

MICROSCOPIC STUDY OF MUSCULAR AND NERVOUS TISSUE

Background ^[1]

A tissue is a group of one or more types of cells and their intercellular substance that perform a particular function. The word “tissue” was given by a French anatomist and physiologist Bichat. Bichat.

Study of tissues is called “histology”. Histology is also called microscopic anatomy. The term “histology” was given by a German histologist Mayer. An Italian scientist Marcello Malpighi is known as “founder of histology”. Bichat is considered “Father of Animal Histology”.

Based on the location and function, the animal tissues are classified into four types:

TYPE	ORIGIN	FUNCTION
1. Epithelial Tissue	Ectoderm, endoderm, mesoderm	Protection, secretion, absorption, excretion, reproduction
2. Connective Tissue	Mesoderm	Attachment, support, storage, protection, transport.
3. Muscular Tissue	Mesoderm	Movement of body parts and locomotion
4. Nervous Tissue	Ectoderm	Control and coordination by nerve impulse.

PART I MICROSCOPIC STUDY OF MUSCULAR TISSUE

Requirements

A compound microscope and permanent tissue slides

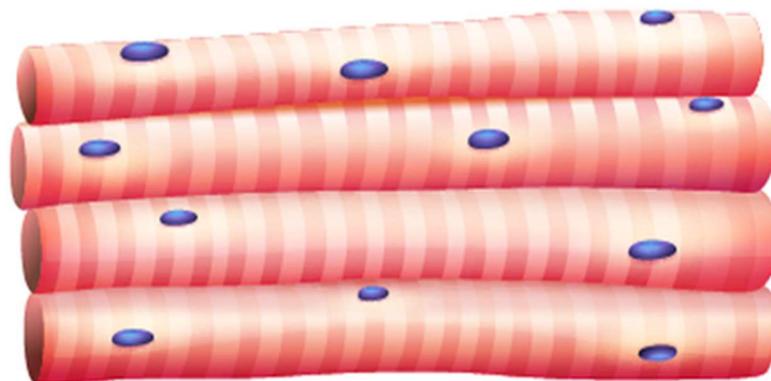
Theory

Study of muscle is called **myology**. Muscle tissue is able to contract and relax, providing movement within the body and of the body itself in response to stimuli. Contraction for motility results mainly from the interaction of two contractile proteins, actin and myosin. These proteins enter into the composition for microfilaments of cellular cytoskeleton. The muscle cells are always elongated, slender and spindle-shaped, fibre-like cells. These are therefore, called muscle fibres. These possess large numbers of myofibrils formed of actin and myosin. Muscle contraction requires an adequate of blood to provide sufficient oxygen, calcium and nutrients and to remove waste products. ^[2,4]

Types Of Muscle Are Following:

- i. **(Skeletal Muscle Tissue) Striated or striped muscles:** Most muscles of body are striated. These generally bring about voluntary movements under conscious control and hence called voluntary muscles. These form those muscles that are inserted at both ends upon bones and move the bones of the skeleton. Hence, these are also called skeletal muscles. They are also called striated muscles because striations or stripes can be seen on microscopic examination. These are called phasic type of muscles, because contraction in these is rapid but brief and fatigue occurs quickly. Skeleton muscle contraction is stimulated by motor nerve impulses originating in the brain or spinal cord and ending at the neuromuscular junction. ^[2,4]

Structure Of Striated Muscle Fibres: Skeleton muscle is made up essentially of long, unbranched, cylindrical fibres. Striated muscle fibres are 0.01mm to 35 cm long, occurs in bundles and normally attached to the skeleton. The diameter of the fibre is also variable (10 to 60 micron). Each muscle fibre is an elongated cell surrounded externally by a delicate membrane called the **sarcolemma**. Just beneath the sarcolemma, many elongated shaped nuclei occur at irregular intervals along the periphery of the fibre. thus, these fibres are **multi-nucleated** or **syncytial** in nature. The cytoplasm of each fibre called sarcoplasm is filled with large number of longitudinal fibrils called **myofibrils** which are tightly packed. ^[1, 3] Two types of fibres can be recognized in most striated muscles, viz white fibres and red fibres. The red fibres are shorter, have more numerous and more deeply situated nuclei, more myoglobin and more numerous mitochondria producing more ATP. These are thus, adapted for prolonged and continued muscle activity required to support the body against gravity and for long continuing athletic events like marathon races. These are therefore also called slow fibres. The white fibres are longer, peripherally situated nuclei and fewer mitochondria, but these degrade glucose rapidly by glycolytic process to obtain energy at a faster rate. Thus, these are adapted for very rapid and powerful muscle contractions required for jumping, fast running etc.^[4]



