

Clinically Oriented ANATOMY

KEITH L. MOORE

Illustrations from Grant's Atlas



CLINICALLY ORIENTED ANATOMY

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The Anatomy Lesson of Dr. Nicolaes Tulp by Rembrandt van Rijn. From a mezzotint in The Bettman Archive.



Dedicated to the memory of

Professor J. C. Boileau Grant

M.C., M.B., Ch.B., Hon. D.Sc.(Man.), F.R.C.S.(Edin.)

Late Professor Emeritus of Anatomy in the University of Toronto and Curator of the Anatomy Museum; for many years Visiting Professor of Anatomy in the University of California, Los Angeles; formerly Professor of Anatomy in the University of Manitoba. The photograph above was taken in 1956 when Professor Grant was awarded an honorary degree by the University of Manitoba, where he began his academic career in North America.

Foreword

The author of this book has endeavoured to continue the tradition of clinically oriented teaching of basic medical science established by the late Drs. *J. C. Boileau Grant* and *William Boyd* who came to the University of Toronto from the University of Manitoba many years before Dr. Moore. To write this new textbook *Moore* imagined himself in the position of a student commencing his medical studies and endeavouring to overcome the difficulties with which many students are faced at this time. Students beginning the study of anatomy are presented with a vast new vocabulary of anatomical terms, many of them in Latin and Greek, together with a large amount of factual information.

The desire for students to acquire an adequate knowledge of anatomy can be greatly increased if it is clearly demonstrated to them that what they are learning will be important to them in their subsequent studies and throughout their careers in medicine. Anatomy is the foundation of all branches of medicine and unfortunately the amount of time allotted to this discipline in the average medical course is far too short, with the result that many students are at a loss when they come to examine a patient. Thus, it is most important that anatomy be presented in a concise and stimulating manner and that the clinical importance of anatomy be clearly explained. Dr. Moore is an experienced writer with a remarkable ability to organize material so that it is interesting and flows logically. In this new textbook the achievement of his established aims has been carried out in the following manner.

First, the meaning of the majority of the Latin and Greek terms has been carefully explained so that the student can relate the words to the structures they describe. This leads to "understanding" rather than "memorization."

Second, keeping in mind that a good illustration is worth a thousand words, Dr. Moore was most fortunate in being able to use the majority of the very accurate illustrations from the *Atlas of Anatomy* produced by the late Professor J. C. B. Grant. The chapters in this book and those in the *Atlas* are keyed in the same manner, making cross reference easy. Further anatomical illustration is presented in a large number of radiographs illustrating both normal and abnormal radiographic anatomy. These have been carefully selected and described with the aid of one of us (DLM). The author has also included numerous photographs and line drawings demonstrating the important surface features of the body which will prove valuable in the clinical examination of patients.

Third, in order to stimulate students to learn, a large number of case studies in anatomy have been placed at the end of each chapter, followed by comments on the anatomy involved in each case. *Learning is more than mere teaching*. It includes questioning, correlation, and justification. Hence, the author has attempted to make this book a learning tool by including in each chapter many clinically oriented comments and patient oriented problems. The clinical comments and patients' problems are at a level that is suitable for beginning medical students who may have similar questions and problems or who will be asked similar questions and posed with similar problems by their friends and relatives. We know of no other text in which this type of anatomy teaching has been carried out to this extent.

We have both read and commented upon this text since its early stages and we feel that the clinical comments and patient oriented problems are worded so as to avoid controversy and to present current medical knowledge. Dr. Moore has produced a

textbook with a refreshingly new approach to anatomical teaching which we feel sure will be appreciated by students, doctors, and teachers alike. We wish him and the text every success.

J. W. A. Duckworth, M.B., Ch.B., M.D.

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D. L. McRae, M.D., F.R.C.P. (C), F.A.C.R.

Professor Emeritus of Radiology, University of Toronto. Formerly Chief of Radiology at the Montreal Neurological Institute and Head of Radiology, Sunnybrook Medical Centre, Toronto, Ontario.

