

## **Exercise 1**

**Subject: Review of internal regulations, safety regulations etc.**

## **Exercise 2**

### **Basis of neurophysiology**

1. Resting Membrane Potentials of Nerves
2. Nerve cells morphology
3. Basic Functions of the Nervous System
4. Supporting Cells of Nervous Tissue
5. Measuring the Membrane Potential
6. Nerve Action Potential
  - 6.1. Local Response and Firing Level (Threshold)
  - 6.2. Latent Period
  - 6.3. Action Potential
  - 6.4. „All-or-None“ Law
  - 6.5. Ionic Basis of Action Potential
  - 6.6. Changes in Excitability During the Action Potential
7. Propagation of the Action Potential
  - 7.1. Contiguous Conduction
  - 7.2. Saltatory Conduction
  - 7.3. Orthodromic and Antidromic Conduction
8. Properties of Mixed Nerves fibers
9. 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
    - 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
3. Smooth Muscles
  - 3.1. Morphology
  - 3.2. Types of Smooth Muscles
  - 3.3. Molecular Basis of Contraction
  - 3.4. Self-generated Electrical Activity in Smooth Muscle

## **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

## **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

## **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**

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

## **Exercise 11**

### **Subject: Electrocardiography**

1. Spread of Cardiac Excitation
  - Recording of depolarization vs repolarization waves
2. Bipolar and Unipolar Leads
  - Limb leads (standard and augmented)
  - Precordial leads
3. Theoretical basis of Electrocardiogram
  - Waves: P, Q, R, S, T
  - Segments: PQ, TP
  - Intervals: PQ, ST
4. Characteristics of the Normal Electrocardiogram
5. The Mean Electrical Axis of the Heart

### **1<sup>st</sup>QuarterlyQUIZ RE-TAKE**

## **Exercise 12**

### **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 13**

### **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 14

#### 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 15

#### 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. Cutaneous Circulation

#### Exercise 16

#### Subject: Quarterly Quiz (Exercises 10-15)

#### Exercise 17

#### 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

#### Exercise 18

#### 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. CO<sub>2</sub>
    - 2.3.3. Oxygen Lack
3. Pulmonary Volumes and Capacities

#### 2<sup>nd</sup> Quarterly QUIZ RE-TAKE

### **Exercise 19**

#### **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 20**

#### **Subject: The Blood II**

1. White Blood Cells
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 21**

#### **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 22**

#### **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 23**

#### **Subject: Quarterly Quiz (Exercises 17-22)**

### **Exercise 24**

#### **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 25

#### 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

### 3<sup>rd</sup> Quarterly QUIZ RE-TAKE

### Exercise 26

#### 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 27

#### 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 28**

### **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 Fluids and Salt in Exercise**

**Exercise 29**

**Subject: Quarterly Quiz (Exercises 24-28)**

**Exercise 30**

**4<sup>th</sup> Quarterly QUIZ RE-TAKE**