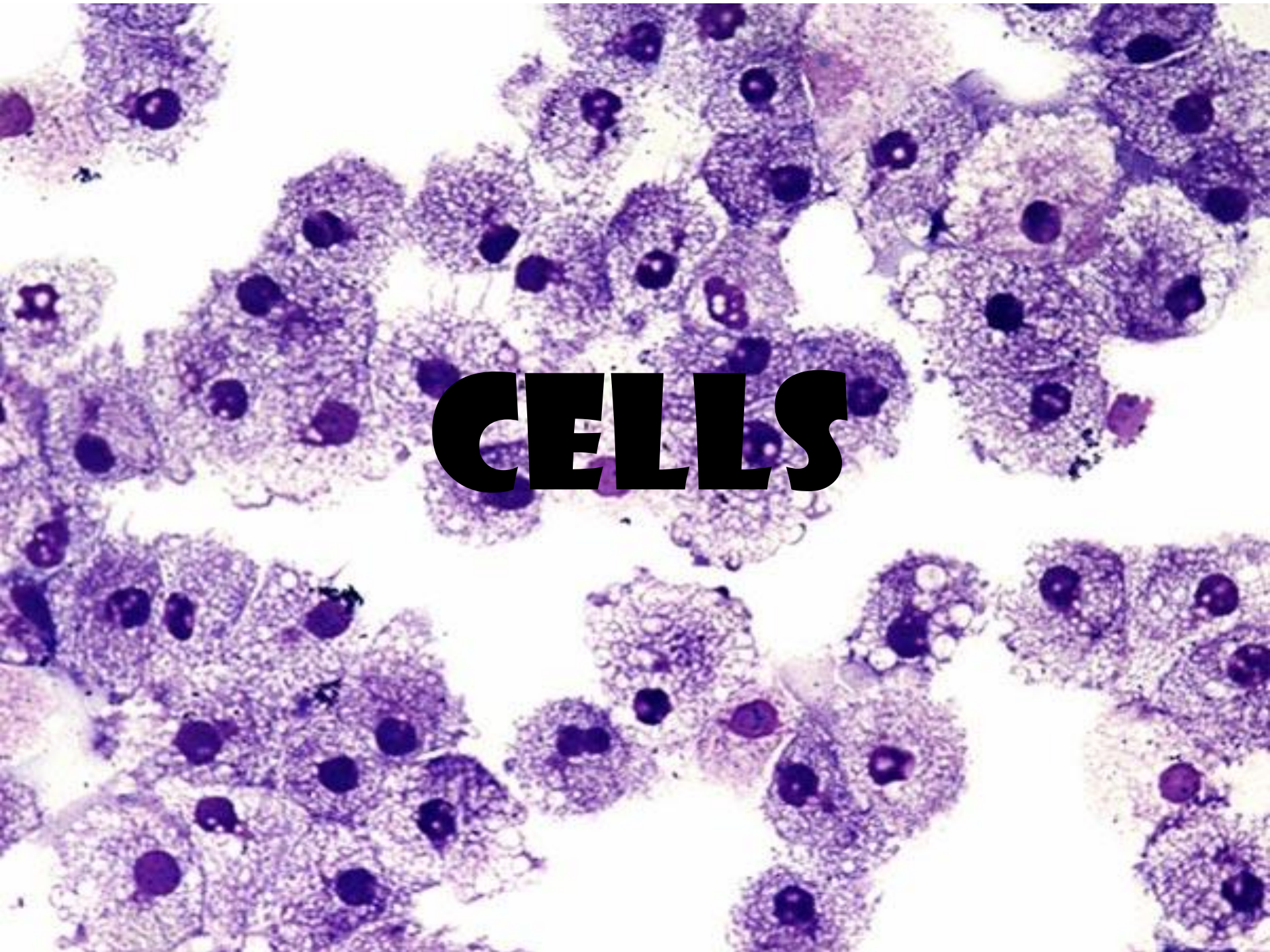
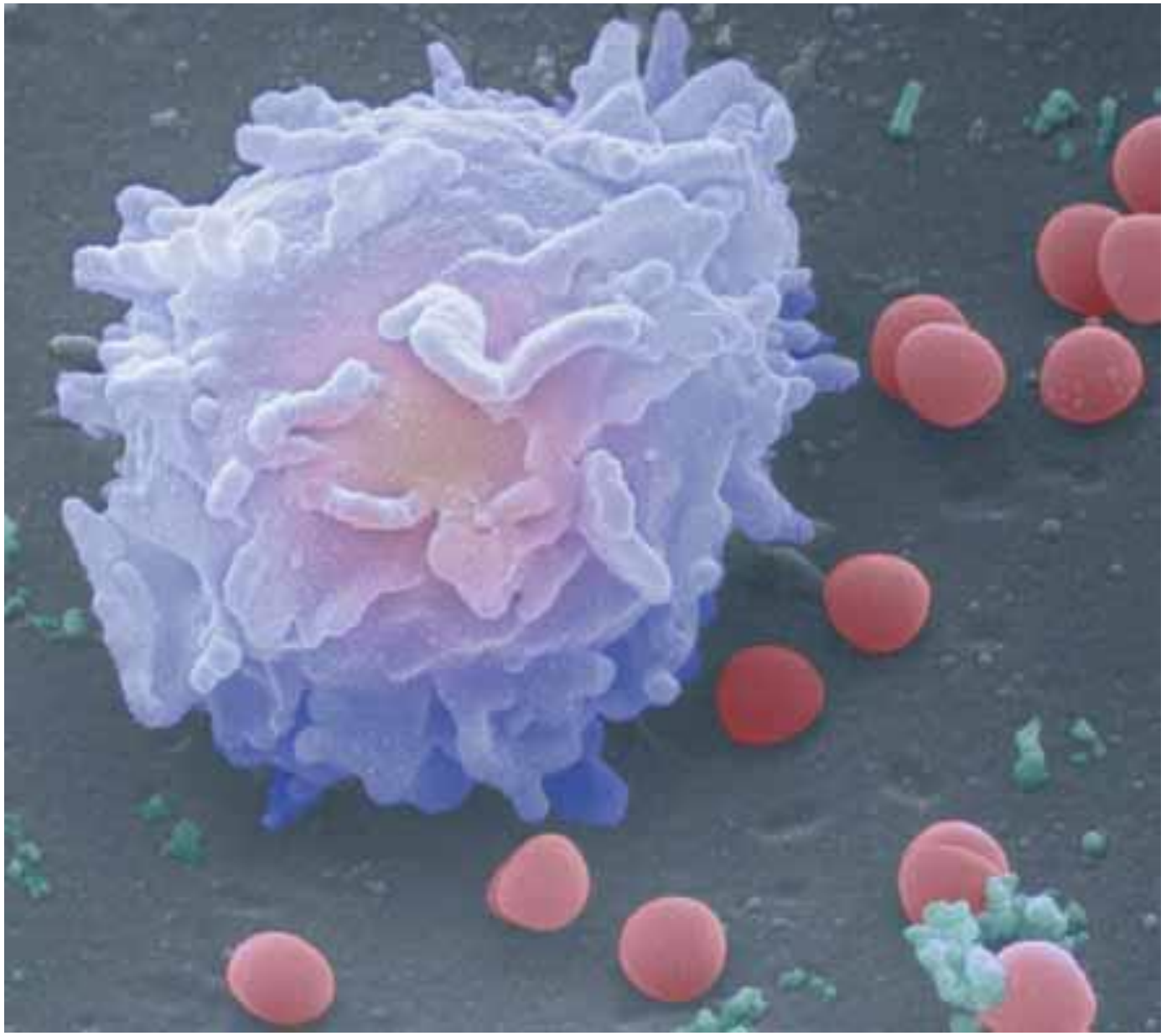

CELLS

The inner life of a cell video clip



Homework for Wednesday:

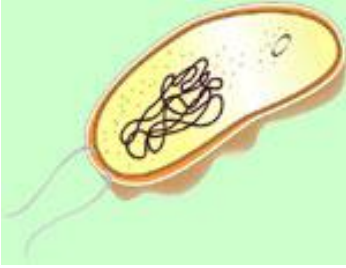
Create and email one Power Point slide of your organelle. Use at least 28 font size.

kdorman708@c2kni.net

Must include:

1. Location
2. Structures
3. Functions
4. Links to other organelles?
5. Other?

Prokaryotic cells (e.g. bacteria)



pro = before karyon = nucleus

- **Have no nuclei (no nucleus)**
- Have no membrane bound organelles (e.g. mitochondria or endoplasmic reticulum)
- Possess naked, circular DNA (not surrounded by a nucleus, not joined to proteins or arranged into chromosomes)
- Do have small ribosomes
- Do have a cell wall (made of peptidoglycan)
- Can have plasmids: small circular DNA separate from the main large circle of DNA. Plasmids are readily accepted by other bacteria (useful in genetic engineering)

Structure of a prokaryotic cell:

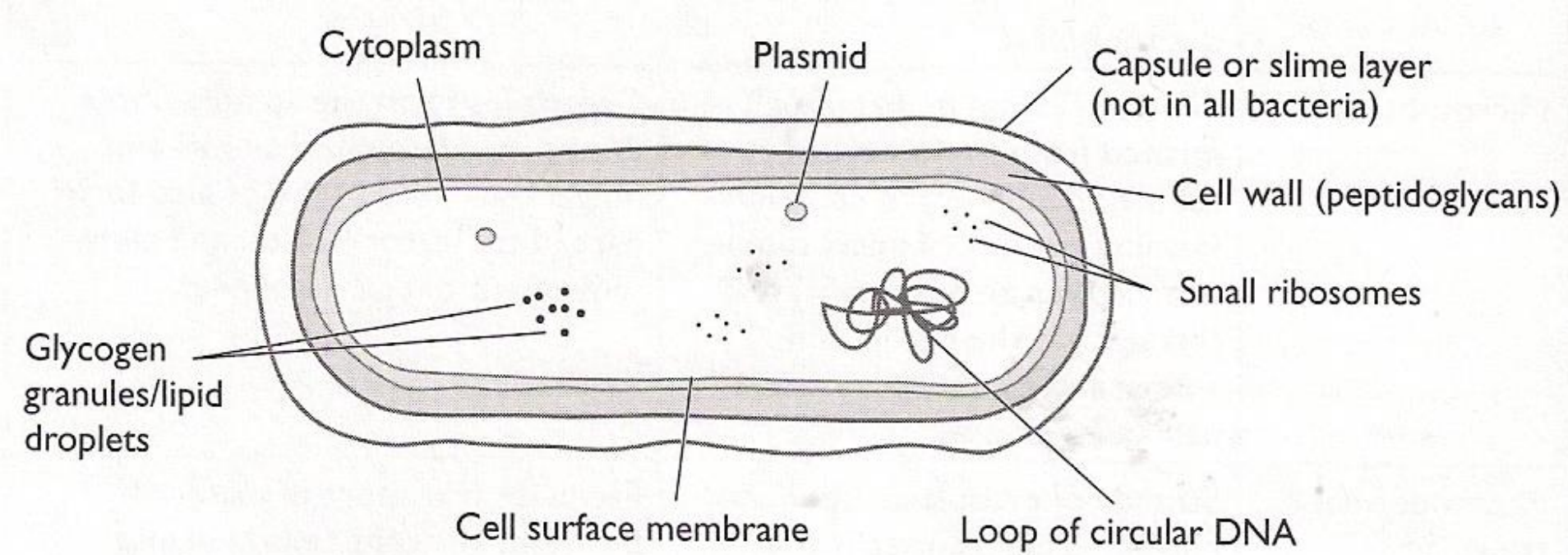
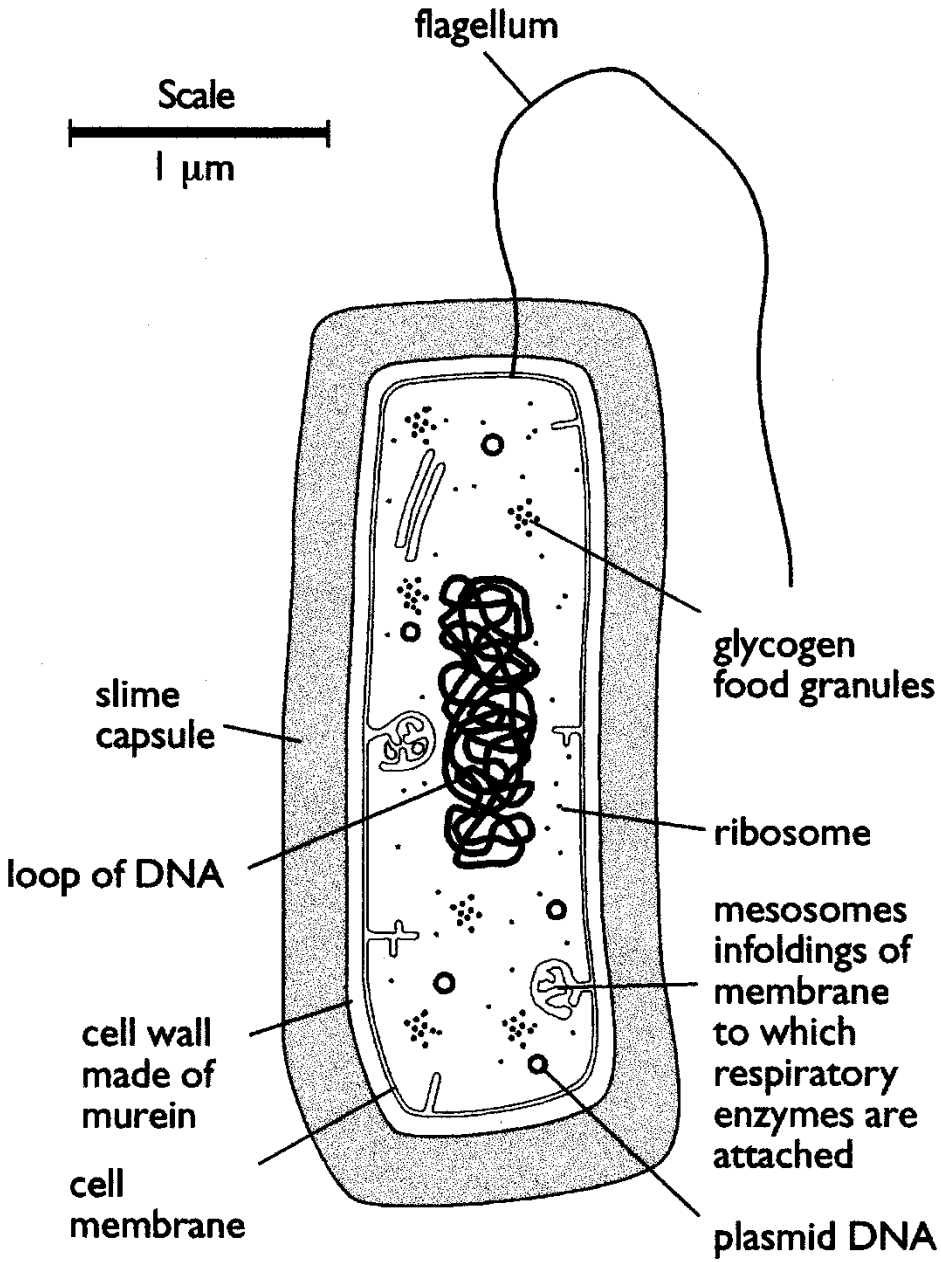
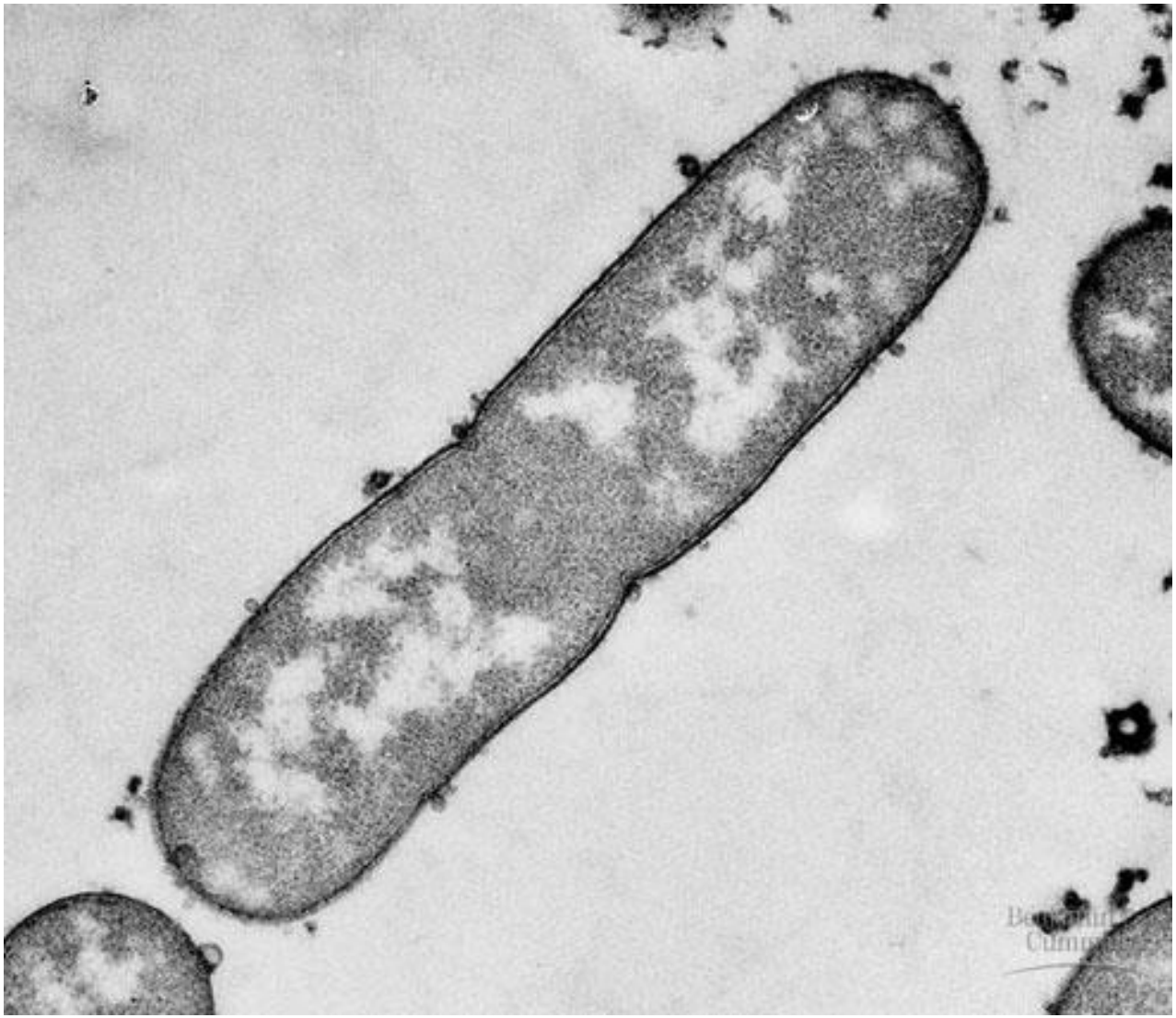


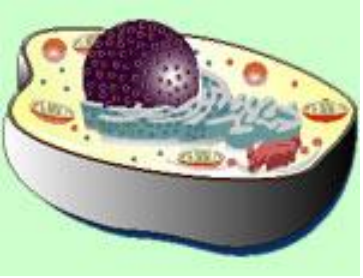
Figure 35 A generalised prokaryotic cell


flagellum
Scale
1 µm
glycogen food granules
slime capsule
ribosome
loop of DNA
mesosomes infoldings of membrane to which respiratory enzymes are attached
cell wall made of murein
cell membrane
plasmid DNA

Prokaryotic cells

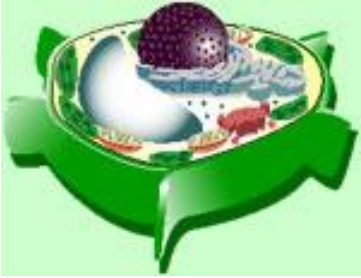


Electron micrograph of a *E. coli* bacterium



Eukaryotic cells (e.g. animal, plant and fungal cells)

eu = true karyon = nucleus



- **Have a membrane bound nucleus**
- Have chromosomes – linear, helical DNA with a histone protein coat. (This forms chromatin, which when condensed, forms a chromosome)
- Have other membrane bound organelles e.g. mitochondria, endoplasmic reticulum, golgi apparatus, vesicles, lysosomes
- Have larger ribosomes
- Have microtubules (makes up the cytoskeleton of the cell, giving structure and transport pathways inside the cell e.g. for vesicles)
- Are larger cells than prokaryotes

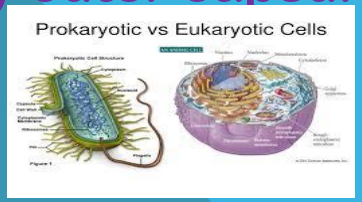
Comparing prokaryotic and eukaryotic cells

Prokaryotic cell	Eukaryotic cell
Small cells — 1–10 µm	Large cells — 10–100 µm
No membrane-bound organelles	Nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus and chloroplasts (in plants) present
Small ribosomes — 20 nm in diameter (70 S)	Large ribosomes — 25 nm in diameter (80 S)
Single circular DNA molecule, without associated protein; the region in the cytoplasm containing the DNA is called the nucleoid	DNA as several linear molecules associated with protein (histones) to form chromosomes; these are contained within a membrane-bound nucleus
Plasmids (small circular pieces of DNA outside the main DNA molecule) usually present	No plasmids
Peptidoglycan cell wall	Cellulose cell wall present in plant cells; and chitin cell walls in fungal cells
No microtubules	Microtubules present and organised into centrioles in animal cells
Slimy outer capsule may be present	No capsule

COMPARING PROKARYOTES AND EUKARYOTES

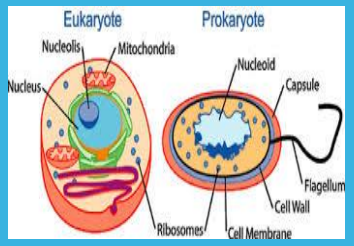
Prokaryotes: e.g. bacteria

- ✓ Have no nuclei
- ✓ Have no membrane bound organelles
- ✓ Possess naked circular DNA
- ✓ (not surrounded by a nucleus, not joined to proteins or arranged into chromosomes)
- ✓ Have small ribosomes (20nm)
- ✓ Have a cell wall made from peptidoglycan
- ✓ Can have plasmids (small circular DNA. Plasmids are readily accepted by other bacteria which is useful for genetic engineering.
- ✓ May have a slimy outer capsule

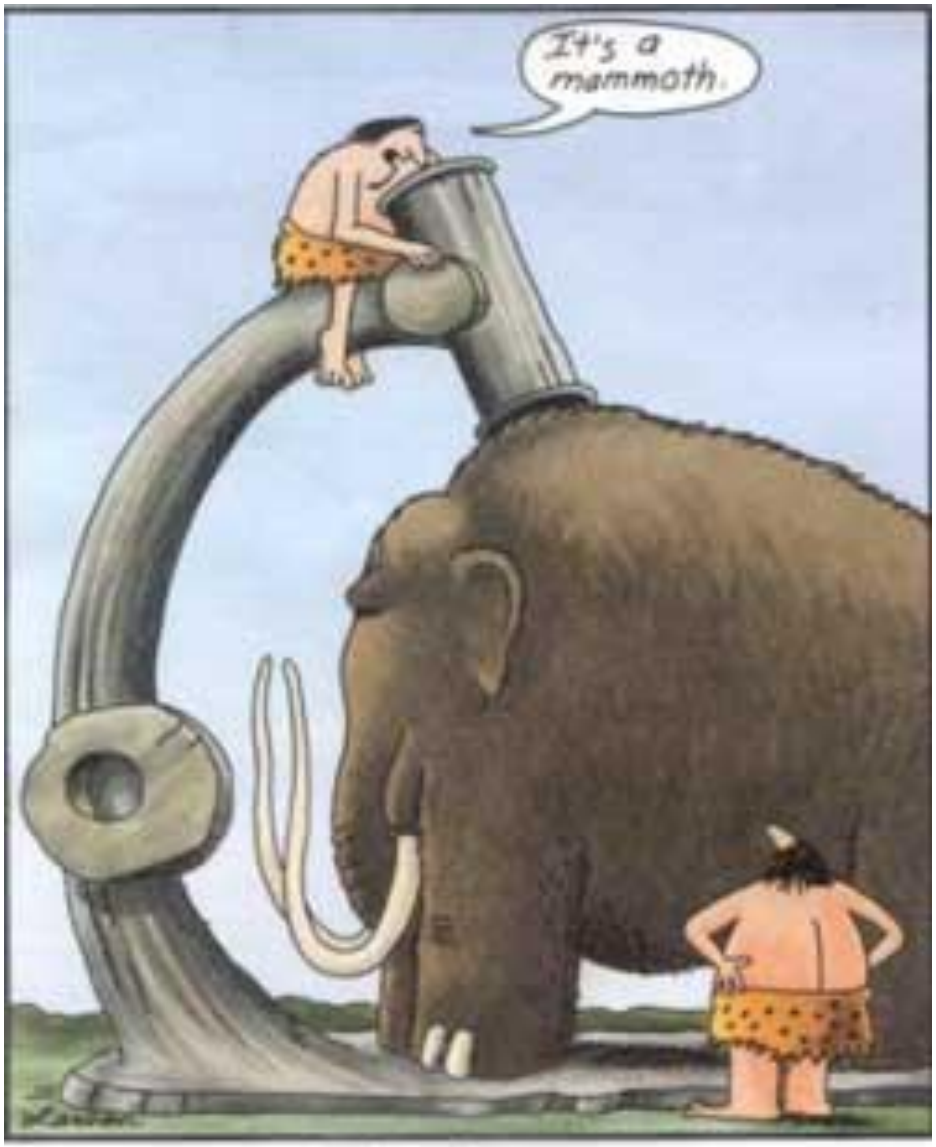


Eukaryotes: e.g. animal, plant, fungal cells

- ✓ Have a membrane bound nucleus
- ✓ Have chromosomes- linear helical DNA with a histone protein coat (this forms chromatin which forms chromosomes)
- ✓ Have other membrane bound organelles e.g. mitochondria, Golgi apparatus, vesicles etc.
- ✓ Have larger ribosomes (25nm)
- ✓ have microtubules(makes up the cytoskeleton of the cell, giving structure and transport pathways
- ✓ Are larger cells.
- ✓ No capsule



Using the microscope:
Scales, magnification and size



Early microscopes

Light Microscopy:

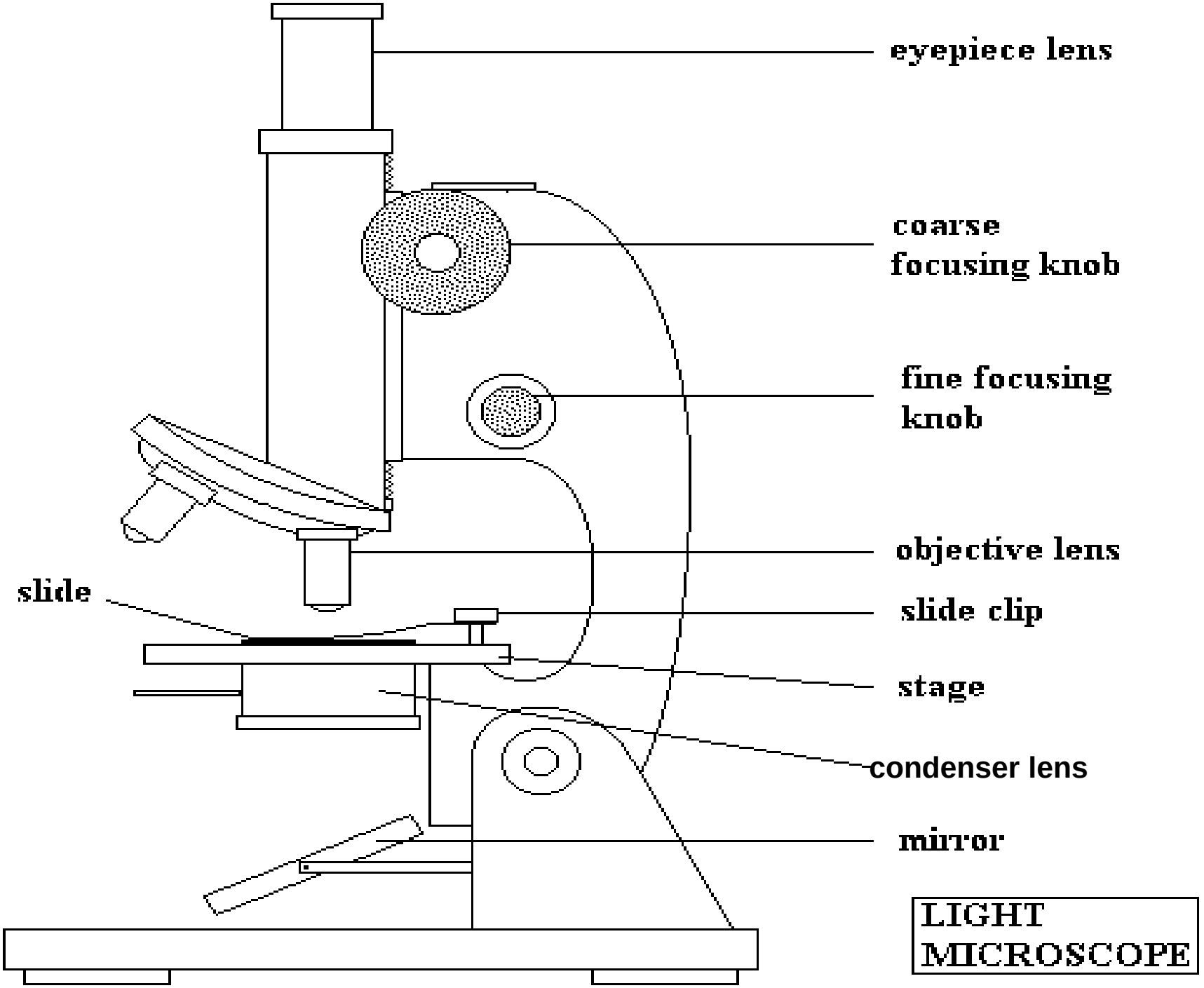
The optical/light microscope has 3 lenses

- the condenser lens (focuses light)
- the objective lens
- the eyepiece lens

These two magnify the specimen on the lens

The image of an object is magnified by the objective then the eyepiece lens e.g.

Objective lens	*Eyepiece lens*	= *Magnification*
X40	*X10*	*X400*

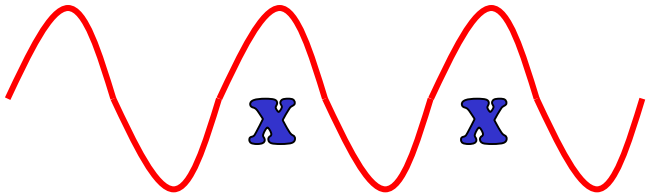

eyepiece lens
coarse focusing knob
fine focusing knob
objective lens
slide
slide clip
stage
condenser lens
mirror
LIGHT MICROSCOPE

Magnification

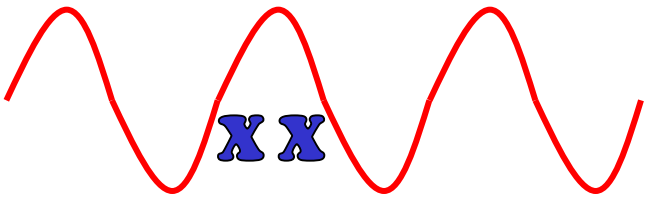
This is the extent to which an object has been enlarged. Although, a better term for describing the power of a microscope is **"resolving power" / resolution.**

wavelength

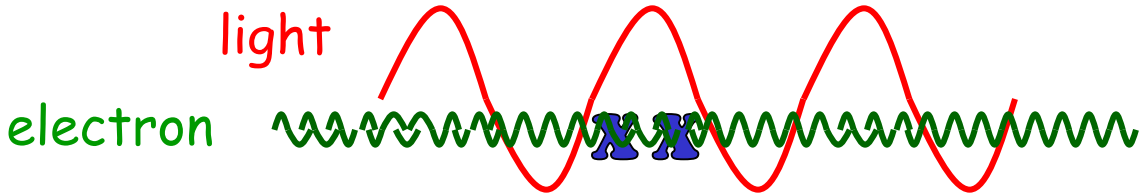
When the specimen objects get closer together, the light microscope does not have the resolving power to view these objects as distinct (separate points)



Both objects seen separately



Both objects seen as a single fused image



Light sees one point (inside one wavelength)
Electron sees 2 distinct images (different waves)

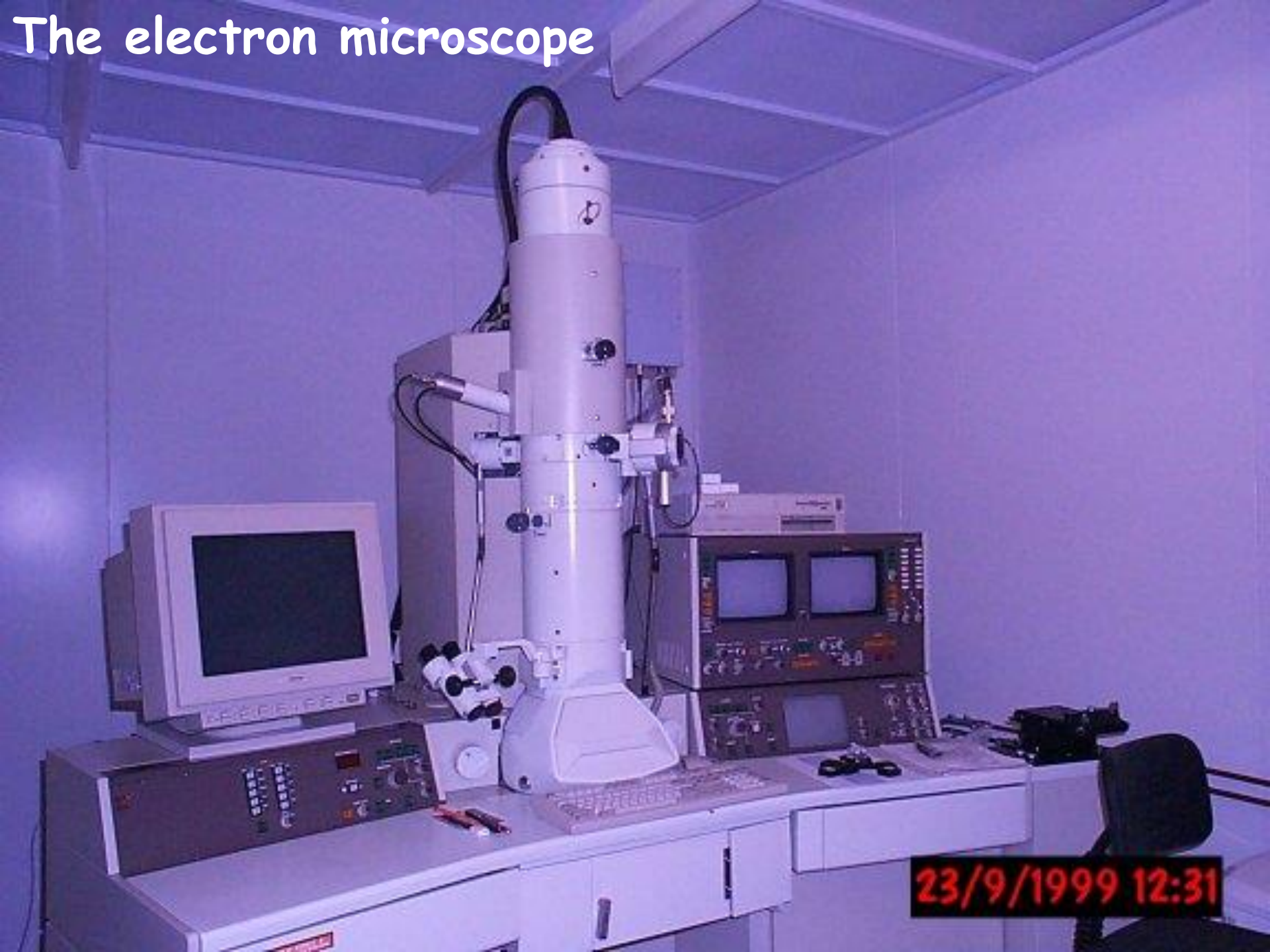
Resolution:

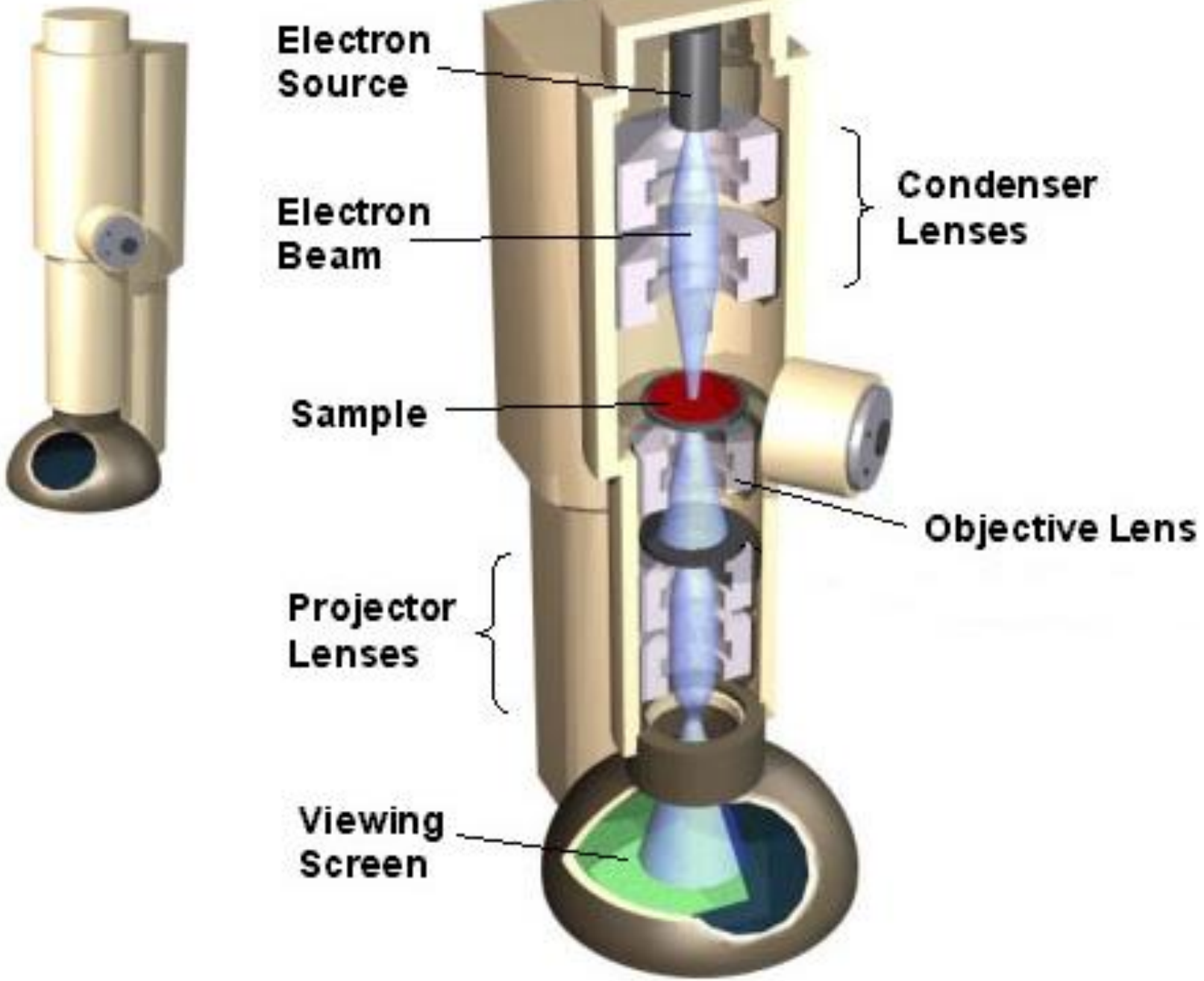
The ability to see two adjacent separate points as distinct, following magnification.

