組織學實驗：骨骼及軟骨
Histology laboratory : Bone & cartilage

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Please study these slides before coming to the class!

Sources of the Pictures & Text

Wheater's Functional Histology (4th ed)
B. Young & J. W. Heath
Histology: A Text and Atlas (4th ed)
M.H. Ross & W. Pawlina
Color Atlas of Histology (4th ed)
L.P. Gartner & J.L. Hiatt

Photomicrographs are Taken by

Department of anatomy,
Kaohsiung Medical University

Learning Objective

Microscopic structure of bone & cartilage is studied from following specimens

93W3211 Mesenchyme (sec.) H&E

93W3265 Hyaline Cartilage (sec.) H&E

93W3267 Cartilage, Composite (sec.) v&e

93W3279 White Fibro-cartilage (sec.) H&E

93W3288 Bone Marrow, Long Bone (cs) H&E

93W6141 Bone, Ground preparation (cs)

Learning Objective

- Understand the microscopic structure of cartilage & bone
- Comparison among three types of cartilage: hyaline, elastic, and fibrocartilage

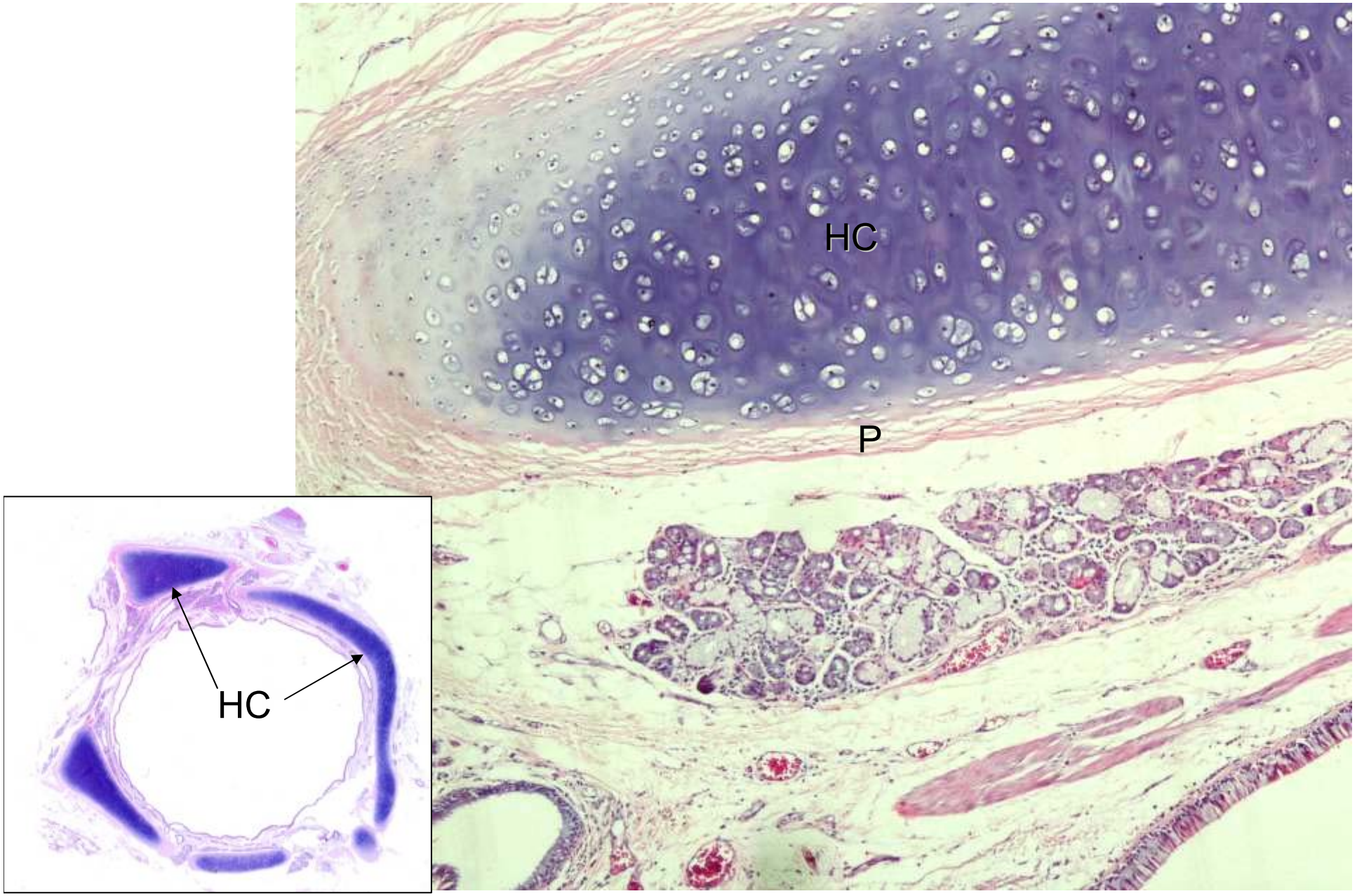

Fig 1. 93W3265 Hyaline Cartilage, H&E.

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Hyaline cartilage (HC) is the most common type of cartilage though the whole body and is also found in the bronchi (as shown here). In the wall of the bronchus, the cartilaginous plates are arranged into flattened, discontinuous plates. The cartilaginous plates are surrounded by the perichondrium (P).

