This course supports the 5 performance assessment tasks for Biochemistry. The course covers 6 competencies and represents 3 competency units.

Introduction

Overview
Biochemistry covers the structure and function of the four major polymers produced by living organisms. These include nucleic acids, proteins, carbohydrates, and lipids.

This course focuses on application! Be sure to understand the underlying biochemistry in order to grasp how it is applied. By successfully completing this course, you will gain an introductory understanding of the chemicals and reactions that sustain life. You will also begin to see the importance of this subject matter to health.

Getting Started
Welcome to Biochemistry! You are encouraged to take notes and reflect on the material throughout the course of study. Our primary learning resource for this course is Thinkwell along with videos made by the course instructors. The Thinkwell sections appear under the Watch and Read Notes and View headers and contain video lectures, notes, exercises, animations and summaries. Competency will be demonstrated by the successful completion of five performance tasks. Information on each task can be located under the Assessment tab.

Watch the following video (6:56) for an introduction to this course:

Note: To download this video, right-click the following link and choose "Save as...": download video.

Teaching Dispositions Statement
Please review the WGU Statement of Teaching Dispositions.

Course Instructor Assistance
As you prepare to demonstrate competency in this subject, remember that course instructors stand ready to help you reach your educational goals. As subject matter experts, mentors enjoy and take pride in helping students become reflective learners, problem solvers, and critical thinkers. Course instructors are excited to hear from you and eager to work with you.

Successful students report that working with a course instructor is the key to their success. Course instructors are able to share tips on approaches, tools, and skills that can help you apply the content you're studying. They also provide guidance in assessment preparation strategies and troubleshoot areas of deficiency. Even if things don't work out on your first try, course instructors act as a support system to guide you through the revision process. You should expect to work with course instructors for the duration of your coursework, so you are welcome to contact them as soon as you begin. Course instructors are fully committed to your success!
Competencies and Objectives

This course provides guidance to help you demonstrate the following 6 competencies:

- **Competency 208.5.1: DNA, RNA**
  The graduate demonstrates how nucleic acid polymers can transform cells and transmit information within the cell.
  - Compare the structure of nucleic acids.
  - Explain the concept of genes and genomes.
  - Summarize the concept of DNA replication.
  - Summarize the concepts of transcription and translation.
  - Demonstrate how mutations will alter the product of transcription and translation.
  - Demonstrate recessive and dominant inheritance patterns.
  - Explain what epigenetic mechanisms are and how they influence the genome.
  - Summarize the DNA repair mechanism.
  - Briefly summarize the PCR mechanism and its application.
  - Taking a sequence of DNA (gene) into consideration, predict the likely polypeptide chain that would result from its expression.
  - Summarize the action of drugs in inhibiting transcription and translation.
  - Describe the most likely biochemical mechanism underlying a disease process based on the symptoms and physical findings manifested by the patient.

- **Competency 208.5.2: Amino Acids and Peptide Bonds, Protein Structure**
  The graduate can construct models of the structure and function of amino acids and peptide bonds, predict ionization of an amino acid, demonstrate peptide bond breaking, and demonstrate how protein structure affects susceptibility or resistance to disease.
  - Demonstrate how a peptide bond is made or broken through dehydration or hydrolysis respectively.
  - Describe the differences between primary, secondary, tertiary, and quaternary protein structure.
  - Predict amino acid structure based on pH.
  - Compare the effect of different conditions on the process of protein folding.
  - Demonstrate how protein structure contributes to protein function.
  - Explain how protein structure contributes to disease.
  - Describe the most likely biochemical mechanism underlying a disease process based on the symptoms and physical findings manifested by the patient.

- **Competency 208.5.3: Protein Function - Myoglobin and Hemoglobin**
  The graduate constructs models of various states of hemoglobin, demonstrates how changes in the usual configuration of hemoglobin can lead to molecular disease, and distinguishes between the chemical structure and function of hemoglobin and myoglobin.
  - Construct a model to demonstrate the physiological roles of a specified oxygen-carrying protein.
  - Explain how pH influences the function of hemoglobin.
Compare the chemical structures of myoglobin and hemoglobin that reflect their functional differences.

Explain what biochemical markers are and the role they play in the diagnosis and treatment of certain disease processes.

Describe the most likely biochemical mechanism underlying a disease process based on the symptoms and physical findings manifested by the patient.

- **Competency 208.5.4: Enzymology and Catalytic Mechanism**
  The graduate constructs models of enzymes, demonstrates how enzymes act as a catalyst in a reaction and factors that influence this reaction, and solves enzyme and catalysis problems.
  - Describe enzymes and their function.
  - Interpret how enzyme activity is influenced by inhibitors and co-factors.
  - Recognize the enzymes, substrates, intermediates, and final products of a pathway.
  - Predict the result of changes to individual components of a pathway.
  - Describe how the presence or absence of enzyme activity affect the biochemical conditions in the body and how this, in turn, is manifested in a person.
  - Describe the most likely biochemical mechanism underlying a disease process based on the symptoms and physical findings manifested by the patient.

