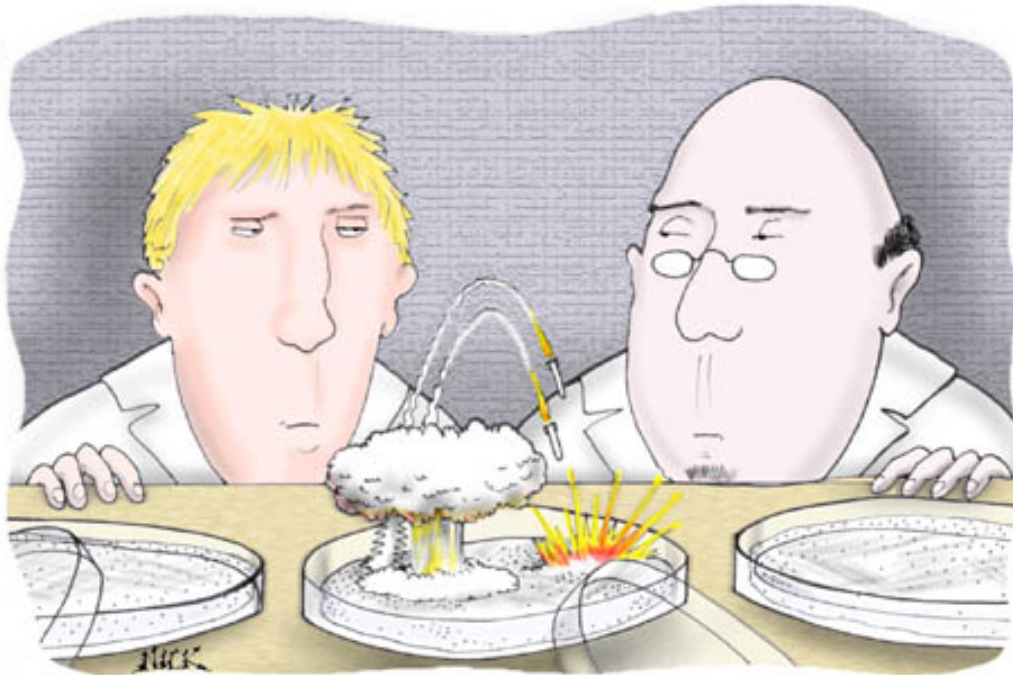



Topic 2: Cells



Once again, war breaks out in the middle yeast.

Topic 2: Cells

2.1 Cell theory

	Assessment statement	IBO Notes	Student Notes
2.1.1	Outline the cell theory.	<p>Include the following.</p> <ul style="list-style-type: none"> • Living organisms are composed of cells. • Cells are the smallest unit of life. • Cells come from pre-existing cells. 	
2.1.2	Discuss the evidence for the cell theory.	<p>TOK: The nature of scientific theories could be introduced here: the accumulation of evidence that allows a hypothesis to become a theory; whether a theory should be abandoned when there is evidence that it does not offer a full explanation; and what evidence is needed for a theory to be adopted or rejected.</p>	
2.1.3	State that unicellular organisms carry out all the functions of life.	<p>Include metabolism, response, homeostasis, growth, reproduction and nutrition.</p>	
2.1.4	Compare the relative sizes of molecules, cell membrane thickness, viruses, bacteria, organelles and cells, using the appropriate SI unit.	<p>Appreciation of relative size is required, such as molecules (1 nm), thickness of membranes (10 nm), viruses (100 nm), bacteria (1 μm), organelles (up to 10 μm), and most cells (up to 100 μm). The three-dimensional nature/shape of cells should be emphasized.</p> <p>TOK: All the biological entities in the above list are beyond our ability to perceive directly. They must be observed through the use of technology such as the light microscope and the electron microscope. Is there any distinction to be drawn between knowledge claims dependent upon observations made directly with the senses and knowledge claims dependent upon observations assisted by technology?</p>	
2.1.5	Calculate the linear magnification of drawings and the actual size of specimens in images of known magnification.	<p>Magnification could be stated (for example, $\times 250$) or indicated by means of a scale bar, for example:</p>  <p>Aim 7: The size of objects in digital images of microscope fields could be analysed using graticule baselines and image-processing software.</p>	
2.1.6	Explain the importance of the surface area to volume ratio as a factor limiting cell size.	<p>Mention the concept that the rate of heat production/waste production/resource consumption of a cell is a function of its volume, whereas the rate of exchange of materials and energy (heat) is a function of its surface area. Simple mathematical models involving cubes and the changes in the ratio that occur as the sides increase by one unit could be compared.</p> <p>Aim 7: Data logging could be carried out to measure changes in conductivity in distilled water as salt diffuses out of salt-agar cubes of different dimensions.</p>	

