The Muscular Tissue
Lec. 9

Second year
Histology
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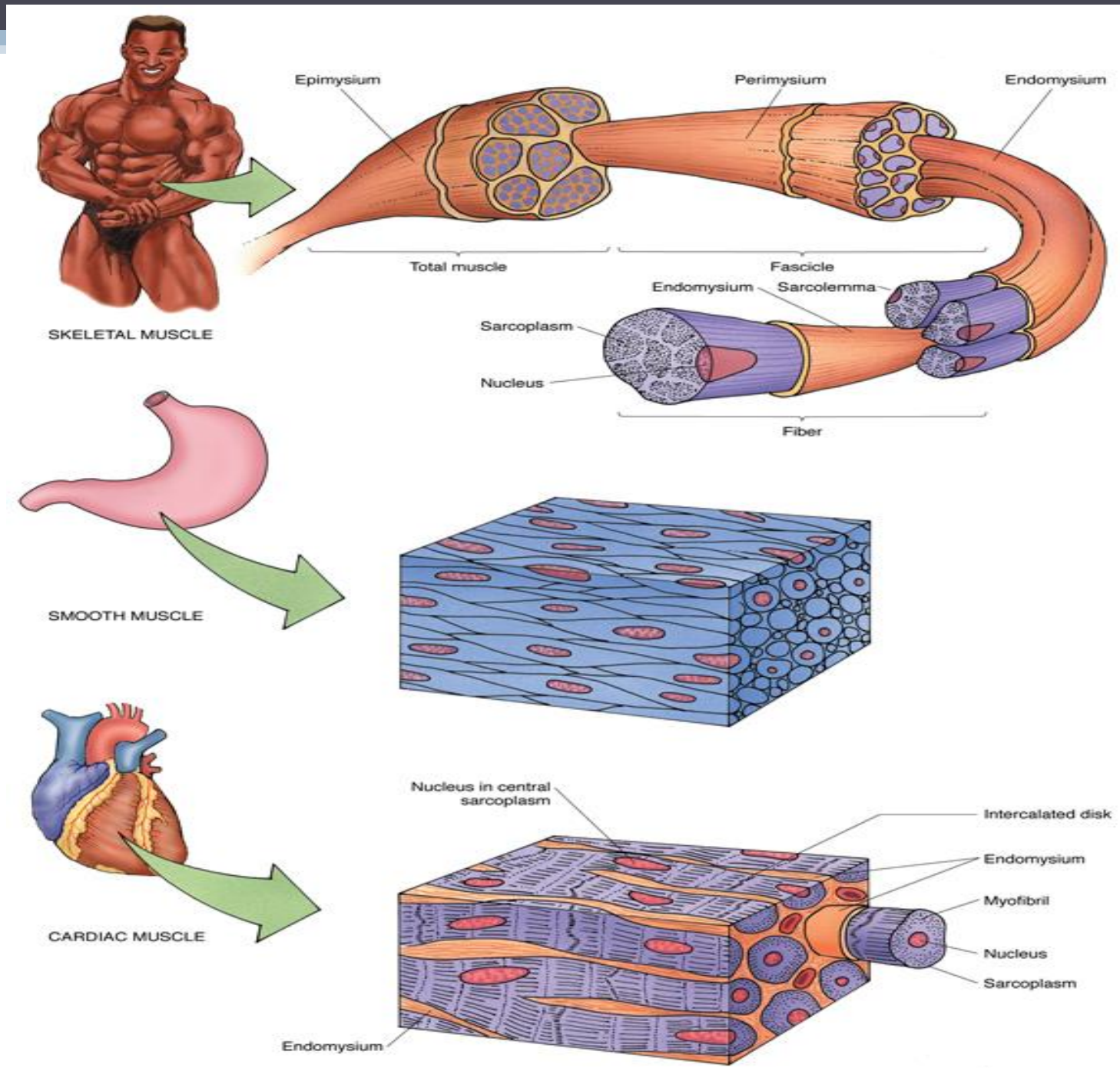
Muscle Tissue

Cells of muscle are elongated and are called **striated** or **smooth** muscle, depending on the respective presence or absence of a regularly repeated arrangement of myofibrillar contractile proteins, the myofilaments.

- **Striated muscle** cells display characteristic alternations of light and dark cross-bands, which are absent in smooth muscle. There are two types of striated muscle: **skeletal,** accounting for most of the voluntary muscle mass of the body, and involuntary **cardiac** muscle, limited almost exclusively to the heart.
- **Smooth muscle** is located in the walls of blood vessels and the viscera as well as in the dermis of the skin.