- **Competency 208.5.5: Carbohydrate Metabolism, Adenosine Triphosphate (ATP)**
  The graduate constructs models of carbohydrates, demonstrates metabolism of carbohydrates, and demonstrates how adenosine triphosphate (ATP) is essential to energy transfer in the cell and how irregularities in ATP synthesis in the cell can cause cytopathologies.
  - Describe how sugars, amino acids, and fatty acids are used to create ATP through the process of aerobic metabolism.
  - Explain how ATP and the energy it provides facilitate cellular processes.
  - Demonstrate how defects in energy metabolic pathways cause disease.
  - Explain how carbohydrates are stored and mobilized in the body.
  - Describe the most likely biochemical mechanism underlying a disease process based on the symptoms and physical findings manifested by the patient.

- **Competency 208.5.6: Lipids**
  The graduate constructs models of fatty acids and demonstrates why lipids are essential to the functioning of cells.
  - Construct a virtual model of the chemical structure of saturated and unsaturated fatty acids.
  - Analyze how the structure of lipids contributes to their function.
  - Identify the structure and function of a cell membrane.
  - Demonstrate how defects in lipid metabolism cause disease.
  - Describe the most likely biochemical mechanism underlying a disease process based on the symptoms and physical findings manifested by the patient.

**Preparing for Success**
The information in this section is provided to detail the resources available for you to use as you complete this course.

**Learning Resources**

The learning resources listed in this section are required to complete the activities in this course. For many resources, WGU has provided automatic access through the course. However, you may need to manually enroll in or independently acquire other resources. Read the full instructions provided to ensure that you have access to all of your resources in a timely manner.

**Automatically Enrolled Resources**

You can access the learning resources listed in this section by clicking on the links provided throughout the course. You may be prompted to log in to the WGU student portal to access the resources.

**Thinkwell**

You will access Thinkwell materials at the activity level within this course. This web-based resource includes multimedia video lectures, review notes, interactive animations, and sample exercises.

*Note: The quizzes are recommended as an exercise, but they are not graded as part of your task.*

**25-Step Plan**

If you'd like help pacing yourself to finish Biochemistry on time, we recommend following our **25-Step Plan** OR explore our weekly cohort options on the left hand panel by clicking "Explore Cohort Offerings."

**25-Step Plan**

Our 25-Step Plan provides step-by-step instructions that lead you to course completion. There are six topic areas; each topic is broken into four or five parts. We recommend setting a goal of completing one part per day. There is a planner that you can personalize to set goal dates for completion. Print it out, and spend some time thinking about a schedule that will work for you. This plan provides the most flexibility for students with irregular schedules. Click **WGU Biochemistry** to begin!

The 25-Step Plan places an emphasis on flexibility, while the cohorts provide a more structured timeline. Please choose what works best for you!

*Please note that both options provide you with the learning resources from the course of study. We don't want you to duplicate your efforts, so if you choose one of these two options you don't need to navigate through the course of study.*

**Contact a Biochemistry Course Instructor**

Please see the following document for a schedule of when mentors are available to take your call:
"Biochemistry Course Instructors Group and Individual office Hours"

If you would like to schedule an appointment with one of your course instructors, you can do so by accessing the team calendar at Biochemistry Team Calendars.

Live Events-Biochemistry

Access:

- **Live Events Calendar**

Click on a specific live event listed in the calendar for full details.

Submitting Your Work for Grading

In order to submit your work for grading in Taskstream, you will prepare your documents using Microsoft Word or some free programs such as Google Documents, Open Office or other similar software. If you use Google Documents, be sure to convert the file into a PDF document prior to submission for grading.

Type your text responses in full sentences and paragraphs in the document. For the tasks that require a diagram or model, you will draw (free hand) or create tangible models accordingly, take a picture of these and insert them into the same document. Ensure that the images and text are visible to the graders.

APA Formatting

When submitting your work, please follow the APA formatting rules for your references and in-text citations. You do not have to follow the APA formatting rules for the layout of the document.

1. You MUST have an in-text citation for EACH reference on your references list. If you have included something on your references list, you will need to put an in-text citation on the slide where you used the information that you learned from that particular reference.

2. You will use references as a way of letting your evaluator know where you learned the information, not something you will use only when directly quoting a source.

3. Do not directly quote sources! If you are having difficulty putting anything in your own words, please set up an appointment with a course instructor so you can receive help to understand the material better. If you must directly quote something, do not quote more than five words in a row.

Creating Your References and In-Text Citations:

1. Use Citation Machine to help you create your references and in-text citations. Enter the information that you know and the website will do the rest. All you have to do is copy and paste it into your document!

2. To reference Thinkwell, remember the following:
from which you obtained the information

2. In-text is: (Wolfe, 2000)

3. If you are using more than one reference by the same author which is published in the same year, please organize them in the reference list alphabetically by the title of the article or chapter. Then, assign letter suffixes to the year in both the full length reference as well as the in-text citation.

3. To reference CM videos, remember the following:
   1. You will find the reference listed beneath each embedded video in this course.
   2. The in-text citation, if using one video by the same author, will be as follows: Author, (Year).
   3. If using more than one video by the same author, the in-text citation will be as following: Author, Title..., (Year). (You will use only the first word of the title.).

Using Taskstream

Uploading your Submission to Taskstream
When you have answered all the task questions, you are ready to submit your work in Taskstream! Make sure your work is in a document or PDF format so it can be checked for originality.

