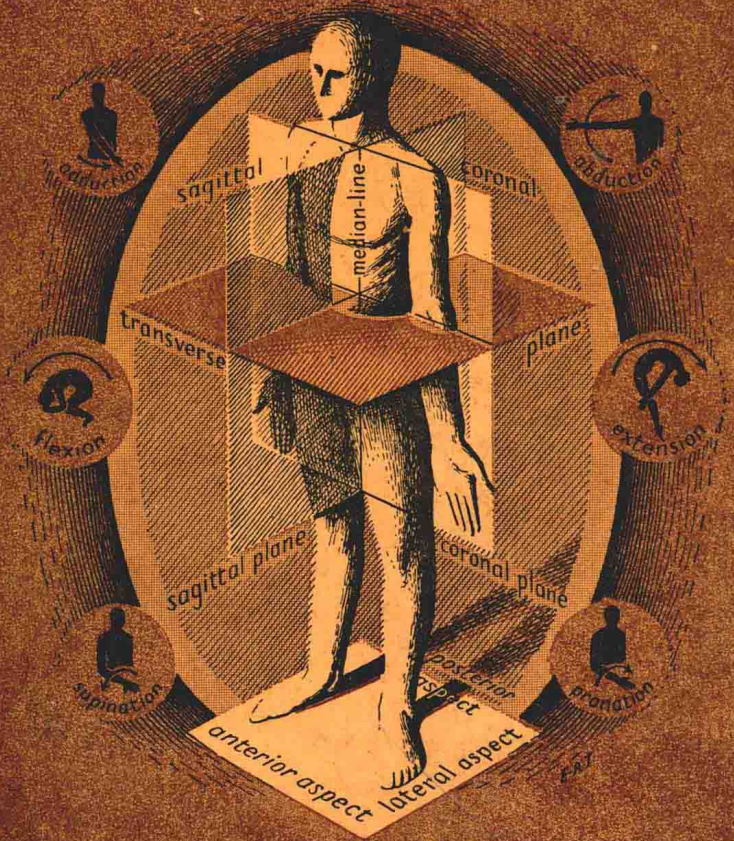
A MANUAL OF HUMAN ANATOMY

III

ABDOMEN AND PELVIS



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E. & S. LIVINGSTONE LTD., EDINBURGH AND LONDON

A MANUAL OF HUMAN ANATOMY

VOLUME III

ABDOMEN

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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,
January, 1957.

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.** Bending of the trunk in this plane is called **lateral flexion.** At certain joints, **rotation** also occurs about a longitudinal axis.

CONTENTS

ABDOMEN

CHAPTER I

GENERAL INTRODUCTION

THE abdominal cavity extends upwards to the diaphragm, which separates it from the thoracic cavity, and downwards as far as the levator ani muscles, which separate it from the perineum. The abdominal walls are mainly muscular but the upper parts contain ribs and costal cartilages, and the lower lateral parts the iliac bones. The lumbar vertebrae form a part of the posterior abdominal wall. The abdominal cavity contains the viscera associated with digestion, excretion and reproduction.

On the articulated skeleton and on the cadaver identify the xiphoid process, the lower ribs with their costal cartilages and the lumbar vertebrae. Examine the bony pelvis which is formed by the **innominate bones** joined together in front by the fibrocartilage of the **symphysis pubis,** and completed behind by the **sacrum.** Each innominate bone is made up of the **ilium** above, the **ischium** below and the **pubis** in front, which fuse together in the **acetabulum** (the deep, articular cavity for the head of the femur). The ilium articulates with the sacrum posteromedially and has a convex upper border, the **iliac crest.** This crest ends in the **posterior superior iliac spine** behind, and the **anterior superior iliac spine** in front. The iliac crest immediately in front of its highest point has on its outer aspect the **tubercle of the iliac crest.** The ilium below the crest is thin and its superomedial surface is smooth and concave, forming the lower lateral part of the abdominal wall. Trace the anterior border of the ilium downwards from the anterior superior spine. There is a small elevation above the acetabulum, the **anterior inferior iliac spine.** Medial to this spine is the **iliopubic eminence** where the pubis and ilium join. From this eminence, the sharp **pectineal line** can be traced medially as far as the **pubic tubercle** at the upper lateral angle of the **body** of the pubic bone. Medial to the pubic tubercle along the upper margin of the pubis is the **pubic crest.** Below the acetabulum is the large **obturator foramen.** Bounding the foramen medially is the body of the pubis and the inferior pubic ramus, and inferiorly

