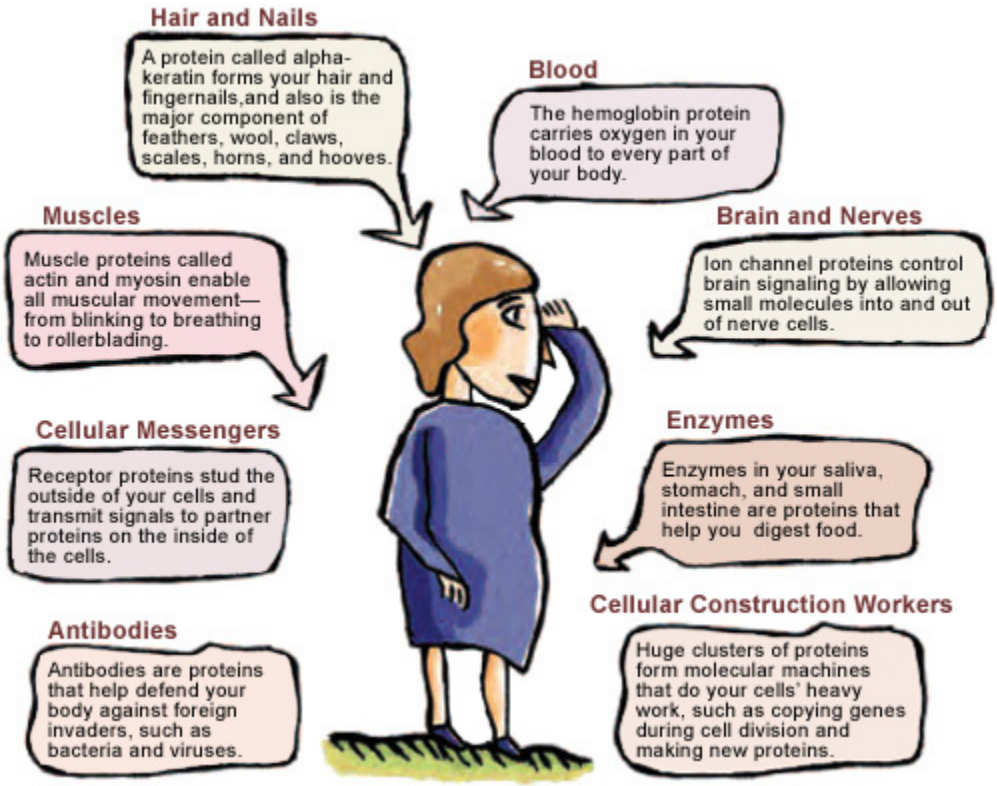
# Amino Acids and Proteins

**What are Proteins?**

Proteins are essential organic compounds that are vital to the proper growth, development and functioning of all living organisms. There are four general classes of proteins that we are going to consider in this class:

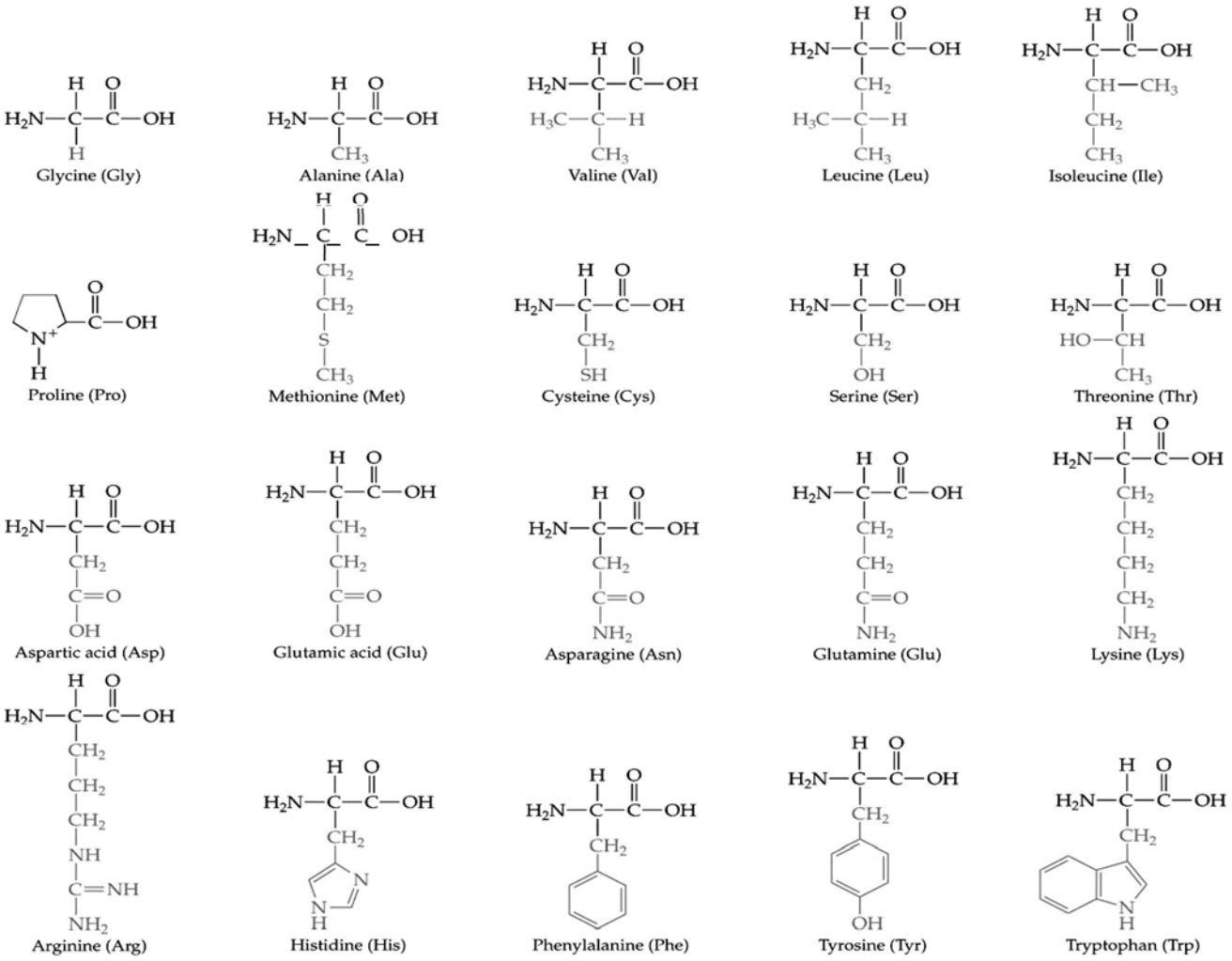
- ✓ **Structural body parts:** hair, nails, connective tissue, parts of cell membranes
- ✓ **Pigments:** hemoglobin (on RBC, carries oxygen to your cells), chlorophyll (involved in capturing sunlight for photosynthesis)
- ✓ **Hormones:** chemical messengers that stimulate specific cells or tissues (adrenalin, estrogen, testosterone)
- ✓ **Enzymes:** organic catalysts that regulate the rate of chemical reactions inside living organisms (catalysts change the rates of chemical reactions ***WITHOUT*** becoming part of the reaction).

Proteins are essentially worker molecules that are necessary for virtually every activity in your body!



**Q: What is a polymer?**

**Proteins are polymers**; proteins are composed of hundreds to thousands of amino acids linked together similar to a chainlike structure. There are 20 different kinds of amino acids that can be connected in innumerable combinations to create a variety of different shapes, where each shape is associated with a unique body function. Below are the structures of the 20 amino acids that represent the building blocks of proteins.