Unique terms are often used to describe the components of muscle cells.

- Thus, muscle cell membrane is referred to as **sarcolemma;** the cytoplasm, as **sarcoplasm;** the smooth endoplasmic reticulum, as **sarcoplasmic reticulum;** and occasionally, the mitochondria, as **sarcosomes.** Because they are much longer than they are wide, muscle cells frequently are called **muscle fibers.**


Epimysium
Perimysium
Endomysium
Total muscle
Fascicle
SKELETAL MUSCLE
Endomysium
Sarcolemma
Sarcoplasm
Nucleus
Fiber
SMOOTH MUSCLE
CARDIAC MUSCLE
Nucleus in central sarcoplasm
Intercalated disk
Endomysium
Myofibril
Nucleus
Sarcoplasm
Endomysium

Muscle Tissue

Characteristics

1. Cells are referred to as muscle fibers.
2. Contracts with force when stimulated.
3. Moves entire body and pumps blood

Types

1. Skeletal: attached to bones
2. Cardiac: muscle of the heart.
3. Smooth: muscle associated with tubular structures and with the skin. involuntary.

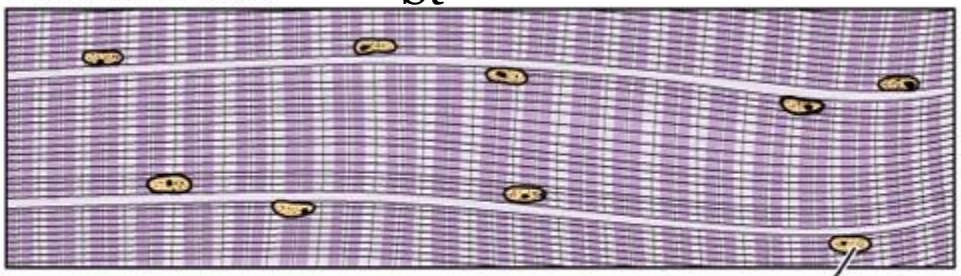
Structure

Muscle types

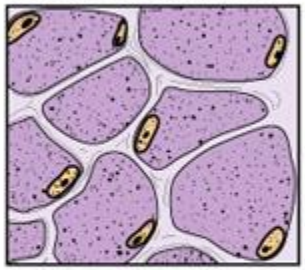
Activity

Skeletal muscle

St



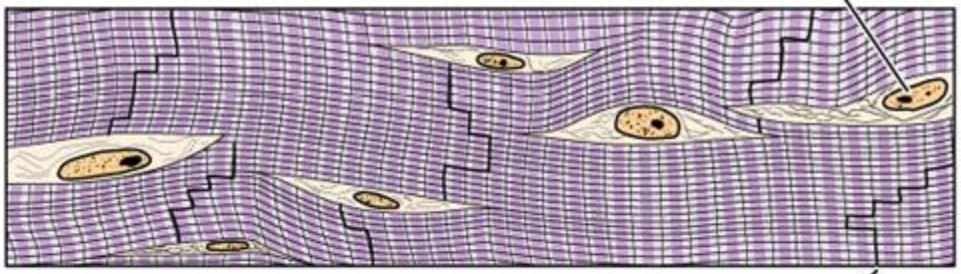
Cross sections

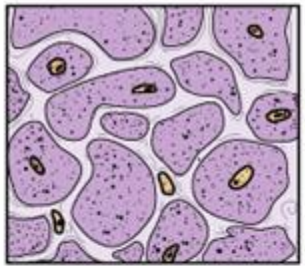


Strong, quick discontinuous voluntary contraction

Nuclei

Cardiac muscle

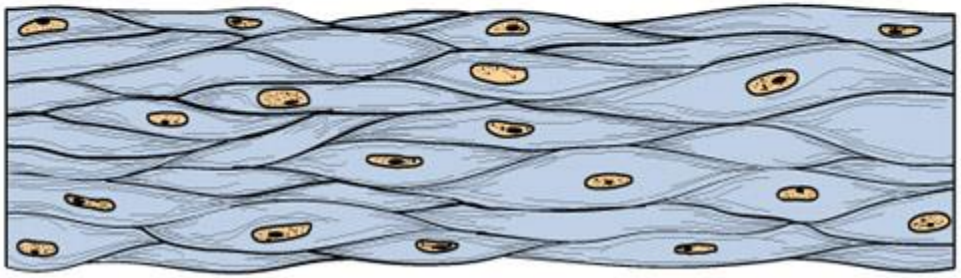


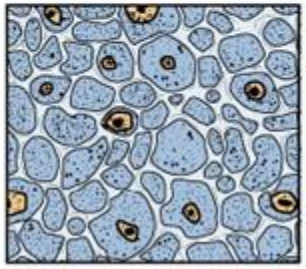


Strong, quick continuous involuntary contraction

Intercalated disks

Smooth muscle





Weak, slow involuntary contraction

Muscle Tissue

Structure of the 3 muscle types. The drawings at right show these muscles in cross section.

