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# Revision

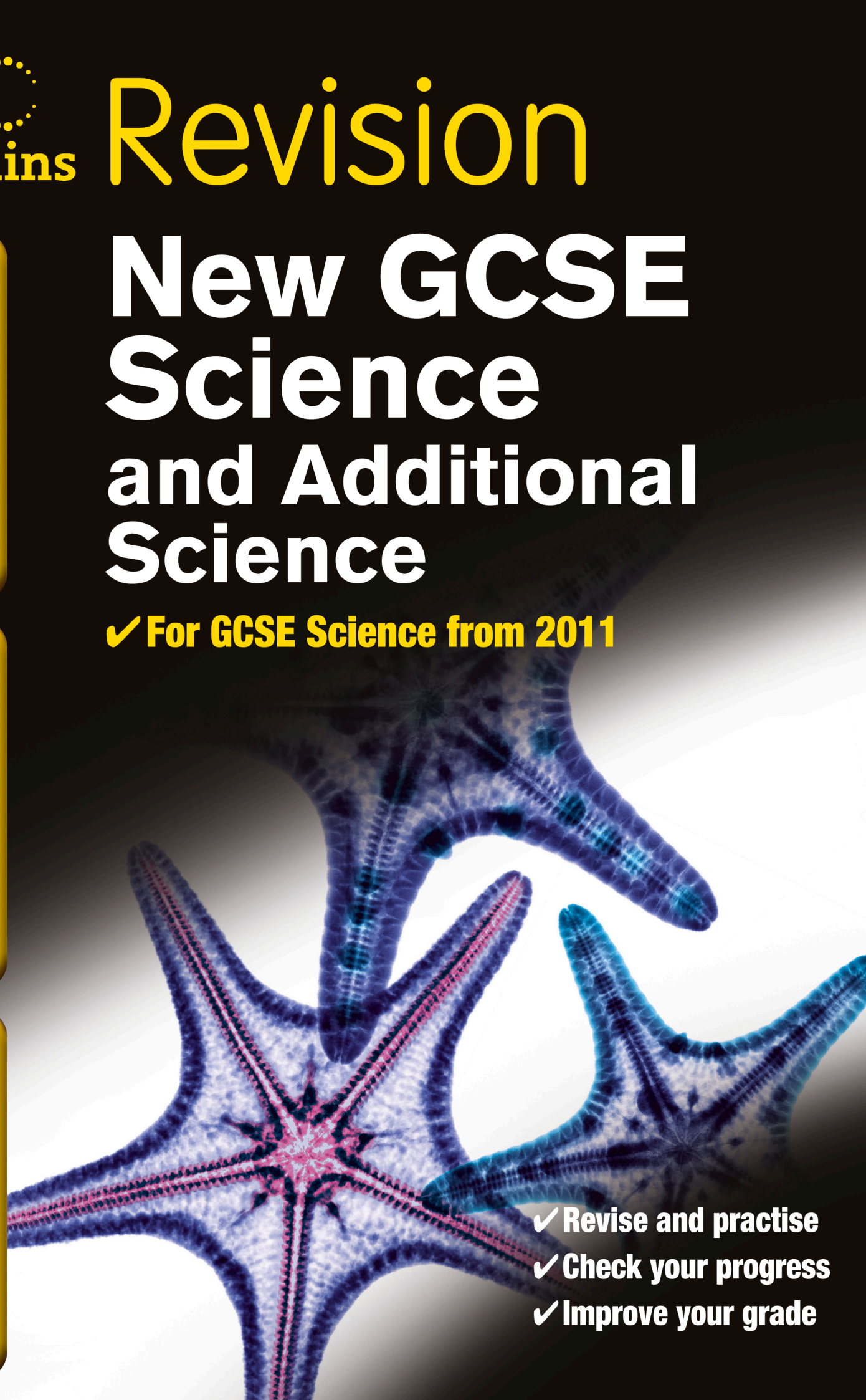
# New GCSE Science and Additional Science

✔For GCSE Science from 2011

GCSE SCIENCE
OCR Twenty First Century A

Foundation + Higher

Revision Guide + Exam Practice Workbook



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Collins

# Revision

NEW GCSE SCIENCE

# Science A and Additional Science A

## OCR

## Twenty First Century Science

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Revision Guide +
Exam Practice Workbook

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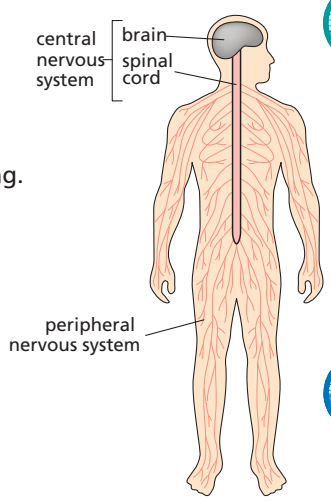
# Contents

# The nervous system

## Sending messages

- **Multicellular** organisms need communication systems, so that the body works as a whole and not as individual cells or organs.
- The two communication systems are the **nervous system** and the hormonal system.
- The nervous system:
  - sends messages using nerve cells or **neurons**, which produce a quick, short response; the nerve message, or nerve **impulse**, is *electrical*
  - has specialised organs called the brain and spinal cord.
- The hormonal system produces chemical messages in the form of **hormones**. The system is slower than the nervous system, but the response is longer-lasting.



The central and peripheral nervous systems.

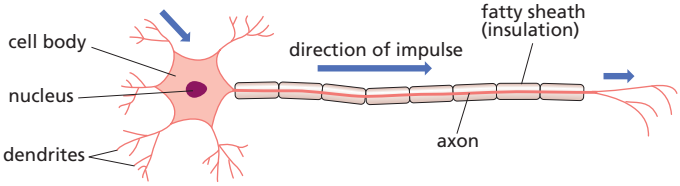
- In humans and other vertebrates, the **central nervous system (CNS)** consists of the brain and spinal cord.
- In the mammalian nervous system, the CNS is connected to the **peripheral nervous system (PNS)**. This is the neurons, which connect the CNS to the whole body.
- There are different types of neurons:
  - **Sensory neurons** connect **receptors**, e.g. in the eyes, ears and skin, which detect changes in the environment (called **stimuli**), with the central nervous system.
  - **Motor neurons** connect the central nervous system to **effectors**, e.g. muscles, which produce a **response**.

- Hormones are chemicals that are produced by **glands**. They are transported in the blood. This means that all organs of the body are exposed to them, but they affect only their 'target' cells.
- In the hormonal system, responses are slower and longer-lasting. For example:
  - **Insulin** is produced by the **pancreas**. It acts on the liver, muscles and body cells to take up **glucose** from the blood.
  - **Oestrogen** is produced by the **ovaries**. It is a sex hormone that controls the development of the adult female body at puberty, and the menstrual cycle.

**Remember!**
The nervous system uses electrical messages; the hormonal system uses chemical messages.

## Neurons

- Neurons are cells **specialised** for carrying nerve impulses, so they are often very long.
- Neurons consist of the **cell body**, which contains the nucleus of the cell, and a long **axon**. Branches on the cell body called **dendrites** receive inputs from other cells (receptors and **nerves**) and conduct impulses towards the cell body.
- Axons carry impulses away from the cell body (to other nerves and muscles).



A motor neuron.

- The axon is a long extension of the **cytoplasm** in a neuron that communicates with the CNS or effector. Some neurons are therefore the longest cells in the body.
- Some axons are covered with an insulating fatty sheath called the **myelin** sheath.

