WERNER SPALTEHOLZ

HAND ATLAS OF HUMAN ANATOMY

HAND-ATLAS

OF

HUMAN ANATOMY

BY

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VOL. I

BONES, JOINTS, LIGAMENTS

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IN THREE VOLUMES

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Preface to the Thirteenth Edition in German.

As an appendix to the section on the bones I have added to the first volume of the 13th German edition of my Hand-Atlas some eighteen roentgenograms made from living persons, by Dr. Gustav Bucky, Director of the Roentgenological Department of the Virchow Hospital in Berlin. They have been taken in large part from a voluminous roentgenological atlas that Dr. Bucky and I have been engaged in preparing during several years past and which will soon be published by Paul B. Hoeber of New York; a few of the roentgenograms have been especially prepared at my request. I desire here to give my heartiest thanks both to my colleague Dr. Bucky for the preparation of the roentgenograms, and to Paul B. Hoeber for permission to use them. I have laid great stress upon the most careful reproduction of these photographs; the clichés have been prepared by Schelter and Giesecke, A.G., Leipzig, under my continuous control and to my entire satisfaction.

Since the interpretation of roentgenograms is often very difficult for the unaccustomed eye I have given especial care to the preparation of the explanatory diagrams that accompany them. These diagrams have been drawn by myself according to the principles laid down in the "Preliminary Remarks to the Interpretation of Roentgenograms." I have made the attempt to make the perspective relations of the contours of the bones clearly understandable in this way. I have thus been able in the tracings to produce a certain plastic effect or at least to make clear the reciprocal depth relations of the single contours.

W. Spalteholz.

Structure of the Bones.

The **skeleton** *(sceleton)* is composed of the *bones (ossa)*, of their *cartilages (cartilagines)*, and of the *ligaments (ligamenta)*, which unite the bones with one another and with the cartilages. The number of bones in the adult (exclusive of the small bones of the ear and the sesamoid bones) is two hundred.

Structure of the Bones.

The **bones** (see figures I and II) are very firm, hard structures, whitish in color though somewhat yellow or red according to their content in blood. They consist, in the main, of the *bony substance (substantia ossea)* and of the *bone marrow (medulla ossium)* lying within them. The bone substance determines the form of the bones but it is always covered; for the most part it is covered externally by a membrane, the *periosteum*, rich in blood vessels and nerves; through the mediation of this, the union of the bones with the ligaments, with the tendons and muscles, as well as with other neighboring structures, is established. In some places the bony substance goes over directly into connective substances of other kinds; at the joint slits the *joint surface (facies articularis)* is usually covered by *joint cartilage (cartilago articularis)* of different structure.

Bone substance (see figures II—XVIII) alone remains over after destruction of the uncalcified soft parts of the bone by bacteria (putrefaction) or by treatment by chemical methods (maceration). Next to the teeth it is the hardest tissue of the body and is found (recognizable by the naked eye) in the human body in two forms: (1) as a tough rounded mass, *substantia compacta*, of *solid bony tissue*, especially in the middle portions of the tubular bones of the extremities, and (2) as a loosely structured mass consisting of thin plates and columns, *(substantia spongiosa)* or *spongy bony tissue* in the end pieces of the tubular bones of the extremities as well as in the other bones. The two forms go everywhere directly and inseparably over into one another, are in the whole bone and in its single parts arranged essentially according to the mechanical laws based upon the demands made upon them and show, accordingly, in the single bones a characteristic behavior. This arrangement is recognizable with variable distinctness in cross sections of the bones and in polished preparations, in decalcified bones that have been made transparent and in rœntgenograms (see, for example, figures IV, V, XIV, and 328a).

