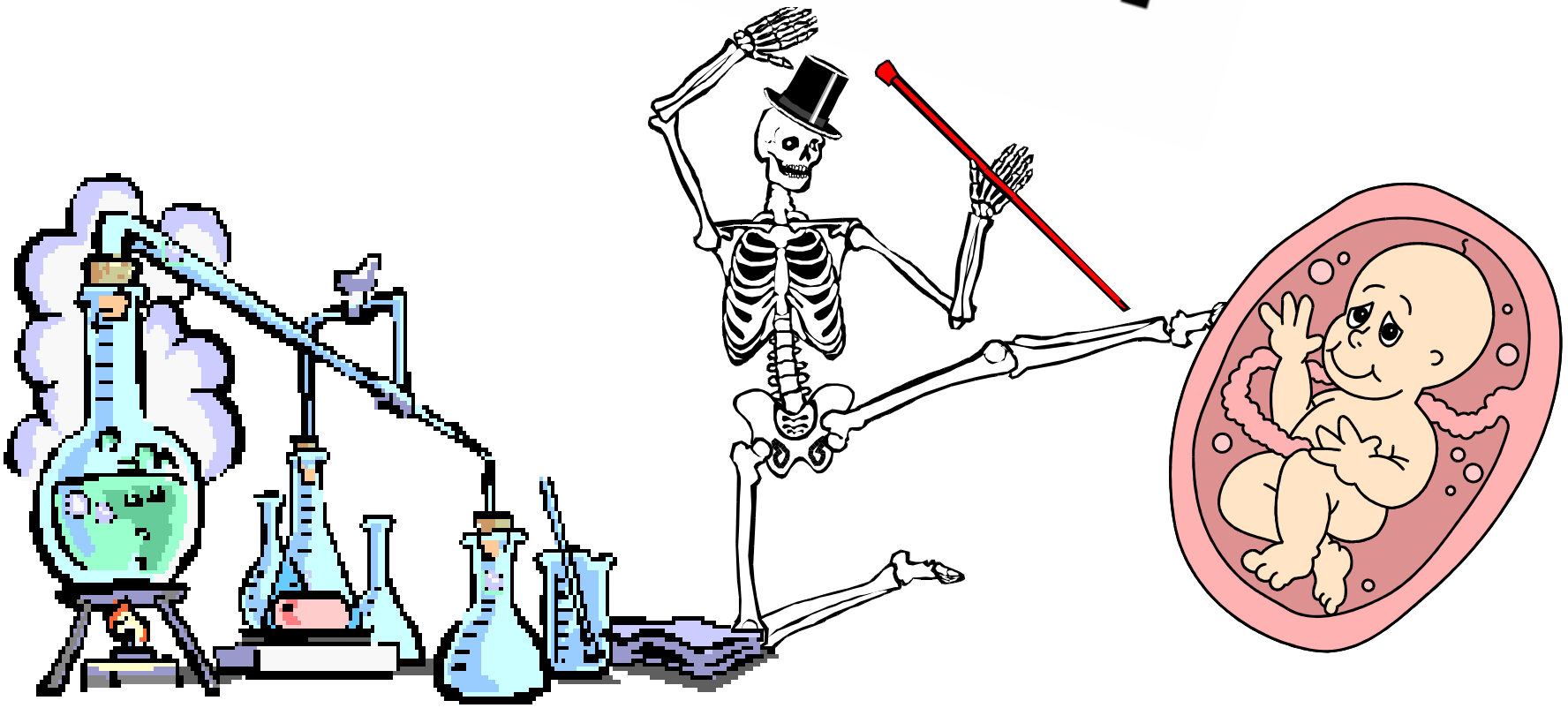
BIOLOGY



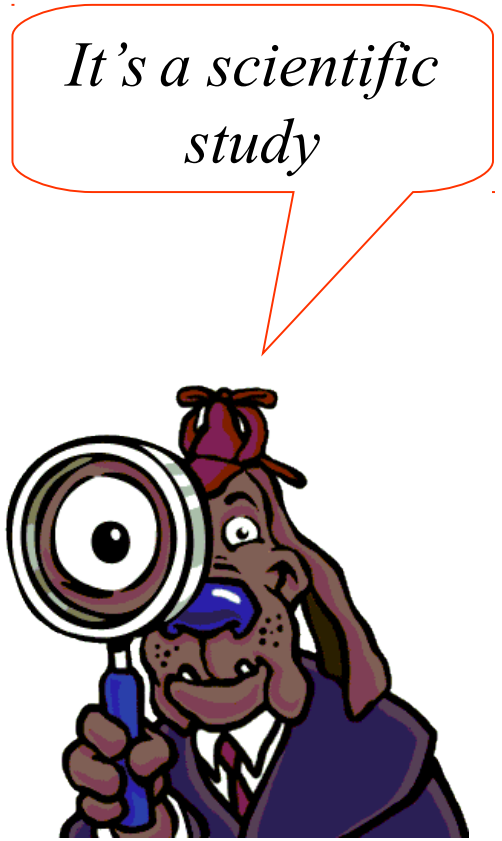
What is Biology?

It is derived from 2 Greek words :

Bios **logos**

life *The study of*

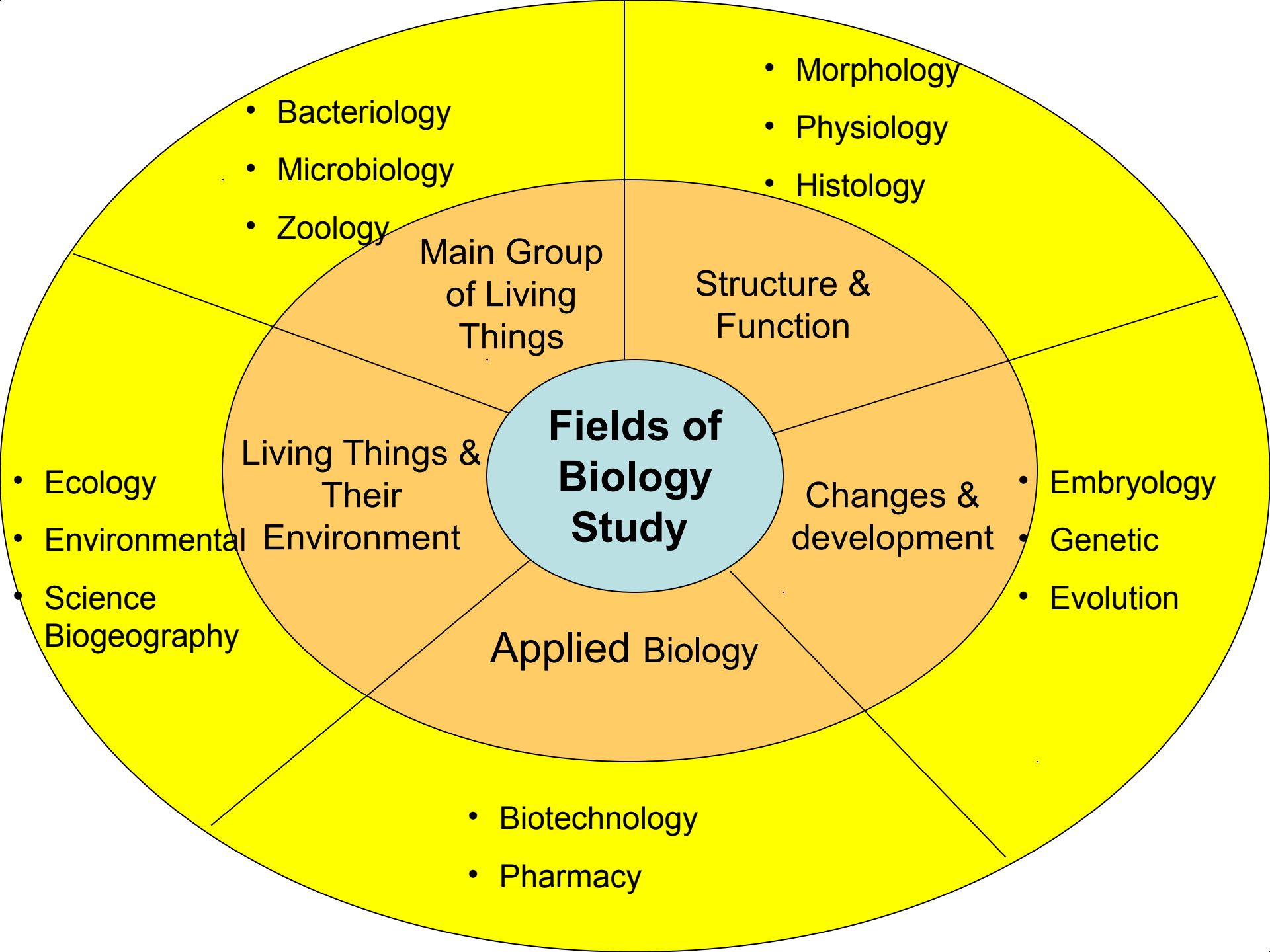
Biology is …



The study of life or living things

The importance of Biology

- Improved understanding on functions of organisms.
- Improved understanding on causes of disease.
- Finding treatment for diseases.
- Improved understanding on ecology.
- Better management on environment problems.
- Improved quality and production of food.


Fields of Biology Study
Main Group of Living Things
Structure & Function
Living Things & Their Environment
Changes & development
Applied Biology
• Bacteriology
• Microbiology
• Zoology
• Morphology
• Physiology
• Histology
• Ecology
• Environmental
• Science Biogeography
• Embryology
• Genetic
• Evolution
• Biotechnology
• Pharmacy

The Different Fields of Study in Biology

Histology

Ornithology

Anatomy

Cytology

Zoology

Bacteriology

Ecology

Microbiology

Biochemistry

Genetic

Taxonomy

Biotechnology

Physiology

Entomology

Bacteriology

Marine biology

Morphology

Job or Careers Related to Biology

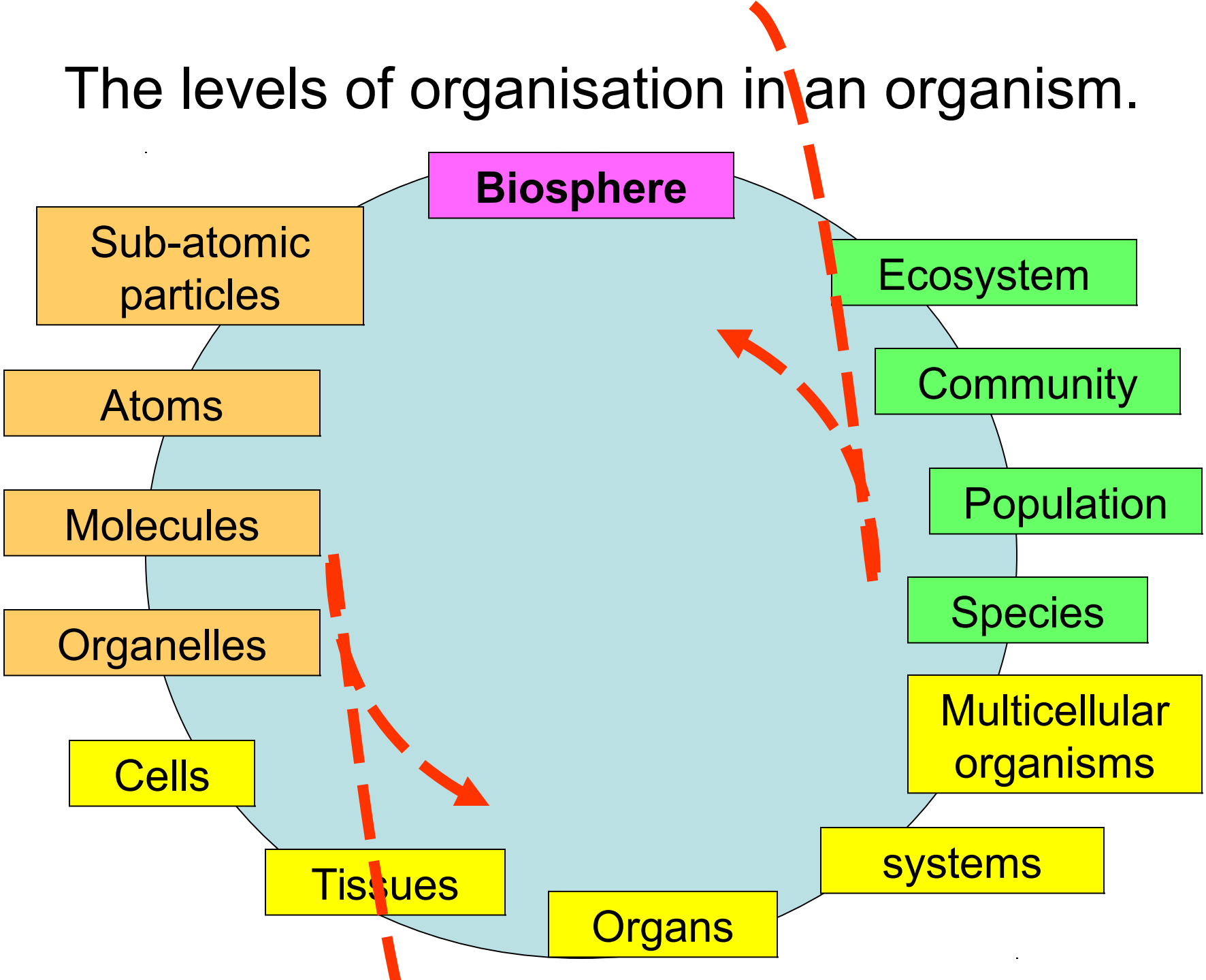
The following are all biologist in different ways:

Doctors	**Biotechnologists**
Nurses	**Forensic Scientists**
Dentists	**Nutritionists**
Physiotherapists	**Farmers**
Veterinarians	**Horticulturalists & Foresters**

The characteristics of living things?

- Cell is basic unit of life.
- They are highly organised.
- They response to stimuli.
- Nutrition – they feed to obtain energy.
- Respiration – they break down food to obtain energy.
- Metabolism – they are capable to increasing in size and number.
- Reproduction – they produce offspring.
- Excretion – they expelled wastes.
- They are able to adapt to different environments.

The levels of organisation in an organism.



THE SCIENTIFIC INVESTIGATION

- Biologist employ the scientific method to make certain discoveries about living things.
- The scientific method requires the use of scientific skills which are **science process skills** and **manipulative skills**.

SPS

Observing, classifying, inferring, interpreting data, controlling variables

Scientifics Investigation

The Scientific Method:

- *Defining the problem*
- *Making hypothesis*
- *Planning the experiment*
- *Controlling variables*
- *Conducting the experiment*
- *Recording the results*
- *Analysing the results*
- *Interpreting the data*
- *Drawing conclusion*
- *Prepare the report*

How to identify a problem?

Observing a specific phenomenon and questioning.

How to form a hypothesis?

- Interpretation based on an observation
- Making an inference
- Formulating a logical explanation to the observation

How to plan an investigation?

- Reviewing available related information about the investigation.
- Determining the reagents and equipment required.
- Determining the financial and time limitations.
- Writing out the protocols of the experiments in the investigation.
- Conducting preliminary research on the hypothesis

3 types of variables that are encountered in an experiment.

Manipulated variable

An independent variable, which is set at different values, to test a hypothesis.

Responding variable

A dependent variable, which is the outcome of an experiment, due to changes in manipulative variable.

fixed variable

A parameter that may affect the outcome of an experiment should be kept constant throughout the experiment.

How to record data efficiently?

- Tabulation of complex data.
- Graphical presentation of data, especially important in showing the connection between manipulative and responding variables.
- Diagrammatic presentation with clear labelling.

How to analyse and interpret data for all the data collected in an experiment?

- Accurate calculation.
- Determine the association between manipulative and responding variables.
- Compare with previous reports.
- Explore any hidden information.
- Understand the limitations of the experiment conducted.

How to make conclusion?

- Keep in short and simple (KISS).
- Stage whether the results support the hypothesis.
- Suggest steps to extend the investigation to obtain more accurate data or to further confirm the hypothesis if necessary.
- Give proper reasons if the experiment is failed.

The typical format for the report of an experiment.

- Title
- Objective
- Hypothesis,
- Variables
- Materials and Apparatus
- Technique
- Procedure
- Results
- Data analysis
- Discussion
- Conclusion

THE SCIENTIFIC INVESTIGATION

10 Steps of Scientific Investigation

Identify a problem

Form a hypothesis

Plan the experiment

Identify & Control variables

Conduct the experiment

Collect data

Analyse data

Interpret data

Draw conclusion

Write a report

Writing a Report

1. Objective
2. Problem
3. Hypothesis
4. Variables
5. Material and Apparatus
6. Technique
7. Procedure
8. Result
9. Discussion
10. Conclusion

Hypothesis

- The higher the _____, the higher the _____.
- The lower the _____, the lower the _____.
- The longer the _____, the higher the _____.
- The fittest student has the shortest recovery time after vigorous exercise.

Variables :

Manipulated Variable	**Subjects**
Responding Variable	**Time taken for the pulse rate return to normal**
Fixed Variable	**The rate of steps, height of the bench, age of subject**

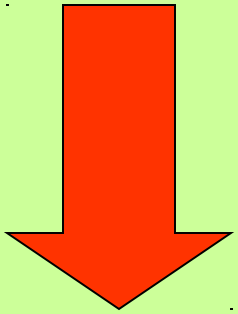
Techniques: *How you handle the responding variable*

Conduct the step test to measure the pulse rate of the subjects at one-minute intervals until the pulse rate returns to normal.

Procedure:

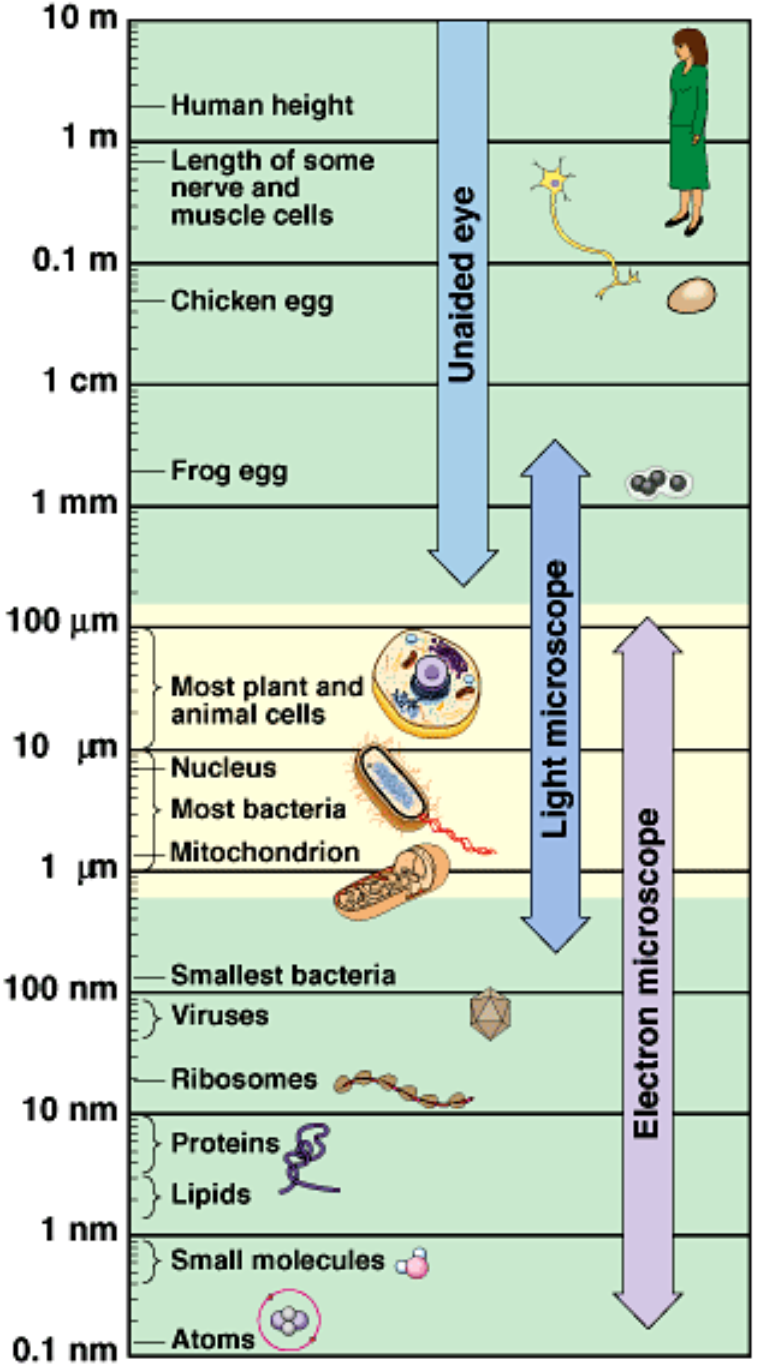
- **Conduct experiment (passive form)**
- **Design experiment (active form)**

1. Measure the pulse rate of each student in your group before the test.



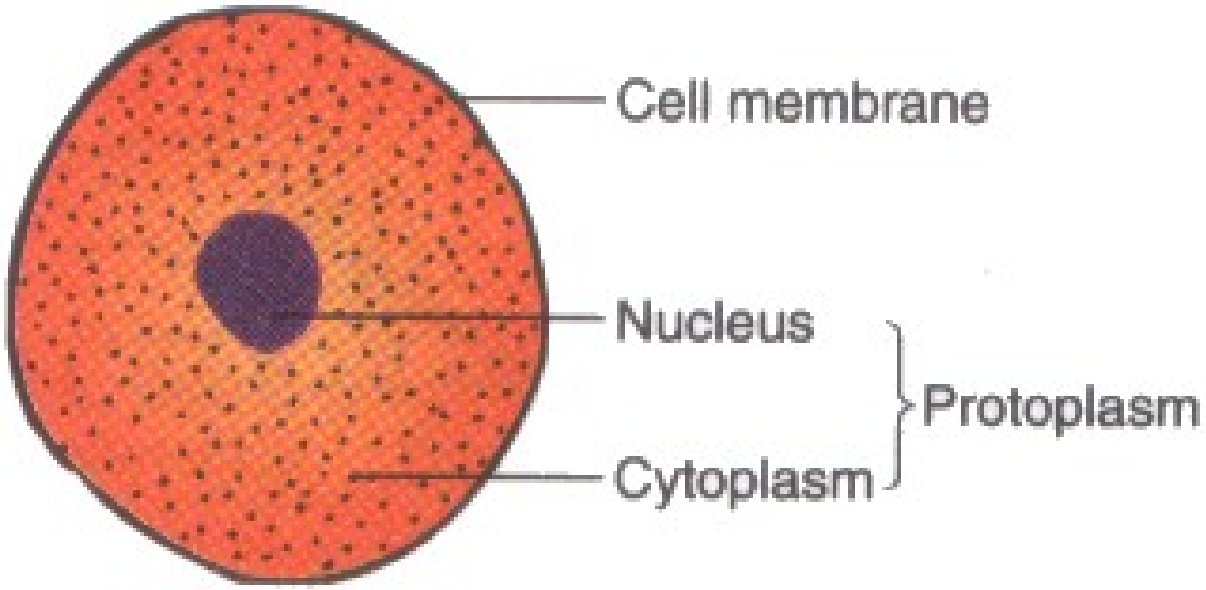
1. The pulse rate of each student is measured before the test.

Cell Structure and Function

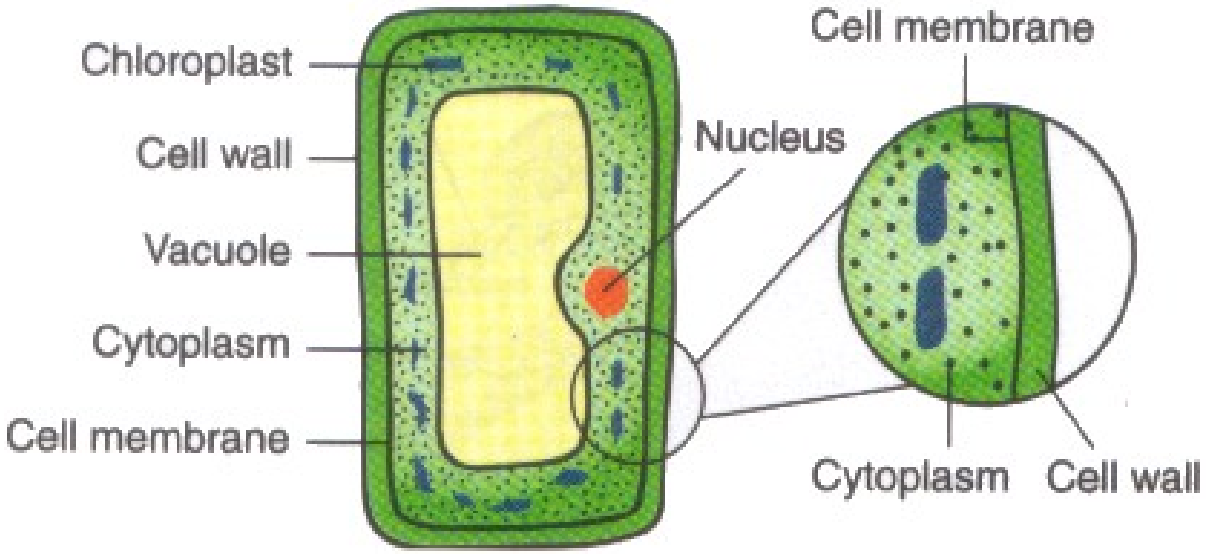

10 m
1 m
0.1 m
1 cm
1 mm
100 µm
10 µm
1 µm
100 nm
10 nm
1 nm
0.1 nm
Human height
Length of some nerve and muscle cells
Chicken egg
Frog egg
Most plant and animal cells
Nucleus
Most bacteria
Mitochondrion
Smallest bacteria
Viruses
Ribosomes
Proteins
Lipids
Small molecules
Atoms
Unaided eye
Light microscope
Electron microscope

- All living things are made up of basic units called **cells**.
- Cells vary in shape, sizes and content depending on their function.
- A **light microscope** is usually used to help us observe microscopic cells.

- The living component of a cell is called **protoplasm**.
- **Protoplasm = cytoplasm + nucleus**
- Protoplasm surrounded by **plasma membrane**.
- Plant cells have an outer boundary called the **cell wall**.

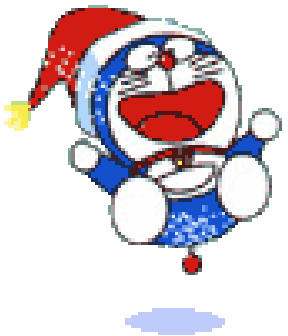


Animal cell



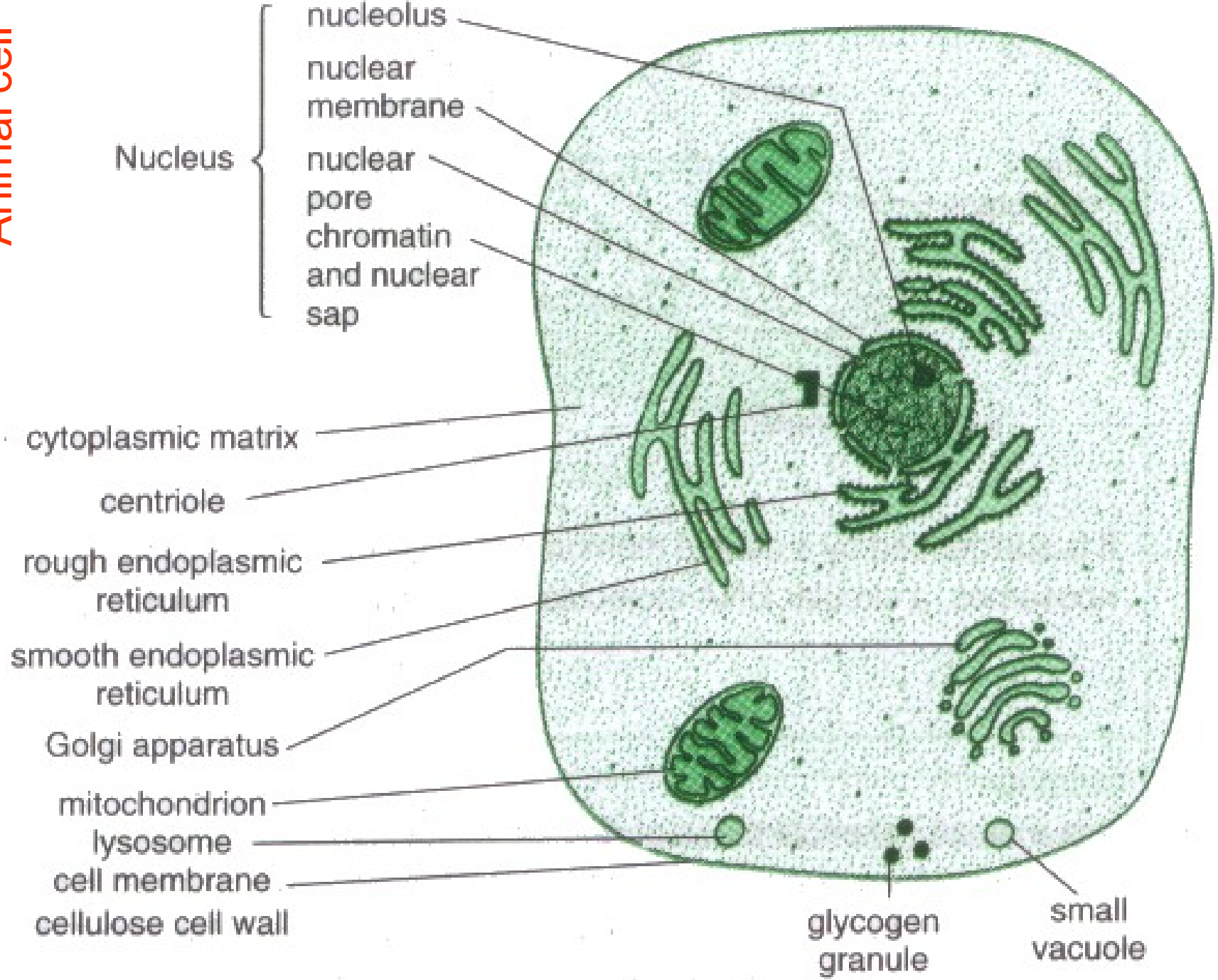
Plant cell

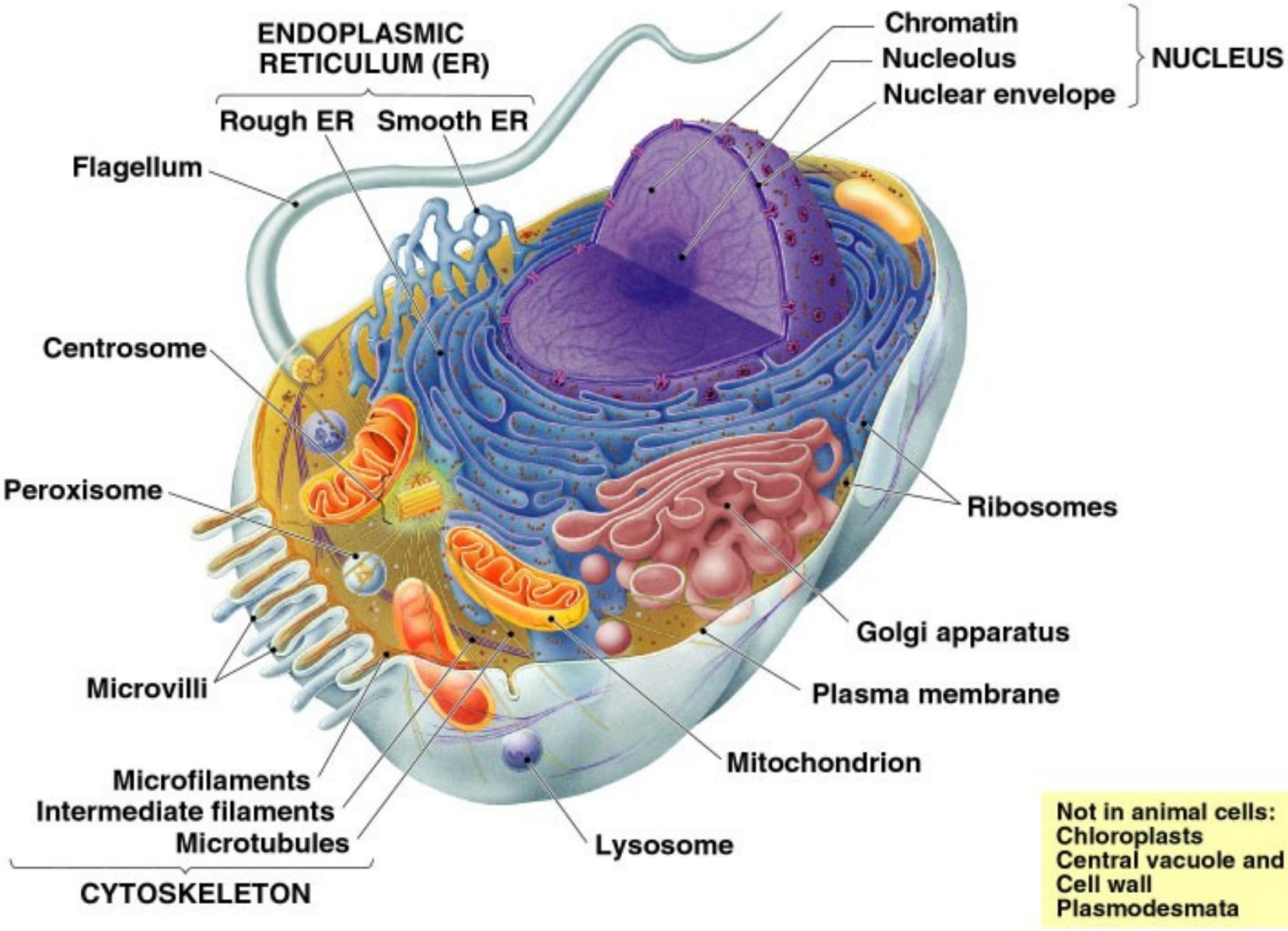
Cell Parts and Structures



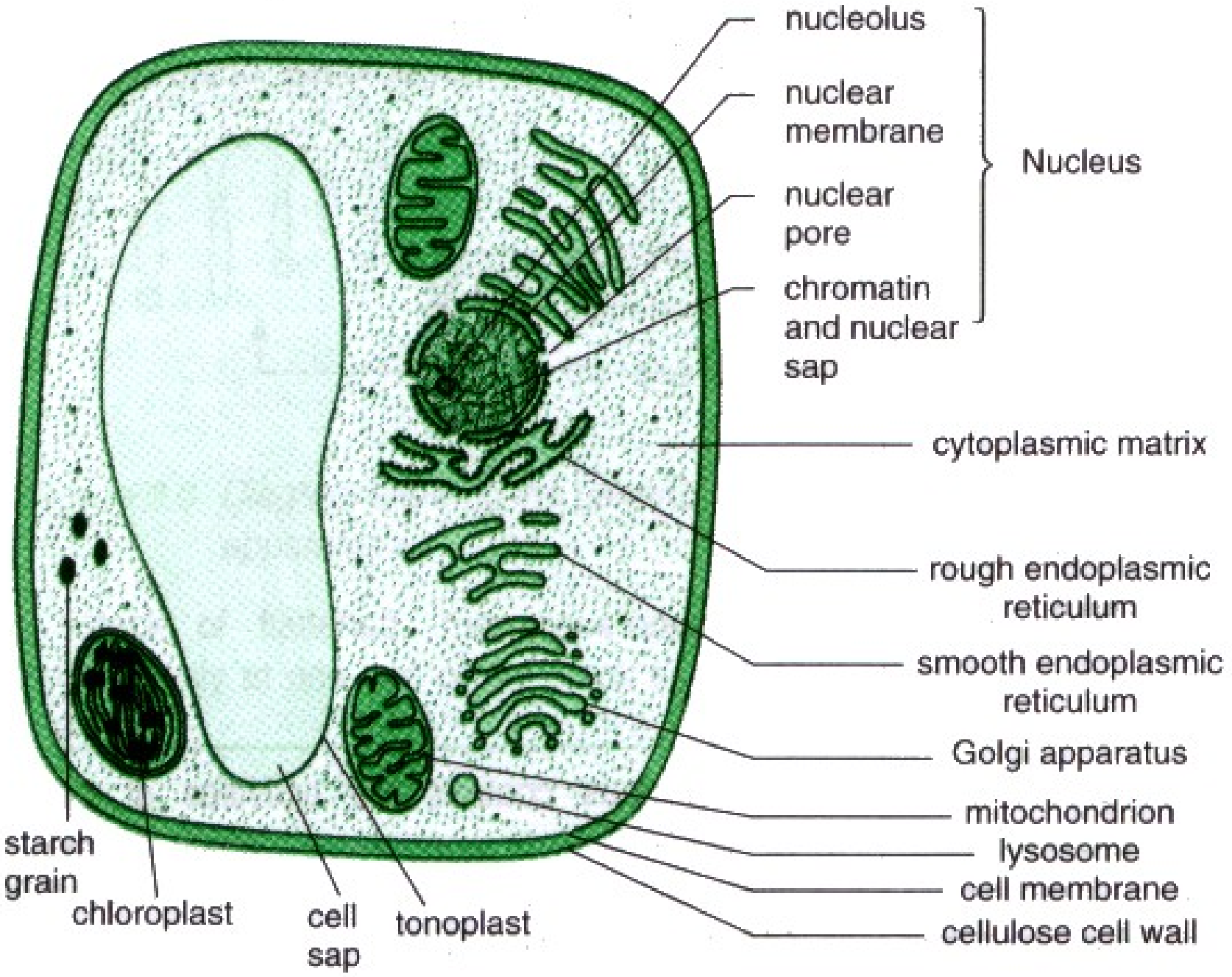
- With **electron microscopes**, scientists are able to see the cellular components of a cell in greater detail.
- The cytoplasm contains structures called **organelles**.
- Organelles perform specific function which enable the cell to function **as a unit of life**.

