



PROTEINS

- **What are proteins ?**
- **structure of protein.**
 1. **Primary structure.**
 2. **Secondary structure.**
 3. **Tertiary structure.**
 4. **Quaternary structure.**
- **Denaturation of protein.**
- **Protein misfolding.**

Proteins

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graph TD; Proteins --> Protein_definition[Protein definition]; Proteins --> Structure_of_proteins[Structure of proteins]; Proteins --> Denaturation_of_proteins[Denaturation of proteins]; Structure_of_proteins --> Primary; Structure_of_proteins --> Secondary; Structure_of_proteins --> Tertiary; Structure_of_proteins --> Quaternary;
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**Protein
definition**

**Denaturation
of proteins**

**Structure of
proteins**

Primary

Tertiary

Secondary

Quaternary

Single amino acids joined together by a covalent bond called peptide bond.

Regular arrangement of amino acid that is located near each other in linear sequence.

Primary Structure

Secondary Structure

Protein Structure

Quaternary Protein

Tertiary Structure

Consist of

α -Helix.

β -Sheet.

Super
Secondary
Structure.

Composed of:

Composed of:

Composed of:

Interactions stabilized by:

Disulfide bond.

Hydrophobic interactions.

Hydrogen Bond.

Ionic interaction.

Secondary Structure interacts with each other forming domains. Domains can be combined to form Tertiary structures.

Is the protein that contains two or more poly-peptide that is identical or unrelated.



What are Proteins?

- **proteins** are made up of **hundreds or thousands** of smaller units called **amino acids**, which are attached to one another in long chains.
- there are mainly **20** different types of amino acids that can be combined to make a **protein**.
- **the sequence of amino acids** determines each protein's unique three-dimensional (**3d**) structure and its specific function.
- proteins can be described according to their large range of functions in the body e.g. **antibody, enzyme, messenger, structural component** and **transport/storage**.

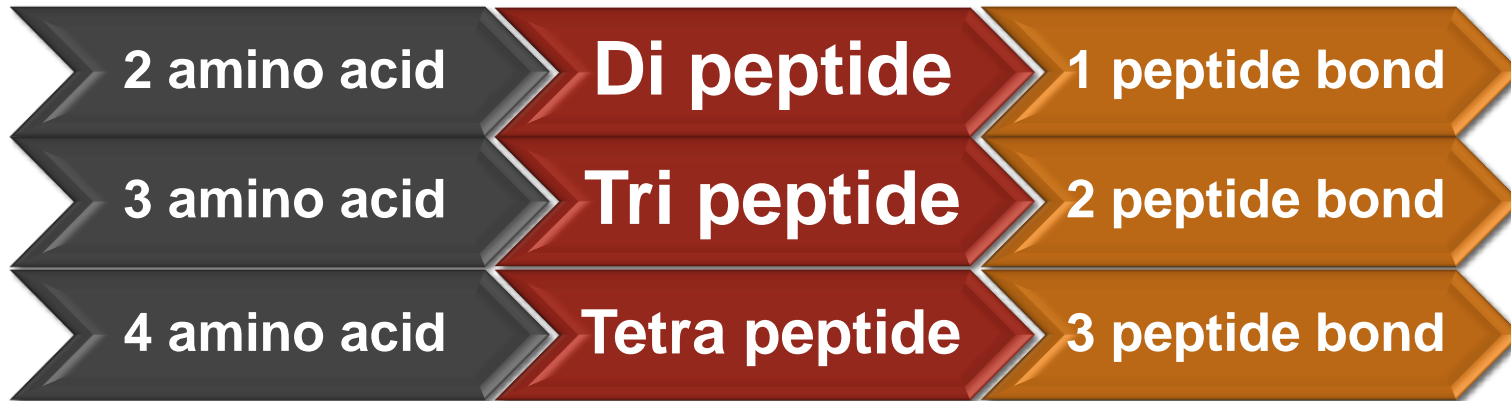
Structure of Proteins

❖ **The job** of a certain protein is very much related to its **shape**. That is why we say we have a **functional protein** when it has a **3D shape (tertiary structure)**. However, proteins have **different levels** of structure that determines its **function** and **shape**; therefore an alteration in a protein's primary structure may affect its final shape.

