BIOLOGY

Cell Transport

Objectives :

- Explain the processes that move particles across membranes: Simple diffusion, facilitated diffusion, osmosis and active transport.

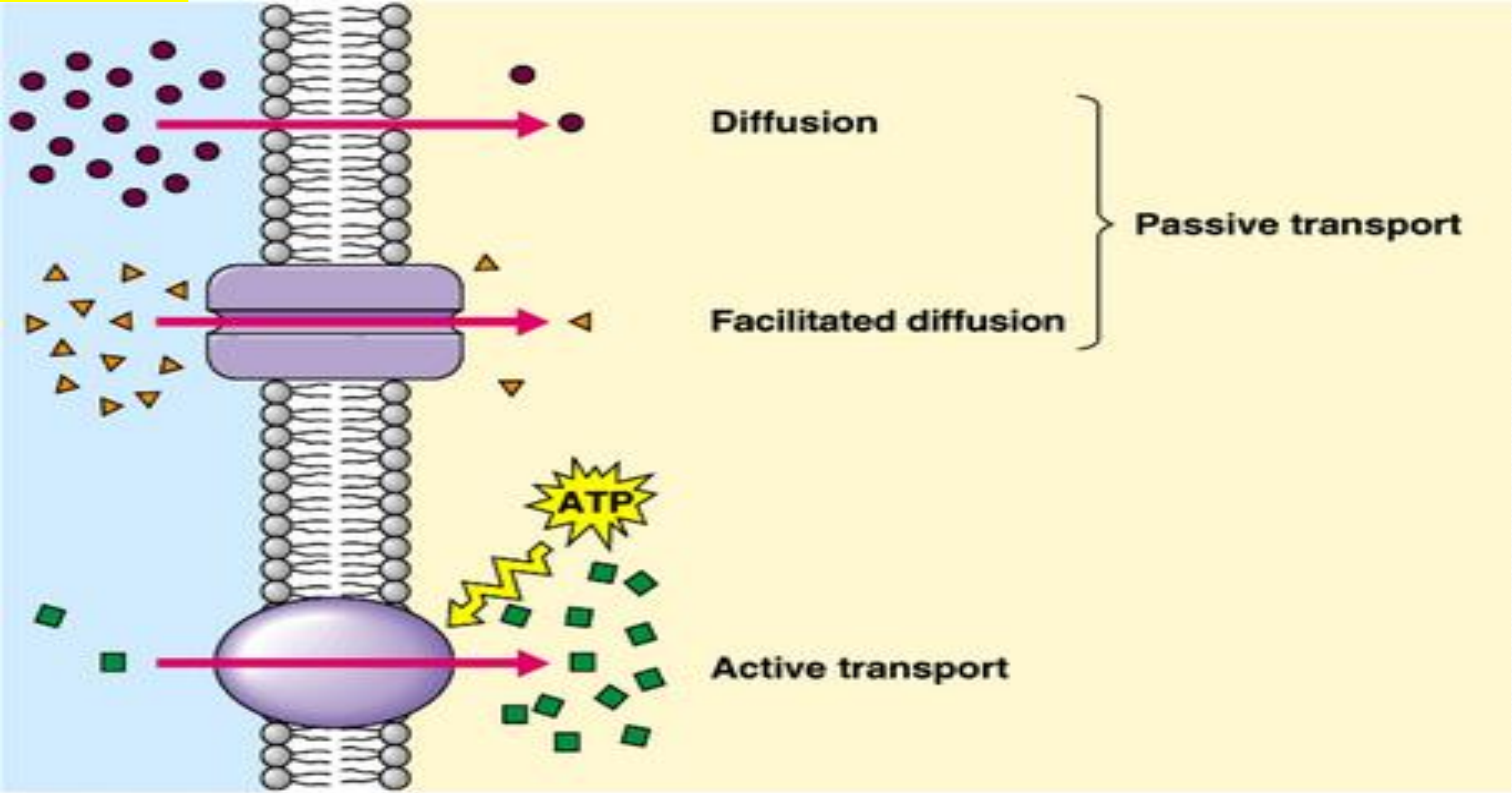
- Understand how the fluidity of membranes allows materials to be taken into cells by endocytosis or released by exocytosis. Vesicles move materials within cells.

- Practical skill : Estimation of osmolarity in tissues by bathing samples in hypotonic and hypertonic solutions.

Resources :

Student book pages 12,13,14

Cell transport



Cell transport is the movement of particles across the cell membrane (the phospholipid bilayer). The phospholipid bilayer is a partially permeable membrane that allows some particles to pass through.

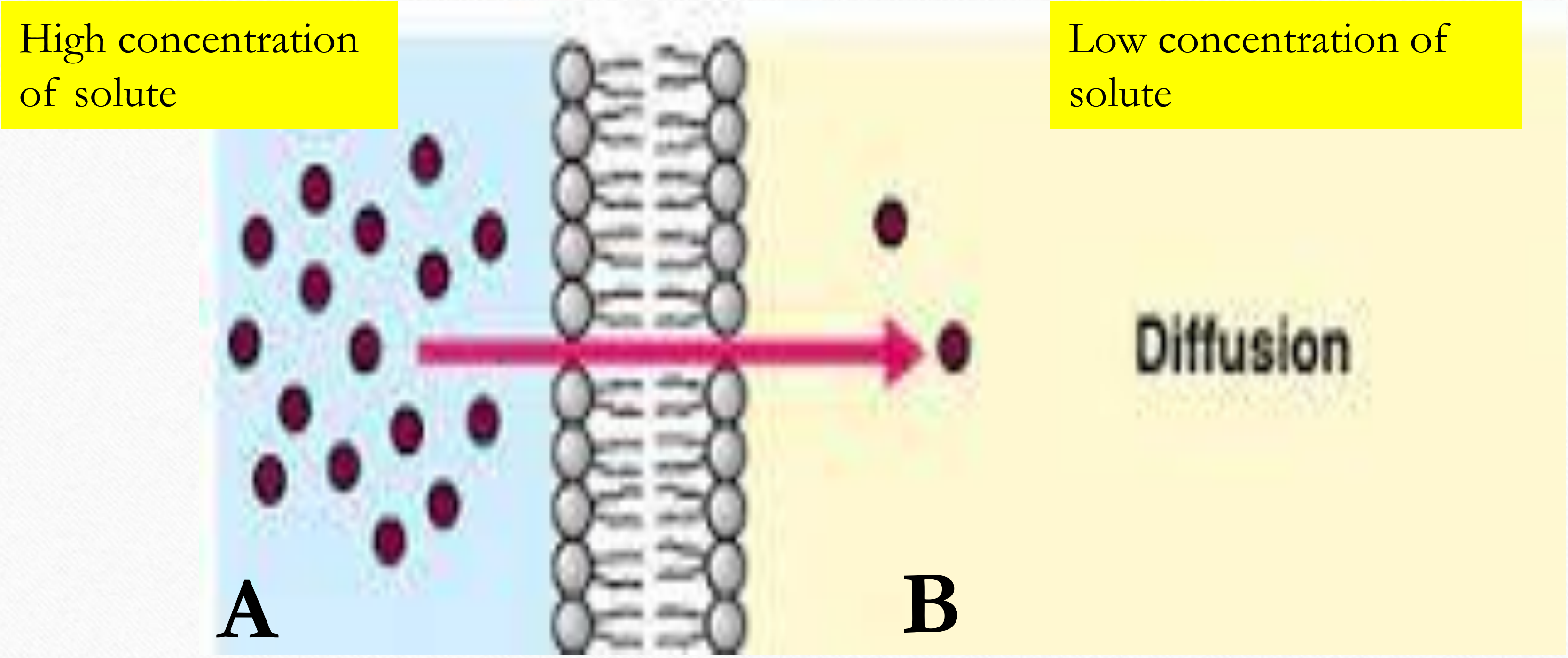
Cell transport includes:

- ✓ Passive transport
- ✓ Active transport.

