Cardiovascular Physiology: Heart & Blood Vessels

I. Definitions
A. Circulation
B. Internal Environment

II. General overview
A. Major Functions

B. Major Components
1. Blood
2. Blood Vessels (and lymph vessels)
3. Heart
   a. Gross Anatomy
   b. Conduction System
   c. Microscopic Anatomy
   d. Mechanism of Contraction

III. Cardiac Cycle I - (mechanical)
   Diastole
   Systole

IV. Cardiac Cycle II - (electrical)
A. Cardiac Action Potentials
   1. Pacemaker Potentials
   2. Myocardial Potentials

B. ElectroCardioGram (ECG)
   1. Normal Rhythm
2. Abnormal Rhythms
   a. Rate (bradycardia, tachycardia)
   b. AV Nodal Block
   c. Fibrillation (circus rhythms)

V. Cardiac Cycle (correlated)

VI. Blood Vessel Divisions of the Circulatory System
   A. Resistance Vessels (arteries, arterioles)
   B. Exchange Vessels (capillaries)
      1. Diffusion
      2. Filtration
      3. Osmosis
   C. Capacitance Vessels (veins & venules)
VII. Regulation of Cardiovascular Activity

A. Principles of Blood Flow
   1. Flow = volume / time ≈ pressure difference / resistance
   2. Pressure Difference (MAP):
      a) Pulse Pressure = systolic pressure - diastolic pressure
      b) Mean Arterial Pressure (MAP) = diastolic pressure + 1/3 pulse pressure
   3. Resistance (TPR):
      Poiseuille's Law: Resistance (TPR) = \( \frac{8\eta L}{\pi r^4} \)
      Cardiac Output (CO) = MAP / TPR (also = stroke volume (SV) x heart rate (HR))

B. Regulation of the Heart
   1. Intrinsic (Frank-Starling Law of the Heart)
   2. Extrinsic
      a. Parasympathetic (chronotropic)
      b. Sympathetic (chronotropic and inotropic)

C. Regulation of Resistance (Blood Vessels)
   1. Intrinsic
   2. Extrinsic
      a. Sympathetic

D. Baroreceptor Reflex

E. Venous Return
   1. Valves
   2. Skeletal Muscle Pump

VIII. Additional Key Terms / Topics (FYI)

aneurysm  auscultate  automaticity  bradycardia  chronotropic  ectopic
edema    embolus    hypertension  hypotension  inotropic  ischemia
murmur    oncotic pressure  palpate  perfusion  syncytium  tachycardia
thrombus
Study Questions – Cardiovascular System:

1. Define “circulation”.
2. Define “internal environment”.
3. Describe the major functions of the cardiovascular system.
4. Identify the three major components of the cardiovascular system and relate each to the major functions you described above.
5. Describe each of the three major types of blood vessels - both anatomically and functionally.
6. What is the function of the lymphatic system?
7. a. Diagram and describe the flow of blood through the heart, naming all of the chambers and valves along the way.
   b. Add to your diagram a description of where the blood leaving the heart goes and where the blood entering the heart comes from. Name the blood vessels and describe the oxygen content of the blood in each blood vessel and heart chamber.
8. What is the primary function of the heart?
9. What is the function of the atria? Of the ventricles?
10. What is the function of the valves? What causes the valves to open and close?
11. Describe the microscopic structures that make the heart function as a pump.
12. Describe the transmission of electrical energy through the conduction system of the heart. What type of tissue is the conduction system made of?
13. Describe the excitation-contraction-coupling mechanism of myocardial contraction.
14. Define diastole and systole.
15. Draw a diagram illustrating the relationship between all of the following: atrial diastole and systole, atrial pressure, ventricular diastole and systole, ventricular pressure, ventricular volume, aortic pressure, heart sounds, valve openings and closures.
16. Describe the pacemaker action potential. What is the mechanism of “autorhythmicity” in the pacemaker tissues?
17. Describe the different stages of the myocardial action potential. What ions / ion channels are responsible for the different stages? How does the myocardial action potential relate to the phases of contraction (twitch)?
18. Describe the different waveforms of the electrocardiogram. What specifically is represented by each waveform? Identify the points in time when the SA and AV nodes begin to depolarize.
19. Define bradycardia and tachycardia.
20. Define and describe each of the different degrees of AV nodal block (aka heart block).
21. Describe the pattern of depolarization known as a circus rhythm. Explain how a circus rhythm can be generated and sustained. What pattern would be observed on an ECG.
22. Draw a diagram illustrating the relationship between all of the following: atrial diastole and systole, atrial pressure, ventricular diastole and systole, ventricular pressure, ventricular volume, aortic pressure, heart sounds, valve openings and closures. Add the following: electrocardiogram, myocardial action potential and ventricular myocardial muscle twitch.
23. Describe the forces that lead to “exchange” between capillaries and interstitial fluid. Pay particular attention to the “exchange” of oxygen, carbon dioxide and water.
24. What factors influence the movement of water between capillaries and interstitial fluid? What effect would altering any of these factors have on water distribution?
25. Describe two different ways to determine cardiac output.
26. What is the principle regulatory factor contributing to peripheral resistance?
27. Describe the Frank-Starling law of the heart. How does this phenomenon help increase cardiac output to match increased physical activity? How does it contribute to maintaining balanced output from the left and right ventricles?
28. Describe (diagram) the innervation of the heart by the parasympathetic and sympathetic systems.
29. Describe the effect and the mechanism of parasympathetic stimulation on the heart.
30. Describe the effect and the mechanism of sympathetic stimulation on the heart.
31. Describe how blood flow (distribution) is regulated intrinsically by carbon dioxide.
32. Describe the effect of the parasympathetic and sympathetic regulation of blood vessels.
33. Describe the baroreceptor reflex.
34. Describe the different factors that effect venous return to the heart.