is the **ischial ramus.** (This lower boundary of the foramen is often called the **ischiopubic ramus.**) Trace the ischial ramus backward to a prominent thickening of bone, the **ischial tuberosity.** Above this, on the posterior border of the innominate bone, is the pointed projection of the **ischial spine,** separated from the ischial tuberosity by the **lesser sciatic notch.** Above the ischial spine is the **greater sciatic notch,** with the **posterior inferior iliac spine** at its superior end.

Look at the articulated pelvis from above and note how the upper borders of the pubes and the pectineal lines continue laterally and then posteriorly to become continuous with the upper anterior border of the sacrum. This outlines the **pelvic inlet** and divides the true pelvis below from the false pelvis above. When standing erect, the two anterior superior iliac spines and the upper edge of the symphysis pubis are in the same vertical plane.

CHAPTER II

THE ANTERIOR ABDOMINAL WALL

INTRODUCTION

THE anterior abdominal wall consists mainly of muscular layers which help to support the abdominal viscera, move with the diaphragm during respiration, and play an important part in the movements of the vertebral column.

Before beginning to dissect, map out the following lines on the anterior abdominal wall: (1) a horizontal line through the lowest part of the costal margin (usually the 10th rib) indicating the **subcostal plane,** (2) a horizontal line through the tubercles of the iliac crests indicating the **intertubercular plane,** (3) a vertical line on each side through the midpoint between the anterior superior iliac spine and the symphysis pubis indicating the **lateral planes.** These four planes divide the abdomen into nine regions, which are used to define the positions of the underlying abdominal viscera. In the middle between the lateral planes, from above downwards, are the **epigastric, umbilical** and **hypogastric regions** and lateral to these regions, again from above downwards, are the right and left **hypochondriac, lumbar** and **iliac regions.**

The **transpyloric plane** is obtained by drawing a horizontal line midway between the suprasternal notch and the upper edge of the symphysis pubis. This plane may be used instead of the subcostal plane for dividing the abdomen into regions. Note that the umbilicus lies approximately in the midline just above the intertubercular plane, but it is somewhat variable in its position.

DISSECTION

Incise the skin in the midline, from the xiphoid process to the symphysis pubis, and also obliquely from the symphysis pubis along the fold of the groin and the iliac crest. (If beginning dissection with the abdomen, incise the skin along the costal margin from the xiphoid process to the midaxillary line.) Reflect these skin flaps laterally. Clear away the superficial fascia, which contains a variable amount of fat. While removing this fat, look