Passive transport **does not require energy** and includes simple diffusion, facilitated diffusion and osmosis. Active transport **requires energy** and includes transport through pumps, endocytosis and exocytosis.

Particles move across cell membranes continuously. Such particles are usually found dissolved in a solution, mainly aqueous solution. This solution contains water as the solvent and various particles as solutes. If the amount of solute is high, the solution is described as a concentrated solution. If the amount of solute is little, the solution is described as a dilute solution.

- Compare between the concentration gradient in A and B
- Describe how the particles move from A to B .(*Down the concentration gradient)*
- Use the book to find examples of particles that are transported by simple diffusion *(carbon dioxide and oxygen).*

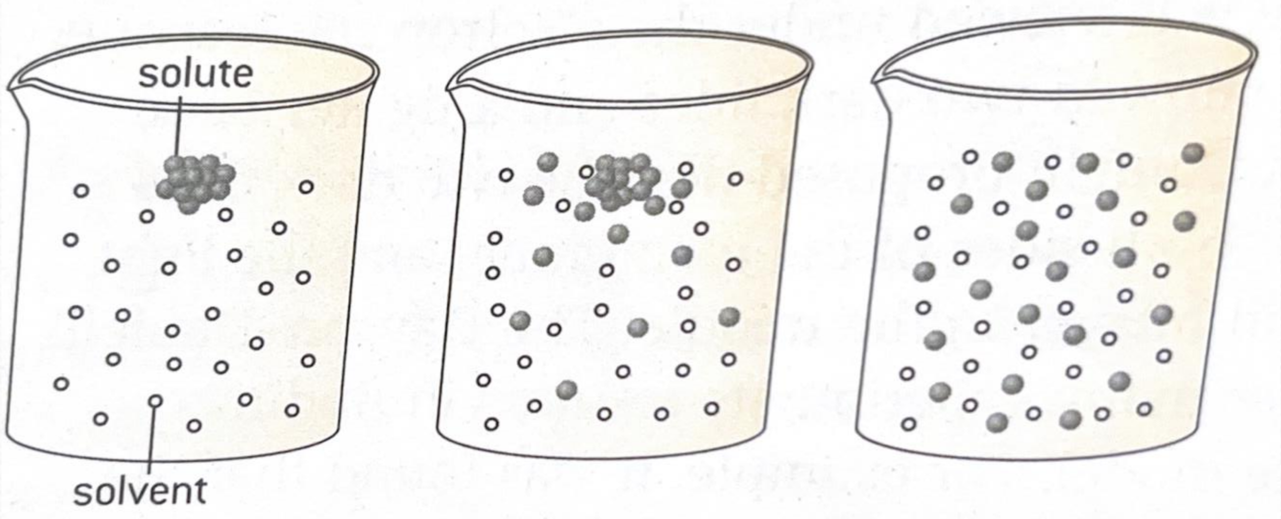


Simple diffusion

Diffusion is the passive movement of particles from a region of high concentration to a region of low concentration until evenly distributed .

Diffusion does not require energy and takes place across a concentration gradient.

The concentration gradient is the difference in concentration between the two regions.



Which particles are transported by simple diffusion ?

The movement of particles by diffusion across the cell membrane does not involve a channel and therefore, **small hydrophobic (non-polar) molecules** can easy pass through the phospholipid bilayer.

Examples of diffusion across the cell membrane (figure 10): ***page 13***

- the movement of O_2 from the blood capillaries to the body cells to carry out cellular respiration.
- the movement of CO_2 (which is a by-product of cellular respiration) from the body cells to the blood capillaries to be transported and removed out of the body.

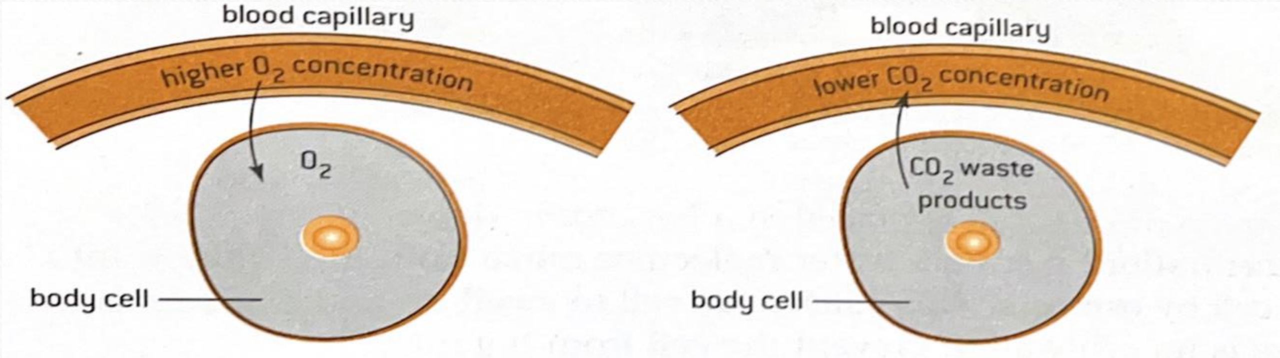
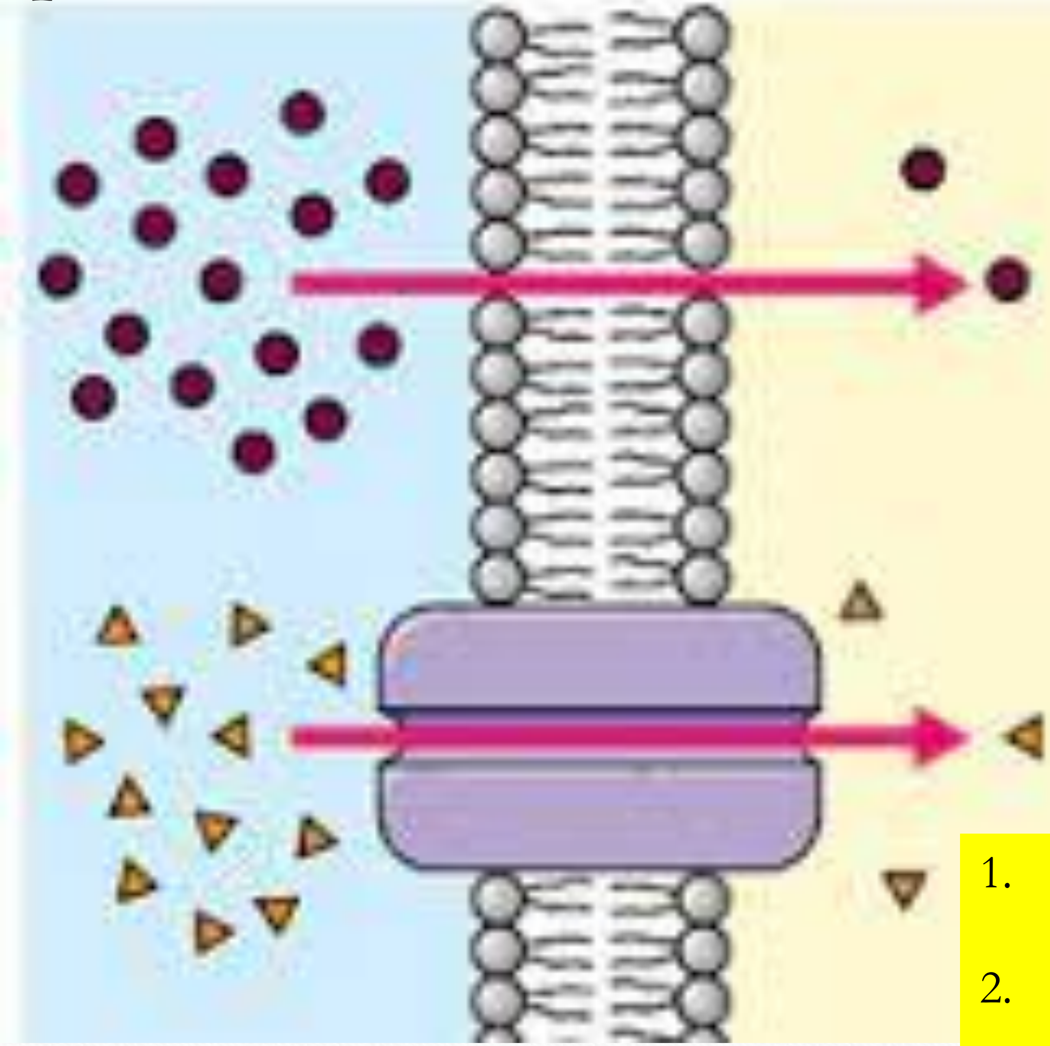


Figure 10. Oxygen and carbon dioxide diffusion

Compare and contrast between the movement of particles in A and B



A Simple diffusion

B Facilitated diffusion

1. In both A and B particles diffuse from high concentration to low concentration
2. In A particles diffuse through the cell membrane but in B particles move through channels

Facilitated diffusion

Is the passive movement of particles from a region of high concentration to a region of low concentration **via a channel protein** . Molecules that are **large and polar** cannot directly pass through the phospholipid bilayer and therefore require a channel protein that is embedded in the membrane to transport them.

