MCB 150

Proteins, Part 2;
Begin Energy & Enzymes

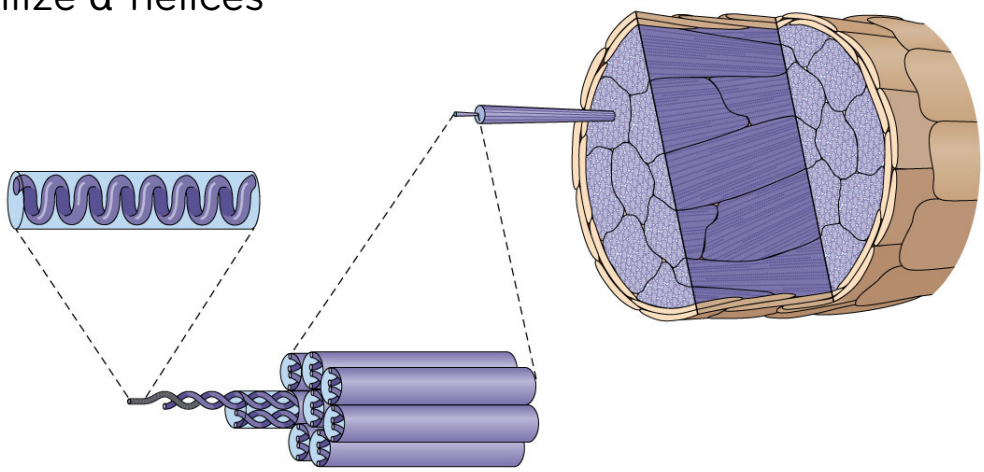
Today's Learning Catalytics Session ID is:
75478146

Announcements:

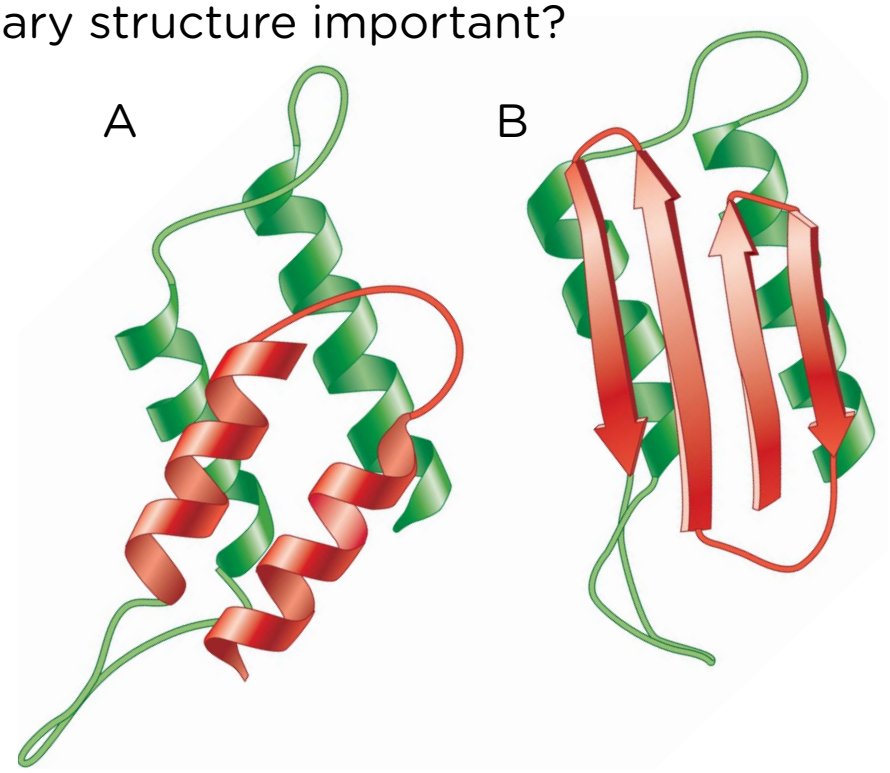
- Exam I is Thursday, February 8, from 7:00–9:00 PM
  - Check Canvas or your TA for room assignments
  - Fill out Conflict Exam Request Form by Monday at 5:00 PM
  - Practice Exam problems include material (cellular respiration) that we will not cover until Exam 2

Is secondary structure important?

