TOP HORIZONTAL

NUMBER 1

NOTES:

BONE AND CALCIUM METABOLISM

I. BONE COMPOSITION

II. BONE FORMATION

III. DEPOSITION AND ABSORPTION OF BONE

IV. CALCIUM AND PHOSPHATE METABOLISM

V. REGULATING FACTORS

VI. EXAMPLE BONE DISEASES

TOP VERTICAL

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TOP HORIZONTAL

NUMBER 2

TOP VERTICAL

NOTES:

I. BONE COMPOSITION

MATRIX

COLLAGEN FIBERS

GROUND SUBSTANCE

CALCIUM SALTS

HYDROXYAPATITE XTALS (Ca, PO_4 & OH)

ADSORBED CALCIUM SALTS (EXCHANGABLE Ca) AND OTHER IONS

(BINDING AND NODULAR ARRANGEMENT ⟶ STRENGTH & FLEXIBILITY)

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NUMBER 3

NOTES:

II. BONE FORMATION

OSTEOBLASTS SECRETE MATRIX (CARTILAGE)

HYDROXYAPATITE XTALS PPT. WITHIN & AROUND
COLLAGEN FIBERS

GROUND SUBSTANCE ABSORBED (MOST OF IT)

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NUMBER 4

NOTES:

III. DEPOSITION AND ABSORPTION OF BONE - A CONTINUAL PROCESS

OSTEOBLASTS ⟶ BONE DEPOSITION

OSTEOCLASTS ⟶ BONE ABSORPTION

NORMALLY, RATES ARE EQUAL THOUGH ACTIVITIES OF EACH NOT IN THE SAME PLACE AND TIME

ADVANTAGES TO CONTINUAL PROCESS:

REPLACEMENT OF BRITTLE OLD BONE (MATRIX DEGENERATION)

REMODELING TO ADAPT TO ALTERED STRESSES

- ALTERED LINES OF FORCE
- ALTERED MAGNITUDES OF FORCE

TOP VERTICAL

TOP HORIZONTAL

NUMBER 5

NOTES:

III. DEPOSITION AND ABSORPTION OF BONE - (Cont'd)

RATES OF DEPOSITION & ABSORPTION:

FASTER IN YOUNG; SLOWER IN OLD

DEPOSITION > ABSORPTION WITH GROWTH, INCREASED BONE STRESS

ABSORPTION > DEPOSITION WITH DECREASED BONE STRESS (WTL., PHYSICAL INACTIVITY), ABNORMAL ALTERATIONS OF REGULATING FACTORS

BONE RESPONSE TO STRESS:

COMPRESSION → PIEZOELECTRIC EFFECT →

NEGATIVE POTENTIAL AT SITE OF COMPRESSION

→ SMALL ELECT. CURRENT → OSTEOBLASTIC STIMULATION AT NEGATIVE END

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NOTES:

III. DEPOSITION AND ABSORPTION OF BONE - (Cont'd)

LACK OF COMPRESSION (OR DECREASE) ⟶

DECREASED OSTEOBLASTIC ACTIVITY;

OSTEOCLASTIC ACTIVITY CONTINUES AT NORMAL

RATE ⟶ NET BONE ABSORPTION

BONE IS A LIVING TISSUE - MAINTAINED BY AND RESPONSIVE TO ACTIVITY; ATROPHYING WITH DISUSE.

TOP HORIZONTAL

NUMBER 7

NOTES:

IV. CALCIUM AND PHOSPHATE METABOLISM

SOURCES

GI ABSORPTION

GI SECRETION

GI EXCRETION

URINARY EXCRETION

BODY DISTRIBUTION

LEVELS IN BLOOD AND ECF

HYPOCALCEMIA

HYPERCALCEMIA

TOP VERTICAL

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TOP HORIZONTAL

NUMBER A

TOP VERTICAL

NOTES:

V. REGULATING FACTORS

- EXCHANGEABLE CALCIUM (minutes to hours)

  PRIMARY SOURCE: ADSORBED Ca SALTS IN BONE

- PARATHYROID HORMONE (hours to days)

  FROM PARATHYROID GLANDS

  STIMULATED BY DECREASED EC Ca LEVELS; INHIBITED BY ELEVATED EC Ca

  ACTS TO INCREASE EC Ca:

  INCREASES OSTEOCLAST ACTIVITY (& NUMBERS)

  DECREASES URINARY OUTPUT OF Ca (INCREASES URINARY OUTPUT OF PO_4)

  INCREASES GI ABSORPTION OF Ca

  HIGHLY DEVELOPED HOMEOSTATIC MECHANISM; NARROW EC Ca RANGE MAINTAINED; GLAND SIZE REFLECTS CHRONIC ACTIVITY STATE, i.e., ATROPHY WITH BONE DISUSE

- VITAMIN D (D_2 & D_3)

  ESSENTIAL FOR ABSORPTION OF Ca FROM GUT

  GENERALLY, SAME EFFECTS AS PTH, BUT GREATER ON Ca ABSORPTION; LESS ON BONE RESORPTION

  ABSENCE GREATLY IMPAIRS PTH ACTION ON BONE RESORPTION

NOTES:

V. REGULATING FACTORS (cont.)

- CALCITONIN (minutes)

  FROM THYROID GLAND IN HUMANS (THYROCALCITONIN)

  STIMULATED BY ELEVATIONS OF EC Ca; INHIBITED BY LOW EC Ca

  ACTS TO SHARPLY INHIBIT BONE ABSORPTION

  CAUSES DECREASE OF EC Ca

  ANTAGONISTIC TO PTH

AS REGULATOR OF EC Ca:

ACTION OPPOSITE TO PTH

ACTION MUCH FASTER THAN PTH

ACTS AS A SHORT TERM REGULATOR - UNLIKE CHRONICALLY DOMINANT PTH SYSTEM

TOP HORIZONTAL

NUMBER 10

NOTES:

VI. EXAMPLE BONE DISEASES

OSTEITIS FIBROSA CYSTICA - PTH XS

RICKETS - VITAMIN D INSUFF.

OSTEOMALACIA - ADULT RICKETS

OSTEOPOROSIS - DISUSE, etc.

TOP VERTICAL

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA FORM 682 (MAY 62)

☆ GPO : 1966 OF—208-861

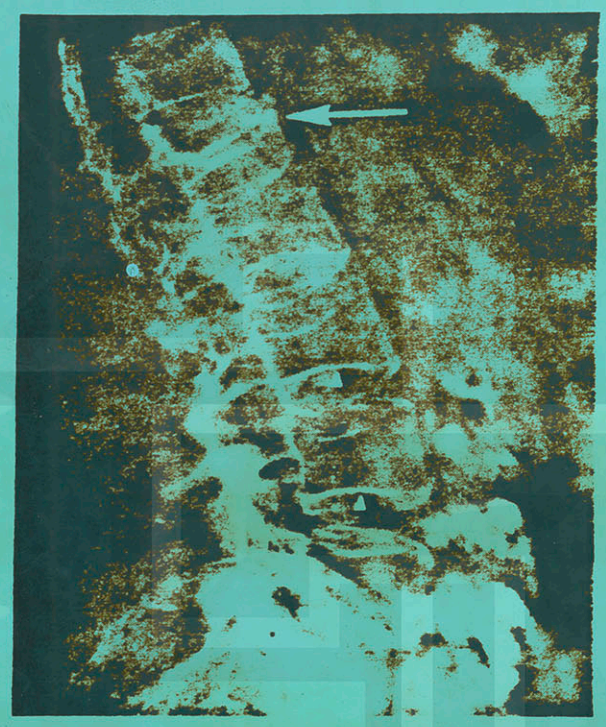
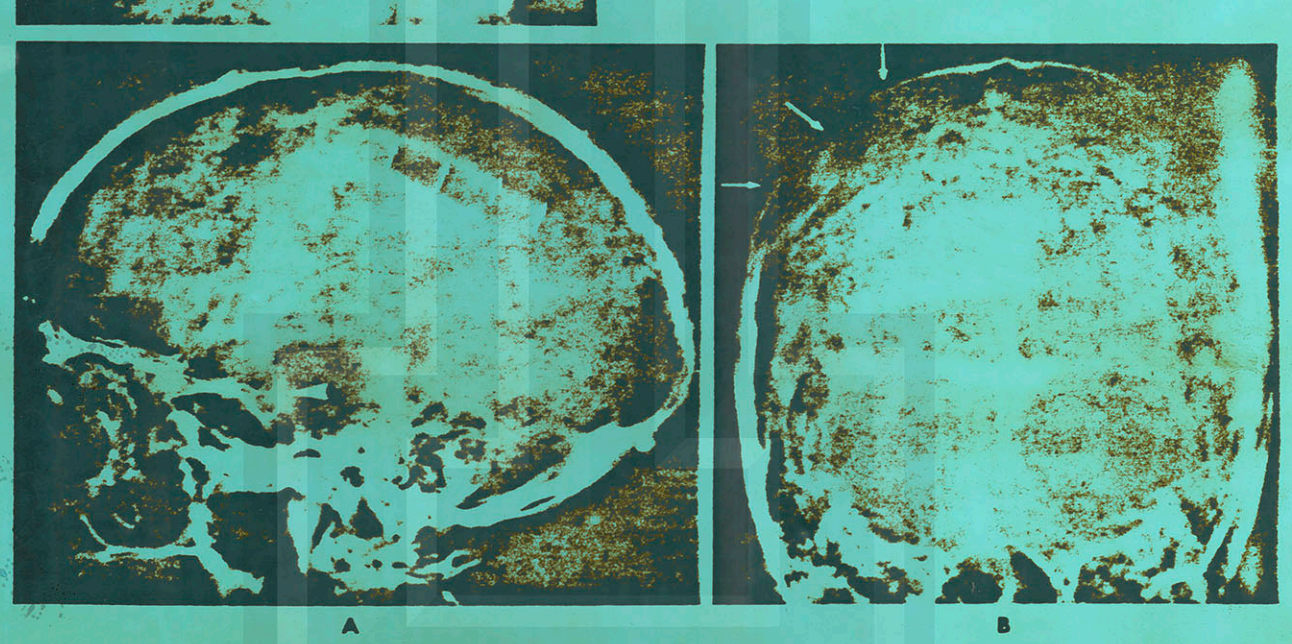


FIGURE 15–1. **Senile Osteoporosis of the Lumbar Spine.** The pronounced lucency of the vertebral bodies is due to extensive resorption of bony trabeculae; by contrast, the cortical end plates are thinned but appear relatively dense (*arrowheads*). There is a compression fracture of L1 (*arrow*). The densities anterior to the spine represent residual barium from a previous contrast study.



