Cartilage :

Cartilage is a non-vascular type of supporting connective tissue that is found throughout the body .

- Cartilage is a flexible connective tissue that differs from bone in several ways; it is avascular and its microarchitecture is less organized than bone.
- The cells (chondrocytes) are scattered and lie firmly fixed in matrix supported by collagen and elastic fibres.
- Cartilage is not innervated and therefore relies on diffusion to obtain nutrients. This causes it to heal very slowly.
- The main cell types in cartilage are chondrocytes, the ground substance is chondroitin sulfate, and the fibrous sheath is called perichondrium.

There are three types of cartilage: hyaline, fibrous, and elastic cartilage.

1. Hyaline cartilage is the most widespread type and resembles glass. In the embryo, bone begins as hyaline cartilage and later ossifies.
2. Fibrous cartilage has many collagen fibers and is found in the intervertebral discs and pubic symphysis.
3. Elastic cartilage is springy, yellow, and elastic and is found in the internal support of the external ear and in the epiglottis

Cartilage Structure

Cartilage is a dense structure, that resembles a firm gel, made up of collagen and elastic fibres. It contains polysacchride derivaites called chondroitin sulfates which complex with protein in the ground substance forming proteoglycan. The matrix is produced by cells call chrondroblasts which form chrondocytes and can be found in small chambers called lacuna

Cartilage is a strong, flexible connective tissue that protects your joints and bones. It acts as a shock absorber throughout your body.

Cartilage at the end of your bones reduces friction and prevents them from rubbing together when you use your joints. It's also the main tissue in some parts of your body and gives them their structure and shape.

Damage to your cartilage can happen suddenly — like a sports injury or other trauma — but it can also build up over the course of your life and lead to osteoarthritis.

Anything that injures or damages your cartilage can make it hard or impossible to use your joints the way you're used to.

FUNCTION

What does cartilage do?

Cartilage protects your bones and joints. It surrounds the ends of your bones and cushions the spaces in your joints where bones meet. Cartilage has three jobs:

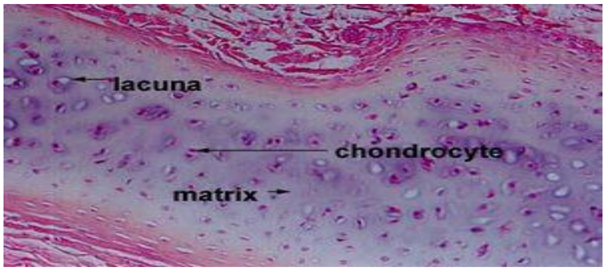
- **Absorbing shock:** Cartilage cushions your bones and joints when you move and use them. It absorbs force and reduces how much stress an impact puts on your bones. Think about the difference between jumping up and down in bare feet and wearing running shoes. Cartilage acts like the cushion in your sneakers on the inside of your joints and around your bones.
- **Reducing friction:** Cartilage lubricates your joints. It helps your bones slide past each other without rubbing together. This lets your joints work as smoothly as they should and reduces wear and tear on them.
- **Supporting structures in your body:** Cartilage helps your joints keep their shape while moving. It also connects other tissue together and to your bones. Muscles, tendons and ligaments are connected to cartilage throughout your body.

Cartilage is also the main tissue in some parts of your body including your:

- Nose.
- Ears.
- Windpipe (your trachea).

Where is cartilage located?

Almost any place where two bones meet in your body is cushioned by cartilage. It's also at the ends of all your bones that form joints.



Cartilage is separated from the surrounding tissues by perichondrium which consist of two layers:

1. Outer Fibrous Layer : Which provide protection , mechanical support and attaches the cartilage to other structures.
2. Inner Cellular : It Is Important in the growth and maintenance of cartilage .[3]

Types of Cartilage

There are three types of cartilage and they all have slightly different structures and function

Hyaline Cartilage

Hyaline Cartilage has a smooth surface and is the most common of the three types of cartilage. It has a matrix that contains closely packed collagen fibers, making it tough but slightly flexible. It consists of a bluish-white, shiny ground elastic material, whose matrix contains chondtoitin sulphate, with many fine collagen fibrils and chrondrocytes. The chondrocytes are arranged in small groups within cell nests and the matrix is solid and smooth. Because of its smooth surfaces it allows tissues to slide/glide more easily, as well as providing flexibility and support. Hyaline cartilage is the most common type of cartilage in your body. It lines your joints and caps the ends of your bones. Hyaline cartilage at the ends of your bones is sometimes referred to as articular cartilage.

