Course Designations & Attributes
Counts as Liberal Arts Credit in L&S
Level: Intermediate

Time & Location
Lectures: Tuesdays and Thursdays 11 AM-12:15 PM, Noland Hall 168
Lab: Wednesdays 1 PM-5 PM, Noland Hall 559

Instructional Mode
All face-to-face

Credit Hours for Zoo 300 Lectures
This class meets for two 75-minute class periods each week over the spring semester and carries the expectation that students will work on course learning activities (reading, writing, problem sets, studying, etc.) for about 3 hours out of classroom for every class period. The syllabus includes more information about meeting times and expectations for student work.

Credit Hours for Zoo 301 Lab
This is a lab course. Students will meet the 2 credits of the course by spending a total of 90 hours (at least 45 hours per credit) on learning activities and working with the instructor. This includes scheduled lab time and any additional time outside lab.

Instructor: Prashant Sharma
psharma37@wisc.edu
Office: 352 Birge Hall
Office hours: Wednesday, 10:30 AM to 11:30 AM

Teaching Assistants:
Guilherme Gainett
guilherme.gainett@wisc.edu
Office: 443 Birge Hall
Office hours:

Andrew Ontano
ontano@wisc.edu
Office: 443 Birge Hall
Office hours:

Zoo 300/301 Course Description
This lecture and lab course together provides an introduction to invertebrate diversity and biology, with emphasis on anatomy, development, and systematic relationships of the main animal phyla. Phyla are discussed in the context of major themes in animal evolution, such
as the origin of tissue layers, the diversity of feeding mechanisms, the evolution of terrestrialization, patterns of diversification through time, and the conservation of transcriptional circuitry. The aim of this course is to understand animal diversity from a phylogenetic and developmental perspective, and to develop analytical ability to interpret organismal diversity.

**Requisites**
Zoology 101/101, 151/152 or Biocore 381
for Zoo 301, concurrent enrollment in Zoo 300

**Learning outcomes**
By the end of Zoo 300, you will be able to:
1. Describe the major macroevolutionary trends spanning animal evolution through the Phanerozoic
2. Interpret and analyze phylogenetic trees
3. Interpret and analyze a gene regulatory network
4. Design and execute a statistical test using R programming language

By the end of Zoo 301, you will be able to:
1. Recognize the differences between animal phyla
2. Identify key morphological structures and/or developmental phenomena that distinguish major divisions of the animal tree of life
3. Describe early development in study species
4. Generate image data from biological samples

**Grading (lecture)**

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<tr>
<th>Points</th>
<th>Component</th>
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<tr>
<td>10</td>
<td>Participation</td>
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<tr>
<td>15</td>
<td>Reading quizzes</td>
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<tr>
<td>25</td>
<td>Midterm exam</td>
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<td>50</td>
<td>Final exam</td>
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<td>100</td>
<td>Total</td>
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**Grading (lab)**

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<th>Points</th>
<th>Component</th>
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<tbody>
<tr>
<td>10</td>
<td>Participation</td>
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<tr>
<td>15</td>
<td>Lab assignments</td>
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<tr>
<td>50</td>
<td>Lab notebook (illustrations and identifications)</td>
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<td>75</td>
<td>Total</td>
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Grading scale: A (93-100%), AB (87-92%), B (83-86%), BC (77-82%), C (70-76%), D (60-70%), F (<60%).

**Readings**
*Mandatory textbooks:* None.

*Recommended textbooks:* The following texts are strongly recommended as helpful resources and/or background reading.


Reading room

Reserve copies of the Brusca et al. text are also kept in the lab space for Zoology 301 (559 Noland Hall). The door code for the key box is 378 and the signup sheet for the text is posted outside the door. **The door key and the text copies should not be removed from this room under any circumstances.** Please do not make marks, highlights, or written notes in the textbook (if you would prefer to annotate while you read, please purchase your own copy or make scans from the class copy).