Preface

The invitation to write a book on patient oriented anatomy using illustrations from *Grant's Atlas* was one that could not be refused by this medical writer, who believes that learning anatomy can be *especially* exciting when its relevance to medicine is emphasized. This book is written primarily for students studying anatomy for the first time.

The title **Clinically Oriented Anatomy** was chosen to indicate that *the book highlights those features of anatomy which are of clinical importance*. Every good teacher of anatomy recognizes that nothing stimulates the student more than correlating anatomy with a problem presented by a patient. Because there is often difficulty relating what one sees in the cadaver to what is seen in patients during physical examinations and in the operating room, *emphasis is placed on living anatomy*. For example, the pancreas is described as a soft, grayish-pink gland to emphasize that it is not a hard, almost colorless organ that one sees in the cadaver or colored yellow or red as depicted in some books and atlases.

Surface anatomy is stressed because ignorance of this aspect is a serious handicap when interpreting the results of a physical examination. Furthermore, the performance of tests requiring the insertion of needles requires a good knowledge of structures that lie under the skin. Throughout the book, *students are urged to examine their own bodies* and those of others because a good knowledge of surface anatomy makes it unnecessary to learn by rote. Used properly, *the body is a "living textbook."*

This book is not designed primarily as a guide to clinical anatomy which would be of concern to practicing doctors. It is *patient oriented anatomy* that was written to stimulate the interest of beginning students so that they can appreciate what is involved anatomically in nerve injuries, stab wounds, surgical approaches, etc. Care has been taken not to expect students to make diagnoses, and treatments have not been suggested for conditions discussed in the patient oriented problems. Errors in surgery may result from failure to appreciate variations in the body (*e.g.*, in the anatomy of the biliary system); therefore *common variations of form and structure are illustrated*.

The *many radiographs in this book* give a clinical orientation to bones, joints, and organs, enabling students to begin identifying normal structures and how they can change in form and appearance in diseased states. At the University of Toronto, 1st year students are expected to be able to interpret normal radiographs of the body and to recognize obvious fractures and developmental abnormalities such as cervical ribs. With this in mind, radiographs are used to illustrate some of the clinically oriented comments and patient oriented problems.

This book is not intended to be a core textbook of anatomy; several of this kind are available for students who wish to know the minimum amount required for them to pass their 1st year examinations. *Neither is it overly detailed*; several excellent books already fulfill this need. An attempt has been made to cover areas that are most important for students to know and to arouse in them an interest in revising their knowledge of anatomy as they progress in their medical studies. The regional plan has been used because most anatomy courses are based on regional dissection and *the chapters in this book follow the same order as in Grant's Atlas and Grant's Dissector*.

Boldface type and *italics* have been used to highlight important concepts and essential terminology. Explanatory notes and supplementary information appear in intermediate type so they can be read once and passed over during reviews. *Clinically oriented comments are screened* for special attention and quick referral.

The terminology in this book adheres to the internationally accepted *Nomina Anatomica* (4th ed.) approved by the Tenth International Congress of Anatomists at Tokyo in August, 1975. In accordance with international agreement, the terminology in this book departs from strict Latin in some cases by anglicizing terms or by using direct English translations. *Eponyms commonly used clinically appear in parentheses, e.g., sternal angle* (angle of Louis), to assist students in translating the clinical terminology used in hospitals and patients' charts. In all cases, the official term is printed in **boldface** as in the example just given.

