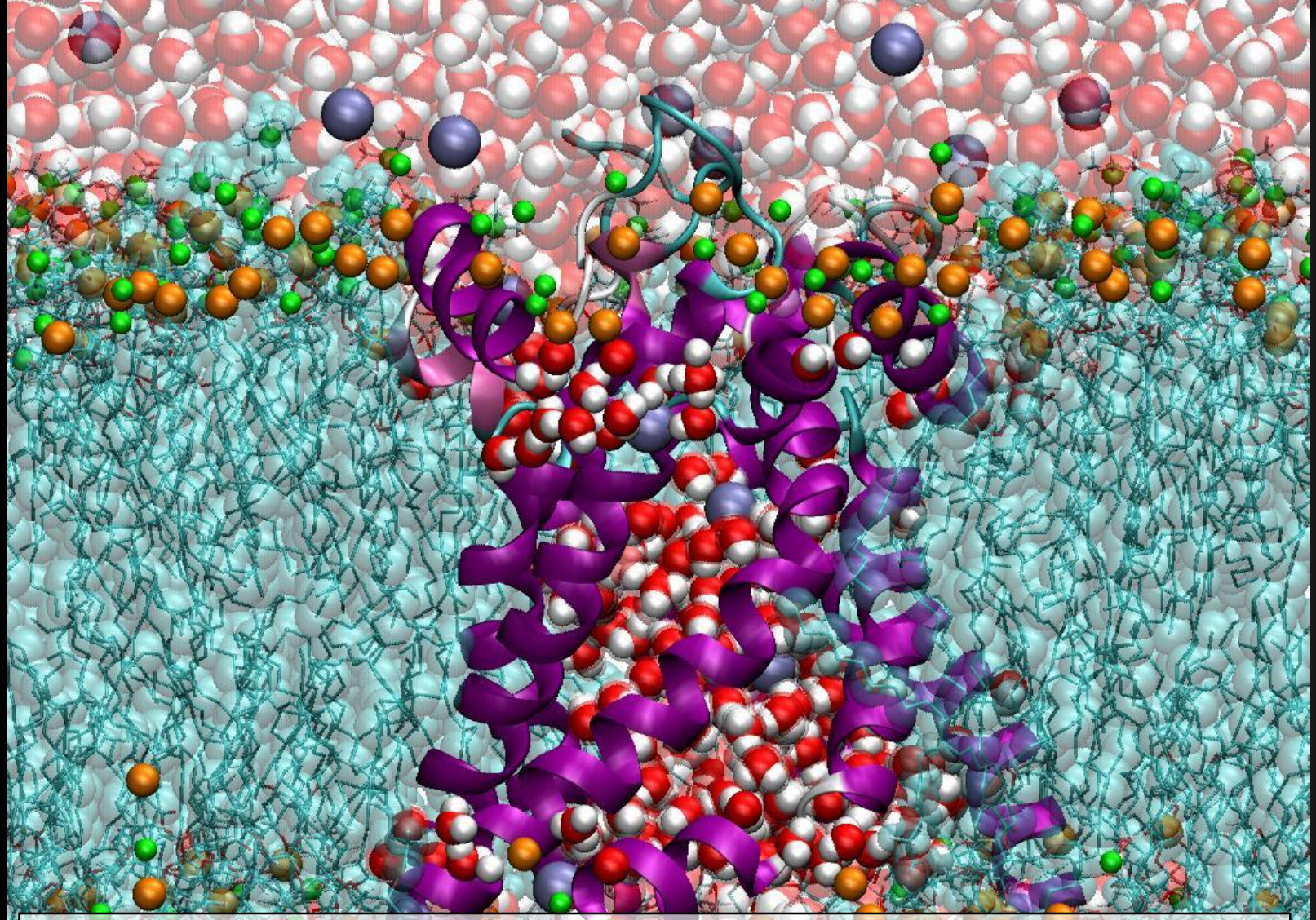
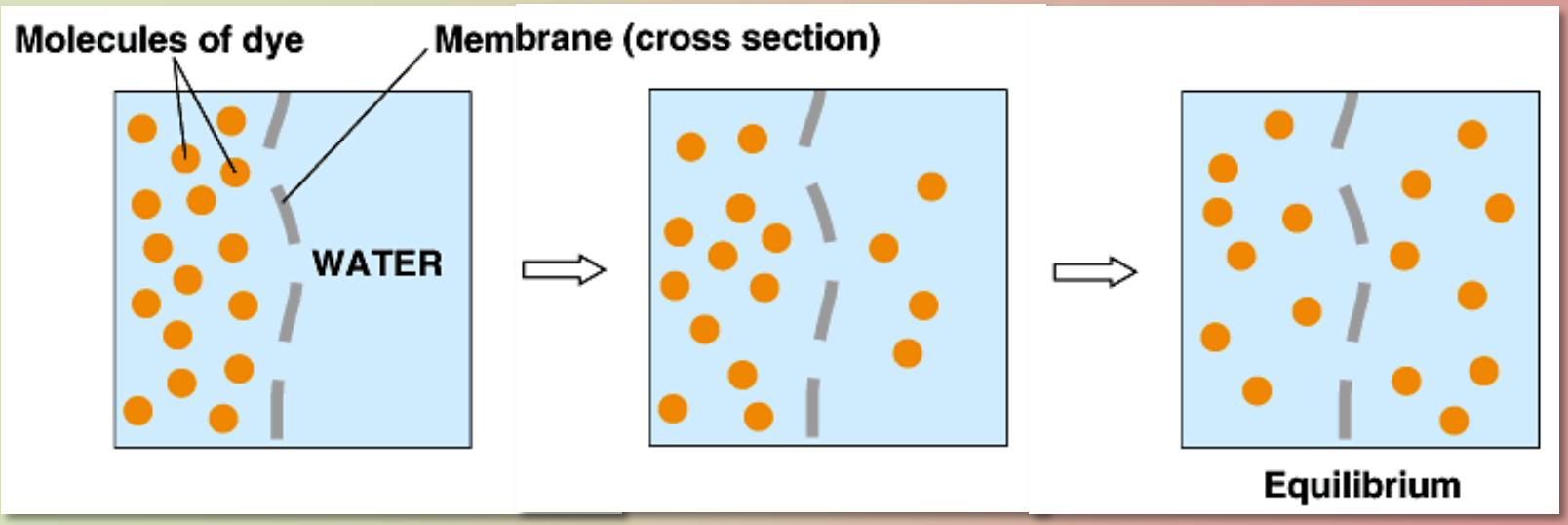


Movement across the Cell Membrane (Ch. 7.3)

2007-2008

Diffusion

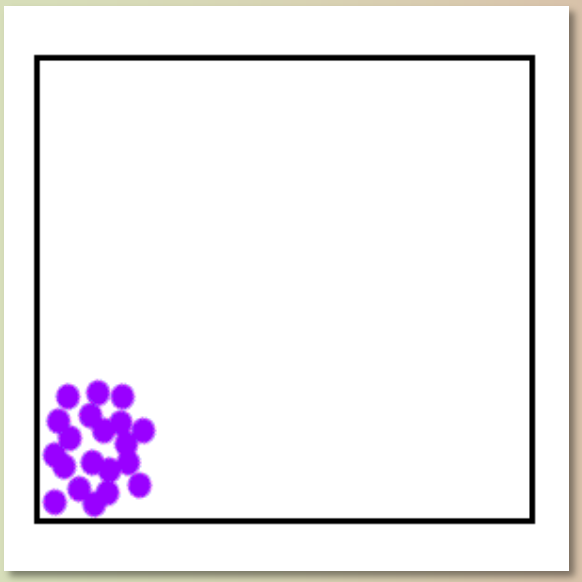
- 2nd Law of Thermodynamics governs biological systems
  - universe tends towards disorder (entropy)



