Amino Acids and Proteins

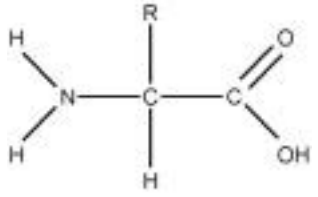
A. Proteins are the most diverse of the large biological molecules.

1. Proteins function as enzymes, in cell movements, as storage and transport agents, as hormones, as anti-disease agents, and as structural material throughout the body.

2. Proteins are polymers of amino acids: small organic molecules with an amino group, an acid group, a hydrogen atom, and one of twenty varying "R" groups.

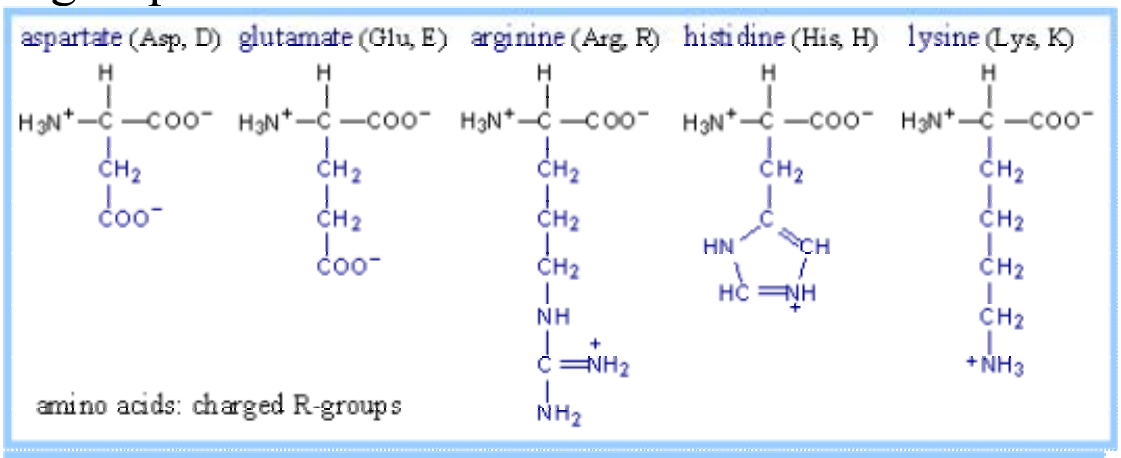
Structure of Proteins

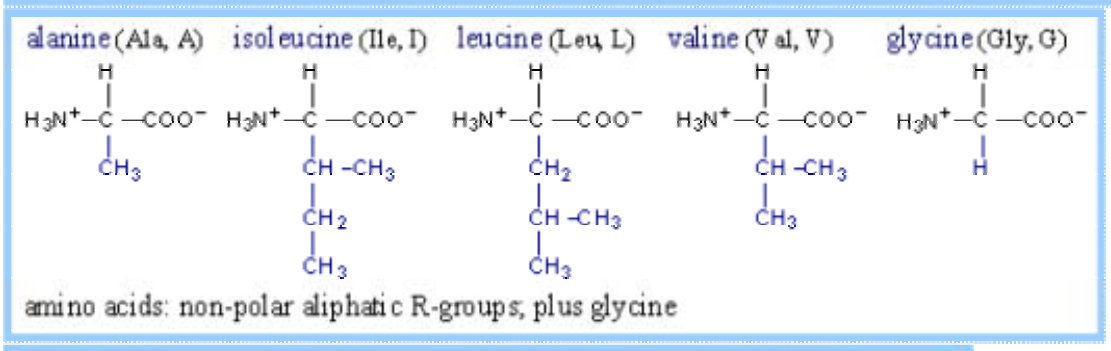
1. Primary structure is defined as the chain (polypeptide) of amino acids.