This book is freely illustrated because much of the difficulty encountered by students results from their inability to visualize the form and structure of parts of the body. The selected line drawings and photographs based on Grant's dissections are familiar to students, physicians, and surgeons around the world. These illustrations form the nucleus around which this book was written. In addition there are many new illustrations (photographs of models, drawings, radiographs, and clinical photographs). *Studying anatomy at the dissecting table with a good teacher, where the parts may be seen, felt, and dissected, is the best way to learn anatomy.* A well illustrated book with accompanying observations, clinical comments, and discussions of patient oriented problems is probably the next best way. *The legends to the figures from Grant's Atlas have not been significantly changed;* hence students who use this classical atlas will be afforded a review when they re-examine them in the present book. Almost all specimens illustrated in this book may be seen in the anatomy museum of the University of Toronto and students are encouraged to come and see them. You will observe, as *Professor Grant said in the Preface to his Atlas*, "Little, if any liberty has been taken with the anatomy; that is to say, the illustrations profess a considerable accuracy of detail."

Sir Isaac Newton once said, "*If I have seen further, it is by standing on the shoulders of giants.*" Much of my knowledge of clinically oriented anatomy was taught to me by a "giant in Anatomy," **Professor I. Maclaren Thompson**, former Professor and Head of Anatomy at the University of Manitoba, who conducted weekly *anatomical clinics* in the Winnipeg General Hospital using patients to illustrate the anatomically related problems. I owe much to this fine gentleman, scholar, and teacher. When I became the Professor of Anatomy and a Consultant at the Health Sciences Centre in Winnipeg, I continued his method of teaching clinically oriented anatomy.

Thanks are due my colleagues in the Department of Anatomy, University of Toronto, especially Dr. W. M. Brown, Associate Professor of Anatomy, **Dr. J. W. A. Duckworth**, Professor Emeritus of Anatomy, and **Dr. D. L. McRae**, Professor Emeritus of Radiology. Drs. Duckworth and McRae have commented on the book in the Foreword. Several other members of the Department also gave much help: Mrs. E. J. Akesson, Dr. E. G. Bertram, Dr. B. Liebgott, Dr. R. G. MacKenzie, Dr. A. Roberts, Dr. C. G. Smith, Dr. I. M. Taylor, and Dr. J. S. Thompson. All these colleagues, most of whom have many years of teaching and clinical experience, were generous with their time and thoughts. I thank all of them most sincerely.

I owe much to the following *Williams & Wilkins authors* who kindly consented to let me use illustrations from their books: Drs. J. E. Anderson, T. A. Baramki, M. Bartalos, J. V. Basmajian, R. F. Becker, M. B. Carpenter, W. M. Copenhaver, P. V. Dilts, Jr., J. A. Gehweiler, J. W. Greene, Jr., D. E. Kelly, J. Langman, J. W. Roddick, Jr., R. B. Salter, E. K. Sauerland, J. W. Wilson, and R. L. Wood. I am also grateful to Mr. A. E. Meier, Vice President and Editor-in-Chief, Health Sciences, W. B. Saunders Company, for allowing me to use many illustrations from my book *The Developing Human: Clinically Oriented Embryology*. I should also like to thank all other authors and publishers, acknowledged elsewhere, who have given me permission to use illustrations from their books.

The medical illustrators for this book merit special attention. Mrs. **Dorothy Chubb**, a pupil of Max Brödel, and Professor **Nancy Joy**, Chairman of the Department of Art as Applied to Medicine in the University of Toronto, prepared most of the illustrations in

this book. Their expert skill is unsurpassed. Most new illustrations were prepared by Mrs. **Nina Kilpatrick**, a recent graduate of the University of Toronto program in Art as Applied to Medicine. I am grateful to her for her work which was carefully and cheerfully done.

The medical photographers also set high standards. The photographs were taken by Messrs. Paul Schwartz, B.A., Mr. John Kozie, B.Sc., Associate Professor of Art as Applied to Medicine and Director of Photographic Services, and Mark Sawyer, B.Sc. Their expertise and friendly help were much appreciated.

My secretaries, especially my wife Marion and Jill Parsons, deserve my most sincere thanks. They have worked hard and cheerfully, often under pressure. *Marion* spent many hours proofreading and discussing the manuscript with me.

Finally I thank the Publishers, Williams & Wilkins—particularly *Sara A. Finnegan*, the Vice President and Editor-in-Chief—for inviting me to write this book and for her enthusiasm, unfailing courtesy, and consideration in endeavoring to fill my many requests.

