ME 411 / ME 511

Biological Frameworks for Engineers

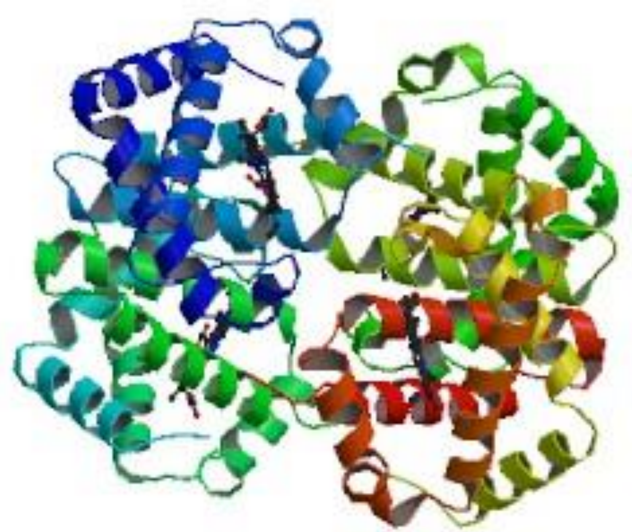
Biological Frameworks for Engineers

ME 411 / 511

UNIVERSITY OF WASHINGTON

Class Organization

- HW2 due on Friday
- Lab 1 – Protein Structure
  - Bring your laptops on Wed
  - Handouts provided



Biological Frameworks for Engineers

ME 411 / ME 511

Proteins

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Protein Functions

- Different shapes and sizes mediate a diverse array of activities
- Function based on proteins binding to themselves, other proteins, small molecules, or ions
- Life is nothing without the function of proteins…

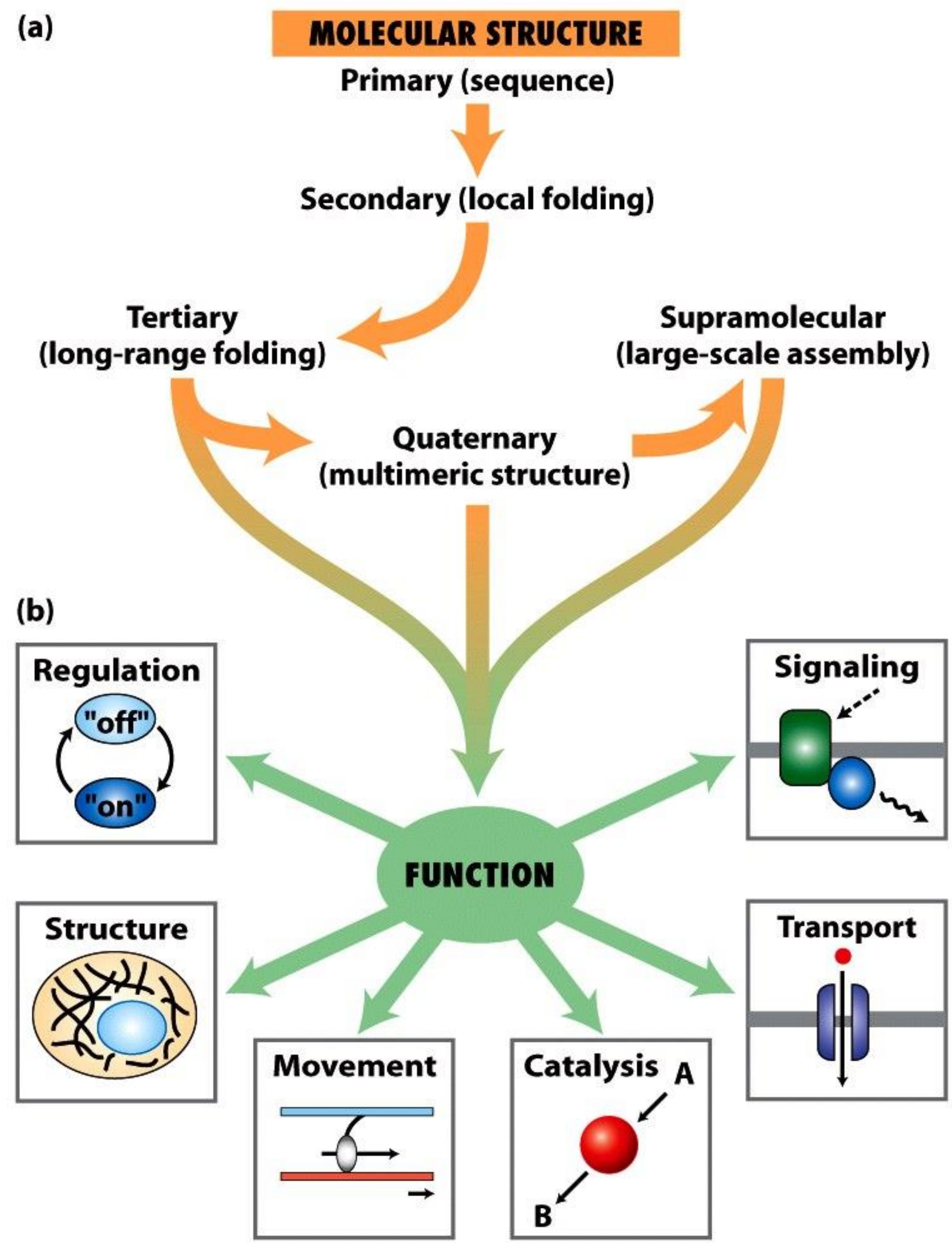
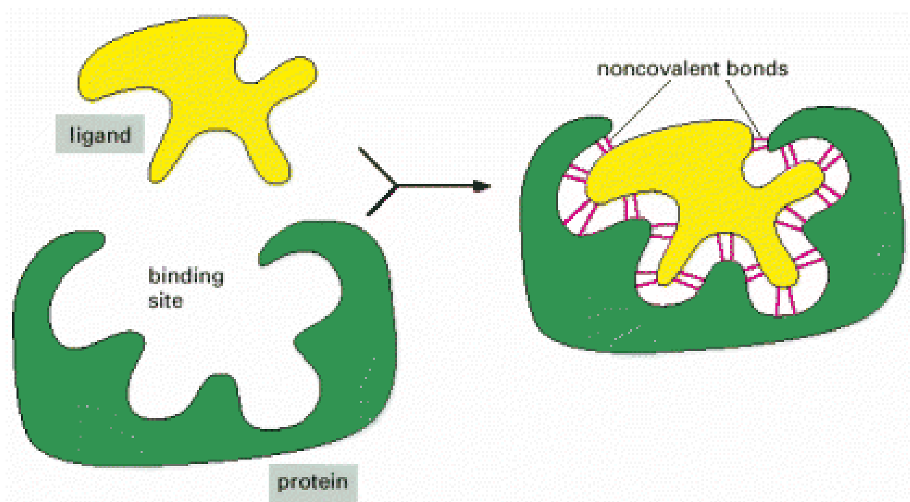