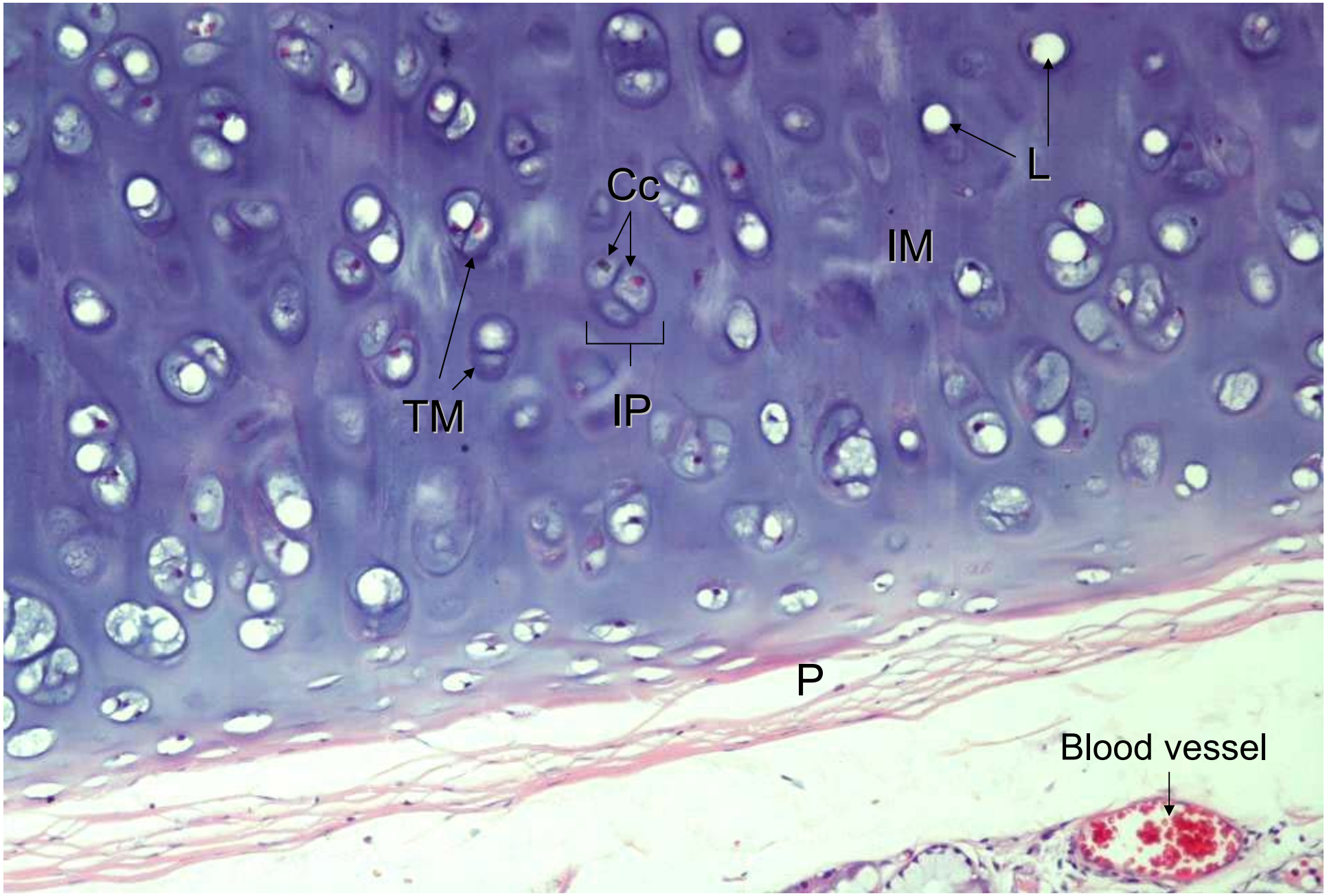

Fig 2. 93W3265 Hyaline Cartilage, H&E.

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This figure shows a higher-magnification micrograph of a hyaline cartilage with its perichondrium (P). The cartilage appears as an avascular expanse of matrix material and a population of cells called chondrocytes (Cc). The chondrocytes produce the matrix; the space each chondrocyte occupies is called a lacuna (L). Hyaline cartilage is surrounded by a thin layer of dense connective tissue, the perichondrium. The perichondrium serves as a source of new chondrocytes during appositional growth of the cartilage. Chondrocytes also undergo interstitial growth in lacunae and form isogenous groups (IP). The chondrocytes produce the cartilage matrix that shows the dark-staining capsule or territorial matrix (TM) immediately surrounding the lacunae. The interterritorial matrix (IM) is more removed from the immediate vicinity of chondrocytes and is less intensely stained.

