



BIOC*2580 Introduction to Biochemistry

Winter 2020

Section(s): C01

Department of Molecular and Cellular Biology

Credit Weight: 0.50

Version 1.00 - December 17, 2019

1 Course Details

1.1 Calendar Description

This course introduces students to the evolution, chemical structure, and biological roles of the major molecular components of the cell: including proteins, nucleic acids, lipids, and carbohydrates. Topics and processes integrated through understanding biological macromolecules include enzymology and intermediary metabolism, with emphasis on catabolic processes. Students will gain basic investigative skills through hands-on experiences in a laboratory setting.

Pre-Requisites: CHEM*1050

1.2 Course Description

There are three main themes that run throughout this foundational course in biochemistry:

1. The principles of Physics and Chemistry can explain Biology.
2. The Structure and Function of biological molecules are inextricably connected.
3. Biochemistry is the link between biological Metabolism and its underlying Chemistry.

1.3 Timetable

Monday, Wednesday & Friday 1:30 PM to 2:20 PM, in ROZH 104

All material covered in lectures is the responsibility of the student, including announcements regarding midterms, labs, and exams.

1.4 Final Exam

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

2 Instructional Support

2.1 Instructional Support Team

Instructor: Dr. Enoka Wijekoon
Email: bioc2580@uoguelph.ca
Telephone: +1-519-824-4120 x56095
Office: SC1 3517
Office Hours: Office hours: Mon and Wed 3:00 - 4:30 pm

Instructor: Dr. John Dawson
Email: bioc2580@uoguelph.ca
Telephone: +1-519-824-4120 x53867
Office: SC1 2248
Office Hours: Mondays 3:30-4:30 pm
 Tuesdays 3:30-4:30 pm

Lab Co-ordinator: Jaspreet Kaur
Email: bioc2580@uoguelph.ca
Telephone: +1-519-824-4120 x58220
Office: SC1 3521

3 Learning Resources

3.1 Recommended Resources

Lehninger Principles of Biochemistry (Textbook)

The following textbook is highly **recommended**, especially if you also intend to take the second biochemistry course, BIOC*3560 Structure and Function in Biochemistry. It is also used in several other senior biochemistry courses.

Lehninger Principles of Biochemistry; D.L. Nelson and M.M. Cox, 7th ed. (2017) **or** 6th ed. (2013) W.H. Freeman, NY.

Multiple copies of this text book are on Reserve in the library.

There are three options, each containing the same information, but in slightly different formats:

1. The hardcover textbook bundled with Sapling Plus* (2-term Access**)
2. The loose-leaf textbook bundled with Sapling Plus (2-term Access)
3. Sapling Plus (1-term or 2-term Access) (The e-book is housed within Sapling plus)

and you will have **24 months access** to the ebook)

4. Ebook only (no Sapling) (Could be purchased from Macmillan Learning student store. The eBook option is not available through the bookstore).

* Sapling Plus will not be used in the course. It comes bundled with the textbook at no added cost. You can use the resources found there for your studies and for self evaluation.

**2-term gives you access to sapling Plus for 2 semesters, whether they are back-to-back or not.

Loose leaf versions cannot be resold as a used textbook at the Bookstore.

BE AWARE: With the eBook, you are purchasing access to the electronic version for a specific period of time; once this is over, you will not be able to access the eBook.

3.2 Getting Help in BIOC*2580

Course Email: bioc2580@uoguelph.ca

You can make use of the course e-mail address to ask questions. Only use your @uoguelph account when sending messages to this address. Enquiries regarding the laboratory should have the word LAB in the subject line. E-mail may not be answered outside of office hours.

PLEASE FOLLOW PROPER EMAIL ETIQUETTE WHEN FORMATTING YOUR EMAILS.

Supported Learning Group (SLG)

SLGs are free study sessions led by students. These trained SLG Leaders sit in on lectures and run sessions that are informal, flexible, and fun. Students who make regular use of the SLG have a higher average grade on this course than those who do not. SLG information and schedules are available in CourseLink.