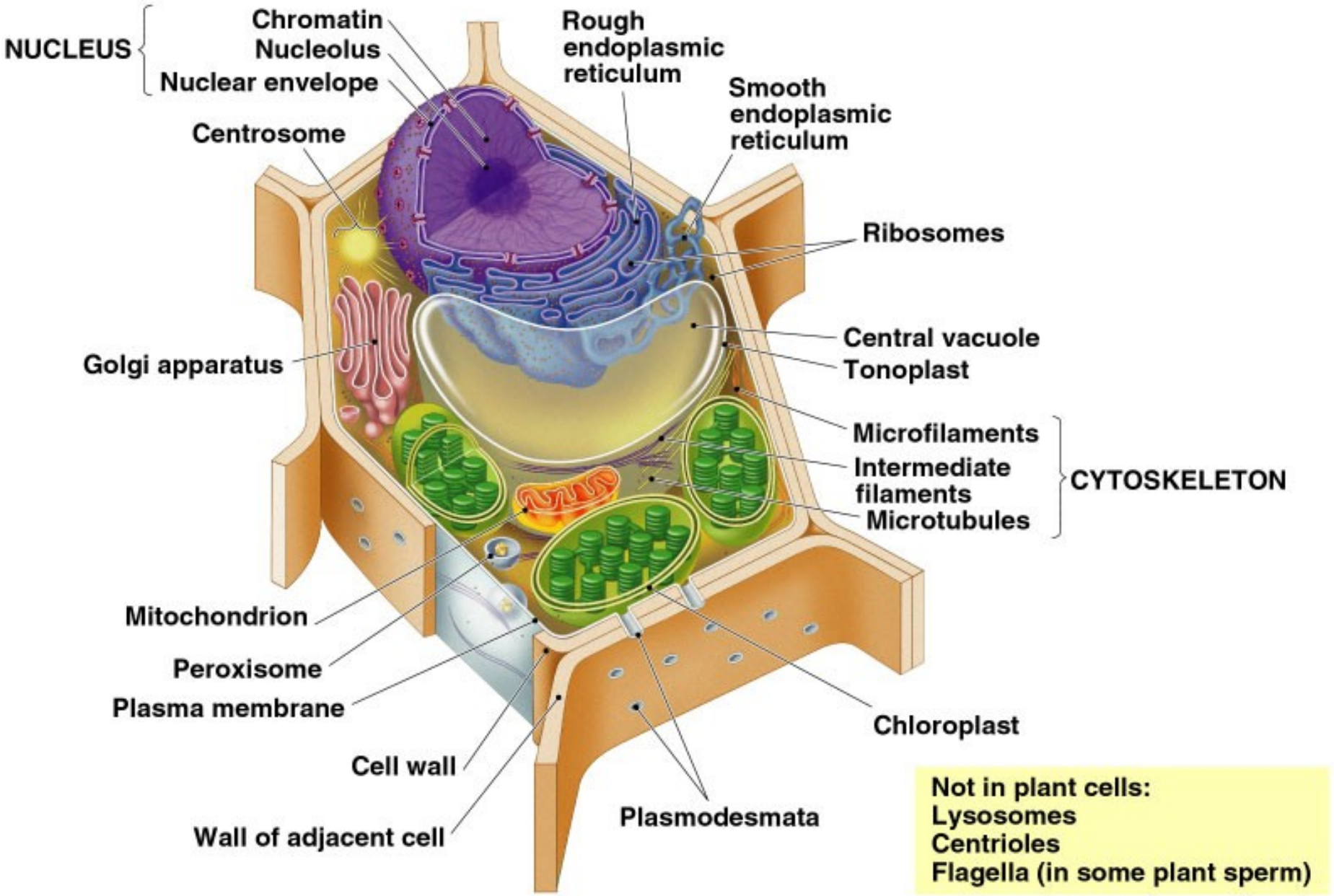
Animal cell

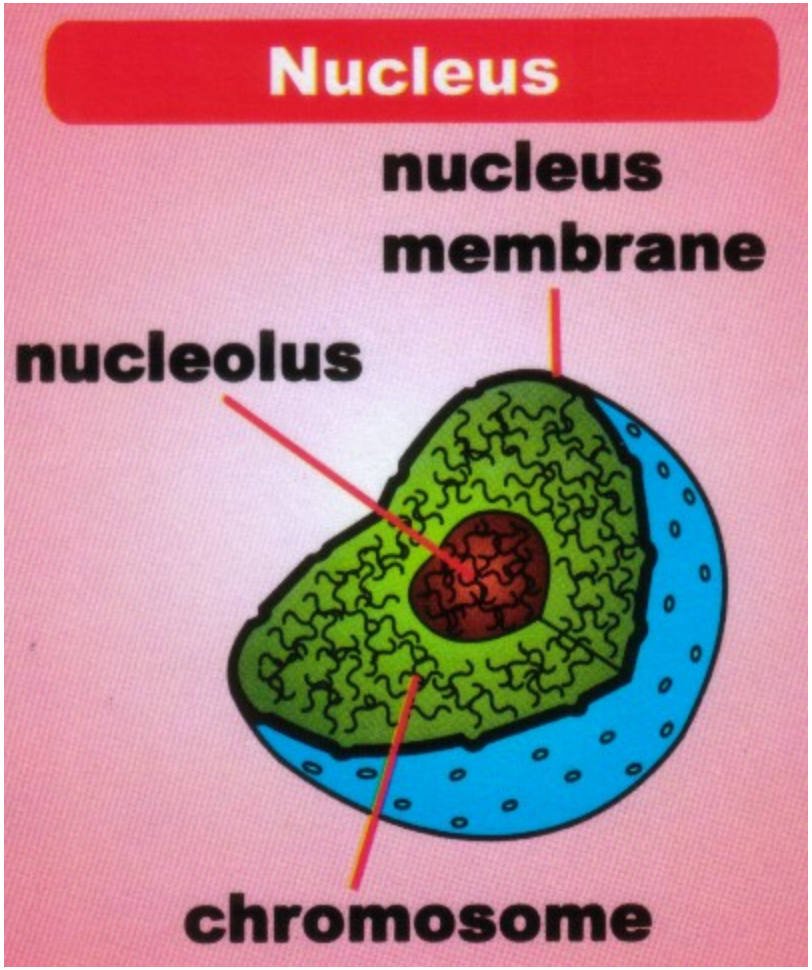

Nucleus
nucleolus
nuclear membrane
nuclear pore
chromatin and nuclear sap
cytoplasmic matrix
centriole
rough endoplasmic reticulum
smooth endoplasmic reticulum
Golgi apparatus
mitochondrion
lysosome
cell membrane
cellulose cell wall
glycogen granule
small vacuole


ENDOPLASMIC RETICULUM (ER)
Rough ER
Smooth ER
Flagellum
Centrosome
Peroxisome
Microvilli
Microfilaments
Intermediate filaments
Microtubules
CYTOSKELETON
Chromatin
Nucleolus
Nuclear envelope
NUCLEUS
Ribosomes
Golgi apparatus
Plasma membrane
Mitochondrion
Lysosome
Not in animal cells:
Chloroplasts
Central vacuole and tonoplast
Cell wall
Plasmodesmata

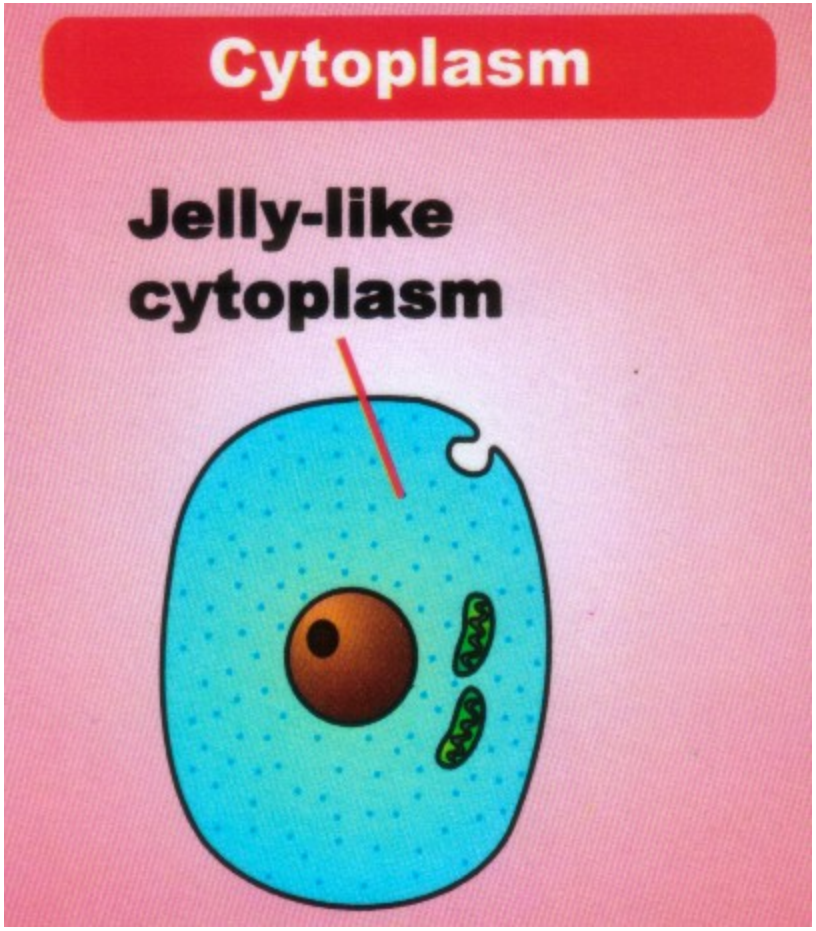
Plant cell


nucleolus
nuclear membrane
nuclear pore
chromatin and nuclear sap
Nucleus
cytoplasmic matrix
rough endoplasmic reticulum
smooth endoplasmic reticulum
Golgi apparatus
mitochondrion
lysosome
cell membrane
cellulose cell wall
starch grain
chloroplast
cell sap
tonoplast

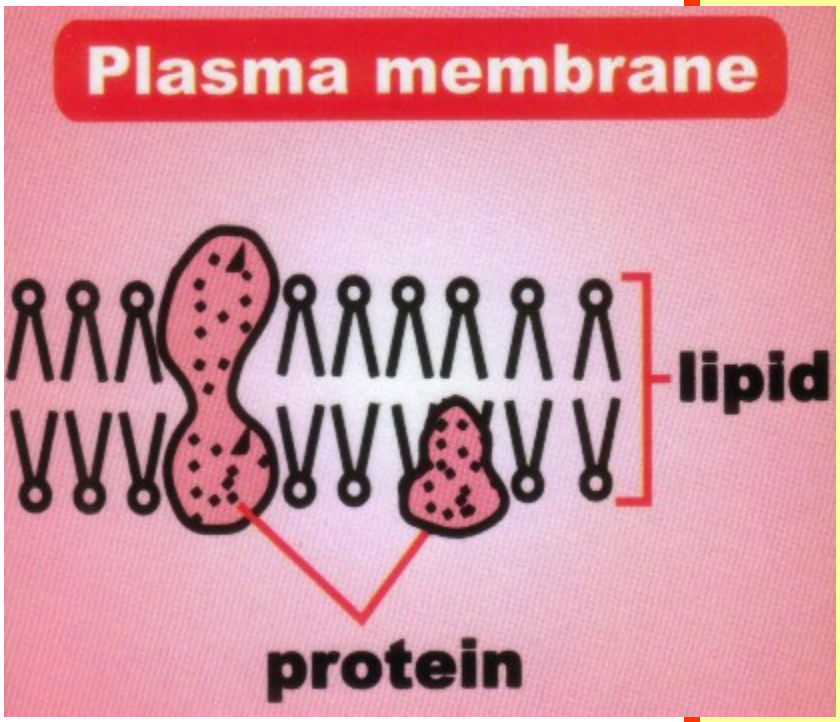

NUCLEUS
Chromatin
Nucleolus
Nuclear envelope
Centrosome
Rough endoplasmic reticulum
Smooth endoplasmic reticulum
Ribosomes
Golgi apparatus
Central vacuole
Tonoplast
Microfilaments
Intermediate filaments
Microtubules
CYTOSKELETON
Mitochondrion
Peroxisome
Plasma membrane
Cell wall
Wall of adjacent cell
Plasmodesmata
Chloroplast
Not in plant cells:
Lysosomes
Centrioles
Flagella (in some plant sperm)



- **Controls cellular activities**.
- Nucleus membrane controls inflow and outflow of material to and from nucleus
- Nucleolus acts as site of ribosome construction.
- Chromosome carries hereditary information.

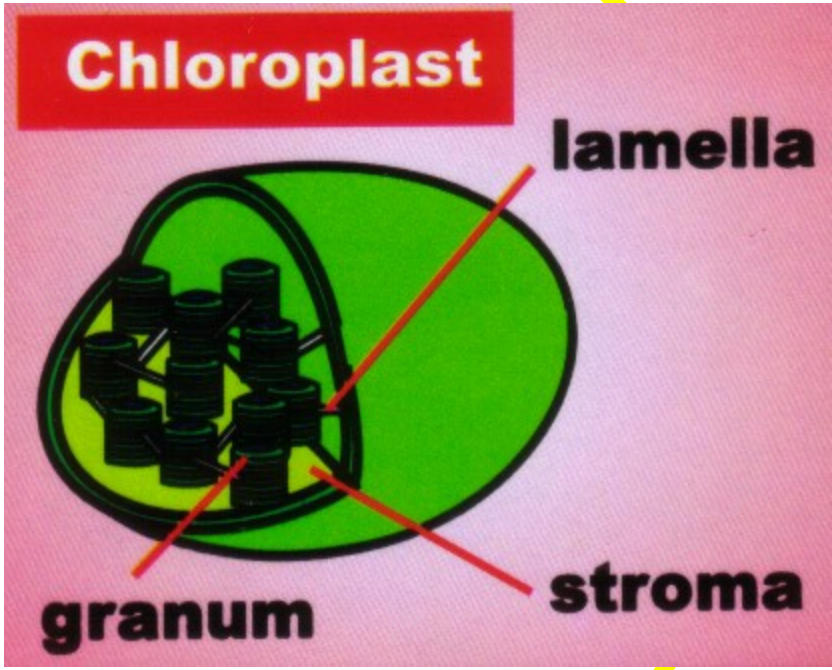


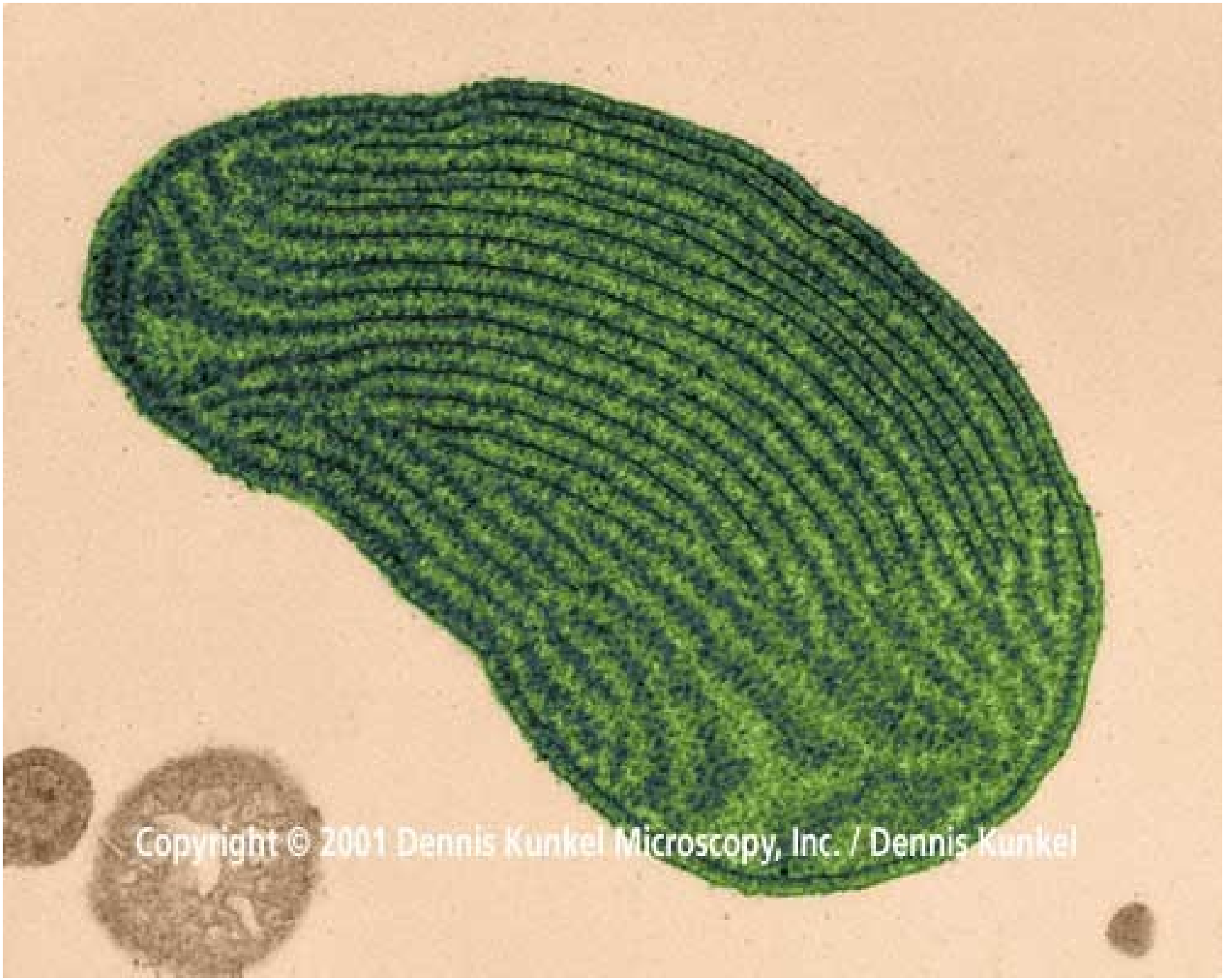
- Acts as a **medium where biochemical reactions and most living processes occur within the cell**.
- Provides the organelles with substances obtained from external environment.



- Separates the content of the cell from its external environment.
- **Regulates the movement of substances entering and leaving the cell**.
- Allows the exchange of nutrients, respiratory gases and wastes products between the cell and its environment.

- Chlorophyll captures the energy of sunlight and converts light energy into chemical energy during **photosynthesis**.
- The green pigment of chlorophyll gives plants their colour.

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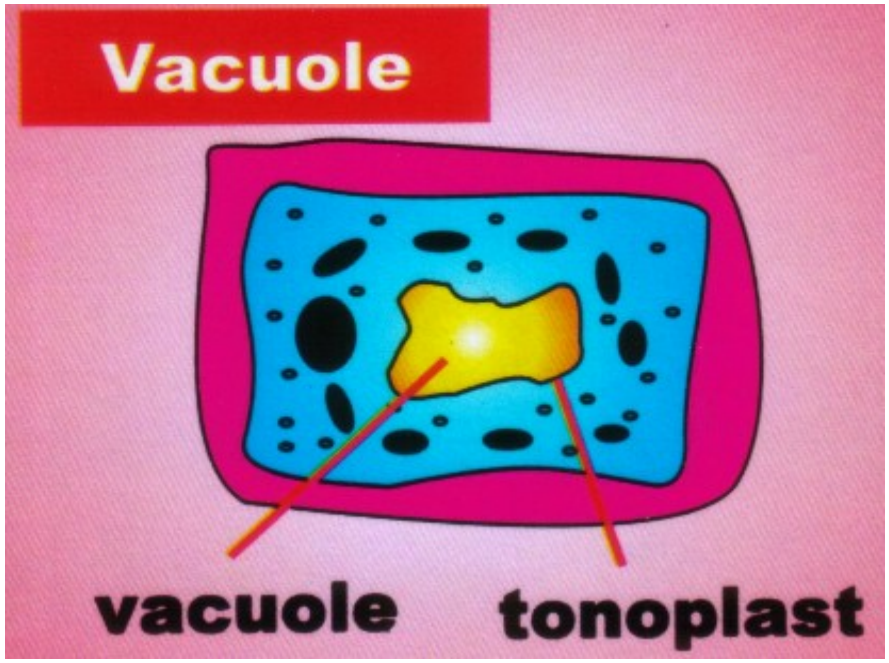
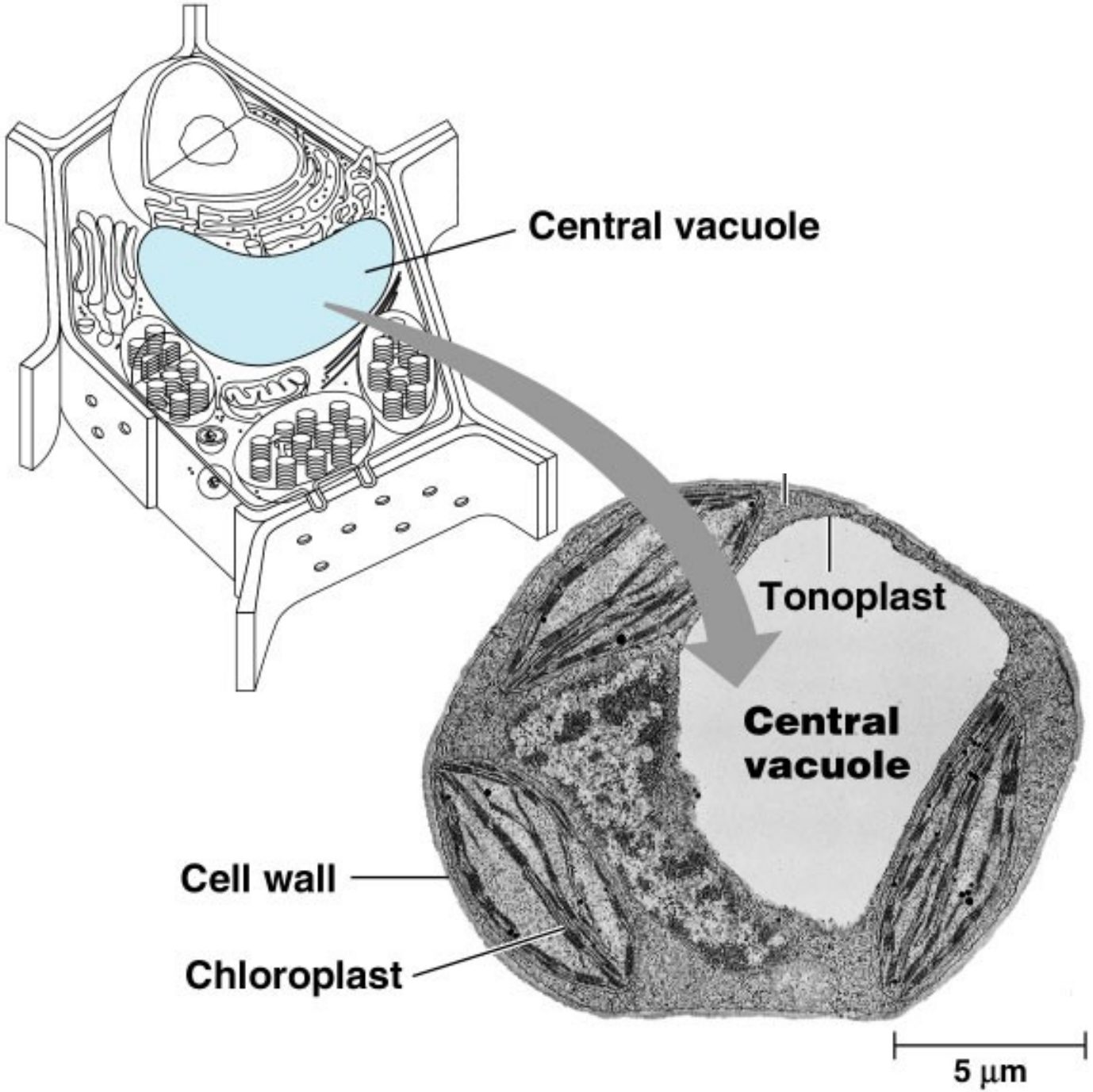
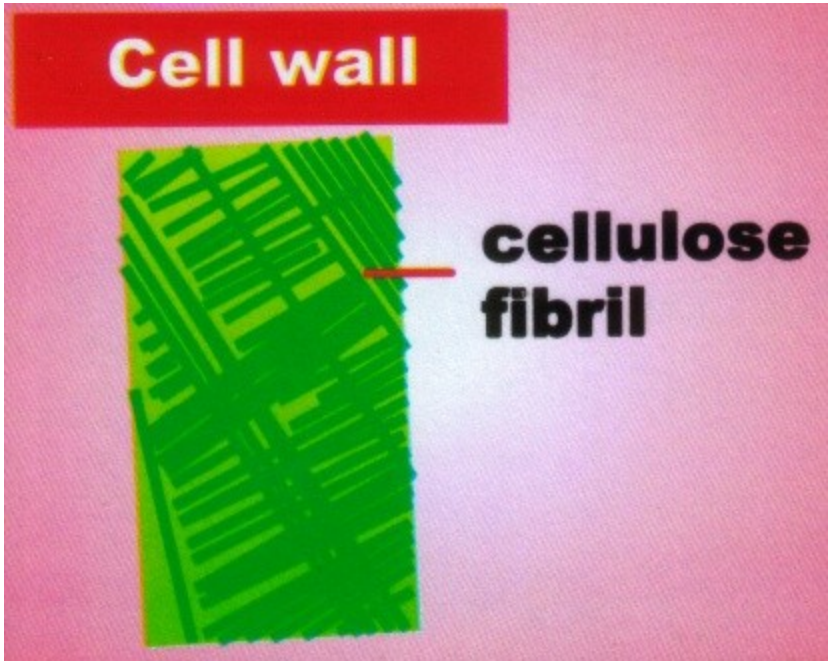
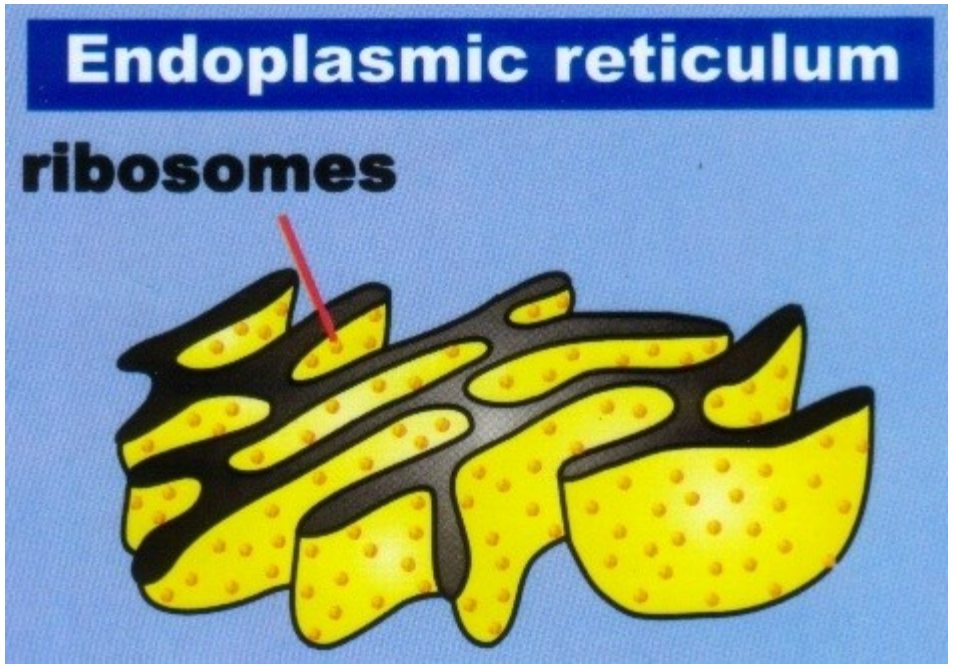


- Stores chemicals such as *organic acids, sugar, amino acids, mineral salts, oxygen, carbon dioxide* and so on.
- Regulates water balance in plant cells.


Central vacuole
Tonoplast
Central vacuole
Cell wall
Chloroplast
5 μm



- Maintains the shape of plant cells.
- Provides mechanical strength and support to plant cells.
- Protects plants cells from ***rupturing*** due to the movement of excess water into the cells.



- Forms a network of transportation within the cell.

Rough endoplasmic reticulum

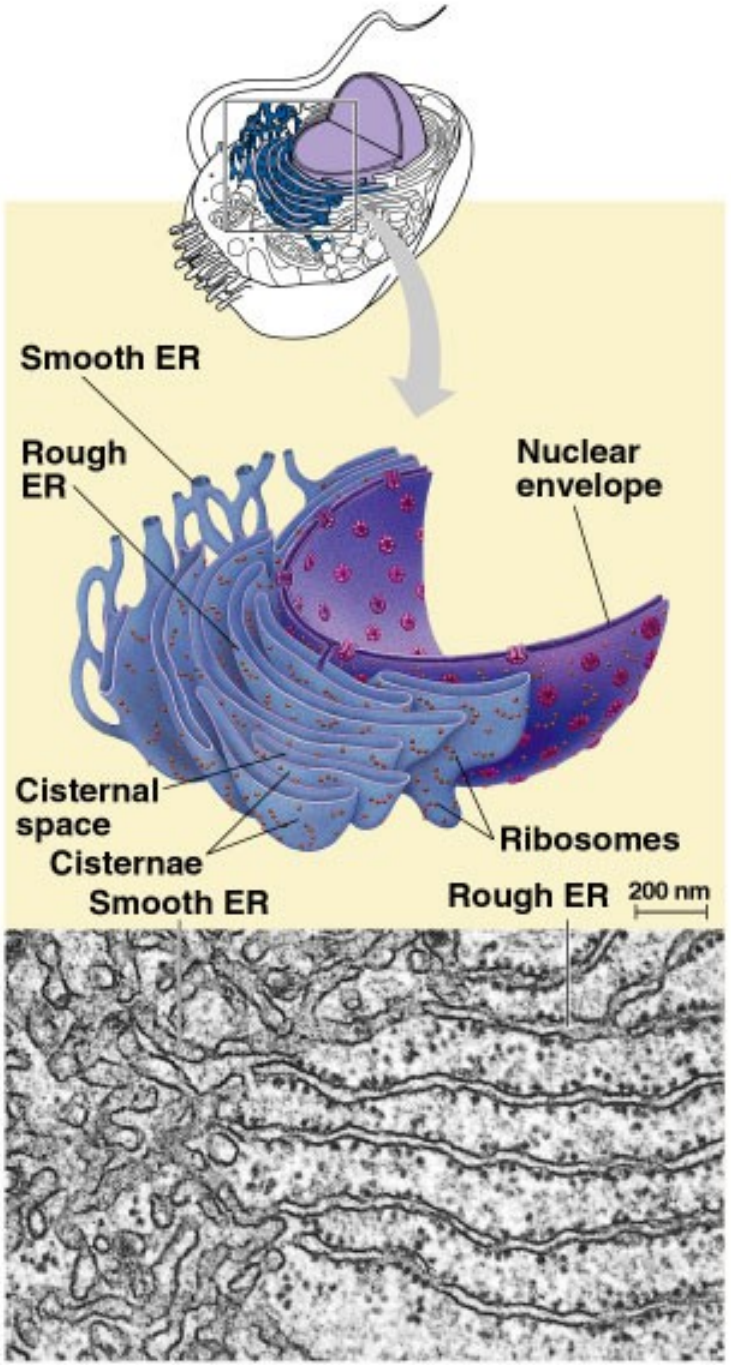
(*has ribosomes attached to its surface*)

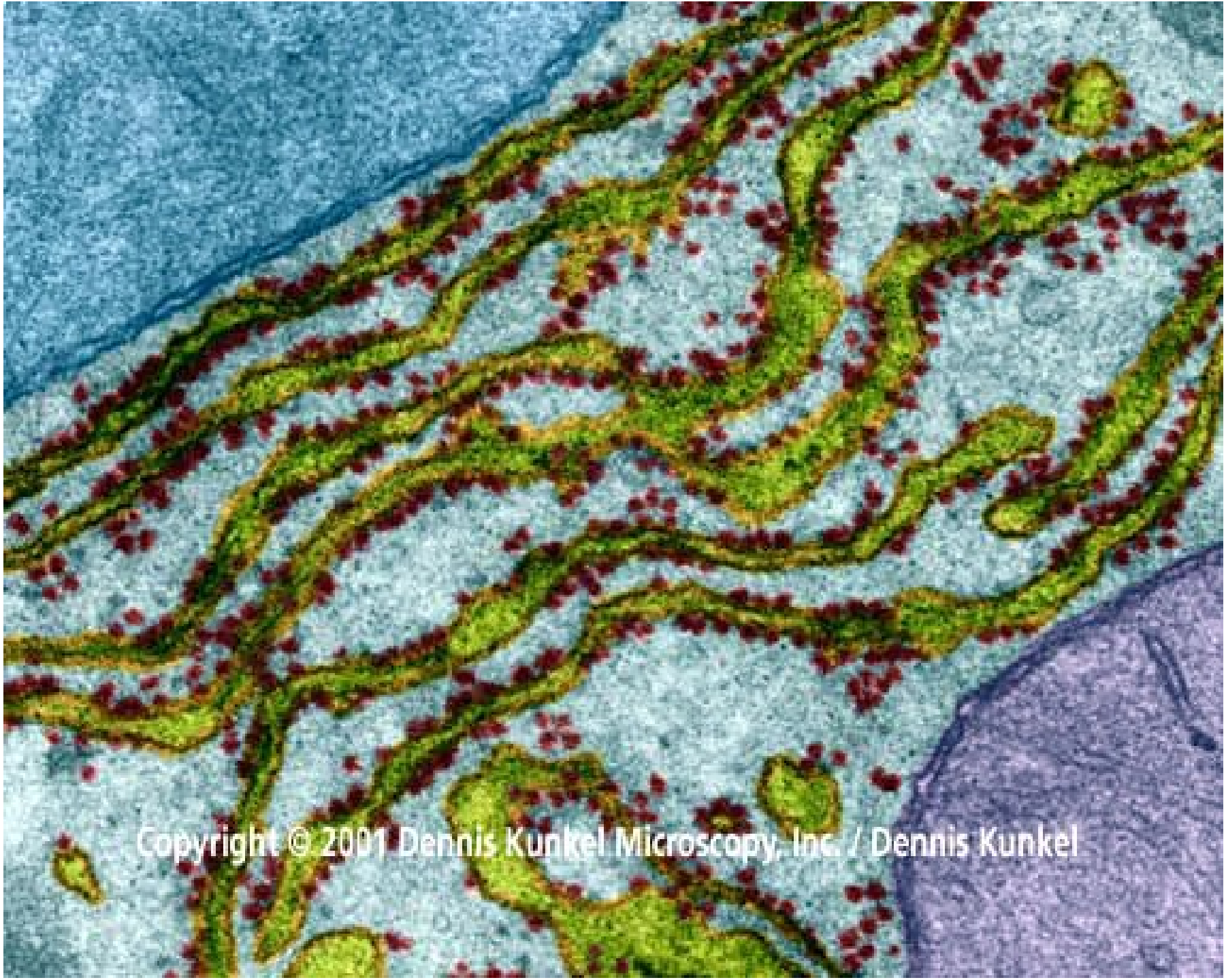
Transports protein which is synthesized in ribosomes.

Smooth endoplasmic reticulum

(does not have ribosome attach to its surface)

Transports and synthesized fat and glyserol

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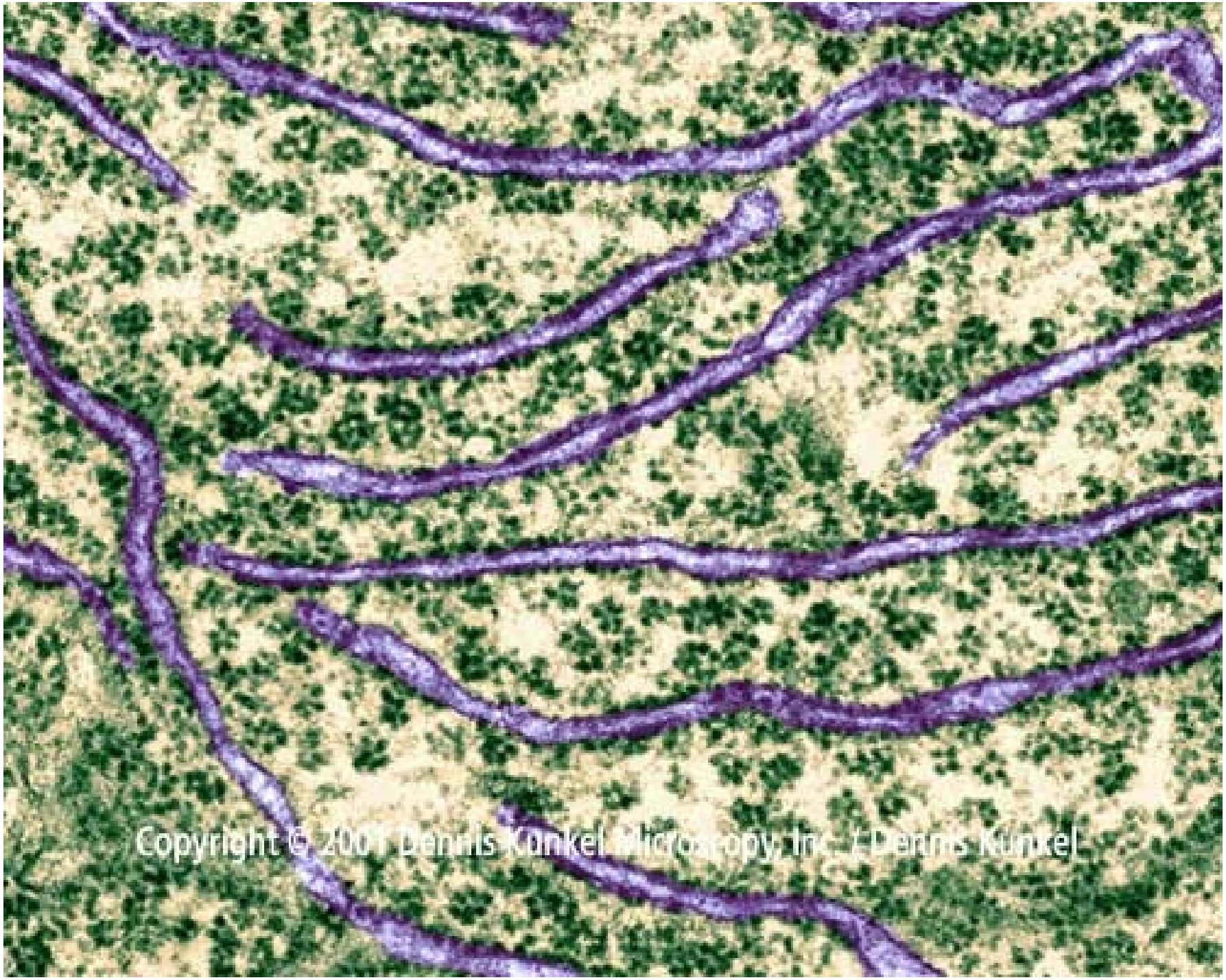
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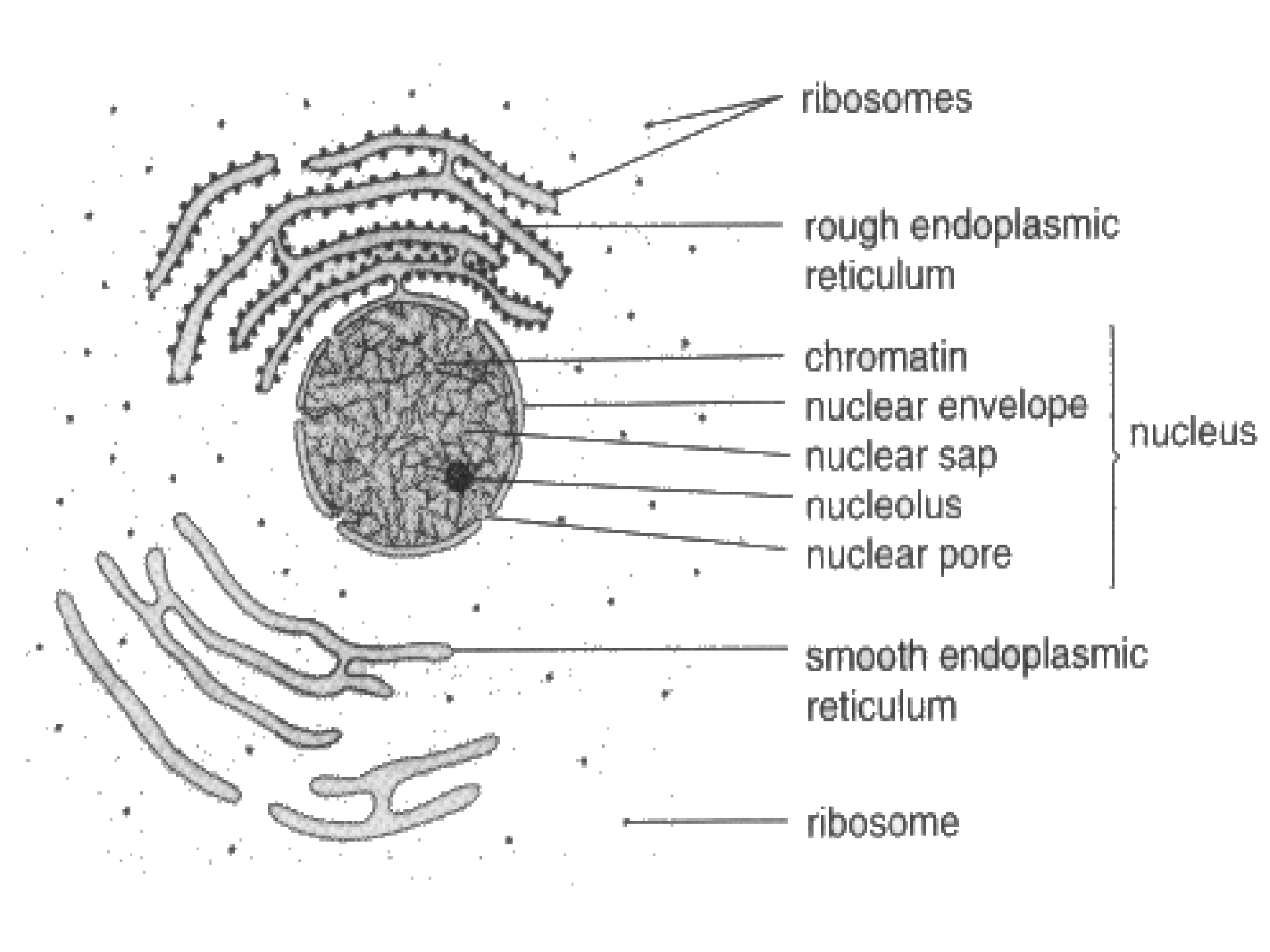
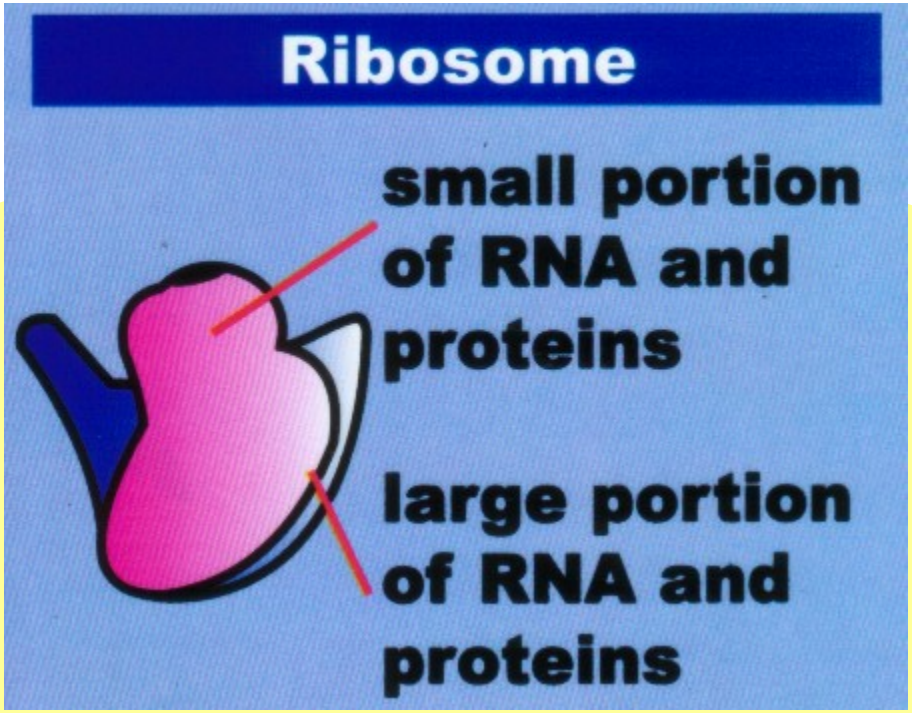
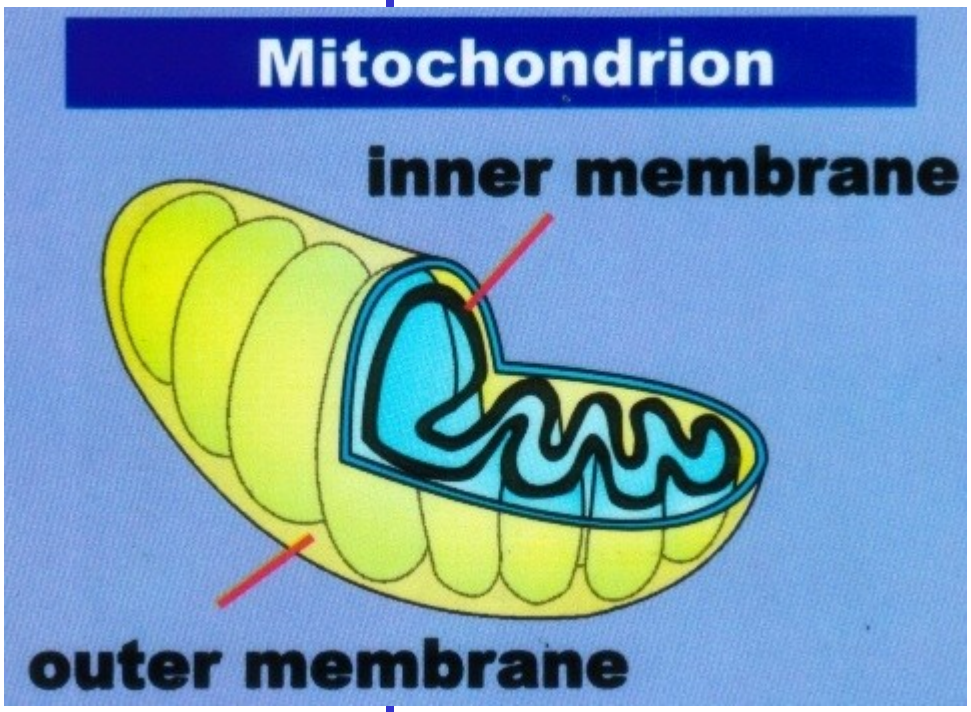
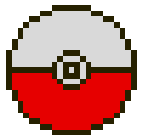

ribosomes
rough endoplasmic reticulum
chromatin
nuclear envelope
nuclear sap
nucleolus
nuclear pore
nucleus
smooth endoplasmic reticulum
ribosome

