Muscles

Muscle cells are structurally and functionally specialized for contraction, which contain two types of special protein filaments called myofilaments; including thin filaments; containing actin and thick filaments containing myosin.

Nearly all muscle cells are mesodermal in origin. Mesenchymal cells differentiate into muscle cells through a process involving accumulations of myofilaments in the cytoplasm and development of special membranous channels and compartments.

Muscle tissue are groups of muscle cells organized by connective tissue. This arrangement allows the groups to act together or separately, generating mechanical forces of varying strength.

Types of Muscles:

Vertebrate have three types of muscles: skeletal or striated voluntary muscle is found mainly in association with bone. It is normally the only type of muscle under the animals voluntary control. Cardiac muscle which is involuntary, it's found exclusively in the walls of heart. Smooth muscle or visceral muscle which is involuntary and found mainly in the walls of hollow organs (eg. intestines and blood vessels).

Skeletal muscles:

Skeletal muscles formed of muscle fiber and connective tissue in between. The muscle fiber is long and cylindrical in shape, the nuclei are multiple, peripheral and elongated, the cytoplasm (sarcoplasm) shows alternative dark and light band. In the middle of dark (A band) there is a pale region called H- zone, and in the middle of light band (I band) there is a dark line called Z- line. The distance between two successive Z- line called sarcomere which serves as the functional unit for muscle contraction. (Fig. 1,2).

Cardiac muscle:

The cytoplasm contain single oval, prominent and central nucleus, the sarcoplasm near nuclear pole contains many mitochondria, glycogen granules. The muscle fibers are branched but shorter than skeletal muscle fibers. The short cardiac muscle fibers are joined together by intercalated discs, these discs appear as dark lines (Fig. 3).

Smooth muscles:

Mature smooth muscles fibers are spindle- shaped cells with a single central ovoid nucleus, the sarcoplasm at the nuclear poles contain abundant mitochondria, some RER, and a large Golgi complex. The cytoplasm is full of actin and myosin filaments. It is smooth because there is no striation. (Fig. 4)

Properties of Muscle Tissue:

Muscle tissue has two distinguishing characteristics: contractility and electrical excitability. Excitability is also a property of neurons, and in both muscle and neurons tissue, it is due to energy stored as an asymmetrical distribution of ions across the plasma membranes depolarize in response to a chemical neurotransmitter released at a neuromuscular junction; in most types of muscle the membrane may also depolarize spontaneously without stimulation by a neurotransmitter.

Although both nervous and muscular tissue transmit electrical impulses, most muscles also contract.

Muscle Contraction:

Each striated muscle- fiber consist of bundle of myofibrils; each myofibril is made up of units called sarcomeres arrange single line along the length of the fiber. A sarcomere is the part of myofibril between two successive Z- line, protein containing structure extending across the myofibril. Some scientists found that Z. line of skeletal muscle fibers

move closer together when a muscle contracts. This sliding filament theory of muscle contraction. (Fig. 5. 6)

Muscle contraction involve two kinds of protein filaments. Attached to each side of Z. line are thin filaments, made of a twisted double strand of the protein called fibrous actin, with smaller amounts of the proteins troponin and tropomyosin.

The thin filaments extent less than halfway of the center of a sarcomere from the Z- lines at either end. When the muscle is at rest, the thin filaments overlap somewhat with thick filaments which lie in the middle of the sarcomere.

