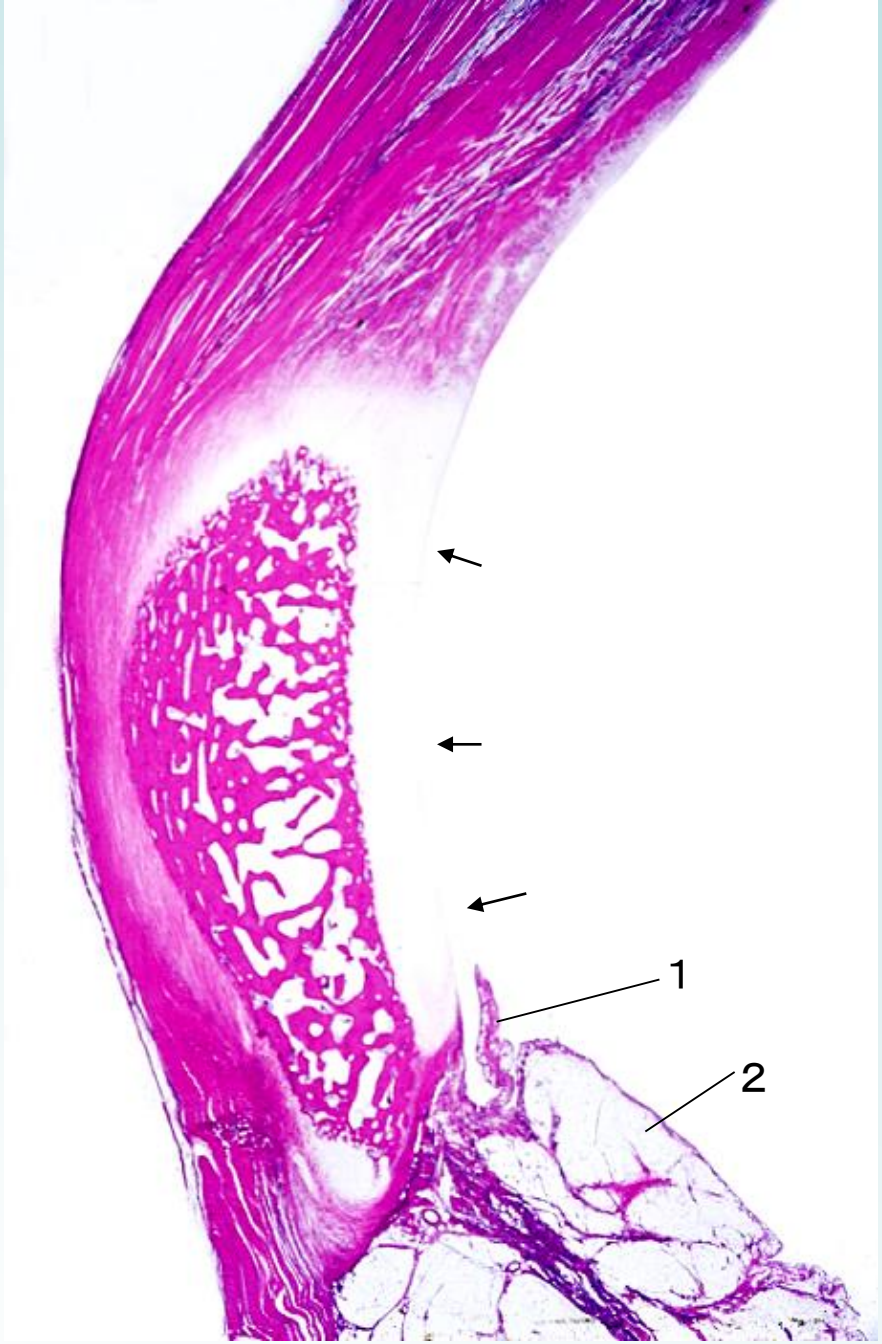
08-00
Bone and Joint

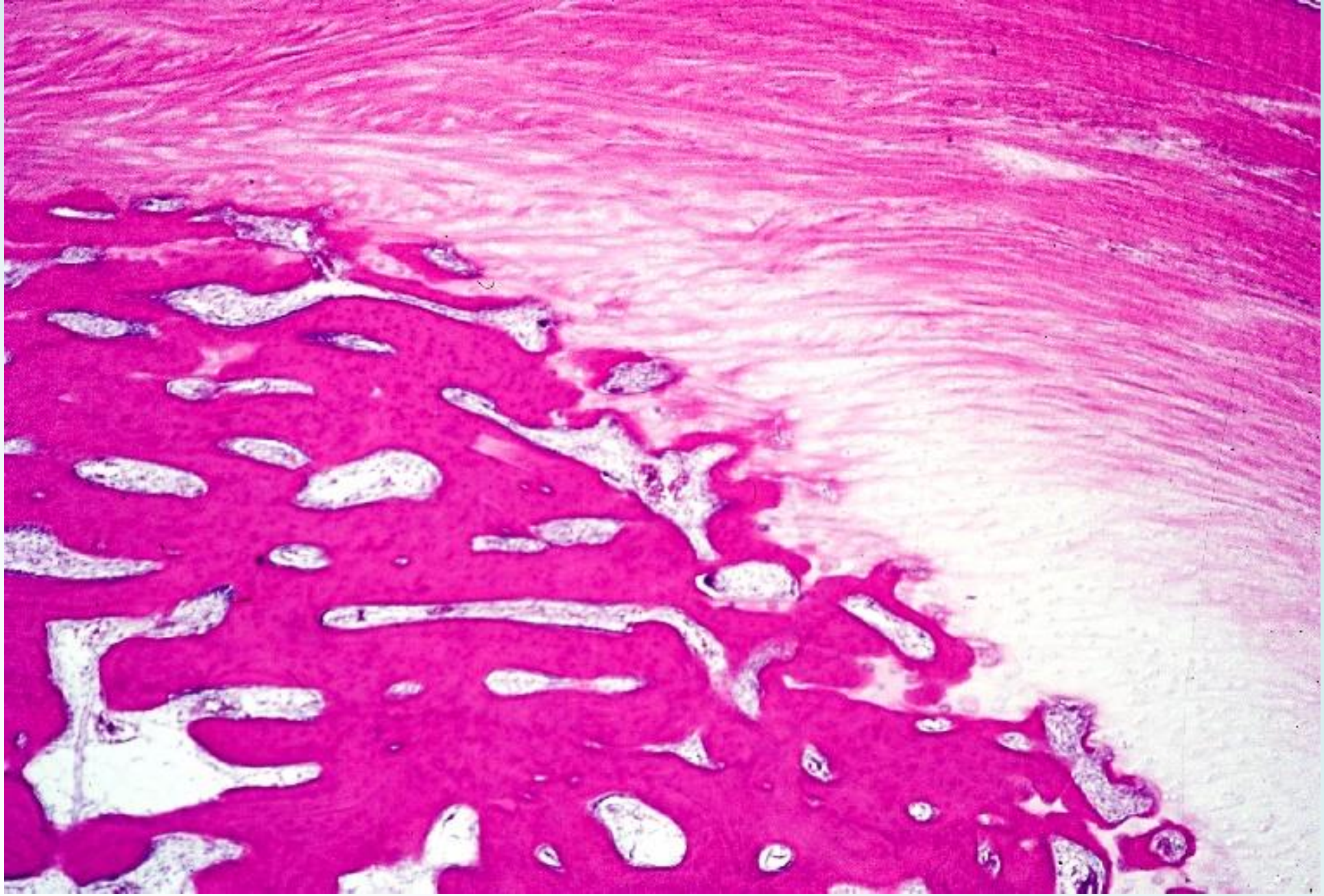
08 Bone and Joint
Menu

08-01 Femur, transverse section. Monkey, H-E stain, x 2.5.

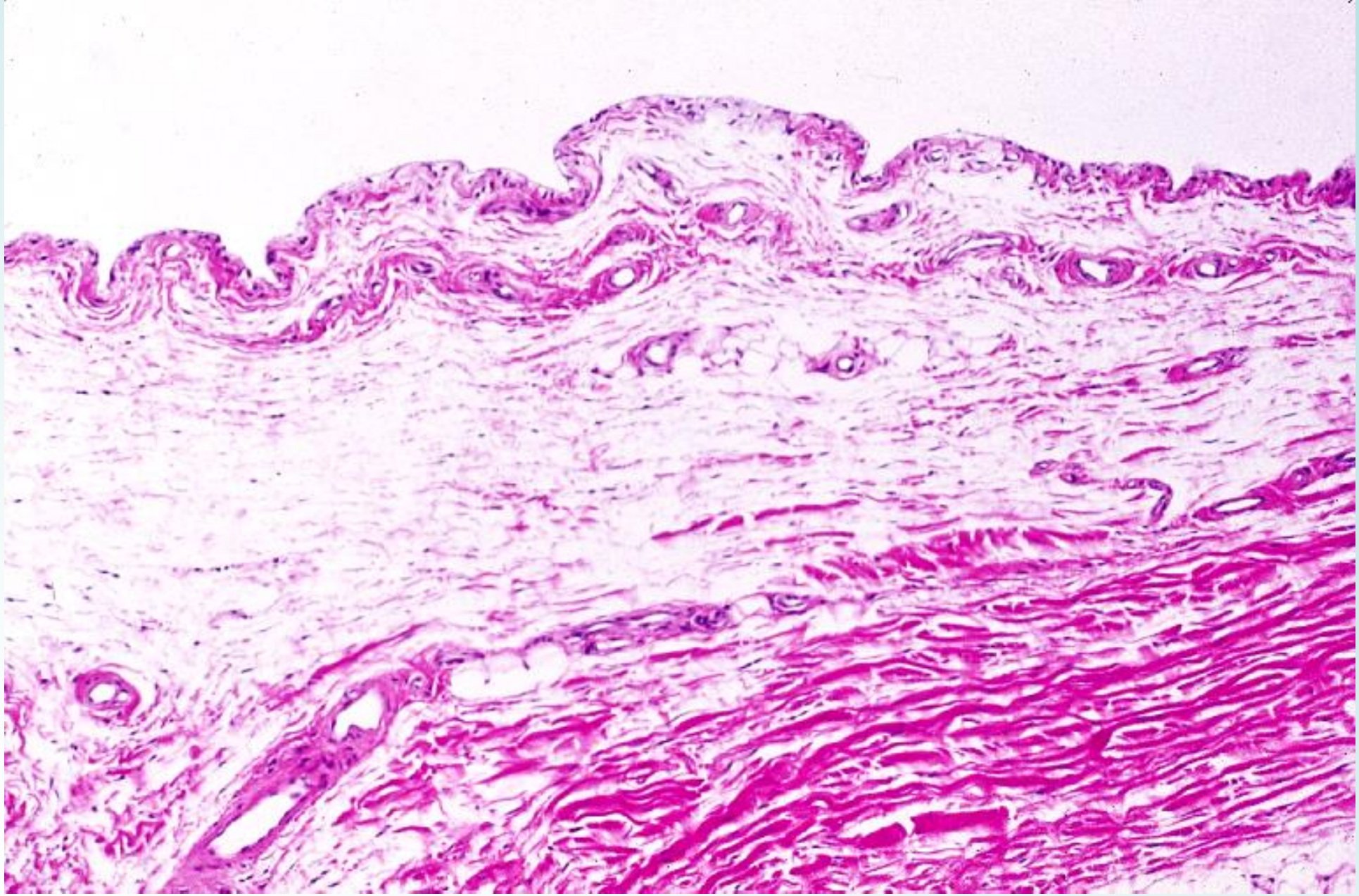
08-02 Distal end of femur, sagittal section. Monkey, H-E stain, x 1.3



