



Suggest **two** ways the student could improve the quality of her scientific drawing of this gill.

1. _____

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2. _____

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(2)

(Total 6 marks)

Q6.

(a) Some autism spectrum disorders (ASDs) are associated with a mutation affecting the neuroligin-3 gene. This gene codes for a protein called NL3, that is found in synapses.

Scientists investigated the effects of a mutation affecting NL3 in mice. They obtained brains from mice with the mutation and from mice without the mutation. For each type of mouse they:

- obtained a solution containing all of the proteins from synapses in one part of the brain
- separated these proteins using gel electrophoresis
- identified and measured the amount of three proteins from the solution using three different labelled antibodies.

The three proteins are parts of a postsynaptic membrane receptor.

The diagram below shows the scientists' results. Each band shows the presence of a protein. The size of a band shows the amount of the protein present.

(i) Suggest how gel electrophoresis separated the proteins obtained from the synapses.

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(2)

(ii) What do these data show about the effects of the mutation on the proteins?

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(2)

(b) A deer was found dead on National Trust land. Some people thought that the wounds that led to the deer's death could have been caused by a big cat such as a black panther.

Samples of DNA from the wounds of this deer were collected.

Investigators used the polymerase chain reaction (PCR) to increase the quantity of DNA in the samples.

The DNA produced by PCR was analysed to find out if a black panther was involved. Explain how gel electrophoresis could be used to find out if this DNA came from a black panther.

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(5)

(Total 9 marks)

Q7.

A student investigated the effect of three types of disinfectant on the growth of *Lactobacillus* bacteria.

During the investigation, the student:

- boiled the agar before pouring the agar plates
- transferred 0.5 cm^3 of a diluted liquid culture of *Lactobacillus* onto each agar plate
- left some agar plates as controls
- added to other agar plates different concentrations of the disinfectants as shown in the table in part (a).

After 2 days, she counted the number of colonies of bacteria on each agar plate.

(a) Explain the purpose of:

boiling the agar _____

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(1)

The three disinfectants used by the student were Lysol, propan-2-ol and ammonia.

The table shows the student's results.

Concentration of disinfectant / arbitrary units	Number of colonies of bacteria		
	Lysol	Propan-2-ol	Ammonia
0	300	300	300
5	0	290	300
10	0	195	295
15	0	0	275
20	0	0	240

The liquid culture the student transferred was diluted by 1 in 10 000 (10^{-4}).

(b) Use information in this question to calculate how many bacteria were present in 1 cm^3 of undiluted liquid culture.

Answer = _____

(2)

(c) The oxidation of ammonia by nitrifying bacteria involves the enzyme ammonia monooxygenase. Each species of nitrifying bacteria has its own specific *amoA* gene that codes for production of ammonia monooxygenase.

In an investigation, scientists determined the expression of the *amoA* gene in two species of bacteria, **S** and **T**. Species **S** was from acid soil and species T was from soil with a neutral pH.

The scientists grew cultures of each species separately in soils of different pH. They determined the amount of mRNA from the *amoA* gene in each culture.

(i) The scientists set up their cultures in sterile glass bottles.

Suggest **one** suitable method for sterilising the bottles and explain why it was necessary to sterilise them.

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(2)
(Total 15 marks)

Q8.

Researchers carried out a study on the prey of predatory ground beetles. They removed the contents of the guts of beetles which had been feeding and analysed them to see if they could identify the species they had fed on.

In one study, to see if the method worked, they fed the beetles on earthworms of the species Allolobophora chlorotica only.

DNA was extracted from the gut contents and analysed.

(a) (i) The DNA in the samples from the beetle guts was cut into fragments. The fragments were different for each species and had to be separated by gel electrophoresis.

Which of the following describes the movement of the DNA fragments in gel electrophoresis?

A large fragments move further than small fragments towards the anode
B large fragments move further than small fragments towards the cathode
C small fragments move further than large fragments towards the anode
D small fragments move further than large fragments towards the cathode

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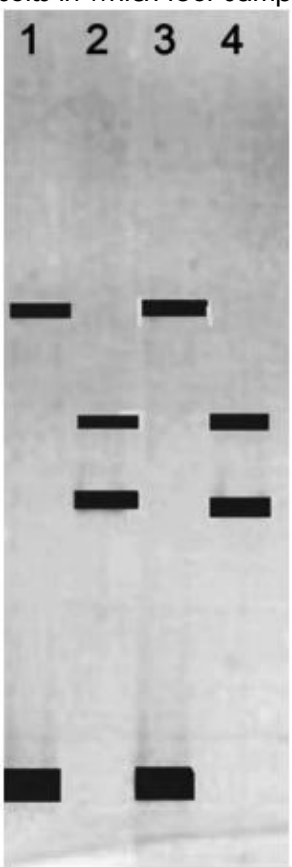
(1)

(ii) The picture shows one set of results in which four samples have been separated.



(Source: Evaluation of temperature gradient gel electrophoresis for the analysis of prey DNA within the guts of invertebrate Sheppard et al. Cardiff School of Biosciences)

Explain what these results show you about the diet of the ground beetles.

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(2)
(Total 3 marks)

Q9.

(a) A group of students wanted to use thin layer chromatography to identify four amino acids.

To produce the chromatogram, the students:

· drew a pencil line 1 cm from the bottom of the chromatography plate and put solvent into the beaker to a height of approximately 0.9 cm

· held the chromatography plate firmly in the middle with their hands and lowered it into the beaker

· left the apparatus to stand as shown in Fig. 1.4.

