DRAFT SYLLABUS

7.431/WH.412 The Biology and Ecology of Coral Reefs

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Meeting: TBA (once per week, 90 minutes)

Course website: https://stellar.mit.edu/S/course/7/fa18/7.431 (anticipated)

Learning Objectives: Through this course, students will (1) gain a foundation in the physical and biological factors that structure coral reefs, (2) examine how reefs have varied over time, particularly in response to human impacts and climate change, and (3) learn how a suite of modern techniques are providing new insight into reef function and capacity for resilience.

Target Participants: This course is appropriate both for students with a specific interest in coral reefs, and those who are more generally interested in marine ecology. Students from many disciplines (biology, chemistry, geology, engineering) have taken this course in previous offerings. We invite and encourage such broad participation. Course is appropriate for participation by SAW students with at least one year of general biology coursework.

Significance: Coral reefs are highly productive and diverse ecosystems that are threatened by factors ranging from local point-source pollution to overfishing and global climate change. There is current concern over the capacity of reef organisms to tolerate and respond to these stressors. This course will introduce key aspects of both the biology of reef-building corals and the ecology of tropical coral reefs. Classes will include both physiological and ecological components. The goals are to examine the adaptations of corals to reef environments, the natural and environmental processes that affect coral physiology and reef structure and function.

Grading and expectations: Students are expected to attend all classes, to read and be prepared to discuss assigned readings. Classes with typically begin with a lecture to provide a foundation and context for the discussion. A student will then be selected (typically randomly but ensuring everyone gets a chance) to lead the discussion. The discussion leader will summarize the paper, pose questions and otherwise lead discussion. Discussion and participation will comprise 50% of the grade. The other half will be based on two written assignments (25% each). The first will be a critical evaluation of one of the assigned readings in the context of related literature. Each student will select a different week for this assignment. The second will be a 15 minute oral presentation on a topic selected by the student, which will include a synthesis of recent literature.

Missed classes: Classes missed due to illness or unavoidable conflicts can be made up in one of two ways: (1) you may read the assigned material and prepare a short (1-2 page) summary and discussion of

the material or (2) if the instructor is available, you may arrange to separately discuss the paper and related material.

Textbook: Students should obtain a copy of: Sheppard, C., Davy, S., Pilling, G. and Graham, N., 2017. *The Biology of Coral Reefs*. Oxford University Press, 370 pp.

Additional readings from the primary literature will be provided by the instructors.

Tentative schedule of lectures, and list of proposed readings for selected class sessions (BCR = Biology of Coral Reefs; not all readings shown):

Week 1	Structure, distribution and diversity of coral reefs (Tarrant) • BCR Ch 1: "Coral reefs: Biodiverse and productive tropical ecosystems"
Week 2	Coral-algal interactions (Tarrant) • BCR Ch 2: "The main reef builders and space occupiers" (**Browse as background**) • Clements, C.S., Rasher, D.B., Hoey, A.S., Bonito, V.E. and Hay, M.E., 2018. Spatial and temporal limits of coral-macroalgal competition: the negative impacts of macroalgal density, proximity, and history of contact. *Marine Ecology Progress Series*, *586*:11-20. • Brown, K.T., Bender-Champ, D., Kubicek, A., van der Zande, R., Achlatis, M., Hoegh-Guldberg, O. and Dove, S.G., 2018. The dynamics of coral-algal interactions in space and time on the southern Great Barrier Reef. *Frontiers in Marine Science*, *5*, p.181. **Sign up for Assignment #1 topic/weeks**
Week 3	Symbiosis and coral bleaching (Tarrant) • BCR Ch 3, sections 3.3-3.4 (temperature and light limitations, **Browse as background**) • BCR Ch 4: "Symbiotic Interactions" • Matthews, J.L., Crowder, C.M., Oakley, C.A., Lutz, A., Roessner, U., Meyer, E., Grossman, A.R., Weis, V.M. and Davy, S.K., 2017. Optimal nutrient exchange and immune responses operate in partner specificity in the cnidarian-dinoflagellate symbiosis. *Proceedings of the National Academy of Sciences*, *114*(50), pp.13194-13199. (**Skim: don't worry about details of the molecular analysis, unless that is your field; focus on main points and the type of experimental system)** • Suggett, D.J., Warner, M.E. and Leggat, W., 2017. Symbiotic dinoflagellate functional diversity mediates coral survival under ecological crisis. *Trends in Ecology & Evolution*, *32*(10:735-745.
Week 4	Coral calcification and OA (Tarrant) • BCR Ch 3, section 3.8 (seawater carbonate chemistry) • Additional Primary Literature (TBA)
Week 5	Adaptation, acclimation and variation (Tarrant)
Week 6	Population genomics of corals
Week 7	Hydrodynamic forcing on coral reefs (Pineda) • Lowe RJ, Falter JL (2015) Oceanic forcing of coral reefs. Ann Rev Mar Sci 7:43-66 (Don't worry about the equations, get the main points.) (**Don't worry about the equations. Focus on the concepts, particularly on the unifying theme of 'scales'**)