A B

FIGURE 15–2. **Osteoporosis of the Skull.**

A, Lateral view discloses spotty demineralization of the calvarium causing a mottled appearance. The area of the parietal bone (*arrows*) is very much thinned. The density of the dorsum sellae and posterior clinoids is decreased (*arrowhead*).

B, In posteroanterior view the outer table in the area of the parietal bones is lacking (*arrows*) and the tables are thinned. Thinning of the parietal bones occurs rarely and usually is associated with senile or postmenopausal osteoporosis. It may also occur in younger patients with hypogonadal osteoporosis. The present patient manifested other evidence of senile osteoporosis.

(Courtesy of Dr. Arlyne Shockman, Veterans Administration Hospital, Philadelphia.)

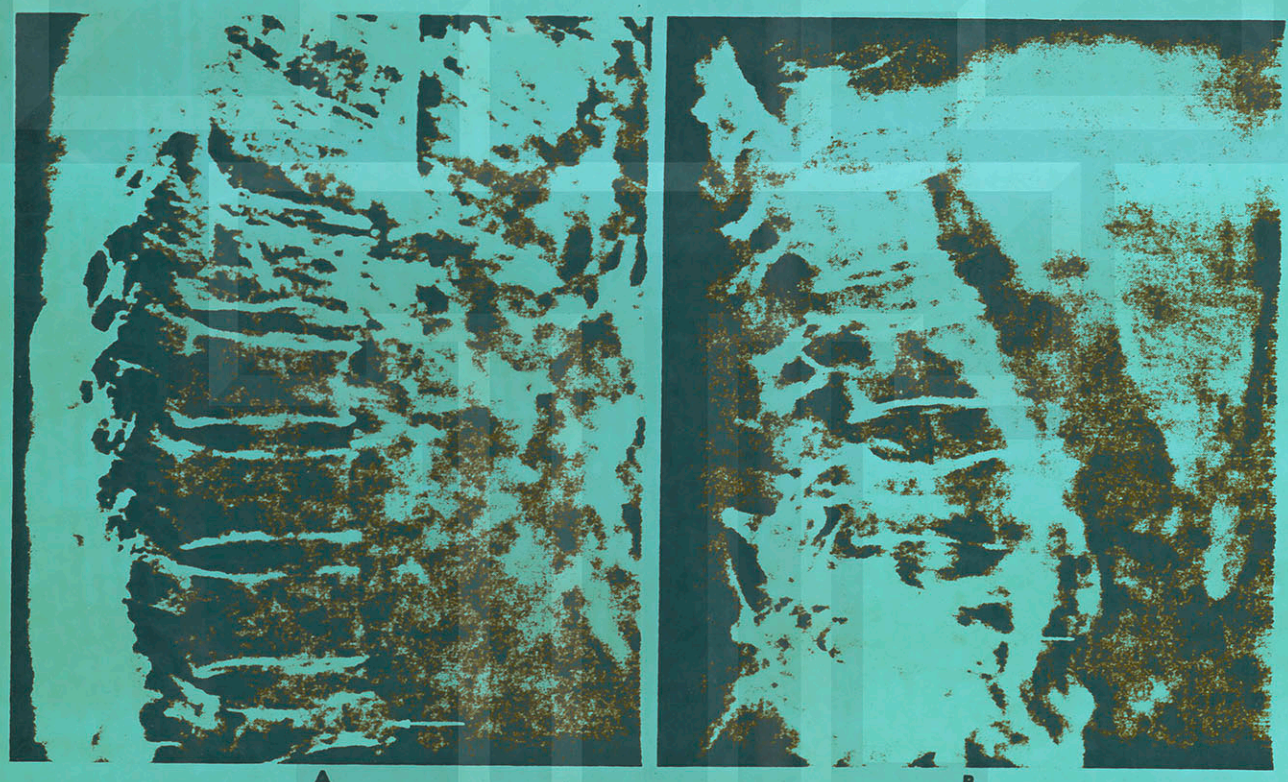


FIGURE 15–4. Osteomalacia of Spine Secondary to Malabsorption.

A, There is generalized demineralization of the spine. Two compression fractures are evident *(arrows)*. The coarse striations *(arrowhead)* represent thickening of the primary trabeculae. Almost all the secondary trabeculae are completely decalcified.

B, Lateral view of the lumbar spine demonstrates two compression fractures *(white arrows)*. The impression on the superior aspect of the body of L4 *(black arrow)* is due to herniation of the nucleus pulposus. The appearance is indistinguishable from that of osteoporosis.

(Courtesy of Dr. Arlyne Shockman, Veterans Administration Hospital, Philadelphia.)

