Biology 1305
Modern Concepts in Bioscience (ICB Textbook)

Hello and welcome to the weekly resources for BIO-1305 - Biology 1

This week is Week 10 of class, and typically in this week of the semester, your professors are covering the topics below. If you do not see the topics your particular section of class is learning this week, please take a look at other weekly resources listed on our website for additional topics throughout the semester.

We also invite you **to look at the group tutoring chart on our website to see if this course has a group tutoring session offered this semester.**

If you have any questions about these study guides, group tutoring sessions, private 30 minute tutoring appointments, the Baylor Tutoring YouTube channel, or any tutoring services we offer, please visit our website www.baylor.edu/tutoring or call our drop in center during open business hours (M-Th 9am8pm on class days at 254-710-4135).

KEYWORDS: Protein Structure, Primary, Secondary, Tertiary, Quaternary, Side Chains

TOPIC OF THE WEEK

Protein Structure and Function

One of the biggest themes in biology is that structure determines function. This week, we will begin to understand how this idea applies to proteins, and why the structure of proteins is so important.

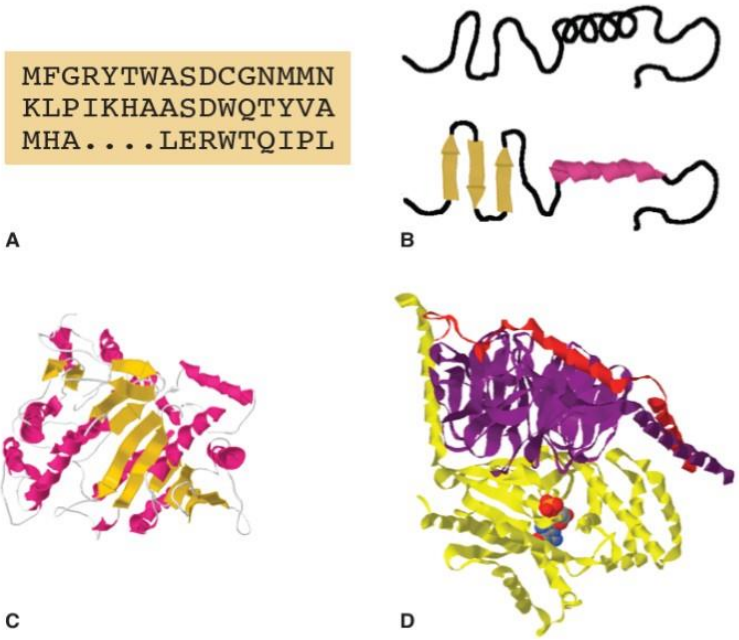
All proteins have at least three layers of structural information that allow them to fold and function correctly.

Primary Structure: the amino acid sequence of a protein; The primary structure of a protein contains all the information that is needed for the protein to form its final 3D structure

Secondary Structure: describes local structures such as alpha helices and beta strands which are part of the overall folded protein

Tertiary Structure: the overall 3D shape of the entire protein

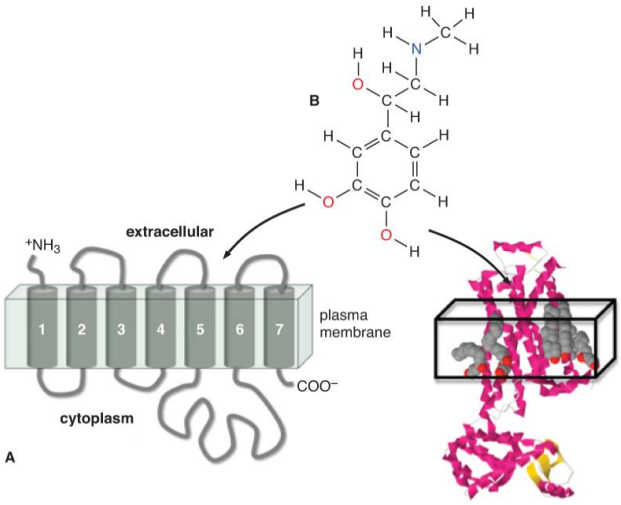
Some proteins also have **quaternary structure,** which occurs when multiple protein subunits assemble to form a larger multi-unit structure.



We can see the four levels of protein information displayed in this figure. **A** shows us the amino acid sequence, which makes up the primary structure. **B** shows us the secondary structure, which includes *alpha helices* (the spirals) and *beta strands* (the zig zagged arrows). **C** shows us the tertiary structure, which includes all secondary structures and also any additional structures and folds, to make up the final (native) three dimensional form of the protein. **D** shows us the quaternary structure. Notice how three different protein subunits (red, purple, and yellow) are interacting to form a larger protein complex.

All amino acids are made up of a carboxylic acid, an amine group, and a variable **side chain.** Each amino acid has a different side chain, and the various properties of each side chain determine which properties each amino acid has and how it behaves and interacts with other molecules in the cellular environment.

