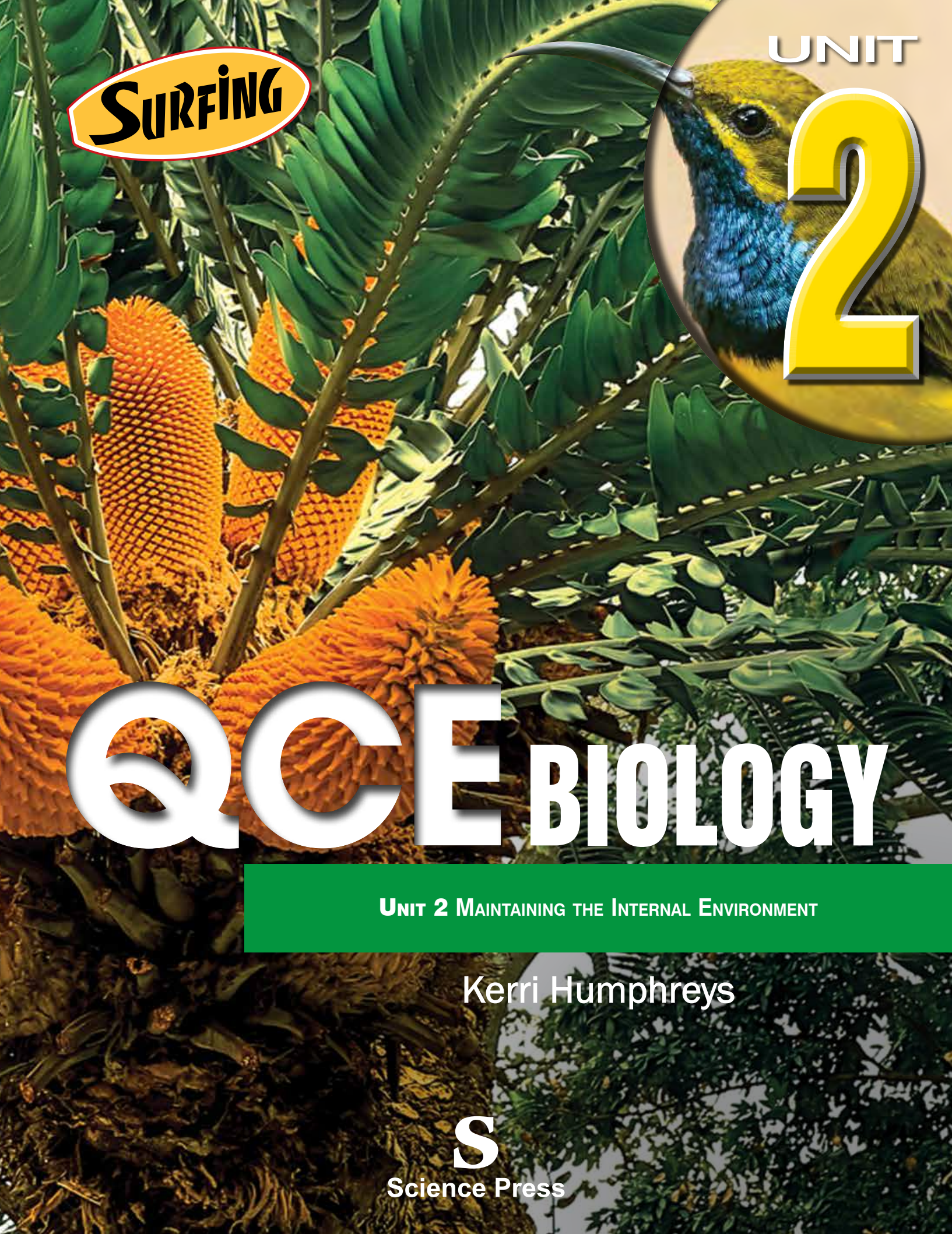
SURFING
UNIT
2
QCE BIOLOGY
UNIT 2 MAINTAINING THE INTERNAL ENVIRONMENT
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Contents

Topic 4 Infectious Disease

Introduction

This book covers the Biology content specified in the Queensland Certificate of Education Biology Syllabus. Sample data has been included for suggested experiments to give you practice to reinforce practical work in class.

Each book in the *Surfing* series contains a summary, with occasional more detailed sections, of all the mandatory parts of the syllabus, along with questions and answers.

All types of questions – multiple choice, short response, structured response and free response – are provided. Questions are written in exam style so that you will become familiar with the concepts of the topic and answering questions in the required way.

Answers to all questions are included.

A topic test at the end of each topic contains an extensive set of summary questions. These cover every aspect of the topic, and are useful for revision and exam practice.

Words To Watch

account, account for State reasons for, report on, give an account of, narrate a series of events or transactions.

analyse Interpret data to reach conclusions.

annotate Add brief notes to a diagram or graph.

apply Put to use in a particular situation.

assess Make a judgement about the value of something.

calculate Find a numerical answer.

clarify Make clear or plain.

classify Arrange into classes, groups or categories.

comment Give a judgement based on a given statement or result of a calculation.

compare Estimate, measure or note how things are similar or different.

construct Represent or develop in graphical form.

contrast Show how things are different or opposite.

create Originate or bring into existence.

deduce Reach a conclusion from given information.

define Give the precise meaning of a word, phrase or physical quantity.

demonstrate Show by example.

derive Manipulate a mathematical relationship(s) to give a new equation or relationship.

describe Give a detailed account.

design Produce a plan, simulation or model.

determine Find the only possible answer.

discuss Talk or write about a topic, taking into account different issues or ideas.

distinguish Give differences between two or more different items.

draw Represent by means of pencil lines.

estimate Find an approximate value for an unknown quantity.

evaluate Assess the implications and limitations.

examine Inquire into.

explain Make something clear or easy to understand.

extract Choose relevant and/or appropriate details.

