F509: Systems Approach to Basic Science I
CARDIOVASCULAR MODULE

VASCULAR PHYSIOLOGY

Spring, 2009

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RECOMMENDED READING: Key Concepts, p. 508**;** p. 544-547; p. 575-615. Rhoades and Pflanzer: *Human Physiology*, 3rd edition. Saunders College Publishing, 1996

WEBSITE: http://www.iuvascular.com/Unthank/teach.html contains lecture slides, handouts, practice quizzes, previous exam questions and sample dental board exam questions.

LECTURE OUTLINE WITH OBJECTIVES:

I. OVERVIEW OF THE PERIPHERAL CIRCULATION

A. Primary function of the peripheral circulation
B. Major components of the peripheral circulation
C. Physical principles associated with blood flow

OBJECTIVES:

1. List the primary functions of the major components of the blood (plasma proteins, red and white blood cells, and platelets).

2. Identify the portions of the vasculature which are characterized by the highest and lowest blood pressures, highest and lowest blood flow velocities, greatest cross-sectional area, and greatest capacity.

3. List the physiological importance of each of three layers of the vessel wall.

4. List major differences between the systemic and pulmonary divisions of the peripheral circulation.

5. Define the terms flow, pressure, resistance, as they relate to vascular function. Write an equation which expresses the relationship between these terms and list the units of each. List the three determinates of resistance to blood flow and explain why one of the three has a much the greater potential to alter resistance than the others. Explain the importance of the parallel arrangement of the vasculature in the peripheral circulation.

II. ARTERIES AND ARTERIOLES

A. Fundamental facts
B. Pressure in the arterial system
C. Total peripheral resistance (tpr)
C. Short-term regulation of arteriolar resistance and blood flow
D. Longterm regulation of arteriolar resistance and blood flow

OBJECTIVES:

1. Explain how the arterial system converts an intermittent input from the heart to a constant output to the tissues. Define systolic, diastolic, pulse, and mean arterial pressure and explain how an increase or decrease in arterial blood volumes or stroke volume and arterial compliance would affect these pressures.

2. Define total peripheral resistance and identify the site of the vasculature responsible for most of the total peripheral resistance. Define the autoregulation of blood flow. Define and give examples of functional hyperemia, myogenic vascular control, metabolic vascular control, and flow-dependent diameter change. Explain the molecular mechanisms by which an increase in flow can be sensed by endothelial cells and result in the relaxation of vascular smooth muscle cells.

3. Give specific examples of agonists and receptors for extrinsic control of arteriolar diameter by sympathetic nerve activity and circulating epinephrine. Describe how each of these extrinsic control mechanisms differ in brain, heart, and skeletal muscle compared to other vascular beds such as skin and gastrointestinal tract.

III. CAPILLARIES

A. Fundamental facts
B. Transcapillary exchange of solute
C. Water filtration and absorption
D. Sites of exchange
E. Conditions altering transcapillary exchange

OBJECTIVES:

1. List the three major mechanisms for transcapillary exchange presented in the text book. Discuss which of these mechanisms are most important in the transcapillary exchange of lipid soluble substances, small water soluble substances, and large water soluble substances.

2. Explain why capillary permeability is different (1) for various solutes within the same capillary and (2) for the same solute in capillaries of different organs.

3. Identify the forces present in capillaries and tissue which act to cause filtration and absorption. Also explain how these forces are thought to change from the arteriolar to the venular end of the capillary. Be able to determine the net force for filtration or absorption given numerical values for these four forces. Explain how arteriolar vasodilation, hemorrhage, arteriolar vasoconstriction, elevated venous pressures, malnutrition, heart failure, and inflamation would alter transcapillary exchange.

IV. VEINS AND VENULES

A. Fundamental facts
B. Venous reservoir
C. Venous "pumps"
D. Venous return and cardiac output

OBJECTIVES:

1. Explain how various factors such as hemorrhage, dehydration, decreased renal excretion, increased capillary absorption, and venous constriction alter total blood volume, venous volume, mean circulatory filling pressure, and the end diastolic volume of the heart.

2. Explain why functional venous valves are important and how venous return is assisted by venous “pumps”.

V. LYMPHATICS

A. Fundamental facts
B. Lymph vessels of the body
C. Major concepts of lymph formation and propulsion
D. Tissue volume-pressure relationships

OBJECTIVES:

1. Explain why lymph vessels are required to balance fluid exchange and describe how lymph is propelled from its site of formation in tissue. Describe why initial lymphatics are not collapsed during edema and why it is easier for fluid and particles to enter than leave the lymphatic capillaries. Explain why valves are essential for normal lymphatic function and venous return

2. Explain why edema is much more serious for encased organs such as teeth and brain than for most tissues.

VI. REGULATION OF SYSTEMIC ARTERIAL PRESSURE

A. Relationship between arterial pressure and cardiac output
B. Summary of factors which influence cardiac output
C. Example of neural control via baroreceptors

OBJECTIVES:

1. Describe how both increases and decreases in blood pressure alter the activity of the baroreceptors and how sympathetic and parasympathetic nerve activities are affected. Explain how an increase and decrease in sympathetic and parasympathetic nerve activity would affect the blood vessels, the heart, and the adrenal medulla.

2. Express the relationship between MAP, CO, and TPR in equation form.