



Faculty of Medicine and Allied Medical Sciences (FM&AMS)



Module 3: Respiratory System

Academic year 2019

Year 1

Prepared by
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Respiratory module details

Module details

Course	MBBS
Year	One
Term	Two
Commencement date	Monday 19th August 2019
Duration of module	04 weeks
Pre-requisites	Successful completion of Module 1A, 1B, 2 & 3
Disciplines covered	Physiology, Biochemistry, Anatomy, Pakistan studies
Learning outcomes	the competent medical practitioner, the professional
Competencies covered	I (Skilful), and II (Knowledgeable/ problem solver),
Module assessment	End-module assessment (9th September 2019)
Assessment methods	one-correct Answer (MCQs) & Structured Answer Questions (SAQs), Objective Structured Practical Examination (OSPE)
Year 1 coordinator	Dr Syna Amir



Respiratory module

Introduction

Welcome to the respiratory system module. This module is designed to facilitate learning of the normal structure/ function relationships of respiratory system. The main content areas of the module are covered over a period of four weeks during the 2nd term of first-year medical education.

Respiration occurs throughout life and respiratory regulations are constantly made in health and in disease states. Therefore, good knowledge of the structure and function of the respiratory system is the key to understand and interpret normal and diseased states. In addition to the aspects related to normal structure and function of respiratory system, features of common respiratory disorders are highlighted in preparation for revisited diseases of the cardiopulmonary module during Term 5 (that is module 12).

Students are encouraged to engage on active self-learning using the respiratory module study guide and the list of reading materials as guides. Teaching and learning activities of this module will be in the form of lectures, tutorials, practical, clinical skills laboratories and small group discussions. Over the course of the medical education, you as students will discover that plenty of self-directed learning will provide an opportunity to cover instructional objectives mentioned in the guide in-depth and read topic of your liking.

As in the previous module guides, this module contains several scenarios of real-life situations that you may see in your daily life. They are introduced to help you learn the structure and function of the respiratory system in an integrated manner.

Dr. Kabir Dherwani.



Aim

The aim of this module is to identify the key themes from the disciplines of anatomy, physiology & biochemistry and apply them to understand clinical problems for each week. And to highlight the more important learning issues and the opportunities for acquiring the essential information.

It is important to point out that the information in this guide is merely a skeleton on which to base your learning from the teaching course and from further reading. At the end of three weeks, you should have acquired the core information required to pass the assessment.

Structure of the Course

To achieve these overall aims, this module comprises seven weeks with a separate theme for almost each week. Therefore, structuring your learning around key areas in cardiovascular health and disease.

Week 01: Structure and function of the lungs

Week 02: Mechanics of ventilation

Week 03: Regulation of respiration & basics of lung diseases

Week 04: Exam week



Module 4: Respiratory System

Outcomes of the module:

At the end of this module, first-year medical student should be able to

- Describe the normal structure and functional relationships of respiratory system in order to better appreciate the pathogenesis of lung diseases.
- Apply the basic scientific knowledge in understanding the respiratory adjustments in health and in disease states.
- Explain the physiological basis of signs and symptoms of altered structure and function of the respiratory system.
- Interpret the results of respiratory investigations in the underlying derangements,
- Analyse the changes in different clinical states of respiratory and metabolic alkalosis and acidosis by applying the knowledge of pH, buffer system and cellular respiration,
- Provide Cardiopulmonary Resuscitation in the event of cardio-respiratory arrest (Revisited).