extrapolate Infer from what is known.

hypothesise Suggest an explanation for a group of facts or phenomena.

identify Recognise and name.

interpret Draw meaning from.

investigate Plan, inquire into and draw conclusions about.

justify Support an argument or conclusion.

label Add labels to a diagram.

list Give a sequence of names or other brief answers.

measure Find a value for a quantity.

outline Give a brief account or summary.

plan Use strategies to develop a series of steps or processes.

predict Give an expected result.

propose Put forward a plan or suggestion for consideration or action.

recall Present remembered ideas, facts or experiences.

relate Tell or report about happenings, events or circumstances.

represent Use words, images or symbols to convey meaning.

select Choose in preference to another or others.

sequence Arrange in order.

show Give the steps in a calculation or derivation.

sketch Make a quick, rough drawing of something.

solve Work out the answer to a problem.

state Give a specific name, value or other brief answer.

suggest Put forward an idea for consideration.

summarise Give a brief statement of the main points.

synthesise Combine various elements to make a whole.

SURFING

QCE BIOLOGY

UNIT 2

UNIT 1

Cells and Multicellular Organisms

In this unit you will:

- Explore the ways biology is used to describe and explain the responses of homeostatic mechanisms to stimuli and the human immune system.
- Understand that personal and communal responses involve lifestyle choices and community health.
- Develop scientific skills and conceptual understanding in homeostasis, the immune system and the relationship between global, community and individual immunity.
- Examine data to analyse strategies that may have personal and communal consequences.
- Investigate historical and current epidemics and pandemics.
- Explore immunisation, quarantine, management strategies and travel preparation for both local and international journeys.

SURFING

QCE BIOLOGY

UNIT 2

TOPIC 3

HOMEOSTASIS

In this topic you will:

- Investigate homeostasis and the stimulus-response model including feedback control mechanisms.
- Determine metabolic activity as catabolic or anabolic and explain why changes in conditions alter enzyme activity.
- Describe neurons and the passage of a nerve impulse in terms of action potential.
- Recognise hormonal control through the endocrine system with cell sensitivity related to the number of receptors.
- Describe how receptor binding activates signal transduction mechanisms.
- Explain thermoregulatory mechanisms of endotherms.
- Explain osmoregulation mechanisms maintaining water balance in plants and animals.
- Conduct an experiment on the distribution of stomates and guard cells.

1 Assumed Knowledge Topic 3

QUESTIONS

1. What is meant by the term ‘metabolism’?
2. Distinguish between anabolic and catabolic reactions.
3. Distinguish between the internal and external environment of an organism.
4. Define receptor and effector.
5. List the five main senses found in animals.
6. Name the five sense organs found in animals.
7. The diagram shows most of the sense receptors found in the skin.

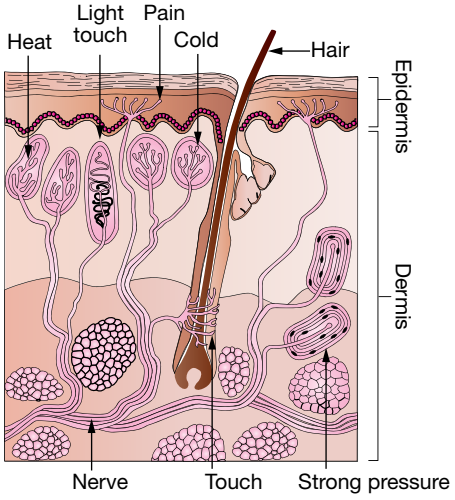

Figure 1.1 Senses in the skin.

Identify the different types of receptors found in the skin.

8. Define homeostasis.
9. Distinguish between an endotherm and an ectotherm.
10. Outline the function of the nervous system.
11. The nervous system is often divided into the central nervous system and the peripheral nervous system. Compare these two systems.
12. What is meant by ambient temperature?
13. In an experiment, what is a control?
14. What is the endocrine system?
15. Briefly describe the lymph system.
16. Define a hormone.
17. Define osmosis.
18. Distinguish between a structural, behavioural and physiological adaptation.
19. What is an enzyme?
20. What is meant by tolerance limits?
21. Define osmoregulation.
22. What is proprioception?
23. Describe the function of stomates.
24. Draw a flow chart diagram to show the stimulus-response pathway.
25. The following diagram shows a cross-section of the human brain.

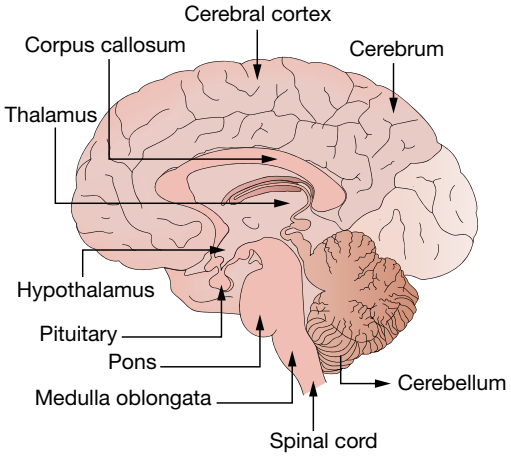

Figure 1.2 Cross-section of human brain.

Outline the function of the spinal cord and cerebrum.

26. The following diagram shows the distribution of body water.

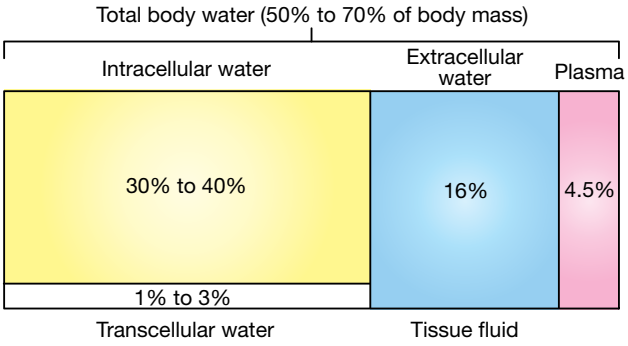

Figure 1.3 Distribution of body water.