An example of facilitated diffusion across a cell membrane is the diffusion of potassium ions across the axon of a neuron through potassium channels. Neurons, also known as nerve cells, are the primary components of the nervous system.

https://www.youtube.com/watch?v=HYzA6owwny4&t=85s

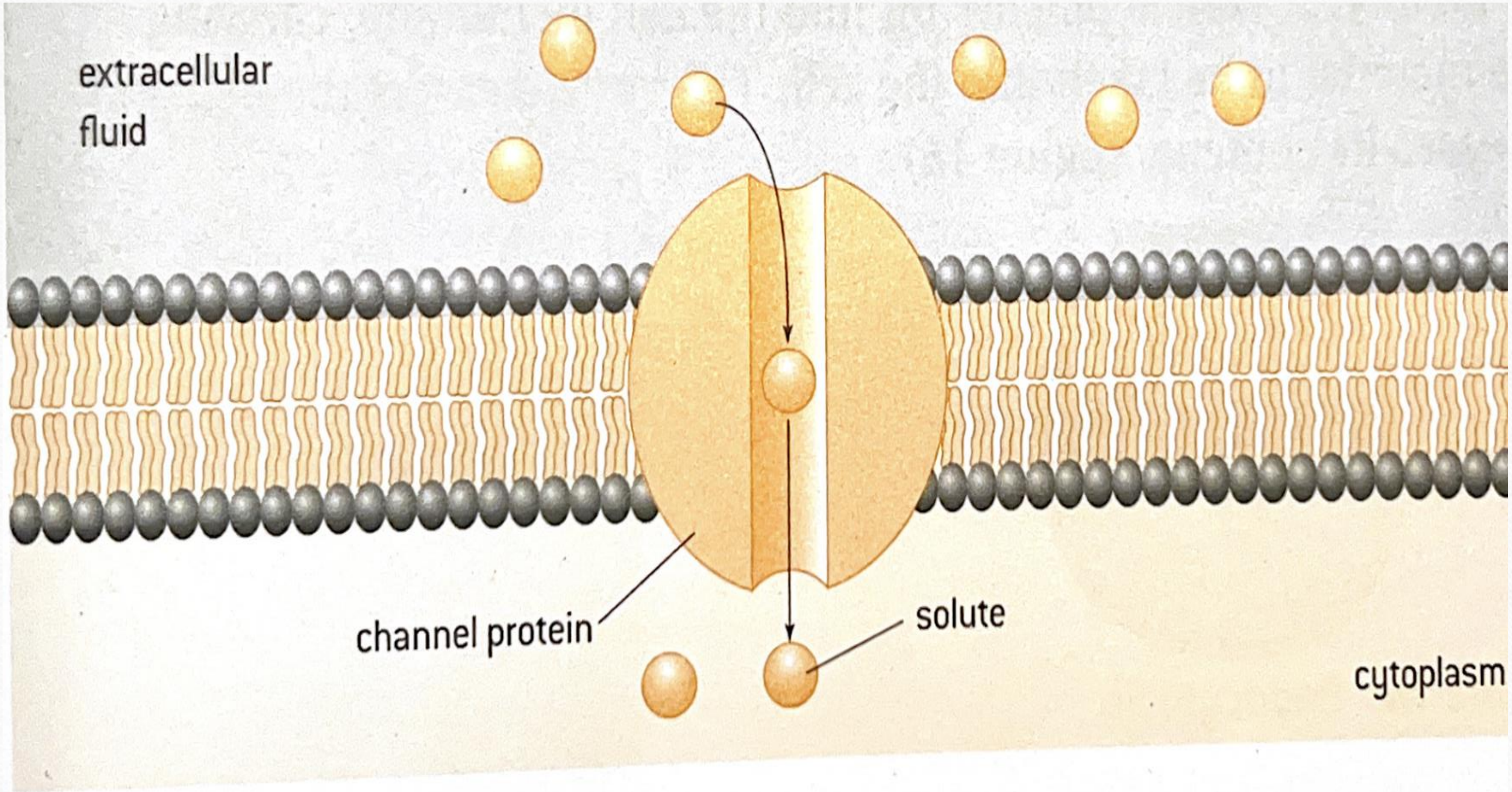
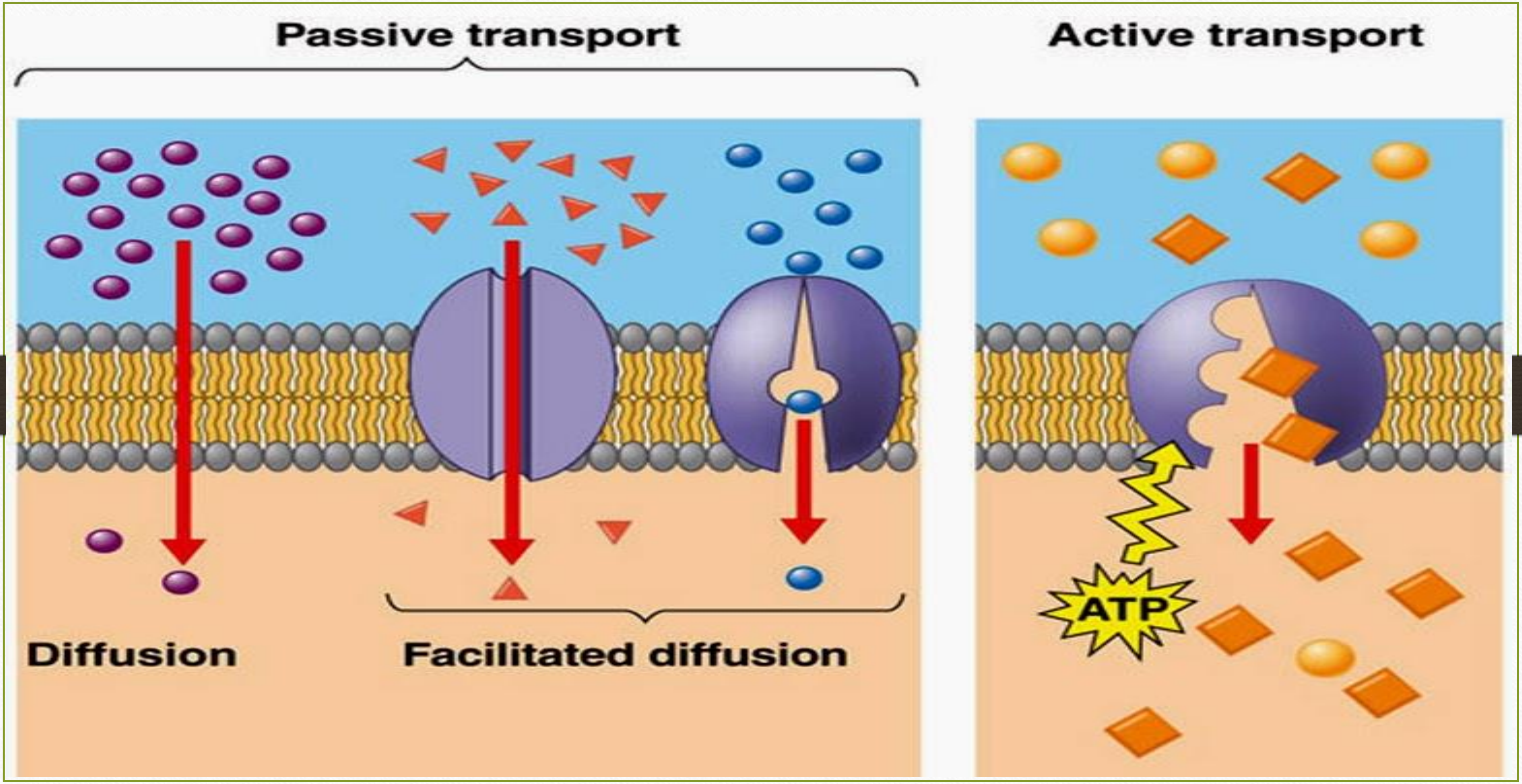
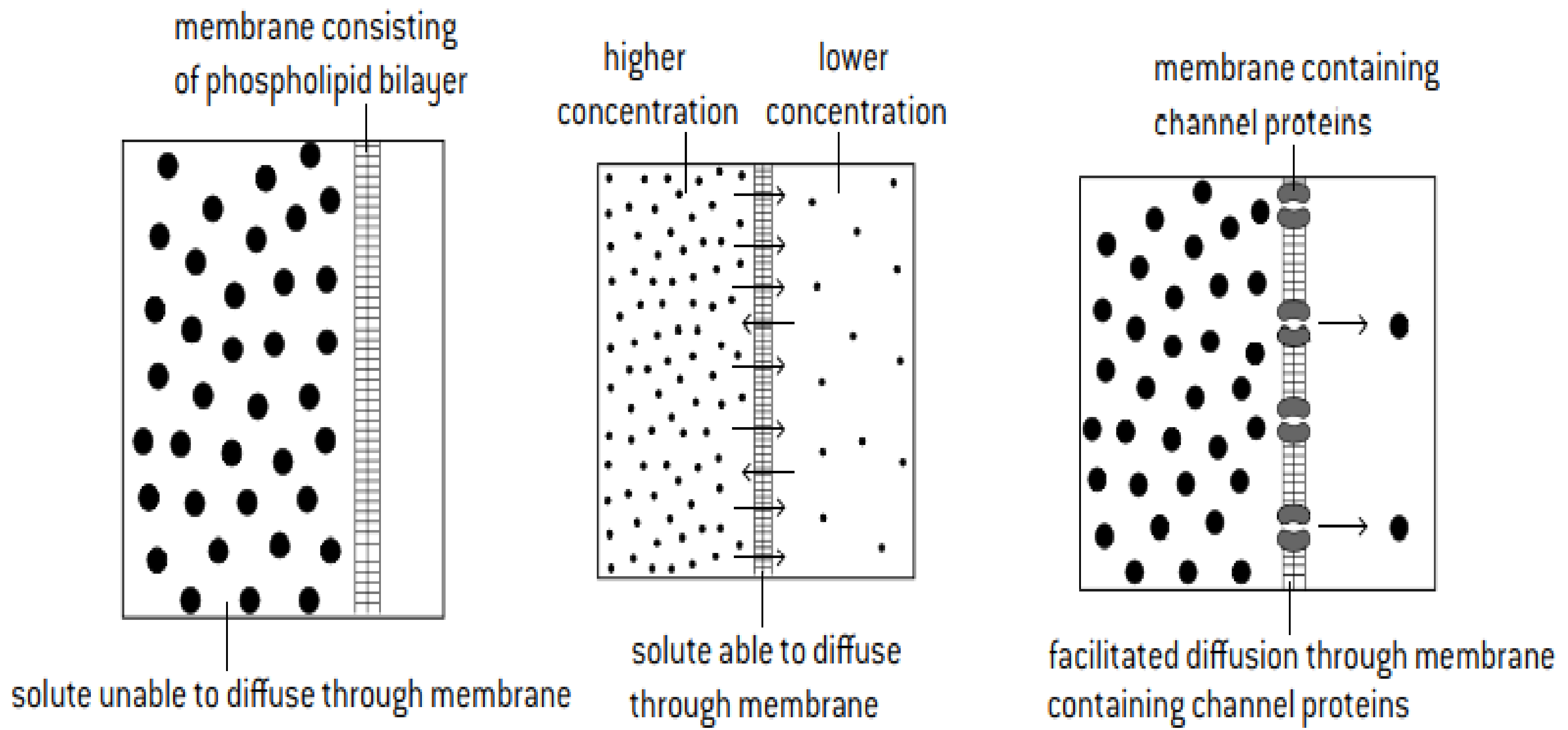


