

Human physiology labs 2026/2027

Exercise 1

Subject: Review of internal regulations, safety regulations etc.

Exercise 2

Subject: Basis of neurophysiology

1. Functional Morphology of the Cell
2. Membrane Physiology
 - 2.1. Membrane Permeability and Transport of Substances Through the Cell Membrane
 - 2.2. Ion Channels
 - 2.3. $\text{Na}^+\text{-K}^+$ ATPase
 - 2.4. Secondary Active Transport
3. Resting Membrane Potentials of Nerves
4. Nerve cells morphology
5. Basic Functions of the Nervous System
6. Supporting Cells of Nervous Tissue
7. Measuring the Membrane Potential
8. Nerve Action Potential
 - 8.1. Electrotonic Potentials, Local Response and Firing Level (Threshold)
 - 8.2. Latent Period
 - 8.3. Action Potential
 - 8.4. „All-or-None“ Law
 - 8.5. Ionic Basis of Action Potential
 - 8.6. Changes in Excitability During Electrotonic Potentials and the Action Potential
9. Propagation of the Action Potential
 - 9.1. Contiguous Conduction
 - 9.2. Saltatory Conduction
 - 9.3. Orthodromic and Antidromic Conduction
10. Properties of Mixed Nerves fibers
11. Nerve Fiber Types & Function

Exercise 3

Subject: Synapses

1. Synaptic Transmission
 - 1.1. Types of Synapses
 - 1.2. Functional Anatomy
 - 1.3. Events in Synaptic Transmission
 - 1.4. Excitatory and Inhibitory Synapses
 - 1.5. Inhibition & Facilitation at Synapses
 - 1.6. Special Characteristics of Synaptic Transmission
 - 1.6.1. Synaptic Fatigue
 - 1.6.2. Synaptic Delay
 - 1.6.3. One-Way Conduction
 - 1.6.4. Summation and Occlusion

1.6.5. Effect of Hypoxia and Drugs on Synaptic Transmission

1.7. Synaptic Plasticity and Learning

Exercise 4

Subject: Muscles

1. Types of Muscles
2. Skeletal Muscles
 - 2.1. Morphology
 - 2.1.1. Organization of Skeletal Muscle
 - 2.1.2. Thick- and Thin-Filament composition
 - 2.2. Neuromuscular Transmission
 - 2.3. Electrical Phenomena and Ionic Fluxes
 - 2.4. Contractile Responses
 - 2.4.1. Sliding Mechanism of Contraction
 - 2.4.2. Molecular Basis of Contraction (Excitation-Contraction Coupling)
 - 2.4.3. Length-Tension Relationship
 - 2.4.4. Force-Velocity Relationship
 - 2.4.5. Types of Contraction
 - 2.4.6. Summation of Contractions
 - 2.5. Fatigue
 - 2.7. Fiber Types
 - 2.8. Motor Units
 - 2.9. Remodeling of Muscle to Match Function
 - 2.9.1. Hypertrophy
 - 2.9.2. Atrophy
 - 2.9.3. Denervation

Exercise 5

Subject: Sensory Physiology

1. Stimulus, adequate stimulus, transduction.
2. Sensory Receptors
3. Transduction of sensory stimuli
4. Generation of Impulses in Different Nerves
5. Adaptation
6. The Labeled Line Law
7. "Coding" of Sensory Information
8. Sensory Units, Receptive Fields, Recruitment of Sensory Units
9. Lateral Inhibition
10. Sensory Neurons
11. Sensory Pathways (Dorsal Column-Medial Lemniscal and Anterolateral Pathway)
12. Somatosensory Cortex
13. Mechanoreception
14. Thermoreception
15. Pain

Exercise 6

Subject: Control of Posture and Movement

1. Muscle Receptors (Muscle Spindle, Golgi Tendon Organ)
2. Spinal Reflexes:
 - 2.1. The Stretch Reflex
 - 2.2. The Inverse Stretch Reflex
 - 2.3. Other Reflexes
3. Control of voluntary movement
 - 3.1. Cortical Motor Areas
 - 3.2. The Corticospinal Tract (Pyramidal Tract)
 - 3.3. The Cerebellum and its Motor Functions
 - 3.4. Basal Ganglia
4. Spatial Orientation
5. Semicircular Canals, Utricle, Saccule
6. Vestibular Function, Responses to Rotational and Linear Acceleration, Nystagmus

Exercise 7

Subject: The Autonomic Nervous System (ANS)

