SURFACE AND RADIOLOGICAL ANATOMY

FOR STUDENTS AND GENERAL PRACTITIONERS

BY

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Fourth Edition

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PREFACE TO THE FOURTH EDITION

IN the present edition many of the original radiographs have been replaced by new ones and a number of new illustrations have been added. The text has been extensively revised and rearranged. Description of the techniques used in radiology have been moved to the introductory chapter on general anatomy and methods, leaving the main part of the book to deal with anatomy and radiological anatomy unencumbered by points of technique. We believe the student will thus be able to concentrate more easily on the anatomical features. The section dealing with bronchography has been completely rewritten and new, enlarged bronchograms introduced. New angiograms of the heart and cerebral vessels have been added. Radiological measurements have been given in the metric system, and anatomical measurements in inches. Minor errors in the text and in the figures have been corrected.

We wish to record our indebtedness to Drs. D. Brown, T. W. Glenister and J. R. W. Ross of the Anatomy Department, Charing Cross Hospital Medical College, for the help they have given in the revision of the text and figures. To Dr. G. du Boulay, Radiologist at St. Bartholomew's Hospital, we are indebted for cerebral angiograms and some other figures and for criticism of the section on the radiology of the skull. We also wish to express our thanks to Mr. E. J. Park, F.I.S.T., Senior Technician, Anatomy Department, Charing Cross Hospital Medical College, for the help he has given with revision.

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PREFACE TO THE THIRD EDITION

IN the present edition many of the original skiagrams have been replaced by new blocks, and a number of new skiagrams have been added. It has been found necessary to modify the text slightly in a number of instances, and this has permitted the rearrangement of a number of the illustrations. Minor errors in the text and figures have been corrected. Two angiocardiograms have been added and a brief description given of the technique used to obtain these.

The description of the radiological appearances of the shoulder region in young children and adolescents has been rewritten.

We have adhered to the description of the actions of the eye muscles given in the second edition. In order to clarify the position, however, the wording has been modified and an explanatory illustration has been added.

The angiocardiograms of the heart after the injection of a radio-opaque substance were presented to us by Drs. I. Chavez, N. Dorbecker and A. Celis, of Mexico, to whom we wish to express our thanks.

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16*th February*, 1948.

FROM THE PREFACE TO THE SECOND EDITION

THE present edition has been entirely rearranged and rewritten, though the method of presentation is unchanged. New illustrations have been made for surface contours and for deeper structures, whilst others have been much modified and improved. All the skiagrams of the previous edition have been replaced by new ones and others have been added. Throughout the text and in the legends we have used the word "skiagram" in preference to "radiograph."

We wish to record our indebtedness to Drs. R. J. Harrison and H. G. Calwell for their help with proof reading. We are indebted to Dr. F. Avery Jones of the Central Middlesex County Hospital for illustrations of the gastroscopic appearances of the living stomach and to Dr. L. G. Blair for some of the bronchograms. We wish to express our thanks to Mr. E. J. Park, former technician in the Anatomy Department of St. Bartholomew's Hospital Medical College, for the care he has taken in pasting up the annotations of the illustrations, and to Miss Fryer, secretary to the Department of Anatomy in St. Thomas's Hospital Medical School, for her painstaking preparation of an enlarged index. We are also grateful to the many radiographers who took the skiagrams, to Miss K. C. Clark, of the Ilford Radiographic Department, for her help and advice with the photographic printing of the skiagrams, and to the Ilford Printing Department for carrying out this work. We have been fortunate in the cordial relationship which has existed between us and Messrs. W. Heffer & Sons, Ltd., Printers and Publishers. Finally, we wish to thank Mr. G. Newman, Works Director of Messrs. W. Heffer & Sons, Ltd., and his staff, for their help and patience.

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FROM THE PREFACE TO THE FIRST EDITION

In this book we have ventured to travel beyond the usually accepted scope of works on surface anatomy. It has been our aim to provide an introduction to the study of features which are accessible to examination in the living subject.

To the time-honoured methods of physical examination we have added the employment of radiology. General recognition, indeed, is now given to the value of X-rays for the study of anatomy. A knowledge of the normal appearances is indispensable as a background to the proper utilization of X-rays for clinical purposes. The radiological approach is further of value for the important influence it exerts on the outlook of the student, in the emphasis it lays on the distinctive features of the living subject as contrasted with the cadaver. It also draws attention to the differences between individuals, and to the differences which are found in the same subject under different conditions. By the extensive use of illustrations we have attempted to supply a means of co-ordinating radiological anatomy with those features which can be determined by external examination and with those details which can be determined only by dissection.

