



## **EDO UNIVERSITY IYAMHO**

### **Department of Physiology**

### **PHS 201 General Principles in Physiology and Cell Biology**

**Instructor:** *Dr. Olugbemi Olaniyan*, email: olaniyan.olugbemi@edouniversity.edu.ng

Lectures: Monday (1.00 ó 3.00 pm), Wednesday and Thursday 8am ó 12.00 pm,

Venue: LT1, LT5 and TEL Laboratory. Phone: (+234) 8055763933

Office hours: Monday ó Friday 12.00 to 1.00 PM (just before class), Office: College Building Ground Floor Room 39.

**Teaching Assistants:** *Mr. Adeniyi M. J.*

**General overview of lecture:** Introduction to Physiology, Composition of the body, Cellular Physiology, Structure of Cell Organelles, Membrane structure and functions, Membrane Transport, Membrane Potential, Intercellular Communication and Signal transduction, Homeostasis, Homeostatic control, Feedback mechanisms, Cellular adaptation, Cell division and cycle, apoptosis, necrosis.

**Prerequisites:** Introduction to general principles, definition of terminologies, basic concepts in cell biology, mechanism of actions, pathways, physiological regulations, pathophysiology and conclusions.

#### **Learning outcomes:**

1. Students must know that cells is the basic units of life.
2. Students must know most cells are subdivided into plasma membrane (is a fluid bilayer embedded with proteins), cell organelles, nucleus and cytoplasm.
3. Students must know the functions of the Endoplasmic Reticulum, Golgi complex, lysosomes, peroxisomes, mitochondria, cytosol, and cytoskeleton.
4. Students must know the mechanisms of osmosis of water and diffusion of lipid soluble substances and small ions through the plasma membrane down their electrochemical gradients.
5. Students must know the special mechanisms used to transport selected molecules unable to cross the plasma membrane on their own: carrier mediated; endocytosis; exocytosis.
6. Communications between cells is largely by extra cellular chemical messengers: paracrine, autocrine, neurocrine and endocrine.
7. Activation of second messengers system by extra cellular (first) messengers: cAMP, cGMP, inositol triphosphate, Ca<sup>++</sup>, diacylglycerol.

8. Understand that homeostasis is essential for cell survival, disruption in homeostasis can lead to illness and death.
9. Homeostatic control systems include: closed and open loop systems
10. Students must know the negative and positive feedback mechanisms
11. Students must know the 3 levels of physiological regulations: intracellular, local (intrinsic) and extrinsic
12. Students must know the neural and endocrine reflexes control many events such as: somatic, autonomic, endocrine reflexes
13. Students should understand the concept of Cell division and cell cycle
14. Students should know the role of apoptosis and necrosis in the regulation of physiological functions.

**Assignments:** We expect to have 2 individual homework assignments throughout the course in addition to a Mid-Term Test and a Final Exam. Home works are due at the beginning of the class on the due date. Home works are organized and structured as preparation for the midterm and final exam, and are meant to be a studying material for both exams.

**Grading:** We will assign 10% of this class grade to homework, 20% for the mid-term test and 70% for the final exam. The final exam is comprehensive.

**Textbook:** The recommended textbook for this class are as stated:

*Ganong's Review of Medical Physiology*

Authors: Kim E. Barrett, Scott Boitano, Susan M. Barman, Heddwen L. Brooks.

Publisher: (Twenty-Third Edition) a LANGE medical book. The McGraw-Hill Companies, Inc.

ISBN: 978-0-07-160568-7

MHID: 0-07-160568-1

*Medical Physiology Principles for Clinical Medicine*

Authors: Rodney A. Rhoades, Ph.D., David R. Bell, Ph.D.

Publisher: Lippincott Williams & Wilkins, a Wolters Kluwer business (Fourth Edition)

ISBN 978-1-60913-427-3

*Essentials of Medical Physiology*

Authors: K Sembulingam Ph.D. and Prema Sembulingam Ph.D.

