Marine Physiological Ecology (MASC 441/ENEC 441)

Section: 001
Meeting Place: Hanes Art Center Room 0117
Meeting Time: Tuesdays and Thursdays 9:30 – 10:45 a.m.
Credits: 3 Semester Hours

Instructor: Dr. Karl D. Castillo
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Course Description and Broad Goals:
This course will introduce students to the eco-physiological factors used by coastal marine organisms to cope with their physical environment. The mechanisms employed by these organisms to meet or surmount these environmental challenges will be explored. Examples will be drawn largely from coastal marine invertebrates within rocky intertidal communities, salt marshes, and coral reefs.

The course content commences with a review of the principles of physiological ecology, expands into some of the central themes of physiological ecology, and then concludes with a discussion of how organisms on rocky shores, salt marshes, and coral reefs cope with their physical environment. These processes are explored from an **ecological** (distribution and abundance etc.), **organismal** (respiration, feeding, growth rates, etc.), **cellular** (acclimatization and adaptations, etc.), and to lesser extent from a **molecular** (DNA and gene level processes) perspective, a trend that emulates the current direction of this rapidly evolving field.

The primary goals of the course are to:

- introduce students to the field of physiological ecology by exploring and examining the strategies employed by coastal marine invertebrates to cope with their physical environment

- characterize biologically relevant parameters used to monitor changes in the habitats where these coastal marine invertebrates reside

- expose students to a variety of techniques and approaches that are employed by marine physiological ecologists and other scientists to study marine invertebrates in coastal marine habitats

- review and examine some of the most recent findings of the response of coastal marine invertebrates to their physical environment

- relate local scale physiological response of coastal marine invertebrates to global climate change

Specific objectives for each unit are listed below in the course schedule. These objectives will be outlined at the beginning of each class session.

Prerequisites:
Marine Physiological Ecology is an introductory level course designed for science majors. Non-science majors will find the class particularly challenging since enrolled students will be expected to have a basic knowledge of biology.

Text and Readings:
There are no required text. However, the following textbook is **highly recommended**. Reading the appropriate section(s) before and after a class meeting session will help clarify the topics discussed. I would at minimum rent this text. You should also be able to purchase an electronic version online. Also, I will have two copies available on reserve. If you plan to study environmental physiology of a particular marine organism in the future, you should probably purchase this text as a reference.

Environmental Physiology of Animals, 2nd Edition, Pat Willmer, Graham Stone, and Ian Johnson, Blackwell Publishing

This textbook is very detailed, as it is meant to be a comprehensive reference of the environmental physiology of animals. There is no way that we can cover, and you can absorb this level of detail in a single course. As we progress from week to week, I will let you know which sections in each chapter you should focus on. In many instances, materials will be taken from other sources.

Other short readings from magazines, newspapers, and journal articles will be assigned periodically. These will be articles on media coverage of current issues and recent developments in marine physiological ecology relevant to the topics discussed in class.

Course Requirements:

Attendance and Participation

Attendance and participation is necessary for successful completion of this course. Thus, attendance will be monitored via unannounced random attendance checks. Absence from class does not relieve the student from any course requirement. Participation is also an important part of the course so students should come to class prepared and ready to share their ideas and thoughts.

Teaching Strategies and Techniques

In this course expect to take an active part in the learning process. You can expect that we will engage in a variety of active learning strategies such as student pair discussions, group exercises, informal debates, demonstrations, simulations, case studies, in-class writing exercises, and problem-based learning. Expect interactive lecturing in burst of 25-to-30 minutes and then we will engage in active learning exercises to reinforce the concepts covered. From time to time we will also use specific lab equipment to learn how to measure various environmental parameters important to coastal marine organisms. In some cases the interactive nature of this course will make the course more challenging than others you may have taken before; however, I hope that this approach will also make the course more enjoyable and interesting.

Poll Everywhere

To get real-time response and for me to see how well you are grasping concepts being covered in class I will incorporate the use of Poll Everywhere in our lessons from time to time. Questions asked will require critical thinking rather than mere recall. The hope is that these questions will stimulate discussion and more class interaction.

Required Weekly Preparations

To be successful in this course I strongly encourage you to complete the assigned readings before class, complete all relevant assignments, review your notes weekly in preparation for upcoming exams, and play an active role in class discussions.

Evaluation:

This course will be evaluated using **ten random attendance checks**, **three assignments**, **two exams,** and a **cumulative final exam**. You will be informed ahead of time about the general composition of the exams. Also, **article reviews** may be requested from time to time for extra credit.

Assignments will include brief research, reading and forum discussion, interpretation of graphs, summarizing, problem-solving, or data analysis. In general, assignments will be issued on Tuesday of one week and due at the beginning of class on Tuesday two weeks later. Take these assignments

seriously as they will provide insights into questions that will appear on the exams. All assignments must be submitted before or on the due date and time via Sakai. After the due date and time has elapsed Sakai will no longer allow you to upload your assignment.