The physical examination may with profit be extended to include percussion and auscultation, and the examination of internal structures by digital exploration or by the employment of special instruments such as the laryngoscope and aural speculum. We have, therefore, in appropriate places, described the anatomical features which may be thus investigated. Peripheral cutaneous nerves may be mapped out by the use of the Smart-Bristow coil; this coil may also be employed in the analysis of muscle-action, and we have accordingly provided diagrams of the motor points of muscles. In these various ways encouragement is given to the study of the living subject on the persons of the students themselves concurrently with their course of dissections. The book has been arranged in sections which correspond with the "parts" in which the body is customarily dissected.

In an introductory section we have set forth some general considerations relating to radiological technique, to the structure of the skin and to the group action of muscles. In sections that follow, more detailed information relating to each "part" is given. In the descriptions of muscle-action emphasis has been placed on the co-ordinated production of movement and maintenance of posture, and the detailed attachments of individual muscles have been omitted.

Surface contours have been shown in their relation to underlying structures by a series of parallel illustrations, a method which has also been employed for the elucidation of the more difficult radiographic appearances such as those of oblique views of the chest. In this way we believe that a better appreciation of surface and radiological anatomy can be obtained than by the provision of elaborate descriptions.

We have stressed the study of surface contours for the importance they have in marking the positions of deeper structures, and have preferred to draw attention to the landmarks by which the positions of structures may be recognized rather than to apply to the living stereotyped projections based upon the cadaver. We offer indications as to which landmarks have the greatest value in surface anatomy and which are most serviceable in radiology. For the topography of intracranial structures we have omitted complicated systems in favour of more direct determination of the positions of structures.

All radiographs have been reproduced as negatives in view of the general practice of examining original radiographs in this form; for a like reason all have been reproduced completely untouched. We have drawn attention throughout to the use of standard positions in view of their importance in clinical radiology, though the applications of radiology in anatomy have a wider scope and the appearances obtained in other positions have received notice.

The nomenclature is that of the Birmingham Revision of 1933, with certain modifications which have been subsequently recommended and adopted by the Anatomical Society of Great Britain and Ireland. We have also made free use of certain well established names such as "seminal vesicle" and "Eustachian tube" for the benefit of those who may be unaccustomed to certain of the current terms.

We owe much to Mr. G. Simon, Lecturer in the Radiological Department and Medical College of St. Bartholomew's Hospital, for invaluable advice and assistance with numerous radiographs. To Dr. Twining, of Manchester, we are indebted for ventriculographs, and to Mr. R. T. Payne for radiographs of injected salivary ducts. We thank Dr. Lysholm and the Publishers of Acta Radiologica for permission to reproduce illustrations of ventriculographs. We have to express our thanks for descriptions of oesophagoscopy and gastroscopy, with permission to reproduce his drawings, to Mr. H. W. Rodgers, for an account of bronchoscopic appearances to Mr. O. S. Tubbs, and for a pneumograph of the ureter and the description of the cystoscopic appearance of the bladder to Mr. W. E. Underwood, of St. Bartholomew's Hospital. We have had the advantage of critical reading by Professor de Wesselow of the section on the chest, by Mr. P. H. Mitchener of the sections on the perineum, anal canal and rectum, and by Mr. R. H. Boggon on ventriculography, of St. Thomas's Hospital; to them and to the many students who assisted as subjects we tender our thanks.

We wish to express our appreciation of the many laborious hours spent by Dr. P. Hamill, of St. Bartholomew's Hospital, and Mrs. Hamilton in painstaking reading of the proofs. Our thanks are due to Dr. J. W. McLaren, Lecturer on Radiological Anatomy and Physiology in the Medical School of St. Thomas's Hospital, for advice and assistance of which we have constantly availed ourselves. We wish to express our indebtedness to Miss Randall, Principal of the School of Physiotherapy in St. Thomas's Hospital, for valuable criticism and advice.

We owe much to Mr. A. K. Maxwell for the skill and care he has shown in the execution of the illustrations, and recognize in them an indispensable contribution to the book. To him we feel deeply grateful.

