

Course Name: Bachelor of Physical Education

Year: IInd

Paper Name: Kinesiology and Physiology of Exercise

Paper No. 1

Topic No. Sec - B (1)

Topic Name: Structural Classification of Muscles

Lecture No.: 4

Lecture Title
Structural Classification of Muscles – 2

Script

When studying the muscle it is important to remember the general pattern of the structure and function of voluntary muscle tissue which has already been described. In addition, some further general information on the structure of muscles, and the way in which they work, will be required before the important muscles can be adequately described.

Muscle is capable of contracting to a great extent producing movements. There are 3 kinds of muscle-

- 1. Skeletal Muscles**
- 2. Smooth Muscles**
- 3. Cardiac Muscles**

Skeletal muscles

These attach to bones. Because muscles cross joints, they have the ability to move one bone in relation to another. Contraction of all skeletal muscles is under voluntary control. Through operation of some skeletal muscle is 'automatic' such as that of muscles of respiration which continue to work during sleep; still one can hold breath. Skeletal muscle is also known as striated muscle because under microscope it appears so.

Skeletal muscle basically consists of two portions,

- 1. Fleshy Portion**
- 2. Tendinous Portion**

Fleshy portion contain muscle fibers. Fibers are actually elongated muscle cells. These may be of a millimeters to several centimeters. These contain several nuclei and myofibrils within sarcoplasm cell membrane. Sarcolemma encases the cell.

Surrounding a bundle of several fibers is a fibrous sheet of endomysium. Surrounding a several fibers is a fibrous sheet of perimysium covering the entire muscle. Each of the levels of membranes is interconnected. Vessels and nerves enter the outer layer to reach individual fibers. Groups of muscles in the limbs can be bound into compartments by intramuscular septa. These separate various groups of muscles.

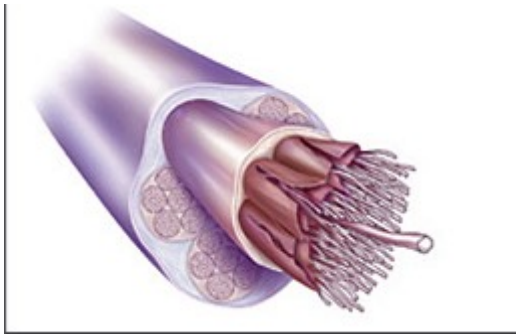
In the limbs proximal portion of muscles is called the origin and distal the insertion.

Tendons

Muscle fibers don't attach directly to bones but rather through specialized extensions of fibrous tissue coverings in the form of tendons. Tendons may be of different shapes.

1. Liner tendons- these have broad fleshy attachment such as temporalis muscle.
2. Cylindrical tendons- the fibers may be closely packed in a cylindrical packed in a cylindrical.
3. Common tendons- some time tendon can serve a common attachment for two muscles.
This may be of 3 types-
 - a. Raphe- it occurs when two flat muscles share a common attachment. The fleshy fibers are separated by a thin fibrous band or raphe.

Tendon Fibers



- b. Aponeurosis- it is a broad fibrous sheet or flattened tendon between two muscles such as between occipitalis and frontalis.
- c. Intermediate tendon- it is common to fleshy type bellies. It is a cylindrical type.

Arrangement of muscle fibers

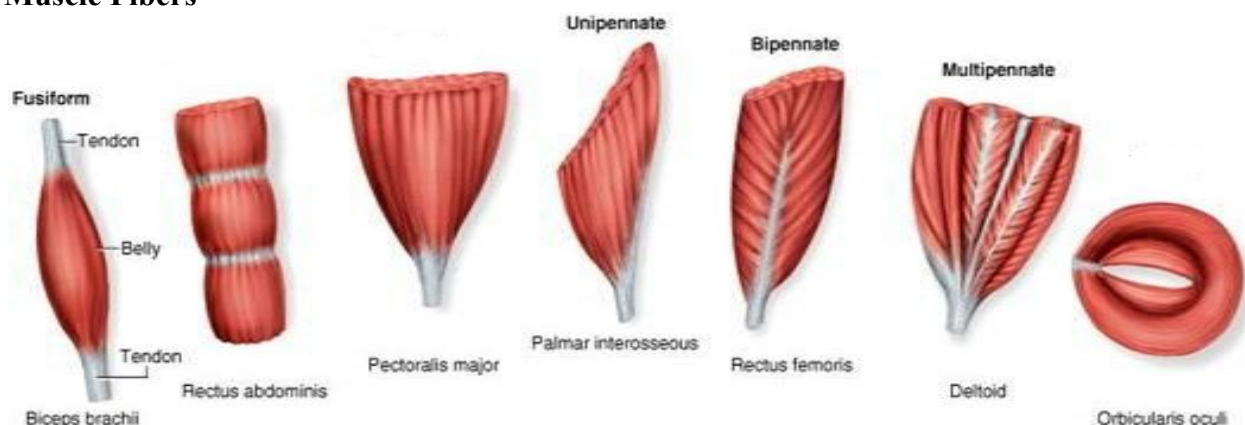
The muscles can also be classified according to muscle fibers/bundles.

