

7. **Examination policy:** No electronic or written aids (e.g. cell phones, tablets, computers, PDAs, notes, textbooks) will be allowed during writing of any exams. Non-programmable calculators will be permitted to answer quantitative questions on exams, if applicable, and permission to do this will be clearly indicated on the examination paper. Students should also read the Calendar, Section G, on Examinations: <http://www.ucalgary.ca/pubs/calendar/current/g.html>.
8. **Writing across the curriculum statement:** In this course, the quality of the student's writing in various written components will be a factor in the evaluation of those components. See also <http://www.ucalgary.ca/pubs/calendar/current/e-2.html>
9. **Ethics in the Biological Sciences:** Studies in the Biological Sciences involve the use of living and dead organisms. Students taking laboratory- and field- based courses in these disciplines can expect involvement with and experimentation on such materials. Students perform dissections on dead or preserved organisms in some courses. In particular courses, students experiment on living organisms, their tissues, cells, or molecules. Sometimes field work requires students to collect a variety of living materials by many methods, including humane trapping. See <http://www.ucalgary.ca/pubs/calendar/current/sc-5-1.html> and also <http://www.ucalgary.ca/pubs/calendar/current/e-5.html>

All work on humans and other animals conforms to the Helsinki Declaration and to the regulations of the Canadian Council on Animal Care. The Department strives for the highest ethical standards consistent with stewardship of the environment for organisms whose use is not governed by statutory authority. Individuals contemplating taking courses or majoring in one of the fields of study offered by the Department of Biological Sciences should ensure that they have fully considered these issues before enrolling. Students are advised to discuss any concern they might have with the Undergraduate Program Director of the Department.

10. **Human studies statement:** If you agree, your course work may be used for research purposes. Your responses will remain anonymous and confidential. Grouped data (no individual responses) may be used in academic presentations and publications. Participation in such research is voluntary and will not influence grades in this course. Students' signed consent forms will be withheld from instructors until after final grades are submitted. More information will be provided at the time student participation is requested. See also Section E.5 of the University Calendar.
11. **Lab photographic device policy:** No photography will be permitted in the lab section of this course. If you violate this policy, your device will be confiscated until the end of the lab period. Repeated abuse may result in a charge of misconduct.
12. **OTHER IMPORTANT INFORMATION FOR STUDENTS:**
 - (a) **Misconduct:** Academic misconduct (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under Section K. Student Misconduct to inform yourself of definitions, processes and penalties.
 - (b) **Assembly Points:** In case of emergency during class time, be sure to FAMILIARIZE YOURSELF with the information on [assembly points](#).
 - (c) **Student Accommodations:** Students needing an Accommodation because of a Disability or medical condition should contact Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities available at http://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities_0.pdf.

Students needing an Accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, preferably in writing, to the Associate Head of Biological Sciences, Dr. H. Addy by email addy@ucalgary.ca or phone 403 220-3140.
 - (d) **Safewalk:** Campus Security will escort individuals day or night (<http://www.ucalgary.ca/security/safewalk/>). Call 220-5333 for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.
 - (e) **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). As one consequence, students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information see also <http://www.ucalgary.ca/secretariat/privacy>.
 - (f) **Student Union Information:** VP Academic Phone: 403 220-3911 Email: suvpaca@ucalgary.ca
SU Faculty Rep. Phone: 403 220-3913 Email: science1@su.ucalgary.ca, science2@su.ucalgary.ca and science3@su.ucalgary.ca;
Student Ombuds Office: 403 220-6420 Email: ombuds@ucalgary.ca; <http://ucalgary.ca/provost/students/ombuds>
 - (g) **Internet and Electronic Device Information:** You can assume that in all classes that you attend, your cell phone should be turned off unless instructed otherwise. Also, communication with other individuals, via laptop computers, Blackberries or other devices connectable

to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.

- (h) **U.S.R.I.:** At the University of Calgary, feedback provided by students through the Universal Student Ratings of Instruction (USRI) survey provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses (www.ucalgary.ca/usri). Your responses make a difference - please participate in USRI Surveys.

Department Approval: _____ ORIGINAL SIGNED _____ Date: _____

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ZOOLOGY 375 - AN INTRODUCTION TO INVERTEBRATE ZOOLOGY

COURSE OUTLINE

Instructor

Dr. Mindi Summers

Office: BI 041

Phone: 403-220-8761

Email: mindi.summers@ucalgary.ca

Email is the preferred method of communication for questions and ideas. I will do my best to read and respond to emails within 24 hours Monday-Friday. I will try to respond to emails received during the weekend by the following Tuesday.

TAs

Contact information for the TAs will be posted in D2L and provided at the first laboratory session.