**Remember!**
Neurons communicate with other neurons, but they do not physically touch each other.

- The speed of the nerve impulse is affected by:
  - temperature (the speed is increased; it's always faster in warm-blooded animals than cold-blooded animals)
  - the diameter of the axon (the wider the axon, the quicker the response)
  - the myelin sheath (as well as insulating the neuron from neighbouring cells, the presence of the myelin sheath speeds up the nerve impulse – it is able to 'jump' from gap to gap along the sheath, making it travel much more quickly).

## Improve your grade

**Neurons**

**Higher:** Explain how nerve cells (neurons) are adapted to transmitting nerve impulses. *AO2* [5 marks]

# Linking nerves together

## Synapses

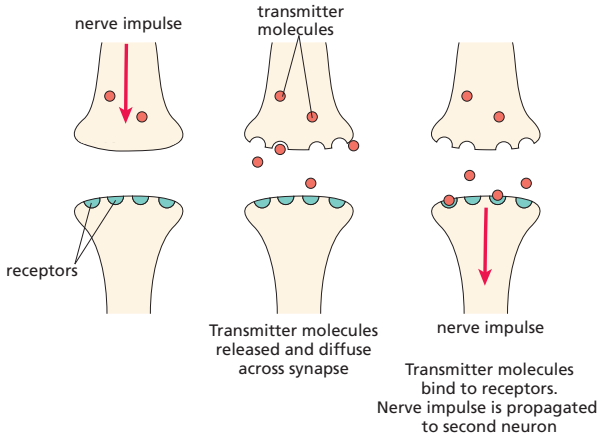
- Some neurons send messages to other neurons. There is a small gap called a **synapse** between one neuron and the next, through which the message has to be transmitted.
- As the nerve impulse reaches the end of the nerve, it is changed to a chemical signal, which crosses the synapse and sets up an electrical impulse in the next neuron.

- Sometimes a neuron has many synapses so that it can communicate information with all these neurons.
- There is no physical connection between neurons. The presence of a synapse means that a nerve is able to communicate better with several neurons that may go to different locations.

- As the nerve impulse reaches the end of the first neuron, a chemical **transmitter substance** is released.
- The transmitter diffuses across the synapse and binds with **receptor molecules** on the membrane on the next neuron. This initiates a nerve impulse in the next neuron.

Higher

- After an impulse has been transmitted across, the chemical transmitter is removed from the synapse (it is taken back up by the neuron or broken down by an enzyme).
- There are many different types of transmitter molecules. These work on different nervous pathways, e.g. serotonin is a transmitter that is important in brain function.
- Some transmitters work by inhibiting the next nerve instead of exciting it. Others work on muscles instead of nerves.
- Different transmitters have different receptor molecules.




The transmission of a nerve impulse across a synapse.

## Nervous co-ordination

- The nervous system responds to changes in the environment called **stimuli** (singular **stimulus**).
- Stimuli are detected by special cells called **receptors**, e.g. light receptors, temperature receptors.
- Sometimes the receptors are grouped together or form part of organs, e.g. the eye and ear.

- A response to a specific stimulus may be required. The CNS co-ordinates the response.
- The response is made by an **effector**. Effectors include **glands** and muscles.
- Glands make and release chemicals such as enzymes and hormones, e.g. the hormone insulin is released after a meal when blood sugar rises.
- Muscles are used for movement. Their contraction helps the body to move away from dangerous stimuli and towards pleasant ones. Muscles are also used for movement we're not conscious of, e.g. our heartbeat.

**EXAM TIP**

You need to be clear about the definitions of receptor cells and effector cells.

## Ideas about science

**You should be able to:**

- identify ethical issues when carrying out investigations on how neurotransmitters work in humans and other mammals
- consider that investigation of these could benefit people with deficiencies in neurotransmitters (acetylcholine in Alzheimer's disease; dopamine in Parkinson's disease), so that research might be justified whatever the consequences.

## Improve your grade

**Synapses**

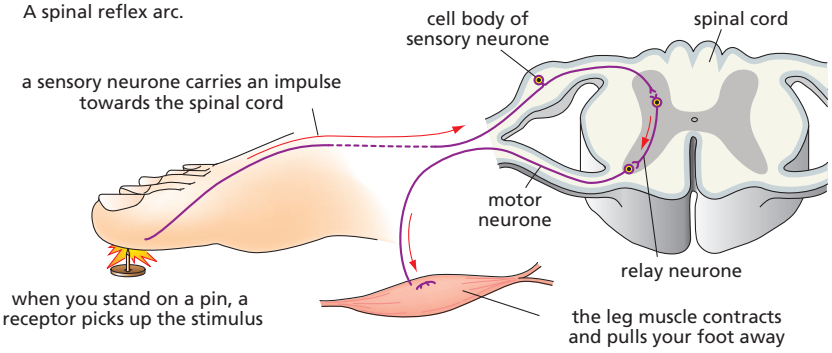
**Higher:** Describe how a nerve impulse is transmitted from a sensory nerve to a nerve close to it in a spinal cord. *AO1*, *AO2* [5 marks]

# Reflexes and behaviour

## Reflexes

- A **reflex** is a simple response to a stimulus, e.g. removing your foot automatically if you step on a sharp object or a hot one.
- The pathway of a reflex action through the nervous system is called the **reflex arc**.

A spinal reflex arc.




- The pathway is:

stimulus → receptor → sensory neuron → relay neuron in CNS → motor neuron → effector (muscle)

- Simple reflexes are automatic; they require no learning and happen from birth.
- Reflexes enable us to respond quickly to stimuli that could harm us. Simple reflexes in humans include:
  - dropping a hot object, the knee-jerk reflex, the pupil reflex (when a bright light is shone into your eye, the pupil gets smaller)
  - when a baby is born, newborn reflexes, e.g. stepping (taking steps when a baby is held under the arms, with head supported), grasping (when a finger is placed into the baby's palm), sucking (when a nipple or finger is placed in a baby's mouth).

- Responses are rapid because they use fixed pathways that do not involve the brain making a *conscious* decision (**relay neurons** are in the CNS, but the brain is not involved at all if the stimulus is below the neck).
- Relay neurons in the CNS connect with other neurons that run to the brain, so we:
  **1** know what's happened after the reflex action has occurred
  **2** can override an action, e.g. keeping hold of a hot object when you'd rather not drop it (the brain then sends a message to motor neurons, which changes the response of the muscles in your hand, so you keep hold of the object).

Higher

## Instinctive and learned behaviour

- Animals have certain **behaviours** that help them to survive in their environment. Behaviour can be **instinctive** or **learned**.
- Instinctive behaviours are controlled by reflex responses, e.g. woodlice moving away from the light. Simple animals have simple nervous systems, so they can't *learn* behaviours.

- A reflex response to a stimulus can be learned by introducing an *unrelated* stimulus in association with the first. This is called **conditioning**.
- Two examples of conditioning are:
  - *Ivan Pavlov's work with dogs*. Dogs produce saliva (salivate) in response to the smell, sight and taste of food. Pavlov rang a bell immediately before giving dogs food. This process was repeated. Soon, the dogs would produce saliva at the sound of the bell, even if not given food. They had learned to associate the sound of the bell with food.
  - *John B. Watson's study with eight-month-old Albert*. Albert liked, and showed no fear of a white lab rat. Albert was then shown the rat while Watson made a loud noise which made Albert cry. Later, when Albert was shown the rat, he showed signs of distress even when there was no loud noise.

- With Pavlov's dogs, the bell is called the **secondary stimulus**; the **primary stimulus** is the food. Here, the secondary stimulus has no direct connection with the primary stimulus.
- **Conditioned reflexes** are a simple form of learning that help us, and other animals, to survive. For example, association of a plant's bright colours with the fact that the plant is poisonous helps an animal that's likely to eat the plant to avoid it and survive (if it survives its first encounter).

