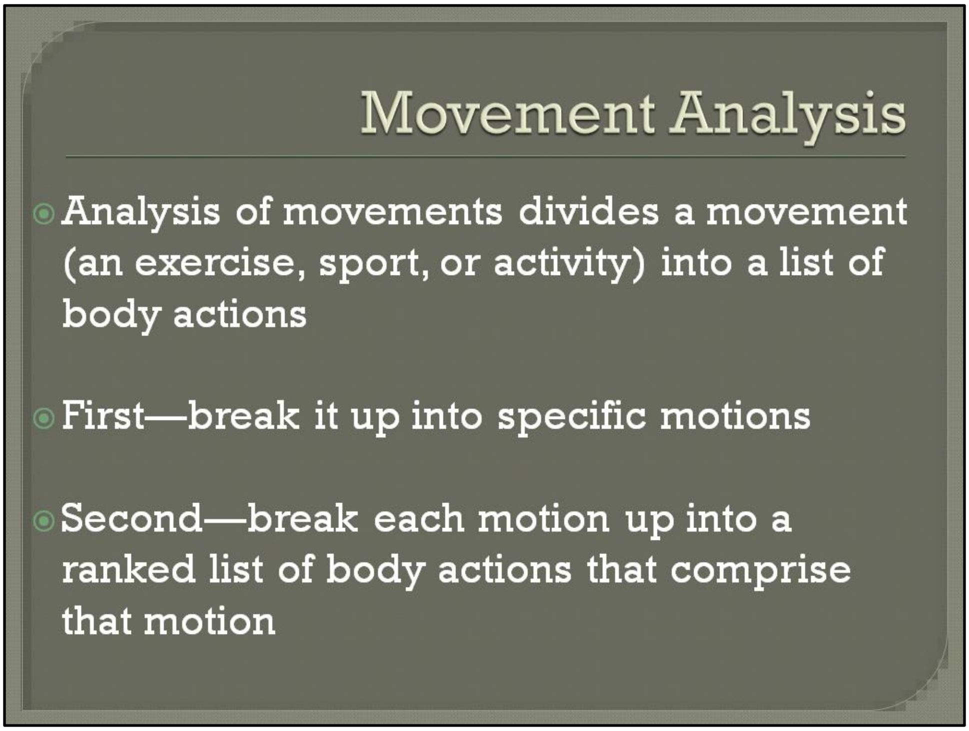
Unit 4

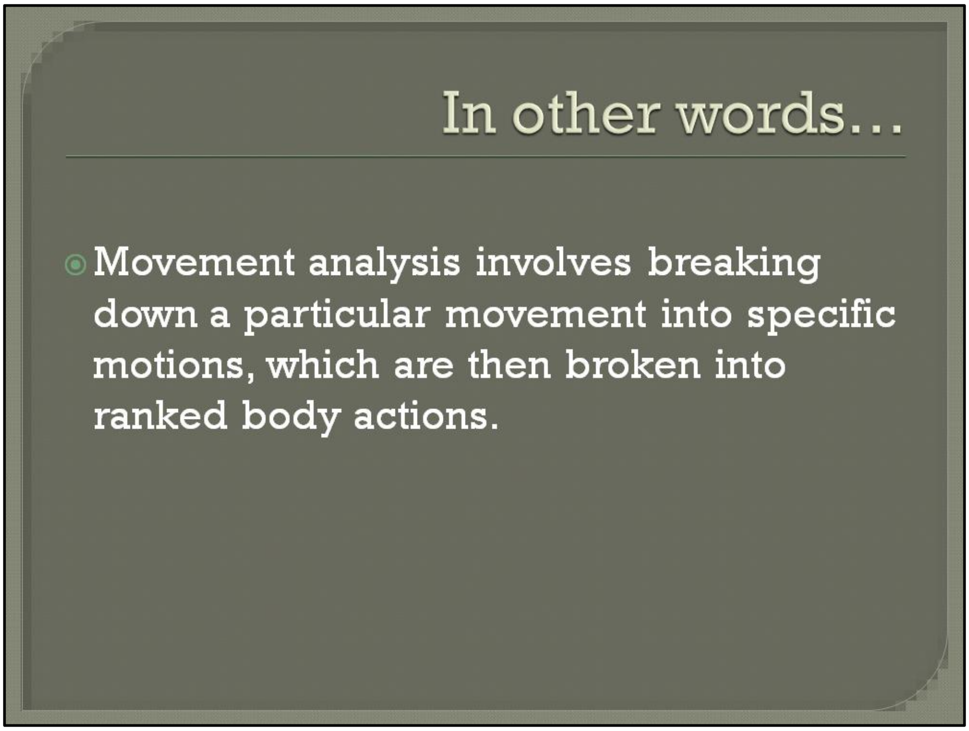
Movement Analysis

This is where you put all of your knowledge from the previous units and combine it to form movements!