Skeletal muscle

The most striking feature of skeletal muscle fibres is the presence of transverse striations in them. After staining with haematoxylin, the striations or stripes are seen as alternate dark and light bands that stretch across the muscle fibre. The dark bands are also called **A-bands** (Anisotropic bands). The light bands are also called **I-bands** (Isotropic bands). At the centre of A-band, a comparatively less dark zone called **H-Zone** is present. In the centre of the H-zone is the **M-line**. Each I-band has at its centre a dark membrane called **Z-line**. The part of the myofibril between two successive Z-lines is called **sarcomere**. Each sarcomere is a bundle of thick and thin myofilaments. The thick myofilaments consists mainly of myosin protein whereas thin myofilaments composed of three different proteins- actin, tropomyosin and troponin.^[1, 3]

Structure of skeletal muscle fiber

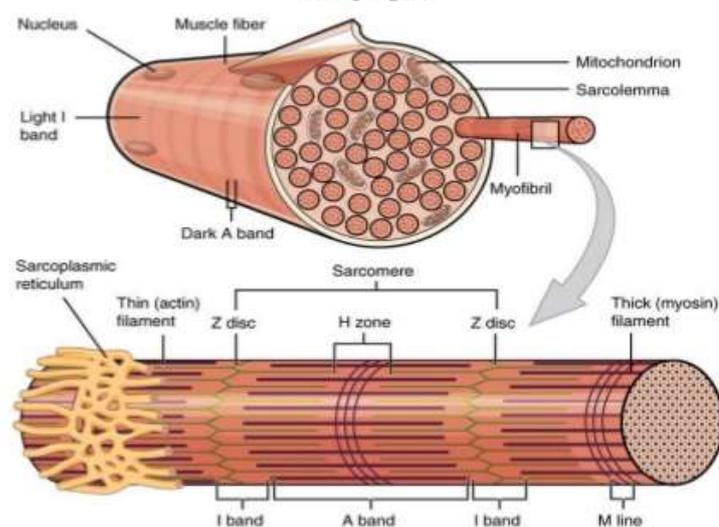


FIGURE: SHOWING LIGHT AND DARK BANDS

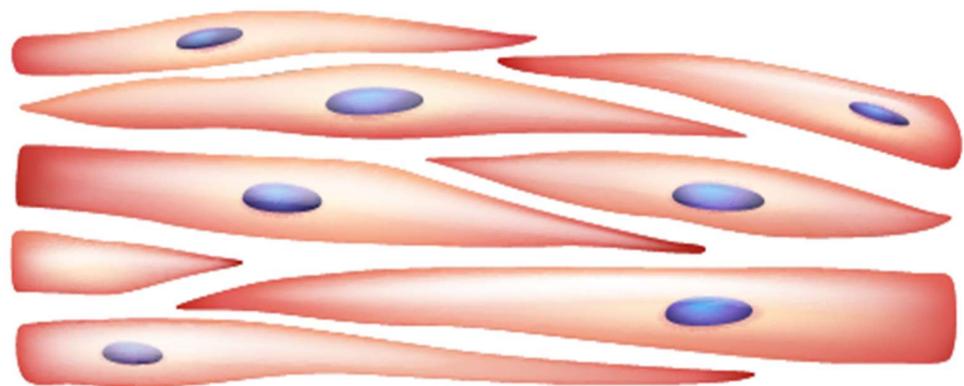
Location: These muscles are found in the limbs, tongue, pharynx, body walls and beginning of oesophagus. ^[1]

- ii. **Smooth (visceral) muscle tissues:** These are called smooth, plain, nonstriated, involuntary or unstriated muscles due to absence of striations and is not under conscious control. Contraction is slower and more sustained than skeletal muscle and under the

control of autonomic nervous system (ANS). Smooth muscles has the intrinsic ability to contract and relax. In addition to this, autonomic nerve impulses, some hormones and local metabolites stimulate contraction. [2,4]

Structure Of Smooth Muscle Fibres: Smooth muscle fibre when examined under microscope are seen to be unbranched, spindle shaped with one oval shaped central nucleus (uninucleated) and has no sarcolemma, however , the fibre is enclosed by plasma membrane.[1,2] Functionally smooth muscle are of two types:

- 1) *Single-unit smooth muscle:* Single unit smooth muscle fibres are composed of muscle fibres closely joined together, contract as a single unit. Eg. Urinary bladder and gastrointestinal tract. The multiunit muscles are pincipally neurogenic, i.e., these contract on nervous stimulations.[4]
- 2) *Multi-unit smooth muscles:* These are composed of more independent muscle fibres not so closely joined together, contract as separate units. Eg. Hair root muscle, muscles on the wall of large blood vessels, ciliary muscles and muscles of iris. The visceral or single unit muscles are, on the other hand, principally myogenic, i.e., self-excitatory, because the action potential is generated spontaneously within the muscles themselves due to non-nervous intrinsic factors like mechanical stretching, temperature, or chemical stimulation by hormones and other substances. [4]



