Question: 1

Organisms require energy in order to carry out essential metabolism. Organisms are able to release energy by carrying out both aerobic and anaerobic respiration.

(a) Complete the table to compare anaerobic respiration in mammals and yeast.

	mammal	yeast
name of hydrogen acceptor after glycolysis		
is CO_2 produced?		
name of final product		

[3]

(b) Suggest one benefit of anaerobic respiration to an organism.

_____

_____

_____

_____

_____

[1]
[Total: 4]

Question: 2

(a) Fig. 2.1 represents the end region of a neurone at a cholinergic synapse.

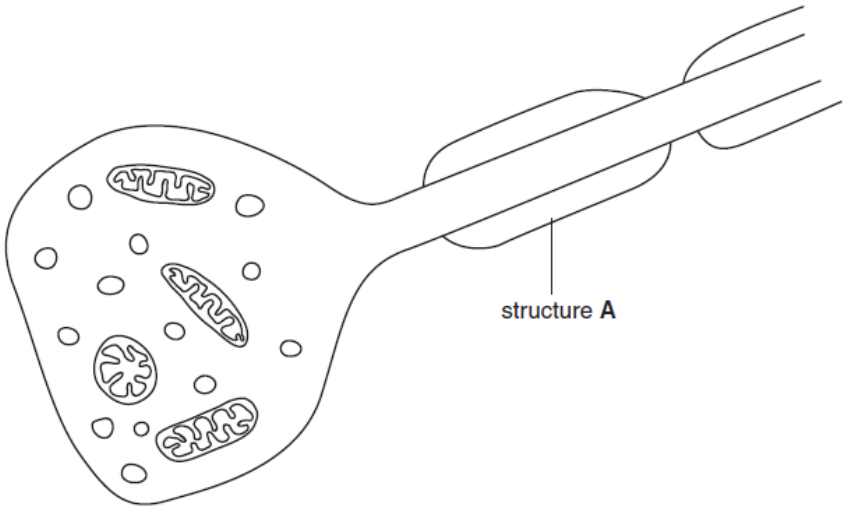


Fig. 2.1

(i) Describe the function of structure A.

In your answer, you should use appropriate technical terms, spelt correctly.

[4]

(ii) Name the process by which acetylcholine leaves the neurone shown in Fig. 2.1.

[1]

(iii) Name the process by which acetylcholine travels across the synaptic cleft.

[1]

(iv) A feature of synapses is that they allow transmission in only one direction.

State how this is achieved.

[1]

(b) The chemical nature of synaptic transmission makes it susceptible to disruption by toxins.

(i) Atropine is a toxin produced by the deadly nightshade plant, *Atropa belladonna*.

Atropine is a similar shape to acetylcholine. The presence of atropine prevents theinitiation of an action potential in the post-synaptic neurone.

Explain how the presence of atropine in the synapse will prevent the initiation of an action potential.

[3]

(ii) Nerve gases have been used as chemical weapons. Some nerve gases act by inhibiting acetylcholinesterase, prolonging the effect of acetylcholine.

Suggest how atropine could act as an antidote to nerve gas.

[2]
[Total: 12]

Question: 3

Fig. 3.1 represents some of the reactions that take place in a leaf cell of a flowering plant.

