**1.** Excretion and secretion are two processes that take place in the body of a mammal.

Complete the table below to compare the processes of excretion and secretion.

|  |  |  |
| --- | --- | --- |
|  | excretion | secretion |
| one difference |  |  |
| one example of a product |  |  |
| one similarity |  |  |

[Total 3 marks]

**2.** Aerobic respiration may be summarised by the following equation:

C6H12O6 + 6O2 → 6CO2 + 6H2O

Although carbon dioxide and water are products of aerobic respiration, the equation is an over-simplification of the process.

State **and** explain **one** way in which this equation is an over-simplification.

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[Total 2 marks]

**3.** Over 2.3 million people in the UK are known to have diabetes. It is also estimated that a further 0.5 million people have the condition but are unaware of it.

(i) Explain how **Type 1** diabetes is caused.

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[2]

(ii) Describe **three** factors that increase a person’s risk of developing **Type 2** diabetes.

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[3]

[Total 5 marks]

**4.** The figure below represents the first stage of respiration.



(i) Name the stage represented by the figure above.

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[1]

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

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[1]

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

**D** ....................................................................................................................

**E** ....................................................................................................................

**F** ....................................................................................................................

[3]

[Total 5 marks]

**5.** 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.

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[Total 5 marks]

**6.** Fig. 1 is a drawing of a common seal, *Phoca vitulina*, an aquatic mammal.



**Fig. 1**

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

Fig. 2 shows a seal at the surface of the water and Fig. 3 shows the same animal then submerging again.



**Fig. 2**



**Fig. 3**

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

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[Total 3 marks]

**7.** (a) The figure below represents part of the axon of a neurone.



Describe the **structure** of the feature labelled **A**.

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[2]

The table below shows details of the diameter and speed of conduction of impulse along the neurones of different animal taxa.

|  |  |  |  |
| --- | --- | --- | --- |
| 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 the table above**, describe the effect of each of the following on the speed of conduction:

(i) myelination,

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[2]

(ii) axon diameter.

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[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.

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[1]

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

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[1]

[Total 8 marks]

**8.** 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.

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[Total 4 marks]

**9.** Blood enters the kidneys through the renal arteries and the human kidneys process 1200 cm3 of blood every minute. This 1200 cm3 of blood contains 700 cm3 of plasma. As this blood passes through a glomerulus, 125 cm3 of fluid passes into the renal tubule.

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

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[1]

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

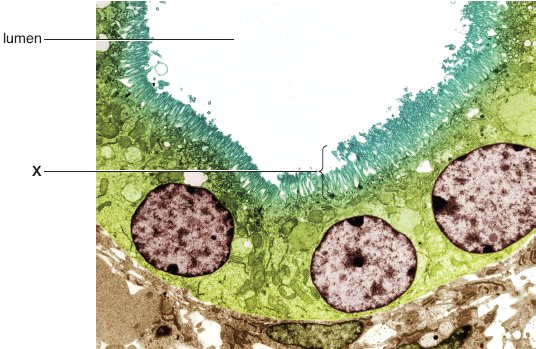
Show your working and **give your answer to one decimal place**.

Answer = ................................................ %

[2]

[Total 3 marks]

**10.** The figure below is an electronmicrograph of a transverse section of part of a proximal convoluted tubule.



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

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[1]

(ii) Name the structures indicated by **X**.

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[1]

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

|  |  |  |  |
| --- | --- | --- | --- |
| 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 the table above, 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*.

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[4]

[Total 6 marks]

**11.** When the kidneys cease functioning or fail to work effectively, renal dialysis may be necessary.

Fig. 1 outlines the procedure of haemodialysis, a type of renal dialysis.



**Fig. 1**

Fig. 2 shows further detail of how **stage 3** is achieved.



**Fig. 2**

(i) State the **types** of blood vessel represented by **L** and **M** in Fig. 1.

**L** ....................................................................................................................

**M** ....................................................................................................................

[1]

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

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[1]

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

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[1]

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

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[1]

(v) Suggest why the direction of flow of the blood and the dialysate is as shown in Fig. 2.

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[1]

[Total 5 marks]

**12.** 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 the table below.

|  |  |
| --- | --- |
| 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.

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[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* ......................................................................................................

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*precaution 2* ....................................................................................................

*explanation* ......................................................................................................

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[2]

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

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[1]

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

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[3]

[Total 7 marks]

**13.** 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.

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[Total 4 marks]

**14.** The pancreas contains endocrine tissue. The figure below shows an electronmicrograph of a section of pancreatic endocrine tissue.



(a) Name the endocrine tissue shown in the figure.

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[1]

(b) Name the hormone present in the secretory vesicles of alpha cells.

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[1]

(c) During vigorous exercise, the blood glucose concentration falls.

Describe the changes that take place to make sure that the blood glucose concentration does not fall to a dangerous level.

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

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[6]

[Total 8 marks]

**15.** The light-dependent stage of photosynthesis takes place on thylakoid membranes in chloroplasts. These membranes surround the thylakoid space (lumen) and are arranged into stacks known as grana. Below is a diagram showing the arrangement of photosystems in the thylakoid membrane, and summarising the processes that take place there.



(a) (i) Name the pigment represented by P680 and P700.

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[1]

(ii) Name the **type** of molecule represented by **G**.

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[1]

(b) Explain, **using the information in the diagram**, why the pH of the thylakoid space (lumen) is lower than that of the stroma **and** what significance this has for ATP production.

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[4]

[Total 6 marks]

**16.** Herbicides (weedkillers) interfere with electron transport by accepting electrons.

Suggest how this causes plants to die.

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[Total 3 marks]

**17.** Define the term *excretion*.

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[Total 2 marks]

**18.** The table below shows the mass of different substances excreted by a volunteer during two 24 hour periods. During the first 24 hour period, the volunteer was fed a protein-deficient diet; during the second 24 hour period, the volunteer was fed a protein-rich diet. All other variables were kept constant.

|  |  |
| --- | --- |
| mass of substance excreted / g | |
| substance excreted | protein-deficient diet | protein-rich diet |
| urea | 2.20 | 14.70 |
| uric acid | 0.09 | 0.18 |
| ammonium ions | 0.04 | 0.49 |
| creatinine | 0.60 | 0.58 |

(i) Calculate the percentage increase in urea excreted when the volunteer switched from a protein-deficient to a protein-rich diet. Show your working.

Answer = ...................................................%

[2]

(ii) Describe how excess protein is converted into urea.

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[3]

[Total 5 marks]

**19.** The figure below shows diagrams of nephrons from the kidneys of three different mammals, **X**, **Y** and **Z**.



|  |  |  |
| --- | --- | --- |
| **X** | **Y** | **Z** |
| name of mammal | beaver | house mouse | desert living gerbil |
| water potential of urine | high | low | very low |

Explain the relationship between the length of the section D in the nephrons and the water potential of the urine each mammal produces.

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[Total 3 marks]

**20.** The figure below shows the relationship between various metabolic processes in yeast



(i) Identify the three metabolic processes.

**A** ......................................................................................................................

**B** ......................................................................................................................

**C** ......................................................................................................................

[3]

(ii) State the letter of the pathway in which acetyl coenzyme A is required.

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[1]

(iii) State the letter of the pathway in which ATP is utilised.

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[1]

[Total 5 marks]

**21.** In an investigation yeast cells were homogenised (broken up) and the resulting homogenate centrifuged. Portions containing only nuclei, ribosomes, mitochondria and cytosol (residual cytoplasm) were each isolated. Samples of each portion, and of the complete homogenate, were incubated in four ways:

1 With glucose.

2 With pyruvate.

3 With glucose and cyanide.

4 With pyruvate and cyanide.

Cyanide inhibits carriers in the electron transport chain, such as cytochromes.

After incubation, the presence or absence of carbon dioxide and lactate in each sample was determined.

The results are summarised in the table below.

 = absent  = present  = a little



(i) Explain why more carbon dioxide is produced when the complete homogenate is incubated with just glucose or pyruvate than when cyanide is present.

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[3]

(ii) Explain why carbon dioxide is produced when mitochondria are incubated with pyruvate but **not** when incubated with glucose.

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[3]

(iii) Explain why, in the presence of cyanide, ethanol production can still occur.

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[3]

[Total 9 marks]

**22.** (a) Fig. 1 is a diagram of a neurone.



Fig. 1

Name the structures **A** and **B**.

**A** ......................................................................................................................

**B** ......................................................................................................................

[2]

Fig. 2 shows a recording of the potential difference across the membrane of an axon as an action potential is transmitted.



Fig. 2

(b) Describe the events taking place in the neurone during stages **X** and **Y**.

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[4]

The table below shows how the speed of conduction of an action potential varies with the diameter of myelinated and non-myelinated axons in different organisms.

|  |  |  |  |
| --- | --- | --- | --- |
| organism | type of axon | axon diameter / µm | speed of conduction / ms-1 |
| crab | non-myelinated | 30 | 5 |
| squid | non-myelinated | 500 | 25 |
| cat | myelinated | 20 | 100 |
| frog | myelinated | 16 | 32 |

(c) Describe the effect of myelination on the **rate** of conduction of an action potential **and** explain how this effect is achieved.

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

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[5]

[Total 11 marks]

**23.** (i) State what is meant by the term respiratory substrate.

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[1]

The equation below shows aerobic respiration of compound **A**.

C55H100O6 + 77O2 *→* 55CO2 + 50H2O

compound **A**

The respiratory quotient (RQ) is defined as:

RQ = 

(ii) Calculate the RQ for this reaction. Show your working.

Answer = .......................................................

[2]

(iii) Compound **A** is a fat.

Suggest what the RQ of a carbohydrate, such as glucose, might be.

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[1]

[Total 4 marks]

**24.** Below is a diagram of a respirometer. A respirometer can be used to measure the oxygen uptake of living organisms.



Describe how the apparatus shown in the diagram could be used to determine the **rate** of respiration of the bread mould, *Mucor*.

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[Total 4 marks]

**25.** The figure below shows the absorption spectra for three different photosynthetic pigments.



(i) Explain what is meant by the term *photosynthetic pigment*.

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[3]

(ii) Using the figure above, describe the pattern shown by chlorophyll *a*.

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[2]

[Total 5 marks]

**26.** Photosynthetic pigments fall into two categories: primary pigments and accessory pigments.

Explain the difference between primary and accessory pigments.

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[Total: 2 marks]

**27.** In this question, one mark is available for the quality of the use and organisation of scientific terms.

Photosynthetic pigments are arranged in light-harvesting clusters called photosystems.

Describe how the light energy absorbed by these photosystems is converted into chemical energy in the **light dependent stage** of photosynthesis.

[8]

Quality of Written Communication [1]

[Total: 9 marks]

**28.** Below is an outline diagram of the Krebs cycle. A two carbon acetyl group enters the cycle by combining with a molecule of oxaloacetate. A molecule of citrate is formed which is decarboxylated and dehydrogenated to regenerate the oxaloacetate.



(a) (i) Explain the following terms:

*decarboxylation* .....................................................................................

*dehydrogenation* ...................................................................................

[2]

(ii) State the **letters** of the individual steps in the cycle where decarboxylation is taking place.

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[1]

(b) ATP is made directly by substrate level phosphorylation in the Krebs cycle.

State the number of ATP molecules that are made directly **per ‘turn’** of the cycle.

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[1]

(c) The diagram also shows that fatty acids can be converted into acetyl CoA units by a process known as β-oxidation. Both this process and the Krebs cycle require NAD. The Krebs cycle also requires FAD. The hydrogen atoms released in β-oxidation and the breakdown of acetyl CoA in the Krebs cycle reduce the NAD and FAD molecules.

(i) State the number of reduced NAD and reduced FAD molecules that are formed in the Krebs cycle from **one** molecule of acetyl CoA.

reduced NAD .........................................................

reduced FAD .........................................................

[2]

(ii) State where the reduced NAD and reduced FAD molecules are reoxidised **and** describe what happens to the hydrogen atoms.

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[4]

(d) The liver is responsible for producing enzymes which detoxify alcohol by breaking it down into smaller units. This breakdown by enzymes uses NAD. This means that other reactions that use NAD are less likely to take place. The build up of fats in the liver is one of the first signs of liver damage due to excessive alcohol intake.

Using the information in the diagram above, explain why the build up of fats occurs in the liver of an individual who consumes large amounts of alcohol.

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[3]

[Total: 13 marks]

**29.** Fig.1 represents **some** of the changes that occur across the membrane of the axon. Three protein complexes are shown to be present in the membrane:

• sodium channels

• potassium channels

• sodium-potassium pumps.



Fig. 1

Fig. 2 shows the change of membrane potential associated with an action potential.



Fig. 2

1. State which of the three diagrams of the axon membrane in Fig. 1 match up to the phases labelled in Fig. 2. Write your answers in the table below.

|  |  |
| --- | --- |
| phase | number |
| **A** |  |
| **B** |  |
| **C** |  |

[1]

(ii) With reference to Fig. 1, explain the changes in membrane potential in  
Fig. 2.

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[5]

[Total 6 marks]

**30.** In this question, one mark is available for the quality of spelling, punctuation and grammar.

In order to transfer information from one point to another in the nervous system, it is necessary that action potentials be transmitted along axons. In humans, the rate of transmission is 0.5 m s–1 in a nonmyelinated neurone, increasing to 100 m s–1 in a myelinated neurone.

Explain how action potentials are transmitted along a nonmyelinated neurone **and** describe which parts of this process are different in myelinated neurones.

**No credit will be given for reference to events at the synapse.**

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[7]

Quality of Written Communication [1]

[Total 8 marks]

**31.** Many seeds contain food stores, including starch, proteins and lipids. A fully developed seed of *H. annuus* contains between 40% and 50% of unsaturated fatty acids, including oleic acid and linoleic acid. These fatty acids can be used as respiratory substrates for the production of ATP.

