

HST.410J/6.021J

Lecture 4
February 15, 2007

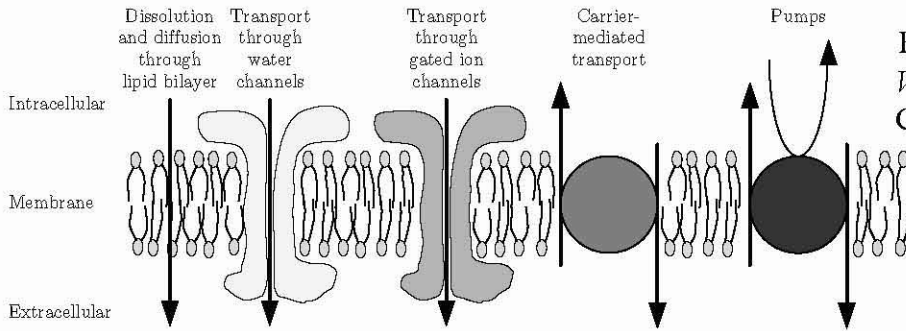


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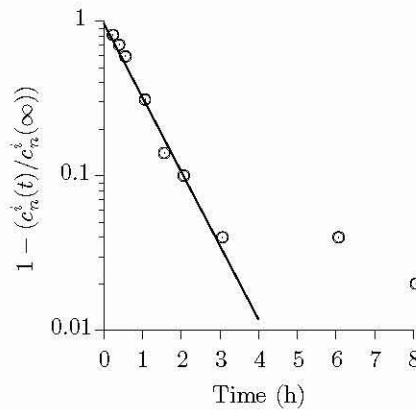
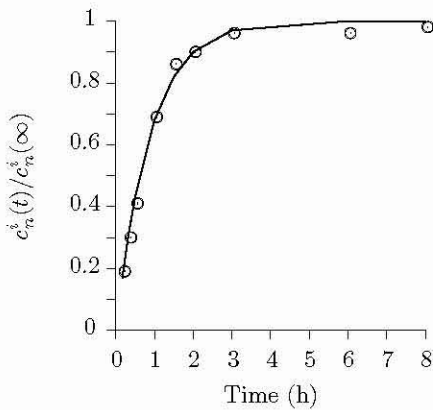
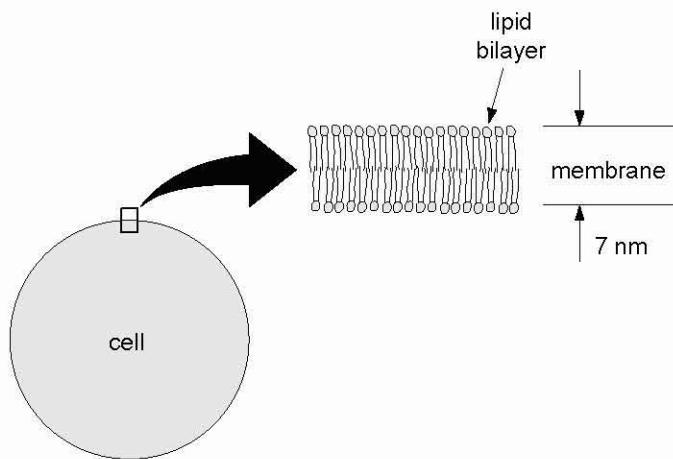
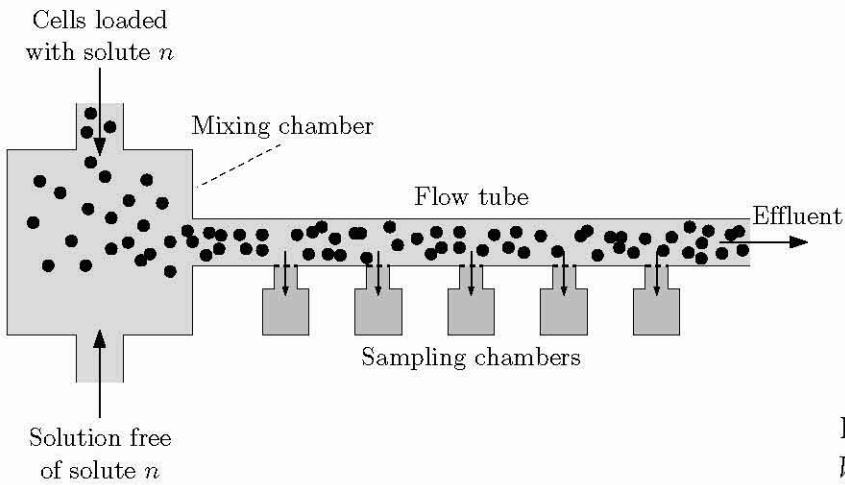
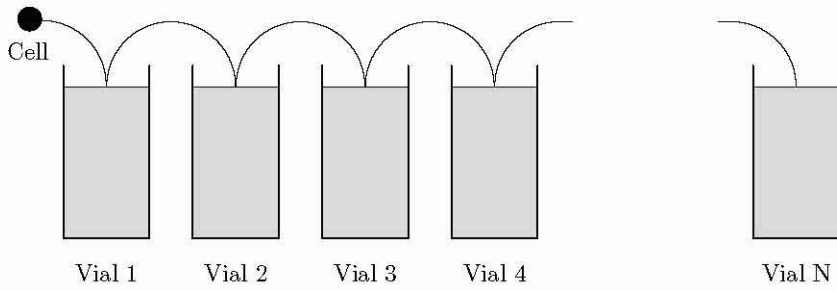
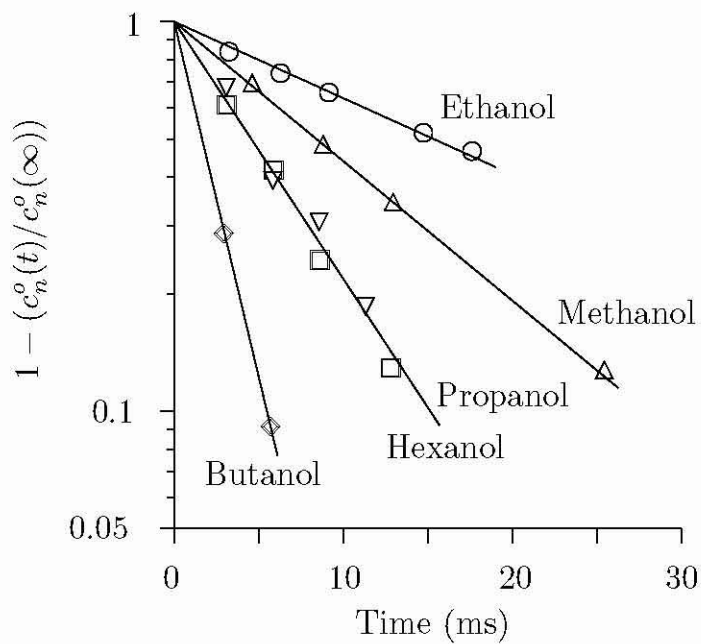


