

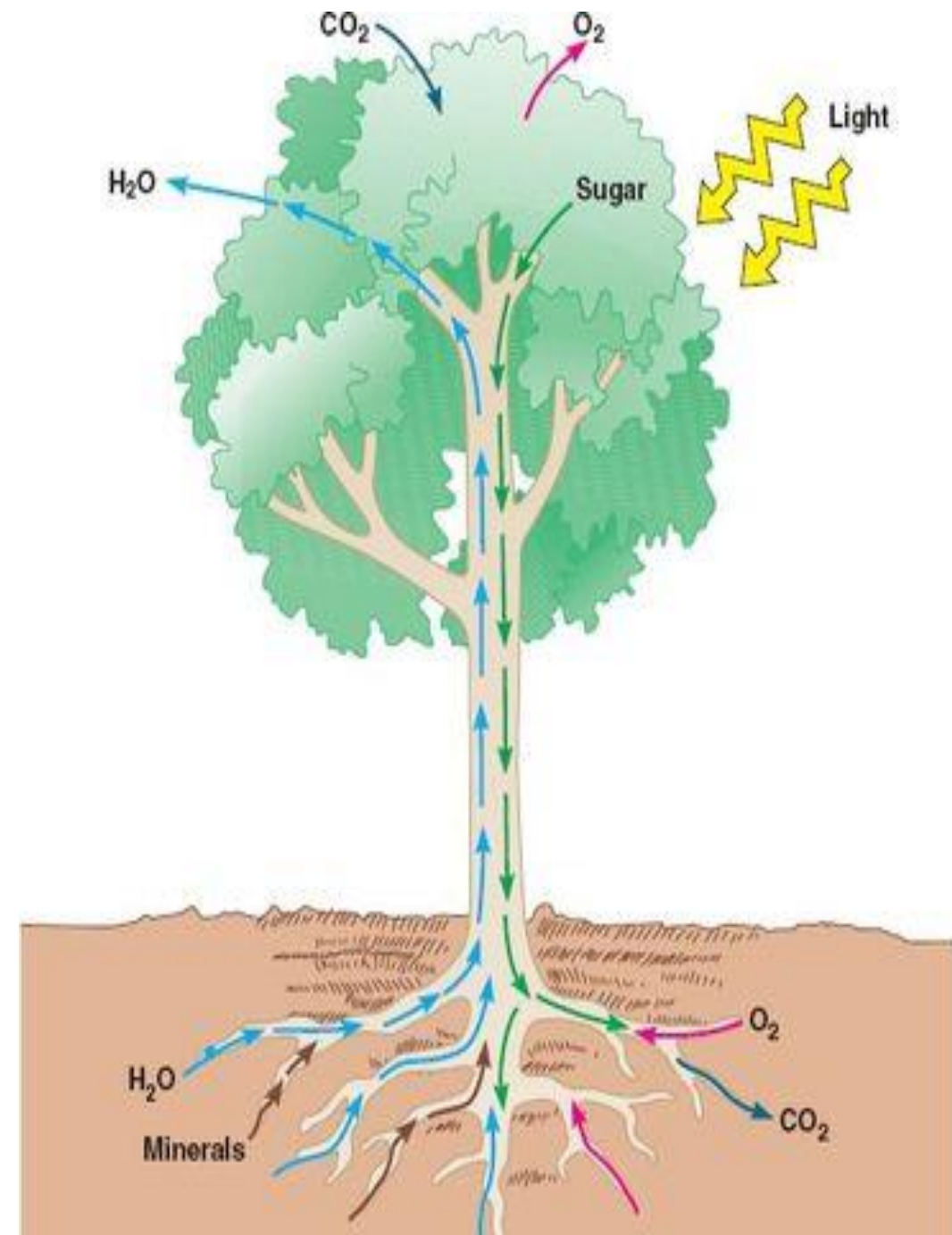
Plant Physiology

Plant physiology is a discipline of botany concerned with the **functioning** of plants.

There is no circulatory system in plants, but water and minerals moves from root to leaves, and nutrients moves from leaves to roots.

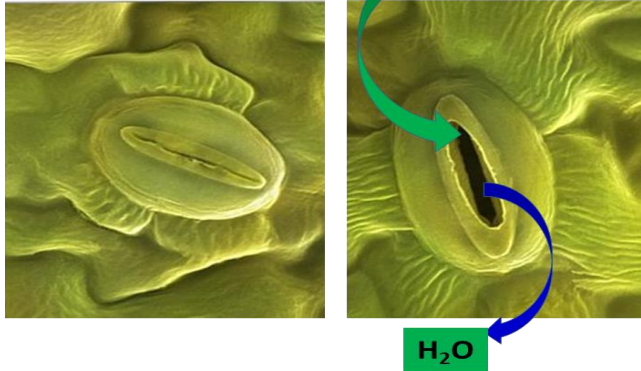
Different levels of structural organization are:

- **Cell** - unit of structure of all living organisms
- **Tissue** - composed of groups of similar cells
- **Organs** - composed of groups of tissues functioning together
- **Organ Systems** - composed of groups of organs functioning together
- **Organism** - an individual animal, plant, or single-celled life form



