Answer **all** the questions.

1 Photosynthesis involves two main stages:

- the light-dependent stage, which involves photosystems
- the light-independent stage, which involves the Calvin cycle.

(a) Photosynthetic pigments are arranged in groups known as photosystems I and II.

(i) Name the primary photosynthetic pigment in these photosystems.

..... **[1]**

(ii) Name an accessory pigment.

..... **[1]**

(iii) State the advantage to the plant of having a range of accessory pigments in photosystems.

.....

.....

..... **[1]**

(iv) Name the compound that is synthesised in the light-dependent stage as a result of the generation of an electrical and pH gradient across the thylakoid membrane.

..... **[1]**

(b) The Calvin cycle takes place in the stroma of the chloroplast.

(i) Identify the enzyme that catalyses the fixation of carbon dioxide.

..... **[1]**

(ii) Identify the first stable product of carbon dioxide fixation.

..... **[1]**

(iii) Identify the compound that is regenerated in the Calvin cycle so that more carbon dioxide can be fixed.

..... **[1]**

(iv) Name **two different polysaccharides** that can be synthesised from the end products of the light-independent stage of photosynthesis.

.... **[1]**

[Total: 8]

Turn over

2 The skin is important in enabling the body to detect changes in the environment. This allows the body to respond to these changes.

(a) Various types of sensory receptor are located in the skin.

Fig. 2.1 is a photomicrograph of a **transverse section** through a pressure receptor known as a Pacinian corpuscle.

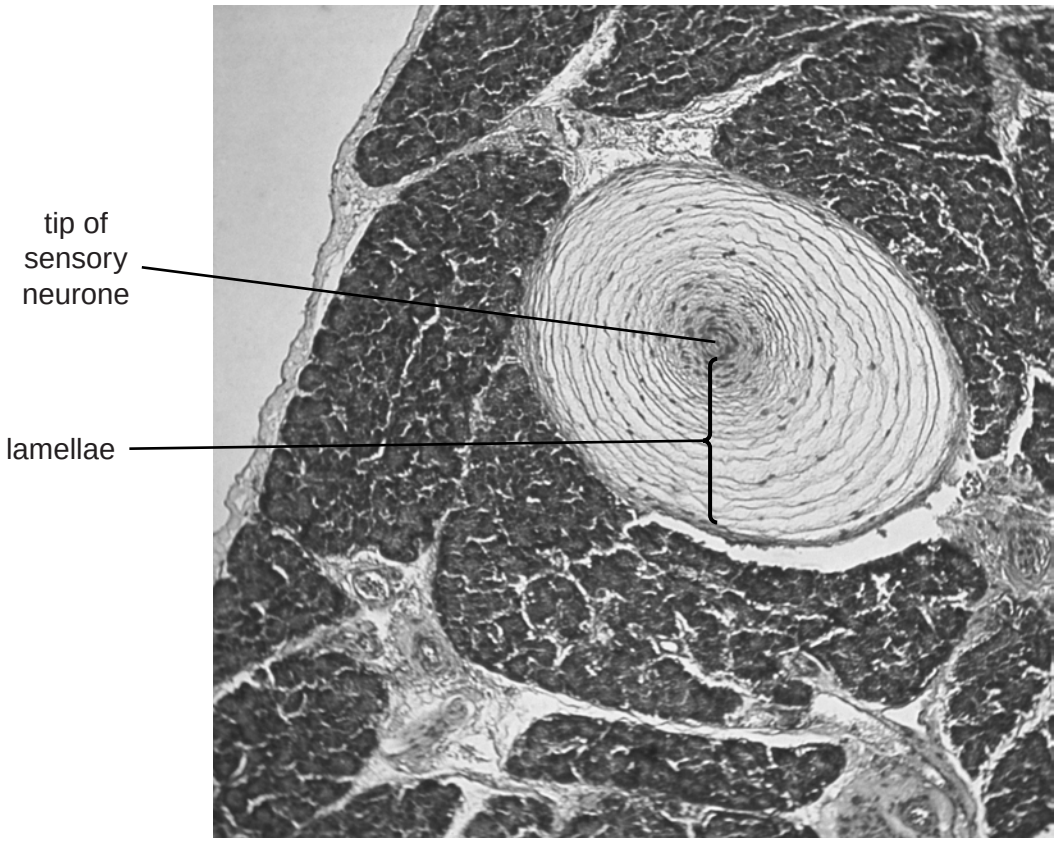

Fig. 2.1

Fig. 2.2 is a diagram of a **longitudinal section** through a Pacinian corpuscle. The tip of the sensory neurone is not covered by the myelin sheath.

