

RPTH 420
Application of Cardiopulmonary Anatomy and Physiology
Study Guide

Module 1: The Respiratory System in a Nutshell

Upon completion of this module, the student shall be able to:

1. State the primary function of the respiratory system.
2. Define external and internal respiration.
3. Define the following general components of the respiratory system as viewed mechanically.
 - a. controller
 - b. the pump
 - c. the mixer
4. Define the following physiological components of the respiratory system:
 - a. ventilation
 - b. diffusion
 - c. perfusion
5. Describe the primary function of the components in objectives 3 & 4.
6. State in general terms how disease can affect each of the above components.

Preparation/Reading: Egan 180-185

TERMS

Respiration

Ventilation

Diffusion

Perfusion

Oxygen

Carbon Dioxide

Medulla

Phrenic nerve

"Blood brain barrier"

Pleural Pressure

Tidal Volume

Elastic resistance

Compliance

Flow resistance

Respiratory muscles

Ventilation/perfusion ratio

Alveolar/capillary membrane

Work of breathing

Respiratory quotient

Respiratory exchange rate

Module 2: Anatomy of the Respiratory System

Upon completion of this module, the student shall be able to:

1. Define terms, symbols and abbreviations relevant to cardiopulmonary anatomy
2. Describe the following components of the cardiopulmonary system in terms of development, anatomical structures and function(s):
 - a. the chest wall
 - b. the respiratory muscles
 - c. the upper airways
 - d. the lower airways
 - e. the terminal respiratory unit
 - f. the alveolar/capillary unit
 - g. the pulmonary circulation and lymphatics
 - h. the mucociliary escalator
 - i. the respiratory neuromuscular system
3. Describe relevant clinical situations related to pulmonary anatomy to include:
 - a. upper airway obstruction
 - b. asthma
 - c. laryngeal edema
 - d. retained secretions
 - e. A/C membrane disruption

Preparation/Reading:Egans Fundamentals of Respiratory Care, Chapter 8

Ciba Collection, Respiratory System, pp 3-33 - Library Reference Section

TERMS

accessory muscles acinus alveolar/capillary membrane alveolar duct alveolus (pl. alveoli) basal cell bronchial artery bronchial glands bronchial veins bronchiole non-respiratory terminal respiratory bronchus (pl. bronchi) Bronchopulmonary anastomoses bronchopulmonary carina cilia circulation canals of lambert clara cell colloid osmotic pressure columnar epithelium conchae conducting airway cricoid cartilage	diaphragm dipalmitoyl lecithin esophagus elastic fibers epiglottis false ribs floating ribs glottis goblet cell granular pneumocyte hilum horizontal fissure hydrostatic pressure intersitium interstitial fluid dichotomous branching irritant receptor J receptor lamina propria larynx lobe of the lung lobule lymphatics superficial deep parenchymatous J lymphatics	mast cell mediastinum mucus nasal turbinates nasopharynx oblique fissure oxygen pharynx pleura (pl. pleurae) parietal visceral pores of kohn potential space pseudostratified columnar epithelium pulmonary circulation pulmonary ventilation segment of the lung sinuses stretch receptor submucosal glands surfactant systemic circulation type 2 pneumocyte
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Module 3: Pulmonary Ventilation

Upon completion of this module, the student will be able to:

1. Define terms, symbols and abbreviations relevant to pulmonary ventilation.
2. Identify lung volumes and capacities on a spirogram.
3. Detail the interrelationships of the following:
 - tidal volume
 - ventilatory frequency
 - minute ventilation
 - dead space volume
 - dead space/tidal volume ratio
 - minute alveolar ventilation
4. Describe factors affecting resting lung volume.
5. Describe factors affecting airway resistance.
6. Describe factors affecting regional ventilation of the lung.
7. Describe factors affecting compliance of the lung, chest wall and respiratory system.
8. Describe the concept of ventilation/perfusion matching
9. Discuss the concept of "work of breathing".
10. Calculate the following:
 - minute ventilation
 - minute alveolar ventilation
 - dead space/tidal volume ratio
 - dead space volume
 - lung compliance
 - chest wall compliance
 - respiratory system compliance
 - lung volumes and capacities