Main Content Areas

- Structure of Nasal air passages
- Structure and function of larynx
- Structure and function of diaphragm
- Embryology of the respiratory system
- General structure of the thorax
- Structure of airways/lungs
- Histology of airways/lungs
- Mechanics of ventilation
- Lung volumes and capacities
- Pulmonary blood flow and its regulation
- Gas exchange across Alveolar Capillary Membrane
- Distribution of ventilation and V/Q quotient
- Modified acts of respiration
- Gas transport between lungs and tissues



- Regulation of respiration
- Lung function tests
- Chest radiography and investigations
- Hypoxia and respiratory failure
- Chronic Obstructive lung Diseases
- Asthma

Practical/ Clinical skills

- Identification of the epithelium over the course of the upper and lower respiratory tract at different magnification level,
- Physical examination of the respiratory system (Anterior and posterior approach) (postponed).
- Conduct Peak Expiratory flow test and interpret Lung Function Tests. (will be revisited during third and final year clinical rotation in the medicine)
- Interpret the arterial blood gases to identify respiratory/ metabolic acidosis/ alkalosis – (this will be revisited in the Urinary system module – second-year MBBS)
- Perform cardiopulmonary resuscitation (CPR)



The Respiratory module team:

Prof. Dr. Zaheer Memon	Anatomy
Dr. Syna Amir	Anatomy/ Year coordinator
Dr. Aftab Abbasi	Anatomy
Dr. Pirha	Anatomy
Dr. Shaukat Memon	Anatomy
Dr. Shahab Hanif	Anatomy
Dr. Saqib Baloch	Anatomy
Prof. Dr. Maria Kazi	Biochemistry
Dr. Hina Khanzada	Biochemistry
Dr. Ruby	Biochemistry
Dr. Sheeraz	Biochemistry
Prof. Dr. Navaid Kazi	Physiology
Dr. Yaar Mohammad Nizamani	Physiology
Dr Abroo Kazi	Physiology
Dr Haji Khan	Physiology
Dr. Arsalan	Physiology
Dr Kabir Dherwani	Medical Education/ Clinical Teaching



Main Content Area

Main Content Area	Lectures	Practical	Clinical Skills	Tutorial	Problem-based Learning	Self-study
Anatomy & Physiology of the Respiratory system: Structure of nasal air passages, Structure and function of larynx, Structure and function of Diaphragm, Embryology of the respiratory system, General Structure of thorax, Structure of airways & lungs, Histology of airways & lungs						
Mechanics of ventilation: Lung volumes & capacities, Pulmonary blood flow & its regulation, gas exchange across the alveolar capillary membrane, Distribution of ventilation & V/Q quotient, Modified acts of respiration, Gas transport between lungs and tissues						
Regulation of respiration: Hypoxia, regulation of respiration, lung function tests, Chronic Obstructive Airway Diseases, Asthma, Air and pollution.						
Total						

Lectures 01 hour (50 minutes approximately)

Practical/ Laboratory 02 hours

Tutorials/ small group discussions (SGD) 02 hours

A – Must know,

B – Should know,

C – Nice to know

L – Lecture,

SGD – Small group discussion,

SS – Self-study



Real life incident – Stridor

Your neighbour visits you to inform that his grandfather was suddenly admitted to the Isra university hospital last night. The reason for the admission was sudden difficulty in breathing and he also noticed a “sound” coming from the throat when “breathing in”. He tells you that his grandfather is about 70-year-old and has had noisy breathing especially at night and his voice was becoming hoarse. He refused to see a doctor as it was not causing much problem. The family has also noticed a recent loss of weight and loss of interest in food, which they attributed to “ageing”.

He was admitted immediately to the hospital via emergency. The family was informed that “a block in the throat” was causing difficulty in breathing. In order to ease the breathing, they had made a hole in his windpipe to bypass the block (tracheostomy). They had been told that certain tests will be needed to find the cause for his “noisy breathing”. They were also told that surgery might be needed.

You neighbour asks you to help him understand his grandfather’s condition and need for surgery.

You are just about to start your module on respiratory system. You are keen to find out the causes for his problems. You make a list of possible causes and identify the areas you need to gather more knowledge to understand his condition.



Real life incident 2 – Sudden Shortness of Breath

You father telephones you in the morning to inform that your younger brother was admitted to the hospital last night following a sudden attack of difficulty in breathing, breathlessness with noisy breathing.

The doctors have told the father that your brother has developed an attack of asthma for which he was being treated with O₂ and nebulized with a drug called Salbutamol. They also have informed your father that your brother may even need admission to the Intensive Care Unit, if he does show any improvement with present treatment.

