Full Name:	Civics group: 22S	Index no.:	Date:

Core Idea 1: The Cell and Biomolecules of Life

Tutorial 1
Section A (Annotated MS)
The Cell Theory
Structures & functions of organelles

MCQ
SECTION A: CELL THEORY, TYPE OF CELLS, NUCLEUS, NUCLEOLUS, CENTRIOLES

ANSWERS FOR SECTION A:

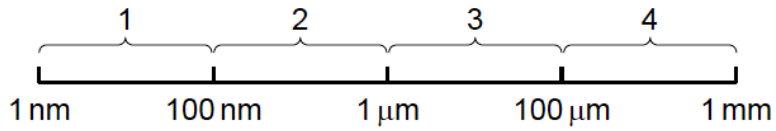
1	2	3	4	5	6	7	8	9	10
A	D	C	B	B	A	A	C	B	D

1 Which of the following is not one of the main components of the cell theory?

A Cells must contain DNA
B All living things are made of cells
C Cells can only come from other cells
D Cells are the basic unit of life

3 tenets of cell theory

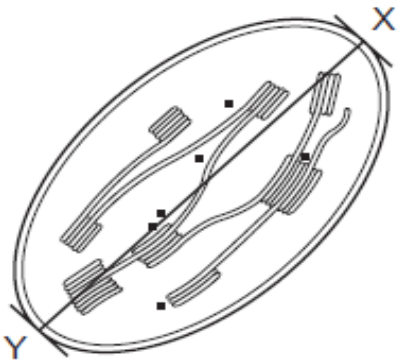
2 Which size ranges can be viewed using a light microscope?



A 4 only
B 1 and 2 only
C 2 and 3 only
D 3 and 4 only

Refer to diagram on lecture notes pg 6

3 The diagram shows a chloroplast drawn from an electronmicrograph.



Indicated use of electron microscopy. Hence ultrastructure inside organelle can be seen.

SI unit is nm, hence indicate actual size of chloroplast.

The length of the chloroplast from X to Y is 5000 nm.

What is the magnification of the drawing of the chloroplast?

A x100
B X1000
C X10 000
D X100 000

Working:
Magnification
= **image / actual**
= 5.7 cm / 5000 nm
= 5.7 x 10^{-2} **m** / 5000 x 10^{-9} **m**
= 1.14 x 10^{4}
~ x 10 000

4 The electronmicrograph is of a chloroplast.

The length of the chloroplast along the line shown is 80 mm. The actual length of the chloroplast is 10 µm.

What is the magnification of the chloroplast?

A x8 x 10^2
B x8 x 10^3
C x8 x 10^4
D x8 x 10^6

Working:
Magnification
= image / actual
= 80 mm / 10 µm
= 80 x 10^{-3} m / 10 x 10^{-6} m
= 8 x 10^3

5 You are told that the cells on a microscope slide are plant, animal, or bacterial. You look at them through a microscope and see cell walls **and** membrane-bound organelles. You conclude that the cells are

A Bacteria cells
B Plant cells
C Bacteria and plant cells
D Bacteria, plant, and animal cells

indicate either Plant cells (cellulose cell wall) or bacterial cell (peptidoglycan cell wall)
- **from Q cannot tell what type of material is cell wall made up of, without the use of specific dye staining**
- **Presence of cell wall eliminate animal cell (which has no cell wall) from answer.**

confirmed Plant cells [eukaryotic cells] (prokaryotes eg bacteria cell lack membrane-bound organelles)

6 Which features enable an organism to be identified as a prokaryote?

1 cell wall →both eukaryote (plant cells) & prokaryote (bacteria) have cell wall [plant cell has cellulose cell wall while bacteria has peptidoglycan cell wall.
2 circular DNA → only prokaryote (bacteria) has circular DNA; eukaryote has linear DNA
3 nucleus → double membrane-bound nucleus only present in eukaryotic cell; prokaryote does not have nucleus but has nucleoid – region where the DNA / genetic material is located.
4 ribosomes → both prokaryote and eukaryote have ribosomes but it is 70S ribosomes in prokaryote, 80S ribosomes in eukaryote

A 2 only
B 3 only
C 1 and 4 only
D 2 and 4 only

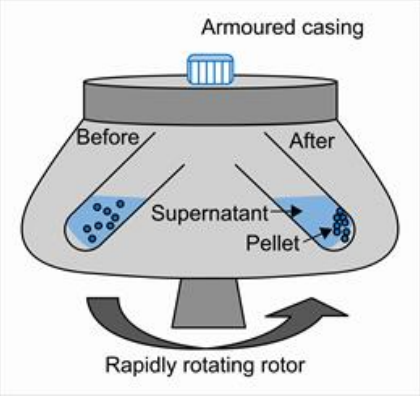
Thinking questions:
1. What do 70S and 80S mean?
2. And why does 30S+50S not add up to 70S, and 40S+60S not add up to 80S?

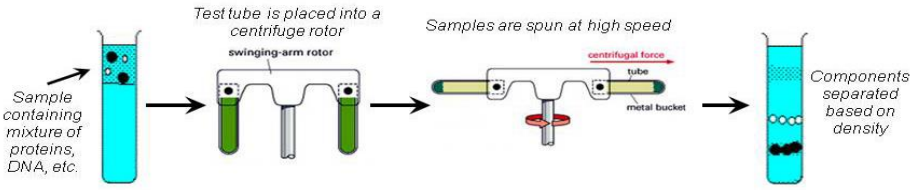
1 What do 70S and 80S mean?

S = sedimentation coefficient of a particle (its behaviour during a sedimentation process – centrifugation)

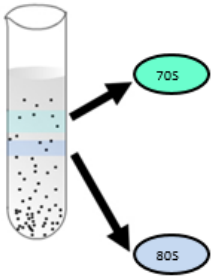
What is centrifugation?

Application of the centripetal force for the **sedimentation** of mixtures with a centrifuge



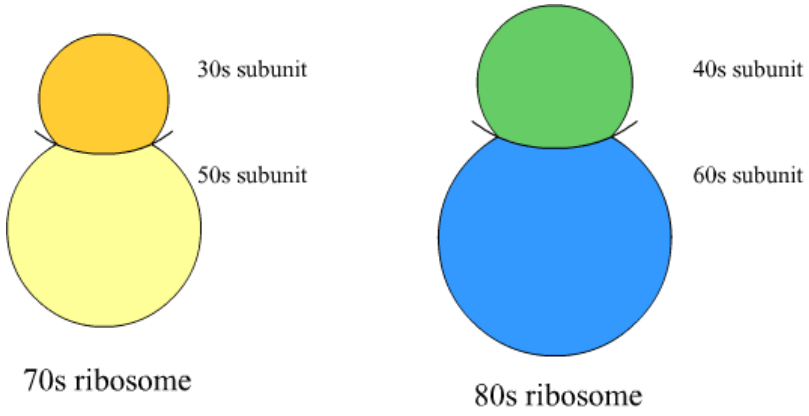


Bigger particles sediment **faster** and have higher sedimentation coefficient (eg 80S).