Describe why water is an important molecule in organisms.

27. The following diagram shows a cross-section of a typical leaf.

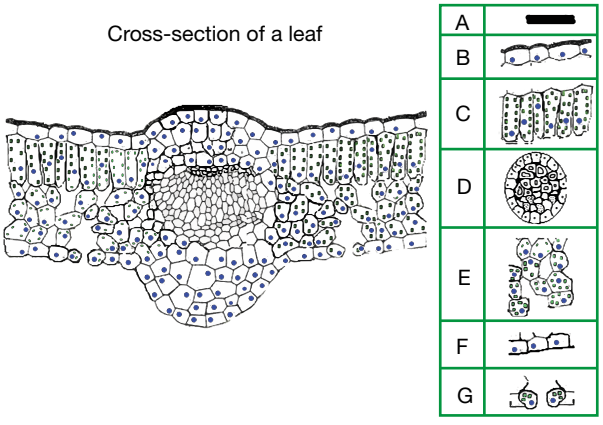

Figure 1.4 Cross-section of a leaf.

Identify the parts of the leaf A, B, C, D, E, F and G.

2 Homeostasis

Homeostasis is the process by which organisms maintain a relatively stable internal environment within narrow limits. To maintain haomeostasis, organisms need to detect stimuli from both their internal environment and from the external environment. Homeostasis is vital for the survival of all cells as all the chemical processes of life can only function within a narrow range of conditions. It maintains optimal metabolic efficiency.

Homeostasis consists of two stages:

- Detecting changes.
- Responding to the change.

Receptors detect the change from the stable state and the **effector** counteracts the change from the stable state with an appropriate response.

The vertebrates, especially the endotherms, have the greatest ability to control their internal environment. **Endotherms** use metabolic heat to regulate body temperature, e.g. birds and mammals. Their body temperature can vary quite markedly from ambient temperature. In humans, homeostasis maintains body temperature at approximately 37°C, maintains pH of interstitial fluid within a tenth of 7.4 and maintains the sugar concentration of the blood at approximately 0.1%. The homeostatic control is carried out by the nervous and endocrine systems.

The nervous system has receptors in the sense organs to detect changes in the external environment. For example, the retina at the back of the eye has rods and cones that can detect light; the cochlea in the ear has hair cells that detect pressure waves in the cochlear fluid; the tongue has taste buds; the nose has olfactory receptors and the skin has a range of mechanoreceptors, thermoreceptors and pain receptors.

A message being carried by the nervous system usually follows the stimulus-response model.

Stimulus → receptor → sensory neuron → interneuron → motor neuron → effector → response

Figure 2.1 Stimulus-response model.

QUESTIONS

1. Define homeostasis.
2. Explain why a constant internal environment is necessary.
3. Identify the two stages of homeostasis.
4. Identify some variables in 'higher' vertebrates that are controlled by homeostasis.
5. Explain why endotherms require the greatest capacity to control their internal environment.
6. Outline the conditions of homeostasis maintained by the human body.
7. Construct a table to show the sense organ, its receptor and the stimuli it detects.
8. Draw a flow diagram to show the steps in the stimulus-response model.
9. The diagram shows a control system.

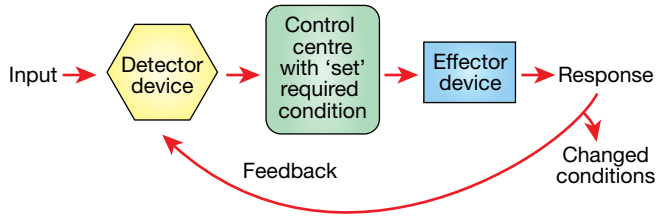

Figure 2.2 Control system.

Outline the functioning of a control system.

10. Define an endotherm.
11. Which of the following best defines homeostasis?
    (A) Inputs such as food and oxygen equal outputs such as faeces and carbon dioxide.
    (B) Metabolic processes are stationary.
    (C) Maintaining constant body temperature.
    (D) Internal environment is kept constant.
12. What are the two stages of homeostasis?
    (A) Detecting and responding to changes.
    (B) Positive and negative feedback.
    (C) Sensory stimuli and nervous impulse.
    (D) Nervous messages and endocrine hormones.
13. Which of the following correctly identifies the stimulus-response pathway?
    (A) Stimulus → control centre → effector → receptor → response
    (B) Stimulus → effector → control centre → receptor → response
    (C) Stimulus → receptor → control centre → effector → response
    (D) Stimulus → effector → receptor → control centre → response
14. Which of the following correctly identifies the stimulus, type of receptor and organ?

	Stimulus	Receptor	Organ
(A)	Light	Photoreceptor	Eye
(B)	Heat, cold	Chemoreceptor	Skin
(C)	Sound	Olfactory receptor	Ear
(D)	Pressure	Thermoreceptor	Nose

15. What is meant by ambient temperature?
    (A) Maximum temperature reached during the day.
    (B) Lowest temperature reached during the day.
    (C) Temperature of surroundings.
    (D) Range of temperatures over one day.

3 The Role Of the Nervous System

The nervous system is involved in coordination and carries out a vital role in detecting and responding to environmental changes.

In embryonic development the **ectoderm** differentiates to form a hollow **neural tube** which becomes the brain and spinal cord and **neural crests** which become the sensory nerve fibres and the autonomic nervous system.