4 Learning Outcomes

4.1 Course Learning Outcomes

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

1. Describe the structures and the chemical properties of the 20 amino acids.
2. Describe the methods used in the separation of amino acids and proteins based on their chemical properties.
3. Describe the first three levels of protein structure and explain how protein structure is influenced by the amino acid sequence.
4. Explain how enzymes catalyze reactions and how enzyme activity is affected by

inactivators and inhibitors.

5. Describe the structure and the chemical properties of carbohydrates (monosaccharides and disaccharides), lipids (fatty acids, triglycerides and glycerophospholipids) and nucleic acids (RNA and DNA).
 6. Describe the chemical reactions involved in the generation of ATP through the oxidation of glucose and fatty acids.
 7. Apply several of the knowledge outcomes in 1-6 by effectively working with a partner to carry out laboratory procedures to collect, properly record and analyse experimental data.
 8. Manage time effectively and follow instructions to meet deadlines for course requirements.
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5 Teaching and Learning Activities

5.1 Lecture Schedule

| Class | Date | Topic | Lehninger (6th ed) | Lehninger (7th ed) |
|-------|-----------|--|--------------------|---------------------|
| 1 | Jan 6 | Biological polymers; building blocks and hydrolyzable bonds. Amino acids, peptides and proteins. | 11-15; 76; 85-86 | 12-16; 75-76; 85-86 |
| 2 | Jan 8 | Amino acids; polarity and ionization. | 75-85 | 75-85 |
| 3 | Jan 10 | Properties of aqueous solutions; dissociation of weak electrolytes | 47-50; 58-65 | 47-50; 58-65 |
| 4 | Jan 13 | Analytical methods and separation by chromatography | 89-96 | 89-96 |
| 5 | Jan 15 | More analytical methods | 89-96 | 89-96 |
| 6 | Jan 17 | Polypeptides and proteins: structural hierarchy, sequence. Basis of reactivity and hydrolysis | 96-102 | 96-102 |
| | Jan 18-24 | Quiz 1 (Lectures 1-6) | | |
| 7 | Jan 20 | Sequence determination | 96-102 | 96-102 |
| 8 | Jan 22 | Secondary structure I: α -helix, β -sheet | 115-125 | 115-125 |
| 9 | Jan 24 | Secondary structure II: α -helix, β -sheet | 115-125 | 115-125 |
| 10 | Jan 27 | Principles of tertiary structure | 125-140 | 125-141 |
| 11 | Jan 29 | Binding and recognition of substrates and specificity of enzymes | 189-200 | 187-198 |

| | | | | |
|----|------------|--|------------------|------------------|
| 12 | Jan 31 | The basis of chemical and enzymatic catalysis | 189-200 | 187-198 |
| | Feb 1-7 | Quiz 2 (lectures 7-12) | | |
| 13 | Feb 3 | Mechanism of action of chymotrypsin | 214-218 | 213-217 |
| 14 | Feb 5 | Enzyme assay and detection | 95-96;204-205 | 95-96; 203 |
| 15 | Feb 7 | Enzyme kinetics | 200-213 | 198-213 |
| 16 | Feb 10 | Enzyme kinetics: linear plots; Enzyme Inhibition and regulation | 200-213 | 198-213 |
| 17 | Feb 12 | Enzyme Inhibition and regulation contd | 200-213 | 198-213 |
| 18 | Feb 14 | Review | | |
| | Feb 17-21 | Winter Break - No Classes | | |
| 19 | Feb 24 | Lipids: fatty acids; TAG | 357-362 | 361-366 |
| 20 | Feb 26 | Lipids: Phospholipids; Analysis of lipids | 362-364; 377-379 | 366-369; 381-383 |
| 21 | Feb 28 | Carbohydrate chemistry: simple sugars | 243-245 | 241-243 |
| | Feb 29 | Midterm 1:00-2:30 PM | | |
| 22 | March 2 | Carbohydrate chemistry: rings; reducing sugars | 245-248; 251 | 243-247; 249 |
| 23 | March 4 | Carbohydrate chemistry: glycosides and disaccharides | 252-254 | 250-252 |
| 24 | March 6 | Chemistry of nucleic acid bases, nucleosides and polynucleotides | 281-287 | 279-285 |
| | March 7-13 | Quiz 3 (Lectures 19-24) | | |
| 25 | March 9 | The DNA double helix | 287-290 | 285-287 |
| 26 | March 11 | ATP as cellular energy currency | 517-524 | 507-514 |
| 27 | March 13 | Introduction to Metabolism: Redox reactions | 501-504; 528-538 | 491-494; 517-522 |
| 28 | March 16 | Catabolism of fats | 665;667 | 649-650; 621 |
| 29 | March 18 | Fatty acid β -oxidation | 667-677; 532-537 | 652-659; 522-526 |
| 30 | March 20 | Glycolysis: anaerobic energy generation | 543-555 | 533-545 |
| | March | Quiz 4 (Lectures 25-30) | | |

