Anatomy and Physiology

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Dr. Prashant Kumar Rai

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Preface

Anatomy is a branch of biology that is the consideration of the structure of living things. It is a general term that includes human anatomy, animal anatomy (zootomy) and plant anatomy (phytotomy). In some of its facets anatomy is closely related to embryology, comparative anatomy and comparative embryology, through common roots in evolution.

Anatomy is subdivided into gross anatomy (or macroscopic anatomy) and microscopic anatomy. Gross anatomy (also called topographical anatomy, regional anatomy, or anthropotomy) is the study of anatomical structures that can be seen by unaided vision. Microscopic anatomy is the study of minute anatomical structures assisted with microscopes, which includes histology (the study of the organisation of tissues), and cytology (the study of cells).

The history of anatomy has been characterized, over time, by a continually developing understanding of the functions of organs and structures in the body. Methods have also advanced dramatically, advancing from examination of animals through dissection of cadavers (dead human bodies) to technologically complex techniques developed in the 20th century.

Anatomy should not be confused with anatomical pathology (also called morbid anatomy or histopathology), which is the study of the gross and microscopic appearances of diseased organs.

Physiology is the study of the mechanical, physical, and biochemical functions of living organisms. Physiology has traditionally been divided between plant physiology and animal physiology but the principles of physiology are universal, no matter what particular organism is being studied. For example,

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what is learned about the physiology of yeast cells may also apply to human cells.

An understanding of anatomy also gives you the tools to analyze your practice and teachings to create effective movement patterns. This encourages proper sequencing techniques that include adequate warm-ups and poses with appropriate counterposes. It also reinforces the importance of alignment for the purpose of safety for our joints, muscles, tendons and ligaments rather than for an esthetic appeal. The patterns we create on our mat have the ability to affect how we progress outside of yoga, meaning that our muscle memory creates healthy habits to impact other activities in our daily lives.

The evolution of yoga suggests that one day it can be utilized for rehabilitation in a clinical setting – perhaps a connection can be made between medical providers and the application of yoga as therapy. This is one of the many reasons anatomy should be part of the curriculum in any yoga teacher training.

In teaching yoga, it is important to realise it is your awareness of anatomy that is useful to the student. In modern yoga it is common for teachers to cue anatomical jargon which becomes problematic. Your students likely came to you for the experience of yoga, not an anatomy lesson, and as a teacher this intention should be your priority. There are a few reasons why this creates a barrier between the teachings and your students.

Hopefully, the present book will be very useful for the students and teachers of physical education and sport and its related fields.

—Prashant Kumar Rai

Contents

Preface (*v*)

1. Introduction to Anatomy and Physiology **1**
- Meaning and Concept of Anatomy
- Need and Importance of Anatomy in the field of Physical Education and Yoga

2. Anatomy of Tissues Organs and Character of Body **16**
- Character of Living Bodies (animals)
- Cell and Its Parts – cell division – cellular basis of life
- Tissues in the Human Body and the General Arrangement of the Body
- Types if Tissues Organs of the Body

3. The Skeleton, Joints of Body and Special Senses **53**
- The Arrangement of the Skeleton – Function of the Skeleton – Ribs and Vertebral Column and the Extremities /Sex Differences in the Skeleton – Arches of the Feet
- General Classification of the Joints of the Body and Examples for each Type
- Types of Muscles in the Body and their Differences
- Special Senses: A Brief Account of the Structure and Functions of the Eye and Ear

4. Physiology of Physical Education and Yoga **110**
- Meaning and Concept of Physiology

SAMPLE

- Need and Importance of Physiology in the Field of Physical Education and Yoga

5. Circulatory, Respiratory, Digestive and Excretory System **131**

- Blood and Circulatory System: Constituents of blood and their Function – Functions of Blood – Blood Groups and Blood Transfusion Clotting of Blood
- Structure of the Heart-Properties of the Heart Muscle Circulation of Blood – Cardiac Cycle-Blood-Pressure-Pulse Blood Vessels – Lymph and Lymphatic Circulation
- The Respiratory system
- The Respiratory Passage – the Lungs and their Structure and Exchange of Gases in the Lungs – Mechanism of Respiration
- The Digestive System: A brief study of the Structure and Functions of the Tongue, Teeth, Salivary Glands, Stomach Small and Large Intestines, Pancreas and the Liver
- The Excretory system: Brief account of the Structure and Functions of the Kidneys and the Skin
- The Ductless Glands: A Brief Account of the Functions only of Pituitary, Thyroid, Parathyroid, Adrenal and the Sex Glands
- Nervous Systems: The Neurone – Function of the Cerebrum and Cerebral Localisation – Function of the Cerebellum, Modula and Spinal Cord – Reflex are-Autonomic Nervous system and Central Nervous System

Bibliography **269**

Index **271**

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1

Introduction to Anatomy and Physiology

MEANING AND CONCEPT OF ANATOMY

In medicine, gross anatomy, macro anatomy, or topographical anatomy refers to the study of the biological structures that are visible to the naked eye. The study of gross anatomy may involve dissection or noninvasive methods. The aim is to collect data about the larger structures of organs and organ systems.

In dissection, the scientist cuts open the human or animal cadaver is cut open and examines its organs. Endoscopy, inserting a tube with a camera at the end, might be used to study structures within living animals. Endoscopy is performed either through the mouth or through the rectum, so the gastrointestinal tract is often the primary organ of interest.