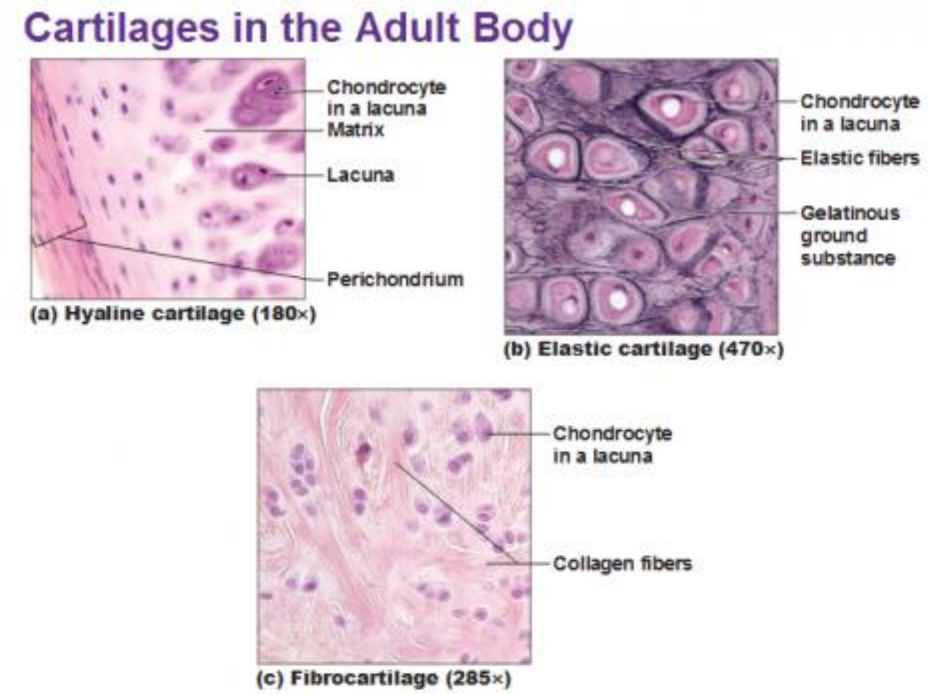
Hyaline cartilage is slippery and smooth which helps your bones move smoothly past each other in your joints. It's flexible but strong enough to help your joints hold their shape.

Hyaline cartilage locations in your body include:

- At the ends of bones that form joints.
- Between your ribs.
- In your nasal passages.

Example : Connection between ribs and sternum, nasal cartilage and articular cartilage (which covers opposing bone surfaces in many joints).

Fibrocartilage



Fibrocartilage is the toughest of the three types of cartilage. This consists of dense masses of white collagen fibres in a matrix similar to that of hyaline cartilage with the cells widely dispersed. It has no perichondrium and has a matrix that contains dense bundles of collagen fibers embedded with chrondrocytes, making it durable and tough. This makes it perfect to provide support and rigidity. Fibrocartilage is what its name sounds like: tough cartilage made of thick fibers. It's the strongest and least flexible of the three types. It's tough enough to hold parts of your body in place and absorb impacts.

Fibrocartilage locations in your body include:

- The meniscus in your knee.
- In disks between the vertebrae in your spine.
- Supporting muscles, tendons and ligaments throughout your body.

Example : Intervertebral discs (between spinal vertebrae), Menisci (cartilage pads of the knee joint), the callus (formed at the ends of bones at the site of a fracture), between the Pubic Symphysis and at the junction where tendons insert into bone.

Elastic Cartilage

Elastic cartilage provides support. It has a yellowish colour and is surrounded by a perichnodrium. Chrondrocytes are located between a network of threadlike elastic fibres, the abundance of elastic fibres makes it flexible and resilient. It provides support and maintains shape of, e.g. the pinna or lobe of the ear, the epiglottis and blood vessel walls.

