# Internship/Apprenticeship course plan

**The name of the course: Medical Physiology for Dentistry Students**

**Attendance Days in Department: Mondays and Tuesdays**

**Program Duration** (Course length**): 3 units**

**Start and End Dates**: **September 29 to January 20**

**Department attendance hours: 12:00 to 14:00 PM**

**Location of In-Person Sessions: Faculty of Dentistry**

**Clinical trainers' information table**

| First Name | Last Name | Rank | Group | Phone Number | Email |
|---|---|---|---|---|---|
| Elham | Karimi-Sales | Assistant Professor | Physiology | +984133364664 | karimi.sales@gmail.com |
| Behnaz | Mokhtari | Assistant Professor | Physiology | +984133364664 | behnaz.sa.mokhtari@gmail.com |

**Main goal of the course**:

In this course, students are expected to learn the concepts, principles, and physiological mechanisms related to the following areas and are able to identify them in both normal and altered physiological processes:

## Cell Physiology

1. Definition and scope of physiology; cellular signaling
2. The cell membrane and its components; transport mechanisms across the membrane
3. Resting and action potentials
4. The internal environment and homeostasis; the role of organ systems in maintaining it
5. Differences in the composition of intracellular and extracellular fluids and their causes
6. Intracellular signaling mechanisms
7. Absolute and relative refractory periods and their physiological basis
8. Skeletal muscle contraction
9. Smooth muscle contraction and its differences from skeletal muscle

## Heart Physiology

1. The heart, its chambers, and layers
2. Cardiac muscle, heart action potential, contraction of cardiac muscle cells
3. The cardiac cycle and its phases
4. Control of heart activity
5. Electrocardiogram curves
6. Blood flow pathway in the heart during a cardiac cycle
7. Physiological characteristics of cardiac muscle and its similarities and differences with skeletal muscle
8. Stages and mechanisms of cardiac muscle contraction
9. Action potential of cardiac muscle cells, its phases, and differences with skeletal muscle
10. Components of the cardiac conduction system and heart rate control
11. The cardiac cycle and its phases
12. Concepts of cardiac output, end-systolic volume, end-diastolic volume, and stroke volume
13. Preload, afterload, and their effects on cardiac output
14. The sympathetic and parasympathetic systems in cardiac function control
15. Electrocardiogram curves and their components
16. Cardiac derivations and electrode placement
17. Mechanisms of generation of P, QRS, and T waves in the electrocardiogram

## Blood Circulation Physiology

1. Basic physical concepts of the circulatory and pulmonary systems
2. Structure of blood vessels, their similarities and differences
3. The process of exchange of fluids and substances between blood and body cells
4. Structure and functions of the lymphatic system
5. Blood pressure, its influencing factors, and how it is regulated
6. Coronary circulation and its control mechanisms
7. Systemic and pulmonary circulations, their components, and differences
8. Relationships between blood pressure, blood flow, and vascular resistance in connection with Ohm's and Poiseuille's laws
9. Measurement of blood flow, difference between laminar and turbulent flow, and how to determine and distinguish them
10. Substances between plasma and interstitial fluid
11. Capillary filtration and factors affecting it related to Starling's law
12. Lymphatic system structure and functions
13. Blood pressure, mean arterial pressure, pulse pressure, and their influencing factors
14. Local control of blood flow in short-term and long-term
15. Neural and hormonal control of blood flow
16. Short-term and long-term regulation of blood pressure
17. Role of kidneys and renin-angiotensin system in long-term regulation of blood pressure
18. Hormonal control of blood pressure and their role in regulation
19. Changes in coronary blood flow with cardiac cycle variations
20. Neural and chemical regulation of coronary blood flow

