



Cooking with proteins

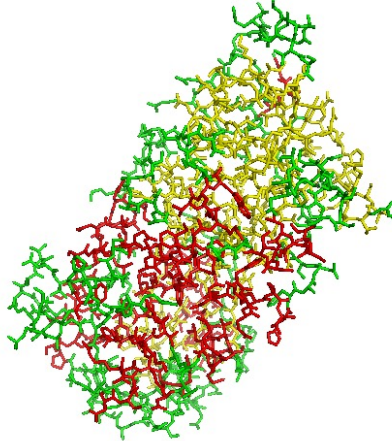
## Denaturation and Coagulation



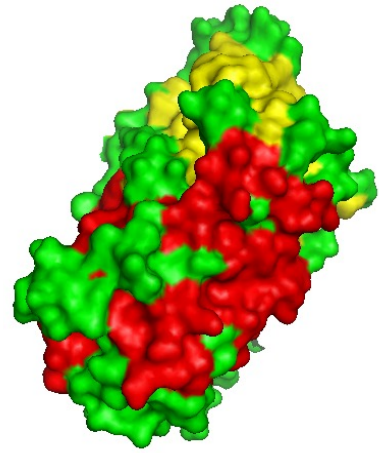
## Representing protein structure



The shape the backbone takes



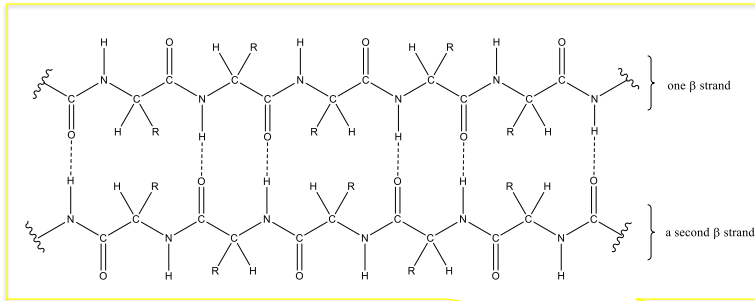
A line drawing of all the atoms



The amount of space the atoms actually take up

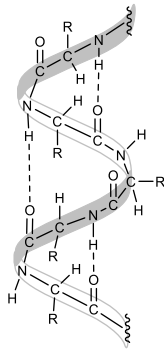


## Chains of amino acids can form organized secondary structure

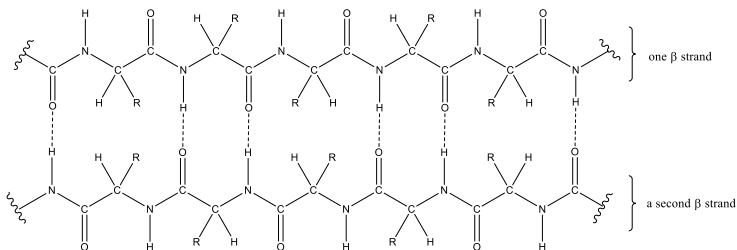
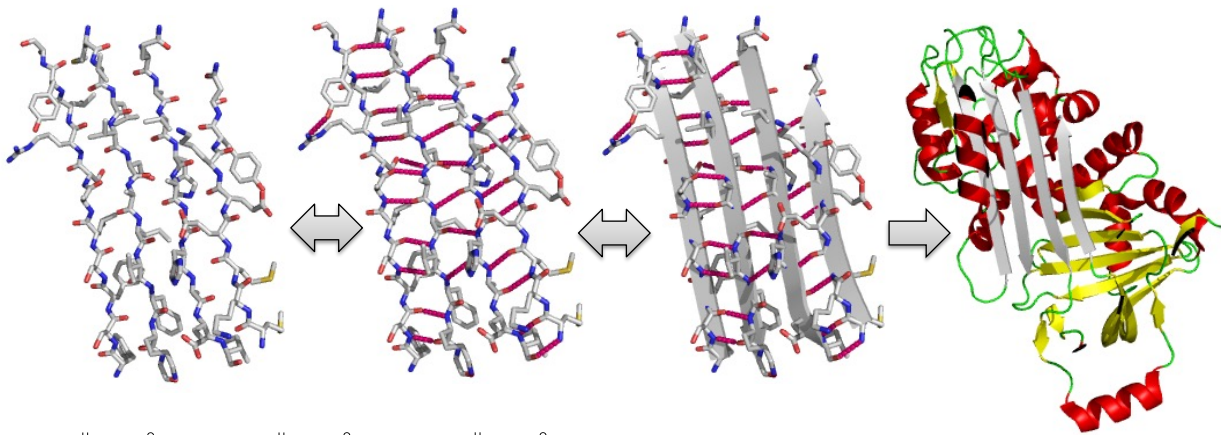