Elastic cartilage is your most flexible cartilage. It supports parts of your body that need to bend and move to function. Elastic cartilage can bounce back to its original shape, even after a strong force. Your ear is made of elastic cartilage. It can bend and move without hurting you before returning to its usual shape.

Elastic cartilage locations in your body include:

- Your external ears (the parts of your ear that are outside your body).
- Your Eustachian tubes (the tube that carries sounds from your external ear into your head).
- Your larynx (your voice box).

- Example : the auricle of the outer ear .

Embryology

- Cartilage is formed from the mesoderm germ layer by the process known as chondrogenesis.
- Mesenchyme differentiates into chondroblasts which are the cells that secrete the major components of the extracellular matrix. The most important of these components for cartilage formation being aggrecan and type II collagen.
- Once initial chondrification occurs, the immature cartilage grows mainly by developing into a more mature state since it cannot grow by mitosis.
- There is minimal cell division in cartilage; therefore, the size and mass of cartilage do not change significantly after initially chondrification. The growth of cartilage is a slow process and occurs by the division of cells.

Mechanical Behaviour of Articular Cartilage

The mechanical behaviour depend on interaction of its component : proteoglycan, collagen and interstitial fluid. In an aqueous environment , proteogylcans are polyanionic which means the molecule has negatively charged sites that arise from sulfate and carboxyl. In solution, the mutual repulsion of these negative charges causes the aggregated proteogylcan to spread out and occupy a large volume .
In the cartilage matrix, the volume occupied by proteogylcan aggregates is limited by the network of collagen fibres. when the cartilage is commpressed the negatively charged sites are pushed together increasing the mutual repulsion force adding to the compressive stiffness of the cartilage. During this process non-aggregated protoegylcans are not affected by the compressive load since they are not easily trapped in the cartilage matrix .Damage to the collagen framework reduces compressive stiffness .
The mechanical response of the cartilage is strongly tied to the application of pressure differences and the flow of fluid through the tissue as, when deformed, the fluid flows across the cartilage and articular surface .
Image: Articular cartilage of the elbow (highlighted in green) - sagittal view [6]

Biphasic Model of Cartilage

All of the solid components of the cartilage (lipid, proteogylcans,cells and collagen) are grouped together to form the solid component of the matrix and the interstitial fluid, that moves freely, forms the fluid component.

Blood Supply and Lymphatics

Cartilage is avascular. Since there is no direct blood supply, chondrocytes receive nourishment via diffusion from the surrounding environment. The compressive forces that regularly act on cartilage also increase the diffusion of nutrients. This indirect process of receiving nutrients is a major factor in the slow turnover of the extracellular matrix and lack of repair seen in cartilage.[4]

Nerves

Cartilage does not contain nerves; it is a aneural The pain, if any, associated with pathology involving cartilage is most commonly due to irritation of surrounding structures, for example, inflammation of the joint and bone in osteoarthritis.[4]

Muscles

Fibrocartilage is a major component of entheses, which is the connective tissue between muscle, tendon or ligament and bone. The fibrocartilaginous enthesis consists of 4 transition zones as it progresses from tendon to bone.

1. Longitudinal fibroblasts and a parallel arrangement of collagen fibers are found at the tendinous area
2. A fibrocartilaginous region where the main type of cells present transitions from fibroblast to chondrocytes
3. A region called the "blue line" or "tide mark" due to an abrupt transition from cartilaginous to calcified fibrocartilage
4. Bone[4]

Clinical Significance

Many pathology exists involving cartilage, for example, osteoarthritis, spinal disc herniation, traumatic rupture/detachment, achondroplasia, costochondritis, neoplasm, and many others. These result from a variety of degenerative, inflammatory, and congenital causes.

Exercise and Cartilage Health:

- Participation in certain sports appear to increase risk of osteoarthritis resulting from breakdown of joint cartilage. Activities that involve torsional loading , fast acceleration and deceleration , repetitive high impact and high level of participation increase risk of osteoarthritis. Increased risks of osteoarthritis are related to excessive exercise or abnormal joint loading
- Some levels of loading and exercise are beneficial for joint health as exercise enhances production of matrix molecules, which can have a positive effect on joint health.[7]

Current Thinking on Articular Repair and Regeneration

A biological approach to cartilage damage is challenging due to its' inherent limited healing potential. Various options have been made available over the years trying to address these issues. New technique have merits and demerits. Stem cells therapy is a strong promise in the treatment of cartilage defects and osteoarthritis.