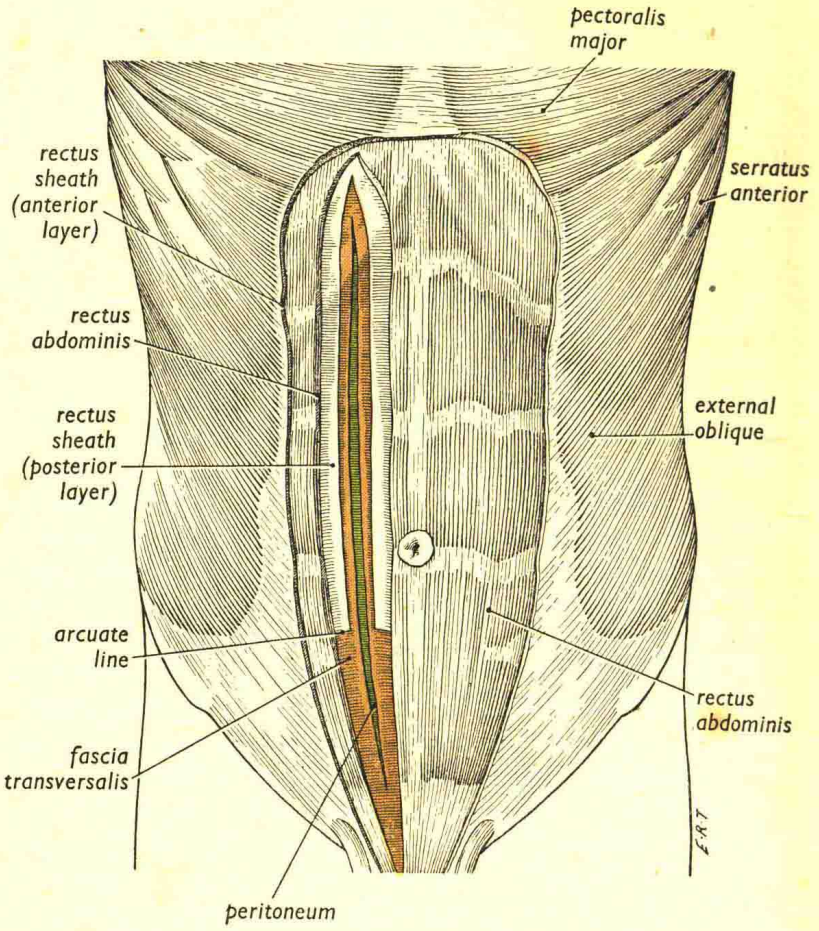

FIG. 1
The anterior layer of the rectus sheath has been removed on both sides and the right abdominal wall has been incised vertically, exposing the peritoneum.

for the branches of some of the cutaneous nerves, which are found emerging from the deep fascia (*a*) close to the midline, and (*b*) in the midaxillary line.

Over the lower part of the anterior abdominal wall two distinct layers of the superficial fascia can often be defined. The more superficial is fatty and is continuous with the superficial fascia of the thigh. The deeper layer is membranous and fuses with

the deep fascia of the thigh just inferior to the groin. Only the membranous layer is found in the scrotum in the male but both layers are found in the labium majus of the female. The deep fascia is represented by the fibrous tissue covering the muscles of the abdominal wall.

On each side of the midline is the vertically running **rectus abdominis muscle,** surrounded by the **rectus sheath.** Lateral to the rectus sheath the muscles form sheets with fibres running obliquely or transversely (Fig. 1). Examine the anterior layer of the rectus sheath and open it by a vertical incision about 3 cm from the midline. There are transverse **tendinous intersections** in the rectus abdominis and the anterior layer of the sheath is attached to them. The most inferior of these intersections is usually about the level of the umbilicus. The posterior layer of the sheath is not attached to the rectus muscle and is pierced by nerves and vessels. The anterior and posterior layers of the rectus sheath unite in the midline to form the **linea alba** consisting of interwoven fibrous tissue, which is stronger and more distinct above the umbilicus than below. Lateral to the rectus abdominis the anterior and posterior layers fuse to form the **linea semilunaris** (Fig. 2).

Clean the **external oblique muscle;** most of its fibres run downwards and medially from the outer surface of the lower ribs towards the linea semilunaris. The lowest and most posterior fibres pass vertically downwards from the ribs to the iliac crest and, having no aponeurotic attachment to the lumbar fascia, form a posterior free border of the muscle. (The **lumbar fascia** is the strong fibrous tissue covering the sacrospinalis muscle of the back and is attached to the lumbar and sacral vertebrae.) The external oblique muscle is attached to the anterior superior iliac spine and to the pubic tubercle, between which it is thickened to form the **inguinal ligament** (Poupart's ligament). Reflect the external oblique muscle medially by cutting through its attachment to the ribs and the iliac crest and by making a horizontal incision through its fibres at the level of the anterior superior iliac spine. The fibres of the **internal oblique muscle** are now exposed, running upwards and medially towards the linea semilunaris. This muscle is attached posteriorly to the lumbar fascia, and to reflect it forwards