Figure 14. Facilitated diffusion


Passive transport
Active transport
Diffusion
Facilitated diffusion
ATP


membrane consisting
of phospholipid bilayer
solute unable to diffuse through membrane
higher
concentration
lower
concentration
solute able to diffuse
through membrane
membrane containing
channel proteins
facilitated diffusion through membrane
containing channel proteins

Active transport :

It is the movement of substances through a membrane **from a region of low concentration to a region of high concentration.** This process occurs **against a concentration gradient** and therefore requires energy and protein pumps that are embedded in the cell membrane.

Each protein pump is specific and can only transport specific substances. The pump is provided with energy from ATP.

ATP molecules that attach to the pump cause a conformational change in the shape of the pump, and molecules that are large and polar may be transported by active transport.

Endocytosis

Endocytosis is the process by which large molecules enter the cell. This process requires energy.

The process begins when the cell membrane is pulled inwards due to its fluidity. A vesicle pinches off into the cell membrane, carrying the material to be taken into the cell. The vesicle enters the cell and releases its contents .

An example of endocytosis is phagocytosis. This is when foreign organisms such as bacteria are engulfed by macrophages (a type of white blood cell), that have a role in immune response. The bacterium is engulfed by endocytosis, and then it is moved towards the lysosome where it is digested by enzymes.

