

### **Medical Biochemistry (3 credits)**

**Instructor:** Yuliya Dobrydneva, Ph.D.

Time: 7.20 – 10.00 pm every Wednesday

Class meets online via zoom. Link to the class is on Bb in the Zoom tab on the left.

**Bulletin Description:** Biochemistry involves the study of the molecular composition of living cells, the organization of biological molecules within the cell, the structure and function of these biological molecules and the relationship between structure and function. Methods and approaches used in the present course will be correlated with the biochemical basis of human disease.

**Number of Credit(s):** 3

**Prerequisites:** Successful (minimum grade of C-) completion of Organic Chemistry I and Organic Chemistry II or equivalent courses

#### **Overall Course Learning Objectives:**

Course is divided into two units. The first unit examines the structure of cellular proteins and catalysis. The second unit focuses on cellular metabolism, the use of biomolecules as energy sources, and the synthesis of key cellular components and intercellular signaling molecules (hormones).

Upon successful completion of the didactic portion this course, the learner will be able to:

1. Create correct representations of 3D structure of biomolecules and spatial arrangement of functional groups
2. Describe the relationship between structure and function for main classes of biomolecules such as proteins, carbohydrates, nucleic acids and lipids.
3. Describe the roles of different classes of biomolecules in metabolism and the regulation and coordination of major metabolic pathways
4. Apply principles of inter and intramolecular interactions, enzyme catalysis, and structural analysis to biochemical reactions.
5. Analyze mechanism of enzymatic reactions and predict the products.
6. Identify molecular and biochemical basis of human disease states and explain biochemical mechanisms of disease.

**Required Text: Biochemistry: Jeremy M. Berg, John L. Tymoczko and Lubert Stryer 9th edition (2019).**

#### **Components of the Final Grade:**

Weekly quizzes, weighted evenly 20%

Exam I 20%

Exam II 20%

Exam III 20%

Final Exam (cumulative) 20%

- All exams, assessments and quizzes are administered via Bb only! Please be sure that you are proficient in basic functionality of Bb
- Course announcements are the main way to communicate with the class. Please be sure that your email is set up to receive announcements from GMU Bb.
- **All exams and quizzes are open book, open notes, open everything and untimed**
- The final exam will be given according to the university schedule.
- Important: **Exams are not repeatable. When you sign up for this class, you are committing to come to the class for exams.**
- Final exam will be administered during the finals week (TBA)

**Grading:** Students will receive a letter grade based on a 100-pointscale. An A+ is not awarded as a final grade. **No extra credit is allowed in this course!**

Letter grades for the course will be assigned as follows:

Letter grades for the course will be based on an overall % for the course and assigned as follows:

>92 A  
 >90 A-  
 >87 B+  
 >84 B  
 >80 B-  
 >77 C+  
 > 70 C  
 > 60 C-  
 F below 60

**Grades will not be rounded up. Therefore, if you receive a grade of 79.99, your grade will be C+, not a B-.**

#### **Expectations:**

- Let Dr. Dobrydneva know of your needs and constraints as early as possible **prior** to the assignment due dates.
- Notify Dr. Dobrydneva during the first week of the semester regarding course schedule conflicts due to military obligations and/or religious observances.
- **Any notifications beyond the first week of classes or after the exam/quiz due date has passed may not be approved and grade of zero will be entered.**

#### **LATE POLICY: PLEASE READ CAREFULLY!**

- Students should make every effort to submit/complete assignments on time.
- ***Any assignment that is not turned in on time, without prior arrangements with the instructor, will result in a zero grade for this assignment***
- Any arrangements to extend a deadline for an assignment must be made prior to the deadline.
- No extension will be granted after the deadline.
- Each student is allowed maximum of two (2) extensions per semester. Other requests may not be granted and grade of zero will be entered

- Any assignment/assessment that has not been completed by the end of the semester will receive a grade of zero.

**Required Equipment** –Since this is an online course and all assessments are complete through the computer, you need to have a computer with a **reliable** internet connection.

