1 **(a)** Nicotine is a toxic chemical. Smokers take in low doses of nicotine that are not toxic in the short term, but these low doses affect cardiovascular health in the longer term.

Nicotine increases blood pressure and increases the likelihood of a thrombosis (formation of a blood clot). Either of these effects can lead to a stroke, which is when cells in part of the brain die, leading to loss of function.

(i) Suggest how each of these stated effects of nicotine could contribute to cell death in the brain.

increased blood pressure .....

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.....

thrombosis .....

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.....

[4]

(ii) It is important that the correct treatment is given when a stroke is suspected.

Research has led to the ability to identify whether a stroke has resulted from a thrombosis or from increased blood pressure.

The standard emergency treatment for a suspected stroke is to give a drug that will counteract a thrombosis. If, however, the cause of the stroke is found to be high blood pressure, an alternative treatment would be more appropriate.

Explain why.

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

(iii) The effects of a stroke will depend on which part of the brain has been affected.

Some possible effects of a stroke are listed below.

- Problems with coordination of movement.
- Loss of memory and speech.
- Paralysis of the body below the neck.

With reference to named parts of the brain, explain how each of these specific effects is caused.

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

(b) Nicotine is produced by plants of the genus *Nicotiana*.

In an experiment, the leaves of a *Nicotiana* plant were punctured with tiny holes. This damage imitated insect attack.

Table 7.1 shows the effect of this damage on the nicotine concentration and seed production of a *Nicotiana* plant compared with a plant that was not damaged.

	Nicotine concentration (%)	**Number of seeds produced**
Control plant	0.67	2600
Plant with leaves punctured with holes	0.98	1100

Table 7.1

Discuss whether the ability to produce nicotine can be considered a selective advantage or a selective disadvantage to *Nicotiana* plants.

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

(c) Nicotine molecules have a shape that is complementary to acetylcholine receptors. As a result, nicotine interferes with the nervous systems of insects and mammals by binding with these receptors.

(i) Where, precisely, are acetylcholine receptors found?

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

(ii) The way that nicotine is thought to work is outlined in Fig. 7.1.

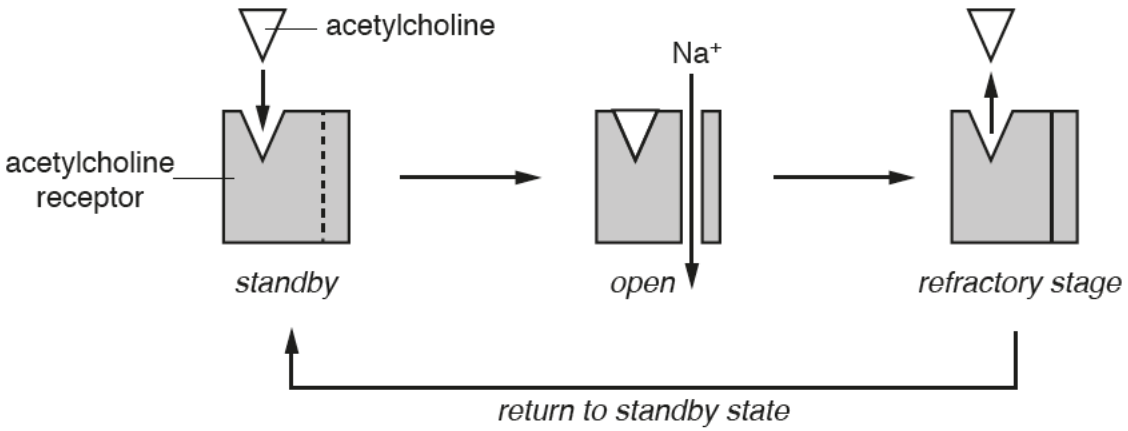


Fig. 7.1(a) When nicotine absent

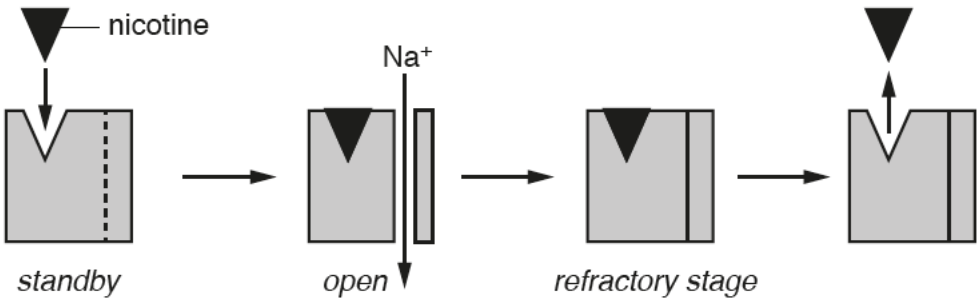


Fig. 7.1(b) When nicotine present

Using the information in Fig. 7.1(a) and Fig. 7.1(b), suggest and explain the effect that nicotine has on the nervous system.

