Fish/Biol 311: Biology of Fishes  
Autumn 2023; 5 credits

Course Description

Overview: Introductory course designed to provide an overview of the wonderful world of fishes. The course covers morphological, physiological, behavioral, ecological, and taxonomic diversity of fishes and is designed to provide a basic foundation for advanced courses in all areas of aquatic sciences.

Lectures: Mon, Wed, Fr 11:30 - 12:20, FSH 102

Labs:
Section AA: T, 9:30 - 12:20
Section AB: T, 1:30 - 4:20
Section AC: W, 1:30-4:20
Section AD: Th, 9:30 - 12:20
Section AE: T, 1:30 - 4:20
Section AF: F, 1:30 - 4:20

Instructor: Luke Tornabene, luke.tornabene@gmail.com, FTR 203, office hours: Friday 2:00-3:45 PM.

Office hours via Zoom by appointment – please let me know via email if you want to meet virtually: https://washington.zoom.us/j/91269430837

Teaching Assistants:
Sarah Yerrace (Section AA, AB): yerrace@uw.edu Office hours Mondays 2:00-3:00 PM
Laurel Nave-Powers (Section AE, AF): navepowl@uw.edu Office hours: Wednesdays 9:00-10:00 AM
Kalena DeBrum (Section AC, AD): kdebrum@uw.edu, Office hours: Thursdays 2:00-3:00 PM

A – undergrad peer TA for lecture: alyliu@uw.edu Office hours:

Rationale:
Fishes are the oldest, most diverse and most abundant group of vertebrates, making up more than half of the 55,000 species of living vertebrates. Fishes have been around for over 500 million years, and have dominated aquatic habitats for much of that time. Today, fishes show a staggering diversity of phylogenetic groups with amazing adaptations to a wide range of
environments. As such, fishes are excellent models of biological evolution, demonstrating the tight link between form and function, and between environment and adaptation. In this class, we will survey the diversity of fishes, paying special attention to adaptation to current environments, but also considering their phylogenetic history as a major component in determining present diversity.

**Aim and Learning Objectives:**
The main aim of this class is to provide a survey of the fascinating biology and diversity of fishes, from jawless hagfishes and lampreys, to extinct armored placoderms, to modern-day sharks, rays, and bony fishes. Our survey will highlight important groups from the freshwaters of shallow lakes and streams to the deepest parts of the world's oceans. More specifically, by the end of this class, you should be able to:

- Provide an overview of the main functional systems of a living fish
- Describe the major groups of fishes and their evolutionary relationships
- Explain the interaction between phylogenetic history and adaptations to various environments
- Evaluate current and historic taxonomic classifications of fishes, and assess their utility in conveying our understanding fish relationships.
- Apply your knowledge of fish diversity and relationships to analyze and evaluate the relative effects of global changes (geological, biological, climatological) on vertebrate evolution.
- Be proficient in the use of taxonomic keys to identify fishes, with an emphasis on species in waters of the Pacific Northwest United States.
- Illustrate examples of how form relates to function, as it pertains to fish morphology, and be familiar with the tools and resources we use to study fish morphology in the 21st century.
- Compare and contrast the relative evolutionary trade-offs of different morphologies and life history strategies fishes display, and how this relates to the environments they inhabit.
- Create a well justified argument for why it is important to study fishes to understand vertebrate evolution and the ecology of marine ecosystems, and defend that argument.

**Course Structure**

**Content Overview:** The course will cover all essential aspects of fish biology, including diversity, evolution, morphology, physiology, reproduction and ecology. In the first half of the class, we will survey form and function of various organ and skeletal systems of living fishes, while the second half will place those components in a phylogenetic framework as we study their diversity and evolution.
Format:
The lecture section of the course utilizes a flipped classroom, with a mix of a pre-recorded videos that you watch before class, synchronous activities/discussions in lecture, PollEverywhere questions, weekly Summary Sheets, and exams. You are expected to show up in person for every class.

Labs will complement the lecture content by providing in-person activities relating to anatomy, identification and classification of preserved specimens from one of the largest fish collection in North America, the UW Fish Collection.