We wish to express our appreciation of the patience, resourcefulness and enthusiasm of Mr. L. T. A. Robinson in the printing of this book.

A. B. APPLETON.
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I. C. C. TCHAPEROFF.

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GENERAL ANATOMY AND METHODS

(1) INTRODUCTION

The anatomy of the living subject may be investigated in a variety of ways. By **inspection,** an assessment can be made of the general proportions of the body, the natural postures, the surface contours and the appearances of the skin and superficial vessels. At the same time movements, e.g., those of respiration and of the heart-beat, may be noted. Observation can be made of the way in which movements are carried out. **Palpation** gives information concerning the texture, position, size, form and mobility of the superficial and certain of the more deeply placed structures, and it also reveals the degree of tonus of the muscles. Additional information regarding the viscera can be obtained by **percussion** and **auscultation.** Differences are elicited in the sounds produced by percussion over the various viscera. Auscultation (usually carried out with the aid of a stethoscope) permits of a study of sounds such as those produced during the cardiac and respiratory cycles.

Certain of the more deeply situated parts of the body may be rendered accessible to examination by the use of special apparatus. It is possible, for example, to examine the nasal part of the pharynx, the larynx and even the trachea and major bronchi. The interior of the oesophagus, stomach, lower bowel, bladder and peritoneal cavity may likewise be inspected. The interior of the eye can be studied with the aid of the **ophthalmoscope,** and the external auditory meatus and tympanic membrane by the use of an **auriscope** or **aural speculum.**

Radiology has proved a valuable aid to the detailed examination of the living subject. Its use has added to our knowledge of individual variability in the form and position of viscera, and of the changes which take place in the same individual under different conditions.

While the study of the cadaver must still remain the foundation of our knowledge of human anatomy, the information so obtained requires amplification by comparison with the living subject. **Post-mortem** examination affords further opportunities of modifying impressions obtained from the study of embalmed material, but the appearances of the living organs and tissues may be best appreciated when seen during the course of **surgical operations.**

(2) INDIVIDUAL VARIATION

Despite the fundamental similarity of structure in all human subjects, striking individual differences do occur. The individuality of anatomical structure is very evident if a series of subjects is examined. Peculiarities of external form are characteristic of certain peoples. The Bushwoman, for example, exhibits a distinctive accumulation of fat in the buttock which is described as steatopygia.

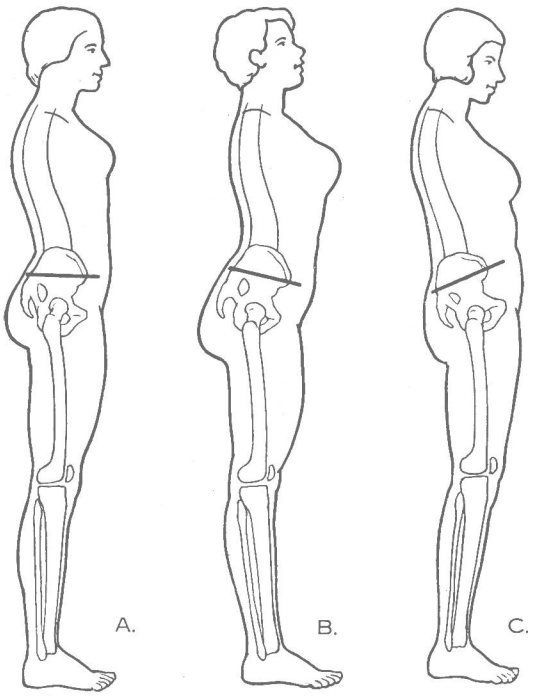

FIG. 1.—Diagrams illustrating differences of posture (adapted from Sturmdorf; Surgery, Gynaecology and Obstetrics, 1931). **A** shows a good posture; in **B** there is a forward tilt of the pelvis and exaggerated posterior concavity of the lumbar region (lordosis); in **C** there is flattening of the lumbar region. Compensatory modifications of the posture of the chest and head are seen in B and C.

The frequency of certain muscular and other anatomical features differs in the various races, e.g., the sternalis muscle is relatively common in the Japanese.

Surface contours are much influenced by the state of development of the musculature and the amount of fat in the superficial tissues. The prominences and depressions produced by underlying structures in a thin subject may be obscured in a fat one; an elevation produced by a bone in a thin subject may even be replaced by a depression if adjacent muscles are well developed, e.g., over the spine of the scapula.