https://www.youtube.com/watch?v=DuDmvlbpjHQ

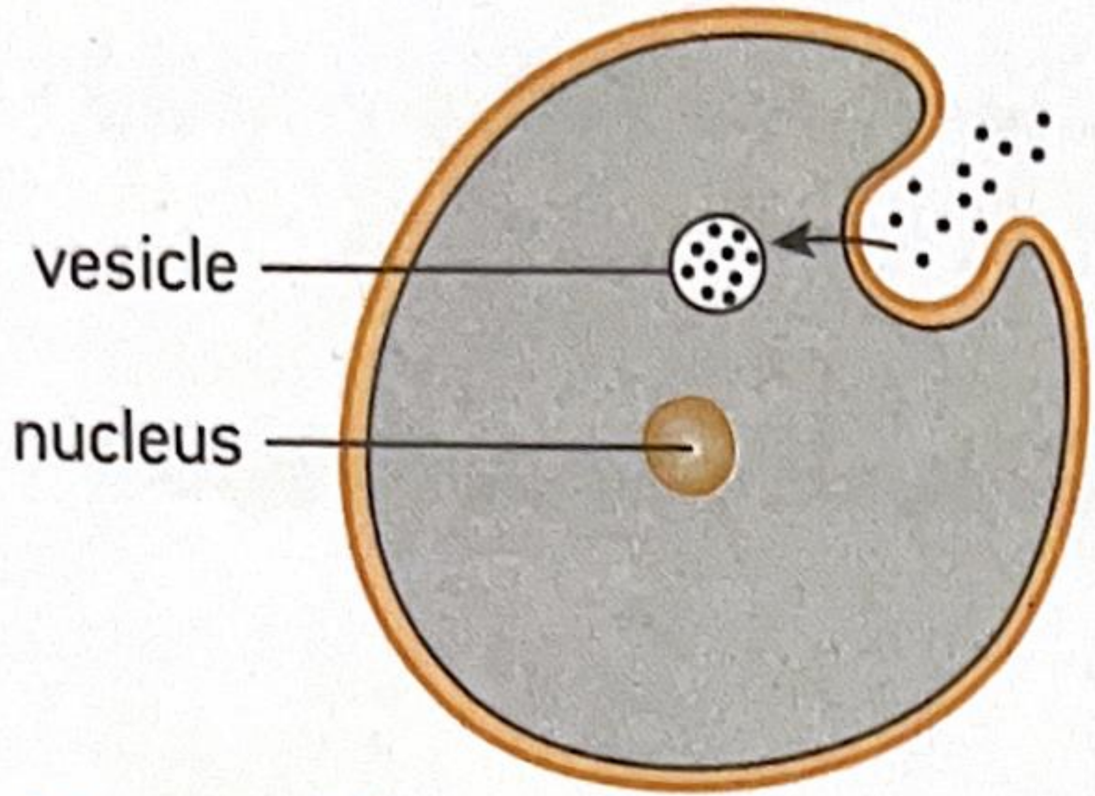


Figure 16. Endocytosis

Exocytosis

Exocytosis is the process by which large molecules are released out of the cell. This process requires energy.

The process begins when the proteins synthesized in the rough endoplasmic reticulum are released in vesicles that are transported to the a side of the Golgi apparatus for further modification. The vesicles carrying the proteins bud off the Golgi apparatus are moved towards the cell membrane. The vesicle fuses with the cell membrane due to its fluidity, thus releasing the materials as it carries them out of the cell .

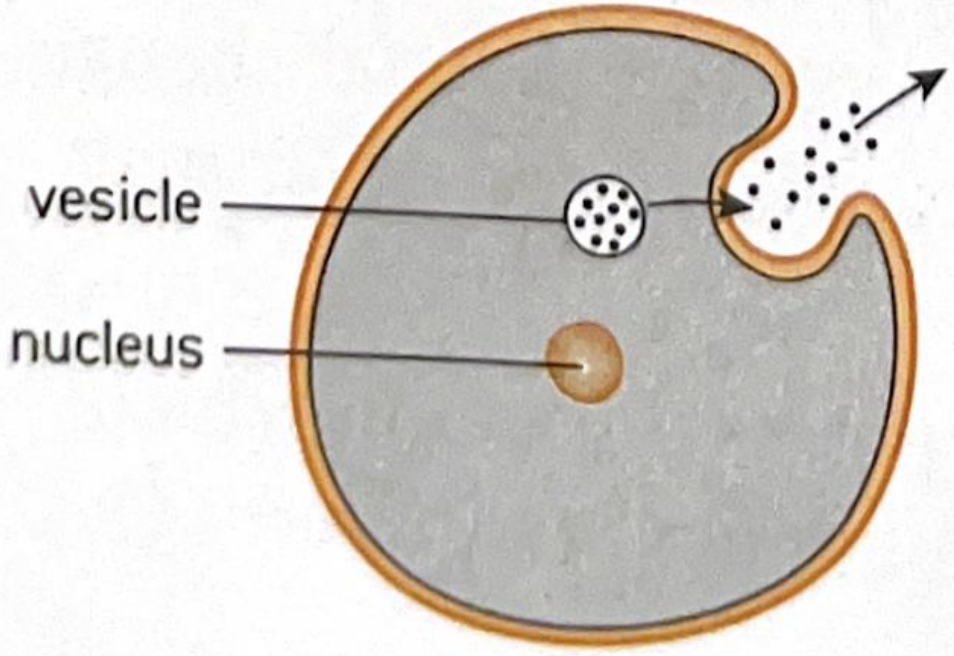
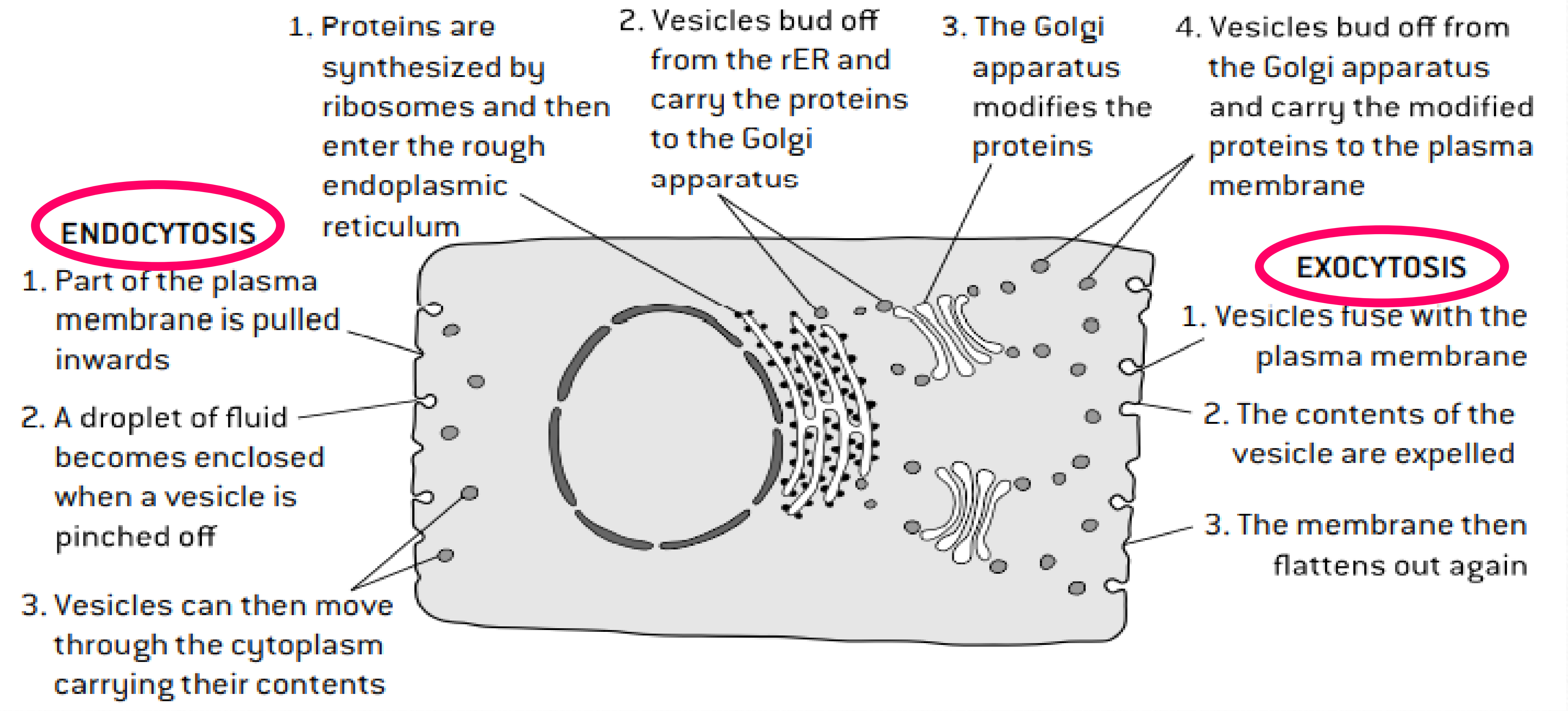
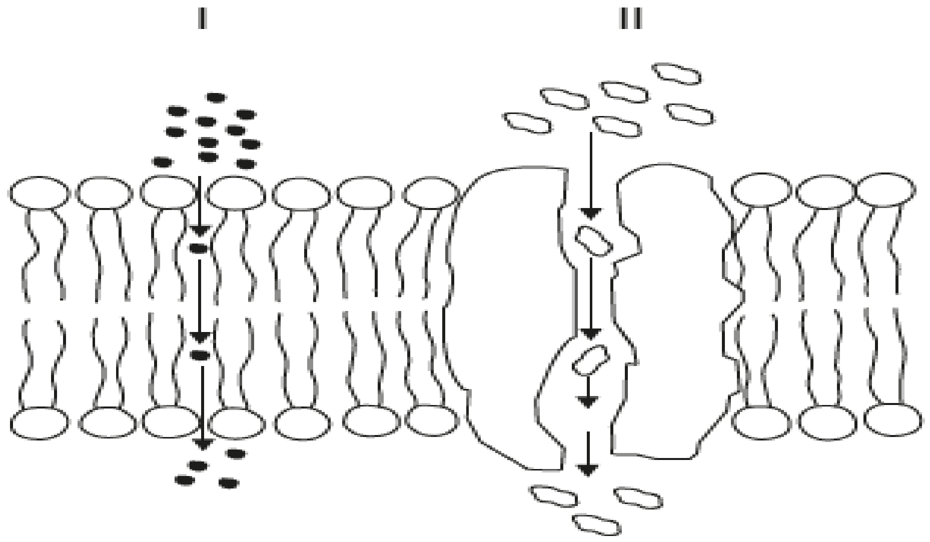


Figure 17. Exocytosis

Transport using vesicles



Q1 The diagram shows a section through a membrane. What are the modes of transport in the diagram?