1. General Organisation and Functions of ANS
2. Autonomic Nerve Pathway
3. Dual Innervation
4. Effects of ANS on Various Organs
 - Sympathetic and Parasympathetic Dominance
5. Anatomic Organisation of Sympathetic and Parasympathetic Divisions
6. Adrenal Medulla
7. Chemical Transmission at Autonomic Junctions
 - Neurotransmitters and Neuromodulators Present Within the ANS
8. Structure of the Membrane Receptors
 - Inositol Triphosphate and Diacylglycerol as Second Messengers
9. The Influence of Drugs on the ANS
10. Central Control of Autonomic Functions
11. Comparison of the Autonomic Nervous System and Somatic Nervous System
12. Smooth Muscles
 - Morphology
 - Types of Smooth Muscles
 - Molecular Basis of Contraction
 - Self-generated Electrical Activity in Smooth Muscle

Exercise 8

Subject: Special Senses: Vision, Hearing, Equilibrium

1. Vision:
 - 1.1. Visible Light
 - 1.2. Physical Principles of Optics and Image Formation

- 1.3. Structure of the Eye
- 1.4. Refractive Errors (Myopia, Hyperopia, Presbiopia), Correction
- 1.5. Accommodation
- 1.6. The Near Response (Accommodation Reflex)
- 1.7. Visual Acuity, the Snellen Charts Design
- 1.8. Characteristics of the Fovea Centralis and Peripheral Retina
- 1.9. Photochemistry of Vision
- 1.10. Dark and Light Adaptation
- 1.11. Scotopic and Photopic Vision
- 1.12. Colour Vision
- 1.13. Visual Pathways
2. Hearing and Equilibrium:
 - 2.1. Sound Waves
 - 2.2. External, Middle and Inner Ear
 - 2.3. Cochlea, Organ of Corti
 - 2.4. Sound Transmission and Amplification
 - 2.5. Sound Transduction (Excitation of the Hair Cells)
 - 2.6. Vestibular Apparatus (Semicircular Ducts and Otolith Organs)
 - 2.7. Detection of Angular and Linear Acceleration

Exercise 9

Quarterly Quiz: exercises 1-8

Exercise 10

Subject: Electrical Activity of the Heart. ECG

1. Membrane Resting Potential in Contractile and Autorhythmic Cells
2. Pacemaker potential
3. Anatomy considerations of Cardiac Conduction System
4. Action Potential in Autorhythmic and Contractile Cells
5. Transmission of the Cardiac Impulse through the Heart
6. The Conduction System of the Heart
7. Excitation-contraction coupling in cardiac contractile cells
8. Spread of Cardiac Excitation
 - Recording of depolarization vs repolarization waves
9. Bipolar and Unipolar Leads
 - Limb leads (standard and augmented)
 - Precordial leads
10. Theoretical basis of Electrocardiogram
 - Waves: P, Q, R, S, T
 - Segments: PQ, TP
 - Intervals: PQ, ST
11. Characteristics of the Normal Electrocardiogram

Exercise 11

Subject: The Heart as a Pump

1. Cardiovascular System Overview
2. Functional Anatomy of Cardiac Muscle

3. Excitation-Contraction Coupling in the Cardiac Muscle
4. Cardiac Output and Its Control
 - 4.1. Cardiac Output, Stroke Volume, Ejection Fraction, Cardiac Index
 - 4.2. Measurement of Cardiac Output – Fick Principle
 - 4.3. Relation of Tension to Length in Cardiac Muscle (The Frank-Starling Law)
 - 4.4. Control of Cardiac Output
5. The Cardiac Cycle
6. Pressure-Volume Relationship
7. Heart Sounds

Exercise 12

Subject: Circulation: Dynamics of Blood and Lymph Flow

1. Blood Vessels
2. Biophysical Considerations
 - 2.1. Velocity and Flow of the Bloodstream
 - 2.2. Pressure and Flow
 - 2.3. Poiseuille's Law
 - 2.4. Resistance to Flow
 - 2.5. Laminar and Turbulent Flow
 - 2.6. Critical Closing Pressure
 - 2.7. Laplace's Law
3. Arterial Pressure
 - 3.1. Systolic Pressure
 - 3.2. Diastolic Pressure
 - 3.3. Pulse Pressure
 - 3.4. Mean Pressure
4. Blood Pressure Measurement in Humans
5. Microcirculation
 - 5.1. Vasoactive Role of Capillary Endothelium
 - 5.2. Passive Role of Capillary Endothelium
 - 5.2.1. Diffusion
 - 5.2.2. Filtration
6. Lymphatic Circulation