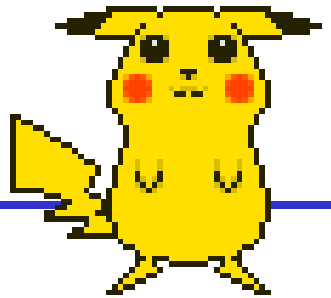


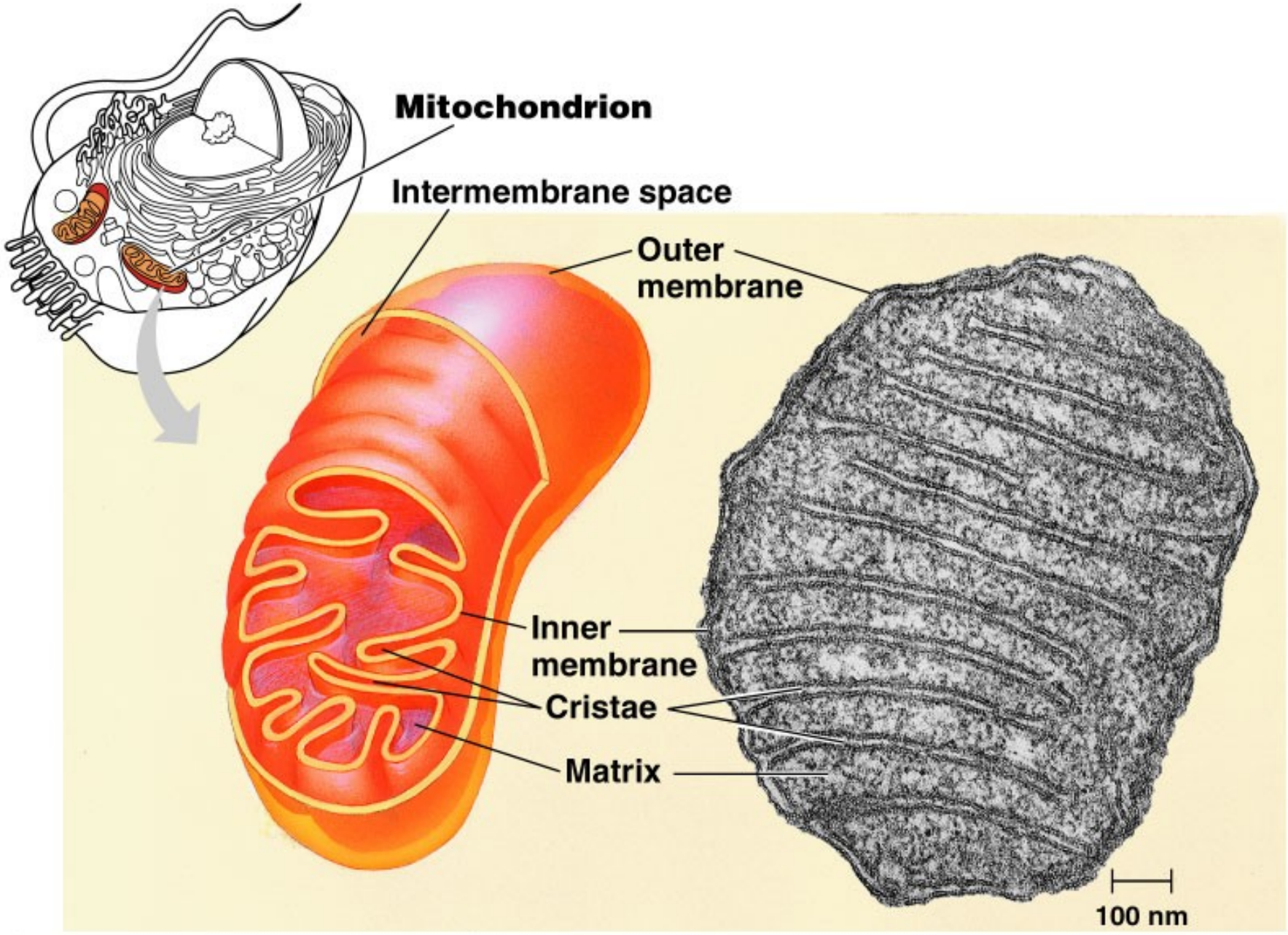
- Site of proteins synthesis.
- They are either bound to the endoplasmic reticulum or lie free in the cytoplasm.

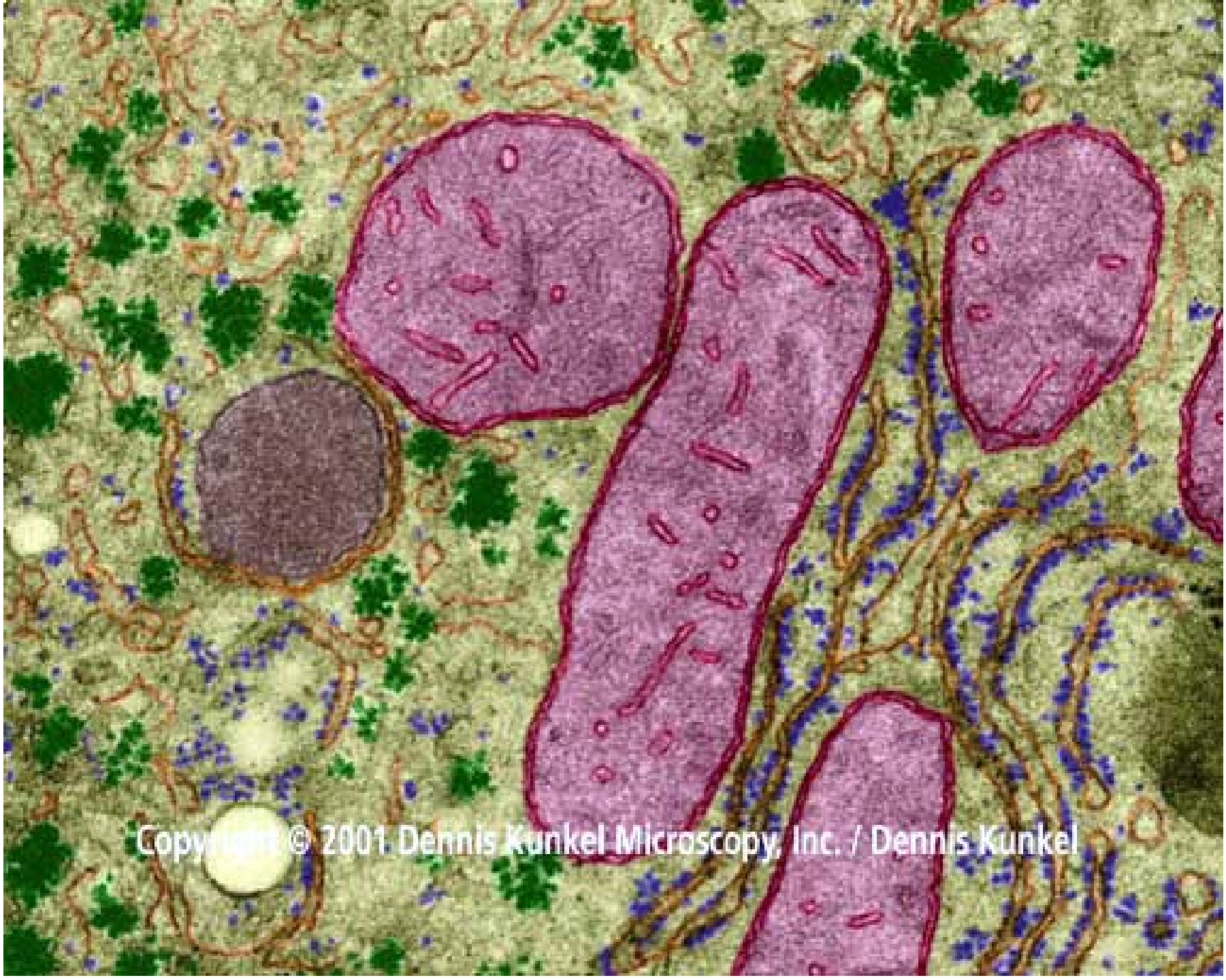


- The **sites of cellular respiration**.
- Principle site of energy production.
- Energy generated or released in the form of **ATP (adenosine triphosphate).**






Mitochondrion
Intermembrane space
Outer membrane
Inner membrane
Cristae
Matrix
100 nm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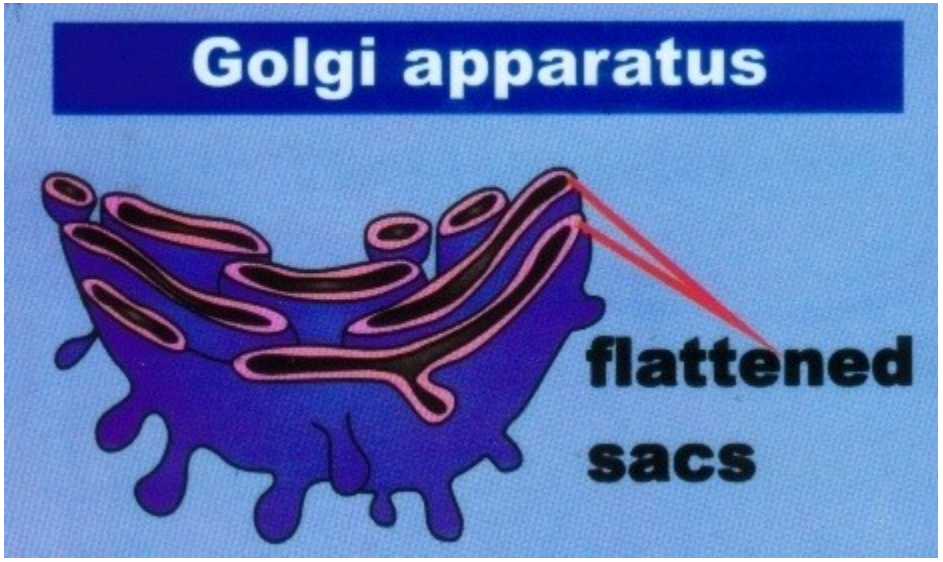

- Functions as a **processing, packaging and transport centre** of carbohydrates, proteins and glycoproteins.
- These materials will be membrane-bound and secrete through vesicles.


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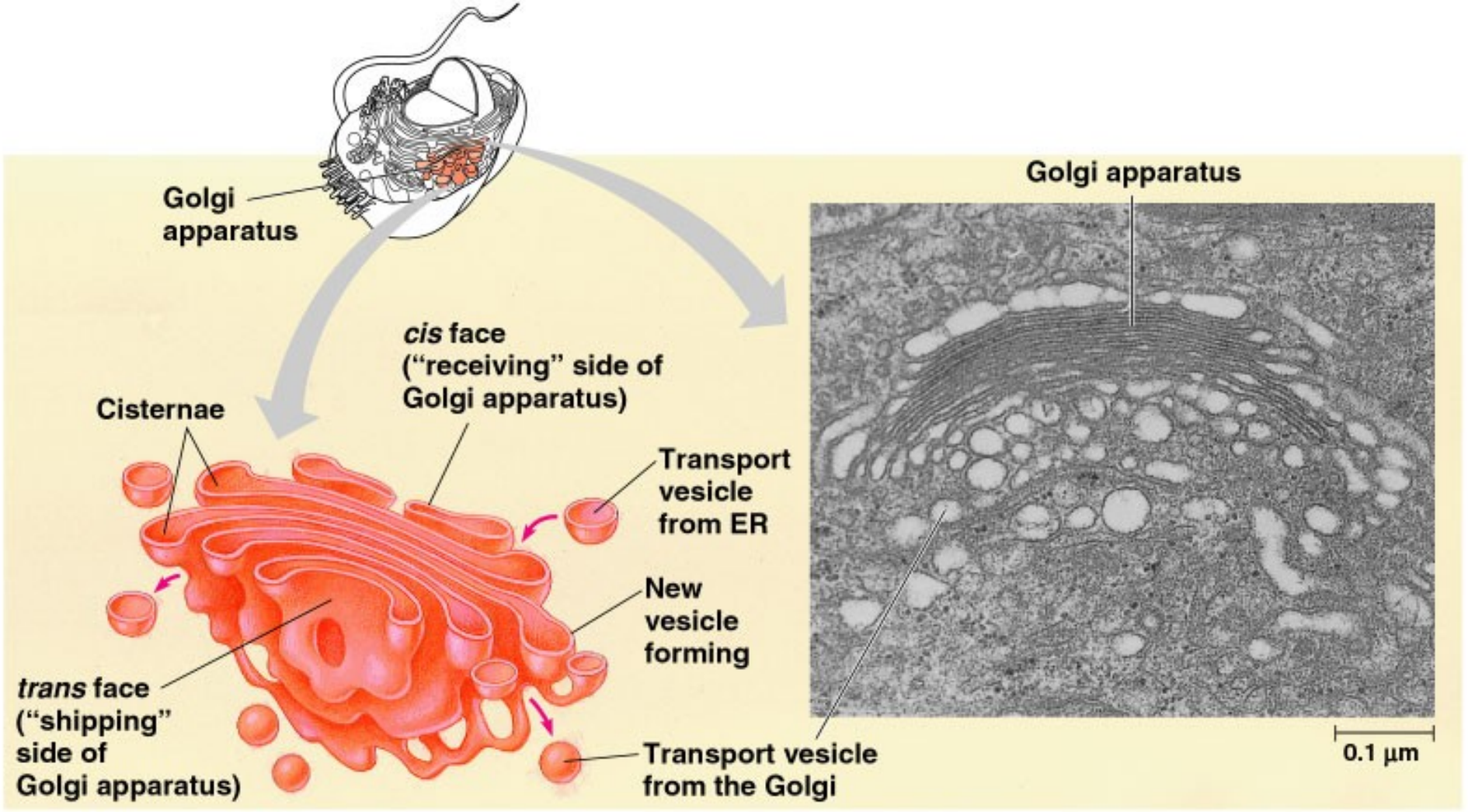
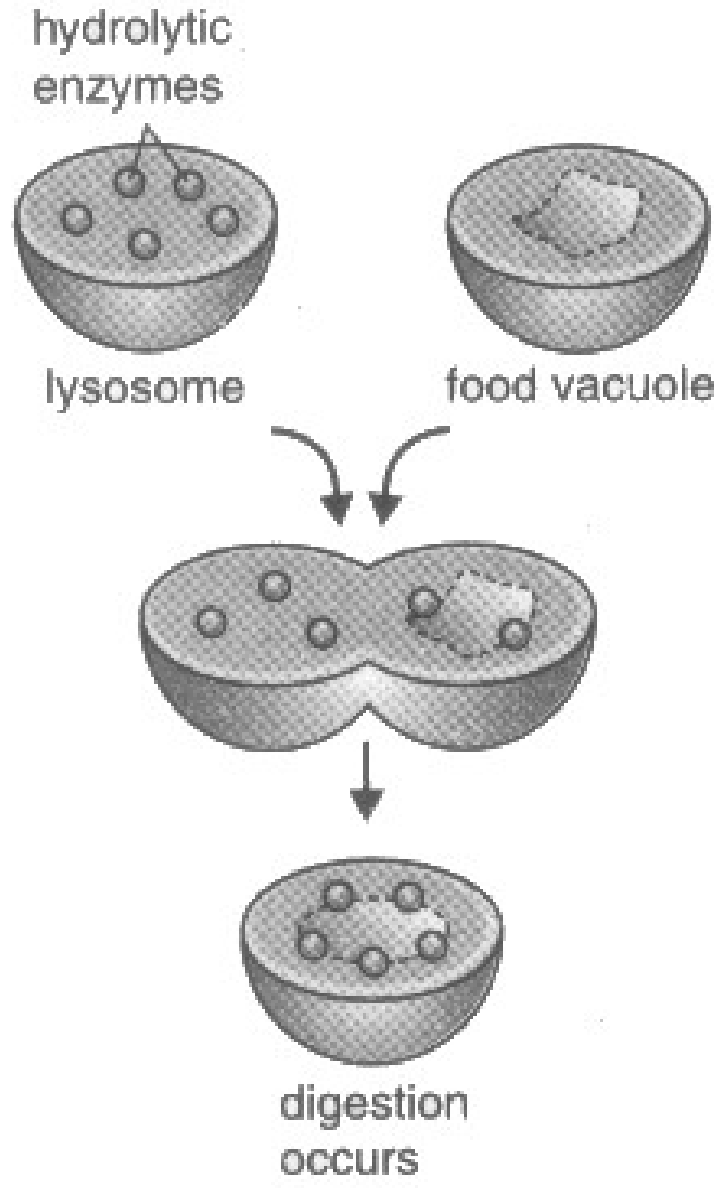
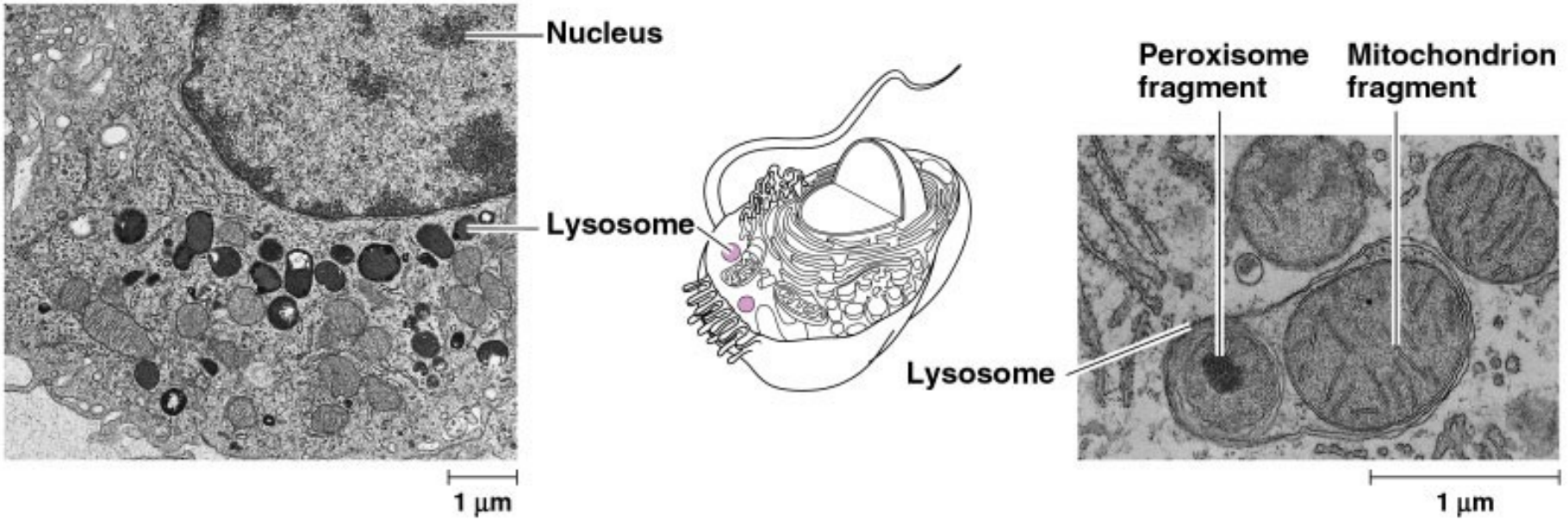

Golgi apparatus
Golgi apparatus
Cisternae
cis face ("receiving" side of Golgi apparatus)
Transport vesicle from ER
New vesicle forming
trans face ("shipping" side of Golgi apparatus)
Transport vesicle from the Golgi
0.1 µm

Lysosomes

- As a **digestive compartments**.
- In certain unicellular organisms, lysosomes fuse with food vacuoles and dispense their enzymes into these vacuoles to digest the contents of the vacuoles

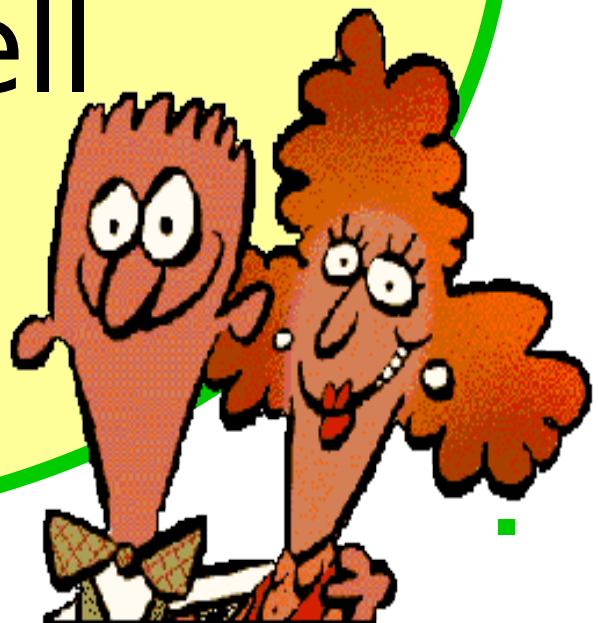




(a) Lysosomes in a white blood cell

(b) A lysosome in action

Comparison of an Animal Cell & a Plant Cell



Animal Cell

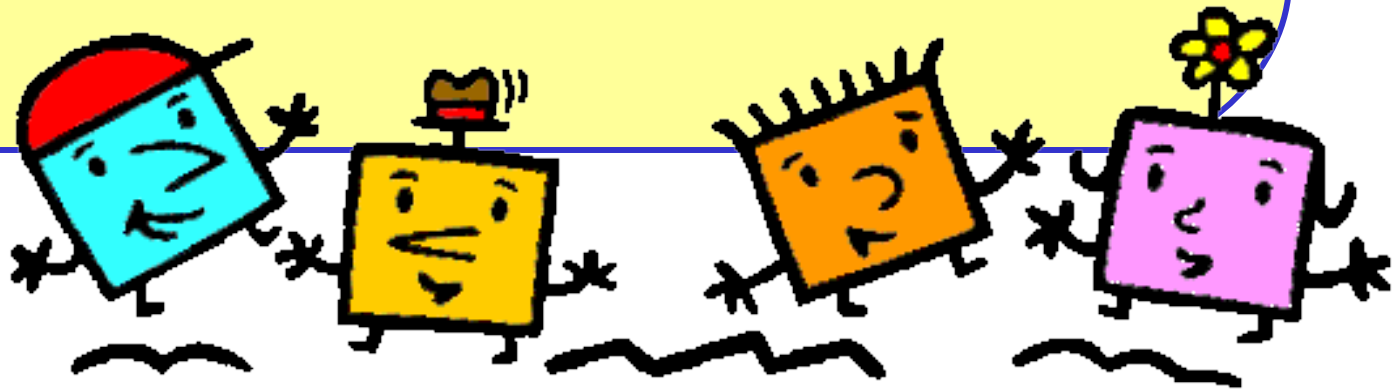
Plant Cell

Similarities

Both has nucleus, cytoplasm, mitochondrion, ribosome, cell membrane, rough endoplasmic reticulum, smooth endoplasmic recticulum and Golgi apparatus

Animal Cell	Differences	Plant Cell
Do not have fixed shape	Shape	Have a fixed shape
Do not have cell walls	Cell walls	Have cell walls
Do not have vacuoles. If present, vacuoles are usually small and numerous	Vacuoles	Have a large central vacuole
Do not have chloroplasts	Chloroplasts	All green plants have chloroplast which contain chlorophyll
Have centrioles	centrioles	Do not have centrioles
Carbohydrate is stored in the form of **glycogen**	Food storage	Carbohydrate is stored in the form of **starch**

The Density of Organelles in Spesific Cells



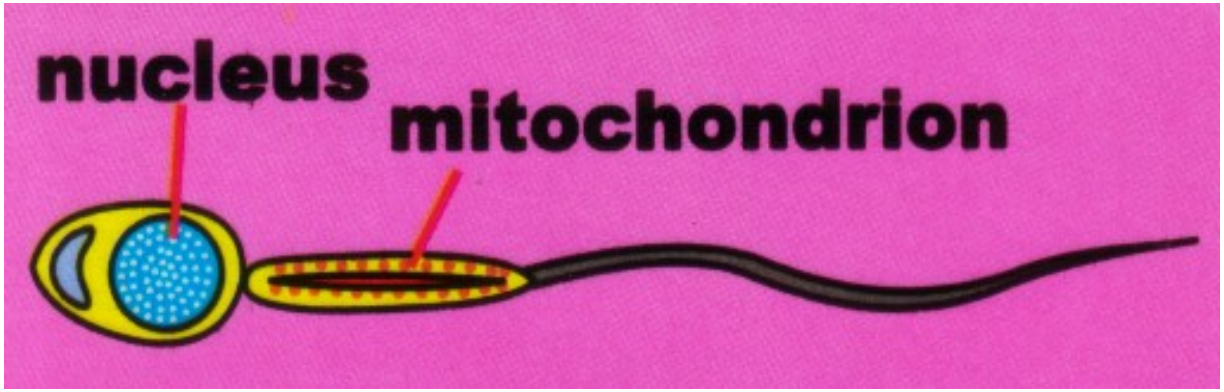
- The number of organelles in each cell varies according to type of organism and nature of the cell.

For example,

- more active cells will possess more **mitochondria** than less active cells.

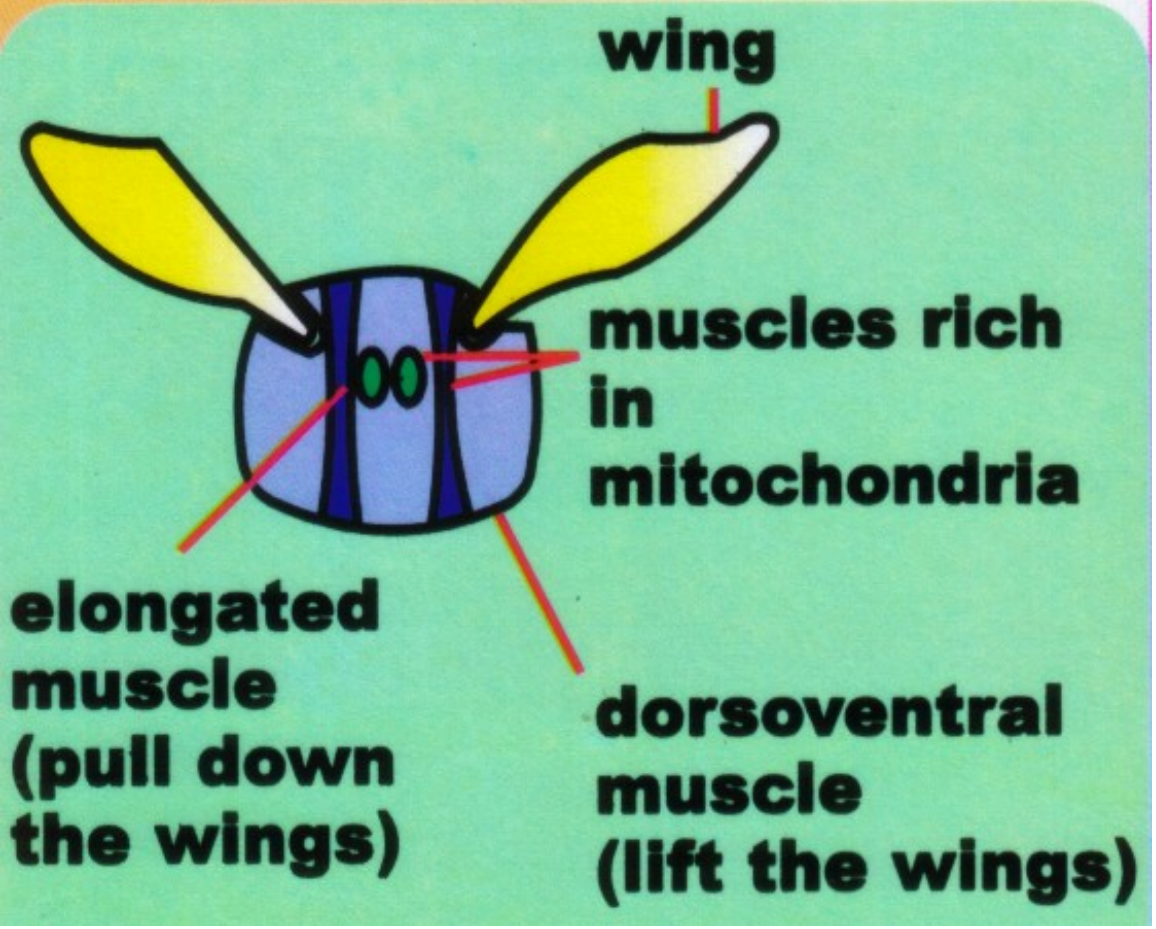
- Abundant **chloroplasts** are found in the **palisade mesophyll** cells than other parts of the leaves.

Sperm cells



Require energy to propel through the uterus towards the Fallopian tubes, so that fertilisation can take place.

High density of _____

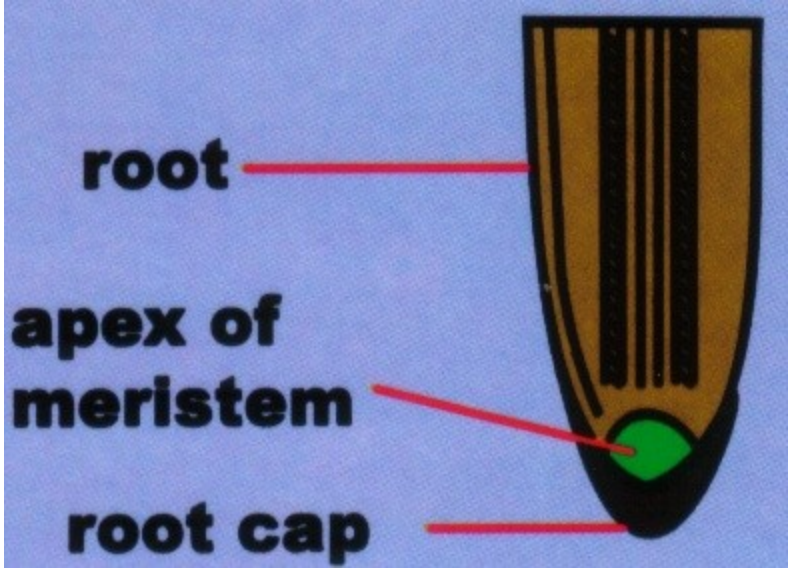


Muscle cells

Contract and relax to enable movement and flight

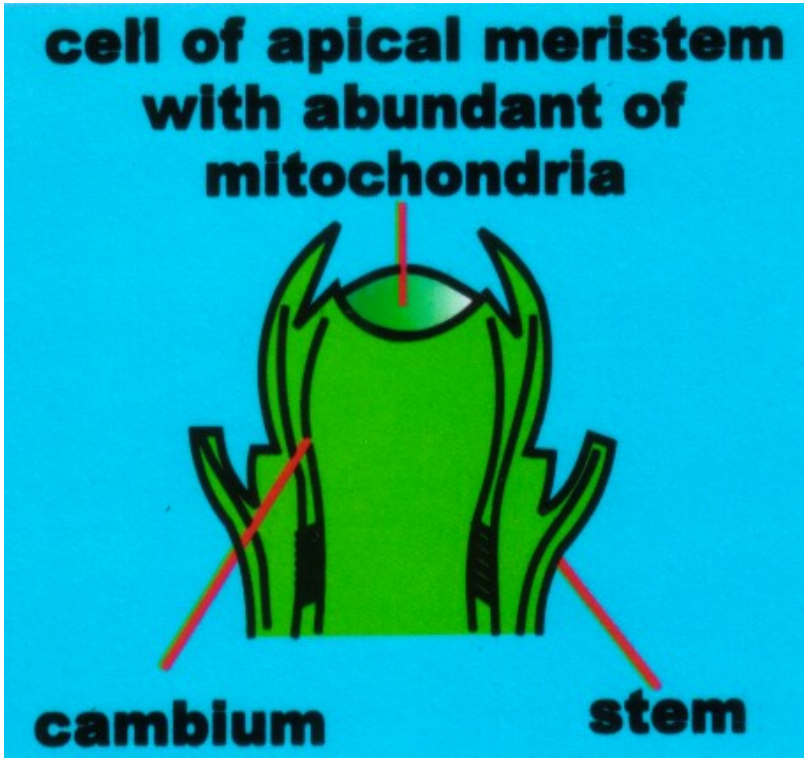
High density of _____

Cells in meristems

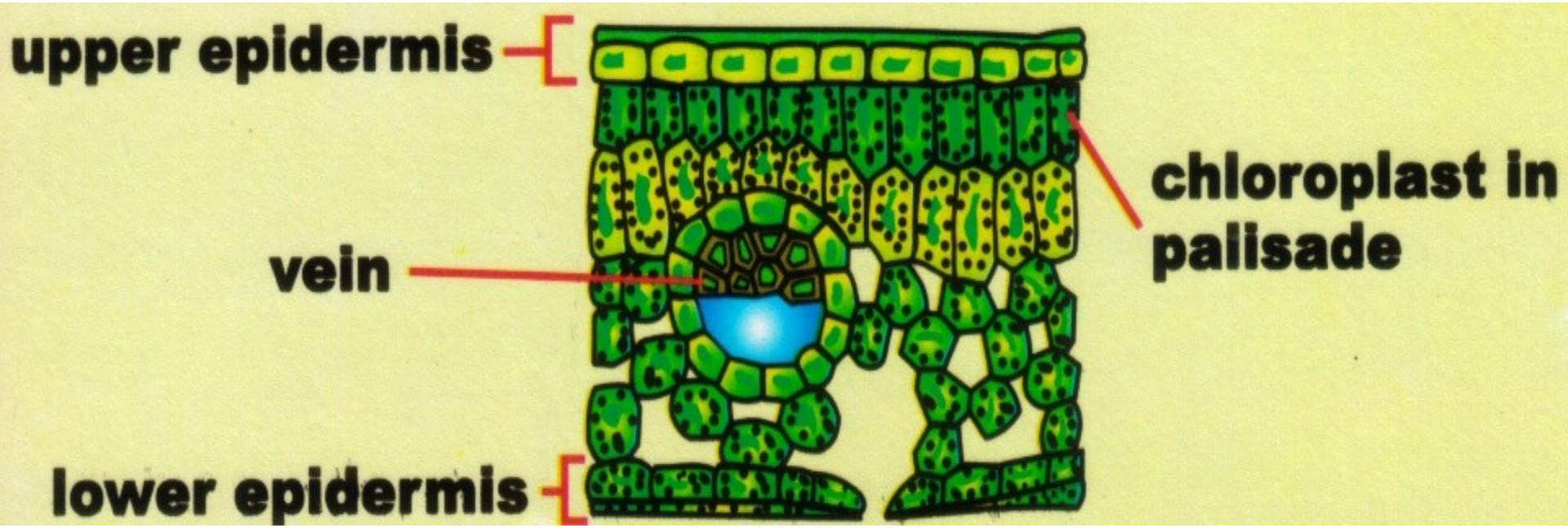


Require large amounts of energy during active cell division to produce new cells

High density of _____

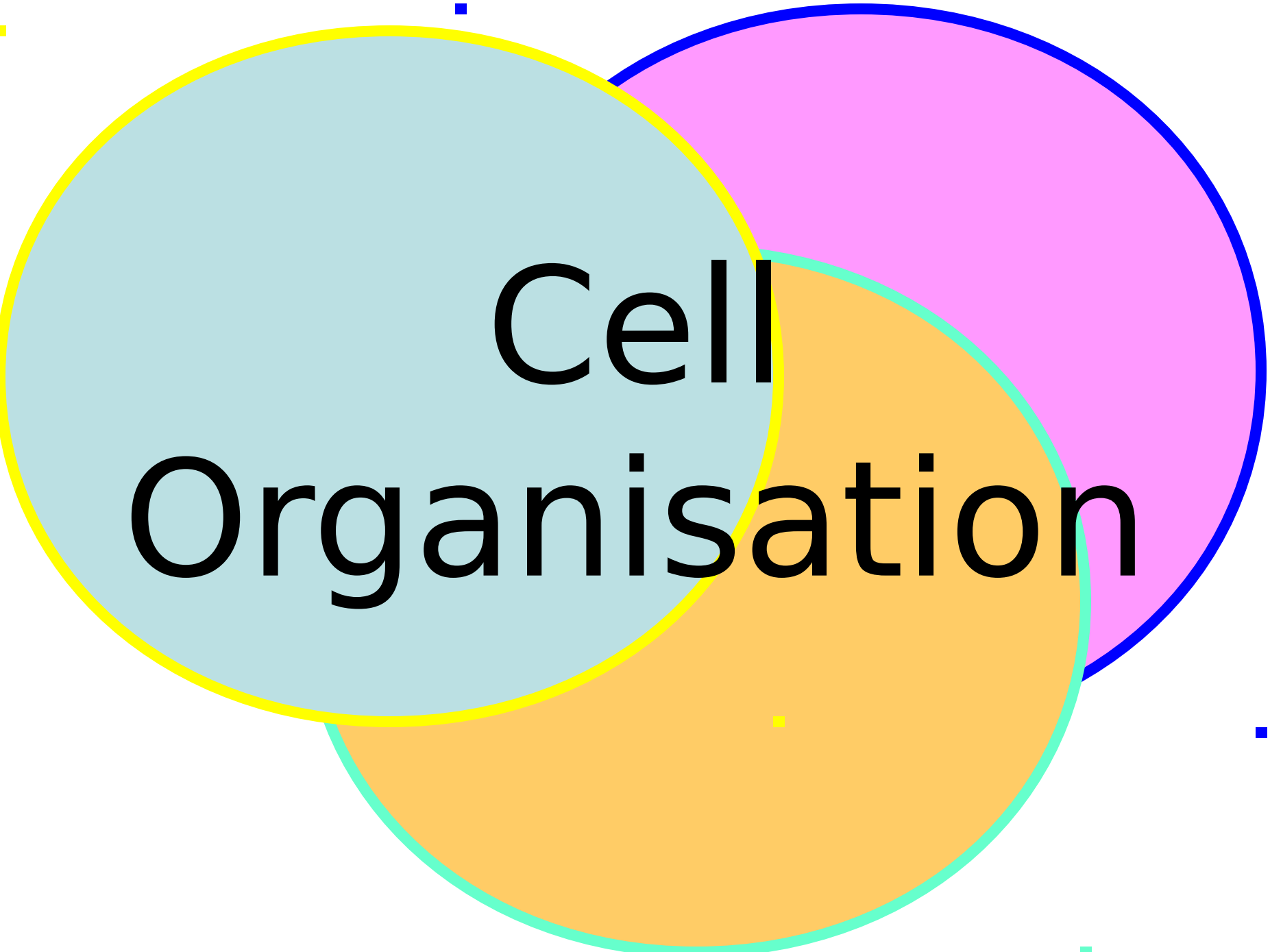


Mesophyll palisade cells



Absorb sunlight during photosynthesis

High density of _____


Cell
Organisation

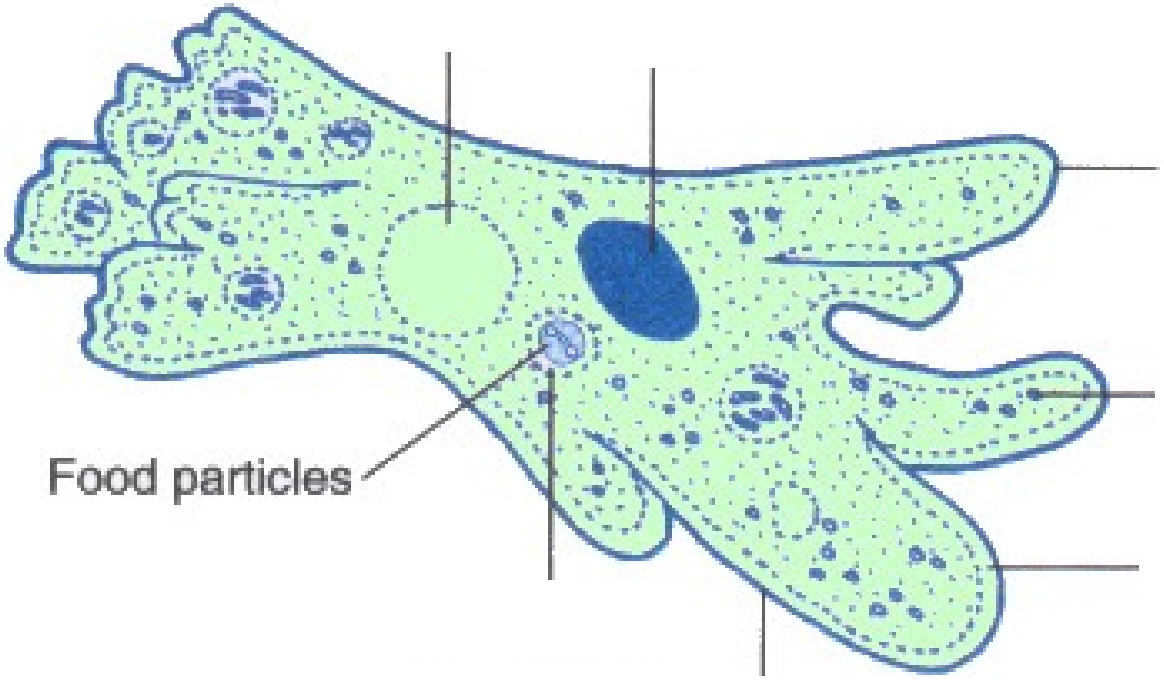
- **Unicellular organisms** are organisms which consist of single cell.