| | | | | |
|----|----------|--|---------------------------|---------------------------|
| | 21-27 | | | |
| 31 | March 23 | Fates of pyruvate and cytosolic NADH; fermentation | 758-759; 633-638; 563-565 | 619-624; 739-740; 553-558 |
| 32 | March 25 | Acetate to CO ₂ : the citric acid cycle | 633; 638-650 | 619; 624-636 |
| 33 | March 27 | The electron transport chain | 731-743 | 711-724 |
| 34 | March 30 | Chemiosmotic energy transduction | 743-747 | 724-728 |
| 35 | April 1 | ATP Synthase | 747-757 | 728-739 |
| 36 | April 3 | Efficiency of Oxidative Phosphorylation | 675-676 | 657-659 |
| | April 8 | Final Examination 11:30 AM-1:30 PM | | |

5.2 Lab Schedule - BIOC*2580 W18 (subject to change)

Group A - All the odd number sections (eg: BIOC*2580*0101)

| Week # | Dates | Activity |
|--------|--------------|------------------------------|
| 1 | Jan 13-16 | Introduction - Sign-up |
| 2 | Jan 21-23 | Lab 1: Amino Acids, Quiz 1 |
| 3 | Jan 27-30 | No Labs |
| 4 | Feb 4-6 | Lab 2: Proteins, Quiz 2 |
| 5 | Feb 10-13 | No Labs |
| 6 | Feb 17-21 | Winter Break - No Labs |
| 7 | Feb 25-27 | Lab 3: Enzymes, Quiz 3 |
| 8 | Mar 2-5 | No Labs |
| 9 | Mar 10-12 | Lab 4: Lipids, Quiz 4 |
| 10 | Mar 16-19 | No Labs |
| 11 | Mar 24-26 | Lab 5: Carbohydrates, Quiz 5 |
| 12 | Mar 30-Apr 2 | No Labs |

Group B - All the even number sections (eg: BIOC*2580*0102)

| Week # | Dates | Activity |
|--------|-------|----------|
|--------|-------|----------|

| | | |
|----|--------------|------------------------------|
| 1 | Jan 13-16 | Introduction - Sign-up |
| 2 | Jan 21-23 | No Labs |
| 3 | Jan 27-30 | Lab 1: Amino Acids, Quiz 1 |
| 4 | Feb 4-6 | No Labs |
| 5 | Feb 10-13 | Lab 2: Proteins, Quiz 2 |
| 6 | Feb 17-21 | Winter Break - No Labs |
| 7 | Feb 25-27 | No Labs |
| 8 | Mar 2-5 | Lab 3: Enzymes, Quiz 3 |
| 9 | Mar 10-12 | No Labs |
| 10 | Mar 16-19 | Lab 4: Lipids, Quiz 4 |
| 11 | Mar 24-26 | No Labs |
| 12 | Mar 30-Apr 2 | Lab 5: Carbohydrates, Quiz 5 |