Parallel or converging fiber bundles are arranged in a parallel fashion along the muscle fibers. It gives a longer range of movements. Muscles can contract up to 33%.

Some fibers have a linear origin and converge to a narrow insertion triangular or a fan-shaped muscle. In some muscles fibers at both ends of insertion and origin are fusiform.

Pennate muscles are for power instead of movement only. These are feather-like. Attaching to the tendon is obliquely arranged muscle bundle in a unipennate, bipennate and multipennate form.

Muscle Fibers



Red/pale muscles

These are the types of striated muscles

Red muscles	Pale muscles
Opaque red in color due to muscle hemoglobin	Pale due to lack of muscle hemoglobin
Sarcoplasm more	Not more of it
Nuclei-scattered through the substance of fiber	A few nuclei under sarcolemma
Longitudinal fibers	Transverse fibres
Not easily fatigued	Quickly fatigued
Latent period long	Short latent period
Deep muscles	Superficial muscle

Actions of skeletal muscles

- Muscles can pull but are unable to push. Group of muscles have specific roles.
- Prime movers are muscles that are given order by brain to act in a particular fashion.
- Antagonists are muscles which can produce movements in the opposite direction of prime movers.
- Synergists are a group of muscles that are controlled by the extrapyramidal system of CNS. They control and refine any undesirable movement.
- Fixators don't play any part in actual movement but keep the body in fixed position to facilitate the action.

Nerve supply of muscles

Motor nerve pierce the sarcolemma and terminate in end plates while sensory nerves end in groups of specially modified muscle fibers, i.e., muscle spindles.

Smooth Muscles

Smooth muscles don't cross joints to produce movements but form the walls of hollow viscera and tubes. These lack the striations of skeletal muscles. Smooth muscle cells are long and tapered cells that overlap neighboring cells. Delicate connective tissue binds the cells. Cells are arranged in sheets around vessels, uterus, guts, and hollow organs.

Longitudinally arranged fibers cause shortening in tubal length while circular fibers decrease human size.

Cardiac muscles

These are composed of longitudinal striated showing faint transverse striations. Fibers are quadrangular. Each cardiac fiber has a centrally situated nucleus. The fibers lie side by side. These branch and unite at frequent intervals. There is no definite cell between the individual fibers. Cementing material is bridged across by fibrils. Diameter is 20 micro m.m.

Special functional tissues-

Bundle of his- it is composed of spindle-shaped cells. These have scanty striations. It has two branches passing to two ventricles. Its vascular supply is poor. Blood supply is mainly from branch of right coronary artery.

Purkinje's fibers- these form a network under the endocardium of ventricles and cells are quadriangular with blurred outline. The cells join at both ends. It contains two nuclei in centre. Protoplasm is granular and cross striations are seen only at ends. The fibers run from auricle to ventricle after piercing A-C septum.

Sino-auricular and auriculoventricular nodes

These are composed of thin fibers. Fibers are fusiform. Cells are shorter and longitudinally striated. These are richly supplied with capillary meshwork.

Physiological properties of cardiac muscle

Conductivity is a property of all heart muscles specially Purkinje's tissue.

Cardiac muscles can contract when stimulated and have power to receive stimulus.

Cardiac muscles observe all or none phenomenon. In this heart behaves as a single muscle. Unit strength of contraction depends on-

- Duration of previous diastolic pause
- Initial length of fibers
- Nutrition and O₂ supply

Cardiac muscle has a long refractory period. During this period muscle does not respond to external stimuli. But cardiac muscle is empowered to initiate its own impulse without external stimuli. It is carried out by S.A. node.

Pace maker

It is a modified muscle fibre and originates stimulus for cardiac contractions; hence, it is known as pace maker. During hot season it can increase frequency of heart rate while cold has slowing effect. Lowering of blood pressure decreases force of cardiac contractions. Lack of oxygen quickness heart and force is diminished. Excess of CO₂ accelerates the heart.

