PHYSIOLOGY
THE COURSE BOOKLET
FOR STUDENTS & STAFF
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INTRODUCTION

Basic Human Physiology" is simply the study of the mechanisms responsible for the homeostatic functions of the human body and mind. Complimentarily, studies of dysfunction, prevention of dysfunction and interventions to compensate for dysfunction of physiology in human disease form the basis of clinical research. Our Department is dedicated to the integration of both basic and clinical approaches to the study of human disease.

The objectives of the Physiology Department are to provide the graduate student with a comprehensive background in mammalian physiology and an opportunity to develop into an independent researcher. While a systematic presentation of physiological concepts under the direction of physiology faculty continues to be the most efficient way to ensure appropriate depth and breadth, physiologically related topics are often spread out over several courses. It is, nevertheless, essential that all medical and health professional students receive sufficient exposure to the physiological concepts that provide the foundations needed for further studies in pharmacology, pathology, pathophysiology, and medicine. The mechanisms of deranged function cannot be appreciated without an in-depth understanding of basic biophysical and physiological mechanisms. The purpose of developing these core competency criteria is to provide guidelines for the breadth and depth of knowledge in the physiological principles and concepts that are considered minimal and essential for further progress in understanding mechanisms of disease and body defenses.

The curricular objectives are focused primarily on normal body function. However, it is recognized that this material must be presented in a context that prepares students for their roles as physicians. Accordingly, it is suggested that wherever possible clinical examples can and should be used to illustrate the underlying physiological principles.

The general objective of the curriculum of Dubai Medical College for Girls has been defined in this part of the preliminary plan as follows: Medical students who acquire a sound knowledge of physiology will be in a position to confront, in practice and research, the two central corners of the health sciences:
1. The understanding & maintenance of health and.
2. The understanding of the mechanism of disease when physiology is deranged.

Physiological studies and good knowledge of physiology have illuminated many aspects of health as well as mechanisms of disease processes which are a pillar in determining treatment modalities. Therefore,
the relationship between medicine and physiology has important implications for the former.

CONTENTs OF THE COURSE:
The course of Physiology includes the following:
1. Lecturing program.
2. Teacher centered tutorials.
3. Student centered seminars.
5. Practical classes.

OBJECTIVES of THE COURSE
The objectives of the physiology course are categorized as ultimate and terminal ones. The ultimate objectives are to be fulfilled by the end of the course, while terminal objectives are those connected with various parts of the course.

Terminal Objectives
Terminal Objectives are classified into the following parts:
1. General physiology.
2. Nerve and muscle.
3. Autonomic nervous system.
4. Circulating body fluids.
5. Cardiovascular system.
6. Respiratory system.
7. Central nervous system.
8. Special Senses.
9. Digestive system.
10. Metabolism.
11. Kidney
12. Endocrine glands.

General Physiology:
Is a review of cellular, molecular and general basis of medical physiology.

Objectives:
The material in this part should help the student to know:
- Classifications of the different fluid compartments in the body, the size of each and ways in which their sizes can be measured.
- Terms of moles, equivalents and osmoles.
- Principles of osmosis, and give examples of its role in moving fluid from one location the body to another.
- Structure of the various parts of the cells and the functions of each.
• Specific facts of the chemical nature and physiologic significance of the compounds that make up the cell membrane.
• Principles of the various passive and active forces that produce movement of substances across cell membranes.
• Criteria and give examples of the coupling of active Na+ transport to the movement of other electrolytes and non electrolytes across the cell membrane.
• Specific facts of the processes of exocytosis and endocytosis and their contribution to normal cell function.
• Principal ways that the chemical messengers in the extra cellular fluid produce changes inside cells.
• Classifications and categories of the receptors.
• The applied principles of the isotonic fluid solutions used clinically or practically.
• Criteria of homeostasis and give examples of homeostatic mechanisms.

NERVE AND MUSCLE
It deals with the morphology of neurons and the electrical and ionic events that underlie their excitation and their ability to conduct impulses. This part comprises and contrasts the morphologic and functional characteristics of the three types of muscle found in the body: Skeletal, Cardiac and smooth muscle. It is concerned also with the synaptic junctions between neurons, with the neuromuscular junction and with the neurotransmitters and receptors involved in transmission at these junctions.

Prerequisites:
An introduction about the histological basis of the neuronal structure is needed. Also, histological criteria of the skeletal and smooth muscles enable the students to interprets structure-functions relationships.

Objectives:
The material in this part should help the students to:
• Know the classification of the various parts of a neuron and the function of each.
• Distinguish between unmyelinated and myelinated neurons. Summarize the differences in the ways in which unmyelinated and myelinated neurons conduct impulses.
• Apply the principles of the resting membrane potential.
• Know the specific facts of excitation and conduction. And describe the changes in membrane permeability and ionic movements that underlie electric potentials and action potentials.
• Interpret the relationships of: Latent period, firing level spike potential, after depolarization and after hyper-polarization.
• Analyze the compound action potential of mixed nerves.
• List the classifications and categories various nerve fiber types found in humans and comment on the relation between their diameter and their rate of conduction.
• Know the criteria of the gross and microscopic anatomy of skeletal muscle, including the gross - striations, the relation of action to myosin and the sarco-tubular system.
• Compare the morphology of cardiac, visceral smooth muscle and multiunit smooth muscle with that of skeletal muscle.
• List the sequence of electrical and ionic events leading from and action potential in the motor nerve to contraction of a skeletal muscle and discuss the significance of each.
• Apply the principles of Isometric and Isotonic contractions.
• Know the specific facts of summation of contractions and the relation between initial muscle length and the strength of contraction.
• Know the principles of the sources of energy in muscle contraction, and explain how energy is transferred to the contractile mechanism.
• Judge the basis of Oxygen debt and describe its role in muscle function during exercise.
• Analyze the differences between fast and slow skeletal muscles.
• Realize the term of motor unit and discuss the effects of denervation on skeletal muscle.
• Classify the electrical and mechanical events in smooth muscle with those in skeletal, and summarize the effects of acetylcholine and norepinephrine on the electrical and mechanical activity of visceral smooth muscle.
• Know the criteria of the neuromuscular junction, and explain how action potentials in the motor neuron at the junction lead to contraction of the skeletal muscle.
• Realize and explain denervation hypersensitivity.