- Although simple, they are able to perform all vital functions and living processes within a cell.

- They can feed, respire, excrete and move.

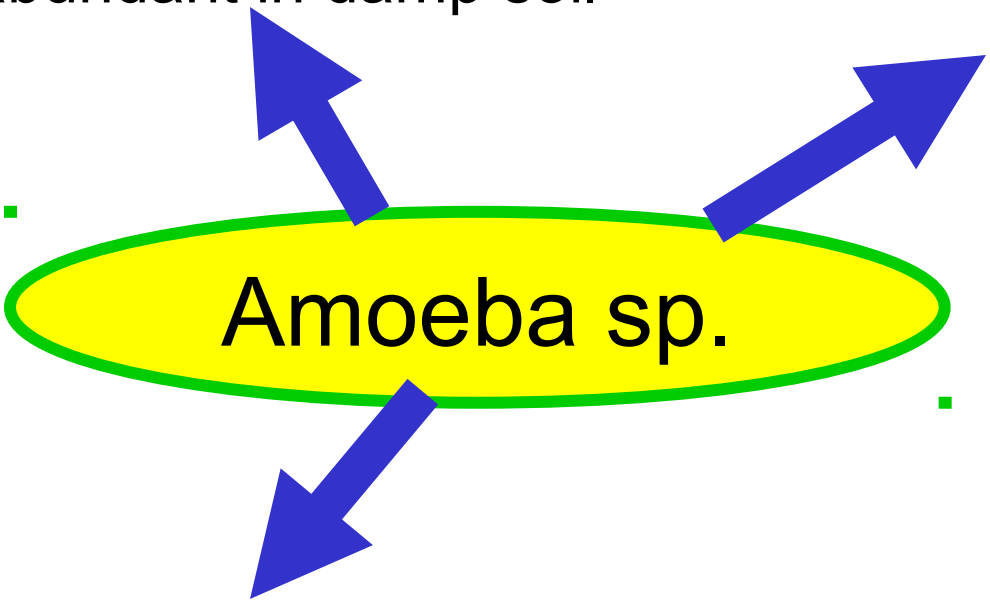
- They are sensitive to external and internal conditions, and are able to reproduce and grow.

Amoeba sp.



Habitat

- Live in freshwater lakes, are also abundant in damp soil

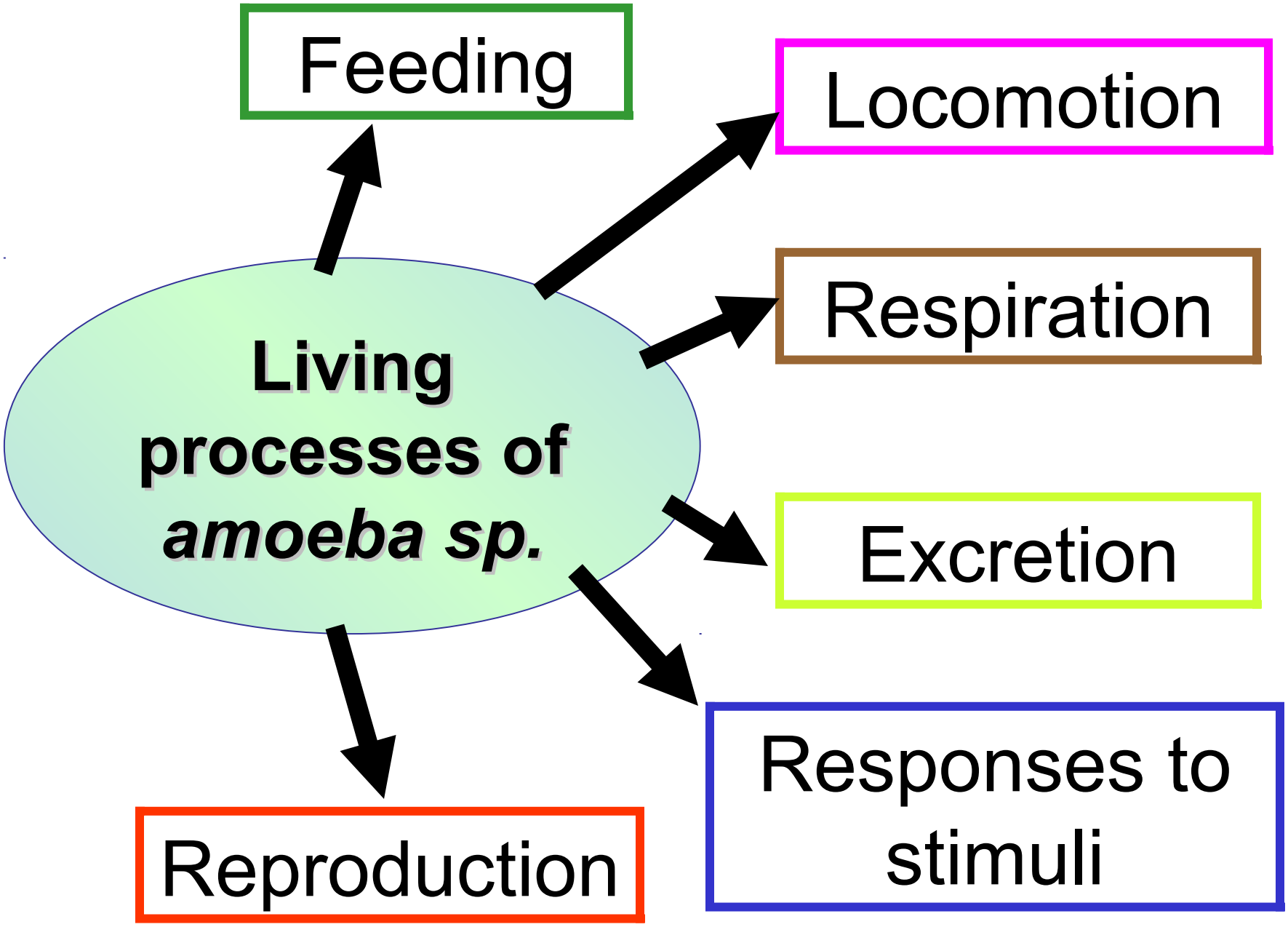


Living processes

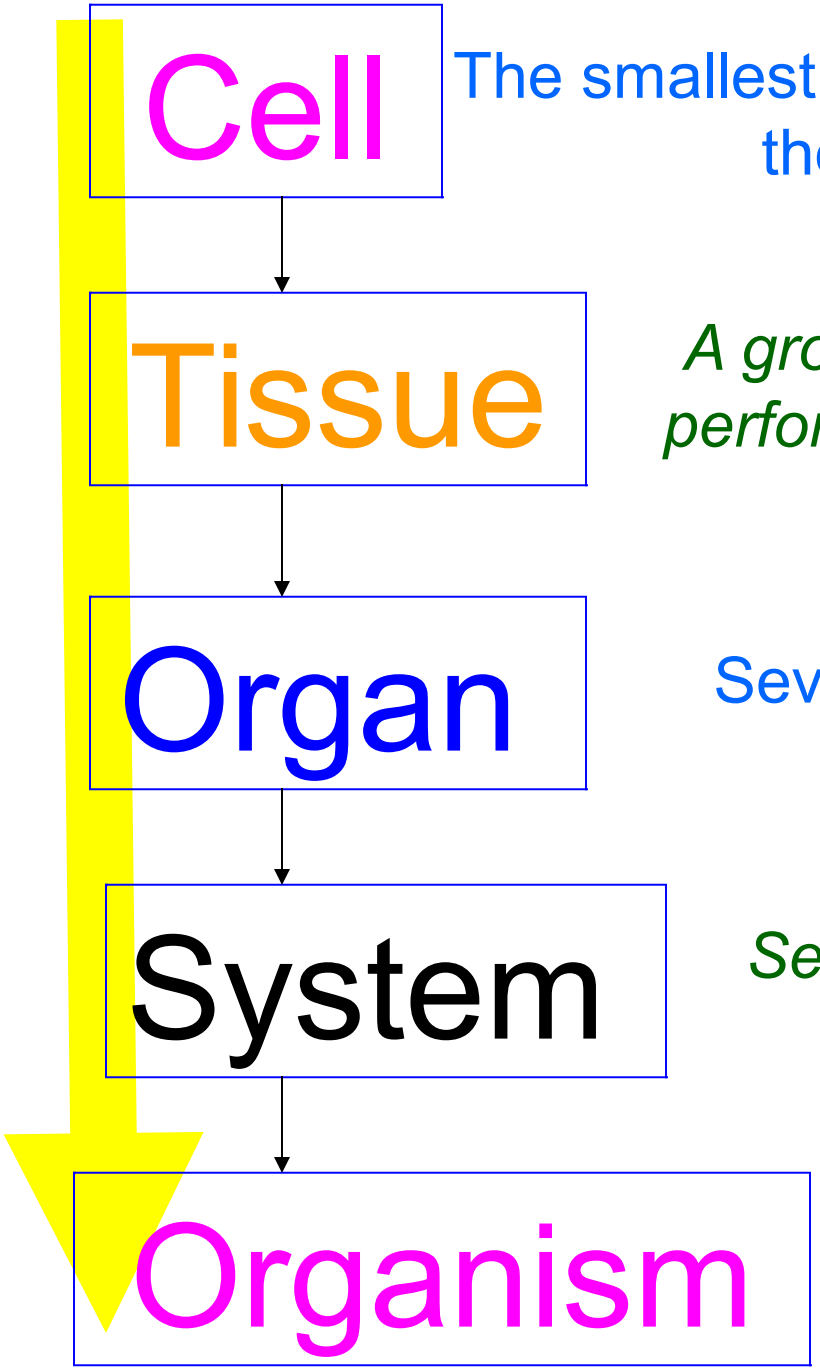
- Feeding
- Locomotion
- Respiration
- Excretion
- Respond to stimuli
- Reproduction

General characteristics

- Enclosed by a plasma membrane.
- Changes its shape constantly as it meets obstacles and responds to stimuli.


Feeding
Locomotion
Respiration
Living processes of *amoeba sp.*
Excretion
Responses to stimuli
Reproduction

Cell Specialisation in multicellular organisms



The smallest unit of life capable of carrying out all the functions of living things

A group of cells of the same type that perform a specific function in organism

Several types of tissue that carry out a particular function

Several organs working together to perform a function

All the systems make up a multicellular organism.

Cell organisation in the formation of tissues, organs and systems in animals

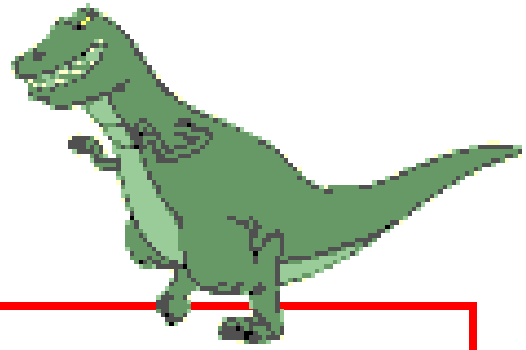
Some of the humans cells and their functions

Cell	Function
Muscle cell	*Able to contract and relax and are involved in movement*
White blood cell	*Involves in defence of the body against diseases*
Red blood cell	*Transports oxygen*
Nerve cell	*Receives and sends out nerve impulses*
Sperm	*Fertilises the ovum*

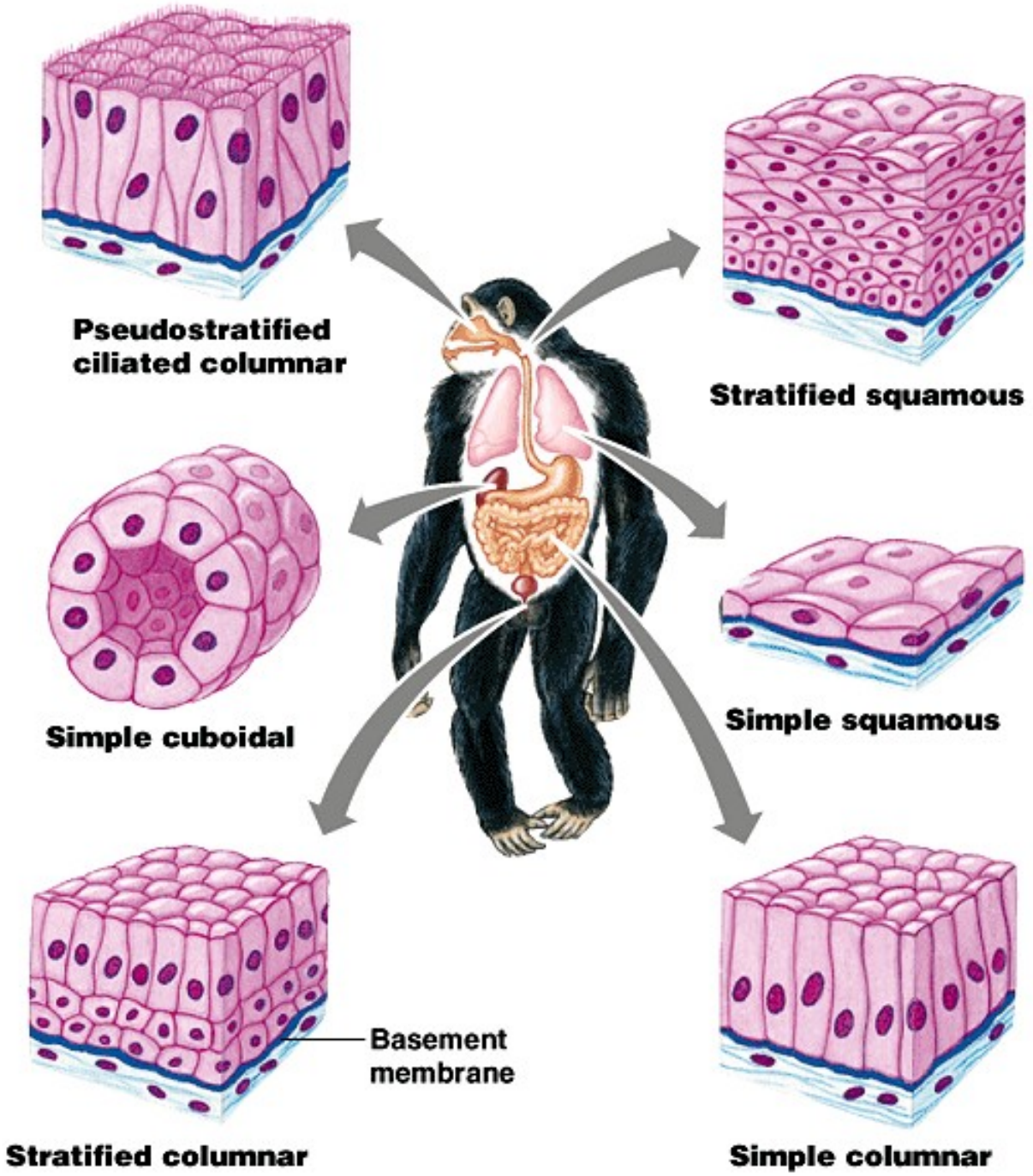
There are 4 major types of tissues in animals:

- Epithelial tissues
- Muscle tissues
- Connective tissues
- Nerve tissues

Epithelial Tissue

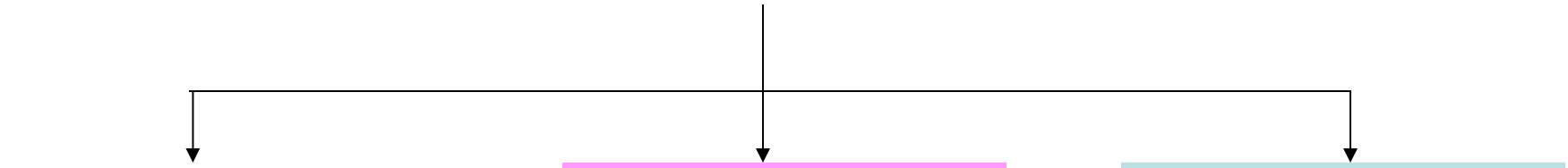


- Form a **skin surface** and protect the tissue beneath it.
- Form a **lining layer** for tubes or lines the cavities of the body.
- Protect against infection, mechanical injuries and dehydration.
- Undergo changes to form **glands**.



Muscle Tissue

- *Most abundant tissue in the body*



Smooth muscle

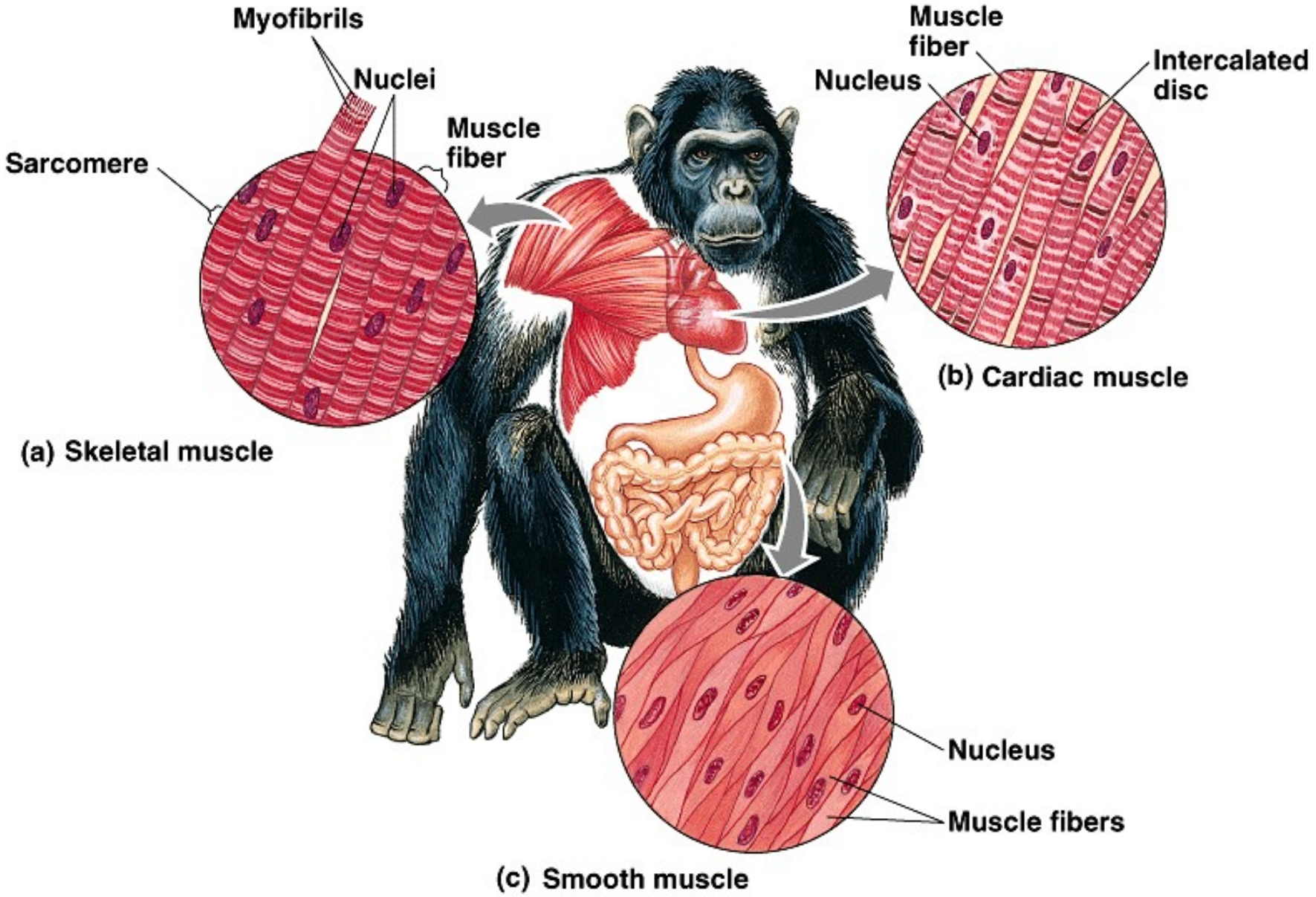
- Contraction and relaxation for involuntary body activities (peristalsis along digestive tract)

Skeletal muscle

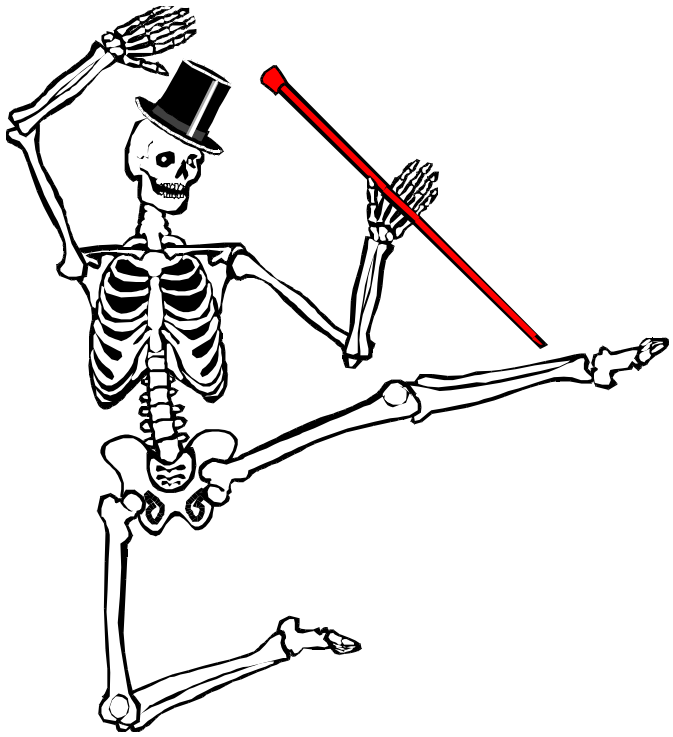
- Voluntary movements
- Contract and relax to move the bone

Cardiac muscle

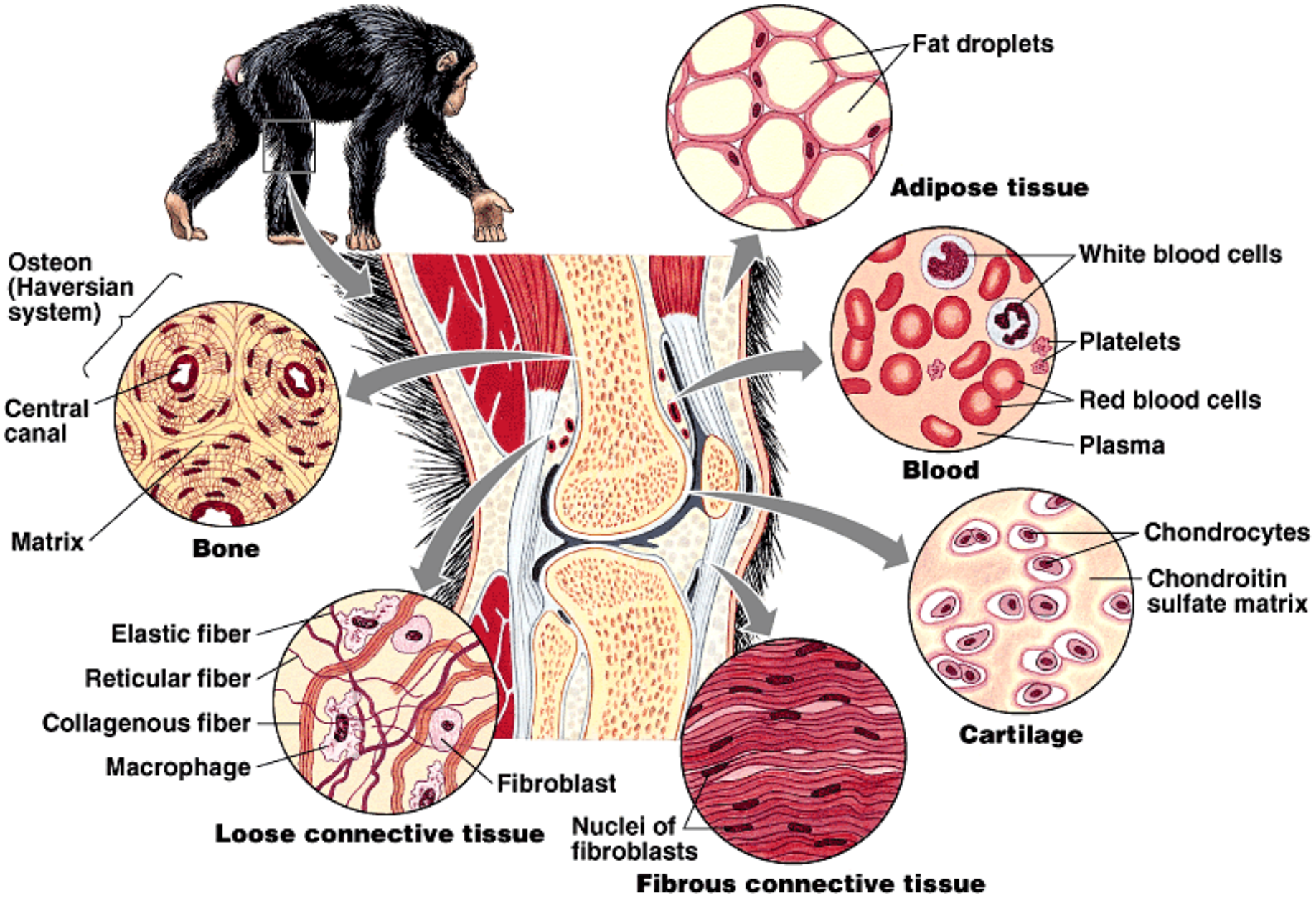
- Contract to pump blood to all parts of the body.
- Involuntary movements



Connective tissue

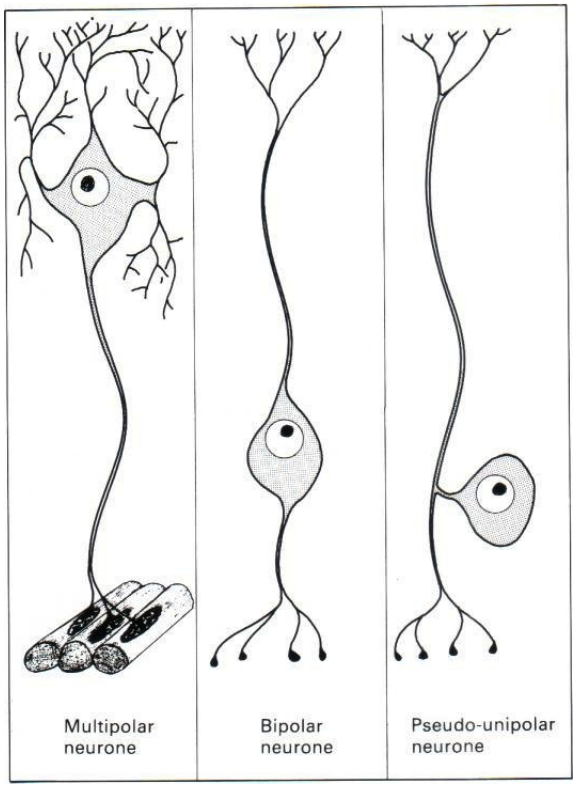


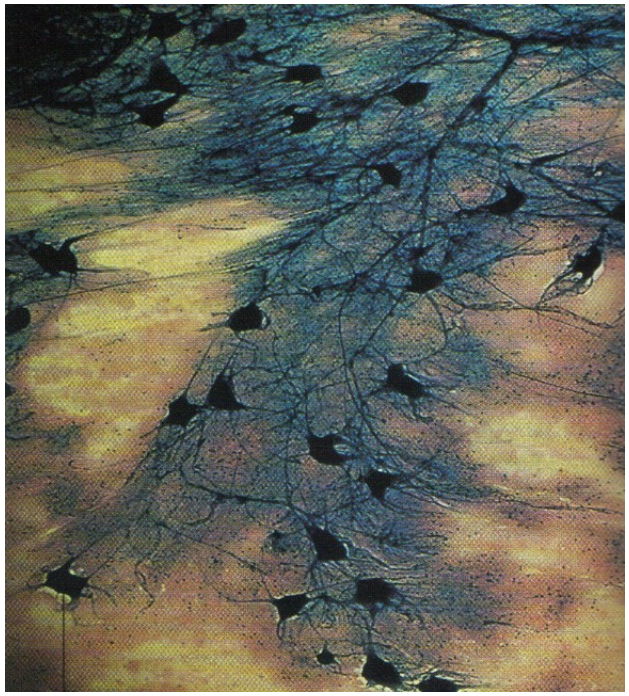
- Hold the body together.
- For example, bone, cartilage, blood, tendons, ligament.



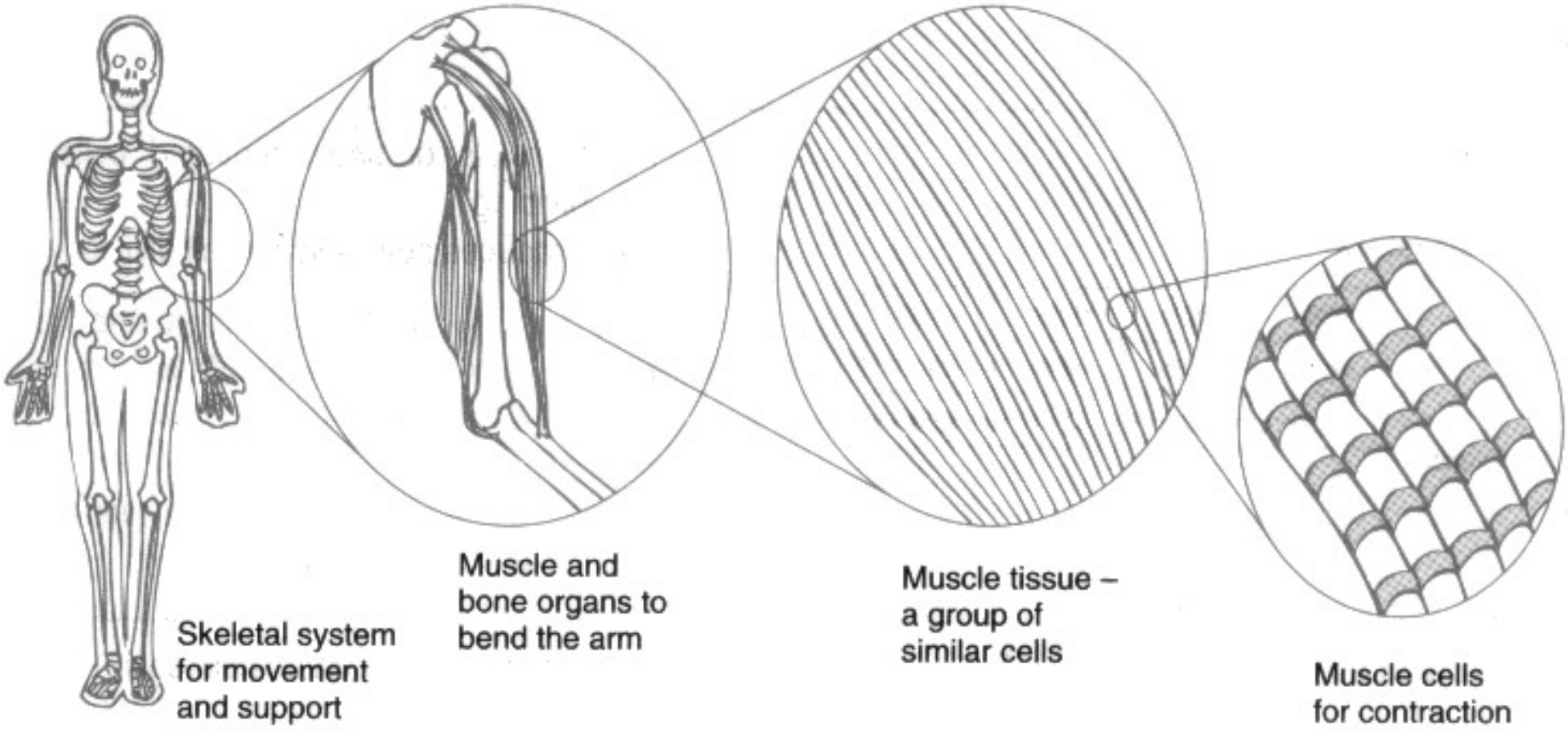
Nerve Tissue

- Transmits and coordinates messages around the body.



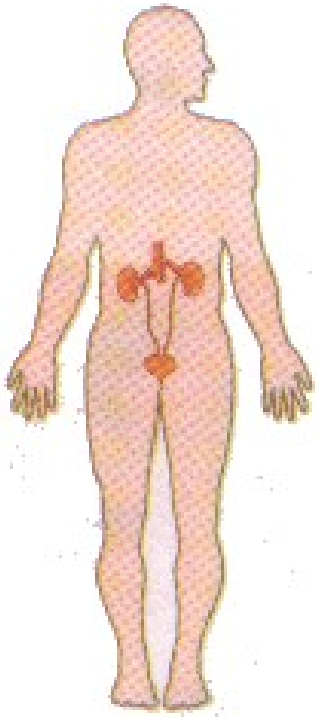


Relationship between cells, tissues, organs and systems.



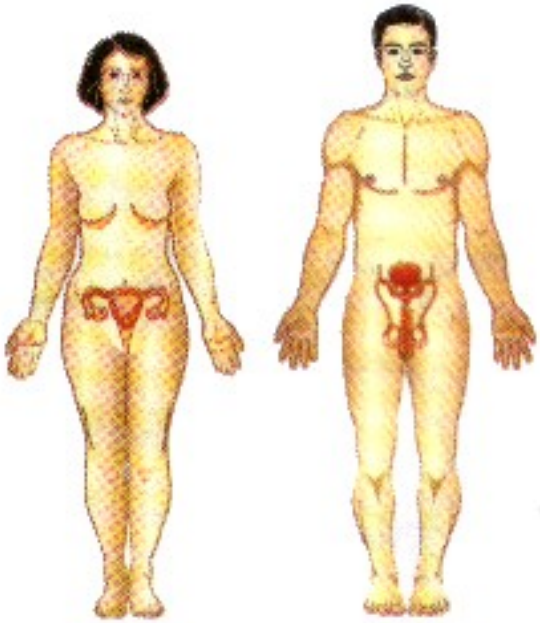
systems ← organs ← tissues ← cells

Systems



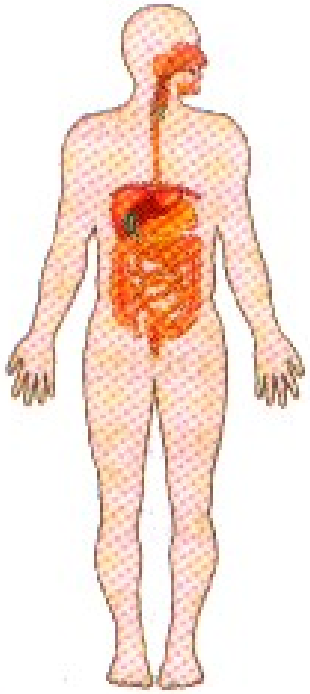
Excretory system

Discards toxic waste products



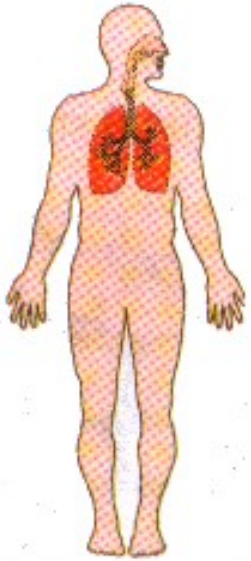
Reproductive systems

Produces off spring



Digestive system

Breaks down complex food into simple substances for easy absorption by body cells



Respiratory system

Absorbs and transports oxygen and discards carbon dioxide

Circulatory system

Transports food substances, oxygen, hormones and others to the entire body

Lymphatic system

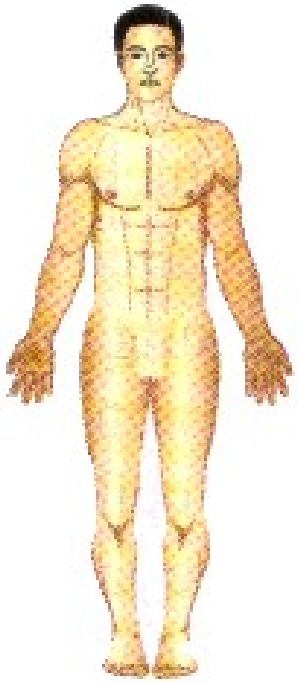
Defends the body against disease

Skeletal system

Provides bodily support and protection to solf internal organs

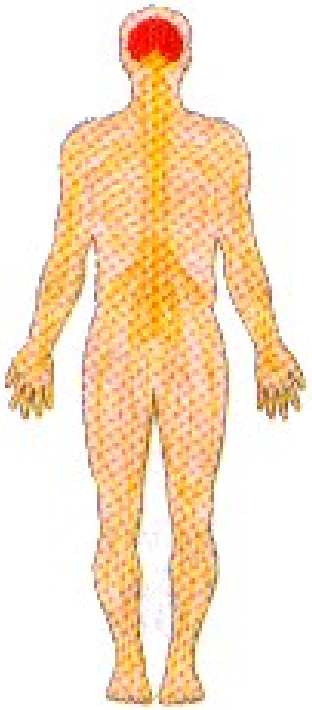
Endocrine system

Produces hormones that control the bodily activities



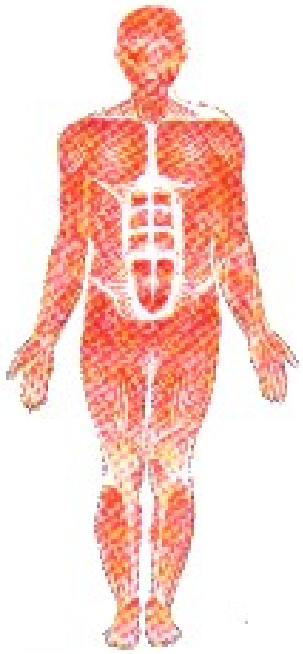
Integumentary system

Skin surface to protects the tissue beneath it.