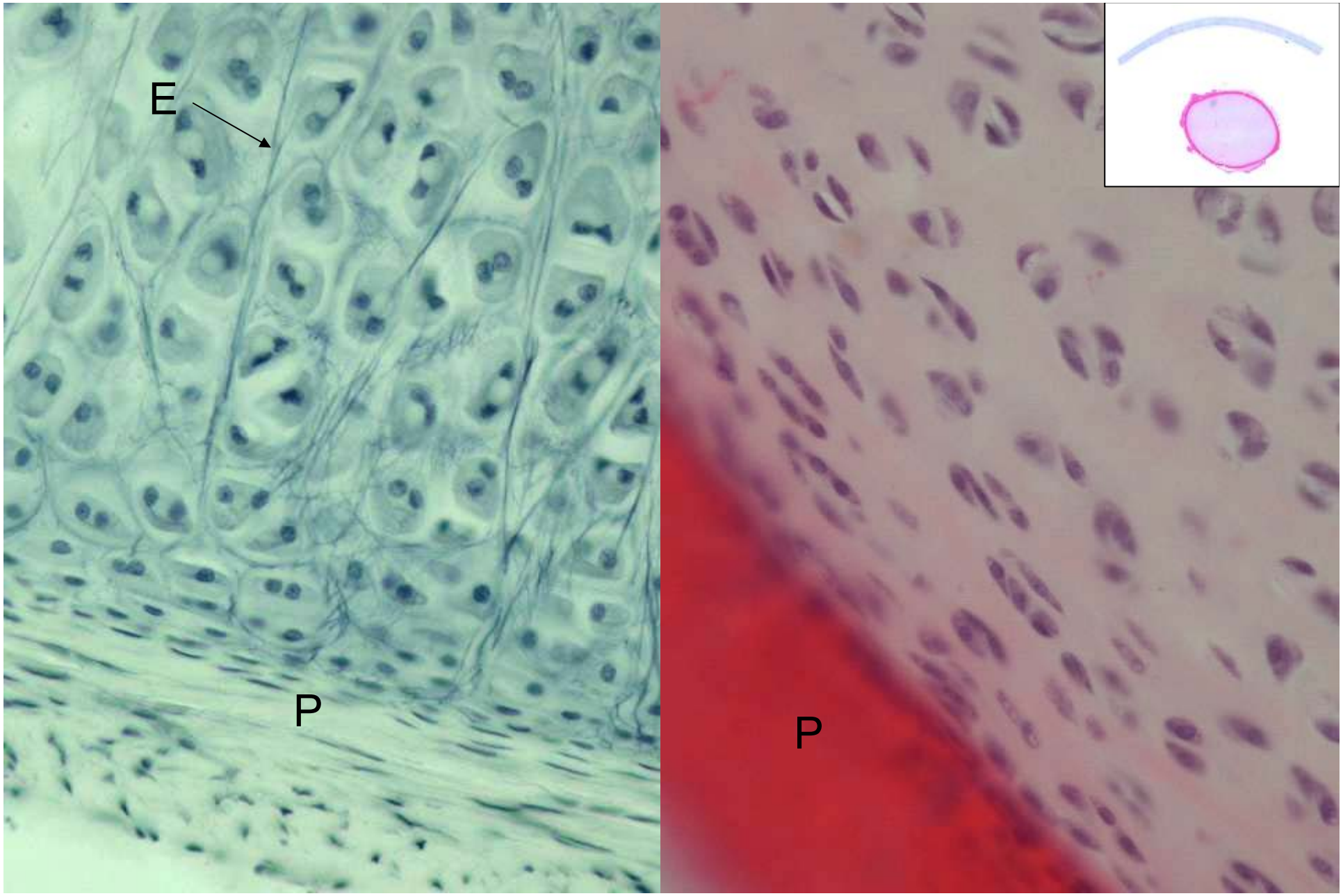
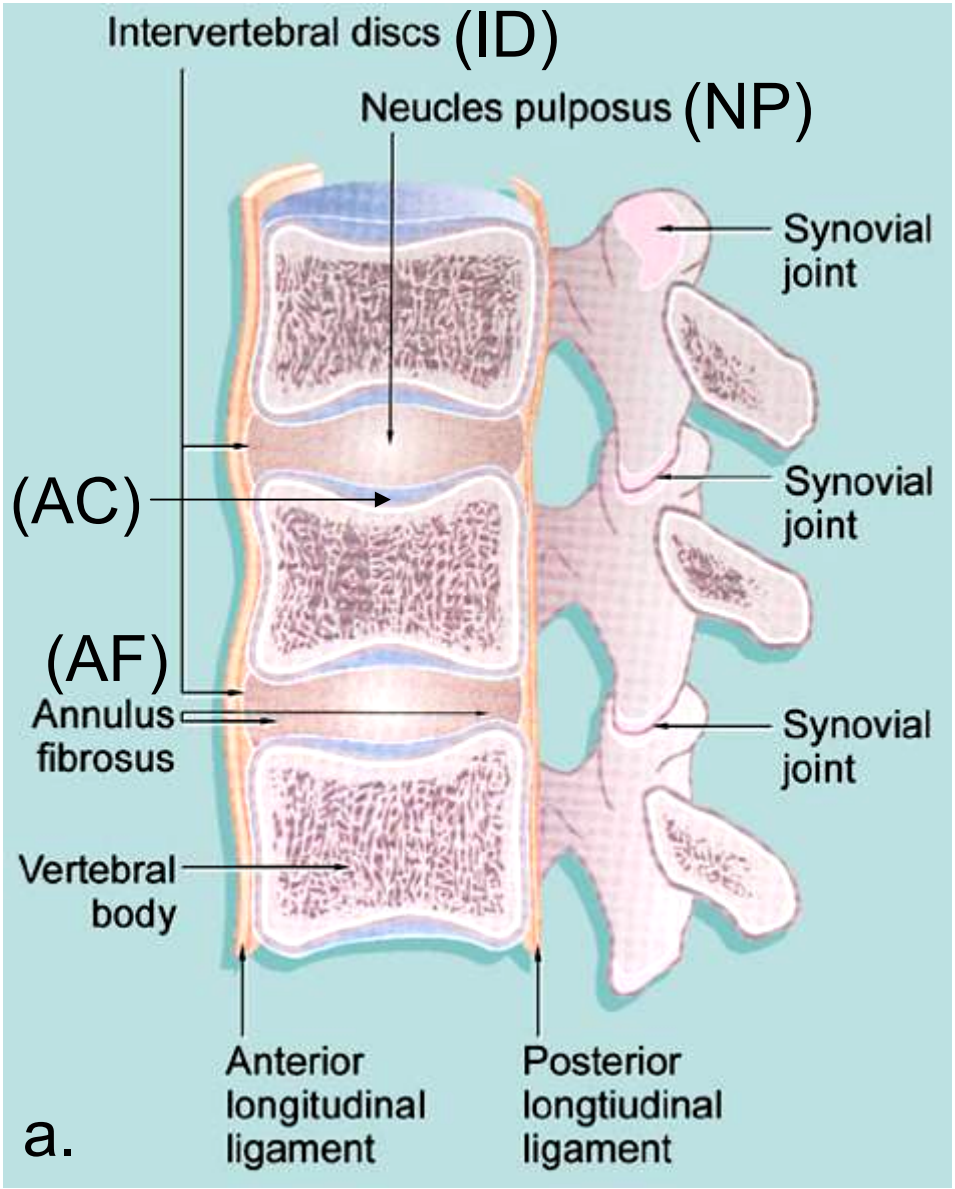
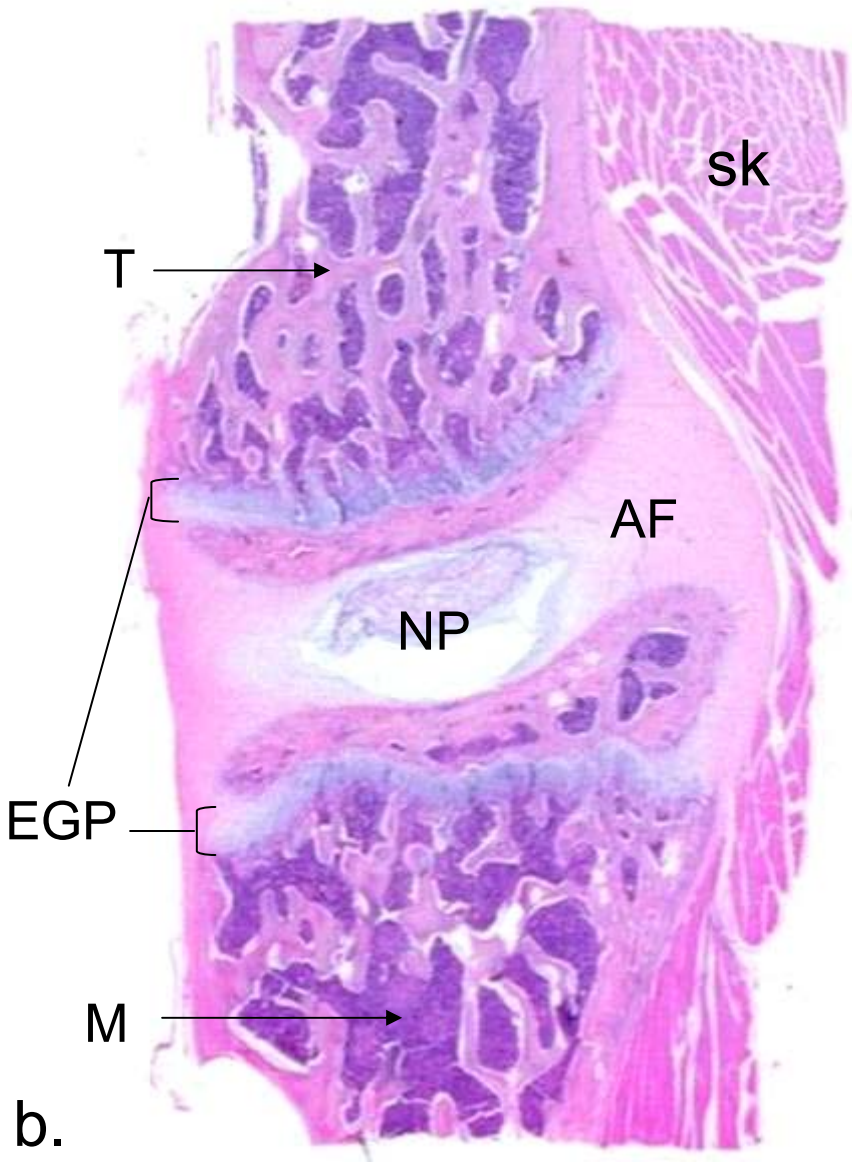


Fig 3. 93W3267 Cartilage, Composite, verhoff (left); H&E (right).

Fig 3. 93W3267 Cartilage, Composite, verhoff (left) H&E (right).

There are two sections in this slide (inset): upper one is elastic cartilage and lower one is hyaline cartilage. These sections are taken from young, growing cartilages and both of them are surrounded by the perichondrium (P). The mainly distinguished feature of hyaline and elastic cartilages is the elastic fibers (E), which are only found in elastic cartilage. The common histological structure of elastic cartilage is similar to that of hyaline cartilage, its elasticity, however, being derived from the presence of numerous bundles of branching elastic fibres in the cartilage matrix.





Wheater's Functional Histology

Fig 4. 93W3279 White Fibro-cartilage, H&E.

