Biochemistry 384 – Foundations in Biochemistry
Arizona Online – Spring 2026

Description of the Course
Fundamental concepts in physical biochemistry (energy conversion, water, and membranes), protein structure/function, methods in protein biochemistry, enzyme mechanisms, protein-mediated cell signaling, and fundamental energy conversion pathways. This course is designed for undergraduate students with majors in any of the STEM fields, as well as pre-professional health science students with liberal arts majors who have taken the necessary prerequisite courses. Bioc 384 is the companion course to Bioc 385 "Metabolic Biochemistry." Note that since the same textbook is used for both courses, it is possible to take them out of sequence by referring to material in the book.

Bioc 384/385 Course Prerequisites: CHEM 142/144 or CHEM 152 (General Chemistry), CHEM 241A (Organic Chemistry), and MCB 181R (General Biology) - and all prerequisites for these listed courses. Note that credit can be earned in Bioc 384 or Bioc 462A, but not both, similarly Bioc 385 or Bioc 462B.

Bioc 384 Course Objectives: *The following topics will be covered in this course:*
1. Energy conversion processes and the importance of water in biochemical reactions.
3. Structure of amino acids and the role of protein structure in mediating protein function.
4. Principles of oxygen transport and protein transport across biological membranes.
5. The catalytic properties, kinetics, and allosteric regulation of metabolic enzymes.
6. Four receptor signaling pathways mediated by GPCRs, RTKs, TNFRs, and nuclear receptors.
7. Enzymatic reactions and bioenergetics of complete glucose oxidation to yield ATP, CO_2, and H_2O.

Bioc 384: Expected Learning Outcomes: *Students will be able to:*
1. Demonstrate proficiency with vocabulary used in biochemical sciences.
2. Be proficient at calculating free energy changes of enzyme catalyzed reactions in metabolism using substrate and product concentrations; understand the functional difference between ΔG and $\Delta G^{o\prime}$.
3. Describe the effect of ATP Energy Charge in the cell on flux through catabolic and anabolic pathways.
4. Be proficient at using standard reduction potentials for redox half-reactions to calculate changes in standard free energy; identify oxidation and reduction reactions, oxidants and reductants, and *e-* pairs.
5. Articulate the biochemical mechanism of O_2 transport by hemoglobin and explain the functional definition of allostery as it applies to hemoglobin structure, as well as catalyzed enzymatic reactions.
6. Describe in detail a) the molecular pathway from GPCR activation to glucose metabolism using glucagon as the first messenger, b) the molecular pathway from insulin receptor activation to glucose metabolism in response to high serum glucose levels, and c) the function of nuclear receptors.
7. Articulate the role of metabolic flux in the complete oxidation of glucose and metabolites by the glycolytic pathway, the citrate cycle, and oxidative phosphorylation; describe metabolic regulation.

Course web site on D2L
Information about lectures, homework, exams, grades, and all other aspects of this course are available on the D2L course web site. The information contained in this course syllabus, other than the grade and absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructors. Any changes will be announced on the course web site. It is the responsibility of each student to check the course web site.

Instructor: Dr. Roger L Miesfeld: rlm@arizona.edu
Zoom Office Hours; Wed/Fri at 11:00am (AZ Time) https://arizona.zoom.us/j/84751911779

Grad Teaching Assistant: Seun Fapohunda: ofapohunda@arizona.edu
Zoom Office Hour; Friday 11:00am-12:00 pm (AZ time)

Land Acknowledgement
We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the O'odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service. The University of Arizona resides on ancestral lands of the Tohono O'odham nation, where many today continuously reside in their ancestral land. We acknowledge the privilege it is to teach and learn in this region and we express our gratitude to the nation.

Textbook: Miesfeld & McEvoy *Biochemistry* (WW Norton, 2nd Edition, July 2021, magenta cover) is made available as an E-book with all e-media ancillaries including the required online graded homework (SmartWork5) at a discount through the UA Bookstore **Inclusive Access** program. An unbound **print copy** of the textbook (loose leaf) is available for **$40** – ***if you keep the Inclusive Access license*** and contact the UA Bookstore by email **after the OPT OUT deadline** to reserve a print copy: digitaltext@arizona.edu.

