

PHOL/ANAT 610 - Oxygen and Physiological Function

Schedule: Summer Semester 2013 - Mon./Wed./Fri. 9:00 am - 11:30 am (5 wks.)
Classes run from Mon. June 3 to Fri. July 5, 2013

Location: Room E-501 Lecture Hall (Physiology & Biophysics Dept.)

Course Director/Professor: Joseph LaManna, PhD, 368-1112; JCL4

Co-Instructors: Michelle Puchowicz, PhD, 368-2501; map10 and Kui Xu, MD/PhD, 368-5950, kxx@case.edu

Suggested Readings:

Pathway for Oxygen: Weibel E. R., Harvard Univ Press 1984; ISBN 0-674-65790-X

Physiology of Oxygen Radicals: Aubrey E. Taylor et al.; Waverly Press, Inc 1986;
ISBN 0-683-08104-7

Atom: L. Krauss, Library of Congress 2001 ISBN 0-316-49946-3

Oxygen: Nick Lane; Oxford University Press 2002; ISBN 0-19-850803-4

Symmorphosis: E. Weibel; Harvard Univ Press 2000; ISBN 0-674-00068-4

Bioenergetics3: David G. Nicholls, Stuart J. Ferguson, 1999;
Academic Press ISBN 0-12-518121-3

Scaling: K. Schmidt-Nielsen, Cambridge Univ Press, 1984; ISBN 0-521-31987-0

High Altitude and Man: J.B. West, S. Lahiri; Amer Physiol Soc.

The Williams & Wilkins Co. 1984; ISBN 0-683-08945-5

SESSION	DATE	TOPIC
1	3-Jun	Introduction I - Kui/MAP
2	5-Jun	Introduction II - JCL The Story of Oxygen - JCL history / discovery; chemistry and physics of oxygen "Oxygen: a play in 2 acts, by Carl Djerassi and Roald Hoffmann"
3	7-Jun	Measurement of Oxygen: Methods of detection - JCL O2 trodes, Optodes, mass spec, fluorescence/phosphorescence, etc <u>Selected readings</u> : 1) <i>Imaging of Phosphorescence: A Novel Method for Measuring Oxygen Distribution in Perfused Tissue</i> ; Rumsey et al. <i>Science</i> 1988 2) <i>Oxygen in mammalian tissue: methods of measurement and affinities of various reactions</i> ; Vanderkooi, J.M. et al; <i>Amer J. Physiol</i> 1991 3) <i>The Redox State of Cytochrome Oxidase in Brain in Vivo: An historical perspective</i> ; Joseph C. LaManna 4) Brain tissue oxygen concentration measurements. Ndubuizu O, LaManna JC. <i>Antioxid Redox Signal.</i> 2007 Aug;9(8):1207-19. Review. Oxygen Toxicity - JCL chemistry of free radicals; mammalian defense mechanisms Hb-O2 dissociation theory; characteristics of blood in various species; oxygen carriage by blood
4	10-Jun	Microcirculation: JCL Historical: Krogh cylinder model (red vs white muscle; brain); Fick's Law, diffusion fields Capillary Distribution / Stewart Hamilton- mean transit time / oxygen delivery-capacity Intro / history- transporters; clinical applications <u>Selected readings</u> : 1) <i>Seider G et al, GLUT-1 deficiency syndrome caused by haploinsufficiency of the blood-brain barrier hexose carrier</i> ; 1998; <i>Nature Genetics</i> 2) <i>De Vivo, D et al, Defective Glucose Transport Across the Blood-Brain Barrier</i> ; 1991; <i>NEJM</i> Blood-Brain Barrier -transporters- glucose, MCT; diffusion vs carrier mediated; substrate uptake from blood to brain- Michaelis-Mentin kinetics
5	12-Jun	Quiz

Heart and Circulation- Blood Vessels, Blood Flow - JCL

hemodynamics; convection, diffusion; measuring O₂ consumption; blood gas content

Suggested reading: L. Sokoloff, *Historical Review of Developments in the field of Cerebral Blood Flow and Metabolism in History of CBF and Metabolism*

Blood and Hemoglobin - MAP

Hb-O₂ dissociation theory; characteristics of blood in various species;

oxygen carriage by blood

6 14-Jun Scaling & Temperature - JCL

Selected Readings: 1) Porter & Brand, *Cellular oxygen consumption depends on body mass, 1995, AJP*, 2) LaManna et al, *Temperature Coefficients for the Oxidative Metabolic Responses to Electrical Stimulation in Cerebral Cortex, J Neurochem 1980*

Adaptation to Altitude: Hypoxia - JCL and Kui ?

Selected reading: J.C. LaManna et al, *Review: Structural and functional adaptation to hypoxia in the rat brain, JEB 2004*

7 17-Jun Mitochondrial Metabolism I - JCL

chemiosmotic energy and bioenergetics (theory and biological applications)

prevention of mitochondrial oxidative damage

Selected Readings: 1) Green K et al, *Prevention of Mitochondrial Oxidative Damage as a Therapeutic Strategy in Diabetes, 2004, Diabetes* 2) Wallace D, *A Mitochondrial Paradigm of Metabolic and Degenerative Diseases, Aging, and Cancer: A Dawn for Evolutionary Medicine, 2005; Annu Rev Genet.*

8 19-Jun Quiz

Ischemia: Focal vs Global - Kui

Selected reading: J.C. LaManna and W.D. Lust, *Intrinsic and Extrinsic Optical Probes of Cerebrovascular and Metabolic function in Cerebrovascular Disease: Pathology, Diagnosis, and Management, 1998; Ginsberg, ed; Blackwell Science*

9 21-Jun Mitochondrial Metabolism II - MAP

oxidative phosphorylation and mitochondrial transport systems; maintenance of redox

Selected Reading: Sato, K. et al, *Insulin, ketone bodies, and mitochondrial energy transduction, 1995; FASEB Journal.*

10 24-Jun Lung and Respiratory Symmorphosis - MAP

structure and function in the mammalian respiratory system

compartmentation; distribution of lung volume; lung capacity; gas exchange;

Selected readings: Weibel, *Pathway for Oxygen*

11 26-Jun Quiz

Energy Expenditure: MAP

total body energy expenditure

energy requirements - use of 2-deoxyglucose and PET for CMRglu; "whisker barrels"

12 28-Jun Brain Functional Imaging - MAP

measuring cerebral energy metabolism: fMRI, BOLD, NMR spectroscopy

Selected readings: 1) Fox PT, et al, *Nonoxidative glucose consumption during focal physiologic neural activity, 1988; Science.*

2) Raichle, M, *Behind the scenes of functional brain imaging: A historical and physiological perspective; 1998; Proc Natl. Acad Sci*

3) *Magnetic Resonance Imaging: From Atomic Physics to Visualization, Understanding and Treatment of Brain Disorders, Breakthroughs in Bioscience www.faseb.org*

13 1-Jul Review

14 3-Jul Final Exam