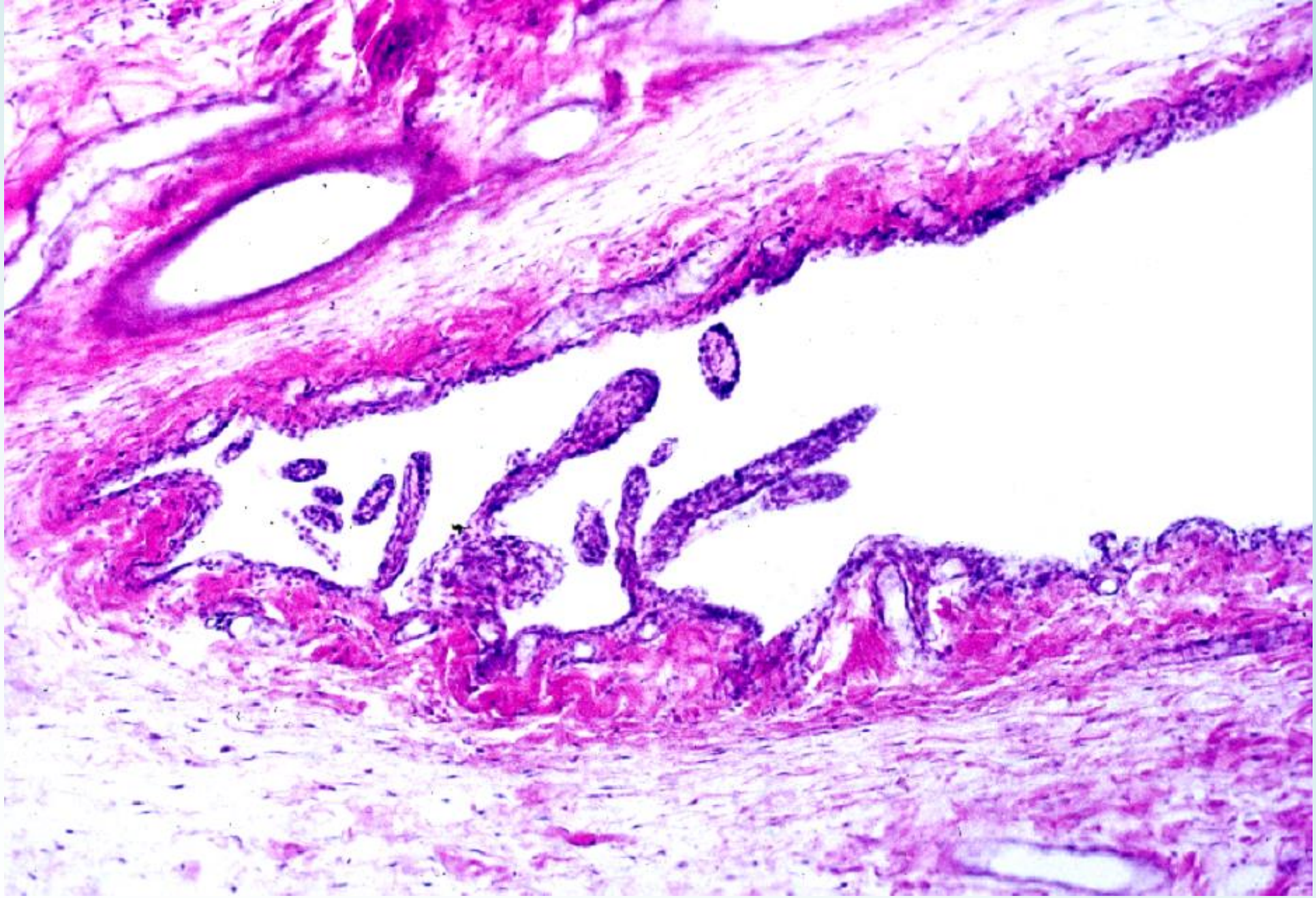
08-03 Patella, sagittal section. Monkey, H-E stain, x 1.3.



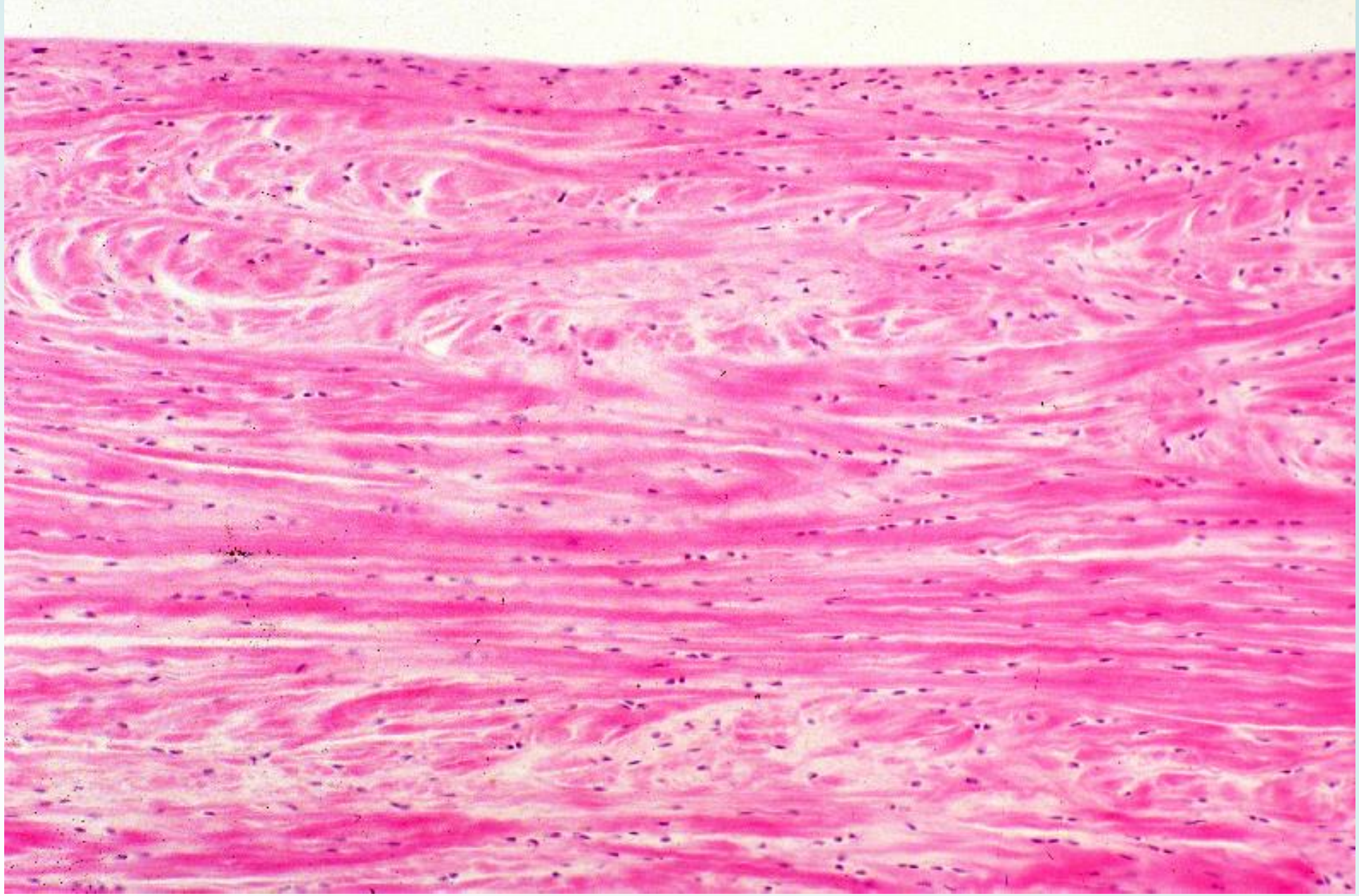
08-04 Transition from tendon to cartilage and bone, longitudinal section. Monkey, H-E stain, x 10.



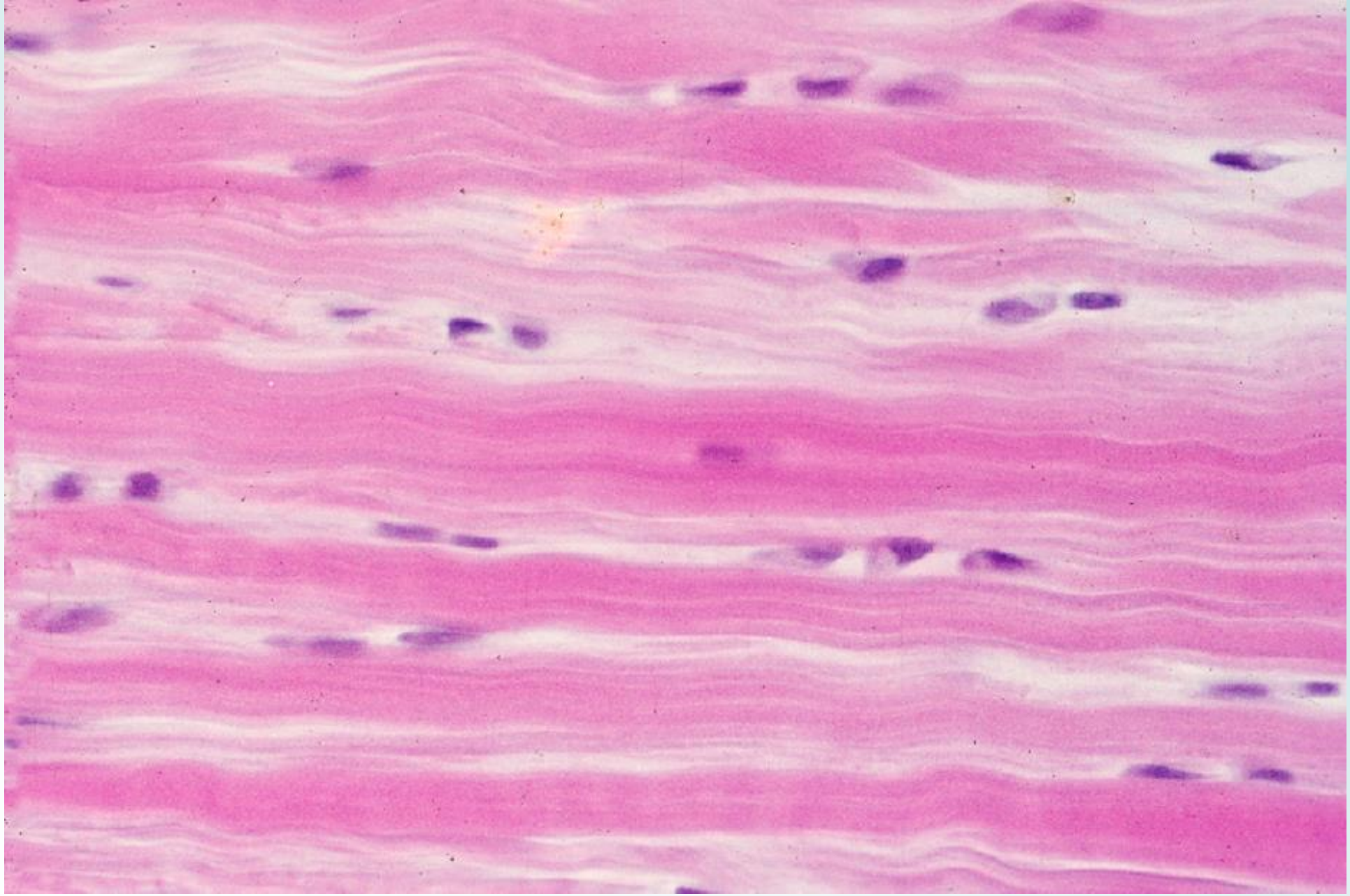
08-05 Synovial membrane. Monkey, H-E stain, x 25.