Publisher: Jaypee Brothers Medical Publishers (P) Ltd (Sixth Edition)

ISBN 978-93-5025-936-8

**Main Lecture:**

**What is Physiology?** Physiology is the study of normal body function that covers the physio-chemical processes taking place in cell and tissue, the electrical event underlining the action of

nervous system and the feedback mechanisms controlling these events to the complex performance of animal/human as a whole.

### **Sub specialization in Physiology:**

1. Aviation and Aerospace Physiology.
2. Exercise and Sport Physiology.
3. Cardiorespiratory Physiology.
4. Environmental Physiology.
5. Reproductive Physiology and Clinical embryology.
6. Neuroscience and Pain Physiology.
7. Cell and Molecular Biology.
8. Membrane Physiology and Biophysics.
9. Oncology and Pathophysiology.
10. Marine Physiology
11. Gastrointestinal and Inflammation
12. Endocrinology and Metabolism
13. Renal Physiology

### **Cell**

The intracellular fluid of living cells, the **cytosol**, has a composition very different from that of the extracellular fluid (ECF). For example, the concentrations of potassium and phosphate ions are higher inside cells than outside, whereas sodium, calcium, and chloride ion concentrations are much lower inside cells than outside. These differences are necessary for the proper function of many intracellular enzymes; for instance, the synthesis of proteins by the ribosomes requires a relatively high potassium concentration. The **plasma membrane** of the cell creates and maintains these differences by establishing a permeability barrier around the cytosol. The ions and cell proteins needed for normal cell function are prevented from leaking out; those not needed by the cell are unable to enter the cell freely. The plasma membrane also keeps metabolic intermediates near where they will be needed for further synthesis or processing and retains metabolically expensive proteins inside the cell. The plasma membrane is necessarily selectively permeable. Cells must receive nutrients to function, and they must dispose of metabolic waste products. To function in coordination with the rest of the organism, cells receive and send information in the form of chemical signals.

The first theory of membrane structure proposed that cells are surrounded by a double layer of lipid molecules, a **lipid bilayer**. This theory was based on the known tendency of lipid molecules to form lipid bilayers with low permeability to water-soluble molecules (Singer and Nicolson, 1972).