- Hair protein (keratin) is very rich in α-helical structures
  - Hair stretches because it is easy to break the H-bonds that stabilize α-helices

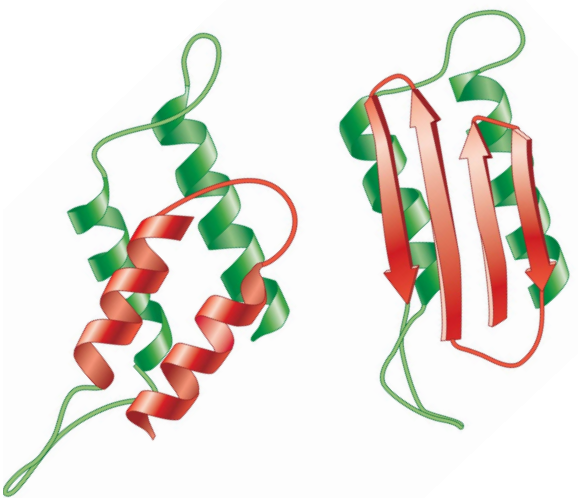


Is secondary structure important?



Prions

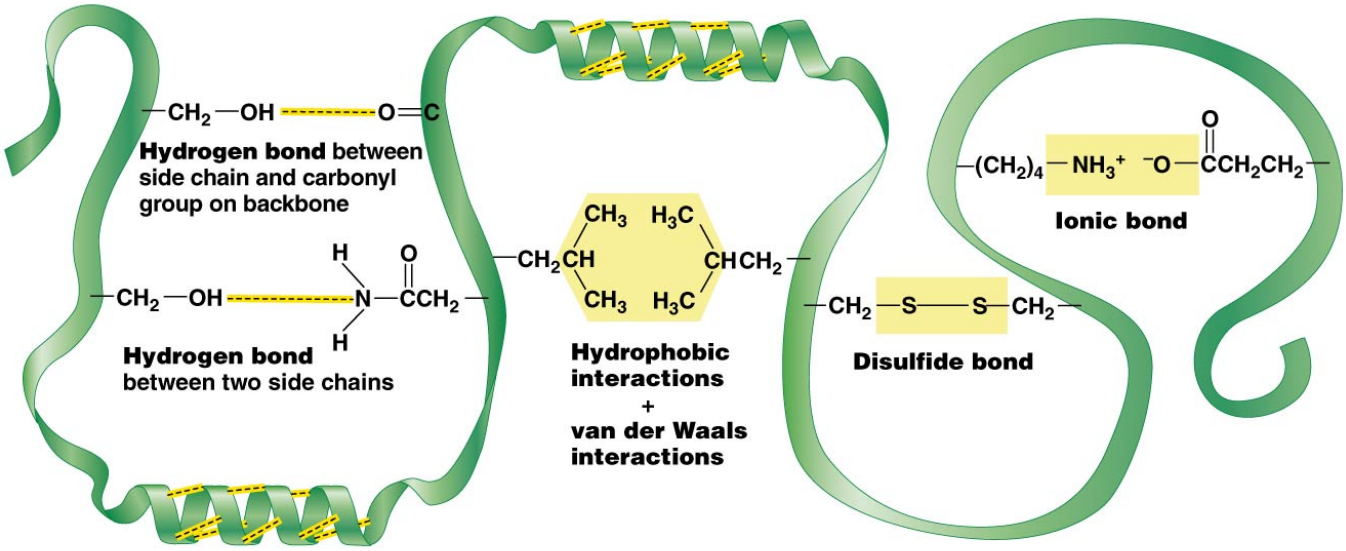
- Misfolded proteins which somehow induce normal versions of that protein to fold the same (incorrect) way
- Misfolded protein comes out of solution, creates plaques
- Causes family of diseases called spongiform encephalopathies like Mad Cow, Scrapies, and Creutzfeldt-Jakob



Tertiary Structure (3°):