What are these two types of secondary structure called?

**alpha helix and beta strand**

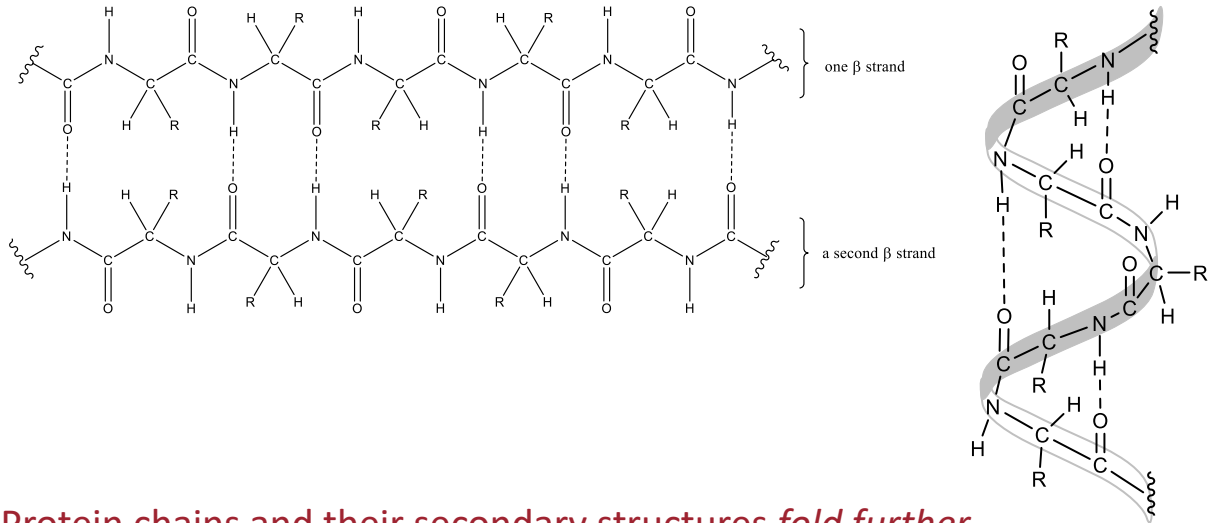


## $\beta$ -strands combine into $\beta$ - sheets





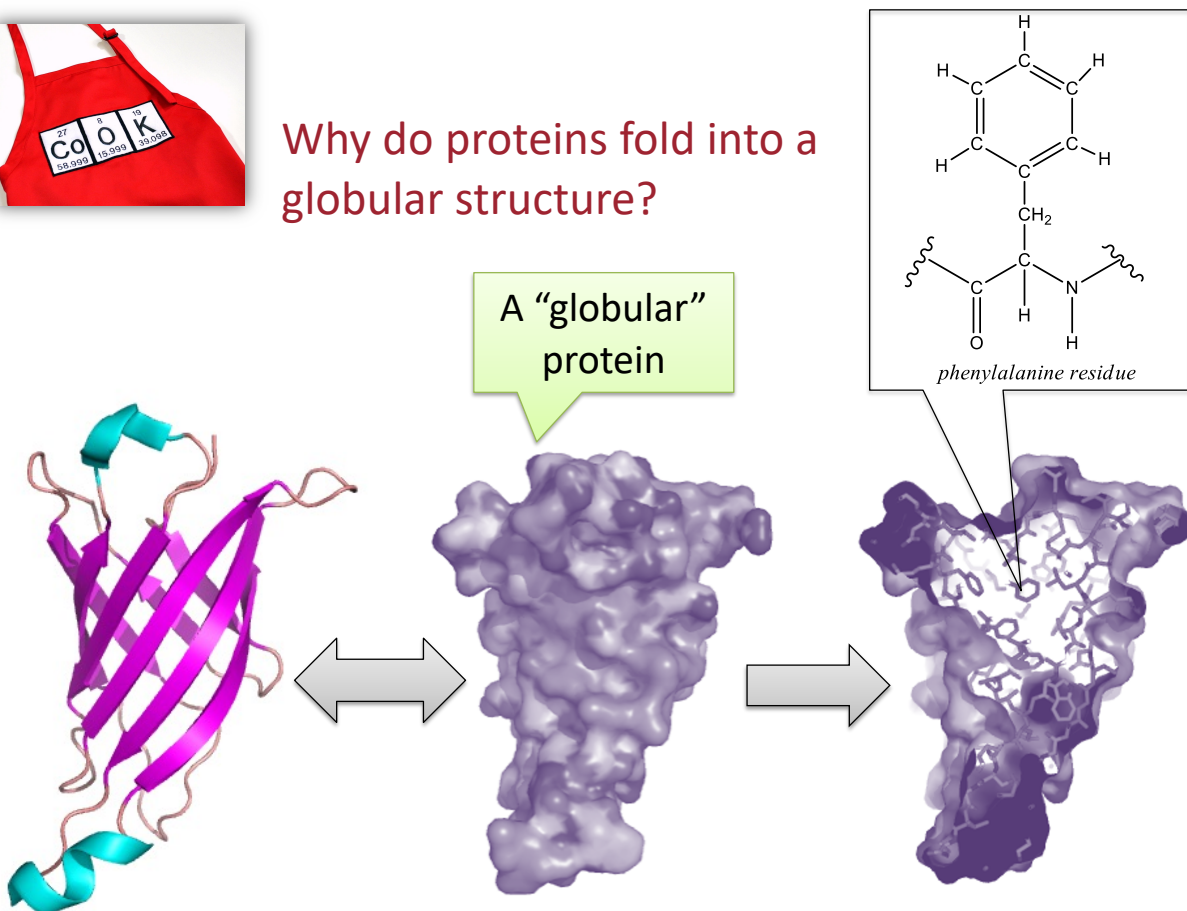
# Alpha helices and beta strands are held together with *hydrogen bonds*



Protein chains and their secondary structures *fold further* into 3-D globs of tertiary structure