AUTONOMIC NERVOUS SYSTEM.
This part is concerned specifically with the motor component of the peripheral autonomic nervous system that innervates the viscera.

Objectives:
The material in this part should help the student to:
• Classify of pre-ganglionic sympathetic and parasympathetic neurons in the central nervous system, and identify the nerves by which they leave the central nervous system.
• Specify the post-ganglionic sympathetic and parasympathetic neurons and the pathways they take to the visceral structures they innervate.
• Separate the autonomic nervous system into divisions on the basis of neurotransmitters secreted by the neurons in it, and compare this
classification to the anatomic classification into sympathetic and parasympathetic divisions.

- Outline the functions of the autonomic nervous system.
- List the ways that drugs act to increase or decrease sympathetic activity, parasympathetic activity or both.

**BLOOD**
The student should have fair knowledge of composition of blood, hemopoiesis, physical properties, and general function of blood.

**Prerequisites:**
Histological appearance and characteristics of different blood cells are essential for the students to know the functional criteria of each.

**Objectives:**
The material of this section should enable the student to know:
- Plasma proteins, functions, separation, importance, their ration in Plasma.
- Hemostasis, its mechanism, the role of platelets and mechanisms of their aggregation, tests of hemostasis and coagulation, disorders of coagulation and hemostasis, anticoagulants (heparin).
- RBCs, factors affecting erythropoiesis the importance of iron, vit B 12 and Folic acid. How to diagnose different types of anemia by blood indices. E.S.R. its clinical significance.
- Blood groups and their determination clinically, cross matching test, RH and its importance, blood transfusion, indications, precautions, and dangers of incompatible blood transfusion.
- Functions of white blood cells.
- Defensive mechanism, immunity and immune response.
- Tissue fluid formation & pathophysiology of edema

**THE CARDIOVASCULAR SYSTEM**
**ORIGIN OF THE HEART BEAT & ELECTRICAL ACTIVITY OF THE HEART.**

This part is a review of the conduction system of the heart and the way the impulse that generates a normal heart beat spreads from SA node through AV node, the bundle of Hiss and the Purkinje system to all parts of the ventricles. The genesis of ECG, some of its abnormalities are also considered.

**Prerequisites:**
Histological and anatomical criteria of the heart the different components of the vascular system enables the students to apply physiological principles on structural basis.

**Objectives:**
The material in this chapter should help students to know:
- The structure and functions of the conduction system of the heart and compare the action potentials in each parts of it with those of cardiac muscle.
- Principles of ECG recording, the waves of the ECG and the relationship of the ECG to the electrical axis of the heart.
- Classifications of the common cardiac arrhythmias and describe the processes that produce them.
- List the principal early and late ECG manifestations of myocardial infarction, and explain the early changes in terms of the underlying ionic events that produce them.
- The specific facts of ECG changes and the changes in cardiac function produced by alterations in the ionic composition of the body fluids.
- Principles of the ionic events underlying the action potential in cardiac muscle.
- Specific facts of excitation contraction coupling occurring in cardiac muscle & explain various factors affecting cardiac muscle contractility.
- Interpretations of the electrical events to the contractile response of the cardiac muscle and ECG.

**The heart as a Pump:**
This part considers the mechanical events in the cardiac cycle as the heart pumps the blood through the circulation, heart sounds and murmurs, and measurement and regulation of cardiac output.

**Objectives:**
The material in chapter should help the students to know:
- The sequence of events that occur in the heart during the cardiac cycle.
- The changes in the duration of systole and diastole that occur with changes in heart rate, and discuss their physiologic consequences.
- Principles of the arterial pulse and jugular venous pulse.
- Classification and categories of the normal heart sounds and the occasionally observed third and fourth heart sounds.
- The timing of the murmurs produced by aortic stenosis, aortic insufficiency, mitral stenosis and mitral insufficiency.
- The factors affecting cardiac output and the effect of each on the later.
- Summary of the factors governing oxygen consumption by the heart.

**Dynamics of blood & Lymph flow:**
This part considers the blood vessels and lymphatics and the movement of fluid through them. It includes the functional anatomy of the vessels, the principles and forces that govern pressure and flow in them, and the factors affecting exchange across the capillary walls.

**Objectives:**
The material in this chapter should help students to know:
• The relative terms the diameter, wall thickness, and total cross sectional area of aorta, smaller arteries, arterioles, capillaries, venules and veins.
• The relationship between flow, pressure and resistance in the vascular system.
• The methods commonly used to measure blood flow.
• Specific facts of the laminar flow and critical closing pressure.
• The Poiseullie - Hagen formula for flow in blood vessels and explain on the basis of this formula why the radius of a vessel is an important determinant of flow.
• Law of La Place and list 3 examples of its operation in the body.
• Principles applied for measuring the blood pressure in humans by the palpatory and auscultation methods.
• The starling forces that determine the net movement of fluid across the capillary wall. Describe the variations in capillary permeability in different parts of the body. Mention and explain causes of edema.