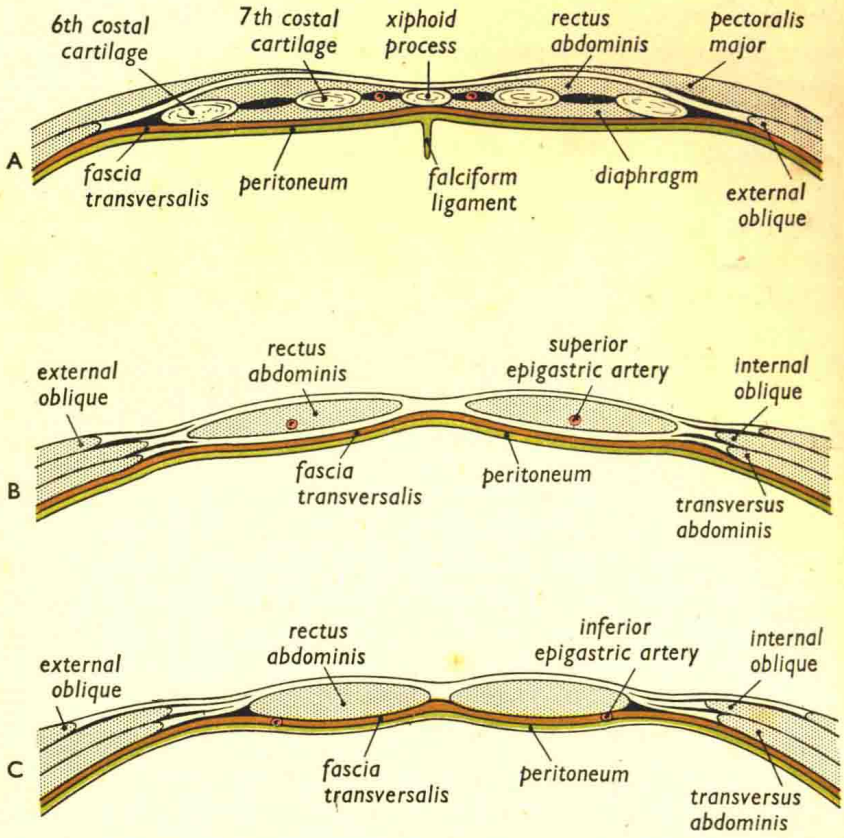

FIG. 2

Diagrams of transverse sections through the anterior abdominal wall. A. Above the costal margin. B. Just above the umbilicus. C. Below the arcuate line.

this attachment must be divided by a vertical cut. Detach it from the iliac crest and divide it by a horizontal incision passing forwards from the anterior superior iliac spine.

The internal oblique and the deeper **transversus abdominis muscles** require careful separation. Note the direction of the muscle fibres of the transversus and find the main vessels and nerves to the abdominal wall lying between these two muscles.

Along the upper two-thirds of the linea semilunaris the aponeurosis of the internal oblique muscle splits into two layers, the anterior layer is reinforced by the fibres of the external oblique

aponeurosis and forms the anterior layer of the rectus sheath. The posterior fibres of the internal oblique aponeurosis pass behind the rectus abdominis and are reinforced by the fibres of the transversus abdominis. Along the lower third, all the fibres of the internal oblique and of the transversus abdominis pass in front of the rectus abdominis so that the lower part of the posterior surface of the rectus abdominis is in contact with the **fascia transversalis** lining the muscles of the abdominal wall. To examine the rectus sheath more closely, make a transverse incision across the rectus abdominis just below the umbilicus. Note the nerves and the superior and inferior epigastric vessels entering the muscle, and the lower edge of the posterior layer of the rectus sheath, the **arcuate line** (Figs. 1 and 2).

The inguinal region should now be dissected (Fig. 3). The description given is for the male. In the female, the dissection is the same but instead of the **spermatic cord** (the collective name given to the duct, vessels and nerves of the testis), the **round ligament of the uterus** is found. The fascial coverings of the cord in the male go into the scrotum, and those of the round ligament go into the labium majus. It is desirable that a dissection of this region in both sexes should be examined.

The **inguinal canal,** associated with the passage of the testis from the inside of the abdomen to the scrotum, passes obliquely through the anterior abdominal wall above the medial half of the inguinal ligament. Examine the **superficial inguinal ring** which is a triangular-shaped thinning of the external oblique muscle. Its base is medial to the pubic tubercle and it extends upwards and laterally so that it lies above and lateral to the pubic tubercle. The upper and lower margins of the ring (the **crura**) are thickened and the aponeurosis of the external oblique muscle between the crura is carried by the testis into the scrotum as the **external spermatic fascia.** The lower margin is attached to the pubic tubercle and the upper margin passes more medially to be attached to the pubic crest. Divide the external oblique aponeurosis along a line from the apex of the external ring to the anterior superior iliac spine. Dissect flaps of the external oblique upwards and downwards, and separate them from the internal oblique. Note that the lower part of the external oblique is

