MUSCULAR SYSTEM

- 650 muscles in the human body control movement, help to maintain posture, circulate blood and move substances throughout the body, controlling walking, talking, sitting, standing, eating and other daily functions that we consciously perform

The nervous system controls the actions of the muscles, although some muscles, including the cardiac muscle, can function autonomously.

Muscles make up more than half of the weight of the human body, and people who do heavy weight training often gain weight because muscle is about three times as dense as fat.

<u>Three types of muscles: skeletal, smooth and cardiac.</u>

Skeletal muscles are the only voluntary muscle tissue in the human body and control every action that a person consciously performs. Most skeletal muscles are attached to two bones across a joint, so the muscle serves to move parts of those bones closer to each other.

Skeletal muscles work in pairs. When one contracts, the other relaxes, eg: the biceps and triceps

Every muscle consists of bundles of thousands of muscle fibers (muscle cells) that are very long and multinucleate. Each is surrounded by a modified plasma membrane called the sarcolemma.
The sarcoplasmic reticulum (SR), modified endoplasmic reticulum, contains sacs of calcium (Ca++) needed for muscle contraction.

The sarcomere is the functional unit of the muscle cell. Its boundaries are the Z-lines, giving skeletal muscle its striated (striped) appearance. Sarcomeres attached end to end make up a myofibril.

Within each muscle cell myofibrils ("myo-" means muscle in Greek) run parallel to the cell's length.

THE SLIDING FILAMENT MECHANISM

Thick myofibrils are double chains of myosin molecules, each with globular heads. The thin myofibrils are another protein called actin. These thick and thin filaments slide past each other to contract (shorten) the muscle when myosin heads hook on to actin filaments and pull them.

At neuromuscular junctions axons send signals to muscle cells to release calcium, which binds with a protein called troponin. This exposes binding sites on actin to which myosin heads can bind. The myosin heads then move, pulling the actin filament along.

A single action potential in a muscle causes it to contract locally for a few milliseconds and then relax. If a second action potential arrives before the first is over, there will be

a summation effect, and the contraction will be larger. If a muscle receives a series of overlapping action potentials, even further summation will occur, in a smooth, sustained contraction called tetanus (not the disease). This can cause a muscle to eventually fatigue and then relax.

Visceral, or smooth, muscle is found inside of organs such as the stomach, intestines, and blood vessels. It is called a smooth muscle because unlike skeletal muscle, it does not have the banded appearance of skeletal or cardiac muscle.

The weakest of all muscle tissues, visceral muscles send signals to contract to move substances through the organ. Because visceral muscle is controlled by the unconscious part of the brain, it is known as involuntary muscle as it cannot be controlled by the conscious mind.

Found only in the heart, cardiac muscle is responsible for pumping blood throughout the body. Like visceral muscles, cardiac muscle tissue is controlled involuntarily. While hormones and signals from the brain adjust the rate of contraction, cardiac muscle stimulates itself to contract.

Muscles are further classified by their shape, size and direction:

- The deltoids have a triangular shape.

- The serratus muscle, which originates on the surface of the second to ninth ribs at the side of the chest and runs along the entire anterior length of the scapula, has a distinguishing saw-like shape.

- The rhomboid major is a diamond shape.

Size can be used to differentiate similar muscles in the same region. The gluteal region contains three muscles differentiated by size — the gluteus maximus (large), gluteus medius (medium), and gluteus minimus (smallest).

The direction in which the muscle fibers run can be used to identify a muscle. In the abdominal region, there are several sets of wide, flat muscles. The muscles whose fibers run straight up and down are the rectus abdominis, the ones running transversely (left to right) are the transverse abdominis, and the ones running at an angle are the obliques. As any exercise enthusiast knows, obliques are among the hardest muscles to develop and achieve "six-pack" abs.

<u>Muscles can also be identified by their function.</u>

- The flexor group of the forearm flexes the wrist and the fingers. The supinator is a muscle that supinates the wrist by rolling it over to face palm up. Abductor muscles in the legs adduct, or pull together, the limbs.
Diseases of the muscular system

There is no one type of doctor that treats muscular diseases and disorders. Rheumatologists, orthopedists, and neurologists may all treat conditions which affect

the muscles.

