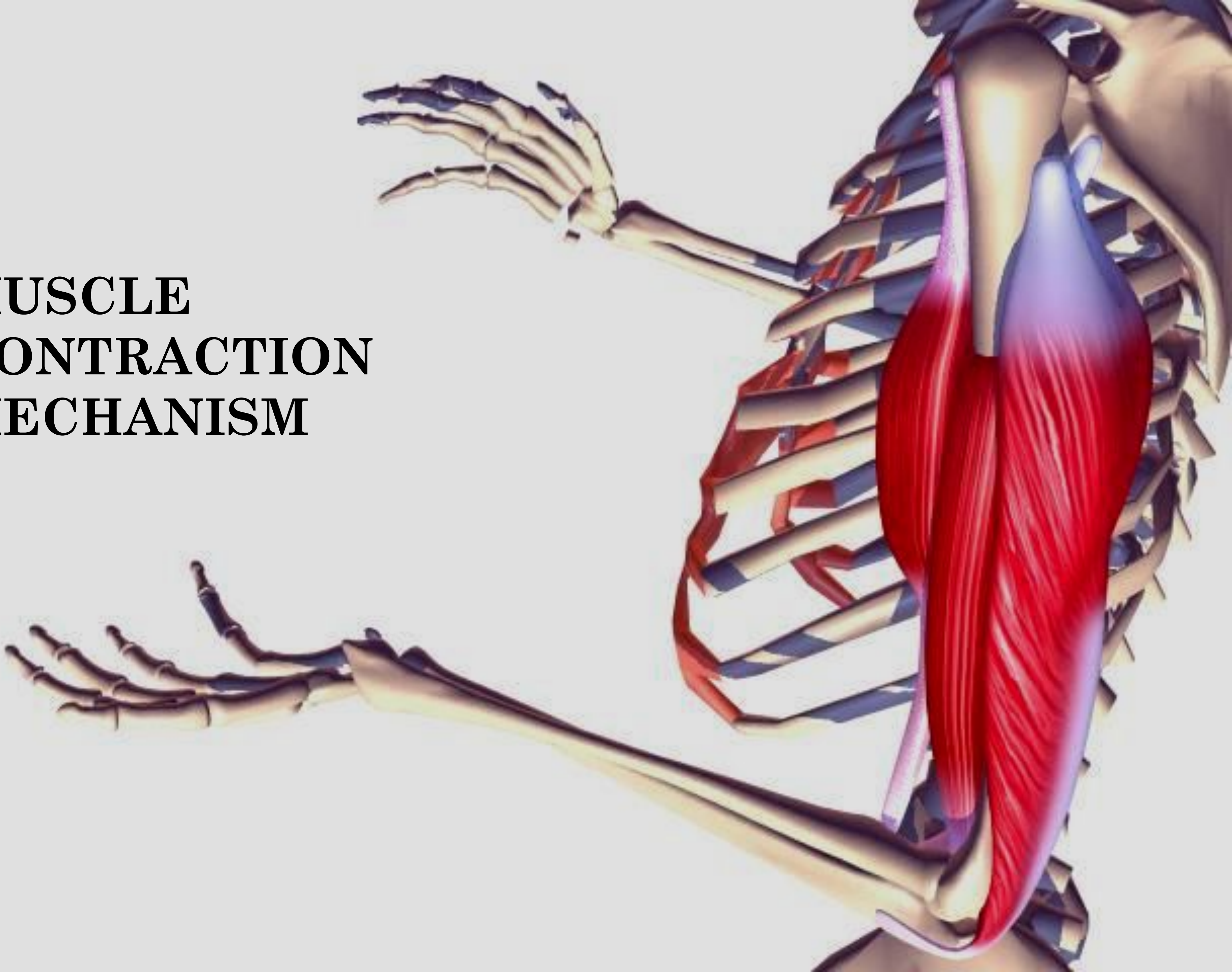
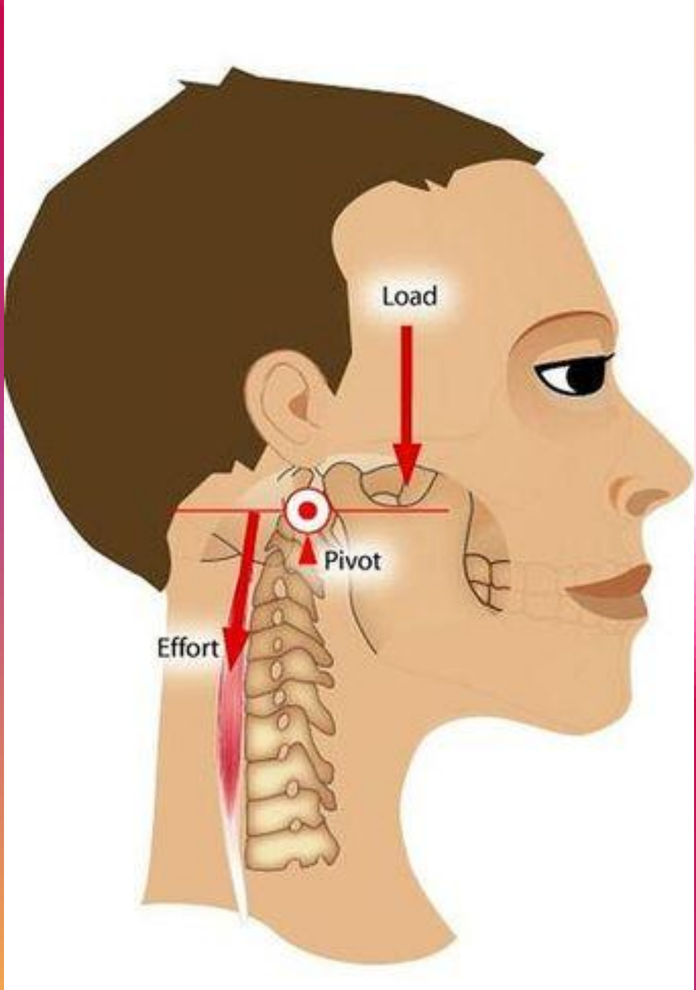
