Proteins & Protein Structure Worksheet

By the end of this packet, you will know the answer to the following questions:

1. What elements proteins made of?
2. What is the structure of a protein?
3. How are proteins used in the body?

Background Reading:

Spider Silk: A Biosteel Protein

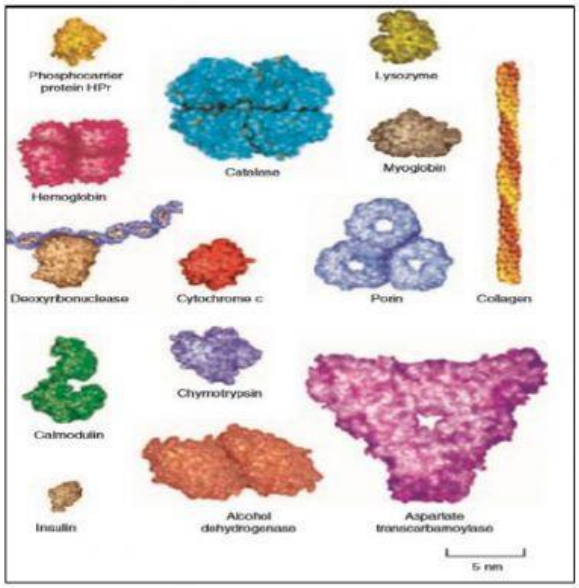
Spiders have evolved over 400 million years into exceptionally successful predators. These invertebrate animals are a class of arthropods, called the arachnids. They have an exoskeleton, a segmented body, and jointed appendages. Although spiders possess an efficient venom injection system, their most impressive feature is the production of silk, a multiuse protein fiber. Silk, which is spun through spinnerets at the end of the spider's abdomen, is used in locomotion, mating, and offspring protection. The most prominent use of spider silk, however, is prey capture. The most sophisticated method of prey capture is the spiral, wheel-shape orb web, which is oriented vertically to intercept fast-moving flying prey. Spider silk's mechanical properties ensure that the web readily absorbs impact energy so that prey is retained until the spider can subdue it. Orb webs (and the species that produce them) have fascinated humans for many thousands of years because of their dramatic visual impact. Ancient Greeks and Romans, for example, explained the occurrence of spiders and orb webs with the myth of Arachne, in which the mortal woman Arachne, an extraordinarily gifted weaver, offended Minerva (Athena in the Greek version), the goddess of weaving and other crafts, with her arrogant acceptance of a challenge to a weaving contest with the goddess. When confronted with Arachne's flawless work, an enraged Minerva transformed her into a spider, doomed to forever weave webs.

Humans have also long appreciated spider webs for their physical properties. Examples range from the ancient Greeks, who used spider webs to treat wounds, to the Australian aborigines who used spider silk to make fishing lines. In modern times spider silk has served as crosshairs in scientific equipment and gun sights. In the past several decades, spider silk and orb webs have attracted the attention of life scientists, bioengineers, and material scientists as they began to appreciate the unique mechanical properties of this remarkable protein.

There are eight different types of spider silk, although no spider makes all of them. Dragline silk, a very strong fiber, is used for frame and radial lines in orb webs and as a safety line (to break a fall or escape other predators). Capture silk, an elastic and sticky fiber, is used in the spiral of webs. Spider silk is a lightweight fiber with impressive mechanical properties. *Toughness*, a combination of stiffness and strength, is a measure of how much energy is needed to rupture a fiber. Spider silk is about five times as tough as high-grade steel wire of the same weight and about twice as tough as synthetic fibers such as Kevlar (used in body armor). Spider silk's *tensile strength*, the resistance of a material to breaking when stretched, is as great as that of Kevlar and greater than that of high-grade steel wire. *Torsional resistance*, the capacity of a fiber to resist twisting (an absolute requirement for draglines used as safety lines), is higher for spider silk than for all textile fibers, including Kevlar. It also has superior *elasticity* and *resilience*, the capacity of a material when it is deformed elastically to absorb and then release energy. Scientists estimate that a 2.54 cm (1 in)-thick rope made of spider silk could be substituted for the flexible steel arresting wires used on aircraft carriers to rapidly stop a jet plane as it lands.

Overview:

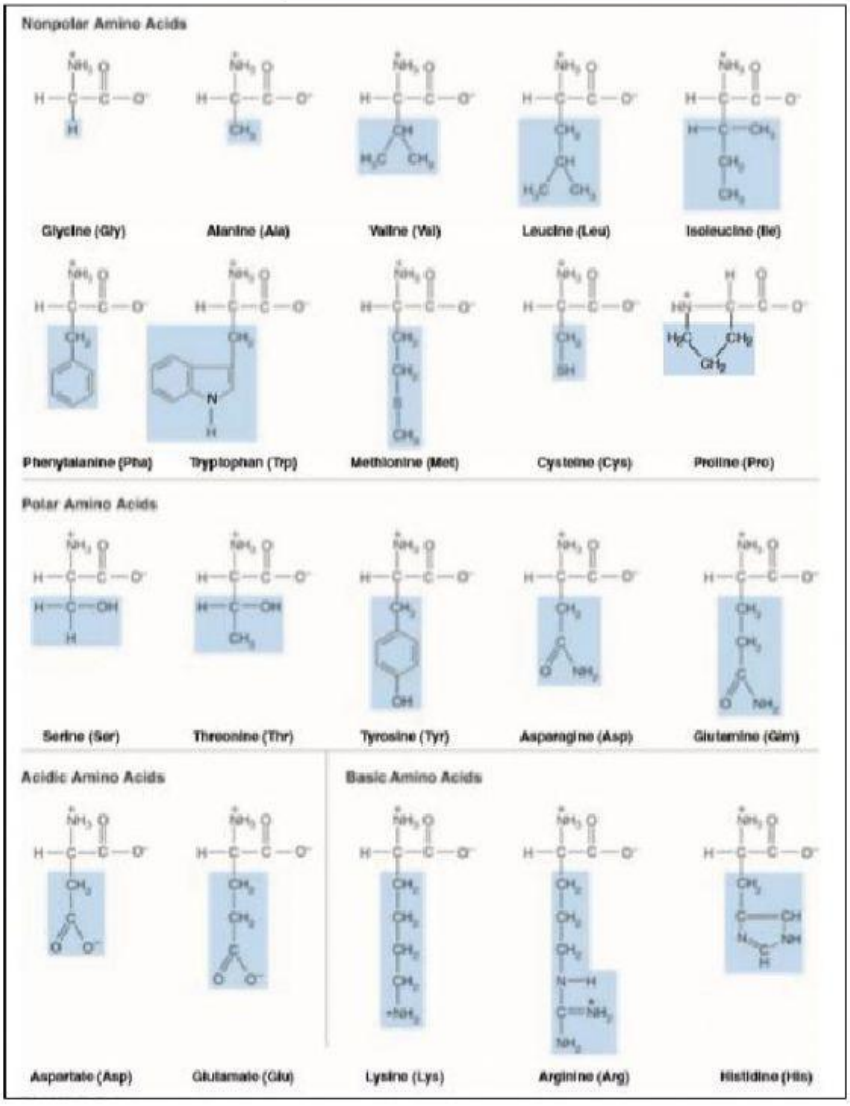
Proteins are a diverse group of macromolecules (*see Figure to the right*). Proteins are composed of one or more amino acids. There are only 20 different amino acids in the human body! Yet, the genomes (DNA code) of most organisms specify the amino acid sequences of thousands or tens of thousands of proteins.



Amino acids can be theoretically linked to form protein molecules in any imaginable size or sequence. For example, in a protein made of 100 amino acids, there are trillions of possible protein sequences. However, only a small fraction is actually produced in all living organisms. An important reason for this is because there is a complex set of structural and functional properties of naturally occurring proteins. This selection has evolved over billions of years in response to natural selection.

Proteins serve as structural materials in all living organisms (ex: actin and myosin in animal muscle cells. Proteins are also involved in diverse functions, such as catalysis (speeding up of chemical reactions), metabolic regulation (communication vs hormones), transport (muscle fibers), and defense (antibodies from white blood cells).

To the right you will find the structures of various amino acids found in the human body. **Note**: All amino acids have the elements CHON in their chemical makeups.



Key Concept Questions: Proteins

1. What elements (atoms) are proteins made of?

2. What types of food can you find proteins in?

3. What are the building blocks (monomers) of proteins?

4. How many different building blocks are there in total? *(HINT: It's a low number!)*

5. About how many different types of proteins can be found in the human body?

   a. Dozens b. Hundreds c. Thousands d. Millions

6. What types of bonds connect these building blocks?

7. What is a chain of amino acids called?

   Poly __ __ ___ ___ ___

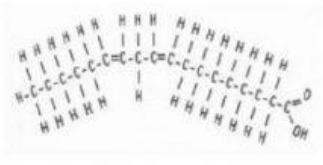
8. Why are there so many different shapes of proteins?

9. What type of catalyst is made of proteins?

10. _____ are made of proteins and help fight disease.

11. _____ are made of proteins and help you feel emotions.

12. Which picture below represents a protein:



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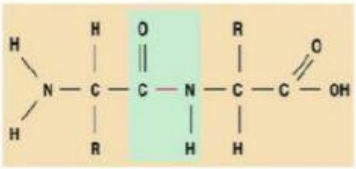

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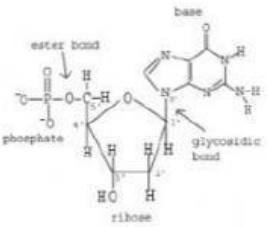

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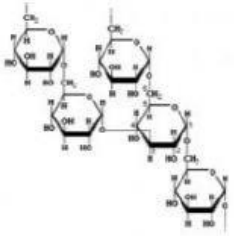

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