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THE ANATOMY OF THE LOCOMOTOR SYSTEM

OSTEOLOGY ARTHROLOGY MYOLOGY

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CUNNINGHAM'S TEXT-BOOK OF ANATOMY
VOLUME II

THE ANATOMY OF
THE LOCOMOTOR SYSTEM

FOREWORD

It is hoped that many students of anatomy will welcome the reappearance of separate bound sections of Cunningham's Text-Book of Anatomy which were last issued in this form fifty years ago. Unlike their predecessors, the volumes now issued are each complete in themselves and may be used independently of the rest of the text as the sections have been arranged so that each of the principal anatomical systems is complete within a single volume. The full index to the Text-Book has been included in each volume as an aid to cross reference from one volume to another since it is felt that many students will use two or more of these separate volumes. As a further aid to quick reference, a Table facing the first page of the index gives the pagination of each section of the book; those sections now issued as separate volumes are distinguished not only by the volume number alongside each entry, but also by the use of roman type; italic is used for those sections not yet available except in the complete Text-Book.

The sections now issued are those most frequently used in a number of medical schools where the complete Text-Book has not been adopted, and it is hoped that not only will the smaller volumes be found more convenient to handle, but that where only one or two sections are required, the considerable saving in the purchase price will be appreciated. The text is that of the ninth edition of the complete work and it will be seen that the page numbers remain the same. Pages 1 to 16, which form an introductory chapter to the complete Text-Book, have been omitted from Volume I, Human Embryology, in which the text commences on page 17. The sections now available as separate volumes are as follows:

Volume I HUMAN EMBRYOLOGY.

Volume II THE LOCOMOTOR SYSTEM.

Containing (i) Osteology. (ii) Arthrology. (iii) Myology.

Volume V THE NERVOUS SYSTEM.

Containing (i) Central Nervous System. (ii) Peripheral Nervous System.
(iii) Autonomic Nervous System.

Volume VI SURFACE AND SURGICAL ANATOMY.

With an appendix on Radiographic Anatomy.

Two further volumes containing the remaining sections may be issued later if it is felt that there is a sufficient demand for them.

The complete Text-Book will remain available as a single volume and the present volumes are intended principally for those who do not require the whole text.

PLATE I



PLATE I.—RADIOGRAPH OF EIGHT-MONTHS FŒTUS (EVISCERATED) TO SHOW THE STATE OF OSSIFICATION OF THE SKELETON. THE RIGHT FOREARM IS SUPINATED, THE LEFT PRONATED.

Note the absence of ossific centres for the Carpus and the presence of centres for the Talus and Calcaneum (cf. Plate XVIII, Fig. 1, p. 273, and Plate XXVIII, Fig. 1, p. 321). Minute centres of ossification for the lower epiphysis of the right Femur and the upper epiphysis of the left Tibia are also faintly visible.

PLATE II

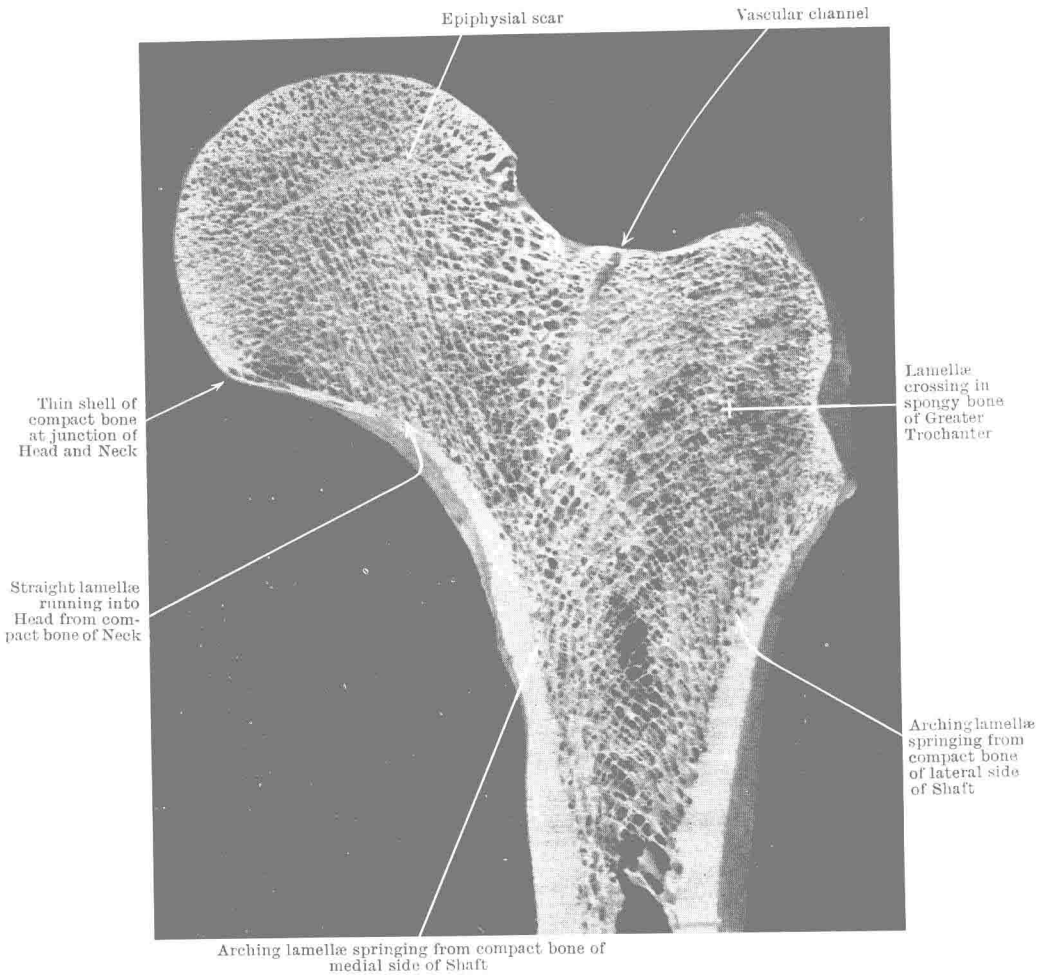


FIG. 1.—PHOTOGRAPH OF CORONAL SECTION OF UPPER END OF LEFT FEMUR TO SHOW ITS ARCHITECTURE.