Assessment statement		IBO Notes	Student Notes
2.1.7	State that multicellular organisms show emergent properties.	Emergent properties arise from the interaction of component parts: the whole is greater than the sum of its parts. TOK: The concept of emergent properties has many implications in biology, and this is an opportunity to introduce them. Life itself can be viewed as an emergent property, and the nature of life could be discussed in the light of this, including differences between living and non-living things and problems about defining death in medical decisions.	
2.1.8	Explain that cells in multicellular organisms differentiate to carry out specialized functions by expressing some of their genes but not others.		
2.1.9	State that stem cells retain the capacity to divide and have the ability to differentiate along different pathways.		
2.1.10	Outline one therapeutic use of stem cells.	This is an area of rapid development. In 2005, stem cells were used to restore the insulation tissue of neurons in laboratory rats, resulting in subsequent improvements in their mobility. Any example of the therapeutic use of stem cells in humans or other animals can be chosen. Aim 8: <i>There are ethical issues involved in stem cell research, whether humans or other animals are used. Use of embryonic stem cells involves the death of early-stage embryos, but if therapeutic cloning is successfully developed the suffering of patients with a wide variety of conditions could be reduced.</i> Int: <i>Stem cell research has depended on the work of teams of scientists in many countries, who share results and so speed up the rate of progress. However, ethical concerns about the procedures have led to restrictions on research in some countries. National governments are influenced by local, cultural and religious traditions, which vary greatly, and these, therefore, have an impact on the work of scientists.</i> TOK: <i>This is an opportunity to discuss balancing the huge opportunities of therapeutic cloning against the considerable risks—for example, stem cells developing into tumours. Another issue is how the scientific community conveys information about its work to the wider community in such a way that informed decisions about research can be made.</i>	

2.2 Prokaryotic cells

Assessment statement		IBO Notes	Student Notes
2.2.1	Draw and label a diagram of the ultrastructure of <i>Escherichia coli</i> (<i>E. coli</i>) as an example of a prokaryote.	The diagram should show the cell wall, plasma membrane, cytoplasm, pili, flagella, ribosomes and nucleoid (region containing naked DNA).	
2.2.2	Annotate the diagram from 2.2.1 with the functions of each named structure.		
2.2.3	Identify structures from 2.2.1 in electron micrographs of <i>E. coli</i> .		
2.2.4	State that prokaryotic cells divide by binary fission.		

2.3 Eukaryotic cells

Assessment statement		IBO Notes	Student Notes
2.3.1	Draw and label a diagram of the ultrastructure of a liver cell as an example of an animal cell.	The diagram should show free ribosomes, rough endoplasmic reticulum (rER), lysosome, Golgi apparatus, mitochondrion and nucleus. The term Golgi apparatus will be used in place of Golgi body, Golgi complex or dictyosome.	
2.3.2	Annotate the diagram from 2.3.1 with the functions of each named structure.		
2.3.3	Identify structures from 2.3.1 in electron micrographs of liver cells.		
2.3.4	Compare prokaryotic and eukaryotic cells.	Differences should include: <ul style="list-style-type: none"> naked DNA <i>versus</i> DNA associated with proteins DNA in cytoplasm <i>versus</i> DNA enclosed in a nuclear envelope no mitochondria <i>versus</i> mitochondria 70S <i>versus</i> 80S ribosomes eukaryotic cells have internal membranes that compartmentalize their functions. 	
2.3.5	State three differences between plant and animal cells.		
2.3.6	Outline two roles of extracellular components.	The plant cell wall maintains cell shape, prevents excessive water uptake, and holds the whole plant up against the force of gravity. Animal cells secrete glycoproteins that form the extracellular matrix. This functions in support, adhesion and movement.	