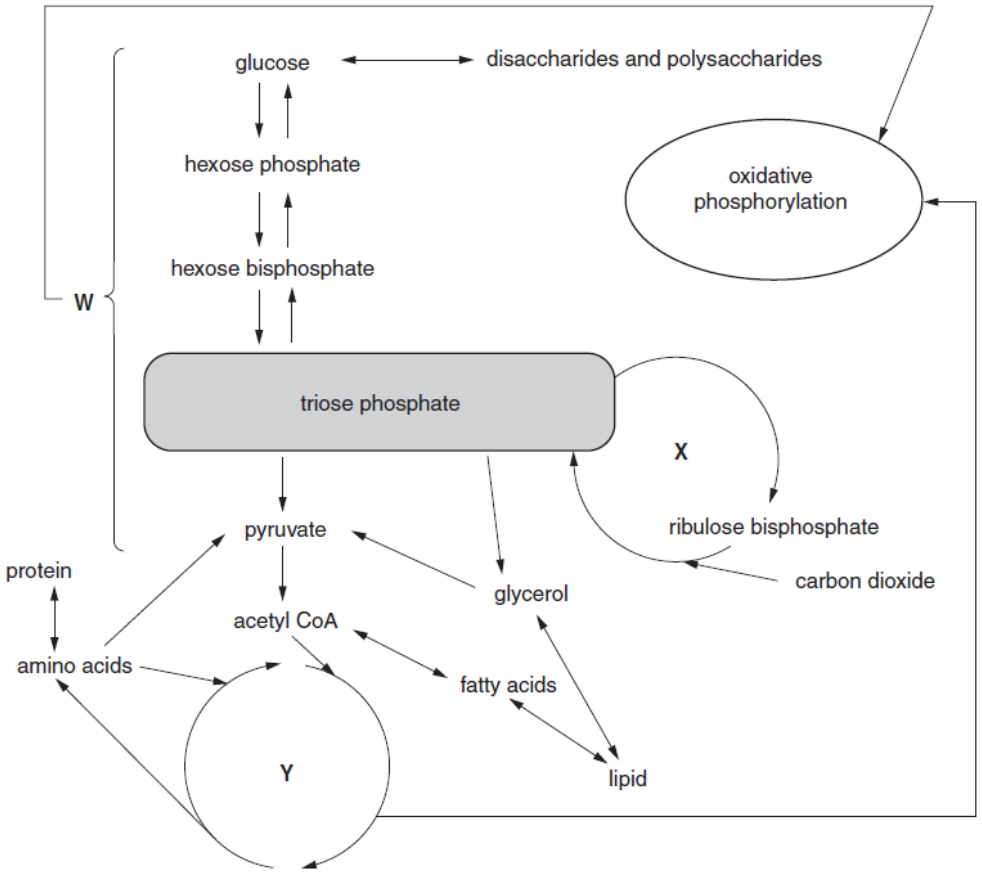


Fig. 3.1

(a) (i) Name the reaction pathways indicated by the letters W, X and Y.

W

X

Y

[3]

(ii) Triose phosphate is a compound that is central to the metabolism of this cell.

Explain how the three reaction pathways (W, X and Y) are able to work independently of each other in the same leaf cell.

[3]

(iii) Identify which of these three reaction pathways (W, X and Y) are associated with:

photosynthesis

aerobic respiration

[2]

(iv) Fig. 3.1 shows that compounds from two of the three pathways are used in oxidative phosphorylation.

State the products of oxidative phosphorylation.

[2]

(b) Explain the role of coenzymes in this leaf cell, with respect to the metabolic reactions outlined in Fig. 3.1.

[3]
[Total: 13]

Question: 4

Osmoregulation is a key feature of homeostasis and maintains the water potential of the blood within certain limits. This is achieved by the action of anti-diuretic hormone (ADH).

(a) Explain the likely effect on the blood cells if the water potential of the plasma was allowed to increase significantly.

[2]

Fig. 4.1 is a simplified diagram of the structure of ADH.

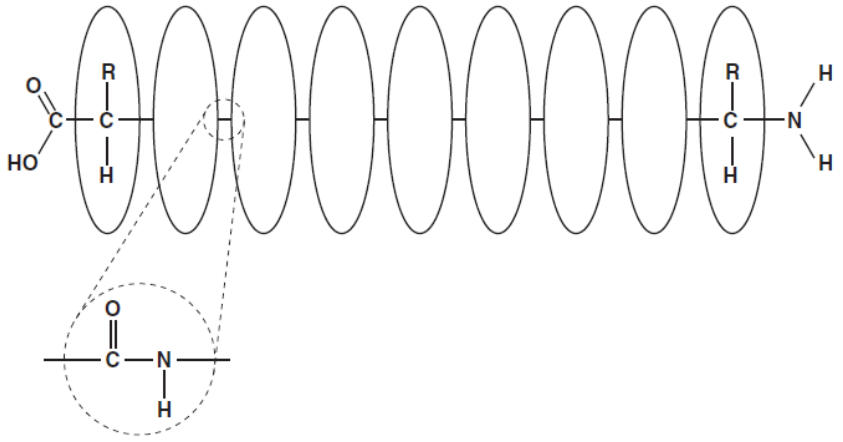


Fig. 4.1

(b) Name the type of monomer that makes up a molecule of ADH and the bond that joins the monomers together.

type of monomer

name of bond

[2]

(c) Complete the following passage, using the most suitable term in each case:

ADH is a hormone that is produced by specialised nerve cells known as _____ cells. These cells detect changes in the waterpotential of the blood flowing through the _____ . If the water potential of the blood is too low then ADH is released.

ADH is not secreted immediately into the blood but passes along the _____ of the specialised nerve cells to the _____ _____ gland, from where it is released into the blood.

ADH acts on the cells of the _____ _____ .

The ADH molecule attaches to receptors on the _____ of these cells and causes protein channels known as _____ to insert themselves into the membrane. Water passes through these channels by _____ and a smaller volume of more concentrated urine is produced.

[8]

(d) ADH does not stay in the blood indefinitely.

Suggest where ADH is removed from the blood and describe what then happens to the ADH molecule.

_____

_____

_____

_____

_____

[3]
[Total: 15]

Question: 5

(a) Fig. 5.1 represents the sequence of events that takes place when adrenaline reaches a liver cell.