Fig 4a. The intervertebral joints

The intervertebral disc (ID) lies between the adjacent vertebral bodies. The articular surface of vertebral body is covered by hyaline articular cartilage (AC). The fibrocartilage of each intervertebral disc is arranged in concentric rings forming the annulus fibrosus (AF). Within the disc, there is a central cavity containing a viscous fluid, the nucleus pulposus (NP).

Fig 4b. 93W3279 White Fibro-cartilage (sec.) H&E.

This section is prepared from the developing vertebral column. Except the structures mentioned above, the skeletal muscle (sk) and the epiphyseal growth plates (EGP) can be identified. In this low power photomicrograph, the vertebral bodies have been partially replaced by bone trabeculae (T), and the bone cavity is filled with bone marrow (M).

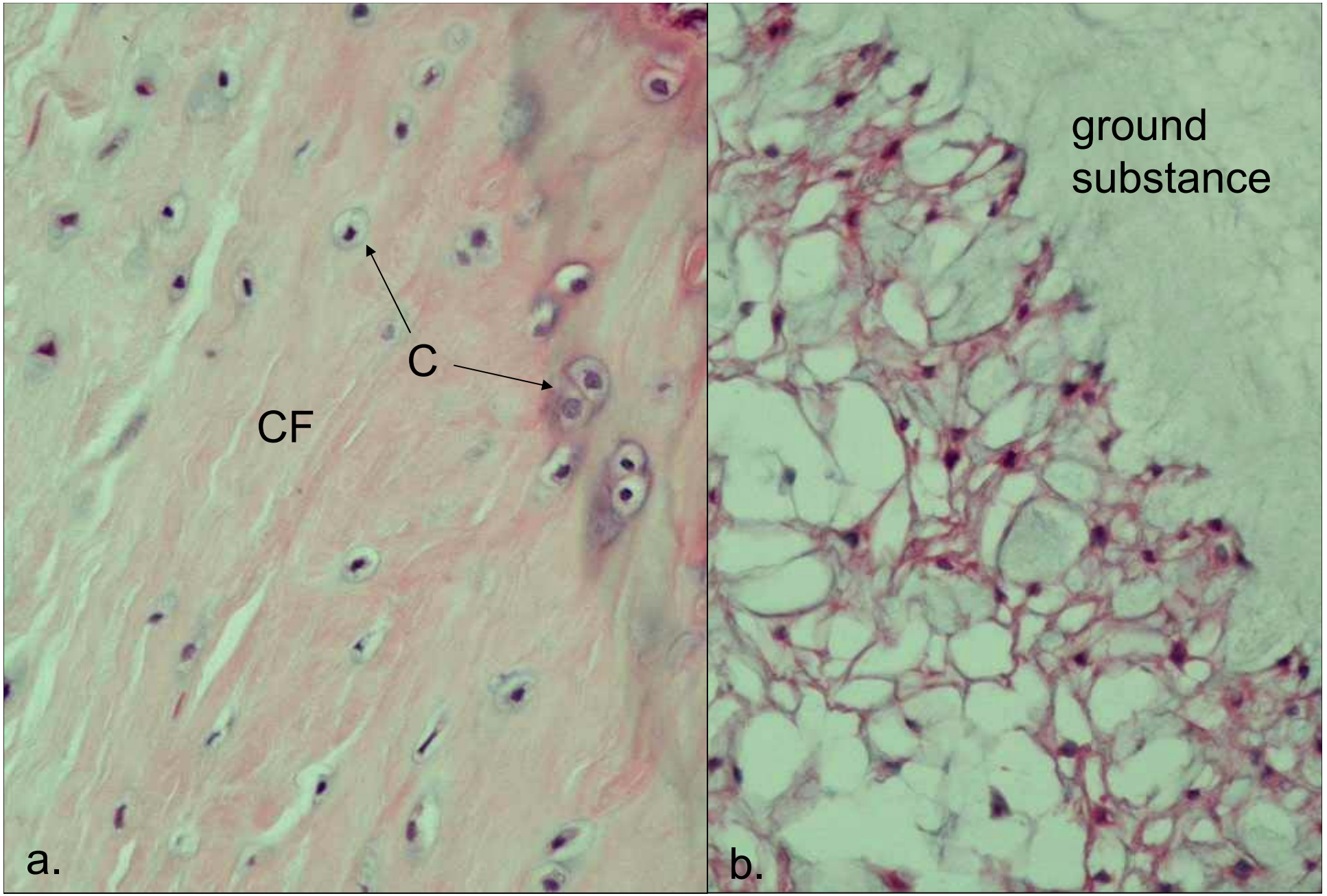


Fig 5. 93W3279 White Fibro-cartilage, H&E.

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Fibrocartilage is a combination of dense regular connective tissue and hyaline cartilage. The chondrocytes (C) are dispersed among the collagen fiber bundles (CF) (Fig 5a).

Fig 5b shows the histological structures in the nucleus pulposus.

