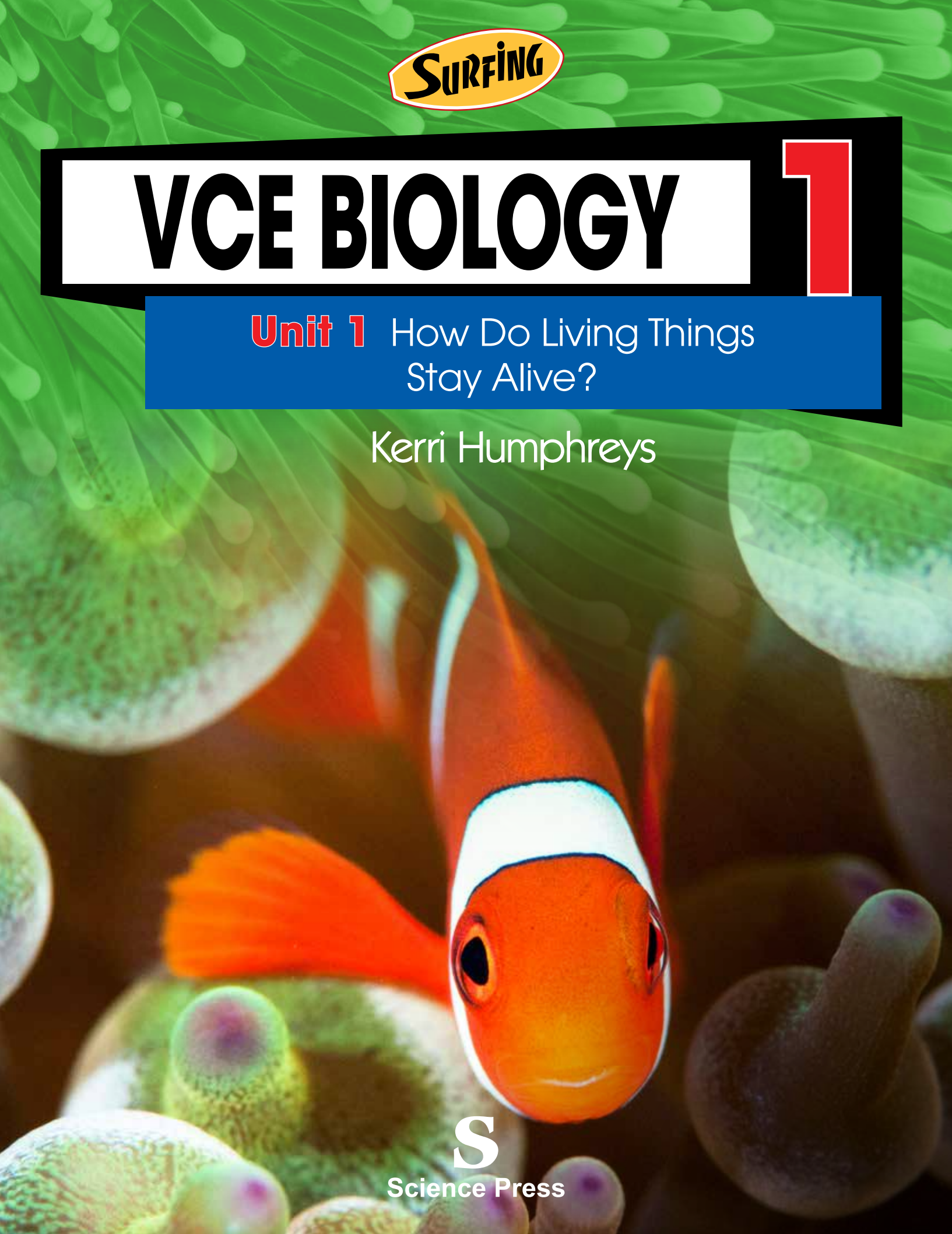
SURFING
VCE BIOLOGY 1
Unit 1 How Do Living Things Stay Alive?
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Contents

Area of Study 2 How Do Living Things Sustain Life?

Introduction

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

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

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

Answers to all questions are included.

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

Words To Watch

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

analyse Interpret data to reach conclusions.

annotate Add brief notes to a diagram or graph.

apply Put to use in a particular situation.

assess Make a judgement about the value of something.

calculate Find a numerical answer.

clarify Make clear or plain.

classify Arrange into classes, groups or categories.

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

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

construct Represent or develop in graphical form.

contrast Show how things are different or opposite.

create Originate or bring into existence.

deduce Reach a conclusion from given information.

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

demonstrate Show by example.

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

describe Give a detailed account.

design Produce a plan, simulation or model.

determine Find the only possible answer.