For example: ***Archery—shooting an arrow.*** Divide it into motions: (1) holding bow out in front of you (2) pulling string & arrow back and aiming (3) releasing the string

Once you have divided the activity into motions, break each motion in to body actions: (1) wrist extension, finger & thumb flexion (2) shoulder horizontal abduction, scapular retraction, finger flexion (3) finger extension

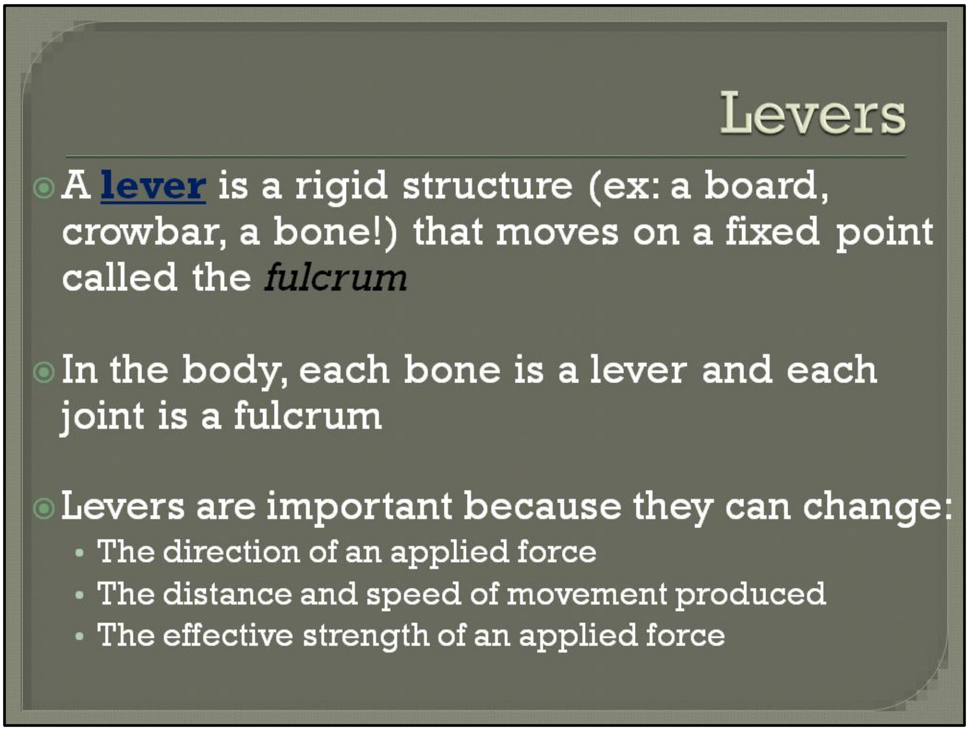


By breaking an activity or movement down into the different phases or motions, and then breaking it down even further into the body actions taking place during each phase or motion, we are able to identify the muscles contracting to cause the motion to occur.

Levers

- When a muscle is attached to the skeleton, the nature and site of the connection will determine the force, speed, and range of movement produced.
- The force, speed, or direction of movement produced by muscle contraction can be modified—by attaching muscle to a lever.

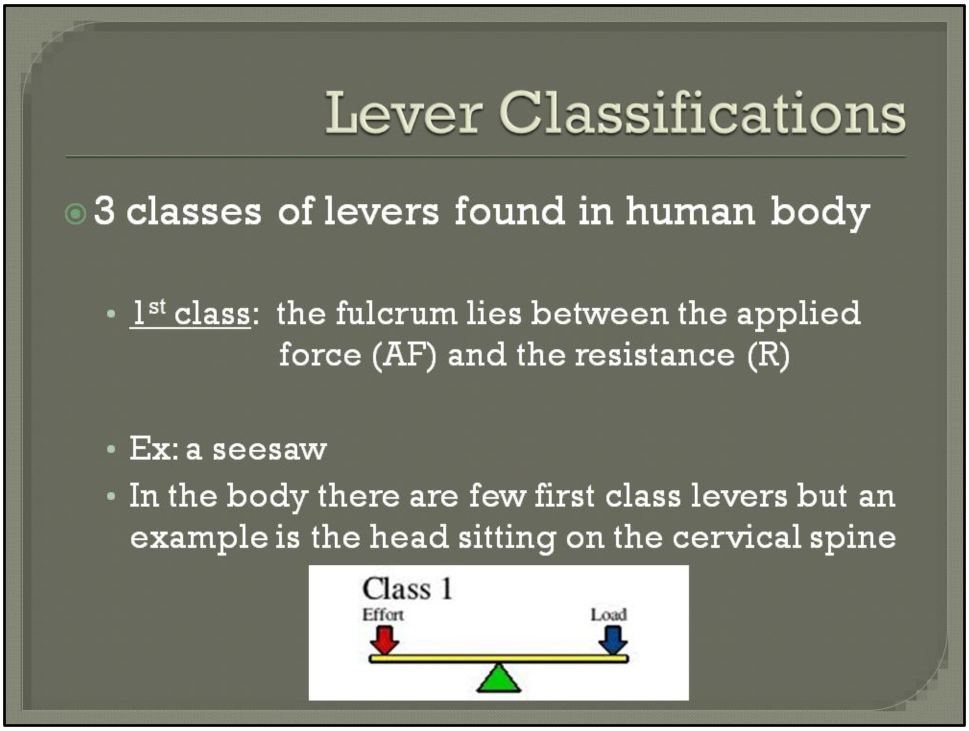
This is why it was important to learn and memorize all of the origins and insertions of the muscles.



