STUDY GUIDE - *Ch. 5.4 - Proteins have a diversity of structures, resulting in a wide range of functions.* **NAME:** _____

- **PHYSICALLY PRINT OUT this PDF and HANDWRITE (with a black or blue pen) your answers directly on this PDF.** *Typed or digitally-written work is **not** accepted. Do **not** answer questions on separate paper.*
- **Importantly, study guides are NOT GROUP PROJECTS!!!** *You, and you alone, are to answer the questions as you **read** your assigned textbook. You are **not** to share answers with other students. You are **not** to copy any answers from any other source, including the internet.*
- **Get in the habit of writing LEGIBLY, neatly, and in a medium-sized font.** *AP essay readers and I will skip grading anything that cannot be easily read so start perfecting your handwriting, and don't write so large you can't add all the relevant details and key elaborations in the space provided.*
- **SCAN physical documents in color and with good resolution. Then, upload your final work as PDFs to Archie.** *Avoid uploading dark, shaded, washed-out, sideways, or upside-down scans of homework. Keep completed physical study guides organized in your biology binder to use as future study and review tools.*
- **READ FOR UNDERSTANDING and not merely to complete an assignment.** ***First**, read a section quickly to get an overview of the topic covered. Then, read it a **second** time slowly, paraphrasing each paragraph **out loud** and analyzing every figure. Finally, read it a **third** time as you answer the study guide questions if assigned and start building your memory. Try to write answers out in your own words, when possible, and try to purposefully and accurately use all new terminology introduced.*

1. Proteins have variety of functions. Study figure 5.13. List the eight general **types of proteins** categories, explain their basic function, and provide one example of each.

I. Type:

Function:

Example:

II. Type:

Function:

Example:

III. Type:

Function:

Example:

IV. Type:

Function:

Example:

V. Type:

Function:

Example:

VI. Type:

Function:

Example:

VII. Type:

Function:

Example:

VIII. Type:

Function:

Example:

2. Some proteins, known as **enzymes, are biological catalysts**. From your studies in chemistry, what is a catalyst?

3. a. **Every different type of protein has a unique three-dimensional shape. In the world of proteins, if you change a protein's shape, you change its function or make in non-functional!** What are the generic names for the monomers and the polymers of proteins?

b. **Proteins are true polymers** and, thus, macromolecules. What are the **chains of protein monomers** called, formed by a series of dehydration synthesis reactions?

c. What is the name of the **covalent bond that forms between two monomers** in the chain?

d. What is a **protein**?

4. a. **The monomers of proteins are amino acids.** Sketch an amino acid here **AND** label the alpha or central carbon, the amino group, the carboxyl group, and R group.

b. How many different types of amino acids are there?

c. What **makes one amino acid have different physical and chemical properties from another amino acid?**

5. a. **All amino acids contain an hydrophilic amino group and hydrophilic carboxyl group**, which ionize when in water at the pH inside cells. Still, some amino acids are referred to as **non-polar** and some as **polar**, some polar ones even being considered **acidic** and some **basic**. These adjectives refer to the R (side) group of the amino acids. Which of these four categories of amino acids are **considered hydrophobic and which hydrophilic**?

Hydrophobic Amino Acids:

Hydrophilic Amino Acids:

b. Why do **some of the polar amino acids act as acids**?

c. Why do **some of the polar amino acids act as bases**?

d. This is not a question, but an action to take. **Study figure 5.14 closely.** Though you do need to know how to draw a generic amino acid, you will not have to memorize how to draw each different type of amino acid. Note though the names of the amino acids. Notice too that each amino acid can be referred to with either a three-letter or one-letter abbreviation. Finally, look for similarities between R (side) groups within the same category of amino acid. **Nonpolar amino acids have R groups (side chains) that are pure hydrocarbons in most cases, whereas polar amino acids contain R groups with polar bonds while amino acids that are considered fully charged contain a carboxyl group or an amino group that ionize in the cell.** If you were given an amino acid with a particular R group, could you place it in the correct group just by noting the properties of that side chain? Make sure you would be able to.

6. a. What are the **TWO products of the chemical reaction (dehydration synthesis reaction) in which two amino acids are covalently bonded together**? Explain.

Two products = _____ + _____

Explanation =

b. **According to convention, amino acids are drawn with the amino group on the left and carboxyl on the right.** Draw the amino acid Phenylalanine and the amino acid Methionine below.

