DOT POINT

QCE BIOLOGY UNITS 1 AND 2

• Kerri Humphreys •

Science Press

Science Press ISBN 978-0-85583-8744

Science Press ISBN 978-0-85583-8744

Topic 2.1 Homeostasis – Thermoregulation and Osmoregulation

Science Press ISBN 978-0-85583-8744

Science Press ISBN 978-0-85583-8744

DOT POINT

Unit 1

Cells and Multicellular Organisms

In this unit you will:

- Explore the ways biology is used to describe and explain how the structure and function of cells and their components are related to the need to exchange matter and energy with their immediate environment.
- Understand the structure and function of cells.
- Examine the structure and function of plant and animal systems at cell and tissue levels to analyse how they facilitate the efficient provision or removal of materials.
- Investigate stem cell research, animal ethics, organ and tissue transplantation, bioartificial organs and photosynthesis productivity.
- Develop your inquiry skills and practical skills.
- Conduct real and/or virtual laboratory work and microscopic examination of cells and tissues.
- Construct models to describe and interpret data.

Science Press ISBN 978-0-85583-8744

DOT POINT

TOPIC 1.1

Cells As the Basis Of Life

In this topic you will:

- Compare prokaryotic and eukaryotic cells.
- Identify key organelles.
- Describe stem cells and their properties.
- Describe the hierarchical organisation of cells, tissues, organs, and systems.
- Explain how the specialised strncture of cells relates to their function.
- Describe the fluid mosaic model of the cell membrane.
- Explain how the cell membrane regulates movement of substances into and out of cells.
- Compare active and passive transport.
- Explain how the size of a cell is limited by surface area to volume ratio and the rate of diffusion.
- Interpret data from surface area to volume ratio and rate of diffusion experiments.
- Investigate advances in technology that allowed scientists to reprogram cells to become pluripotent.
- Appreciate the ethical treatment of animals as sentient beings.
- Use a light microscope and electron micrographs to view cells and tissues.
- Explore the safety, ethics and efficacy of stem cell technologies.

Science Press ISBN 978-0-85583-8744

1.1.1.3 The prokaryotes make up two of the three domains of living things. What are these domains and name some examples that are in each domain.

.....

.....

1.1.1.4 What is the Gram stain and how is it used in identifying prokaryotes?

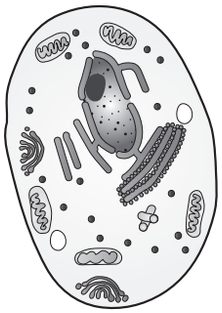
.....

.....

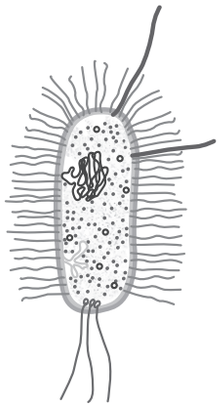
.....

1.1.1.5 Each of the cells are shown as seen under an electron microscope. What type of cell is cell A, cell B and cell C?

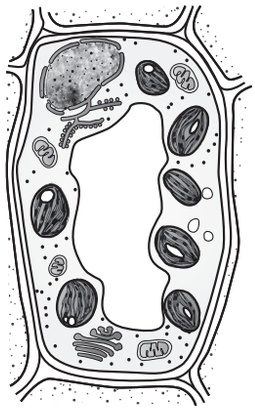
Cell A



Cell B



Cell C



1.1.1.6 Complete the table to summarise differences between prokaryotic and eukaryotic cells.

Feature	Prokaryotic cell	Eukaryotic cell
Membrane bound organelles		
Size		
Chromosome		
Exist as single cell		
Ribosomes		

Science Press ISBN 978-0-85583-8744

1.1.2 Identify key organelles and their functions including the nucleus, mitochondria, rough ER, ribosomes, smooth ER, Golgi apparatus, lysosomes, vacuoles and chloroplasts.

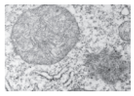
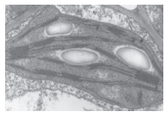
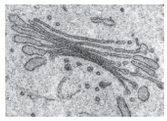
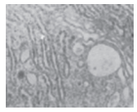
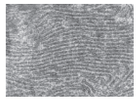
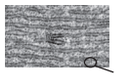
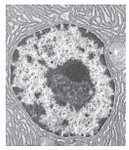
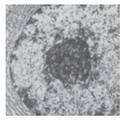
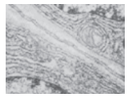
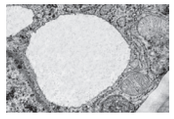
SCIENCE INQUIRY

Compare organelle composition of different cell types using electron micrographs.

1.1.2.1 Define an organelle.

.....

1.1.2.2 Complete the following table to summarise the organelle, its structure and its function.

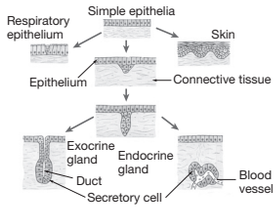
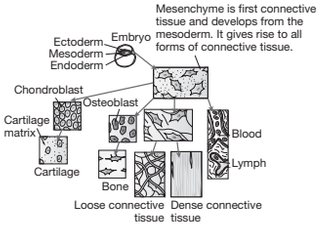
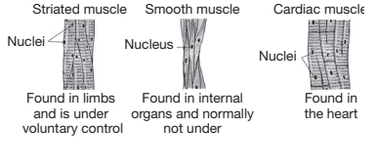
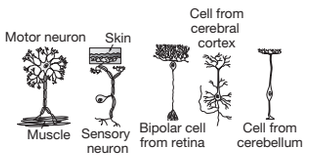
Organelle	Its structure	Description and function
Mitochondria		
Chloroplast		
Golgi body		
Lysosome		
Endoplasmic reticulum		
Ribosome	 Ribosome Black dot on ER	
Nucleus		
Nucleolus		
Cell membrane		
Vacuole		

Science Press ISBN 978-0-85583-8744

1.1.5.2 Complete the following table to outline the function of different mammalian systems.

System	Function	Components
Circulatory system		
Digestive system		
Excretory system		
Respiratory system		

1.1.5.3 Describe each type of tissue to complete the table.

Tissue	Diagram	Description
Epithelial tissue		
Connective tissue		
Muscle tissue		
Nervous tissue		

Science Press ISBN 978-0-85583-8744

1.1.5.12 Describe how the circulatory system is involved in:

(a) Obtaining nutrients.

.....

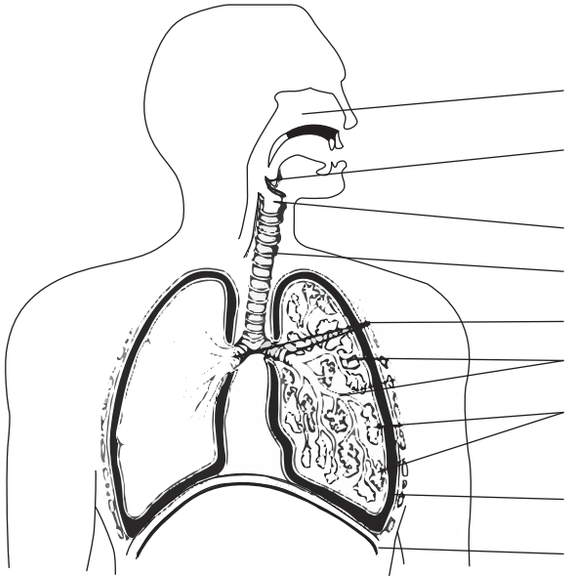
(b) Gas exchange.

.....

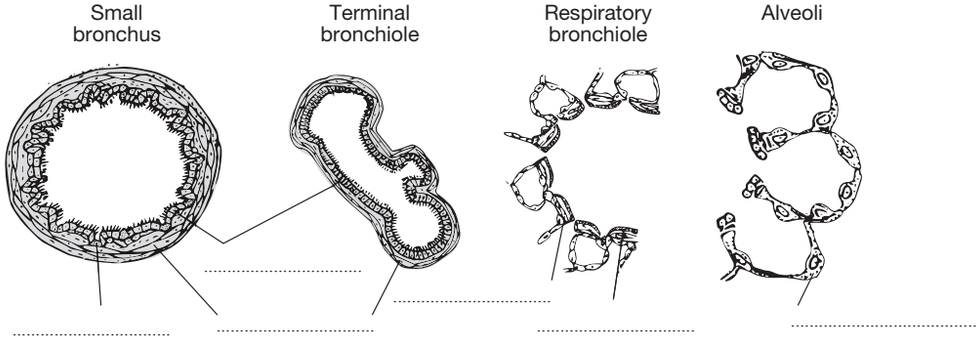
(c) Waste removal.

.....

1.1.5.13 Label and annotate the diagram of the mammalian respiratory system to identify parts and outline the function of each part.

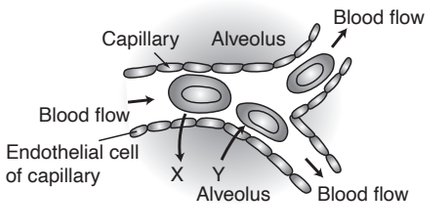


1.1.5.14 The diagram shows the structure of parts of the lung with a decrease in wall thickness from bronchus to alveolus. Label the components of each part.



1.1.5.15 The diagram shows a capillary and an alveolus. Identify gases X and Y.

.....

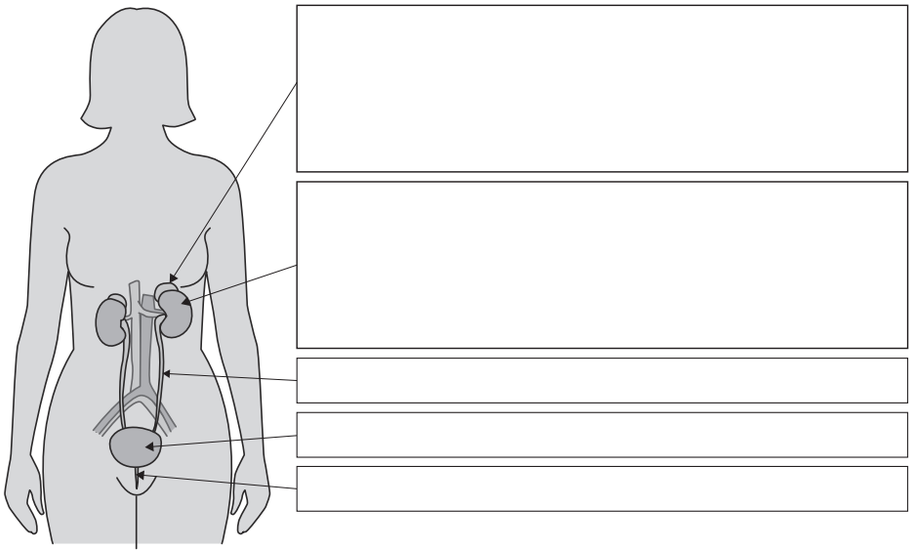


Science Press ISBN 978-0-85583-8744

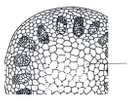
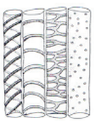
1.1.5.16 Complete the table to identify the metabolic waste excreted by the following parts of the human body.

Body part	How it is involved in excretion
Lungs	
Sweat glands	
Liver and intestines	
Kidneys	

1.1.5.17 The mammalian urinary system is responsible for the removal of nitrogenous wastes. Label and annotate the diagram of the mammalian urinary system to identify parts and outline the function of each part.

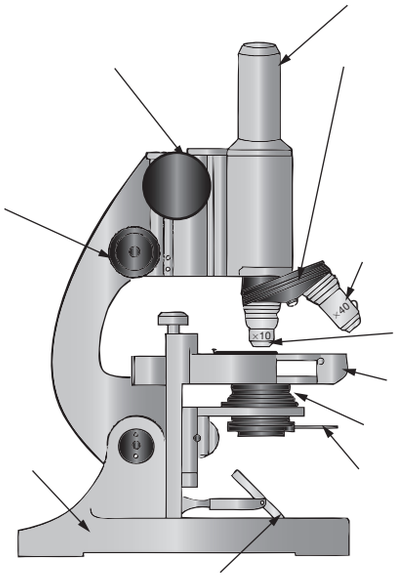


1.1.5.18 Complete the following table to summarise the function of three types of plant tissues.

Plant part	Diagram	Function
Parenchyma	 Parenchyma	
Xylem	 Xylem vessels with different secondary wall thickenings	
Phloem	 Sieve tube Companion cell	

Science Press ISBN 978-0-85583-8744

1.1.5.19 Annotate the diagram of the light microscope identifying each part and outlining the function of that part.

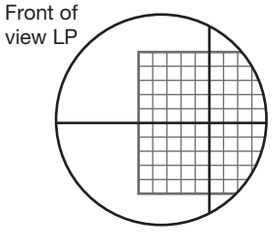


1.1.5.20 When using a light microscope, how do you calculate the total magnification?

.....

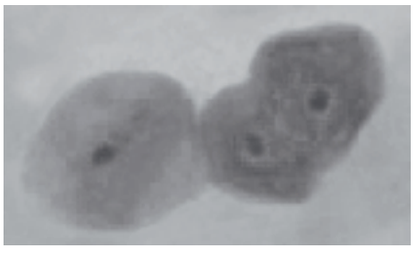
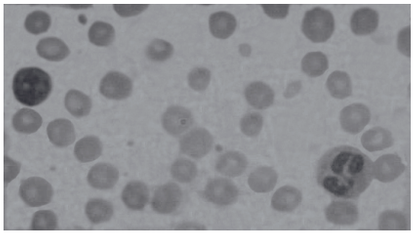
1.1.5.21 The diagram shows a minigrid under lower power of a light microscope using an eyepiece 10× and a low power objective 10×.

Estimate the diameter of the field of view in millimetres and micrometres.