Note how the compact bone of the Shaft thins out over the Greater Trochanter and the Head, and the manner of crossing of the different systems of lamellae in the spongy bone.

Coarse lamellae radiating from articular facets and groove on upper surface

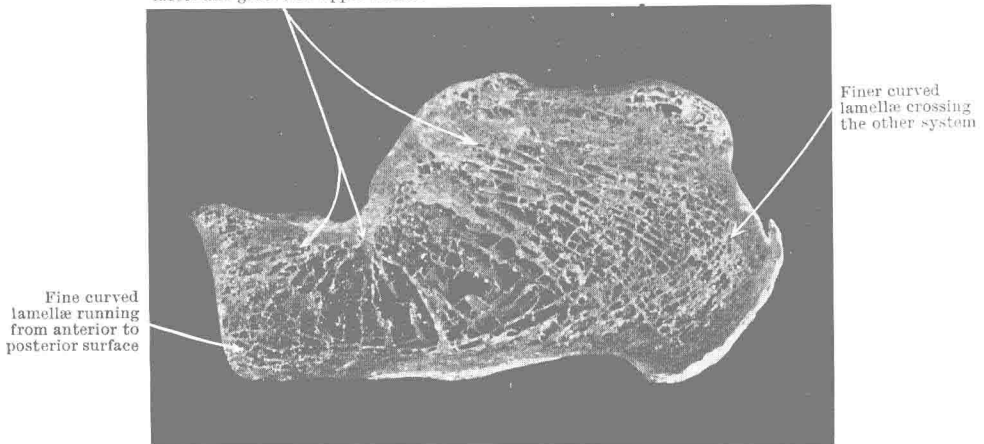


FIG. 2.—PHOTOGRAPH OF SAGITTAL SECTION OF CALCANEUM TO SHOW ITS ARCHITECTURE.

Note the thin shell of compact bone and the arrangement of the lamellae of the spongy bone in two main systems.

PLATE III

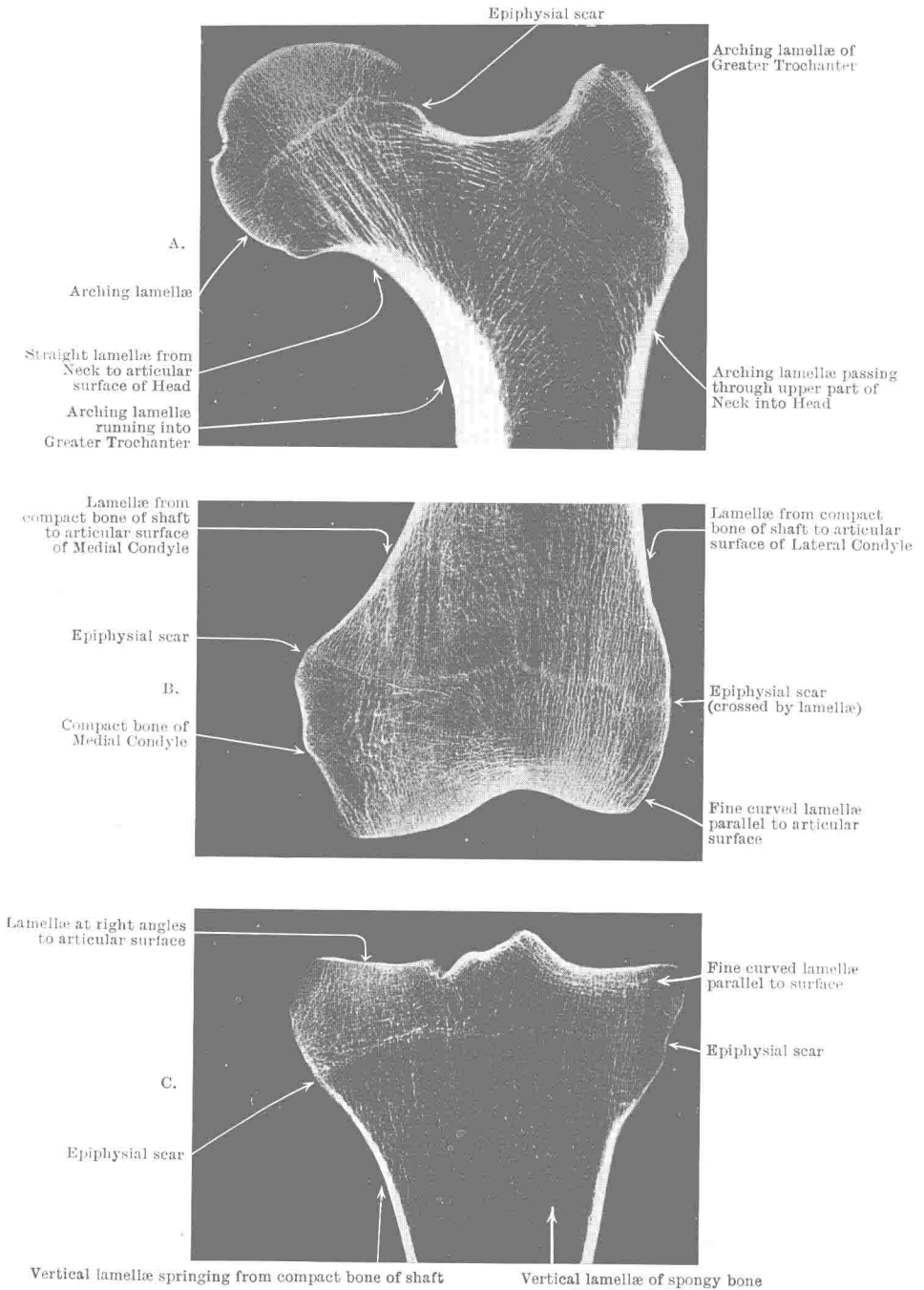


PLATE III.—RADIOGRAPHS OF CORONAL SECTIONS OF A. UPPER END OF FEMUR ; B. LOWER END OF FEMUR ; C. UPPER END OF TIBIA, OF A WOMAN AGED 34.

