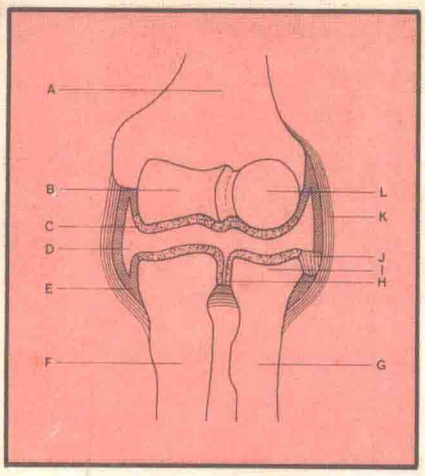

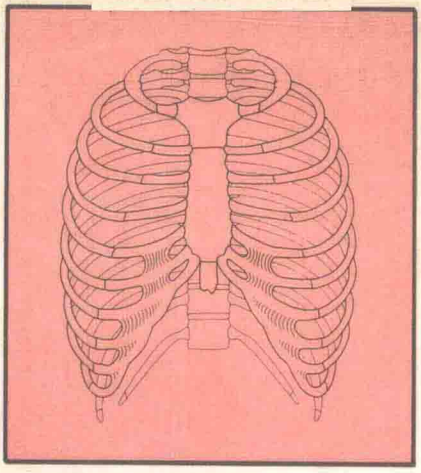

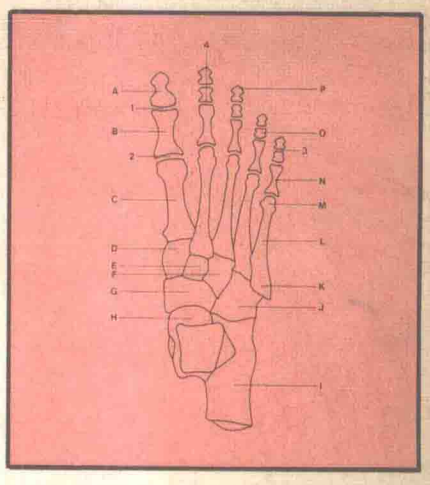

BONES AND JOINTS

Christine Gunn

Churchill Livingstone

Bones and Joints

A Guide for Students

Christine Gunn TDCR
Formerly Deputy Principal,
Derbyshire Royal Infirmary
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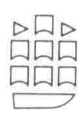

Churchill Livingstone
Edinburgh London Melbourne and New York 1984

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 1984

ISBN 0 443 02683 1

British Library Cataloguing in Publication Data
Gunn, Christine
Bones and joints.
1. Bones 2. Joints
I. Title
612'.75 QM101

Library of Congress Cataloging in Publication Data
Gunn, Christine.
Bone and joints.
Includes index.
1. Bones. 2. Joints. I. Title.
[DNLM: 1. Bone and
bones. 2. Joints. WE 200 G976b]
QM101.G86 1984 611'.71 83–7676

Printed in Singapore by Selector Printing Co (Pte) Ltd

Bones and Joints

Preface

The purpose of this book is to help students who need to understand osteology and arthrology. It is my opinion, based on my experience in teaching students this subject, that it can best be understood by using a systematic, logical approach to the subject and by handling the individual bones. This book attempts to provide that logical framework. It is hoped that students will be able to provide themselves with samples of the individual bones.

In this book all the major bones and joints of the human body have been covered. The text has been written in a 'note' style which it is hoped will be attractive to students. The diagrams have been made as clear and simple as possible so that they can be easily reproduced by students. This style of drawing should alleviate one of the major problems faced by students, of translating the shape of individual bones on to paper.

The book can be used in several ways depending on the individual student: (1) as part of a self-learning programme in conjunction with actual bones and supported by follow-up tutorials (the wide margins in the book may be used for the student's personal notes or comments); (2) as part of a revision programme on completion of a course of study (the legends on the diagrams have been lettered, with the actual terminology listed at the side of the drawing, to allow for self-testing); (3) as a reference book. The individual bones of the skull have been included for completeness and are for reference purposes only.

