General Cardiovascular/Respiratory Sequence Information Fall 2008

Objectives:
For each of the subtopics of the sequence a list of comprehensive behavioral goals and cognitive objectives will explicitly define what a student should know and be able to do by the end of the sequence. These objectives provide a focus for "active" studying. It is important to note that mastery of the "basic facts" concerning structure and function, as defined in these lists of cognitive objectives, is an essential, but only the first step, in life long learning. You must also be able to use these facts in a logical manner to solve problems. Physiologic and pathophysiologic problem solving is the basis of medical practice. Accordingly, examinations will attempt to test not only for mastery of the cognitive objectives but, to the extent we are able, to test for your ability to manipulate this material, i.e., for your ability to solve problems.

The core information necessary to master these objectives will be presented primarily in lecture. Sometimes the lecturer will indicate that specific outside readings are essential for mastery of an objective. Therefore, some material will either not be given at all in lecture or will not be adequately covered in the lecture. Regardless of the level of lecture coverage you are responsible for, and can be examined on, the material designated in the listed sequence objectives.

Small Group Discussions (Cardiovascular, November 6, 1:00 PM & Respiratory, November 20, 1:00 PM)
These sessions will provide you with an opportunity to discuss, analyze, and interpret signs and symptoms as they relate to the underlying physiological principles you have learned. The purpose of these sessions is not to teach you how to diagnosis specific diseases but to provide practice in applying physiological principles to interpreting various pathophysiological states. The problem to be discussed, and the questions you will be expected to consider during the discussion, will be provided prior to the discussion. Attendance at small group discussions is required and specific student room assignments are made by the Office of Medical Education. Failure to attend for any reason will require you to submit written answers to the small group discussion questions to the Sequence Coordinator within 72 hours of the small group session

Required Textbooks: **CARDIOVASCULAR PHYSIOLOGY** David E. Mohrman and Lois Jane Heller, McGraw-Hill, 6th Ed., 2006. ~$35 There will be copies of this textbook are on reserve at Taubman Medical Library. Older editions are similar but some figure numbers and chapter content have changed.

PULMONARY PHYSIOLOGY Michael G. Levitzky, McGraw-Hill, 7h Ed., 2007 There will be copies of this textbook on reserve at Taubman Medical Library.

Supplementary Textbook: **RESPIRATORY PHYSIOLOGY: THE ESSENTIALS** John B. West, Williams and Wilkins, 8th Ed., 2008. There will be copies of this textbook on reserve at Taubman Medical Library.

Sequence Performance, Quiz, Exams and Sequence Grade: Performance will be assessed by participation in the Small Group Exercises as well as by the quizzes and a comprehensive final exam. No "new" content from the Small Group Exercise will be added to the quizzes or final. The final exam will include both written and practical components. The sequence content will be represented on the quiz and final approximately based on the time allocated in class. Questions on the quizzes, practical, and final all will be worth 1 point. In order to pass the course students must achieve a total score of at least 75% on these exercises and fulfill the responsibilities to the Small Group Exercise.

Required Experiences: In the Cardiovascular/Respiratory sequence there are several required experiences. In the **RARE** circumstance where a student cannot attend, the student must contact their class counselor in advance (or as soon as possible in an emergency) to request a deferral. (Please do NOT contact sequence directors with requests for or explanations of deferrals.) Absences will be approved or denied by class counselors based on the same guidelines used for Quiz and Exam deferrals. Should you obtain a deferral from your class counselor, make up instructions for the required experiences (found below) should be followed.

Failure to attend either small group session for any reason will require you to submit written answers to the small group discussion questions to the Sequence Coordinator within 72 hours of the small group session

Remediation for missing the MDC or Dr. Bartlett's talk will be to watch the video and write a 2 page essay detailing your reactions, including knowledge, insights, and inspirations gained from the presentation. This is due to the sequence coordinator within 72 hours of the session.

Additional Books on Reserve at the Medical Library: General Introductory Text:
Vander, Sherman, and Luciano. Human Physiology, The Mechanisms of Body Function, McGraw-Hill Inc, (11th edition), 2008 There will be copies of this textbook are on reserve at Taubman Medical Library

Comprehensive medical physiology texts:

Berne and Levy. Physiology, Mosby Year Book, (5th ed.), 2005.
Guyton & Hall. Textbook of Medical Physiology, W. B. Saunders Company, (11th edition), 2006.
Ganong. Review of Medical Physiology, Lange, (22nd edition), 2005

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S E L E C T E D O B J E C T I V E S

Key words Key words are BOLD TYPE in Objectives lists.

Objectives: The attached full objectives list covers all Chapters. For each lecture there are selected objectives below that indicate areas of focus for the sequence. In addition underlined objectives will NOT be covered in this sequence's quizzes or final.

