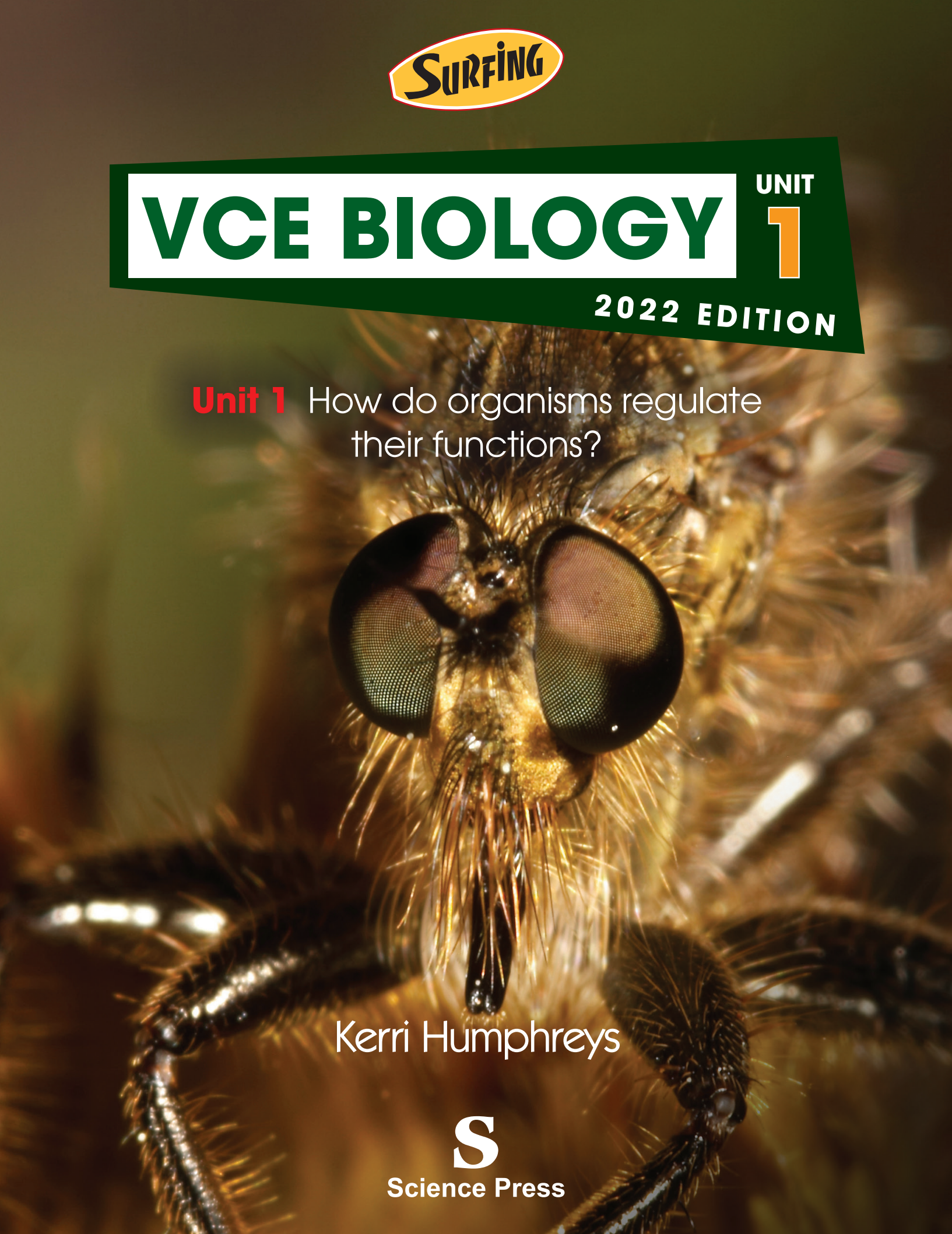
SURFING

VCE BIOLOGY UNIT 1

2022 EDITION

Unit 1 How do organisms regulate their functions?



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Science Press

SURFING

VCE BIOLOGY UNIT 1

2022 EDITION

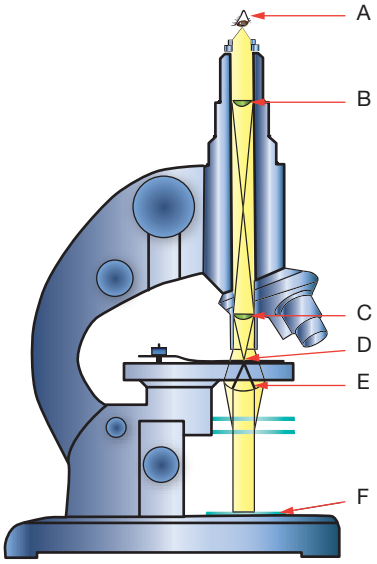
Area of Study 1

How do cells function?

1 Assumed Knowledge

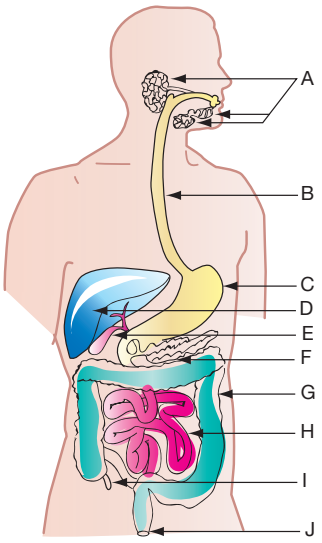
1. Identify seven properties of living organisms.
2. The cell is the basic unit of life. What structural features of cells are possessed by all living things?
3. Draw a fully labelled diagram of a plant cell as seen under a light microscope.
4. Draw a fully labelled diagram of an animal cell as seen under a light microscope.
5. Identify the following parts of a light microscope and use by a person.

Figure 1.1 Light Microscope.



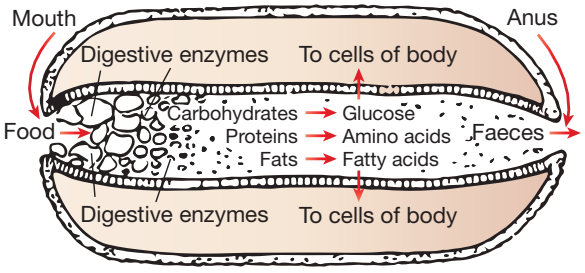
6. Describe one safety precaution you should follow while using a light microscope.
7. What is the function of the nucleus of a cell?
8. What is the function of the cell membrane?
9. What is cytoplasm?
10. Define protoplasm.
11. Describe a chloroplast.
12. Define photosynthesis.
13. Which group of organisms can photosynthesise?
14. Identify the materials required by multicellular organisms for photosynthesis.
15. What is the function of the digestive system?
16. Figure 1.2 shows the human digestive tract. Identify each part.
17. For each of the following parts of the digestive system, outline its structure and its main function.
    (a) Mouth
    (b) Oesophagus
    (c) Stomach
    (d) Small intestine
    (e) Large intestine
    (f) Anus

Figure 1.2 Human Digestive Tract.



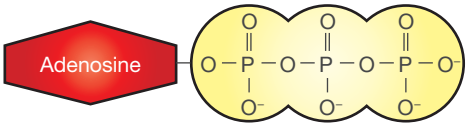
18. In plants, what is the function of each of the following?
    (a) Xylem (c) Leaves
    (b) Phloem (d) Roots
19. The diagram shows a simple model of digestion

Figure 1.3 Simple model of digestion.



    (a) From this model what foods are broken down into:-
        (i) Glucose
        (ii) Amino acids
        (iii) Fatty acids
    (b) Explain why scientists make simple models such as this simple model of digestion.
20. What is meant by cellular differentiation?
21. Define osmosis.

Figure 1.4 Biomolecule.



22. Identify the chemical is the Figure 1.4 and explain why it is important in active transport and many cellular chemical reactions.

2 Characteristics of Living Things

There are nine characteristics of living things. These characteristics are used to define life.

1) Growth and Development

Growth involves an increase in mass. This can occur due to an increase in the size of individual cells and/or an increase in the number of cells.

2) Reproduction

Reproduction is the ability to produce offspring. Reproduction can be asexual or sexual. **Asexual reproduction** involves one parent producing offspring that are genetically identical to the parent eg by binary fission, budding or vegetative propagation. **Sexual reproduction** involves the union of two **gametes** in **fertilisation** to form a **zygote**.

3) Respiration

All living things can respire. Cellular respiration is a series of chemical reactions in which cells obtain energy from food. Each step in the series of reactions is controlled by enzymes with the energy being released at different stages in the process. Some of the energy is transferred to other molecules becoming available for other reactions.