TORONTO, Canada

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- CAMPBELL, J. Sunnybrook Medical Centre, Toronto (Fig. 2-118).
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INTRODUCTION

Anatomy is. . .

THE OLDEST BASIC MEDICAL SCIENCE

Anatomy is one of the disciplines taught in the fourth century B.C. by **Hippocrates**, often called the “*Father of Medicine*.” In addition to the **Hippocratic Oath** attributed to him, he wrote several medical books, and in one of them he stated, “*The nature of the body is the beginning of medical science.*”

Another famous Greek physician and scientist, **Aristotle** (384-322 B.C.), made many new observations, especially concerning **developmental anatomy** or **embryology**. He is also credited with being the first person to use the word “*anatomé*,” a Greek word meaning “to cut up” or, as we now say, “to dissect.” In those days, to perform an “anatomy” was to do a dissection. These two words are no longer synonymous. Dissection is a *technique* used to learn gross anatomy, whereas anatomy is a *discipline* or field of scientific study dealing with all branches of knowledge which are concerned with *the study of bodily structure*.

A STUDY OF STRUCTURE AND FUNCTION

Anatomy is the **basic medical science** dealing with the *structure* and *function* of the human body. In the early days the science of anatomy was mainly concerned with the form and function of parts of the body that could be demonstrated by dissection. This method of study is still widely used because it provides an orderly and consecutive display of the structures of the body. It also helps in obtaining a three-

dimensional concept of its parts. *You must learn to make and to trust your own observations.* You will also find that it is impossible to find two bodies that are identical in structure. Even monozygotic (identical) twins are anatomically dissimilar in *some* respects. During dissection you will observe, feel, move, and dissect the parts of the body. Although this method of studying the body, called **macroscopic** or **gross anatomy**, is closely associated with surgery (Fig. I-1), it forms *an essential basis for all branches of medicine and dentistry.*

Although essentially a morphological science, anatomy has never been just that; even in the writings of Hippocrates and Aristotle there were descriptions of the functions of the various parts of the body. Although many of their ideas were correct, some of them later proved to be false. However, *discussion of the function of a part or organ has always been included in anatomy.* An anatomy course that does not discuss the function of the parts of the body would be analogous to a course in auto mechanics in which the parts of the engine were described but the function of them was not. At one time **physiology** was part of the discipline of anatomy, but as many new methods of investigating function were developed, it became a separate discipline. However, the division between the two sciences is not so sharp as the names imply. When the word anatomy is used without qualification, it is gross anatomy that is generally meant, but the discipline includes all the other **anatomical sciences** (histology, cytology, neuroanatomy, and embryology).

Much can be learned from observing the surface of the body. The diagnostic approach begins when the doctor or dentist



Figure I-1. Rembrandt van Rijn's famous painting, *The Anatomy Lesson*, showing Dr. Nicolaes Tulp teaching **clinically oriented anatomy** to a small group of Amsterdam surgeons in 1632.

first sees a patient; hence, you must practice *the art of observation* as you learn anatomy. For example, you are already aware of the "collar bones" or **clavicles** because they are well known *bony landmarks*. Observe them in the man shown in Figure I-2A. **Palpation**, or examining with the hands and the fingers, is another clinical technique you will use in anatomy. Almost everyone has taken his/her own pulse. *Palpation of arterial pulses is part of every routine evaluation of the living body.* Practice palpating with the pads of your fingers. Do not jab with your fingertips and fingernails.

Children study surface and living anatomy. They soon begin to observe and to feel their muscles and are fascinated when they see them move. Before long you will learn how to use various instruments to observe parts of the body (*e.g.*, the eye using an **ophthalmoscope**) or to listen to the functioning parts of the body (*e.g.*, the heart and lungs using a **stethoscope**). You will also learn to use a **reflex hammer** for examining the functional state of nerves and muscles.