I would like to thank the following people: Mr G. McKenzie, Superintendent, Aberdeen Royal Infirmary, for his valuable comments on the manuscript and his assistance with many of the diagrams; Mr M. Matthews, Principal, Luton and Dunstable School of Radiography, for reading and commenting on the final manuscript; Miss M. Ledger, Principal, Lincoln School of Radiography, for her assistance particularly with the pathology section; Mr J. Young, Deputy Principal, Bradford School of Radiography, for reading the manuscript, and finally Dr D. A. Gunn who spent so many hours on the diagrams and without whose help the book would not have been possible.

1984 C.G.

Contents

1. Bone

Bone is a highly vascular connective tissue, in which bone cells are enclosed in a mineralised intercellular matrix interposed with a system of collagenous fibres.

The organic matrix forms one third of the structure and gives resilience and a degree of flexibility, the mineral salts (mainly calcium and phosphorus) form the remaining two thirds and provide the strength and weight-bearing capabilities of the bone.

STRUCTURE OF BONE

There are two main types of bone — compact (dense) and cancellous (spongy). Compact bone forms the surface layers or cortex of mature bones and cancellous bone the interior aspect.

Compact bone

This type of bone is found mainly in the shafts of long bones where a strong, tubular structure is required. It consists of a number of cylindrical structures called *haversian systems* (Figs. 1.1 and 1.2).

Each system comprises:

A central haversian canal — which contains blood, lymphatic vessels and nerves.

Lamellae — rings of bone round the haversian canal.

Lacunae — spaces between the lamellae which contain osteocytes (mature bone cells).

Canaliculi — channels carrying nutrient fluid which connect the lacunae and communicate with the haversian canal.

Interstitial lamellae — fill the spaces between adjacent haversian systems.

Circumferential lamellae — rings of bone round the edge of the bone.

Volkmann's canals — join the various haversian canals.

Periosteum — a membrane which surrounds the bone, except at the articular surfaces, where articular hyaline cartilage allows friction free movement. The inner layer is vascular and cellular providing nutrition, growth and repair. The outer layer is fibrous and blends with tendons and ligaments.