1. **Skeletal muscle is composed of large, elongated, cylindrical shape muscle cell, multinucleated, which are flattened and peripheral in their location.**

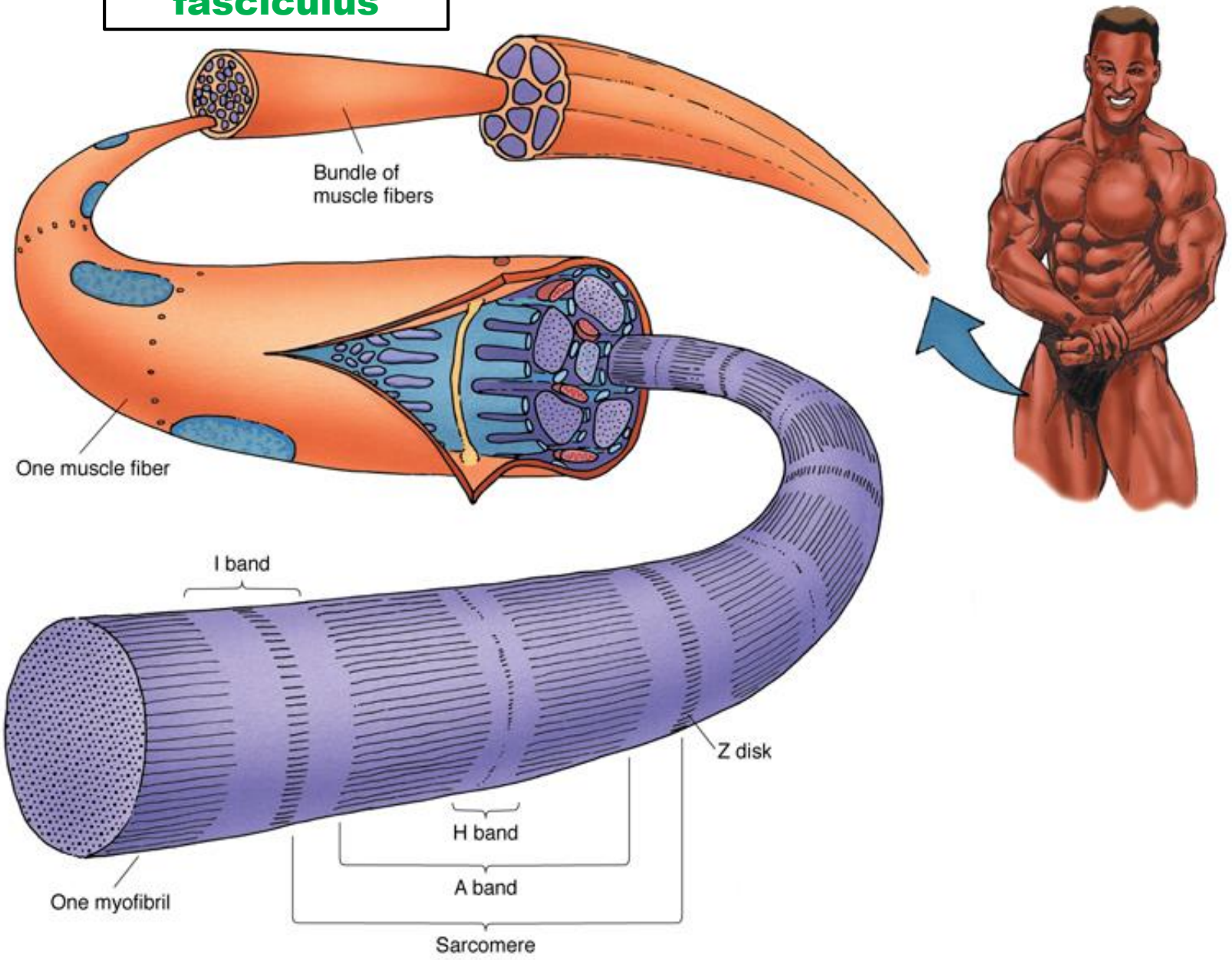
2. **Cardiac muscle is composed of Short cylindrical irregular branched cells bound together longitudinally by intercalated disks with a spherical center located nuclei.**