Because the muscular system impacts so many of the functions necessary to sustain life, any disease or disorder can cause health problems, ranging from minor to severe. Not only do muscular disorders affect mobility, but also affect many other functions, such as breathing, swallowing or speaking.

Muscular dystrophy is a genetic disease that damages muscle fibers. The symptoms of muscular dystrophy disease include weakness, loss of mobility and lack of coordination. More than 50,000 Americans suffer with one of the nine forms of the disease, which can occur at any time in a person's life and has no cure.

Cerebral palsy impacts posture, balance and motor functions. Brain damage during or before childbirth causes a loss of muscle tone, making it difficult to perform everyday tasks. It is one of the most common congenital disorders.

Myasthenia gravis is a chronic autoimmune disease that results in muscle weakness and fatigue. A breakdown of the neuromuscular junction causes the brain to lose control over these muscles, which can result in difficulty breathing and swallowing,

Amyotrophic lateral sclerosis (ALS), often referred to as "Lou Gehrig's disease," is a progressive neuro- degenerative disease that affects nerve cells in the brain. It is a fatal disease that affects 30,000 Americans at any one time and leads to a loss of control over voluntary muscle movement, making it increasingly difficult to swallow, breath and speak. The disease ultimately causes paralysis and death.

Fibromyalgia is a chronic disorder characterized by widespread muscle pain, stiffness, fatigue, and tenderness in localized areas. While this is a difficult disease to pinpoint and diagnose and can mimic many other medical problems, it has gained acceptance as a recognized health issue over the past decade.

THE SKELETAL SYSTEM consists of 206 bones, as well as a network of tendons, ligaments and cartilage that connects them. The skeletal system performs vital functions — support, movement, protection, blood cell production, calcium storage and endocrine regulation — that enable us to move through our daily lives.

Human infants are born with 300 to 350 bones, some of which fuse together as the body develops. By the time most children reach the age of 9 they have 206 bones.

The skeletons of adult males and females have some variation, primarily to accommodate childbirth. The female pelvis is flatter, more rounded and proportionally larger. A male's pelvis is about 90 degrees or less of angle, whereas a female's is 100 degrees or more.

While they become brittle when outside of the body, bones are very much alive inside the body, being fed by a network of blood vessels from the circulatory system and nerves from the nervous system.

A typical bone has a dense and tough outer layer. Next is a layer of spongy bone, which

lighter and slightly flexible. In the middle of larger bones is jelly-like bone marrow, where new blood cells are constantly being produced.

Ossification is the process by which bone is formed. Some bones (e.g. the flat bones of the skull) are formed in one stage from the connective tissue. This process is known as intramembranous or direct ossification.

Other bones (e.g. short bones) are formed from the cartilaginous model of the future bone developed in the embryo, being dissolved and replaced by bone cells. This process is known as endochondral or indirect ossification - most bones are formed this way.

Bones and cartilage that make up the skeleton are the only rigid materials in the body. The 206 bones of the skeleton provide a framework and points of attachment for many of the soft tissues of the body. The five main classifications of bones are : Long (e.g. femur), Short (e.g. tarsal bones of the foot), Flat (e.g. frontal bone of the skull), Irregular (e.g. vertebrae) and Sesamoid (e.g. knee cap)

These structures protect some of the vital tissues and functional organs of the body. Typical examples are:

- **Skull - protects the brain**
- **Vertebrae - protects the spinal cord**
- **Thoracic cage - protects the heart and lungs**

Movement:

Bones act as levers during movement and provide solid structures to which muscles are attached. The joints allow movement between bones and these movements are directly related to the type of joint and range of motion. Joints fall into one of three categories: Fixed fibrous or Synarthroses (e.g. bones of the skull), Slightly moveable or Amphiarthroses (e.g. symphysis pubis) and Freely movable or Diarthroses.

