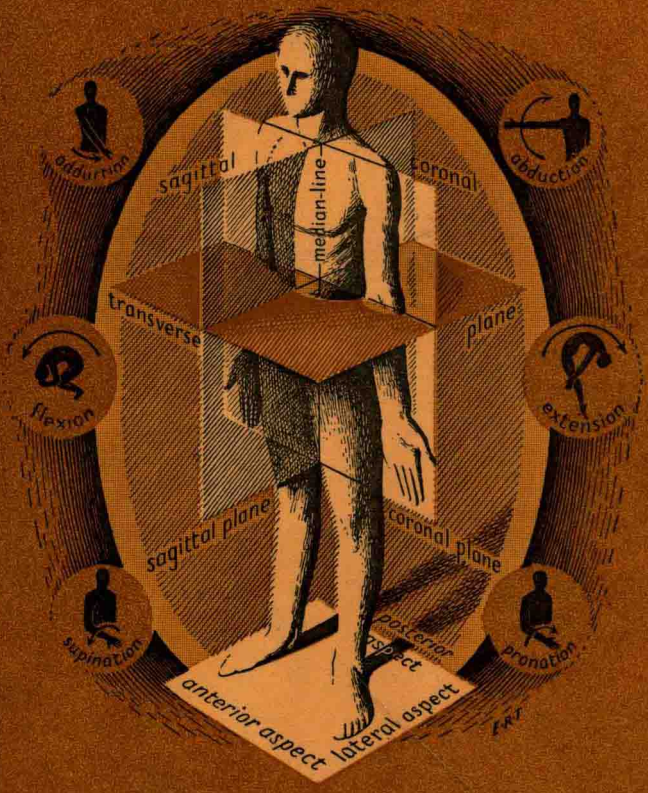
A MANUAL OF HUMAN ANATOMY

IIII
LOWER LIMB



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A MANUAL OF HUMAN ANATOMY

VOLUME IV

LOWER LIMB

PREFACE

THE purpose of these Manuals is to give the student of human anatomy a method of dissecting the body and to guide him as to the extent of the knowledge expected of him in the second medical examination. An attempt has been made to link together the structure and function of the different parts of the body, and the anatomy necessary for a future study of clinical medicine or an understanding of the development of the part is emphasised. Paragraphs indicating the functions of the parts under consideration have, where appropriate, been introduced after the dissecting instructions and topographical details. The study of the anatomy of each part can thus be undertaken with some knowledge of the functional implications and not as a mere exercise of memory. Much detail has been omitted.

A co-ordinated course is more easily organised if all the members of the class are dissecting the same part at the same time and the instructions in the Manuals are presented on this assumption. A most important part of the teaching is carried out by means of small classes on osteology and surface anatomy. For these classes we have found it useful to indicate what the students should know. The students do the work themselves and it is then checked by a demonstrator. Appropriate lists for such work are found at the end of each volume.

It has been found advantageous to begin with the dissection of the thorax. This results in an early acquaintance with the heart and lungs and with the peripheral and autonomic nervous systems, all of which receive attention in most introductory courses of physiology. From the thorax, the student proceeds to dissect the upper limb (vol. I), the head and neck (vol. II), the abdomen and pelvis (vol. III) and the lower limb (vol. IV). The descriptions and instructions in the Manuals assume that this order has been followed. Instructions for the use of the Manuals where a different order is employed are given opposite page 1. The gross and histological structure of the brain and spinal cord are described in vol. V.

Each part of the body is subdivided for convenience into smaller regions. In the limbs these regions centre around the joints and in

other parts around the larger morphological or functional units. In each region, a short introduction is followed by dissecting instructions, including a description of many of the structures being dissected. There follow paragraphs on further details and relations of the structures, and their functions.

Summaries of the cutaneous nerve supply and of the lymphatic drainage of the part dissected are found towards the end of each section of the Manual.

In the early stages of the planning and writing of these Manuals, Dr. W. A. Fell, now of Addenbrooke's Hospital, Cambridge, and Dr. D. H. L. Evans of University College, London, contributed to the work and much helpful criticism has been received from other colleagues and students.

The illustrations were produced by Miss E. R. Turlington and Miss J. de Vere, largely from specimens and drawings in the Anatomy Department at University College, London. As the main object of the pictures is to illustrate the text, all unnecessary complicating details have been omitted and the salient features emphasised by the use of colour.

Our thanks are also due to Miss A. Baxter and Miss M. Lynn for typing the final draft of the Manuals, and Mr. Macmillan and the staff of E. & S. Livingstone for the production and publication of the Manuals.

