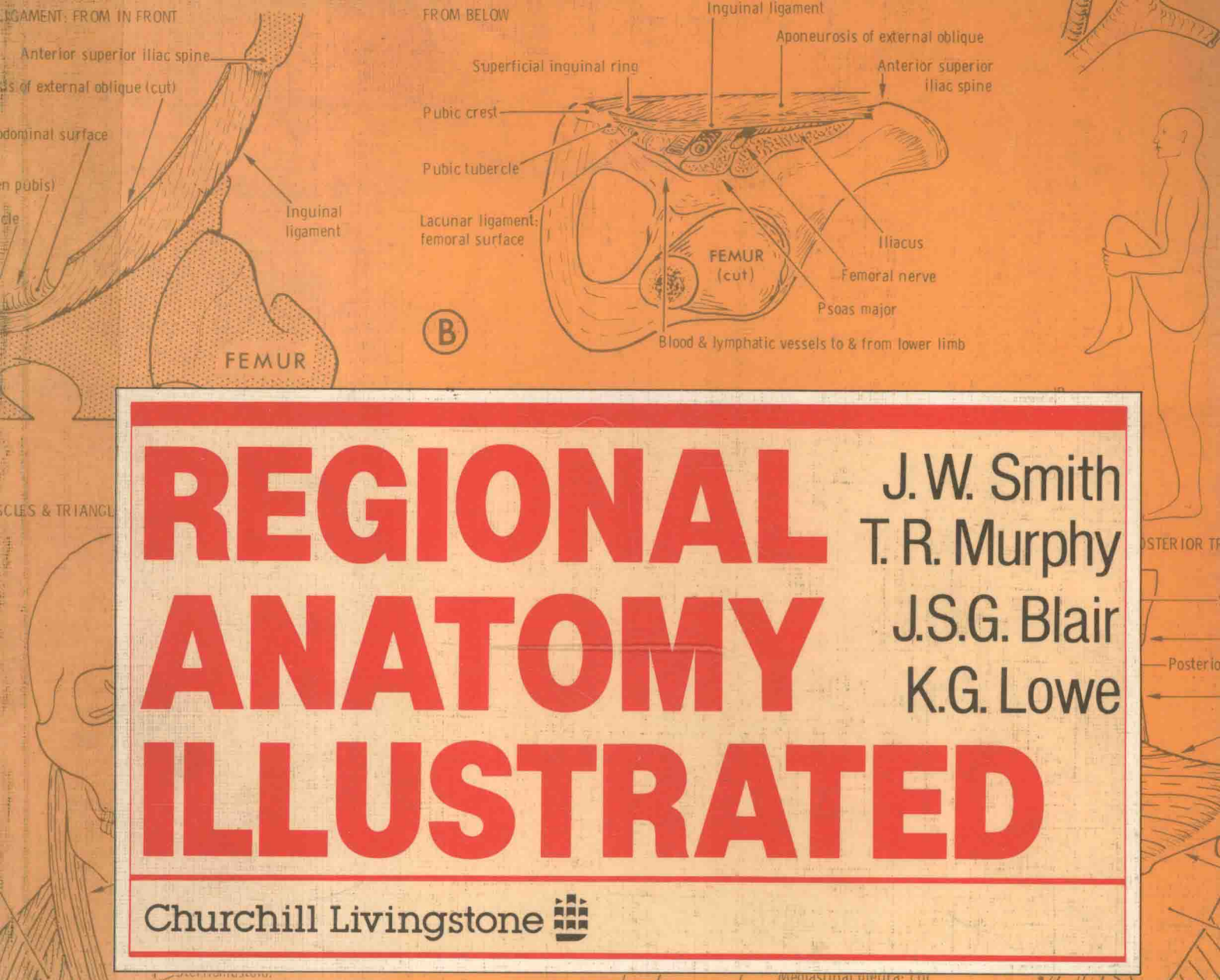


# REGIONAL ANATOMY ILLUSTRATED

J.W. Smith
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Churchill Livingstone

# Regional Anatomy Illustrated

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CHURCHILL LIVINGSTONE
EDINBURGH LONDON MELBOURNE AND NEW YORK 1983

CHURCHILL LIVINGSTONE
Medical Division of Longman Group Limited

Distributed in the United States of America by Churchill Livingstone Inc., 1560 Broadway, New York, N.Y. 10036, and by associated companies, branches and representatives throughout the world.



First published 1983

ISBN 0 443 01615 1

British Library Cataloguing in Publication Data
Regional anatomy illustrated
1. Anatomy, Human—Atlases
I. Smith, J. W.
611'.0022'2 QM25

Library of Congress Cataloging in Publication Data
Main entry under title:

Regional anatomy illustrated.

Includes index.
1. Anatomy, Surgical and topographical
I. Smith, J. W. (James William) [DNLM:
1. Anatomy, Regional. QS 4 R335]
QM531.R425 1983 611'.9 82-19799

Printed in Great Britain by B.A.S. Printers Limited, Stockbridge, Hampshire.

# Preface

Regional anatomy is the study of the gross morphology and spatial interrelations of the structures of the body and the changes which occur in these features in various circumstances. It also customarily includes consideration of the functions of some body structures, particularly those functions which are highly dependent on morphology. Thus the nature of the movements of which the knee joint is capable is dictated by the morphology of the articulating bones, the articular surfaces and the joint ligaments, and the subject is therefore appropriately considered in textbooks of regional anatomy. In contrast, most would regard the inclusion of the functions of the thyroid gland as inappropriate, as these are influenced in no way by the shape of the gland or its relationship to surrounding structures.

Despite its abiding importance as a basis of clinical practice, the subject matter of regional anatomy does not grow or undergo rapid change as it does in many other areas of biology. Consequently the production of a new account of regional anatomy at this time cannot be justified on the grounds that it presents a large volume of new knowledge. Such a production can only be justified if it presents the existing subject matter to medical students in a format which is more relevant than others to present day medical practice and to the present day medical curriculum.

The text of this book is therefore short, amounting to some two hundred and eighty pages. It is also selective. It emphasises those aspects of the subject which clinicians believe from their professional experience to be essential knowledge, and those aspects which the teaching experience of anatomists shows a significant number of students find difficult to understand. These emphases have been achieved at the expense, or even to the exclusion, of aspects of the subject which have always been, or through clinical advances have now become, largely of academic interest.