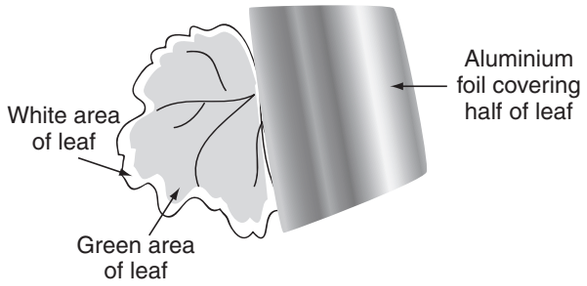
.....

1.1.5.22 Identify the main features of the following types of cells as seen under a light microscope.

Type of cell	Feature
Stained oral epithelial cells 	
Blood cells 	

Science Press ISBN 978-0-85583-8744

1.3.7.8 Some senior biology students set up the following experiment. They chose a variegated geranium plant growing in the school garden. A variegated leaf has some parts white and some parts green. They covered half of one leaf with aluminum foil and left it in place overnight. The next day they picked the leaf off the plant and carried out the test for starch.



(a) Discuss why the students chose a variegated plant for their experiment.

.....

.....

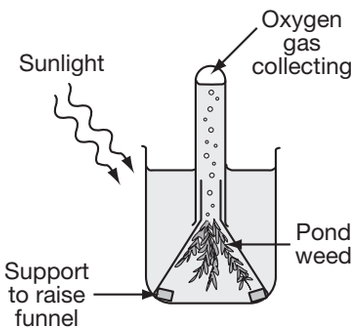
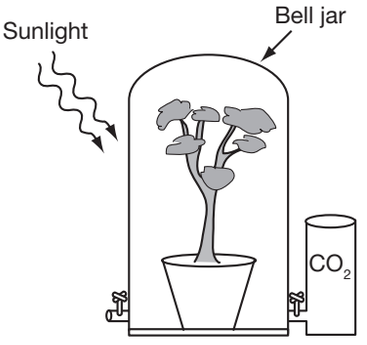
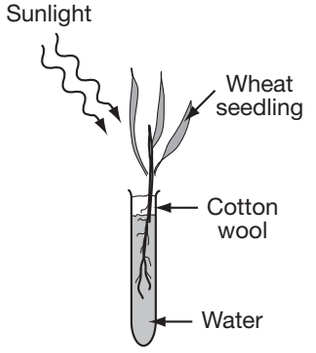
(b) Explain how the students would have tested the leaf for starch.

.....

.....

(c) Draw a diagram to show the expected results for the above leaf.

1.3.7.9 Complete the table by explaining each of the three ways of tracing and measuring the products and the rate of photosynthesis.

Measuring the rate of photosynthesis		
Production of oxygen	**Uptake of CO_2**	**Increase in biomass**
		

Science Press ISBN 978-0-85583-8744

1.3.7.10

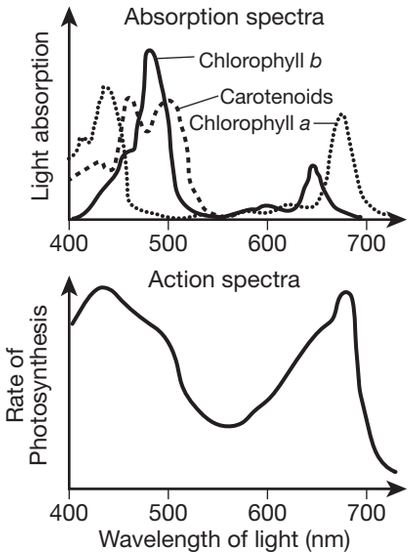
(a) Define action spectra of photosynthetic pigments in green plants.

.....

.....

(b) The graphs show the absorption spectra and action spectra of photosynthesis for a green plant.

Explain how the graphs show the colour of chlorophyll and the carotenoids.



.....

.....

.....

.....

.....

(c) Explain why the absorption spectra of chlorophyll *a* do not exactly fit the action spectra for photosynthesis.

.....

.....

1.3.7.11 Identify other roles of the carotenoids.

.....

.....

1.3.7.12 Explain why the leaves of some trees are green in summer but turn yellow and orange in autumn.

.....

.....

1.3.7.13

(a) Define limiting factor.

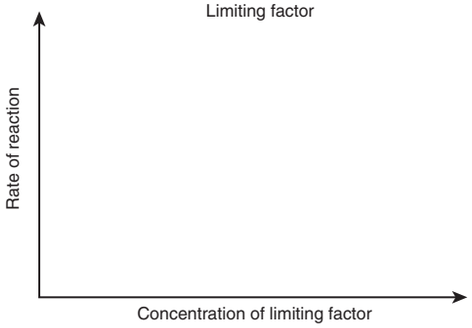
.....

(b) List some limiting factors for photosynthesis.

.....

.....

(c) Draw and annotate a generalised graph to show how the rate of a reaction is affected by a limiting factor.



Science Press ISBN 978-0-85583-8744

1.3.7.14 A senior biology student wished to carry out an experiment to determine the effect of varying light intensity on photosynthesis.

(a) For such an experiment, identify the independent variable, the dependent variable and the factors the student would need to keep constant.

.....

.....

.....

.....

(b) For such an experiment, explain a possible limiting factor.

.....

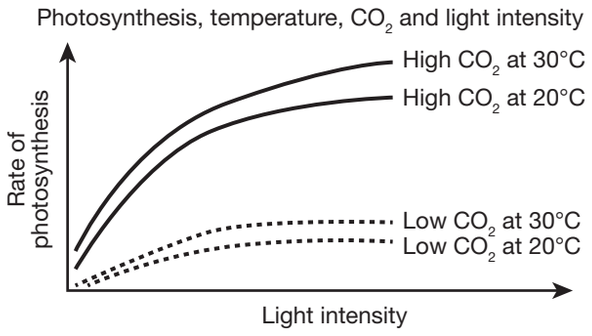
.....

.....

.....

1.3.7.15 The graph shows the rate of photosynthesis at two different concentrations of CO_2, at 20°C and 30°C, for differing light intensities.

Refer to the graph to explain how the levels of carbon dioxide concentration, light intensity and temperature interact to determine the rate of photosynthesis.



.....

.....

.....

.....

.....

1.3.7.16

(a) What is the 'artificial leaf'?

.....

.....

(b) The journal Nature Energy, 2023 presented an article on 'Solar-driven liquid multi-carbon fuel production using a standalone perovskite-BiVO4 artificial leaf'.

Discuss why there is continual research into ways technology can mimic photosynthesis.

.....

.....

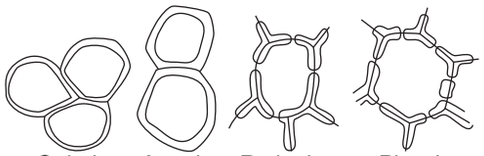
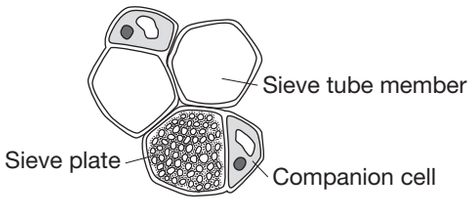
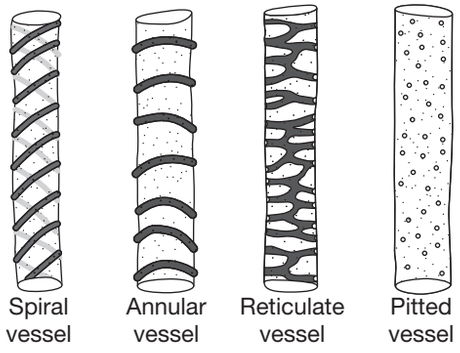
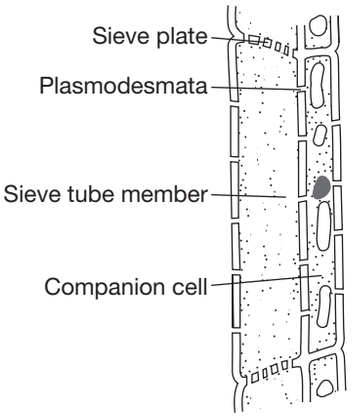
(c) What is one concern with artificial leaves?

.....

Science Press ISBN 978-0-85583-8744

1.3.8 Compare the structure and function of xylem and phloem tissues.

1.3.8.1 Xylem and phloem form the plant vascular system. Complete the table to summarise the features of xylem and phloem

Feature	Xylem	Phloem
Cross-section		
Longitudinal section		
Structure		
Function		

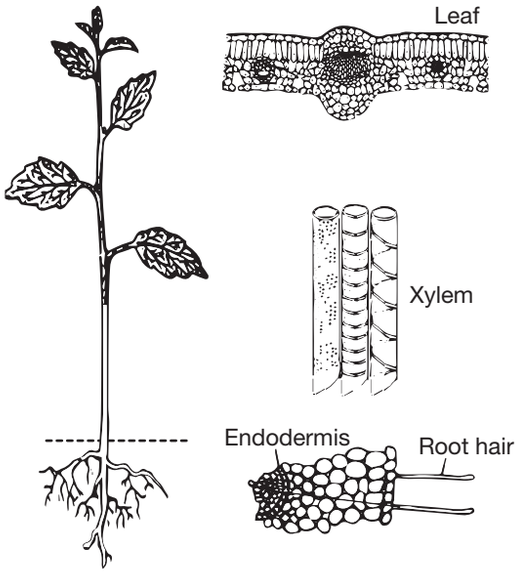
Science Press ISBN 978-0-85583-8744

1.3.8.2 Distinguish between a tracheid and a xylem vessel.

.....

.....

1.3.8.3 Annotate the diagram and explain how each of the following helps transport water and mineral nutrients from the roots via xylem.

Diagram of water movement	Mechanism	Description
	Transpiration pull	
	Adhesion	
	Cohesion	
	Root pressure	
	Structure of xylem	

1.3.8.4 Describe how active transport causes the uptake of some mineral ions from the soil.

.....

.....

.....

Science Press ISBN 978-0-85583-8744

1.3.8.5 Some students left a length of celery in a beaker of coloured water overnight. They cut a transverse section and a longitudinal section, made each into a wet mount and viewed under a light microscope.

(a) Draw a labelled diagram of the expected TS celery stalk and LS celery stalk.

Diagram of results

(b) What conclusion can be drawn from this experiment?

.....

1.3.8.6

(a) Define translocation.

.....

(b) What is meant by the source and the sink in translocation?

.....

(c) Identify some plant organs that can be both sources and sinks.

.....

(d) Identify the main components of phloem sap.

.....

1.3.8.7 The diagram shows ring barking. What information about the structure of plants is shown by ring barking?

.....

.....

.....

.....

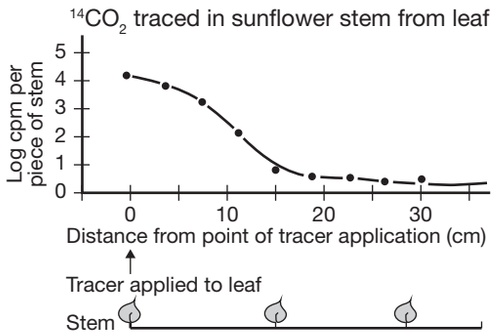
1.3.8.8 The graph shows the result of the radioisotope $^{14}CO_2$ being applied to a leaf and the radioactivity being tracked along the stem. What data about plant functioning can be collected by this research?

.....

.....

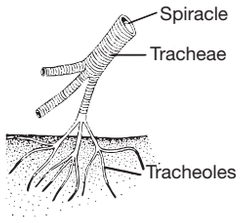
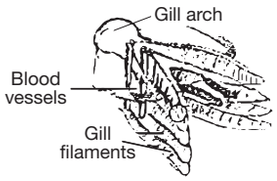
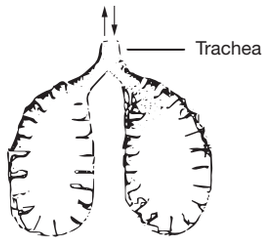
.....

.....

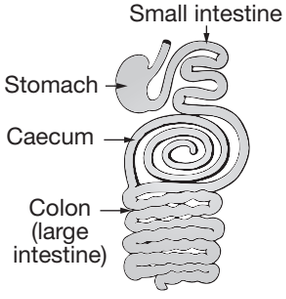
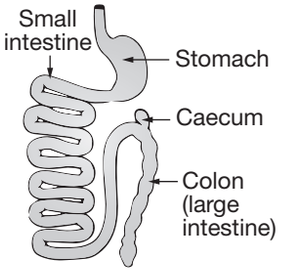


Science Press ISBN 978-0-85583-8744

1.3.10.5 Complete the following table to compare the adaptations for gaseous exchange in an insect, a fish and a frog.

Feature	Insect	Fish	Frog
Diagram			
Pathway into body			
Description of respiratory surface			
Why gases move in/out			

1.3.10.6 Complete the following table to compare the adaptations for nutrient exchange between a koala and a dingo.

Animal	Diagram of digestive system	Structural adaptation	Physiological adaptation
Koala Vertebrate herbivore			
Dingo Vertebrate carnivore			