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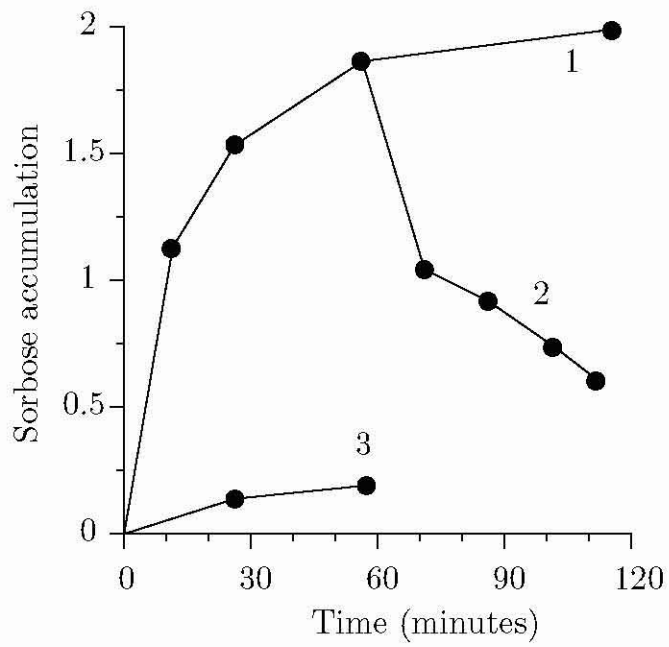
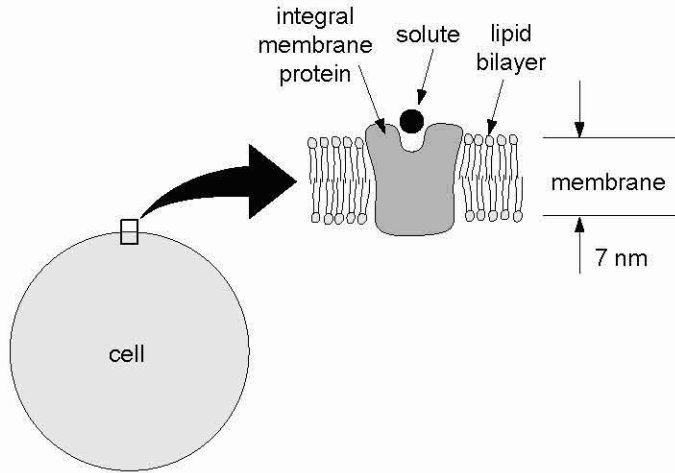


