STUDENT BOOK ANSWERS

Chapter 7 Cells

Experiment 7.1: Microscopes and Cells

Discussion

1 The overall magnification will determine how much the specimen has been enlarged. This can be worked out by multiplying the magnification of the eyepiece of the microscope by the magnification of the objective lens being used.

2 1000

3 Responses will vary.

4

	Total magnification	Total magnification
Objective lens	Eyepiece lens × 10	Eyepiece lens × 5
×4	×40	×20
×10	×100	×50
×40	×400	×200

Question set 7.1

1 Living things are characterised by their ability to move, grow and replicate or reproduce themselves. They detect and respond to changes in their environment; take in food or matter and process it in a variety of ways that involve controlled transformation of energy; and remove the waste products of their activities.

2 All parts of living things are not only made of cells but also the non-cellular products of the cells that living things produce to help them live.

3 1838 Matthias Schleiden observes that individual cells develop as independent units. He believes that the nucleus is involved in this development.

1839 Theodore Schwann theorises that plants and animals are made of cells, which have their own 'life'. Together, Scheiden and Schwann propose the cell theory.

1849 Cell division is first described.

1859 Rudolf Virchow proposes that all cells come from pre-existing cells.

4 **a** Light microscope

Advantages: living samples can be used; no treatment of samples necessary; natural colour can be seen; easy to use in many different locations including a school room.

Disadvantages: fine structures within the cell will not be visible.

b SEM

Advantages: focuses on the sample's surface and its composition; provides three dimensional image; accurate representation of sample; very high magnification; analysis is quick.

Disadvantages: samples are viewed in a vacuum; samples in use are required to have their surface stained with metals in order to produce images; only shows sample bit by bit; SEMs are expensive, large and must be housed in an area free of any possible electric, magnetic or vibration interference; special training is required to operate an SEM as well as prepare samples.

c TEM

Advantages: sees what is inside or beyond the surface of the sample; very high magnification; samples in use do not require metallic stain coating to produce images.

Disadvantages: sample must be thin; only provides two dimensional images; may require interpretation of image; TEMs are large and very expensive; operation and analysis requires special training.

d Scanning probe microscope

Advantages: allows researchers to image, characterise and even manipulate material structures at exceedingly small scales including features of atomic proportions; can be observed in air, liquid or a vacuum at normal temperature and pressure.

Disadvantages: natural colour cannot be seen; images take some time to be produced.

Experiment 7.2: Investigating cells

Discussion

1 Chemical stains usually 'stain' particular parts of the cell, making it easier to distinguish its structures.

2 All the materials required by the cell (e.g. oxygen, glucose) to function normally must first pass through the cell wall before they can enter the cell. This also includes chemical messengers such as hormones. Waste materials such as carbon dioxide and nitrogenous wastes also pass through the cell wall.

3 Chloroplasts are seen to be moving. This is called cytoplasmic streaming. It causes a continual mixing of the cytoplasm, removing wastes from certain areas and supplying requirements.

4 Cytoplasmic streaming stops, implying the cells have been killed. The chloroplast should stain and be more obvious.

5 They should be smaller.

6 No detail would be seen using a light microscope.

7 Light microscopes are limited in the magnification they can reach and they provide a two-dimensional view of the specimen.

8 Responses will vary according to samples. Some possibilities may include the following: prokaryotic cells are smaller; eukaryotic cells have a distinct nucleus.

9 Prepared slides are usually better because the samples they contain are usually stained with a number of different coloured stains, which contrast different parts of the sample more sharply.

10 The resolution of the microscope increases, making the internal structures clearer.

Question set 7.2

1 **a** The cytoplasm is found within the plasma membrane. It is the place where chemical reactions that enable the cell to live are carried out.

b The cytosol is the fluid part of the cytoplasm. It's often described as the 'soup' of the cell because it contains many dissolved substances. Collectively, the cytoplasm is made up of cytosol together with cell organelles.

2 Plasmids are small rings of DNA found in prokaryotic cells.

3 The nucleus controls the functioning of eukaryotic cells. DNA is the main molecule found in the nucleus. It codes for protein production. By coding for different proteins at different times and in different cells, the nucleus can coordinate the activities of a cell.

4 Chromosomes in prokaryotes are circular. Eukaryote chromosomes are rod shaped when visible during cell division.

5 **a** If you look at the internal structure of the cell and see membrane-bound organelles, it would be eukaryotic, but if the DNA was not in a membrane-bound nucleus and small rings of DNA were present it would be prokaryotic.

b For a the cell to be from a plant, you would need to find:

- the presence of chloroplasts
- the presence of large, permanent vacuoles
- a cell wall.