Most students soon associate the facts of surface and living anatomy with those of descriptive anatomy. Hence, their own bodies become useful and honest **memory aids** during examinations. The study of the surface features of bones (**bony landmarks**) and of other structures (*e.g.*, ligaments) that are visible or palpable (perceptible to touch) is called living or **surface anatomy**. The fundamental aim of surface anatomy is the visualization (in the "mind's eye") of structures which lie beneath the skin and are hidden by it. For example, in patients with stab or **gunshot wounds** or other penetrating injuries, the doctor must visualize in his mind's eye the structures beneath the wound that might have been injured. Furthermore, *surface anatomy is the basis for the physical examination of the body that forms a part of physical diagnosis.* The thorough study of a patient's body, with emphasis on the area of complaint, is most helpful in making the correct diagnosis of the anatomical basis for the patient's complaint, *e.g.*, chest pain (see Case 1-1 of **Patient Oriented Problems** at the end of Chap. 1).

The best way to learn surface anatomy is by examining living persons. Recording what you see, feel, and hear is an essential part of **clinical diagnosis**. Begin developing your powers of observation by determining how the **anatomical position** of the persons shown in Figure I-2 differs from the way people usually stand. Check your observations with the subsequent description of this important position. Observe the many **surface features** visible in these young adults.

As methods of investigating structure and function became increasingly complex and following the development of the microscope and good staining procedures, an-

other branch of anatomy was formed. *The study of the make-up of the tissues and organs of the body under the microscope is called **microscopic anatomy** or **histology**.* Again, microscopy (light or electron) is a *technique*, whereas histology is a *sub-discipline* of anatomy, a field of scientific study. It deals with the normal structure and function of cells, their growth and differentiation, and their interrelations in the tissues, organs, and systems of the body.

When **x-rays** were discovered in the 19th century, some new observations were made about the structure and function of the skeleton of the body. The bones and joints were readily visualized on **radiographs** (x-

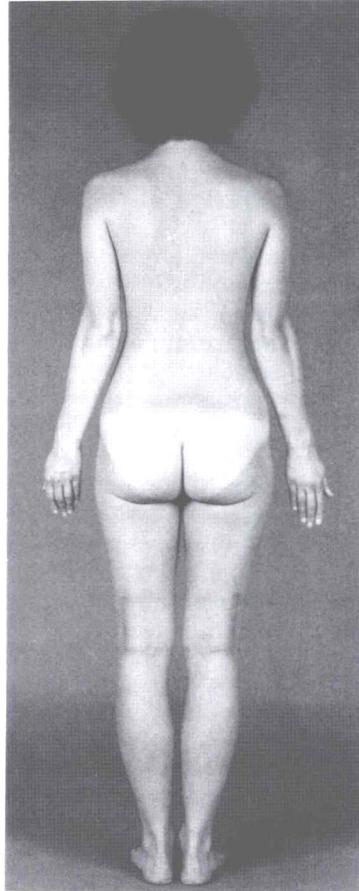
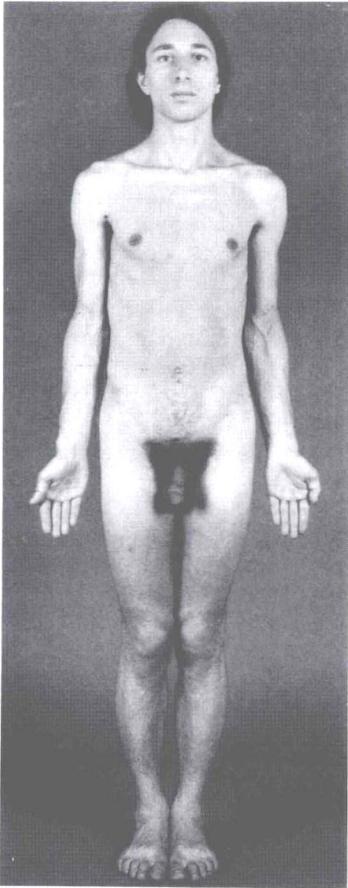