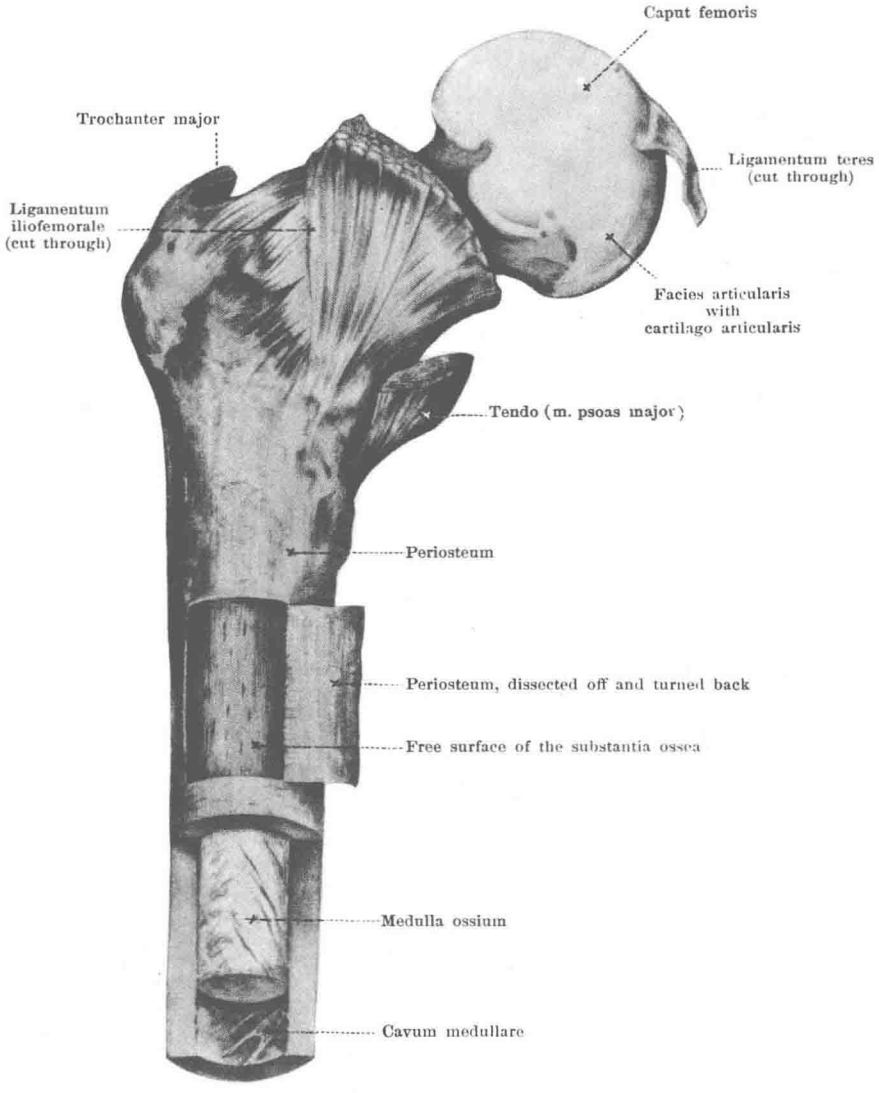
The outermost layer of the bony substance, the *substantia corticalis*, is, in the short bones and in the terminal pieces (epiphyses) of the tubular bones, formed of a thin layer of substantia spongiosa, in the middle portions (diaphyses) of the tubular bones and in the other bones, of a strong layer of substantia compacta (see figures IX—XVIII).

The substantia compacta, in especially thick masses, forms the walls of the middle piece of the tubular bones of the extremties where it surrounds like a mantle a large unitary space, the *medullary cavity (cavum medullare)* (see figures I and III—V). This cavity is directly connected with the innumerable small spaces that lie between the columns of the substantia spongiosa—spaces that communicate with one another.

The **bone marrow** (see figure II) is a soft mass that completely fills the medullary space and the small spaces of the substantia spongiosa of all the bones; it is found also in the larger Haversian canals. According to the varying macroscopic appearances (due to the varying content in fat), we distinguish the *red bone marrow (medulla ossium rubra)*, which is very soft and semi-

fluid and the *yellow bone marrow*, or *fat marrow (medulla ossium flava)*, which resembles subcutaneous fatty tissue. In the foetus and in the new-born one finds only red marrow in all of the bones. But, even in childhood, a fatty change in the marrow begins in the periphery of the extremities and extends proximalward toward the trunk so that, in the adult, all the short and the long bones of the extremities contain almost exclusively yellow marrow; this is true also of the middle portion of the clavicle. On the other hand, red marrow continues to exist throughout the whole of life in the bones of the trunk and of the skull and it is also often met with in the proximal portions of the humerus and the femur (see figure II). In older and severely ill persons the fat may vanish entirely from the yellow marrow; the marrow then becomes gelatinous and of a reddish yellow color and is called *gelatinous bone marrow (medulla ossium gelatinosa)*.