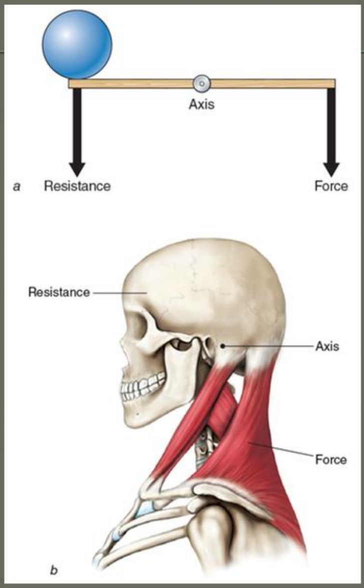
Levers work to create movement in the human body.

Bones, ligaments, and muscles are the structures that form levers in the body to create human movement. In simple terms, a joint forms the axis (or fulcrum), and the muscles crossing the joint apply the force to move a weight or resistance. Levers are typically labeled as first class, second class, or third class. All three types are found in the body, but most levers in the human body are third class.

An example of a familiar lever used in the world is a jack used for lifting up a car to change a flat tire. However, now we are going to be looking at levers in the body!

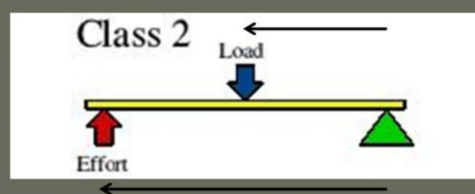


So an example of a 1st class lever in the real world is a teeter-totter. The fulcrum is in the middle with the AF and R on opposite sides of the fulcrum. A 1st class lever is rare in the human body, however, an example of one in the body is the head on the spine. The atlantoccipital joint is the fulcrum, with the weight of the head providing the R on 1 side and the muscles pulling down on the other side as the AF.


Axis
a
Resistance
Force
Resistance
Axis
Force
b

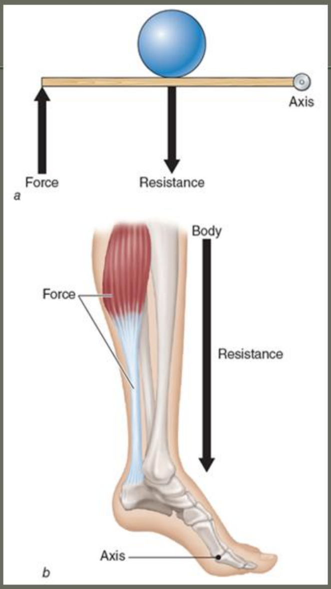
Lever Classifications

- 2nd class: the R is located between the AF and the fulcrum
- Ex: a wheelbarrow
- In the body there are not many second class levers but an example is standing on the tip of your toes.

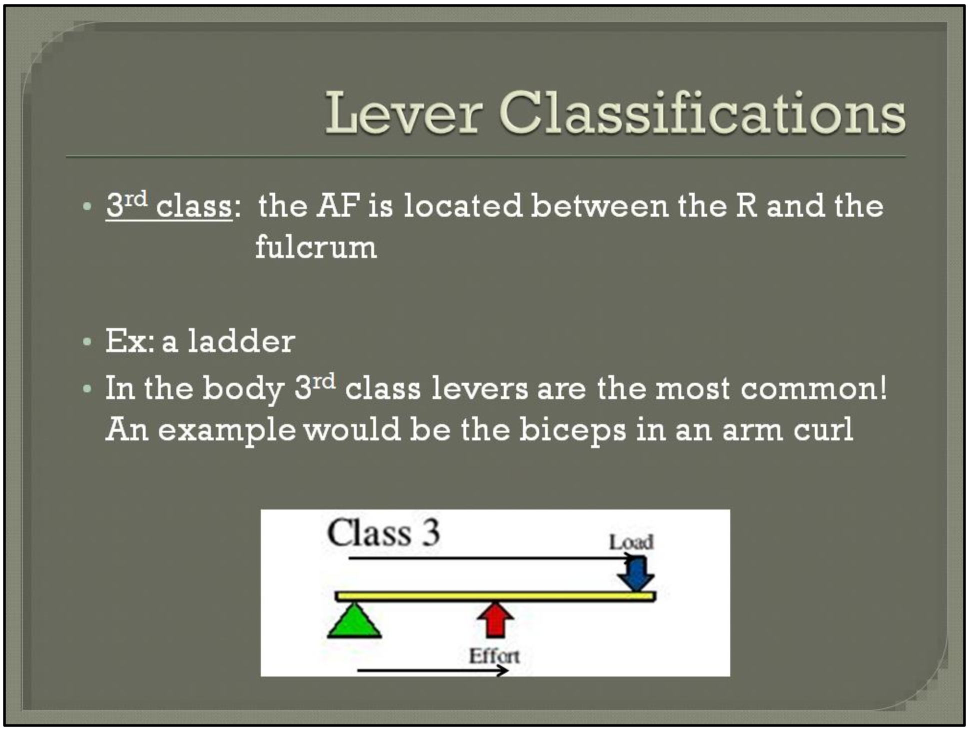


A wheelbarrow is an example of a 2nd class lever because you first have the handles which is where the AF is, then the R is in the bucket, followed by the wheel which is the fulcrum. What is important about 2nd class levers is that they are able to move heavy loads because the AF (effort) lever arm is greater (longer) than the R lever arm (**Notice the black arrows—the arrow showing the R (load) lever arm is shorter than the arrow showing the AF (effort) lever arm. So 2nd class levers move heavy loads since the AF lever arm is greater, however, the load is moved more slowly and doesn't go as far.