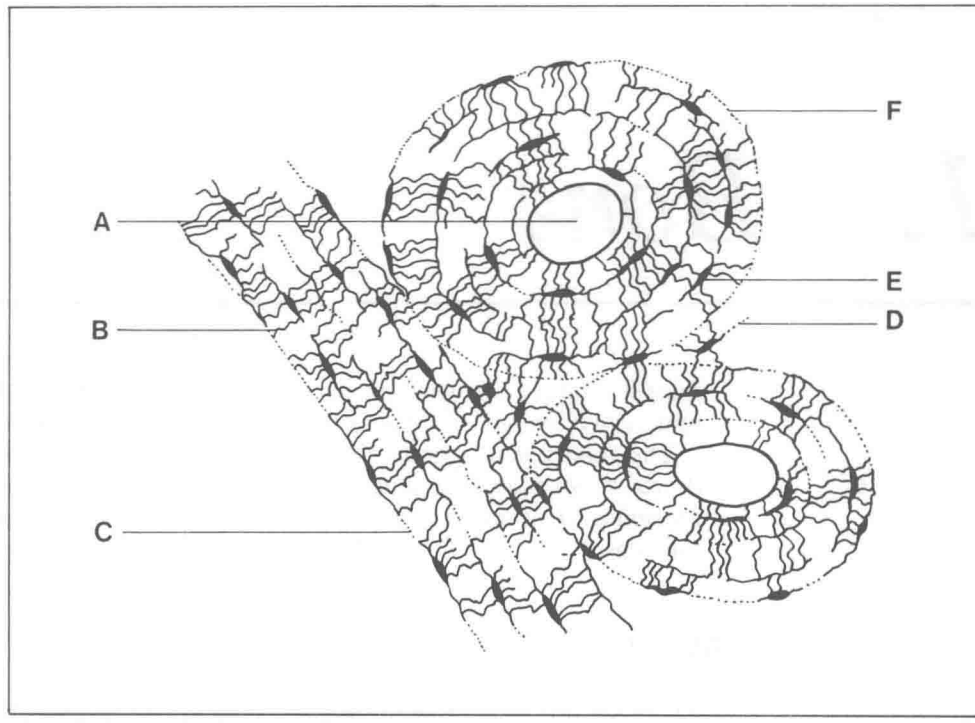

Fig. 1.1
Transverse section of bone (microscopic)
A — Haversian canal
B — Canaliculi
C — Circumferential lamella
D — Interstitial lamella
E — Lacuna
F — Lamella

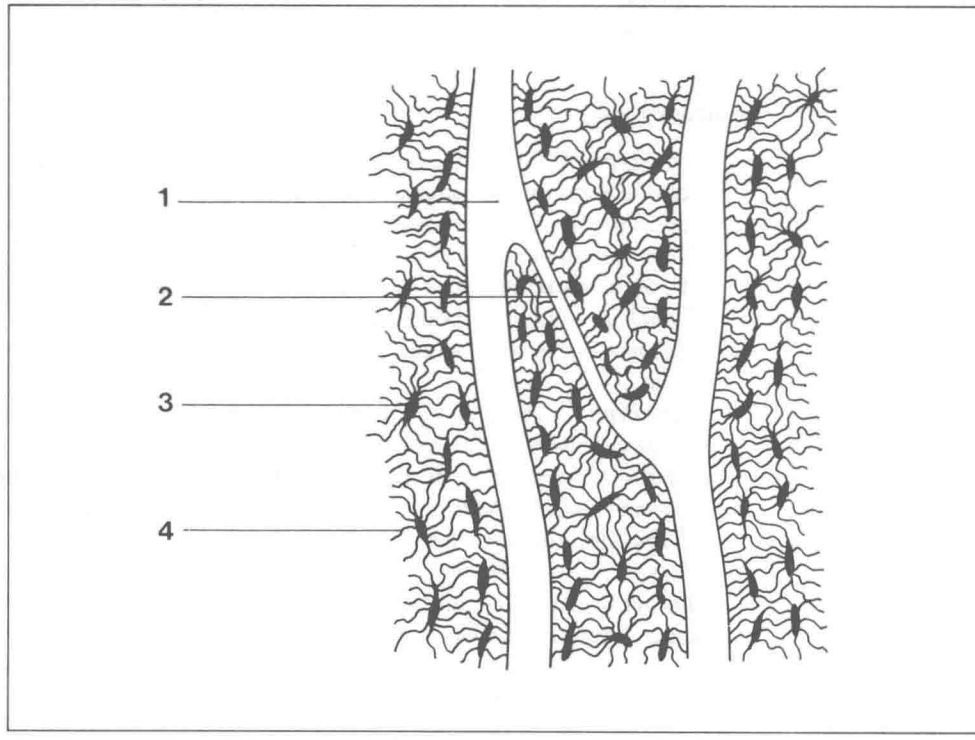

Fig. 1.2
Longitudinal section of bone (microscopic)
1 — Haversian canal
2 — Volkmann's canal
3 — Lacuna
4 — Canaliculi

Cancellous bone

This type of bone is found in the parts of bones where lightness, strength and area are required. It is similar in structure to compact bone but bone marrow is found between the trabeculae which form the internal support structure of the bone.

Bone marrow

The medullary cavity of bone and the spaces between the trabeculae of cancellous bone are filled with bone marrow. At birth this is red bone marrow which produces red and white bone cells.