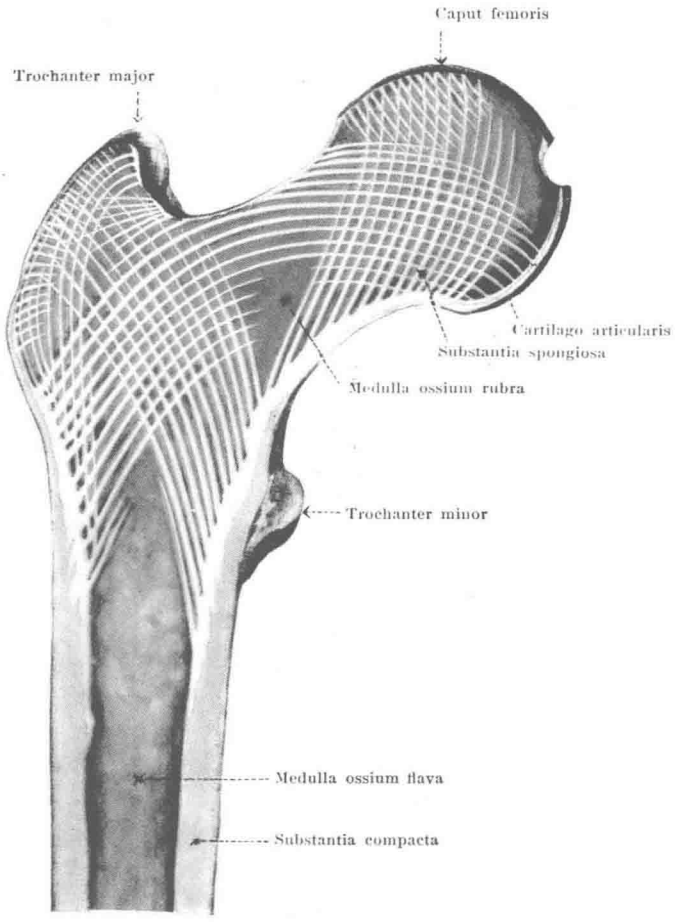
The substantia compacta is penetrated by numerous small tubules *(Haversian canals)* (see figure VIII). These are more or less completely filled by the blood vessels that run through them, usually of the structure of capillaries, but they may contain also small amounts of fat and of marrow tissue. These canals all communicate with one another, run in the tubular bones mainly in the longitudinal direction of the bones, are connected with one another by a large number of transverse canals and, on the external and internal surface of the bones, open into the nutrient canals *(canales nutricii)*. Their arrangement and their size relations are illustrated in figure VIII. The columns of the spongiosa do not contain Haversian canals.



I. Proximal part of a freshly prepared right femur of an adult, anterior view.

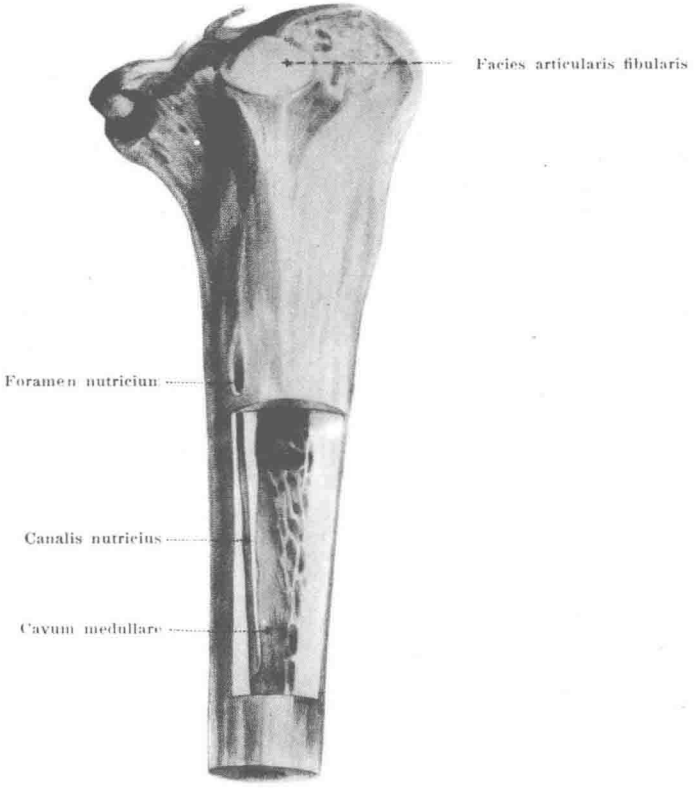
A piece of the periosteum has been dissected off and turned back.

In the distal portion, the anterior half of the substantia compacta has been sawed away and the marrow exposed; from the marrow a small piece has been removed so that the marrow cavity is made visible.



II. Proximal part of freshly prepared right femur of an adult,

Frontal section-made with a saw. Posterior half viewed from in front.
(The lines drawn in the substantia spongiosa are schematic.)