6 Ribosomes build up (synthesise) proteins from their building blocks, amino acids. As the skin cells don't produce as many proteins, they would need fewer ribosomes.

7 This cell could be prokaryotic as no membrane-bound organelles were seen. The size, however, is not typical for prokaryotic cells, which typically range from 1–10 μm in length. A more extensive examination of the cell is needed, particularly a search for chromosomes. If a single circular chromosome with smaller plasmid rings is found, the cell is likely to be an abnormally large prokaryote.

8 By maximising their surface area, through the folding and stacking of internal membranes, a greater amount of chemical reactions can occur at the same time. Organelles also facilitate the synthesis of complex molecules and the entry and exit of substances. Membrane-bound organelles enable a cell to carry out hundreds of different chemical reactions simultaneously, without one reaction interfering with another. This is important when reactions are incompatible. Organelles also separate chemical reactions in time, such as when substances are stored and then later used in other reactions.

Question set 7.3

1 Evidence that both mitochondria and chloroplasts were once free-living organisms. They both:

- make copies of themselves and split in two, like bacteria do, when they reproduce
- have two membranes
- are similar in size to small bacteria and they have their own genetic material, which, like that in bacteria, is contained on a circular DNA molecule. They contain ribosomes and RNA molecules so that they can make their own proteins.

2 Scientists believe that chloroplasts arose from primitive cyanobacteria that were ingested by eukaryotic cells already containing mitochondria.

3 Autotrophs use energy from the sun or the energy released from chemical reactions. Heterotrophs rely on autotrophs to provide their energy for them, usually when consumed.

4 Mitochondria are the organelles that allow cells to access energy. Cellular respiration takes place in these organelles (and the cytoplasm) and the energy released from this process is used to build ATP molecules. It is the ATP that stores the energy needed by a cell to carry out activities.

5 It is thought that chloroplasts probably arose when photosynthetic cyanobacteria were ingested by eukaryotic cells. After a long period of time, the cyanobacteria became chloroplasts.

6 **a** Chemosynthesis is the process whereby the energy released from chemical reactions is used by cells and photosynthesis is the process whereby energy from the sun is used by cells.

b Respiration is a series of chemical reactions using glucose and oxygen and producing carbon dioxide and water, releasing energy. Photosynthesis is a series of chemical reactions using energy from the sun to convert carbon dioxide and water into glucose and oxygen.

c Heterotrophic describes organisms that cannot synthesise their own organic compounds. They rely on other organisms for their nutrients and energy requirements. Autotrophic describes organisms that are able to produce their own food.

7 Human muscle cells use more energy when they perform their task of contraction and relaxation compared to the cells in your big toe. Therefore more mitochondria are needed to supply energy to build up more ATP molecules to be used for contraction of muscle cells.

8 It was likely to be advantageous as the ingested bacteria were able to carry out aerobic cellular respiration increasing the energy available for use by their host cells.

Question set 7.4

1 The four main types of macromolecules are nucleic acids, proteins, complex carbohydrates and lipids.

2 An organic compound is a complex, carbon containing compound.

3 Nucleic acids, proteins and complex carbohydrates are all polymers.

4 Carbohydrates can be classified by the number of monomeric units that make up the carbohydrate: monosaccharides (one monomer), disaccharides (two monomers) and polysaccharides (more than two monomers). Increasing numbers of monomers and the complexity of the linkages determine their structural and storage functions.

5 DNA is found in the nucleus of a eukaryotic cell. Some is also found in mitochondria and chloroplasts. RNA is found in both the nucleus and cytoplasm. In prokaryotic cells, DNA and RNA are found in the cytoplasm as there is no clearly defined nucleus.

6 Because they contain three (tri-) fatty acids and one glycerol.

7 **a** Monosaccharides are composed of one sugar unit. Disaccharides are composed of two sugar units. Polysaccharides are composed of many sugar units.

b Both DNA and RNA molecules are polymers and use a triplet code. DNA is double stranded, and RNA is usually single stranded. Ribose sugar is present in both but is in a deoxygenated form in DNA. The nitrogen base thymine in DNA is replaced by uracil in RNA.

c Monomers are small repeating molecules. When monomers are put together to form a long chain, a polymer is formed.

8 Protein diversity is made possible by arranging the 20 different amino acid monomers in various combinations or sequences that differ in length.

9 Plants don't move around, animals do. Since fats have more energy per unit weight than carbohydrates, more energy can be stored in fat without increasing weight, making it better for a life requiring movement.

Question set 7.5

1 Intracellular transport system: aids the movement of substances around the cell within the channels

Intercellular transport system: aids the movement of substances from one cell to another

2 Similarity: In both endocytosis and exocytosis, vesicles enclose materials to be transported.

Difference: Endocytosis is a process that moves substances into a cell and exocytosis is a process that moves substances out of a cell.

