

Biochemistry

Fall 2024

Course: BIOL 403

Credit Hours - 4

Prerequisites - CHEM 301

Lecture - MWF 1:00-1:50 - 004 Pierce Hall

Laboratory - R 8:00-9:50 - 103 Pierce Hall

Final - W Day 3 Dec. 11 2:00-4:00

Instructor: Dr. Engle

Office - 211 Pierce Hall

Phone - 814-886-6552

Office Hours - MWF 11-1, TR 12-1

Email - JEngle@mtaloy.edu

Web page - DrEngle.net

Texts:

- J.L. Tymoczko, J.M. Berg, G.J. Gatto, and L. Stryer. 2019. Biochemistry: A Short Course 4th ed. W.H. Freeman and Co. New York. 851 pages. ISBN 978-1-319-11463-3
- Composition book - for your lab notebook

Course description - A one semester lecture course which provides an introduction to the structure, properties, reactions, and metabolism of biomolecules. The laboratory component of the course will focus on proteins: structure, isolation, kinetics, quantification, analysis, and their involvement in metabolism.

Grading:

- Quiz - At the end of the first week, there will be a quiz on chapters 1 and 2 which will not be covered in lecture.
- Lecture Exams - Written exams will be given in lecture following each major section see below. Exams will consist of multiple choice (like on grad. & professional program entrance exams) and essay questions.
- Lab - assessed by Student's Laboratory Notebook (2x 60 pts.) and Results figures when appropriate.

Scale

A = 100-92% B+ = 91-88% B = 87-83% C+ = 82-79% C = 78-74% D = 73-65% F = 64-0%

Other grades (E, W, WP, WF) will be assigned as described in the College Catalog.

Additional Resources:

Alberts, B., et al. 2007. Molecular Biology of the Cell 5th ed. Garland Science NY. 1392pp.

Cooper, G.M. & Hausman, R.E. 2006. The Cell: A Molecular Approach 4th ed. Sinauer Associates, Inc. 745pp.

Garrett, R.H. & C. M. Grisham. 2010. Biochemistry 4th ed. Brooks/Cole Boston, MA. 1059pp.

Hames, B.D. 2005. Biochemistry Taylor & Francis 438pp. QP518.3 .H355 2005

Hancock, J.T. 2005. Cell Signaling 2nd ed. Oxford University Press, USA. 316pp.

Harding, J.J. & Crabbe, M.J.C. 1991. Post-translational Modifications of Proteins. CRC. 270pp.

Horton, R.H. et al. 2006. Principles of Biochemistry 4th ed. Pearson/Prentice Hall, Upper Saddle River, NJ 852pp.

Leskovac, V. 2003. Comprehensive enzyme kinetics. Kluwer Academic/Plenum Pub. 438pp. QP601.3 .L47 2003 EB

Lodish, H. et al. 2013. Molecular Cell Biology 7th ed. W.H. Freeman and Company, NY. 1154pp.

Martin, B.L. et al. 1994. Co-And Post-Translational Modification of Proteins: Chemical Principles and Biological Effects. Oxford University Press, USA.

Mayer, R.J. ed. 2006. Protein Degradation: The Ubiquitin-Proteasome System (Protein Degradation). Wiley-VCH. 300pp.

Nelson, D.L. & M.M. Cox. 2013. Lehninger: Principles of Biochemistry 6th ed. W.H. Freeman Co. 1198pp.

Taylor, K.B. 2002. Enzyme kinetics and mechanisms. Kluwer Academic Pub. 227pp. QP601.3 .T39 2002 EB

Voet, D. et al. 2008. Fundamentals of Biochemistry: Life at the molecular level. John Wiley & Sons, Inc. 1099pp.

Whitford, D. 2005. Proteins: structure and function. J. Wiley & Sons. 528pp. QP551 .W535 2005 EB.

