Proteins play many additional roles that are important in sustaining life. Table 3.1 lists several different types of proteins, provides examples, and gives a brief description of their functions.

Protein Types and Functions

Type	Examples	Functions
Digestive Enzymes	Amylase, lipase, pepsin, trypsin	Help in food by catabolizing nutrients into monomeric units
Transport	Hemoglobin, albumin	Carry substances in the blood or lymph throughout the body
Structural	Actin, tubulin, keratin	Construct different structures, like the cytoskeleton
Hormones	Insulin, thyroxine	Coordinate different body systems' activity
Defense	Immunoglobulins	Protect the body from foreign pathogens
Contractile	Actin, myosin	Effect muscle contraction
Storage	Legume storage proteins, egg white (albumin)	Provide nourishment in early embryo development and the seedling

Table 3.1 lists the primary types and functions of proteins. (credit : Clark et al. / Biology 2E OpenStax)

Protein Shape

Proteins have different shapes. For example, hemoglobin is a globular protein, meaning it is shaped kind of like a globe. Its shape is important because it allows hemoglobin to attach and release oxygen molecules easily. Oxygen molecules are needed by all of the cells that make up the human body. Collagen, located in the skin, is a fibrous protein. Fibrous proteins tend to be long and sometimes cylindrical. In our skin, collagen plays an essential protective function and helps hold the skin together.

Twenty types of amino acids are used to make all proteins. Different proteins have different types and different arrangements of their amino acids, which results in each protein being unique. We will now take a closer look at the chemical make-up of an amino acid.

Amino Acids

Amino acids are the monomers that make up proteins. Each amino acid has the same fundamental structure which consists of a central carbon atom bonded to an amino group (NH_2), a carboxyl group (COOH), and a hydrogen atom. Every amino acid has a side chain called the R group (Figure 3.26). The R group is a side chain that can be made up of several different atoms. The R groups are very diverse and ultimately give each amino acid its defining characteristics (Figure 3.27).

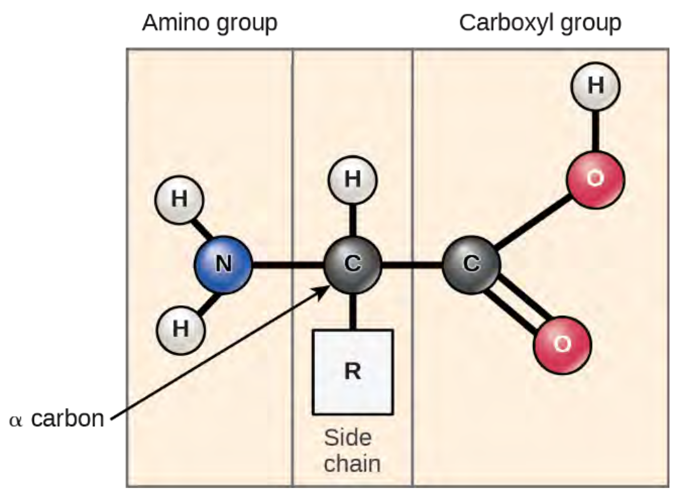

Figure 3.26 Amino acids have a central asymmetric carbon to which an amino group, a carboxyl group, a hydrogen atom, and a side chain (R group) are attached. (credit : Clark et al. / [Biology 2E OpenStax](https://openstax.org/))