D'Alecy Material on Quiz #1

The chapters and objectives are from the required text: **Cardiovascular Physiology by Mohrman and Heller, 6th Ed. 2006**

Homeostasis

Objectives 1-12 in Handout All material in lecture and listed objectives.

Physiologic Basis Of Cardiovascular System
Cardiac Muscle & Mechanics
Cardiac Hydraulics

Chapter 1, Objectives 1-12
Chapter 2, Objectives 3, 4, 6-24
Chapter 3, Objectives 1-16

Physiologic Basis For ECG

Chapter 4, Objectives 1-3
Chapter 5, Objective 1

D'Alecy Material on Quiz #2

Hemodynamics

Chapter 1, Objectives 13-16
Chapter 6, Objectives 6-18, 20, 21

Vascular Control Mechanisms, Nitric Oxide

Chapter 7, Objectives 1-15

Baroreceptor Control of Blood Pressure Regulation

Chapter 9, Objectives 1-6

Cardiovascular reflexes

Chapter 10, Objectives 1-5, 16-20

Coronary Blood Flow Control

Chapter 7, Objectives 16-17

Venous Return & Central Venous Pressure

Chapter 8, Objectives 1-11

D'Alecy Material on Quiz #3

Cerebral & Other Blood Flow Control

Chapter 7, Objectives 16-18

Microcirculation, Transcapillary Exchange, Diffusion, Starling

Chapter 6, Objectives 1-5

Selected Special Circulations, Skin & Temp. Reg.

Chapter 10, Objective 7

Stress Response, Hemorrhage/Shock

Chapter 10, Objective 16-20
Chapter 11, Objectives 1-4

Final Exam is Comprehensive with Respiration

Selected Cardiovascular Objectives D'Alecy

<u>HOMEOSTASIS Objectives (class content)</u>

Student understands the concepts of the internal environment and homeostatic control systems:

1. States the importance of the internal environment for cell survival.
2. Defines and identifies the location of the internal environment.
3. States the relative magnitudes of the body's fluid compartments.
4. Defines the difference between a normalized and an absolute value for a given parameter.
5. Defines the resting or basal state.
6. Defines the term -homeostasis.
7. States the five components of a classical reflex arc, describes their roles and recognizes them in specific physiological control systems.
8. Describes the difference between a controlled variable and a regulated variable.
9. Describes the difference between a reflex arc and a control system.
10. Defines negative feedback and positive feedback.
11. Defines the terms -set point and error signal.
12. Defines feedforward regulation.

Keywords: Know definition and concepts associated with **internal environment, extracellular fluid (ECF), intracellular fluid (ICF), interstitial fluid (ISF), total body water (TBW), normalized parameters, resting -basal state, homeostasis, reflex arc, stimulus, receptor, afferent pathway, integrating center, efferent pathway, effector, response, negative feedback, positive feedback, set point, error signal, feedforward.**

Mohrman & Heller	Objectives per Chapter	Keywords in BOLD TYPE

<u>Underlined Objectives are NOT to be tested in the cardiovascular portion of the sequence.</u>

Chapter 1 – Overview Cardiovascular System (pp. 1 – 18)

The student understands the homeostatic role of the cardiovascular system, the basic principles of cardiovascular transport and the basic structure and function of the components of the system:

1. Defines **homeostasis** (repeat)
2. Identifies the major body fluid compartments and states the approximate volume of each. (repeat)
3. Lists the two conditions, provided by the cardiovascular system, that are essential for regulating the composition of interstitial fluid (i.e., the **internal environment**).
4. Diagrams the blood flow pathways between the heart and other major body organs.
5. States the relationship among blood **flow**, blood **pressure**, and vascular **resistance**.
6. Predicts the percentage change in flow through a tube caused by a doubling of tube length, tube radius, fluid viscosity, or pressure difference.
7. Identifies the chambers and valves of the heart and describes the pathway of blood flow through the heart.
8. Defines **cardiac output**.
9. Describes the pathway of **action potential propagation** in the heart.
10. Lists five factors essential to proper ventricular pumping action.
11. States the relationship between ventricular filling and cardiac output (**Starling's Law of the Heart**) and describes its importance in the control of cardiac output.
12. Identifies the distribution of sympathetic and parasympathetic nerves in the heart and lists the basic effects of these nerves on the heart.
13. Lists the major different types of vessels in the vascular bed and describes the morphological differences among them.
14. Describes the basic anatomical features and functional of the different vessel types.
15. Identifies the major mechanisms in vascular control and blood flow distribution.
16. Describes the basic composition of the fluid and cellular portions of blood.