In adults active, red bone marrow is found only in the:

upper femora	ribs
vertebrae	clavicles
scapulae	diploe of skull bones
sternum	hip bones.

Elsewhere the red bone marrow becomes inactive, yellow marrow.

Development

Some bones develop from rods of cartilage, e.g. the bones which form the limbs, the trunk and the base of the skull. Some bones develop from membranes, e.g. bones of the vault of the skull, the face and the clavicle. Some bones develop in tendons, e.g. sesamoid bones — the patella and fabella.

Ossification

Ossification is the formation of bone from connective tissue and requires:
adequate calcium and phosphate in the blood
a supply of Vitamins A, C and D.

Growth of the bone is influenced by the following hormones:

Parathormone (from the parathyroid glands) — controls the level of calcium, and indirectly the level of phosphates in the blood

Growth hormone (from the anterior lobe of the pituitary gland) — influences growth and replacement of bone tissue

Thyroxin (from the thyroid gland) — influences normal physical development

Testosterone (in the male) and oestrogen (in the female) — influences normal skeletal growth especially at puberty.

Weight bearing and exercise also stimulate bone growth and general ill health inhibits it.

Intramembranous ossification

This takes place in a membrane.

At the point of ossification osteogenic fibres and bone cells appear in the

connective tissue and calcium salts are deposited to form osteoid tissue. Ossification spreads from the centre outwards.

Intracartilaginous ossification (Fig. 1.3)

For example, in a long bone.