Freely movable joints comprises of four main groups: Ball and Socket (e.g. hip), Hinge (e.g. elbow), Pivot (e.g. radius and ulna) and Gliding (e.g. carpal joint of the wrist)

Parts of a synovial joint:

A fibrous capsule surrounds the joint and is strengthened by ligaments. The stability of these joints is dictated by the shape of articulating surfaces, their surrounding ligaments and muscles. For example, the knee is given great strength from 2 cruciate and 2 collateral ligaments. While one of the hardest joints to dislocate is the hip. It is formed with the head of femur fitting neatly into the socket or acetabulum in the pelvis.

Articular or hyaline cartilage covers and protects the ends of bones which meet to form a joint and therefore allows freedom of movement. It is a very hard, smooth material which does not repair itself when damaged.

Tendons connect muscle tissue to bone and although more elastic than ligaments, have

a far greater tensile strength than muscle.

Synovial membrane lines the joint cavity and covers the tendons and ligaments which pass through it. The membrane produces synovial fluid which lubricates the joints

Ligaments are tough fibrous bands of tissue which connect bone to bone and help stabilise a joint, the strongest ligament in the body being situated at the front of the hip capsule, preventing excessive backward movement of the legs. Ligaments, although stronger than muscle tissue, have fewer nerve endings and less blood supply , and therefore take longer to repair when damaged. While these strong fibrous bands offer great stability to a joint in preventing excessive movement, if they are stretched or torn through injury, they do not necessarily return to their former length and therefore may remain stretched; that joint will then be less stable.

A bursa is a small sac formed in connective tissue lined by a synovial membrane and containing a small amount of synovial fluid. It is situated between moving parts, often between tendon and bone, to prevent rubbing.

Two distinctive parts:

THE AXIAL SKELETON: 80 bones, consists of the vertebral column, the rib cage and the skull. The axial skeleton transmits the weight from the head, the trunk and the upper extremities down to the lower extremities at the hip joints, which help humans maintain our upright posture.

THE APPENDICULAR SKELETON : 126 bones, and is formed by the pectoral girdles, the upper limbs, the pelvic girdle and the lower limbs. Their functions are to make walking, running and other movement possible and to protect the major organs responsible for digestion, excretion and reproduction.

DISEASES OF THE SKELETAL SYSTEM

X-rays, MRIs, bone density tests and arthroscopy are some of the primary diagnostic tools used to detect diseases and deformities of the skeletal system. Bone scans and bone marrow biopsies are used to diagnose cancer.

Osteoporosis: is a prevalent disease of the skeletal system, particularly among the elderly, resulting in the loss of bone tissue. In osteoporosis, bone loses calcium, becomes thinner, and may disappear completely.

Also common is scoliosis, a side-to-side curve in the back or spine, often creating a pronounced "C" or "S" shape when viewed on an x-ray of the spine. This condition typically becomes evident during adolescence.

Arthritis is a group of more than 100 inflammatory diseases that damage joints and their surrounding structures. Arthritis can attack joints, joint capsules, the surrounding tissue, or throughout the body. It usually affects the joints of the neck, shoulders, hands, lower back, hips, or knees.

While leukemia is a cancer that primarily affects the blood, the skeletal system is involved as the cancer starts in the marrow of the bone. With this type of cancer, abnormal white blood cells multiply uncontrollably, affecting the production of normal white blood cells and red blood cells.

Bone cancer is another disease of the skeletal system. It may originate in the bones or spread there from another part of the body. In the United States, bone cancer accounts for only about 1 percent of cancer cases.

Bursitis is a disorder that causes pain in the body's joints. It most commonly affects the shoulder and hip joints. It is caused by an inflammation of the bursa, small fluid-filled bags that act as lubricating surfaces for muscles to move over bones.

Rickets, the result of insufficient amounts of vitamin D, calcium and phosphorous, can result in poor bone development in children.

The skeletal system is also susceptible to breaks, strains and fractures. While bones are meant to protect the body’s vital organs, it takes about 10 to 16 pounds of pressure to break an average bone. Bones such as the skull and femur are much tougher to break.

Orthopedics: study and treatment of skeletal system. In the U. S. physicians undergo residency training in orthopedic surgery. Many then specialize in specific areas, such as the spine, hand or sports injuries.