UNIT- I
INTRODUCTION OF KINESIOLOGY

A basic understanding of kinesiology plays an important role in establishing fitness- training programs for beginners.

Kinesiology is the study of human motion and deals mainly with the muscles and muscle functions. It describes movement, which muscles are involved in the movement, and how they are involved. It explores the muscular involvement in strength exercises and sports technique.

Kinesiology from the greek words

‘**kinein**’- to Move,

‘**Logos’**- to Study

Is the scientific study of movements

DEFINITIONS

“Kinesiology is the study of human movements”

“The branch of physiology that studies the mechanics and anatomy in relation to human movements”

AIM AND OBJECTIVES OF KINESIOLOGY

The primary aims of kinesiology are

- Under standing the human body’s physiology and phychological responses to acute short-term physical activity.
- Understanding the various adaptations of the human body to chronic (or) long-term physical activity.
- Understanding the cultural, social and historical importance (or) physical activity.
- Understanding the mechanical qualities of movement.
- Understanding the processes that control movement and the factors that affect the acquisition of motor skills, and
- Understanding the psychological effects of physical activity on human behavior.

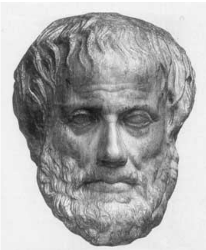
To achieve these aims, research in kinesiology requires the use of a variety of scientific knowledge and research techniques from such field as biology, chemistry, history, physics, psychology, and sociology. The areas of investigation within kinesiology are quite extensive because the responses of the human body to physical activity can be examined at many levels.

A knowledge base in kinesiology provides professional preparation for careers in fitness related industries, athletic training, teaching and coaching, and health related fields such as physical therapy.

History of Kinesiology

ARISTOTLE (384-322 B.C)

Aristotle is the "Father of Kinesiology"; His treatises, PARTS OF ANIMALS, MOVEMENT OF ANIMALS and PROGRESSION OF ANIMALS, described the actions of the muscles and subjected them to geometric analysis for the first time. He first to analyzed and described walking, in which rotatory motion is transformed into translatory motion.



Archimedes (287-212 B.C)

Archimedes another Greek, determined hydrostatic principles governing floating bodies that are still accepted as swimming. In addition, he suggests that his inquiries included the laws of leverage and determining the center of gravity and the foundation of the oretical mechanics.

Galen (131-201 A.D)

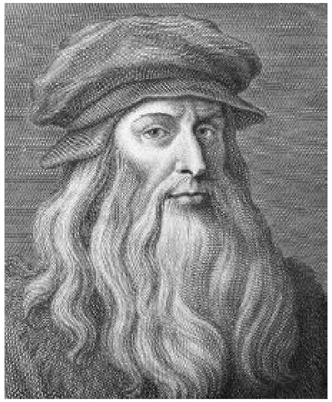
Galen a Roman citizen who tended the Pergamum's gladiators in Asia Minor and is considered to have been the first team physician in history. He used number to describe muscles. His essay DE MOTU MUSCULORUM distinguished between motor and sensory nerves, against and antagonist muscles,

When attempting to pull an object, the same general directions apply, but with this exception. As in the case of pulling the low trunk by a rope, it may be advantageous to pull in a slightly upward direction because the lifting effect would help to reduce friction. Nevertheless, unless one wishes to rotate the object, the pull should be applied in line with the object's line of gravity.

When applying a pull or push to an object that must move on a track, such as a window or a sliding garage door or a weight machine, it is essential to apply the force in the direction that the track or runway permits. Force in any other direction is wasted and friction is increased. Trying to open a heavy window or one the sticks can be done by standing with the right side next to it, the arm close to the frame, and then pushing vertically upward. If more force is needed, the knees and hips should be flexed then supplements the force exerted by the arm with little increase in the length of the resistance arm. If this action is inadequate, both hands can be used by twisting the trunk to face the window. In pulling the window down, one should face it, stand as close as possible, and use both hands, being careful to apply the force vertically downward.

described tonus, and introduced terms such as diarthrosis and synarthrosis. Some of writers consider his treatise the first text book of kinesiology and he has been termed "the father of sports medicine".

Leonardo da Vinci (1452-1519)

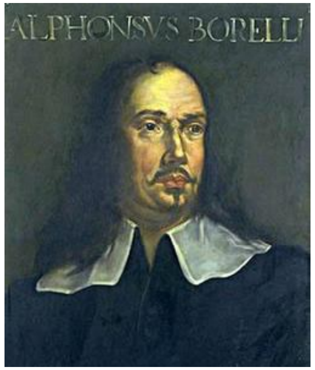


Kinesiology and anatomy lay untouched from the mystical studies of Galen until the 15th century when Leonardo da Vinci (1452-1519) advanced them another step. This artist, engineer, and scientist, da Vinci was particularly interested in the structure of the human body as it relates to performance, center of gravity and the balance and center of resistance. He used letter to identify muscles and nerves in the human body that he retrieved from grave yards in the middle of the night. He described the mechanics of the body during standing, walking up and downhill, rising from a sitting position, jumping and human gait. To demonstrate the progressive action and interaction of various muscles during movement, he suggested that cords be attached to a skeleton at the points of origin and insertion of the muscles.

Galileo

Galileo, the father of parabolic mathematics, also proved that the flight (trajectory) of a projectile through a non-resistant medium is a parabola. His work gave impetus to the study of mechanical events in mathematical terms, which in turn provide a basis for the emergence of kinesiology as a science.

1600's Giovanni Alfonso Borelli



Born in 1608, he is considered to be the Father of Biomechanics for his contributions to the field. The American Society of Biomechanics annually awards the scientist contributing the greatest achievement within the field with it's highest award, the Borelli Award. Borelli's knowledge of mechanics relative to human movement was restricted to the principles of levers and, as such, it appears to generate his accurate account of spinal muscle action. He worked in collaboration with Marcello Malpighi. Malpighi was a professor of theoretical medicine at the University of Pisa. Malpighi recalled "What progress I made in philosophizing stems from Borelli. Borelli states this about Malpighi "I worked hard dissection living animals at his home and observing their parts to satisfy his keen curiosity".

Borelli applied these principles of Equilibrium of Rotation and Equilibrium of Translation to spinal biomechanical analysis. In his work De Motu Animalium, Borelli illustrates the first comprehensive accounts of force of effort provided by posterior spinal musculature in stabilizing a force of resistance. "If the spine of a stevedore is bent and supports a load of 120 pounds carried on the neck, the force exerted by Nature in the intervertebral disks and in the extensor muscles of the spine is equal to 413 pounds. At the fifth lumbar the muscular forces are equal to 413 pounds and the forces exerted by the disc are equal to 1239 pounds."

One of the greatest mechanical features noted of the body, as was shown by his analysis, was that the muscles act with short lever arms so the joint transmits a force that is a magnitude greater than the weight of the load. Borelli overturned older concepts of muscle action, which was that long lever arms allowed weak muscles to move heavy objects.

The magnitude of the force used in pushing, pulling, and lifting can be increased in two ways. The immediate way is by using the lower extremities and, in some instances, the body weight to supplement the force provided by the upper extremities. In many, if not most, pushing and pulling activities the direction and point of application of force are interrelated. They both have an important bearing on the effectiveness of the force exerted, and also on the force is applied in line with the object's center of gravity and in the desired direction of motion. When this application of force is not feasible, the undesirable component of force should be as small as possible. For instance, if one desires to push a low trunk across the floor, it would be difficult to stoop low enough to push with the arms or even the forearms in a horizontal position. One should stoop as low as conveniently possible, however, to reduce the downward component of force that would tend to increase friction. If it were necessary to move the trunk down a long corridor, it would be more efficient to tie a rope to the handle at one end and pull it. By using a long rope, the horizontal component of force would be relatively small. Some lifting component would be desirable, hoe ever, as it would serve to reduce friction.

When friction is a major obstacle, as when pushing a tall object such as filing cabinet across a capered floor, the horizontal push should be applied close to the cabinet's center of gravity at a point found by experimentation. When this point is found, it will be possible to push the cabinet without tipping it. When it does not seem practical to slide a heavy object along the floor, one may try "walking" it on opposite corners. This involves tipping the object until it is resting on one edge of its base and then, by a series of partial rotations, alternately pivoting it first one corner and then other. The arms alternate in a lever action, one hand holding the upper corner that corresponds to the lower one that is serving as the pivot, and the other hand pushing the diagonally opposite upper corner forward.

a common denominator: Each involves moving an external object, either directly by some part of the body or by means of an implement, in a pushing or pulling pattern.

Joint Action Patterns

In pushing and pulling of motion, the basic joint actions are flexion and extension in one or more of the extremities. In the lower extremities, extension occurs simultaneously in the hip, knee, and ankle. This simultaneously and opposite joint action is a primary characteristic of push – pull patterns. All joint motions occur at the same time or very near the same time.

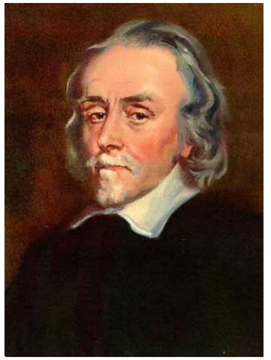
A push, pull, or lift may be applied either directly or indirectly to an object. In the latter instance, the push or pull pattern is used to develop potential energy in an elastic device such as a bow or slingshot. When the elastic structure is released, it imparts force to the movable object, causing the arrow or shot to be projected into the air.

Application

The great majority of pushing, pulling, and lifting activities undoubtedly occur in every day task. A number of sports, however, involve the continuous pushing or pulling of external objects. Archery is an interesting example, since it consists of pulling with one hand while pushing with the other. The same is true of using a forked stick slingshot. Pushing is also used in football, and both pushing and pulling are used in wrestling. Weight lifting is the prime example of a sport activity involving lifting.

Rowing and paddling, although classified as forms of aquatic locomotion, may also be considered activities that involve external objects. Oars and paddles are both moved by continual pushing and pulling movements. Pole vaulting, rope climbing (previously classified as locomotion), and all suspension activities might also be included in the pushing and pulling category, provided one accepts activities that involve the moving of the body by means of pushing or pulling an external object, the object in such cases also servings as the means of body support.

William Harvey (1578-1657)



The circulation of the blood through the body was first demonstrated by William Harvey (1578-1657), although he erroneously attibuted to the heart the foundation of recharging the blood with heat and "vital spirit".

Nicloas Andry (1658-1742)

The word "orthopedics" was coined by Nicolas Andry (1658-1742) from the Greek roots "orthos", meaning "straight" and "pais", meaning "child". Andry believed that skeletal deformities result from muscular imbalances during childhood. In this treatise, ORTHOPEDICS or the ART OF PREVENTING AND CORRECTING IN INFANTS DEFORMITIES OF THE BODY, originally published in 1741, he defined the term "orthopedist" as a physician who prescribes corrective exercise. (Andry, 1961). Although this is not the modern usage, Andy is recognized as the creator of both the word and the science. His theories were directly antecedent to the development of the Swedish system of gymnastics by Per Henrik Ling (1776-1839).

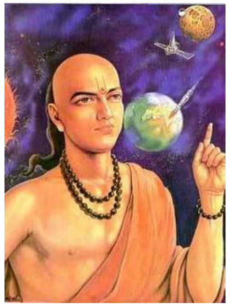
Sir Issac Newton (1642-1727)

In PRINCIPIA MATHEMATICA PHILOSOPHAE NATURALIS, which is "perhaps the most powerful and original piece of scientific reasoning ever published", he laid the foundation of modern dynamics. Particularly important to the future of kinesiology was his formulation of the three laws of rest and movement, which express the relationships between forces (interaction) and their effects:

James Keill (1674-1719)

In his studies of muscular contraction, James Keill (1674-1719) calculated the number of fibers in certain muscles, assumed that on contraction each fiber became spherical and thus shortened and from this deduced the amount of tension developed by each fiber to lift a given weight.

1114 A.D. Bhaskaracharya Second



In his work, Siddhanta Shiromani, Second describes the concepts in trigonometry of sine and cosine. These concepts are essential to mathematically determining forces used and created in lever systems. This knowledge will not make its way into western culture until Britain colonizes India and British mathematicians discover it.

<u>Role of Kinesiology in Physical Education and Sports</u>

1. To provide the future physical education teacher / coaches with the knowledge necessary for analyzing human motion.
2. And appling such analysis to the learning and improvement of motor skills.
3. With applied anatomic background the knowledge of kinesiology helps to prevent injuries.
4. Economy of the movement can be ensured.
5. Effectiveness of the movement can be ensured.
6. For clinical / rehabilitation purpose kinesiology has great importance.
7. Designing and teaching of exercise / conditioning / fundamental movements the knowledge of kinesiology is must.

One general phasing, scheme describes three throwing phases: action, and recovery. The primary functions of the preparation phase are to 1, put the body in a favorable position for execution of the throw, 2, maximize the range of movement, 3, allow for larger body segments to initiate the throw, 4, place the muscle at an advantageous length on their respective length – shorten cycle, 5, place the muscles at an advantageous length on their respective length – tension curves, and 6, store elstic energy to be used during the action phase.

During the action phase, skillful throwers use sequential muscle actions to execute the throw, beginning with muscles of larger segments. In most throws, there is proximal – to – distal muscle action and transfer of momentum and kinetic energy. The exact pattern of muscle action and mechanical transfer depends on the goal of the throw.

The primary purpose of the recovery phase is to slow down, the body and its limb segments through eccentric muscle action. This places the body in a favorable balanced position and reduces the chance of injury.

These general phases often are modified, or subdivided, in describing the throwing motion of a particular sport or type of throw. In basketball, for example, the pitching motion typically is divided in to five phases: windup, cocking, acceleration, deceleration, and follow- through. A six phase, stride, is sometimes included between windup and cocking. In context of the general scheme just presented, windup and cocking would constitute preparation, acceleration would correspond with action, and deceleration and follow – through would combine for recovery.

PUSHING AND PULLING

A person pushes a table across the room, a boxer jabs at an an opponent, a traveler lifts a suitcase onto an overhead rack, an archer shoots an from a bow, and a school teacher lifts open a window. As widely divers as these activities seem, they all have

Throws are categorized according to upper – extremity limb segments motion and the method of imparting force to the projectile. Classification include over arm throws, under arm throws, push throws, and pull throws. Over arm throwing is used, for example, by baseball pitchers and javelin throwers. Softball pitchers employ an underarm throwing motion to deliver the ball to the plate. Shot – putters use a push throw to project the shot, while discus and hammer throwers employ a pull throw to project their respective implements.

Throwing principles

Throwing depends on a number of principles, including the transfer of momentum in a proximal – to – distal manner an object held in the hand. As a result the object is thrust, or propelled, in to the air. The proper sequencing of limb segments motion presents the neuromuscular system with a challenging muscular control problem. In executing a throw, the body makes good use of the stretch – shorten cycle to enhance force production and throwing distance.

Throwing and projectile motion

Projectile move through the air under the influence of only gravity and air resistance along a path called the trajectory. The trajectory is determined by three factors: release height (above the ground), release speed (how fast the object is thrown), and release angle (relative to the horizontal). All the thrower's actions releases are intended to produce the proper combination of height, speed, and angle and thereby achieve the throwing goal.

Throwing Phases

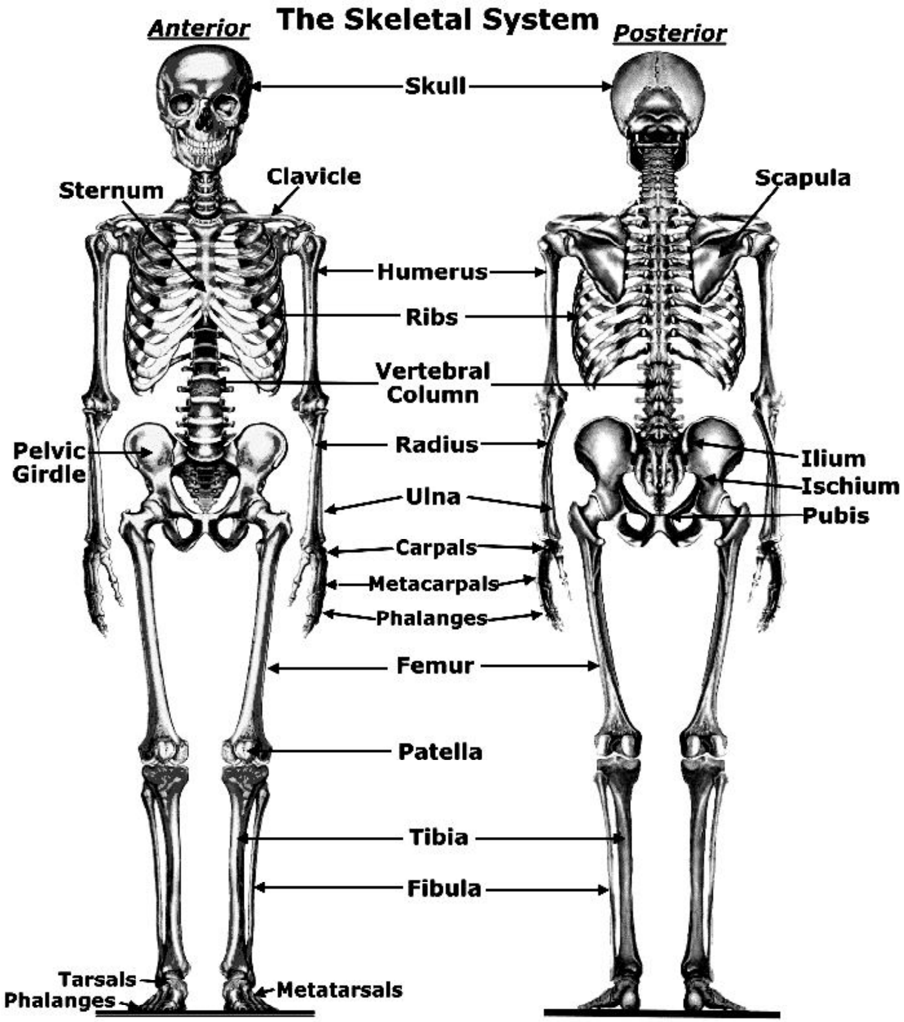
The throwing pattern often is divided in to phases to facilitate analysis. Each phase has defined beginning and end points, as well as specific biomechanical functions that contribute to the success of throw.

8. Self- realization about own performance is best realized by the athlete themselves with the background of kinesiology.
9. To discover and recognize the underlying principles of movement.
10. It is an educational experience for physical education and physical medicine.
11. Effective teaching of motor skills with the knowledge of kinesiology are best achieved in regard to
    a. fundamental motor skills and
    b. specialized motor skills.
12. Evaluation of exercise and activity from the point of view of their effect on the human structure.
13. For physiotherapy, physical medicine purposes.
14. For postural analysis, and correctives physical education.

UNIT- II

Function of Skeletal System

The average human adult skeleton has 206 bones joined to ligaments and tendons to form a supportive and protective framework for underlying soft tissues and muscles.



until landing. Following flight, first ground contact begins the landing phase, during which the hips and knees flex, with ankle dorsiflexion and extension of the arms, as the body absorbs the forces of landing.

The proper timing of joint motions is critical for a successful and proficient jump. During the propulsive phase, for example there is a rapid proximal – to – distal sequencing of maximum angular velocity at the hip, knee, and ankle joints, with very small delays between adjacent segments. This sequencing is necessary for the effective transfer of energy, from one segment to the next, required for optimal jumping performance. Alterations in this sequencing, such as when a jumper is fatigued, can alter the mechanics of the jump and result in a lower jump height.

THROWING

Throwing is as old as humankind. In prehistoric times, hunters threw rocks and spears at animals in hopes of securing food survival. Through the millennia, throwing has been an essential combat skill, early on using rocks and primitive weapons and more recently employing destructive implements such as hand grenades. Many contemporary sports include throwing as an essential skill. These include softball and baseball, American football, basketball, and several events in athletics (i.e., track and field) such as the shot put, discus, and javelin. In noncompetitive situations, throwing sometimes provides nothing more than a pleasant diversion, as when a thrower tries to skip rocks across the still surface of a mountain lake.

Despite the wide range of venues and goals, all throws are similar in that they involve using the upper extremity to launch a handheld object (projectile) through the air. The study of projectile motion is called ballistics, and throwing is one of several ballistics skills in which force is imparted to an object to project it through the air. Other ballistics skills include kicking and striking.

Even though these are descriptive and specific, they still do not include all forms of jumping. In athletic competition, for example, high jumpers leave the ground from one foot and land in the pit on their backs. They clearly jump, but their actions do not fit in to any of the standard definitions.

Types of Jumping

Jumping comes in many forms. Children at play jump out of sheer joy. Athletics jump to grab a rebound in basketball or catch a pass in American football. Ballet dancers jump when performing a grand jet. Physical education students do jumping jacks. Boxers jump rope. The list goes on and on.

Jumping is also used to test lower – extremity power output (e.g., Vertical jump test) and provides performance challenges to see how high (e.g., high jump) and far (e.g., long jump, triple jump) one can jump. Each jump types has a specific goal and therefore requires a unique set of movements and pattern of muscle involvement.

With so many different types of jumps, it is infeasible to analyse here the joint motions and muscle control of all of them. Thus, we describe a basic standing vertical jump with a two – foot take off landing. The fundamental patterns described here are modified for other jump types, but many of the basic concepts, such as preparatory leg and arm action (i.e., Counter movements), apply to most jump types.

A standing vertical jump can be divided into four phases: Preparatory, Propulsive, flight, and Landing. The jump begins from a normal standing position. During the preparatory (down) phase, the hip and knee joints flex, the ankles dorsiflex, and the arms swing back into hyperextension. In the propulsive (up) phase, the hips and knees extend, the ankles planter flex, and the arms swing forward in flexion. The flight phase begins at take off when the toes leave the ground. Throughout the flight phase, the body assumes a relatively upright posture that is maintained

The skeleton system serves several important functions in the body.

- Bones serve as levers that transmit muscular forces.
- Our skeletal system protects our organs.
- Our skeleton system serves as a framework for other tissues and organs.
- Bones serves as banks for storage and release of minerals like calcium and phosphorous.

Axial skeleton

The skeleton consist of the axial and appendicular skeleton. There are 80 bones in the **axial skeleton,** consisting of the skull, spine, ribs and sternum.

Appendicular skeleton:

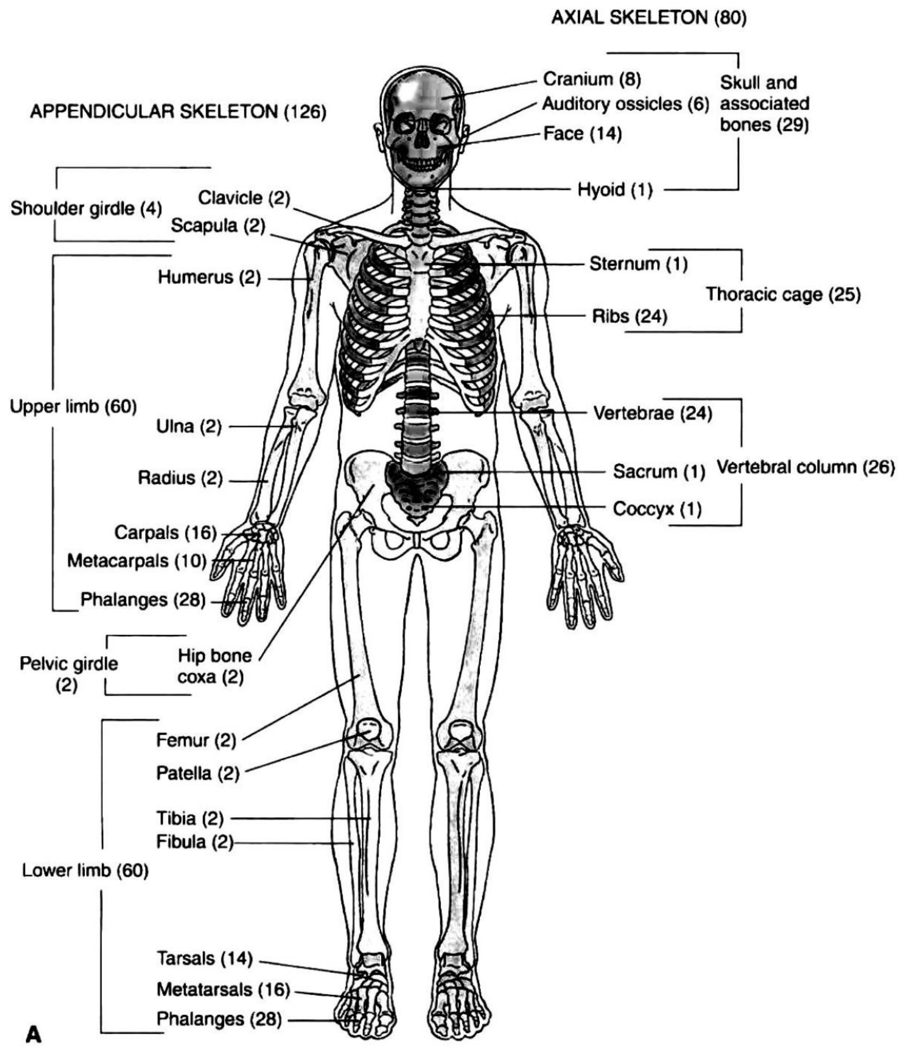
There are 126 bones in the **appendicular skeleton:** 60 in the upper extremities, 60 in the lower extremities, 2 in the pelvic girdle, and 4 in the shoulder girdle.

Bones of the Body

We have about 206 bones, but when we were born we had around 350. This is because many smaller bones join together as we grow.

Bone consists of three layers.

- Bone marrow
- Compact bone
- The periosteum



The human skeleton. (Anterior View) There are 206 bones in the typical human skeleton, 80 in the *axial* skeleton and 126 in the *appendicular* skeleton

The kinematics of the walking gait is often described in terms of strides and steps. A stride is one full lower extremity cycle. In walking and running, a stride is defined as being from heel strike on one leg to the next heel strike with the same leg. Stride length, then is the distance covered during a single stride.

ANATOMICAL ANALYSIS

The six major components of walking have been defined as 1) pelvic rotation, 2) pelvic tilt, 3) knee flexion 4) hip flexion 5) knee and ankle interaction, and 6) lateral pelvic displacement. Each of these components is essential for efficient walking and the loss of any one will cause an increase in the energy cost.

The action taking place in the joints of the lower extremity consists essentially of flexion and extension, But in much the same way that the shoulder girdle comperates with the arm movements of the upper extremity, the pelvic girdle cooperates in movements of the lower extremities.

The adaptations of the pelvic position are made in the joints of the thoracic and lumbar spine as well as in the hip joints. Thus, as first one foot and then the other are put forward, the flexion and extension movements of the thigh are accompanied by slight rotary movements and ab- and adduction at the hips, and by slight lateral flexion and rotation of the spine.

JUMPING

Jumping means “to spring free from the ground or other base by the muscular action of feet and legs”. This provides a general description of the jumping action but does not distinguish between different ways of launching and landing. To make this distinction, jumping applies to when individuals propel themselves from the ground with one or both feet and then land on both feet. Hopping involves propelling from one foot and landing on the same foot. Leaping describes the movement when individuals propel from one foot and land on the other foot.

4. In an efficient run, the foot should strike the ground as close as possible to the line of gravity. If the foot should strike ahead of the line of gravity, the reaction force to this forwards and downward thrust will be a backward and upward force, acting to retard forward motion.

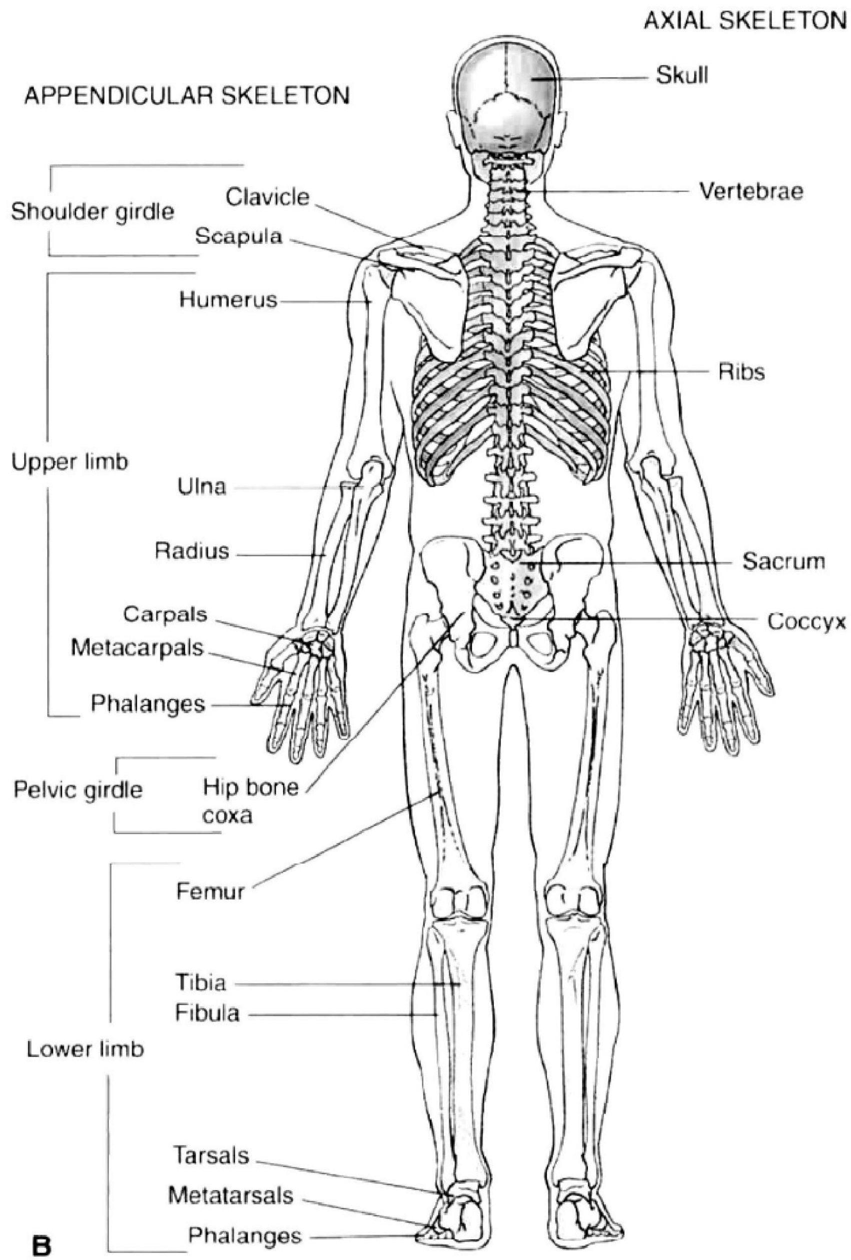
5. The knees should be lifted directly upward and forward, with the motion of the entire lower extremity occurring within the sagittal plane. The arm swing should exactly counterbalance the twist of the pelvis and should not cause additional lateral motion.

6. Resistance force due to the moment, of inertia of the free leg during the swing phase can be minimized. By flexing the free leg at the knee and carrying the heel high up under the hip, the leg is moved more rapidly as well as more economically. His high knee lift increases as speed increases.

7. The force of air resistance can be altered by shifting the center of gravity. A for ward lean will work to counteract a head wind. A tail wind often enhances performance.

WALKING

Walking is accomplished by the alternation action of the two lower extremities It is an example of translatory motion of the body as a whole brought about by rotary motion of some of its parts, It is also an example of a periodic or pedulumlike movement in which the moving segment (in this case the lower extremity) may be said to start at zero, pass through its arc of motion, and fall to zero again at the end of each stroke. In walking, each lower extremity undergoes two phases; the swing or recovery phase and the support phase. The support phase is further divided into heel-strike the heel-strike and foot-flat phase of the other leg, thus producing a period of double support when both feet are on the ground. This double support phase is characteristic of the walk and serves to differentiate it from the run.



The human skeleton. (Posterior view)

BONE MARROW

Within the long bone is a central marrow cavity known as bone marrow.

The red marrow produces red blood cells, which carry oxygen, white blood cells, which fight infection, and platelets, that help stop bleeding.

The yellow marrow consists mainly of fat cells.

COMPACT BONE

Surrounding the marrow is a dense rigid bone called the compact bone.

Cylindrical in shape, the dense layers of the compact bone are honeycombed with thousand of tiny holes and passages. Nerves and blood vessels run through these passages. That supply oxygen and nutrient to the bone.

This dense layer of compact bone supports the weight of the body and is comprised mainly of calcium and minerals.

PERIOSTEUM

Each bone is covered by the periosteum, which is a layer of specialized connective tissue and acts as the skin of the bone.

The inner layer of the periosteum contains cells that produce bone.

These three bone layers work together to handle the aforementioned skeletal system function.

MECHANICAL ANALYSIS

The speed of running is governed by the length of the stride and the frequency of the stride. The length of the stride is determined by the length of the leg, the range of motion in the hip and the power of the leg extensors which drive the entire body forward. Like any projectile, the distance the body will move once it is driven into the air depends upon the angle of take off [distance that center of gravity is ahead of take off foot], the speed of the body‘s projection and the height of the center of gravity at take off and landing.

In running, as in walking, the force exerted to produce and control the movement are in the internal muscular forces and the external forces of gravity, normal reaction, friction, and air assistance. There is no optimal speed in running because the energy needed to run is proportional to the square of the velocity. Therefore, whether the run is an easy jog or a full speed sprint, economy of effort is a highly desirable objective. To achieve this it is essential that the runner observe the principles that apply to efficient running.

MECHANICAL PRINCIPLES IN RUNNING

1. In accordance with the Law of inertia, a body remains at rest unless acted upon by a force. The force required to overcome inertia is greatest at takeoff and least after acceleration has ceased. The problem of overcoming inertia decreases as the speed increases.

2. In accordance with the law of acceleration in the run is directly proportional to the force producing it. Hence, the greater the power of the leg drive, the greater the acceleration of the runner.

3. In accordance with the law of reaction, every action has an equal and opposite reaction. The force for the run is provided through the upward and forward ground reaction force in response to the downward, backward of the foot.

UNIT-V
MUSCULAR ANALYSIS OF FUNDAMENTAL MOVEMENTS
RUNNING

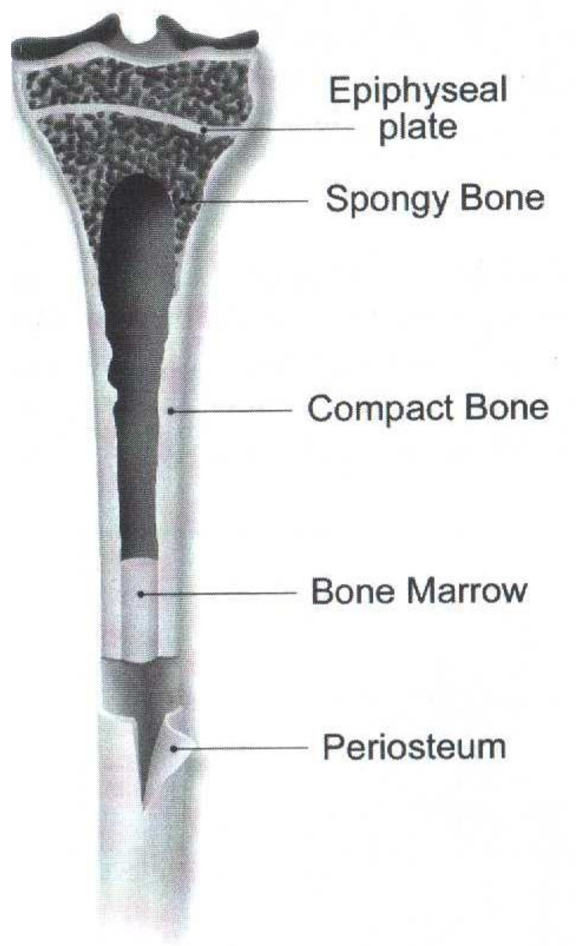
In the run the foot hits the ground in front of the body s center of gravity as in the walk, but not as far in front. As the speed of the run increases, the distance in front decrease until the foot contact is almost directly under the body's center of gravity. This position reduces the restraining part of the support phase and gives greater emphasis to the propulsive part.

There are two major types of running. The first is the kind of running done for its own sake, as in competitive races or jogging. The major concerns here are time and distance in one direction. The second is the type of running that is part of games and sports. Here it is necessary also to consider matters such as change of direction or pace and stability. The technique for a run varies with the purpose, but the basic anatomical and mechanical aspects are the same, regardless of the purpose.

ANATOMICAL ANALYSIS

The difference between the joint action in walking and running is a mater of degree and coordination. The joint actions are essentially the same but the range of motion in running is generally greater. This is especially apparent in the actions of the swinging leg. The different in coordination is evident in the period of non support and the absence of the period of double support.