Selected Cardiovascular Objectives D'Alecy

Chapter 2 – Characteristics of Cardiac Muscle Cells (pp 19 – 46)

The student understands the ionic basis of spontaneous electrical activity of cardiac muscle cells:

(1) Describes how membrane potentials are created across semipermeable membranes by transmembrane ion concentration differences.
(2) Defines equilibrium potential and knows its normal value for potassium and sodium ions.
3 States how membrane potential reflects a membrane's relative permeability to various ions.
4 Defines resting potential and action potential.
5 Describes the characteristics of "fast" and "slow" response action potentials.
6 Identifies the refractory periods of the cardiac cell electrical cycle.
7 Defines threshold potential and describes the interaction between ion channel conditions, and membrane potential during the depolarization phase of the action potential.
8 Defines **pacemaker potential** and describes the basis for rhythmic electrical activity of cardiac cells.
9 Lists the phases of the cardiac cell electrical cycle and states the **membrane permeability** alterations responsible for each phase.

The student knows the normal process of cardiac electrical excitation:

10 Describes **gap junctions** and their role in cardiac excitation.
11 Describes the normal pathway of action potential conduction through the heart.
12 Indicates the timing with which various areas of the heart are electrically excited and identifies the characteristic action **potential shapes** and conduction velocities in each major part of the conduction system.
13 States the relationship between electrical events of cardiac excitation and the **P, QRS, and T waves**, the **PR interval**, and the **ST segment** of the electrocardiogram.

The student understands the factors that control heart rate and action potential conduction in the heart:

14 States how **diastolic potentials** of pacemaker cells can be altered to change heart rate.
15 Describes how cardiac sympathetic and parasympathetic nerves alter heart rate and conduction of cardiac action potentials.
16 Defines the terms ***chronotropic*** and ***dromotropic***.

The student understands the contractile processes of cardiac muscle cells:

17 Describes the subcellular structures responsible for cardiac muscle cell contraction.
18 Defines and describes the excitation-contraction process.
19 Defines **isometric, isotonic, and afterloaded contractions** of cardiac muscle.
20 Describes the influence of altered **preload** on the tension-producing and shortening capabilities of cardiac muscle.
21 Describes the influence of altered **afterload** on shortening capabilities of cardiac muscle.
22 Defines the terms ***contractility*** and ***inotropic state*** and describes the influence of altered contractility on the tension-producing and shortening capabilities of cardiac muscle.
23 Describes the effect of altered sympathetic neural activity on cardiac inotropic state.
24 States the relationship between ventricular volume, muscle tension, and intraventricular pressure (**Law of Laplace**).

Chapter 3 – The Heart Pump (pp 47 – 70)

The student knows the basic electrical and mechanical events of the cardiac cycle:

1 Correlates electrocardiographic events with mechanical events during the cardiac cycle.
2 Lists major distinct phases of the cardiac cycle as delineated by valve opening and closure.
3 Describes the pressure and volume changes in the atria, the ventricles, and the aorta during each phase of the cardiac cycle.
4 Defines and states normal values for (1) **ventricular end-diastolic volume**, **end-systolic volume, stroke volume, diastolic pressure, peak systolic pressure, and (2) aortic diastolic pressure, systolic pressure, and pulse pressure.**
5 States similarities and differences between mechanical events in left and right heart pump.

6 States the origin of the heart sounds.
7 Diagrams the relationship between left ventricular pressure and volume during the cardiac cycle.

The student understands the factors that determine cardiac output:

8 Defines cardiac output and cardiac index.
9 States the relationship among **cardiac output, heart rate, and stroke volume**.
10 Identifies the major determinants of stroke volume.
  a. Describes the relationship between ventricular wall tension, chamber radius, and pressure (the law of Laplace).
  b. States the **Frank-Starling law of the heart**.
  c. Predicts the effect of altered ventricular preload on stroke volume and the ventricular pressure/volume relationship.
  d. Predicts the effect of altered ventricular afterload on stroke volume and the ventricular pressure/volume relationship.
  e. Predicts the effect of altered ventricular contractility (inotropic state) on stroke volume and the ventricular pressure/volume relationship.
11 Summarizes the influences of the autonomic nervous system and alterations in cardiac pre- and afterload on cardiac output.
12 Describes the effect of cardiac sympathetic nerves on contractility, stroke volume, and cardiac output.
13 Draws a family of cardiac function curves describing the relationship between filling pressure and cardiac output under various levels of sympathetic tone.
14 Given data, calculates cardiac output using the Fick principle.
15 Defines ejection fraction and identifies methods to determine it.
16 Describes the end-systolic pressure -volume relationship.

Chapter 4 – The Electrocardiogram (pp 71 – 82)

The student understands the physiological basis of the electrocardiogram:

1 States the relationship between electrical events of cardiac excitation and the **P, QRS, and T** waves, the **PR interval**, and the **ST segment** of the electrocardiogram.
2 States Einthoven's basic electrocardiographic conventions and, given data, determines the mean electrical axis of the heart.
3 Describes the **standard 12-lead electrocardiogram**.