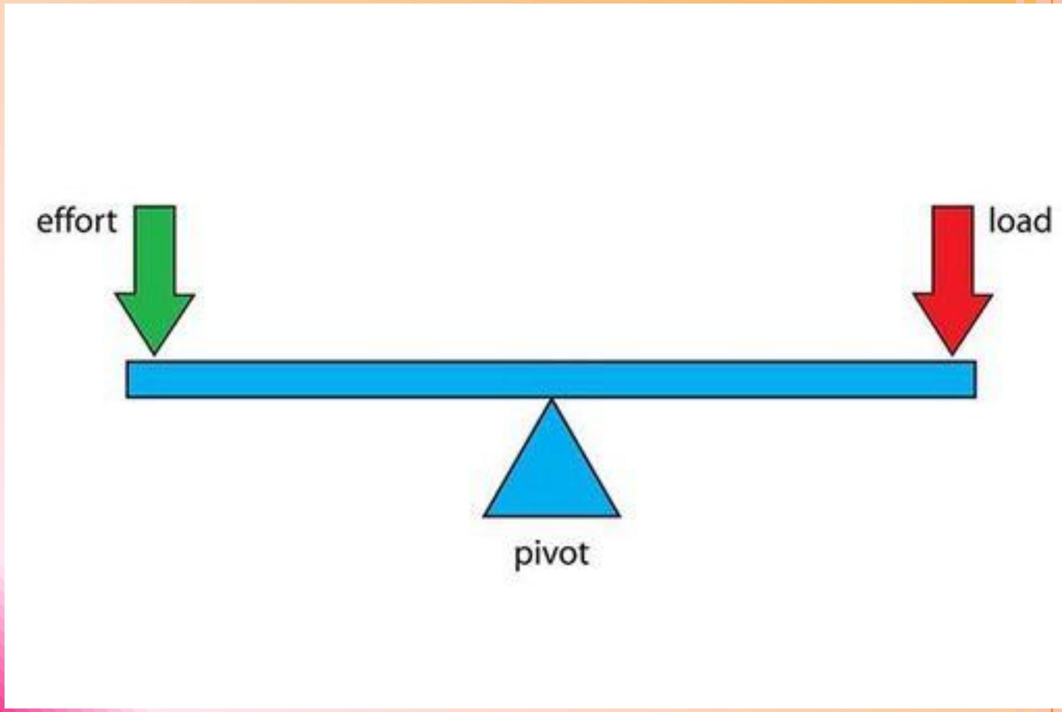
MUSCLE CONTRACTION MECHANISM