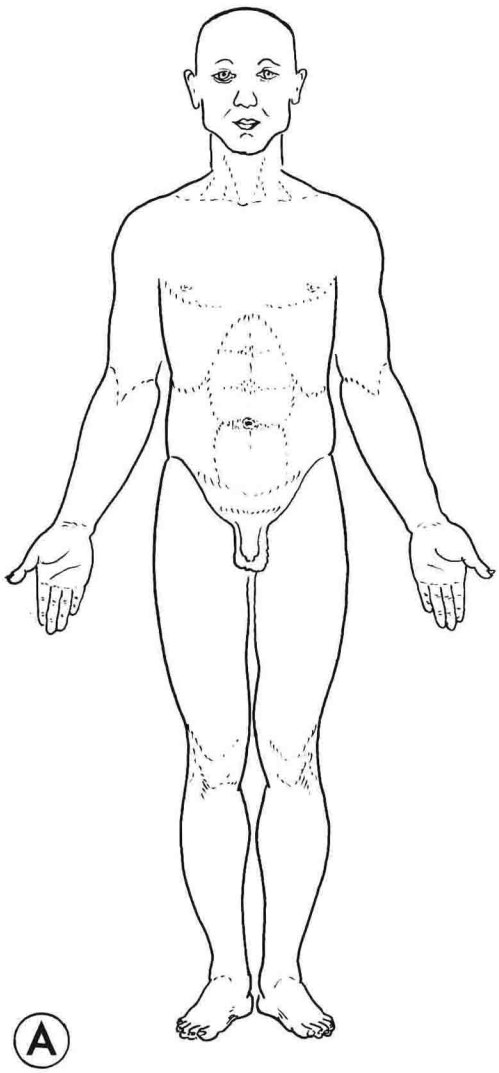
Because the visualisation of complex structural interrelationships is achieved more readily by many students through the visual sense, we have tried (as the name of our book indicates) to illustrate every relationship mentioned in the text by diagrams. In order to facilitate and encourage the use of these diagrams, the manner in which they have been arranged and the methods which have been used to refer to them are unusual, though not unique. As far as possible, diagrams are placed on the page facing the text to which they refer and each is labelled by a capital letter. Thus (**C**) in the text directs the reader to diagram **C** on the apposing page, and (**A, B**) to diagrams **A** and **B** on the apposing page. Although this simple arrangement is maintained as far as possible, it is obviously necessary at some points to refer to distant text or diagrams. A distant textual reference is given by quoting the relevant page number, e.g. (**238**), while a distant diagram reference is given by quoting the relevant page number and diagram letter, e.g. (**239D**). Thus, to take an extreme example, reference on page 122 to (**B, 356, 443B**) directs the reader to diagram **B** on page 123, to the text on page 356 and to diagram **B** on page 443.

We are grateful to a number of colleagues for the help they have given us in the production of this book. Dr D. Emslie-Smith, Department of Medicine, University of Dundee, Dr F. Fletcher, Department of Diagnostic Radiology, Ninewells Hospital, Dundee, Dr J. A. K. Meikle, Department of Diagnostic Radiology, Perth Royal Infirmary and Dr R. N. Johnston, Department of Respiratory Diseases, King's Cross Hospital, Dundee have kindly allowed us to use several of their X-rays. We are indebted to the technical staffs of the Department of Medical Photography, Bridge of Earn Hospital and of the Department of Anatomy and Experimental Pathology, University of St Andrews for their technical assistance. The expert secretarial services of Mrs Wilma Pogorzelec have been invaluable. The staff of Churchill Livingstone, particularly Mr Andrew Stevenson, have guided our work with a patience and understanding for which we have been very grateful.

St Andrews, Perth and Dundee 1983

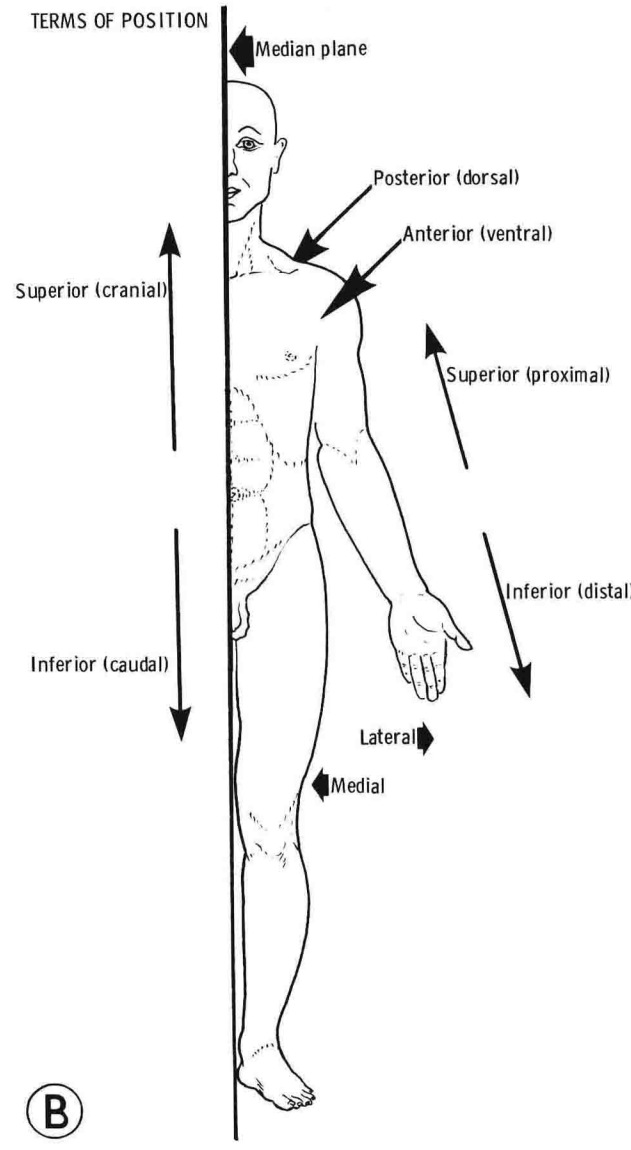
J.W.S.
T.R.M.
J.S.G.B.
K.G.L.