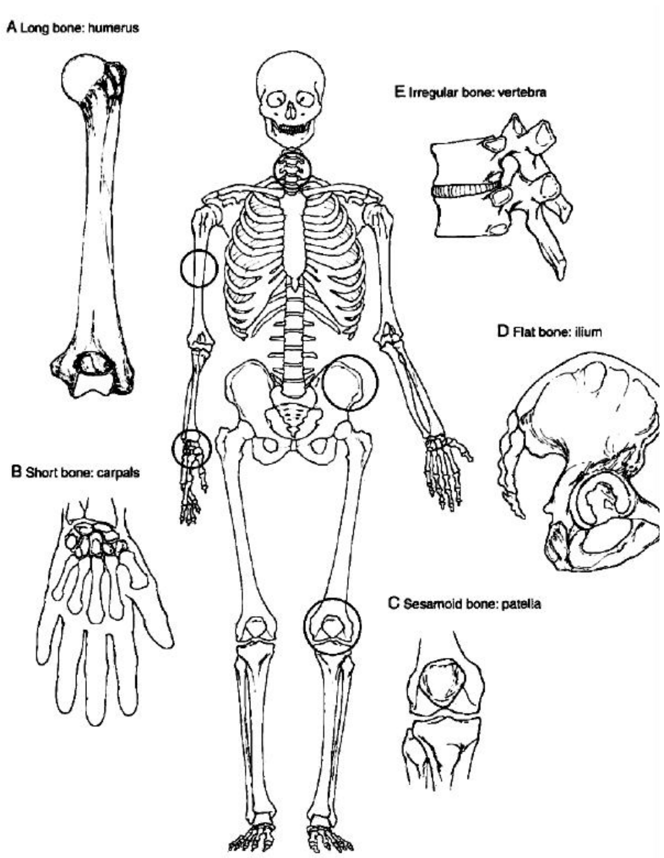
1. Support phase.
2. Swing phase
3. Heel phase.
4. Flat phase.
5. Toe off.



Bone classification

There are six main categories of bones,

- Long bone
- Short bone
- Sesamoid Bones
- Flat bone
- Irregular bones
- Wormian Bones (sutural)



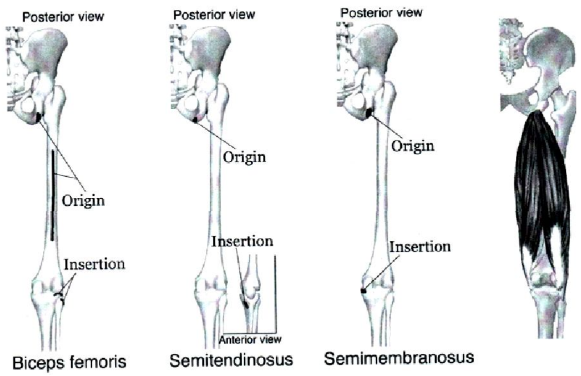
Shapes of bones. A. Long bone (humerus). **B.** Short bones (carpals). **C.** Sesamoid bone (patella), a specialized short bone. **D.** Flat bone (ilium). **E.** Irregular bones (vertebrae). Wormian bones arc not shown.

LONG BONE

Long bones provide structural support and include the tibia, fibula, femur, radius, ulna and humerus. They are long cylindrical shaft with relatively wide.

SHORT BONE

Short bones provide some shock absorption and include carpals and tarsals. They are usually characterized as small, cubical shaped, solid bones.

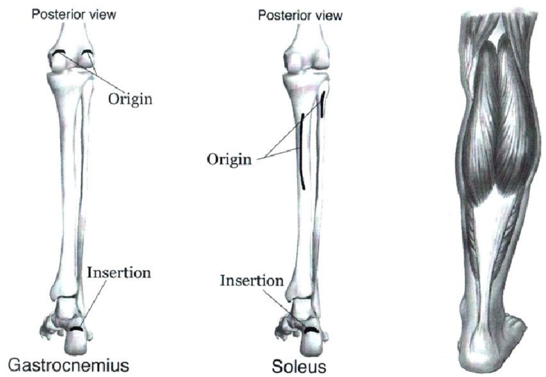


SELECTED LEG EXERCISES

- Leg press
- Lunge (stationary with dumbbells)
- Leg extension
- Seated leg curl
- Basic squat

GASTROCNEMIUS

Location – calf of leg
Origin – posterior surface of the medial and lateral femoral condyle
Insertion – calcaneus
Action – plantar flexes the ankle, flexion of the knee



SELECTED CALF EXERCISES

- Seated calf raise
- Standing calf raise

HAMSTRING GROUP

BICEPS FEMORIS

Location – posterior thigh
Origin – Ischium
Insertion – tibia and fibula
Action – extension of hip, flexion of knee, internal rotation of hip and knee

SEMITENDINOSUS

Location – posterior thigh
Origin – Ischium
Insertion – tibia
Action – extension of hip, flexion of knee, internal rotation of hip and knee

SEMIMEMBRANOSUS

Location – posterior thigh
Origin – Ischium
Insertion – tibia
Action – extension of hip, flexion of knee, internal rotation of hip and knee

GLUTEAL MAXIMUS

Location – buttocks
Origin – ilium and sacrum
Insertion – femur
Action – extends, abducts and laterally rotates thigh; extends lower trunk

SESAMOID BONE

Sesamoid bones provide protection as well as improve mechanical advantage of musculotendinous units and include unit in the patella and the flexor tendons of the toe and thumb.

FLAT BONE

Flat bones provide protection and include the ilium, ribs, sternum, clavicle and scapula. They are usually characterized by a curved surface where it is either thick at the tendon attachment or very thin.

IRREGULAR BONE

Irregular bones serve a variety of purposes in the body and include bones throughout the spine as well as the ischium, pubis and maxilla.

WORMIAN BONES (SUTURAL)

Wormian bones, also known as intra sutural bones, are extra bone pieces that occur within a suture in the cranium. These are irregular isolated bones that appear in addition to the usual centers of ossification of the cranium and, although unusual, are not rare.

CONSTRUCTION AND TYPES OF JOINTS IN THE BODY AND THEIR ACTIONS

A skeletal joint is the union between two or more bones and cartilage; or between two or more cartilages. The junctions between skeletal components may be called JUNCTURE, ARTICULATIONS, or by vernacular terms such as JOINTS.

Function of Joints

- 1. Serve as functional junctions between bones.
- 2. Bind bones , strokes , and other related tissues together.
- 3. Allow bone growth to occur .
- 4. Permit certain structures to change shape during childbirth (i.e. pubic symphysis).
- 5. Enable the body to have movements, lever actions, and body posture.

Classification of Joints by Structure

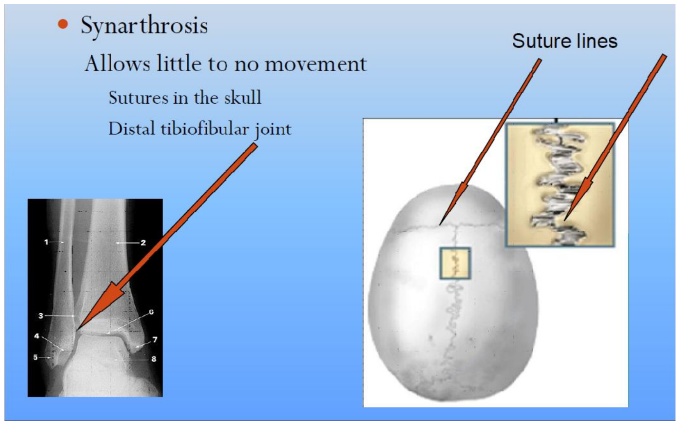
The joints are habitually differentiated into three groups :

1) Synarthroses (or) Fixed joints (or) immovable joints (or) fibrous joints
2) Amphiarthroses (or) slightly movable joints.
3) Diarthrosis (or) freely movable (or) synovial joints.

1) Synarthroses or Immovable Joints

"Sybartgrises" is a Greek word, meaning is "with joint" or a joint in which there is no separation or articular cavity. In this type the surfaces of the bones are in almost direct contact with only a thin layer of fibrous periosteum between the bones. In this joint there is no articular cavity, i.e. no capsule, no synovial membrane or no synovial fluid.

Example : Suture of the skull



VASTUS INTERMEDIUS

Location – anterior thigh
Origin – femur
Insertion – upper border of patella and tibia
Action – knee extension

VASTUS MEDIALIS

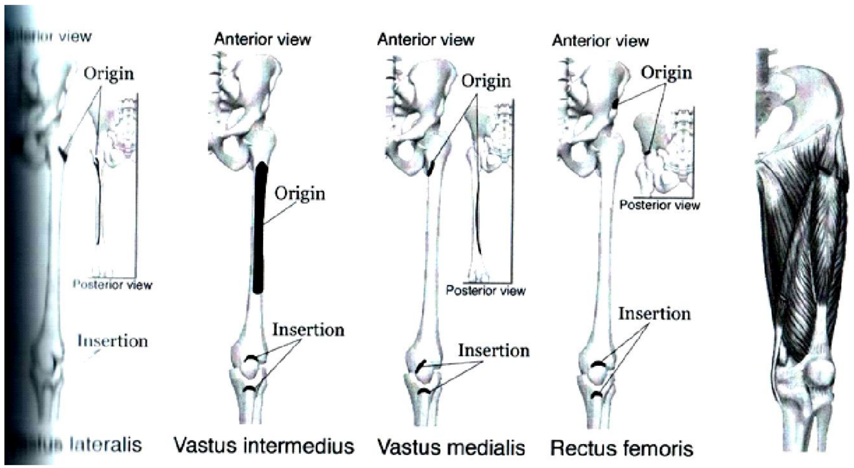
Location – medial thigh
Origin – femur
Insertion – medial border of patella and tibia
Action – knee extension

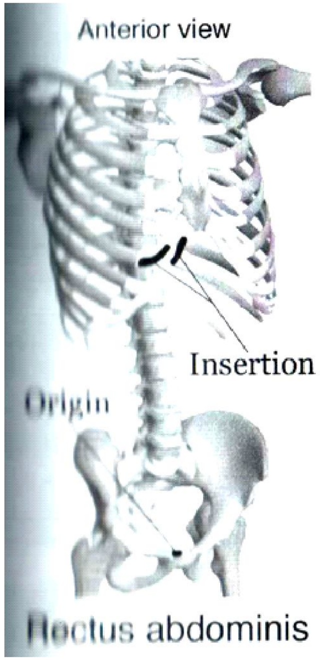
RECTUS FEMORIS

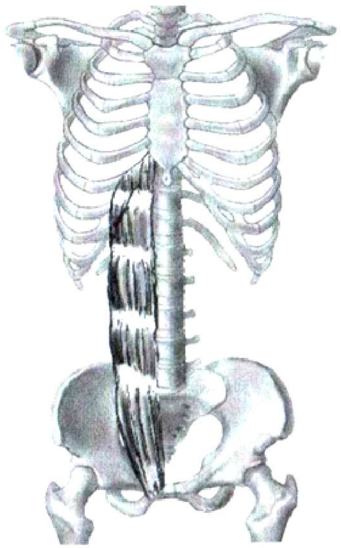
Location – anterior thigh
Origin – ilium
Insertion – patella and tibia
Action – flexion of hip, extension of knee

SARTORIUS

Location – anterior and midial thigh
Origin – ilium
Insertion – tibia
Action – flexes thigh and rotates it laterally







SELECTED ABDOMINAL EXERCISES

- Crunch
- Stability ball crunch
- Oblique stability ball crunch
- Kneeling cable crunch
- Hanging leg raise
- Forward stability ball roll

QUADRICEPS GROUP

VASTUS LATERALIS

Location – lateral thigh
Origin - femur
Insertion – lateral border of patella and tibia
Action – knee extension

2) Ampiarthroses or Slightly Movable

In this type of joint the continuous surfaces are either connected by broad flattened discs of fibro cartilage which adhere to the end of each bone, as in the joint between the bodies of vertebrae, or else, the joint surfaces are covered with fibro cartilage, partially lined by synovial membrane and connected by external ligaments as in public symphysis, both of these joints being capable of limited motion.

There are two types of Amphiarthrosis

a) Ligamentous (or) Synedsmosis

b) Cartilaginous (or) Synchondrosis

a) Ligamentous (or) Synedsmosis

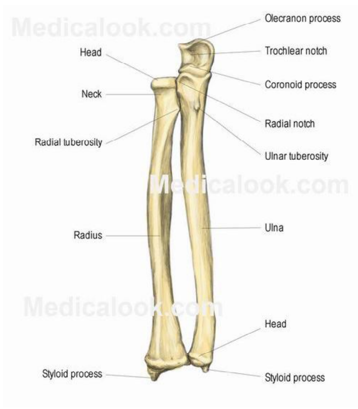
This is a Greek word, meaning is "with ligament". Two bones, which may be adjacent or which may be quite widely separated are tied together by one or more ligaments. These ligaments may be in the form of cords, bands, or flat sheets. The movement that occurs is usually limited and of no specific types.

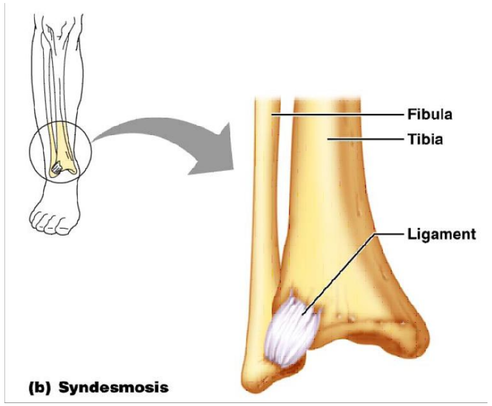
Example

i) Mid Union of Radius and Ulna

ii) Mid tibio - fibular joint

iii) Inferior tibio - fibular joint



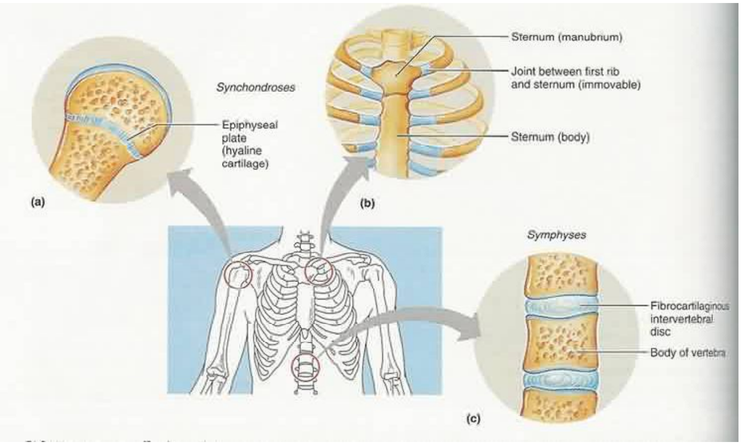


b) Cartilaginous (or) Synchondrosis

This is a Greek word, meaning is “with cartilage”. The joints which are united by fibro cartilage permit motion of a bending and twisting nature. Those united by hyaline cartilage permit only a slight compression.

Example of hyaline type. Epiphysial unions

Example of fibro cartilaginous type : Joints between the bodies of the vertebrae.



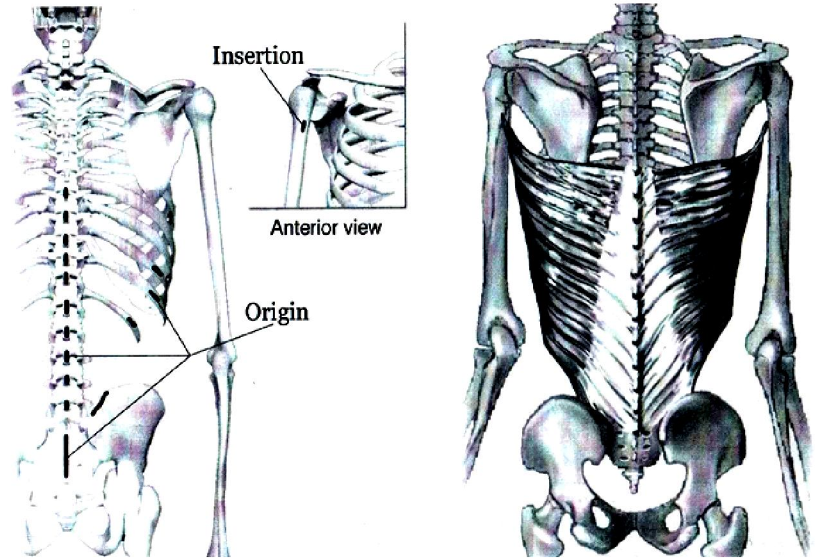
3) Diarthroses (or) Freely movable joints (or) Synovial joints

This is a Greek word, meaning a joint in which there is a separation, or articular cavity.

Characteristic of Diarthrosses Joint

a) An articular cavity is present
b) The joint is encased within a sleeve like ligamentous
c) The capsule is lined with synovial membrane which secretes synovial fluid for lubricating the joint.
d) The articular surfaces are smooth.
e) The articular surfaces are covered with cartilage, usually hyaline, but occasionally fibro cartilage.

Diarthroses or synovial joints are classified into six varieties.



SELECTED LAT EXERCISES

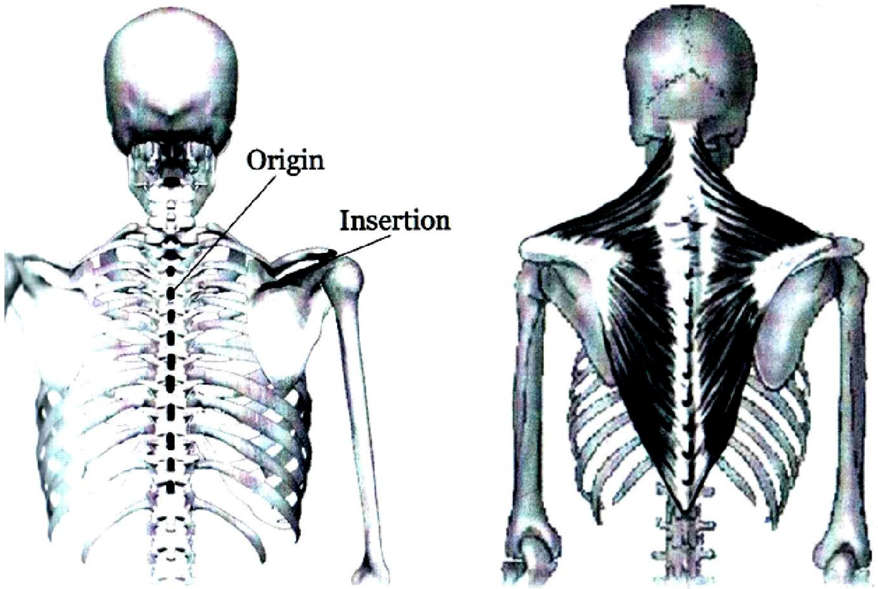
- Overhead pulldown
- Seated machine row
- Chin-up
- Pull-up
- Bent-over row
- Supine pullover on ball

RECTUS ABDOMINIS

Location – anterior midline of abdomen
Origin – superior surface of pubis around syphysis.
Insertion – inferior surface of costal cartilages (ribs 5-7) and xiphoid process of sternum.
Action – depresses ribs, flexes vertebral column

TRAPEZIUS

Location – upper back and neck
Origin – base of skul, spinous process of 7C and T1- T3
Insertion – posterior aspect of the lateral clavicle
Action – scapula elevation, depression and adduction of scapula



SELECTED TRAPEZIUS EXERCISES

- Cable bar shrug
- Barbell shrug
- Dumbbell shrug
- Seated mid row retraction on a machine

LATISSIMUS DORSI

Location – lower back
Origin – posterior side of sacrum, spinous process of lumbar and lower 3 ribs
Insertion – medial side of humerus
Action – internal rotation of humeral joint and horizontal abduction of humeral joint

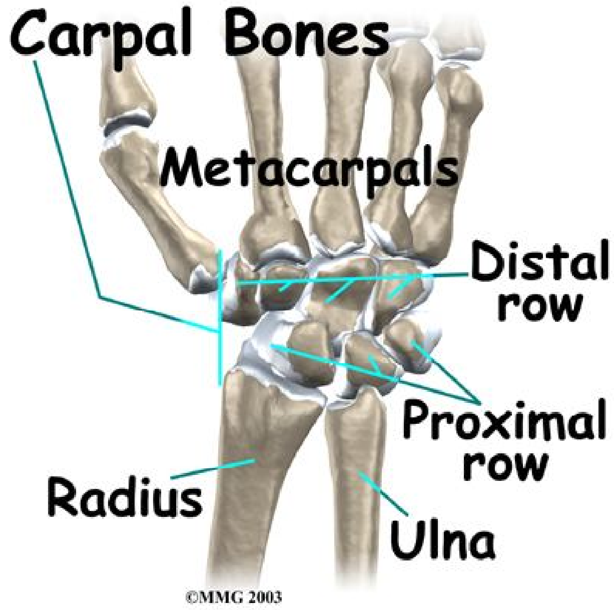
1) Gliding joint (or) Irregular joint (or) Plane joints (or) Arthrodial.
2) Hinge joint (or) Ginglymus
3) Pivot Joint (or) Trochoid (or) Screw Joint
4) Condyloid joint or Ellipsoidal
5) Saddle Joint

Ball and Socket Joint (or) Spheroidal (or) Enarthrodial.

1. Gliding Joint (or) Irregular Joint (or) Plane Joint or Arthrodial

The joint surfaces are irregularly shaped, usually flat or slightly curved. The only movement permitted is of a gliding nature, hence it is NON-AXIAL.

Example : Carpal Joints

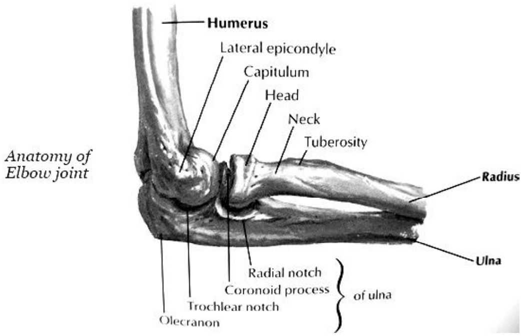


Carpal Joints (Gliding joint)

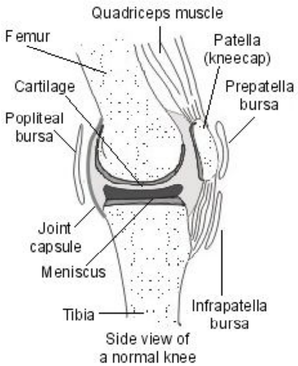
2. Hinge Joint (or) Ginglymus

It is roughly resemble the hinges of a door. One surface is spool-like, the other is concave. The concave surface fits over the spool-like process and glides partially around it in a hinge type of movement. This constitutes movement in one plane about a single axis of motion. Hence it is UNI-Axial. The movement that occurs are FIEXION and EXTENSION.

Example :
1) Elbow joint (or) Humero-ulnar joint
2) 1st and 2nd phalangeial joints
3) Knee joint



Elbow joint

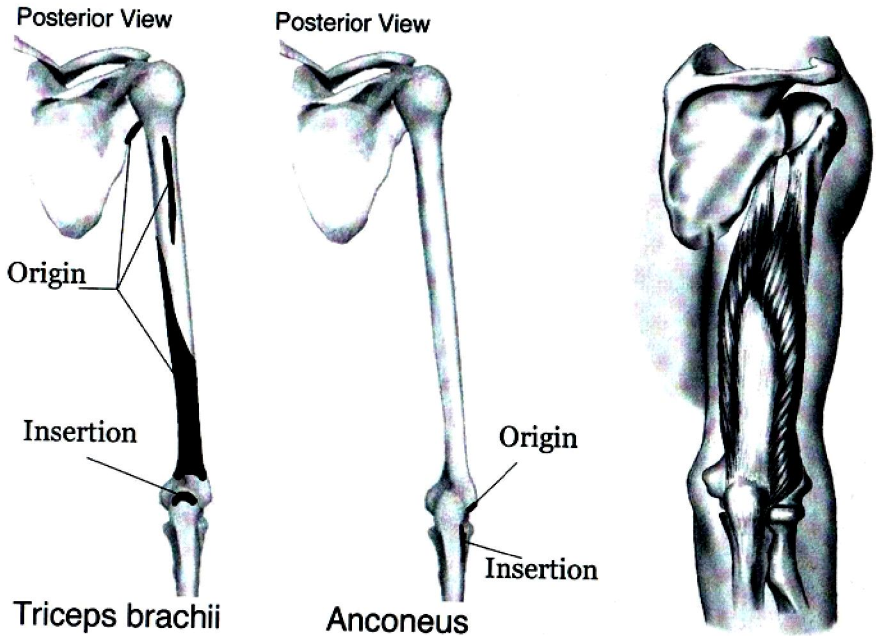


Knee joint

The elbow joint is a DOUBLE GINGLYMUS. This joint consists of the articulation of the lower end of the humerus with the upper ends of the ulna and Radius. The semi-circular structure at the upper end of the ulna is cupped around the back and under side of the spool-like process known as the trochlea, at the lower end of the humerus. The inner surface of this semi-circular structure is known as the semilunar notch. It terminates above and behind in the olecranon process, and below and in front in the coronoid process. Just lateral to the trochlea, on the lower end of the humerus, is the capitulum, the small spherical structure that articulates with the saucer – like surface of the radial head.

TRICEPS BRACHII

Location – posterior humerus
Origin – long head: posterior edge of scapula, medial head: distal 2/3 of posterior surface of humerus, lateral head: upper half of posterior humerus.
Insertion – posterior surface of ulna
Action – adduction of the shoulder joint, extension of elbow

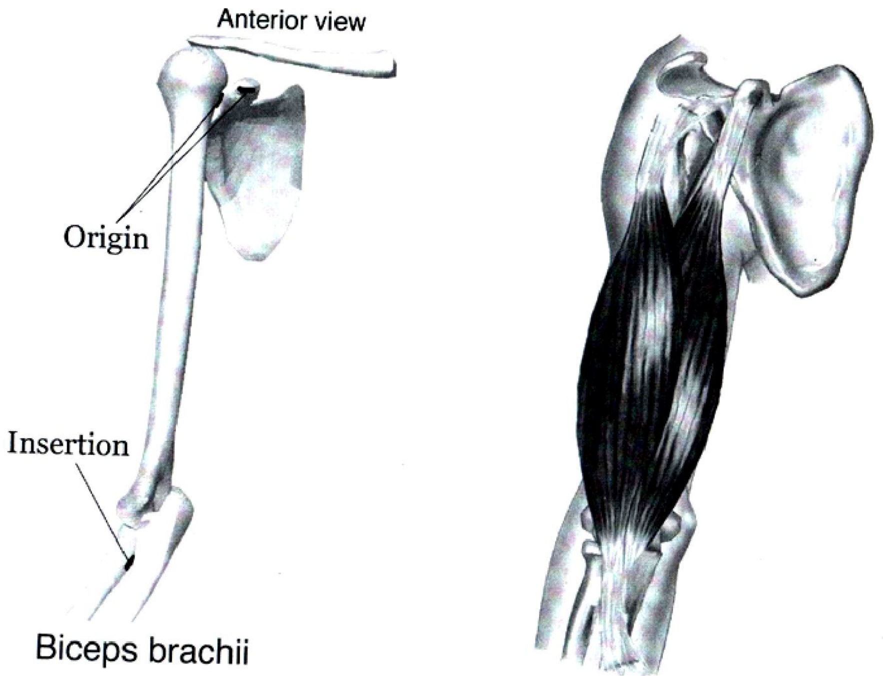


SELECTED TRICEPS EXERCISES

- One arm dumbbell triceps extension on stability ball
- Skull crushers
- French press
- Triceps cable extension with rope
- Bar dips
- French press on ball

BICEPS BRACHII

Location – upper arm
Origin – short head: coracoid process of scapula and long head: above the superior lip of scapula
Insertion – tuberosity of radius
Action – flexion of elbow, supination of forearm



SELECTED BICEPS EXERCISE

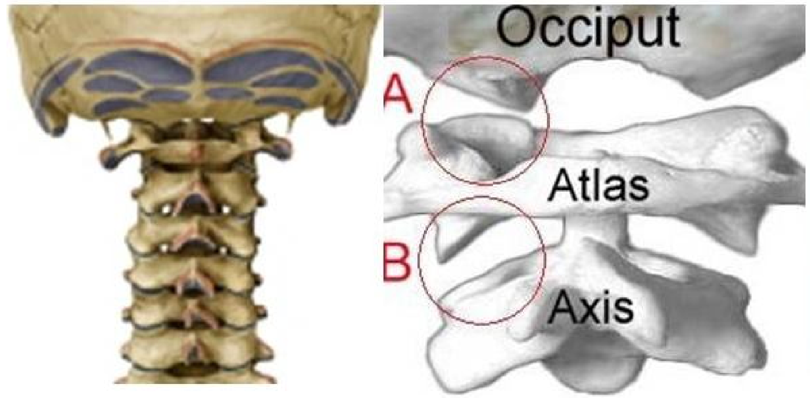
- Cable biceps curl
- Cable rope hammer curl
- Dumbbell biceps curl
- Dumbbell hammer curl
- Dumbbell concentration curl
- Dumbbell hammer curl on ball

The two articulations of the elbow joint, as well as the proximal radiulnar articulation, are completely enveloped in an extensive capsule. The capsule is strengthened on all four sides by bands of fibers which are usually described respectively as the anterior, posterior, ulnar collateral and radial collateral ligaments. Synovial membrane not only lines the capsule, but it also extends into proximal radioulnar articulation, covers the olecranon, coronoid and radial fossae, and line the annular ligament.

3) Pivot Joint (or) Trochoid (or) Screw Joint.

This kind of joint may be characterized by a peg like pivot, as in the joint between atlas and axis, or by two long bones fitting against each other near each end in such a way that one bone can roll around the other one, as do the radius and ulna of the forearm. In the latter type a small concave notch on one bone fits against the rounded surface of the other. The rounded surface may either be the edge of a disk (like the head of the radius), or it may be a rounded knob (like the head of the ulna). The only movement permitted in either kind of pivot joint is rotation. It is a movement in one plane about a single vertical axis, hence the joint in UNI-AXIAL.

Example : Atlanto – axial Joint



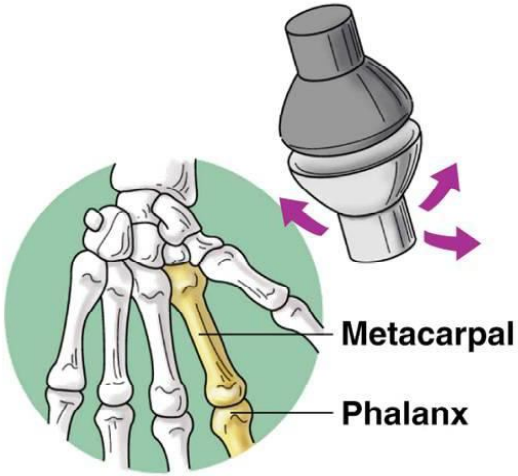
Posterior View
Cervical Spine

A: Atlanto-Occipital Joint
B: Altanto –Axial Joint

4) Condyloid Joint (or) Ellipsoidal

An oval or egg – shaped convex surface fits into a reciprocally shaped concave surface. Movement can occur in two planes, forward and backward, and from side to side. The former movement is flexion and extension and the latter abduction and adduction or lateral flexion. The joint is BI-AXIAL, the axes being frontal horizontal and horizontal and sagittal horizontal. When these movements are performed sequentially, they constitute circumduction.

Example : Metacarpal / Phalangial joint



5. Saddle Joint

This may be thought as a modification of a condyloid joint because the function is a very much like condyloid joints, but their structure is different. From one angle, the articular surfaces appear convex and from the opposite angle, they appear concave. This type of joint consists of two saddle like structure fitted into each other. It has a strong but loose capsule, permitting much more freedom of movement. This is also a BI-AXIAL joint. The possible movements are flexion, extension, abduction, hyper adduction, hyper flexion, circumduction and oppositio.

Example : Carpo – metacarpal joint of the Thumb

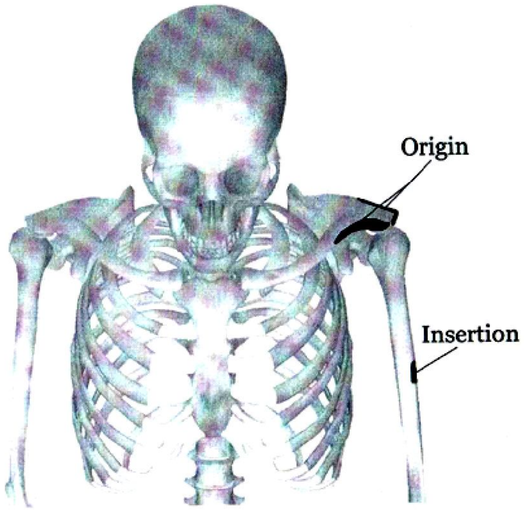
DELTOID

Location – anterior, lateral and posterior upper surface of humerus

Origin – anterior side of clavicle, posterior edge of scapula, lateral aspect of acromion.

Insertion – anterior, middle and posterior: deltoid tuberosity on lateral humerus

Action – abduction, flexion, extension



SELECTED DELTOID EXERCISE

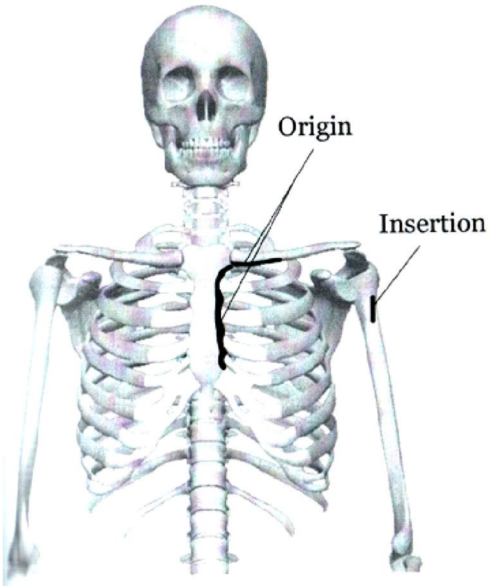
- Seated barbell press
- Barbell upright row
- Dumbbell posterior deltoid raise
- Dumbbell medial deltoid lateral raise
- Single arm cable lateral raise
- Seated alternate dumbbell press on stability ball

UNIT- IV

ORIGIN, INSERTION AND ACTION OF THE MUSCLE

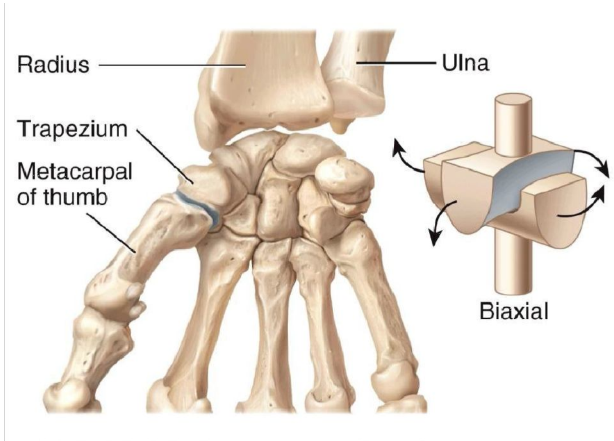
PECTORALIS MAJOR

Location- chest
Origin – anterior surface of clavicle and sternum
Insertion - groove humerus
Action – internal rotation, horizontal adduction



SELECTED CHEST EXERCISE

- Dumbbell flat bench chest press
- Dumbbell incline bench chest press
- Barbell incline bench chest press
- Barbell flat bench chest press
- Bar dips
- Dumbbell chest press on ball

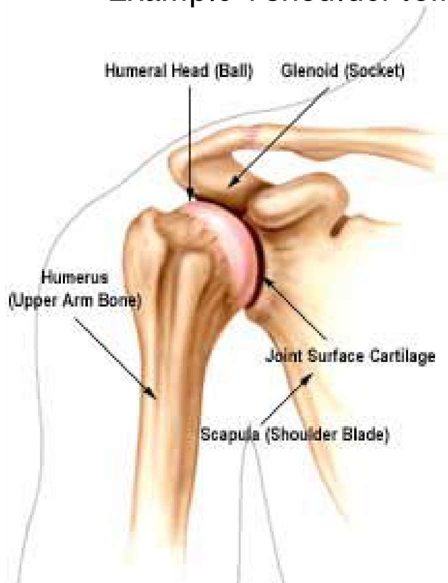


(e) Saddle joint between trapezium of carpus (wrist) and metacarpal of thumb

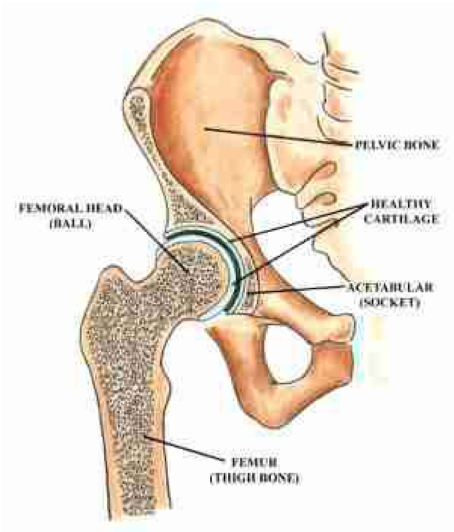
6. Ball and Socket joint (or) Spheroidal (or) Enarthrodial

These joints are formed by the reception of a head of one bone into a cup-like concavity. Such joints are MULTI-AXIAL OR TRI-AXIAL as it permits movement about three axes, namely frontal horizontal, sagittal horizontal and vertical.