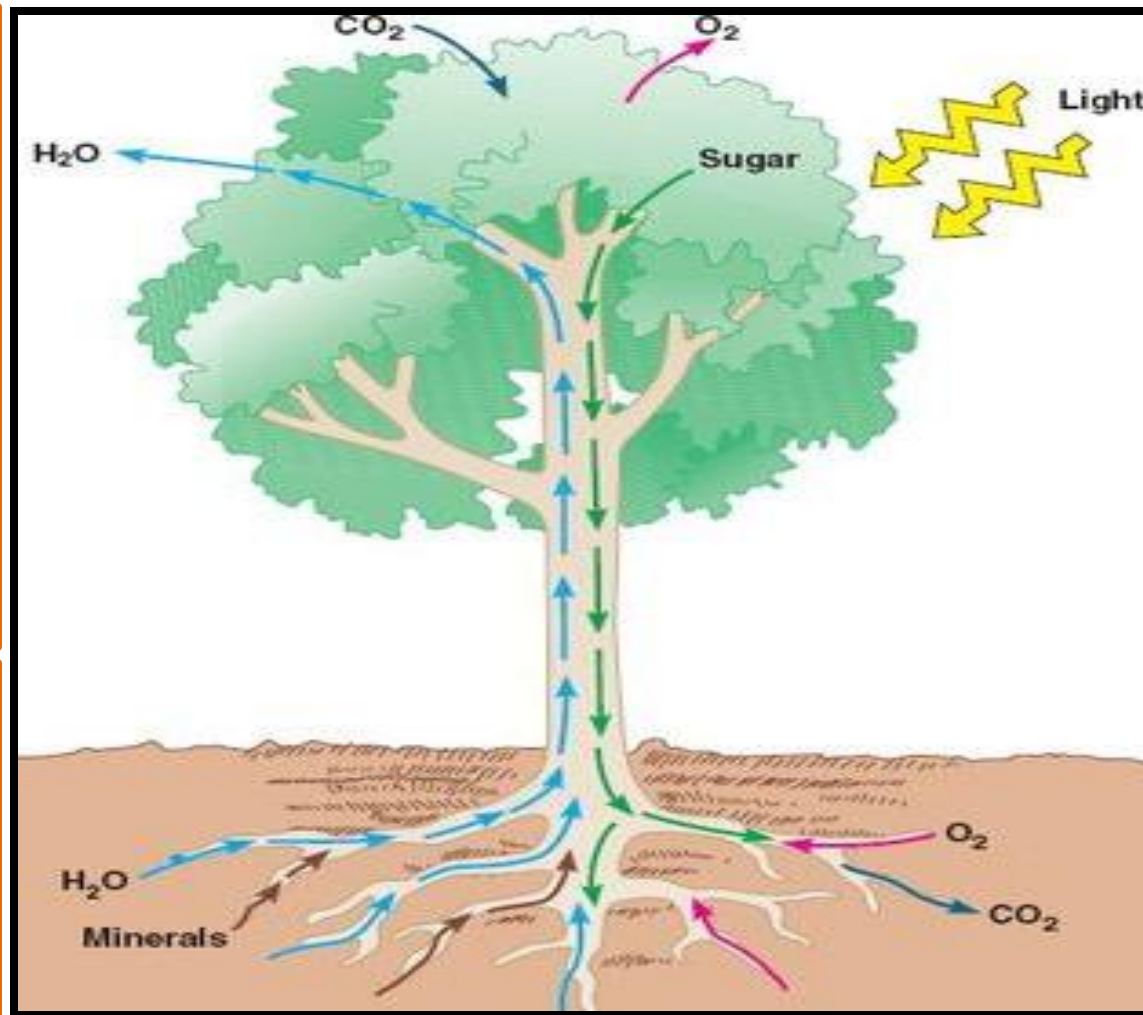
Transpiration

the evaporation of water from plant leaves



Phytohormones (Plant Hormones)

- Auxin
- Cytokinins
- Gibberellins

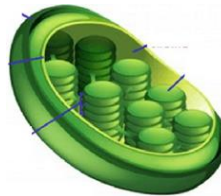
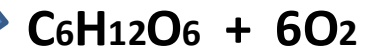


Photosynthesis



1. **Photochemical phase**
(Light reaction)

2. **Biosynthetic phase**
(Calvin cycle)

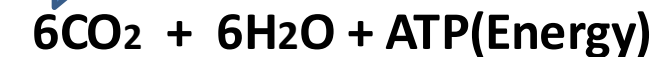


Respiration



1. **Glycolysis**

2. **Krebs cycle (TCA) cycle**



Types of transport in Cells

PASSIVE TRANSPORT (No energy needed (ATP))

Example: diffusion and osmosis

ACTIVE TRANSPORT (Requires cellular energy (ATP))

Plant-Water Relations

Three possible relationships depends on the **type of solution** and its **concentration**

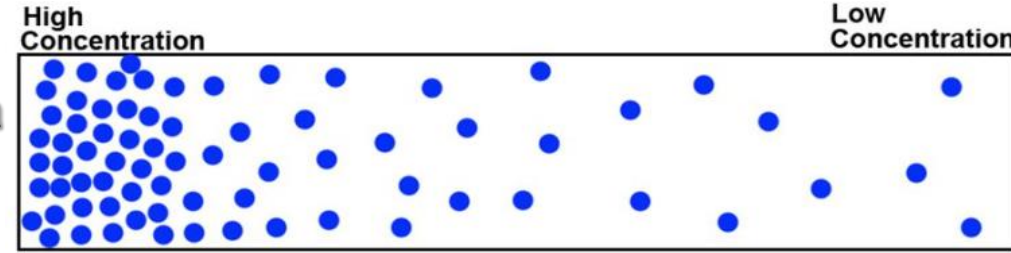
Hypotonic

Isotonic

Hypertonic

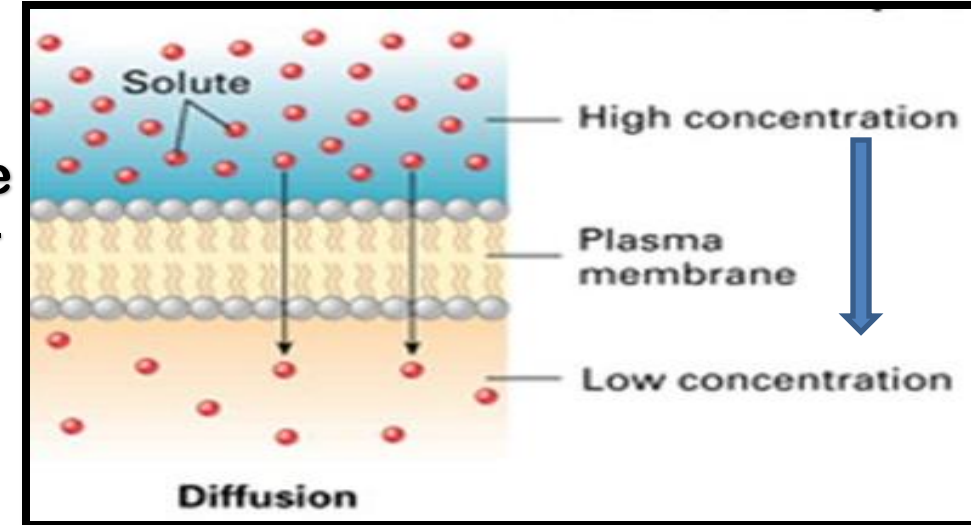
Types of transport in Cells

Concentration - the amount of a particular substance in a contained area compared with the amount of the same substance in another area