Reading, Reviewing and Summarizing Scientific Journal Articles
You will be assigned one scientific article every week to read, review, and to prepare a summary for weekly discussion. Summary format and a sample summary will be provided. These summaries are for your use since we will be discussing these journal articles weekly in our Thursday class. It is important that you complete these summaries since they will allow you to better contribute to our weekly discussions. You will also need to turn in a summary as part of the three assignments in this course. Also, other summaries may be requested at random for extra credit.

Exams will be given as outlined in the course schedule and will be comprised of multiple choice, fill in the blanks, and short answer items. These will be higher level questions as I am less interested in testing your memorization skills and more interested in fostering critical thinking and improving your problem-solving skills. Exam questions will test your overall understanding of the course material presented. If you participate in class, review you notes and study regularly, and complete the assigned readings, you should do very well on the exams and the cumulative final. Exams will be given using the Test/Quizzes tab in Sakai.

A study guide will be issued for each exam. If you will be absent on a scheduled exam day, you **must** schedule a make-up before the actual exam date and time. If you are absent and I was not contacted before the scheduled exam time, you will receive a “zero” for that exam.

Cumulative Final Exam
The final exam will be cumulative. You can expect that approximately 80% of the material in the final exam will be from new material and the remaining 20% will be from material we covered in the previous exams. You will receive a study guide that will outline the composition of the final exam.

Late Work
Late work will not be accepted. This is the major reason you are allowed to drop your lowest assignment grade. Late work interferes with your learning, my grading and teaching schedule, and my ability to give feedback to other students on time. It impacts every student in the class. Even if you are absent on a day when an assignment is due you will be able to upload and submit your assignment on Sakai.

Sakai

You will be required to use Sakai in this class. Spend some time familiarizing yourself with Sakai if you have not done so already. This will give you instant access to class meeting PowerPoints, study guides, assignments, and exams answer keys, and your grades. Also, I will place announcements on Sakai from time to time. Also, news articles, journal articles, library reserves, and other materials relevant to this course will be available to you via Sakai.

Your performance will be evaluated as follows:	**Quantity**	**Percent**	**Points/Item**	**Total**
Random Attendance Checks	10	10%	10	100
Assignments	3	15%	50	150
Exams	2	35%	175	350
Cumulative Final Exam	1	40%	400	400
Total		**100%**		**1000**
Optional Extra Credit	5	5%	10	50

Final letter grades will be assigned as follows:

Total Points	**Percent**	**Letter Grade**
950-1000	95-100	**A**
920-949	92-94.9	**A-**
880-919	88-91.9	**B+**
840-879	84-87.9	**B**
800-839	80-83.9	**B-**
760-799	76-79.9	**C+**
720-759	72-75.9	**C**
680-719	68-71.9	**C-**
640-679	64-67.9	**D+**
600-639	60-63.9	**D**
<600	<60	**F**

Student Responsibilities:
Provisions of UNC-Chapel Hill Honor Code (see pages 410-412 of the Undergraduate Bulletin 2014-2015) are in effect at all times for this course. ***Read your Honor Code and be aware of its implications*.** Please set up an appointment to meet with me if you have questions about how the Honor Code pertains to this course.

Computer, Cell Phones, Other Devices
The use of computers in class should be limited to note taking and specific activities that are directly related to the course. Web browsing and visiting social media sites during class is distracting and disrespectful to yourself, your peers,

and to me. If the teaching assistant or I observe you engaging in these activities, we will warn you. If you continue to distract the class with your computer activities, we will ask you to step outside for that class period. Cell phones and other devices should be turn off or placed in silent mode unless otherwise specified. If you have an "emergency call" step outside to avoid disrupting the rest of the class.

I reserve the right to make changes to the syllabus and course schedule, including project due dates and test dates (excluding the officially scheduled final examination), when unforeseen circumstances occur. These changes will be announced as early as possible so that students can adjust their schedules."

Course Schedule

Week	Date	Topics, Readings, and Exams	Specific Objectives (by the end of the class meeting students will be able to)
1	Thursday January 11 (Class Meeting 1)	**(BASIC PRINCIPLES)** **Introduction to the Course, Overview, Expectations**	Navigate the course syllabus, schedule, and Sakai webpage Discuss how to read, review and critique a scientific paper
2	Tuesday January 16 (Class Meeting 2)	**Adaptations and Mechanisms of Adaptation** *Willmer P, Stone G, Johnston I (2005). The Nature and Levels of Adaptations. In: *Environmental Physiology of Animals*, Chapter 1, p 3-16	Explain the concepts of environment and adaptation Differentiate among acclimation, acclimatization, and adaptation
	Thursday January 18 (Class Meeting 3)	**Sandford and Kelly (2011) Local adaptation in marine invertebrates *Annual Review Marine Science* 3: 509-535 * Assigned Text Readings ** Assigned Journal Article Readings	Describe local adaptation in the marine environment Discuss comparative methods of detecting local adaptation