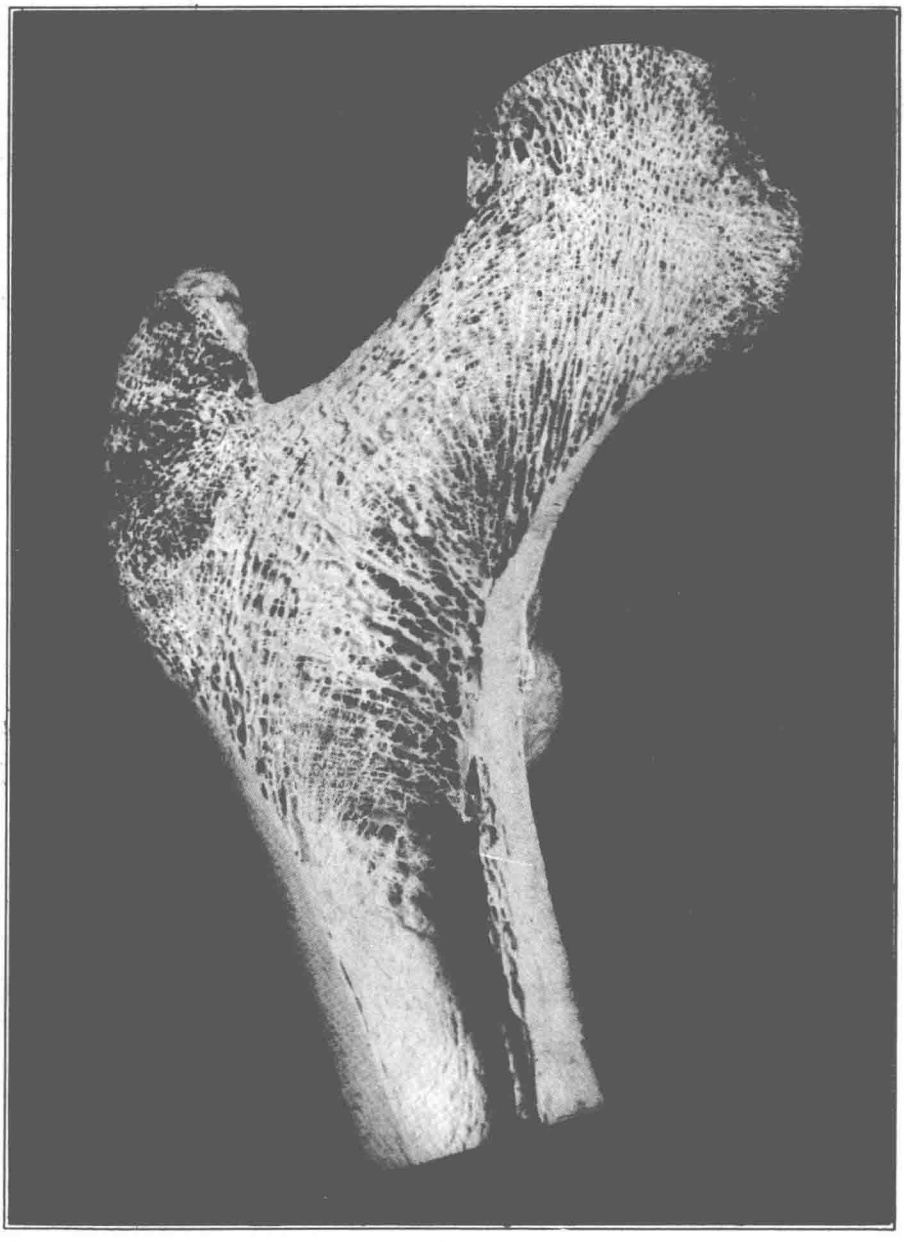
III. Proximal half of the right tibia of an adult,

viewed from the back and the side.

A piece of the substantia compacta has been sawed out in order to show the course of the canalis nutricius from the surface to the marrow cavity.

Structure of the Bones (Continuation).