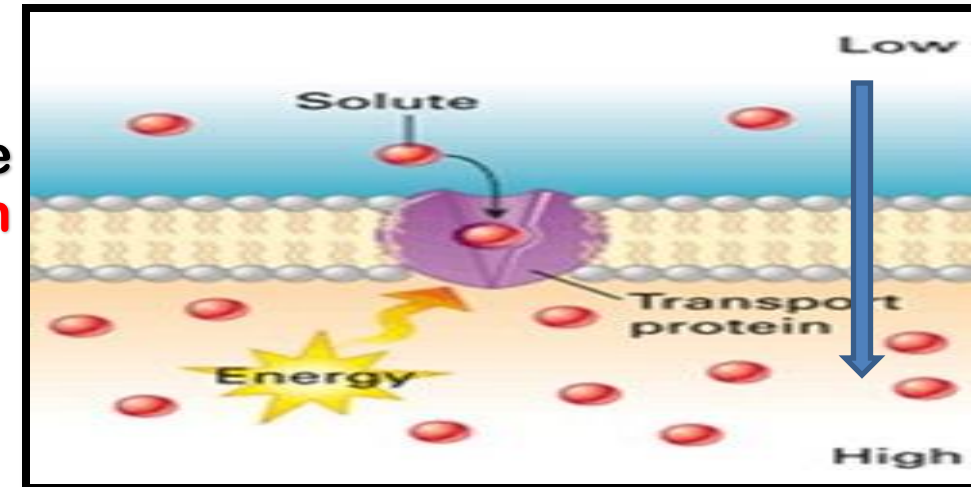
PASSIVE TRANSPORT –

- The movement of substances through a membrane from a region of **high** to a region of **low** concentration –
(النقل السلبي - حركة المواد عبر غشاء من منطقة التركيز الأعلى إلى منطقة التركيز المنخفض)
- No energy needed (ATP)
لا تحتاج للطاقة (أمثلة على ذلك الانتشار والاسموزية)
- Example: diffusion and osmosis



ACTIVE TRANSPORT –

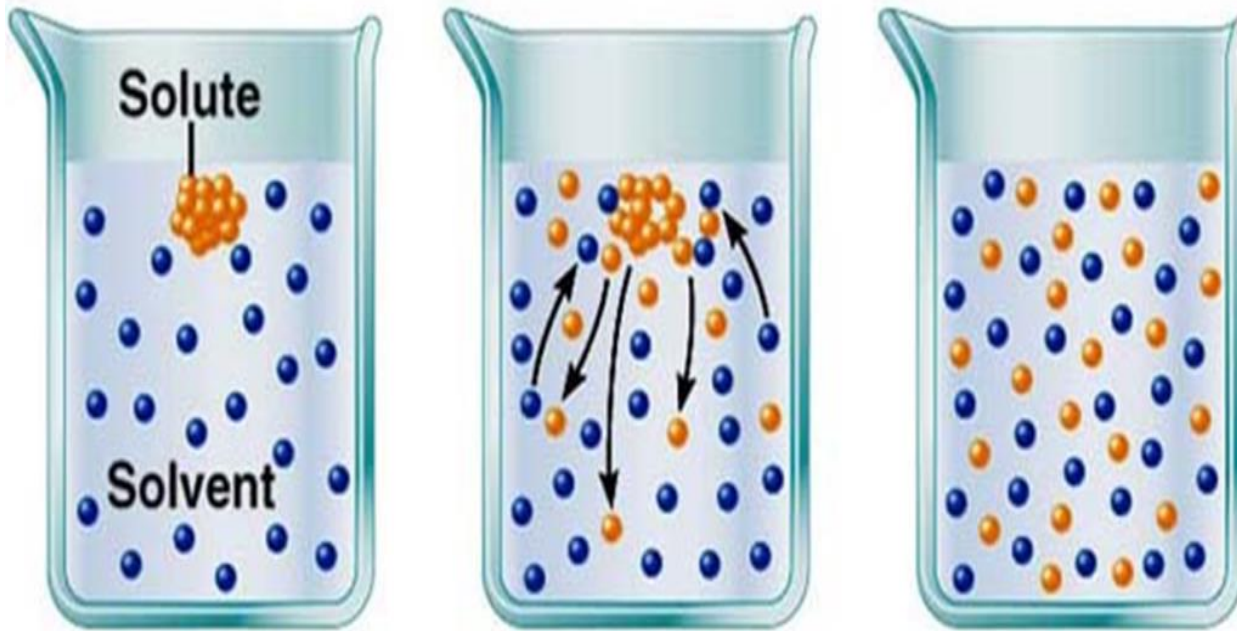
- The movement of substances through a membrane from a region of **low** concentration to a region of **high** concentration –
النقل النشط - حركة المواد عبر غشاء من منطقة التركيز المنخفض إلى منطقة التركيز العالي
- Requires cellular energy (ATP)
يتطلب استخدام طاقة خلوية



Processes of transport in the living system

الانتشار

1. Diffusion: the tendency of molecules to move from an area of **higher concentration** to an area of **lower concentration**



التناضح

2. Osmosis: movement of water through a membrane from a region of higher to lower concentration

المذاب

-Solute - substance being dissolved in a liquid (e.g. salt)

المذيب

-Solvent - substance doing the dissolving (e.g. water)

النفاذية

-Permeability - the extent to which a membrane will allow particular sized molecules to pass

غشاء شبه نافذ (نفاذية اختيارية)

-Semi-permeable membrane (selectively permeable)-allows some molecules to pass but not others

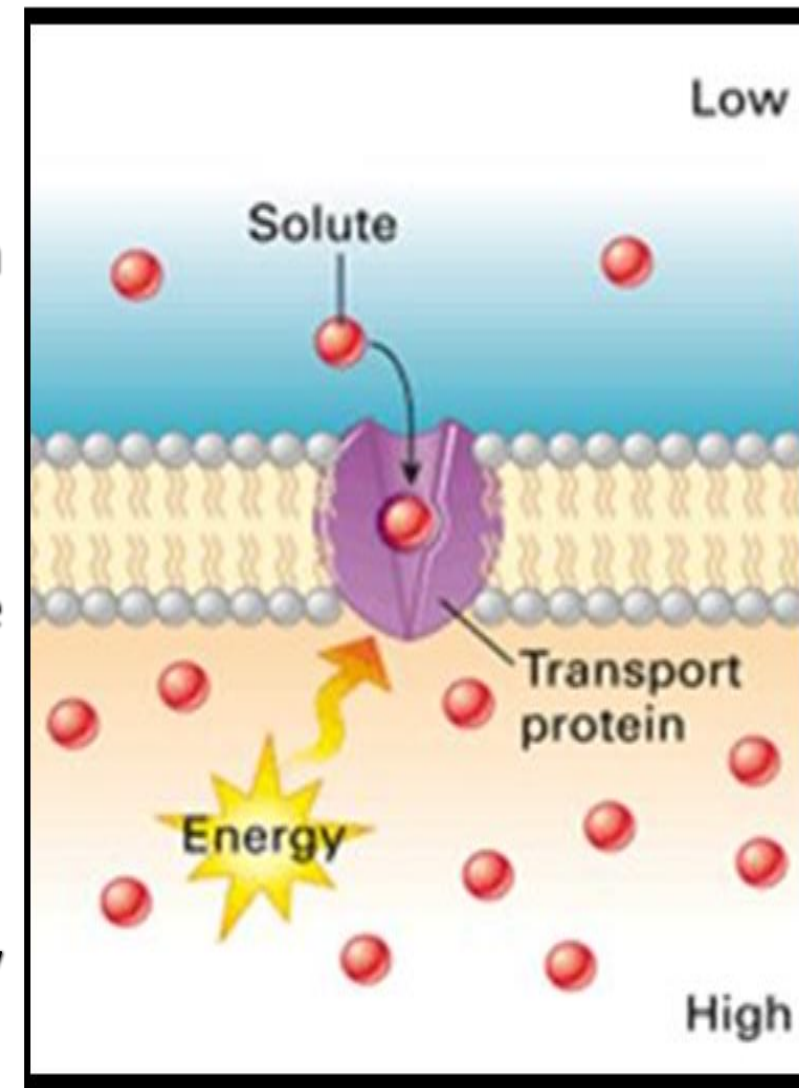
➤ **The goal of both diffusion and osmosis is to reach EQUILIBRIUM within the cell.**