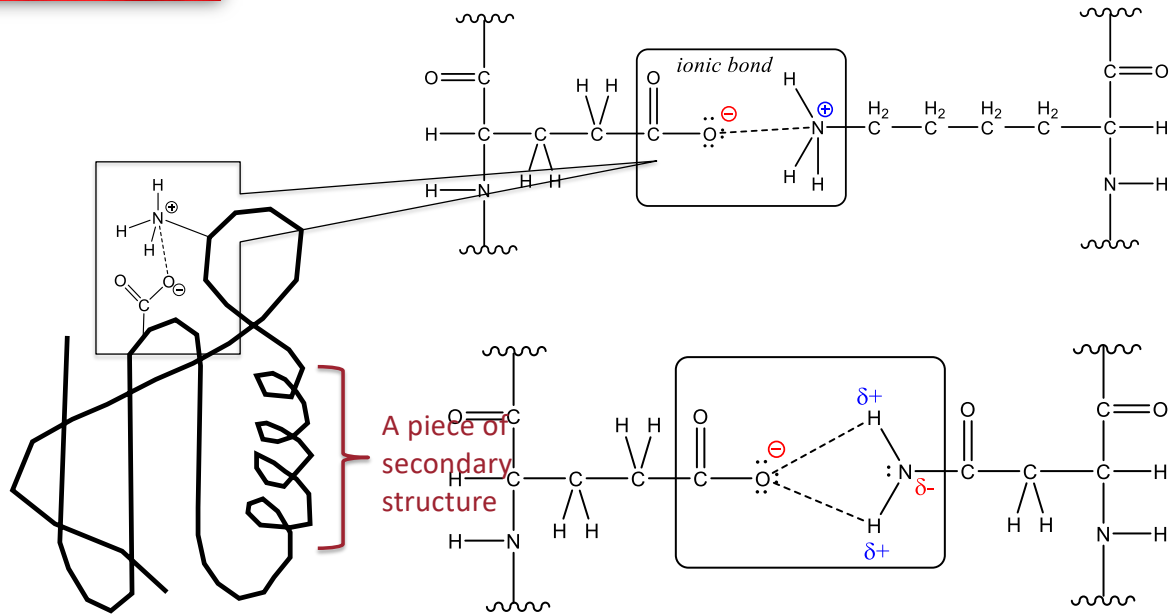


Why do proteins fold into a globular structure?





**3-D protein structure can also be held together by interactions of ionic amino