[Source: © International Baccalaureate Organization 2020.]

	I	II
A.	simple diffusion	osmosis
B.	active transport	facilitated diffusion
C.	simple diffusion	facilitated diffusion
D.	facilitated diffusion	active transport

Q2.

By which process do potassium ions move through potassium channels in axons?

A. Active transport

B. Exocytosis

C. Facilitated diffusion

D. Simple diffusion

Q3.

Active transport is the movement of

A molecules from a region of their higher concentration to a region of their lower concentration.

B particles from a region of lower concentration to a region of higher concentration using energy from respiration.

C urine by relaxation of a sphincter muscle in the bladder.

D water through a partially permeable membrane from a more dilute to a more concentrated solution.

Q4. Why does oxygen diffuse into the blood from an alveolus in the lungs?

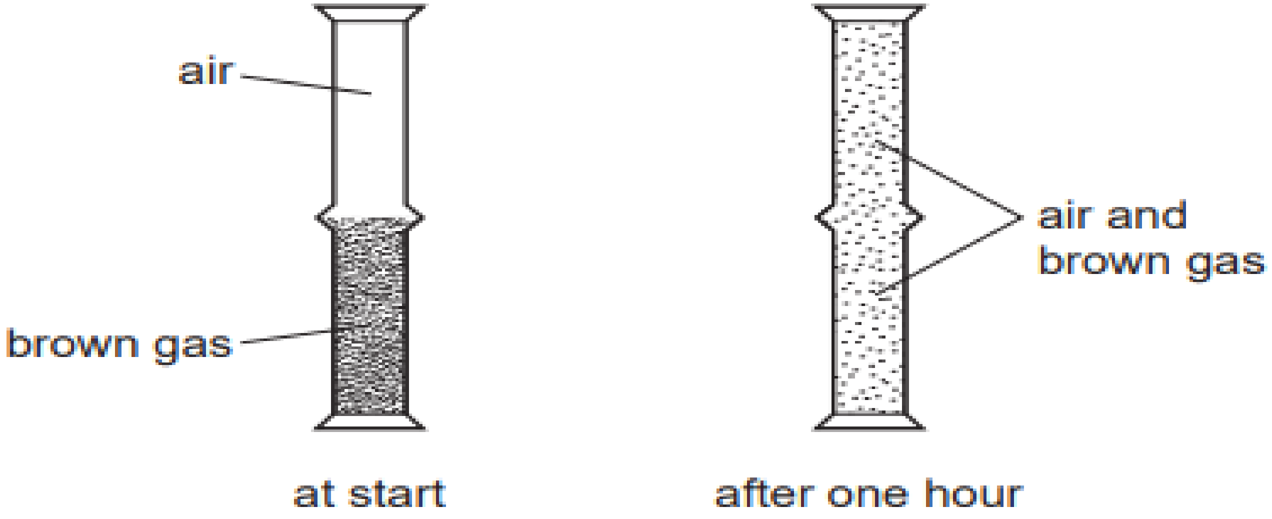
A The oxygen concentration in the alveolus is greater than the carbon dioxide concentration in the blood.

B The oxygen concentration in the alveolus is greater than in the blood.

C The oxygen concentration in the blood is greater than in the alveolus.

D The oxygen concentration in the blood is greater than the carbon dioxide concentration in the alveolus.

Q5. A jar of air was placed upside down on top of a jar containing a brown gas as shown.



Which process has taken place?

A diffusion both upwards and downwards

B diffusion downwards only

C diffusion upwards only

D diffusion and osmosis

Q6.

How do carbon dioxide and oxygen move in and out of a mesophyll cell?

A active transport

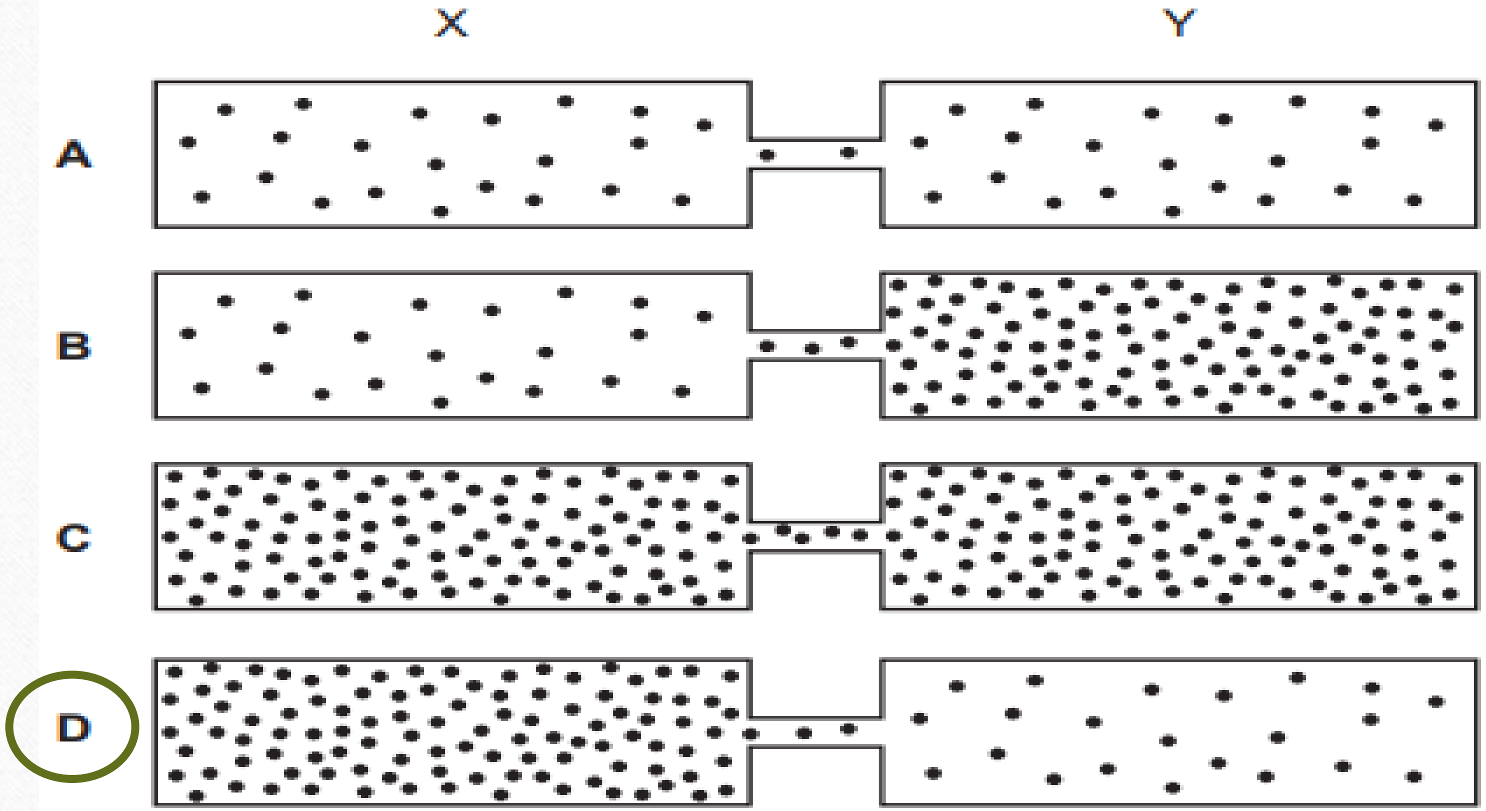
B diffusion

C respiration

D transpiration

Q7. The dots represent molecules of a gas in four tubes at the beginning of an experiment.