2 And why does 30S+50S not add up to 70S, and 40S+60S not add up to 80S?

Sedimentation coefficients are not additive (they do not add up together)



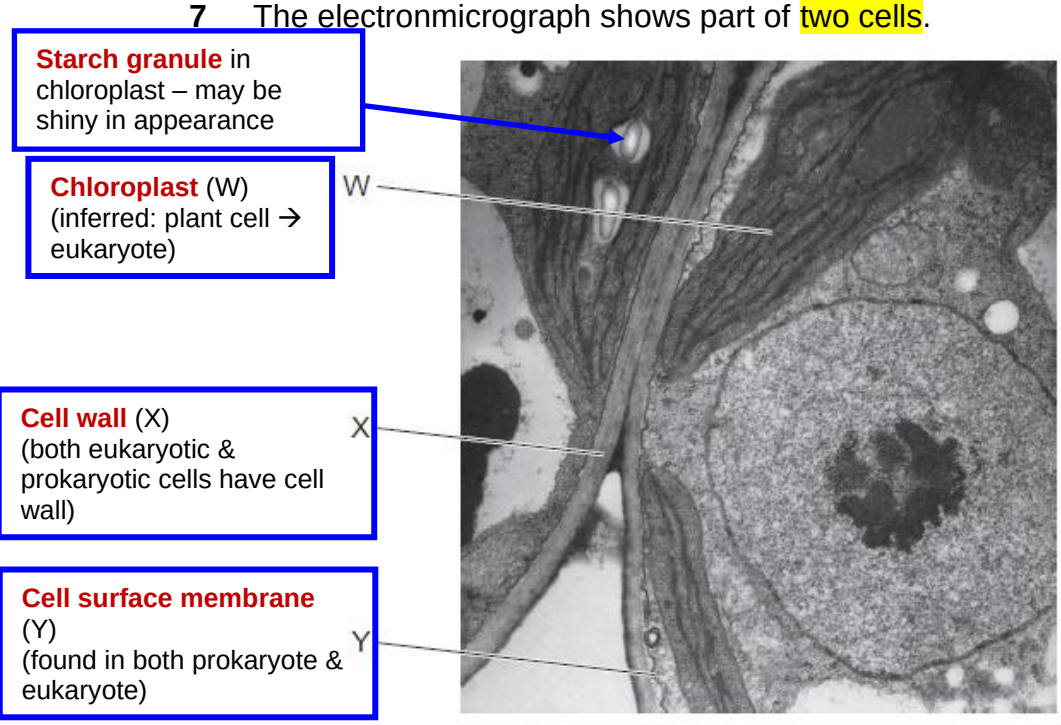
Centrifugation vs Cell fractionation (pg 21)

- **Centrifugation** is the use of an instrument called centrifuge where centripetal force is applied to each test tube containing a mixture (that contain different chemically inert materials***** mixed together) to obtain sediments (pellets of each type of materials).
  ***** chemically inert materials (materials that do not chemically react with one another to form new materials)

- **Cell fractionation** separate the different cell organelles eg nucleus, mitochondria, ribosomes etc via their relative mass with the use of centrifugation.

  How cell fractionation is carried out:
  Cells from a tissue sample are homogenised and mixed with a buffer in a glass tube. The mixture is then spun in a centrifuge at different speeds, starting with the lowest speed. After each spin the sediment at the bottom of the tube contains one type of organelle. The liquid portion is transferred to a new tube and spun at a higher speed, causing another type of organelle to settle in the second sediment. This process can be repeated several times to obtain different sediments containing different organelles. The faster/higher the speed, the smaller the relative mass of the organelles that will settle at the bottom of the glass tube

7 The electronmicrograph shows part of two cells.

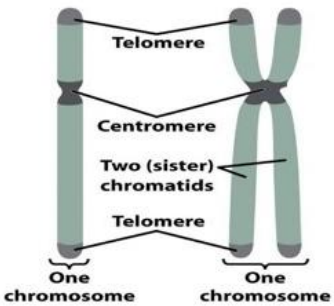


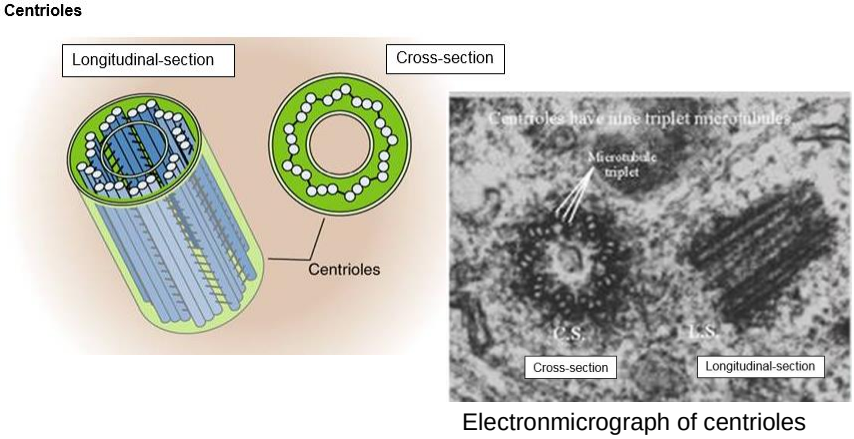
Which of the labelled features enable these cells to be identified as eukaryotic?

A W only
B X only
C W and X only
D W, X and Y

8 What is the function of nucleoli?

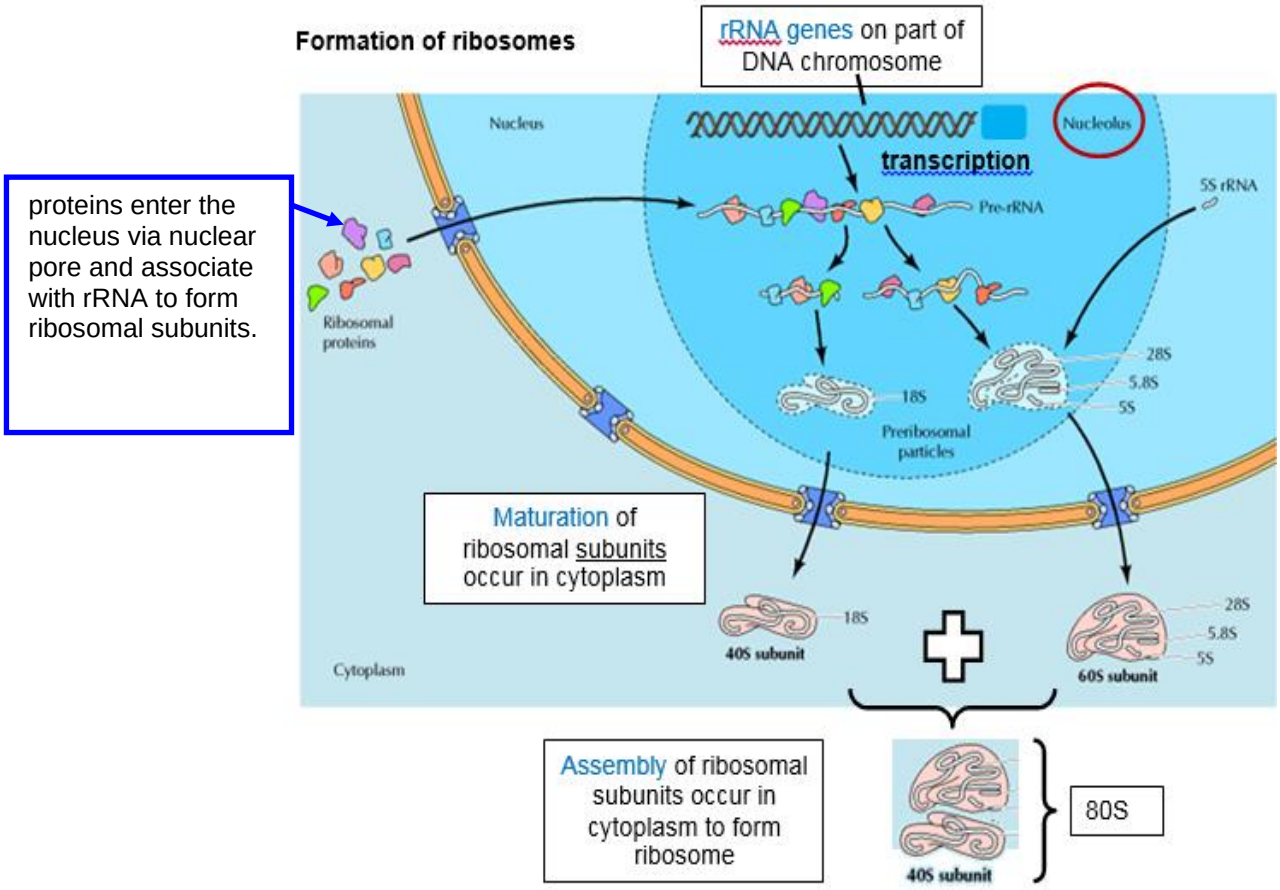
A formation and breakdown of the nuclear envelope
B formation of centromeres → centromere is found on chromosome and it is a region where sister chromatids join (you will learn in nuclear division later)
C formation of ribosomes (this is an A level equivalent question and question is given as-is. You should note that it is more accurate to state function of nucleoli is the formation of ribosomal subunits which assembled to form ribosomes).
D formation of the spindle during nuclear division → centrioles