THE ANATOMICAL POSITION



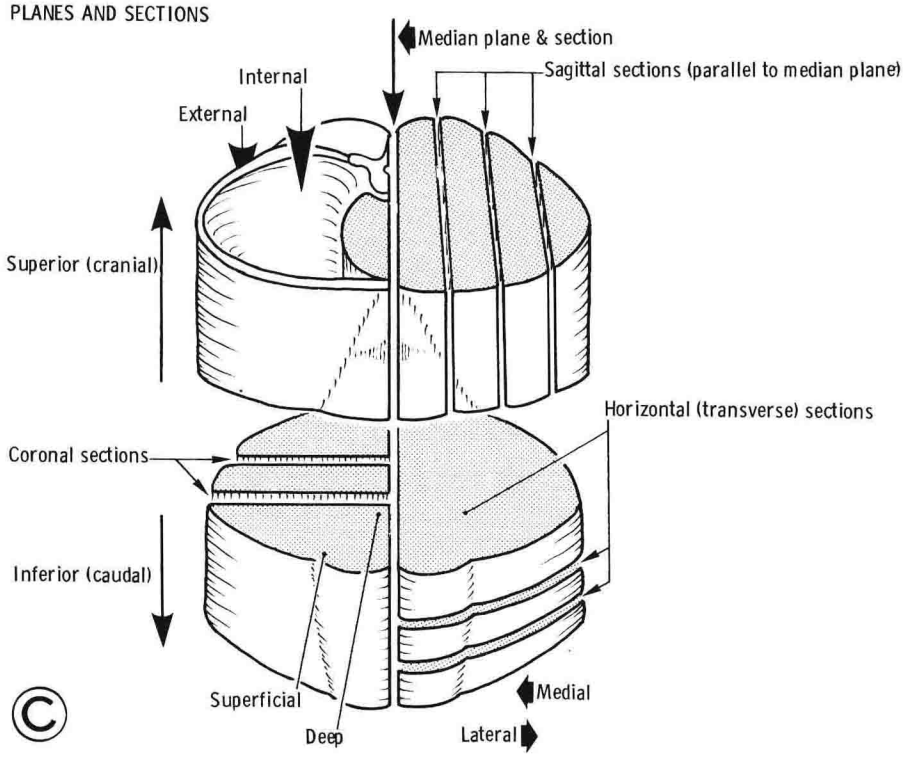
A

TERMS OF POSITION




B

PLANES AND SECTIONS




C

# Introduction

The interpretations of the structures of the body are described in the context of a standard position of the body which is called the *anatomical position* (**A**). In this position the body is standing upright, the upper limbs hang downwards and the palms of the hands and the eyes are directed forwards. The body so orientated is divided into right and left halves by the *median plane* (**B**). As far as the body surface is concerned, the two halves are symmetrical, but the same symmetry does not apply to all internal structures. Thus the normal spleen is entirely in the left half of the body.

The body in the anatomical position is also regarded as being traversed by three orthogonally intersecting sets of planes which form a reference grid (**C**). *A sagittal plane* is any vertical plane which is parallel to the median plane. *A coronal plane* is any vertical plane at right angles to the median plane. *A horizontal plane* is any plane at right angles to both sagittal and coronal planes. As defined above, sagittal, coronal and horizontal planes are all multiple, but it should be noted that there is an alternative usage of the term sagittal plane. Some authors regard the term as synonymous with median plane. For them, therefore, there is only one sagittal plane and all planes parallel to it are described as parasagittal.

Aspects of the surface of the body as a whole or of the surfaces of individual structures are named in the following manner.

1. The terms *anterior* or *ventral*, which are synonymous in human anatomy, are applied to aspects which face forwards. Aspects which face backwards are described by one of the synonymous terms *posterior* or *dorsal*. Note, however, that the anterior or ventral aspect of the hand is customarily designated *palmar*.
2. Aspects which face away from the median plane are called *lateral* and those which face towards the median plane *medial*.
3. Aspects which face upwards are described as *superior* and those which face downwards as *inferior*. Note however that these aspects of the foot are customarily designated *dorsal* and *plantar* respectively.

The spatial relationship of separate structures are described on the basis of their relative proximity to aspects or parts of the body in the anatomical position and to the median plane.

1. Thus, of two structures, one is *anterior* to the other (an anterior relation of the other) if it is the closer to the anterior aspect of the body, and *posterior* to the other (a posterior relation of the other) if it is closer to the posterior aspect of the body. Similarly, one is *medial* to the other if it is closer to the median plane and *lateral* to the other if it is farther from that plane. Again, one is *superior* to the other if it is at a higher level and *inferior* to the other if it is at a lower level.
2. Some relationships are best described by compound terms. Thus one structure is *anterolateral* to another if it is both closer to the anterior aspect of the body and farther from the median plane.
3. The terms *superficial* and *deep* refer to the comparative distances of structures from the skin surface.
4. In the limbs, the term *proximal* indicates relative proximity to the root of the limb, and *distal* relative separation. The same terms are sometimes used to indicate relative distances along the course of a nerve or vessel (e.g. one branch of a nerve is given off proximal to another).

The six cardinal movements which occur at the joints of the body are called flexion, extension, adduction, abduction, rotation and circumduction. These can be defined in the following very general terms.

1. *Flexion* is the movement which makes the angle between the articulating bones more acute and thus reduces the length of the part.
2. *Extension* tends to bring the articulating bones into alignment and thus lengthens (extends) the part.
3. *Adduction* displaces the distal articulating bone towards the median plane, while *abduction* displaces it away from the median plane.
4. *Rotation* occurs around the long axis of the moving bone and is designated *medial* or *lateral rotation* according to the direction of displacement of the anterior aspect of the bone.
5. In *circumduction* the moving bone describes a cone with its apex at the joint concerned.

Many movements do not conform to these simple definitions and several are indeed given individual names not included in the above list. Consequently, joint movements will be discussed throughout the text with the descriptions of the joints at which they occur.

# Contents

CHAPTER 1

# The vertebral column and skull

# THE VERTEBRAL COLUMN

The vertebral column consists of a large number of ring-like bones united in series by joints and ligaments. These bones, joints and ligaments enclose the longitudinal vertebral canal (**A**).

In the neck there are seven cervical vertebrae, in the thorax twelve thoracic, in the abdominal region five lumbar, and in the pelvic region five sacral and a variable number of vestigial coccygeal vertebrae (**A**).

In the foetus and newborn infant the vertebral column has a continuous primary curvature which is concave forwards (**B**). Throughout postnatal life the thoracic, sacral and coccygeal parts of the column retain this form (**A**), but secondary curves which are convex forwards appear, first in the cervical region when the child learns to sit up at about 6 months, and later in the lumbar region when standing is accomplished at about 18 months (**A**). The primary and secondary curvatures merge smoothly into one another except at the lumbosacral junction where the change in direction is abrupt (lumbosacral angle). These curvatures may be altered by disease of the vertebrae or by spasm of the vertebral muscles.

The first cervical vertebra supports the skull, while the thoracic vertebrae articulate with the ribs which enlose the thorax. The sacral part of the column articulates laterally with the hip bones which join anteriorly to complete the bony pelvis. The outer aspects of the hip bones articulate with the bones of the lower limbs.

The vertebral column has three main functions.

1. It supports the weight of the head and neck, upper limbs, and trunk and transmits this force through the hip bones to the lower limbs.
2. It contains and protects the spinal cord and the spinal nerve roots within the vertebral canal.
3. It allows considerable changes in the form of the trunk and neck by virtue of the summation of small movements between the cervical, thoracic and lumbar vertebrae. These movements are flexion (forward bending), extension (backward bending), lateral flexion (bending to one side) and rotation.

## The general features of vertebrae

Most vertebrae exhibit the same basic features and these can be examined from above in **C** and in a median section in **D**.