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

(d) Neonicotinoids are chemicals with a similar structure to nicotine. The effects of these chemicals on insects have led to their use as insecticides over the last 20 to 30 years.

(i) Neonicotinoid insecticide molecules are absorbed by the roots and leaves of maize plants.

Describe how, once these molecules have been absorbed, they may be transported to the fruits of the maize plant.

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

(ii) Despite the similarity to nicotine, neonicotinoids have been permitted for use on crops that would be used for human consumption.

Suggest why neonicotinoids have been considered to be safe.

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

[Total: 19]

2 Animals and plants respond to changes in their environment.

(a) Plants respond to changes in their environment using chemicals known as plant hormones or plant growth regulators.

A student carried out a two-part experiment to identify the contents of two unlabelled bottles, **J** and **K**. One bottle contained auxin and the other contained gibberellin.

In Part 1 of the experiment, 30 seedlings had their shoot tips removed. The 30 seedlings were then divided into three groups of 10 and treated as shown in Table 3.1 and Fig. 3.1.

Group	Treatment
1	no treatment applied
2	solution of **J** applied to cut stem at apex of seedling
3	solution of **K** applied to cut stem at apex of seedling

Table 3.1

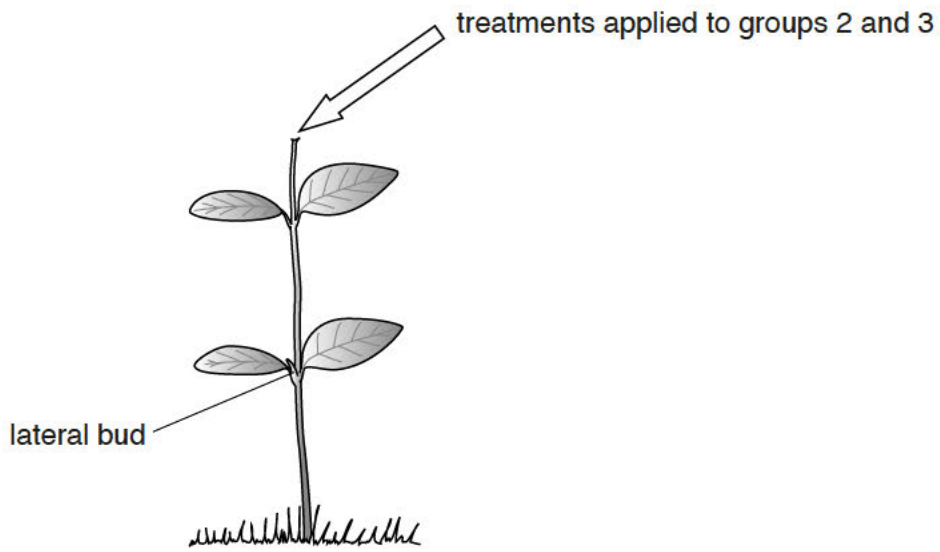


Fig. 3.1

All the seedlings were then exposed to light from **all** directions and left for seven days.

In Part 2 of the experiment, 30 coleoptiles had their tips removed. They were then divided into three groups of 10 coleoptiles and treated as shown in Table 3.2 and Fig. 3.2.

Group	Treatment
4	no treatment applied
5	solution of **J** applied to cut tip of coleoptile
6	solution of **K** applied to cut tip of coleoptile