Note the persisting epiphysial scars and the arrangement of the systems of lamellæ in the spongy bone.

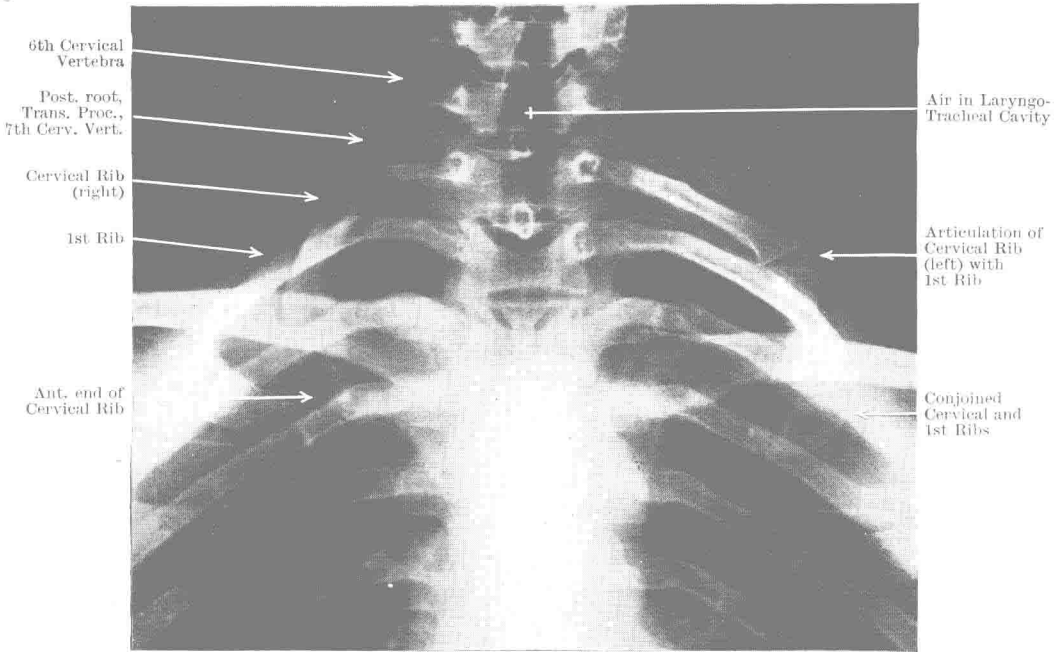


FIG. 1.—RADIOGRAPH OF CERVICO-THORACIC REGION OF WOMAN AGED 35, SHOWING A PAIR OF WELL-DEVELOPED CERVICAL RIBS.

Note the asymmetry of the cervical ribs and that the left one articulates with a projecting process of the first thoracic rib. For view of the right cervical rib on a larger scale see Plate LXVIII, Fig. 2, p. 721, which shows also more clearly the evidence of the presence of a "lobe of the vena azygos" in the right lung.