**Cardiovascular regulatory mechanisms:**
This part reviews the local mechanisms, circulating humeral agents, and neural mechanisms that act together to maintain blood pressure and blood flow to the various organs at rest and during emergency situation.

**Objectives:**
The material in this chapter should help students to know:
• Term autoregulation, its role in physiology and summarize the theories that explain its occurrence.
• List of the important vasodilator metabolites and discuss their role in regulation of tissue perfusion.
• Outlines of the neural mechanisms that control blood pressure and heart rate, including the receptors, afferent and efferent pathways, central integrating pathways and effector mechanisms involved.
• List of the principal hormones that affect blood pressure and comments on the physiologic role of each.
• The direct effects of CO2 and hypoxia on the vasomotor areas in medulla oblongata.

**Circulation through special organs:**
This part describes special aspects of the circulation of the brain including the blood brain barrier, the heart and the lungs.

**Objectives:**
The material in this chapter should help students to know:
• The approximate values for blood flow per unit weight and blood flow per organ at rest in the major organs of the body.
• Formation, absorption and functions of cerebro-spinal fluid.
• The characteristics of the blood brain barrier, and comment on its importance in clinical medicine.
The chemical and neural factors that regulate the coronary circulation and describe the role of each.
- The triple response produced by firmly stroking the skin and explains each of its components.
- The main differences between systemic and pulmonary circulation. Explain the different factors that affect pulmonary circulation.

**Cardiovascular homeostasis in health and disease:**
This part summarizes the cardiovascular adjustments that occur on assuming the upright position & during exercise. It also describes the pathophysiology of shock, syncope, hypertension and heart failure and the cardiovascular compensations that occur in these conditions.

**Objectives:**
The material in this chapter should help students to know:
- Outlines of the compensatory mechanisms that maintain blood pressure on rising from the supine to the standing position.
- The effects of positive and negative gravitational acceleration (g) on the body.
- The circulatory changes that occur during exercise.
- The term shock, name the major causes and summarize the main abnormalities that occur during each type of shock. Summarize the short term and long term compensatory mechanisms that operate in each type.
- List of the common causes of high blood pressure in humans and the mode of treatment of each.
- List of the main symptoms of heart failure and how each is produced.

**RESPIRATION**

**Pulmonary Function:**
This part is an analysis of the functions of the respiratory system, including the properties of gases, the way that the lungs and chest operate to produce inspiration and expiration, gas exchange in the lungs, the special features of the pulmonary circulation, lung defense mechanisms and the metabolic functions of the lungs.

**Prerequisites:**
Anatomical and histological features of the lung and airways are required prior to application of physiological basis of respiration.

**Objectives:**
The material in this chapter should help students to know:
- Specific facts of the partial pressure, and calculate partial pressure of each of the important gases in the atmosphere at sea level.
- How to draw a graph of the changes in intrapulmonary and intrapleural pressure and lung volume that occur during inspiration and expiration.
• Classification and categories of the air passages through which air passes from the exterior to the alveoli and the cells that line them.
• List of the major muscles involved in respiration and state the role of each.
• Terms of tidal volume, inspiratory reserve volume, expiratory reserve volume and residual volume, and give approximate values for each in a normal adult.
• Principles of pulmonary compliance, and give example of diseases in which it is abnormal.
• The chemical composition and function of surfactant.
• List of the factors that determine alveolar ventilation.
• Criteria of diffusion capacity and diffusion of O2 with that of CO2 in the lungs.
• Compare the pulmonary and systemic circulation, listing the main differences between them.

Gas transport between the lungs & the tissues:-
This part describes the flow of O2 from the lungs to the tissues and the flow of CO2 from the tissues to the lungs, with emphasis on the physical and chemical mechanisms that greatly augment the ability of the blood to carry O2 and CO2.

Objectives:
The material in this chapter should help students to know:
• The manner in which O2 flows from the lungs to the tissues and CO2 flows from the tissues to the lungs.
• The reactions of O2 with hemoglobin and the oxygen Hemoglobin dissociation curve.
• The important factors affecting the affinity of hemoglobin for O2 and comments on the physiologic significance of each.
• Structure of myoglobin and outline its physiologic role.
• List of the reactions that increase the amount of CO2 in the blood and draw the CO2 dissociation curve for arterial and venous blood.

Regulation of respiration:-
This part is a review of the mechanisms that regulate respiration. These include the fundamental rhythm generator in the medulla oblongata, and pons; chemical control via the carotid and aortic chemoreceptors and the chemoreceptors located in medulla oblongata, and nonchemical control via inputs from higher centers and receptors in the lungs, muscles, tendons and joints.

Objectives:
The material in this chapter should help students to know:
• Location and functions of the dorsal and ventral groups of respiratory neurons, pneumotaxic center and the apneustic center in the brain stem.
• The specific respiratory functions of the vagus nerves and the respiratory receptors in the carotid body, the aortic body and the medulla oblongata.
• The ventilatory responses to increased CO2 concentrations in the inspired air.
• The ventilatory responses to decreased O2 concentrations in the inspired air.
• The effects of each of the nonchemical factors that influence respiration.
• The effect of sleep on respiration.