***Q:*** Examine each of the amino acids depicted above. **In general, how are they similar? How are they different?**

**A:**_____

_____

_____

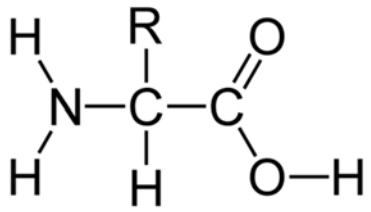
_____

_____

**What is the structure of an Amino Acid?**

As you may have discovered, the basic structure of each amino acid is the same. Each amino acid has a central Carbon to which an amino group (-$NH_2$) is attached on one side, a carboxyl group (-COOH) is attached to the other side and a hydrogen atom at the top or bottom. The only difference between one amino acid and another is the variable "R" group which can be as simple as another H bonded to the central carbon or a complex group of atoms. Below is the general formula for an amino acid.

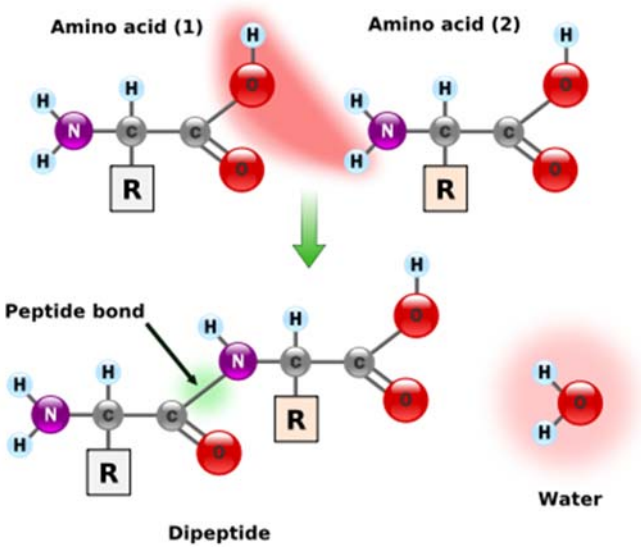
***Q:* Circle the central carbon. Draw a rectangle around the amino group and label it. Do the same for the carboxyl group. Draw triangle around the R group and label it the variable group.**



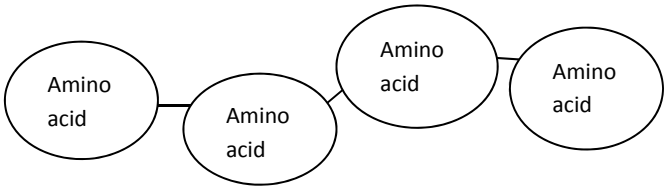

**Q: By what process do you think you would bind two amino acids together?**

**A: _____**

In the diagram below, two glycine molecules are bound together by the process of dehydration synthesis to form a dipeptide. **The bond formed between the carbon of the carboxyl group of the first glycine and the nitrogen of the second, is called a PEPTIDE BOND (C-N) link.**




**Q: Suppose a piece of protein consisting of four amino acids undergoes hydrolysis. How many water molecules must be used in order to break apart this small protein?**