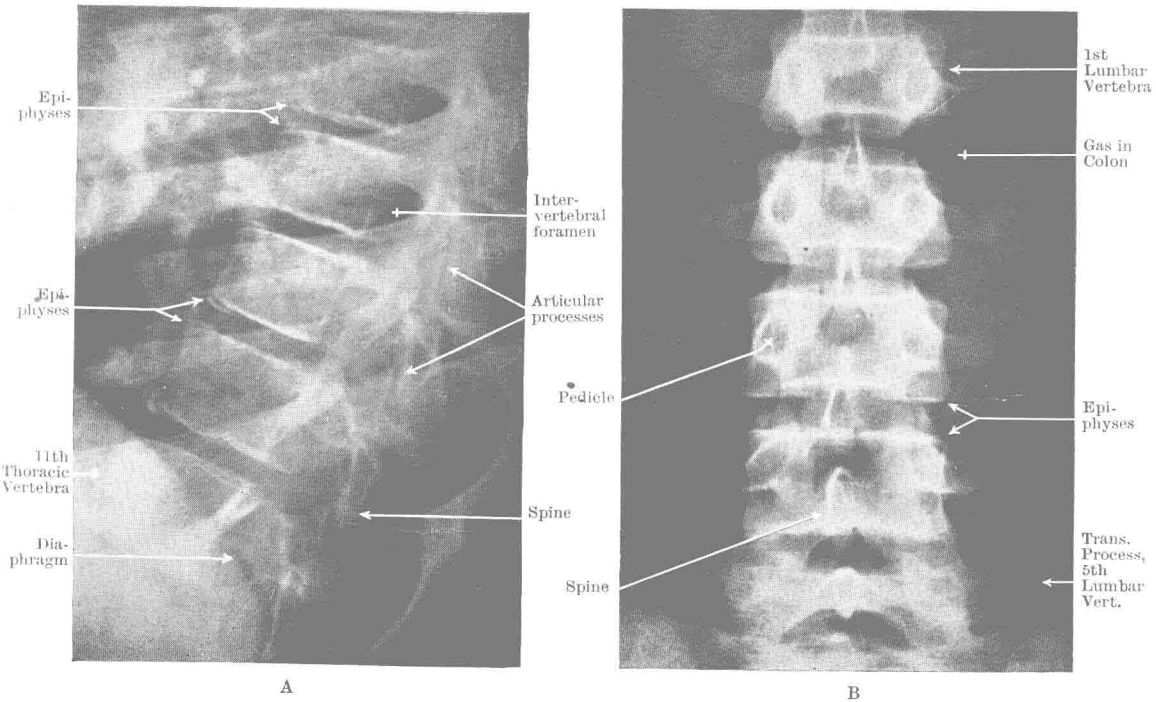


FIG. 2.—RADIOGRAPHS OF (A) THORACIC AND (B) LUMBAR VERTEBRÆ OF A GIRL AGED 12, SHOWING THE EPIPHYSES OF THE VERTEBRAL BODIES.

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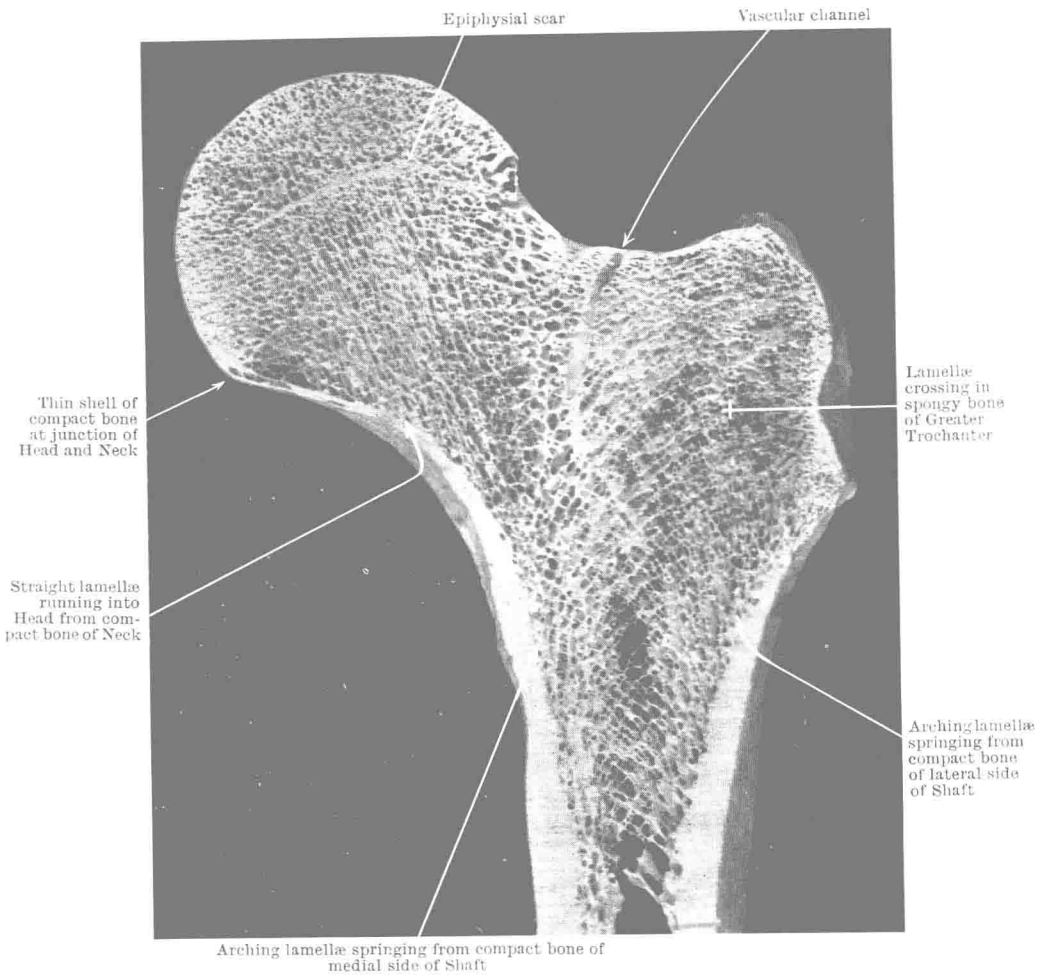


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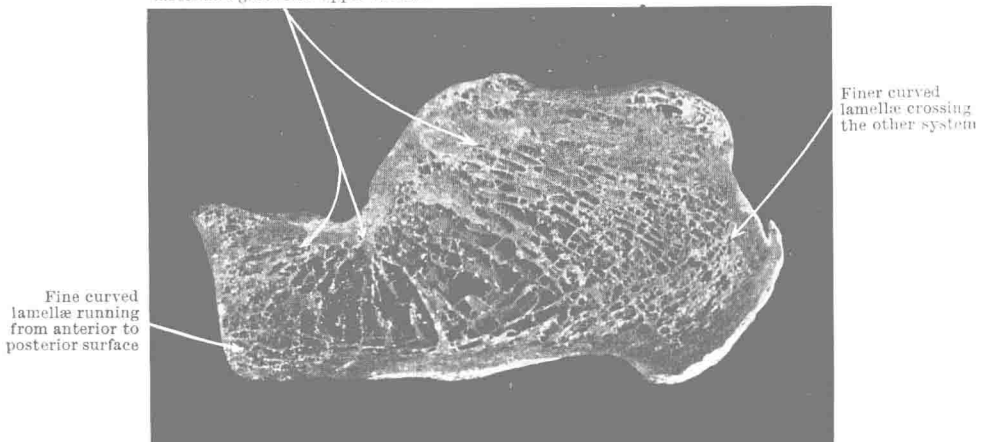