Science Press ISBN 978-0-85583-8744

DOT POINT

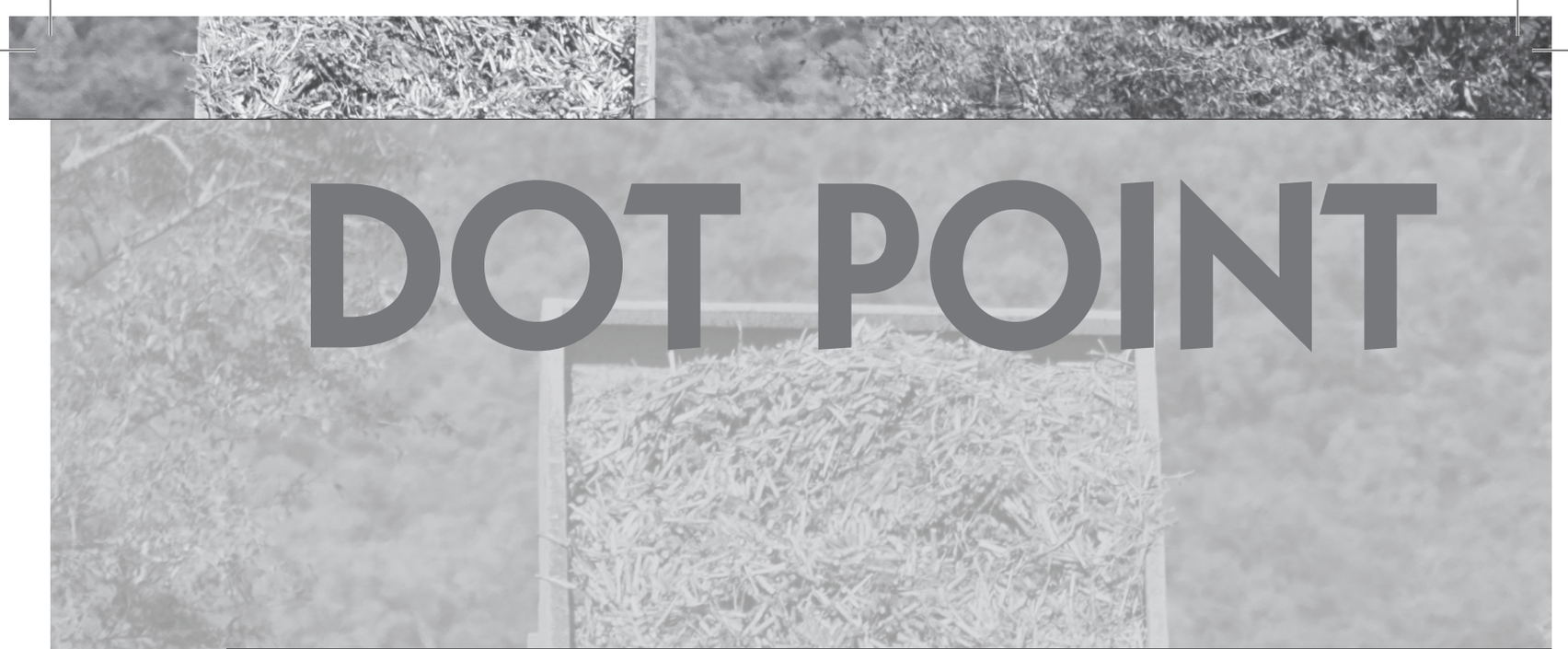
Unit 2

Maintaining the Internal Environment

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.

Science Press ISBN 978-0-85583-8744



DOT POINT

TOPIC 2.1

Homeostasis – Thermoregulation and Osmoregulation

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 term 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.

Science Press ISBN 978-0-85583-8744

Topic 2.1 Homeostasis – Thermoregulation and Osmoregulation.

2.1.1 Explain how the nervous and endocrine systems use negative feedback to coordinate responses to interna/external stimuli and maintain homeostasis (stimulus-response model).

2.1.1.1 Define homeostasis.

.....

2.1.1.2 Outline the role of the nervous system in homeostasis.

.....

2.1.1.3 What is the role of the endocrine system in homeostasis?

.....

2.1.1.4

(a) Draw a flow chart for the stimulus-response pathway.

.....

(b) Use an example to explain how the stimulus-response pathway enables the nervous system to respond to an environmental temperature change.

.....

.....

2.1.1.5 What is a reflex?

.....

2.1.1.6

(a) What is a feedback mechanism?

.....

(b) Distinguish between negative and positive feedback.

.....

.....

2.1.1.7 From the diagram, how are hormones involved in the feedback mechanism for the regulation of blood glucose levels?

.....

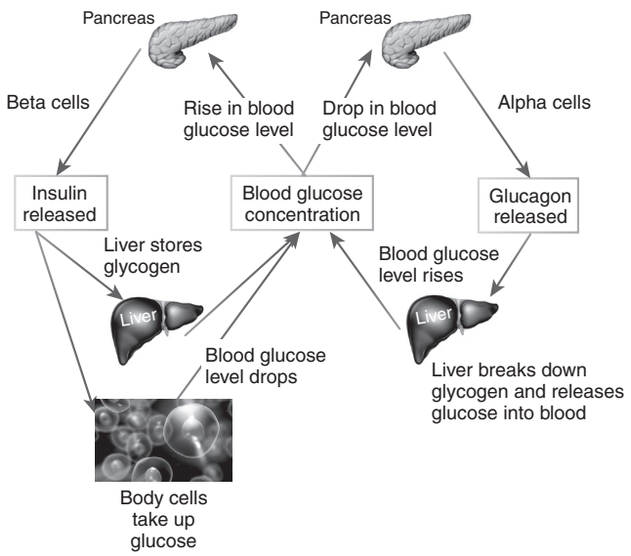
.....

.....

.....

.....

.....



Science Press ISBN 978-0-85583-8744

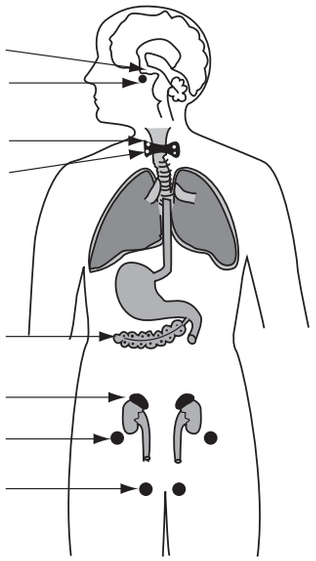
2.1.6 Describe how hormones relay messages to cells displaying specific receptors via the circulatory or lymphatic system.

2.1.6.1 Define hormone.

.....

.....

2.1.6.2 On the diagram, identify the endocrine glands and for each gland name a hormone it secretes.



2.1.6.3 Complete the table to list the components of the circulatory system and the lymphatic system.

Lymphatic system	Circulatory system

2.1.6.4 Identify some factors that can either stimulate or inhibit the secretion of hormones.

.....

.....

2.1.6.5 What is a target cell or organ?

.....

2.1.6.6 Explain why the pituitary gland is called the 'master' gland.

.....

.....

2.1.6.7 How does an endocrine gland differ from an exocrine gland?

.....

.....

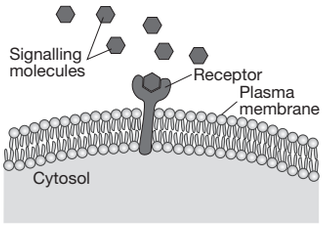
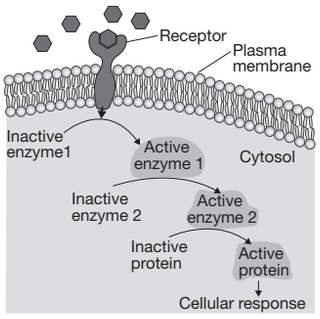
Science Press ISBN 978-0-85583-8744

2.1.6.8 Explain why the pancreas is both an endocrine gland and an exocrine gland.

.....

.....

2.1.6.9 Complete the table to summarise how hormones relay messages to cells and receptor binding alters cellular activity.

Step	Diagram	Description
Reception		
Transduction		
Cellular response		

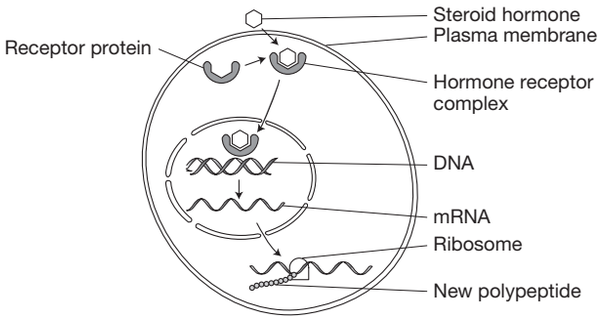
2.1.6.10 Explain why calcitonin and parathyroid hormone are antagonistic hormones.

.....

.....

2.1.6.11 The diagram shows signal transduction for a steroid hormone.

Refer to this diagram to describe how receptor binding leading to changes in cellular activity is different for a steroid hormone than for a water soluble hormone.



.....

.....

.....

.....

.....

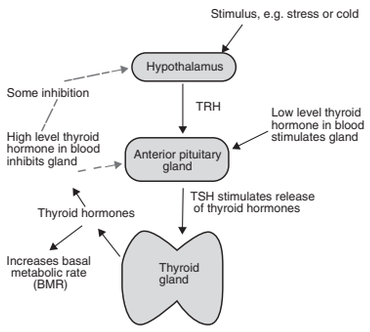
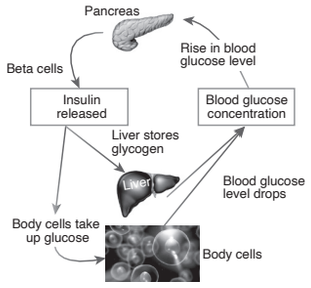
Science Press ISBN 978-0-85583-8744

2.1.9.12

(a) Explain, using at least one example, why computer models for designs of clothing and environments need to enter precise data about human thermoregulatory responses to different temperatures and conditions.

(b) List some clothing designs that have been improved by using computer models of human thermoregulatory responses.

2.1.9.13 Complete the table to summarise how thyroid hormones and insulin aid homeostatic mechanisms in thermoregulation.

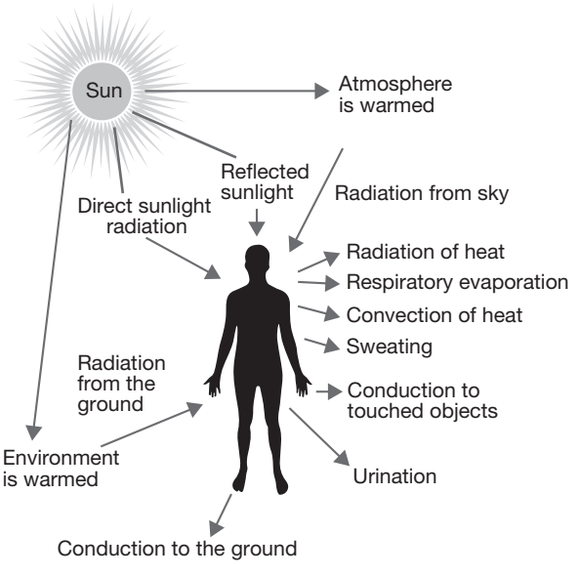
Feature	Thyroid hormones	Insulin
Where it is produced		
Function		
Diagram of regulation		
How it aids thermoregulation		
Disorder		

Science Press ISBN 978-0-85583-8744

2.1.9.14 Complete the table to explain how each factor needs to be regulated within the tolerance range of enzymes for the survival of living things.

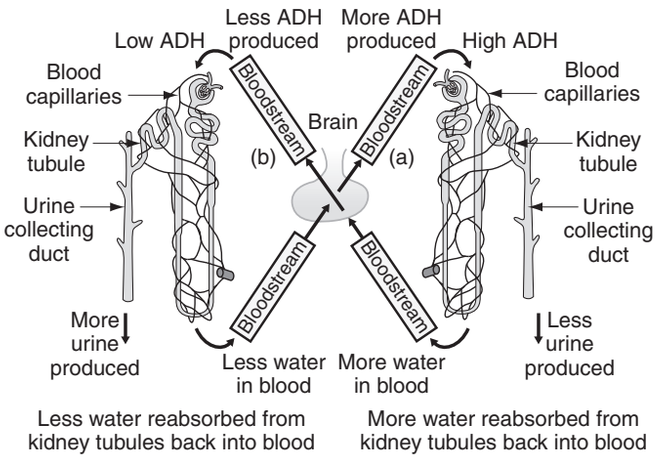
Factor	How it affects metabolic activity
Temperature	
pH	
Salt concentration	
Substrate concentration	
Presence of cofactors	

2.1.9.15 Use the diagram to make a list of heat transfer processes between the environment and a human.



Science Press ISBN 978-0-85583-8744

2.1.10.7 The diagram shows a feedback mechanism for osmoregulation controlled by ADH (antidiuretic hormone).



(a) Identify the receptors, control centre and effector which controls the release of ADH.

.....

.....

.....

.....

.....

.....

(b) Outline the conditions which would cause very little ADH to be released.

.....

.....

2.1.10.8

(a) What is a diuretic, giving some examples of some foods and drinks that are diuretics.

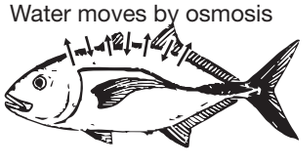
.....

.....

(b) Suggest why diuretics are banned in some sports.

.....

2.1.10.9 Complete the table to distinguish between an osmoconformer and an osmoregulator.

Feature	Osmoregulator	Osmoconformer
Definition		
Diagram	Water moves by osmosis 	
Relationship of body fluid to environment		
Movement of water		
Advantage		
Disadvantage		

Science Press ISBN 978-0-85583-8744

DOT POINT

TOPIC 2.2

Infectious Disease and Epidemiology

In this topic you will:

- Distinguish between infectious and non-infectious diseases giving examples of each.
- Identify pathogens, the virulence factors that aid in pathogenesis and how pathogens cause changes in host cells.
- Describe modes of disease transmission.
- Conduct an experiment into the effect of an antimicrobial on the growth of a microbe.
- Recognise innate immune responses and physical defence strategies.
- Describe the inflammatory response and the complement system.
- Explain the adaptive immune response in vertebrates and compare passive and active immunity and naturally and artificially acquired immunity.
- Interpret long term immune response data.
- Investigate epidemiology and evaluate strategies to control the spread of disease.

Science Press ISBN 978-0-85583-8744

Topic 2.2 Infectious Disease and Epidemiology.

2.2.1 Distinguish between infectious and non-infectious disease.

2.2.1.1 Distinguish an infectious disease from a non-infectious disease.

.....

.....

2.2.1.2 Define a pathogen.

.....

2.2.1.3 Robert Koch conducted experiments to link a specific bacterium with a specific disease, e.g. anthrax in sheep by growing bacterial colonies on agar plates. He established a series of steps known as Koch's postulates which are still followed today to link a particular micro-organism to a particular disease.