Note: To download this video, right-click the following link and choose "Save as...": download video.

Originality

Checking for Originality

It is very important for you to check for originality prior to submitting a task in biochemistry. Your work must meet the 30/10 rule: no more than 30% of your work can be identical to other work, and no more than 10% of your work can match a single source.

Please access the following document to learn more about the 30/10 rule and other important information about originality at WGU:

- Taskstream Turnitin.com Integration

In order to check your work for unoriginal content, you must submit all documents as PDF files.

Please access the following document to find out how to convert different files into PDF files.

- How to Save Files as a PDF

Watch the following video to learn how to check your work for originality. Keep in mind that if your work is over the 30/10 rule, it will not be evaluated.
Pacing Guide
Following this schedule will help you complete the course in the suggested timeframe.

Week 1 – Introduction to Biochemistry
- Chemistry Fundamentals

Week 2 – Nucleic Acids at Work
- Nucleic Acids Introduction
- DNA Replication
- RNA and Protein Synthesis
- Performance Task – DNA and RNA (Task 1)

Week 3 – Protein Structure
- Linking Amino Acids to Form Proteins
- Performance Task – Protein Structure (Task 2)

Week 4 – Protein Function
- Hemoglobin and Myoglobin
- Performance Task – Protein Function (Task 3)

Week 5 – Metabolism
- Enzymes
- Carbohydrates
- Cellular Respiration
- Performance Task – Enzymology and Metabolism (Task 4)

Week 6 – Lipids (Task 5)
- Lipids Introduction
- Performance Task – Lipids

Introduction to Biochemistry

Biochemistry is the study of the chemical structures and reactions that sustain life. To successfully study and understand biochemistry, you need to have a solid understanding of chemistry and biology.

Chemistry Fundamentals
To understand the more complicated molecules in the human body, you need to understand the basic principles of chemistry. If you believe you are already competent in these areas, skip to the multiple-choice exercises for each subsection of Thinkwell.

An Introduction to Atoms
Watch and Read Notes

- **2.1.1 Atomic Structure: SPONCH and the Atom** (8:34)
- **2.1.2 Electrons, Orbitals, & Shells** (10:44)

Atoms and Bonding

Watch and Read Notes

- **2.2.2 Ionic and Covalent Bonds** (10:44)
- **2.2.3 Polar Covalent Bonds, Hydrogen Bonds, and Van der Waals Interactions** (11:33)

Properties of Water

Watch and Read Notes

- **2.3.1 Water: Hydrogen Bonding, Solubility, and Specific Heat** (11:11)
- **2.3.3 Water: Hydrophilic and Hydrophobic Substances** (13:40)
- **2.3.4 Dissociation of Water & pH** (12:41)

Carbon Chemistry

Watch and Read Notes

- **2.4.1 Carbon Chemistry and Isomers** (12:26)
- **2.4.2 Functional Side Groups** (11:10)

In section 2.4.2 Functional Side Groups, there is a link to the Functional Side Group Chart. You can use this as reference during your studies.

Nucleic Acids at Work

In this section, you will learn about the structure of DNA and DNA replication. You will also study the structure of RNA and discover its role in protein synthesis.

Nucleic Acids Introduction

Nucleic acids are chains of nucleotides, and they make up DNA and RNA.

An Introduction to Genetic Material

Watch and Read Notes

- [Nucleic Acids: An Introduction to Genetic Material](#) (10:49)

Read

- Nucleic Acids through RNA Structure, pages 57–62 of Chapter 3 Structure & Function in
Reflect

- The basic structure of a nucleotide.
- Differences between the DNA and RNA structures.

**DNA Replication**

All cells divide during their lifespan. The ability of cells to duplicate themselves accurately and efficiently is essential. Before a cell divides, its DNA needs to be copied so that each cell receives the same DNA information. DNA is copied through a process called DNA replication.

**The Process of DNA Replication**

Watch and Read Notes

- **DNA Replication** (sound version)
- 6.4.1 [*Events at the Replication Fork: The Leading Strand*](#) (12:33)
- 6.4.2 [*Events at the Leading Strand, Part II*](#) (10:31)
- 6.4.3 [*Events at the Replication Fork: The Lagging Strand*](#) (08:53)
- 6.4.4 [*Proofreading, End Replication, and Telomeres*](#) (12:40)

Reflect

- What does it mean for DNA replication to be semi-conservative?
- What is the function of DNA polymerase during DNA replication?
- What other enzymes are needed, and what are their roles?
- How does the synthesis of the leading and lagging strands differ?