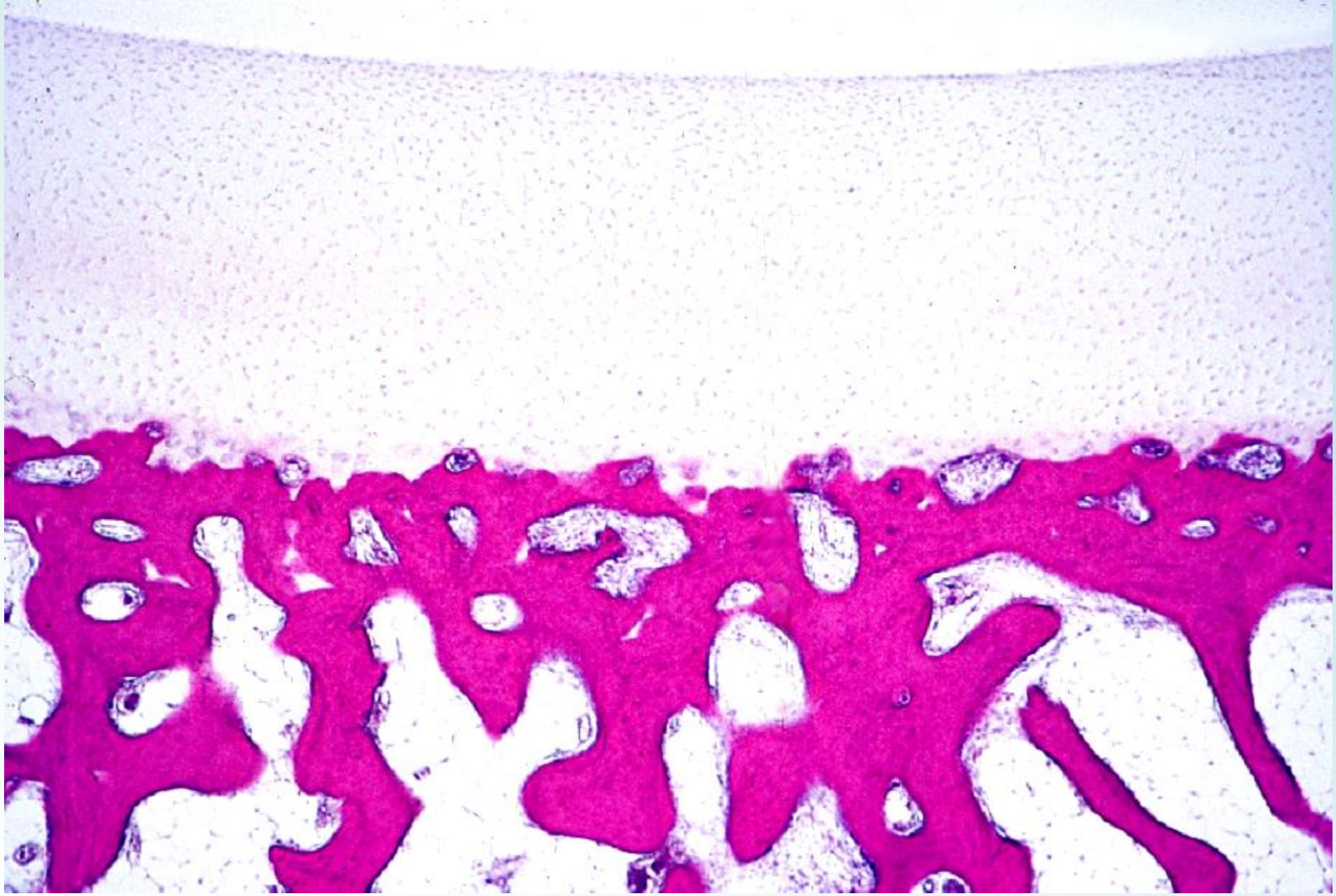
08-06 Synovial villi. Monkey, H-E stain, x 25.



08-07 Meniscus articularis, 1. Monkey, H-E stain, x 66.

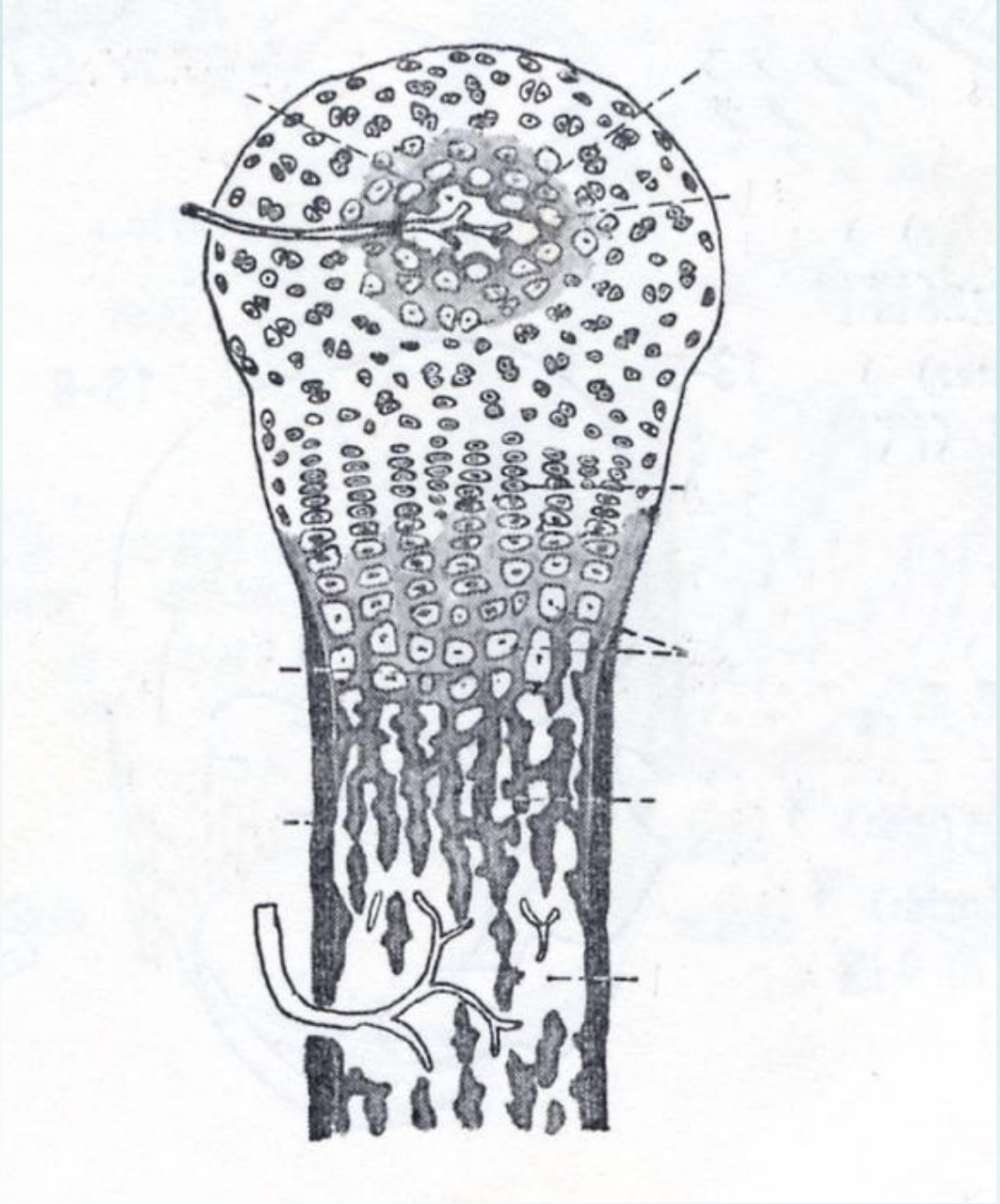


08-08 Meniscus articularis, 2. Monkey, H-E stain, x 160.