Light microscope: 0.2µm
Electron microscope: 0.1 nm

The reason the electron microscope has such a better, higher resolving power is because **ELECTRONS HAVE A SHORTER WAVELENGTH THAN LIGHT**

The electron microscope




Electron Source
Electron Beam
Condenser Lenses
Sample
Objective Lens
Projector Lenses
Viewing Screen

There are 2 different types of electron microscope

Transmission electron microscope (TEM)

Electrons pass through the VERY THIN specimen

Used to view cell ultrastructure (the cell organelles)

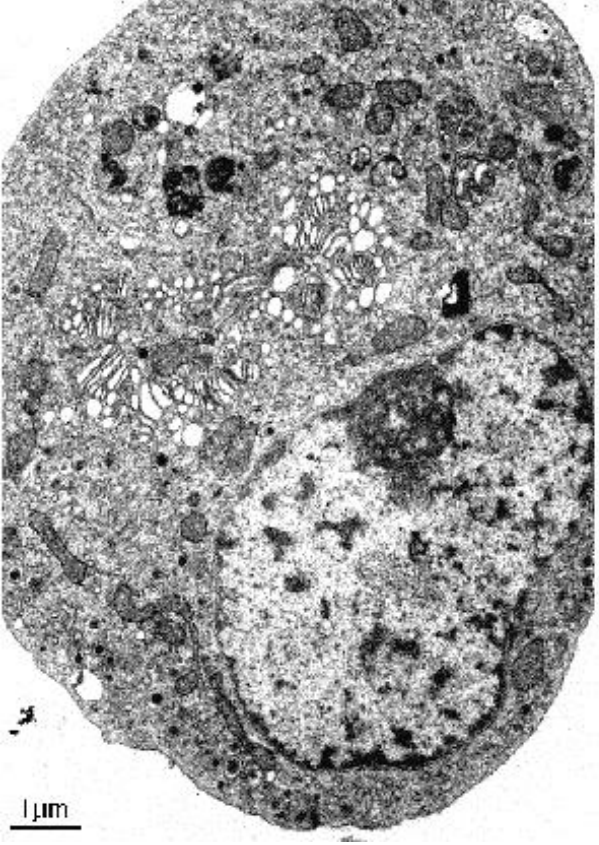
HIGH RESOLVING POWER SO HIGH MAGNIFICATIONS USED

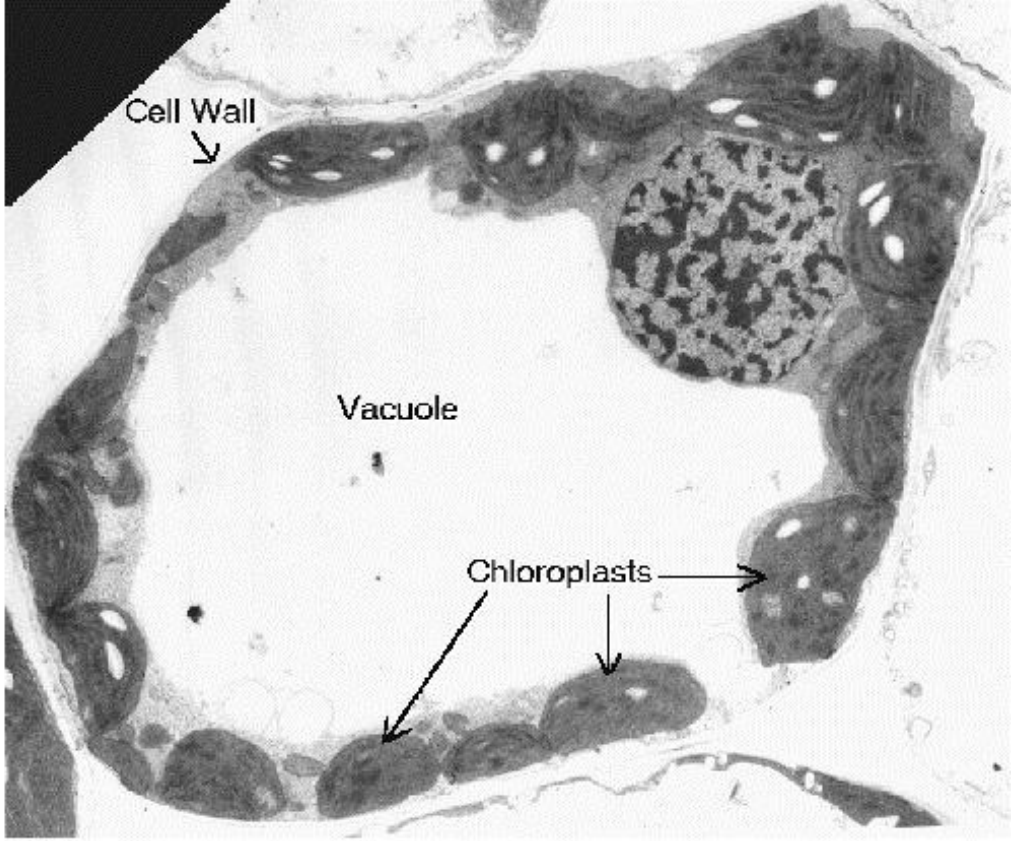
Scanning electron microscope (SEM)

Electrons bounce off the surface of the specimen giving 3D images

Used to view cell surface and whole organisms

RESOLVING POWER AND MAGNIFICATIONS NOT AS HIGH



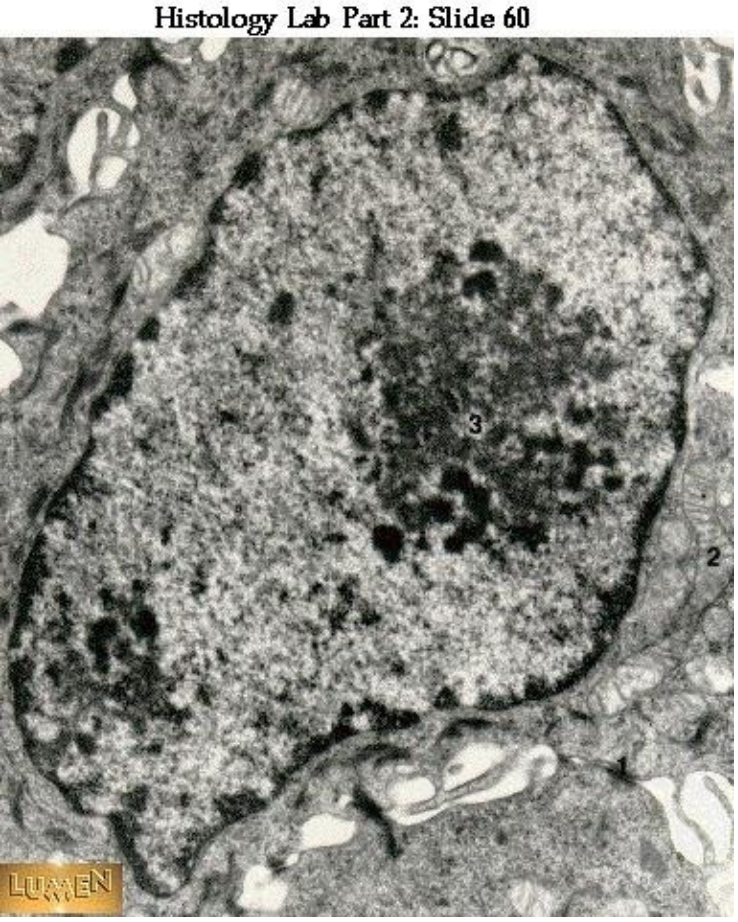


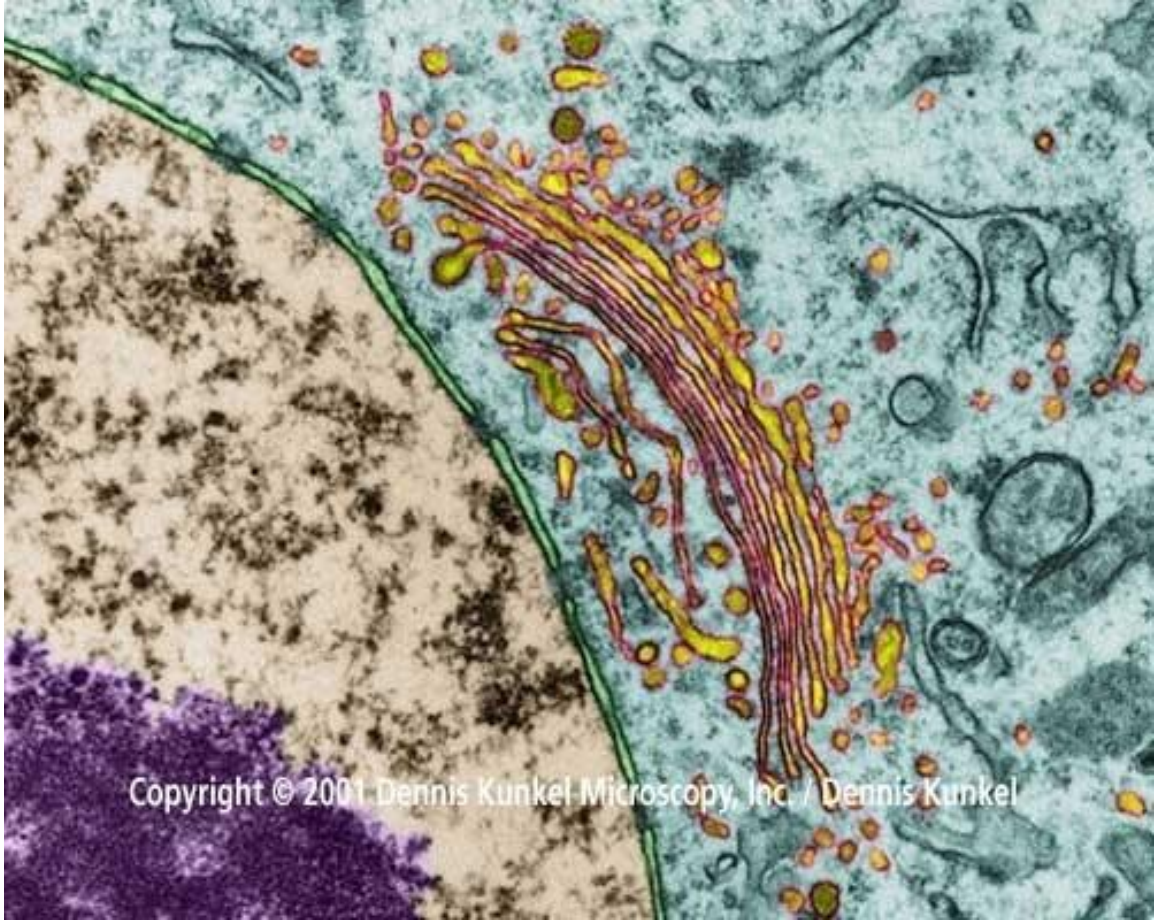
Courtesy of Dr. Julian Thorpe – EM & FACS Lab,
Biological Sciences
University Of Sussex

ANIMAL CELL

PLANT CELL

These electron micrographs illustrate the detail obtained when using the TEM





Coloured images are obtained using computer software as electrons do not show colour

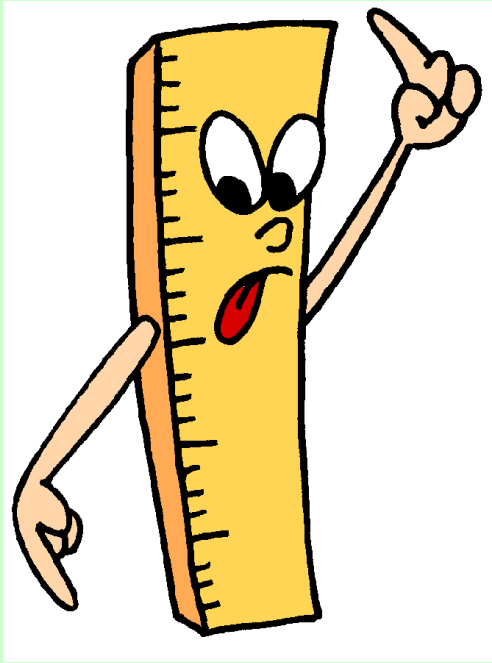
What microscope produced this image of a fly head?

It is 3D, so it was the SEM

Comparison of light and electron microscopes:

	Light microscope	Electron microscope
Radiation used	**Light rays (wavelength 450-700 nm)**	**Electron beams (wavelength 0.01 nm)**
Magnification	**X3000**	**X1 000 000**
Resolving power	**200 nm**	**0.1 nm**
Focused by	**Glass lenses onto the retina of the eye, or recorded on photographic film**	**Electromagnets onto a fluorescent screen or onto photographic paper**
Biological material	**Living or dead material i.e. an advantage as biological processes and behaviour can be observed**	**Only dead specimens can be viewed. Also "artefacts" can appear (deviations from true specimen due to preparation process)**
Size	**Small & portable**	**Very large& static**
Prep of material	**Quick & simple**	**Time consuming complex**
Cost	**Relatively cheap to buy and operate**	**Very expensive to buy and operate**

unit	Symbol	Size in metres
1 millimetre	1 mm	10^{-3} m
1 micrometre	1 µm	10^{-6} m
1 nanometre	1 nm	10^{-9} m



Converting units:

1 millimeter /mm = 1000 micrometers *(i.e. to go from mm to µm you X 1000)*

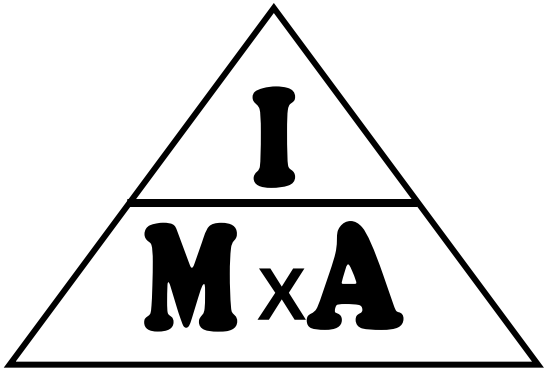
1 micrometer /µm = 0.001 millimeters *(i.e. to go from µm to mm you ÷ 1000)*

1 micrometer = 1000 nanometers /nm *(i.e. to go from µm to nm you X 1000)*

1 nanometer = 0.001 micrometers *(i.e. to go from nm to µm you ÷ 1000)*

1 nanometer = 0.000001 milimeters (1 millionth!) so to convert nm into mm you divide by 1000000 or to convert mm to nm you X 1000000

The magic triangle for calculations with microscopy

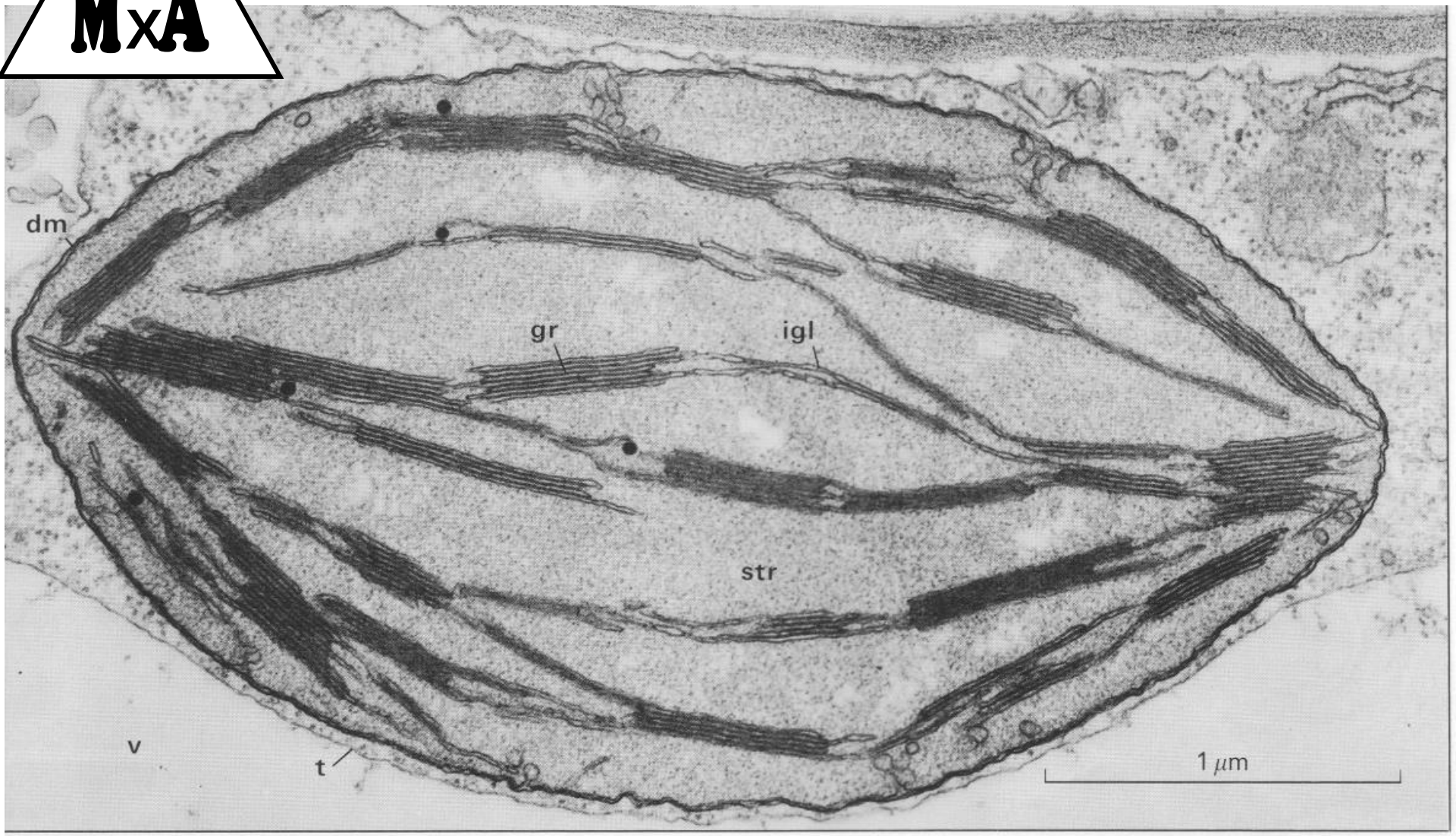


I = IMAGE SIZE

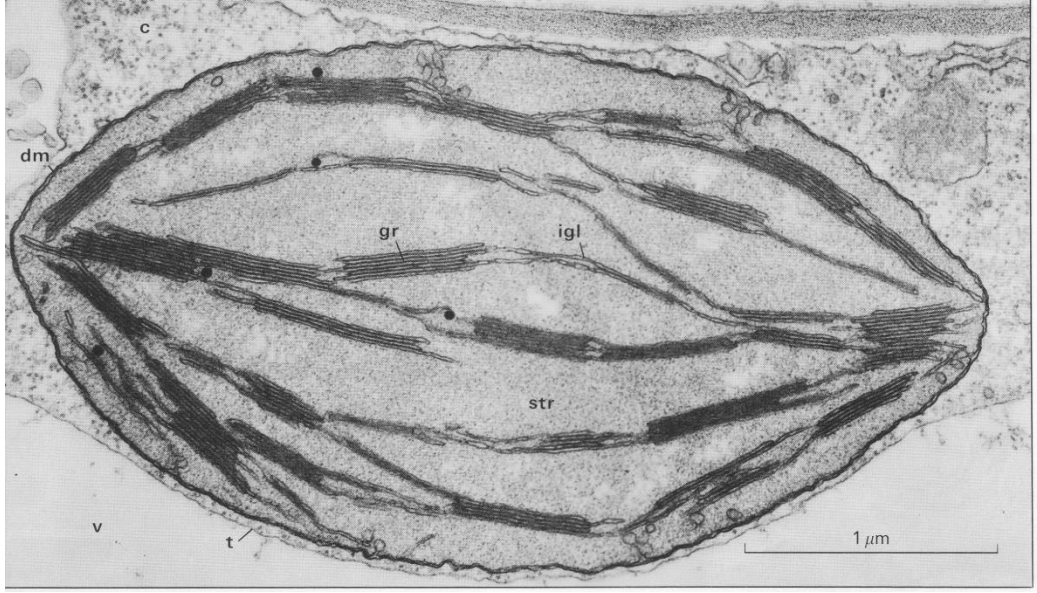
M = MAGNIFICATION

A = ACTUAL SIZE

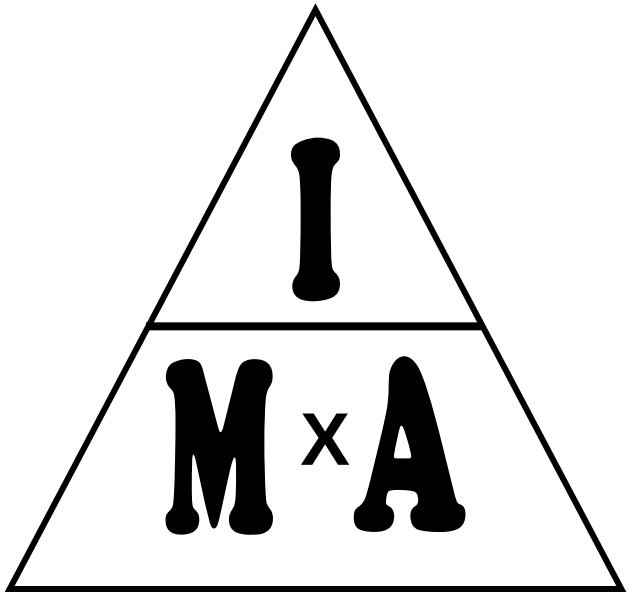
NOTE: BEFORE CACULATING THE MAGNIFICATION, MAKE SURE YOU CONVERT I AND A INTO THE SAME UNITS - USUALLY MICROMETRES


dm
gr
igl
str
v
t
1 μm

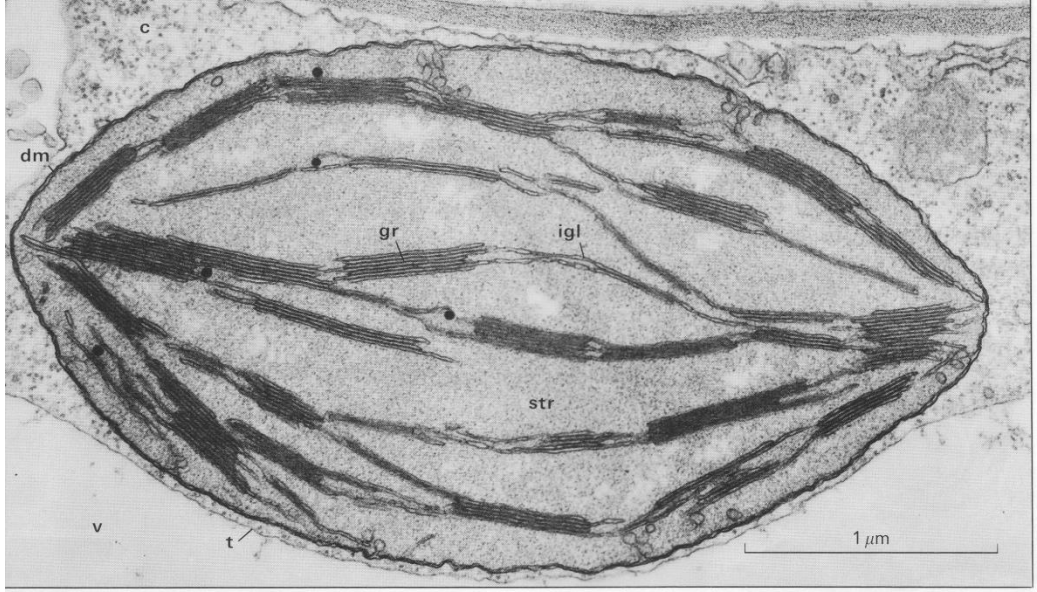
Calculate the (M) magnification of your photomicrographs:



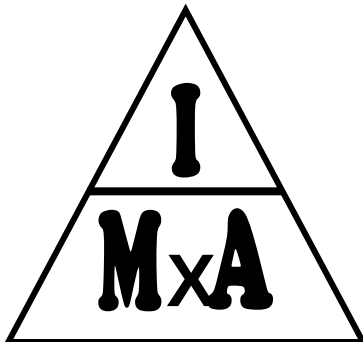
1. Get your image size e.g. length is 140mm and convert into micrometres e.g. 140000 μm
2. Divide this by your actual size e.g. 140000/3.89 μm
3. Magnification = X35990



Calculating magnification (M) of photomicrograph using scale bar:



1. Measure the scale bar (I) e.g. = 36mm
2. Convert to μm: 36 X 1000 = 36000
3. Divide the image size by the actual size of the scale bar (A) (what it represents):
   36000 ÷ 1 = 36000



Plant and animal cell cross section

http://www.cellsalive.com/cells/cell_model.htm

Cell organelle information

http://www.s-cool.co.uk/alevel/biology/cells-and-organelles/organelles.html

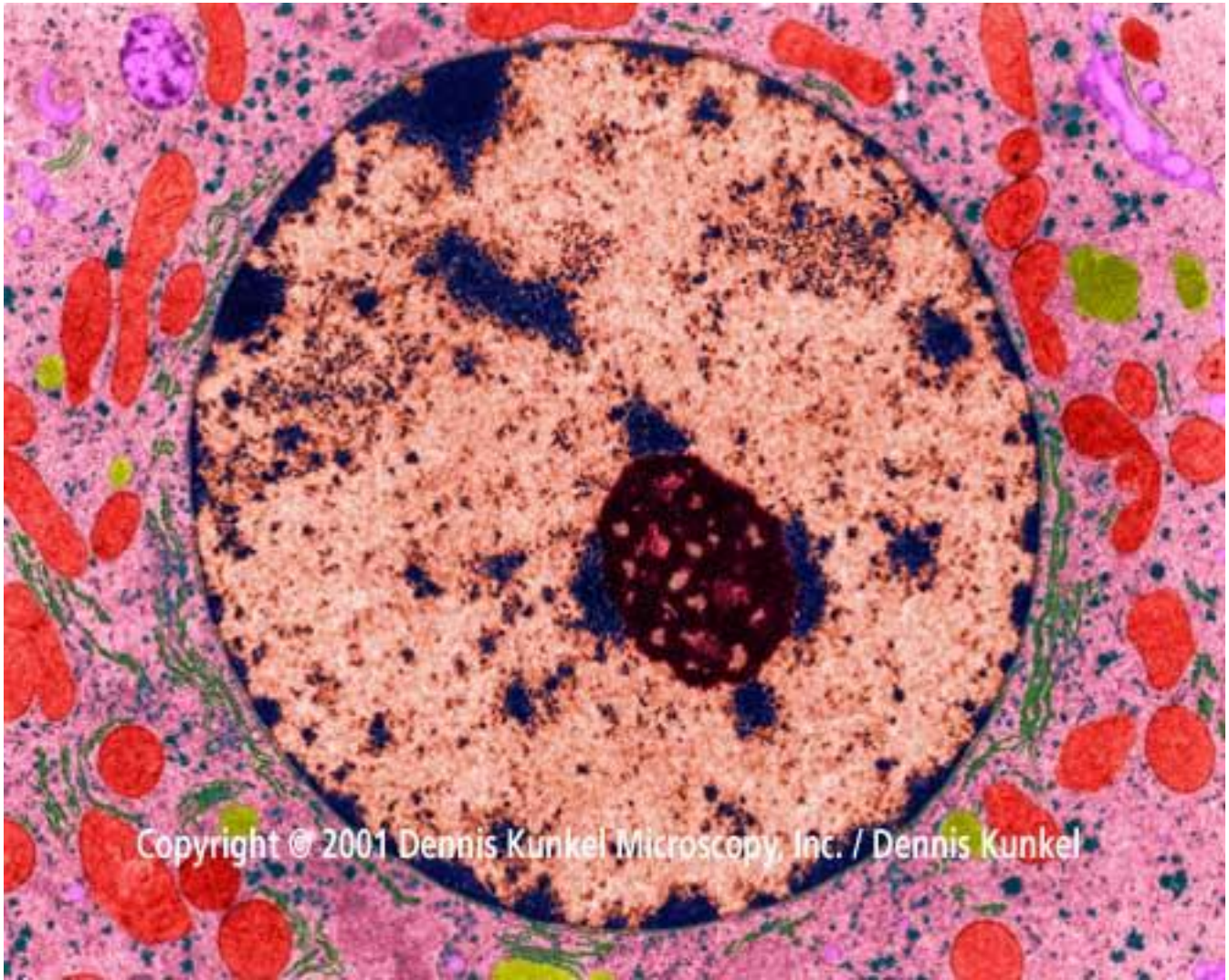
http://www.biologymad.com/

Organelle	Pupil	Organelle	Pupil
Nucleus	KO'N	Microtubules + centrioles	LF
Endoplasmic reticulum	ED	Plant cell wall	OC
Ribosomes	KL	Chloroplasts	RK
Golgi apparatus	BC	Large vacuole	KR
Lysosomes	JF	Plasmodesmata	JE
Mitochondria	KS	Vesicles	KR
Cell surface membrane	NN	Prokaryotes and eukaryotes	AD

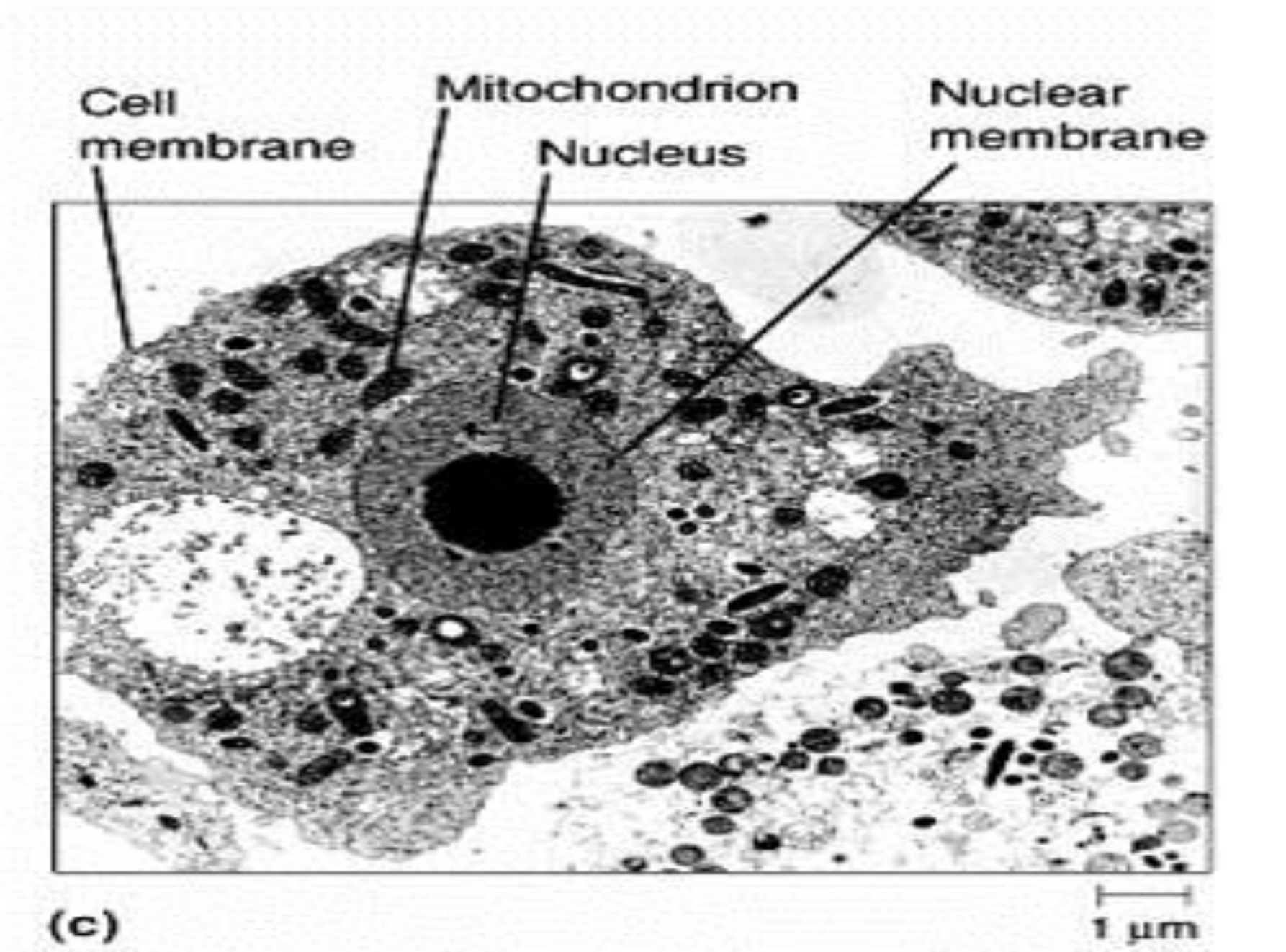
Eukaryotic cells:

The appearance of the cell through the electron microscope is its **ultrastructure**

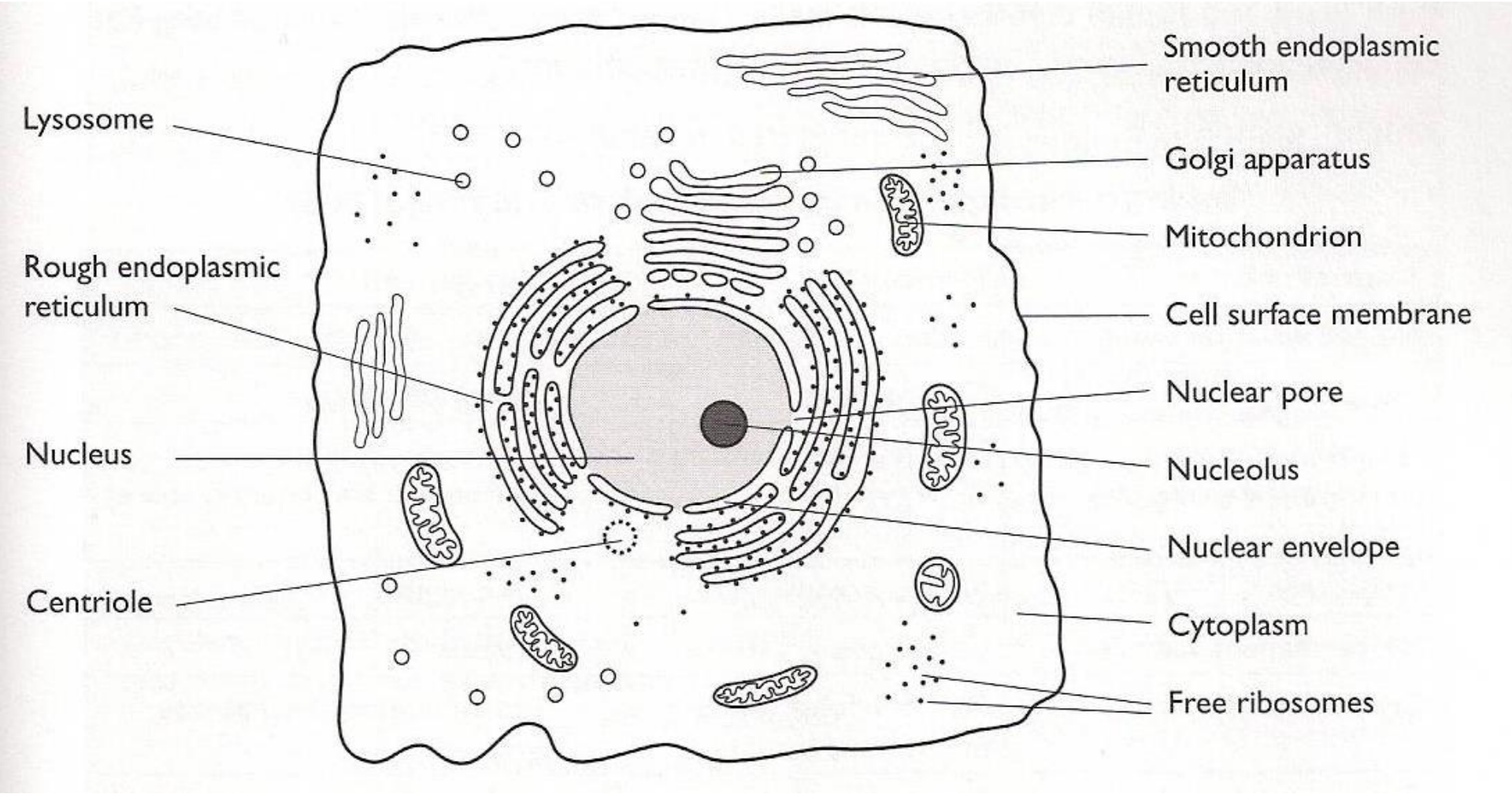
Electron micrograph of a liver nucleus:



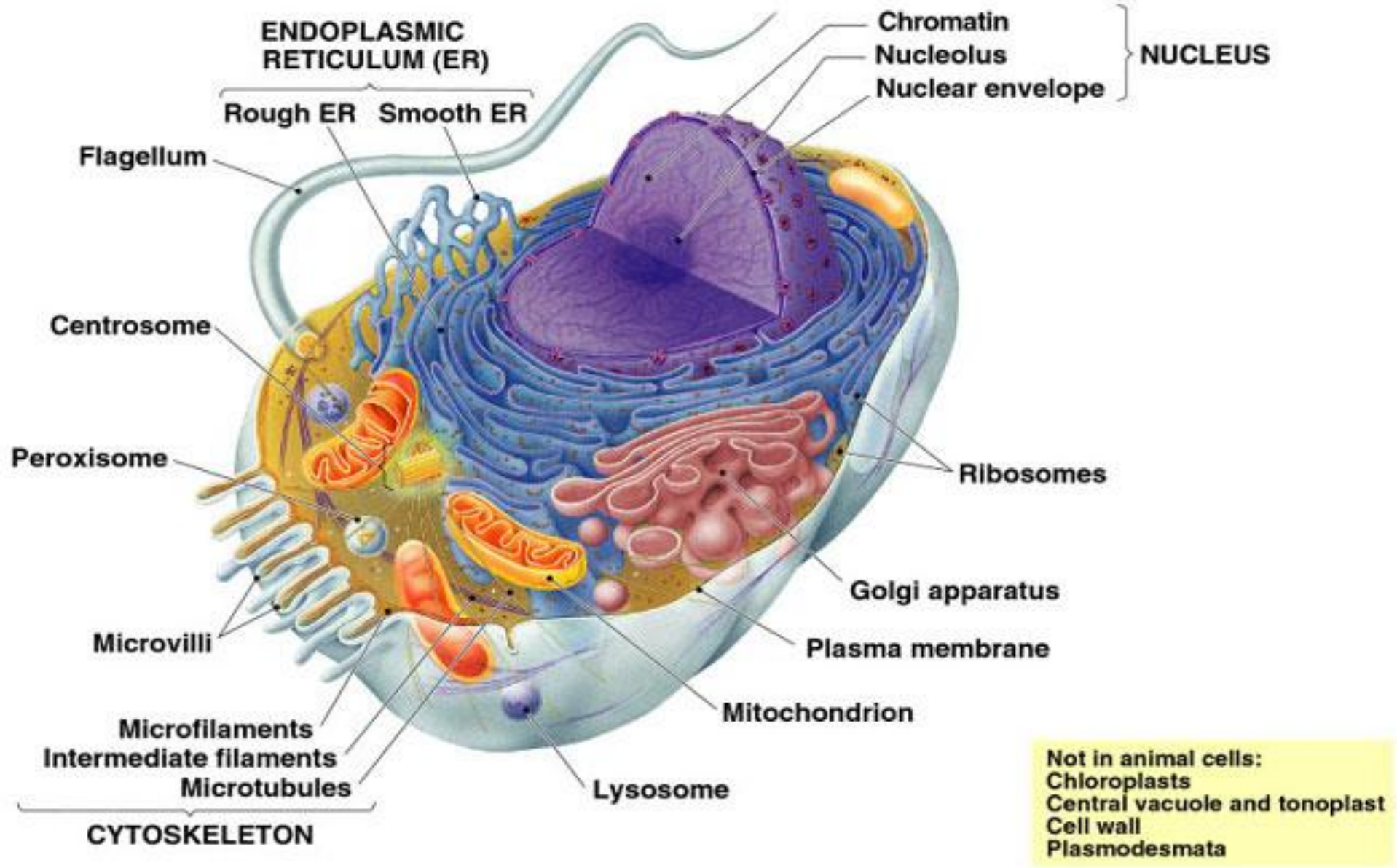
Electron micrograph of an animal eukaryotic cell



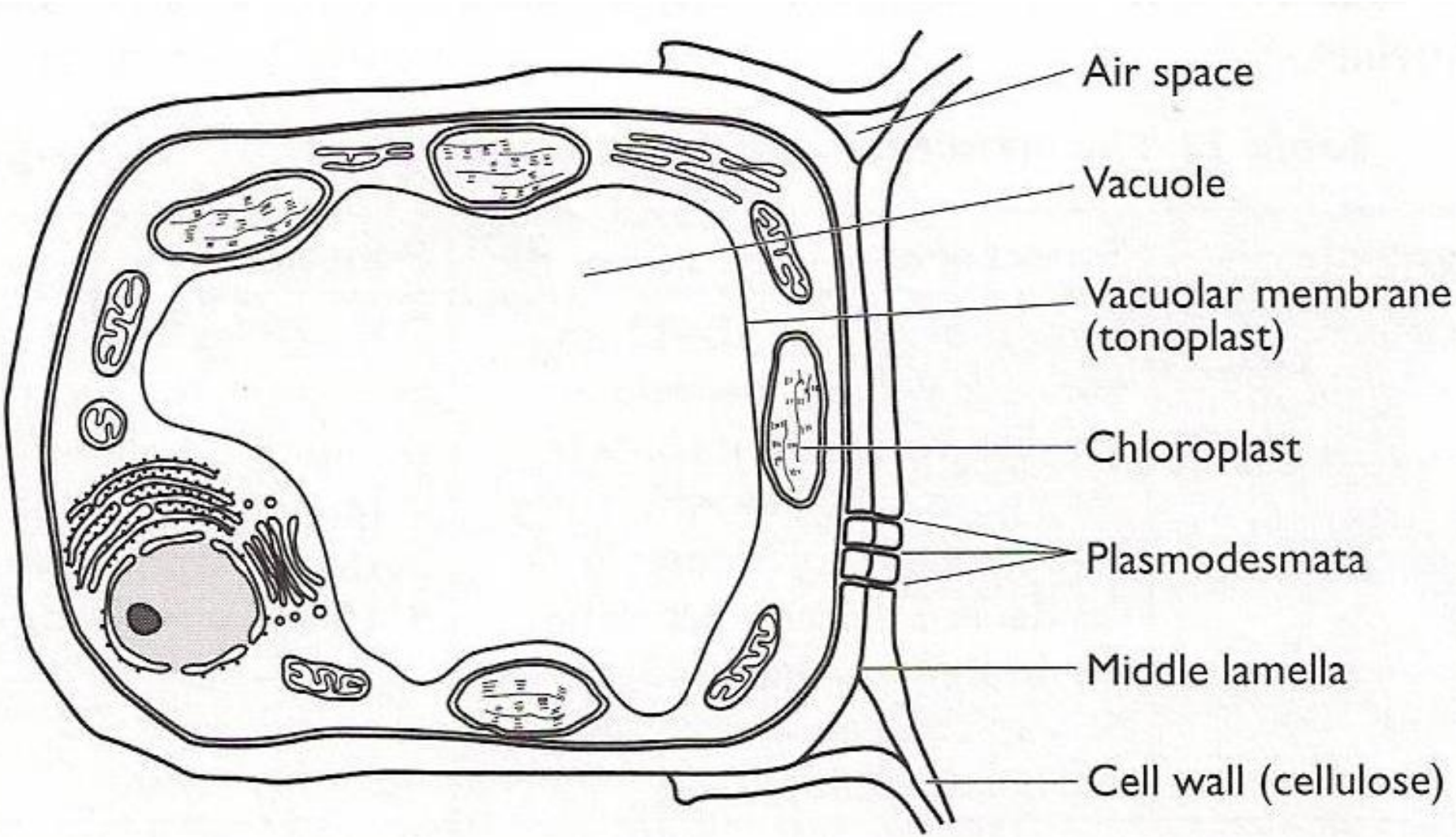
Try and identify the ultrastructure of the animal cell...



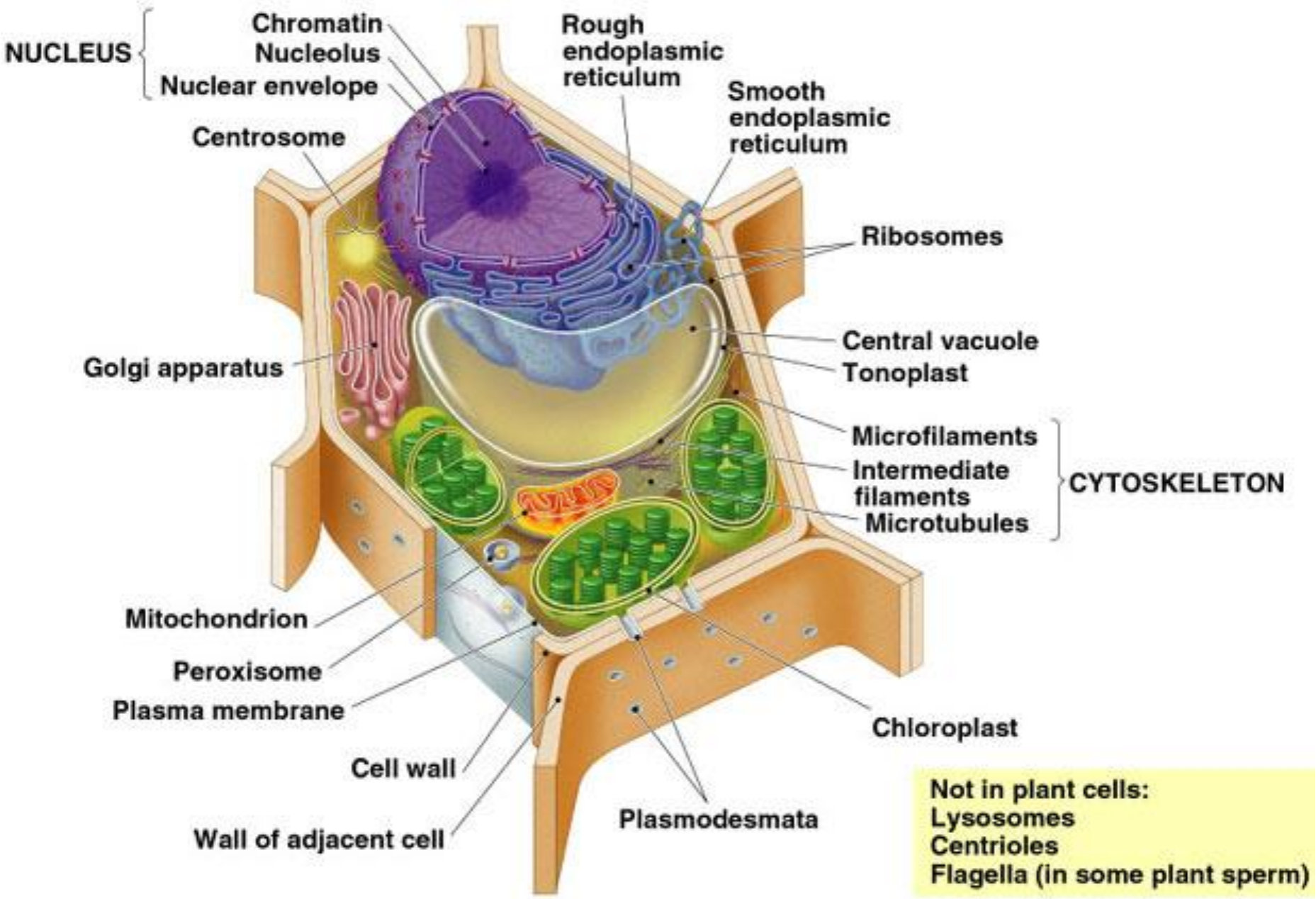
An Animal eukaryotic cell



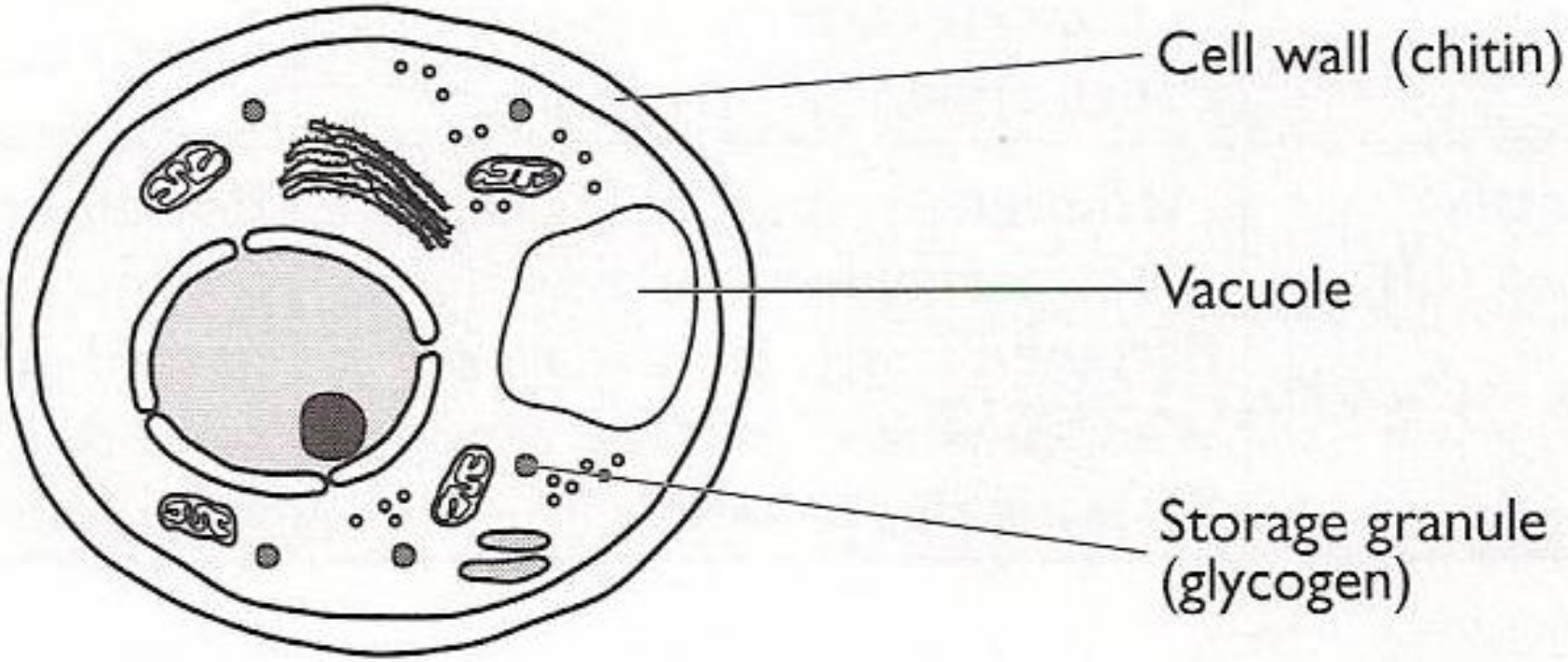
Try and identify the ultrastructure of the plant cell...



A Plant Eukaryotic cell



Try and identify the ultrastructure of the fungal cell...



Eukaryotes: Comparing animal, plant and fungal cells

Animal cell	Plant cell	Fungal cell
No cell wall	Cellulose cell wall	Chitin cell wall
No chloroplasts	Chloroplasts	No chloroplasts
Glycogen granules (carbohydrate (energy) store)	Starch grains (carbohydrate (energy) store)	Glycogen granules (carbohydrate (energy) store)
Lysosomes	No lysosomes	Lysosomes
No permanent vacuole	Large central vacuole	Vacuole
Centrioles	No centrioles (except mosses and ferns)	No centrioles (except one group)
No plasmodesmata	Plasmodesmata	No plasmodesmata

Plant cells are protoplasts (membrane and contents) bordered by an extracellular cellulose cell wall. Neighbouring cell walls adhere (stick to each other) by a middle lamella (sticky material made of calcium pectate)

Fungal cells contain protoplasm (cyto and nucleoplasm) that is often multinucleate (more than one nucleus)

Quick cell structure quiz – DO IT!

http://www.zerobio.com/target_practice_quiz/target_practice_quiz_cells.htm

Homework for Wednesday:

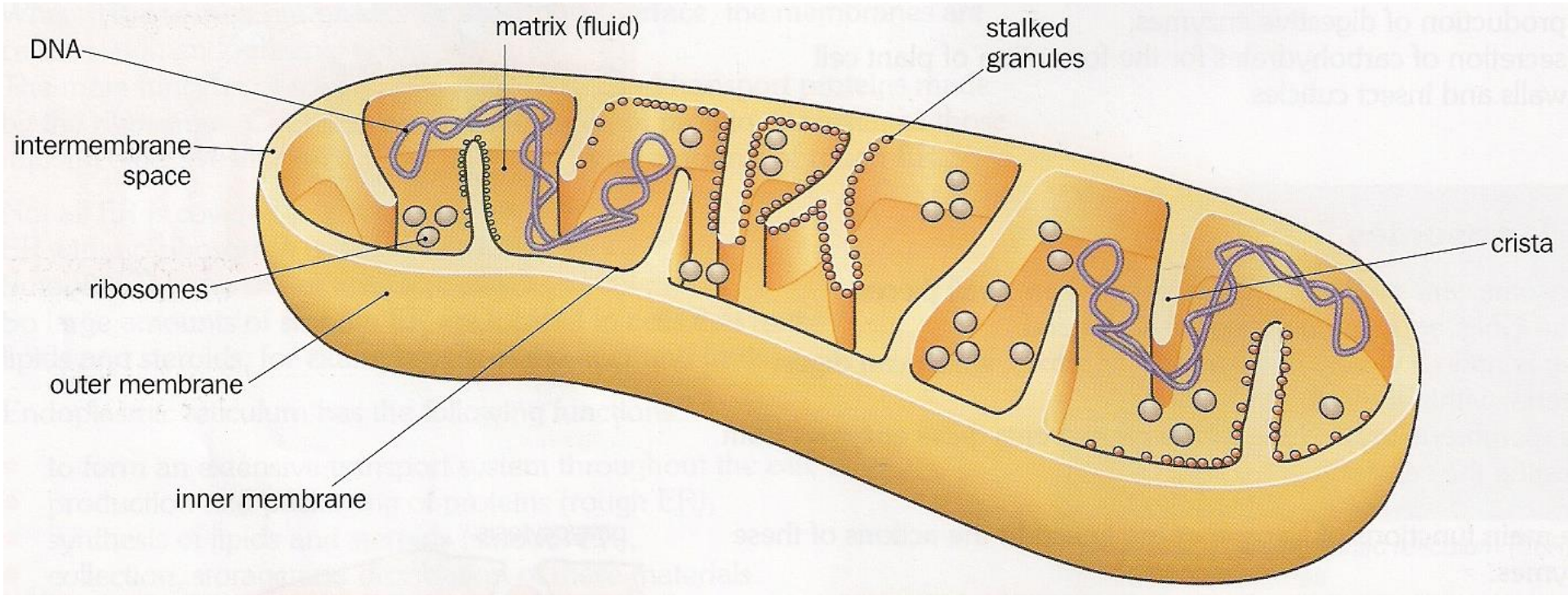
Create and email one Power Point slide of your organelle. Use at least 20 font size.

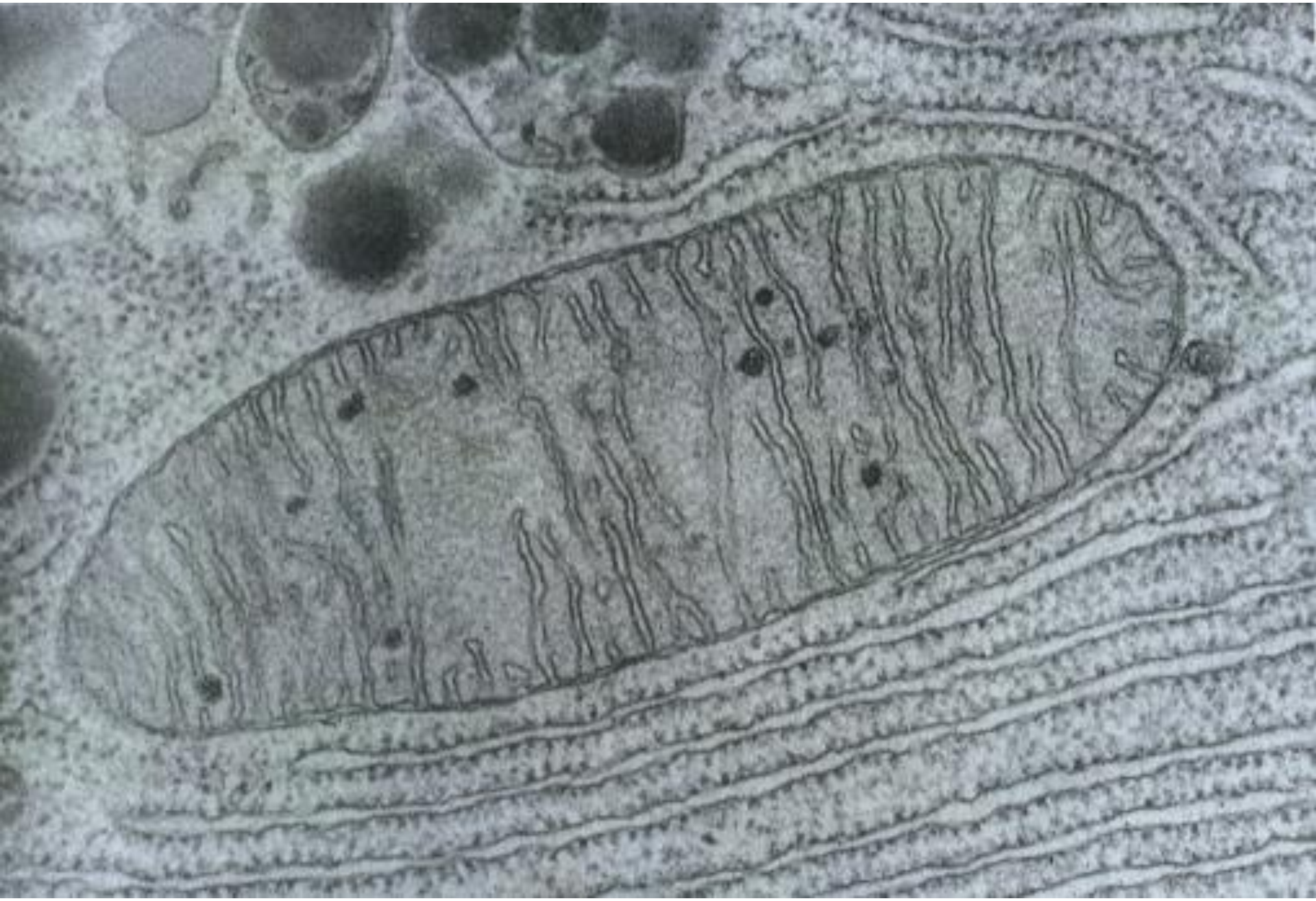
kdorman708@c2kni.net

Must include:

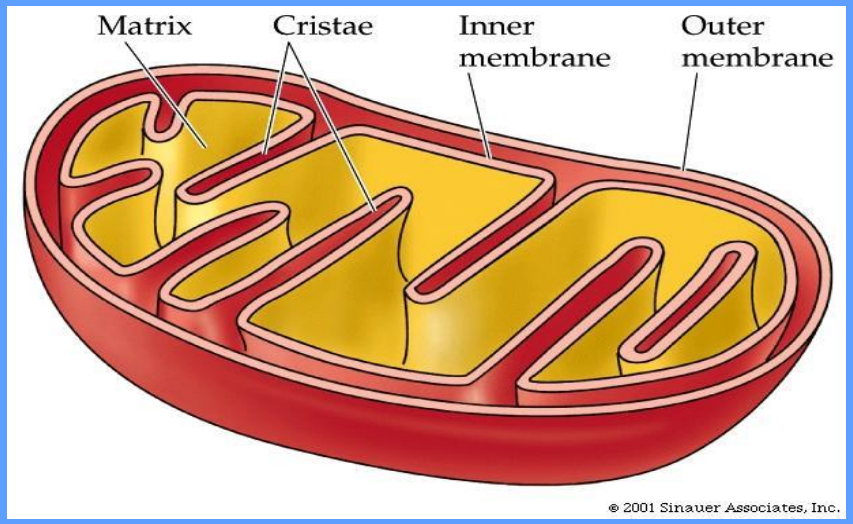
1. Location
2. Structures
3. Functions
4. Links to other organelles?
5. Other?

MITOCHONDRIA (singular: mitochondrion)





MITOCHONDRIA are present in almost all types of ***ANIMAL CELLS.*** Located in the ***CYTOPLASM*** of the cell.



They are common in cells that have high energy requirements, such as ***MUSCLE CELLS.***

Mitochondria are enclosed within a double membrane, separated by and ***INTER-MEMBRANE*** *space.*

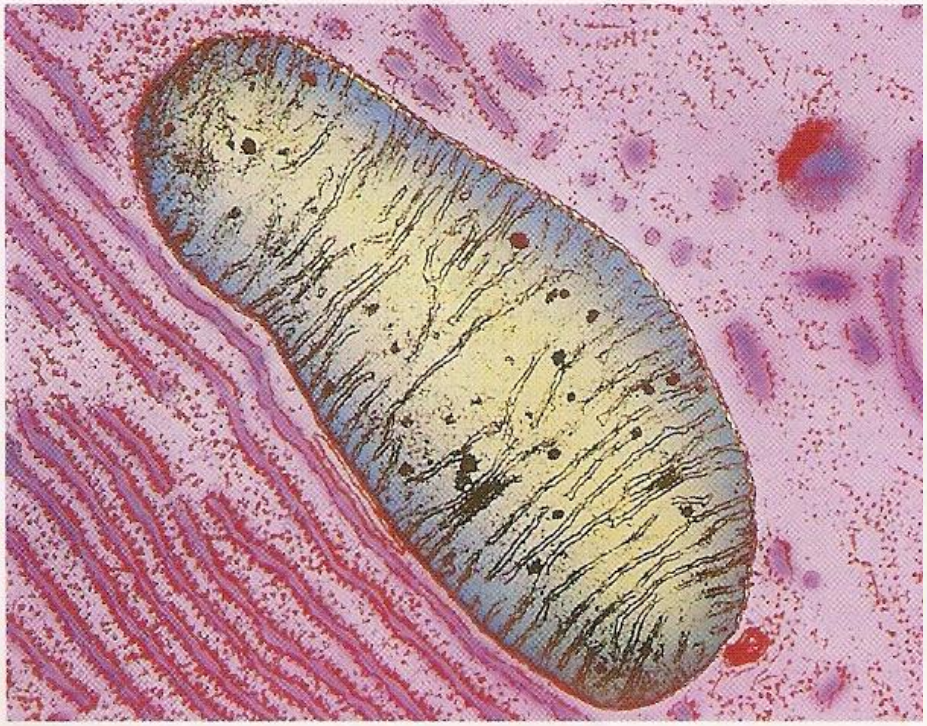
The inner membrane is ***FOLDED*** to from ***CRITSAE.*** That extends into the matrix.

This infolding gives the inner mitochondrial membrane a ***GREATER SURFACE AREA-*** *therefore increasing the number of enzymes (involved in aerobic respiration) that can be embedded within the membrane.*

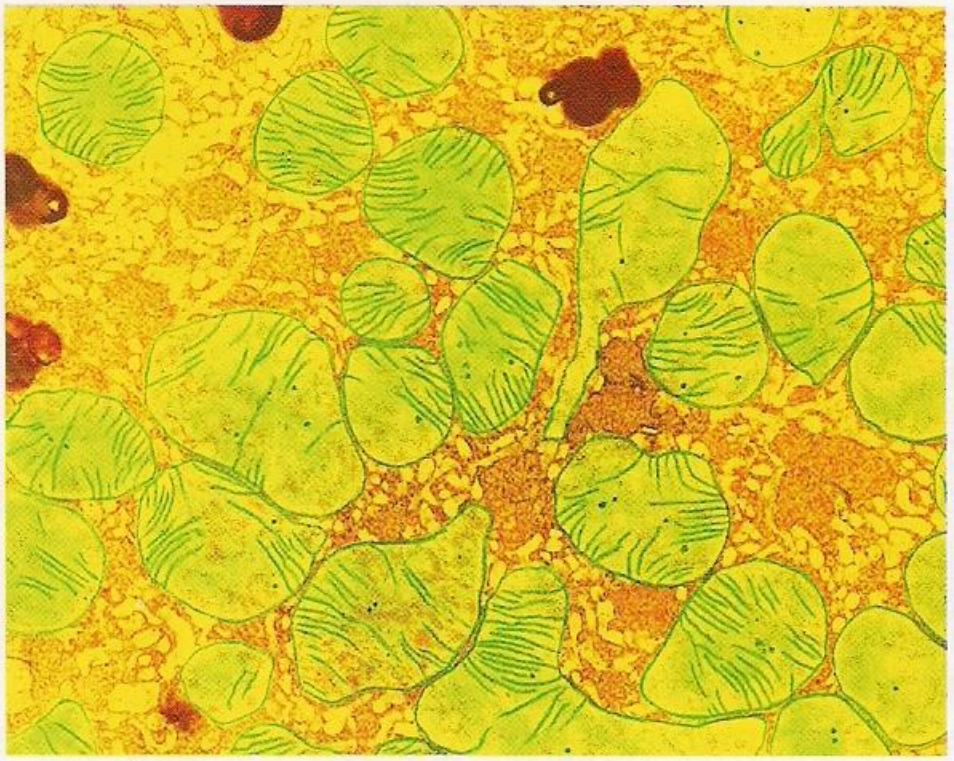
It is the site of ***ATP SYNTHESIS*** during ***AEROBIC RESPIRATION.***

The mitochondrion is the of the cell.