Nervous system

Coordinates and controls all bodily activities related to impulses and reactions



Muscular system

Helps in movement of the body.

Cell organisation in plants

Some of the plants cells and their functions

Cell	Function
Parenchyma cell	For support and storage
Xylem	Transports water and mineral salts
Sieve tube element	Transports organic product of photosynthesis
Companion cell	Regulates the metabolic activity of sieve tube element
Epidermal cell	For protection and covering of other cells beneath

Tissues of plants

Meristemic tissue

- Small cell, thin walls, large nuklei, dense cytoplasm, no vacuole.
- Young, actively dividing

permanent tissue

Epidermal tissues

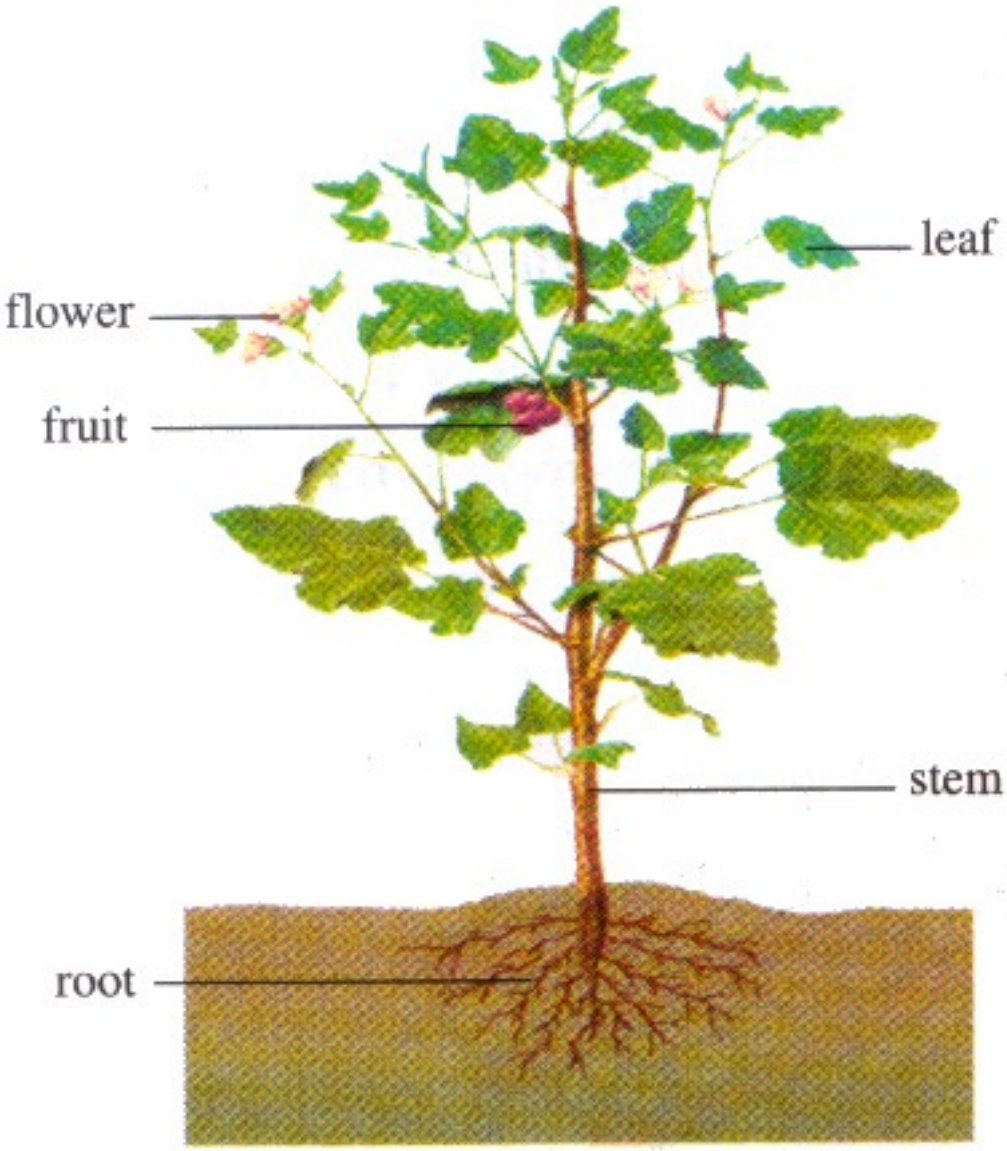
- Form a layer to cover, protect entire surface of plant and reduces water loss

Ground tissues

- Provides support and strengthens the plants

Vascular tissues

- Transports water, food and support



Bears flowers, fruits, buds and leaves

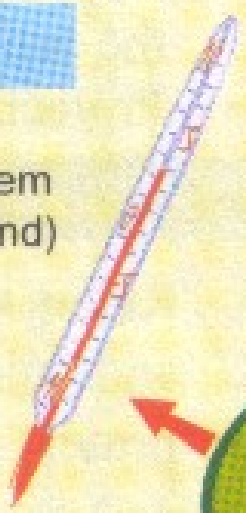
Anchors the plant, absorbs water and mineral, stores food.

Internal Environment

- refers to the tissue fluid or interstitial fluid surrounding the cell.

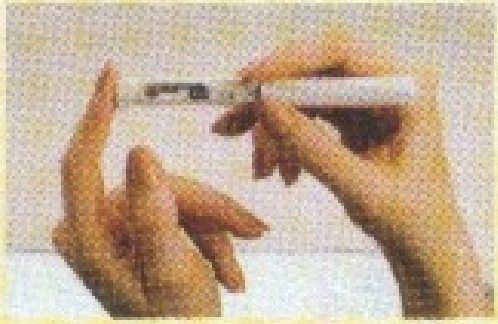
Temperature

Regulated by
- integumentary system (skin and sweat gland)
- nervous system
- circulatory system
- muscular system
- endocrine system



Blood glucose level

Regulated by
- endocrine system (pancreas)
- circulatory system



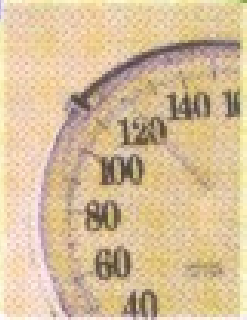
Factors affecting the internal environment

Concentration of oxygen and carbon dioxide in the blood

Regulated by
- Circulatory system
- Nervous system

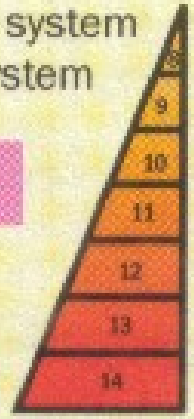
Osmotic pressure of blood

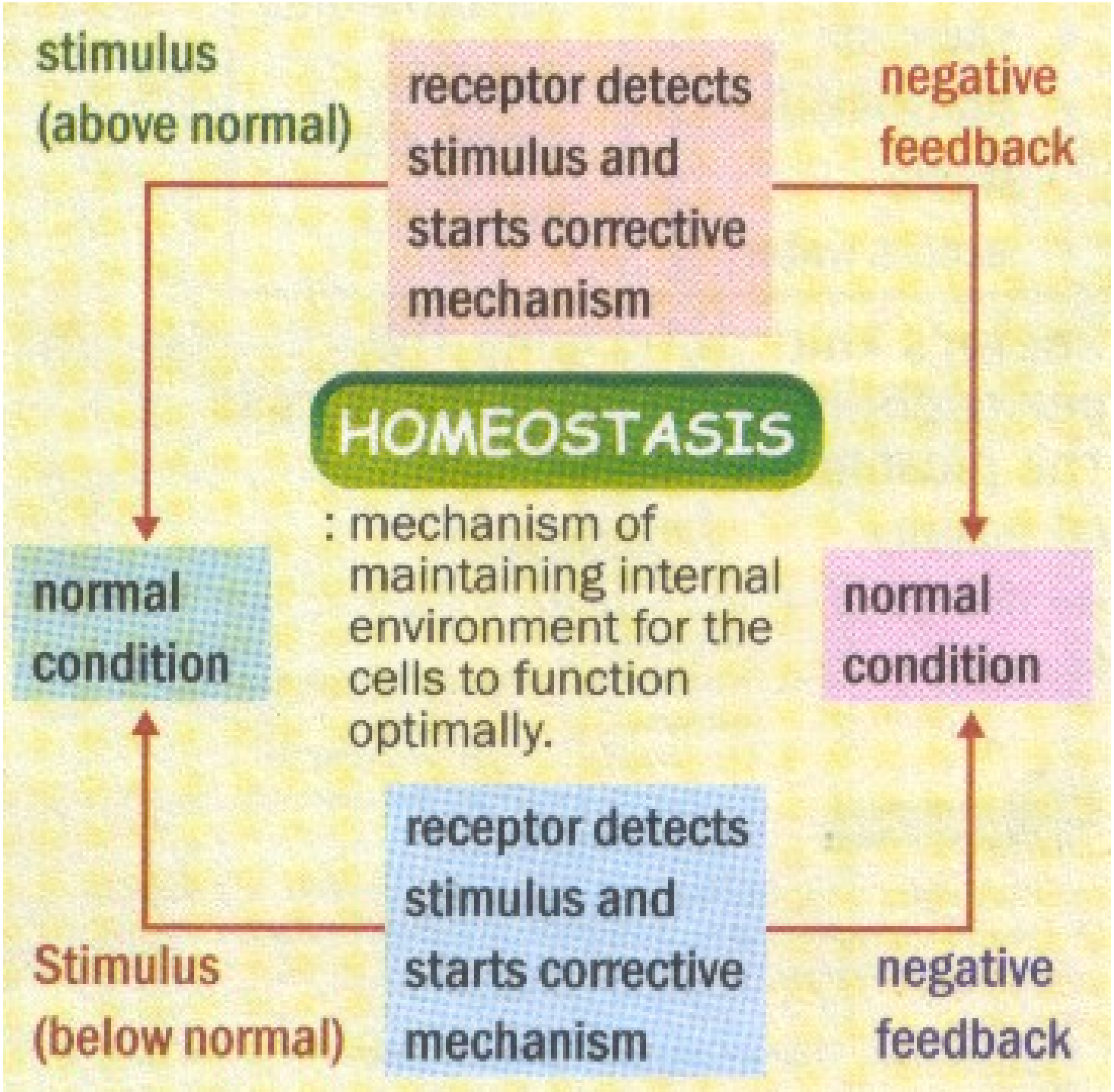
Involves the
- nervous system
- endocrine system
- excretory system
- circulatory system



pH value

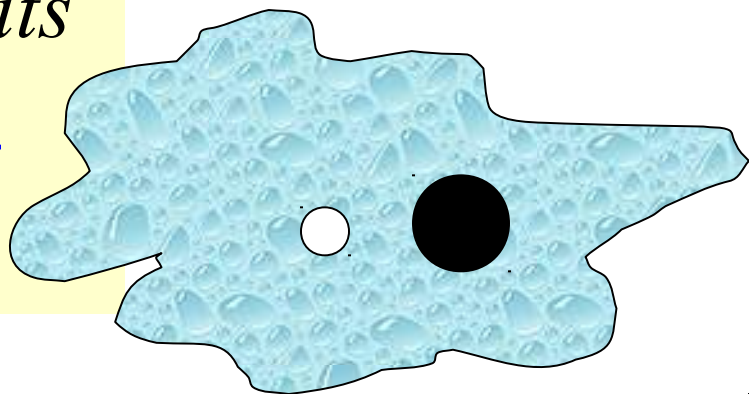
Involves the
- respiratory system
- circulatory system
- excretory system




stimulus
(above normal)
receptor detects
stimulus and
starts corrective
mechanism
negative
feedback
HOMEOSTASIS
: mechanism of
maintaining internal
environment for the
cells to function
optimally.
normal
condition
normal
condition
receptor detects
stimulus and
starts corrective
mechanism
Stimulus
(below normal)
negative
feedback

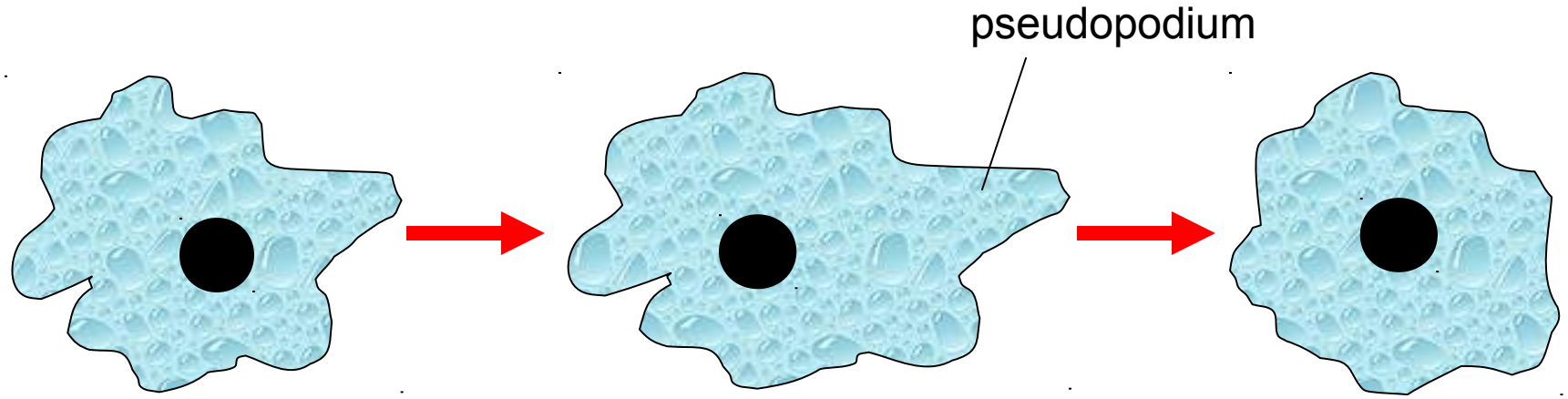
Excretion of Amoeba sp.

- *The **contractile vacuole** is involved in osmoregulation.*
- *Water diffuses into the cell and fills the contractile vacuole.*
- *When the vacuole is filled to its maximum size, it contracts to expel its contents.*

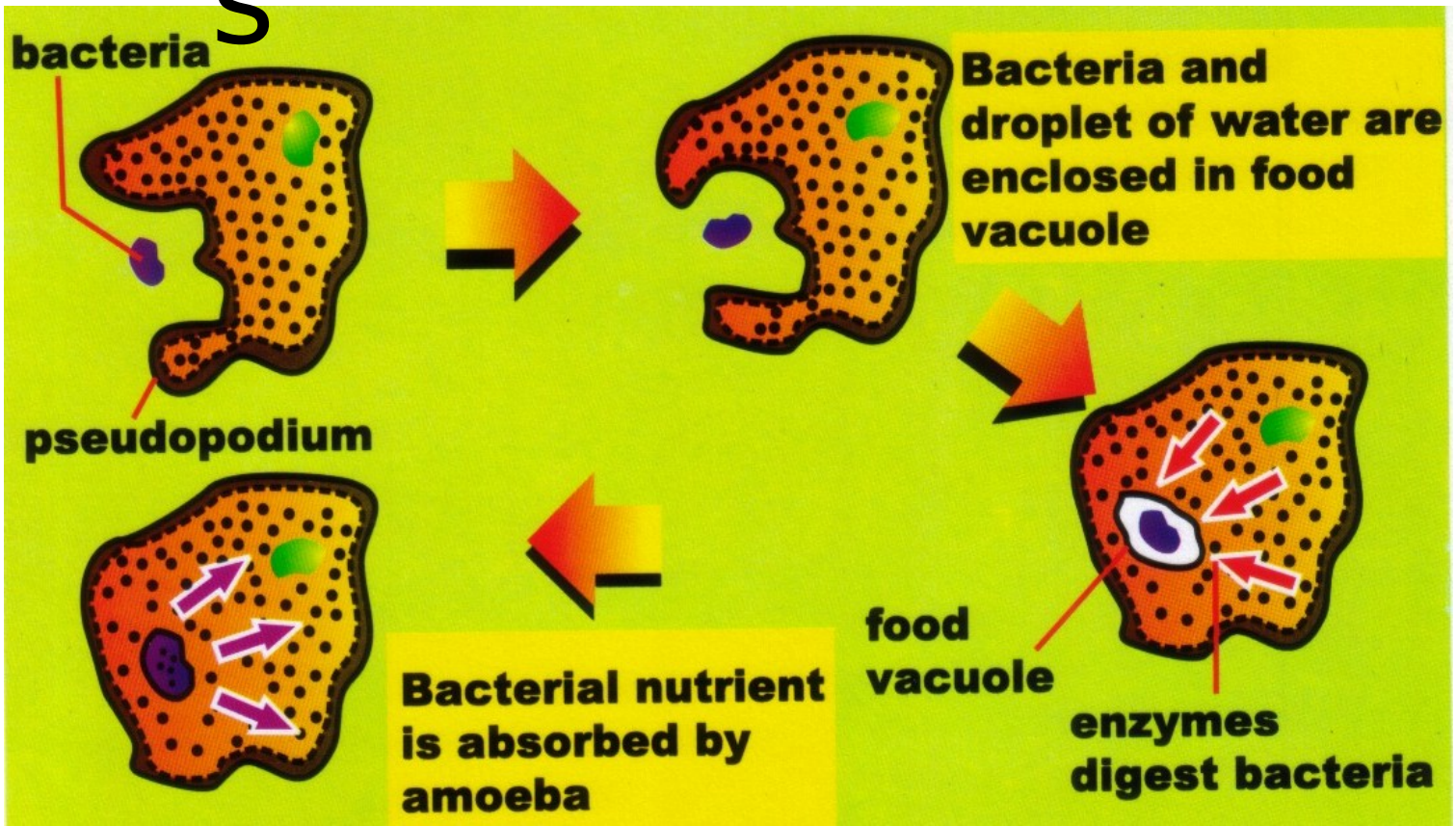


Locomotion

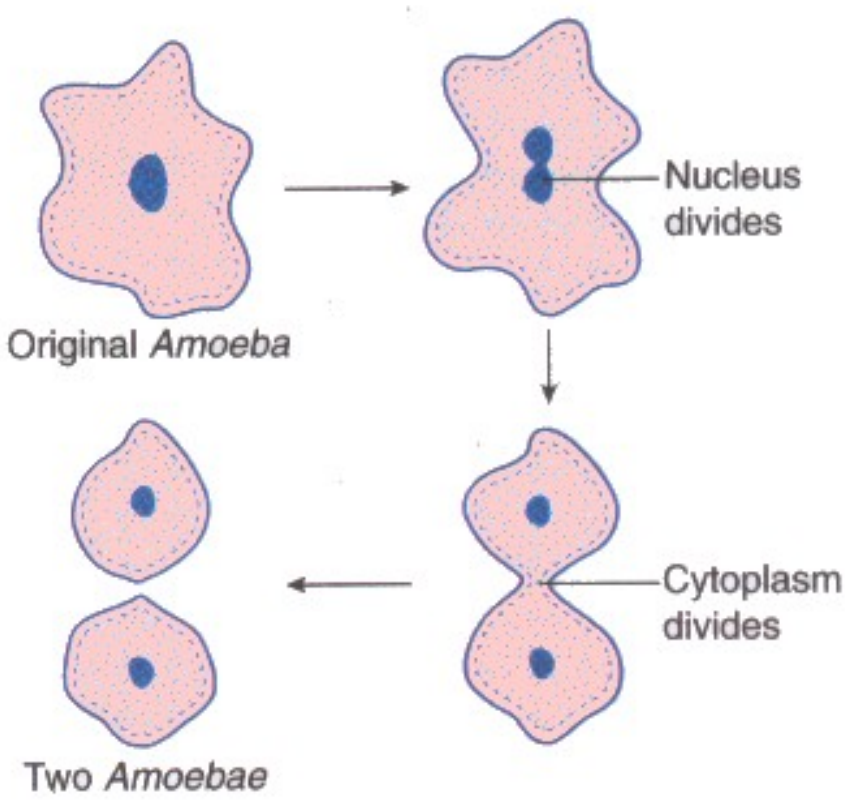
- Amoeba sp. moves by **cytoplasmic projection**, that is, *by extending its* **pseudopodia** *or 'false feet' and anchoring the tips to the ground*.



Phagocytosis

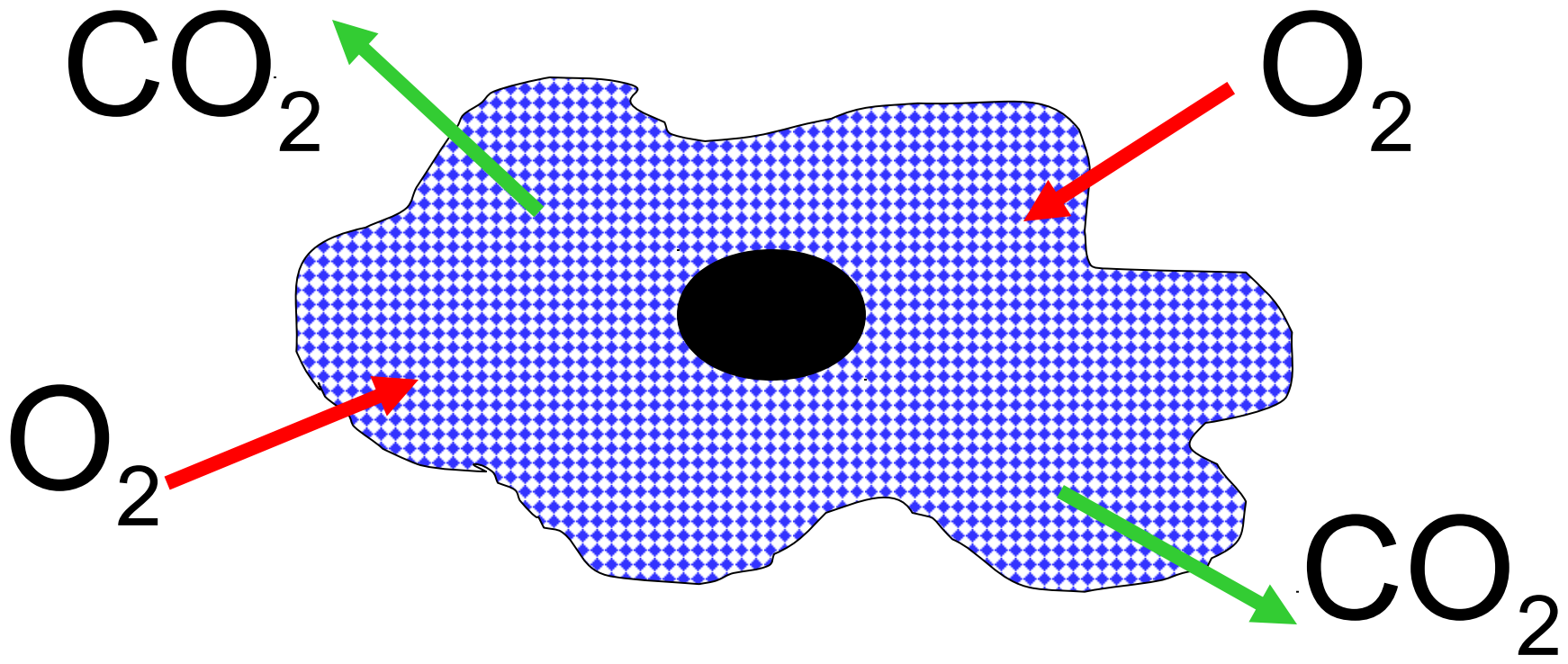


Binary fission



- Asexual reproduction.
- When food abundant, binary fission.
- When the *amoeba* reaches a maximum size, the nucleus divides into two and the cytoplasm constricts, forming two new *amoeba*.

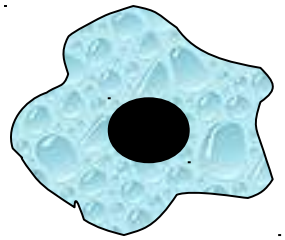
Respiration of Amoeba sp.



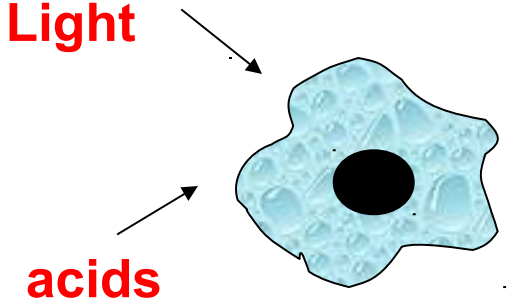
- Exchange of oxygen and carbon dioxide occurs through the plasma membrane.

Responses to stimuli

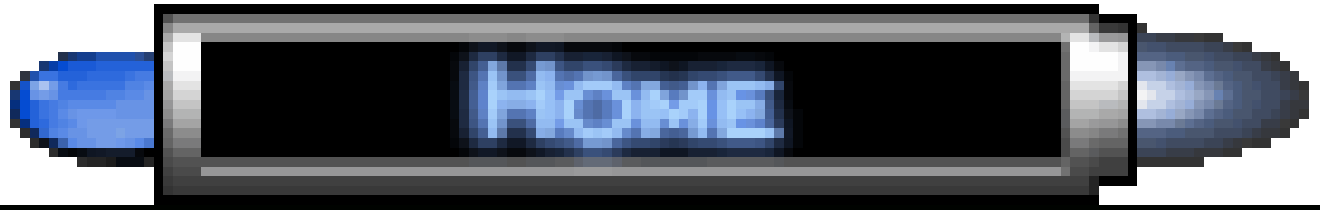
- *Amoeba sp. reacts by retreating from adverse stimuli such as bright light and acidic solution.*
- *In contrast, favourable stimuli such as contact with food, cause it to move towards the stimuli.*



Food



MOVEMENT OF SUBSTANCES ACROSS THE PLASMA MEMBRANE



The necessity for movement of substances across the plasma membrane

- All movement of substances go through the **cell membrane**, which is also known as the **plasma membrane**.
- The necessity for the movement of substances across a plasma membrane are:

a) Cells need nutrients and oxygen.

b) Cells produce waste product which exit through the plasma membrane.

c) The plasma membrane control the types and the amounts of substances needed by the cell at any one time.

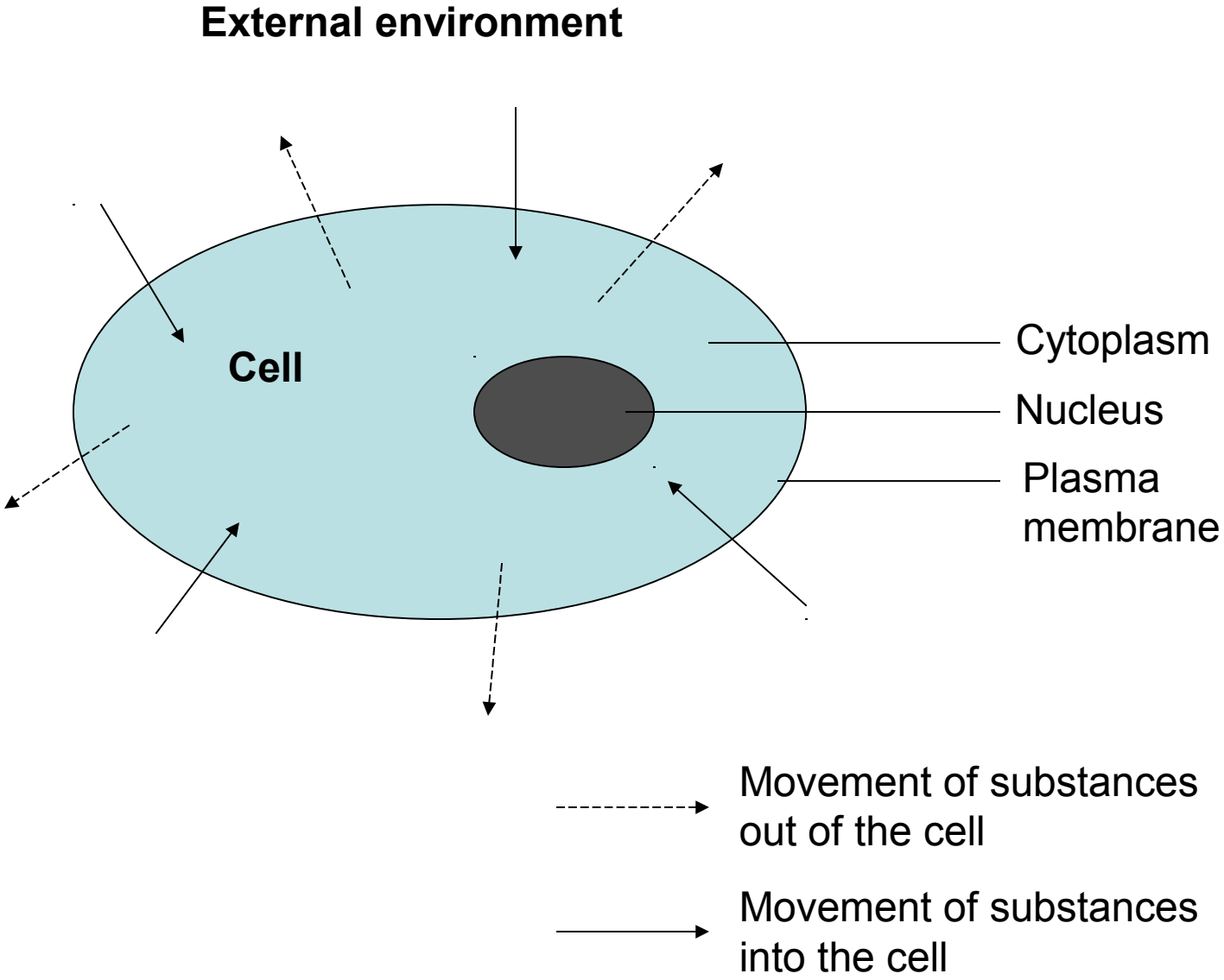


Figure 3.1: Movement of substances in and out of the cell

The structure of the plasma membrane

- Singer and Nicholson proposed the **fluid mosaic** model in 1972 to explain the structure of the plasma membrane
- The fluid mosaic model is the currently accepted model of the cell membrane.
- The basic unit of the plasma membrane is the phospholipid molecule.
- The phospholipid molecule consists of:

a) A polar molecule carries an unequal distribution of electric charge. This unequal distribution of electric charge produce a polar molecule which can attract other polar molecule such as water molecules.

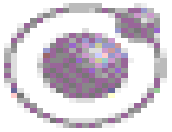
b) Hydrophilic means 'water-loving' or attracted to water molecule

c) Hydrophobic 'water-hating', or repelling water molecules.

- Phospholipid units (polar head) attract each other.
- One layer of phospholipid form over another to produce a phospholipid bilayer
- In this phospholipid bilayer the:

a) Hydrophilic heads points outwards facing water molecule on both sides.

b) Hydrophobic tails points inwards, away from water molecules.



- Other molecule present in the plasma membrane are:

a) **Cholesterol** molecules which fit in between the phospholipid molecules, making the plasma membrane more **rigid** and **stable**.

b) **Carrier protein** and **channel protein** which assist and control the movement of water-soluble ions and certain molecules across the membrane.

c) **Glycolipids** which are combination of **lipids** and **polysaccharides**, help cells to recognise each other.

d) **Glycoprotein** which are combination of **protein** and **polysaccharides**, also help cells to recognise each other.

Permeability of the plasma membrane

- **Permeability of the phospholipid bilayer.**

1. **Permeable means allowing something to pass through.**
2. **The plasma membrane is selective permeable or semi-permeable as it allows only certain substances to pass through it but not others.**
3. **The phospholipid bilayer is permeable to:**

a) **Small non-polar (hydrophobic) molecules that are lipid-soluble, such as fatty acids, glycerol, steroid, vitamin A, D, E and K.**

b) **Small unchanged molecules, such as water, oxygen and carbon dioxide. These molecules are small enough to squeeze through between the phospholipid gaps by simple diffusion or osmosis down their respective concentration gradients.**

4. **The phospholipid bilayer is not permeable to:**

a) **Large polar molecule, that are not soluble in lipid, such as glucose, amino acids, nucleic acids and polysaccharides.**

b) **Ions (charged), regardless of size, such as: H^+, Na^+, HCO_3^-, K^+, Ca^{2+}, and Mg^{2+}**

Types of transport across the plasma membrane.

1. Solute move across the plasma membrane by two main process:

a) Passive transport- which does not require a cell to use energy, and

b) Active transport- which requires a cell to use energy to move molecules through its cell membrane.

2. Passive transport consists of:

a) Simple diffusion and

b) Facilitated diffusion (aided by carrier protein or channel protein of the plasma protein).

3. Osmosis is the special name given to simple diffusion of water molecules through a semi-permeable membrane.

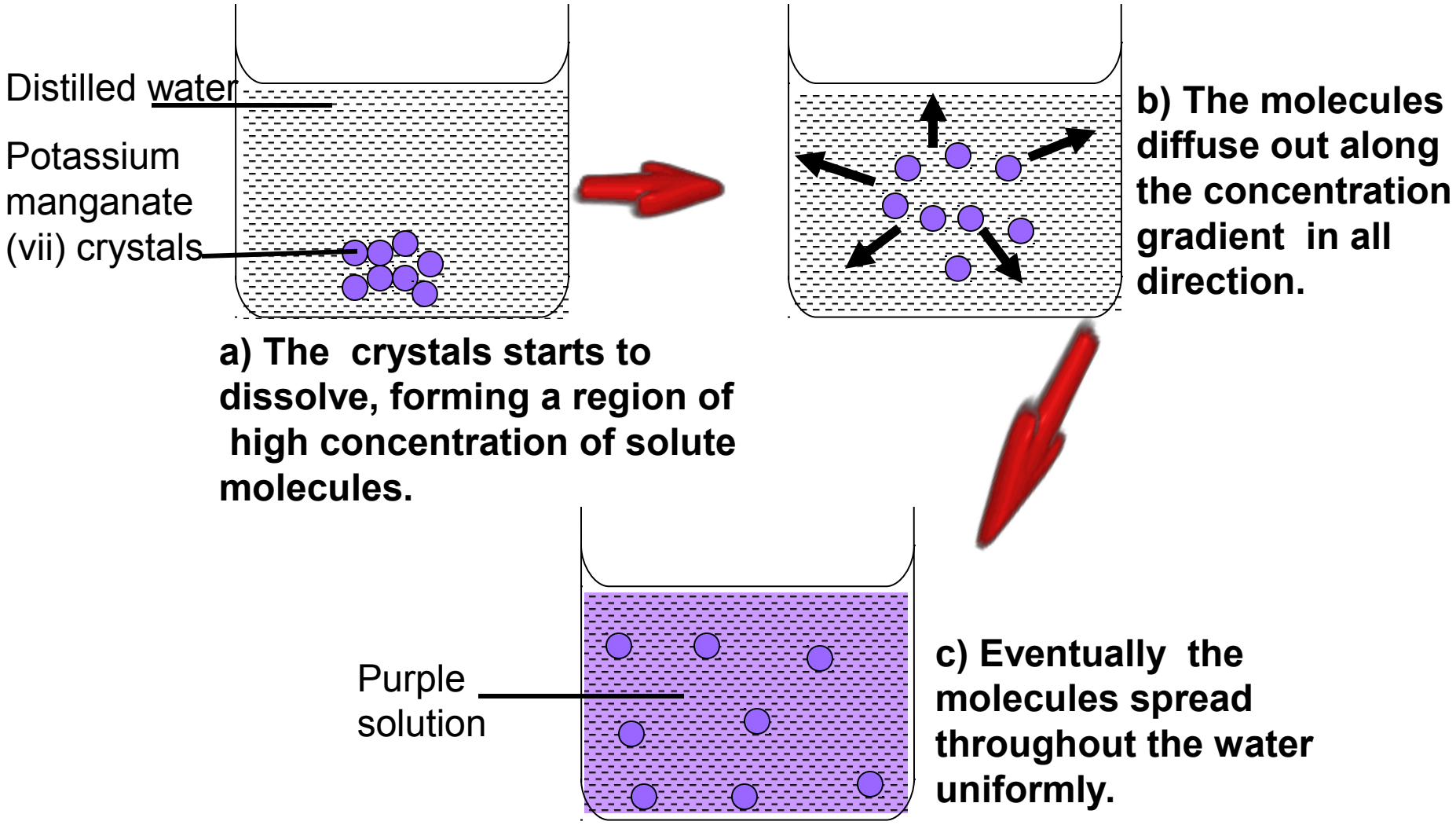
Simple diffusion

1. **Simple diffusion is the random movement of ions or molecules from a region of their high concentration to a region of their low concentration down a concentration gradient until an equilibrium is achieved.**
2. **Molecules have kinetic energy, move randomly, and collide with each other.**
3. **There are more collision in a region of high concentration than in a region of low concentration.**
4. **Random collision of molecules spread the molecules out, down the concentration gradient.**

Concentration gradient = difference in concentration of a particular substance in one region compared to another region

Factors affecting the rate of diffusion

Factor	Effect on the rate of simple diffusion
Diffusion gradient	The steeper, the higher the rate
Size of molecules or ions	The smaller the size, the higher the rate
Temperature	The higher the temperature, the higher the rate
Diffusion medium	Rate in gas > rate in liquid > rate in solid



A sample experiment to illustrate the physical process of diffusion

Facilitated diffusion

- Facilitated diffusion is the movement of specific molecules (or ions) across the plasma membrane.
- Facilitated diffusion is assisted either by pore proteins or by carrier protein, and the direction of movement is down the concentration gradient of the molecules concerned.
- No energy required.

The function of pore protein and carrier protein:

a) **Pore protein (channel protein)**

i. Charge ions (such as Na^+, K^+, Ca^{2+}, and Mg^{2+}) cannot diffuse across the non-polar center of the phospholipids bilayer.

ii. Pore proteins open up pores or channel across the membrane to allow entry or exit.

iii. Each pore or channel is specific and will only allow one particular type of ion through

b) **Carrier proteins**

i. They allow larger polar molecules (such as sugar and amino acids) to pass through.

ii. A particular protein attaches itself to the binding site of a carrier protein.

iii. Then the carrier protein changes shape and delivers the molecule across the plasma membrane.

OSMOSIS

- Osmosis is the movement of water molecules from region of high water concentration to low water concentration through a semi-permeable membrane.
- Osmosis is the diffusion of water only and not of the substances that dissolved in water.

ACTIVE TRANSPORT

- Active transport is the movement of particles across the plasma membrane against the concentration gradient, that is from a region of low concentration to a region of high concentration.
- Energy is provided by adenosine triphosphate (ATP) molecules.
- Active transport also required a specific carrier protein to carries molecules in or out of the cell.
- Active transport only take place in living organisms.
- Examples of active transport in biology:

a) Absorption of dissolved mineral salt by root hairs.

b) Absorption of glucose and amino acids by cell in the small intestine.