**Events of DNA Replication**

Watch and Read Notes

- 6.4.5 [*DNA Replication: A Summary*](#) (11:15)

Read

- DNA Replication, pages 92–100 of Chapter 5 Flow of Genetic Information in *Biochemistry Free and Easy*

Watch

- Part I: DNA replication (06:50)

*Note: View the video in full screen at 720p for best results.*

http://wgu.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=47a74859-22cd-4ed6-b58b-c733e6a34dfb

- Part II: DNA Replication (05:19)

*Note: View the video in full screen at 720p for best results.*

*Reference: Thompson, J. (2014) Part II: DNA Replication*

http://wgu.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=b377c785-4283-4b9d-af8f-8483ef842213

- Part III: DNA Replication (09:27)

*Note: View the video in full screen at 720p for best results.*


http://wgu.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=13d48cc5-f503-459d-b12d-3825fa84d5d3

Watch

- **Replication: Mechanism of Replication** (1:05 minutes)

**DNA Replication Diagram**

Do

Create a diagram or series of diagrams showing how DNA replicates. Make sure all of the important steps are shown and that all of the important parts are labeled, with detailed labels for all enzymes (i.e. end in -ase) that explain what the enzymes are doing in 4–5 words. Include the following:

- DNA
- replication fork
- helicase
- single-stranded binding proteins
- leading strand
- lagging strand
- 5' and 3' ends
DNA polymerase III
Okazaki fragments
primase
RNA primer

Take a picture of your diagram and include it as a part of your Task 1 submission.

Watch

- How to create your diagram (03:04)

Keep in mind that the diagram and text in the video are not designed to teach content and is incorrect.

*Note: To download this video, right-click the following link and choose "Save as...": [download video](#).

*Note: View the video in full screen at 720p for best results.

Reference: Yatherajam, G. (2013) *Diagramming DNA*


**DNA Ligase Diagram**

Do

Create a diagram of the last step of DNA replication, showing what DNA ligase does to complete the process. This diagram should include:

- DNA
- Okazaki fragments
- DNA polymerase I
- DNA ligase

Take a picture of your diagram and include it as a part of your task 1 submission.

**RNA and Protein Synthesis**

Your body needs hundreds of thousands of proteins to function properly. A gene, which is a segment of a DNA strand, codes for the synthesis of a specific protein. While DNA is used to store this genetic information, the primary job of RNA is to use the genetic information stored in DNA to synthesize specific proteins. There are three primary types of RNA (mRNA, tRNA, and rRNA) used in the process of protein synthesis.

**Transcription and Translation**
Watch and Read Notes

- 6.5.1 Transcription and Translation: An Overview (10:32)
- 6.7.2 Protein Synthesis: An Overview (9:21)

View

- Animation on DNA Transcription and Translation (sound version)

Watch

- DNA Transcription (00:40)
- DNA Translation (01:49)

Do

Take notes on the role of RNA polymerase in the process.

Read

- Transcription, pages 106–113 of Chapter 5 Flow of Genetic Information in Biochemistry Free and Easy
- Translation, pages 121–126 of Chapter 5 Flow of Genetic Information in Biochemistry Free and Easy

Watch

- Transcription (01:52)
- Translation (02:04)

Role of mRNA Diagram

Do

Create a diagram showing how mRNA is made and also used to create polypeptides/proteins. Depict where in the cell activities are occurring, and include the following components:

- Transcription
  - DNA
  - mRNA
  - RNA polymerase
  - nucleus
- Translation
  - Ribosome
  - mRNA
  - tRNA
  - amino acids
- protein (or polypeptide)
- cytoplasm

Take a picture of your diagram and include it as a part of your performance task on nucleic acids at work.

Watch

- Diagramming DNA/RNA (3:05)

Keep in mind that the diagram in this video is not designed to teach content and is incorrect.

Note: To download this video, right-click the following link and choose "Save as...": download video.

Note: View the video in full screen at 720p for best results

https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=e1138c06-c567-4a24-862e-9761f95846e9

Death Cap Mushrooms

Read

- Acute Liver Failure caused by Amanita phalloides poisoning from The International Journal of Heptology

Watch

- Death Cap Mushrooms (05:59)

Note: To download this video, right-click the following link and choose "Save as...": download video.

Note: View the video in full screen at 720p for best results

Reflect

- Which processes of protein synthesis are affected by death cap mushroom toxin?
- How does this affect the organism?

**DNA and RNA Performance Task**

You are now ready to complete the DNA and RNA performance task (Task 1). To view the Task 1 instructions and to submit your work, click on the assessment tab to access Taskstream. Contact the biochemistry course instructors if you have any questions as you work on the task.

**Protein Structure**

You will study the amino acids that make up proteins, the peptide bonds that hold these amino acids together, and the three-dimensional characteristics of protein structure.

**Linking Amino Acids to Form Proteins**

A protein is a biopolymer that consists of a chain of amino acid monomers that are held together with peptide bonds.

**Amino Acids**

Watch and Read Notes

- 2.7.1 *Proteins: Amino Acids and the Peptide Bond* (09:34)
- 2.7.2 *Amino Acids: The R Groups* (10:51)

In the above section 2.7.2 Amino Acids: The R Groups, there is a link to *Naturally Occurring Amino Acids* that describes the molecular structure of the 20 amino acids coded by DNA: Read

- Proteins, pages 42–43 of Chapter 3 Structure & Function in *Biochemistry Free and Easy*
- *Essential Amino Acids*

Reflect

- What is an amino acid?
- What is a peptide bond?
- What is a polypeptide?
- What are the essential amino acids?

**Chemical Properties of Amino Acids**

Visit

- *The Chemistry of Amino Acids*

Click through the list of amino acids on the right. Read through the chemical and the physical properties for each amino acids listed. If there is another link available under Chemistry Properties, click through and learn more about that amino acid.

