General Principals of Remedial Exercise

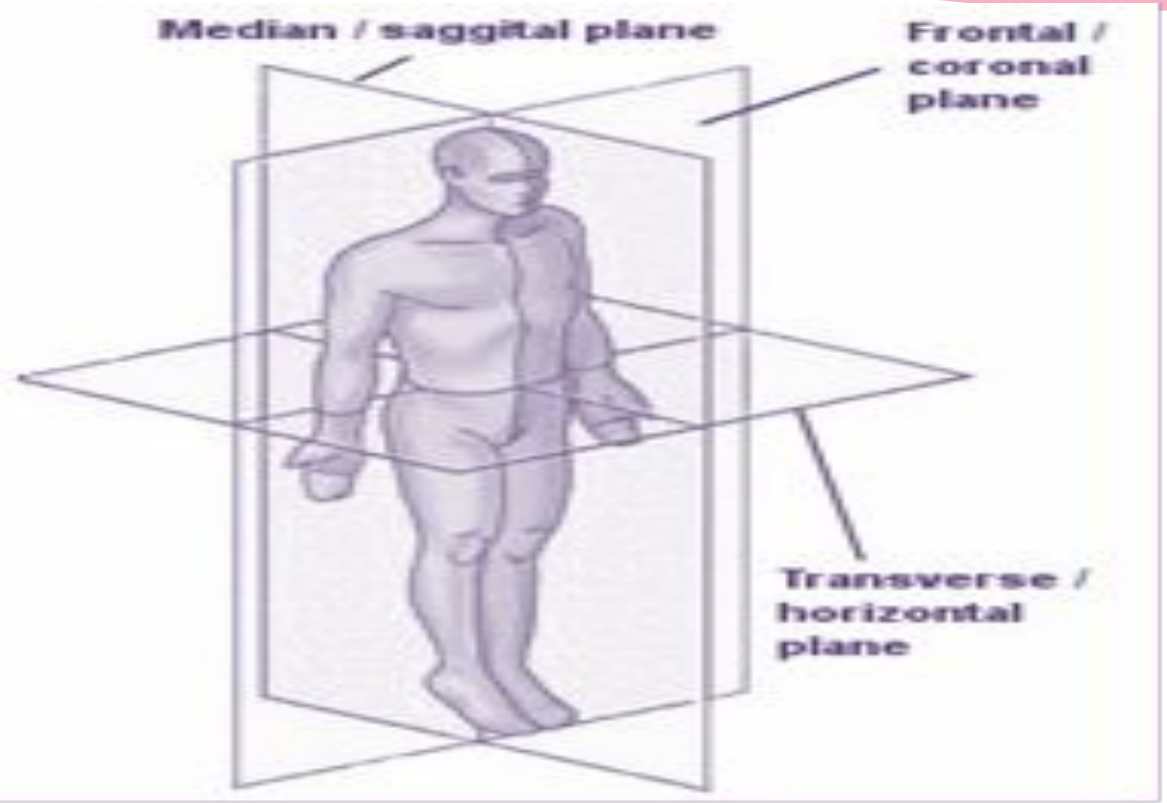
Anatomical Planes

* Based on 4 imaginary planes that intersect the body in the anatomical position
* Sagittal Plane
  * The vertical plane passing longitudinally though the body
  * Divides the body into right and left halves
  * Mid-Sagittal Plane divides the body into equal right and left sides
  * The plane intersects the midline of the anterior and posterior surfaces of the body
  * Sometimes called midline
* Para-Sagittal Plane
  * Vertical plane passing through the body parallel to the sagittal plane
  * This plane divides the body unequally into right and left sides, not at the midline.
  * It is helpful to name the structure intersected when referring to a para-saggital plane (ie. Para-Saggital plane through midline of the right clavicle)

Anatomical Planes Continued

* Frontal or Coronal Plane
  * Vertical plane passing through the body at right angles to the median or sagittal plane
  * Dividing the body into anterior and posterior parts
  * A point of reference is helpful to indicate the position of the plane (ie. Frontal plane through the heads of mandible)
* Transverse Plane
  * Planes passing through the body at right angles to the median and frontal planes
  * Dividing the body into superior and inferior parts
  * It is helpful to give a reference point to identify the level of the plane (ie. transverse plane through umbilicus)

Anatomical Planes Continued

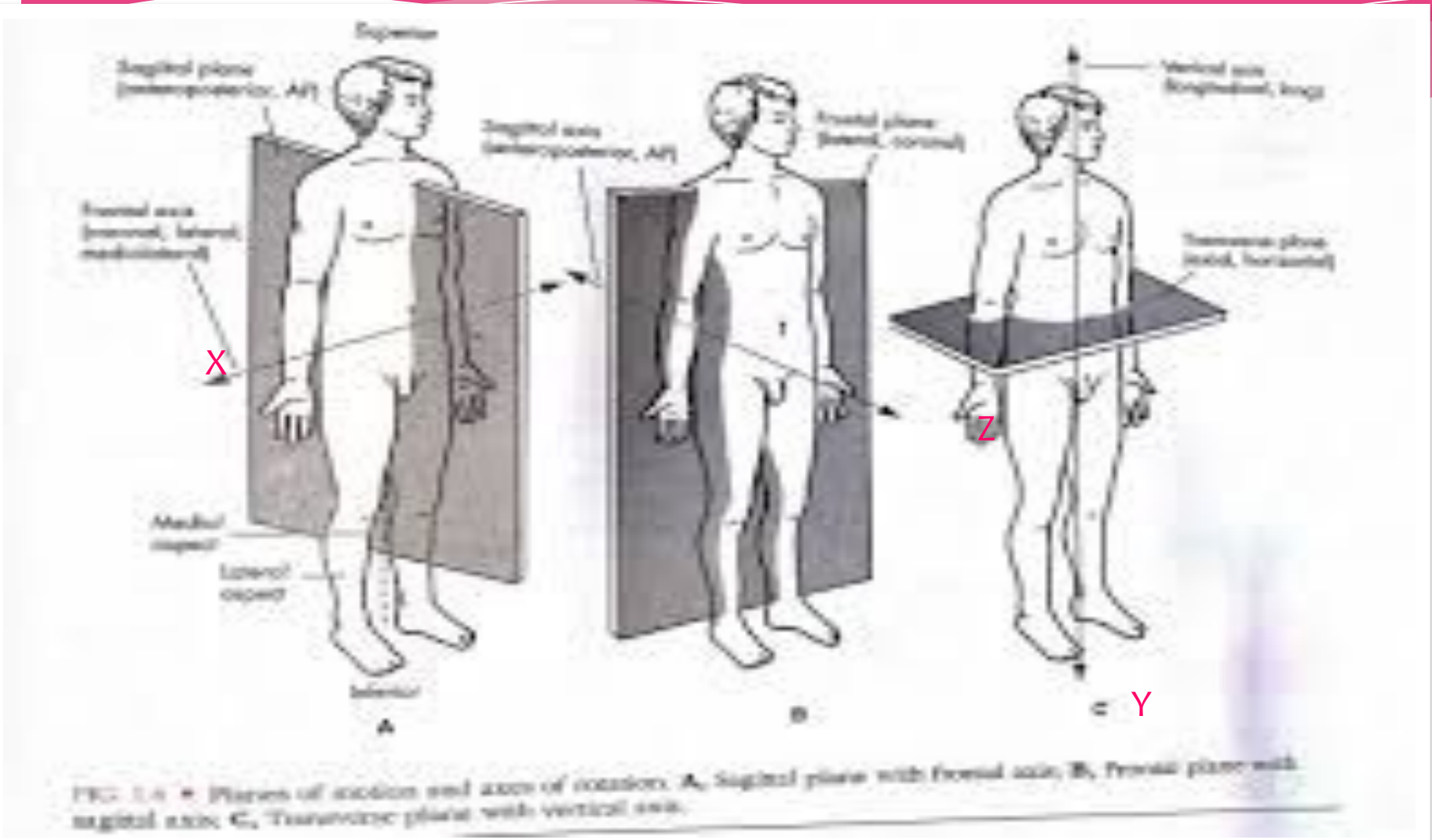


Axis of the Body

* Tranverse – Travels left to right, rotation occurs around axis top to bottom. Intersects with Sagittal Plane. Flexion and Extension
* Longitundinal– Travels top to bottom, rotation occurs around axis left and right. Intersects with transverse plane. Internal and External rotation
* Sagittal - Travels front to back, rotations occurs around axis clockwise and counter clockwise. Intersects with the Frontal/Coronal Plane. Abduction and Adduction, Lateral Flexion

https://youtu.be/yq8cE-EDtuE

Axes and Planes



Movements in the Body

* Active ROM
  * Is movement of a segment within the unrestricted ROM that is produced by active contraction of the muscles crossing it
* Passive ROM
  * Is movement of a segment within the unrestricted ROM that is produced entirely by an external force
  * There is little to no voluntary muscle contraction
  * The external force may be from gravity, a machine, another individual or another part of the individuals own body