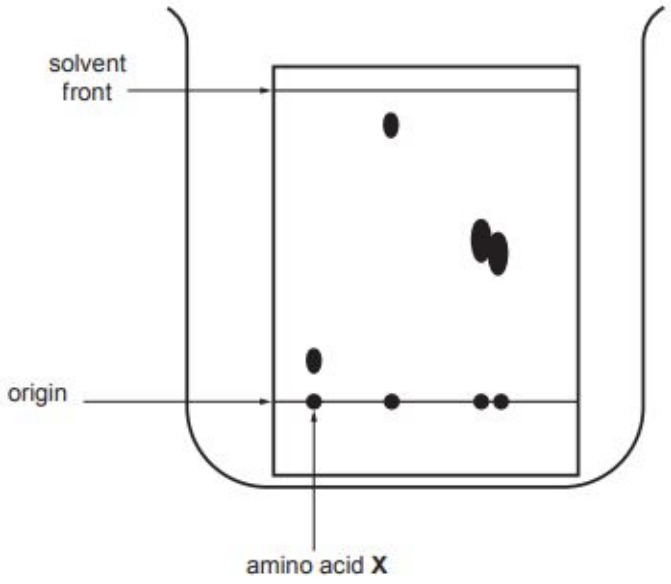

Fig. 1.4

Describe four ways you would refine the method used by the students. For each change you suggest, give a reason why this would improve the results of the experiment.

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(4)

(b) Four pigments, A, B, C and D, were extracted from a Heliamphora plant. Thin layer chromatography (TLC) was carried out on the pigments. The results of the TLC are shown in Fig. 18.3.

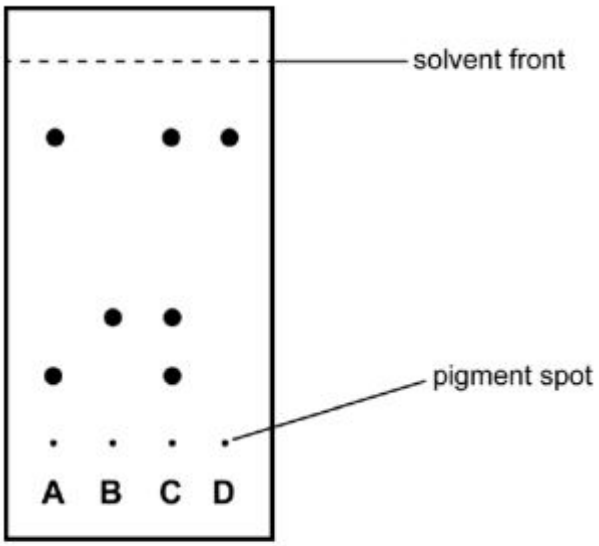

Fig. 18.3

(i) Using Fig. 18.3, what can you conclude about the composition of pigments A to D?

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(3)
(Total 7 marks)

Q10.

Figure 1, below, shows photographs of sheep's hearts that were considered for use in a school dissection.

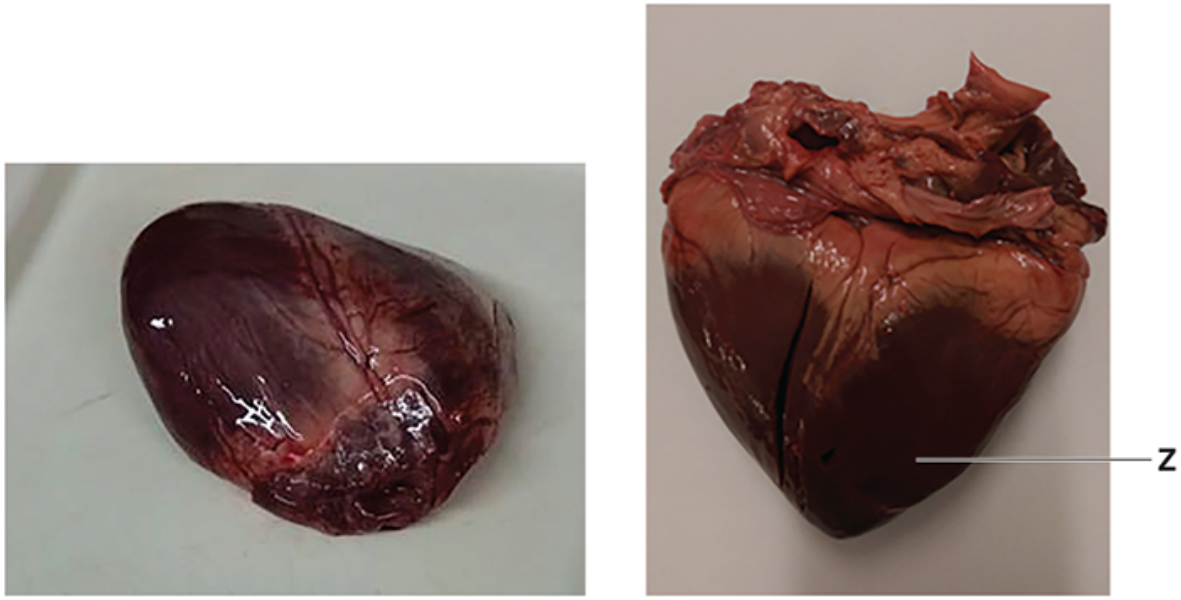

Figure 1

i. Looking at the two hearts, a student decided that Heart 2 was a better choice for the dissection because it had more structures present.

What evidence from the two hearts in Fig. 2.2 supports the student's decision?

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(1)

ii. Name the structure labelled Z on figure 1

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(1)
(Total 2 marks)