	• Paris CB, Cowen RK (2004) Direct evidence of a biophysical retention mechanism for coral reef fish larvae. Limnol Oceanogr 49:1964-1979

Week 8	• Reproduction, larval biology and recruitment (Pineda)
	  • Doherty PJ, Dufour V, Galzin R, Hixon MA, Meekan MG, Planes S (2004) High mortality during settlement is a population bottleneck for a tropical surgeonfish. Ecology 85:2422-2428
	  • Additional Primary Literature (TBA)

Week 9	Small-scale biological-physical interactions on reefs (Pineda)
	  • Sebens KP, Witting J, Helmuth B (1997) Effects of water flow and branch spacing on particle capture by the reef coral *Madracis mirabilis* (Duchassaing and Michelotti). J Exp Mar Biol Ecol 211:1-28
	  • Genin A, Karp L, Miroz A (1994) Effects of flow on competitive superiority in scleractinian corals. Limnol Oceanogr 39:913-924
	  • Safaie A, Silbiger NJ, McClanahan TR, Pawlak G, Barshis DJ, Hench JL, Rogers JS, Williams GJ, Davis KA (2018) High frequency temperature variability reduces the risk of coral bleaching. Nature communications 9

Week 10	Phase shifts, resilience and recovery (Tarrant)
Week 11	Evolution and ecology of coral reef fishes (Thorrold) • BCR Ch 6: “Reef fish: Evolution, diversity and function” • Primary literature (TBA) • **Assignment #2 topic due (1 paragraph)**
Week 12	Coral reef food webs (Thorrold)
Week 13	Mesophotic Reefs (Thorrold)
Week 14	Coral Reef Conservation (Thorrold)
Week 15	**Student presentations (Assignment 2) and wrap-up.**

Assignment 1

Briefly discuss an assigned article in the context of related literature (~2 pages double spaced). Summarize the major objectives and findings of the paper. Discussion points may include strengths and weaknesses of the study design, evaluation of controversial aspects of the interpretation and discussion and suggestions for future research. Consider the contribution of the assigned article in relation to other published studies. This may include “classic” papers that provided a foundation for the current study, papers that provide contradictory results, related studies conducted in other environments or taxa, etc. Papers referenced by the authors are a good starting place, but do not feel limited by these. This is an opportunity to make new comparisons and bring diverse material into the discussion.

Assigned readings will be posted 1-2 weeks before the deadline/class date.

A selection of possible topics and weeks will be distributed once the schedule is finalized.

Assignment 2

(1) Select a topic of interest to you that is related to coral reef research. This could be something we have discussed in class where you would like to go into more detail, or something that we have not covered. The idea is to learn something new, so the topic should not be closely related to your own thesis research (we can discuss this on a case-by-case basis).
(2) Write a few sentences proposing the topic due by Nov 6 (sooner is fine). The purpose of this deadline is try to minimize overlap among presentations and to allow the instructors to provide suggestions.
(3) Prepare a 15 minute oral presentation (using appropriate visual aids, such as powerpoint) on your chosen topic, to be given on the last day of class. The presentation should be targeted toward members of the class (who have different scientific backgrounds) and should include direct reference to primary literature (e.g., including figures taken directly from published papers, much as the instructors do during lecture).