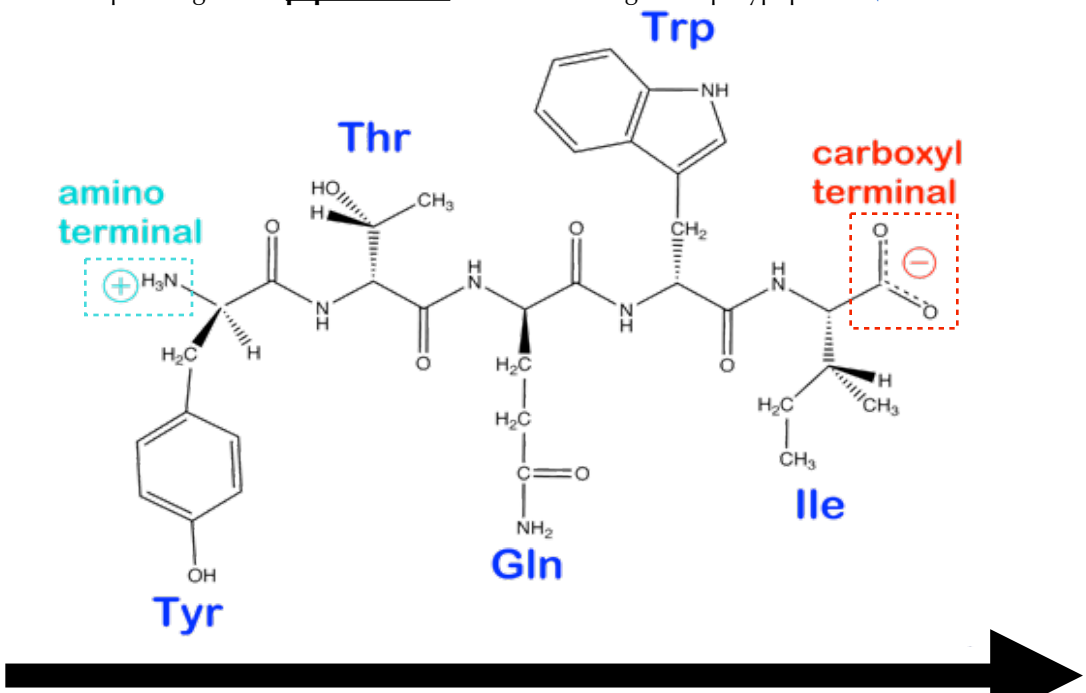
Phenylalanine	**Methionine**

c. On your drawing in 4.b., circle the particular specific **carboxyl group and amino group where the dehydration synthesis reaction will occur** when these two amino acids get covalently bonded together through a peptide bond. Some of the atoms you circled will be removed from the monomers & will join to form a water molecule.

d. Now, draw below the **resulting dipeptide** that forms once the dehydration synthesis reaction has occurred between Phenylalanine and Methionine. *(Try to draw first **without** copying from your textbook. When done, check the accuracy of your answer to see if you drew the peptide bond correctly by referencing Figure 5.15.)*

e. Draw arrows pointing to the **peptide bonds** in the following three polypeptides. ***(Notice the N- and C-termini).***

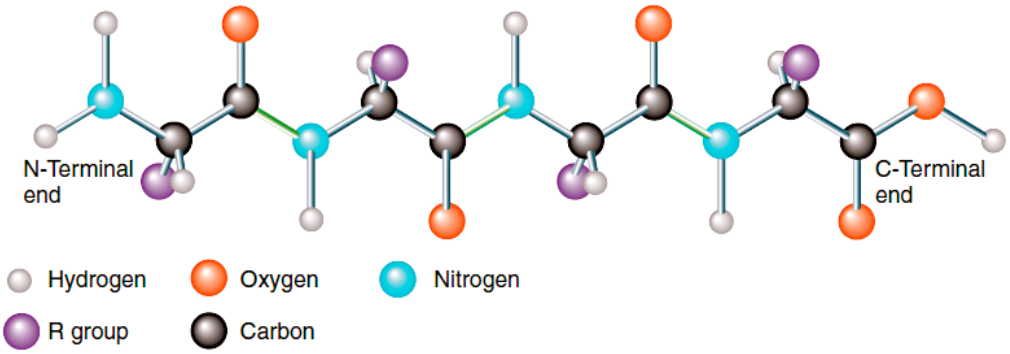
1.



The **amino terminal** of a polypeptide is the beginning of the sequence. The sequence is written starting with the residue at the amino terminal and ending at the **carboxyl terminal** residue. For this example:

Tyr-Thr-Gln-Trp-Ile

2.