Note the approximately cylindrical body anteriorly and the approximately semilunar vertebral arch attached to its posterior aspect. The vertebral foramen is enclosed by these two parts. The arch consists of two pedicles and two laminae which converge posteriorly to unite in a single spinous process. On both sides a transverse process and superior and inferior articular processes arise from the junction of pedicle and lamina. The transverse and spinous processes are strong struts which give attachment to many of the vertebral muscles and their associated fascial layers.

## Intervertebral articulations

These articulations, which involve a number of joints and ligaments, are similar throughout the vertebral column except in the upper cervical, sacral and coccygeal regions.

### *The intervertebral disc*

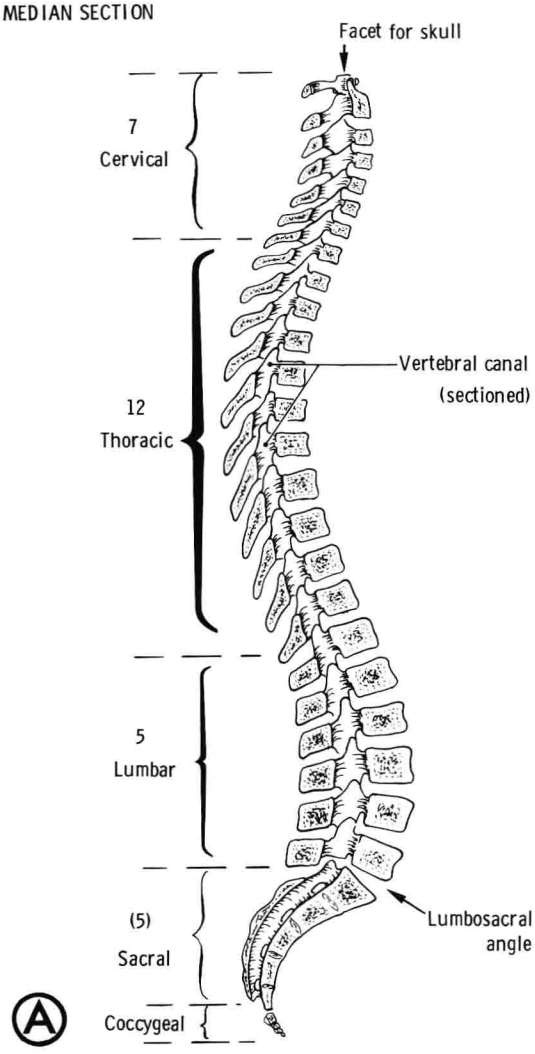
On the apposed surfaces of adjacent vertebral bodies a circular strip of dense bone surrounds a plate of hyaline cartilage which lies directly over cancellous bone (**C, D, E**). These surfaces are joined by a thick ring of fibrocartilage, the anulus fibrosus, which encloses the nucleus pulposus (**E, F**). The anulus fibrosus, the nucleus pulposus and the two hyaline cartilage plates constitute a secondary cartilaginous joint (symphysis) called an intervertebral disc.

When an intervertebral disc is compressed by the longitudinal stress caused by body weight, radial forces in the incompressible nucleus pulposus are directed against the elastic cartilage plates and anulus fibrosus so that the whole complex acts as a shock absorber (**F**).

In youth an intervertebral disc is as strong as the vertebrae it unites and the nucleus pulposus is opalescent and gelatinous. However from early adulthood the nucleus becomes more rigid and fibrosed while the anulus often undergoes degenerative changes.

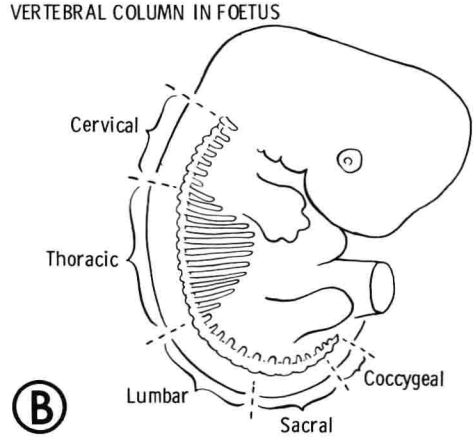
An excessive stress, particularly acting on a degenerate disc, may rupture either one of the cartilage plates or the anulus fibrosus and allow herniation (prolapse) of the nucleus pulposus. Although herniations may occur in any direction, those which protrude through the anulus in a posterolateral direction are of particular clinical interest (see below).

VERTEBRAL COLUMN:
MEDIAN SECTION



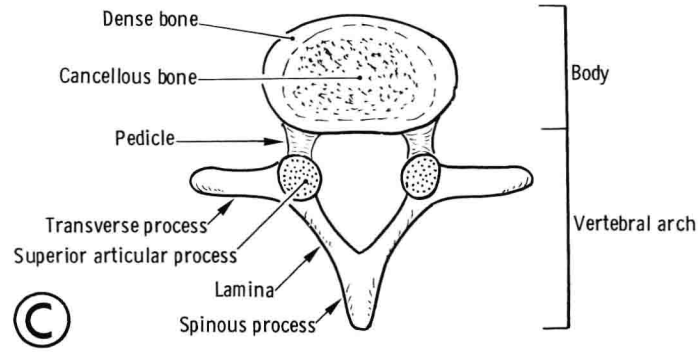

A

VERTEBRAL COLUMN IN FOETUS




B

GENERAL STRUCTURE OF VERTEBRA: SUPERIOR ASPECT

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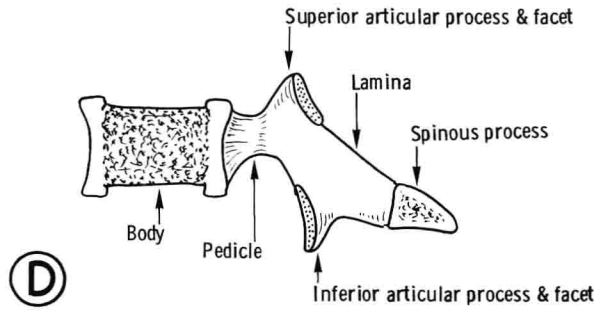
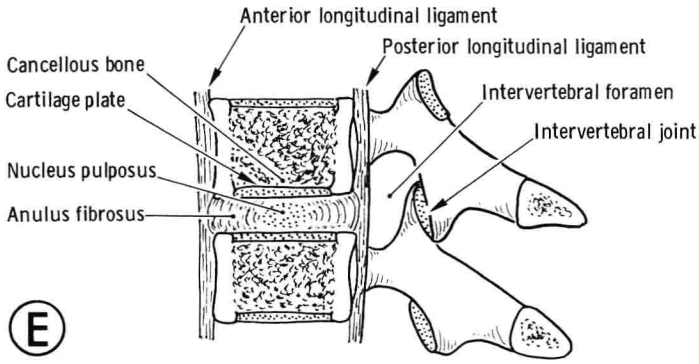
GENERAL STRUCTURE OF VERTEBRA: MEDIAN SECTION