Stem cells(SC), in particular mesenchymal SCs, are expected to revolutionise the treatment for cartilage defects and osteoarthritis in the near future. It is hoped that the whole cartilage can be repaired not just focal defects.
Muscle is a soft tissue found in both animals and humans. The cells of the muscles comprise protein filaments of actin and myosin that slide past one another, which produces contraction and changes both the length and the shape of the cell.
The term muscle is derived from the Latin word “musculus” which refers to a little mouse, which is due to the shape of certain muscles or the contraction of muscles that look like a moving mouse.
In humans, muscles function by producing force and motion and are primarily responsible for:

1. Locomotion.
2. Maintaining and changing body posture.
3. Circulation of blood cells throughout the body.
4. Movement of internal organs, such as the contraction of the heart and the movement of food through the digestive system via peristalsis.

The human muscular system includes more than 600 muscles, which make up about 40 to 50 per cent of the total body weight. These muscles are attached to bones, **blood vessels** and other internal organs of our body and are mainly composed of skeletal muscles, tissue, tendons, and nerves. The muscles of the human muscular system are composed of a kind of elastic tissue.
Every movement in our body is the result of muscle contraction and is found in every organ, including the blood vessels, heart, digestive organs, etc. In these organs, muscles function by transferring substances throughout the body. There are three types of muscle and are mainly classified based on their movements and structures.
The energy required for the functioning of muscles is predominantly powered by the oxidation of fats and carbohydrates particularly and from the stored energy molecules adenosine triphosphate (ATP).

Types of muscles

There are about 600 muscles in the human body. Muscles have a range of functions from pumping blood and supporting movement to lifting heavy weights or giving birth. Muscles work by either contracting or relaxing to cause movement. This movement may be voluntary (meaning the movement is made consciously) or done without our conscious awareness (involuntary).

Glucose from carbohydrates in our diet fuels our muscles. To work properly, muscle tissue also needs particular minerals, electrolytes and other dietary substances such as calcium, magnesium, potassium and sodium.

A range of problems can affect muscles – these are collectively known as myopathy. Muscle disorders may cause weakness, pain or even paralysis.

Different types of muscle

The three main types of muscle include:

Skeletal muscle – the specialised tissue that is attached to bones and allows movement. Together, skeletal muscles and bones are called the musculoskeletal system (also known as the locomotor system). Generally speaking, skeletal muscle is grouped into opposing pairs such as the biceps and triceps on the front and back of the upper arm. Skeletal muscles are under our conscious control, which is why they are also known as voluntary muscles. Another term is striated muscles, since the tissue looks striped when viewed under a microscope. Skeletal muscle, attached to bones, is responsible for skeletal movements. The peripheral portion of the central nervous system (CNS) controls the skeletal muscles. Thus, these muscles are under conscious, or voluntary, control. The basic unit is the muscle fiber with many nuclei. These muscle fibers are striated (having transverse streaks) and each acts independently of neighboring muscle fibers.

Skeletal muscle is a muscle tissue that is attached to the bones and is involved in the functioning of different parts of the body. These muscles are also called voluntary muscles as they come under the control of the **central nervous system** in the body.

Structure of Skeletal Muscle

Skeletal muscle is a series of muscle fibres composed of muscle cells, which are long and multinucleated.

Skeletal muscles are cylindrically shaped with branched cells attached to the bones by an elastic tissue or collagen fibres called tendons, which are composed of connective tissues.

The end of each skeletal muscle has a tendon, which connects the muscle to bone and connects directly to the collagenous, the outer covering of skeletal muscle.

There is a group of muscle fibres, present below the epimysium, which are collectively called the fascicles. These muscle fibres are surrounded by another protective shield formed from collagen.

The perimysium, a sheath of connective tissue surrounding the muscle fibres allows nerve and blood vessels to make their way through the muscle.

