

the most efficient manner in which stresses are transmitted is by the arrangement of the resisting material in lines parallel to the direction in which the stresses occur and in the paths taken by the stresses. Theoretically the most efficient manner to attain these objects would be to prolong the innermost filaments of the bone as straight lines parallel to the longitudinal axis of the bone, and gradually to flare the outer shell of compact bone outward, and continuing to give off filaments of bone parallel to the longitudinal axis as the distal end of the femur is approached. These filaments should be well-braced transversely and each should carry its proportionate part of the total load, parallel to the longitudinal axis, transmitting it eventually to the articular surface, and in a direction perpendicular to that surface."

Referring to Fig. 249, it is seen that the large expansion of the bone is produced by the gradual transition of the hollow shaft of compact bone to cancellated bone, resulting in the production of a much larger volume. The trabeculae are given off from the shaft in lines parallel to the longitudinal axis, and are braced transversely by two series of trabeculae at right angles to each other, in the same manner as required theoretically for economy.

Although the action of the muscles exerts an appreciable effect on the stresses in the femur, it is relatively small and very complex to analyze and has not been considered in the above analysis.

Ossification (Figs. 252, 253, 254).—The femur is ossified from *five* centers: one for the body, one for the head, one for each trochanter, and one for the lower extremity. Of all the long bones, except the clavicle, it is the first to show traces of ossification; this commences in the middle of the body, at about the seventh week of fetal life, and rapidly extends upward and downward. The centers in the epiphyses appear in the following order: in the lower end of the bone, at the ninth month of fetal life (from this center the condyles and epicondyles are formed); in the head, at the end of the first year after birth; in the greater trochanter, during the fourth year; and in the lesser trochanter, between the thirteenth and fourteenth years. The order in which the epiphyses are joined to the body is the reverse of that of their appearance; they are not united until after puberty, the lesser trochanter being first joined, then the greater, then the head, and, lastly, the inferior extremity, which is not united until the twentieth year.

The Patella (Knee Cap).

The **patella** (Figs. 255, 256) is a flat, triangular bone, situated on the front of the knee-joint. It is usually regarded as a sesamoid bone, developed in the tendon of the Quadriceps femoris, and resembles these bones (1) in being developed in a tendon; (2) in its center of ossification presenting a knotty or tuberculated outline; (3) in being composed mainly of dense cancellous tissue. It serves to protect the front of the joint, and increases the leverage of the Quadriceps femoris by making it act at a greater angle. It has an anterior and a posterior surface three borders, and an apex.



FIG. 255.—Right patella.
Anterior surface.



FIG. 256.—Right patella.
Posterior surface.

Surfaces.—The **anterior surface** is convex, perforated by small apertures for the passage of nutrient vessels, and marked by numerous rough, longitudinal striae. This surface is covered, in the recent state, by an expansion from the tendon of the Quadriceps femoris, which is continuous below with the superficial fibers of the ligamentum patellae. It is separated from the integument by a bursa. The **posterior surface** presents above a smooth, oval, articular area, divided into two facets by a vertical ridge; the ridge corresponds to the groove on the patellar surface of the femur, and the facets to the medial and lateral parts of the same surface; the lateral facet is the broader and deeper. Below the articular surface is a rough, convex, non-articular area, the lower half of which gives attachment to the ligamentum patellae; the upper half is separated from the head of the tibia by adipose tissue.

Borders.—The **base** or **superior border** is thick, and sloped from behind, downward, and forward: it gives attachment to that portion of the Quadriceps femoris