Topic: **MUSCLE PHYSIOLOGY**

BA PART I, 1st PAPER, By: Dr. AMARJEET KUMAR, Home Science Department, Rohtas Mahila College, Sasaram. E-mail ID: amarjeetkumar11@gmail.com

MUSCLE PHYSIOLOGY

All physical functions of the body involve muscle activity. These functions include skeletal movements, contraction of the heart, contraction of blood vessels, peristalsis in the digestive tract and many more. There are 3 different types of muscle tissues responsible for these activities.

1. Skeletal, Voluntary or striated muscle.

2. Visceral, involuntary or smooth muscle.

3. Cardiac muscle.

Skeletal muscle tissue

This may be described as skeletal, striated, striped or voluntary muscle. It is called voluntary because contraction is under the control of the will. When voluntary muscle is examined microscopically the cells are found to be roughly cylindrical in shape and may be as long as 35 cm. Each cell, commonly called a fiber, has several nuclei situated just under the **sarcolemma**, or cell membrane of each muscle fiber. The muscle fibers lie parallel to one another, and when viewed under the microscope, they show well-marked transverse dark and light bands, hence the name striated or striped muscle. A **muscle** consists of a large number of muscles fiber. In addition to the **sarcolemma** mentioned previously, each fiber is enclosed in and attached to fine fibrous tissue called **endomysium.** Small bundles of fibers are enclosed in **perimysium,** and the whole muscle in **epimysium.** The fibrous tissue enclosing the fibers, the bundles and the whole

muscle extends beyond the muscle fibers to become the **tendon** which attaches the muscle to bone or skin.

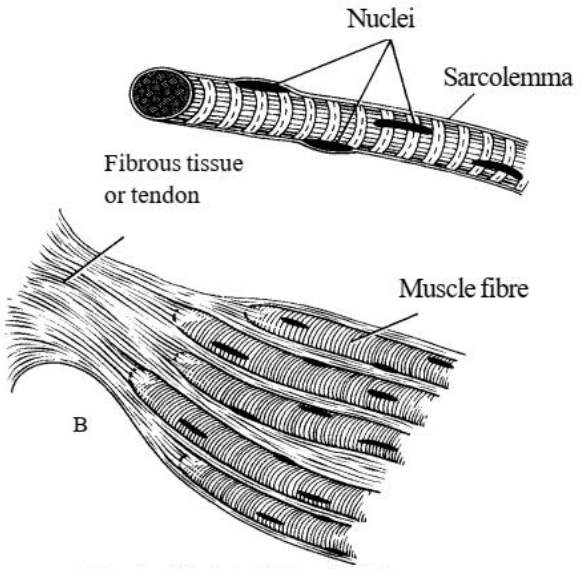

Fig. 9 - Skeletal Muscle Fibre

Visceral muscle tissue

Visceral muscle may also be described as **smooth or involuntary** (figure 10). It is not under the control of the will. It is found in the walls of blood and lymph vessels, the alimentary tract, the respiratory tract, the urinary bladder, the biliary tract and the uterus.

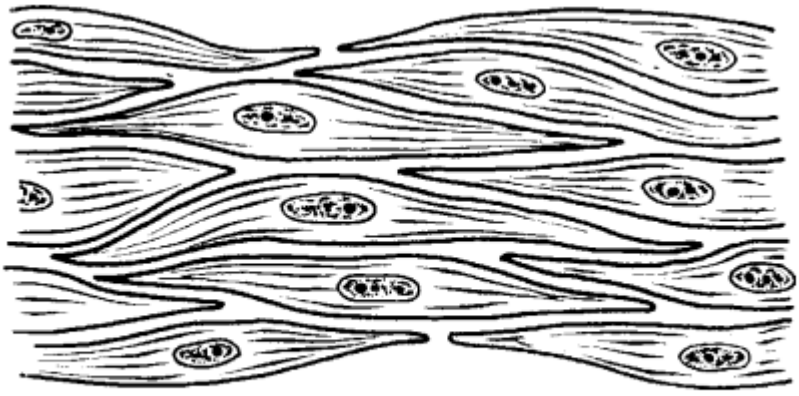

Fig. 10 - Smooth Muscle fibre

When examined under a microscope, the cells are seen to be spindle-shaped with only one central nucleus. There is no distinct sarcolemma but a very fine membrane surrounds each fiber. Bundles of fibers form sheets of muscle, such as those found in the walls of the above structures.

Cardiac muscle

This type of muscle tissue is found exclusively in the wall of the heart. It is not under the control of the will but, when viewed under a microscope, cross stripes characteristic of voluntary muscle, can be seen. Each fiber (cell) has a nucleus and one or more branches. The ends of the cells and their branches are in very close contact with the ends and branches of adjacent cells. Microscopically these 'joints', or **intercalated** discs, can be seen as lines which are thicker and darker than the ordinary cross stripes. This arrangement gives cardiac muscle the appearance of a sheet of muscle rather than a very large number of individual fibers. A wave of contraction spreads from cell to cell across the intercalated discs which means that cells need not be stimulated individually.