POWERHOUSE

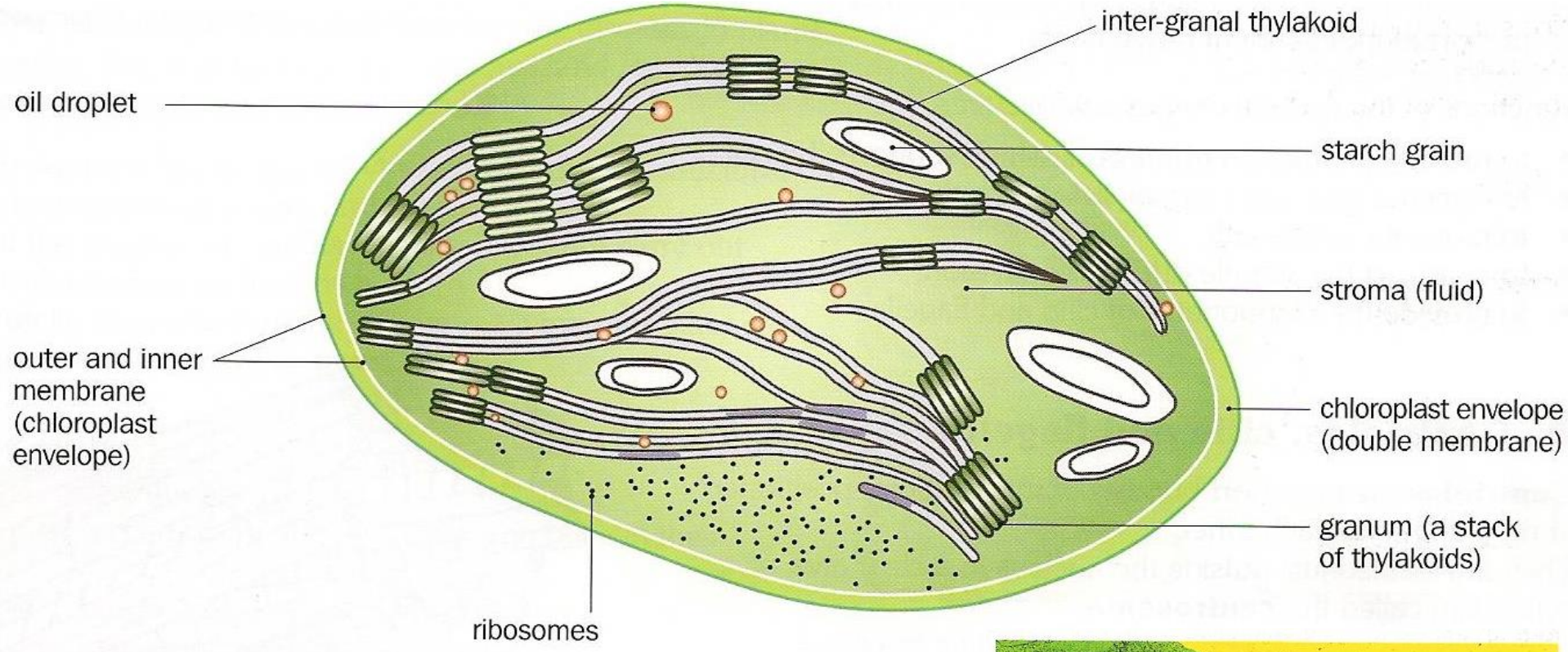


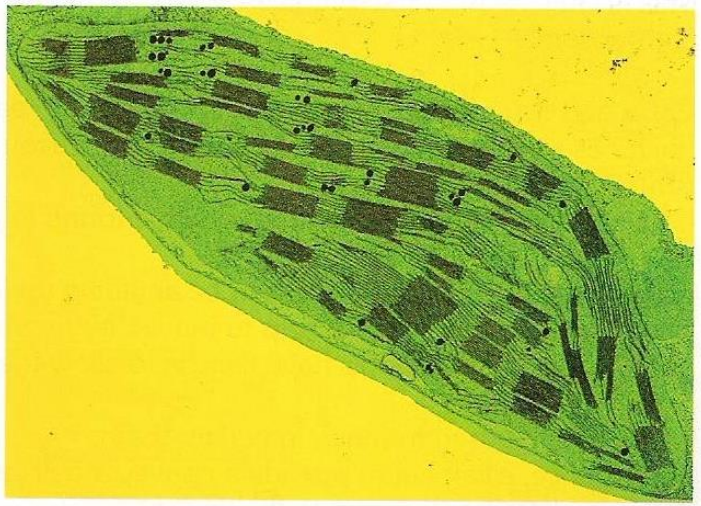
TEM of a mitochondrion in section



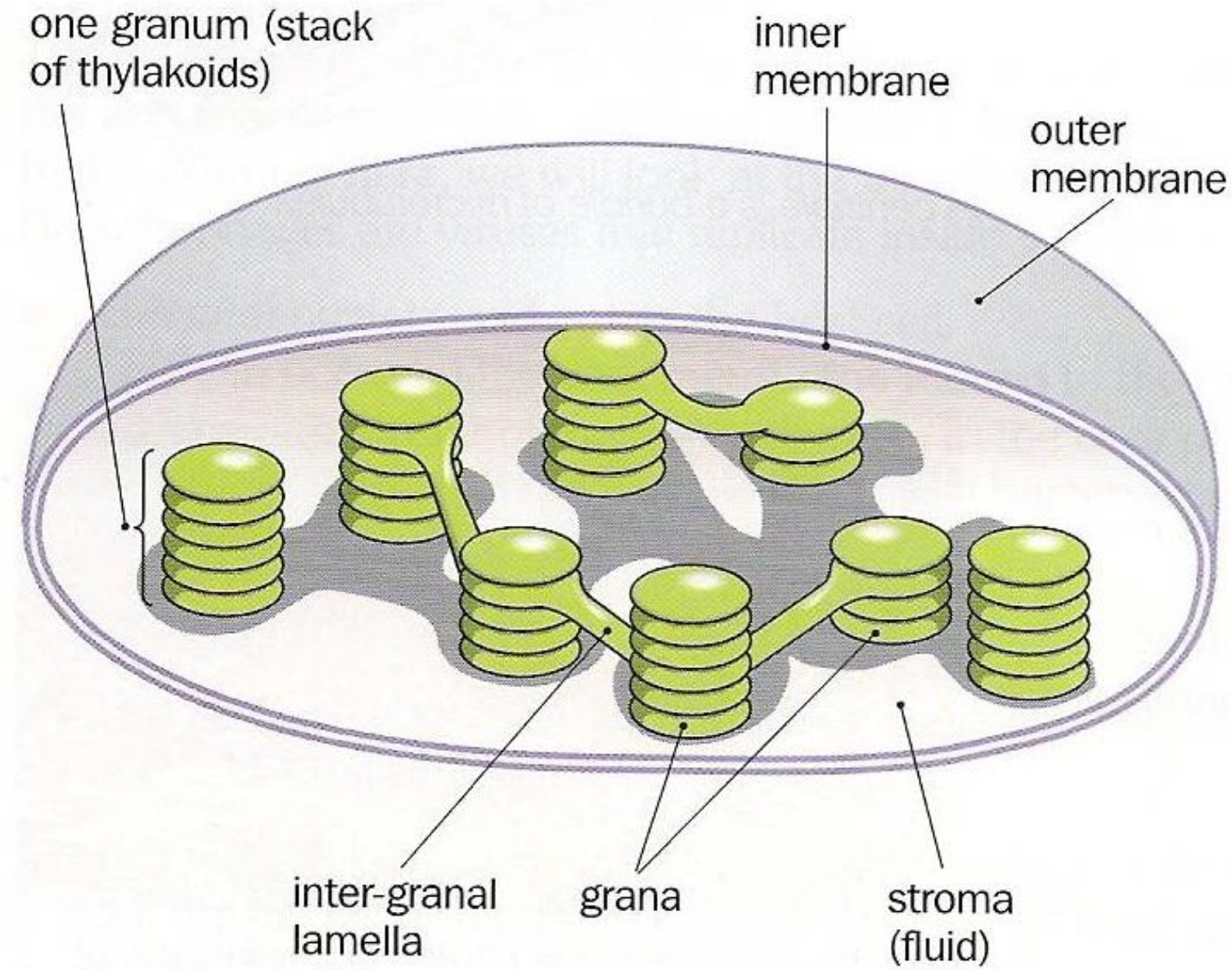
TEM of a mitochondria mainly cut in cross section, note the cristae

CHLOROPLASTS





TEM of section of a chloroplast



3-D representation of the structure of a chloroplast

Chloroplasts

Location

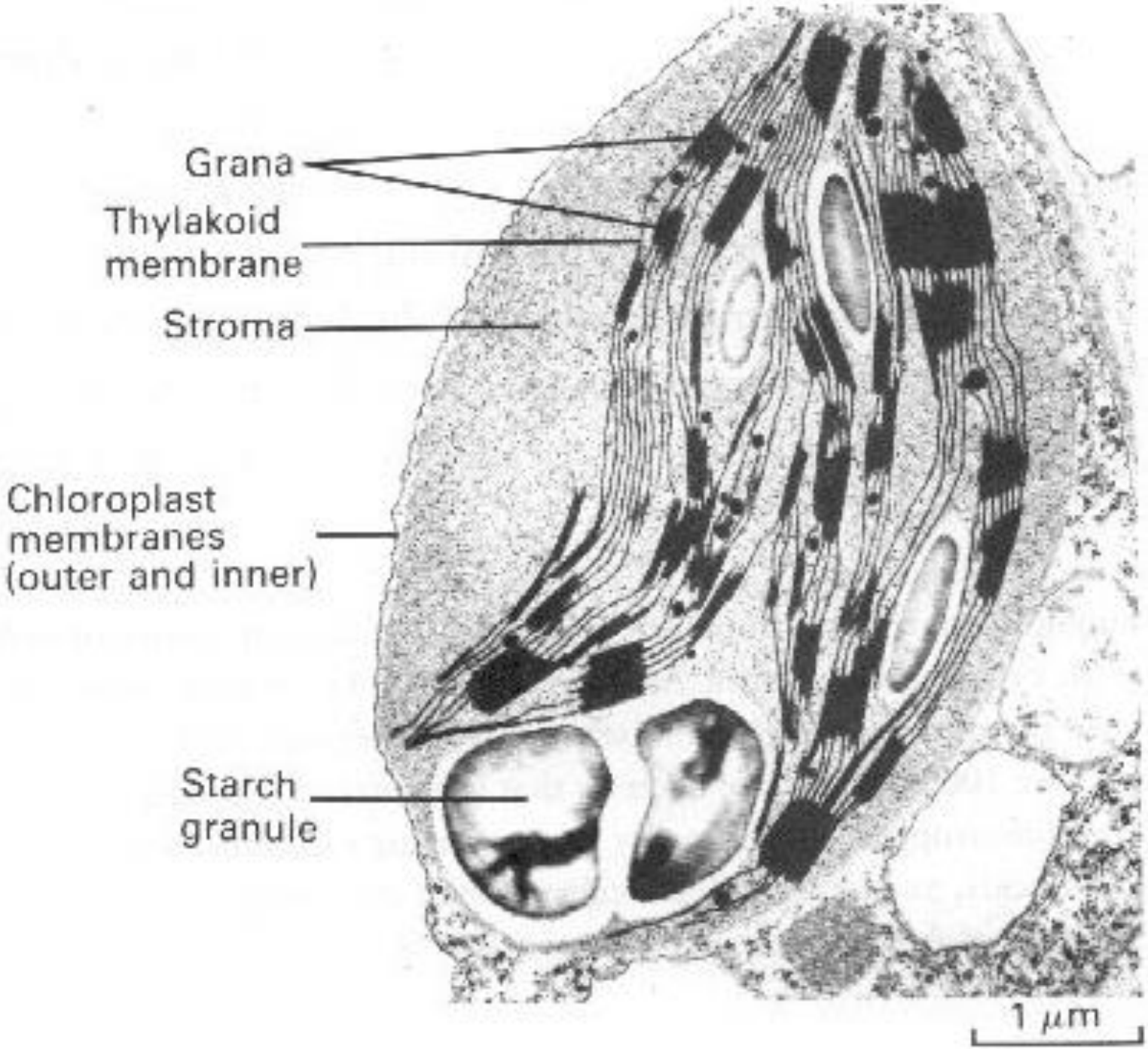
- Leaves of plants in photosynthesising cells e.g mesophyll cells, also guard cells & palisade layer

Structure

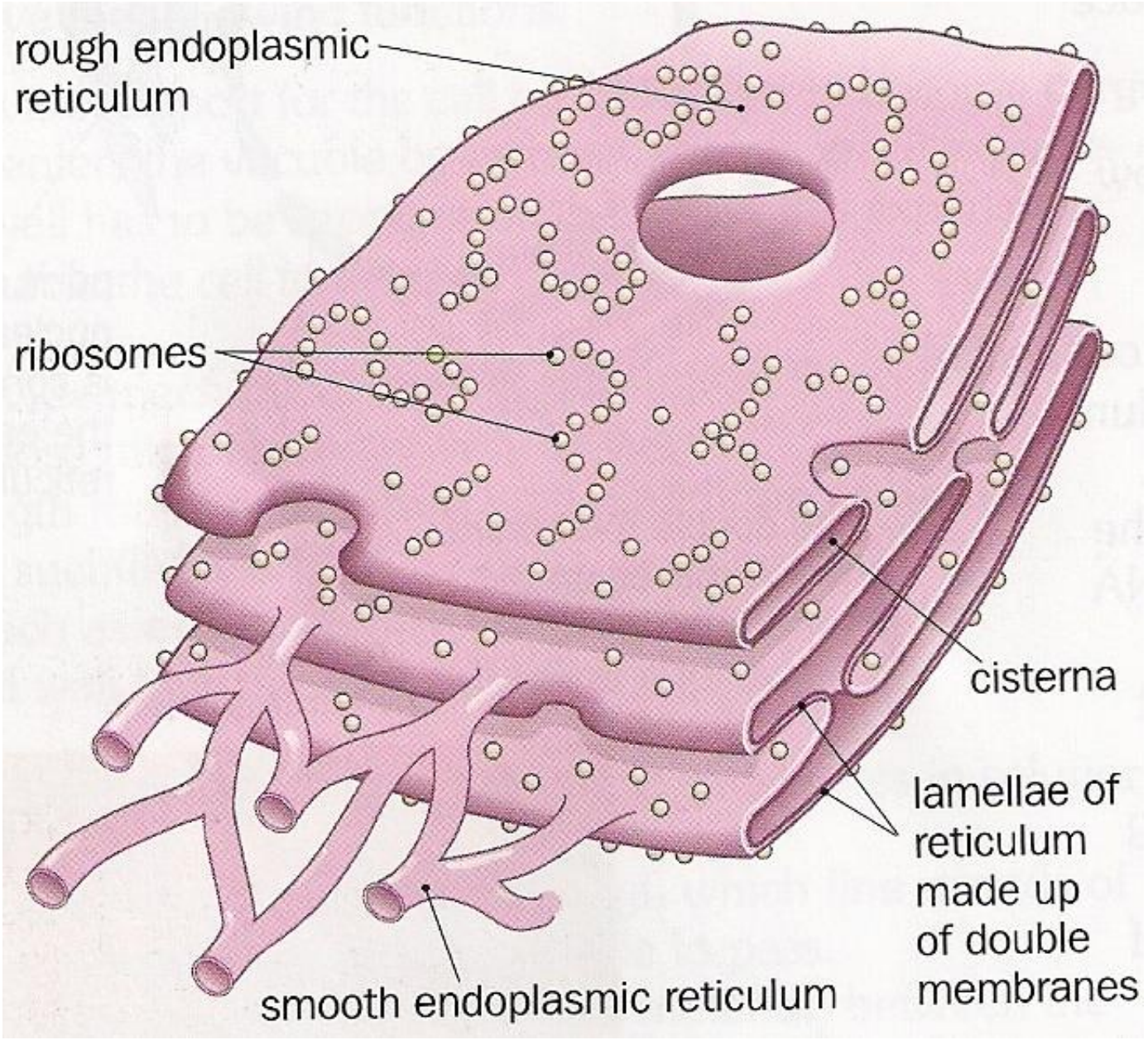
- Large organelle: 10μm - 25μm in diameter
- Bounded by double membrane, outer & inner (protects inner parts of chloroplast)
- Within the stroma (where sugars are synthesised) is a system of membranes (thylakoids) which can be are arranged in stacks (grana, singluar = granum)
- Thylakoids have chlorophyll molecules (capture light energy from the Sun) on their surface, & are most densely concentrated in the grana
- Between the grana, membranes are less concentrated (inter-grana)
- Stacks of sacs are connected by stroma lamellae (skeleton of chloroplasts - keeps sacs safe distance from each other & ensures max. efficiency in capturing light energy)

Function

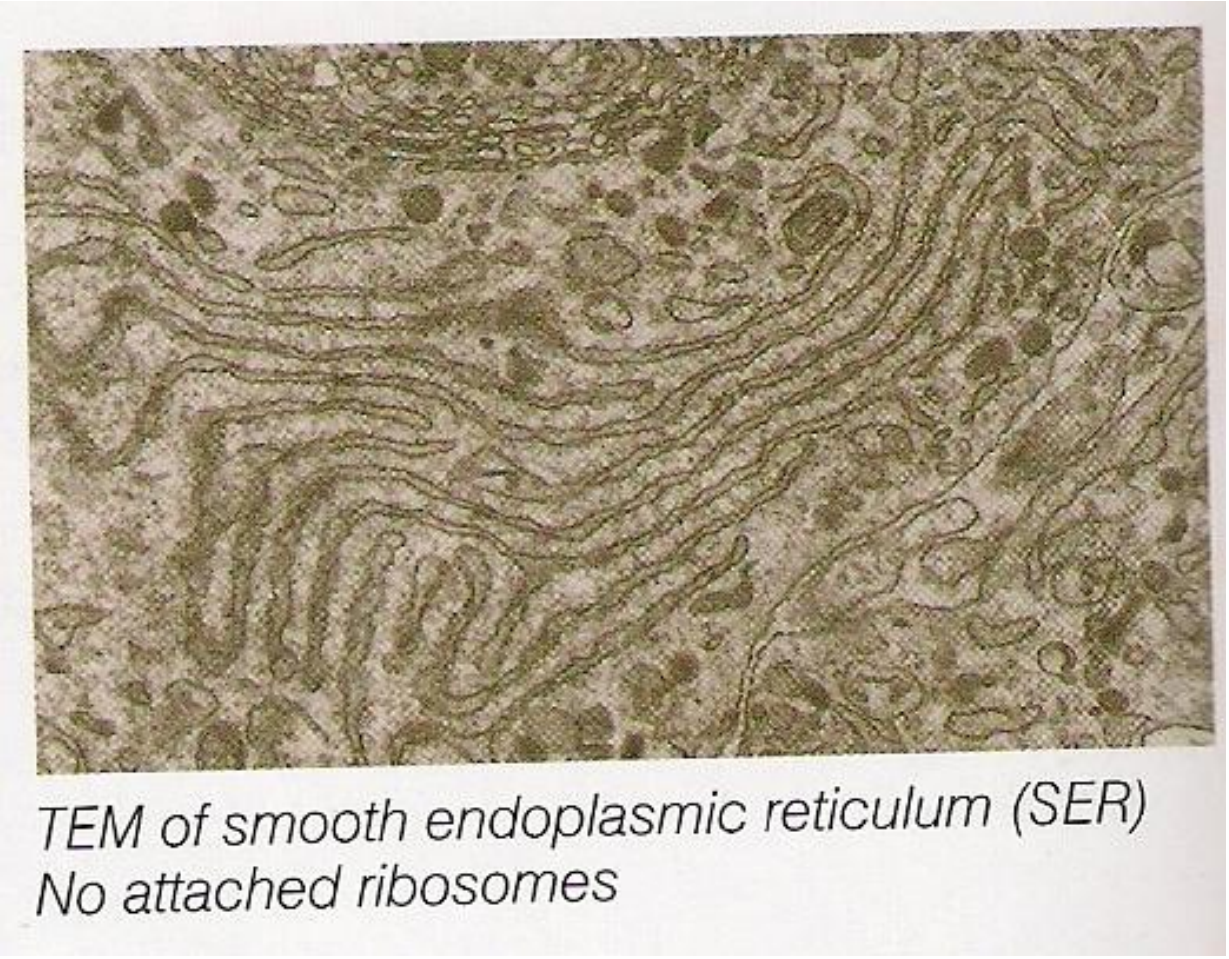
- Site of photosynthesis: aids process of food production which is crucial for plant survival
- Chlorophyll causes green colouration of leaves & uses sunlight energy to make sugars/starch grains/lipid droplets through process of photosynthesis
- Photosynthesis equation: light + CO_2 + H_2O -> glucose (stored as ATP energy) + O_2
- Mitochondria work in the opposite direction to chloroplasts, use O_2 in process of releasing chemical energy from sugars and produce CO_2 + H_2O


Grana
Thylakoid membrane
Stroma
Chloroplast membranes (outer and inner)
Starch granule
1 μm

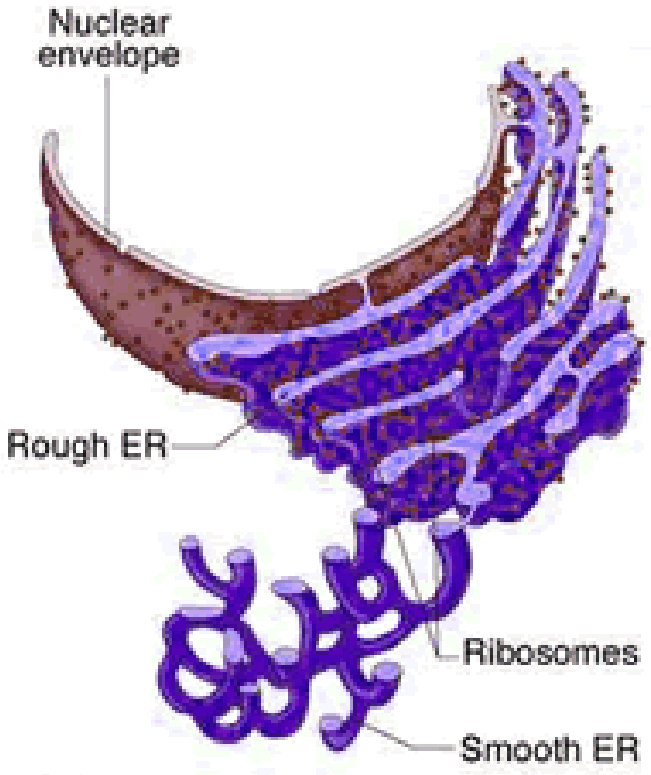
ROUGH ENDOPLASMIC RETICULUM (RER)



SMOOTH ENDOPLASMIC RETICULUM (SER)



TEM of smooth endoplasmic reticulum (SER)
No attached ribosomes



ENDOPLASMIC RETICULUM

Location→

- ER is a membrane that extends throughout the cytoplasm.
- IT is often very near the nucleus, meaning that the mRNA doesn't have to travel too far.
- **RER** is more common in cells whose function it is to secrete proteins.
- **SER** is more common in cells that release oils.

Structure→

Rough ER:

- RER is flattened and looks like sheets of membranes.
- It has ribosomes encrusted along the outside of the membranes.

Smooth ER:

- Smooth ER has a more tubular appearance.
- It doesn't have ribosomes.

The double membranes of the ER form sacs called cisternae.

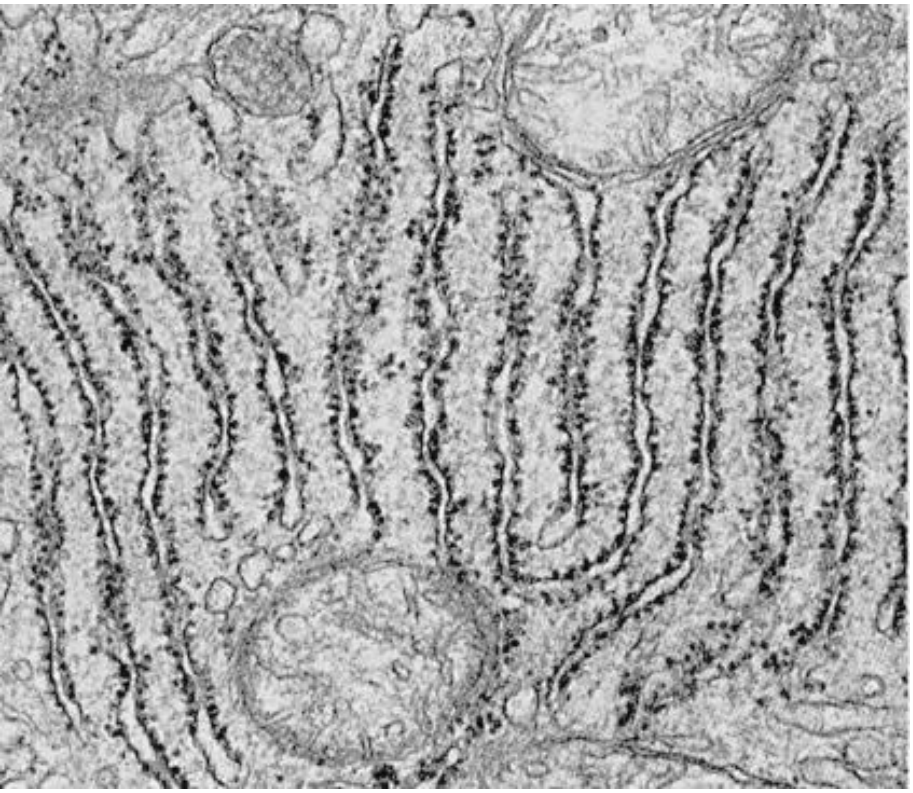
Function→

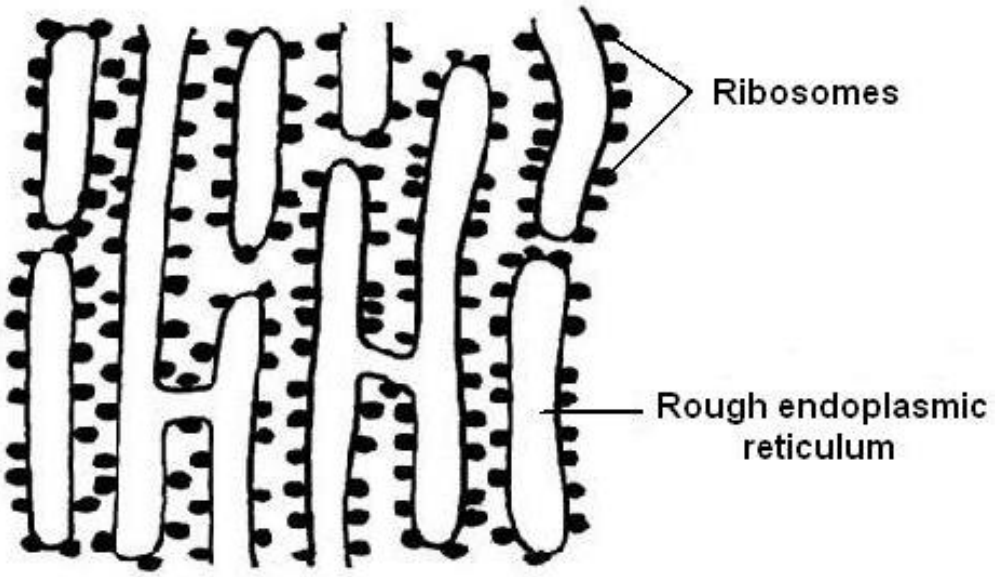
RER:

- The RER has ribosomes attached to it.
- Ribosomes contain rRNA and are the site of protein synthesis.
- The RER provides the scaffolding for the ribosomes to make the primary proteins.
- Once synthesised, the proteins are either stored in the cisternal space or pinched off the RER in vesicles to be sent to the Golgi Apparatus for modification.

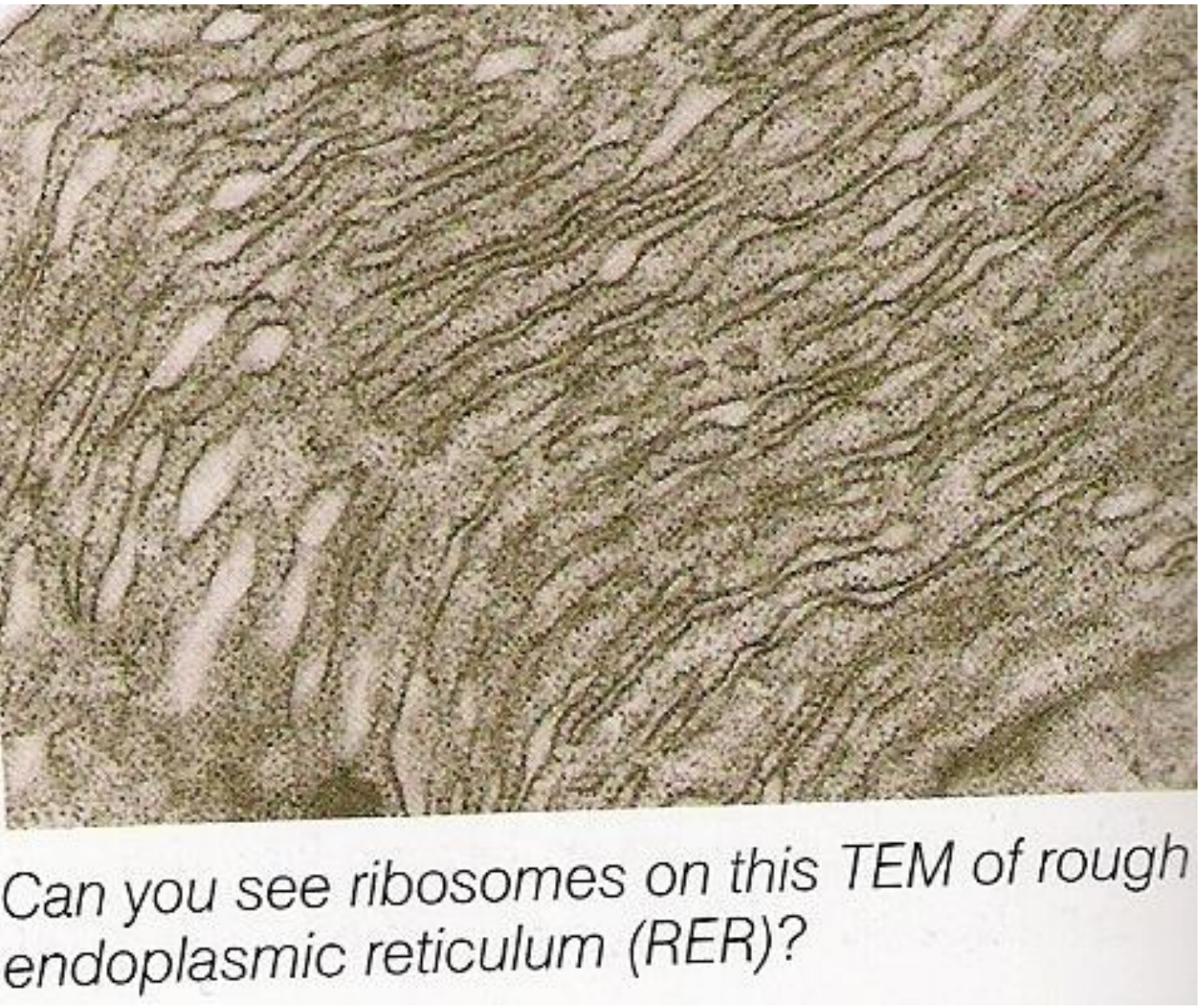
SER:

- The SER is responsible for lipid synthesis and metabolism.
- Steroid and lipid storage also occurs here.
- Proteins synthesised in the RER can also travel in the cisternae to be pinched off the SER as vesicles.

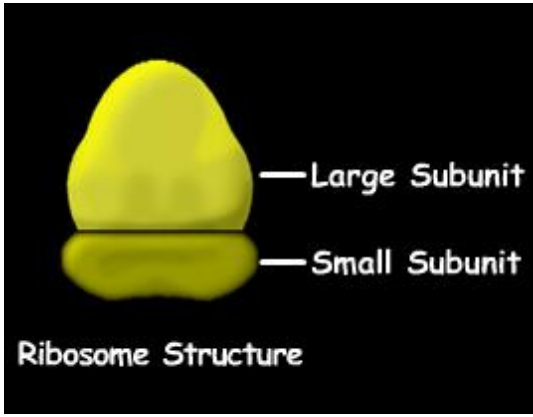


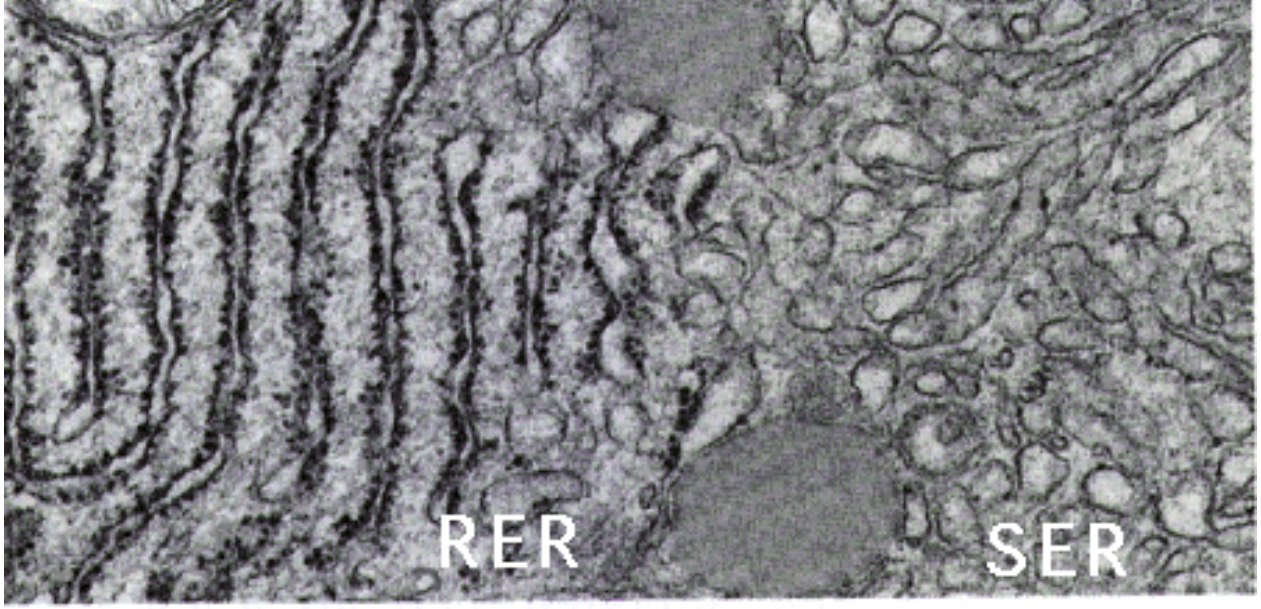

Ribosomes
Rough endoplasmic reticulum

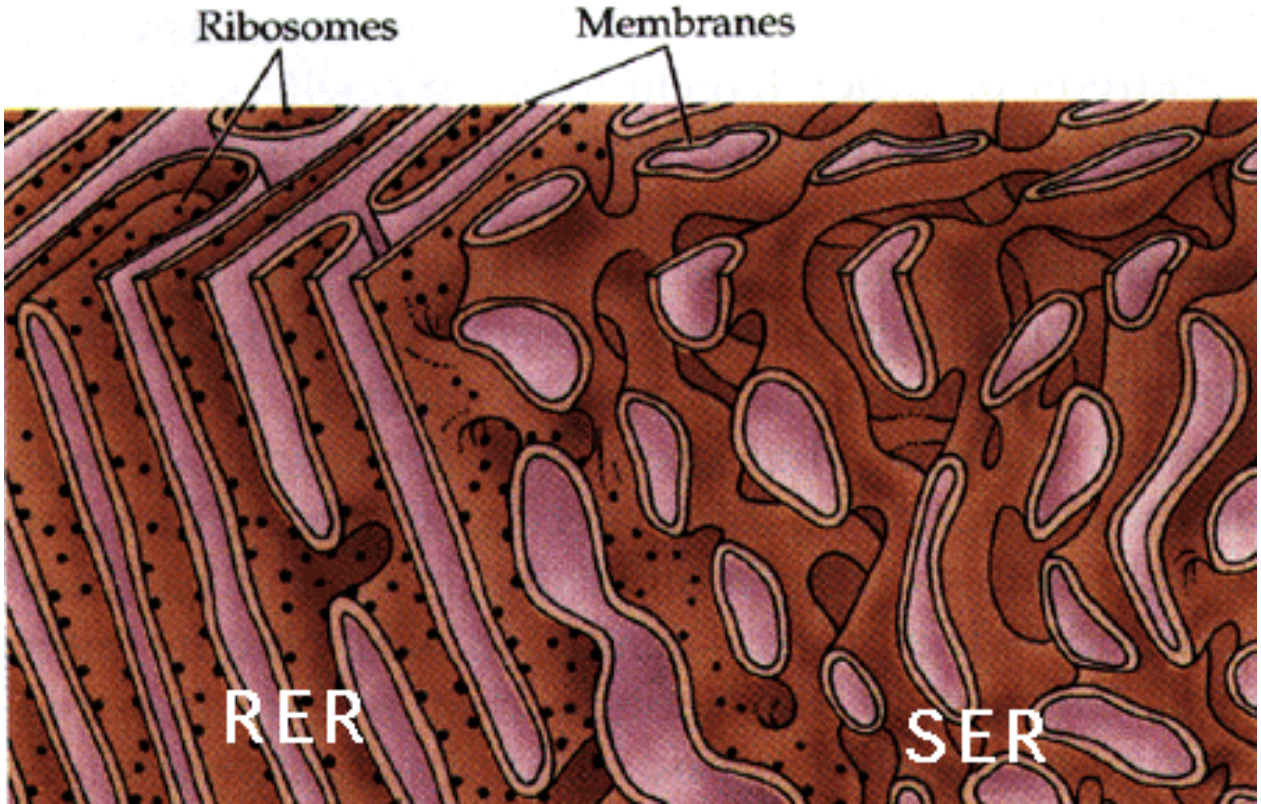
RIBOSOMES



Can you see ribosomes on this TEM of rough endoplasmic reticulum (RER)?