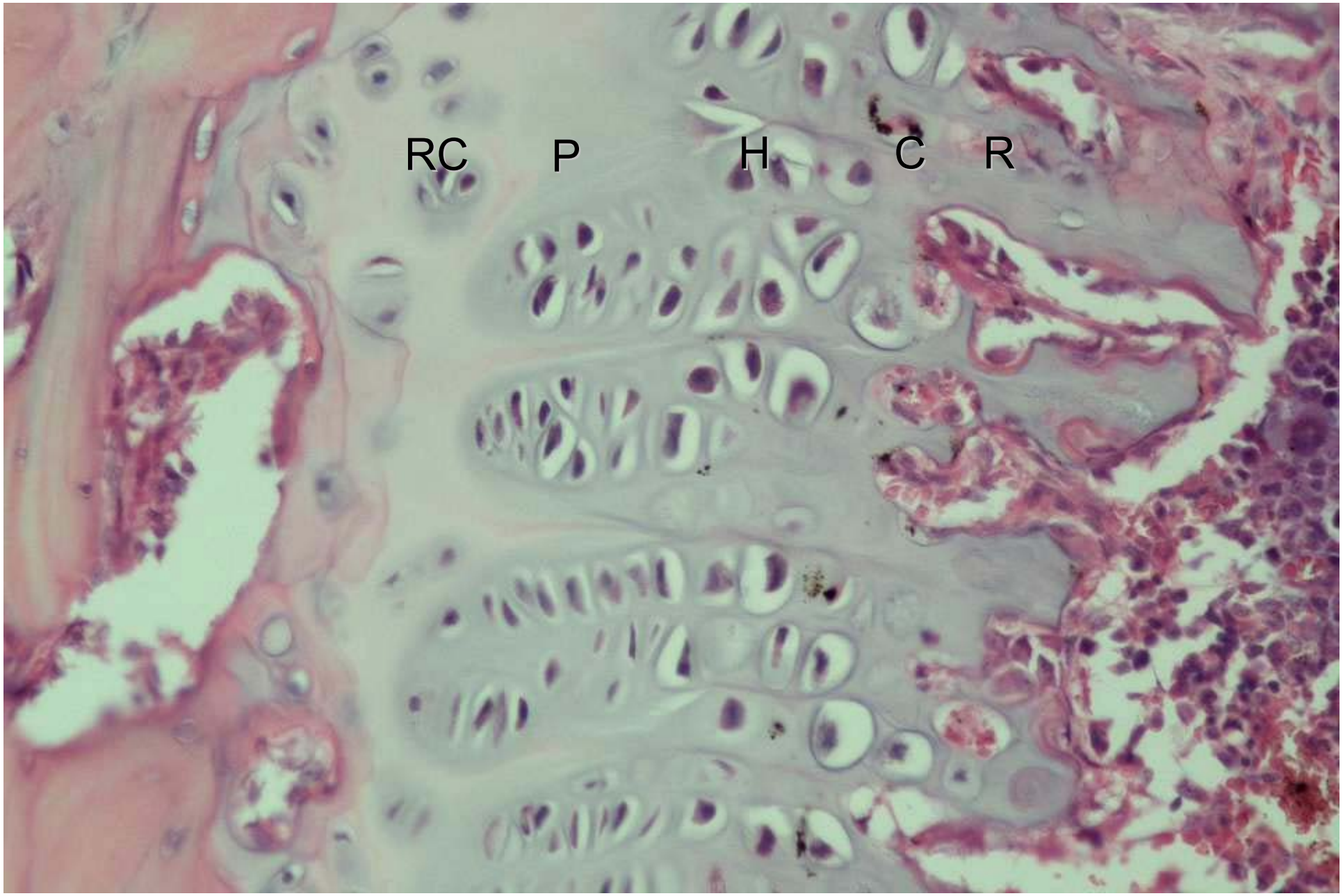

Fig 6. 93W3279 White Fibro-cartilage, H&E.

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The vertebrae are formed by endochondral ossification. The dynamic process of endochondral ossification is summarized in this micrograph of the epiphyseal growth plate.

Zone of reserve cartilage (RC): resting hyaline cartilage.

Zone of proliferation (P): the cartilage cells undergo division and appear as distinct columns.

Zone of hypertrophy (H): the chondrocytes become greatly enlarged and vacuolated.

Zone of calcified cartilage (C): the enlarged cells begin to degenerate and the matrix becomes calcified.

Zone of resorption (R): blood vessels and connective tissue invade and the osteogenic cells differentiate into osteoblasts which produce osteoid.

You don’t have to focus on the terminology of zones of endochondral ossification. Just take notice of the dynamic process events during ossification.

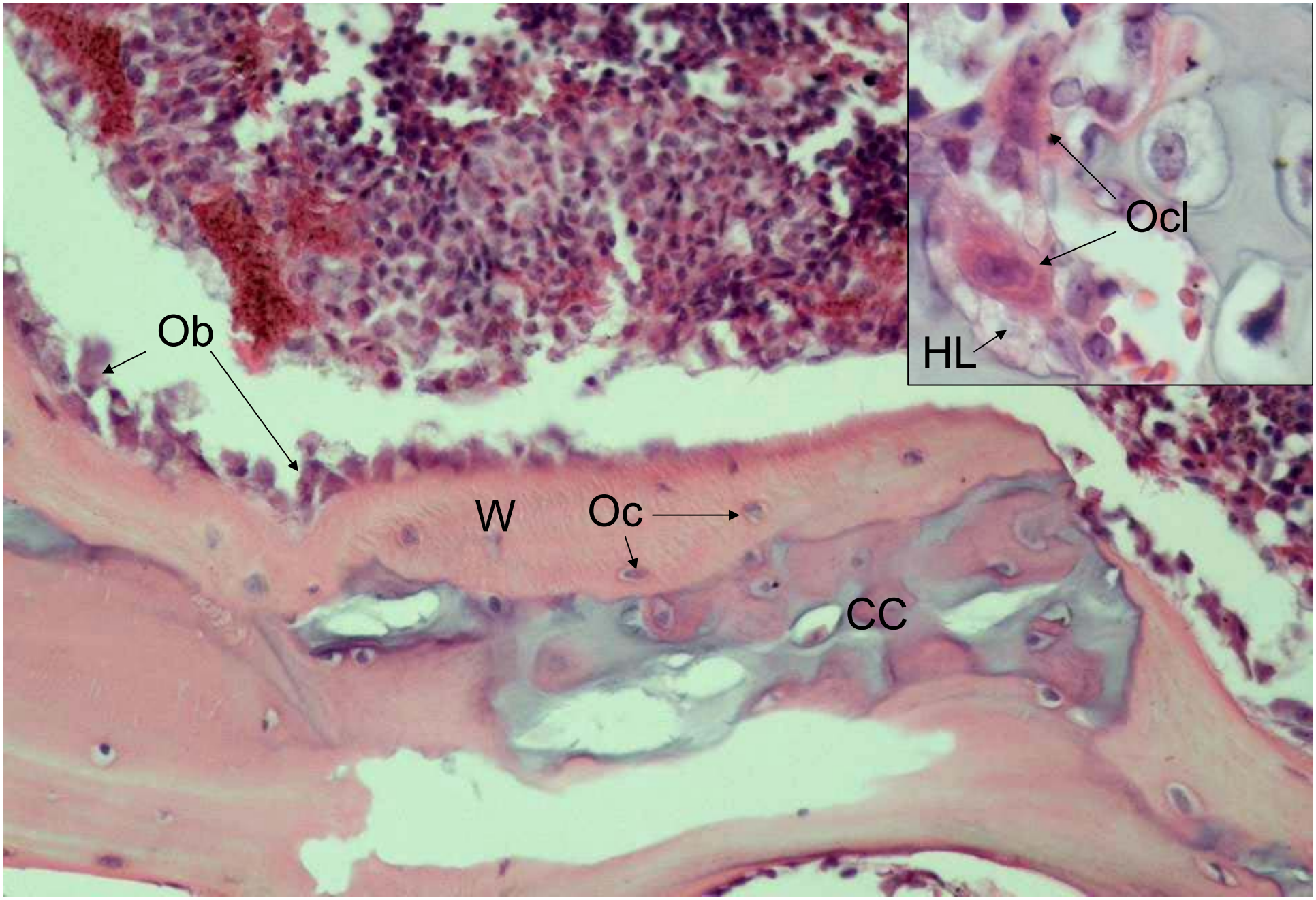

Fig 7. 93W3279 White Fibro-cartilage, H&E.

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The blue-stained spicules of calcified cartilage (CC) are surrounded by active osteoblasts (Ob) and newly formed woven bone (W), which is stained pink. The osteocytes (Oc) are embedded in the bone matrix. The inset reveals two large, multinucleated osteoclasts (Ocl) and the underlying absorptive space, Howship’s lacunae (HL), is also identified.

Fig 8. 93W3211, Mesenchyme, H&E.