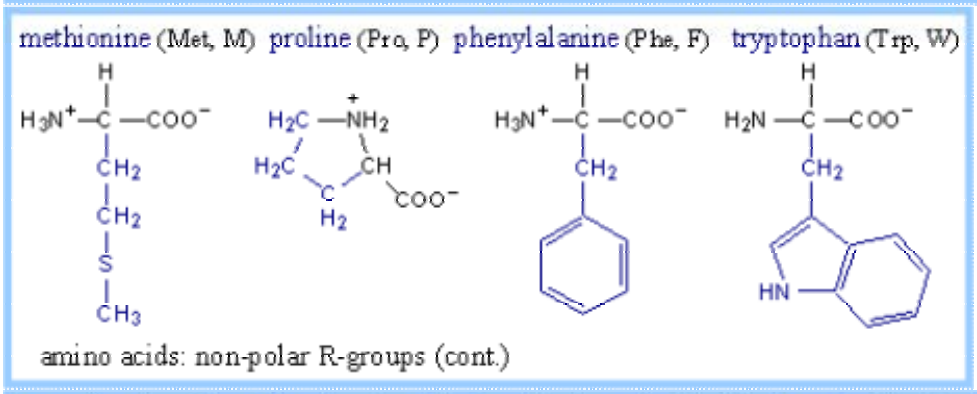


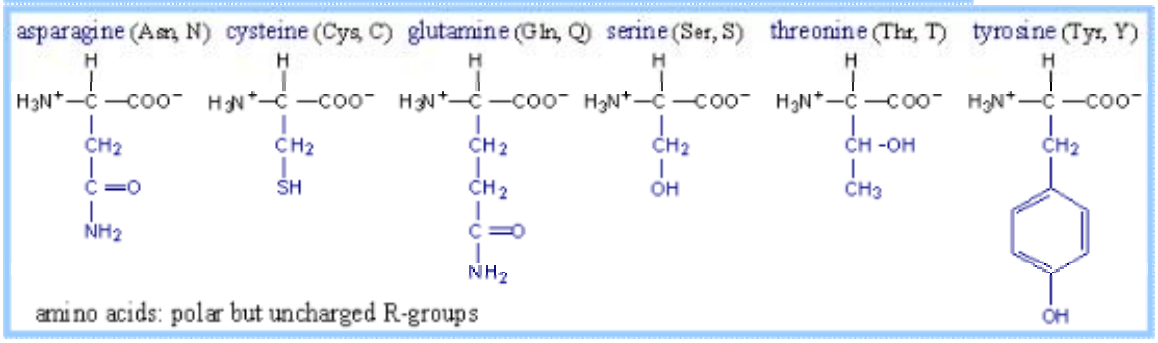
Each amino acid has an amino group (NH_2), as well as a carboxylic acid COOH.

R groups can be:

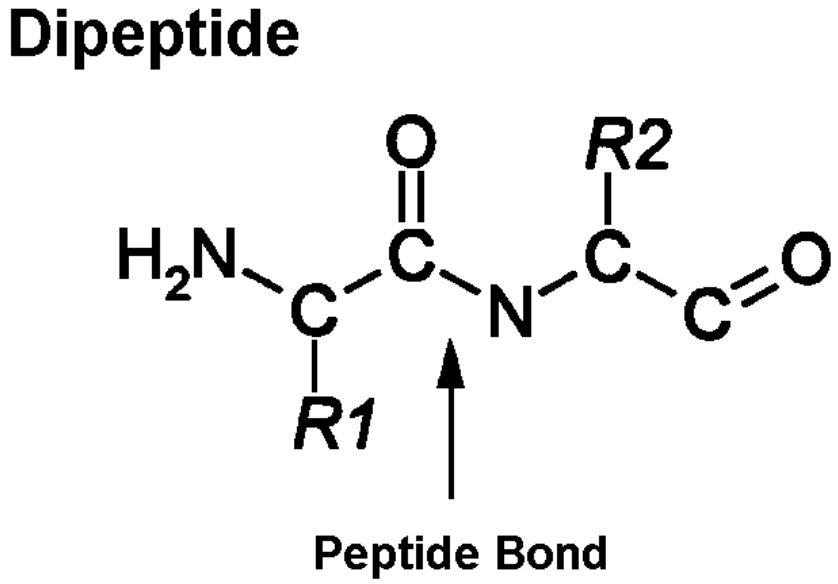




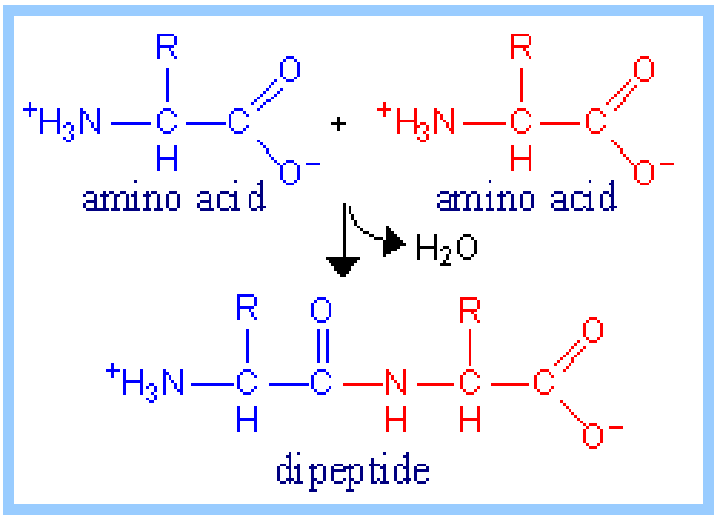




2. The amino acids are linked together in a definite sequence by peptide bonds between an amino group of one and an acid group of another- making a peptide bond.

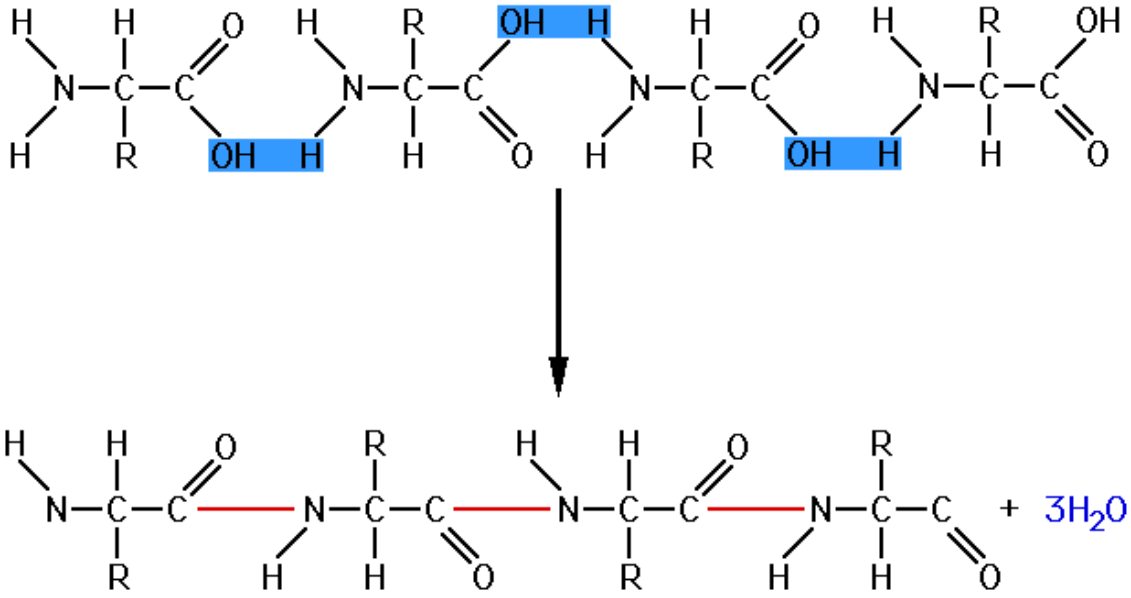


How does this happen?