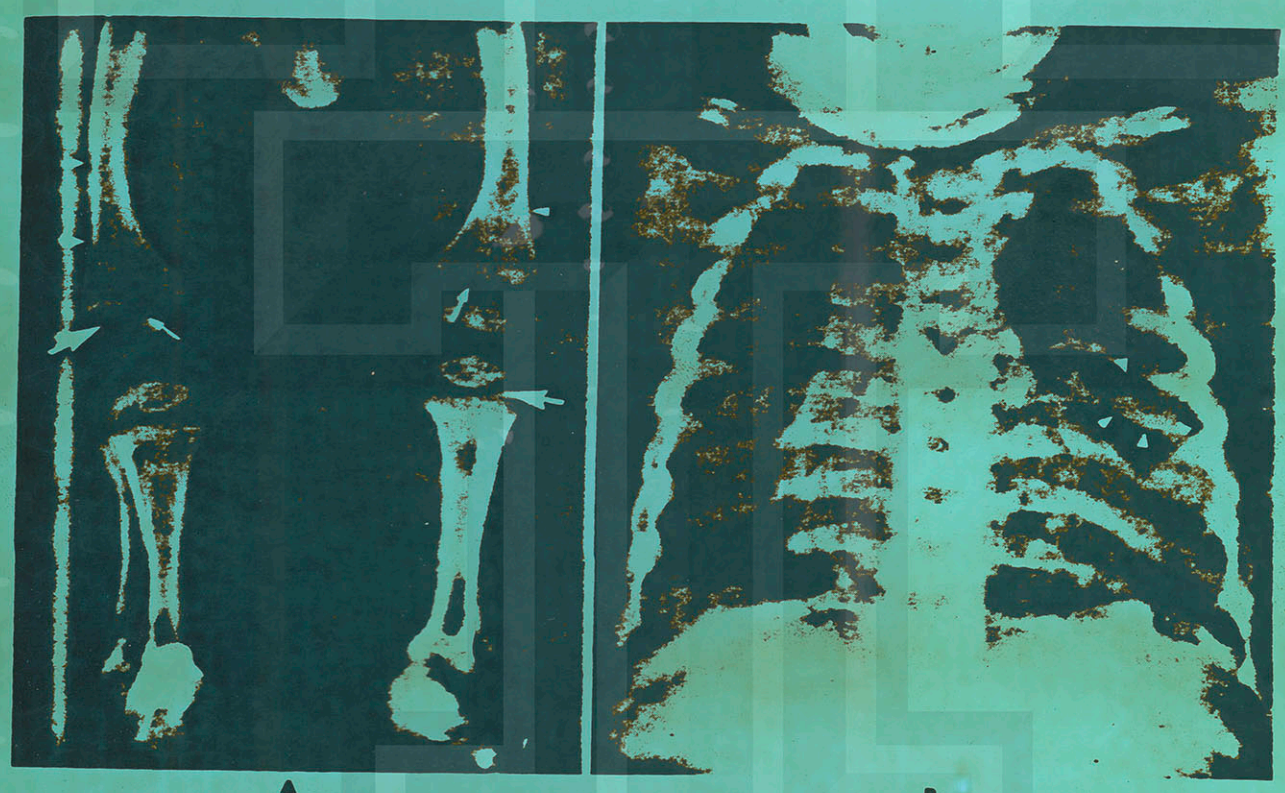
Top

10 B

St-2-34 TREND CHARTS (COLOR)