Course Outline & Learning Objectives:

Buffers - Concept, Physiological buffers, Location and function, Quantitative expression
Define biochemistry; Explain the importance and uniqueness of water;
Explain how buffers stabilize pH

Amino acids - Side group structure and function, Nutritional aspects, & Titration
Describe amino acid structure and group classifications; Explain PKU;
Draw and annotate a titration curve; Define isoelectric point (pI)

Exam 1

Proteins - Biological function, Globular proteins
Describe all four levels of protein structure; List protein prosthetic groups

Enzymes - Physical properties
Detail the functioning of enzymes; Explain allosteric feedback
List the enzyme classes;

Enzyme Kinetics and Regulation
Explain the difference between first and zero order kinetics
Describe the enzyme substrate complex
Detail the Michaelis-Menten Equation
Draw and annotate the Lineweaver-Burk plot
Contrast the different types of inhibition

Exam 2

Bioenergetics - Redox and High energy compounds
Detail Gibbs free energy
Contrast enthalpy and entropy; Explain ΔG in light of pathways

Glycolysis - Glucose to pyruvate
Detail each step in glycolysis including the enzyme involved and the product;
State which reactions are irreversible in the pathway; List the energy input and outputs
Explain starch catalysis; Detail the entry of other monosaccharides into glycolysis
Describe fermentation and why it is necessary

Exam 3

Krebs cycle
Detail each step in the Krebs cycle including enzyme names and products
List each step energy is released and in what form

Electron Transport Chain
Explain proton motive force; Detail each of the four complexes of the pathway
Describe the structure and function of complex V
Trace the electron pathway through ATP synthase

Mitochondrial Shuttles
Detail the malate-aspartate shuttle and the glycerol 3-phosphate shuttle
Total the ATP generated per glucose from the respiratory pathways

Exam 4

Gluconeogenesis
Define gluconeogenesis along with its necessity, energy requirements, and controls
List the three crucial steps in gluconeogenesis
List precursors to gluconeogenesis

Lipids

Describe the structure of lipids; Explain how lipids are digested and transported
Contrast the differences between VLDL, LDL, and HDL; Detail fatty acid oxidation
Explain how unsaturated fatty acid oxidation differs from saturated fatty acid oxidation
Explain how odd numbered fatty acids are oxidized
Describe ketone bodies

Exam 5

If time permits we will cover additional topics like:

Prostaglandins, hormonal & allosteric regulation of Metabolism in liver, muscle, adipose, & brain tissue; or topics the class would like to cover.

Text book references are not provided on purpose. By this time students should be able to find topics in a text book on their own, that is what the table of contents and the index are for.

It is assumed that you are studying the text book as well the lecture material. As a result, you will be responsible for the material in the text book that corresponds to the topics listed in the course outline.

Biochemistry Laboratory

	Topic	Figure due the following week	Procedure
Laboratory 1	Solutions		Review solution mathematics. Calibrating and using a pH meter. Make solutions needed during the semester.
Laboratory 2	Protein structure	Secondary structure report	Computer laboratory exercise. Start with DNA sequences -> translate -> three dimensional visualization.
Laboratory 3	Enzyme kinetics	Kinetic graph	Initial velocities of enzymatic reactions.
Laboratory 4	Enzyme kinetics	Kinetic graph & calculations	The effects of substrate concentration. Plotting data and calculating the values of V_{max} and K_m .
Laboratory 5	Enzyme kinetics - inhibitors	Kinetic graph	Competitive and noncompetitive inhibitors
Laboratory 6	Protein isolation		Myoglobin from ground beef.
Laboratory 7	Spectroscopic analysis of reduced & oxidized myoglobin	Sprectroscopic analysis graph Turn in Notebook	Oxidize & reduce myoglobin & analyze spectroscopically. Pour chromatography columns.
Laboratory 8	Column chromatography		Purify (de-salt) myoglobin protein.
Laboratory 9	Protein quantification	Graph and calculations	Bradford assay in 96 well plates. Pour SDS PAGE gels.
Laboratory 10	Protein electrophoresis Fungal isolation (culturing)		SDS-PAGE - Coomassie blue staining of gels. Fungi from student collected fruits.
Laboratory 11	Gel documentation & drying Begin fermentation lab	Labeled gel picture	Publication figure preparation. Fermentation - a model of metabolism.
Laboratory 12	Caffeine metabolism	Graph and calculations	ELISA of saliva.
Laboratory 13	Analyze fermentation results by spectroscopy	Spectrophotographic graph and data table	Phenolic cpds, International Bitterness Units, Color by Std. Reference Method.
Laboratory 14	Clean up and finish any last projects	Turn in Notebook	

Laboratory Notebook

The purpose of a laboratory notebook is to allow anyone with some biochemical knowledge to understand exactly what you did. You need to record the information in sufficient detail so that another researcher would be able to repeat what you did. In addition, your laboratory notebook should contain exactly what your results were. You will need good notes to be able to write your lab reports; in addition, as your understanding of biochemistry improves, your notebook may allow you to figure out why some parts of your experiments did not work as expected.