*An example of a 2nd class lever in the human body is when you do plantar flexion. The toes and ball of your foot is the fulcrum with the weight of the body and bones of the tibia and fibula as the R. The calf muscles (gastrocnemius and soleus) are then the AF.



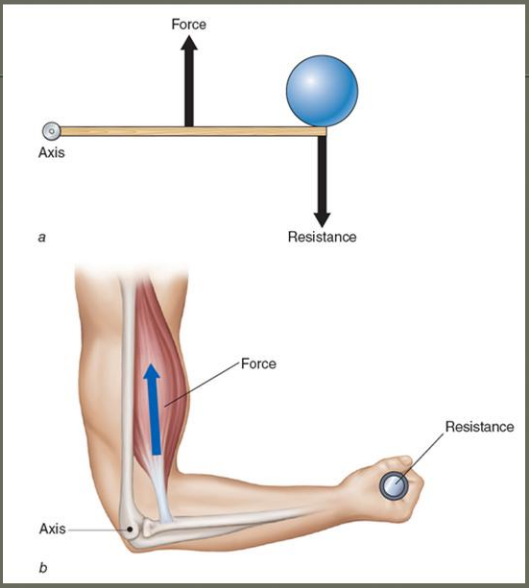
In a second-class lever, the weight (resistance) is located between the axis (fulcrum) and the force (figure a). The most obvious example is a wheelbarrow, where a weight is placed in the bed of the wheelbarrow between the wheel (axis) and the hands of the person using the wheelbarrow (force). In the human body, an example of a second-class lever is found in the lower leg when someone stands on tiptoes (figure b). The axis is formed by the metatarsophalangeal joints, the resistance is the weight of the body, and the force is applied to the calcaneus bone (heel) by the gastrocnemius and soleus muscles through the Achilles tendon.

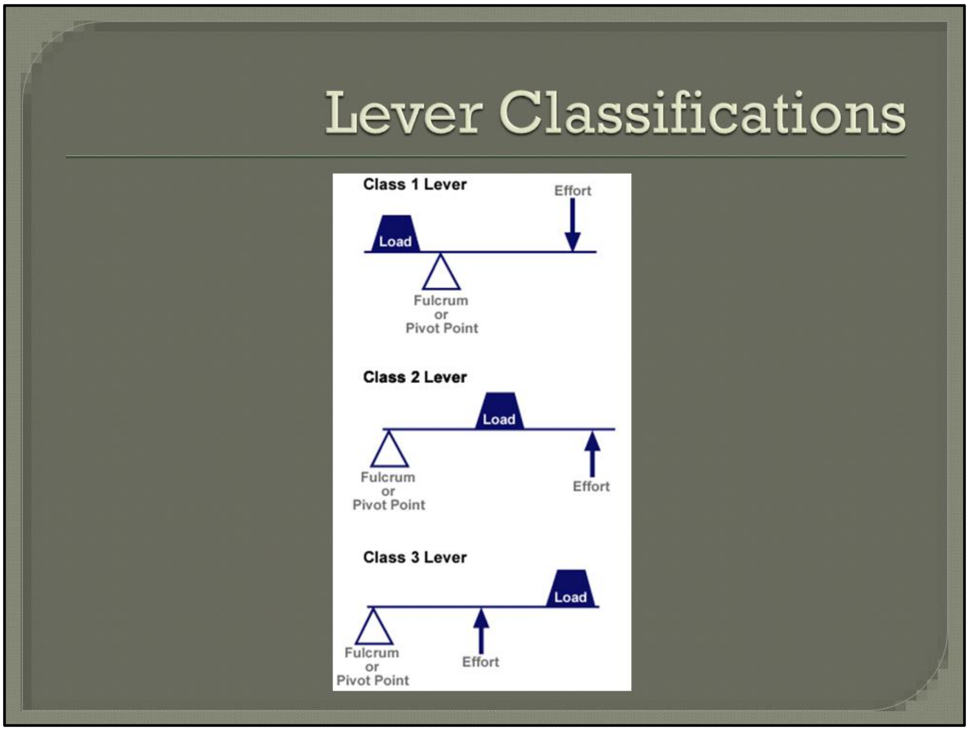


3rd class levers are the most common levers in the human body! A ladder is a 3rd class lever in the real world because the base of the ladder on the ground is the fulcrum. Then, by grasping the rungs of the ladder you have the AF in the middle, with the free end of the ladder providing the R. What is important about 3rd class levers is that the AF (effort) lever arm is less (shorter) than the R lever arm (**Notice the black arrows—the arrow showing the R (load) lever arm is greater than the arrow showing the AF (effort) lever arm.