More specifically:

1. Each day of lecture will have a set of videos for you to watch on your own before attending lecture. The videos, accompanying PowerPoint slides, and other relevant material for each lecture will be in that lecture’s unique folder on Canvas.

2. During lecture, students will meet in person and will participate in activities based on the material you watched prior to coming to lecture. You will typically be put into breakout rooms in groups of 4-5. These groups will be based on your same groups from lab. The activities in lecture are graded, therefore it is imperative you watch/read the material before coming to lecture. Some of the activities may be PollEverywhere questions, others will be shared google docs, others simply questions that you will answer as a group and submit to canvas as a word document. A laptop or other device will be critical for completing in-class assignments. You will largely be working in groups and at least one person from each group will need to record your answers on the Google doc.

3. To help develop an integrative approach to learning ichthyology, you will create a summary sheet that synthesizes and integrates your understanding of the week’s material in a pictorial format using flowcharts, diagrams and graphs – rather than text. In addition to implementing deep conceptual learning, this approach allows us to keep track of your learning and misconceptions on a weekly basis. Summary sheets are due every Friday at 11:59 pm, and submissions will be via Canvas. You will also be asked to provide feedback to other students’ summary sheets. Your feedback on those sheets is due the following Tuesday at 11:59 pm. Your actual grade for the summary sheets is based both on the quality of your own sheet, plus your feedback given to other students.

4. There are two exams. The midterm exam will take place at the end of week 5. The final exam is during finals week. The final exam is cumulative, but will be more heavily biased towards the second half of the lecture material.

Communication with Instructors, TAs and classmates: We will use Piazza for all correspondence. The instructor and TAs will use Piazza for announcements about syllabus changes, course scheduling, labs, and other general comments. You can use Piazza to contact us directly, or to post general questions to everyone about course material. I will generally encourage students to answer each other’s questions before an instructor or TA answers them. I also encourage you to use Piazza to form study groups. For emergencies or personal issues you
What if you cannot make lecture in person?

You are expected to attend every lecture, as there are in-class assignments and group work that you need to complete as part of your grade. Other students are relying on you. Our discussions in lecture are also critical to your learning in this class.

In the event that you cannot make a lecture, you will be responsible for turning in the assignments that the other students completed in class. This should be done via email both to Luke Tornabene (ltorna1@uw.edu) and Natalie Mattera (nmattera@uw.edu). The assignments are due before the start of the next lecture session. You may do assignments on your own up to 5 times. Beyond that these assignments will not be accepted unless arrangements are made in advance with the instructor.

For example, if you miss a Monday lecture, you must watch the recorded zoom session and complete in the in-class assignment and submit it no later 11:29 am Wednesday.