The steps in Koch's postulates are as follows.

1. Examine all infected hosts and the suspected micro-organism must be present in all cases.
2. Make a pure culture of the suspect organism.
3. Infect a healthy suitable host with a sample from the pure culture and this host must get the same symptoms as the original host.
4. Isolate the suspect micro-organism from the second host, grow it in pure culture and show it is identical to the first culture.

Explain why each step in Koch's postulates is needed to link a specific pathogen to a specific disease.

.....

.....

.....

.....

.....

.....

.....

2.2.1.4 Complete the table by identifying some infection and non-infectious diseases.

Infectious diseases		Non-infectious diseases		
Caused by macroscopic pathogen	**Caused by microscopic pathogen**	**Inherited**	**Nutritional**	**Environmental**

Science Press ISBN 978-0-85583-8744

2.2.15.5 There was a pandemic of swine influenza (also called Mexican flu) in 2009. Discuss suitable control measures to prevent the spread of swine flu and the availability of influenza vaccinations in Queensland.

Feature	Description
Name of disease	Swine influenza (also called Mexican flu).
Causative pathogen	H1N1 influenza virus, subtype of influenza A.
Persistence of pathogen within host	Swine flu is contagious for about 1 day before to 5 to 7 days after symptoms develop and the pathogen has long persistence outside host especially at low temperatures.
Transmission	Mainly through direct contact between infected and uninfected animals, e.g. pigs touching noses or through dried mucus. Airborne transmission occurs through coughing and people who work in close contact with the animals can become infected with the pathogen.
Effect on host (symptoms)	Chills, fever, sore throat, muscle pain, severe headache, coughing, weakness. Pregnant women, younger children and a person of any age with certain chronic lung or other medical condition has risks of more complicated or severe illness. Adults over 65 and children under 5 years of age have a higher risk of becoming seriously ill.
Host response	Antibodies are produced by the immune system.
Treatment	Antiviral drugs reduce symptoms and can prevent serious complications, e.g. Tamiflu or Relenza. Other medications can be used to relieve symptom, e.g. headache pain relievers.
Origin of pandemic	The H1N1 form of swine flu is one of the descendants of the strain that caused the 1918 flu pandemic. Swine flu has been reported several times in humans usually with limited distribution. The first two cases were reported in the USA followed by hundreds of cases in Mexico. On 2 May 2009, it was reported in pigs at a pig farm in Alberta, Canada caught from a farm worker who had returned from Mexico.
Control	
Immunisation	

Science Press ISBN 978-0-85583-8744

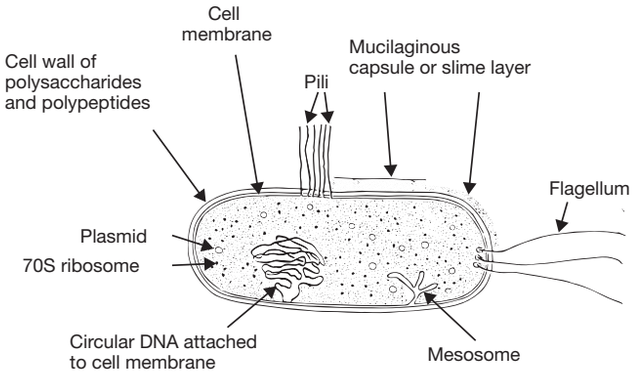
DOT POINT

Answers

Science Press ISBN 978-0-85583-8744

Unit 1 Cells and Multicellular Organisms

1.1.1.1 Generalised structure of prokaryotic cell.



1.1.1.2

Component	Structure	Function
Cell wall	Bacterial cell walls contain peptidoglycan (sugar polymers cross-linked by short polypeptides). Archaean cell walls contain polysaccharides and protein with no peptidoglycan.	Protects cell, gives cell shape.
Capsule	Cell wall can be covered by a capsule layer of polysaccharide or protein.	Capsule allows bacteria to attach to other cells, e.g. to form a colony or to adhere to a substrate or pathogens attach to host.
Plasma membrane	Phospholipid bilayer with wide variety of fatty acids present.	Controls substances in/out of cell.
Cytoplasm	Gel-like substance composed mainly of water with salts, enzymes, cell components and various organic molecules.	Most cellular activities occur in the cytoplasm.
Fimbriae	Protein tubes that extend from outer membrane. Usually short and present in large numbers.	Assist attaching to surfaces and other cells. Some used for motility.
Pili	Protein tubes that extend from outer membrane. Usually longer and fewer in number than fimbrae.	Sex pili used during conjugation and transfer of DNA.
Flagella	Protein structure with one end embedded in cells wall and plasma membrane. Can be concentrated at the end(s) or scattered over the surface.	Used for motility and cellular locomotion.
Ribosome	70S ribosome consisting of two units – a small unit (30S) and a large unit (50S). (The S stands for Svedberg unit which is a measure of time in sedimentation process during centrifuging.)	Responsible for protein synthesis as site of translation of mRNA code into a polypeptide.
Nucleoid	Area that contains the single bacterial DNA circular molecule.	DNA hold the hereditary genetic information of the prokaryote.
Plasmid	Small circular DNA molecule that is not part of the chromosomal DNA and can replicate independently. Carries accessory genes.	Genes aid survival in stress situations, e.g. some plasmids give antibiotic resistance.

1.1.1.3 The prokaryotes are in the Archaea domain, e.g. extremophiles such as methanogens *Methanosarcina*, halophiles *Halobacterium* and thermophiles *Thermococcus* and in the bacteria domain, e.g. cyanobacteria *Nostoc* and nitrogen fixing bacteria *Rhizobia*.

1.1.1.4 The Gram stain was instigated by Christian Gram in 1884 and shows two different kinds of bacterial cell walls – gram negative stain red, gram positive stain purple. Gram positive bacteria have a thick layer of peptidoglycan (50% to 90%) in their cell wall while gram negative bacteria have a thinner layer of peptidoglycan (10% envelope).

1.1.1.5 Cell A is eukaryote, animal cell, cell B is a prokaryote and cell C is a eukaryote, plant cell.

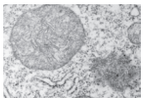
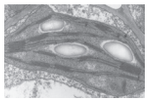
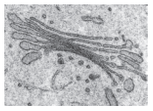
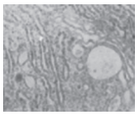
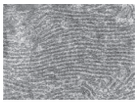
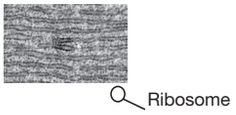
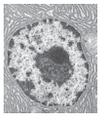
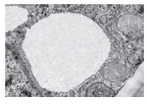
Science Press ISBN 978-0-85583-8744

1.1.1.6

Feature	Prokaryotic cell	Eukaryotic cell
Membrane bound organelles	Not present.	Present, e.g. nucleus, mitochondria.
Size	Significantly smaller than eukaryotes, e.g. approximately 1 to 5 micrometres.	Significantly larger than prokaryotes, e.g. approximately 10 to 100 micrometres.
Chromosome	Single circular chromosome not bound with proteins.	Multiple linear chromosomes bound to histone proteins.
Exist as single cell	Exist as single cell.	Some are unicells, some colonial and many are multicellular.
Ribosomes	70S with 50S large subunit and 30S small subunit.	80S with 60S large subunit and 40S small subunit.

1.1.2.1 An organelle is a small membrane bound structure that has a specialised function. They are embedded in the cytosol of eukaryotic cells.

1.1.2.2

Organelle	Its structure	Description and function
Mitochondria		It is the site of aerobic respiration. Mitochondria are oval shaped with a double membrane. The inner membrane is highly folded (folds called cristae) to increase surface area for site of chemical reactions.
Chloroplast		It is the site for photosynthesis in plant cells. Chloroplasts have a double membrane with stacks or grana containing chlorophyll to trap sunlight. The grana are in a proteinaceous matrix (stroma).
Golgi body		Modification of lipids and proteins and storage and packaging of materials for export from the cell. Is a single membrane structure with sacs stacked like pancakes. Vesicles contain macromolecules, e.g. enzymes, hormones and pinch off from the stack.
Lysosome		Pick up and break down unwanted materials or foreign invaders, e.g. old organelles, bacteria, food. Contain enzymes and are produced in Golgi bodies.
Endoplasmic reticulum		It is involved in transport of materials in the cell and connects the cell membrane with the nuclear membrane. Network of tubules and vesicles which increase in number as the cell becomes more active in protein synthesis.
Ribosome	 Black dot on ER	It is the site of protein synthesis. Very small, spherical often attached to endoplasmic reticulum.
Nucleus		Controls cell activities, e.g. controls cell division, differentiation, metabolism and it also contains genetic information as DNA. It is surrounded by a double membrane with pores.
Nucleolus		It manufactures ribosomes which move out of the nucleus to the endoplasmic reticulum for protein synthesis. It is a darkly stained part of the nucleus and is made of chromatin.
Cell membrane		Holds the cell contents in place and controls the movement of substances into and out of the cell. It is a lipid bilayer.
Vacuole		Involved in intracellular digestion and release of cellular waste products. In animals they are usually small, but in plants can be large and play a role in turgor pressure and maintaining the shape of the cell.

Science Press ISBN 978-0-85583-8744

1.1.2.3 Endoplasmic reticulum and ribosomes can only be seen under an electron microscope.

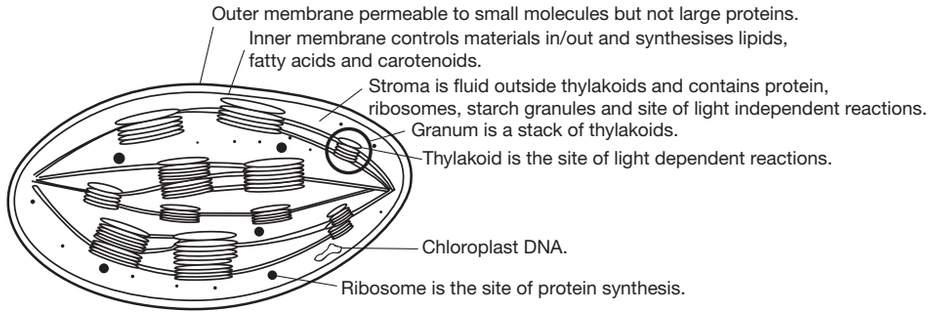
1.1.2.4 The cytoskeleton is a network of microtubules, microfilaments and intermediate filaments that are found throughout the cytoplasm and used for mechanical support, transport and signalling functions. The cytoskeleton forms a matrix that is found in both prokaryotes and eukaryotes.

1.1.2.5 A TEM shows the internal structures inside a cell such as organelles. Whereas a SEM gives a three-dimensional image showing the outside of the specimen and does not show organelles.

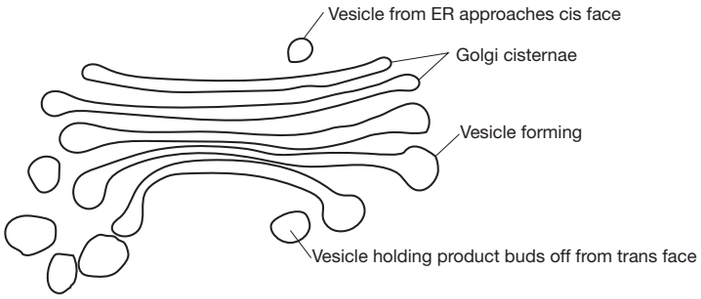
1.1.2.6 Magnification refers to making things appear larger whereas resolution is the ability to distinguish between two points and makes detail appear more clearly.

1.1.2.7 Cytosol is a semi-fluid, jelly-like substance that contains the subcellular component of a cell and is the semi-fluid part of the cytoplasm.

1.1.2.8



1.1.2.9



1.1.2.10 The diagram shows rough ER extending from the nuclear membrane. ER is covered by ribosomes on its surface and is involved in protein synthesis. Smooth ER is further away from the nucleus and is a continuous tubular membrane involved in the synthesis and storage of lipids.

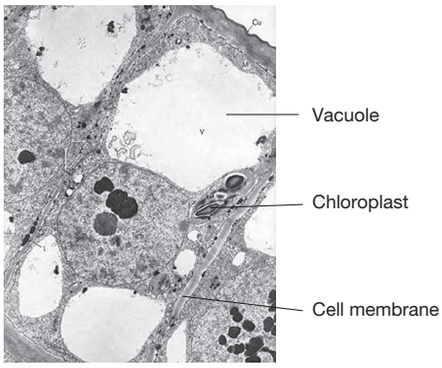
1.1.2.11 (a) Mitochondria are involved in aerobic respiration and release energy in the form of ATP to cells. Therefore any cell that needs to produce large amounts of ATP will have large numbers of mitochondria, e.g. muscle cells.

(b) Chloroplasts are the site of photosynthesis. Therefore any photosynthesising plant cell will have large numbers of chloroplasts, e.g. palisade mesophyll cells.

(c) Any cell that is packaging and secreting substances will have large numbers of Golgi bodies, e.g. endocrine cells secreting hormones.

Science Press ISBN 978-0-85583-8744

1.1.2.12 (a)



(b) The chloroplast is the site of photosynthesis to capture sunlight and convert this energy into chemical energy. The reactants carbon dioxide and water are used to make glucose and oxygen. The structure of the chloroplast is highly suited to photosynthesis. The stacks (grana) of thylakoids contain chlorophyll and their increased surface area allows for increased light reactions of photosynthesis. The dark reaction occurs in the stroma and the lamellae form a continuous channel within the chloroplast for movement of materials.

(c) The diagram shows a plant cell. This cell has a cell wall and chloroplasts which are present in plant cells and not in animal cells.

1.1.3.1 Stem cells are relatively unspecialised cells that can produce from cell division a daughter cell that is identical to the parent cell and a more specialised daughter cell that can become more specialised.

1.1.3.2 Stem cells originate through the process of mitosis.

1.1.3.3 (a) The different types of stem cells relate to different times of life and different parts of the body, e.g. embryonic stem cells only exist at the earliest stages of development while adult or tissue-specific stem cells appear during foetal development and remain in specific parts of the body throughout life.