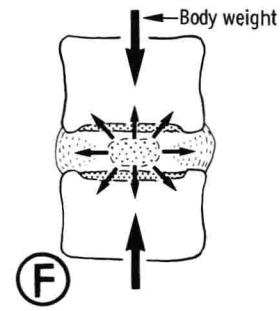

D

INTERVERTEBRAL DISC: MEDIAN SECTION




E

DISC COMPRESSION




F

*The longitudinal ligaments*

The strength of the intervertebral discs is augmented by two powerful ligaments. The broad, strap-like anterior longitudinal ligament is attached to the anterior aspects of the vertebral bodies and the discs, and extends from the base of the skull to the upper end of the sacrum (**A**). The posterior longitudinal ligament lies on the anterior wall of the vertebral canal, from skull to sacrum. Note its pectinate margins (**B**). Each wide segment of the ligament is firmly attached to the back of an intervertebral disc, but the narrow segments are separated from the vertebral bodies by the large basi-vertebral veins which issue from them.

*The intervertebral joints*

The superior and inferior articular processes of adjacent vertebral arches articulate by small synovial intervertebral joints. Each is enclosed by a fibrous capsule (**3E**) (**C**).

The intervertebral joints are strengthened by a series of ligaments which lie between adjacent transverse processes (intertransverse ligaments), between adjacent spinous processes (interspinous and supraspinous ligaments), and between adjacent laminae (ligamenta flava) (**C**). The supraspinous ligament becomes wider in the median plane as it is followed upwards into the cervical region, and is attached above to a median ridge on the base of the skull. This part is known as the ligamentum nuchae. In large quadrupeds such as the ox, in which a large force is necessary to support the head, it is a thick structure containing a very high proportion of elastic fibres. In man it is much thinner and almost purely fibrous. The ligamenta flava are so called because of their content of yellow elastic fibres.

*The intervertebral foramina*

Paired intervertebral foramina lead laterally from the vertebral canal between adjacent vertebrae (**3E**) (**C**). Observe that a typical foramen is bounded above and below by pedicles, in front by a vertebral body and an intervertebral disc and behind by the fibrous capsule of an intervertebral joint.

Each foramen is largely occupied by a spinal nerve, artery and vein. These contents may be compressed by pathological expansion of any of the boundaries. Compression may be caused by arthritic changes in intervertebral joints or, more commonly, by posterolateral herniation of a nucleus pulposus (**C**). The latter usually occurs in the lumbosacral region where it gives rise to the symptoms of sciatica (**9D**) or in the cervical region where it causes neuritis in the arm.

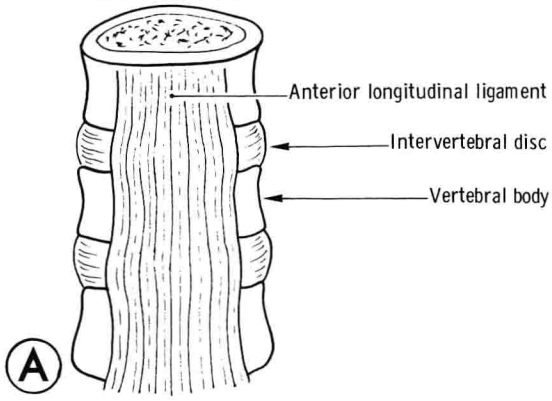
## Regional differences in the vertebrae and intervertebral articulations

*The typical cervical vertebrae*

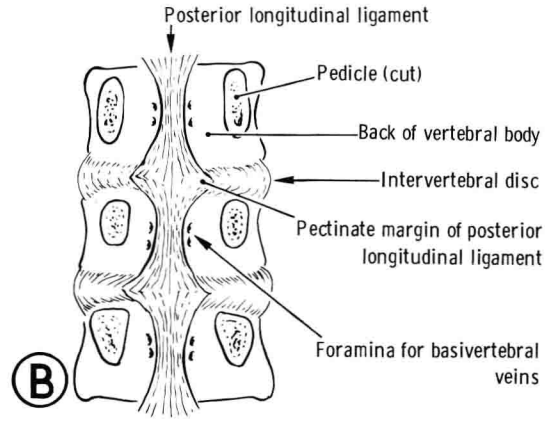
Apart from the first and second (the atlas and axis) the cervical vertebrae are similar though not identical in form and have features which readily distinguish them from vertebrae of other regions (**D, E**).

1. The spinous processes are bifid.
2. The facets on the superior and inferior articular processes are flat and face upwards and backwards, and downwards and forwards, respectively.
3. The most lateral parts of the upper surfaces of the vertebral bodies and to a less marked degree the same parts of the lower surfaces incline upwards and are separated by small synovial joints on either side of each intervertebral disc. These are the joints of Lushka, which may become arthritic in later life and give rise to chronic pain.
4. The transverse processes arise from the lateral aspects of the bodies and pedicles (**D**). Their upper surfaces are in continuity with the lower boundary of intervertebral foramina and are deeply grooved in a mediolateral direction (**E**). Each process is pierced by a large foramen transversarium. The bar of bone forming the anterior boundary of the foramen represents a vestigial rib, and in a few individuals the costal element of the seventh transverse process is abnormally long and projects laterally into the root of the neck as a cervical rib.
5. The seventh cervical vertebra differs from the others in this group in a few minor respects. The spinous process is long, palpable and ends in a single tubercle. The transverse processes are longer and contain foramina transversaria which are comparatively small and sometimes double.
6. Because of the orientation of the articular facets, intervertebral movements in this region are relatively free in all directions.