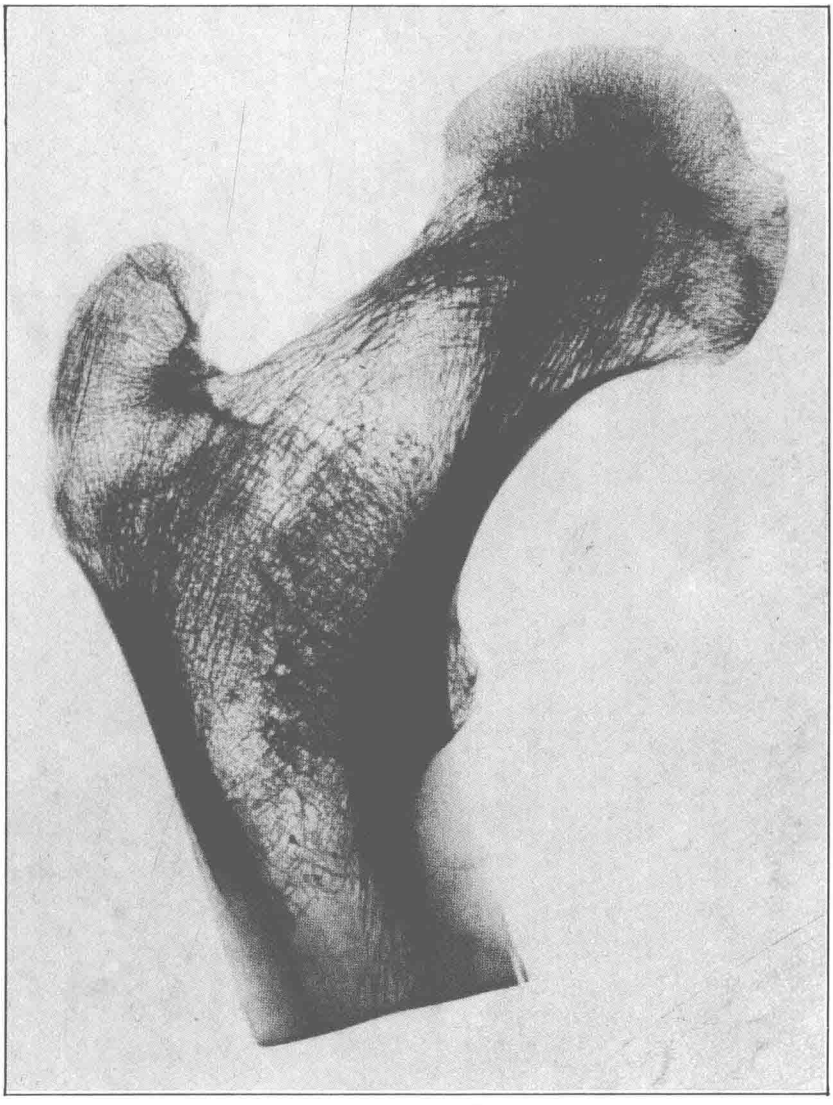
On the surface of most bones one can see one or several larger openings, *foramina nutricia*, from each of which a canal, *canalis nutricius*, leads into the marrow cavity or into the spaces of the substantia spongiosa. These canals are lined by a continuation of the periosteum and contain the *vasa nutricia*, vessels, which serve essentially for the nutrition of the bones, as well as vasomotor nerves. In the diaphyses of the tubular bones these canals, owing to uneven growth of the two bony end-pieces, perforate the compacta at a very acute angle and are therefore relatively long.



IV. Proximal end of the macerated right femur of an adult, sawed through in frontal section, in the natural state.

Dorsal half, viewed from the ventral surface.

Size, 1 : 1.



Phot. M. Schmetz.