Continued

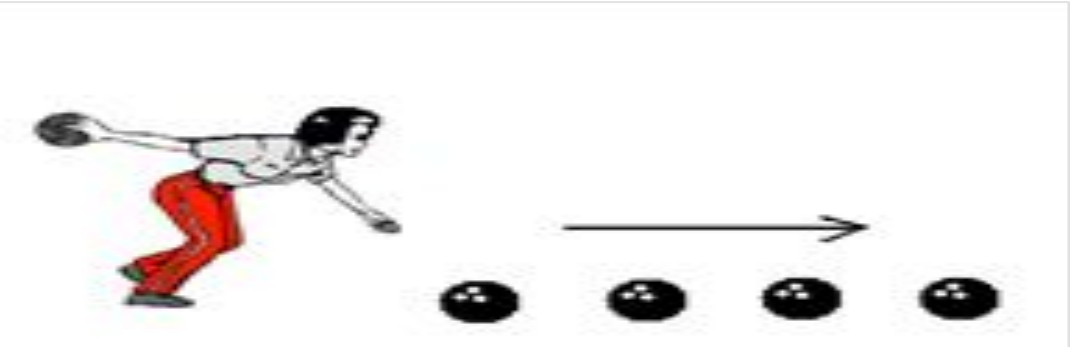
* Active-Assisted ROM
  * Is a type of active ROM in which assistance is provided manually or mechanically by an outside force because the prime mover muscles need assistance to complete the motion
* End Feel
  * Is the sensation transmitted at the very end of a joints range
  * The quality of the end feel will depend on the joint and its condition

Types of Motion

* Rotary Angular Motion
  * Movement of an object around a fixed axis in a curved path
  * Called rotary because every point on a segment adjacent to the joint follows the arc of a circle, the center of which is the joint axis

Continued

* Translatory Linear Motion
  * Movement of a body in which all its parts move in the same direction with equal velocity
  * Occurs in a straight line



Continued

* Curvilinear Motion
  * Rotation of a linear object through space (throw a ball)
  * Combination of rotation and gliding occurs at joint surfaces

Continued

* General Plane Motion
  * Type of curvilinear motion where the object is segmented and free to move rather than rigid or fixed
  * Object rotates about an axis while the axis is translated in space by motion of an adjacent segment
* • Ie. Person brings cup to mouth, the humerus is translating forward while the elbow is rotating the forearm/hand segment

Osteokinematics

* These are motions that we see
* Also known as physiological movements or normal movements
  * Flexion/extension
  * Abduction/Adduction
  * Medial/lateral rotation
  * Lateral flexion
  * Circumduction

Directions of Motion

* Flexion and Extension – occur in the sagittal plane around a coronal (Transverse) axis
* Abduction and Adduction – occur in the frontal plane around a Sagittal (Anteroposterior) Axis
* Lateral Flexion – these motions occur in the frontal plane around a Sagittal (anteroposterior) Axis
* Medial and Lateral Rotation – motion occurs in the transverse plane around a Longitudinal (vertical) axis

Arthokinematics

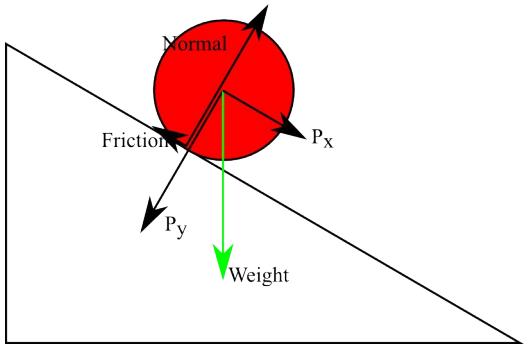
* **Definition** –The study of the motions that occurs within joint spaces during bone movements. They are motions you can feel not see
* These accessory motions take place with all active and passive motion and are required for full, pain free range of motion
* These motions can not occur independently, or voluntarily and if restricted can limit normal movement
* For the most part synovial joints in the body have a convex and concave relationship

Roll, Spin and Glide

* Three primary motions occur in the joint space of a synovial joint are
  * Roll
  * Spin
  * Glide/Slide

Roll

* Roll – New points on one surface touch new points on another surface. An example is a car wheel or ball rolling along the ground. It only occurs when joint surfaces are incongruent.



Spin

* Rotation where one point of contact spins in one stationary spot around a longitudinal axis, clockwise or counter clockwise. An example would be a tire losing traction

Glide/Slide

* Translatory motion in which one constant point on one surface is making contact with new points on the other surface. Similar to a car tire braking and sliding along a surface. Also known as translation. Pure glides occur on congruent flat surfaces or congruent curved surfaces

Glide and Roll

https://youtu.be/PGF2B01qekY

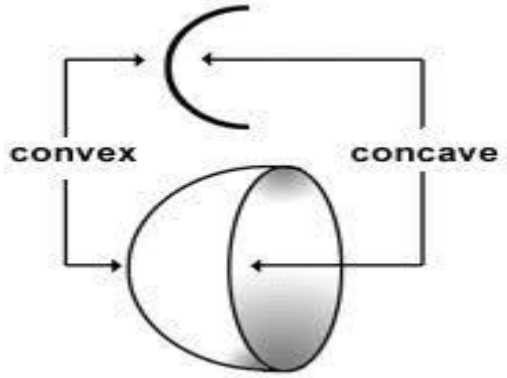
* Because no joint is completely congruent Glide and roll must occur together for all motions
* Glide and roll occur simultaneously but are not necessarily proportionate
* The more congruent the more glide
* The more incongruent the more roll

https://youtu.be/XMzh37kwnV4

Convex/Concave

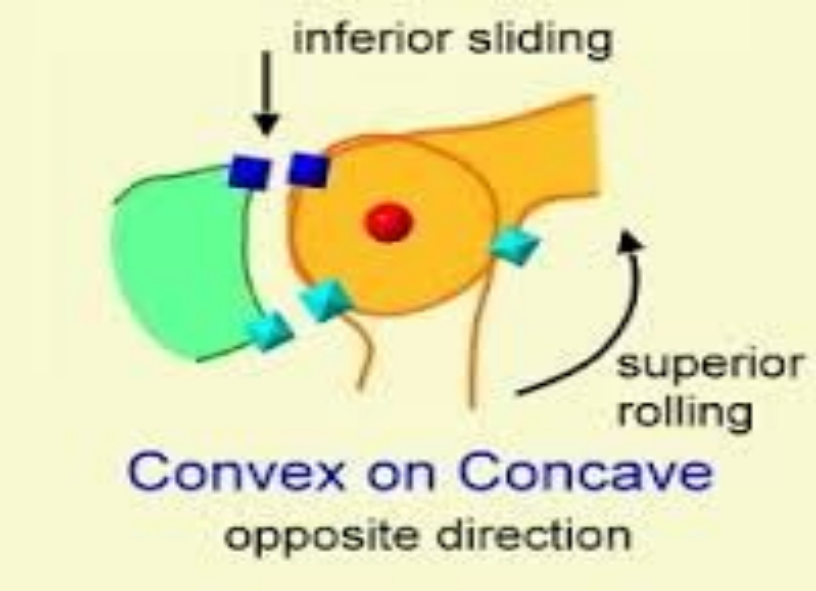
https://youtu.be/gz0aJWnZEJU

* Convex – Male, rounded or arched, more cartilage in the centre
* Concave – Female, hollowed or shallow, more cartilage on the edges



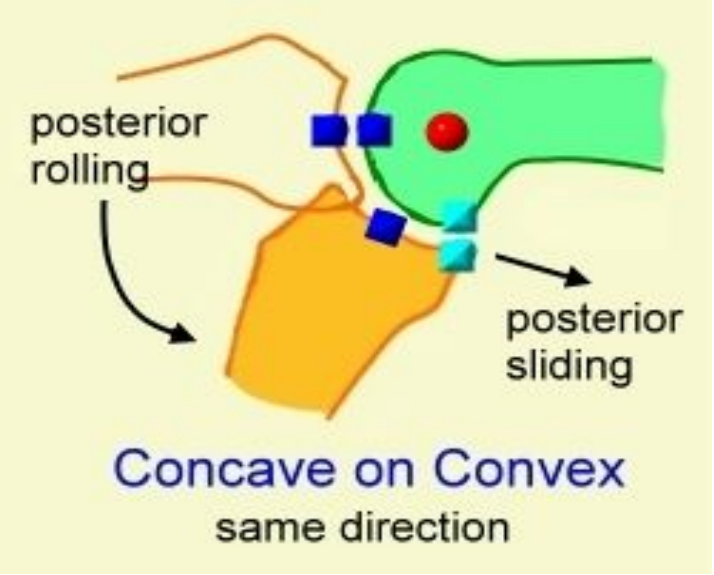
Convex on Concave Rule

* When a Convex surface is moving on a stationary concave surface the motion of glide and roll occur in the opposite direction
* Examples
  * Glenohumeral joint



Concave on Convex Rule

* When a concave surface moves on a stationary convex surface, Glide and Roll occur in the same direction
* Example Tibofemoral joint



Open Chain Exercises

* Exercise in which a distal segment of the body moves freely in space
* Independent joint movements (no predictable motion in adjacent joints) – Usually but not always occurs at one joint
* Muscle activation occurs predominantly in the prime mover and is isolated to muscles of the moving joint
* Typically performed in non-weight bearing positions
* Resistance is applied to the moving distal segment
* External stabilization usually required (manually or with equipment)

Closed Chain Exercises

* Exercise in which the distal end of the segment is fixed and proximal segment moves over the fixed part (ie. Squats)
* Interdependent joint movements (relatively predictable movement patterns in adjacent joints)
* Movement of body segments may occur distal and/or proximal to moving joint
* Muscle activation occurs in multiple muscle groups, both distal and proximal to moving joint
* Typically but not always performed in weight bearing positions
* Resistance is applied simultaneously to multiple moving segments
* Use of axial loading (Application of weight or force along the course of the long axis of the body.)
* Internal stabilization by means of muscle action, joint compression and congruency and postural control

Open and closed chain Exercises Continued

* Both open and closed chain exercises should be incorporated into a good exercise or rehab plan
* Most open chain exercises occur in the upper body, but not all, examples include
  * Bicep curls
  * Lateral raises
  * Shoulder Pendulum swing
* Closed Chain of the upper body examples include
  * Push ups
  * Ball stabilizations
  * Forward Planks
* Homework read about open and closed chain exercises in your text page 195

Continued

* Examples of Lower body open chain exercises include
  * Knee curls or extensions
  * Hip Abduction and ADDuction
* Primarily used during rehab or in weightlifting to promote growth, lessens the chance of additional or incurring injury
* Examples of lower body closed chain exercises include
  * Squats
  * Lunges
  * Stairclimbing
* Primarily used sport specific training and simulations of ADL's during advanced rehab

Kinetics

* Defintion - the branch of mechanics that deals with the actions of forces in producing or changing the motion of masses.

