Major Learning Objectives - Cardiovascular Physiology for Osteopathic Medicine
Lecture numbers and content are approximate and depend on class progress and many other factors

Lectures 1-2 Overall Cardiovascular System Function and Features
1. Describe the structure-function features and arrangements of the cardiovascular system (CVS) components and their interrelationships.
2. Contrast the features and functions of systemic, pulmonary and lymphatic circulations
3. Define cardiac output (CO), stroke volume (SV), and heart rate (HR) and be able to relate any two to the third.
4. Define the concepts of mean arterial pressure (MAP), central venous pressure (CVP), and total peripheral resistance (TPR) and be able to predict how changes in one of these affects the others.
5. Explain the effect of changes in vascular bed resistance on cardiac output distribution.
6. Describe the relationship between TPR, MAP, CO and CVP and be able to evaluate changes in one given adequate information about the others.
7. Describe the main features and function of each of the vessel types comprising the various vascular segments.
8. Describe how blood pressure and blood volume vary within the circulation.

Lectures 3-5 Essential Aspects of Blood Flow, Pressure and Resistance
1. Describe the factors that affect the resistance of a single blood vessel and be able to evaluate how resistance changes when any of these factors change
2. Define and contrast perfusion pressure and transmural pressure.
3. Describe and contrast blood flow (Q) in a blood vessel vs. blood velocity (U) in a blood vessel and explain the relationship of each to the diameter (D) or area (A) of the vessel.
4. Describe the effect of changes in resistance (R) on blood flow and pressure.
5. Define and contrast laminar vs. turbulent blood flow and describe the conditions that predict turbulent flow.
6. Explain what a stenosis is and its effects on blood pressure, flow and velocity
7. Define shear stress and shear rate in a blood vessel and the concept of velocity profile.
8. Define blood viscosity and explain the factors that effect is value and the effect that changes in viscosity have on blood flow and pressure.
9. Describe the manner in which blood velocity varies within the circulation and be able to explain this variation.
10. Describe the relationship of shear stress to blood viscosity, blood flow and diameter.
11. Contrast series with parallel vascular arrangements and be able to contrast the effects on blood flow and pressure and be able to calculate combined resistances.
12. Explain and be able to utilize the resistance partitioning concept to determine blood flow and pressures within a vascular bed or organ.

Lectures 6-7 Vascular/Cardiac Compliance and Mechanics
1. Define the concept of compliance qualitatively and quantitatively and be able to interpret its value from graphical representations.
2. Contrast the concept of compliance with that of distensibility.
3. Describe the factors that influence compliance and be able to explain how directional changes in any of these factors effects the value of compliance.
5. Describe how both resistance and compliance interact to determine MAP
6. Define Laplace’s law as it applies to heart and blood vessels.
7. Contrast the concepts of wall stress vs. wall tension.
8. Describe blood flow from the viewpoint of energy considerations.
Lectures 8-12 Cardiac Electrical Activity and Basic Electrocardiography
1. Describe the main features, arrangements, pathways and sequence of electrical excitation and conduction in the heart and the types and features of the cardiac action potentials.
2. Describe the ionic basis for cardiac fast and slow response action potentials and be able to explain how changes in ionic currents may occur and the effect of these changes on action potential features and cardiac function.
3. Define and explain the following cardiac electrophysiological concepts/terms: rectification, ectopic pacemaker, overdrive suppression, refractory periods, vulnerable periods, arrhythmia, reentry, decremental conduction, reentrant and triggered arrhythmias, conduction block, supraventricular arrhythmias
4. Describe the origin of the electrocardiogram and be able to explain the relationship between its deflections, segments and intervals to underlying electrophysiological events and timing.
5. Describe and explain the concepts of moving dipoles, mean instantaneous vectors, mean QRS vector, mean electrical axis, and vector projection onto EKG leads, and how these affect the voltages recorded on the EKG.
6. Describe the conventions used to place electrocardiographic limb and chest leads and describe the actual limb lead axis directions.
7. Identify normal ranges for cardiac rate and cardiac mean vector directions.
8. Determine an electrical axis from a standard EKG recording.
9. Determine and EKG deflection direction and relative magnitude from a given mean electrical axis.
10. Identify and relate altered EKG patterns with underlying electrophysiological changes in impulse formation or conduction.