Respiratory adjustments in health & disease:-
This part analyzes the changes in respiration that occur with exercise, during exposure to altitude and other forms of hypoxia, during hypercapnia and hypocapnia, and with increased barometric pressure. Drowning and artificial respiration are also discussed.

Objectives:
This part should help students to know:
• The effects of exercise on ventilation and O2 exchange in the tissues.
• Classification of hypoxia, and its four principal forms.
• The acute effects of high altitude on respiration and discuss acclimatization to altitude.
• Terms with examples about ventilation - perfusion imbalance.
• List and explain the effects of carbon monoxide on the body.
• List of the adverse effects of excess O2.
• Term periodic breathing and its occurrence in various disease states.
• List of the problems of undersea diving and their causes.
• The technique of mouth to mouth breathing and explain how it works to maintain life.

THE CENTRAL NERVOUS SYSTEM
Prerequisites:
Anatomy and histology of the brain and the spinal cord should proceed physiological application especially for connections and effects of lesions of the different components of the nervous system.

1- Synaptic transmission:-
This part is concerned with the synaptic junctions between neurons and with neurotransmitters and receptors involved in transmission of these junctions.

Objectives:
The material in this chapter should help the students to know:
• The main morphologic features of synapses.
• How to distinguish between chemical and electrical transmission at synapses.
• Terms as convergence & divergence in neural networks and discuss their implication.
• How signals are prolonged, inhibited and sharpened as it passes in different neural pools in CNS & discuss their significance.
• List of the properties of synaptic transmission.
• The excitatory and inhibitory postsynaptic potentials and mention the characters of these potential.
• The types of chemicals that serve as synaptic transmitters.
• Terms like opioid peptide; list the principal opioid peptides in the body.
• Principles of direct inhibition, indirect inhibition, presynaptic inhibition & postsynaptic inhibition.

2- Initiation of impulses in sense organs:
This part describes generator potentials and the way they produce action potentials in sensory nerves, lists the senses, and summarizes the principles and laws that govern the coding of sensory information.

Objectives:
The material in this chapter should help the students to know:
• Classifications of the sensory receptor and their functions.
• Term of an adequate stimulus and give examples
• Classifications of the somatic sensations.
• Types of receptors found in the skin, and discuss their relation to the four cutaneous senses: touch, cold, warmth and pain.
• The relationship between the size of generator potential in a sensory receptor and the number of impulses generated at its sensory nerve.
• Term receptor adaptation and its mechanisms.
• Sensory coding.

3-Sensations: Cutaneous, deep & Visceral Sensations:
This part describes the sensory mechanisms responsible for touch, proprioception, warmth, cold, pain, itching and sensations produced by combinations of these stimuli. Pain is considered in detail including the characteristics of fast and slow pain, deep pain and visceral pain. Treatment of pain is also discussed.

Objectives:
The material in this chapter should help students to know:
• Outlines of the neural connections and pathways from skin, deep tissues and viscera to the cerebral cortex that mediate sensations from them.
• Types of nerve Fibers that mediate warmth and cold in peripheral nerves.
• Receptors that mediate pain and explain the differences between fast and slow pain.
• Compare superficial, deep and visceral pain.
• Term hyper-algesia & mention its types & explain the mechanisms involved.
• Specific facts related to referred pain.
• List of the main procedures that have been used for relief of intractable pain.
• Principles of vibratory sensibility, two points discrimination and stereognosis.

4-Reflexes:-
This part describes the components that make up the reflex arc, the mono-synaptic and poly-synaptic spinal reflexes and the properties and functions of muscle spindles.

Objectives:
The material in this chapter should help students to:
• Distinguish between monosynaptic and polysynaptic reflexes.
• Give examples of stretch reflexes including those that are frequently used clinically.
• Know the structure of the muscle spindles and analyze their function with particular attention to know how they operate as a part of a feedback system to maintain muscle length.
• Knows the criteria of the reciprocal innervations, inverse stretch reflex clonus and lengthening reaction.
• Know the terms of fractionation & occlusion.

5- Control of Posture & movement:-
This part reviews the somatic motor function with specific contribution of the spinal cord, medulla, midbrain, basal ganglia, cerebral cortex and the cerebellum.

Objectives:
This chapter should help the students to know:
• How posture and movement are regulated and outline the function of each component of the regulatory system.
• Functions of Cerebral Cortex, Cerebellum, basal ganglia and corticospinal and corticobulbar tracts in skill voluntary movements.
• Term of spinal shock and explain the initial and long term changes in spinal reflexes that follow transaction of the spinal cord.
• List of the complications that make it difficult to treat patients with spinal cord injuries.
• Terms decerebrate and decorticated rigidity, and comment on the cause and physiological significance of each.
• Types of the postural reflexes that are integrated at the medulla oblongata, the pons, the midbrain and the cerebral cortex.
• Structure of the basal ganglia and list the pathways that interconnect them, along with the neurotransmitters in each pathway.
• Symptoms of Parkinson's disease.
• Connections of the cerebellum.
• Functions of the cerebellum and the neurological abnormalities produced by diseases of this part of the brain.

7-Central regulation of visceral function:
This part reviews central integration of autonomic and related visceral functions at the level of spinal cord, medulla oblongata and hypothalamus.