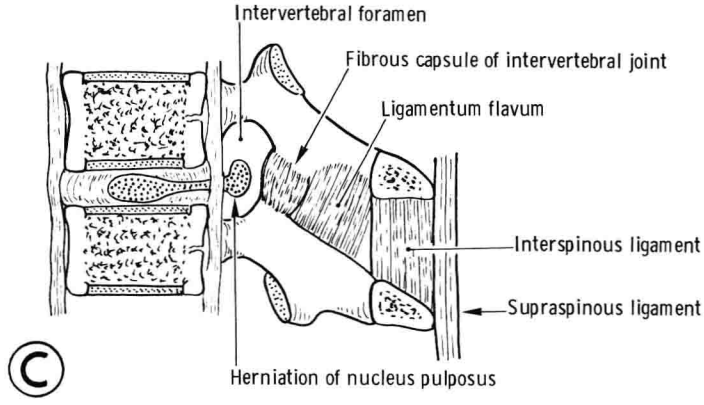
ANTERIOR LONGITUDINAL LIGAMENT



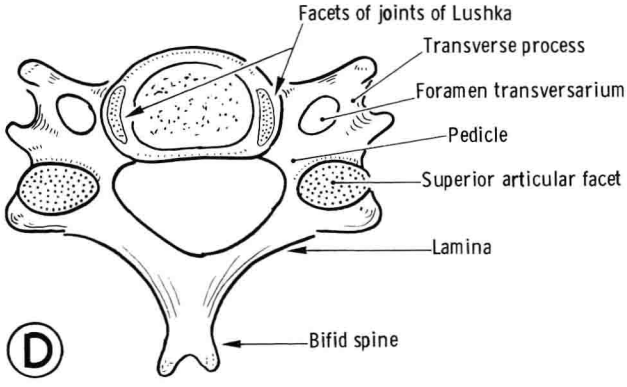

POSTERIOR LONGITUDINAL LIGAMENT: VERTEBRAL ARCHES REMOVED



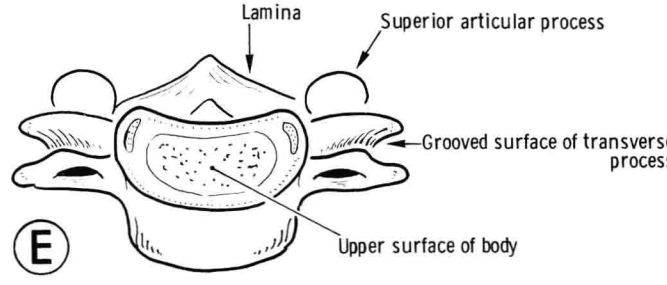

INTERVERTEBRAL ARTICULATION: MEDIAN SECTION




TYPICAL CERVICAL VERTEBRA: SUPERIOR ASPECT




TYPICAL CERVICAL VERTEBRA: ANTERIOR ASPECT



*The axis*

The axis is the second cervical vertebra (**A, B**). Its inferior aspect is similar to those of the typical cervical vertebrae described above and its articulation with the superior aspect of the third cervical vertebra is of typical form (**E**). However its superior surface presents a number of atypical features (**A, B**).

1. A stout tooth-like process called the dens or the odontoid process extends vertically upwards from the anterior part of the body. Its posterior aspect is grooved transversely while its anterior aspect exhibits a small oval cartilaginous facet.
2. Two larger lateral facets, which are flat, oval and more or less horizontal, lie on the upper surface of the body and the anterior part of the pedicle on either side of the dens.
3. There are no superior articular processes at the junctions of the pedicles and the laminae.

*The atlas*

This is the first cervical vertebra and is of unique shape. It consists essentially of a ring of bone from which transverse processes extend laterally on either side (**C**).

1. The lateral masses carry articular facets on both upper and lower surfaces. The superior facets are elongated anteroposteriorly and concave upwards along their long axes. As will be seen later in this chapter, they articulate with the occipital condyles on the base of the skull forming the paired atlanto-occipital joints. The inferior facets are flat and articulate with the lateral facets on the upper surface of the axis (**A**) forming the paired lateral atlanto-axial joints (**E**).
2. The short anterior arch joins the anterior parts of the lateral masses. A small facet on the posterior aspect of its central part articulates with that on the anterior aspect of the dens of the axis forming the median atlanto-axial joint (**A, B, C, D**).
3. The longer posterior arch joins the posterior parts of the lateral masses. Immediately behind each lateral mass its upper surface is crossed by a wide transverse groove.
4. The transverse processes of the atlas are longer than others in the cervical region, so that their tips are usually palpable just behind the angle of the lower jaw.

*The atlanto-axial articulation*

This consists of three synovial joints, the median and the paired lateral atlanto-axial joints (**D, E**). The articulation is equipped with a number of stabilising accessory ligaments.

1. The strong transverse ligament of the atlas extends between the medial aspects of the lateral masses of the atlas and is separated from the grooved posterior aspect of the dens of the axis by a bursa (**D**). It prevents backward displacement of the dens from the anterior arch of the atlas.
2. The upper part of the anterior longitudinal ligament joins the anterior surface of the body of the axis to the anterior arch of the atlas (**E**).
3. The uppermost pair of ligamenta flava bridge the interval between the laminae of the axis and the posterior arch of the atlas. They are continuous in the midline with the ligamentum nuchae (**E**).
4. Notice in **E** the unusual boundaries of the atlanto-axial intervertebral foramen.

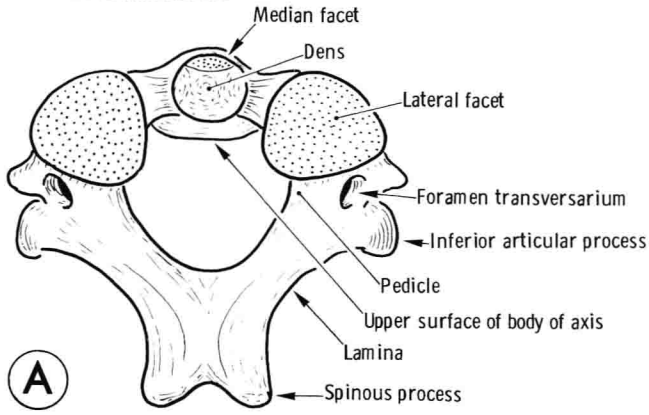
*Movements* at the atlanto-axial articulation involve rotations of the atlas and the skull, moving as one, around the dens together with anteroposterior sliding movements at the lateral atlanto-axial joints.

*Injury* of the articulation may be produced by hyperflexion or hyperextension of the region as when the head whiplashes during the rapid deceleration associated with many road accidents. The dens may be snapped off from the body of the axis or it may be displaced backwards relative to the atlas through tearing of the transverse ligament. Such injuries distort the upper part of the vertebral canal and may damage severely the related part of the spinal cord.

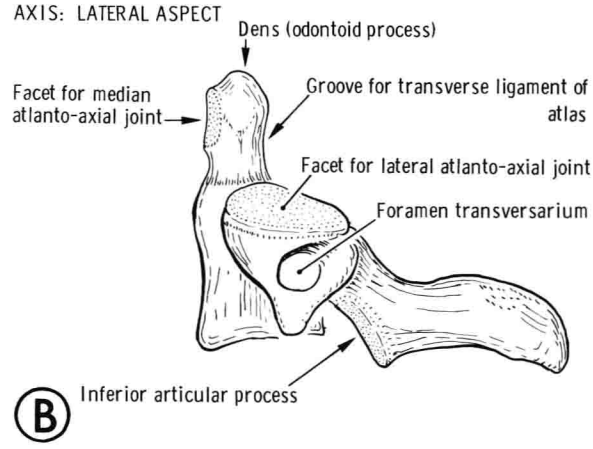
*The thoracic vertebrae*

1. The thoracic intervertebral discs are uniformly thick from before backwards and the normal thoracic curve (see above) is due to the vertebral bodies being slightly deeper behind than in front (**F**).
2. The spinous processes are long, sharp and angled acutely downwards (**F**). Thus palpation of a spine does not indicate directly the level of the corresponding vertebral body.
3. Nearly all the vertebrae carry characteristic facets on the upper and lower margins of the lateral aspects of their bodies and on the anterior aspects of their transverse processes (**F**) for articulation with the ribs (**129A, 129B**).
4. At the thoracic intervertebral joints the superior facets face backwards and to a much lesser extent laterally and upwards (**F**). The inferior have the opposite orientation.
5. The attachment of the thoracic cage to this part of the vertebral column considerably restricts its movements in all directions.