Course Schedule
**Lectures:**
F&F – form and function
B – biodiversity

<table>
<thead>
<tr>
<th>Week</th>
<th>Day</th>
<th>Date</th>
<th>Lecture</th>
<th>Lecture Topic</th>
<th>Readings</th>
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<tbody>
<tr>
<td>1</td>
<td>W</td>
<td>Sep 27</td>
<td>1</td>
<td>Intro</td>
<td>Chapter 1in Helfman</td>
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<tr>
<td>1</td>
<td>F</td>
<td>Sep 29</td>
<td>2</td>
<td>F&amp;F: external anatomy</td>
<td>Bond PDF, 36-40, 44-48</td>
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<tr>
<td>2</td>
<td>M</td>
<td>Oct 2</td>
<td>3</td>
<td>F&amp;F: skeleton (body)</td>
<td>Bond PDF, 49-50, 54-64</td>
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<tr>
<td>2</td>
<td>W</td>
<td>Oct 4</td>
<td>4</td>
<td>F&amp;F: feeding (head)</td>
<td>Feeding; Jaw protrusion; Pharyngeal jaws; Helfman 119-124</td>
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<tr>
<td>2</td>
<td>F</td>
<td>Oct 6</td>
<td>5</td>
<td>F&amp;F: feeding</td>
<td></td>
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<tr>
<td>3</td>
<td>M</td>
<td>Oct 9</td>
<td>6</td>
<td>F&amp;F: swimming</td>
<td>Locomotion, Helfman Chap 8; Gas bladder; Helfman 50-52, 68-70</td>
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<tr>
<td>3</td>
<td>W</td>
<td>Oct 11</td>
<td>7</td>
<td>F&amp;F: glass bladder and buoyancy</td>
<td>Locomotion, Helfman Chap 8; Gas bladder; Helfman 50-52, 68-70</td>
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<tr>
<td>3</td>
<td>F</td>
<td>Oct 13</td>
<td>8</td>
<td>F&amp;F: integument and skin</td>
<td>Helfman 32-39, &quot;Skin and Scales&quot; in Bond PDF</td>
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<td>4</td>
<td>M</td>
<td>Oct 16</td>
<td>9</td>
<td>F&amp;F: respiration</td>
<td>Respiration and ventilation; Helfman 57-59</td>
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<tr>
<td>Week</td>
<td>Day</td>
<td>Date</td>
<td>Day</td>
<td>Topic</td>
<td>Notes</td>
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<td>4</td>
<td>W</td>
<td>Oct 18</td>
<td>10</td>
<td>F&amp;F: osmoregulation</td>
<td>Osmoregulation, excretion, ion and pH balance, Helfman 100-105</td>
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<td>4</td>
<td>F</td>
<td>Oct 22</td>
<td>11</td>
<td>F&amp;F: senses</td>
<td>Mechnoreception, Equilibrium and balance, Hearing, Chemoreception, Helfman, 75-80, 87-89</td>
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<td>5</td>
<td>M</td>
<td>Oct 23</td>
<td>12</td>
<td>F&amp;F: vision</td>
<td>Vision, Helfman 84-87</td>
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<td>5</td>
<td>W</td>
<td>Oct 25</td>
<td>13</td>
<td>F&amp;F: electric fishes</td>
<td>Electric reception, Helfman 80-84</td>
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<td>5</td>
<td>F</td>
<td>Oct 27</td>
<td></td>
<td>EXAM 1</td>
<td></td>
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<td>6</td>
<td>M</td>
<td>Oct 30</td>
<td>14</td>
<td>F&amp;F: reproduction</td>
<td>Adult sexual maturation, Fishes as Social Animals, Helfman 52-54, 154-155, Chapter 21</td>
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<td>6</td>
<td>W</td>
<td>Nov  1</td>
<td>15</td>
<td>F&amp;F: reproduction II</td>
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<tr>
<td>6</td>
<td>F</td>
<td>Nov  3</td>
<td>16</td>
<td>B: Taxonomy and species concepts and intro to tree thinking</td>
<td>Chapter 2 Helfman, Green PDF on Tree Thinking</td>
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<tr>
<td>7</td>
<td>M</td>
<td>Nov  6</td>
<td>17</td>
<td>B: Systematics and Cladistics</td>
<td>Chapter 2 Helfman, Green PDF on Tree Thinking</td>
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<tr>
<td>7</td>
<td>W</td>
<td>Nov  8</td>
<td>18</td>
<td>B: Taxonomy in fisheries Management</td>
<td>Guest Lecture – Duane Stevenson and James Orr</td>
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<tr>
<td>7</td>
<td>F</td>
<td>Nov 10</td>
<td>19</td>
<td>VETERANS DAY</td>
<td>NO CLASS</td>
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<tr>
<td>8</td>
<td>W</td>
<td>Nov 15</td>
<td>21</td>
<td>B: Fossil fishes, Agnatha II</td>
<td>Jawless fishes, Helfman 169-174, 231-241</td>
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<tr>
<td>8</td>
<td>F</td>
<td>Nov 17</td>
<td>22</td>
<td>B: Elasmobranchs</td>
<td>Helfman 175-177</td>
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<tr>
<td>9</td>
<td>M</td>
<td>Nov 20</td>
<td>23</td>
<td>B: Early Bony Fishes - Sarcopterygii</td>
<td>Helfman 205-229</td>
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<tr>
<td>9</td>
<td>W</td>
<td>Nov 22</td>
<td>24</td>
<td>B: Early Bony Fishes - Bichirs through early Euteleosts</td>
<td>Helfman 178-188, 242-248</td>
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<tr>
<td>9</td>
<td>F</td>
<td>Nov 24</td>
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<td>THANKSGIVING BREAK</td>
<td>NO CLASS</td>
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<td>10</td>
<td>M</td>
<td>Nov 27</td>
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<td>B: Early Teleosts</td>
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<td>10</td>
<td>W</td>
<td>Nov 29</td>
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<td>B: Bony tongues and Otomorpha</td>
<td>Helfman Chap 14</td>
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<td>10</td>
<td>F</td>
<td>Dec  1</td>
<td>27</td>
<td>B: Pre-Acanthomorpha</td>
<td>Helfman 248-258</td>
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<td>11</td>
<td>M</td>
<td>Dec  4</td>
<td>28</td>
<td>B: Acanthomorpha</td>
<td>Helfman Chap 14</td>
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<tr>
<td>11</td>
<td>W</td>
<td>Dec  6</td>
<td></td>
<td>B: Acanthomorpha</td>
<td>No reading</td>
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<tr>
<td>11</td>
<td>F</td>
<td>Dec  8</td>
<td></td>
<td>B: Review session</td>
<td>No reading</td>
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F&F: form and function; B: fish biodiversity
Grading

