

Muscular system

Hello everyone, welcome to module 2 and section on Muscular System. In this section, we will discuss about a brief overview of the muscular system. And then we will look at the different type of muscles, functions of muscles, the structure of the skeletal muscle because in human movement, skeletal structure are the important component as a force production element. So, we will look at its structure, then muscle fiber structures, and finally, the major muscle groups which are involved in the movement production at different joints. So, muscular system is one of the critical systems in the human body to understand the movement. It is crucial for optimizing physical performance and well-being.

At an average, a human body contains more than 600 muscles. So, let us look at the important functions of muscles. So, one of the major function of muscle is to produce movement. So, muscles action generate tension that is transferred to the bone and, finally, result in a movement.

Under conscious control, skeletal muscles can be controlled for deliberate movement such as walking, running, or lifting. So, with we can consciously we can control the skeletal muscles to use the same muscle groups for different movement outputs. For example, walking, running, and lifting may use some common muscles also, and with the deliberate control or conscious control, we can get specific movement output. Apart from skeletal muscles, there are smooth muscles which are found in organs like digestive tract or cardiac muscles in the heart, which operate without conscious control and they facilitate the processes like digestion and blood circulation. Muscles also help in posture maintenance.

Different muscle groups work together to keep the body in an upright position against the pull of the gravity. They also support the spine and ensure proper alignment of bones. So, this posture maintenance can be in day-to-day activities like standing or sitting while performing a task or sports-specific activity like maintaining the posture while lifting the weight also. Muscles also help in joint stability. For example, different muscle groups surrounding the joints they act together to provide stability that will result in reduction of the injury or dislocations and other injuries due to imbalance of the muscles about a joint during a movement.

Muscles also help in heat production in the body. So, while producing the heat they will contribute to the maintenance of the body temperature. So, what happens when muscles contract energy is expanded, and that result in generation of heat, and that heat is essential for regulating our body temperature. So, it also help in homeostasis. Another important function which muscles do is the protection of organs.

So, muscles surround various vital organs such as the rib cage and abdominal muscles provide support and barrier for various vital organs such as heart and lungs and visceral organs like liver, pancreas, and intestine against the external force or trauma. There are some other functions which muscles also facilitate, for example facilitation of breathing. So, muscles like diaphragm and intercostal muscles in the chest facilitate the process of inhalation and exhalation. They also

regulate the blood flow in the body. Smooth muscles found in blood vessels help regulate the blood pressure by constricting or dilating the blood vessels, which in results control the flow of blood to various parts of the body.

Muscles also help in swallowing; for example, the muscles in your throat and esophagus move food from mouth to the stomach. Now, let us look at the classification of muscles. Muscles can be classified based on the following distinct characteristics. They can be classified as voluntary or involuntary muscles which is dependent upon whether they can be controlled consciously or not. For example, skeletal muscles.

So, these muscles can be controlled consciously. For example, if I want to bend my arm or extend my arm I can do it consciously. But in case of cardiac muscles, I cannot control the rhythmic beating of heart at my own will. Similarly, the muscles present in our digestive tract are under involuntary control. The next classification of the muscle is based upon whether they are striated or smooth, or smooth muscles are also known as unstriated.

So, how you define whether a muscle is striated or unstriated, or smooth muscle. Because when we look the muscle tissue under a microscope, whether there are stripes present or not. For example, in skeletal muscles, we can clearly see the striped nature of the muscle tissue, as shown in the image. Similarly, the cardiac muscles are also come under the category of striated muscles. So, in these muscles also we can see the stripes. However, in smooth muscles, there are no stripes.

So, they come under the category of smooth muscles. So, muscles can further be classified into whether they are somatic muscles or visceral muscles. So, this depends upon the location in the body where they are present. For example, somatic muscles are present in the wall of the body or in the different limbs. For example, our skeletal muscles they are present in the body walls and the limbs, whereas the visceral muscles make up the hollow organs, for example, our digestive tract.

So, to sum up, muscles can be classified into skeletal muscles, which are under voluntary control and they are also known as striated muscles. The cardiac muscles come under the category of striated muscles, but they are under involuntary control. And finally, the smooth muscles or unstriated muscles, striated muscles, so, these are muscles which are under involuntary control. Now, let us look at the various muscle types which we discuss, such as skeletal, cardiac, or smooth muscles, their location in the body, and the type of activity which they perform in the body. So, first, we will start with the skeletal muscles.