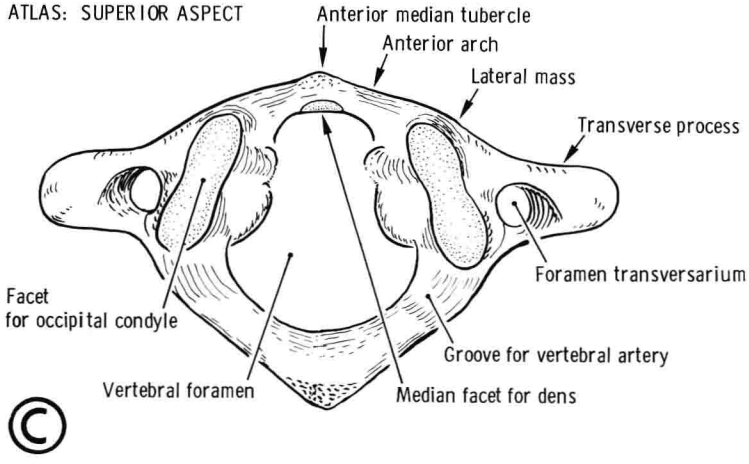
AXIS: SUPERIOR ASPECT



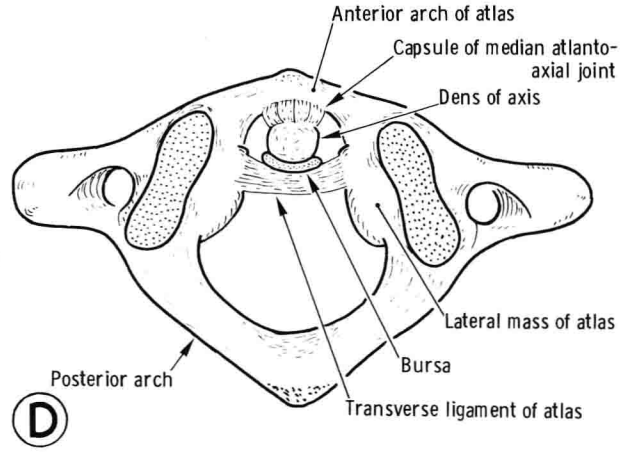

AXIS: LATERAL ASPECT



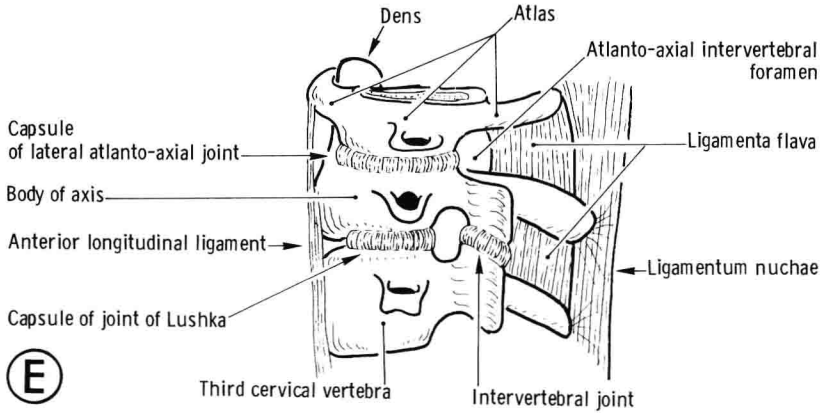

ATLAS: SUPERIOR ASPECT



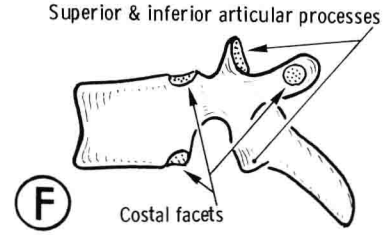

ATLANTO-AXIAL ARTICULATION: SUPERIOR ASPECT




ATLANTO-AXIAL ARTICULATION: LATERAL ASPECT




THORACIC VERTEBRA: LATERAL ASPECT



*The lumbar vertebrae*

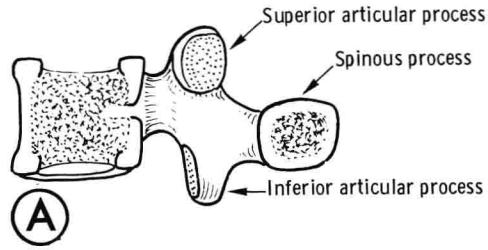
1. The bodies are large, deep and kidney-shaped in the transverse plane. Unlike thoracic vertebral bodies they have equal anterior and posterior depths (**A**), and the normal lumbar curve is due to wedging of the intervertebral discs.
2. The spinous processes are massive and square (**A**).
3. The intervertebral joints are distinct from those in other regions. The facets on the superior articular processes face backwards and medially and are concave, while those of the inferior processes face forwards and laterally and are convex (**A**).
4. As a result of the orientations of the paired facets at the intervertebral joints, they interlock and almost entirely prevent rotation in the lumbar region. On the other hand flexion and extension are quite free.

*The sacrum and coccyx*

In the lower part of the vertebral column five originally separate vertebrae fuse at about 20 years to form the single consolidated sacrum of the adult. The fusion process converts the vertebral foramina of the five original vertebrae into a continuous central bony canal called the sacral canal (**C**). The sacrum is concave forwards from above down and approximately triangular in shape. Observe the following features of the bone.