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

distinguish Give differences between two or more different items.

draw Represent by means of pencil lines.

estimate Find an approximate value for an unknown quantity.

evaluate Assess the implications and limitations.

examine Inquire into.

explain Make something clear or easy to understand.

extract Choose relevant and/or appropriate details.

extrapolate Infer from what is known.

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

identify Recognise and name.

interpret Draw meaning from.

investigate Plan, inquire into and draw conclusions about.

justify Support an argument or conclusion.

label Add labels to a diagram.

list Give a sequence of names or other brief answers.

measure Find a value for a quantity.

outline Give a brief account or summary.

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

predict Give an expected result.

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

recall Present remembered ideas, facts or experiences.

relate Tell or report about happenings, events or circumstances.

represent Use words, images or symbols to convey meaning.

select Choose in preference to another or others.

sequence Arrange in order.

show Give the steps in a calculation or derivation.

sketch Make a quick, rough drawing of something.

solve Work out the answer to a problem.

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

suggest Put forward an idea for consideration.

summarise Give a brief statement of the main points.

synthesise Combine various elements to make a whole.

SURFING

VCE BIOLOGY 1

Area of Study 1

How Do Organisms Function?

1 Assumed Knowledge

QUESTIONS

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.

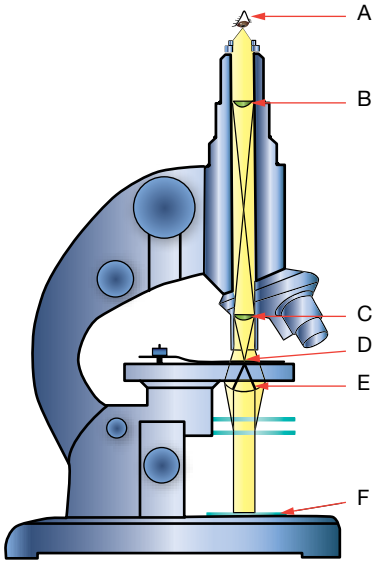


Figure 1.1 Light microscope.

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. Why is photosynthesis an important process in ecosystems?
16. Name the four basic groups of organic compounds.
17. What are inorganic compounds?
18. What is the function of the digestive system?
19. Figure 1.2 shows the human digestive tract. Identify each part.
20. 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.

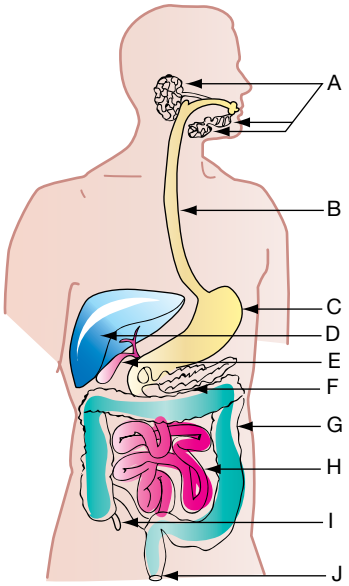


Figure 1.2 Human digestive tract.

21. Define respiration.
22. In humans, what structures make up the respiratory system?
23. Outline the function of the respiratory system.
24. Outline the function of the circulatory system.
25. In humans, what is the function of the heart in the circulatory system?
26. Identify the components of the human circulatory system.
27. In plants, what is the function of each of the following?
    (a) Xylem. (b) Phloem.
    (c) Leaves. (d) Roots.
28. The diagram shows a simple model of digestion.

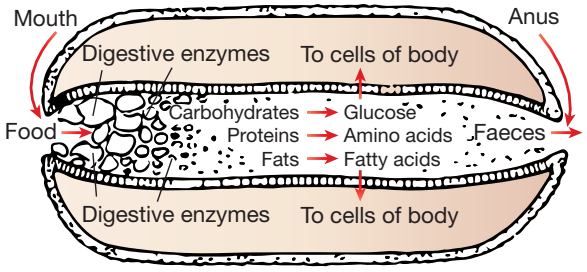


Figure 1.3 Simple model of digestion.

    (a) From this model identify what foods are broken down into:
        (i) Glucose.
        (ii) Amino acids.
        (iii) Fatty acids.
    (b) Explain why scientists make simple models such as this model of digestion.
29. What are the two main uses of food?
30. Distinguish between an autotroph and a heterotroph.

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, e.g. 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, e.g. 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, e.g. a running animal or very slow and involve only part of the organism, e.g. 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, e.g. 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 sulfide (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, e.g. photosynthesis. In **catabolic reactions** chemical bonds are broken and complex molecules are broken down into smaller units, e.g. 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.