The thick filaments consists of many molecules of protein myosin, twisted into rope- like structure with "heads" of the molecules sticking out at the edges of filament. (Fig. 7)

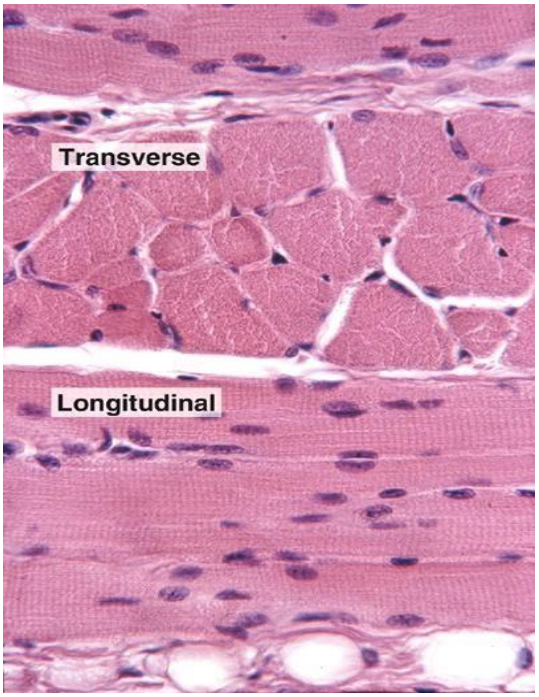

Fig.1: Transverse and longitudinal sections of skeletal muscle

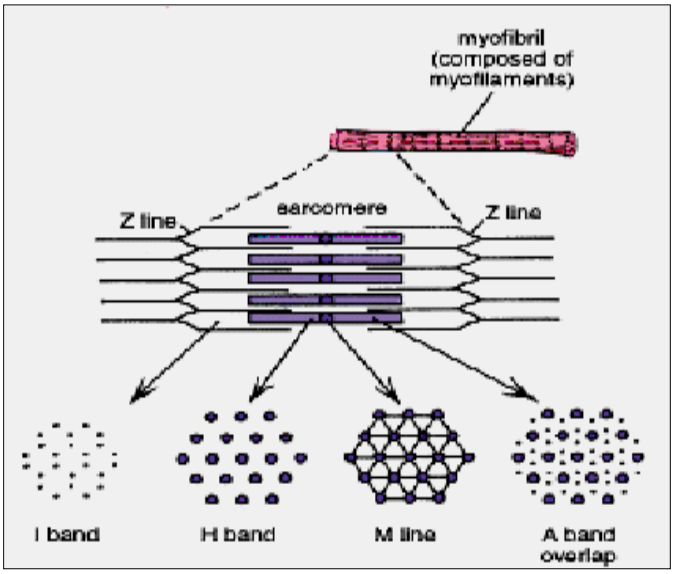

Fig.2: Organization of myofilaments showing the dark and light bands as well as sarcomere.

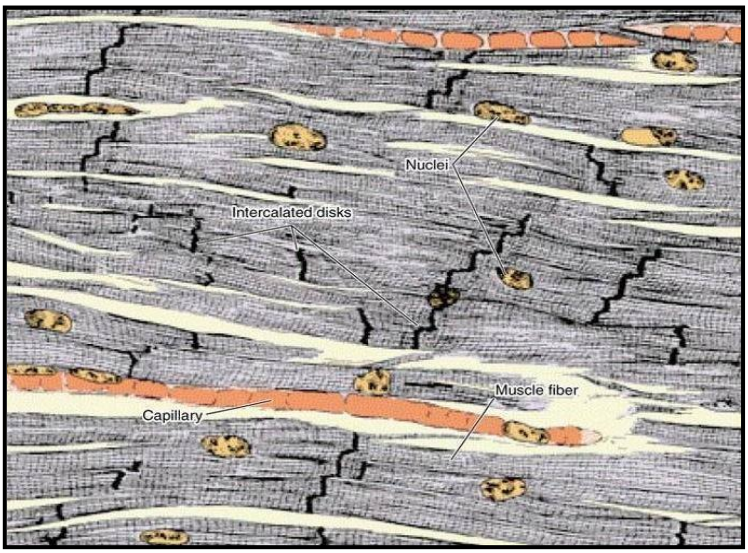

Fig.3: Cardiac muscle showing the muscle fibers, nuclei, and the intercalated discs