In your notebook, each experiment should begin with a title, a date, and a statement of the objective of the planned work. You should also record exactly what you did at each step. You can reference a company or educational manual instead of recording each step of the procedure. But you must be sure to mention anything that you did that differed from the information in the manual. In addition, you should record any numerical information, such as the weights of reagents used, absorbance readings, enzyme activities, protein concentrations, and buffer concentrations.

Everything you do should be recorded directly into your lab notebook in pen. If you make a mistake, draw a line through it, and write the correction next to the mistake. (It may turn out that the original information was correct after all, so do not obliterate the original information by erasing it, or by removing the page from your notebook.) Any calculations performed should be written directly into your book. Writing important information on scrap paper, and then recording it in your notebook later is not acceptable. If you are writing something while in the laboratory, you should be writing it directly into your notebook.

At each step in your experiment (after each assay or measurement), in addition to the results, record your thoughts regarding the experiment and how you think it is going. Record your mistakes, and your attempts to rectify them. Record the calculations involved in any type of data analysis, as well as explanations for both what you did and what you think it means. Do not say “well, I will remember what this means”; instead, write it down! If you use your lab notebook properly, you will find that writing your lab reports is much easier, and you will be developing good habits for the future.

Grading - You will turn in your notebook twice during the semester. Each time the notebook will be graded 60 points based on the above information.

Results Figures

When we collect enough data to present a figure, you will be required to turn in a publishable figure at the beginning of the following laboratory. The figure must be correctly labeled and be accompanied by a legend. One sheet of paper should suffice for each figure plus its legend.

In addition to the above policies and procedures, the instructor reserves the right to alter, augment, or delete from existing policies if in so doing the proper atmosphere for teaching and learning is maintained. All such policy changes will be announced.

MAC Policies

Weather Delays and Compressed Schedule

In the event of a delayed opening, MAC will follow a compressed schedule. This will provide students with the opportunity to attend all scheduled classes on delay days with each class meeting for a shorter than usual session. For the Compressed Schedule for delay days, go to the following link: <http://www.mtaloy.edu/delays-cancelations>

Technology and Communication Assistance Statement

All students are expected to regularly log in to the Canvas course website. The site contains the syllabus and assignments, and supplementary materials will be placed there on a regular basis. Furthermore, important announcements will be posted on the site (especially if a class period is canceled due to weather, illness, etc.). For assistance in using Canvas, please contact the Canvas administrator at (Canvas@mtaloy.edu).

College offices and instructors often communicate important information through the MAC email system. Students should check their school email account regularly. For technical or log-in credential questions, please contact the help desk at (helpdesk@mtaloy.edu or 814-886-6502).

College Academic Integrity Statement

Mount Aloysius College is committed to the academic integrity of the entire community. All share responsibility for maintaining high standards of academic integrity, and no forms of academic dishonesty are tolerated. Forms of academic dishonesty include but are not restricted to: giving or receiving unauthorized assistance on an examination, project, or assignment; using unauthorized forms of assistance such as crib notes or cell phones on an examination; falsification of data or plagiarism (using another person's ideas or words as your own); and lying or falsifying reasons for missing examinations or class.

A student found guilty of lying, cheating, or plagiarism, depending on the nature of the offense and the history of the student, is usually subject to one or both of the following: a grade of zero on the assignment, project, or examination or a grade of F in the course. All cases of lying, cheating, or plagiarism where a punishment is incurred are reported to the Senior Vice President of Academic Affairs, who maintains a record of all offenses. Serial offenders may be subject to suspension or dismissal.

College Accommodations Statement

Mount Aloysius College is committed to providing reasonable accommodations to students with disabilities. Students with disabilities who wish to request an accommodation are required to contact Michele Leamer, Office Manager, Student Health and Wellness Center (MLeamer@mtaloy.edu or 814-886-6515) to formally request accommodations and provide supporting documentation. If you receive approval for accommodations, it is important that you stop in at the start of the semester so necessary arrangements can be made.