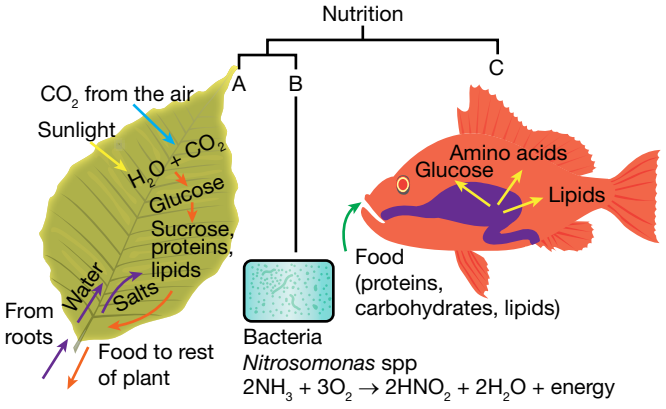


Figure 2.1 A feature of living things.

   (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 Developing the Cell Theory

The cell theory states the following.

- All living things are made of cells and of substances produced by cells.
- All cells come from pre-existing cells.
- The cell is the basic unit in which the processes of living take place.

The development of the cell theory is linked with the invention of technology that enabled scientists to see cells and to investigate the properties of cells.

Humans have made observations and recorded their findings about living things since the first mark was put on a cave wall, clay tablet or sheet of papyrus paper. These observations record the **macroscopic appearance** of living things – the features observed with the naked eye.

The development of glass lenses and the construction of the first microscope using a glass lens enabled scientists to observe the **microscopic appearance** of living things. The first cells were observed and the ideas about the structure of the building blocks of life were forever changed.

Hans and Zacharias Janssen

Hans and Zacharias Janssen are believed to have created the **first compound light microscope** around the 1590s. They placed several lenses in a tube and realised the object near the end of the tube could be magnified more than using a single lens in a magnifying glass.

Zacharias Janssen | Francesco Redi | Anton van Leeuwenhoek | Robert Brown

Figure 3.1 Janssen, Redi, van Leeuwenhoek and Brown.

Robert Hooke

In 1663 Robert Hooke observed cork under a microscope and introduced the term '**cell**'. He published his microscopical observations in 1665 in his book *Micrographia*. This book led to public interest in microscopy.

Francesco Redi

In 1668 Francesco Redi published the results of his experiment with insects which was one of the first steps in proving that living things do not arise from **spontaneous generation**. He showed that fly maggots did not spontaneously arise from dead meat as meat kept in jars covered with gauze did not get maggots.

Anton van Leeuwenhoek

Anton van Leeuwenhoek produced higher quality lenses that gave greater magnification and aided the development of the light microscope. He is considered to be the 'Father of Microbiology'. In 1674 he was the first to observe and describe **single-celled organisms** which he called *animalcules*. In 1676 when he sent his drawings of single-celled organisms to the Royal Society of London, his credibility was questioned. In 1680 his observations were vindicated after others observed the unicells. He discovered and made drawings of protozoa, bacteria, the vacuole of the cell, the banded pattern of muscle fibres and spermatozoa.

Robert Brown

Robert Brown described the **nucleus** in cells of the orchid and gave the structure its name. He travelled to Australia in 1801 on the HMS *Investigator* as the naturalist at the request of the commander of the vessel, Matthew Flinders. He collected many specimens and left Australia in 1805. In 1831 he read a paper about the cell nucleus to the Linnaean Society and published this work in 1833. Although the nucleus had been drawn by others, e.g. van Leeuwenhoek and Franz Bauer, Brown gave the structure its name. His observations of the random movement of pollen grains led to the naming of the phenomena now known as Brownian motion.

Matthias Schleiden

In 1838 Matthias Schleiden wrote *Contributions to Phytogenesis* and proposed that different parts of plants are made of cells. With Schwann he was the first to propose the **cell theory**. He also recognised the importance of the cell nucleus and its possible relationship with cell division.

Theodor Schwann

Theodor Schwann noted that parts of animals are made of cells and that non-cellular parts, e.g. nails, feathers and tooth enamel had a cellular origin. In 1839 he extended Schleiden's cell theory to animals and proposed that all living things are made of cells and cell products. The cell was the basic unit of life. This is now called the **Schleiden and Schwann cell theory**. Schwann also observed the cells associated with nerve fibres which are now called Schwann cells.

Rudolf Virchow

In 1855 Rudolf Virchow published a work that proposed that the origin of cells was the division of pre-existing cells and the cell theory was expanded to include the point that every cell originated from another living cell like it. This rejected the concept of spontaneous generation. Virchow is known as the 'father of modern pathology' and he developed a standard method of autopsy procedure.