(b) Embryonic stem cells are found in very young embryos, before the formation of the blastocyst, or from the inner mass of the blastocyst, while adult stem cells are found within specific tissues or organs of the body, e.g. found in bone marrow, skin, brain and the gut.

1.1.3.4 Stem cell differentiation means the stem cell divides and the daughter cell becomes specialised with specific structures and functions, e.g. nerve cells have a particular shape and are used to carry nervous impulses.

1.1.3.5 A multicellular organism needs specialised cells with division of labour so particular tasks, e.g. supply of oxygen and nutrients and removal of wastes can be carried out more efficiently.

1.1.3.6 Clinical trials investigate specific new treatments or new ways of using a current treatment to determine if a proposed new therapy is effective and safe. Clinical trials usually start with a small number of people with procedures following strict ethical practices governed by regulatory agencies. The results are shared with global medical and scientific communities. Current research involves transformation of regular adult stems cells using genetic reprogramming to aid people with neurological or heart diseases.

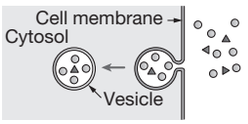
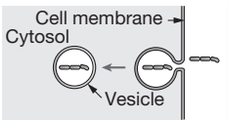
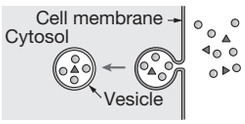
1.1.3.7

Type of stem cell	Source of stem cell
Autologous stem cell	From the same individual.
Allogenic stem cells	From genetically different donor but same species as recipient.
Xenogenous stem cells	From different species than recipient.

1.1.3.8 Autologous stem cell transplants reduce the risk of incompatibility between the donor's cells and the recipient's cells and tissue rejection. Stem cells are often collected before high doses of chemotherapy, which is being used to treat an underlying disease, e.g. myeloma. The autologous stem cells are then transplanted back into the patient.

Science Press ISBN 978-0-85583-8744

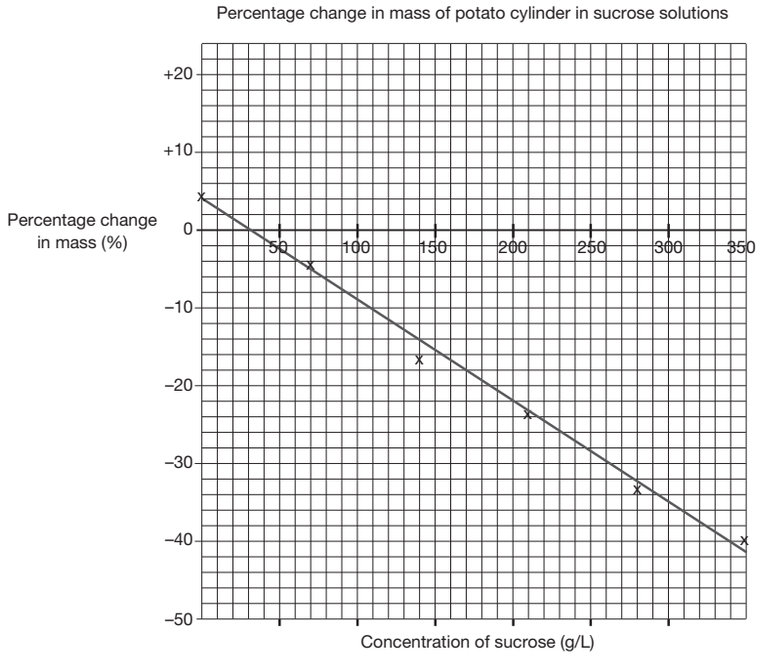
1.1.8.10

Feature	Exocytosis	Endocytosis	
		Phagocytosis	Pinocytosis
Diagram			
Definition	The release of substances from a cell when a vesicle fuses with the cell membrane.	Endocytosis – a cell takes up substances by forming a vesicle around them with the cell membrane.	
		Phagocytosis – the cell engulfs a particle by cell membrane wrapping around it and packaging it into a vesicle.	Pinocytosis – the cell membrane encloses droplets of extracellular fluid packaging it into a vesicle.
How it affects the membrane	During exocytosis the membrane fuses with the vesicle, changes shape and expels the substance. Vesicles are created by rER and then modified by Golgi apparatus. The fluidity of the membrane allows the phospholipids from the vesicle to combine with the plasma membrane to form the new membrane that includes the phospholipids from the vesicle.	During phagocytosis the membrane changes shape, infolds and encloses the substance to be taken into the cell. This occurs if the substance is highly polar or too large to enter by other means. The particle is often digested after the vesicle fuses with a lysosome which contains digestive enzymes.	During pinocytosis the membrane changes shape, infolds and encloses the extracellular fluid to be taken into the cell. It is non-specific and often is concerned with obtaining the dissolved substances in the fluid, e.g. movement of fluids into a small blood vessel.

1.1.8.11 (a) Student results.

Concentration of sucrose (g/L)	Initial mass (g)	Final mass (g)	Difference in mass	Percentage change in mass: $\frac{\text{Difference}}{\text{Initial mass}} \times 100$
350	1.11	0.67	–0.44	– 39.6%
280	1.14	0.76	–0.38	– 33.3%
210	1.15	0.88	–0.27	–23.5%
140	1.17	0.97	–0.20	–17.1%
70	1.15	1.09	–0.06	–5.2%
0	1.14	1.19	+0.05	+4.4%

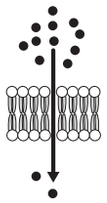
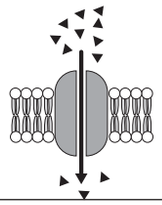
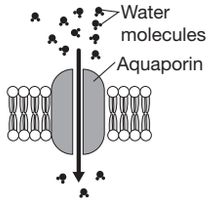
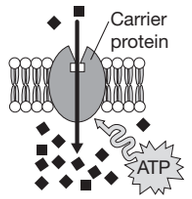
(b)



(c) As the sucrose concentration increases there is a corresponding increase in loss of mass of the potato cylinders.

Science Press ISBN 978-0-85583-8744

1.1.9.1

Feature	Diffusion	Facilitated diffusion	Osmosis	Active transport
Diagram				
Definition	Diffusion is the movement of any type of molecule from an area of high concentration to an area of low concentration.	Allows diffusion of large, membrane insoluble compounds across a membrane.	Is the diffusion of water across a semipermeable membrane.	Movement across a membrane against a concentration or electrochemical gradient requiring an energy input, e.g. in the form of ATP.
Type of substances that move	Oxygen, water, carbon dioxide diffuse across lipid bilayer.	Sugars and amino acids.	Water.	Selected substances for which there are carriers.
Concentration gradient	High to low.	High to low.	High to low.	Low to high.
Energy requirements	Passive movement – no energy input.	Passive movement – no energy input.	Passive movement – no energy input.	Active movement – requires input of cellular energy (ATP).
Examples	Gases in/out lungs or gills. Salts into plant roots.	Glucose moving into cells.	Water into plant roots. Water out of lungs during breathing.	Uptake of digestive nutrients and excretion of wastes. Sodium/potassium pump.

1.1.9.2 Osmotic pressure is the pressure needed to stop the flow of water across a semipermeable membrane.

1.1.9.3 Osmoregulation is the active regulation of the osmotic pressure of body fluids so they do not become too dilute or concentrated in particular areas.

1.1.10.1 (a)

Cube	Surface area	Volume	Ratio SA:V	Reduced ratio
Large	3 × 3 × 6 = 54	3 × 3 × 3 = 27	54:27	2:1
Medium	2 × 2 × 6 = 24	2 × 2 × 2 = 8	24:8	3:1
Small	1 × 1 × 6 = 6	1 × 1 × 1 = 1	6:1	6:1

(b) The rate of diffusion of acid into the cubes is the same for all cubes. The acid penetrates to a depth of 3 mm after four minutes.

(c) Acid, e.g. HCl, is corrosive to skin and clothing which means gloves, laboratory coat and goggles needed to be worn to protect eyes and skin from damage. When using knives to cut the jelly, care must be taken as sharp objects can cause injury and broken skin can lead to infection.

(d)

Cube	Original volume	Volume after acid	Percentage diffusion into cell
Large	3 × 3 × 3 = 27	2.4 × 2.4 × 2.4 = 13.824	$\frac{27 - 13.824}{27} \times 100 = 48.8\%$
Medium	2 × 2 × 2 = 8	1.4 × 1.4 × 1.4 = 2.744	$\frac{8 - 2.744}{8} \times 100 = 65.7\%$
Small	1 × 1 × 1 = 1	0.4 × 0.4 × 0.4 = 0.064	$\frac{1 - 0.064}{1} \times 100 = 93.6\%$

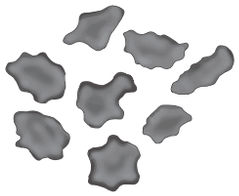
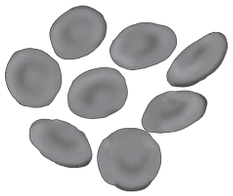
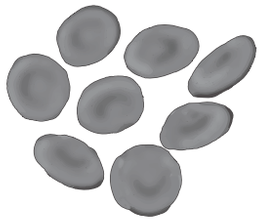
(e) The results of this e×periment show that the rate of diffusion into the cubes was the same for all cubes. However, after 4 minutes the acid had reached 93.6% of the small cube but only 48.8% of the large cube. The small cube had the largest SA:V (6:1) and the large cube had the smallest SA:V (2:1). This shows that cell size is influenced by the rate of diffusion as smaller cells, with larger SA:V have an advantage over larger cells. Materials and nutrients can reach all parts of the cell by diffusion more quickly than larger cells.

Science Press ISBN 978-0-85583-8744

1.1.10.2 Small cells have a larger surface area to volume ratio. This means that diffusion is more efficient allowing nutrients and o×ygen into the cell and releasing wastes from the cell. As a cell grows in size the surface area to volume ratio becomes larger and diffusion becomes less efficient. If the cell becomes too large wastes may accumulate to to×ic levels, o×ygen and nutrients may be deficient for the cell's needs and the cell will not function properly and could die. To prevent this from occurring the cell will divide, making two new cells and thus each cell now has a larger surface area to volume ratio.

1.1.10.3 No, larger organisms do not usually have larger cells than smaller organisms. Larger organisms have more cells. Each cell needs a surface area to volume ratio that allows sufficient exchange of materials with its surroundings to maintain nutrients into the cell and wastes out of the cell.

1.1.10.4

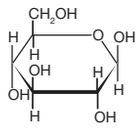
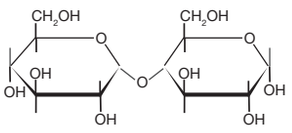
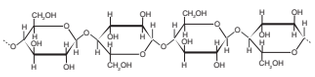
Cells placed in solution	Hypertonic	Isotonic	Hypotonic
Red blood cells diagram			
What is happening	Water is leaving the cell by osmosis	No osmotic pressure with no net movement in/out of cells	Water is entering the cell by osmosis

1.2.1.1 (a) Carbohydrates contain the elements carbon, oxygen and hydrogen.

(b) Basic sugar unit is a monosaccharide, e.g. glucose (hexose sugar).

(c) General formula is $C_m(H_2O)_n$ where m is nearly equal to n.

1.2.1.2

Carbohydrate	Diagram	Description	Examples
Monosaccharide		Are the simplest carbohydrate or simple sugars that can be active alone or acting as a monomer for disaccharides or polysaccharides. The formulas of monosaccharides are usually some multiple of CH_2O.	Glucose – used as a source of energy (ATP) in cellular respiration and is the form sugars are transported in the blood. Fructose – fruit sugar gives sweetness in honey and flower nectar to attract pollinators. Is a source of energy for plants.
Disaccharide		Are double sugars consisting of two monosaccharides joined by condensation (dehydration) synthesis.	Sucrose – cane sugar is main sugar translocated in plant phloem and used to store energy. Lactose – milk sugar is found in the milk of mammals and is the source of energy for growing infants.
Polysaccharide		Are polymers made up of many monosaccharide monomers formed by condensation reactions. Used for energy storage or structural purposes.	Starch – storage in plants. Cellulose – plant cell walls giving strength and support for plant cell. Glycogen – storage in animals, e.g. in liver.

1.2.1.3 (a) Elements present in lipids are carbon, oxygen and hydrogen with a much lower proportion of oxygen than carbohydrates.

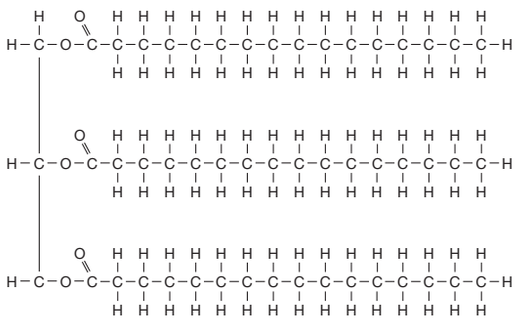
(b) Basic unit is fatty acid chain.

1.2.1.4 A fatty acid is a long carbon chain, e.g. 16 or 18 carbon atoms long that has a non-polar end due to the long hydrocarbon chain. This end is hydrophobic. The other end has a carboxyl group –COOH which gives the chain acidic properties. The hydrogen of the carboxyl group can dissociate and makes it an acid (carboxylic acid). Fatty acids are carboxylic acids with long hydrocarbon chains.

Science Press ISBN 978-0-85583-8744

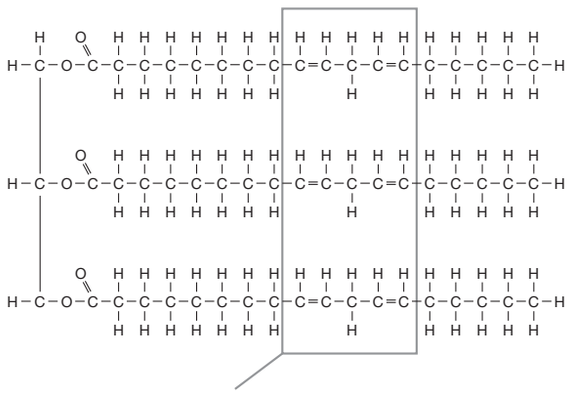
1.2.1.5

Fat X



Saturated fat as there are as many hydrogen atoms as possible bonded to the carbon skeleton (no double bonds).