This muscle is attached to the bones by an elastic tissue or collagen fibres called tendons. These tendons are comprised of connective tissues. The skeletal muscles consist of a bundle of muscle fibres namely fascicule. These fascicules are cylindrical in shape as shown in the figure. These muscle fibres are surrounded by blood vessels and a number of layers of other tissues enclosing it.
Each muscle fibre is lined by plasma membrane namely sarcolemma reticulum. It encloses a cytoplasm called sarcoplasm which has the endoplasmic reticulum. The muscle fibres consist of myofibrils, which have two important proteins, namely actin and myosin in it. The fascicule is enclosed by perimysium and the endomysium is the connective tissue that encloses the muscle fibres.

Properties Of Skeletal Muscle
The skeletal muscles have the following properties:

- Extensibility: It is the ability of the muscles to extend when it is stretched.
- Elasticity: It is the ability of the muscles to return to its original structure when released.
- Excitability: It is the ability of the muscle to respond to a stimulus.
- Contractility: It is the ability of a muscle to contract when in contact with a stimulus.

Types Of Skeletal Muscle
There are two types of skeletal muscles named as red and white muscles-

- **Red Muscles**

Red muscles are due to the red pigment called myoglobin, which is in high amounts in the human body. These muscles are smaller in diameter and have a large number of mitochondria in it. The myoglobin stores the oxygen, which is used by the mitochondria for the synthesis of ATP. Red muscles have a large number of blood capillaries in it.

- **White Muscles**

Unlike the red muscles, the white muscles are bigger in diameter and have a small amount of myoglobin in it. They also have less number of mitochondria in it.

Functions Of Skeletal Muscle
Following are the important skeletal muscle function:

1. The skeletal muscles are responsible for body movements such as typing, breathing, extending the arm, writing, etc. The muscles contract which pulls the tendons on the bones and causes movement.
2. The body posture is maintained by the skeletal muscles. The gluteal muscle is responsible for the erect posture of the body. The Sartorius muscles in thighs are responsible for body movement.
3. The skeletal muscles protect the internal organs and tissues from any injury and also provide support to these delicate organs and tissues.
4. These also support the entry and exit points of the body. The sphincter muscles are present around the anus, mouth and the urinary tract. These muscles contract which reduces the size of the openings and facilitates the swallowing of food, defecation, and urination.
5. The skeletal muscles also regulate body temperature. After a strenuous exercise, the body feels hot. This is due to the contraction of skeletal muscles which converts energy into heat.

For example-The sphincter muscles present:

1. Around the mouth – These muscles reduce the size of the openings by the contraction of the muscles and facilitate the swallowing of food.
2. Around the urinary tract- These muscles control urination by the contraction of the muscles in the urethra.
3. Around the anus- These muscles reduce the size of the openings by the contraction of the muscles and facilitate defecation.

- **Smooth muscle** – located in various internal structures including the digestive tract, uterus and blood vessels such as arteries. Smooth muscle is arranged in layered sheets that contract in waves along the length of the structure. Another common term is involuntary muscle, since the motion of smooth muscle happens without our conscious awareness. Smooth muscle, found in the walls of the hollow internal organs such as blood vessels, the gastrointestinal tract, bladder, and uterus, is under control of the autonomic nervous system. Smooth muscle cannot be controlled consciously and thus acts involuntarily. The non-striated (smooth) muscle cell is spindle-shaped and has one central nucleus. Smooth muscle contracts slowly and rhythmically.

- **Cardiac muscle** – the muscle specific to the heart. The heart contracts and relaxes without our conscious awareness. Cardiac muscle, found in the walls of the heart, is also under control of the autonomic nervous system. The cardiac muscle cell has one central nucleus, like smooth muscle, but it also is striated, like skeletal muscle. The cardiac muscle cell is rectangular in shape. The contraction of cardiac muscle is involuntary, strong, and rhythmical.

Cardiac muscles are found only in the heart and are self-stimulating, which has an intermediate speed of contraction and energy requirement. This muscle is not part of the musculoskeletal system.

Cardiac muscles are striated muscles, which are responsible for keeping our heart functioning by pumping and circulating blood throughout the body and performing muscular involuntary movements. They are involved in continuous rhythmic contraction and relaxation. The interconnected muscle cells or fibres provide strength and flexibility to the cardiac muscle tissue.