Matthias Schleiden | Theodor Schwann | Rudolf Virchow

Figure 3.2 Matthias Schleiden, Theodor Schwann and Rudolf Virchow.

Louis Pasteur

In 1861 Louis Pasteur published his experiments demonstrating that fermentation was caused by micro-organisms which finally disproved the theory of spontaneous generation. The experiment also supported the germ theory.

Friedrich Miescher

In 1869 Friedrich Miescher isolated nucleic acids which he called *nuclein* from the nuclei of white blood cells. This was the first time DNA had been purified and led to investigations into its composition, properties and structure.

Camillo Golgi

In 1898 Camillo Golgi described the Golgi apparatus by staining cells with silver nitrate. At first some believed the structure was an optical illusion caused by the staining technique. The invention of the electron microscope in the 20th century proved the existence and shape of this organelle.

Louis Pasteur | Friedrich Miescher | Camillo Golgi

Figure 3.3 Louis Pasteur, Friedrich Miescher and Camillo Golgi.

Max Knoll and Ernst Ruska

In 1932 Max Knoll and Ernst Ruska invented the transmission electron microscope. The higher magnification and higher resolution meant greater details of the ultrastructure of cells could be observed and analysed and new structures were discovered, e.g. ribosomes.

QUESTIONS

1. State the cell theory.
2. Construct a table to summarise the historical development of the cell theory.
3. Explain how the invention of the light microscope is linked with the development of the cell theory.
4. Explain why Anton van Leeuwenhoek is known as the 'Father of Microbiology'.
5. Suggest why Leeuwenhoek's discovery of animalcules was at first disbelieved and explain why it was finally accepted.
6. Outline the discovery and naming of the nucleus.
7. What are the two points of the cell theory proposed by Schleiden and Schwann?
8. What is the theory of spontaneous generation?
9. Discuss how the theory of spontaneous generation was finally disproved.
10. How is the theory of spontaneous generation linked with the development of the cell theory?
11. (a) Why did people question the actual existence of the Golgi body in cells?
    (b) What evidence proved the existence of the Golgi body?
12. Explain how the invention of the electron microscope aided the development of knowledge about cell structure.
13. Who was the first person to isolate DNA?
    (A) Robert Hooke. (B) Robert Brown.
    (C) Rudolf Virchow. (D) Friedrich Miescher.
14. The timeline shows events in the development of the cell theory.
    From this timeline which event occurred before the nucleus was named?
    (A) Single-celled organisms were observed.
    (B) Golgi apparatus was described.
    (C) Nucleic acids were isolated.
    (D) Cell theory was expanded.

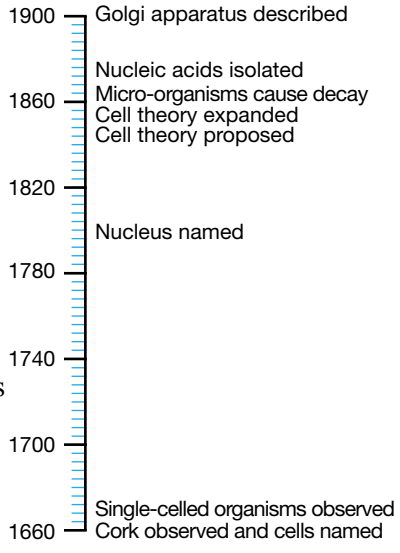


Figure 3.4 Cell theory timeline.

4 Cell Theory and Robert Hooke

Robert Hooke (1635-1703) was an experimental scientist who was interested in physics, astronomy, chemistry, biology, geology, architecture and naval technology, although his primary interest was microscopy, mechanics and instrumentation. There are no authenticated surviving portraits of Robert Hooke.

Robert Hooke invented a compound light microscope, i.e. a microscope with more than one lens and devised an illumination system for this microscope. Using this microscope he observed many organisms and drew accurate and detailed drawings of his findings. He also developed a micrometer; the universal, or Hooke's joint found in all cars; the spring control of the balance wheel in watches; the first reflecting telescope and was involved in creating different types of barometers.

Robert Boyle was Hooke's patron when Hooke began studying at Oxford. However, Hooke clashed with Isaac Newton and this may have affected his fame in history. It is believed that Newton destroyed the only portrait known to exist of Hooke.

Figure 4.1 Hooke's microscope.