There are also less invasive methods. For example, to study the blood vessels of living animals or humans, the scientist may insert an opaque dye into the animal that will highlight the circulatory system when imaging technology, such as angiography.

Techniques such as magnetic resonance imaging (MRI), computed tomography (CT), or x-ray also reveal information about the inside of a living body. Medical and dental students perform dissection as part of their practical work in gross human anatomy during their studies. They may dissect a human corpse.

Students of gross anatomy will need to learn about the major body systems. Anatomy is the study of the structure and

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relationship between body parts. Physiology is the study of the function of body parts and the body as a whole. Some specializations within each of these sciences follow:

- *Gross (macroscopic) anatomy* is the study of body parts visible to the naked eye, such as the heart or bones.
- *Histology* is the study of tissues at the microscopic level.
- *Cytology* is the study of cells at the microscopic level.
- *Neurophysiology* is the study of how the nervous system functions.

Organizations of living Systems

Living systems can be defined from various perspectives, from the broad (looking at the entire earth) to the minute (individual atoms). Each perspective provides information about how or why a living system functions:

- At the chemical level, *atoms, molecules* (combinations of atoms), and the chemical bonds between atoms provide the framework upon which all living activity is based.
- The *cell* is the smallest unit of life. Organelles within the cell are specialized bodies performing specific cellular functions. Cells themselves may be specialized. Thus, there are nerve cells, bone cells, and muscle cells.
- A *tissue* is a group of similar cells performing a common function. Muscle tissue, for example, consists of muscle cells.
- An *organ* is a group of different kinds of tissues working together to perform a particular activity. The heart is an organ composed of muscle, nervous, connective, and epithelial tissues.
- An *organ system* is two or more organs working together to accomplish a particular task. The digestive system, for example, involves the coordinated activities of many organs, including the mouth, stomach, small and large intestines, pancreas, and liver.
- An *organism* is a system possessing the characteristics of living things—the ability to obtain and process energy, the

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ability to respond to environmental changes, and the ability to reproduce.

Homeostasis

A characteristic of all living systems is homeostasis, or the maintenance of stable, internal conditions within specific limits. In many cases, stable conditions are maintained by negative feedback.

In negative feedback, a sensing mechanism (a receptor) detects a change in conditions beyond specific limits. A control center, or integrator (often the brain), evaluates the change and activates a second mechanism (an effector) to correct the condition; for example, cells that either remove or add glucose to the blood in an effort to maintain homeostasis are effectors. Conditions are constantly monitored by receptors and evaluated by the control center. When the control center determines that conditions have returned to normal, corrective action is discontinued. Thus, in negative feedback, the variant condition is canceled, or negated, so that conditions are returned to normal.

The regulation of glucose concentration in the blood illustrates how homeostasis is maintained by negative feedback. After a meal, the absorption of glucose (a sugar) from the digestive tract increases the amount of glucose in the blood. In response, specialized cells in the pancreas (alpha cells) secrete the hormone insulin, which circulates through the blood and stimulates liver and muscle cells to absorb the glucose. Once blood glucose levels return to normal, insulin secretion stops. Later, perhaps after heavy exercise, blood glucose levels may drop because muscle cells absorb glucose from the blood and use it as a source of energy for muscle contraction. In response to falling blood glucose levels, another group of specialized pancreatic cells (beta cells) secretes a second hormone, glucagon. Glucagon stimulates the liver to release its stored glucose into the blood. When blood glucose levels return to normal, glucagon secretion stops.

Compare this with positive feedback, in which an action intensifies a condition so that it is driven farther beyond normal limits. Such positive feedback is uncommon but does occur during

blood clotting, childbirth (labor contractions), lactation (where milk production increases in response to an increase in nursing), and sexual orgasm.

Gross Anatomy

This ancient discipline reached its culmination between 1500 and 1850, by which time its subject matter was firmly established. None of the world's oldest civilizations dissected a human body, which most people regarded with superstitious awe and associated with the spirit of the departed soul. Beliefs in life after death and a disquieting uncertainty concerning the possibility of bodily resurrection further inhibited systematic study. Nevertheless, knowledge of the body was acquired by treating wounds, aiding in childbirth, and setting broken limbs. The field remained speculative rather than descriptive, though, until the achievements of the Alexandrian medical school and its foremost figure, Herophilus (flourished 300 BCE), who dissected human cadavers and thus gave anatomy a considerable factual basis for the first time. Herophilus made many important discoveries and was followed by his younger contemporary Erasistratus, who is sometimes regarded as the founder of physiology. In the 2nd century CE, Greek physician Galen assembled and arranged all the discoveries of the Greek anatomists, including with them his own concepts of physiology and his discoveries in experimental medicine. The many books Galen wrote became the unquestioned authority for anatomy and medicine in Europe because they were the only ancient Greek anatomical texts that survived the Dark Ages in the form of Arabic (and then Latin) translations.

Owing to church prohibitions against dissection, European medicine in the Middle Ages relied upon Galen's mixture of fact and fancy rather than on direct observation for its anatomical knowledge, though some dissections were authorized for teaching purposes. In the early 16th century, the artist Leonardo da Vinci undertook his own dissections, and his beautiful and accurate anatomical drawings cleared the way for Flemish physician Andreas Vesalius to "restore" the science of anatomy with his monumental *De humani corporis fabrica libri septem* (1543; "The