## Gastrointestinal Physiology

1. Structure and function of the gastrointestinal system
2. Gastrointestinal motility
3. Gastrointestinal secretions and their functions
4. Processes of digestion and absorption in different parts of the gastrointestinal tract
5. Functions of bile, saliva, pancreas, and liver
6. Neural and hormonal regulation of the gastrointestinal system
7. The process and stages of swallowing
8. Mixing and propulsive movements of the gastrointestinal tract and their roles
9. Gastric movements and their role in digestion
10. Migrating myoelectric complex and hunger contractions
11. Mechanisms regulating gastric emptying
12. Types of small intestinal movements, their functions, and control mechanisms
13. Movements of various parts of the large intestine, their characteristics, and regulatory mechanisms
14. Defecation reflex
15. Salivary glands, composition of saliva, and regulation of salivary secretion
16. Types of gastric cells and their specific secretions
17. Mechanism of gastric acid production
18. Mechanisms and phases of gastric secretion regulation
19. Pancreatic secretions, their functions, and regulation
20. Bile and its role in fat digestion and absorption
21. Enterohepatic circulation of bile
22. Secretions of the small and large intestines and their regulation
23. Mechanisms of carbohydrate digestion and absorption
24. Digestion and absorption of proteins
25. Digestion and absorption of fats in the gastrointestinal tract

## Renal Physiology

1. Structure of the kidneys, nephrons, and urinary system
2. Renal processes.
3. Regulation of glomerular filtration and factors affecting it
4. Reabsorption and secretion of substances in different parts of the nephro.
5. Neural and hormonal control of body fluid volume and osmolality
6. Mechanisms of body pH regulation
7. Concept of GFR autoregulation and its mechanisms
8. Components and role of the juxtaglomerular apparatus
9. Reabsorption and secretion in the tubules
10. Mechanism of urine concentration
11. Factors involved in establishing and maintaining the high osmolality of the renal medulla
12. Role of the sympathetic nervous system in maintaining body fluid volume
13. Mechanisms of action of angiotensin, aldosterone, and ANP in the regulation of body fluid volume

14. Role of osmoreceptors in regulating extracellular fluid osmolality
15. Mechanisms of pH regulation of body fluids and the roles of the respiratory and renal systems

## Respiratory Physiology

1. Components of the respiratory system and their functions.
2. Pulmonary ventilation.
3. Gas exchange between alveoli and blood, and between blood and body cells.
4. Gas transport in the blood, respiratory centers, and the regulation of respiration.
5. Pulmonary circulation and its differences from systemic circulation.
6. The pleura and its role in the respiratory system.
7. Non-respiratory functions of the lungs.
8. Bronchial circulation and its differences from pulmonary circulation.
9. The respiratory cycle: inspiration and expiration.
10. Changes in intrapulmonary and intrapleural pressures during a respiratory cycle.
11. Surfactant secretion and its role in reducing surface tension.
12. Pulmonary function tests, lung volumes, and capacities.
13. Pulmonary ventilation and alveolar ventilation: differences and methods of calculation.
14. The ventilation-perfusion ratio and its role in determining arterial gas pressures.
15. Gas exchange between blood and alveoli.
16. Gas exchange between blood and tissue cells.
17. Mechanisms of oxygen and carbon dioxide transport in the blood.
18. The oxygen-hemoglobin dissociation curve and its characteristics.
19. Respiratory control centers and their role in regulating respiration.
20. Peripheral chemoreceptors and their role in regulating respiration.
21. Central chemoreceptors and their role in regulating respiration.

**Learning objectives:**

Learners, after completing this course, are expected to:

## Cell Physiology

1. Define terms such as physiology, internal environment, homeostasis, and cellular signaling.
2. List the body's homeostatic systems and briefly describe their functions.
3. Explain negative, positive, and feed-forward feedback control mechanisms with examples.
4. Describe the differences between intracellular and extracellular fluid compositions and their causes; explain the structure, arrangement, and function of membrane components.
5. Describe the mechanisms of substance exchange and transport across the cell membrane (diffusion, facilitated diffusion, active transport, osmosis).
6. Define the concept of resting membrane potential.
7. Explain the Nernst and Goldman–Hodgkin–Katz equations.
8. Identify types of action potentials, their phases, and the mechanisms of initiation and propagation.