الهدف من كل من الانتشار والتناضح هو الوصول إلى التوازن أو الإتزان داخل الخلية

➤ **EQUILIBRIUM is a condition in which the movement in one direction is equal to the movement in another direction.** التوازن أو الإتزان هو حالة يكون فيها حركة الماء في اتجاه أي اتجاه تساوي حركته في الاتجاه الآخر

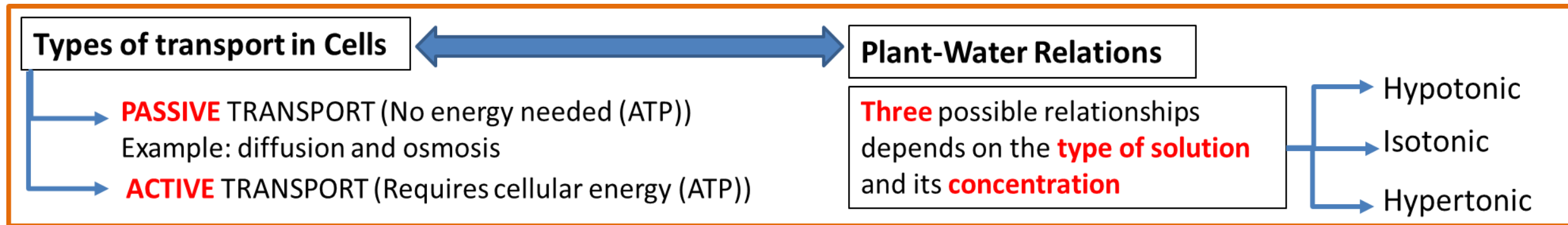
Active Transport

- the movement of a substance against the concentration gradient. (uphill)
- Active transport requires cell to **USE ENERGY**
- **Sodium pump** - transports three sodium ions out of the cell and two potassium ions into the cell
- Both are against the concentration gradient
- The energy needed to perform this activity is supplied by ATP (adenosine tri-phosphate)
- ATP is a unit of energy made by the cell



النقل النشط هو حركة المادة ضد تدرج التركيز. (وهذا أمر شاق)
الخلية تتطلب وتحتاج استخدام طاقة في النقل النشط
مضخة الصوديوم - عبارة عن نقل ثلاثة أيونات من الصوديوم إلى خارج الخلية واثنين من أيونات البوتاسيوم إلى داخل الخلية
كل من النقل النشط ومضخة الصوديوم ضد تدرج التركيز
يتم توفير الطاقة اللازم لتنفيذ هذا النشاط بواسطة مركب ادينوسين ثلاثي الفوسفات (أي تي بي) الغني بالطاقة
(أي تي بي) هي وحدة الطاقة التي تبنيها وتنتج في الخلية

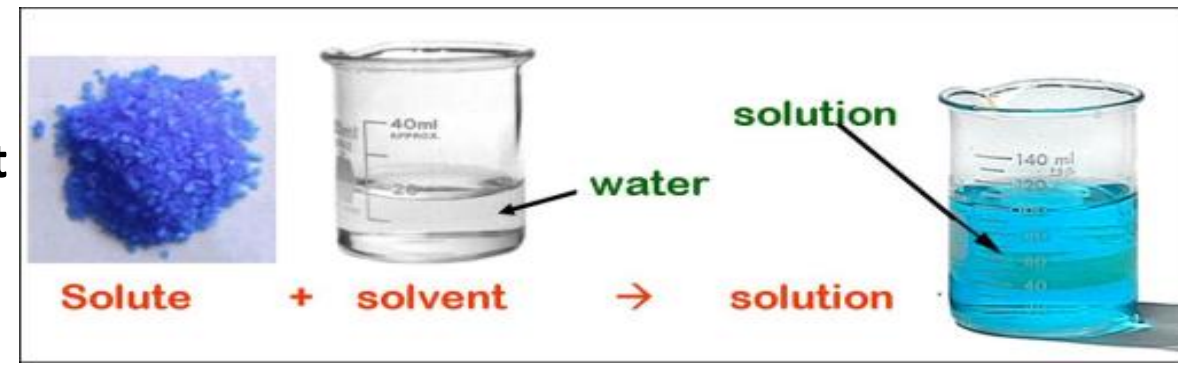
- Whether passive or active transport is needed depends on the **CONCENTRATION GRADIENT**
- The concentration gradient is the **difference** in the concentration of a substance in two different spaces
- **Concentration** - the amount of a particular substance in a contained area compared with the amount of the same substance in another area



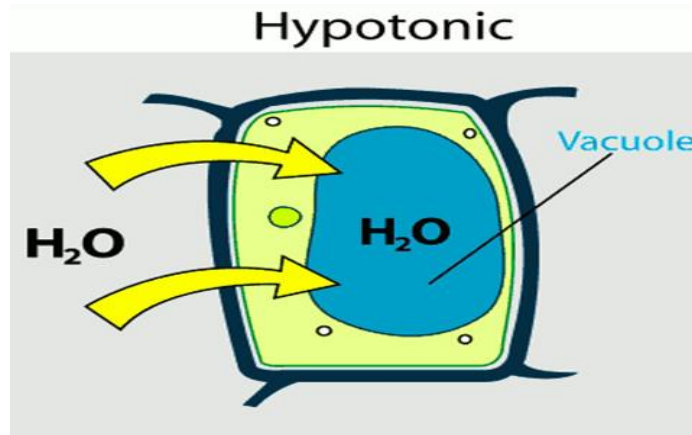
سواء النقل السلبي أو النقل النشط يعتمدان على ممال التركيز
 التدرج التركيز - هو الفرق في تركيز مادة في مكانين مختلفين
 التركيز - كمية من مادة معينة في مكان ما مقارنة مع كمية من نفس المادة في مكان أخرى

Plant-Water Relations

SOLUTION: A liquid mixture in which the minor component (the solute) is uniformly distributed within the major component (the solvent).