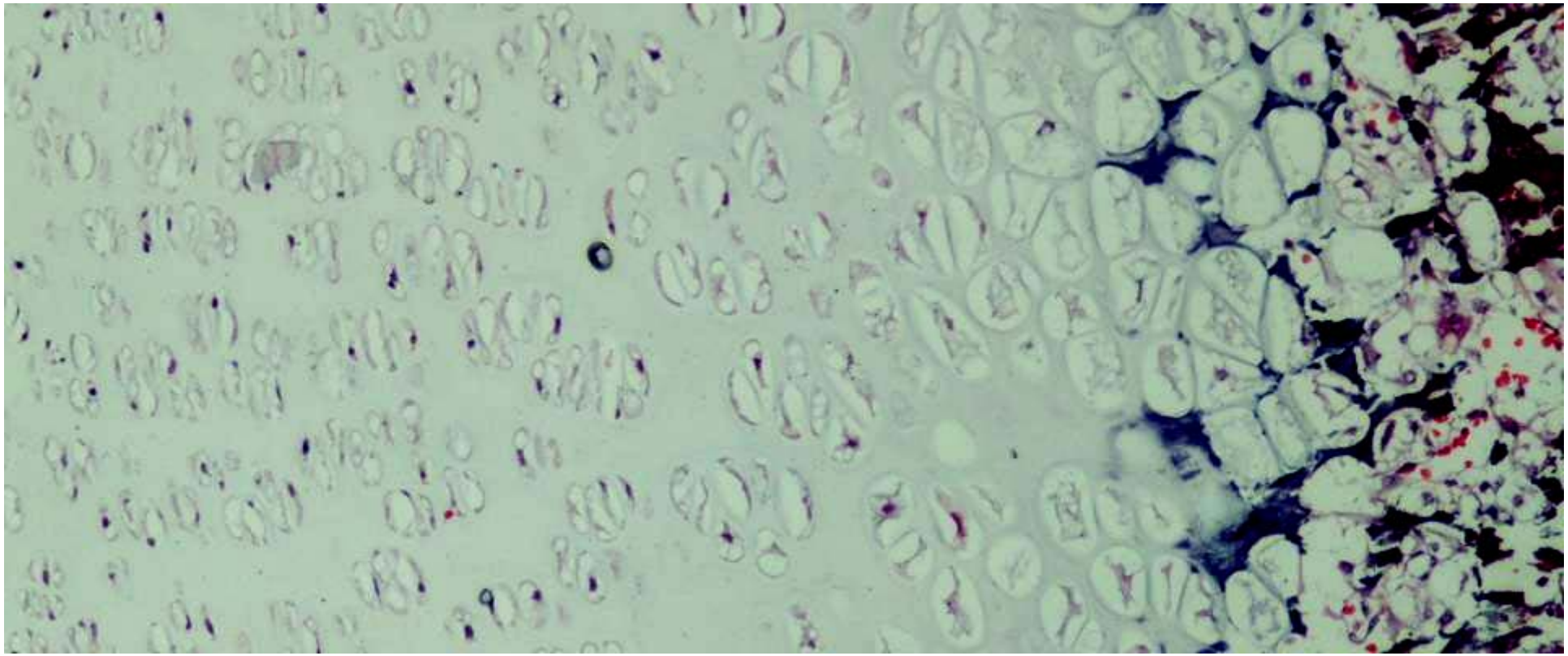

Fig 8. 93W3211 Mesenchyme, H&E.

This photomicrograph shows a longitudinal section of embryonic distal phalanx. This developing bone is undergoing endochondral ossification (similar to 93W3279).

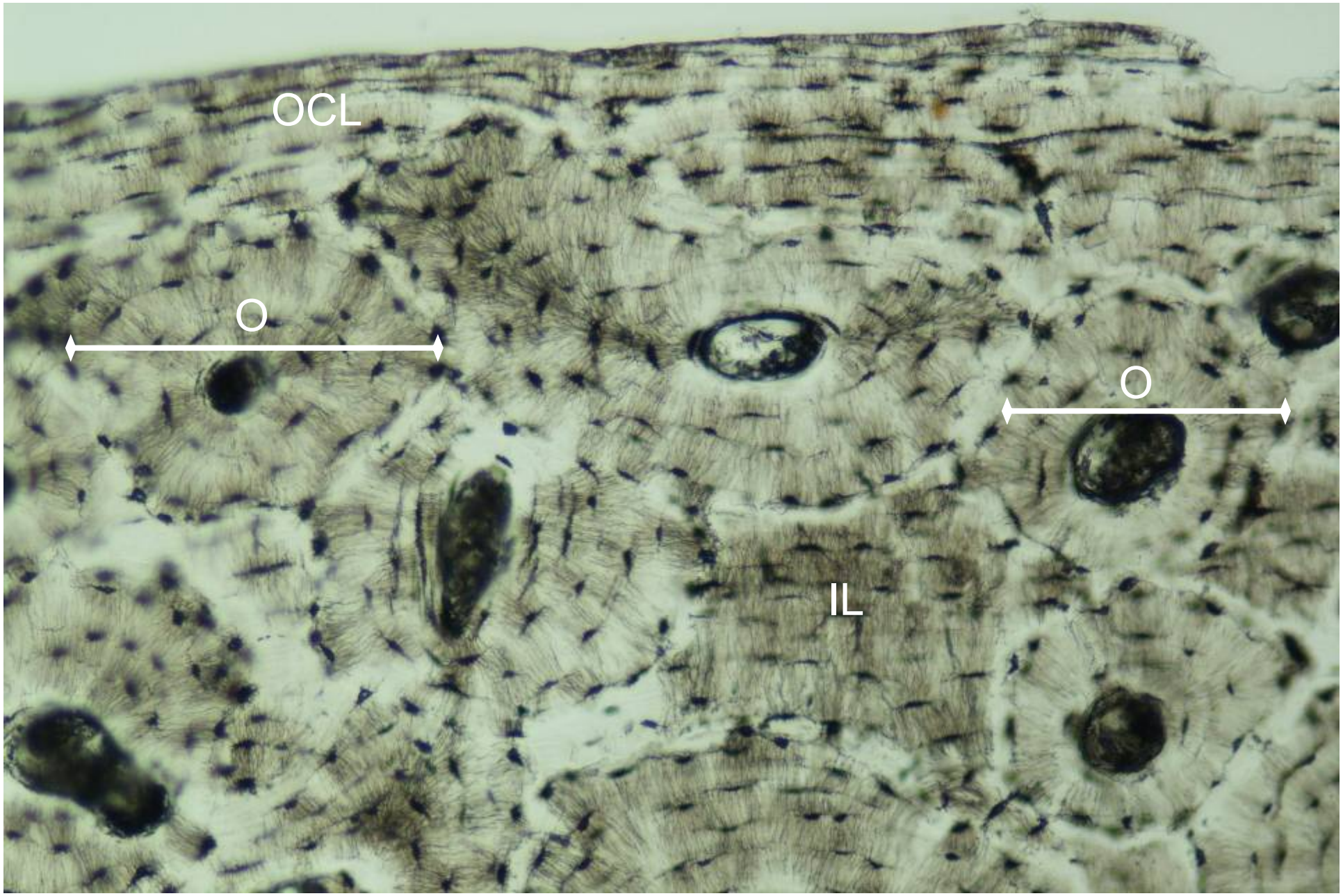

Fig 9. 93W6141 Bone, Ground preparation (cs).

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This figure reveals a cross-sectioned area of a long bone at low magnification and includes the outer or peripheral aspect of the bone, identified by the presence of outer circumferential lamellae (OCL). The osteons or Haversian systems appear as circular profiles. Between the osteons, there are interstitial lamellae (IL), the remnants of previously existing osteons. Osteons are essentially cylindrical structures. In the shaft of a long bone, the long axes of the osteons are oriented parallel to the shaft of a long bone.

