**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