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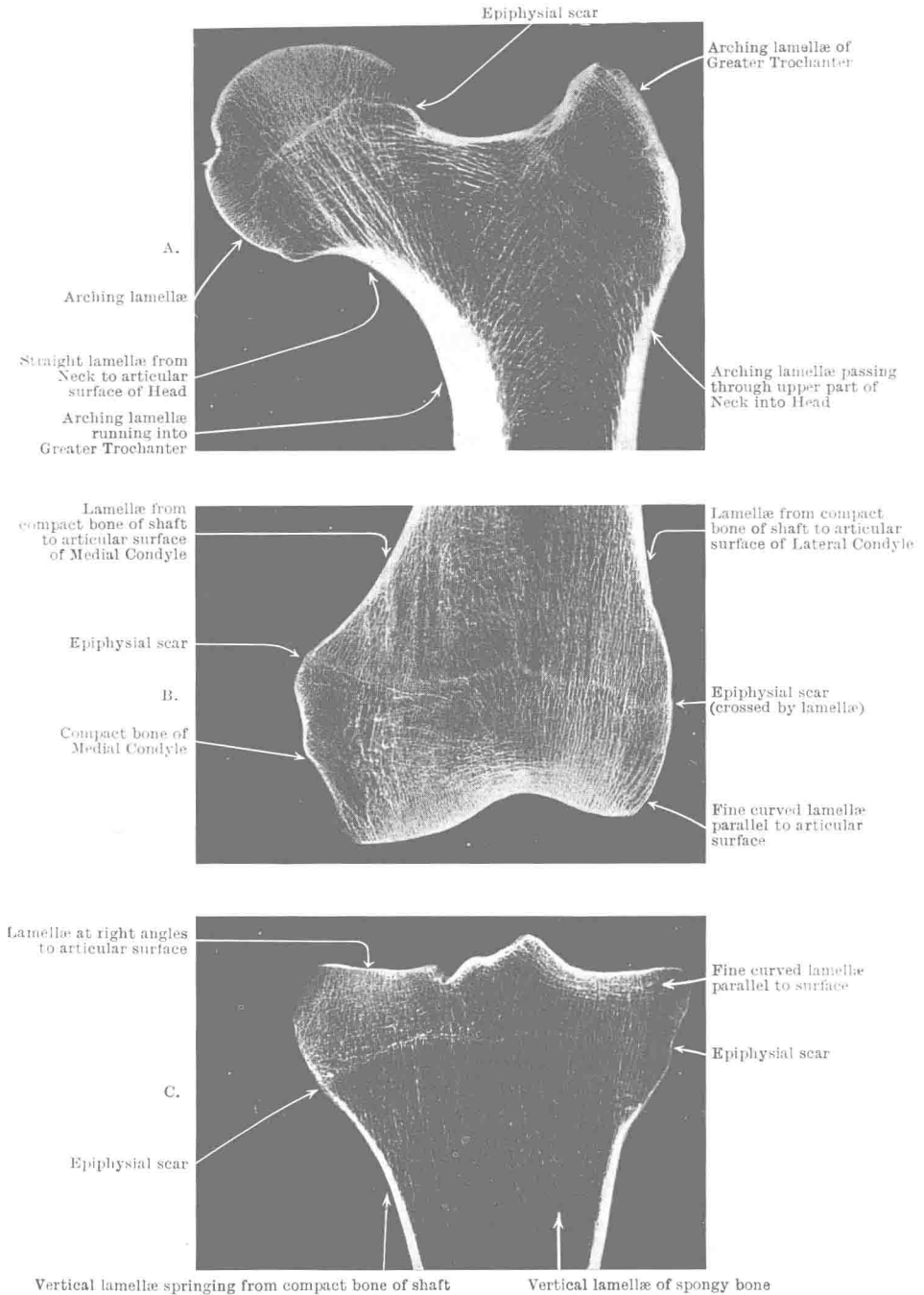


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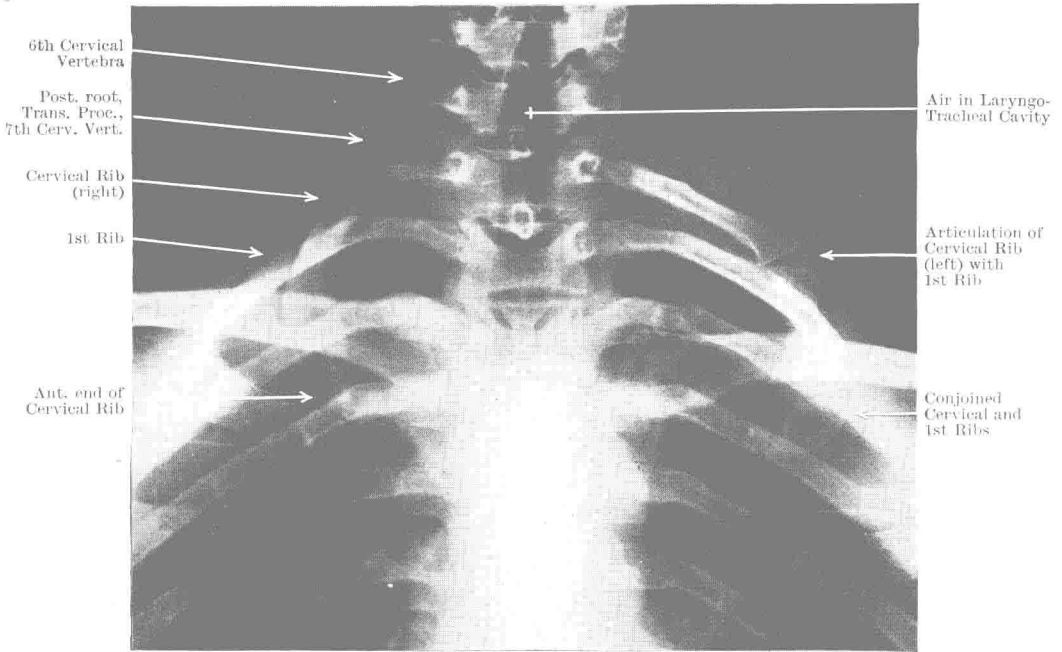


