PHOL 410/NTRN410 - Basic Oxygen and Physiological Function

Schedule: lecture vedios will be posted on Mondays and Wednesdays

Course Director/Professor: Joseph LaManna, PhD, 368-1112; JCL4@case.edu

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

Course TA: Alireza Abdollahifar<axa860@case.edu>

Class: 02/01/2021 - 05/19/2021

Lecture : online only

Office Hour (Zoom) for questions and disussion. Thursday 2-3pm

Suggested readings:

Pathway for Oxygen: Weibel E. R., *Harvard Univ Press 1984; ISBN O-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*

Grading: A: 85 and above; B: 70 -84; C: <70

Weekly quizzes: 15%, Block 1: 25%, Block 2: 30%, Block 3: 30%; Extra credit book report up to 10 points.

SESSION	DATE	TOPIC
1	1-Feb	**Origin of Oxygen - JCL**
2	3-Feb	**Discovery of Oxygen - JCL** history / discovery; chemistry and physics of oxygen *"Oxygen: a play in 2 acts, by Carl Djerassi and Roald Hoffmann"*
3	8-Feb	**Life before Oxygen - JCL**
4	10-Feb	**Photosynthesis - JCL**
5	15-Feb	**Oxygen Toxicity, Hyperoxia ad Hyperbaric Oxygen Therapy - JCL** chemistry of free radicals; mammalian defense mechanisms
6	17-Feb	**Measurement of Oxygen: Methods of Detection - JCL** O2 trodes, Optodes, mass spec, fluorescence/phosphorescence, etc Selected readings: 1) *Imaging of Phosphorescence: A Novel Method for Measuring Oxygen Distribution in Perfused Tissue; Rumsey et al. Science 1988* *2) Oxygen in mammalian tissue: methods of measurement and affinities of various reactions; Vanderkooi, J.M. et al; Amer J. Physiol 1991* *3) The Redox State of Cytochrome Oxidase in Brain in Vivo: An historical perspective; Joseph C. LaManna* *4) Brain tissue oxygen concentration measurements. Ndubuizu O, LaManna JC. Antioxid Redox Signal. 2007 Aug;9(8):1207-19. Review.*
7	22-Feb	***Block Exam 1***
8	24-Feb	**Evolution of Lung - JCL**
9	1-Mar	**Structure and Fuction of the Respiratory System - KX** structure and function in the mammalian respiratory system compartmentation; distribution of lung volume; lung capacity; gas exchange; Selected readings: *Weibel, Pathway for Oxygen*
10	3-Mar	**Blood and Hemoglobin, Heart and Circulation - KX** Hb-O2 dissociation theory; characteristics of blood in various species; oxygen carriage by blood cardiac ouput, CaO2, etc
11	8-Mar	**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 Suggested reading *L. Sokoloff, Historical Review of Developments in the field of Cerebral Blood Flow and Metabolism in History of CBF and Metabolism*
12	10-Mar	**Blood Brain Barrier and Gas Channels, Transporters - JCL** Selected readings: *1) Seider G et al, GLUT-1 deficiency syndrome caused by haploinsufficiency of the blood-brain barrier hexose carrier; 1998; Nature Genetics*

2) De Vivo, D et al, Defective Glucose Transport Across the Blood-Brain Barrier; 1991; NEJM
glucose, MCT; diffusion vs carrier mediated;
substrate uptake from blood to brain- Michaelis-Mentin kinetics
hemodynamics; convection, diffusion; measuring O2 consumption; blood gas content

13 15-Mar Energy Expenditure - JCL
total body energy expenditure

14 17-Mar Temperature, Hibernation- JCL
Selected Reading: *LaManna et al, Temperature Coefficients for the Oxidative Metabolic Responses to Electrical Stimulation in Cerebral Cortex, J Neurochem 1980*

15 22-Mar Symmorphosis - JCL
Selected Reading: *Porter & Brand, Cellular oxygen consumption depends on body mass, 1995, AJP*

24-Mar No-class day

16 29-Mar Scaling - JCL
Selected Reading: *Porter & Brand, Cellular oxygen consumption depends on body mass, 1995, AJP*

17 31-Mar Induction to Mitochondria - JCL
Introduction/Origin of Mitochondria; Discovery of respiratory chain; chemiosmotic energy and bioenergetics (theory and biological applications); prevention of mitochondrial oxidative damage

18 5-Apr Discovery of Cytochrome - JCL

19 7-Apr Mitochondrial Metabolism - MAP
Selected Readings: 1) *Green K et al, Prevention of Mitochondrial Oxidative Damage as a Therapeutic Strategy in Diabetes, 2004, Diabetes 2) Wallace D, A MitochondrialParadigm of Metabolic and Degenerative Diseases, Aging, and Cancer: A Dawn for Evolutionary Medicine, 2005; Annu Rev Genet.*
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.*

20 12-Apr Reading day

21 14-Apr Block Exam 3

22 19-Apr Hypoxia: Adaptation/acclimatization to Altitude - JCL
Selected reading: *J.C. LaManna et al, Review: Structural and functional adaptation*
Beall CM: Tibetan and Andean patterns of adaptation to high-altitude hypoxia

23 21-Apr Hypoxic Adaptation: Angioplasticity - JCL

24 26-Apr Anoxia - JCL

25 28-Apr Metabolic State of Ketosis, and its Protective Properties - MAP

26 3-May Brain Evolution - JCL

27 5-May Brain Functional Imaging - JCL
measuring cerebral energy metabolism: fMRI, BOLD, NMR spectroscopy
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*

28 10-May Ischemia: Focal vs Global, Experimental Studies - KX
Blood flow, autoregulation, edema
Circle of Willis; cardiac arrest and resuscitation; edema
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*

29 12-May *Reading Day*

30 17-May *Block Exam 3*

31 20-May *Extra credit paper due 5pm EST*