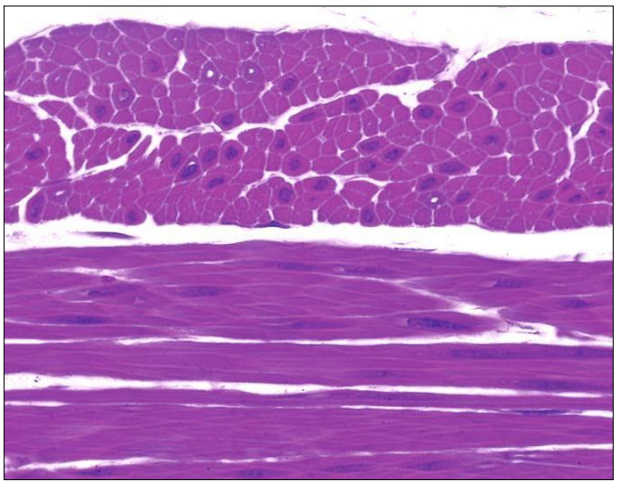

Fig.4: Transverse and longitudinal section of smooth muscle fibers

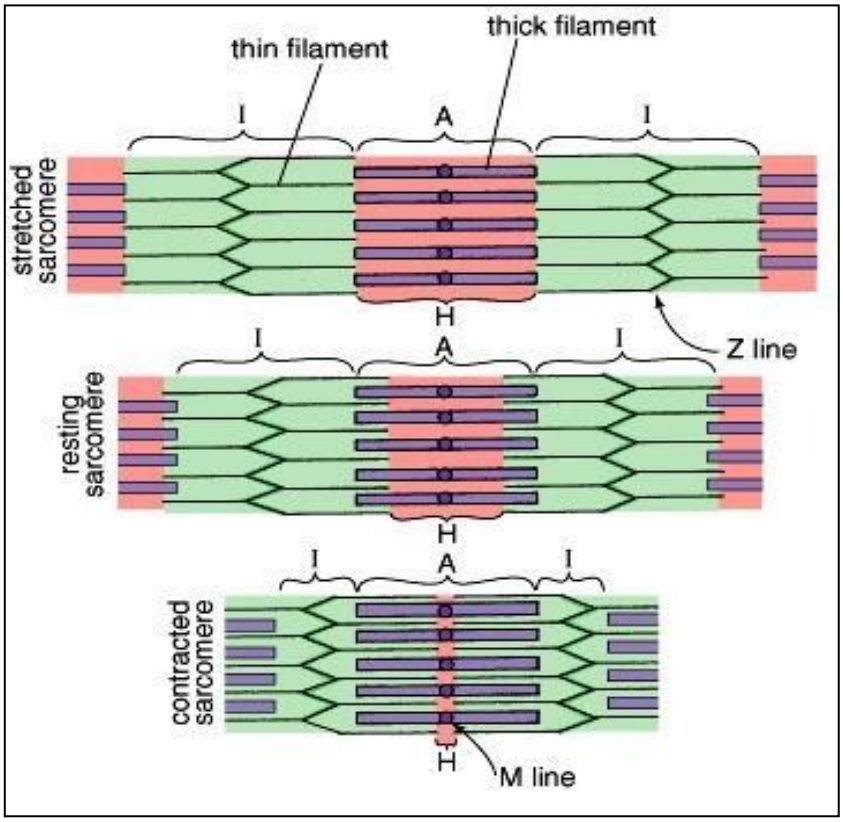

Fig.5: Sarcomere in different functional stages