Preparation/Reading:

Egans Fundamentals of Respiratory Care, Chapter 10

Practice word and calculation problems

TERMS

accessory muscles
 airway resistance
 alveolar instability
 breathing frequency
 collagen
 compliance
 lung
 chest wall
 respiratory system
 compliance curve
 cross-sectional area
 diaphragm
 dead space
 anatomic
 alveolar
 physiologic
 mechanical
 distensibility
 elastance
 elastic recoil
 elastin
 equal pressure point
 expiratory reserve volume
 frictional resistance
 functional residual capacity
 heliox therapy
 hysteresis
 inspiratory capacity
 inspiratory reserve volume
 intercostal muscles
 Laplace's equation
 minute alveolar ventilation
 minute ventilation
 perfusion
 pleural fluid
 pleural pressure gradient
 residual volume
 resistance
 airway
 chest wall
 pulmonary alveolar
 respiratory rate
 surface tension
 surfactant
 tidal volume
 total lung capacity
 transpulmonary pressure
 transthoracic pressure
 vital capacity

SYMBOLS - ABBREVIATIONS

ERV
 FRC
 IC
 IRV
 RV
 TLC
 V_t
 VC

 f
 V_d
 V_A
 V_d/V_t
 P_{alv}
 P_{bs}
 P_{pl}
 P_{esoph}

Module 4: The Cardiovascular System and its Relation to the Pulmonary System

Upon completion of the module, the student will be able to:

1. Define terms, symbols and abbreviations related to the circulatory system.
2. Identify the chambers of the heart and their pressures in torr.
3. Identify the vessels in the pulmonary circulation and for each state:
 - a. anatomy
 - b. specific function(s)
 - c. normal pressure
4. Compare and contrast the pulmonary and systemic circulations.
5. Identify factors affecting fluid movement between the intravascular and interstitial spaces.
6. Identify factors affecting pulmonary and systemic vascular resistance.
7. Identify factors affecting regional perfusion and V/Q ratio in the lung.

Preparation/Reading:

Egans Fundamentals of Respiratory Care, Chapter 9

TERMS

adult respiratory distress syndrome
 cardiac output
 congestive heart failure
 cor pulmonale
 hydrostatic pressure
 cardiac index
 hypoxic vasoconstriction
 index
 osmotic pressure
 permeability
 pulmonary circulation
 bronchial circulation
 pulmonary edema
 pulmonary embolus (pl. emboli)
 pulmonary hypertension
 pulmonary vascular resistance
 nitric oxide
 Starling equation
 systemic circulation
 system vascular resistance
 vasoconstriction
 ventricular hypertrophy
 pulmonary artery occlusion pressure (wedge pressure)

SYMBOLS - ABBREVIATIONS

ARDS
 Qt
 CHF
 CO
 HTN
 PAOP (PAW, PCWP)

Module 5: Diffusion and Exchange of Pulmonary Gases

Upon completion of the module, the student will be able to:

1. Define terms, symbols, and abbreviations related to gas diffusion and transport.
2. Name the structures of the alveolar/capillary membrane.
3. Identify factors which affect diffusion of pulmonary gases.
4. Describe differences in diffusion of O₂ and CO₂.
5. Describe and quantify movement of O₂ and CO₂ between the atmosphere and erythrocyte.
6. State normal values for: PAO₂, PACO₂, PaCO₂, PaO₂, PvO₂, PvCO₂
7. Describe how alterations in V/Q affect gas exchange.
8. Calculate the following:
 - a. PAO₂
 - b. P(A-a)O₂
9. Describe the chemical makeup of hemoglobin, its oxygen carrying capacity and several reasons for inadequate carrying capacity.
10. Describe oxyhemoglobin equilibrium in terms of:
 - a. partial pressure versus hemoglobin saturation
 - b. factors affecting shifting of the oxyhemoglobin dissociation curve
 - c. factors affecting cellular oxygen availability
11. State normal values for SaO₂ and SvO₂
12. State methods of measuring oxygenation to include:
 - a. PaO₂
 - b. SaO₂ (oximetry and co-oximetry)
 - c. TcPO₂ (surface PO₂)
13. Define and give clinical examples of the following causes of hypoxemia:
 - a. ambient changes
 - b. hypoventilation
 - c. ventilation/perfusion mismatch
 - d. shunt
 - e. diffusion defect
14. Define and give clinical examples of the following causes of hypoxia
 - a. anemia
 - b. hypoxemia
 - c. ischemia (cardiovascular)
 - d. histotoxic (cellular)
15. Detail carbon dioxide transport and impaired CO₂ removal