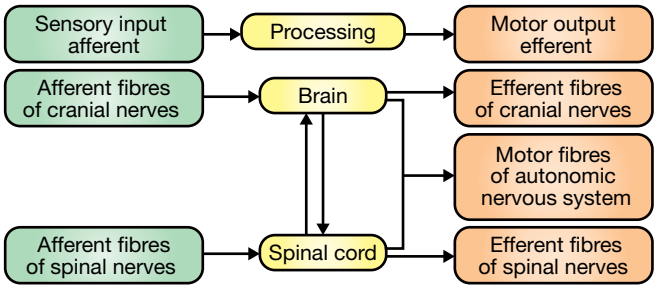

Figure 3.1 Organisation of the nervous system.

Detecting environmental changes

Sense organs contain **receptors** that detect changes in the environment. Sensory nerve endings in the skin respond to touch, pain, pressure, and heat and cold.

Taste buds on the tongue recognise four classes of chemicals – sweet, sour, salty and bitter.

Olfactory receptors are chemical receptors in the nasal cavity that determine the 'flavour' of food and detect smell.

The **retina** in the eye has photoreceptor cells called rods and cones. Cones respond to bright light and determine colour while rods respond to dim light.

The **cochlea** in the inner ear has sensory nerve endings that detect vibrations and messages sent to the brain are interpreted as sound.

Receptor → sensory neuron → connector neuron → motor neuron → effector

Figure 3.2 Path of nervous message.

Responding to environmental change

Some responses of the CNS involve reflex arcs which are **involuntary reactions**. Reflex arcs are important in protecting the body, e.g. blinking if dirt flicks in your eye, coughing if particles touch the lining of the windpipe. You cannot stop this reflex and often are not aware it is happening, e.g. iris dilation in dim light.

The brain determines **voluntary actions** in response to stimuli. The brain sends a message along motor neurons to instruct the effector to carry out a particular action, e.g. put on a jumper because you 'feel' cold.

QUESTIONS

1. What is the main role of the nervous system?
2. Trace the pathway from receptor to effector.
3. From which cells in the embryo does the nervous system develop?
4. The diagram shows a simple spinal reflex arc.

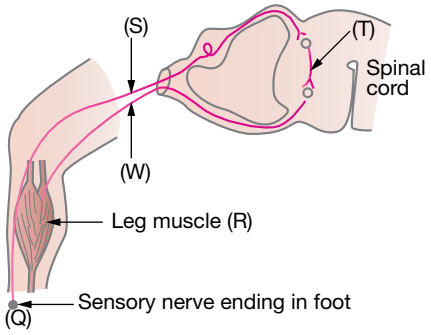

Figure 3.3 Spinal reflex arc.

Identify the type of neuron labelled (T) and explain its function.

5. Use examples to show how the tongue can be both a receptor and an effector.
6. The diagram shows a flow chart for the coordination of body temperature in response to changes in environmental conditions.

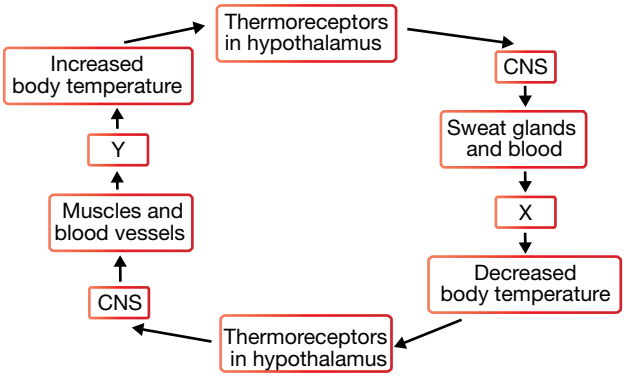

Figure 3.4 Coordination of body temperature.

Suggest suitable responses for part X and part Y.

7. The following steps are involved in the pathway of a nervous message.
   Step I – detection of change in environment.
   Step II – reaction by body to stimulus.
   Step III – electrochemical message sent from receptor.
   Step IV – motor neuron transmits nerve impulse.
   What is the correct order of these steps?
   (A) I, III, IV, II (B) I, II, III, IV
   (C) I, IV, III, II (D) III, I, II, IV

4 The Stimulus-Response Model

The stimulus-response model gives the basic pathway for a nervous impulse where a receptor picks up a stimulus, the message is interpreted and another message is transmitted to an effector which carries out the response.

A **stimulus** is a change in the environment of an organism that is detected.

Stimulus → receptor → nervous system → effector → response

Figure 4.1 Simple stimulus-response model.

The three main parts of the stimulus-response model are:

- **Receptor** – there are many types of receptors in the body that can detect specific stimuli both internal and external. The receptor converts the stimulus into a nerve impulse which is transmitted by a sensory neuron to the central nervous system (CNS).
- **CNS** – connector neurons in the spinal cord and brain take the message to a control centre where the information is processed.
- **Effector** – motor neurons that connect to the CNS transmit a resultant nervous impulse from the CNS to an effector organ which is a muscle or a gland. The effector carries out the response.

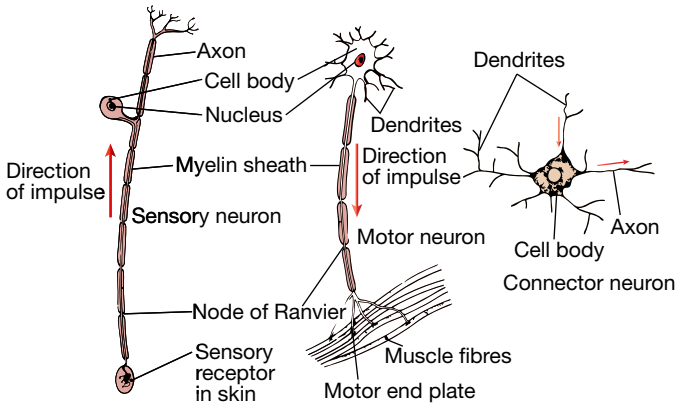

Figure 4.2 Three types of neurons.

Types of neurons

There are three main types of neuron which have specific functions – sensory, motor and connector neurons.

