

**Diving Physiology & Biomedicine**

BIL 326 (will be co-listed with MSC 372 & MBE 670)

Tue & Thu 2:00-3:15 PM

Location – Gables Campus Cox Science 217

**Instructor:**

Kevin G. McCracken

Department of Biology

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**Office & Lab:**

188 Cox Building (Lab - Coral Gables Campus)

**Office Hours:**

Tue & Thu prior to class, after class, or by appointment

**Course Website:**

<http://www.duckdna.org/diving/>

**Email:**

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**Course Description:**

This course provides an introduction to the biomedical related issues encountered by diving underwater. Primarily it studies breath-hold divers and the effects of intermittent hypoxemia (low blood O<sub>2</sub>) in relation diving physiology, as well as other physiological effects of diving in hypobaric conditions, such as decompression sickness, barotrauma, and nitrogen narcosis. It focuses on mechanisms influencing the requirement to match O<sub>2</sub> supply and demand throughout the O<sub>2</sub> cascade including during both the breath hold and during dive recovery: a) gas exchange (hypoxic ventilatory responses (HVR) & morphology of lungs and air sacs), b) circulatory O<sub>2</sub> storage and delivery (Hb-O<sub>2</sub> affinity, blood hemoglobin content [Hb]), hematocrit (Hct), & cardiac output), c) tissue O<sub>2</sub> diffusion (muscle capillarity & myoglobin (Mb) function), and d) tissue energy metabolism (mitochondrial respiration & enzyme function). Lectures and discussions will draw from disciplines as diverse as genomics, integrated physiology, population genetics, biochemistry, gene expression, evolution, and medicine. The taxonomic examples from the literature will include birds and mammals primarily.

**Student Learning Objectives:**

By the end of this course students will have a solid foundation in the physiological and molecular mechanisms related to function and physiological adaptations for underwater diving, especially those pathways influencing O<sub>2</sub> transport. For undergraduate students, this course will prepare you for an entry into fields of medicine, integrated physiology, and population genetics and genomics, including applications to medical fields. For graduate students, this course is meant to be a beginning. It will offer an opportunity to integrate physiological, evolutionary, and biomedical thinking into your current research and will give you perspective for future forays in the field. The course also has strong relevance to recreational and professional divers.

- Understand the physiological and molecular mechanisms influencing the O<sub>2</sub> transport cascade, especially as applies to breath-hold divers, emphasizing but not limited to mammals and birds.
- Survey, read, and critically assess the diving physiology literature.
- Obtain understanding of why cross-discipline scientific interactions are important to the biomedical fields, such as the fields of medicine, integrated physiology, and genomics.
- Obtain the perspective required to integrate physiological, evolutionary, and biomedical thinking into your current research (primarily for graduate students).
- Achieve a basic understanding of safety issues pertaining to recreational and professional diving.
- Develop your discussion skills in a comfortable setting with your peers.
- Communicate and develop both written and oral presentation skills, especially speaking skills via a short presentations of ~15 min to peers.

## Schedule of Lecture Topics

Lecture Topic	
<u>Introduction</u>	Intro
--- Diving behavior	1
<u>Gas Exchange</u>	
--- Challenges of the breathhold	2
--- Respiratory gas exchange	3
--- Oxygen storage & transport	4
Cardiovascular	
--- Cardiovascular dive response	5
--- Cardiovascular anatomy & hemodynamics	6
Mid-term Exam (after spring break)	TBA
<u>Muscle physiology</u>	
--- Muscle & locomotory work	7
--- Thermoregulation	8
--- <u>Diving metabolism</u>	9
<u>Aerobic dive limit</u>	10
--- Oxygen depletion & hypoxemia tolerance	11
Pressure tolerance	12
Biomedical issues	13
Final Exam	TBA

### Course Format:

The course will be highly interactive, a hybrid between traditional and guest lectures and student-led discussion of assigned readings. Students will be expected to prepare for each class section by completing the assigned readings, thinking about previous lecture topics, and preparing insightful questions for the instructor and their classmates. Early during the semester, each student will choose a particular example of a specific environmental challenge related to diving physiology and present to the class a 15-min PowerPoint presentation followed by time for questions and answers. These presentations will begin after spring break. There will be a mid-term exam following spring break and then a final exam with a small number of possible quizzes during the semester.

**Textbook:**

[Diving Physiology of Marine Mammals & Seabirds, 1<sup>st</sup> edition](#)

2016, by Paul J. Ponganis

ISBN-13: 978-0521765558

Most readings will be from the primary literature supplied by your professor. These articles are made available on the course website each week via the following shared Dropbox link:

**Grading:**

Participation	20%
Exam 1	25%
Exam 2	25%
Presentations	20%
Quizzes	10%

\*Attendance is mandatory.

Participation: You are signing up for a course called “Diving Physiology & Biomedicine” so I assume you are self motivated to learn the material. I expect everyone to show up for every class unless you are sick or have an acceptable excuse. “Participation” doesn’t mean just showing up, though. This is a small class, so participation means engaging in the material, asking relevant questions, and providing insights that others do not see. Most class sessions will follow a discussion format and we also will work through problem sets together. You should also take notes as you read so that you are prepared for a discussion part. We will review the answers to these questions during our discussion, but you should also strive to come up with some of your own questions regarding the readings. So.... participation means being fully engaged and prepared for class.

Exams: Two exams will be assigned, a mid term and a final. These will differ somewhat for graduate and undergraduate students.

Presentation: Animals offer many diverse and intriguing solutions to the problem of high-altitude hypoxia. **The August Krogh Principle states: "For many problems there is an animal on which it can be most conveniently studied"**. Early during the semester, each student will follow August Krogh’s advice and choose a particular example of how a specific animal solves problems and challenges related to diving in hyperbaric conditions and present to the class a 15-min PowerPoint presentation.

**Exam Make-up and Incomplete Policy:**

Make-up exams are discouraged. If circumstances are such that you are unable to take the exam at the scheduled time, please contact me by e-mail ([kevin.g.mccracken@gmail.com](mailto:kevin.g.mccracken@gmail.com)) in advance of the exam. Incomplete grades will only be authorized under special circumstances. Your participation in the course will factor into this decision.

**Student Code of Conduct:**

Students are subject to the UM Student Honor Code. The \*existence or appearance\* of plagiarism, cheating, or any other forms of academic dishonesty will not be tolerated, and will result in immediate failure of the course (not just the assignment). Students that \*participate or appear to participate\* in these types of activities will receive a F as the final recorded grade, be withdrawn from the course, and referred to the Dean of Students and Honor Council. Participation in this course implies that these terms are mutually agreed upon.

**Civil rights and Disability protections:**

The University of Miami strives not to discriminate on the basis of race, color, creed, national origin, religion, age, sex, sexual orientation, gender identity, veteran status, physical or mental disability, marital status, changes in marital status, pregnancy or parenthood, or genetic information. The University of Miami strictly prohibits retaliation for opposing discriminatory practices by all its personnel. This policy affects employment policies and actions, as well as the delivery of educational services at all levels and facilities of the university.

Needs of students with disabilities will be accommodated in a confidential and respectful manner following university and federal policies pertaining to ADA accessibility with efforts to make all possible reasonable accommodations. Please talk to the instructor if you require any special assistance. The Office of Disability Services in the Academic Resource Center, N201, Whitten University Center provides disability services; 305-284-2374 (Voice), 305-284-3401 (TDD).

**Student Athletes and Military:**

Student athletes and members of the U.S. military should coordinate their absences with the instructor in advance. The same applies to off-campus interviews such as for medical school admission.