Objectives:
This chapter should help the students to know:
• The autonomic reflexes integrated at the level of the spinal cord.
• The anatomic connections between the hypothalamus and the pituitary gland and the functional significance of each connection.
• The relationship of the hypothalamus to sleep and to body rhythms.
• The contribution of the hypothalamus and the role of other factors in the regulation of food intake.
• List of the factors that control water intake and outline the way they exert their effects.
• Mechanisms of heat production and loss inside our body.
• The temperature regulating mechanisms, and the way in which they are integrated under hypothalamic control to maintain normal body temperature.

8-Neural basis of behavior and emotions:
This part is concerned with the limbic system and with neural circuits involved in motivation, emotional responses such as fear and rage and several behaviors.

Objectives:
This chapter should help students to know:
• The structure and functions of the limbic system.
• The brain areas and hormones involved in the regulation of sexual behavior in both sexes.
• Discuss the role of punishment and reward sensations in control of behavior.

9-Arousal mechanisms, sleep and the electrical activity of the brain:
This part deals with alertness and sleep, the mechanisms that produce these states, and the correlation between them and the electrical activity of the brain.

**Objectives:**
The material in this part of physiology should help students to know:
- The anatomy and functions of the reticular formation.
- Terms of primary evoked potential and diffuse secondary response.
- Classifications of the primary types of rhythms that make up the EEG and the behavioral states that correlate with each.
- Terms of synchronization, & block and de-synchronization.
- Summary of the EEG and other characteristics of rapid eye movement (REM) sleep and describe the mechanisms responsible for its production.
- List of the main clinical uses of the EEG.

**10-Higher functions of the nervous system: Conditioned reflexes, learning and related phenomena:**
This part is concerned with the "higher functions of nervous system" and specifically with learning, memory, the specialized nature of the left and right cerebral hemispheres and the language functions of the human brain.

**Objectives:**
The material in this part should help the students to know:
- Conditioned reflexes, their properties and analyze their physiologic basis.
- List of the parts of the brain that appear to be involved in memory in mammals, and summarize the role of each part in memory processing and storage.
- Abnormalities of brain structure and function found in Al-Zheimer's disease.
- Terms of categorical hemisphere and representational hemisphere, and summary the difference between the hemisphere and their relationship to handiness.
- Summary the differences between fluent and non fluent aphasia and explain each type on the basis of its patho-physiology.

**SPECIAL SENSES**
**Prerequisites:**
Anatomy and histology of the eye, ear, nose and the oral cavity are of great help to apply physiological specific facts of these organs.
This branch of physiology deals with vision, hearing, smell and taste.
- **Vision:** - This part reviews the functional anatomy of the visual system, then analyzes in order the processes involved in vision: formation of the
visual image on the retina conversion of light energy to electrical responses in the rods and cones, processing of impulses in the retina, transmission of impulse to the visual cortex, and the events that occur in the visual cortex.

**Objectives:**
The material in this part should help the students to know:

- Structure of the eye and list of the functions of each
- The neural pathways that transmit visual information from the rods and cones to the visual cortex.
- How light rays in the environment are brought to focus on the retina and the role of accommodation in this process.
- Terms of hypermetropia, myopia, astigmatism, presbyopia, and strabismus.
- The electrical responses produced by rods and cones, and explain how these responses are produced.
- The electrical responses seen in bipolar cells, horizontal cells, amacrine cells, and ganglion cells, and comment on the function of each type of cell.
- The responses of cells in the visual cortex and the functional organization of the areas of the cerebral cortex that process visual information.
- Criteria of dark adaptation and visual acuity.
- Functions of cones, the neural pathways to visual cortex and the visual cortex in colour vision.
- Types of eye movements and the function of each.

**Hearing:**
This part is concerned with the auditory system.

**Objectives:**
The material in this part should help the student to know:

- Basis of the way by which the movements of air molecules are converted into impulses generated in the cells in the Cochlea.
- How deformation in the basilar membrane is converted to impulses in the auditory nerve fibers.
- Path of auditory impulses in the neural pathways from the cochlear hair cells to the auditory cortex and the function of the auditory cortex.
- Terms of pitch, loudness, and how to be coded in the auditory pathways.
- Types of deafness.

**Taste & Smell:**

**Objectives:**
This part considers olfaction and taste from the point of view of signal transduction, pathways to the CNS, Central representation, and the
molecular and neural mechanisms that make it possible to discriminate among different odors and tastes.

**Objectives:**
The material in this chapter should hold the student to know:

- The olfactory receptors and the way in which impulses are initiated in them.
- Outlines of the pathways by which impulses generated in the olfactory mucosa reach the cerebral cortex.
- Analyze olfactory sensitivity, discrimination and adaptation.
- Structure of the taste buds and their characteristics and distribution in relation to the four basic tastes.
- Outlines of the taste pathways.
- List of the substances that produce sweet, sour, bitter and salt tastes, and comment on how the signal for each is transduced.

**KIDNEY**

**Prerequisites:**
Specific facts regarding histological characteristics of the urinary tract forms an important base needed to apply physiological rules of the system.

**Objectives:**
The student should be able to know:

- The structure of the kidney (nephron, nerve supply, blood supply, renal blood flow and its measurement).
- The importance of juxtaglomerular apparatus, renin secretion and renal hypertension.
- Functions of the glomeruli, mechanisms of glomerular filtration (importance), its measurement and factors affecting it.
- Renal tubules: Functions of proximal, distal convoluted tubules and loop of Henley. Mechanism of reabsorption of Na+, glucose electrolytes, amino acid & urea.
- Hormones affecting tubular reabsorption, Hormononal regulation (control) of the kidney.
- Electrolyte and water balance.
- Role of the kidney in regulation of blood pH, renal regulation of electrolyte and water balance.
- Diuresis, its mechanism and some diuretic drugs.
- Renal function tests.
- Mechanism of micturition (micturition reflexes; voluntary control).
- Effects of various lesions on micturition automatic micturition.
- The urine: Physical properties and normal constituents, factors affecting urine, volume.
- Renal failure, (uremia).
ENDOCRINES

Prerequisites:
Anatomical as well as histological specific facts of the different endocrine glands enable the student to apply the physiological basis of the endocrine system both in health and disease.

