



Appledore Island, Isle of Shoals, Kittery, Maine
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Shoals Marine Laboratory
Anatomy and Function of Marine Vertebrates (BIOSM 3210/MEFB 754)
17 July – 31 July 2017

Course Syllabus and Schedule

Faculty: Dr. Stacy Farina (stacyfarina@fas.harvard.edu)
Dr. Nicholas Gidmark (gidmark@knox.edu)

Prerequisites: One semester of college level biology or equivalent

Class enrollment limit: 20

Credit hours: 3

Course Objectives/Goals:

Welcome to Anatomy and Function of Marine Vertebrates (AFMV), a course on the structure, function, and evolution of vertebrates that live in or near marine habitats. Study of anatomy will be integrated with analyses of function, ecology, and evolution. Marine vertebrates include hagfishes, lampreys, cartilaginous fishes, ray-finned fishes, coelacanth, sea turtles, crocodylians, marine lizards and snakes, many groups of birds, and marine mammals. Of the 60,000+ living species of vertebrates, roughly 30% are marine or marine-associated. In this course, we will review the diversity of these animals and learn to think in terms of their 500 million year history.

Fieldwork includes an offshore trip to collect hagfish, local fishing, tide pooling, a whale watch, and a seal study at Duck Island. Laboratory exercises will include dissections of marine vertebrates, including hagfishes, sharks, ray-finned fishes, and marine birds and reptiles. We will also conduct necropsies of marine mammals. Through comparisons of internal and external anatomy, we will explore how these animals are adapted for life in aquatic environments and how they meet basic functions for living, such as eating, breathing, swimming, flying and reproducing. Students will also complete an independent project on a topic of their choosing. Projects generally focus on studies of anatomy, physiology, behavior, and biomechanics. Examples of past research projects include measuring drag force on sea turtle flippers, comparing tooth shape among seal species with different diets, and quantifying scaling of ventilation rate with body size in fishes.

Course Materials: No textbook is required for this course, although textbooks and other resources on anatomy and function will be available in the Shoals Marine Laboratory library. Here is one book that will be available and is most relevant to the course material:

Liem, KF, WE Bemis, WF Walker, L Grande. 2001. **Functional Anatomy of the Vertebrates: An Evolutionary Perspective, 3rd Edition**. Thomson/Brooks Cole, Belmont, CA.



Cornell University



University of
New Hampshire

Assignments & Grading:

Lecture exam	250
Lab Practical	150
Quizzes (2)	150
Individual Projects	350
In Class/On Site Evaluations	100
TOTAL	1000

Quizzes and Exam

We will have two quizzes and one exam based on lecture material. The quizzes are short assessments of mastery of lecture material prior to the exam, and they will consist of short answer, fill-in, and T/F questions. The lecture exam will include essay, short answer and multiple-choice questions.

Laboratory Practical

The lab practical will be an assessment of mastery of laboratory material, including internal and external anatomy of fishes and biodiversity of Gulf of Maine marine vertebrates. The practical will be given in the laboratory and will consist of 20 stations with 50 questions total.

Individual Projects

Each student will complete an independent project pertaining to some aspect of marine vertebrate anatomy and function. More details will be explained in class.

In Class/On Site Evaluations

You are expected to participate fully in lecture, project discussions, and laboratory exercises. This component of the grade is based on our subjective evaluation of your involvement in the course.

Expectations and Conduct:

Students are responsible for fully understanding all of the information presented in this syllabus. If there are any questions regarding this information, it is the student's responsibility to bring it to the instructor's attention. In addition, students are responsible for attending all activities associated with this course and completing all assignments. Students are responsible for asking questions anytime they need clarification (remember, there is no such thing as a bad question).

Every student is responsible for their own behavior- specifically in being respectful and collegial to other students and with instructors. Students are responsible for fully understanding and adhering all of the information presented in the SML Appledore Handbook (http://www.sml.cornell.edu/sml_forms.html)

1. *Personal Technology.* Do not use cell phones, smart phones, iPads, mp3 players, headphones, or similar devices in the classroom or during course activities. If you take notes with your computer, disable wireless access during lecture
2. The lab has a modest computer facility in Loughton Library; please treat this shared facility with respect. Printers are available, but please limit printing to your FINAL document (if required).
3. *Transmission of Course Materials.* Students are not authorized to replicate, reproduce, copy or transmit lectures and course materials presented, or derivative materials including class notes, for sale or free distribution to others without written consent of the instructors who are the original source of the materials.
4. *Academic Integrity.* Any work submitted must be your own. Uncredited use of another person's words, data or images is considered plagiarism, a serious violation of the Code, whether the material comes from another student, a web site, or a published paper. Students must adhere to Cornell's and UNH's Policy for Academic Honesty/Plagiarism and Discrimination
 - i. Cornell: <http://cuinfo.cornell.edu/aic.cfm>
 - ii. UNH: <http://www.unh.edu/vpsas/handbook/welcome-university-new-hampshire>
5. *Disabilities & ADA Accommodation:* Students with a disability must contact Cornell's (420 CCC building; 607-254-4545) or UNH's Student Disability

Services(<http://www.unh.edu/disabilityservices>) four weeks prior to start of class for confidential discussion of needs and for registration to verify eligibility for academic accommodations. No retroactive accommodations can be made.