4) Respond to Stimuli

All living things respond to stimuli from both their external environment and their internal environment. The stimuli can be physical or chemical changes in the environment eg a response to the intensity and direction of light or a change in the carbon dioxide levels in body fluids.

5) Movement and locomotion

Movement can be very obvious eg a running animal or very slow and involve only part of the organism eg a plant leaf moving to catch the maximum amount of sunlight. Locomotion is the ability to move from one place to another.

6) Nutrition or Feeding

Nutrition is a process by which organisms obtain **matter** to produce their physical structure and **energy** to continue the functions of life. **Autotrophs** can make their own organic nutrients from inorganic materials eg plants and cyanobacteria can use the energy from sunlight in **photosynthesis** and bacteria living in hot springs or oceanic hydrothermal vents use the energy in hydrogen sulphide (H_2S) in chemosynthesis. Heterotrophs consume other organisms to obtain organic nutrients. Their food needs to be broken down before it can be used.

7) Assimilation

Assimilation is the process of converting food into the living material of life.

8) Metabolism

Metabolism is the sum of all chemical reactions within the organism. In **anabolic reactions** small molecules are combined to form complex molecules eg photosynthesis. In **catabolic reactions** chemical bonds are broken and complex molecules are broken down into smaller units, eg digestion. Sometimes energy is released.

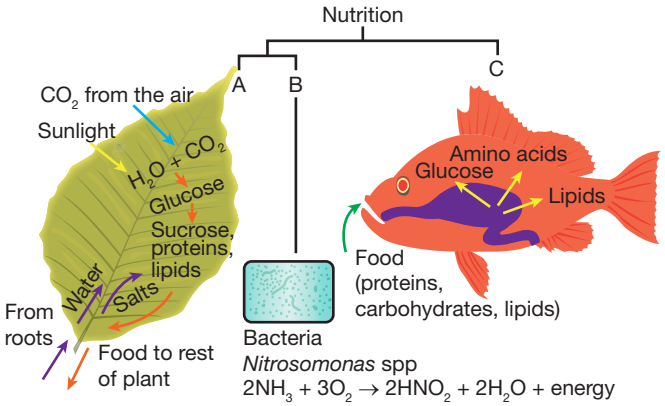
9) Excretion

Excretion is the removal of unwanted waste products of metabolic reactions.

QUESTIONS

1. Construct a table to summarise the nine characteristics of living things.
2. Distinguish between asexual reproduction and sexual reproduction.
3. Define *fertilisation*.
4. Crystals can grow in size. Explain why crystals are not considered to be living though they show a characteristic of living things.
5. Distinguish between autotrophic and heterotrophic nutrition.
6. Distinguish between photosynthesis and chemosynthesis.
7. The diagram shows one of the features of living things.

Figure 2.1 A feature of living things.



   (a) For the types of nutrition labelled A, B and C, which are autotrophic and which are heterotrophic?
   (b) What is the energy source for the bacteria *Nitrosomas spp*.?
8. Distinguish between an anabolic reaction and a catabolic reaction.
9. Is respiration a catabolic or anabolic reaction? Explain your reasoning.

3 The Modern Light Microscope

The compound light microscope operates on the main principle that an objective lens with a very short focal length can form a highly magnified real image of the object. Visible light passes through the specimen and then a series of lenses. The resolution of the microscope is limited by the shortest wavelength of light used to view the specimen.

Images from a light microscope can be captured with a camera to produce a **photomicrograph**. Digital images can be shown directly on a computer screen.

Table 3.1 Features of the Modern Light Microscope.

Feature	Light Microscope
Magnification	Effective up to 1000×
Resolution	Up to 0.2 µm
Stains	Allows the use of many different coloured stains to identify substances, structures and provide contrast for easier viewing
Living specimen	The light microscope allows viewing of living specimen and processes occurring within a cell or within an organism.
Mounting	The specimen is mounted on a glass slide in air
Focusing	By glass lenses
Energy source for viewing	A beam of light is passed through the specimen

How a light microscope works

The objective lens is brought close to the specimen to create an enlarged image of the object. The image is inverted. In most modern light microscopes the eyepiece is a compound lens near the back of an eyepiece tube. Light travels from the light source up the microscope to form an image at the eye.

Figure 3.1 How light travels through a light microscope.

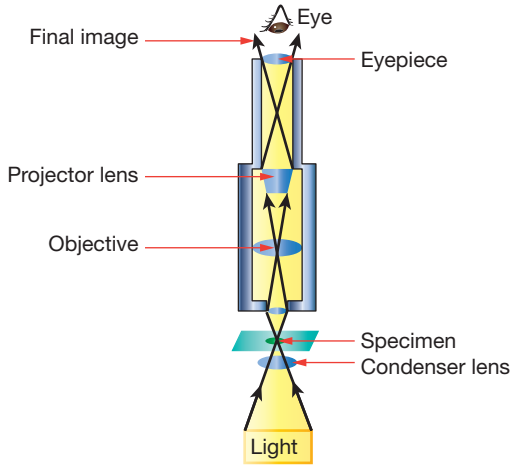
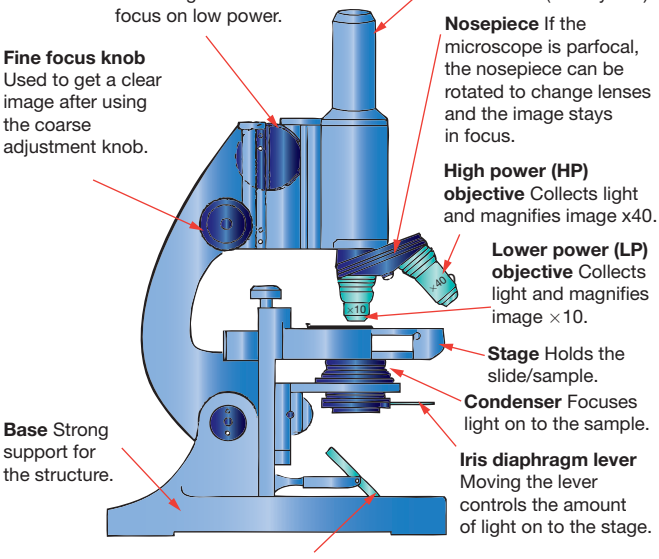


Figure 3.2 Features of the Modern Light Microscope.



Advantages of a light microscope

The main advantages of light microscopes are that –

- living cells can be observed
- coloured stains can be used
- the specimens are easy to prepare
- the microscopes are relatively inexpensive (compared to the cost of an electron microscope)
- their size means they are relatively easy to store.
- Disadvantages of a light microscope
- The main disadvantages of the light microscope is –
- its limited magnification (effective magnification begins to reduce after 1000×)
- its limited resolution.
- During the 20th century many different illumination techniques and other developments have increased the detection power of the light microscope for observing living cells.

Phase contrast microscope

The phase contrast microscope uses interference rather than absorption of light to increase the contrast in unstained cells by amplifying variations in density within the cell. It improves our ability to study living, unpigmented cells in biological and medical research. Many dyes and stains stop chemical processes in cells which means the phase contrast microscope has improved our ability to see detail in living cells eg the process of cell division. Fritz Zernike was awarded with the Nobel Prize in Physics, 1953 for the development of phase contrast illumination.

4 The Electron Microscope

The electron microscope provides greater detail about cell structure. The electron microscope sends a stream of electrons through a vacuum. The electron beam is focused by electromagnets, magnified by an objective lens and projected onto a fluorescent screen or photographic film. Since the beam of electrons has a much shorter wavelength than visible light resolution is greatly improved eg approx 0.002 nm, although in practical situations it can be limited to 2 nm. Typically they provide a resolution of 0.5nm (400 times better than a light microscope) and magnify up to 500,000 times.

Transmission Electron Microscope

The transmission electron microscope (TEM) uses the same basic principles as the light microscope with a beam of electrons passing through the specimen instead of a beam of light. The TEM is used to study the internal ultrastructure of cells. The specimen is stained with heavy metal atoms which attach to particular cellular structures, preserved by a chemical fixative, embedded in plastic then cut into exceedingly thin slices (50-100nm). You can see objects to the order of a several nanometres (10-9 m) increasing the capacity for medical, biological and materials research. Many organelles were discovered using the TEM eg ribosomes. One of the main disadvantages of the TEM is that the method of specimen preparation kills the cells and the specimen is viewed in a vacuum. This means living cells cannot be viewed. Specimen preparation also produces artefacts and structural features that do not exist in living cells.

Figure 4.1 Features of the Electron Microscope.