**EXAM TIP**

You need to be able to describe and explain two examples of conditioning, including Pavlov's dogs.

Higher

## Improve your grade

**Instinctive and learned behaviour**

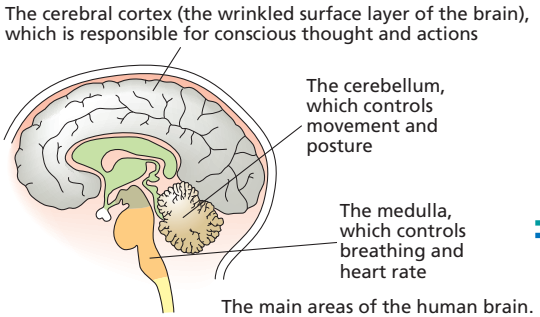
**Higher:** A bird eats a poisonous, brightly coloured caterpillar. It is sick, but survives. In future, it avoids eating this type of caterpillar. Explain how this is an example of a conditioned reflex and how it might help the bird's survival. *AO2* [5 marks]

# The brain and learning

## Brain structure

- Humans and other mammals have complex brains made up of billions of neurons. This larger brain gave early humans a better chance of survival; it enables learning by experience, including social behaviour, where we are able to interact with others.
- The **cerebral cortex** – the thin, folded, outer layer of the brain – is involved with:
  - *Intelligence* – how we think and solve problems.
  - *Memory* – how we remember experiences.
  - *Language* – how we communicate verbally.
  - *Consciousness* – being aware of ourselves and our surroundings.

  A larger number of folds in the cerebral cortex increases our ability to process information.



The main areas of the human brain.

- **Neuroscientists** map the regions of the brain using invasive and non-invasive methods.
- Invasive methods include:
  - studying how a person is affected when a certain part of the brain is damaged
  - during brain surgery, using electrodes to stimulate parts of the brain electrically, and seeing how patients are affected, including reporting memories and sensations.
- Non-invasive methods include producing images and mapping activity with scanning techniques, e.g. magnetic resonance imaging (MRI). These are useful in:
  - comparing non-diseased brains with the brains of people with brain disease, e.g. Alzheimer's disease
  - looking at activity in the brain when it's stimulated (by music, language or images).

## Learning

- Transmitting impulses in the brain leads to links forming between the neurons. This is called a **neuron pathway**.
- If an experience is repeated, more and more impulses follow the same pathway. The pathway is strengthened.
- Neuron pathways are also strengthened by strong stimuli using colour, light, smell and sound.
- Learning happens in the brain as neuron pathways develop in the brain.

- Repeating actions strengthens neuron pathways; we get better at certain skills the more we practise.
- Learning results from experience where:
  - new neuron pathways form (and other pathways may be lost)
  - certain pathways in the brain become more likely to transmit impulses than others.
- Neuron pathways are formed more easily in children than adults.

Higher

- With billions of neurons in our brains, the potential number of neuron pathways is huge. This means we can adapt to new situations and respond to new stimuli.
- Children are born with certain instinctive responses to stimuli, e.g. the rooting reflex, where they turn their face towards a stimulus to aid breast feeding, but soon develop learned behaviours.
- Children not presented with new, appropriate stimuli, or those isolated during development, may not progress in their learning.
- Evidence suggests that children can only acquire certain skills at a particular age. **Feral** children (children who have lived away from human contact since a very early age) develop only limited language skills when returned to civilisation.

**Remember!**
It's the interaction between humans and their environment that enables neuron pathways to develop.

## Ideas about science

**You should be able to:**

- identify that some forms of scientific research into the development of learning in humans and other mammals have ethical implications
- consider arguments and actions in ethical issues concerning techniques used to map the human brain.

## Improve your grade

**Brain structure**

**Foundation:** Describe how scientists have mapped the areas of the brain to see how it works. *AO1* [3 marks]

# Memory and drugs

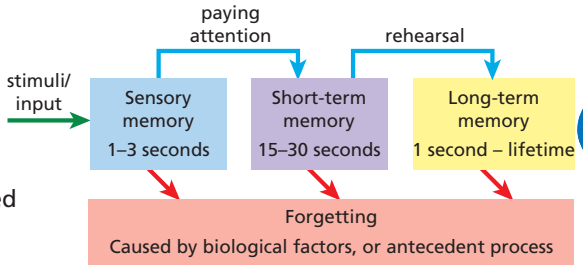
## Memory

- **Memory** is the storage and then retrieval (bringing back) of information.
- There are two types of memory:
  - **Short-term memory** involves information from our most recent experiences, which is only stored for a brief period of time.
  - **Long-term memory** involves information from our earliest experiences onwards that can be stored for a long period of time
- You are more likely to remember information if:
  - There is a *pattern* to it. To remember information with no obvious link, you could try to put a pattern to it.
  - You use *repetition* (repeating things), especially over an extended period of time. You could read or rehearse something several times. Evidence suggests that the time intervals between the repeats is important.
  - There is a strong stimulus associated with it. Strong colours, bright light, strong smells or loud sounds associated with information can help us to remember it.

**EXAM TIP**

You need to understand the terms storage, retrieval, repetition and forgetting when referring to memory models.

- Scientists use models to try to explain how we store and retrieve information.
- The **multi-store model** splits memory into sensory memory, short-term memory and long-term memory, and shows how these work together.
- If information arrives in a memory **store** that is not passed on or retrieved, the information is lost, i.e. forgotten.




The multi-store memory model.

- Models are limited in explaining how memory works. This is because:
  - Memory is more complicated than shown in the model.
  - No models have an exact explanation of how long-term memory works.
  - The multi-store model is too linear, and doesn't provide sub-divisions of short-term and long-term memory.
  - The model does not differentiate between different types of stimulus and the difference in performance of individuals.

## Drugs and the nervous system

- Many drugs and **toxins** work by affecting the transmission of nerve impulses across synapses, stopping the transmission, changing the speed of the transmission, or making the impulse stronger or weaker. For example:
  - The **antidepressant** Prozac increases levels of the **transmitter substance** called **serotonin**.
  - Curare, used by South American Indians as an arrow poison, blocks the action of another type of transmitter molecule.
- **Beta blockers** are prescription drugs that block the transmitter molecule **adrenaline**, so they reduce the heart rate. They're used to treat people with problems with their heart rhythm, but some people use them to control anxiety during public performances.
- The drug **Ecstasy (MDMA)** works on serotonin, the same transmitter that Prozac affects.

Higher

- Following the transmission of a nerve impulse, the transmitter molecules should be removed from the synapse.
- MDMA blocks the sites on the neuron where MDMA is reabsorbed, increasing its concentration.
- MDMA therefore gives a feeling of well-being, because of increased levels of serotonin.
- After taking MDMA, the brain's serotonin is depleted, so the person is irritable and tired.

## Improve your grade

### Drugs

**Foundation:** Some chemicals affect how nerve impulses are transmitted across synapses. Give **two** examples of these chemicals, and state how these chemicals work. *AO1*, *AO2* [3 marks]

# B6 Summary

## Responding to change

A receptor is used to detect a stimulus; the response is produced by an effector.

Receptors and effectors can form part of complex organs.

The nervous system produces a quick, short-lived response to a stimulus.

The hormonal system produces a slower, longer-lasting response.

## The nervous system

The nervous system is the central nervous system (brain and spinal cord) and the peripheral nervous system (the nerves).

The CNS co-ordinates an animal's response to a stimulus.

Sensory neurons carry impulses from receptor cells to the CNS.

Motor neurons carry impulses from the CNS to effectors.

Sensory and motor neurons are linked by relay neurons.

