High-altitude Biology & Medicine
BIL 261 | BIL 661
Tue & Thu 5:00-6:15 PM
Cox Building - 166

Instructor:
Kevin G. McCracken
Department of Biology
Marine Biology & Ecology, Rosenstiel School of Marine & Atmospheric Science
Human Genetics & Genomics, Hussman Institute for Human Genomics
University of Miami
Miami, FL 33146

Office & Lab:
188 Cox Building (Lab - Coral Gables Campus) & 211 South Grosvenor (Office - RSMAS)

Office Hours:
Tue & Thu 2:00-5:00 PM (prior to class), after class, or by appointment

Course Website:
http://www.duckdna.org/hi-alt/

Email:
kevin.g.mccracken@gmail.com

Telephone:
+1 (786) 414-4780

Course Description:
This course provides an introduction to high-altitude biology and medicine. It focuses on mechanisms of hypoxia resistance influencing the requirement to match O₂ supply and demand throughout the O₂ cascade: a) gas exchange (hypoxic ventilatory responses (HVR) & morphology of lungs and air sacs), b) circulatory O₂ delivery (Hb-O₂ affinity, blood hemoglobin content [Hb]), hematocrit (Hct), & cardiac output), c) tissue O₂ 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 alpine medicine. The taxonomic examples from the literature will include humans, other mammals, birds, herps, and fish.
Student Learning Objectives:
By the end of this course students will have a solid foundation in the physiological and molecular mechanisms influencing the O₂ transport cascade. 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.

- Develop foundation in the physiological and molecular mechanisms influencing the O₂ transport cascade.

- Preparation for entry into fields of medicine, integrated physiology, and population genetics and genomics, including cross-discipline applications to biomedical fields.

- Integrate physiological, evolutionary, and biomedical thinking into your current research (primarily for graduate students).

- Develop presentation & speaking skills.
### Schedule of Lecture Topics

<table>
<thead>
<tr>
<th>Lecture Topic</th>
<th>Intro</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>TBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of High-altitude Medicine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas Exchange</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--- Hypoxic Ventilatory Response (HVR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--- Lung Morphology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circulatory O₂ delivery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--- Hemoglobin-O₂ Affinity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--- Blood Hemoglobin Content [Hb] &amp; Hematocrit (Hct)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--- Cardiac Output</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-term Exam (after spring break)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TBA</td>
</tr>
<tr>
<td>Tissue O₂ Diffusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--- Muscle Capillarity &amp; Myoglobin (Mb) Function</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--- Diving Birds &amp; Mammals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tissue Energy Metabolism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--- Mitochondrial Respiration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--- Enzyme Function</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--- Gene Expression</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Exam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TBA</td>
</tr>
<tr>
<td>Class Presentations (30 min talk + Q&amp;A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TBA</td>
</tr>
<tr>
<td>Class Presentations (30 min talk + Q&amp;A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TBA</td>
</tr>
</tbody>
</table>

**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 high-altitude hypoxia and present to the class a 30-min PowerPoint presentation followed by time for questions and answers. There will be a mid-term exam following spring break and then a final exam.

**Optional Text:**

There is no textbook for this course per se. It does not exist. This is the book that comes closest.  
*High Altitude: An Exploration of Human Adaptation*  

Most readings will be from the primary literature supplied by your professor. These articles are made available on the course website ([http://www.duckdna.org/hi-alt/](http://www.duckdna.org/hi-alt/)) each week via the following shared Dropbox link:  
[https://www.dropbox.com/sh/9mpgidatsfs3qnm/AACOzaZsu9nEhW_N1ZKFOz6Ua?dl=0](https://www.dropbox.com/sh/9mpgidatsfs3qnm/AACOzaZsu9nEhW_N1ZKFOz6Ua?dl=0)
Grading:
Participation 20%
Exam 1 30%
Exam 2 30%
Presentations 20%

*Attendance is mandatory.

Participation: You are signing up for a course called “High-altitude Biology & Medicine” 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 high-altitude hypoxia and present to the class a 25-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) 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.