Lecture1: Medical Physiology Introduction, Homeostasis and cellular function

Learning Objectives

By the end of this lecture, students should be able to:

1. Define physiology and its importance in medical sciences.
2. Explain the concept of homeostasis and its role in maintaining life.
3. Describe the main functional components of the cell.
4. Relate how cell functions support the stability of the internal environment.

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1. What is Physiology?

• **Physiology** is the study of how the body functions in normal conditions.

• It explains the mechanisms that keep cells, tissues, organs, and systems working together to maintain life.

• Example: how the heart pumps blood, how lungs exchange oxygen and carbon dioxide, how kidneys regulate water and electrolytes.

☞ It focuses on understanding how living things work, how they adapt to their environment, maintain internal balance **(homeostasis)** and how these processes are disrupted in disease.

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2. The Concept of Homeostasis

• **Homeostasis** is the ability of the body to maintain a stable internal environment despite external changes.

• Examples of controlled variables:

• Body temperature (~37°C)

• Blood glucose (~70–110 mg/dL)

• Blood pressure (~120/80 mmHg)

• pH of blood (~7.35–7.45)

• Mechanism: Usually through negative feedback loops.

• Example:

• When blood glucose rises after a meal → pancreas releases insulin → cells take up glucose → blood glucose returns to normal.

• Importance: Without homeostasis, cells cannot survive, and disease occurs.

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main mechanisms of homeostasis :

1. Receptor (Sensor): Detects change in the body (e.g., temperature sensors in skin).

2. Control Center: Compares the change to the normal set point and decides what to do (usually the brain or endocrine glands).

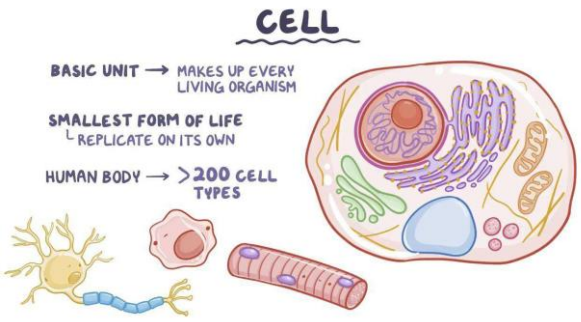
3. Effector: Carries out the response to restore balance (e.g., sweat glands, muscles, pancreas).

4. Negative Feedback: The most common mechanism → response reverses the change to bring conditions back to normal (e.g., insulin lowers high blood sugar).

5. Positive Feedback: Less common → response increases the change (e.g., oxytocin during childbirth contractions, blood clotting).

☞ In short: Receptor → Control Center → Effector → Feedback → Balance restored.

3. Cell Functions



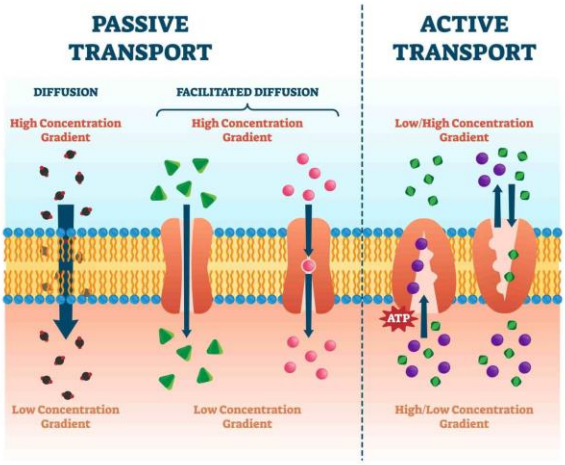
The cell is the basic unit of life .

Every organ function depends on the activity of its cells.

Major functions include:

1. Transport of Substances

• Nutrients, ions, and waste products move in/out through the cell membrane.



• Two main mechanisms:

• Passive transport (diffusion, osmosis).

• Active transport (requires energy, e.g., Na^+/K^+ pump).

2. Energy Production

• Mitochondria convert nutrients (mainly glucose, fatty acids) into ATP through cellular respiration.

• ATP is the "energy currency" of the cell.

3. Communication & Signaling

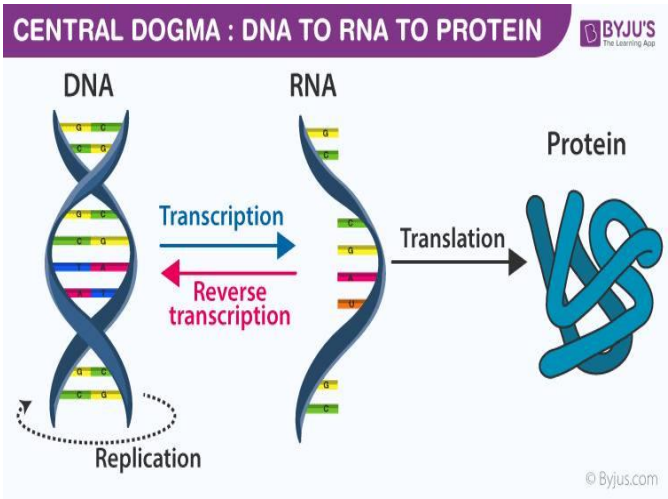
• Cells communicate via chemical messengers (hormones, neurotransmitters).

• Receptors on cell membranes recognize and respond to signals.

4. Protein Synthesis

• DNA → RNA → Protein (Central Dogma).

• Proteins are needed for enzymes, hormones, and structural support.



5. Growth, Differentiation, and Reproduction

• Cells divide (mitosis) for growth and repair.

• Specialized cells differentiate to perform unique functions (e.g., nerve cells, muscle cells).

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4. Clinical Relevance

- **Failure of homeostasis leads to disease:**
- Diabetes mellitus → failure to regulate blood glucose.
- Hypertension → failure to regulate blood pressure.
- Heat stroke → failure of temperature regulation.
- **Understanding physiology is essential for diagnosing and treating disease, because pathology is often "physiology gone wrong."**

✓ Key Takeaways:

- **Physiology studies how the body normally works.**
- **Homeostasis is the foundation of health.**
- **Cells are the functional units of life, performing transport, energy production, communication, synthesis, and growth.**
- **Medicine builds on physiology: without it, pathology and treatment cannot be understood.**