

Syllabus: MASC 444 Marine Phytoplankton (3 credits)
University of North Carolina at Chapel Hill

Instructor:

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Meeting Times and Locations:

Lectures: Mondays and Wednesdays from 10:00-10:50am (Dey Hall 306)

Practical sessions and paper discussions: Fridays from 10:00-10:50am (Dey Hall 306 or Venable Hall 3302)

Prerequisites: Restricted to junior and senior science majors and graduate students, with permission of the instructor.

Course Description: This course will introduce students to the biology of marine photosynthetic cyanobacteria and protists, identifying and classifying phytoplankton from marine and estuarine habitats and recognizing the role phytoplankton play in ocean biogeochemical cycles. Topics to be covered include phytoplankton evolution, biodiversity and phylogeny, structure and function, genomics, the role of phytoplankton in the marine environment, harmful algal blooms, commercial products derived from phytoplankton and climate change effects on phytoplankton.

Student Learning Objectives: After completing this course, students should have developed an understanding of:

- 1) the biology and biodiversity of marine phytoplankton
- 2) endosymbiosis and the origin of chloroplasts in phytoplankton
- 3) practical skills in identifying the major groups of phytoplankton and assessing their growth characteristics
- 4) the role phytoplankton play in the biological carbon pump as well as in the cycles of other important elements
- 5) ecology of harmful algal bloom formation and toxin production
- 6) commercial products derived from algae including biofuels
- 7) the predicted effects of climate change on phytoplankton abundance and distributions

Course Readings: There is no required textbook. I do recommend the following two books for additional reading to help assimilate the concepts I will cover in this course. These books will also be made available in the Kenan Science Library located in room G301 of Venable Hall.

1. Falkowski, PG and Knoll, AG (Editors). Evolution of Primary Producers in the Sea, Elsevier Academic Press (2007).
2. Lee, RE. Phycology, Cambridge University Press (2008)

Readings will also be assigned from the primary scientific literature and made available on Sakai in advance. Log in using your Onyen and password, and click on MASC 444 (all courses that you are registered for should appear under "my courses"). You may download readings as PDF files. Some of these readings will be discussed during the lectures and laboratory sessions. You will be responsible for absorbing and comprehending the reading assignments for the exams.

Lecture Schedule:

1. Evolution of photosynthetic algae
 - a. What are phytoplankton?
 - b. Energy and elemental requirements for life
 - c. Chloroplasts and endosymbiosis
 - d. Phytoplankton evolution through geologic time

2. Phytoplankton diversity
 - a. Prokaryotic algae (cyanobacteria)
 - b. Chlorophytes
 - c. Heterokontophytes, emphasis on diatoms
 - d. Prymnesiophytes
 - e. Dinophytes
 - f. Cryptophytes, Raphidophytes, Rhodophytes (etc.)

3. Role of phytoplankton in geochemical cycles
 - a. Nutrient requirements
 - b. Marine food webs
 - c. Distribution and abundance
 - d. Biological carbon pump

4. Phytoplankton physiology and ecology
 - a. Light acclimation and adaptation
 - b. Bloom formation
 - c. Grazing defenses
 - d. Does cell size matter?
 - e. Physiological trade-offs
 - f. Phytoplankton-bacteria interactions

5. Phytoplankton genomics
 - a. Phylogenetics and molecular clocks
 - b. Whole-genome sequences and transcriptomics
 - c. Environmental genomics (the meta-omics)

6. Special topics
 - a. Harmful algal blooms and toxin production
 - b. Ocean fertilization
 - c. Biofuels and other commercial products made from algae
 - d. Phytoplankton models
 - e. Climate change effects on phytoplankton

Practical Sessions: There will be five practical sessions held in Venable Hall Rm 3302 on select Fridays. These sessions will provide you with practical skills and experiences in identifying phytoplankton and measuring phytoplankton biomass and other growth characteristics. You will also be introduced to bioinformatic tools and methods currently implemented for *in silico* analyses of phytoplankton genomics. For these practical sessions, you will also be working with a Graduate Research Consultant (Ms. Carly Moreno) who will assist you with your data analysis. The GRC Program is sponsored by the Office for Undergraduate Research (www.unc.edu/depts/our). I encourage you to visit this website to see other ways that you might engage in research, scholarship and creative performance while you are at Carolina.