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 Illustration of a water channel in a cell membrane.

Water transport in digestive system

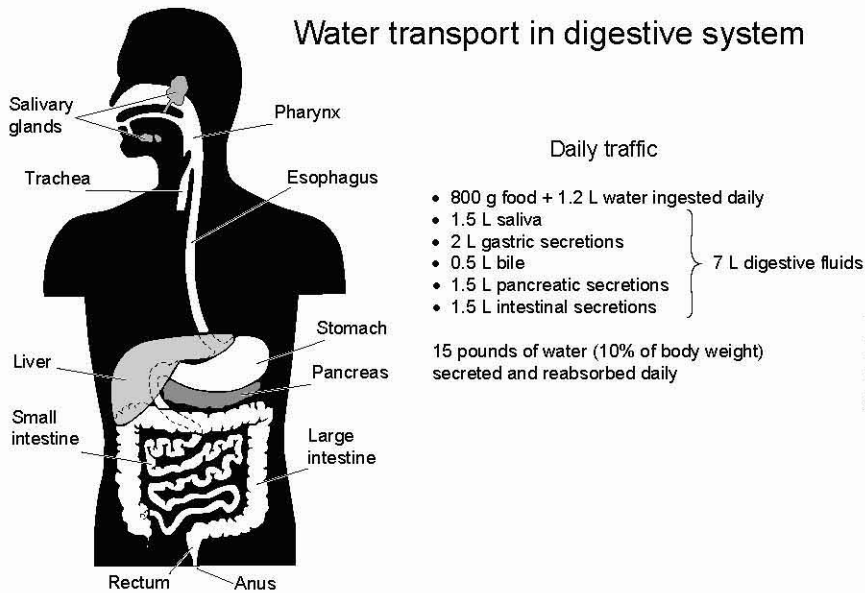
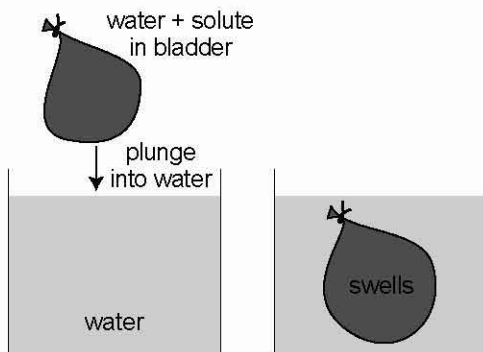


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Osmosis Observations

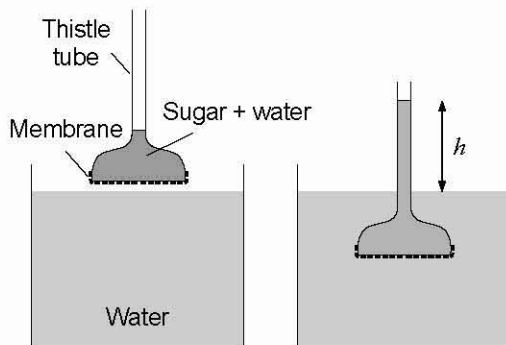
Henri Dutrochet (early 1800s)

- first described phenomenon and called it osmosis
- developed first osmometer: animal bladder filled with test solution, plunge into water, swells, turgid
- pressure greater for solutions with more solute