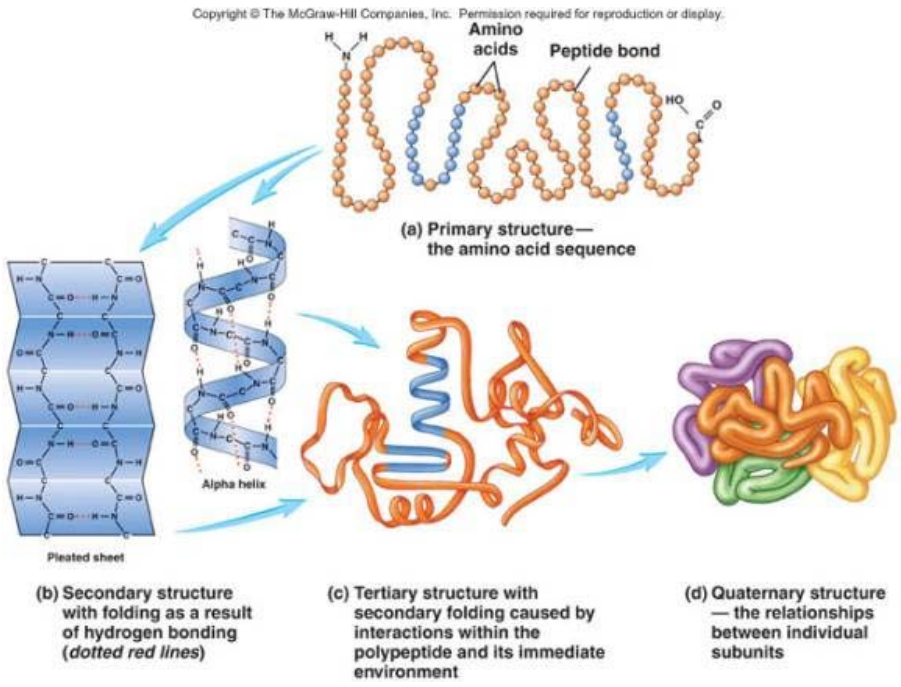

A:_____

When three or more amino acids are linked together in a chain, the resulting molecule is called a **polypeptide.**

**Q: By what process is a polypeptide broken down into its component amino acids?**

**A:**_____

**The sequence of amino acids in a polypeptide chain determines the protein's shape; the shape of the protein determines the protein's function.** Below is a diagram that illustrates how a polypeptide (primary structure) is linked together by hydrogen bonds to form secondary structures. When the secondary structures fold on themselves, tertiary structures are formed. Other polypeptide chains sometimes combine tertiary structures to form a quaternary structure. **The final shape of the protein is specific and will determine the exact function of the protein.**




**Proteins in our Diets**

Of the 20 amino acids we need to manufacture proteins in our bodies, only 12 of these can be synthesized by our bodies. The other 8, called **ESSENTIAL AMINO ACIDS** must be ingested through food. In order for protein synthesis to occur, all 20 amino acids must be present at the time of synthesis.

In order to obtain the essential amino acids, you can either eat complete protein foods such as red meat, poultry fish, cheese, eggs, milk, and yogurt. Incomplete protein foods include grains, nuts, beans, seeds, peas, and corn. These foods must be eaten together to obtain all 8 essential amino acids at one time. Examples of combinations of incomplete proteins eaten together include:

- ✓ Grains with Legumes - sample meal: lentils and rice with yellow peppers.
- ✓ Nuts with Legumes - sample meal: black bean and peanut salad.
- ✓ Grains with Dairy - sample meal: white cheddar and whole wheat pasta.
- ✓ Dairy with Seeds - sample meal: yogurt mixed with sesame and flax seeds.
- ✓ Legumes with Seeds - sample meal: spinach salad with sesame seed and almond salad dressing.

If all 20 amino acids are NOT present for protein synthesis, the amino acids will be sent to the liver where **DEAMINATION** of the amino acids will occur (removal of the amino groups). The amino groups will then be converted to ammonia (which is toxic to our bodies) and then

through a series of reactions, into **UREA** which is sent via the bloodstream to the kidneys to be **EXCRETED** from the body as urine. The rest of the amino acid can be used in the process of cellular respiration to obtain energy for cellular activities.

**Questions:**

1. Describe 6 functions of proteins in our bodies.
2. Draw the structure of an amino acid and label all of its parts.
3. How do amino acids differ from one another?
4. Describe the process by which 2 amino acids are bonded together.
5. Differentiate between a dipeptide and a polypeptide.
6. Identify the type of bond that links amino acids together in a chain.
7. Relate the sequence of the polypeptide chain and the shape of the protein to structure and function.
8. How are proteins we ingest broken down in our digestive systems?
9. Differentiate between essential and non-essential amino acids.
10. Differentiate between complete protein and incomplete protein foods.
11. Describe what happens to amino acids when deamination occurs.