Muscles and movement

Hello, and welcome to module 3, Functional Anatomy. We've already looked at the previous aspects in functional anatomy like the skeletal muscles, the joints, how the joints move, what are some of the anatomical directions, planes of motion. In this module, the little module, we will be looking at muscle and movement. So, in this module, we will be looking at a few learning outcomes beginning with a brief on introduction to muscles, their function, the role of muscles in movement, type of different contractions, factors influencing muscle function and also muscle health, what it takes to maintain good muscle health and some of the common muscle injuries. So let's look at a brief recap of muscles. So let us recollect that muscles are contractile tissues which means they have the ability to contract, producing movement, and maintaining body posture.

So, they play a key role in that. So, you've learned the previous module that muscles are stimulated by nerve impulses, how exactly the contraction happens, and how the sarcomeres in the myofibrils of the muscle fibers are the functional units for muscle contraction. So, we've looked at the different layers that are there in the muscle, the superficial layer, the deep layer that has all of your muscle bundles, sarcomeres, myofibrils, what these components are, and how they are the key functional units for muscle contraction. We also looked at sliding filament theory in neuromechanics, where we looked at the role of actin and myosin filaments which are the two key filaments during that are responsible for muscle contraction.

So how exactly these happen, how they act and coordinate and collaborate with each other is what we've looked at in sliding filament theory earlier. So, for muscle and movement, let's start looking at to facilitate the movement at the synovial joints. We looked at what synovial joints are, the different type of joints, why they are called synovial joints as well. So, to facilitate movement at these joints which means to effectively modify the joint angle. So, for efficient and effective modification of the joint angle, we know skeletal muscles play a key role.

So how does this movement exactly occur? So, before we get into that, we need to understand two important terminologies, which is origin and insertion of the muscle. So, the end of the skeletal muscle that is attached to the fixed part of the skeleton is called a muscle origin. So, it is attached to this the end of the skeletal muscle, which is attached to the fixed part of the skeleton. Whereas insertion on the other hand, is the movable end of the muscle which is attached to the bone that's

being pulled. So, origin and insertion of the muscle are key terminologies and concepts to understand how exactly muscle pulls onto the bone to cause a change in modification in the joint angle.

So, let's take an example of the muscle biceps brachii or the bicep muscle. So the origin of this muscle is in the shoulder girdle, the insertion of which is on the radius bone which is in the forearm. So that's the insertion, and that's the origin. So what is this movement that we are looking at here? So, we are looking at, we are looking at actually, let me just erase that. So alright, I'll just write here.

So, we are looking at elbow flexion, which we studied in the previous module. What view is this? This is the sagittal view that we are looking at. And where is the bicep present? It's in the anterior compartment of the upper arm. So, let's look at the movement of bicep curl. So, the muscle contracts.

Origin point at the shoulder remains stable. So, this point here remains stable that acts as an anchor and the muscle insertion point, which is here at the radius bone in the forearm. So that's your forearm. That is the one that moves, resulting in elbow flexion. So, the action eventually is elbow flexion which is bringing your hand, so bringing this closer to your shoulder.

So, before we move on to understanding how muscles coordinate with each other to cause complex movements, let us understand the concepts of agonist, antagonist, and synergist. So, the principal muscle involved in the joint action, so the main one, of course, you have groups of muscles, different muscles for one particular action. But the main, so principal, which is the main muscle involved in the joint action, is called as the prime mover. So, the main mover or is called as the agonist. So, the agonist is the main muscle that is involved in the joint action.

The muscle that assists this prime mover, so the muscle that assists this prime mover is called a synergist. So synergist works in synergy with the prime mover and assist in the movement. The third terminology is the antagonist. So the muscle with the opposite action, very key to remember, very important to remember, the muscle with the opposite action of the prime mover is an antagonist. So, your principal mover is your agonist, the muscle that assists the principal mover is the synergist, and the muscle with opposite action of the prime mover is the antagonist.

Now let us look at how these work together to cause movement. So let us look at an example. So the same previous example that we are looking at, elbow flexion, and what is the opposite of flexion? Extension. We are looking at sagittal view. So, this is where your elbow is flexing, and this is where it is extending.

So, your bicep muscle here is an agonist. So, when does it become an agonist? When you are flexing and your antagonist is tricep brachii which is your tricep muscle. So as marked here, biceps contract and your tricep is sort of relaxed. So, bicep flexes the elbow, and the tricep extends it. Now you will notice a new word here which is brachioradialis.