Table 3.2

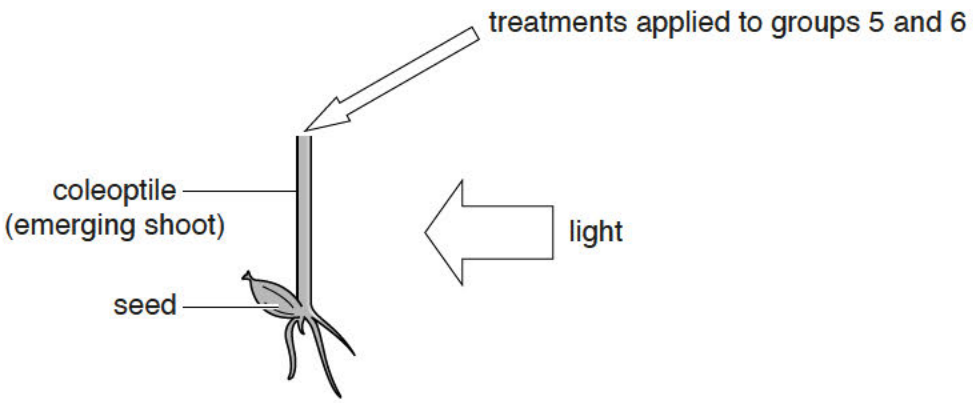


Fig. 3.2

The coleoptiles in groups **4**, **5** and **6** were then exposed to light from **one direction**, as shown in Fig. 3.2, and left to grow for two days.

(i) Identify **three** variables that must be controlled in this experiment to produce valid results.

1 .....

2 .....

3 .....

[3]

(ii) Groups **1** and **4** were controls in this experiment.

Explain why these controls were necessary.

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

The observations at the end of each part of the experiment are shown in Table 3.3.

Group	Treatment	Observations
1	none	increase in stem length of 10 mm and growth of lateral buds
2	**J** on cut stem apex	no growth of lateral buds
3	**K** on cut stem apex	increase in stem length of 40 mm and growth of lateral buds
4	none	vertical growth of the coleoptiles
5	**J** on cut coleoptile tip	growth of the coleoptiles towards the light source
6	**K** on cut coleoptile tip	vertical growth of the coleoptiles

Table 3.3

(iii) Using the information from Table 3.3, identify the contents of bottles **J** and **K and** give reasons for your answer.

J .....

K .....

reasons .....

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

(b) Fig. 3.3 is a diagram representing the neuromuscular junction in mammals.

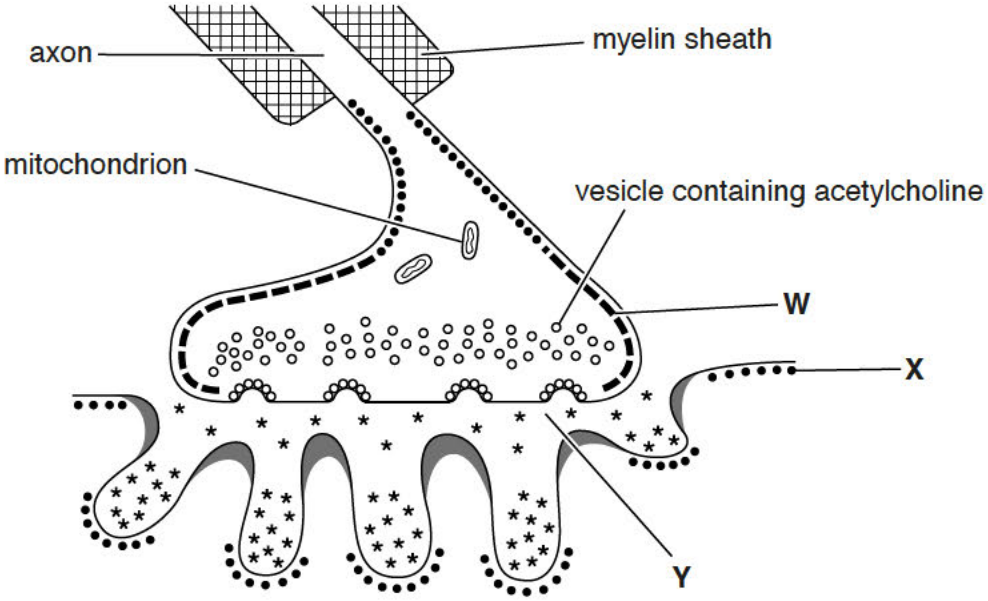


Fig. 3.3

(i) What type of molecule forms ion channels **W** and **X**?

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

(ii) Identify region **Y**.

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

(iii) Name the enzyme found in region **Y**.

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

(c) As mammalian muscle uses energy to contract, it needs an energy supply.

Complete the following passage by choosing the best term to fill each gap.

Most ATP for muscle contraction is generated by aerobic respiration in organelles called ..... . Most of this ATP is produced by the stage of aerobic respiration called ..... .

If the oxygen supply is insufficient, ATP can also be obtained from anaerobic respiration, in which pyruvate is converted to the toxic product ..... .