The Thyroid Gland:-
This chapter reviews the functional anatomy of the thyroid gland and considers in detail the biosynthesis, storage, secretion, binding, metabolism and effects of thyroxin (T4) and triiodothyronine (T3). Iodine metabolism is also considered in relation to thyroid function. The regulation of thyroid function is reviewed and in addition there is a brief review of the major diseases of the thyroid gland and drugs that affect thyroid function.

Objectives:
This chapter should help students to:
- Describe the gross and microscopic anatomy of the thyroid gland and the effects of TSH excess and deficiency on its morphology.
- Outline the steps involved in the biosynthesis of thyroid hormones and their storage in colloid.
- Describe the steps involved in the transfer of thyroid hormones from the colloid to the blood stream.
- Name the proteins that bind thyroid hormones in the plasma, describe the relationship between bound and free thyroid hormones and summarize the mechanism that regulate thyroid hormone binding.
- Outline the principal pathways by which thyroid hormones are metabolized.
- List the main physiologic actions of thyroid hormones.
- Describe the mechanisms by which thyroid hormones exert their principal effects.
- Outline the processes involved in the regulation of secretion of thyroid hormones.
- List the principal drugs that affect thyroid function and describe the mechanism by which each exerts its effects.
- List the major diseases of the thyroid and their principal symptoms.

Endocrine functions of the pancreas and the regulation of carbohydrate metabolism:
This part is concerned primarily with insulin and glucagon, the 2 principal carbohydrate-regulating hormones secreted by the pancreas. Diabetes mellitus, the syndrome that results from insulin deficiency, is reviewed in detail, along with hypoglycemia. In addition, pancreatic polypeptide and somatostatin, the other hormones of the pancreatic islets, are discussed.

Objectives:
The material in this chapter should help students to:-
- List the hormones that affect the blood glucose concentration and briefly describe the action of each.
- Describe the structure of the pancreatic islets, and name the hormones secreted by each of the cell type in the islet.
- Describe the structure of insulin, and outline the steps involved in its biosynthesis and release into the blood stream.
- List the consequences of insulin deficiency, and explain how each of these abnormalities is produced.
- Describe the effects of insulin excess, and summarize the homeostatic mechanisms that combat hypoglycemia.
- List the major factors that affect the secretion of insulin.
- List the physiological significant effects of glucagon.
- Describe the physiologic effects of the hormones of the pancreatic islets other than insulin and glucagon.
- List the common causes of hypoglycemia in humans, and describe how each acts to lower the blood sugar concentration.
- Outline the mechanisms by which thyroid hormones, adrenal glucocorticoids, catecholamines and growth hormone affect carbohydrate metabolism.

**The adrenal medulla & adrenal cortex:**
This chapter is concerned with the adrenal glands, which are really 3 glands in one. The catecholamines secreted by the adrenal medulla are considered first, and the mechanisms regulating their secretion are analyzed. The mineralocorticoid, aldosterone, which is secreted by the outer zone of the adrenal cortex, is reviewed and the role of angiotensin II, electrolytes and ACTH in the regulation of aldosterone secretion is analyzed. The glucocorticoids secreted from adrenal cortex are also reviewed along with their control by ACTH. Finally, there is a brief review of the clinical features of adrenocortical deficiency, Cushing's syndrome, Conn's syndrome, and the adrenogenital syndrome. The material in this chapter should help students to:-
- Name the catecholamines secreted by adrenal medulla, and outline their biosynthesis.
- Compare the actions of the main catecholamines in the body.
- Name the principal metabolites of epinephrine and norepinephrine.
- List the principal stimuli that increase adrenal medullary secretion, and describe the way they bring about the increases.
- Name the plasma proteins that bind adrenocortical steroids, and discuss the role they play in adrenocortical physiology.
- Name the major site of adrenocortical hormone metabolism and the principal metabolites produced from glucocorticoids and aldosterone.
- List and briefly describe the physiologic & pharmacological effects of glucocorticoids.
- Describe the mechanisms that regulate glucocorticoids and sex hormones’ secretion by the way of ACTH.
- Outline the actions of aldosterone.
- Describe the mechanisms that regulate aldosterone secretion.
- Describe the main features of the diseases caused by excess or deficiency of each of the hormones of the adrenal gland.

**HORMONAL Control of Calcium metabolism & The Physiology of bone:**
In this part, the metabolism of calcium and phosphorus is discussed and the physiology of bone is reviewed. The 3 hormones that are the primary regulators of calcium metabolism - 1- 25 dihydroxy -cholecalciferol parathyroid hormone, and calcitonin are discussed in detail.

**Objectives:**
The material in this chapter should help students to:
- Describe the distribution of calcium in the body and the forms in which exists in plasma.
- Name the factors affecting Ca2+ concentration and discuss the mechanism by which each exerts its effect.
- Summarize the distribution of phosphorus in the body.
- Name the types of cells found in bone, and describe the function of each.
- Describe the formation of vitamin D in the skin; it is subsequent hydroxylation in the liver and kidneys, and the actions of its biologically active metabolites.
- Describe the actions of parathyroid hormone.
- Identify the source of calcitonin, its chemical nature, and its principal actions.
- Summarize the effects of glucocorticoids, growth hormone, thyroid hormones and estrogens on Ca2+ metabolism.

