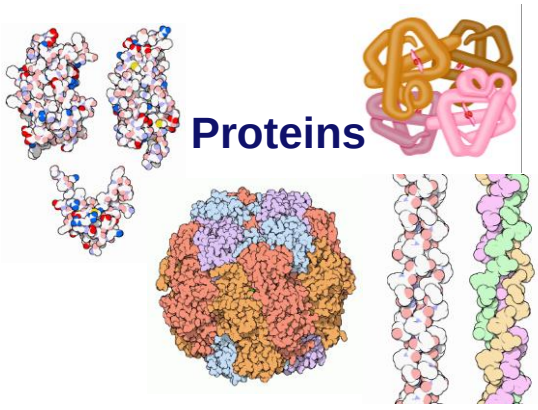
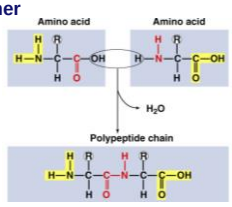


Proteins

- Most structurally & functionally diverse group of biomolecules
- Functions:
  - involved in almost everything
    - enzymes
    - structure (keratin, collagen)
    - carriers & transport (membrane channels)
    - receptors & binding (defense)
    - contraction (actin & myosin)
    - signaling (hormones)

Proteins

- Structure:
  - monomer = amino acids
    - 20 different amino acids
  - polymer = polypeptide
    - protein can be 1 or more polypeptide chains folded & bonded together
    - large & complex molecules
    - complex 3-D shape

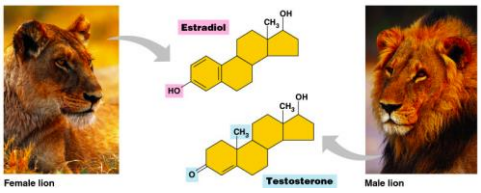


Types of functional groups

- 6 functional groups most important to chemistry of life:
  - hydroxyl
  - carbonyl
  - carboxyl
  - amino
  - sulfhydryl
  - phosphate
- Affect reactivity
  - hydrophilic
  - increase solubility in water

Viva la difference!

- Basic structure of male & female hormones is identical
  - identical C skeleton
  - attachment of different functional groups
  - interact with different targets in the body



Hydroxyl

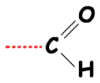
····OH

- –OH
  - organic compounds with OH = alcohols
  - names typically end in *-ol*
    - ethanol

Table 4.1 Functional Groups of Organic Compounds

Functional Group	Formula	Name of Compounds	Example
Hydroxyl	—OH	Alcohols	Ethanol (the drug of alcoholic beverages)

Carbonyl

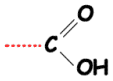


- C=O
  - O double bonded to C
    - if C=O at end molecule = aldelhyde
    - if C=O in middle of molecule = ketone

Table 4.1 Functional Groups of Organic Compounds

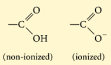
Functional Group	Formula	Name of Compounds	Example
Carbonyl		Aldehydes	 Propanal
		Ketones	 Acetone

Carboxyl

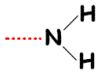


- –COOH
  - C double bonded to O & single bonded to OH group
    - compounds with COOH = acids
      - fatty acids
      - amino acids

Table 4.1 Functional Groups of Organic Compounds

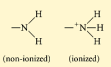
Functional Group	Formula	Name of Compounds	Example
Carboxyl	 (non-ionized) (ionized)	Carboxylic acids	 Acetic acid* (the acid of vinegar)

Amino



- -NH_2
  - N attached to 2 H
    - compounds with NH_2 = amines
      - amnio acids
    - NH_2 acts as base
      - ammonia picks up H^+ from solution

Table 4.1 Functional Groups of Organic Compounds

Functional Group	Formula	Name of Compounds	Example
Amino	 (non-ionized) (ionized)	Amines	 Glycine*

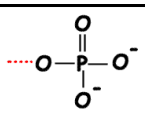
Sulfhydryl

- –SH
  - S bonded to H
    - compounds with SH = thiols
    - SH groups stabilize the structure of proteins

Table 4.1 Functional Groups of Organic Compounds

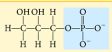
Functional Group	Formula	Name of Compounds	Example
Sulfhydryl	—SH	Thiols	 Ethanethiol