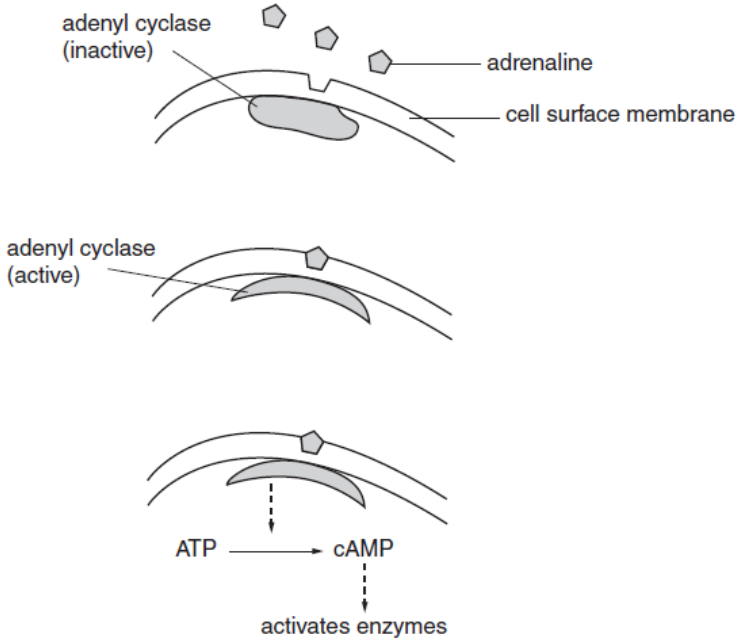


Fig. 5.1

(i) In terms of cell signalling, name the compound in Fig. 5.1 that is acting as:

the second messenger

_____

_____

_____

_____

_____

the first messenger

_____

_____

_____

_____

_____

[2]

(ii) Suggest what happens to polysaccharides in the liver cell as a result of the events shown in Fig. 5.1.

[1]

(iii) Adrenaline affects a range of target tissues in the body.

Suggest how the adrenaline molecule can cause different effects in different target tissues.

[2]

(b) Outline the hormonal and nervous mechanisms involved in the control of heart rate.

In your answer, you should use the appropriate technical terms, spelt correctly.

[5]
[Total: 10]

Question: 6

One way of calculating the rate of respiration is to measure the volume of oxygen taken up over a period of time.

A student carried out an experiment to investigate the effect of temperature on the rate of respiration in soaked (germinating) pea seeds and dry (dormant) pea seeds.

A simple piece of apparatus called a respirometer was used, as shown in Fig. 4.1.

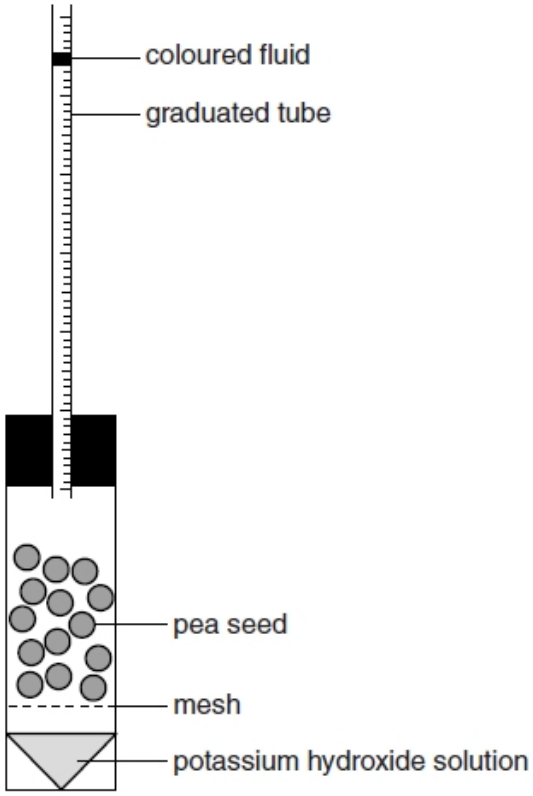


Fig. 4.1

The potassium hydroxide solution in this apparatus absorbs carbon dioxide. If the apparatus is kept at a constant temperature, any changes in the volume of air in the respirometer will be due to oxygen uptake.

(a) State the stage or stages of aerobic respiration during which:

(i) carbon dioxide is produced

_____

_____

_____

_____

_____

[1]

(ii) oxygen is used.

_____

_____

_____

_____

_____

[1]

(b) The student set up three respirometers, A, B and C, in water baths at two different temperatures. The respirometers were left for 10 minutes in order to equilibrate.

The contents of each respirometer are shown in Table 4.1.

Table 4.1

temperature (°C)	respirometer	contents
15	**A**	30 soaked pea seeds
	B	glass beads + 30 dry pea seeds
	C	glass beads
25	**A**	30 soaked pea seeds
	B	glass beads + 30 dry pea seeds
	C	glass beads

At each temperature, respirometer C, which contained only glass beads, was a control.

Respirometer B, at each temperature, also contained some glass beads.

(i) Suggest why, at each temperature, respirometer B contained some glass beads.

_____

_____

_____

_____

_____

[2]

(ii) Suggest how the student determined the quantity of glass beads to place in respirometer B at each temperature.

_____

_____

_____

_____

_____

[2]

(c) After the student had left each respirometer to equilibrate, a small volume of coloured fluid was introduced into each graduated tube.

The respirometers were then left in the appropriate water baths for 20 minutes and maintained at the correct temperature. During this time, the coloured fluid in the graduated tube moved.