Figure 3-1
Molecular Cell Biology, Sixth Edition

Binding

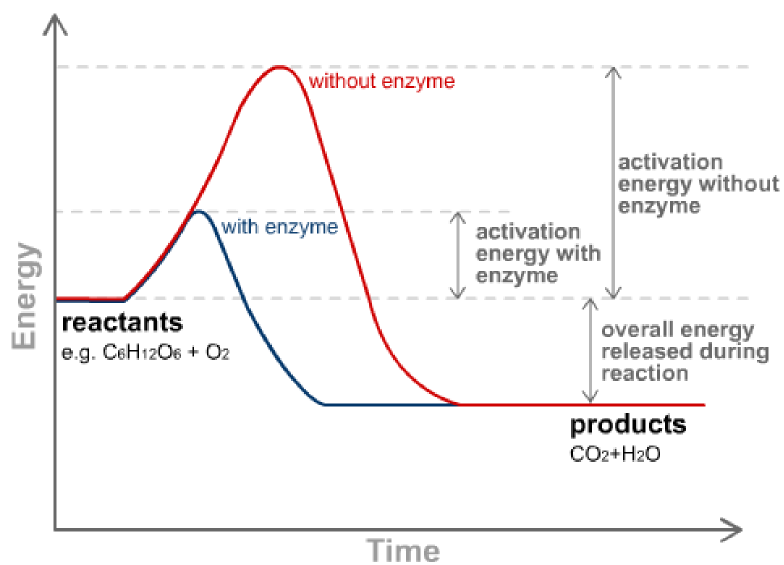
- Specific binding of a target molecule regulates protein function

<u>Specificity</u>



Enzymatic Function

- Enzyme – catalyze the rate of reactions inside a cell
- Substrate – target for enzymes that become the products of the reaction