Structure of a cardiac muscle

Cardiac muscle exists only within the **human heart.** It is a specialized form of muscle evolved to continuously and repeatedly contract, providing circulation of blood throughout the body. Cardiac muscle has a regular pattern of fibres similar to that of smooth muscles. These muscles comprise the cylindrical, branched fibres and a centrally located nucleus. The T-tubules or transverse tubules are rich in ion channels and are found in the atrial muscle cells.

These muscles are striated muscles with cylindrical-shaped cells, which include intercalated discs and join neighbouring fibres.

Functions of a cardiac muscle

The primary function of the cardiac muscle is to regulate the functioning of the heart by the relaxation and contraction of the heart muscles. Other functions of cardiac muscles include:

- The cardiac muscles function as the involuntary muscle.
- The cardiac muscles are also involved in the movement or the locomotion.
- The cardiac muscles work without stopping, day and night. They work automatically and make the heart contract so that the heart can squeeze the blood vessels and release them so that the heart can fill up with blood again.
- The heart comprises a specialized type of cardiac tissue, which consists of “pacemaker” cells. These contract and expand in response to electrical impulses from the nervous system.

Smooth muscles are non-striated, involuntary muscles, which are controlled by the Autonomous Nervous System (ANS). These muscles are found almost in all organ such as the stomach, bladder, blood vessels, bile ducts, the eye, the sphincters, the uterus, etc.

The smooth muscles function by stimulating the contractility of the digestive, urinary, reproductive systems, blood vessels, and airways. These smooth muscles are spindle-shaped with a single nucleus. They are under involuntary control, therefore you cannot move these muscles with conscious thought.

Structure of smooth muscles

The smooth muscles of the human muscular system are spindle-shaped muscle fibres with a single nucleus. The thickness of the smooth muscles ranges between 3-10 μm and their length ranges between 20 to 200 μm, which are shorter compared to the skeletal muscle. These muscles lack filaments, special protein, actin and myosin and produce their own connective tissue.

Functions of a smooth **muscle**

Like all other types of muscles, smooth muscles are also involved in contraction and relaxation. Other functions of smooth muscles include:

- It is involved in the sealing of orifices.
- It produces connective tissue proteins such as collagen and elastin.
- Transports chyme (a pulpy acidic fluid) for the contractions of the intestinal tube.
- Smooth muscle plays a vital role in the circulatory system by maintaining and controlling the blood pressure and flow of oxygen throughout the body.
- Smooth muscles are also responsible for:

1. Contracting the irises.
2. Raising the small hairs on your arm.
3. Contracting the sphincters in our body.
4. In the movement of the fluids through organs.
5. It is much more useful for providing consistent and elastic tension.

Based on the muscle action, muscles are further classified into:

- **Voluntary muscles.**

Voluntary muscles are long, multinucleated cells, containing sarcomeres arranged into bundles. These muscles are composed of cylindrical fibres and are usually attached to bones and the skin. They play an important role in allowing the body to move by contracting and relaxing and their actions are mainly under the control of the somatosensory **nervous system**. These voluntary muscles include skeletal muscles.

- **Involuntary muscles**

Involuntary muscles are striated and branched in the case of cardiac muscle. The actions of involuntary muscles are mainly controlled by the autonomic nervous system in the body. These involuntary muscles include smooth muscles and cardiac muscles.

-

Based on the muscle action, muscles are further classified into:

- Voluntary muscles
- Involuntary muscles

Make-up of muscle

Skeletal, smooth and cardiac muscle have very different functions, but they share the same basic composition. A muscle is made up of thousands of elastic fibres bundled tightly together. Each bundle is wrapped in a thin transparent membrane called a perimysium.

An individual muscle fibre is made up of blocks of proteins called myofibrils, which contain a specialised protein (myoglobin) and molecules to provide the oxygen and energy required for muscle contraction. Each myofibril contains filaments that fold together when given the signal to contract. This shortens the length of the muscle fibre which, in turn, shortens the entire muscle if enough fibres are stimulated at the same time.

