Notogenesis

Notogenesis = development of chorda dorsalis.

Chorda dorsalis

From the primitive fossa of Hensen's node of the germinal target's **epiblast**, the cephalic = **chordomesoderm process** grows cranially toward the prechordal plate. The cells of the process are inserted between the epiblast and the **hypoblast**. The chordal (Lieberkühn) canal, which connects with the endoderm and flattens into the chordal plate in the ceiling of the entodermal yolk sac → the plate separates into a solid column of cells = **chorda dorsalis**.

The chorda dorsalis is the axial structure of the body that lies beneath the nascent neural tube. First, the chorda arises at the cranial end; it increases caudally along with the caudal displacement of Hensen's node. In the region of the primitive fossa of Hensen's node, the amniotic sac and yolk sac temporarily communicate through the neurenteric duct. Initiation and development of the primitive streak and primitive node are further essential:

- for the development of axial structures and the later induction of prosencephalon pouches (telencephalon, diencephalon);
- for development of laterality (in cooperation with mesoderm and neural plate); laterality disorders = situs viscerum inversus (complete or partial, eventual duplication or hypoplasia of asymmetric organs – heart, spleen, etc.)

Mesoderm and coelom

The **Mesoderm** formed during gastrulation on the sides of the chordal plate has longitudinal regions:

- **paraaxial mesoderm** - in chorda, segments craniocaudally into somites (42–44 pairs);
- **intermediate mesoderm** - between paraxial and lateral, luminesces;
  - cervical and thoracic regions segment into nephrotomes, caudal intermediate mesoderm remains unsegmented as nephrogenic blastema;
  - is the basis for the formation of the pronephros, mesonephros, metanephros, ureter and the base of the gonads;
- lateral unsegmented mesoderm forms leaves separated by cavity = intraembryonic coelom to:
  - **somatopleuru** → dorsal (somatic, parietal mesoderm) – gives rise to the lateral and ventral body wall incl. muscles and the parietal sheet of the mesothelium serous membranes;
  - **splanchnopleura** → ventral (splanchnic, visceral mesoderm) – gives rise to the mesentery, wall of the alimentary canal (outside the epithelium of the intestinal tube, which is endodermal) and the visceral sheet of mesothelium serous membranes.

The intraembryonic *coelom* is initially connected at the edge with the extraembryonic coelom, later with the expansion of the amniotic sac and the delimitation of the embryo, the intra- and extraembryonic coelom are separated:

- serous body cavities (peritoneal, pleural, pericardial) later arise from the uniform embryonic coelom;
- areas in which there is no interposed mesoderm between ectoderm and endoderm have temporary direct contact of ecto- and endoderm even after gastrulation, and later the oropharyngeal membrane (cranially) disappears with the cloacal membrane (caudally) through perforation;
- sufficient development of the mesoderm is essential for the formation of the skeleton and muscles of the limbs, the development of the cardiovascular system, the urogenital system, vertebrae, etc.

Somites (first segments)

18th-19th day, the paraaxial mesoderm begins to segment. It is the first morphologically obvious segmentation of body structures (later followed by the segmentation of the skeleton, muscles, blood vessels and nerves). In the craniocaudal direction, mesoderm cells condense to form somitomeres (thickened bases of future somites) – of which there are a total of 42–44 pairs of fully segmented somites (end of week 5) with mesodermal epithelium surrounding the cavity inside each somite (somitocoel):

- 20th day – first occipital somites, then approx. 3 pairs per day until the end of the 5th week;
- 5 pairs of occipital, 7 cervical, 12 thoracic, 5 lumbar, 5 sacral, 8–10 pairs of coccygeal somites;
- the first occipital and 5–7 most caudal somites disappear, possibly they merge;
- persistent somites (38–40 pairs) break up into three formations, while the mesoderm acquires the character of mesenchyme through the production of intercellular matter.

