Republic of Iraq
Ministry of Higher Education
and Scientific Research
The Islamic University college
AL-Najaf Al-Ashraf
College of Dentistry

MUSCLE TISSUE

By
T.A. Hawra'a F. AL.Baghdady

Muscle tissue is composed of cells differentiated for optimal use of the universal cell property termed contractility. Microfilaments and associated proteins together generate the forces necessary for cellular contraction, which drives movement within certain organs and the body as a whole. Nearly all muscle cells are of mesodermal origin and they differentiate mainly by a gradual process of cell lengthening with simultaneous synthesis of myofibrillar proteins.
Three types of muscle tissue can be distinguished on the basis of morphologic and functional characteristics and the structure of each type is adapted to its physiologic role.

1- skeletal muscle
2- cardiac muscle
3- smooth muscle.

The cytoplasm of muscle cells is called sarcoplasm and the smooth ER is called sarcoplasmic reticulum. The sarcolemma is the cell membrane, or plasmalemma.

SKELETAL MUSCLE

Skeletal muscle consists of muscle fibers, which are long, cylindrical multinucleated cells with diameters of 10–100 m. Multinucleation results from the fusion of embryonic mesenchymal cells called myoblasts. The long oval nuclei are usually found at the periphery of the cell under the cell membrane. This characteristic nuclear location is helpful in discriminating skeletal muscle from cardiac and smooth muscle, both of which have centrally located nuclei.
Their contraction is quick, forceful, and usually under voluntary control. It is caused by the interaction of thin actin filaments and thick myosin filaments whose molecular configuration allows them to slide upon one another. The forces necessary for sliding are generated by weak interactions in the bridges between actin and myosin.

Development of skeletal muscle

Skeletal muscle begins to differentiate when mesenchymal cells called myoblasts align and fuse together to make longer, multinucleated tubes called myotubes.

Myotubes synthesize the proteins to make up myofilaments and gradually begin to show cross striations by light microscopy. Myotubes continue differentiating to form functional myofilaments and the nuclei are displaced against the sarcolemma. Part of the myoblast population does not fuse and differentiate, but remains as a group of mesenchymal cells called muscle satellite cells located on the external surface of muscle fibers inside the developing external lamina. Satellite cells proliferate and produce new muscle fibers following muscle injury.

Muscle Fibers

As observed with the light microscope, longitudinally sectioned skeletal muscle fibers show cross-striations of alternating light and dark bands. The darker bands are called A bands the lighter bands are called I bands . In the TEM each I band is seen to be bisected by a dark transverse line, the Z line . The repetitive functional subunit of the contractile apparatus, the sarcomere, extends from Z line to Z line and is about 2.5 µm long in resting muscle.

CARDIAC MUSCLE

Cardiac muscle also has cross-striations and is composed of elongated, branched individual cells that lie parallel to each other. At sites of end-to-end contact are the intercalated disks, structures found only in cardiac muscle. Contraction of cardiac muscle is involuntary, vigorous, and rhythmic. Smooth muscle consists of collections of fusiform cells that do not show striations. Their contraction process is slow and not subject to voluntary control.
during embryonic development, the mesoderm cells of the primitive heart tube align into chainlike arrays. Rather than fusing into multinucleated cells, as in the development of skeletal muscle fibers, cardiac muscle cells form complex junctions between extended processes . Cells within a fiber often branch and bind to cells in adjacent fibers. Consequently, the heart consists of tightly knit bundles of cells, interwoven in a fashion that provides for a characteristic wave of contraction that leads to a wringing out of the heart ventricles Mature cardiac muscle cells are approximately 15 µm in diameter and from 85 to 100 µm in length. They exhibit a cross-striated banding pattern comparable to that of skeletal muscle. Unlike multinucleated skeletal muscle, however, each cardiac muscle cell possesses only one or two centrally located pale-staining nuclei.

Surrounding the muscle cells is a delicate sheath of endomysium containing a rich capillary network. A unique and distinguishing characteristic of cardiac muscle is the presence of dark-staining transverse lines that cross the chains of cardiac cells at irregular intervals . These intercalated discs represent the interface between adjacent muscle cells where many junctional complexes are present . Transverse regions of these steplike discs have many desmosomes and fascia adherentes (which resemble the zonula adherentes between epithelial cells) and together these serve to bind cardiac cells firmly together to prevent their pulling apart under constant contractile activity.

The more longitudinal portions of each disc have multiple gap junctions, which provide ionic continuity between adjacent cells. These act as "electrical synapses" and allow cells of cardiac muscle to act as in a multinucleated syncytium, with contraction signals passing in a wave from cell to cell.

SMOOTH MUSCLE

Smooth muscle fibers are elongated, tapering, and nonstriated cells, each of which is enclosed by a thin basal lamina and a fine network of reticular fibers. The connective tissues serve to combine the forces generated by each smooth muscle fiber into a concerted action, eg, peristalsis in the intestine.

Smooth muscle cells may range in length from 20 µm in small blood vessels to 500 µm in the pregnant uterus. Each cell has a single nucleus located in the center of the cell's broadest part. To achieve the tightest packing, the narrow part of one cell lies adjacent to the broad parts of neighboring cells. Such an arrangement viewed in cross section shows a range of diameters, with only the largest profiles containing a nucleus . The borders of the cell become scalloped when smooth muscle contracts and the nucleus becomes distort.