The level of the coloured fluid in each respirometer was recorded at the start of the experiment and after 20 minutes.

The results are summarised in Table 4.2.

Table 4.2

temperature (°C)	respirometer	reading at start (cm^3)	reading after 20 minutes (cm^3)	difference (cm^3)	corrected difference (cm^3)	rate of oxygen uptake ($cm^3\,min^{-1}$)
15	**A**	0.93	0.74	0.19	0.16	0.008
	B	0.93	0.86	0.07	0.04	0.002
	C	0.91	0.88	0.03		
25	**A**	0.94	0.63	0.31	0.27	
	B	0.93	0.84	0.09	0.05	0.003
	C	0.95	0.91	0.04		

(i) Table 4.2 is incomplete.

Calculate the missing value for the rate of oxygen uptake for soaked pea seeds (A) at 25 °C.

Show your working.

Answer = ... $cm^3\,min^{-1}$

[2]

(ii) Explain why there is an increased rate of respiration in soaked seeds at 25 °C compared with soaked seeds at 15 °C.

_____

_____

_____

_____

_____

[2]

(iii) Suggest a reason for the difference in the rate of respiration between soaked and dry pea seeds.

_____

_____

_____

_____

_____

[2]

[Total: 12]

Question: 7

(a) The nervous system is made up of a number of different types of neurone, which transmit electrical impulses.

Complete the table below by stating three differences in the structure of motor and sensory neurones.

motor neurone	sensory neurone

[3]

(b) Complete the following passage, using the most appropriate term(s) in each case.

When an impulse is not passing along a neurone, a resting potential of _____ mV is established. When the neurone is stimulated, it causes _____ of the cell surface membrane. This will not generate an action potential unless it is large enough to exceed the _____ _____.

A neurone will either conduct an action potential or not; this is described as the _____ - _____ - _____ law.

Action potentials all have the same _____. The only way in which the intensity of a stimulus can be interpreted is by the _____ of the action potential.

[6]
[Total: 9]

Question: 8

(a) The pancreas is an unusual gland as it is both an endocrine and an exocrine gland.

Fig. 4.1, on the insert, shows a group of cells in the pancreas.

(i) State the name given to the group of cells labelled X.

_____

_____

_____

_____

_____

[1]

(ii) Describe the different ways in which the pancreas acts as both an endocrine and an exocrine gland.

In your answer, you should use appropriate technical terms, spelt correctly.

_____

_____

_____

_____

_____

[5]

(b) One particular type of cell in the pancreas is responsible for secreting insulin. The various events involved in the secretion of insulin are listed below.

A	Glucose is phosphorylated and metabolised to produce ATP
B	Potassium channels open, allowing potassium ions to diffuse out of the cell
C	The change in voltage across the membrane causes calcium channels to open
D	Glucose enters the cell
E	The movement of ions results in a potential difference across the cell surface membrane of –70 mV
F	Calcium ions diffuse into the cell
G	The presence of extra ATP causes the potassium channels to close
H	The membrane potential changes to –30 mV
J	The calcium ions cause the vesicles to fuse with the membrane and release insulin

Complete the following list by placing the events in the correct order.

B E [ ] [ ] [ ] [ ] [ ] [ ] J

[4]

(c) (i) State two advantages of treating Type 1 diabetes by using insulin that has been produced by genetically modified bacteria rather than insulin that has been extracted from pigs.

_____

_____

_____

_____

_____

[2]

(ii) A potential treatment for Type 1 diabetes is the use of stem cells.

State an advantage of this form of treatment compared to treatment using insulin.

_____

_____

_____

_____

_____

[1]
[Total: 13]

Question: 9

(a) Fig. 2.1 represents the first stage of respiration.

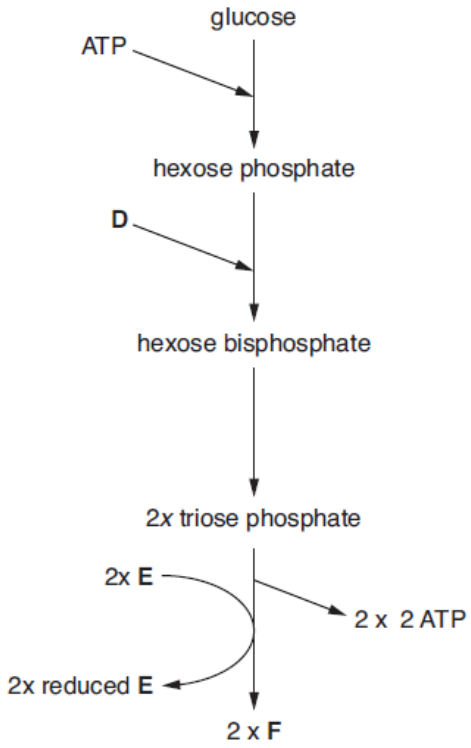


Fig. 2.1

(i) Name the stage represented by Fig. 2.1.

_____

_____

_____

_____

_____

[1]

(ii) State precisely where in the cell this stage takes place.

