

What do cells use energy for?

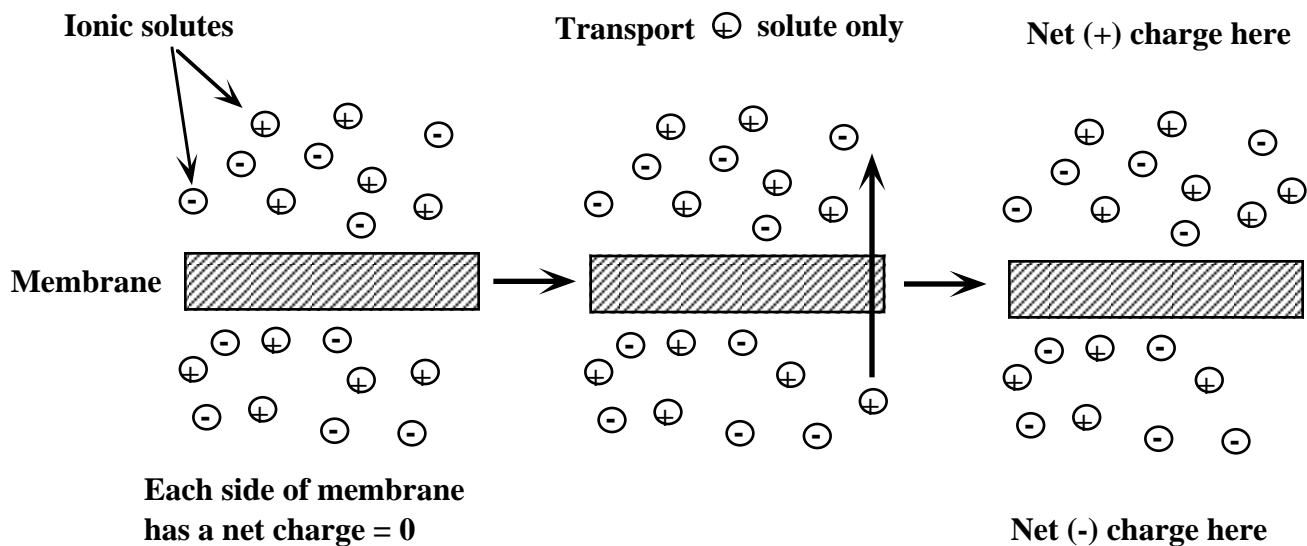
- **Energy** is defined as the capacity to do work, that is, to do work requires energy.
- **Work** is often viewed in terms of movement against, or resisting, an opposing force.

Mechanical work: Resisting gravitational and frictional forces

- Familiar types of mechanical work from physics include lifting an object against the force of gravity or dragging/moving an object against a frictional force.
- Cells perform mechanical work. Ciliary motion, segregation of chromosomes and muscle contraction are all examples of mechanical work as the molecules involved collide with others and experience friction.

Electrical work: Resisting the electrical force

- Electrical work involves separating positive and negative charges against the force of electrical attraction.
- When cells transport an ion across a membrane without transporting a counterion they do electrical work because they separate charges.
- For example transporting H^+ without transporting OH^- causes one side of the membrane to acquire a net positive charge and the other side to acquire a net negative charge.



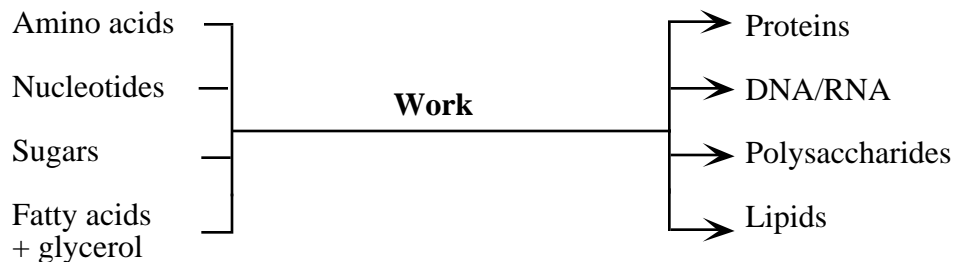
- Electrical work results in one side of the membrane becoming more positively (or negatively) charged than the other side and the formation of an **electrical gradient**.
- Because an electrical gradient cannot be created without creating a **concentration gradient** it is more useful to talk about an **electroconcentration** gradient.
- **Electroconcentration** gradients are also called “**electrochemical**” gradients but this is not such a good term because everything that happens in a cell is “chemical.”

Chemical work: Resisting the “force for equilibrium”

- Clearly the term “chemical work” is not a very useful term because when it comes to describing what happens in a cell almost everything is “chemical.”
- Nevertheless, two kinds of chemical work, **synthetic work** and **concentration work**, are distinguished.

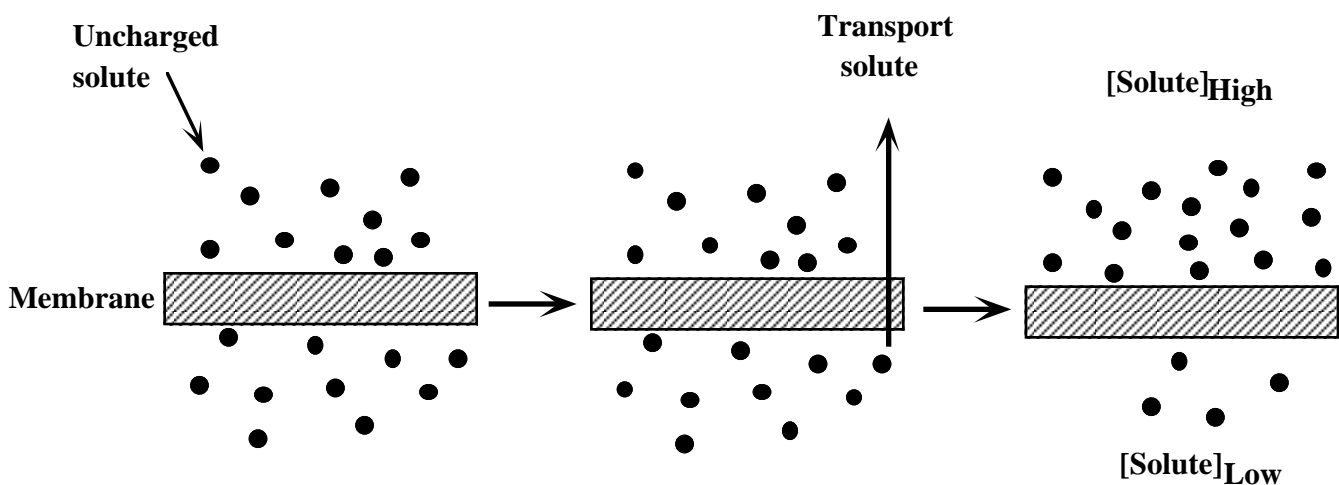
Synthetic work

- Cells need to synthesize macromolecules such as proteins, DNA, RNA, lipids and polysaccharides.



Concentration work

- Cells maintain different concentrations of solutes across membranes in order to create membrane-bound compartments with different chemical compositions.
- Another name for a concentration difference is a **concentration gradient**.



Equilibrium

[Solute] the same
on both sides of the
membrane

Disequilibrium

[Solute] not the same
on both sides of the
membrane = "concentration
gradient" across membrane