Smooth muscle

Location: These occur in the walls of hollow internal organs (alimentary canal, gall bladder, bile ducts, respiratory tract, uterus, urinogenital ducts, urinary bladder, blood vessels, etc.), in capsules of lymph glands, spleen etc., in iris and ciliary body of eyes, skin dermis, penis and other accessory genitalia, etc. ^[3]

- iii. **Cardiac muscle tissue:** Heart wall is made up of cardiac muscles and hence, called myocardium. Structurally, these muscles resemble striated muscle but, functioning independently of the conscious control of brain, these are involuntary like the smooth muscles. ^[4]

Structure Of Smooth Muscle Fibres: Cardiac muscle fibres show the characteristics of both unstriated and striped muscle fibres. Each fibre is comparatively shorter and thicker, cylindrical, mostly uninucleate with a central nucleus, somewhat branched and covered by a sarcolemma. The fibres have some lateral branches known as **oblique bridges**. Cardiac muscle cells divided at places by dark **intercalated disc**. The intercalated disc function as boosters of contraction wave and permit the wave of muscle contraction to be transmitted from one cardiac fibre to another.^[1, 4]The mechanism of contraction and relaxation in fibres of these muscles is the same as in skeletal muscle fibres, except that the duration of contraction is much longer in cardiac muscle fibres. Cardiac muscles contract quickly and do not get fatigue. These muscles continue rhythmic contraction throughout life under the control of ANS. Heart is composed of three cardiac muscles viz. atrial muscle, ventricular muscle and self excitatory and conducting muscle.^[4]

Location: The cardiac muscles are found in the wall of the heart and in the wall of large veins (pulmonary veins and superior vena cava) where these veins enter the heart. ^[1]

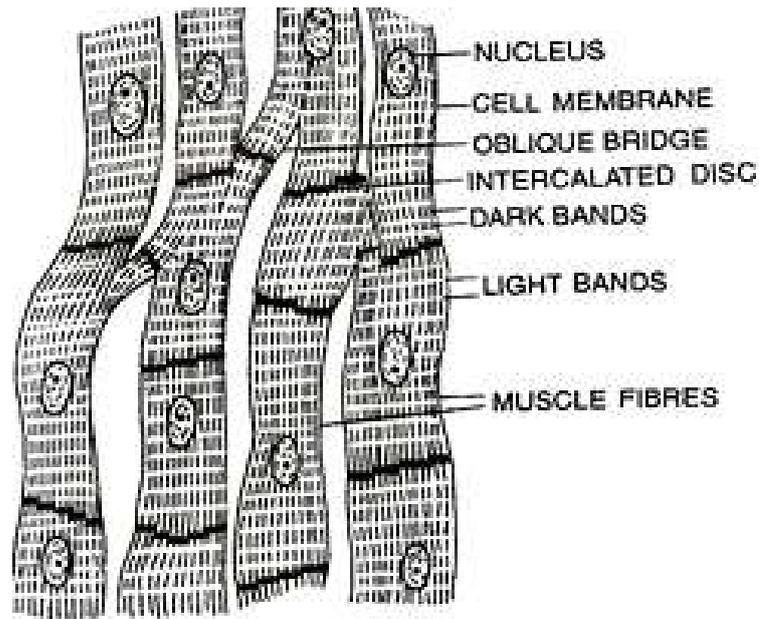


FIGURE: Showing Cardiac Muscle Tissue

PART II

MICROSCOPIC STUDY OF NERVOUS TISSUE

Requirements

A compound microscope and permanent tissue slides

Theory

A most complex tissue in the body, composed of densely packed interconnected nerve cells called neurons. It is specialized in being able to communicate between the various parts of the body and in integration of their activities through impulses. Nervous tissue is ectodermal in origin. It forms the nervous system of the body which controls and coordinates the body functions. Nerve cells are specialized to receive the external and internal stimuli. A stimulus of adequate strength (threshold stimulus) causes the depolarization or reversal of polarity of the neuron locally and initiates a nerve impulse. The neurons are capable of conducting this depolarization as a wave along their length in a particular direction either to other nerve cells or to effectors like muscles and glands which give the response. The response may be in the form of sensation such as pain or some activity such as muscle contraction or glandular secretion.

Therefore, the special properties of the cells of nervous tissue are excitability and conductivity.^[1,3,4]

Structure of neurons

A neuron is a nerve cell with all its branches. Neuron is formed from neuroblast. It is the structural and functional unit of neural system. It is the longest cell of the body.

