

THE UNIVERSITY OF BRITISH COLUMBIA
SCHOOL OF KINESIOLOGY
Pulmonary Physiology of Exercise: KIN 475

Instructor Dr. Bill Sheel
Email bill.sheel@ubc.ca
Lecture Tuesday and Thursday; 11-12:30
Office Osborne Centre, Unit II, Room 208
Office hours By appointment; arranged via email or during class
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Course Description: The purpose of this course is to understand how it is the lungs, chest wall, and ventilatory control mechanisms operate during dynamic whole-body exercise. Additional emphasis is placed on how it is the respiratory and cardiovascular systems interact during exercise. Different human models will be used to illustrate key physiological principles and provide context (i.e., application of physiology). For example, elite athletes, pulmonary disease (i.e., asthma, obstructive lung disease, lung transplant) and environmental hypoxia will be discussed.

Course Format: The material will be presented weekly in two 90-minute classes.

Prerequisites: Third year standing or permission of the instructor.

Required Text and Readings

- West J.B. Respiratory Physiology – The Essentials. 10th Edition
- Course notes will be made available on the web (as appropriate)
- Assigned readings available through UBC library electronic journals. It is expected that readings will be completed prior to the assigned class

Learning Outcomes

At the conclusion of this course, successful students will:

1. Know the key mechanisms of ventilatory control during exercise.
2. Understand how breathing pattern is determined.
3. Be able to describe how gas is exchanged in the lung at rest and exercise.
4. Appreciate how the heart and lung interact and how the exert influences on each other.
5. Apply concepts of pulmonary physiology to different population groups and environmental conditions

Course Evaluation

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| Oral presentation and paper (dates TBD) | 30% |
| Midterm examination (October 11 TH) | 30% |
| Final examination (based on entire term's content) | 40% |
| | <hr/> 100% |

Important Dates

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| September 6 th | Classes begin |
| October 10 th | Thanksgiving. UBC closed |
| November 11 th | Remembrance Day. UBC closed |
| December 2 nd | Last day of classes |
| December 6 th to 21 nd | Final examination period. DO NOT SCHEDULE HOLIDAY TRAVEL DURING THIS PERIOD. SATURDAYS ARE INCLUDED IN THE EXAM SCHEDULE. |

COURSE CONTENT

There are at least four major challenges to the respiratory system during exercise. This course examines how the human respiratory system is structured and regulated to meet these exercise requirements.

1. Increased muscle metabolism causes mixed venous oxygen content to fall to less than one-fifth of its resting value and the partial pressure of mixed venous carbon dioxide to double.
2. Cardiac output increases 5 to 6 times resting values, and because all of the cardiac output must go through the lungs all of the time, this poses substantial threats, not only to the time available in the pulmonary capillaries for gas exchange but also to the regulation of pulmonary vascular resistance and capillary pressure and therefore to the containment of plasma water within the pulmonary vasculature.
3. Ventilatory requirements of 20 to 30 times that of rest must be met while the increase in mechanical work required for each breath is minimized. To these ends the medullary respiratory network must integrate a host of sensory feedback and feed-forward stimuli (a) to ensure that ventilation is driven precisely in proportion to metabolic requirements, and (b) to preserve precise synchronization of respiratory motor output to the upper airway and to the primary and accessory pump muscles of the chest and abdominal walls.
4. The work done by the locomotor muscles and the respiratory muscles increases several fold, and the blood flow requirements of both sets of these essential muscles must be met.

PART I – PHYSIOLOGY

| TOPIC | REQUIRED READINGS |
|---|--|
| Course Overview: <i>challenges to the respiratory system during exercise</i> | n.a. |
| Structure and Function: <i>how the architecture of the lung subserves its function</i> | West Ch. 1 |
| Ventilation: <i>how gas gets to the alveoli</i> | West Ch. 2 |
| Control of Ventilation: <i>how gas exchange is regulated</i> | West Ch. 8 |
| Diffusion: <i>how gas gets across the blood-gas barrier</i> | West Ch. 3 |
| Blood Flow and Metabolism: <i>how the pulmonary circulation removes gas from the lung and alters some metabolites</i> | West Ch. 4 |
| Ventilation-Perfusion Relationships: <i>how matching of gas and blood determines gas exchange</i> | West Ch. 5 |
| Gas Transport by the Blood: <i>how gases are moved to the peripheral tissues</i> | West Ch. 6 |
| Mechanics of Breathing: <i>how the lung is supported and moved</i> | West Ch. 7 |
| Interactions: <i>how the respiratory and cardiovascular systems operate in tandem</i> | Consequences of exercise-induced respiratory muscle work. <i>Respiratory Physiology and Neurobiology</i> 151(2-3):242-250, 2006. |

