



COMMON COURSE NUMBER: RET 1485

COURSE TITLE: CARDIOPULMONARY ANATOMY AND PHYSIOLOGY

CREDIT HOURS: 3

CONTACT HOUR BREAKDOWN:

Lecture/Discussion: 48

Laboratory: 0

Other: 0

CONTACT HOURS/WEEK: 3

CATALOG COURSE DESCRIPTION:

This course provides an in depth study of the anatomy of the cardiopulmonary system. Included is a review of the physiology of respiration including ventilation mechanics and control, internal and external respiration, gas exchange and acid base balance.

Prerequisite: BSC 1085, CHM 1033, MAT 1033 or MTB 1310

Co requisite: RET 1026 OR CPT 2620

General Education Requirements - Associate of Arts Degree, meets Area(s): none

General Education Requirements - Associate in Science Degree, meets Area(s): none

UNIT TITLES:

1. Pulmonary anatomy
2. Cardiac anatomy and physiology
3. Pulmonary circulation
4. Ventilation/perfusion distribution
5. Blood and tissue oxygenation
6. Dynamics of ventilation
7. CO₂ transport and acid base physiology
8. Neurogenic control of ventilation

I. Course Overview:

Upon successful completion of this course, the students should be able to

II. Units:

| UNIT 1. | PULMONARY ANATOMY |
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| General outcomes | The student will identify the primary structures of the pulmonary system and describe their function. |
| | SPECIFIC LEARNING OUTCOMES To successfully complete this unit the student will: |
| 1.1 | Identify the major thoracic surface landmarks. |
| 1.2 | list the primary and accessory muscles of ventilation and identify their primary function. |
| 1.3 | Describe the action of the diaphragm in ventilation. |
| 1.4 | Describe the clinical significance of a flattened diaphragm. |
| 1.5 | Identify the costaphrenic angle and describe its importance in evaluating diaphragmatic function and pulmonary disorders. |
| 1.6 | Identify the location of the lung fissures and the names and location of all lung lobes and segments. |
| 1.7 | Identify the mediastinum and describe its contents. |
| 1.8 | Describe the structure and function of the upper airways |
| 1.9 | Compare and contrast the large and small airways with emphasis on the structure and function of each. |
| 1.10 | Identify, describe and differentiate between the portions of the airway which comprise the anatomic dead space and the parenchyma or acinus. |
| 1.11 | Define anatomic and physiologic dead space. |
| 1.12 | Calculate dead space ventilation, minute ventilation and alveolar ventilation when given respiratory rate, tidal volume and patient weight. |
| 1.13 | Determine the appropriate tidal volume and tidal volume to weight ratios for mechanically ventilated patients. |
| 1.14 | Describe the primary defense systems of the lungs and airways. |

| UNIT 2. | CARDIAC ANATOMY and PHYSIOLOGY |
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| General outcomes | The student will identify the structures of the heart and the cardiac conduction system. |
| | <p style="text-align: center;">SPECIFIC LEARNING OUTCOMES</p> <p style="text-align: center;">To successfully complete this unit the student will:</p> |
| 2.1 | Identify the pericardium and describe its structure and function. |
| 2.2 | Identify the layers of the heart wall and describe the location and structure of each layer. |
| 2.3 | Identify the four chambers of the heart and describe the location and function of each chamber. |
| 2.4 | List the four cardiac valves and describe their location and function. |
| 2.5 | Identify the major coronary blood vessels. |
| 2.6 | Indicate the location of each of the coronary blood vessels and the area of the myocardium each vessel perfuses. |
| 2.7 | Identify the major vessels of the body's venous and arterial circulatory systems. |
| 2.8 | Identify the structural characteristics of the venous and arterial blood vessels. |
| 2.9 | Describe the process of synchronization of cardiac muscle function. |
| 2.10 | Describe the cardiac conduction pathway |
| 2.11 | Define the terms depolarization, repolarization and the refractory period with emphasis on their relationship to P, QRS and T waves on the ECG tracing. |
| 2.12 | Define systole and diastole. |
| 2.13 | Describe action potential and the role of electrolytes during the cardiac cycle. |
| 2.14 | List the four phases of cardiac muscle contraction. |
| 2.15 | Describe myocardial contraction in terms of the sliding filament model. |
| 2.16 | Describe the Frank Starling's law of the heart. |
| 2.17 | Define the terms preload, afterload, contractility and ejection fraction as they relate to cardiac function. |
| 2.18 | List the normal values for ventricular stroke volume, ejection fraction and end diastolic pressure. Describe the interrelationship of these variables to each other. |
| 2.19 | Define cardiac output and list the methods used to measure and calculate cardiac output. |

