



ZOO*2700 Invertebrate Morphology & Evolution

Winter 2020

Section(s): C01

Department of Integrative Biology

Credit Weight: 0.50

Version 1.00 - November 01, 2019

1 Course Details

1.1 Calendar Description

This course examines the vast diversity of invertebrate taxa and the tools and concepts used to classify them and understand their origins. Principles of zoogeography, phylogeny, natural selection and comparative analyses will form the conceptual backbone of the course. In lectures and labs, students will 'climb' the tree of life, from the most ancient pre-invertebrates to more derived forms, and explore their anatomical and morphological diversity.

Pre-Requisites: 4.00 credits including BIOL*1070

1.2 Course Description

This course examines the vast diversity of invertebrate taxa and the tools and concepts used to classify them and understand their origins. Principles of zoogeography, phylogeny, natural selection and comparative analyses will form the conceptual backbone of the course. In lectures and labs, students will explore the tree of life, from the most ancient pre invertebrates to more derived forms, and explore their anatomical and morphological diversity. The knowledge and skills gained during this course will form an essential foundation for ZOO*3700 Integrative Biology of Invertebrates. (Prerequisites 4.0 credits including BIOL*1070)

1.3 Timetable

- Lectures: 10:30 11:20 Mon, Wed, Fri ROZH 103
- Labs:
 - 14:30 17:20 Mon, Tues, Wed SSCIE 2314
 - 10:00 12:50 Tues, SSCIE 2314

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. Andreas Heyland
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Lab Co-ordinator:	Sheri Hincks
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3 Learning Resources

3.1 Required Resources

Invertebrates (Textbook)

R.C. Brusca and G.J. Brusca. Invertebrates, 3rd ed. Sinauer. (new in 2017)

Lab Manual (Lab Manual)

ZOO*2700 Invertebrate Zoology Laboratory Manual – You must purchase this prior to the beginning of lab 1. Details will be made available week 1.

Disecting Kit (Equipment)

Available from the University Bookstore

Bound Lab Notebook (Equipment)

Available from the University bookstore

Courselink (Website)

<https://courselink.uoguelph.ca>

This course will make use of the University of Guelph's course website on D2L (via Courselink). Consequently, you are responsible for all information posted on the Courselink page for ZOO*2700. Please check it regularly.

Top Hat (Software)

- To facilitate interactions and discussions in and out of lecture, we will be using Top Hat (<https://tophat.com/>). Top Hat software allows you to answer

- questions from your smartphone, tablet, or laptop. You will be able to review the questions that you answered on Top Hat, and your marks will be uploaded to the Courselink gradebook at the end of the
- You will receive an email with instructions for purchasing Top Hat. The instructions will also be posted on the ZOO*2700 Courselink site.
 - We will practice using Top Hat in class on before graded questions begin

3.2 Additional Resources

Invertebrate Zoology: A Functional Evolutionary Approach (Textbook)

- E. E. Ruppert, R. S. Fox, and R. D. Barnes *Invertebrate Zoology: A Functional Evolutionary Approach*, 7th ed. Thomson
- On reserve

The Invertebrates: A Synthesis (Textbook)

- R.S.K. Barnes, P. Calow, P.J.W. Olive, D.W. Golding, and J.I. Spicer. *The Invertebrates: A Synthesis*, 3rd ed. Blackwell Science.
- On reserve

4 Learning Outcomes

4.1 Course Learning Outcomes

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

1. Appreciate the vast diversity of invertebrate taxa
2. Demonstrate a solid understanding of basic evolutionary principles
3. Construct and interpret simple phylogenetic trees
4. Appreciate and summarize the evolutionary history of invertebrates
5. Outline key morphological innovations of the major invertebrate taxa
6. Recognize and identify the major groups of invertebrates using practical skills
7. Recognize the evolutionary trends that exist among invertebrate taxa
8. Explain how one would answer a question using the scientific method
9. Produce a proper lab notebook
10. Prepare and present short oral presentations

11. Identify and quantify the inherent natural variation and diversity within and among individuals, populations and species through examination of variability among real organisms or their parts
 12. Develop tactile skills involved in effective dissection, cell and tissue preparation and live animal observation
 13. Observe real animals (alive or dead) or their component parts to pose questions about form and function that motivate self-directed research leading to enhanced understanding of process in animal biology
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5 Teaching and Learning Activities

5.1 The Invertebrates Curriculum at Guelph

If you are interested in invertebrates, you are extremely lucky to be at the University of Guelph, which is one of only a few universities that offer two full semesters of invertebrate biology. This plus the huge range of upper level courses in Entomology offered by the Department of Environmental Biology in OAC means that Guelph offers more opportunities to study invertebrates for undergraduates than most other universities in the world. This term in ZOO*2700, we will focus primarily on getting a handle on the unity and staggering diversity of invertebrates. To do this, we will use an evolutionary framework and expose you in lab to as many of the major groups of invertebrates that we can. In ZOO*3700 (which many of you will take in F19), we will take a more comparative, synthetic approach to try and understand the various strategies that invertebrates use to survive and reproduce in their respective habitats.