- **Diffusion**
  - **movement from HIGH → LOW concentration**

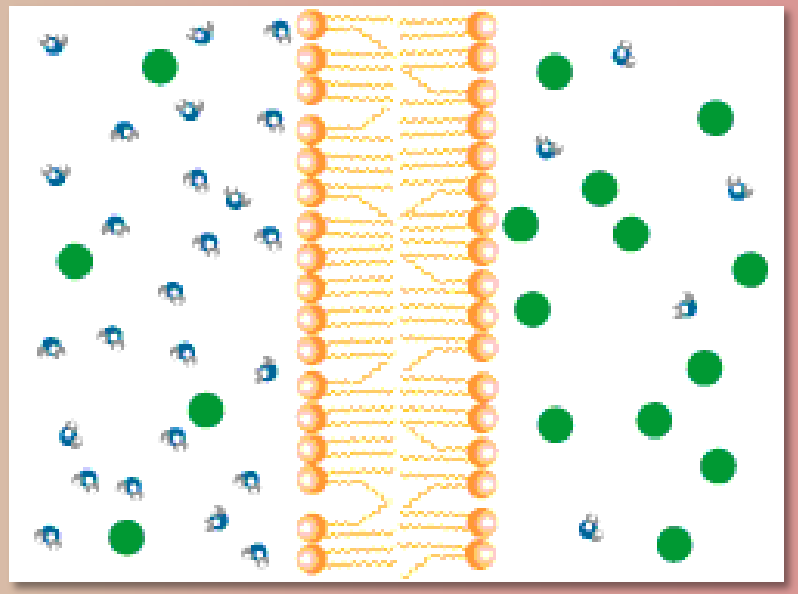
Simple Diffusion

- Move from HIGH to LOW concentration
  - “passive transport”
  - no energy needed



diffusion

movement of water



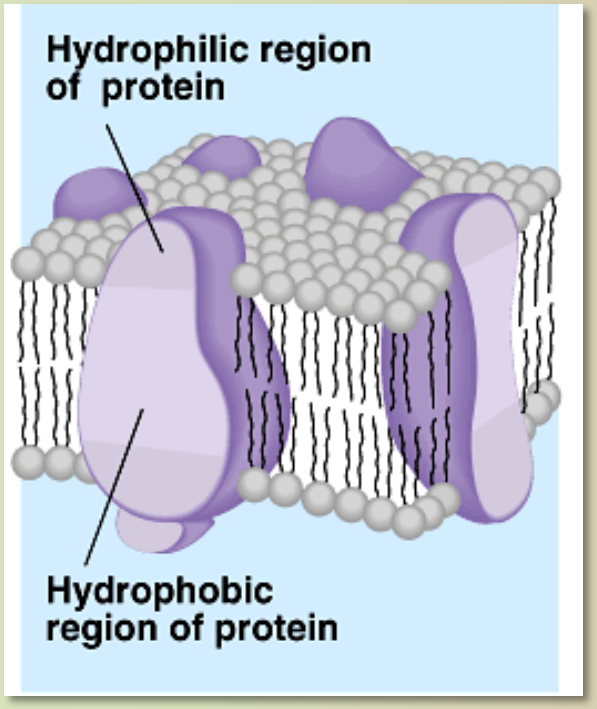
osmosis

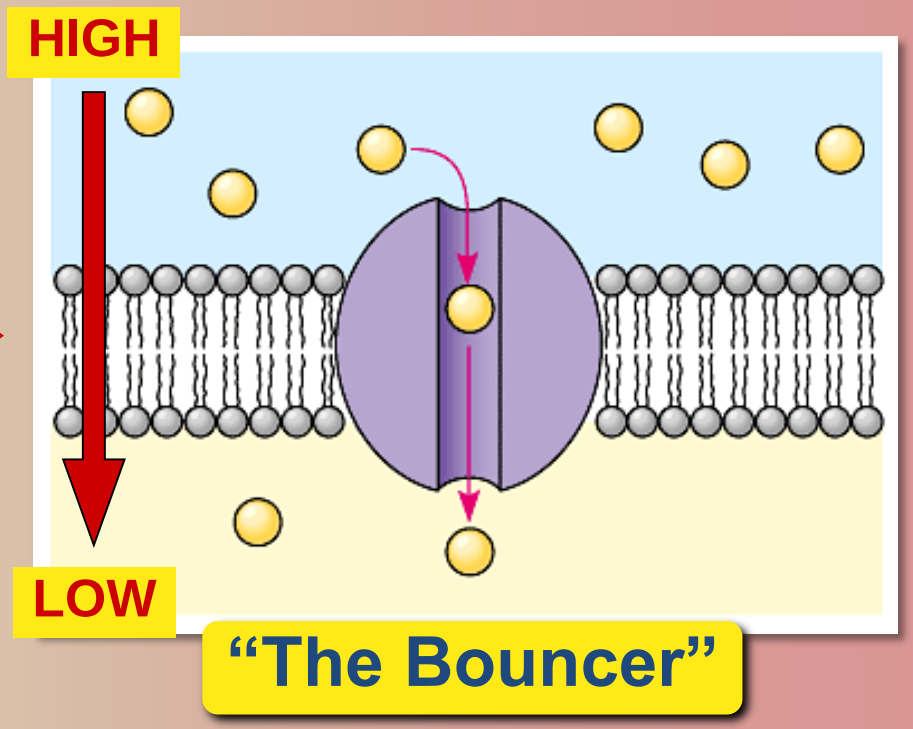
Facilitated Diffusion

- Diffusion through protein channels
  - channels move specific molecules across cell membrane
  - no energy needed

