

## Circulation and Gas Exchange Video Lectures: Table of Contents

### **Circulation 1: Overview and Evolution (25:56 min:sec)**

0:00	Introduction
0:33	Need for a circulatory system: functions.
2:37	Need for a circulatory system: size dependence.
5:26	Phylogeny of Circulatory Systems
8:06	Open v. Closed Circulatory Systems, phylogeny, advantages
12:50	Open Circulatory System: Insects
15:31	Closed Circulatory System: Vertebrates (co-evolution of heart and lungs, 2 chamber to 4 chamber hearts)
17:15	Evolution of Lungs from Swim Bladder
19:44	Co-evolution of circulatory and respiratory systems in vertebrates
23:45	Advantages of a 4 chambered heart – blood pressure and body size
24:50	Summary: Functions of Circulatory Systems

### **Circulation 2: Mammalian Circulatory System Design (52:27 min:sec)**

0:00	Introduction
0:08	Anatomy of Heart and Circulatory System: terms and definitions
5:14	Heart: heart muscle, action potentials, regulation by $Ca^{++}$ and ATP
10:15	Heart: electrical/contractile properties of individual heart cells, refractory period, pacemaker – autostimulatory (myogenic)
14:50	Heart: electrical/contractile properties of individual heart cells – gap junctions, intercalated discs, electrical coupling
18:40	Heart: conductive system – SA, AV node, bundle of His & Purkinje system, differential conduction velocities of APs – neurotransmitter and hormonal control
24:12	Heart: EKGs
27:40	Heart: Relationship between blood pressure and blood volume in ventricles
33:10	Heart, systole v diastole, pressure to pulmonary v body v placental circulatory systems
36:56	Vascular System: Veins and arteries – structural properties
39:57	Vascular System: Capillaries, structural properties and permeability
43:15	Vascular System: Relationships between cross-sectional area, blood pressure and blood volume.
46:58	Vascular System: Capillaries – moving material in and out of capillaries, blood pressure v colloidal osmotic pressure
50:51	Vascular System: Capillary bed regulation – capillary beds as modules receiving blood on demand.

### **Circulation 3: Regulation of Mammalian Circulatory System (33:58 min:sec)**

0:00	Introduction
0:08	Regulation of Circulatory System, Why?
2:08	Targets of Regulation: Heart (neural and hormonal), Arterioles (neural and hormonal), Capillary Beds (local, hormonal). Roles of Acetylcholine (ACh), Epinephrine and Norepinephrine
9:30	Signals and Sensors: Baroreceptors and the regulation of Blood Pressure (BP) through ACh action on heart
12:25	Signals and Sensors: Mechanoreceptors and the regulation of Blood Volume through the inhibition of ADH release (thus increasing urine production and decreasing Blood Volume and Blood Pressure
16::30	Signals and Sensors: Blood volume and Blood Pressure. Osmoreceptors regulate blood volume by regulating ADH release from hypothalamus (ADH acts on kidneys). Juxtaglomerular Assembly (JGA – kidneys) regulates BP through renin, angiotensinogenII and aldosterone, countered by ANF (atrial natriuretic factor) released from heart.
23:20	Signals and Sensors: CO <sub>2</sub> and pH receptors in carotid artery and brain regulate respiratory center (ventilation)
26:01	Signals and Sensors: Precapillary sphincters regulated by histamine, hormones
29:30	Overview: Regulation of blood flow by regulating capillary modules and ensuring sufficient blood flow (Blood Pressure and Blood Volume)

**Gas Exchange 1: Anatomy (22:43 min:sec)**

0:00	Introduction
0:34	O <sub>2</sub> /CO <sub>2</sub> Cycle / Function of O <sub>2</sub> / Problem of CO <sub>2</sub>
4:29	Respiratory Surfaces: Skin, Gills, Lungs, Trachea. Adaptational Significance
8:35	Gills and Trachea - Properties
12:15	Mammalian Lungs – Alveolar Sacs and Alveolus – surface area
14:19	Aveolar Dimensions – Surfactants and surface tension
18:35	Overview of Respiratory structures – air vs. aquatic, size of organism, environmental conditions

**Gas Exchange 2: Chemistry (50:34 min:sec)**

0:00	Introduction
0:27	O <sub>2</sub> and CO <sub>2</sub> movements between air and tissue
2:21	Gas Pressure: gas composition of air, terms (atmosphere, mmHg), Partial Pressure.
7:30	Gas Volume: Partial Pressures in air and water. Gas solubilities in H <sub>2</sub> O influenced by [salt] and temperature.
12:27	CO <sub>2</sub> / bicarbonate chemical reactions
16:12	Shifting Chemical Equilibria
19:06	Respiration (gas exchange) without Hemoglobin (Hb). Movements driven by CO <sub>2</sub> production and O <sub>2</sub> consumption. Slow and ineffecient (OK for small organisms, small distances), limited by rate of diffusion.
22:43	Adaptive significance of O <sub>2</sub> binding proteins: Hemoglobin, Hemocyanin, Myoglobin
27:48	Hemoglobin: Structure, non-linear binding of O <sub>2</sub> (Cooperativity), Fetal v Adult Hemoglobin (differential binding affinities).
31:28	Red Blood Cells (RBCs). Development, differentiation, maturation. Factors influencing O <sub>2</sub> capacity of blood.
35:54	Three Chemical Reactions that control gas exchange: (1) O <sub>2</sub> + Hb; (2) Bicarbonate; (3) CO <sub>2</sub> + Hb-O <sub>2</sub>
40:11	Gas Exchange in Tissues: Details
43:50	Gas Exchange in Lungs: Details
46:50	Adaptive Modifications – things not discussed Aerobic v anaerobic metabolism – modifications in animals that switch Specializations in Lung Design – birds Aclimitization v. Adaptation - high altitude (low [O <sub>2</sub> ]) Developmental switches – fetal v. adult Hb Breathing – regulation of breathing