If you have your own print copy, you will need to purchase a license for the SmartWork online homework at a cost of ~$55 from the publisher. You can purchase the SmartWork package at https://digital.wwnorton.com/biochem2 (choose "purchase options" upper corner). ***Information about the UA Inclusive Access Program and process you need to follow to OPT OUT:*** https://shop.arizona.edu/textbooks/Inclusive.asp *Do NOT sign up for the "21-day free trial" through the publisher website - everything is through D2L.*

Note that this textbook was chosen because it was specifically developed for majors with an interest in the health professions or environmental studies. Royalties in excess of $500 that are received by RLM from textbook sales to UA students in this class will be donated to the College of Science Galileo Circle for the awarding of undergraduate student scholarships: https://cos.arizona.edu/content/galileo-circle-scholars.

Lecture Videos: This course is organized in a hybrid format containing 12 content modules divided into six topics (mini lectures) per module. There are four midterm exams each of which covers the content in three modules, e.g., Exam 1 covers Modules 1, 2, and 3, Exam 2 covers Modules 4, 5, and 6, etc.. Since each topic is presented by Professor Miesfeld in a short video, there are a total of 72 lecture topics (and videos) that cover the entire course. The lecture videos of ~16-20 minutes each are available asynchronously and were produced in the UArizona film studios using professional editing equipment.

All 72 lecture videos are open throughout the course and you can view them as many times as you wish with full playback control (pause, rewind, fast-forward). Importantly, each lecture video is accompanied by a PPT deck in PDF file format for taking notes while watching the videos. All PPT decks contain a "Big Picture" introductory slide, ~10-14 content slides, and a concluding "Key Concepts" slide to help guide your learning. This PPT deck is the same one used in the videos. You will need to watch the six videos covering each module *before* the course moves on to the next module; plan on six videos per week.

Student Assessment: ***Homework, Quizzes, Discussions, and Exams***
There are **4 Midterm Exams** worth 250 points each and an optional **Final Exam** also worth 250 pts. Only the top four scores of these five exams are counted for a maximum of **1000 points**. The midterm exams and final exam are 90 minutes and consist of 25 multiple choice questions (10 pts each) drawn randomly from a pool of ~120 questions. Questions in the RLM Midterm Exam Library are proprietary and unavailable to students.

The exams are proctored by Honorlock (the Honorlock link is in the D2L navigation bar). The exams are open for scheduling for 60 hours from **11am on Day 1** (AZ time) until **11pm on Day 3** (AZ time). As long as you begin the exam before the 11pm (AZ time) deadline on Day 3, you will have the full 90 minutes to complete the exam without penalty. The optional **Final Exam** is based on a set of 250 multiple choice review questions taken from the Norton Publishing Test Bank, which will be posted on D2L one week before the final exam (posted in the Quizzes tab on D2L). Answers to all 250 questions are provided using the submission view. The Final Exam is not required and can be a dropped exam.

There are 12 **D2L Quizzes** (D2Qs) worth 15 pts each with *three submission attempts*. Only the top 10 scores will be counted to give a total of **150 pts**. In addition, there are 12 **SmartWork (SW) Assignments** each worth 15 points with *three submission attempts* for each question. Only the top 10 scores will be counted to give a total of **150 pts**. There are **12 Discussion Assignments** worth 10 pts each. Only the top 10 scores will be counted to give a total of **100 pts**. The format for the Discussions consists of answering all of the instructor questions *in your own words*, pose a follow-up question and choose a peer's follow-up questions and describe why you thought it was good.

There are a total of **1400 pts** available with 1000 pts earned from the Honorlock proctored exams and 400 pts earned from the quizzes and discussions.