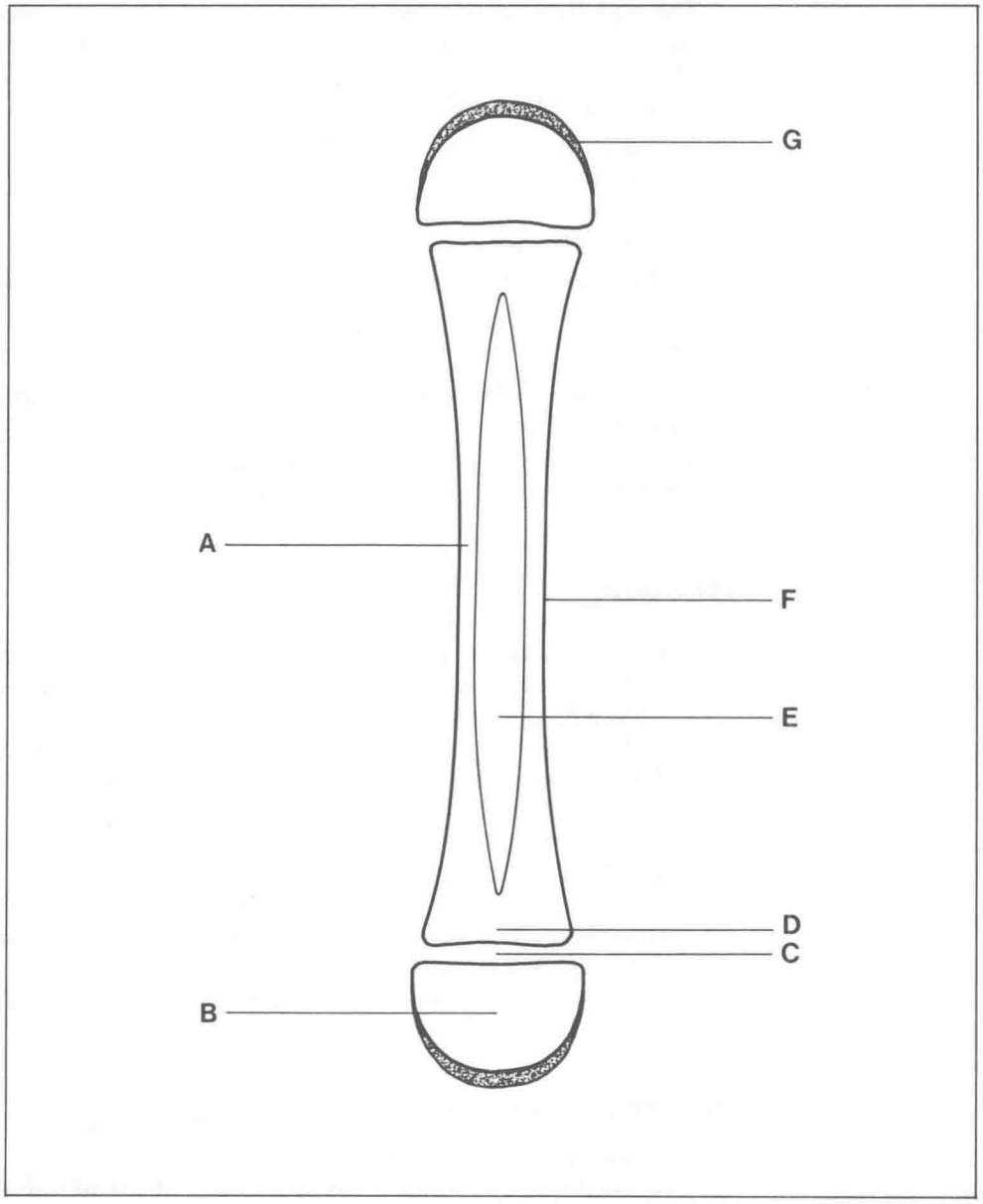

Fig. 1.3
Section through a developing long bone
A — Diaphysis
B — Epiphysis
C — Epiphyseal plate
D — Metaphysis
E — Medullary cavity
F — Periosteum
G — Articular hyaline cartilage

Primary centre of ossification

This appears in the middle of the *diaphysis*. *Osteoblasts* (bone cells) appear and calcium is laid down.
Osteoblasts '**B**uild the bone' by laying down fibres, matrix and calcium.
Osteoclasts area type of cell which 'destroy the bone' and therefore mould the bone into the required shape — 'remodelling'.

Osteoclasts are responsible for forming the *medullary canals* and *sinuses* within the bone.

At the same time as the diaphysis is being formed bone is being built up on the outside of the shaft which later forms the *periosteum*.

Secondary centres of ossification

These appear at the ends of the bone and form the *epiphyses* (singular epiphysis). The epiphysis is separated from the diaphysis by a thin layer of cartilage called the *epiphyseal plate*.

Growth

This occurs during childhood by the production of bone at the epiphyseal plate. It occurs at the side nearer the shaft which is called the *metaphysis*.

Fusion

The fusion of the epiphysis with the diaphysis occurs when the bone reaches the desired size.

Function of bone

Bone

supports soft tissue
supports the body weight
enables movement
protects organs, e.g. the brain
stores calcium
produces blood cells from the red bone marrow.

Blood supply

The blood to the bone supplies:

bone tissue
bone cells
bone marrow
epiphyseal cartilage
periosteum.

There are several distinct points where the large blood vessels enter the bone, called the nutrient foramina. These usually point away from the dominant

growing end of the bone. Numerous smaller vessels enter through the nonarticular surfaces of the epiphyses.

The arterial blood feeds the bone and then drains into venous channels which leave the bone through the surfaces which are not covered with articular hyaline cartilage.

Nerve supply

Nerves are widely distributed in the periosteum and nerve fibres accompany the arteries into the bone via the nutrient foramen.

TYPES OF BONES

Long bones

These consist of a shaft of compact bone with a central medullary cavity. The expanded ends are formed by cancellous bone covered with compact bone.

Examples

humerus	fibula
radius	phalanges
ulna	metatarsals
femur	metacarpals
tibia	clavicle.

Short bones (shape — cuboidal)

These are formed by cancellous bone with a thin covering of compact bone, giving strength but with limited movement.

Examples

carpal bones
tarsal bones.