acid side chains with ionic or polar side chains.**



A cartoon of tertiary structure

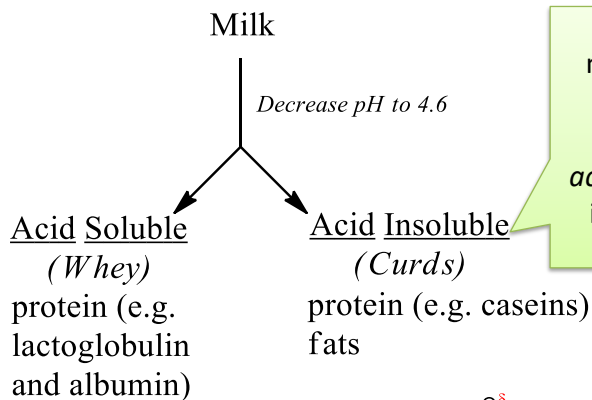
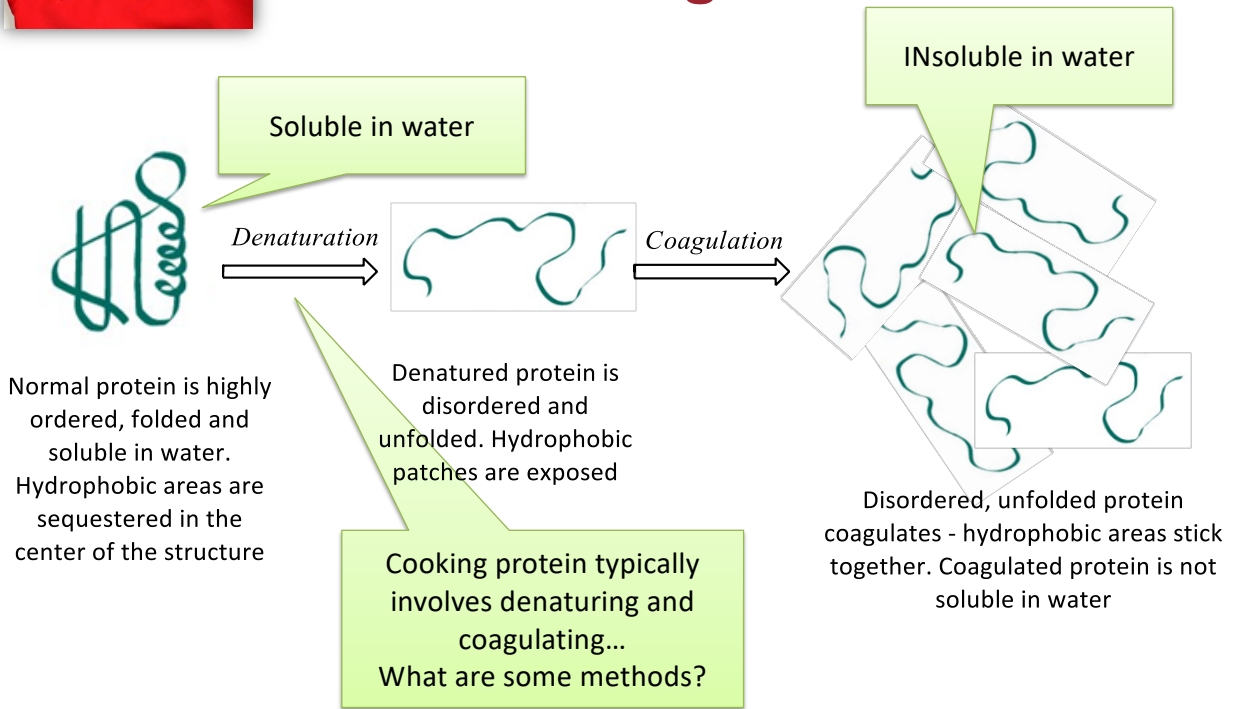