Certain superficially placed muscles are present in some individuals but absent in others; among these the following deserve note. The **omo-cervicalis** (levator claviculae) muscle, only exceptionally present, occupies a superficial position in the posterior triangle of the neck between the trapezius and sternomastoid muscles. The **dorsi-epitrochlearis** muscle occupies a superficial position in the medial bicipital furrow of the arm and extends from the posterior wall of the axilla to the medial epicondyle of the humerus. The **palmaris longus** muscle is absent in many individuals; when present it varies greatly in size and the differences in the size of its tendon are evident on examination of the wrist in a number of living subjects.

Differences occur in the detailed form of bones. The **peroneal** tubercle of the calcaneum may be inconspicuous or it may form a salient prominence which is very evident on inspection of the foot. The humerus may exhibit a projection, the **supracondylar process,** a short distance above the medial epicondyle (Fig. 75). Occasionally, in this situation, a flange of bone is present which is perforated by an **"entepicondylar foramen"** through which pass the median nerve and brachial artery.

There are individual differences of habit in what is popularly known as **"posture."** The stance, i.e., the standing attitude, of different people shows distinctive features which are so characteristic that they often serve for recognition of the individual. The sitting position may also show individual characteristics which depend on differences in the positions at the various joints. The movements of individuals are likewise distinctive, and recognition of a person by his gait is an everyday experience. The differences depend on variations of detail in the sequence and range of movement at different joints. The joint postures on which attitudes depend affect the relative position of parts of the skeleton; thus the level of the scapulae relative to the vertebral column shows much variation. The general form of the trunk is greatly influenced by postural habit. If the upper ribs occupy a more oblique position than usual the upper part of the chest appears flattened; if they are more horizontal the chest becomes "barrel shaped." If the lumbar convexity of the spine is pronounced (Fig. 1), the hollow of the back is correspondingly exaggerated (lordosis). A forward bend of the upper thoracic spine, which is often combined with a lateral and forward displacement of the scapulae towards the side of the chest, produces the familiar "round shoulders."

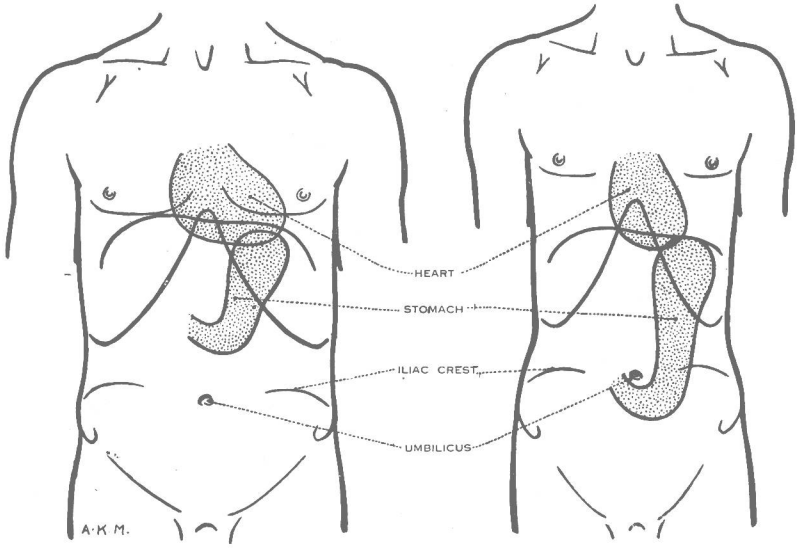

FIG. 2.—Diagrams of the stocky and slender body types, to show the forms of stomach and heart which characterize these types.

Protuberance of the abdomen is usually produced by an excess of subcutaneous fat in the anterior abdominal wall. Prominence of the lower part of the abdomen may also be produced by a forward tilt of the pelvis (Fig. 1), or may be due to a weakness of the musculature of the abdominal wall. Forward tilting of the pelvis is a normal feature in young children. Protuberance of the abdomen is sometimes due to gas in the alimentary canal, pregnancy, a pathological enlargement of some organ or an accumulation of fluid in the peritoneal cavity. It tends to modify body balance, as exemplified in the characteristic stance and gait of the pregnant woman.