They are attached to the skeletal or fascia of the limbs and body walls. They act as a primarily to produce the movement by shortening or controlled relaxation of the muscle tissue. This also helps in the maintenance of posture or position against the gravity or some other external resisting forces which does not result in a movement. The cardiac muscles are present in the heart. They are known as myocardium and also present in the adjacent portion of the great vessels, such as aorta and vena cava.

These muscles are strong in nature, have quick response, and provide continuous rhythmic contractions, which help to pump the blood from here to the different body parts. And finally, the smooth muscles these are present in the walls of hollow viscera, blood vessels in the eye, and also attached to the follicles of the skin. So, these muscles are weak in nature, have slow and rhythmic contraction, and also they undergo sustained tonic contractions also. These mainly help to propel the substances in the body and also restrict the flow of various fluids in the body. For example, pumping of blood.

Now, let us focus on the skeletal muscles because in human movement skeletal muscles are the prime movers. So, skeletal muscles commonly referred to as muscles only. They are voluntarily controlled, attached to the bones and help in the movement of skeleton, and play a very crucial role in day-to-day activities such as walking, sit to stand, or even if you want to look from performance perspective in sports activities also. So, let us look at the various characteristics of skeletal muscles. So, skeletal muscle is very resilient in nature and can be stretched and shortened at reasonably high speed without significant damage to the tissue.

There are four main properties of skeletal muscles which help determine the performance of muscle under varying conditions such as various loads and velocities. So, these conditions are irritability or excitability, contractility or contractibility, extensibility, and elasticity. So, let us look at these one by one now. So, irritability or excitability is the ability of the muscle to respond to a stimulation. So, if there is an external stimulation, the muscle will respond to it or either get a signal from the nervous system to respond to that stimulation.

Contractility or contractibility is the ability of a muscle to shorten while it receives sufficient stimulation. Extensibility is the characteristic of muscle which help or which help it to lengthen or stretch beyond its resting length. And elasticity is the property by which a muscle can return to its resting length once the stretch is removed. Now, let us look at the types of skeletal muscles. So, muscles can be categorized based upon their arrangement of fibers.

For example, parallel fiber muscles. So, here, the muscle architecture is in a such a way the fibers are parallel to the force-producing axis like over here. So, the muscle fibers are parallel to the force generation or force-producing axis. These muscles are commonly used for fast or extensive movements and can be measured by its cross-sectional area. Next type of muscle is like convergent muscle.

So, convergent muscles are those muscles where their base is much wider, their base is much by wider than their insertions. These muscles give a triangular shape and enable the muscles to contract with a great force. For example, your chest muscles. Another form of muscle is fusiform muscles. It has a shape of a spindle, which is being wider in the middle and thinner at the ends.

These two ends, between these two ends, the muscle fibers are arranged parallel to the long axis. So, sometimes, fusiform muscle also called as parallel muscle. There are circular muscles which has the fiber arranged in circular manner. For example, found in our lips or in our eyes, which

contract our lips or control the movement of our eyes. So, another type of skeletal muscle is unipennate muscles.

So, these muscles have fiber arranged obliquely like at a certain angle. Like if this is the tendon, so, they are at a certain angle, let's call theta, at an oblique position, and they are inserted into the tendon on one side like uni means one side and they had been placed on a tendon at an angle. Similarly, bipennate muscles are the muscles like which has been arranged obliquely, but they are inserted on the both side of the central tendon. And finally, the multipennate muscles in these muscles multi means like they have multiple rows of muscle fibers whose central tendon branches from one of the main attachments or one or two tendons like they branches from the central tendon into sub tendons and then they have oblique muscle fibers. So, this is in short, like multipennate muscles have multiple rows of muscle fibers whose central tendon branches into two or more tendons.

So, this is the central tendon, and it branches into two or more sub tendons and these tendons then have muscle fibers which are obliquely attached to them on both the sides. So, let us now move to the structure of move to understand the structure of skeletal muscles. So, as we know, muscles are attached to the bone through tendons. So, the whole muscle bundle, which is attached to the bone is wrapped by an external tissue which is known as epimysium or an external layer or covering which consists of fascicles which are wrapped in perimysium. So, these fascicles are made up of muscle fibers.