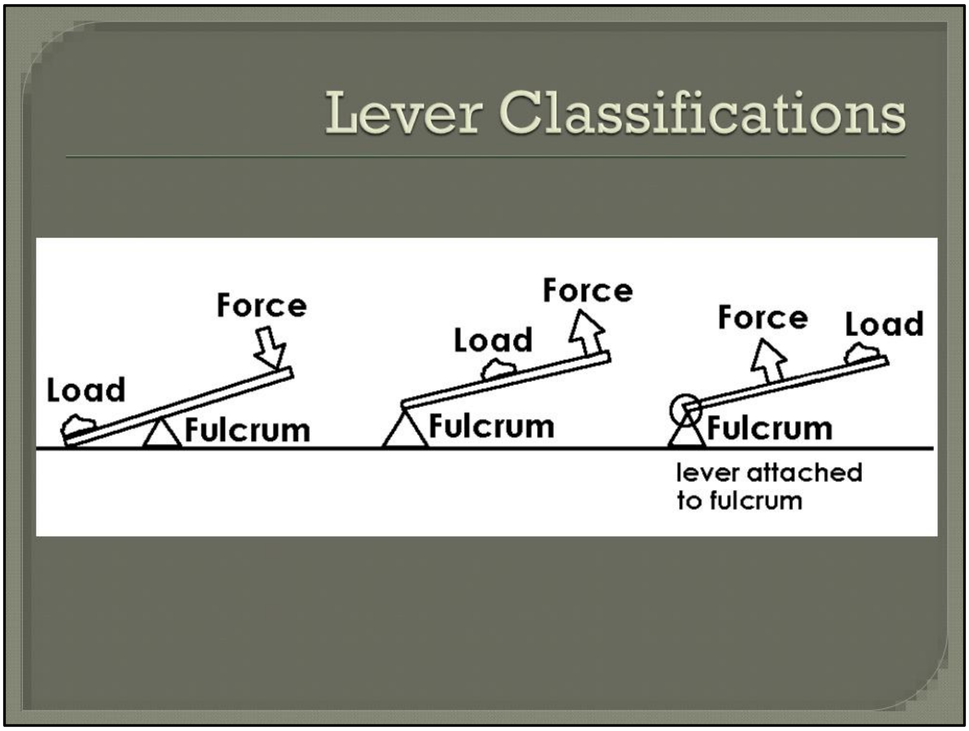
*An example of a 3rd class lever is elbow flexion with the biceps. The elbow joint is the fulcrum with the AF of the biceps at the radial tuberosity and then the R is the forehand/hand. The quadriceps are another example of a 3rd class lever. How? The fulcrum is the knee joint. The AF of the quads is at the tibial tuberosity (where they insert) and the R is the foot.

*3rd class levers allow the speed and distance traveled (range of motion) to increase. For example, say the R load is 6 times farther from the fulcrum than the AF of the biceps. This means the biceps must generate 180 kg of tension at its attachment to support the 30 kg held in the hand—however, speed and distance traveled increases by 6:1. The resistance has to travel say 45 cm when the point of attachment for the biceps travels only 7.5 cm.

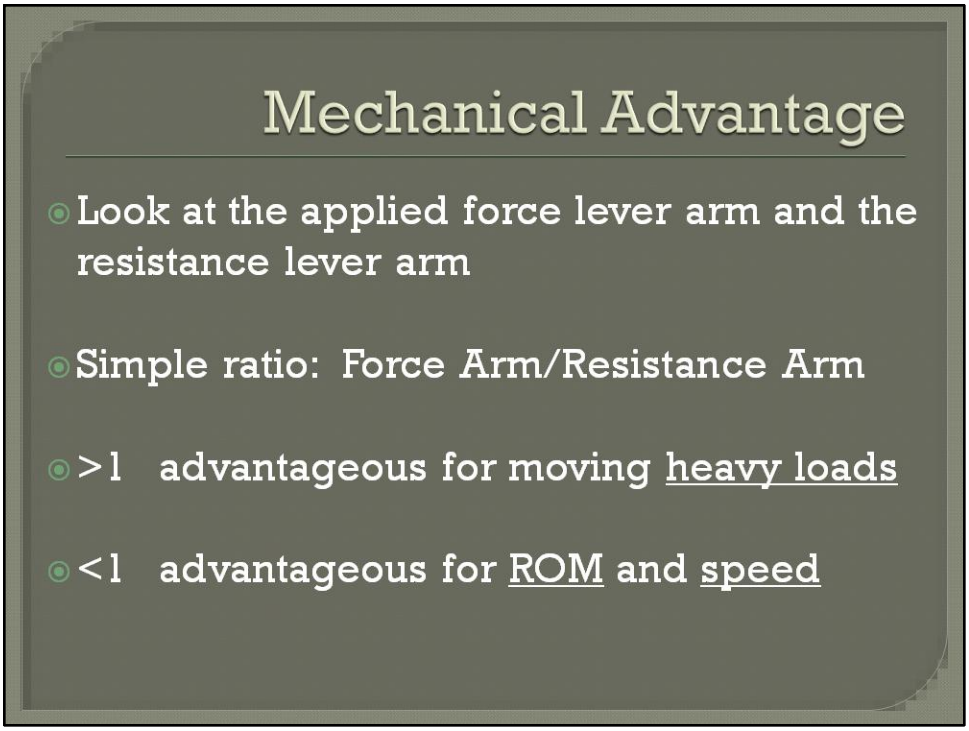

Force
Axis
a
Resistance
Force
Resistance
Axis
b



The differences between the 3 classes of levers has to do with the relative locations of the applied force (effort), resistance (load), and the fulcrum (the joint of axis of rotation).