_____

_____

_____

_____

_____

[1]

(iii) Identify the compounds D, E and F.

D

E

F

[3]

(b) In anaerobic conditions, compound F does not proceed to the link reaction.

Describe the fate of compound F during anaerobic respiration in an animal cell and explain the importance of this reaction.

[5]

(c) Fig. 2.2 is a drawing of a common seal, *Phoca vitulina*, an aquatic mammal.

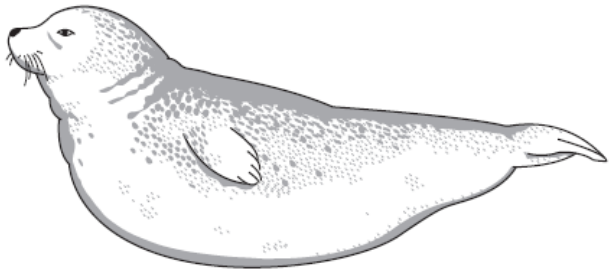


Fig. 2.2

The seal comes to the surface of the water to obtain air and it can then stay underwater for over 20 minutes.

Fig. 2.3 shows a seal at the surface of the water and Fig. 2.4 shows the same animal then submerging again.

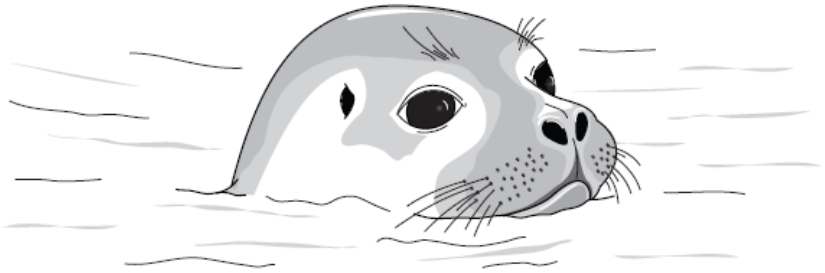


Fig. 2.3

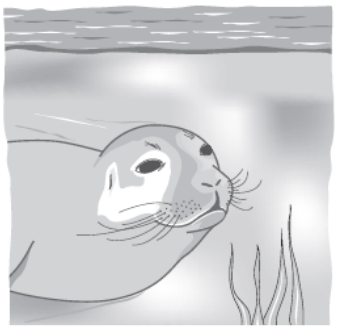


Fig. 2.4

Suggest how the seal is adapted to respire for such a long time underwater.

_____

_____

_____

_____

_____

[3]
[Total: 13]

Question: 10

(a) Fig. 3.1 represents part of the axon of a neurone.

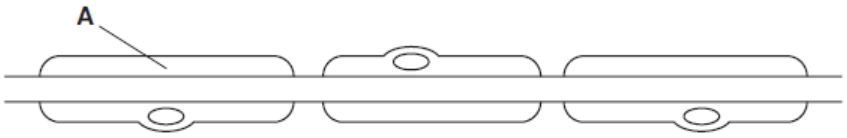


Fig. 3.1

Describe the structure of the feature labelled A.

[2]

Table 3.1 shows details of the diameter and speed of conduction of impulse along the neurones of different animal taxa.

Table 3.1

type of neurone	axon diameter (μm)	speed of conduction ($m\,s^{-1}$)	animal taxon
myelinated	4	25	mammal
myelinated	10	30	amphibian
myelinated	14	35	amphibian
unmyelinated	15	3	mammal
unmyelinated	1000	30	mollusc

(b) Using only the data in Table 3.1, describe the effect of each of the following on the speed of conduction:

(i) myelination,

[2]

(ii) axon diameter.

[2]

(c) The speed of conduction of a nerve impulse is also affected by temperature.

(i) Suggest why an increase in temperature results in an increase in the speed of conduction.

[1]

(ii) As the temperature continues to increase, it reaches a point at which the conduction of the impulse ceases. Suggest why.

[1]

(d) Outline the events following the arrival of an action potential at the synaptic knob until the acetylcholine has been released into the synapse.

In your answer, you should use appropriate technical terms, spelt correctly.

[4]
[Total: 12]

Question: 11

(a) Blood enters the kidneys through the renal arteries and the human kidneys process 1200cm^3 of blood every minute. This 1200cm^3 of blood contains 700cm^3 of plasma. As this blood passes through a glomerulus, 125cm^3 of fluid passes into the renal tubule.

(i) Name the process by which the fluid passes from the glomerulus into the renal tubule.

[1]

(ii) Calculate the percentage of plasma that passes into the renal tubule.

Show your working and give your answer to one decimal place.

Answer = ... %

[2]

(b) Fig. 4.1, on the insert, is an electronmicrograph of a transverse section of part of a proximal convoluted tubule.

(i) Name the tissue that lines the proximal convoluted tubule.

[1]

(ii) Name the structures indicated by X.

[1]

(iii) Table 4.1 shows the approximate concentration of some of the substances in the blood plasma, the glomerular filtrate and the urine leaving the collecting duct.