The OH group from the COOH of one amino acid is removed, as is the H from the amino group of the other amino acid. So… water is removed to join the molecules; called <u>dehydration synthesis</u>

For many amino acids, it would look like this……



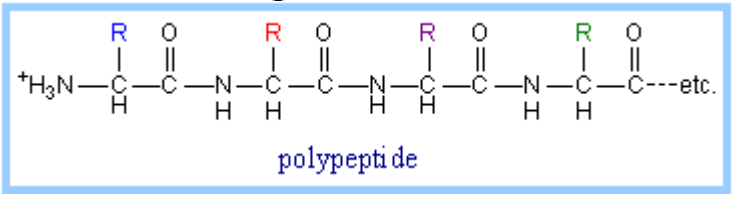
Three-Dimensional Structure of Proteins

1. The primary structure determines the protein's shape, and ultimately its function in two ways:

a. by positioning groups so that hydrogen bonds can form between different amino acids in the chain;

b. by putting R groups in positions that force them to interact.

It is the amino acid sequence:



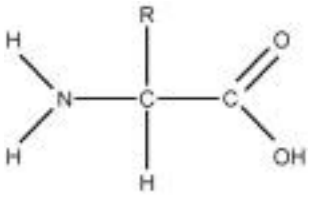
2. Secondary structure is the helical coil or sheet-like array that will result from hydrogen bonding of side groups on the amino acid chains.
(draw in)

3. Tertiary structure is caused by interactions among R groups and results in a complex three-dimensional shape.
(draw in)

4. Final Protein Structure (Quaternary structure): a complexing of two or more polypeptide chains to form globular or fibrous proteins.
(draw in)

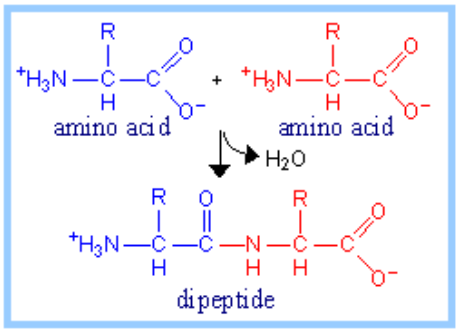
Name:_____
Circle period: 1, 2 , 3

Amino Acid and Protein Structure Modeling with Molecule Kits and Register Receipts

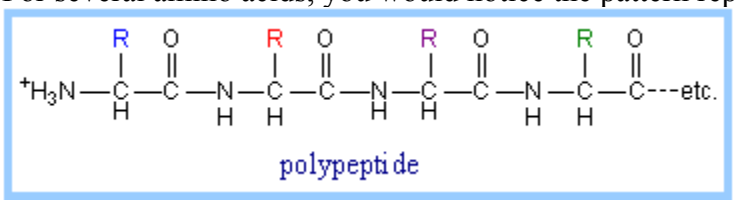


On your receipt paper, you will be connecting 7 amino acids with peptide bonds as discussed in class. For the molecules of amino acid that you make on the receipt paper, number the R groups 1 through 7, respectively.

Remember that the amino groups connect in the following fashion, removing water.



For several amino acids, you would notice the pattern repeating, as below.



When you have completed drawing the polypeptide made up of 8 amino acids with a partner, follow the directions below, answering the questions as you work.

1. Take the amino acid sequence that you have created, and color each amino acid as follows-

amino acid 1: red
amino acid 2: blue
amino acid 3: green
amino acid 4: yellow
amino acid 5: red
amino acid 6: purple
amino acid 7: green
amino acid 8: pink

This is the primary protein structure- the straight chain of amino acids.

How does this model differ from the molecule kit model?

Which do you think is more accurate- the paper model, or the molecule kit model? Explain.

2. To form the primary structure into a secondary structure, twist the primary sequence into a helix (spiral staircase), keeping the colored units on the outside. This is the secondary structure. (There is another possibility called a pleated sheet- we will return to that idea).

Does your secondary structure look like your partner's?

Should everyone's look alike? Why or why not?

What causes the helix to form?

3. To make the tertiary structure from the secondary structure, attach the secondary structure to itself by attaching amino acid 1 to amino acid 5, and amino acid 3 to amino acid 7. This may be tricky!

Compare your tertiary structure to your partner's. Is it the same? Explain.