Preparation/Reading:

Egans Fundamentals of Respiratory Care, Chapter 11

Computer Tutorial: Arterial Blood Gases

TERMS, SYMBOLS AND ABBREVIATIONS

alveolar air equation

anemia

diffusion

gas density

Graham's law

Henry's law

solubility coefficient

venous admixture

ventilation/perfusion ratio

Bohr effect

carbon monoxide

cyanosis

desaturation

Haldane effect

hemoglobin

hemoglobinopathy

histotoxic

hypoperfusion

hypoxemia

hypoxia

methemoglobin

oxyhemoglobin dissociation curve

reduced hemoglobin

sickle cell anemia

spectrophotometry

2,3 diphosphoglycerate (2,3 DPG)

PAO₂

PaO₂

PACO₂

PaCO₂

PvO₂

PvCO₂

P(A-a)O₂

DLCO

V/Q

Module 6: Control of Ventilation

Upon completion of this module, the student will be able to:

1. Describe receptors in the cardiopulmonary system responsible for modification of ventilatory drive to include:
 - a. chemoreceptors
 - aortic
 - carotid
 - medullary
 - b. baroreceptors
 - c. irritant receptors
 - d. J receptors
 - e. stretch receptors

2. Describe respiratory components of the following areas of the central nervous system
 - a. medulla
 - b. pons
 - c. pneumotaxic center
 - d. dorsal respiratory group
 - e. ventral respiratory group
 - f. cerebral cortex
 - g. spinal cord

3. Describe conditions that affect the control of respiration to include:
 - a. sleep
 - b. traumatic injury
 - c. neuromuscular disorders

Preparation/Reading

Egans Fundamentals of Respiratory Care, Chapter 14

TERMS

aortic bodies
 apneustic breathing
 ataxic breathing
 Biots breathing
 Cheyne Stokes breathing
 baroreceptors
 carotid bodies
 central chemoreceptors
 eupnea
 Hering-Breuer reflex
 irritant receptors
 J receptors
 medulla
 Ondines curse
 stretch receptors

Vagus nerve

Phrenic nerve

Module 7: Gas Transport and Acid - Base Balance

Upon completion of this module, the student will be able to:

1. Define terms, symbols and abbreviations relevant to acid-base balance.
2. Discuss the Henderson-Hasselbach equation.
3. State categories of acid-base disorders.
4. Define and describe methods to determine respiratory and metabolic compensation.
5. State conditions which can cause respiratory and metabolic disturbances
6. Interpret arterial blood gas studies.
7. Calculate CaO_2 , SaO_2 , CvO_2 and $C(a-v)O_2$.
8. Use the Siggard-Anderson nomogram to determine Given ABG values.

Preparation/Reading:

Egans Fundamentals of Respiratory Care, Chapter 13

Computer Tutorial: Arterial Blood Gases

TERMS

acidemia
acidosis
aerobic
alkalemia
alkalosis
ambient
anaerobic
anemia
base excess/deficit
bicarbonate
 plasma
 standard
Bohr effect
buffer
carbonic acid
carbonic anhydrase
carbon monoxide
chloride shift
compensation
diabetic ketoacidosis
Haldane effect
Henderson-Hasselbalch equation
hydrogen ion
hypercarbia
hypoperfusion
mass action
metabolic
plasma proteins
renal compensation
respiratory compensation

SYMBOLS - ABBREVIATIONS

BE/BD
DKA
2.3 DPG
A (subscript)
a (subscript)
F
[H+]
HCO₃
I (subscript)
P
pH
v (subscript)