Feature	Electron microscope
Magnification	Up to 300 000×.
Resolution	Approximately 0.0005 μm.
Stains	Heavy metal stains identify substances, structures and provide contrast for easier viewing. No colour stains.
Living specimen	The electron microscope does not allow viewing of living cells.
Mounting	Metal background in a vacuum chamber.
Focusing	By electromagnetic lenses.
Energy source for viewing	A beam of electrons is passed through the specimen.

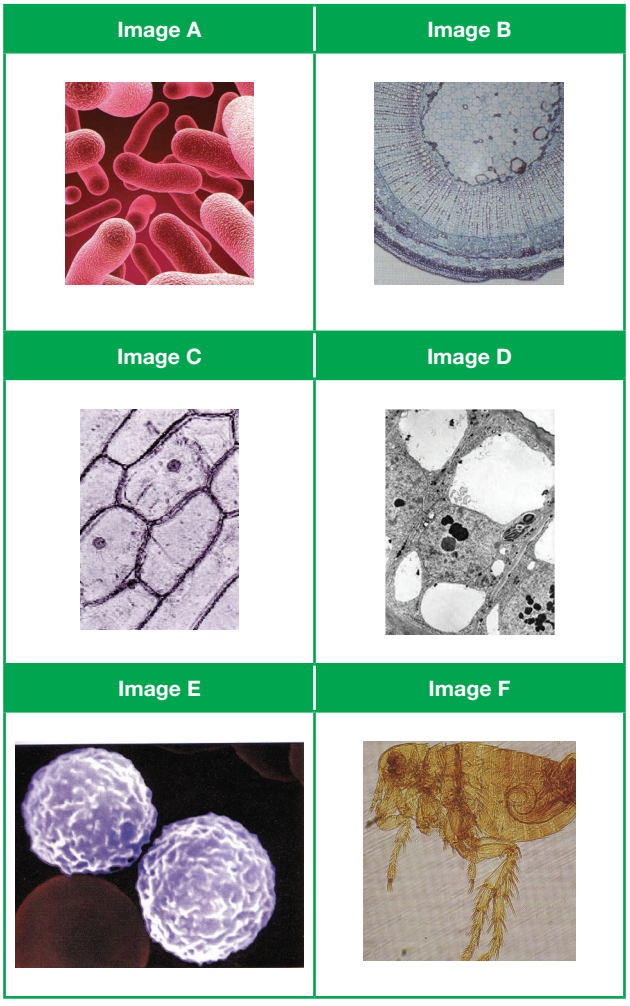
Scanning Electron Microscope

The scanning electron microscope (SEM) emits an electron beam which is rapidly passed back and forth over the surface of the specimen. Surface variations alter the pattern of the scattering of the electrons and the pattern is recorded, amplified and transmitted to a TV monitor. This gives a three-dimensional detailed view of the surface of the specimen. The image has great depth of field.

QUESTIONS

1. Outline why the electron microscope has better resolution than the light microscope.
2. Outline the basic principle behind the operation of an electron microscope.
3. Construct a table to compare the advantages and disadvantages of a light microscope.
4. Discuss the importance of the transmission electron microscope.
5. Discuss the importance of the scanning electron microscope.
6. Identify the type of microscope that was used to view each of the following.

Figure 4.2 Images from different types of microscopes.



7. What is the limit of resolution of a transmission electron microscope?
   - (A) 0.5 centimetres
   - (B) 0.5 millimetres
   - (C) 0.5 micrometres
   - (D) 0.5 nanometres

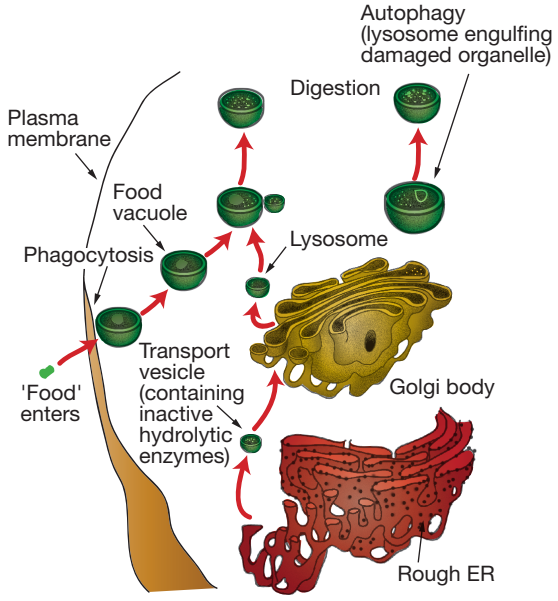
20 Electron Microscope and Cell Organelles

The invention of the electron microscope allowed cell organelles (or little organs) to be seen in more detail, or seen for the first time.

Lysosomes

Lysosomes are small membrane-bound sacs which contain enzymes. The enzymes break down large molecules such as fats, proteins and polysaccharides and recycle the unwanted material inside the cell.

Figure 20.1 Lysosomes digest material taken into the cell and recycle unwanted material inside the cell.



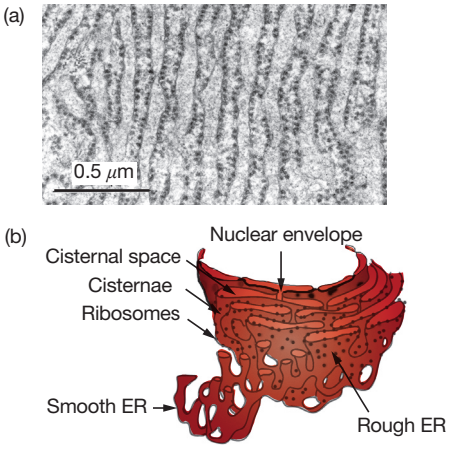
Endoplasmic Reticulum

The endoplasmic reticulum is a large network of membranes throughout the cell. It is involved in transport of materials in the cell. Rough endoplasmic reticulum has ribosomes on its surface. The ribosomes are the site of protein synthesis. Smooth endoplasmic reticulum has no ribosomes and is involved in the production of enzymes that assist with making various chemicals eg. steroids, lipids and assists in inactivating some drugs eg. alcohol.

Ribosomes

Ribosomes are particles made of ribosomal RNA and protein and they carry out protein synthesis. There are free ribosomes in the cytosol and bound ribosomes attached to the endoplasmic reticulum. The free ribosomes mainly produce proteins that function within the cytosol. As all ribosomes are structurally identical they can alternate between these two roles.

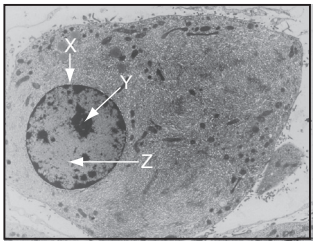
Figure 20.2 Endoplasmic reticulum. (a) Electron micrograph. (b) A system of tubes and flattened sacs within the cell. Ribosomes cover the rough endoplasmic reticulum and are the site where protein synthesis takes place.



QUESTIONS

1. Outline the function of lysosomes.
2. Identify the dark spots attached to endoplasmic reticulum and outline their function.
3. The following electron micrograph shows a cell.

Figure 20.3 Electron micrograph.



Identify the parts labelled X, Y and Z.

4. Explain why lysosomes are needed in a cell.
5. State two advantages and two disadvantages of the light microscope compared with the electron microscope.
6. Explain how the structure of endoplasmic reticulum is related to its function.
7. Which of the following organelles are found in both plant and animal cells?
   (A) Nucleus, nucleolus, cell wall, very large vacuoles
   (B) Endoplasmic reticulum, chloroplasts, nucleoli, ribosomes
   (C) Nuclear membrane, mitochondria, endoplasmic reticulum, lysosomes
   (D) Ribosomes, cell membrane, cell wall, mitochondria
8. Which of these organelles can only be seen under an electron microscope?
   (A) Mitochondria (C) Golgi body
   (B) Chloroplasts (D) Ribosome

The table shows some of the body parts associated with each germ layer.