Phosphate



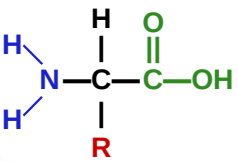
- –PO_4
  - P bound to 4 O
    - connects to C through an O
    - PO_4 are anions with 2 negative charges
    - function of PO_4 is to transfer energy between organic molecules (ATP)

Table 4.1 Functional Groups of Organic Compounds

Functional Group	Formula	Name of Compounds	Example
Phosphate		Organic phosphates	 Glycerol phosphate

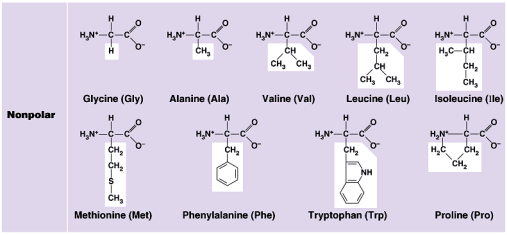
Amino acids

- Structure:
  - central carbon
  - amino group
  - carboxyl group (acid)
  - R group (side chain)
    - variable group
    - confers unique chemical properties of the amino acid



Nonpolar amino acids

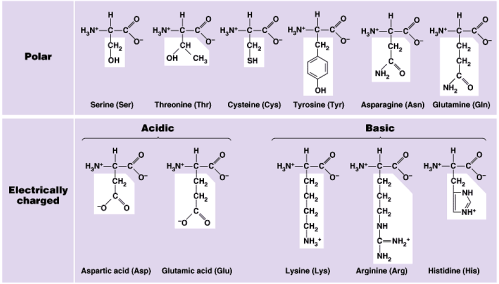
- nonpolar & hydrophobic



Why are these nonpolar & hydrophobic?

Polar amino acids

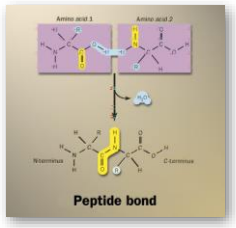
- polar or charged & hydrophilic

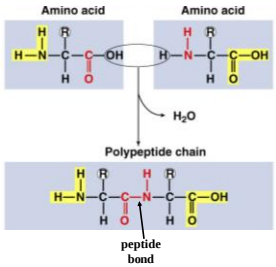


Why are these polar & hydrophillic?

Building proteins

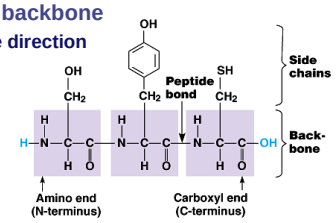
- Peptide bonds: dehydration synthesis
  - linking NH_2 of 1 amino acid to COOH of another
  - C–N bond





Building proteins

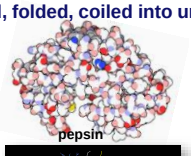
- Polypeptide chains
  - N-terminal = NH_2 end
  - C-terminal = COOH end
  - repeated sequence (N-C-C) is the polypeptide backbone
    - grow in one direction

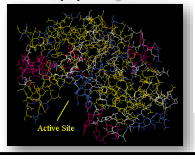


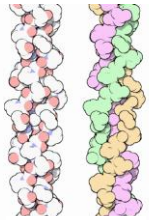
Protein structure & function

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


hemoglobin

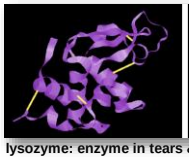

pepsin

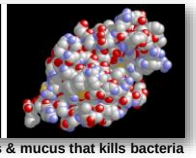



collagen

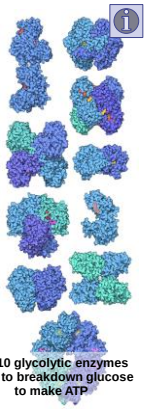
Protein structure & function

- function depends on structure
  - all starts with the order of amino acids
    - what determines that order of amino acids?





lysozyme: enzyme in tears & mucus that kills bacteria



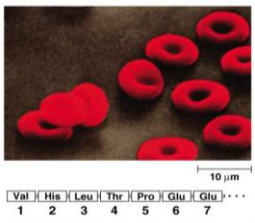
the 10 glycolytic enzymes used to breakdown glucose to make ATP

Primary (1°) structure

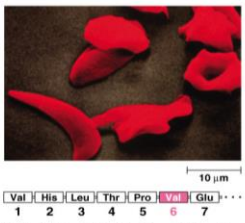
- Order of amino acids in chain
  - amino acid sequence determined by DNA
  - slight change in amino acid sequence can affect protein's structure & it's function
    - even just one amino acid change can make all the difference!