3. **Smooth muscle is an agglomerate of fusiform [spindle shape] cells. The density of the packing between the cells depends on the amount of extracellular connective tissue present.**

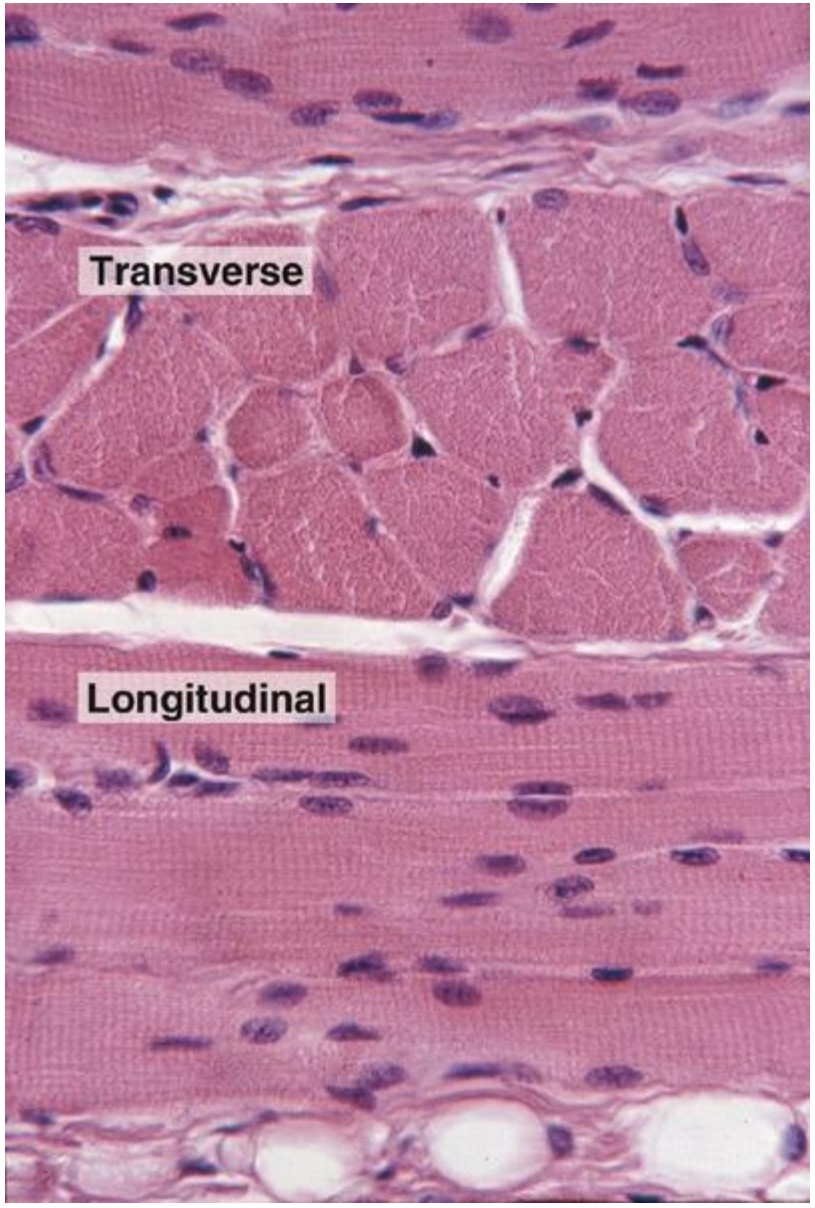
A\ Skeletal Muscle

- Organization of myofibrils and sarcomeres within a skeletal muscle cell. Note that the entire gross muscle is surrounded by a thick connective tissue investment, known as the **epimysium,** which provides finer connective tissue elements (the **perimysium**) that surround bundles of skeletal muscle fibers **[muscle fasciculus]**. Individual muscle cells are surrounded by still finer connective tissue elements, the **endomysium**.
- Individual skeletal muscle fibers possess a **sarcolemma** that has tubular invaginations (T tubules) that course through the sarcoplasm and are flanked by terminal cisternae of the sarcoplasmic reticulum. The contractile elements of the skeletal muscle fiber are organized into discrete cylindrical units called myofibrils. Each myofibril is composed of thousands of sarcomeres with their characteristic A, I, and H bands and Z disk.