6 Assessments

6.1 Marking Schemes & Distributions

| Name | Scheme A (%) |
|----------------|--------------|
| Online Quiz #1 | 2.5 |
| Online Quiz #2 | 2.5 |
| Midterm | 25 |
| Online Quiz #3 | 2.5 |
| Online Quiz #4 | 2.5 |
| Final Exam | 40 |
| Laboratories | 25 |
| Total | 100 |

6.2 Assessment Details

Online Quiz #1 (2.5%)

Date: Sat, Jan 18 - Fri, Jan 24

Learning Outcome: 1, 2, 8

Lectures 1-6

Online Quiz #2 (2.5%)

Date: Sat, Feb 1 - Fri, Feb 7

Learning Outcome: 2, 3, 8
Lectures 7-12

Midterm (25%)

Date: Sat, Feb 29, 1:00 PM - 2:30 PM, TBA

Learning Outcome: 1, 2, 3, 4, 8

Lectures 1-18

Online Quiz #3 (2.5%)

Date: Sat, Mar 7 - Fri, Mar 13

Learning Outcome: 5, 8

Lectures 19-24

Online Quiz #4 (2.5%)

Date: Sat, Mar 21 - Fri, Mar 27

Learning Outcome: 5, 6, 8

Lectures 25-30

Final Exam (40%)

Date: Wed, Apr 8, 11:30 AM - 1:30 PM, TBA

Learning Outcome: 1, 2, 3, 4, 5, 6, 8

Cumulative, with emphasis on lectures 19-36

Laboratories (25%)

Date: Bi-Weekly

Learning Outcome: 7, 8

Laboratory experiments and write-up

6.3 Note

- Lecture Component: 75%
- Laboratory Component: 25%
- Total: 100%

Students must pass the Lecture component on its own AND the Laboratory component on its own to pass the course as a whole (i.e. students need to achieve an overall grade of at least 37.5/75 for the 4 quizzes and the 2 exams and a minimum of 12.5/25 for the laboratory). This means that a high laboratory mark cannot be used to secure a pass if the lecture component is failed or *vice versa*. In cases where this standard is not achieved, the final grades assigned will either be the calculated grade or 47%, whichever is *less*.

6.4 Online Quizzes

The online quizzes are meant to ensure that students keep up with and have a chance to assess their understanding of the lecture material. Although these assignments are online, **STUDENTS ARE EXPECTED TO ANSWER THE QUESTIONS BY THEMSELVES.** The goal of the quizzes is to have students review and reflect on the material, and facilitate studying for the midterm and final exam in a lower-stakes format. As such, students will be given **three**

attempts at the quiz over a period of one week and the **best attempt will be taken towards the overall grade**. The time limit required per attempt is one hour. However, everyone will be given DOUBLE TIME (2 hrs) to complete each quiz.

Access to grades, answers and feedback: Students will be granted access to the feedback and answers to the quiz questions on the day following the closing of the quiz. Questions about the grades must be made to the instructor within a period of one-week following that. **Since this is an assessment of your learning, questions regarding specific quiz questions will not be answered while the quiz is still open.**

Deferrals policy: Students with medical or compassionate issues that **cover the entire one-week period the quiz is open** will be granted a changed mark weighting. The value of quizzes missed will be added to the value of the final exam. Accommodation forms from Program Counselors and documentation are **required** within one week of the end of the assignment deadline. **Extensions to the quiz cannot be granted beyond the one week period as answers are released once the quiz closes.** Be sure you have access to a working computer with a stable Internet connection. **Technical problems are not grounds for a deferral.**

6.5 Midterm Exam

DATE: Saturday, February 29, 2020, 1:00-2:30 PM

STUDENTS MUST NOTIFY THE INSTRUCTOR OF ANY ACADEMIC CONFLICTS BY Friday, January 17th. Academic conflicts are courses or labs that are scheduled at the exact same time. An alternate time will be provided for these students to write the midterm.

