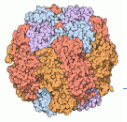
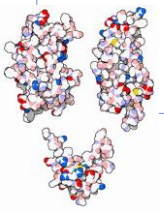
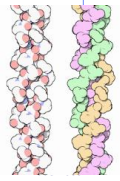
Proteins






Proteins



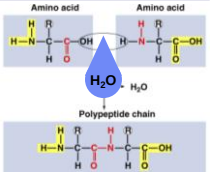
Multipurpose molecules

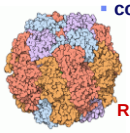
Proteins

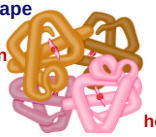
- Most structurally & functionally diverse group
- Function: involved in almost everything
  - enzymes (pepsin, DNA polymerase)
  - structure (keratin, collagen)
  - carriers & transport (hemoglobin, aquaporin)
  - cell communication
    - signals (insulin & other hormones)
    - receptors
  - defense (antibodies)
  - movement (actin & myosin)
  - storage (bean seed proteins)

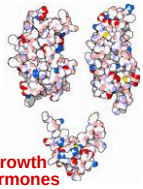
Proteins

- Structure
  - monomer = amino acids
    - 20 different amino acids
  - polymer = polypeptide
    - protein can be one or more polypeptide chains folded & bonded together
    - large & complex molecules
    - complex 3-D shape



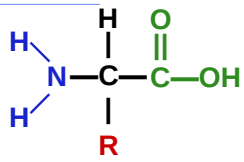

Rubisco

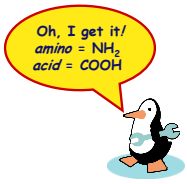

hemoglobin


growth hormones

Amino acids

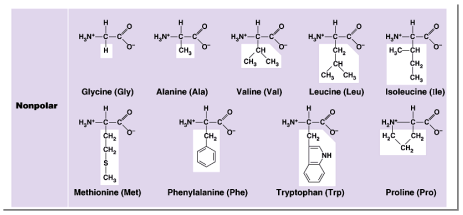
- Structure
  - central carbon
  - amino group
  - carboxyl group (acid)
  - R group (side chain)
    - variable group
    - different for each amino acid
    - confers unique chemical properties to each amino acid
      - like 20 different letters of an alphabet
      - can make many words (proteins)





Effect of different R groups: Nonpolar amino acids

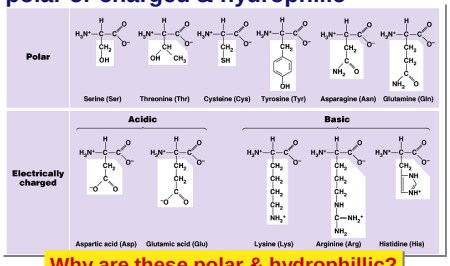
- nonpolar & hydrophobic



Why are these nonpolar & hydrophobic?

Effect of different R groups: Polar amino acids

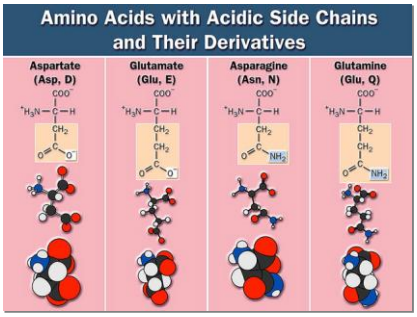
- polar or charged & hydrophilic



Why are these polar & hydrophillic?

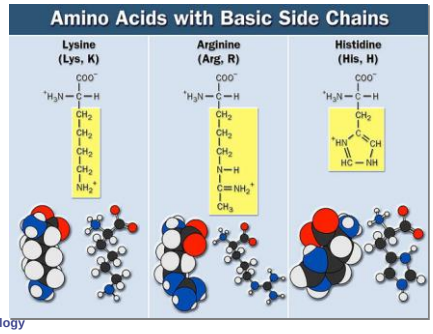
Ionizing in cellular waters

H+ donors



Ionizing in cellular waters

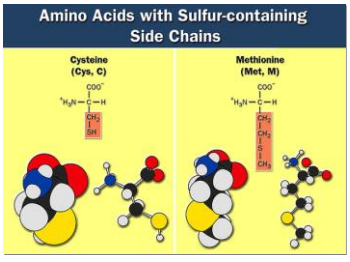
H+ acceptors



Sulfur containing amino acids

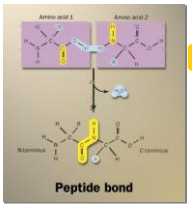
- Form <u>disulfide bridges</u>
  - covalent cross links betweens sulfhydryls
  - stabilizes 3-D structure

H-S – S-H

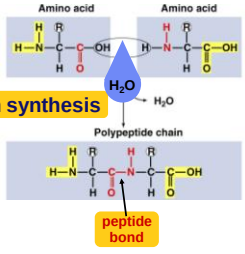


Building proteins

- <u>Peptide bonds</u>
  - covalent bond between NH_2 (amine) of one amino acid & COOH (carboxyl) of another
  - C–N bond

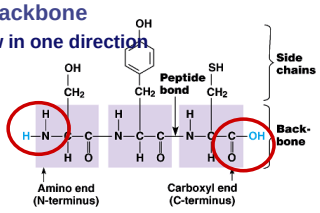


dehydration synthesis



Building proteins

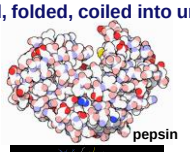
- Polypeptide chains have direction
  - <u>N-terminus</u> = NH_2 end
  - <u>C-terminus</u> = COOH end
  - repeated sequence (N-C-C) is the polypeptide backbone
    - can only grow in one direction