muscle fasciculus



- **Skeletal muscle fibers are multinucleated cells, with their numerous nuclei peripherally located just beneath the cell membrane. Each cell is surrounded by endomysium, whose fine reticular fibers intermingle with those of neighboring muscle cells.**
- **Much of the skeletal muscle cell is composed of longitudinal arrays of cylindrical myofibrils, each 1 to 2 μm in diameter. They extend the entire length of the cell and are aligned precisely with their neighbors. This strictly ordered parallel arrangement of the myofibrils is responsible for the cross-striations of light and dark banding that are characteristic of skeletal muscle viewed in longitudinal section.**
- **The dark bands are known as A bands and the light bands as I bands. The center of each A band is occupied by a pale area, the H band, which is bisected by a thin M line. Each I band is bisected by a thin dark line, the Z disk (Z line). The region of the myofibril between two successive Z disks, known as a sarcomere, is 2.5 μm in length and is considered the contractile unit of skeletal muscle fibers.**
- **During muscle contraction, the various transverse bands behave characteristically. The I band becomes narrower, the H band is extinguished, and the Z disks move closer together (approaching the interface between the A and I bands), but the width of the A bands remains unaltered.**



- **Striated skeletal muscle in longitudinal section (lower) and in cross section (upper).**
- **The nuclei can be seen in the periphery of the cell, just under the cell membrane, particularly in the cross sections of these striated fibers.**

[H&E stain. Medium magnification]

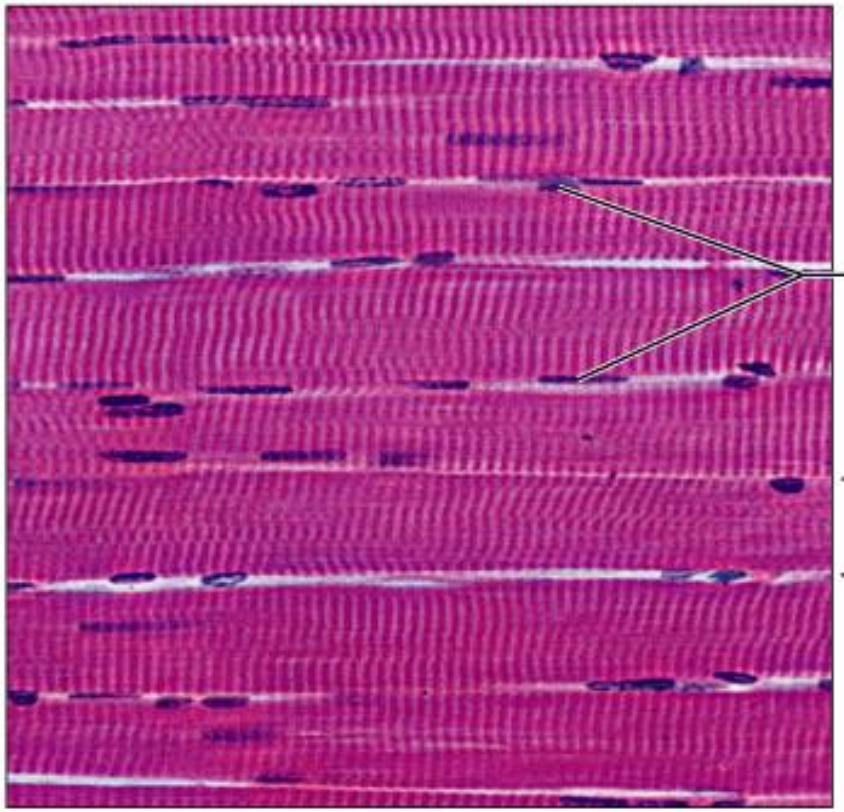
Skeletal Muscle Tissue

(a) Skeletal muscle

Description: Long, cylindrical, multinucleate cells; obvious striations.

Function: Voluntary movement; locomotion; manipulation of the environment; facial expression; voluntary control.

Location: In skeletal muscles attached to bones or occasionally to skin.



Photomicrograph: Skeletal muscle (approx. 300×). Notice the obvious banding pattern and the fact that these large cells are multinucleate.