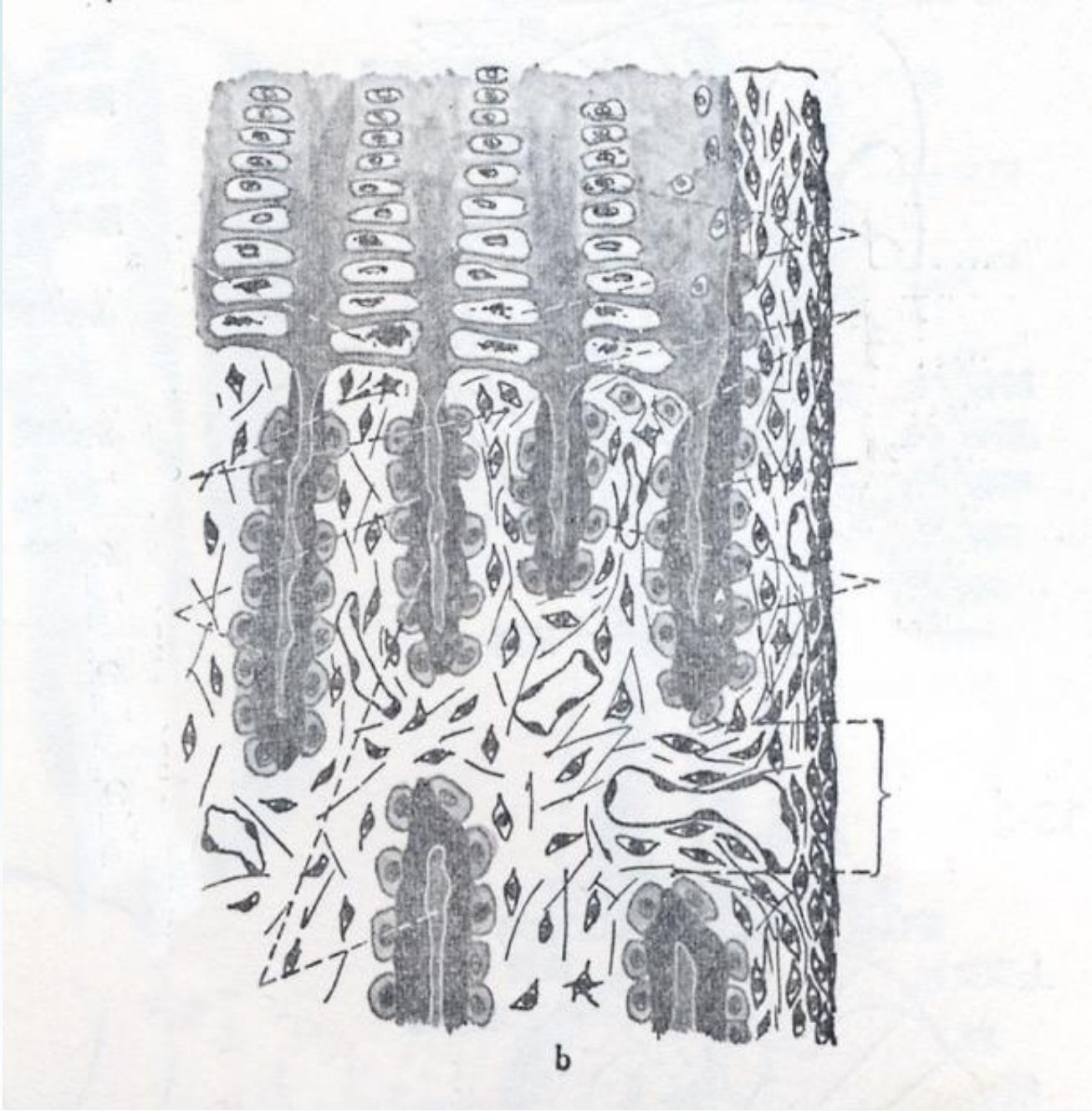


08-09 Cartilago articularis. Monkey, H-E stain, x 10.

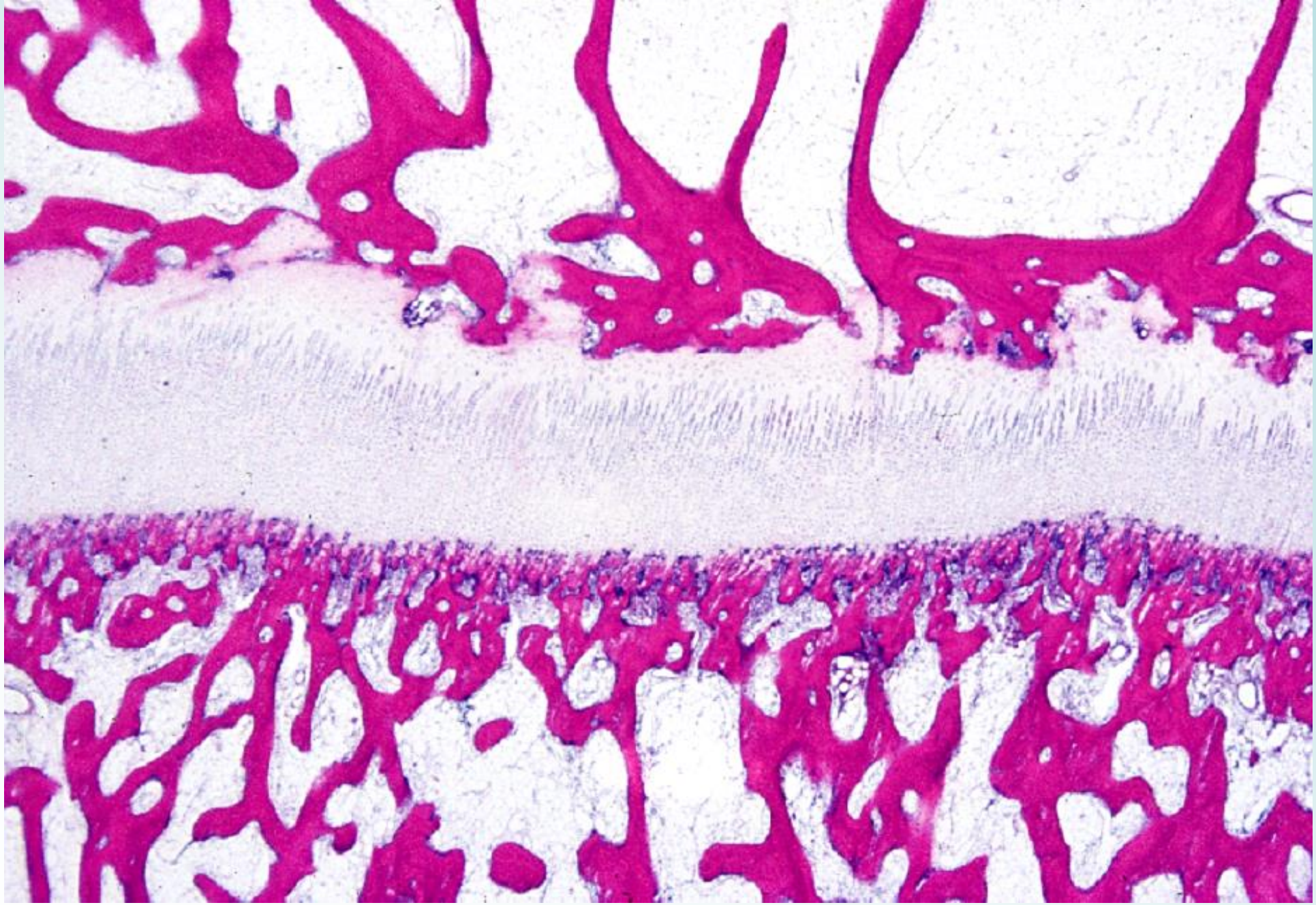
08-10 Periosteum and bone. Monkey, H-E stain, x 66.



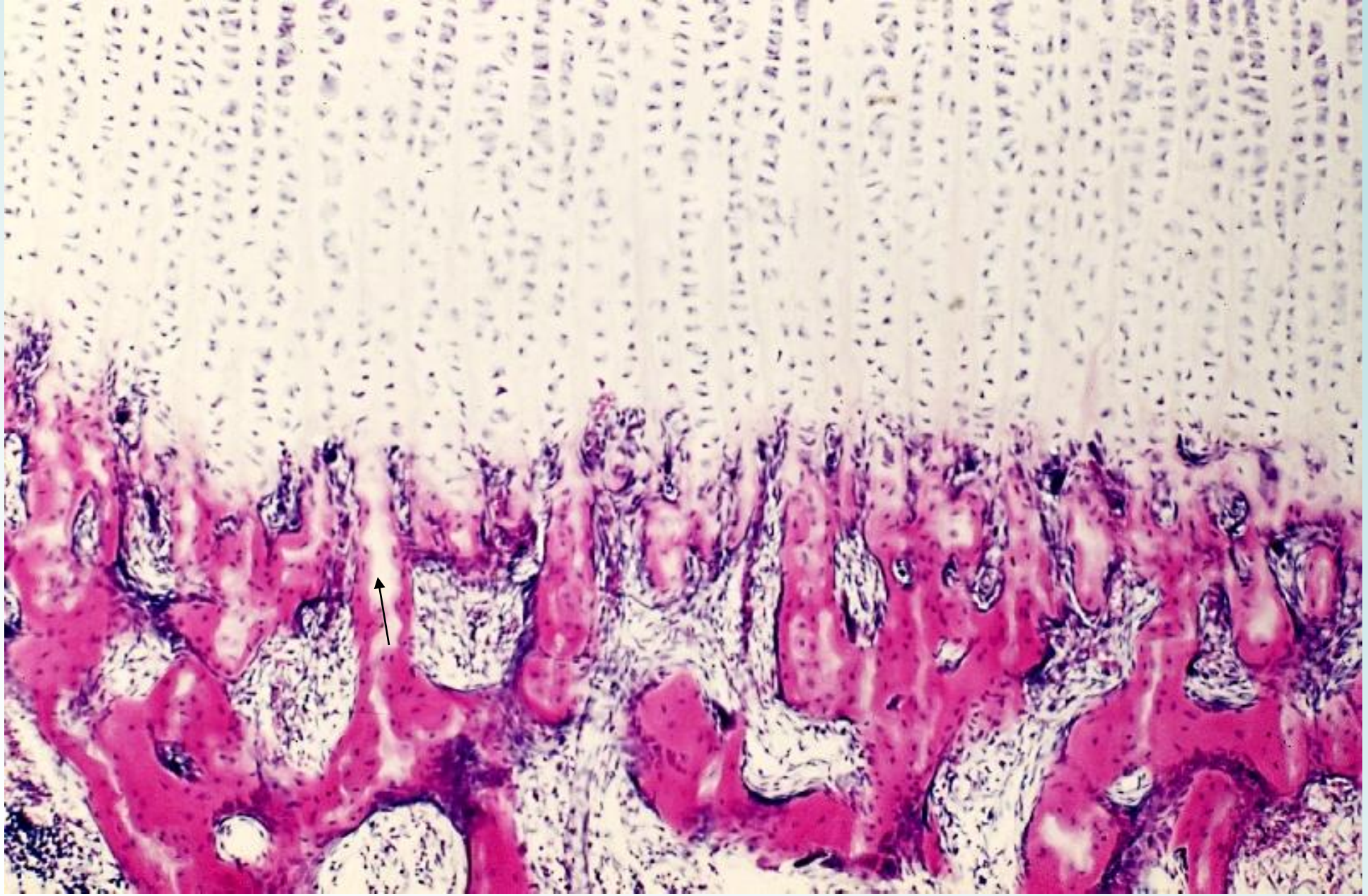
08-11 Development of long tubular bone, 1. Scheme.