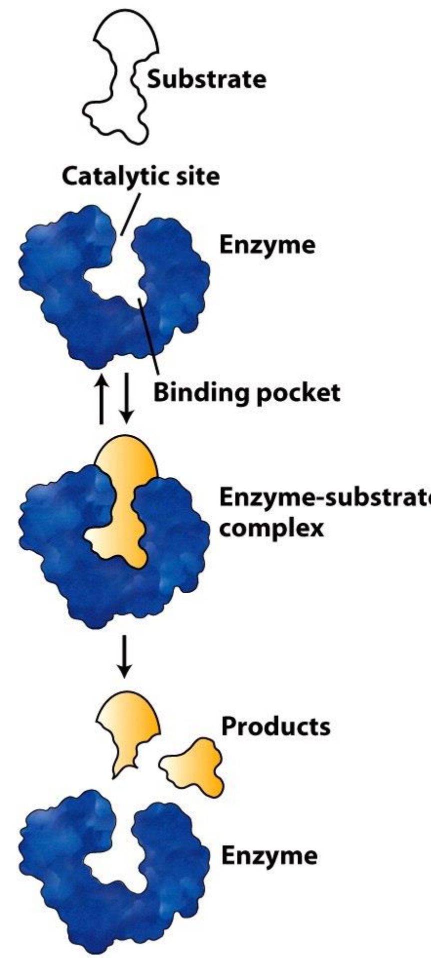
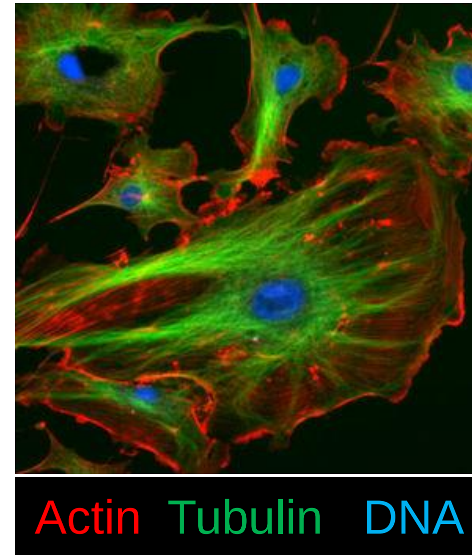


Figure 3-23
Molecular Cell Biology, Sixth Edition

Structure

- Cytoskeleton – actin, microtubules, intermediate filaments, cadherins, integrins, and others
- Extracellular matrix – collagen, elastin, laminin, fibronectin, and others