(i) Explain why seeds need ATP.

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[2]

(ii) Explain the **advantages** of storing lipid for use as a respiratory substrate in seeds.

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[2]

[Total 4 marks]

**32.** After chasing prey, a cheetah breathes rapidly (pants) for half an hour before it can run again.

Explain why panting is necessary.

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[Total 4 marks]

**33.** The hypothalamus produces anti-diuretic hormone (ADH) that is released by the posterior pituitary gland into the blood.

Brain damage can occur due to trauma to the head. Traumatic brain injury (TBI) can cause many and varied malfunctions of parts of the brain. One condition that can arise from TBI is a lack of ADH in the blood.

Suggest the symptoms you would expect in a person with a lack of ADH.

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[Total: 3 marks]

**34.** Hummingbirds are very small. Typically their mass is between 3 and 5 g. They are able to hover at a fixed point in the air by beating their wings very rapidly. The rufous hummingbird, *Selasphorus rufus*, is a migratory species. It breeds in Canada and Alaska in the summer, migrates south to Mexico in the autumn and returns to high latitudes in spring after completing its annual moult (loss of feathers, which are then re-grown).

(a) Suggest why the rufous hummingbird has a very high requirement for energy.

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[4]

In order to save energy, rufous hummingbirds can enter a state called torpor during the night. This is when their metabolic rate and body temperature both drop to a very low level. An investigation into how rufous hummingbirds use, save and store energy at different times of year was carried out. Key findings of the study are given in Figs. 1, 2 and 3 below.



Fig. 1 Fig. 2



Fig. 3

© Sara Hiebert, Hummingbird Torpor and Body Mass, from The Auk, vol. 110, October 1993.  
Reproduced by kind permission of Sara Hiebert

• Fig. 1 shows how use of torpor by the birds varies according to season.

• Fig. 2 compares the oxygen consumption of birds resting at normal body temperature with that of birds resting in a state of torpor.

• Fig. 3 shows how body mass of the birds changes over the course of a year.

(b) Use Figs. 1, 2 and 3 to describe and explain the results for the birds in the September-October (autumn) period.

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[4]

(c) Suggest how the low body mass of the birds in spring may be related to enhancing the birds’ survival during the moulting period, when the feathers are lost and regrown.

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[2]

(d) It is suggested that **smaller** birds, which have a larger surface area to volume ratio when compared to larger birds, require **more** oxygen per gram of their body mass.

Discuss whether the data given in Figs. 3.1, 3.2 and 3.3 support this hypothesis.

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[3]

[Total: 13 marks]

**35.** In this question, one mark is available for the quality of spelling, punctuation and grammar.

Some of the key physiological areas of a mammal are the:

• blood

• alveoli

• gut

• kidney.

The figure below shows some of the pathways where biochemicals are exchanged between these areas, the tissue fluid (extracellular fluid) and a liver cell.



Use the diagram to describe how these exchange pathways function to maintain relatively constant concentrations of biochemicals **in the liver cell**.

[7]

Quality of Written Communication [1]

[Total 8 marks]

**36.** The bulb of the onion plant, *Allium cepa*, is widely used in food preparation. It has a strong smell and flavour when raw due to sulphur-containing chemicals that are released when an onion is cut. The precursor of these flavour molecules is in the cytoplasm of the onion bulb cells. This precursor is acted on by an enzyme called alliinase, which is stored in the cell vacuole. Alliinase breaks the precursor molecule into two volatile flavour molecules, which enter the air, and into a third product, pyruvate, which remains dissolved in the onion tissue.

(a) Explain why the strong smell of an onion is only released when the onion is cut or damaged.

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[3]

The strength of an onion’s flavour can be estimated by measuring the concentration of pyruvate in cut onions. The table below shows the pyruvate concentration of fresh onions, onions from the previous season that have overwintered, and onions of a new variety called Supasweet.

|  |  |
| --- | --- |
| type of onion | pyruvate concentration / μmol g–1 |
| fresh | 7 |
| overwintered | 4 |
| Supasweet | 3 |

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(b) Suggest why the concentration of pyruvate is lower in an overwintered onion.

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[2]

(c) The mild Supasweet onions were produced by a process of artificial selection. The growing environment also needs to be manipulated to decrease the concentration of flavour molecules.

(i) Explain how artificial selection was used to produce the mild Supasweet onions.

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[3]

(ii) Use the information given about the biochemistry of the onion smell and flavour to suggest an environmental change that would enable a milder onion to be grown.

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[1]

(d) It is claimed that strong onions, with a more pungent smell and flavour, are able to resist rotting over the winter better than milder onions.

Describe how you would test this claim.

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[3]

[Total: 12 marks]

**37.** The rate of photosynthesis is affected by a number of environmental factors. The figure below shows the effect of light intensity on the rate of photosynthesis.



(i) State the limiting factor in region **A** of the graph.

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[1]

(ii) Explain why there is no further increase in the rate of photosynthesis beyond point **C**.

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[2]

[Total 3 marks]

**38.** For many plants living in temperate regions the optimum temperature for photosynthesis is approximately 25°C.

Explain why the rate of photosynthesis decreases at temperatures above 25°C.

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[Total 4 marks]

**39.** Plants that live in the Arctic have a relatively short growing season in which the light intensity is always relatively low. Many species growing in these conditions have a high level of anthocyanin pigments in their leaves. The combined effect of these red pigments with the green chlorophyll makes the leaves appear dark purple or black.

Suggest why this adaptation is useful in increasing photosynthetic rates.

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[Total: 3 marks]

**40.** All organisms require energy in order to remain alive. Plants use solar energy to combine water and carbon dioxide into complex organic molecules. Both plants and animals then break down organic molecules in respiration. Energy released in this process is used in the formation of ATP.

Describe the structure of ATP.

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[Total: 4 marks]

**41.** In this question, one mark is available for the quality of use and organisation of scientific terms.

There are a number of organic molecules in cells whose role is to transfer hydrogen atoms from one compound to another. Examples include NAD, FAD and NADP.

NAD, FAD and NADP are important molecules in plant cells. Describe, in detail, the role of these molecules within a **palisade mesophyll cell**.

[7]

Quality of Written Communication [1]

[Total 8 marks]

**42.** The first stage in the formation of urine is glomerular filtration. This results in the production of glomerular filtrate in the Bowman’s (renal) capsules. Below is a diagram that shows the structures and forces involved in the filtration process.



(a) The normal blood hydrostatic pressure in other capillaries is 3.3 kPa.

(i) Using the diagram, explain why the blood pressure in the glomerular capillaries is considerably higher than in other capillaries.

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[2]

(ii) Using the data given in the diagram, calculate the effective filtration pressure.

Answer = ........................................kPa

[2]

(b) The presence of protein molecules in the urine of an individual is a sign of kidney disease or kidney damage.

(i) Explain why it is unusual for protein molecules to appear in the urine.

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[2]

(ii) Explain why protein in the urine is often a symptom of chronic high blood pressure.

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[2]

(c) A complex barrier exists between the blood plasma in the glomerular capillaries and the fluid in the renal capsule.

Describe in detail the structure of the region labelled **A** on the diagram above.

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[4]

(d) Coffee contains the drug caffeine, which inhibits the release of ADH.

Describe **and** explain the effect of drinking coffee on the volume **and** concentration of urine produced.

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[4]

[Total: 16 marks]

**43.** The presence of CG in the urine can be used in pregnancy testing. Information about a pregnancy testing kit is given below and in the figure.

• An absorbent membrane is dipped into urine.

• The membrane contains free antibodies that are specific to CG.

• The free antibodies are attached to coloured markers.

• There is a line of immobilised antibodies above position **A**.

• A positive result is shown by a coloured line at position **A**.



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‘New Understanding Biology for Advanced Level’ Fourth Edition  
by Glen Toole and Susan Toole (978-0-7487-3957 -8), first published in 1999.

Using information from the figure, explain how the presence of CG in the urine results in a coloured line at position **A**.

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[Total 4 marks]

**44.** An investigation was carried out into the effect of consuming meals rich in carbohydrate on two hormones in the blood.

The figure below shows the relationship between glucose concentration in the blood and the concentrations in the blood of the two hormones, **Q** and **R**.



Name hormones **Q** and **R**.

**Q** ..................................................................

**R** ..................................................................

[Total 2 marks]

**45.** The liver is responsible for many aspects of protein metabolism, such as transamination and deamination.

What is transamination **and** why is it necessary?

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[Total 2 marks]

**46.** In this question, one mark is available for the quality of the use and organisation of scientific terms.

The medulla oblongata controls breathing, heart rate and blood pressure.

Describe how the medulla oblongata responds to an increase in carbon dioxide concentration in the blood during exercise. Explain how this response leads to a decrease in the concentration of carbon dioxide in the blood.

[7]

Quality of Written Communication [1]

[Total 8 marks]

**47.** The figure below shows a simplified diagram of a mammalian reflex arc.



(i) Name **S** and **T**.

**S** ......................................................................................................................

**T** ......................................................................................................................

[2]

(ii) Explain why the withdrawal of a hand, which has been subjected to pressure, is an example of a reflex action.

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[3]

(iii) In this reflex, when pressure is applied to the receptor, impulses are generated in the sensory neurone.

Outline what happens in the membrane of the sensory receptor in response to pressure.

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[3]

(iv) Explain why, in the reflex arc shown in the figure above, impulses can only travel in the direction shown.

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[2]

[Total: 10 marks]

**48.** The figure below is an electronmicrograph of a chloroplast.



Identify the structures labelled **A** to **D**.

**A** ..............................................................................................................................

**B** ..............................................................................................................................

**C** ..............................................................................................................................

**D** ..............................................................................................................................

[Total 4 marks]

**49.** Some bacteria can survive in anaerobic conditions by utilising light energy to drive the production of ATP in the cell membrane. In such conditions*, Halobacterium salinarium* makes the protein bacteriorhodopsin. When this protein absorbs light, protons (H+) are pumped outwards across the cell membrane. This is shown in the figure below.



Using the information above together with your knowledge of photophosphorylation and oxidative phosphorylation, explain how *H. salinarium* makes ATP in anaerobic conditions.

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[Total 4 marks]

**50.** Define the term *excretion.*

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[Total 2 marks]

**51.** Name **two** groups of macromolecules that are broken down to form nitrogenous excretory products in mammals.

1 ...............................................................................................................................

2 ...............................................................................................................................

[Total 2 marks]

**52.** The table below shows the amount of different substances excreted by a volunteer during two 24 hour periods. During the first 24 hour period the volunteer was fed a protein-deficient diet; during the second 24 hour period the volunteer was fed a protein-rich diet. All other variables were kept constant.

|  |  |  |
| --- | --- | --- |
| substance excreted | protein-deficient diet | protein-rich diet |
| urea / g | 2.20 | 14.70 |
| uric acid / g | 0.09 | 0.18 |
| ammonium ions / g | 0.04 | 0.49 |
| creatinine / g | 0.60 | 0.58 |

(i) Calculate the percentage increase in urea excreted when the volunteer switched from a protein-deficient to a protein-rich diet. Show your working.

Answer = ………………………………..%

[2]

(ii) Explain why more urea is produced when eating a protein-rich diet.

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[2]

[Total 4 marks]

**53.** Explain why the main nitrogenous excretory product of humans is urea rather than ammonia*.*

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[Total 2 marks]

**54.** The following table shows the concentrations of glucose and urea in the renal artery and renal vein.

|  |  |  |
| --- | --- | --- |
|  | concentration / mg 100 cm–3 plasma | |
|  | renal artery | renal vein |
| glucose | 90 | 80 |
| urea | 30 | 16 |

Both substances are present in lower concentration in the renal vein than in the renal artery. However, urea appears in the urine of a healthy individual but glucose does not.

Explain why this is so.

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[Total 5 marks]

**55.** In both plants and animals, chemical messengers help to transfer information from one part of the organism to another to achieve coordination.

The table below lists some of these chemicals together with their functions.

Complete the table.

|  |  |
| --- | --- |
| name of chemical messenger | function |
| ................................................................ | controls water permeability of collecting ducts in kidney |
| insulin | ................................................................  ................................................................ |
| glucagon | ................................................................  ................................................................ |
| ................................................................ | stimulates stomatal closure during water stress |
| ................................................................ | controls apical dominance |

[Total 5 marks]

**56.** In this question, one mark is available for the quality of spelling, punctuation and grammar.

Mammals also rely on nerves to transfer information in the form of electrical impulses.

Using the information shown in the figure below, outline how impulses are transmitted from receptor to effector.



[8]

Quality of Written Communication [1]

[Total 9 marks]

**57.** The following figure is an outline of the glycolytic pathway.



With reference to the figure, state the letter, **A**, **B** or **C**, in the glycolytic pathway where the following processes occur.

phosphorylation using ATP ………………………………..

dehydrogenation ………………………………..

formation of ATP ………………………………..

splitting of a hexose ………………………………..

[Total 4 marks]

**58.** Explain why, under **aerobic** conditions, lipids have a greater energy value per unit mass than carbohydrates or proteins.

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[Total 2 marks]

**59.** Many chemicals will ‘uncouple’ oxidation from phosphorylation. In this situation, the energy released by oxidation of food materials is converted into heat instead of being used to form ATP. One such compound is dinitrophenol, which was used in munition factories for the manufacture of explosives during the First World War. People working in these factories were exposed to high levels of dinitrophenol.

Suggest **and** explain why people working in munitions factories during the First World War became very thin regardless of how much they ate.

