**Cellular and Molecular Physiology - Complex Exam Questions**

**1. Metabolism and Effects of Secondary Messengers**

- Synthesis of secondary messengers: receptors and G proteins

- Metabolism of cAMP

- Metabolism of phosphoinositides and inositol phosphates

- Generation and actions of inositol 1,4,5-trisphosphate (IP3)

- Role of protein kinases and protein phosphatases in cell physiology

- Cellular calcium homeostasis

- Synthesis and known effects of cGMP

**2. Ion Transport Mechanisms**

- General kinetics of transport and types of transport mechanisms

- Pump mechanisms in plasma membranes and intracellular membranes

- Carrier-mediated ion transport in plasma membranes and intracellular membranes

- Structure and electrophysiological characteristics of ion channels

- Cation channels

- Anion channels

- Regulation of ion channels

- Role of lipids in the regulation of ion transport

**3. Intracellular Membrane Trafficking**

- Endocytosis, exocytosis, and receptor internalization

- Interactions between cell components

- Targeting components of plasma membranes and intracellular membranes

- Plasma membranes of polarized cells

- Role of small GTP-binding proteins (ARF, Rab proteins) in intracellular membrane trafficking

**4. Biological Role of Reactive Oxygen Species (ROS)**

- Compounds and formation of ROS

- Subcellular sources of ROS and mechanisms of their formation

- Structure and function of NADPH oxidases

- Physiological role of ROS

- Pathophysiological role of ROS

- Antioxidant defense mechanisms

**5. Structure and Function of Membrane Receptors**

- Ion channel receptors

- G protein-coupled receptors (GPCRs)

- Enzyme-linked receptors

- Cytokine receptor family, including leptin receptors

- Receptor kinetics

- Processes following receptor activation

- Regulation of receptor activity

- Role of small GTP-binding proteins in receptor signaling pathways

- Regulatory proteins of small GTP-binding proteins

**6. Intercellular Communication**

- Cell adhesion molecules (CAMs)

- Physiological roles of extracellular matrix molecules

- Types of humoral communication

- Role of direct and cytokine-mediated cell interactions in immune function

- Cell interactions involved in antigen presentation

- Lymphocyte homing mechanisms

- Signal transduction mechanisms regulating angiogenesis

- Molecular mechanisms regulating lymphatic vessel proliferation

- Role of extracellular vesicles in intercellular communication

**7. Receptors and Functions of Different Cell Types**

- Neutrophil granulocytes

- T lymphocytes (T cells)

- B lymphocytes (B cells)

- Lymphatic endothelial cells

- Vascular endothelial cells

- Osteoclasts

- Natural killer (NK) cells

- Eosinophil granulocytes

- Zona glomerulosa cells

- Mast cells

**Additional Subjects**

- Physiology of the cardiovascular system

- Physiology of the respiratory system

- Physiology of endocrine organs and reproduction

- Physiological functions of erythrocytes (red blood cells) and thrombocytes (platelets)

- Mechanisms of innate immunity

- Mechanisms of adaptive immunity

- Physiology of phagocyte-derived cells

- Physiology of absorption and excretion

- Mechanisms of exocrine secretion

- Hormonal regulation of carbohydrate and lipid metabolism

- Regulation of energy metabolism and food intake

- Molecular physiology of neuronal function

- Physiology of sensory neuron function

- Regulation of signal transduction and cell proliferation

- Physiological roles of the contractile system and extracellular matrix

- Autoimmune diseases

- Regulation of bone metabolism

- Physiological and pathophysiological roles of lymphatic vessels beyond fluid balance regulation

- Circadian regulation of physiological functions

- Regulation of food intake and energy balance