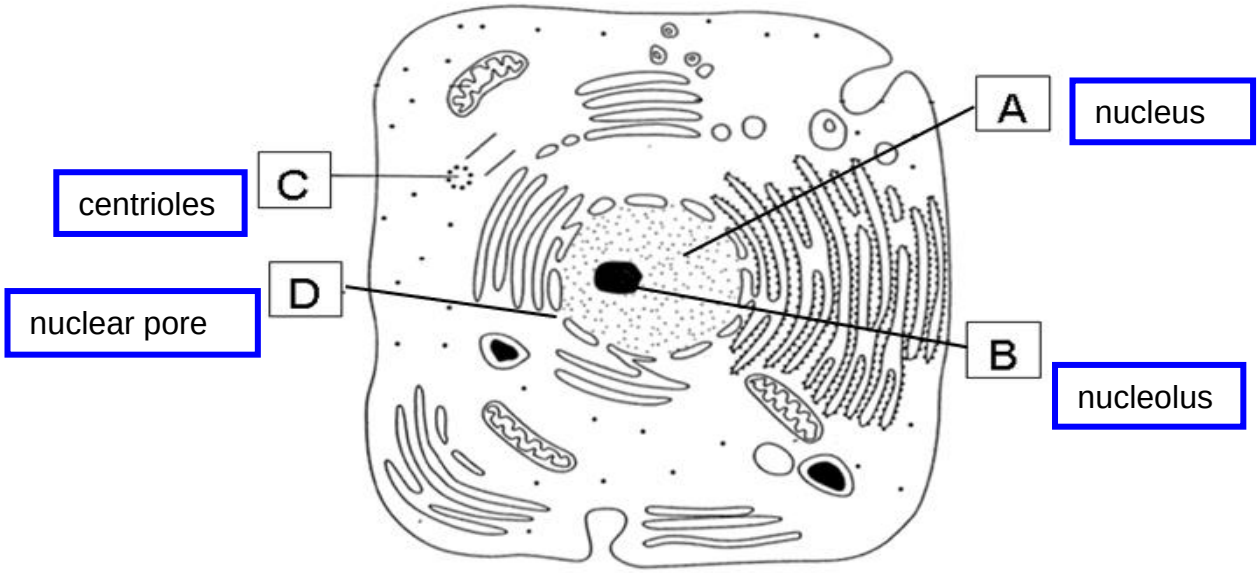
Electronmicrograph of centrioles

Please examine this diagram carefully: Note that **rRNA is synthesised in nucleolus (in nucleus)**. rRNA combines with ribosomal proteins which pass through the nuclear pore of nuclear envelope to form ribosomal subunits. Ribosomal subunits then move out from the nucleus to the cytoplasm via the nuclear pores. The big and small ribosomal subunits attached together in the cytoplasm to form fully functional 80S ribosomes.



Inferred electron microscopy used

9 The figure below shows an ultrastructure of a cell.

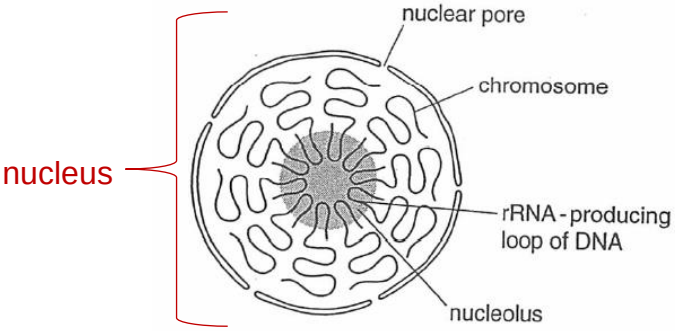


1 Both A and B are membrane-bound structures. A is nucleus and has 2 membranes (inner and outer nuclear membranes). B is nucleolus which does not have a membrane, not membrane-bound
2 D facilitates movement of mRNA and ribosomal subunits out of A.
3 C occupies a region in the cytoplasm of the cell and its position is important in determining the polarity of the cells during nuclear division.
4 A is the site of transcription of rRNA. rRNA is transcribed in B (nucleolus), not A (nucleus). Nucleolus (see diagram below) lies within the nucleus. Chromosomes found in nucleus and nucleolus (contain part of chromosome) contain genes which are short segment of DNA. DNA is transcribed into RNA. So rRNA gene (DNA material which is a poly**deoxy**ribonucleotide) is transcribed into rRNA (a product which is a poly**ribo**nucleotide that is a biological molecule different from DNA).

Which of the above statements are correct?

A 1 and 2
B 2 and 3
C 3 and 4
D 1 and 4

Nucleolus contains rRNA genes (see lecture note pg 26)



A diagrammatic structure of nucleolus (in nucleus)

[The genes that code for ribosomal RNA in human cells are located near the tips of 5 different chromosomes (total: 10 chromosomes / 5 pairs of homologous chromosomes)]

transcription
rRNA gene (nucleolus) → rRNA (nucleolus)

10 When **not** involved in protein synthesis, ribosomes exist as two separate structures. Identify the site of assembly and the components of these structures.

	Site of assembly	Components
A	nucleus	rRNA
B	nucleus	rRNA and protein
C	nucleolus	rRNA
D	nucleolus	rRNA and protein

refers to ribosomal subunits

STRUCTURED QUESTIONS: CELL THEORY, TYPE OF CELLS, NUCLEUS, NUCLEOLUS, CENTRIOLES

11 Plant and animal cells have different structural features.

(a) (i) Name **two** features of plant cells that are not features of animal cells.

1 ……...
2 ……...
[2]

Any two:
1 cellulose cell wall ;
2 chloroplast(s) ;
3 **large / prominent**, vacuole ;
4 tonoplast ;
5 Plasmodesma(ta) ;

Guidance in marking: **Mark the first answer on each prompt line**. If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = 0 marks. Do not give marks if "vacuole" is written alone – must be qualified as large or prominent. Underlined word in mark scheme is compulsory. E.g no marks to be awarded for writing "cell wall" or "peptidoglycan cell wall" instead of "cellulose cell wall".

(ii) Name **one** structure present in animal cells that is not present in plant cells.

……[1]

Any one:
1 centriole ;
2 glycogen granule ;

Guidance in marking: **Mark the first answer on each prompt line**. If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = 0 marks.

12 Table gives the functions of certain organelles in a eukaryotic cell.

Complete the table by stating the function associated with each organelle. [3]

Organelle	**Function**
nucleus	
nucleolus	
centrioles	

Nucleus *(any one)*

1 contains the chromosomes (hereditary material) of an organism ;

2 essential for cell division ;

3 directs protein synthesis by synthesising mRNA using the genetic information of genes on chromosomes, and sending mRNA to the cytoplasm via nuclear pore for translation into a polypeptide chain ;

Nucleolus *(any one)*

4 site of transcription of **rRNA genes** / synthesis of ribosomal ribonucleic acid (rRNA) ;

5 rRNA is assembled with proteins within the nucleolus to form ribosomal subunits ;

Centrioles *(any one)*

6 Centrioles play a role in nuclear division in animal cells.

7 **Organises** the synthesis and assembly of spindle fibres during nuclear division.

8 Position of the pair of centrioles at each pole during nuclear division important in determining the **polarity** of the cells ;

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Core Idea 1: The Cell and Biomolecules of Life

Tutorial 1
Section B (Annotated MS)
The Cell Theory
Structures & functions of organelles

MCQ
SECTION B: MITOCHONDRIA & CHLOROPLASTS

ANSWERS FOR SECTION B:

1	2	3	4	5	6	7	8	9	10
A	B	C	B	B	C	C	C	A	B

13 Which pair of organelles has internal membranes?

A chloroplasts and mitochondria [chloroplasts have inner chloroplast membrane and thylakoid membranes, mitochondria have inner mitochondrial membrane folded into cristae]
B chloroplasts and lysosomes [lysosomes have one single membrane enclosing hydrolytic enzymes, no internal membrane]
C mitochondria and ribosomes [ribosomes have no membrane. Ribosomes are make up of 2 ribosomal subunits, each ribosomal subunit composed of proteins and rRNA].
D lysosomes and ribosomes

14 For which process is the large surface area of the cristae in the mitochondria important?

Mitochondria required for aerobic respiration to produce ATP which when hydrolyse (broken down) will release energy for chemical reaction to occur. Energy is released via hydrolysis ie chemical reaction. Energy may be emitted in the form of radiation via heat loss. This radiation process has nothing to do with having large surface area of the cristae in the mitochondria.