(A) BODILY TYPES

Differences in the general build of the body have a general hereditary basis. Individuals may be classified into two contrasting types based primarily on the form of the trunk:—one with a **short broad trunk** and termed **"hypersthenic"** or **pyknic** (Fig. 3), the other with a **long narrow trunk** and termed **"asthenic," "hyposthenic"** or **"leptosomatic"** (Fig. 4). Certain associations can be recognized between the general body-form and the position of the viscera (Fig. 2). The heart, lungs, stomach and colon exhibit considerable individual differences of form and position. These two widely different types also tend to exhibit characteristic differences in temperament in their illnesses and in the kinds of psychological disturbance to which they are liable.

The Broad Trunk. This type may be associated with relatively long or short lower limbs. The lumbar region tends to be short, the ribs are situated more horizontally than in the slender subject, the infrasternal (subcostal) angle is wider and the sternum lies at a higher level (Fig. 3). In contrast with the slender subject the muscular system of the broad subject tends to be well developed, and for this reason the term hypersthenic has been frequently applied to the pyknic type. In these subjects the heart tends to lie more transversely than in the slender type; the pyloric (distal) part of the stomach tends to be situated at a relatively higher level (Fig. 2) and the stomach is thus generally less elongated in a vertical direction and lies more transversely in the upper part of the abdomen than it does in the subject with a long narrow trunk.

The Slender Trunk. This type of subject tends to have a long lumbar region; the ribs are very obliquely placed; the infrasternal angle is small and the sternum lies at a low level (Fig. 4).

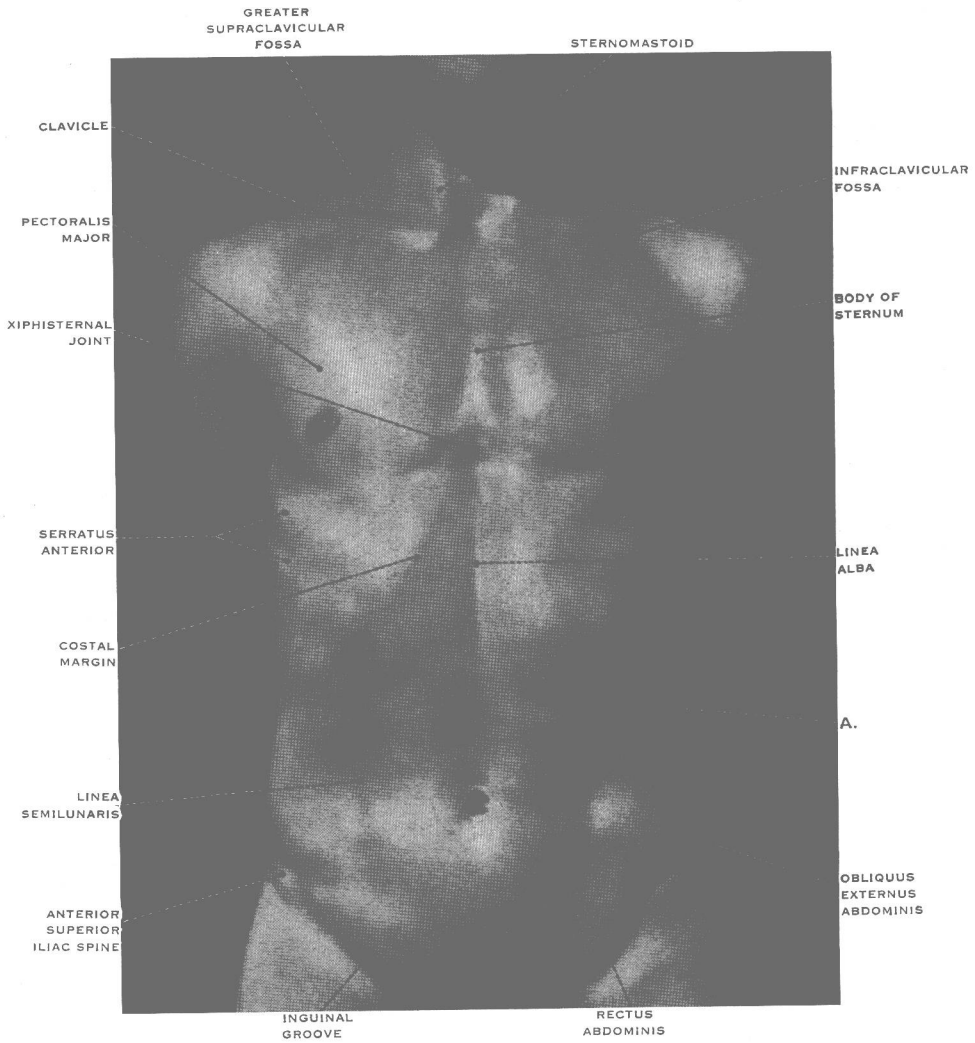

FIG. 3.—Surface features of the trunk of a young male adult. Broad type.
A—tendinous intersection of rectus abdominis muscle.