وسط او محلول ناقص التوتر. (منخفض التركيز)



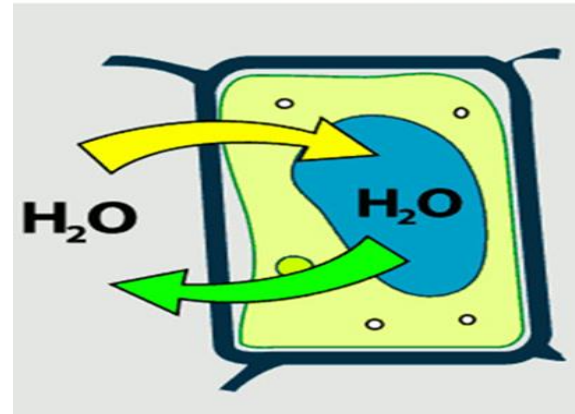
Turgid ممتلئة

إذا كان الخلية النباتية ممتلئة تكون قوية جداً،
وهي حالة صحية في معظم النباتات

Hypotonic-

A solution that causes a cell to swell because of osmosis meaning water rushes into the cell

وسط او محلول متساوية التوتر (سوي التركيز)

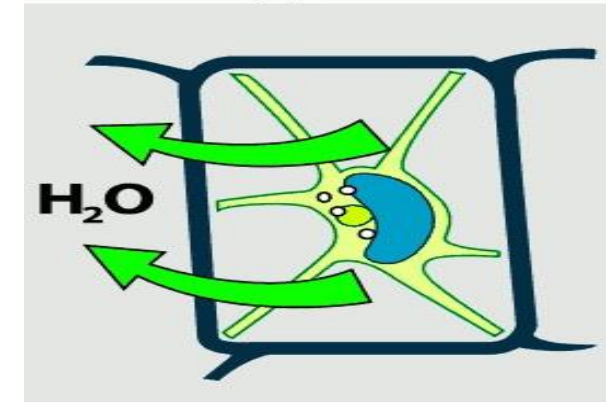


Flaccid مترهلة

Isotonic-

A solution that causes no change in cell size. Meaning there is no movement of water.

وسط او محلول مفرط التوتر (عالي التركيز)



Plasmolyzed منكمشة

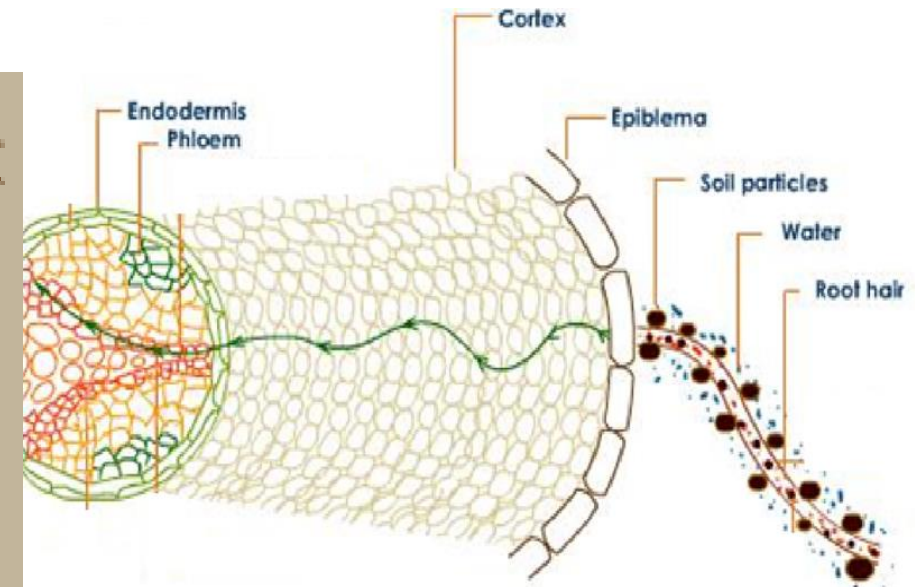
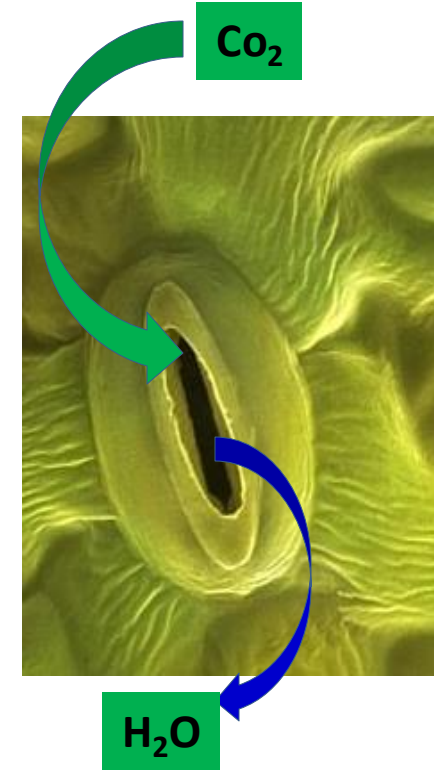
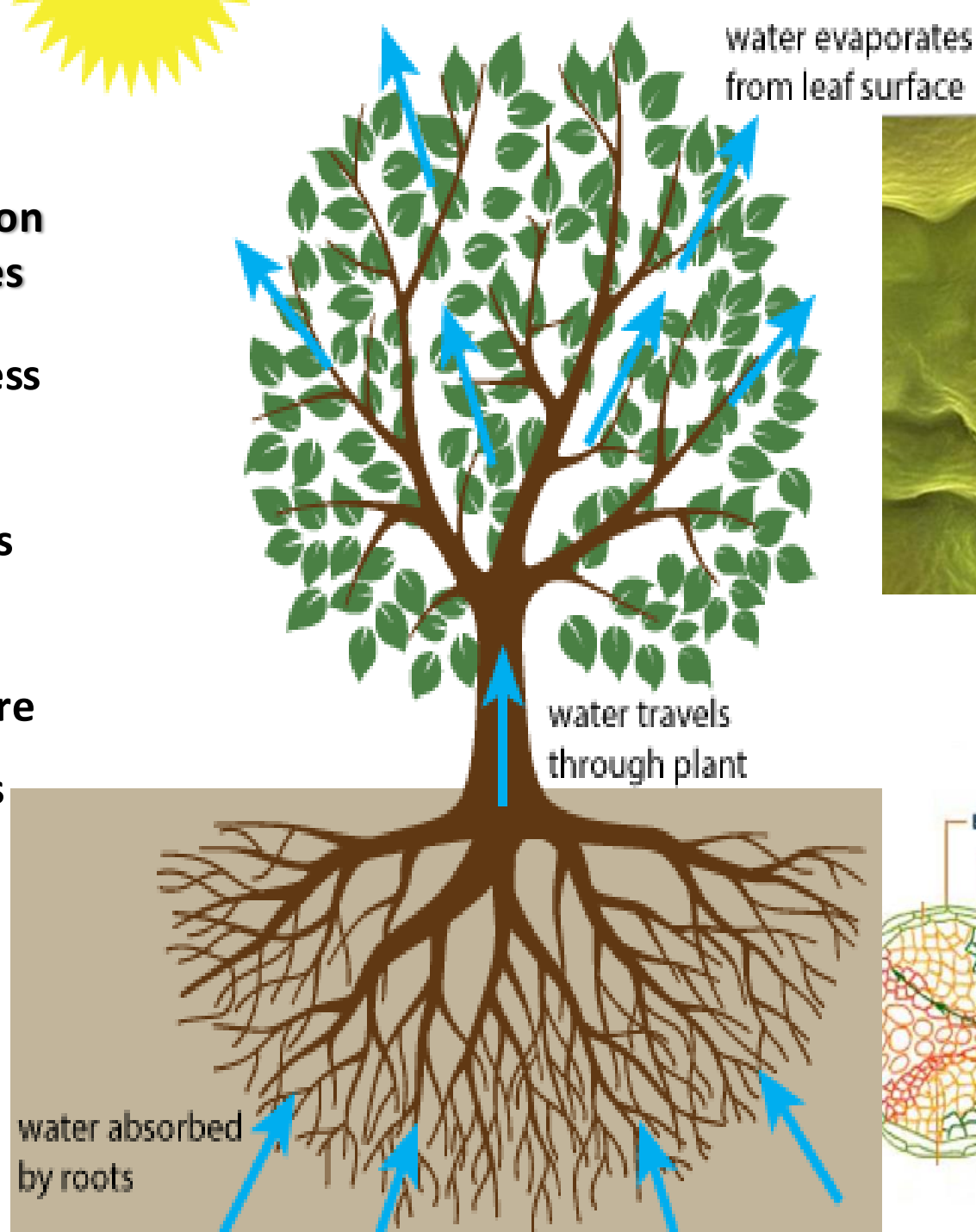
Hypertonic-

