



Appledore Island, Isle of Shoals, Kittery, Maine
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Shoals Marine Laboratory
Evolution and Marine Diversity (BIOSM 1780/MEFB 530)
July 11 – 29, 2022

Course Syllabus and Schedule

Faculty: Dr. Warren Allmon (wda@cornell.edu)
Dr. Jan Factor (jan.factor@purchase.edu)
Dr. Cinnamon Mittan (cinnamon.mittan@gmail.com)

TA: Caren Shin (cps257@cornell.edu)

Prerequisites: None

Credit hours: 4

Course Objectives/Goals:

This course explores the patterns of diversity and processes of evolution. Topics include the diversity of life, the fossil record, macroevolutionary patterns, the genetics and developmental basis of evolutionary change, processes at the population level, evolution by natural selection, modes of speciation, long-term trends in evolution, and human evolution. Field exercises and laboratory work are emphasized. During this course, students will:

- Understand the underlying causal principles of evolutionary diversification.
- Apply these principles to understand historical and contemporary evolutionary scenarios.
- Identify core taxa in the tree of life, their characteristics, and understand the relationships among them. Use basic conceptual and analytical tools to describe complex relationships within the tree of life.
- Become familiar with a number of experimental and synthetic approaches to analyzing and discovering evolutionary processes (microevolution) and establishing evolutionary patterns (macroevolution).
- Knowledgeably discuss the dimensions of evolutionary issues that require decisions in our society.

Course Materials:

We will make a few explicit reading assignments (see below). You can freely consult the textbook by Freeman and Herron, listed below. Copies are in the Loughton Library or Palmer-Kinne Laboratory.

Alberch, P. 1986. Possible dogs. *Natural History* 95(12).

Allmon, W.D., 2009, Evolution and creationism. A very short guide. Second edition. Paleontological Research Institution Special Publication No. 35, 128 p.

Freeman, S., and J.C. Herron, 2007, Evolutionary analysis. 4th ed. Benjamin Cummings, San Francisco

Gosner, K.L., 1978, A Field Guide to the Atlantic Seashore: From the Bay of Fundy to Cape Hatteras (Peterson Field Guides). Houghton Mifflin Co.

Gould, S.J., 1981. Evolution as fact and theory. *Discover*, 2(5): 34-37. (Reprinted in: Hen's teeth and horse's toes [1983d]. New York: W.W. Norton, pp. 253-262.)

Gould, S.J., and R.C. Lewontin, 1979. The spandrels of San Marco and the Panglossian paradigm: A critique of the adaptationist programme. *Proceedings of the Royal Society of London*, B 205: 581-598.

Assignments & Grading:

Quizzes and Examinations: Scheduled lecture quizzes introduce you to our examination style. There will be one midterm exam and practical. The final exam and practical will be cumulative but concentrated on material from the latter-half of the class.

Field/Laboratory Work and Research Project: Field and laboratory sessions develop topics covered in lecture, explore some topics in depth, and hone your skills in reading and critically evaluating scientific literature. You also will write a natural history paper; we will explain more about this in class.

Grading:

Quizzes consisting of five in-class short-answer quizzes	100 points
Preliminary examination with written and practical components	300 points
Final examination with written and practical components	300 points
Research project	300 points

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 and participating fully in 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). Failure to follow these expectations will affect the grade and may cause referral to the appropriate campus authorities.

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

Positive and Constructive Attitude. Maintaining a positive and constructive attitude and working together in a collegial and productive manner is essential for a successful and enjoyable experience and is expected of all students. This is especially true in a field environment, where flexibility is required.

Personal Technology. Do not use cell phones, smart phones, tablets, mp3 players, headphones, or similar devices in the classroom or during course activities. Computers may be used for taking notes only with the instructor's permission, and only with wireless access disabled during lecture.

Computer Facilities. 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).

Transmission of Course Materials. Students are not authorized to replicate, reproduce, copy, post, or transmit lectures, powerpoints, or other course materials presented as part of the course, 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.

Recording Course Materials. Lectures and other class sessions may not be recorded (neither video nor audio) without written consent of the instructors.

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:

Cornell: <http://cuinfo.cornell.edu/aic.cfm>

UNH: <http://www.unh.edu/vpsas/handbook/welcome-university-new-hampshire>

Disabilities and 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.

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 Hamilton House office between 8am – 7pm or knock on the door of Bartels House after hours.



