**Department of Kinesiology**

**Course Syllabus**

**Spring 2024**

**Course Number:** KINE 8780

**Course Title:** Biochemistry of Exercise

**Credit Hours:** 3 semester hours (Lecture 3)

**Meeting Times:** 2:00 pm – 4:30 pm, Tuesday

**Meeting Place:** Student Activities Center – Room 247

**Prerequisite:** KINE 7680 and KINE 7700 or equivalent or Dept. Approval.

**Instructor**: L. Bruce Gladden – 844-1466; [gladdlb@auburn.edu](mailto:gladdlb@auburn.edu).

Office Hours, Room 280 Kinesiology Building:

T and Th – 2:30 – 3:30 pm and by appointment

**Textbook:** If you wish, you can consult the following textbook, but it is not required.

Tiidus, Tupling, and Houston. (2012). Biochemistry Primer for Exercise Science (4th ed.). Champaign, IL: Human Kinetics,

Required Handouts

A required set of course Hand-Outs and a required set of Course Readings will be available on Canvas. These are to be treated as the textbooks for the class.

**This class is planned for in-person but may switch to Zoom entirely or be supplemented with Zoom meetings, depending on ongoing events. You will receive a Zoom invitation for this class if needed. See the end of this syllabus for additional detailed information relative to COVID-19, RSV, and Flu considerations.**

**Course Description:** Regulation of the metabolic pathways of energy metabolism with emphasis on carbohydrates, the energetic response to acute exercise and exercise training.

This is a Graduate School, doctoral level course. Therefore, much material will be taken for granted as baseline knowledge. Along the same lines, some of the assigned reading material will be from scientific review articles; read this material at least as carefully as you would a textbook. Although the teaching format is that of lecturing, you should come to class prepared to discuss the topic of the day. In order to derive optimal benefits from any discussions, previous knowledge of the topic to be discussed is required. Therefore, all students are expected to read all assignments prior to class. There will be a significant amount of reading for this course; stay on top of it. If the readings sometimes seem too difficult for you, fight your way through them trying to get the overall message. Hopefully, during my lectures I will be able to bring all of the information together in a comprehensible and digestible lump.

**Course Objectives:**  Upon completion of this course, students will understand:

1. Energetics, thermodynamics, and kinetics of chemical reactions;

2. Key regulators of glycolysis and their response to exercise;

3. Key regulators of the TCA cycle and their response to exercise;

4. Key regulators of the electron transport chain and their response to exercise.

**Course Content and Schedule:**

Week 1: A Simple Overview of Organic Compounds. Acid-Base.

Week 2: Acid-Base, continued. Overview of Proteins.

Week 3: Energetics, Thermodynamics, and Kinetics of Chemical Reactions.

Week 4: Equilibrium and Nonequilibrium Reactions.

Week 5: Enzyme Kinetics.

Week 6: The Immediate Energy System and Its Control.

Week 7: Glycolytic Pathway.

Week 8: Lactate Shuttles.

Week 9: Regulation of Glycolysis During Exercise.

Week 10: Tricarboxylic Acid Cycle.

Week 11: Regulation of Tricarboxylic Acid Cycle During Exercise.

Week 12: Electron Transport Chain.

Week 13: Electron Transport Chain, continued.

Week 14: Regulation of Electron Transport Chain During Exercise.

Week 15: Lactate Formation and Removal (if we get there).

**Note the following:**

M Jan 15 **MLK, Jr. Holiday –** no classes.

Th Feb 22 – Sat Feb 24 – **SEACSM Annual Meeting;** Greenville, SC.

T Feb 27 **Mid-Semester for our class.**

Mar 4-8 **Spring break.**

T Apr 2 **Gladden out of town.** This is Exam 3, so you may or may not be

Assigned a recorded lecture – to be determined.

T Apr 23 Last class day of this course for Spring 2024 semester.

**GRADING**

1. There will be four examinations, each worth 100 points for a total of 400 points.

2. Surprise quizzes are a possibility. If given, they would be worth 10 points each.

3. If an exam is missed, there can be a makeup test. The make-up test may not be the same format as that given during the regular test time.