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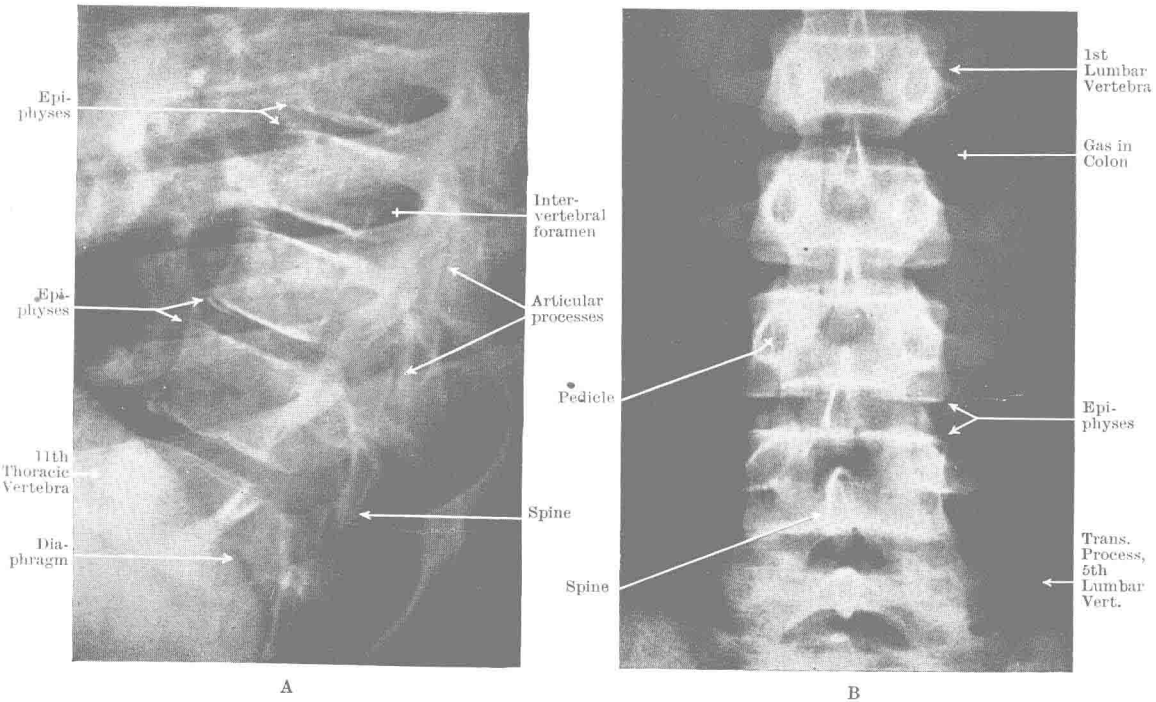


FIG. 2.—RADIOGRAPHS OF (A) THORACIC AND (B) LUMBAR VERTEBRÆ OF A GIRL AGED 12, SHOWING THE EPIPHYSES OF THE VERTEBRAL BODIES.

CONTENTS

OSTEOLOGY

BY

R. G. INKSTER

	PAGE		AGE
USES AND ARTICULATION OF BONES	105	GROWTH AND AGE-CHANGES OF SKULL	210
CONSTITUENTS OF BONE	105	SEX DIFFERENCES IN THE SKULL	211
STRUCTURE OF BONE	106	DEVELOPMENT AND MORPHOLOGY OF SKULL	211
ARCHITECTURE OF BONE	107	BONES OF THE CRANIUM	214
CLASSIFICATION OF BONES	108	Frontal Bone	214
CHARACTERS OF LIVING BONE	109	Parietal Bones	216
BONE-MARROW	109	Occipital Bone	217
APPEARANCES OF A DRIED BONE	110	Temporal Bones	220
CARTILAGE	111	Sphenoid Bone	225
DEVELOPMENT OF BONE	112	Ethmoid Bone	228
Growth of Bone	115	Inferior Nasal Conchæ	230
Epiphyses	116	Lacrimal Bones and Vomer	231
THE SKELETON	118	Nasal Bones and Maxillæ	232
VERTEBRAL COLUMN	118	Palatine Bones	235
A Typical Vertebra	121	Zygomatic Bones	237
CERVICAL VERTEBRÆ	122	Sutural Bones	238
THORACIC VERTEBRÆ	126	BONES OF UPPER LIMB	238
LUMBAR VERTEBRÆ	128	Scapula	239
SACRUM AND COCCYX	130	Clavicle	246
VERTEBRAL COLUMN AS A WHOLE	134	Humerus	249
OSSIFICATION OF VERTEBRÆ	137	Ulna	255
VARIATIONS IN VERTEBRÆ	139	Radius	260
SERIAL HOMOLOGIES OF VERTEBRÆ	139	Carpus	264
STERNUM	141	Metacarpus	269
RIBS	143	Phalanges of Fingers	272
COSTAL CARTILAGES	146	Sesamoid Bones of Hand	274
THORAX AS A WHOLE	147	BONES OF LOWER LIMB	274
OSSIFICATION, STRUCTURE, AND VARIATIONS OF RIBS	149	Hip-Bone	275
DEVELOPMENT OF VERTEBRÆ, RIBS, AND STERNUM	150	Pelvis	281
THE SKULL	151	Femur	289
SKULL AS A WHOLE	152	Patella	298
Norma Verticalis	152	Tibia	299
Norma Frontalis	154	Fibula	305
Norma Occipitalis	160	Tarsus	309
Norma Lateralis	161	Calcaneum	310
Norma Basalis	166	Talus	313
CRANIAL CAVITY	177	Cuboid	315
Roof of Cranial Cavity	178	Navicular	316
Floor of Cranial Cavity	178	Cuneiform Bones	317
Anterior Cranial Fossa	179	Metatarsus	319
Middle Cranial Fossa	181	Phalanges of Toes	321
Posterior Cranial Fossa	186	Arches of the Foot	322
CAVITY OF NOSE	191	Sesamoid Bones of Foot	324
PARANASAL AIR-SINUSES	197	DEVELOPMENT AND MORPHOLOGY OF THE LIMBS	325
MANDIBLE	200	MEASUREMENTS AND INDICES EMPLOYED IN PHYSICAL ANTHROPOLOGY	328
TEETH	206	REFERENCES	329
HYOID BONE	206		
THE SKULL AT BIRTH	208		