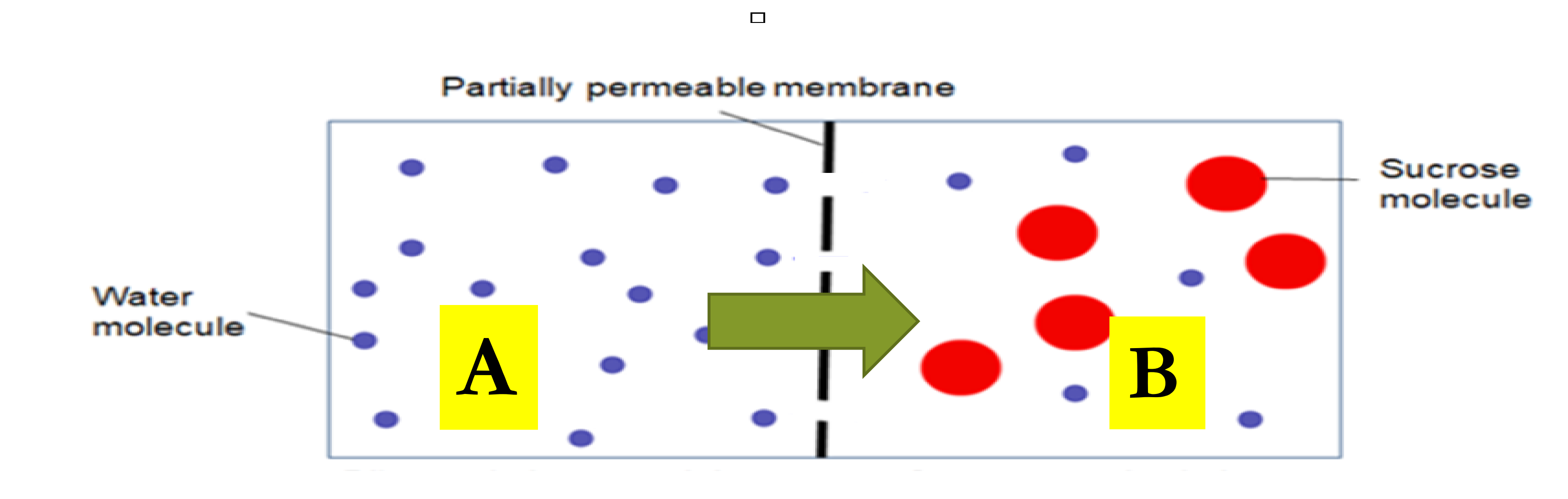
In which tube will more molecules move from X to Y than in the opposite direction?



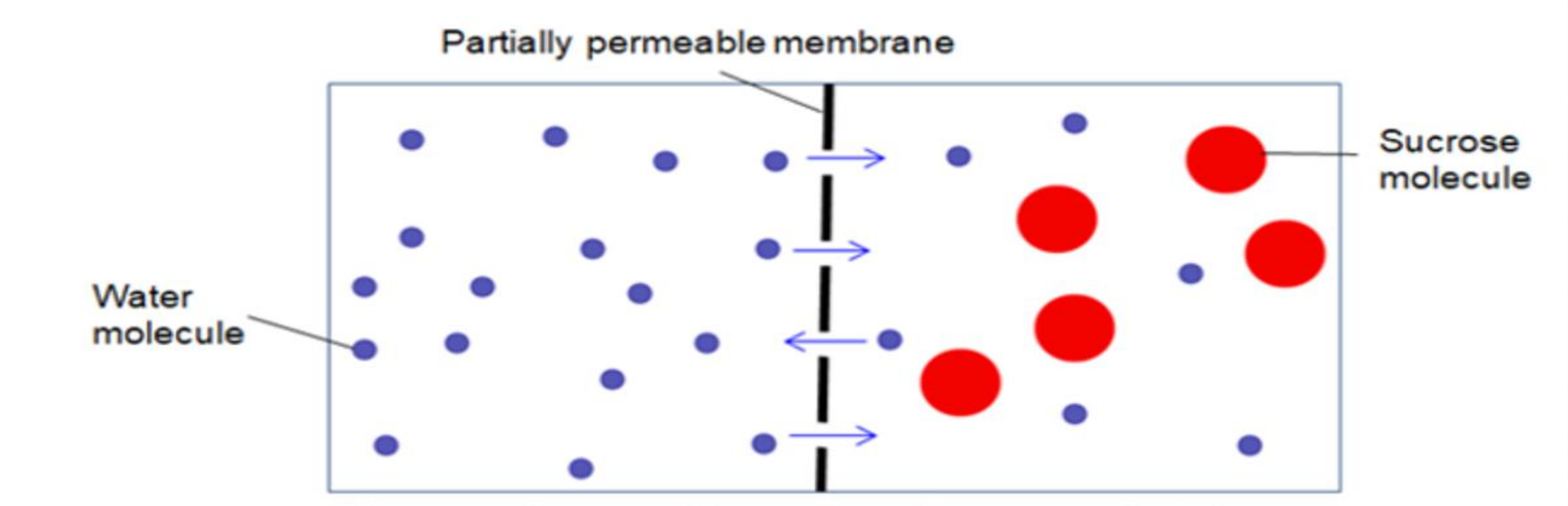
Activity 1 : Raisins in water *https://www.youtube.com/watch?v=IjbO28Mh-vo*

Activity 2 : Salt added to potato
https://www.youtube.com/watch?v=Dfgkeg1lOS4

Draw an arrow to predict the movement of water between solutions A and B



Osmosis



https://www.youtube.com/watch?v=MCvbfqz7ASs

Experiment blood cells

Hypotonic solution : *lower solute concentration (higher water concentration).*

Hypertonic solution : *higher solute concentration (lower water concentration).*

Isotonic solution : *same concentrations*

Osmolarity : a measure of the solute concentration in a solution.

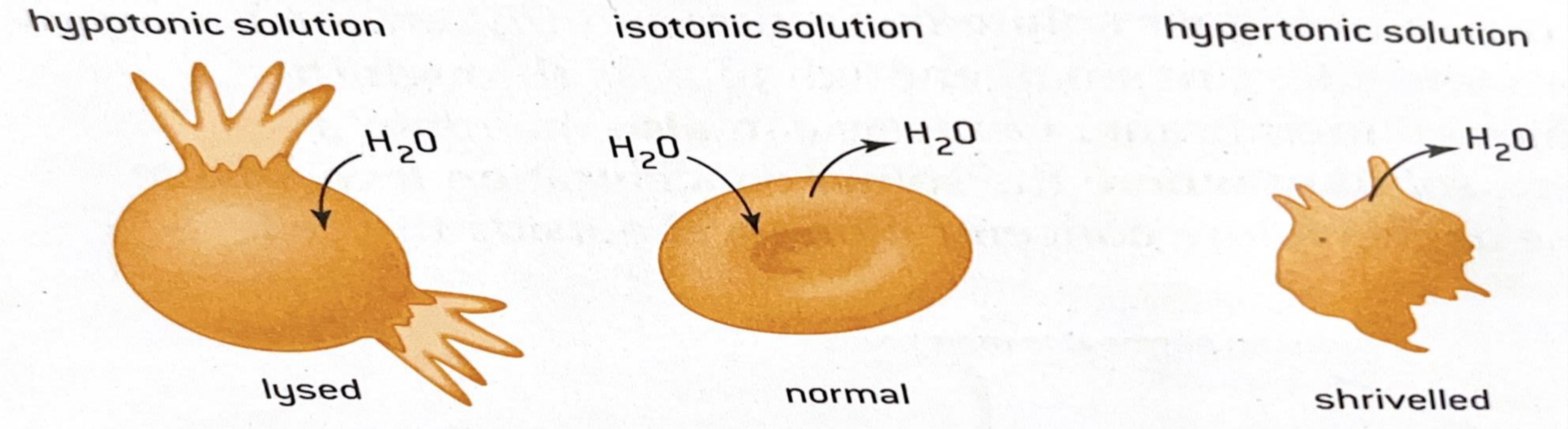


Figure 13. Osmosis in animal cells

The figure represents osmosis in plant cells .