Components of Kinetics

* Stability
  * The stability of a mass depends on:
    * Its weight
    * The size of its base of support
    * The height of its center of gravity above its base of support
    * The location of the gravity line within the base of support

Continued - Force

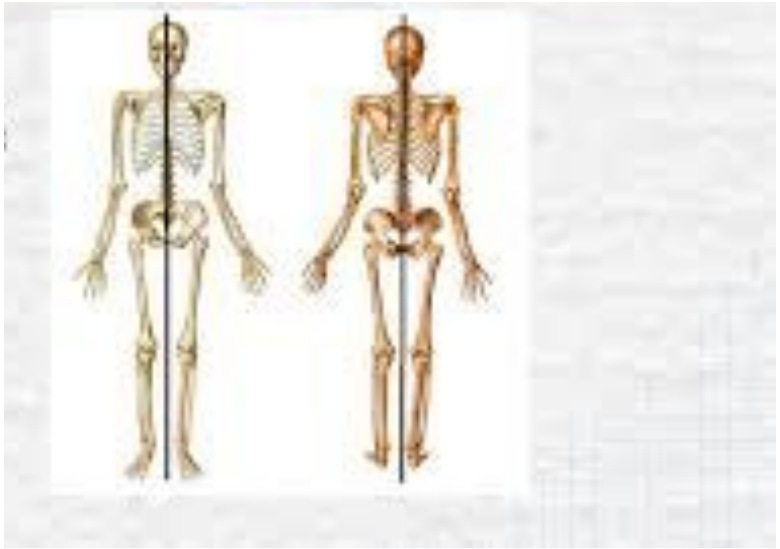
* Is a pull or push exerted by one material object or substance on another
* External forces - gravity, wind, water, floor
* Internal forces – muscles, ligaments, bones
* Internal forces serve to counter-act those external forces that jeopardize the integrity of human joint structure

Continued – Centre of Gravity

* Lies approximately anterior to the second sacral vertebra (In men, the center of gravity lies at or above the navel, while in women, it is located below the navel, close to the hips.)
* Will change as the body moves or carries an object
* Closer the center of gravity is to the base of support, the more stable the object
* Center of gravity will shift toward the additional weight

Continued – Line of Gravity

* Plumb line
* Plumb line should fall through the location of the center of gravity listed above



Newton's Laws

* Law of Inertia
  * States that every body continues in its state of rest or persists in its state of motion in a straight line, unless it is compelled to change by external forces exerted upon it
* Example - When walking hip flexors start to swing leg and hamstrings stop it. Muscle force needed to start action or change speed therefore less energy required to keep steady pace like a jog.

Law of Acceleration

* States that the rate of change of momentum (acceleration of a body with a constant mass) is proportional to the force causing it and takes place in the direction in which the force acts.
* ** ACCELERATION is proportional to FORCE divided by MASS **

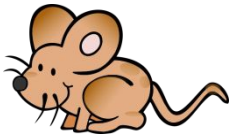
Law of Reaction

* States that for every action there is an equal and opposite reaction

Law of Gravitation

* States that any two particles attract one another with a force directly proportional to the product of their masses and inversely proportional to the square of the distance between them
* This means that a greater force is required to move a large mass than a small one.

https://youtu.be/kKKM8Y-u7ds

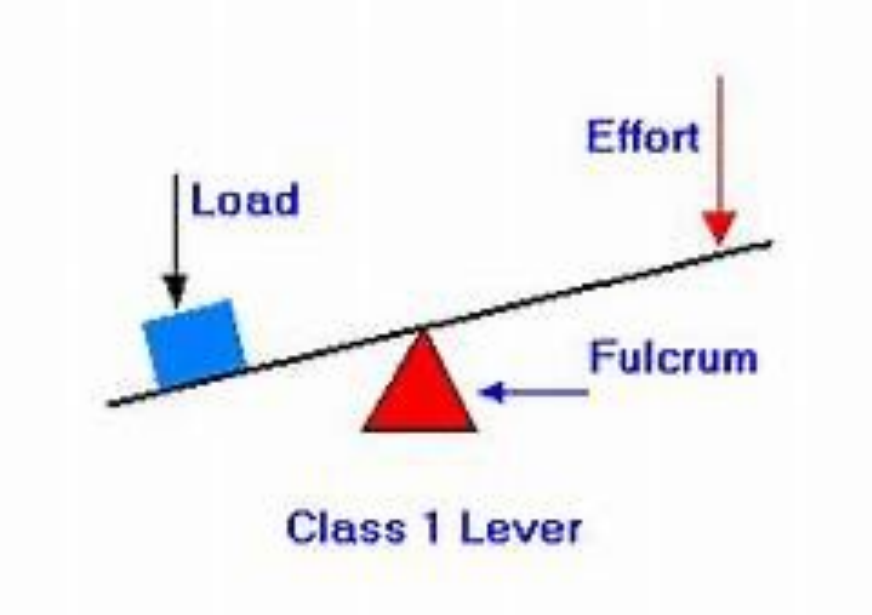


Levers

* " FRE123"
* The letters represent the center of the lever and the numbers represent the corresponding class of lever. Ie. Fulcrum in the centre=1st class lever. Resistance in the middle=2nd class.**
* F = Fulcrum
* R= Resistance (Often interchanged with the word Load)
* E= Effort (often interchanged with the word Force)

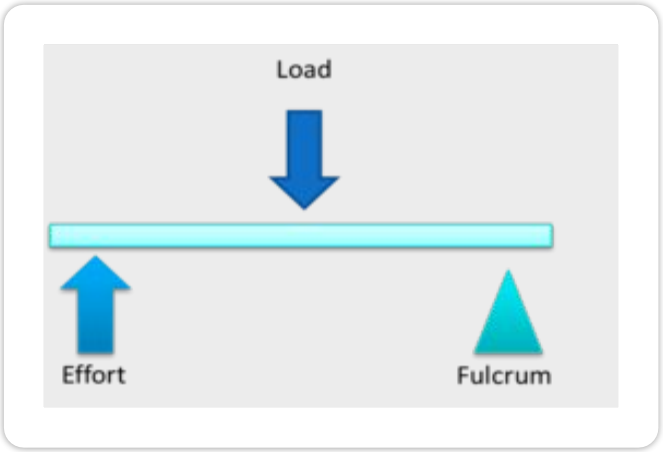
Definitions

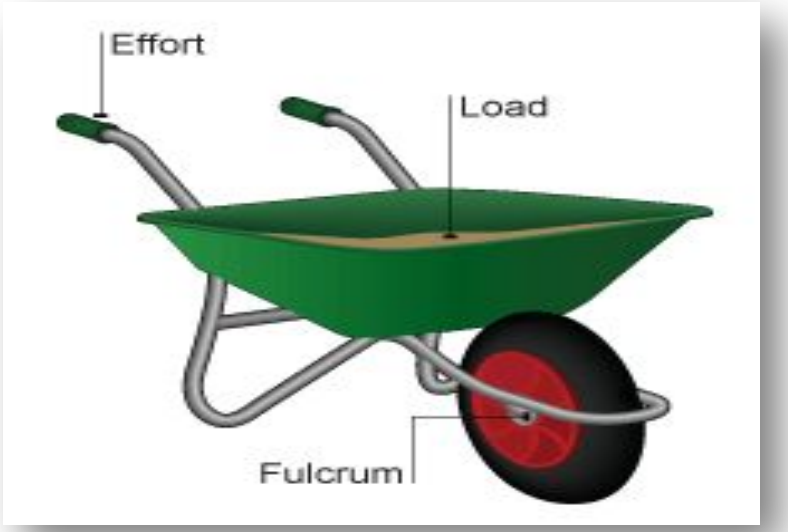
* Fulcrum – The support, or point of rest, on which a lever turns in a moving body (Dictionary.com)



Resistance (Load)