A third source of ATP in muscle involves the transfer of a phosphate group to ADP from a substance called ..... .

During the contraction of skeletal muscle, energy from ATP is used to break the ..... that hold the actin and ..... together. **[6]**

[Total: 16]

3 Fig. 2.1 is a diagram showing a section through the human brain.

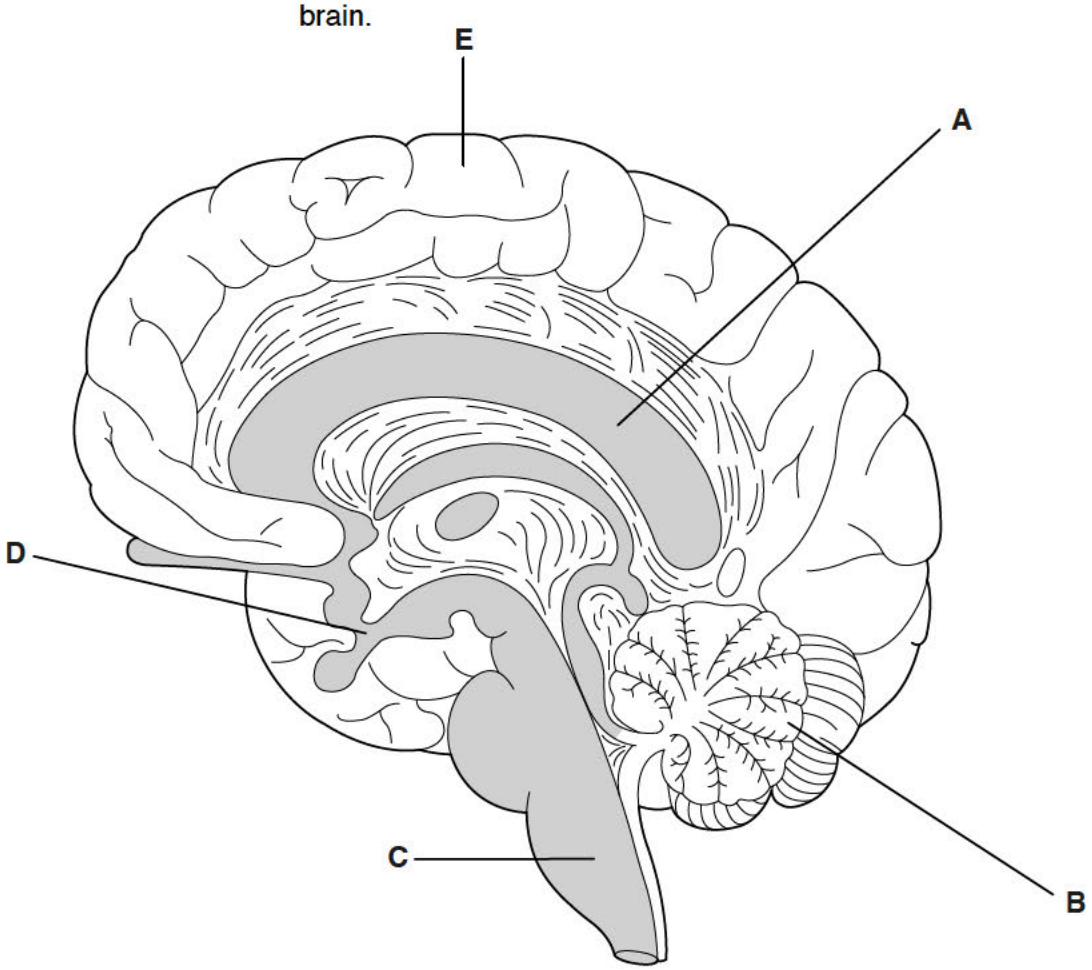


Fig. 2.1

(a) Use Fig. 2.1 to identify a part of the brain, **A**, **B**, **C**, **D**, or **E**, that is responsible for:

(i) co-ordination of the autonomic control of heart rate ..... **[1]**

(ii) co-ordination of osmoregulation by the kidney ..... **[1]**

(iii) co-ordination of the muscles involved in walking in an adult ..... **[1]**

(iv) co-ordination of the muscles required to bend the elbow joint deliberately ..... **[1]**

Fig. 2.2 shows the components of the human elbow joint.