HYPOTONIC, HYPERTONIC AND ISOTONIC SOLUTION

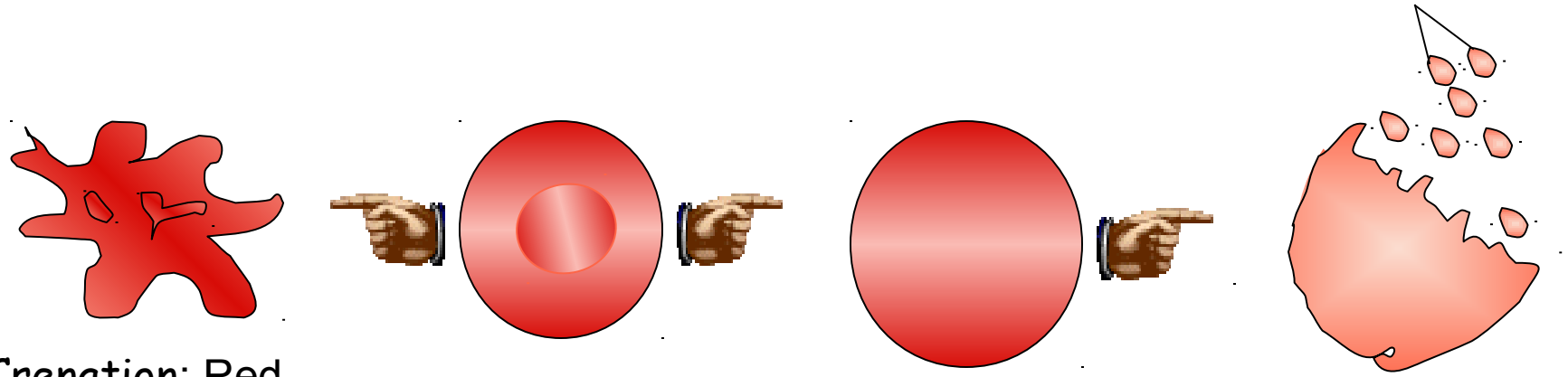
1. *'ISO'* means the same as and tonicity refers to the strength (concentration of solute) of the solution. Two solution are isotonic if they have the same solute concentrations.
2. *'HYPER'* means more than. Solution A is hypertonic to solution B if solution A has a higher solute concentration than solution B.
3. *'HYPO'* means less than. Solution A is hypotonic to solution B if solution A has a lower solute concentration than solution B

Hypertonic solution

Isotonic solution

Hypotonic solution

Remains of cell surface membrane



Crenation: Red blood cell shrinks and turns 'spiky'

Red blood cell

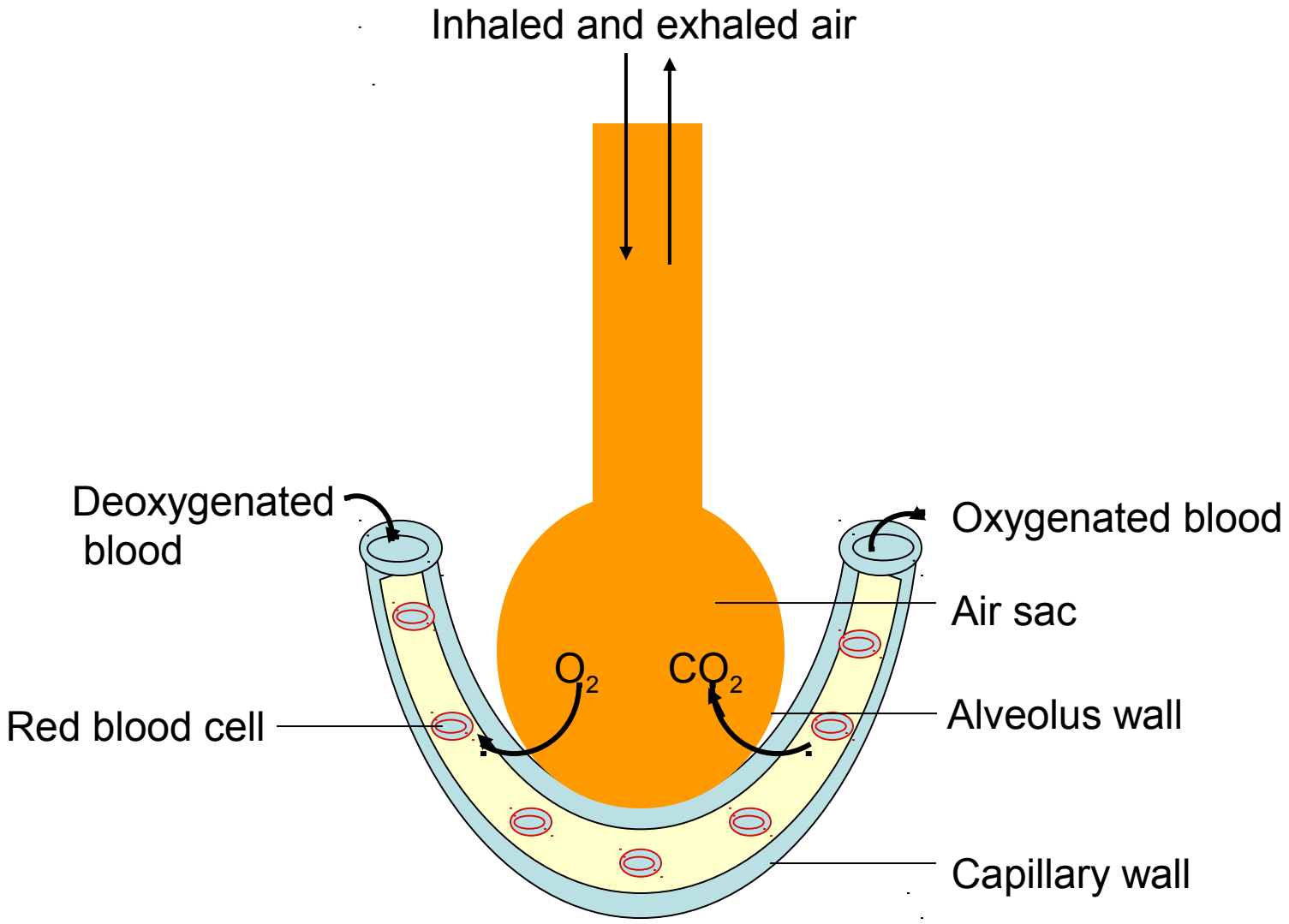
Swells up

Haemolysis: Red blood cell finally burst

CRENATION AND HAEMOLYSIS OF RED BLOOD CELL

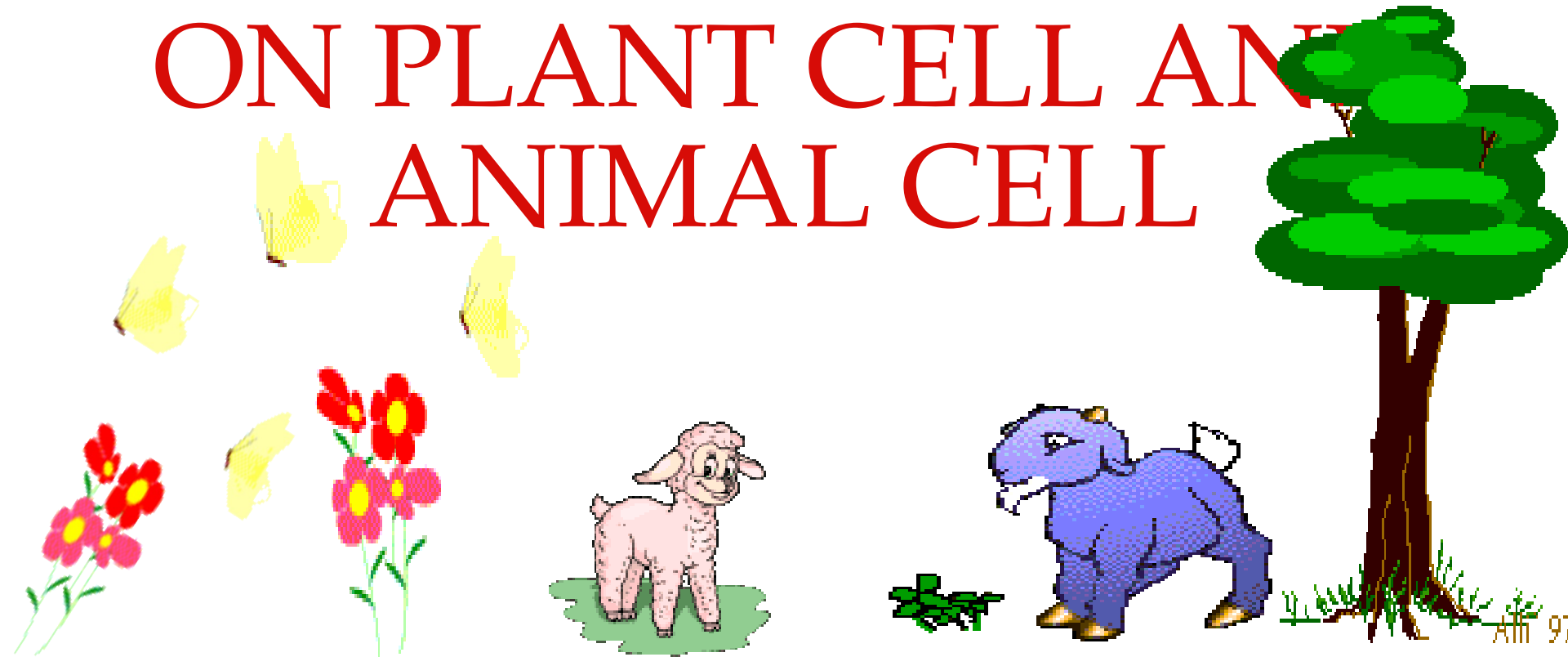
GASEOUS EXCHANGE IN THE ALVEOLI AND BLOOD CAPILLARIES BY SIMPLE DIFFUSION

1. In the lungs, capillary blood takes in oxygen from the alveolar air space.
2. Alveolar oxygen diffused across the alveolar walls and the capillary walls into the capillary blood, down the oxygen concentration gradient.
3. The blood circulation system takes the oxygen rich blood away and replaces it with blood low in oxygen, but high in carbon dioxide.
4. Carbon dioxide from the capillary blood diffused across the capillary and the alveolar walls into the alveolar air spaces, down the carbon dioxide concentration gradient.



GASEOUS EXHANGE BY SIMPLE DIFFUSION IN THE ALVEOLUS

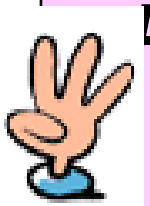
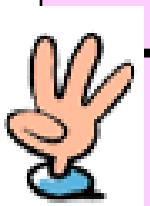
THE EFFECT OF HYPOTONIC, HYPERTONIC AND ISOTONIC SOLUTION ON PLANT CELL AN ANIMAL CELL



PRESERVATION OF FOOD USING SALT OR SUGAR

1. Food goes bad due to bacterial and fungal activities .
2. To make food last for a long time, we preserve them.
3. Here, we shall look at how osmosis help us preserve our food
4. A concentrate salt solution has a high concentration of salute (Na^+ and Cl^- ions) and very low concentration of water molecules.
5. When we leave food in a concentrated salt solution or the water molecules within the food cells a drawn out by osmosis, making the food really ‘dry’ .
6. Without water bacteria and fungus cannot survive
7. The same reason goes for why we use sugar to preserve our food, too.
8. The only different is in our concentrate sugar solution, sugar molecules from the high concentration of solute, with a very low concentration of water molecules.

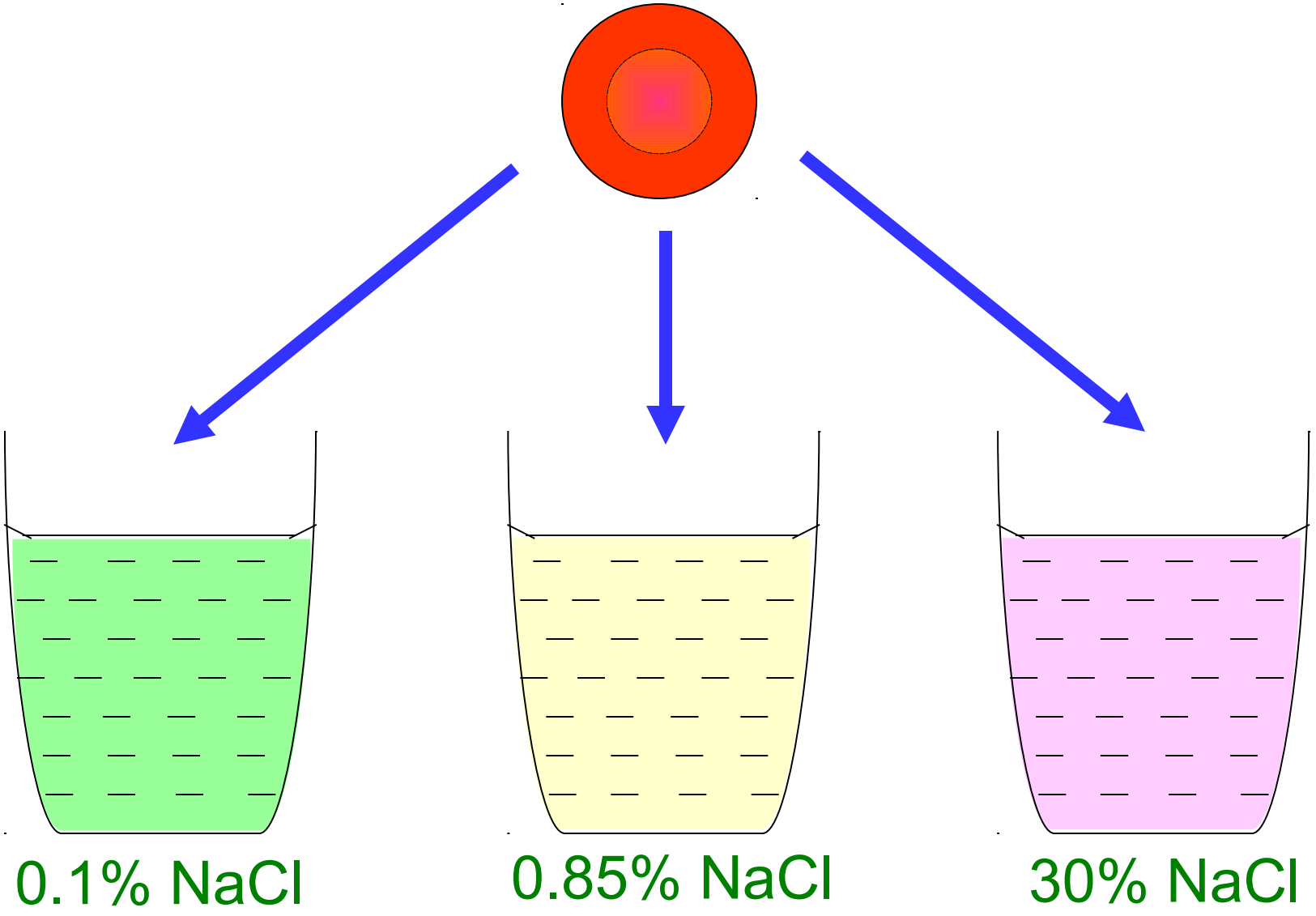
Hypotonic, Hypertonic & Isotonic Solutions

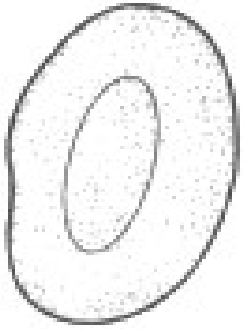
 *Isotonic Solution*	A solution which has the same water potential than another solution
 *Hypotonic Solution*	A solution which has a higher water potential than another solution
 *Hypertonic Solution*	A solution which has a lower water potential than another solution

A solution in which the concentration of solutes is _____ the concentration of solutes in another solution.

The effects of hypotonic, hypertonic & isotonic solutions on an animal cells

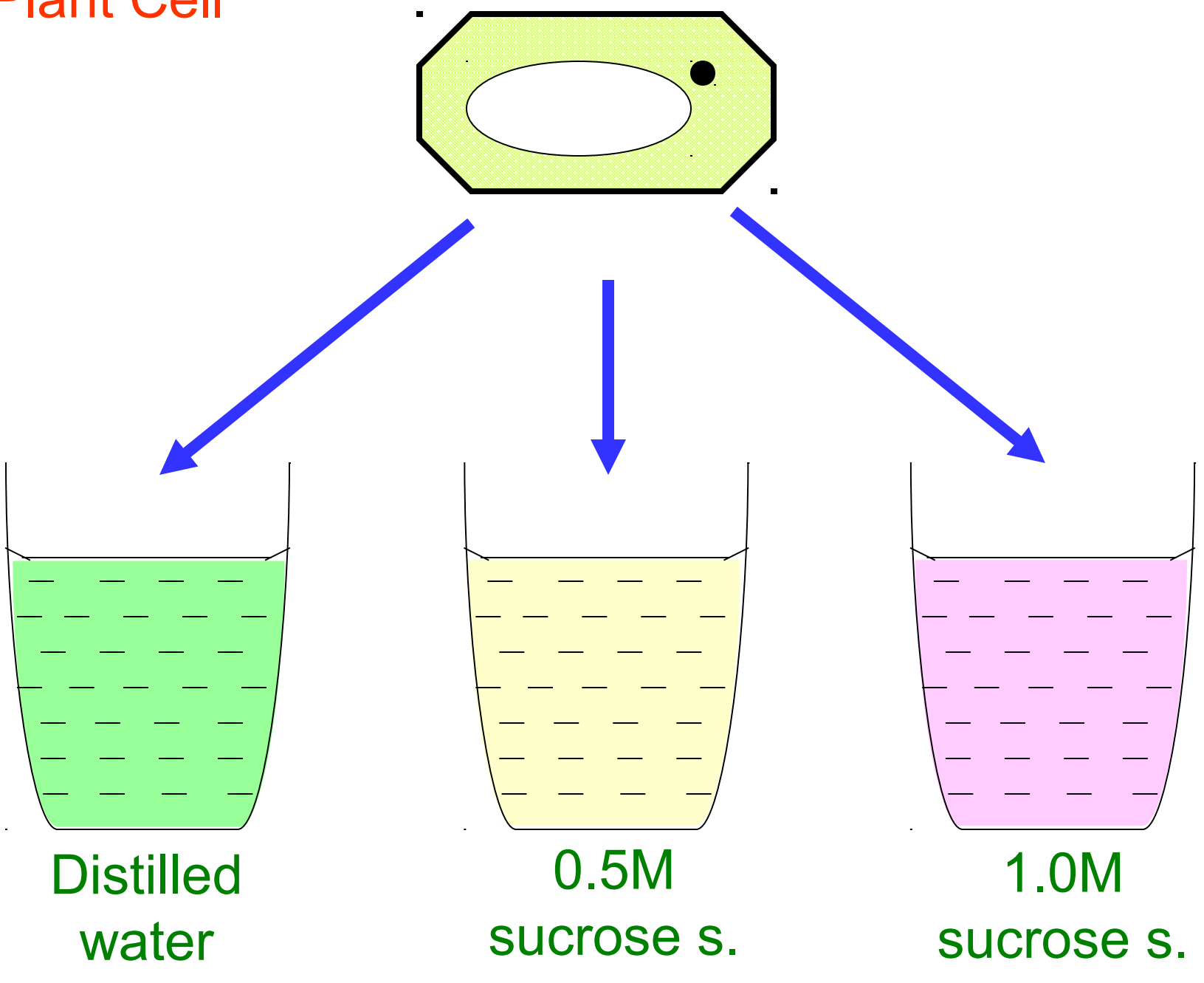
Red blood cell

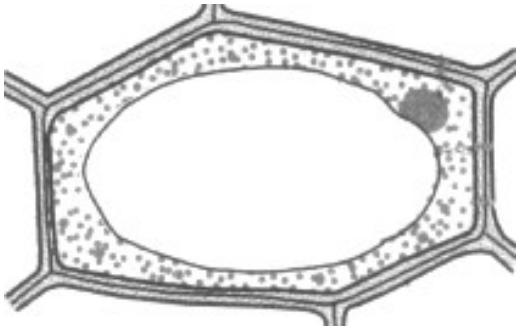
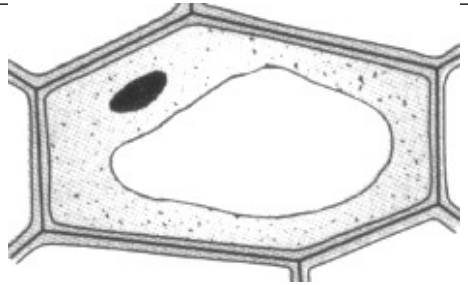
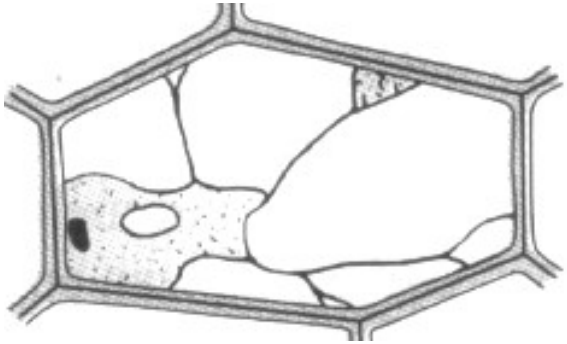


Solutions	Observation	Discussion	Condition
Hypotonic solution		• **Water diffuses into the cell by osmosis.** • **The cell swell up and eventually burst**	The condition is known as **haemolysis**.
Isotonic solution		• **Water diffuses into and out of the cell at equal rates.** • **No net movement of water.**	The cell retain their normal shape. 
Hypertonic solution		• **Water diffuses out of the cell by osmosis.** • **The cell shrinks.**	The red blood cell is said to have undrgone creanation.

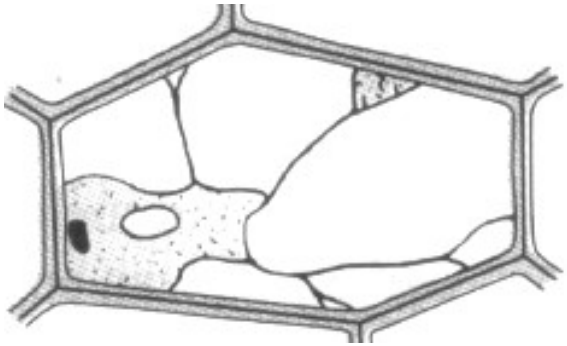
The effects of hypotonic, hypertonic & isotonic solutions on an plant cells

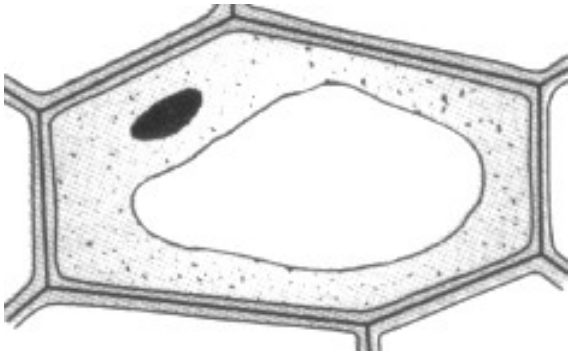
Plant Cell



Solutions	Observation	Discussion	Condition of cell
Hypotonic solution		• Water diffuses into the large central vacuole by osmosis. • The large central vacuole expands, causing the cell to swell.	The cell is said to be **turgid** 
Isotonic solution		• Water diffuses into and out of the cell at equal rates.	The cell retain their normal shape
Hypertonic solution		• Water diffuses out of the large central vacuole by osmosis. • Both the vacuole and cytoplasm lose water to surroundings and shrink. • The plasma membrane pulls away from the cell	This condition is called **plasmolysis.** The plant cell becomes **flaccid** and less turgid.

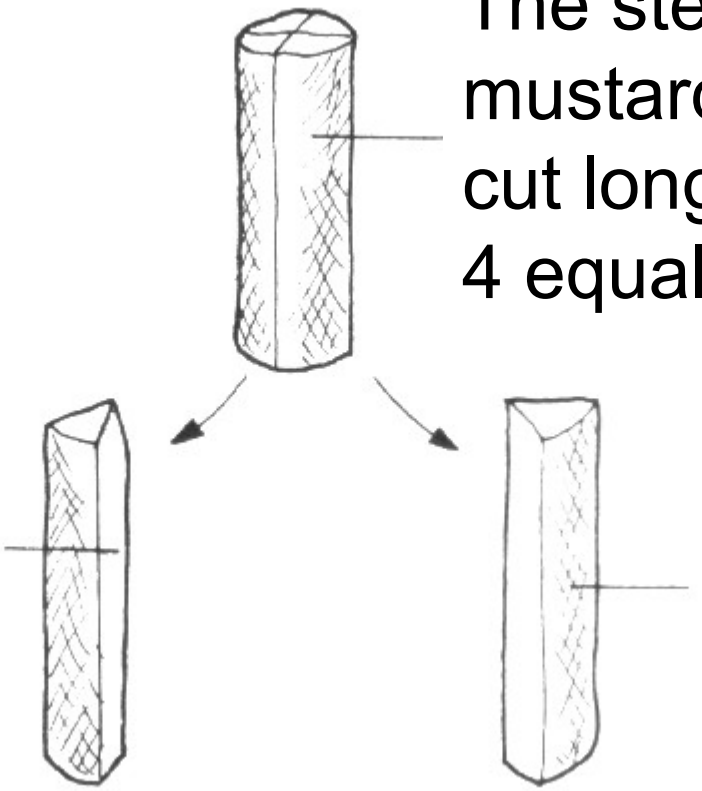
When a plasmolysed plant cell is immersed in a hypotonic solution again…





Water is taken up by osmosis and the cell become turgid again. The cell is said to have undergone **deplasmolysis**.

The stem of a mustard green is cut longitudinally to 4 equal strips.

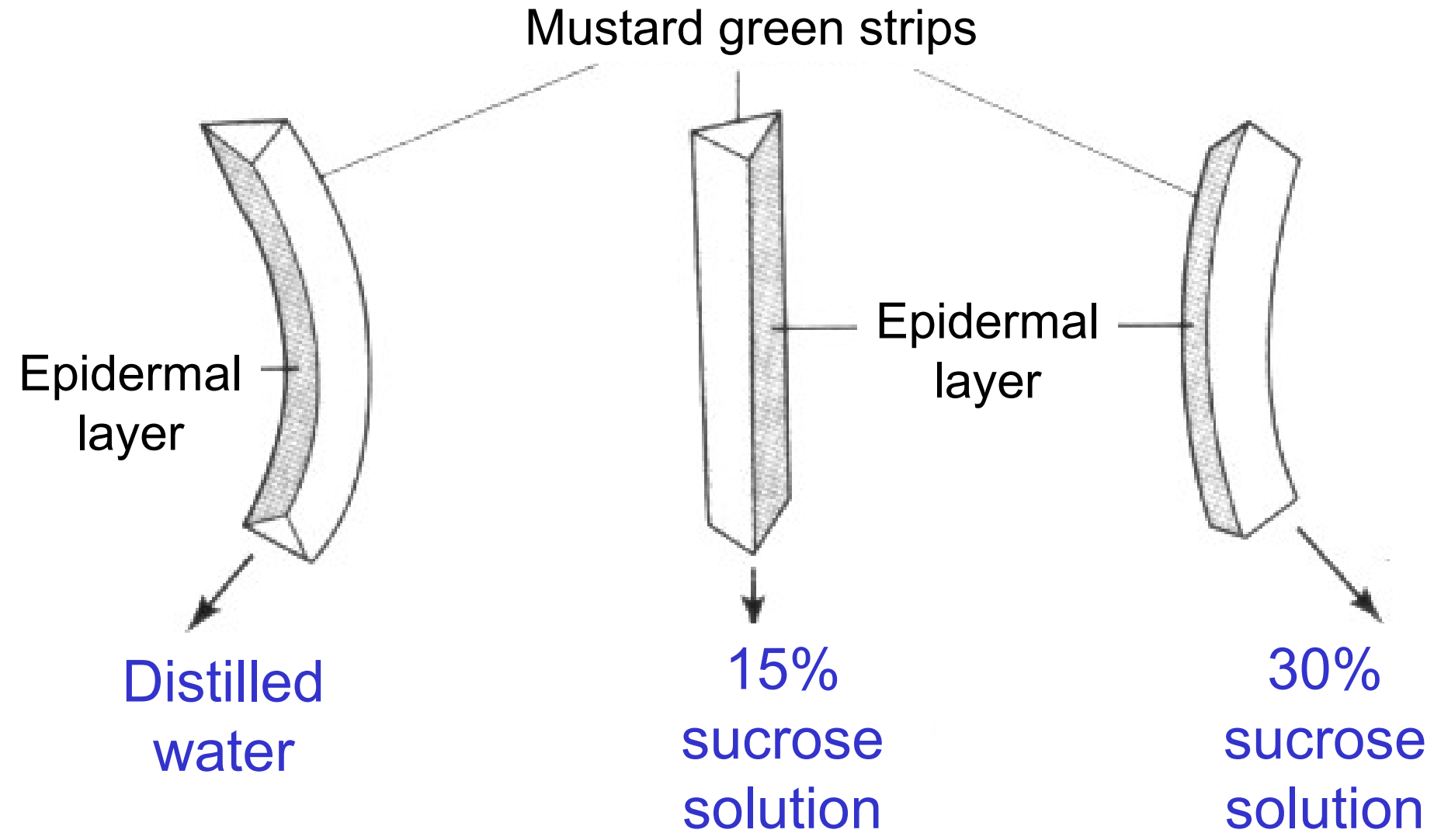


The portion which is cut

Epidermal layer

One of the strips is placed in distilled water, another in 15% sucrose solution and the third in 30% sucrose solution. What will happen after 20 minutes?

Observations



The Effects And Applications Of Osmosis In Everyday Life

Wilting of Plants

- Problems can arise if chemical fertilisers are added in excess to the soil.
- The soil solutions becomes **hypertonic** to the cell sap of the root hair cells.
- **Water moves out** of the plant **by osmosis**.
- When **flaccidity** spreads throughout the plant, **wilting occurs**.

Preservation of Food

- Food can be preserved by using **salt or sugar**.
- When salt or sugar is added to the food, it creates a **hypotonic** condition for the microorganisms that spoil the food.
- **Water passes out from the microorganisms into the concentrated solution**. This results in slower growth of the microorganisms or even death.

BIOLOGY FORM 4

CHAPTER 5

CELL DIVISION

CHAPTER 4 : CHEMICAL COMPOSITION OF THE CELL

4.1 THE CHEMICAL COMPOSITION OF THE CELL

LEARNING OUTCOMES

- State the element in the cell
- List the chemical compounds in the cell
- Explain the importance of organic compounds in the cell
- Explain the importance of water in the cell

ELEMENTS IN CELLS

- All living & non-living things are made up of elements.
- At least 25 elements have been found to be essential to living organisms.
- C, O, H & N make up about 96% of the chemical composition of living matter.
- Major elements : C, H, N, O, Ca, P, S, K, Na, Cl & Mg.
- Trace elements : boron (B), chromium (Cr), cobalt (Co), copper (Cu), fluorine (F), iodine (I), iron (Fe), manganese (Mn), molybdenum (Mo), selenium (Se), silicon (Si), tin (Sn), vanadium (V), & zinc (Zn).

- ***Element :*** a substance, composed of only one kind of atom which cannot be broken down into simpler substances by a chemical reaction.
- Types of elements :
- Chemical compound in the cell :
- Can be divided into two :

IMPORTANCE OF ORGANIC COMPOUNDS IN THE CELLS

- **CARBOHYDRATES**
  - A major common energy source in cell. (1g glucose → 17kJ)
  - To provide energy during respiration
  - To build cell walls
  - To form external skeleton of insects (chitin)
  - As food storage (starch in plant cells, glycogen in animal cells)
  - To be converted to other organic compounds i.e. amino acids & fats.
  - To form glycoproteins
    - Mucus lining of human respiratory system to trap dust & microbial spores
    - In plasma membrane for cell recognition
  - To produce sugary nectar in some flower to attract feeding insects (pollination)

IMPORTANCE OF ORGANIC COMPOUNDS IN THE CELLS

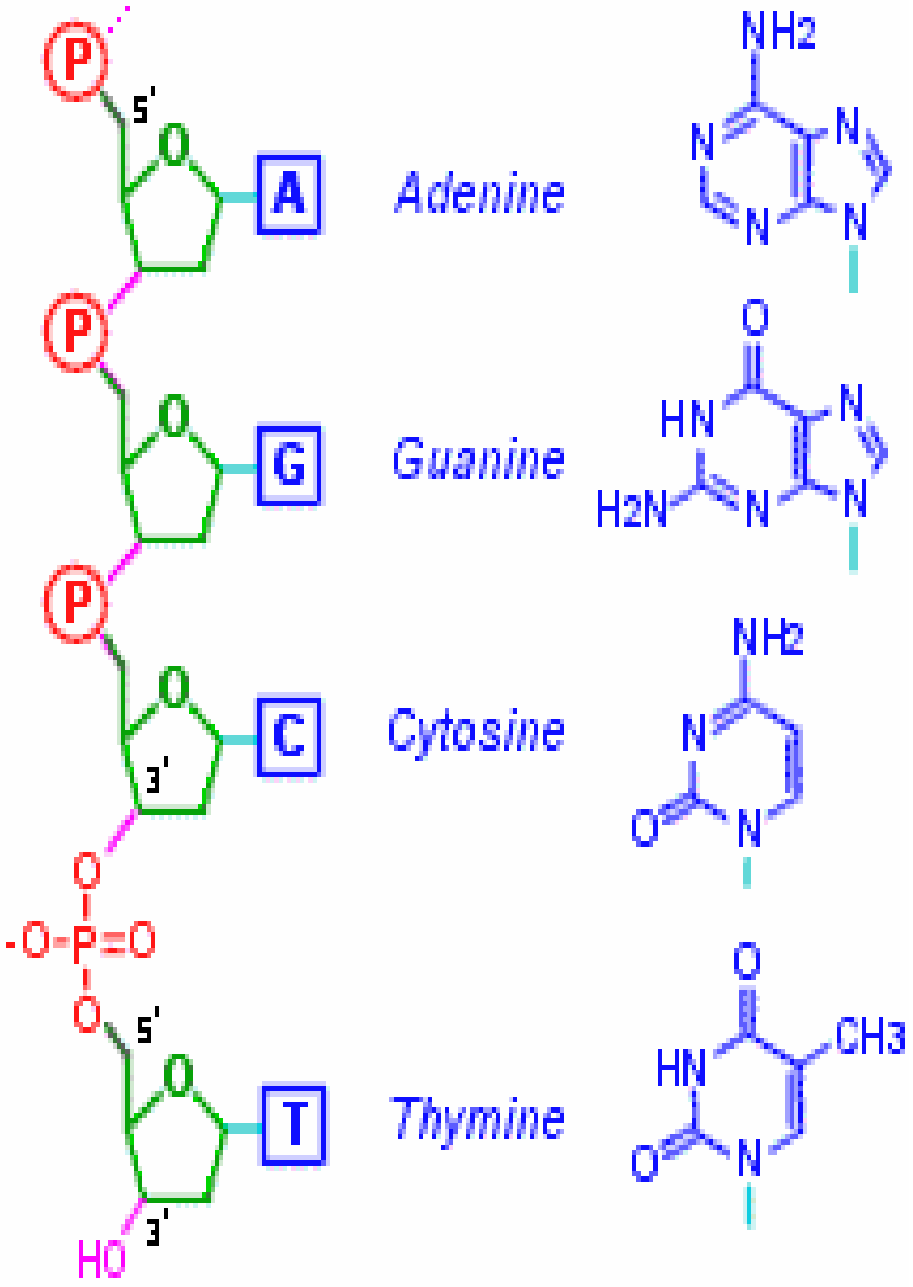
- **LIPIDS**
  - Sources & storage of energy (1g → 38kJ)
  - To form lipid bilayer of PM
  - To protect organ & as heat insulator
  - As a stored product in the form of adipose tissues
  - Solvent for vitamins A,D,E,K
  - Source of energy
  - To produce liver bile : for the digestion of fats
  - To synthesise steroid hormones
  - To form waxy cuticle
  - To lubricate the skin & reduces water loss (sebum)

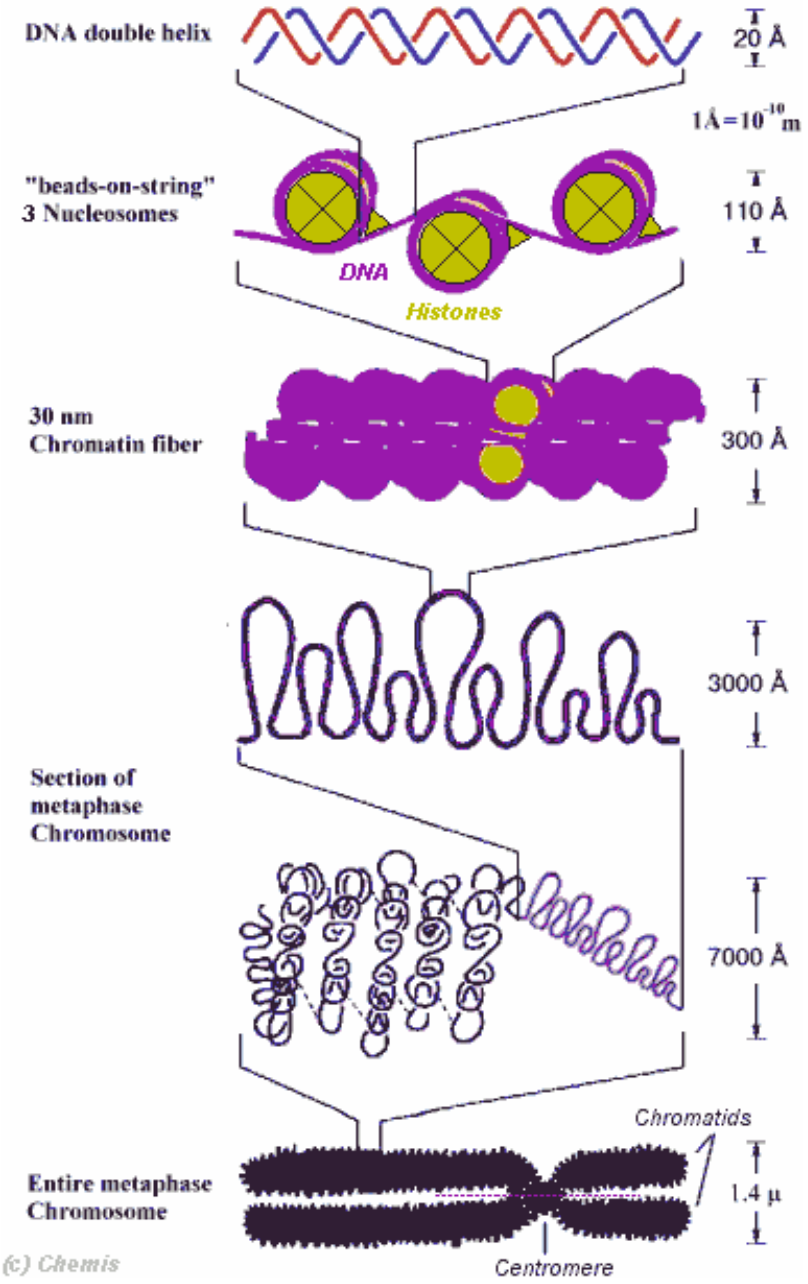
IMPORTANCE OF ORGANIC COMPOUNDS IN THE CELLS

- **PROTEINS**
  - To form the structure of cell (protoplasm)
  - To form connective tissues such as tendons, ligaments & muscle covering
  - To form the protein molecules in the plasma membrane
  - To build up muscles for movement
  - To synthesise enzymes, hormones, antibodies, haemoglobin
  - To produce new cells

IMPORTANCE OF ORGANIC COMPOUNDS IN THE CELLS

- **NUCLEIC ACIDS**
  - Contain **C, H, O, N & P**.
  - Its basic unit structure is nucleotide which consist of a sugar, a phosphate & a nitrogen base.
  - Two types : **DNA** (deoxyribonucleic acid) & **RNA** (ribonucleic acid)
  - Importance :
    - Carry genetic information
    - Direct protein synthesis
    - Determine the traits which are inherited from the parents
    - Control all the core activities that characterise life such as chemical reactions & growth


P
5'
O
A
Adenine
NH2
N
N
N
N
P
O
G
Guanine
O
HN
N
H2N
N
N
P
O
C
Cytosine
NH2
N
3'
O
N
O
-O-P=O
O
5'
O
T
Thymine
O
CH3
HN
O
N
HO
3'


DNA double helix
20 Å
1Å=10⁻¹⁰m
"beads-on-string"
3 Nucleosomes
110 Å
DNA
Histones
30 nm
Chromatin fiber
300 Å
3000 Å
Section of
metaphase
Chromosome
7000 Å
Chromatids
Entire metaphase
Chromosome
1.4 µ
Centromere
(c) Chemis

IMPORTANCE OF WATER IN THE CELLS

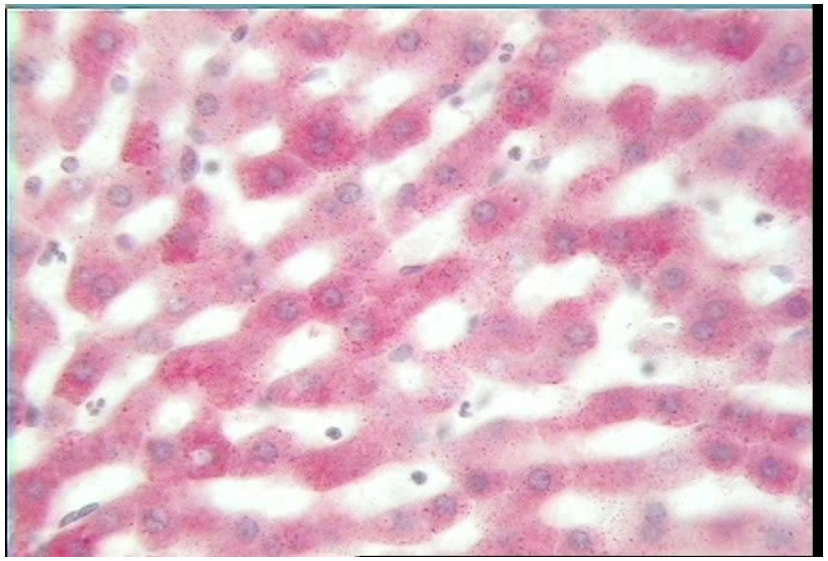
- Inorganic compound
- Importance :
  - As a major component of protoplasm
  - As a transport medium within cells & between cells
  - Allows chemical changes to take place in solution
  - As a medium for biochemical reactions in the cell
  - As a universal solvent to dissolve respiratory gases & allow diffusion during gaseous exchange at alveolus & cells
  - To provide support especially in non-woody plants when cells are turgid & hydrostatic skeleton in some animals
  - Component of lubricants & secretion (synovial fluid, digestive juices, mucus & sweat)

CHAPTER 4 : CHEMICAL COMPOSITION OF THE CELL

4.2 CARBOHYDRATES

CARBOHYDRATES

- Contain the element carbon, hydrogen & oxygen
- 3 main groups : monosaccharides, disaccharides & polysaccharides



Monosaccharides

- Basic building blocks
- Simple sugar as glucose, fructose & galactose
- Consist of single chemical group made up of a ring of carbon, hydrogen & oxygen atoms
- Reducing sugars
- Can be detected by using Benedict's test.