Chapter 5 – Cardiac Abnormalities (pp 83-92)

The student, through understanding normal cardiac function, diagnoses and appreciates the consequences of common cardiac abnormalities.

1 Detects common cardiac arrhythmias from the electrocardiogram, identifies their physiological bases, and describes their physiological consequences.
2 <u>Lists four common valvular abnormalities for the left heart and describes the alterations in heart sounds, intracardiac pressures, and flow patterns that accompany them.</u>

Chapter 6 – The Peripheral Vascular System (pp 93 – 116)

The student understands the basic principles of cardiovascular transport and its role in maintaining homeostasis:

1 Defines **bulk transport** (convective transport) and **diffusion** and lists factors that determine the rate of each.
2 Given data, uses the **Fick principle** to calculate the rate of removal of a solute from blood as it passes through an organ.
3 Describes how **capillary wall permeability** to a solute is related to the size and lipid solubility of the solute.
4 Lists the factors that influence **transcapillary fluid movement** and, given data, predicts the direction of transcapillary fluid movement.
5 Describes the lymphatic vessel system and its role in preventing fluid accumulation in the **interstitial space**.

Selected Cardiovascular Objectives D'Alecy

The student understands the physical factors that regulate blood flow through the various components of the vasculature:

6 Given data, calculates the equivalent vascular **resistances** of networks of vessels arranged in **parallel** and in **series**.
7 Describes differences in the blood flow **velocity** in the various segments and how these differences are related to their **total cross-sectional area**.
8 Describes **laminar** and **turbulent flow** patterns and the origin of flow sounds in the cardiovascular system.
9 Identifies the approximate percentage of the total blood volume that is contained in the various vascular segments in the systemic circulation.
10 Defines a **peripheral venous pool** and **central venous pool**.
11 Describes the pressure changes that occur as blood flows through a vascular bed and relates them to the vascular resistance of the various vascular segments.

12 States how the resistance of each consecutive vascular segment contributes to an organ's overall vascular resistance and, given data, calculates the overall resistance.
13 Defines **total peripheral resistance** and states the relationship between it and the vascular resistance of each systemic organ.
14 Defines **vascular compliance** and states how the **volume-pressure curves** for arteries and veins differ.
15 Predicts what will happen to venous volume when venous smooth muscle is activated or venous pressure is changed.
16 Describes the role of arterial compliance in storing energy for blood circulation.
17 Describes how arterial compliance changes with age and how this affects arterial pulse pressure.
18 Describes the auscultation technique of determining arterial systolic and diastolic pressures.
(19) Identifies the physical bases of the **Korotkoff sounds**.
20 Indicates the relationship between arterial pressure, cardiac output, and total peripheral resistance and predicts how arterial pressure will be altered when cardiac output and/or total peripheral resistance change.
21 Given arterial systolic and diastolic pressures, estimates mean arterial pressure.
(22) Indicates the relationship between pulse pressure, stroke volume, and arterial compliance and predicts how pulse pressure will be changed by changes in stroke volume, or arterial compliance.
(23) Describe how arterial compliance changes with age and how this affects arterial pulse pressure.

Chapter 7 – Vascular Control (pp 117 – 145)

The student understands the general mechanisms involved in local vascular control:

1 Identifies the major ways in which **smooth muscle** differs anatomically and functionally from **striated muscle**.
2 Lists the steps leading to **cross-bridge cycling** in smooth muscle.
3 Lists major ion channels involved in regulation of membrane potential in smooth muscle.
4 Describes the processes of **electromechanical** and **pharmacomechanical coupling** in smooth muscle.
5 Defines **basal tone.**
6 Lists several substances potentially involved in **local metabolic control**.
7 States the **local metabolic vasodilator hypothesis**.
8 Describes how vascular tone is influenced by prostaglandins, histamine, and bradykinin.
9 Describes the **myogenic response** of blood vessels.
10 Defines **active** and **reactive hyperemia** and indicates a possible mechanism for each.
11 Defines **autoregulation** of blood flow and briefly describes the metabolic, myogenic, and tissue pressure theories of autoregulation.
12 Defines **neurogenic tone** and describes how sympathetic (and parasympathetic) neural influences can alter it.
13 Describes how vascular tone is influenced by circulating catecholamines, vasopressin, and angiotensin II.
14 Lists the major influences on venous diameters.
15 Describes in general how control of flow differs between organs with strong local metabolic control of arteriolar tone and organs with strong neurogenic control of arteriolar tone.