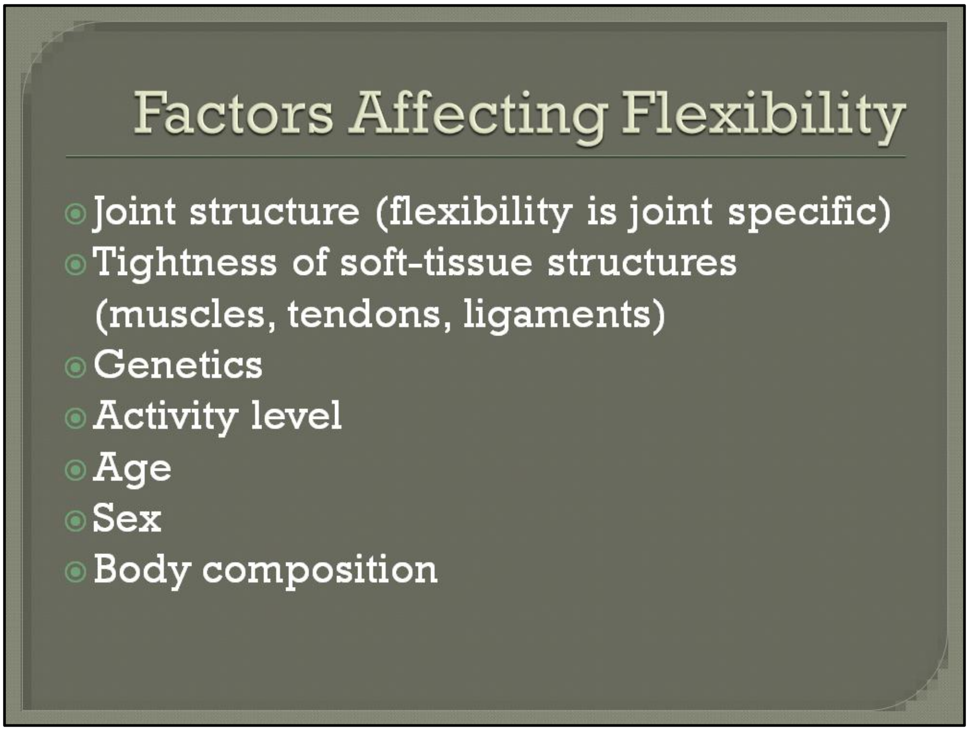
Which picture resembles a 3rd class lever? 2nd? 1st? Be sure to recognize which is which when it comes to the 3 classes of levers.



Mechanical Advantage is defined as applied force lever arm divided by the resistance lever arm. If the mechanical advantage is greater than 1 (>1) it is always a 2nd class lever. Why?? Because the AF lever arm is greater than the R lever arm…remember the black arrows from the previous slides. It has huge muscle force and can move heavy loads, but not quickly or for very long. If the mechanical advantage is less than 1 (<1) it is a 3rd class lever because the AF lever arm is less than the R lever arm. It has a small muscle force, but is fast and has huge range of motion, which is excellent for throwing and kicking. A 1st class lever can have a mechanical advantage less than, equal to, or greater than 1—it just depends on the locations of the AF and R with the fulcrum in between.

Flexibility

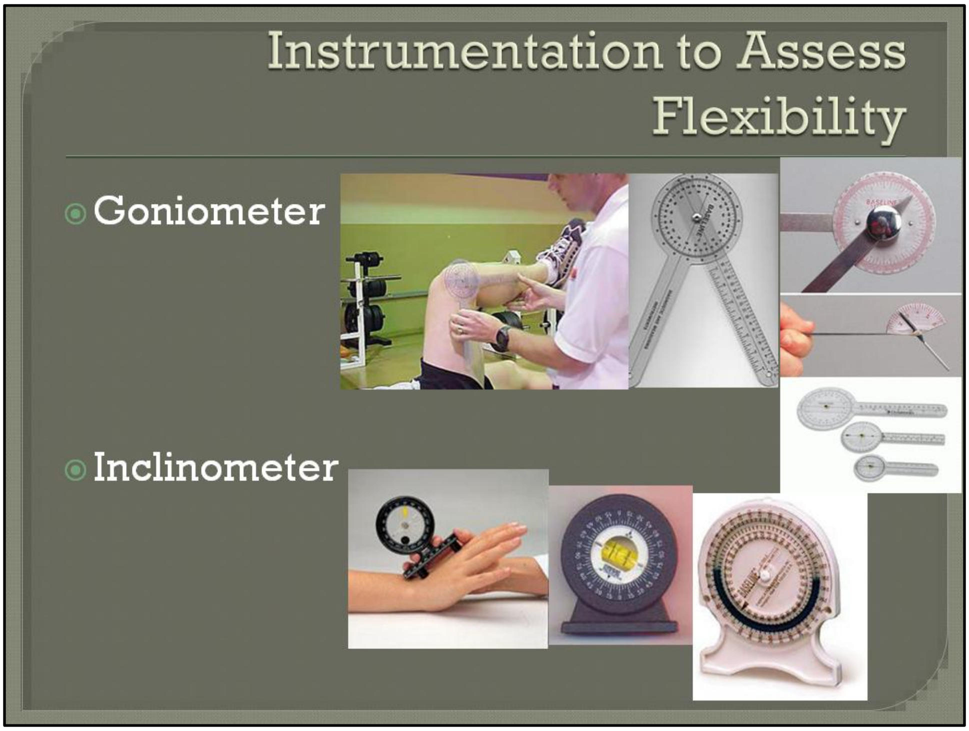
- Flexibility: range of motion achievable at a joint
  - Static Flexibility: ability to assume and maintain an extended position at one end point in a joint's range of motion (ex: split)
  - Dynamic Flexibility: ability to move a joint quickly and fluidly through its range of motion (ex: split leap)