This type is frequently described as the hyposthenic or asthenic with reference to the frequency with which a relative weakness or deficiency of tone occurs in the muscular system, resulting in "round" shoulders and a sagging abdominal wall (Fig. 1). The heart is narrow and long, in a vertical direction, and is situated at a lower level than in the broad type (cf. Figs. 151 and 152). The pyloric part of the stomach tends to lie at a relatively low level, and the stomach is thus elongated in a vertical direction.

(B) ASYMMETRY

A slight asymmetry affects both the proportions and the movements of the body. Thus one limb may be $\frac{1}{2}$ an inch shorter than its fellow, and breathing movements may be more extensive on one side than on the other. Such asymmetries commonly show a relationship to the right- or left-handedness of the individual. In the right-handed person the thoracic part of the vertebral column may show a slight convexity to the right (with rotation of the vertebrae), and the right

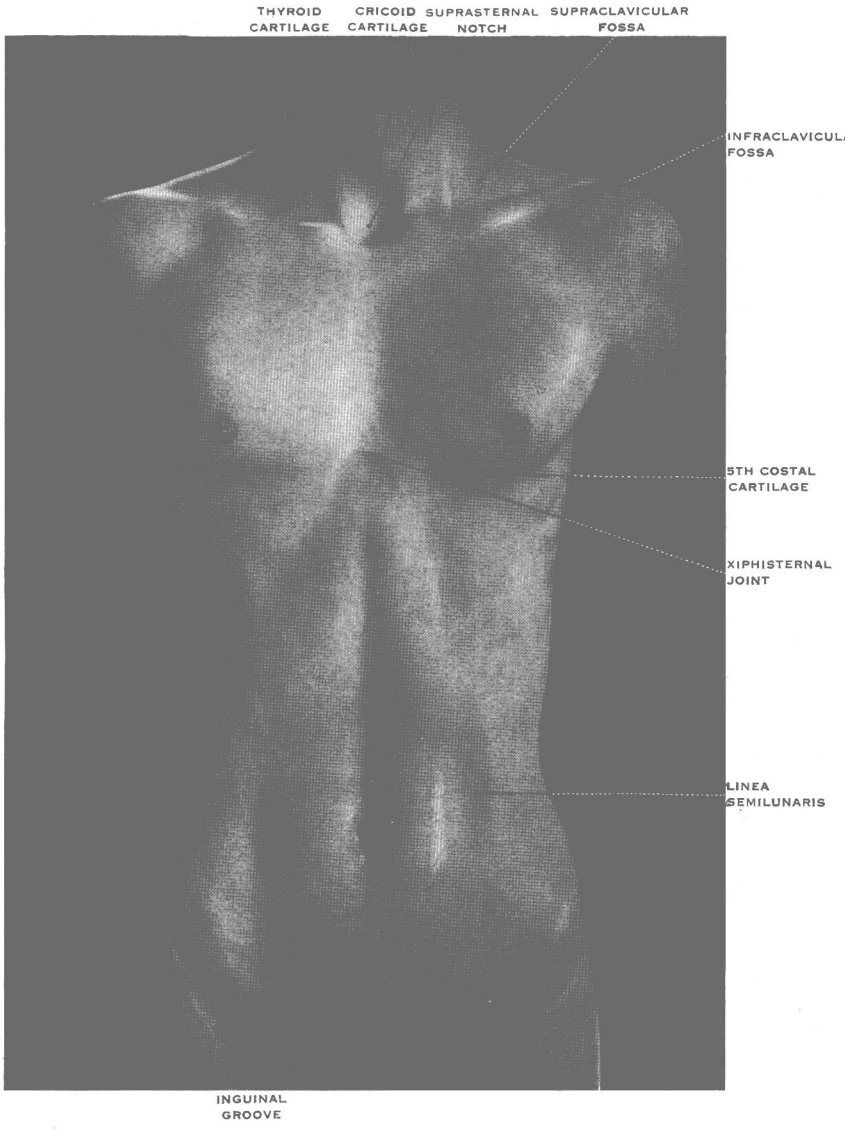

FIG. 4.—Surface features of the trunk of a young male adult. Slender type.

clavicle tends to be shorter, stouter and more horizontally placed than the left one. In consequence of the associated rotation of the vertebrae the ribs may be more sharply curved posteriorly on the right, whilst the left side of the chest may be more prominent anteriorly. The converse asymmetry is usual in the left-handed.