**Lecture:**
Summary sheets: total points/points available X 150 = 150 possible points  
Lecture Activities: total points / points available X 150 = 150 possible points  
Midterm exam: total points / points available X 150 = 150 possible points  
Comprehensive final exam: total points / points available X 150 = 150 possible points

**Lab:**
Weekly Labs: total points/points available X 200 = 200 points  
Prelab quizzes: total points/points available X 100 = 100 points  
Comprehensive lab practical: total points/points available X 100 = 100 points

**Total:** 1000 points

Approximate Grade Conversion:

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<th>GPA</th>
<th>Percentage</th>
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<td>844</td>
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<tr>
<td>3.5</td>
<td>90</td>
<td>897</td>
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| 4   | 95         | 950    | or higher

**Strategies for Success:**

The most important things you can do to be successful is watch lecture videos, show up, and participate.

Since you are being graded on activities you do in class, and since these are largely done in groups, you have a responsibility to do watch the lecture videos before coming to class. Thus the most important strategy in this class is to keep up to date with readings and videos, attend class, and be an active participant in lab.
Make sure to take notes during lecture, and while watching the videos before you come to lecture. While the lecture slides are based loosely on the optional supporting readings from the textbook, there will be additional information on my slides that is not covered in the readings. Thus, seeing the lectures is critical, as this is what the test material will be based on.

The final half of the class is very heavy in terminology and names of the organisms/classifications. I am not aware of any way to teach you about the relationships without having you be responsible for knowing the names of some of them, so unfortunately you will need to commit these to memory. However, our approach to learning about this is rooted heavily in ‘tree-thinking’, that is, understanding the patterns of evolution in a phylogenetic context, incorporating synapomorphies and major evolutionary advances into our thinking. In this regard, simply memorizing only names is neither sufficient nor desired. A useful strategy for the second half of class is drawing the fish tree of life at the beginning and end of each lecture, updating it with the new taxa we cover and their key characteristics. By constantly working with phylogenetic trees (drawing them, reading them, editing them, annotating them, expanding and contracting them), the names will come much easier, and before you know it you will be a living, breathing ichthyologist.

The final lecture exam will be cumulative, so make sure to keep track of past material and integrate it with new information. Most importantly, ask if you have any questions!

As a general rule at UW, 5 credits = 15 hours of work each week. This mean 3 hours physically in lecture, 3 hours in lab, 9 hours out of class. Videos and readings should take no more than 4 hours each week, which leaves 5 hours for studying and working on summary sheets.

How do I study?
- Review lecture slides / videos
- Review past summary sheets
- Review key points from textbook
- Review lecture activities
- Write your won mock test questions
- Draw trees! Not actual trees – phylogenetic trees
- Work in groups

Course Policies

Plagiarism and Cheating:

The university’s policy on plagiarism and academic misconduct is a part of the Student Conduct Code, which cites the definition of academic misconduct in the WAC 478-121. (WAC is an abbreviation for the Washington Administrative Code, the set of state regulations for the university. The entire chapter of the WAC on the student conduct code is here.) According to this section of the WAC, academic misconduct includes:
“Cheating”—such as “unauthorized assistance in taking exams”, “Falsification” “which is the intentional use or submission of falsified data, records, or other information including, but not limited to, records of internship or practicum experiences or attendance at any required event(s), or scholarly research”; and “Plagiarism” which includes “[t]he use, by paraphrase or direct quotation, of the published or unpublished work of another person without full and clear acknowledgment.”