PART II – “APPLICATION” OF PHYSIOLOGY CONCEPTS

Topics listed below are tentative and meant as examples. The final content (3-4 topics) will be agreed upon by consensus of students enrolled in the course.

| TOPICS | READINGS |
|---|---|
| Hypoxia of high altitude | Air to muscle O ₂ delivery during exercise at altitude. <i>High Altitude Medicine and Biology</i> 10(2):123-134, 2009. |
| Exercise-induced arterial hypoxemia | Exercise-induced arterial hypoxemia. <i>Journal of Applied Physiology</i> 87(6):1997-2006, 1999. |
| Asthma in the elite athlete | Asthma and the elite athlete: summary of the International Olympic Committee's consensus conference. <i>Journal of Allergy and Clinical Immunology</i> 122(2):254-260, 2008. |
| Specific training of the respiratory muscles | Inspiratory muscle training enhances pulmonary O ₂ uptake kinetics and high-intensity exercise tolerance in humans. <i>Journal of Applied Physiology</i> 109(2):457-468, 2010. |
| Chronic Obstructive Pulmonary Disease (COPD) | Exertional dyspnea in chronic obstructive pulmonary disease: mechanisms and treatment approaches. <i>Current Opinion in Pulmonary Medicine</i> 16(2):144-149, 2010. |
| Sex-based differences in the pulmonary physiology of exercise | Mechanics of breathing during exercise in men and women: sex versus body differences? <i>Exercise & Sport Science Reviews</i> 36(3):128-134, 2008. |
| Obesity | Weight loss via diet and exercise improves exercise breathing mechanics in obese men. <i>Chest</i> 140(2):454-460, 2011. |

PART III – PAPER AND STUDENT ORAL PRESENTATIONS

The format and specific details will be distributed in class. Two requirements are: (i) a major paper that provides a comprehensive review of literature will be handed near the end of term and (ii) an oral presentation of the paper will be made to the class. Students will receive a collective mark for both components.

Course Policies

1. Students who know in advance that they will be unavoidably absent from class should appeal for special accommodation from the instructor, as early in the term as possible, to determine how course requirements will be met and how any missed graded work will be completed. The School of Kinesiology will not normally consider special accommodation without timely notification. A minimum of two weeks notification is expected.
2. Where prior notification of absence is not possible, students should contact the instructor as soon as possible upon their return to class. Supportive documentation, submitted to the Undergraduate Advising Centre, may be required.
3. Students who miss the final examination in December MUST apply to the Undergraduate Advising Office at the earliest possible date to request consideration for Academic Concession. Students will be asked to complete an Academic Concession Form and provide supportive documentation. Academic Concession is a privilege, not a right, and can be granted only by the Undergraduate Advising Office.
4. Students, whose attendance or academic performance may be severely affected by medical, emotional, or other disabilities, should consult with the instructor early in the term to discuss any special accommodations that might be needed in order to complete course requirements. Supportive documentation, (as required) from either the Access Diversity Center or a physician must be submitted to the Undergraduate Advising Office.
5. The University accommodates students with disabilities who have registered with the Access Diversity Resource Centre. The University accommodates students whose religious obligations conflict with attendance, submitting assignments, or completing scheduled tests and examinations. A list of religious holidays involving fasting, abstention from work or study, or participation in all-day or fixed-time activities is available at <http://students.ubc.ca/publications/multifaith/>. Please let your instructor know in advance, preferably in the first week of class, if you will require any accommodation on these grounds. Students who plan to be absent for varsity athletics, family obligations, or other similar authorized commitments, cannot assume they will be accommodated, and should discuss their commitments with the instructor before the course drop date.
6. Please review the UBC Calendar “Academic regulations” for the university policy on cheating, plagiarism and other forms of academic dishonesty.