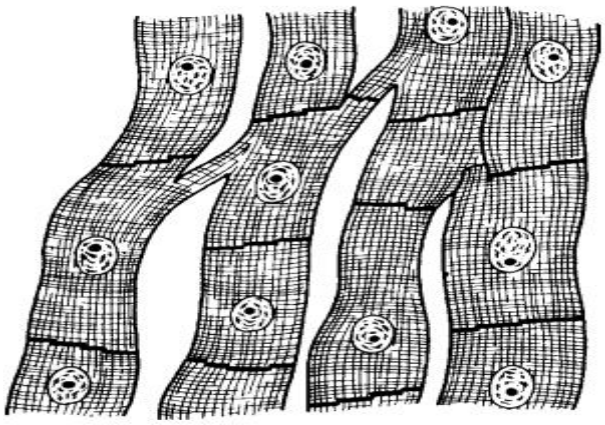

Fig.11. Cardiac muscle tissue

Muscle contraction

A single muscle is made up of thousands of individual muscle fibers. Every fiber extends the entire length of the muscle and is attached at each end to **muscle**

tendons. When stimulated, muscle fibers contract, and the force of contraction is transmitted to the bones through the tendons.

Anatomy of skeletal muscle fiber

Each muscle fiber is between 10 and 100 microns in diameter and it varies from a few millimeters to 50 cm. in length, depending on the muscle. The longitudinal view shows dark and light bands along the fiber. This is characteristic of skeletal and cardiac muscle but not smooth muscle. The segment of fiber between each two successive bands is called a **sarcomere.** Each muscle fiber contains several hundred to several thousand myofibrils. Each myofibril is composed of several filaments. There are two types of filaments - actin and myosin filaments which are responsible for muscle contraction. These can be seen in longitudinal view in an electron micrograph as shown below.

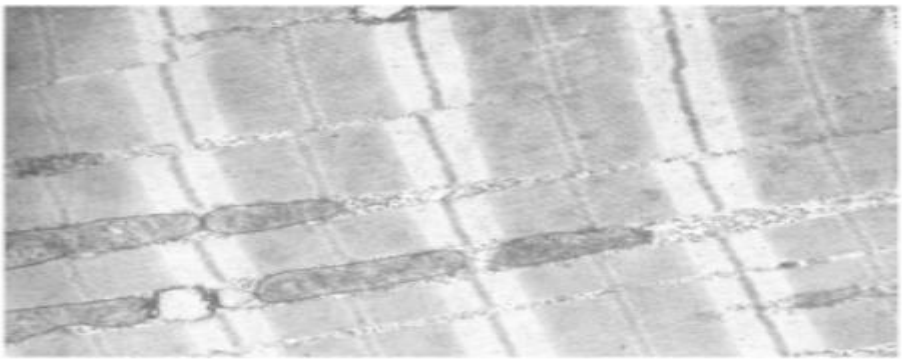

Fig. 12- Electromicrograph of a Muscle fibre

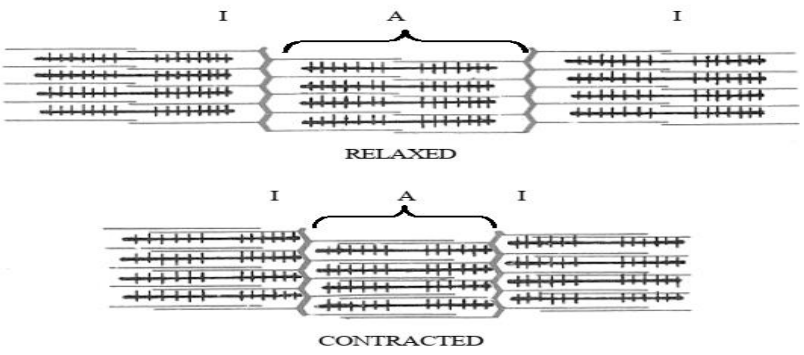

Fig. 13- The relaxed and contracted states of a myofibril

The diagrammatic representation is as shown in figure 13.

The **actin** filaments are thin filaments and form light bands called **I-bands**. The **myosin** filaments are thick filaments that form the dark bands called **A-bands**. The myosin filaments have small projections from the sides called **cross-bridges**. The actin and myosin filaments partially interdigitate and thus cause the myofibrils to have alternate light and dark bands. The interaction between the cross-bridges and the actin filaments cause contraction of a muscle fiber. The actin filaments are attached to the Z-line. Numerous mitochondria are present which provide the energy for muscle contraction. Presence of Ca ++ ions are necessary for activating muscle contraction. Basic mechanism of contraction involves the actin filaments to slide over the myosin filaments. Thus, muscle contraction occurs by a **sliding filament mechanism**.

Characteristics of whole muscle contraction Motor Unit

Several hundreds to several thousand nerve fibers enter most muscles. On an average, a single motor nerve fiber can innervate about 180 muscle fibers. Thus, stimulating one nerve fiber, can cause contraction of 180 muscle fibers all at the same time. All the muscle fibers innervated by the same nerve fiber is called a **motor unit** because they are always excited simultaneously and contract together.

Isometric and Isotonic contraction

In the human body, muscle contraction is of both isometric and isotonic types. When a person is simply standing, he tenses his leg muscles to maintain a fixed position of the joints. This is **isometric contraction.** Isometric means **'same length'**. Here the muscle tightens but does not shorten. When a person is walking and moving his legs, or when he is lifting his arms, the contraction is **isotonic contraction**. Isotonic means **'same force'.** Here the muscle shortens in length.