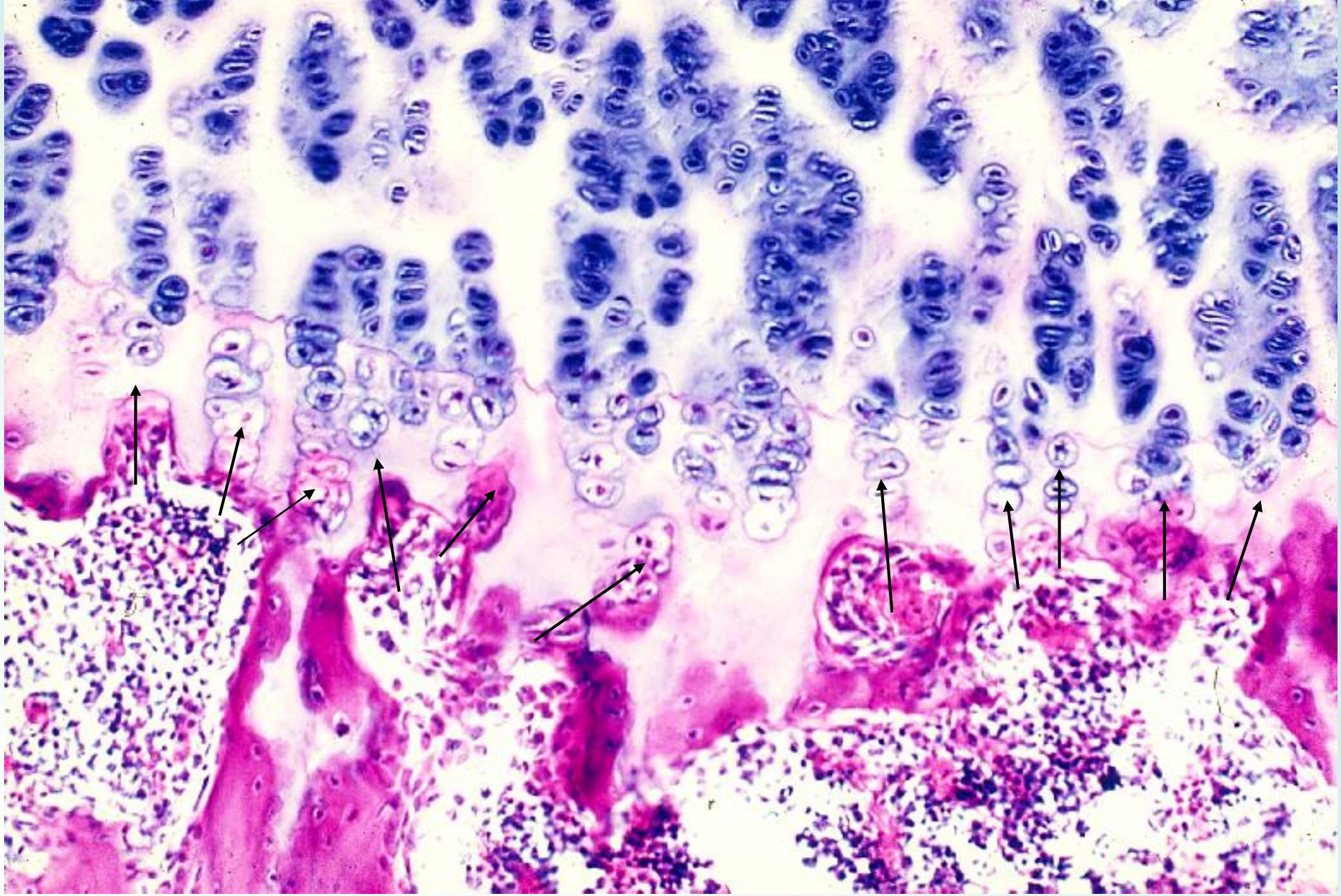
08-12 Development of long tubular bone, 2. Scheme.



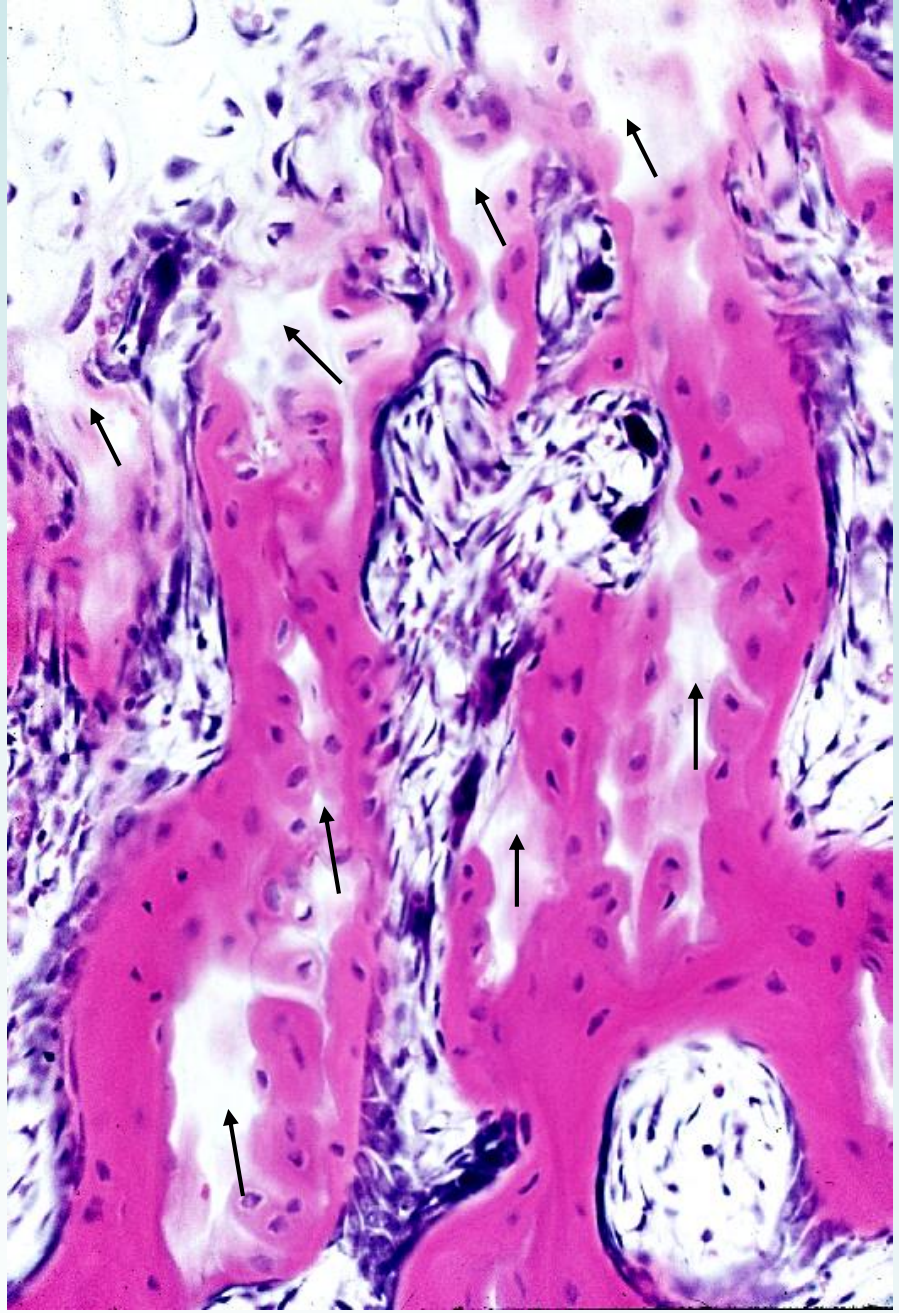
08-13 Epiphyseal plate, 1. Monkey, H-E stain, x 4.0.



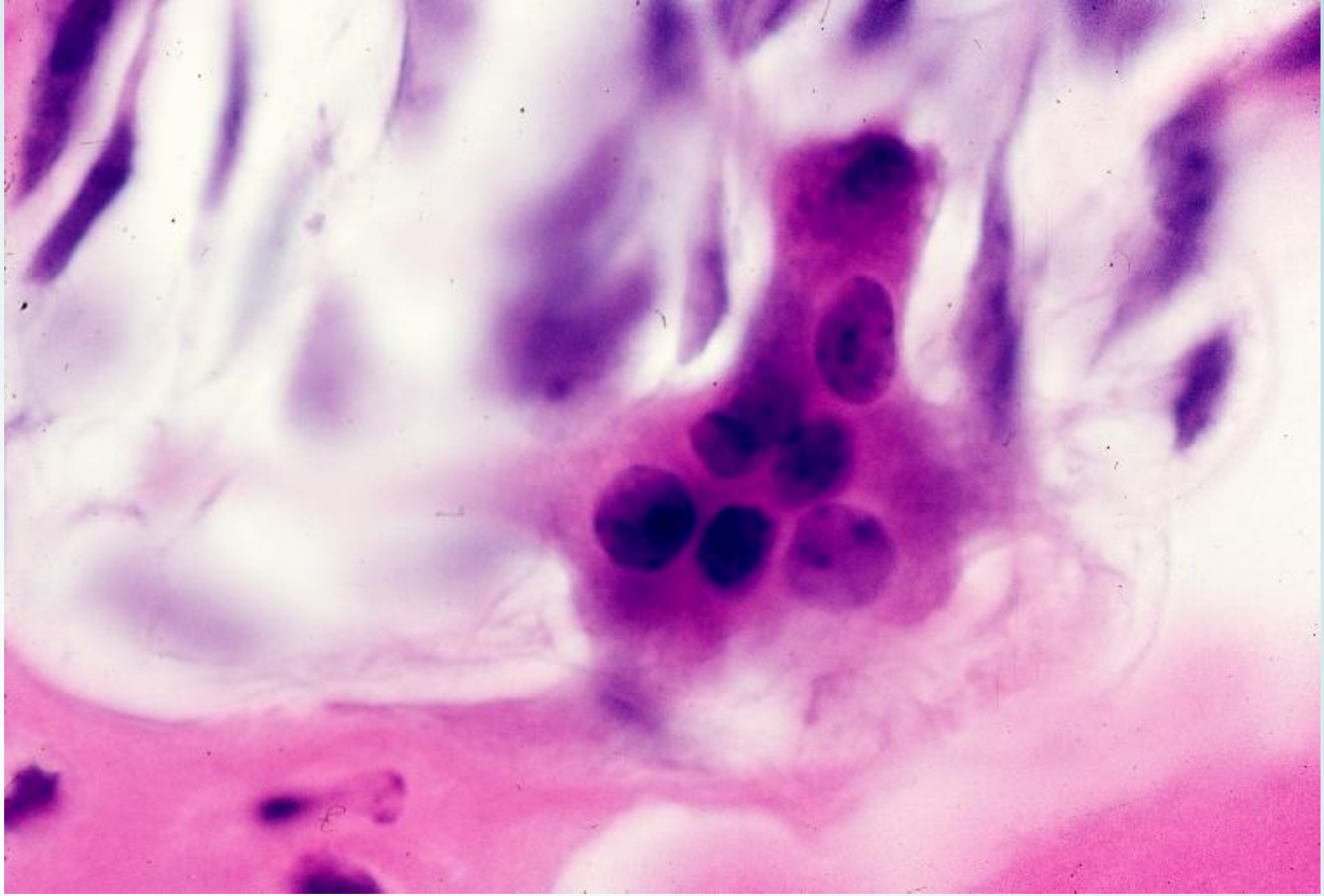
08-14 Epiphyseal plate, 2. Monkey, H-E stain, x 25.