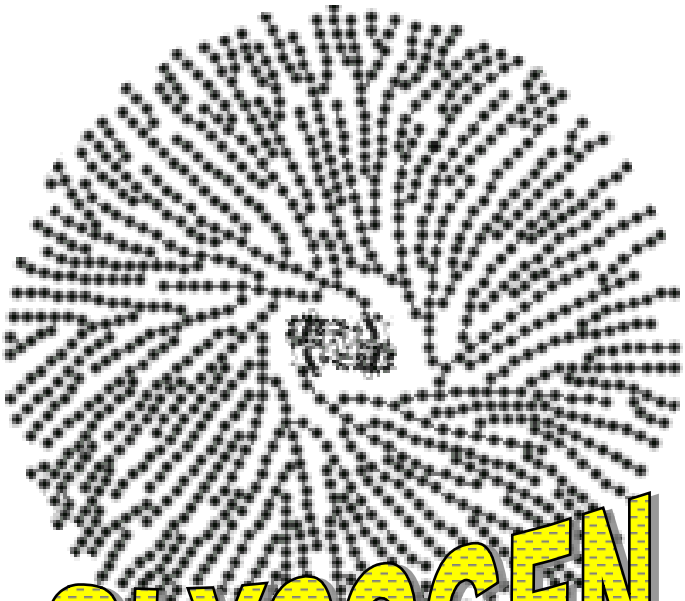
Disaccharides

- Complex sugars
- Consist of *two monosaccharides* combined chemically through *condensation*.
- Mono + mono → disaccharides + water
- Eg.: maltose (malt sugar), sucrose (cane sugar), lactose (milk sugar)
- Glucose + glucose → maltose + water
- Glucose + fructose → sucrose + water
- Glucose + galactose → lactose + water

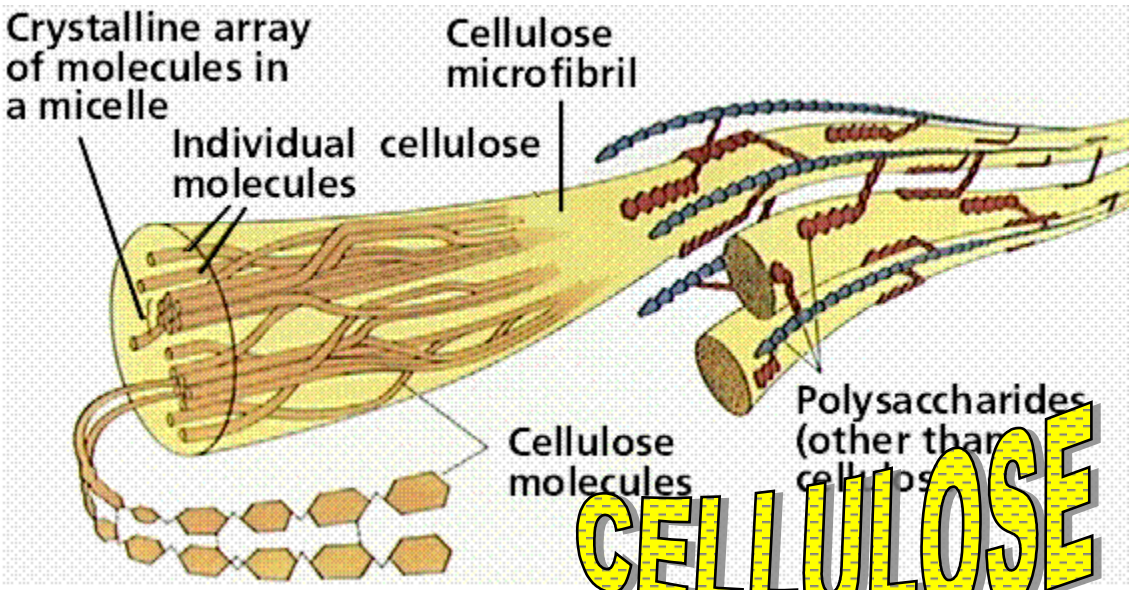
- Can be broken down into monosaccharides through *hydrolysis*
- All are reducing sugar except sucrose

Polysaccharides

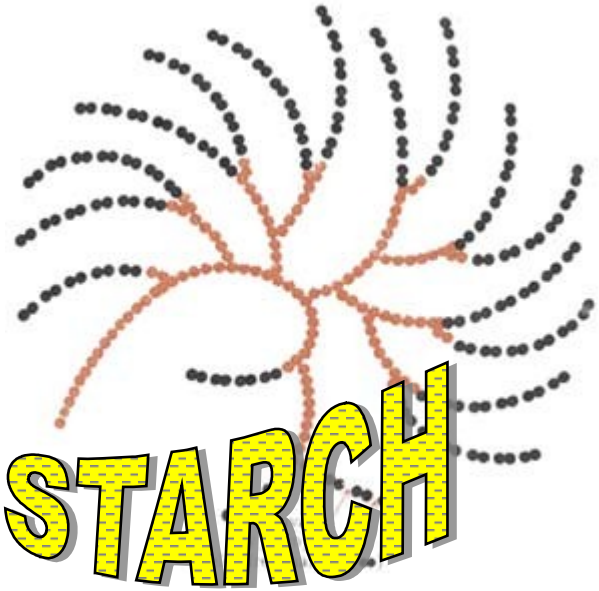
- Large complex sugar
- Many monosaccharides are joined together to form long chain of simple sugar called *polymers*.
- Eg. : starch, glycogen & cellulose



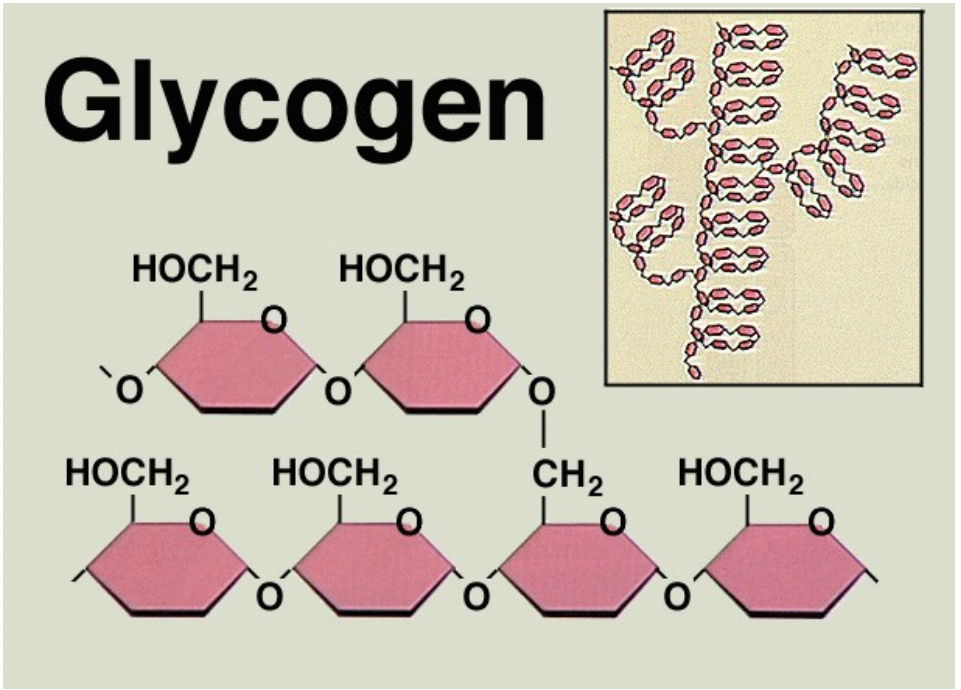
GLYCOGEN



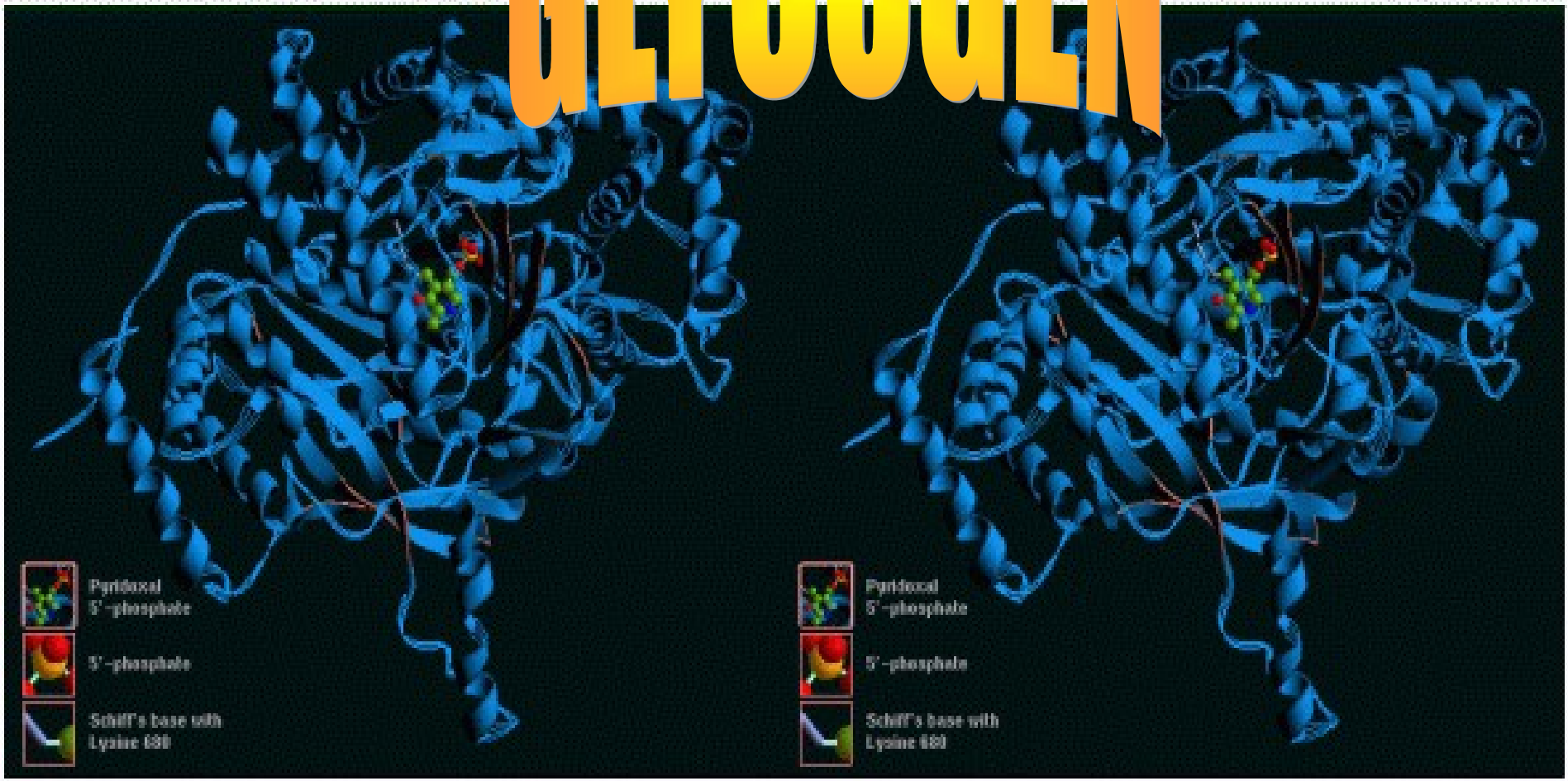
CELLULOSE



STARCH



GLYCOGEN


Pyridoxal
5'-phosphate
5'-phosphate
Schiff's base with
Lysine 680
Pyridoxal
5'-phosphate
5'-phosphate
Schiff's base with
Lysine 680

CHAPTER 4 : CHEMICAL COMPOSITION OF THE CELL

4.3 PROTEINS

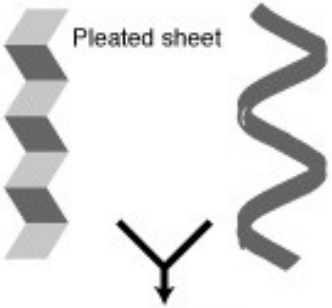
- Elements : C, H, O, S, N & P.
- Large & complex molecules
- Monomer : amino acid
    - Molecules of amino acids are joined together through condensation
    - Amino acids are joined together by *peptide bond*
    - Amino acid + amino acid → dipeptide + water
  - Polypeptides are formed when many molecules of amino acids are joined together to form long chains of a.a.
    - Polypeptides broken down through a series of hydrolysis reactions to become dipeptides & finally amino acids.

- 20 amino acids found in the proteins of living cells
- Two types of a.a. :
  - Essential amino acids : cannot synthesised by body cells
  - Non-essential amino acids : can be synthesised by body cells
- Food that contain all the essential a.a. are called 1st class protein. (milk, meat, eggs)
- Food that lacks a few essential a.a. are 2nd class protein. (corn)

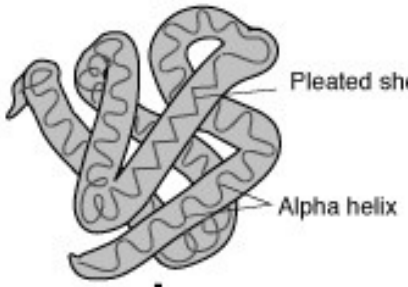
Protein Structures

- *Primary structure* : a long straight chain of polypeptide
- *Secondary structure* : coiled to form helix or pleated sheet.
- *Tertiary structure* : helix or pleated sheet is folded in various ways to form globular protein
- *Quarternary structure* : folded protein chains are joined together to form a single protein

Primary protein structure
is sequence of a chain of amino acids

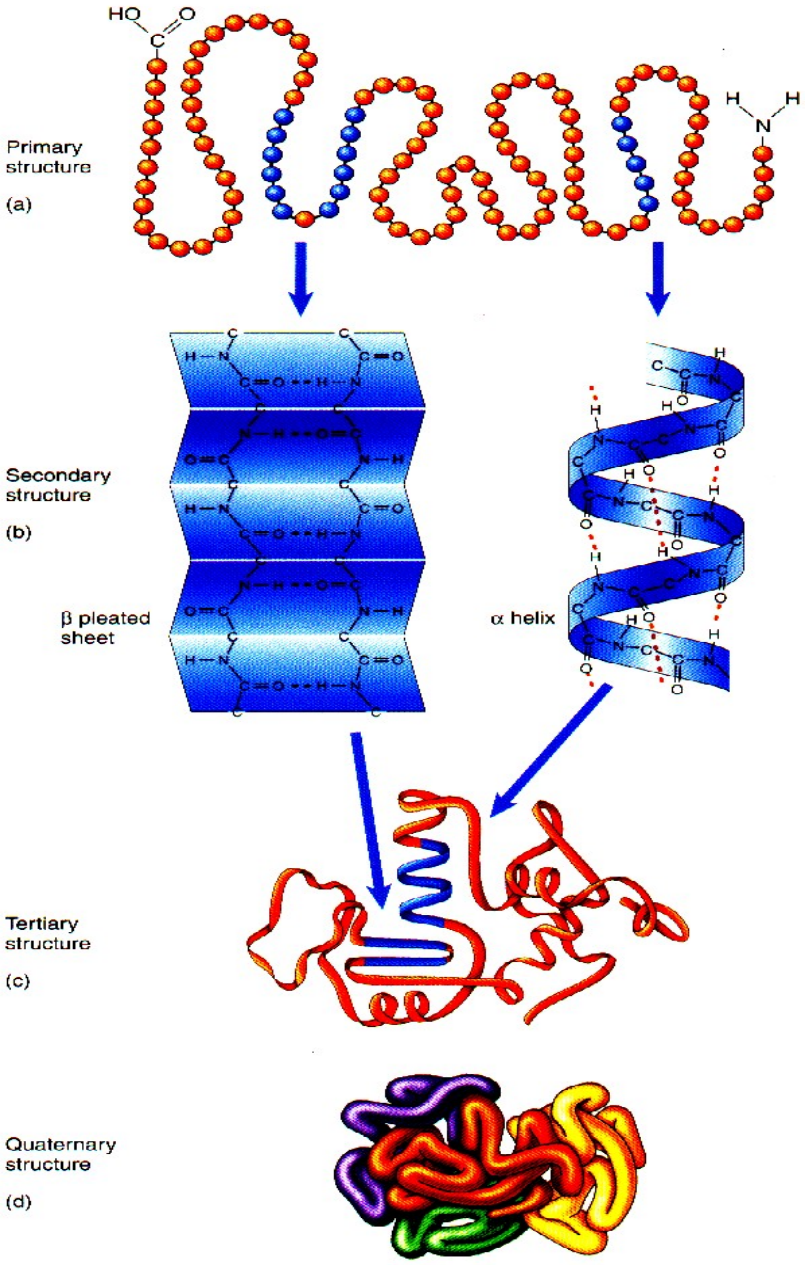


Secondary protein structure
occurs when the sequence of amino acids are linked by hydrogen bonds



Tertiary protein structure
occurs when certain attractions are present between alpha helices and pleated sheets.

Quaternary protein structure
is a protein consisting of more than one amino acid chain.



CHAPTER 4 : CHEMICAL COMPOSITION OF THE CELL

4.4 LIPIDS

LEARNING OUTCOMES

- To state the elements in lipids.
- To state the main types of lipids.
- To state the components of fats & oils.
- To explain the formation & breakdown of fats & oils.
- To compare & contrast saturated fats & unsaturated fats.

- Elements : *C, H & O*
- Types of lipids : *fats, oils, waxes, phospholipids, steroids (cholesterol, testosterone, oestrogen, progesterone)*
- Fats & oils are placed in a category called *triglycerides.*
- 3 categories of lipids : *monoglycerides, diglycerides, triglycerides*

- Fats → solid in room temperature (high melting point)
- Oils → liquid in room temperature (lower melting point)
- Triglyceride → made up of one glycerol & 3 fatty acids.

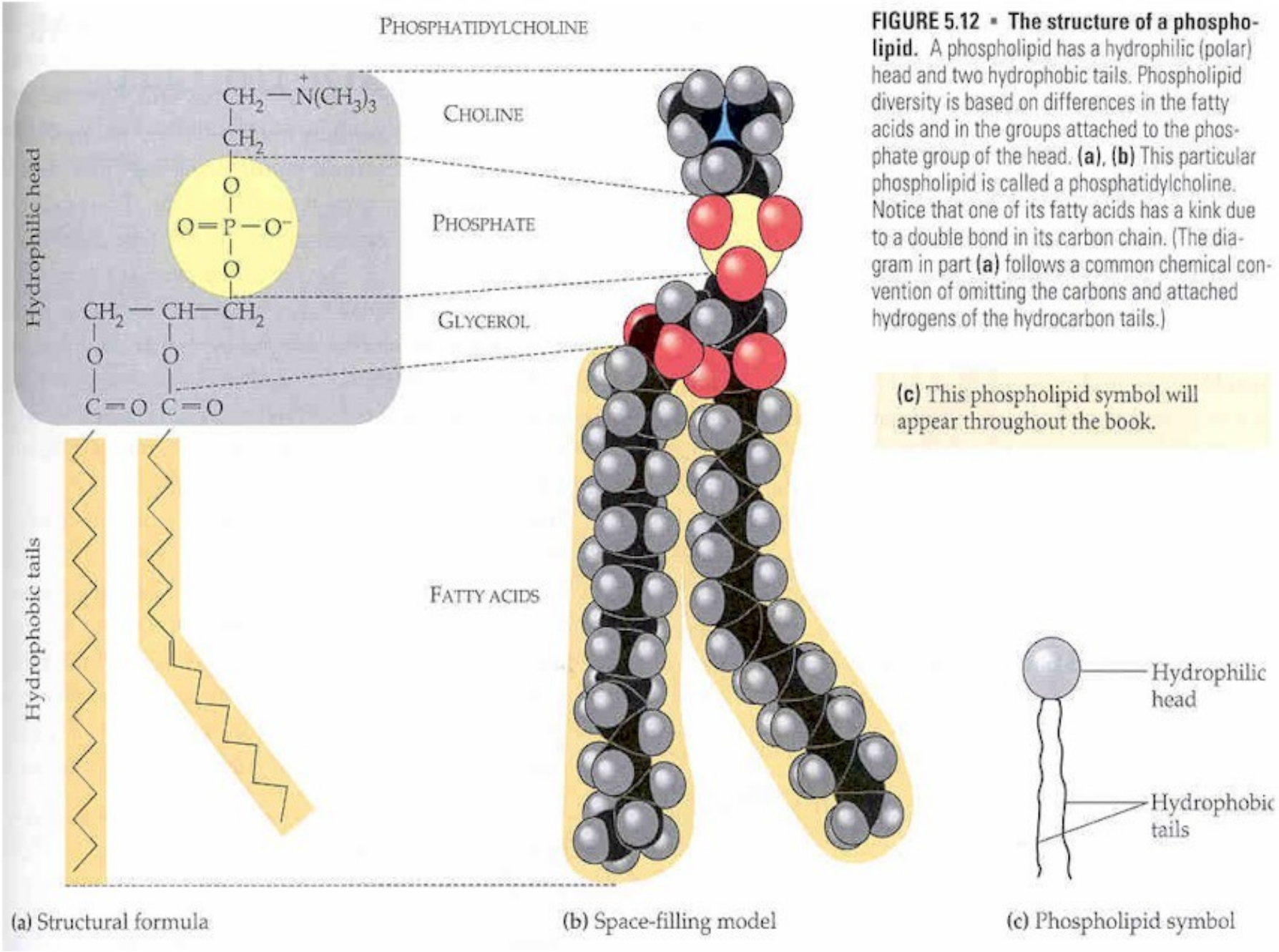


FIGURE 5.12 ▪ The structure of a phospholipid. A phospholipid has a hydrophilic (polar) head and two hydrophobic tails. Phospholipid diversity is based on differences in the fatty acids and in the groups attached to the phosphate group of the head. **(a)**, **(b)** This particular phospholipid is called a phosphatidylcholine. Notice that one of its fatty acids has a kink due to a double bond in its carbon chain. (The diagram in part **(a)** follows a common chemical convention of omitting the carbons and attached hydrogens of the hydrocarbon tails.)

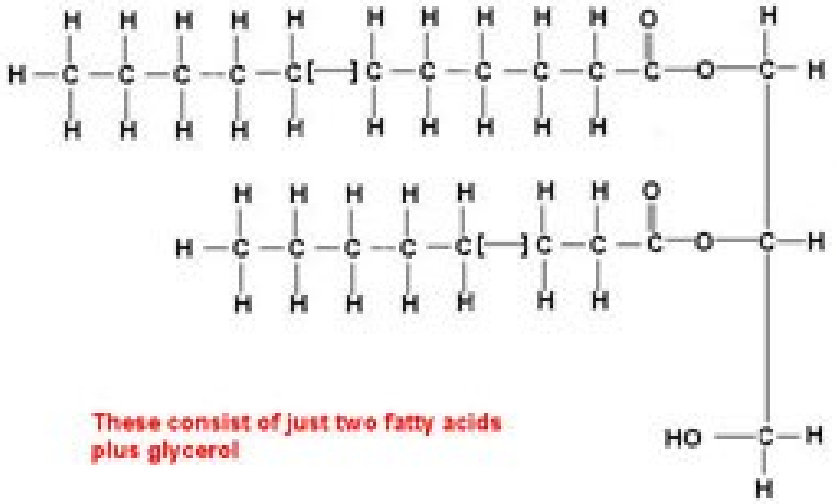
(c) This phospholipid symbol will appear throughout the book.

- 1 Glycerol + 1 fatty acid → monoglyceride + 1 water
- 1 Glycerol + 2 fatty acids → diglyceride + 2 water
- 1 Glyceride + 3 fatty acids → triglyceride + 3 water
- The formation of fats & oils involves the reaction of *condensation* between glycerol & fatty acids

- In the presence of enzymes, three fatty acids become covalently bonded to one glycerol & produces 3 molecules of water.

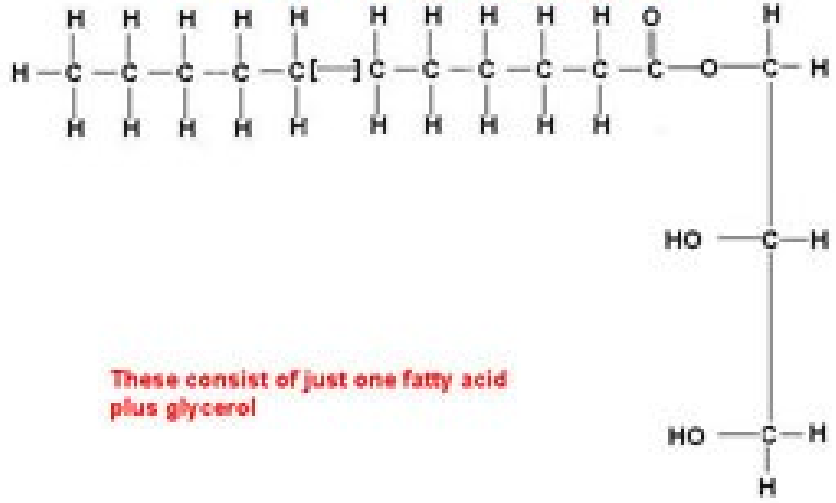
- The breakdown of fats & oils → hydrolysis + enzymes → glycerol & fatty acids.

STRUCTURE OF A DIGLYCERIDE LIPID

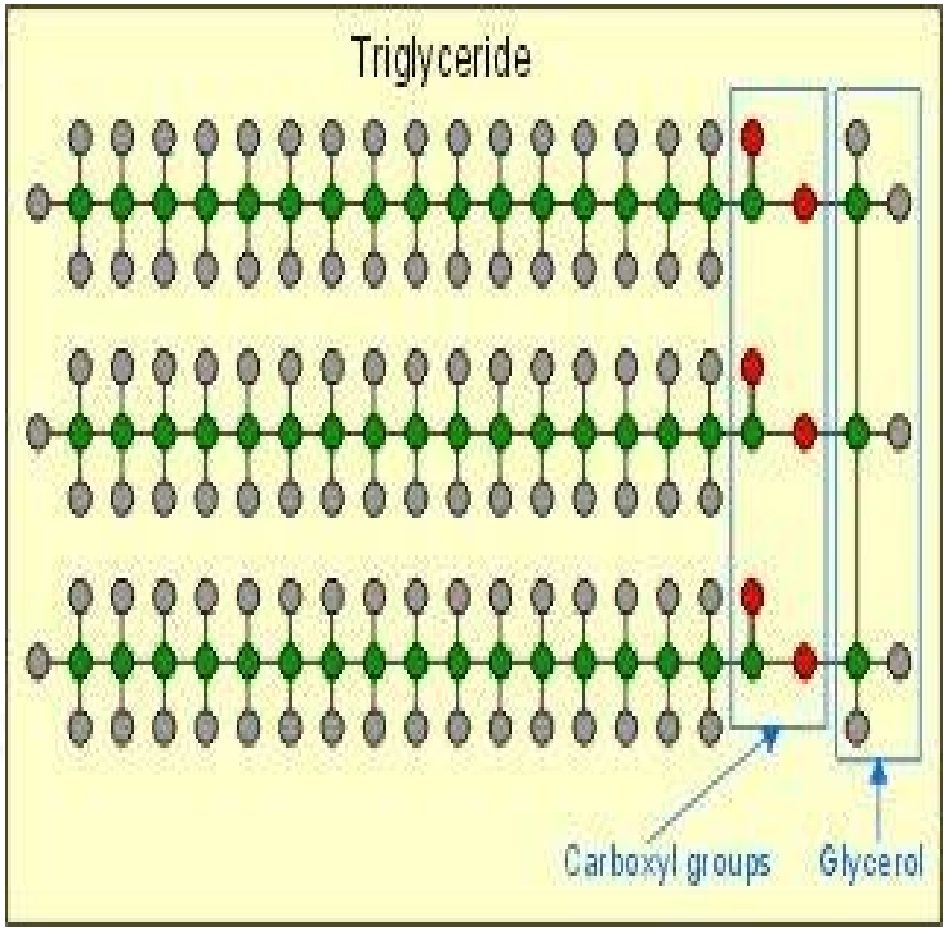


These consist of just two fatty acids plus glycerol

STRUCTURE OF A MONOGLYCERIDE LIPID



These consist of just one fatty acid plus glycerol

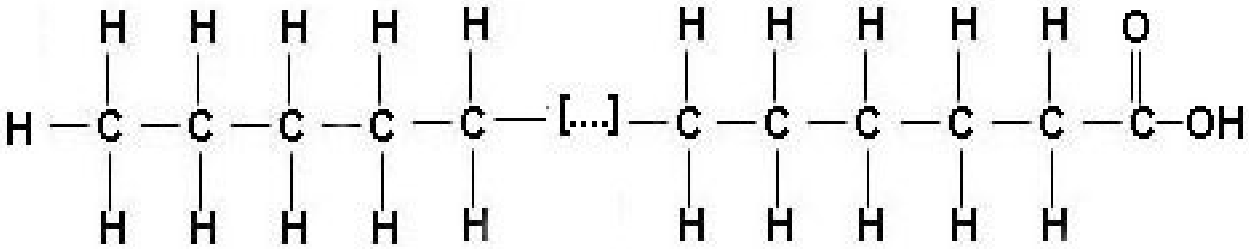


SATURATED & UNSATURATED FATS

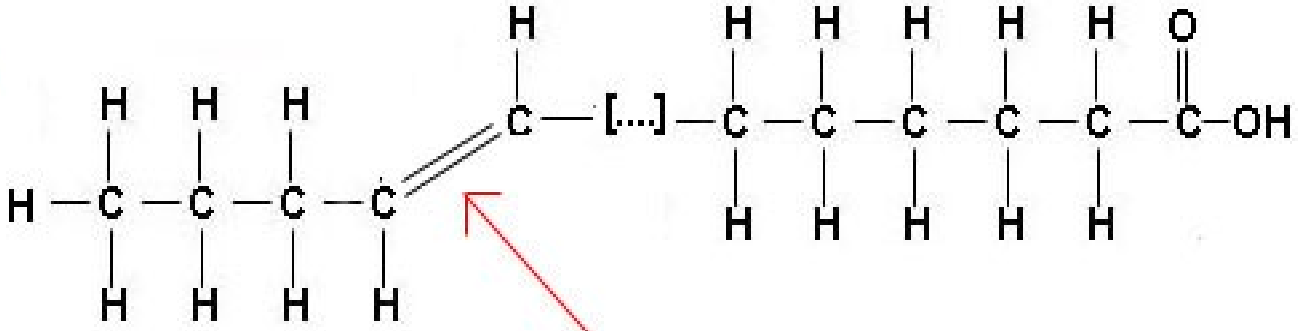
- Saturated fats : contain saturated fatty acids (do not have any double bond between the carbon atoms) SOLID FORM AT ROOM TEMPERATURE, 27^{o}C (butter)

- Unsaturated fats : contain unsaturated fatty acids (at least one double bond between the carbon atoms) LIQUID FORM AT ROOM TEMPERATURE, 27^{o}C (corn oil, palm oil)

SATURATED FATTY ACID



UNSATURATED FATTY ACID



One or more double C=C bonds present in the fatty acid.
This puts a 'kink' in the molecule

COMPARISON

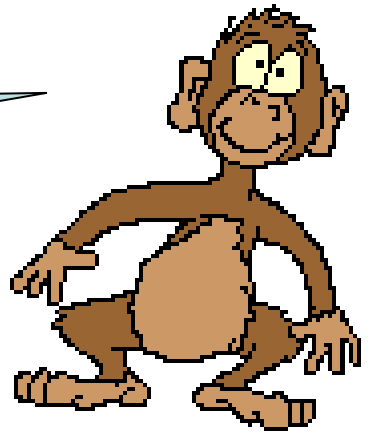
SATURATED FAT	UNSATURATED FAT
SIMILARITIES	
BOTH are triglyceride & contain fatty acids.	
differences	
Contain saturated fatty acid	Contain unsaturated fatty acid
Its Carbon chain contains max. num. of hydrogen	Its carbon chain is not saturated with hydrogen.
Single bond between carbon atoms (-c-c-)	At least 1 Double bond between carbon atoms (-c=c-)

COMPARISON (cont.)

differences	
Solid at room temperature	Liquid at room temperature
High melting point	Low melting point
Increase the level of cholesterol in the blood	Decrease the level of cholesterol in the blood
Increase the risk of heart diseases	Does not increase the risk of heart diseases
Example : animal fats (lard, butter)	Example : vegetable oils (palm oil, corn oil)

END OF SUBTOPIC 4.4

YAHOOO!!



4.4 ENZYMES

LEARNING OUTCOMES

- To state what enzymes are.
- To explain why enzymes are needed in life processes.
- To list the general characteristics of enzymes.
- To relate the name of enzyme to substrate.
- To state sites where enzymes are synthesised.
- To state the meaning of intracellular enzymes & extracellular enzymes.

ENZYME & ITS REQUIREMENT IN LIVING PROCESSES

- *Metabolism* : biochemical processes in the cells

- Involves a series of chemical reactions (complex compound *can be synthesised* from simple substances *or broken down*). Its control by enzymes.

- *ENZYMEs* : organic catalyst that increase the rate of a biochemical reaction

- A proteins which function as *biocatalyst*.

- Organisms depends on enzymes for the biochemical processes in the cells

- Enable biochemical reactions to take place quickly in the cells where the internal environment such as temperature may not favourable for chemical reactions

- *Substrate* : the substance that is acted upon by an enzyme.

- Required for :
  - Digestion, synthesis of substances, contraction of muscles, respiration, etc.

1. Speed up the rate of biochemical reactions.
    - Increase the rate at which chemical rxns occur
    - Much more efficient than inorganic compound
2. Proteins produced by living cells
3. Not destroyed / changed by the rxn
4. Effective in small amount.
5. The action is extremely specific.
    - Each rxn need its own specific enzyme
    - Each enzyme only act on one substrate based on lock & key hypothesis.

6. Can work in either direction (reversible rxn)
7. Denatured by high temperature
    - 40-60^{o}C – denatured
    - Low temp. – less active
    - Optimum temp. – 35-40^{o}C
8. Sensitive to pH.
    - Most active at pH7
    - Some enzymes require specific acidic (pepsin)/alkaline condition (trypsin)
9. Affected by inhibitors
    - Inhibitors slow down/ stop enzyme activity
    - Examples : cyanide, lead & mercury

10.Some enzymes require cofactors

- Some enzymes only work in the presence of other chemicals = cofactors
- Examples : copper (II) ion (Cu^{2+}), iron (II) ion (Fe^{2+}) & vitamins

NAMING OF ENZYMES

- By adding ‘-ase’ to the main part of the name of substrate on which they act.
- Examples :
  - Maltose – maltase
  - Sucrose – sucrase
  - Lactose – lactase
  - Protein – protease
  - Lipids – lipase
  - Amylum (starch) - amylase
- Some enzymes which cannot be named this way because names of these enzymes have been used for a long time.
  - Examples : rennin, pepsin, erepsin, trypsin

SITES OF ENZYME SYNTHESIS

- Made by protein synthesis within the cells.
- Located at the **ribosomes** in the protoplasm of the cells.
- Depends on the DNA code.
- DNA → RNA → mRNA → leaves the nucleus → enters into cytoplasm → binds with the ribosomes → RNA assembles the a.a into specific proteins → modified to become enzymes.

INTRACELLULAR & EXTRACELLULAR ENZYMES

- **Intracellular enzymes** = produced by the cell & function within the cell.

- Examples : enzymes that are involved in respiration (mitochondria) & in photosynthesis (chloroplast)

- Extracellular enzymes = secreted out of the cell & functions outside the cell.

- Examples : salivary amylase, trypsin, & lipase are produced in the pancreas & transported to the duodenum.

- Production of extracellular enzymes

FACTORS AFFECTING ENZYME ACTIVITY

pH level

- Protein are denatured by changes in the pH level of the reaction medium.
- Most enzymes are effective in only a narrow pH range.
- The optimum pH : the particular pH at which the rate of reaction is fastest.

Temperature

- Low temperature, the rate of enzyme reaction is low.
- Temperature >, rate of reaction >. → increasing the force & the rate of collision.
- Low temp (below 40°C), a rise of 10°C will double the rate of reaction.
- Optimum temp = 37°C @ body temperature.
- Over 40°C, enzymes becomes denatured rapidly
- At 60°C, enzymes are denatured & the reaction stop.

Concentration of Substrate

- pH value, temperature & enzyme concentration are kept constant, the rate of enzyme reaction increases directly proportional to the amount of substrate present until a limiting value.
- The rate of enzyme reaction does not increase even though the [substrate] increase.

Concentration of Enzyme

- pH value, temperature, substrate concentration are kept constant.
- Reaction increases directly proportional to the [enzyme] until it reaches a limiting value.
- Any increase in the enzyme concentration does not increase the rate of reaction.

USES OF ENZYMES IN DAILY LIFE & INDUSTRY

APPLICATION	ENZYMES	USES
Daily products	Rennin	To coagulate milk proteins in cheese production
	Lactose	To produce lactose-free milk.
Meat industry	Trypsin Papain	To digest & tenderise meat, which makes it easier to cook the meat & shortens cooking time.

APPLICATION	ENZYMES	USES
Baking industry	α-amylase	To breakdown starch flour into sugars in the making of breads & buns.
Production of fruit juices	α-amylase Amyloglucosidase Glucose isomerase Pectinase	To produce fructose syrup from corn starch. Used as food drink sweeteners. To digest the pectin in plant cells & increase the volume of fruit juices.