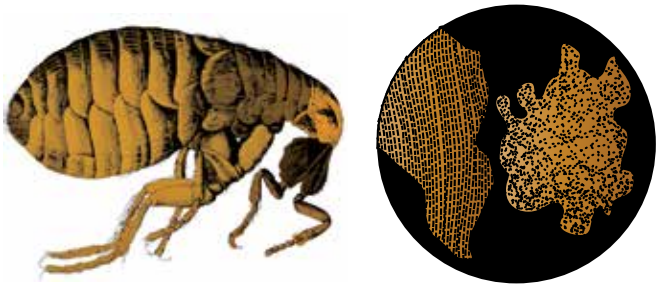
Robert Hooke's first publication was printed in 1661 and was a pamphlet on capillary action. In 1665, he published a book, *Micrographia*, which contained many drawings and records of his observations under the microscope, e.g. diagrams of insects, sponges, foraminifera, bird feathers and bryozoans. It also included a theory of light. The diagrams in *Micrographia* created a public interest in microscopy with some people believing it was a great advance in scientific knowledge and others calling it a trifling pursuit.

When Hooke observed a slice of cork under his microscope he discovered plant cells. He coined the term 'cells' to describe what he saw.

> 'Yet it was not unlike a Honeycomb in these particulars … these pores, or cells, … consisted of a great many little Boxes.'

He also put fossils under his microscope and observed the similarities of fossil shells with living mollusc shells. He noted that dead wood could be turned to stone due to minerals being deposited throughout the wood. Hooke suggested the fossils gave clues to the past history of life on Earth.

In 1678 Anton van Leeuwenhoek (1632-1723) reported the presence of 'little animals' in lake water. The Royal Society of London asked Robert Hooke to investigate these findings and when he confirmed the presence of small organisms, Leeuwenhoek's work was accepted.



(a) Drawing of a flea. (b) Drawing of a slice of cork.

Figure 4.2 Drawings by Robert Hooke from his book *Micrographia.*

QUESTIONS

1. Name two instruments invented by Robert Hooke.
2. What is meant by a 'compound' microscope?
3. Discuss the significance of the invention of the compound microscope.
4. How did the term 'cell' originate as used in biology?
5. Robert Hooke observed a honeycomb appearance under the microscope which he called 'cells'. What was he actually viewing?
6. The lenses used by Hooke were relatively low quality and caused some image distortion and separated colours giving a rainbow 'fringe' effect. Explain how opponents of Robert Hooke used these details to discredit his findings.
7. In *Micrographia* Hooke drew the microscopic structure of fossilised wood and compared its structure to a piece of rotten oak wood. Why did some people reject his conclusions about fossils showing extinction and past life forms?
8. In his book *Micrographia* Robert Hooke drew many diagrams.

Figure 4.3 Hooke's drawing of *Mucor* from Micrographia.

Discuss why the drawings in *Micrographia* were important in making the book a 'best seller'.

5 Cell Theory and Robert Brown

Robert Brown (1773-1858) was a Scottish botanist and protégé of Joseph Banks. He sailed on the HMS *Investigator* in 1801 under Captain Matthew Flinders. When he reached Australia, then called New Holland, he collected more than 500 plant species and made many drawings and notes of animals and plants, naming more than 140 new genera and over 1700 new species. He returned to England in 1805 and spent five years describing the 2200 species he had observed. He published his notes in 1811 in *Prodromus Florae Novae Hollandiae et insulae Van-Diemen* and further notes in 1814 in 'General Remarks, Geographical and Systemic, on the Botany of Terra Australis' as an appendix to Matthew Flinders' *Voyage to Terra Australis*.

Figure 5.1 Brown's microscope.

From 1805 he was Secretary to the Royal Linnean Society and from 1810 to 1820 he was the personal librarian to Joseph Banks. Brown was given the care of Sir Joseph Banks' home and collections when Banks died and when Brown organised the transfer of the specimens to the British Museum, he became the curator and Keeper of the British Museum for the rest of his life.

Using microscopes all through his adult life, in 1827 Brown was the first person to notice the constant movement of suspended particles and since then this movement has been called 'Brownian motion'.

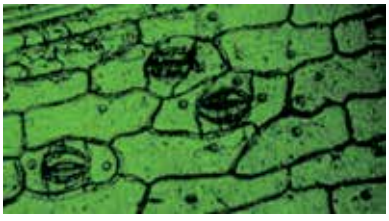


Figure 5.2 View obtained by Brown of cell nucleus in orchid epidermal cells.

In 1833, Brown observed the epidermis of orchids under his microscope and discovered an 'opaque spot' which he called the nucleus.

Early microscopists had drawn nuclei in animal cells Leeuwenhoek in 1700 figured nuclei in red blood cells of salmon in a letter to the Royal Society, but it was Hooke who coined the term 'nucleus'.