6. **Mental Health:** Shoals Marine Laboratory cares about you and your well-being. If you experience unusual personal or academic stress during the course or need to talk with someone about a personal problem, seek support from your instructors as soon as possible. In addition, any SML staff is available for consultation 24/7. Find staff in the office in the Hamilton House between 8am – 7pm or knock on the door of Bartell House after hours

About the Instructors

Dr. **Stacy Farina** is a postdoctoral fellow at Harvard University, funded by an NSF Postdoctoral Research Fellowship in Biology. She studies evolutionary morphology and biomechanics of fishes and other marine vertebrates. She primarily works on the evolution and function of the gill ventilatory system in fishes. She received her B.S. in Marine and Freshwater Biology from the University of New Hampshire in 2010 and her Ph.D. in Ecology and Evolutionary Biology from Cornell University in 2015. She has been an instructor for *Anatomy and Function of Marine Vertebrates* since 2016 and was a teaching assistant for this and other SML courses from 2010 – 2013. At Cornell, she was a teaching assistant for *The Vertebrates* and *Evolutionary Biology and Diversity*, and she designed and instructed a First-Year Writing Seminar titled *Exploring Form and Function in Vertebrates*. In 2014, she was a teaching assistant for *Functional Morphology and Ecology of Marine Fishes* at Friday Harbor Laboratories (FHL), and in 2017, she was a guest instructor for the FHL CORALS program. Stacy has mentored undergraduate and graduate research at SML, FHL, and Cornell University, including studies of eider duck locomotion, terrestrial walking and jumping of tidepool fishes, cutting performance of shark teeth, and biomechanics of fish burial, resulting in eleven student presentations at national and international meetings and four student-authored publications.

Dr. **Nick Gidmark** is an Assistant Professor at Knox College. He is an equal opportunity zoologist, but he typically studies musculo-skeletal biomechanics, focusing on food capture and processing (i.e. teeth, jaws, and their associated muscles). His research has taken him throughout the vertebrates, from sharks to salmon to shiners to swine. His least favorite surgical subject is the turkey, though that may be his favorite culinary subject. Nick's current research program focuses on: I) chewing & swallowing in monkeys; and II) prey processing in pharyngeal (throat) jaws of minnows. Nick has conducted NIH- and NSF-funded postdoctoral research fellowships at Brown University, Friday Harbor Marine Laboratories (University of Washington), and the University of Chicago. He finished his PhD in comparative anatomy and biomechanics at Brown University in 2012. His undergraduate degree from the University of Minnesota was in fisheries management and conservation biology. He has taught two courses at Shoals (This course and one on shark biology) and taught Biology of Fishes at Friday Harbor Marine Laboratories while in residence there. At Knox, he teaches introductory biology, research methods, Comparative Vertebrate Anatomy, Biology of Fishes, Comparative Animal Physiology, and Marine Biology. Collaboration with undergraduates in research is the single most rewarding highlight of Nick's career (and why he now is faculty at a small liberal arts college instead of a university), and these endeavors have led to dozens of conference presentations and several peer-reviewed publications.

Lecture, Laboratory, and Field Schedule

Note: This schedule is tentative. The timing and order of activities are likely to change, due to factors such as weather conditions and unexpected opportunities that may arise. We will also be providing plenty of breaks throughout lectures and activities, during which you'll have time to rehydrate, refuel on snacks in the Commons, or take SML selfies to send to your friends back home. Appledore Island is a dynamic place, so expect to have fun, work hard, and be flexible!

Day 1 - Mon July 17

- 5:30 — 6:00 Introductions and Welcome!
- 6:00 — 6:30 Dinner
- 7:00 — 8:30 Island tour
- 8:30 — 9:30 Perceptions of Anatomy (Commons)

Day 2 - Tue July 18

- 7:30 — 8:00 Breakfast
- 8:00 — 9:30 Lecture: Introduction to Evolution and Vertebrate Phylogeny
- 9:30 — 11:00 Lecture: Jawless Fishes
- 11:00 — 12:30 **Seal Watch Trip [Low Tide 12:38AM (0.2 ft)]**
- 12:30 — 1:00 Lunch
- 1:30 — 3:00 Workshop: Tree Thinking
- 3:00 — 4:30 Lecture: Cranial Skeletal Anatomy
- 4:30 — 6:00 Lecture: Cartilaginous Fishes
- 6:00 — 6:30 Dinner
- 6:30 — 8:00 *Signals for Survival*
- 8:00 — 9:00 **Rock Talk**

