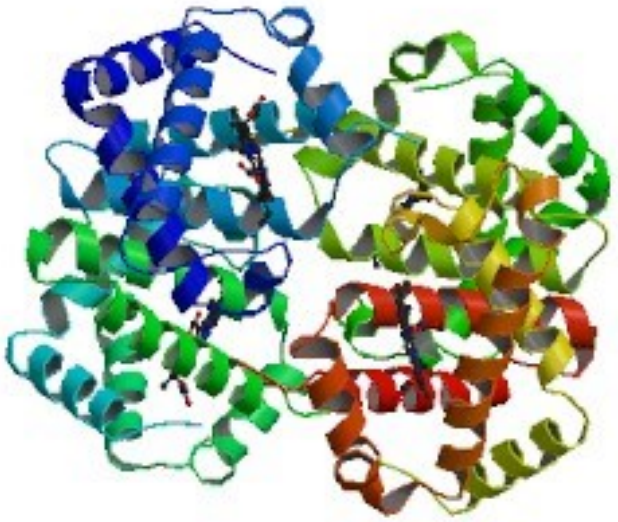
ME 411 / ME 511

Biological Frameworks for Engineers

Class Organization

- Lab 1 – Protein Structure
  - Bring your laptops
  - 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…

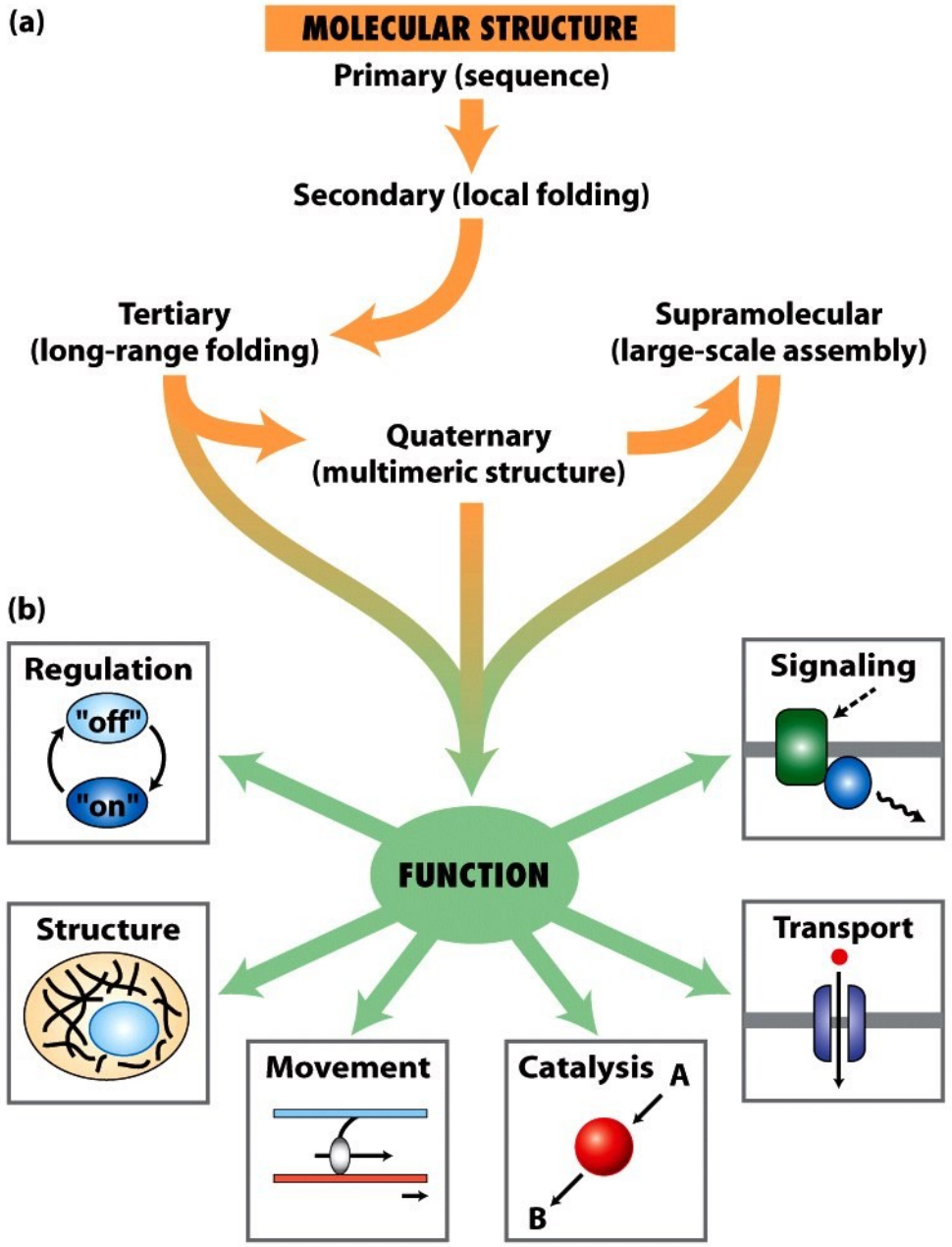
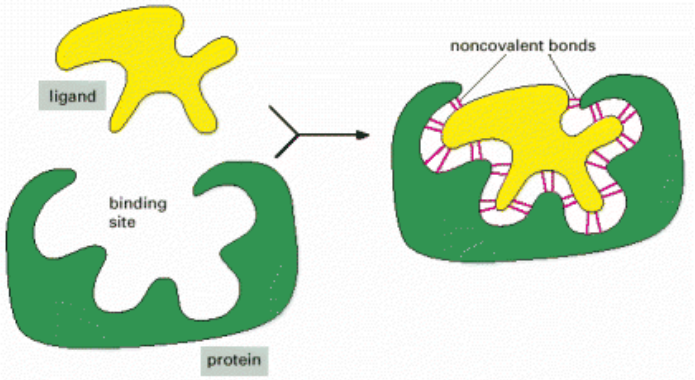