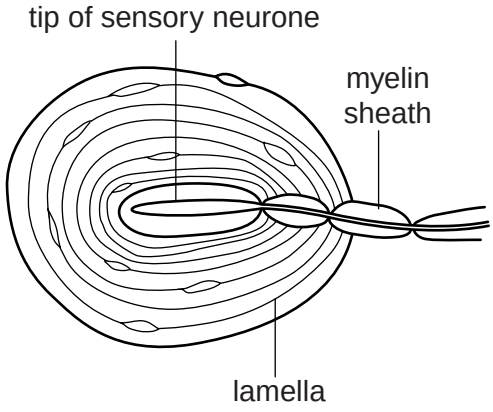

Fig. 2.2

The Pacinian corpuscle is a type of biological transducer.

- As a pressure stimulus is exerted on the corpuscle, the lamellae are compressed and exert pressure on the tip of the sensory neurone.
- The plasma (cell surface) membrane of the tip of the neurone becomes deformed and more permeable to sodium ions (Na^+).
- This region of the neurone becomes depolarised, reaching the threshold potential, and an action potential is generated.

(i) Why is the Pacinian corpuscle described as a transducer?

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..... **[1]**

(ii) Deformation of the plasma membrane of the tip of the neurone causes the membrane to become more permeable to Na^+.

Suggest why.

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..... **[1]**

(iii) The generation of an action potential follows the 'All-or-Nothing' law.

Explain what this means.

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..... **[1]**

(iv) Describe how information about the strength and intensity of a stimulus is communicated to the brain.

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..... **[2]**

Turn over

(b) When clothes are first put on the body, a constant gentle pressure is applied to the pressure receptors in the skin. After a short time, action potentials are no longer generated unless there is a change in pressure as the clothes move over the surface of the skin.

Suggest an explanation for the fact that action potentials are not generated constantly whilst wearing clothes.

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..... **[1]**

(c) Synapses are an integral part of the nervous system.

Outline the roles of synapses in the nervous system.

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..... **[3]**

[Total: 9]

3 **(a)** A doctor arranged for a 59-year-old patient to have a series of blood tests. One of these tests was to determine the patient's 'fasting blood glucose' concentration.

- The result of this test indicates whether or not the patient's blood glucose concentration is being regulated within the normal range.
- The validity of the result relies on the patient not having eaten for at least eight hours before the test.
- The patient confirmed to the doctor that he had not eaten since the previous evening.

(i) What condition was being tested for in this 59-year-old patient?

..... **[1]**

(ii) Why was it important that the patient had not eaten for at least eight hours before the test?

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..... **[1]**

(iii) The result of the patient's fasting blood glucose test was 7.0 mmol dm^{-3}.

The upper limit for 'normal' blood glucose concentration is considered to be 5.9 mmol dm^{-3}.

Calculate the percentage by which this patient's blood glucose concentration is higher than the upper limit for normal concentration.

Show your working. **Give your answer to one decimal place.**

Answer = ... % **[2]**

Turn over

(b) The patient was sent for a further blood test, known as the haemoglobin A1C (HbA1C) test.

- Glucose combines with haemoglobin in the bloodstream to form a 'glycosylated haemoglobin' molecule, HbA1C.
- The concentration of HbA1C is directly proportional to the mean concentration of glucose in the blood over an eight to twelve week period.

Suggest why a single HbA1C test cannot indicate accurately the mean blood glucose concentration for a period longer than twelve weeks.

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..... **[2]**

(c) The result of the patient's fasting blood glucose test showed a blood glucose concentration higher than the normal range even though the patient had not eaten food for at least eight hours before providing a blood sample.

The result of the patient's HbA1C test indicated that his mean blood glucose concentration had been within the normal range for the previous eight to twelve weeks.

Suggest an explanation for the patient's high value for the **fasting blood glucose test**.

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..... **[1]**

(d) Another patient shows severe symptoms of unregulated blood glucose concentration. Under certain circumstances this condition may need to be treated with glucagon injections.

(i) Under what circumstances might this patient need to be given a glucagon injection?

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..... **[1]**

(ii) Describe how glucagon is involved in the regulation of blood glucose concentration in a person who is able to regulate their blood glucose concentration correctly.

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

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..... **[5]**

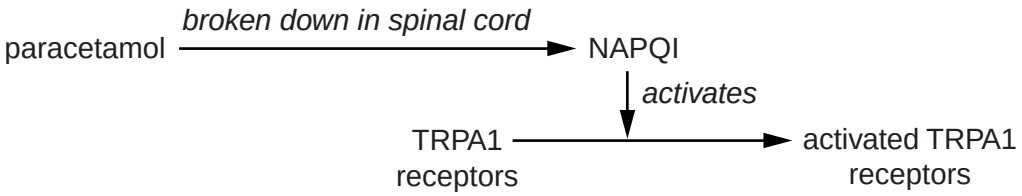
[Total: 13]

Turn over

4 **(a)** Paracetamol is a drug that is commonly used as a painkiller. For many years, scientists have been uncertain about the way in which paracetamol works.

