**Protein functions:**
- enzymes
- regulation
- receptor
- structure
- transport
- defense
- hormone
- storage

**DEFINITION OF PROTEIN:** Linear polymer of amino acids, connected by peptide bonds

Amino acids have one asymmetric carbon, levorotary = “L”. (“D” AAs in odd peptides, eg: peptidoglycan)

**Drawn:** vertical groups point away, horizontal groups toward: NH₂ left, COOH right, functional group below

All are zwitterions. (STUDENTS: Use model kits to construct amino acids: 4 H; 2 C; 2 O, 1 N; 1 “R” = silver.)

Properties of AAs depend on side chain (R group)
- 8 are hydrocarbon, thus hydrophobic
- 7 contain O, N or S (nonionized) polar
- 5 have either -COOH or -NH₂ ionic

Proteins unidirectional, N terminal to C terminus, joined by peptide bonds (dehydration condensation, p 45)

Read 2nd paragraph p 32 for summary of self assembly.

**Protein structure:**
- **primary:** Linear sequence of amino acids (sequence determines everything else) (p 48 for insulin)
- **secondary:** local interactions: H bonding between peptide bonds, not side chains. Highly predictable. α helix à la Pauling and Corey, 1951 (p 49), keratin, β pleated sheet: fibroin in silk, troughs and peaks fibrous proteins have repeating structure, helix and pleated

See excellent 3D demo of example proteins:
- ribonuclease = http://www.pdb.org/pdb/explore/jmol.do?structureId=5RSA&bionumber=1
- collagen = http://www.pdb.org/pdb/explore/jmol.do?structureId=1k6f&bionumber=1
- hexokinase = http://www.pdb.org/pdb/explore/jmol.do?structureId=2yhx&bionumber=1

- **tertiary:** depends on side chains, non-repetitive: (p. 45)
  - H bonds, ionic bonds, hydrophobic bonds, disulfide not easily predictable
  - disulfide bridges: rearrange for permanent wave:
    - 1 reduce
    - 2 set
    - 3 oxidize
globular proteins rely more on tertiary

- **quaternary:** multimeric proteins, above 50,000 MW same forces determine 4th level as third.

**Self Assembly** In water, the protein spontaneously folds itself:

Folded structure is critical for the properties of the protein.

Disrupted protein structure = denatured, often makes protein insoluble
- heat/cold: cook eggs, bake a roast (blood gels and turns brown)
- acid: cerviche, pickled meats
- salts: salami, etc

Example of ricotta: acidification, bring to near boiling, albumin ppt.
STUDENTS BUILD AMINO ACIDS
28 August 2013

Each student pick up:
2 carbons (black)
2 oxygens (red)
4 hydrogens (white)
1 nitrogen (blue)
1 "reactive group" (purple)
4 large bonds
2 flexible bonds
4 stubby bonds

Build these amino acids with shown side chains (2-3 students cooperate):

Non-POLAR (hydrophobic):
glycine R-H
alanine R-CH₃
phenylalanine R-C₆H₅

Polar (form hydrogen bonds, hydrophilic):
serine R-CH₂OH
cysteine R-CH₂SH (substitute S for O in serine)
tyrosine R-C₆H₄OH (add -OH to a phenylalanine)

Ionic (form ionic bonds, charge affected by pH):
aspartic acid R-CH₂-COOH
lysine R-CH₂CH₂CH₂CH₂-NH₂

Join two amino acids by dehydration condensation reaction to form a peptide bond.