



BIOC*4520 Metabolic Processes

Fall 2017

Sections(s): C01

Department of Molecular and Cellular Biology

Credit Weight: 0.50

Version 1.00 - September 06, 2017

1 Course Details

1.1 Calendar Description

This course is an in-depth study of the role of bioenergetics, regulation, and chemical mechanisms in carbohydrate, lipid, and nitrogen metabolism.

Pre-Requisite(s): BIOC*3560 or BIOC*3570

1.2 Course Description

Objectives:

This course presents an in-depth study of metabolic pathways. The governing role of free energy in determining the extent and direction of reactions will be used as a guiding principle to demonstrate the patterns and associations that contribute to the ordered functioning of a complete biochemical system. Principles of organic reaction mechanisms will be introduced and used to demonstrate the chemical logic governing synthesis and breakdown of the major groups of biochemical substances. A basic organic chemistry background (nucleophiles, electrophiles, electron pushing) is *assumed*. Regulatory mechanisms and their roles in integrating complete biochemical systems will be studied.

1.3 Timetable

Lectures: Monday Wednesday Friday 12:30 - 1:20, MacK 115.

1.4 Final Exam

Exam time and location is subject to change. Please see WebAdvisor for the latest information.

2 Instructional Support

2.1 Instructor(s)

Manfred Brauer

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Office: SC1 3520
Office Hours: Monday Wednesday Friday 1:30 - 2:20, OR e-mail me!

3 Learning Resources

Very Highly Recommended Texts (not required).

Detailed and comprehensive texts, esp. for metabolism and chemical mechanisms.

One of the following three recommended texts.

Those texts listed as "Additional" are also recommended.

You need not buy a new book, if you already have any of these. These books are on reserve at the library.

3.1 Recommended Resources(s)

Biochemistry (Textbook)

Very Highly Recommended:

Nelson and Cox, *Lehninger's Biochemistry* - 6th or 7th Edition, 2013 or 2017

Biochemistry (Textbook)

Very Highly Recommended:

Voet and Voet, *Biochemistry* - 4th Edition, 2011

Biochemistry (Textbook)

Very Highly Recommended:

Mathews, Van Holde, Appling, Cahill, *Biochemistry* 4th Edition, 2013.

3.2 Additional Resources(s)

Biochemistry (Textbook)

Voet and Voet, *Biochemistry* - 3^d Edition, 2004

Biochemistry (Textbook)

Berg, Tymoczko and Stryer, *Biochemistry* - 6th Edition, 2006

Voet and Voet (Textbook)

Voet and Voet 2nd Edition, 1995

Biochemistry (Textbook)

Matthews, Van Holde, Ahern, *Biochemistry* - 43th Edition, 2012

Basis of Life (Textbook)

McKee and McKee, *Mol. Basis of Life*, 5th Edition 2012

Biochemistry (Textbook)

Lehninger's *Biochemistry*, Nelson & Cox, 2005

4 Learning Outcomes

4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Critically evaluate a scientific claim with human health implications for a primary research article published in the last year.
 2. Explain the role of entropy and enthalpy, Gibbs free energy change, equilibrium constants, coupled reactions and redox reactions in biochemical processes.
 3. Understand the four basic types of metabolic reactions, and the general mechanisms that most enzymes use to catalyze these reactions. Be able to predict how an enzyme should work, and what cofactors (vitamins) it needs to work.
 4. Describe the key metabolic pathways, i.e. the overall purpose, reactants and products, tissue distribution and metabolic regulation and coordination between glycolysis, the TCA cycle (catabolic and anabolic), electron transport, oxidative phosphorylation, fat breakdown and biosynthesis, ketone bodies, cholesterol biosynthesis, amino acid breakdown and biosynthesis and nucleic acid metabolism.
 5. Explain how disorder of metabolic regulation results in important medical consequences, such as increased glycolysis in tumours, insulin resistance and diabetes in obesity, reactive oxygen species and free radical damage in electron transport disruption, atherosclerosis in high cholesterol states and neurotransmitter imbalance in amino acid metabolic dysfunction.
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5 Teaching and Learning Activities

5.1 Presentation

There will be three lectures a week. There are no labs or assigned readings, but you are responsible for *everything* that occurs in lecture. Problem sets will be given out to reinforce the lecture material. Solutions to these problems will be given out.

5.2 Detailed Course Outline - Approximate Time Line

1. Introduction to Thermodynamics - forms of energy, life and the second law.

2 & 3. Free Energy - free energy of formation, coupled reactions.

1. Free Energy Calculations - free energy of hydrolysis, bioenergetic status.
2. Redox Reactions and Free Energy - standard potentials, Nernst equation.
3. Metabolic Flux and Metabolomics.
4. Introduction to Reaction Mechanisms.