THE AUTHORS.

London,
September, 1956.

NOTE

IN Departments where different groups of students dissect the various parts of the body at the same time, some re-arrangement of the order of dissection is required. Dissectors of the upper limb should work in the first stages with those dissecting the thorax (Volume I, pages 1 to 7) and then proceed to the rest of the dissection of the upper limb (Volume I, Chapter IX). The dissectors of the lower limb begin with the front of the thigh (Volume IV, Chapter IV). Dissectors of the abdomen and the head and neck can begin with the appropriate Volumes.

If dissection is begun with the body on its face, those dissecting the head and neck should work with the dissectors of the upper limb for the dissection of the superficial muscles of the back (Volume I, Chapter XII), and then dissect the suboccipital triangle, etc. (Volume II, Chapter II). Dissectors of the thorax and abdomen wait until the body is placed on its back. The dissectors of the lower limb begin with the gluteal region (Volume IV, Chapter III).

ORIENTATION

TO help in the description of a structure or a region certain terms are used and they have an agreed interpretation. The **anatomical position** is one in which the person stands upright, with the feet together, the eyes looking forward, and the arms straight along the sides with the palms of the hands directed forwards. The front of the body is called the **anterior** surface and the back is called the **posterior** surface (see cover drawing). The terms **ventral** and **dorsal** may be used for the front and back respectively. Higher structures are **superior** and lower structures are **inferior. Median** structures are found in the midline of the body (or of a limb) and the terms **medial** (nearer to) and **lateral** (further from) are relative to the midline.

A **sagittal plane** passes vertically anteroposteriorly through the body and movements in this plane are called **flexion** (forwards) or **extension** (backwards). A vertical plane at right angles to the sagittal is called a **coronal** or **frontal plane.** Movements of the limb in this plane are **abduction** (away from) and **adduction** (towards) the midline. At certain joints, **rotation** also occurs about a longitudinal axis.

CONTENTS

LOWER LIMB

CHAPTER I

GENERAL INTRODUCTION

THE FUNCTIONS OF THE LOWER LIMB IN MAN

THE lower limb is concerned with the maintenance of posture and with locomotion, and its structure is an expression of these two functions. The description of the anatomy of the limb will therefore be arranged round the joints and the structure of the whole limb will be broken up into its functional components, just as the movement of the whole limb can be analysed by considering the movements of its individual segments. The dissection falls easily into regional subdivisions—the pelvic girdle, the hip joint, the knee joint, the ankle joint and the foot. In each one of these regions the student must examine the arrangement of the soft tissues around the pivots of the movements, *i.e.* the joints, in order that he may understand how such movements can be performed. To get a clear idea of the arrangement of the soft tissues, a knowledge of the bones of the region is necessary because muscles are attached to and act on the bones.

The description of the anatomy of each region is arranged so that the greatest attention is given to those structures that subserve the main functions of the limb, namely the muscles and the joints. Thus when dissection of the limb is finished the student should have a clear idea of the movements of each segment of the limb, but he must still integrate these separate segments into one whole, since the limb is mostly used as a single functional entity. The concluding section will show how the separate functions of the segments can be integrated, or in other words, how the muscles and the joints function in the maintenance of posture and locomotion. Also in this concluding section will be considered the anatomy of certain structures that cannot be split up into regions but must be integrated into the concept of the entire limb—the superficial venous drainage, the cutaneous nerve supply, and the lymphatic drainage.

The pelvic girdle, thigh, leg and foot should be considered as a system of jointed levers serving to support and propel the weight of the body. On account of the mobility at the joints the bones

seldom support the weight in stable equilibrium, *e.g.* as the legs support the top of a table to which they are firmly fixed. In the lower limb, in addition to the stresses due to the body weight, which are taken by the bones, there will continually be stresses set up by forces tending to upset the balance. These are compensated for, and stability achieved, by muscles and ligaments that will be found arranged as braces guarding each joint on all sides. A similar type of bracing is seen in some wireless transmitting masts, where the long steel mast is supported on a ball and socket at its base, and has braces of long and short steel hawsers on all sides. In the case of the human legs, the braces serve not only for stabilisation but, since they are mostly muscular, they move the body by their contraction. Stabilisation where there is little movement is thus effected by ligaments and where there is free movement by muscles.