**The Pituitary gland:**
This part reviews the formation of pituitary gland in the fetus and it's morphology in the adult. The intermediate lobe hormones and their physiology in various species are discussed. The posterior pituitary hormones are also discussed, and most of the anterior pituitary hormones are considered in chapters on the glands they regulate, but growth hormone is detail in this chapter. Somatomedins are also reviewed.

**Objectives:**
The material in this chapter should help students to:
- Name the hormones secreted by the pituitary gland in humans, and list the main functions of each.
- Describe the 3 lobes of the pituitary gland in terms of their embryologic origin and their structure in adults.
- Name the 5 types of secretory cells found in the anterior pituitary and note whether each is acidophilic, basophilic or chromophobic.
- Describe the pro-opiomelanocortin and the products produced from it in the anterior and intermediate lobes of the pituitary gland.
- List the principal somatomedins and describe their relationship to the actions of growth hormone.
- List the 2 hypothalamic hypophyseotropic hormones that regulate growth hormone secretion and the principal stimuli that bring about increases or decreases in growth hormone secretion.
- List the factors needed for normal growth, and describe the contribution each makes during prenatal and postnatal development.
- Describe and explain the main features of hypopituitrism and acromegaly.

**Other Organs with Endocrine Functions:**
This part is concerned with renin erythropoietin, atrial natriuretic factor and melatonin.

**Objectives:**
The material in this chapter should help students to:
- Outline the reactions that lead to the formation of angiotensin II in the circulation.
- Name the enzymes involved in the metabolism of angiotensin II and the products that are formed.
- List the functions of angiotensin II and the sites at which it acts to carry out these functions.
- Describe the juxtaglomerular cells.
- Name the sources of erythropoietin in the body.
- Describe the site and mechanism of action of erythropoietin.
- Define the atrial natriuretic factor and list its known actions.
- Diagram the steps involved in the formation of melatonin from serotonin in the pineal gland, list the proposed functions of melatonin and discuss the regulation of melatonin secretion.

**REPRODUCTION**

**Gonads:**

**Development and Function of the reproductive system**
This part discusses the physiology of the reproductive system in adult males and females as well as the physiology of lactation and pregnancy. Puberty and menopause are also reviewed.

**Objectives:**
This chapter should help students to:
- Name the important hormones secreted by the Leydig and sertoli cells of the testes and by graffian follicles and the corpora lutea of the ovaries.
- Summarize the hormonal and other changes that occur at puberty in males and females.
- Outline the hormonal and other changes that occur at menopause.
- Describe the hypothalamic mechanisms that regulate prolactin secretion and list the principal stimuli that increase its secretion.
- Outline the steps involved in spermatogenesis from the primitive germ cells to mature motile spermatozoa.
- List principal components of semen.
- Describe the mechanisms that produce erection and ejaculation.
- List the activities of testosterone.
- Outline the mechanisms involved in regulation of testosterone secretion.
- Describe the changes that occur in the ovaries. Uterus, cervix and vagina during menstrual cycle.
- List the actions of estrogen.
- List the actions of progesterone.
- Describe the hormonal changes that accompany pregnancy.
- Outline the processes that lead to parturition.
- Outline the processes involved in development of breasts, production of milk, milk ejection, and termination of lactation.

**GASTROINTESTINAL SYSTEM:**

**Prerequisites:**
Translation of communications between the structure and the functions of the different components of digestive system needs well coordination between physiology and anatomy in addition to histology lectures.

**Objectives:**
This part is concerned with the digestion and absorption of the ingested food. The material in this chapter should help students to know:
- Criteria of the overall functions of the gastro intestinal system.
- The principal digestive enzymes, their precursors, their substrates and the products of the action of the enzymes.
- Terms of unstirred water layer, and brush border.
- Criteria of conversion of dietary carbohydrates into glucose and other hexoses ready for absorption from the intestine.
- Summary of the processes involved in the absorption of hexoses and pentoses from the intestine into the blood stream.
- Specific facts of conversion of dietary protein into amino acids and small peptides ready for absorption from the intestine.
- Summary of the processes involved in the absorption of amino acids and small peptides from the intestine into the blood stream.
- Outlines of the events occurring during digestion of fats.
- Basis of the processes by which fatty acids and other lipids are absorbed from the intestine into blood stream.
- Summary the processes that regulate the absorption of water, Na+, K+ and HCO3- from the gastro intestinal tract.
- Outlines of the processes that regulate calcium absorption.
- Outlines the processes that regulate iron absorption.

**Regulation of Gastro Intestinal Functions:**
This part is concerned with the operation of the gastro intestinal tract and its associated glands, the salivary glands, liver and pancreas in carrying out digestion and absorption of food. The gastrointestinal hormones and reviewed and then the functions of the mouth and salivary glands are regulation of gastric secretion and motility are considered along with regulations of pancreatic exocrine secretion, the multiple functions of the liver are summarized and bile secretion and the functions of the gall bladder are reviewed. The functions of the small intestine and regulation of its motility and secretion is discussed. The functions of the colon and regulation of its motility along with defecation is also reviewed.