Feb 25, 1994 Stratus

TOP HORIZONTAL



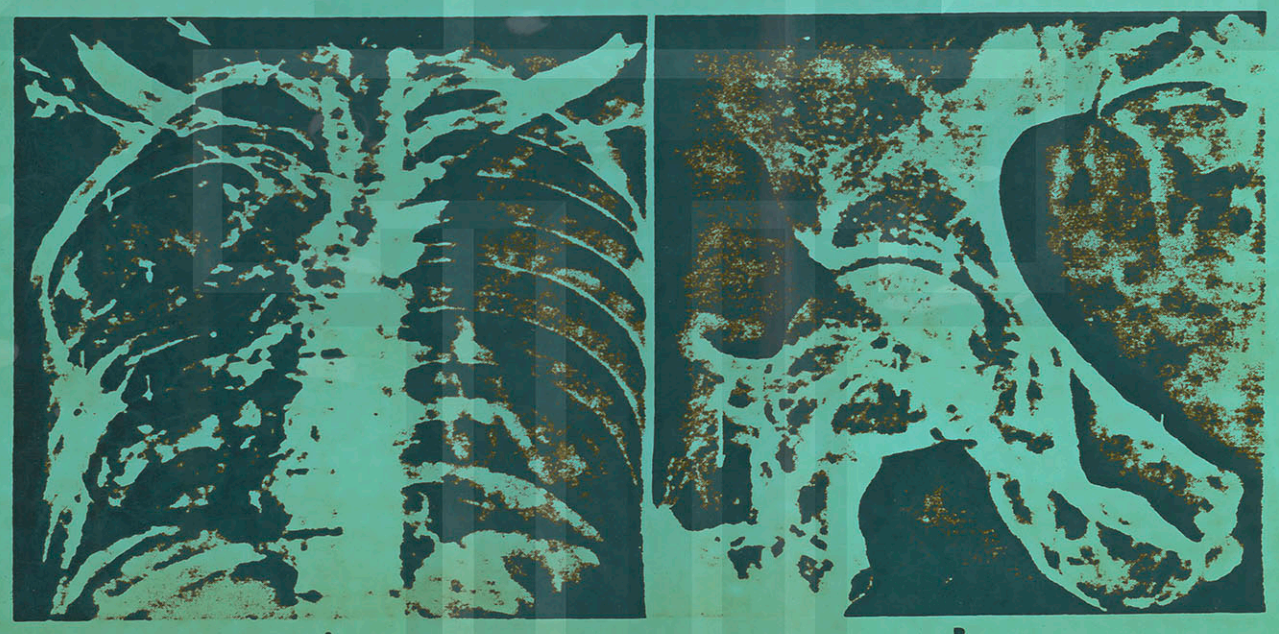
A B

FIGURE 11–4. Advanced Rickets.

A, The long bones are demineralized, and the trabeculae are coarsened in a two-year-old child. The metaphyseal ends are broadened, frayed, and irregular *(small arrows)*. The usually sharp metaphyseal line of density is absent, and the distal tibial metaphyses are cupped *(black arrow)*. There is increased space between the metaphysis and epiphysis *(large arrows)*. The femora are bowed, with thickened cortices medially. Periosteal layering *(arrowheads)* in the femora represents early healing with vitamin D therapy.

B, Bulbous enlargement of the anterior ends of the ribs, mainly osteoid tissue *(arrowheads)*, is often seen. There is marked osseous demineralization and coarsened trabeculae.

NUMBER 10B



A B

FIGURE 15–8. **Osteitis Fibrosa Cystica Generalisata.**

A, Posteroanterior view discloses great expansion and distortion of multiple ribs on the right *(arrows)*. There is cortical thinning and loss of trabeculae. The first rib has a multicystic appearance *(large arrow)*.

B, Enlarged view of the right hip area demonstrates multiple cystic lucent areas—so called brown tumors *(arrows)*. There is resorption of bony trabeculae as well as cortical thinning and expansion.

The appearance closely resembles that of advanced fibrous dysplasia. Brown tumors may be single or they may be multiple and diffuse as in the present case. The serum alkaline phosphatase level is invariably elevated.

TOP HORIZONTAL

NUMBER 4B

NOTES:

How haversian systems can be added to older shafts.