(C) SEX DIFFERENCES

There are physical differences between the male and female form which are independent of race and civilization and are, in the main, due to secondary sexual characteristics. Some differentiation is, however, apparent at a very early age. In the pelvic region, for example, certain of these characteristics are present during early foetal life.

FIG. 5.—Back view of a female figure.

FIG. 6.—Back view of a male figure.

At birth and for several years there is little difference between the male and female child. Until the age of puberty the main differences are those of weight and height; there are periods of special **height-increase,** "stretching out," and **weight-increase,** "filling in," which have different distributions in the sexes during growth. Over a period of a few years, centred round puberty, girls are on the average taller and heavier than boys of the same age.

In general the bony prominences and the superficial muscles are more clearly defined in the adult male than in the female. Owing to the presence of an abundance of subcutaneous fat in women the general contours of the body are more rounded; in particular we may notice the distinctive curves of the breasts, hips and thighs (Figs. 5, 6 and 119). Bony landmarks of the skull, e.g., the glabella and superciliary ridges, are more conspicuous in men than in women. The facial skeleton is smaller

in proportion and the jaws are narrower and less prominent in the female than in the male. Notwithstanding these differences it is not possible to determine with certainty the sex of an individual from the size or shape of the skull.

In both men and women the trunk is ovoid in form, but in men the difference between the upper and lower parts is considerable; in men the transverse diameter at the shoulders tends to be greater than that at the hips, while in women the diameter at the hips is equal to or even greater than that at the shoulders (Figs. 5, 6 and 8). On the average the limbs are relatively shorter in women than in men, and this difference is more noticeable in the lower limbs. The carrying angle of the forearm is greater in the female (p. 60). Owing to the relative shortness of the lower limbs in the female a larger proportion of the height is formed by the trunk. The thighs are also more obliquely placed due to the relatively greater width of the pelvis. The large amount of fat in the upper part of the thigh and the relative shortness causes the thigh to taper more rapidly in the female than in the male.

(3) LANDMARKS

The use of carefully selected landmarks is essential for determining and describing the positions of organs and structures. Landmarks comprise conspicuous features of the skeleton, elevations produced by muscles and tendons, and cutaneous features such as the nipple and umbilicus.

In employing landmarks it must be recalled that:—

(*a*) individuals exhibit habitual differences in the relative positions of various parts of the skeleton, e.g., of the scapula to the trunk;

(*b*) the relative positions differ in the same individual in different attitudes of the body; the position of the scapula, for example, changes with most movements of the upper limb.

The more important changes in the relative positions of landmarks on the trunk are those due to respiratory movements and those brought about by changing from the standing to the recumbent