A energy radiation [emission of energy in the form of wave – e.g heat]
B enzyme reaction [for aerobic respiration process to be taught later in greater details. More enzymes cannot be embedded in the inner mitochondrial membranes because of the extensive infoldings forming cristae that would give the large surface area compared to membrane that has no cristae]
C gaseous exchange [at alveoli of lungs requires mechanical breathing by lungs]
D protein synthesis [by ribosomes within the mitochondrial matrix. Ribosomes not bound to inner mitochondrial membrane]

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15 On an electron micrograph, a diameter of a chloroplast measures 240 mm. If the magnification of the micrograph is x 30 000, what is the actual diameter of this organelle?

A 8.0 nm
B 0.8 μm
C 8.0 μm
D 80.0 μm

Magnification = Image size / Actual size
30 000 = 240 mm / Actual size
Actual size = 240 mm / 30 000
= 0.008 mm
= 0.008 x 10^3
= 8.0 μm

16 What are the inner folds of the mitochondria called?

A cisternae [this term is used in endoplasmic reticulum and Golgi body]
B cristae
C granum [consists of a stack of thylakoids, term used in chloroplasts]
D matrix [viscous aqueous solution in the space enclosed by the inner mitochondrial membrane, containing enzymes, circular DNA, 70S ribosomes etc]

prokaryotes

17 There are evidences that mitochondria and chloroplasts were once bacterial cells that entered eukaryotic cells millions of years ago and established a symbiotic (inter-dependent) relationship with the eukaryotic cell. This is known as the endosymbiotic theory.

Which of the following features of mitochondria and chloroplasts support the theory?

1 Presence of 70s ribosomes. [prokaryotes]
2 Presence of 80s ribosomes. [eukaryotes]
3 Contains linear, double-stranded DNA [eukaryotes]
4 Contains circular, double-stranded DNA [prokaryotes]

A 1 and 3
B 1 and 4
C 2 and 3
D 2 and 4

18 Which cell organelles contain DNA?

1 centriole [non-membrane bound organelle – exist as a pair of rod-like structure, positioned with their longitudinal axis at right angles to each other. Each cylinder is made up of 9 triplets of microtubules (polymers of tubulin subunits which are proteins in nature) arranged in a ring].
2 mitochondrion [double-membrane bound organelle, evolved from prokaryotic cells based on endosymbiotic theory. **Contain circular DNA**, 70S ribosomes]
3 nucleolus [non-membrane bound organelle containing the **rRNA gene** (DNA)]
4 ribosome [non-membrane bound organelle, made up of 2 ribosomal subunits. Ribosomal subunit is composed of **rRNA** and protein]

A 1 and 2
B 1 and 4
C 2 and 3
D 3 and 4

In-class activity:

Complete the table using the information given for your own revision:

Organelle	Presence (✓) or absence (✗) of membrane(s)	Single / double / no membrane?	DNA?
Centriole			
Mitochondrion			
Nucleolus			
Ribosome			

ANSWERS:

Organelle	Presence (✓) or absence (✗) of membrane(s)	Single / double / no membrane?	DNA?
Centriole	✗	No membrane	No
Mitochondrion	✓	Double (ie 2) membranes	Yes (circular DNA)
Nucleolus	✗	No membrane	Yes (rRNA gene)
Ribosome	✗	No membrane	No

Inferred electron microscope used. Implied ultrasturucture can be seen.

19 The electronmicrograph shows part of a cell.

Which organelles shown in the electronmicrograph have more than one membrane?

A 1, 2 and 5
B 1, 3 and 5
C 2, 3 and 4
D 3, 4 and 5

Thinking through:
Step 1: **identify** the organelles 1 – 5 [requires practising by identifying organelles in electronmicrograph] ;
Step 3: **factual recall** of single or double membrane for each organelle ;
Step 2: **identify** what type of cells (plant cell or animal cell; prokaryotic or eukaryotic cells) – has chloroplasts; nucleus; central vacuole ➔ plant cell (eukaryotic cells) ;

This is plant cell.
1 central vacuole – "empty" space enclosed by a single membrane (called tonoplast).
2 chloroplast – double membrane bound organelle, characteristic "look" of intergranal membrane system with darkly stained starch granules – has inner & outer chloroplast membranes.
3 mitochondrion – double membrane bound organelle, characteristic cristae within organelle – has inner & outer mitochondrial membrane.
4 nucleus – double membrane bound organelle with characteristics "pattern" on the inner "skirting" of the membrane – has inner and outer nuclear membrane.
5 nucleolus – densely stained organelle within nucleus, not membrane bound.

Microscope using natural light = light microscope

20 Plant cells are fixed, stained and viewed using a student microscope. The light source was natural light.

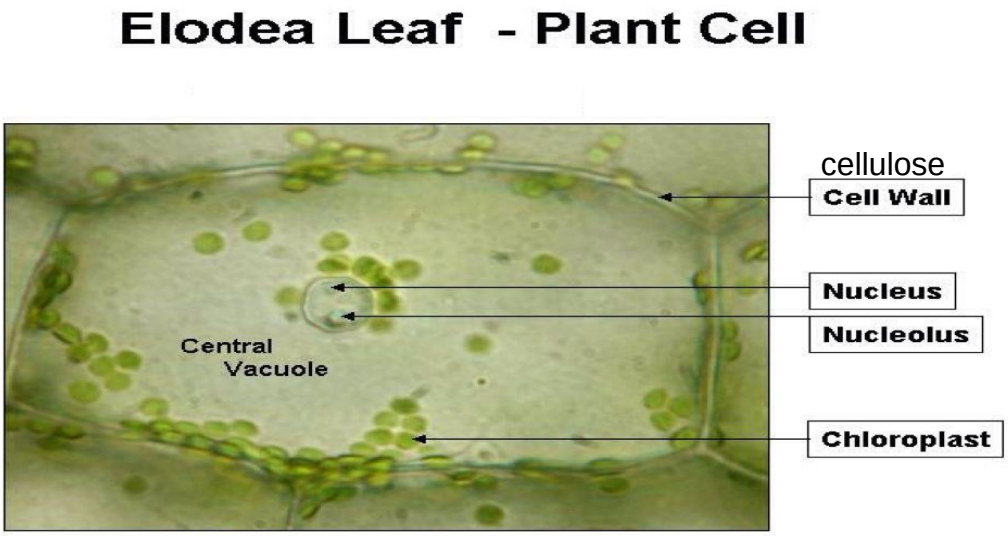
x10 eyepiece lens and x40 objective lens
⇨ X400 magnification

What would be clearly visible at ×400 magnification?

A cristae of mitochondria
B grana of chloroplasts
C nucleoli
D ribosomes

Cannot be seen under light microscope

can only be seen under electron microscopy



21 What are found in chloroplasts **and** mitochondria?

1 DNA
2 70S ribosomes
3 mRNA

A 1, 2 and 3
B 1 and 2 only
C 1 only
D 2 and 3 only

Central dogma:
DNA → mRNA → protein
You will learn in later chapter that DNA is transcribed by enzyme (RNA polymerase) to mRNA (messenger ribonucleic acid). mRNA will be translated by ribosomes to form protein.
Matrix of mitochondrion and stroma of chloroplast contained enzymes, circular DNA and 70S ribosomes. mRNA are products of transcription of DNA.

22 Which statement is correct?

A Prokaryotes and chloroplasts have circular DNA where genes carrying the code for cell walls are located. ➔ True that prokaryotes and chloroplasts have circular DNA but chloroplasts do not have genes coding for cellulose cell wall, due to (1) it only has **genes coding for proteins** needed within the chloroplast itself and (2) plant cell walls are made up of cellulose, which is a carbohydrate, not a protein. **Only proteins** are encoded by genes. Carbohydrates are not encoded by genes.

B Prokaryotes and chloroplasts have 70S ribosomes that are the sites for translation and polypeptide synthesis.

