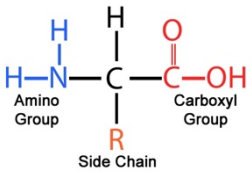
Amino-acids and proteins

Amino-acids

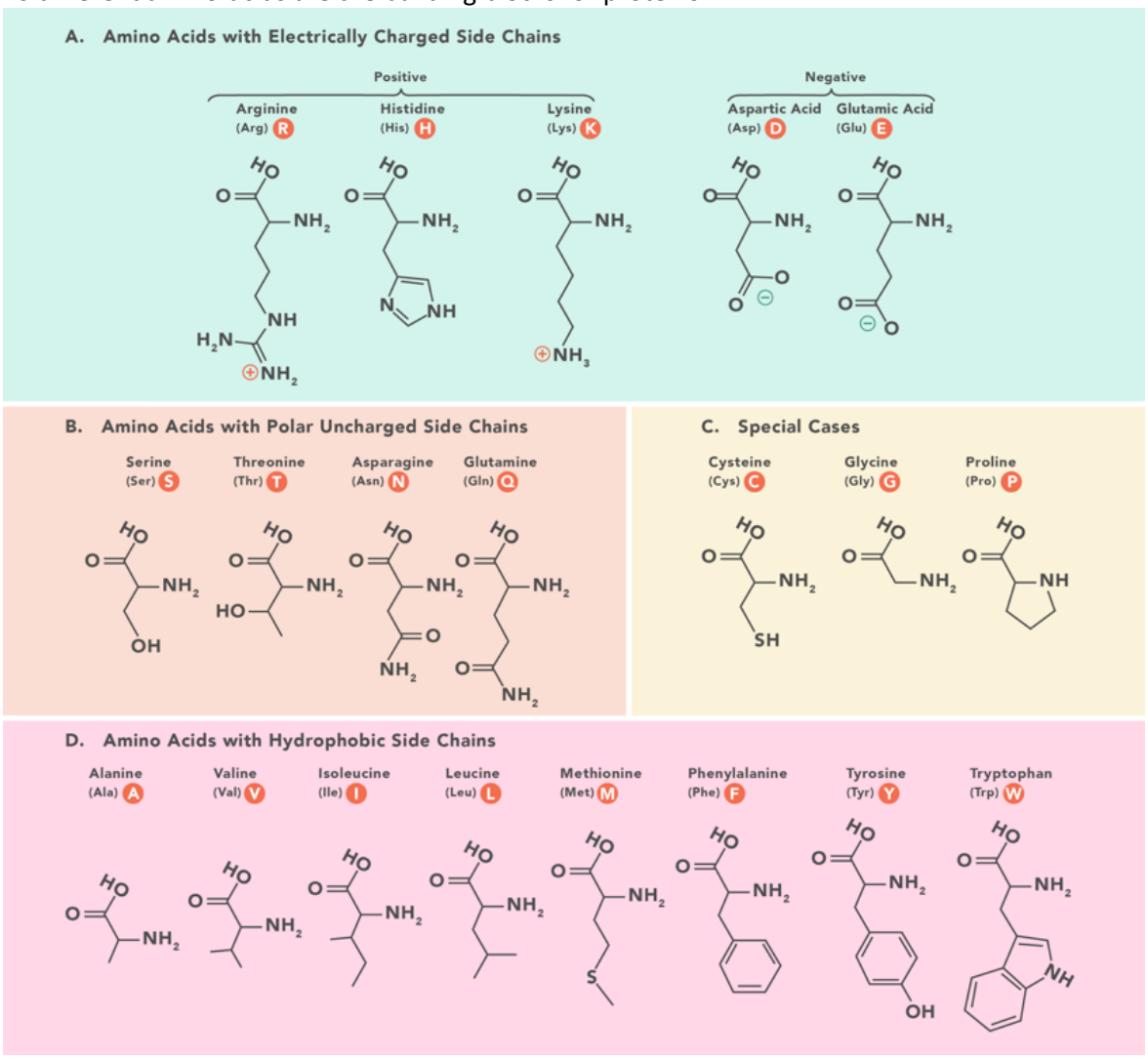
An amino-acid is an organic molecule with a central carbon atom linked to an amino group (- NH_2), a carboxyl group (- COOH) and a variable side chain R (for residue)



Both the amino end and the carboxyl end can be ionized to respectively NH_3^+ and COO^-, depending on the acidic or basic environment. At pH = 7, both groups are ionized.

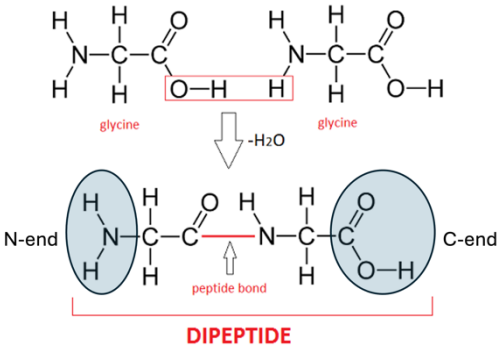
The structure of the side chain gives the individual properties of the amino-acid (polar/non polar, acidic/basic/neutral).

20 different amino-acids are the building blocks for proteins.



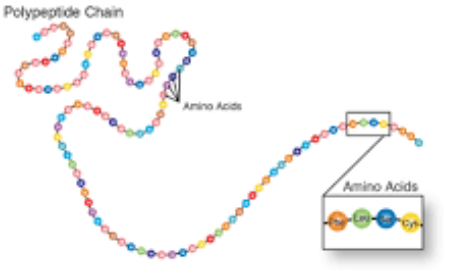
Note: These are not the only ones existing in nature, but others do not play any role in the synthesis of proteins.
Essential amino-acids cannot be synthesized by the organism. They must be part of their diet.