1. Compare, with the aid of a diagram, the structure of generalised prokaryotic and eukaryotic animal cells.

(Total 8 marks)

2. (a) Distinguish between diffusion and osmosis.

.....
.....
.....

(1)

(b) Explain how the properties of phospholipids help to maintain the structure of the cell surface membrane.

.....
.....
.....
.....

(2)

(c) State the composition and the function of the plant cell wall.

.....
.....
.....
.....

(2)

(Total 5 marks)

3. Outline the advantages of using light microscopes in comparison with electron microscopes.

(Total 3 marks)

4. Distinguish between the structure of plant and animal cells.

(Total 6 marks)

5. What is/are the advantage(s) of using an electron microscope?

- I. Very high resolution
- II. Very high magnification
- III. The possibility of examining living material

- A. I only
- B. I and II only
- C. II and III only
- D. I, II and III

(1)

6. Draw a diagram of the ultrastructure of an animal cell as seen in an electron micrograph.

(Total 6 marks)

7. (a) An organelle is a discrete structure within a cell with a specific function. In the table below, identify the missing organelles and outline the missing functions.

Name of organelle	Structure of organelle	Function of organelle
Nucleus	Region of the cell containing chromosomes, surrounded by a double membrane, in which there are pores.	Storage and protection of chromosomes
Ribosome	Small spherical structures, consisting of two subunits.
.....	Spherical organelles, surrounded by a single membrane and containing hydrolytic enzymes.	Digestion of structures that are not needed within cells.
.....	Organelles surrounded by two membranes, the inner of which is folded inwards.

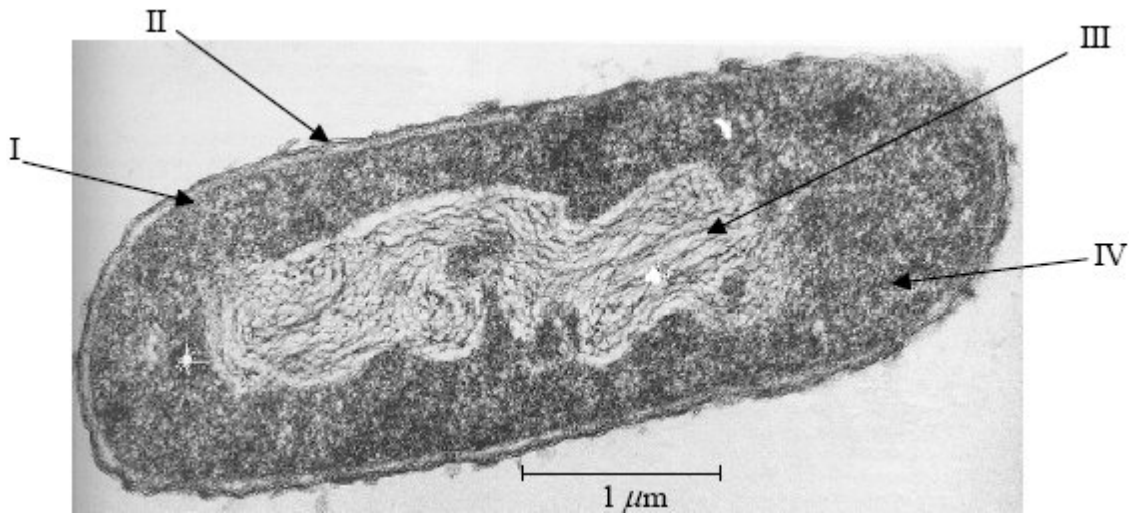
(2)

(b) The table above shows some of the organelles found in a particular cell. Discuss what type of cell this could be.

.....
.....
.....
.....
.....