Practical	Date	Topic
1	12-Sep	Phytoplankton Identification 1
2	26-Sep	Phytoplankton Identification 2
3	3-Oct	Phytoplankton Physiology - cell density, biomass and growth rates
4	31-Oct	Phytoplankton Physiology - variable fluorescence
5	14-Nov	Phytoplankton genomics and bioinformatics (please bring laptop)

Grading: You will be expected to have a thorough understanding of both the basic concepts covered in class as well as the empirical studies that examine these concepts. Your grasp of material presented in lectures will be evaluated in two exams. These exams will be a combination of short answer and essay questions. Each of the five practical sessions will include a small assignment that is due one week after the session. Late assignments will not be accepted. Near the end of the course, you will be expected to give a 20-minute team presentation on a special topic of your choosing that has been covered in the course for which you will be graded.

Midterm (scheduled on Oct. 13 in class)	20%
Final Exam (scheduled on Dec. 12 at 8:00am)	40%
Practical Session Assignments	20%
Student Presentation (scheduled on Nov. 21 and 24)	15%
Participation	5%

Student Responsibilities: All work done in this class must be carried out within the letter and spirit of the UNC Honor Code (see page 5 of the Instrument of Student Judicial Governance 2014). You are also responsible for consulting with me if you are unclear about the meaning of plagiarism or about whether any particular act on your part constitutes plagiarism. Please talk to me if you have any questions about how the Honor Code pertains to this course. (<http://studentconduct.unc.edu/sites/studentconduct.unc.edu/files/documents/Instrument.pdf>)

Feedback: Your feedback on how the course is progressing is important to me. At any time throughout the semester I encourage you to provide me with feedback regarding any aspects of the course. There will also be an anonymous online evaluation at the end of the semester to allow you to provide structured feedback.

Marine Phytoplankton MASC 444

MASC 444 Schedule (subject to change)

Date	Day	Lect. #	Module	Topic
20-Aug	W	1		Class Introduction
22-Aug	F	2	Photosynthetic algae	What are phytoplankton?
25-Aug	M	3		Energy and elemental requirements for life
27-Aug	W	4		Chloroplasts and endosymbiosis
29-Aug	F	5		Phytoplankton evolution through geologic time
1-Sep	M			Labor Day (no class)
3-Sep	W	6	Phytoplankton diversity	Prokaryotic algae 1
5-Sep	F			Paper Discussion 1
8-Sep	M	7		Prokaryotic algae 2
10-Sep	W	8		Eukaryotic algae 1
12-Sep	F			Practical Session 1
15-Sep	M	9		Eukaryotic algae 2
17-Sep	W	10		Eukaryotic algae 3
19-Sep	F			Paper Discussion 2
22-Sep	M	11		Eukaryotic algae 4
24-Sep	W	12		Eukaryotic algae 5
26-Sep	F			Practical Session 2
29-Sep	M	13	Role of phytoplankton in geochemical cycles	Marine food webs
1-Oct	W	14		Biological carbon pump
3-Oct	F			Practical Session 3
6-Oct	M	15	Phytoplankton physiology and ecology	Light acclimation and adaptation
8-Oct	W	16		Nutrients
10-Oct	F			Midterm Review
13-Oct	M			Midterm
15-Oct	W	17		Ocean fertilization 1
17-Oct	F			Fall break (no class)
20-Oct	M	18		Ocean fertilization 2
22-Oct	W	19		Bloom formation
24-Oct	F			Paper Discussion 4
27-Oct	M	20		Grazing defenses
29-Oct	W	21		Resource competition and physiological trade-offs
31-Oct	F			Practical Session 4
3-Nov	M	22		Does size matter?
5-Nov	W	23		Phytoplankton-bacteria interaction
7-Nov	F	24	Phytoplankton genomics	Whole-genome sequences and transcriptomics
10-Nov	M	25		Environmental genomics (the meta-omics)
12-Nov	W	26	Special topics	Phytoplankton models (Barton)
14-Nov	F			Practical Session 5
17-Nov	M	27		Algal biofuels (Moreno)
19-Nov	W	28		Climate change effects on phytoplankton
21-Nov	F			Student Presentations 1
24-Nov	M			Student Presentations 2
26-Nov	W			Thanksgiving holiday (no class)
28-Nov	F			Thanksgiving holiday (no class)
1-Dec	M	29		Harmful algal blooms (Paerl)
3-Dec	W			Final Review
12-Dec	F			Final Exam (8-10am)