Guaranteed minimum cutoffs:
1253 total pts. (89.5%) for an "A" grade
1113 total pts. (79.5%) for a "B" grade
903 total pts. (64.5%) for a "C" grade
623 total pts. (44.5%) for a "D" grade
<623 total pts. (<44.5 %) for a "E" grade

*A grade of **Incomplete*** is very rare and can only be obtained at the end of the semester when all but a very minor portion of the course work needs to be completed (<10%). The incomplete portion will need to be satisfied within TWO weeks of the end of the course (*not one year*). In all other hardship cases, the student will need a **Withdrawal** from the course or earn a final grade and repeat the course later using the **GRO**. Registrar's Office: https://registrar.arizona.edu/dates-and-deadlines

D2Q quizzes use a question library format, which means that questions for these quizzes are pulled from the RLM D2Q quiz library at random. Since only the highest quiz score counts, it is advisable to use all three attempts to have access to as many questions in the pool as possible for use in exam preparation. There are *~35 questions* in each pool, which are proprietary and unavailable to students.

Adjustments to final grade cutoffs
The individual final grade cutoffs listed in the syllabus will be adjusted to meet the following **minimum** final grade frequencies based on students who completed the course (took four exams). These grade distribution frequencies are based on similar outcomes over the past 5 years and are designed to accommodate variations from year to year in student achievement in this very challenging BIOC course.

The A/B grade cutoff will be adjusted so that **at least 40%** of the students earn a final grade of **A**.
The B/C grade cutoff will be adjusted so that **at least 30%** of the students earn a final grade of **B**.
The C/D grade cutoff will be adjusted so that **at least 20%** of the students earn a final grade of **C**.

Extra Credit Opportunities: *50 points are possible*

1) You may submit the **Everyday Biochemistry Extra Credit Assignment**, which is worth a maximum of **45 points** to earn extra credit points added to the final grade as bonus points. The Everyday Biochemistry extra credit assignment should be ~300-600 words in *.doc, docx,* or .pdf file format and submitted through the D2L Drop box. The assignment will be evaluated by TurnItIn.com software to detect plagiarism. This extra credit opportunity consists of visiting my everyday biochemistry website you will find at: https://everydaybiochemistry.com/everyday-biochem/ and choosing one of the examples of Everyday Biochemistry derived from the 23 chapter openings in the course textbook.

2) If >60% of the students in the class complete the anonymous **UArizona Student Survey** at the end of the semester sent from the Provost office, then every student in the class will receive **5 points**.

The *HONORLOCK proctoring service.* In this course, you'll have the convenience of taking your exams remotely, supported by Honorlock (opens in a new tab) (https://honorlock.com/home-c/). To help you navigate the Honorlock process effortlessly, you will receive a Student Guide. To ensure a seamless testing experience, please have your CatCard or a government-issued ID ready for identity verification. Before initiating your exam, we recommend reviewing the system requirements and acquainting yourself with Honorlock's standard rules and expectations. There's no need to create an account or pre-schedule an appointment; Honorlock access is available 24/7 via D2L, ensuring flexibility in your testing schedule.

Note: *specific instructions* for **Bioc 384.385 students** are posted in the D2L Content bar.

Watch this video: https://honorlock.kb.help/how-to-use-honorlock-student/

System Requirements: *You will need a desktop or laptop with an operating system.*

- Windows 10+
- MacOSX 10.15 or ChromeOS 120+ and Google Chrome browser 120+
- Internet: >2 Mbps download and >1 Mbps upload (Hotspots not recommended)

NOTE: Tablets and iPads are not compatible Your device must have a webcam and microphone.