Wilhelm Pfeffer (mid 1800s)

- osmosis can be stopped with hydraulic pressure
- thistle tube + animal bladder (or artificial membrane by late 1800s)
 - water flows in direction to equalize sugar concentration
 - hydraulic pressure develops
 - flow stops when osmotic pressure = hydraulic pressure
- pressure proportional to concentration of solute
- pressure increases slightly with temperature



Henricus van't Hoff (1886)

- formulated mathematical law
- count number of particles in volume V
- measure temperature T
- osmotic pressure = pressure produced by gas with same number of particles, same volume, and same pressure

van't Hoff's Law

$$\underbrace{\pi(x,t)}_{\substack{\text{osmotic} \\ \text{pressure}}} = \underbrace{R}_{\substack{\text{molar gas} \\ \text{constant} \\ 8.314 \text{ J/(mol}\cdot\text{K)}}} \underbrace{T}_{\substack{\text{absolute} \\ \text{temperature}}} \underbrace{\sum_n C_n(x,t)}_{\substack{\text{total solute} \\ \text{concentration}}}$$

- salts are different

Svante Arrhenius (1884)

- PhD (age 25): dissolution of salts into ions
- $\text{NaCl} \rightarrow \text{Na}^+ + \text{Cl}^-$ (\therefore conducts electricity)
- count ions as separate particles
 \rightarrow van't Hoff's law works for salts as well

$$\underbrace{\pi(x,t)}_{\substack{\text{osmotic} \\ \text{pressure}}} = R T \sum_n C_n(x,t) = R T \underbrace{C_\Sigma(x,t)}_{\substack{\text{osmolarity}}} \\ \text{[Pa = N/m}^2 \qquad \qquad \qquad \text{[osmol/m}^3 \text{]}$$

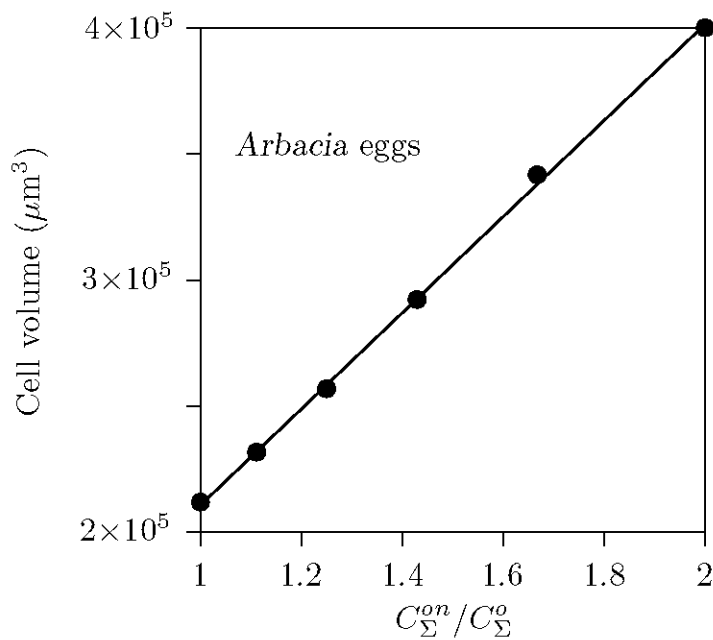


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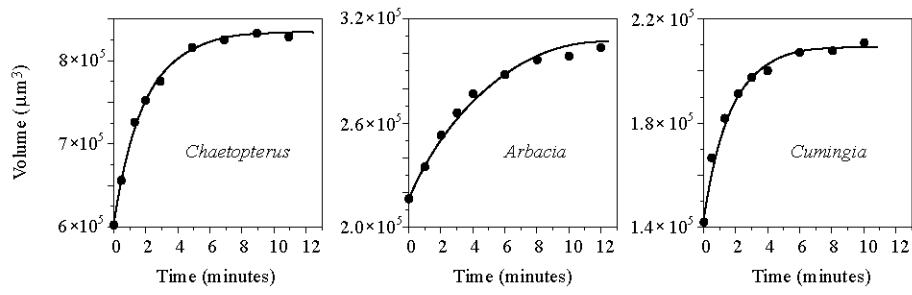


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