You decide to find out how your brother is doing in his condition and why he is being treated with O₂. You also wish to know why the doctors think your brother may need admission to Intensive Care Unit (ICU).

You remember that your brother had similar problems of cough and wheeze in the past for which he was treated. However, he never needed hospital admission before. You decide to go and meet the doctors immediately. Therefore, you decide to make a list of what you already know and the issues you would need more information about.



Anatomy of the respiratory system

Topic: Structure of the nasal air passages

Content area:

1. General structure of external nose, nasal cavity, pharynx, sinuses and nasopharynx.

Instructional objectives:

- Describe the general structure of external nose, nasal cavity, paranasal sinuses and nasopharynx.

Topic: Structure and function of the larynx

Content area:

1. Structure of the larynx (A)
2. Laryngoscopy view of laryngeal inlet (A)
3. Surface mark the site for cricothyroid puncture (A)
4. Surface mark the site for tracheostomy (A)

Instructional objectives:

- Describe the anatomy of the larynx.
- Explain the structure and function relationship of larynx.
- Draw and label the structure seen during laryngoscopy.
- Identify the landmarks for cricothyroid puncture.
- Identify the landmarks for tracheostomy.

Topic: General structure of the thorax

Content area:

1. Bones, cartilages and joints of thoracic skeleton (A)
2. Muscles of the respiration (A)
3. Segmental innervation and blood supply of the thoracic wall (A)
4. Boundaries of thoracic inlet and outlet (A)
5. Surface marking of the lungs and pleura (A)
6. General structure of the diaphragm (A)

Instructional objectives:

- Describe the general structure of the thoracic cage.
- Draw the anterior, middle and posterior axillary lines and midclavicular line on the chest wall.
- Surface mark the lungs and pleura on the chest wall.
- Describe the general structure of the diaphragm.
- Identify the following important bony landmarks:
 - Sternal angle,
 - Sternocostal joints,
 - xiphoid process,
 - Midclavicular line
 - Tip of the 9th costal cartilage.



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Medical Education Department

Topic: Structure of the airways and lungs

Content area:

1. Structure anatomy of trachea, bronchial tree, bronchopulmonary segments, lung and pleura (A)

Instructional objectives:

- Describe the anatomy of trachea, bronchial tree, lungs and pleura.

Topic: Histology and Embryology of airways and lungs

Content area:

1. Histology of the upper and lower respiratory tracts and alveoli (A)
2. Normal developmental embryology of the nasal passages, larynx, bronchi, lungs, pleura and thoracic cavity and diaphragm. (A)

Instructional objectives:

- Identify and describe the microstructure of upper and lower respiratory tracts and alveoli.
- Describe the normal development embryology of the respiratory system.



Physiology of the respiratory system

Topic: Mechanics of ventilation

Content area:

1. Physiological principles of ventilation (A)
2. Mechanism of air trapping/ airway closure during forceful respiratory effort (A)
3. Compliance and its influences on ventilation of the lungs (A)
4. Airway resistance and its influence on ventilation (A)
5. Respiratory adaptations in conditions with altered compliance and airway resistance (A)
6. Surfactant: synthesis, physical properties aiding the reduction of surface tension, explain alveolar stability based on the 'law of Laplace', deficiency states and associated problems. (A)
7. Definition and calculation of respiratory quotient (RQ), conditions with altered RQ (A)

Instructional objectives:

- Describe the mechanics of ventilation.
- Describe the terms compliance and airway resistance.
- List the conditions with altered compliance and airway resistance.
- Explain the respiratory adaptations in conditions with altered compliance and airway resistance.
- Describe the role of surfactant in maintaining the alveolar stability.
- Name the conditions with surfactant deficiency and outline the deranged physiology.
- Define the term respiratory quotient (RQ).
- Apply the knowledge on RQ in enumerating the conditions with altered RQ.

