INTRODUCTORY PHYSIOLOGY

DR O. A ADEJUMO

- Physiology is one the core components of the basic medical sciences which provides the basic foundation needed for medical education and practice.
- The course is designed to give an introduction to the principle governing normal function of human body

- OBJECTVES
- To help the students understand the scientific basis of medical and dental practice and development
- To help the students relate basic knowledge of normal organ function to common abnormalities
- To use this basic knowledge to explain common pathological disturbances, especially failure of certain functions
- To use the description of these disturbances to reinforce basic knowledge
- To encourage students to think of disease in terms of disturbed functions

PHYSIOLOGY

- Definition : Study of the characteristics and mechanisms of the human body
- Cells are the basic unit of life within the human body
- Approximately 100 trillion cells make up the typical human, each specially adapted to perform one or a few particular functions
- 25 trillion red blood cells act to transport oxygen from the lungs to all tissues in the body
- All cells have some common basic characteristics:

Oxygen reacts with carbohydrates, fat, and protein to release energy
Nutrient consumption and energy production mechanisms are similar
Nearly all cells have the ability to reproduce additional, similar cells

- The functional unit of life is the cell
- Specialized group/ aggregate of cells to form organs so systems such as GIT system, Cardiovascular system
- These various organs systems work in coordinated manner to ensure life
- Physiology is concerned about how these various systems function and the contribute to the functions of the body as a whole.

- 60% of the total body weight is made up of water which is equivalent to 42kg in a 70kg physiologic man.
- This is equivalent to 42 Litres
- Two-thirds (28L) of this as Intracellular fluid (ICF) and remaining one-third (14 L) as Extracellular fluid (ECF)
- The ECF is made up of plasma volume(3.5L) and interstitial fluid (10.5L)

- This extracellular fluid is in constant motion throughout the body
- It is transported rapidly in the circulating blood and then mixed between the blood and the tissue fluids by diffusion through the capillary walls.
- Components of the ECF are ions and nutrients needed by the cells to maintain cell life.
- All cells live in essentially the same environment—the extracellular fluid also known as the *internal environment* of the body, or the *milieu intérieur or internal milieu*

- The term internal milieu was introduced by a French physiologist known as Claude Bernard.

- The cells of the body are continuously bathed in the ECF
- The ECF is transported through all parts of the body in two stages; movement of blood through the blood vessels and movement of fluid between the intercellular spaces and blood capillaries
- Hence there is continuous exchange of substances between the ISF and plasma

Some Chemical Composition of the ECF

Sodium	142 mEq/L	138-146 mEq/L	
Potassium	4.2mEq/L	3.8-5.0 mEq/L	
Bicarbonate	28 mEq/L	24-32 mEq/L	
Chloride	108 mEq/L	103-112 mEq/L	
Oxygen	40 mEq/L	35-45 mEq/L	
Carbon dioxide	40 mEq/L	35-43 mEq/L	
pH	7.4	7.3-7.5	

	ECF	ICF	
Sodium	142 mEq/L	10mEq/L	
Potassium	4 mEq/L	140 mEq/L	
Calcium	2.4 mEq/L	0.0001 mEq/L	
Bicarbonate	28mEq/L	10 mEq/L	
Phosphate	4 mEq/L	75 mEq/L	
Sulphate	1 mEq/L	2 mEq/L	
Protein	2 mEq/L	16 mEq/L	

HOMEOSTASIS

- Homeostasis means maintenance of nearly constant conditions in the internal environment.
- All organ systems of the body work together to achieve homeostasis
- Some systems to nutrients supply, removal of waste products of metabolism and regulation of other organ systems

Systemic Contribution to Homeostasis

- REMOVAL OF WASTE: Kidneys, Lungs
- SUPPLY OF NUTRIENTS: Liver, Gastrointestinal system, Musculoskeletal system
- REGULATION OF BODY FUNCTIONS: Endocrine system, Nervous system

CONTROL SYSTEMS OF THE BODY

- There are various control systems in the body operating at various levels.

- Some control system operate within a single organ system while operate within the entire body to control interrelations between the various organs

Examples of Control Systems

1. Regulation of Oxygen and Carbon Dioxide concentrations in the ECF: The role of hemoglobin and respiratory centre
2. Regulation of Blood pressure: The role of baroreceptor, medulla and the autonomic nervous system

Characteristics of Control Systems

- Negative feedback
- Positive feedback
- Feedforward/Adaptive feedback

NEGATIVE FEEDBACK

- When some factors become excessive or deficient, series of changes occur that return the factor towards a certain mean value, thus maintaining homeostasis

NEGATIVE FEEDBACK

- Most control systems of the body act by negative feedback
- A stimulus causes a reaction that opposes the acting stimulus.
- The negative feedback system acts to maintain homeostasis

Examples

1. Increased CO_2 causes increased pulmonary ventilation, which decreases CO_2
2. Decreased arterial pressure activates the baroreceptor system which acts increase heart rate and arterial constriction, which increases arterial pressure

GAIN OF CONTROL SYSTEM

The gain of a control system is a parameter which describes the degree of effectiveness with which a control system can maintain constant conditions

Gain = Correction / Error

Example

In a normal person with a functioning baroreceptor control system, a defined stimulus causes arterial pressure to increase from 100 mmHg to 125 mmHg . Error is +25 mmHg

If the baroreceptor system provided perfect control, there would be no change in arterial pressure

A person with a non-functioning baroreceptor control system, the same stimulus causes arterial pressure to increase from 100 mmHg to 200 mmHg . Difference from the normal response is 75 mmHg.

Thus, the baroreceptor system provides a correction of -50 mmHg

Gain = -75 mmHg / +25 mmHg = -3

- The higher the value of the gain of a control system, the more effective the system in achieving homeostasis.

POSITIVE FEEDBACK

- In a positive feedback control system, a stimulus causes responses that promote the stimulus
- In general, positive feedback systems lead to instability and therefore are not utilized as often as negative feedback systems

- Examples of useful positive feedback in the body include:

1. Blood clotting : A rupture of a blood vessel initiates clot formation, and enzyme activation within the clot causes other enzymes in the blood to clot .The cycle continues until the vessel in plugged and bleeding stops
2. Uterine contractions in childbirth
3. Sodium ion flux in nerve signal propagation

Typically, positive feedback control systems work within a larger negative feedback control system e.g The blood clotting cycle works within the maintenance of blood volume negative feedback cycle

FEEDFORWARD/ADAPTIVE CONTROL

- A feed forward system reacts to changes within its environment, typically to maintain some form of equilibrium
- The information is sent ahead of time to prepare a part of a control system.
- The effector system is activated before any change has taken place.
- By anticipating change the environment is in a prolong change of readiness