> 'In each cell of the epidermis of a great part of this family [Orchidaceae], … a singular areola, generally somewhat more opaque, … is observable … This areola, or nucleus of the cell as perhaps it might be termed, is not confined to the epidermis …'

Robert Brown continued to use his microscope and discovered nuclei in a range of plant tissues. At this stage the importance of the nucleus was still unknown.

QUESTIONS

1. Outline the epic expedition of discovery of Robert Brown.
2. Name two publications of Robert Brown.
3. How did the work of Robert Brown increase knowledge about Australian plants and animals?
4. What is 'Brownian motion'?
5. How did Brown discover the plant nucleus?
6. What term was coined by Brown?
7. Comment on the statement:
   'Robert Brown was the first to describe the structure and function of the nucleus'.
8. When Robert Brown described '… a singular areola, generally somewhat more opaque' spot in a cell, what organism was he studying?
   (A) Mouse epidermis. (B) Orchid epidermis.
   (C) Slice of cork. (D) Pond water.
9. The diagram shows a leaf epidermis with stomates under high power of a light microscope.

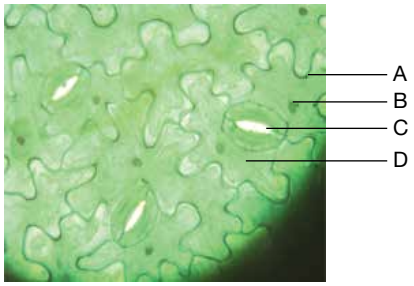


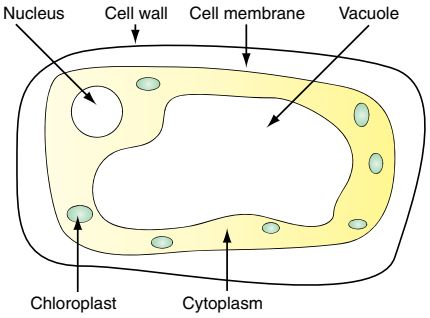
Figure 5.3 High power view of leaf epidermis.

   Which structure is the nucleus of a leaf epidermal cell?
   (A) A (B) B (C) C (D) D
10. Matthias Schleiden built on the work of Robert Brown. Schleiden believed that the nucleus is the most important part of a cell and has a vital role in cell reproduction. Why would Schleiden freely talk about his indebtedness to Robert Brown?
    (A) Brown was the first person to give a description of a cell.
    (B) Brown invented the staining techniques used by Schleiden.
    (C) Brown had named the nucleus and noted its presence in a range of different plants.
    (D) Brown showed that cells are formed from pre-existing cells.

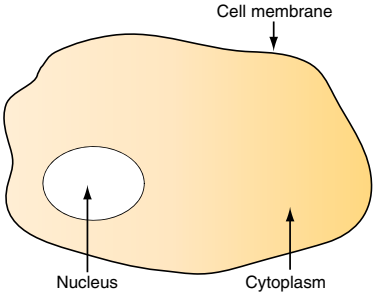
Answers

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. Move about.
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 semifluid 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. Photosynthesis is important in ecosystems as it converts light energy into chemical energy to begin most food chains on Earth and also provides oxygen which is needed for respiration.
16. The four basic groups of organic compounds are proteins, carbohydrates, lipids and nucleic acids.
17. Inorganic compounds are molecules that do not contain carbon (excluding some carbonates and simple oxides of carbon).
18. The function of the digestive system is to break down ingested food into smaller particles so that nutrients can be absorbed into the body.
19. A = salivary glands, B = oesophagus, C = stomach, D = liver, E = gall bladder, F = pancreas, G = large intestine, H = small intestine, I = appendix, J = anus
20.

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

21. Respiration is the chemical reactions in which cells obtain energy from food.
22. In humans, the respiratory system consists of the lungs and passages which bring air into and out of the lungs, e.g. trachea, bronchi and alveoli.
23. The function of the respiratory system is the intake, expulsion and exchange of oxygen and carbon dioxide.
24. The circulatory system is the transport system of the body, e.g. it carries the glucose and oxygen to the cells and distributes heat around the body.
25. In humans the heart pumps the blood to keep it flowing away from the heart through the arteries.
26. The human circulatory system consists of the heart and blood vessels, e.g. arteries, veins and capillaries and blood.
27. (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.
28. (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.
29. Food is needed to provide: 1. The chemical substances which can be built into large molecules that make up the structure of cells. 2. Chemical substances that can be oxidised to yield energy. The energy is needed for movement, for synthesis of large molecules from simple molecules and in endotherms for the production of heat.
30. An autotroph can make its own organic molecules from inorganic substances whereas a heterotroph obtains organic food molecules by eating other organisms.