Reading room hours are any time of the week except for lab hours (Wednesdays, 1-5 PM). You are welcome to examine living and preserved specimens on display in this room during the week, but please do not disturb or change the lab setup—many of these specimens are rare, delicate, and/or painful to touch, and we have taken great pains to make them available to the class. **Please be respectful of these specimens and your fellow students’ access to the reading room.**

If the door key, textbooks, living specimens, or preserved displays are at any point damaged, removed, altered, injured, and/or destroyed, the teaching staff reserves the right to recall access to the reading room for the whole class for the rest of the semester (at which time all students are welcome to enjoy the 0.7 mile walk to Steenbock Library mid-winter for the single copy we have on reserve there).

Office hours policy

The teaching staff is here to support your learning needs, including outside of class. If the available office hours do not fit your schedule, please schedule an appointment with us outside of those hours. I strongly recommend visiting office hours at least once during the semester to introduce yourself! If you find another student already in a meeting with me during office hours, please make your presence known by knocking on the door, so I do not keep you waiting.

Lectures and sections

Attendance is mandatory in lectures and sections (Zoology 300 only) and in labs (Zoology 301). Absences are permitted only for cases of medical emergency or religious obligation.

**A 45-minute section will be scheduled for Zoology 300.** This section will be led by one of the TAs and will cover the weekly mandatory readings, which will consist of one to two papers from the literature. You are expected to have read the paper(s), understood the content, and bring questions about unclear points. The goals of the section are to (1) help you understand the lecture content and the weekly readings; (2) help us assess topics that are unclear or otherwise in need of more explanation; and (3) help you prepare for reading quizzes and the two exams.

Readings and lab materials

Course materials will be made available online on the course website. We strongly **recommend** completing each weekly reading by the Tuesday of each week and we **require** completing each weekly reading before the start of your section.
Zoology 301 only: Lab worksheets are due by 5 pm on Friday of each week. Late assignments are docked a full grade for every 24-hour period.

Reading quizzes and exams
Reading quizzes are given at the start of every Thursday’s lecture. They will consist of 2-4 questions about main ideas or takeaways from each week’s reading(s). Your readings will be discussed in your weekly sections, so **attendance in section will improve your quiz scores.** There are no makeup quizzes except in the case of medical emergency or religious obligation.

There is one midterm exam and one final exam given in class, as indicated below in the lecture schedule. Practice exam questions will be posted online one week before each of these. There are no makeup exams except in the case of medical emergency or religious obligation.

Cell phone policy
In keeping with time-honored Department of Zoology tradition, if your cell phone rings or is used during class, I will stop the lecture and make you sing for your classmates. The teaching staff reserves the right to record your performance and post it to YouTube.

A note about participation
Participation in Zoology 300 and 301 is about more than showing up to class and section. This class is kept intentionally small (maximum of 15 students in lab, and 25 in lecture) to facilitate a high level of engagement and participation.

At various points in lecture, I may ask you to discuss a question or problem with your neighbors, and then ask you to share your thoughts or solutions with the class. For those of you taking the lab, we will periodically ask you to conduct a 3-minute show-and-tell about an interesting animal, problem, or question that you explored that day.

**I do not care if you don’t come up with the right answer right away.** Invertebrate biology has changed radically over the last 40 years precisely through the interactions of different scientists with different, often contradicting, ideas (and major controversies remain unresolved to this very day). **Getting a wrong answer is often a necessary part of the scientific process.** More important than being “right” is to exercise your ability to apply logic and reason, in a scientific context.

So be bold. Be respectful of your peers. Trust your instincts.
Have fun.

