Lecture 2

Organization of the body II. The Scope of Anatomy Physiology. Human Structure. Human Function.

Plan of the Lecture

1. The Scope of Anatomy Physiology
    a. Anatomy—The Study of Form
    b. Physiology—The Study of Function
2. Human Structure
    a. The Hierarchy of Complexity
    b. Anatomical Variation
3. Human Function
    a. Characteristics of Life
    b. Physiological Variation
    c. Homeostasis and Negative Feedback
    d. Positive Feedback and Rapid Change
    e. Gradients and Flow

LEARNING OUTCOMES

1. define anatomy and physiology and relate them to each other;
2. describe several ways of studying human anatomy;
3. define a few subdisciplines of human physiology.
4. list the levels of human structure from the most complex to the simplest;
5. discuss the value of both reductionistic and holistic viewpoints to understanding human form and function;
6. discuss the clinical significance of anatomical variation among humans.
7. state the characteristics that distinguish living organisms from nonliving objects;
8. explain the importance of physiological variation among persons; 9. define homeostasis and explain why this concept is central to physiology;
10. define negative feedback, give an example of it,
11. explain its importance to homeostasis;
12. define positive feedback and give examples of its beneficial and harmful effects;
13. define gradient, describe the variety of gradients in human physiology,
14. identify some forms of matter and energy that flow down gradients.

Anatomy is the study of structure, and physiology is the study of function. These approaches are complementary and never entirely separable. Together, they form the bedrock of the health sciences. When we study a structure, we want to know,

What does it do? Physiology thus lends meaning to anatomy; conversely, anatomy is what makes physiology possible. This unity of form and function is an important point to
bear in mind as you study the body. Many examples of it will be apparent throughout the book—some of them pointed out for you, and others you will notice for yourself.

The Hierarchy of Complexity

Organism is composed of organ systems

• Organ Systems composed of organs

• Organs composed of tissues

• Tissues composed of cells

• Cells composed of organelles

• Organelles composed of molecules

• Molecules composed of atoms

Any science is more enjoyable if we consider not just the current state of knowledge, but how it compares to past understandings of the subject and how our knowledge was gained. Of all sciences, medicine has one of the most fascinating histories. Medical science has progressed far more in the last 50 years than in the 2,500 years before that, but the field did not spring up overnight. It is built upon centuries of thought and controversy, triumph and defeat. We cannot fully appreciate its present state without understanding its past—people who had the curiosity to try new things, the vision to look at human form and function in new ways, and the courage to question authority.

A quick look around any classroom is enough to show that no two humans are exactly alike; on close inspection, even identical twins exhibit differences. Yet anatomy atlases and textbooks can easily give the impression that everyone's internal anatomy is the same.

This simply is not true. Books such as this one can teach you only the most common structure—the anatomy seen in about 70% or more of people. Someone who thinks that all human bodies are the same internally would make a very confused medical student or an incompetent surgeon.

Why do we consider a growing child to be alive, but not a growing crystal? Is abortion the taking of a human life? If so, what about a contraceptive foam that kills only sperm? As a patient is dying, at what point does it become ethical to disconnect life-support equipment and remove organs for donation? If these organs

are alive, as they must be to serve someone else, then why isn't the donor considered alive? Such questions have no easy answers, but they demand a concept of what life is—a concept that may differ with one's biological, medical, legal, or religious perspective.

Physiological variables differ with sex, age, weight, diet, degree of physical activity, genetics, and environment, among other things. Failure to consider such variation leads to medical mistakes such as overmedication of the elderly or medicating women on the basis of research done on young men. If a textbook states a typical human heart rate, blood pressure, red blood cell count, or body temperature, it is generally assumed, unless otherwise stated, that such values refer to a healthy 22-
year-old weighing 58 kg (128 lb) for a female and 70 kg (154 lb) for a male, and a lifestyle of light physical activity and moderate caloric intake (2,000 and 2,800 kcal/day, respectively).

The human body has a remarkable capacity for self-restoration. Hippocrates commented that it usually returns to a state of equilibrium by itself, and people recover from most illnesses even without the help of a physician. This tendency results from homeostasis, the body's ability to detect change, activate mechanisms that oppose it, and thereby maintain relatively stable internal conditions.

Internal conditions are not absolutely constant but fluctuate within a limited range, such as the range of body temperatures noted earlier. The internal state of the body is best described as a dynamic equilibrium (balanced change), in which there is a certain set point or average value for a given variable (such as 37°C for body
temperature) and conditions fluctuate slightly around this point. The fundamental mechanism that keeps a variable close to its set point is negative feedback—a process in which the body senses a change and activates mechanisms that negate or reverse it. By maintaining stability, negative feedback is the key mechanism for maintaining health.

Positive feedback is a self-amplifying cycle in which a physiological change leads to even greater change in the same direction, rather than producing the corrective effects of negative feedback. Positive feedback is often a normal way of producing rapid change.

A physiological gradient is a difference in chemical concentration, electrical charge, physical pressure, temperature, or other variable between one point and another. If matter or energy moves from the point where this variable has a higher value to the point with a lower value, we say it flows down the gradient—for example, from a warmer to a cooler point, or a place of high chemical concentration to one of lower
concentration. Movement in the opposite direction is up the gradient.

## Check yourself! The questions for self-control

1. What is the difference between anatomy and physiology? How do these two sciences support each other?
2. Name the method that would be used for each of the following: listening to a patient for a heart murmur; studying the microscopic structure of the liver; microscopically examining liver tissue for signs of hepatitis; learning the blood vessels of a cadaver; and performing a breast selfexamination.
3. In the hierarchy of human structure, what is the level between organ system and tissue? Between cell and molecule?
4. How are tissues relevant to the definition of an organ?
5. Why is reductionism a necessary but not sufficient point of view for fully understanding a patient's illness?
6. Why should medical students observe multiple cadavers and not be satisfied to dissect only one?
7. List four biological criteria of life and one clinical criterion. 8. Explain how a person could be clinically dead but biologically alive. 9. What is meant by dynamic equilibrium? Why would it be wrong to say homeostasis prevents internal change?
10. Explain why stabilizing mechanisms are called negative feedback. 11. Explain why positive feedback is more likely than negative feedback to disturb homeostasis.
12. Active tissues generate carbon dioxide, which diffuses out of the tissue into the bloodstream, to be carried away. Is this diffusion into the blood a case of flow up a gradient, or down? Explain.

## Recommended readings:


1. Kenneth S Saladin - Anatomy & Physiology. The Unity of Form and Function (2016, McGraw-Hill Education)
2. Barbara Gylys - Medical Terminology Systems (2012, F.A. Davis Company)