- 1) **Cyton:** It is also called perikaryon or soma or cell body. The cyton contains granular cytoplasm called neuroplasm. It also contains prominent spherical nucleus, mitochondria, golgi bodies, endoplasmic reticulum, lysosomes, fat globules, **Nissl's granules** and neurofibrils. Nissl's granules are irregular masses of ribosomes. ^[1]
- 2) **Neuron processes:** The processes of neurons called neurites, extend varying distances from the cyton and are of two types-dendrites or dendrons and an axon or axis cylinder (neuraxon).
 - i. *Dendron:* These are several short, tapering much branched processes. The dendrites contain neurofibrils, neurotubules, Nissl's granules and mitochondria. The dendrites are characterized by the fact that they conduct nerve impulse towards the cell body. ^[1,3]
 - ii. *Axon:* This is a single very long, cylindrical process of uniform diameter. The axon arises from a conical projection, **the axon hillock**, of the cyton. The axon contains neurofibrils and neurotubules but lacks Nissl's granules, golgi bodies ribosomes and fat globules. As axon lacks nissl's granules, the axon is therefore dependent on the cell body for supply of proteins. The cell membrane of axon is called **axolemma** and its cytoplasm is called **axoplasm**. The axon conducts impulses away from the cell body. It may give off lateral branches termed collateral fibres. The latter arise from a node at right angle. Axon is usually branched only terminally into slender branches called telodendria. The latter have knobbed ends called endbulbs or axon terminlas or synaptic knobs or end plates. The synaptic knobs contain mitochondria and secretory vesicles. ^[1,3]

The nerve fibre is either medullated or **myelinated** and non medullated or **non-myelinated**. In medullated nerve fibre medullary sheath is present whereas medullary sheath is absent in non-myelinated fibre. The medullary is composed of **myelin**. Myelin contains lipids, proteins and water. The presence of myelin or medullary sheath increases the velocity of conduction and also reduces the energy expended in the process of conduction. An axon is related to a large number of **Schwann cells** over its length. Each schwann cell provides the myelin sheath for a short segment of the axon. The medullary sheath is continuous around the nerve fibres in the central

nervous system. However, in the nerve fibres of the peripheral nerve fibres, myelin sheath is absent at certain points called the **nodes of Ranvier**. The part of a nerve fibre between two successive nodes of Ranvier is called **internode**. Outside the myelin sheath a thin layer of Schwann cell cytoplasm persists to form an additional sheath which is called the **neurilemma**.^{1,3]}

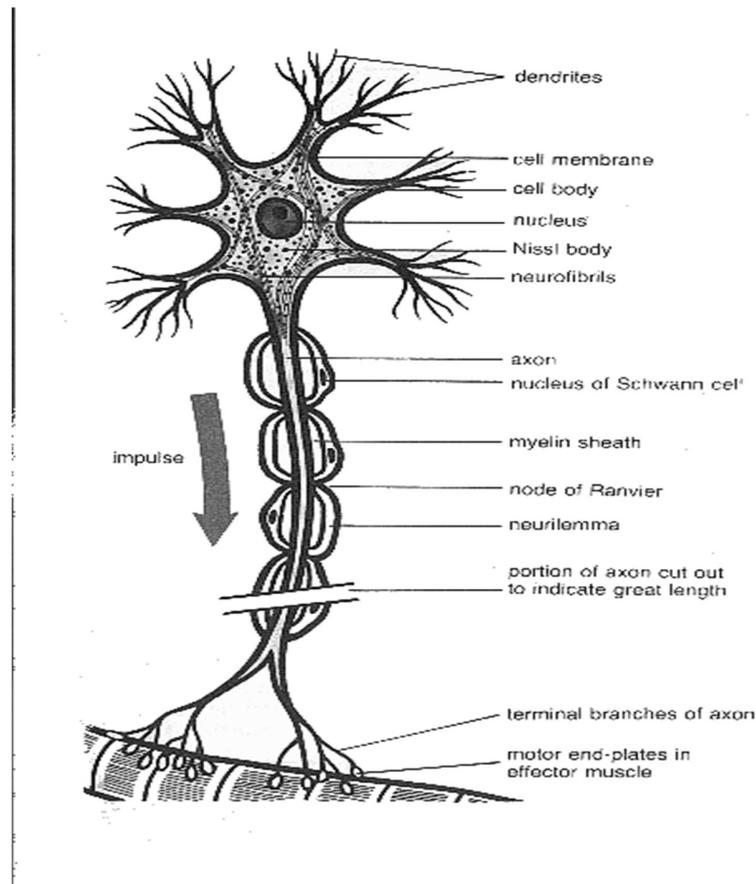


FIGURE: Showing A Nerve Cell

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