facilitated = with help

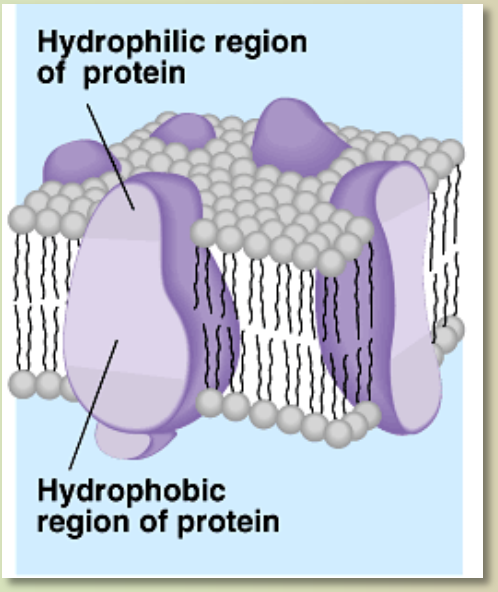
open channel = fast transport

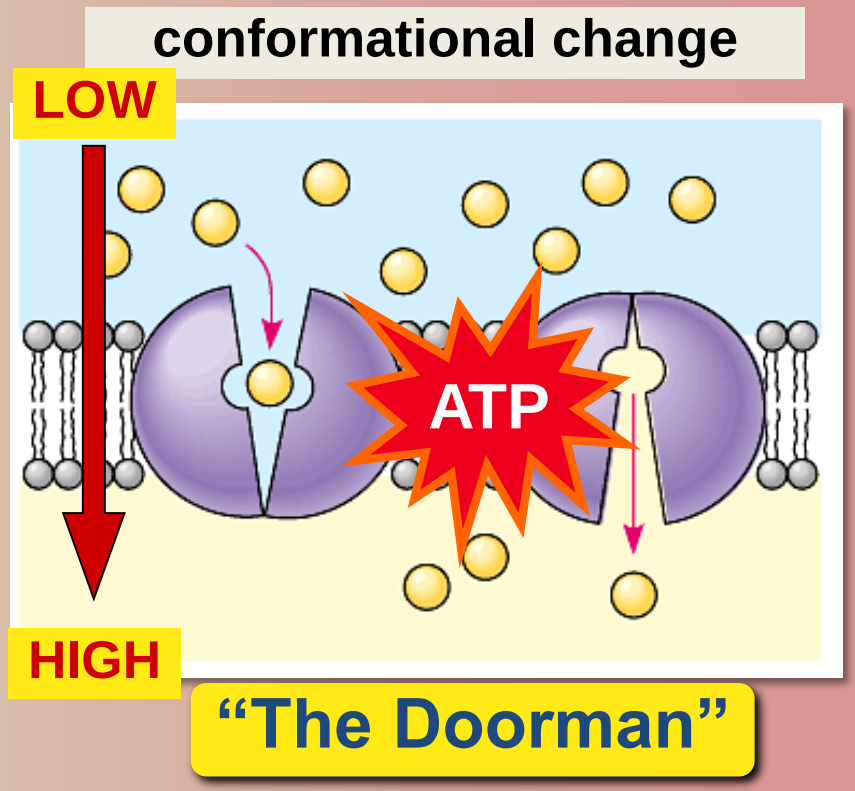




Active Transport

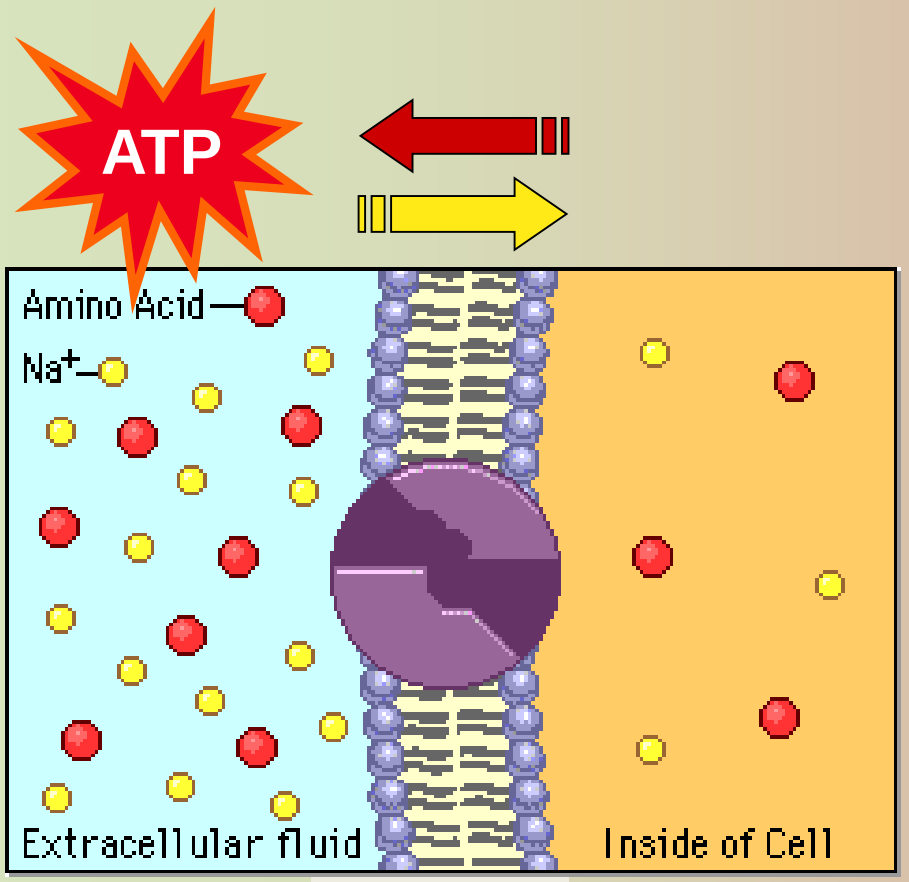
- Cells may need to move molecules *against* concentration gradient
  - conformational shape change transports solute from one side of membrane to other
  - protein "pump"
  - "costs" energy = ATP