**Technology Requirements:** *It is a student's responsibility to ensure access to a reliable internet for quizzes, exams and lectures.*

- **Hardware:** You will need access to a Windows or Macintosh computer with at least 2GB of RAM and access to a fast and reliable broadband internet connection (e.g., cable, DSL). A larger screen is recommended for better visibility of course material. You will need speakers or headphones to hear recorded content and a headset with a microphone is recommended for the best experience. For the amount of Hard Disk Space required, when taking a distance education course, consider and allow for:
  1. the storage amount needed to install any additional software and
  2. space to store work that you will do for the course.

If you consider the purchase of a new computer, please go to [Patriot Tech](#) to see recommendations.

- **Software:** Many courses use Blackboard as the learning management system (LMS). You will need a browser and operating system that are listed compatible or certified with the Blackboard version available on the [myMason Portal](#) . See [supported browsers and operating systems](#). Login to [myMason](#) to access your registered courses. Some courses may use other learning management systems. Check the syllabus or contact the instructor for details. Online courses typically use [Acrobat Reader](#), [Flash](#), [Java](#), and [Windows Media Player](#), [QuickTime](#) and/or [Real Media Player](#). Your computer should be capable of running current versions of those applications. Also, make sure your computer is protected from viruses by downloading the latest version of Symantec Endpoint/Anti-Virus software for free [here](#).
- Students owning Macs or Linux should be aware that some courses may use software that only runs on Windows. You can set up a mac computer with Boot Camp or virtualization software so Windows will also run on it. Watch [this video](#) about using Windows on a Mac. Computers running Linux can also be configured with virtualization software or configured to dual boot with Windows.
 

Note: If you are using an employer-provided computer or corporate office for class attendance, please verify with your systems administrators that you will be able to install the necessary applications and that system or corporate firewalls do not block access to any sites or media types.

### Schedule Spring 2022 Medical Biochemistry BIOL 508

Schedule may be subject to change! Please stay tuned for the announcements.

<b>Week</b>	<b>Lecture dates</b>	<b>Assignment</b>
Week 1	January 26	Lecture <b>Enzymes</b> Weekly quiz
Week 2	February 2	Lecture <b>Enzyme kinetics</b> Weekly quiz
Week 3	February 9	Lecture <b>Hemoglobin</b> Weekly quiz
Week 4	February 16	Lecture <b>Enzyme regulation</b> Weekly quiz
<b>Week 5</b>	<b>February 23</b>	<b>Exam 1</b>
Week 6	March 2	Lecture <b>Metabolism overview</b> Weekly quiz
Week 7	March 9	Lecture <b>Glycolysis</b> Weekly quiz
<b>Spring break</b>	<b>March 14 – March 20</b>	<b>No classes</b>
Week 8	March 23	Lecture <b>Krebs</b> Weekly quiz
Week 9	March 30	Lecture <b>Oxphos</b> Weekly quiz
<b>Week 10</b>	<b>April 6</b>	<b>Exam 2</b>
Week 11	April 13	Lecture <b>Glycolysis/gluconeogenesis</b> Weekly quiz
Week 12	April 20	Lecture <b>PPP. Lipids.</b> Weekly quiz
Week 13	April 27	Lecture <b>Integration metabolism</b> Weekly quiz
<b>Week 14</b>	<b>May 4</b>	<b>Exam 3</b>
<b>Week 15</b> <b>Finals week</b>	<b>May 11 – May 18</b>	<b>Final Exam (TBA)</b>



### Medical Biochemistry weekly schedule

Note: reading chapters are form Stryer, 8<sup>th</sup> edition.

