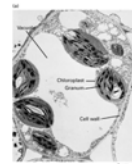


Transport of ions and metabolites:

1. How do plants take up, distribute, & sort nutrients in organs and in cells?
2. How do plants deal with excess ions and toxic metals?
3. What controls guard cell movement?
Changes in ion levels and water movement
4. Form of communication



TRANSPORT

How are essential mineral nutrients taken up and distributed in the plant?

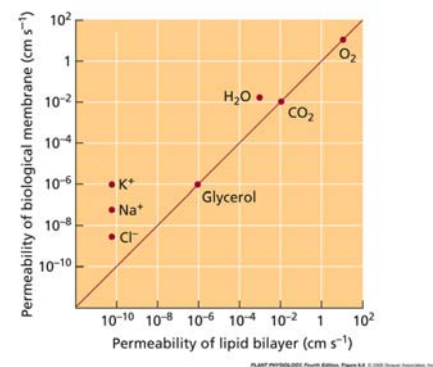
Concepts

1. p-lipid bilayer is a remarkable barrier
2. **Proteins catalyze transport** of nutrients and metabolites just as enzymes catalyze chemical reactions. There are 3 main classes of transport proteins.
Channels,
Pumps
Carriers
3. **Transport can be active or passive.**
Passive and active transport of ions result in electric potential difference across membranes

4. Major Transport Proteins in Plants

- a. H^+ pumping ATPases are the major ion pumps in plants
- b. Active transport of many nutrients and metabolites depend on H^+ -coupled co-transport. Energy from H^+ gradient is used to drive uphill movement of other nutrients.
- c. Channels allow rapid, passive transport of ions and metabolites.
- d. Water is transported via **WATER CHANNELS** or **AQUAPORINS** in membranes that conduct large volumes of water rapidly.

Taiz. P-lipid is a remarkable barrier to ions



6-7. Proteins catalyze transport.

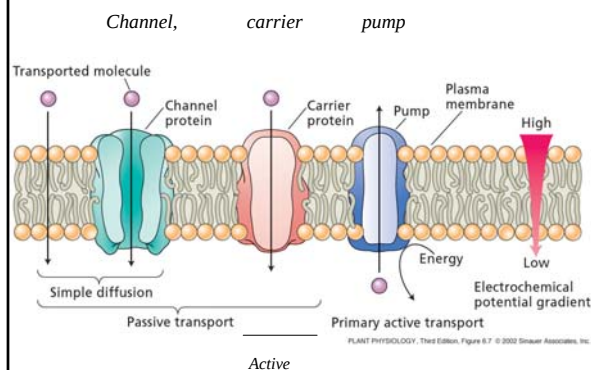
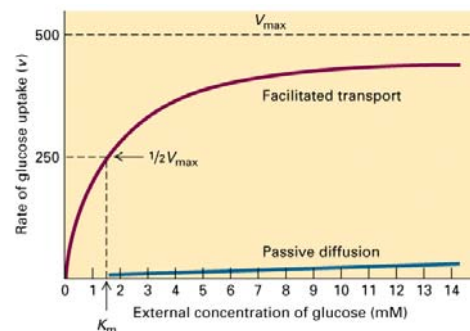


Fig. 2-17 Taiz. Protein catalyze transport just like enzymes catalyze chemical reactions. Specific, fast



3. Transport can be active or passive.

- **Passive** transport is movement **down** an **electrochemical** gradient.
- **Active** transport is movement **against** an electrochemical gradient.

What is an electrochemical gradient?

$$\Delta\mu = \text{conc gradient} + \text{electrical gradient}$$

Chemical gradient

Electrical gradient: unequal distribution of charges across a membrane.

Passive or active transport of ions result in electric potential difference across membranes.

- **How do you know if an ion is moving uphill or downhill?**

Nernst equation

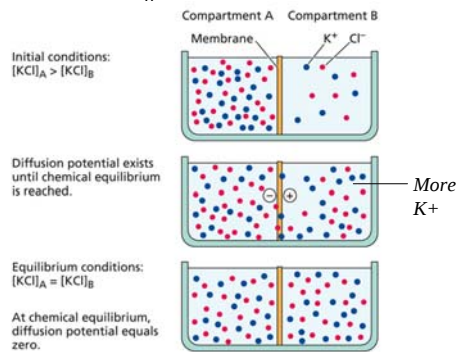
- It predicts passive ion distribution for a given electrical potential.

Diffusion of **uncharged** species depend only on the **concentration** gradient.

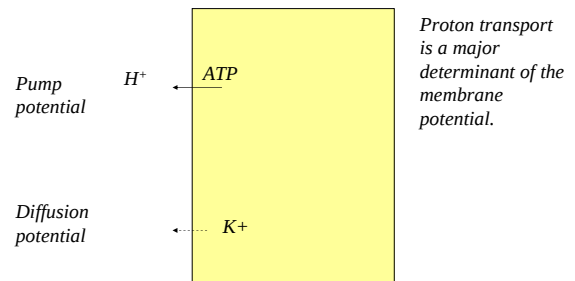
Diffusion of **charged** species is dependent on the **concentration** and the **electrical** gradient.

At equilibrium, the conc gradient of an ion between two compartments is balanced by the electrical gradient.

6-2. Taiz. A diffusion potential develops when + & - ions diffuse across a membrane at different rates.



Pump potential is generated when there is an active ion pump.



What is the driving force for uphill movement?

ATP and a H⁺ electrochemical gradient