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| UNIT 3. | CARDIAC ANATOMY AND PULMONARY CIRCULATION |
| General outcomes | The student will identify the structures of the heart and the pulmonary vascular system and indicate the methods used to evaluate pulmonary vascular function. |
| | SPECIFIC LEARNING OUTCOMES |
| | To successfully complete this unit the student will: |
| 3.1 | Identify the four chambers of the heart, describe their location and function and indicate the normal pressures which are generated in each. |
| 3.2 | Indicate the volume of blood which normally occupies the pulmonary vascular bed and the volume which occupies the pulmonary capillaries. |
| 3.3 | Describe the mechanism which enables the pulmonary vascular bed to handle high volume cardiac output. |
| 3.4 | List the normal pulmonary artery systolic, diastolic and mean pressures. |
| 3.5 | List the normal values for left ventricular stroke volume, ejection fraction and end diastolic pressure. |
| 3.6 | Describe the relationship between ventricular stroke volume, ejection fraction and end diastolic pressure. |
| 3.7 | Describe how changes in ventricular stroke volume, ejection fraction and end diastolic pressure affect pulmonary vascular volumes and pressures. |
| 3.8 | List the normal value for colloid osmotic pressure (COP) in the pulmonary capillaries. |
| 3.9 | Describe the primary factor which regulates COP. |
| 3.10 | Describe the pulmonary complications which occur when COP is exceeded by pulmonary hydrostatic pressure. |
| 3.11 | Differentiate between cardiogenic and non cardiogenic pulmonary edema. |
| 3.12 | Describe how chronic hypoxemia and left heart failure cause right failure and cor pulmonale. |

| UNIT 4. | VENTILATION/PERFUSION DISTRIBUTION |
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| General outcomes | The student will describe the normal ventilation perfusion characteristics of the lung and indicate the cause and effect of ventilation/perfusion defects. |
| | SPECIFIC LEARNING OUTCOMES To successfully complete this unit the student will: |
| 4.1 | List the normal average value for \dot{V}_A/\dot{Q}_C for the lung. |
| 4.2 | Describe the normal variation in \dot{V}_A/\dot{Q}_C ratio distribution in the upright lung. |
| 4.3 | List and describe the physiologic causes for nonuniform capillary perfusion. |
| 4.4 | List and describe the physiologic causes for nonuniform ventilation. |
| 4.5 | List and describe the pathologic causes for nonuniform pulmonary ventilation |
| 4.6 | List and describe the pathologic causes for nonuniform capillary perfusion. |
| 4.7 | List the normal P_{O_2} and P_{CO_2} in the systemic and pulmonary blood vessels and in the alveoli. |
| 4.8 | Calculate $P_{A_{O_2}}$ when given F_{iO_2} , P_B , P_{aCO_2} and R. |
| 4.9 | Describe the physiologic consequences of \dot{V}_A/\dot{Q}_C variation on arterial blood gas parameters. |
| 4.10 | Differentiate between alveolar ventilation and dead space ventilation. |
| 4.11 | Differentiate between alveolar and anatomic dead space ventilation. |
| 4.12 | List and describe the causes and effects of increased dead space ventilation. |
| 4.13 | Differentiate between dead space ventilation and shunts |
| 4.14 | Calculate \dot{V}_E and \dot{V}_A when given tidal volume, respiratory rate and dead space ventilation. |