- Built-in or external devices are ok.
- Students will need to also have the following minimum requirement to test with Honorlock:
  - Desktop computer, laptop, or Chromebook (tablets and cell phones do not meet our requirements)
  - A working built-in or external webcam and microphone
  - Use of Google Chrome and disable pop-up blocker

NOTE: Honorlock is not compatible with Walmart Branded Camera (ONN) You will need stable internet connection speed. To check if your device meets minimum system requirements: https://prep.honorlock.com/system-check

Honorlock's Standard Rules and Regulations

Testing Area

- Lighting in the room must be bright enough to show the student's face and the surrounding area in a clear and detailed manner. Students should be seated at a desk or table. Laying down in bed or elsewhere when taking the exam is not allowed.
- Students should clear their desk or table of all other materials (e.g., books, papers, notebooks, calculators, etc.)
- No visible writing on the desk or walls is permitted.
- All third-party programs and windows (websites, Excel, Word, etc.) on the testing computer must be closed before logging into the proctored test environment.
- Loud music, television, or other distractions playing in the background are prohibited.
- No other people or parties aside from the exam taker is permitted near the testing environment, and all communication between the exam taker and other people is prohibited.

Testing Behavior:

- Students must not leave the room during the testing period at any time or take the computer into another room without Honorlock's permission.
- No breaks will be permitted.
- Use of hats, hoodies, headsets, or earplugs is prohibited.
- **Having a cell phone or tablet in the room for use during the exam is strictly prohibited.**
- The student's face must remain within view of the camera at all times.
- Honorlock will not add more time for proctoring questions or technical issues during the exam.

For assistance, email support@honorlock.com or chat directly with support through the Live Chat feature on the Honorlock dashboard.

Make-Up Exam Policy Students who know in advance that they will be unable to take an examination must contact the instructor to *request* an alternate time to take the exam. Depending on the justification, a make-up exam *may* be given. In the case of an emergency during the window of the scheduled class exam, the student must contact the instructor as soon as possible to make exam arrangements.

Accessibility and Accommodations: At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, https://drc.arizona.edu) to establish reasonable accommodations.

UA Nondiscrimination and Anti-harassment Policy The University is committed to creating and maintaining an environment free of discrimination;
http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy
Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

Absence and Class Participation Policy The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop The UA policy regarding absences from exams for any sincerely held religious belief, observance or practice will be accommodated where reasonable, http://policy.arizona.edu/human-resources/religious-accommodation-policy. Absences from exams as pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: https://deanofstudents.arizona.edu/absences.

Code of Academic Integrity Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog.

See: http://deanofstudents.arizona.edu/codeofacademicintegrity
http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.
The University Libraries have some excellent tips for avoiding plagiarism, available at
http://new.library.arizona.edu/research/citing/plagiarism.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may constitute copyright infringement.

Classroom Behavior Policy To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Safety on Campus and in the Classroom Policy For a list of emergency procedures for all types of incidents, please visit the website of the Critical Incident Response Team (CIRT): https://cirt.arizona.edu/case-emergency/overview . Also watch the video available at: https://arizona.sabacloud.com/Saba/Web_spf/NA7P1PRD161/common/learningeventdetail/crtfy000000000003560

Threatening Behavior Policy The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

University-wide Policy links to the following UA policies are provided here, http://catalog.arizona.edu/syllabus-policies

Confidentiality of Student Records http://www.registrar.arizona.edu/ferpa/default.htm

Subject to Change Statement

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.