The outer, folded layer of the brain is the cerebral cortex. It is concerned with intelligence, memory, language and consciousness.

Scientists map the brain using several techniques.

The nervous system is made up of nerve cells or neurons; these transmit electrical impulses.

A neuron has a cell membrane and cytoplasm, which is extended into an axon. The myelin sheath (which surrounds some axons) insulates the nerve and speeds up the nerve impulse.

## Reflex actions

A reflex arc is a fixed nervous pathway that enables quick, 'automatic' responses independent of the brain.

Simple reflexes include dropping a hot object and newborn reflexes, e.g. sucking.

A spinal reflex arc includes a receptor → sensory neuron → relay neuron → motor neuron → effector.

## Synapses

Neurons do not connect physically; impulses are transmitted across gaps called synapses.

Some toxins and drugs affect the transmission of nerve impulses across synapses.

There are many different transmitters, each corresponding to a specific receptor.

An impulse arriving at the end of a nerve causes the release of a chemical transmitter.

The transmitter diffuses across the synapse, binds to receptor molecules, and sets up an impulse in the next neuron.

## Learning and behaviour

Simple organisms rely on reflexes for most of their behaviour; these aid survival.

More complex organisms show learned behaviours.

Conditioning is a reflex response to a new (secondary) stimulus, learned by introducing it together with a main (primary) stimulus.

The human brain has billions of neurons that allow learning by experience.

When interacting with the environment, new neuron pathways form in the brain.

New skills can be learnt by repetition (this strengthens neuron pathways).

The number of pathways possible enables mammals to adapt to new situations.

Evidence suggests that children may only acquire some skills at a certain age.

## Memory

Memory is the storage and retrieval of information.

You are more likely to remember something if you can see, or put, a pattern to it, repeat the information over a period of time, or associate a strong stimulus with it.

Memory can be short-term memory or long-term memory.

The multi-store model shows how short- and long-term memory are linked, but models of memory are limited for a number of reasons.

## Page 71 Neurons

**Higher:** Explain how nerve cells (neurons) are adapted to transmitting nerve impulses. *AO2* [5 marks]

*Nerves are the longest cells in the body as they have to reach all parts of the body. They have a long extension to the cell called the axon. The axon is insulated by a fatty covering called the myelin sheath.*

**Answer grade: D/C.** Both of these statements are correct, but the student has missed some important points.

For full marks, begin by saying that the nerve impulse is an electrical impulse (which explains why it's important to be insulated). To extend the answer to an A grade, say that the presence of the myelin sheath not only insulates the neuron, but also enables much greater transmission speeds, as the nerve impulse jumps from one gap in the sheath to the next.

For a C grade it's important to mention that the neuron has extensions called dendrites, which enable it to communicate with other neurons. A more subtle point, at A/A* grade, is that the end of the axon contains chemical transmitter molecules that enable it to communicate with other nerve cells and other effectors.

## Page 72 Synapses

**Higher:** Describe how a nerve impulse is transmitted from a sensory nerve to a nerve close to it in a spinal cord. *AO1*, *AO2* [5 marks]

*As the nerve impulse reaches the end of the nerve, a chemical transmitter is released. This passes across the synapse, and sets up a nerve impulse in the nerve on the spinal cord.*

**Answer grade: B.** The answer is correct but misses some detail. Also, although the student has said correctly that the nerve passes across a synapse, they have not defined what a synapse is.

For full marks, you need to say that nerves are not connected together physically; instead a chemical transmitter is released from the first nerve and passes across a gap called a synapse. Point out that the type of chemical transmitter used is dependent on the location and type of nerve. Finally, you need to describe how, after the impulse has passed, the remaining chemical transmitter in the synapse is reabsorbed into the first nerve (or alternatively broken down by an enzyme).

## Page 73 Instinctive and learned behaviour

**Higher:** A bird eats a poisonous, brightly coloured caterpillar. It is sick, but survives. In future, it avoids eating this type of caterpillar. Explain how this is an example of a conditioned reflex and how it might help the bird's survival. *AO2* [5 marks]

*After being sick, the bird learned to avoid the poisonous, brightly coloured caterpillars. It had associated the bright colours of the caterpillar with the unpleasant experience. This is called a conditioned reflex.*

**Answer grade: C.** While this answer is correct, the student has not defined the two stimuli involved. For full marks, you need to define the poisonous/distasteful nature of the caterpillar as the primary stimulus, and the bright colours of the caterpillar as the secondary stimulus.

The student has also not explained how the response involved in the conditioned reflex – avoiding brightly coloured caterpillars – has no direct connection with their distastefulness or poisonous nature. You need to explain that, after tasting the caterpillars once or possibly a few times, the bird would come to associate the bright colours with distastefulness.

Finally, you need to mention how this can help the bird's (and the caterpillar's) survival. In being sick, the bird removed the poisonous caterpillar from its gut, but on another occasion may have eaten sufficient or kept it in its gut for long enough to kill it. So in not eating the caterpillar again, poisoning would be avoided.

## Page 74 Brain structure

**Foundation:** Describe how scientists have mapped the areas of the brain to see how it works. *AO1* [3 marks]

*Neuroscientists have studied people with brain injuries and investigated how people react when their brains are stimulated using electrodes.*

**Answer grade: D.** Both of these statements are correct, but the answer lacks detail. For full marks, you should refer to invasive and non-invasive techniques, and describe these. It's also important to say how the effects of brain injury are studied.

The answer also gives no information on non-invasive techniques, e.g. scanning techniques such as MRI scanning. You need to explain that these are used to compare the structure and activity of the brains of healthy people and people with brain disease, and when a person is stimulated by music, language, etc.

## Page 75 Drugs

**Foundation:** Some chemicals affect how nerve impulses are transmitted across synapses. Give **two** examples of these chemicals, and state how these chemicals work. *AO1*, *AO2* [3 marks]

*Prozac increases levels of a chemical transmitter substance that carries the impulse between nerves. Toxins can block certain chemical transmitters.*

**Answer grade: E.** The first sentence is correct, and is complete, as the question only says 'state' and doesn't ask for a description. The second sentence is also correct, but does not give an example, just a type of chemical that affects transmission. For full marks, you need to provide an example of a toxin that blocks a chemical transmitter, e.g. curare, which is a poison used on the tips of arrows by South American Indians, or botulin toxin ('botox').

## Page 77 The history of the Periodic Table

**Foundation:** Explain why Mendeleev's arrangement of elements was an improvement on Döbereiner's triads and Newlands' octaves. *AO1* [4 marks]

*Mendeleev's arrangement was better because it used the properties of elements and put them into groups. All of the element properties fitted, but elements in triads and octaves did not all fit. Triads and octaves only worked for some elements.*

**Answer grade: D/C.** A good feature of this answer is that it talks about Döbereiner and Newlands, as the question asks. However, the student only discusses one aspect of the table – the idea that all of the element properties fit the table. The most important reasons that Mendeleev's table was an improvement are because he left gaps and he predicted the properties of new elements. When they were discovered, the 'missing' elements fitted Mendeleev's predictions.

## Page 78 Finding elements in the Periodic Table

**Higher:** An atom has the electronic arrangement 2.8.1.

Identify the element and explain why its electronic arrangement shows that it is likely to be a metal. *AO2* [3 marks]

*The element is sodium. It is a metal because sodium is a metal.*

**Answer grade: C.** The answer scores only 1 mark, for identifying the metal. You can do this by working out that the total number of electrons in the atom is 11, which is the same as the proton number of sodium. However, the answer does not explain what the electron arrangement shows. For the other 2 marks you would need to say that atoms with one electron in the outer shell are likely to be metals, and that they will be in Group 1, which only contains metals.

