Development of the Muscular System

With the exception of some smooth muscle tissue the muscular system develops from the mesodermal germ layer and consists of skeletal, smooth, and cardiac muscle. Skeletal muscle is derived from paraxial mesoderm, which forms somites from the occipital to the sacral regions and somitomeres in the head.

Smooth muscle differentiates from Visceral (splanchnic) mesoderm surrounding the gut and its derivatives
and from ectoderm (pupillary, mammary gland, and sweat gland muscles). Cardiac muscle is derived from Visceral (splanchnic) mesoderm surrounding the heart tube.

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Head musculature (see Chapter 17 langman's medical Embryology *Ed14*) is derived from seven somitomeres, which are partially segmented whorls of mesenchymal cells derived from paraxial mesoderm (see Chapter 6, p. 80).

Musculature of the axial skeleton, body wall, and limbs is derived from somites, which initially form as somitomeres and extend from the occipital region to the tail bud. Immediately after segmentation, these somitomeres undergo a process of epithelization and form a "ball" of epithelial cells with a small cavity in the center .

The ventral region of each somite then becomes mesenchymal again and forms the sclerotome , the bone-forming cells for the vertebrae and ribs. Cells in the upper region of the somite form the dermatome and two muscle-forming areas at the ventrolateral (VLL) and dorsomedial (DML) lips (or edges),
respectively.

Cells from these two areas migrate and proliferate to form progenitor muscle cells ventral to the dermatome, thereby forming the dermomyotome .

Some cells from the VLL region also migrate into the adjacent parietal layer of the lateral plate mesoderm. Here, they form infrahyoid, abdominal wall (rectus abdominis, internal and external oblique, and transversus abdominis), and limb muscles. The remaining cells in the myotome form muscles of the back, shoulder girdle, and intercostal muscles .

Initially, there is a well-defined border between each somite and the parietal layer of lateral plate mesoderm called the lateral somatic frontier . This frontier separates two mesodermal domains in the embryo:

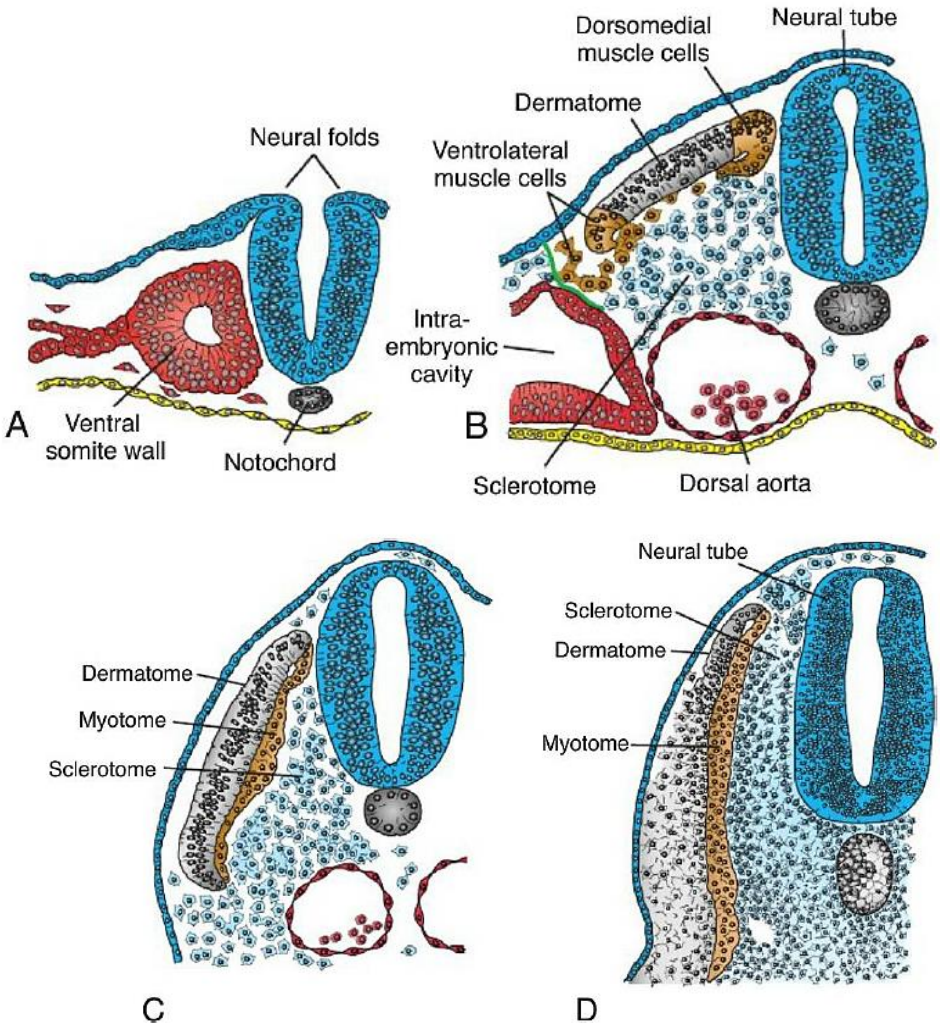
1. **The primaxial domain** that comprises the region around the neural tube and contains only somite-derived (paraXial mesoderm) cells
2. **The abaxial domain** that consists of the parietal layer of lateral plate mesoderm together with somite cells that have migrated across the lateral somitic frontier

Muscle cells that cross this frontier (those from the VLL edge of the myotome) and enter the lateral plate mesoderm comprise the abaxial muscle cell precursors and receive many of their signals for differentiation from lateral plate mesoderm
; those that remain in the paraXial mesoderm and do not cross the frontier

(the remaining VLL cells and all of the DML cells) comprise the primaxial muscle cell precursors and receive many of their developmental signals from the neural tube and notochord .

Regardless of their domain, each myotome receives its innervation from spinal nerves derived from the same segment as the muscle cells.

The lateral somitic frontier also defines the border between dermis derived from dermatomes in the back and dermis derived from lateral plate mesoderm in the body wall . It also defines a border for rib development, such that the bony components of each rib are derived from primaXial sclerotome cells and the cartilaginous parts of those ribs that attach to the sternum are derived from sclerotome cells that migrate across the lateral somitic frontier (abaxial cells).



Cross-sectional drawings showing the stages of development in a somite. A. Mesoderm cells become epithelial and are arranged around a small lumen. B. Cells in the ventral and medial walls of the somite lose their epithelial characteristics and migrate around the neural tube and notochord, and some move into the parietal layer of lateral píate mesoderm. Collectively, these cells constitute the sclerotome. Cells at the DML and VLL regions of the somite form muscle cell precursors. Cells from both regions migrate ventral to the dermatome to form the dermomyotome. VLL cells aiso migrate into the parietal layer of lateral píate mesoderm across the lateral somitic frontier [green Une]. In combination, somitic cells and lateral píate mesoderm cells constitute the abaxial mesodermal domain, whereas the primaxial mesodermal domain oniy contains somitic cells [paraxial mesoderm). C. Together, dermatome cells and the muscle cells that associate with them form the dermomyotome. D. The dermomyotome begins to differentiate: Myotome cells contribute to primaxial muscles, and dermatome cells form the dermis of the back.