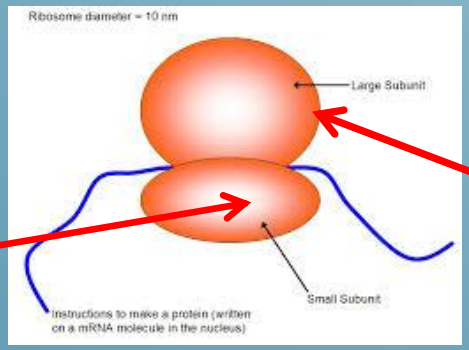

RER
SER


Ribosomes
Membranes
RER
SER

Ribosomes

- Ribosomes are small bodies of proteins
- Up to 30nm
- Each ribosome is formed of a large and a small subunit
- Visible as black dots in electron micrographs
- Frequently occur in groups called *polyribosomes* which create 'hot spots' for protein synthesis

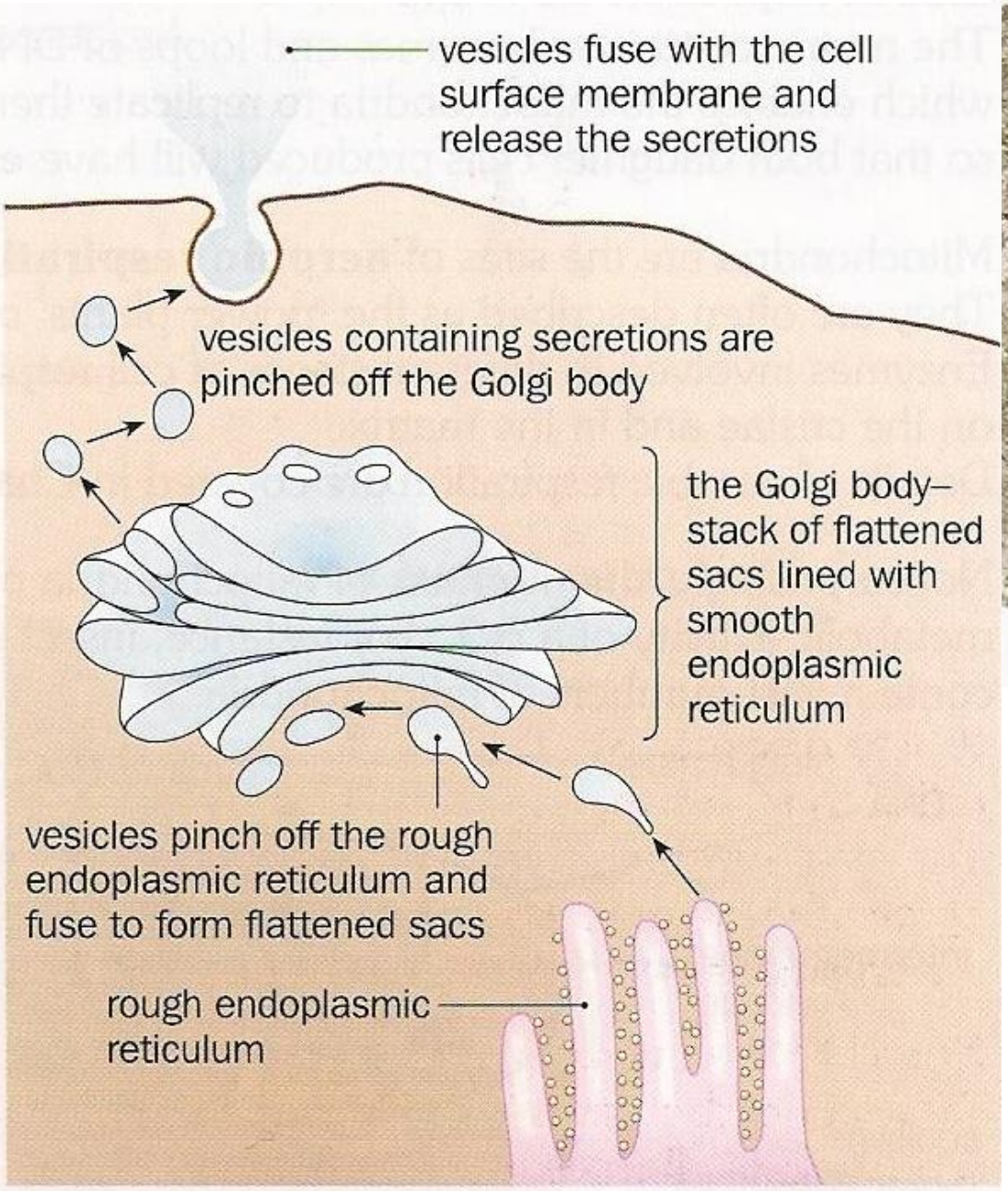
- Found either free in the cytoplasm or attached to the outer surface of the endoplasmic reticulum(RER)
- The mRNA in the nucleus leaves and travels to the ribosomes where the message is read and translated to protein
- Proteins made in the ribosomes accumulate in the RER and then the ER operates as a distribution network for proteins

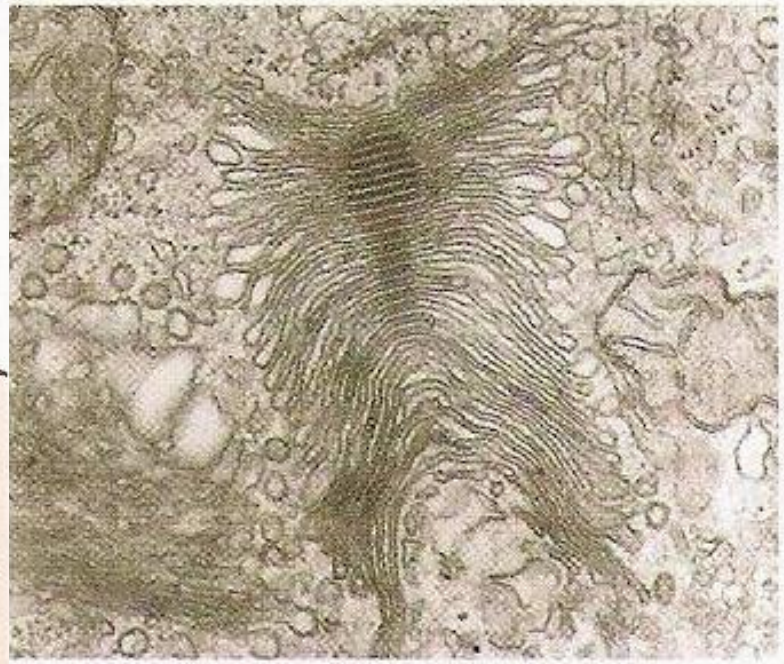


Small subunit

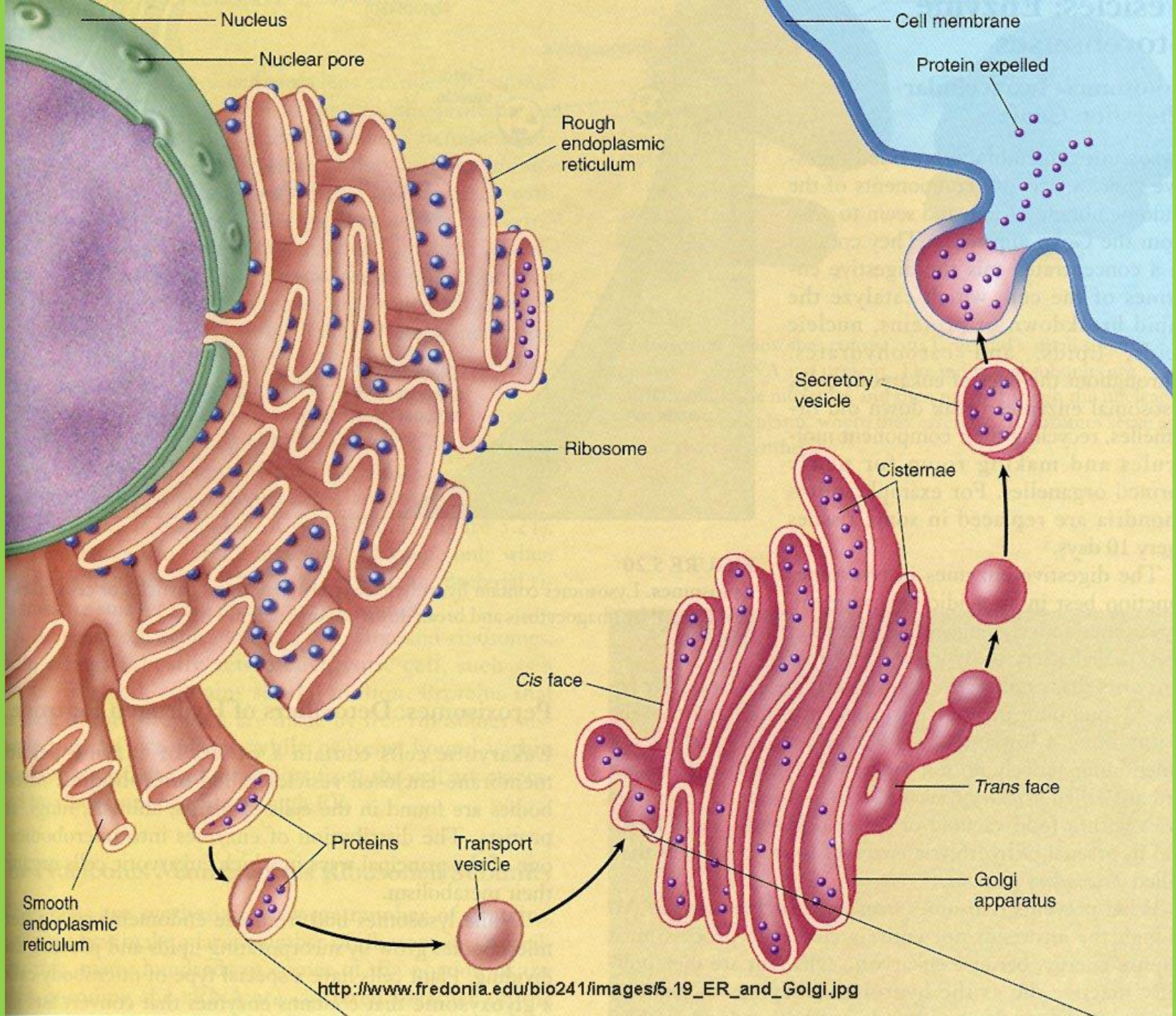
Large subunit

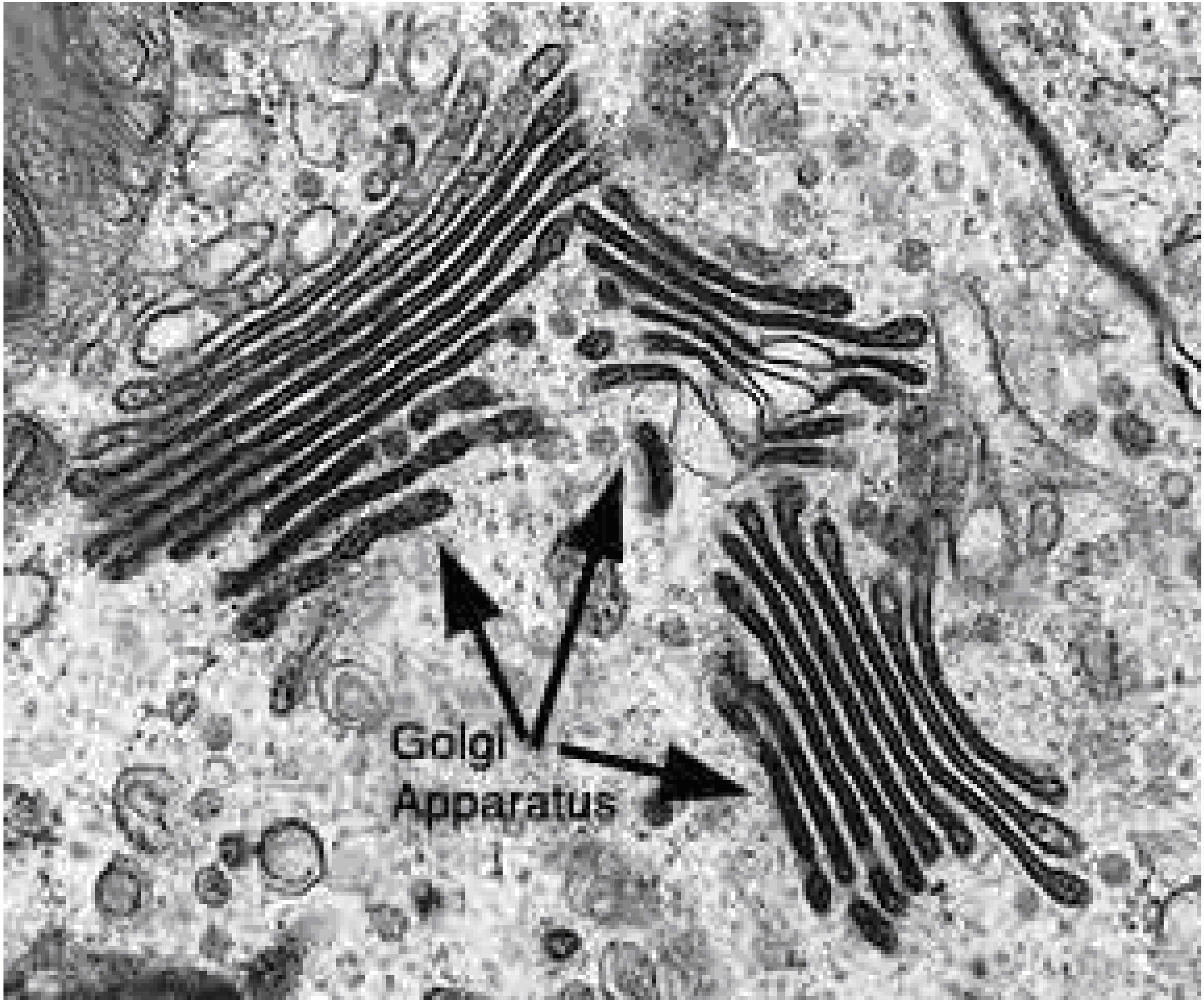
GOLGI APPARATUS (BODY)



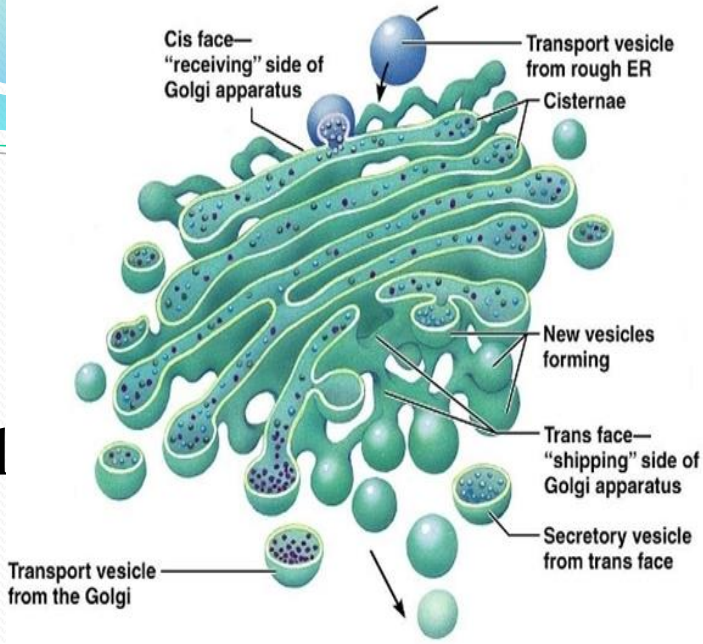


TEM of a Golgi body in section


Nucleus
Nuclear pore
Rough endoplasmic reticulum
Ribosome
Cell membrane
Protein expelled
Secretory vesicle
Cisternae
Cis face
Trans face
Golgi apparatus
Proteins
Transport vesicle
Smooth endoplasmic reticulum
http://www.fredonia.edu/bio241/images/5.19_ER_and_Golgi.jpg


Golgi
Apparatus

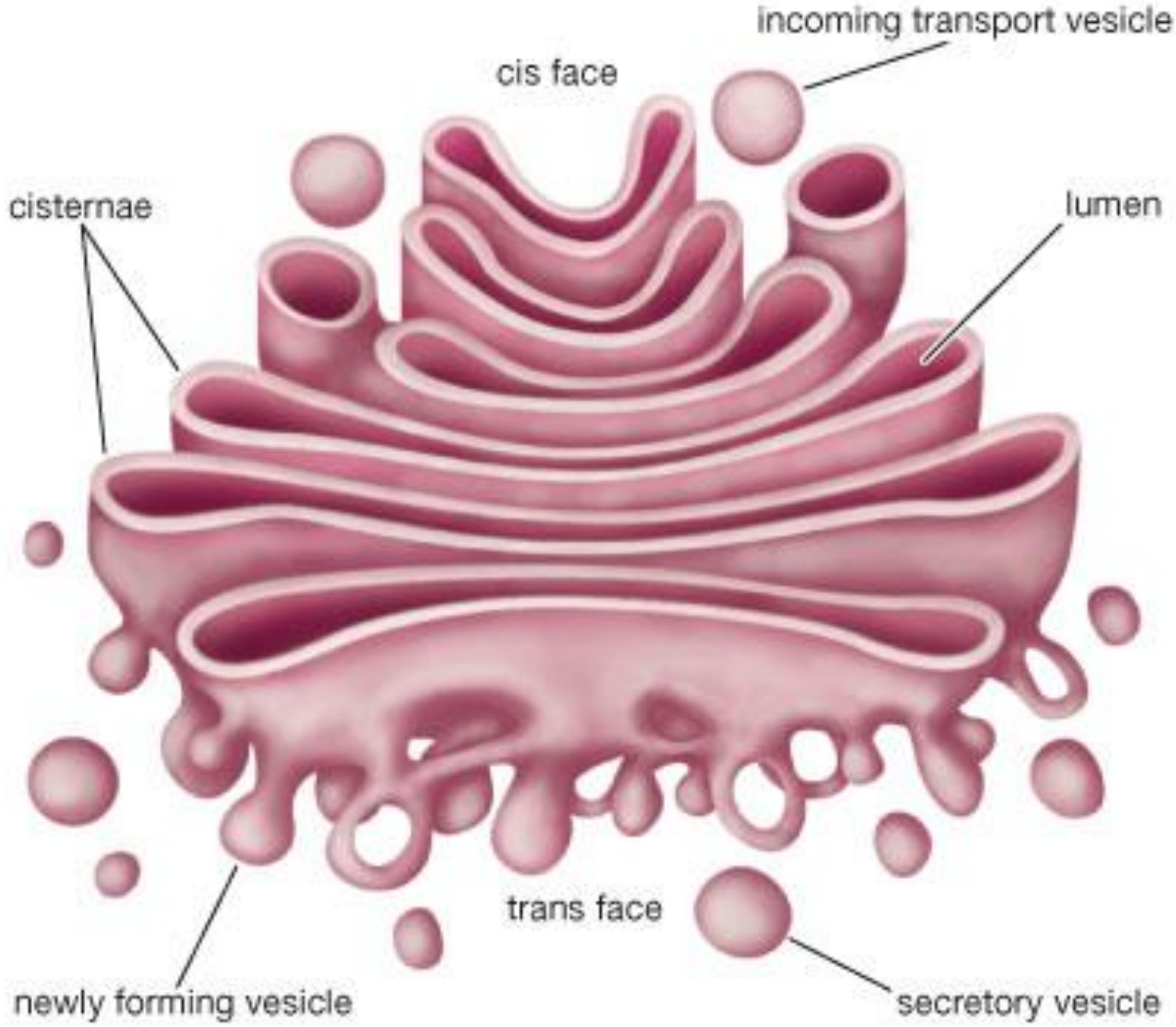
GOLGI APPARATUS

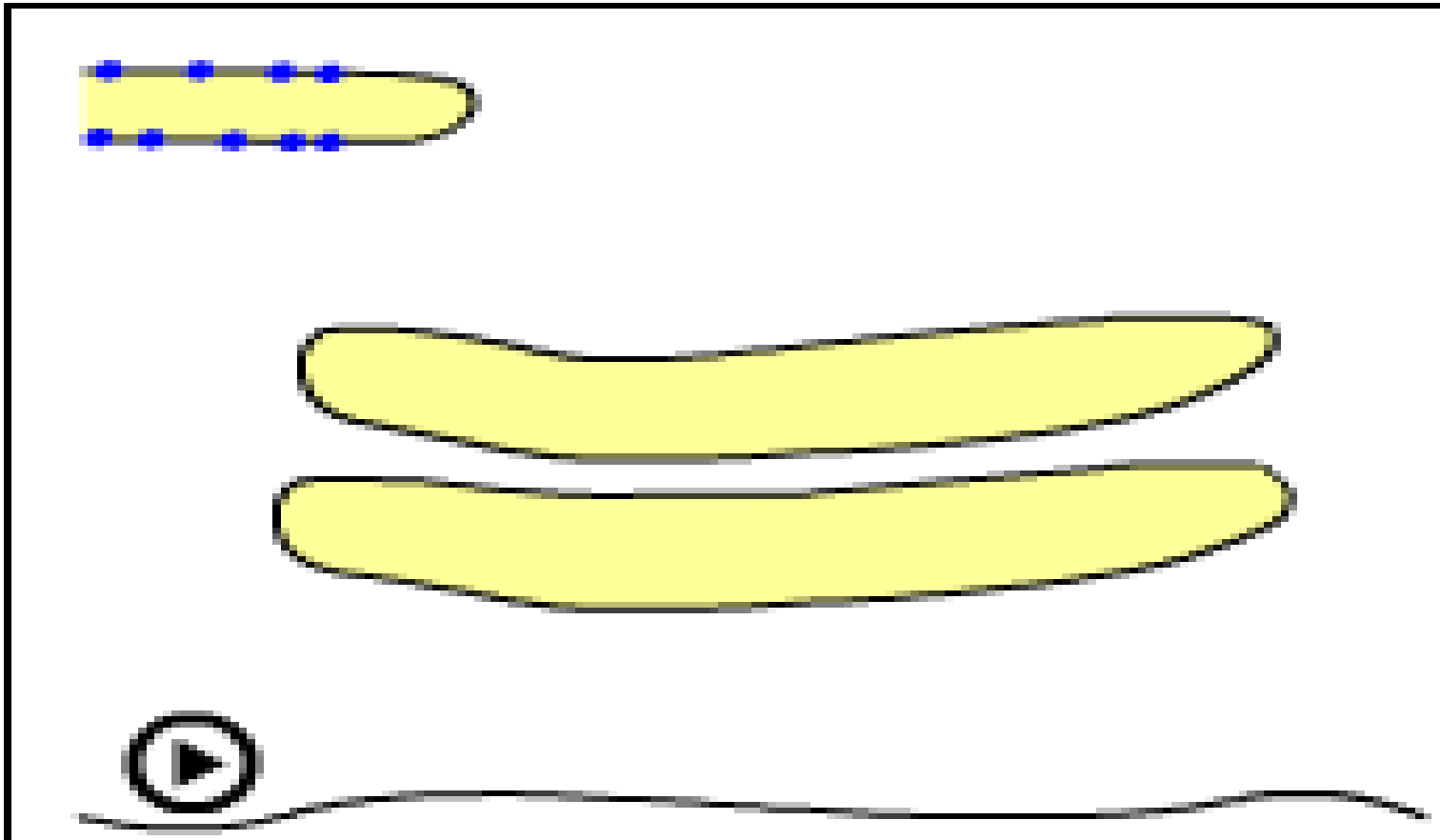


- The Golgi is made up of a number of Cisternae and found in the cytoplasm of cell
- The Golgi's main function is to gather primary proteins to modify them to making molecules that are more complex,

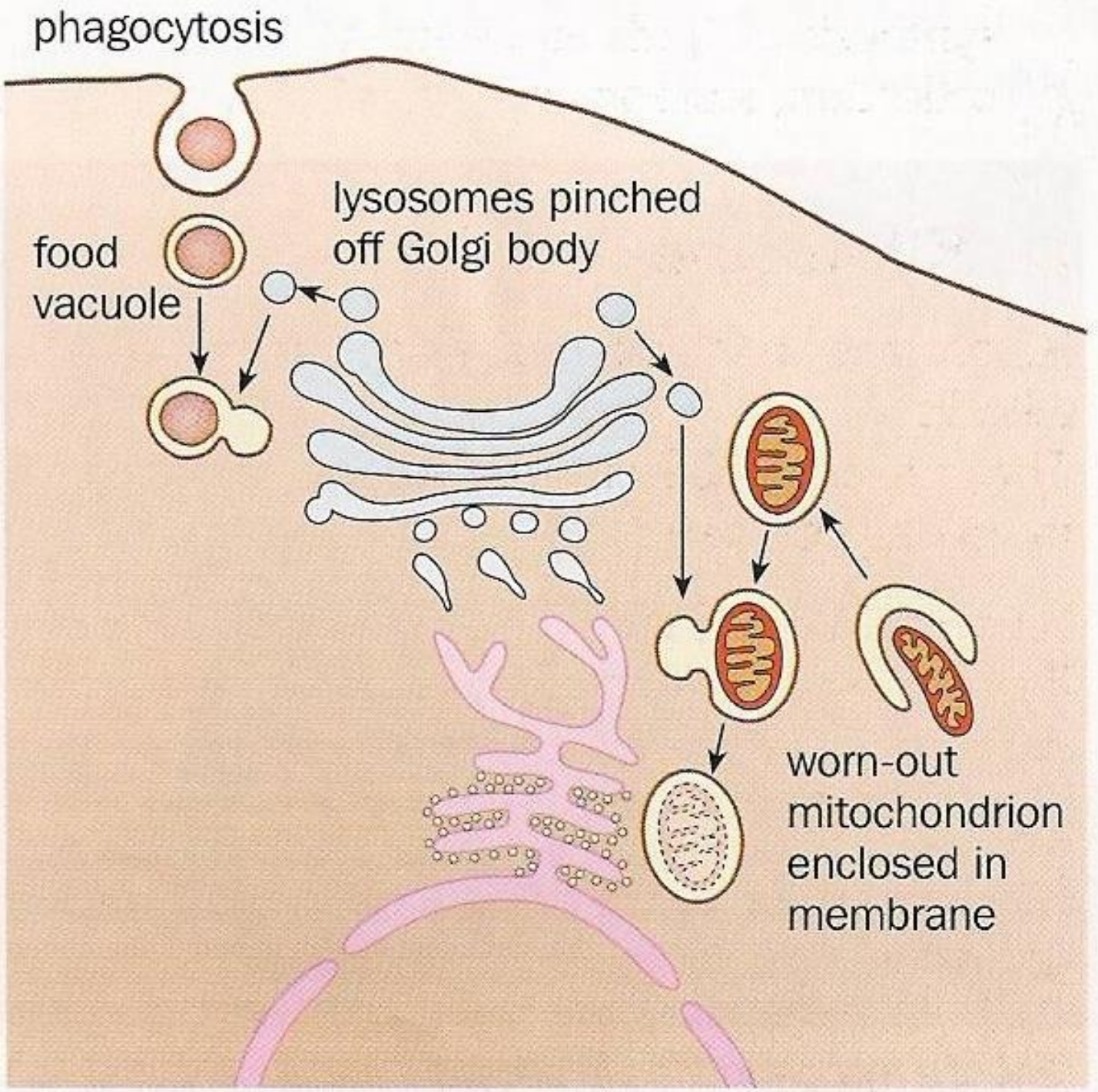
e.g glycoprotein.

- When a newly synthesised protein is released from the ER, it travels through the cytoplasm in a transport vesicle. When the vesicle reaches the Golgi it fuses with the (convex) forming face.
- In the main body of the Golgi the protein becomes modified and packaged into a secretory vesicle to be pinched off from the maturing face of the Golgi and exocytosed into the cytoplasm. From there, the vesicle moves to the cell membrane and the protein is released out of the cell.


incoming transport vesicle
cis face
cisternae
lumen
trans face
newly forming vesicle
secretory vesicle


Click on the Play Button to start the animation.

LYSOSOMES


phagocytosis
food vacuole
lysosomes pinched off Golgi body
worn-out mitochondrion enclosed in membrane

LYSOSOMES

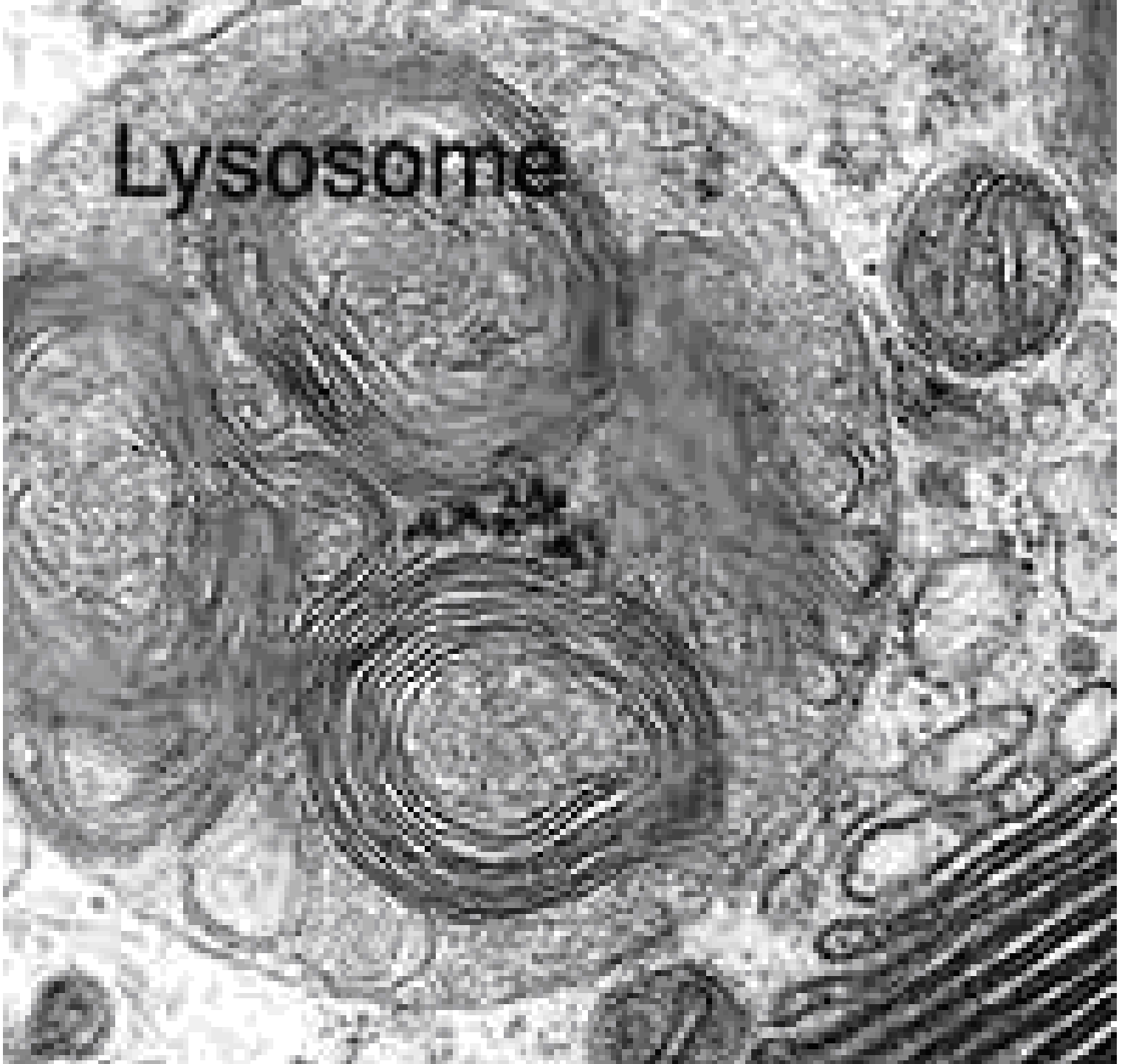
Location?
Cytoplasm

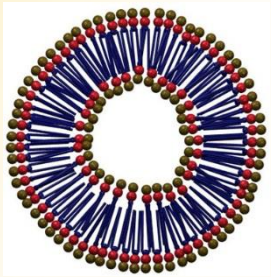
Structures?
Thick lipoprotein membrane
Hydrolytic Enzymes

Other Information?
- A thick membrane is necessary to insulate the enzymes from the rest of the cell because they would digest it
- Organic debris is removed by AUTOLYSIS

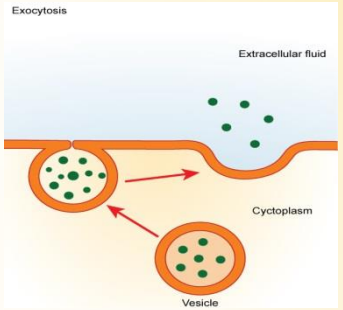
Functions?
- Fusion with other vesicles that contain organic debris (e.g. worn out cell organelles) to release digestive enzymes. Here they form secondary lysosomes.
- Important role in phagocytes, they digest engulfed bacteria in a phagosome
- Protect cell by destroying foreign bacteria/virus
- Destroying an old/ damaged cell by bursting

Links to other organelles?
- Lysosomes are formed by the Golgi apparatus
- Lysosomes have the ability to digest ANY organelle


Lysosome



Vesicles



Structure

Vesicles are small structures within a cell that contain fluids and are bound by a single membrane.
Lysosomes are vesicles produced by the Golgi Apparatus (contain hydrolytic enzymes)

Function

- **Vesicles are used for storage and transport of substances.**
- **They 'pinch off' newly synthesised primary proteins from RER and transport it to the Golgi apparatus where it fuses with the forming face to allow protein modification.**
- **<u>Secretory</u> Vesicles then transport the modified protein from the concave face of the Golgi to the cell surface membrane. Here they fuse to release the contents outside the cell.**
- **Lysosomes combine with vesicles to destroy whatever it contains (worn out cell organelles etc)**

IMPORTANT: ER, RER AND GOLGI SUMMARY

Describe the role of ER and the Golgi apparatus in the creation of a protein enclosed within an organelle.

[5]

Tip Students often confuse secretory vesicles and lysosomes. The Golgi apparatus produces *both*. However, their roles are quite distinct. Secretory vesicles are moved to the cell surface membrane and their contents are exocytosed (see p. 55). Lysosomes remain in the cell where they are involved in intracellular digestion (see Figure 34).