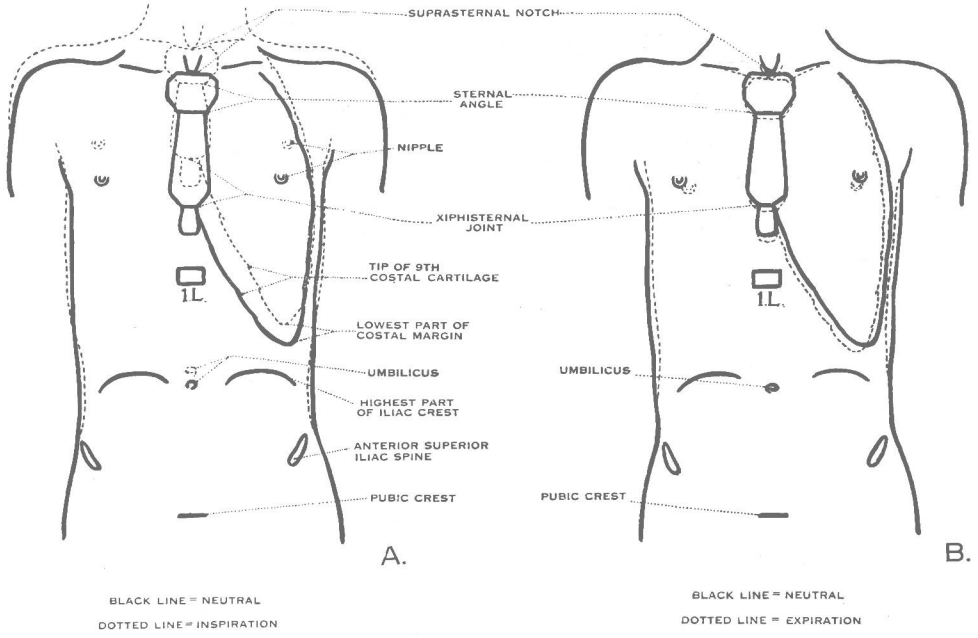

FIG. 7.—Outlines illustrating the respective ranges of movement of the chest and abdominal wall, in full inspiration in **A**, and in full expiration in **B** (from photographs, broad type of individual). The displacements of the umbilicus and nipples are shown.

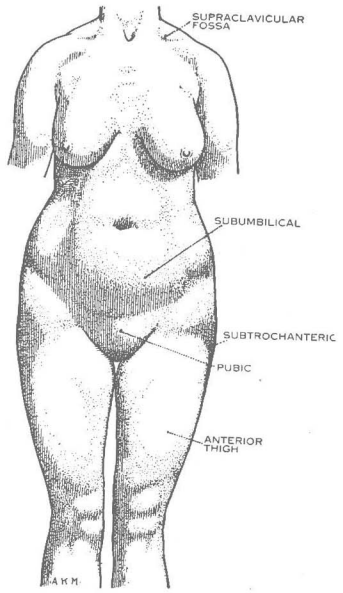

FIG. 8.—Sites of accumulation of subcutaneous fat in the female subject (anterior view).

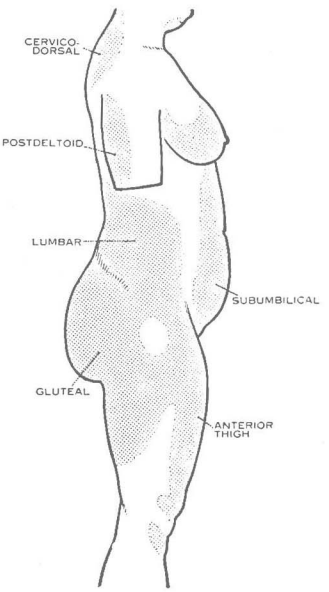

FIG. 9.—Sites of accumulation of subcutaneous fat in the female subject (lateral view).

position or vice-versa. In deep inspiration the sternum is elevated one or two inches relative to the vertebral column (Fig. 7), the costal margin is raised somewhat less, and the umbilicus is drawn upwards through a distance $\frac{1}{2}$ to 1 inch further from the symphysis pubis (Fig. 7). In the recumbent position the costal margin is at a higher level with reference to the vertebral column than in the erect position.

Landmarks should be selected with reference to the particular purpose in view. A given structure may offer a more constant relation to one landmark than to another and preference should be given accordingly. For example, the lower limits of the pleural cavities maintain an approximately constant relation to the ribs during the various phases of respiration, whereas their relation to the levels of the spinous processes of the vertebrae changes. Similarly the vertebral column and pelvis are better guides than the umbilicus to the level of the bifurcation of the abdominal aorta.

Skeletal features which can be determined in the majority of subjects, even in the obese, are preferable as landmarks. Special value is attached to landmarks which can be used both for radiological and general examination, e.g., the level of the highest parts of the iliac crest.

Cutaneous landmarks such as the nipple and umbilicus undergo displacement with reference to underlying structures during movements of the body, and their position is also influenced by the amount of superficial fat. They are of value mainly as guides to the position of superficial features such as zones of segmental innervation (e.g., around the umbilicus) or the distribution of lymphatic vessels (e.g., around the nipple).

(4) THE SKIN

The skin consists of two main layers:—(1) an avascular surface layer, the **epidermis,** and (2) a vascular deeper layer, the **corium.**

The corium merges imperceptibly into the underlying superficial fascia (subcutaneous tissue) in which a considerable amount of fat occurs in most parts of the body. Situated deep to the superficial