Table 44.1 Body development from three embryonic germ layers

Ectoderm	Mesoderm	Endoderm
Skin epidermis Sensory receptors in skin Epithelial lining of mouth and rectum Nervous system	Notochord Skeletal and muscular system Excretory system Circulatory and lymphatic systems Dermis of skin	Epithelial lining of digestive tract and respiratory system Liver and pancreas Thyroid and parathyroid glands Lining of urethra, urinary bladder and reproductive system

Adult Stem Cells

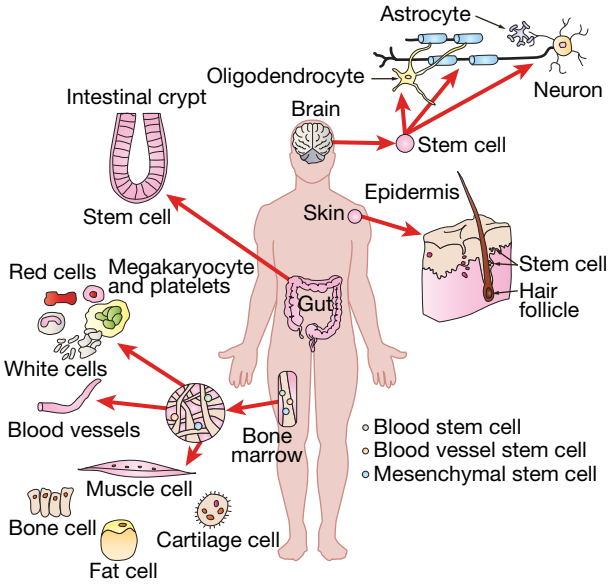
Adult stem cells or tissue-specific stem cells are unspecialised and undifferentiated and found in particular locations in the body. They divide and produce new cells for repair and maintenance of body parts. The daughter cells will differentiate and become specialised with specific structures and functions. There are several types of adult stem cells eg hematopoietic stem cells in the bone marrow, mammary stem cells, intestinal stem cells, mesenchymal stem cells, endothelial stem cells, neural stem cells, testicular stem cells, olfactory adult stem cells and neural crest stem cells.

Neurospheres are free-floating clusters of neural stem cells cultured in vivo. Investigations into neurospheres aim to isolate neural stem cells which could be used in treating brain diseases.

QUESTIONS

1. Define a stem cell.
2. What are totipotent stem cells and where are they found in mammals?
3. What are pluripotent stem cells and where are they found in mammals?
4. What are multipotent stem cells and where are they found in mammals?
5. What is a blastocyst?
6. In humans what happens to the blastocyst?
7. What is the trophoblast?
8. What happens to the trophoblast?
9. Which cells of the blastocyst become the embryo?
10. In humans when does an embryo become a foetus?
11. Define organogenesis.
12. Jellyfish and corals are diploblastic with an ectoderm and an endoderm. How does this compare with humans and other vertebrates?
13. What is cell differentiation?
14. Describe adult stem cells.
15. What is the function of adult stem cells?
16. In humans what body parts develop from –
    a) Ectoderm
    b) Mesoderm
    c) Endoderm
17. The diagram shows the location of stem cells in an adult human.

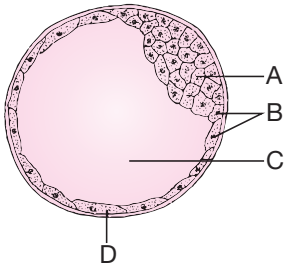
Figure 44.3 Location of stem in in an adult human.



Construct a table to show the location of stem cells in the human body and the cell types that are produced at that site.

18. What are induced pluripotent stem cells?
19. Which cells are likely to form from hematopoietic stem cells?
    (A) Lining of blood vessels
    (B) Mammary gland cells
    (C) Lining of the lung
    (D) Blood cells
20. The diagram shows a blastocyst.

Figure 44.4 Blastocyst.



Which part of the blastocyst has the stem cells that will develop into the embryo and give rise to all cells of the body?
(A) Part A
(B) Part B
(C) Part C
(D) Part D

SURFING

VCE BIOLOGY UNIT 1

2022 EDITION

Area of Study 2

How do plant and animal systems function?

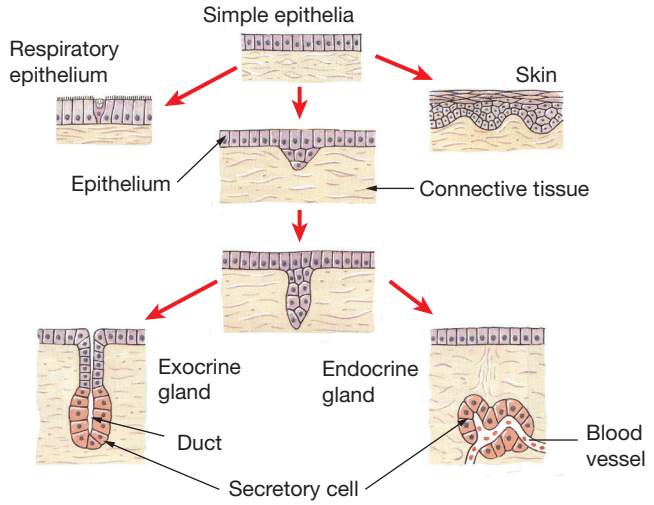
45 Differentiation and Specialised Cells

Differentiation is a process when a young, relatively unspecialised cell develops into a more mature state to become a more specialised cell. When cells differentiate they are no longer similar to the parent cell in structure or function. Specialised cells carry out particular functions leading to a division of labour which means particular tasks can be carried out more efficiently.

Cell specialisation occurs when there is **differential gene expression**. The nucleus of each nucleated cell (except gametes which are haploid and have half the number of chromosomes) has a full set of chromosomes. When a specific gene is 'switched on' the cell can change structure and shape so that it becomes specialised to carry out a particular function. Differentiated cells have genes that are switched on that make them specialists in making tissue-specific proteins. For example muscle cells are specialised to produce the proteins myosin and actin which are needed for muscle contraction. In the human body there are over 200 recognizably different types of cells.

Tissues are groups of cells carrying out a particular function. A tissue may have only one kind of cell or several kinds of cells. There are four main types of mammalian tissue.

Figure 45.1 Epithelial Tissue.



Epithelial Tissue

Epithelial tissue (epithelia) covers many surfaces and linings of body cavities. Endothelia lines internal cavities. Epithelial tissue acts as a protective layer and as a barrier against infection by microbes or water loss. Epithelial tissue is found in the outer part of the skin and the linings of the digestive tract, the lungs, the blood vessels, the body cavity and various ducts.

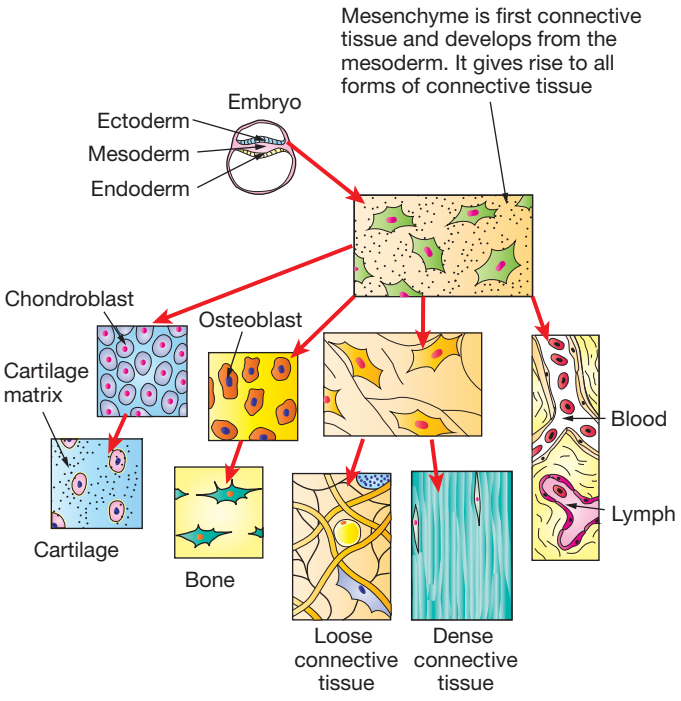
Epithelial cells group together to form sheets which can be strengthened with bundles of filaments running from cell to cell. Simple epithelia can be squamous (flat), cubical or columnar with some having microvilli on one side. Microvilli increase the surface area of the cell to aid the movement of substances into and out of the cell eg in the small intestine and the walls of kidney tubules. Epithelium tissues is usually separated from the underlying tissue by an extracellular fibrous **basement membrane**. The basement membrane is usually made of a network of white, wavy, non-elastic collagen fibres.

Epithelia can differentiate to form the secretory cells of glands or become sensory cells eg olfactory cells in the nose. The gland cells can be unicellular gland cells or a section of the epithelial tissue can invaginated to form a multicellular gland such as an endocrine gland (ductless gland) or an exocrine gland (has duct)

Connective Tissue

Connective tissue is found in many areas of the body and includes bone, cartilage, blood, tendons and ligaments. A large proportion of connective tissue is an intercellular matrix that contains a network of protein fibres in a semiliquid ground substance. The matrix is secreted by connective tissue cells and can be liquid, semisolid or solid. Blood and lymph have liquid matrixes. Connective tissue contains **collagenous fibres** which are non-elastic and do not easily tear when puled lengthwise, **elastic fibres** which can stretch and return to their original length and **reticular fibres** which are thin, branched and crosslink to form a fine network..

