Unit 1: Introduction to Human Physiology – Notes

1 · What is Physiology?

Physiology is the scientific study of how living organisms perform their vital functions. From ionic currents across a neuron's membrane to the finely-tuned hormonal dialogue that maintains blood glucose, physiology explains *how* structure begets function.

- **Levels of Organisation** – chemical → cellular → tissue → organ → system → whole body.
- **Foundational concept** – *milieu intérieur* (internal environment) articulated by Claude Bernard and expanded into *homeostasis* by Walter Cannon: dynamic equilibrium via negative feedback.

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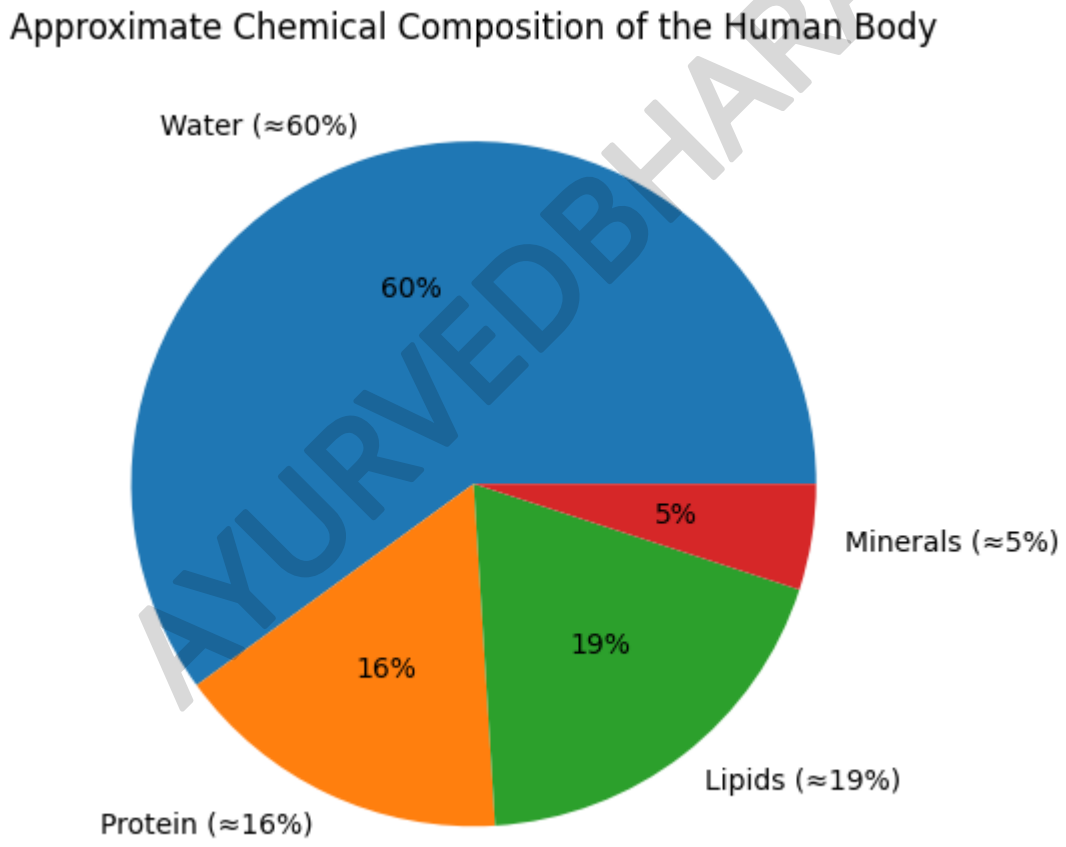
2 · Body Composition & Compartments

- **Chemical make-up** – the pie chart above shows an average adult: ~60 % water, 16 % protein, 19 % lipids, 5 % minerals. Trace elements (< 1 %) include iron, iodine, zinc, etc.
- **Fluid partitioning** – two-thirds intracellular, one-third extracellular (interstitial + plasma). Osmotic balance hinges on Na^+, K^+ and plasma proteins (oncotic pressure).



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3 · Overview of Organ Systems

The table below **"Major Human Organ Systems and Their Core Functions"** summarises 11 systems, their key organs, and headline roles—from integumentary defence to reproductive continuity. Use it as a rapid refresher while delving into each system's detailed physiology later in the course.