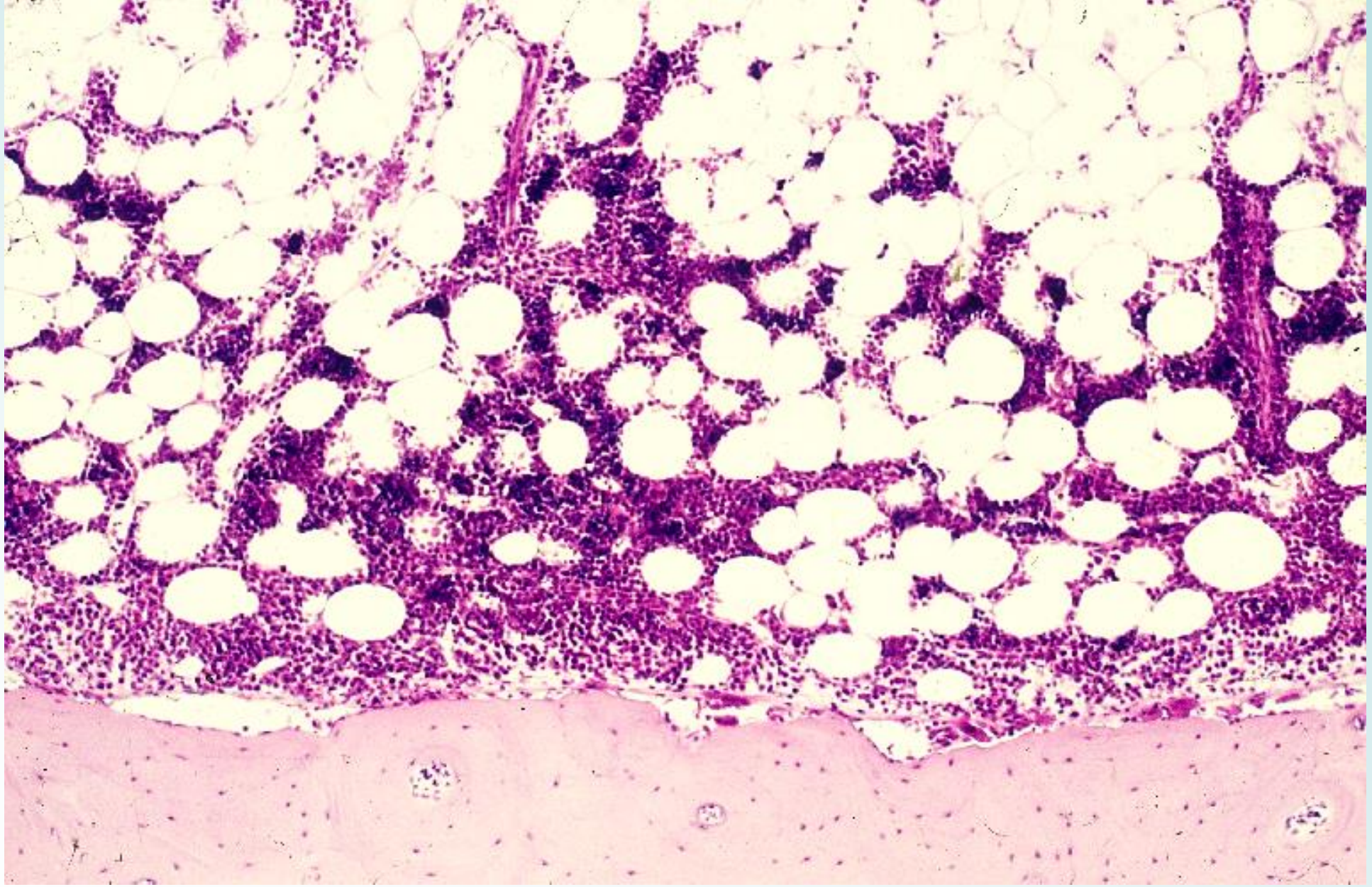
08-15 Epiphyseal plate, 3. Monkey, H-E stain, x 40.



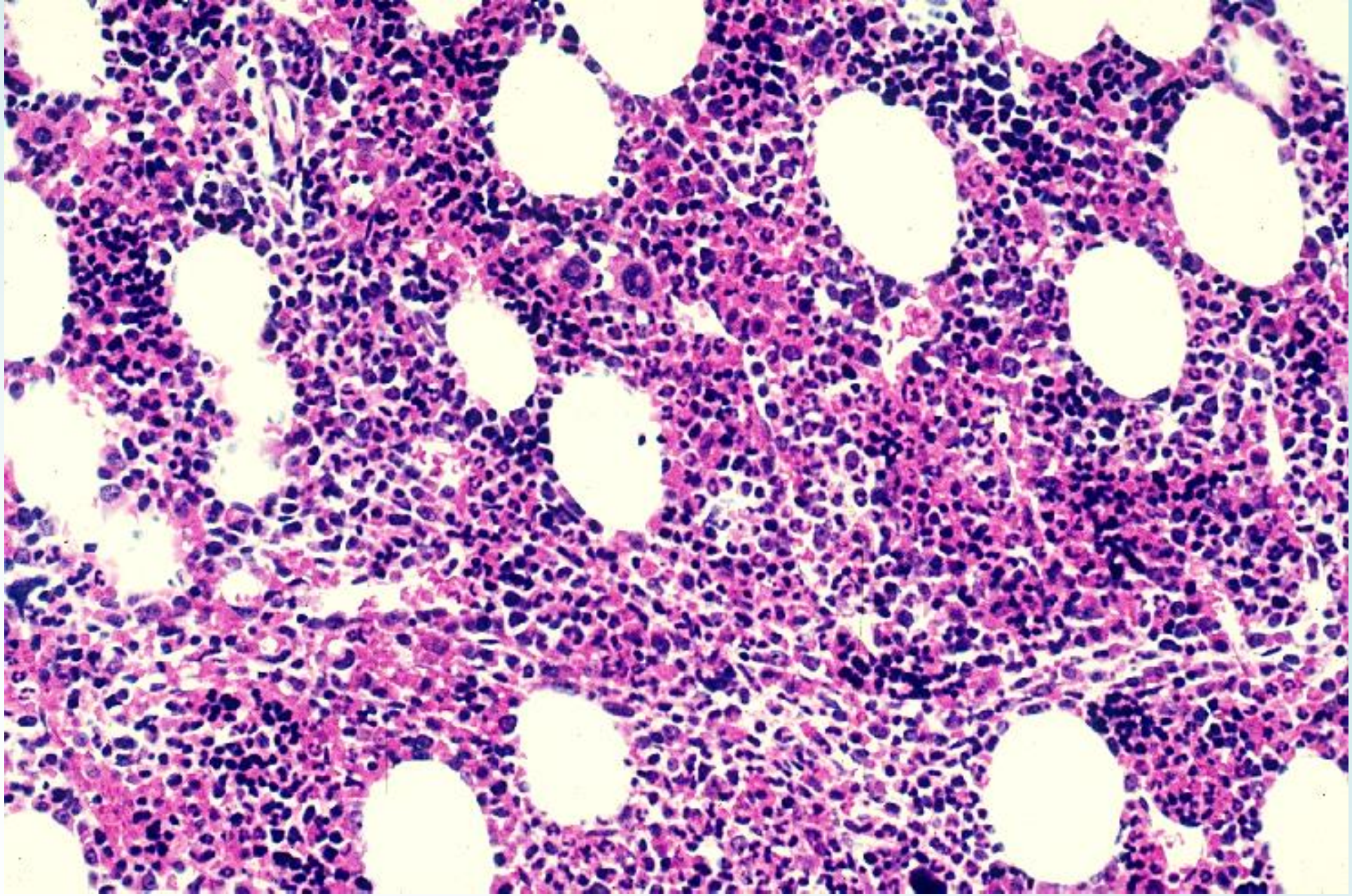
08-16 Osteoblastic tissue. Monkey, H-E stain, x 64.



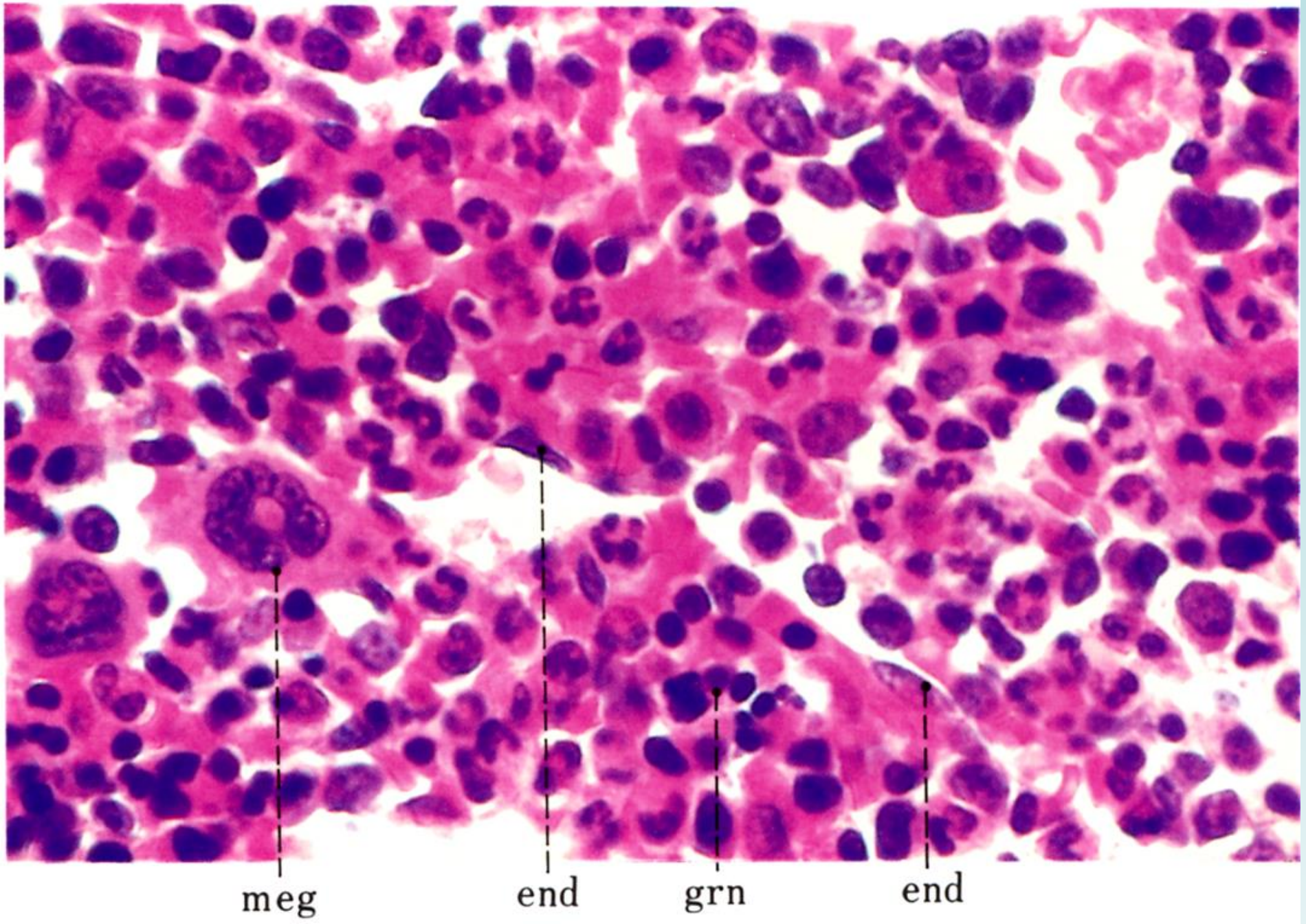
08-17 Osteoclast. Monkey, H-E stain, x 400.