Watch
• Chemical Characteristics of Amino Acids (05:02)

*Note: View the video in full screen at 720p for best results.*


https://wgu.hosted.panopto.com/Panopto/Pages/Embed.aspx?id=75cdbe43-4ca0-4709-b50c-69df4b64b0aa&v=1

**Do**

After completing this activity, choose an essential amino acid of which you will make a model for your performance task for protein structure. Choose an essential amino acid that has chemical characteristics that are easy to describe. Chemical characteristics can include the following:

- hydrophobic/hydrophilic (this is the same as non-polar/polar)
- flammability (found in a material safety and data sheet (MSDS) for the amino acid)
- reactivity (a reaction that can occur on the side chain)
- pKa of charged sidechain groups
- heat of combustion
- oxidation state

**Amino Acid Model**

**Watch**

- Structure of Amino Acids (09:33)

*Note: To download this video, right-click the following link and choose "Save as...": download video.*

*Note: View the video in full screen at 720p for best results.*


https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=e6507ba4-d491-4dd8-a633-a01027c88572

• Building an Amino Acid Model (05:54)

*Note: To download this video, right-click the following link and choose "Save as...": download video*
Note: View the video in full screen at 720p for best results.


https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=66359c94-8149-4a0e-aa7d-4e33bf6b927b

Do

Using household products, construct a three-dimensional model of an essential amino acid. Make sure your model is of an essential amino acid, not a conditionally essential or nonessential amino acid, or it will be returned for revision. Represent both single and double bonds and each atom that makes up the essential amino acid. Take a picture of your model for your performance task on protein structure.

Traditional colors for atoms include green for carbon, white for hydrogen, red for oxygen, and blue for nitrogen, but it is not required for you to follow this color pattern in your model.

**Dehydration and Hydrolysis**

Watch

- Peptide Bond Formation (03:00 minutes)

Watch

- Dehydration and Hydrolysis (05:32)

Note: To download this video, right-click the following link and choose "Save as...": download video.

Note: View the video in full screen at 720p for best results.


https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=b78d41cc-a691-49ff-a315-d40f30a48307

Do

Create one or two diagrams showing how the peptide bond is broken and formed using a complete chemical equation. For a chemical equation to be complete, it must include the
structures of the reactants, an arrow indicating the direction of the reaction, and the structures of the products of the reaction. You will need to take a picture of these diagrams for inclusion in your performance task on proteins.

**Protein Structure**

Watch and Read Notes

- 2.7.3 *Primary and Secondary Structure* (09:49)
- 2.7.4 *Tertiary Structure* (09:40)
- 2.7.5 *Quaternary Structure* (08:36)
- 2.7.6 *Protein Structure: A Summary* (06:36)

Read

Primary Structure through Quaternary Structure and Forces Stabilizing Structure, pages 43–51 and 55 of Chapter 3 Structure & Function; skip the section "Ramachandran plots" in *Biochemistry Free and Easy*

Watch

- Bonds that Stabilize Protein Tertiary Structure (08:59)

*Note: To download this video, right-click the following link and choose "Save as...":* [download video](https://wgu.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=b8686074-1a41-428c-ab18-037fa5e070e3).

*Note: View the video in full screen at 720p for best results.*

*Reference:*

https://wgu.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=b8686074-1a41-428c-ab18-037fa5e070e3.

Reflect

- What are the primary, secondary, tertiary, and quaternary structures of proteins?
- What are an alpha-helix and a beta-sheet?
- What are the forces (bonds, interactions) that stabilize protein structure?

**Protein Structure Drawing**

Do

Create a diagram or series of diagrams of the different levels of protein structure. Make sure to label the important points at each level. Your diagram(s) should include:
Primary structure
Secondary structure (both types)
Tertiary structure
Quaternary structure

Take a picture of your diagram(s) for inclusion in your performance task on protein structure.

**Mad Cow Disease Affects Protein Structure**

Watch and Read Notes

- 11.14.1 *Viruses and Prions: Living or Nonliving* (Start at 11:20 minutes into the video until the end) (02:21)

Read

- Irreversible Denaturation and Prions and Misfolding, pages 56–57 of Chapter 3 Structure & Function in *Biochemistry Free and Easy*

Visit

- Mad Cow Disease
- Prions

Reflect

- What are prions?
- How does Mad Cow Disease affect protein structure?
- What are the effects of changing a protein's structure?
- What is aggregation and how does it affect BSE?

Read

- *Unraveling the Mystery of Protein Folding*

Watch

- Bovine Spongiform Encephalopathy (BSE) (09:10)

*Note: To download this video, right-click the following link and choose "Save as...":* [download video](http://wgu.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=3c62aca1-68ff-4033-9f02-f07a8)
Mad Cow Disease Prevention

Do

Visit the following web pages to learn about what the United States has done to prevent the spread of BSE:

- BSE (Bovine Spongiform Encephalopathy, or Mad Cow Disease)
- BSE Control Measures

Reflect

What measures should be implemented in a country that does not already have regulations in place?

Protein Structure Performance Task

You are now ready to complete the Amino acids and Peptide bonds, Protein structure Performance task (Task 2). To view the Task 2 instructions and to submit your work, click on the assessment tab to access Taskstream. Contact the biochemistry course instructors if you have any questions as you work on the task.