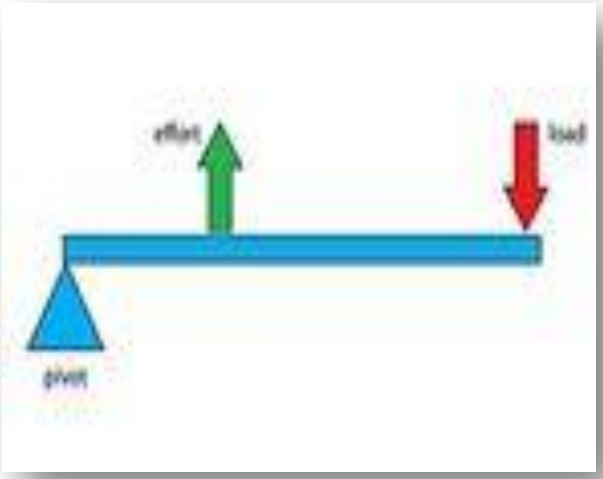
* Resistance – 1) The act of opposing, resisting or withstanding 2) The opposition, by one thing to another (dictionary.com)

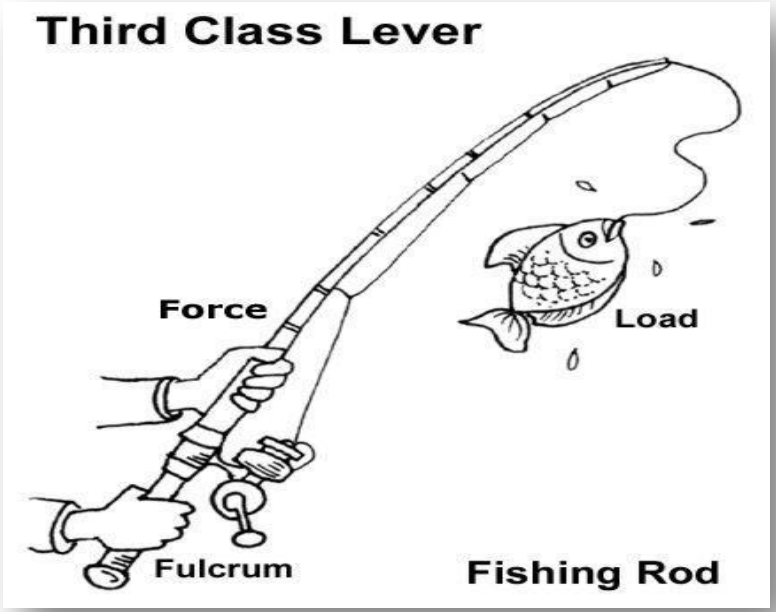




Effort

* Effort – **1)Exertion of physical power** 2) An earnest or strenuous attempt 3) Something done by hardwork or exertion (Dictionary.com)





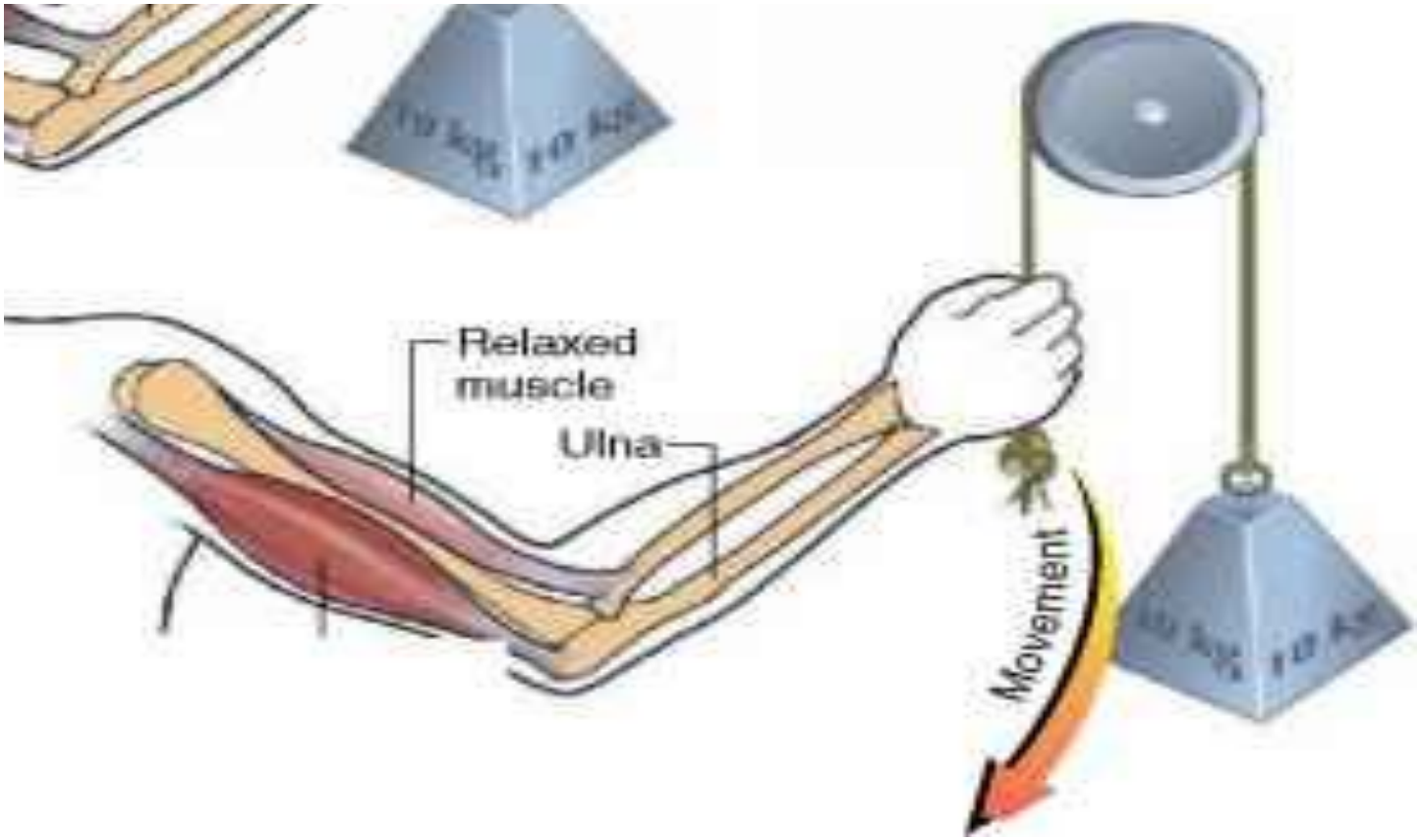
First Class Lever (See Saw)

* **F = 1 Fulcrum in the middle of Resistance and Effort**
* Very few in the human body
* The fulcrum is located between the Effort and the Resistance
* Exists whenever 2 resultant forces are applied on either side on an axis at some distance from that axis, creating rotation in opposite directions
* Rotation of the lever will always occur in the direction exerted by the effort force (force attempting to cause motion)

First Class Lever Example

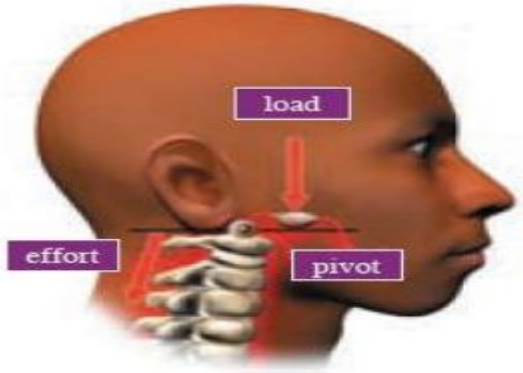
* When the upper limb straightens at the elbow, the forearm bones again serve as the rigid bar, the hand as the resistance, and the elbow joint as the pivot. the triceps brachii supplies the Effort. A tendon of this muscle is attached to the olecranon process of the ulna bone at the point of the elbow. Since the parts of the lever are arranged resistance-Fulcrum-Effort, it is a first-class lever

Tricep Example



Other Examples

* atlanto-occipital joint where head is balanced by neck extensor muscle force

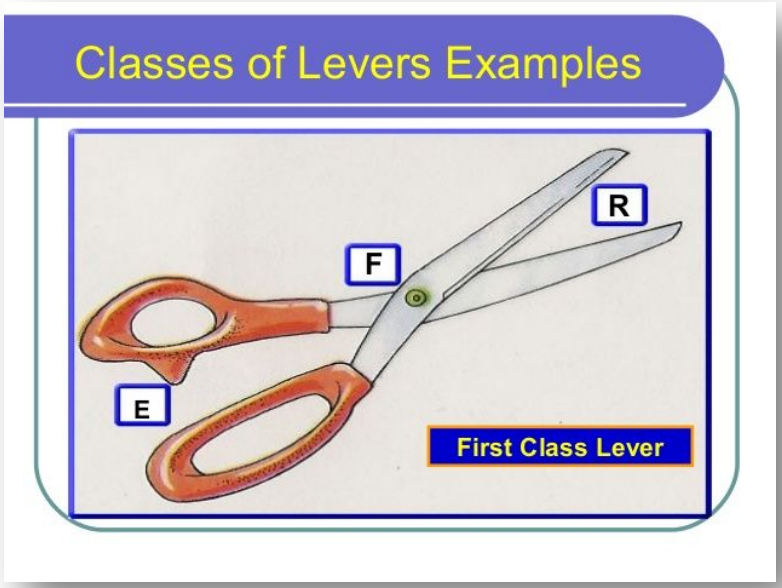


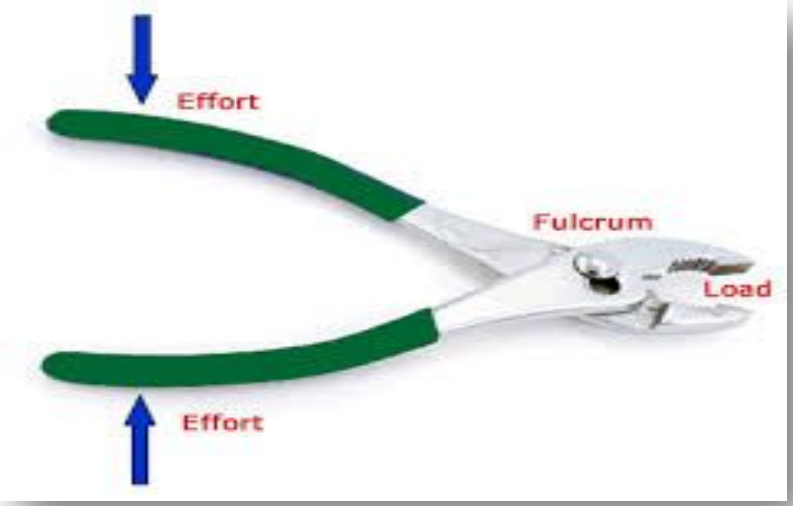
Nodding action of the head – an example of a first-class lever.
The fulcrum is between the load and effort.