Lecture 1 Ch.8	Enzymes: Mechanisms of Catalysis Part 1 <i>Nutrition and Vitamins</i>  Weekly Quiz	<ol style="list-style-type: none"> <li>1. Describe properties of enzymes as biological catalysts</li> <li>2. Describe how Enzymes Accelerate Reactions by Facilitating the Formation of the Transition State</li> <li>3. Apply classification Types of enzymatic reactions depending on the reaction mechanism</li> <li>4. Describe structure and function Vitamins as Coenzymes</li> </ol>
Lecture 2 Ch.9	Enzymes: Mechanisms of catalysis Part 2 <i>Food digestion</i>  Weekly quiz	<ol style="list-style-type: none"> <li>1. Describe types of catalytic mechanism.</li> <li>2. Describe mechanism of catalysis by Serine Proteases.</li> </ol>
Lecture 3 Ch.8	Enzymes: Kinetics and Inhibition Part 1  Weekly Quiz	<ol style="list-style-type: none"> <li>1. Explain how The Michaelis-Menten Model Accounts for the Kinetic Properties of Many Enzymes.</li> <li>2. Explain how Enzymes Can Be Inhibited by Specific Molecules</li> <li>3. Determine V max and K M by Double-Reciprocal Plots</li> <li>4. Describe how Isozymes Provide a Means of Regulation Specific to Distinct Tissues and Developmental Stages.</li> <li>5. Explain how enzymes Are Activated by Proteolytic Cleavage</li> </ol>
Lecture 4 Handout	Enzymes: Kinetics and Inhibition Part 2 <i>Drug discovery and development</i>  Weekly Quiz	<ol style="list-style-type: none"> <li>1. Explain the types of Types of enzyme inhibition: reversible vs irreversible.</li> <li>2. Draw and analyze Double reciprocal plots.</li> <li>3. Apply Kinetics of reversible inhibition and distinguish between competitive, uncompetitive, non-competitive and Substrate inhibition.</li> </ol>

Lecture 5 Ch.7	Enzyme regulation. Hemoglobin <i>Anemia. Sickle cell disease</i>  Weekly Quiz	<ol style="list-style-type: none"> <li>1. Explain how Hemoglobin functions as an honorary enzyme.</li> <li>2. Describe the mechanism of Hb Transports of Oxygen</li> <li>3. Explain mechanism Cooperativity and Allosterism</li> <li>4. Explain how Regulation of oxygen affinity to Hb promotes oxygen release in hypoxia.</li> <li>5. Analyze Bohr effect.</li> <li>6. Explain mechanism of CO poisoning.</li> <li>7. Explain molecular mechanism of Sickle cell disease</li> </ol>
Lecture 6 (Ch.3)	Protein Analysis and Purification techniques <i>Medical laboratory technology</i>  Weekly Quiz	Explain biochemical principle and analyze data obtain by the following techniques: electrophoresis and 2D electrophoresis, affinity chromatography, ion exchange chromatography, gel filtration, HPLC, Mass spectroscopy, ultracentrifugation, dialysis, western blots, enzyme-linked assay radioimmunoassay
Lecture 7 Ch.9 and 10	Enzyme regulation. <i>Blood clotting. Bacterial infections</i>  Weekly Quiz	<ol style="list-style-type: none"> <li>1. Explain biological basis of enzyme regulation, including feedback inhibition, allosteric control, proteolysis.</li> <li>2. Explain how Aspartate Transcarbamoylase is allosterically inhibited by the end product of its pathway.</li> <li>3. Explain mechanism of protein kinases</li> <li>4. Explain how Serine-threonine kinases regulate signal transduction. Explain Kinase-phosphatase cascades and their reciprocal regulation. Explain second messenger system and role of cAMP and PKA.</li> <li>5. Describe PKA regulation by cAMP.</li> <li>6. Describe ADP ribosylation of G-proteins.</li> <li>7. Explain mechanism of Proteolytic cascades and their role in digestion and blood clotting.</li> </ol>
Exam I		Midterm exam

