

General Physiology

1. Importance and Scopes of Physiology in Medicine
2. Structure and Function of a Cell and Intercellular Communication
3. Principles of Homeostasis
4. Physiology of Apoptosis
5. Transport Mechanisms Across the Cell Membrane
6. Body Fluids
7. Concept of pH, Buffer System of the Body, and Physiological Basis of Acid–Base Disorders
8. Membrane Potential

“

On Will Power

*The Power can do everything,
change everything and will do that
but it can do it perfectly and easily and permanently only when
your own will mental vital and physical has been put on the side of the truth.*

—Sri Aurobindo

”

Importance and Scopes of Physiology in Medicine

BEFORE THE EXAM: This chapter should leave you with six essential ideas:

1. Physiology explains normal body function; disease is usually a disturbance of normal function.
2. Homeostasis is the basis of health; dyshomeostasis produces dysfunction and disease.
3. Pathology, pharmacology and clinical medicine become easier when their physiological basis is clear.
4. A good physician uses physiology for diagnosis, rational treatment and prevention of disease.
5. Physiology drives medical research; hence the Nobel field is called Physiology or Medicine.
6. Modern physiology includes clinical, interventional, preventive and integrative health applications.

Learning Objectives

After reading this chapter, the student should be able to:

1. Define physiology, human physiology and medical physiology.
2. Explain why physiology is the foundation of pathology, pharmacology and medicine.
3. Describe the role of physiology in diagnosis, treatment and prevention of diseases.
4. Relate physiology to medical research and Nobel Prize discoveries.
5. List the major scopes of physiology in modern medicine.

BASIC CONCEPTS

Physiology is the study of body functions, their mechanisms and regulation. **Human physiology** studies functions of cells, tissues, organs and organ systems in the human body. **Medical physiology** applies these functions to understand the pathophysiology of the disease, treatment and prevention.

Physiology: The Mother of Medicine

Medical physiology provides the knowledge to understand that **homeostasis** (internal balance of body systems) as the *basis of normal health* and **dyshomeostasis** (disruption of balance within the system) *resulting from bodily dysfunctions*. Disturbance or abnormality in functions (**pathophysiology**) results in disease, and disease disappears by improving physiology and eliminating pathology (Table 1.1).

Therefore, the knowledge in physiology helps **understand, diagnose and treat the diseases** (Clinical Link 1.1).

Table 1.1: Physiology terminologies to understand medicine

Term	Simple meaning
Homeostasis	Stable internal environment needed for health
Dyshomeostasis	Disturbed internal balance leading to dysfunction
Pathophysiology	Altered function that produces disease
Clinical physiology	Use of physiology in patient care



CLINICAL LINK 1.1: Why first-year physiology matters

- ♦ A symptom is not just a complaint; it is a physiological signal of an underlying pathology.
- ♦ A test result is useful only when the underlying physiological basis of estimation is understood.
- ♦ A drug is selected rationally when its physiological basis of action is known.

Example: Acute myocardial infarction

1. Coronary circulation explains reduced blood supply to myocardium.

2. Pain physiology explains ischemic chest pain and radiation to the left arm.
3. Cardiac electrophysiology explains ECG changes.
4. Drug physiology explains improvement of coronary flow, oxygen demand and myocardial perfusion.

PHYSIOLOGY FOR LEARNING MEDICINE

Physiology for Learning all Subjects

Physiology is essential for learning all branches of medicine. It provides the mechanism and the physiological basis of the disease and its management (Table 1.2). Other subjects build on that physiological mechanism (Exam Box 1.1).

Table 1.2: Physiological—the basis of learning medicine

Subject	How physiology helps	Example
Pharmacology	Explains drug action, dynamics and adverse effects	β_2 -agonists relax bronchial smooth muscle in asthma
Pathology	Explains disturbed function and tissue response	Neutrophils suggest acute inflammation; macrophages suggest chronic inflammation
Medicine	Explains physiological basis of symptoms, signs, diagnosis and treatment	ECG interpretation needs cardiac electrophysiology
Surgery	Guides fluid and blood infusion, shock, ventilation and peri-operative care	Shock management depends on circulation physiology



EXAM BOX 1.1: Physiology links all subjects (revise in few seconds)

- Pharmacology = applied physiology of drugs
- Pathology = abnormal physiology with structural change
- Medicine = clinical application of physiology
- Surgery = applied physiology during operative stress

PHYSIOLOGY FOR MEDICAL PRACTICE

A good physician does not treat only the symptom. The physician identifies the functional disturbance, removes the cause when possible and supports natural recovery.

1. Use emergency treatment promptly when life is at risk (Clinical Caution 1.1).
2. Use drugs rationally according to physiological basis of prescription.

Clinical Caution 1.1: Rational Prescribing

- ☞ Physiology supports natural healing, but it does not replace essential treatment.
- ☞ Antibiotics are life-saving when indicated, but unnecessary use promotes resistance and adverse effects.
- ☞ Lifestyle measures help chronic disease control, but medicines should not be delayed when clearly required.

Physiology for Becoming a Good Physician

The knowledge in physiology guides a physician not only to understand the pathophysiology and diagnosis of diseases, but also to properly treat the diseases by adhering to the *rational management protocol*. For treatment of many chronic diseases especially *in the early stage*, **lifestyle modifications** such as dietary alteration, reduction in stress level, practice of mental relaxation, regular physical exercises and yoga are very useful. Physiology educates that effective treatment of many diseases requires **improvement of immunity**.