(2)
(Total 4marks)

8. (a) Label the following electron micrograph of a prokaryotic cell.



[Source: Stephen Wolfe, *Biology of the Cell*, (1995) 2nd edition, Brooks Cole, page 5]

I:

II:

III:

IV:

(2)

(b) Calculate the magnification of the prokaryotic cell.

.....
.....
.....

(1)

(c) State **two** advantages of using a light microscope over an electron microscope.

.....
.....
.....
.....

(2)
(Total 5 marks)

9. State **one** function of each of the following organelles.

- Lysosome
- Golgi apparatus
- Rough endoplasmic reticulum
- Nucleus
- Mitochondrion

(Total 5 marks)

10. Which of the following is a characteristic of organelles?

- A. They are only found in eukaryotic cells
- B. They are only found in prokaryotic cells
- C. They are sub-cellular structures
- D. They are all membrane bound

(1)

11. Discuss possible exceptions to the cell theory.

(Total 4 marks)

12. (a) Explain how the surface area to volume ratio influences cell sizes.

.....
.....
.....
.....
.....]
.....
.....

(3)

(b) State **one** function for each of the following organelles.

(i) Ribosomes

.....

(ii) Rough endoplasmic reticulum

.....

(iii) Golgi apparatus

.....

(3)

(c) Compare prokaryotic and eukaryotic cells in regards to **three** different features.

	Prokaryotic	Eukaryotic
1.
2.
3.

(3)

(Total 9 marks)

13. Outline the differentiation of cells in a multicellular organism.

(Total 4 marks)

14. Draw a labelled diagram of a prokaryotic cell as seen in electron micrographs.

(Total 6 marks)

15. If a red blood cell has a diameter of 8 μm and a student shows it with a diameter of 40 mm in a drawing, what is the magnification of the drawing?

- A. $\times 0.0002$
- B. $\times 0.2$
- C. $\times 5$
- D. $\times 5000$

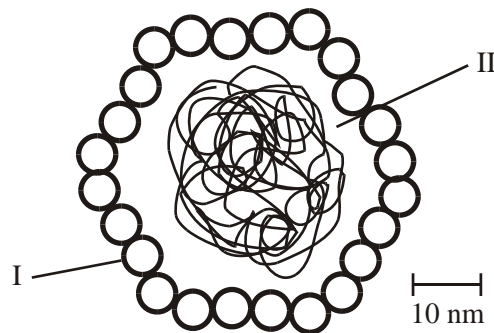
(1)

16. The key below can be used to identify some of the structures in the cytoplasm of liver cells. Which structures are ribosomes?

- 1. Enclosed in a membrane go to 2
 Not enclosed in a membrane go to 3
- 2. Diameter less than 100 nm A.
 Diameter greater than 100 nm B.
- 3. Composed of one globular structure C.
 Composed of two sub-units D.

(1)

17. The drawing below shows the structure of a virus.



(a) Identify structures labelled I and II.

I:

II:

(2)

(b) Use the scale bar to calculate the maximum diameter of the virus. Show your working.

Answer:

(2)

(c) Explain briefly why antibiotics are effective against bacteria but not viruses.

.....
.....
.....
.....
.....
.....
.....
.....

(3)

(d) Explain how antibiotic resistance develops in bacteria.

.....
.....
.....
.....
.....
.....

(3)

(Total 10 marks)

18. What is an advantage of using an electron microscope?

- A. Living cells can be observed
- B. Virus particles can be observed
- C. Pigments can be observed
- D. Whole cells can be observed

(1)

19. Which group of organisms, identified by this key, represents the Fungi?

- 1 Nuclei present2
- No nuclei presentA
- 2 Develops from an embryo3
- Does not develop from an embryo4
- 3 Cell wall presentB
- No cell wallC
- 4 Cell wall of chitinD
- Cell wall of cellulose or no cell wallProtoctista

(1)

20. (a) State **two** processes which involve mitosis.

.....

.....

.....

(2)

(b) Explain the importance of the surface area to volume ratio as a factor limiting cell size.

.....

.....

.....

.....

.....

.....