Day 3 - Wed July 19

- 7:30 — 8:00 Breakfast
- 8:00 — 9:30 Lecture: Post-cranial Skeletal Anatomy
- 10:00 — 12:30 **Lab: Shark Dissection**
- 12:30 — 1:00 Lunch
- 1:00 — 4:30 Lecture: Ray-Finned Fishes (with break for food run)
- 4:30 — 6:00 Lecture: Muscle Biomechanics
- 6:00 — 6:30 Dinner
- 6:45 — 9:30 **Hagfish pick up (RV Heiser)**

Day 4 - Thu July 20

- 7:30 — 8:00 Breakfast
- 8:00 — 8:30 Quiz 1 (25 points)
- 8:30 — 10:00 Lecture: Respiration and Circulation
- 10:00 — 12:30 **Lab: Ray-finned Fish Dissection and Gulf of Maine Biodiversity**
- 12:30 — 1:00 Lunch
- 1:00 — 4:30 **Trawling**
- 4:30 — 6:00 Lecture: Lobe-Finned Fishes and Marine Reptiles
- 6:00 — 6:30 Dinner
- 7:00 — 9:30 Lecture: Whale Watch Prep

Day 5 - Fri July 21

- 7:30 — 8:00 Breakfast
- 8:00 — 9:30 Lecture: Prey Capture and Processing
- 10:00 — 2:00 **Whale Watch**
- 2:00 — 3:00 Study Time
- 3:00 — 4:30 Lecture: Sensory Systems
- 4:30 — 6:00 Lecture: Marine Birds
- 6:00 — 6:30 Dinner
- 7:00 — 9:30 Lab Practical Review Session

Day 6 Sat July 22

7:30 — 8:00 Breakfast
8:00 — 9:00 Study and Review
9:00 — 10:00 **Lab Practical**
10:30 — 12:30 Lecture: Buoyancy and Locomotion
12:30 — 1:00 Lunch
1:30 — 3:00 Lecture: Marine Mammals
3:00 — 6:00 **Lab: Marine Mammal Necropsy**
6:00 — 6:30 Dinner
7:00 — 9:00 **Fishing**

Day 7 Sun July 23

10:00 — 11:00 Brunch
11:00 — 11:30 Quiz 2 (25 points)
11:30 — 1:00 Lecture: Diving Adaptations
1:00 — 2:30 Lecture: Reproduction and Development
2:00 — 4:00 Study and Review
4:00 — 5:00 **Tide Pool Trip [Low at 5:33PM]**
5:00 — 5:30 Dinner
6:00 — 7:30 Study Time
7:30 — 8:30 Exam Review Session

Day 8 Mon July 24

7:30 — 8:00 Breakfast
8:00 — 10:00 Study Time
10:00 — 12:30 **Lecture Exam**
12:30 — 1:00 Lunch
1:30 — 2:30 **Workshop: How to Read a Scientific Research Paper**
2:30 — 4:00 **Workshop: Data Analysis**
4:30 — 6:00 **Project Planning Discussion**
6:00 — 6:30 Dinner
7:00 — 8:30 Project Time

Day 9 Tue July 25

7:30 — 8:00 Breakfast
8:00 — 9:30 **Special Lecture**
9:30 — 12:30 **Lab: Special Dissections**
12:30 — 1:00 Lunch
1:00 — 6:00 Project Time
6:00 — 6:30 Dinner
6:30 — 8:00 Project Time
8:00 — 9:00 **Rock Talk**

Day 10 Wed July 26

7:30 — 8:00 Breakfast
8:00 — 10:00 Project Time
10:00 — 12:30 **Special Lecture: Biomimetics**
12:30 — 1:00 Lunch
1:30 — 3:00 Project time
3:00 — 5:00 **White Island Trip**
5:00 — 6:00 Project time
6:00 — 6:30 Dinner
7:00 — 8:30 Project time

Day 11 Thu July 27

7:30 — 8:00 Breakfast
8:30 — 12:30 Project Time
12:30 — 1:00 Lunch
1:00 — 6:00 Project time
6:00 — 6:30 Dinner
7:00 — 9:00 Project time

Day 12 Fri July 28

7:30 — 8:00 Breakfast
8:00 — 12:30 Project Time
12:30 — 1:00 Lunch
1:30 — 6:00 Project Time
6:00 — 6:30 Dinner
7:00 — 8:30 Project Time

Day 13 Sat July 29

7:30 — 8:00 Breakfast
8:00 — 12:30 Project Writing Time
12:30 — 1:00 Lunch
1:00 — 1:30 Turn in Paper Drafts
1:30 — 6:00 Work on Presentations
6:00 — 6:30 Dinner
7:00 — 9:30 Work on Paper Revisions and Presentations

Day 14 Sun July 30

10:00 — 11:00 Brunch
11:00 — 1:00 Project Presentations
2:30 — 3:00 Turn in Final Paper
3:00 — 5:00 Lab cleanup
5:00 — 6:00 Dinner
6:00 — 8:30 Evening festivities

Day 15 Mon July 31 Students depart