| UNIT 5. | BLOOD and TISSUE OXYGENATION | | | | | | | | | | | | |
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| General outcomes | The student will identify the factors which are responsible for maintaining normal pulmonary, blood and tissue oxygenation. | | | | | | | | | | | | |
| | SPECIFIC LEARNING OUTCOMES To successfully complete this unit the student will: | | | | | | | | | | | | |
| 5.1 | List the normal values for: <table style="margin-left: auto; margin-right: auto; border: none;"> <tr> <td style="padding: 0 15px;">PaO_2</td> <td style="padding: 0 15px;">$P\bar{v}O_2$</td> <td style="padding: 0 15px;">$P_{A}O_2$</td> <td style="padding: 0 15px;">$\dot{V}C_{O_2}$</td> </tr> <tr> <td style="padding: 0 15px;">SaO_2</td> <td style="padding: 0 15px;">$S\bar{v}O_2$</td> <td style="padding: 0 15px;">$P(A-a)O_2$</td> <td style="padding: 0 15px;">$\dot{V}O_2$</td> </tr> <tr> <td style="padding: 0 15px;">CaO_2</td> <td style="padding: 0 15px;">$C\bar{v}O_2$</td> <td style="padding: 0 15px;">$C(a-\bar{v})O_2$</td> <td style="padding: 0 15px;">\dot{V}_A/\dot{Q}_c</td> </tr> </table> | PaO_2 | $P\bar{v}O_2$ | $P_{A}O_2$ | $\dot{V}C_{O_2}$ | SaO_2 | $S\bar{v}O_2$ | $P(A-a)O_2$ | $\dot{V}O_2$ | CaO_2 | $C\bar{v}O_2$ | $C(a-\bar{v})O_2$ | \dot{V}_A/\dot{Q}_c |
| PaO_2 | $P\bar{v}O_2$ | $P_{A}O_2$ | $\dot{V}C_{O_2}$ | | | | | | | | | | |
| SaO_2 | $S\bar{v}O_2$ | $P(A-a)O_2$ | $\dot{V}O_2$ | | | | | | | | | | |
| CaO_2 | $C\bar{v}O_2$ | $C(a-\bar{v})O_2$ | \dot{V}_A/\dot{Q}_c | | | | | | | | | | |
| 5.2 | Calculate $P_{A}O_2$ when given FiO_2 , P_B , $PaCO_2$ and R. | | | | | | | | | | | | |
| 5.3 | Calculate CaO_2 when given PaO_2 , SaO_2 , and Hemoglobin. | | | | | | | | | | | | |
| 5.4 | Calculate $C\bar{v}O_2$ when given $P\bar{v}O_2$, $S\bar{v}O_2$, and Hb. | | | | | | | | | | | | |
| 5.5 | Calculate the shunt fraction when given the information in 5.2, 5.3 and 5.4 above. | | | | | | | | | | | | |
| 5.6 | Calculate cardiac output when given $\dot{V}O_2$ and the information in 6.3 and 6.4 | | | | | | | | | | | | |
| 5.7 | When given any two of the following, $\dot{V}O_2$, \dot{Q} and $C(a-\bar{v})O_2$, will calculate the third. | | | | | | | | | | | | |
| 5.8 | Draw the oxyhemoglobin dissociation curve. | | | | | | | | | | | | |
| 5.9 | Indicate the P_{O_2} which would correspond to oxygen saturations of 50%, 75%, 90% and 95%. | | | | | | | | | | | | |
| 5.10 | List all of the factors which cause the curve to shift and the direction of the shift each causes. | | | | | | | | | | | | |
| 5.11 | List the 4 types of hypoxemia. | | | | | | | | | | | | |
| 5.12 | List the primary causes and effects for each type of hypoxia. | | | | | | | | | | | | |
| 5.13 | Describe how hypoventilation, \dot{V}_A/\dot{Q}_c mismatch and shunts affect blood oxygenation and $P(A-a)O_2$. | | | | | | | | | | | | |
| 5.14 | Define cyanosis, list its primary causes, and describe its value as an indication of hypoxemia. | | | | | | | | | | | | |