.....

(3)

(c) State **one** difference between the proteins produced by free ribosomes and those produced by ribosomes attached to the endoplasmic reticulum.

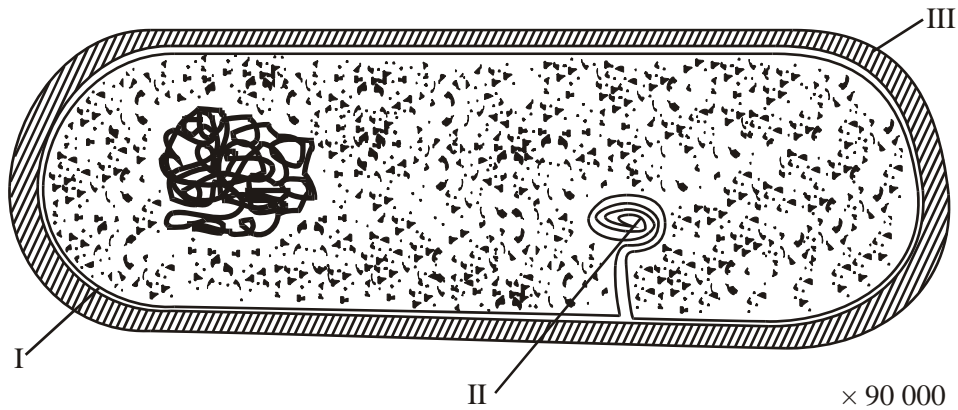
.....

.....

(1)

(Total 6 marks)

21. The diagram below shows the structure of a cell.



(a) State the names of I and II.

I:

II:

(2)

(b) Calculate the actual length of the cell, showing your working.

Answer:

(2)

(c) State the function of the structure labelled III.

.....

.....

(1)

(d) Deduce which type of cell is shown in the diagram, giving reasons for your answer.

.....

.....

.....

.....

.....

.....

(2)

(Total 7 marks)

2.4 Membranes

Assessment statement		IBO Notes	Student Notes
2.4.1	Draw and label a diagram to show the structure of membranes.	<p>The diagram should show the phospholipid bilayer, cholesterol, glycoproteins, and integral and peripheral proteins. Use the term plasma membrane, not cell surface membrane, for the membrane surrounding the cytoplasm.</p> <p>Integral proteins are embedded in the phospholipid of the membrane, whereas peripheral proteins are attached to its surface. Variations in composition related to the type of membrane are not required.</p> <p>Aim 7: Data logging to measure the changes in membrane permeability using colorimeter probes can be used.</p>	
2.4.2	Explain how the hydrophobic and hydrophilic properties of phospholipids help to maintain the structure of cell membranes.		
2.4.3	List the functions of membrane proteins.	Include the following: hormone binding sites, immobilized enzymes, cell adhesion, cell-to-cell communication, channels for passive transport, and pumps for active transport.	
2.4.4	Define <i>diffusion</i> and <i>osmosis</i> .	<p>Diffusion is the passive movement of particles from a region of high concentration to a region of low concentration.</p> <p>Osmosis is the passive movement of water molecules, across a partially permeable membrane, from a region of lower solute concentration to a region of higher solute concentration.</p>	
2.4.5	Explain passive transport across membranes by simple diffusion and facilitated diffusion.		
2.4.6	Explain the role of protein pumps and ATP in active transport across membranes.		
2.4.7	Explain how vesicles are used to transport materials within a cell between the rough endoplasmic reticulum, Golgi apparatus and plasma membrane.		
2.4.8	Describe how the fluidity of the membrane allows it to change shape, break and re-form during endocytosis and exocytosis.		

1. Outline the process of endocytosis.

(Total 5 marks)

2. (a) Distinguish between diffusion and osmosis.

.....
.....
.....

(1)

(b) Explain how the properties of phospholipids help to maintain the structure of the cell surface membrane.

.....
.....
.....
.....