## Page 79 Reactions of Group 1 elements with chlorine

**Higher:** Write the word and symbol equations for the reaction of sodium with bromine. Compare the rate of reaction of sodium and potassium with bromine. *AO1* [3 marks]

*sodium + bromine → sodium bromide*

*Na + Br → NaBr*

*Potassium reacts faster because it is further down the group.*

**Answer grade: C/B.** The word equation is correct but the formula for bromine is wrong – it should be Br2. If you are aiming at grades A or B you need to be able to write equations for the reactions with bromine and iodine as well as chlorine. They follow the same pattern: just swap 'Br' for 'Cl' or 'I' in the equations. The correct equation is $2Na + Br_2 \rightarrow 2NaBr$. The last point is correct, the reactivity increases down the group, so potassium reacts faster.

## Page 80 Pattens in Group 7

**Higher:** Liz adds chlorine water to potassium bromide solution. The table shows what she sees and her explanation.

| Halogen | Compound | Observations | Explanation |
|---|---|---|---|
| Chlorine | Potassium bromide | Solution turns brown | Bromine is made because chlorine displaces bromine. Chlorine is more reactive than bromine. |

Predict what you will see when chlorine water is added to potassium iodide solution. Explain your reasoning. *AO2* [4 marks]

*You would see the solution go brown because iodine is made and it looks brown.*

**Answer grade: C/B**. This answer gets 2 marks. The observations are correct, and it is correct that iodine is made, but you need to 'model' your answer on the explanation in the table. Look at the number of marks – there are 4 in total. To gain the other 2 marks available you need to mention that chlorine displaces iodine and explain that this is because chlorine is more reactive than iodine.

## Page 81 Explaining properties

**Foundation:** Explain why sodium chloride conducts electricity when it is molten or dissolved in water but not when solid. *AO1* [4 marks]

*Sodium chloride conducts because it is an ionic compound and the ions need to move to be able to conduct electricity.*

**Answer grade: D.** There are 4 marks available and several parts to the question, so you need to give an 'in-depth' answer here.

First, you need to explain why sodium chloride conducts electricity. This answer gains 1 mark by saying that sodium chloride is an ionic compound. However, this is a 'why' question so a higher-level answer is needed. The answer goes on to correctly say that the ions must be able to move, and gets 1 mark for this.

Notice that the question also asks about 'when molten' and 'when dissolved in water' and 'not when solid'. The answer has not mentioned any of these, so is only worth 2 marks. A better answer would go further to say that ions can only move when the compound is molten or when dissolved in water, but that ions cannot move in the solid.

# The nervous system

**1** Humans have two communication systems.

**a** Write down the names of the two communication systems.

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

**b** Write down **two** differences between the systems.

.....

.....

.....

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

G–E

**2** Here are some statements about neurons. Use the words provided to complete the sentences.

**central** **effectors** **eyes** **motor** **muscles** **peripheral**
**receptors** **sensory** **stimuli**

..... neurons connect ....., which detect ....., with the ..... nervous system. ..... neurons connect the ..... nervous system to ....., e.g. ....., which produce a response. **[4 marks]**

D–C

**3** Write down the names of **two** hormones. For each hormone, state:

– where in the body that it is made

– the effects it has on the body.

.....

.....

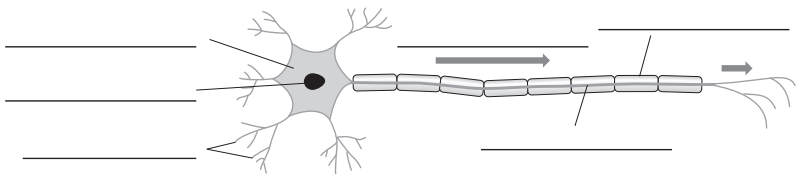
.....

.....

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

B–A*

**4** The diagram below shows the structure of a neuron.



G–E

**a** Label the diagram. **[5 marks]**

**b** On the diagram, draw an arrow showing the direction of the nerve impulse. **[1 mark]**

**5** Write down **three** factors that affect the speed of transmission of a nerve impulse. Describe how each factor affects the speed.

.....

.....

.....

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

B–A*

# Linking nerves together

**1** Here are some statements about the way nerves link with other. Some statements are correct, while some are incorrect.

Tick (✓) the boxes next to the **two** correct statements.

G–E

**a** One nerve can connect physically with many others. ☐

**b** As a nerve impulse reaches the end of the nerve, a chemical signal is released. ☐

**c** The junction between one nerve and another is called a synapse. ☐

**d** Few nerves in the body pass messages to other nerves. ☐ **[2 marks]**

**2** The human body is thought to use around 50 different neurotransmitters.

**a** Give **three** reasons why we need different neurotransmitters.

B–A*

.....

.....

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

**b** How are nerves adapted to work with different neurotransmitters?

.....

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

**3** Here are some statements about nervous co-ordination. Use the words provided to complete the sentences.

| | | | | |
|---|---|---|---|---|
| **axon** | **brain** | **ear** | **effectors** | **eye** |
| **receptors** | **spinal cord** | **stimulus** | **muscle** | **organ** |

G–E

The nervous system responds to a change in the environment called a .....

These are detected by special cells called .....

Sometimes these special cells are grouped together or form part of an .....,

e.g. the ..... and the ..... **[5 marks]**

**4** Here are some statements about nervous co-ordination. Use the words provided to complete the sentences.

| | | | | |
|---|---|---|---|---|
| **central** | **contraction** | **enzymes** | **expansion** | **heartbeat** |
| **hormones** | **limb movement** | **peripheral** | **stimuli** | **transmitters** |

D–C

**a** The part of the nervous system that co-ordinates responses is called the ..... nervous system.

**b** Glands make and release chemicals such as .....

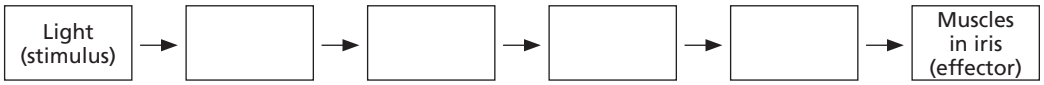
and .....

**c** Muscles are used for movement. Their ..... helps the body to move away from or towards ..... Muscles are also used for movement we're not conscious of, e.g. our ..... **[3 marks]**

# Reflexes and behaviour

**1** If a bright is shone into your eyes, muscles in the iris of your eye contract, reducing the amount of light that enters your eye.

**a** Complete the flow chart below to show this process.




**[4 marks]** G–E

**b** Explain how this reflex is useful.

.....

.....

**[1 mark]**

**2** You pick up a dinner plate that is hot. The dinner plate is very expensive, and you do not drop it.

Explain how you have prevented yourself from dropping the plate.

.....

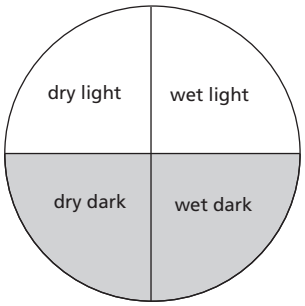
.....

.....

.....

**[3 marks]** B–A*

**3** A scientist carried out an experiment on the behaviour of woodlice. Twenty woodlice were placed in a choice chamber (see diagram), where four different environmental conditions had been produced.




After one hour, the following results were obtained:

| Conditions | Dry | | Wet | |
|---|---|---|---|---|
| | Light | Dark | Light | Dark |
| Number of woodlice | 1 | 5 | 3 | 11 |

**a** What percentage of woodlice are found in the light; dark; wet; dry?

.....

.....

**[4 marks]** G–E

**b** What conclusion can be drawn from the experiment?

.....