CHAPTER II

THE PELVIC GIRDLE

INTRODUCTION

WEIGHT is transferred from the vertebral column to the sacrum at the lumbosacral joints and from the sacrum to the innominate bones through the sacro-iliac joints. Since very little movement occurs at the latter joints they are stabilised mainly by ligaments. Weight is transferred partly across the interlocking joint surfaces and partly across a system of ligaments by which the sacrum is, as it were, slung between the innominate bones.

The main line of weight-bearing in the innominate bone runs from the sacro-iliac joint to the acetabulum and the bone is thickest along this line. The whole arrangement may be considered as an arch of which the sacrum is the keystone, and these thickened regions of bone are the pillars, continued downwards to the femora. The symphysis pubis is thus a tie beam, preventing the arch from spreading apart. The analogy is very imperfect, however, since the sacrum is partly slung from the ilium and thus acts as a movable keystone.

The hip joint is a ball and socket joint allowing a wide range of movement. The body is balanced on it, with the help of a large number of muscles acting as braces. Some of these are short whereas the longer ones, inserted far away from the joint, exert considerable leverage and produce powerful movements.

On the skeleton, note, on the back of the sacrum, the **sacral crest** in the midline and the **posterior** (dorsal) **sacral foramina.** On the front of the sacrum identify the **anterior** (pelvic) **sacral foramina** and the bodies and lateral masses of the individual vertebral components of the sacrum. Examine the sacro-iliac surfaces and note the ear-shaped (auricular) articular surface, and the rough nonarticular area behind for the attachment of the posterior sacro-iliac ligaments. Passing from the back of the sacrum to the tuberosity and the spine of the ischium are the **sacrotuberous** and **sacrospinous ligaments.**

On the innominate bone, note the surface for articulation with the sacrum and the large area for the attachment of the posterior

sacro-iliac ligaments. In front of the joint, the anterior sacro-iliac ligament is attached, and above, the iliolumbar ligament passes from the transverse process of the 5th lumbar vertebra to the ilium. The **symphysis pubis** is the joint between the two pubic bones and consists of a capsule with supporting ligaments and a fibro-cartilaginous disc between the two bony surfaces.

DISSECTION

Remove the structures in front of the sacro-iliac joint, cut through the anterior ligament and separate the joint surfaces. Do not cut the posterior ligaments at this stage but note their thickness. Examine the structure of the symphysis pubis and note that the surfaces of the bones are covered by hyaline cartilage and between them is a mass of fibrocartilage.

STRUCTURAL DETAILS

The **sacro-iliac joint,** although a synovial joint, does not permit much movement because of the interlocking depressions and elevations on the corresponding cartilaginous surfaces of the bones. The cartilage covering the surfaces may disappear in places and be replaced by a fibrous union, which limits movement. Immediately behind the cartilaginous surfaces, the bones are united by thick **interosseous ligaments.** The posterior sacro-iliac ligaments are very strong and form the sling which carries the sacrum and its superimposed weight on the innominate bones. There is a tendency for the top of the sacrum to tilt downwards and forwards into the pelvis. The corresponding backward and upward movement of the coccyx and lower part of the sacrum is prevented by the sacro-spinous and sacrotuberous ligaments.

The **symphysis pubis** is between the bodies of the two pubic bones. The joint surfaces are covered with hyaline cartilage and between them is a disc of fibrocartilage. The capsule of the joint is not strong.

Towards the end of pregnancy some increased movements at the joints of the pelvic girdle may occur and walking may be difficult. Bone may be absorbed, especially in the region of the symphysis pubis, but later it is replaced.

CHAPTER III

THE LATERAL AND POSTERIOR ASPECTS OF THE HIP JOINT

INTRODUCTION

IN this region, the largest structures are the gluteal and hamstring muscles, which are strong extensors of the hip joint. The more important action of the hamstrings, however, is flexion of the knee. The sciatic nerve, the largest nerve in the body, is a prominent structure in this region.

The pelvic bones were examined during the dissection of the abdomen and pelvis. The principal bony landmarks were identified, but special attention should now be paid to the outer surface of the innominate bones. The outer surface of the ilium is divided into a small posterior area, a large anterosuperior area and a large anteroinferior area, and these areas serve for the attachment of gluteus maximus, medius and minimus respectively. Identify the outer surface of the **ischiopubic ramus,** to which the adductor muscles are attached, and the **ischial tuberosity,** where the hamstring muscles arise. Above the obturator foramen, find the **acetabulum** for articulation with the head of the femur. The articular surface is horseshoe-shaped and the acetabular edge is incomplete below (the **acetabular notch**).