Figure I-2. Photographs of a 27-year-old man and woman *standing in the anatomical position*. *A*, anterior view of a male. Note particularly the bony landmarks formed by his clavicles (collar bones) and the position of his hands and feet. *B*, posterior view of a female. Note the effect ultraviolet has had on the areas of exposed skin. You can also see the bony landmarks of her scapulae (shoulder blades).

ray films). Later, by introducing radiopaque or radiolucent substances, the form and function of various organs and cavities could be studied (*e.g.*, during swallowing). **Radiographic anatomy** is the study of the structure and function of the body using radiographic techniques. It is an important part of gross anatomy and is the anatomical basis of **radiology**, the branch of medical science dealing with the use of radiant energy in the diagnosis and treatment of disease. The sooner you learn to identify the normal structures of the body on radiographs, the easier it will be for you to recognize and understand the changes visible on radiographs that are caused by disease and injury.

The study of the structure and function of the nervous system is specialized because of the intricacies of neuronal connections. Courses in **neuroanatomy** deal with the gross, microscopic, developmental, and radiographic anatomy of the nervous system, with special emphasis on the *central nervous system*, consisting of the brain and spinal cord.

Just as anatomy and physiology overlap, so do gross anatomy, histology, and neuroanatomy; *e.g.*, the contents of the skull and the vertebral canal are studied in both gross anatomy and neuroanatomy. In addition, the microscopic anatomy of the nervous system forms an important part of courses in histology and physiology. Hence, you must integrate information on the nervous system that is presented in the various disciplines called the **neurosciences**.

The study of growth and development is called **developmental anatomy** or **embryology**. Much can be learned about the structure and function of the adult body by studying the changes that occur during its development from a single cell (the **zygote**) into a multicellular adult person. Growth and development occur throughout life, but developmental processes are most pronounced during *prenatal life* (*i.e.*, before birth), particularly during the **embryonic period** (4 to 8 weeks). The rate of growth and development slows down after birth, but there is active ossification (bone formation) and other important changes during infancy and childhood.

Many developmental changes occur during puberty, the period between 12 and 15 years in girls and 13 and 16 years in boys (*e.g.*, the development of **secondary sexual characteristics** such as breasts in females). Although sometimes given as a separate course, embryology is often integrated with gross anatomy, histology, and neuroanatomy because it explains how structures develop and acquire their adult structure and functions.

Although the anatomy of the body is studied in various ways and is often taught in three or four different courses, you must strive to **learn anatomy as an integrated subject**, keeping in mind that the various subdisciplines arose as new techniques for studying anatomy were developed and more knowledge was obtained. Your professors in the various courses are specialists who will help you learn which facts are of clinical importance and what is **essential knowledge** for you to retain in order to perform adequately as a doctor or a dentist. You will find that *many clinical problems can be understood by using knowledge acquired in anatomy courses*. This explains why this book is called **Clinically Oriented Anatomy**. The many references to the clinical significance of anatomy are inserted in this book as **clinically oriented comments** and **patient oriented problems** to indicate what is *essential knowledge* and to add interest to your anatomical studies.

The body is generally examined regionally, *i.e.*, by regions such as the thorax (Chap. 1), the abdomen (Chap. 2), and the pelvis (Chap. 3). The study of all structures in one area or region, including their relationships to each other, is known as **regional anatomy** or topographical anatomy. During regional anatomy, the body is generally divided into the following regions: (1) the **thorax**, (2) the **abdomen**, (3) the **perineum** and **pelvis**, (4) the **lower limb**, (5) the **back**, (6) the **upper limb**, (7) the **head**, (8) the **cranial nerves**, and (9) the **neck**. The chapters in this book and in Grant's *Atlas* are arranged in this order. For purposes of description, some regions are further subdivided; *e.g.*, the upper limb, which you probably call the arm, is subdivided

vided into (1) the shoulder, (2) the arm, (3) the forearm, and (4) the hand.