C Prokaryotes and mitochondria have an outer membrane and a separate inner, folded membrane where ATP synthesis occurs. ➔ Statement true only for mitochondria. Prokaryote has a cell surface membrane which has infoldings called mesosome where ATP synthesis occur. There is only one cell membrane separating the cell contacnts and the environment for prokaryote, no inner and outer membrane unlike mitochondria.

D Prokaryotes and mitochondria have double-stranded linear DNA where genes carrying coded information are located. ➔ Prokaryotes and mitochondria have circular DNA. The code information refer to the sequence of nucleotides on DNA which are transcribed into mRNA which are then translated into proteins.

STRUCTURED QUESTIONS: MITOCHONDRIA & CHLOROPLASTS

23 One theory about the evolution of organelles is the endosymbiotic theory. This theory suggests that the mitochondria and chloroplasts found in eukaryotic cells represent formerly free-living bacteria that were absorbed into a larger cell.

The following list describes a number of features of mitochondria and chloroplasts.

Place a tick (✓) next to the **three** statements that could be used as evidence for the endosymbiotic theory.[➔ ie identify commonality in prokaryotes & mitochondria, chloroplasts] [3]

mitochondria contain ribosomes that are smaller than those found in the cell cytoplasm	☐	✓
chloroplasts contain chlorophyll and other photosynthetic pigments ➔ unique to chloroplasts only	☐	
mitochondria are a similar size to bacteria	☐	✓
the inner membrane of mitochondrion is folded to form cristae ➔ unique to mitochondria only	☐	
chloroplasts contain many disc-shaped membranes called thylakoids ➔ unique to chloroplasts only	☐	
chloroplasts have their own circular DNA	☐	✓

Mark scheme:
If four ticks give reduce mark by 1.
If five ticks give reduce mark by 2.
If six ticks give reduce mark by 3.

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Core Idea 1: The Cell and Biomolecules of Life

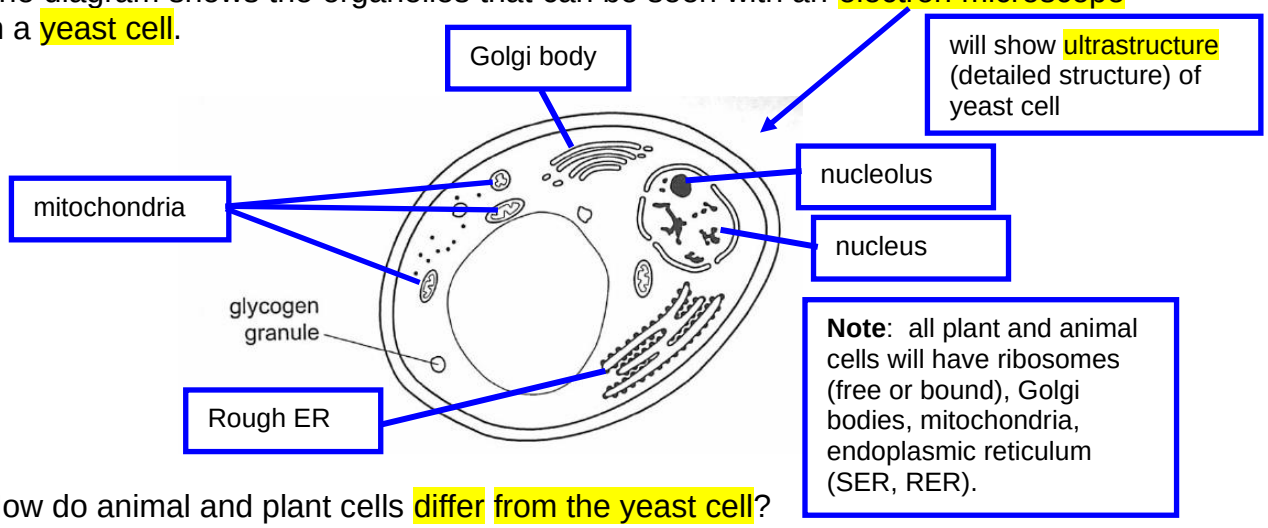
Tutorial 1
Section C (Annotated MS)
The Cell Theory
Structures & functions of organelles

SECTION C: RIBOSOMES, ENDOPLASMIC RETICULUMS (SMOOTH & ROUGH), GOLGI BODY, LYSOSOME

ANSWERS FOR SECTION C:

1	2	3	4	5	6	7	8	9	10
C	C	C	D	A	A	B	C	C	A

24 The diagram shows the organelles that can be seen with an electron microscope in a yeast cell.



How do animal and plant cells differ from the yeast cell?

	animal cell	plant cell
A	do not have free ribosomes	have chloroplasts
B	have Golgi bodies	do not have free ribosomes
C	have centrioles	do not store glycogen ➔ plant cell store starch
D	store glycogen	have Golgi bodies

25 A lysosome measures 0.4µm in diameter.

What is the diameter in nm?

A 4 nm
B 40 nm
C 400 nm
D 4000 nm

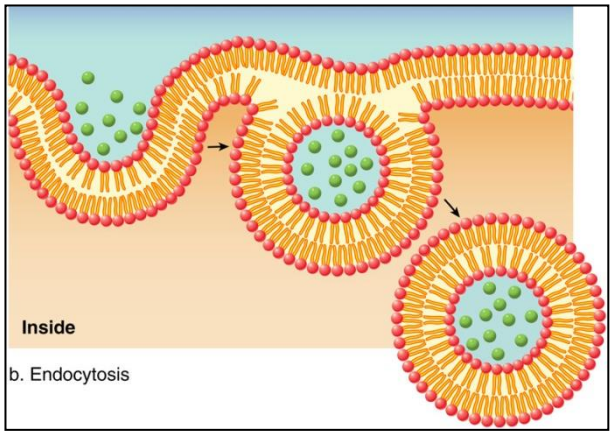
simple conversion from µm (micrometer, 10^{-6}) to nm (nanometer, 10^{-9})

0.4 µm = 0.4 x 10^3 nm

one membrane = 1 phospholipid **bi**layer

26 Which organelles are enclosed in a single phospholipid bilayer and contain hydrolytic enzymes?

A endocytotic vesicles ➔ vesicles formed via endocytosis process (will learn in membrane topic), contains particles/dissolved substances taken into the cell, but not hydrolytic enzymes. (see diagram on endocytosis below)
B Golgi body ➔ single phospholipid bilayer (membrane) but arranged as stacks of flatten membrane-bound sacs, contains enzymes for chemically modifying proteins, not hydrolytic enzymes (see diagram on Golgi body below)
C lysosomes
D Mitochondria ➔ **double membrane bound organelle = 2 phospholipid bilayer**



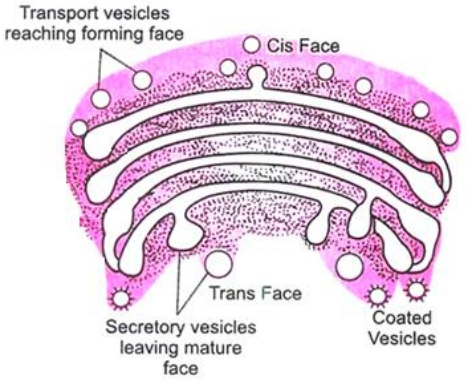


Figure : GOLGI APPARATUS IN SECTION

Steroids (lipids) in nature

27 A gland cell capable of producing large quantities of sex hormone testosterone would be likely to have well developed

A Lysosome
B Centrioles
C Rough endoplasmic reticulum
D Smooth endoplasmic reticulum

Try to write down the function for each organelle in the options as a form of recall and revision.