A solution that causes a cell to shrink because of osmosis. Meaning water leaves the cell.

TRANSPIRATION

It is mainly the evaporation of water from plant leaves

Transpiration is the process by which water is carried through plants from roots to small pores on the underside of leaves, where it changes to vapor and is released to the atmosphere.

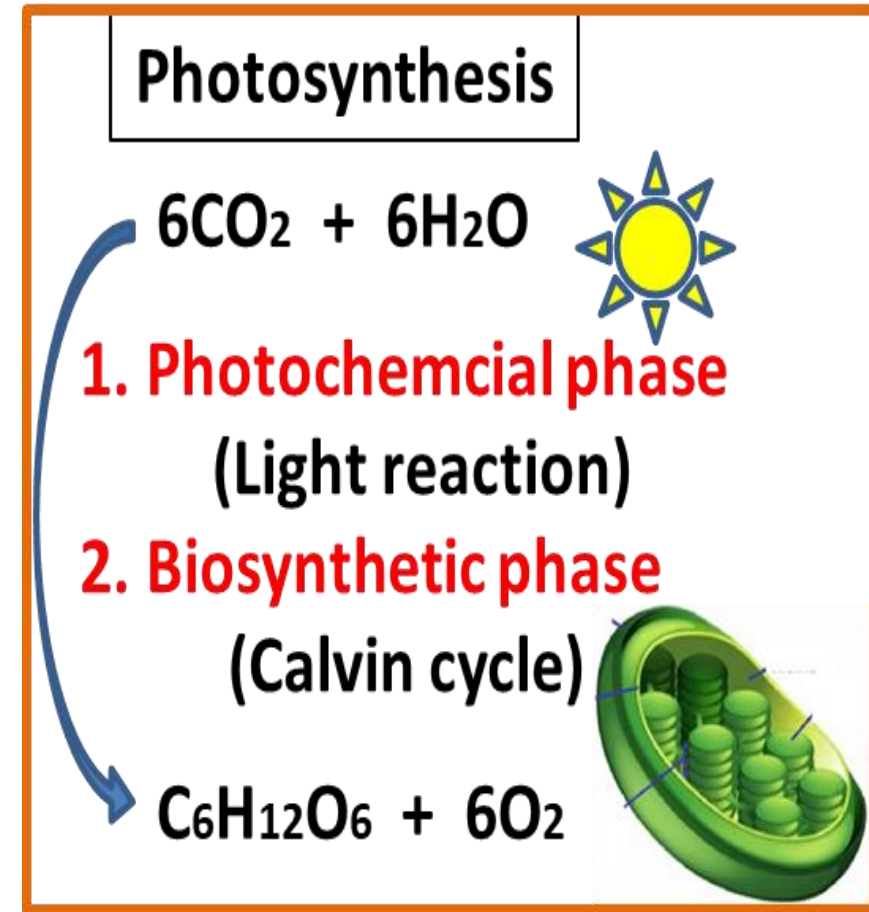


Why is water important to (plant) cells?

- Water constitutes about **70% by weight** of annual plants
- Water has **multiple roles** in plant cells
 1. Thermal property: a liquid!
 - High heat potential: can absorb energy changes without large temperature changes (slows heating and cooling)
 2. “Universal” solvent required for mineral uptake and transport
 3. It is a requirement for biochemical reactions to proceed
 - Most enzymes are water soluble

Photosynthesis

- Green plants take carbon dioxide (CO_2) from the air, and water (H_2O) from the soil. The plants combine the CO_2 with the H_2O to make the sugar (Glucose ($\text{C}_6\text{H}_{12}\text{O}_6$))
- Photosynthesis is the **conversion of light energy to chemical energy** by chlorophyll in chloroplasts
- Overall Net equation for photosynthesis:
 - 6 Water + 6 Carbon dioxide gives glucose + 6 oxygen (when catalyzed by chlorophyll in the presence of sunlight)