Daily Schedule (version 1.4 – 6/30/22)

1. Monday July 11 — *Low tides for the day are always listed here, with time and tidal height (in feet):* 3:05 am (-0.3), 3:12 pm (0.4)



2:45 – 4:00 Portsmouth to Appledore

4:00 – 6:00 Unload and move-in; Island orientation (“Fire and Water”; SML staff)

6:00 – 7:00 Dinner

7:15 – 8:30 Island tour (EMD faculty); course introduction; *Signals for Survival* movie

2. Tuesday July 12 — 4:03 am (-0.7), 4:09 pm (0.2)

7:30 – 8:00 Breakfast

8:15 – 9:45 **Lecture:** Physical environment of the Gulf of Maine (**Allmon**)

10:00 – 11:00 **Lab exercise:** “Why do these organisms look like this?” (**Allmon**)

11:15 – 12:15 **Lecture:** Why do we think evolution is true? (**Allmon**) **READING:** Allmon (2009), pp. 9-46; Dobzhansky (1973); Gould (1981)

12:30 – 1:30 Lunch

1:30 – 2:45 **Lecture:** Origin of life (**Allmon**)

3:00 – 4:00 **Lecture:** Daily Diversity 1: Algae & the origin of plants (**Factor**)

4:15 – 6:00 **Field & Lab:** Intertidal Field Trip #1 (Smith’s Cove, SW) (**Factor**)

6:00 – 7:00 Dinner

8:00 – **Rock Talk:** Dr. Catherine Mattase, “Fear and Hiding in New England: Tales from Rocky Shores”



3. Wednesday July 13 — 4:49 am (-1.1), 5:06 pm (0.0)

7:30 – 8:00 Breakfast

8:15 – 9:45 **Lecture:** Daily Diversity 1: Algae & the origin of plants (**Factor**) (continued)

10:00 – 11:00 **Art** with artist-in-residence Ashley Williams

11:15 – 12:30 **Lecture:** Microevolution, heritability, and Mendelian inheritance (**Mittan**)

12:30 – 1:30 Lunch

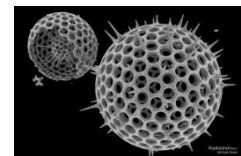
1:30 – 3:00 **Lecture:** Daily Diversity 2: Protists and the tree of life (**Allmon**)

3:15 – 4:15 **Lab:** *Nucella* sorting (**Mittan**)

4:30 – 5:45 **Field & Lab:** Intertidal Field Trip #2 (Larus Ledge, NW) (**Factor**)

6:00 – 7:00 Dinner

7:15 – 8:45 **Lecture:** Mendelian inheritance and population genetics (**Mittan**)



4. Thursday July 14 — 5:55 am (-1.3), 6:03 pm (-0.2)

7:30 – 8:00 Breakfast

8:15 – **Quiz #1**

8:30 – 9:45 **Lecture:** Evolutionary mechanisms: selection, drift, migration, mutation (**Mittan**)

10:00 – 11:00 **Lecture:** Intro to invertebrate diversity (**Factor**)

11:15 – 12:15 **Lab:** Sea table exercise (**Factor, Allmon**)

12:30 – 1:30 Lunch

1:45 – 2:45 *Nucella* sorting recap (**Mittan**)

3:00 – 4:30 **Lecture:** Daily Diversity 3: Plants (**Allmon**)

4:45 – 5:45 **Field:** Plant walk (**Allmon**)

6:00 – 7:00 Dinner

7:15 – 8:45 **Lab:** Protists (**Allmon/Factor**)



5. Friday July 15 — 6:50 am (-1.4), 6:59 pm (-0.2)

7:30 – 8:00 Breakfast

8:15 – 9:45 **Lecture:** Daily Diversity 4: Sponges (**Factor**)

10:00 – 11:00 **Art** with artist-in-residence Ashley Williams

11:15 – 12:15 **Lecture:** Daily Diversity 4: Sponges (**Factor**) (continued)

12:30 – 1:30 Lunch

1:45 – 3:15 **Lecture:** Daily Diversity 5: Non-coral Cnidarians (**Factor**)

3:15 – 4:45 **FREE/STUDY TIME!**

4:45 – 5:45 **Lecture:** Daily Diversity 5: Non-coral Cnidarians (**Factor**) (continued)

6:00 – 7:00 Dinner

7:15 – 8:45 **Discussion:** Genetics review Q&A (**Mittan**)



6. Saturday July 16 — 7:43 am (-1.3), 7:55 pm (-0.1)

7:30 – 8:00 Breakfast

8:15 – **Quiz #2**

8:30 – 9:45 **Lecture:** A brief history of evolutionary biology (**Allmon**) **READING:** Allmon (2009) pp. 17-31.