Sensory neurons carry messages from receptors in the sense organs, or in the skin to the brain and spinal cord.

Motor neurons carry messages from the brain and spinal cord to the effectors. A motor neuron to a muscle has many branches in the muscle fibre forming a motor end plate.

Connector neurons are located in the brain and spinal cord. These neurons are also called relay neurons, association neurons or interneurons.

A **nerve** is a bundle of nerve fibres, e.g. axons held together by connective tissue.

A **synapse** is a small gap at the junction between adjacent neurons.

A **neuromuscular junction** is the small gap between the end of an axon and a skeletal muscle cell.

Neurotransmitters are substances that diffuse across a chemical synapse transmitting the message from the synaptic terminal of a neuron to the postsynaptic cell triggering a response, e.g. from the axon to dendrite or from axon to cell body. There are many neurotransmitters, e.g. acetylcholine, adrenaline and dopamine. Acetylcholine is the neurotransmitter at neuromuscular junctions between a neuron and a skeletal muscle.

QUESTIONS

1. What is meant by the stimulus-response model?
2. Define a stimulus.
3. Draw a flow chart to show the steps in the stimulus-response model.
4. Construct a table to summarise the three main parts of the nervous system.
5. Distinguish between a motor neuron and a sensory neuron.
6. What is a nerve?
7. What is the synapse?
8. Outline the function of neurotransmitters.
9. Identify the following cell.

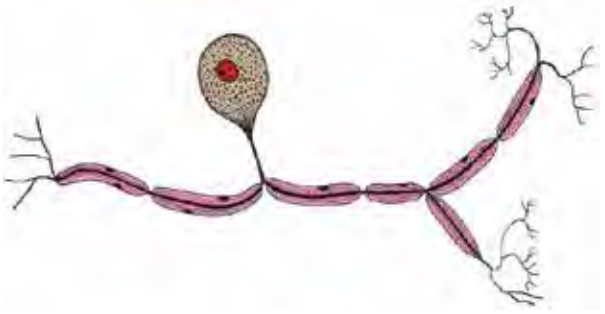

Figure 4.3 Type of cell.

(A) Motor neuron.
(B) Sensory neuron.
(C) Connector neuron.
(D) Muscle cell.

10. Which neurons are never myelinated?
(A) Motor neurons and sensory neurons.
(B) Sensory neurons.
(C) Motor neurons.
(D) Connector neurons.

5 Reflexes

A reflex is a fast response that is involuntary and does not involve the brain in the decision making process. Reflexes help maintain homeostasis. In some reflexes the message from the receptor enters the spinal cord and is passed to motor neurons at the same level in the cord or may travel a few segments up the cord before travelling out through a motor neuron. Once the response has been made a person becomes consciously aware of the situation.

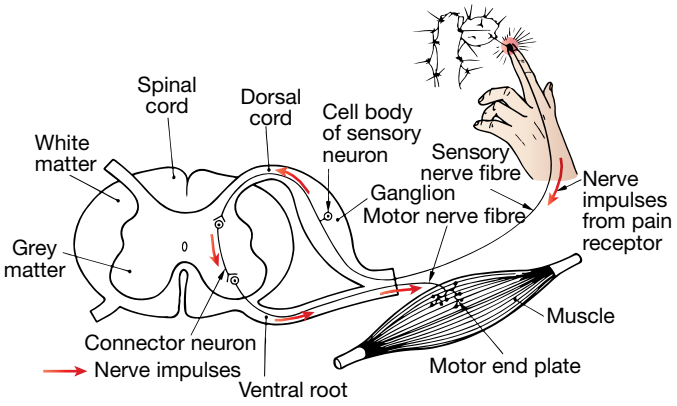

Figure 5.1 Reflex arc.

The brain and spinal cord contain grey matter and white matter. **Grey matter** is mainly the cell bodies of neurons, dendrites and unmyelinated axons. **White matter** consists of axons with myelin sheaths. In the spinal cord the white matter is on the outside to allow linking of the CNS to sensory and motor neurons of the PNS. The grey matter in the spinal cord is roughly in the shape of the letter H. Most of the grey matter in the brain is on the outside surrounding the white matter.

In a **monosynaptic reflex** there are only two neurons – a sensory neuron and a motor neuron, e.g. peripheral muscle reflexes such as the Achilles reflex. In a polysynaptic reflex arc there are one or more connector neurons in the circuit. Most reflexes are **polysynaptic**.

Autonomic nervous system

The autonomic nervous system is a subdivision of the motor nervous system of vertebrates that controls the internal environment. It controls involuntary muscle, e.g. it is the nerves that control cardiac muscle, glands and the smooth muscle that is found in the walls of blood vessels and in the digestive, respiratory, excretory and reproductive tracts. The autonomic nervous system is subdivided into the sympathetic nervous system and the parasympathetic nervous system. The **parasympathetic nervous system** generally produces responses that maintain the body during quiet conditions while the **sympathetic nervous system** usually produces response that prepare the body for activity, e.g. fight or flight responses.

QUESTIONS

1. What is a reflex?
2. When does a person know a reflex has happened?
3. Distinguish between grey matter and white matter.
4. Identify the location of grey matter and white matter:
   (a) In the brain.
   (b) In the spinal cord.
5. Distinguish between a monosynaptic reflex arc and a polysynaptic reflex arc.
6. The diagram shows a reflex arc.