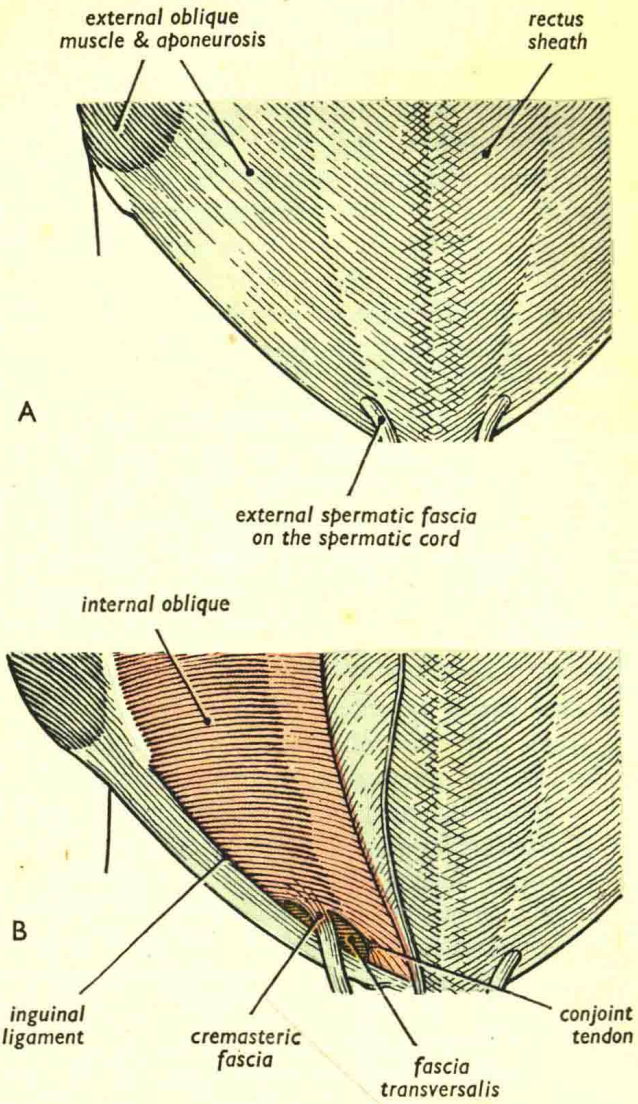
external oblique
muscle & aponeurosis
rectus
sheath
A
external spermatic fascia
on the spermatic cord
internal oblique
B
inguinal
ligament
cremasteric
fascia
fascia
transversalis
conjoint
tendon

FIG. 3

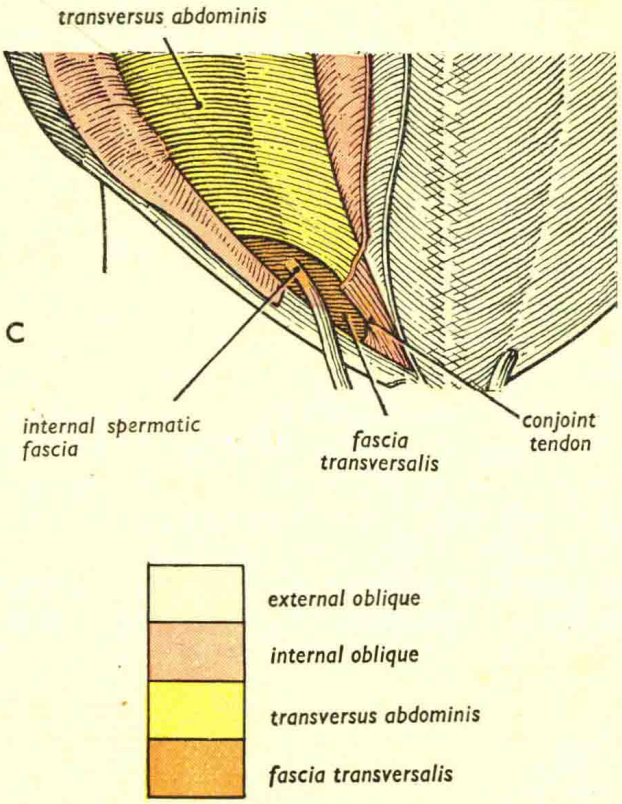

FIG. 3

Diagrams indicating the structure of the inguinal canal. A. Skin and fascia have been removed, exposing the external oblique muscle and the superficial inguinal ring with the external spermatic fascia surrounding the spermatic cord. B. The external oblique muscle has been reflected, exposing the internal oblique and the cremasteric fascia on the spermatic cord. C. The internal oblique has been separated from the transversus abdominis and the conjoint tendon is seen medially. The cord is surrounded by the internal spermatic fascia derived from the fascia transversalis.