28 Where are cisternae found in a cell?

1 endoplasmic reticulum
2 Golgi body
3 mitochondrion

A 1 and 2
B 1 and 3
C 1 only
D 2 and 3

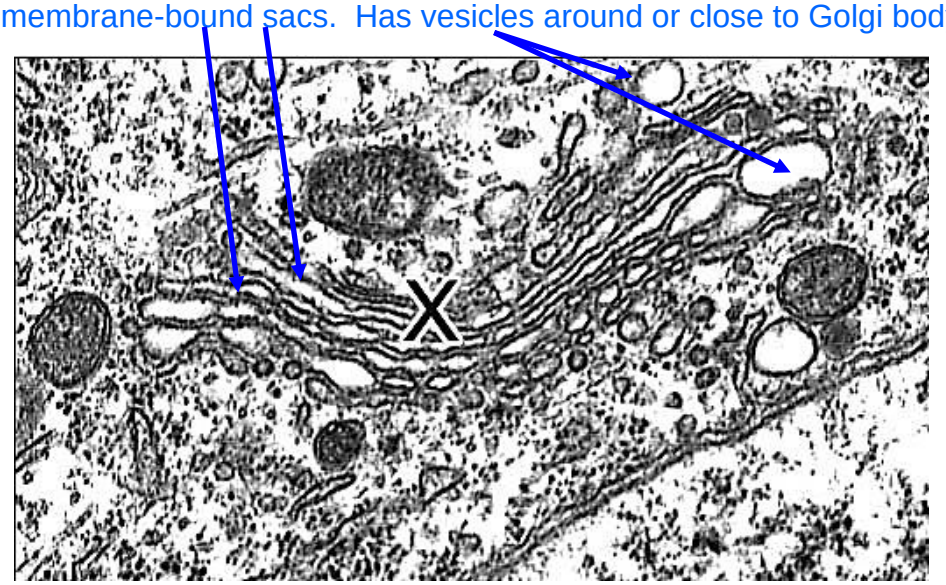
Students often get confused with the terms "cisternae" and "cristae". Cristae in mitochondria.

29 Which of the following statements correctly characterize(s) bound ribosomes?

1 Bound ribosomes are enclosed in their own membrane. ➔ ribosomes have no membrane
2 Bound ribosomes are structurally different from free ribosomes. ➔ no structural different between free or bound ribosomes. In eukaryotes, they are 80S ribosomes, made up of 2 subunits and each subunit is composed of rRNA and proteins.
3 Bound ribosomes are concentrated in the cisterna space of rough endoplasmic reticulum. ➔ bound ribosomes found on the surface of rough ER not in the cisterna space inside the RER.
4 Bound ribosomes generally synthesize membrane proteins and secretory proteins. ➔ general function of ribosomes – site of protein synthesis ; ribosomes synthesise proteins, be it membrane proteins, secretory proteins etc.

A 4 only
B 1 and 3
C 2 and 4
D 3 and 4

30 The electron micrograph below depicts organelle X ➔ characterised by stacks of flattened membrane-bound sacs. Has vesicles around or close to Golgi body.



Which of the following options is not a function of organelle X?

A Chemical modification of proteins
B Synthesis of steroids ➔ Golgi body involves in chemical processing (not synthesising) steroids (lipids). Synthesis of steroids is in smooth endoplasmic reticulum (SER). Golgi body is involved in synthesis of sphingomyelin which is a lipid bit not a steroid.
C Formation of secretory vesicles
D Formation of lysosomes

Note: option A, C and D are functions of Golgi body. If unsure, review lecture notes again.

Homogenised means cell surface membrane was broken up to release cell contents e.g organelles, cytoplasm etc.

31 A technique called cell fractionation can be used to separate cell organelles by their relative mass. ➔ this is definition of cell fractionation.

Describe the cell fractionation technique

Cells from a tissue sample are homogenised and mixed with a buffer in a glass tube. The mixture is then spun in a centrifuge at different speeds, starting with the lowest speed. After each spin the sediment at the bottom of the tube contains one type of organelle. The liquid portion is transferred to a new tube and spun at a higher speed, causing another type of organelle to settle in the second sediment. This process can be repeated several times to obtain different sediments containing different organelles. The faster the speed, the smaller the relative mass of the organelles that will settle at the bottom of the glass tube.

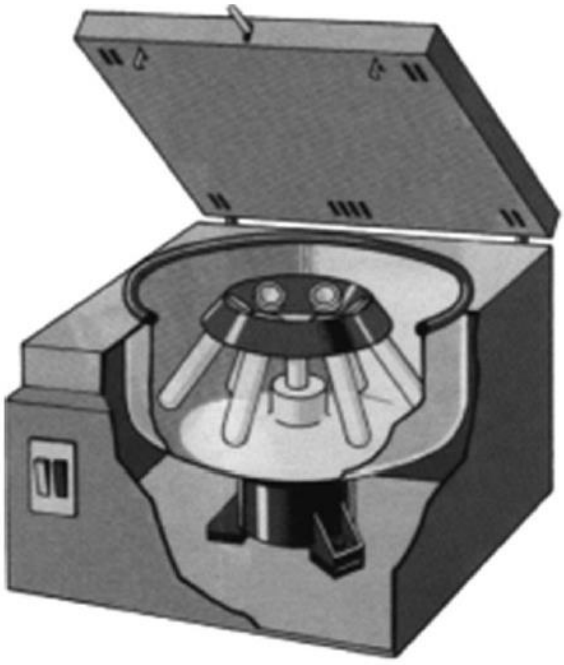
A ***buffer solution*** is one which resists changes in pH when small quantities of an acid or an alkali are added to it

Below are some organelles.

1 lysosomes
2 mitochondria
3 Nuclei ➔ heaviest
4 free ribosomes ➔ lightest

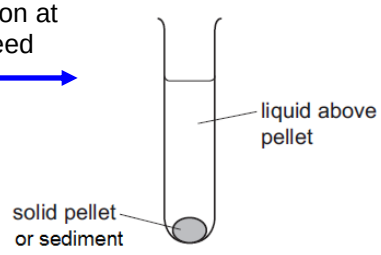
In which order would these organelles settle during cell fractionation?

A 2 → 3 → 1 → 4
B 2 → 3 → 4 → 1
C 3 → 2 → 1 → 4
D 3 → 2 → 4 → 1

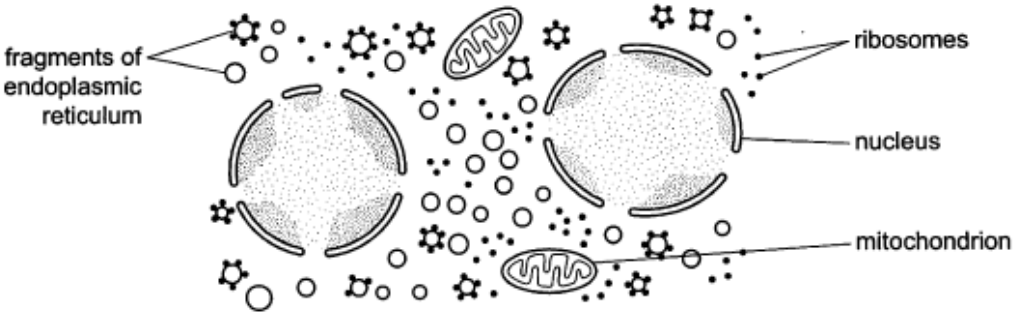


A centrifuge

Remove tube after centrifugation at a given speed



32 The flow diagram shows a technique called cell fractionation used to separate cell organelles by their relative size. Cells are homogenised and mixed with buffer to prepare them for cell fractionation. The diagram shows the appearance of the homogenised cell mixture.



homogenised cell mixture

↓

mixture centrifuged at low speed (1000× force of gravity for 10 minutes) → sediment 1 removed

Lowest speed, heaviest organelles settled first as sediment 1.