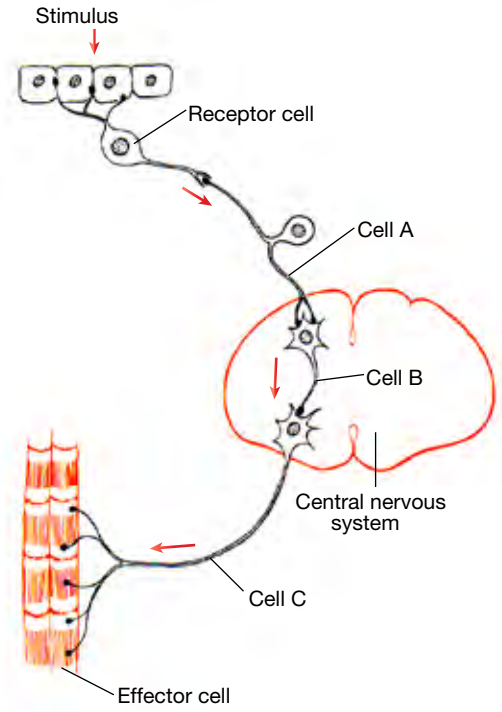

Figure 5.2 Reflex arc.

   Identify the cells labelled A, B and C and explain your reasoning.
7. What is the autonomic nervous system?
8. The change in the size of the pupil of the eye is controlled by the autonomic nervous system. Explain why the size of the pupil needs to be a reflex caused by involuntary muscles.
9. Which of the following would *not* be part of the autonomic nervous system?
   (A) Muscle layer in wall of arteries.
   (B) Cardiac muscle.
   (C) Skeletal muscle.
   (D) Muscle layer in wall of intestines.
10. A flexor reflex is a spinal reflex that moves a limb away from a stimulus detected by a skin receptor. Which of the following would cause a flexor reflex?
    (A) Your hand touches a hot object.
    (B) You smell some pepper.
    (C) You see a ball coming towards you.
    (D) You hear a loud noise behind you.

6 Receptors

One of the characteristics of living things is that they can respond to stimuli. A **stimulus** may come from the external environment (e.g. light intensity, sound) or may come from the internal environment (e.g. hormone levels, arrival of food). **Receptors** detect stimuli.

There are many types of receptors and each type of receptor is highly sensitive to one type of stimulus. Central receptors are found in the **sensory organs**, e.g. the **cochlea** has hair cells that detect pressure waves in the ear.

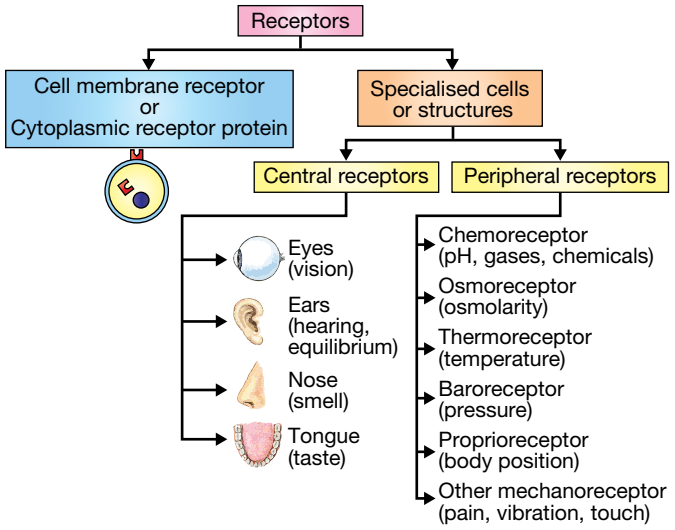

Figure 6.1 Types of receptors.

Proprioceptors are position receptors with one type receiving data about static position and another type receiving data about rate of movement, e.g. in muscles, tendons and joints.

Mechanoreceptors detect mechanical compression or stretching of the receptor or of adjacent tissue, e.g. respond to stretching, movement, touch, pressure, gravity and pain receptors in the skin. The number of mechanoreceptors varies in different parts of the body and varies between types of receptors, e.g. pain receptors are nearly 27 times more abundant than cold receptors.

Chemoreceptors respond to and are activated by the binding to a particular chemical, e.g. detecting taste in the mouth, smell in the nose, oxygen levels in arterial blood, osmolarity of body fluids. There are **olfactory receptors** in the nasal cavity and **gustatory receptors** in the taste buds on the tongue. **Osmoreceptors** are in the anterior hypothalamus and detect changes in plasma sodium concentrations. An increase in sodium causes the osmoreceptor cells to shrink which in turn causes the cells to send nerve signals to the pituitary gland to stimulate the release of antidiuretic hormone (ADH). ADH stimulates the nephrons in the kidney to increase water reabsorption.

Photoreceptors are sensory receptors in the retina of the eye that detect light. There are two types of photoreceptors – rods which are responsible for monochromatic night time vision and work in low light levels and cones which give colour vision during the daytime and high acuity vision.

Thermoreceptors detect heat and cold and changes in temperature.

Internal receptors are found in many locations. For example, **chemoreceptors** in the **medulla** of the brain monitor carbon dioxide levels in the blood. If the carbon dioxide level rises, impulses are sent to the inspiratory centre of the hindbrain, which in turn sends impulses to the diaphragm and intercostal muscles to increase the rate of breathing. Receptors in the hypothalamus detect levels of blood glucose, amino acids and fatty acids.

When a stimulus excites a receptor the membrane potential of the receptor is changed. This is the **receptor potential**. When the receptor potential rises above the threshold an action potential is initiated in the nerve fibre attached to the receptor.

The messenger, usually nerve impulses, takes the message from the receptor to the effector (e.g. muscles and glands in multicellular organisms), which carries out the response. The response to the stimuli helps the organism survive.

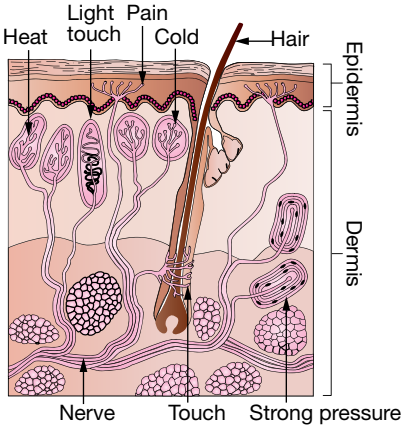

Figure 6.2 Senses in the skin. Most sense receptors in the dermis have capsules around them. Those in the epidermis and those wrapped around the hairs have naked nerve endings.