Although you are familiar with the common or layman's terms for many of the parts and regions of the body, you should use the internationally adopted nomenclature; *e.g.*, use the word "**axilla**" instead of "armpit" and "**clavicle**" instead of "collar bone." Despite this, you must know what the common terms mean so that you can understand the words your patients use when they describe their complaints to you. In addition, you must be able to explain their problems to them in terms that they can understand.

From the functional standpoint, it is helpful to describe the parts and organs of the body by systems. This is referred to as **systemic (systematic) anatomy**. The systems of the body are:

1. **The integumentary system**, consisting of the skin and its appendages (*e.g.*, hair and nails).
2. **The skeletal system**, composed of the bones and their articulations (joints).
3. **The muscular system**, comprising the muscles that, with few exceptions, move the joints. Sometimes the muscular and skeletal systems are considered together as the musculoskeletal or locomotor system.
4. **The nervous system**, consisting of nerves, the brain, and the spinal cord, including their coverings (**meninges**).
5. **The circulatory (vascular) system**, comprising the heart and blood vessels and including the **lymphatic system** composed of lymph nodes and lymph vessels. The heart and the blood vessels are often referred to as the **cardiovascular system**.
6. **The visceral system**, exclusive of the heart, is usually considered separately as the **alimentary or digestive system**, the **respiratory system**, the **urinary system**, and the **genital system**. Because of their close association during development and in the adult, especially in the male, the urinary and genital systems are often described together as the **urogenital system**.

7. **The endocrine system** consists of ductless glands which produce secretions, called **hormones**, that pass into the circulatory system and are carried to all parts of the body.

THE FOUNDATION OF MEDICAL LANGUAGE

Anatomy is the basis of the language of medicine and dentistry. As a beginning student you will learn a **fascinating new language** consisting of at least 7500 words; however, do not be overwhelmed! You will learn these words gradually and when you can speak the anatomical language fluently, you will feel at ease talking to your clinical colleagues because *the anatomical language constitutes about three-fourths of the words making up the medical language.*

To describe the relationship of one structure to another, the accepted **anatomical nomenclature** should be used. *To be understood you must express yourself clearly, using the official terms in the correct way.* If you are like most people, you have not studied the classics, Latin and Greek; consequently you may not pick up the anatomical language as quickly as those who have studied these old languages. Many anatomical and medical terms are derived from *Greek* because of the studies of **Hippocrates** and **Aristotle**, two famous Greek physicians. Similarly, many terms come from *Latin* mainly because of the influence of **Vesalius** (1514–1564), a great Flemish anatomist who was the Professor of Anatomy at the University of Padua in Italy for many years. His gross anatomy textbook, emphasizing the importance of *human dissection*, was used for over two centuries. Some words also stem from French, Italian, and Arabic. If you have not studied any of these languages, do not feel depressed! You can learn all you need to know by using a good medical dictionary. The study of the derivation of words (**etymology**) can help you remember anatomy and, at the same time, you are likely to find the process enjoyable. The following are good examples. (1) The term **cecum** is from the Latin

word *caecus* meaning “blind.” Your cecum is a blind pouch or **cul-de-sac** (French words meaning “bottom of a sac”) lying below the terminal portion of your **ileum** (from a Latin verb meaning “to roll up or twist”). The jejunum and ileum are the highly coiled or rolled up parts of the small intestines. (2) **Decidua**, used for the lining of the uterus during pregnancy, is from

Latin and means “a falling or cutting off.” This is an appropriate term because this lining layer “falls off” or is shed after the baby is born, just as the leaves of deciduous trees fall off after the summer.

