**Department of Kinesiology**

**Course Syllabus**

**Spring 2020**

**1. Course Number:** KINE 8780

**Course Title:** Biochemistry of Exercise

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

**Prerequisite:** KINE 7680 and KINE 7700 or equivalent or dept. approval.

**Corequisite:** None

**2. Course Instructor:** L. Bruce Gladden, School of Kinesiology

**Meeting Place & Time:** Student Activities Center 249 at 4:00 – 6:30 pm W

**Office Hours:** TR – 9:00-10:00 am

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

and

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

**4. 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.

**5. 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.

**6. 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.

**Note the following:**

**January 8** (W) – Gladden out for surgery recovery. We will meet at a mutually agreed-upon time to make up this class.

**January 20** (M) - Martin Luther King Holiday – no need to make up since it’s an official holiday and not on our class day.

**March 11** (W) – Spring break (March 9-13).

**7. Course Requirements/Evaluation:**

There will be four examinations of about 90 minutes each. Each of these exams will be worth 100 points for a total of 400 points. These exams are scheduled outside of class time at approximately Jan 30-Feb 3 (Th-M), Feb 27-Mar 2 (Th-M), April 2-6 (Th-M) and completely through the course, Apr 27-May 1 (M-F).

Item Final Letter Grade

Exams & Tests - 100% ≥ 88 = A

≥ 79 but < 88 = B

≥ 70 but < 79 = C

≥ 60 but < 70 = D

< 60 = F

**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.

**8. Class Policy Statements:**

**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.

**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. 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-Burke, 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.*2020 SPRING TERM

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

1 W Jan 8 – Gladden out – to be made up at mutually agreed upon time.

2 W Jan 15

M Jan 20 – Martin Luther King, Jr. Holiday.

3 W Jan 22

4 W Jan 29

EXAM #1 – Jan 30-Feb 03, Th-M

5 W Feb 05

6 W Feb 12

Th-Sat – Feb 13-15 – SEACSM Meeting in Jacksonville, FL

7 W Feb 19

8 W Feb 26

EXAM #2 – Feb 27-Mar 02, Th-M

9 W Mar 04

March 09-13 – NO CLASS – SPRING BREAK.

10 W Mar 18

11 W Mar 25

12 W Apr 01

EXAM #3 – Apr 02-06, Th-M

13 W Apr 8

14 W Apr 15

15 W Apr 22

EXAM #4 – Apr 27-May 01, M-F

**TENTATIVE TESTING SCHEDULE**

**EXAM #1** (Jan 30-Feb 03, Th-M)  **EXAM #2** (Feb 27-Mar 02, Th-M)

**EXAM #3** (Apr 02-06, Th-M) **EXAM #4** (Apr 27-May 01, M-F)