Example: Nodding action of the head.
Fulcrum – Point where the skull connects with the vertebral column.
Load – Weight of the head
Effort – Neck muscles at the back of skull

Continued

* Other examples included scissors and pliers

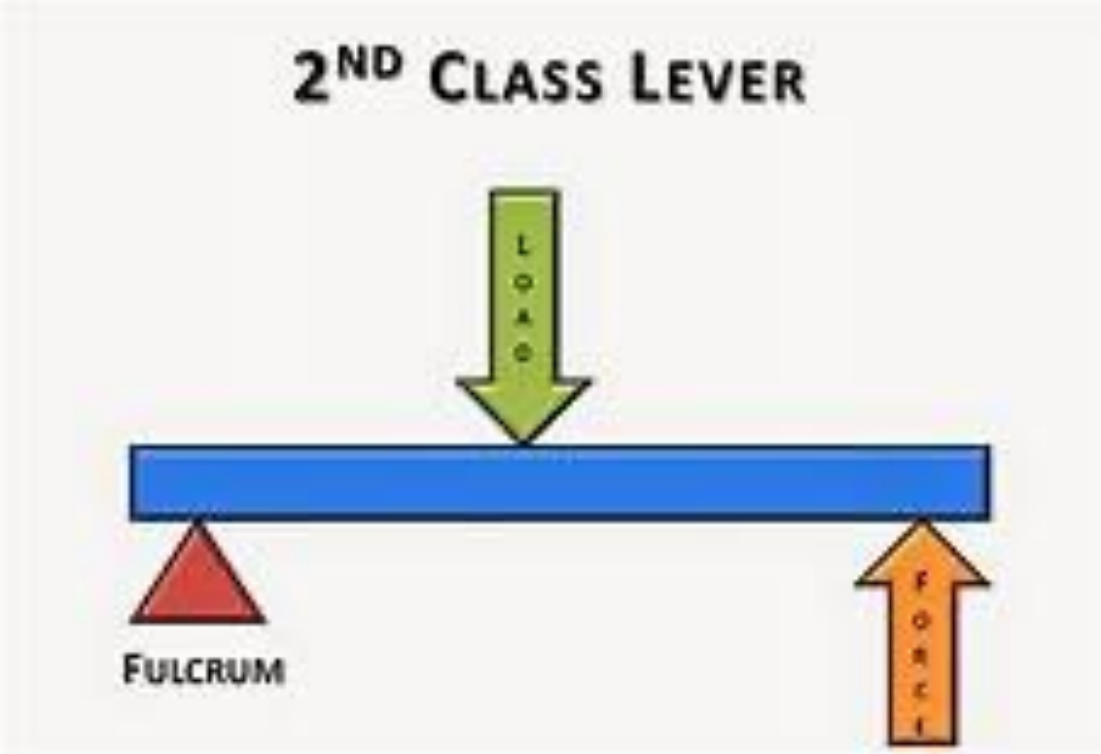




Second Class Levers

* **R = 2 Resistance is in the middle in a 2nd class Lever**
* Commonly occurs in the human body when gravity is the effort force (force attempting to cause motion)and muscles are the resistance (force opposing motion)
* Resistance lies between the fulcrum and the force
* The result is movement of the proximal rather than distal lever

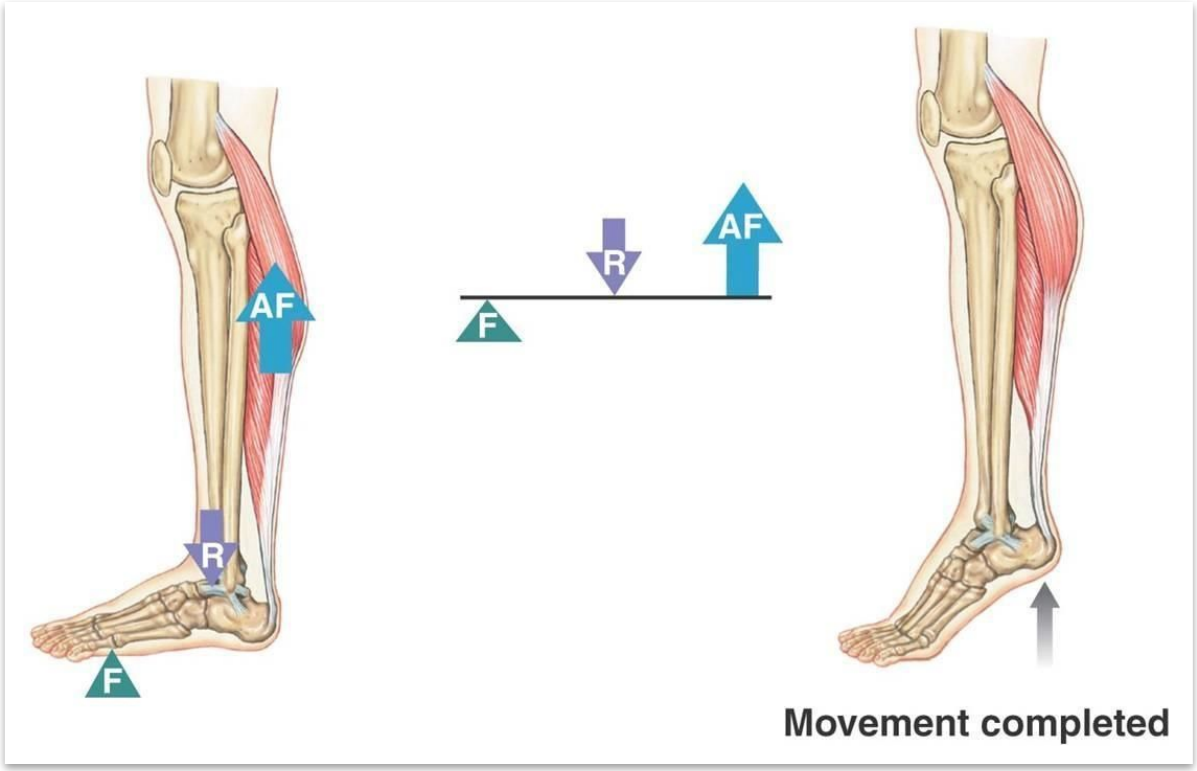
2nd Class Lever Continued



Example of 2nd class Lever in the body

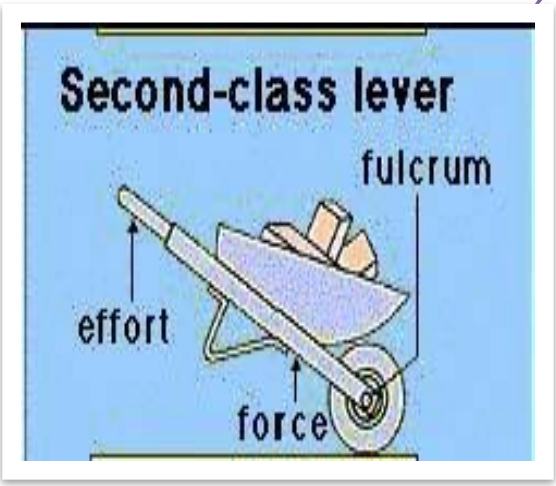
* The gastrocs lifting the body around the axis of the toes, since the muscles are the effort and the body weight is the resistance, a 2nd class lever is formed. When rising onto the toes, the fulcrum is the point of contact with the ground, the Effort is applied at the heel and the resistance is at the ankle joint where the body weight is transferred to the foot