A physician with ample knowledge in physiology helps patient in facilitating the natural remission with optimal medicines, which is the physiological basis of disease management (Special Note 1.1).



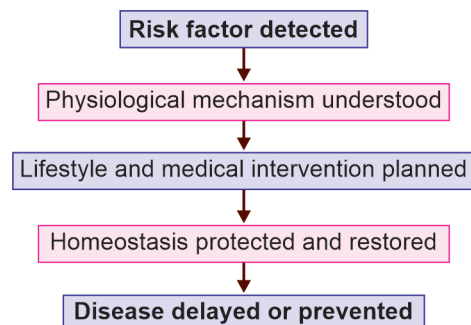
Special Note 1.1

All good physicians are physiologists, and all physiologists are the physicians.

FOR PREVENTION AND COMMUNITY HEALTH

Knowledge of pathophysiology helps prevent disease. For example, exercise, healthy diet, adequate sleep and stress control reduce risk factors for atherosclerosis, hypertension, diabetes and metabolic diseases (Flowchart 1.1).

Flowchart 1.1: Physiology for disease prevention and community health promotion



PHYSIOLOGY FOR MEDICAL RESEARCH

Physiology is the **mother of medical research**. The inventions and discoveries in medical science and advances in medicine are mainly due to research contributions from physiology (**translational physiology**). Therefore, from its inception in 1901, *Nobel Prize in the field of medical sciences* has been designated as **Nobel Prize in 'Physiology or Medicine'** (Exam Box 1.2).



Scientist Contributed

The **Nobel Prize in Physiology or Medicine 2025** is awarded to **Mary E. Brunkow, Fred Ramsdell and Shimon Sakaguchi** for their groundbreaking discoveries in the field of physiology of immune-regulation concerning *peripheral immune tolerance* that prevents the immune system from harming the body.



Brunkow



Ramsdell



Sakaguchi



EXAM BOX 1.2: Why the Nobel name matters (learn in few seconds)

- The Nobel prize is "Physiology or Medicine" because discoveries in body function create medical advances.
- Research in physiology connects molecules, cells, organs, laboratories, patients and public health.

MAJOR SCOPES IN MEDICINE

DM Course in Physiology

With introduction of post-doctoral three years **DM Course in Clinical and Interventional Physiology** in July 2023, by the author of this book when he was Ex-Director at AIIMS Patna, the subject 'physiology' has now become "interventional physiology" with the provision of therapies as listed in Table 1.3. Physiologists now can work as a scientist, faculty and physician in basic medical science, clinical physiologist, therapeutic physiologist, preventive medicine specialist, medical researcher and interventional physiologist (Table 1.3).

Table 1.3: Promising scopes in physiology

Scope	What it includes
Basic science	Cell, organ and system functions; mechanisms and regulation
Clinical physiology	Functional diagnosis: ECG, EEG, lung function, autonomic tests, exercise testing

Therapeutics physiology	Physiological basis of prescription, fluid therapy, oxygen therapy, etc.
Preventive physiology	Exercise, diet, sleep, stress regulation, yoga and lifestyle medicine
Research and translational physiology	Mechanisms of disease, devices, interventions and translational medicine
Interventional physiology	HRV biofeedback, respiratory biofeedback, vagus nerve stimulation, DBS support, intra-operative neuro-monitoring intervention, yoga therapy, exercise therapy and many more.

INTEGRAL HEALTH

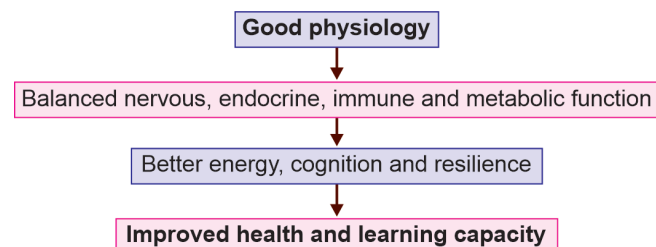
The body works as an integrated unit. Good health needs coordinated function of all systems. Exercise, nutrition, sleep, breathing practices and mental relaxation support this integration (**Clinical Note 1.1**). Physiology links all these elements to provide integral health (**Flowchart 1.2**).



CLINICAL NOTE 1.1: Mitochondrial disease

- ♦ It is used in ICU, OT, OPD, research laboratory, rehabilitation and community medicine.
- ♦ Every clinical decision becomes stronger when the physiological basis is clear.

Flowchart 1.2: Integral health approach



EXAM PREPARATION POINTS



Last-Minute Revision

Read this section just before the exam to lock the flow of the chapter.

- **Physiology** = study of normal body functions and their regulation.
- **Medical physiology** = application of physiology to disease, treatment and prevention.
- Homeostasis maintains health; dyshomeostasis produces dysfunction.
- Pharmacology, pathology and medicine are easier **when mechanisms are understood**.
- Clinical practice needs rational physiological basis of treatment, not only symptomatic relief.
- Prevention uses physiology before disease develops.
- Research in physiology explains disease mechanisms and creates new therapies.
- **Interventional physiology** is the promising scope for medical doctors.