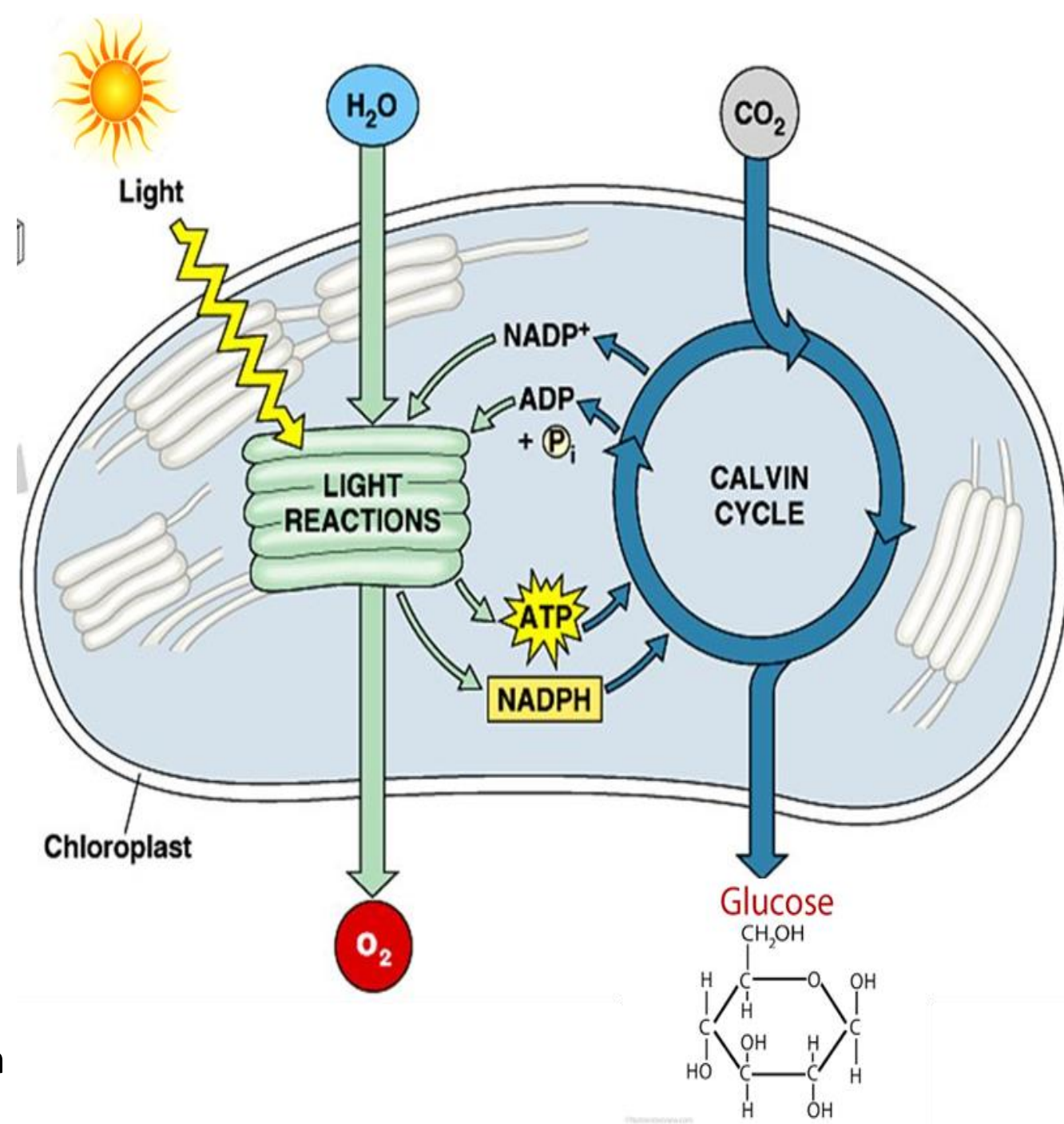


- **Photosynthesis** completes in **two phase-**

- Photochemical** phase (**Light reaction**)

- Biosynthetic** phase (**Calvin cycle**)

- In the Photochemical phase (light reaction), the water molecular breakdown into Hydrogen and Oxygen.
- The released Hydrogen molecules helps in the conversion Adenosine diphosphate (ADP) into Adenosine triphosphate (ATP),
- The released Hydrogen molecules also help in the conversion of Nicotinamide adenine dinucleotide phosphate (NADPH) into reduced Nicotinamide adenine dinucleotide phosphate (NADP⁺)
- ATP and Nicotinamide adenine dinucleotide phosphate (NADP⁺)
- used in Biosynthetic phase called as Calvin cycle in which CO₂ molecules convert into Glucose.



Types of photosynthesis

- **C3**
 - **The majority of plants** In the case of C3 photosynthesis, the first organic product of carbon fixation is a three-carbon compound, 3-phosphoglycerate, which is the reason these plants are termed the C3 plants.
- **C4**
 - **CO₂ temporarily stored as 4-C organic acids resulting in more efficient C exchange rate**
 - **Advantage in high light, high temperature, low CO₂**
 - **Many grasses and crops (e.g., corn, sorghum, millet, sugar cane)**
- **CAM**
 - **Stomata open during night**
 - **Advantage in arid climates**
 - **Many succulents (e.g., cacti, euphorbs, bromeliads, agaves)**

C3

النباتات بنباتات ثلاثية الكربون أو (نباتات C3 غالبية النباتات على الأرض من هذه الفئة ، المنتج العضوي الأول الناتج من تثبيت الكربون هو مركب ثلاثي ذرات الكربون، (3- فسفوجليسرates)، وهذا هو سبب تسميت)

C4

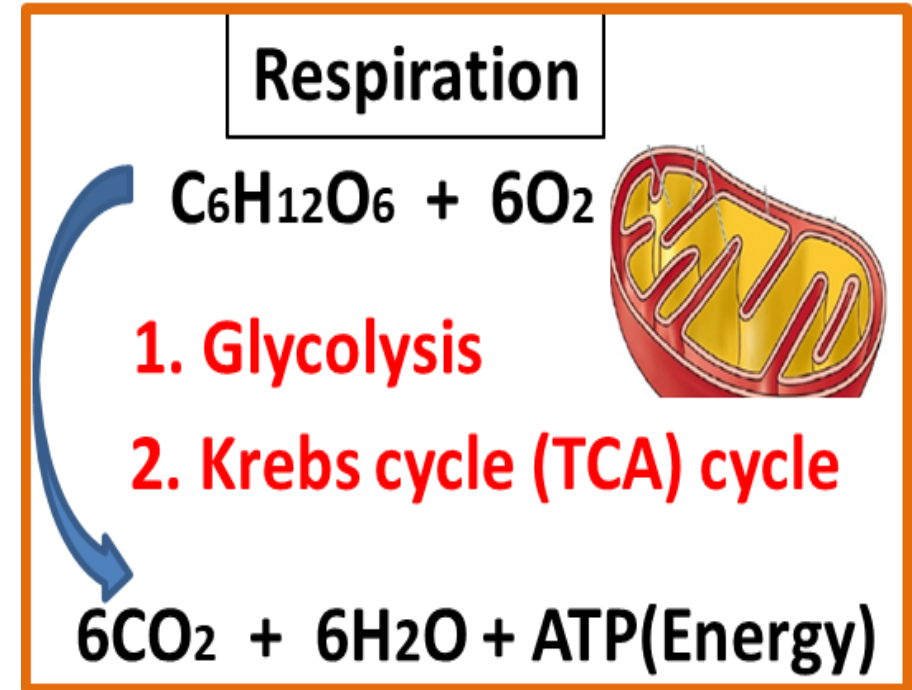
تخزن ثاني اكسيد الكربون مؤقتا كأحماض عضوية رباعية ذرات الكربون المنتج العضوي الأول الناتج من تثبيت الكربون هو مركب رباعي ذرات الكربون، (3- فسفوجليسرates). تتميز بكفاءتها العالية في شدة الضوء (الإضاءة العالية)، درجة الحرارة العالية، والتراكيز المنخفضة من ثاني اكسيد الكربون العديد منها أعشاب ومحاصيل (على سبيل المثال، الذرة، والذرة الرفيعة والدخن وقصب السكر)