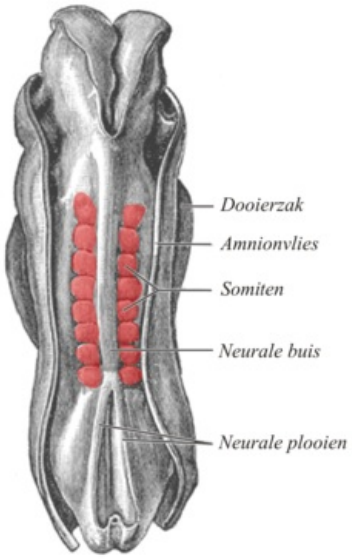
1. **Dermatoma**
   - Most lateral part of somite;
   - does not retain segmentation, breaks up into a continuous layer → future dermis of the skin.
2. **Myotome**
   - Median region of original somite;

- epaxially, myotomes retain somitic segmentation → base of paravertebral muscles;
- ventrolaterally, the mesodermal mesenchyme grows into the trunk wall → the base of the hypaxial trunk musculature.

3. **Sclerotome**
   - Medial part of original somite;
   - condenses around the chorda dorsalis;
   - each sclerotome is divided into a cranial and a caudal half;
   - the gap between the halves of the sclerotomes filled with mesenchyme → the base of the intervertebral disc (persistence of the nucleus pulposus in the center as a remnant of the chorda dorsalis);
   - the caudal half of the previous sclerotome fuses with the cranial half of the following sclerotome → formation of a vertebral body (each vertebral body composed of two halves of two somites);
   - somites of paraxial mesoderm remain attached laterally to unsegmented mesoderm by a band of intermediate mesoderm.

Defects due to incomplete notochord development

1. Neural Tube Defects (NTDs):[1]
   - Spina Bifida: This condition occurs when the neural tube fails to close properly, leading to defects in the vertebrae. Spina bifida can range from mild forms, where there is a small gap in the spine but no symptoms, to severe forms, where there is significant nerve damage and physical disability.
   - Anencephaly: This severe defect occurs when the neural tube fails to close at the cranial end, leading to the absence of a major portion of the brain, skull, and scalp. Infants with anencephaly are usually stillborn or die shortly after birth.
   - Encephalocele: This condition involves a sac-like protrusion of the brain and the membranes that cover it through openings in the skull. The severity of encephalocele depends on the size and location of the defect.
2. Vertebral Column Defects:[1] - Scoliosis: Abnormal lateral curvature of the spine that can be caused by asymmetrical development of the vertebrae. - Klippel-Feil Syndrome: This congenital condition is characterized by the fusion of two or more cervical vertebrae, leading to a short neck, limited neck mobility, and sometimes neurological problems.



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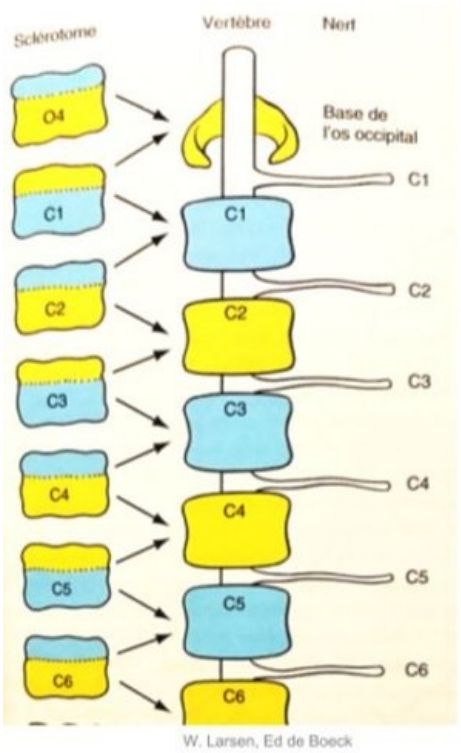
1. Langman's Embryology Textbook



Differentiation of sclerotomes