The upper end of the femur consists of a **head,** for articulation with the acetabulum, a **neck** and a **shaft** on which are the two trochanters. The **lesser trochanter** is medial and inferior and the **greater** is lateral and superior. Joining the trochanters are the **trochanteric crest** behind and the **trochanteric line** in front. The shaft of the bone is smooth except along its posterior surface where the ridge of the **linea aspera** is found.

DISSECTION

Make incisions along the whole of the lateral and medial sides of the thigh as far as the knee. Reflect the anterior and posterior flaps of skin downwards. Remove the subcutaneous tissue from the buttock and the back of the thigh without identifying the cutaneous nerves. Examine the deep fascia of the thigh (the **fascia lata**) and of the gluteal region, noting its toughness and thickness. It is particularly thick on the outer side and is here known as the **iliotibial tract,** which can be followed down as far as the lateral condyle of the tibia. Examine the large **gluteus maximus muscle** exposed at the back. Note its upper attachments to the posterior area on the outer surface of the ala of the ilium, to the back of the sacrum and to the sacrotuberous ligament. It is attached below partly to the gluteal ridge on the shaft of the femur between the greater trochanter and the linea aspera, but mostly to the iliotibial tract. In the same plane, but further forwards, note another smaller muscle also attached to the iliotibial tract. This is the **tensor fasciae latae**, which arises from the iliac crest in front.

Having cleaned the surface of the gluteus maximus, cut through it at right angles to its fibres, one third distal to its upper attachment. Reflect its two parts medially and laterally, cutting any branches of the gluteal vessels and the inferior gluteal nerve which supply it. The deeper portion of the gluteal region is now exposed (Fig. 1).

Begin by identifying the **piriformis muscle.** It arises inside the pelvis on the front of the sacrum and passes into the thigh through the greater sciatic foramen to be attached to the tip of the greater trochanter. Clean its surface and its upper and lower edges. Pass the handle of a scalpel forwards above the upper border of the muscle and note that it is stopped by the back of the hip joint. Above the upper edge of the piriformis, branches of the superior gluteal artery and nerve are found emerging from the pelvis. Trace the branches of the nerve forwards and upwards between the gluteus medius and minimus muscles. These muscles arise from the outer surface of the ilium, and pass downwards to their attachments to the greater trochanter. Clean them and dissect their tendons to their insertions, cutting across the medius to expose the minimus.