Example : Shoulder Joint & Hip Joint



Shoulder Joint



Hip Joint

The shoulder joint is formed by the articulation of the spherical head of humerus with the small, shallow, some-what perar-shaped glenoid fossa of the scapula. The structure of the joint and the looseness of the capsule account for the remarkable mobility of the shoulder joint. Both the humeral head and the glenoid fossa are covered with hyaline cartilage. The cartilage on the head is thicker at the center. The glenoid fossa is further protected by a flat rim of white fibro cartilage, likewise thicker around the circumstance. This cartilage is called the glenoid labrum, serves both to deepen the fossa and to cushion it against the impact of the humeral head in forceful movements.

The joint is completely enveloped in a loose sleeve like articular capsule which is attached proximally to the circumference of the glenoid cavity, and distally to the anatomic neck of humerus. The capsule reinforced both by ligaments and by muscle tendons. The muscle tendons are particularly important in preserving the stability of the joint.

Possible movements are flexion, extension, abduction, adduction, circumduction, inward rotation and outward rotation. Another example : Hip Joint

SUMMARY CLASSIFICATION OF DIARTHROSIS JOINTS

No. of Axes	Non-Axial	Uni-Axial	Bi-Axial	Tri-Axial
	No moment	**One moment**	**Two moments**	**3 or more moments**
Classification	Gliding	Hinge & Pivot	Condyloid & Saddle	Ball and Socket

MOVEMENT AT THE ANKLE JOINT

The foot is articulated with leg at the ankle joint. Two joints in this region are of sufficient important. These are the sub tarsal and mid tarsal joints, the latter including the tranodanicular and callanioouboid articulations. These movements with in the foot occur mainly at these two joints.

- Dorsiflexion
- Planterflexion
- Eversion
- Inversion

MOVEMENT AT THE TRUNK

The trunk constitutes the vertebral column of lumbar region and thoracic region, which are slightly movable cartilaginous joints, collectively results into bigger movements as followings

- Flexion
- Extension
- Hyper Extension
- Lateral Flexion
- Lateral Extension
- Rotation
- Circumduction

MOVEMENT AT THE NECK JOINT

Neck segment comprises seven cervical vertribral. The joint are slightly movable joints but collectively executes the greater range of motion (ROM).

- Flexion
- Extension
- Hyper extension
- Lateral Flexion
- Lateral extension
- Neck rotation
- Circumduction

- Flexion
- Extension
- Hyperextension
- Radial Flexion (Abduction)
- Ulnar Flexion (Adduction)
- Reduction of Hyper Flexion
- Radial Extension
- Ulnar Extension
- Circumduction

MOVEMENT OF HIP JOINT

The hip joint is formed by the articulation of the spherical head of the femur with the acetabulum of the pelvis. It is a ball and socket joint thus permits for triaxial movement.

- Flexion
- Extension
- Hyperextension
- Abduction
- Adduction
- Outward Rotation
- Inward Rotation
- Horizontal Flexion
- Horizontal Abduction
- Circumduction

MOVEMENT OF KNEE JOINT

The knee joint is formed with the help of bones namely, femur, tibia, and patella. It a hinge type of joint, thus permits uniaxial movement of Knee. The movements which occur at the knee joint are as follows:

- Flexion.
- Extension.
- Inward rotation.
- Outward rotation.

Types of Muscle

All our movement happens as a result of the shortening (contracting) and lengthening (extending) of muscles.

The human organism has more than 600 muscle fibers present in their body. There are three different types of muscles in the human body, namely

- Skeletal muscles
- Smooth muscles
- Cardiac muscles

SKELETAL MUSCLES

Skeletal muscles (or, voluntary) are under our control. We use them for everyday and sporting activities. Examples of skeletal muscles would include those used for walking, running and jumping.

SMOOTH MUSCLES

Smooth muscles (or, involuntary) work automatically and are not under our conscious. They work our internal organs. Examples include the bowel, uterus and bladder.

CARDIAC MUSCLES

Cardiac muscles (or, involuntary) are a very special type of involuntary muscle. The fibers in the cardiac muscle contract on their own and they work all the time without tiring. The heart muscle is under constant nervous and chemical control.

Structural Classification of Muscles on the Basis of Fiber Arrangement

The arrangement of the fibers and the method of attachment vary considerably among different muscles. These structural variations form the basis for a classification of the skeletal muscles.

LONGITUDINAL

This is a long strap like muscle whose fibers lie parallel to its long axis. Two examples are the rectus abdominis on the front of the abdomen, and the sartorius, which slants across the front of the thigh.

QUADRATE OR QUADRILATERAL

Muscles of this type are four sided and usually flat. They consist of parallel fibers. Examples include the pronator quadrates on the front of the wrist and the rhomboid muscle between the spine and the scapula.

TRIANGULAR OR FAN-SHAPED

This is relatively flat type of muscle whose fibers radiate from a narrow attachment at one end to a broad attachment at the other. The pectoralis major on the front of the chest an excellent example.

FUSIFORM OR SPINDLE SHAPED

This is usually a rounded muscle that tapers at either end. It may be long or short, large or small. Good examples are the branchialis and the branchioradialis muscles of the upper extremity.

UNIPENNIFORM

In this type of muscle, a series of short, parallel, featherlike fibers extends diagonally from the side of a long tendon, giving the muscle as a whole the appearance of a wing feather. Examples include the extensor digitorum longus and tibialis posterior muscles.

BIPENNIFORM

This is a double penniform muscle. It is characterized by a long central tendon with the fibers extending diagonally in pairs from either side of the tendon. It resembles of symmetrical tail feather. Examples include the flexor hallucis longus and rectus femoris of the leg and thigh respectively.

The movements of the shoulder girdle expressed in terms of the composite movement of the scapula are as follows:

- Elevation
- Depression
- Abduction and protraction
- Upward Tilt
- Adduction and Retraction
- Upward Rotation
- Downward Rotation
- Reduction of Upward Tilt

MOVEMENT OF ELBOW JOINT

In elbow joint the two bones of the forearm attach to the humerus, the humero-ulnar joint is indeed a true hinge joint but the radioulnar joint is far from it. It is a hinge type of joint. Movement takes place at elbow joint are as follows

- Flexion
- Extension
- Pronation
- Supination

MOVEMENT OF WRIST AND HAND

The hand and wrist owe their mobility to their generous supply of joints. The most prominent of these is the radio carpal or wrist joint. The wrist joint collectively comprises of radio-carpel joints, Instracarpal joint and carpo-meta carpo joint, the hand comprises the joints namely Meta-carpo- phallengial and interphallengial joints.

UNIT- III

JOINT WISE MOVEMENT

MOVEMENT OF SHOULDER JOINT

The shoulder joint is formed by the articulation of the spherical head of the humerus with the small, shallow, pear-shaped glenoid fossa of the scapula.

This forms the glenohumeral articulation. It is ball and socket joint, a triaxial joint. The movement of the humerus, all of which takes place at the glenohumeral articulation is:

- Flexion
- Hyper Flexion
- Reduction of Hyper Flexion
- Extension
- Hyper Extension
- Reduction of Hyper Extension
- Abduction
- Hyper Abduction
- Reduction of Hyper Abduction
- Horizontal Abduction
- Horizontal Adduction
- Adduction
- Reduction of hyper adduction
- Outward rotation
- Inward rotation
- Circumduction
- Diagonal abduction
- Diagonal adduction

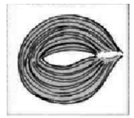
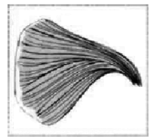
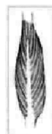
MOVEMENTS OF SHOULDER GIRDLE

The articulation between the acromion process of the scapula and the distal end of the clavical forms the acromioclavicular and the proximal end articulates with the sternum to form sterno-clavicular articulation. The movement of scapula by means of acromioclavical joint and sterno-clavicular joint known as the movement of shoulder girdle.

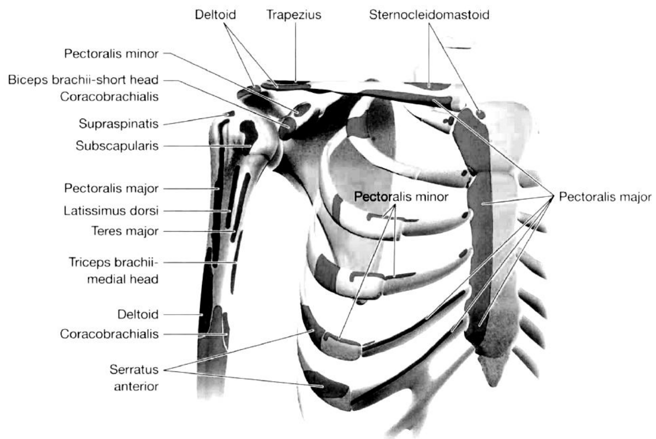
MULTIPENNIFORM

In this type of muscle there are several tendons present, with the muscle fibers running diagonally between them. The middle portion of the deltoid muscle of the shoulder and upper arm is a prime example of a multipenniform muscle.

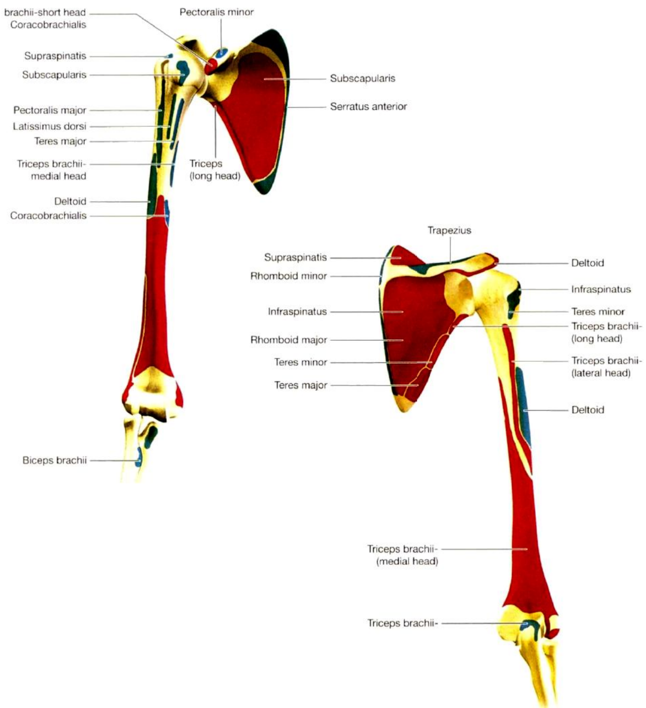
Types of Muscles

	Appearance	Purpose	Examples
Parallel Arrangements		Shorten equally and in the same direction to maximize range of motion.	
Fusiform		Focus force production into specific bony landmarks.	Brachialis Biceps brachii
Circular		Contract and close passages or relax and open them.	Orbicularis oris Sphincter ani
Triangular		Diversification of actions, creating multiple movement possibilities.	Pectoralis major Trapezius
Pennate Arrangements		Maximize the number of fibers in an area for greater force production.	
Unipennate		Slicing force production from one direction.	Tibialis posterior Biceps femoris
Bipennate		Strong force production from two directions.	Rectus femoris
Multipennate		Weaker force production from many directions.	Deltoid

Multi Joint Muscles



Axial muscle attachments: anterior view. The ribcage forms a stable attachment for several muscles of the shoulder. Large, prime mover muscles such as the pectoralis major have broad origins on the ribcage and smaller insertionson the humerus.



Special rotation occurs at the forearm and feet. **Pronation** is the rotation of the forearm to the palms- down position (as in a basketball dribble or on the seated chest press machine). **Supination** is the rotation of the forearm segment to the palms-up position (as in doing a standard curl on the arm curl machine). **Eversion** (also called pronation of the foot) is the outward tilting of the sole of the foot, while **inversion** (also called supination of the foot.

Circumduction is the sequential combination of movements outlining a geometric cone. Examples include circles of the trunk, shoulder, hip, ankle and thumb.

Abduction is the movement of a body segment away from the mid line. Example; spreading of the fingers or toes and the legs moving apart.

Adduction is the movement of a body segment toward a midline, or the return from abduction. Example; the legs moving together.

Rotation is the circular movement of a body segment about a long axis. Inward rotation occurs when a body segment moves towards the midline (the upper arm when throwing a screw ball), while outward rotation occur when a body segment moves away from the midline (the upper arm in a back hand tennis stroke). The right and left rotation defines the directional rotation of the head or trunk.

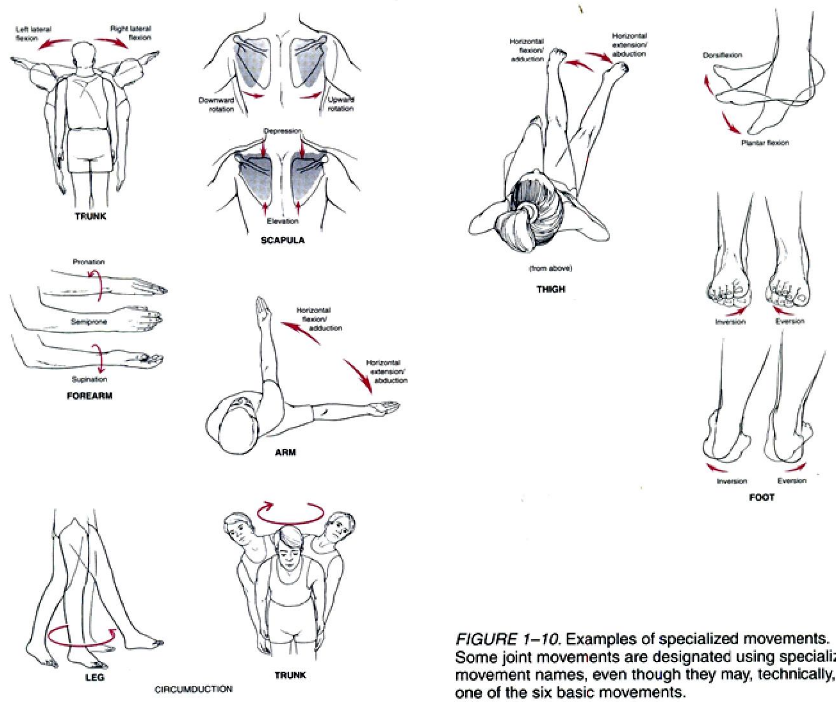
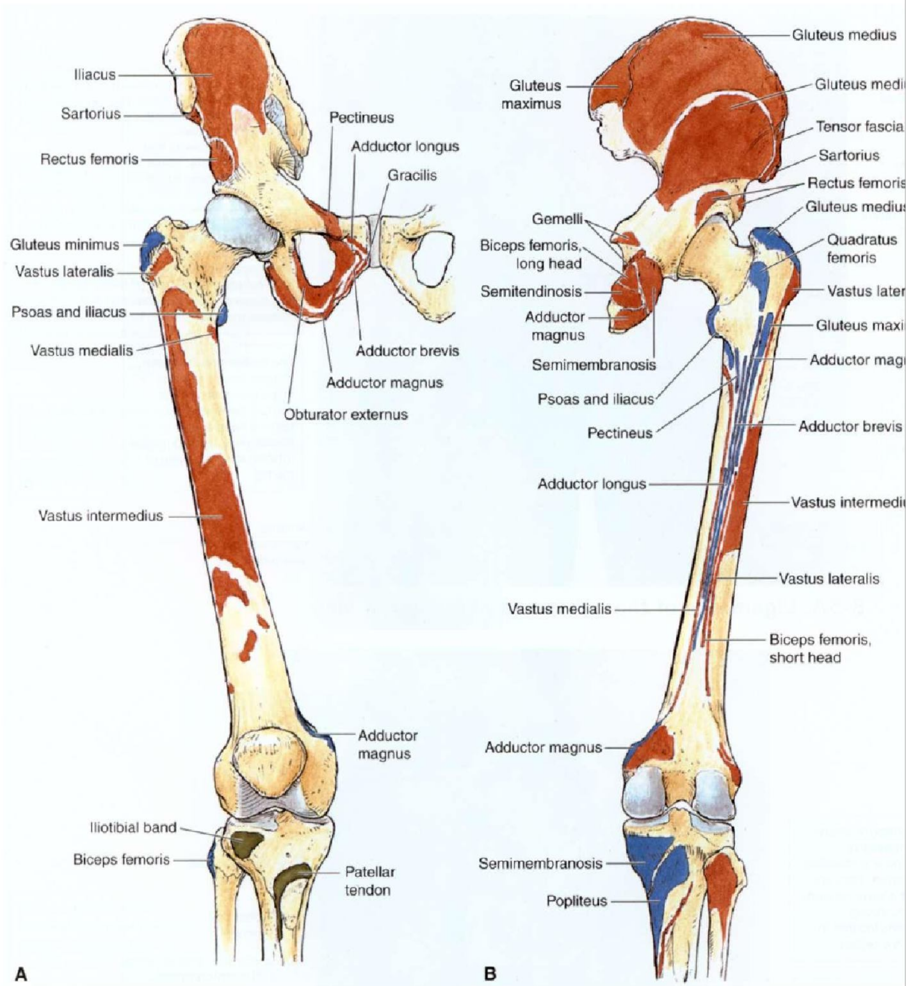
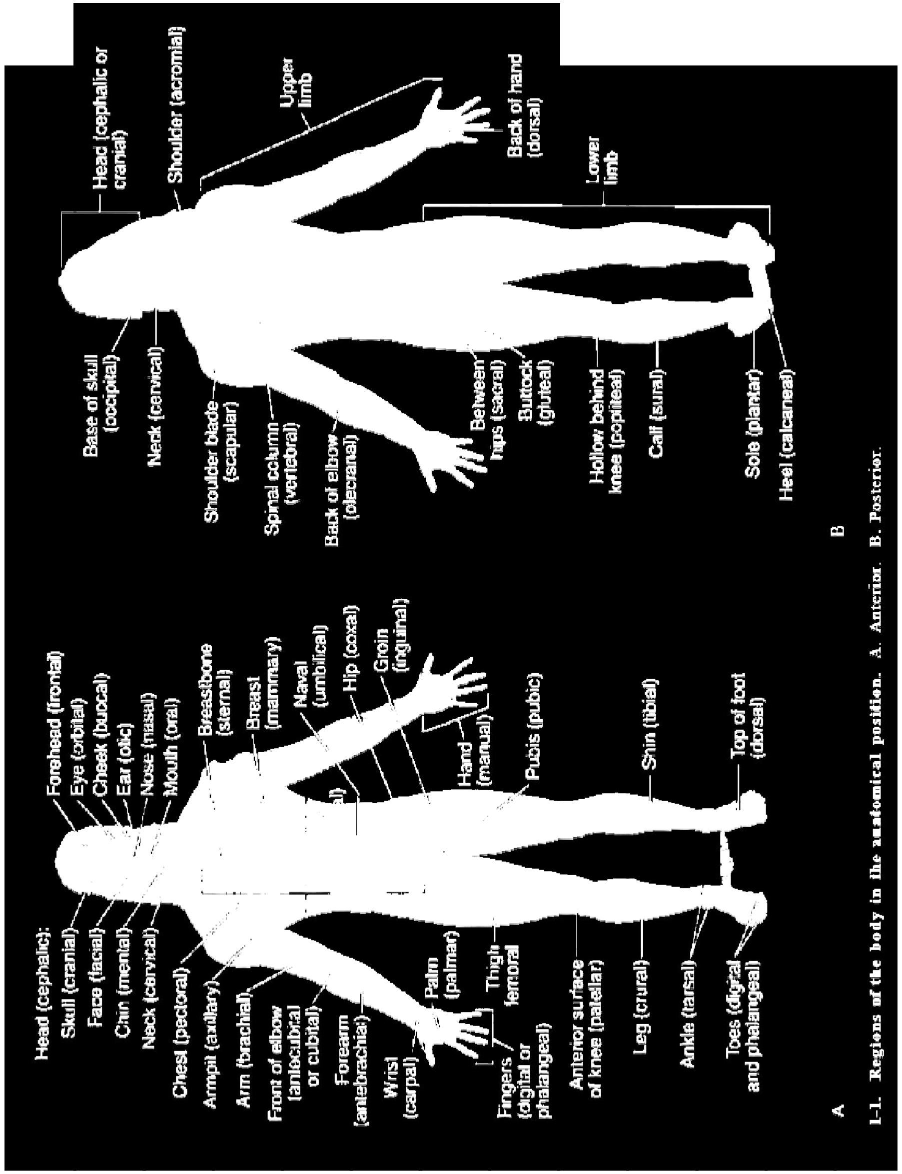


FIGURE 1–10. Examples of specialized movements. Some joint movements are designated using speciali: movement names, even though they may, technically, one of the six basic movements.

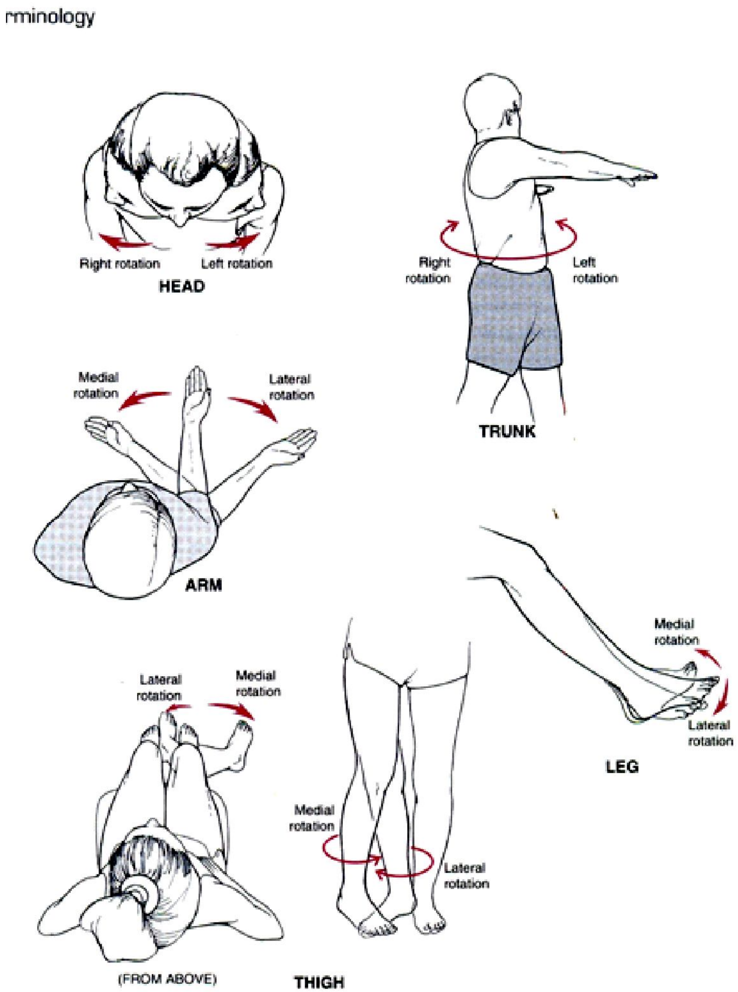
MUSCLE ATTACHMENT SITES

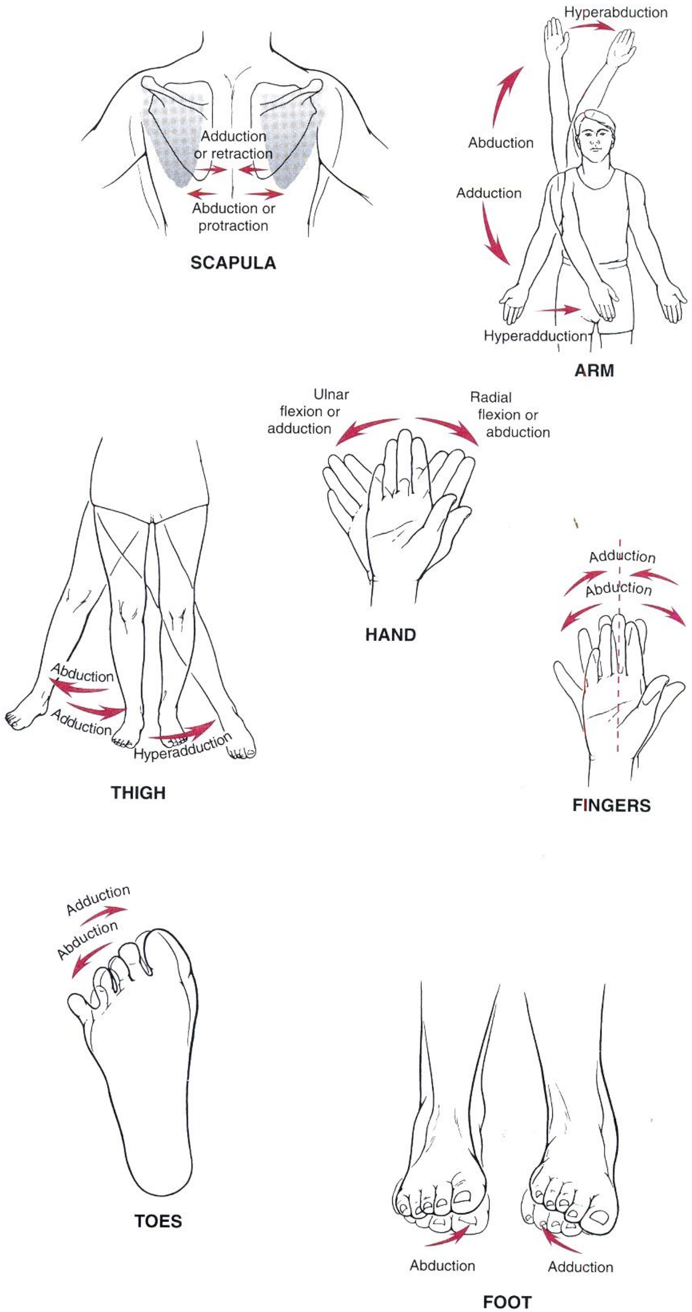


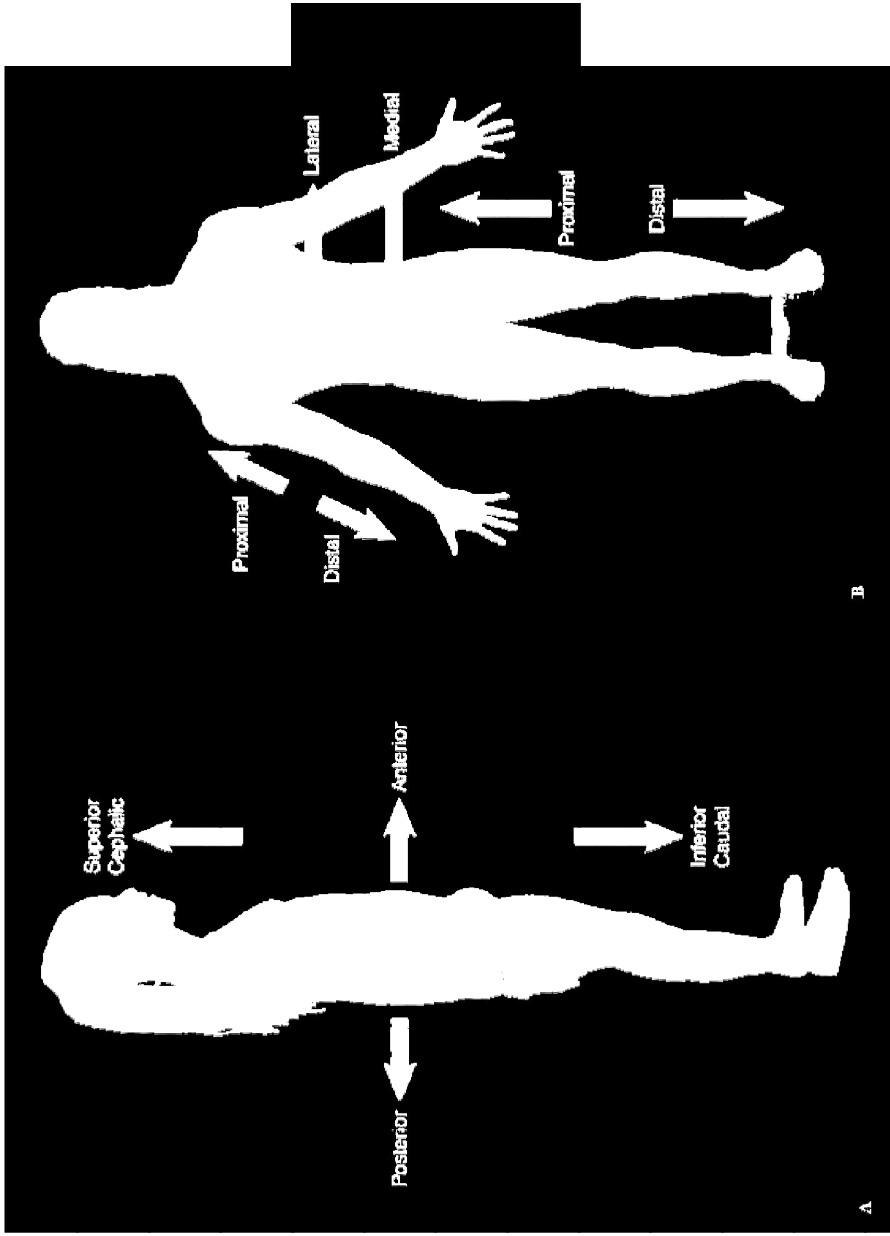
8-4 Muscle attachments of the pelvis, thigh, and knee. A. Anterior view. **B.** Posterior view



Extension is an increase in the angle between two body segment, or the return from flexion. For example, extension occurs at the knee on the leg extension machine. **Hyperextension** is the increase in the angle beyond the anatomical point of normal joint movement. Hyper extension occurs during the back swing in bowling (shoulder joint), in a neck bridge in wrestling (neck), and on the standing hip machine when the hip is lifted behind the body (hip joint).







1-2. Directional terms. A. lateral view. B. Anterior view.

Planes of Movement

Now that anatomical position and appropriate directional terminology have been established, we're ready to explore the language of human movement. The human body moves in complex ways, which can make description difficult. Scientists have categorized and simplified the terminology of human movement in an effort to heighten understanding and communication. This strategy encourages consistent description and analysis of complex human movements by breaking them down into simpler parts.

Motions occur at the joints of the body in one of three general directions: front to back, side to side, or rotationally. To describe these movements precisely, it helps to visualize the body transected by one of three large imaginary planes.

The first plane, which divides the body vertically into right and left halves, is called the **sagittal plane (**FIG. I-3A). Front-to-back movements occur parallel to this imaginary plane. Swinging your arms and legs back and forth with walking are examples of sagittal movements.

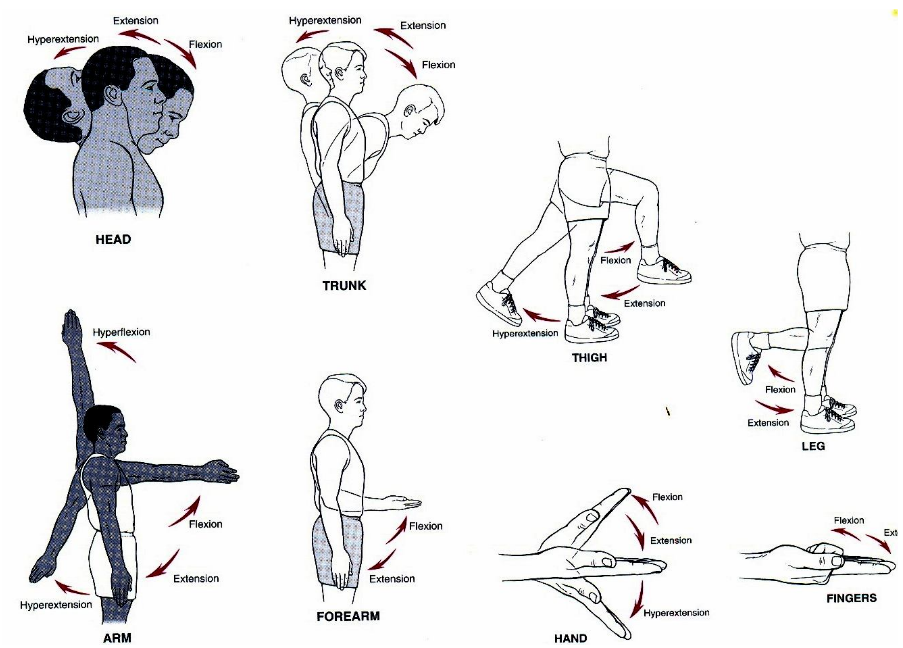
The second plane divides the body into front and back halves. It is called the **frontal plane (**FIG. 1-3B). Side-to-side movements occur parallel to this imaginary plane. The arm and leg movements that occur when you do jumping jacks are examples of frontal movements.

The third plane divides the body into superior and inferior regions. It is called the **transverse plane** (FIG. 1-3C). Rotational or turning movements occur parallel to this imaginary plane. Turning your leg out or your head to look over your shoulder are examples of transverse movements. The word *transverse* means "across," so a transverse view of the body is sometimes referred to as a *cross-section.*

Fundamental movements of major body segments

Several movements are possible in many joints. Six primary movements occur at the joints between the body segments: flexion, extension, abduction, adduction, rotation and circumduction.

Flexion is a decrease in the angle between two body segments. Flexion occurs at the shoulder, elbow, hip and knee joints. Special flexions occur at the trunk (lateral flexion or bending sideways); the wrist (ulnar flexion or bending toward the pinky side of the hand, and radial flexion or bending toward the thumb side); and the ankle (**dorsiflexion** or toes up, and **planter flexion**, or toes down).



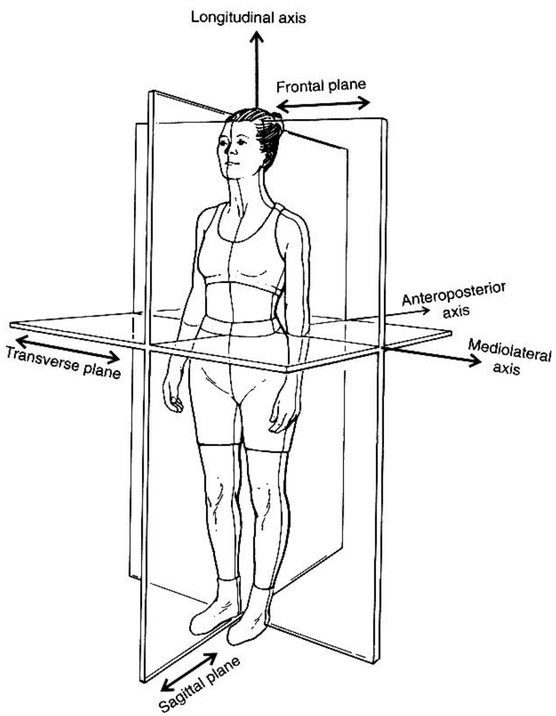
Planes of motion

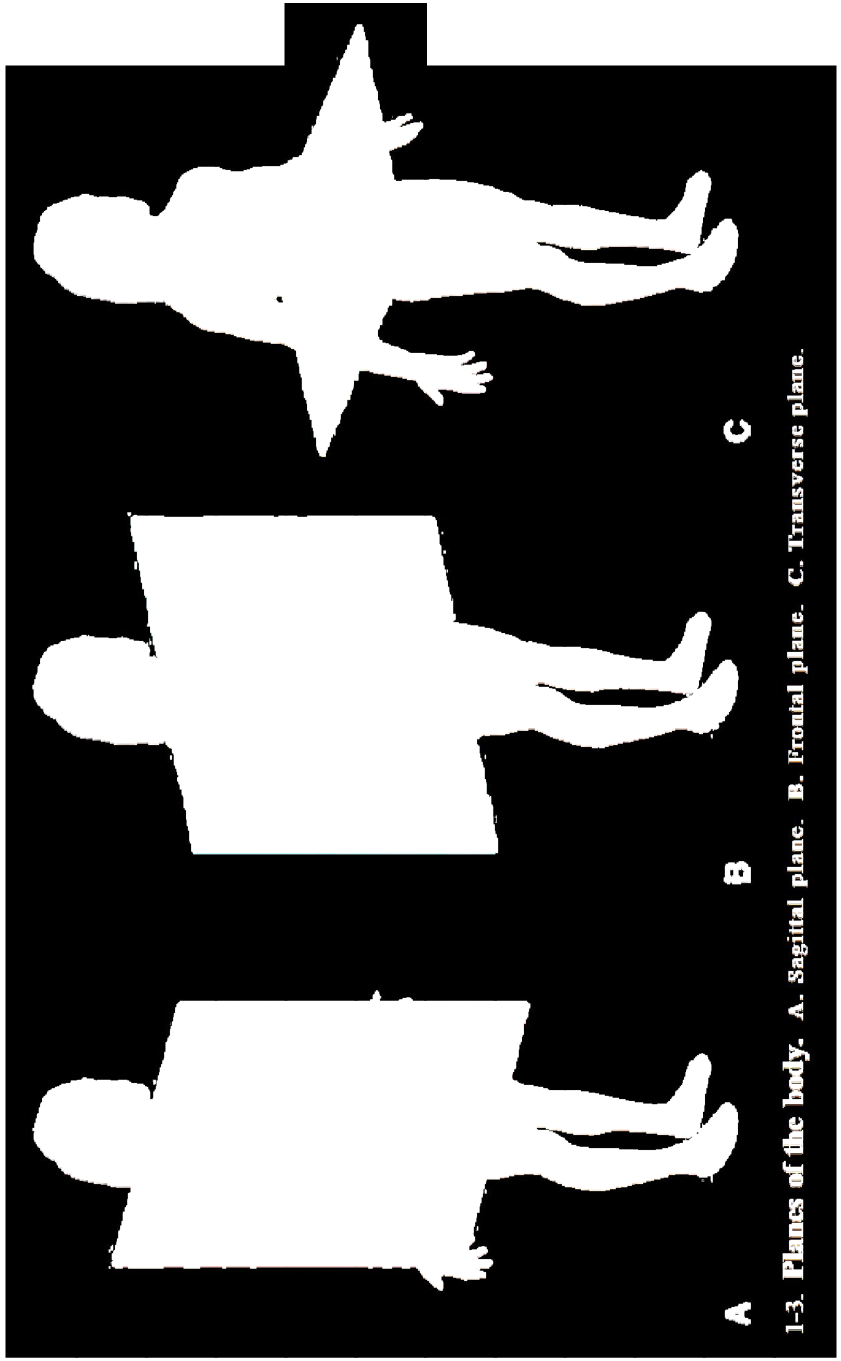
Human movements are commonly described in terms of the planes that they occupy. A plane is a flat surface. There are three imaginary planes that pass through the human body. Each plane is perpendicular to each of the other two.