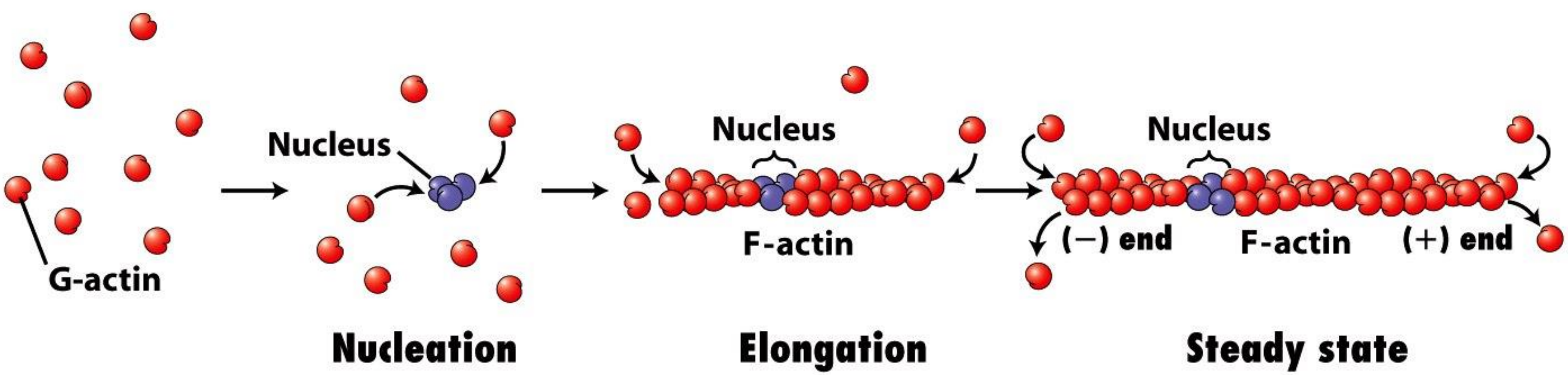


Figure 17-7a
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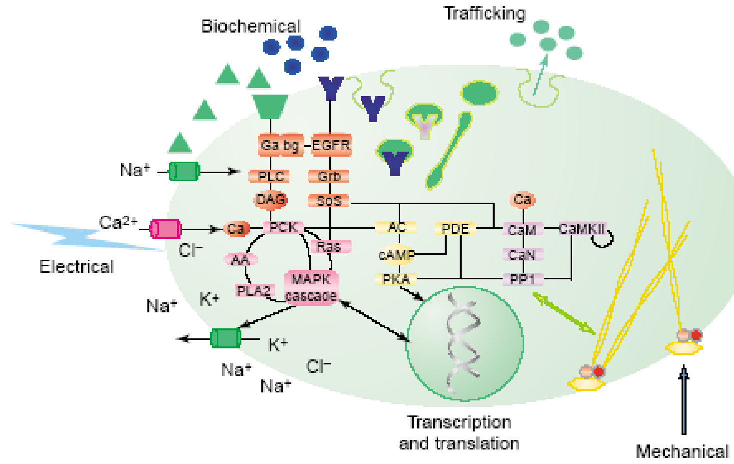
Signaling



- Signaling Proteins – molecules and receptors
- Membrane receptor joins with co-receptor to initiate a signal cascade inside the cell

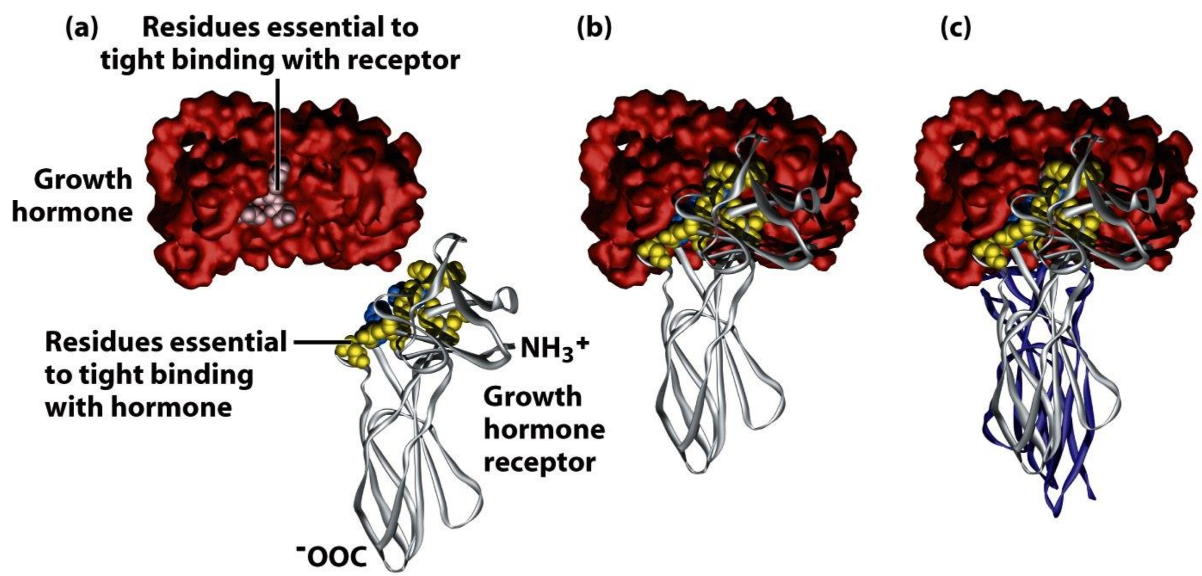
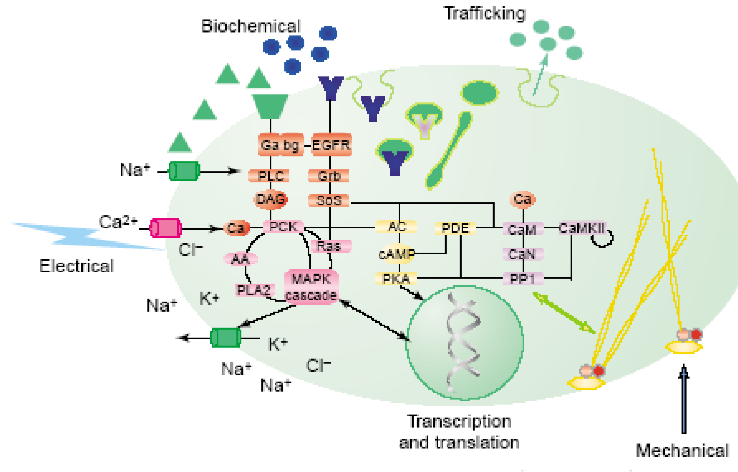