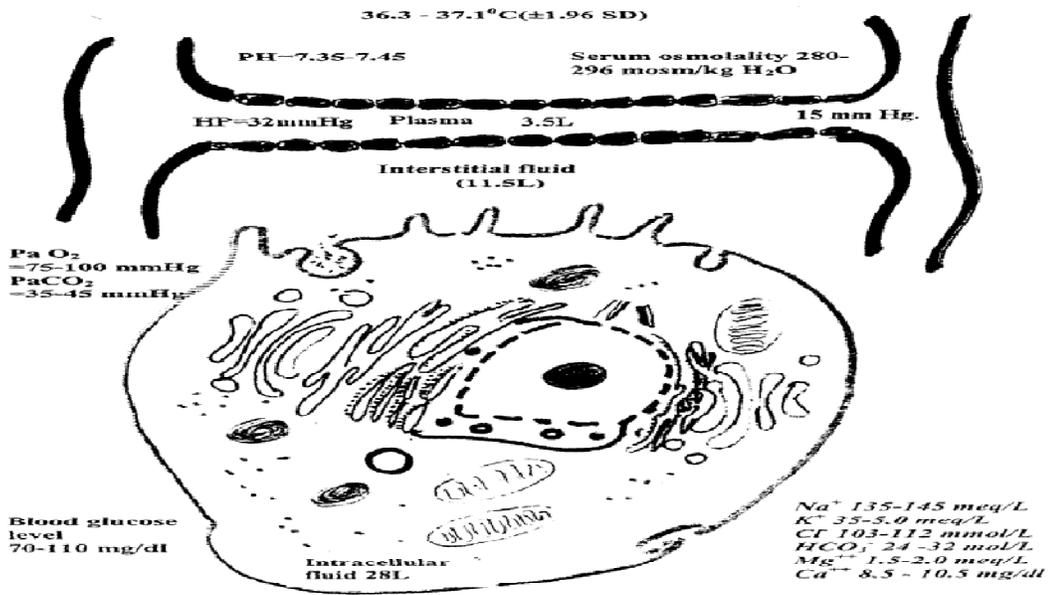
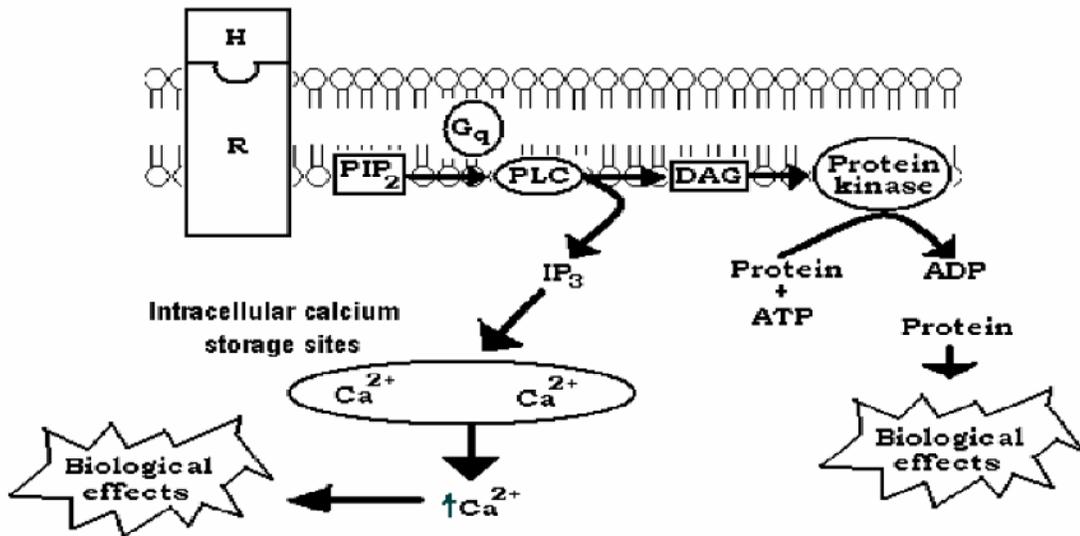


Figure 1: Diagram of a cell showing the intracellular and extracellular compartments.



**Figure 2: Diagram showing Hormone/receptor activation of second messengers.**

### Homeostatic Control Mechanisms

Our bodies are made up of incredibly complex and delicate materials, and we are constantly subjected to all kinds of disturbances, yet we keep going for a lifetime. It is clear that conditions and processes in the body must be closely controlled and regulated. The 19th-century French physiologist Claude Bernard was the first to formulate the concept of the internal environment (*milieu intérieur*). He pointed out that an external environment surrounds multicellular organisms (air or water) and a liquid internal environment (extracellular fluid) surrounds the cells that make up the organism.

Homeostatic regulation of a physiologic variable often involves several cooperating mechanisms activated at the same time or in succession. The more important a variable, the more numerous and complicated are the mechanisms that operate to keep it at the desired value. When the body is unable to restore physiologic variables, then disease or death can result. The ability to maintain homeostatic mechanisms varies over a person's lifetime, with some homeostatic mechanisms not being fully developed at birth and others declining with age. For example, a newborn infant cannot concentrate urine as well as an adult and is, therefore, less able to tolerate water deprivation. Older adults are less able to tolerate stresses, such as exercise or changing weather, than are younger adults.

## Cell Communication

### Synaptic Transmission

Neurons communicate at synapses. Two types of synapses have been identified: electrical and chemical. At **electrical synapses**, passageways known as **gap junctions** connect the cytoplasm of adjacent neurons and permit the bidirectional passage of ions from one cell to another. Electrical synapses are uncommon in the adult mammalian nervous system. Typically, they are found at dendrodendritic sites of contact; they are thought to synchronize the activity of neuronal populations. Gap junctions are more common in the embryonic nervous system, where they may act to aid the development of appropriate synaptic connections based on synchronous firing of neuronal populations. Gap junctions are also important for cell-to-cell communication in smooth and cardiac muscle.