**[2 marks]**

**c** What type of behaviour are the woodlice showing?

.....

**[1 mark]**

**d** Suggest why this type of behaviour is essential to simple animals.

.....

**[2 marks]**

**4** The doorbell rings and a person's dog starts to bark loudly. Explain how this is an example of a conditioned reflex.

.....

.....

.....

**[3 marks]** D–C

**5** The hoverfly is a harmless insect that has black and yellow stripes resembling those of a wasp. Explain how a conditioned reflex that develops in predatory birds increases a hoverfly's chances of survival.

.....

.....

.....

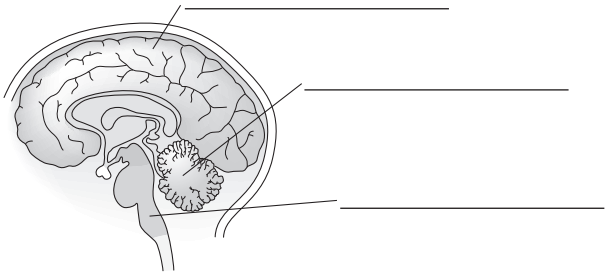
.....

**[3 marks]** B–A*

# The brain and learning

**1** The brain co-ordinates the activities of the body.

**a** Label the diagram of the brain below.



G–E

**b** Write down **four** traits, most developed in humans, that the cerebral cortex is most involved with.

.....

.....

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

**2** When investigating how the brain works, explain the advantages of using techniques such as magnetic resonance imaging (MRI) over invasive techniques.

D–C

.....

.....

.....

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

**3** List **four** traits linked with the highly developed structure of our brains that make us human.

B–A*

.....

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

**4** Here are some statements about how we learn things. Use the words provided to complete the sentences.

| | | | | |
|---|---|---|---|---|
| **axons** | **drugs** | **gaps** | **impulses** | **neuron pathway** |
| **neurons** | **preventing** | **repeating** | **links** | **stimuli** |

G–E

Transmitting impulses between ..... in the brain leads to ..... forming between the neurons. This is called a ..... These are strengthened by ..... the experience, so more and more ..... follow the same route. Another way of strengthening these is using strong ..... **[3 marks]**

**5** Explain why children find it easier to learn new skills than adults.

D–C

.....

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

**6** Describe and explain what happens if a child is not given the appropriate stimuli early in life.

B–A*

.....

.....

.....

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

# Memory and drugs

**1** Jodie is trying to remember a list of things for her science exam next week.

**a** Write down a definition of the term **memory**.

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

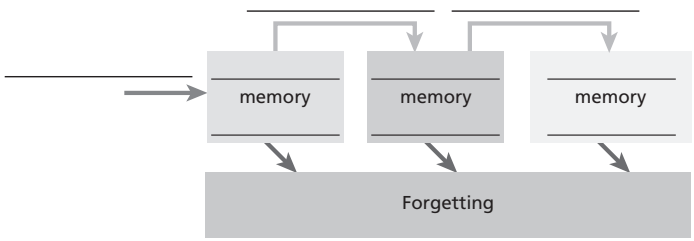
G–E

**b** Which type of memory will Ruby need to use? ..... **[1 mark]**

**c** Write down **two** ways that might help Ruby to remember items in the list.

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

**2** Complete the diagram of the multi-store model of memory opposite.




**[5 marks]**

D–C

**3** Some friends are discussing how they are revising for their science exam. Here are some quotes:

**Amir**: 'When I'm preparing, I condense my science notes into key points.'

**Justine**: 'When I'm revising a list of points, I use the initial letter of each word, and arrange them into a word or list that I can remember easily. It's called a mnemonic.'

**Lucas**: 'When I've finished reading through my science notes, I write down as much as possible of what I've read.'

**Bethany**: 'If I listen to loud rock music while I'm revising, it helps things to sink in.'

B–A*

**a** Which of the friends has used a stimulus to help them to memorise their science?

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

**b** Which of the friends is using both processes involved in memory? Explain your answer.

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

**4** Write down the names of **two** groups of chemicals that interfere with nerve impulses moving between a nerve and another nerve, and a nerve and a muscle.

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

G–E

**5** When a transmitter substance called acetylcholine crosses a synapse between a nerve and a muscle, it causes the muscle to contract.

Bungarotoxin, a venom produced by the banded krait snake, blocks acetylcholine receptors. Explain what happens to the muscles of someone bitten by a banded krait.

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

D–C

**6** One of the effects of the drug MDMA (Ecstasy) is to block the re-uptake of a chemical called serotonin into a neuron at a synapse. Serotonin is a chemical transmitter, which in the brain, is important in regulating mood. Explain the science involved when a nerve impulse is transmitted, and the effect of Ecstasy on this.

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

B–A*

# B6 Extended response question

Use the work of Pavlov to explain how animals can develop and learn a reflex response to a stimulus by introducing a new, unrelated stimulus.

The quality of written communication will be assessed in your answer to this question.

B–A*

**[6 marks]**

# B6 Grade booster checklist

| | |
|---|---|
| I understand the definition of a stimulus, and that stimuli are detected by receptors. | |
| I know that the nervous and hormonal systems coordinate our responses to stimuli. | |
| I know that the cerebral cortex is connected with traits that make us human. | |
| I know that nerve cells, or neurons, transmit electrical impulses when stimulated. | |
| I am familiar with the structure of a neuron (cell membrane; cytoplasm; nucleus; an extension called an axon). | |
| I know the path followed by a nerve impulse in a reflex arc. | |
| I know that reflex actions enable 'automatic' responses to aid survival, and can give examples. | |
| I understand that nerve impulses are transmitted across gaps between nerves called synapses. | |
| I know that chemical transmitter substances transmit an impulse across a synapse. | |
| I know that behaviours in simple animals are instinctive and depend on reflexes. | |
| I know that as humans interact with their environment, new neuron pathways are formed. | |
| I understand that memory is the storage and retrieval of information, and that there are two forms of memory. | |
| **I am working at grades G/F/E** | |

| | |
|---|---|
| I know that the central nervous system (CNS) is made up of the brain and spinal cord. | |
| I know that the peripheral nervous system (PNS) is made up of the nerves. | |
| I understand that the axon of a nerve is covered with a fatty (myelin) sheath, which has gaps. | |
| I am familiar with how conditioning works and can give two examples of conditioned reflexes. | |
| I am familiar with the techniques used to map the brain. | |
| I know that neuron pathways can be strengthened by repetition. | |
| I understand how models can be used to describe memory, including the multi-store model. | |
| **I am working at grades D/C** | |

| | |
|---|---|
| I know about and can compare the responses of the nervous and hormonal systems. | |
| I know that the myelin sheath insulates the nerve and speeds up the transmission of nerve impulses. | |
| I know that a transmitter binds to a receptor and initiates the nerve impulse in a second nerve. | |
| I understand that some drugs affect the transmission of nerve impulses across a synapse. | |
| I know how Ecstasy affects the concentration of a transmitter called serotonin. | |
| I know how, in certain circumstances, a reflex action can be overridden. | |
| I know that conditioning can develop in response to a new stimulus, introduced with the primary stimulus. | |
| I understand that because of the huge number of potential neuron pathways, humans are able to adapt. | |
| I know about evidence to suggest that children may only acquire skills at a certain age. | |
| I can explain how models can be used to describe memory, and their limitations. | |
| **I am working at grades B/A/A*** | |