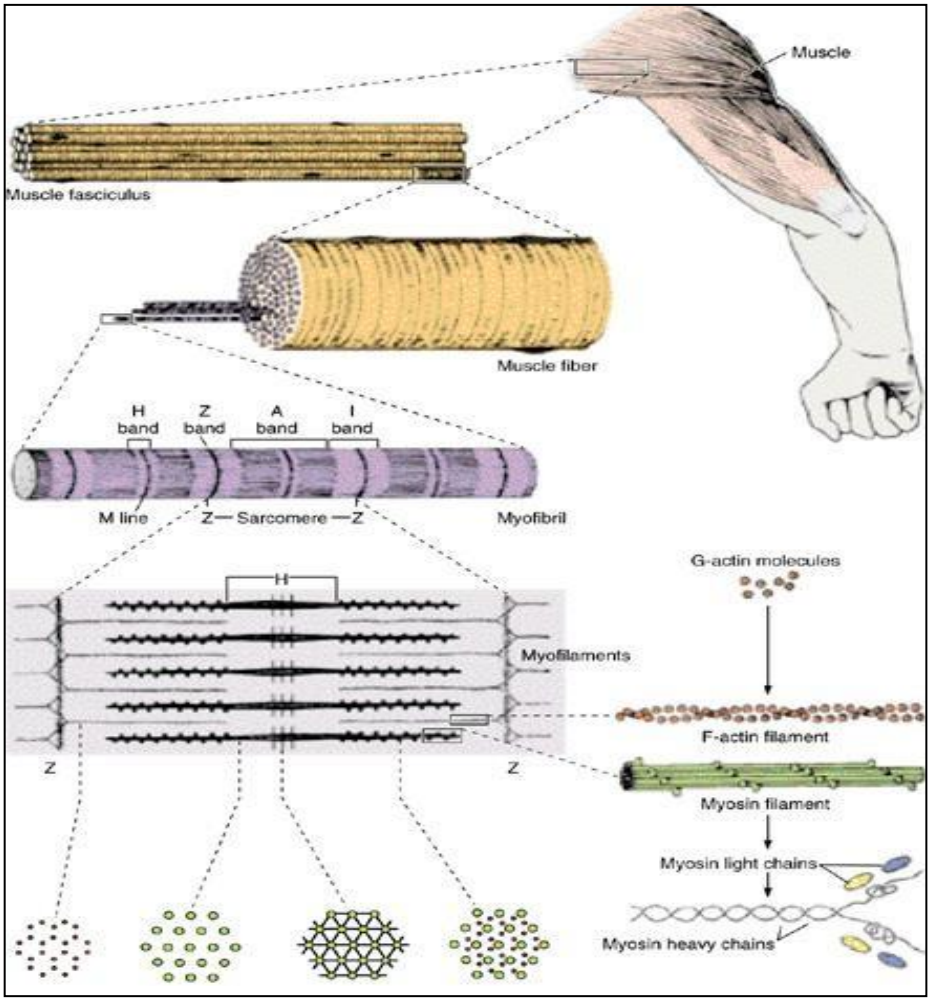

Fig.6: Organization of myofilaments showing the dark and light bands as well as actin and myosin filament in the sarcomere.

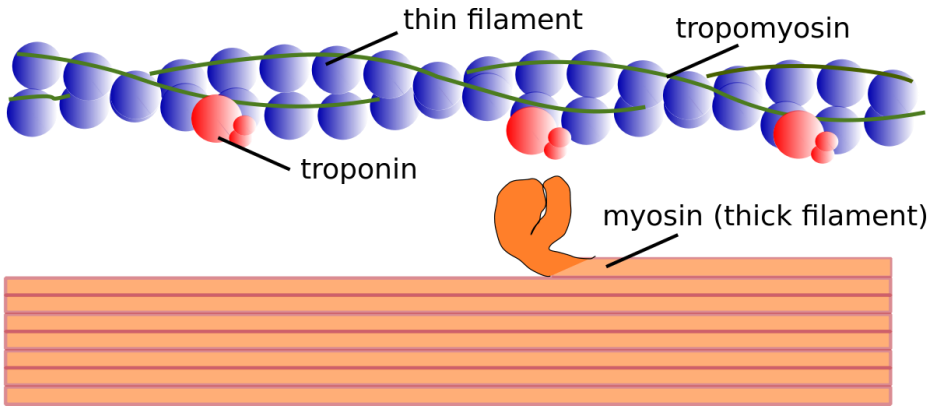

Fig.7: Thick and thin myofilaments