(2)

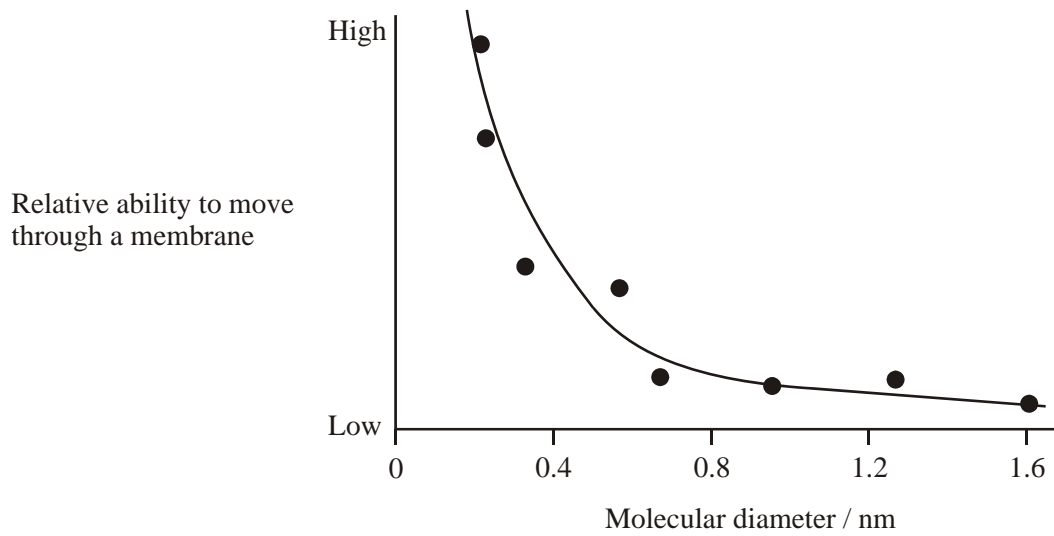
(c) State the composition and the function of the plant cell wall.

.....
.....
.....
.....

(2)

(Total 5 marks)

3. A study was carried out to determine the relationship between the diameter of a molecule and its movement through a membrane. The graph below shows the results of the study.



[Source: Knox, *et al.*, *Biology*, McGraw Hill, Sydney, 1994, page 65]

- (a) From the information in the graph alone, describe the relationship between the diameter of a molecule and its movement through a membrane.

.....

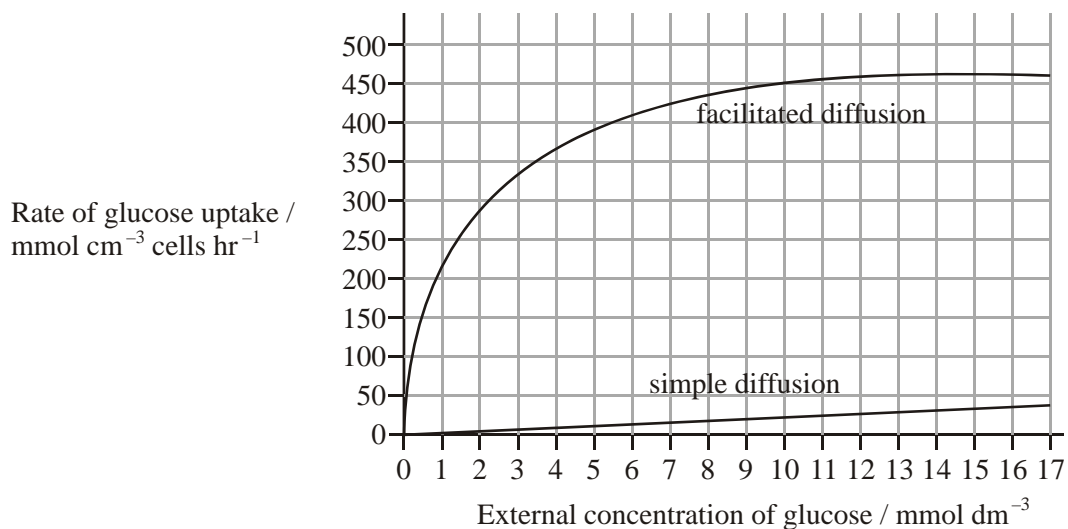
.....