Topic: Lung volumes and capacities & Pulmonary blood flow

Content area:

- Lung volumes and capacities (A)
- Dead space volumes (A)
- Usefulness of FEV1/FVC ratios in differentiating obstructive from restrictive airway diseases (A).
- Pressure and flow characteristics of pulmonary circulation (A)
- Factors governing the distribution of pulmonary blood flow (A)

Instructional objectives:

- Enumerate and define the tests used in the assessment of the ventilator functions and gas exchange of the lungs.
- Explain the characteristics of pulmonary circulation in comparison to systemic circulation.
- Explain the distribution of pulmonary blood flow in standing and recumbent positions.
- Explain the regulation of pulmonary blood flow.



Topic: Gas exchange across the alveolar capillary membrane

Content area:

1. Physical factors governing gas exchange across alveolar capillary membrane (ACM) (A)
2. Characteristics of ACM facilitating gas exchange (A)
3. Disease states with altered gas exchange (A)
4. Alpha 1 antitrypsin deficiency and emphysema (A)
5. Factors governing the distribution of ventilation (A)
6. V/Q ratios (A)
7. Normal V/Q scatter and its influence on blood gases (A)

Instructional objectives:

- Describe the factors governing gas exchange across the Alveolar capillary membrane.
- Apply the knowledge on gas exchange in outlining the mechanisms of altered gas exchange.
- Explain the regional variation in the distribution in standing and recumbent positions.
- Explain the distribution of ventilation in relation to alveolar perfusion (V/Q ratios).

Topic: Gas transport

Content area:

1. Methods of O₂ transport between lungs and tissues (A)
2. Relation between PaO₂ and SO₂ with reference to oxygen haemoglobin dissociation curve (A)
3. Factors altering the affinity of haemoglobin for O₂. (A)
4. Significance of right and left shift of oxygen dissociation curve with reference to O₂ transport. (A)
5. CO₂ transfer factor (A)
6. Methods of CO₂ transport between lungs and tissues (A)
7. Mechanism of release of CO₂ at the pulmonary capillaries. (A)
8. Role of Haldane effect on CO₂ transport. (A)

Instructional objectives:

- Describe the carriage of oxygen to the tissues with reference to the oxygen flux equation.
- Describe the influence of PaO₂ on the affinity of haemoglobin for O₂ (SO₂) with reference to Oxygen haemoglobin Dissociation Curve (O-Hb DC)
- Describe the role of red blood cells and plasma in the transport of CO₂

Topic: Regulation of respiration and hypoxia

Content area:

1. Role of the respiratory centre in controlling respiration (A)
2. Chemical control of respiration via chemoreceptors (A)
3. Neuronal (non-chemical) influences on respiration (A)
4. Respiratory adjustments in diseased states (A)
5. Define hypoxia (A)



6. Describe the types and causes of hypoxias (A)
7. Compensatory mechanisms of acute and chronic hypoxias (A)
8. Diffusion of O₂ to the tissues and role of Bohr's effect on O₂ delivery to the tissues (A)

Instructional objectives:

- Explain the mechanisms of respiratory regulation and in diseased state.
- Explain the types and causes of hypoxia.
- Explain the pathophysiological basis of hypoxia in restrictive lung disease and obstructive lung disease.
- Explain the compensatory mechanisms in the body in hypoxia.
- Explain the mechanism of O₂ uptake by the tissues.

Topic: Lung function tests

Content area:

1. Lung volumes and capacities (A)
2. Dead space volumes (A)
3. Usefulness of FEV₁/FVC ratios in differentiating obstructive from restrictive diseases (A).
4. Interpretation of lung function test with reference to the deranged lung functions and underlying diseases of the lungs. (A)

Instructional objectives:

- Enumerate and define the tests used in the assessment of ventilator functions and gas exchange of the lungs.
- To interpret the results of lung function tests to diagnose underlying physiological derangement and clinical abnormality (Lung volumes and capacities, PEF, Blood gas reports and FEV₁/FVC).



Biochemistry

Topic: pH and its biochemical significance related to respiratory system

Content area:

1. Regulation of pH and its disturbances (A)
2. Arterial blood gases. (A)
3. Blood gas analysis-based diagnosis of the type and severity of the respiratory failure (A).