The receptors for **water soluble hormones** are found on cell membranes while the receptors for **lipid soluble hormones** are found inside the cell.

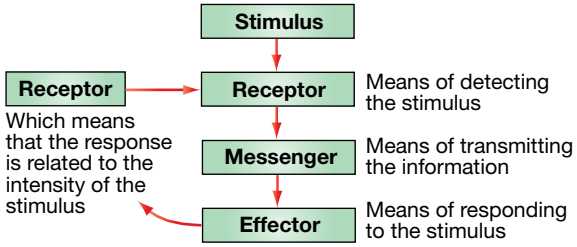

Figure 6.3 Main features of a coordinating system.

QUESTIONS

1. Create a table to show the relationship between the stimulus, the receptor and the sense organ.
2. Distinguish between proprioceptors, mechanoreceptors, chemoreceptors, photoreceptors, thermoreceptors and electroreceptors.
3. Identify the steps in the stimulus-response pathway.
4. Choose one type of sensory receptor found in the skin and briefly describe how it operates.
5. The flow chart shows the control of breathing in humans.

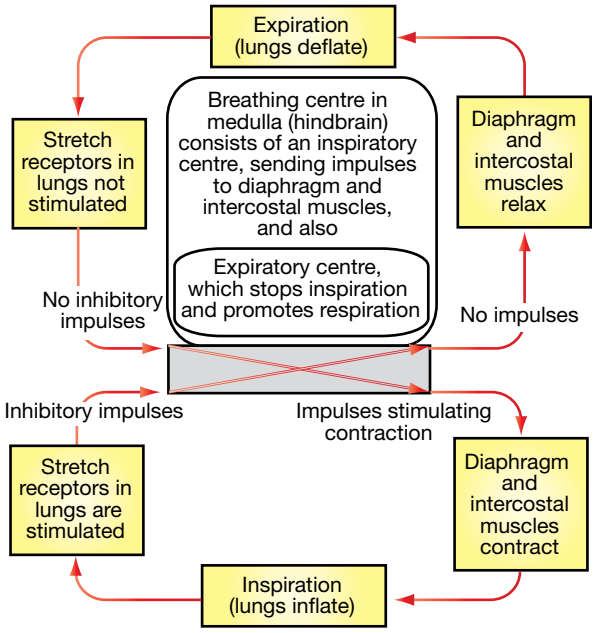

Figure 6.4 Flow chart of breathing in humans.

   (a) Identify the receptors involved with the control of the rate of breathing.
   (b) Explain a response in this example to show the stimulus, receptor, messenger, effector and response.
   (c) Explain how a feedback mechanism could turn off the response you described in part (b).
   (d) Use an example to show how the rate of breathing can be influenced by conscious thought.

6. Osmoreceptors in the hypothalamus detect changes in the concentration of solutes in body fluids. For example, the osmoreceptors detect an increase in the salt levels if a person has drunk little water or has been sweating heavily or has eaten large amounts of salty food. The osmoreceptors generate an impulse to the posterior pituitary gland to trigger the release of antidiuretic hormone (ADH) into the bloodstream. The target organ for the hormone is the kidney, where the ADH causes increased permeability of the walls of the collecting ducts so that more water is reabsorbed and the urine becomes more concentrated. Draw a flow chart to show the sequence of events in this stimulus-response example.
7. The diagram shows some different types of receptors.

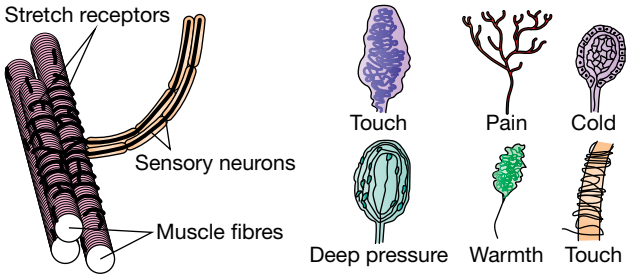

Figure 6.5 Different types of receptors.

   (a) Outline the function of the stretch receptors.
   (b) From the diagram name some of the different types of receptors found in the skin and comment on their abundance and distribution.

8. Identify the range of senses used in communication.
9. Suggest why it is important for people to be able to detect changes in their environment.
10. Give an example of how humans use touch as a form of communication.
11. The diagram shows the stimulus-response model in a human.

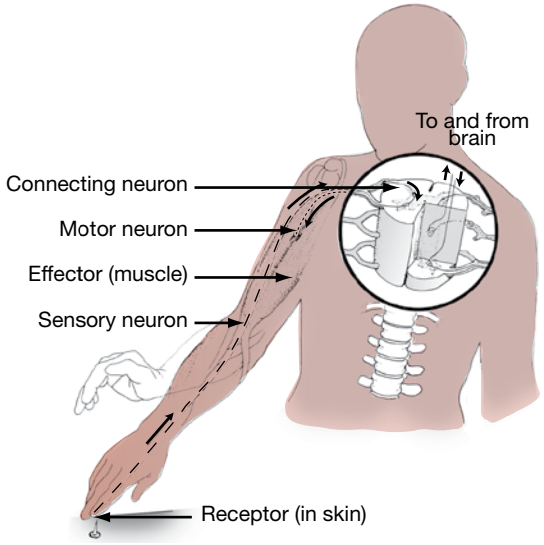

Figure 6.6 Stimulus-response model.

   (a) In this diagram, what is the stimulus?
   (b) What is the response?
   (c) Identify the type of receptor cell.
   (d) Draw a flow chart to show the pathway from receptor to response.
   (e) The knee jerk stimulus-response is an example of a reflex arc. Compare this example with the stimulus of a ball coming towards you and you deciding to dodge away, rather than catching it.