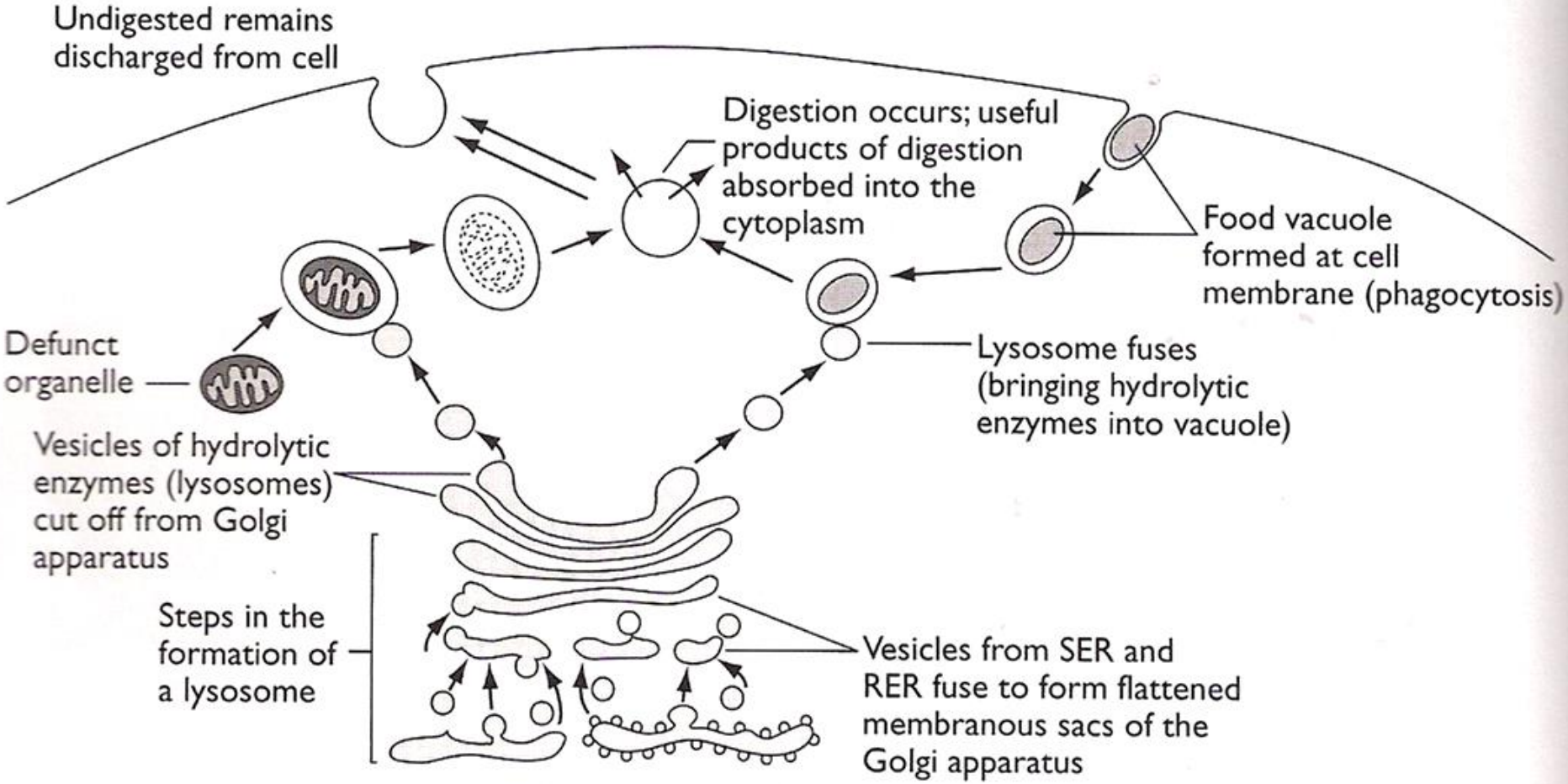
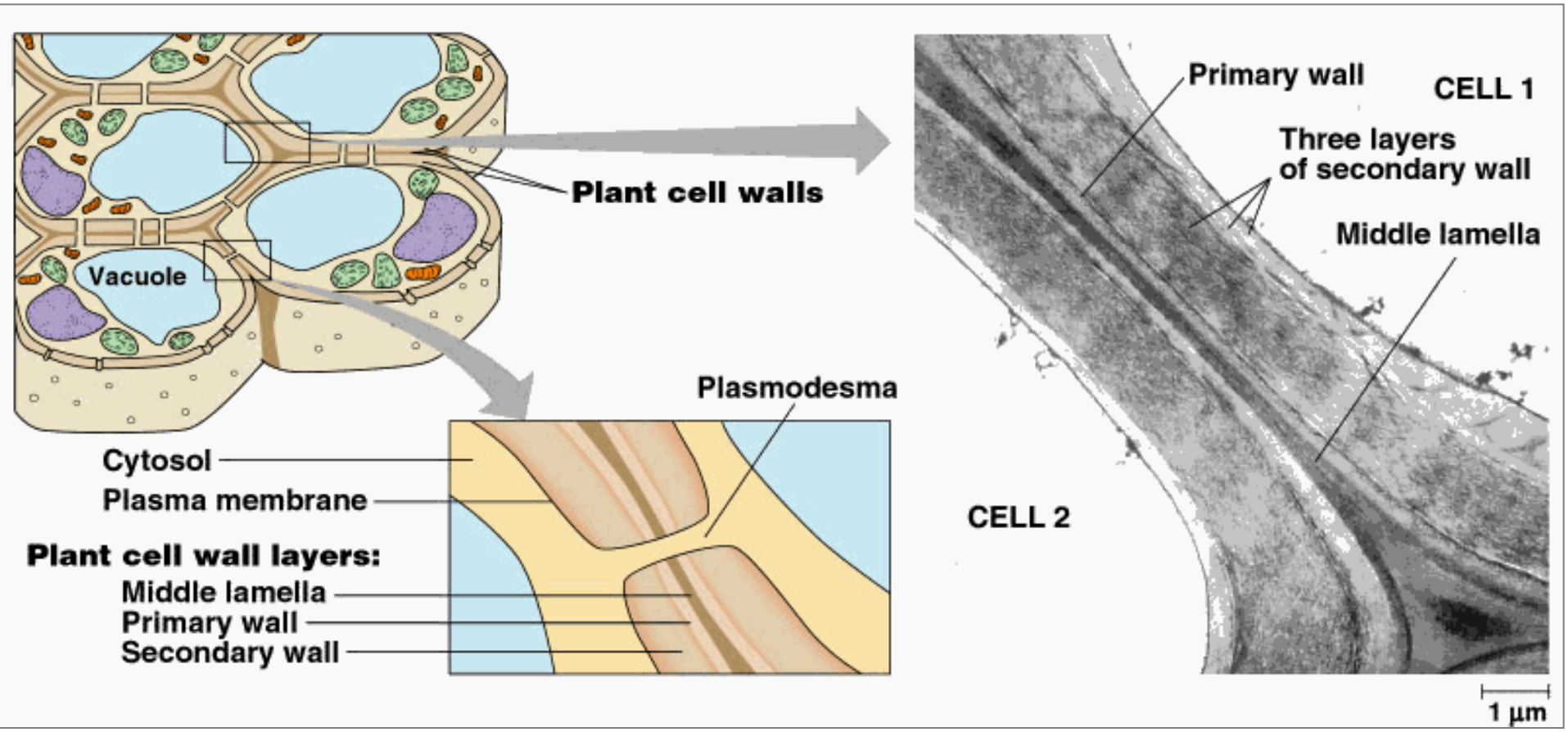
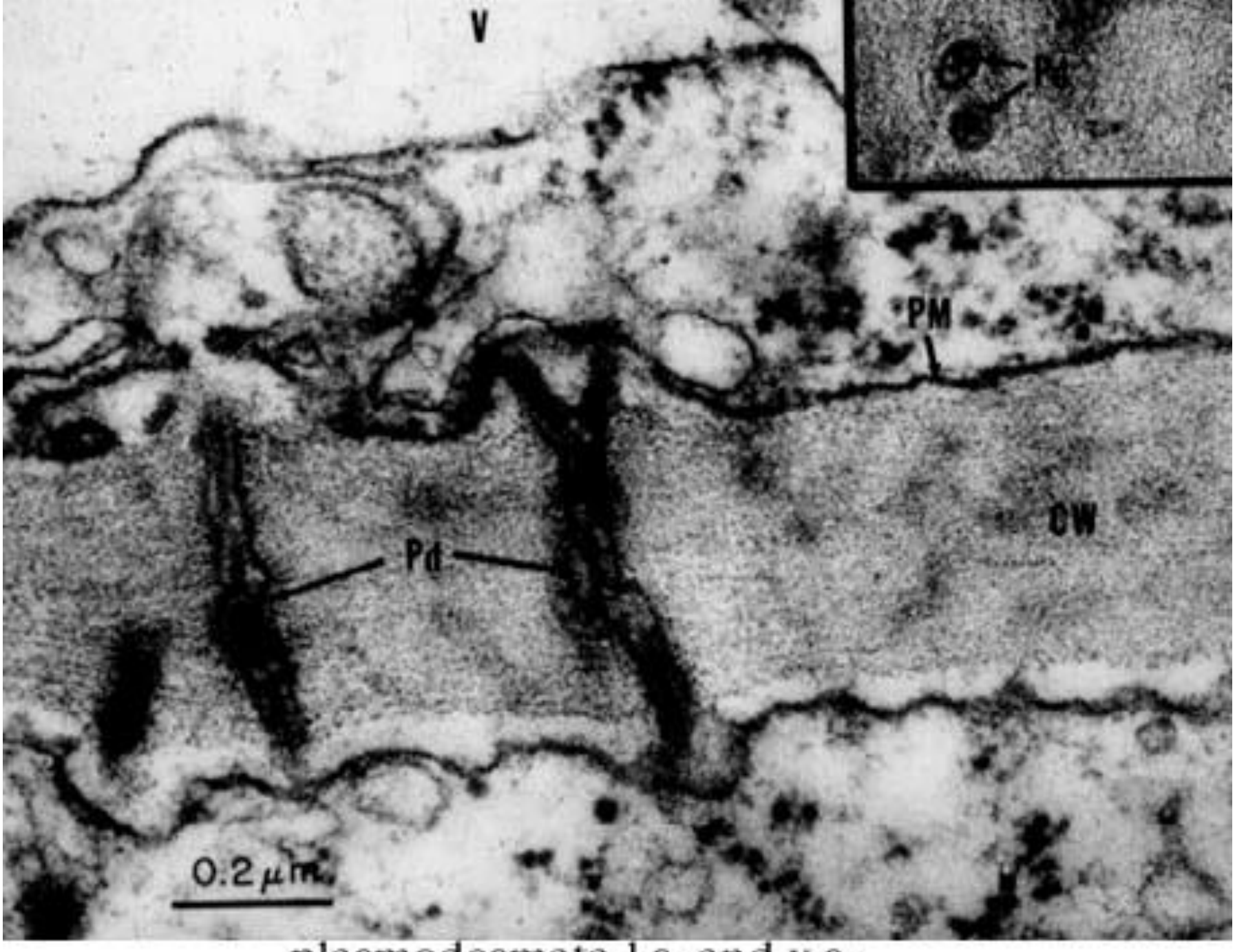


Figure 34 The role of lysosomes

PLASMODESMATA



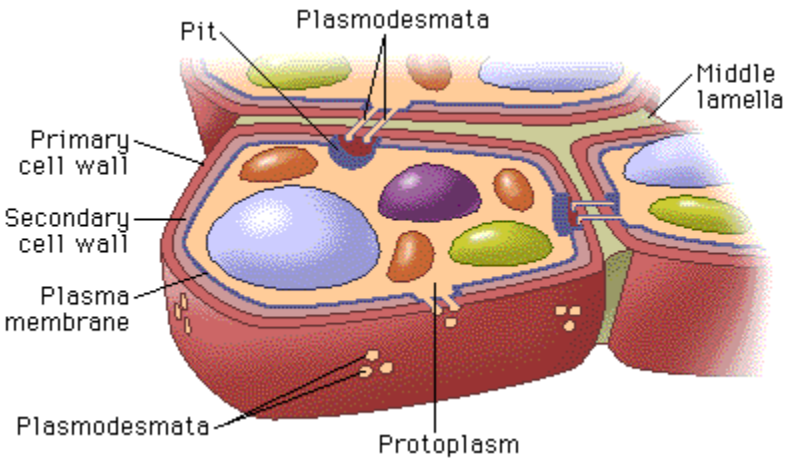


plasmodesmata-l.s. and x.s.

Plasmodesmata

Plasmodesmata are strands of cytoplasm that extend between neighbouring plant cells

Link to other organelles- Plasmodesmata link other cells as they are gaps in the cell wall



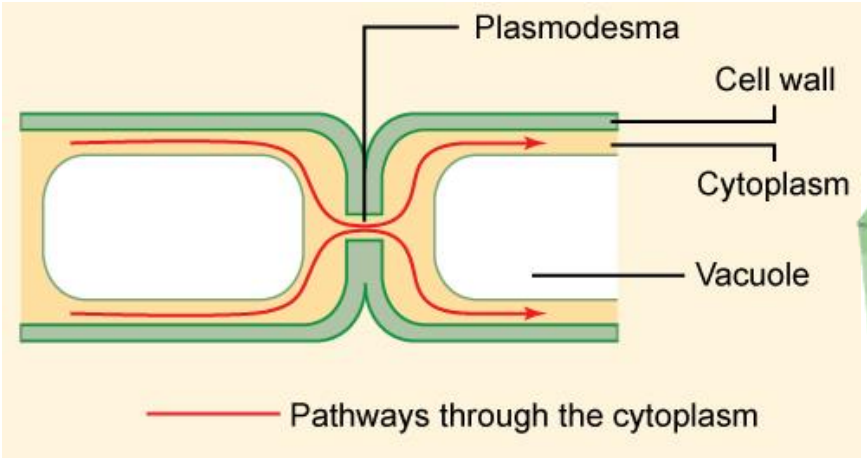
Function-

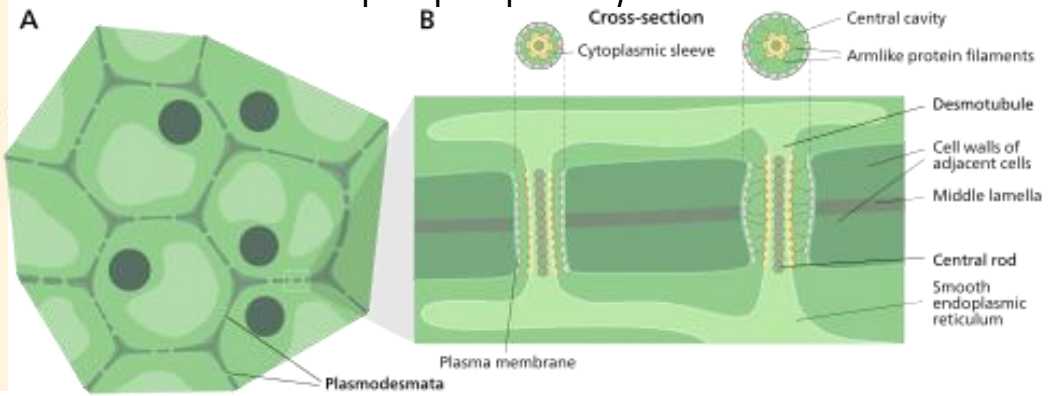
Plasmodesmata provide 'gaps' in the cell walls of adjacent cells that enable different kinds of molecules to pass through. As the cell membranes of the cells beside pass through the pores, the neighbouring cells are joined, physically and metabolically.

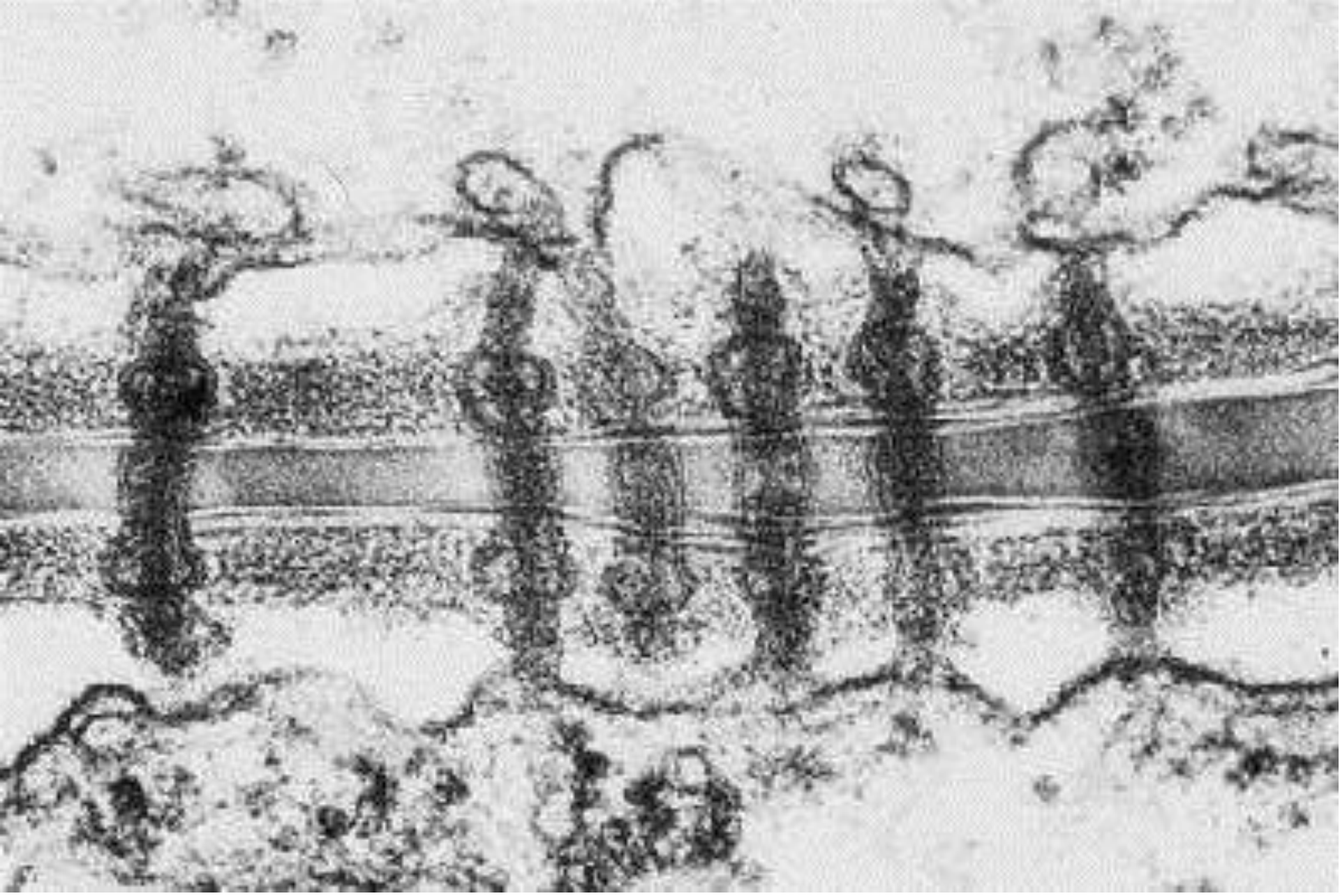
Structures-

A typical plant cell will have between 10^3 and 10^5 plasmodesmata connecting it with neighbouring cells equalling up to between 1 and 10 per μm^2. Plasmodesmata are roughly 50-60 nm in diameter at the midpoint and is made up of three main layers, the plasma membrane, the cytoplasmic sleeve, and the desmotubule. The plasma membrane part of the plasmodesma is a continuous extension of the cell membrane, as it has a similar phospholipid bilayer structure

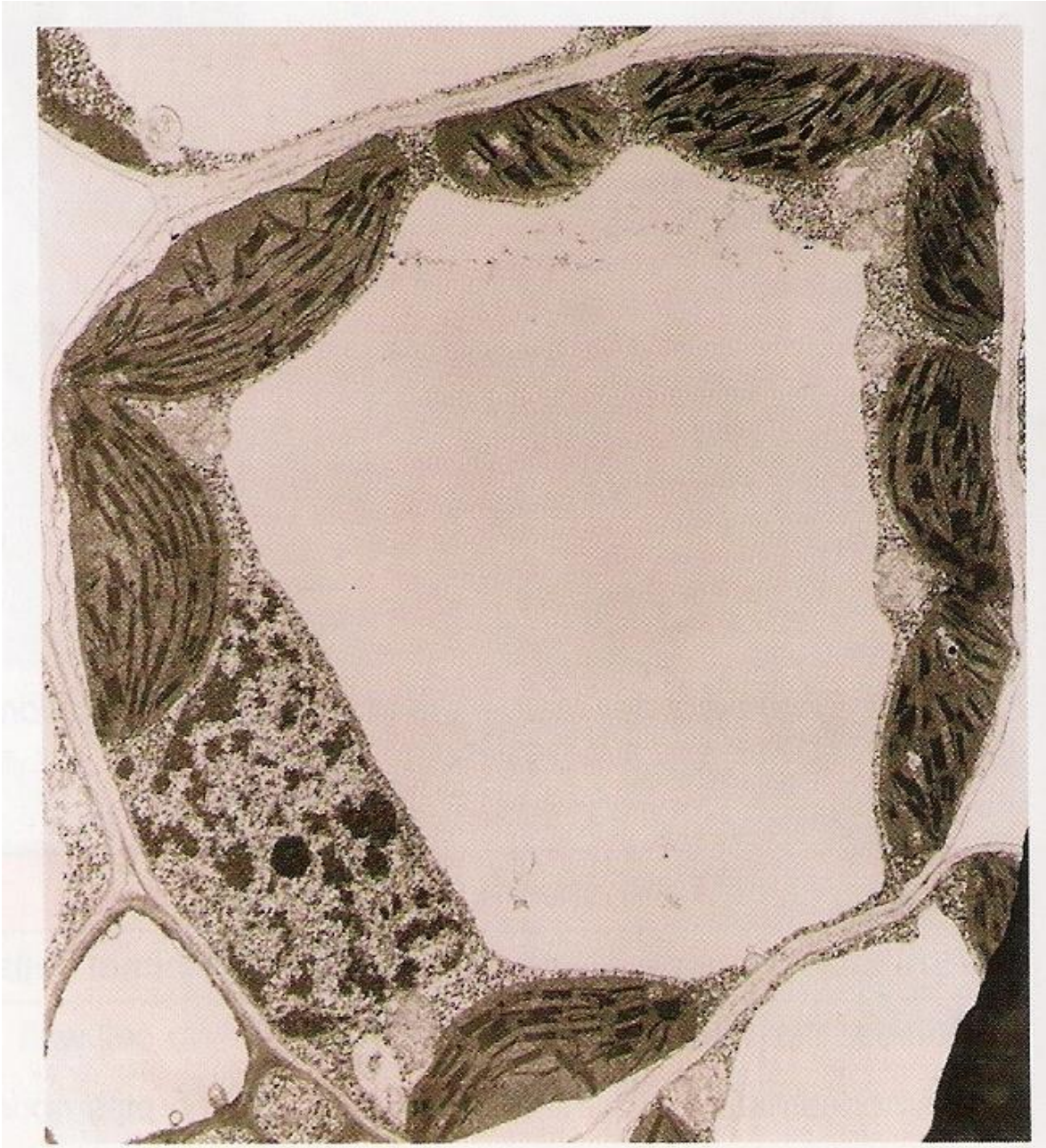
Location- In the plant cell







VACUOLE



In this mature plant cell, the vacuole, bounded by the tonoplast takes up most of the cell volume

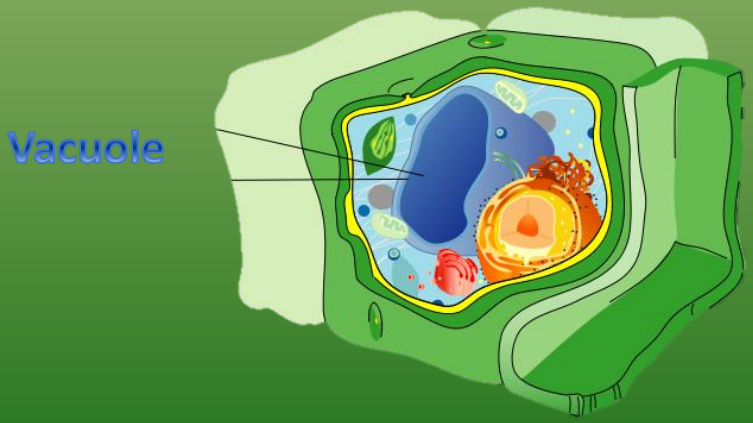
Large permanent vacuole

Location: Located in the cytoplasm of the plant cell.

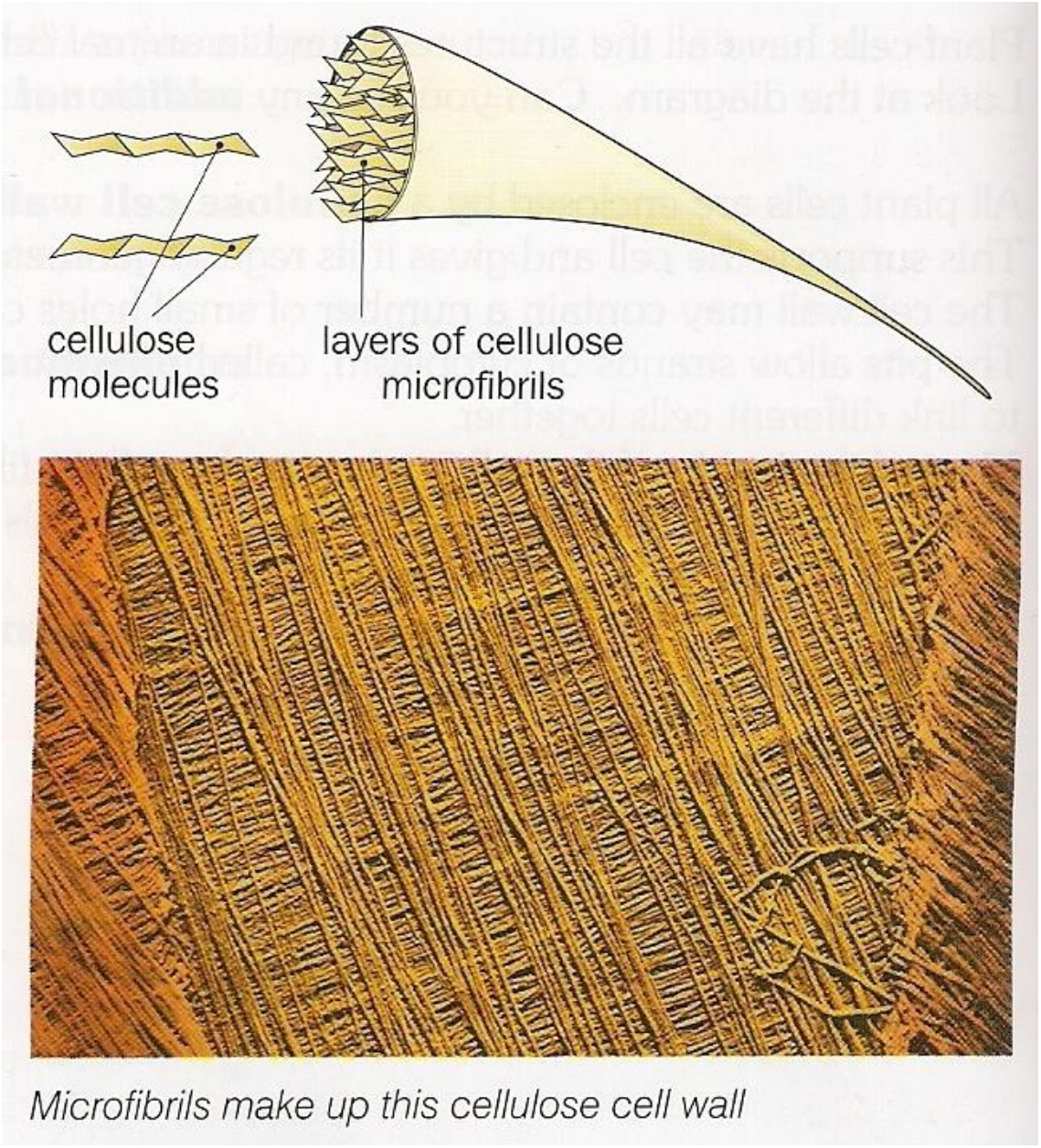
Function: It plays an important role in storing ions and water, and provides tugor pressure for support.

Links: The waste products generated in cells are accumulated in vacuoles. Thus, vacuoles protect other organelles of the cell from harmful effects of wastes.

Structure:



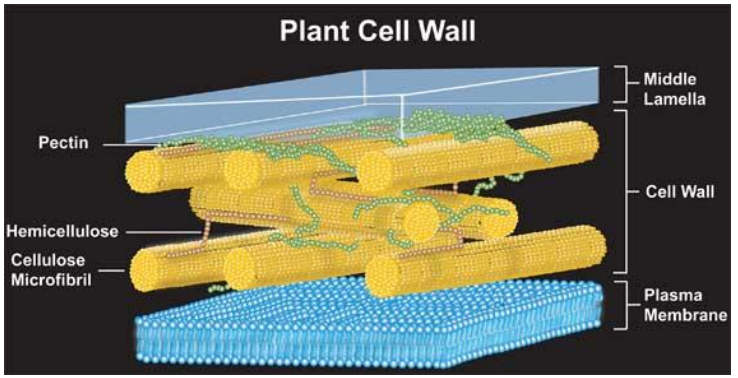
Cell Wall



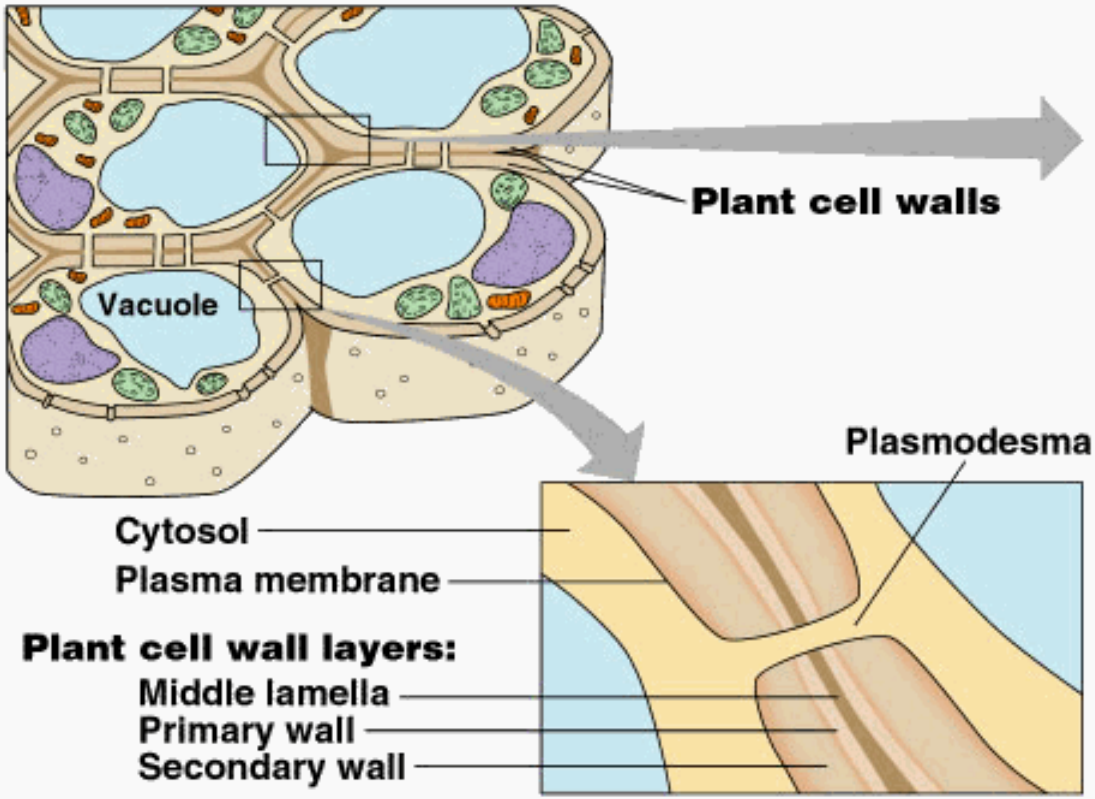
Microfibrils make up this cellulose cell wall

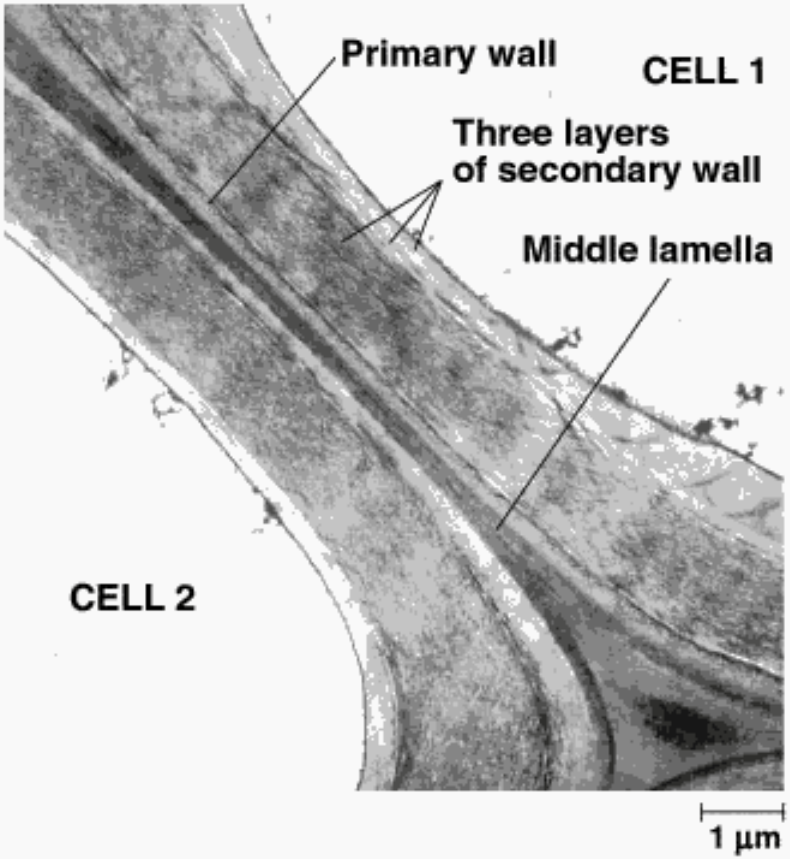
Cell Wall

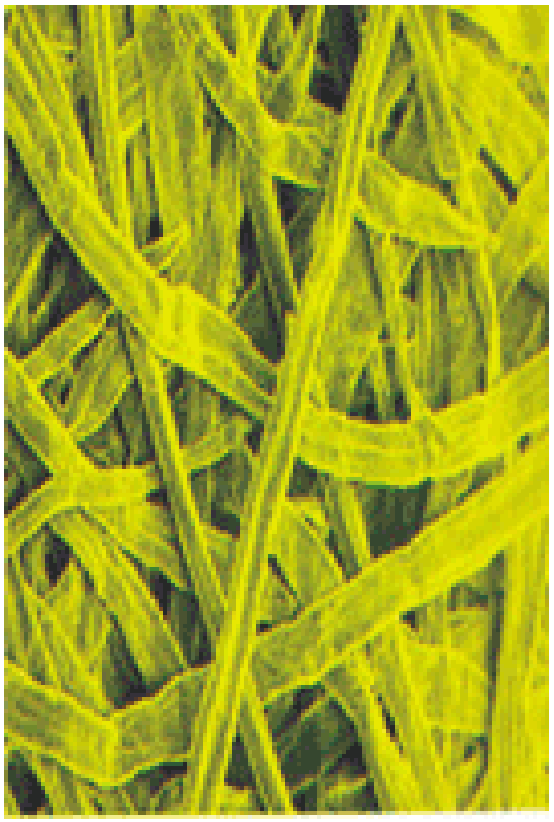
- Location: lies immediately outside the cell-surface membrane
- Structure: main component of plant cell walls is the polysaccharide cellulose, which is laid down in microfibrils. These microfibrils consist of many cellulose molecules cross linked to each other. The primary cell wall is made up of many microfibrils orientated in different and random directions. The secondary cell wall is formed when the cell reaches full size. The microfibrils here are orientated in the same direction and additional layers are orientated in the same direction- lattice type arrangement. Cell walls or adjacent cells are linked by the middle lamella, largely made up of polysaccharides called pectin. Calcium pectate forms a gel holding neighbouring cells together.
- Function: PROVIDE SUPPORT-restrict outward expansion of cell content (protoplast) as the cell takes in water, providing the supporting force against turgor pressure. FULLY PERMEABLE.
- Links: plasmodesmata