Figure 3-1
Molecular Cell Biology, Sixth Edition

Ligands

- Specific ligand binding makes function

Specificity



Affinity

Binding Reaction:

$$P + L \leftrightarrow PL$$

Dissociation Constant:

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

- Binding can induce conformational changes that lead to new 'abilities'

Dissociation Constant

- Tight:

  $K_d \leq 10^{-9}$ M

- Moderate

  $K_d \approx 10^{-6}$ M

- Weak:

  $K_d \geq 10^{-3}$ M

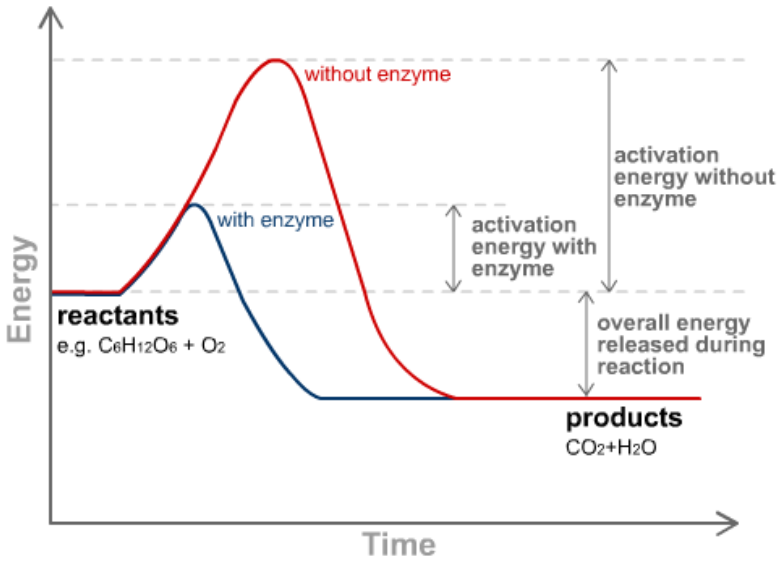
- Biotin-Avidin:

  $K_d \geq 10^{-15}$ M!