Lectures

**Tuesday, 23 January**
Introduction and general concepts in invertebrate biology
- Course overview
- What are animals?
- Themes in metazoan diversity

**Thursday, 25 January**
Systematics and tree thinking
- What does a phylogenetic tree tell you?
• Constructing phylogenies
• Characters, states, and costs

Tuesday, 30 January
The Cambrian Explosion
• Animal architecture and body plans
• The end of the Ediacaran biota
• Oxygen and complexity

Readings (mandatory): Invertebrates, Chapter 2

Readings (recommended): Invertebrates, Chapter 4

Thursday, 1 February
Multicellularity, complexity, and deep relationships
• Porifera: organization without nervous systems

Readings (mandatory):

Readings (recommended): Invertebrates, Chapters 6-8

Tuesday, 6 February
Deep relationships and the root of Metazoa
• Placozoa
• Cnidaria
• Ctenophora

Readings (mandatory):

Readings (recommended): Invertebrates, Chapter 9

Thursday, 8 February
Bilateral symmetry, blastopores, and nephridia
• Further problematica: Placozoa and Xenoturbella
• Nemertodermatida

Readings (mandatory):

Readings (recommended):
Invertebrates, Chapters 14-15

Tuesday, 13 February
Annelids, segmentation, and spiral cleavage

Readings (mandatory):

Readings (recommended): Invertebrates, Chapter 13

Thursday, 15 February
Developmental data and body plan disparity

Readings (mandatory):

Readings (recommended): Invertebrates, Chapters 13, 17

Tuesday, 20 February
Mollusks

Readings (mandatory):

Readings (recommended): Invertebrates, Chapter 13

Thursday, 22 February
The lophophorate phyla
  ● Phoronida
  ● Brachiopoda
  ● Bryozoa (Ectoprocta)
  ● Entoprocta (Kamptozoa)

Readings (mandatory):

Readings (recommended): Invertebrates, Chapters 15, 17

Tuesday, 27 February
Platyhelminthes, Orthonecida, Dicyemida, and Gastrotricha

Readings (mandatory):

Readings (recommended): Invertebrates, Chapters 10, 11
Thursday, 1 March
Cycliophora and Gnathifera
- Gnathostomulida
- Rotifera/Syndermata
- Micrognathozoa

Readings (mandatory):

Readings (recommended): Invertebrates, Chapter 16

Tuesday, 6 March
Midterm exam

Thursday, 8 March
Introduction to Ecdysozoa
- What are ecdysozoans?
- Ecdysone and molting

Readings (mandatory):

Readings (recommended): Invertebrates, Chapters 18

Tuesday, 13 March
Scalidophora
- Kinorhyncha
- Priapula
- Loricifera

Readings (mandatory):

Readings (recommended): Invertebrates, Chapter 19

Thursday, 15 March
Introduction to Panarthropoda
- Tardigrada
- Onychophora

Readings (mandatory):
Readings (recommended): Invertebrates, Chapter 20

Tuesday, 20 March
Introduction to Arthropoda
  ● The arachnid book lung
  ● The insect tracheal tubules
  ● The Malpighian tubule system

Readings (mandatory):

Readings (recommended): Invertebrates, Chapters 23, 24

Thursday, 22 March
Arthropod diversity and diversification
  ● Insects and mouthpart evolution
  ● The origin of insect wings
  ● Detecting co-diversification using dated phylogenies
  ● Hyperdiverse groups

Readings (mandatory):

Readings (recommended): Invertebrates, Chapters 21, 22

Tuesday, 3 April
New axes of symmetry
  ● Chaetognatha
  ● Ambulacraria

Readings (mandatory):

Readings (recommended): Invertebrates, Chapters 11, 25

Thursday, 5 April
The journey of the notochord
  ● Chordata
  ● Neurogenesis and the road to Vertebrata

Readings (mandatory):

Readings (recommended): Invertebrates, Chapters 26, 27

Tuesday, 10 April
Metazoan phylogeny and genome-scale datasets

Readings (mandatory):

Thursday, 12 April
Historical biogeography of invertebrates

Readings (mandatory):

Tuesday, 17 April
Population genetics and delimiting species

Readings (mandatory):

Thursday, 19 April
Emerging non-model organisms in invertebrate evodevo

Readings (mandatory):

Tuesday, 24 April
Homology concepts and gene networks

Readings (mandatory):

Thursday, 26 April
Morphology in the genomic era
Readings (mandatory):

Tuesday, 1 May
Review

Thursday, 3 May
Final exam