All of these factors can affect how flexible someone can be…

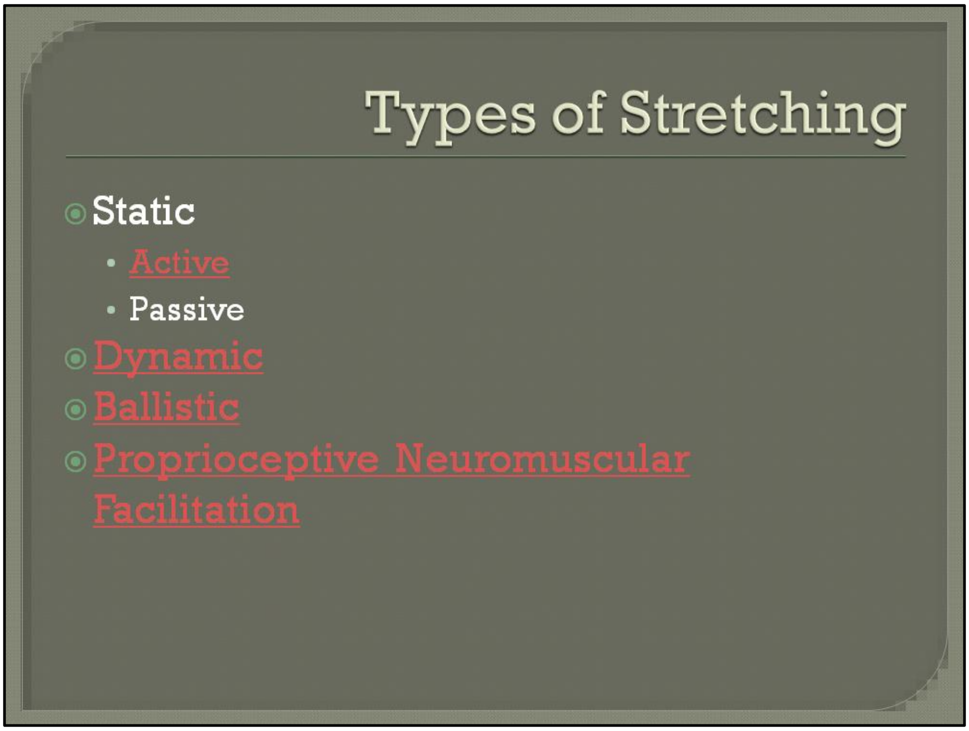
Measuring Joint Range of Motion (Flexibility)

- The range of motion capable at a joint can be measured with many sophisticated devices. The links below are some examples of such devices that typically run about $75,000.00-$100,000.00.
- Vicon link http://www.vicon.com/
- Motion analysis http://www.motionanalysis.com/



A less expensive measuring device, that is commonly used in clinical environments, is the manual goniometer shown below. It basically works as a protractor; the stationary arm is placed on the stationary segment and the moving arm is placed on the moving segment. Units are in degrees.

If you have had surgery on a joint (ex: knee or shoulder) and needed to go through physical therapy to regain your range of motion, you will probably recognize these instruments. Both the goniometer and inclinometer help determine a joints range of motion.



Be sure to view the videos demonstrating these different techniques of stretching.