You do not have to worry, brachioradialis is a muscle that is present in the forearm. It is one of the main muscles in the forearm, and that acts as a synergist which means it should assist the bicep in the contraction. Let us look at a lower body example. So quadricep muscles are group of four muscles in which the main one is rectus femoris. So, the rectus femoris is the main muscle that acts as the agonist.

The hamstrings, which are on the posterior side or compartment of thigh are a group of three muscles. So, the entire group acts as the antagonist, and your synergist here are the other muscles of the quadricep group. So, you have got one here and the other muscles here, so the other three that act as the synergist for the movement, and the movement here is knee, movement here is knee extension. So, during knee extension, you have quadriceps that extend the knee and hamstring that flexes it back. So that is your knee flexion.

So now that we have looked at the different roles that the muscles play and how they come together for movement, let us look at the type of different muscle contractions. Now these are extremely important for us to understand because these are the underlying factors to understand how movement occurs, what type of movement results, sorry, what type of muscle contraction results in what kind of a movement and hence for training purposes, it is extremely important to understand these muscle contractions that happen within the skill for us to improve our strength and take care of the muscular imbalances and weaknesses. So, for types of muscle contractions, they are usually, sorry, for type of muscle contractions they are categorized based on a common word iso, so all of them have a word iso in them. What does iso mean? It means same, right? So let us look at the different types of muscle contractions. So isometric is same in length.

So, let us try and understand here that what we are trying to say here is although it is same in length, relatively you cannot have the muscle constantly similar or maintaining length, but it hardly changes or has a very low change in length, right? So isometric contraction is when the muscle maintains its length. Isotonic, on the other hand, so isotonic is, so isotonic on the other hand is same tension. So, in reality, we need to understand for isotonic contractions, you will not have same tension maintained throughout the unit, but there is hardly any change in tension. So isotonic can be divided into concentric and eccentric. We will be looking at these two specific contractions in the coming few slides, looking at them in the coming few slides.

The last type of contraction is isokinetic. So isokinetic here refers to same velocity. So, maintaining a relatively same velocity throughout the range of movement. So let us look at these individually and try and understand how these contractions happen, what happens to the muscle during these contractions. So, type of muscle contractions, let us look at the first one, which is isometric.

So, as you can see here in this diagram, you will have that it is maintaining length. So, the force that is coming is equal and opposite. So, the muscle contraction wherein there is no external movement or change in joint angle and, like I said, it is under relatively very low change in muscle length, almost negligible. So the force generated by the muscle is equal, and opposing force applied to it. So it is equal to the opposing force.

It is able to maintain the muscle length. So, for example, let us look at core muscles. So core muscles while they are maintaining a static position, so static, it is like they are holding position during a plank. So, plank exercise. So, the core muscles are undergoing a isometric contraction.

Another example is a wall sit. So, it is a very common type of exercise which is a wall sit specifically for training your core. So, your quadricep muscles which are a group of four muscles, they are maintaining a static position or a hole against the wall. So, these are two examples where you have group of muscles that are not changing in length, and there is no external movement or change in joint angle during the entire movement. So where do these isometric contractions help us or what is the significance of these isometric contractions? They are extremely crucial for movement. So they are extremely crucial for movement that requires static strength.

Now where would we require static strength? So static strength is required for maintaining balance. It is also required for holding a position as we looked at earlier static hold like a plank or a wall sit and also in providing stability. So let us look at all of these characteristics for static strength provided by the isometric contraction in sport examples. For example, gymnastics and rock climbing as sport, the core muscles undergo isometric contraction to hold static positions. So, as you must be aware that when you are doing, when you are rock climbing; you need to have extremely strong core muscles for good holds when you are going on to the next move or in gymnastics when you are performing a routine or holding a position from a parallel bar and a flip when you land you need to hold a static position.

So, the core muscles are extremely important in that scenario. Whereas sport like wrestling, for example, again very key core muscles that help in maintaining balance. Let us move on to concentric contraction. So, in concentric contraction, the force is applied again from both sides, and the muscle contracts or shortens. So concentric contractions is where muscle generates force by shortening when a resistance is applied.

So, for example, in the same bicep muscle that we saw earlier, it shortens during the bicep curl exercise. So, it shortens as it is concentrically contracting. When you are doing a calf raise, when you are raising your heel up, the calf muscles shorten. So, during a calf raise they shorten during the up phase of the exercise. For concentric contractions it is important to know that they are crucial when you require generation of power.