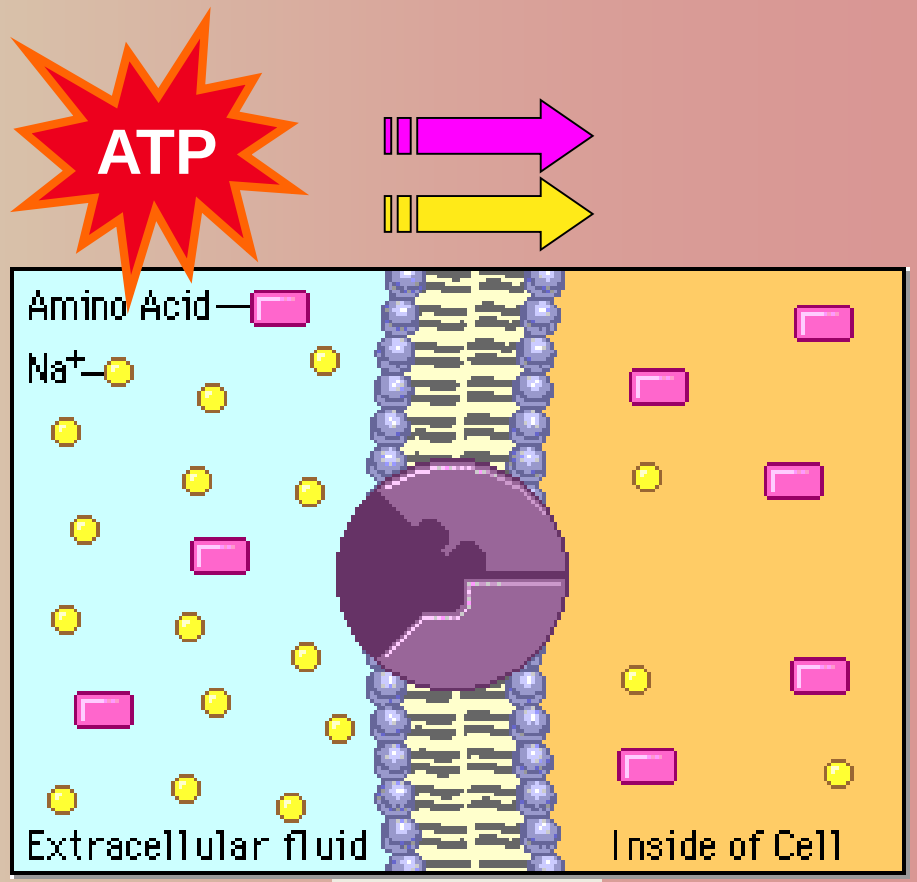


Active transport

- Many models & mechanisms



antiport

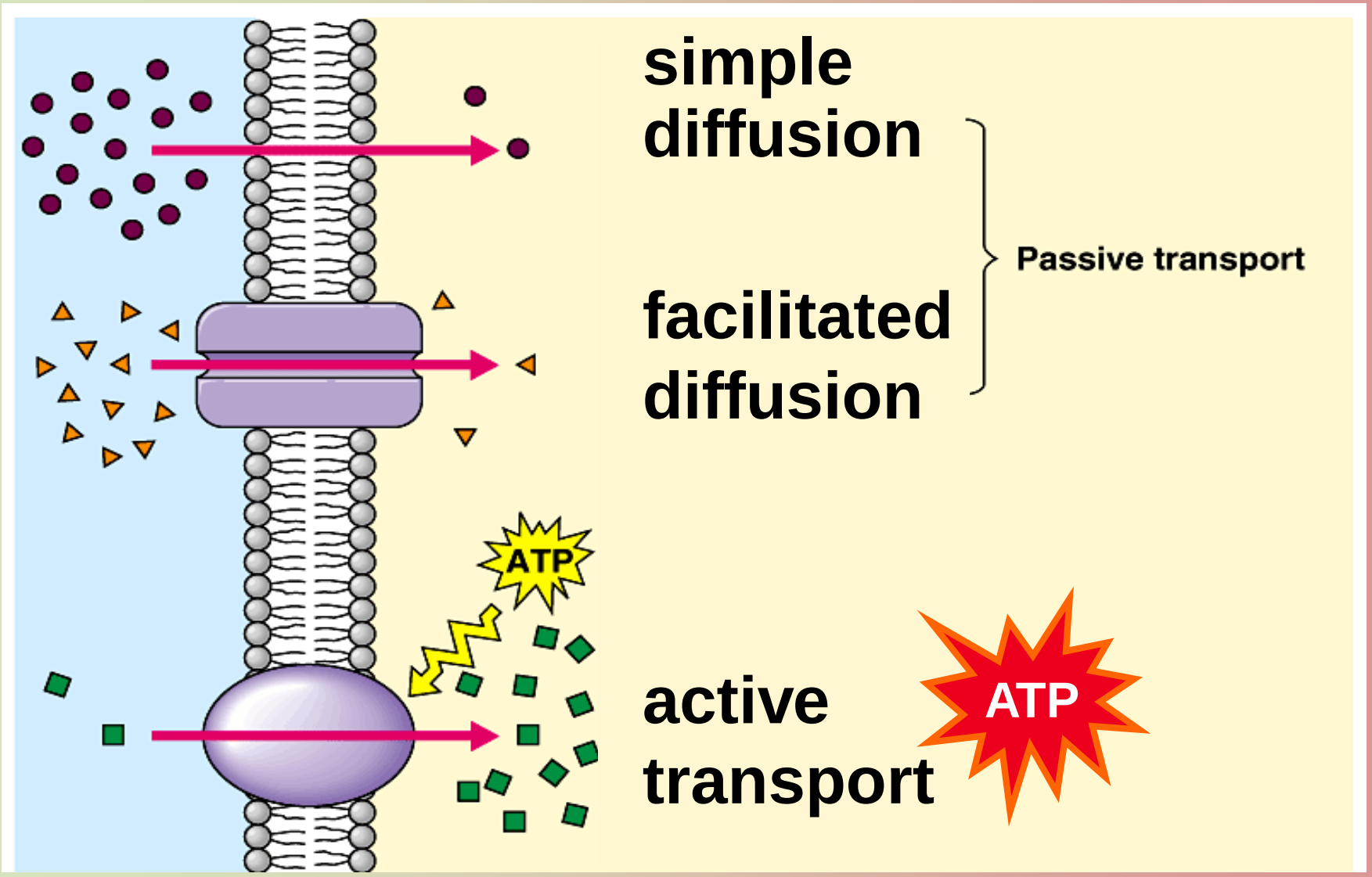


symport

Getting through cell membrane

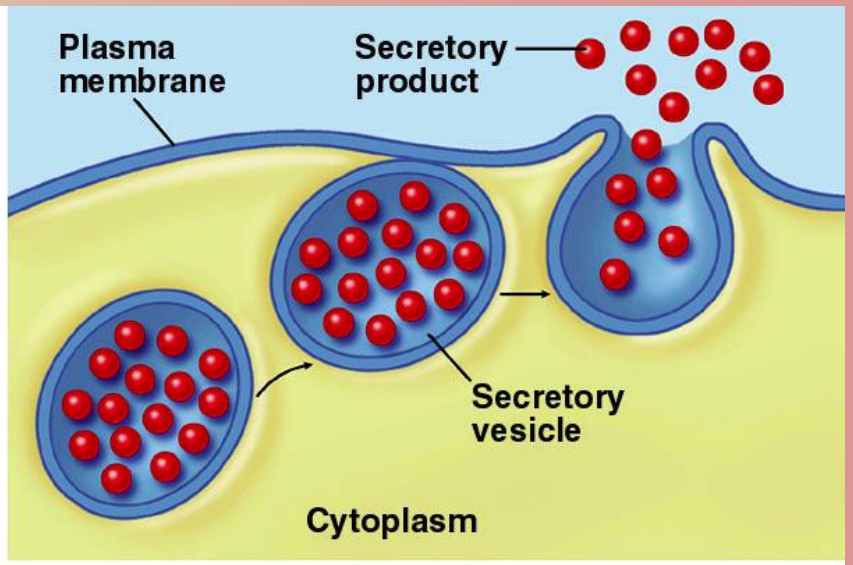
- Passive Transport
  - Simple diffusion
    - nonpolar, hydrophobic molecules
      - HIGH → LOW concentration gradient
  - Facilitated transport
    - polar, hydrophilic molecules
    - through a protein channel
      - HIGH → LOW concentration gradient
- Active transport
  - *against* concentration gradient
    - LOW → HIGH
  - uses a protein pump (requires ATP)

Transport summary



What about large molecules?

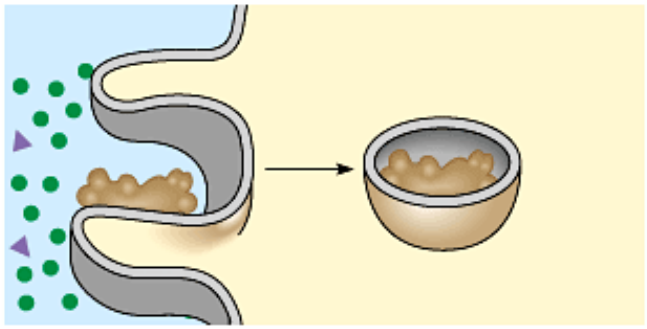
- Moving large molecules into & out of cell
  - through vesicles & vacuoles
  - endocytosis
    - phagocytosis = “cellular eating”
    - pinocytosis = “cellular drinking”
  - exocytosis