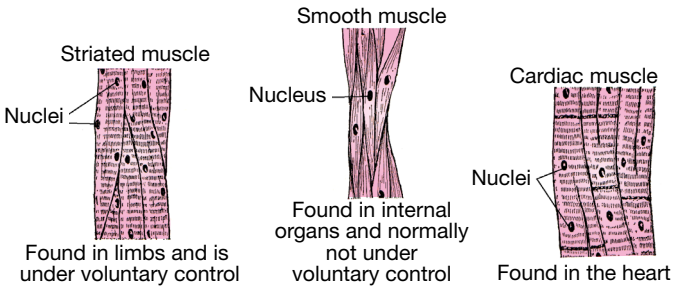
Figure 45.2 Connective tissue.



Muscle Tissue

Muscle tissue is specialised to convert chemical energy in ATP into mechanical energy for movement. Smooth muscle forms the walls of many internal cavities eg intestines, blood vessels and bladder. Striated muscle is connected to bones either directly or via a tendon to give voluntary motion. The heart is made of cardiac muscle.

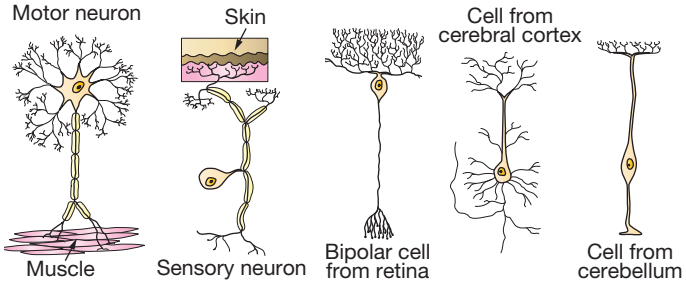
Figure 45.3 Muscle tissue.



Nervous Tissue

Nervous tissue consists of specialised cells called neurons (nerve cells) and glial cells. The stem cells in the embryonic brain produce both neurons and glia. A neuron consists of dendrites which pick up the signal and transmit the impulse from their tips to the rest of the neuron. There are several types of neurons eg in the retina there are bipolar cells and ganglion cells and in the brain the neurons of the cerebellum are different to the neurons of the cerebral cortex. Motor neurons take messages from the central nervous system to muscles or glands. Sensory neurons take messages from a sensory receptor to the central nervous system. Supporting glial cells help neurons function correctly.

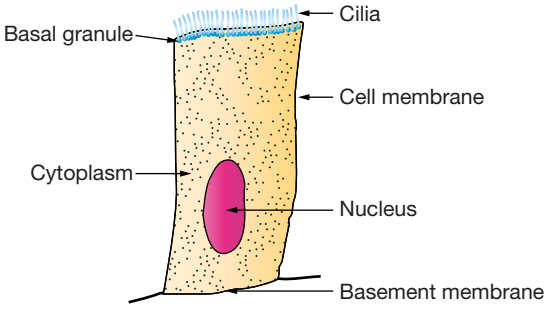
Figure 45.4 Different Types of Neurons



QUESTIONS

1. Define differentiation.
2. Explain why multicellular organisms need specialised cells.
3. What is meant by differential gene expression?
4. Identify some proteins made by muscle cells that give these cells their particular ability to contact and relax and outline why this is an important substance for muscle cells.
5. Are all cells in a tissue identical? Use an example to explain your answer.
6. Identify the four main types of mammalian tissue.
7. Describe where epithelial tissue is found.
8. What are the three basic shapes of epithelial cells?
9. Explain why the presence of microvilli on epithelial cells.
10. What is the basement membrane?
11. Distinguish between an exocrine gland and an endocrine gland.
12. Where is connective tissue found in the body?
13. Outline the function of muscle cells.
14. Identify the function of the three types of muscle cells.
15. Name the types of cells found in nervous tissue.
16. Use examples to show the range of different specialised nerve cells.
17. The diagram shows a type of specialised cell.

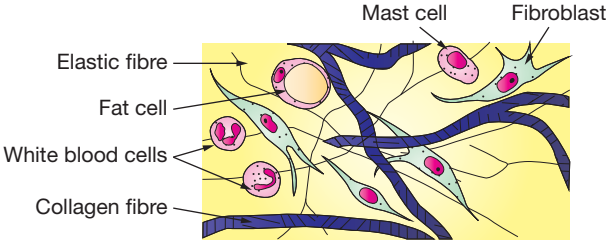
Figure 45.5 A specialised cell.



What is the name of this type of cell?
(A) Columnar epithelial cell
(B) Muscle cell
(C) Neuron
(D) Squamous epithelial cell

18. The diagram shows a type of tissue.

Figure 45.6 A specialised tissue.



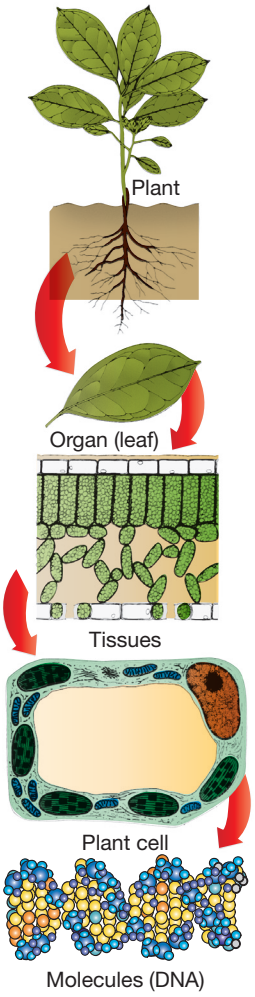
What is the name of this type of tissue?
(A) Nervous tissue
(B) Dense connective tissue
(C) Loose connective tissue
(D) Epithelial tissue

19. What type of cells can become specialised to form gland cells?
(A) Neurons (C) Muscle cells
(B) Epithelial cells (D) Connective tissue cells

46 Cells, Tissues, Organs and Systems

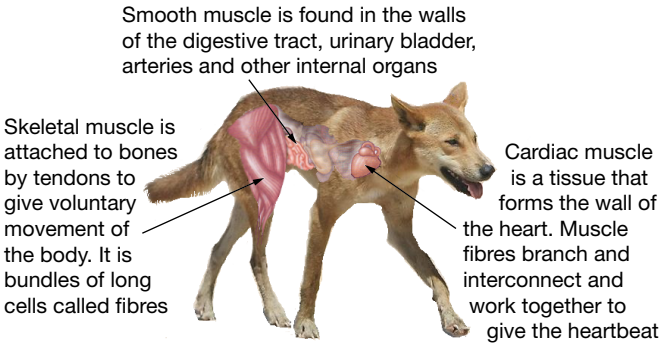
Multicellular organisms consist of many cells and many require specialised cells to carry out particular jobs. Specialisation allows a more efficient supply of nutrients, removal of wastes, and the other processes essential to life.

Figure 46.1 Levels of organisation.



The **cell** is the basic unit of life. Many cells are specialised to carry out particular tasks, e.g. red blood cells carry oxygen. This means that specialised cells often have a distinct shape and special kinds of chemical reactions occur in their cytoplasm. A **tissue** is a group of cells with similar structure and function. For example, muscle tissue is made of many aligned muscle cells which are long cells able to shorten to produce movement. An **organ** is a group of tissues grouped together to make a structure with a special function. For example, the stomach is an organ which has an epithelial lining, gland tissue and muscle layer supplied with blood vessels and nerves. A **system** is usually a group of organs whose function is closely related. For example, the stomach, intestines, oesophagus etc. make up the digestive system.

Figure 46.2 Muscle tissue.

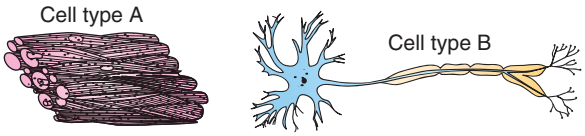


Muscle tissue generates motion and generates force. It can also generate heat and help maintain body temperature in endotherms. The three different types of muscle tissue are found in different organs and different systems.