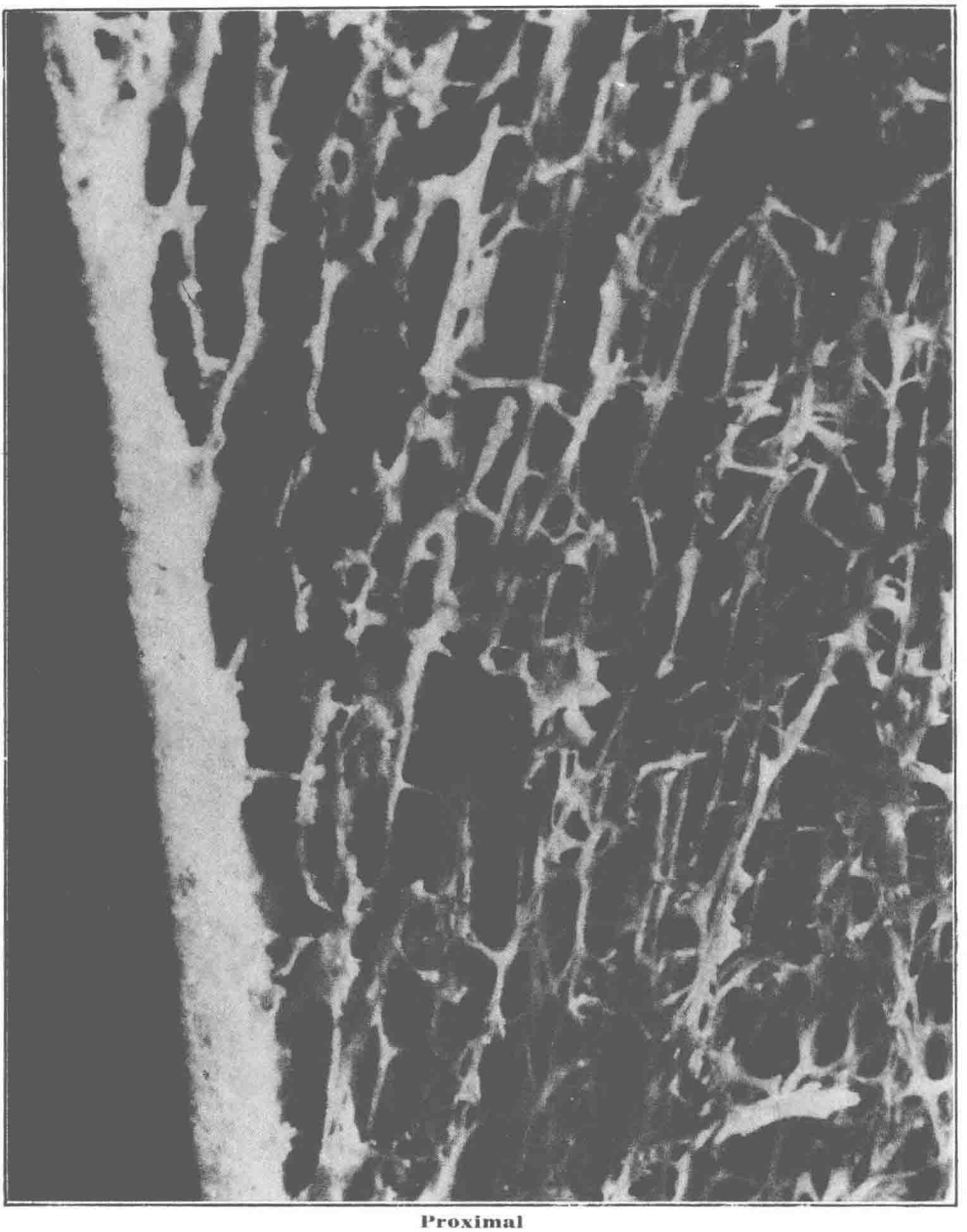
V. Proximal end of the macerated right femur of an adult,

sawed through in frontal section, decalcified and made transparent.
Dorsal half, viewed from the ventral surface.

Size. 1 1.

Distal

Medial

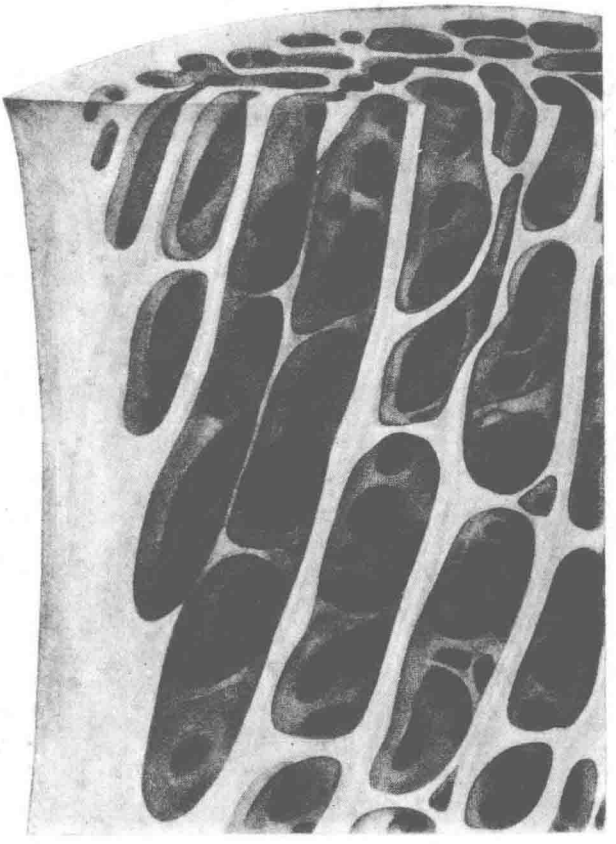


Proximal

VI. Distal portion of the body of the macerated right tibia of an adult,

sawed through in frontal section. Dorsal half, viewed from the ventral surface.