exocytosis

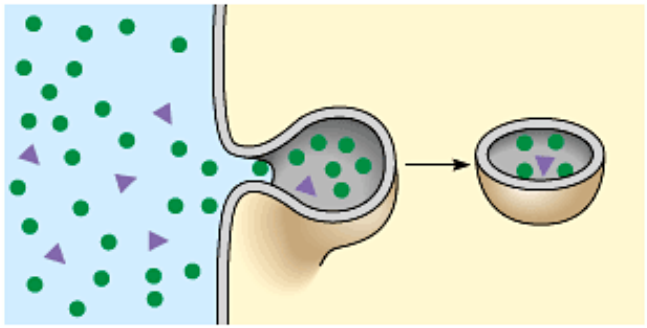
Endocytosis

phagocytosis



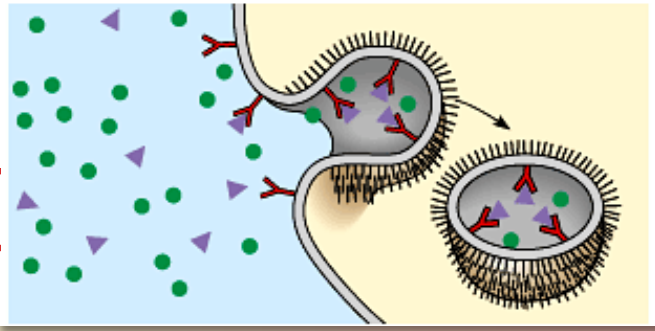
fuse with lysosome for digestion

pinocytosis



non-specific process

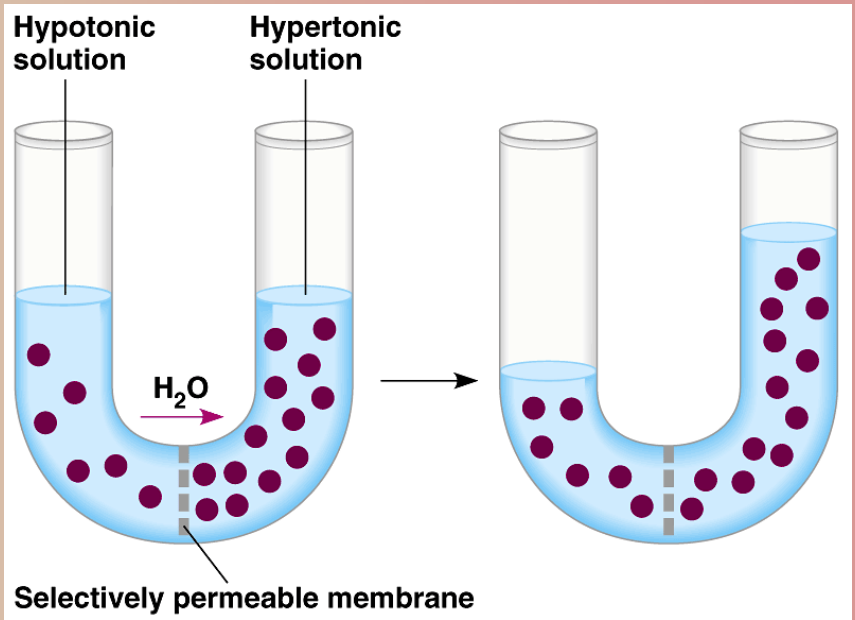
receptor-mediated endocytosis



triggered by molecular signal

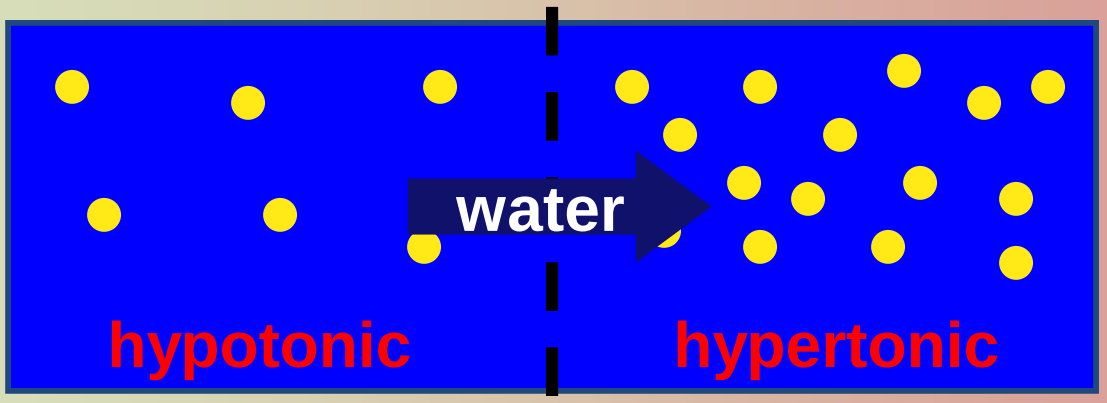
About Osmosis

- Water is very important to life, so we talk about water separately
- Diffusion of water from *HIGH concentration* of <u>water</u> to *LOW concentration* of <u>water</u>
  - across a semi-permeable membrane



Concentration of water

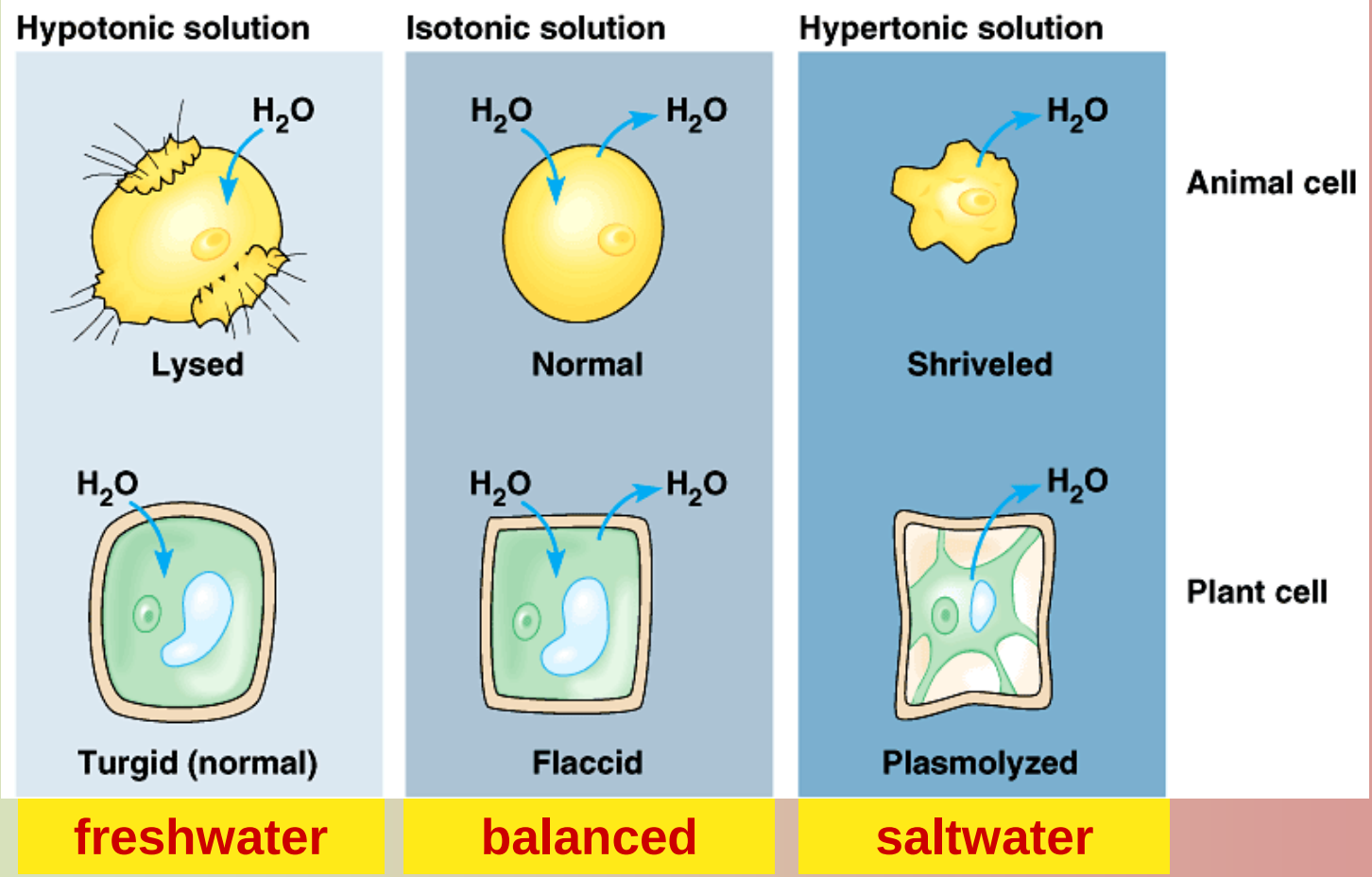
- Direction of osmosis is determined by comparing total solute concentrations
  - Hypertonic - more solute, less water
  - Hypotonic - less solute, more water
  - Isotonic - equal solute, equal water