9. Explain absolute and relative refractory periods and their causes.
10. Describe the physiological structure of skeletal muscle.
11. Explain the excitation–contraction coupling mechanism in skeletal muscle.
12. Define the concepts of motor unit and muscle tension.
13. Classify motor unit types and describe their roles in contraction strength.
14. Explain the relationship between load and contraction velocity.
15. Define atrophy, hypertrophy, hypotrophy, and rigor mortis.
16. Describe the structure and features of the neuromuscular junction.
17. Explain calcium release from the sarcoplasmic reticulum.
18. Describe the histological structure of smooth muscle and compare it with skeletal muscle.
19. Classify types of smooth muscle and explain their distinct features.
20. Explain the excitation and contraction mechanisms in smooth muscle.
21. Describe membrane potential and action potentials in smooth muscle and the effects of hormonal and local factors.
22. Identify the calcium sources for smooth muscle contraction.
23. Explain electrical membrane changes in smooth muscle, including slow waves and plateau potentials.

## Heart Physiology

1. Describe the physiological anatomy of cardiac muscle.
2. Explain the blood flow through the heart chambers.
3. Describe the practical pacemaker function in the heart.
4. Explain the generation of action potential and refractory phases in the heart.
5. Describe the excitation-contraction relationship of cardiac muscle.
6. Define the cardiac cycle and name its different phases.
7. Explain the phases of ventricular filling and emptying.
8. Describe isovolumetric contraction and relaxation.
9. Draw the pressure-volume curve of the heart and explain the stages of the cardiac cycle on it.
10. Explain cardiac output and how the heart consumes energy.
11. Identify the location and function of heart valves and papillary muscles.
12. Describe the generation of heart sounds and their relation to the pumping function of the heart.
13. Define cardiac output, end-systolic volume, and end-diastolic volume.
14. Define preload, afterload, contractile force, and contractility of the heart.
15. Explain intrinsic self-regulation of cardiac function (Frank-Starling mechanism).
16. Explain the effect of the autonomic nervous system on heart function.
17. Describe the relationship between preload, afterload, stroke volume, and cardiac output in normal and altered states.
18. Explain the impact of various factors such as ions and temperature changes on cardiac function.

## Blood Circulation Physiology

1. Describe the systemic and pulmonary circulatory circuits.

2. Explain the branches and vascular structure from the aorta to the vena cavae and state their differences.
3. Explain the interrelationships of vascular resistance, blood pressure, and blood flow using Ohm's law and Poiseuille's formula.
4. Describe types of blood flow in vascular beds and how to differentiate them.
5. Explain factors affecting blood viscosity and their impact on vascular resistance and blood flow in various vessels.
6. Define vascular compliance and explain differences between veins and arteries.
7. Explain delayed compliance mechanisms in vessels.
8. Calculate pulse pressure and mean arterial pressure and describe pulse pressure patterns in various diseases.
9. Describe methods of blood pressure measurement in humans.
10. Explain factors involved in venous return to the heart.
11. Describe capillary structure.
12. Explain capillary filtration.
13. Describe Starling's equilibrium in capillary exchanges.
14. List factors contributing to edema formation.
15. Define the lymphatic system and name its components.
16. List the functions of the lymphatic system.
17. Explain local control of blood flow in tissues.
18. Describe metabolic and myogenic mechanisms in vascular autoregulation.
19. Define reactive and active hyperemia.
20. Explain neural and hormonal control of blood flow.
21. List vasoconstrictors and vasodilators.
22. Name factors affecting blood pressure and explain their effects.
23. Describe the role of the vasomotor center and autonomic nervous system (sympathetic and parasympathetic) in regulating vessel diameter and blood pressure.
24. Explain the nervous system's role in rapid blood pressure regulation.
25. Describe baroreceptor-mediated blood pressure control.
26. Explain chemoreceptor-mediated blood pressure control.
27. Describe atrial and pulmonary arterial reflexes in blood pressure regulation.
28. Explain the central nervous system's response importance in blood pressure control.
29. Describe the effect of respiratory waves on blood pressure.
30. Describe components of the renin-angiotensin system and their role in blood pressure control.
31. Explain the kidney's role in long-term control of extracellular fluid volume and blood pressure.
32. Describe Frank-Starling mechanism's role in cardiac output control.
33. Explain factors affecting increase and decrease in cardiac pump strength.
34. Describe the nervous system's role in cardiac output control.
35. Sketch the cardiac output curve and the effects of various factors.
36. Define mean systemic circulatory filling pressure.
37. Draw the venous return curve and explain factors influencing it.
38. Write the venous return formula.
39. Overlay venous return (right atrial pressure) and cardiac output curves and explain the effects of blood volume infusion and sympathetic stimulation.
40. Describe the coronary vessel anatomy and physiology.
41. Compare the effect of cardiac activity on right and left ventricular coronary blood flow.
42. Explain factors influencing coronary circulation.
43. Describe chemical regulation of coronary blood flow.