Exercise 13

Subject: Cardiovascular Regulatory Mechanisms

1. General overview of blood pressure regulation
2. Autoregulation (Myogenic and Metabolic)
3. Substances Secreted by the Endothelium
4. Systemic Regulation by Hormones
5. Cardiac Innervation
6. Innervation of the Blood Vessels
7. Systemic Regulation by the Nervous System:
 - Baroreceptors

- Left-Ventricular Receptors, Bezold-Jarisch Reflex
 - Atrial Stretch Receptors, Bainbridge's Reflex
 - Pulmonary Receptors
 - Effect of Chemoreceptor Stimulation

Exercise 14

Subject: Circulation through Special Regions

1. Coronary Circulation
 - 1.1. Anatomic Considerations
 - 1.2. Factors Affecting the Coronary Flow (Mechanical, Chemical and Neural)
2. Pulmonary Circulation
 - 2.1. Anatomic Considerations
 - 2.2. Effect of Gravity and Ventilation
 - 2.3. Regulation of Pulmonary Blood Flow
3. Cerebral Circulation
 - 3.1. Anatomic Considerations
 - 3.2. The Blood-Brain Barrier
 - 3.3. Regulation of the Cerebral Blood Flow
4. Splanchnic Circulation
 - 4.1. Intestinal Circulation
 - 4.2. Hepatic Circulation
5. Cutaneous Circulation
6. Placental and Fetal Circulation

Exercise 15

Subject: Quarterly Quiz (Exercises 10-14)

Exercise 16

Subject: Respiration

1. Overview of the Respiratory System
2. Anatomy of the Lungs
3. Mechanics of Respiration
 - 3.1. Inspiration and Expiration
 - 3.2. Respiratory Muscles
 - 3.3. Compliance of the Lungs and the Chest Wall
 - 3.4. Alveolar Surface Tension and Surfactant
 - 3.5. Differences in Ventilation and Blood Flow in Different Parts of the Lungs
 - 3.6. Dead Space and Uneven Ventilation
4. Gas Exchange in the Lungs
 - 4.1. Composition of Alveolar Air – Its Relation to Atmospheric Air
 - 4.2. Diffusion Across the Respiratory Membrane
5. Pulmonary Volumes and Capacities

Exercise 17

Subject: Regulation of Respiration

1. Neural Control of Breathing
 - 1.1. Respiratory Center
 - 1.2. Pontine and Vagal Influences
 - 1.3. Receptors in the Airways and Lungs
2. Chemical Control of Breathing
 - 2.1. Peripheral Chemoreceptors
 - 2.2. Chemoreceptors in the Brain Stem
 - 2.3. Ventilatory Responses to:
 - 2.3.1. Changes in Acid-Base Balance
 - 2.3.2. CO₂
 - 2.3.3. Oxygen Lack

Exercise 18

Subject: The Blood I

1. Blood Composition
2. Red Blood Cells
3. Hemoglobin
4. Transport of Oxygen and Carbon Dioxide in the Blood and Body Fluids
5. Iron Metabolism

Exercise 19

Subject: The Blood II (Blood types. Hemostasis)

1. White Blood Cells
 - 1.1. Granulocytes
 - 1.2. Monocytes
 - 1.3. Lymphocytes
2. Platelets
3. Hemostasis
 - 3.1. Events in Hemostasis
 - 3.2. Mechanism of Blood Coagulation
 - 3.3. Lysis of Blood Clots
 - 3.4. Anticlotting Mechanisms
 - 3.5. Anticoagulants
4. Blood Types
 - 4.1. The ABO System
 - 4.1.1. A and B Antigens
 - 4.1.2. Agglutinins
 - 4.2. Rh Blood Types

Exercise 20
Subject: The Kidneys

1. Functions of the Kidneys
2. Functional Anatomy
 - 2.1. General Organization
 - 2.2. The Nephron
 - 2.3. Blood Vessels
 - 2.4. Innervation of the Renal Vessels
3. Renal Circulation
 - 3.1. Renal Blood Flow (RPF, ERPF, RBF)
 - 3.2. Regulation of the Renal Blood Flow
4. Glomerular Filtration
 - 4.1. Determinants of Glomerular Filtration Rate (GFR)
 - 4.2. Control of GFR
5. Mechanisms of Tubular Reabsorption and Secretion Water Excretion
 - 5.1. Countercurrent Multipliers and Countercurrent Exchangers
 - 5.2. Role of Urea
 - 5.3. Role of ADH
6. Micturition