Protein Function

Proteins have a number of important roles in living organisms. For example, proteins can be enzymes, antibodies, or fibers, and they can transport materials throughout the body. In this section, you will focus on proteins as oxygen carriers in the bloodstream.

Hemoglobin and Myoglobin

Hemoglobin binds to molecular oxygen in the lungs and transports it to the myoglobin in the muscles. Myoglobin stores molecular oxygen until required for metabolic oxidation.

Watch and Read Notes

- 2.3.5 Hemoglobin as a Buffer (8:54)
- 12.4.3 Human Gas Exchange: The Roles of Respiratory Pigments (11:40)

Read

- Other Protein Structural Features through Bohr Effect, pages 51-53 of Chapter 3 Structure & Function in Biochemistry Free and Easy

Reflect

- How many oxygen molecules bind hemoglobin?
- What part of hemoglobin do the oxygen molecules bind?

Hemoglobin Model
Do

Using pipe cleaners, yarn, beads, or other household materials, prepare a model of hemoglobin showing how oxygen is carried by the molecule.

Watch

- Fake Smemoglobin (05:52)

*Note: To download this video, right-click the following link and choose "Save as...": download video.*

*Note: View the video in full screen at 720p for best results.*


https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=4c4992fd-99ab-4255-911e-6ece1ec7c7bf

This model will need to contain the proper number of the following items with accurate labels:

- subunits
- heme groups
- iron molecules
- oxygen molecules

Take a picture of your model. You will need this picture for your performance task on Hemoglobin.

**Comparison of Oxygenated and Deoxygenated Hemoglobin**

Visit

- Hemoglobin: Studying the T to R Transition

Watch

- Oxygenated vs Deoxygenated Hemoglobin (04:56)

*Note: To download this video, right-click the following link and choose "Save as...": download video.*

*Note: View the video in full screen at 720p for best results.*

https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=7de31b64-41e8-4dae-9177-1f6543b9f048

**Comparison of Hemoglobin and Myoglobin**

Watch

- Hemoglobin and myoglobin (07:30)

*Note: To download this video, right-click the following link and choose "Save as...": [download video](https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=7de31b64-41e8-4dae-9177-1f6543b9f048)*


https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=18a5eba7-163e-4dce-8523-617e32445a9c

Do

Create a diagram that highlights the differences in structure between hemoglobin and myoglobin, starting with the differences in the number of subunits. At the bottom of the diagram, describe the function of each, once again highlighting the differences between the two proteins. Take a picture of your diagram for inclusion in your performance task on hemoglobin.

Watch

- Diagramming Smemoglobin (02:49)

*Note: To download this video, right-click the following link and choose "Save as...": [download video](https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=18a5eba7-163e-4dce-8523-617e32445a9c)*

https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=607c7264-8019-48e9-9d2d-7d35988598a9

**The Bohr Effect**

Watch

- The Bohr Effect (10:15)
Note: To download this video, right-click the following link and choose "Save as...": download video.

Note: View the video in full screen at 720p for best results.


https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=79e7a8cd-d935-4406-a097-83eae8479a8a

Reflect

- What causes a change in blood pH?
- How does a change in blood pH affect hemoglobin's ability to bind oxygen?

Bohr Effect Diagram

Do

Create a diagram (graph) showing how pH affects the ability of hemoglobin to bind oxygen with proper labels of the axes and lines on the graph. Take a picture of your diagram for inclusion in your performance task on hemoglobin.

Sickle-Cell Anemia

Watch

- Sickle Cell Anemia (01:30)

Visit

- What is Sickle Cell Anemia?
- How Does Sickle Cell Cause Disease?

Watch and Read Notes

- 9.7.3 Sickle Cell Anemia: The Case against Dominant and Recessive (09:35)

Watch

- Sickle Cell Anemia (09:07)

Note: To download this video, right-click the following link and choose "Save as...": download video.
Note: View the video in full screen at 720p for best results.


Reflect

- What type of inheritance is sickle cell anemia?
- What mutation causes sickle cell anemia?

Sickle Cell Anemia Diagrams

Do

Create three diagrams:

1. Diagram the difference between normal and sickle red blood cells.
2. Diagram the amino acid mutation of hemoglobin that causes sickle cell anemia.
3. Diagram the inheritance pattern of sickle cell anemia.

Take pictures of these diagrams for your performance task on hemoglobin.

Protein Function Performance Task

You are now ready to complete the Protein Function-Myoglobin and Hemoglobin performance task (Task 3). To view the Task 3 instructions and to submit your work, click on the assessment tab to access Taskstream. Contact the biochemistry course instructors if you have any questions as you work on the task.

Metabolism

Metabolism is the set of chemical reactions that occur in living organisms to sustain life. Metabolic processes can be classified as anabolism (the creation of complex molecules from simple ones) or catabolism (breaking down complex molecules into simple ones). In this section, you will learn about enzymes, pathways, and processes involved in both anaerobic and aerobic metabolism.

Enzymes

Many chemical reactions occur at a rate that is too slow to be useful. A catalyst is a substance that can be added to increase the rate of these reactions. An enzyme is a biomolecule that catalyzes chemical reactions.