The student knows the dominant mechanisms of flow and blood volume control in the major body organs:

16 States relative importance of local metabolic and neural control of **coronary blood flow**.
17 Defines **systolic compression** and indicates its relative importance to blood flow in the endocardial and epicardial regions of the right and left ventricular walls.

18 Describes the major mechanisms of flow and blood volume control in each of the following specific systemic organs: skeletal muscle, brain, splanchnic organs, skin, and kidney.
19 States why mean pulmonary arterial pressure is lower than mean systemic arterial pressure. (Respiratory Sequence)
20 Describes how pulmonary vascular control differs from that in systemic organs. (Respiratory Sequence)

Chapter 8 – Central Venous Pressure as an Indicator of Circulatory Hemodynamics (pp 146-160)

The student understands how central venous pressure can be used to assess circulatory states and how venous return, cardiac output, and central venous pressure are interrelated:

1 Describes the overall arrangement of the systemic circulation and identifies the primary functional properties of each of its major components.
2 Defines mean circulatory filling pressure and states the primary factors that determine it.
3 Defines **venous return** and explains how it is distinguished from cardiac output.
4 States the reason why cardiac output and venous return must be equal in the steady state.
5 Lists the factors that control venous return.
6 Describes the relationship between venous return and **central venous pressure** and draws the **normal venous return curve**.
6 Defines **peripheral venous pressure**.
7 Lists the factors that determine peripheral venous pressure.
8 Predicts the shifts in the venous return curve that occur with altered blood volume and altered venous tone.
9 Describes how the output of the left heart pump is matched to that of the right heart pump.
10 Draws the normal venous return and cardiac output curves on a graph and describes the significance of the point of curve intersection.
11 Predicts how normal venous return, cardiac output, and central venous pressure will be altered with any given combination of changes in cardiac sympathetic tone, peripheral venous sympathetic tone, or circulating blood volume.
12 Identifies possible conditions that result in abnormally high or low central venous pressure.

Chapter 9 – Regulation of Arterial Pressure (pp 161-184)

The student understands the mechanisms involved in the short-term regulation of arterial pressure:

1 Identifies the **sensory receptors**, **afferent pathways**, **central integrating centers**, **efferent pathways**, and **effector organs** that participate in the **arterial baroreceptor reflex**.
2 States the location of the arterial baroreceptors and describes their operation.
3 Describes how changes in the afferent input from arterial baroreceptors influence the activity of the sympathetic and parasympathetic preganglionic fibers.
4 Describes how the sympathetic and parasympathetic outputs from the medullary cardiovascular centers change in response to changes in arterial pressure.
5 Diagrams the chain of events that are initiated by the arterial baroreceptor reflex to compensate for a change in arterial pressure.
6 Describes how inputs to the medullary cardiovascular centers from cardiopulmonary baroreceptors, arterial and central **chemoreceptors**, receptors in skeletal muscle, the cerebral cortex, and the hypothalamus influence sympathetic activity, parasympathetic activity, and mean arterial pressure.
(7) Describes and indicates the mechanisms involved in the **Bezold-Jarisch reflex**, the cerebral ischemic response, the **Cushing reflex**, the alerting reaction, blushing, **vasovagal syncope**, the **dive reflex**, and the cardiovascular responses to emotion and pain.
(8) Graphs the relationships between mean arterial pressure and sympathetic nerve activity that describe the overall operation of (1) the heart and peripheral vessels and (2) the arterial baroreceptors plus the medullary cardiovascular centers. Uses the graphs to do the following:

a State what determines the normal mean arterial pressure and the normal level of sympathetic nerve activity.
b Indicate how the relationship between sympathetic nerve activity and arterial pressure is shifted by a disturbance on the heart or vessels and how this alters the equilibrium within the arterial baroreceptor reflex control system.

c Indicate how the relationship between mean arterial pressure and sympathetic nerve activity is altered by inputs to the medullary cardiovascular centers not from arterial baroreceptors and how these shift the equilibrium within the arterial baroreceptor reflex control system.

The student understands the mechanisms involved in the long-term regulation of arterial pressure:

(9) Describes **baroreceptor adaptation**.
(10) Describes the influence of changes in body fluid volume on arterial pressure and diagrams the steps involved in the process.
(11) Indicates the mechanisms whereby altered arterial pressure alters glomerular filtration rate and renal tubular function to influence urine output.
(12) Describes how mean arterial pressure is adjusted in the long term to that which causes fluid output rate to equal fluid intake rate.