3	Tuesday January 23 (Class Meeting 4)	**Adaptations and Mechanisms of Adaptation (Cont.’)** *Willmer P, Stone G, Johnston I (2005). The Nature and Levels of Adaptations. In: *Environmental Physiology of Animals*, Chapter 1, p 3-16	Differentiate among physiological response on different scales Explain physiological response on different temporal scales. Explain physiological response on different functional scales Explain physiological response on different spatial scales Provide examples of physiological response on different temporal, functional, and spatial scales
	Thursday January 25 (Class Meeting 5)	**Sandford and Kelly (2011) Local adaptation in marine invertebrates *Annual Review Marine Science* 3: 509-535	Discuss geographic patterns of adaptive differentiation and Describe the spatial scales of adaptive differentiation
4	Tuesday January 30 (Class Meeting 6)	**Mechanisms of Adaptation** **(ASSIGNMENT 1)** *Willmer P, Stone G, Johnston I (2005). Fundamental Mechanisms of Adaptation. In: *Environmental Physiology of Animals*, Chapter 2, p 17-35	Explain why adaptation is a phenomenon associated with proteins Characterize the essential mechanisms that control protein action Discuss how proteins may be synthesized, controlled, and degraded within cells
	Thursday February 01 (Class Meeting 7)	**(Guest Lecture: Dr. Sarah Davies)** *Assistant Professor, Biology Department Boston University*	Discuss how evolutionary changes occur in proteins Explain how gene expression are physiologically regulated

5	Tuesday February 06 (Class Meeting 8) Thursday February 08 (Class Meeting 9)	**Scaling and Size** *Willmer P, Stone G, Johnston I (2005). The Problems of Size and Scale. In: *Environmental Physiology of Animals*, Chapter 3, p 36-47 **Vollmer and Edmunds (2000). Allometric scaling in small colonies of the scleractinian coral *Siderastrea siderea* (Ellis and Solander) *Biological Bulletin* 199: 21-28	Explain the importance of size and scale in physiological ecology Distinguish between isometric and allometric scaling Describe scaling of metabolic rate and provide examples Review and describe allometric scaling in small colonies of the scleractinian coral *Siderastrea siderea*.
6	Tuesday February 13 (Class Meeting 10) Thursday February 15 (Class Meeting 11)	**Review Session 1** **(ASSIGNMENT 1 DUE)** **EXAM 1 – BASIC PRINCIPLES**	**Review Session 1** **(ASSIGNMENT 1 DUE)** **EXAM 1 – BASIC PRINCIPLES**
7	Tuesday February 20 (Class Meeting 12)	**(CENTRAL ISSUES)** **Osmotic Physiology** **(ASSIGNMENT 2)** *Willmer P, Stone G, Johnston I (2005). Animal water balance, osmoregulation, and excretion. In: *Environmental Physiology of Animals*, Chapter 5, p 76-111	Summarize and explain some of the problems associated with water balance Summarize the various routes through which water and ions can be gained and lost in idealized animals Discuss exchanges occurring at the outer body surface of an animal and how it controls osmotic fluxes

	Thursday February 22 (Class Meeting 13)	**Wolcott and Wolcott (2001) Role of behavior in meeting osmotic challenges. *American Zoologist* 41:795-806	Explain osmoregulation at external surfaces including how organisms deal with situations where they are hyperosmotic and hypoosmotic to the medium in which they live
8	Tuesday February 27 (Class Meeting 14) Thursday March 01 (Class Meeting 15)	**Metabolism/Respiration** **(Guest Lecture: Justin Baumann)** *Graduate Student, Marine Sciences Department, UNC Chapel Hill* *Willmer P, Stone G, Johnston I (2005). Metabolism and energy supply. In: *Environmental Physiology of Animals*, Chpt. 6, p 112-140 **Brown JH et al. (2004). Towards a metabolic theory of ecology. *Ecology* **85**: 1771- 1789	Explain what metabolic rate is and why it is one of the most commonly measured physiological variable Describe the relationship between metabolic rate and organismal activity Describe the relationship between metabolic rate and size Use energy budgets to describe the partitioning of the ingested energy into various components Explain how organisms cope with hypoxia an anoxia Describe how organisms control their gas exchange and respiratory rates under stressful environmental conditions
9	Tuesday March 06 (Class Meeting 16) Thursday March 08 (Class Meeting 17)	**Review Session 2 (ASSIGNMENT 2 DUE)** **Exam 2 – CENTRAL ISSUES**	**Review Session 2 (ASSIGNMENT 2 DUE)** **Exam 2 – CENTRAL ISSUES**
10	**Friday March 09** **Friday March 16**	**SPRING BREAK!**	**SPRING BREAK!**