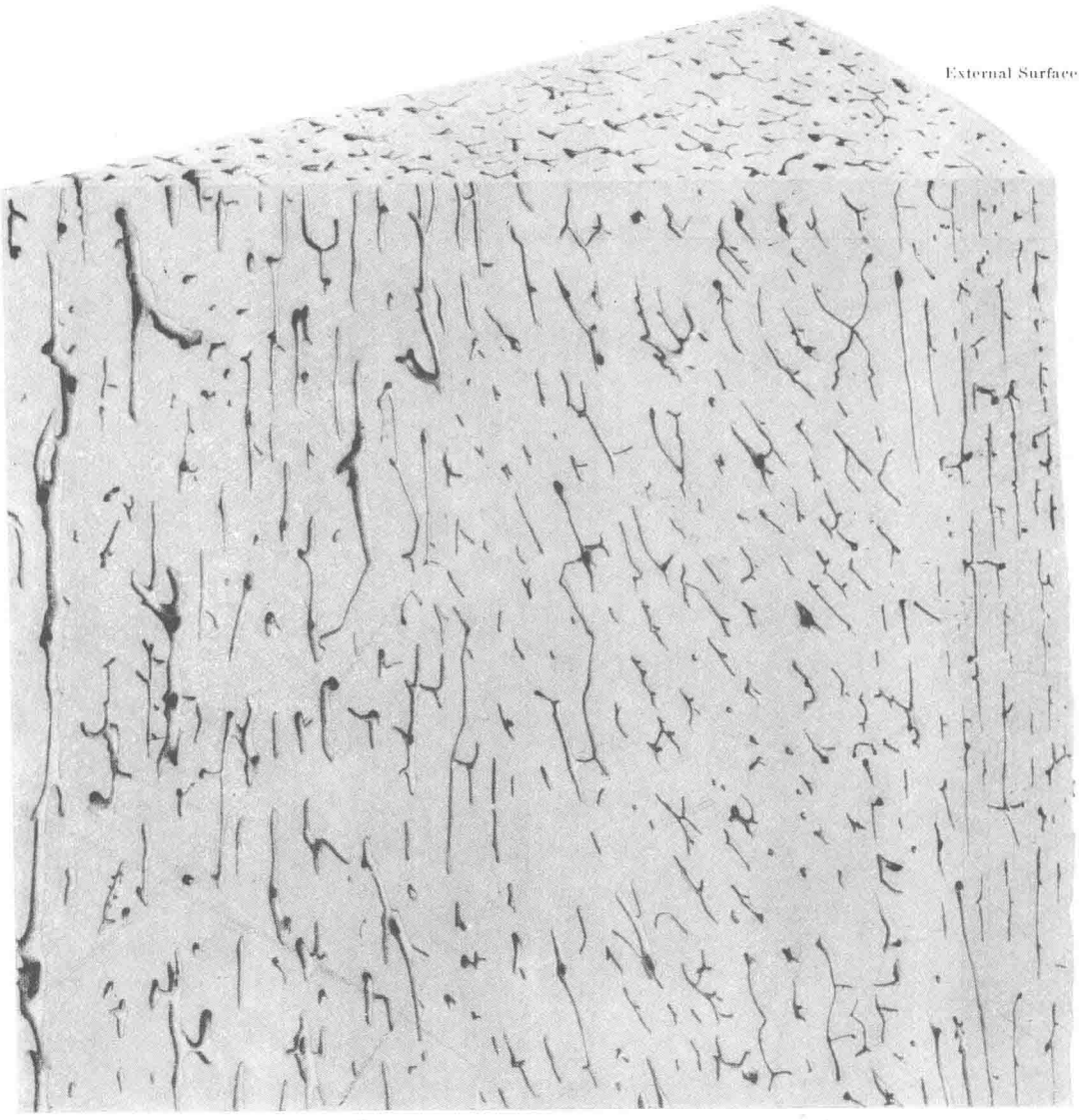
Size, 8 : 1.



VII. Relation of the substantia compacta and the substantia spongiosa

A piece of the bony structure represented in figure VI has been further enlarged and schematized.

Size, about 10 : 1.

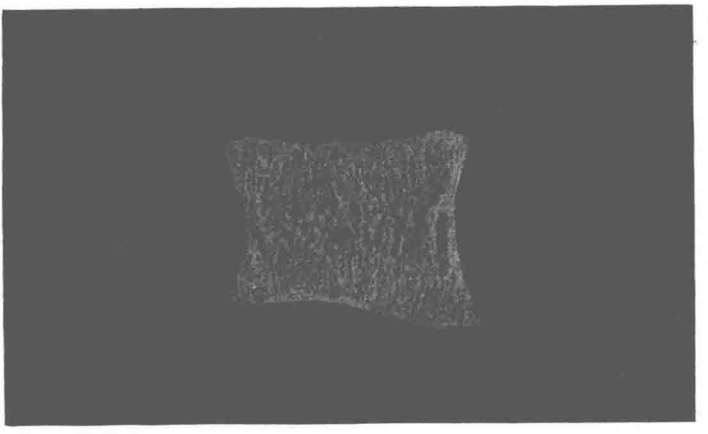


Dr. Ettold.