The **sagittal plane** is a vertical plane passing through the body from front to back, dividing the body into left and right portions.

The **frontal plane** is a vertical plane passing through the body from left to right, dividing it into front and back portions.

The **transverse plane** passes through the body in a line parallel to the ground, dividing the body into upper and lower portions.





1-3. Planes of the body. A. Sagittal plane. B. Frontal plane. C. Transverse plane.

Axes

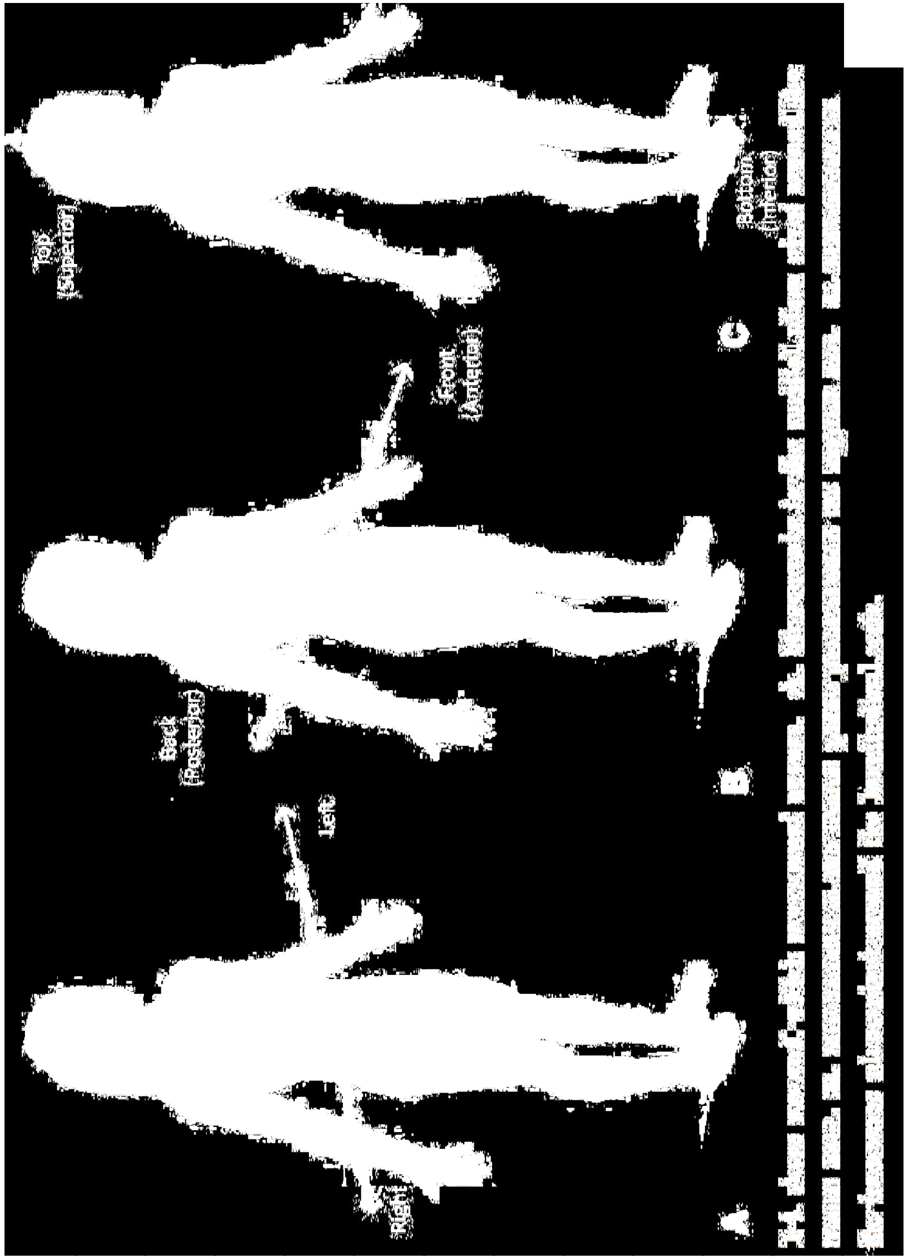
Each of the three types of movement, sagittal (front-toback), frontal (side-to-side), and transverse (rotational) must occur around an **axis** (a pivot point). Visualize a wheel turning on its axle. The axle is the axis that the wheel turns around. Each of the three planes of movements has a corresponding axis around which movement occurs. This axis is always perpendicular (at a right angle) to the corresponding plane.

Understanding these imaginary axes, along with their counterpart planes, helps us communicate precisely about movement. For example:

• The front-to-back movements that occur on the sagittal plane pivot around the **frontal axis** (FIG. A). This means that movements such as swinging your arms while walking (front to back) occur in the sagittal plane and pivot around an imaginary line that goes through the shoulder from right to left. This is also true when you bend forward at the waist. The body is moving in the sagittal plane (front to back) around a frontal axis (transecting at a right angle side to side) that goes through the pelvis.

• The side-to-side movements that occur in the frontal plane pivot around the **sagittal axis** (FIG. B). This means that the leg and arm movements during jumping jacks occur in the frontal plane and pivot around imaginary lines that go through the hips and shoulders from front to back. This is also true when you tip your head to the side. This movement occurs on the frontal plane (side to side) around a sagittal axis (transecting at a right angle front to back) that goes through the cervical vertebrae of the neck.

• Finally, the rotational movements that occur on the transverse plane pivot around the **longitudinal axis** (FIG.C). For example, the movement of turning your head to look over your shoulder occurs in the transverse plane and pivots around an imaginary line that runs superiorly- inferiorly through the spine. Similarly, when you turn your shoulder to throw a Frisbee, your arm turns on the transverse plane (rotation) around a longitudinal axis through the shoulder (transecting at a right angle up and down).



UNIT- I
INTRODUCTION OF KINESIOLOGY

A basic understanding of kinesiology plays an important role in establishing fitness- training programs for beginners.

Kinesiology is the study of human motion and deals mainly with the muscles and muscle functions. It describes movement, which muscles are involved in the movement, and how they are involved. It explores the muscular involvement in strength exercises and sports technique.

Kinesiology from the greek words

‘**kinein**’- to Move,

‘**Logos’**- to Study

Is the scientific study of movements

DEFINITIONS

“Kinesiology is the study of human movements”

“The branch of physiology that studies the mechanics and anatomy in relation to human movements”

AIM AND OBJECTIVES OF KINESIOLOGY

The primary aims of kinesiology are

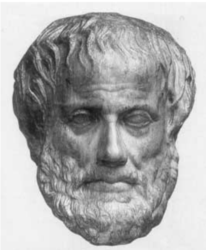
- Under standing the human body’s physiology and phychological responses to acute short-term physical activity.
- Understanding the various adaptations of the human body to chronic (or) long-term physical activity.
- Understanding the cultural, social and historical importance (or) physical activity.
- Understanding the mechanical qualities of movement.
- Understanding the processes that control movement and the factors that affect the acquisition of motor skills, and
- Understanding the psychological effects of physical activity on human behavior.

To achieve these aims, research in kinesiology requires the use of a variety of scientific knowledge and research techniques from such field as biology, chemistry, history, physics, psychology, and sociology. The areas of investigation within kinesiology are quite extensive because the responses of the human body to physical activity can be examined at many levels.

A knowledge base in kinesiology provides professional preparation for careers in fitness related industries, athletic training, teaching and coaching, and health related fields such as physical therapy.

History of Kinesiology

ARISTOTLE (384-322 B.C)



Aristotle is the "Father of Kinesiology"; His treatises, PARTS OF ANIMALS, MOVEMENT OF ANIMALS and PROGRESSION OF ANIMALS, described the actions of the muscles and subjected them to geometric analysis for the first time. He first to analyzed and described walking, in which rotatory motion is transformed into translatory motion.

Archimedes (287-212 B.C)

Archimedes another Greek, determined hydrostatic principles governing floating bodies that are still accepted as swimming. In addition, he suggests that his inquiries included the laws of leverage and determining the center of gravity and the foundation of the oretical mechanics.

Galen (131-201 A.D)

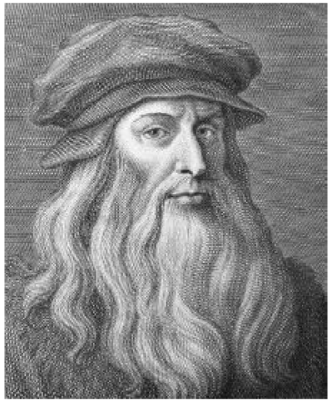
Galen a Roman citizen who tended the Pergamum's gladiators in Asia Minor and is considered to have been the first team physician in history. He used number to describe muscles. His essay DE MOTU MUSCULORUM distinguished between motor and sensory nerves, against and antagonist muscles,

When attempting to pull an object, the same general directions apply, but with this exception. As in the case of pulling the low trunk by a rope, it may be advantageous to pull in a slightly upward direction because the lifting effect would help to reduce friction. Nevertheless, unless one wishes to rotate the object, the pull should be applied in line with the object's line of gravity.

When applying a pull or push to an object that must move on a track, such as a window or a sliding garage door or a weight machine, it is essential to apply the force in the direction that the track or runway permits. Force in any other direction is wasted and friction is increased. Trying to open a heavy window or one the sticks can be done by standing with the right side next to it, the arm close to the frame, and then pushing vertically upward. If more force is needed, the knees and hips should be flexed then supplements the force exerted by the arm with little increase in the length of the resistance arm. If this action is inadequate, both hands can be used by twisting the trunk to face the window. In pulling the window down, one should face it, stand as close as possible, and use both hands, being careful to apply the force vertically downward.

described tonus, and introduced terms such as diarthrosis and synarthrosis. Some of writers consider his treatise the first text book of kinesiology and he has been termed "the father of sports medicine".

Leonardo da Vinci (1452-1519)

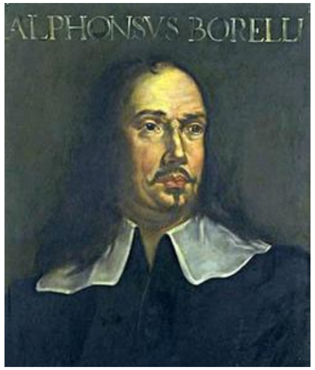


Kinesiology and anatomy lay untouched from the mystical studies of Galen until the 15th century when Leonardo da Vinci (1452-1519) advanced them another step. This artist, engineer, and scientist, da Vinci was particularly interested in the structure of the human body as it relates to performance, center of gravity and the balance and center of resistance. He used letter to identify muscles and nerves in the human body that he retrieved from grave yards in the middle of the night. He described the mechanics of the body during standing, walking up and downhill, rising from a sitting position, jumping and human gait. To demonstrate the progressive action and interaction of various muscles during movement, he suggested that cords be attached to a skeleton at the points of origin and insertion of the muscles.

Galileo

Galileo, the father of parabolic mathematics, also proved that the flight (trajectory) of a projectile through a non-resistant medium is a parabola. His work gave impetus to the study of mechanical events in mathematical terms, which in turn provide a basis for the emergence of kinesiology as a science.

1600's Giovanni Alfonso Borelli



Born in 1608, he is considered to be the Father of Biomechanics for his contributions to the field. The American Society of Biomechanics annually awards the scientist contributing the greatest achievement within the field with it's highest award, the Borelli Award. Borelli's knowledge of mechanics relative to human movement was restricted to the principles of levers and, as such, it appears to generate his accurate account of spinal muscle action. He worked in collaboration with Marcello Malpighi. Malpighi was a professor of theoretical medicine at the University of Pisa. Malpighi recalled "What progress I made in philosophizing stems from Borelli. Borelli states this about Malpighi "I worked hard dissection living animals at his home and observing their parts to satisfy his keen curiosity".

Borelli applied these principles of Equilibrium of Rotation and Equilibrium of Translation to spinal biomechanical analysis. In his work De Motu Animalium, Borelli illustrates the first comprehensive accounts of force of effort provided by posterior spinal musculature in stabilizing a force of resistance. "If the spine of a stevedore is bent and supports a load of 120 pounds carried on the neck, the force exerted by Nature in the intervertebral disks and in the extensor muscles of the spine is equal to 413 pounds. At the fifth lumbar the muscular forces are equal to 413 pounds and the forces exerted by the disc are equal to 1239 pounds."

One of the greatest mechanical features noted of the body, as was shown by his analysis, was that the muscles act with short lever arms so the joint transmits a force that is a magnitude greater than the weight of the load. Borelli overturned older concepts of muscle action, which was that long lever arms allowed weak muscles to move heavy objects.

The magnitude of the force used in pushing, pulling, and lifting can be increased in two ways. The immediate way is by using the lower extremities and, in some instances, the body weight to supplement the force provided by the upper extremities. In many, if not most, pushing and pulling activities the direction and point of application of force are interrelated. They both have an important bearing on the effectiveness of the force exerted, and also on the force is applied in line with the object's center of gravity and in the desired direction of motion. When this application of force is not feasible, the undesirable component of force should be as small as possible. For instance, if one desires to push a low trunk across the floor, it would be difficult to stoop low enough to push with the arms or even the forearms in a horizontal position. One should stoop as low as conveniently possible, however, to reduce the downward component of force that would tend to increase friction. If it were necessary to move the trunk down a long corridor, it would be more efficient to tie a rope to the handle at one end and pull it. By using a long rope, the horizontal component of force would be relatively small. Some lifting component would be desirable, hoe ever, as it would serve to reduce friction.

When friction is a major obstacle, as when pushing a tall object such as filing cabinet across a capered floor, the horizontal push should be applied close to the cabinet's center of gravity at a point found by experimentation. When this point is found, it will be possible to push the cabinet without tipping it. When it does not seem practical to slide a heavy object along the floor, one may try "walking" it on opposite corners. This involves tipping the object until it is resting on one edge of its base and then, by a series of partial rotations, alternately pivoting it first one corner and then other. The arms alternate in a lever action, one hand holding the upper corner that corresponds to the lower one that is serving as the pivot, and the other hand pushing the diagonally opposite upper corner forward.

a common denominator: Each involves moving an external object, either directly by some part of the body or by means of an implement, in a pushing or pulling pattern.

Joint Action Patterns

In pushing and pulling of motion, the basic joint actions are flexion and extension in one or more of the extremities. In the lower extremities, extension occurs simultaneously in the hip, knee, and ankle. This simultaneously and opposite joint action is a primary characteristic of push – pull patterns. All joint motions occur at the same time or very near the same time.

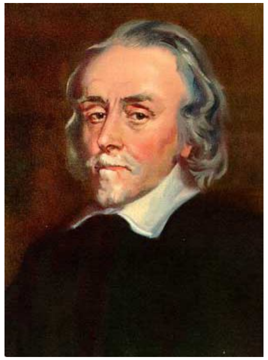
A push, pull, or lift may be applied either directly or indirectly to an object. In the latter instance, the push or pull pattern is used to develop potential energy in an elastic device such as a bow or slingshot. When the elastic structure is released, it imparts force to the movable object, causing the arrow or shot to be projected into the air.

Application

The great majority of pushing, pulling, and lifting activities undoubtedly occur in every day task. A number of sports, however, involve the continuous pushing or pulling of external objects. Archery is an interesting example, since it consists of pulling with one hand while pushing with the other. The same is true of using a forked stick slingshot. Pushing is also used in football, and both pushing and pulling are used in wrestling. Weight lifting is the prime example of a sport activity involving lifting.

Rowing and paddling, although classified as forms of aquatic locomotion, may also be considered activities that involve external objects. Oars and paddles are both moved by continual pushing and pulling movements. Pole vaulting, rope climbing (previously classified as locomotion), and all suspension activities might also be included in the pushing and pulling category, provided one accepts activities that involve the moving of the body by means of pushing or pulling an external object, the object in such cases also servings as the means of body support.

William Harvey (1578-1657)



The circulation of the blood through the body was first demonstrated by William Harvey (1578-1657), although he erroneously attibuted to the heart the foundation of recharging the blood with heat and "vital spirit".

Nicloas Andry (1658-1742)

The word "orthopedics" was coined by Nicolas Andry (1658-1742) from the Greek

roots "orthos", meaning "straight" and "pais", meaning "child". Andry believed that skeletal deformities result from muscular imbalances during childhood. In this treatise, ORTHOPEDICS or the ART OF PREVENTING AND CORRECTING IN INFANTS DEFORMITIES OF THE BODY, originally published in 1741, he defined the term "orthopedist" as a physician who prescribes corrective exercise. (Andry, 1961). Although this is not the modern usage, Andy is recognized as the creator of both the word and the science. His theories were directly antecedent to the development of the Swedish system of gymnastics by Per Henrik Ling (1776-1839).

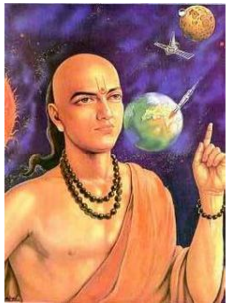
Sir Issac Newton (1642-1727)

In PRINCIPIA MATHEMATICA PHILOSOPHAE NATURALIS, which is "perhaps the most powerful and original piece of scientific reasoning ever published", he laid the foundation of modern dynamics. Particularly important to the future of kinesiology was his formulation of the three laws of rest and movement, which express the relationships between forces (interaction) and their effects:

James Keill (1674-1719)

In his studies of muscular contraction, James Keill (1674-1719) calculated the number of fibers in certain muscles, assumed that on contraction each fiber became spherical and thus shortened and from this deduced the amount of tension developed by each fiber to lift a given weight.

1114 A.D. Bhaskaracharya Second



In his work, Siddhanta Shiromani, Second describes the concepts in trigonometry of sine and cosine. These concepts are essential to mathematically determining forces used and created in lever systems. This knowledge will not make its way into western culture until Britain colonizes India and British mathematicians discover it.

<u>Role of Kinesiology in Physical Education and Sports</u>

1. To provide the future physical education teacher / coaches with the knowledge necessary for analyzing human motion.
2. And appling such analysis to the learning and improvement of motor skills.
3. With applied anatomic background the knowledge of kinesiology helps to prevent injuries.
4. Economy of the movement can be ensured.
5. Effectiveness of the movement can be ensured.
6. For clinical / rehabilitation purpose kinesiology has great importance.
7. Designing and teaching of exercise / conditioning / fundamental movements the knowledge of kinesiology is must.

One general phasing, scheme describes three throwing phases: action, and recovery. The primary functions of the preparation phase are to 1, put the body in a favorable position for execution of the throw, 2, maximize the range of movement, 3, allow for larger body segments to initiate the throw, 4, place the muscle at an advantageous length on their respective length – shorten cycle, 5, place the muscles at an advantageous length on their respective length – tension curves, and 6, store elstic energy to be used during the action phase.

During the action phase, skillful throwers use sequential muscle actions to execute the throw, beginning with muscles of larger segments. In most throws, there is proximal – to – distal muscle action and transfer of momentum and kinetic energy. The exact pattern of muscle action and mechanical transfer depends on the goal of the throw.

The primary purpose of the recovery phase is to slow down, the body and its limb segments through eccentric muscle action. This places the body in a favorable balanced position and reduces the chance of injury.

These general phases often are modified, or subdivided, in describing the throwing motion of a particular sport or type of throw. In basketball, for example, the pitching motion typically is divided in to five phases: windup, cocking, acceleration, deceleration, and follow- through. A six phase, stride, is sometimes included between windup and cocking. In context of the general scheme just presented, windup and cocking would constitute preparation, acceleration would correspond with action, and deceleration and follow – through would combine for recovery.

PUSHING AND PULLING

A person pushes a table across the room, a boxer jabs at an an opponent, a traveler lifts a suitcase onto an overhead rack, an archer shoots an from a bow, and a school teacher lifts open a window. As widely divers as these activities seem, they all have

Throws are categorized according to upper – extremity limb segments motion and the method of imparting force to the projectile. Classification include over arm throws, under arm throws, push throws, and pull throws. Over arm throwing is used, for example, by baseball pitchers and javelin throwers. Softball pitchers employ an underarm throwing motion to deliver the ball to the plate. Shot – putters use a push throw to project the shot, while discus and hammer throwers employ a pull throw to project their respective implements.

Throwing principles

Throwing depends on a number of principles, including the transfer of momentum in a proximal – to – distal manner an object held in the hand. As a result the object is thrust, or propelled, in to the air. The proper sequencing of limb segments motion presents the neuromuscular system with a challenging muscular control problem. In executing a throw, the body makes good use of the stretch – shorten cycle to enhance force production and throwing distance.

Throwing and projectile motion

Projectile move through the air under the influence of only gravity and air resistance along a path called the trajectory. The trajectory is determined by three factors: release height (above the ground), release speed (how fast the object is thrown), and release angle (relative to the horizontal). All the thrower's actions releases are intended to produce the proper combination of height, speed, and angle and thereby achieve the throwing goal.

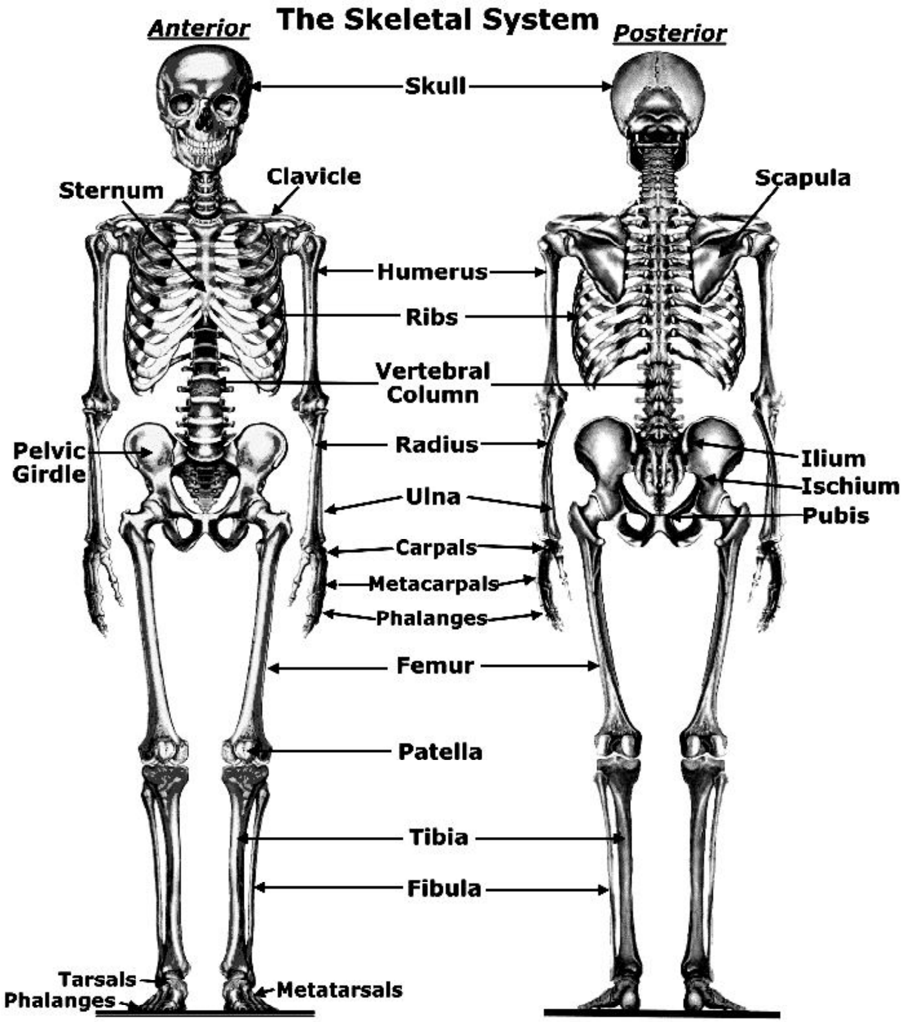
Throwing Phases

The throwing pattern often is divided in to phases to facilitate analysis. Each phase has defined beginning and end points, as well as specific biomechanical functions that contribute to the success of throw.

8. Self- realization about own performance is best realized by the athlete themselves with the background of kinesiology.
9. To discover and recognize the underlying principles of movement.
10. It is an educational experience for physical education and physical medicine.
11. Effective teaching of motor skills with the knowledge of kinesiology are best achieved in regard to
    a. fundamental motor skills and
    b. specialized motor skills.
12. Evaluation of exercise and activity from the point of view of their effect on the human structure.
13. For physiotherapy, physical medicine purposes.
14. For postural analysis, and correctives physical education.

UNIT- II
Function of Skeletal System

The average human adult skeleton has 206 bones joined to ligaments and tendons to form a supportive and protective framework for underlying soft tissues and muscles.



until landing. Following flight, first ground contact begins the landing phase, during which the hips and knees flex, with ankle dorsiflexion and extension of the arms, as the body absorbs the forces of landing.

The proper timing of joint motions is critical for a successful and proficient jump. During the propulsive phase, for example there is a rapid proximal – to – distal sequencing of maximum angular velocity at the hip, knee, and ankle joints, with very small delays between adjacent segments. This sequencing is necessary for the effective transfer of energy, from one segment to the next, required for optimal jumping performance. Alterations in this sequencing, such as when a jumper is fatigued, can alter the mechanics of the jump and result in a lower jump height.

THROWING

Throwing is as old as humankind. In prehistoric times, hunters threw rocks and spears at animals in hopes of securing food survival. Through the millennia, throwing has been an essential combat skill, early on using rocks and primitive weapons and more recently employing destructive implements such as hand grenades. Many contemporary sports include throwing as an essential skill. These include softball and baseball, American football, basketball, and several events in athletics (i.e., track and field) such as the shot put, discus, and javelin. In noncompetitive situations, throwing sometimes provides nothing more than a pleasant diversion, as when a thrower tries to skip rocks across the still surface of a mountain lake.

Despite the wide range of venues and goals, all throws are similar in that they involve using the upper extremity to launch a handheld object (projectile) through the air. The study of projectile motion is called ballistics, and throwing is one of several ballistics skills in which force is imparted to an object to project it through the air. Other ballistics skills include kicking and striking.

Even though these are descriptive and specific, they still do not include all forms of jumping. In athletic competition, for example, high jumpers leave the ground from one foot and land in the pit on their backs. They clearly jump, but their actions do not fit in to any of the standard definitions.

<u>Types of Jumping</u>

Jumping comes in many forms. Children at play jump out of sheer joy. Athletics jump to grab a rebound in basketball or catch a pass in American football. Ballet dancers jump when performing a grand jet. Physical education students do jumping jacks. Boxers jump rope. The list goes on and on.

Jumping is also used to test lower – extremity power output (e.g., Vertical jump test) and provides performance challenges to see how high (e.g., high jump) and far (e.g., long jump, triple jump) one can jump. Each jump types has a specific goal and therefore requires a unique set of movements and pattern of muscle involvement.

With so many different types of jumps, it is infeasible to analyse here the joint motions and muscle control of all of them. Thus, we describe a basic standing vertical jump with a two – foot take off landing. The fundamental patterns described here are modified for other jump types, but many of the basic concepts, such as preparatory leg and arm action (i.e., Counter movements), apply to most jump types.

A standing vertical jump can be divided into four phases: Preparatory, Propulsive, flight, and Landing. The jump begins from a normal standing position. During the preparatory (down) phase, the hip and knee joints flex, the ankles dorsiflex, and the arms swing back into hyperextension. In the propulsive (up) phase, the hips and knees extend, the ankles planter flex, and the arms swing forward in flexion. The flight phase begins at take off when the toes leave the ground. Throughout the flight phase, the body assumes a relatively upright posture that is maintained

The skeleton system serves several important functions in the body.

- Bones serve as levers that transmit muscular forces.
- Our skeletal system protects our organs.
- Our skeleton system serves as a framework for other tissues and organs.
- Bones serves as banks for storage and release of minerals like calcium and phosphorous.

Axial skeleton

The skeleton consist of the axial and appendicular skeleton. There are 80 bones in the **axial skeleton,** consisting of the skull, spine, ribs and sternum.

Appendicular skeleton:

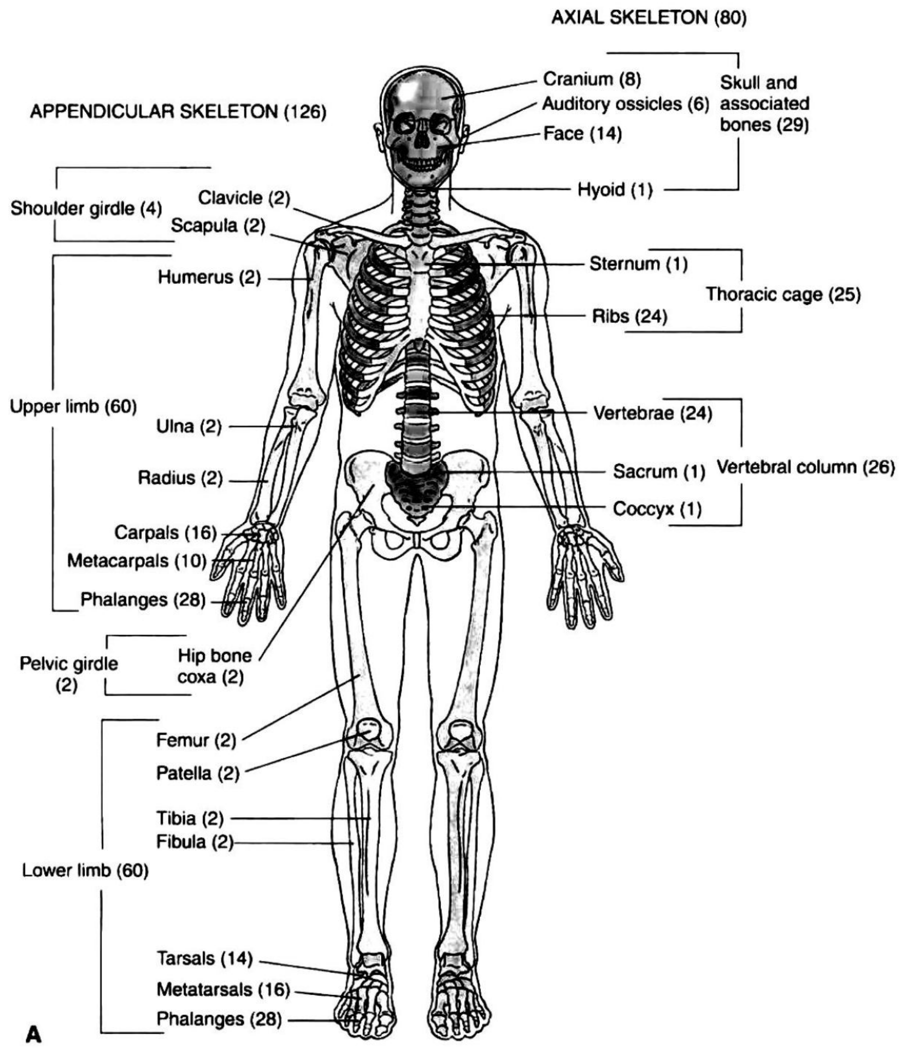
There are 126 bones in the **appendicular skeleton:** 60 in the upper extremities, 60 in the lower extremities, 2 in the pelvic girdle, and 4 in the shoulder girdle.

<u>Bones of the Body</u>

We have about 206 bones, but when we were born we had around 350. This is because many smaller bones join together as we grow.

Bone consists of three layers.

- Bone marrow
- Compact bone
- The periosteum



The human skeleton. (Anterior View) There are 206 bones in the typical human skeleton, 80 in the *axial* skeleton and 126 in the *appendicular* skeleton

The kinematics of the walking gait is often described in terms of strides and steps. A stride is one full lower extremity cycle. In walking and running, a stride is defined as being from heel strike on one leg to the next heel strike with the same leg. Stride length, then is the distance covered during a single stride.

ANATOMICAL ANALYSIS

The six major components of walking have been defined as 1) pelvic rotation, 2) pelvic tilt, 3) knee flexion 4) hip flexion 5) knee and ankle interaction, and 6) lateral pelvic displacement. Each of these components is essential for efficient walking and the loss of any one will cause an increase in the energy cost.

The action taking place in the joints of the lower extremity consists essentially of flexion and extension, But in much the same way that the shoulder girdle comperates with the arm movements of the upper extremity, the pelvic girdle cooperates in movements of the lower extremities.

The adaptations of the pelvic position are made in the joints of the thoracic and lumbar spine as well as in the hip joints. Thus, as first one foot and then the other are put forward, the flexion and extension movements of the thigh are accompanied by slight rotary movements and ab- and adduction at the hips, and by slight lateral flexion and rotation of the spine.

JUMPING

Jumping means “to spring free from the ground or other base by the muscular action of feet and legs”. This provides a general description of the jumping action but does not distinguish between different ways of launching and landing. To make this distinction, jumping applies to when individuals propel themselves from the ground with one or both feet and then land on both feet. Hopping involves propelling from one foot and landing on the same foot. Leaping describes the movement when individuals propel from one foot and land on the other foot.

4. In an efficient run, the foot should strike the ground as close as possible to the line of gravity. If the foot should strike ahead of the line of gravity, the reaction force to this forwards and downward thrust will be a backward and upward force, acting to retard forward motion.