Flat bones

These have a thin layer of cancellous bone enclosed in two thin layers of compact bone and are found where protection for underlying organs or extensive muscle attachment is required.

Examples

scapulae
ribs
vault of the skull.

Irregular bones

These are composed of cancellous bone surrounded by a thin layer of compact bone.

Examples
vertebrae
facial bones
hip bones.

Sesamoid bones

These develop in tendons, usually near a joint, and their main function is to protect the tendon from wear as it moves over the bony surface.

Examples
patella
fabella.

'NORMAL' BONE APPEARANCES — RADIOGRAPHIC

Cortex — is more dense than the medullary cavity and therefore absorbs more radiation, producing a reasonably solid 'white line' round the periphery of the bone.
Medullary cavity — is less dense than the cortex and therefore appears slightly darker.
Cancellous bone — the trabeculae, which are the support structure of the cancellous bone, have the appearance of very fine 'white lines' throughout the bone.
Epiphyseal plate — as this is formed by cartilage it is radiolucent and therefore care must be taken not to confuse it with a fracture. It has the appearance of a radiolucent area with two fairly regular margins, extending to the periphery of the bone and situated near the ends.
Fused epiphyses — appear, usually, during the teenage years, and occur as a thin 'white line' along the site of the old epiphyseal plate. With age these lines are no longer visible.
Joint cavity — this contains articular hyaline cartilage and synovial fluid and is radiolucent (and therefore not demonstrated).

TERMINOLOGY

The names of most aspects of bone can be built up logically from a combination of some of the following:
(a) an adjective derived from the name of the bone
(b) an adjective derived from the bone with which they articulate
(c) an adjective derived from part of the bone with which they articulate
(d) a prefix
(e) a descriptive term — see the list of elevations, projections, holes and depressions.

Examples

Subscapular fossa — a depression below the scapula.
Trochlear notch — a large groove which articulates with the trochlea.
Radial fossa — a depression which receives the head of radius.
Supracondylar ridge — a ridge above a condyle.

Elevations and projections

Ala — wing-like projection.
Auricular — ear-shaped.
Condyle — smooth, rounded elevation, often covered with articular hyaline cartilage.
Crest — a sharp ridge.
Epicondyle — elevation above a condyle.
Facet — smooth area, usually covered with articular hyaline cartilage.
Hamulus — hook-like projection.
Lamina — a thin plate.
Line – a low, narrow ridge.
Process — a localised projection.
Spine — an elongated process.
Squamous — thin, flat, like a scale.
Trochanter — a large rounded elevation.
Trochlea — a pulley-shaped surface.
Tubercle — a small rounded elevation.
Tuberosity — a large rounded elevation.

Holes or depressions

Canal — a bony tunnel.
Fissure — a narrow slit.
Foramen — a hole.
Fossa — a wide depression.
Groove — an uncovered passage.
Meatus – a narrow passage.
Notch — a large groove.

Prefixes

Demi — half.
Epi — above.
Infra — below.
Inter — between.
Intra — within.
Sub — below.
Supra — above.

Descriptive terms

Anterior — nearer the front of the body.
Costal — associated with the ribs.
Distal — away from the trunk.
Dorsal — nearer the back of the body.
External — outside.
Inferior — below.
Internal — inside.
Lateral — away from the midline of the body.
Medial — nearer the midline of the body.
Posterior — nearer the back of the body.
Proximal — towards the trunk.
Superior — above.
Ventral — nearer the front of the body.

2. Joints

A joint is formed where two or more bones meet and is classified as being either synovial, fibrous or cartilaginous in nature.

The main types of joints found in the body are classified as synovial joints.