- Example
  - Consider a cell having
    - 10^3 molecules of protein P
    - 10^3 of molecules of ligand L
    - 1.66 x 10^{-12} L volume
  - If $K_d = 10^{-9}$ M, then at eq.
    - 270 molecules of P
    - 270 molecules of L
    - 730 molecules of PL
  - If $K_d = 10^{-8}$ M,
    - 915 molecules of P
    - 915 molecules of L
    - 85 molecules of PL

Enzymatic Function

- Enzymes – catalyze the rate of reactions inside a cell
- Substrates – ligands for enzymes that become the products of the reaction



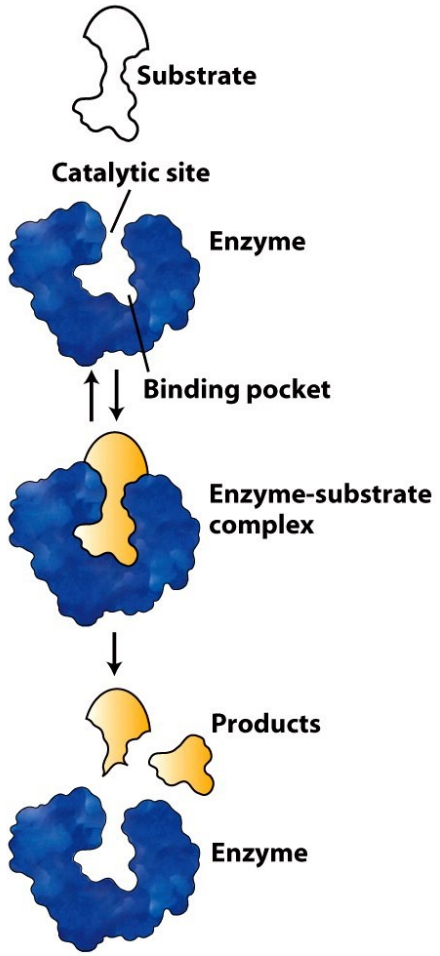


Figure 3-23
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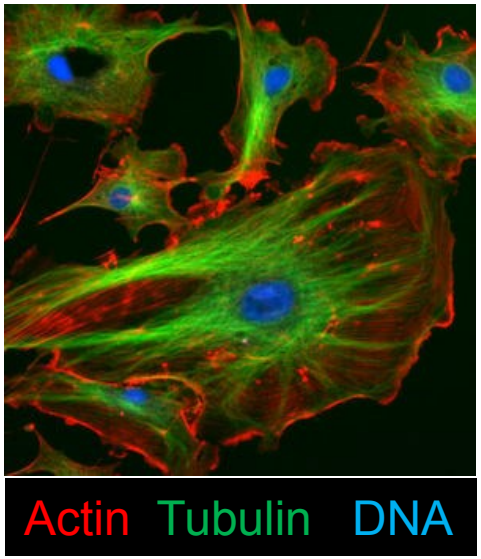
Structure