Difference between voluntary and cardiac Muscle

Voluntary	Cardiac
Fibres are cylindrical	Fibres are round nucleated quadrangular
Transversely striated	Striations are faint
Nucleus under sarcolemma	Nucleus at the centre
Granular protoplasm at poles of nucleus	Granular protoplasm surrounds nucleus
Supplied by cerebro spinal nerves	Supplied by automatic nerve ending
Forms skeletal muscles	Forms cardiac muscle
Under the control of will conductivity is more	Not under will conductivity is minimal
All or none phenomenon absent	All or none phenomenon present
Contains more of glycogen	Not so

Difference between voluntary and involuntary muscles

Voluntary muscles	Involuntary muscles
Transversely striated	Longitudinally striated
Fibers cylindrical	Spindle-shaped
Fibers don't supply	Slightly branch
Abundant blood supply	Not so
Forms skeletal muscle	Forms visceral muscle
Excitability more	Least
Rhythmicity more	Absent
Peristalsis	Present
Sarcolemma present	Absent

Muscle contraction

These are of two types-

1. Isotonic contraction-the muscle becomes freely shortened and consequently thickened or swollen. The different muscle units at any one point of time are all in different phases of activity. Individual variations are evened out and muscle gives a steady pull. In case of isolated muscle about 40% of total chemical energy is converted into mechanical work.
2. Isometric contraction- shortening of muscles is minimal. Mechanical work done by muscles is negligible. The muscles of back contract isometrically and maintain its length.

Nerve supply of skeletal muscles

People say that these are supplied by motor nerves but these actually contain mixed fibers. Three-fifth are motor (efferent) and two-fifth are sensory (afferent).

1. Afferent fibers- these originate as receptors on the muscle itself from spindles and tendon. These endings carry information back to the CNS. It gives us an awareness of our parts of body without seeing them.
2. Efferent fibers- nerve fibers terminate as branches beneath the sarcolemma or cell membrane as motor end plates. Acetylcholine, released by nerve ending results in contraction of muscle fibers.

Chemical changes in muscle contraction

During muscular contraction adenylyl phosphogen and glycogen break down, not separately.

- Adenylyl pyrophosphate + glycogen → adenylic acid hexose monophosphate
- Adenylic acid + phosphogen → adenylyl phosphate + creatinine
- Creatinine + hexose phosphate → reformed phosphogen + lactic acid + phosphate

The lactic acid is neutralized immediately after liberation by muscle protein.

Lactic acid + food stuff in muscle + O_2 → glycogen + CO_2 + H_2O

Reconstruction of muscle goes side by side with:

Extensibility and elasticity

Muscles can easily be stretched. But it has the power to recover to its original size. When muscle contracts it is more extensible.

Thermal changes in muscles

There is initial heat production during muscle contraction and relaxation. It does not require O_2 but delayed heat production which is required after contraction phase needs O_2 .

Electrical change

When muscle is at rest all muscles fibers are in same electrical condition but when it contracts charge becomes negative and lateron becomes positive. A diphasic current of action is produced. Galvanometer needle deflects in one direction and lateron in another direction.

Circulatory change

Venous return is increased, increasing cardiac output.

Respiratory change

Pulmonary ventilation increases due to raised CO_2 in blood. More O_2 is taken in and more CO_2 is driven out.

Muscle fatigue

Repeated muscle contractions use ATP faster than it is produced and lactic acid accumulates faster than it can be removed. Muscles become tired. Efficiency of contraction weakens.

If person takes rest production of ATP increases and lactic acid is removed. During fatigue lactic acid concentration may reach to 0.3%.

Membranes

The most important of these areas-

1. Serous membranes- these are which line the large body cavities like pleura pericardium and peritoneum. These are composed of single layer of squamous epithelium with a connective tissue. Surface remains moist and free movement with minimal friction is possible.
2. Synovial membranes- these line the capsule of joints and sheaths of tendons. These are moist and allow free movement.

3. Muscular membranes- it lines the nose, the mouth, the respiratory, the alimentary, bladder and ureters etc. it is composed of simple and compound epithelial cell, may be squamous, columnar ciliated etc.

Clinical importance

Muscular dystrophy- it is a genetic disease. There develops gradual atrophy and weakening of muscle. Muscular dystrophy progresses the muscle fibres atrophy and one is replaced by adipose tissue.

Poliomyelitis- paralysis of muscles develops due to viral disease affecting anterior horn of disease.

Aging muscles- there is a decrease in muscle mass. Atrophy of muscles results in arms and legs to appear thin and bony. Degeneration of CNS decreases motor activity. Hence there develops a marked reduction in physical capabilities.

Neoplasia- it is an uncontrolled cell growth without any need. It can be either benign or malignant.

Malignant cells

Nuclei of all cancer cells are often large. These are irregular in shape. Chromosomal abnormality and fragility of chromosomes are generally found. Mitosis occurs more frequently. These have ability to spread or transfer cancerous cells from one part or organ to another part either by invasion or metastasis. Invasion occurs in many ways. It may proliferate and invade host tissue. Metastasis is the spread of malignant cells to distant specific sites through lymphatics or blood.