SYNOVIAL JOINTS

Features of a typical synovial joint (Fig. 2.1)

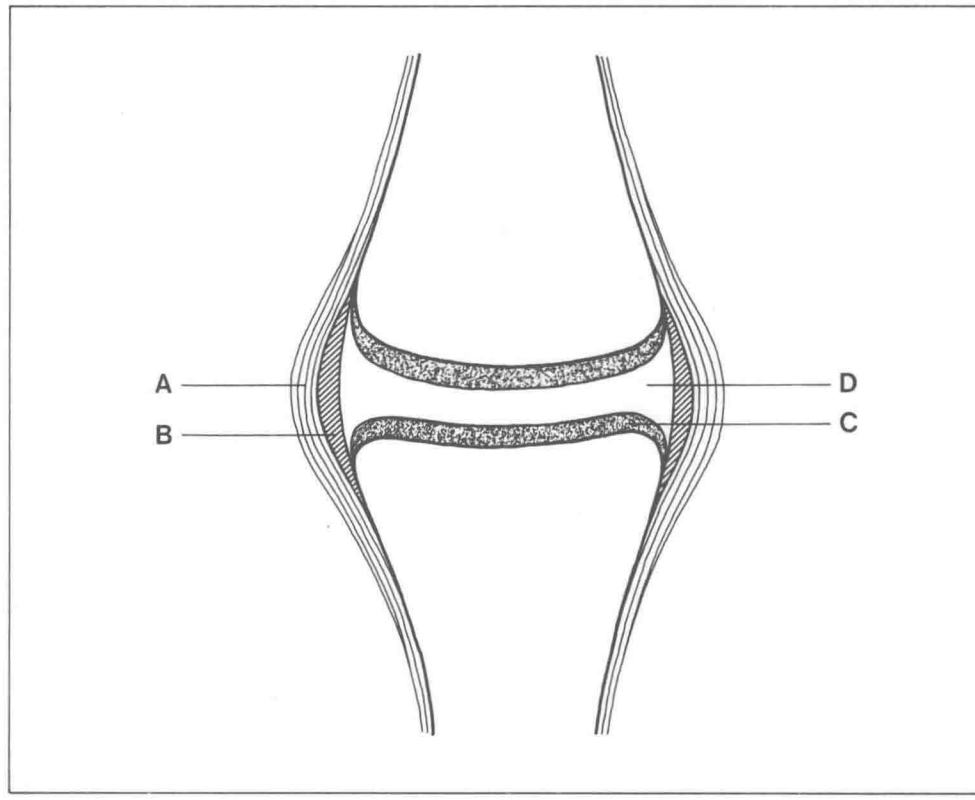

Fig. 2.1
A typical synovial joint — coronal section
A — Fibrous capsule
B — Synovial membrane
C — Articular hyaline cartilage
D — Synovial fluid

Articular hyaline cartilage covers the articular surfaces.

A fibrous capsule surrounds the joint.

Synovial membrane lines the joint, except where articular hyaline cartilage is found.

A lubricant film of synovial fluid is secreted into the 'joint cavity' by the synovial membrane.

Ligaments strengthen the joint capsule. These may be separate from the capsule or may blend with it.

Movement occurs at the joint but the amount varies with the type of synovial joints.

Nerves and blood vessels supply the joint.

Intracapsular structures may be present, e.g. tendons, ligaments, joint discs, pads of fat.

Movements of the joints

Flexion — bending the joint, i.e. decreasing the angle between the bones.
Extension — straightening the joint, i.e. increasing the angle between the bones.
Abduction — to move away from the midline.
Adduction — to move towards the midline.
Internal rotation — to turn inwards.
External rotation — to turn outwards.
Circumduction — a combination of the above movements.
Gliding — one articular surface sliding smoothly over another.

Types of synovial joints

Synovial hinge joints

Uniaxial joints (movement round one axis).
Movements — flexion and extension.
Examples
- elbow joint
- interphalangeal joints.

Synovial condylar joints

Uniaxial joints.
Movements — flexion, extension and rotation.
Examples
- knee joint
- temporomandibular joint.

Synovial ellipsoid joints

Biaxial joints (movement round two axes).