Muscle fibers are wrapped by a covering known as endomyosin. These endomyosin contain different muscle fibers. So, these muscle fibers, if we look further down, are made up of myofibrils. So, this myofibril is the basic element which contains the repetitive unit known as sarcomere, which is nothing but a combination of actin and myosin filaments. So, during contraction, the overlap between actin and myosin is more, and during relaxation, it is a nominal position, and during extension, there will be less overlap between actin and myosin filaments.

Now, we will look at the major muscle groups present in the body, starting with the upper limb and then we will move towards the lower limb. So, here we can see the major muscle groups which are present on the upper body, such as trapezius, deltoid, pectoral, biceps and triceps, latimus dorsi, abdominal muscles, teres group. However, it might be very overwhelming to remember and understand the function of these muscles. However, if we look at the nomenclature of skeletal muscles we will be able to understand the function as well as it will help us to remember names also. Since most of the earlier work has been performed by the Greeks and Romans, and they used Latin language or Greek.

So, till today, we are using those nomenclature in our understanding of the human body. So, let us look at this example. In this like, let us consider this muscle and try to understand its nomenclature that will help us to extend this understanding of nomenclature to other muscles or

other muscle groups also. For example, this muscle is abductor digiti minimi. So, it consists of three words, which are abductor, digiti, and minimi.

Since in the first word, it is a combination of two words, one is ab, and another is ductor. So, ab in Latin means away from, and duct means to move. Similarly, digitus in Latin mean digit, and minimus means mini or tiny. So, overall, what does this mean? Particularly from abductor muscle that moves away from and digiti leads to a finger or toe. So, what function that muscle will perform? A muscle that moves the little finger or toe away.

So, abductor is moving away, digiti mean digit or toe or finger, and minimi means minimum or tiny. So, in this way, you know it will become a bit easier to understand the name and function of muscles parallelly. So, there are other root words which are being used in human body in the understanding of human body. For example, ad means toward, and as we already saw in the example, away from. Sub means under, ductor means something that moves, anti means against, epi on the top, apo to the side, longissimus means longest, longus long, brevis short.

Similarly, maximus means large, medius means medium, minimus means tiny or little, rectus means straight, multi means many, uni means one, bi or di means two, tri three, quad four, externus mean outside, and internus means inside. So, you can see all these root words being used in various muscles over here. So, this will give us a better understanding on the nomenclature as well as the function being performed by the muscles. So, let us look at the major muscle groups at the shoulder joint now since we have a better understanding of the naming and the function of the muscles or how we can remember the function from the name itself. So, the major muscles at shoulder joint are predominantly grouped into four major groups.

So the first one is the extrinsic shoulder group. So, extrinsic means external. So, it is further subdivided into superficial like trapezius and latissimus dorsi. So, they are external to the shoulder joint, and they are superficial, like near to the skin. And then, there are deep muscles like levator scapulae, rhomboid major, and rhomboid minor. Another group, second group is intrinsic muscles, which consists of deltoid and teres major.

Third group consists of rotator cuff, which is supraspinatus, infraspinatus, subscapularis, and teres minor. The fourth group consists of pectoral or is known as pectoral. It consists of pectoralis major, pectoralis minor, serratus anterior. So, now let us see how these muscles will help in different movements. However, you will be introduced to different anatomical movements in the following modules.

But in this module, we will assume like in a very simple terms, what these movements means in at that particular joint or between those two particular segments. And then, in the following chapters, when you revisit the fundamental or anatomical movements, then you will have a better understanding how these muscles will help in the production of those movements. For example, at shoulder joint, the extension means upper limb backward behind the back. So, in this, this is being produced by the posterior deltoid, latissimus dorsi, and teres major.

Then, flexion upper limb forward past the chest. So, in this is being produced by your biceps brachii, pectoral major, anterior deltoid, and coracobrachialis. Abduction in which the upper limb moves away from the trunk, for example, spreading arms wide. This is being produced by supraspinatus and deltoid muscles, and past 90 degrees, the scapula need to be rotated by the trapezius and serratus anterior to achieve the abduction. Adduction is another anatomical movement in which your upper limb moves towards the trunk, for example, bringing arms down to the side.