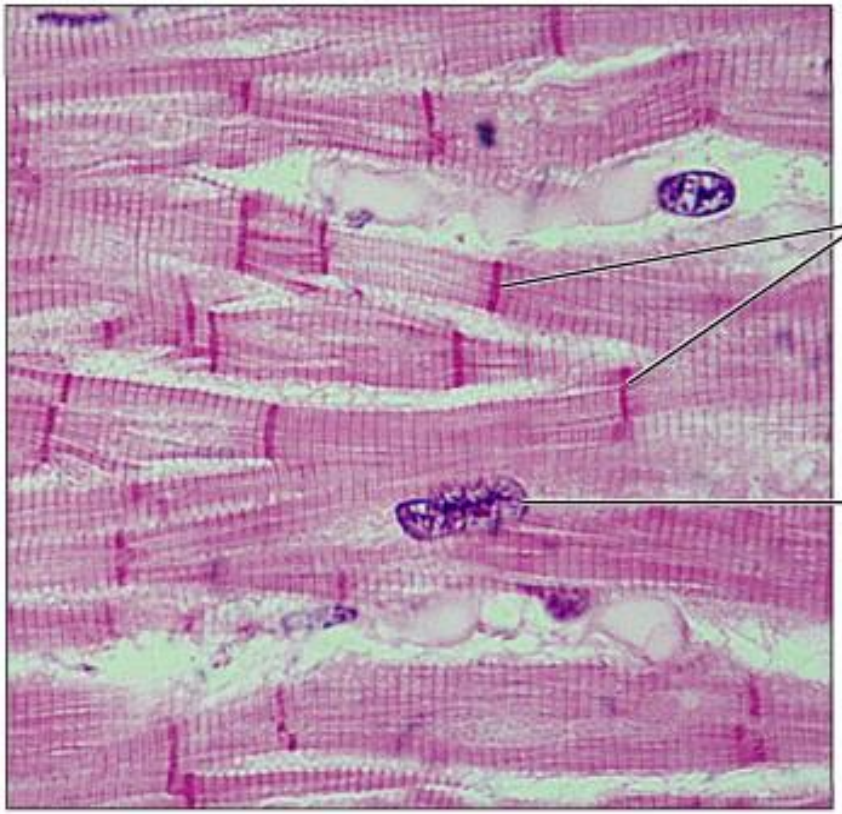
Cardiac Muscle Tissue

(b) Cardiac muscle

Description: Branching, striated, generally uninucleate cells that interdigitate at specialized junctions (intercalated discs).

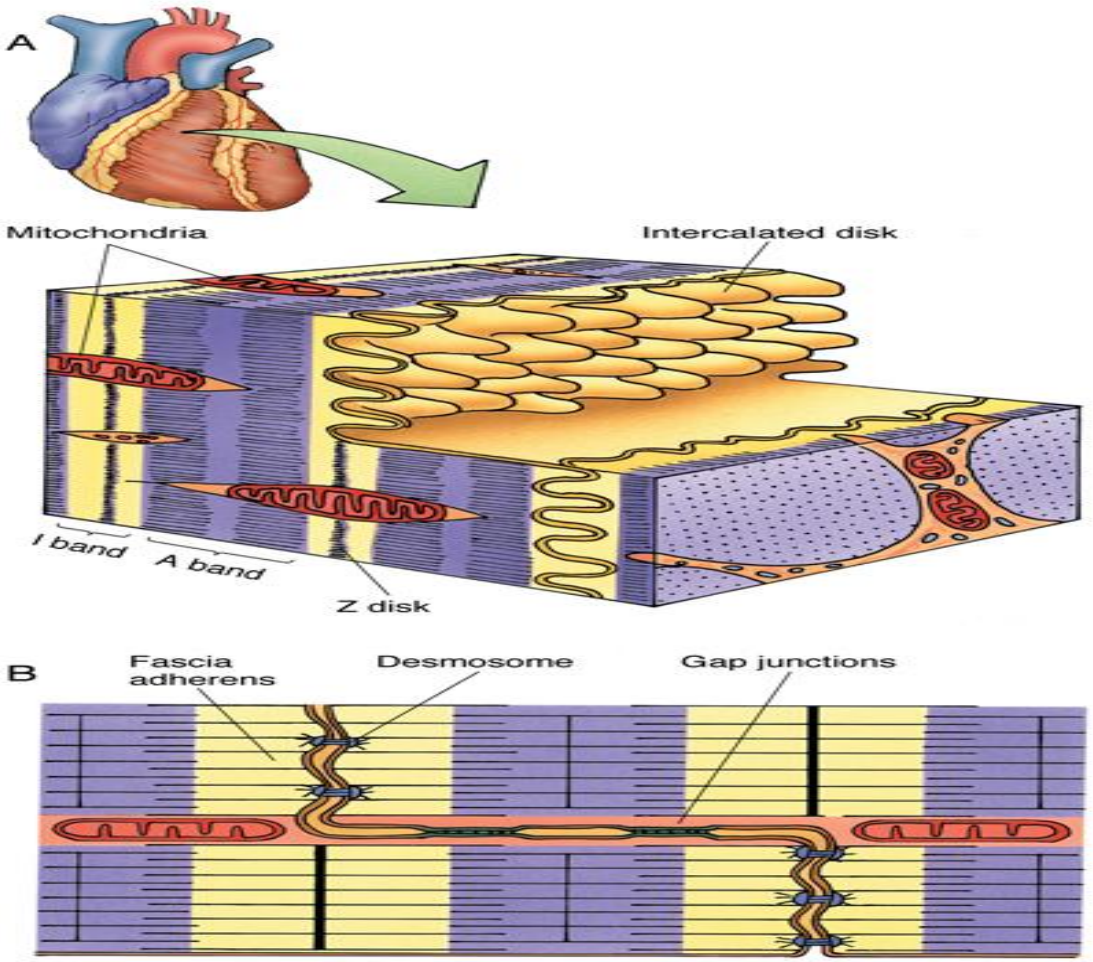
Function: As it contracts, it propels blood into the circulation; involuntary control.