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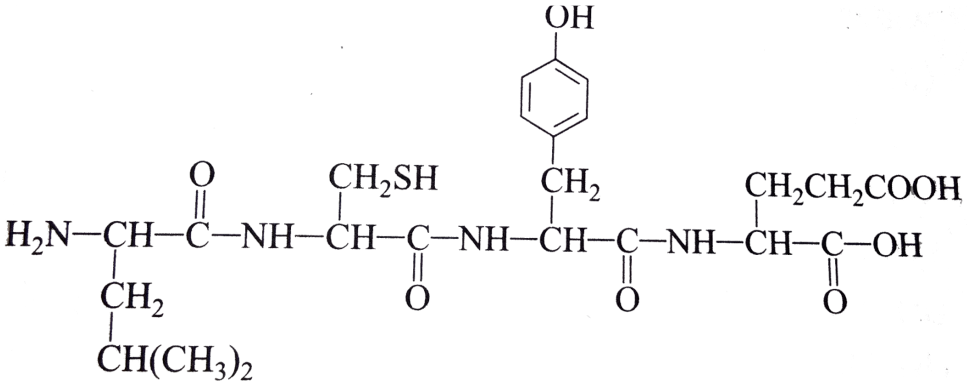
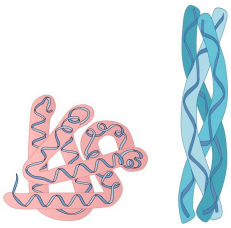


f. On molecule 3 of question 6.e, highight in a color or shade with a pencil the **polypeptide backbone** of this molecule and put square boxes around the **side chains** that stick off this polypeptide backbone.

7. Explain why a polypeptide is **not** the same as a protein.

8. What **determines the three-dimensional structure of any protein**?

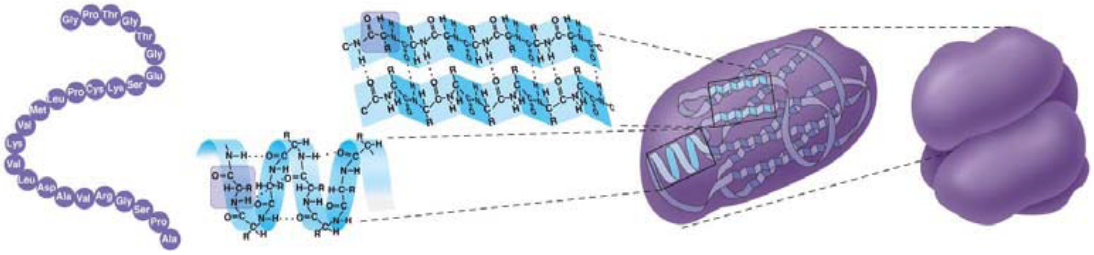
9. What is the difference in general shape between **globular versus fibrous proteins**?



Globular Proteins:

Fibrous Proteins:

10. Always remember, **the shape of a protein, determines the function of the protein.** This is because the function of a protein depends on its ability to recognize and bind to other molecules. **Study Figure 5.18 VERY well, highlighting the four levels of protein folding or structure!**



1° **2°** **3°** **4°**

1° = PRIMARY STRUCTURE

a. What is the **primary structure of a protein**?

b. What **determines the primary structure of the polypeptides of proteins**?

2° = SECONDARY STRUCTURE

a. What is the **secondary structure of a protein**?

b. What **determines the formation of secondary structures in the polypeptides of proteins**?

c. Explain what **α helices** are **and** how they form.

d. Explain what **β pleated sheets** are **and** how they form.

3° = TERTIARY STRUCTURE

a. What is the **tertiary structure of a protein**?

b. Multiple interactions determine the tertiary structure of a polypeptide of a protein. Weak **hydrophobic interactions** (a.k.a. **hydrophobic exclusions**) play a role in determining tertiary structure. Explain what these are.

Think: Recall from **Ch.2**, what is the name of the weak van der Waals interaction that occasionally occurs between nonpolar molecules (and so may occur between nonpolar R groups situated close together)?

c. **Disulfide bridges** are another, albeit very strong, interaction that help a polypeptide take on its tertiary level of structure. Explain what these are **and** how they are formed.