The peptide bond



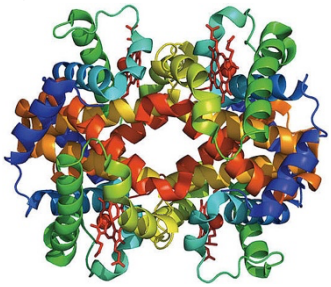
Through a condensation reaction (reaction releasing water), the carboxyl group of an amino acid molecule and the amino group of another amino acid molecule form a strong covalent bond.
This bond is called a peptide bond and the new molecule a dipeptide.

A N terminal end and a C terminal end remain available for new peptide bonds, leading to the formation of a polypeptide.

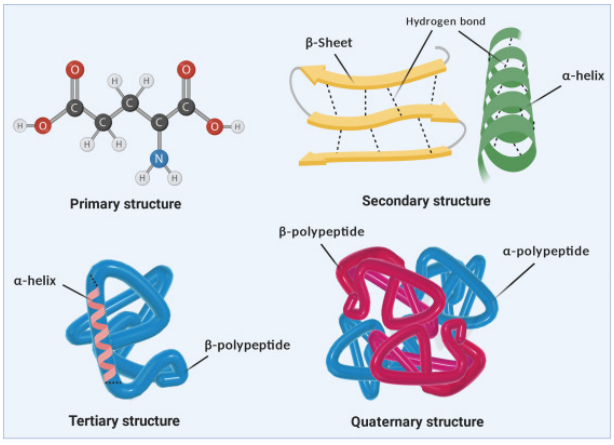


Proteins

Proteins are large biomolecules made of one or more long chains of amino acids.
Note: Polypeptides containing less than 20-30 amino acids are rarely considered to be proteins.

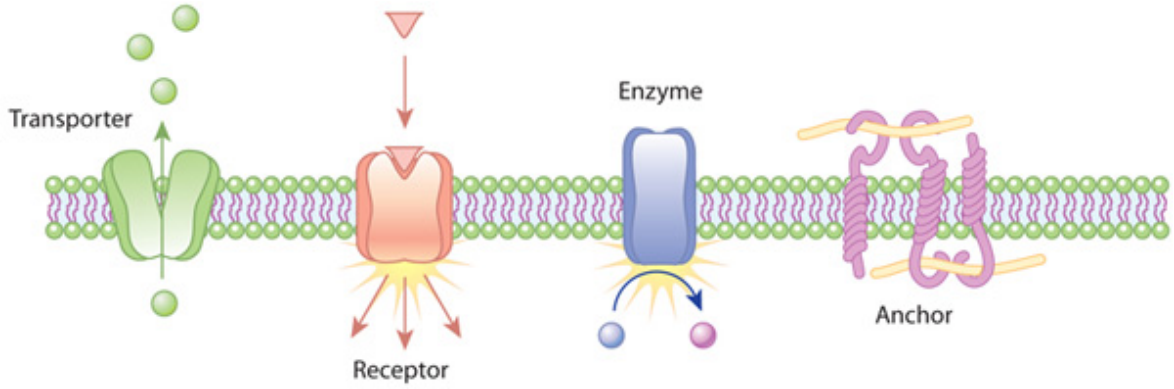


The sequence of amino acids constitutes the **primary structure** of the protein.
The properties of the sidechains of the amino acids leads to repeating local structures stabilized by hydrogen bonds: a-helix, b-sheets, turns form the **secondary structure** of the protein.
The whole molecule is stabilized by several non local interactions , like salt bridges, hydrogen bonds or disulfide bonds. This leads to an overall shape called **tertiary structure**, which controls the basic function of the protein.
Sometimes, several protein molecules (subunits) interact to form the **quaternary structure**, which acts as a unique protein complex.



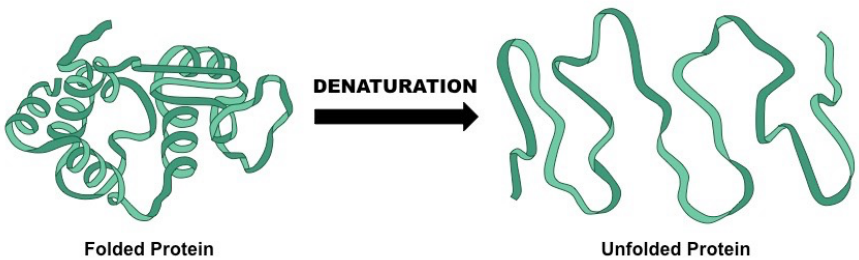
Shape and function of Proteins

Protein structure determines its shape and therefore its function. Fibrous proteins will be involved in the structure or movement, while globular proteins are used as binding sites or receptor sites.



Type	Examples	Functions
Structure	Collagen, elastin, keratin	Give tissues (bone, tendons, ligaments, cartilage, skin, muscles) strength and structure
Enzymes	Amylase, lipase, pepsin, lactase	Digest macronutrients into smaller monomers that can be absorbed; performs steps in metabolic pathways to allow for nutrient utilization
Hormones	Insulin, glucagon, thyroxine	Chemical messengers that travel in blood and coordinate processes around the body
Fluid and acid-base balance	Albumin, hemoglobin	Maintains appropriate balance of fluids and pH in different body compartments
Transport	Hemoglobin, albumin, protein channels, carrier proteins	Carry substances around the body in the blood or lymph; help molecules cross cell membranes
Defense	Collagen, lysozyme, antibodies	Protect the body from foreign pathogens

Denaturation or inhibition which may change a proteins structure will change its function.



This can happen through a change in the environment (temperature, pH, …), or after mutations impacting the structure of DNA, and therefore the genetic code, which defines the primary structure of proteins.