Location: The walls of the heart.



Photomicrograph: Cardiac muscle (800×); notice the striations, branching of cells, and the intercalated discs.

Cardiac Muscle



Cardiac muscle. A, Three-dimensional view of an intercalated disk. B, Two-dimensional view of the intercalated disk with a display of adhering and communicating junctions. The transverse portions of the intercalated disk act as a Z plate, and thin filaments are embedded in them.

Cardiac Muscle

Cardiac muscle (heart muscle), another form of striated muscle, is found only in the heart and in pulmonary veins where they join the heart. The adult myocardium consists of an anastomosing network of branching cardiac muscle cells arranged in layers **(laminae).** Laminae are separated from one another by slender connective tissue sheets that convey blood vessels, nerves, and the conducting system of the heart. Capillaries, derived from these branches, invade the intercellular connective tissue, forming a rich, dense network of capillary beds surrounding every cardiac muscle cell. Cardiac muscle differs from skeletal and smooth muscles in that it possesses an **inherent rhythmicity** as well as the ability to **contract spontaneously**.

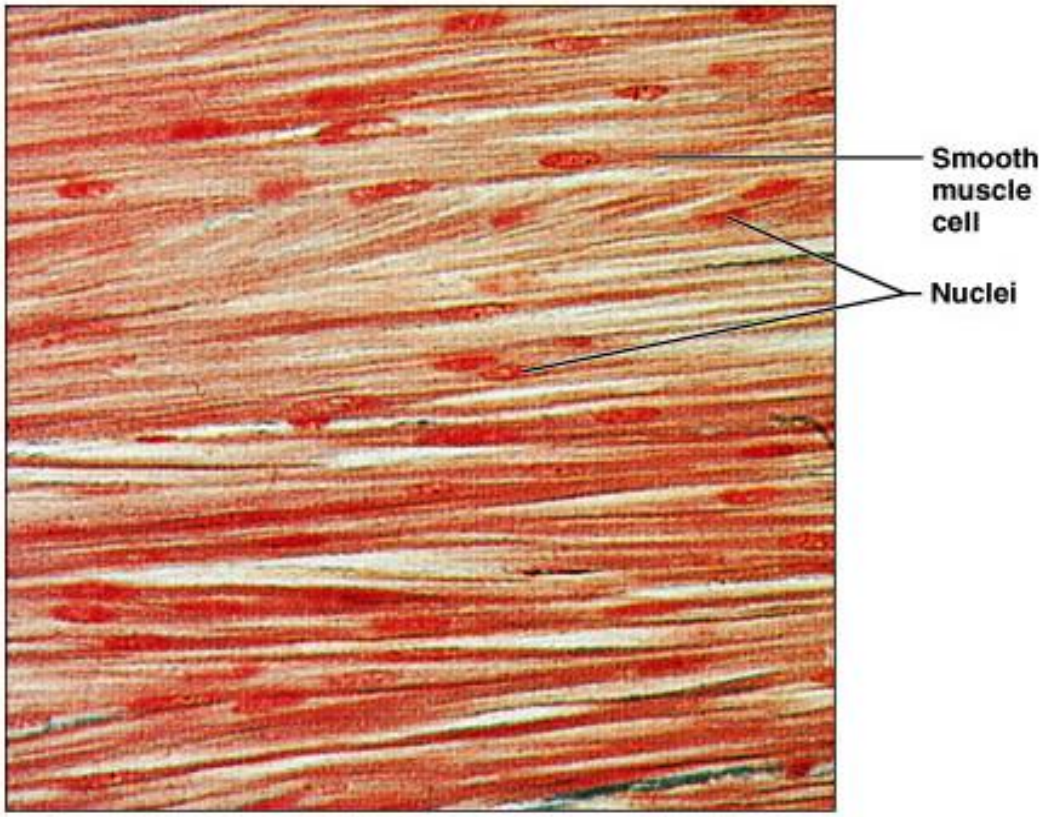
Smooth Muscle Tissue

(c) Smooth muscle

Description: Spindle-shaped cells with central nuclei; no striations; cells arranged closely to form sheets.