88.00% or greater = A

79.00%-87.99% = B

70.00%-78.99% = C

60.00%-69.99% = D

less than 60.00% = F

**TENTATIVE TESTING SCHEDULE**

**EXAM #1** – ≈January 30.

**EXAM #2** – ≈February 27.

**EXAM #3** – ≈April 2.

**EXAM #4**  – Shortly after April 23.

**Curving** – DO NOT request that grades be adjusted (curved); the grading scheme above is based on 30+ years of teaching this class.

**Extra Credit** – There is no extra credit in this class; there is only credit. Should “extra” credit opportunities arise, they will be offered to all students in the class.

**KINE 8780 Course Outline.**

The course outline below is a baseline order for our approach. It is subject to change. This allows flexibility in dealing with different topics. For example, if more discussion arises on a particular subject, it may take longer to cover it. In other cases, less time may be required. You will be informed regularly and promptly of any changes. The topics are listed and followed by the readings which accompany them.

**Topic # 1:**

**A Simple Overview of Organic Compounds. Acid-Base.**

*Chapter 3. Chemical Composition of the Body, pp. 24-47, In: Human Physiology: The Mechanisms of Body Function, by Vander, Sherman, and Luciano, 1985, McGraw-Hill Book Company, New York.*

*Appendix., pp. 123-127, First edition of Biochemistry Primer (by Houston).*

*Chapter 1. pp 3-17. Biochemistry Primer 4th Edition (by Tiidus, Tupling, and Houston).*

**Topic #2:**

**How are Reactions Studied? Energetics, Thermodynamics and Kinetics of Chemical Reactions. Equilibrium and Nonequilibrium Reactions.**

*Chapter 4, pp. 99-103, Biochemistry Primer 4th Edition (by Tiidus, Tupling, and Houston).*

*Chapter 2. Bioenergetics, pp.19-26, and Chapter 3. The Maintenance of ATP Homeostasis in Energetics and Human Movement, pp. 31-36. In: Exercise Physiology, by Brooks, Fahey, and Baldwin, Fourth Edition, 2005, McGraw-Hill, Boston.*

*Chapter 1. Methods and Approaches in Metabolism, pp. 1-9, In: Biochemistry for the Medical Sciences, by Newsholme and Leech, 1983, John Wiley & Sons, New York.*

*Chapter 12. Introduction to Metabolism, pp. 434-438, In: Biochemistry, by Mathews, van Holde, and Ahern, Third Edition, 2000, Addison Wesley Longman, Inc., San Francisco.*

**Topic # 3:**

**ATP and High Energy Compounds - The Energy Derived from ATP Breakdown.**

*Chapter 4, pp. 83-99, Biochemistry Primer 4th Edition (by Tiidus, Tupling, and Houston).*

*Chapter 2. Bioenergetics, pp. 26-29, In: Exercise Physiology, by Brooks, Fahey, and Baldwin, Fourth Edition, 2005, McGraw-Hill, Boston.*

*Chapter 2.B. The Thermodynamics of the Role of ATP in Metabolism, pp. 29-36, In: Biochemistry for the Medical Sciences, by Newsholme and Leech, 1983.*

*Chapter 3. The Energetics of Life, pp. 74, 76-79, In: Biochemistry, by Mathews, Van Holde, and Ahern, Third Edition, 2000, Benjamin/Cummings, New York.*

**Topic # 4:**

**Enzyme Kinetics (Michaelis-Menten, Lineweaver-Burk, Eadie-Hofstee, and Hanes).**

*Chapter 2. Enzymes, pp. 19-37, Biochemistry Primer 4th Edition (by Tiidus, Tupling, and Houston).*

*Chapter 4. Molecular Control Mechanisms: DNA and Protein, pp. 48-58, and Chapter 5. Energy and cellular metabolism, pp. 80-89, In: Human Physiology: The Mechanisms of Body Function, by Vander, Sherman, and Luciano, 1985.*

*Chapter 3. The Maintenance of ATP Homeostasis in Energetics and Human Movement, pp. 36-41, In: Exercise Physiology, by Brooks, Fahey, and Baldwin, Fourth Edition, 2005, McGraw-Hill, Boston.*