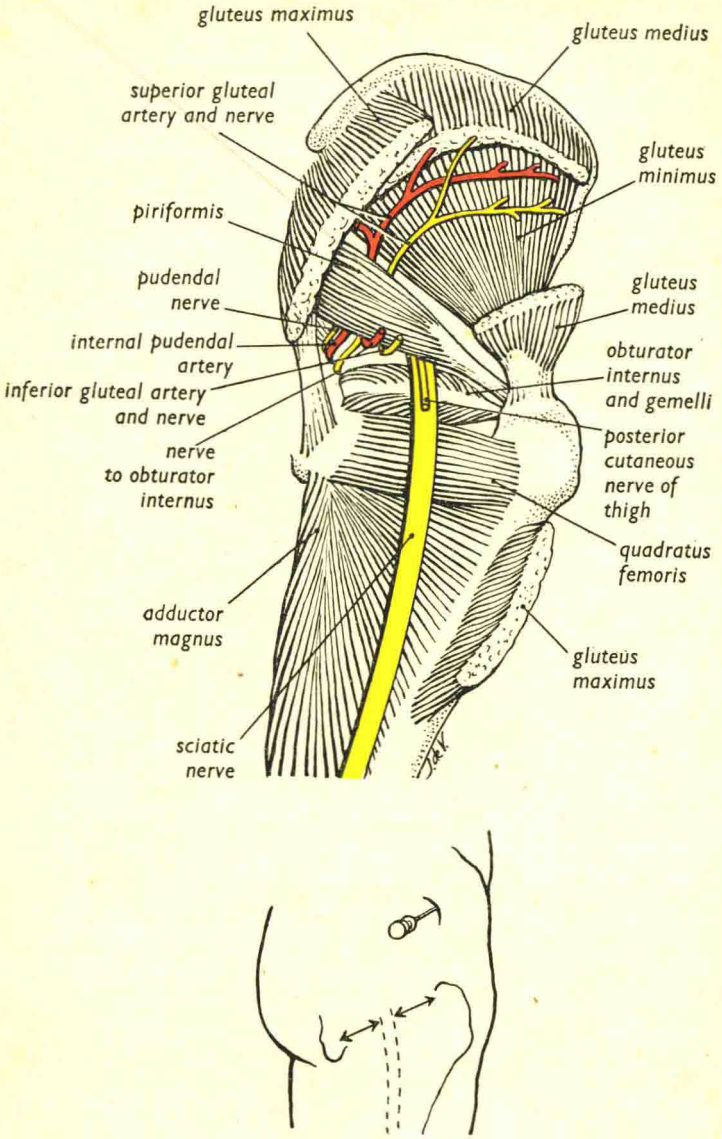

FIG. 1

Diagram of the gluteal region. The lower figure indicates the position of the sciatic nerve and a site commonly used for intramuscular injections.

The **gluteus medius** is attached above to the upper outer surface of the ilium and below to the lateral surface of the greater trochanter. It is a most important lateral brace or abductor of the hip joint, preventing the body from falling to the opposite side when the weight is carried on one leg. The **gluteus minimus** is attached above to the lower outer surface of the ilium and below to the anterior surface of the greater trochanter. It is an abductor and medial rotator of the thigh. The superior gluteal nerve supplies these two muscles and the tensor fasciae latae.

At the lower border of the piriformis find the large **sciatic nerve,** the main motor and sensory nerve of the lower limb. Clean it for a short distance down the thigh. Be careful not to confuse it with a large sensory nerve which is found lying superficial to it, the **posterior cutaneous nerve of the thigh.** On the medial side of the sciatic nerve are branches of the inferior gluteal artery and vein and the stump of the inferior gluteal nerve. This nerve was cut during the reflection of the gluteus maximus, which it supplies. Deep to the sciatic nerve and just below the piriformis find the tendon of the **obturator internus muscle,** flanked on either side by two muscular slips, the **gemellus superior** and **inferior.** Trace the tendon of the obturator internus medially. It can be followed through the lesser sciatic foramen into the pelvis where it is attached to the inner surface of the obturator membrane and the surrounding bone. Laterally the tendon is attached to the upper edge of the greater trochanter. The piriformis is supplied by branches of the anterior primary rami of the upper sacral nerves and the obturator internus by a branch of the sacral plexus. They are both lateral rotators of the thigh.

Identify the edge of the large **sacrotuberous ligament,** first on a specimen of the pelvis with the ligaments attached, and then in the dissection. Remove the fibres of gluteus maximus and cut the ligament away in order to expose more fully the back of the ischial spine. Note the **sacrospinous ligament** attached to the spine and, on a specimen of the pelvis with ligaments attached to it, identify its medial attachment to the sacrum. Dissect carefully over the back of the spine and adjacent portion of the ligament. Identify, from lateral to medial, the nerve to obturator internus, the internal pudendal artery and vein and the pudendal nerve, passing over