Biochemistry 384 – Foundations in Biochemistry

Module	Video	Lecture Title	Video Length	Textbook (2nd Edition)
1	M1T1	*What is Biochemistry?*	*17:06*	*Chapter 1.1*
	M1T2	*The Chemical Basis of Life*	*18:30*	*Chapter 1.2*
	M1T3	*Storage and Processing of Genetic Information*	*15:51*	*Chapter 1.3*
	M1T4	*Biomolecular Structure and Function*	*18:10*	*Chapter 1.4*
	M1T5	*Energy Conversion in Biological Systems*	*23:12*	*Chapter 2.1*
D2Q-01 SW-01	M1T6	*Bioenergetics: Gibbs Energy Changes (ΔG and $\Delta G^{o\prime}$)*	*21:13*	*Chapter 2.1*
2	M2T1	*Coupled Reactions in Metabolism*	*23:33*	*Chapter 2.2*
	M2T2	*Properties of H_2O and Weak Noncovalent Interactions*	*19:00*	*Chapter 2.3*
	M2T3	*Review of Acids, Bases, and pK_a*	*22:59*	*Chapter 2.3*
	M2T4	*Structure of DNA and RNA*	*22:42*	*Chapter 3.1*
	M2T5	*Methods in Nucleic Acid Biochemistry*	*17:37*	*Chapter 3.3*
D2Q-02 SW-02	M2T6	*Introduction to Amino Acids*	*23:32*	*Chapter 4.1*
3	M3T1	*Amino Acid Functional Groups*	*16:56*	*Chapter 4.1*
	M3T2	*Peptide Bonds Link Amino Acids Together*	*16:58*	*Chapter 4.1*
	M3T3	*Protein Structure: Primary and Secondary*	*25:59*	*Chapter 4.2*
	M3T4	*Protein Structure: Tertiary and Quaternary*	*21:47*	*Chapter 4.2*
	M3T5	*Principles of Protein Folding*	*26:02*	*Chapter 4.3*
D2Q-03 SW-03	M3T6	*Protein Purification: Column Chromatography*	*25:24*	*Chapter 5.1*
		EXAM 1 covers Modules 1-3 (18 topics)		
4	M4T1	*Protein Purification: Electrophoresis Methods*	*13:42*	*Chapter 5.1*
	M4T2	*Protein Sequencing Methods*	*13:22*	*Chapter 5.2*
	M4T3	*Methods for Determining 3-D Protein Structures*	*18:46*	*Chapter 5.3*
	M4T4	*Five Major Protein Classes*	*10:21*	*Chapter 6.1*
	M4T5	*Mechanism of O_2 Binding to Globin Proteins*	*28:58*	*Chapter 6.2*
D2Q-04 SW-04	M4T6	*Allosteric Control of O_2 Transport by Hemoglobin*	*22:05*	*Chapter 6.2*

Module	Video	Lecture Title	Video Length	Textbook (2nd Edition)
5	M5T1	*Hemoglobin Gene Mutations*	*17:27*	*Chapter 6.3*
	M5T2	*The Actin-Myosin Motor*	*15:28*	*Chapter 6.4*
	M5T3	*Introduction to Enzymes*	*23:03*	*Chapter 7.1*
	M5T4	*Enzyme Active Sites Mediate Chemical Catalysis*	*18:08*	*Chapter 7.2*
	M5T5	*Enzyme-Mediated Chemical Reactions in Cells*	*12:06*	*Chapter 7.2*
D2Q-05 SW-05	M5T6	*Enzyme Mechanisms: Chymotrypsin and Enolase*	*16:52*	*Chapter 7.2*
6	M6T1	*Enzyme Kinetics: Michaelis-Menten Kinetics*	*19:52*	*Chapter 7.3*
	M6T2	*Enzyme Kinetics: Comparing Enzyme Properties*	*13:08*	*Chapter 7.3*
	M6T3	*Mechanisms of Enzyme Inhibition*	*23:31*	*Chapter 7.4*
	M6T4	*Regulation of Enzyme Activity*	*24:09*	*Chapter 7.4*
	M6T5	*Cell Membranes Function as Selective Barriers*	*15:14*	*Chapter 2.3*
D2Q-06 SW-06	M6T6	*Membrane Transport Proteins Control Homeostasis*	*17:16*	*Chapter 6.3*
		EXAM 2 covers Modules 4-6 (18 topics)		
7	M7T1	*Structure and Function of Passive Transporters*	*15:01*	*Chapter 6.3*
	M7T2	*Active Transport Proteins Require Energy Input*	*25:10*	*Chapter 6.3*
	M7T3	*Active Transport Proteins as Drug Targets*	*14:56*	*Chapter 6.3*
	M7T4	*Adaptive Immunity: Structure of Antibody Proteins*	*16:19*	*Chapter 4.2*
	M7T5	*Overview of Cell Signaling Pathways*	*29:34*	*Chapter 8.1*
D2Q-07 SW-07	M7T6	*Nicotinic Acetylcholine Receptors: Gated Ion Channels*	*7:19*	*Chapter 8.1*
8	M8T1	*Mechanism of G Protein-Coupled Receptor Signaling*	*17:50*	*Chapter 8.2*
	M8T2	*G Protein-Coupled Receptor Signaling in Metabolism*	*24:15*	*Chapter 8.2*
	M8T3	*Receptor Tyrosine Kinases: Cell Growth and Cancer*	*29:48*	*Chapter 8.3*
	M8T4	*Receptor Tyrosine Kinases: Insulin Signaling*	*17:33*	*Chapter 8.3*
	M8T5	*Tumor Necrosis Factor Receptor: Cell Death Pathway*	*18:38*	*Chapter 8.4*
D2Q-08 SW-08	M8T6	*Nuclear Receptor Signaling: Glucocorticoid Receptors*	*22:44*	*Chapter 8.5*
9	M9T1	*Overview of Metabolism: Control of Metabolic Flux*	*25:45*	*Chapter 9.1*