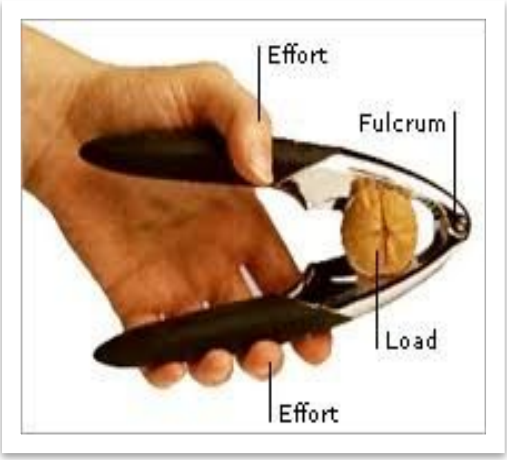
Continued



Other Examples

* wheel barrow, nut cracker, fire bellows



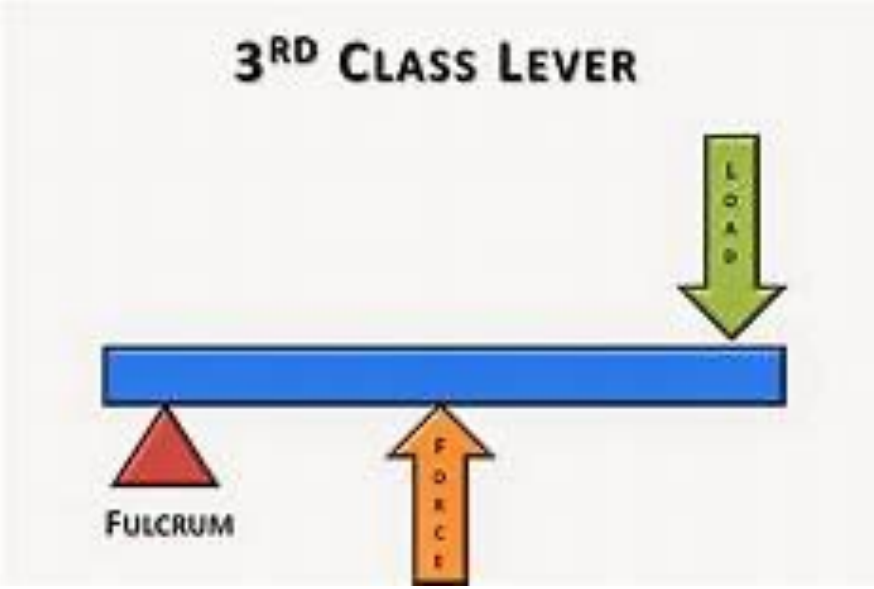


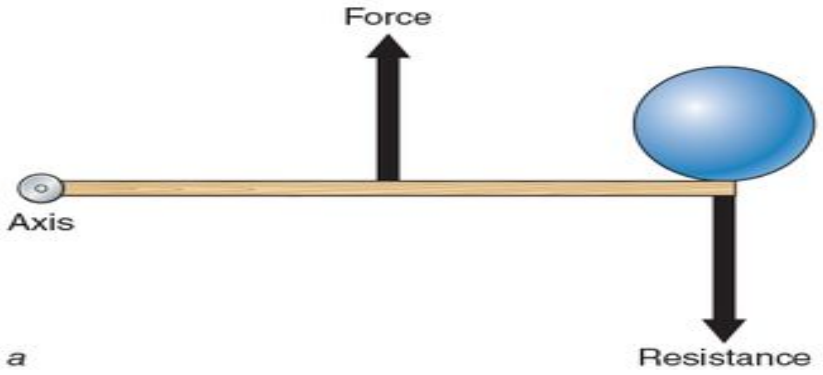
Third Class Levers

* **E = 3, Effort is in the middle of the resistance and the Fulcrum. Most common Lever type in the Body**
* Most muscles creating rotation of their distal segments are part of a 3rd class lever system
* The force is applied between the fulcrum and the resistance
* The point of attachment of the muscle causing the motion is almost always closer to the joint axis than the external force, which is usually the resisting motion

Example

* Found in most open chain motions of the extremities
* Example (1) bicep (2) tibialis anterior acting on ankle joint (3) ECR acting on the wrist





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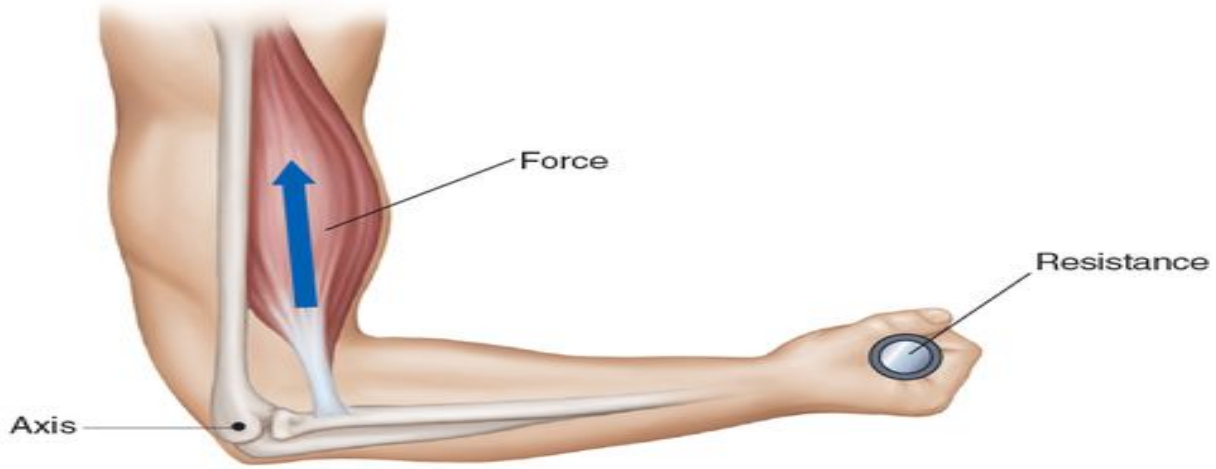

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Videos

https://www.youtube.com/watch?v=iezOKl3Uawc

Types of Muscles

* Agonist
  * Responsible for producing desired motion at a joint
* Antagonist
  * Is the opposing group of muscles to the agonist
* Fixator
  * Muscle which anchors steadies or supports a bone providing an active muscle with a firm base of support.
* Synergists
  * Muscles that help the agonist to perform their action
  * biceps

Continued

* Spurt Muscles
  * Have a proximal attachment that is far from the joint axis and distal attachment that is close to joint axis
  * Usually able to produce a wide range of motion of the bony lever to which they are attached
  * Ie. Biceps brachii, hamstrings
* Shunt Muscles
  * Have a proximal attachment that is close to joint axis and distal attachment that is far from the joint axis
  * Helps maintain joint stability since a large component of their force is towards the joint and compresses the joint surfaces
  * Ie. Brachioradialis

Continued

* Tonic Muscles
  * Similar characteristics to shunt muscles
  * High proportion slow twitch fibers
  * Do not fatigue easily
  * Often called postural muscles
  * React rapidly to training
  * React to overstress by shortening
  * Demonstrate slow reaction to immobilization
  * Eg. Iliopsoas

Continued

Phasic Muscles

* Similar characteristics to spurt muscles
* High proportion of fast twitch
* Produce large ROM
* Fatigue more rapidly
* Slower to recover after high intensity exercise
* React slower to training
* React to overstress by weakening
* Demonstrate immediate reaction to immobilization
* Eg. Gluteal muscles

Types of Muscle Fibers

* Slow Twitch (type 1)
  * Recruited for endurance tasks
  * Activities of low intensity and long duration
  * Fatigue resistant / aerobic
  * Stabilizing muscles and posture
* Fast Twitch Oxidative (type 2 a)
  * Recruited for speed, power and endurance
  * Rely on energy sources intrinsic to muscle (glycogen)
  * Opposite end of spectrum / anaerobic
* Fast Twitch Glycolytic (type 2b)
  * Recruited for speed and power tasks of short duration

https://youtu.be/3L9JUfzh66I

Types of muscle Contractions

* Concentric Contraction
  * As the velocity of muscle shortening increases, the force the muscle can generate decreases
  * Torque decreases as a muscle shortens at faster contractile velocities
  * the force generated is sufficient to overcome the resistance, and the muscle shortens as it contracts
* Eccentric Contractions
  * As the velocity of active muscle lengthening increases, force production in the muscle initially also increases but then quickly levels off
  * The force generated is insufficient to overcome the resistance placed on the muscle and the muscle fibers lengthen as they contract or an eccentric contraction is used as a means of decelerating a body part or an object.

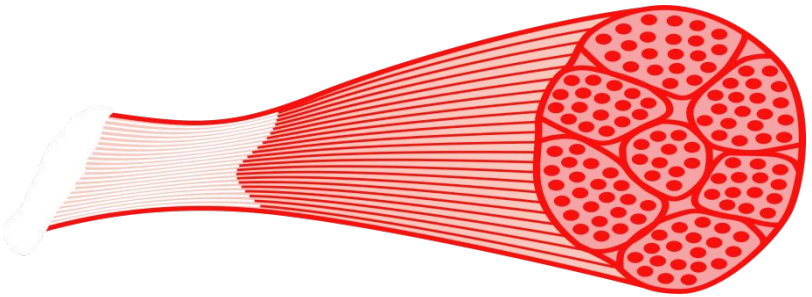
Isometric Contraction

* Occurs when the muscle remains the same length despite building tension; an example of this is muscle contraction in the presence of an after load. Ie. Maintaining the joint angle, but increasing the workload. Occur when carrying an object in front of you. Also seen in yoga poses held for a length of time so that the muscles begin to fatigue

Isotonic Contraction

* Occur when tension in the muscle remains constant despite a change in muscle length
* This can occur only when a muscle's maximal force of contraction exceeds the total load on the muscle
* Ie. Bicep curls; tension is maintained during the concentric contraction, as well as the eccentric

https://youtu.be/T3OiOJ6-x34



What do you remember?