.....

.....

(2)

A second study was carried out to investigate the effect of passive protein channels on the movement of glucose into cells. The graph below shows the rate of uptake of glucose into erythrocytes by simple diffusion and facilitated diffusion.



(b) Identify the rate of glucose uptake at an external glucose concentration of 4 mmol dm^{-3} by

(i) simple diffusion. (1)

(ii) facilitated diffusion. (1)

(c) (i) Compare the effect of increasing the external glucose concentration on glucose uptake by facilitated diffusion and by simple diffusion.

.....
.....
.....
.....
.....
.....

(3)

(ii) Predict, with a reason, the effect on glucose uptake by facilitated diffusion of increasing the external concentration of glucose to 30 mmol dm^{-3} .

.....
.....
.....
.....

(2)

(Total 9 marks)

4. Explain how the structure and properties of phospholipids help to maintain the structure of cell membranes.

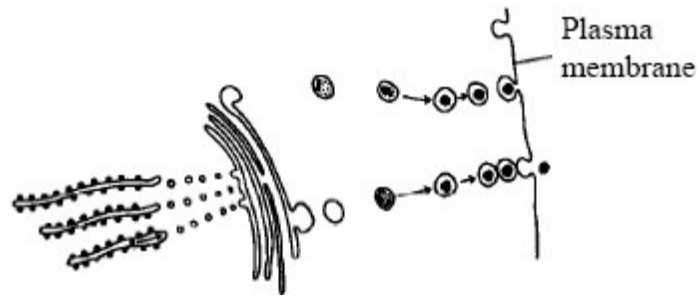
(Total 9 marks)

5. What is essential for diffusion?

- A. A concentration gradient
- B. A selectively permeable membrane
- C. A source of energy
- D. A protein

(1)

6. In the diagram below macromolecules are being transported to the exterior of a cell.



What is the name of this process?

- A. Exocytosis
- B. Pinocytosis
- C. Endocytosis
- D. Phagocytosis

(1)

7. Describe the process of active transport.

(Total 4 marks)

8. List the functions of membrane proteins.

(Total 4 marks)

9. Draw a labelled diagram of the fluid mosaic model of the plasma membrane.

(Total 5 marks)

10. Describe passive transport across a biological membrane.

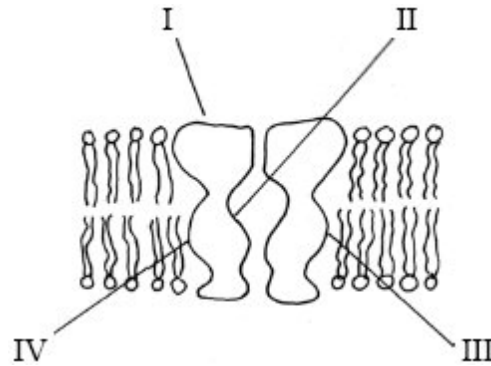
(Total 5 marks)

11. How do animals use cholesterol?

- A. To form part of the structure of cell membranes
- B. To increase the blood pressure during exercise
- C. To insulate neurones between nodes of Ranvier
- D. To help in the storage of energy

(1)

12. The diagram below shows a channel protein in a membrane. Which parts of the surface of the protein would be composed of polar amino acids.



- A. I and II only
- B. II and III only
- C. III and IV only
- D. I and IV only

(1)

13. Describe the process of active transport across membranes.

(Total 5 marks)

14. Explain the various methods cells use to transport materials across membranes.

(Total 8 marks)

15. Explain how vesicles are used in cells, including the way in which they form and are reabsorbed.

(Total 8 marks)

16. (a) State **one** type of secondary structure of a protein.

.....

(1)

(b) Outline the differences between globular and fibrous proteins, giving a named example of each.

.....
.....
.....
.....
.....
.....

(3)

(c) Explain the significance of polar amino acids for membrane proteins.

.....
.....
.....
.....
.....