## The rubric of protein structure...

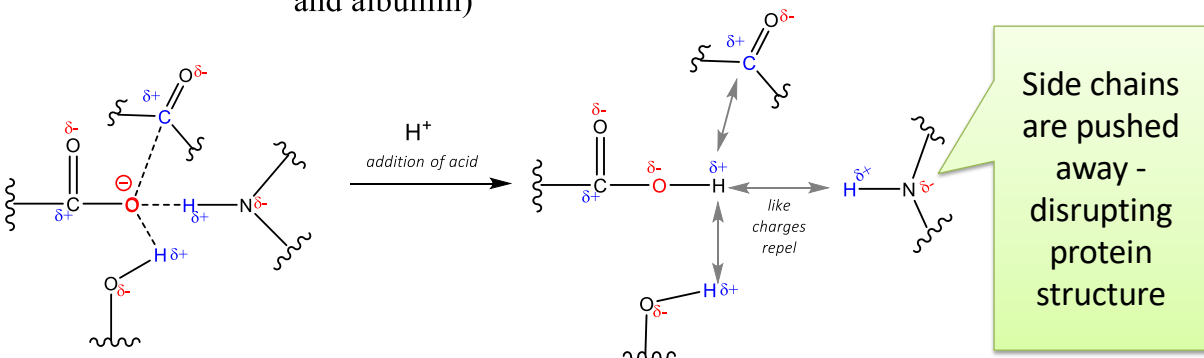
- Proteins are made of amino acids chemical joined in a long chain called: **primary structure**
  - The order of the amino acid residues *in the chain* matters
- Chains of amino acids can form organized **secondary structure** held together with **hydrogen bonds**
  - α-helices
  - β-strands (combine into β- sheets)
- The chains of secondary structures *fold* into a 3-dimensional blob (“globular”) called **tertiary structure**
  - 3-D protein structure is held together by **non-covalent interactions** between atoms of the protein
    - Electrostatic interactions of cation and anions
    - Electrostatic interactions between the atoms of polar bonds
    - Additional hydrogen bonds



# Denaturation and Coagulation



The protein in curds is made entirely of casein. The protein casein is particularly unstable to *acid denaturation* because it has so many negative charges.



**Acid denaturation** unfolds the *globular* protein structure. The disruption of *non-covalent* attractions between charged or partially charged atoms in amino acids weakens the folded structure until the protein unravels. The process of turning milk into cheese or yogurt can be accomplished by **acid denaturation** of the milk protein, casein.



## Denaturation by heat

Denaturation is always followed by coagulation



Clear, transparent, raw egg white is full of happy, folded proteins



Opaque, white, cooked egg white is made of heat denatured, coagulated and solidified protein