↓

liquid centrifuged at higher speed (20 000× force of gravity for 20 minutes) → sediment 2 removed

↓

liquid centrifuged at higher speed (80 000× force of gravity for 60 minutes) → sediment 3 removed

↓

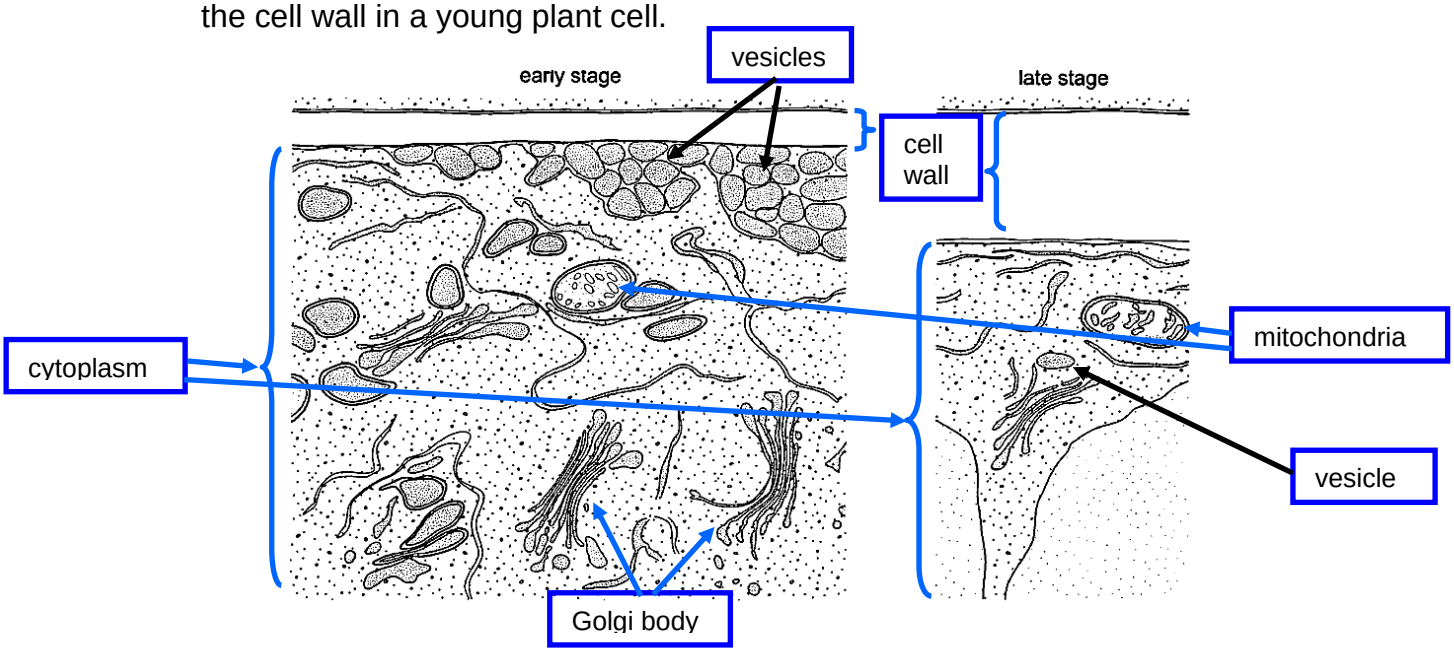
liquid centrifuged at higher speed (150 000× force of gravity for 180 minutes) → sediment 4 removed

highest speed, lightest organelles settled as sediment 4.

Which organelle is found in each of the sediments?

	sediment			
	1	**2**	**3**	**4**
A	endoplasmic reticulum	ribosome	mitochondrion	nucleus
B	mitochondrion	nucleus	endoplasmic reticulum	ribosome
C	nucleus	mitochondrion	endoplasmic reticulum	ribosome
D	nucleus	ribosome	mitochondrion	endoplasmic reticulum

33 The photo electron micrographs show early and late stages in the development of the cell wall in a young plant cell.



Which statement describes the events leading to the development of the cell wall?

A Complex carbohydrates assembled in the Golgi body are exported to the cell wall by the Golgi vesicles.

B Enzymes in the cell surface membrane synthesise the cell wall components from soluble carbohydrates brought by the Golgi vesicles. ➔ this is a visual stimulation question. No enzyme indicated or shown in the cell surface membrane. So between option A or B, option A is the best option for this question as visually, there are numerous Golgi body and vesicles in the early stage in the diagram.

C Polysaccharides are exported to the cell wall and synthesized into wall components by the Golgi body. ➔ cellulose is a type of polysaccharides and is the component of cell wall.

D Ribosomes synthesise glycoproteins (factually inaccurate!) that are exported by Golgi vesicles to be used in the cell wall. ➔ ribosomes synthesise proteins which enter into the lumen of rough endoplasmic reticulum, where carbohydrates are added to proteins to form glycoproteins.

Important knowledge to note:

Enzymes present in the Golgi lumen modify the carbohydrate (or sugar) portion of glycoproteins by adding or removing individual sugar monomers. **In addition, the Golgi apparatus manufactures a variety of macromolecules on its own, including a variety of polysaccharides:**

Cellulose – synthesized at the cell surface by enzymes in the plasma membrane/cell surface membrane.

Other cell wall polysaccharides (hemicellulose & pectins) – complex carbohydrates synthesized in Golgi apparatus then transported in vesicles to cell surface.

TEACHERS' COMMENTS

Students choosing option B or C indicates that they did not know the role of the Golgi body in carbohydrate synthesis. Observation of the diagram provides a clue to the expected answer as the early stage has several Golgi bodies and a large number of vesicles beneath the cell surface membrane but less in late stage.

STRUCTURED QUESTIONS: RIBOSOMES, ENDOPLASMIC RETICULUMS (SMOOTH & ROUGH), GOLGI BODY, LYSOSOME

34 Fig. 1.1 is a transmission electron micrograph of a cell from a leaf.

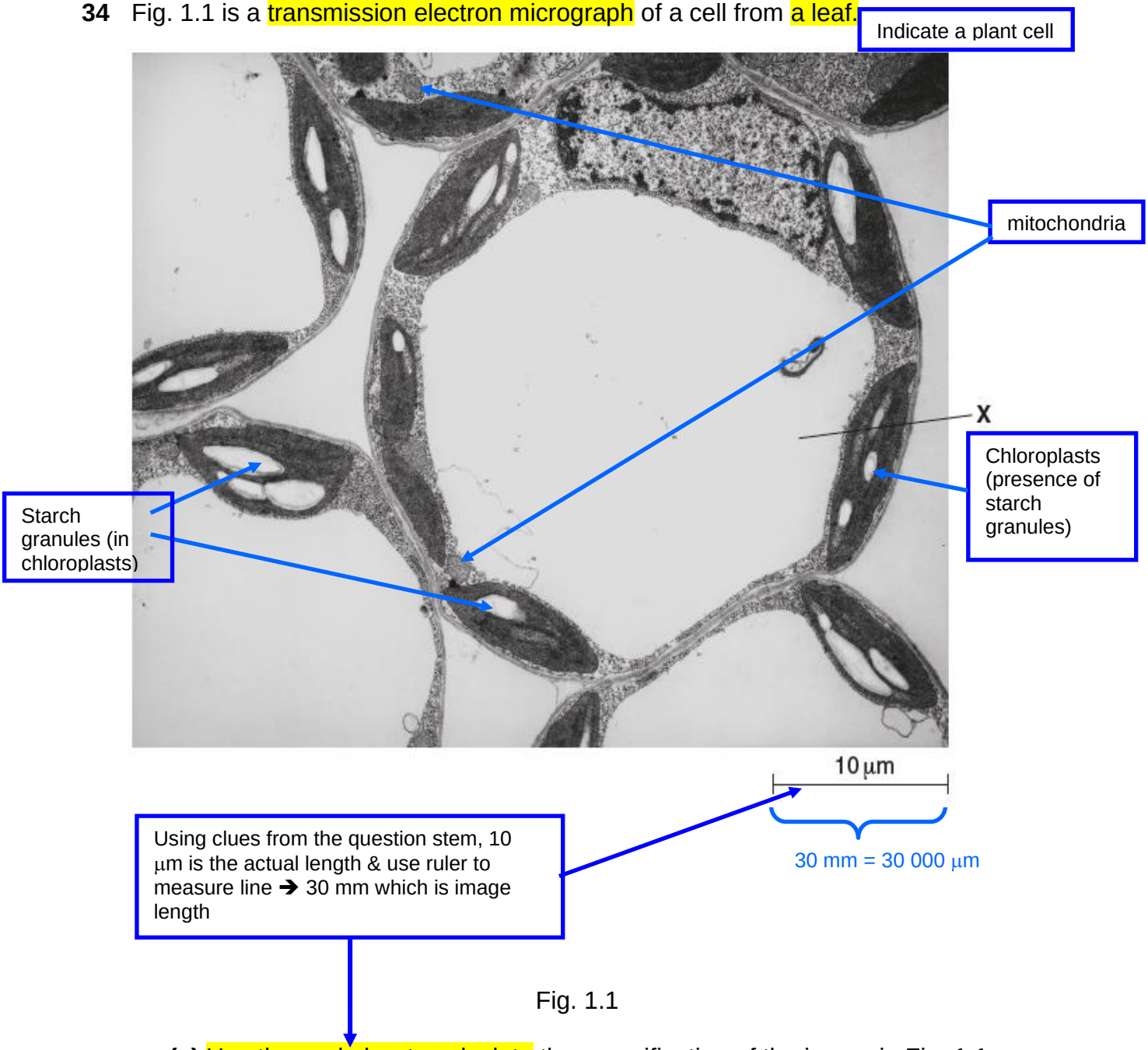


Fig. 1.1

(a) Use the scale bar to calculate the magnification of the image in Fig. 1.1. Write down the formula that you will use and show your working.