11	Tuesday March 20 (Class Meeting 18) Thursday March 22 (Class Meeting 19)	**(MARINE SYSTEMS)** **Marine Life/Rocky Shores** *Willmer P, Stone G, Johnston I (2005). Shorelines and Estuaries. In: *Environmental Physiology of Animals* Chapter 12: 444-445 **Tomanek and Helmuth (2002) Physiological Ecology of Rocky Intertidal Organisms Integrative and Comparative Biology **42**: 771- 775	Describe zonation and patterns of biota in rocky intertidal organisms. Describe the different physiological tolerances of rocky intertidal organisms Provide examples of how rocky intertidal organisms can cope with various environmental gradients Discuss the physiological ecology of rocky intertidal organisms.
12	Tuesday March 27 (Class Meeting 20) Thursday March 29 (Class Meeting 21)	**Marine Life/Salt Marshes** **(ASSIGNMENT 3)** *Willmer P, Stone G, Johnston I (2005). Shorelines and Estuaries. In: *Environmental Physiology of Animals* Chapter 12: 444-445 **Iacrella and Helmuth (2011) Experiencing the salt marsh environment through the foot of *Littoraria irrorata*. *Journal of Experimental Marine Biology and Ecology* **409**: 143-153	Describe patterns of biota in salt marshes. Describe the different physiological tolerances of organisms in salt marshes Provide examples of how salt marshes organisms can cope with various environmental gradients Discuss how *Littoraria irrorata* copes with the salt marsh environment

13	Tuesday April 03 (Class Meeting 22) Thursday April 05 (Class Meeting 23)	**Marine Life/Coral Reefs** **(Guest Lecture: Justin Baumann)** *Graduate Student, Marine Sciences Department, UNC Chapel Hill* *Willmer P, Stone G, Johnston I (2005). Shorelines and Estuaries. In: *Environmental Physiology of Animals* Chapter 12: 444-445 **Weis et al. (2010) The susceptibility and resilience of corals to thermal stress: adaptation, acclimatization or both? *Molecular Ecology* **8**: 1515-1517	Describe patterns of biota in coral reef environments. Describe the different physiological tolerances of corals across the reef system Provide examples of how corals can cope with various environmental gradients
14	Tuesday April 10 (Class Meeting 24) Thursday April 12 (Class Meeting 25)	**Extreme Aquatic Habitats** **(ASSIGNMENT 3 DUE)** *Willmer P, Stone G, Johnston I (2005). Special Aquatic Habitats. In: *Environmental Physiology of Animals*, Chapter 14, p 526-539 **Ansart and Vernon (2003) Cold Hardiness in Molluscs. Acta *Oecologica* **24**: 95-102	**(ASSIGNMENT 3 DUE)** Describe the different physiological tolerances of organisms found in high salinity lakes, brine ponds, and brine seeps Describe the different physiological tolerances of organisms found in thermally extreme waters including deep sea thermal vents, hot springs, and thermal ponds

15	Tuesday April 17 (Class Meeting 26)	**Physiological Ecology and Climate Change** Somero (2012) The physiology of Global Change: Linking patterns to mechanisms. Annual Review of Marine Science 4: 39-61	Discuss the importance of climate change studies to marine physiological ecology
	Thursday April 19 (Class Meeting 27)	Castillo et al. (2014) The reef-building coral *Siderastrea siderea* exhibits parabolic responses to ocean acidification and warming. *Proceedings of the Royal Society of London B* 281: 20141856	Describe what ocean acidification is and discuss some ways in which organisms have adapted physiologically to cope with ocean acidificidification.
16	Tuesday April 24 (Class Meeting 28)	**Physiological Ecology and Climate Change** **(Guest Lecture: Colleen Bove)** *Graduate Student, Marine Sciences Department, UNC Chapel Hill*	Describe ocean acidification and discuss some ways in which organisms have adapted physiologically to cope with ocean acidification.
	Thursday April 26 (Class Meeting 29)	**Review Session 3**	**Review Session 3**
	Friday May 04 @ 8:00 A.M. (Class Meeting 29)	**Final Exam Cumulative**	**Final Exam Cumulative**

MASC 441 – Marine Physiological Ecology
Instructor: Dr. Karl D. Castillo

Student Syllabus Receipt

Please read the following paragraph, sign your name, date the form, and return to your instructor on Tuesday **January 16, 2016** at the beginning of class.

I acknowledge receipt of the attached syllabus and understand the course requirements as they are written above. I also acknowledge that the information stated above has been explained by the instructor and I have been given ample opportunity to clarify any questions that I may have. I will abide by the Honor Code of the University of North Carolina at Chapel Hill in all matters relevant to this course.

Name _____

Date _____