What are some reasons why the secondary structure would fold in on itself?

4. To make the quaternary structure, attach amino acid 4 of one protein to amino acid number 4 of the other protein.

Compare your final quaternary structure to another group's in class. Are they the same? Explain.

Why do you think the protein chains interact?

Jennifer Tareila
July 14, 2004
Lesson Plan: Proteins

Title: Protein structure
Audience: 11th and 12th grade Human Biology (some previous chemistry; all have had biology)
Goals: To introduce amino acid and protein structure
Student Objectives:

At the end of the lesson, students will be able to:

1. Recognize amino acid structure as compared to other biomolecules (carbohydrates, lipids, and nucleic acids as covered in class)
2. Demonstrate how peptide bonds are created given two amino acids, both on paper and with molecules
3. Compare paper models with molecule kit models of a polypeptide.
4. Explain primary, secondary, tertiary, and quaternary structure of proteins, and why each forms.

Purpose: Proteins play an important role in living things. In a human biology course, proteins are discussed during several major topics presented during the year. Students need to understand what, exactly, proteins are composed of, and their overall structure in organisms. In addition, dehydration synthesis reactions are also a common biological reaction, and should be likewise recognized. This section would be the first section covered on the four major classes of biomolecules.

Materials/ Resources:

Overhead of attached notes
Molecule kits
Colored pencils
Glue sticks
Cash register tape

Prior preparation: Collection of materials

Time required: One class period (48 minutes); perhaps half a class more.

Procedure: Students should have read the corresponding section in text the previous evening. Begin class by discussing the role of proteins in the body. As you go over the outline notes (on overhead or board), ask students to explain what they know.

Have students get molecule kits, and build a generic amino acid (have students use a halogen atom as the R group). Explain that there are twenty different amino acids, and that there are subsequently twenty different R groups. Show students the different R groups, explaining the nature of the types of groups (which will H bond, ect). Have students join the amino acids, until they have a chain of about 6 or seven amino acids. Leave the polypeptide assembled for the following sequence.

Have students begin the worksheet on protein structure; end class a few minutes early for discussion. Go over the questions asked during the activity. Assign homework.
Assessment: Quiz (attached)

Name:_____

Biology II

Protein Quiz

1. Which element would I not find in proteins?
   A. Nitrogen B. Oxygen
   C. Phosphorus D. Carbon

2. Proteins may function as:
   A. structural units (build things)
   B. hormones
   C. movement/ transport molecules
   D. all of the above are functions of proteins

3. The building blocks of proteins are:
   A. nucleic acids
   B. lipids
   C. monosaccharides
   D. amino acids

4. When two amino acids are joined:
   A. water is added
   B. water is removed
   C. an –OH is removed
   D. an –OH is added

5. The primary structure of a protein is:
   A. the ά-helix or β-pleated sheet
   B. the sequence of amino acids
   C. the individual amino acids
   D. the folded ά-helix or β-pleated sheet
   E. none of the above

6. The secondary structure of a protein is
   A. the ά-helix or β-pleated sheet
   B. the sequence of amino acids
   C. the individual amino acids
   D. the folded ά-helix or β-pleated sheet
   E. none of the above

7. The quaternary structure of a protein is
   A. the ά-helix or β-pleated sheet
   B. the sequence of amino acids
   C. the individual amino acids
   D. the folded ά-helix or β-pleated sheet
   E. none of the above

8. Which elements are capable of hydrogen bonding?
   A. nitrogen only
   B. oxygen only
   C. fluorine only
   D. oxygen and nitrogen
   E. oxygen and fluorine
   F. fluorine and nitrogen
   G. all three: nitrogen, oxygen, and fluorine

9. There are ____ possible "R" groups in proteins.
   A. 5 B. 16 C. 20
   D. 26 E. 30

10. In proteins, the ____ group is responsible for determining the structure.
    A. "R"
    B. Amino
    C. Ketone
    D. Carboxyl
    E. Hydroxyl
    F. β

11. Draw out two separate amino acids, and then join them making a dipeptide.