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 in which cells obtain energy from food.
Respond to stimuli	Stimuli from either the internal or external environvment 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.

2. Sexual reproduction involves the union of two gametes in fertilisation to form a zygote. Asexual reproduction only involves one parent producing offspring that are identical to the parent.
3. Fertilisation is the union of two gametes.
4. Although crystals can grow in size they do not show any other characteristic of living things, e.g. respiration, response to a stimulus. To be classified as a living thing a combination of characteristics need to be present.
5. In autotrophic nutrition the organism can make its own organic nutrients from inorganic materials. In heterotrophic nutrition the organism needs to consume organic materials and existing foods.
6. In photosynthesis the autotroph uses energy from sunlight to create their own organic material while in chemosynthesis the autotroph uses a chemical source of energy to create their own organic material.
7. (a) A and B are autotrophic nutrition and C is heterotrophic nutrition.
   (b) *Nitrosomonas* spp uses ammonia as its source of energy. It oxidises ammonia to nitrous acid.
8. In anabolic reactions small molecules are combined to form more complex molecules. In catabolic reactions chemical bonds are broken and complex molecules are broken down into smaller units.
9. Respiration is a catabolic reaction as complex organic molecules, e.g. glucose are broken down into smaller units, e.g. carbon dioxide and energy is released.

3 Developing the Cell Theory

1. The cell theory states that: 1. All living things are made of cells and of substances produced by cells. 2. All cells come from pre-existing cells. 3. The cell is the basic unit in which the processes of living take place.

2.

Date	Person	Contribution
1590s	Hans and Zacharias Janssen	Created the first compound light microscope.
1663	Robert Hooke	Observed cork under a microscope and introduced the term 'cell'.
1668	Francesco Redi	Published the results of his experiments with insects showing living things do not arise from spontaneous generation.
1674	Anton van Leeuwenhoek	Improved the quality of lenses and aided the development of the light microscope. Discovered unicells, e.g. protozoa and bacteria. Discovered the vacuole and drew the banded pattern of muscle fibres and spermatozoa.
1833	Robert Brown	Published a paper naming and describing the cell nucleus in orchids.
1838	Matthias Schleiden	Proposed that different parts of plants are made of cells. This became part of the Schleiden and Schwann cell theory.
1839	Theodor Schwann	Extended Schleiden's cell theory to include animals. Schleiden and Schwann cell theory: 1. All living things are made of cells and cell products. 2. The cell is the basic unit of life.
1855	Rudolf Virchow	Extended the cell theory to include that every cell originated from a living pre-existing cell.
1861	Louis Pasteur	Fermentation experiments finally disprove the theory of spontaneous generation.
1869	Fredrich Miescher	Isolated DNA for the first time.
1898	Camillo Golgi	Described the Golgi apparatus by staining cells with silver nitrate.
1932	Max Knoll and Ernst Ruska	Invented the transmission electron microscope which gave greater resolution and magnification to study the ultrastructure of cells.

3. The invention of the light microscope is tightly linked with the development of the cell theory. When Robert Hooke used his compound microscope to view cork he discovered the cellular nature of plants and called the structures 'cells'. When van Leeuwenhoek used improved lenses to observe unicells he was not initially believed. It was the invention and development of light microscopes with higher magnification and resolution that enabled scientists to observe and study the cellular nature of living things.
4. Anton van Leeuwenhoek produced higher quality lenses and made many microscopes. The improved resolution and magnification of his microscopes meant he was able to observe smaller objects and he was the first to draw and describe single-celled organisms, e.g. protozoa and bacteria. This work led to him being called the 'Father of Microbiology'.
5. Leeuwenhoek's discovery of animalcules was at first disbelieved as the idea of single-celled organisms did not fit in with the early 17th century concept of 'life'. His work was finally accepted six years later when others observed unicells under the microscope.