8 & 9. Glycolysis - Reaction Mechanisms.

10 & 11. Glycolysis - Bioenergetics and Regulation.

1. Start and End of Glycolysis - glycogen, glucose, lactate, ethanol, tumours.
2. Pyruvate Dehydrogenase - Mechanism of Action.

14 & 15. TCA Cycle - Mechanisms, Bioenergetics and Control.

1. TCA Cycle - Anaplerotic Reactions, Fat vs. CHO.
2. Electron Transport-components, leakage of electrons, free radical scavengers.

18 & 19. Electron Transport/ Oxidative Phosphorylation - states of mitochondria.

1. Compartmentation and Transport in the Mitochondria.
2. Triglycerides and Fatty Acids - lipoproteins, transport and β oxidation.

22 & 23. Ketone Bodies, Terpenoids.

24 & 25. Cholesterol Metabolism, Steroid Biosynthesis and Function.

26 & 27. Amino-acid catabolism, Mechanism of Action of Pyridoxal Phosphate

1. The Urea Cycle.

29 & 30. Amino Acid and Neurotransmitter Biosynthesis.

1. Beyond Amino Acid Biosynthesis - nitric oxide synthase, folate.
2. Amino Acids and Porphyrin Biosynthesis.

33 & 34. Pyrimidine Biosynthesis, Purine Catabolism - xanthine oxidase and hypoxia.

35 & 36. Review of Coenzymes, Metabolic Regulation and Integration of Pathways.

6 Assessments

6.1 Course Evaluation

The course grade will be based on performance on two midterms (in class, 16% each), assignments (10%), a term paper on a current research paper (24%) and a cumulative final examination (34%).

6.2 Midterm Examinations

There will be 2 in-class midterm exams. Persons with a scheduled academic conflict should inform the instructor immediately. Alternative midterm exams will be arranged where appropriate and possible.

6.3 Final Examination

The Registrar sets the time (Thursday, Dec. 14, 8:30 - 10:30 pm) and location (to be determined.) The final exam is cumulative, but will stress material since the last midterm. A metabolic map will be provided on the final exam.

7 Course Statements

7.1 Policy on Missed Examinations

If you miss an exam or assignment, you must have documentation. Only valid excuses (medical or compassionate reason) will prevent a grade of zero for any missed test. It is the student's responsibility to arrange for the necessary verification from the Medical or Psychological Services or the Director of Student Affairs. *Make-up tests will not be given.*

7.2 Exam Aids

No materials may be brought to the exam except for pencils, pens and an eraser. No electronic devices (other than calculators), pencil cases, purses, bags, tissue boxes or other containers may be present. All materials are subject to inspection.

8 Department of Molecular and Cellular Biology

Statements

8.1 Academic Advisors

If you are concerned about any aspect of your academic program:

- Make an appointment with a program counsellor in your degree program. [B.Sc. Academic Advising](#) or [Program Counsellors](#)

8.2 Academic Support

If you are struggling to succeed academically:

- Learning Commons: There are numerous academic resources offered by the Learning Commons including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills. You can also set up individualized appointments with a learning specialist.
<http://www.learningcommons.uoguelph.ca/>
- Science Commons: Located in the library, the Science Commons provides support for physics, mathematic/statistics, and chemistry. Details on their hours of operations can be found at: <http://www.lib.uoguelph.ca/get-assistance/studying/chemistry-physics-help> and <http://www.lib.uoguelph.ca/get-assistance/studying/math-stats-help>

8.3 Wellness

If you are struggling with personal or health issues:

- Counselling services offers individualized appointments to help students work through personal struggles that may be impacting their academic performance.
<https://www.uoguelph.ca/counselling/>
- Student Health Services is located on campus and is available to provide medical attention. <https://www.uoguelph.ca/studenthealthservices/clinic>
- For support related to stress and anxiety, besides Health Services and Counselling Services, Kathy Somers runs training workshops and one-on-one sessions related to stress management and high performance situations. <http://www.uoguelph.ca/~ksomers/>

9 University Statements

9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The regulations and procedures for [Academic Consideration](#) are detailed in the Undergraduate Calendar.

9.3 Drop Date

Courses that are one semester long must be dropped by the end of the fortieth class day; two-semester courses must be dropped by the last day of the add period in the second semester. The regulations and procedures for [Dropping Courses](#) are available in the Undergraduate Calendar.

9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required, however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance, and not later than the 40th Class Day.

More information: www.uoguelph.ca/sas

9.6 Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The [Academic Misconduct Policy](#) is detailed in the Undergraduate Calendar.

9.7 Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

9.8 Resources

The [Academic Calendars](#) are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.