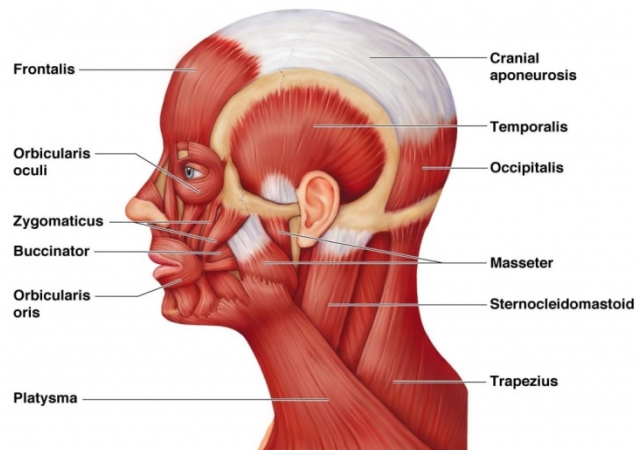
Difference between benign and malignant neoplasm

Character	Benign	Malignant
Cells	Nearly normal	Anaplasia & pleomorphism
Growth	Tumor grows by expansion Growth is slow	Infiltrate and destroy the surrounding Growth is fast
Metastasis	Does not spread by metastasis	Spreads through blood and lymph
Recurrence	Once removed no	Tends to recur when removed
Destruction	Does not cause much of damage	Extensive tissue damage
Death	Not necessary	Fatal

Occipito frontalis

It is a broad, musculo fibrous layer covering the front of skull. It consists of 4 parts, two occipital and two frontal connected by galea aponeuratica. Each occipital part is thin and quadrilateral, arising from nuchal line of occipital bone. It ends in galea aponeuratica. Frontal part is thin and adherent to superficial fascia.

Muscle of facial expression, face and neck



Orbicularis oculi

It is a broad, elliptical, flat muscle occupying eyelids. It surrounds the circumference of the orbit. It consists of three parts-

- Orbital part is reddish and thicker than palpebral fasciculi. It arises from nasal part of frontal bone.
- Palpebral part is thin and pale. It arises from palpebral ligament.
- Lacrimal part lies behind the lacrimal sac.

It is supplied by temporal and zygomatic branches of facial nerve.

It is a sphincter muscle of the eyelids. Palpebral portion acts under voluntary control closing lids during sleep. This muscle is involved in transporting tears.

Buccinators

It is a thin, quadrilateral muscle. It occupies the interval between maxilla and mandible. It is attached to the outer surfaces of alveolar processes of maxilla and mandible. The fibers of it angles of mouth.

The buccinators is supplied by lower buccal branches of facial nerve. It compresses the cheek against teeth, helping in mastication.

Orbicularis oris

It is made up of several strata surrounding the orifice of mouth but in different directions. It contains some fibres of other muscles.

It is supplied by lower buccal and mandibular marginal branches of facial nerve.

It acts in closing of lips. It brings the lips together and protrudes them.

Masseter

It is quadrilateral and consists of three superimposed layers blending anteriorly. Superficial layer is largest. Middle layer arises from deep surface of zygomatic arch. Middle and deep layers together constitute the deep part of ramus.

The masseter is supplied by a branch of anterior trunk of mandibular nerve. The masseter elevates the mandible to occlude the teeth in mastication.

Sternocleidomastoid

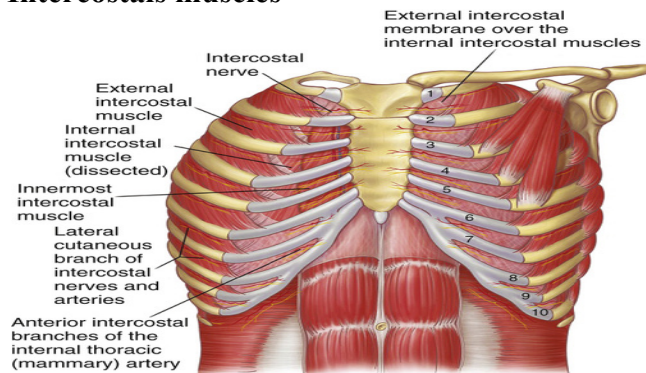
It passes obliquely down across the side of neck and forms a prominent landmark. It is thick and narrow centrally but broader at ends. Below it has two heads: sternal and clavicular head. The muscle divides the side of neck into two triangles- anterior and posterior.

It is supplied by accessory nerve. Its action is to tilt the head towards the shoulder. When head is fixed they assist in raising the thorax during inspiration.

Intercostal muscles

These are thin superimposed layers. Intercostals externi are eleven in number. Each muscle passes from the lower border of one rib to the upper border of rib below. These are thicker than the intercostals interni and their fibres are directed obliquely downwards and laterally.

Intercostals muscles



Intercostals interni are also eleven in number. Their attachments commence anteriorly at sternum. Each muscle descends from the floor of costal groove and the corresponding costal cartilage and is inserted into the upper border of rib below.

Both external intercostals are elevators and internal intercostals are depressors of ribs.