So, for example, you are bringing up down to the side. So, this is being produced by the contraction of pectoralis major, latissimus dorsi, and teres major. Another rotation which is being produced at the shoulder joint is medial rotation that is rotation of arm inward to cover abdominal like you are rotating your arm. So, in this, this movement is being produced by the contraction of subscapularis, pectoralis major, latissimus dorsi, teres major, and anterior deltoid. Similarly, the lateral rotation is being produced by the infraspinatus and teres minor.

Now, let us move to elbow joint. So, this image shows the interior and posterior view and the various muscles which are present in our arms. So, again, the elbow joint has four major muscle groups, which are subdivided into upper arm and lower arm, and within upper and lower arm, they are subdivided into anterior compartment and posterior compartment. For upper arm, the interior compartment consists biceps brachii, coracobrachialis, and brachialis. The posterior compartment consists of triceps brachii. In the forearm, the anterior compartment consists of pronator teres and pronator quadratus.

In the posterior compartment, it consists of anconeus, brachioradialis, and supinator. So, what functions these muscles will produce at the elbow joint? As we looked at the various functions being produced by muscles at the shoulder joint. So similarly, at elbow joint, they put the muscles which produce extension that is forearm away from the upper arm. So, this is extension. So this is being produced by triceps brachii and anconeus of the forearm.

The flexion where forearm is moving towards your upper arm. This is being produced by brachialis, biceps brachii, brachioradialis of the arm. Pronation the rotation of the forearm so that the palm faces downwards. So, this is your pronation. So, this movement, which muscles help in this production of this movement are pronator quadratus. So, from the name you can see pronator, which helps in pronation, and quadratus means it has like four component.

Pronator teres of the forearm. Similarly, supination is the process where your forearm is facing upwards. So, this is being produced by the supinator of the forearm and biceps brachii. Now, let us move to the wrist joint. So, wrist joint which is between your hand segment and your forearm segment. Most of the muscles which control the movement at wrist are from the forearm.

However, there are certain muscles which are present in our hands they also contribute to the motion at wrist joint. So, let us look at those. So, flexion at the wrist that is bending of wrist towards

the palm. So, flexion of the wrist towards the palm. So, it is being produced by flexor carpi ulnaris, flexor carpi radialis, palmaris longus, flexor digitorum superficialis.

The extension where the wrist is moving backwards, and it is being produced by the extensor carpi radialis longus. So, here extensor it is an muscle, which results in extension; radialis means towards the radius, and longus means it is long, as we looked at the nomenclature. Similarly, extensor carpi radialis brevis, extensor carpi ulnaris, and extensor digitorum are the muscles which are responsible for extension at the wrist joint. We also have radial deviation where the hand where the hand and wrist tilt toward the thumb and the radius.

So, this is the radius bone, this is thumb. So, this movement. So, if this hand. So, this movement like if I am moving it this way like this is straight, and moving this way is called radial deviation. It is being controlled by flexor carpi radialis and extensor carpi radialis. And finally, the ulnar deviation. So, where the hand and wrist tilt towards your pinky finger or the ulnar bone, which we have studied in our skeletal system.

So, this movement. So, this is called ulnar deviation. So, this is being controlled by flexor carpi ulnaris, extensor carpi ulnaris. Now, let us look at the major muscle groups in the lower limb also like we looked in the upper limb, such as at the shoulder, elbow, and wrist joint. Similarly, we will look at the major muscle groups which are present in the lower limb, specifically at hip joint, knee joint, and ankle joint. So, this image shows three different views of the lower limbs, which is anterior, lateral, and posterior, and has been labeled with the location of various muscles which are present in the lower limb.

So, we will start with the hip joint. So, hip joint has four major muscle groups they are divided into gluteal group, which consists of gluteus maximus, gluteus medius, gluteus minimus and tensor fascia latae. Second group is adductor group, which consists of adductor brevis, adductor longus, adductor magnus, pectineus, and gracilis. Third group is iliopsoas group which consists of iliacus and psoas major, and finally, the lateral rotator group, which consists of external obturator, internus obturator, piriformis, superior gemelli, inferior gemelli, and quadratus femoris. At hip joint, similarly, as we looked at other joints, extension happens where where you what you do is you are if you are standing, you are bringing your thigh behind your body. So, this movement is being produced by your gluteus maximus, adductor magnus and biceps femoris.