Office hours

Students are invited to discuss the homework, lecture, laboratory, and other invertebrate-related topics during office hours held from 10:30-11:30pm on Thursdays in BI 041 or immediately after lecture on Monday, Wednesday, and Friday. You may also schedule a time to meet individually through email.

Required and recommended texts and other supplies

Required textbook: (1) Biology of the Invertebrates, Pechenik, McGraw-Hill, 7th edition. ISBN: 0073524182.

Recommended laboratory guide: (2) Custom Adaptation from General Zoology Laboratory Guide, Lytle & Meyer. McGraw-Hill. 16th edition. ISBN: 9781259938405.

Required other supplies: Dissecting equipment.
Laboratory sketchbook or binder with blank pages.
Drawing pencils.
Set of 12 colored pencils (recommended) or fine-tipped colored markers.

Course D2L site

D2L: [ZOOL 375 L01 - \(WINTER 2017\) - INTRO TO INVERTEBRATE ZOOLOGY \(F2017ZOOL375L01\)](#). This website will have the most updated schedule, homework assignments, readings, and slides and materials. You will also use D2L to complete your homework.

Course description and themes

Understanding animal biodiversity requires the study and appreciation of invertebrates. Invertebrates are found within every animal phyla and include a far greater number of species and span a vaster range of diversity (in morphology, structure, development, reproduction, etc.) than vertebrates (a sub-phylum). Invertebrates are also model organisms for biological study, play both positive and negative roles in human and animal health, and are key indicators of environmental health. Studying invertebrates will broaden your career options in environmental monitoring/management, environmental consulting, environmental toxicology, invasive species monitoring/management, conservation and resource management, fisheries biology, basic research, and graduate studies in ecology, evolution, and organismal biology.

This course will explore the diversity of invertebrates, emphasizing evolutionary, structure-function, and ecological relationships. We will explore the following four themes:

- 1) Invertebrate diversity is the result of ongoing **evolution**.
- 2) Observing **structure/function** relationships highlights that the basic requirements for animal life have been met in many different ways.
- 3) The **ecology** of invertebrates is complex, diverse, and fundamental to many ecosystems.
- 4) Knowledge of invertebrates has countless **applications** – they are important model organisms, impact human health, provide information on environmental health, and inspire engineering.

Course goals

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

- 1) Identify and explain the morphological characteristics, including synapomorphies, of the major clades of animals (as shown in Dunn et al. 2014) and the well-supported clades of Bilateria, Deuterostomia, Protostomia, Spiralia, and Ecdysozoa.
- 2) Compare and contrast the structure and function relationships found in different invertebrate groups for feeding, mechanics and movement, respiration, excretion, ionic and osmotic regulation, reproduction and lifecycles, and buoyancy, defense, development, and control systems (e.g., nervous systems).

- 3) Use an evolutionary framework, basic taxonomy, and phylogenetic theory to critically compare different evolutionary hypotheses, map traits and present arguments for evolution of key (given) features, and identify homologies and synapomorphies among invertebrate groups.
- 4) Communicate scientific observations of live, preserved, and sectioned organisms in the form of scientific drawings and descriptions, which include accurate scalebars, labels, and identifications.
- 5) Find, analyze, interpret, and discuss primary and popular literature, particularly graphs, tables, and figures, on topics in invertebrate zoology.
- 6) Discuss invertebrate biology and ecology in the context of conservation problems, scientific investigation using model organisms, design, and environmental monitoring.

Course organization

The course is designed so that you are engaging as a scientist in lecture, laboratory, and out-of-class assignments. Concepts, ideas, and skills developed in lecture will be practiced and assessed in laboratory sessions and vice versa. Although hands-on work with animals will be restricted to laboratory sessions, all other techniques to foster learning – peer discussions, reading primary literature, writing, problem-solving, and regular feedback – will be interwoven throughout lecture, laboratory, and assignments. I expect you to teach and learn from each other in all of these settings and your full participation in all of these activities will help you succeed in this course.

Each week we will focus on a different group of organisms. All lecture, lab, and assignments outside of class are designed to help you more fully understand and apply the material. You will first be exposed to the organisms through independent exploration as part of the homework and lab preparation. During lecture, you will actively explore the research literature on the evolution, ecology, morphology, and functional biology (e.g., development, feeding, movement). You will be expected to engage in activities and assignments, including but not limited to, responding to writing prompts, answering clicker questions, engaging in discussion, and completing worksheets and assignments. During lab, you will carefully observe the form and consider the function of anatomical features, identify the diagnostic morphology of groups, observe developmental stages, and develop skills in scientific drawing, slide preparation, microscope use, and observation. You will synthesize and apply this knowledge to critical problem-solving and evaluation in the exams.