*Chapter 7.A. Introduction to Metabolic Regulation, pp. 300-311, In: Biochemistry for the Medical Sciences, by Newsholme and Leech, 1983.*

*Enzymes, Energy and Endurance, pp. 1-35, by Newsholme, In: Principles of Exercise Biochemistry, 3rd, revised edition, ed. by Poortmans, 2004, Karger, Basel, New York.*

**Topic # 5:**

**Immediate Energy System.**

*pp. 92-97 of Chapter 4, Biochemistry Primer 4th Edition (by Tiidus, Tupling, and Houston).*

*High-Energy Phosphates and Muscle Energetics, pp. 87-107, by Sahlin, In: Principles of Exercise Biochemistry, 3rd, revised edition, ed. by Poortmans, 2004, Karger, Basel, New York.*

**Topic # 6:**

**Carbohydrate Metabolism - Glycolytic Pathway, The Shuttles, Control.**

*Chapter 6. Carbohydrate Metabolism, pp. 153-204; Biochemistry Primer 4th Edition (by Tiidus, Tupling, and Houston).*

*Chapter 13. Carbohydrate Metabolism I: Anaerobic Processes in Generating Metabolic Energy, pp. 446-479, In: Biochemistry, by Mathews, Van Holde, and Ahern, Third Edition, 2000, Benjamin/Cummings, New York.*

*Chapter 5. Glycogenolysis and Glycolysis in Muscle: The Cellular Degradation of Sugar and Carbohydrate to Pyruvate and Lactate, pp. 59-96, In: Exercise Physiology, by Brooks, Fahey, and Baldwin, Fourth Edition, 2005, McGraw-Hill, Boston.*

*Lactate Metabolism during Exercise, pp. 152-196 (but only pp. 157-160 and 181-185), by Gladden, In: Principles of Exercise Biochemistry, 3rd, revised edition, ed. by Poortmans, 2004, Karger, Basel, New York.*

**Topic # 7:**

**The TCA Cycle - Pathway and Control.**

*Chapter 5. Oxidative Phosphorylation, pp. 107-152, Biochemistry Primer 4th Edition (by Tiidus, Tupling, and Houston).*

*Chapter 14. Oxidative Processes: Citric Acid Cycle and Pentose Phosphate Pathway, pp. 483-508, In: Biochemistry, by Mathews, Van Holde, and Ahern, Third Edition, 2000, Benjamin/Cummings, New York.*

*Chapter 6. Cellular Oxidation of Pyruvate and Lactate, pp. 97-123, In: Exercise Physiology, by Brooks, Fahey, and Baldwin, Fourth Edition, 2005, McGraw-Hill, Boston.*

**Topic # 8:**

**The Electron Transport Chain - Pathway and Control.**

*Chapter 5. Oxidative Phosphorylation, pp. 107-152, Biochemistry Primer 4th Edition (by Tiidus, Tupling, and Houston).*

*Chapter 14. Energy Conversion: Mitochondria and Chloroplasts, pp. 813-840, In: Molecular Biology of the Cell, by Alberts, Johnson, Lewis, Raff, Roberts, and Walter, Fifth Edition, 2008, Garland Science, Taylor & Francis Group, New York.*

*Chapter 6. Cellular Oxidation of Pyruvate and Lactate, pp. 97-123, In: Exercise Physiology, by Brooks, Fahey, and Baldwin, Fourth Edition, 2005, McGraw-Hill, Boston.*

*Lactate transport and metabolism during exercise, pp. 614-648 (but only 618-621), by Gladden, In: Handbook of Physiology. Exercise: Regulation and Integration of Multiple Systems, ed. By Rowell and Shepherd, 1996, Oxford University Press, New York.*

**Topic # 9:**

**Lactate Formation and Removal.**

*Chapter 6. Carbohydrate Metabolism, pp. 176-184, 187-190, Biochemistry Primer 4th Edition (by Tiidus, Tupling, and Houston).*

*Chapter 9. Neural-endocrine Control of Metabolism: Blood Glucose Homeostasis During Exercise, pp. 196-202, In: Exercise Physiology, by Brooks, Fahey, and Baldwin, Fourth Edition, 2005, McGraw-Hill, Boston.*