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[Total 3 marks]

**60.** The mammalian liver is made up of lobules that consist of liver cells (hepatocytes) arranged in plates.

The figure below shows a section of a liver lobule and its associated blood vessels.



Name structures **A** to **D**.

**A** .......................................................................

**B** .......................................................................

**C** .......................................................................

**D** .......................................................................

[Total 4 marks]

**61.** Sometimes the liver does not function normally. This may result in a condition known as jaundice. The symptoms of jaundice include yellowing of the sclera at the front of the eyes, yellow skin, orange coloured urine and white faeces.

Suggest what abnormal events are happening in the liver to produce these symptoms.

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[Total 2 marks]

**62.** Read the passage below and answer the questions that follow, which relate to this passage.

**How fireflies light up**

Fireflies are insects which have organs producing flashes of light. Fireflies are active at night and the light flashes are an important part of their sexual behaviour.

Within their light-producing organs are tubes, filled with air, called tracheae. These tracheae supply oxygen to light-producing cells. The figure below shows the arrangement of light-producing cells around a trachea.



Light is produced by organelles situated well away from the surfaces of the cells nearest the trachea.

The reaction that produces light requires **both** oxygen **and** ATP.



When the organ is not producing any light, the numerous mitochondria use oxygen very fast. These mitochondria lie between the tracheae and the light-producing organelles, just under the cell membrane, so that no oxygen is available for the oxidation of luciferin.

A flash of light is produced when nerve impulses stimulate the walls of the tracheae and the cytoplasm of the light-producing cells, to produce nitrous oxide. Nitrous oxide diffuses rapidly through the cells. It enters mitochondria and inhibits oxidative phosphorylation, so the oxygen concentration increases in the cytoplasm of the light-producing cells.

Nitrous oxide is very unstable and breaks down quickly, so its effects are temporary.

An extract of crushed fireflies was found to be an extremely sensitive test for the presence of ATP in foods, such as milk and meat. The more bacteria there are in the food, the more light is produced, provided the mixture of food and firefly extract is well oxygenated.

Fortunately for fireflies, luciferin can be synthesised artificially and luciferase has been produced by gene technology, using methods similar to those for producing human insulin.

(a) Different species of firefly often live in the same habitat. The frequency with which a firefly flashes its light organ on and off, is a characteristic of a species.

Suggest an advantage, for fireflies, of flashing at a characteristic frequency.

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[1]

(b) (i) State the process by which oxygen reaches the light-producing organelles.

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[1]

(ii) Explain why the light-producing organelles are located well away from the plasma (cell surface) membrane.

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[1]

(c) Suggest why it is important for the effects of nitrous oxide to be temporary.

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[2]

(d) Light-producing cells in fireflies do not divide. State **three** ways in which these cells might use ATP **other** than in the production of light.

1 ......................................................................................................................

2 ......................................................................................................................

3 ......................................................................................................................

[3]

(e) If a firefly is suddenly crushed, for example by hitting a car windscreen, it produces a prolonged and unusually bright flash of light after which all light production ceases.

Suggest an explanation for these observations.

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[3]

(f) A solution containing luciferin, luciferase and oxygen glows when painted onto the surface of meat contaminated by live bacteria, but not if the meat is contaminated by dead bacteria.

Explain this observation.

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[1]

(g) What substance would be extracted and purified from light-producing cells of fireflies in order to produce luciferase by gene technology?

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[1]

[Total 13 marks]

**63.** An investigation was carried out into photosynthesis and respiration in a leaf. The net uptake of carbon dioxide by the leaf in bright light, and the mass of carbon dioxide released in the dark were determined at different temperatures. The results are shown in the following table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| temperature / °C | 5 | 10 | 15 | 20 | 25 | 30 |
| net uptake of CO2 in bright light / mg g-1 dry mass h-1 | 1.3 | 2.4 | 3.0 | 3.3 | 3.0 | 2.2 |
| release of CO2 in dark / mg g-1 dry mass h-1 | 0.4 | .07 | 1.0 | 1.4 | 1.9 | 2.8 |
| true rate of photosynthesis / mg CO2 g-1 dry mass h-1 |  |  |  |  |  |  |

(i) State **two** types of tissue in a leaf where there is a net uptake of carbon dioxide in bright light.

1 ......................................................................................................................

2 ......................................................................................................................

[2]

(ii) Assuming the rate of respiration in the light is equal to the rate of respiration in the dark, calculate the true rate of carbon dioxide uptake in photosynthesis at each temperature and **add the figures to the table above**.

[1]

(iii) The term temperature coefficient (Q10) is used to express the effect of a 10 °C rise in temperature on the rate of a chemical reaction. It is calculated in the following way:

Q10 = 

where **t** = any given temperature.

Between 5 °C and the optimum temperature for enzyme-catalysed reactions, the Q10 is approximately 2.

Discuss whether the data in the table above supports this statement for both respiration and photosynthesis.

respiration .......................................................................................................

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photosynthesis ................................................................................................

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[4]

(iv) When plants are grown in glasshouses during autumn and winter, when the natural light intensities are low, it is important that temperatures are kept relatively low.

With reference to respiration **and** photosynthesis, explain why it is essential to do this.

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[3]

[Total 10 marks]

**64.** The carbon dioxide taken up by a leaf enters the chloroplasts.

Name and describe the **biochemical pathway** which fixes the carbon dioxide into hexose sugars in the chloroplasts.

name of pathway ......................................................................................................

description ................................................................................................................

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[Total 5 marks]

**65.** An investigation was conducted into the filtration and reabsorption of glucose in the kidney of a mammal.

The glucose concentration in the plasma of the renal artery was increased. The glucose concentrations were measured in the following fluids:

• glomerular filtrate

• urine.

From the measurements obtained, the concentration of glucose in the fluid reabsorbed from the glomerular filtrate was calculated. The results of this investigation are shown below.



Use the data in the figure above to answer the following questions.

(i) Describe the relationship between plasma glucose concentration in the renal artery and the concentration of glucose in the glomerular filtrate.

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[1]

(ii) State the plasma glucose concentration in the renal artery above which the kidney is unable to reabsorb all the glucose from the glomerular filtrate.

Answer = .................... mg cm-3

[1]

(iii) Explain why plasma glucose concentrations in the renal artery greater than the figure you have given in **(ii)** would result in the presence of glucose in the urine.

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[3]

[Total 5 marks]

**66.** Following a meal rich in carbohydrates, the plasma glucose concentration rises.

Describe the homeostatic mechanisms that would normally prevent glucose appearing in the urine.

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[Total 5 marks]

**67.** The kangaroo rat, *Dipodomys spectabilis*, is common in the deserts of North America. It does not need to drink water and feeds mostly on seeds and other dry plant material. It produces very little urine.

(i) Suggest how the kidney of this mammal is adapted to reduce the volume of urine produced.

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[3]

(ii) Suggest how desert mammals, such as the kangaroo rat, are able to obtain water from dry seeds.

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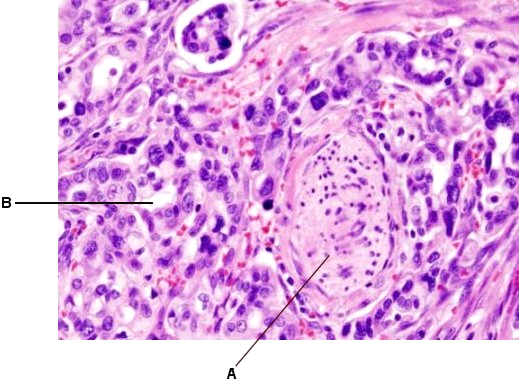
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[3]

[Total 6 marks]

**68.** The pancreas is a gland that has both endocrine and exocrine functions.

The figure below shows a section through part of the pancreas.



magnification × 400

(i) Name **A** and **B**.

**A** ......................................................................................................................

**B** ......................................................................................................................

[2]

(ii) Explain the difference between the terms *endocrine* and *exocrine* with regard to the pancreas.

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[4]

[Total 6 marks]

**69.** In this question, one mark is available for the quality of spelling, punctuation and grammar.

The autonomic nervous system contains neurones that carry impulses to the internal organs.

Describe the role of the autonomic nervous system in the control of the heart beat.

[7]

Quality of Written Communication [1]

[Total 8 marks]

**70.** *Tradescantia* is a genus of plants that is found in North and South America. The genus has many species which are found in different types of habitat. *Tradescantia sillamontana* and *Tradescantia fluminensis* are two of these species.

Fig 1 shows typical shoots of these plants. The photographs of the shoots are life size. Fig 1 **A** is *T. sillamontana* and **B** is *T. fluminensis.*

**Fig 1**

(a) Describe **two** ways in which the shoot of *T. sillamontana* differs from the shoot of *T. fluminensis*, as shown in Fig.1.

1 ......................................................................................................................

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2 ......................................................................................................................

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[2]

Table 1 shows the numbers of stomata in six random microscope fields of view of the lower epidermis from each of the species.

**Table 1**

|  |  |
| --- | --- |
| number of stomata seen in microscope fields of view | |
| *T. sillamontana* | *T. fluminensis* |
| 13 | 16 |
| 12 | 21 |
| 13 | 19 |
| 17 | 21 |
| 16 | 18 |
| 14 | 19 |
| mean | mean |

(b) (i) Calculate the mean number of stomata per field of view for each species **to the nearest whole number**. Insert your answers in Table 1.

[1]

(ii) State **two** precautions that should be taken to ensure that the data in  
Table 1 is a valid comparison between the two species.

1 .............................................................................................................

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2 .............................................................................................................

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[2]

*T. sillamontana* originates in Mexico and *T. fluminensis* in Brazil. Table 2 shows climate data for the areas from which the plants originate.

**Table 2**



(c) *T. sillamontana* is found growing in the open, where there is no shade, whilst *T. fluminensis* is found growing in the shade of trees.

Use the information provided by Fig.1 and Tables 1 and 2 to explain how each species is adapted to its natural habitat.

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[5]

(d) Explain how the data in Fig. 2 provide information about the adaptations of  
*T. sillamontana* and *T. fluminensis* to their environments.



**Fig. 2**

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[3]

[Total 13 marks]

**71.** After a lawn had been cut using a mower, the grass cuttings were piled up in a corner of the garden.

Ten days later, the heap of grass cuttings had steam rising from it.

A tube was pushed into the heap and an air sample was obtained from near its centre. This air sample was dried and then analysed to find the percentages of oxygen and carbon dioxide present. These concentrations could be measured to an accuracy  
of ±1 %.

A thermometer was also inserted into the centre of the heap and the temperature was recorded.

The results of the investigation are shown in the table below, which also shows data for the air above the ground near the heap.

|  |  |  |  |
| --- | --- | --- | --- |
| sampling point | oxygen concentration / % | carbon dioxide concentration / % | temperature / °C |
| near the centre of the heap of grass | 13 | 8 | 42 |
| above the ground near the heap | 21 | 0 | 16 |

As the heap of grass was in the shade for several hours before the readings were taken, it could **not** have become warm by absorbing solar radiation.

Explain the results shown in the table.

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[Total 5 marks]

**72.** The liver plays an important role in carbohydrate metabolism. The balance between the processes of glycogenesis and glycogenolysis helps to regulate the concentration of glucose in blood plasma. The figure below shows some of the stages of these processes.



(a) (i) Name **one** other hormone that promotes **glycogenolysis**.

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[1]

(ii) Explain why glycogen is suitable for energy storage in cells.

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[3]

The last step in **glycogenesis** is catalysed by the enzyme glycogen synthetase. The first step in **glycogenolysis** is catalysed by the enzyme glycogen phosphorylase.

Glucose molecules have direct effects on glycogen synthetase and on glycogen phosphorylase. These effects do **not** require the presence of insulin and glucagon.

The table below shows the rate of activity of glycogen synthetase and glycogen phosphorylase inside liver cells, during exposure of the cells to a concentrated solution of glucose.

|  |  |  |
| --- | --- | --- |
| time after addition of glucose solution / s | rate of activity of glycogen synthetase / arbitrary units | rate of activity of glycogen phosphorylase / arbitrary units |
| 0 30 60 90 120 150 180 210 | 28 28 32 49 94 136 189 272 | 410 280 140 65 42 40 40 40 |

(b) Explain how a high concentration of glucose causes the storage of glycogen in liver cells. You will gain credit if you use the data in the table in your answer.

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[5]

(c) After a prolonged period of fasting, glycogen levels in the liver are depleted. However, the liver can still produce glucose by the process of **gluconeogenesis**.

Describe **one** way in which this is done.

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[3]

[Total 12 marks]

**73.** Palisade cells have both chloroplasts and mitochondria. Exchanges between a mitochondrion, a chloroplast and the cytoplasm surrounding them are shown in the figure below.



(a) A leafy shoot can be sealed inside a transparent container. The concentration of oxygen in the atmosphere within this container can be measured. In the dark, the oxygen concentration falls. At high light intensities, the oxygen concentration increases. At a particular light intensity, the oxygen concentration in the container remains constant.

Use the figure above to explain how it is possible for the oxygen concentration to remain constant.

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[4]

(b) Explain why there is no build up in the concentration of phosphate ions inside mitochondria as a result of the inward passage of phosphate ions.

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[2]

(c) Triose phosphate moves out of chloroplasts by passing through carrier proteins that are part of the chloroplast envelope. These proteins allow an inorganic phosphate ion to pass inwards at the same time as triose phosphate moves outwards.

Suggest why the movement of triose phosphate out of chloroplasts is an example of facilitated diffusion rather than active transport.

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[2]

(d) Many biologists believe that both mitochondria and chloroplasts evolved, at an early stage in the history of the earth, from prokaryotic organisms that inhabited the cytoplasm of eukaryotic host cells.