44. Describe neural regulation of coronary blood flow.
45. Explain muscle blood flow during muscular contraction.
46. Describe regulation of skeletal muscle blood flow during activity.
47. Compare sympathetic nervous system effects on skeletal muscle vessels at rest and during activity.
48. Explain the importance of increased cardiac output and arterial pressure during muscle activity on muscle blood flow.
49. Describe the physiology of shock causes.
50. List stages of shock development.
51. Explain types of circulatory shock.
52. Describe cardiovascular system changes following circulatory shock.
53. State the physiological basis of shock therapy.
54. Explain circulatory arrest.

## Gastrointestinal Physiology

1. Explain the general principles of regulation in the gastrointestinal system.
2. Describe the hormonal regulation of the gastrointestinal system.
3. Explain the role of the autonomic nervous system in the regulation of the gastrointestinal system and describe the enteric nervous system and its components.
4. Describe the intrinsic control of gastrointestinal smooth muscles, and explain slow waves and their role in regulating gastrointestinal functions.
5. Explain the mechanism, importance, and control of mastication (chewing) in the mouth.
6. Describe the different stages of swallowing and explain their control mechanisms.
7. Explain the roles of the upper and lower esophageal sphincters and define the concepts of reflux and achalasia.
8. Describe gastric motility and identify the factors that affect the rate of gastric emptying.
9. Explain the types of small intestinal movements and the role of each in facilitating digestion and absorption of nutrients in the small intestine.
10. Describe the movements of the large intestine and their physiological functions.
11. Explain the defecation reflex and the neural centers involved in its regulation.
12. Describe the composition, importance, and regulation of salivary gland secretions.
13. Identify the gastric secretory cells and describe the types of gastric secretions produced by each.
14. Explain the different phases of gastric acid secretion stimulation.
15. Describe the effects of parietal cell stimulation on the ionic composition of gastric acid.
16. Identify the types of exocrine pancreatic secretions and explain the functions of each.
17. Describe the components and physiological significance of bile, and explain the enterohepatic circulation.
18. Explain the secretions of the small intestinal wall and their roles in digestion.
19. Describe the metabolic functions of the liver.
20. Explain the mechanisms of carbohydrate absorption in the small intestine.
21. Describe the mechanisms of protein absorption in the small intestine.
22. Explain the mechanisms of fat absorption in the small intestine.
23. Explain the mechanisms of water absorption in the gastrointestinal tract.
24. Describe the role of the large intestine in the absorption of water and electrolytes.

## Renal Physiology

1. Identify body fluids and their compartments.
2. Describe osmotic pressure and osmolality of body fluids.
3. Explain the effects of hypo- and hypernatremia on the regulation of body fluid volume.
4. Explain the physiological basis, causes, and mechanisms of edema formation and understand kidney and nephron physiology.
5. Describe glomerular filtration rate and the factors affecting it.
6. Understand the process of tubular reabsorption in various parts of the nephron, including the proximal tubule, loop of Henle, distal tubule, and collecting ducts.
7. Explain renal clearance and its role in estimating glomerular filtration rate (GFR) and renal blood flow.
8. Understand renal mechanisms involved in the excretion of dilute and concentrated urine.
9. Explain the control of osmolality and regulation of extracellular sodium concentration.
10. Describe the role of antidiuretic hormone (ADH) and the factors affecting its secretion.
11. Describe the regulation of extracellular potassium concentration.
12. Explain the control of calcium concentration and renal absorption and secretion of calcium.
13. Define acids and bases and describe the body's defense mechanisms against changes in acid-base balance.
14. Describe respiratory control of acid-base disturbances.
15. Describe renal control of acid-base balance and related disorders.