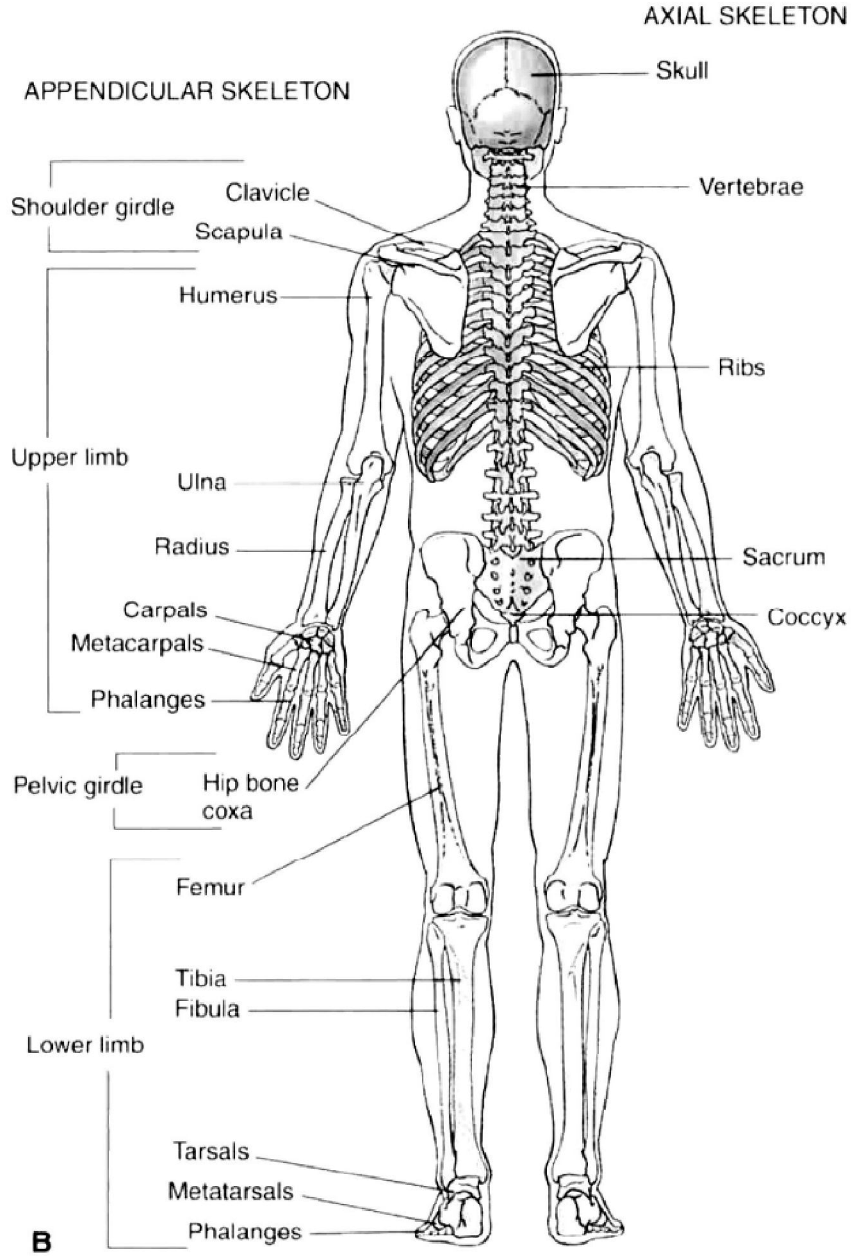
5. The knees should be lifted directly upward and forward, with the motion of the entire lower extremity occurring within the sagittal plane. The arm swing should exactly counterbalance the twist of the pelvis and should not cause additional lateral motion.

6. Resistance force due to the moment, of inertia of the free leg during the swing phase can be minimized. By flexing the free leg at the knee and carrying the heel high up under the hip, the leg is moved more rapidly as well as more economically. His high knee lift increases as speed increases.

7. The force of air resistance can be altered by shifting the center of gravity. A for ward lean will work to counteract a head wind. A tail wind often enhances performance.

WALKING

Walking is accomplished by the alternation action of the two lower extremities It is an example of translatory motion of the body as a whole brought about by rotary motion of some of its parts, It is also an example of a periodic or pedulumlike movement in which the moving segment (in this case the lower extremity) may be said to start at zero, pass through its arc of motion, and fall to zero again at the end of each stroke. In walking, each lower extremity undergoes two phases; the swing or recovery phase and the support phase. The support phase is further divided into heel-strike the heel-strike and foot-flat phase of the other leg, thus producing a period of double support when both feet are on the ground. This double support phase is characteristic of the walk and serves to differentiate it from the run.



The human skeleton. (Posterior view)

BONE MARROW

Within the long bone is a central marrow cavity known as bone marrow.

The red marrow produces red blood cells, which carry oxygen, white blood cells, which fight infection, and platelets, that help stop bleeding.

The yellow marrow consists mainly of fat cells.

COMPACT BONE

Surrounding the marrow is a dense rigid bone called the compact bone.

Cylindrical in shape, the dense layers of the compact bone are honeycombed with thousand of tiny holes and passages. Nerves and blood vessels run through these passages. That supply oxygen and nutrient to the bone.

This dense layer of compact bone supports the weight of the body and is comprised mainly of calcium and minerals.

PERIOSTEUM

Each bone is covered by the periosteum, which is a layer of specialized connective tissue and acts as the skin of the bone.

The inner layer of the periosteum contains cells that produce bone.

These three bone layers work together to handle the aforementioned skeletal system function.

MECHANICAL ANALYSIS

The speed of running is governed by the length of the stride and the frequency of the stride. The length of the stride is determined by the length of the leg, the range of motion in the hip and the power of the leg extensors which drive the entire body forward. Like any projectile, the distance the body will move once it is driven into the air depends upon the angle of take off [distance that center of gravity is ahead of take off foot], the speed of the body‘s projection and the height of the center of gravity at take off and landing.

In running, as in walking, the force exerted to produce and control the movement are in the internal muscular forces and the external forces of gravity, normal reaction, friction, and air assistance. There is no optimal speed in running because the energy needed to run is proportional to the square of the velocity. Therefore, whether the run is an easy jog or a full speed sprint, economy of effort is a highly desirable objective. To achieve this it is essential that the runner observe the principles that apply to efficient running.

MECHANICAL PRINCIPLES IN RUNNING

1. In accordance with the Law of inertia, a body remains at rest unless acted upon by a force. The force required to overcome inertia is greatest at takeoff and least after acceleration has ceased. The problem of overcoming inertia decreases as the speed increases.

2. In accordance with the law of acceleration in the run is directly proportional to the force producing it. Hence, the greater the power of the leg drive, the greater the acceleration of the runner.

3. In accordance with the law of reaction, every action has an equal and opposite reaction. The force for the run is provided through the upward and forward ground reaction force in response to the downward, backward of the foot.

UNIT-V
MUSCULAR ANALYSIS OF FUNDAMENTAL MOVEMENTS
RUNNING

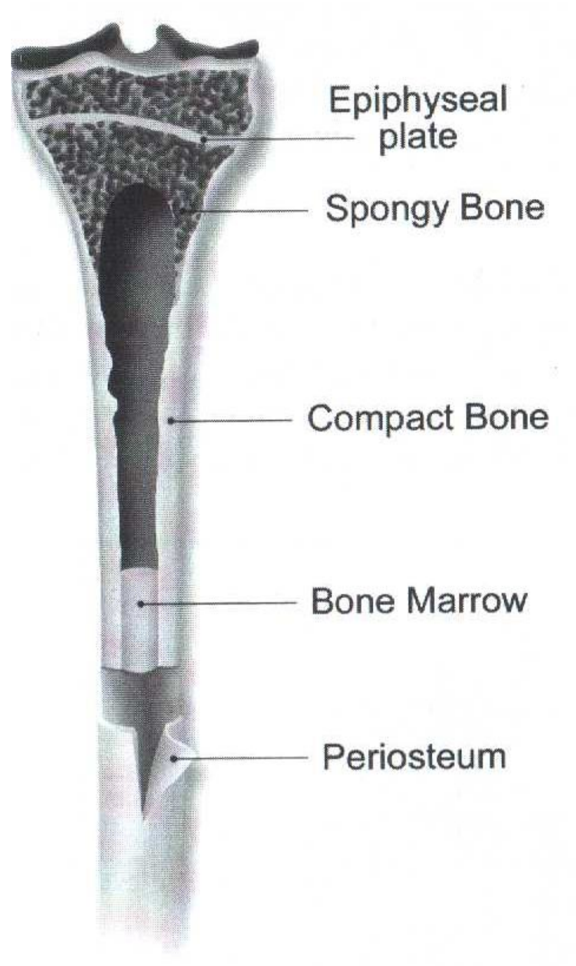
In the run the foot hits the ground in front of the body s center of gravity as in the walk, but not as far in front. As the speed of the run increases, the distance in front decrease until the foot contact is almost directly under the body's center of gravity. This position reduces the restraining part of the support phase and gives greater emphasis to the propulsive part.

There are two major types of running. The first is the kind of running done for its own sake, as in competitive races or jogging. The major concerns here are time and distance in one direction. The second is the type of running that is part of games and sports. Here it is necessary also to consider matters such as change of direction or pace and stability. The technique for a run varies with the purpose, but the basic anatomical and mechanical aspects are the same, regardless of the purpose.

ANATOMICAL ANALYSIS

The difference between the joint action in walking and running is a mater of degree and coordination. The joint actions are essentially the same but the range of motion in running is generally greater. This is especially apparent in the actions of the swinging leg. The different in coordination is evident in the period of non support and the absence of the period of double support.

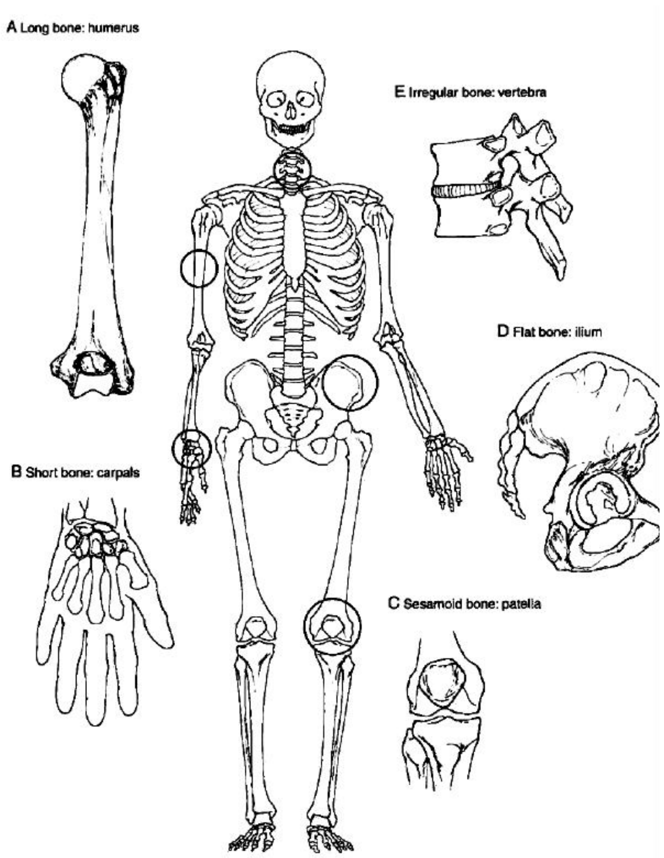
1. Support phase.
2. Swing phase
3. Heel phase.
4. Flat phase.
5. Toe off.



Bone classification

There are six main categories of bones,

- Long bone
- Short bone
- Sesamoid Bones
- Flat bone
- Irregular bones
- Wormian Bones (sutural)



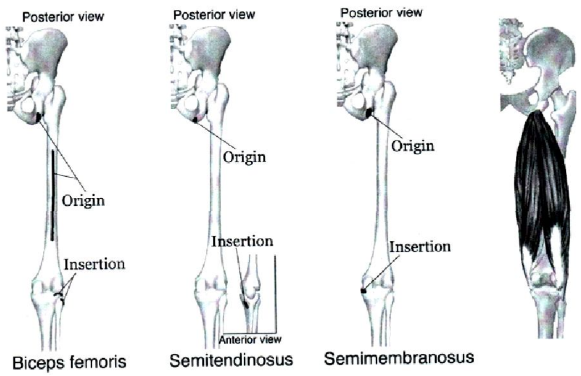
Shapes of bones. A. Long bone (humerus). **B.** Short bones (carpals). **C.** Sesamoid bone (patella), a specialized short bone. **D.** Flat bone (ilium). **E.** Irregular bones (vertebrae). Wormian bones arc not shown.

LONG BONE

Long bones provide structural support and include the tibia, fibula, femur, radius, ulna and humerus. They are long cylindrical shaft with relatively wide.

SHORT BONE

Short bones provide some shock absorption and include carpals and tarsals. They are usually characterized as small, cubical shaped, solid bones.

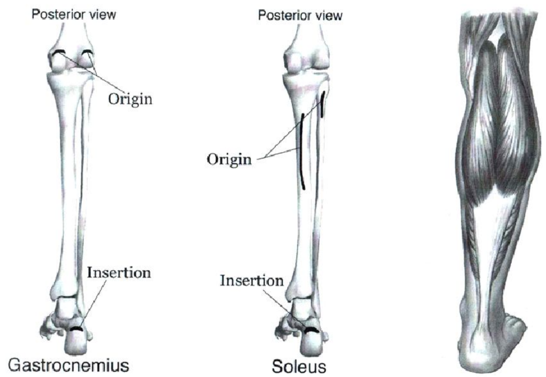


SELECTED LEG EXERCISES

- Leg press
- Lunge (stationary with dumbbells)
- Leg extension
- Seated leg curl
- Basic squat

GASTROCNEMIUS

Location – calf of leg
Origin – posterior surface of the medial and lateral femoral condyle
Insertion – calcaneus
Action – plantar flexes the ankle, flexion of the knee



SELECTED CALF EXERCISES

- Seated calf raise
- Standing calf raise

HAMSTRING GROUP

BICEPS FEMORIS

Location – posterior thigh
Origin – Ischium
Insertion – tibia and fibula
Action – extension of hip, flexion of knee, internal rotation of hip and knee

SEMITENDINOSUS

Location – posterior thigh
Origin – Ischium
Insertion – tibia
Action – extension of hip, flexion of knee, internal rotation of hip and knee

SEMIMEMBRANOSUS

Location – posterior thigh
Origin – Ischium
Insertion – tibia
Action – extension of hip, flexion of knee, internal rotation of hip and knee

GLUTEAL MAXIMUS

Location – buttocks
Origin – ilium and sacrum
Insertion – femur
Action – extends, abducts and laterally rotates thigh; extends lower trunk

SESAMOID BONE

Sesamoid bones provide protection as well as improve mechanical advantage of musculotendinous units and include unit in the patella and the flexor tendons of the toe and thumb.

FLAT BONE

Flat bones provide protection and include the ilium, ribs, sternum, clavicle and scapula. They are usually characterized by a curved surface where it is either thick at the tendon attachment or very thin.

IRREGULAR BONE

Irregular bones serve a variety of purposes in the body and include bones throughout the spine as well as the ischium, pubis and maxilla.

WORMIAN BONES (SUTURAL)

Wormian bones, also known as intra sutural bones, are extra bone pieces that occur within a suture in the cranium. These are irregular isolated bones that appear in addition to the usual centers of ossification of the cranium and, although unusual, are not rare.

CONSTRUCTION AND TYPES OF JOINTS IN THE BODY AND THEIR ACTIONS

A skeletal joint is the union between two or more bones and cartilage; or between two or more cartilages. The junctions between skeletal components may be called JUNCTURE, ARTICULATIONS, or by vernacular terms such as JOINTS.

Function of Joints

- 1. Serve as functional junctions between bones.
- 2. Bind bones , strokes , and other related tissues together.
- 3. Allow bone growth to occur .
- 4. Permit certain structures to change shape during childbirth (i.e. pubic symphysis).
- 5. Enable the body to have movements, lever actions, and body posture.

Classification of Joints by Structure

The joints are habitually differentiated into three groups :

1) Synarthroses (or) Fixed joints (or) immovable joints (or) fibrous joints

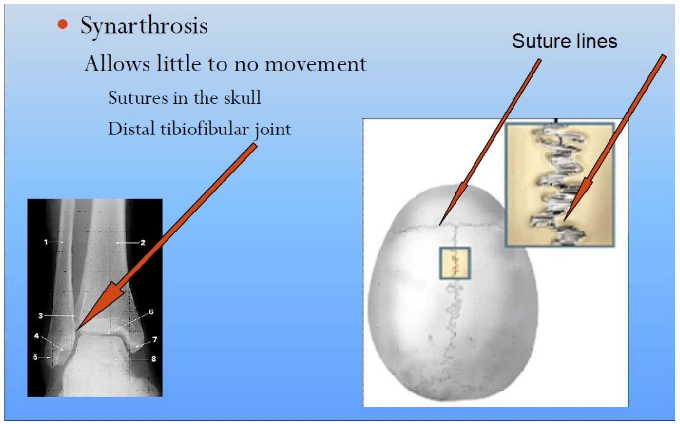
2) Amphiarthroses (or) slightly movable joints.

3) Diarthrosis (or) freely movable (or) synovial joints.

1) Synarthroses or Immovable Joints

"Sybartgrises" is a Greek word, meaning is "with joint" or a joint in which there is no separation or articular cavity. In this type the surfaces of the bones are in almost direct contact with only a thin layer of fibrous periosteum between the bones. In this joint there is no articular cavity, i.e. no capsule, no synovial membrane or no synovial fluid.

Example : Suture of the skull



VASTUS INTERMEDIUS

Location – anterior thigh

Origin – femur

Insertion – upper border of patella and tibia

Action – knee extension

VASTUS MEDIALIS

Location – medial thigh

Origin – femur

Insertion – medial border of patella and tibia

Action – knee extension

RECTUS FEMORIS

Location – anterior thigh

Origin – ilium

Insertion – patella and tibia

Action – flexion of hip, extension of knee

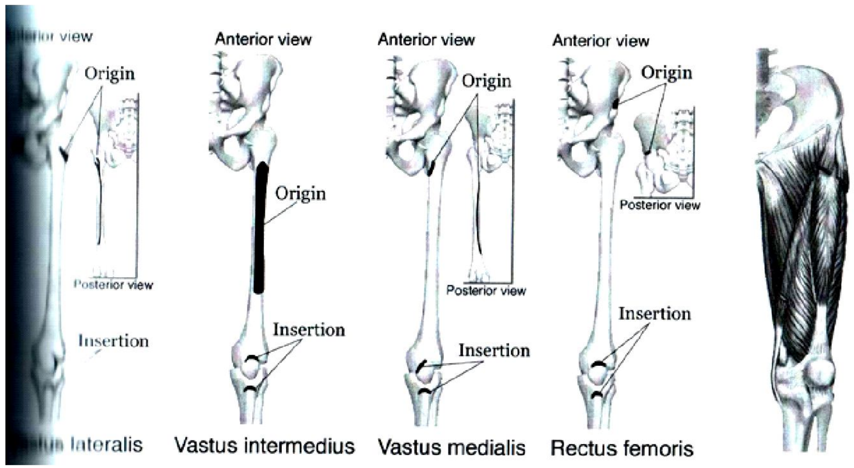
SARTORIUS

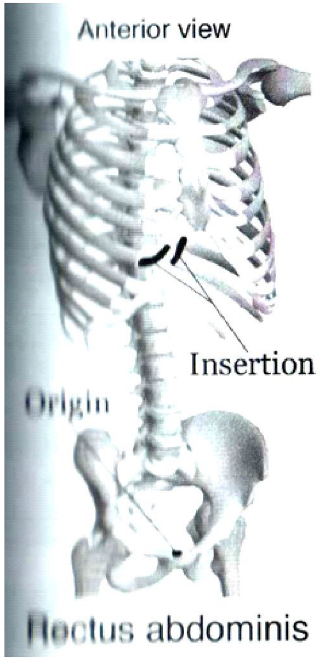
Location – anterior and midial thigh

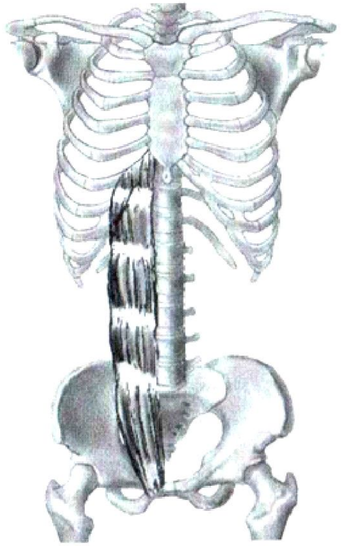
Origin – ilium

Insertion – tibia

Action – flexes thigh and rotates it laterally







SELECTED ABDOMINAL EXERCISES

- Crunch
- Stability ball crunch
- Oblique stability ball crunch
- Kneeling cable crunch
- Hanging leg raise
- Forward stability ball roll

<u>QUADRICEPS GROUP</u>

VASTUS LATERALIS

Location – lateral thigh

Origin - femur

Insertion – lateral border of patella and tibia

Action – knee extension

2) Ampiarthroses or Slightly Movable

In this type of joint the continuous surfaces are either connected by broad flattened discs of fibro cartilage which adhere to the end of each bone, as in the joint between the bodies of vertebrae, or else, the joint surfaces are covered with fibro cartilage, partially lined by synovial membrane and connected by external ligaments as in public symphysis, both of these joints being capable of limited motion.

There are two types of Amphiarthrosis

a) Ligamentous (or) Synedsmosis

b) Cartilaginous (or) Synchondrosis

a) Ligamentous (or) Synedsmosis

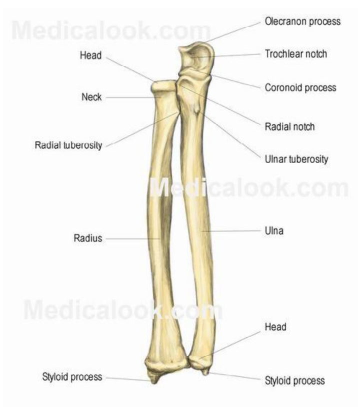
This is a Greek word, meaning is "with ligament". Two bones, which may be adjacent or which may be quite widely separated are tied together by one or more ligaments. These ligaments may be in the form of cords, bands, or flat sheets. The movement that occurs is usually limited and of no specific types.

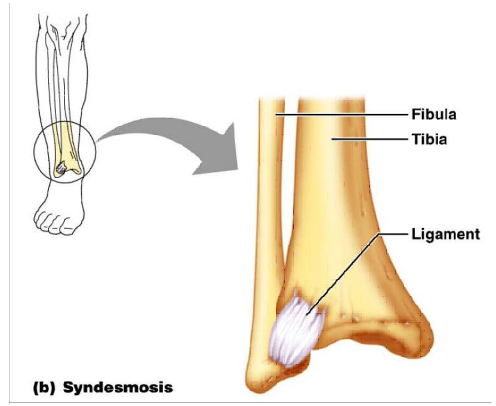
Example

i) Mid Union of Radius and Ulna

ii) Mid tibio - fibular joint

iii) Inferior tibio - fibular joint



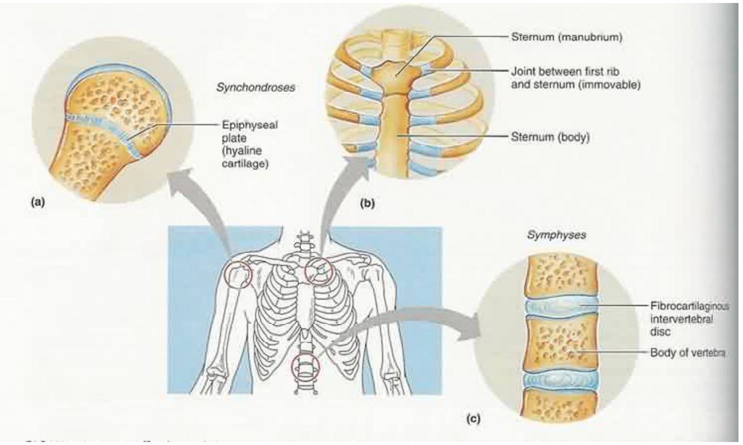


b) Cartilaginous (or) Synchondrosis

This is a Greek word, meaning is “with cartilage”. The joints which are united by fibro cartilage permit motion of a bending and twisting nature. Those united by hyaline cartilage permit only a slight compression.

Example of hyaline type. Epiphysial unions

Example of fibro cartilaginous type : Joints between the bodies of the vertebrae.



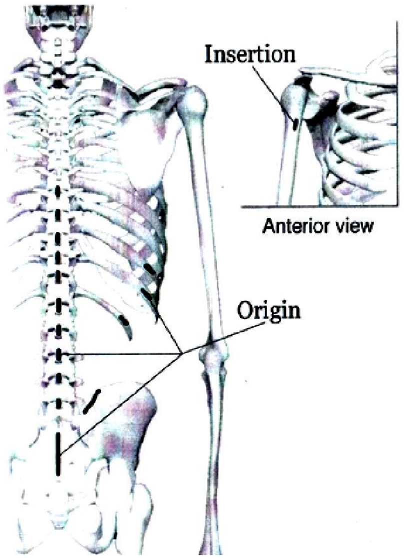
3) Diarthroses (or) Freely movable joints (or) Synovial joints

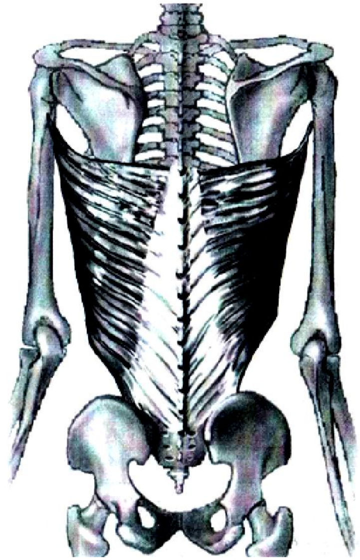
This is a Greek word, meaning a joint in which there is a separation, or articular cavity.

Characteristic of Diarthrosses Joint

a) An articular cavity is present
b) The joint is encased within a sleeve like ligamentous
c) The capsule is lined with synovial membrane which secretes synovial fluid for lubricating the joint.
d) The articular surfaces are smooth.
e) The articular surfaces are covered with cartilage, usually hyaline, but occasionally fibro cartilage.

Diarthroses or synovial joints are classified into six varieties.





SELECTED LAT EXERCISES

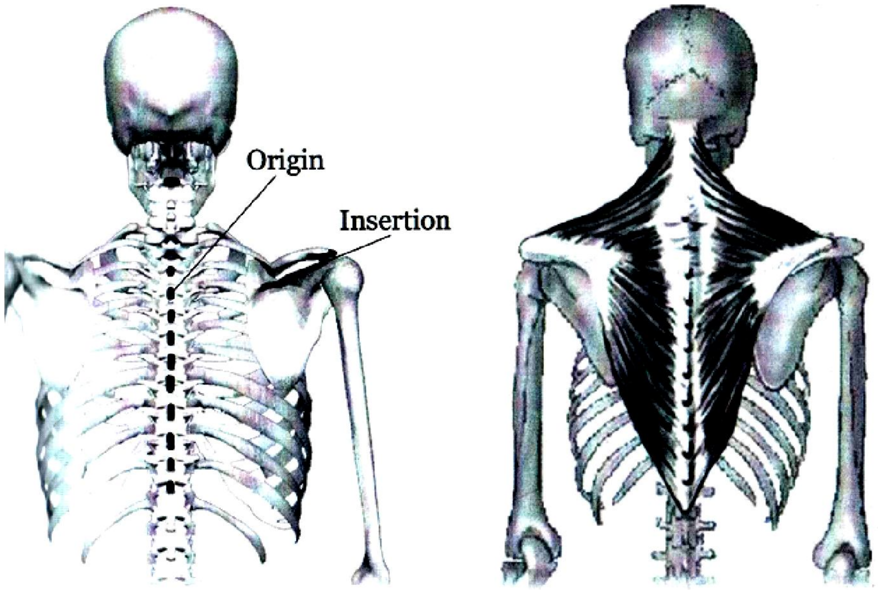
- Overhead pulldown
- Seated machine row
- Chin-up
- Pull-up
- Bent-over row
- Supine pullover on ball

RECTUS ABDOMINIS

Location – anterior midline of abdomen
Origin – superior surface of pubis around syphysis.
Insertion – inferior surface of costal cartilages (ribs 5-7) and xiphoid process of sternum.
Action – depresses ribs, flexes vertebral column

TRAPEZIUS

Location – upper back and neck
Origin – base of skul, spinous process of 7C and T1- T3
Insertion – posterior aspect of the lateral clavicle
Action – scapula elevation, depression and adduction of scapula



SELECTED TRAPEZIUS EXERCISES

- Cable bar shrug
- Barbell shrug
- Dumbbell shrug
- Seated mid row retraction on a machine

LATISSIMUS DORSI

Location – lower back
Origin – posterior side of sacrum, spinous process of lumbar and lower 3 ribs
Insertion – medial side of humerus
Action – internal rotation of humeral joint and horizontal abduction of humeral joint

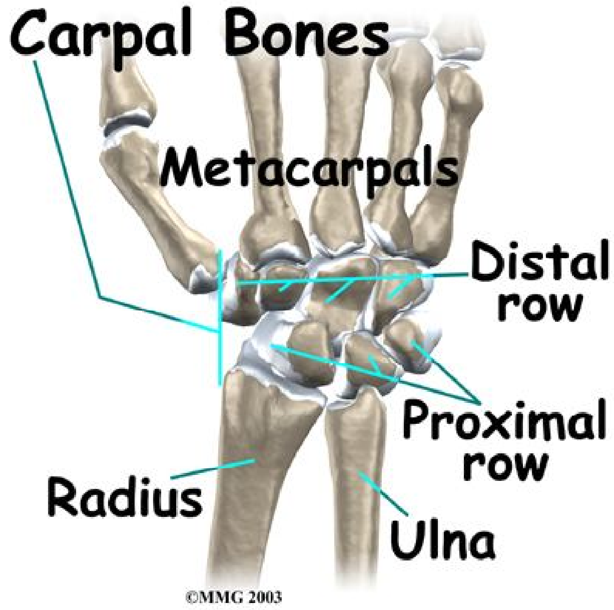
1) Gliding joint (or) Irregular joint (or) Plane joints (or) Arthrodial.
2) Hinge joint (or) Ginglymus
3) Pivot Joint (or) Trochoid (or) Screw Joint
4) Condyloid joint or Ellipsoidal
5) Saddle Joint

Ball and Socket Joint (or) Spheroidal (or) Enarthrodial.

1. Gliding Joint (or) Irregular Joint (or) Plane Joint or Arthrodial

The joint surfaces are irregularly shaped, usually flat or slightly curved. The only movement permitted is of a gliding nature, hence it is NON-AXIAL.

Example : Carpal Joints

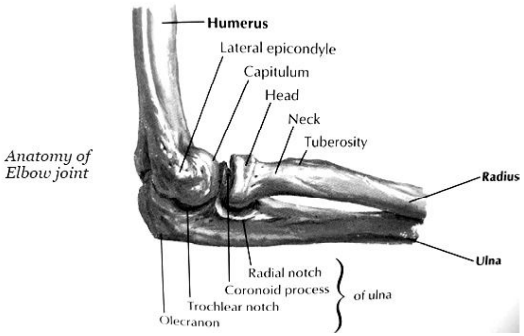


Carpal Joints (Gliding joint)

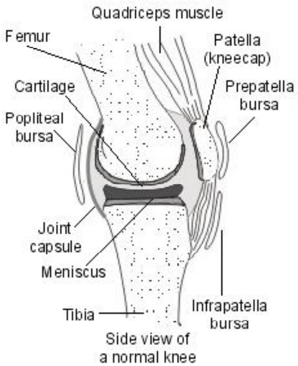
2. Hinge Joint (or) Ginglymus

It is roughly resemble the hinges of a door. One surface is spool-like, the other is concave. The concave surface fits over the spool-like process and glides partially around it in a hinge type of movement. This constitutes movement in one plane about a single axis of motion. Hence it is UNI-Axial. The movement that occurs are FIEXION and EXTENSION.

Example :
1) Elbow joint (or) Humero-ulnar joint
2) 1st and 2nd phalangeial joints
3) Knee joint



Elbow joint

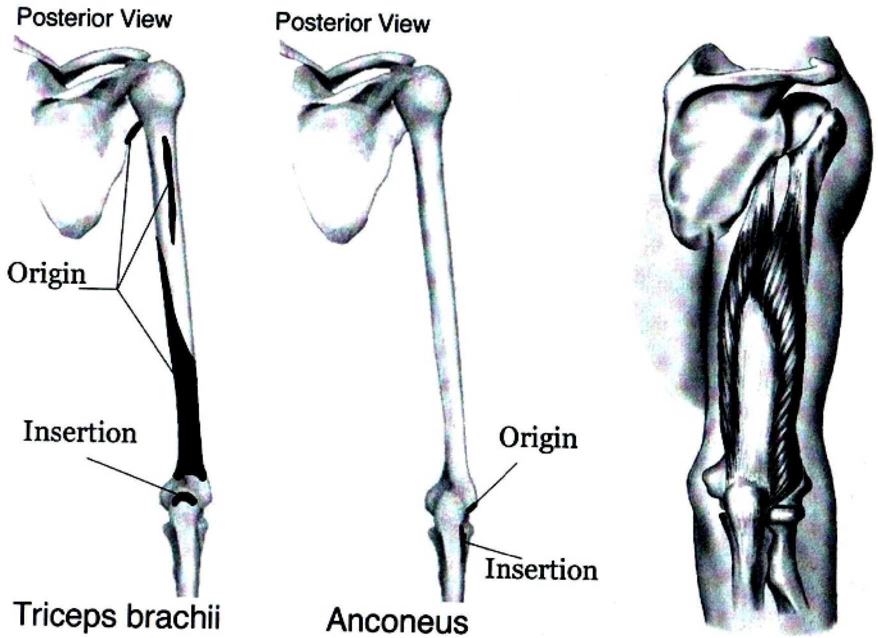


Knee joint

The elbow joint is a DOUBLE GINGLYMUS. This joint consists of the articulation of the lower end of the humerus with the upper ends of the ulna and Radius. The semi-circular structure at the upper end of the ulna is cupped around the back and under side of the spool-like process known as the trochlea, at the lower end of the humerus. The inner surface of this semi-circular structure is known as the semilunar notch. It terminates above and behind in the olecranon process, and below and in front in the coronoid process. Just lateral to the trochlea, on the lower end of the humerus, is the capitulum, the small spherical structure that articulates with the saucer – like surface of the radial head.

TRICEPS BRACHII

Location – posterior humerus
Origin – long head: posterior edge of scapula, medial head: distal 2/3 of posterior surface of humerus, lateral head: upper half of posterior humerus.
Insertion – posterior surface of ulna
Action – adduction of the shoulder joint, extension of elbow

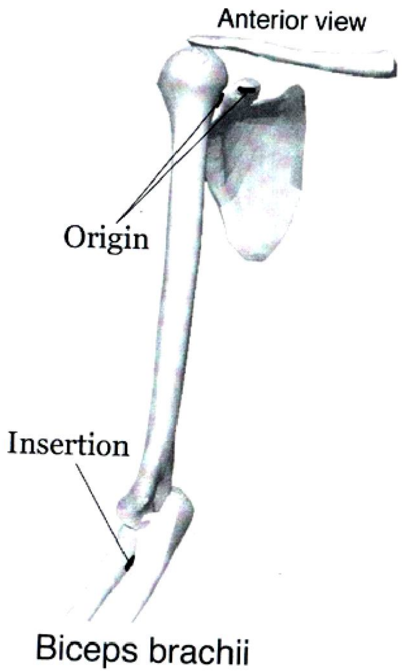


SELECTED TRICEPS EXERCISES

- One arm dumbbell triceps extension on stability ball
- Skull crushers
- French press
- Triceps cable extension with rope
- Bar dips
- French press on ball

BICEPS BRACHII

Location – upper arm
Origin – short head: coracoid process of scapula and long head: above the superior lip of scapula
Insertion – tuberosity of radius
Action – flexion of elbow, supination of forearm



SELECTED BICEPS EXERCISE

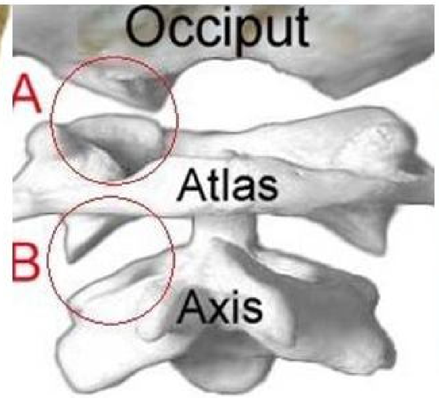
- Cable biceps curl
- Cable rope hammer curl
- Dumbbell biceps curl
- Dumbbell hammer curl
- Dumbbell concentration curl
- Dumbbell hammer curl on ball

The two articulations of the elbow joint, as well as the proximal radiulnar articulation, are completely enveloped in an extensive capsule. The capsule is strengthened on all four sides by bands of fibers which are usually described respectively as the anterior, posterior, ulnar collateral and radial collateral ligaments. Synovial membrane not only lines the capsule, but it also extends into proximal radioulnar articulation, covers the olecranon, coronoid and radial fossae, and line the annular ligament.

3) Pivot Joint (or) Trochoid (or) Screw Joint.