Fat Y



Unsaturated fat as there is at least one double bond caused by the removal of hydrogen atoms from the carbon skeleton.

1.2.1.6

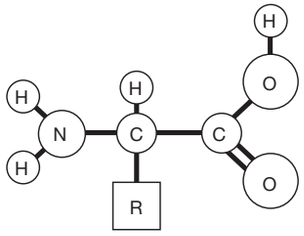
Function	Description
Energy storage	Many organisms especially store food as fat, e.g. hibernating animals. Plants store food as lipids in nuts and seeds. There is a relationship between storing energy as lipids rather than as carbohydrates and with increased mobility. Energy stored as fat weighs less than carbohydrates or proteins. This means that an animal using fat for energy storage is less bulky and has less weight to move in locomotion. Several sessile animals or animals that move very little, e.g. clams store food as carbohydrates. Plants store energy as carbohydrates, e.g. in roots, while seeds which are mobile for dispersal often contain lipids.
Cell structure	Cell membranes are a lipid bilayer with phospholipids forming a large part of the structure.
Transport material in/out cells	The polar head and non-polar tails of the phospholipid help determine the substances that can move through a membrane.
Thermal insulation	Fat is a good insulator, e.g. subcutaneous fat layer reduces heat loss from animals. Aquatic mammals have large fat deposits.
Shock absorber	Adipose (fat) tissue around vital organs cushions movement.
Buoyancy	Oils are less dense than water and some aquatic organisms use oil to aid buoyancy.

1.2.1.7 (a) Elements in proteins are C, H, O, N and some have S (sulfur).

(b) Basic unit of proteins is the amino acids joined by peptide bonds.

1.2.1.8

Generalised structure of an amino acid



1.2.1.9 Twenty kinds of amino acids are commonly found in polypeptides.

1.2.1.10 Polypeptides are synthesised in cells on ribosomes.

1.2.1.11 A polypeptide is a chain of many amino acids linked together by peptide bonds. Whereas a protein is a three-dimensional biological polymer made from a set of amino acids. Some proteins consist of only one polypeptide chain while others have more than one polypeptide chain, e.g. haemoglobin has four linked polypeptides with alpha and beta polypeptide chains and glucagon consists of only one alpha helix polypeptide.

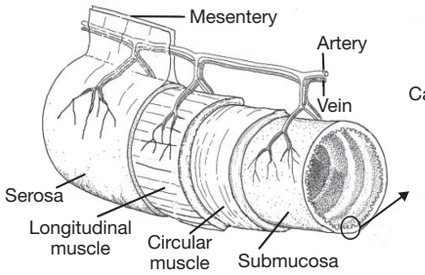
Science Press ISBN 978-0-85583-8744

1.2.2.5

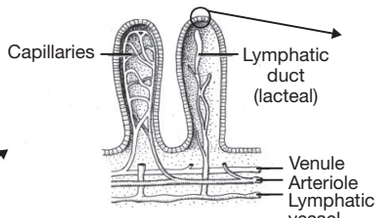
Enzyme	Source	Substrate	Product	Optimum pH
Salivary amylase	Saliva from salivary glands	Starch	Maltose	pH 7
Pepsin	Gastric juice from cells in stomach wall	Protein	Small polypeptides	pH 2
Pancreatic lipase	Pancreatic juice by exocrine cells of pancreas	Lipids	Glycerol, fatty acids	pH 8

1.2.3.1

Tissue layers of small intestine

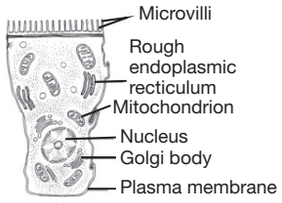


Villus structure



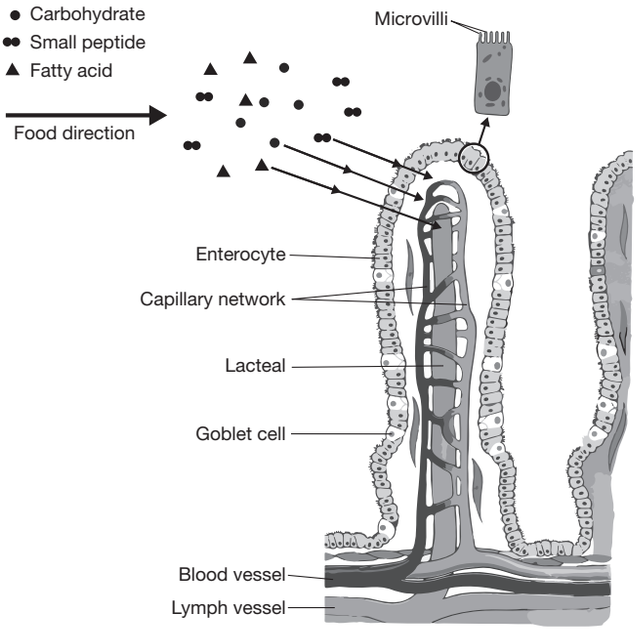
For clarity, the villus on the right is shown with a lacteal only and the villus on the left is shown with capillaries only.

Epithelial cell



1.2.3.2 Each epithelial cell in a villus has a brush border of many microvilli, which massively increase the surface area and increase nutrient absorption. Capillaries have a single layer of endothelium which reduces distance for nutrient delivery.

1.2.3.3

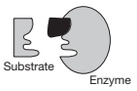
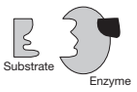


1.2.3.4

Nutrient group	Form absorbed	Description
Carbohydrates	Usually monosaccharide, e.g. glucose	Active transport in small intestine, e.g. villi into circulatory system via capillaries.
Proteins	Amino acids	Active transport in small intestine, e.g. villi into circulatory system via capillaries.
Lipids	Fatty acids and glycerol	Diffusion in small intestine, e.g. villi into lymphatic system via lacteal.
Fat soluble vitamins	Vitamins A and D	Diffusion in small intestine, e.g. villi into lymphatic system via lacteal.
Water soluble vitamins	Vitamins B and C	Diffusion in small intestine, e.g. villi into circulatory system via capillaries.
Water	Water	Osmosis into circulatory system via capillaries.

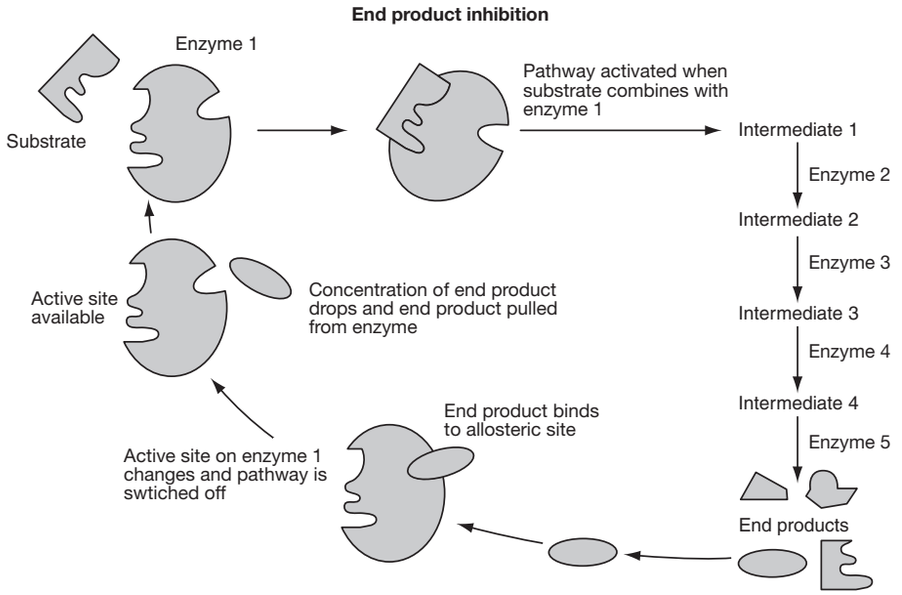
Science Press ISBN 978-0-85583-8744

1.2.8.7

Diagram	Type of inhibition	How inhibition works	Example
	Competitive inhibition	The competitive inhibitor binds with the enzyme and competes with the substrate for the active site.	Methanol poisoning is caused by the oxidation in the body of methanol by formaldehyde oxidase to formaldehyde and formic acid which attack the optic nerve and cause blindness. Treatment for methanol poisoning involves giving the patient ethanol. The ethanol is a competitive inhibitor for formaldehyde oxidase and is oxidised in preference to methanol and thus prevents the build-up of the toxic by-products.
	Non-competitive inhibition	The non-competitive inhibitor binds to the enzyme away from the active site and alters the enzyme so that the enzyme can no longer bind with the substrate.	Heavy metal poisoning, e.g. silver (Ag^+) is caused when the silver binds with the enzyme away from the active site and this causes a change in the shape of the active site so that the enzyme can no longer function properly.

1.2.8.8 End product inhibition is a feedback mechanism in a multi-step pathway where the end product binds to an enzyme that is early in the chain of reactions. This inhibits the series of reactions and prevents the production of more end product.

1.2.8.9



1.2.9.1

(a) Test tube B was the control at each temperature.

(b) The dependent variable was the time for the milk to clot and the independent variable was the temperature.

(c) Variables kept constant include the amount of junket solution added to each test tube, the amount of milk, the source and type of milk added to each test tube, size of the test tube.

(d) Junket contains the enzyme rennin which clots milk (substrate) in the stomach. The stomach has a low pH and the graph shows the optimum pH for rennin around pH = 3.

(e) The water baths were kept at 37°C as this is body temperature and rennin has optimal activity at this temperature.

(f) The graph for enzyme 1 would be most similar to the action of the enzyme rennin as rennin works in the stomach which is highly acidic (e.g. approximate pH = 2).

1.2.9.2

(a) The potato was the source of the catalase.

(b) The potato was ground because catalase is an intracellular enzyme and cell walls and membranes need to be broken to release the enzyme.

(c) The bubbles were oxygen gas.

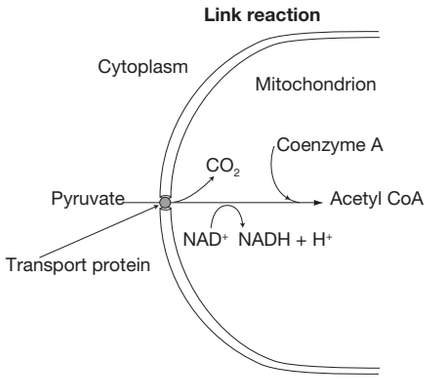
(d) A more concentrated solution has a greater number of substrate molecules and therefore there is a greater chance of a collision between enzyme and substrate. An increase in the rate of reaction is an increase in the number of collisions between the reacting particles.

1.2.9.3 Enzyme activity would be approximately 4.5 μM/sec/g if the substrate concentration were increased to 75 μM.

Science Press ISBN 978-0-85583-8744

1.3.3.11 After glycolysis the pyruvate is taken into a mitochondrion and converted to acetyl CoA (acetyl coenzyme A) in the link reaction. Hydrogen is removed from the pyruvate (oxidation) and a carbon dioxide is removed from the pyruvate (decarboxylation).

1.3.3.12



1.3.3.13 The Krebs cycle is an 8-step chemical cycle that is the second stage in cellular respiration and completes the breakdown of glucose into carbon dioxide.

1.3.3.14

Aspect	Description
Beginning of cycle	Acetyl CoA transfers its two-carbon acetyl group to the four-carbon acceptor compound (oxaloacetate) to form a six-carbon compound (citrate).
Waste products of cycle	Water and carbon dioxide are produced as waste products.
Net energy gain	3 NADH, 1 $FADH_2$, 1 ATP
C2 + C4 = C6 → C5 → C4 and cycles	The C4 (oxaloacetate) combines with acetyl CoA (C2) from the link reaction to form C6 (citrate). Within the Krebs cycle decarboxylation forms a C5 compound and then a C4 compound. Further reactions lead to the formation of oxaloacetate and the cycle forms.

1.3.3.15 The electron transport chain is a series of electron carrier molecules, e.g. membrane proteins that move electrons during redox reactions in order for the energy to be used to make ATP.

1.3.3.16 Oxidative phosphorylation is the addition of a phosphate group to ADP to form ATP using energy from the electron transport chain and redox reactions. In most instances NADH is oxidised to NAD^+. ATP synthase is a membrane protein in the inner membrane of a mitochondrion as shown in the diagram. It is the enzyme that catalyses the reaction of ADP and an inorganic phosphate to form ATP. The enzyme uses the ion gradient of H^+ on either side of the inner mitochondrial membrane to synthesise ATP with hydrogen ions moving from the intermembrane space back into the matrix.

1.3.3.17

Step in aerobic respiration	Location	What is happening
Glycolysis	Cytoplasm	6-carbon glucose is converted into two 3-carbon pyruvate molecules with the formation of ATP and NADH.
Link reaction	Mitochondria	Each pyruvate is oxidised to a 2-carbon molecule (acetate) that combines with coenzyme A forming acetyl coenzyme A (acetyl CoA) with carbon dioxide and NADH being released.
Krebs cycle	Mitochondria	An 8-step chemical cycle where acetyl CoA is completely degraded to carbon dioxide and hydrogen ions released.
Electron transport system and chemiosmosis	Mitochondria	Chain of several electron transport molecules where hydrogen ions (or their electrons) are passed along a chain and the energy released is used to form a proton gradient, ATP is synthesised as protons move across the gradient and oxygen is the final hydrogen acceptor forming water.

1.3.3.18 Respiration is a series of reactions and each step is controlled by enzymes with energy being released at several stages in the pathway.