A recent study has shown that:

- paracetamol is broken down in the spinal cord into a compound called NAPQI
- NAPQI activates a receptor protein called TRPA1
- TRPA1 is found on the plasma (cell surface) membranes of neurones
- the activated receptor protein, TRPA1, interferes with the transmission of the nerve impulses from one neurone to the next.



(i) Name **one** chemical that transfers a nerve impulse from one neurone to another.

..... **[1]**

(ii) Suggest the part of the neurone where the plasma membrane has TRPA1 receptors.

Explain your answer.

part of neurone .....

explanation .....

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[2]

(b) One role of the liver is detoxification. Detoxification includes the breakdown of drugs such as paracetamol.

(i) Fig. 4.1 is a diagram that represents the structure of part of a liver lobule.

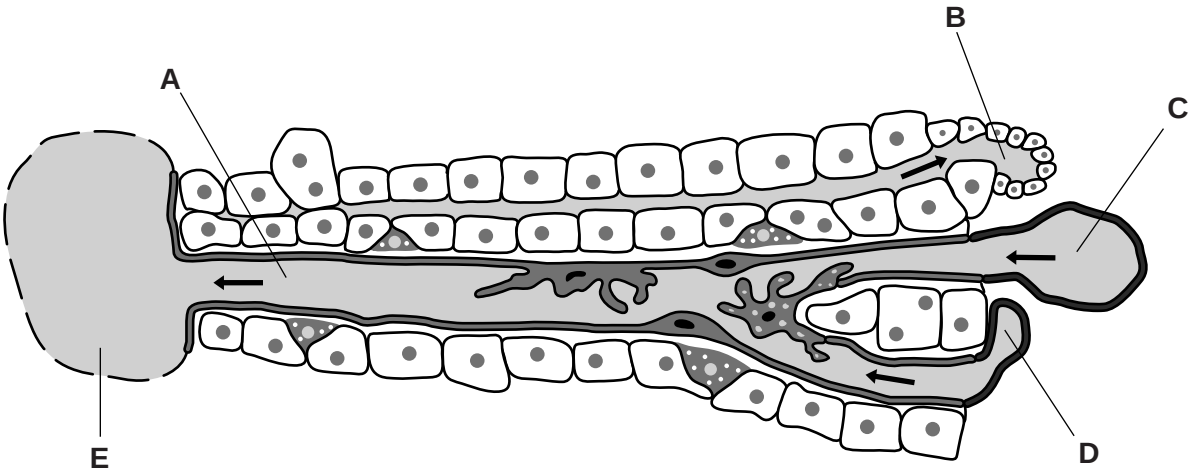

Fig. 4.1

Identify the parts labelled **A** to **E**.

A .....

B .....

C .....

D .....

E .....

[5]

(ii) During detoxification, paracetamol is metabolised in the liver cells as follows:

- approximately 90% is combined with two chemicals, sulfate and glucuronide, and excreted
- approximately 5% is oxidised by the P450 enzyme system, which produces NAPQI
- the NAPQI is then metabolised using another compound called glutathione.

Once the sulfate and glucuronide reserves in the liver are used up, the P450 system takes over completely. However, continued metabolism of paracetamol will result in high concentrations of NAPQI accumulating in the liver cells, causing cell death.

Suggest a reason for the accumulation of high concentrations of NAPQI in the liver cells.

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..... **[1]**

(iii) The liver has considerable powers of regeneration, even if a high proportion of its cells are damaged.

Name the liver cells that can lead to this regeneration **and** the type of cell division that they carry out.

name of liver cells .....

type of cell division ..... **[1]**

[Total: 10]

5 **(a)** Humans harvest a wide range of fruits and vegetables as food. Cellular respiration supplies energy and forms part of the natural ripening process in fruits and vegetables. This ripening process may continue after the fruits and vegetables are harvested, as the cells continue to respire.

The rate of cellular respiration after harvesting affects the shelf-life of fruits and vegetables as it can lead to changes in food quality. After harvesting, some fruits and vegetables enter a dormant (inactive) state while others remain active during storage.

Table 5.1 contains data that show the respiration rate of a selection of fruits and vegetables stored at different temperatures after harvesting. The respiration rate is measured by the rate of carbon dioxide produced.