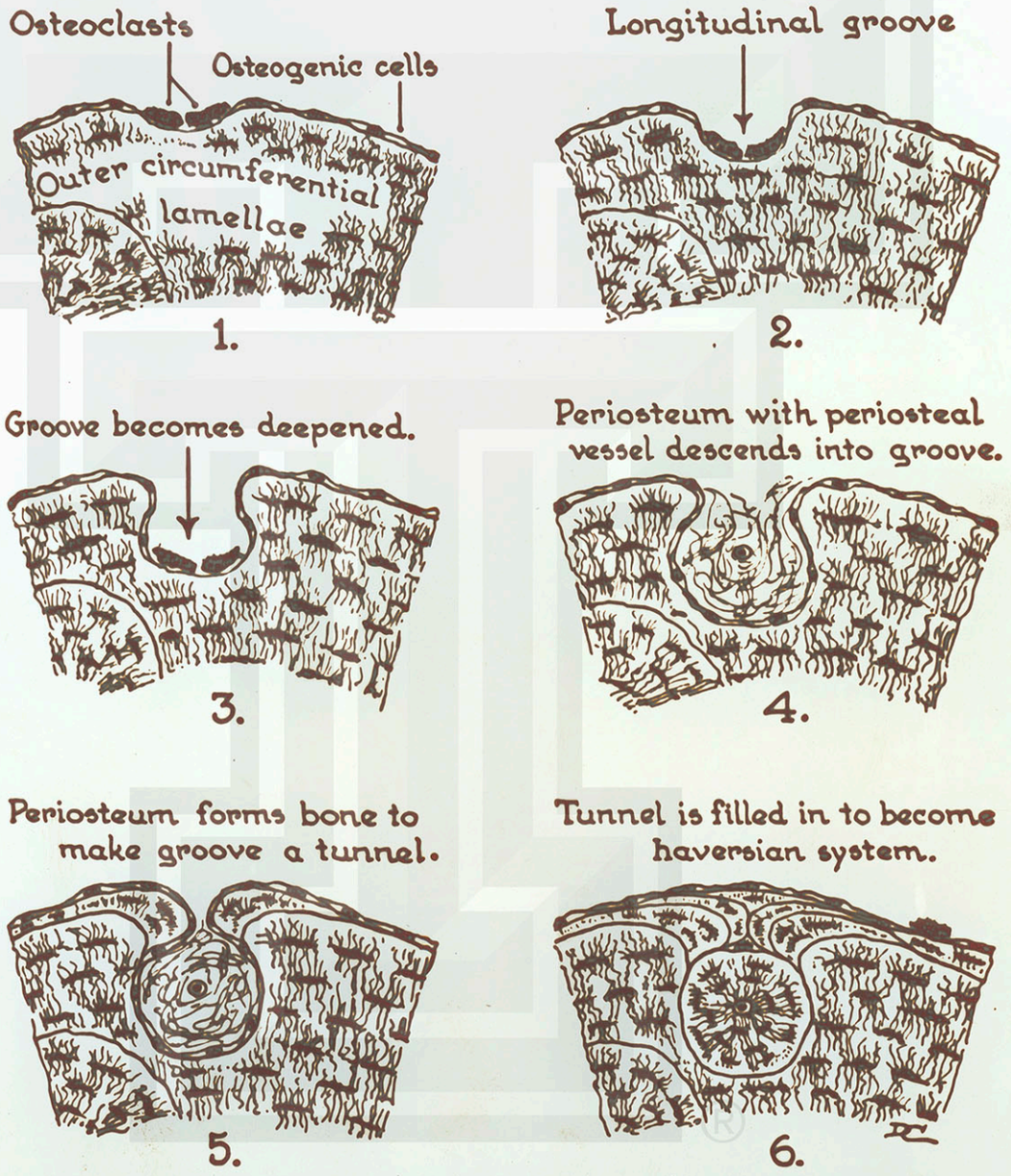


FIG. 158. Diagrams of cross sections of the shaft of a bone showing how haversian systems are laid down under the periosteum in older bones to replace outer circumferential lamellae.

TOP VERTICAL

4C

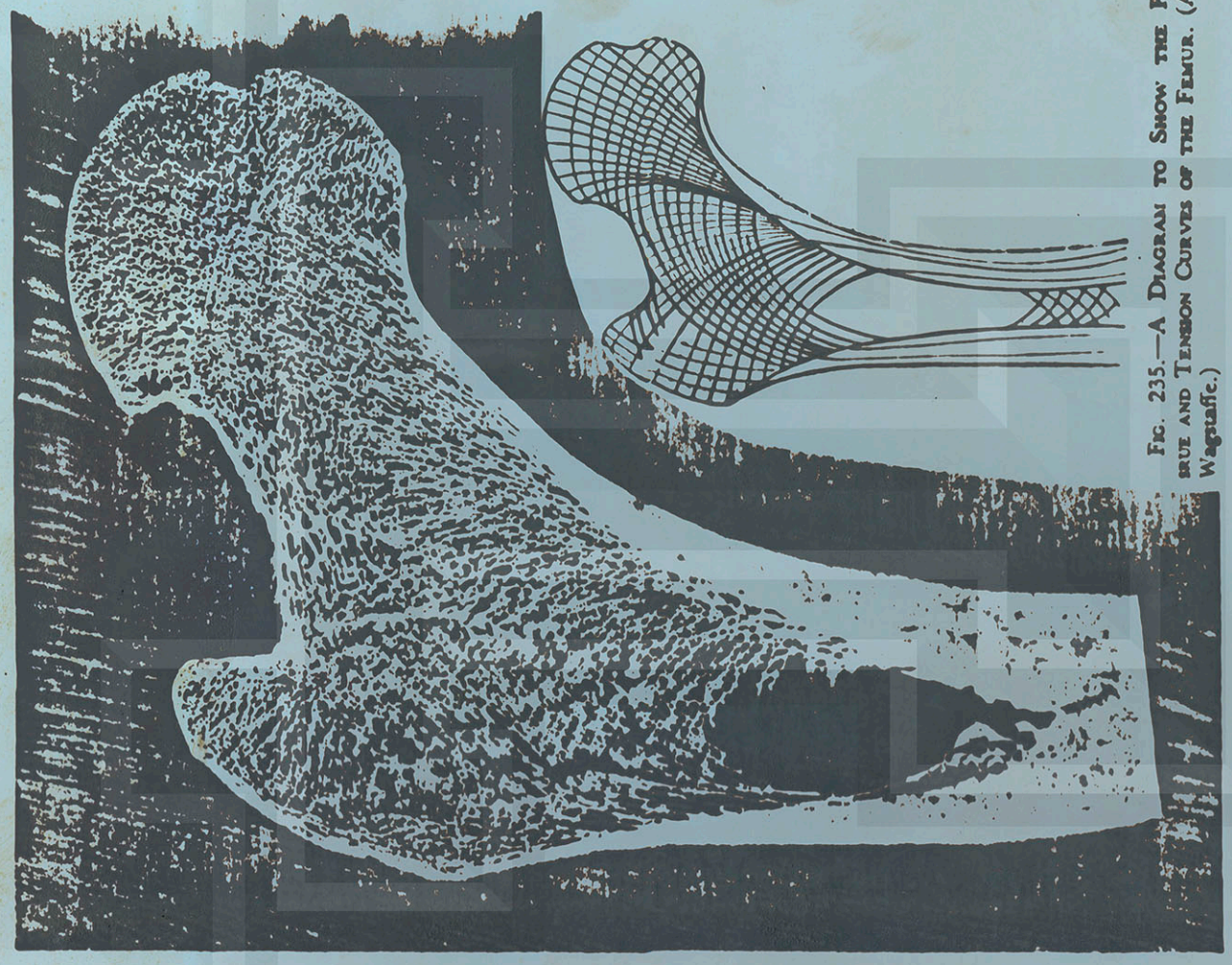


FIG. 235.—A DIAGRAM TO SHOW THE PRESSURE AND TENSION CURVES OF THE FEMUR. (After Wagstaffe.)