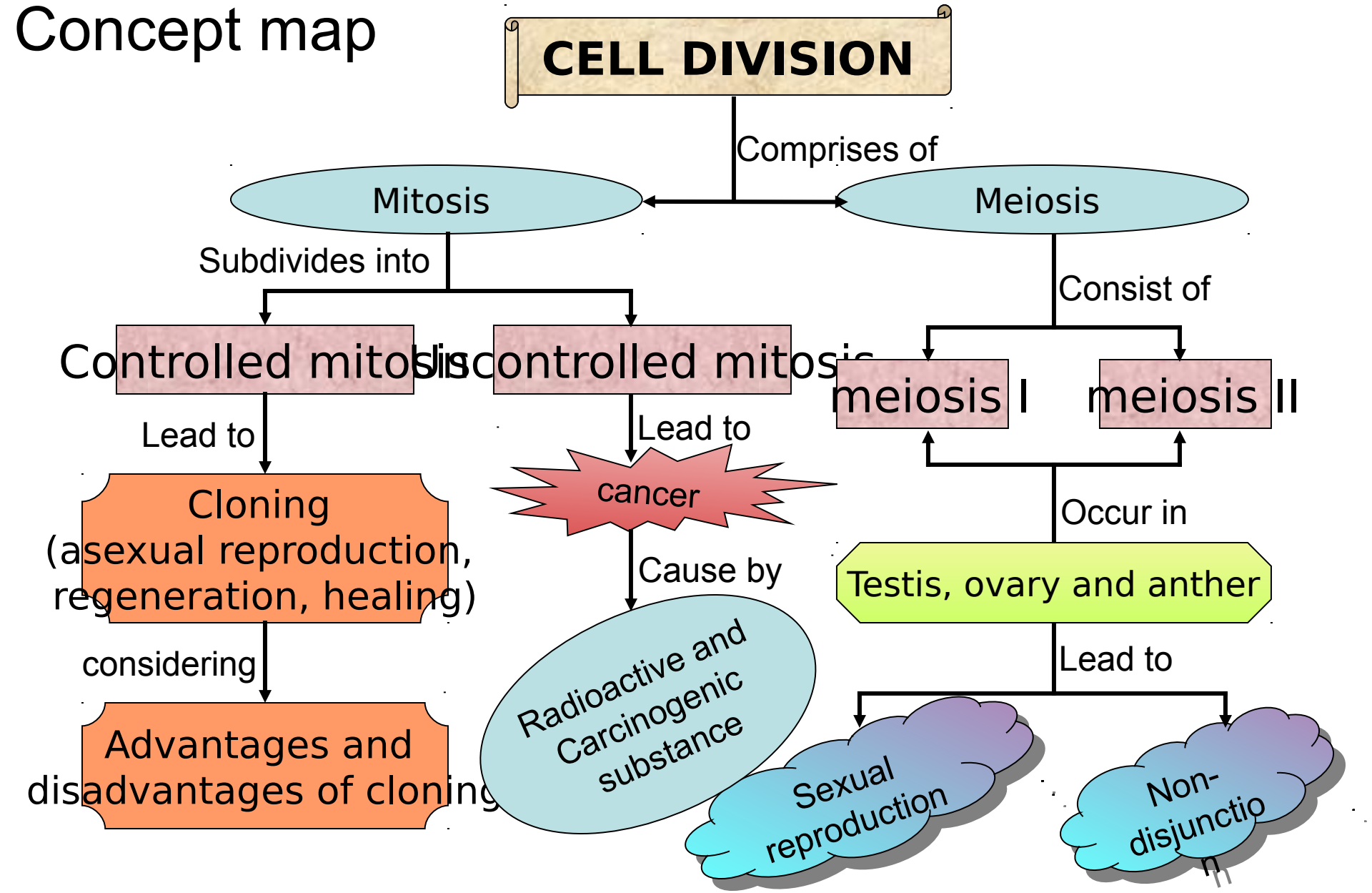
APPLICATION	ENZYMES	USES
Brewing industry	α-amylase Zymase	To digest starch into sugars To convert sugars into alcohol
Extraction of agar from marine seaweed	Cellulase	To breakdown plant cell walls from seaweeds. Makes it easier to extract agar from seaweeds.
Biological detergent	Amylase Protease Lipase	To be used in dish washers & in washing powders.

APPLICATION	ENZYMES	USES
Leather industry	Protease	To remove hair & to soften leather to make bags, belts & shoes.
Paper industry	Amylase	To digest starch into smaller molecules to fill spaces between cellulose fibres to produce smoother paper.
Medicine	Microbial trypsin	To dissolve blood clots

APPLICATION	ENZYMES	USES
Genetic engineering	Ligase Restriction endonuclease	To produce GMO to increase food production, hormones & pharmaceutical products.

CELL DIVISION

Concept map



MITOSIS / MEIOSIS

- **Objectives**
- **Students should be able to:**
- Identify and describe the stages of the cell cycle
- Identify, using prepared slides, the phases of plant and animal mitosis.
- Describe the phases of mitosis
- Describe the events of karyokinesis and cytokinesis
- Identify and describe the phases of meiosis
- Compare and contrast mitosis with meiosis
- Describe spermatogenesis and oogenesis

Mitosis

- Mitosis is a division of the nucleus to produce two new daughter cells containing chromosomes identical to the parent cell.

Significance of mitosis

- Growth- allows a zygote to produce more cell in order to grow
- Repair and replacement- allow the multicellular organism maintain its tissues, example skin cells and blood
- Asexual reproduction- clone

Phases in the cell cycle

- The cell cycle divided into two major phases

a. Interphase

b. Mitosis

- Interphase is the period between division, divided into 3 sub phases (G1, S and G2)

a. G1- cells grow rapidly and new organelle are synthesis

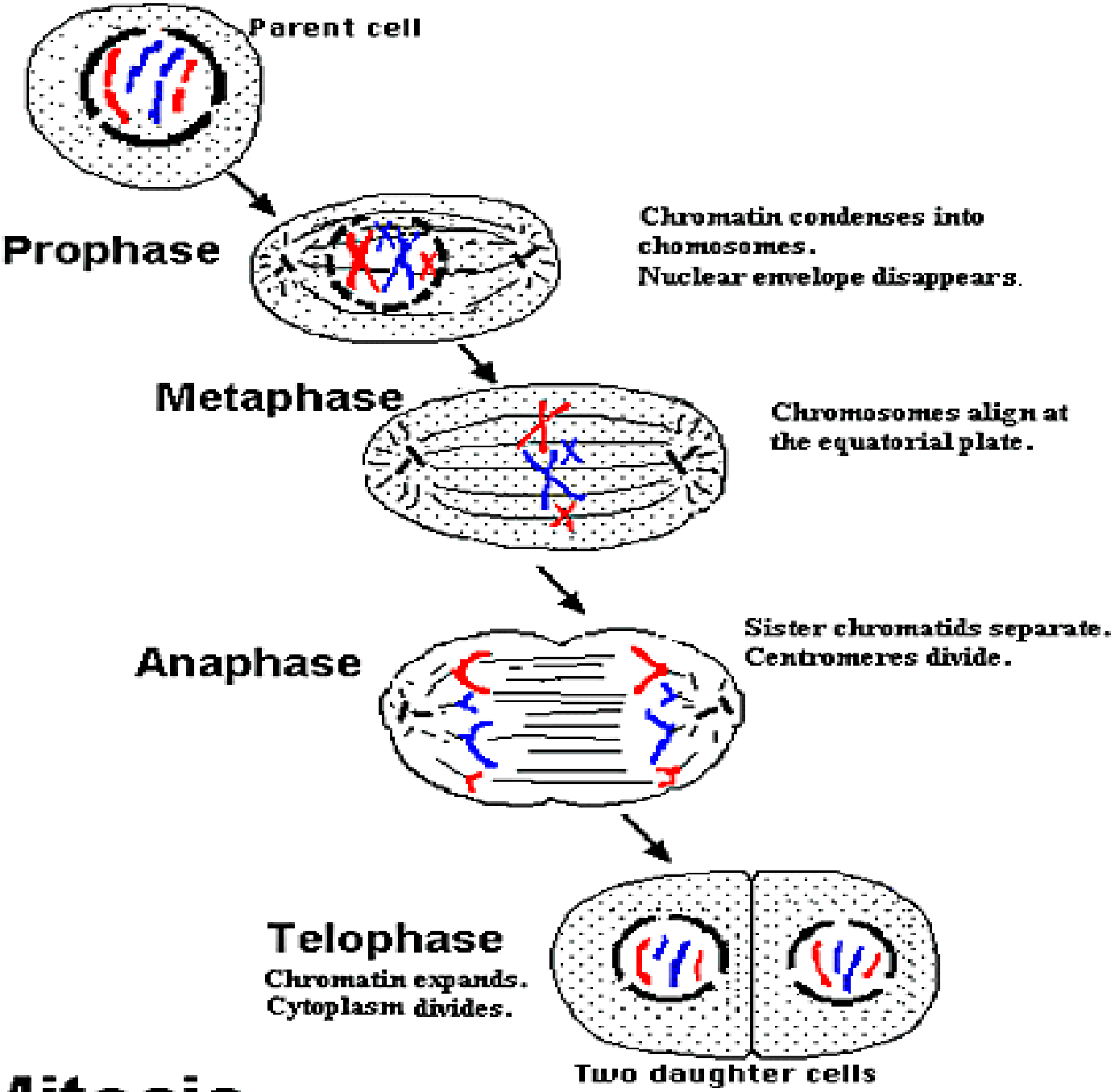
b. S- synthesis of DNA and chromosomes are replicated

c. G2- cells prepares for mitosis, synthesis protein and mitotic spindle begin to form

Mitosis

- Mitosis is a continuous process and divided into 4 main phases based on the appearance and behavior of the chromosomes.

1. Prophase
2. Metaphase
3. Anaphase
4. Telophase


Parent cell
Prophase
Chromatin condenses into chomosomes.
Nuclear envelope disappears.
Metaphase
Chromosomes align at the equatorial plate.
Anaphase
Sister chromatids separate.
Centromeres divide.
Telophase
Chromatin expands.
Cytoplasm divides.
Two daughter cells

Mitosis

Prophase

Early prophase

- Chomatids condense and become visible in a light microscope
- Nucleolus disappears
- Paired centrioles move to opposite ends of the cell

Late prophase

- Nuclear membrane disappears
- Spindle form

Metaphase

- Spindle fibres are fully form
- Sister cromatids line up at the spindle equator
- At the end of metaphase, the centromers divide

Anaphase

- Anaphase begin with the separation of the centromers
- The sister cromatids are drawn to opposite poles of the cell by contraction of spindle fibres

Telophase

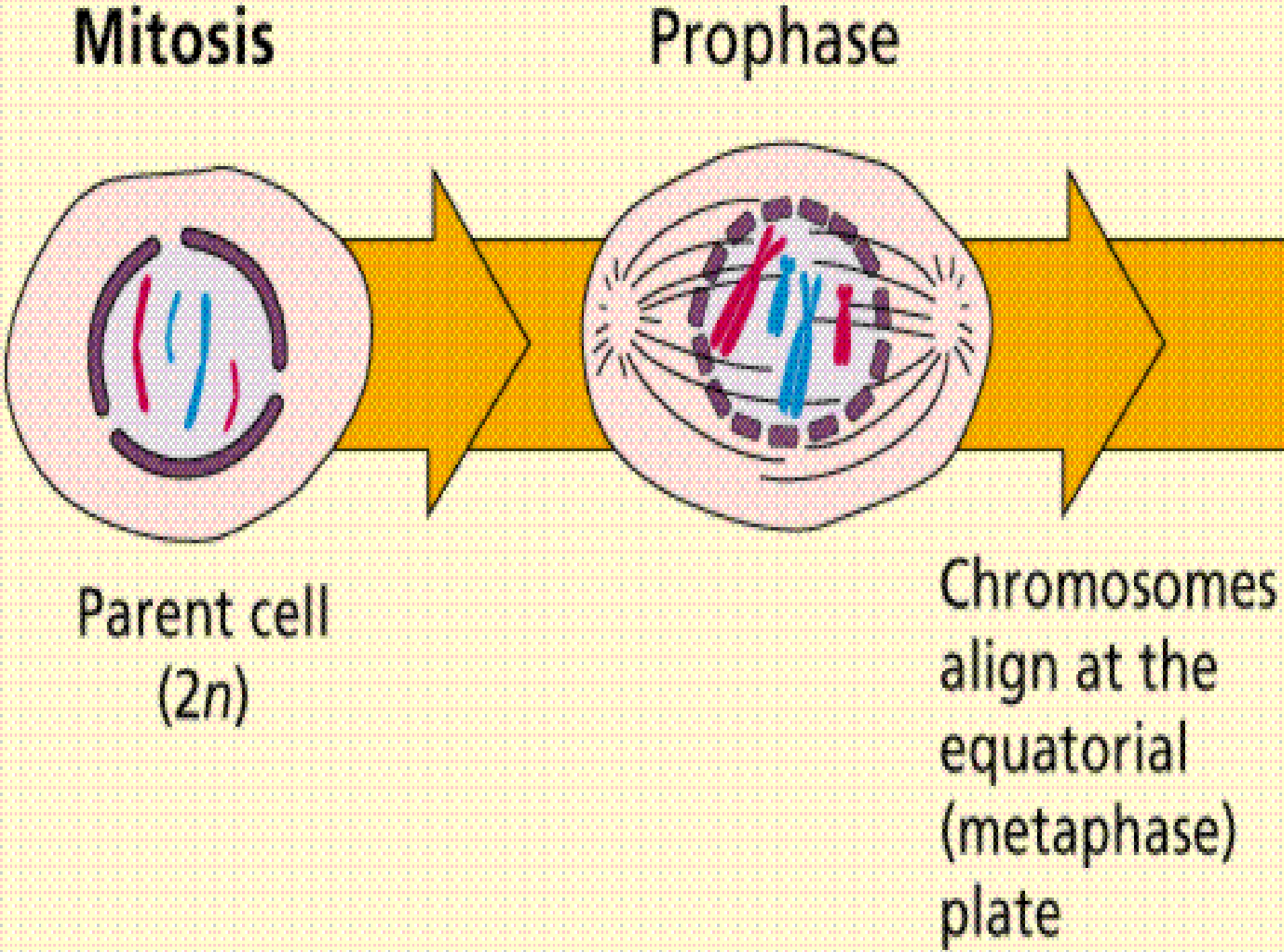
- Telophase begin when the two sets of daughter chromosomes have reached the two poles of the cell.
- The spindle fibres disintegrate, the nuclear membrane forms around each set of daughter chromosomes and the nucleoli reappear
- The chromosomes uncoil and become less visible under the light microscope

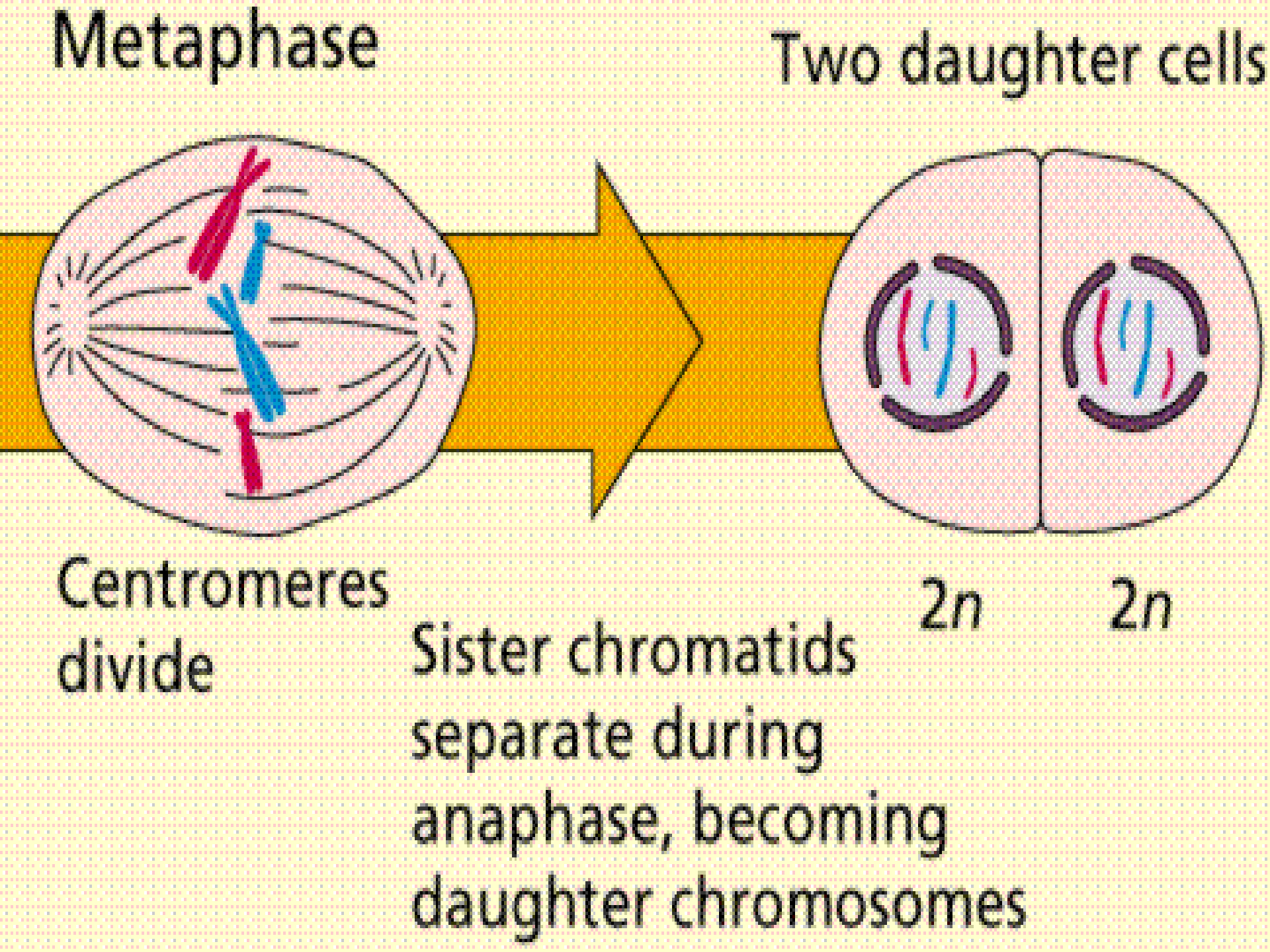
- In plant cells, the stages of mitosis are same. Only cytokinesis in plant cells is markedly different.
- A cleavage furrow does not form. Instead, membrane-enclosed vesicle gather at a plant cell's equator between the two nuclei.
- Vesicle fuse to form a cell plate

Cytokinesis

Cytokinesis is the process of cytoplasmic division to form two daughter cells.

- Cytokinesis usually begins before nuclear division is completed.
- Cytokinesis in animal cells and plant cells are different.
- Animal cells, the cytoplasm contracts to pull the plasma membrane inwards, forming groove called a cleavage furrow


Mitosis
Prophase
Parent cell
(2n)
Chromosomes
align at the
equatorial
(metaphase)
plate


Metaphase
Two daughter cells
Centromeres divide
Sister chromatids separate during anaphase, becoming daughter chromosomes
2n
2n

Meiosis

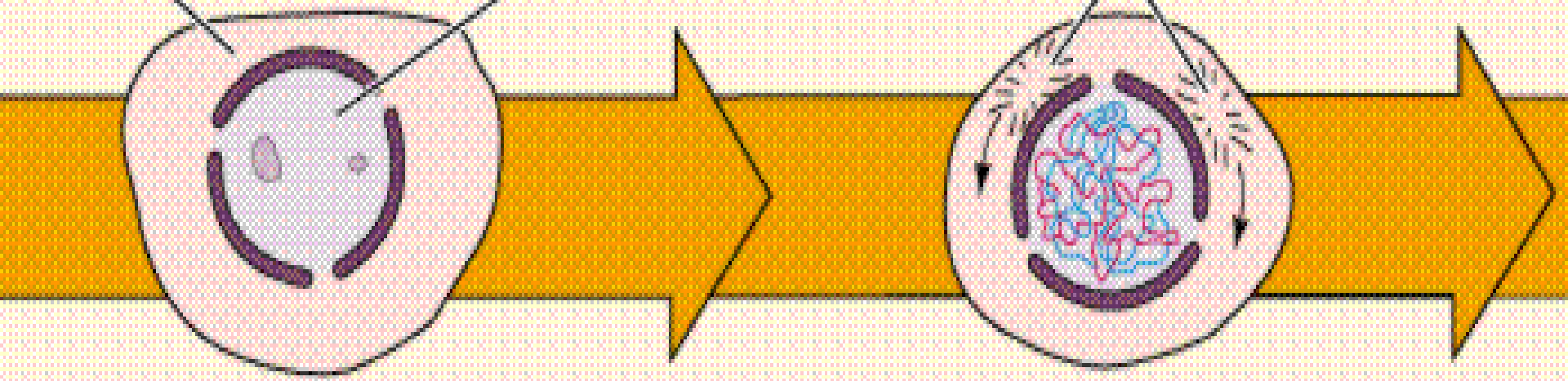
- In a diploid cell, chromosomes occur as pairs (homologous chromosomes).
- Meiosis is a process to convert a diploid cell to a haploid gamete and cause a change in the genetic information to increase diversity in the offspring
- Meiosis involves two successive nuclear division that produce four haploid cells. The first division (meiosis I) is the reduction division; the second division (meiosis II) separates the chromatids.

Meoisis I

Early prophase I

Nuclear envelope

Chromatin



The chromatin begins to condense following interphase

Middle prophase I

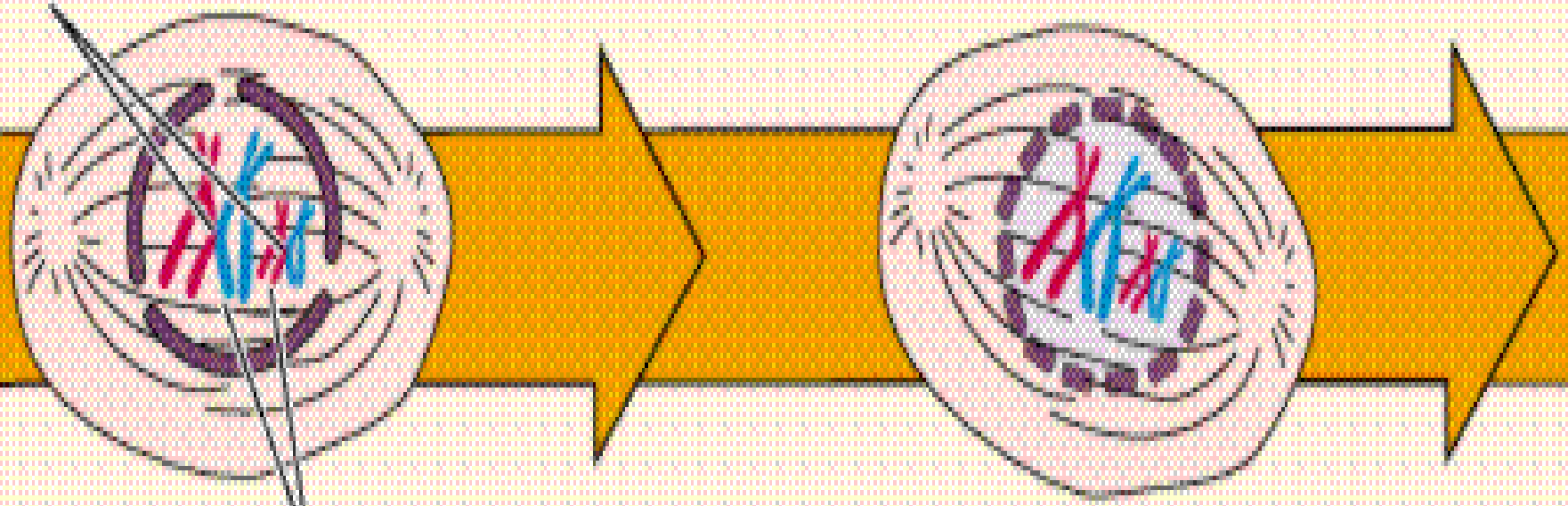
Centrosomes

Synapsis aligns homologs, and chromosomes shorten

Middle prophase I

Late prophase I

Chiasmata



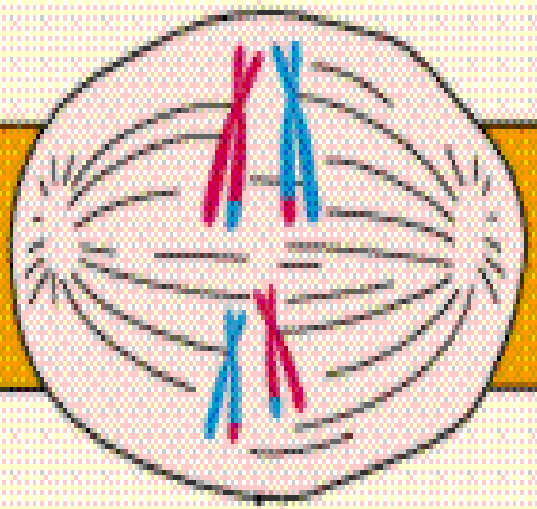
Pairs of homologs

Chiasmata become evident

Coiling and shortening of the chromosomes continue

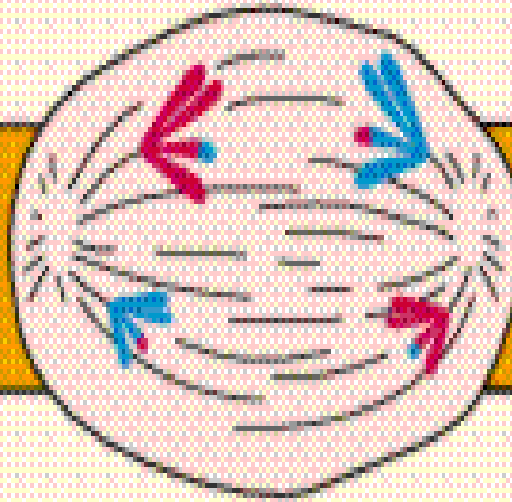
Metaphase I

Equatorial plate



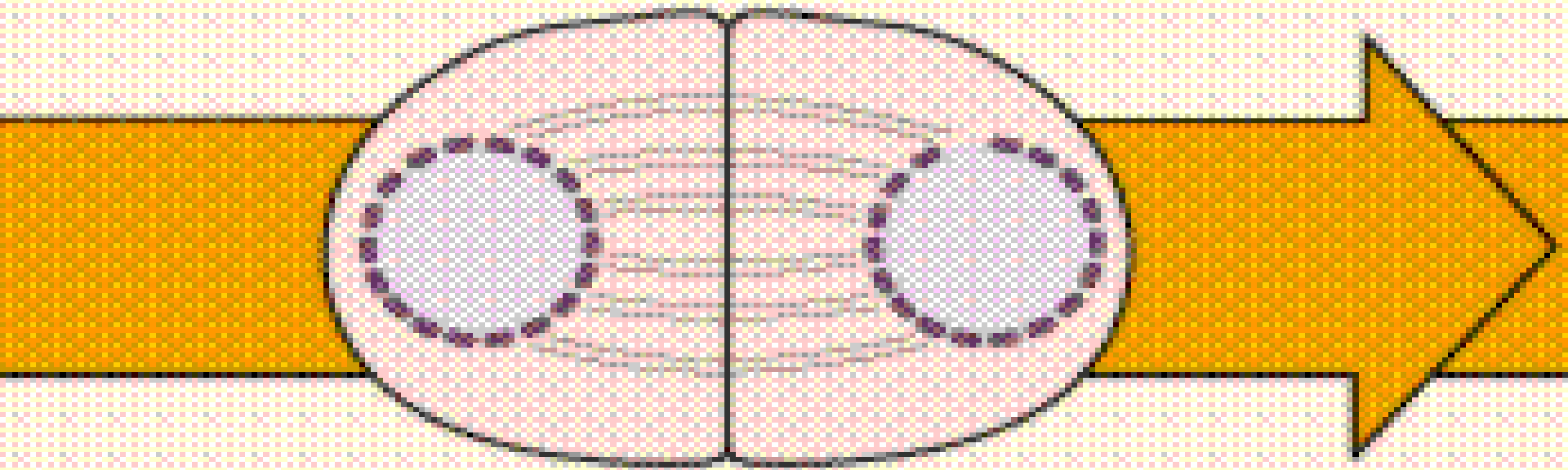
The chromosomes line up on the equatorial (metaphase) plate

Anaphase I



The homologous chromosomes move to opposite poles of the cell

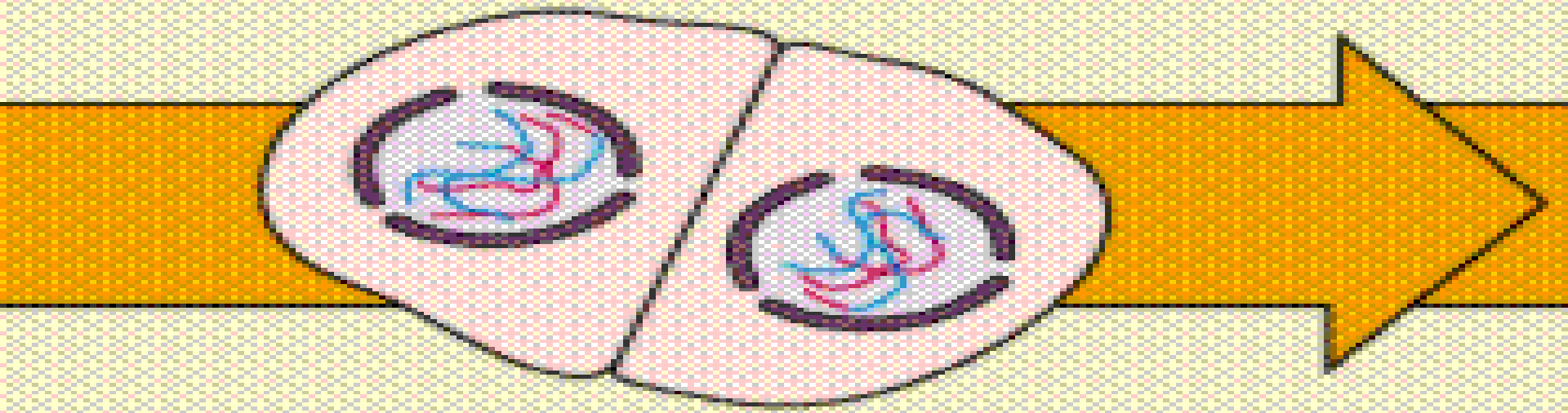
Telophase I



The chromosomes gather into nuclei, and the original cell divides

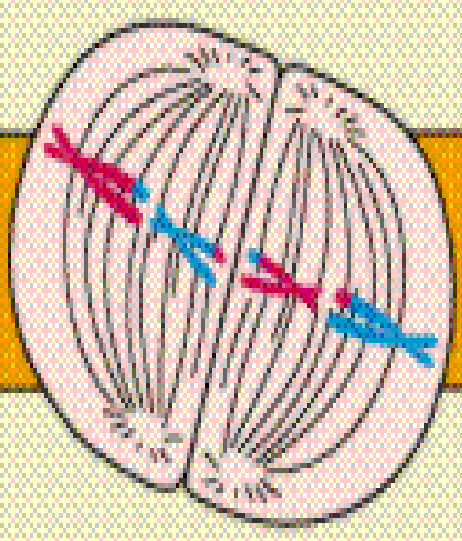
Meiosis II

Prophase II



The chromosomes condense again, following a brief interphase in which DNA does not replicate

Metaphase II



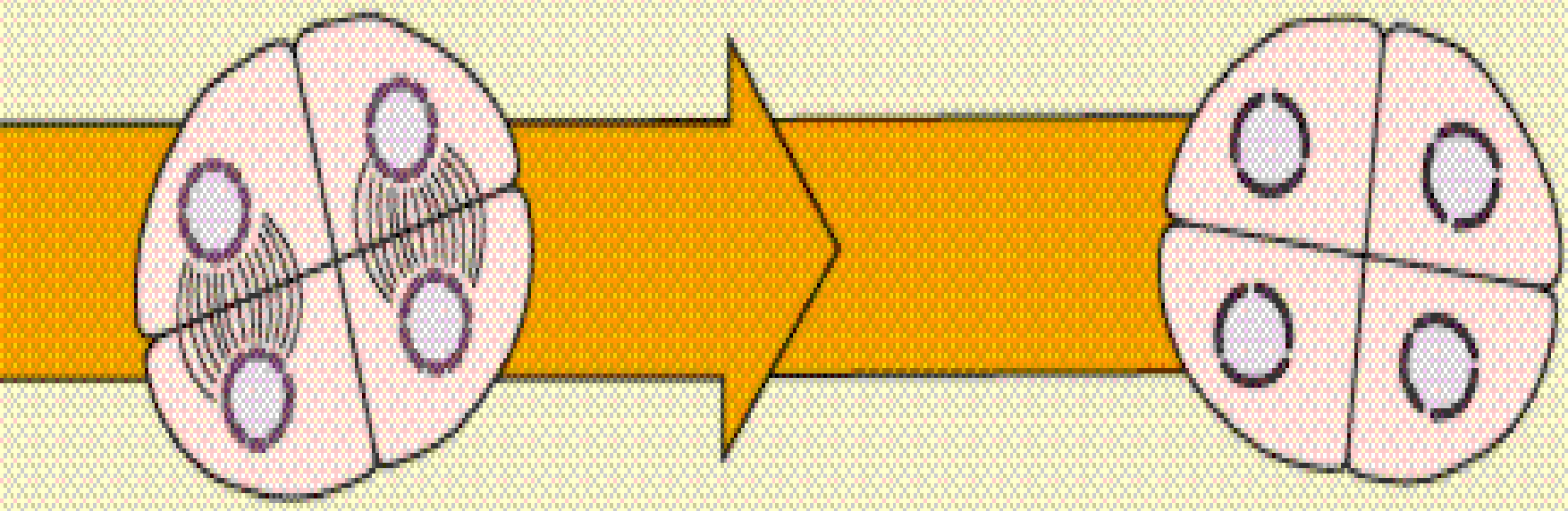
Kinetochores of the paired chromatids line up across the equator of each cell

Anaphase II

The chromatids of the chromosomes finally separate, becoming chromosomes in their own right, and are pulled to opposite poles

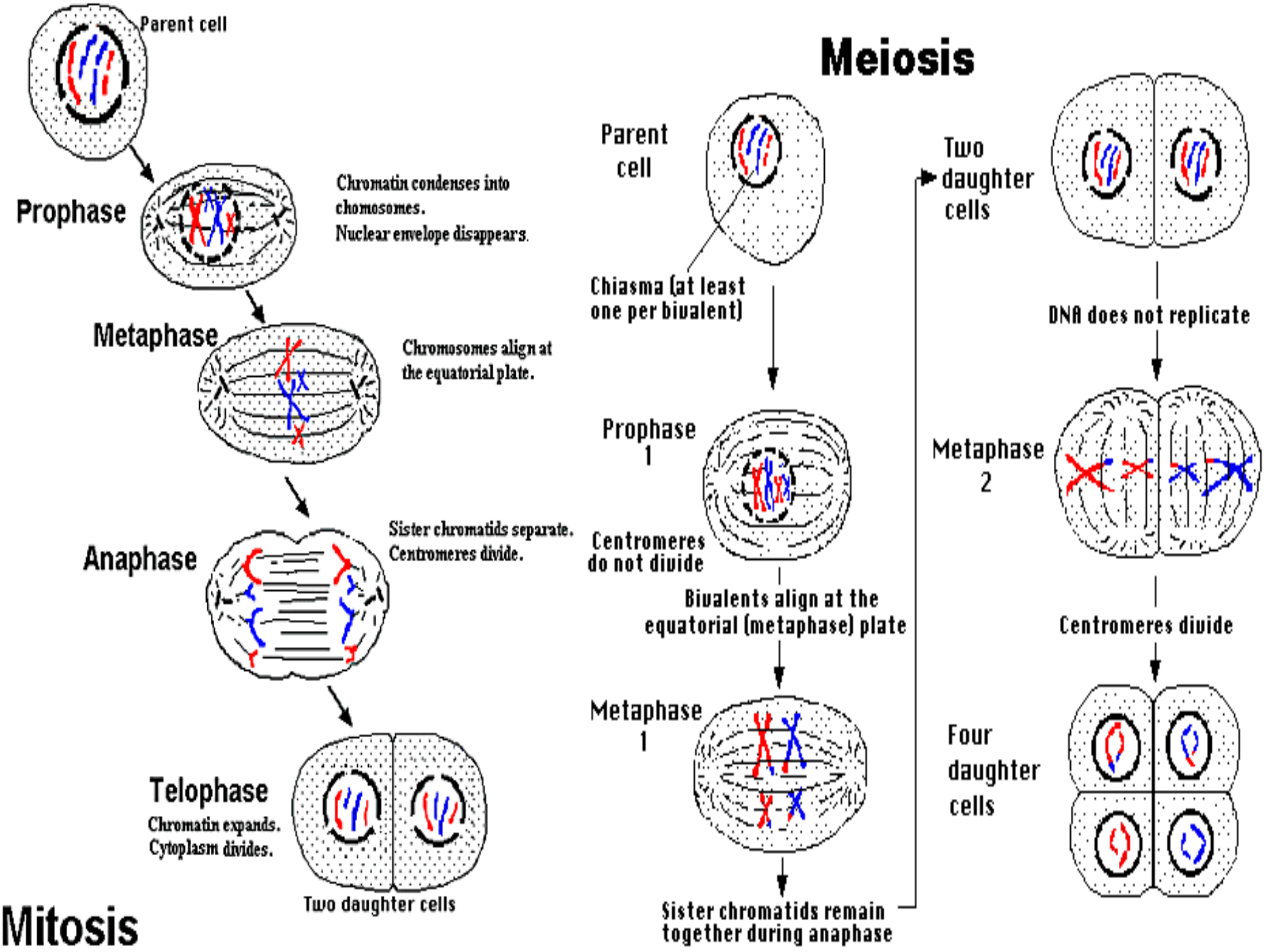
Telophase II

Products of meiosis



The chromosomes gather into nuclei, and the cells divide

Each of the four cells has a nucleus with a haploid number of chromosomes.


Parent cell
Prophase
Chromatin condenses into chomosomes.
Nuclear envelope disappears.
Metaphase
Chromosomes align at the equatorial plate.
Anaphase
Sister chromatids separate.
Centromeres divide.
Telophase
Chromatin expands.
Cytoplasm divides.
Two daughter cells
Mitosis
Meiosis
Parent cell
Chiasma (at least one per bivalent)
Prophase 1
Centromeres do not divide
Bivalents align at the equatorial (metaphase) plate
Metaphase 1
Sister chromatids remain together during anaphase
Two daughter cells
DNA does not replicate
Metaphase 2
Centromeres divide
Four daughter cells

The effects of uncontrolled mitosis in living things

- Mutation is the change in the DNA structure of the cell.
- This change in the DNA corrupts the coded genetic instructions for mitosis control.
- This leads to uncontrolled mitosis, which is the non-stop division of cells, producing a mass of new daughter cells, called tumour.

Causes of cancer

1. Genetic- some forms of cancer like prostate, colon, breast, skin, ovary are suspected to be inherited from the parents
2. Carcinogens- these are chemicals which affect genetic activity and cause cancer, e.g. of carcinogen a diesel exhaust, cigarette smoke, hair dyes, soot, arsenic, benzene and formaldehyde.
3. Radiation- excess exposure to x-ray, gamma-rays and ultra violet rays lead to increase cancer risk.
4. Age- some cancers are found primarily in young people (e.g. leukemia), while some cancers (e.g. colon cancers) are found mostly in older adults.
5. Viruses- some viruses (such as the EB and HIV-1) cause cancer.

Cloning

1. Cloning is the process of the making Clones are genetically identical cells produced from a single parent cell by mitotic division, or through asexual reproduction.
2. genetically identical copies of an original plant or animal.
3. We shall study the application of knowledge on mitosis the cloning of

a) Microbes
b) Plants
c) animals

Cloning of microbes

- Clone microbes using cells culture and fermenters,
- Cell culture

a) You can easily clone microbes (bacteria and some fungi) in you science laboratory through natural asexual reproduction.
b) First, grow a sample of microbial cells on a solid nutrient medium in an agar plate.
c) Then identify, isolate and select strain from the agar plate and grow it in liquid medium in a culture flask.

- Fermenters

a) Fermenters are vessels use in biotechnology to grow microbes on a large scale.
b) Microbes, like yeast are mixed with a culture medium and left in a fermenters to grow by mitosis.
c) The fermenters is constantly stirred, and aerated.
d) The environmental conditions (such as pH, oxygen, pressured and temperature) are constantly monitored using proves ti ensure the maximum growth of the microbes.

Cloning in plants-tissue culture

1. Plants can be cloned using tissue culture.
2. Tissue culture is the process of growing cells artificially in the laboratory, it is a modern and efficient way of cloning plants.
3. Tissue culture produces genetically identical clones.

The main principals of tissue culture:

a) A pieces of tissue, called explants, its taken from a parents plant (e.g. carrot root or stem tissue,)
b) The pieces of tissues are sterilised with dilute sodium hypochlorite solution to prevent the growth of pathogens (such as bacteria and fungus).
c) Each sterile tissue piece is placed on to a growth medium (gel containing nutrients and growth regulators).
d) The tissues cells divided by mitosis to produce a mass of loosely arranged undifferentiated cells called callus.
e) Callus is stimulated with shoot-stimulating hormone to form multiple shoots.
f) The shoots are separated and each is placed in nutrient medium with root-stimulating hormone to encourage rooting
g) Once the roots grow, the plantlets (little plants) are planted in sterile compost to grow.

Cloning of animals

- There are two types of animal cloning according to purpose:

1. Reproductive cloning

- Producing an entire animal that is genetically identical to the parent animal
- The entire animal is produced from a single cell by asexual reproduction through mitosis.

2. Therapeutic cloning

- Is a branch of medicine concerned with the treatment of diseases.
- Parts of a person skin, heart, liver or even just a few cells are duplicated to produce a clone.
- The clone tissue is used to replace a damaged or diseases tissue without the risk of tissue rejection.