

About the sixteenth year (Fig. 102), five secondary centers appear, one for the tip of each transverse process, one for the extremity of the spinous process, one for the upper and one for the lower surface of the body (Fig. 103). These fuse with the rest of the bone about the age of twenty-five.

Exceptions to this mode of development occur in the first, second, and seventh cervical vertebræ, and in the lumbar vertebræ.

Atlas.—The atlas is usually ossified from *three* centers (Fig. 104). Of these, one appears in each lateral mass about the seventh week of fetal life, and extends backward; at birth, these portions of bone are separated from one another behind by a narrow interval filled with cartilage. Between the third and fourth years they unite either directly or through the medium of a separate center developed in the cartilage. At birth, the anterior arch consists of cartilage; in this a separate center appears about the end of the first year after birth, and joins the lateral masses from the sixth to the eighth year—the lines of union extending across the anterior portions of the superior articular facets. Occasionally there is no separate center, the anterior arch being formed by the forward extension and ultimate junction of the two lateral masses; sometimes this arch is ossified from two centers, one on either side of the middle line.

Epistropheus or Axis.—The axis is ossified from *five* primary and *two* secondary centers (Fig. 105). The body and vertebral arch are ossified in the same manner as the corresponding parts in the other vertebræ, viz., one center for the body, and two for the vertebral arch. The centers for the arch appear about the seventh or eighth week of fetal life, that for the body about the fourth or fifth month. The dens or odontoid process consists originally of a continuation upward of the cartilaginous mass, in which the lower part of the body is formed. About the sixth month of fetal life, two centers make their appearance in the base of this process: they are placed laterally, and join before birth to form a conical bilobed mass deeply cleft above; the interval between the sides of the cleft and the summit of the process is formed by a wedge-shaped piece of cartilage. The base of the process is separated from the body by a cartilaginous disk, which gradually becomes ossified at its circumference, but remains cartilaginous in its center until advanced age. In this cartilage, rudiments of the lower epiphysial lamella of the atlas and the upper epiphysial lamella of the axis may sometimes be found. The apex of the odontoid process has a separate center which appears in the second and joins about the twelfth year; this is the upper epiphysial lamella of the atlas. In addition to these there is a secondary center for a thin epiphysial plate on the under surface of the body of the bone.

The Seventh Cervical Vertebra.—The anterior or costal part of the transverse process of this vertebra is sometimes ossified from a separate center which appears about the sixth month of fetal life, and joins the body and posterior part of the transverse process between the fifth and sixth years. Occasionally the costal part persists as a separate piece, and, becoming lengthened lateralward and forward, constitutes what is known as a *cervical rib*. Separate ossific centers have also been found in the costal processes of the fourth, fifth, and sixth cervical vertebræ.

Lumbar Vertebræ.—The lumbar vertebræ (Fig. 106) have each *two* additional centers, for the mammillary processes. The transverse process of the first lumbar is sometimes developed as a separate piece, which may remain permanently ununited with the rest of the bone, thus forming a lumbar rib—a peculiarity, however, rarely met with.

Sacrum (Figs. 107 to 110).—The *body* of each sacral vertebra is ossified from a primary center and *two* epiphysial plates, one for its upper and another for its under surface, while each vertebral arch is ossified from two centers.

The anterior portions of the *lateral parts* have *six* additional centers, two for each of the first three vertebræ; these represent the costal elements, and make their appearance above and lateral to the anterior sacral foramina (Figs. 107, 108).

On each *lateral surface* two epiphysial plates are developed (Figs. 109, 110): one for the auricular surface, and another for the remaining part of the thin lateral edge of the bone.¹

PERIODS OF OSSIFICATION.—About the eighth or ninth week of fetal life, ossification of the central part of the body of the first sacral vertebra commences, and is rapidly followed by deposit of ossific matter in the second and third; ossification does not commence in the bodies of the lower two segments until between the fifth and eighth months of fetal life. Between the sixth

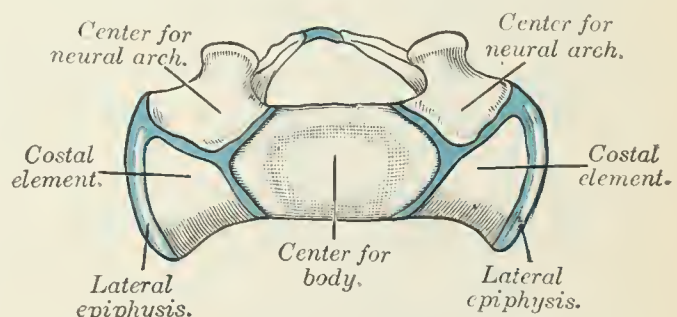


FIG. 110.—Base of young sacrum.

¹ The ends of the spinous processes of the upper three sacral vertebræ are sometimes developed from separate epiphyses, and Fawcett (*Anatomischer Anzeiger*, 1907, Band xxx) states that a number of epiphysial nodules may be seen in the sacrum at the age of eighteen years. These are distributed as follows: One for each of the mammillary processes of the first sacral vertebra; twelve—six on either side—in connection with the costal elements (two each for the first and second and one each for the third and fourth) and eight for the transverse processes—four on either side—one each for the first, third, fourth, and fifth. He is further of opinion that the lower part of each lateral surface of the sacrum is formed by the extension and union of the third and fourth "costal" and fourth and fifth "transverse" epiphyses.