**Objectives:**
The material in this chapter should help students to know:-
- Summary the structure and innervations of the gastro intestinal tract.
- List of the principal gastro intestinal hormones. For each hormone, list the sites where it is secreted and its main physiologic function.
- Summary the functions of the mouth, the salivary glands, and the esophagus.
- Terms of functional anatomy of the stomach.
- How acid HCl is secreted by cells in gastric mucosa.
- Mechanisms that regulate the secretion and motility of the stomach.
- Interpret the relationship between cyanocobalamin and intrinsic factor.
- List of the main components in pancreatic juice, and outline the mechanisms that regulate its secretion.
- The functional anatomy of the liver, and discuss the formation of bile.
- The functions of the gall bladder and the process that regulate the passage of bile to the intestinal lumen.
- List of the types of movement seen in the small intestine and the function of each.
- Components of the intestinal secretion.
- List of the types of movements seen in the colon and the function of each.
- Mechanism of defecation, and outline the neural pathways that control it.

**INSTRUCTION MEDIA**
The previously mentioned objectives whether optimal or terminal are covered by the followings:-
1) Lecturing program
2) Practical classes
3) Teacher centered tutorials
4) Elective seminars
5) Audio-visual material and demonstrations.

1. **Lecturing Program:-**
The physiology course is presented theoretically to the students into 220 lectures, 90 minutes each, covering as much as possible of its objectives and is continuously updated.
It has to be emphasized that it is neither possible nor desirable to cover the whole physiology by any number of lectures. Bearing in mind the limitation of lecturing as teaching, the objectives of lectures should be:-
   a) To cover the basic minimal knowledge required for all physicians.
   b) To utilize the available time in presenting the knowledge as simple, updated, well illustrated and easily understood as possible. Rare topics and those irrelevant to our department should be omitted or given less importance and time.
X. Lectures are delivered only by the senior academic staff.
XI. Participation of students is essential even during the very traditional lectures. Therefore certain subjects will be given to an individual student or group of students to be prepared and presented before the class.
XII. Lecturers should preferably, submit a summary of their lectures to be distributed to the students in advance and the sessions becomes a panel discussion about the topic rather than a didactic dictating way of lecturing.
The order to lectures need not be traditional otherwise; students will receive some sorts of applied knowledge in the theoretical sessions.

2) **Practical Classes:-**
The student attends practical classes in physiology in 70 weeks, 2 hours per each week. She has to attach herself of a practical team. In these practical classes, the student has to know to apply the theoretical knowledge practically. Whenever, possible, the theoretical knowledge given should be practiced at the same week.
Topics in practical classes:
I- Tests for blood analysis:
1. The hematocrit value (HCl)
2. Hemoglobin percentage (HB %)
3. Erythrocyte Sedimentation rate (ESR)
4. Osmotic Fragility (OF)
5. Blood grouping
6. Bleeding and coagulation time.
7. Calculation of blood indices & diagnosis of anemia.
II. Experiments with isolated skeletal muscle:
1. Simple muscle twitch (SMT)
2. Effect of temperature on SMT
3. Effect of two successive stimuli
4. Effect of fatigue
5. Geneses of tetanus

III. Circulation:
1. ECG record & electrical axis of the heart.
2. Arterial pulse
3. Extra systole
4. Heart block
5. Venous pulse
6. Heart sounds
7. Arterial blood pressure
8. Heart rate
9. Cold pressor test
10. Venous occlusion - plethysmography
11. Capillary circulation

IV. Respiration:
1. Record of Respiratory Volumes & Capacities.
2. Record of Respiratory Movement.

V. Kidney:
1. Urea clearance test
2. Urea concentration test
3. Urine dilution and concentration tests.

VI. Digestive System:
1. Effect of drugs on motility of rabbit ileum.

VII. Metabolism:-
Calculation of Oxygen consumption and "Basal Metabolic Rate".

VIII. Central Nervous System:
1. Mapping of cutaneous sensation (Pain, temperature, & touch).
2. Tests for sensations transmitted by the antero-lateral system (pain, temp & crude touch).
3. Tests for sensations transmitted by dorsal column lemniscal system. (Fine touch, stereognosis, pressure, vibration & position sense).
4. Examination of superficial reflexes (corneal, conjunctival, abdominal, planter, cremasteric and anal).
5. Examination of deep reflexes. Tendon jerks (Biceps, Triceps, Knee, and Ankle).
6. Flexion withdrawal reflex.
7. Examination of motor functions (muscle state, muscle tone, muscle power).

**IX. Vision:**
1. Test of Visual acuity
2. Ophthalmoscopy
3. Color Vision

**X. Hearing tests:**

**XI. Examination of smell & Taste Sensations:**

**2. Teacher Centered Tutorials:**
There are 70 tutorials (40 for first year students and 30 for second year students) to cover 7 terms. In these tutorials, the tutor is one of the senior academic staff in the department. In these tutorials part of the theoretical knowledge given during the week lectures is discussed by the tutor with the students. This trains them how pronunciation of the scientific terminology can be done in the correct way. Also, tutorial classes train the students to discuss the scientific subjects in group meetings.

**4. Elective seminars:-**
Each three to four students select one topic in seminar, they prepare it together through several sittings in the library. Each student should write the whole subject by herself. After finishing the preparation, presentation of seminars is carried out by the students themselves. The academic staff members from different departments attend these seminars according to their specialties. They conduct, direct and supervise the students and share in explaining some points which are difficult to the students. These seminars are trials to make the students self learners. They search by themselves for the references. They will be trained how to write the scientific knowledge in the correct manner.