Reminder : water moves from hypotonic to hypertonic solutions .

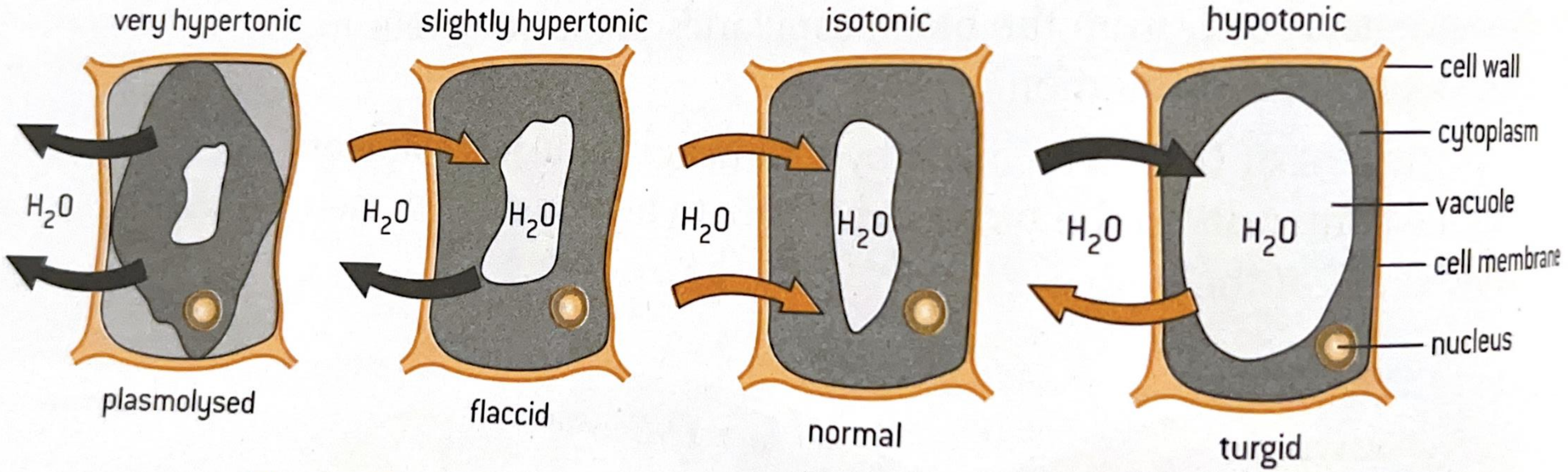


Figure 12. Osmosis in plant cells

Experimental design – accurate quantitative measurement

(lab visit)

Cubes or chips of potato tissue are weighed accurately and placed in test tubes each containing a sucrose solution of a different solute concentration (molarity) .

The potato samples are then removed and reweighed and the percentage change in their mass is recorded. **% change = change in mass ÷ original mass × 100**

A solution that causes no change in mass of the potato has the same solute concentration as the tissue. It is said to be **isotonic**. (Solutions of greater solute concentration than the tissue are **hypertonic**, while solutions whose solute concentration is lower than that of the tissue are known as **hypotonic**.).

Figure 1.25 shows the results of such an experiment. From the graph it can be seen that the molarity that causes no change in mass is approximately 0.35mol dm 3 , no net movement of water by osmosis.

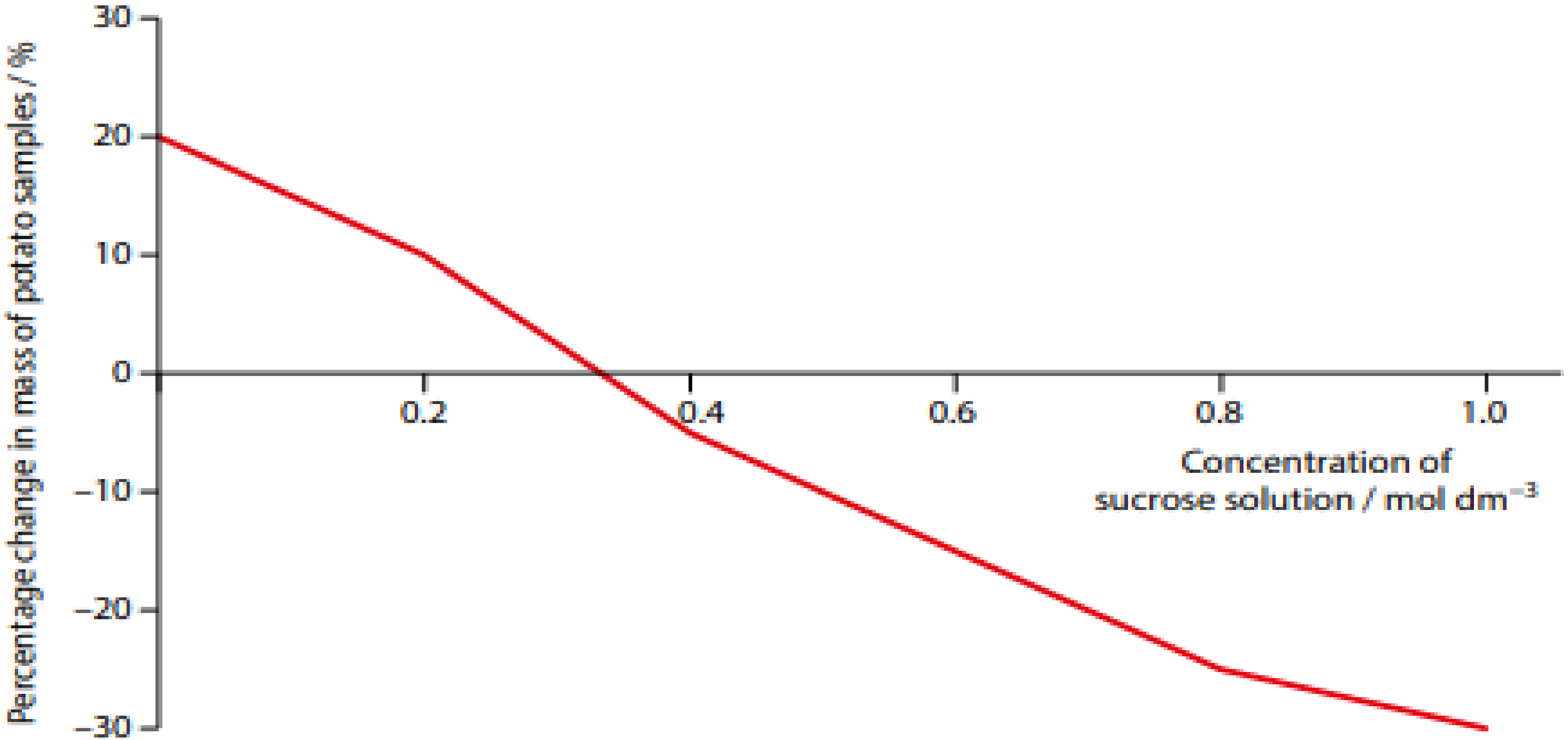


Figure 1.25 Graph to show the results of an experiment with potato samples placed in different sucrose solutions.