1 What are the 4 main types of muscle contractions we discussed?

2 Are open chain generally weight bearing or non weight bearing?

3 What are Kinetics?

4 What is the Convex on concave rule?

5 What are the 3 accessory arthokinetic motions?

6 List 4 osteokinetic motions?

7 name one of newtons laws?

8 What are the three types of muscle fibers?

9 What two accessory motions must occur together for motion to occur correctly?

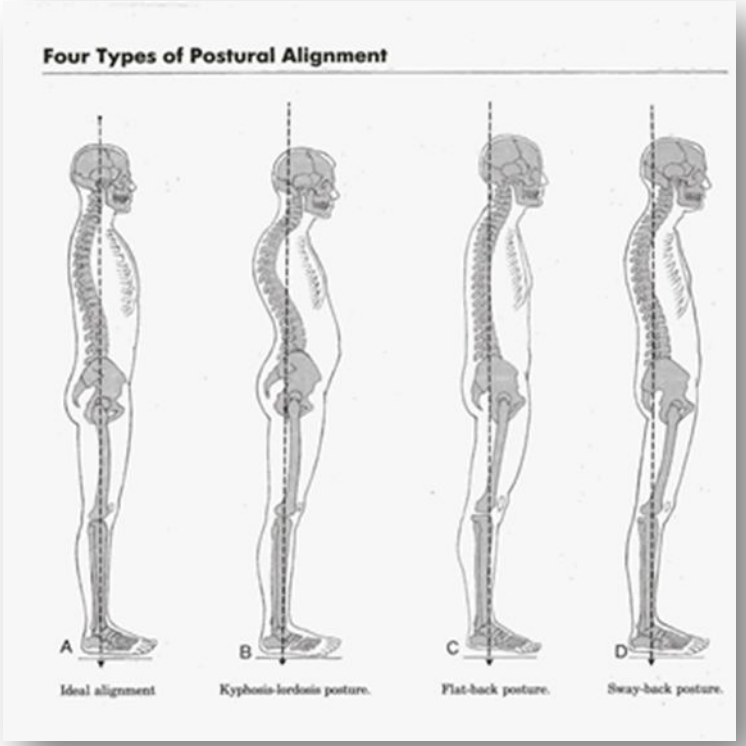
10 Movement of a body in which all its parts move in the same direction with equal velocity that occurs in a straight line is what type of motion?

Valgus/Varus Angles

* A Valgus Angle or position is one where the more distal end of the bone is placed more laterally
* A Varus Angle or position is one where the more distal end of the bone is placed more medially

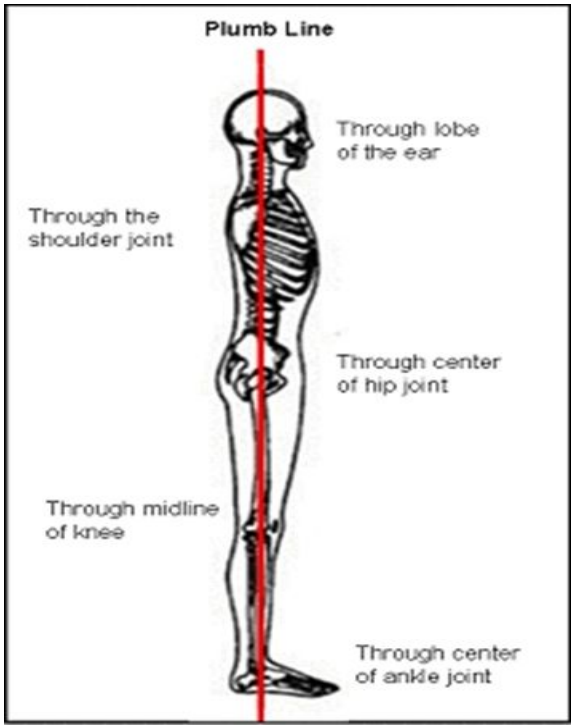
Postural Alignment

* Five main types of Postures
  * Ideal Alignment
  * Kyphotic – Lordotic
  * Sway Back
  * Military
  * Flat Back



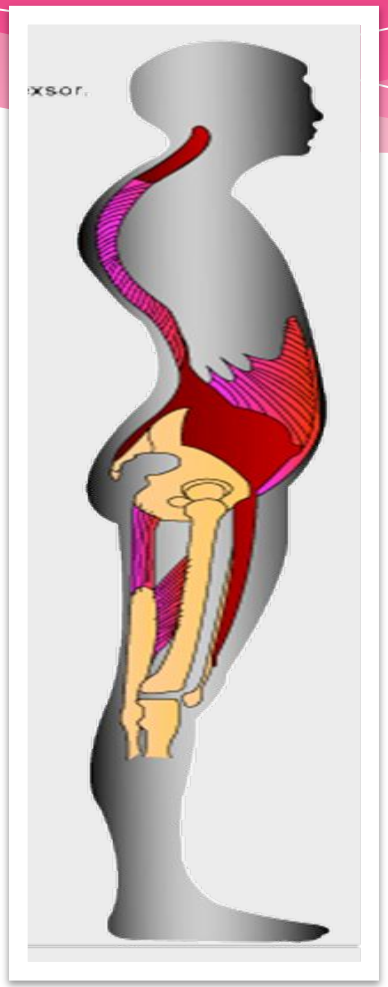
Plumb Line

* Side view passes through
  * earlobe
  * Shoulder joint
  * Centre of hip joint
  * Midline of knee
  * Centre of ankle joint

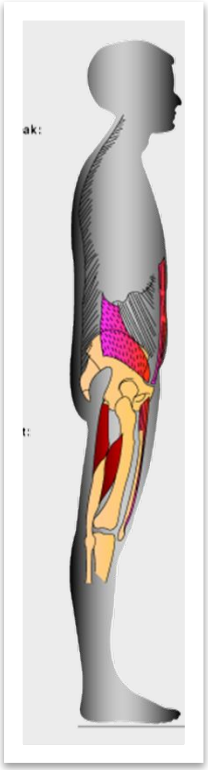


Kyphotic/Lordotic

* Muscles Lengthened and weak
  * Neck Flexors
  * Upper Back
  * Erector Spinae
  * Hamstrings
  * Possible Abdominals
* Muscles shortened and Tight
  * Neck Extensors
  * Hip Flexors
  * Lower Back



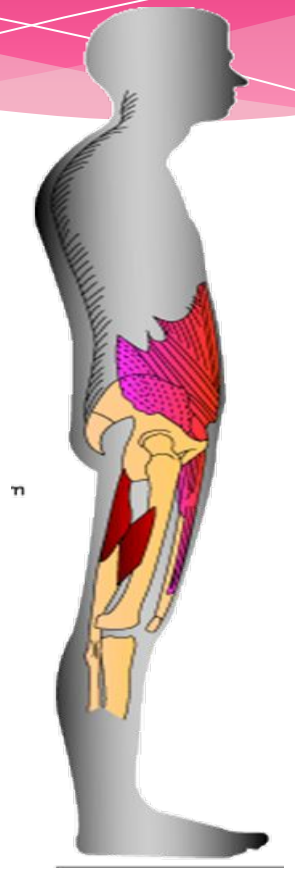
Flat Back Posture



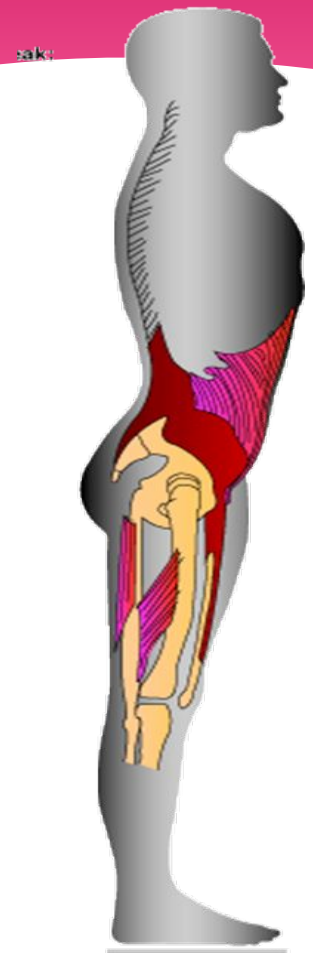
* Muscles lengthened and weak
  * Hip Flexors
* Muscles Shortened and Tight
  * Hamstrings
  * Abdominals to a certain degree

Sway Back Posture

* Muscles Lengthened and weak
  * Hip Flexors
  * Upper back extensors
  * Neck Flexors
  * External obliques
* Shortened and Tight
  * Hamstrings
  * Internal obliques
  * Low back – Erector Spinae and QL



Military Posture



* Muscles Lengthened and Weak
  * Abdominals
  * Hamstrings
* Muscles Short and Tight
  * Low Back
  * Hip Flexors

Question Time??

11) What are the names of the three lever Classifications?

12) What is the mnemonic to remember the levers and what does it tell you?

13) What muscles are short and tight in a kyphotic lordotic posture

14) What are lengthened and weak in a sway back posture?