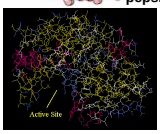
Protein structure & function

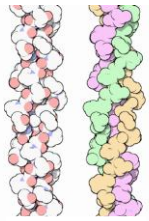
- Function depends on structure
  - 3-D structure
    - twisted, folded, coiled into unique shape

hemoglobin



pepsin

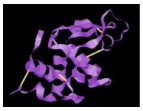


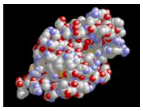


collagen

Primary (1°) structure

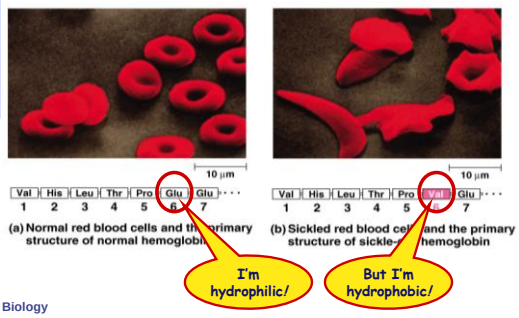
- Order of amino acids in chain
  - amino acid sequence determined by gene (DNA)
  - slight change in amino acid sequence can affect protein's structure & its function
    - even just one amino acid change can make all the difference!





lysozyme: enzyme in tears & mucus that kills bacteria

Sickle cell anemia

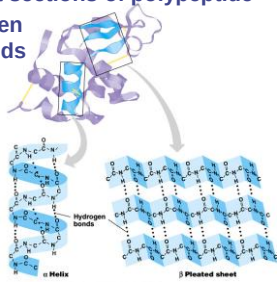


(a) Normal red blood cells and the primary structure of normal hemoglobin

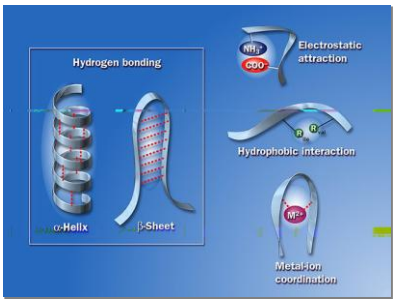
(b) Sickled red blood cells and the primary structure of sickle-cell hemoglobin

Secondary (2°) structure

- "Local folding"
  - folding along short sections of polypeptide
  - interactions between adjacent amino acids
    - H bonds
      - weak bonds between R groups
  - forms sections of 3-D structure
    - α-helix
    - β-pleated sheet

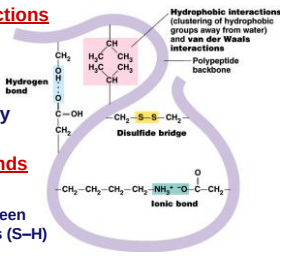


Secondary (2°) structure



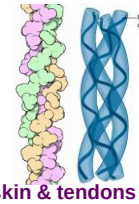
Tertiary (3°) structure

- "Whole molecule folding"
  - interactions between distant amino acids
    - hydrophobic interactions
      - cytoplasm is water-based
      - nonpolar amino acids cluster away from water
    - H bonds & ionic bonds
    - disulfide bridges
      - covalent bonds between sulfurs in sulfhydryls (S–H)
      - anchors 3-D shape

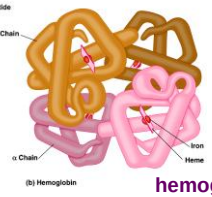


Quaternary (4°) structure

- More than one polypeptide chain bonded together
  - only then does polypeptide become functional protein
    - hydrophobic interactions

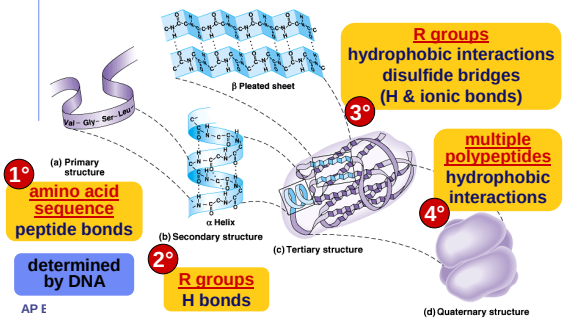


collagen = skin & tendons



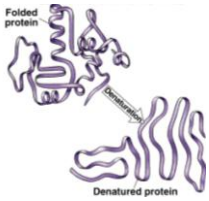
hemoglobin

Protein structure (review)



Protein denaturation

- Unfolding a protein
  - conditions that disrupt H bonds, ionic bonds, disulfide bridges
    - temperature
    - pH
    - salinity
  - alter 2° & 3° structure
    - alter 3-D shape
  - destroys functionality
    - some proteins can return to their functional shape after denaturation, many cannot



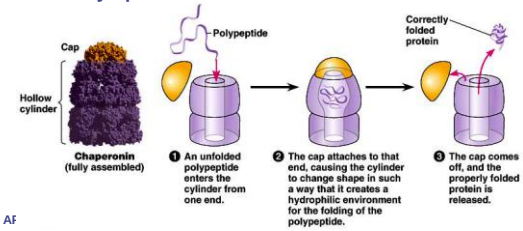
EAT

Let's build some Proteins!

Oh, One more thing…

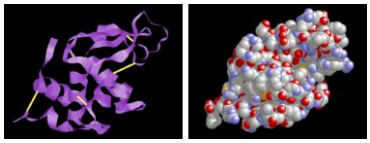
Chaperonin proteins

- Guide protein folding
  - provide shelter for folding polypeptides
  - keep the new protein segregated from cytoplasmic influences



Protein models

- Protein structure visualized by
  - X-ray crystallography
  - extrapolating from amino acid sequence
  - computer modelling



lysozyme