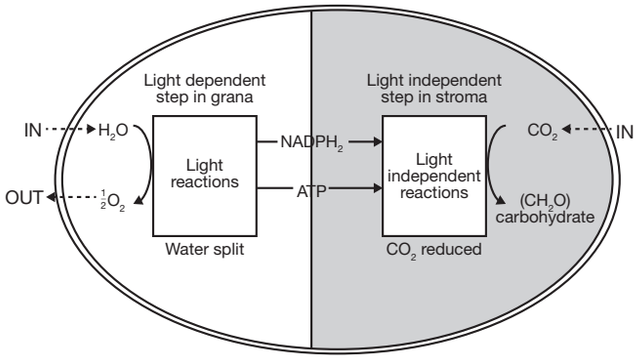
1.3.3.19 The ATP/ADP cycle is linked to cellular respiration as the breakdown of the organic molecules in respiration is a catabolic reaction that releases energy that causes a phosphate to add to ADP forming ATP. Of the energy released in respiration only the energy trapped in ATP is available for metabolic reactions – a proportion of energy is lost as heat.

Science Press ISBN 978-0-85583-8744

1.3.7.6

Feature	Structure	Function
Thylakoid membrane	Flattened disc shape with large surface area.	Photosynthesis takes place on the thylakoid membrane. The large surface area increases the ability to absorb light and cause photoactivation of the photosystems. Since the reactions in the electron transport chain need to occur in a specific order, the large surface area assists in allowing many reactions to occur at the same time.
Space (or lumen) inside thylakoids	Small space between two thylakoid membranes with small volume.	The space inside the thylakoids functions as a H^+ reservoir tvo maintain the concentration gradient for chemiosmosis. Since the space is small, the movement of a few H^+ (protons) can have a significant effect on the concentration gradient and substantially change the pH of the lumen.
Fluid stroma	Material inside the chloroplast containing ribosomes, proteins and small circular DNA.	The light independent reaction occurs in the stroma. The concentration of needed enzymes, e.g. RuBisCO is maintained to assist photosynthesis. Mg^{2+} is needed at the active site for RuBisCO to function correctly and the concentration of Mg^{2+} is maintained at higher levels than typical cytoplasm. To maintain the pH gradient across the membrane the stroma is kept slightly alkaline, e.g. pH = 8.

1.3.7.7



1.3.7.8

(a) Variegated leaves have sections with chlorophyll (green) and other sections which were white (no chlorophyll). Thus, one leaf can be used to test for the need for chlorophyll (comparing white and green sections) and the need for light (comparing area under aluminium foil with exposed area).

(b) To test for starch the students need to remove the aluminium foil and immediately place the leaf in boiling water until it is limp. This kills and softens the leaf. The leaf is then transferred to a beaker of boiling ethanol to remove the green pigment. When the leaf is pale it is placed on a watch glass with a few drops of iodine solution and any change in colour observed.

(c) Results – the green area exposed to the sun will turn blue-black, the rest of the leaf will be white (or slightly yellow from the iodine solution colour).

Science Press ISBN 978-0-85583-8744

1.3.7.14 (a) To investigate the effect of varying light intensity on photosynthesis, the independent variable will be light intensity (the student will need to choose specific levels of irradiance to use) and the dependent variable will be the rate of photosynthesis. Factors that will need to be kept constant are – the species of plant being used and its 'healthiness', the size (surface area) of the leaves, the 'greenness' of the leaves, the temperature, the concentration of carbon dioxide, the humidity around the leaves, water supply to the plant.

(b) Light absorption is dependent upon the number of chloroplasts present and the number of photosynthetic pigments present in each chloroplast – this determines the colour of the leaf and the 'darkness' of the green colour. Increasing light intensity will only increase the rate of photosynthesis until a certain point. If all photosynthetic pigments in a leaf are activated, then the rate of the reaction cannot go faster, and the amount of photosynthetic pigment is a limiting factor. Shade plants usually have dark green leaves (higher concentration of photosynthetic pigments) and plants found in areas with high light intensity usually have a paler green colour (less need for as many photosynthetic pigments).

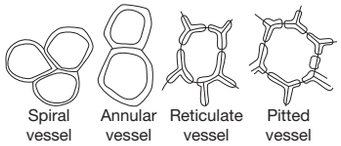
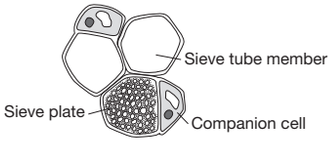
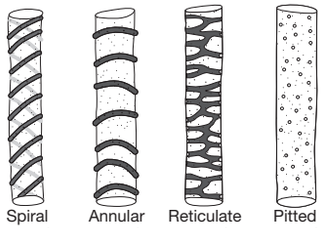
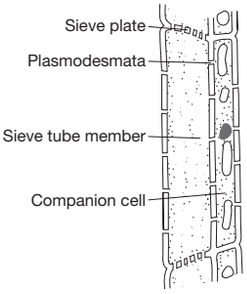
1.3.7.15 The graph shows that the rate of photosynthesis increases as light intensity increases. However, the rate is also dependent on temperature, e.g. for the same light intensity the rate of photosynthesis is higher at 30°C than at 20°C. The graph also shows that the rate of photosynthesis is dependent upon the concentration of CO_2. Higher concentrations of CO_2 enable a faster rate of photosynthesis. Thus, the rate of photosynthesis is dependent upon the interaction of CO_2 concentration, light intensity and temperature.

1.3.7.16 (a) The 'artificial leaf' is a device that uses sunlight to split water into hydrogen and oxygen, e.g. placing in water a silicon multi-junction solar cell with embedded catalysts and collecting each gas on the side of the 'artificial leaf'.

(b) The rising problems caused by climate change and the burning of fossil fuels heightens the need for new technologies that sustainably produce fuels at low cost, and the evolution of the artificial leaf to mimic photosynthesis.

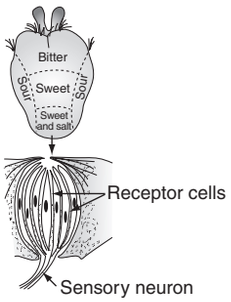
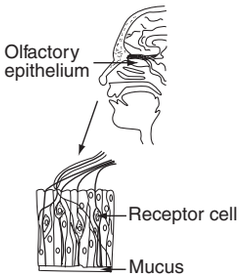
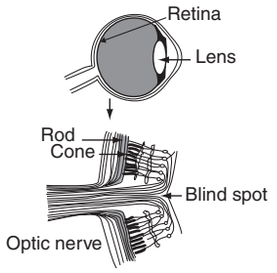
(c) Artificial leaves are not efficient at removing atmospheric carbon dioxide and the process needs to be more economically competitive to dominate the fuel market.

1.3.8.1

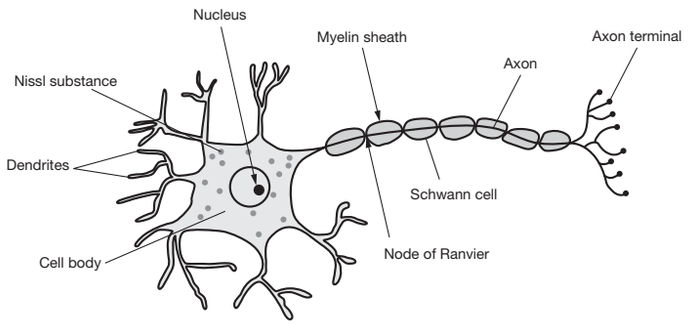
Feature	Xylem	Phloem
Cross-section		
Longitudinal section		
Structure	Xylem vessel elements are long tubular cells that are dead at maturity with no nucleus or cytoplasm. The cell walls are thickened with lignin, e.g. with rings (annular vessels), or spiral bands (spiral vessels), irregular thickened areas (reticulate vessels) or organised pitted areas (pitted vessels). The end walls of the cells break down so that the cells form a continuous tube.	Phloem consists of sieve tube members and companion cells. It is alive at maturity as the companion cell has a nucleus which allows metabolic functioning to occur. Sieve tube members do not have organelles, e.g. nucleus and the end wall between sieve tube members becomes a sieve plate to allow flow from one cell to the next. Plasmodesmata form direct connections between sieve tubes and their companion cell.
Function	Xylem conducts water and mineral salts up the plant and the pits and the structure provides mechanical support for the plant. Perforations in the wall allow lateral movement of water.	Translocates sugars and other organic material up and down the plant. The main sugar is sucrose and the pressure flow theory explains how companion cells use active transport to load or unload sugars into the sieve tube member and the sugars move by bulk flow in the sieve tube member.

1.3.8.2 Tracheids are small, narrow, thin walled, imperforated, have tapered ends and are found in all vascular plants, while xylem vessels are thick walled, perforated, not tapered and are found in most angiosperms, only a few gymnosperms and seedless vascular plants.

Science Press ISBN 978-0-85583-8744

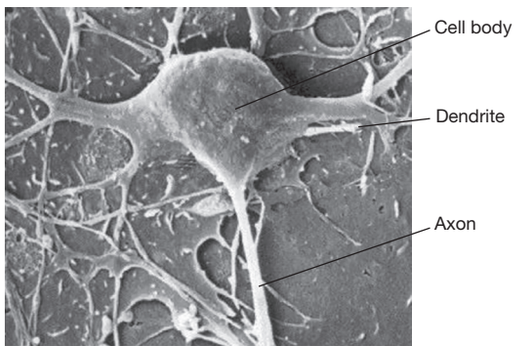
		
Taste receptors are chemoreceptors sensitive to solutions of different chemicals. Taste buds on the upper surface of the tongue detect sweet, sour, salty, bitter. The 'taste' of a food involves stimulation of both taste and smell, e.g. if you have a cold, taste becomes restricted to the above four tastes.	Olfactory receptors are chemoreceptors in the two clefts in the upper part of the nasal passage. Cell bodies of receptors are embedded in the epithelial layer of the walls of the olfactory area of the nasal chamber. Dendrites go from the cell bodies to the surface of the epithelium where hair-like filaments function as receptor sites.	Sight receptors are photoreceptors and the retina contains rod cells which are towards the periphery of the retina and are sensitive in dim light, and cone cells which detect colour, are more abundant in the central region and are used in bright light.

2.1.3.1

Part	Function
Neuron definition	A nerve cell – the functional unit of the nervous system.
Diagram	
Axon	Long process that carries nerve impulses away from the nerve cell body to another nerve cell or effector.
Dendrite	Short processes that carry nerve impulses into the nerve cell body.
Myelin sheath	Insulating coat of cell membrane of Schwann cell that protects axon from damage and speeds up the movement of nerve impulses.
Nissl substance	Granular bodies found in neurons of rough endoplasmic reticulum and site of protein synthesis.
Schwann cell	Type of glial cell that forms the myelin sheath around axon in peripheral nervous system.
Node of Ranvier	Is a gap in the myelin sheath between adjacent Schwann cells that speeds up transmission of nerve impulses as the impulse jumps from one node to the next.

2.1.3.2

(a)



(b) The picture was taken with a scanning electron microscope. The magnification shows it was taken with an electron microscope. The external appearance of the neuron is shown in three dimensions and this indicates the type of electron microscope.

Science Press ISBN 978-0-85583-8744

2.1.5.16 (a) Cytokines are a group of small signalling proteins secreted by several different types of cells, e.g. macrophages, neutrophils, helper T cells that regulate the function of other cells, e.g. for growth, differentiation and to enhance the immune response.

(b) Cytokines are unusual as they have both effector and regulatory activities.

(c) Cytokines include interferons, interleukins, lymphokines and chemokines.

(d) Diagram A shows cytokines acting in an autocrine manner with signalling affecting the producer cell to cause a cell response while diagram B shows cytokines acting in a paracrine manner with signalling affecting neighbouring cells to cause a cell response.

2.1.5.17 (a) Pheromones are small volatile or water soluble chemicals used in communication, e.g. in animals and fungi that act in a hormone-like manner in influencing behaviour and physiology of the same species.

(b) Signalling pheromones will induce a behaviour response which is usually fast acting while priming pheromones act on individuals to modify development which is usually not as fast acting.

(c) Any of the following can be used – e.g. many species use signalling sex pheromones to attract partners for mating, such as yeast, water mould, slime mould, insects (ants, moths, bees, butterflies, wasps), and mammals (pigs, cows, dogs). Alarm pheromones are released to signal a certain type of behaviour is needed, e.g. causing aggression in ants, bees and termites or flight in aphids. Trail pheromones are released by social insects such as ants which lay down a trail from nest to food for others of their colony to follow. The 'queen factor' is a priming pheromone released by the queen bee in a hive to keep worker bees in a sterile female state. If the colony gets too large the pheromone is diluted and another queen may arise. In rats if there is a group of females without a male they release a pheromone that lengthens or stops their oestrus cycles. In mice the male mouse urine which contains pheromones can accelerate puberty in young female mice.

2.1.5.18 (a) Signal transduction is the transmission of a molecular signal from the exterior of the cell into its interior using cell surface receptors.

(b) Signal transduction is highly important in cell functioning and maintaining homeostasis. It enables a cell to sense physical and chemical stimuli in its environment. Once a stimulus is recognised the signal transduction pathway is activated leading to intracellular activities that produce an appropriate response for that stimulus.

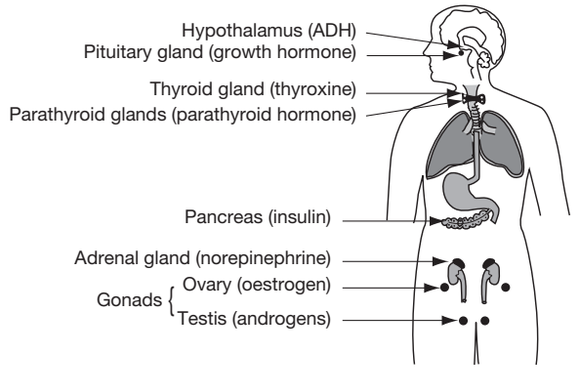
(c) Water soluble hormone ⟶ membrane signal receptor ⟶ reactions produce secondary messengers ⟶ cytoplasmic responses and/or gene regulation which causes further cytoplasmic responses.