State **two** structural features of mitochondria and chloroplasts that are also present in prokaryotic cells.

1 ......................................................................................................................

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2 ......................................................................................................................

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[2]

[Total 10 marks]

**74.** The figure below is a diagram of a section through a mitochondrion.



In each case, state the letter which indicates the site of:

the Krebs cycle ……………….

oxidative phosphorylation ……………….

decarboxylation ……………….

[Total 3 marks]

**75.** Name a hydrogen carrier that links the Krebs cycle to the electron transport chain.

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[Total 1 mark]

**76.** There are several different pigments involved in the light-dependent reactions of photosynthesis in flowering plants.

Name **two** photosynthetic pigments found in flowering plants.

1 ...............................................................................................................................

2 ...............................................................................................................................

[Total 2 marks]

**77.** In this question, one mark is available for the quality of spelling, punctuation and grammar.

In the palisade cells of a leaf, the fixation of carbon dioxide occurs in the Calvin cycle.

Describe the main features of this cycle. **No credit will be given for a flow diagram of** **the cycle**.

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[7]

Quality of Written Communication [1]

[Total 8 marks]

**78.** Explain the term *endocrine gland*.

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[Total 2 marks]

**79.** Untreated diabetes is a condition that can lead to blood glucose concentrations often rising above 120 mg 100 cm–3 of blood. Genetic engineering has been used to improve the treatment of diabetes.

Explain the advantages of using genetic engineering in the treatment of diabetics.

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[Total 3 marks]

**80.** The table below shows how the speed of nerve impulse conduction varies with the diameter of myelinated and non-myelinated axons in different organisms.

|  |  |  |  |
| --- | --- | --- | --- |
| organism | type of axon | axon diameter /μm | speed of impulse /m s–1 |
| crab | non-myelinated | 30 | 5 |
| squid | non-myelinated | 500 | 25 |
| cat | myelinated | 20 | 100 |
| frog | myelinated | 16 | 32 |

Describe the trends shown in the table above.

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[Total 2 marks]

**81.** Explain the term *refractory period* **and** outline its importance in nerve impulse conduction.

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[Total 4 marks]

**82.** (a) During winter, the brown bear, *Ursus arctus*, enters a long period of inactivity. Whilst inactive, the brown bear undergoes various physiological changes, for example a decrease in core body temperature and a decrease in resting heart rate. There are also changes in the brown bear’s metabolism of protein and lipids.

Explain the role of the autonomic nervous system in achieving a decrease in resting heart rate.

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[3]

During periods of inactivity, the brown bear reabsorbs all urea molecules from the filtrate in its kidneys and from the bladder. Urea is then transported in the bloodstream to the large intestine. Bacteria in the large intestine convert urea to ammonia and carbon dioxide, which diffuse back into the blood. When the ammonia reaches the liver, it is converted into amino acids. These newly produced amino acids are then used to synthesise proteins in the body, especially in the liver and muscle cells.

(b) Name **two** plasma proteins that will be produced by the liver.

1 ......................................................................................................................

2 ......................................................................................................................

[2]

(c) Describe the **similarities** and **differences** between the metabolism of nitrogen-containing compounds in inactive brown bears, **as described in the passage**, and in humans.

similarities

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differences

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[5]

The blood plasma cholesterol concentration of inactive brown bears rises to twice the concentration found in normally active bears and in humans. However, brown bears do not suffer any of the cardiovascular diseases associated with high cholesterol concentrations in humans, as their liver produces a protective substance, which prevents these diseases from developing.

(d) Explain the importance of cholesterol in the metabolism of mammals.

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[3]

(e) Suggest how the protective substance produced by their liver prevents brown bears developing cardiovascular diseases.

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[2]

[Total 15 marks]

**83.** In an investigation of photosynthesis, the rate of carbon dioxide absorption by leaves of two plants, barley and sugar cane, was measured. The leaves were provided with air, moving at a constant rate, through an apparatus that is illustrated by Fig. 1.



**Fig. 1**

• The light intensity was kept constant and high, equivalent to full sunlight.

• The concentration of carbon dioxide in the air entering the apparatus could be varied.

• The carbon dioxide taken up or given out by the leaves was determined by calculating the **difference** between the concentration in the inflowing and outflowing air.

• The leaves remained attached to the plants during the investigation.

• Two different temperatures, 10 °C and 25 °C, were used for each type of plant.

The results of the investigation are shown in Fig. 2.



**Fig. 2**

(a) In all four experiments, the rate of carbon dioxide uptake reached a maximum and became constant.

Suggest why.

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[2]

(b) Explain why carbon dioxide was released when the carbon dioxide concentrations were low.

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[2]

(c) Explain why all the measurements were made at the same light intensity.

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[1]

(d) Suggest why it was important that the leaves remained attached to the plants while the measurements were made.

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[2]

(e) Comment on the similarities and differences in response of the two species, sugar cane and barley, to differences in carbon dioxide concentration and temperature.

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[5]

[Total 12 marks]

**1.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | *excretion* | *secretion* |  |
| **1** | *one difference* | (metabolic) waste ***or*** toxin / harmful ***or***substance is to be removed from body ***or*** does not use vesicles | useful product ***or*** used in cell communication (e.g. to target tissues) ***or*** released from glands (ducts or ductless) ***or*** uses vesicles ***or*** remain in body | ; |
| **2** | *one example of a product* | urea / carbon dioxide / water / bile *pigment* / named example | hormone / enzyme / antibodies / mucus / bile *salts* / neurotransmitter / named example | ; |
| **3** | *one similarity* | requires ATP ***or***(involved in) homeostasis ***or***(compounds) produced by cell(s) / produced by metabolism / need to cross membrane / need to move through membrane / need to leave cell / (may be) transported in blood | | ; |

**One mark per row.**

**CREDIT** converse statements on either side or unmatched statements for each

**1** **IGNORE** name or type of product without qualification  
 **DO NOT CREDIT** any ref to egestion in ‘excretion’

**2** **IGNORE** sweat / urine / bile / saliva / salt /  
 (named) digestive juice

**3** **CREDIT** method of leaving cell e.g. exocytosis  
 **IGNORE** going into cells (as some excretory products do)

[3]

**2.** ***S & C***

**Mark the first answer**. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**

**CREDIT one statement and a suitable explanation related to that (first) given statement** (e.g. S3 + E3 but not S4 + E1)

**DO NOT AWARD** **2 marks for 2 statements or 2 explanations**

**S1** glucose is not the only substrate / there are other substrates;

‘fats can (also) be respired’ = E1  
‘fats can be respired as well as glucose’ = S1 + E1

**E1** named alternative substrate;

***or***

**S2** ATP is produced / energy is released;

**DO NOT CREDIT** **energy** produced / made / created

**E2** (by) substrate level / oxidative, phosphorylation;

**or**

**S3** ATP / energy, required;

**E3** (for) phosphorylation / glycolysis;

***or***

**S4** is not a single step reaction / other steps involved /  
other products / other intermediates;

**E4** named stage(s) / named intermediate compound(s);

Krebs cycle / ETC, happens = E4  
‘other stages such as link reaction are involved’ = S4 + E4  
e.g. pyruvate / acetyl CoA / acetate

**IGNORE** NAD(H) / FAD(H) / ATP

**or**

**S5** enzymes are involved;

**E5** dehydrogenation / decarboxylation / oxidative phosphorylation / named  
(respiratory) enzyme;

***or***

**S6** coenzymes / NAD, involved;

**DO NOT CREDIT** NADP

**E6** oxidative phosphorylation / link reaction / Krebs cycle / glycolysis;

***or***

**S7** glucose does not, combine / react, (directly) with oxygen;

**E7** (oxygen) used in oxidative phosphorylation / is final electron acceptor /  
is final hydrogen acceptor;

[2]

**3.** (i) ***Max 1 if referring to insulin receptors***

**1** unable to produce (enough) insulin / do not secrete insulin /  
produces ineffective insulin;

**DO NOT CREDIT** excrete’ as incorrect

**2** insulin-producing cells / beta cells / islets of Langerhans,  
not functioning (correctly) / damaged / destroyed / attacked;

**ALLOW** lack of beta cells / ref to b cells

**DO NOT CREDIT** alpha cells / B cells (if lymphocytes implied)

**3** by (body’s own) immune system / by (body’s own) antibodies /  
auto-immune disease;

**CREDIT** description

**4** (idea of) family history / genetic / hereditary;

**5** (condition can be) triggered by, virus / environmental factor;

e.g.

• shock

• drugs side effect

• (pancreatic) cancer

• infection / disease

2 max

(ii) ***Mark the first 3 responses only***

**1** increasing age / older / ageing / more prevalent over 40;

**DO NOT CREDIT** age without ‘older’ implication

**2** (idea of) family history / genetic / hereditary;

**3** (more common in) males;

**4** (more common in)  
some ethnic groups / African / Afro-Caribbean / Asian / Hispanic /  
Oceanic;

**5** obese / overweight / fat around abdomen;

**CREDIT** ‘apple shaped’

**6** high / frequent, intake of, sugar / highly processed food / high  
GI food;

**IGNORE** ‘poor diet’ / ‘bad diet’ / ‘unhealthy diet’  
**IGNORE** fat / carbohydrate, in diet

**7** lack of physical activity / sedentary lifestyle;

**8** high blood pressure;

**CREDIT** history of, heart attack / stroke

**9** excessive alcohol intake;

idea of too much is needed

3 max

[5]

**4.** (i) ***Mark the first answer****. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then =* ***0 marks***

glycolysis / glycolytic pathway;

**CREDIT** phonetic spelling but must have ‘glycol...’

1

(ii) ***Mark the first answer****. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then =* ***0 marks***

cytoplasm;

**CREDIT** cytosol

**DO NOT CREDIT** cytoplasm, in / of, mitochondrion

1

(iii) ***Mark the first answer for each letter****. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then =* ***0 mark***

**D** ATP;

**E** NAD;

**ALLOW** oxidised NAD  
**DO NOT CREDIT** NADP / reduced NAD

**F** pyruvate;

**ACCEPT** pyruvic acid

3

[5]

**5.** ***Award marks from labelled / annotated diagrams – but ensure that mp 2 only awarded if H clearly shown to be accepted by pyruvate***

**1** (pyruvate / **F**) converted to lactate;

**ACCEPT** lactic acid  
**DO NOT CREDIT** if pyruvate → ethanol in the animal  
is indicated/implied  
**DO NOT CREDIT** wrong reaction type (e.g. oxidation)

**2** **F** / pyruvate, accepts hydrogen (atoms);

**ACCEPT** pyruvic acid  
**DO NOT CREDIT** hydrogen **ions** (unless also e–) / molecule

**3** hydrogen from, **reduced** NAD / **reduced E**;

**ACCEPT** NADH / NADH2 / NADH + H+

**4** (catalysed by) lactate dehydrogenase;

for pyruvate → lactate **ACCEPT** LDH

**5** no, oxygen / O2, to act as (final),  
hydrogen / electron, acceptor;

**6** (so) link reaction / Krebs cycle / ETC, cannot take place;

Needs a clear statement of **not** taking place  
**CREDIT** no, electron transport chain / electron carrier chain / chemiosmosis / oxidative phosphorylation

**7** NAD / **E**, regenerated / recycled / able to be re-used;

**IGNORE** reduced NAD, oxidised / reoxidised (as this does not give the idea of reusing it)

**8** allows glycolysis to continue / pyruvate continues to be made;

Needs a clear statement

**9** limited / small amount of / some, ATP can be produced;

**CREDIT** 1 ATP (per pyruvate) / 2 ATP (rather than 28-38 per glucose) / only substrate level phosphorylation

**IGNORE** ‘enough ATP for ...’

[5]

**6.** *physical (probably from diagrams)*

**1** large nostrils (open) to take in air;

**ACCEPT** oxygen

**2** (when submerged) nostrils close / nose closes, to, keep air  
in / stop air from escaping;

**ACCEPT** oxygen  
**IGNORE** ref to keeping water out

**3** lungs / airways, have high (vital) capacity;

**ACCEPT** deep / barrel / large, chest **IGNORE** big lungs  
**CREDIT** large lung volume /  
 takes in large volume of oxygen /  
 larger numbers of alveoli /  
 larger (exchange) surface area /  
 increased number of capillaries

*links to respiration*

**4** *idea that* seal, has low(er) metabolic rate / has low(er) respiratory  
rate / has low(er) energy requirements / uses (relatively) little ATP;

e.g. • (streamlined, less resistance so) uses less energy  
 • (insulated so retain heat so) uses less energy  
 • (buoyant so) less energy required  
 • (small flippers so less surface area of extremity  
 so loses less heat so) uses less energy

**5** able to respire anaerobically for a long time / more glycolysis;

‘anaerobic’ needs time ref

**6** large supplies of NAD (to accept H);

**7** (this) prevents, build-up of lactate / lowering of pH;

**ACCEPT** lactic acid

**8** *idea that* (seal) tolerates lactate / removes lactate quickly;

**ACCEPT** lactic acid

**9** *idea that* (seal) tolerates high CO2 concentration;

**10** *idea that* (seal) tolerates low pH / has **more** pH buffers;

*synoptic / inference*

**11** *idea that* blood diverted from certain regions / certain regions have  
reduced metabolic activity;

**DO NOT CREDIT** zero respiration rate

**12** *idea that* has plenty of, haemoglobin / red blood cells / myoglobin  
(as oxygen source);

**13** *idea that* haemoglobin has a higher affinity for oxygen / dissociates  
less readily / dissociation curve shifted to **left**;

[3]

