

**University of Guelph**  
**College of Biological Science**  
**Integrative Biology**  
**COURSE OUTLINE**  
**ZOO\*2700 INVERTEBRATE MORPHOLOGY & EVOLUTION**  
**WINTER 2016 (W16)**

**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 'climb' 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\*1040 OR BIOL\*1070)

**TEACHING TEAM**

**Professor:** Dr. M. Alex Smith, Room 2464 Science Complex ext. 52007, [salex@uoguelph.ca](mailto:salex@uoguelph.ca)

**Instructor:** Sheri Hincks, Room 3509 Science Complex ext. 56010, [shincks@uoguelph.ca](mailto:shincks@uoguelph.ca)

**COURSE SCHEDULE**

**Lectures**

09:30-10:20 Mon, Wed, Fri ALEX 200

**Labs**

14:30-17:20 Mon, Tues, Wed SCIE 2314

10:00-12:50 Tues, SCIE 2314

**LEARNING GOALS AND RATIONALE**

**LEARNING OUTCOMES:** By the end of this course, students 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.

## **COURSE RESOURCES**

### **Required Textbook**

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

### **Useful and on reserve**

- R.C. Brusca and G.J. Brusca. *Invertebrates*, 2nd ed. Sinauer.
- 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.

### **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.

### **Dissecting Kit**

- Available from the University Bookstore

### **Bound lab notebook**

- Available from the University bookstore.

### **Courselink**

- 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.

### **Undergraduate Calendar**

- This is the source of information about the University of Guelph's procedures, policies and regulations, which apply to undergraduate programs. It can be found at [Undergraduate Calendar](#)

## **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 F15), 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.

## 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. I will post a skeletal outline of my lectures 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. I will also post a list of “Study Questions” on our 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.

## COURSE CONTENT

### Weekly Schedule

WEEK	LECTURE TOPIC (TENTATIVE)	LAB TOPIC	TAXA TO READ UP ON	TEXTBOOK
Week 1 Jan 11- 15	Metazoan origins Protozoans and the rise of multicellularity	No Labs	Intro Intro to Eukaryotes Protists, Metazoa, Porifera and Placazoa	1-7  11-21 22-54 58-74 <del>76-95</del>
Week 2 Jan 18- 22	Body plans, symmetry, and development	* Protozoa	Eumetazoa Cnidaria, Ctenophora Bilateria, Protostomia Rotifera Bryozoa Chaetognatha	98-109 111-194 196-222 789-800 829-845 851-856
Week 3 Jan 25-29	Flatworms and segmented worms	*Ctenophora, Porifera, Cnidaria  <b>SELF INTRODUCTION</b>	Platyhelminthes Annelida Echiura Sipuncua	225-263 414-482 490-495 495-501
Week 4 Feb 01-05	Ribbon worms, horseshoe worms, and lamp shells	Rotifera, Bryozoa Platyhelminthes	Nemertea Phoronida Brachiopoda	270-280 817-821 821-829
Week 5 Feb 08-12	Molluscan body plan and radiation	*Annelida	Mollusca	283-408

WEEK	LECTURE TOPIC (TENTATIVE)	LAB TOPIC	TAXA TO READ UP ON	TEXTBOOK
Feb 15-19	<b>WINTER BREAK</b>			
Week 6 Feb 22 - 26	Moulting animals and the segmented body plan	<b>LAB MIDTERM</b>	Cycloneuralia Panarthropoda	753-766 505-515
Week 7 Feb 29- Mar04	Intro to Arthropoda <b>LECTURE MIDTERM</b>	*Brachiopoda, Mollusca	Arthropoda Crustacea, Malacostraca	517-540 606-669
Week 8 Mar 7-11	Arthropod radiation part I	Tardigrada, Onychophora Crustacea <b>ORAL PRESENTATION</b>	Crustacea, Maxillopoda Hexapoda	669-695 723-750
Week 9 Mar 14-18	Arthropod radiation part II	*Hexapoda, Myriochelata, Nematoda	Myriapoda Chelicerata	703-720 555-571
Week 10 Mar 21- 25 (no classes Friday)	The arthropod radiation part III and Intro to Deuterostomes	*Echinodermata, Hemichordata, Chordata	Chelicerata Deuterostomia	571-600 858-870
Week 11 Mar 28 - Apr 01	The echinoderm radiation	<b>ORAL PRESENTATIONS</b>	Echinodermata	876-926
Week 12 Apr 04 - Apr 08	The chordate body plan and radiation	<b>LAB FINAL EXAM</b>	Chordata	931-960

\*indicate graded weekly lab handouts

**\*Some laboratories will involve dissection of selected invertebrates\***

### Reading 'Assignments':

Although the content we cover will span nearly every chapter of your Ruppert, Fox, and Barnes text, we appreciate that it is *nearly* impossible for you to read and learn the entire text in one semester. Keep in mind that Integrative Biology of Invertebrates ZOO\*3700 uses the same text, and we will focus on more functional aspects of invertebrate biology in that course. The above

reading assignments, 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 a good resource for clearing things up.