1) Primary structure:

- **Single amino acids** are joined by a **covalent bond** called a **peptide bond or disulfide bond (if any)**. When single amino acids are joined in this fashion, we call the result of this a **polypeptide**.
- The peptide bond is formed via a **dehydration reaction**. The amino group (**NH₂**) gives **one hydrogen** atom, and the carboxyl group (**COOH**) donates a **hydroxyl group (OH)**.
- Because the final amino acids on both sides have only one peptide bond, in one side there should be an **amino group** (called the **N terminus**) and on the other side there should be a **carboxyl group (C terminus)**.

Peptides



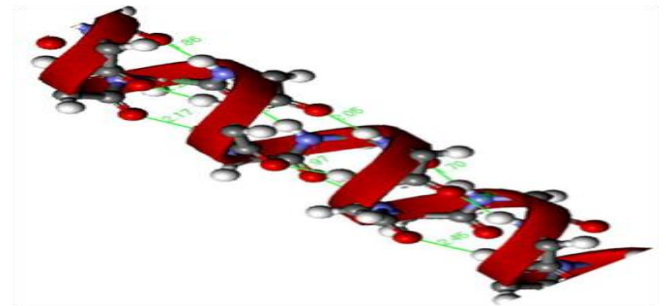
2) Secondary structure:

They are regular arrangements of amino acids that are located near to each other in the linear sequence. Excluding the conformations (3D arrangements) of its side chains.

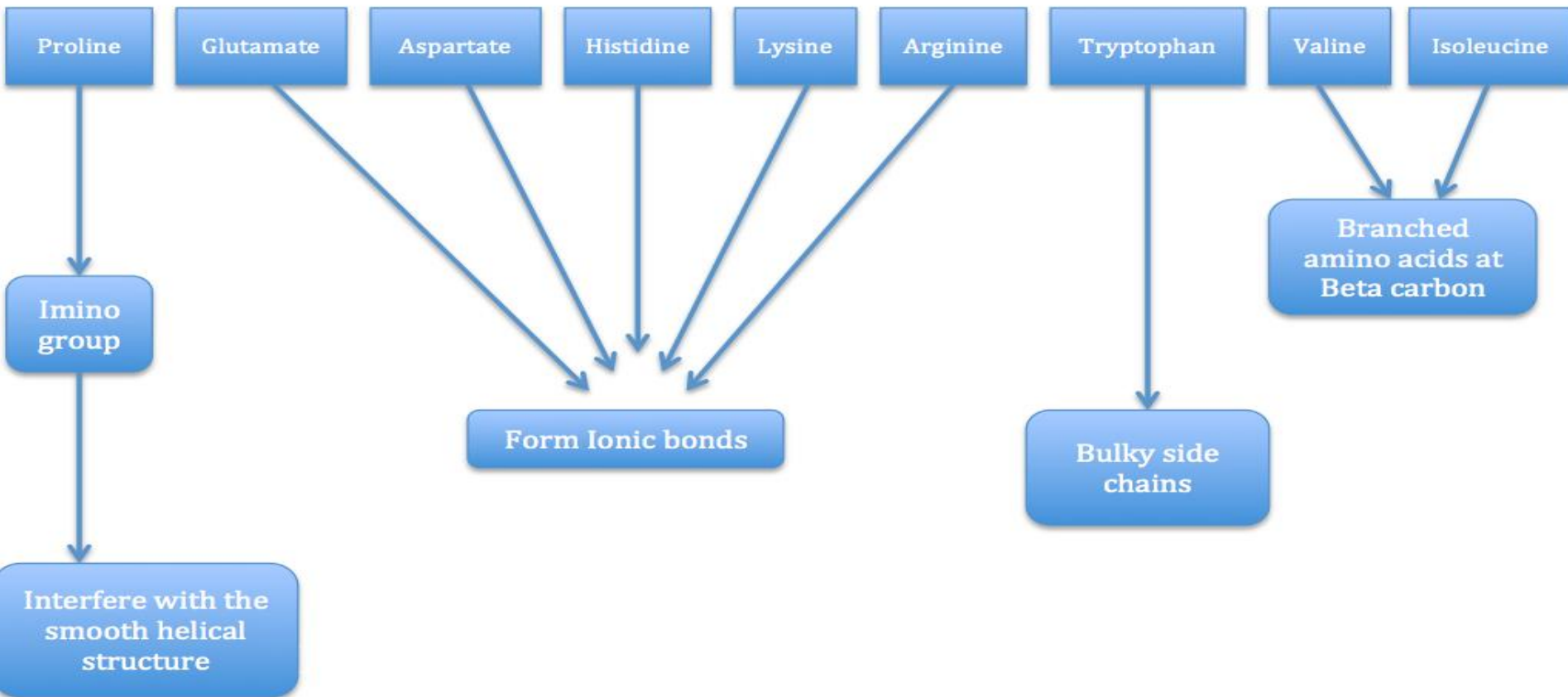
- Alpha helix:

It is a **right-handed spiral**, in which side chains of amino acids **extended outward**. **Hydrogen bonds stabilize** the helix; formed between the peptide bond **carbonyl oxygen** and **amide hydrogen**.