Table 4.1

substance	concentration in blood plasma ($g\,dm^{-3}$)	concentration in glomerular filtrate ($g\,dm^{-3}$)	concentration in urine leaving collecting duct ($g\,dm^{-3}$)
amino acids	0.50	0.50	0.00
glucose	1.00	1.00	0.00
inorganic ions	7.30	7.30	15.60
nitrogenous waste (not including urea)	0.03	0.03	0.28
protein	80.00	0.00	0.00
urea	0.30	0.30	21.00

Some of the changes observed between the glomerular filtrate and the urine are as a result of activity in the proximal convoluted tubule.

With reference to Table 4.1, explain how these observed changes in concentration are brought about by the proximal convoluted tubule.

In your answer, you should use appropriate technical terms, spelt correctly.

[4]

(c) When the kidneys cease functioning or fail to work effectively, renal dialysis may be necessary.

Fig. 4.2 outlines the procedure of haemodialysis, a type of renal dialysis.

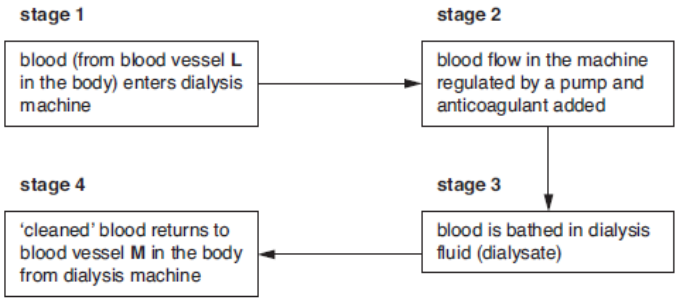


Fig. 4.2

Fig. 4.3 shows further detail of how stage 3 is achieved.

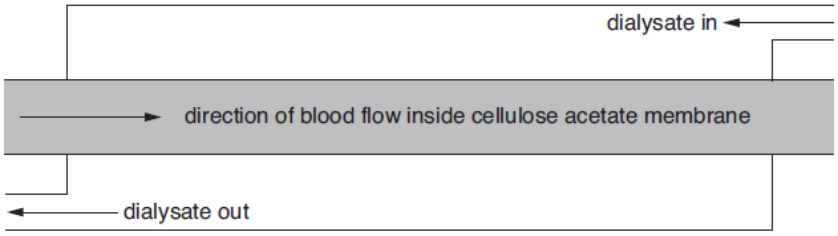


Fig. 4.3

(i) State the types of blood vessel represented by L and M in Fig. 4.2.

L

M

[1]

(ii) Suggest why it is necessary to add an anticoagulant to the blood in stage 2.

[1]

(iii) Suggest why no anticoagulant is added to the blood towards the end of a dialysis session.

[1]

(iv) State the process by which molecules and ions, other than water, will move from the blood into the dialysate.

[1]

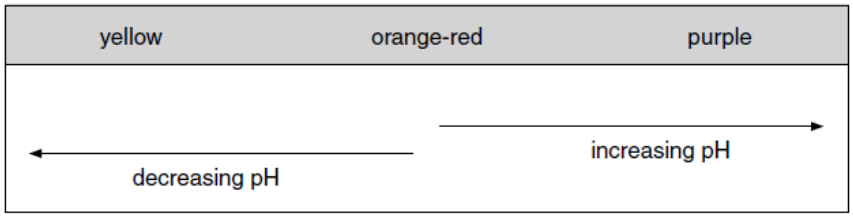
(v) Suggest why the direction of flow of the blood and the dialysate is as shown in Fig. 4.3.

[1]
[Total: 14]

Question: 12

(a) An experiment was carried out into the effect of different wavelengths of light on the rate of photosynthesis.

Four sealed test-tubes were set up, each containing three leaf discs from the same plant suspended above hydrogencarbonate indicator solution. This solution changes colour at different pH values, as shown below.



At the start of the experiment, the contents of all four tubes were orange-red.

Each tube was illuminated by a lamp with a coloured filter in front of it. The tubes were illuminated for the same length of time. The colour changes were noted and the results are shown in Table 5.1.

Table 5.1

colour of filter	final colour of hydrogencarbonate indicator
colourless	purple
blue	purple
green	orange-yellow
red	red

A fifth tube was set up in the same way as the other tubes. This tube was then covered in black paper before being illuminated for the same length of time. The final colour of the hydrogencarbonate indicator in this tube was yellow.

(i) State the purpose of the tube covered with black paper.

_____

_____

_____

_____

_____

[1]

(ii) State two precautions that need to be taken when designing and carrying out this experiment in order to obtain results from which valid conclusions can be drawn. Explain the need for each precaution.

precaution 1

explanation

precaution 2

explanation

[2]

(iii) Name the pigment at the reaction centre of photosystems I and II.

[1]

(iv) Explain the change observed in the tube exposed to green light.

[3]

(b) In order to maximise production, market gardeners often grow plants in glasshouses.

Light conditions can be controlled along with a number of other factors.