Chapter 10 – Cardiovascular Responses to Physiological Stresses (pp 185-204)

The student understands the general mechanisms involved in the cardiovascular responses to *any* given normal homeostatic disturbance on the intact cardiovascular system and can predict the resulting alterations in all important cardiovascular variables:

1 Identifies the primary disturbances that the situation places on the cardiovascular system.

2 Lists how the primary disturbances change the influence on the medullary cardiovascular centers from (1) arterial baroreceptors and (2) other sources.
3 States what reflex compensatory changes will occur in sympathetic and parasympathetic nerve activities as a result of the altered influences on the medullary cardiovascular centers.
4. Indicates what immediate reflex changes will occur in heart rate, cardiac contractility, stroke volume, arteriolar tone, venous tone, peripheral venous pressure, central venous pressure, total peripheral resistance, resistance in any major organ, and blood flow through any major organ.
5 Predicts what the net effect of the primary and reflex influences on the cardiovascular variables listed in objective 4 will be on mean arterial pressure.
6 States whether mean arterial pressure and sympathetic nerve activity will settle above or below their normal values.
7 Predicts whether and states how cutaneous blood flow will be altered by temperature regulation reflexes.
8 Indicates whether and how transcapillary fluid movements will be involved in the overall cardiovascular response.
9 Indicates whether, why, how, and with what time course renal adjustments of fluid balance will participate in the response.
10 Predicts how each of the basic cardiovascular variables will be influenced by long-term adjustments in blood volume.

The student understands how respiratory activities influence the cardiovascular system: (Respiratory Sequence)

11 Describes how the "**respiratory pump**" promotes venous return.
12 Identifies the primary disturbances on cardiovascular variables associated with normal respiratory activity.
13 Describes the reflex compensatory responses to respiratory activity.
14 Defines the causes of "**normal sinus arrhythmia**."
15 Lists the cardiovascular consequences of the **Valsalva maneuver and of positive pressure ventilation**.

The student understands the specific processes associated with the homeostatic adjustments to the effects of gravity:

16 States how gravity influences arterial, venous, and capillary pressures at any height above or below the heart in a standing individual.
17 Describes and explains the changes in central venous pressure and the changes in transcapillary fluid balance and venous volume in the lower extremities caused by standing upright.
18 Describes the operation of the "**skeletal muscle pump**" and explains how it simultaneously promotes venous return and decreases capillary hydrostatic pressure in the muscle vascular beds.
19 Identifies the primary disturbances and compensatory responses evoked by acute changes in body position.

20 Describes the chronic effects of a gravity-free environment and compares these to those induced by long-term bed rest.

The student understands the specific processes associated with the homeostatic adjustments to exercise:

21 Identifies the primary disturbances and compensatory responses evoked by acute episodes of dynamic exercise.
22 Describes the conflict between pressure reflexes and temperature reflexes on cutaneous blood flow.
23 Indicates how the "skeletal muscle pump" and the "respiratory pump" contribute to cardiovascular adjustments during exercise.
24 Compares the cardiovascular responses to static exercise with those to dynamic exercise.
25 Lists the effects of chronic exercise and physical conditioning upon cardiovascular variables.

The student understands that gender may influence the cardiovascular system:
26 Describes gender-dependent differences in cardiovascular variables.

The student understands the cardiovascular alterations that accompany birth, growth, and aging.
27 Identifies the pathway of blood flow through the fetal heart and describes the changes that occur at birth.
28 Indicates the normal changes that occur in cardiovascular variables during childhood.
29 Identifies age-dependent changes that occur in cardiovascular variables such as cardiac index, arterial pressure, and cardiac workload.
30 Describes age-dependent changes in the arterial baroreceptor reflex.
31 Distinguishes between age- and disease-dependent alterations that occur in cardiovascular function of the aged.

Chapter 11 – Cardiovascular Function in Pathological Situations (pp 205-222)

The student understands the primary disturbances, compensatory responses, decompensatory processes, and possible therapeutic interventions that pertain to various abnormal cardiovascular situations.
1 Defines **circulatory shock**.
2 Identifies the primary disturbances that can account for **cardiogenic**, **hypovolemic**, **anaphylactic**, **septic**, and **neurogenic shock** states.
3 Lists the compensatory processes that may arise during.
4 Identifies the decompensatory processes that may arise during shock and describes how these lead to **irreversible shock** states.
(5) Indicates how coronary artery disease may lead to abnormal cardiac function.
(6) Defines the term ***angina pectoris*** and describes the mechanisms that promote its development.
(7) Indicates the mechanisms by which various therapeutic interventions may alleviate angina and myocardial ischemia in association with coronary artery disease.
(8) Defines the term ***heartfailure***.
(9) Identifies short-term and long-term compensatory processes that accompany heart failure.
(10) Describes the benefits and detriments of the fluid accumulation that accompanies heart failure.
(11) Defines arterial ***hypertension***.
(12) Identifies the various factors that may contribute to the development of primary hypertension.
(13) Describes the role of the kidney in establishing and/or maintaining hypertension.