327. Right thigh bone, *femur*, upper extremity; ground frontal section, from in front.

NUMBER 4A

TOP HORIZONTAL

NOTES:

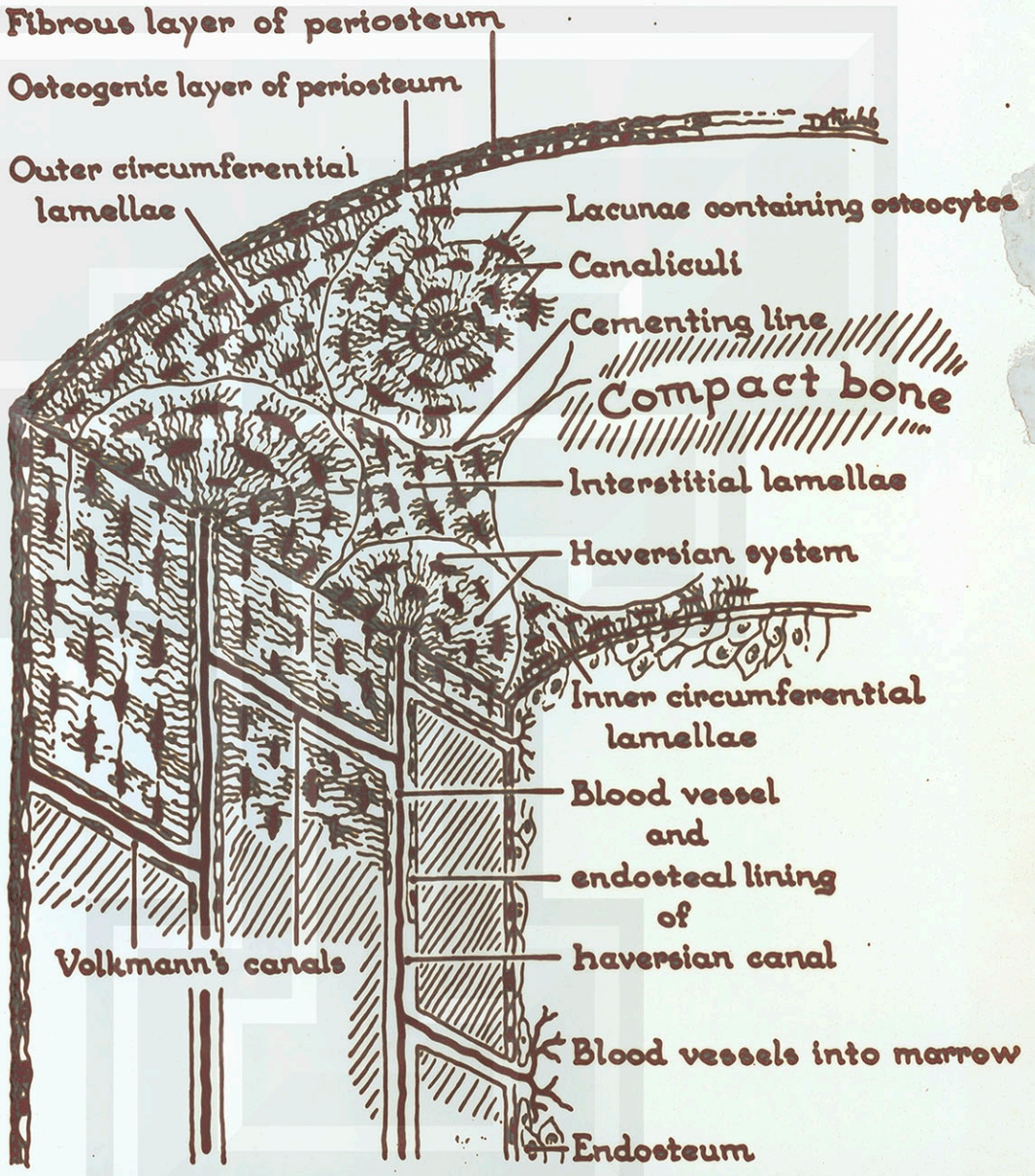


FIG. 160. A three-dimensional diagram showing the appearance of both a cross section and a longitudinal section of the shaft of a mature long bone. This diagram shows the relationship between the blood vessels of the periosteum, Volkmann's canals, haversian canals and the marrow cavity.

TOP VERTICAL

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TOP HORIZONTAL

NUMBER 7

NOTES:

How haversian systems are added to periphery of young shaft.