DESCRIPTIVE TERMS

To describe the body and to indicate the position of its parts and organs relative to

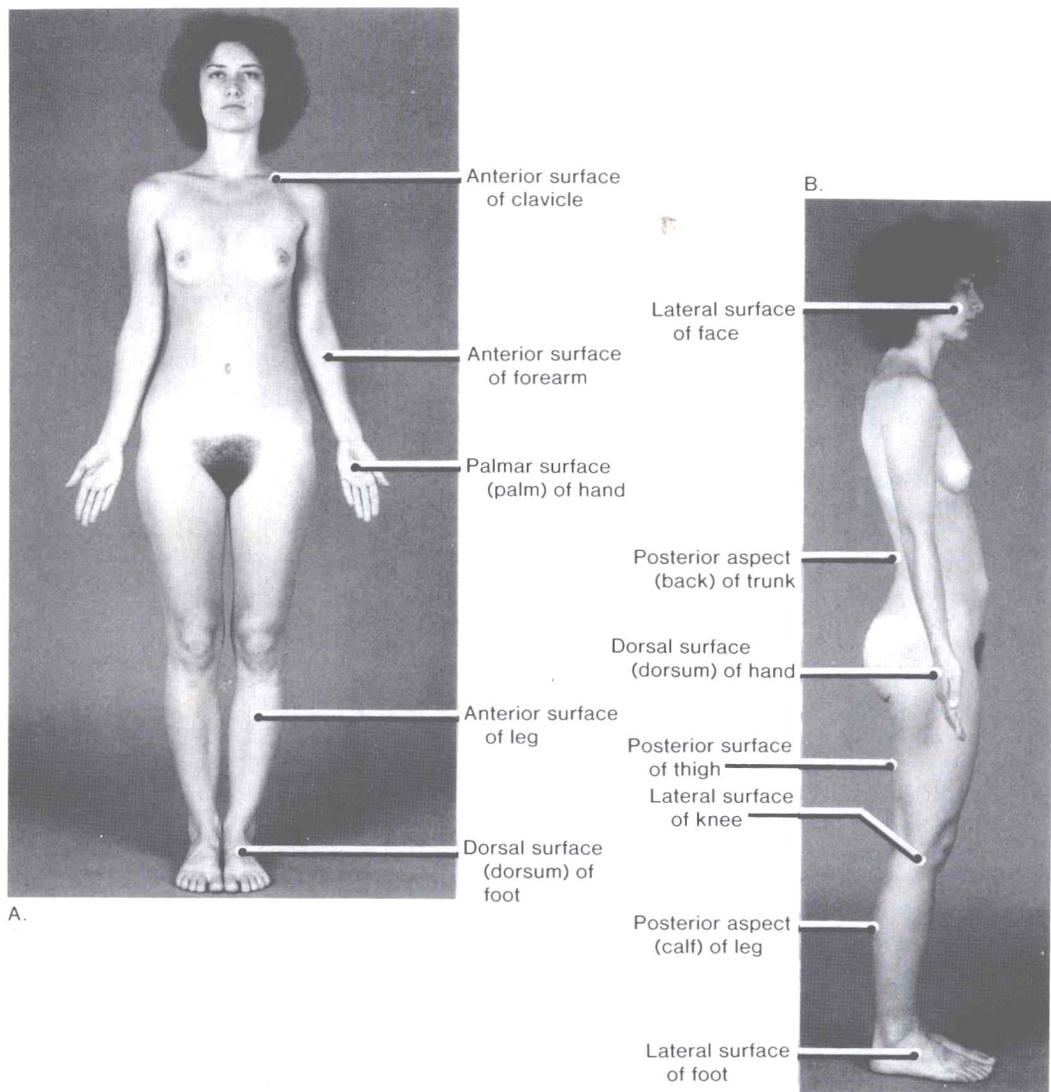


Figure I-3. Photographs of a 27-year-old woman demonstrating the anatomical position and some anatomical terms. *A*, anterior view. *B*, lateral view. Note: (1) she is standing erect; (2) her face and eyes are directed forward; (3) her hands are by her sides with the palms directed forward or anteriorly; (4) her heels are together; (5) her toes are pointed anteriorly; and (6) her great toes are touching.