Enzymes in Action

Watch and Read Notes

- 2.8.2 Activation Energy (08:25)
- 2.9.1 Enzyme Action: The Induced Fit Model (12:11)
Note: Dr. Wolfe defines enzymes as catalysts and further proceeds to explain that catalysts can either speed up or slow down reactions. This is not an entirely accurate interpretation. Please note that enzymes do not slow down reactions.

View

- Animation on Enzyme Action

Read

- Introduction through Active Site, pages 72–75 of Chapter 4 Catalysis in Biochemistry Free and Easy

Watch

- Enzymes and fructose breakdown (09:07)

Focus solely on the beginning section on enzymes.

Note: To download this video, right-click the following link and choose "Save as...": download video.


https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=c99ccc40-4cf5-4e53-b8b1-ccbb100a65c2

Lock and Key or Induced Fit Diagram

Do

Create a diagram showing the lock and key model of enzymatic activity. Be sure to show substrate, enzyme, and product in your diagram. You will take a picture of this diagram to include in your performance task on metabolism.

Activation Energy Diagram

Do

Create a diagram of a graph showing how enzymes affect the activation energy of a reaction. You will take a picture of this diagram to include in your performance task on metabolism.

Carbohydrates

Carbohydrates are the most common source of energy in living things. They are an important storehouse of chemical energy in plants (starch).

The Structure of Carbohydrates
Watch and Read Notes

- 2.5.1 Carbohydrates: Monosaccharides (10:22)
- 2.5.2 Polysaccharides: Energy Storage Molecules (10:10)

Read

- Carbohydrates through Glycosaminoglycans, pages 63–70 of Chapter 3 Structure & Function in *Biochemistry Free and Easy*

**Cellular Respiration**

Metabolic pathways are a series of chemical reactions that take a specific molecule and create a metabolic product to be used immediately, to be stored by the cell, or to initiate another metabolic pathway.

**Cells and Mitochondria**

Watch and Read Notes

- 3.1.3 Plant and Animal Cell Overview: The Basics (09:03)

Read

- Cells: The Bio of Biochemistry, pages 13–14 of Chapter 1 Cells, Water, and Buffers in *Biochemistry Free and Easy*

Watch and Read Notes

- 3.2.5 Mitochondria: Welcome Guests (11:21, but stop watching after 7:30 (skip the section on Endosymbiosis))

Reflect

Why is extra surface area important to the mitochondria? Consider this as you continue your studies on aerobic respiration and the electron transport chain.

**An Introduction to Cellular Respiration**

Watch and Read Notes

- 4.1.1 ATP Structure and Function (11:08)
- 4.1.3 Respiration: An Overview (13:09)

**Metabolism Overview**

Watch

- Metabolism (08:30)
GRT1 - Biochemistry
Course of Study

Note: To download this video, right-click the following link and choose "Save as...": download video.


https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=53a02622-f9d3-4aac-badb-4cbfe6498e94
Glycolysis and Fermentation

View

- Animation on Glycolysis and Fermentation

Read

- Glycolysis through Gluconeogenesis, pages 132–141 of Chapter 6
  Metabolism in Biochemistry Free and Easy

Fructose Metabolism

Read

- Carbohydrate Metabolism

This section describes the processes that occur in the liver. Notice that the enzyme aldolase B is used in the metabolism of fructose. The diagram to the left of this section titled Hepatic Glucose and Fructose Metabolism After Sugar Consumption illustrates how glucose and fructose are metabolized in the liver.

Enzymes have the suffix "ase" in their name. What other enzymes are needed for these processes?

Watch

- Role of Aldolase B (07:38)

Note: To download this video, right-click the following link and choose "Save as...": download video.


http://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=ce81226c-d293-4232-997e-fb2957530367
Hereditary Fructose Intolerance (HFI)
Read

- HFI Laboratory at Boston University
- Fructose Intolerance/Malabsorption and HFI

Watch

- Enzymes, and Fructose Metabolism (09:07)

Note: To download this video, right-click the following link and choose "Save as...": download video.

Note: View the video in full screen at 720p for best results.


https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=c99ccc40-4cf5-4e53-b8b1-ccbb100a65c2

View

- Hereditary Fructose Intolerance (HFI) (07:00)

Note: To download this video, right-click the following link and choose "Save as...": download video.

Note: View the video in full screen at 720p for best results.


http://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=4b4de18d-60f5-4866-a77c-b673ce51aab6

The Cori Cycle

Watch and Read Notes

- 4.2.3 Anaerobic Respiration: The Fermentation of Pyruvate (10:27)

View

- The Cori Cycle
Read

- Cori Cycle, page 141 of Chapter 6 Metabolism I in *Biochemistry Free and Easy*

Watch

- Cori Cycle (03:07)

*Note: To download this video, right-click the following link and choose "Save as...": download video.*


https://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=d0651973-3ef6-4c01-bb4d-4288c30e3ffe

Reflect

- Where does the lactate go after it is produced in the muscle during anaerobic respiration?
- What is the relationship between the Cori cycle and the citric acid cycle?
- What happens during the process of gluconeogenesis?
- What metabolic processes are connected with the Cori cycle?
- What does it mean to be a futile cycle?