How can factors other than light conditions be controlled to increase the rate of photosynthesis and maximise production?

In your answer you should explain why the rate of photosynthesis is affected by the controlled factors you have discussed.

[4]
[Total: 11]

Question: 13

The leaves of flowering plants have the ability to develop differently, depending on environmental conditions such as the amount of sun or shade a leaf receives.

A student carried out an investigation into sun and shade leaves from different parts of the same plant. Her observations and results are shown in Table 6.1.

Table 6.1

type of leaf	number of leaves studied	mean no. of stomata per mm^2 on lower surface	mean thickness of leaf (μm)	cuticle
sun	55	170	208	thick
shade	8	92	93	thin

(a) Calculate the percentage difference in the mean thickness of the sun leaves compared to the shade leaves.

Show your working.

Answer = ...

[2]

(b) Suggest and explain one benefit of the greater mean number of stomata per mm^2 on the lower surfaces of the sun leaves.

[2]

(c) Describe two ways in which the student could improve her investigation.

_____

_____

_____

_____

_____

[2]
[Total: 6]

Question: 14

(a) Fig. 1.1 represents a molecule of ATP.

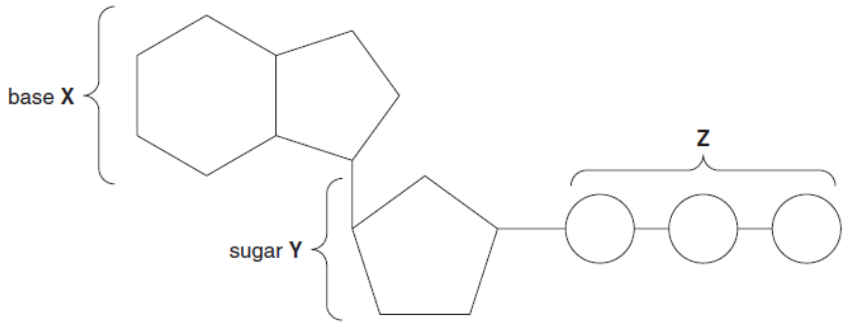


Fig. 1.1

(i) Name the parts of the ATP molecule labelled X, Y and Z.

X

Y

Z

[3]

(ii) With reference to Fig. 1.1, describe and explain the role of ATP in the cell.

[3]

(b) Fig. 1.2 is an electron micrograph of a mitochondrion from an animal cell.

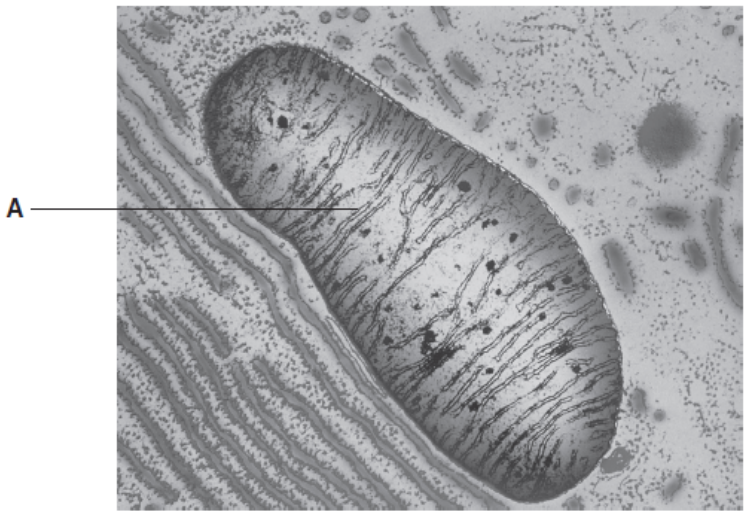


Fig. 1.2

(i) Name the structure labelled A .

[1]

(ii) Name the specific process that is carried out by structure A in the mitochondrion.

[1]

(c) Some animals conserve energy by entering a state of torpor (a short period of dormancy), in which they allow their body temperature to fall below normal for a number of hours.

In an investigation into torpor in the Siberian hamster, *Phodopus sungorus*, the animal's respiratory quotient (RQ) was measured before and during the period of torpor.

The respiratory quotient is determined by the following equation:

$$RQ = \frac{\textit{volume of carbon dioxide produced}}{\text{volume of oxygen consumed in the same time}}$$

RQ values for different respiratory substrates have been determined and are shown in Table 1.1.

Table 1.1

substrate	RQ
carbohydrate	1.0
lipid	0.7
protein	0.9

(i) Initially, the RQ value determined for the hamster was 0.95, but as the period of torpor progressed, its RQ value decreased to 0.75.

What do these values suggest about the substrates being respired by the hamster during the period of the investigation?

_____

_____

_____

_____

_____

[3]

(ii) Describe the way in which an endothermic animal, such as a mammal, normally prevents its body temperature from decreasing when the external temperature decreases.

In your answer, you should use appropriate technical terms, spelt correctly.

_____

_____

_____

_____

_____

[5]
[Total: 16]

Question: 15

(a) Fig. 2.1 is a photomicrograph through the centre of a lobule of a mammalian liver.