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

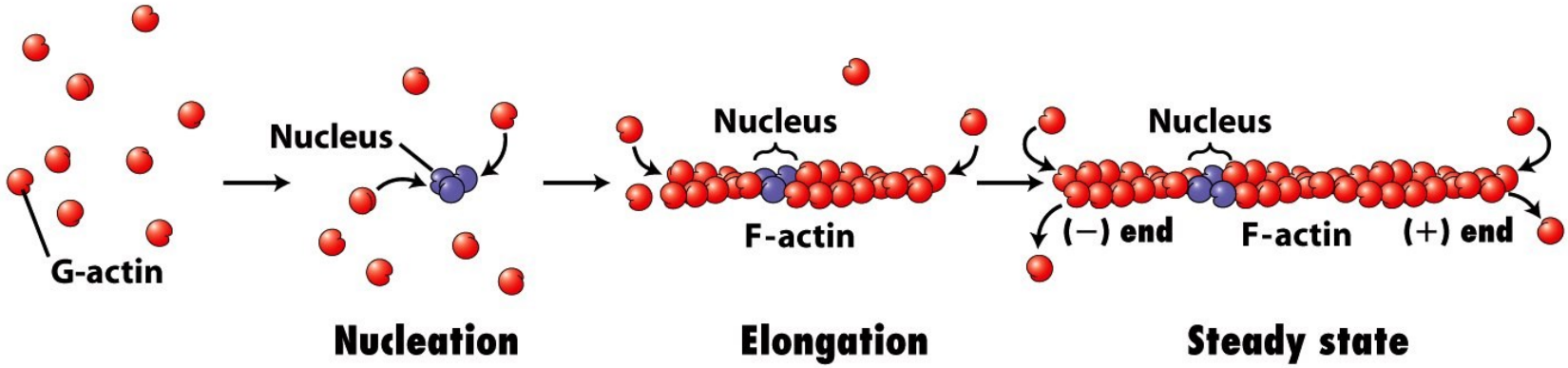


Figure 17-7a
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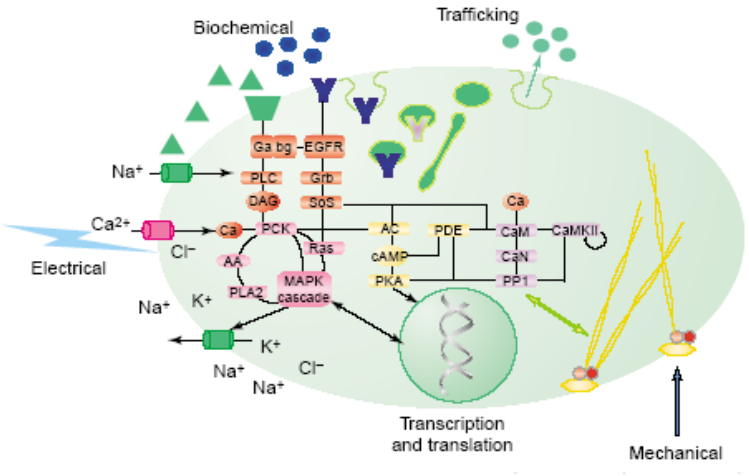
Signaling