CAM

تغورها مفتوحة أثناء الليل تتميز بكفاءتها في المناخات الجافة العديد منها عسارية (على سبيل المثال، الصبار،، أجافيس)

RESPIRATION

- The breakdown of food materials within the cell to release energy in the form of ATP (Adenosine Tri Phosphate).
- $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 = 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{ATP (Energy)}$
- It involves Cytoplasm and Mitochondria



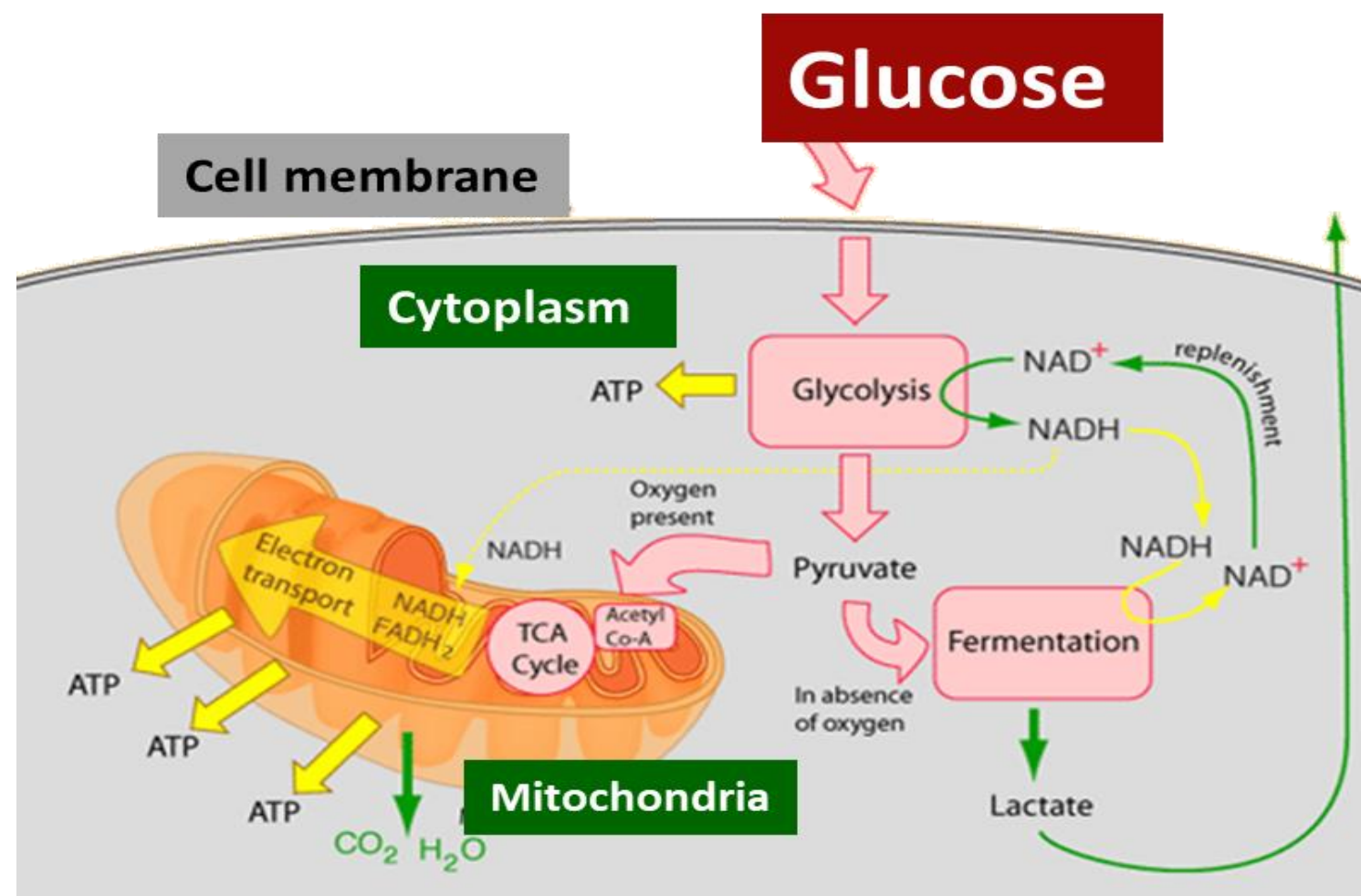
Glycolysis:

- Glucose enters into cytoplasm.
- Glucose passed thru series of enzymatic reaction in which glucose converted in to pyruvic acid.
- The process is called as Glycolysis.
- Glycolysis occurs in cytoplasm

The citric acid cycle – also known as Tricarboxylic acid (TCA) cycle or Krebs cycle:

In this cycle, in presence of oxygen, pyruvic acid resulted from the process of glycolysis enters into mitochondria, and passed thru a cyclic enzymatic reaction, and finally gives

ATP.



ATP is used in the cell as a energy for various reactions.

The ATP produced in the Mitochondria; hence, the mitochondria is called as power house of the cell

PLANT GROWTH HORMONES

Plant hormones (also known as phytohormones) are chemicals that regulate plant growth

Hormone	Where Produced or Found in Plant	Major Functions
Auxin (IAA)	Embryo of seed, meristems of apical buds, young leaves	<u>Stimulates stem elongation</u> (low concentration only), root growth, cell differentiation, and branching; regulates development of fruit; enhances apical dominance; functions in phototropism and gravitropism; promotes xylem differentiation; retards leaf abscission
Cytokinins	Synthesized in roots and transported to other organs	Affect root growth and differentiation; <u>stimulate cell division and growth</u> ; stimulate germination; delay senescence
Gibberellins	Meristems of apical buds and roots, young leaves, embryo	<u>Promote seed and bud germination, stem elongation, and leaf growth</u> ; stimulate flowering and development of fruit; affect root growth and differentiation