5.2 Course Structure

The lab and lecture components of this course are inseparable, and it will be very difficult for you to succeed in this course if you neglect either of them. Skeletal outlines of lectures will be posted after the lecture period. These are by no means a substitute for taking notes; rather they should be used as a way of reviewing the lectures in concert with the appropriate material in the textbook. We may also occasionally post a list of "Study Questions" on the course website that will give you examples of the kinds of questions you should be able to answer after that lecture. We also expect you to come prepared to the lab sessions. Please read the lab outline prior to that week's lab and bring your dissection kit and textbook each week.

5.3 Course Content

WEEK	LECTURE TOPIC (TENTATIVE)	LAB TOPIC	TAXA TO READ UP ON	TEXTBOOK
Week 1 Jan 06-10	Metazoan origins Protozoans and the rise of multicellularity	No Labs	<ul style="list-style-type: none"> • Intro • Intro to Eukaryotes • Protists, Metazoa, • Porifera and Placazoa 	Chapter 1, 2, 28
Week 2 Jan 13-17	Body plans, symmetry, and development	<ul style="list-style-type: none"> • *Protozoa 	<ul style="list-style-type: none"> • Eumetazoa • Cnidaria, Ctenophora • Bilateria, Protostomia • Rotifera • Bryozoa • Chaetognatha 	Chapter 3,4,5,6
Week 3 Jan 20-24	Cnidarians and ctenophores	<ul style="list-style-type: none"> • *Ctenophora, • Porifera, Cnidaria • SELF INTRODUCTION (online) 	<ul style="list-style-type: none"> • Platyhelminthes • Annelid Echiura Sipuncula 	Chapter 7, 8, 9
Week 4 Jan 27 – 31	Bilateria, flatworms and segmented worms ribbon worms, horseshoe worms, rotifers and lamp shells	<ul style="list-style-type: none"> • Rotifera, Bryozoa • Platyhelminthes • Brachiopods 	<ul style="list-style-type: none"> • Nemertea • Phoronida • Brachiopoda 	Chapter 10, 16, 17

WEEK	LECTURE TOPIC (TENTATIVE)	LAB TOPIC	TAXA TO READ UP ON	TEXTBOOK
Week 5 Feb 04-08	Annelids, Molluscan body plan and radiation	<ul style="list-style-type: none"> *Annelida 	Mollusca	Chapter 12, 13
Week 6 Feb 03-14	Molluscs and moulting animals and the segmented body plan	LAB MIDTERM	<ul style="list-style-type: none"> Cycloneuralia Panarthropoda 	Chapter 14, 20, 18
Feb 17-21	WINTER BREAK			
Week 7 Feb 24 29	Intro to Arthropoda	<ul style="list-style-type: none"> Mollusca 	<ul style="list-style-type: none"> Arthropoda Crustacea, Malacostraca LECTURE MIDTERM (Feb. 26) 	Chapter 20, 21
Week 8 Mar 02 06	Arthropod radiation part I	<ul style="list-style-type: none"> Tardigrada, Onychophora, Crustacea ORAL PRESENTATION 	<ul style="list-style-type: none"> Crustacea, Maxillopoda Hexapoda 	Chapter 23, 24
Week 9 Mar 9 13	Arthropod radiation part II	<ul style="list-style-type: none"> *Hexapoda, Myriochelata, Nematoda 	<ul style="list-style-type: none"> Myriapoda Chelicerata 	Chapter 22

WEEK	LECTURE TOPIC (TENTATIVE)	LAB TOPIC	TAXA TO READ UP ON	TEXTBOOK
Week 10 Mar 16-20	The arthropod radiation part III and Intro to Deuterostomes	<ul style="list-style-type: none"> • *Echinodermata, • Hemichordata, Chordata 	<ul style="list-style-type: none"> • Chelicerata • Deuterostomia 	Chapter 25, 26
Week 11 Mar 23-27	The echinoderm radiation	ORAL PRESENTATIONS	<ul style="list-style-type: none"> • Echinodermata • Chordata 	Chapter 27
Week 12 Mar 30- Apr 03	The chordate body plan and radiation	LAB FINAL EXAM		

- *indicate graded weekly lab handouts
- Some laboratories will involve dissection of selected invertebrates

5.4 Readings

Although the content we cover will span nearly every chapter of your Brusca text, we appreciate that it is nearly impossible for you to read and learn the entire text in one semester. The above assigned readings, therefore, are a rough guide to the parts of your text that cover the material we will be exploring in lecture and lab each week. You should use the lectures as a guide for deciding which parts of the text to focus on, and if you missed something in lecture, the text is often the best place for clearing things up.