**7.** (a) **1** myelin / myelinated / lipid / fatty (sheath);

**DO NOT CREDIT** fatty acids

**2** (Schwann) cell, wrapped around / surrounds / AW, axon;

**3** except at nodes of Ranvier / (sheath) not continuous / presence  
of gaps (in the sheath);

must be in the context of structure rather than function  
(as many refer to it in context of saltatory conduction)

2 max

(b) (i) **1** (myelination produces) greater speeds;

**IGNORE** ref to axon diameter for this mp

**2** unmyelinated needs larger diameter to produce same speed;

**3** comparative figs, **all** with units, to support either the general  
trend or the exception to the trend with the mollusc;

1 speed for myelinated (25 / 30 / 35, **m s–1**) **and** 1 speed for unmyelinated (3 / 30, **m s–1**) (allow m/s)  
**or**calculated difference in speed between myelinated and unmyelinated (**with units unless** a multiple e.g. approx. × 12)

2 max

(ii) **1** larger axon diameter produces greater speeds; **ora**

needs to be a general statement

**2** comparative figs, **all** with units, to support;

2 diameters & speeds (**both with units**) for **myelinated**  
**or**calculated difference in diameter for 2 stated speeds (**both with units unless** diameter is a multiple e.g. around × 1.4 / around 140%)

|  |  |  |  |
| --- | --- | --- | --- |
| type of neurone | diameter (µm) | speed (m s–1) | animal taxon |
| myelinated | 4 | 25 | mammal |
| myelinated | 10 | 30 | amphibian |
| myelinated | 14 | 35 | amphibian |

**or**2 diameters & speeds (**both with units**) for **unmyelinated  
or**calculated difference in diameter for 2 stated speeds  
(**both with units unless** diameter is a multiple e.g. about × 10)

|  |  |  |  |
| --- | --- | --- | --- |
| type of neurone | diameter (µm) | speed (m s–1) | animal taxon |
| unmyelinated | 15 | 3 | mammal |
| unmyelinated | 1 000 | 30 | mollusc |

2 max

(c) (i) **1** increased kinetic energy / KE so,

• ions diffuse, across (axon) membrane / into neurone / into  
cell / between nodes / along neurone, more quickly

***or***

• faster movement of (neurotransmitter) vesicles / exocytosis (of neurotransmitter)

***or***

• neurotransmitter diffuses more quickly across,  
synapse / synaptic cleft

**o*r***

• neurotransmitter (ACh) broken down by enzyme (acetylcholinesterase)  
more quickly;

**2** faster diffusion of ions leads to,

• faster depolarisation

***or***

• shorter duration of action potential

***or***

• shorter refractory period

***or***

• faster repolarisation;

description of ion movement must be correct (e.g. Na+ in for depolarisation / Ca2+ into presynaptic knob)

1 max

(ii) ***DO NOT CREDIT*** *general denaturation of proteins / enzymes*

**1** ion, channels / pumps,  
disrupted / denatured / no longer function;

**2** fluidity of, membrane / phospholipid / bilayer, disrupted;

**IGNORE** leaky membrane unless qualified

**3** (named) synaptic enzymes denatured;

1 max

[8]

**8.**

***IGNORE*** *ref to influx of Na+ and events when action potential arrives at the synaptic knob - start when the Ca2+ channels open*

**1** calcium **channel**s open;

**2** Ca2+ / Ca++ / calcium ions, enter / diffuse into,

**DO NOT CREDIT** ‘calcium’ alone  
**DO NOT CREDIT** Ca+  
**DO NOT CREDIT** ‘enter membrane’ - must cross it

**3** acetylcholine / ACh / **neurotransmitter**, in **vesicle(s)**;

**4** (synaptic) vesicles move towards **presynaptic** membrane;

**CREDIT** pre-synaptic

**5** vesicles fuse with membrane;

**DO NOT CREDIT** attach / bind / join

‘vesicles move and fuse with presynaptic membrane’ = mps 4 & 5  
‘vesicles move and fuse with membrane’ = mp 5 only

**6** release acetylcholine, by **exocytosis**, into synaptic **cleft**;

3 max

**QWC** – technical terms used appropriately and spelt correctly;

Use of **three** terms from:  
**channel(s),** **vesicle(s),  
neurotransmitter,** **presynaptic / pre-synaptic,  
exocytosis,** **cleft,**

1

[4]

**9.** (i) ***Mark the first answer****. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then =* ***0 marks***

ultrafiltration;

This term required but **ACCEPT** phonetic spelling

1

(ii) 17.9;;

**Correct answer = 2 marks**If answer incorrect, not rounded or incorrectly rounded then allow 1  
mark for working  
 125 ÷ 700  
 **or** an unrounded answer e.g. 17.857412

2

[3]

**10.** (i) ***Mark the first answer****. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then =* ***0 marks***

(cuboidal) epithelium / epithelial;

**DO NOT CREDIT** ‘epithelium **cells**’ / ‘ciliated epithelium’ / ‘squamous epithelium’ / endothelium  
**ALLOW** columnar epithelium

1

(ii) ***Mark the first answer****. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then =* ***0 marks***

microvilli / microvillus;

**ACCEPT** ‘brush border’  
**DO NOT CREDIT** cilia

1

(iii) ***This*** ***is a QWC question***

**1** selective **reabsorption**;

**2** of glucose and amino acids;

**DO NOT CREDIT** if glucose & amino acids **& proteins**

**3** **co-transport** / ***facilitated* diffusion** / uptake described;

**ACCEPT** direct uptake, of glucose / amino acids,  
by active transport

**4** water follows by **osmosis** so concentration of, ions / nitrogenous  
waste / urea / remaining substances, increases;

**5** AVP;

e.g.   
• microvilli provide large surface area for uptake  
• many mitochondria provide energy for uptake  
• many brush border enzymes (ATPase) for active uptake  
• active secretion of nitrogenous waste into lumen

3 max

**QWC** - technical terms used appropriately and spelt correctly;

Use of **three** terms from:  
**reabsorption** (or derived term),  
**co-transport** (or derived term),  
**facilitated diffusion, osmosis**

1

[6]

**11.** (i) **L** artery / shunt / vein (at arterial end of shunt)  
 **AND**  
**M** vein;

**IGNORE** names of artery / vein (e.g. renal)

**DO NOT CREDIT** aorta and vena cava

1

(ii) so that clots don’t form,  
while in the (dialysis) machine / during dialysis;

**ALLOW** congeal instead of clot

**IGNORE** prevents clotting in the body

**IGNORE** clumping

1

(iii) *idea of* allowing blood to clot normally after treatment;

**CREDIT** preventing low blood pressure (as low viscosity)

1

(iv) ***Mark the first answer****. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then =* ***0 marks***

(simple) diffusion;

**IGNORE** dialysis  
**DO NOT CREDIT** facilitated diffusion

1

(v) *idea that* it,

maintains diffusion gradient /

**IGNORE** unqualified ref to countercurrent

maintains concentration gradient /

maximises diffusion gradient /

maximises concentration gradient /

e.g.  
• solutions in contact over greater distance  
• provides maximum contact for exchange  
• allows exchange over longer distance

allows maximum removal of waste /

allows maximum rate of diffusion / AW;

**IGNORE** ref to surface area

1

[5]

**12.** (i) control;

**CREDIT** a description e.g.  
• comparison  
• to compare results with  
• to show that (wavelengths of) light is producing the  
 effect  
• to show the result produced without light  
• create baseline  
• create set point  
• validity

**IGNORE** fair test’

**DO NOT CREDIT** ‘control variable’ / ‘controlled variable’

1

(ii) **Read as paragraph. Mark the first 2 responses only.**

**DO NOT CREDIT** ref to **time** / same **number** of leaf discs /  
**same plant** (as these given in the question)

**IGNORE** ‘fair test’ without further explanation

**1** discs, the same size / cut with same cutter, ***so***same surface area;

**ALLOW** for same amount of pigment / chloroplast

**2** discs taken from same part of the leaf / leaves used from the same  
part of the plant ***so***same amount of, pigment / chloroplast;

**3** tubes same distance from light source ***so***light intensity is the same;

**4** light bulb the same (wattage) each time ***so***light intensity is the same;

**5** same thickness of filter ***so***light intensity is the same;

**6** carry out in darkened room / only 1 light source in room / completely  
cover tube with filter, ***so***only light of desired wavelength enters;

**7** CO2 in excess / AW, ***so***CO2 not limiting / enough CO2 for  
photosynthesis / enough CO2 for Calvin cycle / enough CO2 for  
light independent stage;

**8** same, volume / concentration / batch, of indicator ***so***that  
colour changes are comparable;

**9** heat, sink / shield, between light source and tube ***to***reduce  
temperature changes;

**10** carry out at, same / constant, temperature ***as***temperature  
affects enzyme, activity / structure;

Enzyme ref must be qualified

**11** carry out, repeats / replicates, ***to***, calculate mean / identify  
anomalies;

**IGNORE** ref to improving reliability  
**IGNORE** how anomalies dealt with  
**DO NOT CREDIT** preventing anomalies

**12** AVP (to include precaution and explanation);;

**CREDIT** any reasonable precaution with a suitable  
explanation (even if explanation already given)  
e.g. • rinse test tubes with distilled water **so** starting pH  
 is the same

2 max

(iii) ***Mark the first answer.*** *If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then =* ***0 marks***

chlorophyll **a**;

**ALLOW** chlorophyll A / chlorophyll α  
**IGNORE** p680 / p700 / PSI / PSII  
**DO NOT CREDIT** chlorophyll a and b  
**DO NOT CREDIT** chlorophyll alone

1

(iv) **1** chlorophyll / pigments / leaf, reflect / does not absorb / absorbs  
little, green light / light of this wavelength;

Needs to refer to green rather than other colours

**2** (green light) cannot be used in  
photosynthesis / no photosynthesis / little photosynthesis /  
no light dependent reaction (or described) / little light  
dependent reaction (or described)  
correct ref to action spectrum in green region;

Needs to refer to green rather than other colours

**3** little / no, photolysis / splitting of water;

**CREDIT** (some) photolysis with accessory pigments

**4** little / no, CO2, taken up / fixed (in light independent reaction);

**5** some CO2 produced during respiration;

**6** (slight) increase in CO2, increases acidity / decreases pH;

**CREDIT** increase in H+ decreasing pH for accessory pigments

**7** AVP;

e.g. • accessory pigments absorb (some) green light

3 max

[7]

**13.** ***Question is asking for an increased rate of photosynthesis and maximum production***

**IGNORE LIGHT**

**1** photosynthesis / named stage, is controlled by / needs / involves / uses, (named photosynthetic) enzymes;

Needs to be a clear generalised statement – cannot be implied from a description of the effects  
**IGNORE** ‘enzymes are affected by temperature’

**2** temperature can be, increased by heater / reduced by ventilation (or fan) maintained by air conditioning (or other method);

Needs to indicate **how** factor is controlled

**3** increase CO2 concentration (in environment) by burning, fuel / gas / paraffin;

Needs to indicate **how** factor is controlled  
**CREDIT** increase in CO2 by other reasonable methods

**4** *idea that* increased / more / higher, CO2 (conc),  
so CO2 no longer a limiting factor / increases CO2 fixation / (or described) increases Calvin cycle (or described);

**ALLOW** ref to maximum rate for increase in rate

**5** *idea that* easier to control,  
water supply / irrigation (to prevent wilting) / humidity / minerals / fertiliser;

Look for the idea that factors can be more easily regulated in the greenhouse rather than outside  
**CREDIT** use of hydroponics

**6** *idea that* easier to control use of, pesticides / pest control / biological control;

Look for the idea that factors can be more easily regulated in the greenhouse rather than outside

**7** AVP;

e.g. • gas / paraffin, heater supplies heat **and** CO2  
 • prevents described damage of plants by,  
 wind chill / frost / wind / hail / etc  
 • description / effect, of photorespiration

[4]

**14.** (a) islets of Langerhans; 1

(b) glucagon; 1

(c) 1 fall detected by, pancreas / islets of Langerhans / alpha cells / beta cells;  
2 fall inhibits insulin, secretion / production;  
3 stimulates, secretion / production, of glucagon (by alpha cells);  
4 into blood;  
5 binds to receptor on, liver cell / hepatocyte;  
7 stimulates conversion of glycogen to glucose / glycogenolysis;  
8 gluconeogenesis / detail of gluconeogenesis;  
9 glucose into blood stream; 6

[8]

**15.** (a) (i) chlorophyll; *treat refs to a and b as neutral* 1

(ii) electron carrier / cytochrome / protein / electron acceptor / ferredoxin /  
plastoquinone; 1

(b) hydrogen ions are moved into the thylakoid space by action of electron  
 carriers;  
higher concentration of / more, hydrogen ions / protons reduces the pH;  
 **R** *hydrogen, H* **A** *hydrogen ions produced in lumen*hydrogen ions, move / diffuse, down concentration gradient;  
across / through, (thylakoid) membrane / from lumen to stroma;  
through ATP synthetase / synthase / protein channel / stalked particles;  
generates ATP;

AVP; e.g. ref. to by chemiosmosis  
 ref. to an electrochemical gradient / proton motive force max 4

[6]

**16.** no photophosphorylation;  
no ATP produced;  
no reduced NADP produced;  
no Calvin cycle / no light-independent stage;  
no GP to TP / no TP to RuBP;  
no fixation of carbon dioxide;

AVP; e.g. no production of, organic molecules / named molecules  
 **A** *autotrophic nutrition stops* **R** *food* ref to no respiratory substrate max 3

[3]

**17.** removal of, unwanted / toxic / waste, products;  
of metabolism; 2

[2]

**18.** (i) *award both marks for correct answer  
evidence of 14.7 - 2.2 = 12.5 or 14.7 / 2.2 gains one calculation mark*