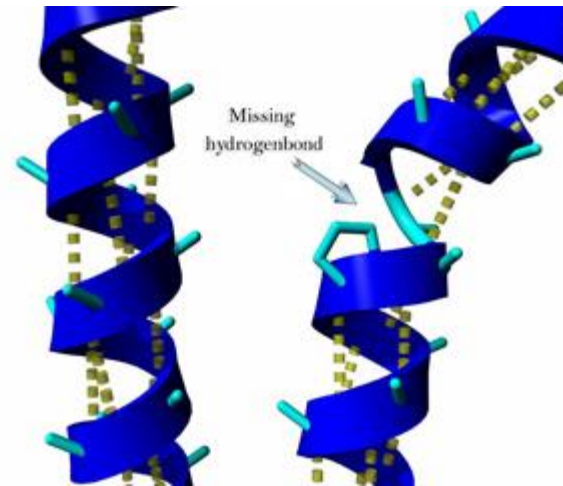
Look at slide no.16 →



Amino acids that interfere with α -helix

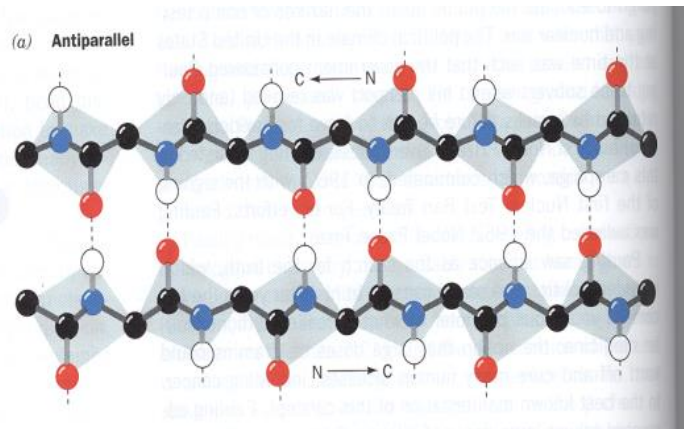


- The picture shows an alpha helix with a proline group.

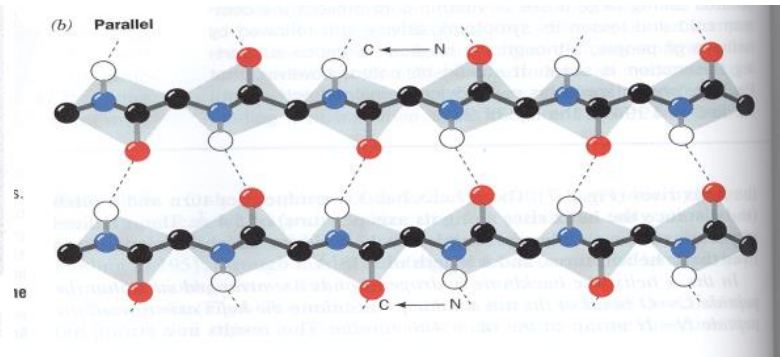
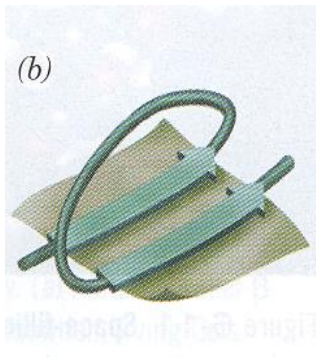


- **Beta sheet:** You could imagine them as sheets of paper above each other. These sheets are **stabilized** by **hydrogen bonds**.
- The sheets are represented by strands that could be part of **one polypeptide** or part of **many** different polypeptides.
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- Antiparallel:

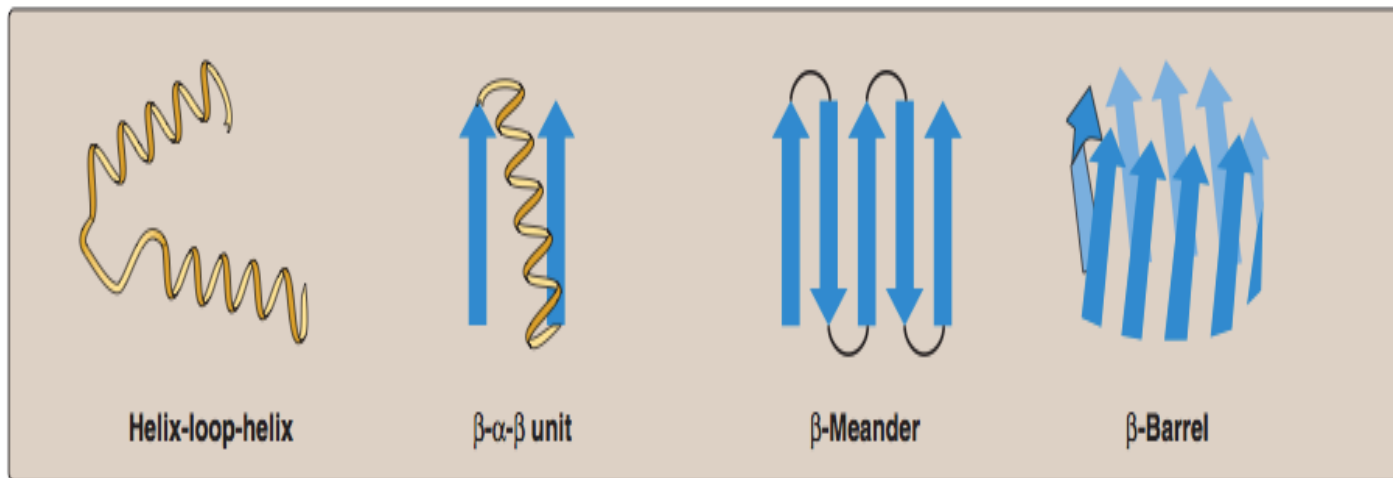


- Parallel:



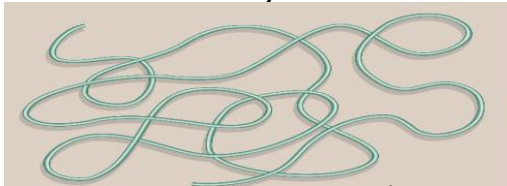
- We could recognize the difference between these two by looking at the pictures above. **Antiparallel** sheets' **hydrogen bond** are **shorter**, **thus**, **stronger**.
- **Other secondary structure examples:**
- **Beta bends (reverse turn):**
- In the **antiparallel beta sheet**, the **“U turn”** resembles the **beta turns**, it is also the same in parallel strands. The **beta bend** connects **beta sheets** together. Beta sheets often include charged residues (**why do they? Because charged amino acids make “kinks” which make the beta bend actually bend**).
- **Nonrepetitive secondary structure:**
e.g. loop or coil conformation.

- **Super secondary structures:** are the combination of secondary structure elements
 - **α α motif:** two α helices together
 - **β α β motif:** a helix connects two β sheets
 - **β hairpin:** reverse turns connect antiparallel β sheets
 - **β barrels:** rolls of β sheets

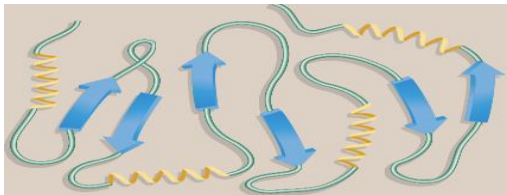


3) Tertiary structure

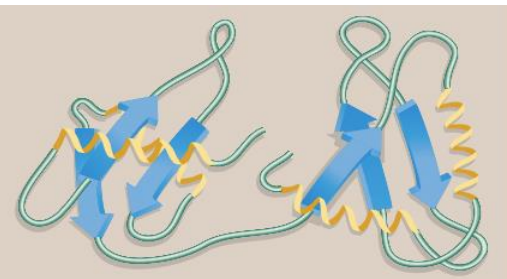
- so far we have only been talking about the core of amino acids, hydrogen bonds between the peptide bonds that link amino acids. When talking about the tertiary structure, we also include the **side chains**.