# C4 Grade booster checklist

| | |
|---|---|
| I understand that elements are arranged into patterns in the Periodic Table. | |
| I know that an atom consists of a nucleus containing protons and neutrons, with electrons arranged in shells around the outside. | |
| I know that the first electron shell holds 2 electrons and the second shell holds 8 electrons. | |
| I know that a horizontal row across the Periodic Table is called a Period. | |
| I know that a vertical column in the Periodic Table is called a Group. | |
| I know the colours and states of the halogens (Group 7) at room temperature and as gases. | |
| I know that the halogens react with Group 1 metals and iron. | |
| I understand that ionic compounds contain charged particles and conduct electricity when they are molten or dissolved in water. | |
| **I am working at grades G/F/E** | |

| | |
|---|---|
| I know that Döbereiner, Newlands and Mendeleev were three scientists who had different ideas about how to arrange elements into patterns. | |
| I know that each element has a unique flame colour and line spectrum. | |
| I understand that the proton number of an atom gives the number of electrons for the atom. | |
| I know that for the first 20 elements, the third electron shell in an atom holds 8 electrons. | |
| I know that proton numbers, numbers of electrons and properties change across a period. | |
| I know that Group 1 metals have trends in their physical properties. | |
| I can explain how Group 1 metals react with water and chlorine. | |
| I know that the halogens have trends in their physical properties. | |
| I understand that halogens contain diatomic molecules (molecules that contain two atoms). | |
| I know that the halogens get less reactive down the group. | |
| I know that more reactive halogens can displace less reactive halogens from their compounds. | |
| I understand that ionic compounds conduct electricity when their ions are free to move. | |
| **I am working at grades D/C** | |

| | |
|---|---|
| I can use the Periodic Table to work out the number of protons, neutrons and electrons in an atom. | |
| I know that the electron arrangement of the atoms in an element is linked to its position in the Periodic Table. | |
| I know that the electron arrangement in atoms is linked to the reactivity of the element. | |
| I know that Group 1 elements are more reactive when they have more electron shells and Group 7 are less reactive when they have more electron shells. | |
| I understand that positive ions form when atoms lose electrons and negative ions form when they gain electrons, and that the formula of an ionic compound contains positive and negative ions with a balance of charges. | |
| **I am working at grades B/A/A*** | |

**5**

| | Bacteria | Yeast |
|---|---|---|
| **Outer layer of cell** | Cell wall | Cell wall |
| **Genetic material** | As circular DNA in the cytoplasm | In the nucleus (as chromosomes) |
| **Respiration** | Enzymes for respiration associated with cell membrane | In mitochondria (with some in the cytoplasm) |

## Page 203 Providing the conditions for photosynthesis

**1** The movement of molecules from an area of high concentration to an area of low concentration

**2** Carbon dioxide; into; diffusion; oxygen; out of; passive; increase

**3 a** The chip in the distilled water increased in mass, and the chip in the concentrated sucrose solution decreased in mass. The potato cells contain a dilute solution (in their vacuoles), and the water concentration in the cells is lower than in the distilled water; so the water moves in by osmosis. In the concentrated sucrose solution, the water concentration is lower than in the potato cells; so water is lost by osmosis

**b** Cut a number of potato chips and place them in a range of solutions with known concentrations of sucrose. Calculate the percentage change in mass. Repeat the experiment; and calculate the mean change in mass. Plot a graph of percentage change in mass over sucrose concentration. Read off the sucrose concentration where the line crosses the *x*-axis

**4** The concentration of nitrates is higher in the root cells than in the soil, so they cannot be taken up by diffusion. They must be taken up against a concentration gradient; by active transport, which requires energy

**5 a** As the light intensity increases, the rate of photosynthesis increases; as light energy is required to drive the process. At a certain point, the graph levels off, so any further increase in light intensity will result in no further increase in photosynthesis. At this point, some other factor must be limiting, e.g. carbon dioxide

**b i** The graph for the high carbon dioxide concentration has an identical gradient, but reaches a greater height, i.e. photosynthesis reaches faster rate, before levelling off)

**ii** In a higher concentration of carbon dioxide, the graph will continue to a higher point (i.e. a higher rate of photosynthesis); until it levels off. At this point (with light and carbon dioxide being available), some other factor (e.g. temperature); must be preventing any further increase in the rate of photosynthesis

## Page 204 Fieldwork to investigate plant growth

**1** By examining the leaf and answering a sequence of yes or no questions; e.g. does the leaf have needles/is the leaf a typical shape/ are the leaves in groups; Ruby will be able to place the leaf in smaller groups; until she identifies the tree it is from

**2 a i** 5 cm × 5 cm; **ii** 0.5 m × 0.5 m; **iii** 0.5 km × 0.5 km

**b** 6 dandelions per $m^2$ / 5.6 dandelions per $m^2$ (the total number of dandelions over the 10 quadrats is 14, so the mean is 1.4 per quadrat; each quadrat is 0.25 $m^2$, so the distribution is 5.6 per $m^2$) *(1 mark for answer; 1 mark for units)*

**c** When the plants show an obvious change in distribution across a location

**3 a** Light is needed for photosynthesis; and products of photosynthesis are required to synthesise the molecules required for growth; in low light intensities, plants will not be able to photosynthesise; but the tolerance of low light intensities will vary from plant to plant, so some are better able to live in shade than others

**b** This evidence supports/increases confidence in the hypothesis; and a mechanism relating to photosynthesis could account for these; but correlation does not prove cause; other factors could also contribute, e.g. competition among the plants for water and minerals

## Page 205 How do living things obtain energy?

**1** c; e

**2** Glucose, oxygen; carbon dioxide, water, energy

**3 a** 1 mark for reactants; 1 mark for products

$C_6H_{12}O_6 + 6O_2$; ⟶ $6CO_2 + 6H_2O$ + energy

**b** The reaction takes place as a series of stages/the equation is a summary; with energy being released in stages

**4** Human muscle cells during vigorous exercise; plant roots in waterlogged soil; bacteria in deep puncture wounds

**5 a** Ethanol/alcohol; carbon dioxide; lactic acid

**b** Yeast – beer/wine/other alcoholic drink/bread or bacteria – yogurt

**6** Aerobic respiration requires the presence of oxygen; anaerobic respiration takes place in the absence of oxygen, or in very low oxygen concentrations. The products of aerobic respiration are carbon dioxide and water; the products of anaerobic respiration vary/ products include alcohol, carbon dioxide, lactic acid, but not water. The energy released by aerobic reaction is much greater than that released by anaerobic respiration

## Page 206 B4 Extended response question

**5–6 marks**
Explains how the sucrose is an exact fit to the enzyme in terms of the active site, protein structure and sequence of amino acids. Explains enzyme specificity and that maltose will not be an exact fit to the active site, and uses an accurate diagram to illustrate these principles. Explains the importance of pH in enzyme action, and the effects of an inappropriate pH on the structure of the active site. Recognises that the optimum pH for invertase must be around 4.5, but the pH optima for other enzymes involved in brewing must also be around this pH. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. There are few, if any, errors in grammar, punctuation and spelling

**3–4 marks**
Explains enzyme action in terms of the enzyme and lock and key mechanism, but explanation is incomplete, not fully detailed, or related to sucrose. States that enzyme action is specific to one substrate and that enzymes work best at a specific pH, and relates these to enzyme shape, but the answer does not go beyond this. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling

**1–2 marks**
Limited description of enzyme action. States that the enzyme works on sucrose only and at a certain pH, with little or no explanation of this. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science

**0 marks**
Insufficient or irrelevant science. Answer not worthy of credit

# B5 Growth and development

## Page 207 How organisms develop

**1 a** Multicellular; specialised

**b** Tissue; nerve cells; nervous tissue

**c** Tissues; organs; brain

**2** After the eight-cell stage of the embryo, cells become specialised. This is called differentiation. In these specialised cells, only the genes needed to enable the cell to function as that type of cell remain switched on; other genes are switched off