*Pascoe, David D. and L. Bruce Gladden. Muscle glycogen resynthesis after short term, high intensity exercise and resistance exercise. Sports Medicine 21:98-118, 1996.*

*Donovan and Pagliassotti. Quantitative assessment of pathways for lactate disposal in skeletal muscle fiber types. Medicine & Science in Sports and Exercise 32:772-777, 2000.*

*Lactate Metabolism during Exercise, pp. 152-196 (but only pp. 160-165), by Gladden, In: Principles of Exercise Biochemistry, 3rd, revised edition, ed. by Poortmans, 2004, Karger, Basel, New York.*2024 SPRING TERM

**CLASS DAYS – KINE 8780 Biochemistry of Exercise**

1 T Jan 16

2 T Jan 23

3 T Jan 30

4 T Feb 6

5 T Feb 13

6 T Feb 20

7 T Feb 27

8 T Mar 12

9 T Mar 19

10 T Mar 26

11 T Apr 2 – Gladden out of town.

12 T Apr 9

13 T Apr 16

14 T Apr 23

**Class Policy Statements:**

**Covid-19, RSV, Flu issues –** please see the end of this syllabus for details.

**Unannounced Quizzes -** There could be unannounced quizzes in this class.

**Email –** You are responsible for checking your e-mail regularly and in a timely manner for any communications related to this class. The University has requested that all students use their Auburn University email accounts. This is the most efficient way for instructors to communicate with an entire class, and the University will occasionally send global notices that are important for all students. For this class, it is a requirement that you check your Auburn University email frequently.

**Electronic Devices** - As a courtesy to others, turn your cell phone completely off during class or individual meetings with me. If you are expecting an extremely important call, please let me know at the beginning of class or appointment. Similarly, texting, surfing, or other electronic use (e.g., computer, iPad, etc.), unless directly related to the class or appointment, is strictly prohibited. If these policies are violated, you will be asked to leave class or the appointment.

**Attendance -** Although roll will not be taken specifically, it is expected that students taking a graduate class will attend every class meeting and will actively participate in class discussions. Please refer to the Student Policy eHandbook (<http://www.auburn.edu/student_info/student_policies/>) for the definition of excused absences. Students are expected to show evidence of thorough reading of assigned materials. Students are responsible for initiating arrangements for missed work.

**Disability Accommodations -** Students who need accommodations are asked to electronically submit their approved accommodations through AU Access and to arrange a meeting during office hours the first week of classes, or as soon as possible if accommodations are needed immediately. If you have a conflict with my office hours, an alternate time can be arranged. To set up this meeting, please contact me by e-mail. If you have not established accommodations through the Office of Accessibility, but need accommodations, make an appointment with the Office of Accessibility, 1228 Haley Center, 844-2096 (V/TT).

**Honesty Code** – The University Academic Honesty Code and the Student Policy eHandbook (<http://www.auburn.edu/student_info/student_policies/>) pertaining to Cheating will apply to this class.

**Professionalism** – As faculty, staff, and students interact in educational settings, they are expected to demonstrate professional behaviors as defined in the College of Education’s conceptual framework. These professional commitments or dispositions are as follows: 1) engage in responsible and ethical practices, 2) contribute to collaborative learning communities, 3) demonstrate a commitment to diversity, and 4) model and nurture intellectual vitality.

**COVID-19, RSV, Flu CONSIDERATIONS/POLICIES**

**Health and Well-Being Resources**

These are difficult times, and academic and personal stress is a natural result. Everyone is encouraged to take care of themselves and their peers. If you need additional support, there are several resources on campus to assist you:

● COVID Resource Center (http://auburn.edu/covid-resource-center/)

● Student Counseling and Psychological Services (http://wp.auburn.edu/scs/)

● AU Medical Clinic (https://cws.auburn.edu/aumc/)

● If you or someone you know are experiencing food, housing or financial insecurity, please visit the Auburn Cares Office (http://aucares.auburn.edu/)

**A Healthier U Campus Community Expectations**

We are all responsible for protecting ourselves and our community. Please go to the AU COVID Resource Center for AU’s information/instructions about COVID, and be aware of other communicable diseases (e.g., RSV and the Flu) that might be circulating within our community.