This kind of joint may be characterized by a peg like pivot, as in the joint between atlas and axis, or by two long bones fitting against each other near each end in such a way that one bone can roll around the other one, as do the radius and ulna of the forearm. In the latter type a small concave notch on one bone fits against the rounded surface of the other. The rounded surface may either be the edge of a disk (like the head of the radius), or it may be a rounded knob (like the head of the ulna). The only movement permitted in either kind of pivot joint is rotation. It is a movement in one plane about a single vertical axis, hence the joint in UNI-AXIAL.
Example : Atlanto – axial Joint

Posterior View
Cervical Spine

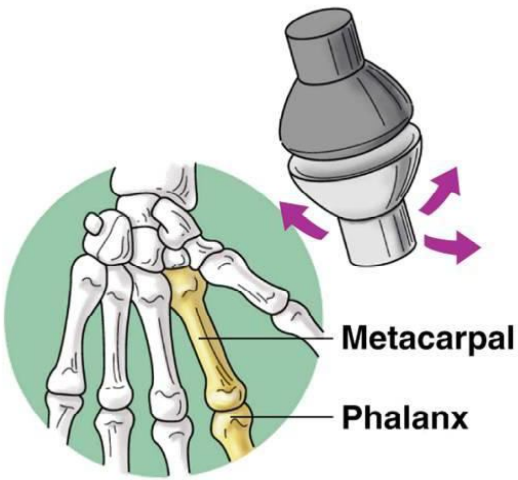


A: Atlanto-Occipital Joint
B: Altanto –Axial Joint

4) Condyloid Joint (or) Ellipsoidal

An oval or egg – shaped convex surface fits into a reciprocally shaped concave surface. Movement can occur in two planes, forward and backward, and from side to side. The former movement is flexion and extension and the latter abduction and adduction or lateral flexion. The joint is BI-AXIAL, the axes being frontal horizontal and horizontal and sagittal horizontal. When these movements are performed sequentially, they constitute circumduction.

Example : Metacarpal / Phalangial joint



5. Saddle Joint

This may be thought as a modification of a condyloid joint because the function is a very much like condyloid joints, but their structure is different. From one angle, the articular surfaces appear convex and from the opposite angle, they appear concave. This type of joint consists of two saddle like structure fitted into each other. It has a strong but loose capsule, permitting much more freedom of movement. This is also a BI-AXIAL joint. The possible movements are flexion, extension, abduction, hyper adduction, hyper flexion, circumduction and oppositio.

Example : Carpo – metacarpal joint of the Thumb

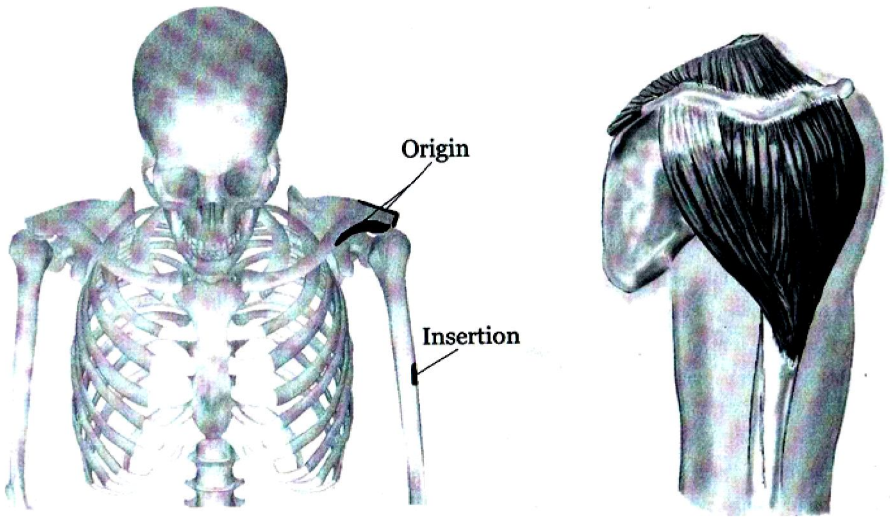
DELTOID

Location – anterior, lateral and posterior upper surface of humerus

Origin – anterior side of clavicle, posterior edge of scapula, lateral aspect of acromion.

Insertion – anterior, middle and posterior: deltoid tuberosity on lateral humerus

Action – abduction, flexion, extension



SELECTED DELTOID EXERCISE

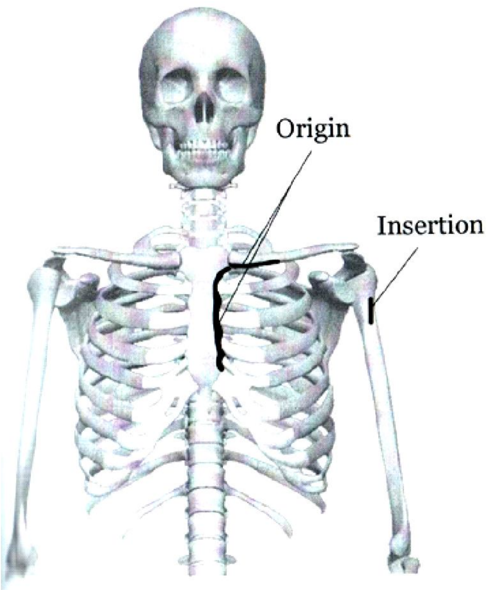
- Seated barbell press
- Barbell upright row
- Dumbbell posterior deltoid raise
- Dumbbell medial deltoid lateral raise
- Single arm cable lateral raise
- Seated alternate dumbbell press on stability ball

UNIT- IV

ORIGIN, INSERTION AND ACTION OF THE MUSCLE

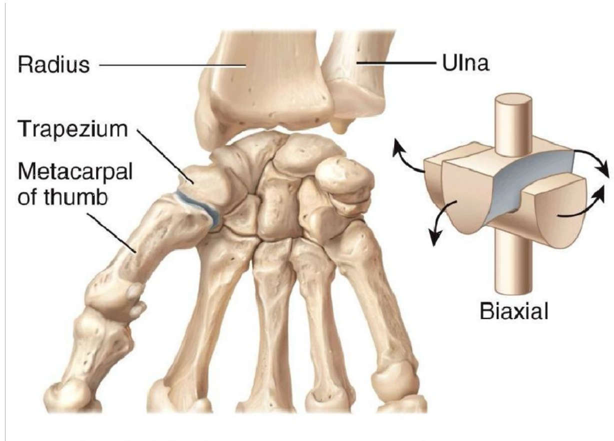
PECTORALIS MAJOR

Location- chest
Origin – anterior surface of clavicle and sternum
Insertion - groove humerus
Action – internal rotation, horizontal adduction



SELECTED CHEST EXERCISE

- Dumbbell flat bench chest press
- Dumbbell incline bench chest press
- Barbell incline bench chest press
- Barbell flat bench chest press
- Bar dips
- Dumbbell chest press on ball

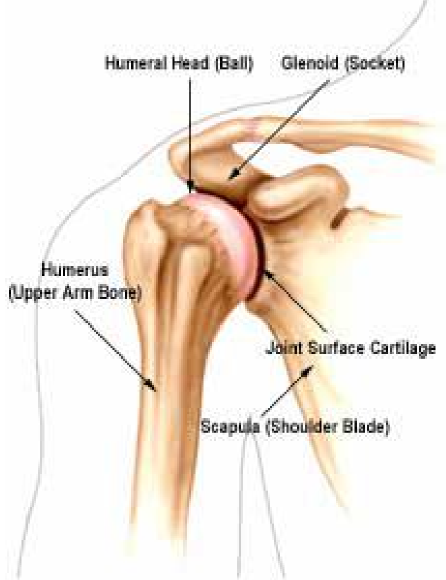


(e) Saddle joint between trapezium of carpus (wrist) and metacarpal of thumb

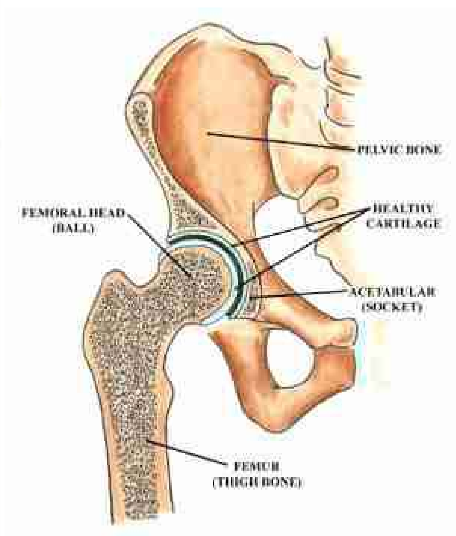
6. Ball and Socket joint (or) Spheroidal (or) Enarthrodial

These joints are formed by the reception of a head of one bone into a cup-like concavity. Such joints are MULTI-AXIAL OR TRI-AXIAL as it permits movement about three axes, namely frontal horizontal, sagittal horizontal and vertical.

Example : Shoulder Joint & Hip Joint



Shoulder Joint



Hip Joint

The shoulder joint is formed by the articulation of the spherical head of humerus with the small, shallow, some-what perar-shaped glenoid fossa of the scapula. The structure of the joint and the looseness of the capsule account for the remarkable mobility of the shoulder joint. Both the humeral head and the glenoid fossa are covered with hyaline cartilage. The cartilage on the head is thicker at the center. The glenoid fossa is further protected by a flat rim of white fibro cartilage, likewise thicker around the circumstance. This cartilage is called the glenoid labrum, serves both to deepen the fossa and to cushion it against the impact of the humeral head in forceful movements.

The joint is completely enveloped in a loose sleeve like articular capsule which is attached proximally to the circumference of the glenoid cavity, and distally to the anatomic neck of humerus. The capsule reinforced both by ligaments and by muscle tendons. The muscle tendons are particularly important in preserving the stability of the joint.

Possible movements are flexion, extension, abduction, adduction, circumduction, inward rotation and outward rotation. Another example : Hip Joint

SUMMARY CLASSIFICATION OF DIARTHROSIS JOINTS

No. of Axes	Non-Axial	Uni-Axial	Bi-Axial	Tri-Axial
	No moment	**One moment**	**Two moments**	**3 or more moments**
Classification	Gliding	Hinge & Pivot	Condyloid & Saddle	Ball and Socket

MOVEMENT AT THE ANKLE JOINT

The foot is articulated with leg at the ankle joint. Two joints in this region are of sufficient important. These are the sub tarsal and mid tarsal joints, the latter including the tranodanicular and callanioouboid articulations. These movements with in the foot occur mainly at these two joints.

- Dorsiflexion
- Planterflexion
- Eversion
- Inversion

MOVEMENT AT THE TRUNK

The trunk constitutes the vertebral column of lumbar region and thoracic region, which are slightly movable cartilaginous joints, collectively results into bigger movements as followings

- Flexion
- Extension
- Hyper Extension
- Lateral Flexion
- Lateral Extension
- Rotation
- Circumduction

MOVEMENT AT THE NECK JOINT

Neck segment comprises seven cervical vertribral. The joint are slightly movable joints but collectively executes the greater range of motion (ROM).

- Flexion
- Extension
- Hyper extension
- Lateral Flexion
- Lateral extension
- Neck rotation
- Circumduction

- Flexion
- Extension
- Hyperextension
- Radial Flexion (Abduction)
- Ulnar Flexion (Adduction)
- Reduction of Hyper Flexion
- Radial Extension
- Ulnar Extension
- Circumduction

MOVEMENT OF HIP JOINT

The hip joint is formed by the articulation of the spherical head of the femur with the acetabulum of the pelvis. It is a ball and socket joint thus permits for triaxial movement.

- Flexion
- Extension
- Hyperextension
- Abduction
- Adduction
- Outward Rotation
- Inward Rotation
- Horizontal Flexion
- Horizontal Abduction
- Circumduction

MOVEMENT OF KNEE JOINT

The knee joint is formed with the help of bones namely, femur, tibia, and patella. It a hinge type of joint, thus permits uniaxial movement of Knee. The movements which occur at the knee joint are as follows:

- Flexion.
- Extension.
- Inward rotation.
- Outward rotation.

Types of Muscle

All our movement happens as a result of the shortening (contracting) and lengthening (extending) of muscles.

The human organism has more than 600 muscle fibers present in their body. There are three different types of muscles in the human body, namely

- Skeletal muscles
- Smooth muscles
- Cardiac muscles

SKELETAL MUSCLES

Skeletal muscles (or, voluntary) are under our control. We use them for everyday and sporting activities. Examples of skeletal muscles would include those used for walking, running and jumping.

SMOOTH MUSCLES

Smooth muscles (or, involuntary) work automatically and are not under our conscious. They work our internal organs. Examples include the bowel, uterus and bladder.

CARDIAC MUSCLES

Cardiac muscles (or, involuntary) are a very special type of involuntary muscle. The fibers in the cardiac muscle contract on their own and they work all the time without tiring. The heart muscle is under constant nervous and chemical control.

Structural Classification of Muscles on the Basis of Fiber Arrangement

The arrangement of the fibers and the method of attachment vary considerably among different muscles. These structural variations form the basis for a classification of the skeletal muscles.

LONGITUDINAL

This is a long strap like muscle whose fibers lie parallel to its long axis. Two examples are the rectus abdominis on the front of the abdomen, and the sartorius, which slants across the front of the thigh.

QUADRATE OR QUADRILATERAL

Muscles of this type are four sided and usually flat. They consist of parallel fibers. Examples include the pronator quadrates on the front of the wrist and the rhomboid muscle between the spine and the scapula.

TRIANGULAR OR FAN-SHAPED

This is relatively flat type of muscle whose fibers radiate from a narrow attachment at one end to a broad attachment at the other. The pectoralis major on the front of the chest an excellent example.

FUSIFORM OR SPINDLE SHAPED

This is usually a rounded muscle that tapers at either end. It may be long or short, large or small. Good examples are the branchialis and the branchioradialis muscles of the upper extremity.

UNIPENNIFORM

In this type of muscle, a series of short, parallel, featherlike fibers extends diagonally from the side of a long tendon, giving the muscle as a whole the appearance of a wing feather. Examples include the extensor digitorum longus and tibialis posterior muscles.

BIPENNIFORM

This is a double penniform muscle. It is characterized by a long central tendon with the fibers extending diagonally in pairs from either side of the tendon. It resembles of symmetrical tail feather. Examples include the flexor hallucis longus and rectus femoris of the leg and thigh respectively.

The movements of the shoulder girdle expressed in terms of the composite movement of the scapula are as follows:

- Elevation
- Depression
- Abduction and protraction
- Upward Tilt
- Adduction and Retraction
- Upward Rotation
- Downward Rotation
- Reduction of Upward Tilt

MOVEMENT OF ELBOW JOINT

In elbow joint the two bones of the forearm attach to the humerus, the humero-ulnar joint is indeed a true hinge joint but the radioulnar joint is far from it. It is a hinge type of joint. Movement takes place at elbow joint are as follows

- Flexion
- Extension
- Pronation
- Supination

MOVEMENT OF WRIST AND HAND

The hand and wrist owe their mobility to their generous supply of joints. The most prominent of these is the radio carpal or wrist joint. The wrist joint collectively comprises of radio-carpel joints, Instracarpal joint and carpo-meta carpo joint, the hand comprises the joints namely Meta-carpo- phallengial and interphallengial joints.

UNIT- III

JOINT WISE MOVEMENT

MOVEMENT OF SHOULDER JOINT

The shoulder joint is formed by the articulation of the spherical head of the humerus with the small, shallow, pear-shaped glenoid fossa of the scapula.

This forms the glenohumeral articulation. It is ball and socket joint, a triaxial joint. The movement of the humerus, all of which takes place at the glenohumeral articulation is:

- Flexion
- Hyper Flexion
- Reduction of Hyper Flexion
- Extension
- Hyper Extension
- Reduction of Hyper Extension
- Abduction
- Hyper Abduction
- Reduction of Hyper Abduction
- Horizontal Abduction
- Horizontal Adduction
- Adduction
- Reduction of hyper adduction
- Outward rotation
- Inward rotation
- Circumduction
- Diagonal abduction
- Diagonal adduction

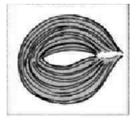
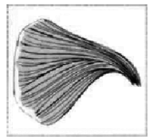
MOVEMENTS OF SHOULDER GIRDLE

The articulation between the acromion process of the scapula and the distal end of the clavical forms the acromioclavicular and the proximal end articulates with the sternum to form sterno-clavicular articulation. The movement of scapula by means of acromioclavical joint and sterno-clavicular joint known as the movement of shoulder girdle.

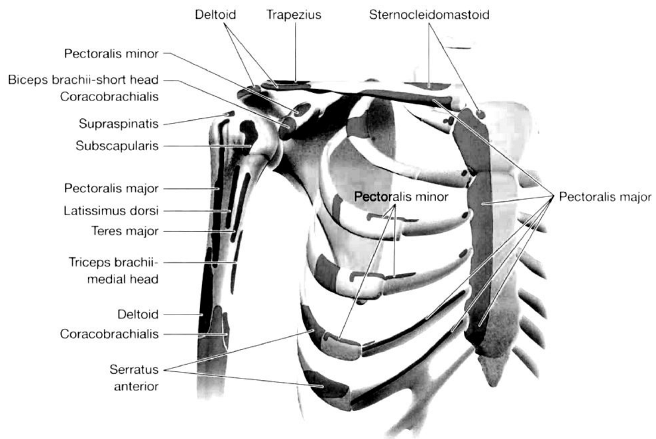
MULTIPENNIFORM

In this type of muscle there are several tendons present, with the muscle fibers running diagonally between them. The middle portion of the deltoid muscle of the shoulder and upper arm is a prime example of a multipenniform muscle.

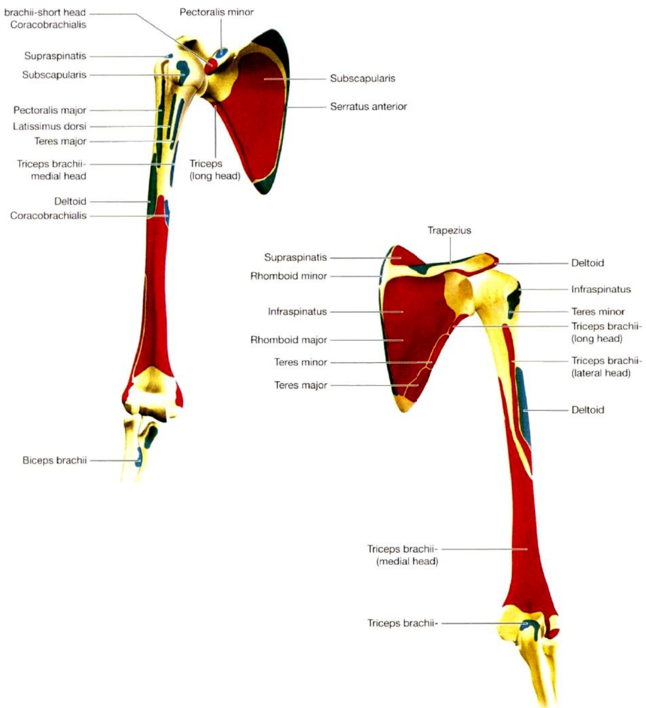
Types of Muscles

	Appearance	Purpose	Examples
Parallel Arrangements		Shorten equally and in the same direction to maximize range of motion.	
Fusiform		Focus force production into specific bony landmarks.	Brachialis Biceps brachii
Circular		Contract and close passages or relax and open them.	Orbicularis oris Sphincter ani
Triangular		Diversification of actions, creating multiple movement possibilities.	Pectoralis major Trapezius
Pennate Arrangements		Maximize the number of fibers in an area for greater force production.	
Unipennate		Slicing force production from one direction.	Tibialis posterior Biceps femoris
Bipennate		Strong force production from two directions.	Rectus femoris
Multipennate		Weaker force production from many directions.	Deltoid

Multi Joint Muscles



Axial muscle attachments: anterior view. The ribcage forms a stable attachment for several muscles of the shoulder. Large, prime mover muscles such as the pectoralis major have broad origins on the ribcage and smaller insertionson the humerus.



Special rotation occurs at the forearm and feet. **Pronation** is the rotation of the forearm to the palms- down position (as in a basketball dribble or on the seated chest press machine). **Supination** is the rotation of the forearm segment to the palms-up position (as in doing a standard curl on the arm curl machine). **Eversion** (also called pronation of the foot) is the outward tilting of the sole of the foot, while **inversion** (also called supination of the foot.

Circumduction is the sequential combination of movements outlining a geometric cone. Examples include circles of the trunk, shoulder, hip, ankle and thumb.

Abduction is the movement of a body segment away from the mid line. Example; spreading of the fingers or toes and the legs moving apart.

Adduction is the movement of a body segment toward a midline, or the return from abduction. Example; the legs moving together.

Rotation is the circular movement of a body segment about a long axis. Inward rotation occurs when a body segment moves towards the midline (the upper arm when throwing a screw ball), while outward rotation occur when a body segment moves away from the midline (the upper arm in a back hand tennis stroke). The right and left rotation defines the directional rotation of the head or trunk.

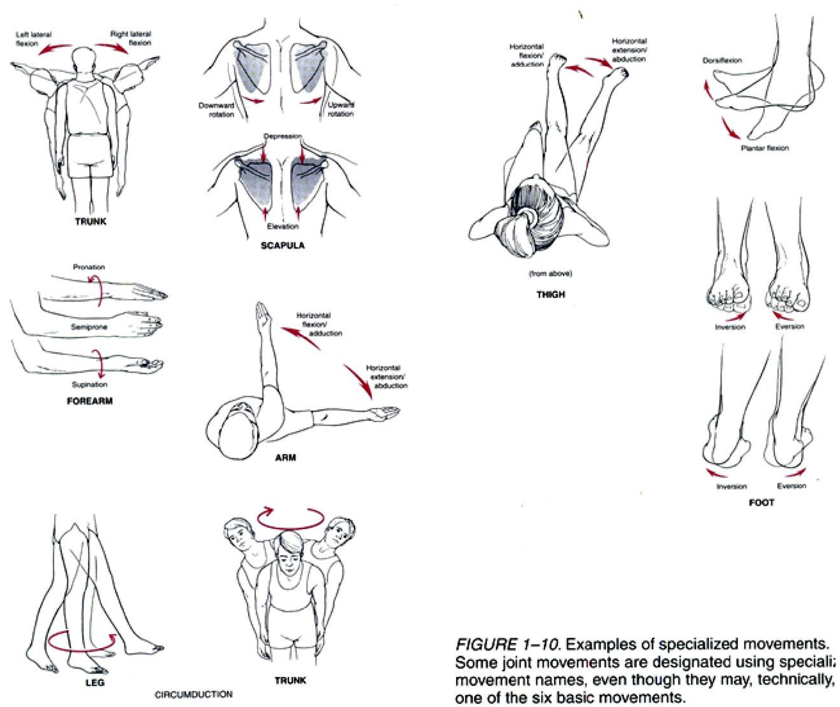
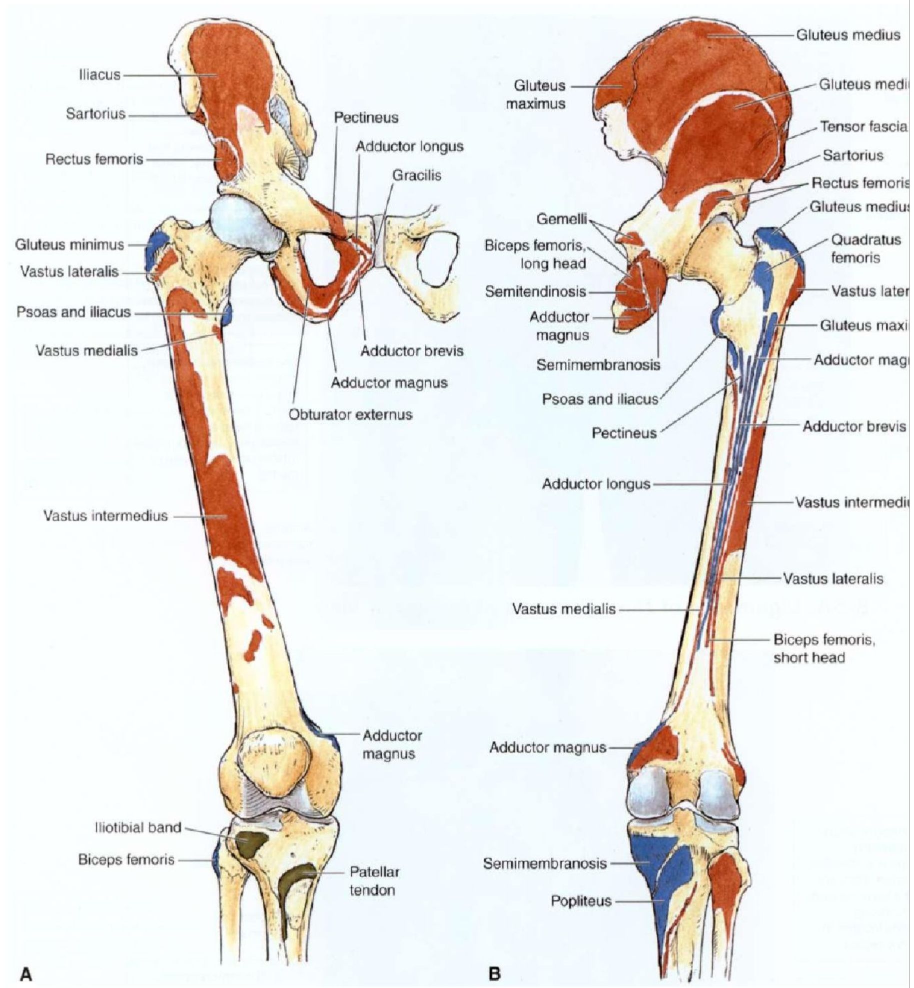
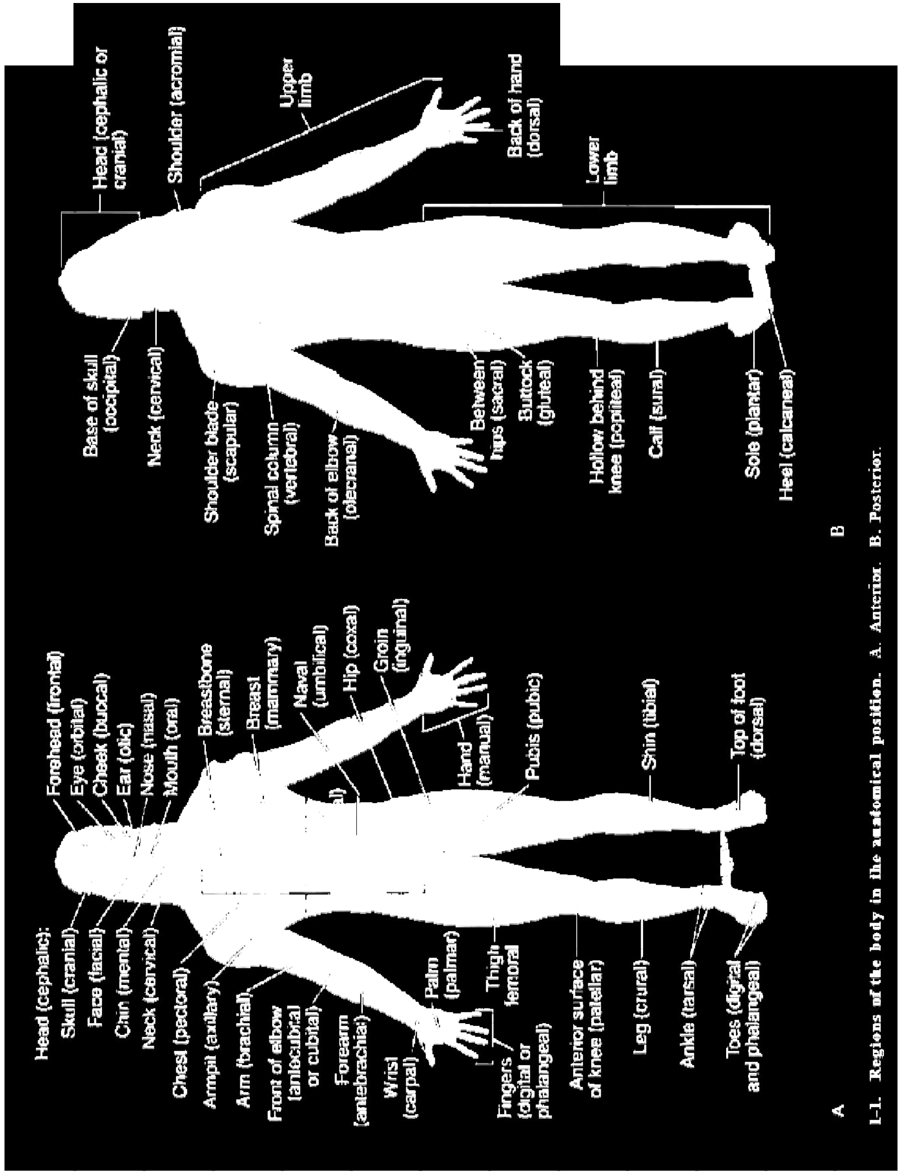


FIGURE 1–10. Examples of specialized movements. Some joint movements are designated using speciali: movement names, even though they may, technically, one of the six basic movements.

MUSCLE ATTACHMENT SITES

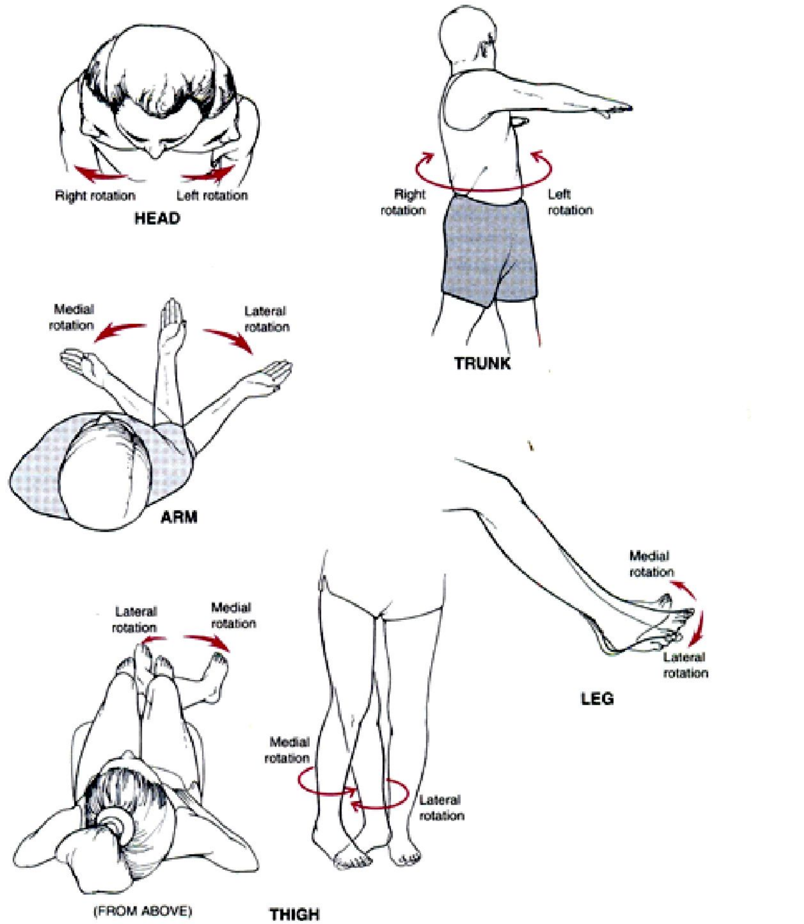


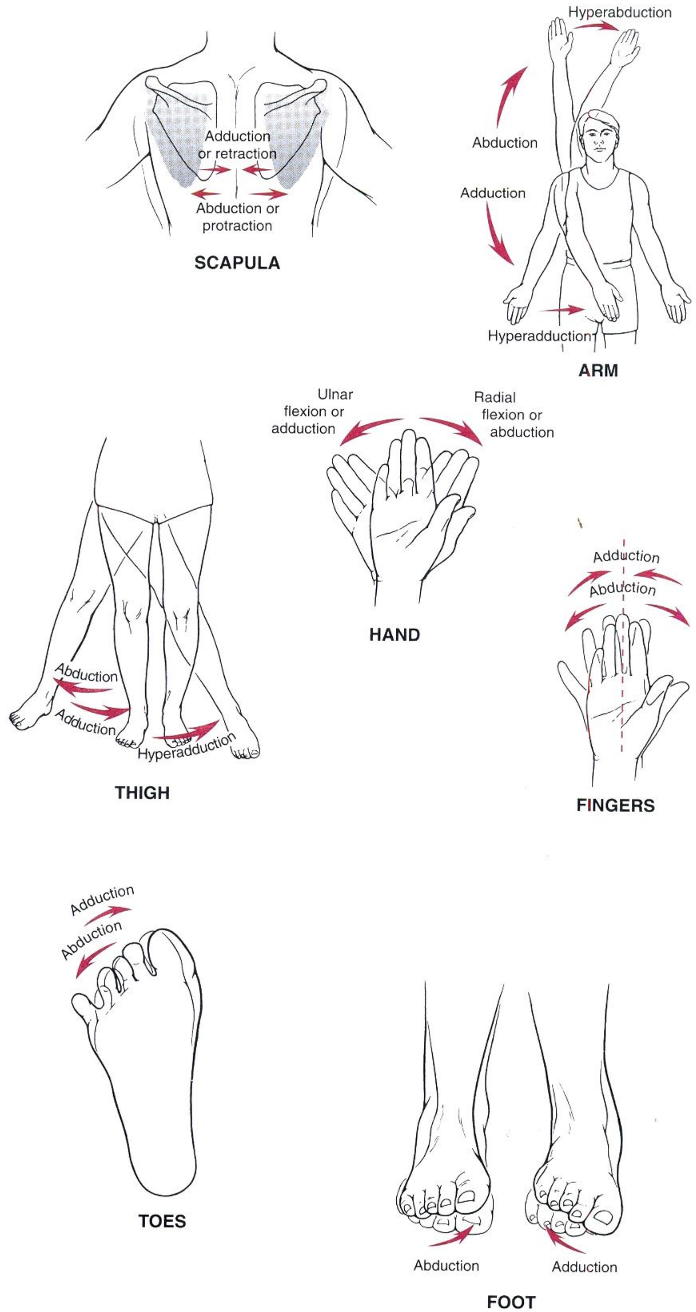
8-4 Muscle attachments of the pelvis, thigh, and knee. A. Anterior view. **B.** Posterior view

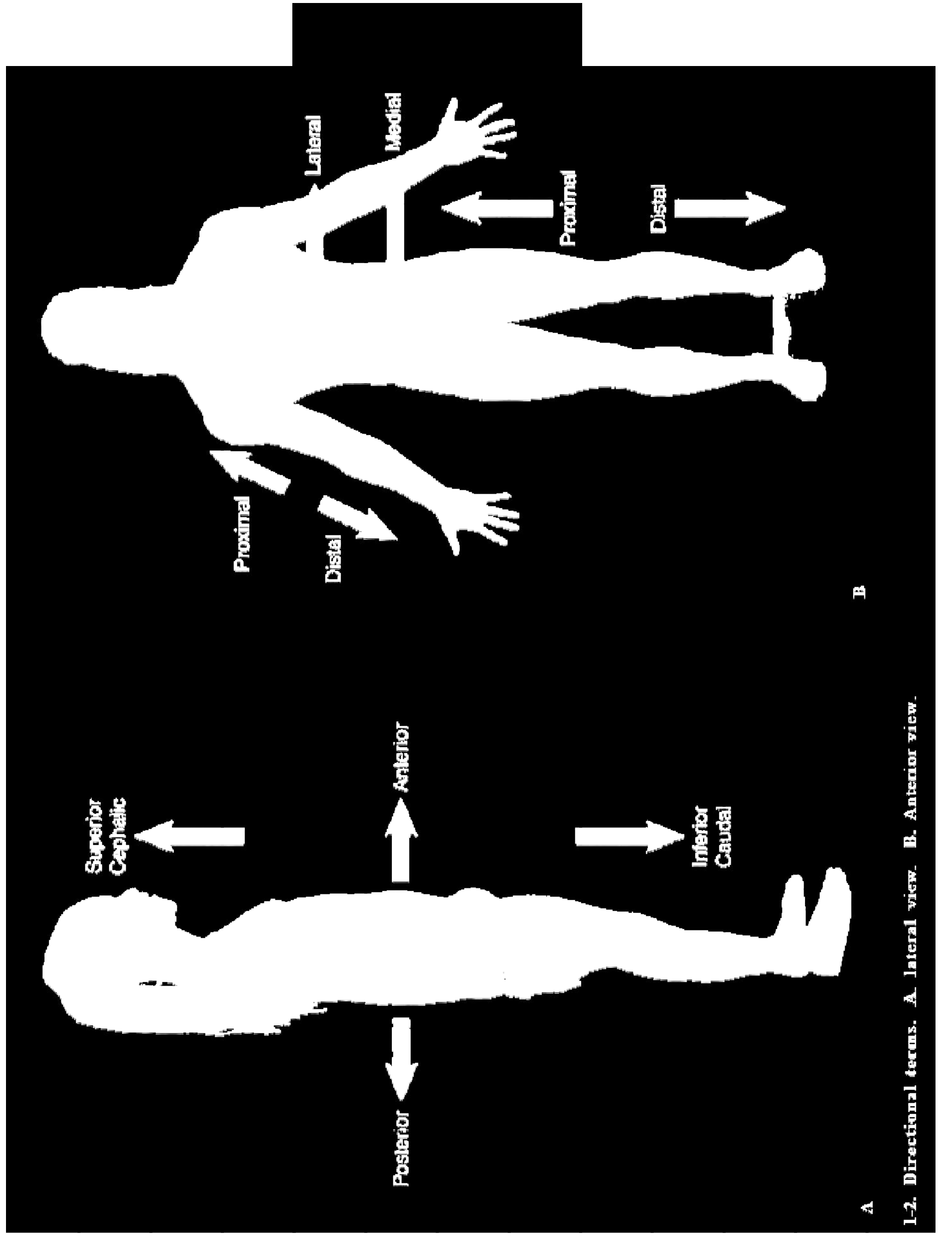


1-1. Regions of the body in the anatomical position. A. Anterior. B. Posterior.