net movement of water

Managing water balance

- Cell survival depends on balancing water uptake & loss

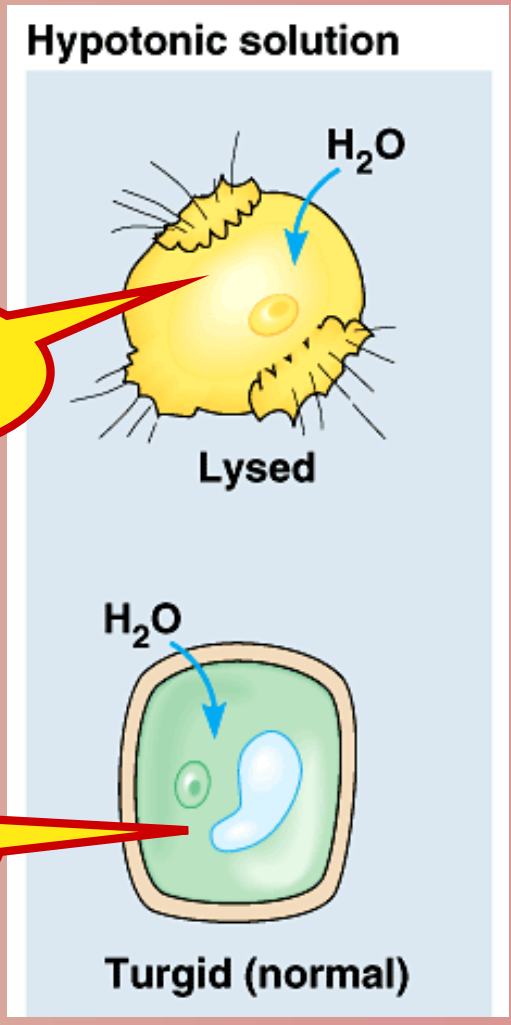


1

Managing water balance

- Hypotonic
  - a cell in fresh water
  - high concentration of water around cell
    - problem: cell gains water, swells & can burst
    - example: *Paramecium*
    - solution: contractile vacuole
      - pumps water out of cell
      - Uses ATP
  - plant cells
    - turgid = full
    - cell wall protects from bursting

ATP



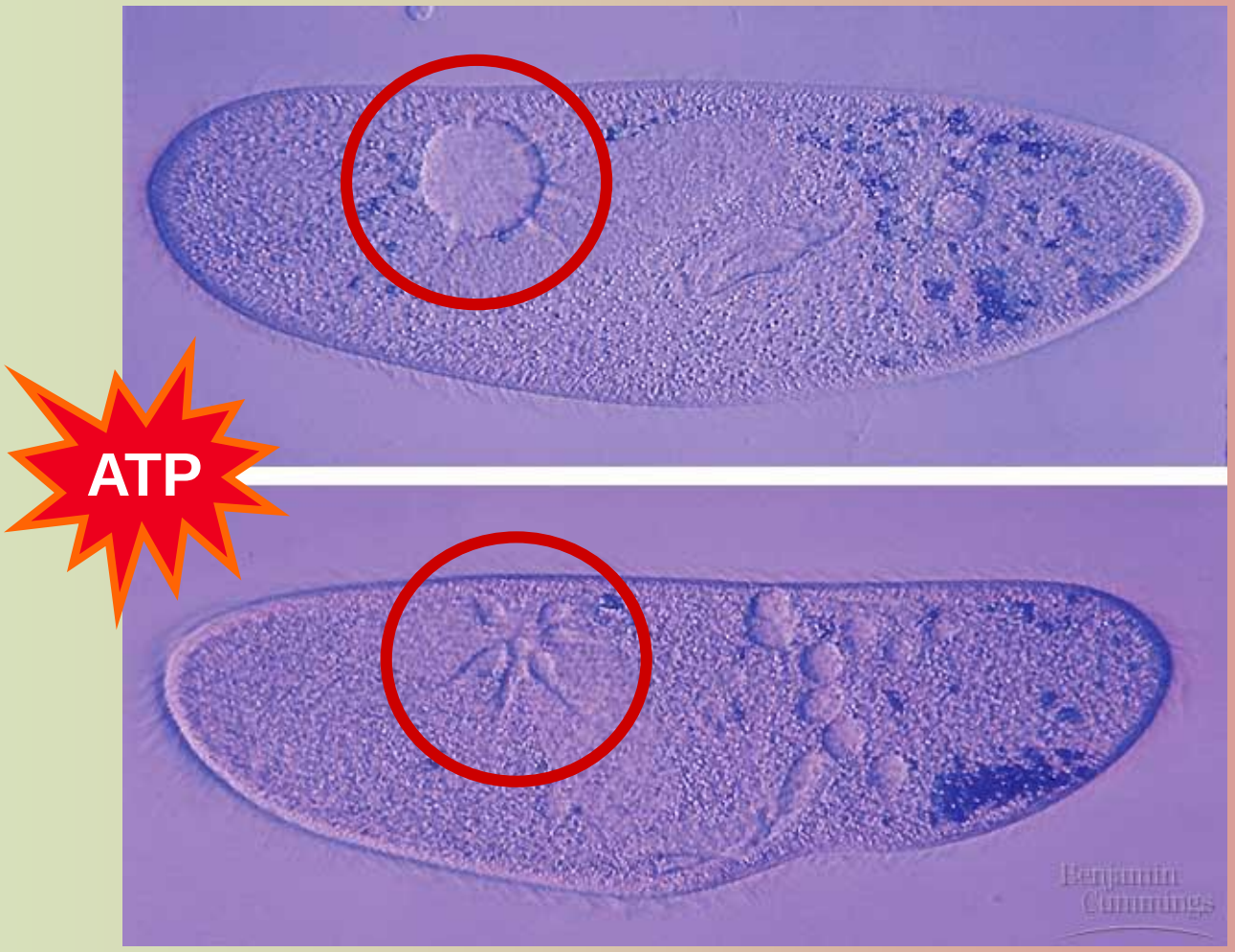
KABOOM!