| UNIT 6. | DYNAMICS OF VENTILATION |
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| General outcomes | The student will describe the methods used to evaluate lung function and the causes of pulmonary abnormalities. |
| SPECIFIC LEARNING OUTCOMES To successfully complete this unit the student will: | |
| 6.1 | Describe intrapleural and transpulmonary pressure |
| 6.2 | Describe how intrapleural and transpulmonary pressures change during the ventilatory cycle |
| 6.3 | indicate how changes in lung volumes affect lung compliance, transpulmonary pressure and intrapleural pressure. |
| 6.4 | Define the terms lung compliance and airway resistance and give the normal values for each. |
| 6.5 | Write the formula for lung compliance |
| 6.6 | Write the formula for airway resistance |
| 6.7 | Calculate lung compliance when pressure change and tidal volume are known. |
| 6.8 | Calculate airway resistance when pressure change and flow rates are known. |
| 6.9 | List the portions of the airway in which resistance is greatest and indicate the reason for variability. |
| 6.10 | List the three pathologic factors which tend to decrease airway size. |
| 6.11 | Describe frequency dependent airway resistance |
| 6.12 | Give the formulas for Poiseuille's and La Place's Laws. |
| 6.13 | Describe surface tension |
| 6.14 | Describe how surface tension affects lung stability. |
| 6.15 | Describe the role of α_1 - antitrypsin and surfactant in maintaining pulmonary stability. |
| 6.16 | List the diseases which are associated with α_1 - antitrypsin and surfactant deficiency. |
| 6.17 | Identify the source of surfactant. |
| 6.18 | Draw a pulmonary function curve. Label each of the lung volumes and capacities, define each and describe their relationships to each other. |
| 6.19 | Calculate the size of any of the lung capacities when the size of the appropriate lung volumes or other lung capacities is known. |
| 6.20 | Calculate the size of any of the lung volumes when the size of the appropriate lung capacities or other lung volumes is known. |
| 6.21 | Indicate how abnormal lung size, lung compliance and airway resistance are used to detect the presence of obstructive and restrictive pulmonary diseases. |
| 6.22 | Describe air trapping |
| 6.23 | Describe the affect that air trapping has on lung function. |

| UNIT 7. | CO ₂ TRANSPORT and ACID BASE PHYSIOLOGY |
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| General outcomes | The student will describe the methods used to measure and evaluate blood acid base status. |
| | SPECIFIC LEARNING OUTCOMES To successfully complete this unit the student will: |
| 7.1 | Describe the relationship between $\dot{V}CO_2$, \dot{V}_A and P_ACO_2 . |
| 7.2 | Identify all of the forms in which CO ₂ is found in the body. |
| 7.3 | Correlate PCO ₂ with the amount of dissolved CO ₂ in the blood. |
| 7.4 | Explain the function of carbonic anhydrase in CO ₂ transport. |
| 7.5 | Describe the Chloride Shift. |
| 7.6 | Describe the Bohr and Haldane effects. |
| 7.7 | Define acids, bases and buffers. |
| 7.8 | Write the Henderson-Hasselbalch equation. |
| 7.9 | Calculate the pH when given the HCO ₃ :CO ₂ ratio by using the Henderson-Hasselbalch equation |
| 7.10 | Calculate pH when given the H ⁺ concentration. |
| 7.11 | Describe the role of the lungs and kidneys in acid base regulation. |
| 7.12 | Recognize and identify acid base abnormalities when presented with blood gas values. |
| 7.13 | Correlate acid base disturbances with causative disorders. |
| 7.14 | Identify the compensatory mechanisms the body employs in acid base disturbances. |
| 7.15 | List the appropriate corrective measures for specified acid base disorders. |

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| UNIT 8. | NEUROGENIC CONTROL OF RESPIRATION |
| General outcomes | The student will describe the physiologic controls which maintain eupnea and neurogenic abnormalities which disrupt normal function. |
| | SPECIFIC LEARNING OUTCOMES To successfully complete this unit the student will: |
| 8.1 | Describe the function of the peripheral and central chemoreceptors. |
| 8.2 | Describe the differences and similarities between the central and peripheral chemoreceptors with specific reference to: location response time substance sampled chemical stimulants afferent and efferent pathways |
| 8.3 | Describe the Hering-Breuer Reflex |
| 8.4 | Describe the function of stretch receptors, J receptors and the vagus nerve in maintaining ventilatory control. |
| 8.5 | Describe and diagram these breathing patterns: Biot's, Cheyne-Stokes, eupnea, apnea and apneustic breathing |
| 8.6 | Differentiate between the mechanisms for voluntary and involuntary respiratory control. |