12.5/2.2 × 100;  
= 568.2 / 568 / 570;; 2

(ii) protein converted to amino acids;  
excess amino acids undergo deamination / removal of amino group;  
ammonia formed;  
ammonia converted to urea;

AVP; e.g. ref. to ornithine cycle max 3

[5]

**19.** the longer the loop of Henle the lower the water potential (of urine); ora  
ions pass out from ascending limb into, medulla / tissue fluid;  
creating lower water potential in the medulla / AW;  
water reabsorbed from collecting duct in medulla;  
by osmosis; (*linked to previous marking point*)

AVP; e.g. ref to countercurrent multiplier max 3

[3]

**20.** (i) A glycolysis;  
B fermentaion / anaerobic respiration / reduction of pyruvate;  
C aerobic respiration / Krebs cycle and oxidative phosphorylation /  
ETC / electron transport chain; 3

(ii) C;  
*allow ecf from (i)* 1

(iii) A;  
*allow ecf from (i)* 1

[5]

**21.** (i) (when cyanide absent) complete homogenate can fully respire the  
glucose/pyruvate to produce carbon dioxide;

(when cyanide is present), pyruvate does not enter the mitochondria;  
some carbon dioxide produced when pyruvate is converted to ethanal;  
breakdown of the glucose / pyruvate is incomplete;

ref. to anaerobic respiration; max 3

(ii) pyruvate is end product of glycolysis;  
pyruvate can enter mitochondria;  
carbon dioxide produced in the Krebs cycle and link reaction;  
by, decarboxylation / decarboxylase(s);

glucose cannot enter the mitochondria;

AVP; further detail e.g. no carriers for glucose in mitochondrial  
 membranes  
 glycolytic enzymes not found in mitochondria  
 portion (of homogenate)  
 glycolytic enzymes found in, cytoplasm / cytosol max 3

(iii) pyruvate is converted to ethanal in cytoplasm;  
ethanal is converted to ethanol;  
does not involve, cytochromoes / ETC / oxidative phosphorylation;  
enzymes in cytoplasm not inhibited by cyanide; max 3

[9]

**22.** (a) A axon terminal / synaptic knob / synaptic bulb;  
B cell body / centron; 2

(b) *at X*:  
sodium channels open and sodium ions move into neurone;  
potential difference rises from –70mV to 30mV;

*at Y*:  
potassium channels open and potassium ions move out of neurone;  
potential difference falls from 30mV to –76mV;

AVP;; e.g. ref. to voltage gated channels  
 ref to movement by diffusion / passively  
 ref to electrochemical gradient 4

(c) *effect*:  
myelinated fibres conduct more quickly than unmyelinated / AW;  
ref. to one set of comparative figures from table;

*explanation - max 4*myelin sheath acts as (electrical) insulator;  
lack of sodium and potassium gates in myelinated region;  
depolarisation occurs at nodes of Ranvier only;  
(so) longer local circuits;  
(action potential) jumps from one node to another / saltatory conduction; 5

[11]

**23.** (i) a biological molecule that can be broken down in respiration to release  
energy; 1

(ii) *award both marks for correct answer*  
55/77;  
0.7 / 0.71; 2

(iii) 1.0; 1

[4]

**24.** ref. to potassium hydroxide / soda lime;  
ref. to equilibration / use syringe to set manometer fluid (level);

leave for suitable length of time (minimum 20 minutes) and  
 measure distance moved by fluid;  
repeats and calculate mean;  
calculate volume of oxygen taken up per minute;

AVP; e.g. ref to set-up of control tube (e.g. same mass of beads as of  
 fungus) or (same volume of inert substance as substance A)  
 detail of how to calculate volume of oxygen (by multiplying  
 distance moved by fluid in capillary by 2πr) max 4

[4]

**25.** (i) light absorbing/AW;  
ref to excited electrons/AW;  
used in light dependent stage;  
ref. to location; e.g. chloroplasts, thylakoids,  
photosystems, grana, lamellae  
AVP; e.g. (long) hydrocarbon chains,  
different pigments absorb different wavelengths. max 3

(ii) high absorption of, wavelengths 450 – 480 nm/  
blue region of spectrum;  
high absorption of, wavelengths 660 – 710 nm/  
red region of spectrum;  
low absorption of, wavelengths 500 – 620 nm/  
green region of spectrum;

*for each marking point accept single figure in range.  
If candidate gives range it  
must fall within the range on the mark scheme*.

*only penalise lack of units once*. max 2

[5]

**26.** (primary) act as reaction centres/where electrons are excited;  
(accessory) other part of photosystem/antenna unit/surround reaction centre;  
(accessory) absorb different wavelengths of light (not absorbed by primary);  
(accessory pigments) transfer energy to primary pigments;  
names of primary (chl a, P680, P700) and accessory pigment  
(chl b, carotenoid); max 2

[2]

**27.** **1** non-cyclic photophosphorylation;  
**2** ref to photosystems 1 and 2 being involved; **A** *PS1 and 2/P700 and P680***3**excited electrons emitted/AW;  
**4** ref to electron acceptor molecules;  
**5** (electrons pass along) chain of, electron carriers/ETC/cytochromes;  
**6** occurs in, thylakoid membranes/grana/lamellae;  
**7** sets up a, proton/H+/hydrogen ion/pH gradient; **A** *proton pump idea***8**ref to ATP synth(et)ase; **A** *ATPase, stalked particle***9**ref to, proton motive force/flow of protons;  
**10** chemiosmosis;  
**11** formation of ATP;  
**12** movement of electrons from PS2 to PS1;  
**13** ref to photolysis;  
**14** movement of electrons from water to PS2;  
**15** cyclic photophosphorylation;  
**16** PS1 only;  
**17** AVP; e.g. named electron acceptors, named electron carriers, ref. to water  
 splitting enzyme, ref to position of photosystems.(PS1 intergranal  
 membrane and PS2 grana) max 8

**QWC – clear well organised using specialist terms**; 1

[9]

**28.** (a) (i) removal of, carbon dioxide/carboxyl group;  
removal of hydrogen; **R** *H2/hydrogen molecules/hydrogen ions* **A** *H/2H* 2

(ii) P and Q; 1

(b) 1; 1

(c) (i) 3;  
1; 2

(ii) 1 inner mitochondrial membrane/cristae;  
2 ref to (NADH) dehydrogenase;  
3 hydrogen split into protons and electrons;  
4 ref to, electron carriers/ETC/cytochromes;  
5 energy released from electrons;  
6 ref to protons pumped across membrane;  
7 protons accumulate in intermembranal space;  
8 proton gradient/pH gradient/H+ gradient;  
9 protons pass through ATPase; **A** *ATPsynthase/* *ATP synthetase/stalked particle*10 ref. to oxygen (final) hydrogen/electron acceptor;  
11 formation of water; max 4

(d) fats/fatty acids, not respired;  
ref to (β-)oxidation (of fatty acids) requires NAD;  
NAD used in breakdown of alcohol;  
NAD is, limiting/in short supply/AW;  
fats formed from fatty acids plus glycerol;  
AVP; e.g. further detail of alcohol/fat metabolism max 3

[13]

**29.** (i) **A** 3  
**B** 2  
**C** 1; 1

(ii) **A** 1 (voltage gated) sodium channels open;  
 2 sodium (ions) enter (axon);  
 3 positive feedback/more sodium channels open;  
 4 depolarisation/description of depolarisation;  
 5 sodium channels close;  
 6 ref to + 40 mV;

**B** 7 (voltage gated) potassium channels open;  
 8 potassium (ions) move out (of axon);  
 9 positive feedback/more potassium channels open;

*only award marking points 3* ***or*** *9, not both*

10 repolarisation/description of repolarisation;  
11 beyond -65 mV/hyperpolarisation/AW;

**C** 12 Na/K pump (helps to), restore/maintain, resting potential;  
 13 membrane more permeable to potassium ions  
 (at resting potential);  
 14 (many) potassium channels open (at resting potential); max 5

[6]

**30.** 1 sodium ions (inside axon), move/diffuse  
2 towards, resting/negative region;  
3 causes, depolarisation of this region/change of PD to reach threshold value;  
4 (more) sodium channels open;  
5 sodium (ions) move in;

*marking points 3-5 only available if linked to sodium ions moving within axon*

6 ref to local circuits;  
7 one way transmission;  
8 ref refractory period/region of axon behind AP recovering;

9 ref to insulating role of, myelin sheath/Schwann cells;  
10 depolarisation cannot occur through myelin/  
 impermeable to (Na+ and K+) ions/ora;  
11 ref to nodes of Ranvier;  
12 longer local circuits;  
13 saltatory conduction/AW;  
14 AVP; e.g. fewer (Na+ and K+) ion channels in myelinated region/ora.  
15 AVP; ref. to absolute and relative refractory period, ref. to actual  
 distance between nodes (1 – 3mm); max 7

**QWC – legible text with accurate spelling, punctuation and grammar**; 1

[8]

**31.** (i) releases/source of/provides/to give, energy;  
for germination;  
for growth/protein synthesis/spindle formation/organelle replication/  
 DNA replication/active transport/cell division/other named function; 2 max

(ii) higher energy density/release twice as much energy per, g/unit mass;  
compared to, glucose/protein;  
39 kJ g–1;  
higher proportion of, hydrogen atoms/carbon-hydrogen bonds;  
advantage for dispersal/named advantage;  
AVP; e.g. ref to coenzyme A formation 2 max

[4]

**32.** *heat loss*1 body/blood, temperature rises;  
2 may affect/denature, enzymes/proteins;  
3 panting cools body;  
4 ref. evaporative cooling;

*fate of lactate*5 (high) lactate concentration needs to be reduced;  
6 due to anaerobic respiration;  
7 panting provides extra oxygen/ref. oxygen debt;  
8 lactate oxidized to pyruvate;

*respiratory gases*9 myoglobin would be reoxygenated;  
10 haemoglobin would be reoxygenated;  
11 ATP/CP, resynthesised in muscle tissue;  
12 removal of extra carbon dioxide; 4 max

[4]

**33.** 1 frequent need to urinate/diuresis;  
2 large volume of urine/very dilute urine;  
3 persistent feeling of thirst/excessive drinking;  
4 electrolyte/mineral, imbalance;  
5 AVP; e.g. dehydration, 3 max

[3]

**34.** (a) for, flying/hovering/beating wings;  
muscle activity/AW;  
ref. ATP/respiration;  
AVP; e.g. explanation of energy demand of flight

small size qualified; e.g. increases heat loss/  
ref. large surface area to volume ratio

homeothermic qualified;

migration qualified;

feather growth qualified; e.g. ref. mitosis/protein synthesis max 4

(b) *description*  
**D1** high(est) incidence of torpor/AW;  
**D2** low(est) oxygen consumption/AW;  
**D3** high(est) body mass/AW;  
**D4** data quote; *3 max*

*explanation***E1** less food used;  
**E2** (for) less respiration/lower BMR/lower body temperature;  
**E3** more food stored;  
**E4** as fat;  
**E5** (food store/fat) for, migration/flight; max 4

(c) flying, easier/uses less energy (with incomplete feathers if mass low);  
can, escape predators/find food, (by flying);  
food used for feather growth;  
therefore, fat stores used/less food stored;  
incomplete/missing feathers may reduce body mass; max 2

(d) *yes*  
(autumn) high(est) mass birds have low(est) oxygen consumption;  
(spring) low(est) mass birds have high(est) oxygen consumption;  
data quote mass plus O2 consumption;  
only generate heat in proportion to (small) mass;  
but lose it in proportion to (large) surface area;  
homeothermic/small birds find it hard to keep warm; max 3

[13]

**35.** 1 blood = transport fluid/AW;  
2 blood has high (hydrostatic) pressure;  
3 tissue fluid created/plasma moves out of capillaries/AW;

4 named substance; glucose/amino acids/fatty acids/glycerol,  
 oxygen, carbon dioxide, urea

5 from area; gut, alveoli, liver cell, liver cell  
6 moves to; blood/liver cell, blood/liver cell, tissue  
 fluid/alveoli, tissue fluid/kidney

7 method; diffusion/facilitated diffusion/active transport/  
 endocytosis, diffusion, diffusion, diffusion

8 detail of transport in blood; plasma/dissolved, red blood cells/  
 haemoglobin,  
 HCO3- ions/dissolved/carbamino-  
 haemoglobin, plasma/dissolved

9 ref. respiration;  
10 ref. maintaining diffusion gradients;

11 osmoregulation by kidney/AW;  
12 pH regulation by kidney/AW;  
13 ref. osmosis;

14 AVP; e.g. deamination, ornithine cycle, ref. CO2 acidic  
15 AVP; e.g. ref. glycogen, ref. insulin/glucagon max 7

**QWC – legible text with accurate spelling, punctuation and grammar**; 1

[8]

**36.** (a) cut/damage, breaks tonoplast/opens vacuole/mixes enzyme and  
precursor/  
 AW;  
enzyme-substrate collisions/AW;  
(enzyme-substrate complex) releases, smell/volatile chemicals; 3

(b) less precursor chemical;  
due to, herbivore/fungal/bacterial damage;  
due to sulphur recycling;  
due to onion being older;  
used pyruvate for, link reaction/Krebs cycle/respiration;  
AVP; max 2

(c) (i) identify mildest/AW;  
and breed together;  
detail cross-pollination;  
idea, repeat/many generations AW;  
directional selection;  
AVP; e.g. reference to frequency of alleles max 3

(ii) grow in low level of, sulphur/sulphate; 1

(d) method of quantifying onion strength/producing extracts of different  
concentration;  
method of measuring, rotting/antibiotic effect of onion extract;  
replicates/mean;  
ref. control variable or example;  
ref. fungi/bacteria;  
AVP; e.g. reference to timescale  
AVP; e.g. second controlled variable max 3