Instructional objectives:

- Explain the process of regulation of pH by the respiratory system and urinary system,
- Discuss the biochemical significance of the anion gap.
- Explain the mechanism of respiratory & metabolic pH disturbances after interpreting arterial blood gas report.

Topic: Phospholipids & its biochemical significance

Content area:

1. Molecular structure of the phospholipids – (A)
2. Biochemical significance – (A)

Instructional objectives:

- Describe the molecular structure of the phospholipids
- Discuss the biochemical significance of the phospholipids in developing lungs and acute respiratory distress syndrome.

Topic: Oxidative phosphorylation & Electron transport chain

Content area:

1. Ion transporters in inner mitochondrial membrane (A)
2. Synthesis of ATP (A)
3. Organization of electron transport chain (A)
4. Functions of the complexes of the ETC (A)
5. Significance of co-enzyme Q (B)

Instructional objectives:

- List the ion transporters in the inner mitochondrial membranes,
- List the genetic defects of oxidative phosphorylation,
- Explain the mechanism of ATP synthesis and its sites of synthesis,
- Describe the organization of the electron transport chain,
- Explain how protons are pumped from the matrix to the intermembrane space.
- Discuss the biochemical significance of co-enzyme Q and the Q-cycle.



Recommended and additional Reading for the module

Respiratory system:

Essential Read

- Ward, J. P., Ward, J., & Leach, R. M. (2010). **The respiratory system at a glance** (Vol. 19). John Wiley & Sons.

Embryology:

Recommended reading

- Webster S & De Wreede R. (2012). **Embryology at a Glance**. John Wiley & Sons.
- Moore, Keith L., *et al.* **The developing human: clinically oriented embryology**. Philadelphia: *Saunders/Elsevier*, 2013 9th edition.

Additional reading

- **Snell's Clinical Embryology for medical students** (Latest Edition)
- Sadler, Thomas W. **Langman's medical embryology**. Wolters Kluwer Health, 2014. 13th edition

Histology:

Recommended reading

- Peckham, M. (2011). **Histology at a Glance (Vol. 50)**. John Wiley & Sons.
- Junqueira, C. L., J. Carneiro, and R. O. Kelley. "**Basic histology**." *Basic histology* (2013) 13th edition.
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Additional reading:

- Fawcett, D. W., and R. P. Jensch. "**Bloom and Fawcett's Concise Histology 2nd.**" *Arnold-Hodder Headline Group*. London (2002): 1-360.
- Young, Barbara, ed. **Wheater's functional histology: a text and colour atlas**. Elsevier Health Sciences, 2014. 6th edition

Anatomy:

Recommended reading

- Faiz O, Blackburn S & Moffat D. (2011). **Anatomy at a Glance** (Vol. 66). John Wiley & Sons.
- Drake, Richard, A. Wayne Vogl, and Adam WM Mitchell. **Gray's anatomy for students**. Elsevier Health Sciences, 2015. 3rd edition.

Physiology:

Recommended reading

- Ward, J. P., & Linden, R. W. (2013). **Physiology at a Glance**. John Wiley & Sons.
- Sherwood L, **Human Physiology: From cells to systems** *West Publishing Company*, New York. 7th edition.



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Medical Education Department

Additional reading

- Ganong's **Review of Medical Physiology**. *Lange Medical Publications* McGraw Hill
- Guyton, A.C., **Textbook of Medical Physiology**, Saunders, Philadelphia

Male and female students should refer to the main university library (or ask librarian) for interactive materials available in the form of Compact Discs (CDs).

Note: You are requested to read the latest edition available.

All students are informed to come prepared for the lectures after reading the “at a glance” series mentioned in the recommended books. After the lectures, students are suggested to read the recommended textbook. The faculty members will provide the page numbers for the topics covered at the end of the lecture or an activity.



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Medical Education Department

Teaching and Learning opportunities

About attendance

Assessment and grading

Timetable

Three-year curriculum

Academic Calendar 2016 (First-Year MBBS: Batch 2015-2016)

For the above refer to www.isra.edu.pk

For any feedback regarding the study guide, kindly email

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