Fruits and vegetables	**Respiration rate (mg CO_2 kg^{-1} h^{-1})**				
	at 0 °C	**at 5 °C**	**at 10 °C**	**at 15 °C**	**at 20 °C**
Apple	3	6	9	15	20
Asparagus	60	105	215	235	270
Blackberry	19	36	62	75	115
Cauliflower	17	21	34	44	69
Onion	3	5	7	7	8
Orange	4	6	8	18	28
Parsnip	12	13	22	37	n/a*
Potato	n/a*	12	16	17	22
Turnip	8	10	16	23	25

***** no data were collected at these temperatures

Table 5.1

(i) Describe the pattern of respiration shown by cauliflower at increasing storage temperatures of 0 °C to 20 °C.

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..... **[2]**

(ii) Discuss what the data in Table 5.1 indicate about the best conditions for storage of fruits and vegetables.

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..... **[2]**

(iii) Identify, with reasons, which fruit or vegetable listed in Table 5.1 is **least** likely to spoil during storage.

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..... **[3]**

(iv) Which fruit or vegetable listed in Table 5.1 is likely to be the most difficult to keep fresh during storage? Give a reason for your answer.

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..... **[1]**

(b) Respiration can be aerobic or anaerobic.

(i) Certain parasites live in the blood of mammals.

Suggest why, even though blood carries oxygen, these parasites are adapted to respire anaerobically.

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..... **[2]**

(ii) The anaerobic respiration pathway in animal cells can be reversed, but the anaerobic respiration pathway in yeast cells cannot be reversed.

Explain why, using your knowledge of the differences between the two pathways.

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

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..... **[4]**

[Total: 14]

6 Fig. 6.1 is a diagram that represents the nephron in a mammalian kidney.

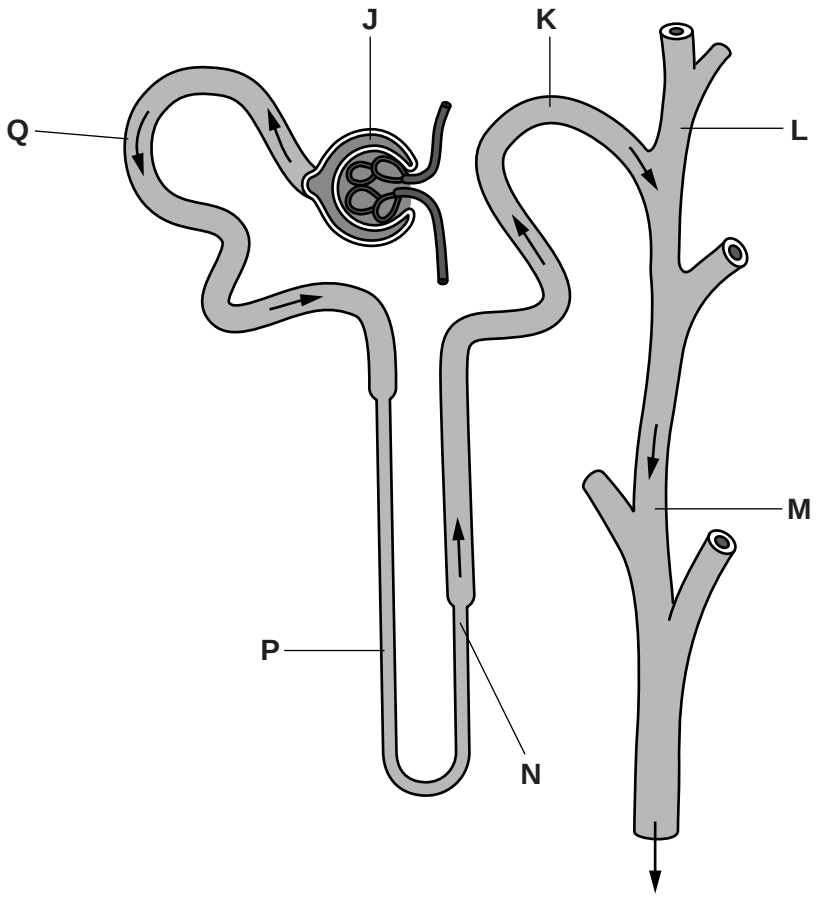

Fig. 6.1

(a) Use the letter or letters from Fig. 6.1 to identify:

(i) the region or regions where glucose is selectively reabsorbed into the blood capillaries

..... **[1]**

(ii) the region or regions present in the cortex

..... **[1]**

(iii) the region or regions where podocytes are located.

..... **[1]**

(b) The desert kangaroo rat, *Dipodomys deserti*, lives in dry and hot conditions. It excretes a very small volume of urine relative to its size.

The loops of Henle in the kidneys of these mammals are longer than those found in mammals of a similar size that do not live in desert conditions.

Explain how the longer loop of Henle is able to assist the desert kangaroo rat in preventing excessive water loss.

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..... **[2]**

(c) Urine can be tested to detect a person's misuse of certain drugs in body-building.

State the **type** of drug that can be misused in this way.

..... **[1]**

[Total: 6]

END OF QUESTION PAPER