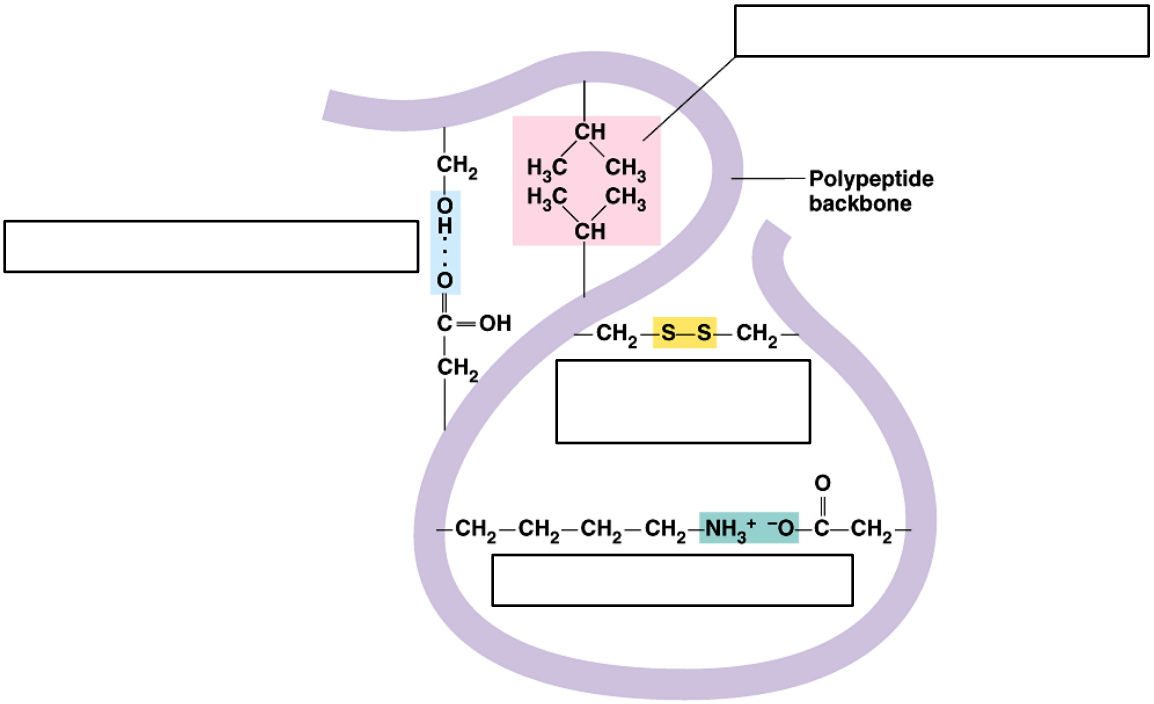
d. What **additional two types of molecular interactions help determine a proteins tertiary level of folding**?

Interaction #1 =

Interaction #1 =

Note: Tertiary level of folding is determined not only by interactions (attractions & repulsions) between R groups within a polypeptide, but also by interactions of R groups with the surrounding environment (the aqueous solution).

e. Now that you know the four **interactions between amino acid R groups (side chains) that help determine the tertiary level of protein folding**, identify the molecular interactions in the illustration below.



4° = QUATERNARY STRUCTURE

a. What is the **quaternary structure of a protein**?

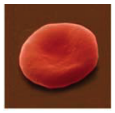
b. Do all proteins exhibit quaternary structure?

c. How does **hemoglobin** exhibit quaternary structure?

11. a. **Change the shape of a protein and the protein changes in its ability to function!** The primary sequence of a protein is determined by the information in our DNA. **Changes in DNA (mutations) can, thus, alter primary structure, which can alter protein shape and/or protein behavior.** What kind of a disorder is **sickle-cell disease**?

b. Study Figure 5.19. What **causes sickle-cell disease**? *(Explain not only what causes changes to the protein in question and how those changes in protein shape change protein behavior inside the cell, but also how those changesin protein shape change the shape of the entire cell too)*

c. What are two **symptoms of sickle-cell disease**?




1.

2.

12. a. Besides **DNA mutation that can change the primary structure of a protein**, protein shape can be changed by denaturation. What does **denaturation mean**?

b. What **three environmental factors can alter the weak chemical bonds and interactions within the protein** that helps it maintain its functional shape?

I.

II.

III.

c. Why is protein **denaturation important**?

13. a. Review Figure 5.21. What is **X-ray crystallograpy** used for?

b. How does the process work?

14. Where would you expect a polypeptide region rich in the amino acids valine, leucine, and isoleucine to be located in a folded polypeptide? Explain

*(Check your answer to #14 by going to the **Ch.5.4 Concept Check Question #4** answer in Appendix A)*