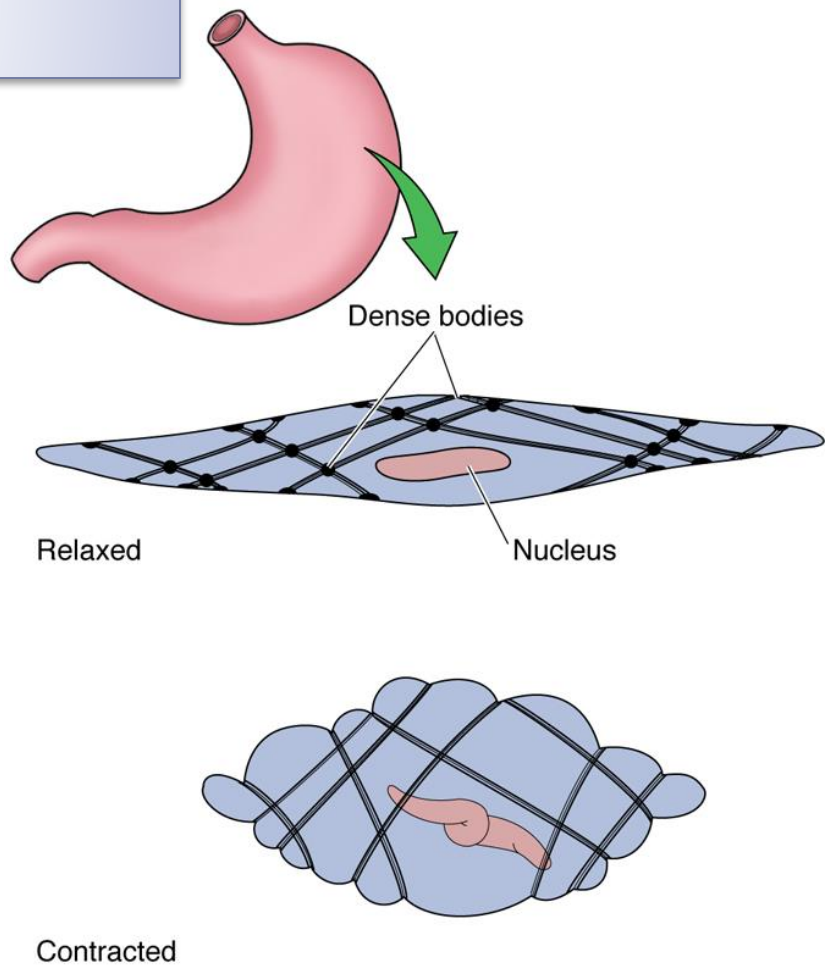
Function: Propels substances or objects (foodstuffs, urine, a baby) along internal passageways; involuntary control.

Location: Mostly in the walls of hollow organs.



Photomicrograph: Sheet of smooth muscle (approx. 600×).

Smooth Muscle Tissue



A relaxed smooth muscle cell and a contracted smooth muscle cell. Note that in a contracted smooth muscle cell the nucleus appears corkscrew-shaped.

Smooth Muscle Tissue

The cells of the third type of muscle exhibit no striations; therefore, they are referred to as **smooth muscle.** Additionally, smooth muscle cells do not possess a system of T tubules. Smooth muscle is not under voluntary control; it is regulated by the autonomic nervous system and local physiological conditions. Hence, smooth muscle is also referred to as **involuntary muscle**.

There are two types of smooth muscle:

1. Cells of **multiunit smooth muscle** can contract independently of one another, because each muscle cell has its own nerve supply.

2. Cell membranes of **unitary (single-unit, vascular) smooth muscle** form gap junctions with those of contiguous smooth muscle cells, and nerve fibers form synapses with only a few of the muscle fibers. Thus, cells of unitary smooth muscle cannot contract independently of one another.

In addition to its contractile functions, some smooth muscle is capable of exogenous **protein synthesis.** Among the substances manufactured by smooth muscle cells for extracellular utilization are collagen, elastin, glycosaminoglycans, proteoglycans, and growth factors.

Smooth muscle fibers are **fusiform,** elongated cells that cells taper at either end, whereas the central portion contains an oval nucleus housing two or more nucleoli. During muscle shortening, the nucleus assumes a characteristic “corkscrew appearance.”