3 The Golgi apparatus is an assembly point through which raw materials for secretion, such as enzymes, are stored before being removed from the cell. It serves as a collecting and packaging centre of the cell.

4 Smooth endoplasmic reticulum has no ribosomes attached to it, but rough endoplasmic reticulum is studded with ribosomes. If a cell has more rough ER its function is likely to be secretory. Proteins produced by the ribosomes can move directly into the ER and move about the cell. However, if some proteins are not required by the cell in which they are made then they can be exported or secreted into other cells.

5 Like a recycling station, complex chemical compounds are split into simpler ones. The lysosomes produce digestive enzymes that break down the compounds. A membrane forms around the unwanted structure and lysosomes discharge their contents into this bag. Soluble products are absorbed into the surrounding cytoplasm, to be used as building blocks for new compounds and organelles.

6 **a** Exocytic vesicles

b They transport large molecules and particles across the plasma membrane and out of the cell.

c Exocytosis

d Lysosomes remain within a cell. They do not transport substances.

Chapter review questions

1 I – d, II – c, III – f, IV – e, V – a, VI – b

2 **a** The term structure is used to refer to the form and features that make up a cell. The function is what the cell does.

b Chlorophyll is the green pigment situated within the chloroplast organelle.

c Carbon containing compounds are described as organic. Simpler carbon compounds and those that don't contain carbon are classed as inorganic.

d Rough endoplasmic reticulum has ribosomes attached, whereas smooth endoplasmic has no attached ribosomes.

3 a Mitochondria and chloroplasts both contain two membranes, ribosomes and nucleic acid. Mitochondria are the site for respiration and are found in all eukaryotic cells. Chloroplasts are the site for photosynthesis and are found in photosynthetic eukaryotic cells.

b Both mitochondria and chloroplasts have their own genomes and have ribosomes that are distinct from cellular ribosomes. They divide in the same way as bacteria; their chromosomes are circular like bacteria and sequencing of their genetic material show a close relationship with each other.

4 It is the order of amino acids that determines the many different types of proteins. The amino acids are ordered into different chains that can be arranged differently in loops and folds to give each protein its characteristic features.

5 a All cells have hereditary material and arise from pre-existing cells. They sense and respond to their surroundings. Cells use proteins to control chemical reactions. They enclose their contents within a plasma membrane and contain cytoplasm and ribosomes.

b i Prokaryotic cells have a circular chromosome and small circular plasmids within the cytoplasm.

ii Eukaryotic cells have membrane-bound organelles including a nucleus with rod shaped chromosomes.

6 These cells would require a lot of instant energy, for example sperm cells. Mitochondria are the cell's energy-producing organelles so the presence of large numbers of them implies a need for lots of energy.

7 Autotrophic organisms need light as their source of energy whereas heterotrophic organisms feed off others and use their energy. They are therefore able to live without light.

8 a This will depend on students' responses.

b Cells divide and reproduce, factories do not.

c This will depend on students' responses.

9 So that many different chemical reactions can occur simultaneously in discrete areas of the cytoplasm.

10 a Eukaryote cell, because it has membrane-bound organelles.

b Electron microscope because of the level of detail.

c A cell is three-dimensional; other organelles may be present in a different area of the cell.

d (I) chloroplast (II) nucleus

11 It is the job of the lysosomes to break down cells, such as bacteria. They contain digestive enzymes that split complex chemical compounds into simpler ones.

12 This will depend on students' responses. They should relate the functions of organelles to specialised cell types.

13 Proteomics. Interactions between proteins and the effect of different combinations of proteins on cell functioning can be studied.

14 This feature is usually not observed in bacteria. It is more commonly associated with eukaryotes.

15 All cells need mitochondria. The ATP built up in mitochondria as a result of cellular respiration is the source of energy for all cellular processes. Plant cells synthesise glucose as a product of photosynthesis but the glucose cannot be used as a direct source of energy in cells. It must be broken down to release the energy to form ATP.

16 Arguments could include: Mitochondria may need to be stained to make them visible in a light microscope; the section of the cell observed may not contain mitochondria although they would be elsewhere in the cell.

17 a Ribosomes, endoplasmic reticulum, Golgi apparatus, plasma membrane

b Complex proteins, enzymes, hormones, glycoproteins

18 Proteins would not be synthesised. Chemical reactions that maintain life processes would not be controlled. The cell would die.

19 All biomacromolecules contain carbon. There would be no life without these molecules.

20 This will depend on students' responses. There may be some discussion on determining if life is possible on other planets, decisions about living, dead and non-living things and misconceptions of life arising spontaneously as believed prior to the 1600s.

21 Responses will vary.

22 Responses will vary.