### **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](http://www.tol.org)) is a searchable and browseable phylogenetic tree that is packed with great resource material. We will be using a phylogeny that is based on a paper by Dunn et al. (2008) as well as many of the phylogenies presented in your textbook. To help you keep track of all the taxa we are going to discuss, we have constructed an online phylogeny that resides on the D2L site and which will help you explore the invertebrate tree of life in as little or as much detail as you want at any time. 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.

## METHODS OF ASSESSMENT

ASSESSMENT	% OF FINAL GRADE	DATE	LEARNING OUTCOME	COURSE ACTIVITY
Midterm Lab Exam	15	Feb. 22, 23, 24 (in lab) (W6)	1,3,4,5,6,7	Labs 1- 4
Midterm Lecture Exam	20	March 02 (in lecture)	1,2,3,4,5,7,8,	Lectures (W1-W6)
Oral Presentations (3)	5	1. Jan 27 (online) (W3) 2. Mar 7,8,9 (in lab) (W8) 3. Mar 28,29, 30 (in lab) (W11)	10	
Weekly lab handouts	5	See stated lab dates above	1,5,6,7	Lab 1,2,4,5,7,8
Lab Notebook (Optional)	5	Feb. 22, 23, 24 (2 labs of your choice) Apr. 4,5,6 (2 labs of your choice)	4,6,7,9	
Lab Final Exam	25 (or 20%- lab notebook)	Apr 4, 5, 6 (W12)	1,3,4,5,6,7	Labs 1-8
Lecture Final Exam	30	13/04/2016 08:30 <a href="#">Winter 2016 Exam Schedule</a>	1,2,3,4,5,7,8,	Lectures Jan 6-Apr 4

Grades will be assigned according to the standards outlined in the U of G Undergraduate Calendar (p. 40- 41)

Final marks will be calculated from six or seven 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.**

### Weekly lab handouts

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 Notebook

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 20%. Lab books will be collected twice during the semester- once during your lab midterm, and 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 25%.

### Oral Presentations

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. Each presentation will be pass/ fail and will be worth a total of 5%. 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 (~ 1minute) 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 may bring a picture with you, or an image on your smartphone can be projected at the front. You will be given the opportunity to “vote” for your favorite one. Winners will receive bonus marks on their final grade.
- **Ignite/ Flash talk:** Each group will have a total of 5 minutes to recap a specific group of organisms (assigned by the instructor). More details will be provided in lab. This fun and interactive assignment will be great review for the final exam!

### Midterm Exams

The **Midterm exams** (lab and lecture) will be written during your lab and lecture time slots.

### Lab Final

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.

The **Final Lecture Exam** will be written as a formal exam and will be based on lecture material only. No specimens will be presented. The exam may consist of multiple choice, short and essay questions. For the lecture midterm and final exams, 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.

## **IMPORTANT DATES**

- First Class – 09:30 Mon Jan 11 – ALEX 200
- First Lab Sessions – Jan 18,19, 20, (depending on section) – Room 2314 SCIE
- Oral Presentation 1 (Self Introduction)- Submitted online January 27
- Midterm Lab Exam – Feb. 22, 23,24 in lab
- Lab Notebook #1- Feb. 22,23 24 (in lab)
- Winter Break – Feb. 15-19 NO CLASSES
- Midterm Lecture Exam – March 02 in lecture
- Oral Presentation 2- Coolest Invert.- March 7, 8, 9
- 40<sup>th</sup> CLASS DAY (last day to drop) – Friday March 11
- Oral Presentation 3- Ignite Talk - March 28, 29, 30 (slides must be submitted to the DropBox the day before!)
- Lab Final Exam –April 4, 5, 6 (during lab)
- Lab Notebook #2- April 4,5,6 (during lab)
- Final Exam – 13/04/2016 08:30-10:30



## **COURSE AND UNIVERSITY POLICIES**

### **Absence and 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. 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: [Undergraduate Calendar - Academic Consideration](#)

### **Late Policy**

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

### **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. For more information [Animal Care Policy and Procedures](#)

### **Drop Date**

The last date to drop one-semester courses, without academic penalty, for Winter 2016 is March 11, 2016. For regulations and procedures for Dropping Courses, see the Undergraduate Calendar: [Undergraduate Calendar - Dropping Courses](#)

### **E-mail Communication**

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

### **Accessibility**

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This

relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact the Centre for Students with Disabilities as soon as possible.

For more information, contact CSD at 519-824-4120 ext. 56208 or email [csd@uoguelph.ca](mailto:csd@uoguelph.ca) or see the website: [Centre for Students with Disabilities](#)

### **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: [Undergraduate Calendar - Academic Misconduct](#)

### **Recording of Materials**

Presentations which are made in relation to course work—including lectures and oral presentations—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.

## CAMPUS RESOURCES

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

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](#)

If you are struggling to succeed academically:

- 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. [The Learning Commons](#)

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. [Counselling Services](#)
- Student Health Services is located on campus and is available to provide medical attention. [Student Health Services](#)
- 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. [Stress Management and High Performance Clinic](#)

If you have a documented disability or think you may have a disability:

- The Centre for Students with Disabilities (CSD) can provide services and support for students with a documented learning or physical disability. They can also provide information about how to be tested for a learning disability. For more information, including how to register with the centre please see: [Centre for Students with Disabilities](#)