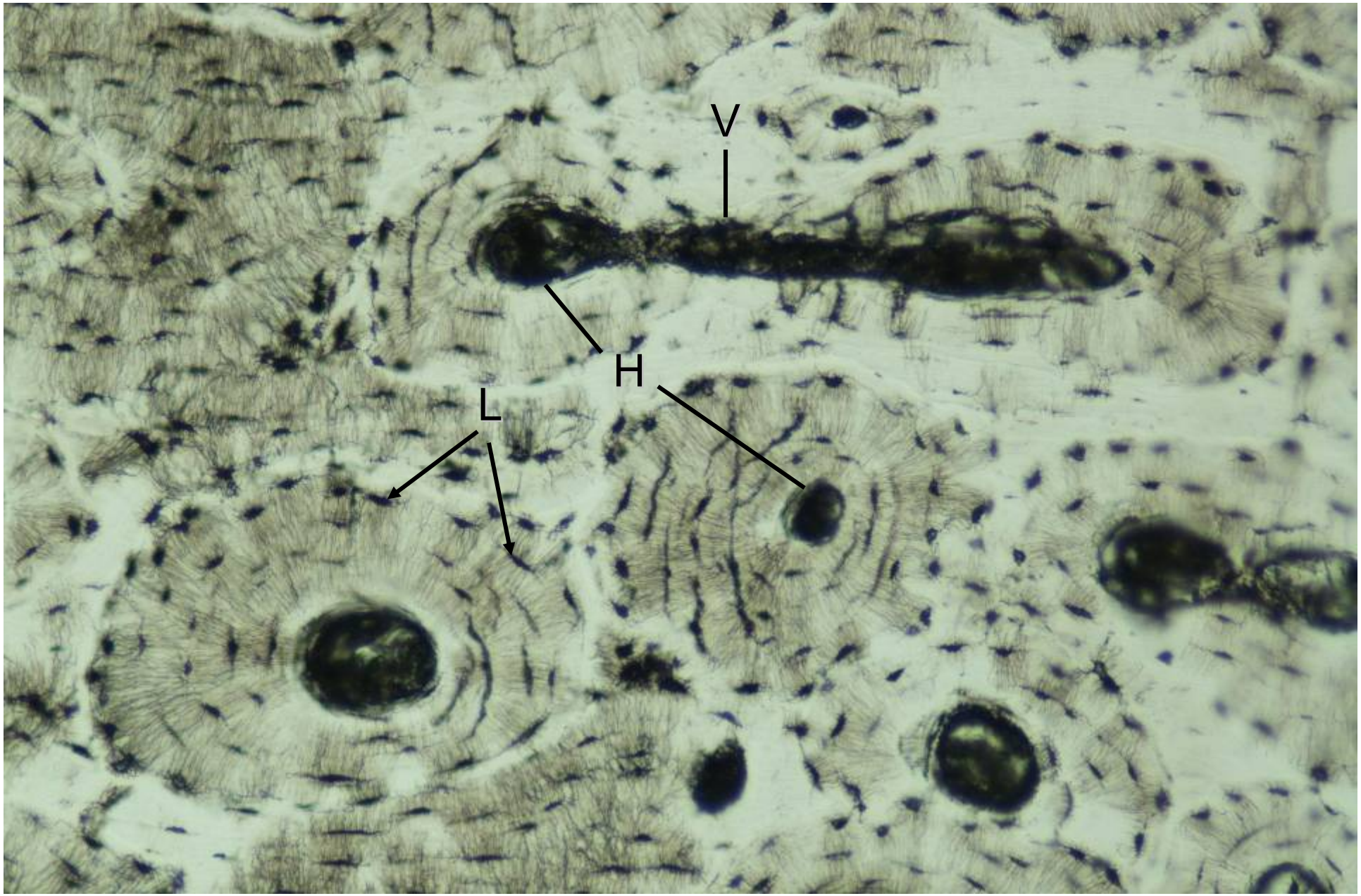

Fig 10. 93W6141 Bone, Ground preparation (cs).

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At the center of osteon is an osteonal canal (Haversian canal, HC) that contains soft tissues (not retained in ground sections). The Haversian canals and other spaces will appear black if filled with India ink or air. Layers of mineralized concentric lamellae surround the Haversian canal. The canal is also surrounded by concentric arrangements of lacunae (L).

Perforating canals (Volkmann's canals, VC) travel from one Haversian canal to another. These canals pass blood vessels reach the Haversian canals from the periosteal and endosteal surface to reach other tunnels. Volkmann's canals can be distinguished from Haversian canals in that they pass through lamellae, whereas Haversian canals are surrounded by concentric rings of lamellae.