Learning groups

In this class, you will be working within small learning-groups within the lecture and laboratory sections. After solving problems as individuals, the group will engage in peer-instruction and collaboration to answer questions, solve problems, and develop learning strategies – a technique that has been shown to increase learning compared to instructor lecture and explanation only (see Smith et al., 2011). You will take all exams using this peer-instruction format – first individually, and then as a group. You will be sent a link before the first day of class to complete a survey on CATME. CATME will design lecture groups to maximize student diversity.

Exams

There will be two midterm exams held during the regularly scheduled lecture and one final exam during the exam period. These exams are an opportunity to synthesize and apply your knowledge of material covered in previous lectures, laboratory periods, and homework assignments.

Midterm exam 1 – **Friday, February 3rd** – 10% of overall course grade

This exam is cumulative and will cover all information discussed in the course (in lecture, lab, homework, and readings), with a major focus on:

- Introduction and general phylogeny
- Porifera
- Placozoa
- Cnidaria

This exam will be first taken individually (worth 90% of the midterm grade) and then as a group (worth 10% of the midterm grade). If your individual score is higher than the group score, your individual score will be 100% of your midterm grade.

Midterm exam 2 – **Friday, March 17th** – 10% of overall course grade

This exam is cumulative and will cover all information discussed in the course (in lecture, lab, homework, and readings), with a major focus on:

- Xenacoelomorpha
- Chaetognatha
- Spiralia
- Scalidophora
- Nematoida

This exam will be first taken individually (worth 90% of the midterm grade) and then as a group (worth 10% of the midterm grade). If your individual score is higher than the group score, your individual score will be 100% of your midterm grade.

Final exam – **Scheduled by the Registrar** – 30% of overall course grade

This exam is cumulative and will cover all information in the course (in lecture, lab, homework, and readings), with a slight focus on:

- Panarthropoda
- Deuterostomia

The final exam will have two parts:

Part I (200 points) will be first taken individually (worth 90% of the final exam grade) and then as a group (worth 10% of the final exam grade). If your individual score is higher than the group score, your individual score will be 100% of your final exam grade.

Part II (100 points) will be a one-page individual research proposal. The rubric for scoring this proposal is posted on D2L. You may write or type this proposal before or during the exam, but it cannot exceed one-side of a letter-sized sheet of paper.

Laboratory notebook

You will record and communicate your observations during each laboratory section in a laboratory notebook that will remain in the laboratory space unless signed-out during specified times to study for the midterm exams. Your TA will provide you formative feedback on your work based on the rubric posted on D2L. Your laboratory notebook will be marked for points twice following the completion of the laboratory during the week of Feb 13 (Mollusca lab) (10% of overall course grade) and April 3 (Hemichordata and Craniata lab) (15% of overall course grade). Knowing the names of the animals, their body parts, and laboratory procedures during the lab period will allow you to better engage with the animals, make useful observations, more easily communicate your findings, and complete all components within the given lab time period.

Attendance in all laboratory sessions is required for full points on the laboratory notebook (see rubric on D2L). Unless you have a university-sanctioned absence from your laboratory period, you will not be able to complete the laboratory notebook assignment outside of or in a different laboratory period.

Homework

There will be eleven homework assignments in this course. **All homework is to be submitted on D2L before the start of class (14:59) on Mondays.** Late assignments will not be graded. Homework is intended to prepare you to engage in lecture and laboratory activities and will consist of two parts:

- 1) Questions that guide your reading of the textbook and primary articles in preparation to engage in lecture and laboratory activities. You will answer a sub-set of these questions online on D2L.
- 2) You will find a newspaper report, video, popular science, or primary research or review article related to the focus organisms in the upcoming or previous week's lecture and lab. You will post an internet link with a one paragraph description to the discussion forum on D2L. You will also briefly (more than three sentences) respond to at least two other student's posts on the discussion forum.

Surveys

There will surveys announced throughout the course that will be available on D2L. These surveys will be marked for completion only and will count for 5% of your overall course grade. These surveys are designed to improve instruction in this course and your effort on these surveys is important. You are asked to not use outside resources when completing these surveys.

Invertebrate book club (optional)

There are many non-fiction and fiction works that star invertebrates. You have the option of choosing a book that features invertebrates (>200 pages), writing a one-page review, and participating in a discussion held outside of class during the week of February 27-March 3. Participating in the invertebrate book club is optional, but highly recommended to expand your thinking about invertebrates. A list of possible books, template for the one-page review, and rubric for participation are on D2L. If you participate, your mark in the invertebrate book club (up to 50% of a midterm grade) will be added onto your lowest grade for one of the midterms to a maximum midterm score of 100%. For example, if your lowest midterm grade was 45% and your grade for the invertebrate book club was 100%, your midterm grade would increase to 95%. If you do not participate in the invertebrate book club, a grade of 0 will be assigned for this course component and the grade for the lowest midterm will not be modified.