Figure 15-3
Molecular Cell Biology, Sixth Edition

Co-receptor (blue)

Regulation

- Regulatory Proteins – kinases, phosphatases, GTPases, etc. interpret a receptor signal for gene expression or cell function
- RasGTP has allosteric change in conformation
- Dissociation of GTP to GDP is an “egg timer”



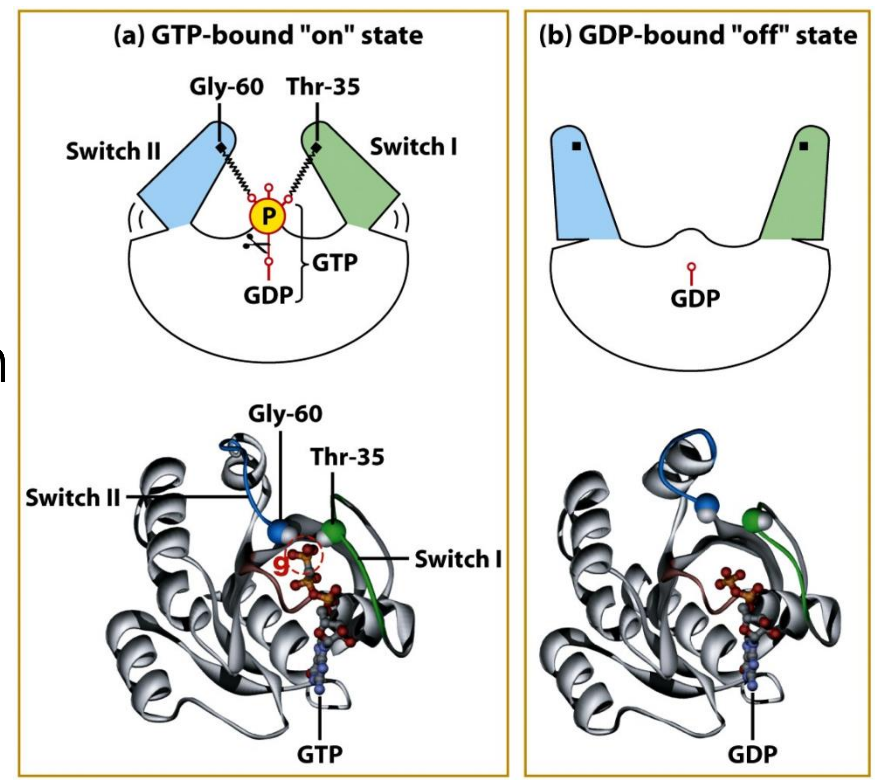


Figure 15-8
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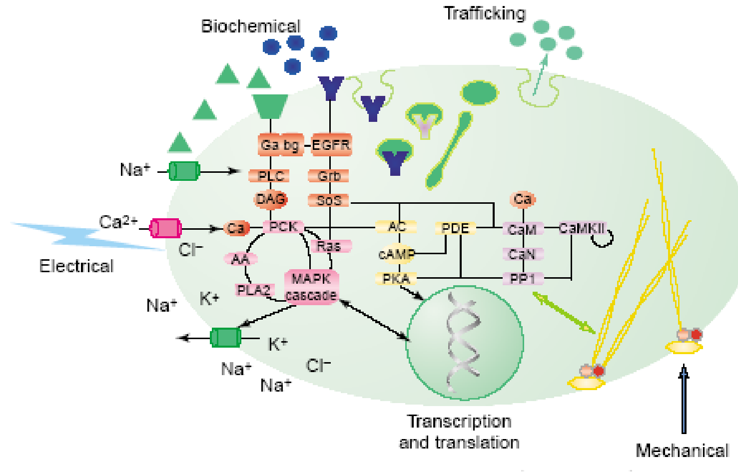
Transport

- Membrane transport proteins – control the transport of ions and small molecules across membranes