SELECTED KEY TERMS FOR RESPIRATION

ventilation
biotransformation
conducting zone
respiratory zone
trachea
bronchi
bronchioles
respiratory bronchioles
alveolar ducts
alveolar sacs
alveoli
Boyle's law
intrapleural fluid
elastic recoil
intrapleural pressure
alveolar pressure
transmural pressure
transpulmonary pressure
atelectasis
pneumothorax
intercostal muscles
diaphragm
inspiration
expiration
spirometer
tidal volume
inspiratory reserve volume
expiratory reserve volume
residual volume
inspiratory capacity
functional residual capacity
vital capacity
total lung capacity
compliance
surface tension
surfactant
type I epithelial cells
type II epithelial cells
respiratory distress syndrome of newborn (RDS)
obstructive lung disease
asthma
chronic obstructive pulmonary disease (COPD)
bronchitis
emphysema
restrictive lung disease
pulmonary fibrosis
forced vital capacity FVC
one second forced expiratory volume FEV1
flow -volume curves
airway mucus
histamine
cilia
mucus escalator
minute volume
anatomical dead space
alveolar dead space
physiological dead space
alveolar ventilation
partial pressure
Dalton's law of partial pressures
hypoventilation
hyperventilation
alveolar gas equations
Henry's law
gas solubility
diffusing capacity
carbon monoxide
hemoglobin
dissolved O2
Hb bound O2 (HbO2)
blood gas content
anemia
hypoxemia
erythropoietin
Bohr shift
2,3 -diphosphoglycerate
carbon dioxide
carbonic anhydrase
carbamino groups
bicarbonate
chloride shift
Haldane shift
ventilation/perfusion ratio (V/Q)
right-left shunt
bronchial circulation
alveolar-arterial (A - a) difference in PO2
medullary respiratory center
Hering-Breuer reflex
peripheral chemoreceptors
carotid body chemoreceptors
aortic arch chemoreceptors
central chemoreceptors
cerebrospinal fluid
blood-brain barrier
respiratory acidosis/alkalosis

RESPIRATION OBJECTIVES

Ventilation and Mechanics

1. Describes the anatomical relationships between lungs, pleura, and chest wall.
2. Defines elastic recoil pressure as applied to the alveolar wall and lung wall.
3. Defines intrapleural pressure, alveolar pressure, and transpulmonary pressure, gives normal values at FRC, and describes how changes in them explain air flow during inspiration and expiration.
4. Defines the term atelectasis, and describes the effects of a pneumothorax on lung mechanics.
5. Describes the differences in the origin of the forces producing inspiration and expiration.
6. Describes the origin of the forces required to decrease lung volume below the functional residual capacity.
7. Defines the various lung volumes and capacities and states the physical forces that determine the value of the functional residual capacity.
8. Describes the effects of posture (lying vs standing) on functional residual capacity.
9. Defines lung compliance and states how it changes during inspiration.
10. States differences in transpulmonary pressures, alveolar volumes and ventilation at apex and base of lung in the upright posture.
11. Defines surface tension; states its effect on lung compliance.
12. Defines surfactant; states its effect on lung compliance.
13. Describes the changes in surfactant secretion with changes in lung volume.
14. Identifies the problem in a child with respiratory distress syndrome of the newborn.
15. Identifies the major mechanical problems associated with obstructive and restrictive lung disease.
16. Defines forced vital capacity (FVC) and one second forced expiratory volume (FEV_1).
17. Describes the effects on airway resistance of changes in lung volume.
18. Identifies the change in airway resistance produced by: parasympathetic stimulation, epinephrine, histamine, and carbon dioxide action on airway smooth muscle.

Alveolar ventilation and Gas Exchange

1. Defines the terms: minute volume (pulmonary-ventilation), alveolar ventilation, anatomical dead space, alveolar dead space and physiological (total) dead space.
2. Defines partial pressure and calculates it for oxygen or carbon dioxide in a gas, given the percentage of each in the gas and the total gas pressure.
3. Lists typical partial pressures of O_2, CO_2, and water in air (at sea level), alveolar air, arterial blood, and mixed venous blood in a healthy individual.
4. Defines hypoventilation, hyperventilation, and hyperpnea.
5. States the difference in solubility in water of O_2 and CO_2 and the effect this difference has on gas diffusion across the alveolar wall.
6. Defines pulmonary diffusing capacity. States how it changes with exercise, alveolar-wall thickening, alveolar edema, and emphysema.
7. States whether O_2 and CO_2 reach equilibrium across the alveolar wall by the end of the pulmonary capillaries, at rest and during exercise in normal and abnormally thickened alveoli.