Plant cell wall







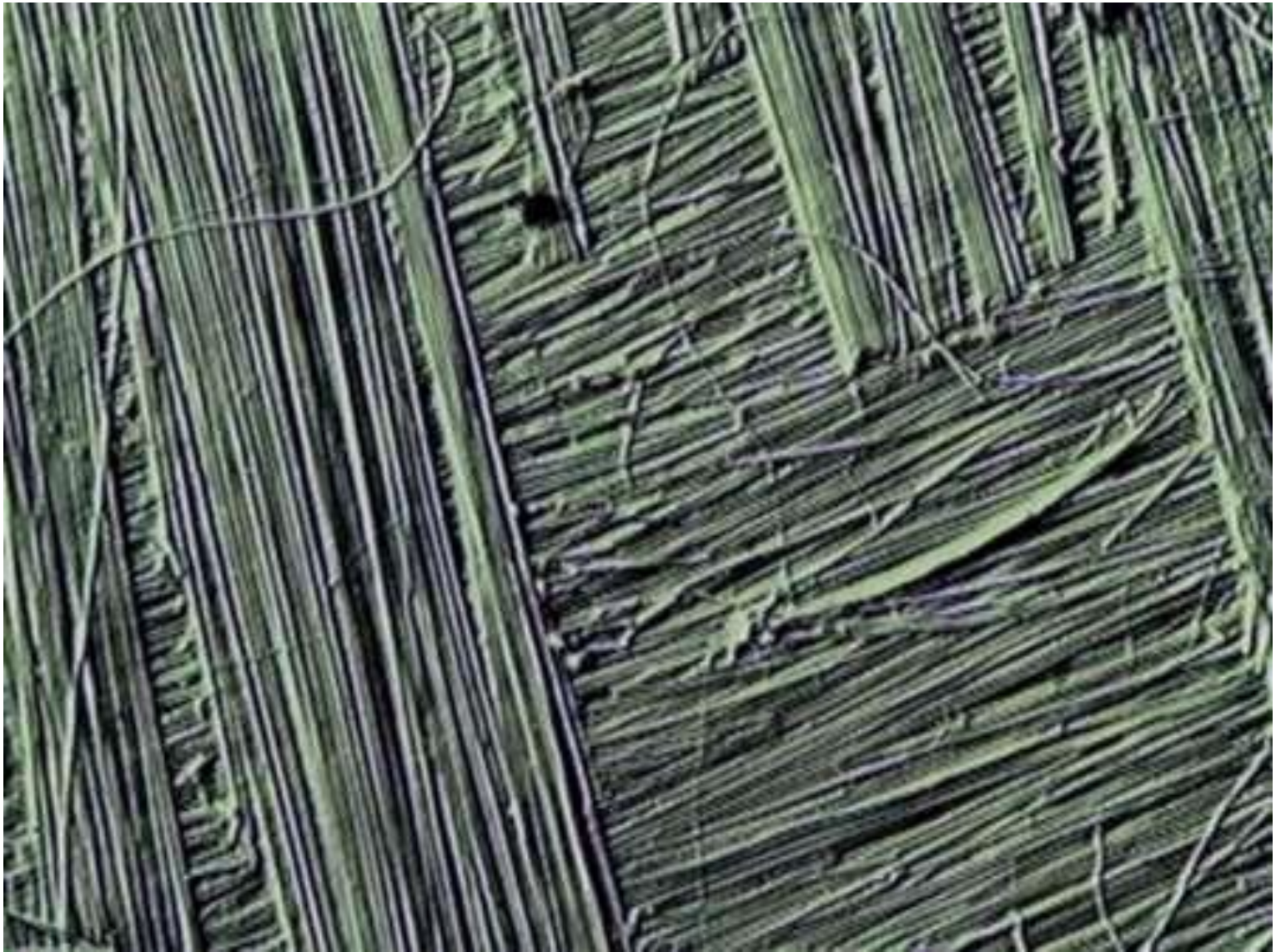
(a) Cellulose fibres

(b) Macrofibril

(c) Microfibril

(d) Chains of cellulose molecules

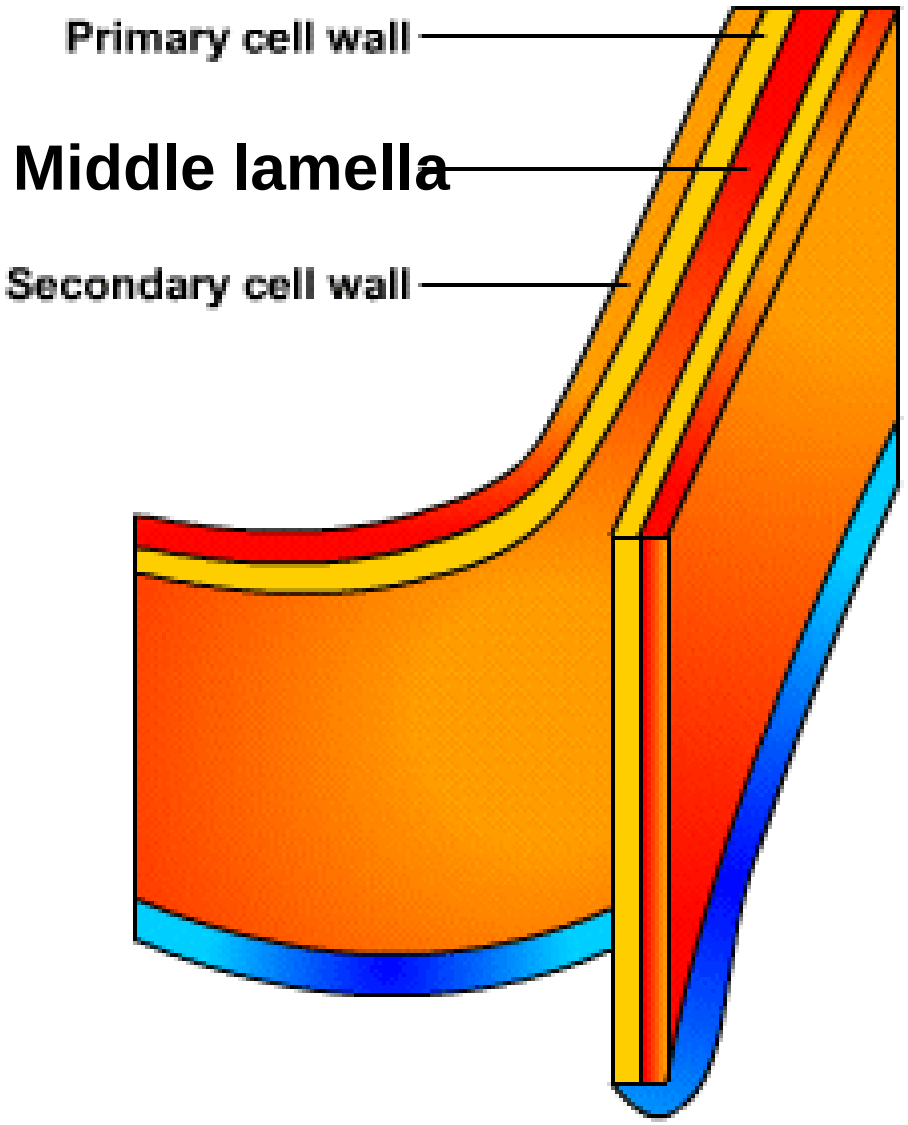
Photomicrograph of microfibrils that make up the cell wall surface:

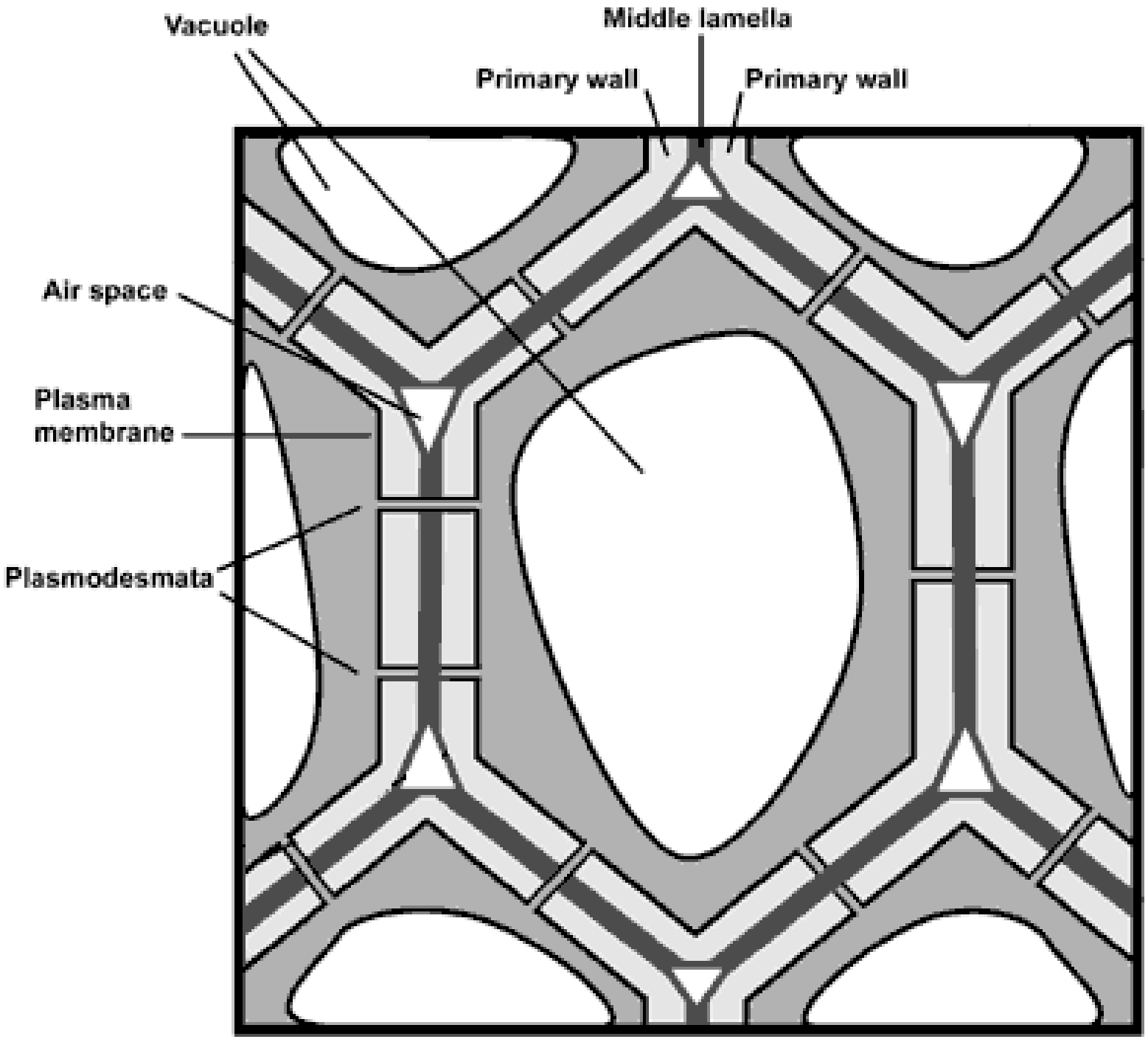


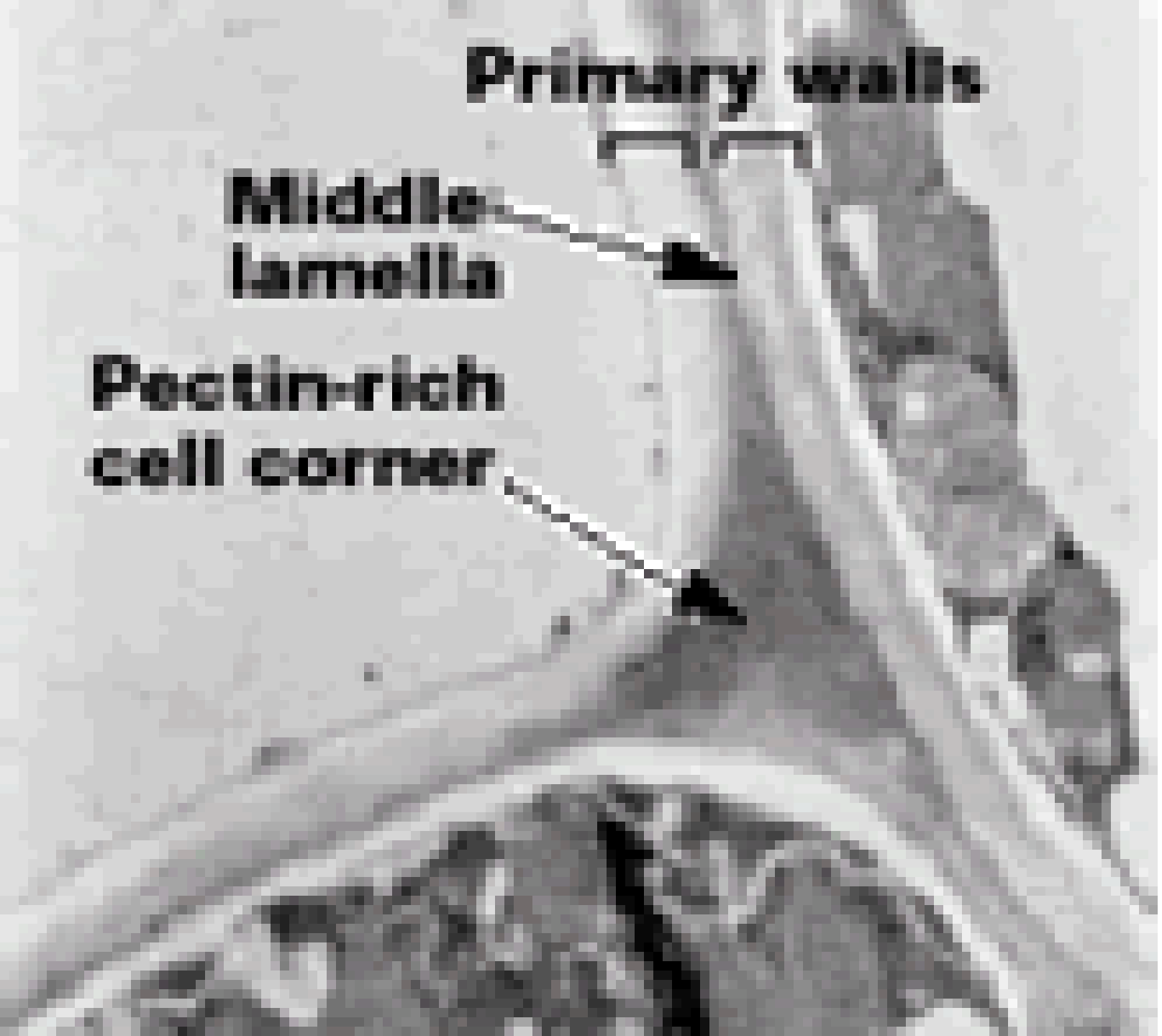
Cell walls of adjacent cells are linked together by a sticky polysaccharide called **pectin**.

Composed of **calcium pectate,** this forms the **middle lamella** which cements the cells together.

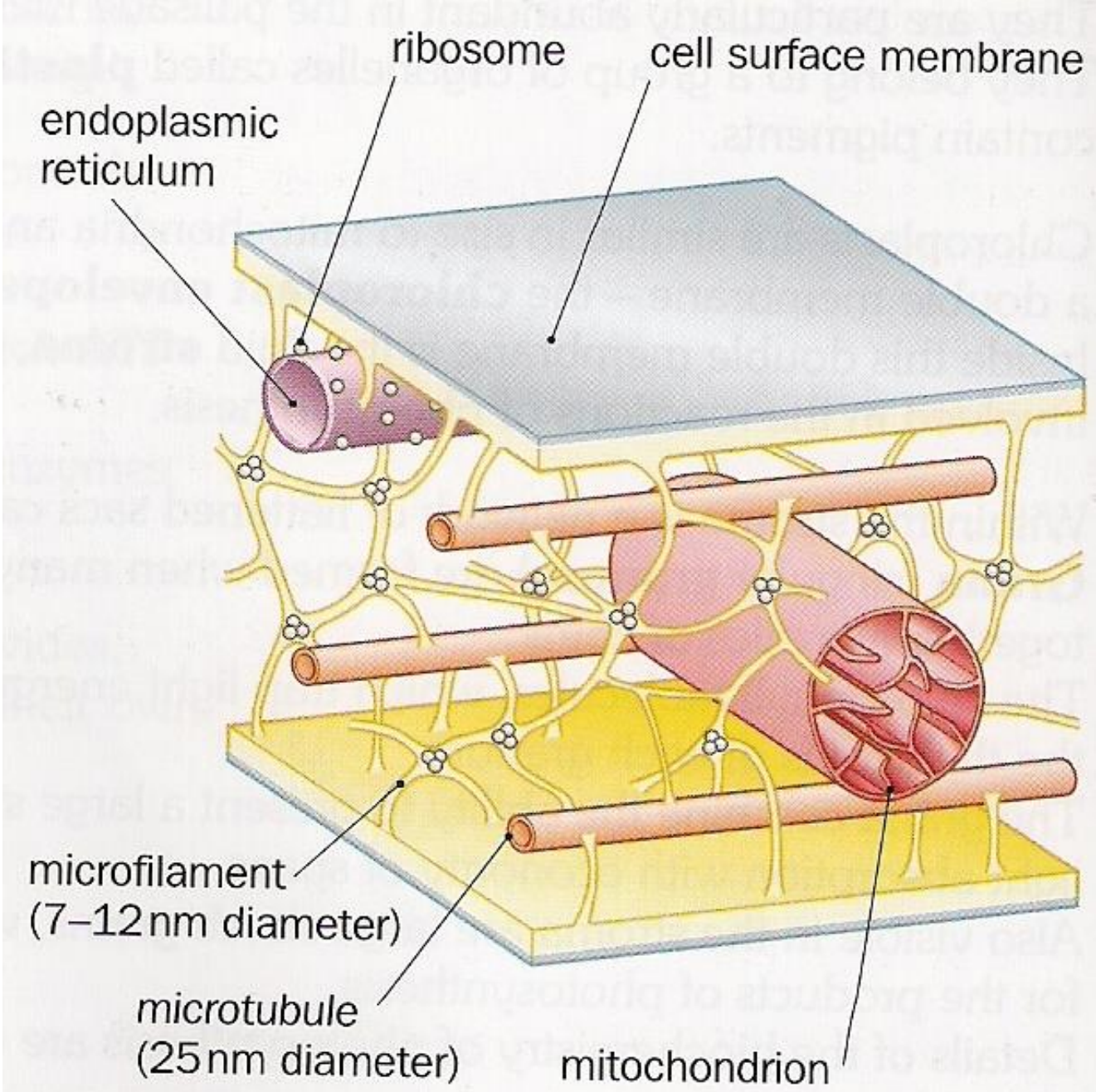
REMEMBER: Adjacent plant cells are physically and metabolically linked through their plasmodesmata




Vacuole
Middle lamella
Primary wall
Primary wall
Air space
Plasma membrane
Plasmodesmata

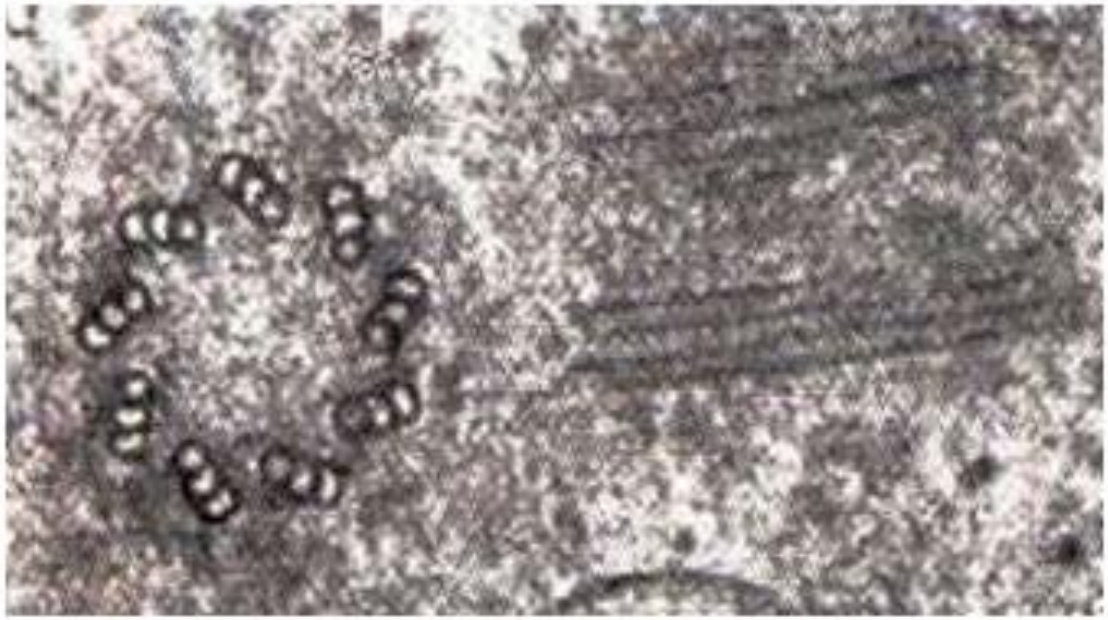

Primary walls
Middle lamella
Pectin-rich cell corner

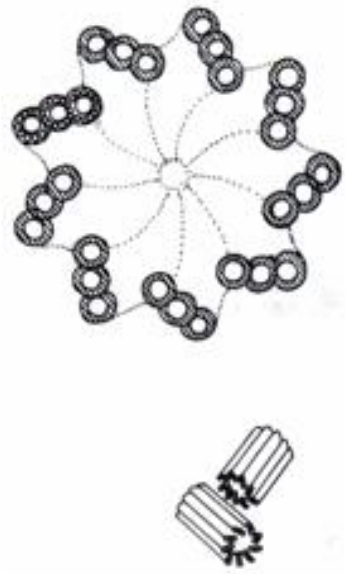
MICROTUBULES

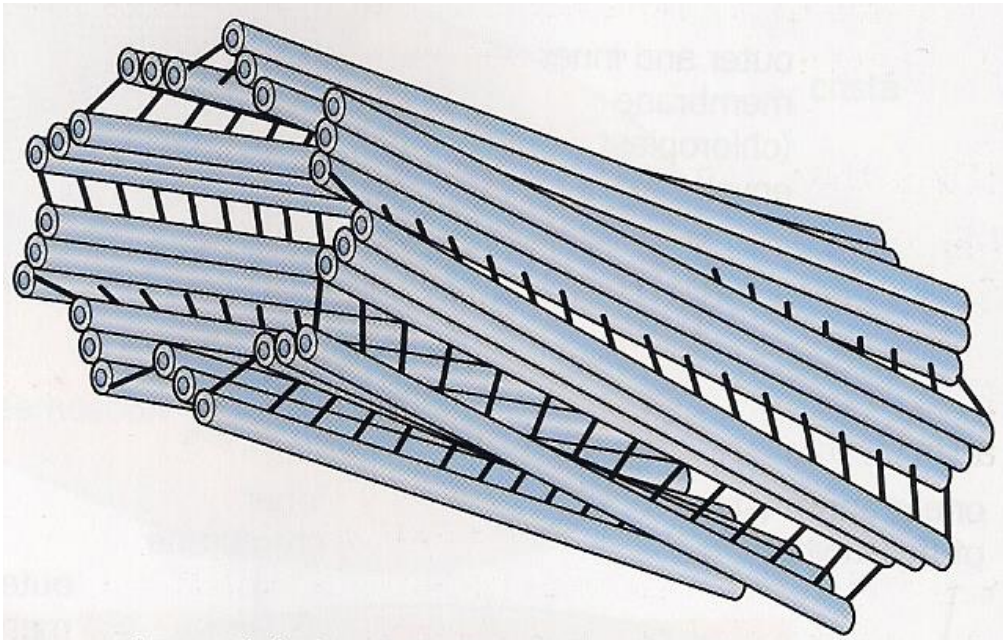


The cytoskeleton has a complex 3-D framework

Above and side view of centrioles:







A centriole is a bundle of microtubules

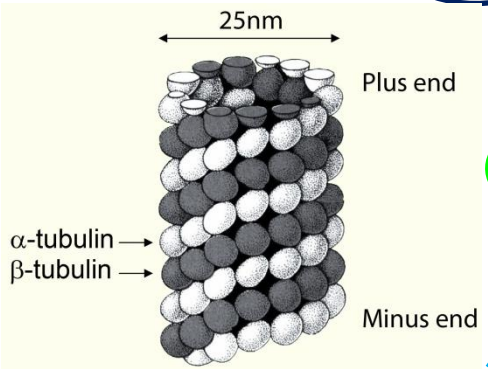
Microtubules and Centrioles.

Microtubules: Hollow cylinders formed from a protein called Tubulin.

Length: Up to 10μm

Concentrated in specific areas for specific functions.

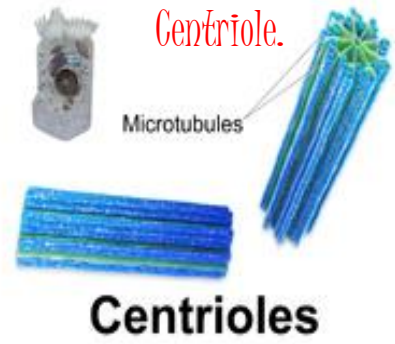
Microtubule.



Found: Within Centrioles as 9 triplets in a circular formation, throughout the Cytoplasm.

Diameter: 25nm

Form part of cytoskeleton

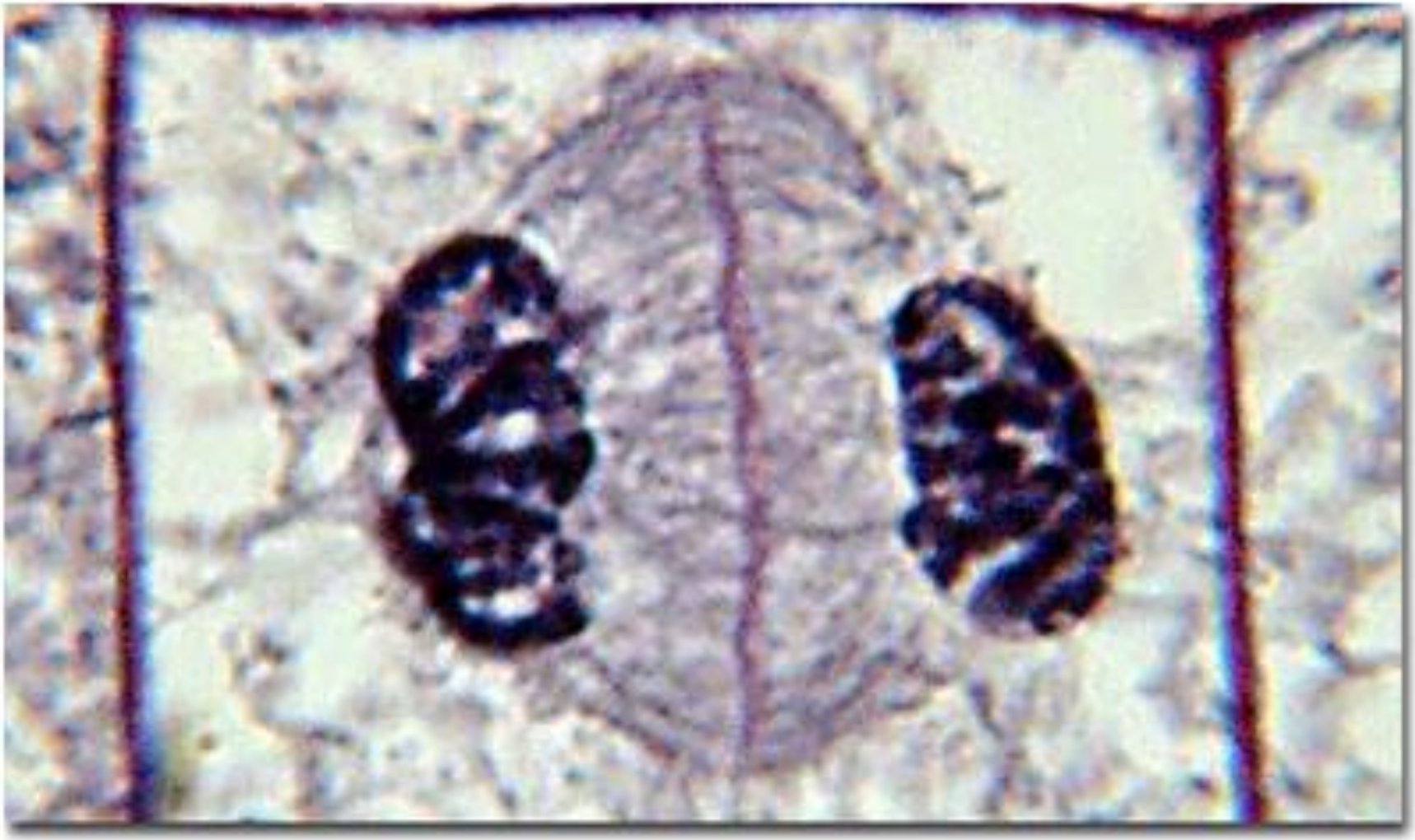


Form spindle fibres during cell division.

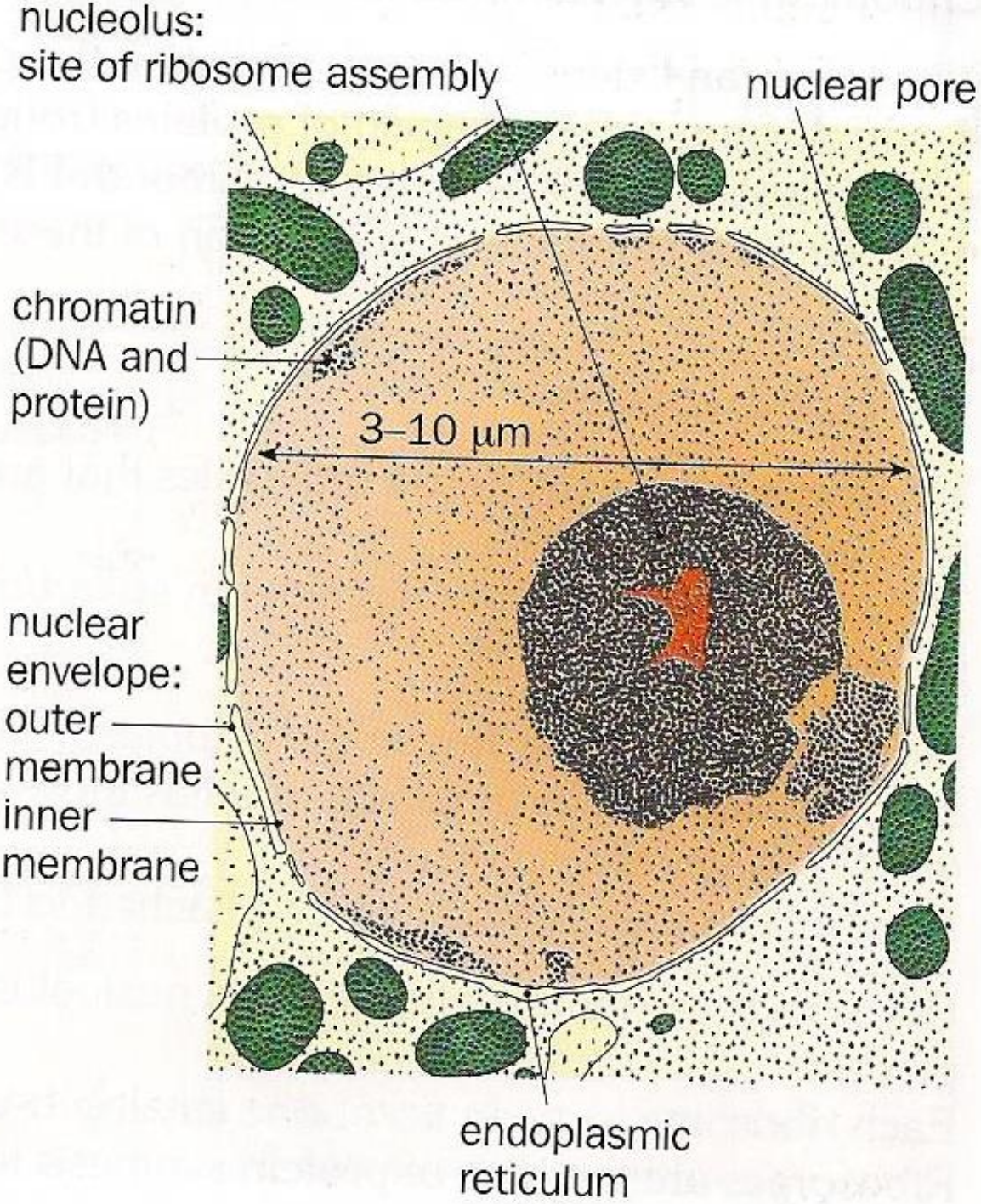
Allow movement of cell organelles.

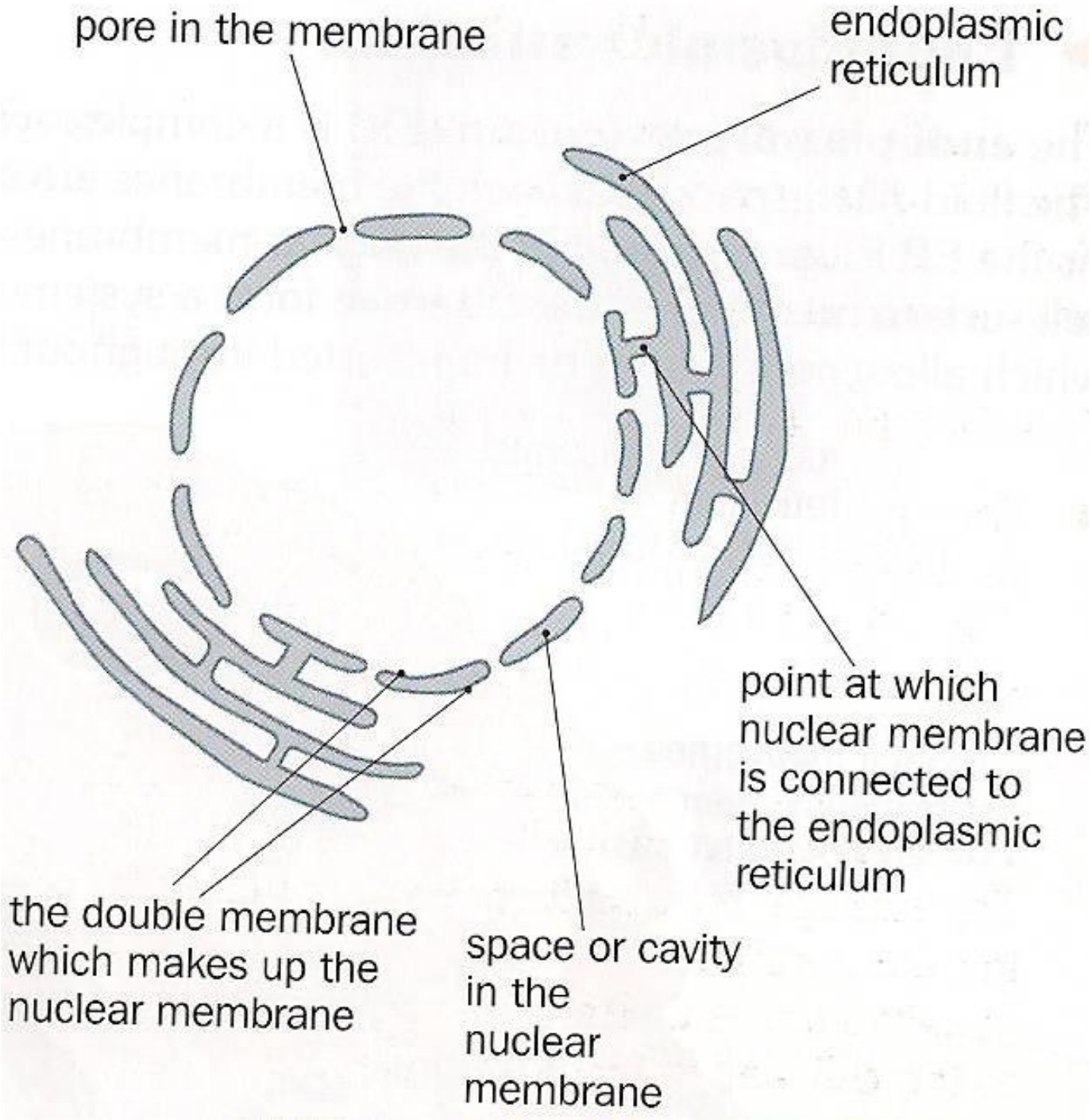
Centrioles: Animal and Fungal cells.