No problem, here

freshwater

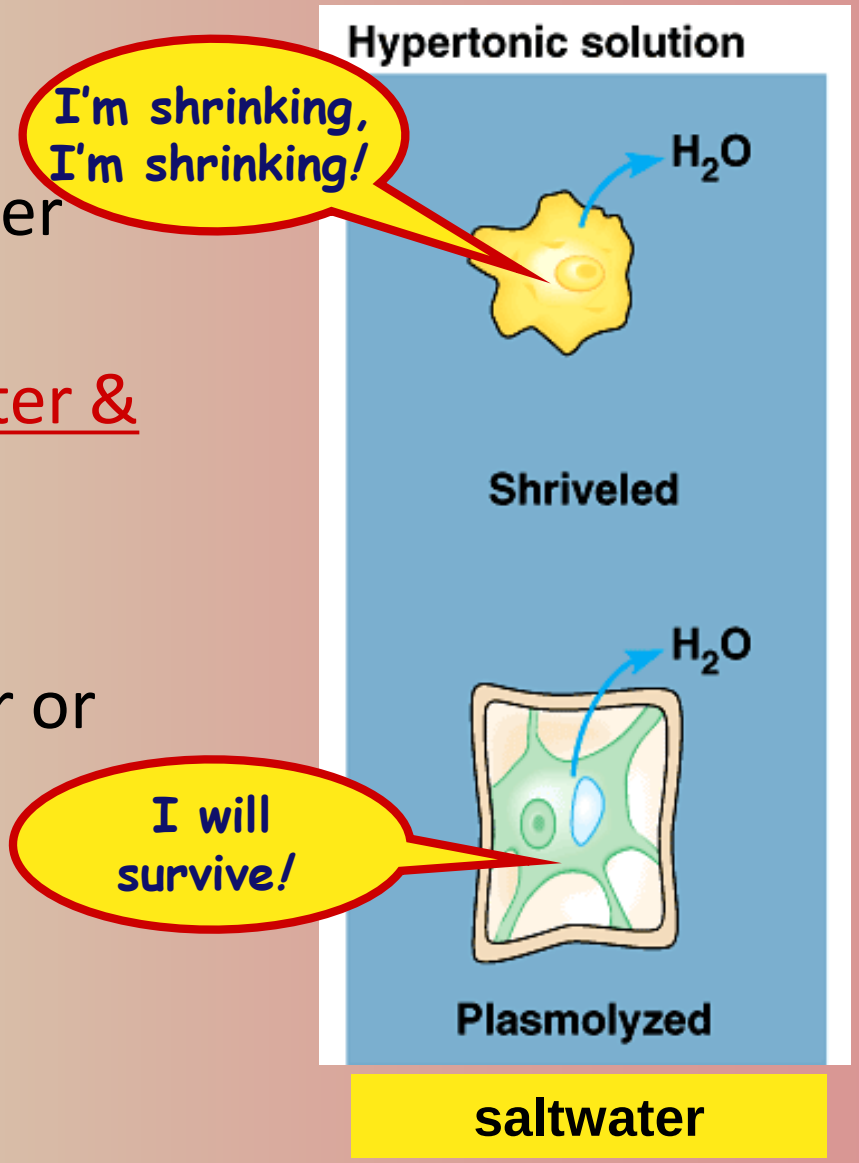
Pumping water out

- Contractile vacuole in *Paramecium*



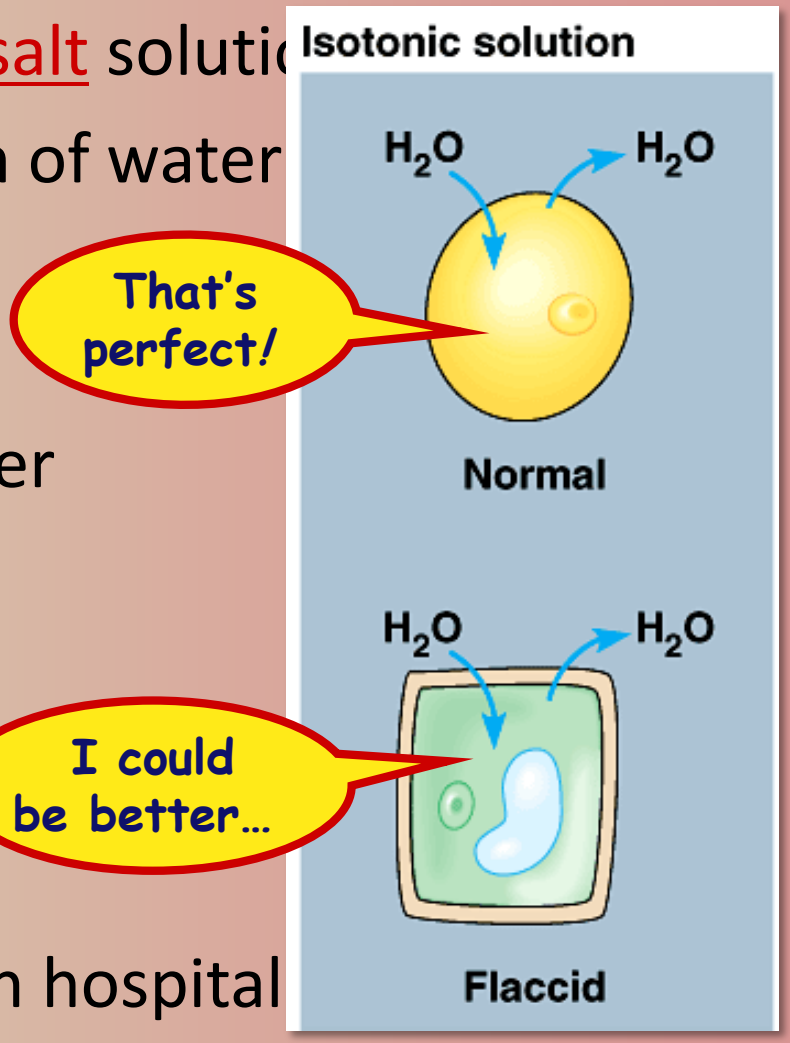
2 Managing water balance

- Hypertonic
  - a cell in salt water
  - low concentration of water around cell
    - problem: cell loses water & can die
    - example: shellfish
    - solution: take up water or pump out salt
  - plant cells
    - plasmolysis = wilt
    - can recover



3 Managing water balance

- Isotonic
  - animal cell immersed in mild salt solutio
  - no difference in concentration of water between cell & environment
    - problem: none
      - no net movement of water
      - cell in equilibrium
      - volume of cell is stable
    - example: blood cells in blood plasma
      - slightly salty IV solution in hospital