Pulmonary Blood Flow (Sisson)

1. The student will know the structure, function, distribution and control of pulmonary blood supply
2. Compare pulmonary and bronchial circulation
3. Compare and contrast pulmonary and systemic circulation
4. Describe and explain the effects of cardiac output and lung volume on pulmonary vascular resistance
5. Describe the effects of hypoxia on pulmonary vascular resistance
6. Describe the effects of gravity of pulmonary blood flow
7. Explain Starling's equation
8. Describe the mechanisms of pulmonary edema

Gas Transport

1. States the amount of oxygen dissolved in I L of blood at 100 mm Hg P_{O2} and how this amount will change with changes in P_{O2}.
2. States the amount of oxygen combined with hemoglobin in I L of normal arterial or venous blood (Hb conc. = 15 g/100 ml); defines O_2 carrying capacity.
3. Defines oxygen delivery to a tissue in terms of blood flow and blood oxygen content.
4. Describes the characteristics of the oxygen-Hb saturation curve and gives the % saturation and volume of oxygen per liter of blood in arterial and mixed venous systemic blood.
5. Describes the effect of hyperventilation on the dissolved and Hb-bound oxygen in arterial blood.
6. States the shifts produced in the oxygen-Hb saturation curve by pH, P_{CO2}, temperature, and 2-3 DPG and their adaptive significance.
7. States the effects of anemia on arterial blood oxygen content and P_{O2}.
8. Lists the various causes of tissue hypoxia and the potential benefits of increasing inspired P_{O2}.
9. Describes the stimulus for erythropoietin secretion by the kidney. (Not in Levitzky text.)
10. States the three forms in which CO_2 is carried in the blood and their relative proportions.
11. Describes the role of carbonic anhydrase in CO_2 transport and identifies the location of this enzyme in the blood.
12. Describes the chemical events associated with the uptake and release of CO2 in tissue and lung capillaries respectively.
13. Defines chloride shift and its effect on the location of bicarbonate transported by the blood.
14. Describes the effect of hypo- and hyperventilation on the CO_2 content of the blood.

Respiratory Control (Control of Ventilation)

1. Identifies the location of the respiratory center in the brain.
2. States the types of inputs (stimuli and receptors) that modify the firing of the medullary inspiratory neurons.
3. Identifies the location of the major peripheral and central chemoreceptors affecting respiration and the primary stimuli to which these receptors respond.
4. Describes the effect on ventilation of a decrease in arterial P_{O2} and the reason, in terms of the blood oxygen content, that the response is only significant at very low P_{O2}.
5. Explains why anemia or carbon monoxide poisoning produces no effect on ventilation.
6. Describes the change in ventilation in response to an increase in arterial $[H^+]$ and P_{CO2}.
7. Explains why a decrease in the arterial blood pH produced by an increase in P_{CO2} produces a greater increase in ventilation than the same pH change produced by a metabolic acidosis.
8. Describes the changes in P_{O2}, P_{CO2} and pH in systemic arterial blood during moderate and heavy exercise.

Diffusion of Gases (Sisson)

1. To understand the diffusion of gases in the lung
2. Define diffusion and contrast with bulk flow
3. State Fick's law for diffusion
4. Distinguish between diffusion limitation and perfusion limitation
5. Describe the diffusion of oxygen from the alveoli into the blood
6. Describe the diffusion of CO2 from blood to alveoli
7. Define diffusing capacity and discuss its measurement

Ventilation-Perfusion (V/Q) Relationships (Sisson)

1. Compares the pulmonary arterial blood pressure with systemic arterial pressure and gives the reason for the lower value of the pulmonary arterial pressure.
2. Identifies the bronchial circulation and its effect on arterial gas content.
3. States two reasons that an increased pulmonary arterial pressure causes a reduction in pulmonary resistance.
4. Describes the effect of a forced expiration below FRC and an inspiration above FRC on pulmonary vascular resistance.
5. States the effects of decreased alveolar P_{O2} on pulmonary vascular resistance.

6. States qualitatively the changes in the P_{O2} and P_{CO2} of a "lung unit" produced by increasing or decreasing V/Q.
7. States the normal distribution of V/Q from top to bottom of the lung in an upright individual.
8. Describes the effect of V/Q inequalities on the systemic O_2 and CO_2 content.
9. States the reason that CO_2 content is less affected than O_2 content by V/Q inequalities.
10. Describes the local effects of alveolar O_2 and CO_2 in producing V/Q matching in the normal lung.
11. States the normal value of the (A-a) difference (alveolar Po2 - arteriolar Po2), the causes of this difference and conditions that increase the A-a difference.
12. To recognize the importance of matching ventilation and perfusion
13. To explain the consequences of mismatched ventilation and perfusion
14. To define shunt and dead space physiology
15. To be able to determine the alveolar pO2
16. To be able to determine the A-a O2 gradient and understand the implications of an increased gradient
17. To explain and understand the consequences of regional differences in ventilation and perfusion due to effects of gravity