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



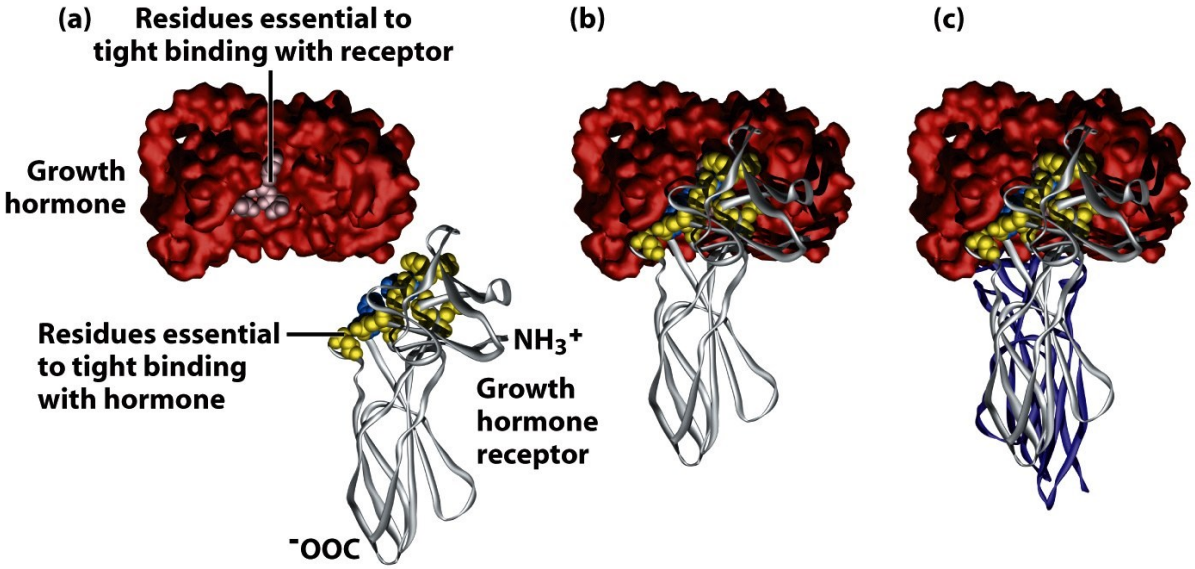


Figure 15-3
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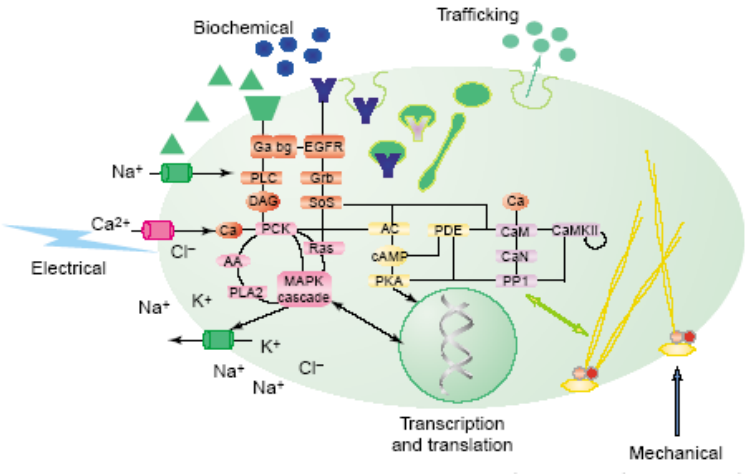
Co-receptor (blue)

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"



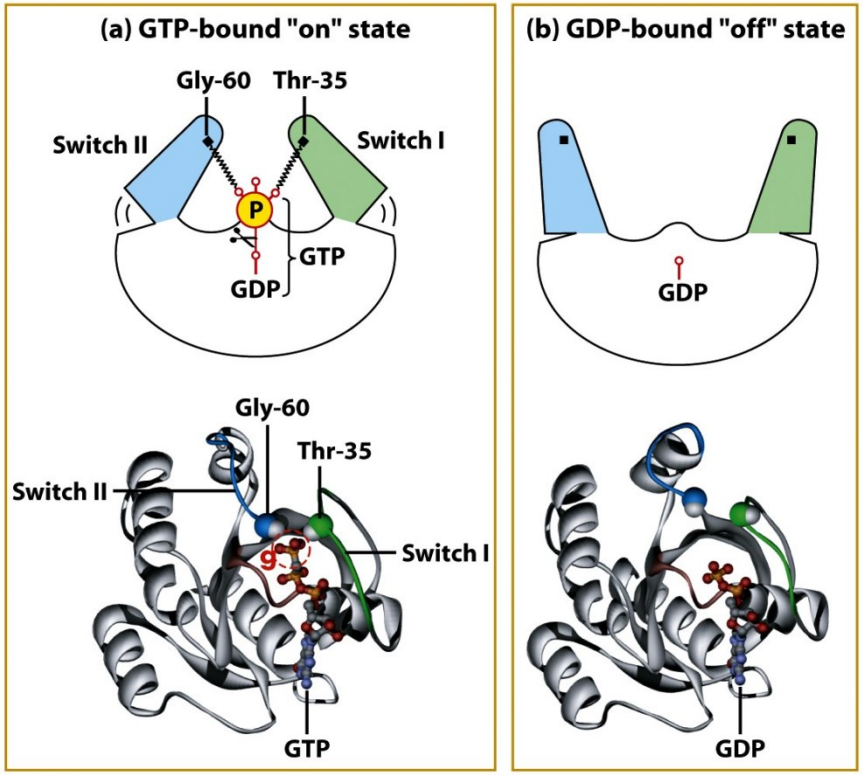


Figure 15-8
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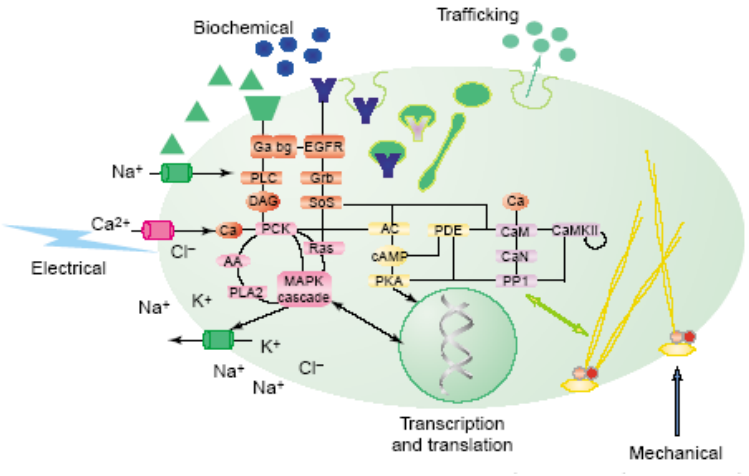
Transport