ARTHROLOGY

BY

ROBERT WALMSLEY

	PAGE		PAGE
CLASSIFICATION OF JOINTS	333	Carpo-Metacarpal Joints	370
Fibrous Joints	334	Intermetacarpal Joints	371
Cartilaginous Joints	334	Metacarpo-Phalangeal Joints	371
Synovial Joints	336	Interphalangeal Joints	372
Classification of Synovial Joints	342	JOINTS OF THE PELVIS	372
JOINTS OF TRUNK AND HEAD	343	Lumbo - Sacral and Sacro - Coccygeal	
Intervertebral Joints	343	Joints	373
Atlanto-Occipital Joints	347	Sacro-Iliac Joint	373
Atlanto-Axial Joints	348	Pubic Symphysis	375
Occipito-Axial Ligaments	349	Pelvic Mechanics	375
Mandibular Joint	350	JOINTS OF LOWER LIMB	376
JOINTS OF RIBS AND STERNUM	351	Hip Joint	376
Costo-Vertebral Joints	352	Knee Joint	380
Anterior Connexions of Ribs	353	Tibio-Fibular Joints	388
Sternal Joints	353	Ankle Joint	390
JOINTS OF UPPER LIMB	354	Joints of the Foot	393
Joints of Shoulder Girdle	354	Arches of the Foot	393
Sterno-Clavicular Joint	355	Intertarsal Joints	394
Acromio-Clavicular Joint	356	Tarso-Metatarsal Joints	398
Shoulder Joint	357	Intermetatarsal Joints	399
Elbow Joint	361	Metatarso-Phalangeal Joints	399
Radio-Ulnar Joints	365	Interphalangeal Joints	400
Wrist Joint	367	Mechanism of the Foot	400
Intercarpal Joints	368	REFERENCES	401

MYOLOGY

BY

R. D. LOCKHART

	PAGE		PAGE
SKELETAL MUSCLES	403	MUSCLES OF PERINEUM	465
Attachments	403	FASCLE OF PERINEUM	468
Form and Nomenclature	404	MUSCLES OF PELVIS	469
Variations	405	FASCLE OF PELVIS	473
Muscular Action	405	APPENDICULAR MUSCLES	474
FASCLE, SYNOVIAL SHEATHS, BURSEÆ	409	MUSCLES OF UPPER LIMB	474
AXIAL MUSCLES	411	Superficial Muscles of Back	475
MUSCLES OF VERTEBRAL COLUMN	411	Muscles of Pectoral Region	478
Deep Muscles of Back	411	Fasciæ of Pectoral Region	484
FASCLE OF BACK	419	Muscles of Shoulder	484
MUSCLES OF HEAD AND NECK	420	Deep Fascia of Shoulder	488
Deep Lateral and Prevertebral Muscles		Muscles of Upper Arm	488
of Neck	420	Fasciæ of Upper Arm	492
Muscles of Scalp	422	Muscles of Forearm	493
Muscles of Face	423	Short Muscles of Hand	504
Fasciæ and Muscles of Orbit	427	Fasciæ of Forearm and Hand	510
Muscles of Mastication	431	MUSCLES OF LOWER LIMB	515
Muscles of Neck	434	Muscles of Groin	515
Muscles of Hyoid Bone	434	Muscles of Gluteal Region	516
Muscles of Tongue	438	Muscles of Thigh	519
Muscles of Pharynx	440	Fasciæ of Thigh and Gluteal Region	531
Muscles of Soft Palate	441	Muscles of Leg and Foot	534
FASCLE OF HEAD AND NECK	445	Fasciæ of Leg and Foot	549
MUSCLES OF THORAX	447	DEVELOPMENT AND MORPHOLOGY OF	
Diaphragm	449	SKELETAL MUSCLES	553
MUSCLES OF ABDOMINAL WALL	454	REFERENCES	556
Inguinal Canal	462		
FASCLE OF ABDOMINAL WALL	464	INDEX	1561

OSTEOLOGY

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INTRODUCTION

BONES AND CARTILAGES

THE body is supported by an internal framework or *skeleton* of **bones** [σκελετός (skeletos)=dried]. This skeleton accounts for about one-seventh of the body-weight in a man and rather less in a woman; and the bones are supplemented in many places by gristle or **cartilage**—more so in a growing person than in an adult.

Uses of Bones.—Bones give support to the softer tissues which surround them and in some cases form protective boxes or cages for internal organs such as, for example, the brain in the skull, the heart and lungs in the chest and the spinal cord in the backbone. They also act as levers to which muscles or their tendons are attached and can transmit either tensile or compression stresses without appreciable deformation.

In addition, the spaces found inside bones are used for the production of blood-cells, for these spaces contain bone-marrow in which the blood-corpuscles develop, and the bone-substance itself is a store of lime-salts upon which the body may draw when necessary.