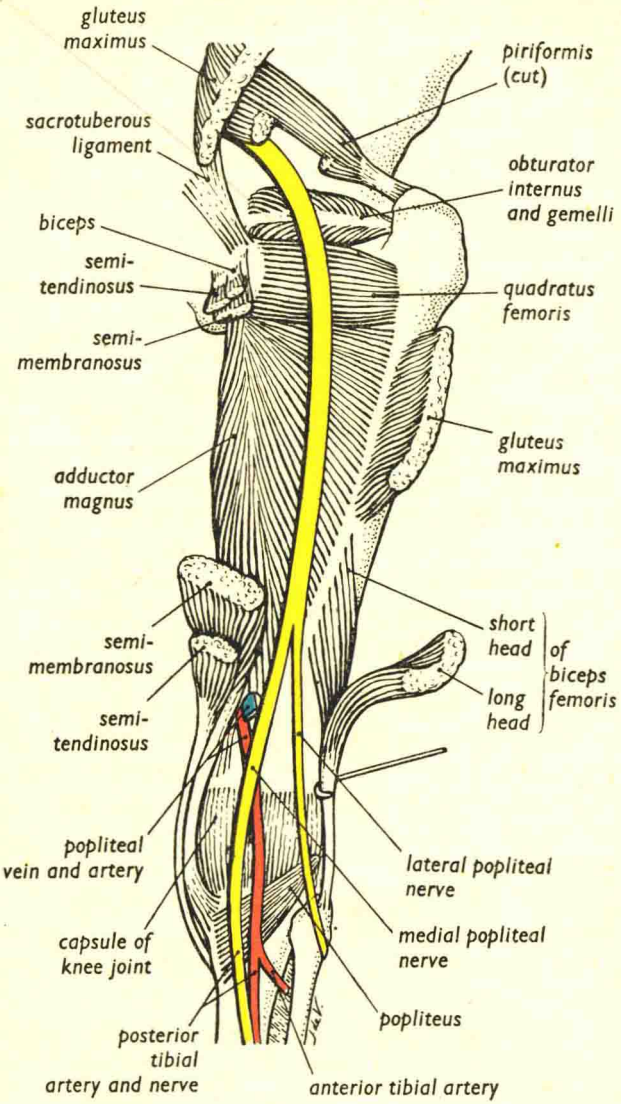

FIG. 2
The course and important relations of the sciatic nerve.

the back of the spine and ligament. Note the position of the quadratus femoris muscle, below the edge of the inferior gemellus, clean its posterior surface and identify, at its lower border, the upper border of the adductor magnus muscle. The **quadratus femoris** runs between the ischial tuberosity and the quadrate tubercle on the trochanteric crest. It is supplied from its deep surface by a branch of the sacral plexus and is a lateral rotator of the thigh.

You have now dissected the muscles close to the hip forming the lateral and posterior braces of the joint, that is to say, those that prevent the body falling medially and forwards. They arise from various parts of the innominate bone and are inserted on to the greater trochanter.

On the back of the thigh are long muscles that act on the hip and also on the knee. Identify the three **hamstring muscles,** arising from the ischial tuberosity (Fig. 2). The long head of biceps and the semitendinosus have a common origin medially and the semimembranosus arises lateral to the other two. Clean them and separate them to show the **biceps** lying laterally and the **semitendinosus** and **semimembranosus** lying medially. The semitendinosus lies on the posterior surface of the semimembranosus. Clean all three down to the level of the knee joint. They all assist the gluteus maximus and act as posterior braces of the hip, preventing the body from falling forwards. When the lower limb is free they extend it, pulling it backwards. The three hamstring muscles are also very powerful flexors of the knee joint. Examine the posterior surface of the **adductor magnus;** clean it and the sciatic nerve, which lies on it. The posterior fibres of the adductor magnus come from the ischial tuberosity and gain attachment below to the adductor tubercle of the femur. They act as extensors of the hip joint and are functionally associated with the other muscles attached to the ischial tuberosity—biceps, semimembranosus and semitendinosus. Biceps femoris has a second head of attachment from the linea aspera, and the whole muscle is attached below to the head of the fibula. Semitendinosus and semimembranosus pass along the inner side of the knee to be attached to the upper medial aspect of the tibia and to the back of the medial tibial condyle respectively (*see* page 33). Find the branches of the sciatic nerve to the hamstring

muscles and note its division into medial and lateral popliteal nerves. Occasionally this division occurs in the pelvis, in which case the lateral popliteal nerve usually splits the piriformis muscle.

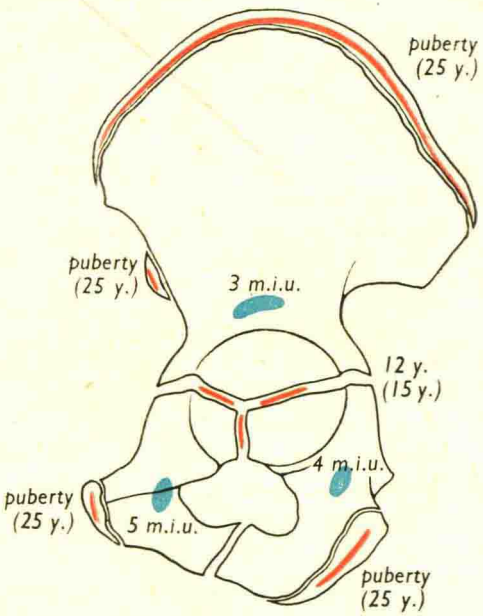

FIG. 3

The primary centres of ossification of the innominate bone are shown in blue and the secondary centres in red. The figures in brackets indicate the times of fusion of the primary and secondary centres (y., years; m.i.u., months in utero).

STRUCTURAL DETAILS

The innominate bone (see also Vol. III)

The inner and outer aspects of the innominate bone have already been described. The three bones forming the innominate are modified for weight-bearing or for muscular attachment (iliopubic line and ischial tuberosity). Parts of the bone where there are few stresses are thin or replaced by membrane (obturator foramen).

The innominate bone is **ossified** in three main parts (Fig. 3). All three centres appear near the acetabulum between the third