Now where would you require generation of power? Pretty much for any or every important movement in sport or in a physical activity like pushing, pulling, lifting, jumping, running all of these activities require generation of power. So your muscles that are responsible for generation of power are concentrically contracting. So let us look at a few sport examples. In basketball, the leg muscles they generate force, so they concentrically contract for you to lift off the ground. So when you are doing when you are scoring a basket, and you are jumping up in the air, or you are running your the leg muscles generate force to lift you off the ground. To lift you off the ground.

Another major example where concentric contraction happens another crucial example is to provide explosive strength. Now sports that have explosive strength, for example, weightlifting, where you need to lift the barbell, you also have boxing and in sprinting. So, all of the muscles

that are responsible, different group of muscles for different skills mentioned here, they require explosive strength, and to generate that explosive strength, the muscles that are responsible concentrically contract. What about eccentric contractions? So, as you can see the arrows here again, the muscle lengthens when a resistance is applied, and it is more of a controlling action.

Sorry, let us do that again. So eccentric contractions, the muscle lengthens under tension while controlling a resistance. So, for example, the bicep muscle again the bicep muscle lengthens during the bicep curl while lowering the arms. So, to have a controlled lowering, the bicep muscle lengthens or undergoes eccentric contraction. So, your quadricep muscles undergo eccentric contraction as they are walking down the stairs. So, they lengthen under tension to control the resistance.

So, for eccentric contractions, they are extremely crucial for controlling movements, as we looked at earlier. So, for example, when you are sprinting or when you are running down the hill or skiing, you need to maintain a good deceleration technique. So that is where your eccentric contractions come in play. They are also quite key to maintain stability and control.

So let us look at a few sport examples. So skiing, so during skiing, when you are skiing down the slope, the leg muscles are responsible for controlled deceleration, and they eccentrically contract to achieve that. So, during running, your quadricep muscles assist or eccentrically contract during the leg descent phase, which happens before the next ride starts. So, the last category of muscle contractions we have is the isokinetic one. So isokinetic is what we saw earlier.

So same speed or velocity. So, in isokinetic contractions, the muscle contraction happens at constant velocity throughout the entire range of movement, and to achieve that, usually, it is with the assistance of specialized equipment. For example, a dynamometer. Now why would this be essential? So this is quite important for injury rehabilitation. So, you would be seeing that a lot of the athletes that are coming from injury or to prevent injury you undergo training where you have exercises that have isokinetic controlled contractions. So, in injury rehabilitation provide control and adjustable resistance, these devices, and that helps in reducing the risk of further damage.

And preventive care they also help in assessing and improvement of muscular imbalances and weakness. So you can also assess for muscular imbalances and weakness that help us to detect these injuries that the athlete might suffer from. So, muscle health and common muscle injuries.

So it is extremely crucial for us to maintain good muscle health for effective and efficient human movement as they play a key role, as you observed in this module. So, in order to maintain good muscle health, you need to have good nutrition, a good exercise routine, active lifestyle, good bone health, good hormone regulation as well is needed to maintain good muscle health.

And some of the common muscle injuries that we observe are bruises, strains. So, you might. For strains, an example would be like an ankle sprain. For tear, it could be a muscle tear. So, muscle tears there are different degrees of muscle tears and depending on what degree of muscle tear happens, the rehabilitation or the recovery process depends on the degree of the tear.

So tears can occur because of you know, you could have overstretched or pulled a muscle, or you know, been in a position where the muscle overstretched basically. You can also have a muscle injury of laceration. Although these are quite rare injuries but laceration usually happens during dramatic events like events like accidents. So, when you have an open wound accident, so when you have an accident with an open wound you might have muscle laceration. Another type of muscle injury is contusion. So contusion is an injury commonly seen in contact sports like football.

So, for example, when you get a blow on the thigh from another player's knee, for example, during football there are chances of the injury of contusion, muscle contusion. So just to summarize the entire module, muscles are contractile tissues that have contractile ability. We've looked at that producing movement, and that help us to maintain good body posture. So, to facilitate this movement at the joints, the skeletal muscles play a key role. So, the functional role of we've also looked at the functional role of the muscles, which is the agonist, antagonist, and synergist muscle.

What's a prime mover? What assists in it, and what causes the opposite action? All right, so we've looked at types of muscle contractions like isometric, isotonic and isokinetic. The examples of different sporting skills where these contractions are key. We've also looked at maintaining good muscle health is effective and efficient for human movement and some of the common injuries as well that happen due to micro damage to the muscle. Thank you.