thickened to form the inguinal ligament. The spermatic cord should be identified lying deep to the external oblique. The **ilio-inguinal nerve** is found running near the inguinal ligament and should be traced both medially and laterally. Examine the internal oblique muscle now exposed. It partly arises by muscle fibres from the lateral two-thirds of the inguinal ligament and these fibres arch medially over, and then pass downwards behind, the spermatic cord. These fibres together with fibres from the transversus abdominis muscle form the **conjoint tendon** which strengthens the medial part of the fascia transversalis forming the posterior wall of the canal. The cord is covered by a fascial extension of the internal oblique muscle, the **cremasteric fascia,** which contains loops of muscle fibres, the **cremasteric muscle.** Pull the cord downwards and laterally and note that, lateral to the arch of the internal oblique, the posterior wall of the inguinal canal is formed by the fascia transversalis. The cord is covered by a prolongation of the fascia transversalis called the **internal spermatic fascia.**

Examine the structures in the **spermatic cord.** The **vas deferens** (the duct of the testis) can be identified by its round cord-like feel when rolled between the fingers. Clean the vas and identify the **testicular artery,** the **pampiniform plexus of veins** and the **genital branch** of the **genitofemoral nerve.** The nerve supplies the cremaster muscle. Trace these structures laterally until they disappear into the abdominal cavity through the **deep inguinal ring,** an opening in the fascia transversalis.

Make an incision through the fascia tranversalis behind the cord, divide the extraperitoneal tissues, and verify that the vas is extraperitoneal as it passes posteriorly along the pelvic inlet. Note that as the vas leaves the internal ring it hooks round the lateral side of the **inferior epigastric artery** (a branch of the external iliac artery). Find the deep circumflex iliac artery which arises from the external iliac artery near the deep ring and passes laterally towards the iliac crest.

FURTHER STRUCTURAL DETAILS

The muscles of the anterior abdominal wall

The **rectus abdominis muscle** is attached to the pubic crest and to the fascia in front of the symphysis pubis. The muscle

passes vertically upwards in the rectus sheath on either side of the linea alba and is attached to the outer surface of the xiphoid process and the cartilages of the 5th, 6th and 7th ribs. In front of the lower part of the rectus muscle is the **pyramidalis,** a small slip of muscle attached below to the pubic crest and medially to the linea alba.

The **external oblique muscle** is attached to the outer surface of the lower eight ribs and interdigitates with the serratus anterior and latissimus dorsi muscles. From this attachment the upper and middle fibres become aponeurotic and pass medially towards the rectus sheath. The lower fibres remain muscular and pass almost vertically downwards to the iliac crest. Between the anterior superior iliac spine and the pubic tubercle, the lower border of the muscle is aponeurotic and thickened to form the inguinal ligament. The lateral part of this ligament is round and rolled inwards. The medial part of the ligament is more flattened and its upper surface supports the spermatic cord in the inguinal canal. The posterior border of the medial part of the ligament passes backwards, forms a shelf attached to the pectineal line and is called the **pectineal part of the inguinal ligament** (the lacunar ligament). Above the pubic tubercle, the external oblique aponeurosis is thin and forms the **superficial inguinal ring,** from the edges of which the external spermatic fascia arises. This fascia is much thinner than the aponeurosis and covers the cord and the testis.

The **internal oblique muscle** is attached to the lateral two-thirds of the inguinal ligament, to the anterior two-thirds of the iliac crest, and to the lumbar fascia. The lowest fibres arising from the inguinal ligament are at first in front of the spermatic cord. They then arch over the spermatic cord and, passing medially, form a flattened tendon, the **conjoint tendon,** which lies behind the spermatic cord and is reinforced by some fibres of the transversus muscle. The conjoint tendon is attached to the pubic crest in front of the pyramidalis and to the medial part of the pectineal line, and forms the medial part of the posterior wall of the inguinal canal, strengthening the portion behind the superficial inguinal ring. The curved margin of the conjoint tendon is continuous with the cremasteric fascia which contains fibres of