**3** Plant tissue: phloem; xylem. Plant organ: flower; root; stem

**4** a, b

**5** Meristem at tip of shoot/stem: division of meristem cells, followed by enlargement of one of the daughter cells, produces an increase in height/length of stem, or growth of new leaves or flowers. Meristem in side bud: division of meristem cells, followed by enlargement of one of the daughter cells, produces side growth, or growth of new leaves or flowers. Meristem along the length of the stem/shoot and root: division of meristem cells, followed by enlargement of one of the daughter cells, produces an increase in girth/thickness of the stem and root. Meristem in tip of root: division of meristem cells, followed by enlargement of one of the daughter cells, produces an increase in the length of the root *(1 mark for each)*

## Page 208 Plant development

**1** Roots grow at the base of the stem; while the shoot continues to grow. The technique enables people to produce many new plants from a single plant

**2** Description of taking a cutting or tissue culture:
- Taking a cutting – cut a small length of plant stem which includes a meristem; dip the cut end into hormone rooting powder; put the end of the stem into damp compost
- Tissue culture – remove a small piece of tissue, or a few cells from a plant; place on agar; containing nutrients and plant hormones

**3** Cell division; cell enlargement

**4** Light is coming from one direction, so the plant grows towards the light to expose more surface to the light. This helps the plant's survival by enabling it to photosynthesise. Without photosynthesis, the plant would not be able to grow (as it produces glucose, from which the molecules needed for growth are produced)

5 One direction; towards; phototropism; photosynthesis

6 There is no significant difference between the amount of auxin in the plants kept in the dark or light, or total auxin in plants illuminated on one side; so light has no effect on the *production* of auxin. About 71% of the auxin in the plant illuminated from one side is on the dark side; so as the total auxin was unaffected by light, the auxin must have been *redistributed* from the light to dark side

### Page 209 Cell division

1 **a** A type of cell division; that produces two cells that are genetically identical; and have identical numbers of chromosomes as the parent cell

**b** During growth; and when cells divide to repair tissues

2 Percentage of total time spent in mitosis: stomach – 2.2%; small intestine – 3.9%; large intestine – 1.3%

3 **a** The cell increases in size; the number of organelles increases; the DNA in each chromosome is copied

**b** Rat intestine (30/2000 = 0.15 or 1.5%)

**c** The developing fruit fly egg; because the egg is developing, so is undergoing rapid cell divisions

4 a, c

### Page 210 Chromosomes, genes, DNA and proteins

1 Chromosomes; DNA; genetic; amino acids; cytoplasm

2 **a** Phosphate (green circle); bases (white rectangles); sugar (yellow pentagon)

**b** An alpha-helix / like a twisted ladder

3 The genetic code carries the instructions for protein synthesis

4 c, b, e, d

### Page 211 Cell specialisation

1 a, d

2 Damaged / diseased; diseased / damaged; adult; limited

3 Michael's first sentence is correct. So for many people, their use is unethical, and is sufficient to prevent their use. Ahmed's first statement is also correct, but many people think that any individual – even an early embryo – has the right to life. Beatrice's statement is correct in that most embryonic stem cells currently come from embryos surplus to IVF treatments, but it is very controversial. Many consider that embryo use is justifiable under any circumstances, but work with, and use of stem cells, is subject to legislation in many countries. Maia is incorrect. While adult stem cells have the potential to replace some cell types, this is much less than that of embryonic stem cells

4

| Source of stem cells | One advantage | One disadvantage |
|---|---|---|
| Embryo | Can be used to produce any cell type | Removal of stem cells involves destruction of an embryo |
| Adult | Can be removed from the patient | Used to produce a limited number of cell types only |
| Therapeutic cloning | Stem cells are genetically identical to those of the patient, so won't be rejected | The 'embryo' produced is still destroyed as stem cells are extracted |
| Transformed body cells | Potentially, could be used to produce any cell type | None (although the technique is only in its early stages of development) |

### Page 212 B5 Extended response question

**5–6 marks**
States that auxins are plant hormones that regulate plant growth, and explains that auxin promotes cell elongation (and cell division) in a plant, so is involved in the plant's growth response to light (phototropism). States that auxin is produced by the tip of the shoot and produces growth below the tip. Describes how, when a plant is exposed to light from one side, auxin is redistributed away from the light to the shaded side, where it produces growth. The shoot therefore grows towards the light. Describes how this is an advantage to the plant because the plant needs light energy for photosynthesis, in order to produce the materials for growth (and energy). All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. There are few, if any, errors in grammar, punctuation and spelling

**3–4 marks**
Describes that the plant grows towards the light because there is more auxin on the shaded side, but the explanation is incomplete and not fully detailed. States that the plant grows towards the light, and describes how, as light is needed for photosynthesis, this is important for the plant to stay alive, but the answer does not go beyond this. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling

**1–2 marks**
States that the plant grows towards the light, but there is limited or no description of the action of auxin. States that light is essential for the plant to live, with little or no explanation of this. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science

**0 marks**
Insufficient or irrelevant science. Answer not worthy of credit

## B6 Brain and mind

### Page 213 The nervous system

1 **a** Nervous; hormonal

**b** The nervous system uses electrical impulses/messages, the hormonal system uses chemical messages. The nervous system produces a quick, short response, while the hormonal system produces a slower response, but the response is longer-lasting. The nervous system sends messages using nerve cells or neurons, while in the hormonal system, hormones are transported in the blood *(Any 2)*

2 Sensory, receptors, stimuli, central; Motor, central, effectors, muscles

3 Insulin – produced by the pancreas; Oestrogen – produced by the ovaries. It is a sex hormone that controls the development of the adult female body at puberty and the menstrual cycle

4 **a** Dendrite; Myelin (fatty) sheath; Cell body; Nucleus; Axon

**b** Arrow is from left to right

5 Temperature – a higher temperature (but not higher than the body temperature of mammals and birds) speeds up transmission. The diameter of the axon – the wider the axon, the faster the speed. The myelin sheath – the presence of the sheath increases the speed of transmission

### Page 214 Linking nerves together

1 b, c

2 **a** Work in different areas of the body; work between nerves and other nerves, and nerves and muscles; some excite nerves or muscles, different ones inhibit them

**b** The receptors on the second nerve or muscle are a specific shape to receive each type of chemical transmitter

3 Stimulus; receptors; organ; ear/eye; eye/ear

4 **a** Central

**b** Hormones, enzymes

**c** Contraction, stimuli, heartbeat

### Page 215 Reflexes and behaviour

1 **a** Eye/ receptor; Sensory neuron; Relay neuron in CNS/ brain; Motor neuron

**b** It helps to protect the eye from damage if it's suddenly exposed to a bright light

2 Picking up a hot object normally sets up a reflex action where you would drop the plate; when a message reaches the brain that you have picked up the plate, the brain sends a message to motor neurons; which instead of causing you to release the plate, make you hold on to it

3 **a** 20%; 80%; 70%; 30%

**b** Woodlice move towards dark; and wet places

**c** Instinctive

**d** It assists their survival; since they cannot learn from experience

4 As it has happened many times, the dog has learned to associate the ringing of the doorbell with the arrival of a stranger/someone at the door, so will bark, anticipating the arrival of the stranger

5 A predatory bird, at some stage, will have tried to eat a wasp and will have been stung/harmed in the process. The bird will have come to associate the yellow and black pattern of the wasp with danger; so will avoid insects with similar patterns, such as hoverflies

### Page 216 The brain and learning

1 **a** Cerebral cortex; cerebellum; medulla/brain stem

**b** Intelligence; memory; language; consciousness