> **Systems interact, not isolate:** e.g., muscle contraction (muscular) depends on Ca^{2+} from bone (skeletal), ATP generated by mitochondria supplied with O_2 (respiratory & cardiovascular) and regulated by motor neurones (nervous) plus thyroid hormones (endocrine).

Major Human Organ Systems and Their Core Functions

Organ System	Primary Components	Essential Physiological Roles
Integumentary	Skin, hair, nails, sweat & sebaceous glands	Barrier protection, temperature regulation, vitamin D synthesis
Skeletal	Bones, cartilage, ligaments	Support, mineral storage, hematopoiesis, leverage
Muscular	Skeletal, smooth & cardiac muscles	Movement, posture, thermogenesis
Nervous	Brain, spinal cord, peripheral nerves	Rapid communication, coordination, cognition
Endocrine	Pituitary, thyroid, adrenals, pancreas, gonads	Chemical coordination, long-range regulation, growth & metabolism
Cardiovascular	Heart, blood, vessels	Transport of nutrients, gases, wastes; pH & heat balance
Respiratory	Nasal passages, trachea, lungs	Gas exchange, acid-base balance, vocalisation
Digestive	Oral cavity, esophagus, stomach, intestines, liver, pancreas	Mechanical & chemical food processing, absorption, excretion
Urinary	Kidneys, ureters, bladder, urethra	Waste removal, water-electrolyte & acid-base balance, blood pressure
Immune/Lymphatic	Lymph nodes, spleen, thymus, leukocytes	Defense against pathogens, fluid return, lipid transport
Reproductive	Testes, ovaries, associated ducts & glands	Gamete production, sex hormones, species propagation

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4 · Core Themes in Human Physiology

Theme	Illustration	Clinical Relevance
Homeostasis & Feedback	Baroreceptor reflex maintains arterial pressure within seconds.	Orthostatic hypotension when reflex fails.
Transport Across Membranes	Na^+/K^+-ATPase, facilitated diffusion (GLUT-4), secondary active transport (SGLT-1).	Digoxin targets Na^+/K^+-pump in heart failure.
Signal Integration	Neural (milliseconds) vs. hormonal (seconds-hours) vs. paracrine (local).	Diabetes = deranged insulin signalling.
Energy Transduction	ATP generation via aerobic/anaerobic pathways.	Cyanide poisoning halts oxidative phosphorylation.
Plasticity & Adaptation	Muscle hypertrophy, renal concentrating ability in deserts, altitude acclimatisation.	Bed-rest atrophy; chronic kidney disease impairs adaptation.

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5 · Methods of Physiological Study

- **In vivo** monitoring – ECG, spirometry, blood pressure, indirect calorimetry.
- **In vitro** & **ex vivo** – perfused organ baths, patch-clamp electrophysiology.
- **Imaging** – fMRI maps brain activity; Doppler ultrasound tracks haemodynamics.
- **-Omics** – transcriptomics & metabolomics link molecular flux to systemic outputs.

6 · Physiology & Nutrition Interface

- Nutrient bioavailability affects cellular energetics, endocrine axes, and immune resilience.
- Malnutrition disrupts homeostasis: hyponatraemia in marathoners, kwashiorkor's oedema from hypo-albuminaemia, vitamin D's hormonal role in calcium physiology.
- Diet-induced obesity alters leptin signalling, intersecting with neuro-endocrine appetite circuits (see prior Hormonal Control topic).

7 · Key Take-aways

1. Physiology deciphers *function*; anatomy supplies *form*—both inseparable.
2. Homeostasis relies on layered feedback, with nervous and endocrine systems as command networks.
3. All organ systems interlock; no single nutrient or hormone exerts effects in isolation.
4. Quantitative tools—from ion-channel kinetics to whole-body calorimetry—enable mechanistic understanding.
5. Integration of physiology with nutrition empowers preventive and therapeutic strategies.

Self-Reflection Questions

1. Trace the path of a sodium ion from dietary salt to its role in generating a neuronal action potential.
2. Explain how failure of negative feedback in thyroid hormone production leads to goitre.
3. Describe one physiological adaptation that allows long-distance runners to maintain homeostasis during endurance events.

End of Unit 1