Exercise 21
Subject: The Body Fluid Compartments and Acid-Base Balance

1. Fluid Intake and Output
2. The Body Fluid Compartments
3. Constituents of Extracellular and Intracellular Fluids
4. Osmotic Equilibrium between Intracellular and Extracellular Fluids
5. Regulation of Acid-Base Balance
 - 5.1. Principal Buffers of Body Fluids
 - 5.1.1. The Bicarbonate Buffer System
 - 5.1.2. The Phosphate Buffer System
 - 5.1.3. The Protein Buffer System
 - 5.1.4. The Hemoglobin Buffer System
 - 5.2. Respiratory Regulation of Acid-Base Balance
 - 5.3. Renal Regulation of Acid-Base Balance
 - 5.3.1. Secretion of Hydrogen Ions and Reabsorption of Bicarbonate Ions by the Renal Tubule
 - 5.4. Clinical Evaluation of Acid-Base Status

Exercise 22
Subject: Quarterly Quiz (Exercises 16-21)

Exercise 23
Subject: Endocrinology I

1. Coordination of Body Functions by Chemical Messengers

2. Chemical Structure of Hormones
3. Hormone Secretion, Transport and Clearance from the Blood
4. Mechanism of Action of Hormones
5. The Hypothalamic Control of Pituitary Secretion
6. The Pituitary Hormones:
 - 6.1. Growth Hormone
 - 6.2. ADH and Oxitocin
 - 6.3. MSH
7. The Pancreas Hormones:
 - 7.1. Insulin
 - 7.2. Glucagon
8. Leptin

Exercise 24

Subject: Endocrinology II

1. The Thyroid Gland
 - 1.1. Iodine Metabolism
 - 1.2. The Thyroid Hormones
2. ACTH
3. Adrenocortical Hormones:
 - 3.1. Mineralocorticoids (Aldosterone)
 - 3.2. Glucocorticoids (Cortisol)
 - 3.3. Adrenal Androgens
4. The Renin-Angiotensin System

Exercise 25

Subject: Endocrinology III

1. Hormonal Control of Calcium Metabolism
 - 1.1. Vitamin D
 - 1.2. PTH
 - 1.3. Calcitonin
2. The Gonads:
 - 2.1. The Male Reproductive System
 - 2.1.1. Endocrine Function of the Testes
 - 2.2. The Female Reproductive System
 - 2.2.1. Ovarian Cycle
 - 2.2.2. Uterine Cycle
 - 2.2.3. Ovarian Hormones

Exercise 26

Subject: Gastrointestinal Physiology

1. Characteristics of the Gastrointestinal Wall
2. Functional Types of Movements in the Gastrointestinal Tract
3. Mastication (Chewing)
4. Swallowing
5. Defecation

6. Vomiting
7. Gastrointestinal Hormones
8. Gases in the Gastrointestinal Tract
9. Secretion of Saliva
 - 9.1. Characteristics of Saliva
 - 9.2. Regulation of Salivary Secretion
10. Gastric Secretion
 - 10.1. Characteristics of the Gastric Secretions
 - 10.2. Regulation of Gastric Secretion
 - 10.3. Mucosal Barrier
11. Exocrine Pancreatic Secretion
 - 11.1. Composition of Pancreatic Juice
 - 11.2. Regulation of Pancreatic Secretion
12. Liver and Biliary System
 - 12.1. Anatomic Considerations
 - 12.2. Functions of the Liver
 - 12.3. Biliary Secretion
 - 12.3.1. Storage and Concentration of Bile in the Gallbladder
 - 12.3.2. Characteristics of Bile
 - 12.3.3. Emptying of the Gallbladder
 - 12.3.4. Function of the Bile Salts in Fat Digestion and Absorption
 - 12.3.5. Enterohepatic Circulation of the Bile Salts

Exercise 27

Subject: Exercise Physiology

1. Muscle Fiber Types
2. Strength, Power and Endurance of Muscles
3. Muscle Metabolic Systems in Exercise:
 - 3.1. Phosphocreatine-Creatine System
 - 3.2. Glycogen-Lactic Acid System
 - 3.3. Aerobic System
4. Recovery of the Aerobic System After Exercise
 - 4.1. Oxygen Debt
 - 4.2. Recovery of Muscle Glycogen
5. Muscle Fatigue
6. Effect of Training on Muscle Performance
7. Respiration in Exercise
8. Cardiovascular System in Exercise
9. Body Heat in Exercise
10. Body Fluids and Salt in Exercise

Exercise 28

Subject: Quarterly Quiz (Exercises 23-27)

Exercise 29

Quarterly test additional take (for all eligible students)