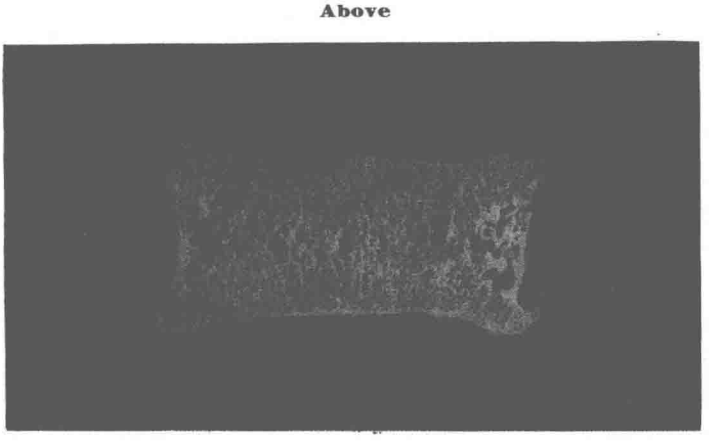
VIII. A sector of the substantia compacta of a macerated femur of an adult,

after polishing. Size, 12 : 1.

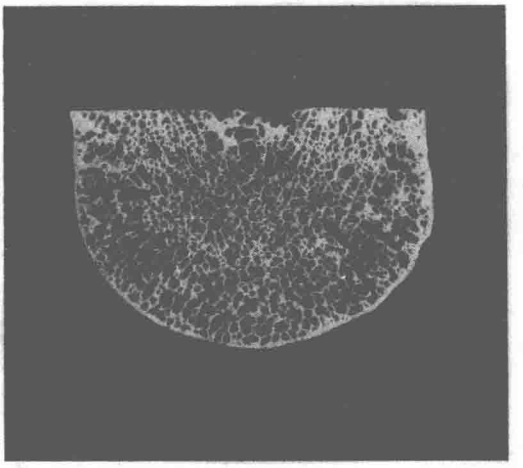
The small spaces shown are the Haversian canals.



IX. Lumbar vertebra, *vertebra lumbalis,*
ground sagittal section, from the side.

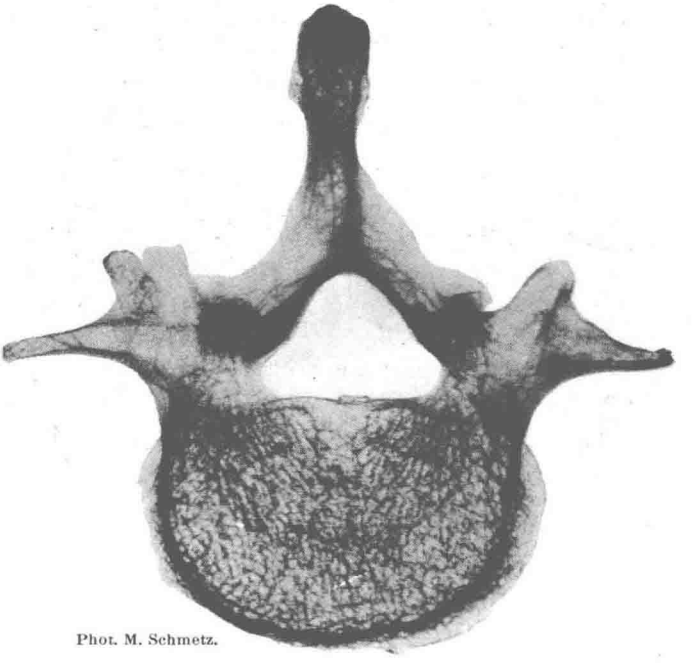


X. Lumbar vertebra, *vertebra lumbalis,*
ground frontal section, from in front.



XI. Lumbar vertebra, *vertebra lumbalis,*

ground horizontal section, from above.



Phot. M. Schmetz.

XII. Fourth lumbar vertebra, *vertebra lumbalis IV,*

decalcified and made transparent, viewed from above.

The cranial and caudal parts of the vertebral body have been sawed off in horizontal section, so that only a disc approximately 1 cm in thickness remains.