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



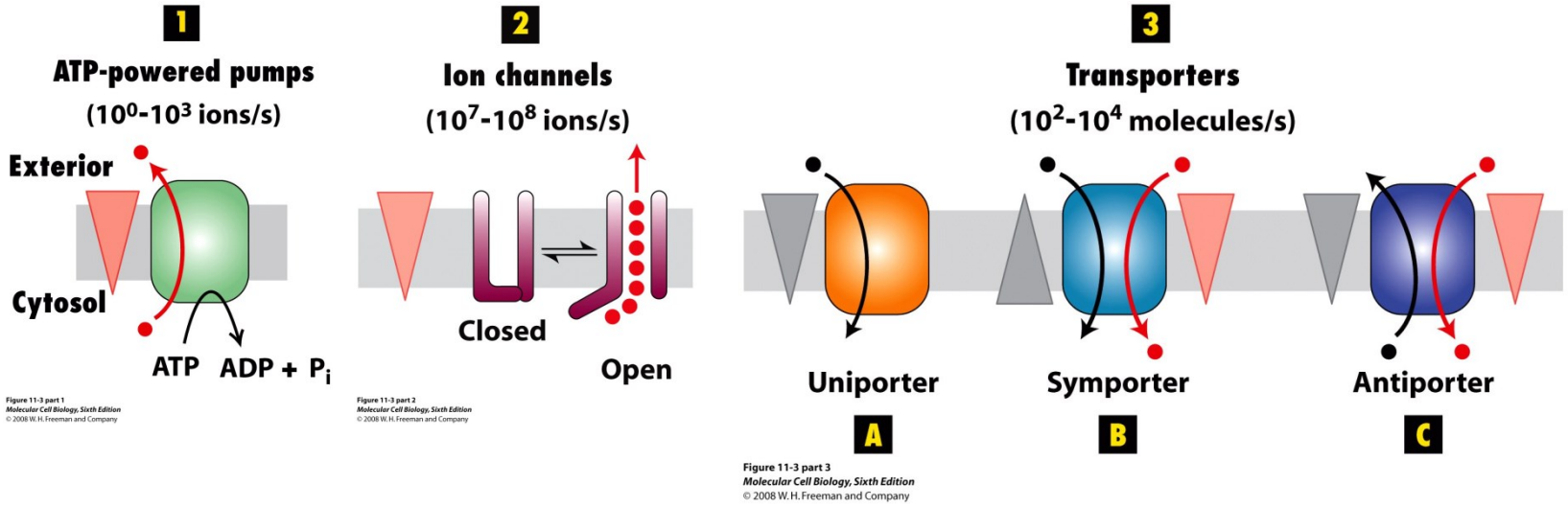


Figure 11-3 part 1
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Figure 11-3 part 2
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Figure 11-3 part 3
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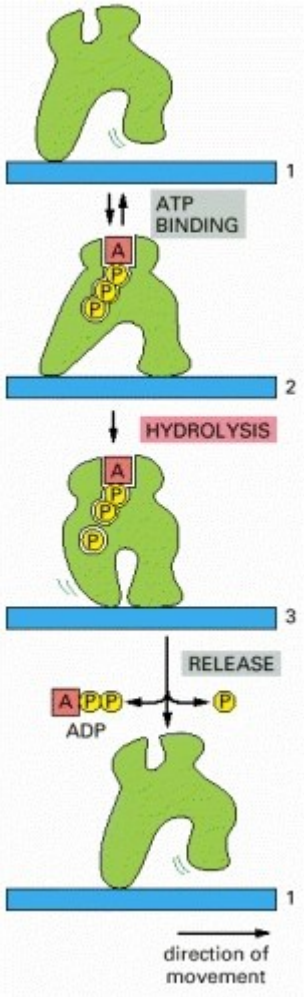
Motor Proteins

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



Questions ?