Extension is an increase in the angle between two body segment, or the return from flexion. For example, extension occurs at the knee on the leg extension machine. **Hyperextension** is the increase in the angle beyond the anatomical point of normal joint movement. Hyper extension occurs during the back swing in bowling (shoulder joint), in a neck bridge in wrestling (neck), and on the standing hip machine when the hip is lifted behind the body (hip joint).







1-2. Directional terms. A. lateral view. B. Anterior view.

Planes of Movement

Now that anatomical position and appropriate directional terminology have been established, we're ready to explore the language of human movement. The human body moves in complex ways, which can make description difficult. Scientists have categorized and simplified the terminology of human movement in an effort to heighten understanding and communication. This strategy encourages consistent description and analysis of complex human movements by breaking them down into simpler parts.

Motions occur at the joints of the body in one of three general directions: front to back, side to side, or rotationally. To describe these movements precisely, it helps to visualize the body transected by one of three large imaginary planes.

The first plane, which divides the body vertically into right and left halves, is called the **sagittal plane (**FIG. I-3A). Front-to-back movements occur parallel to this imaginary plane. Swinging your arms and legs back and forth with walking are examples of sagittal movements.

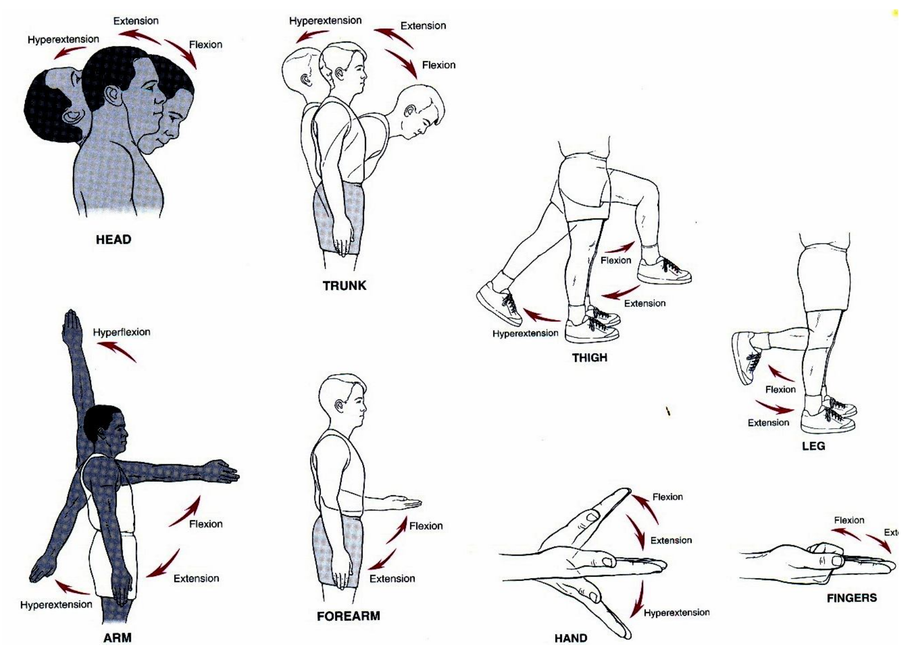
The second plane divides the body into front and back halves. It is called the **frontal plane (**FIG. 1-3B). Side-to-side movements occur parallel to this imaginary plane. The arm and leg movements that occur when you do jumping jacks are examples of frontal movements.

The third plane divides the body into superior and inferior regions. It is called the **transverse plane** (FIG. 1-3C). Rotational or turning movements occur parallel to this imaginary plane. Turning your leg out or your head to look over your shoulder are examples of transverse movements. The word *transverse* means "across," so a transverse view of the body is sometimes referred to as a *cross-section.*

Fundamental movements of major body segments

Several movements are possible in many joints. Six primary movements occur at the joints between the body segments: flexion, extension, abduction, adduction, rotation and circumduction.

Flexion is a decrease in the angle between two body segments. Flexion occurs at the shoulder, elbow, hip and knee joints. Special flexions occur at the trunk (lateral flexion or bending sideways); the wrist (ulnar flexion or bending toward the pinky side of the hand, and radial flexion or bending toward the thumb side); and the ankle (**dorsiflexion** or toes up, and **planter flexion**, or toes down).



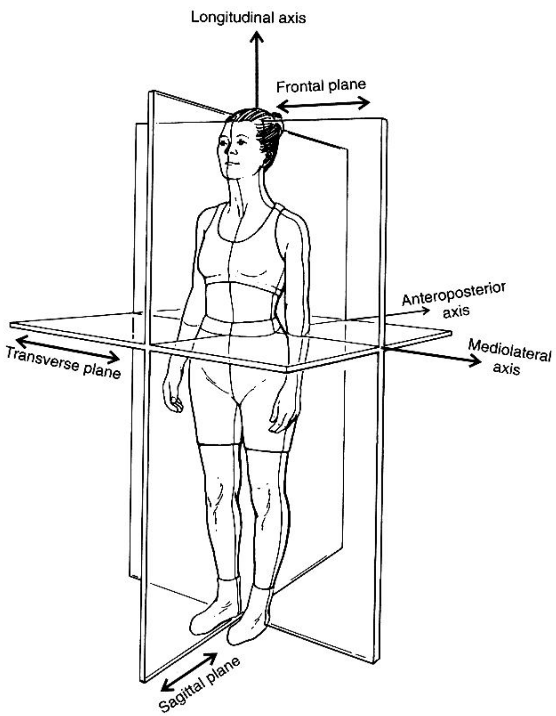
Planes of motion

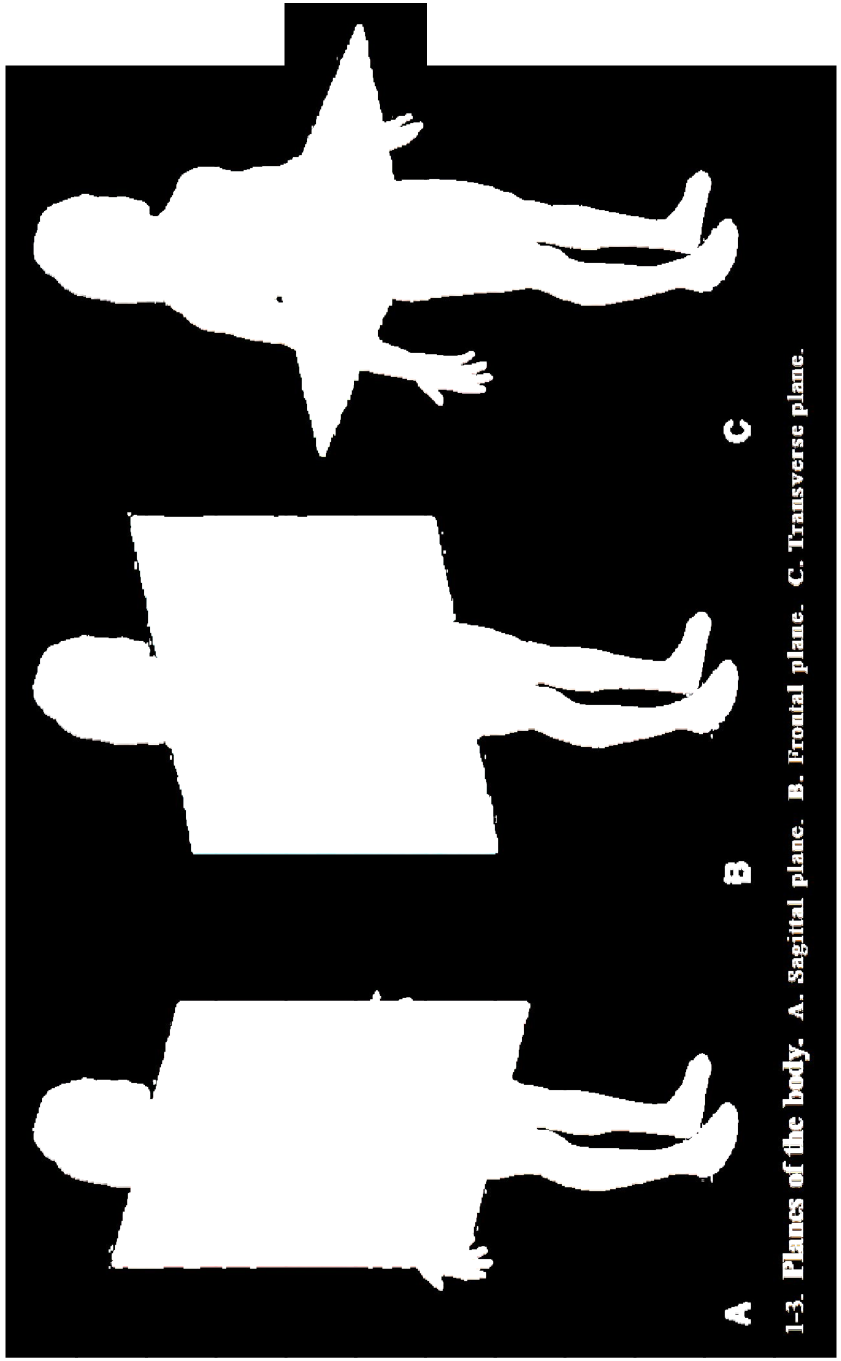
Human movements are commonly described in terms of the planes that they occupy. A plane is a flat surface. There are three imaginary planes that pass through the human body. Each plane is perpendicular to each of the other two.

The **sagittal plane** is a vertical plane passing through the body from front to back, dividing the body into left and right portions.

The **frontal plane** is a vertical plane passing through the body from left to right, dividing it into front and back portions.

The **transverse plane** passes through the body in a line parallel to the ground, dividing the body into upper and lower portions.





1-3. Planes of the body. A. Sagittal plane. B. Frontal plane. C. Transverse plane.

Axes

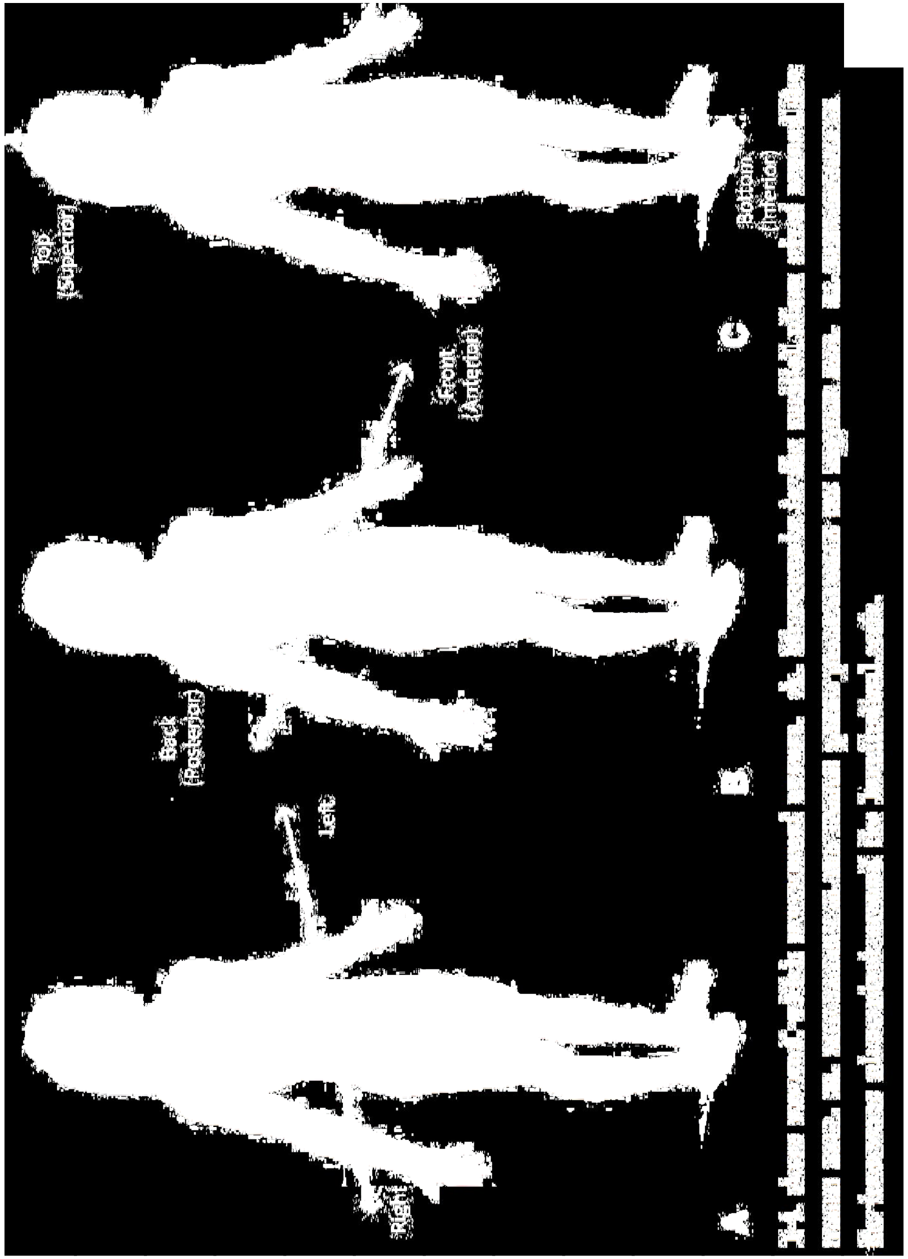
Each of the three types of movement, sagittal (front-toback), frontal (side-to-side), and transverse (rotational) must occur around an **axis** (a pivot point). Visualize a wheel turning on its axle. The axle is the axis that the wheel turns around. Each of the three planes of movements has a corresponding axis around which movement occurs. This axis is always perpendicular (at a right angle) to the corresponding plane.

Understanding these imaginary axes, along with their counterpart planes, helps us communicate precisely about movement. For example:

• The front-to-back movements that occur on the sagittal plane pivot around the **frontal axis** (FIG. A). This means that movements such as swinging your arms while walking (front to back) occur in the sagittal plane and pivot around an imaginary line that goes through the shoulder from right to left. This is also true when you bend forward at the waist. The body is moving in the sagittal plane (front to back) around a frontal axis (transecting at a right angle side to side) that goes through the pelvis.

• The side-to-side movements that occur in the frontal plane pivot around the **sagittal axis** (FIG. B). This means that the leg and arm movements during jumping jacks occur in the frontal plane and pivot around imaginary lines that go through the hips and shoulders from front to back. This is also true when you tip your head to the side. This movement occurs on the frontal plane (side to side) around a sagittal axis (transecting at a right angle front to back) that goes through the cervical vertebrae of the neck.

• Finally, the rotational movements that occur on the transverse plane pivot around the **longitudinal axis** (FIG.C). For example, the movement of turning your head to look over your shoulder occurs in the transverse plane and pivots around an imaginary line that runs superiorly- inferiorly through the spine. Similarly, when you turn your shoulder to throw a Frisbee, your arm turns on the transverse plane (rotation) around a longitudinal axis through the shoulder (transecting at a right angle up and down).



UNIT- I
INTRODUCTION OF KINESIOLOGY

A basic understanding of kinesiology plays an important role in establishing fitness- training programs for beginners.

Kinesiology is the study of human motion and deals mainly with the muscles and muscle functions. It describes movement, which muscles are involved in the movement, and how they are involved. It explores the muscular involvement in strength exercises and sports technique.

Kinesiology from the greek words

‘**kinein**’- to Move,

‘**Logos’**- to Study

Is the scientific study of movements

DEFINITIONS

“Kinesiology is the study of human movements”

“The branch of physiology that studies the mechanics and anatomy in relation to human movements”

AIM AND OBJECTIVES OF KINESIOLOGY

The primary aims of kinesiology are

- Under standing the human body’s physiology and phychological responses to acute short-term physical activity.
- Understanding the various adaptations of the human body to chronic (or) long-term physical activity.
- Understanding the cultural, social and historical importance (or) physical activity.
- Understanding the mechanical qualities of movement.
- Understanding the processes that control movement and the factors that affect the acquisition of motor skills, and
- Understanding the psychological effects of physical activity on human behavior.

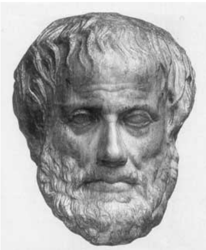
To achieve these aims, research in kinesiology requires the use of a variety of scientific knowledge and research techniques from such field as biology, chemistry, history, physics, psychology, and sociology. The areas of investigation within kinesiology are quite extensive because the responses of the human body to physical activity can be examined at many levels.

A knowledge base in kinesiology provides professional preparation for careers in fitness related industries, athletic training, teaching and coaching, and health related fields such as physical therapy.

History of Kinesiology

ARISTOTLE (384-322 B.C)

Aristotle is the "Father of Kinesiology"; His treatises,



PARTS OF ANIMALS, MOVEMENT OF ANIMALS and PROGRESSION OF ANIMALS, described the actions of the muscles and subjected them to geometric analysis for the first time. He first to analyzed and described walking, in which rotatory motion is transformed into translatory motion.

Archimedes (287-212 B.C)

Archimedes another Greek, determined hydrostatic principles governing floating bodies that are still accepted as swimming. In addition, he suggests that his inquiries included the laws of leverage and determining the center of gravity and the foundation of the oretical mechanics.

Galen (131-201 A.D)

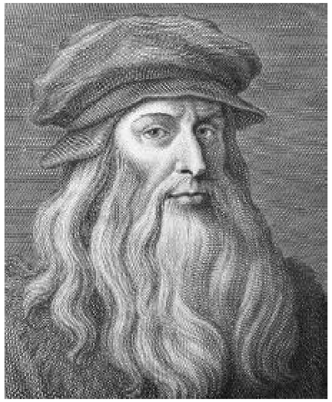
Galen a Roman citizen who tended the Pergamum's gladiators in Asia Minor and is considered to have been the first team physician in history. He used number to describe muscles. His essay DE MOTU MUSCULORUM distinguished between motor and sensory nerves, against and antagonist muscles,

When attempting to pull an object, the same general directions apply, but with this exception. As in the case of pulling the low trunk by a rope, it may be advantageous to pull in a slightly upward direction because the lifting effect would help to reduce friction. Nevertheless, unless one wishes to rotate the object, the pull should be applied in line with the object's line of gravity.

When applying a pull or push to an object that must move on a track, such as a window or a sliding garage door or a weight machine, it is essential to apply the force in the direction that the track or runway permits. Force in any other direction is wasted and friction is increased. Trying to open a heavy window or one the sticks can be done by standing with the right side next to it, the arm close to the frame, and then pushing vertically upward. If more force is needed, the knees and hips should be flexed then supplements the force exerted by the arm with little increase in the length of the resistance arm. If this action is inadequate, both hands can be used by twisting the trunk to face the window. In pulling the window down, one should face it, stand as close as possible, and use both hands, being careful to apply the force vertically downward.

described tonus, and introduced terms such as diarthrosis and synarthrosis. Some of writers consider his treatise the first text book of kinesiology and he has been termed "the father of sports medicine".

Leonardo da Vinci (1452-1519)

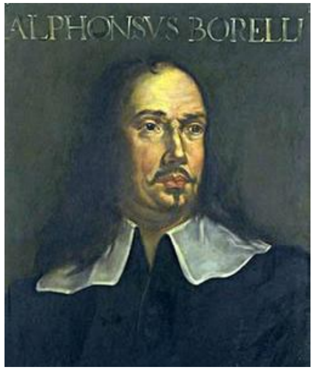


Kinesiology and anatomy lay untouched from the mystical studies of Galen until the 15th century when Leonardo da Vinci (1452-1519) advanced them another step. This artist, engineer, and scientist, da Vinci was particularly interested in the structure of the human body as it relates to performance, center of gravity and the balance and center of resistance. He used letter to identify muscles and nerves in the human body that he retrieved from grave yards in the middle of the night. He described the mechanics of the body during standing, walking up and downhill, rising from a sitting position, jumping and human gait. To demonstrate the progressive action and interaction of various muscles during movement, he suggested that cords be attached to a skeleton at the points of origin and insertion of the muscles.

Galileo

Galileo, the father of parabolic mathematics, also proved that the flight (trajectory) of a projectile through a non-resistant medium is a parabola. His work gave impetus to the study of mechanical events in mathematical terms, which in turn provide a basis for the emergence of kinesiology as a science.

1600's Giovanni Alfonso Borelli



Born in 1608, he is considered to be the Father of Biomechanics for his contributions to the field. The American Society of Biomechanics annually awards the scientist contributing the greatest achievement within the field with it's highest award, the Borelli Award. Borelli's knowledge of mechanics relative to human movement was restricted to the principles of levers and, as such, it appears to generate his accurate account of spinal muscle action. He worked in collaboration with Marcello Malpighi. Malpighi was a professor of theoretical medicine at the University of Pisa. Malpighi recalled "What progress I made in philosophizing stems from Borelli. Borelli states this about Malpighi "I worked hard dissection living animals at his home and observing their parts to satisfy his keen curiosity".

Borelli applied these principles of Equilibrium of Rotation and Equilibrium of Translation to spinal biomechanical analysis. In his work De Motu Animalium, Borelli illustrates the first comprehensive accounts of force of effort provided by posterior spinal musculature in stabilizing a force of resistance. "If the spine of a stevedore is bent and supports a load of 120 pounds carried on the neck, the force exerted by Nature in the intervertebral disks and in the extensor muscles of the spine is equal to 413 pounds. At the fifth lumbar the muscular forces are equal to 413 pounds and the forces exerted by the disc are equal to 1239 pounds."

One of the greatest mechanical features noted of the body, as was shown by his analysis, was that the muscles act with short lever arms so the joint transmits a force that is a magnitude greater than the weight of the load. Borelli overturned older concepts of muscle action, which was that long lever arms allowed weak muscles to move heavy objects.

The magnitude of the force used in pushing, pulling, and lifting can be increased in two ways. The immediate way is by using the lower extremities and, in some instances, the body weight to supplement the force provided by the upper extremities. In many, if not most, pushing and pulling activities the direction and point of application of force are interrelated. They both have an important bearing on the effectiveness of the force exerted, and also on the force is applied in line with the object's center of gravity and in the desired direction of motion. When this application of force is not feasible, the undesirable component of force should be as small as possible. For instance, if one desires to push a low trunk across the floor, it would be difficult to stoop low enough to push with the arms or even the forearms in a horizontal position. One should stoop as low as conveniently possible, however, to reduce the downward component of force that would tend to increase friction. If it were necessary to move the trunk down a long corridor, it would be more efficient to tie a rope to the handle at one end and pull it. By using a long rope, the horizontal component of force would be relatively small. Some lifting component would be desirable, hoe ever, as it would serve to reduce friction.

When friction is a major obstacle, as when pushing a tall object such as filing cabinet across a capered floor, the horizontal push should be applied close to the cabinet's center of gravity at a point found by experimentation. When this point is found, it will be possible to push the cabinet without tipping it. When it does not seem practical to slide a heavy object along the floor, one may try "walking" it on opposite corners. This involves tipping the object until it is resting on one edge of its base and then, by a series of partial rotations, alternately pivoting it first one corner and then other. The arms alternate in a lever action, one hand holding the upper corner that corresponds to the lower one that is serving as the pivot, and the other hand pushing the diagonally opposite upper corner forward.

a common denominator: Each involves moving an external object, either directly by some part of the body or by means of an implement, in a pushing or pulling pattern.

Joint Action Patterns

In pushing and pulling of motion, the basic joint actions are flexion and extension in one or more of the extremities. In the lower extremities, extension occurs simultaneously in the hip, knee, and ankle. This simultaneously and opposite joint action is a primary characteristic of push – pull patterns. All joint motions occur at the same time or very near the same time.

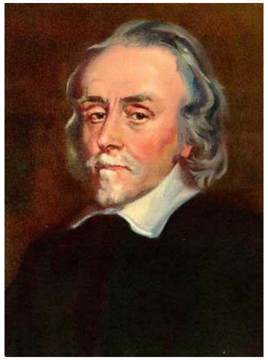
A push, pull, or lift may be applied either directly or indirectly to an object. In the latter instance, the push or pull pattern is used to develop potential energy in an elastic device such as a bow or slingshot. When the elastic structure is released, it imparts force to the movable object, causing the arrow or shot to be projected into the air.

Application

The great majority of pushing, pulling, and lifting activities undoubtedly occur in every day task. A number of sports, however, involve the continuous pushing or pulling of external objects. Archery is an interesting example, since it consists of pulling with one hand while pushing with the other. The same is true of using a forked stick slingshot. Pushing is also used in football, and both pushing and pulling are used in wrestling. Weight lifting is the prime example of a sport activity involving lifting.

Rowing and paddling, although classified as forms of aquatic locomotion, may also be considered activities that involve external objects. Oars and paddles are both moved by continual pushing and pulling movements. Pole vaulting, rope climbing (previously classified as locomotion), and all suspension activities might also be included in the pushing and pulling category, provided one accepts activities that involve the moving of the body by means of pushing or pulling an external object, the object in such cases also servings as the means of body support.

William Harvey (1578-1657)



The circulation of the blood through the body was first demonstrated by William Harvey (1578-1657), although he erroneously attibuted to the heart the foundation of recharging the blood with heat and "vital spirit".

Nicloas Andry (1658-1742)

The word "orthopedics" was coined by Nicolas Andry (1658-1742) from the Greek roots "orthos", meaning "straight" and "pais", meaning "child". Andry believed that skeletal deformities result from muscular imbalances during childhood. In this treatise, ORTHOPEDICS or the ART OF PREVENTING AND CORRECTING IN INFANTS DEFORMITIES OF THE BODY, originally published in 1741, he defined the term "orthopedist" as a physician who prescribes corrective exercise. (Andry, 1961). Although this is not the modern usage, Andy is recognized as the creator of both the word and the science. His theories were directly antecedent to the development of the Swedish system of gymnastics by Per Henrik Ling (1776-1839).

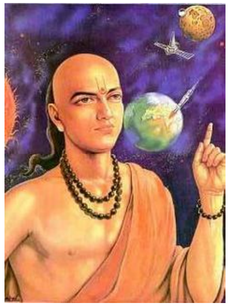
Sir Issac Newton (1642-1727)

In PRINCIPIA MATHEMATICA PHILOSOPHAE NATURALIS, which is "perhaps the most powerful and original piece of scientific reasoning ever published", he laid the foundation of modern dynamics. Particularly important to the future of kinesiology was his formulation of the three laws of rest and movement, which express the relationships between forces (interaction) and their effects:

James Keill (1674-1719)

In his studies of muscular contraction, James Keill (1674-1719) calculated the number of fibers in certain muscles, assumed that on contraction each fiber became spherical and thus shortened and from this deduced the amount of tension developed by each fiber to lift a given weight.

1114 A.D. Bhaskaracharya Second



In his work, Siddhanta Shiromani, Second describes the concepts in trigonometry of sine and cosine. These concepts are essential to mathematically determining forces used and created in lever systems. This knowledge will not make its way into western culture until Britain colonizes India and British mathematicians discover it.

<u>Role of Kinesiology in Physical Education and Sports</u>

1. To provide the future physical education teacher / coaches with the knowledge necessary for analyzing human motion.
2. And appling such analysis to the learning and improvement of motor skills.
3. With applied anatomic background the knowledge of kinesiology helps to prevent injuries.
4. Economy of the movement can be ensured.
5. Effectiveness of the movement can be ensured.
6. For clinical / rehabilitation purpose kinesiology has great importance.
7. Designing and teaching of exercise / conditioning / fundamental movements the knowledge of kinesiology is must.

One general phasing, scheme describes three throwing phases: action, and recovery. The primary functions of the preparation phase are to 1, put the body in a favorable position for execution of the throw, 2, maximize the range of movement, 3, allow for larger body segments to initiate the throw, 4, place the muscle at an advantageous length on their respective length – shorten cycle, 5, place the muscles at an advantageous length on their respective length – tension curves, and 6, store elstic energy to be used during the action phase.

During the action phase, skillful throwers use sequential muscle actions to execute the throw, beginning with muscles of larger segments. In most throws, there is proximal – to – distal muscle action and transfer of momentum and kinetic energy. The exact pattern of muscle action and mechanical transfer depends on the goal of the throw.

The primary purpose of the recovery phase is to slow down, the body and its limb segments through eccentric muscle action. This places the body in a favorable balanced position and reduces the chance of injury.

These general phases often are modified, or subdivided, in describing the throwing motion of a particular sport or type of throw. In basketball, for example, the pitching motion typically is divided in to five phases: windup, cocking, acceleration, deceleration, and follow- through. A six phase, stride, is sometimes included between windup and cocking. In context of the general scheme just presented, windup and cocking would constitute preparation, acceleration would correspond with action, and deceleration and follow – through would combine for recovery.

PUSHING AND PULLING

A person pushes a table across the room, a boxer jabs at an an opponent, a traveler lifts a suitcase onto an overhead rack, an archer shoots an from a bow, and a school teacher lifts open a window. As widely divers as these activities seem, they all have

Throws are categorized according to upper – extremity limb segments motion and the method of imparting force to the projectile. Classification include over arm throws, under arm throws, push throws, and pull throws. Over arm throwing is used, for example, by baseball pitchers and javelin throwers. Softball pitchers employ an underarm throwing motion to deliver the ball to the plate. Shot – putters use a push throw to project the shot, while discus and hammer throwers employ a pull throw to project their respective implements.

Throwing principles

Throwing depends on a number of principles, including the transfer of momentum in a proximal – to – distal manner an object held in the hand. As a result the object is thrust, or propelled, in to the air. The proper sequencing of limb segments motion presents the neuromuscular system with a challenging muscular control problem. In executing a throw, the body makes good use of the stretch – shorten cycle to enhance force production and throwing distance.

Throwing and projectile motion

Projectile move through the air under the influence of only gravity and air resistance along a path called the trajectory. The trajectory is determined by three factors: release height (above the ground), release speed (how fast the object is thrown), and release angle (relative to the horizontal). All the thrower's actions releases are intended to produce the proper combination of height, speed, and angle and thereby achieve the throwing goal.

Throwing Phases

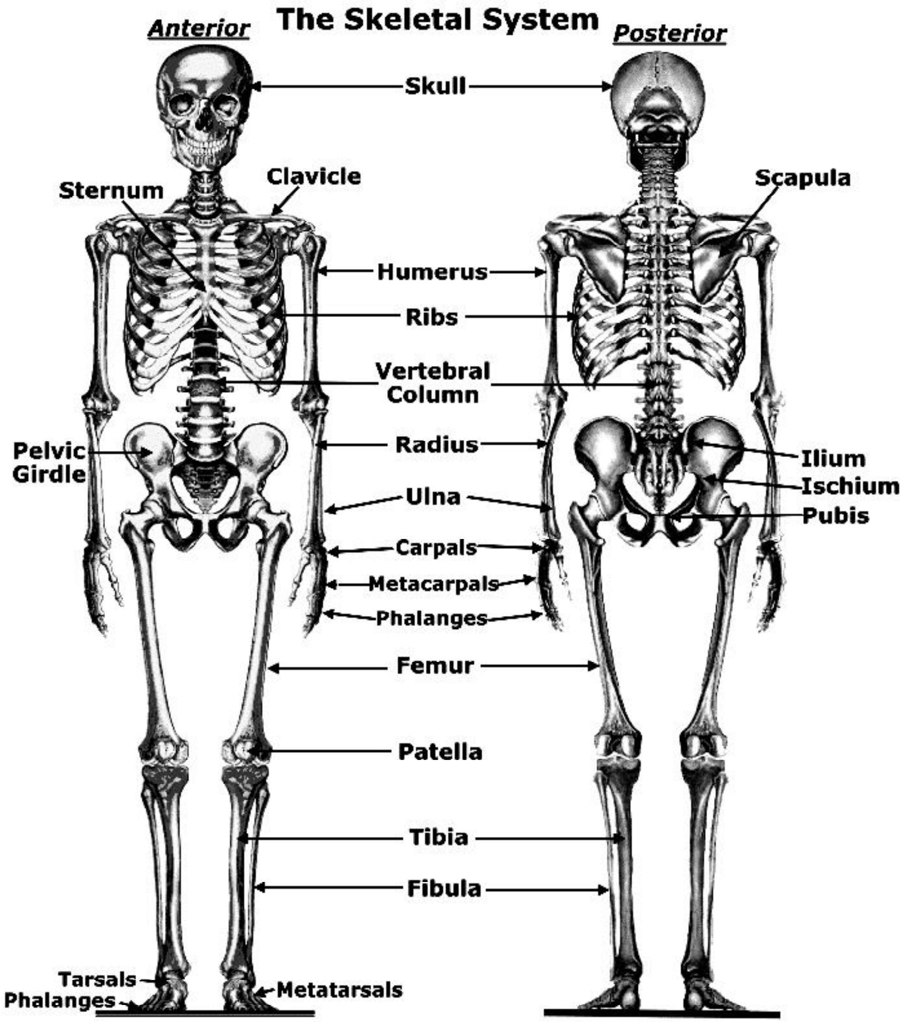
The throwing pattern often is divided in to phases to facilitate analysis. Each phase has defined beginning and end points, as well as specific biomechanical functions that contribute to the success of throw.

8. Self- realization about own performance is best realized by the athlete themselves with the background of kinesiology.
9. To discover and recognize the underlying principles of movement.
10. It is an educational experience for physical education and physical medicine.
11. Effective teaching of motor skills with the knowledge of kinesiology are best achieved in regard to
    a. fundamental motor skills and
    b. specialized motor skills.
12. Evaluation of exercise and activity from the point of view of their effect on the human structure.
13. For physiotherapy, physical medicine purposes.
14. For postural analysis, and correctives physical education.

UNIT- II

Function of Skeletal System

The average human adult skeleton has 206 bones joined to ligaments and tendons to form a supportive and protective framework for underlying soft tissues and muscles.



until landing. Following flight, first ground contact begins the landing phase, during which the hips and knees flex, with ankle dorsiflexion and extension of the arms, as the body absorbs the forces of landing.

The proper timing of joint motions is critical for a successful and proficient jump. During the propulsive phase, for example there is a rapid proximal – to – distal sequencing of maximum angular velocity at the hip, knee, and ankle joints, with very small delays between adjacent segments. This sequencing is necessary for the effective transfer of energy, from one segment to the next, required for optimal jumping performance. Alterations in this sequencing, such as when a jumper is fatigued, can alter the mechanics of the jump and result in a lower jump height.

THROWING

Throwing is as old as humankind. In prehistoric times, hunters threw rocks and spears at animals in hopes of securing food survival. Through the millennia, throwing has been an essential combat skill, early on using rocks and primitive weapons and more recently employing destructive implements such as hand grenades. Many contemporary sports include throwing as an essential skill. These include softball and baseball, American football, basketball, and several events in athletics (i.e., track and field) such as the shot put, discus, and javelin. In noncompetitive situations, throwing sometimes provides nothing more than a pleasant diversion, as when a thrower tries to skip rocks across the still surface of a mountain lake.

Despite the wide range of venues and goals, all throws are similar in that they involve using the upper extremity to launch a handheld object (projectile) through the air. The study of projectile motion is called ballistics, and throwing is one of several ballistics skills in which force is imparted to an object to project it through the air. Other ballistics skills include kicking and striking.

Even though these are descriptive and specific, they still do not include all forms of jumping. In athletic competition, for example, high jumpers leave the ground from one foot and land in the pit on their backs. They clearly jump, but their actions do not fit in to any of the standard definitions.

Types of Jumping

Jumping comes in many forms. Children at play jump out of sheer joy. Athletics jump to grab a rebound in basketball or catch a pass in American football. Ballet dancers jump when performing a grand jet. Physical education students do jumping jacks. Boxers jump rope. The list goes on and on.

Jumping is also used to test lower – extremity power output (e.g., Vertical jump test) and provides performance challenges to see how high (e.g., high jump) and far (e.g., long jump, triple jump) one can jump. Each jump types has a specific goal and therefore requires a unique set of movements and pattern of muscle involvement.

With so many different types of jumps, it is infeasible to analyse here the joint motions and muscle control of all of them. Thus, we describe a basic standing vertical jump with a two – foot take off landing. The fundamental patterns described here are modified for other jump types, but many of the basic concepts, such as preparatory leg and arm action (i.e., Counter movements), apply to most jump types.