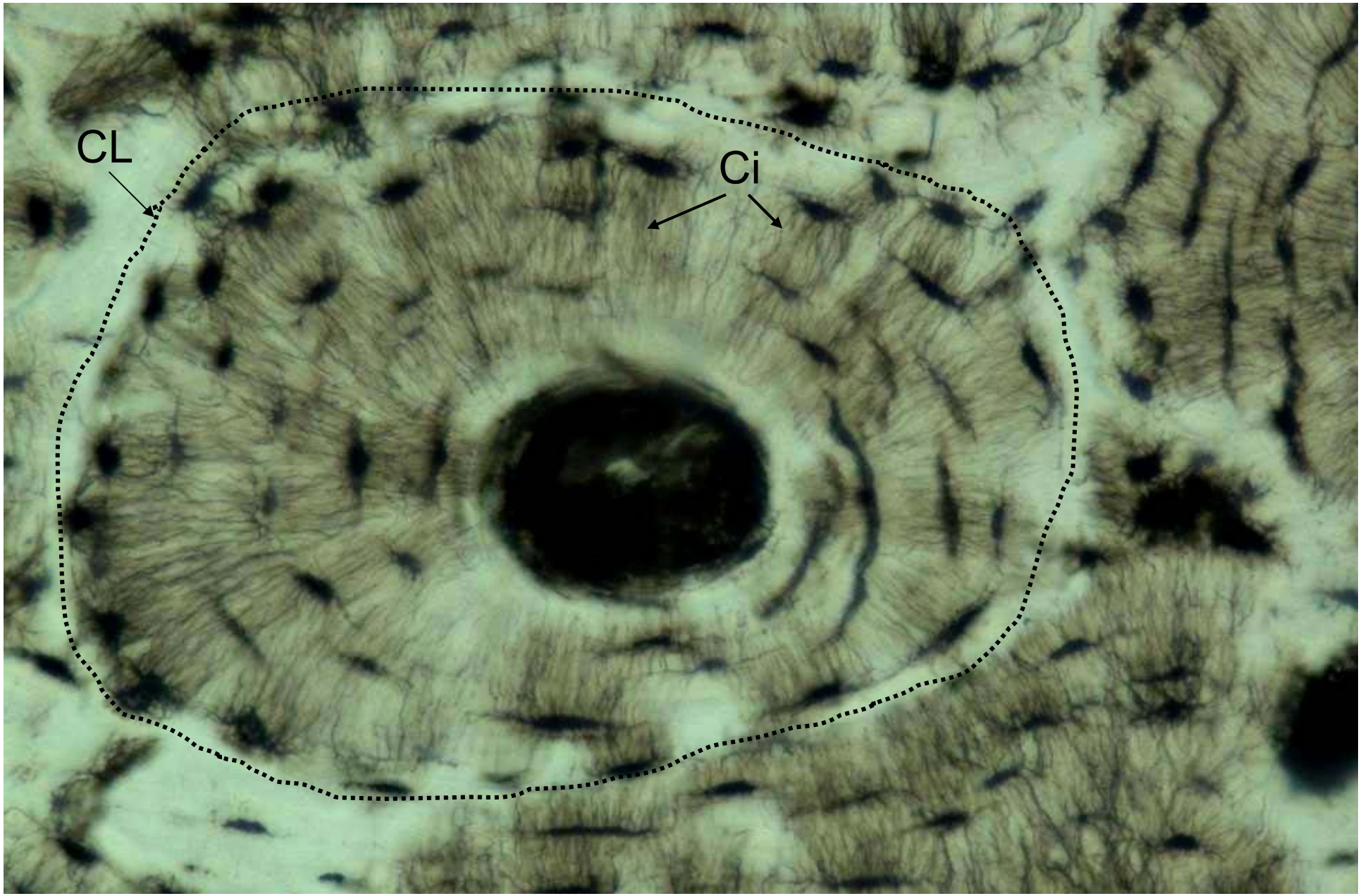

Fig 11. 93W6141 Bone, Ground preparation (cs).

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Note the lacunae and the fine thread-like profiles emanating from the lacunae. These thread-like profiles represent the canaliculi (Ci). They are spaces within the bone matrix that contain cytoplasmic processes of the osteocyte. The canaliculi of each lacuna communicate with these of neighboring lacunae to form a three-dimensional channel system throughout the bone. Cement line (CL) is the outer limits of a newly formed osteon.

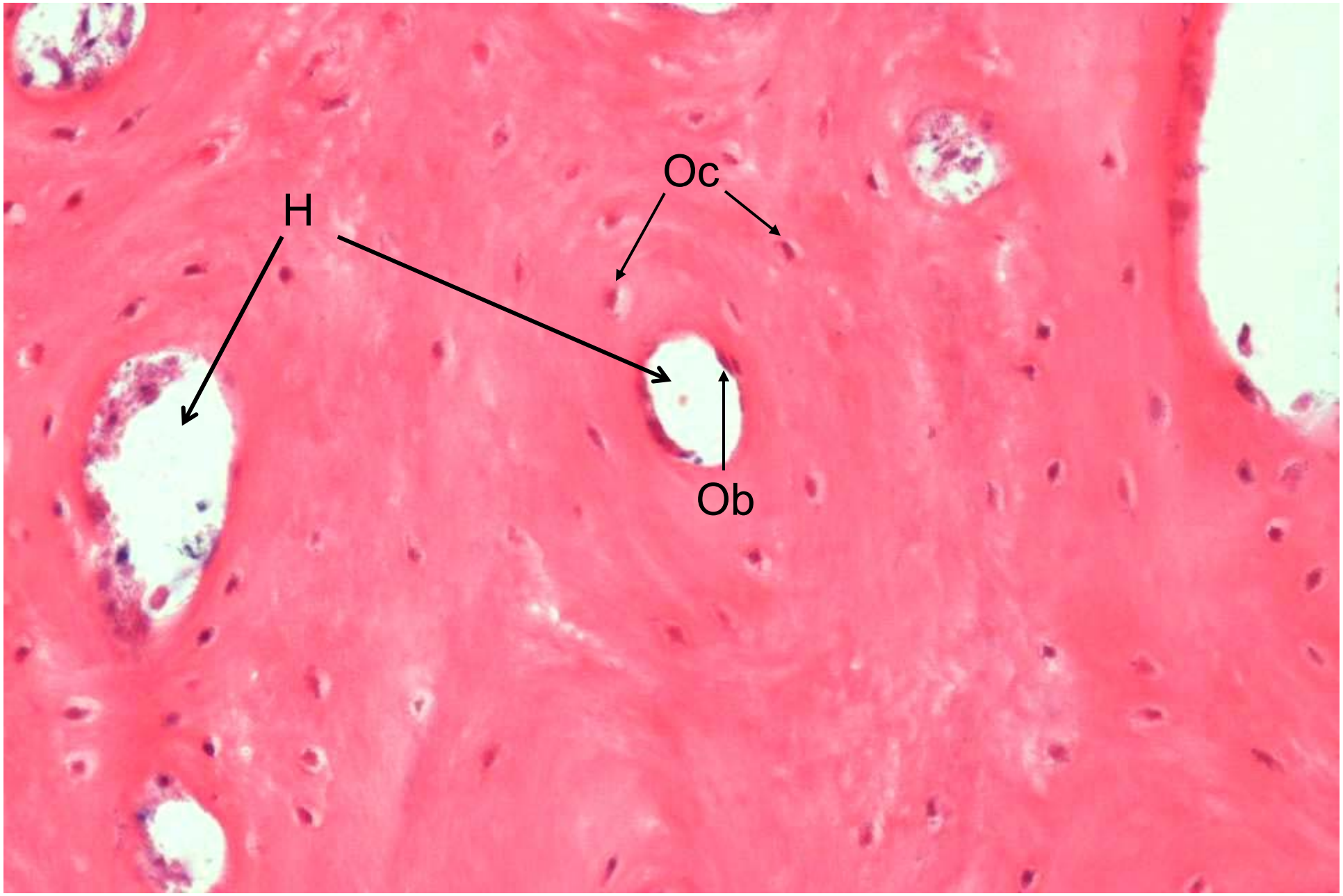

Fig 12. 93W3288 Compact bone, (cs) decalcified, H&E.

Fig 12. 93W3288 Bone Marrow, Long Bone (cs) H&E.
Decalcified mature bone is cross-sectioned and is stained with H&E. Haversian canal (H) is at the center of each osteon. The canals contain osteoblasts (Ob), blood vessels and connective tissue. Osteocytes (Oc) show dark staining nuclei and lie in lacunae from which canaliculi radiate (canaliculi can not be identified in this preparation.) The lamellae of the osteon are not clearly distinguished in this section.

Summary

93W3265 Hyaline Cartilage **93W3267** Cartilage, Composite	Hyaline cartilage, elastic cartilage Perichondrium Chondrocyte, lacunae, isogenous group Territorial & interterritorial matrix
93W3279 White Fibro-cartilage	Fibrocartilage, intervertebral disc Hyaline articular cartilage Annulus fibrosus, nucleus pulposus Marrow, chondrocyte Ground substance, physaliphorous cells

Summary

93W3279 White Fibro-cartilage **93W3211** Mesenchyme	Endochondral ossification, bone marrow Epiphysial growth plates, trabecula Zone of reserve cartilage, proliferation, hypertrophy, calcified cartilage & resorption Osteocyte, osteoblast, osteoclast, osteoid Woven bone, Howship's lacunae
93W6141 Bone, Ground preparation	Circumferential lamellae, interstitial lamellae Haversian systems or osteons Haversian canal, Volkmann's canals Lacunae, canaliculi, Cement line
93W3288 Bone Marrow, Long Bone	Haversian systems or osteons Haversian canal, Volkmann's canal Osteocyte, osteoblast