Tell 'em about the Colonie Youth in a lineup!

Primary (1°) structure: Sickle cell anemia



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

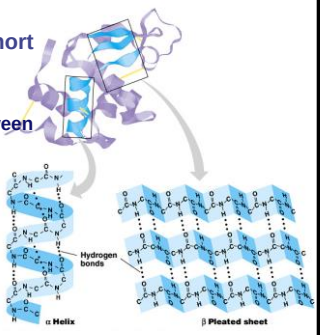


(b) Sickled red blood cells and the primary structure of sickle-cell hemoglobin

Just one "letter" change in the DNA causes a different amino acid to be positioned… Valine instead of Glutamic Acid.

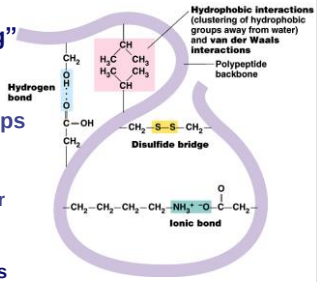
Secondary (2°) structure

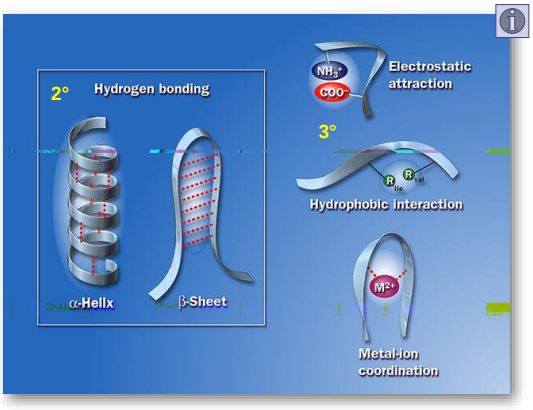
- "Local folding"
  - folding along short sections of polypeptide
    - interaction between adjacent amino acids
    - H bonds in backbone
    - α-helix
    - β-pleated sheet



Tertiary (3°) structure

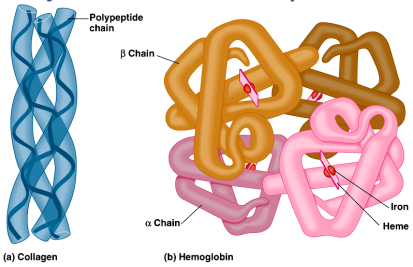
- "Global (whole molecule) folding"
  - determined by interactions between R groups
    - hydrophobic interactions
      - effect of water in cell
    - anchored by disulfide bridges (H & ionic bonds)





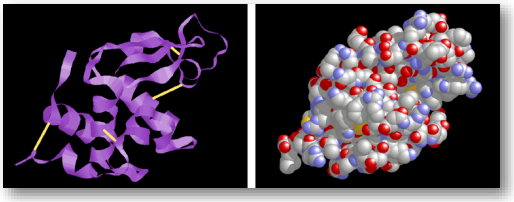
Quaternary (4°) structure

- Joins together more than 1 polypeptide chain
  - only then is it a functional protein



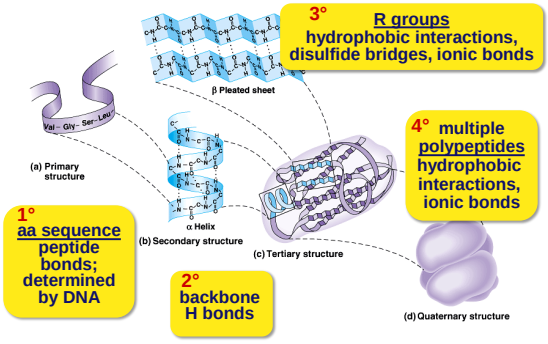
Protein models

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



lysozyme

Protein structure (review)



Denature a protein

- Disrupt 3° structure
  - pH
  - temperature
  - salt
  - unravel or denature protein
  - disrupts H bonds, ionic bonds & disulfide bridges
- Some proteins can return to their functional shape after denaturation, many cannot!