A standing vertical jump can be divided into four phases: Preparatory, Propulsive, flight, and Landing. The jump begins from a normal standing position. During the preparatory (down) phase, the hip and knee joints flex, the ankles dorsiflex, and the arms swing back into hyperextension. In the propulsive (up) phase, the hips and knees extend, the ankles planter flex, and the arms swing forward in flexion. The flight phase begins at take off when the toes leave the ground. Throughout the flight phase, the body assumes a relatively upright posture that is maintained

The skeleton system serves several important functions in the body.

- Bones serve as levers that transmit muscular forces.
- Our skeletal system protects our organs.
- Our skeleton system serves as a framework for other tissues and organs.
- Bones serves as banks for storage and release of minerals like calcium and phosphorous.

Axial skeleton

The skeleton consist of the axial and appendicular skeleton. There are 80 bones in the **axial skeleton,** consisting of the skull, spine, ribs and sternum.

Appendicular skeleton:

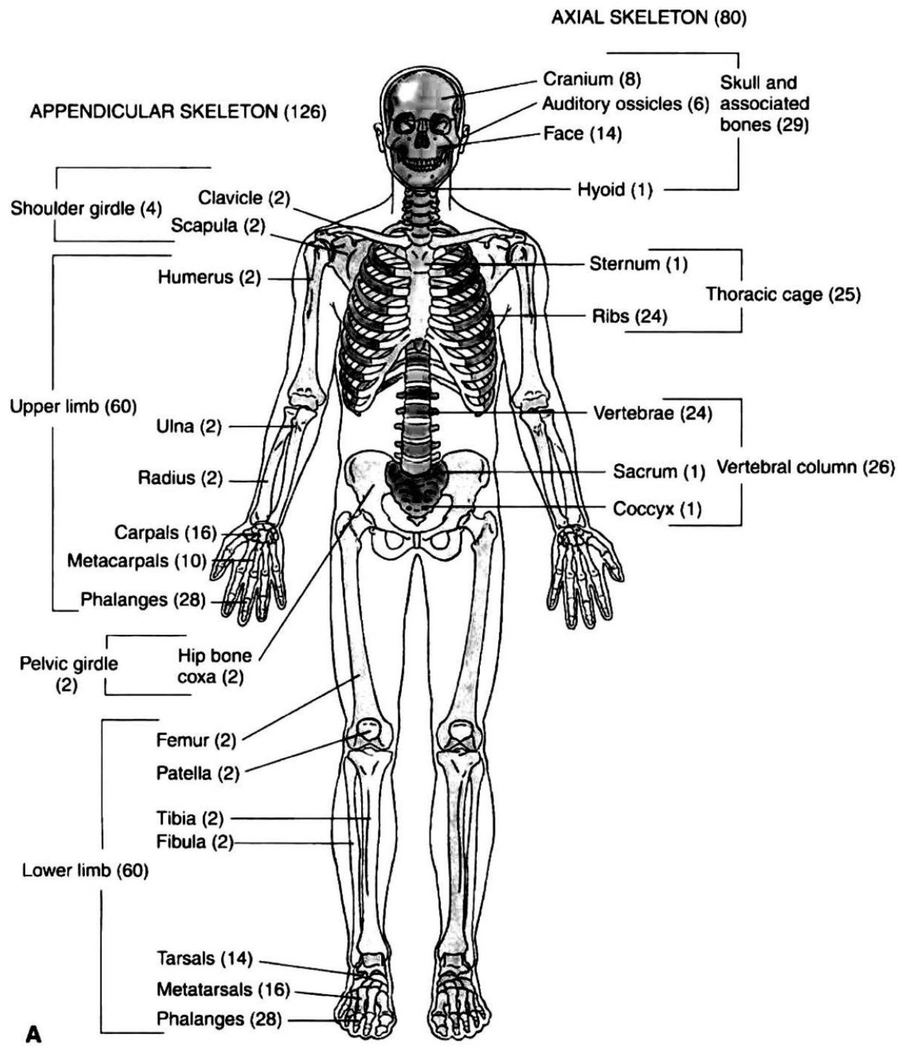
There are 126 bones in the **appendicular skeleton:** 60 in the upper extremities, 60 in the lower extremities, 2 in the pelvic girdle, and 4 in the shoulder girdle.

Bones of the Body

We have about 206 bones, but when we were born we had around 350. This is because many smaller bones join together as we grow.

Bone consists of three layers.

- Bone marrow
- Compact bone
- The periosteum



The human skeleton. (Anterior View) There are 206 bones in the typical human skeleton, 80 in the *axial* skeleton and 126 in the *appendicular* skeleton

The kinematics of the walking gait is often described in terms of strides and steps. A stride is one full lower extremity cycle. In walking and running, a stride is defined as being from heel strike on one leg to the next heel strike with the same leg. Stride length, then is the distance covered during a single stride.

ANATOMICAL ANALYSIS

The six major components of walking have been defined as 1) pelvic rotation, 2) pelvic tilt, 3) knee flexion 4) hip flexion 5) knee and ankle interaction, and 6) lateral pelvic displacement. Each of these components is essential for efficient walking and the loss of any one will cause an increase in the energy cost.

The action taking place in the joints of the lower extremity consists essentially of flexion and extension, But in much the same way that the shoulder girdle comperates with the arm movements of the upper extremity, the pelvic girdle cooperates in movements of the lower extremities.

The adaptations of the pelvic position are made in the joints of the thoracic and lumbar spine as well as in the hip joints. Thus, as first one foot and then the other are put forward, the flexion and extension movements of the thigh are accompanied by slight rotary movements and ab- and adduction at the hips, and by slight lateral flexion and rotation of the spine.

JUMPING

Jumping means “to spring free from the ground or other base by the muscular action of feet and legs”. This provides a general description of the jumping action but does not distinguish between different ways of launching and landing. To make this distinction, jumping applies to when individuals propel themselves from the ground with one or both feet and then land on both feet. Hopping involves propelling from one foot and landing on the same foot. Leaping describes the movement when individuals propel from one foot and land on the other foot.

4. In an efficient run, the foot should strike the ground as close as possible to the line of gravity. If the foot should strike ahead of the line of gravity, the reaction force to this forwards and downward thrust will be a backward and upward force, acting to retard forward motion.

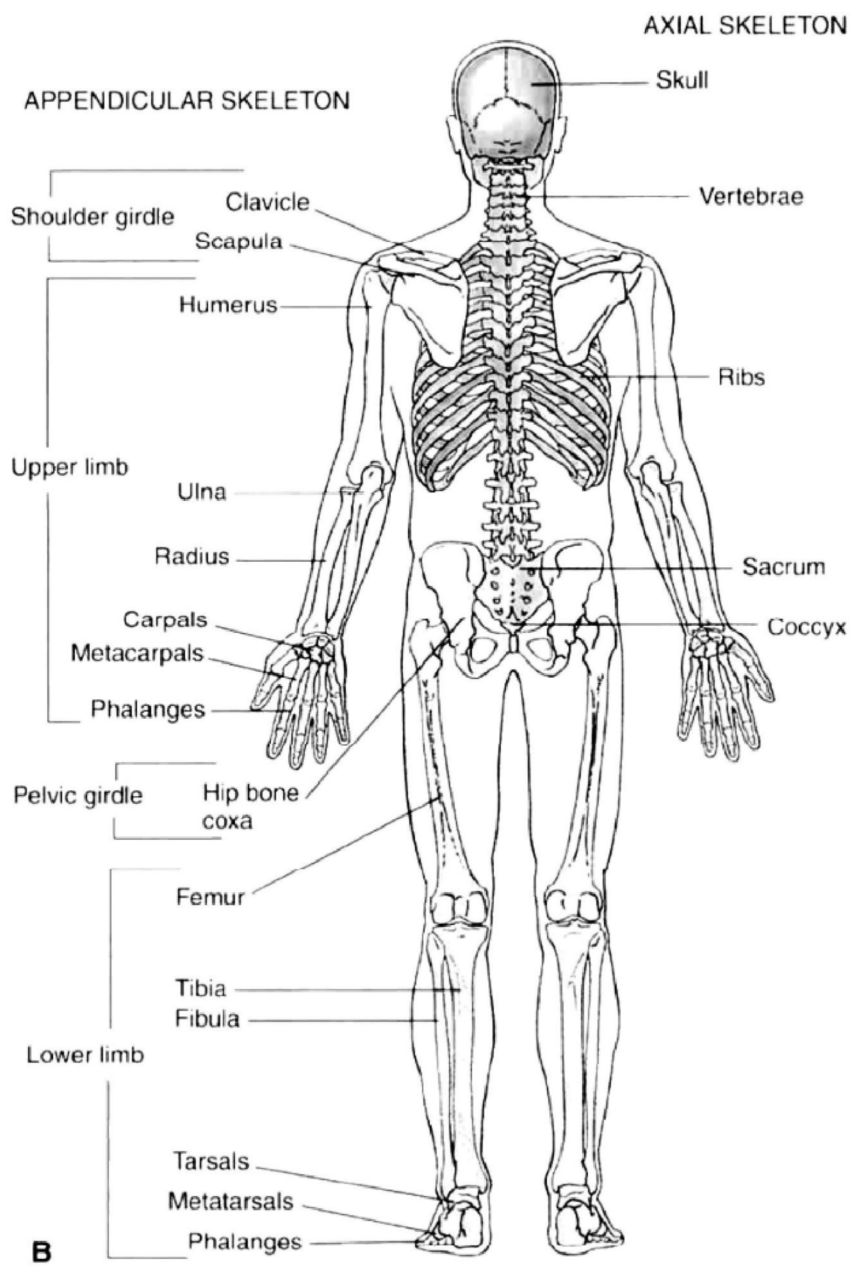
5. The knees should be lifted directly upward and forward, with the motion of the entire lower extremity occurring within the sagittal plane. The arm swing should exactly counterbalance the twist of the pelvis and should not cause additional lateral motion.

6. Resistance force due to the moment, of inertia of the free leg during the swing phase can be minimized. By flexing the free leg at the knee and carrying the heel high up under the hip, the leg is moved more rapidly as well as more economically. His high knee lift increases as speed increases.

7. The force of air resistance can be altered by shifting the center of gravity. A for ward lean will work to counteract a head wind. A tail wind often enhances performance.

WALKING

Walking is accomplished by the alternation action of the two lower extremities It is an example of translatory motion of the body as a whole brought about by rotary motion of some of its parts, It is also an example of a periodic or pedulumlike movement in which the moving segment (in this case the lower extremity) may be said to start at zero, pass through its arc of motion, and fall to zero again at the end of each stroke. In walking, each lower extremity undergoes two phases; the swing or recovery phase and the support phase. The support phase is further divided into heel-strike the heel-strike and foot-flat phase of the other leg, thus producing a period of double support when both feet are on the ground. This double support phase is characteristic of the walk and serves to differentiate it from the run.



The human skeleton. (Posterior view)

BONE MARROW

Within the long bone is a central marrow cavity known as bone marrow.

The red marrow produces red blood cells, which carry oxygen, white blood cells, which fight infection, and platelets, that help stop bleeding.

The yellow marrow consists mainly of fat cells.

COMPACT BONE

Surrounding the marrow is a dense rigid bone called the compact bone.

Cylindrical in shape, the dense layers of the compact bone are honeycombed with thousand of tiny holes and passages. Nerves and blood vessels run through these passages. That supply oxygen and nutrient to the bone.

This dense layer of compact bone supports the weight of the body and is comprised mainly of calcium and minerals.

PERIOSTEUM

Each bone is covered by the periosteum, which is a layer of specialized connective tissue and acts as the skin of the bone.

The inner layer of the periosteum contains cells that produce bone.

These three bone layers work together to handle the aforementioned skeletal system function.

MECHANICAL ANALYSIS

The speed of running is governed by the length of the stride and the frequency of the stride. The length of the stride is determined by the length of the leg, the range of motion in the hip and the power of the leg extensors which drive the entire body forward. Like any projectile, the distance the body will move once it is driven into the air depends upon the angle of take off [distance that center of gravity is ahead of take off foot], the speed of the body‘s projection and the height of the center of gravity at take off and landing.

In running, as in walking, the force exerted to produce and control the movement are in the internal muscular forces and the external forces of gravity, normal reaction, friction, and air assistance. There is no optimal speed in running because the energy needed to run is proportional to the square of the velocity. Therefore, whether the run is an easy jog or a full speed sprint, economy of effort is a highly desirable objective. To achieve this it is essential that the runner observe the principles that apply to efficient running.

MECHANICAL PRINCIPLES IN RUNNING

1. In accordance with the Law of inertia, a body remains at rest unless acted upon by a force. The force required to overcome inertia is greatest at takeoff and least after acceleration has ceased. The problem of overcoming inertia decreases as the speed increases.

2. In accordance with the law of acceleration in the run is directly proportional to the force producing it. Hence, the greater the power of the leg drive, the greater the acceleration of the runner.

3. In accordance with the law of reaction, every action has an equal and opposite reaction. The force for the run is provided through the upward and forward ground reaction force in response to the downward, backward of the foot.

UNIT-V

MUSCULAR ANALYSIS OF FUNDAMENTAL MOVEMENTS

RUNNING

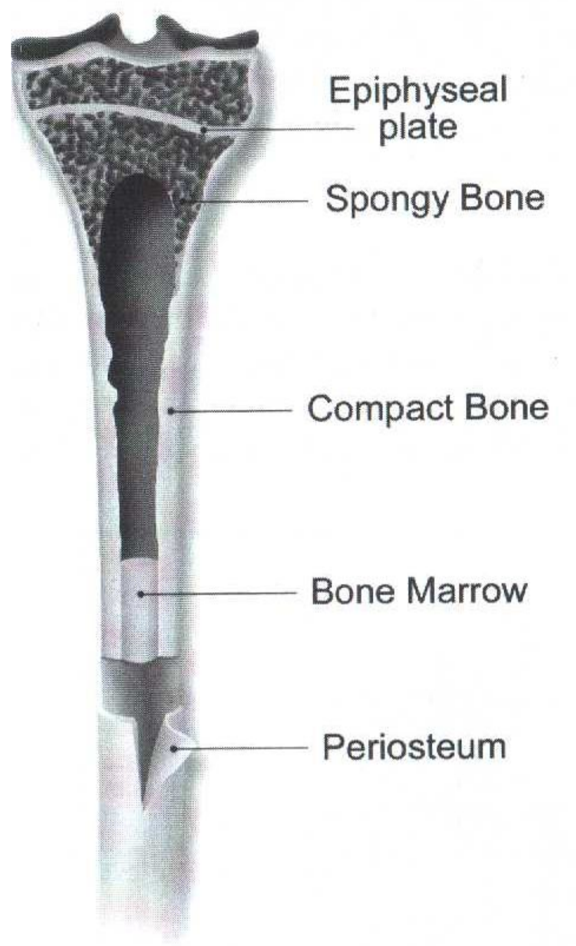
In the run the foot hits the ground in front of the body s center of gravity as in the walk, but not as far in front. As the speed of the run increases, the distance in front decrease until the foot contact is almost directly under the body's center of gravity. This position reduces the restraining part of the support phase and gives greater emphasis to the propulsive part.

There are two major types of running. The first is the kind of running done for its own sake, as in competitive races or jogging. The major concerns here are time and distance in one direction. The second is the type of running that is part of games and sports. Here it is necessary also to consider matters such as change of direction or pace and stability. The technique for a run varies with the purpose, but the basic anatomical and mechanical aspects are the same, regardless of the purpose.

ANATOMICAL ANALYSIS

The difference between the joint action in walking and running is a mater of degree and coordination. The joint actions are essentially the same but the range of motion in running is generally greater. This is especially apparent in the actions of the swinging leg. The different in coordination is evident in the period of non support and the absence of the period of double support.

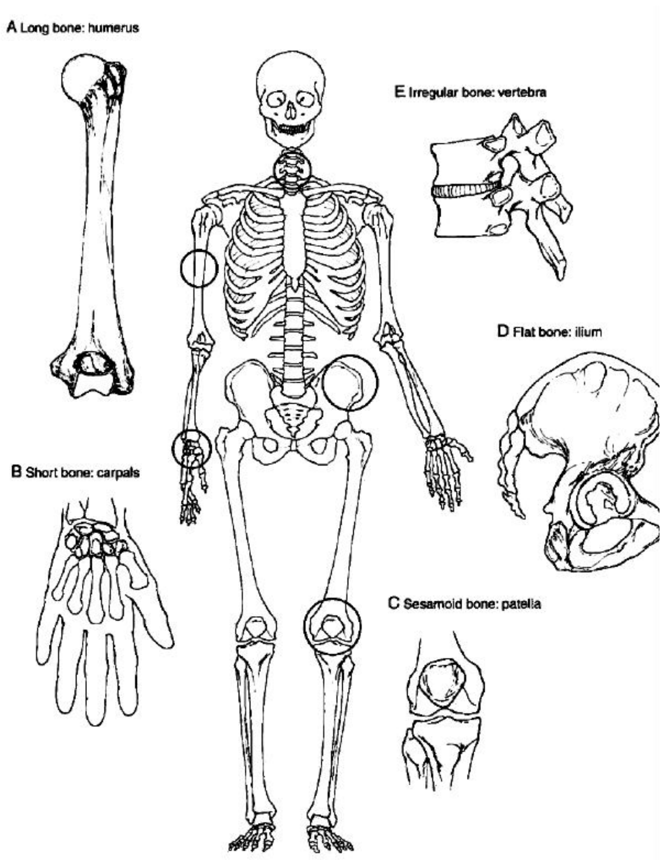
1. Support phase.
2. Swing phase
3. Heel phase.
4. Flat phase.
5. Toe off.



Bone classification

There are six main categories of bones,

- Long bone
- Short bone
- Sesamoid Bones
- Flat bone
- Irregular bones
- Wormian Bones (sutural)



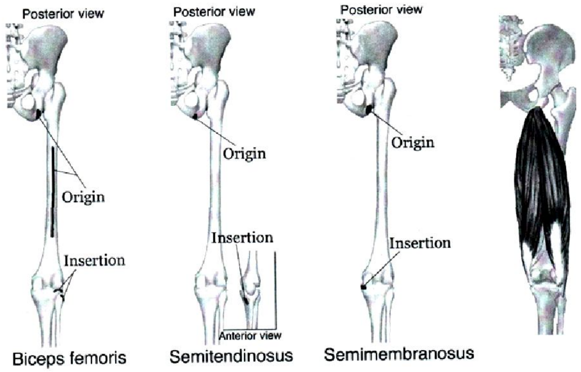
Shapes of bones. A. Long bone (humerus). **B.** Short bones (carpals). **C.** Sesamoid bone (patella), a specialized short bone. **D.** Flat bone (ilium). **E.** Irregular bones (vertebrae). Wormian bones arc not shown.

LONG BONE

Long bones provide structural support and include the tibia, fibula, femur, radius, ulna and humerus. They are long cylindrical shaft with relatively wide.

SHORT BONE

Short bones provide some shock absorption and include carpals and tarsals. They are usually characterized as small, cubical shaped, solid bones.

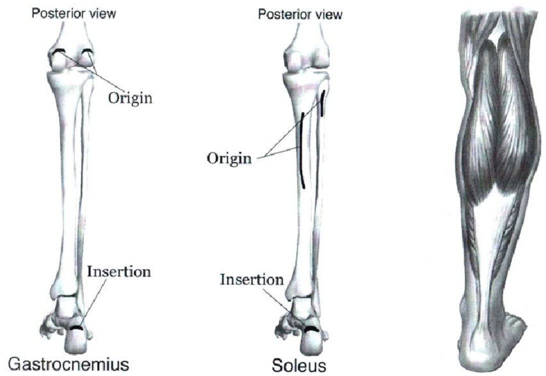


SELECTED LEG EXERCISES

- Leg press
- Lunge (stationary with dumbbells)
- Leg extension
- Seated leg curl
- Basic squat

GASTROCNEMIUS

Location – calf of leg
Origin – posterior surface of the medial and lateral femoral condyle
Insertion – calcaneus
Action – plantar flexes the ankle, flexion of the knee



SELECTED CALF EXERCISES

- Seated calf raise
- Standing calf raise

HAMSTRING GROUP

BICEPS FEMORIS

Location – posterior thigh
Origin – Ischium
Insertion – tibia and fibula
Action – extension of hip, flexion of knee, internal rotation of hip and knee

SEMITENDINOSUS

Location – posterior thigh
Origin – Ischium
Insertion – tibia
Action – extension of hip, flexion of knee, internal rotation of hip and knee

SEMIMEMBRANOSUS

Location – posterior thigh
Origin – Ischium
Insertion – tibia
Action – extension of hip, flexion of knee, internal rotation of hip and knee

GLUTEAL MAXIMUS

Location – buttocks
Origin – ilium and sacrum
Insertion – femur
Action – extends, abducts and laterally rotates thigh; extends lower trunk

SESAMOID BONE

Sesamoid bones provide protection as well as improve mechanical advantage of musculotendinous units and include unit in the patella and the flexor tendons of the toe and thumb.

FLAT BONE

Flat bones provide protection and include the ilium, ribs, sternum, clavicle and scapula. They are usually characterized by a curved surface where it is either thick at the tendon attachment or very thin.

IRREGULAR BONE

Irregular bones serve a variety of purposes in the body and include bones throughout the spine as well as the ischium, pubis and maxilla.

WORMIAN BONES (SUTURAL)

Wormian bones, also known as intra sutural bones, are extra bone pieces that occur within a suture in the cranium. These are irregular isolated bones that appear in addition to the usual centers of ossification of the cranium and, although unusual, are not rare.

CONSTRUCTION AND TYPES OF JOINTS IN THE BODY AND THEIR ACTIONS

A skeletal joint is the union between two or more bones and cartilage; or between two or more cartilages. The junctions between skeletal components may be called JUNCTURE, ARTICULATIONS, or by vernacular terms such as JOINTS.

Function of Joints

- 1. Serve as functional junctions between bones.
- 2. Bind bones , strokes , and other related tissues together.
- 3. Allow bone growth to occur .
- 4. Permit certain structures to change shape during childbirth (i.e. pubic symphysis).
- 5. Enable the body to have movements, lever actions, and body posture.

Classification of Joints by Structure

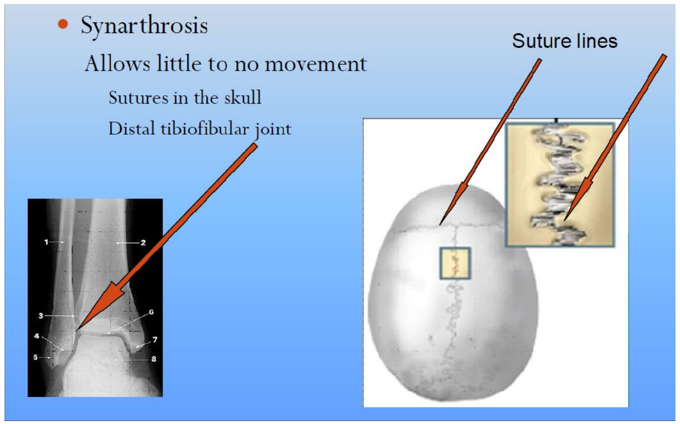
The joints are habitually differentiated into three groups :

1) Synarthroses (or) Fixed joints (or) immovable joints (or) fibrous joints
2) Amphiarthroses (or) slightly movable joints.
3) Diarthrosis (or) freely movable (or) synovial joints.

1) Synarthroses or Immovable Joints

"Sybartgrises" is a Greek word, meaning is "with joint" or a joint in which there is no separation or articular cavity. In this type the surfaces of the bones are in almost direct contact with only a thin layer of fibrous periosteum between the bones. In this joint there is no articular cavity, i.e. no capsule, no synovial membrane or no synovial fluid.

Example : Suture of the skull



VASTUS INTERMEDIUS

Location – anterior thigh
Origin – femur
Insertion – upper border of patella and tibia
Action – knee extension

VASTUS MEDIALIS

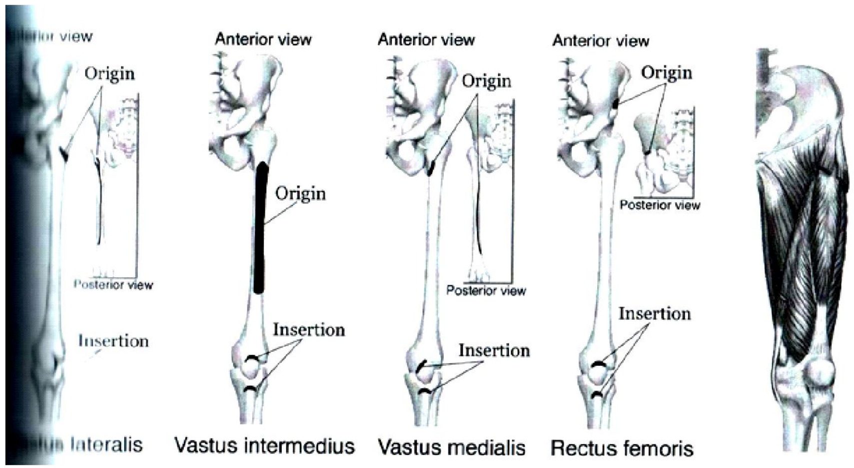
Location – medial thigh
Origin – femur
Insertion – medial border of patella and tibia
Action – knee extension

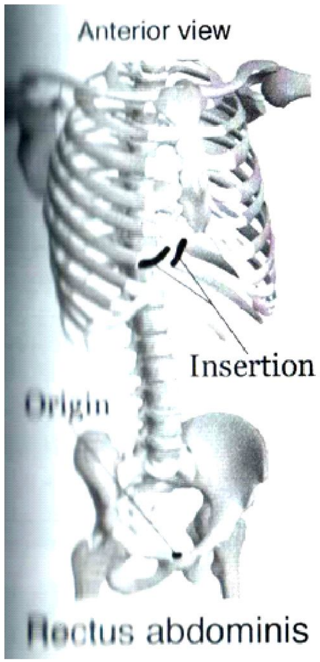
RECTUS FEMORIS

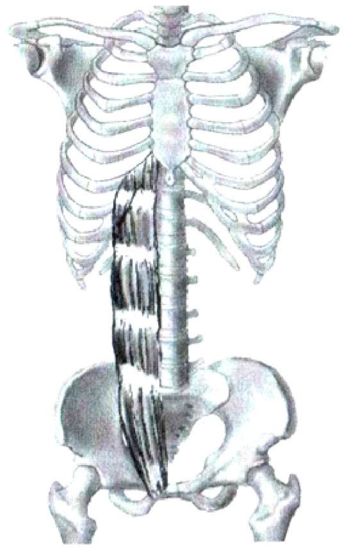
Location – anterior thigh
Origin – ilium
Insertion – patella and tibia
Action – flexion of hip, extension of knee

SARTORIUS

Location – anterior and midial thigh
Origin – ilium
Insertion – tibia
Action – flexes thigh and rotates it laterally







SELECTED ABDOMINAL EXERCISES

- Crunch
- Stability ball crunch
- Oblique stability ball crunch
- Kneeling cable crunch
- Hanging leg raise
- Forward stability ball roll

<u>QUADRICEPS GROUP</u>

VASTUS LATERALIS

Location – lateral thigh

Origin - femur

Insertion – lateral border of patella and tibia

Action – knee extension

2) Ampiarthroses or Slightly Movable

In this type of joint the continuous surfaces are either connected by broad flattened discs of fibro cartilage which adhere to the end of each bone, as in the joint between the bodies of vertebrae, or else, the joint surfaces are covered with fibro cartilage, partially lined by synovial membrane and connected by external ligaments as in public symphysis, both of these joints being capable of limited motion.

There are two types of Amphiarthrosis

a) Ligamentous (or) Synedsmosis

b) Cartilaginous (or) Synchondrosis

a) Ligamentous (or) Synedsmosis

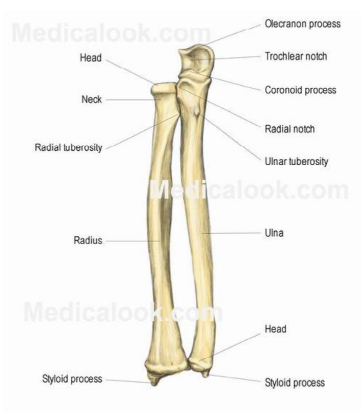
This is a Greek word, meaning is "with ligament". Two bones, which may be adjacent or which may be quite widely separated are tied together by one or more ligaments. These ligaments may be in the form of cords, bands, or flat sheets. The movement that occurs is usually limited and of no specific types.

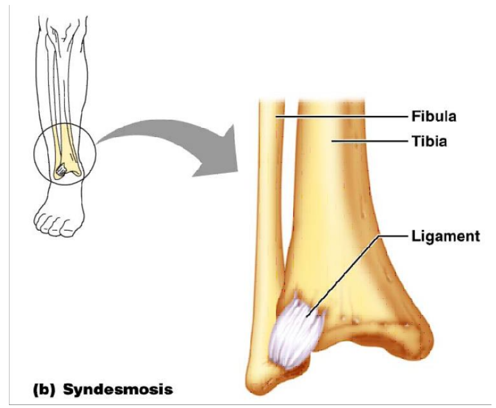
Example

i) Mid Union of Radius and Ulna

ii) Mid tibio - fibular joint

iii) Inferior tibio - fibular joint



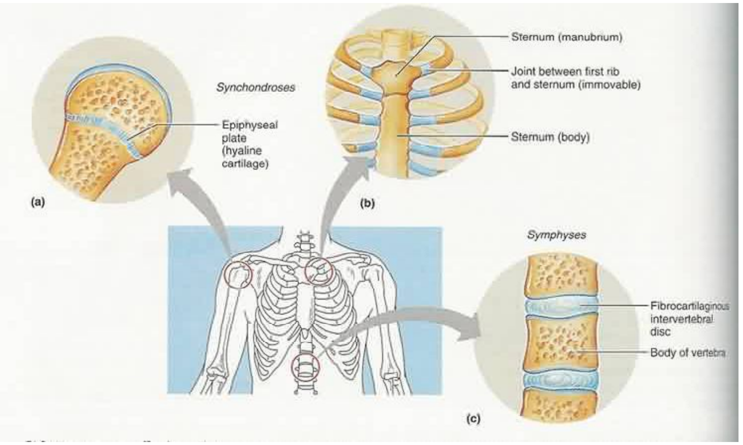


b) Cartilaginous (or) Synchondrosis

This is a Greek word, meaning is “with cartilage”. The joints which are united by fibro cartilage permit motion of a bending and twisting nature. Those united by hyaline cartilage permit only a slight compression.

Example of hyaline type. Epiphysial unions

Example of fibro cartilaginous type : Joints between the bodies of the vertebrae.



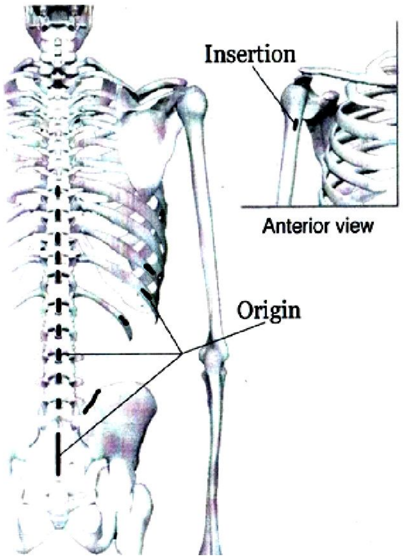
3) Diarthroses (or) Freely movable joints (or) Synovial joints

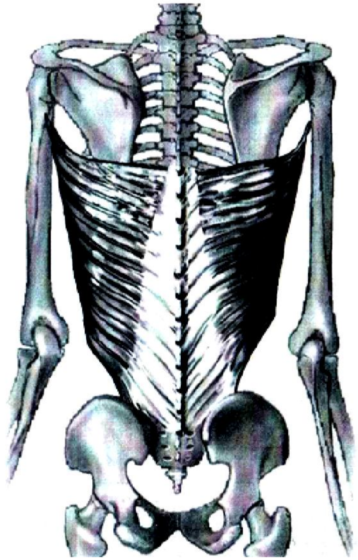
This is a Greek word, meaning a joint in which there is a separation, or articular cavity.

Characteristic of Diarthrosses Joint

a) An articular cavity is present
b) The joint is encased within a sleeve like ligamentous
c) The capsule is lined with synovial membrane which secretes synovial fluid for lubricating the joint.
d) The articular surfaces are smooth.
e) The articular surfaces are covered with cartilage, usually hyaline, but occasionally fibro cartilage.

Diarthroses or synovial joints are classified into six varieties.





SELECTED LAT EXERCISES

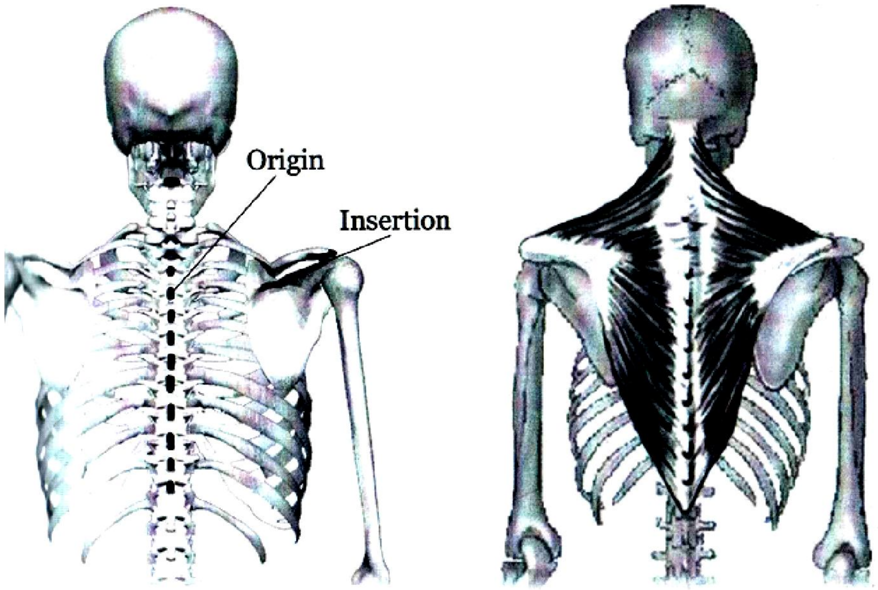
- Overhead pulldown
- Seated machine row
- Chin-up
- Pull-up
- Bent-over row
- Supine pullover on ball

RECTUS ABDOMINIS

Location – anterior midline of abdomen
Origin – superior surface of pubis around syphysis.
Insertion – inferior surface of costal cartilages (ribs 5-7) and xiphoid process of sternum.
Action – depresses ribs, flexes vertebral column

TRAPEZIUS

Location – upper back and neck
Origin – base of skul, spinous process of 7C and T1- T3
Insertion – posterior aspect of the lateral clavicle
Action – scapula elevation, depression and adduction of scapula



SELECTED TRAPEZIUS EXERCISES

- Cable bar shrug
- Barbell shrug
- Dumbbell shrug
- Seated mid row retraction on a machine

LATISSIMUS DORSI

Location – lower back
Origin – posterior side of sacrum, spinous process of lumbar and lower 3 ribs
Insertion – medial side of humerus
Action – internal rotation of humeral joint and horizontal abduction of humeral joint

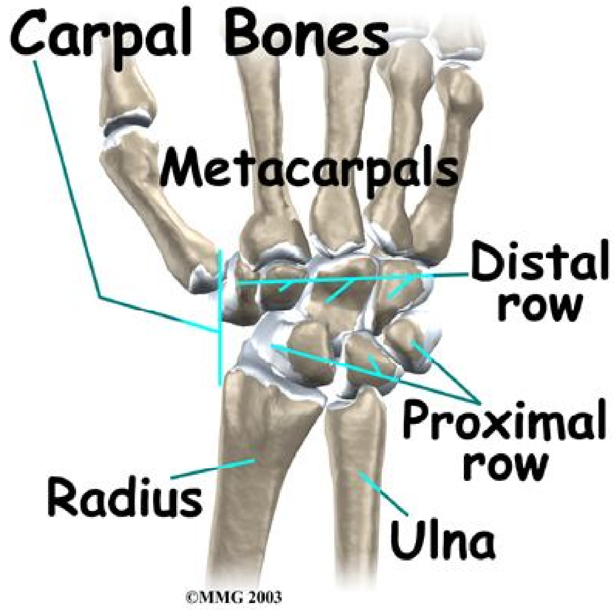
1) Gliding joint (or) Irregular joint (or) Plane joints (or) Arthrodial.
2) Hinge joint (or) Ginglymus
3) Pivot Joint (or) Trochoid (or) Screw Joint
4) Condyloid joint or Ellipsoidal
5) Saddle Joint

Ball and Socket Joint (or) Spheroidal (or) Enarthrodial.

1. Gliding Joint (or) Irregular Joint (or) Plane Joint or Arthrodial

The joint surfaces are irregularly shaped, usually flat or slightly curved. The only movement permitted is of a gliding nature, hence it is NON-AXIAL.

Example : Carpal Joints



Carpal Joints (Gliding joint)