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Medical Physiology: An Overview

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Human physiology is the science that explains how cells, tissues, and organs interact to allow the body to function while coping with changes in the internal and external environment. Accordingly, an important facet of physiology is to examine how the body's different systems are integrated to maintain optimal health and our survival.

► SCOPE OF MEDICAL PHYSIOLOGY

This book is designed to examine the connection between the basic sciences, human function, and health. As such, the basic concepts discussed in this book highlight the relationship between physiology and foundational principles for clinical medicine. Often, interns, residents, and practicing physicians become so focused on medical diagnoses, bodily traumas, and the treatment of diseases that they lose sight of the most important part of medicine—that is, *living and surviving*. Long before any disease leads to dysfunction and threatens a person's life, the human body is faced with difficulties and constraints to its survival that are dictated by natural chemical, physical, and biological laws. The body expends enormous energy to maintain normal function and to survive. In short, the body encounters many challenges to simply stay alive.

Organ systems are designed to regulate the body's internal environment.

The human body is made up of more than 65 trillion cells. That is correct—over 65 *trillion*, not 65 billion—that are organized into specialized tissues and organs that regulate our internal environment in a manner compatible to sustain cell function and survival. Organ systems are responsible for regulating many essential cellular processes to maintain the physical and chemical conditions of the extracellular fluid within a narrow range. These include water volume and osmolality, essential electrolyte concentrations, metabolic substrates, oxygen and carbon dioxide gas concentrations, pH, and temperature, to name a few. The ability to maintain a relative consistency in the chemical and physical environment surrounding the cells of our body, in the face of a variable external environment, is called **homeostasis**.

The ability to control our internal environment against the very intense challenges to our survival is part of the scientific essence of physiology. For example, the human body can be viewed as a warm, wet organism that has to survive

in a cool, dry, and harsh world. The energy our body needs to keep all cellular processes running is derived from the oxidation of basic organic molecules. However, this essential metabolic process consumes enormous amounts of oxygen and, in the process, dumps enough carbon dioxide into the extracellular fluid to potentially quickly lower the blood pH from 7.4 to 1. Therefore, the body must contend constantly with the threat of dehydration, hypothermia, and acidosis. The metabolic fuel required for energy-producing oxidation reactions in our body is needed continually by the cells. Some organs, particularly the brain, can only use glucose as a source of energy for this purpose. Moreover, the nutrient sources that originate from the foods in our diet comprise complex polymer molecules of highly different chemical natures. These complex sources require energy and coordinated processing in the body in order to be rendered into monomeric substrates that can be taken up and utilized by the cells. The oxygen needed to combine with these substrates to produce energy for cellular functions moves into cells by simple diffusion, which itself does not require expenditure of energy by the cells. However, considerable effort is required for the lungs to take up enough oxygen to meet the consumption required by the body. Furthermore, the energy-saving process of diffusion will not work unless oxygen is brought to within 100 μM of all cells in the body. Without some sort of mechanism to bring oxygen from the external environment into our body and then transport it to within 100 μM of our cells, we could not survive. Similarly, carbon dioxide cannot simply percolate out of the body from wherever it is produced. It must be neutralized, transported away from cells, and expelled from the body via the lungs. The transport of nutrients, oxygen, carbon dioxide, and waste products to and from cells is carried out by the circulatory system. In tandem with the circulatory system is the respiratory system, also with a mechanical component, that takes oxygen from the atmosphere and transfers it to the circulatory system and expels acid-producing CO_2 as well. It is little wonder that should either our cardiovascular or pulmonary systems become dysfunctional, major complications can occur in a manner of minutes, even death.

Finally, normal function of the body and its survival as a whole require communication between our internal and external environment. Our survival is, therefore, very much dependent on such communication to support of the regulation of basic physiologic conditions within our body.