(2)

(Total 6 marks)

17. Which of the following is required for osmosis to occur?

- A. An enzyme
- B. A fully permeable membrane
- C. ATP
- D. A solute concentration gradient

(1)

18. What is facilitated diffusion?

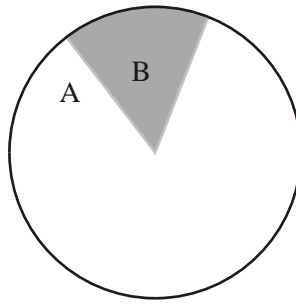
- A. The passive movement of a particle through the phospholipid bilayer of the cell membrane.
- B. The passive movement of a particle across a cell membrane via a channel protein.
- C. The movement of a particle down a concentration gradient helped by active pumping.
- D. The movement of a particle up a concentration gradient helped by active pumping.

(1)

2.5 Cell division

	Assessment statement	IBO Notes	Student Notes
2.5.1	Outline the stages in the cell cycle, including interphase (G ₁ , S, G ₂), mitosis and cytokinesis.		
2.5.2	State that tumours (cancers) are the result of uncontrolled cell division and that these can occur in any organ or tissue.		
2.5.3	State that interphase is an active period in the life of a cell when many metabolic reactions occur, including protein synthesis, DNA replication and an increase in the number of mitochondria and/or chloroplasts.		
2.5.4	Describe the events that occur in the four phases of mitosis (prophase, metaphase, anaphase and telophase).	<p>Include supercoiling of chromosomes, attachment of spindle microtubules to centromeres, splitting of centromeres, movement of sister chromosomes to opposite poles, and breakage and re-formation of nuclear membranes.</p> <p>Textbooks vary in the use of the terms chromosome and chromatid. In this course, the two DNA molecules formed by DNA replication are considered to be sister chromatids until the splitting of the centromere at the start of anaphase; after this, they are individual chromosomes. The term kinetochore is not expected.</p> <p>Aim 7: Students could determine mitotic index and fraction of cells in each phase of mitosis. Individual groups could paste data into a database. Pie charts could be constructed with a graphing computer program. If a graphing computer program is used in DCP for internal assessment, it should be according to the IA and ICT clarifications.</p>	
2.5.5	Explain how mitosis produces two genetically identical nuclei.		
2.5.6	State that growth, embryonic development, tissue repair and asexual reproduction involve mitosis.		

1. According to cell theory all cells arise from pre-existing cells. The following diagram shows the cell cycle of a eukaryotic (body) cell of a diploid organism.



- (a) Define the term diploid.

.....
.....

(1)

- (b) Identify the parts of the cell cycle labelled A and B.

A

B

(1)

- (c) State **three** activities that occur during part A of the cell cycle.

.....
.....
.....
.....

(3)

- (d) Outline the differences in cytokinesis in animal and plant cells.

.....
.....
.....
.....
.....

(2)

(e) Explain the significance of complementary base pairing in relation to the cell cycle.

.....

.....

.....

.....

.....

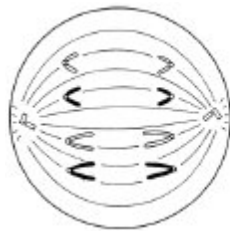
.....

.....

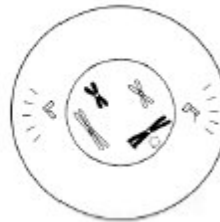
.....

(3)
(Total 10 marks)

2. Which phases of mitosis are shown in diagrams I and II?



I



II

	I	II
A.	metaphase	prophase
B.	metaphase	telophase
C.	anaphase	prophase
D.	anaphase	metaphase

(1)

3. (a) State **two** processes which involve mitosis.

.....

.....

.....

(2)

(b) Explain the importance of the surface area to volume ratio as a factor limiting cell size.

.....

.....

.....

.....

.....

.....

.....

(3)

(c) State **one** difference between the proteins produced by free ribosomes and those produced by ribosomes attached to the endoplasmic reticulum.

.....

.....

(1)

(Total 6 marks)

4. Draw diagrams to show the four stages of mitosis in an animal cell with four chromosomes.

(Total 5 marks)