Questions

1. Define the following terms.
   (a) Cell (c) Organ
   (b) Tissue (d) System
2. Use a plant as a multicellular organism to give an example of each of the following.
   (a) Organ
   (b) Tissue
   (c) Specialised cell
3. Describe how the different types of muscle tissue are in different systems but they have a similar general function.
4. The kidneys, certain nerves, bladder, urethra and ureters cooperate to remove chemical wastes from the body. Identify the level of organisation for this cooperation.
   (A) Tissue
   (B) Organ
   (C) System
   (D) Cell
5. The diagram shows two types of cells.

Figure 44.3 Two types of cells.



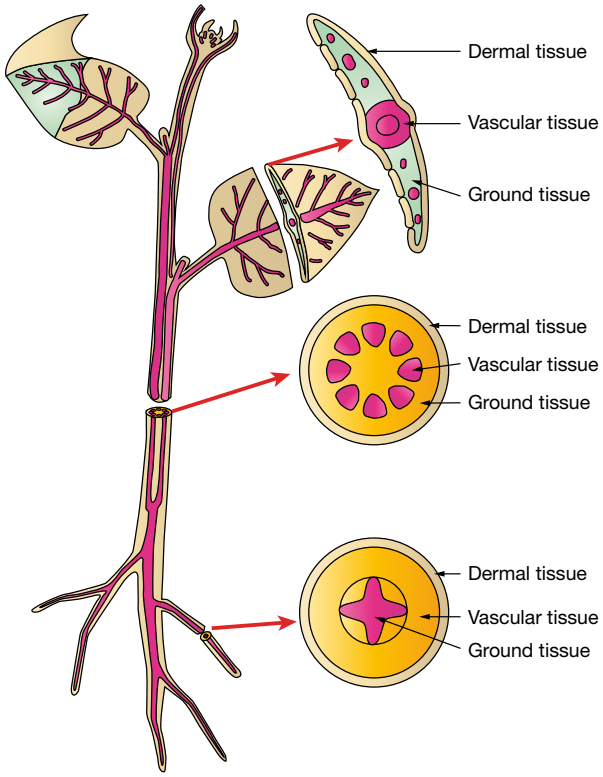
What is the importance of cells having different shapes?

(A) More cells can fit into the same space
(B) Different cell shape is related to different function
(C) Cell shape indicates different species
(D) Different cell shape shows evolutionary relationships.

47 Plant Tissues and Cells

Tissues are groups of cells carrying out a particular function. A tissue may have only one kind of cell (simple plant tissue) or several kinds of cells (mixed plant tissue). Plant tissues can be divided into dermal, vascular or ground tissue.

Figure 45.1 Plant tissues.



Dermal Tissue

Dermal tissue forms the outer protective coating of plant organs eg epidermis of roots, stems and leaves. In leaves and some stems the epidermis is coated with a waxy cuticle.

Vascular Tissue

Vascular tissue is the xylem and phloem. **Xylem** transports water up the plant from the roots to the leaves. **Phloem** translocated organic materials eg sugars up or down the plant from where they are made or stored to where they are needed.

Ground Tissue

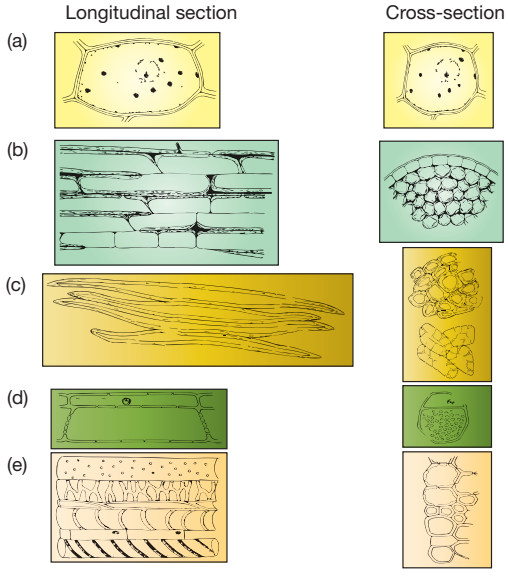
Ground tissue is the **pith** (internal to the vascular tissue) and the cortex (external to the vascular tissue).

Plant Cell Types

There are several types of plant cells

- **Parenchyma** – are long cells with a roughly spherical cross-section that have relatively thin cell walls. They make up the bulk of herbaceous plants forming the packing cells of stems and roots. They are the 'typical' plant cells and are where most metabolic functions of the plant occur eg synthesising and storing organic products such as photosynthesis in the leaf.
- **Collenchyma** – are narrow, elongated cells with additional cell wall deposits at the corners of the cells which makes the cell walls unevenly thickened. They are never lignified which means they are flexible and can be stretched. They provide support eg in stems and leaves.
- **Sclerenchyma** – have thickened walls strengthened with lignin to give support. There are two types of sclerenchyma – fibres and sclereids. **Fibres** form long, slender threads. **Sclereids** are shorter and more circular and have branching pits eg giving hardness to nutshells and seed coats.
- **Phloem** – consists of sieve tubes and companion cells. **Sieve tubes** lack a nucleus and have end walls with pores that form a sieve plate which allows the translocation of sugars and other organic compounds all over the plant.
- **Xylem** – consists of xylem vessels and tracheids which lose their nucleus and cytoplasm as they mature. **Tracheids** are long thin cells with tapered ends. **Xylem vessels** are wider, shorter and offer less resistance to water flow as the end walls are broken down to form a continuous tube. Xylem gives mechanical support to the plant and conducts water and mineral salts from the roots to the leaves.

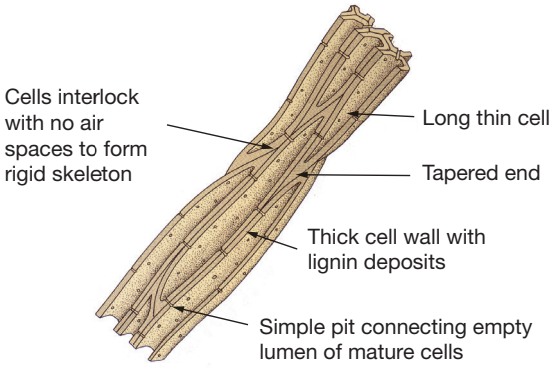
Figure 47.2 Different types of plant cells (a) Parenchyma. (b) Collenchyma. (c) Sclerenchyma with additional cross section of sclereids.. (d) Phloem. (e) Xylem.



QUESTIONS

1. What is a tissue?
2. Distinguish between a simple plant tissue and a mixed plant tissue.
3. Name the three types of plant tissue.
4. Construct a table to summarise the function of each type of plant tissue and give an example for each type.
5. Where do you find the pith and the cortex in a plant?
6. Construct a table to summarise the structure and role of the five types of plant cells.
7. In the laboratory under certain conditions scientists have been able to produce an entire plant from a single parenchyma cell. What does this show about parenchyma?
8. The diagram shows a type of plant cell.

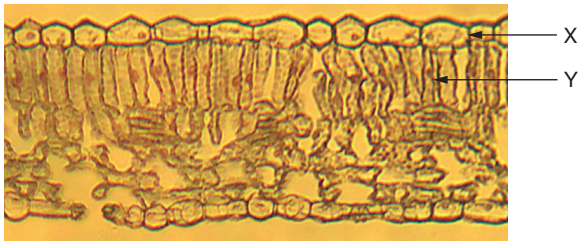
Figure 47.3 Type of plant cell.



Identify this type of cell and give reasons for your decision.

9. The 'strings' of a celery stalk are strands of collenchyma cells found between the epidermis and a vein. What is the function of the collenchyma in celery stalks?
10. The diagram shows a cross section of a stem.

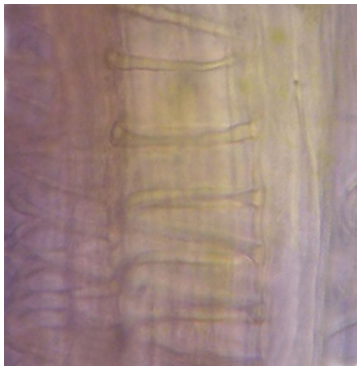
Figure 45.4 Cross section through a leaf.



Identify the cell types labelled X and Y and identify the tissues they form.

11. The first formed plant tissues in seedlings and herbs are called primary tissues. Meristems in the tips of roots and in the buds of shoots allow primary growth of plants. Outline an advantage of having meristems that can act as an embryonic tissue throughout the life of the plant.
12. The diagram shows a longitudinal section through a stem.

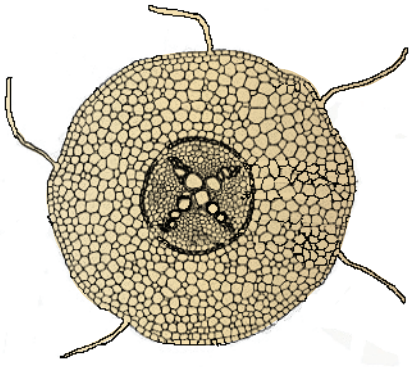
Figure 47.5 Stem longitudinal section.