12. What is the function of proprioceptors?
   (A) Senses light.
   (B) Senses sound.
   (C) Senses temperature.
   (D) Senses movement, position of the body.

Answers

Topic 3 Homeostasis

1 Assumed Knowledge Topic 3

1. Metabolism is the sum of all the chemical reactions occurring within a cell or other parts of an organism.
2. Catabolic reactions involve the breakdown of complex molecules into smaller units which usually releases energy while anabolic reactions involve the building of complex macromolecules from simpler molecules.
3. The environment is everything, both living and non-living, around an organism. The external environment refers to anything outside the body; the internal environment refers to anything inside the body.
4. A receptor is a cell or organ that can detect variations of some kind in an organism's environment. An effector is a structure that causes a response to counteract changes from the stable state.
5. Five senses are hearing, sight, touch, taste and smell.
6. Five sense organs are eyes, ears, tongue, nose and skin.
7. Skin has heat and cold receptors, light touch, pain and strong pressure receptors.
8. Homeostasis is a process by which organisms maintain a relatively stable internal environment within narrow limits.
9. Endotherms maintain a constant internal environment because of internal processes while ectotherms use the energy from their environment to regulate their body temperature.
10. The nervous system coordinates sensory information with the body's responses.
11. Both the CNS and PNS are composed of neurons and together make up the nervous system. The CNS consists of the brain and spinal cord and is mainly composed of interneurons, while the PNS consists of the nerves branching from the CNS and passing to all other body parts.
12. Ambient temperature is the temperature of surroundings.
13. A control is part of an experiment that has the identical situation but often without the variable, and is used for comparison.
14. The endocrine system is a body system composed of different endocrine glands that are ductless glands which secrete hormones directly into the bloodstream or body fluids.
15. The lymph system is a network of nodes, veins and blind-end capillaries which carry lymph from body tissues and drain into blood vessels.
16. A hormone is an organic chemical produced by one part of the body and transported to another part where it affects the metabolism of the target cells.
17. Osmosis is the movement of water across a semipermeable membrane from an area of high water to an area of low water.
18. Behavioural adaptations are those concerned with how an organism behaves – how it moves around or acts. Whereas structural adaptations are concerned with the anatomy of the organism – the size, shape or appearance of its body or part of its body and physiological adaptations are those involved with the internal functioning of the body's metabolism.
19. Enzymes are proteins produced by living cells that control metabolic activity by regulating the rate of chemical reactions.
20. Tolerance limits refers to a set of environmental conditions needed for survival of an organism or cell or for metabolic functioning.
21. Osmoregulation is the way organisms regulate solute concentrations and balance the gain and loss of water.
22. Proprioception is the ability to sense body position, motion and balance stimuli.
23. Stomates are small pores in leaves or stems of plants which allow gas exchange into/out of the leaf, e.g. allow carbon dioxide to enter for photosynthesis.
24. Stimulus → receptor → nervous system → effector → response
25. Cerebrum controls conscious thought, memory, sensory reception and motor activities. The spinal cord is involved in reflex actions involving body structures below the neck and sending sensory impulses to the brain and carrying motor impulses from the brain.
26. Water is an important molecule because of its unique properties as a solvent; many solutes dissolve in water. It also enters such reactions as photosynthesis, respiration and digestion. It can also act as a cooling agent, e.g. water evaporates from the skin and removes heat from the body.
27. A = waxy cuticle
    B = upper epidermis
    C = palisade mesophyll
    D = vein
    E = spongy mesophyll
    F = lower epidermis
    G = stomate

2 Homeostasis

1. Homeostasis is the maintenance of a constant internal environment within narrow limits.
2. Homeostasis is necessary to maintain optimal metabolic efficiency.
3. The two stages of homeostasis are detecting changes from the stable state and counteracting or responding to changes from the stable state.
4. Variables controlled by homeostasis in 'higher' vertebrates include blood composition, e.g. blood sugar level, oxygen and carbon dioxide concentrations, pH and water potential; blood pressure, and in endotherms body temperature.
5. Endotherms use internal processes to keep a constant body temperature and hence they require extremely efficient homeostasis mechanisms to maintain this temperature.
6. In humans, homeostasis maintains body temperature at approximately 37°C, maintains pH of interstitial fluid within a tenth of 7.4 and maintains the sugar concentration of the blood at approximately 0.1%.
7.

Sense organ	Receptor	Stimuli detected
Eye	Rods and cones in retina	Light
Ear	Hair cells in cochlea	Sound
Tongue	Gustatory receptors in taste buds	Chemicals
Nose	Olfactory receptors in nasal cavity	Chemicals
Skin	Mechanoreceptor	Pressure, touch
Skin	Thermoreceptor	Heat, cold
Skin	Pain receptor	pain

8. Stimulus → receptor → sensory neuron → interneuron → motor neuron → effector → response.
9. In a control system there is: 1. A detector device that picks up the input, e.g. detects a change in temperature. 2. A control centre that has a 'set' required condition, e.g. a certain temperature such as body temperature. 3. An effector device functions to counteract the change to return the system to the set condition, e.g. to return the system to body temperature. 4. The return to the set condition is detected by a feedback mechanism and the new change becomes the input.
10. Endotherms use metabolic heat to regulate body temperature, e.g. birds and mammals.
11. D
12. A
13. C
14. A
15. C

3 The Role Of the Nervous System

1. The main role of the nervous system is coordination with the detection and response to environmental stimuli.
2. Receptor → sensory neuron → connector neuron → motor neuron → effector.
3. The nervous system develops from the ectoderm with differentiation to form a hollow neural tube which becomes the brain and spinal cord and neural crests which become the sensory nerve fibres and the autonomic nervous system.