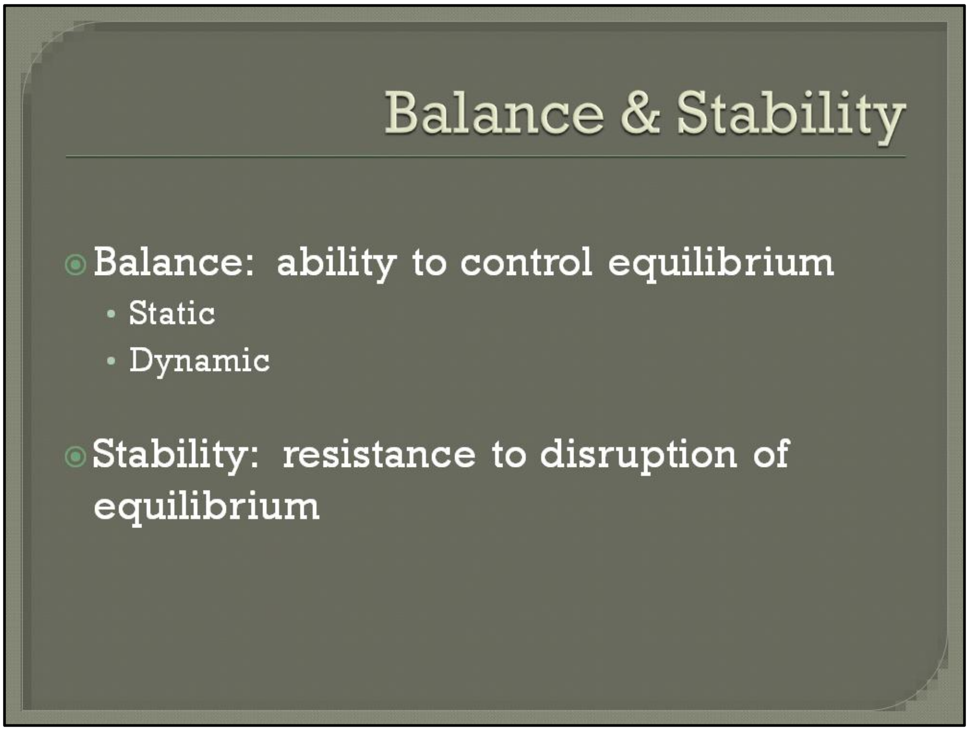
Active static—assume a position and hold it there with no resistance other than using the strength of your agonist muscles.

Passive static—hold the stretch with some part of your body, a partner, or other apparatus. You are relaxed and make no contribution to the range of motion—only an external force does.

Dynamic stretch—performed doing controlled movements to increase reach and speed of movement (ex: high knees)

Ballistic—go beyond the normal range of motion by bouncing (ex: touching your toes—start bouncing to increase ROM and touch the floor)

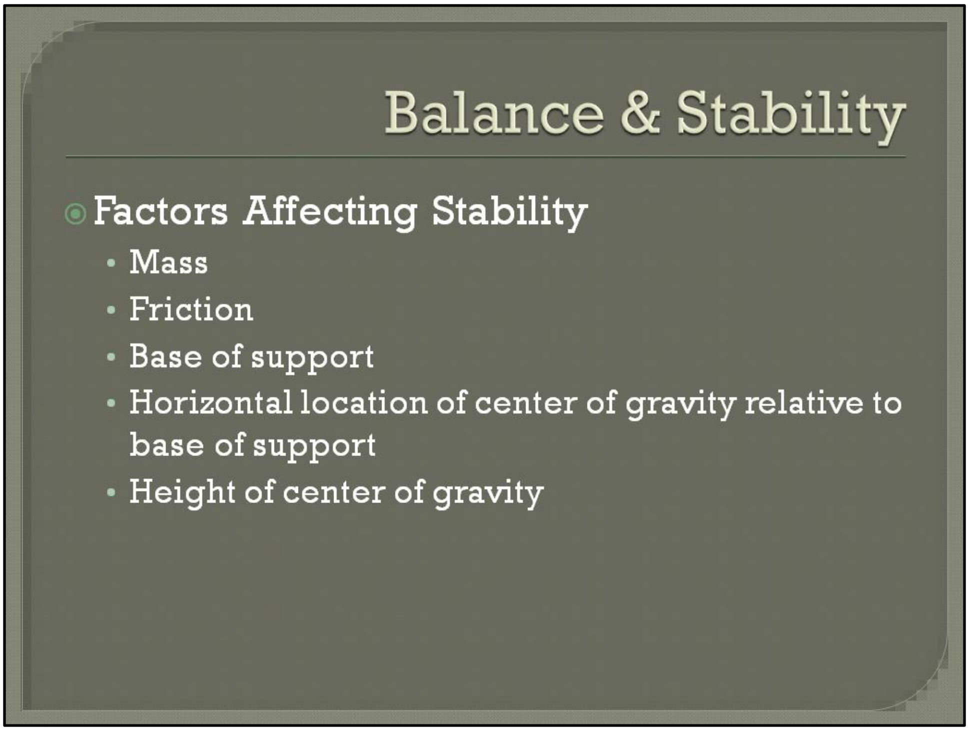
PNF—this is performed by being passively stretched by a partner, then you contract isometrically against the resistance to the partner while in the stretched position, and then you are stretched again past the previous range of motion by your partner.



A lot of people think that balance and stability are the same things, but that is not true.

Equilibrium means that opposing forces or moments are balanced (sum of all forces of moments is 0).
Static Equilibrium—no movement; standing
Dynamic Equilibrium—moving, but there is no change in velocity and no change in direction of movement. (Example: punting the football with 1 leg)

Stability—the level where you can retain your balance while experiencing factors that disturb balance. (Example: punter getting tackled=not stable)



More mass, more friction=more stable
Broader base of support=more stable
Horizontal location of COG relative to base of support—ex: by having a straight back and head held upright, it centralizes the line of gravity which leads to being more stable
Lower COG=more stable (Example: a catcher—being in a crouched position increases his stability)