Chromosomes lined up on spindle fibres during cell division:



NUCLEUS


nucleolus:
site of ribosome assembly
nuclear pore
chromatin
(DNA and
protein)
3–10 μm
nuclear
envelope:
outer
membrane
inner
membrane
endoplasmic
reticulum


pore in the membrane
endoplasmic reticulum
point at which nuclear membrane is connected to the endoplasmic reticulum
the double membrane which makes up the nuclear membrane
space or cavity in the nuclear membrane

NUCLEUS

A nucleolus synthesis ribosomal RNA (rRNA) makes ribosomes, which are the component essential in process of protein synthesis.

The nucleus often contains one or more nucleoli, under the microscope this appears even darker than densely packed heterochromatin and is more discrete in structure that the more diffuse heterochromatin, often concentrated close to the nuclear membrane.

Chromatin

When cells are not dividing the chromosomes are not visible but are more diffusely organised in a form called chromatin.

In parts of the nucleus, the chromatin is more densely packed (heterochromatin), appearing dark when viewed by electron microscope.

In other parts, it is less densely packed (euchromatin), and therefore appears lighter when viewed.

It is the largest and most obvious organelle in most cells.

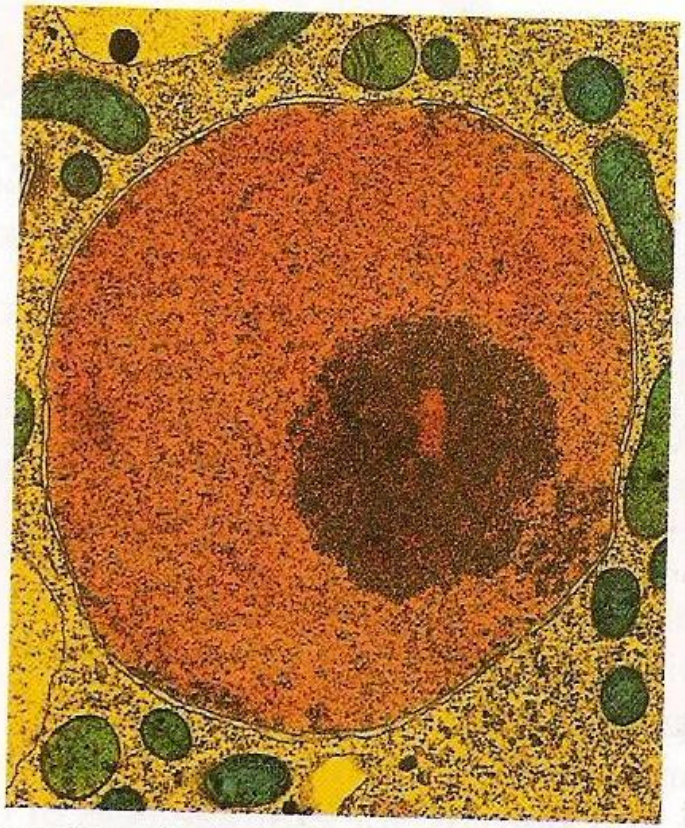
Nucleus contains DNA in chromosomes

Control centre of the cell, as the DNA in chromosomes codes for the synthesis of proteins in cytoplasm.

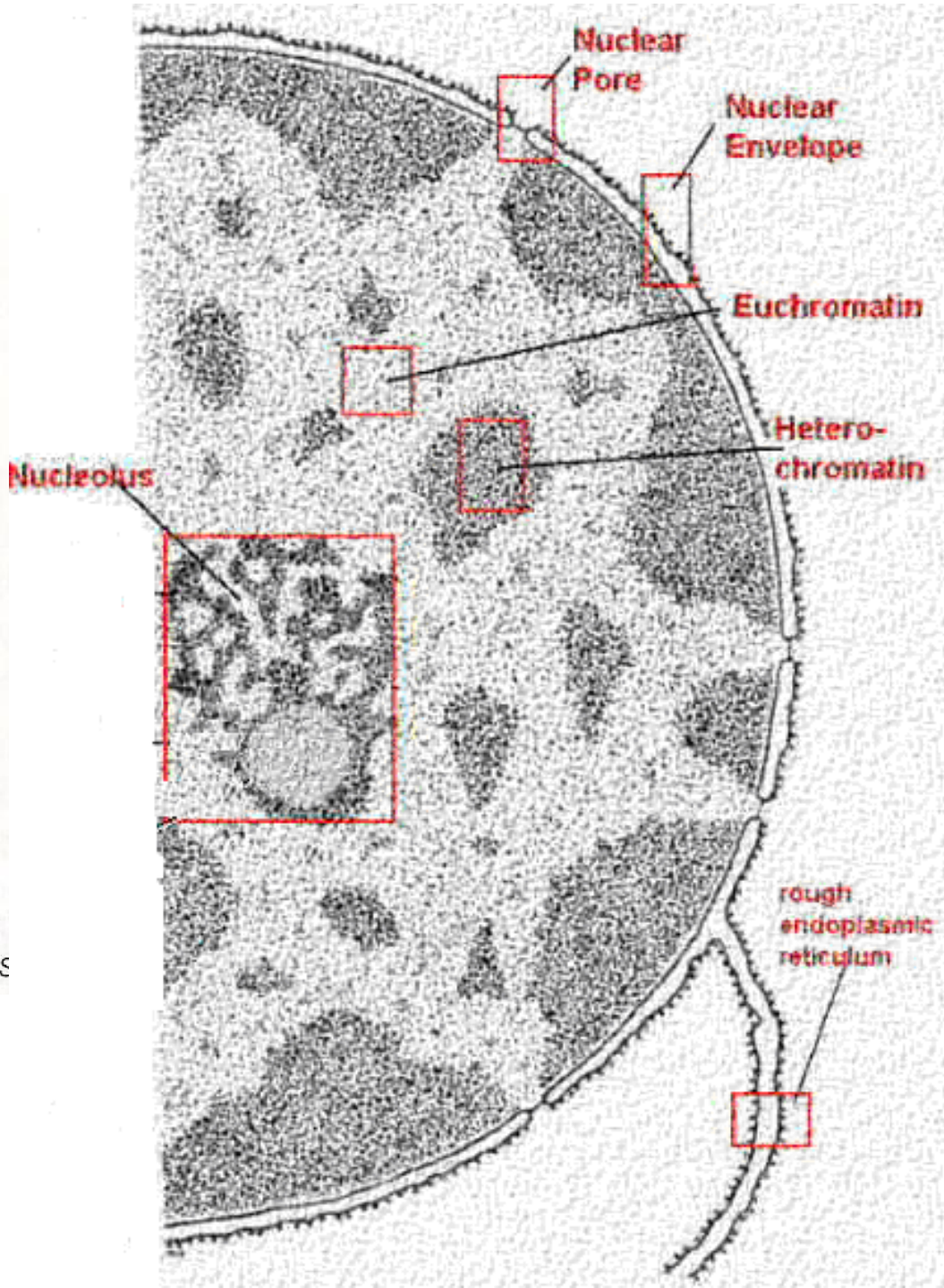
The chromosomes in nucleus are isolated so that the DNA are safe from damage.

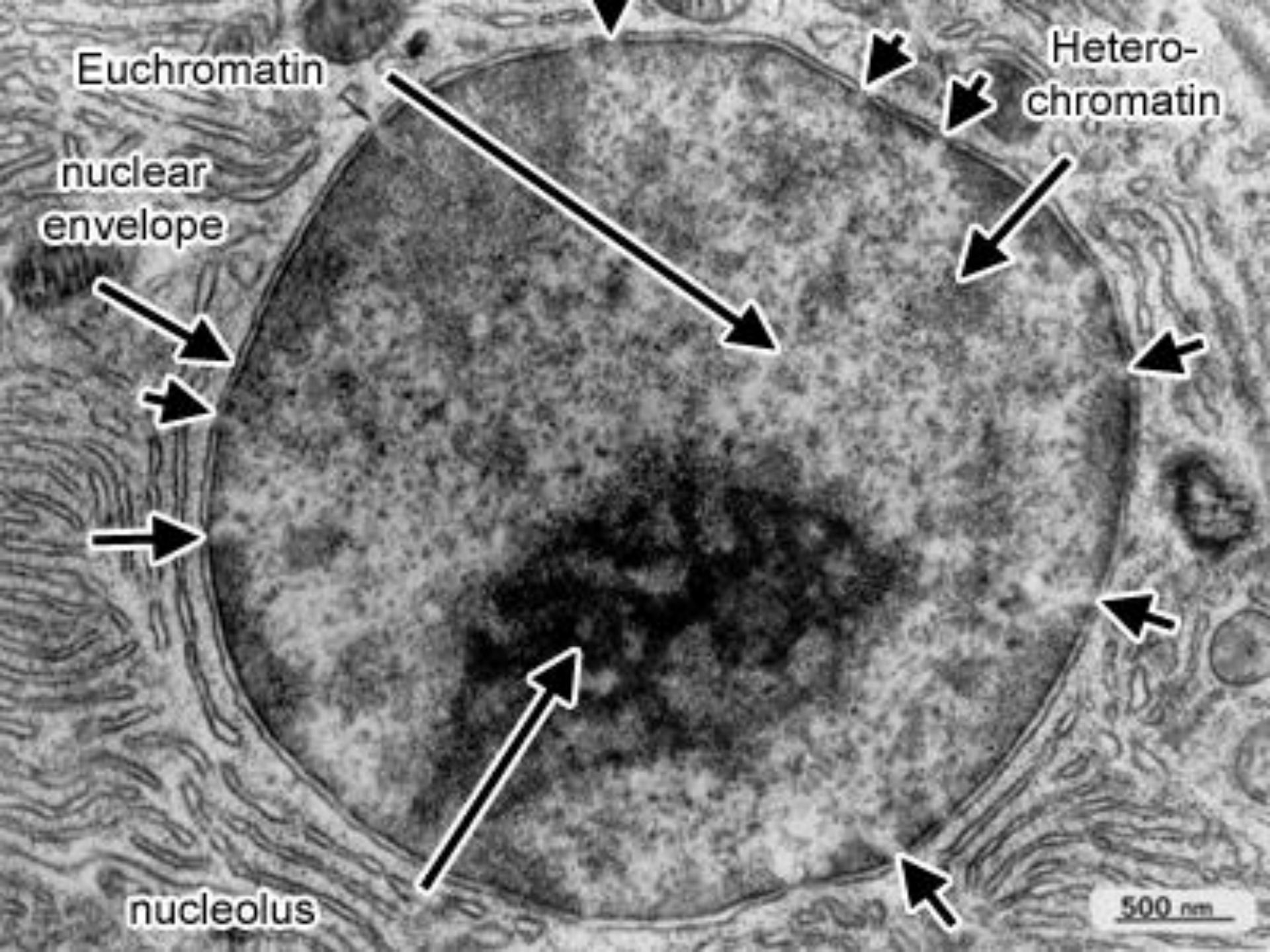
The DNA code for protein synthesis needs to be taken from the safety of the nucleus to the cytoplasm. This is achieved by the presence of nuclear pores in the nuclear envelope (membrane).

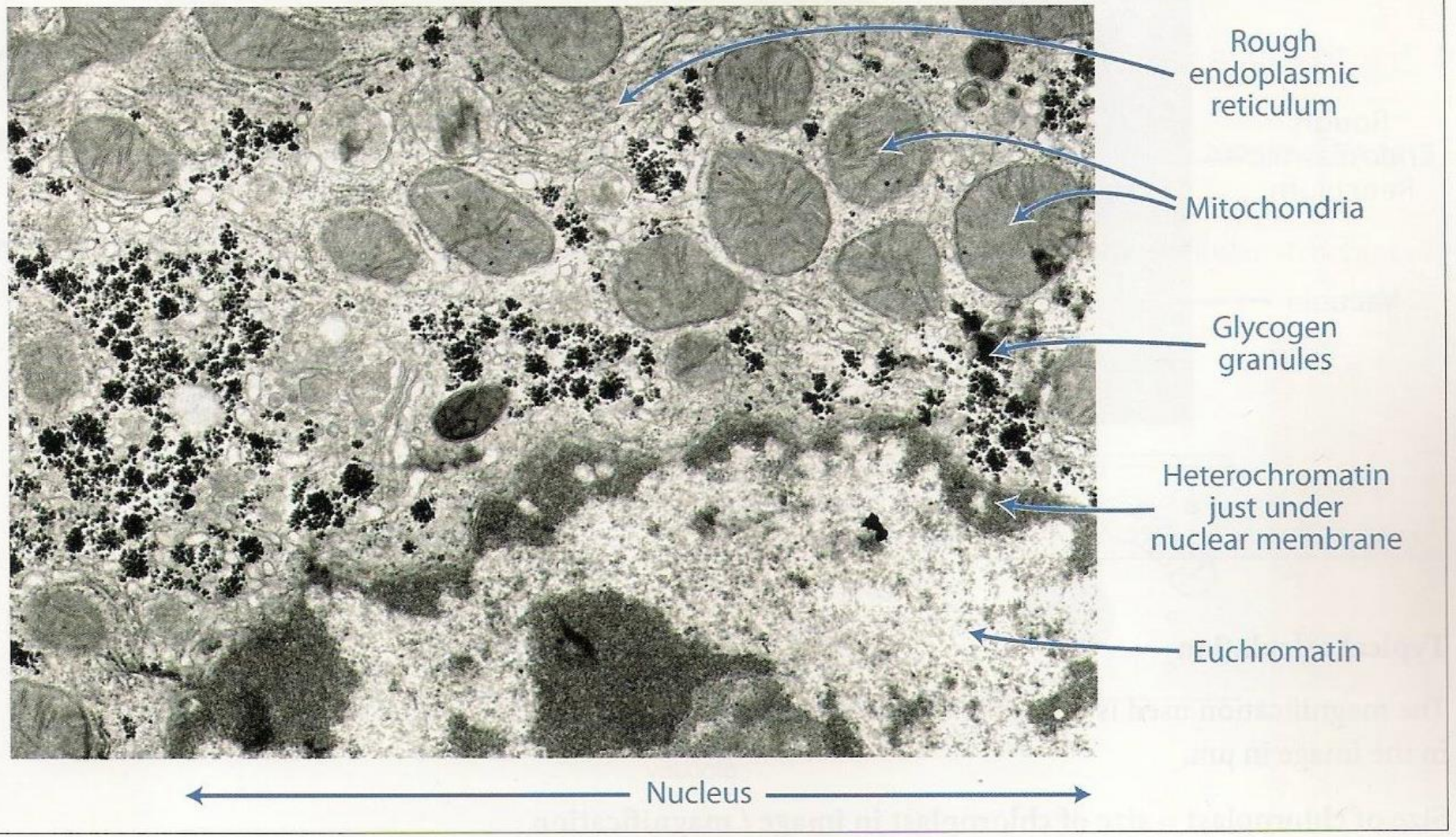
The nuclear envelope is a double membrane with very narrow space between each membrane.



A false colour electron micrograph of a cell nucleus




Euchromatin
Hetero-
chromatin
nuclear
envelope
nucleolus
500 nm


Rough endoplasmic reticulum
Mitochondria
Glycogen granules
Heterochromatin just under nuclear membrane
Euchromatin
Nucleus

Liver cell

This TEM image of a liver cell shows many of the features of animal cells you need to know. The level of detail of the cell ultrastructure suggests a high magnification is involved and absence of a 3-D appearance suggests that this is a TEM as opposed to a SEM electron micrograph.

As is expected with liver cells, there are numerous glycogen granules and the high density of mitochondria suggests that this cell has a high rate of metabolic activity. Many of the mitochondria are transverse sections (TS) as opposed to longitudinal (LS) sections and are therefore round in appearance as opposed to the more characteristic 'bean' shape.

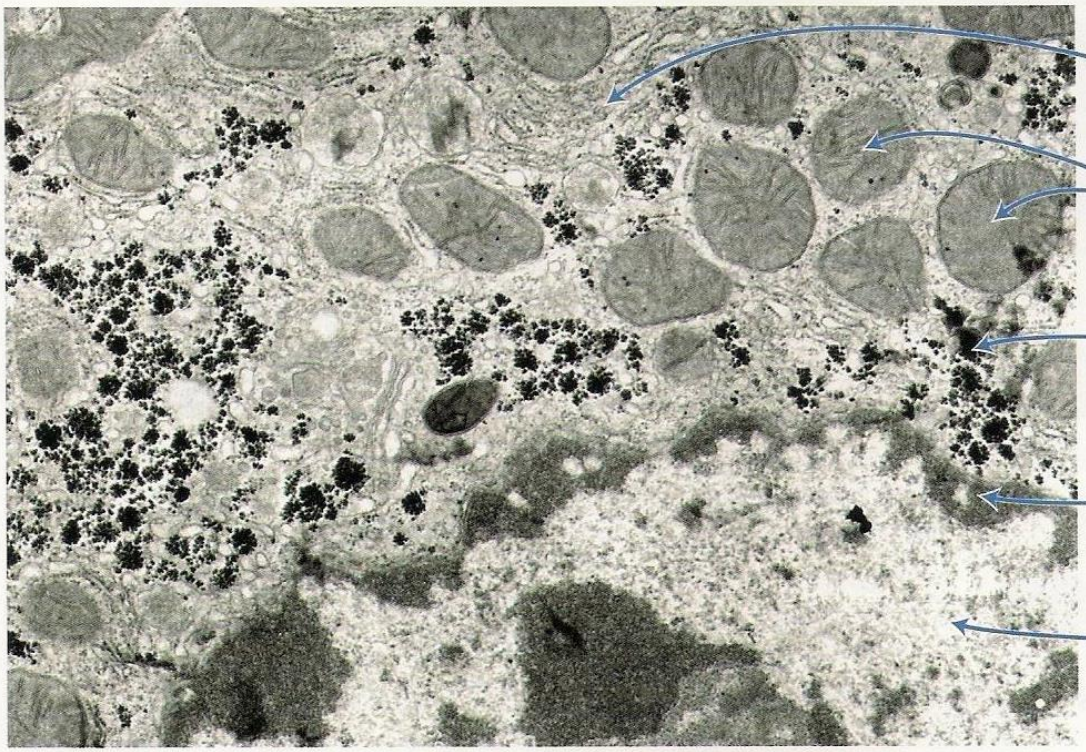


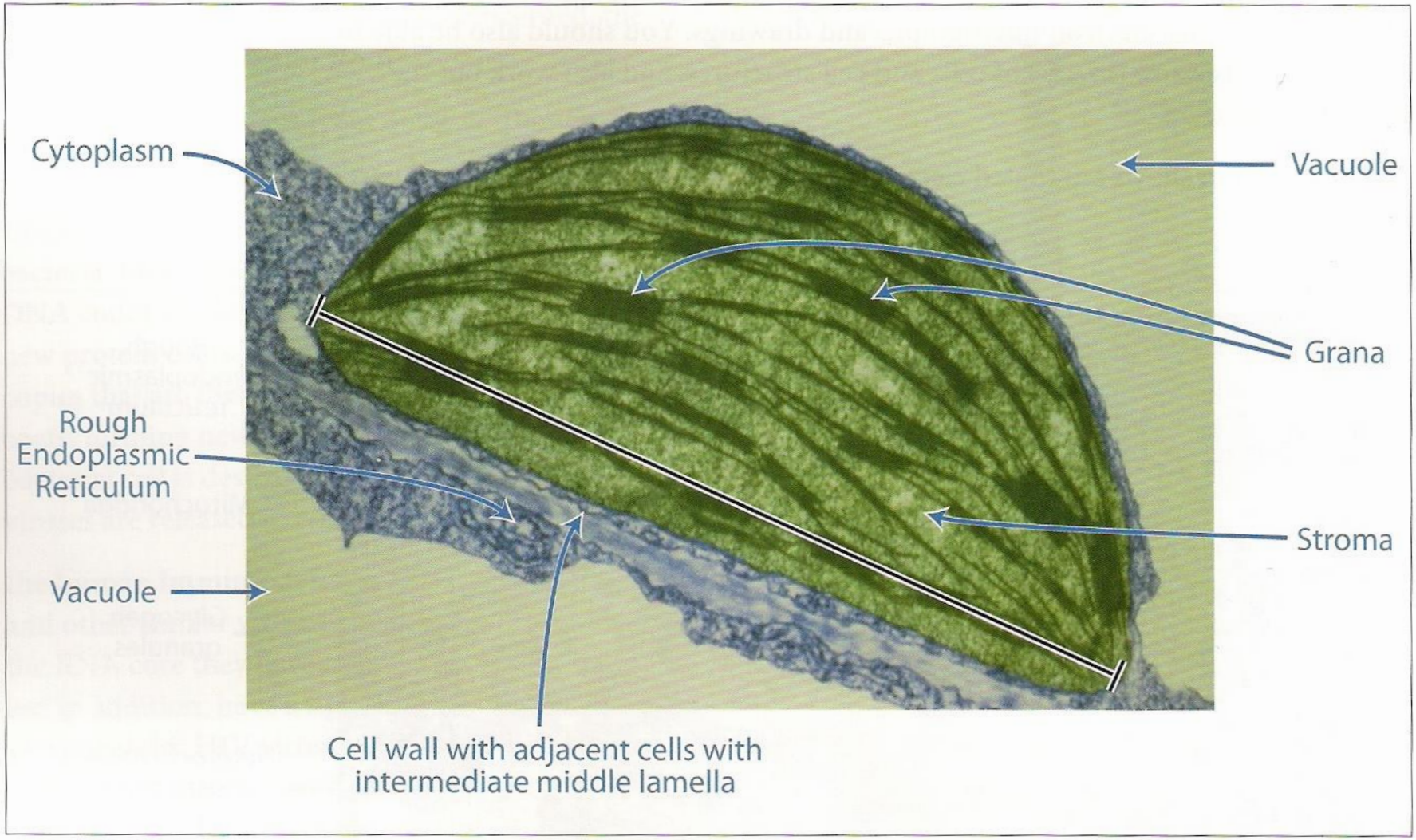
Image courtesy of Dr Gerard Brennan, School of Biological Sciences, Queen's University, Belfast

Chloroplast in a plant cell (TEM)

The chloroplast is embedded in a thin layer of cytoplasm running round the edge of the cell, with the bulk of each cell in the image below appearing to be vacuole, as is typical with many mature plant cells. The cell walls separating the two cells shown are held together by the middle lamella (seen as the slightly more opaque central area).

Chloroplast in a plant cell (TEM)

Dr Jeremy Burgess/ Science Photo Library



Typical calculation

The magnification used is × 20,000. Calculate the actual size of the chloroplast shown in the image in μm.

Size of chloroplast = size of chloroplast in image / magnification

= 105 mm / 20,000

= 105 × 10^3 μm / 20,000

= 5.25 μm

You could also be asked to calculate the magnification used. You would then be given the actual size of the chloroplast.

Magnification = size of chloroplast in image / actual size of chloroplast

= 105 mm / 5.25 μm

= 105,000 μm / 5.25 μm

= × 20,000

Sample question:

3 **Photograph 1.3** is an electron micrograph of a Golgi body (×90 000).

(a) Identify the two faces of the Golgi body labelled **A** and **B**.

A _____

B _____ [2]

(b) Describe how the Golgi body is formed in the cytoplasm.

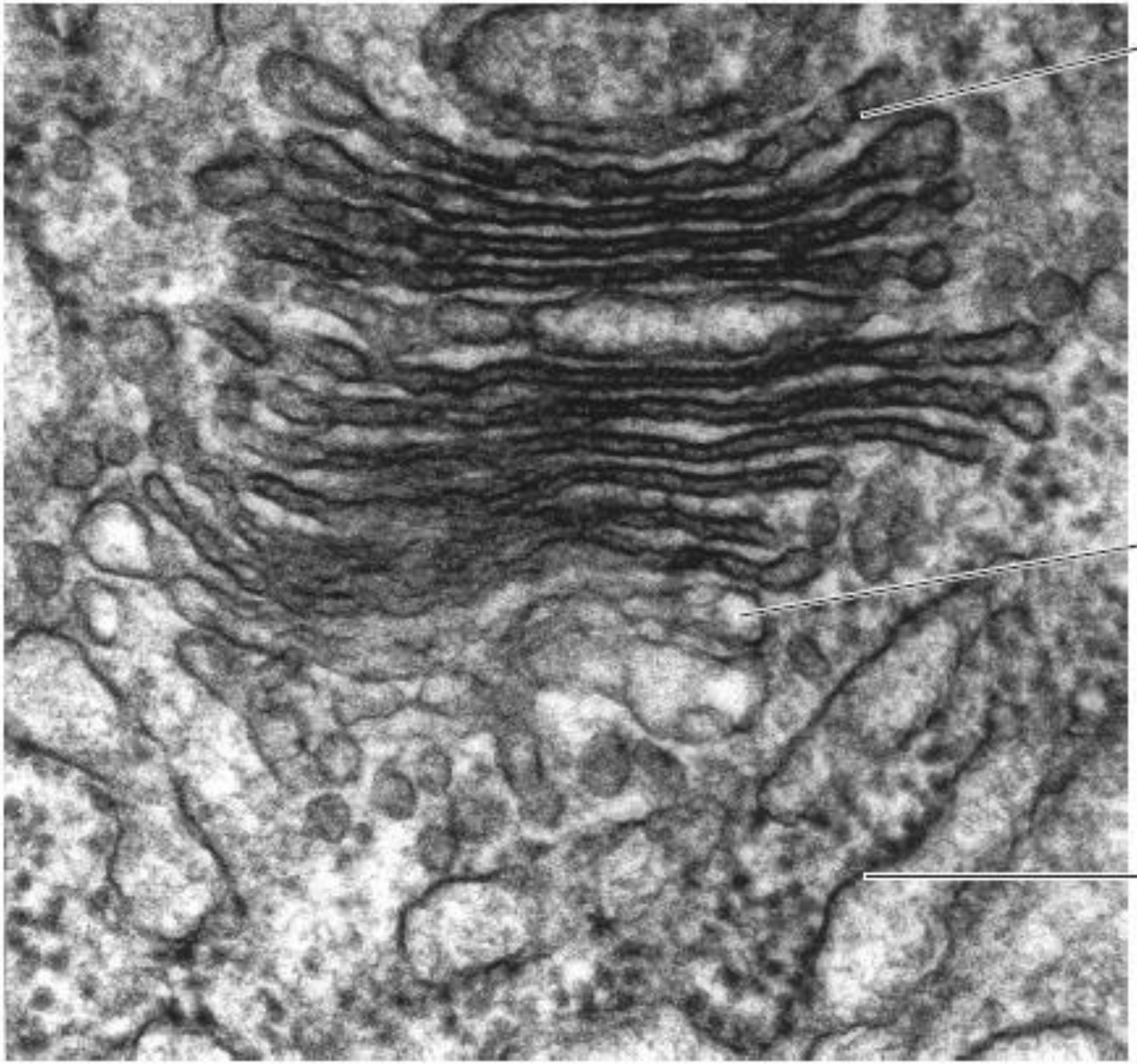
_____

_____

_____

_____

_____ [2]

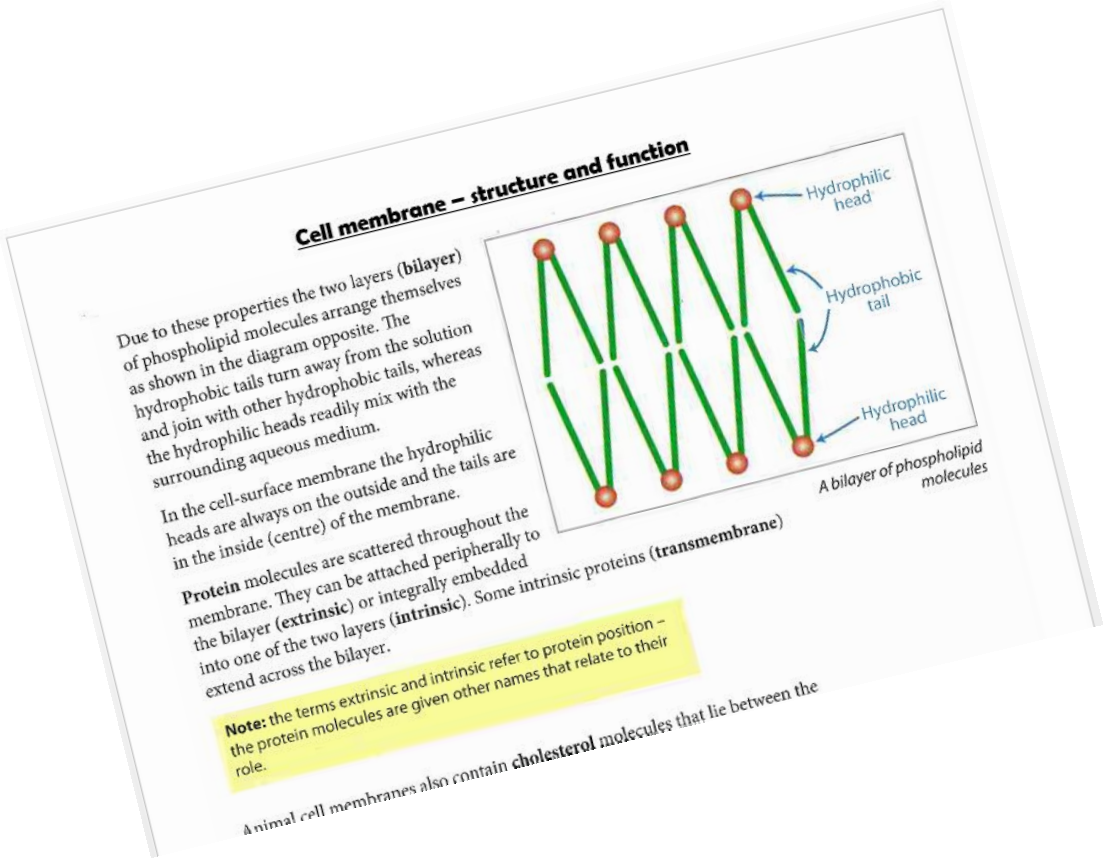

A
B
rough
endoplasmic
reticulum

Sample answer:

(a) A: maturing/trans face;
B: forming/cis face; [2]
Wrong way round [1]

(b) Originates from the endoplasmic reticulum;
vesicles pinch off the ER/fuse to form the cisternae of the Golgi body; [2]

The cell membrane and the fluid mosaic model



Cell membrane – structure and function

Due to these properties the two layers (**bilayer**) of phospholipid molecules arrange themselves as shown in the diagram opposite. The hydrophobic tails turn away from the solution and join with other hydrophobic tails, whereas the hydrophilic heads readily mix with the surrounding aqueous medium.

In the cell-surface membrane the hydrophilic heads are always on the outside and the tails are in the inside (centre) of the membrane.

Protein molecules are scattered throughout the membrane. They can be attached peripherally to the bilayer (**extrinsic**) or integrally embedded into one of the two layers (**intrinsic**). Some intrinsic proteins (**transmembrane**) extend across the bilayer.

Note: the terms extrinsic and intrinsic refer to protein position – the protein molecules are given other names that relate to their role.

Animal cell membranes also contain **cholesterol** molecules that lie between the

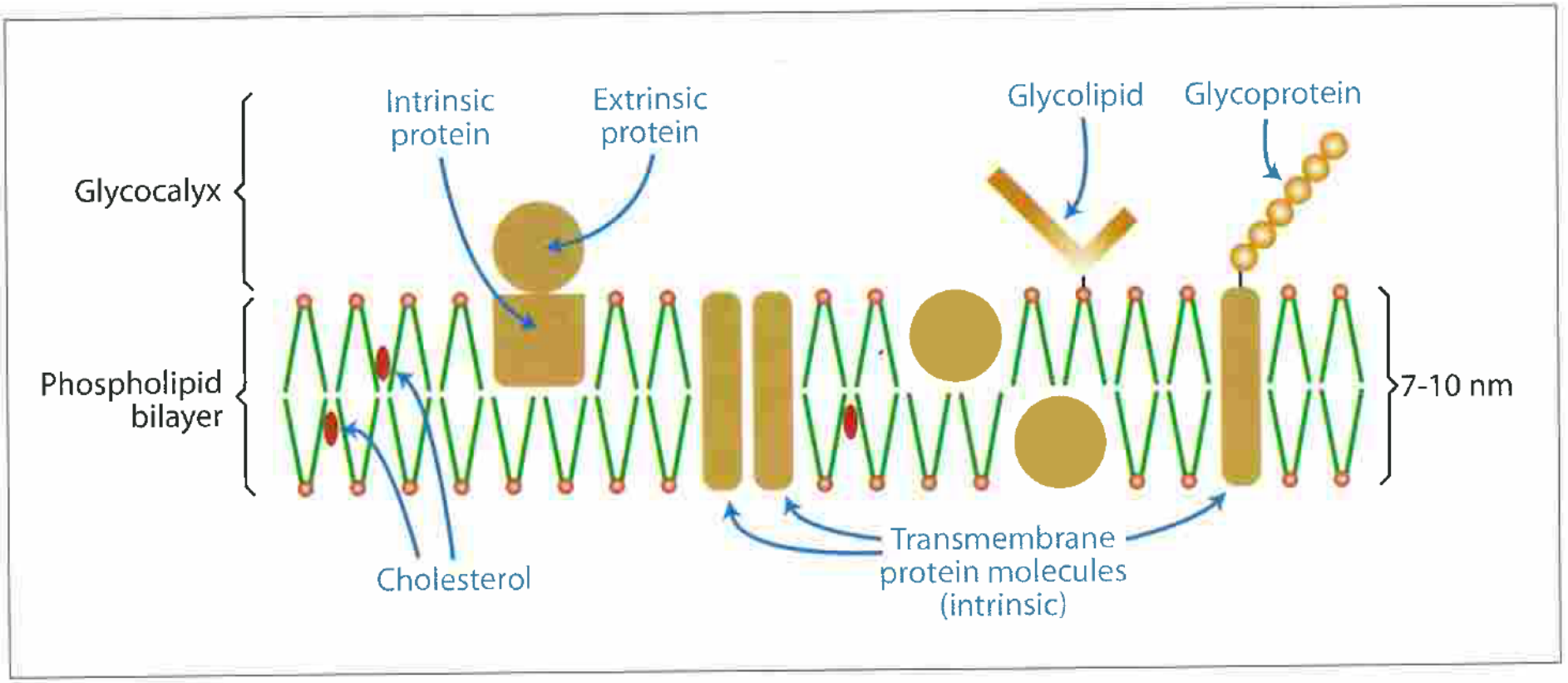
Hydrophilic head

Hydrophobic tail

Hydrophilic head

A bilayer of phospholipid molecules

Fill in the blanks on your worksheet as we talk through the structures and functions…



The fluid mosaic model of cell-surface membrane structure