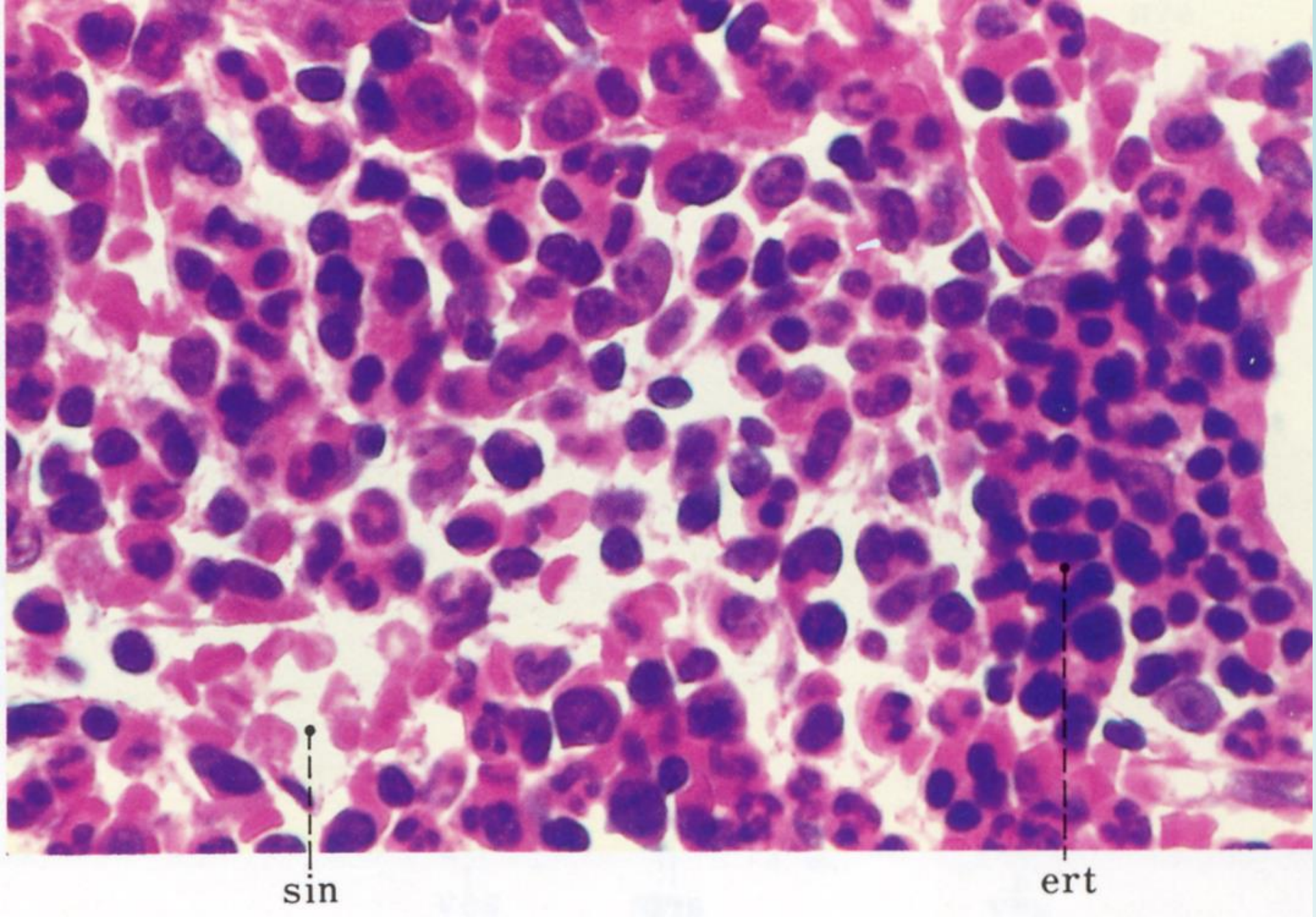
08-18 Bone marrow, 1. Monkey, H-E stain, x 25.



08-19 Bone marrow, 2. Monkey, H-E stain, x 64.



08-20 Hemopoietic center 1. Monkey, H-E stain, x 250.



08-21 Hemopoietic center 2. Monkey, H-E stain, x 250.

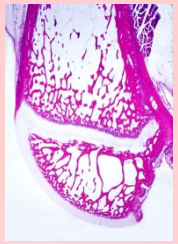
08-00 Bone and Joint

- Bone is hard and unyielding organ with special form being suitable for its supportive and protective functions in the skeleton. It provides for the internal support of the body and for the attachment of the muscles and tendons essential for locomotion. It protects the vital organs of the cranial, thoracic and abdominal cavities, and it encloses the blood-forming elements of the bone marrow. In addition to these mechanical functions, it plays an important metabolic role as a mobilizable store of calcium, which can be drawn on as needed in the homeostatic regulation of the concentration of this important ion in the blood and other body fluids.
- Macroscopically two forms of bone are distinguished; compact bone and spongy bone. The spongy bone consists of a three-dimensional lattice of branching bony spicules, or traceculae, delimiting a labyrinthine system of interspaces that are occupied by bone marrow. The compact bone appears as a solid continuous mass in which spaces can be seen only with the aid of microscope. The two forms of bone grade into one another without a sharp boundary.
- In typical long bones, such as the frmur or humerus, the shaft, diaphysis, consists of a thick walled hollow cylinder of compact bone with a voluminous central marrow cavity occupied the bone marrow. The ends of long bones consist mainly of spongy bone covered by a thin cortex of compact bone. The intercommunicating spaces among the trabeculae of this spongy bone, in the adult, are directly continuous with the marrow cavity of the shaft. In the growing animal, the ends of the long bones, called the epiphysis, arise from separate centers of ossification and are separated from the shaft, diaphysis, by a cartilaginous plate, episeal plate, which is united to the diaphysis by columns of spongy bone in a transitional region called metaphysic. The epiphyseal cartilage and adjacent spongy bone of the metaphysis constitute a growth zone in which all increment in length of the growing bone occurs. On the articular surface, at the ends of the long bones, the thin cortical layer of compact bone is covered by a layer of hyaline cartilage, articular cartilage.
- Except for the articular surface, covered by articular cartilage, bones are invested by periosteum, a layer of specialized connective tissues, which is endowed with osteogenic potency, the ability to form bone. The marrow cavity of the diaphysis and the cavities within spongy bone are lined by enosteum, a thin cellular layer that possesses osteogenic properties.

08-01 Femur, transverse section. Monkey, H-E stain, x 2.5.

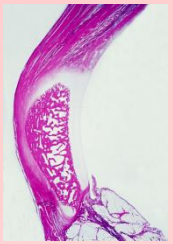
- This is a general view of a transverse section of decalcified monkey femur. The deeply pink stained ring is the compact bone of the shaft, diaphysis, whose cavity is occupies the bone marrow, stained dark blue. At the center are an large artery and a large vein. In this specimen the periosteum is remained only in small area (arrow).

08-02 Distal end of femur, sagittal section. Monkey, H-E stain, x 1.3



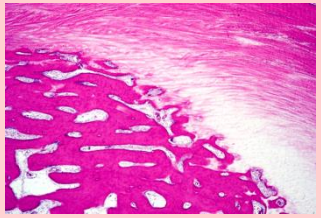
- This is a general view of the distal end of the femur sectioned sagillally. The lower end is the articular surface, about tree fifths of which is covered by the articular cartilage (long arrows).and the remaining two fifths is covered by synovial membrain (arrow heads). The upper half of the field occupies the diaphysis, constituted by the cylinder of compact bone. Between epiphysis and diaphysis the epiphyseal cartilage is very conspicuous. At upper left the synovial membrane constituting the joint capsule is seen (double arrows). The dark red stained mass at upper right is the skeletal muscle. The left side of this field is front and the right side is back.

08-03 Patella, sagittal section. Monkey, H-E stain, x 1.3.



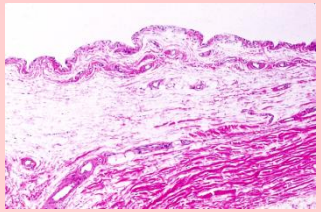
- This is a general view of the sagittally sectioned patella. In the middle, top to down runs the thick tendon of M. quadriceps femoris and its lower half contains the patella as sesaminoid bone. The right surface of the patella faces to the knee joint cavity and is covered by hyaline cartilage (arrows). (1) indicates synovial villus and (2) adipose fold. The left side is front and the right side is back.

08-04 Transition from tendon to cartilage and bone, longitudinal section. Monkey, H-E stain, x 10.



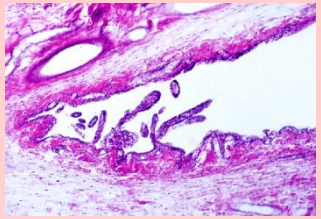
- Higher magnification of 08-03. Here collagenous fibers of the tendon, upper and right, enter into the cartilage and further into the bone of the patella, left and down. Deep red hue of collagenous fibers of the tendon is faded out colorless in the cartilage.

08-05 Synovial membrane. Monkey, H-E stain, x 25.



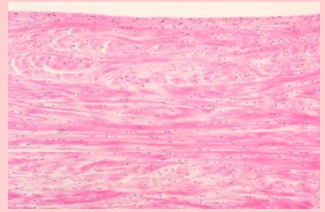
- The articular cavity is enclosed by the joint capsule consisting of thick connective tissue. The inner surface of the joint capsule is covered by synovial membrane, consisting of a thin flat cell layer and underlying loose connective tissue. The thick connective tissue mass at bottom is the main component of joint capsule.

08-06 Synovial villi. Monkey, H-E stain, x 25.



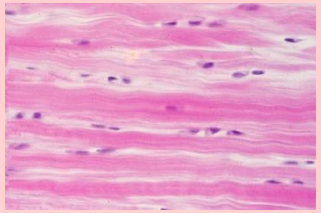
- This is a higher magnification of the synovial villi in 08-02, at upper left corner indicated by double arrows. At the turning point of synovial membrane along the diaphysis (upper and left) to that of joint capsule (lower and right) synovial membrane sends the thin long processes into the cavity; these are synovial villi.

08-07 Meniscus articularis, 1. Monkey, H-E stain, x 66.



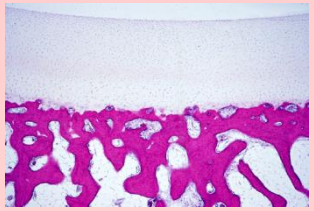
- This is longitudinal section of a meniscus articularis in the knee joint. In the knee joint capsule there are some fibrous cartilages that help the smooth movement of the joint, that are meniscus articularis.

08-08 Meniscus articularis, 2. Monkey, H-E stain, x 160.



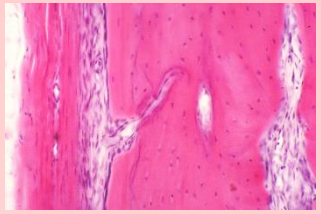
- This is a typical sample of the fibrous cartilage. Thick collagenous fiber bundles run parallel to one another densely and among that there are cartilage cells, mostly in pairs.