Gait Review

Video – Review of Gait https://youtu.be/1u6d1CX709c

Examination of Gait

* lower limb pathologies are more prominent during gait
* two phases of normal gait:
  * stance phase - foot is on ground; 60% of normal cycle with 25% of this phase in double stance
  * swing phase - foot is moving forward; 40% on normal cycle
* both of the above phase can be broken down into subdivisions:
  * stance phase - heel strike, foot flat, midstance, push-off (toe off),
  * swing phase - acceleration, midswing, deceleration

Gait Review

* most pathologies are more prominent during stance phase, since weight bearing is occurring during most of the phase and therefore the greatest amount of stress is being applied
* remember gait analysis begins as soon as the client walk into your line of sight

Gait Examination

* observe and pinpoint involved components/structures
  * width of base: 2-4 inches from heel to heel
  * center of gravity: 2inch in front of 2nd sacral vertebra, and should only oscillate no more than 2inches (in the vertical direction)
  * knee flexed during stance phase - prevent excessive vertical displacement of the center of gravity
  * lateral shift of pelvis and trunk: 1inch toward weight bearing side during gait to center the weight over the hip - gluteus medius weakness will result in increase shift
  * step length: average 14-16inch: age, pain, pathology, and fatigue, may cause step length to decrease
  * normal cadence: 90-120 steps per minute with an average of 100 calories being used per minute per mile; note that with age, fatigue, pain, and slippery surface to walk on ones cadence may decrease
  * the pelvis rotates 40degrees in swing phase - which leaves the opposite extremity, which is in stance phase, to act as a fulcrum for rotation

Problems in Phases of Gait

* STANCE PHASE:
  * Antalgic gait is most commonly seen in this phase as result from pain (Anti=against Alge=pain) Stance phase is abnormally shortened relative to swing phase.
  * quick to remove weight form the affected extremity (pain with weight bearing)
  * this phase is also commonly affected by improper foot wear, causing pain and discomfort through the entire phase

Stance Phase Continued

* heel strike pain may be caused by: heel spur; a protective bursa may develop:
* knee extended on heel strike, if quads are weak resulting in unstable knee gait, the knee will not extend
* knee is fused in flexion, the client may push attempt to push the knee into extension with hand - if this in not possible then the knee will remain unstable through the phase

Stance Phase Continued

* flat feet - tibialis anterior, extensor digitorum longus, and extensor hallucis longus permit plantar flexion through eccentric elongation so that the foot flattens smoothly on floor surface, therefore if the dorsiflexors are weak or non-functioning the client will have “slap foot” instead of smooth contact with the floor; note: clients with fused ankles may not be able to reach flat foot until midstance

Stance phase Continued

* Midstance
* foot- fallen arches may be evident by painful calluses over the metatarsal heads; pes planus and subtalar arthritis will have increased pain when walking on uneven surfaces; corns may be painful during this phase due to rubbing against shoe as the toes start to grip:
* knee - weak quads may result in hyperflexion and instability of knee
* Hip - weakened glut medius forces the client to lurch toward the involved side placing the center of gravity over the hip-- aka gluteus medius lurch; weakened glut maximus forces the thorax to thrust posteriorly to maintain hip extension

Stance Phase Continued

* push-off –foot -lateral forefoot push off may indicate osteoarthritis or fused metatarsophalangeal joint: knee - gastrocnemius, soleus and flexor hallucis longus are strong push-off muscles therefore weakness = flat feet

Swing Phase

* less pathologies will be evident in this phase due to non weight bearing phase
* Acceleration –foot - dorsiflexors are active throughout swing phase:
* knee-max flexion of 65% is reached
* hip-quads contract before toe-off to initiate forward swing of leg, therefore if the quads are weak rotation of the pelvis will be present anteriorly to promote forward thrust of the leg

Swing Phase Continued

* Midswing –foot - if dorsiflexors are weak shoe scraping will occur, flexion of the hip with bending of the knee will be present to permit the foot to clear the ground
* deceleration - knee -hamstrings contract and slow down swing prior to heel strike to maintain control with smooth contact of the ground; therefore if hamstrings are weak then heel strike may become harsh with hyperextended knee
* examination of gait should include examination of the lower limb
* and remember to assess the entire body - arm swing in tandem etc....

https://youtu.be/GsRkYpE_fX4

Remedial Exercise

* Massage therapy is frequently considered to be passive exercise because while simply lying on a table and being treated the client may as well experience: circulation greatly increased thus waste removal increased, soft tissues stretched, soft tissues change tone, soft tissue strengthened
* Even with the above you are encouraged to promote active exercise for your clients - this is to promote general health and increase heart rate, circulation, and respiratory functions. Remedial exercises are those the client does at home to encourage healing and improvement with their presenting condition

Benefits of Active Excercise

* Muscles:
  * Increase the blood flow (and therefore nutrition and waste removal) in working muscles
  * Increase muscle metabolism
  * Create muscle hypertrophy (increase in size) as the muscle adapt to the demands put on them
  * Increase muscle elasticity and extensibility with pre and post exercise stretching
* If a muscle, particularly a weak one, is overworked, the result will be muscle strain, characterized by undue fatigue, inflammation and tenderness

Benefits of Active Exercises

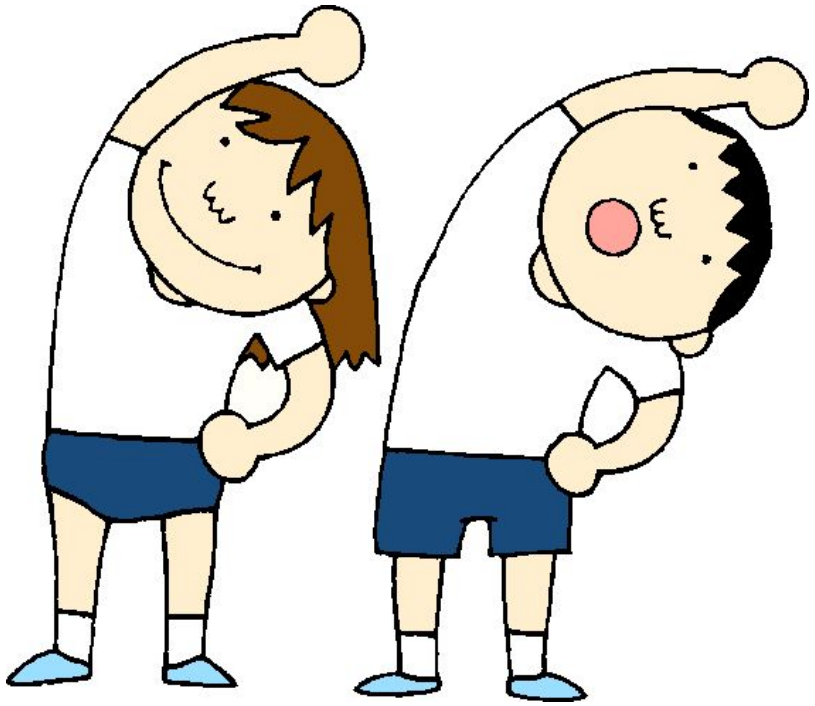
* Bones and joint:
  * Increase nutrition to bones
  * Maintain or increase the mobility of joints and increase bone density to meet the demands of the exercise placed upon them
* Heart:
  * Heart contractions become stronger and more rapid, increasing the cardiac output
  * The heart muscle may become stronger and function more efficiently
  * Pulmonary circulation is also enhanced

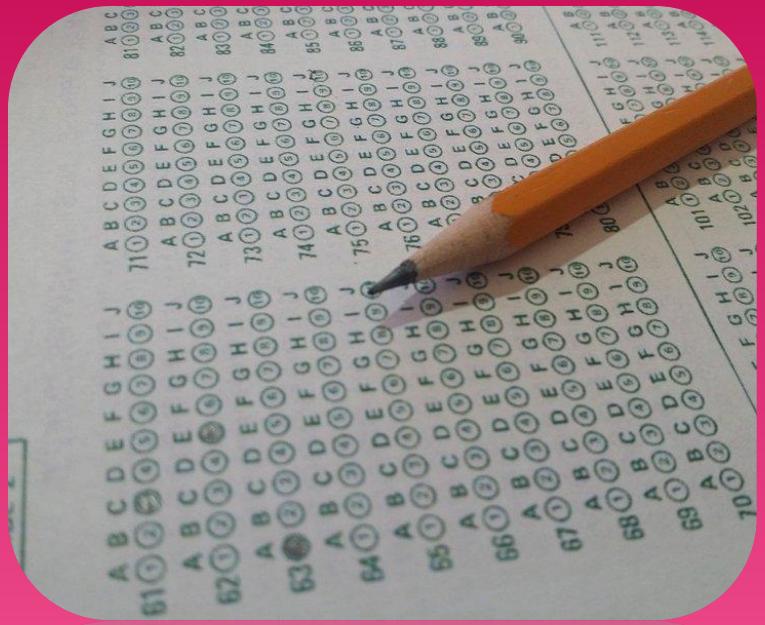
Benefits of Active Excercise

* Arterial Circulation:
  * Increase the arterial flow to working muscles through vasodilation and the law of supply and demand
  * Increased cardiac output tends to increase the arterial blood pressure until further arterioles and capillary beds become vasodilated to process the extra blood, thus decreasing arterial blood pressure
* Venous and Lymphatic Circulation:
  * Through alternate stretching and compression or pumping of the blood vessels, active exercise increases the flow of venous and blood and lymph (through muscle contraction, they compress the veins and lymphatic vessels, forcing blood and lymph toward the heart)

Types of Exercise

* Endurance – improves cardiovascular fitness
* Strength – Increases muscle strength
* Balance – Prevents falls, helps in older individuals to maintain independence
* Flexibility – stretches muscles, provides greater freedom of movement





Quiz 1 next class