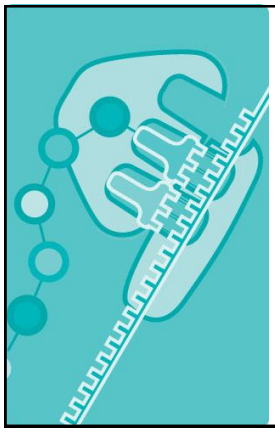


Chapter 3

Proteins

1

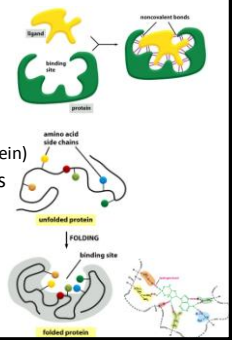
Cellular Functions of Proteins

Catalysts, signal receptors, switches, motors, pumps & more

2

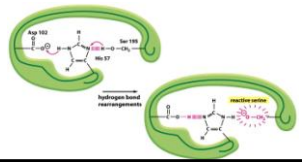
All Proteins Bind to Other Molecules

- Great specificity
- Ligand
  - Substance bound to protein
    - Ion
    - Small molecule
    - Macromolecule (another protein)
  - Binding relies on weak bonds
  - & hydrophobic interactions
- Binding site
  - Cavity
    - Specific arrangement of aa's



The Surface Conformation of a Protein Determines Its Chemistry

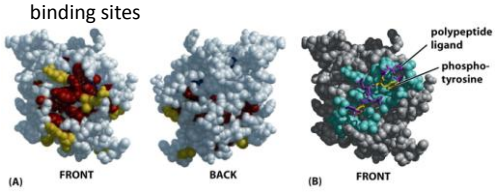
- Two main categories
  - Keep ligand-binding sites "dry"
  - Side chain positions
    - Increase affinity for oppositely charged ligand
    - Normally unreactive groups become reactive



4

Sequence Comparisons Between Protein Family Members Highlight Crucial Ligand-Binding Sites

- Domains crucial to function are usually conserved during evolution
  - Comparison of related proteins highlight potential binding sites

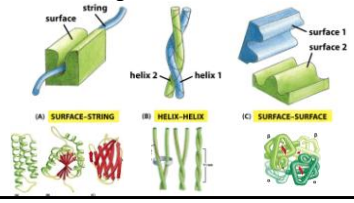


  - Decipher unknown proteins

5

Proteins Bind to Other Proteins Through Several Types of Interfaces

- Common types of binding
  - Extended loops
  - Coiled-coil
  - Surface matching



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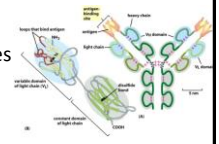
Antibody Binding Sites Are Especially Versatile

- Antibodies (immunoglobulin's)
  - Mark foreign molecules for destruction
- Antigen
  - Target recognized by antibodies
  - Billions
- Antibody diversity
  - Change length & sequence of antigen-binding sites (loops of protruding polypeptide)

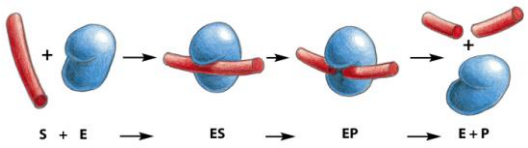


7

Will cover enzyme kinetics in Unit 3

- Important general concept

  E + S → ES → EP → E + P



8

Tightly Bound Small Molecules Add Extra Functions to Proteins

- Small molecules often form transient covalent bonds during reaction
- Coenzymes
  - Small organic molecules
  - Often obtained from vitamins

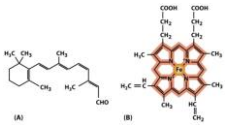


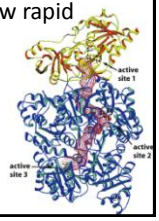
Table 3–2 Many Vitamins Provide Critical Coenzymes for Human Cells

VITAMIN	COENZYME	ENZYME-CATALYZED REACTIONS REQUIRING THESE COENZYMES
Thiamine (vitamin B_1)	thiamine pyrophosphate	activation and transfer of aldehydes
Riboflavin (vitamin B_2)	FADH	oxidation–reduction
Niacin	NADH, NADPH	oxidation–reduction
Pantothenic acid	coenzyme A	acyl group activation and transfer
Pyridoxine	pyridoxal phosphate	amino acid activation; also glycogen phosphorylase
Biotin	biotin	CO_2 activation and transfer
Lipoic acid	lipoamide	acyl group activation; oxidation–reduction
Folic acid	tetrahydrofolate	activation and transfer of single carbon groups
Vitamin B_{12}	cobalamin coenzymes	isomerization and methyl group transfers

9

Molecular Tunnels Channel Substrates in Enzymes with Multiple Catalytic Sites

- Intermediates
  - Unstable
  - Readily diffuse out of cell
- Tunnels connect active sites to allow rapid processing of intermediates



Multienzyme Complexes Help to Increase the Rate of Cell Metabolism

- Reaction rate faster than rate of decay
  - ATP use
    - 1-2 min turn over
    - 10^7 per second
    - 1 gram per min
- Optimized enzymes
  - Diffusion-limited
- Multienzyme complexes
  - Products directly passed to next enzyme
- Compartmentalization

11

Many Changes in Proteins Are Driven by Protein Phosphorylation

- Affect of phosphorylation
  - Conformational change
  - Phosphate group becomes part of binding site

12

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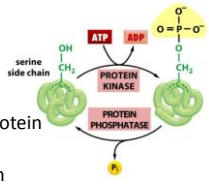
A Eucaryotic Cell Contains a Large Collection of Protein Kinases and Protein Phosphatases

- Phosphorlyation
  - Terminal phosphate from ATP
  - To hydroxyl group in side chain
    - Serine, threonine, tyrosine
- Protein kinase
  - Moves phosphate from ATP to protein
- Protein phosphatase
  - Removes phosphate from protein
    - Dephosphorylation
- Kinases and phosphatases can be general or very specific



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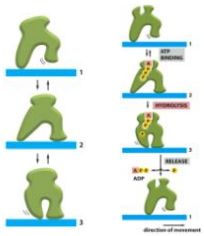
Motor Proteins Produce Large Movements in Cells

- Movement
  - Muscle contraction
  - Crawling
  - Swimming
  - Chromosomes
  - Organelles
  - Enzymes
- Conformational changes driven by ATP hydrolysis



14

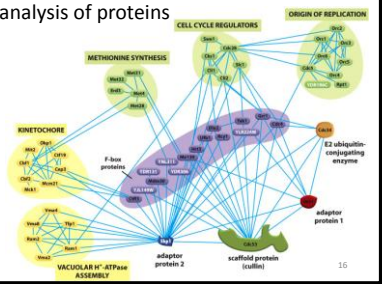
Proteins Often Form Large Complexes That Function as Protein Machines

- Central cell processes
  - DNA replication
  - Protein synthesis
  - Vesicle budding
  - Transmembrane signaling
- Linked sets of >10 proteins
  - Driven by ATP (or GTP) hydrolysis

15

A Complex Network of Protein Interactions Underlies Cell Function

- Proteomics
  - Large scale analysis of proteins



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