Lectures 13-16 Cardiac Pump Function
1. Define/explain concepts of isometric and isotonic contraction as applicable to cardiac muscle.
2. Define and explain the concept of contractility and inotropic state as it applies to cardiac muscle and describe the effect of changes in contractility on cardiac force development.
3. Define and explain the concepts of preload and afterload as they pertain to the intact heart and the effects that changes in these have on cardiac pump function.
4. Define and explain the Frank-Starling 'law of the heart' and its significance.
5. Describe in detail the cardiac cycle in terms of the cardiac pressure-volume loop and in terms of temporal relationship between all associated electrical, mechanical and hemodynamic events.
6. Define and be able to determine stroke volume and ejection fraction from either the pressure-volume loop or from ventricular end diastolic and end systolic volumes.
7. Explain the concept of myocardial wall stress, its variation during the cardiac cycle and its relationship to myocardial afterload.
8. Describe the factors that increase myocardial oxygen demand and the clinical indices that correlate with these.
9. Explain the peak isovolumic pressure (PIP) curve in relation to the Frank-Starling mechanism.
10. Explain the effect of contractility changes on the PIP curve.
11. Interpret pump function changes based on the combined use of cardiac pressure-volume curves and PIP curves.
12. Describe the significance of the 'calcium pool' in relation to cardiac pump function.
13. Predict the dynamic changes in cardiac pressure, volume and flow associated with changes in myocardial contractility.
14. Describe the genesis of the cardiac heart sounds and their timing in relation to the cardiac cycle.
15. Explain the basis of vascular and cardiac murmurs and describe the type of murmurs and hemodynamic changes associated with aortic and mitral stenosis and aortic and mitral regurgitation.

Some Major Learning Objectives CV Physiology Dr. HN Mayrovitz 2
Lectures 17-18 Arterial System Function
1. Define systolic, diastolic, pulse and mean blood pressures and be able to estimate mean pressure from sphygmomanometry.
2. Describe the factors that influence systolic and pulse pressure and predict the directional changes in pressures caused by these factors.
3. Define essential and isolated systolic hypertension.
4. Define pulse-wave speed and explain the effects of arterial compliance on its speed.
5. Explain the concept of pulse-wave reflections in the arterial system.
6. Contrast reflection features of pressure vs. flow waves.
7. Describe factors that effect reflection and the effect of reflection on measured arterial pulses.
8. Describe the manner in which arterial pulses vary in different parts of the arterial circulation.
9. Define the ankle-brachial index and its significance.
10. Describe the pressure and flow pulse changes associated with peripheral arterial disease.

Lectures 19-21 Microvascular, Lymphatic and Venous System Function
1. Describe the components and main functions of the microcirculation and contrast the difference in capillary structure-function among organs.
2. Describe the process of transcapillary exchange and the factors by which it is determined and controlled.
3. Explain the roles of pre- and post capillary resistance and capillary pressures in this process and be able to determine how changes in these effect both capillary pressure and capillary filtration processes.
4. Describe the function of lymphatic capillaries and the process of lymph transport.
5. Describe and explain the conditions that tend to cause edema.
6. Describe the oxygen carrying capacity of the blood via the Hb-O2 equilibrium curve.
7. Describe the concept of oxygen delivery and uptake.
8. Explain the concept of oxygen demand vs. supply and the vascular factors that may impact on this balance.
9. Describe and explain the effects of gravity on the venous system.
10. Describe the effects of normal and abnormal venous valve function on venous pressures.
11. Describe and explain the effects of respiration on venous flows and pressures.
12. Describe venous reservoir function and its significance to venous return and cardiac output.

Lecture 22-24 Cardiovascular Controls, Reflexes and Regulation
1. Describe the general framework by which receptors and efferent and afferent pathways control primary cardiovascular parameters.
2. Describe the concept of negative feedback and the role of the medullary cardiovascular 'control centers'.
3. Describe the high pressure baroreceptor reflex and how it functions in response to changes in arterial blood pressure.
4. Describe the low pressure receptor reflexes and how they function in response to changes in blood volume or pressure.
5. Describe the interaction between high and low pressure reflexes.
6. Describe the cardiovascular reflexes associated with the peripheral and central chemoreceptors.
7. Describe the basic mechanisms responsible for the modulation of vascular smooth muscle that leads to either vasodilation or vasoconstriction including the roles of the following in these processes: calcium, vascular and receptors, catecholamines, voltage operated channels, receptor operated channels, shear stress, nitric oxide, and metabolic factors and substances.
8. Describe myogenic control, autoregulation, functional hyperemia and reactive hyperemia.
Lecture 25-26  **Cardiac-Vascular Coupling and Interactions**
1. Discuss and be able to graphically represent cardiac function curves and vascular function curves and the significance of their intersection.
2. Determine the changes in cardiac and vascular function curves due to changes in vascular compliance, vascular resistance, central venous pressure, blood volume, cardiac contractility, posture, sympathetic activity and cardiac failure.

Lectures 27-30  **Features of Specific Circulations and CV Integration**
1. Describe the phasic features of coronary blood flow
2. Describe the metabolic and autoregulatory aspects of coronary blood flow
3. Describe intramyocardial blood flow and the factors that influence its features.
4. Describe the determinants of cerebral blood flow
5. Describe the structure-function aspects of cutaneous circulation
6. Discuss cutaneous blood flow in relation to temperature regulation and blood pressure.
7. Describe skeletal muscle blood flow in terms of its extrinsic and intrinsic control.