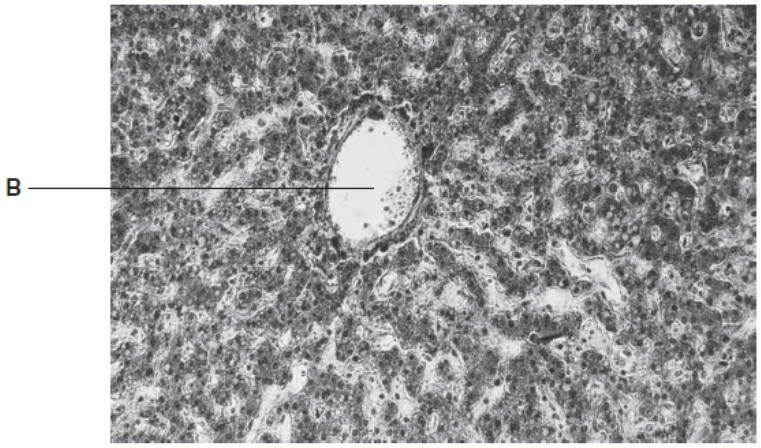


Fig. 2.1

(i) Name the type of vessel labelled B.

_____

_____

_____

_____

_____

[1]

(ii) Name the cells that make up the lobule.

_____

_____

_____

_____

_____

[1]

(b) Fig. 2.2 outlines the formation of urea in the liver.

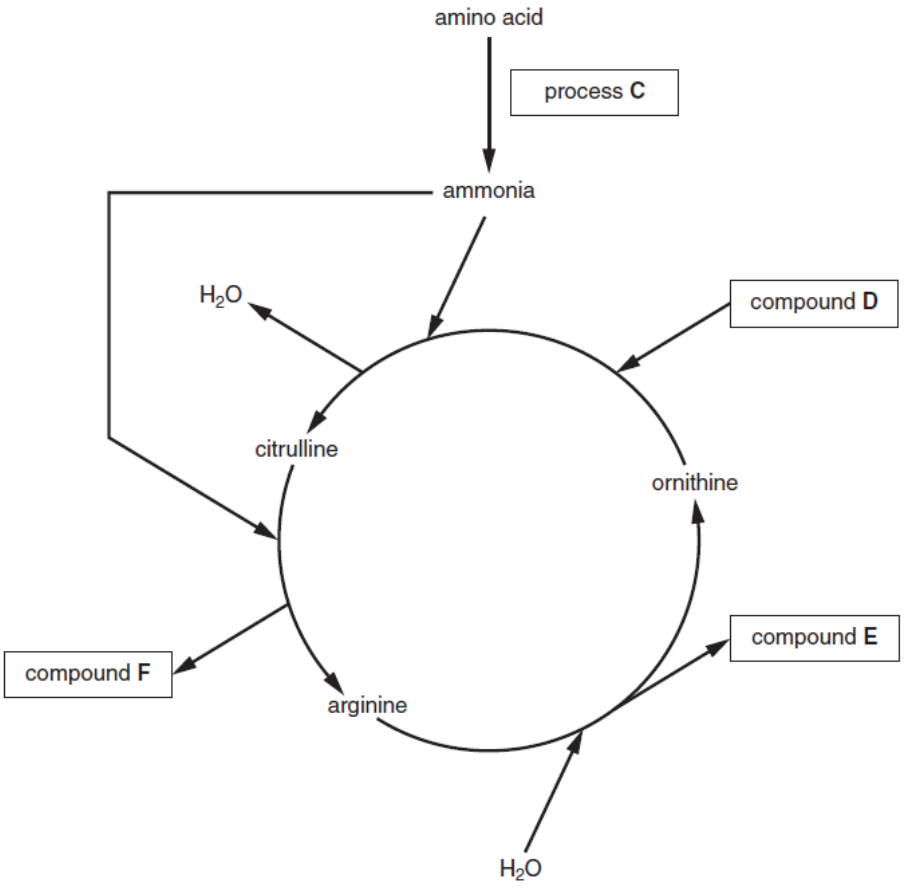


Fig. 2.2

Using Fig. 2.2, identify:

process C

_____

_____

_____

_____

_____

compound D

_____

_____

_____

_____

_____

compound E

compound F

[4]

(c) The urea formed in the ornithine cycle will be excreted from the body in urine. Urine also contains other chemicals.

Procedures have been developed to test for the presence of some of these chemicals, such as hormones.

(i) A pregnancy testing kit contains a testing 'stick' to detect a hormone in the urine.

Explain how the stick detects this pregnancy hormone.

In your answer, you should use the appropriate technical terms, spelt correctly.

[4]

(ii) The urine of some high profile athletes has been tested and found to contain abnormally high levels of banned steroids or their metabolites.

The pressure on elite athletes to succeed in their sport leads some of them to resort to the use of these performance-enhancing steroids.

Comment on whether the use of steroids should be permitted in sport.

[3]
[Total: 13]