(d) A multi-step pathway means the signal can be amplified and allows a fine tuned and coordinated response.

(e) Malfunction or damage to cell surface receptors is associated with many diseases, e.g. asthma, heart disease, cancer.

2.1.6.1 Hormones are signal chemicals that are produced in specialised cells, travel in the blood and body fluids and act on specific target cells to cause a specific response.

2.1.6.2



2.1.6.3

Lymphatic system	Circulatory system
Lymph Lymph nodes Lymph vessels Tonsils, thymus, spleen, Peyer's patches	Heart Blood vessels Blood

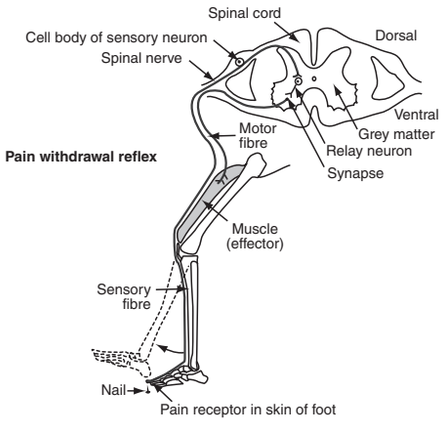
2.1.6.4 The secretion of hormones can be stimulated or inhibited by: 1. Other hormones, e.g. stimulating hormones or releasing hormones. 2. Neurons or mental activity. 3. Environmental changes, e.g. temperature, light. 4. Plasma concentrations of ions or nutrients including globulins.

2.1.6.5 Target cells or organs are cells which respond to stimulation by a hormone, e.g. the target cells for the hormone prolactin are the milk-producing cells of the breast.

2.1.6.6 The pituitary gland is often called the 'master gland' as its hormones stimulate other endocrine glands to secrete hormones, e.g. anterior pituitary produces thyroid stimulating hormone that stimulates the thyroid gland to produce thyroxine.

Science Press ISBN 978-0-85583-8744

2.1.8.4 (a)



(b) The pain withdrawal reflex is an involuntary action in which the body detects pain and immediately tries to move away from the source of pain to reduce or eliminate the pain.

(c) The leg muscle is the effector.

2.1.8.5 The flow chart shows positive feedback for the birth of a baby. This flow chart shows the stimulus as the head of the baby is pushing against the cervix. Receptors in the cervix detect the pressure and a message is sent to the brain (control centre) which stimulates the posterior pituitary gland to release oxytocin. The oxytocin hormone travels in the blood to the uterus to start contractions and the placenta is stimulated to produce prostaglandins which also stimulate uterine contractions. Positive feedback occurs with the contractions stimulating further release of oxytocin.

2.1.9.1 Tolerance limits refers to a set of environmental conditions needed for survival of an organism or cell or for metabolic functioning.

2.1.9.2 Endotherms use internal metabolic processes to control their body temperature, e.g. mammals and birds. Whereas ectotherms use the energy from their environment to regulate their body temperature, e.g. fish, reptiles, amphibians and all invertebrates.

2.1.9.3 The body temperature of endotherms is balanced by controlling heat production with heat loss. If core body temperature falls below a set point, e.g. 35°C for a human, they will suffer hypothermia. The low temperature affects normal metabolism and body functioning. If core body temperature rises above the normal set point, without a change in the temperature set point the endotherm has hyperthermia, e.g. heat stroke.

2.1.9.4 (a) The sweat glands are exocrine glands – coiled tubes that connect to the skin surface by ducts.

(b) Sweat glands release sweat through the duct to the sweat pore under the control of the nervous system. Evaporative cooling uses heat from the body for the surface water molecules in the sweat to evaporate from liquid to gas. This stops the body from overheating.

2.1.9.5 (a) A change in internal body temperature in humans is detected by thermoreceptors in the hypothalamus in the brain.

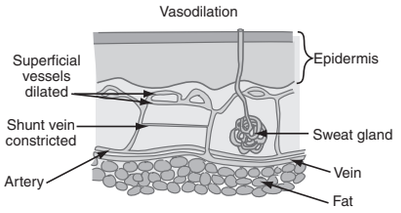
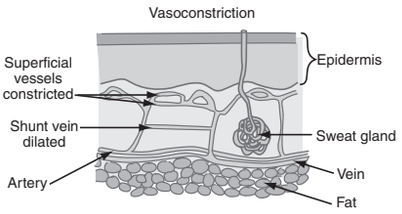
(b) The effector is the muscles controlling the diameter of blood vessels. The muscles cause the blood vessels to dilate to help cool the body, or to constrict to help warm the body.

(c) In this example if there is a temperature increase (initial situation) and the hypothalamus sends a message to cause blood vessels to dilate to drop body temperature (response that becomes the new stimulus) then this response will be switched off (negative feedback).

Science Press ISBN 978-0-85583-8744

2.1.9.8 Thermogenesis means the production of heat, e.g. by the body of an animal.

2.1.9.9

Body response	Diagram	How it assists regulating body temperature.
Vasodilation of skin arterioles		Vasodilation increases the diameter of superficial blood vessels, e.g. arterioles near the skin surface. Nerve signals relax the muscle walls of the blood vessels leading to an increase in blood flow to the skin which becomes warmer and takes on a pinkish colour (flush). Heat is transferred by radiation, conduction and convection to cool the body.
Vasoconstriction of skin arterioles		Vasoconstriction decreases blood flow to the superficial blood vessels by decreasing the diameter of blood vessels near the skin surface. This keeps blood away from the surface giving the skin a bluish colour, reduces heat loss and keeps the body warmer.

2.1.9.10 Drinking water increases the internal supply of water which increases the water available for evaporative cooling, e.g. from sweat glands in the skin. Moving location/habitat to a cooler area, e.g. in the shade reduces the temperature difference between body and environment putting less stress on body thermoregulatory mechanisms.

2.1.9.11

Feature	Details of feature
Core body temperature	Normal human core body temperature is 37°C. If the thermometer is placed under the tongue the accepted normal range is 36.8°C ± 0.4°C.
Skin temperature	Skin temperature, unlike core temperature, can rise and fall with the temperature of the surroundings and there is no 'normal' skin temperature, varying from 28°C when exposed to low ambient temperature, e.g. less than 10°C, to 37°C on a hot day, e.g. over 35°C.
Hypothermia	If core body temperature falls below 35°C a person will suffer hypothermia. The low temperature causes numbness in extremities, altered heart rate and breathing, drowsiness and rigidity in muscle. It affects normal metabolism and body functioning and severe hypothermia is life threatening.
Hyperthermia	If core body temperature rises above the normal set point, without a change in the temperature set point the person has hyperthermia, e.g. heat stroke. Stages of hyperthermia include heat stress, heat fatigue, fainting, heat cramps, heat oedema, heat rash, heat exhaustion.
Fever	A fever occurs when the core temperature is set higher by the heat control centre and hypothalamus in response to an infection.
Allergies	Allergies are harmful immune responses to particular substances, e.g. food, pollen, fur, dust. Agents used in production of clothing, e.g. resins, dyes, glues, chemical additives, tanning agents and some fibres can cause irritant and allergic contact dermatitis.

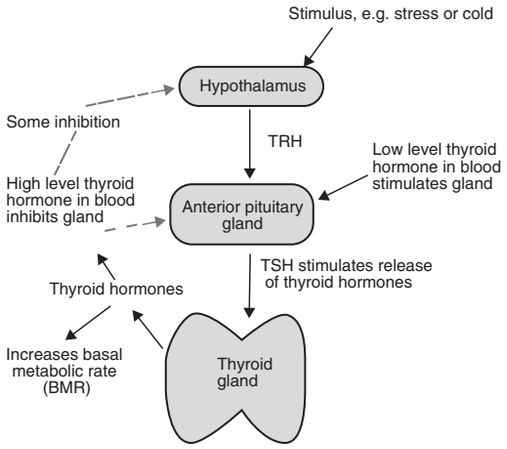
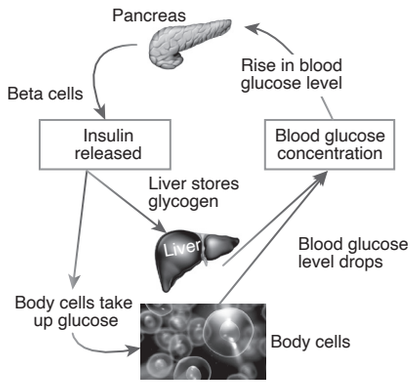
2.1.9.12

(a) Computer models for designs of clothing and environments need to enter precise data about human thermoregulatory responses to different temperatures and conditions so that simulations can be run to determine safety levels for new products and if these products and designs will function in a suitable manner. For example, the design of new clothing for firefighters needs to be tested under extreme heat conditions to make sure the materials will not burn, will protect the firefighter, prevent the person overheating while wearing the clothing and be light and flexible enough to allow freedom of movement to carry out their job. It is cost effective to carry out simulations before actual testing of materials and design.

(b) Computer modelling has been used to design clothing for – military chemical suits, industrial protective clothing, space suits and clothing for firefighters.

Science Press ISBN 978-0-85583-8744

2.1.9.13

Feature	Thyroid hormones	Insulin
Where it is produced	Thyroid gland produces two main hormones thyroxine (T_4) and triiodothyronine (T_3) and also secretes calcitonin.	Beta cells in the pancreas.
Function	T_4 and T_3 increase basal metabolic rate and bring about the release of energy when complex molecules are synthesised from simple molecules. They are also necessary for cellular differentiation. Calcitonin inhibits the release of calcium from bones.	It stimulates nearly all body cells to take up glucose and also slows down glycogen breakdown in the liver and stopping the conversion of glycerol and amino acids to glucose.
Diagram of regulation		
How it aids thermoregulation	Increasing basal metabolic increases heat production and thyroxine can be released in response to a decrease in body temperature.	Insulin receptors in the hypothalamus gland lead to messages sent to brown adipose tissue to release heat.
Disorder	Hyperthyroidism is the overproduction of thyroxine and causes nervousness, insomnia and excessive excitability; heat intolerance and excessive sweating; increased heart rate and blood pressure; and weight loss.	Diabetes mellitus is caused by a deficiency of insulin or a reduced response of target cells to insulin. Symptoms include excessive thirst, blurred vision, feeling hungry, slow healing cuts, fatigue. Increasing environmental temperatures increase the risk of hypoglycaemia (low blood glucose) for diabetics.

2.1.9.14

Factor	How it affects metabolic activity
Temperature	At higher temperatures molecules have more kinetic energy and there are more successful collisions between the enzyme and substrate increasing the rate of reaction until the optimal temperature is reached. At temperatures above the optimal temperature the three-dimensional shape of an enzyme is disrupted with the inter- and intramolecular bonds (e.g. hydrogen or S-S bonds) broken which becomes irreversible if the protein breaks down (denatures). At low temperatures molecules have less kinetic energy leading to a low rate of reaction.
pH	The rate of most metabolic processes is controlled by enzymes. Each enzyme has optimal activity at a specific pH and only functions within a small pH range. Changes in pH can affect the inter- and intramolecular bonds causing a change in shape of the enzyme which will be irreversible if the enzyme denatures.
Salt concentration	Intercellular and intracellular reactions function at optimal salt (electrolyte) concentrations. Changes in salt concentrations affect osmotic pressure leading to the movement of water into/out of cells which affects the rate of chemical reactions.
Substrate concentration	The rate of reaction increases until the point of saturation, after which other limiting factors prevent a further increase in the rate of reaction.
Presence of cofactors	Cofactors are needed for the binding of the substrate to the enzyme at its active site, e.g. metal ions such as iron, copper, zinc, manganese, or organic coenzymes, e.g. many vitamins.

2.1.9.15

Heat transfer process between environment and human	
Input	**Output**
Radiation from sky Reflected sunlight Direct sunlight radiation Radiation from ground	Heat radiation. Respiratory evaporation Heat convection. Sweating Urination Conduction to ground

Science Press ISBN 978-0-85583-8744

2.2.16.4 It is highly important to recognise and protect the intellectual property rights of those with knowledge of particular bush medicines. Intellectual property is the property of your mind or privately owned knowledge. Recognition and protection will ensure that the use of traditional remedies by traditional owners of the knowledge is not forbidden due to the development of new drugs based on components from traditional remedies.

2.2.16.5

Plant used	Diagram of plant	Illness	Treatment
Alstonia actinophylla, milkwood tree		Skin sores.	The toxic milky sticky sap is an irritating latex that is applied to sores. Care is needed not to touch the sap with fingers as if it touches the eyes it can cause blindness.
Cymbopogon ambiguous, lemon grass		Colds and chest congestion. Diarrhoea. External wash for fever. Ear ache.	Made into a tea or steam inhalation for colds and chest congestion, treat diarrhoea. Boiled leaves as an external wash. Grass tufts can be stored and dried remains used to make a tea. Roots made into concentrated liquid and put into ears for ear ache.
Ehretia saligna, peach bush		Aches and pains. Coughs. Asthma. Fever. High blood pressure. Skin sores and scabies.	Crushed leaves made into a tea, strained and drunk as a tonic.
Grewia retusifolia, dysentery bush		Diarrhoea.	Roots made into a tea and drunk and/or the leaves can be chewed or made into a concentrated tea.
Melaleuca alternifolia, tea tree		Wound antiseptic. Cough and colds. Bandages.	Tea tree oil from crushed leaves is made into a paste and applied to wounds as an antiseptic. Oil inhaled for coughs and colds. Bark wrapped as bandage.
Pemphis acidula, digging stick tree		Toothache.	Tip of burnt twig applied to site of a toothache.
Tinospora smilacina, snake vine		Headache. Stings.	Crushed vine wrapped around the head treats headaches. Root poultice uses to treat stings.

Science Press ISBN 978-0-85583-8744

Index

Science Press ISBN 978-0-85583-8744