**Aerobic Respiration**

Watch and Read Notes

- 4.3.3 *Glycolysis and the Krebs Cycle*

Read

- Citric Acid Cycle, pages 141–143 Chapter 6 Metabolism I in *Biochemistry Free and Easy*

Citric Acid Cycle Diagram

Watch

- The Centrality of the Citric Acid Cycle (08:56)

*Note: To download this video, right-click the following link and choose "Save as...": download video.*

*Note: View the video in full screen at 720p for best results.*
Do

Create a diagram of the citric acid cycle showing all the products produced, including any side products with arrows that are pointing away from the cycle.

Items to include are the following:

- What types of molecules feed into the citric acid cycle
- All substrates and products (names only, no need to draw structures)
- All enzyme names
- All side products produced:
  - NADH
  - FADH
  - GTP
- How citric acid cycle products participate in the electron transport chain
- Role of oxygen
- How oxygen is used in the electron transport chain
- Where and how ATP is produced

Take a picture of this diagram as you will include it in your performance task on metabolism.

**The Electron Transport Chain and Oxidative Phosphorylation**

Watch and Read Notes

Learn about how proton gradient is formed across the mitochondrial membranes and used to make ATP during aerobic metabolism.

- 4.4.1 Electron transport chain (11:37)
- 4.4.2 Oxidative Phosphorylation (09:50)

Watch

- Electron Transport Chain (10:26)

*Note: To download this video, right-click the following link and choose "Save as...": [download video].

*Note: View the video in full screen at 720p for best results.*

http://wgu.hosted.panopto.com/Panopto/Pages/Viewer/Default.aspx?id=9ec716ab-3610-47a4-bb37-41b4805935d6

Read


Reflect

- How is proton gradient created in the mitochondria?
- How does proton gradient lead to ATP synthesis?

Enzymology and Metabolism Performance Task
You are now ready to complete the Enzymology and Metabolism performance task (Task 4). To view the Task 4 instructions and to submit your work, click on the assessment tab to access Taskstream. Contact the biochemistry course instructors if you have any questions as you work on the task.

Lipids

Lipids are essential biomolecules used to store energy, to send chemical messages, and as a component for constructing membranes.

Lipids Introduction
Lipids include fats, oils, waxes, phospholipids, steroids, and other related compounds. They are primarily used to store energy, as signaling molecules, and they are a vital component of membranes.

The Structure of Lipids

Watch and Read Notes

- 2.6.1 Lipids: An Introduction (08:29)
- 2.6.2 Saturated vs. Unsaturated Fats (09:28)
- 2.6.3 Phospholipids, Waxes, and Steroids (10:13)

Watch

- Fatty Acid Structure (07:38)

Note: To download this video, right-click the following link and choose "Save as...": download video.

Reference: Sanders, J. (2013) Fatty acid structure
Fatty Acid Models

Do

Using ordinary household/craft materials, create two (2) three-dimensional models: one of a saturated fatty acid and one of an unsaturated fatty acid. Be sure to label or color-code the different atoms and make sure that all single and double bonds are clear. Take a picture of your models to include in your performance task on lipids.

Watch

- Model Building Lipids (05:02)

Note: To download this video, right-click the following link and choose "Save as...": [download video]


Lipids within the Plasma Membrane

Watch and Read Notes

- 3.1.4 Membranes: Basic Structure (10:24)
- 3.4.2 The Plasma Membrane: The Fluid Mosaic Model (08:16)

Plasma Membrane Drawing

Do

Draw a diagram of the fluid mosaic model of a plasma membrane. Be sure to include and label the following in your diagram:

- phospholipid
- hydrophobic part of the bilayer
- hydrophilic part of the bilayer
- membrane protein(s)

Take a picture of your diagram to include in your performance task on lipids.

Lipids are Energy
Watch

- Fatty Acid Oxidation (First 03:45)

Note: To download this video, right-click the following link and choose "Save as...": download video.

Reference

https://wgu.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=0a7a8229-fcac-43a8-913e-16871f29545a

Reflect

- How does your body use lipids to store energy?
- How do you create ATP energy from fats?

Lipids in the Body

Visit

- You Are What You Eat: The Role of Lipids and Carbohydrates in the Body

Vitamins A, D, E and K are fat soluble vitamins. They are present in trace amounts in our diets. Fat-soluble vitamins are essential to maintaining normal metabolic and biochemical functions in the body. Dietary fat is required for these vitamins to be absorbed from the gastrointestinal tract. Fat malabsorption may result in fat-soluble vitamin deficiencies. Please read the following article on fat soluble vitamins:

Read

- Fat Soluble Vitamins

Reflect

- Explain different ways in which fats are needed in the body.
- How would you expect the body to be affected if fats were not available?

No Fat Diets

Read

- Fatty Acid Molecules: A Role in Cell Signaling

Lipids Performance Task

You are now ready to complete the lipids performance task (Task 5). To view the Task 5
instructions and to submit your work, click on the assessment tab to access Taskstream. Contact the biochemistry course instructors if you have any questions as you work on the task.

**Final Steps**

Congratulations on completing the activities in this course! This course has prepared you to complete the assessment associated with this course. If you have not already been directed to complete the assessment, schedule and complete your assessment now.