Articulation of Bones (see also the Section on Joints).—Since a continuous rigid framework would prevent movement, the bony skeleton is divided into separate bones joined by softer tissues which are, as a rule, sufficiently flexible to allow movement to take place.

The union between two or more adjacent bones is called a joint or *articulation* (*articulus*, diminutive of *artus*=a joint) and the bones so united are said to *articulate* with each other at the joint. The surface of one bone which comes into direct relation with another at a joint is its **articular surface** and, when the bones can glide or rotate on each other freely, an actual space is present between them; the articular areas are then covered with an adherent layer of smooth glistening **articular cartilage**. The bone underlying the cartilage is also smooth so that the articular part of a dried bone is easily identified even although the cartilage has been removed. In other cases, where less movement is required, the union of adjacent bones is made by some form of connective tissue, such as fibrous tissue or cartilage, when the articular surface will usually be rough; or else the union may be made complete by fusion of the two bones so that movement is prevented. Movements at joints are controlled or produced chiefly by muscles which are attached to the bones, but the bones are held together by all the tissues which surround them. In the majority of cases fibrous tissue runs from bone to bone as thickened bands or ligaments (*ligamentum*=a band or bandage, from *ligare*=to bind). These ligaments or other soft tissues maintain the continuity of the skeleton and transmit tensile stresses when required. Compression stresses cannot be transmitted through ligaments of this kind and the articular ends of long bones are likely to be enlarged so as to distribute such stresses and provide a good bearing surface in any normal position of the joint.

Constituents of Bone.—On analysis, bone can be broken down into approximately equal parts of solids and water. The solids are partly organic matter (31 per cent)

and partly inorganic (69 per cent). The *inorganic matter* consists of various *mineral salts*, the chief of which is calcium phosphate. This makes up over 80 per cent of the mineral or inorganic matter, though not necessarily in such a simple form, and, because of its abundance, bones are one of the sources of phosphorus. The *organic matter* is *white fibrous tissue*. It consists of:—(a) fine fibres embedded in a little amorphous material, called 'ground-substance', which unites the fibres into interlacing bundles; (b) connective-tissue cells, called *bone-corpuscles*, placed in rows among the bundles of fibres. The ground substance is completely impregnated with the mineral salts and a bone which has been burned to destroy the connective tissue element (calcined) still retains its form, though it becomes brittle and inelastic and may crumble. On the other hand, if the mineral salts are removed from a bone by soaking it in dilute acid, the bone again retains its form completely but becomes flexible. It can be cut with a knife and a sufficiently long and thin bone can be tied in a knot. Bones are

therefore not only hard but, because of the fibrous tissue, are also tough and elastic. This combination of organic and inorganic substances makes bones almost unique in that resistance to compression and extension is nearly equal (D'Arcy Thompson, 1942). In old age bones become more brittle owing to diminution of the elasticity of the fibrous tissue and not to any increase in the salts.

Structure of Bone.—There is only one kind of bone, but it may be either compact or spongy in texture (see Plate II, p. 104). **Compact bone** is hard and dense and forms the outer shell of a bone within its covering of periosteum (see p. 109). It is frequently thick and strong and is well seen when the shaft of a long bone, such as the thigh

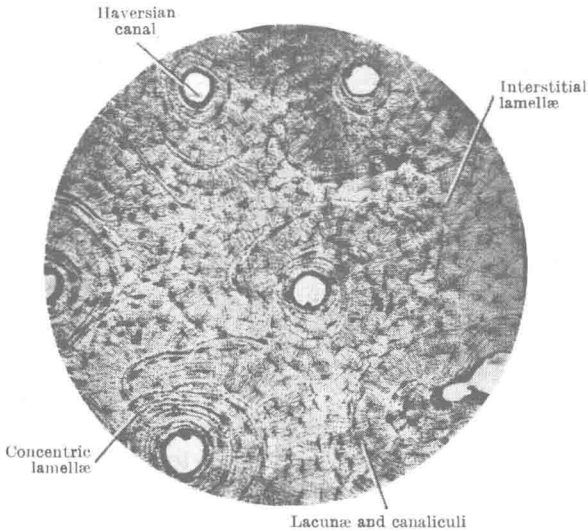


FIG. 122.—PHOTOGRAPH OF GROUND TRANSVERSE SECTION OF COMPACT BONE, showing Haversian systems (Haversian canal, concentric lamellae, lacunae, and canaliculi). $\times c. 75$.

bone or femur, is sawn across. **Spongy bone** is also hard, but this is not so evident because it consists of thin intersecting lamellae of bone substance with spaces between them, like a sponge (*lamella* or *lamina*—a leaf, blade, layer). This arrangement is well seen when the end of a long bone such as the femur is cut across. The spaces between the lamellae are filled with red marrow.

The **microscopical structure of bone** is essentially the same in the spongy and compact varieties and is closely associated with its mode of formation. Bone substance is laid down in two ways;—(a) Successive thin layers are formed under the periosteum. These lie approximately parallel with the surface and are called **periosteal lamellae**. (b) Successive thin concentric layers are deposited around blood-vessels so as to form canals which therefore contain the blood-vessels as well as any lymph-channels, nerves and loose areolar tissue associated with them. The systems of tubular lamellae so formed are called **Haversian systems** (after Clopton Havers who first described them in detail, 1691) and consist of three to ten or more concentric tubes, the **Haversian lamellae**, which surround the central cavity named the **Haversian canal**. The cells associated with the laying down of bone are named **osteoblasts**. Numbers of them are trapped between the lamellae during development and remain as **osteocytes** or **bone-corpuscles** in the substance of the bone. The minute cavities occupied by the bone-corpuscles during life are called **lacunae** (*lacuna*—a pit, hole, or cavity) and, since the living cells are connected with each other by slender cytoplasmic processes, the substance of the lamellae formed around them is penetrated by minute channels. These are called **canaliculi** and connect