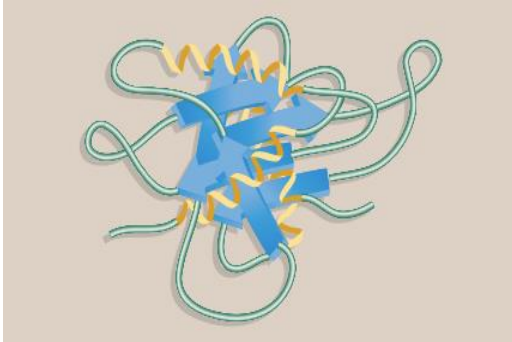
*This is our polypeptide in the primary



*Then it is designed in secondary structures (alpha helices and beta sheets)



*Secondary structures interact with each other forming **domains**. The core of a domain is built from combinations of supersecondary structural elements (**motifs**) and their side chains.

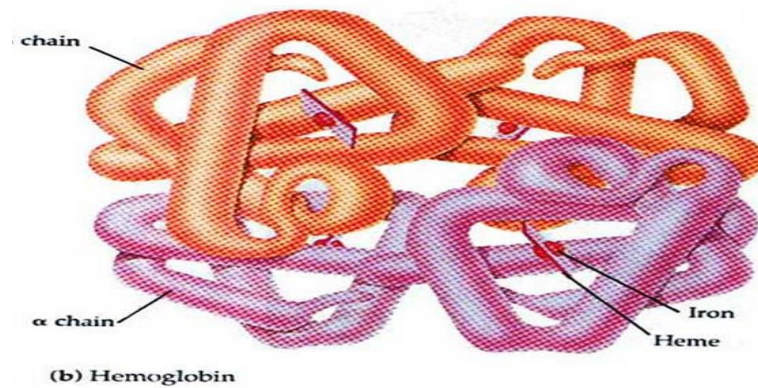


*Domains can be combined to form tertiary structures.

Note: looking at the pictures above you might have the impression that this process is random, however, it is **NOT**. Chaperons are a specialized group of proteins, required for the proper folding of many species of proteins. They are also known as “heat chock” proteins. They interact with the polypeptide primary structure and make it fold in a way that forms its precise shape.