Attendance Policy

Attendance at all lecture and lab sessions is mandatory. It is your responsibility to notify the instructor **prior** to missing an exam or laboratory and you must have a valid reason. The instructor reserves the right to judge the validity of the excuse. If you miss an exam, you are responsible for taking the exam within one week of your return. There are no makeup labs unless you are able to come to another section during the same week and obtain instructor permission. *Failure of the student to follow the steps outlined above will result in a grade of "0" for the missed exam or lab!*

Conflict Resolution

Should a student encounter difficulty with course content or other aspects of the course, the first action should be to make an appointment to speak with the instructor. The instructor may suggest resources on campus or other tips to assist student learning. If a student has concerns with their instructor, then the best course of action is to seek out a meeting with the Science and Math Department Chair, Dr. John Whitlock, 814-886-6536, JWhitlock@mtaloy.edu. to discuss the difficulties. If an agreeable decision is not reached, the student should then request a meeting with the Dean, Dr. Chris Lovett, 814-886-6458, CLovett@mtaloy.edu. The Faculty, Department Chairs, and Deans are committed to treating all students with respect and fairness. Additional information is outlined in the academic grievance policy in the College catalog.

Title IX: Confidentiality and Responsible Employee Statement

Mount Aloysius College faculty are committed to creating a safe learning environment for all members of our community, free from gender and sex-based discrimination, including sexual harassment, domestic and dating violence, sexual assault, and stalking, in accordance with Title IX of the Education Amendments of 1972.

Please note that the Title IX and Sexual Misconduct Policy designates all faculty members, including teaching assistants, as "Responsible Employees". Under Mount Aloysius College's policy, all "Responsible Employees" must report all disclosures of sex or gender-based discrimination or violence to Mount Aloysius' Title IX Coordinator, Ms. Tonia Gordon, Vice President for People & Mission Integration/Chief Human Resource Officer, tgordon@mtaloy.edu or 814-886-6390. The Title IX Coordinator will reach out to provide resources, support, and information after receiving a report, but community members are not required to respond to such outreach. Reported information will remain private.

If you have (or someone you know has) experienced any form of sex or gender-based discrimination or violence and wish to speak with someone *confidentially*, please contact one of our counselors at counseling@mtaloy.edu or call 814-886-6515. For more information regarding Mount Aloysius College's Title IX procedures, reporting, or support measures, please visit sites.google.com/mtaloy.edu/titleix/home.

Disclosures of gender and sex-based discrimination or violence made in relation to an assignment and/or educational prompt will not result in a referral to Mount Aloysius College's Title IX Coordinator unless requested otherwise.

Laboratory Safety Contract

Every laboratory user should observe the following rules:

- Know the potential hazards and appropriate safety precautions before beginning work.
- Know the location and use of emergency equipment, including safety showers, eyewash stations and safety kits.
- Know the types of personal protective equipment available and how to use it for each procedure. Goggles must be used when there is a risk of splash, when working with Bunsen burners or when doing dissections. Disposable gloves must be used when doing dissections and must be supplied by the student. **Closed-toed shoes** should be worn at all times when using any Pierce Hall laboratory. Loose and torn clothing may pose a hazard in the laboratory. For your protection you must use clothing that is at least knee length when seated during laboratories. Wear clothing that, if damaged, would not be a serious loss, or use aprons or laboratory coats because chemicals may damage fabric.
- Never block safety equipment or doors and keep aisles clear and free from tripping hazards.
- Familiarize yourself with the emergency response procedures, alarms and building evacuation routes.
- Familiarize yourself with the equipment you will be using. Pay extra care when working with glass and when using dissecting equipment, whether cutting or assisting. Take good care of equipment and report any damage to your instructor.
- Prevent pollution by following waste disposal procedures. Chemical reactions may require traps to prevent the release of toxic substances to the laboratory or to the environment. Use fume hoods if necessary.
- Combine reagents in the appropriate order and avoid adding solids to hot liquids.
- Do not prepare, store or consume food or beverages in any Pierce Hall laboratory. Microwaves and refrigerators are for laboratory use only, not to heat or store food.
- Do not smoke in any Pierce Hall laboratory.
- Do not apply cosmetics when in the laboratory.
- Use a pipette bulb or a mechanical pipetting device to provide a vacuum. Never use mouth suction to pipette chemicals or to start a siphon.
- Be alert to unsafe conditions and actions and bring them to the attention of your supervisor or lab manager immediately so that corrections can be made as soon as possible. Report any injury to your instructor immediately. After dealing with the incident, instructors should fill out an incident report.

For additional information you can consult Mount Aloysius College Laboratory Chemical Hygiene Plan and the Science and Mathematics Department Safety Manual