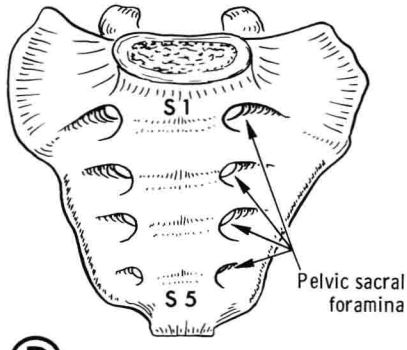
1. On the anterior or pelvic surface (**B**) four transverse ridges indicate the lines along which the bodies of the sacral vertebrae have fused. On either side of these ridges lie four large pelvic sacral foramina.
2. The posterior or dorsal surface (**C**) presents four comparatively small dorsal sacral foramina on either side of the median plane. In the lower part of the surface the posterior wall of the bony sacral canal is deficient and this sacral hiatus is filled in by a fibrous membrane.
3. Openings on each lateral wall of the sacral canal lead into the stems of four T-shaped canals which run through the substance of the sacrum to open at the pelvic and dorsal sacral foramina (**F**). The canals transmit the upper four sacral spinal nerves and the ventral and dorsal rami (**27A**).
4. Around the upper end of the sacral canal the upper surface of the sacrum has features similar to those of a lumbar vertebra and it is joined to the fifth lumbar vertebra by typical lumbar intervertebral joints and ligaments and the lumbosacral intervertebral disc (**C, D**). The sharpness of the lumbosacral angle is due to the pronounced wedge shape of the intervertebral disc (**D**). The upper surfaces of the lateral parts of the sacrum (the alae) are smooth (**E**).
5. The upper half or so of each lateral surface of the sacrum carries the auricular articular facet (**G**) which articulates with the hip bone at the sacro-iliac joint. Note the orientation of this ear-shaped facet.
6. The narrower lower end of the sacrum is joined by fibrous tissue to a small number of bony nodules. These are the vestigial coccygeal vertebrae which collectively constitute the coccyx (**C, G**).

LUMBAR VERTEBRA: MEDIAN SECTION



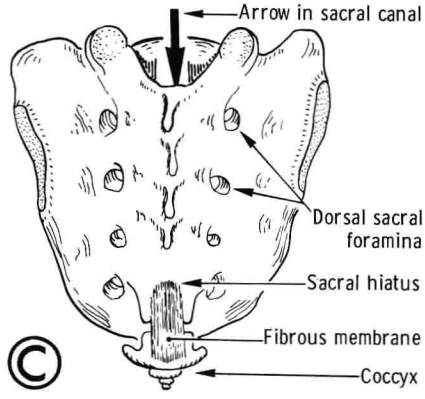

A

SACRUM: ANTERIOR ASPECT



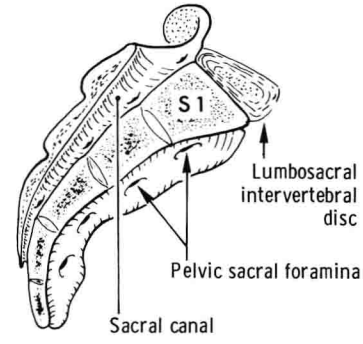

B

SACRUM: POSTERIOR ASPECT



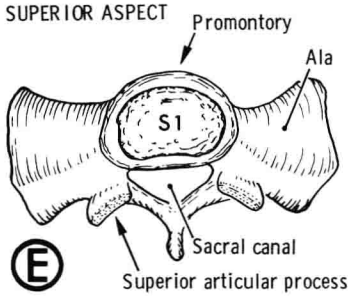

C

SACRUM: MEDIAN SECTION



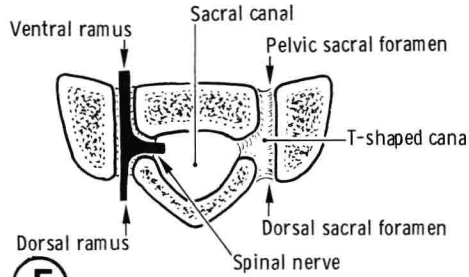

D

SACRUM:
SUPERIOR ASPECT



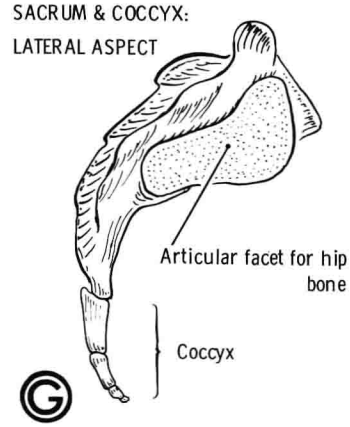

E

SACRUM: TRANSVERSE SECTION




F

SACRUM & COCCYX:
LATERAL ASPECT




G

### Ossification of a typical vertebra

After two months or so of intrauterine life three primary centres of ossification appear in the cartilage model of the vertebra (**A**). Although that in the body is nearly always central, it occasionally forms in the right or left half and produces a half vertebral body (hemivertebra). During the first year the two halves of the vertebral arch unite behind, while at about 4 or 5 years of age the pedicles unite with the vertebral body (**A**).

At puberty the upper and lower surfaces of the vertebral body and the extremities of the transverse processes and the spinous process are still cartilaginous. At about 14 years secondary ossification occurs in these sites (**B**). On the vertebral bodies this process produces upper and lower anular bony epiphyses, surrounding persistent cartilage plates (**B, C**). All secondary centres fuse with the rest of the vertebra in early adult life (**D, E**).

### Abnormalities of the vertebral column

1. Variations in the fusion process which normally affects the five sacral segments of the vertebral column may produce either a separate first sacral vertebra (lumbarisation of the first sacral vertebra) or incorporation of the fifth lumbar vertebra in the sacrum (sacralisation of the fifth lumbar vertebra).
2. In spina bifida the two primary centres of ossification in the vertebral arch fail to fuse. The defect usually occurs in the lumbar region. The bony abnormality of itself is of little importance and may indeed be accidentally discovered on radiological examination. Frequently, however, this bony defect is associated with gross abnormalities of the spinal cord, the meninges and the overlying skin which give rise to very serious symptoms and are extremely difficult to treat.
3. Permanent lateral flexion of part of the vertebral column is called scoliosis. It is usually observed in the thoracic region. In the majority of cases the cause is obscure but in a few instances the condition is due to a hemivertebra.
4. Spondylolisthesis is a condition in which there is bilateral discontinuity of the fifth lumbar vertebral arch between the superior and inferior articular process which is probably of developmental origin (**F**). This allows backward displacement of the sacrum and the posterior part of the fifth lumbar vertebral arch on the rest of the vertebral column.

## THE SKULL

*Parts of the skull*

The skull may be divided into three parts (**13A**).

1. The cranium encloses the cranial cavity which contains the brain and its associated membranes and blood vessels. It consists of the vault above and the base below.
2. The facial skeleton, which is stippled in (**13A**), consists of light and irregular bones. It is attached to the antero-inferior aspect of the brain box and 'tied' to its lateral aspects by slender bony bridges called the zygomatic arches. This part contains the paired orbital cavities which are occupied by the eyeballs and their associated structures, and the bony parts of the nasal cavity which open both forwards and backwards. The inferior margins of the maxillae, which are the longest components of the facial skeleton, carry the upper teeth and are often described as the upper jaw.
3. The mandible which carries the lower teeth is the lower jaw. It articulates with the base of the skull by the paired synovial temporomandibular joints and is thus freely movable on the other two parts.

During the first half of life the cranium and facial skeleton consist of a number of separate bones. Some of these are paired while others are single.