HIGHLIGHT #1: Epinephrine Receptor



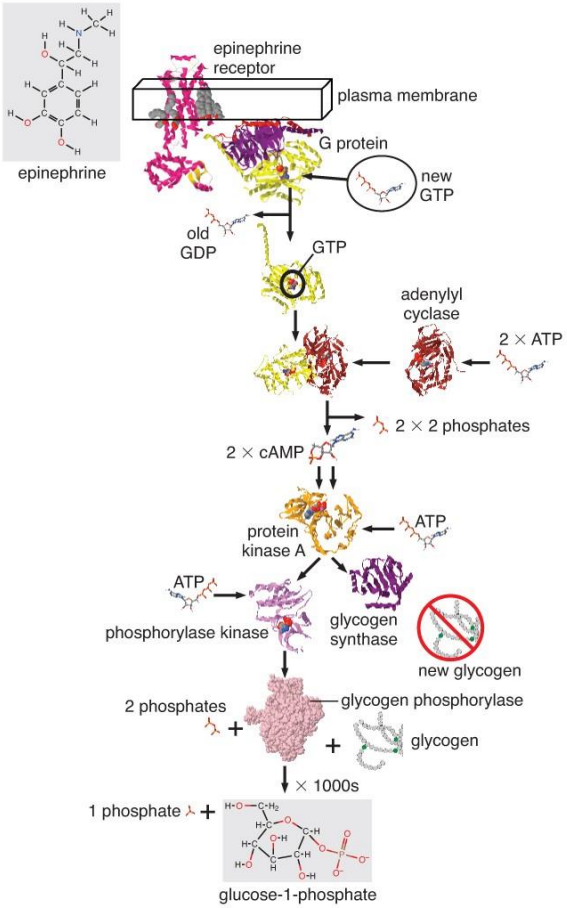
This figure shows the **receptor** which epinephrine binds to in order to initiate a cellular response. **Figure A** shows us the structure of the receptor. Notice how it is made up of seven subunits. We call these subunits transmembrane domains because they span the entire cell membrane. Each of these domains is made up of alpha helices (see previous section). **Figure B** shows epinephrine, which binds to the receptor on the extracellular side in a specific binding pocket.

Interestingly, the majority of the mass of the receptor is found in the intracellular region, or on the inside of the cell. In order for the information from the signaling molecule (epinephrine) to cross the membrane, the receptor changes the shape of its intracellular domain after epinephrine binds. The change of shape is initiated outside the cells when epinephrine binds, but it is propagated to the large cytoplasmic domain inside the cell, almost like a domino effect. In this way, the epinephrine's signal is transferred to the inside of the cell and is able to initiate a cellular response even though the molecule itself does not enter the cell.

HIGHLIGHT #2: Signal Transduction

Section 7.2 presents a case study of the epinephrine signal transduction pathway. Epinephrine is a hormone which is secreted by your adrenal glands as part of your body's fear response (you may have heard this described as your **fight or flight** response). When your body thinks you are in a dangerous or scary situation, epinephrine is released. The end result of this pathway is that your liver cells will be stimulated to release glucose, which will provide all of your cells and muscles with the energy you need to face what your body perceives as a dangerous situation.

This figure provides an overview of the epinephrine signal transduction pathway. We will focus more on the details later; for now, the important thing to understand is that a **signal transduction pathway** conveys molecular information from the extracellular environment to the intracellular environment and ultimately initiates a **cellular response.** Epinephrine is the ligand, which is a small molecule that binds to a receptor. One important feature of signal transduction pathways is **amplification. Signal amplification** increases the intensity of the signal throughout the pathway so that one ligand can ultimately initiate the release of a very large number of molecules of the final product. This occurs at various steps in the pathway each time one molecule is able to activate many other molecules.



CHECK YOUR LEARNING

(Answers below)

1) What is the ligand in the signal transduction pathway we studied?
2) Why are only specific cells (such as liver cells) affected by epinephrine if it is released in the bloodstream and can circulate throughout the body?
3) What level of protein structure do we identify beta strands as part of?
4) What is the part of an amino acid that gives it its properties? Why is this group important?

THINGS YOU MAY STRUGGLE WITH

- Although there are at least three levels of organization that describe the information in a protein, remember that the primary structure contains all of the information that is needed for the protein to fold into its final tertiary and quaternary structures
- Epinephrine binds to the receptor on the extracellular side of the cell, but due to changes in the structure of the receptor, this change is propagated to the intracellular (cytoplasmic) environment across the membrane
- All amino acids contain the same groups, and the only group that varies is the side chain, which determines the properties of the amino acid

ANSWERS

1) Epinephrine
2) Only cells that have the specific receptor for epinephrine will be affected. Epinephrine cannot bind without this receptor.
3) Secondary structure
4) Side chain (aka the R group): this group is what makes each amino acid unique and it determines the properties of the amino acid.