formula

magnification × .....[3]

1 x3000 ;
2 Working: 30 000/10 ; using 30 mm as measured length ; [ACCEPT: calculated values for measured lengths of 29 - 31 mm]
3 magnification $\frac{\text{image / scale bar (length)}}{\text{actual / object (length)}}$ =

Guidance:
- *allow 1 mark if correct answer given with units (as appropriate)*
- *allow 1 mark if incorrect answer but*
  correct measurement and correct working
  correct measurement and formula but incorrect conversion
  measurement ± 2 mm and correct

(b) Name structure **X** and state **one** function of this structure.

name .....

function .....

.....[2]

1 **large/central** vacuole ;
2 function: any *one from:*
- store of / holds / AW, cell sap ; [**REJECT** if contains organelles] ;
- store of / holds / AW, water / ions / named ion(s) / minerals / salts / sugars / named sugars ; [ACCEPT: nutrients] ;
- gives turgidity / turgor pressure / hydrostatic pressure / support / AW ; [**REJECT**: gives shape / strengthen / provides structure] ;
- store of / holds, waste (products)

Additional guidance: allow function mark even if name of organelle left blank or incorrect.

Teacher's comments: You would have learnt about central vacuole in plant cells in secondary school (see image extracted from 9744 syllabus). This question serves to refresh your memory.

PREAMBLE

This preamble sets out the approach, objectives, directions and philosophy of the H2 Biology syllabus.

In Singapore, Biology education from Primary to A-Level has been organised as a continuum in the following manner:

(a) from Primary 3 to Primary 6, students learn about how life works at the systems level

(b) from Lower Secondary Science to O-Level Biology, students learn about how life works at the physiological level

(c) at A-Level, students learn about how life works at the cellular and molecular levels while understanding the implications of these at the macro level.

The Biology syllabus is developed as a seamless continuum from O-Level to A-Level, without the need for topics to be revisited at A-Level. The O-Level syllabus is foundational and thus should provide the necessary background for study at A-Level. Students who intend to offer H2 Biology will therefore be assumed to have knowledge and understanding of O-Level Biology, either as a single subject or as part of a balanced science course.

(c) Name two structures, **visible** in the cell in Fig. 1.1, that contain DNA.

1 .....

2 .....[2]

any two:

1 nucleus ;

2 chloroplast(s) ;

3 mitochondrion ; [ACCEPT: mitochondria]

[Note: chloroplasts and mitochondria contain circular DNA and have 70S ribosomes. Chloroplasts and mitochondria have been proposed to evolved from prokaryotes based on endosymbiotic theory]

35 Fig.2.1 shows a diagram of a hepatocyte, which is a type of cell found in the liver.

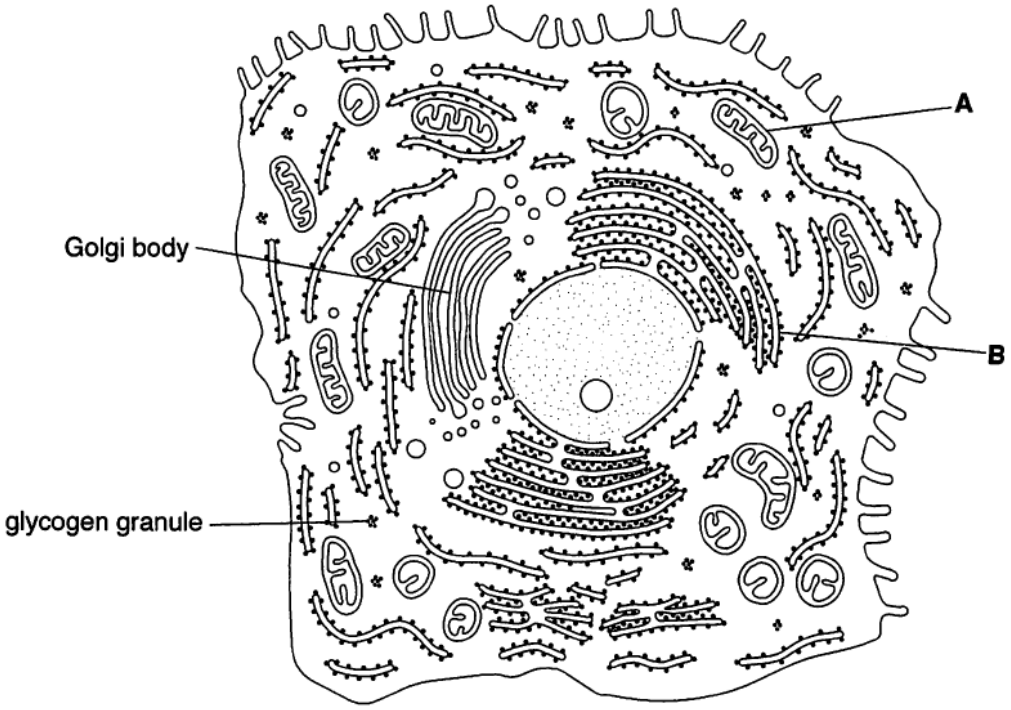


Fig. 2.1

(a) Identify the structures labelled **A** and **B**, as shown in Fig. 2.1.

For each structure, state **two** features that can be seen in Fig. 2.1.

structure **A** .....

feature 1 .....

feature 2 .....

structure **A:** mitochondrion
feature 1 : double membrane
feature 2 : cristae

structure **B** .....

feature 1 .....

feature 2 .....

[6]

structure **B** : rough endoplasmic reticulum
feature 1 : cisternae /network of flattened membrane-bound sacs
feature 2 : bound ribosomes

Teacher's comments: The question stated that features of the identified structures should be visible in Fig.2.1. Thus, students must not mentioned features that could not be seen, e.g. the presence of DNA.

(b) Describe **two** functions of the Golgi body.

……

……

……

……**[2]**

Any two:

1 **Further** post-translational modifications of proteins and lipids received from the ER (rER and sER) e.g. formation of glycoprotein, glycolipid ;
2 Sorting and packaging of proteins before being targeted to various cellular locations ;
3 Synthesis, chemical modification and transport of lipids ;
4 Formation of secretory vesicles (containing enzymes or proteins for release outside cell) or lysosomes ;
5 Involved in carbohydrates synthesis for the **formation of cell walls in plants** *(Ref: 9648/P1/2010)*

(c) Suggest **two** advantages to eukaryotic cells of having membrane-bound organelles.

……

……

……

……**[2]**

1 Provides a boundary between the cytoplasm and specific contents within the membrane-bound organelles so that separate compartments can be formed within a cell ; allowing specific biochemical reactions to occur within membrane-bound organelles ;
2 Increase surface area for reaction to occur e.g. in-folding of inner mitochondrial membrane results in a greater surface area for attachment of more proteins and enzymes of the electron transport chain and ATP synthase ; for higher rates of ATP synthesis ;

Examiner's report: Many candidates considered compartmentalisation to be an advantage of having membrane-bound organelle. Since

compartmentalisation is only another way of describing this feature, responses citing compartmentalisation *required further qualification and relevant details*.

(d) Explain the role of glycogen in animal cells.

……

……

……

……**[2]**

Any two:

1 Stored in large quantities without having any great effect on the water potential of cells and can be prevented from diffusing out of cells ;

2 Stored in large quantities within the limited space in animal cells ;

3 Ease of breakdown allow glycogen to be a good energy source for respiration and to raise glucose levels quickly when blood sugar level drops in animals.

[Total: 12]

~ END OF TUTORIAL 1 ☺ ~