Access to grades, answers and feedback: Students will be granted access to their grades and answers to the midterm once the exams are graded. Questions about the grades must be made to the instructor within one week of the midterm being available for return.

Deferrals policy: Only medical or compassionate accommodations will be granted a missed midterm. Accommodation forms from Program Counselors and documentation are **required** within one week after the midterm. If a missed midterm is granted, the final exam will be reweighted to 65%. Alternate times to write a missed midterm cannot be granted.

6.6 Final Exam

DATE: Wednesday, April 8, 2020, 11:30 AM-1:30 PM

This exam will **cover the entire course (lectures 1-36)**, with strong emphasis on the material covered after the midterm examination. A **metabolic chart** will be posted on Courselink and provided at the final examination. The chart shows chemical structures organized into metabolic pathways, but it does not show compound or enzyme names, reaction stoichiometries and mechanisms, etc. Students are expected to be familiar with these, as outlined in the Learning Outcomes for the course.

Technology in all exams: Students may use a numerical calculator with ln and log functions for exams. Advanced calculators, computers, tablets or smart phones may **not** be used.

6.7 Laboratory Component

Laboratory sessions are designed to relate to the lecture content and to introduce students to proper scientific recording of data and analysis of results. Students are expected to be punctual, obey all safety instructions, cooperate with your lab partner and the lab demonstrator, follow good work habits in the lab, work efficiently and independently from your lab partner (where applicable), and wear proper apparel (lab coat, goggles, appropriate footwear).

Attendance:

Attendance at all laboratory periods is *mandatory*. Students missing **more than one lab without documentation** will not earn credit for the lab component of the course. Students missing **more than 2 laboratories, even with valid documentation (medical or compassionate), cannot pass the course**, and will be assigned a final grade of either the calculated grade or 47%, whichever is less. Please see your lab manual (page Intro-2) for details of these policies.

Laboratory sessions begin the week of Jan 13 (see Laboratory Schedule on Courselink and at the end of this document)

Location:

Science Complex 3110, 3111 and 3112. Each student must, in advance:

- Purchase a current laboratory manual; the dates and times for lab manual sales will be notified to you via email. The lab manual cost is \$10, cash only; please bring exact change.
- Have a lab coat and approved safety goggles; these are required in all biochemistry laboratories.

Lab Quizzes and Write-up:

There will be a 10 min. quiz (2% each) at the start of each lab, in which you will be tested on the theory behind the day's experiment. Once the experiments are done, you will complete the Lab write-up (3% each) for that experiment in the lab itself and hand it in before you leave.

Lab exemptions:

If you have earned a passing lab grade in a previous attempt at BIOC*2580 within the last 12 months, you may apply for a lab exemption. Send your request to bioc2580@uoguelph.ca (put *Lab exemption* on the Subject line). **You do not have a valid lab exemption unless you have received confirmation that it has been granted.**

Lab times:

Attend the section assigned to you by the registrar. If you are unassigned for a lab or have a conflict, WebAdvisor now handles all lab section assignments. You must be assigned in time for your first laboratory in the week of January 13th. The last 3 digits on your class schedule are your section number; e.g. for BIOC*2580*0110, the section number is 110. Please follow the Lab Schedule given on the last page of this document.

7 Course Statements

7.1 E-mail Communication

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

7.2 Statement on the Use of Animals

No animals are used directly in the laboratory exercises for BIOC*2580. However it is in the nature of biochemistry that some enzymes or biochemical substances may be derived from animal sources. Efforts have been made to reduce the use of animal related products by using equivalent enzymes or substances derived from microbial or plant sources, but in some cases it may be necessary to use these products.

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.selfregulationskills.ca/>

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 grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester.

This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

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.

For Guelph students, information can be found on the SAS website

<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website

<https://www.ridgetownc.com/services/accessibilityservices.cfm>

9.6 Academic Integrity

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 encourages academic integrity. 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.

Undergraduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, 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 that apply to undergraduate, graduate, and diploma programs.

Academic Calendars

<https://www.uoguelph.ca/academics/calendars>