10:00 – 12:00 Sea table evolutionary tree activity presentations

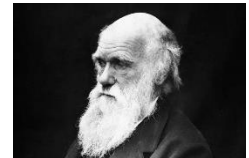
12:30 – 1:30 Lunch

1:45 – 3:45 **Lab:** Sponges and Cnidarians (**Factor**)

4:00 – 5:45 **Lecture:** History of the Earth and life (**Allmon**) **READING:** Freeman & Herron (2007) Ch. 18

6:00 – 7:00 Dinner

7:15 – 8:30 **Lecture:** Daily Diversity 5 (continued): Corals and coral reefs (**Factor**)



7. Sunday July 17 — 8:36 am (-1.1), 8:53 pm (0.0)

9:00 – 10:00 **Field:** Geology walk (**Allmon**)

10:00 – 11:00 Brunch

11:15 – 12:45 **Lecture:** Daily Diversity 6: Lophotrochozoa (**Factor**)

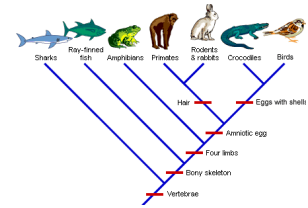
1:00 – 3:00 **Lab:** Lophotrochozoa (**Factor**)

3:15 – 4:15 **Exercise:** “The great clade race” (**Shin**)



5:00 – 6:00 Dinner

6:15 – 7:45 **Lecture:** Systematics, part 1 (**Allmon**) **READING:** Freeman & Herron (2007) Ch. 4



8. Monday July 18 — 9:29 am (-0.7), 9:52 pm (0.2)

7:30 – 8:00 Breakfast

8:15 – **Quiz #3**

8:30 – 10:30 **Field & Lab:** Intertidal Field Trip #3 (Halftide Ledges, SW)

10:45 – 12:15 **Lecture:** Systematics, part 2 (**Allmon**)

12:30 – 1:30 Lunch

1:45 – 3:15 **Lecture:** Daily Diversity 7: Mollusks etc. (**Factor**)

3:30 – 5:45 **Lab:** Mollusk Madness! (**Factor, Allmon, Shin**)

6:00 – 7:00 Dinner

8:00 – **Rock Talk:** Antoinette Clemetson, title TBA



9. Tuesday July 19 — 10:22 am (-0.2), 10:53 pm (0.5)

7:30 – 8:00 Breakfast

8:15 – 9:45 **Lecture:** Daily Diversity 8: Ecdysozoa (**Factor**)

10:00 – 12:15 **Lab:** Lobsterfest! (**Factor**)

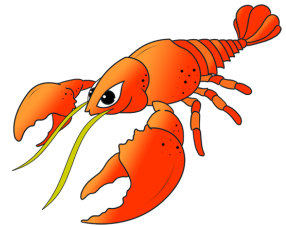
12:30 – 1:30 Lunch

1:45 – 3:15 Lecture: Systematics, part 3 – Phylogenetic reconstruction (**Allmon**)

3:15 – 6:00 **FREE/STUDY TIME**

6:00 – 7:00 Dinner

7:15 – Review for Lab Practical (all faculty), then study time



10. Wednesday July 20 — 11:16 am (0.3), 11:54 pm (0.7)

7:30 – 8:00 breakfast

8:15 – 11:15 **Preliminary Written Exam & Practical Exam**

11:15 – 12:30 **FREE TIME!**

12:30 – 1:30 Lunch

1:30 – 2:30 **Lecture:** Natural selection and adaptation, part 1 (**Allmon**)

READING: Allmon (2009) pp. 48-55

2:45 – 4:00 **Group project:** Intro and methods for field transects (**Allmon, Factor**)

4:15 – 5:45 **Lecture:** Natural selection and adaptation, part 2 (**Allmon**)

READING: Gould & Lewontin (1979); Kricher (1988)

6:00 – 7:00 Dinner

7:15 – 8:45 **Lecture:** Biogeography and evolution (**Allmon**)



11. Thursday July 21 — 12:10 pm (0.8)

Field Trip to Creek Farm (mainland) MUD FLAT HABITAT!