## Respiratory Physiology

1. Mechanics of pulmonary ventilation.
2. The pleura, pleural pressure, and their changes during respiration.
3. Compliance of the lungs and chest wall.
4. Lung volumes and capacities.
5. Alveolar ventilation and dead space.
6. Respiratory airways and their functions.
7. Reflexes of coughing, sneezing, and speech.
8. Pulmonary circulation and its characteristics.
9. Pulmonary edema and its mechanisms.
10. Gas diffusion in alveoli and tissues and the factors affecting it.
11. The ventilation-perfusion ratio and its variations.
12. The concept of shunt and physiological dead space.
13. Oxygen transport in the blood and the role of hemoglobin.
14. The oxygen-hemoglobin dissociation curve and factors that shift it.
15. Carbon dioxide transport in the blood.
16. The carbon dioxide dissociation curve.
17. Respiratory control mechanisms.

**Teaching Methods**

| Objective/Setting | Morning Report | Educational Rounds | Outpatient clinics | Clinical Skills Center (Skill lab) | Other |
|---|---|---|---|---|---|
| Students will learn the concepts, principles, and physiological mechanisms related to the areas listed above, and to be able to identify them in both normal and altered physiological processes. | | | | | Lecture Sessions |

**Student Evaluation Methods and rubric**

1. The theoretical exam will be conducted as a written MCQ (multiple-choice questions) worth 18 points.
2. A score of 2 point will be given for regular class attendance, active participation in discussions, and completion of optional assignments.

| Topic | Logbook | DOPS | Written Exam | OSCE | Other | The weight of the total score |
|---|---|---|---|---|---|---|
| | | | * | | Class Activity | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **Total** | | | 18 | | 2 | 20 |

Minimum Passing Grade: 10

**The maximum number of excused absences permitted for this course unit, subject to the trainer(s)'s approval:**

According to the total educational hours of this course (based on approved educational regulations), the student is not allowed to be absent from any session. Only in cases of justified absence, the student is permitted to be absent for up to four seventeenths of the total hours.

**Educational References:**

The latest editions for recommended physiology books are:

1. Guyton and Hall Medical Physiology: Latest edition 2024 (13th Edition)

2. Ganong Review of Medical Physiology: Latest edition 27th Edition, 2021
3. Berne & Levy Physiology: Latest edition 8th Edition, 2024, translated by Dr. Seyed Ali Haeri Rouhani and others, published by Andisheh Rafie

**Supplementary Learning References:**

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**Learning Opportunities**

The Weekly Journal Club in the Physiology Department is held on Tuesdays from 12:30 to 14:00.

**Contact Information:**

- Trainer(s): (Phone, Email)

Dr. Elham Karimi-Sales; +984133364664; karimi.sales@gmail.com

Dr. Behnaz Mokhtari; +984133364664; behnaz.sa.mokhtari@gmail.com

- Course Coordinator: (Phone, Email)

Dr. Elham Karimi-Sales; +984133364664; karimi.sales@gmail.com

Dr. Behnaz Mokhtari; +984133364664; behnaz.sa.mokhtari@gmail.com

- Educational staff of the department: (Phone, Email)

Prof. Reza Badalzadeh, +984133364664; reza.badalzadeh@gmail.com

**Signature of Course Director:**

**Dr. Behnaz Mokhtari**

**Dr. Elham Karimi-Sales**

**Signature of Department Chair:**


**Signature of the head of Educational Development Office (EDO):**