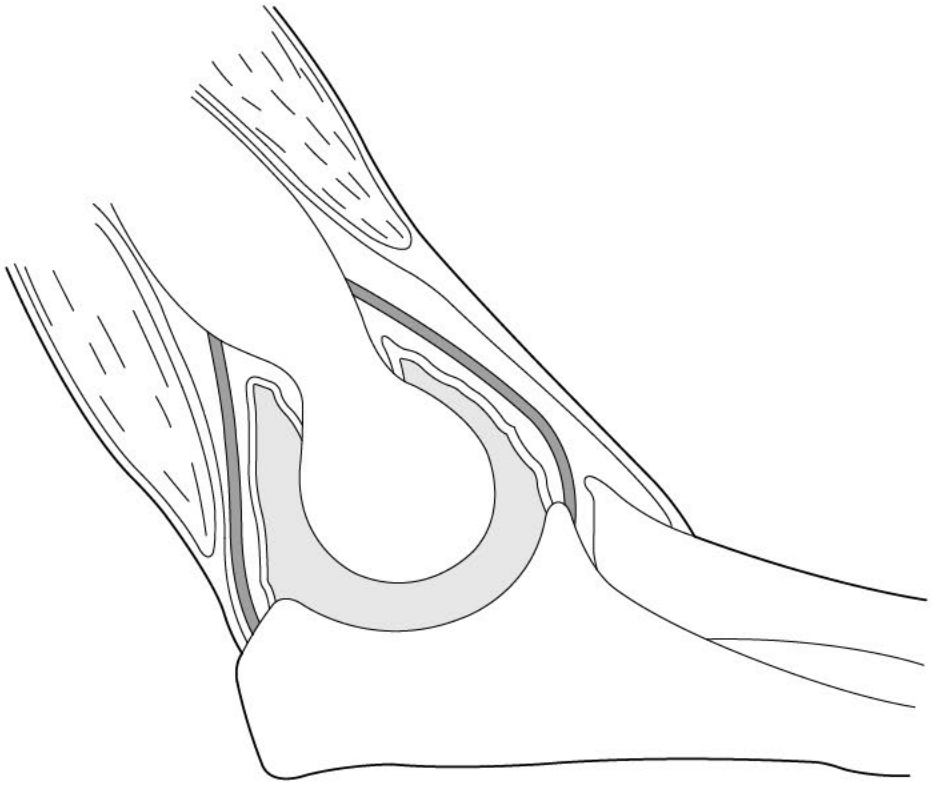


Fig. 2.2

(b) Describe how **three** named components of the **elbow joint** interact to bring about hinge movement (bending of the arm).

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

(c) Outline the **organisation** and **roles** of the autonomic nervous system in mammals.



In your answer you should discuss the differences in physical arrangement and the differences in function, of both parts of the autonomic nervous system.

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4 **(a)** Animals and plants need to respond to changes in their environment.

(i) Give **two** reasons why **both** plants and animals need to be able to respond to changes in their environment.

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

(ii) Plants co-ordinate their responses to environmental stimuli using hormones. Mammals also co-ordinate responses to some stimuli using hormones.

State **three differences** in the ways in which plant and mammalian hormones operate.

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

(b) Most mammalian hormones are made of protein. An example is human growth hormone (HGH). Lack of this hormone causes dwarfism (short height).

(i) Explain why dwarfism can be described as a genetic condition.

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

(ii) Children with dwarfism can be given HGH produced by genetic engineering. A method for engineering bacteria to make HGH has many stages that are similar to the method used to produce human insulin, and is described below.

Complete the following paragraph using the most suitable term or terms to fill in the gaps.

The ..... for HGH is cut from human DNA using a restriction enzyme. The human DNA fragments are then inserted into plasmids using the enzyme called ..... . Bacterial cells are treated so that they take up these plasmids. Bacteria that contain the new DNA are described as ..... bacteria. They are first grown on agar plates containing ..... which allow scientists to distinguish them from bacteria that have not taken up any new DNA. A ..... can then be used to identify the bacteria that have the desired sequence of DNA. **[5]**

(c) Steroid hormones are not made of protein. They are classed as lipids. Their structure means that they can diffuse through the cell surface and nuclear membranes. The hormones then bind to DNA in the nucleus and switch genes on and off.

Explain why steroid hormones can diffuse through cell membranes.

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

(d) Steroid hormones are one example of molecules that can switch genes on and off in mammalian cells.

Other molecules involved in genetic control have been studied in both eukaryotes and prokaryotes.

Describe **one** other example of genes being switched on or being switched off by a molecule that binds directly to DNA.

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

[Total: 18]