**Course contingency**

If normal class is disrupted due to illness, emergency, or crisis situation, the syllabus and other course plans and assignments may be modified to allow completion of the course. If this occurs, an addendum to your syllabus and/or course assignments will replace the original materials.

**Face Covering Request**

Should health conditions within Auburn University or the Auburn community at large warrant it, I may ask that you wear a properly worn, acceptable face mask in our in-person class meetings.

**Physical Distancing Policy Request**

Face coverings are not a substitute for physical distancing. Should local health conditions warrant it, I will request that students observe appropriate physical distancing and follow all classroom signage. If the instructional space has designated entrance and exit doors, you should use them.

**Possibility of going remote**

This course may require particular technologies to complete coursework. If you need access to additional technological support, please contact the AU Bookstore at aubookstore@auburn.edu. In the event that the University is forced to move to fully online instruction, please be assured that the learning goals and outcomes of the course will not change; however, some aspects of the course will change in terms of the mode of delivery, participation, and testing methods. Those details will be shared via an email message within 24 hours of the announcement that we are going remote. Please be prepared for this contingency by ensuring that you have access to a computer and Internet.

**Assignment/Schedule subject to change due to health conditions**

Please be aware that the situation regarding communicable diseases is frequently changing, and the delivery mode of this course may adjust accordingly. In the event that the delivery method is altered, please be assured that the learning goals and outcomes of the course will not change; however, some aspects of the course will change in terms of the mode of delivery, participation, and testing methods. Those details will be shared via email as soon as possible. Please be prepared for this contingency by ensuring that you have access to a computer and reliable Internet. The course schedule and assignments are designed with the most up-to-date information and policies in mind. If the situation changes, I will make every effort to keep the schedule as consistent as possible; however, please note that the due dates for assignments and tests may be changed during the semester in response to the changing health and safety requirements or policies of the University. When changes are made, they will be communicated via email and all assignment due dates will be updated.

In the event a student in class becomes ill, and in-person meetings are occurring, please contact me immediately and I will make arrangements for you to receive class instruction at home until you feel better.

If I am unable to attend any in-person portions of the class, we will transition to a fully online course until I am allowed to return. If I become ill or unable to lead the class, a backup instructor will be identified and he/she will communicate any changes or updates to the course schedule or mode of instruction as soon as possible.

**Zoom policies**

If we meet on Zoom, your attendance, attention, and participation are expected. Zoom participation requires you to keep your video on and your microphone muted when you are not speaking. Although you may be participating from your domicile, our Zoom meetings are professional interactions. You should dress and behave as you would in a normal in-person classroom. To the extent possible, please minimize distractions in the background. I reserve the right to dismiss anyone from a Zoom meeting whose environment or behavior is distracting or problematic. If you have any issues with sharing your video feed, adhering to this policy, or anything else related to your use of Zoom please notify me via email in the first week of class. I’m happy to consider and provide accommodations, but you will need to be in communication with me.

**Attendance**

Your health and safety, and the health and safety of your peers, are my top priorities. If you are experiencing any symptoms of COVID-19 or other contagious diseases, or if you discover that you have been in close contact with others who have symptoms or who have tested positive, you should not attend in-person classes. You will not be penalized for such an absence nor will you be asked to provide formal documentation from a healthcare provider. My hope is that if you are feeling ill or if you have been exposed to someone with the virus or other contagious illness, you will stay home to protect others.

Please do the following in the event of any illness or COVID-related absence:

* Notify me in advance of your absence if possible
* If you are quarantined or otherwise need to miss class because you have been advised that you may have been exposed to COVID-19, you will be expected to develop a plan to keep up with your coursework during any such absences
* Participate in class activities and submit assignments electronically as much as possible
* Notify me if you require a modification to the deadline of an assignment or exam

Students with questions about COVID-related illnesses should reach out to the COVID Resource Center at (334) 844-6000 or at <http://auburn.edu/covid-resource-center/>.

Finally, if remaining in a class and fulfilling the necessary requirements becomes impossible due to illness or other COVID-related issues, please let me know as soon as possible so we can discuss your options.