The use of any artificial intelligence text generators or similar tools, including but not limited to ChatGPT, during exams and for other written assignments, is also considered cheating. Text from any content from this class, including exams, study guides, quizzes, etc., may not be shared, used, or distributed elsewhere without permission from the instructor.

Students caught violating these terms will receive no credit on that assignment, and will be subjected to a full investigation regarding academic misconduct. Students have a right to due process, particularly regarding academic misconduct. University Libraries provides a comprehensive list of tools for understanding and preventing plagiarism.

**Attendance and absences:** Attendance is not part of your grade, however completion of activities during lecture is 15% of your overall grade. Being present in class is the best way to do well on this activity, since you work in groups.

**Make-up labs:** All laboratories take considerable time to prepare. Therefore, we cannot always offer make-up labs. We will do our best to accommodate make-ups due to unavoidable absences. If you know you cannot come to a lab for an unavoidable absence, let us know at least a week in advance so we can attempt to accommodate you in another lab section or try to find other solutions.

In accordance with UW Policy, examples of unavoidable absences cause include death or serious illness in the immediate family, illness of the student, and, provided previous notification is given, observance of regularly scheduled religious obligations and might possibly include attendance at academic conferences or field trips, or participation in University-sponsored activities such as debating contests or athletic competition.

**Missed Exams:** Acceptable reasons to miss an exam are listed in here. Other reasons are deemed unacceptable and you will receive a 0 on the missed exam. Make-Up exams for excused reasons may be provided after the exam - these make-up exams will consist of questions different from the scheduled exam. UW Policy states, “An instructor shall not, except in very unusual circumstances, permit a student to take a final examination earlier than the scheduled time.” I will adhere to that guideline.

**Regrading:** regrading requests must be submitted in writing together with the exam within a week of publishing grades. We will regrade the entire question, and so your grade may go down as well as up.
Disability Accommodation

Your experience in this class is important to me. It is crucial that all students in this class have access to the full range of learning experiences. At the University of Washington, it is the policy and practice to create inclusive and accessible learning environments consistent with federal and state law. If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course.

Full participation in this course requires the following types of engagement:

- **Lectures**
  - The ability to watch lecture videos. The ability to collaborate in teams while working on a computer. Assignments include worksheets, short discussions of data, the ability to conduct short computer exercises.
  - The ability to spend 3 hours in lab in person, where you will frequently move around the room and visit other lab benches. The ability to collaborate in teams.

- **Labs**
  - The ability to conduct short computer exercises.

- **Polls**
  - The ability to respond to multiple choice questions within a short period of time.
  - The ability to write a set of short-answer questions designed to be completed within

- **Exams**
  - 50 minutes online via Canvas. 1 hour 50 minutes online via Canvas for final exam.

If you anticipate or experience barriers to your learning or full participation in this course based on a physical, learning, or mental health disability, please immediately contact the instructor to discuss possible accommodation(s). A more complete description of the disability policy of the College of the Environment can be found [here](https://www.uw.edu/students/drs).

If you have, or think you have, a temporary or permanent disability that impacts your participation in any course, please also contact Disability Resources for Students (DRS) at: 206-543-8924 V / 206-543-8925 TDD / uwdss@uw.edu e-mail / [http://www.uw.edu/students/drs](http://www.uw.edu/students/drs).

Health and Wellness

Please see the SAFS website below, which has a list of helpful resources regarding physical health and wellness, mental health and wellness, tutoring, counselling, and academic advising.

[https://fish.uw.edu/students/advising/support-resources](https://fish.uw.edu/students/advising/support-resources)

Religious Accommodations

Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW’s policy, including more information about how to request an accommodation, is available at Religious Accommodations Policy ([https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/](https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/)).
Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form (https://registrar.washington.edu/students/religious-accommodations-request/).