Lecture 8 Ch.15	Overview of Metabolism <i>Exercise and obesity</i>  Weekly Quiz	<ol style="list-style-type: none"> <li>1. Describe three Stages of catabolism.</li> <li>2. Explain how ATP availability regulates metabolism.</li> <li>3. Compare and contrast Anabolic vs catabolic pathways and NADP vs NADPH.</li> </ol>
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Lecture 10 Ch.17	Krebs cycle <i>Hereditary diseases</i>  Weekly Quiz	<ol style="list-style-type: none"> <li>1. Describe Aerobic catabolism of pyruvate.</li> <li>2. Describe PDH complex, reaction sequence and cofactors and clinical forms of PDH deficiency.</li> <li>3. Describe a biochemical basis of TCA.</li> <li>4. Describe and name main Enzymes of TCA cycle.</li> <li>5. Predict ATP yield in TCA cycle.</li> <li>6. Explain the Regulation of TCA cycle.</li> <li>7. Describe how Anaplerotic reactions regenerate TCA cycle intermediates.</li> </ol>
Lecture 11 Ch.18	Ox-phos <i>Respiration. Toxins and poisons.</i>  Weekly Quiz	<ol style="list-style-type: none"> <li>1. Describe the function of Oxidative phosphorylation and electron transfer chain.</li> <li>2. Explain the biochemical foundation of Chemiosmotic hypothesis.</li> <li>3. Describe organization of Respiratory complexes in mitochondria.</li> <li>4. Explain how Electron transport is coupled to ATP synthesis.</li> <li>5. Describe molecular mechanism of ATP synthase.</li> <li>6. Explain molecular mechanism of Regulation of ox-phos.</li> </ol>
Lecture 12 Ch.16,21	Glucose homeostasis <i>Diabetes</i>  Weekly Quiz	<ol style="list-style-type: none"> <li>1. Compare and contrast Glycolysis and gluconeogenesis.</li> <li>2. Explain Reciprocal regulation of glycolysis vs gluconeogenesis in liver.</li> <li>3. Describe stages of Glycogen metabolism.</li> <li>4. Describe Metabolic fate of glucose-6-phosphate.</li> <li>5. Describe the Reciprocal regulation of glycogen metabolism and degradation.</li> <li>6. Compare and contrast Glycogen phosphorylase vs glycogen synthase.</li> <li>7. Describe action of Bicyclic cascades.</li> <li>8. Explain molecular mechanism of Insulin action.</li> </ol>



Lecture 13 Ch.20	Pentose phosphate pathway <i>Hereditary diseases</i>  Weekly Quiz	<ol style="list-style-type: none"> <li>1. Describe biochemical role of PPP, or hexose monophosphate shunt. Explain G-6-P dehydrogenase deficiency in erythrocytes.</li> <li>2. Describe biochemical role of Glutathione.</li> </ol>
Lecture 14 Ch.22	Lipids. <i>Atherosclerosis.</i>  Weekly Quiz	<ol style="list-style-type: none"> <li>1. Explain the role of Fatty acids and triacyl glycerols as a source of energy.</li> <li>2. Describe Metabolic fate of fat.</li> <li>3. Compare and contrast Fatty acid degradation vs synthesis.</li> <li>4. Define Distinct pathways and cofactors of FA acid degradation and synthesis.</li> <li>5. Describe molecular mechanism of Beta-oxidation. Describe biological role of Phospholipids, Arachidonic acid and eicosanoids.</li> <li>6. Explain Regulation of FA metabolism.</li> <li>7. Explain biological mechanism of Fasting and Diabetes.</li> <li>8. Describe biological role of Ketone bodies.</li> </ol>
Lecture 15 Ch. 27,	Metabolic regulation <i>Fasting, starvation and diabetes</i>	<ol style="list-style-type: none"> <li>1. Explain Metabolic regulation of energy homeostasis.</li> <li>2. Compare and contrast Fate of dietary glucose, FA and a/a in fed vs fasting vs starved state.</li> <li>3. Describe biochemistry of Fuel metabolism of the major organs. Compare and contrast how Insulin vs glucagon maintain fuel homeostasis.</li> <li>4. Describe the Metabolic fate of glycolytic intermediates.</li> </ol>
Exam II		Final, cumulative