[12]

**37.** (i) light intensity; 1

(ii) some other factor becomes limiting;  
carbon dioxide or temperature (linked to point 1); 2

[3]

**38.** 1 denaturing of enzyme;  
2 change in shape of active site;  
3 named photosynthetic enzyme;  
4 less photolysis;  
5 less ATP produced;  
6 named step in Calvin cycle which is affected; **A** step described

7 increase in rate of respiration;  
8 respiration occurring at faster rate than photosynthesis;  
9 temperature compensation point;

10 increased rate of transpiration;  
11 stomatal closure;  
12 less carbon dioxide uptake;

13 AVP; e.g. ref to photorespiration 4 max

[4]

**39.** less reflection of light;  
less transmission of light;  
more light absorbed;  
more, wavelengths absorbed; **A** colours of light  
more, ATP / red NADP, formed;  
increases temperature of leaf;  
enzymes work more efficiently;  
light intensity / temperature, being limiting; 3 max

[3]

**40.** *accept labelled sketch diagram for marking points below*

nitrogenous base / purine;  
adenine;  
pentose / 5 carbon, sugar;  
ribose;  
three, phosphate groups / Pi; **R** phosphate molecule  
phosphorylated nucleotide;

**A** adenosine as an alternative to adenine **plus** ribose 4 max

[4]

**41.** 1 NAD / FAD, involved in respiration;  
2 associated with, dehydrogenase enzymes / dehydrogenation;  
3 2 molecules of NAD (reduced) in glycolysis;  
4 link reaction producing 1 molecule of NAD (reduced);  
5 Krebs cycle produces 3 NAD (reduced) (per turn of cycle);  
6 detail of any one step in respiration where NAD (reduced) is produced;  
7 Krebs cycle produces 1 FAD (reduced) (per turn of cycle);  
8 carriers / transfers, hydrogen to, inner mitochondrial membrane / cristae /  
 cytochromes / ETC;  
9 mitochondrial shuttle (bringing NAD reduced from glycolysis into matrix);

10 NADP involved in photosynthesis;  
11 produced in non-cyclic (photo)phosphorylation;  
12 hydrogen comes from, water / photolysis;  
13 (used in) Calvin cycle / light independent stage;  
14 GP to TP step;  
15 AVP; e.g. NADP involved in transporting hydrogen from grana to stroma  
16 AVP; e.g. hydrogen split into electrons and protons at ETC

*credit annotated diagrams* 7 max

**QWC – clear, well organised using specialist terms**;  
*award QWC mark if three of the following are used*photophosphorylation cristae  
glycolysis photolysis  
Calvin cycle link reaction  
Krebs cycle dehydrogenase / dehydrogenation 1

[8]

**42.** (a) (i) wide / large, afferent arteriole;  
narrow / small, efferent arteriole;

*afferent arteriole, wider / larger, than efferent arteriole – 2 marks*

ref to ‘bottleneck’ effect / AW; **R** *build up pressure on own*to achieve filtration;  
must be greater than 6.7 kPa for filtration; 2 max

(ii) *award two marks if correct answer (1.3) is given  
incorrect answer (or no answer) but correct working = 1 mark*

8 – (4 + 2.7) **A** *8 – 6.7*1.3;; 2

(b) (i) (too) large / RMM greater than 69000 *or* 70000;  
to pass through basement membrane; 2

(ii) glomerular blood pressure is greater;  
proteins forced through;  
damage to capillaries / AW;  
damage to basement membrane; 2 max

(c) 1 endothelium of capillaries;  
2 large / many, fenestrations / gaps / holes;  
3 modified epithelial cells of capsule / podocytes;  
4 slit pores / foot-like processes; **A** finger like  
5 basement membrane;  
6 made up of, collagen / glycoproteins / molecular mesh;

*accept annotated diagrams* 4 max

(d) 1 volume will increase;  
2 concentration decrease;  
3 (wall of), collecting duct / DCT, (relatively) impermeable to water;  
4 fewer water channels; **A** aquaporins  
5 in membrane of epithelial cells;  
6 less water reabsorbed (from the urine);  
7 by osmosis (linked to marking point 6);  
8 drinking increases liquid intake and therefore liquid loss; 4 max

[16]

**43.** CG acts as antigen;  
move, attached to, free antibodies;  
attach to, immobilised antibody;  
coloured particles, form line;  
ref to complementary shapes;  
ref to antigen, antibody complex;  
AVP; e.g. further detail of antibody structure  
 monoclonal  
 CG-antibody complex 4 max

[4]

**44.** **Q** – glucagon; **A** adrenaline  
**R** – insulin; 2

[2]

**45.** conversion of one amino acid to another / AW;  
(free) amino acids in body may not match body’s requirements / AW;  
can only occur with non-essential amino acids; 2 max

[2]

**46.** 1 increase in, HCO3- / H+;  
2 carotid / aortic / medulla, receptors;  
3 increase of frequency of impulses;  
4 along, accelerator / sympathetic / phrenic, nerve;  
5 to diaphragm and intercostal muscles;  
6 faster breathing;  
7 deeper breathing / increased tidal volume;  
8 to sino-atrial node;  
9 causes heart to beat faster;  
10 increased stroke volume / stronger contraction;  
11 more / faster, removal of carbon dioxide;  
12 (blood carbon dioxide falls to) norm / set point;  
13 negative feedback / homeostasis;  
14 AVP; e.g. buffering effect of haemoglobin,  
 ref chemoreceptors 7 max

**QWC – clear well organised using specialist terms**; 1

*award the QWC mark if three of the following are used in the correct* *context*

carotid  
 aortic  
 sympathetic  
 diaphragm  
 intercostal  
 tidal volume  
 sino-atrial node  
 stroke volume  
 negative feedback  
 homeostasis

[8]

**47.** (i) S dorsal root ganglion;  
T relay / intermediate / bipolar / internuncial, neurone; 2

(ii) 1 rapid / fast acting;  
2 short lived;  
3 automatic / involuntary / no conscious thought / brain not involved;  
4 not learned / innate / genetic / inborn / instinctive;  
5 response the same each time / stereotypical;  
6 AVP; e.g. safety / survival 3 max

(iii) 1 distortion / AW;  
2 Na+, gates / channels, open; **A** sodium / Na  
3 Na+ / sodium ions, enter; **R** sodium / Na  
4 depolarisation / –65mV to +40mV;  
5 receptor / generator, potential;  
6 ref to threshold;  
7 action potential; *allow only if linked to idea of threshold reached* 3 max

(iv) neurotransmitter only, in presynaptic knob / released from presynaptic  
membrane;  
receptors only on postsynaptic membrane;  
ref to refractory period / hyperpolarisation; 2 max

[10]

**48.** **A** - stroma ; **A** ribosome

**B** - (outer/ inner) membrane / (chloroplast) envelope ; **R** cell membrane

**C** - thylakoid / lamella ; **A** lamellae

**D** - granum / granal stack ; **A** grana **A** thylakoid stack

[4]

**49.** **1** light absorbed by, pigment / bacteriorhodopsin / protein ;

**2** ref to electron carriers / change in shape of bacteriorhodopsin ;

**3** energy released from electrons ; **R** produced / created / made

**4** protons into cell wall ;

**5** create, proton gradient / electrochemical gradient / pH gradient / proton  
motive force ;

**6** protons, diffuse / move down gradient ;

**7** through, ATP synth(et)ase complex / stalked particles ; **A** ATPase

**8** (ATP formed from) ADP + P(i) ;

**9** AVP ; e.g. ref to chemiosmosis,

ref to energy transducing membrane,

ref to redox reactions. 4 max

[4]

**50.** removal of, unwanted / toxic / waste, products ;

of metabolism ;

[2]

**51.** proteins / polypeptides ; **R** amino acids **A** enzymes

nucleic acids / DNA / RNA / polynucleotides ;

[2]

**52.** (i) *award two marks if correct answer (568.18 / 568.2 / 568 / 570) is given*  
*evidence of 14.7 – 2.2 = 12.5 or 14.7/2.2 gains one calculation mark*

12.5/2.2 × 100 = 568.18 / 568.2 / 568 / 570 ; ; 2

(ii) (more) proteins to amino acids ;

ref to deamination / removal of amino group ;

(more) ammonia formed ;

ref to ornithine cycle ;

(more) ammonia converted to urea ; 2 max

[4]

**53.** ammonia is, alkaline / highly toxic / *ora* ;

ammonia is more soluble / *ora* ;

large volumes of water to excrete it ;

would cause dehydration ; 2 max

[2]

**54.** **1** both filtered / AW ;

**2** both small molecules / AW ; **A** RMM close to 69 000

**3** (all filtered) glucose reabsorbed ;

**4** active uptake, carrier / cotransporter, proteins ;

**5** (some) glucose used in, respiration / active processes, in kidney ;

**6** some urea reabsorbed ;

**7** by diffusion ;

**8** ref to reabsorption in PCT ; *apply once to either glucose or urea* 5 max

[5]

**55.** ADH / anti diuretic hormone ;

reduces blood sugar levels / correct mechanism to achieve this ;

increases blood sugar levels / correct mechanism to achieve this ;

ABA / abscisic acid ;

auxin / IAA ;

[5]

**56.** **1** ref to change in receptor ;

**2** creates, receptor potential / generator potential ;

**3** if greater than threshold value ;

**4** depolarisation / AW, (of axon / sensory / afferent, neurone) ;

**5** ref to action potential (*anywhere in answer*) ;

**6** ref to, myelin sheath / myelinated neurones ;

**7** saltatory conduction / AW ;

**8** ref to nodes of Ranvier ;

**9** synapse with, motor / effector / efferent, neurone ;

**10** ref to, calcium ions / calcium channels ;

**11** vesicles of neurotransmitter fuse with presynaptic membrane ;

**12** named neurotransmitter ;

**13** secretion / exocytosis (from presynaptic membrane) ; **R** release

**14** diffusion across synaptic cleft ;

**15** receptors on postsynaptic membrane ;

**16** depolarisation / AW, (of postsynaptic membrane / motor neurone) ;

**17** ref to, neuromuscular junction / motor end plate ;

**18** AVP ; e.g. ion movement,

refractory period

voltage-gated channels 8 max

**QWC – legible text with accurate spelling, punctuation and grammar** ; 1

[9]

**57.** **A** ;

**C** ;

**C** ;

**B** ;

[4]

**58.** ref to oxidative phosphorylation and ATP production ;

needs supply of hydrogen ;

to form reduced, NAD / FAD ;

lipids have more, hydrogen / hydrogen – carbon bonds ;

more acetyl coenzyme A generated / more ‘turns’ of Krebs cycle ; 2 max

[2]

**59.** dinitrophenol in body ;

ETC still functioning ;

less ATP formed in respiration ;

food not enough to meet metabolic demands of body / AW ;

had to respire, body tissues / food stores ;

AVP ; e.g. heat production increasing metabolic rate 3 max

[3]

**60.** **A** – sinusoid ;

**B** – (branch of) bile duct ;

**C** – (branch of hepatic) portal vein / HPV ;

**D** – (branch of) hepatic artery ;

[4]

**61.** bile pigments build up in blood ;

(pigments) do not enter gut / AW ;

AVP ; e.g. bile, canaliculi / duct, blocked / gall stones 2 max

[2]

**62.** (a) avoid attracting a mate of a different species ; *ora*

ensure reproductive isolation ; 1 max

(b) (i) diffusion ; 1

(ii) so that they do not receive oxygen constantly ;

there are mitochondria between them and the cell surface ; 1 max

(c) mitochondria / aerobic respiration / oxidative phosphorylation, inhibited  
only briefly ;

oxygen concentration decreases again ;

preventing, action of luciferase / production of light ;

each flash short ; *ora* e.g. so not continuously lit

AVP ; 2 max

(d) active transport ; **A** e.g. Na+/K+ pump

protein synthesis ;

synthesis of named substance ;

movement of organelles ;

phosphorylation of glucose ;

AVP ; ; ; e.g. transcription, translation, anabolic reaction

**R** respiration, DNA replication, chromosome movement, mitosis 3 max

(e) cells / membranes, damaged / disrupted ;

nitrous oxide released ;

mitochondria stop using oxygen ;

oxygen, allows light production / reaches light-producing organelles ;

in unlimited quantities / continuously, so light is brighter ;

respiration / oxidative phosphorylation, ceases ;

no more, ATP / NADH2 ;

luciferin, synthesis / regeneration, stops ;

AVP ; 3 max

(f) live bacteria, respire / produce ATP ; *ora* 1

(g) mRNA (coding for luciferase) ; **A** DNA 1

[13]

**63.** (i) palisade (mesophyll) ;

spongy (mesophyll) ;

mesophyll / chlorenchyma – 1 mark 2

(ii) 1.7, 3.1, 4.0, 4.7, 4.9, 5.0 ; 1

(iii) selection of two temperatures 10 ºC apart ;

*respiration*

ref to release of carbon dioxide (in dark is measure of respiration) ;

state two figures very close to value of 2, therefore supports ;

(all steps in) respiration enzyme catalysed ;

*photosynthesis*

*data quotes must be from true rate of photosynthesis*

only value between 5 ºC and 15 ºC is close ;

photosynthesis does not support as (other) values not near 2 ;

**A** data quote to illustrate this / ecf

not just enzyme-controlled process / AW ; 4 max

(iv) light intensity limiting factor ;

low rate photosynthesis ;

rate respiration increases at higher temperatures ;

rate respiration, close to / exceeds, rate of photosynthesis ; **A** ora

net primary productivity is lower / sugars broken down more quickly  
than formed ; 3 max

[10]