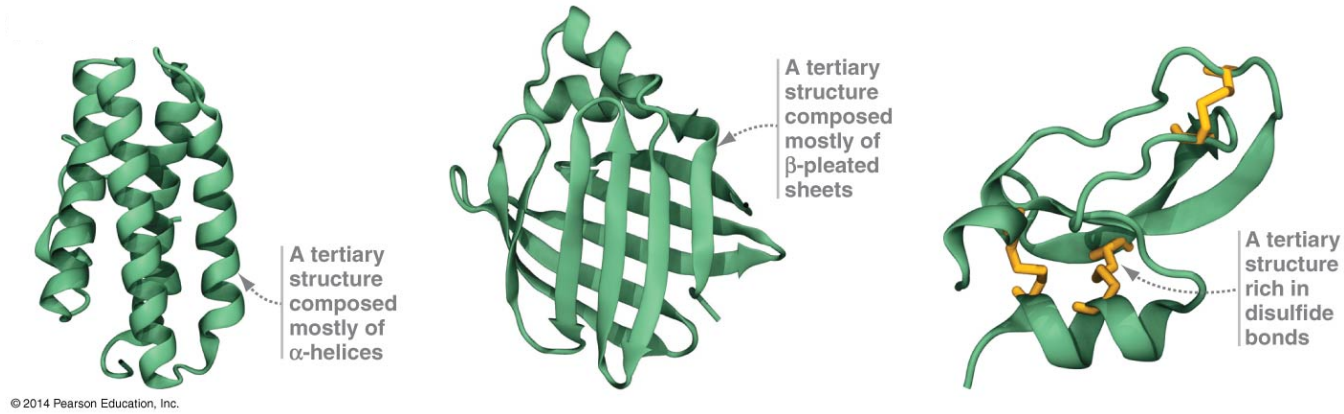
- Unique 3D folded structure
- Final conformation of some proteins
- Due to interactions between R-groups with each other and with backbone
- Stabilized by:
  - H-bonds between polar (or charged) side chains
  - H-bonds between hydrophilic side chains and backbone
  - Ionic bond between an acidic and a basic amino acid
  - Hydrophobic clustering of non-polar side chains
  - Van der Waals forces
  - Disulfide linkages

Tertiary Structure (3°):



Tertiary Structure (3°):

- Thousands of water molecules surround a protein, contorting the protein so that its hydrophilic R groups are on outside and hydrophobic R groups are on inside
- Line up sites for functional activity of that protein



Quaternary Structure (4°):

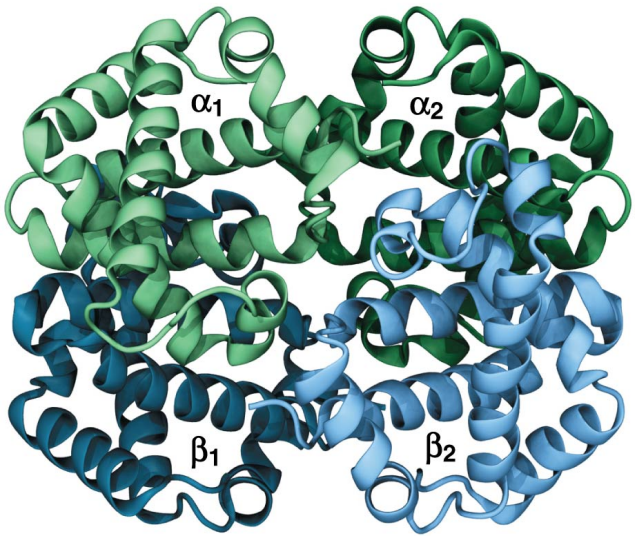
- Found in proteins with multiple polypeptide chains (subunits)
- Subunits can be same or different
  - 2 identical subunits = homodimer
  - 2 different subunits = heterodimer

Cro protein from an *E. coli* virus

- Ferritin (iron storage protein) has 24 identical subunits

Quaternary Structure (4°):

- Hemoglobin (Hb)
  - 4 separate polypeptides (2 α and 2 β chains)
  - Sickle Cell mutation
    - ❖ changes a Glu (HydroPHILIC) to a Val (HydroPHOBIC)
    - ❖ affected amino acid is on outside of protein
    - ❖ Hb molecules stick together to "hide" Val from water
    - ❖ oxygen levels fall, Hb precipitates, distorts RBC



Relative stabilities of biomolecular forces:

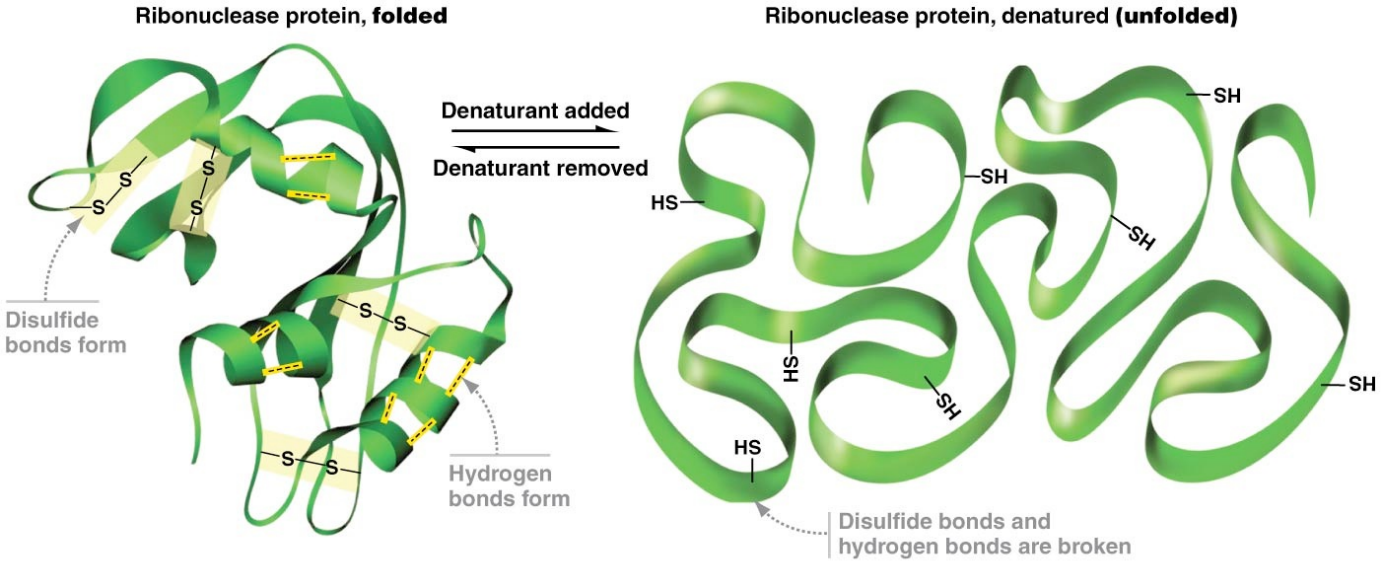
- Disulfide linkages → Covalent
- Ionic bonds → Easily made and broken
- Hydrogen bonds
- Hydrophobic clusters
- Van der Waals forces

Does the information for how a protein will fold lie in its primary structure?

- How could we determine this?

Removal or inactivation of stabilizing forces unfolds (**denatures**) the protein to 1° structure, but no peptide bonds are broken

- All 2° and 3° structure is lost
- Almost always leads to loss of function
- Acids/bases, heat, detergents



If denaturing agent is removed, some proteins will resume properly folded 3D structure

- "instructions" are in 1° structure

Many proteins are **enzymes**: biological catalysts; they facilitate biological reactions

- This is necessary because most cellular reactions proceed at a very slow rate

Two broad categories of cellular reactions based on change in energy level (E):

- Reactions that **require** an input of energy
- Reactions that **release** energy upon completion

Reactions that *require* energy are called **biosynthetic** or **anabolic**

- Linking together of smaller molecules into larger ones, such as condensation reactions of monomers to macromolecules

Reactions that *release* energy are called **catabolic**

- Break down larger molecules into smaller ones, such as the hydrolysis reactions of macromolecules to monomers
- Also referred to as **spontaneous** reactions

2 different meanings for the word **spontaneous**:

- Typical meaning: happens automatically
- Biology meaning: a reaction that *releases energy*, much of which is lost as heat
- If the meanings were equivalent, what would happen?

Catabolic (E–releasing) reactions require a certain amount of energy to get started

- **Energy of Activation**, or E_a
- Could come from heat, but why not? [Learning Catalytics]
- Instead, comes from Enzymes