The neuromuscular system

The brain, nerves and skeletal muscles work together to cause movement. This is collectively known as the neuromuscular system. A typical muscle is serviced by anywhere between 50 and 200 (or more) branches of specialised nerve cells called motor neurones. These plug directly into the skeletal muscle. The tip of each branch is called a presynaptic terminal. The point of contact between the presynaptic terminal and the muscle is called the neuromuscular junction.

To move a particular body part:

- The brain sends a message to the motor neurones.
- This triggers the release of the chemical acetylcholine from the presynaptic terminals.
- The muscle responds to acetylcholine by contracting.

Shapes of skeletal muscle

Generally speaking, skeletal muscles come in four main shapes, including:

- **Spindle** – wide through the middle and tapering at both ends, such as the biceps on the front of the upper arm.
- **Flat** – like a sheet, such as the diaphragm that separates the chest from the abdominal cavity.
- **Triangular** – wider at the bottom, tapered at the top, such as the deltoid muscles of the shoulder.
- **Circular** – a ring-shape like a doughnut, such as the muscles that surround the mouth, the pupils and the anus. These are also known as sphincters.

Muscle disorders

Muscle disorders may cause weakness, pain, loss of movement and even paralysis. The range of problems that affect muscles are collectively known as myopathy. Common muscle problems include:

- Injury or overuse, including sprains or strains, cramps, tendonitis and bruising
- Genetic problems, such as muscular dystrophy
- Inflammation, such as myositis
- Diseases of nerves that affect muscles, such as multiple sclerosis
- Conditions that cause muscle weakness, such as metabolic, endocrine or toxic disorders; for example, thyroid, and adrenal diseases, alcoholism, pesticide poisoning, medications (steroids, statins) and myasthenia gravis
- Cancers, such as soft tissue sarcoma.

Changes during muscle contraction

Types of Striated Muscle Contraction

There are four types of striated muscle contractions: isometric, isotonic, concentric, and eccentric.

Isometric striated muscle contraction is characterized by a change in muscle tension without change in muscle length. Isometric contractions are seen when pushing against an immovable object or trying to lift a weight that is too heavy.[12]

Isotonic striated muscle contraction is characterized by a constant muscle tension without a change in muscle length. This type of contraction occurs when the contraction force matches the total load on a muscle. Isotonic contractions are seen during activities such as walking, running, or squatting.

Concentric striated muscle contraction occurs when there is sufficient muscle tension to overcome the load, and the muscle contracts and shortens.[13] During this type of contraction, a muscle is stimulated to contract according to the sliding filament theory. Concentric contractions are seen during activities such as a biceps curl or standing from a squatting position.

Eccentric striated muscle contraction occurs when the muscle works to decelerate a joint at the end of a movement as opposed to pulling a joining in the direction of the contraction. This type of contraction can occur involuntarily (e.g., while attempting to move a weight too heavy for the muscle to lift) or voluntarily (e.g., when the muscle is 'smoothing out' a movement or resisting gravity, such as during downhill walking). Eccentric contractions act as a braking force in opposition to a concentric contraction to protect joints from damage.

General Mechanism of Skeletal Muscle Contraction

Skeletal muscle contraction initiation and execution occur in the following steps.

1. An action potential (AP) travels along a motor nerve to its endings on muscle fibers.
2. At each motor nerve ending, the nerve secretes acetylcholine (ACh).
3. ACh acts locally on the muscle fiber membrane to open ACh-gated cation channels.
4. The opening of ACh-gated channels allows large quantities of sodium (Na) ions to diffuse to the interior of the muscle fiber membrane.
5. This action causes a local depolarization, leading to the opening of voltage-gated sodium (Na) channels, which initiates an AP at the membrane.
6. The AP depolarizes the muscle membrane, causing the sarcoplasmic reticulum (SR) to release large quantities of Ca ions stored within the reticulum.
7. The Ca ions produce attractive forces to act between actin and myosin filaments, causing them to slide alongside each other leading to the contractile process.
8. After a fraction of a second, the Ca ions are pumped back into the SR by a Ca-membrane pump and remain stored in the SR until a new muscle AP occurs.
9. The removal of Ca ions from the myofibrils causes muscle contraction to cease.