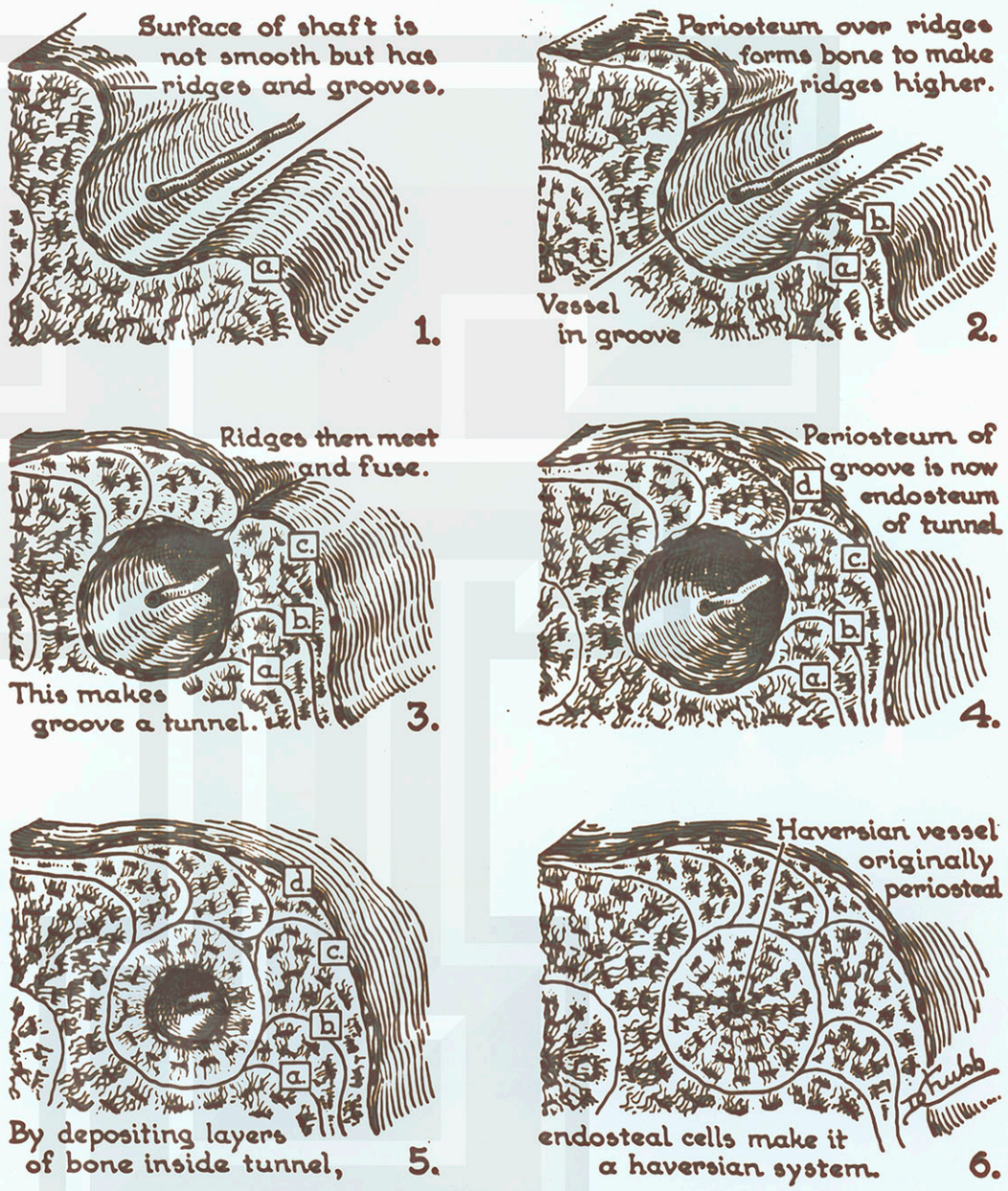

FIG. 157. Three-dimensional diagrams to show how the longitudinally disposed grooves on the exterior of a growing shaft become roofed over to form tunnels and how these become filled in to form haversian systems which thereupon are added to the exterior of the shaft. These diagrams also show how the blood supply of a shaft of a long bone comes to be derived, when it is fully grown, almost entirely from the periosteum by means of vessels having been buried in its substance.

TOP VERTICAL

SL-2-3-4 MEDICAL TREND CHARTS
(COLOR)
MARCH 4, Status

TOP HORIZONTAL

NUMBER _____

_____

NOTES:

TOP VERTICAL

FIGURE 11-5. Vitamin D Deficiency Rickets: Active and Healing Stages.

A, The patient was two and one-half years old. Characteristic changes consequent to active rickets are demonstrated in the wrists. The metaphyses are cupped, frayed, broadened, and irregular (*large arrows*); the space between the metaphyses and epiphyses (*small arrows*) is widened—possibly the most diagnostic finding in active rickets. All the bones are demineralized to some extent and the trabeculae are coarsened; this is seen most clearly on comparison with later films.

B, Six months after vitamin D therapy, the metaphyses are less cupped and frayed, and they are narrower. Although some irregularities persist, the metaphyses will become normal with further growth.

The distance between metaphysis and epiphysis is normal, indicating disappearance of the excess noncalcified osteoid tissue, and the bones have the normal mineral density.

NOTES:

FIGURE 11–7. **Active Rickets: Healing.** Periosteal new bone layering is best seen in the humerus *(arrowheads)*. The typical frayed cupped metaphysis *(black arrows)* and the widened space between the epiphysis and metaphysis *(white arrow)* are prominent signs.

Areas of normally calcified trabeculae have developed within the otherwise demineralized bones as a result of vitamin therapy.