**64.** **1** Calvin cycle ;

*max 4 from marking points 2 to 10*

**2** ribulose bisphosphate carboxylase / rubisco ; *linked to marking point 3*

**3** RuBP + carbon dioxide ;

**4** (2 molecules of) GP ; **A** PGA

**5** GP to TP ; **A** PGAL, GALP

**6** uses ATP (from light reaction) ; *linked to marking point 5*

**7** and red NADP / AW, (from light reaction) ; *linked to marking point 5*

**8** some TP forms hexose sugars ;

**9** (some) TP regenerates RuBP ; 5 max

**10** AVP ; e.g. (unstable) 6C compound, detail of RuBP regeneration

*accept an annotated diagram of the cycle*

[5]

**65.** (i) directly proportional / AW ; 1

(ii) 2.6 ; 1

(iii) **1** high levels of glucose in glomerular filtrate ;

**2** unable to reabsorb all glucose (in, PCT / kidney tubule) ;

**A** no more glucose can be reabsorbed

**3** ref to glucose carriers / AW ;

**4** at threshold value carriers, all saturated / limiting factor ;

**5** AVP ; e.g. ref to renal threshold 3 max

[5]

**66.** **1** detected by cells in pancreas ;

**2** β cells of islets of Langerhans ;

**3** insulin produced ;

**4** secreted into, blood / circulation / HPV ;

**5** cells / named example, take up more glucose ;

**6** more glucose carriers in membrane ;

**7** conversion to glycogen / glycogenesis ;

**8** increased rate of glucose use in respiration ;

**9** ref to negative feedback ;

**10** glucose concentration kept below threshold value in glomerular filtrate ;

**11** all reabsorbed in PCT ;

**12** AVP ; inhibits glucagon secretion, suppresses gluconeogenesis 5 max

[5]

**67.** (i) long loop of Henlé or/ deep / wide, medulla ;

very low water potential in medulla / AW ; **A** higher concentration of salts

collecting duct more permeable to water ;

large number of, water permeable channels / aquaporins, in collecting duct ;

more sensitive to ADH / more ADH produced ;

AVP ; e.g. other correct ref to kidney histology

all loops of Henlé are long

CD more permeable to urea

more capillary loops in medulla 3 max

(ii) seeds contain, storage molecules / AW ; **A** named example of storage  
molecule

aerobic ;

respiration ;

water is produced ; *linked to respiration*

**R** reference to condensation reactions

*accurate equation for aerobic respiration can gain 3 marks*

*metabolic water = 2 marks* 3 max

[6]

**68.** (i) **A** islet of Langerhans / α and β cells ;

**B** (branch of pancreatic) duct ; 2

(ii) *endocrine* ductless gland ;

hormones / named hormone ; e.g. insulin / glucagon

into blood ;

*exocrine* enzymes / pancreatic juice / HCO3– ;

amylase / trypsin / chymotrypsin / lipase / carboxypeptidase ;

into duct ;

*if answers are interchanged then mark to 2 max* 4 max

[6]

**69.** **1** ref to, medulla (oblongata) / cardiovascular centre (in brain) ;

**2** sympathetic nervous system / accelerator nerve (to heart) ;

**3** short preganglionic, neurone / fibre ;

**4** (transmitter substance) noradrenaline ;

**5** to sino atrial node (SAN) (in correct context) ;

**6** heart rate increases ;

**7** increased force of contraction ;

**8** ref to adrenaline ;

**9** parasympathetic nervous system / vagus nerve ;

**10** (transmitter substance) acetylcholine ;

**11** long preganglionic, neurone / fibre ;

**12** heart rate decreases ;

**13** AVP ; e.g. myogenic heart muscle / cardiac inhibitory centre

*if answers to sympathetic and parasympathetic are interchanged mark to*  
*4 max* 7 max

**QWC – legible text with accurate spelling, punctuation and**  
**grammar** ; 1

[8]

**70.** (a) *T. sillamontana*

thicker / fleshier / succulent ;

hairy ;

more compact / AW ;

ref to different leaf shape ;

AVP ; e.g. petiole rolled round stem 2 max

(b) (i) *T. sillamontana* 14, *T. fluminensis* 19 ; 1

(ii) same magnification / AW ;

several leaves ;

leaves from similar parts of plants ;

same (environmental / light / water / soil / fertiliser) conditions ;

AVP ; e.g. same age 2 max

(c) **1** *T. sillamontana* drier / *T. fluminensis* wetter / AW ;

*T. sillamontana*

**2** xerophytic / xeromorphic ;

**3** fewer stomata / ora ;

**4** hairs ;

**5** trap water vapour / water potential gradient lower ; **R** trap, water /  
moisture

**6** (so) transpiration / evaporation, slower ;

**7** white hairs qualified ;

**8** fleshy, stem / leaves, store water ;

**9** AVP ; ref surface area to volume ratio, ref to rolling qualified

*T. fluminensis*

**10** leaves further apart ;

**11** so do not, trap air / shade each other ;

**12** leaves, darker / have more chlorophyll ;

**13** so improved photosynthesis ;

**14** smooth / shiny, leaves allow water to drip off ; 5 max

(d) *T. fluminensis* has, max / optimum, rate at, 7 a.u. / 42 (- 50) % ;

*T. sillamontana* rate increases with increasing light intensity ;

*T. sillamontana* data quote (x + y) ;

comparative statement re data ;

comparative statement re conditions ;

AVP ; e.g. *T. fluminensis* may be damaged by high light intensity 3 max

[13]

**71.** **1** decomposition / decay / rotting (of grass) ;

**2** (microbial) respiration ;

**3** (releases) heat ;

**4** temperature figures ;

**5** uses up oxygen / aerobic ;

**6** oxygen figures ;

**7** produces carbon dioxide ;

**8** carbon dioxide figures ;

**9** grass cuttings provide insulation ;

**10** AVP ; 5 max

[5]

**72.** (a) (i) noradrenaline / adrenaline / thyroxine / growth hormone  
/ glucocorticosteroid; **R** steroid 1

(ii) insoluble;

unreactive / stable / inert;

cannot diffuse out of cell / AW;

no effect on water potential;

compact / branched;

lots of glucose in small space / AW; **R** lots of energy in  
small space

easy to, convert to glucose / hydrolyse;

lots of ‘ends’ for enzyme action; max 3

(b) **1** increases activity of glycogen synthetase;

**2** slow initial effect / AW;

**3** ref to figures to show an increase;

**4** (overall effect) increases, production of glycogen  
/ glycogenesis; **R** storage of

**5** glycogen

**6** lowers activity of glycogen phosphorylase;

**7** rapid effect;

**8** ref to figures to show a decrease;

**9** prevents / reduces, breakdown of glycogen / glycogenolysis;

**10** (glucose binds to) allosteric site / AW;

(glucose acts as) inhibitor / activator; **R** competitive inhibitor max 5

(c) *either*

deamination of amino acids / removal of NH2 from amino acids;

pyruvate / carbon skeleton / AW;

triose phosphate / TP;

condensation / increasing number of carbon atoms;

*or*

breakdown of, lipid / triglyceride;

glycerol;

triose phosphate / TP;

condensation / increasing number of carbon atoms; max 3

[12]

**73.** (a) **1** rate of respiration can equal rate of photosynthesis / CO2 used = CO2  
 produced / O2 used = O2 produced;

**2** ref to compensation point;

**3** mitochondria use oxygen;

**4** chloroplasts produce oxygen;

**5** mitochondria are always active / respiration continues  
independently of light;

**6** chloroplasts are inactive in dark / photosynthesis does not take  
place without light;

**7** oxygen released by, chloroplasts / photosynthesis, can be utilised by  
mitochondria / respiration;

**8** at high light intensities, chloroplasts produce more oxygen than the  
mitochondria consume;

**9** AVP; e.g. valid refs to CO2 exchange max 4

(b) phosphate ions are used to produce ATP;

in oxidative phosphorylation / Krebs cycle / chemiosmosis / electron  
transport / ATP synth(et)ase;

ATP leaves mitochondria; max 2

(c) carrier protein / transport protein / transmembrane protein involved;

**A** ref to a specific channel

concentration of triose phosphate is higher in the chloroplast (than in the

cytoplasm);

because it is a product of, photosynthesis / light independent reaction /

Calvin cycle;

triose phosphate moves, down concentration gradient / from high to low

concentration;

ATP not involved / no energy used; max 2

(d) *ignore references to chloroplasts or mitochondria being cells, having*  
*cytoplasm and reference to free ribosomes*

free / naked, DNA; **A** DNA not surrounded by, membrane / envelope

have an inner folded membrane / AW;

ribosomes, smaller than those in cytosol / similar in size to prokaryotic

ribosomes; **A** ref to 70S and 80S

circular DNA; **A** loop

AVP; e.g. absence of introns

**R** absence of a nucleus from the chloroplast or mitochondrion

**R** ref to membranous organelles as chloroplasts and mitochondria  
are these organelles max 2

[10]

**74.** **S;**

**R;**

**S;**

**A** – correct names instead of letters

[3]

**75.** FAD / NAD; **A** reduced FAD / reduced NAD / AW

[1]

**76.** chlorophyll a; **A** chlorophyll for one mark as an alternative to chl. a and b

chlorophyll b;

xanthophylls;

carotenoids / carotene;

[2]

**77.** **1** occurs in stroma;

**2** a series of enzyme-controlled reactions;

**3** carbon dioxide fixed by RuBP;

**4** carboxylation;

**5** enzyme is Rubisco;

**6** (unstable) 6C intermediate;

**7** forms (2 molecules) of GP;

**8** forms TP;

**9** using ATP (linked to point 8);

**10** reduction step;

**11** using reduced NADP;

**12** ref to either ATP or NADP red coming from light dependent reaction;

**13** (most of) TP regenerates RuBP;

**14** rearrangement of carbons to form pentose sugars;

**15** ATP required, for phosphorylation / ribulose phosphate to ribulose  
bisphosphate;

**16** AVP; e.g. TP can be used to form, lipids / amino acids / hexose sugars  
/ suitable named example max 7

**QWC – legible text with accurate spelling, punctuation and grammar;** 1

[8]

**78.** ductless gland;

secretes hormones; **R** excrete

(directly) into blood;

[2]

**79.** insulin produced by, microorganisms / bacteria;

cheaper source of insulin / more reliable supply / ref to large scale production;

more rapid response / shorter duration of response;

less chance of, immune / allergic, response; **R** reference to rejection

better for people who have developed a tolerance for animal insulin / less needed;  
**R** immune

acceptable to people who have ethical, moral or religious objections; **A**  
vegetarians

no risk of, infection / contamination;

[3]

**80.** thick axons transmit impulses quicker than thin ones / AW;

myelinated fibres quicker than unmyelinated / AW;

invertebrates have slower speed of impulse / *ora*;

ref to one set of comparative figures from table;

[2]

**81.** following an action potential;

need to, redistribute sodium and potassium ions / restore resting potential;

sodium voltage gated channels are closed;

(during which) another impulse cannot be, generated / conducted;

ensures impulses separated;

determines maximum frequency of impulse transmission;

impulse passes in one direction only along axon;

AVP; e.g. ref to absolute and relative refractory periods

[4]

**82.** (a) ref parasympathetic NS / AW;

sympathetic NS less active / AW;

more impulses in vagus nerve / less impulses in accelerator nerve;

more acetylcholine / less noradrenaline;

effect on SAN; max 3

(b) *any two of*

fibrinogen; **R** fibrin

prothrombin; **R** thrombin

albumin; **A** albumen

(named) globulin; **R** immunoglobulin or antibodies

AVP; e.g. transferrin max 2

(c) *similarities*

**1** production of urea;

**2** urea transported in blood;

**3** urea filtered from blood;

**4** synthesis of proteins from amino acids;

*differences (assume refs are to brown bears unless otherwise stated)*

**5** amino acids synthesised from ammonia;

**6** all urea reabsorbed;

**7** from kidney and bladder;

**8** urea converted to ammonia by bacteria;

**9** AVP; e.g. (humans) less tolerant to high ammonia (in blood) max 5

(d) component of cell membranes / AW;

ref to, mechanical stability / impermeability / fluidity; *ignore* rigidity

production of, steroid hormone / named hormone;

production of vitamin D;

production of bile salts; max 3

(e) increases high density lipoproteins (HDLs);

reduces low density lipoproteins (LDL);

prevents, deposition of cholesterol / plaques / atherosclerosis; max 2

[15]

**83.** (a) ref limiting factor;

not carbon dioxide;

named factor e.g. light / temperature / limited number of  
chloroplasts; **R** water

photosynthesis at maximum rate;

explanation of effect of named factor e.g. ref to enzyme action; max 2

(b) ref respiration;

production of carbon dioxide; **R** release

(at low concentrations, CO2 was) diffusing / moving down a  
concentration gradient;

respiration faster than photosynthesis / AW;

AVP; e.g. below compensation point max 2

(c) control of variables / light is a variable; **R** ‘fair test’ unqualified 1

(d) *accept ora here*

maintenance of water supply;

xylem / vascular bundles, intact;

water required for, photosynthesis / turgor; **A** water prevents wilting

stomata might close if the leaf detached;

leaves site of photosynthesis;

AVP; e.g. ABA, water stress, sugar transport max 2

(e) **1** one similarity between barley and sugar cane;

**2** one difference between barley and sugar cane;

**3** temperature ref between or within species;

**4** CO2 concentration ref between or within species; **A** ppm for  
concentration

**5** data quote comparison with units;

**6** ref to habitat; e.g. tropics, named country, biomes (biological  
zones), climate

**7** ref to biochemistry; e.g. C4 / C3, different enzymes

**8** ref to enzymes;

**9** AVP; e.g. ref compensation point max 5

[12]