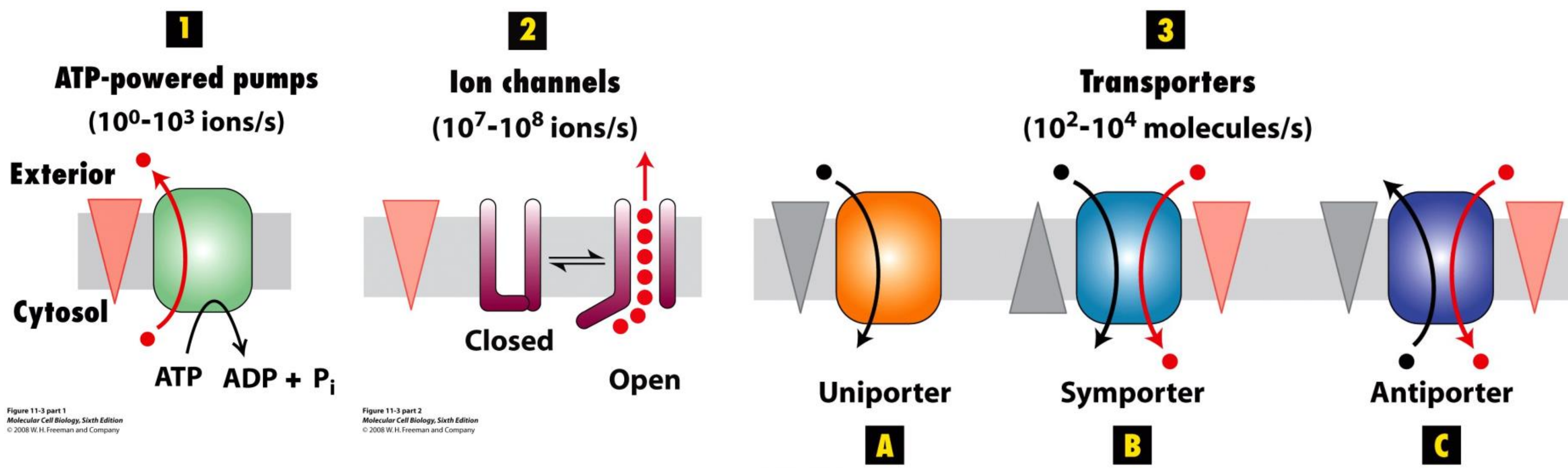


Figure 11-3 part 1
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Figure 11-3 part 2
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Figure 11-3 part 3
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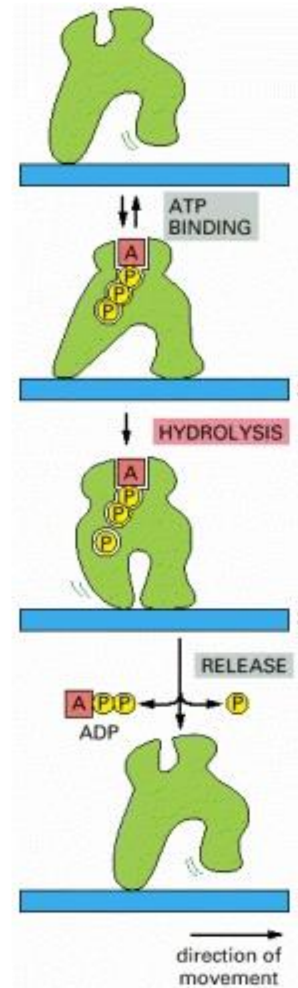
Motor Proteins

- Allosteric motor protein
- Transition between three conformations allows stepping motion
- Regulated by
  - ATP binding
  - Hydrolysis of ATP to ADP
  - ADP unbinding



Dissociation Constant

Affinity

Binding Reaction:

$$P + L \leftrightarrow PL$$

Dissociation Constant:

$$K_d = [P][L] / [PL]$$

where [ ] is concentration
e.g. molarity (mol/L)

Comparisons

- Weak:
  $K_d \geq 10^{-3}$ M
- Moderate
  $K_d \approx 10^{-6}$ M
- Tight:
  $K_d \leq 10^{-9}$ M
- Biotin-Avidin:
  $K_d \geq 10^{-15}$ M

How Much Binding?

- Consider a cell having
  - 100 copies of protein P
  - 100 copies of ligand L
  - 10^{-15} L volume
  - Reaction at equilibrium
- If $K_d = 10^{-6}$ M, then

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88 copies of unbound P

88 copies of unbound L

12 copies of PL (P bound to L)

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  - 10^{-15} L volume
  - Reaction at equilibrium

- If $K_d = 10^{-9}$ M, then

How Much Binding?

- Consider a cell having
  - 100 copies of protein P
  - 100 copies of ligand L
  - 10^{-15} L volume
  - Reaction at equilibrium
- If $K_d = 10^{-9}$ M, then
  - 8 copies of unbound P
  - 8 copies of unbound L
  - 92 copies of PL (P bound to L)

Questions ?