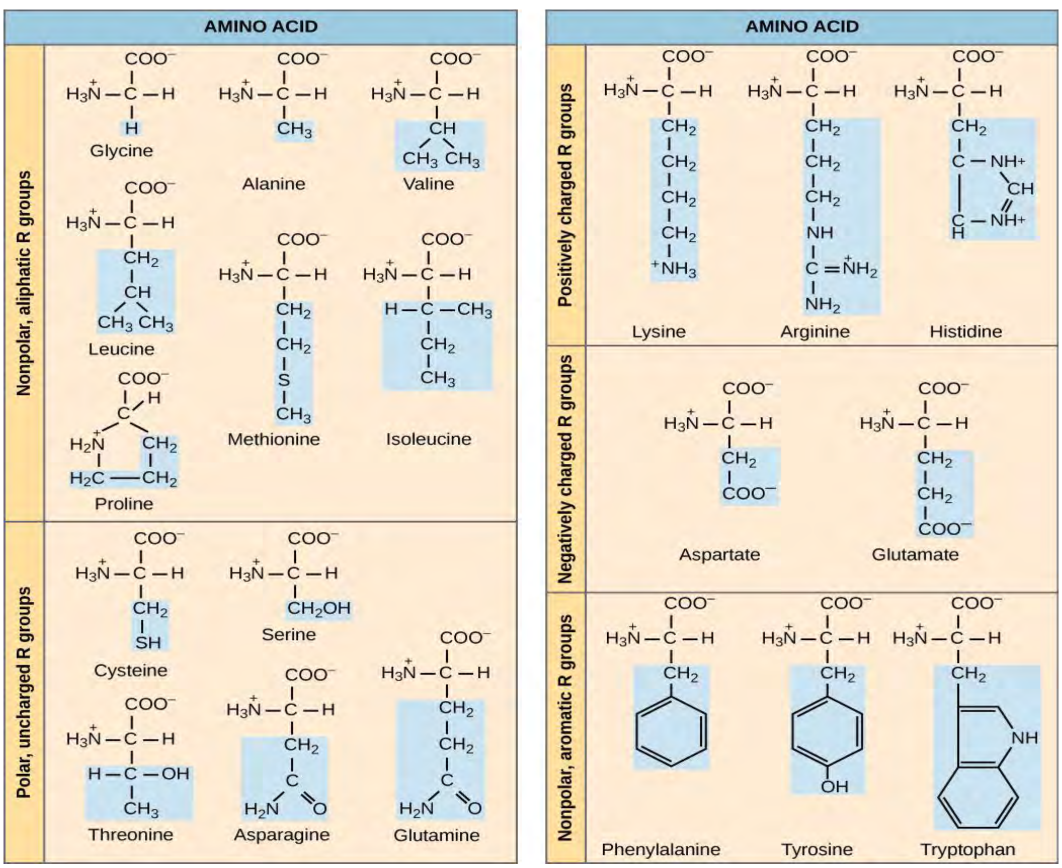

Figure 3.27 There are 20 common amino acids commonly found in proteins, each with a different R group (variant group) that determines its chemical nature. (credit : Clark et al. / [Biology 2E OpenStax](https://openstax.org/))

The chemical nature of the side chain determines the amino acid's nature (that is, whether it is acidic, basic, polar, or nonpolar). For example, the amino acids valine, methionine, and alanine are nonpolar or **hydrophobic** (Figure 3.27). Note that these R groups are mostly hydrocarbons, which consist of nonpolar covalent bonds. Amino acids such as serine, threonine, and cysteine, are polar and have **hydrophilic** side chains. The side chains of lysine and arginine are positively charged, and therefore these amino acids have a basic pH. (Figure 3.28). By understanding the chemical nature of each amino acid, it is easier to understand why proteins function the way they do.

The sequence and the number of amino acids ultimately determine the protein's shape, size, and function. Amino acids can be linked together using a dehydration synthesis reaction. One amino acid’s carboxyl group and the incoming amino acid’s amino group combine, releasing a water molecule. The resulting bond that forms is covalent and called a **peptide bond** (Figure 3.28).

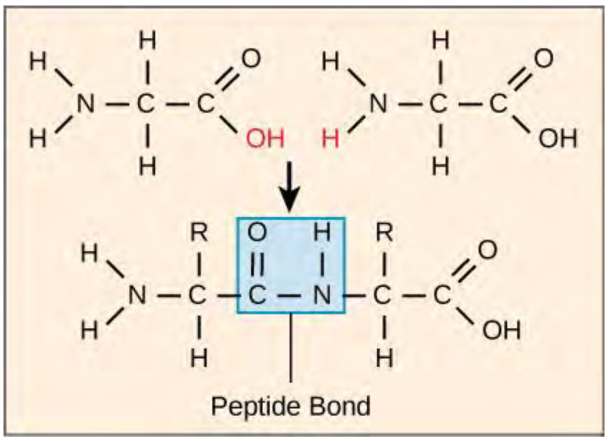

Figure 3.28 Peptide bond formation is a dehydration synthesis reaction. (credit : Clark et al. / Biology 2E OpenStax)

As two amino acids are linked together they form a peptide chain. As more amino acids are added it is called a polypeptide chain. A polypeptide chain is technically a polymer of amino acids. However, the term protein is not usually used until the polypeptide chain(s) have folded into their distinct three-dimensional shape and can carry out their unique function(s). After a polypeptide chain is made, most are modified. Parts of the polypeptide chain may be removed, or other chemical groups may be added. Only after these modifications are made is the protein completely functional.

CONCEPTS IN ACTION - Click through the steps of protein synthesis in this interactive tutorial.

Check your knowledge

What type of bond is a peptide bond?

True or False: All amino acids are polar.

Answers: Peptides bonds are covalent bonds between amino acids. Amino acids are both polar and non-polar.