5.5 A Note on Evolution and Phylogenies

The most important unifying theme of this course is that the diversity and unity of invertebrates can best be explained by the theory of Evolution by Natural Selection. It is therefore critical that students understand this process. It is also important that students understand how biologists construct phylogenies that explain the ancestry and degree of relatedness between different groups of organisms. There has been great progress made even in the last ten years in elucidating the structure of the tree of life, and we will use the most recent phylogenies available for this course. Some of these phylogenies will conflict directly with trees presented in your textbook. In these cases, you should use the trees we provide for you in lecture and lab. You should be aware that the tree of life is constantly being revised as biologists collect more and more data and carry out more sophisticated analyses. The Tree of Life web project (www.tol.org) is a searchable and browse-able phylogenetic tree that is packed with great resource material. Once you have read this syllabus to completion, please email salex@uoguelph.ca a picture of an ant. We will be using a phylogeny that is based on a paper by Dunn et al. (2014) as well as many of the phylogenies presented in your textbook. Although phylogenies are hypotheses about biological evolution and are therefore likely to shift over time, for our purposes, this online phylogeny will be used throughout the course. The Dunn et al. phylogeny (*Annu. Rev. Ecol. Evol. Syst.* 2014. 45:371–95) will be the authoritative large-scale phylogeny.

5.6 Important Dates

- First Class – 10:30 Mon Jan 06 (ROZH 103)
- First Lab Sessions – Jan 13, 14, 15 (depending on section) – Room 2314 SCIE
- Oral Presentation 1 – Self Introduction (Submitted online January 24)
- Midterm Lab Exam – Feb. 10, 11, 12 in lab
- Winter Break – Feb. 17-21 NO CLASSES
- Lecture Exam 1 – Wednesday February 26 in lecture
- Oral Presentation 2 – Coolest Invert. March 2, 3, 4
- Oral Presentation 3 Final Exam Review – March 24-26
- Lab Final Exam – March 30, 31, April 1 (during lab)
- Lecture Exam 2 – TBD during Final Examination Period

6 Assessments

6.1 Marking Schemes & Distributions

Name	Scheme A (%)	Scheme B (%)
Laboratory Midterm exam	15	15
Lecture Midterm exam	20	20

Name	Scheme A (%)	Scheme B (%)
Oral Presentations (3)	5	5
Top Hat Quizzes	5	5
Lab Notebook (optional)	0	5
Weekly Lab Handouts	5	5
Lab Final Exam	20	15
Lecture Final Exam	30	30
Total	100	100

6.2 Assessment Details

Midterm Lab Exam (15%)

Date: Feb 10,11,12, In lab

Learning Outcome: 1, 3, 4, 5, 6, 7

- Course activity: Labs 1-4

Midterm Lecture exam (20%)

Date: Wed, Feb 26, In class

Learning Outcome: 1, 2, 3, 4, 5, 7, 8

- Course activity: Lectures (Jan 6-Feb 14)
- No specimens will be presented.
- The exam may consist of multiple choice, short answer and essay questions.

Oral Presentations (3) (5%)

Date: 1. Jan 24 (online), 2. Mar 2,3, 4, (in lab), 3. Mar 23, 24, 25 (in lab)

Learning Outcome: 10

- The Oral Presentations will be presented during your lab period (except #1- which will be submitted online). The goal of these presentations is to get you more comfortable presenting information, as well as to present information succinctly. More details about these presentations will be given in lab and online. The presentations will be worth a total of 5% and will be pass/ fail. You must present during your assigned time slot. If for a documented medical/ compassionate reason you cannot present, you may present during lecture at a time arranged with the professor.

Self Introductory Speech: This assignment is to give your audience an

understanding of who you are. You will record a self-introduction (~1 minute) and post it to the course website.