6. Several scientists observed and drew diagrams of cells showing the presence of a nucleus, e.g. Anton van Leeuwenhoek and Franz Bauer. Robert Brown observed the nucleus in orchid cells and named the structure in 1831.
7. Schleiden and Schwann proposed that: 1. All living things are made of cells and of substances produced by cells. 2. The cell is the basic unit and building block of life.
8. The theory of spontaneous generation proposed that living things arose from non-living matter, e.g. maggots from dead flesh, rats from rubbish bins.
9. Fermentation experiments carried out by Louis Pasteur finally disproved the theory of spontaneous generation. He showed that micro-organisms were responsible for fermentation and bacteria caused the growths in boiled nutrient broths.
10. The cell theory states that all living cells come from pre-existing cells and clashes with the theory of spontaneous generation which proposes that living things can arise from non-living matter. As the cell theory developed, the theory of spontaneous generation had to be abandoned.
11. (a) Camillo Golgi discovered and used a new staining technique using silver nitrate to observe cells, e.g. in nervous tissue and to identify cell structures. Many believed that the body he found inside cells was an optical illusion caused by his staining technique.
    (b) The invention of the electron microscope which had greater magnification and resolution than the light microscope proved the existence and showed the ultrastructure of the Golgi body.
12. The invention of the electron microscope has greatly aided the development of knowledge about cell structure. The greater magnification and resolution gave more detailed information about known cell organelles, e.g. Golgi body and also discovered new structures, e.g. ribosomes that can only be seen under an electron microscope.
13. D
14. A

4 Cell Theory and Robert Hooke

1. Robert Hooke invented: 1. The compound microscope. 2. The first reflecting telescope.
2. A compound microscope has more than one lens arranged in such a way that the image is larger than the object being viewed.
3. The invention of a compound microscope meant that organisms could be seen with greater magnification and the structure of cells was now visible.
4. Robert Hooke used the term 'cell' to describe the structures he saw when he placed a slice of cork under his compound microscope.
5. Hooke saw the cell walls of cork tissue which formed a honeycomb appearance.
6. Opponents of Robert Hooke discredited Hooke's microscopic observations using the details about lens distortion and fringe effect to claim he was drawing artificial images created by the lenses. This led to some sections of the scientific community initially rejecting his findings.
7. In the 17th century there were several theories to explain the origin of fossils. Some believed, similar to Aristotle that fossils formed and grew within the Earth. When Hooke suggested that the fossils were clues to the past history of life on Earth, some people found it theologically unacceptable.
8. The drawings in *Micrographia* are highly detailed and accurately show the structure of many common organisms. People were fascinated by this new view of life making the book a subject of interest and discussion and thus a 'best seller'.

5 Cell Theory and Robert Brown

1. Brown sailed with Mathew Flinders on the *HMS Investigator* expedition 1801-1805. He travelled to Australia and Tasmania, collecting many plant specimens and describing over 2200 different plant and animal species.
2. He published his notes in 1811 in *Prodromus Florae Novae Hollandiae et insulae Van-Diemen* and further notes in 1814 in 'General Remarks, Geographical and Systemic, on the Botany of Terra Australis' as an appendix to Mathew Flinders' *Voyage to Terra Australis*.
3. Robert Brown travelled to Australia and collected and made drawings of many Australian species. He published his findings increasing the amount of data about Australian plants and animals available to the public. He also became responsible for the work and collection of Joseph Banks which preserved specimens collected by Banks on his Australian voyage with Captain James Cook.
4. Brownian motion is the constant movement of suspended particles.
5. Brown observed the epidermis of orchids under his microscope and discovered an 'opaque spot' which he called the nucleus.
6. Brown coined the term 'nucleus'.
7. The statement is inaccurate and untrue. It is inaccurate as Robert Brown was not the first to describe the nucleus – both Anton van Leeuwenhoek and Franz Bauer had drawn diagrams showing the presence of nuclei. It is untrue as the function of the nucleus had not yet been discovered.
8. B
9. B
10. C

6 Technology and the Development of the Cell Theory

1. The light microscope uses glass lenses to magnify objects. Thus the development of the light microscope is tightly linked with the ability to produce high quality glass lenses.
2. The first cells were observed in 1665, when Robert Hooke used his compound microscope to observe cork.
3. Anton van Leeuwenhoek made better lenses with greater curvature which gave better magnification. He also improved grinding and polishing techniques for making lenses.
4. August Kohler's illumination method gave an even distribution of light in the field of view. This meant that better and higher quality photomicrographs could be taken.
5. Schleiden and Schwann did not correctly understand how cells arose.
6. Virchow proposed that all cells come from pre-existing cells which provided the last point in the cell theory.
7.

Year	Person	Contribution
1665	Hooke	Observed cells in a slice of cork
1678	Leeuwenhoek	Observed micro-organisms
1824	Dutrochet	Living things are made of cells
1833	Brown	Observes nucleus in plant cells and names structure as nucleus
1838	Schleiden and Schwann	Tissues in all living things made of cells and cells function both independently and in cooperation
1858	Virchow	Cells come from pre-existing cells

8. Hooke observed cells in a slice of cork using his compound microscope, providing evidence that the tissue consists of cells.
9. The electron microscope has enabled scientists to see more details within the cell, e.g. the structure of the nuclear membrane, as well as discovering new parts, e.g. ribosomes.