Identify this type of cell and give reasons for your decision.

13. The diagram shows the cross section of a part of a plant.

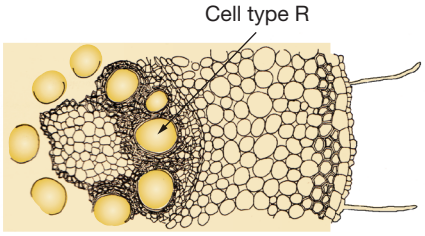
Figure 45.6 Cross section through a part of a plant.



(a) Identify the part of the plant from where this section was cut.
(b) Copy this diagram and label the dermal tissue, the vascular tissue and the ground tissue.

14. The diagram shows a cross section through a part of a plant.

Figure 47.7 Cross section through a part of a plant.



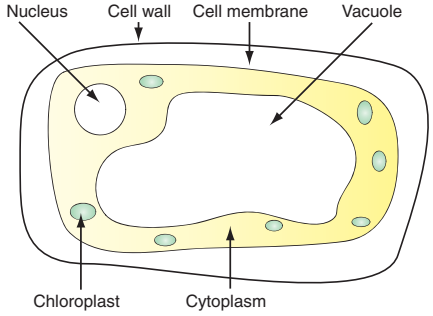
What is cell type R and its function?

(A) It is a sieve tube and involved in the transport of sugars in the plant
(B) It is sclerenchyma and supports the stem
(C) it is collenchyma and supports the root
(D) it is a xylem vessel and involved in the transport of water in the plant

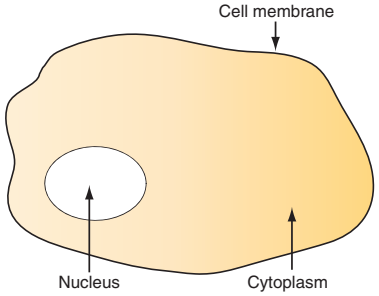
Answers

1 Assumed Knowledge

1. Living organisms can – 1) Respire 2) Assimilate food and synthesise organic molecules 3) Grow 4) Reproduce 5) Respond to stimuli from their environment 6) Excrete 7) Locomotion
2. The cells of living things have a cell membrane, cytoplasm and DNA.
3. Plant cell.



4. Animal cell.



5. A = eye of person using the light microscope, B = ocular lens, C = objective lens, D = specimen, E = condenser lens, F = light source
6. When using a light microscope, you should always wear shoes with covered toes, as the microscope is heavy and if you drop it you could damage exposed skin on your feet.
7. The nucleus stores information needed to control all cell activities.
8. The cell membrane surrounds the cell contents from the external environment and controls the substances that can leave or enter the cell.
9. Cytoplasm is a general term for the contents of a cell outside the nucleus and within the cell membrane.
10. Protoplasm is the semi-fluid transparent substance that makes up the living matter of plant and animal cells including the nucleus and cytoplasm.
11. A chloroplast is a green organelle found in green tissues of plants that captures sunlight in photosynthesis to manufacture sugars from carbon dioxide and water.
12. Photosynthesis is a process where the energy of sunlight is used to convert carbon dioxide and water into sugars and oxygen.
13. Groups of organisms that can photosynthesise include plants, algae and photosynthetic bacteria.
14. Carbon dioxide and water are needed for photosynthesis using light energy and in the presence of chlorophyll.
15. The function of the digestive system is to break down ingested food into smaller particles so that nutrients can be absorbed into the body.
16. A = Salivary glands, B = oesophagus, C = stomach, D = liver, E = gall bladder, F = pancreas, G = large intestine, H = small intestine, I = appendix, J = anus
17.

Part	Structure	Function
Mouth	Has teeth and openings from salivary glands	Teeth break food into small pieces and salivary enzymes begins chemical digestion
Oesophagus	Long tube	Moves food to stomach by peristalsis
Stomach	Muscles and glands in wall	Churns food and produces digestive enzyme to digest protein
Small intestine	Long thin tube with villi and glands	Digestion is completed and nutrients absorbed through walls
Large intestine	Long tube	Water, salts and vitamins absorbed
Anus	Muscular ring	Eliminates faeces

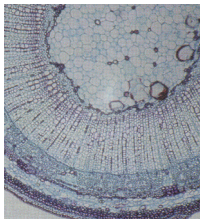
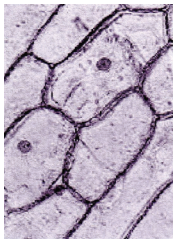
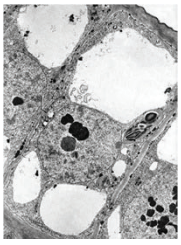
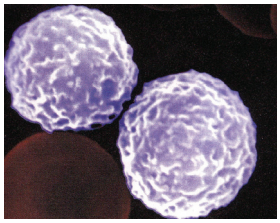
18. (a) Xylem transports water up the plant from roots to leaves.
    (b) Phloem transports sugars up and down the plant.
    (c) Leaves are the site of photosynthesis where light energy is changed into chemical energy to be used by the plant.
    (d) Roots support the plant, anchor it in the soil and are the site of water absorption.
19. (a) (i) Carbohydrates are broken down into glucose
    (ii) Proteins are broken down into amino acids
    (iii) Fats are broken down into fatty acids
    (b) Scientists make simple models to make it easier to understand complex systems providing, as in this case of the model of the digestive system, a basic idea of the structure and functioning of a multifaceted body system. The diagram shows the digestive system as a long tube through the body that acts as a a functional unit of life.
20. Cellular differentiation is the process in which a cell become specialised in structure so it can perform a specific function eg red blood cell, liver cell, cardiac muscle cell.
21. Osmosis is the movement of water across a semi-permeable membrane from a region of high water to a region of low water.
22. ATP (adenosine triphosphate) is the main source of energy to drive cellular reactions and active transport. It is hydrolysed when a phosphate bond is broken and free energy is released.

2 Characteristics of Living Things

1

Characteristic	Description of characteristic
Growth and development	Involves an increase in mass due to an increase in the size of individual cells and/or and increase in the number of cells.
Reproduction	Is the ability to produce offspring and can be either sexual or asexual.
Respiration	Is a series of chemical reactions win which cells obtain energy from food.
Respond to stimuli	Stimuli from either the internal or external environment cause a response in or by the organism.
Movement and locomotion	Part or the whole organism can move.
Nutrition or feeding	Organisms obtain matter and energy to build their physical structure and continue the functions of life.
Assimilation	Is the process of converting food into the living material of life.
Metabolism	Is the sum of all chemical reactions within the organism
Excretion	Is the removal of unwanted waste products of metabolic reactions.

6.

Image A	Image B
 Scanning electron microscope	 Light microscope
Image C	**Image D**
 Light microscope	 Transmission electron microscope
Image E	**Image F**
 Scanning electron microscope	 Light microscope

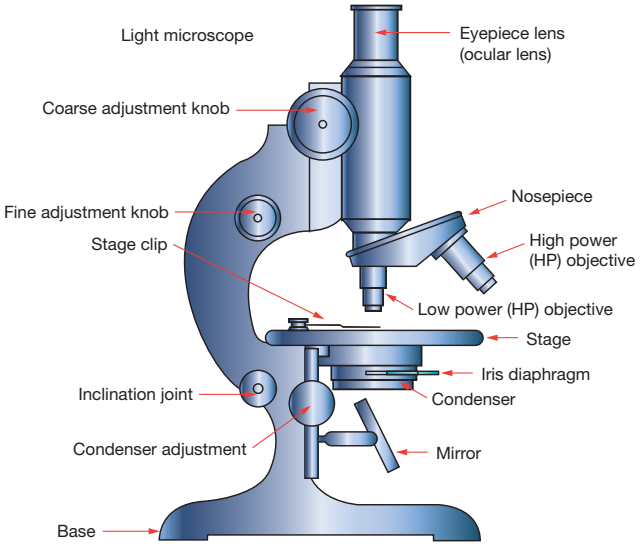
7. (D)

5 The Stereo Microscope

1. The stereo microscope is easily identified as it has two ocular eyepieces that each view the object from different angles. There are two separate optical paths for viewing.
2. You are likely to use a stereo microscope when dissecting small organisms or when you need to observe the external features of a specimen.
3. The parts of the stereo microscope are 0
   A = ocular lens
   B = objective lens
   C = stage clip
   D = stage
   E = focus knob
   F = arm
4. If a compound microscope has two eyepieces which give the same image then the image will not be three dimensional and give a 'stereo' image. To provide a three dimensional image there must be two images each from slight different viewing angles.
5. In a stereo microscope the lens is a distance away from the object and this gives poor resolution.
6. A typical school stereo microscope has a magnification ranging from 10× to 40× while a typical school monocular microscope has a magnification from 40× to 400×.
7. Salt crystals are light coloured and usually translucent. The dark colour beneath the crystal is needed to provide contrast so that the crystal can be properly viewed.
8. When using a stereo microscope some parts of an organism may not be in focus as the specimen is three-dimensional with several levels. The microscope is focusing on one level making other levels appear out of focus.
9. (A)

6 Experiment – The Light Microscope

1.