Elevator pitch: "The coolest invert is...." You will have 1 minute (or less) to convince us, that the invertebrate that you present (along with an image) is the coolest/ most fascinating one ever! You will be given the opportunity to "vote" for your favorite one. Winners will receive bonus marks on their final grade.

Final Exam Review: More details will be provided in lab. This fun and interactive assignment will be great review for the final exam!

Top Hat Quizzes (5%)

Date: Once per week, In lecture

Learning Outcome: 1, 2, 3, 4, 5, 7, 8

Top Hat (<https://tophat.com/>) will be used to test your comprehension of the assigned readings, stimulate participation in class discussions, and enhance your understanding of course content.

Lab Notebook (optional) (5%)

Date: Feb. 10, 11, 12 (2 labs of your choice) & Mar. 30, 31, Apr. 1 (2 labs of your choice)

Learning Outcome: 4, 6, 7, 9

Each student will keep and maintain his/her own Lab Notebook. We recommend bound lab book that can be purchased from the campus Book Store, but other styles of lab books are also acceptable as long as they are sturdy and will survive a year in the lab. Loose leaf binders are not acceptable because the pages can easily be torn out and lost. Your lab book will serve as a written record of every- thing you do in the lab and will include observations, data sheets, drawings, questions, insights, ponderings, and aha moments. If you keep a neat and tidy lab book and carefully record what you do and see in lab, it will serve as an invaluable study tool for exams. The grading of lab notebooks is optional. If you chose to submit your lab notebook, it will be worth 5% of your final grade and your lab final exam will be worth 15%. **Lab books will be collected twice during the semester- once during your lab midterm, an again during the lab final exam.** In order to receive a grade for this assignment, the notebook **MUST** be submitted during both of these times. We will grade 2 labs of your choice for each of these (a total of 4 labs). More details of this assignment and a grading rubric can be found at the back of your lab manual, and more details will be provided in lab. If you chose not to submit your lab notebook, your final lab exam will be worth 20%.

Weekly Lab Handouts (5%)

Date: See starred (*) lab dates in Course Content table

- Course activity: Lab 1, 2, 4, 5, 7, 8
- Six weekly lab handouts will be given throughout the semester and will be worth a total of 5%.

- Students will complete and submit these handouts with their lab group (maximum 4 students per group) during the lab period.
- They will be graded in lab and students **MUST** be present during the marking of these activities in order to receive a grade.
- **NO** make-up handouts will be given.
- We will count your top 5 of 6 handouts/ quizzes in your final grade.

Lab Final Exam (20%)

Date: March 30, 31, April 1

Learning Outcome: 1, 3, 4, 5, 6, 7

- This will be worth 15% if you do the optional Lab Notebook
- Course activity: Labs 1-8
- Students will be encouraged to submit possible exam questions via the course website. Some of these questions will appear on the exam. The reason for doing this is give you practice in asking questions in addition to answering them.
- The Lab Final exam will cover only lab material and will be written in the laboratory. Specimens will be provided for some questions and you will be required to answer questions about the organisms on display. Both exams will have short answer and longer essay questions.

Final Examination (30%)

Date: TBD, During Final Examination Period

Learning Outcome: 1, 2, 3, 4, 5, 7, 8

- Course activity: Focus on post mid-term material but expect a cumulative question that should be answered utilising trends you learned throughout the course.
- No specimens will be presented.
- The exam may consist of multiple choice, short and essay questions.

6.3 Final Marks

Final marks will be calculated from six different assessments. In all cases, students will be expected to write using complete sentences and proper grammar. All students are expected to complete and submit work individually unless otherwise stated.

7 Course Statements

7.1 Absence & Illness

If you are absent from classes during the semester, you will be expected to make up missed lecture and laboratory material on your own. Oral presentations must be submitted by the due dates above. No make-up or late weekly handouts will be provided. When, for legitimate, documented medical or compassionate reasons any assignments are missed, make sure that you have both given the instructor supporting documentation and obtained a written statement of your revised grade evaluation from the instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration.

7.2 Late Policy

Oral presentations must be submitted by the due dates above. No make-up or late weekly handouts will be provided.

7.3 Use of Animals

This course uses selected invertebrates for dissection. The University is committed to principles of conducting research and teaching in accord with the highest ethical standards. Given that the use of animals, in research and teaching, is a critical aspect of the work of the University of Guelph, the Department of Integrative Biology is committed to minimizing the use, pain, and suffering of animals used for teaching and to ensuring that animals which are used will receive care and treatment that meets or exceeds the standards outlined by provincial guidelines and statutes, and by the Guidelines of the Canadian Council on Animal Care.

8 Department of Integrative 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>