7:30 – 8:00 Breakfast

8:00 – 9:00 **Lecture:** Daily Diversity 9a: Deuterostomia, part 1: Nonvertebrate chordates (**Factor**)

9:30 – Depart Appledore

10:30 – 1:00 **Fieldwork & collecting**

~1:00 – Lunch at Creek Farm

~1:30 – Depart Creek Farm

2:15 – Arrive Appledore – rinse off equipment, unpack organisms in lab

3:00 – 5:00 **Lecture:** Daily Diversity 9b: Deuterostomia, part 2: Echinodermata (**Factor**)

5:00 – 6:00 Dinner

6:15 – 7:45 **Lab:** Echinoderms and nonvertebrate chordates (**Factor**)



2. Friday July 22 — 12:56 am (0.8), 1:06 pm (1.2)

7:30 – 8:00 Breakfast

8:15 – 9:45 **Lecture:** Species and speciation, part 1 (**Allmon**)

9:45 – 12:30 **Project field time**

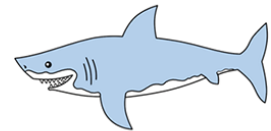
12:30 – 1:30 Lunch

1:45 – 3:15 Daily Diversity 10: Vertebrates 1 – Fishes (**Allmon**)

3:15 – 5:30 **Lab:** Fishes (**Allmon**)

6:00 – 7:00 Dinner

7:15 – 8:30 Species and speciation, part 2 (**Allmon**)



13. Saturday July 23 — 1:58 am (0.8), 2:03 (1.5)

7:30 – 8:00 Breakfast

8:15 – 9:45 **Lecture:** Origin of tetrapods (**Allmon**)

10:00 – 12:30 **Project field time**

12:30 – 1:30 Lunch

1:45 – 3:15 **Lecture:** Daily Diversity 11: Vertebrates 2 – Reptiles & Birds (**Allmon**)

3:30 – 5:30 **Lab:** Reptiles & Birds (**Allmon**)

6:00 – 7:00 Dinner

7:15 – 8:45 **Lecture:** Macroevolution (**Allmon**)



14. Sunday July 24 — 2:56 (0.8), 2:57 (1.6)

10:00 – 11:00 Brunch

11:15 – 12:45 **Lecture:** Evolution of behavior (**Allmon**)

12:45 – 3:15 **Project field time**

3:30 – 5:00 **Lecture:** Sexual selection (**Allmon**)

5:00 – 6:00 Dinner

7:15 – 8:45 **Lecture:** Life history evolution (**Allmon**)



15. Monday July 25 — 3:47 am (0.7), 3:46 pm (1.6)

7:30 – 8:00 Breakfast

8:30 – 10:00 **Lecture:** Daily Diversity 12: Vertebrates 3 -- Mammals
(Allmon)

10:15 – 12:15 **Lab:** Mammals (Allmon)

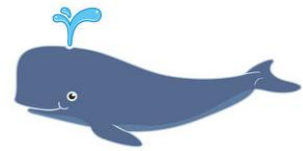
12:30 – 1:30 Lunch

1:45 – 2:45 **Lecture:** Evolution and development (Allmon) **READING:** Alberch (1986)

2:45 – 5:45 **Project field time**

6:00 – 7:00 Dinner

Project paper & study time



16. Tuesday July 26 — 4:33 am (0.6), 4:31 pm (1.5)

7:30 – 8:00 Breakfast

8:15 – 9:45 **Lecture:** Humanity as an evolutionary force (Allmon) **READING:**
Steffen et al. (2007)

9:45 – 12:30 **Project paper & study time**

12:30 – 1:30 Lunch

1:30 – 6:00 **Project paper & study time**

6:00 – 7:00 Dinner

8:00 – **Rock Talk:** Dr. Leah Gerber, “Trace metal influence on the microalgal circle of life: Relationships, food, stress, and death”

17. Wednesday July 27 — 5:16 am (0.4), 5:12 pm (1.4)

7:30 – 8:00 Breakfast

Project paper & study time

12:30 – 1:30 Lunch

Project paper & study time

6:00 – 7:00 Dinner

Project paper & study time

18. Thursday July 28

7:30 – 8:00 Breakfast

8:15 – 11:15 **Final Written Exam & Practical Exam**

12:30 – 1:30 Lunch

FREE TIME and Lab cleanup

6:00 – 7:00 Dinner

19. Friday July 29 — 6:31 am (0.3), 6:28 pm (1.2)

7:30 – 8:00 Breakfast

10:15 – Boat from Appledore to Portsmouth



“It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us. These laws, taken in the largest sense, being Growth with Reproduction; Inheritance which is almost implied by reproduction; Variability from the indirect and direct action of the external conditions of life, and from use and disuse; a Ratio of Increase so high as to lead to a Struggle for Life, and as a consequence to Natural Selection, entailing Divergence of Character and the Extinction of less-improved forms. Thus, from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows. There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.”

- Charles Darwin, *On the Origin of Species* (1859), pp. 489-490