Module	Video	Lecture Title	Video Length	Textbook (2nd Edition)
	M9T2	*Structure of Monosaccharide and Disaccharide Sugars*	*26:30*	*Chapter 9.2*
	M9T3	*Overview of the Glycolytic Pathway*	*21:15*	*Chapter 9.2*
	M9T4	*Glycolytic Reactions: Stage 1*	*10:20*	*Chapter 9.3*
	M9T5	*Glycolytic Reactions: Stage 2*	*12:09*	*Chapter 9.3*
D2Q-09 SW-09	M9T6	*Regulation of Metabolic Flux in Glycolysis*	*17:32*	*Chapter 9.3*
		EXAM 3 covers Modules 7-9 (18 topics)		
10	M10T1	*Supply and Demand of Glycolytic Intermediates*	*15:14*	*Chapter 9.4*
	M10T2	*Metabolic Fate of Pyruvate*	*17:17*	*Chapter 9.4*
	M10T3	*Overview of the Citrate Cycle*	*12:21*	*Chapter 10.1*
	M10T4	*Calculating Redox Energies*	*26:37*	*Chapter 10.1*
	M10T5	*Pyruvate Dehydrogenase Requires Five Coenzymes*	*21:03*	*Chapter 10.2*
D2Q-10 SW-10	M10T6	*Pyruvate Dehydrogenase is a Metabolic Machine*	*23:08*	*Chapter 10.2*
11	M11T1	*The Citrate Cycle: Reactions 1-4*	*16:33*	*Chapter 10.3*
	M11T2	*The Citrate Cycle: Reactions 5-8*	*5:24*	*Chapter 10.3*
	M11T3	*Citrate Cycle: Regulation of Metabolic Flux*	*14:12*	*Chapter 10.4*
	M11T4	*Metabolism of Citrate Cycle Intermediates*	*10:51*	*Chapter 10.5*
	M11T5	*The Chemiosmotic Theory: An Unconventional Idea*	*23:44*	*Chapter 11.1*
D2Q-11 SW-11	M11T6	*Electron Transport System: NADH/$FADH_2$ Oxidation*	*11:31*	*Chapter 11.2*
12	M12T1	*Protein Components of the Electron Transport System*	*22:38*	*Chapter 11.3*
	M12T2	*Proton Motive Force: Energy Conversion Calculations*	*12:17*	*Chapter 11.3*
	M12T3	*Structure and Function of the ATP Synthase Complex*	*26:27*	*Chapter 11.4*
	M12T4	*Mitochondrial Transport Proteins and Shuttle Systems*	*16:39*	*Chapter 11.5*
	M12T5	*Inhibitors and Uncouplers of Oxidative Phosphorylation*	*21:31*	*Chapter 11.5*
D2Q-12 SW-12	M12T6	*Inherited Mitochondrial Diseases in Humans*	*10:56*	*Chapter 11.5*
		EXAM 4 covers Modules 10-12 (18 topics)		
		ONLINE - FINAL EXAM: Based on a Set of 250 Questions *(Final Exam Question Set is available in the D2L Quiz tab)*		