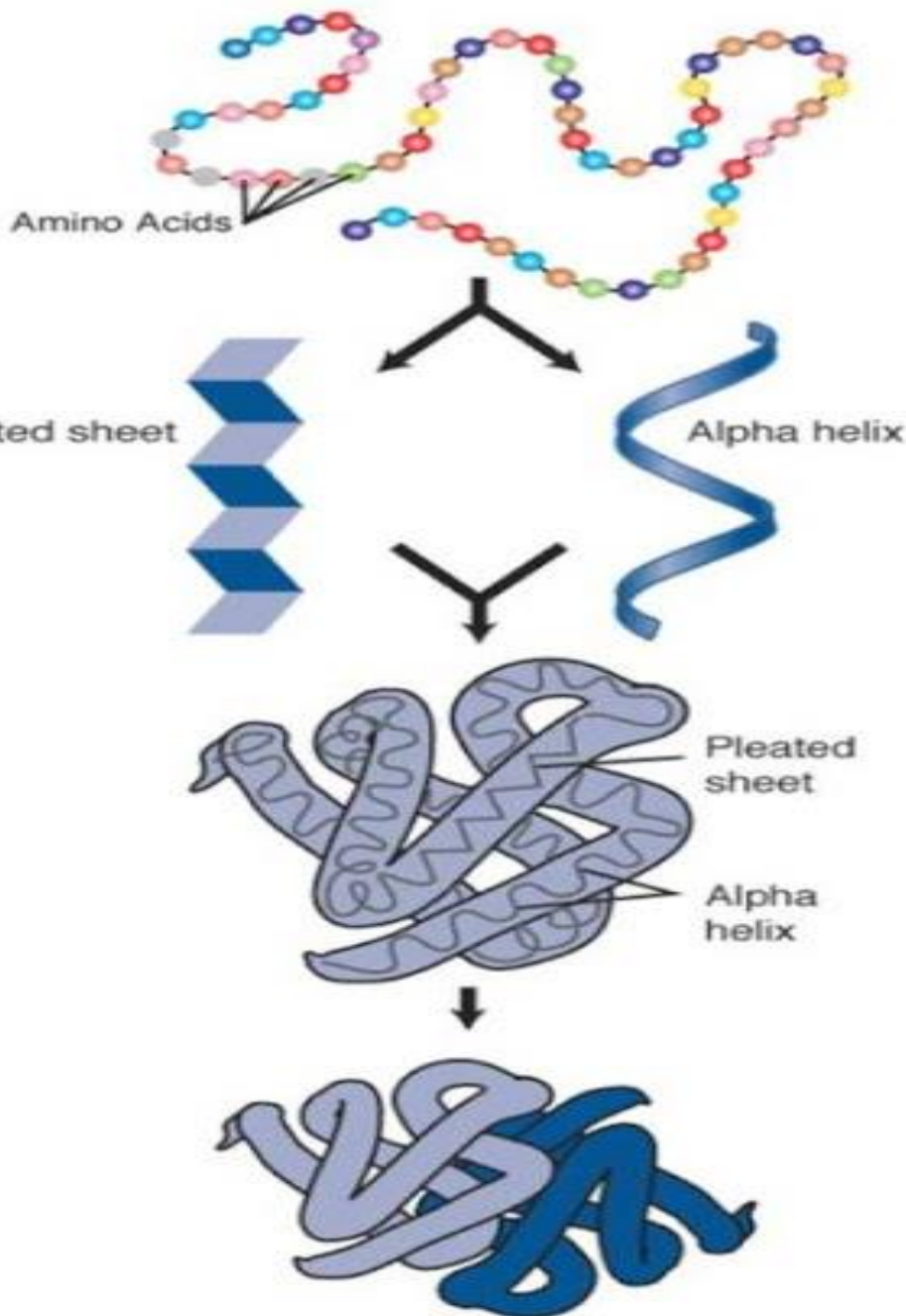
- **Interactions stabilizing tertiary structure:**
 - Disulfide bonds.
 - as explained some side chains contain **sulfur** which interacts with others making **disulfide bonds**.
 - Hydrophobic interactions.
 - Side chains may be **hydrophobic or hydrophilic**. These types of side chains could interact to **stabilize** the tertiary structure.
 - Hydrogen bonds.
 - A **hydrogen atom** could bond with (N,O,F) to form **hydrogen bonds**.
 - Ionic interactions.
 - Side chains could be **ionized** and make **ionic interactions**.

4) **Quaternary structure:** Some proteins contain two or more polypeptide chains that may be structurally **identical** or totally **unrelated**.



Looking at the structure of hemoglobin we can see that it has **four subunits** (these subunits are at their **tertiary structure** if they were independent, but as they combine they become subunits to hemoglobin) these **combined subunits** create the **quaternary structure**.

Note: not all proteins have to have a quaternary structure.



Levels of protein organization

Primary protein structure

is sequence of a chain of amino acids

Secondary protein structure

occurs when the sequence of amino acids are linked by hydrogen bonds

Tertiary protein structure

occurs when certain attractions are present between alpha helices and pleated sheets.

Quaternary protein structure

is a protein consisting of more than one amino acid chain.

- **DENATURATION OF PROTEINS:-**
- it results in the **unfolding** and **disorganization** of the protein's secondary and tertiary structures.
- *denaturing agents include:
 - **Heat.**
 - **organic solvents.**
 - **mechanical mixing.**
 - **strong acids or bases.**
 - **Detergents.**
 - **ions of heavy metals (e.g. lead and mercury).**
- *most proteins, once **denatured**, remain permanently **disordered**.

- **PROTEIN MISFOLDING:-**
- alzheimer's disease:
- β amyloid protein is a misfolded protein.
- it forms fibrous deposits or plaques in the brains of alzheimer's patients.
- creutzfeldt-jacob or prion disease:
- prion protein is present in normal brain tissue.
- in diseased brains, the same protein is misfolded.
- it, therefore, forms insoluble fibrous aggregates that damage brain cells.

- Quiz:
- <http://www.onlinequizcreator.com/protein-structure/quiz-39801>
- In case the link do not work just press back space button

- Protein definition:
- www.youtube.com/watch?v=Q7dxi4ob2O4
- **Alpha helix:**
- <http://www.youtube.com/watch?v=eUS6CEn4GSA&list=UUGsuuOOUDgZPKLALDSWd7BA>
- **Beta sheet:**
- <http://www.youtube.com/watch?v=wM2LWCTWlrE>
- **Denaturation of proteins**
- <http://www.youtube.com/watch?v=SUCgAxl8rhg>

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