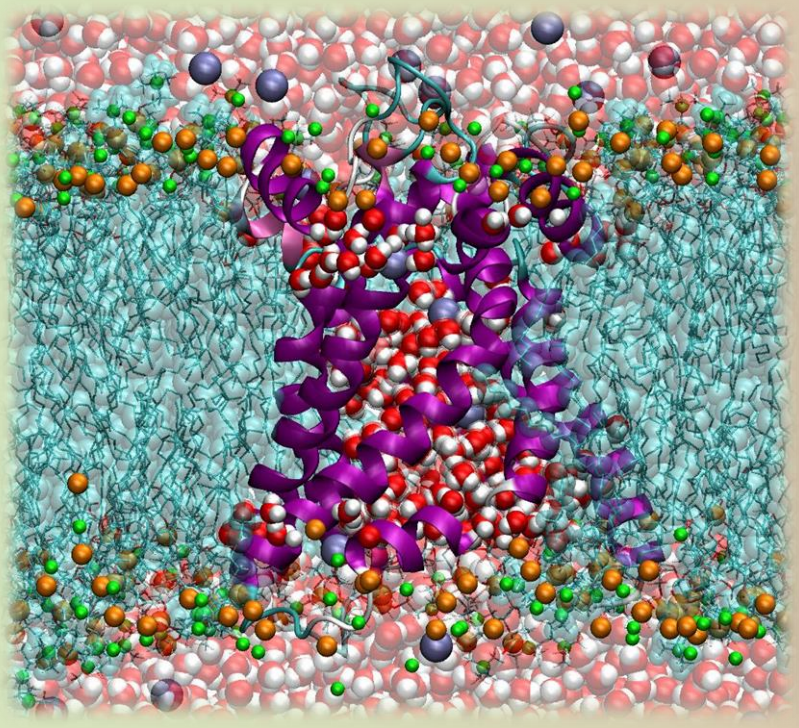


balanced

Aquaporins

1991 | 2003

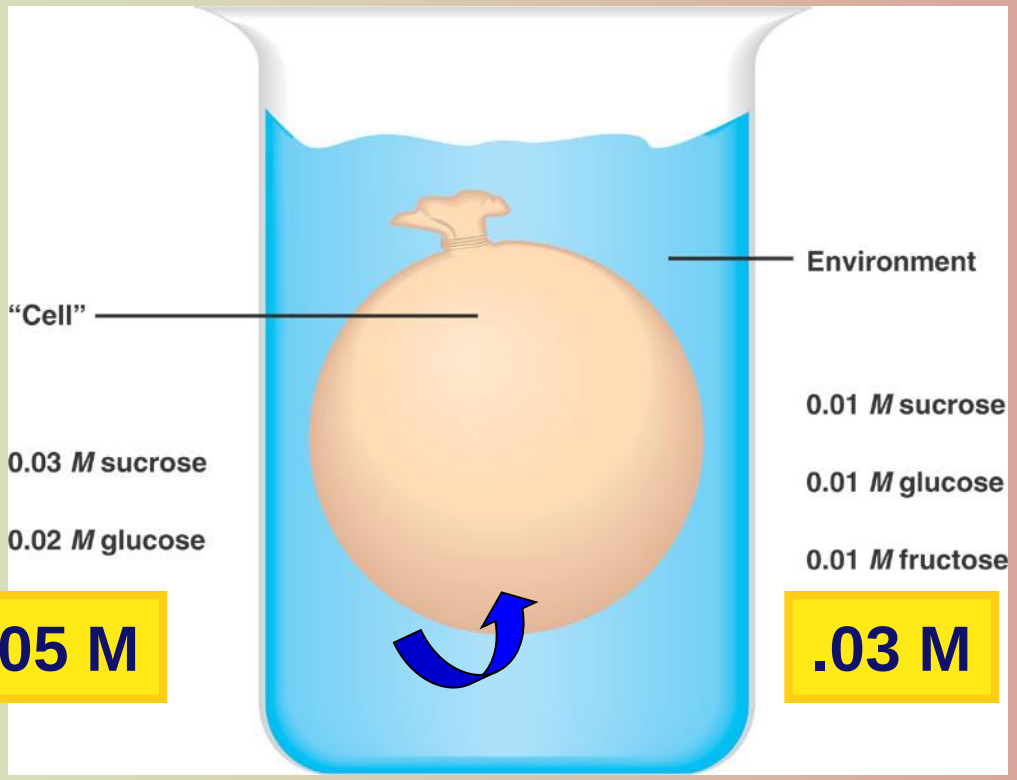
- Water moves <u>rapidly</u> into & out of cells
  - evidence that there were water channels
    - protein channels allowing flow of water across cell membrane



Peter Agre
John Hopkins

Roderick MacKinnon
Rockefeller

Do you understand Osmosis…

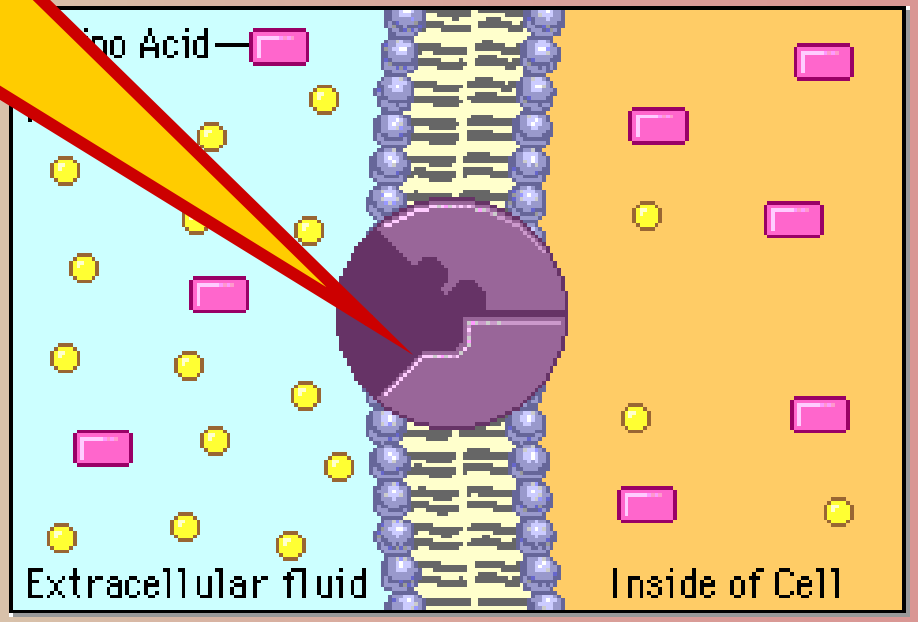


Cell (compared to beaker) → hypertonic or hypotonic

Beaker (compared to cell) → hypertonic or hypotonic

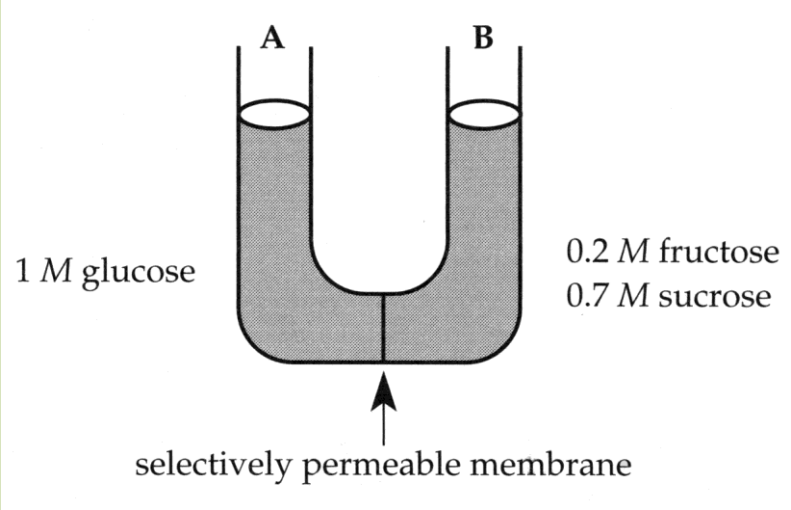
Which way does the water flow? → in or out of cell

Any Questions??



Review Questions

1. A solution of 1 *M* glucose is separated by a selectively permeable membrane from a solution of 0.2 *M* fructose and 0.7 *M* sucrose. The membrane is not permeable to the sugar molecules. Which of the following statements is correct?



A. Side A is hypotonic relative to side B.

B. The net movement of water will be from side B to side A.

C. The net movement of water will be from side A to side B.

D. Side B is hypertonic relative to side A.

E. There will be no net movement of water.

2. You observe plant cells under a microscope that have just been placed in an unknown solution. First the cells plasmolyze; after a few minutes, the plasmolysis reverses and the cells appear normal. What would you conclude about the unknown solute?
   A. It is hypertonic to the plant cells, and its solute can not cross the pant cell membranes.
   B. It is hypotonic to the plant cells, and its solute can not cross the pant cell membranes.
   C. It is isotonic to the plant cells, but its solute can cross the plant cell membranes.
   D. It is hypertonic to the plant cells, but its solute can cross the plant cell membranes.
   E. It is hypotonic to the plant cells, but its solute can cross the plant cell membranes.