Resources for further investigation into invertebrates

- 1) Web of Science is an excellent search engine to find primary articles in invertebrate zoology.
- 2) The World Register of Marine Species (WoRMS - <http://www.marinespecies.org/>) provides updated taxonomic information.
- 3) The Encyclopedia of Life (EOL - <http://eol.org/>) gives descriptions for many groups.
- 4) Paleos is another great resource for information on invertebrates (<http://paleos.com/>).
- 5) AskNature is a website that provides biomimicry examples.
- 6) *The zoology coloring book* - Lawrence M. Elson. ISBN: 978-0064603010 – includes some of the groups we cover in this class.
- 7) Other textbooks on invertebrates include:
 - Invertebrates* - Richard C. Brusca, Wendy Moore, Stephen M. Shuster. ISBN: 978-1605353753.
 - Invertebrate zoology: a functional evolutionary approach* - Edward E. Ruppert, Richard S. Fox, and Robert D. Barnes. ISBN: 978-0030259821.
 - The invertebrates: a synthesis* - R.S.K. Barnes, Peter P. Calow, P.J.W. Olive, D.W. Golding, J.I. Spicer. ISBN: 978-0632047611.

Tentative Schedule for Zoology 375.

The most up-to-date class topics, readings, and assignment information can be found on D2L.

WEEK	TOPIC	WEEKLY READINGS
		(1) Pechenik – Biology of Invertebrates (2) Lytle & Meyer - Laboratory Guide
Jan 9-13	M Introduction and overview *W Natural history and classification F Evolutionary history and phylogeny LAB Introduction to scientific observation & record-keeping	(1) Chapters 1, 2, 5, & 24 (2) Chapter 5
Jan 16-20	*M Ctenophora W Porifera 1 F Porifera 2; Placozoa LAB Porifera	(1) Chapters 7 & 4 (2) Chapter 7
Jan 23-27	*M Cnidaria 1 W Cnidaria 2 F Introduction to Bilateria; Xenacoelomorpha LAB Cnidaria	(1) Chapters 6 & 22 (2) Chapter 8
Jan 30-Feb 3	*M Chaetognatha; Platyhelminthes 1 W Platyhelminthes 2 F Midterm 1 LAB Platyhelminthes	(1) Chapters 18 (part) & 8 (2) Chapter 9 (part)
Feb 6-10	*M Rotifera (incl. Acanthocephala); Gnathostomulida; Micrognathozoa; Orthonectida; Dicyemida; Gastrotricha; W Bryozoa; Entoprocta; Cycliophora F Nemertea; Brachiopoda; Phoronida LAB Rotifera; Acanthocephala; Bryozoa; Brachiopoda; Phoronida; Nemertea; Mollusca	(1) Chapters 9, 10, 11, 18(part), & 19 (2) Chapter 9 (part)
Feb 13-17	*M Mollusca 1 W Mollusca 2 F Mollusca 3 *LAB Mollusca	(1) Chapter 12 (2) Chapter 10
Feb 19-26	Reading Week	
Feb 27-Mar 3	*M Annelida 1 W Annelida 2 F Annelida 3 LAB Annelida TBD Invertebrate Book Club Discussion	(1) Chapter 13 (2) Chapter 11
Mar 6-10	*M Nematoda & Nematomorpha W Priapulida; Kinorhyncha; Loricifera F Arthropoda 1 LAB Nematoida; Nematomorpha; Arthropoda	(1) Chapters 16 & 17 (2) Chapter 12
Mar 13-17	*M Arthropoda 2 W Arthropoda 3 F Midterm 2 LAB Arthropoda	(1) Chapter 14 (2) Chapter 13
Mar 20-24	*M Arthropoda 4 W Arthropoda 5 F Arthropoda 6; Tardigrada; Onychophora LAB Arthropoda	(1) Chapter 14 & 15 (2) Chapter 13
Mar 27-31	*M Echinodermata W Echinodermata F Echinodermata LAB Echinodermata	(1) Chapter 20 (2) Chapter 14
April 3-7	*M Hemichordata W Cephalochordata; Urochordata; Craniata F Synthesis 1 *LAB Hemichordata & Chordata	(1) Chapters 21 & 23 (2) Chapter 15
April 10-12	M Synthesis 2 *W Future directions in invertebrate zoology	
April 15-26	Final Exam	

(*) **Indicate due dates for homework, pre/post surveys, and laboratory notebooks.** All homework must be submitted before class on Mondays (14:59). The pre/post class surveys must be submitted before class on Wednesday, January 11 and Wednesday, April 12 (14:59). The lab portfolio is due twice, at the end of your laboratory periods the weeks of February 13-17 and April 3-7.