2. It is important to always use two hands when carrying a light microscope as they are heavy and if dropped could damage skin and feet. If dropped the fall will likely irreparably damage sections of the microscope and the school may not be able to replace the equipment. You should NEVER swing a microscope and hold it with one hand.
3. It is very important to always view the stage from the side when lowering the low power objective as many microscopes allow the lens to be lowered as far as the slide and even lower, which can break the slide. Cut glass can pierce skin and potentially cause infection if it is not clean. By always raising the lens away from the slide you reduce the possibility of breaking the glass slide.
4. (a) Using the low power objective (10×) gives an overall magnification of $10 \times 10 = 100\times$
   (b) Using the high power objective (40×) gives an overall magnification of $10 \times 40 = 400\times$
5. The iris diaphragm controls the amount of light reaching the stage and passing through the specimen.
6. When changing objective lenses it is usually necessary to adjust the amount of light as higher magnification lenses require more light and you need the correct amount of light to see details in the specimen. When changing from high power to low power a decrease in the amount of light is usually needed.
7. A stereo microscope is usually a low powered microscope that has two eyepieces and provides a stereoscopic view of the specimen. It is usually used for looking at organisms or parts of organisms eg in dissections and does not use thin sections on a microscope slide as used by light compound microscopes.
8. If you touch the lens with your finger you will leave a print that has body oil which smudges the glass. If the oil is on the glass for a lengthy time period, it can etch the glass. Lens paper must be used to clean the lens. Other types of paper eg paper towel, tissues, toilet paper scratches the lens.

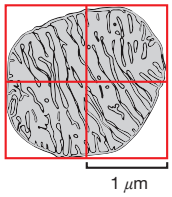
7 Experiment – Using a Light Microscope

1. Magnification refers to the ratio between the size of the image (the apparent size of the object under the microscope) and the actual size of the object. Resolution is the ability to distinguish between two points as separate.
2. (a) The diameter of the field of view under low power is 1.4mm which is 1400 μm.
   (b) If the high objective lens (40×) is used then the change is from an overall magnification of 100× to 400×.
   New diameter field of view = $1400 \times \frac{100}{400}$
   $= 350\ \mu m$

6. Random errors include writing down incorrect data, misreading scales, parallax error when reading a scale, poor mathematical skills, using the wrong conversion formula or misusing a calculator. Random errors can be reduced by very carefully making measurements, using instruments with a high degree of accuracy, taking repeated measurements and by eliminating outliers. Whereas systematic errors cause readings to be spread around a value that is not the correct value. Systematic errors can be reduced by correct calibration of equipment before beginning the task and correct use of the equipment.
7. The precision of the results is shown by the amount of variation in repeated measurements eg the dimensions of red blood cells may be consistently measured as a diameter of 35 micrometres (diameter is considered to be 7-8 μm) – showing precision but not accuracy. While accuracy refers to how close the result is to the theoretically known result eg the average diameter of red blood cells may be calculated as 7.5 μm but the range of readings varies from 26-3 μm – showing accuracy but not precision.
8. (a) The limit of reading of an instrument is equal to the smallest graduation on the scale.
   (b) If a ruler is marked in centimetres and millimetres the limit of reading is 0.1 cm.
9. The maximum uncertainty of a reading is half the limit of reading. This is also called the absolute uncertainty.
10. Relative uncertainty is the absolute uncertainty divided by the measurement while percentage uncertainty is relative uncertainty multiplied by 100.
11. (a) Limit of reading is 0.1 cm
    (b) Absolute uncertainty is ± 0.05 cm
    (c) Relative uncertainty = 0.05/3.2 = 0.015625 = 0.02
    (d) Percentage error = 0.02 × 100 = ± 2%
12. Reliability means an experiment or set of results can be repeated by other people at other times and the results will be the same whereas validity refers to how a test measures what it is meant to measure eg variables are controlled, instruments are suitable, aim is achieved.
13. (a)

Reading (μm)	6.5	7.2	3.8	10.4	6.6	5.9	8.2
Average reading (μm)	6.94285 = 6.94						
Difference of each reading from average (μm)	-0.44	+ 0.26	-3.14	+ 3.46	-0.34	-1.04	+ 1.26

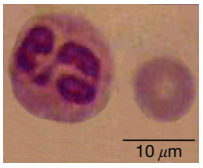
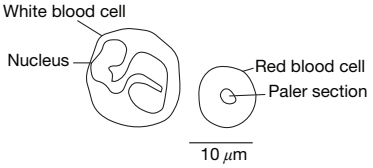
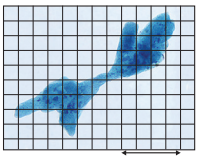
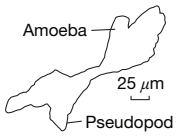
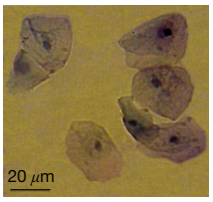
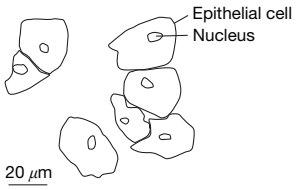
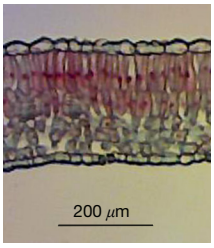
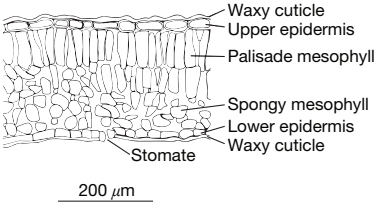
    (b) Size is 6.9 ± 3.5 μm
14. Bacterium = 2 μm, human red blood cell = 10 μm, human epithelial cell = 60 μm, plant mesophyll cell 100 μm.
15. The diameter of the mitochondrion is 2 μm.



16. D

11 Drawing Scaled Diagrams

1. Using ×10 means it is times 10 (eg 10 times bigger), while 10× is the rating of the lens.
2. (a) Ocular lens 10× and objective lens 10× gives total magnification of ×100.
   (b) Ocular lens 10× and objective lens 40× gives total magnification of ×400.
3. (a) Diameter FOV 1.5 mm = 1500 μm
   (b) (i) New magnification ×400.
   (ii) New FOV = 1500 × 100/400 = 375 μm.
4. The drawing field of view needs to have a diameter of 13 cm.
5.

Photomicrograph	Description
	
	
	
	

12 Writing a Practical Report

1. (a) A suitable hypothesis could be 'As the amount of direct sunlight decreases, the size of the leaf increases.'
   (b) The independent variable is the amount of direct sunlight and the dependent variable is the size of the leaf.
   (c) To test their hypothesis the students would need to – 1) Use the same species of plant (preferably cuttings from the same parent plant so all experimental plants had the same genotype), 2) Grow the plants in the same amount of soil 3) Grow the plants in the same soil composition – nutrients, sand, humus etc, 4) Grow the plants in the same environment – temperature, water availability, humidity, wind speed and direction. The only factor that should vary is the amount of direct sunlight to each plant.
2. (a) A suitable aim would be –'To use a light microscope to determine the size of red blood cells and white blood cells'.
   (b) Red blood cells are approx 6 to 8 micrometres in diameter. A high power objective is needed to clearly see red blood cells to determine their dimensions.
   (c) The students would need a light microscope with lamp, lens tissues and a prepared slide of blood.
   (d) When using a light microscope you need to carry it using two hands to avoid dropping it as it is heavy and if dropped could hurt legs and feet. If using a separate microscope lamp you should take care to not touch the hot lamp to avoid burns and wait till the lamp is cool before packing away.
3. The independent variable is time and the dependent variable is the average plant height.
4. The results from Group 3 using Method 3 would be the most valid. This method uses a control with half the plants in the dark and half the plants in normal sunlight.