08-09 Cartilago articularis. Monkey, H-E stain, x 10.



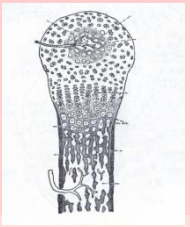
- This is a higher magnification of 08-03, the joint cartilage of the patella. The free surface of the patella consists of hyaline cartilage which unites firmly with spongy bone of the patella. Between the cartilage and bone no active osteoblastic process is observed.

08-10 Periosteum and bone. Monkey, H-E stain, x 66.



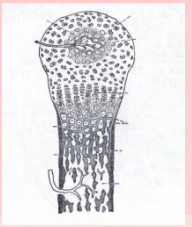
- This is a higher magnification of the bone (diaphysis) and enclosing periosteum.
- The periosteneum consists of two layers: outer layer (1) consisting of densely composed thick collagenous fiber bundles and inner layer (2) of loosely composed thin fibers containing numerous fibroblasts and blood vessels. (3) is the bone and (4) bone marrow.
- The surface of the bone is covered by a thin layer of the osteoblastic cells provided by the inner layer of the periosteum. From the inner layer numerous blood vessels penetrate the bone (arrow) and unite with the vessels in the Haversian canals.
- The outer layer of the periosteum provides the insertion for the muscles.

08-11 Development of long tubular bone, 1. Scheme. (1/2)



- There are two different modes of bone formation: intramembranous ossification in which bone is directly formed in primitive connective tissue, and endochonral ossification in which bone formation takes place in preexisting cartilage. Bones of the extremities are first formed of hyaline cartilage, and this cartilage model is then replaced with bone. In the development of a long bone, the first indication of the formation of a center of ossification is a local enlargement of the chondrocytes in the middle of the shaft of its cartilage model. The cells in this region hypertrophy, glycogen accumulates within them, and their cytoplasm becomes highly vacuolated. As their lacunae enlarge, the intervening cartilage matrix is gradually reduced in thin fenestrated septa and irregularly shaped spicules. These become calcifiable and small aggregation of calcium phosphate crystals are deposited within them. Hypertrophy of the chondrocytes is followed by regressive changes leading to their death and degeneration.

08-11 Development of long tubular bone, 1. Scheme. (2/2)

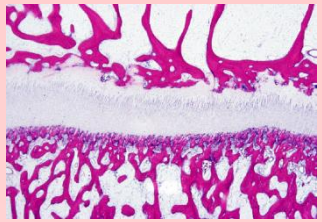


- Concurrent with these changes in the interior of the cartilage model, the osteogenic potencialities of cells in the perichondrium are activated and thin periosteal coller of bone is deposited around the midportion of the shaft, diaphysis. At the same time, blood vessels from the investing layer of connective tussue, now periosteum, grow into the diaphysis, invading the irregular cavities in the cartilage matrix created by the enlargement of the chondrocytes and confluence of their lacunae. The thin walled vessels branch and grow toward either end of the cartilage model, forming capillary loops that extend into the blind ends of the cavities. Cells with mesenchymalpotencies are carried into the interior of the cartilage in the perivascular connective tissue that accompanies the invading blood vessels. Some of these cells differentiate into hemopoetic elements of the bone marrow. Others, coming into contact with the cartilage, differentiate into osteoblasts. These gather in an epitheloid layer on the surface of persisting spicules of the calcified cartilage matrix and deposit bone matrix upon them. The earliest trabeculae formed in centers of endochondral ossification thus have a core of carcified cartilage covered by a layer of bone of varing thickness.
- Figure 08-11 shows the superficial portion of the ossification center, the right edge of which is the perichondrium and the upper half of the field is the cartilage, where the cartilage cells make columunar arrangement and their cytoplasm becomes highly vacu- olized by the contact with osteoblastic tissue. The cartilage matrix between the rows of the swollen cartilage cells is calcified. In the lower half of the field there are spilules having a core of calcified cartilage covered by a thin layer of bone. The surface of these spicules is covered by an epitheloid layer of the osteoblasts. At lower right a thin walled blood vessel enters the center with the osteoblastic tissue. The spaces among the spicules are all filled with the osteoblastic tissue.

08-12 Development of long tubular bone, 2. Scheme.

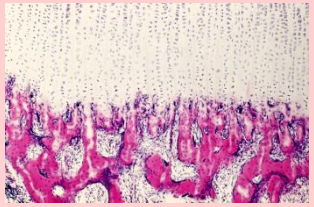
- This figure shows ossification centers in diaphysis and epiphysis and epiphyseal plate. At diaphysis primitive bone marrow cavity is already formed and is expanding on either side. Blood vessels and mesenchyme enter upper epiphyseal cartilage and epiphyseal ossification center develops in it. Between epiphysis and diaphysis remains the cartilage, epiphyseal plate, in which, adjacent to the osteoblastic site, cartilage cells are densely arranged in row parallel to the longitudinal axis. Cartilage matrix remaining between the cartilage cell columns becomes thin spicule and is calcified. The cartilage cells become swollen and are invaded and destroyed by osteoblastic tissue. The mesenchymal cells, now osteoblasts, surround the persisting thin calcified cartilage matrix making an epitheloid layer and deposit bone matrix upon them. These processes advance always toward the epiphysis and thus diaphysis grows in length.
- The epiphyseal ossification center develops slowly forming the loose network of the bone spicules consuming the epiphyseal cartilage. As the center enlarges and the bone marrow cavity widens, the epiphyseal plate becomes thinner and is pressed against the osteoblastic site of the diaphysis. The cartilage covering distal surface of the epiphysis remain and becomes joint cartilage.

08-13 Epiphyseal plate, 1. Monkey, H-E stain, x 4.0.



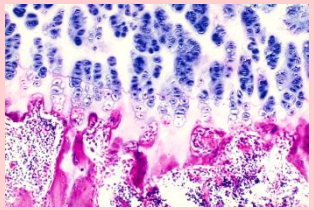
- Between the epiphysis (top) and diaphysis (down) conspicuous epiphyseal plate traverses the middle of this field.
- In the epiphysis trabeculae of bone are thick and their network is loose, whereas that in the diaphysis are thin and their network is dense. In the epiphyseal plate rows of the cartlage cells are innumerable and very densely arranged parallel to the long axis of the femur. Along the lower edge of the epiphyseal plate the active ossification is carrying on. Because of the dense aggregation of the osteoblastic tissue this zone appears dark blue.

08-14 Epiphyseal plate, 2. Monkey, H-E stain, x 25.



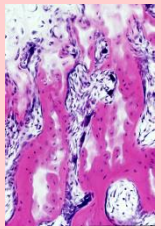
- Higher magnification of 08-13. The upper half of this field is the epiphyseal cartilage, where numerous rows of cartilage cells are densely arranged parallel to the long axis of the femur. The cartilage matrix persisting between these rows are thin and calcified. Along the lower edge osteoblastic tissue is invading the cartilage. At the lower end of the rows of the cartilage cells, the cells become enlarged, vacuolated and then destroyed by the osteoblastic tissue, and on the surface of the persisting calcified cartilage spicules (arrows) osteoblasts form an epitheloid layer and deposit bone matrix upon them. Bone matrix stains deep red and calcified cartilage matris, faintly pink. Meshes of the network of the bone trabeculae are filled by active osteoblasts stained dark blue. The osteoblastic process advances epiphyseal-wards consuming the epiphyseal cartilage, in the upper portion of the epiphyseal plate, cartilage cells divide actively and supply new cells to the rows of cartilage cells. Thus the diaphysis grows up in length.

08-15 Epiphyseal plate, 3. Monkey, H-E stain, x 40.



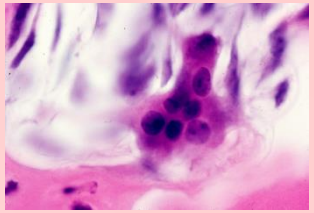
- Higher magnification of 08-14. The osteoblastic tissues are destroying the swollen cartilage cells (arrows) and persisting calcified cartilage matrix appears light pink. Cartilage cells still not invaded shows distinct basophilia and are stained deep blue. The bone matrix formed on the surface of calcified cartilage matrix is stained deep red.

08-16 Osteoblastic tissue. Monkey, H-E stain, x 64.



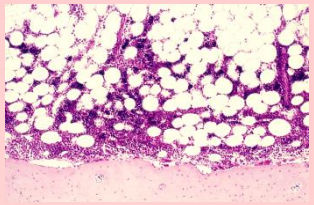
- At upper left corner is the cartilage matrix and cartilage cells invaded by osteoblastic tissue. The newly formed bone trabeculae containing the core of the calcified cartilage matrix (faintly pink stained, arrows) are follow downward. At the lower half of the field bone matrix becomes thick and contains osteocytes within it. Surface of the bone trabeculae is covered by flat dark blue stained cells, osteoblasts. In the meshes among the bone trabeculae are densely filled by the slender small spindle-shaped cells; that are osteoblastic tissue. In the middle, on the surface of the bone matrix several large dark violet stained cells are observed They are osteoclasts.

08-17 Osteoclast. Monkey, H-E stain, x 400.



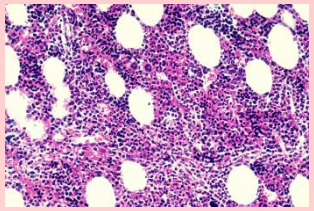
- In the areas of bone resorption there are oteoclasts, giant cells with a variable numberof nuclei. They are frequently found in concavities in the surface of bone, called Howship's lacunae. In the growth and reformation of the trabeculae of spongy bone, they are commonly seen enveloping the tip of each spicule of bone undergoing resorption. In this figure an osteoclast is shown, which has a large cytoplasm and many fine cyto- plasmic processes and contains about ten nuclei. This cell seats down in the concavity on the surface of the bone matrix (Howship's lacuna). Around this cell numerous osteoblasts are seen.

08-18 Bone marrow, 1. Monkey, H-E stain, x 25.



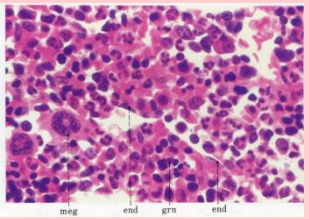
- The bottom of this figure is bone and above adjacent to the bone is the red bone marrow. In the upper portion increase the fat cells and gradually begins the yellow marrow.

08-19 Bone marrow, 2. Monkey, H-E stain, x 64.



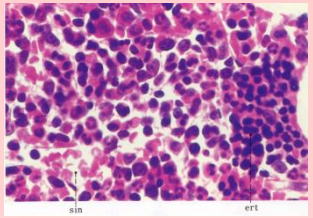
- The stroma of the bone marrow is filled with a lot of hemopoietic cells.

08-20 Hemopoietic center 1. Monkey, H-E stain, x 250.



- Higher magnification of 08-19. The granular leukocytes forming center is shown. At lower left there are two megakaryocytes.

08-21 Hemopoietic center 2. Monkey, H-E stain, x 250.



- Higher magnification of 08-19. The erythrocytes forming center (ert) is shown and sin indicates sinusoid.