Similarly, flexion in which you are bringing your knee or bringing extending the thigh in front of the knee like you are doing you know bringing your knee up on and standing on the other leg. So this is being produced by gracilis, psoas major, iliacus, and pectineus muscles. Abduction in which you are moving your thigh literally away from the pelvis like you are kicking outside towards the side. So this is being produced by your gluteus medius and minimus, obturator externus, gemelli and sartorius muscles. And adduction where you are bringing your thigh towards the center of the body or midline of the body, and it is being produced majorly by the adductor group of muscles.

In addition to that, there is a rotation at the hip joint, which is whether you are like if you are standing whether you are bringing your foot in towards the midline of the body or away from the midline of the body. And it is being produced by the lateral rotator group and biceps femoris, sartorius, and gluteus medius, and minimus. Now, let us move to the knee joint. So, knee joint has three major muscle groups, maybe many of you are familiar with these names. So, now, today we will look into these groups and then see what are the muscles which are part of these groups.

For example, hamstring group, it consists biceps femoris, semitendinosus, and semimembranosus. The quadriceps femoris which is vastus lateralis, vastus intermedius, vastus medialis, and rectus femoris. And finally, the popliteus. So, the extension similarly like the extension at the hip, extension at the knee means you are sitting on a chair you keep your knee position fixed and try to extend your arm that is called the extension or like bringing the shank in front of the body. So, it is being produced by the sartorius and quadriceps femoris. Similarly, flexion bringing shank to the back of the body for example, you are standing and then try to touch your heels to your thigh.

This is being produced by biceps femoris, semitendinosus, and semimembranosus. The popliteus muscle, which is a deep muscle in the knee region, facilitate this movement by unlocking the fully extended knee joint. The rotation is the rotation of shank or the lower leg around the knee joint and this slight rotation is possible when knee is flexed, which is produced by bicep femoris, semitendinosus, semimembranosus, gracilis, and sartorius muscles. Now, let us move our discussion towards the ankle joint. As the case with the wrist joint, in ankle joint also, the movement at the ankle joint are being controlled majorly by the muscles present in the lower leg. However, there are couple of muscles which are present in your foot also and help in the movement at ankle joint.

So, at ankle joint, there are three major muscle groups. The first one is anterior compartment, which consists of tibialis anterior, extensor digitorum longus, extensor hallucis longus. In posterior compartment, we have superficial muscles like gastrocnemius, plantaris, and soleus, and deep muscles are tibialis posterior. And the third one is the lateral compartment, which consists of fibularis longus and fibularis brevis. So, these muscles you can see in both these images, like there are some of the plantar muscles shown in this image, although not all of them are shown over here.

However, other muscles which are present in the lower limb are shown in this figure. So, the first movement which is being produced at the ankle joint is the eversion of the foot. It is the tilting of the sole of the foot away from the midline. So, it is tilting of the foot away from the midline. So, you are moving it away.

It is being performed by the fibularis brevis and fibularis longus. The inversion of foot, in which the sole of the foot is tilted towards the midline and is being performed by the tibialis posterior and tibialis anterior. Another movement which is present at the ankle joint is the dorsiflexion of the foot, and it is one of the important movements which we will study in gait analysis. It is nothing but pulling of foot upwards towards the leg like you are standing this is your neutral position, and

if you are pulling foot upward toward the leg, that is known as dorsiflexion, and it is being performed by tibialis anterior, extensor hallucis longus, and extensor digitorum longus. Similarly, plantar flexion of the foot.

So, you are moving your foot away from the lower leg. So, it is being performed by the gastrocnemius, plantaris, soleus and fibularis longus. Although with this discussion, you might think like it is actually very overwhelming to remember all these muscle movements. However, I would suggest at least you would remember the major muscle groups which are present at these six joints, and then, depending upon your application area, if you are more into clinical side, like you are from physical therapy background, then you will be more familiar and more comfortable with muscle nomenclature. However, people who are not from biology background they find it bit difficult to remember all these names. So, with over time or with a detailed revision of the muscles and their functions from a standard anatomical atlas or books will help them to remember and then use this knowledge.

However, I would expect the participants to remember at least the name of the major muscle groups acting at different joints, that will help them to understand the movements being produced at those different joints. Thank you.