FIRST CLASS LEVER

For a Class 1 lever the pivot lies between the effort and the load. A see saw in a playground is an example of a Class 1 lever where the effort balances the load. The place where your skull meets the top of your spine is a Class 1 lever. Your skull is the lever arm and the neck muscles at the back of the skull provide the force (effort) to lift your head up against the weight of the head (load). When the neck muscles relax, your head nods forward.

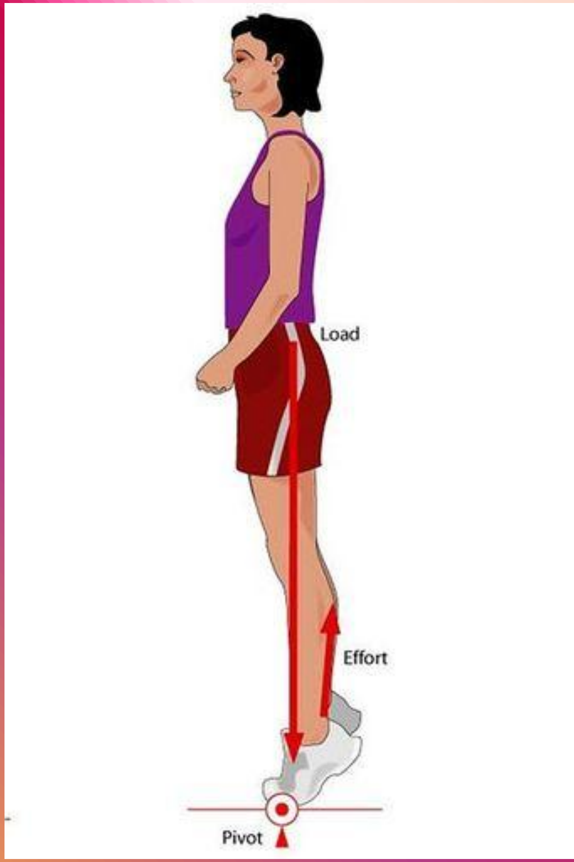


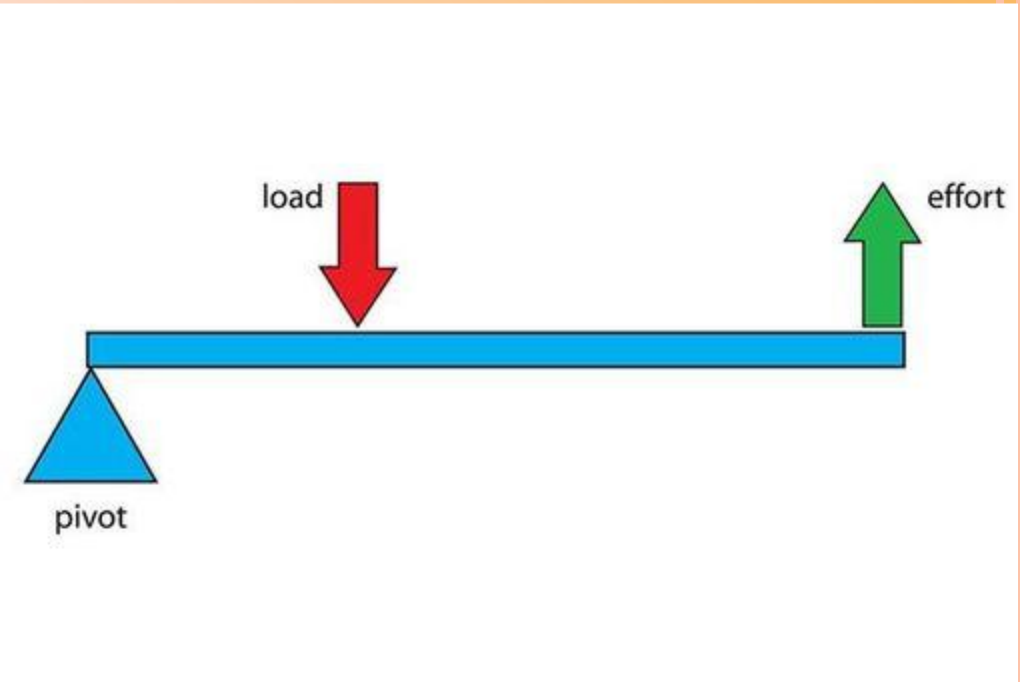


SECOND CLASS LEVER

For the Class 2 lever the load is between the pivot and the effort (like a wheelbarrow). The effort force needed is less than the load force, so there is a mechanical advantage.

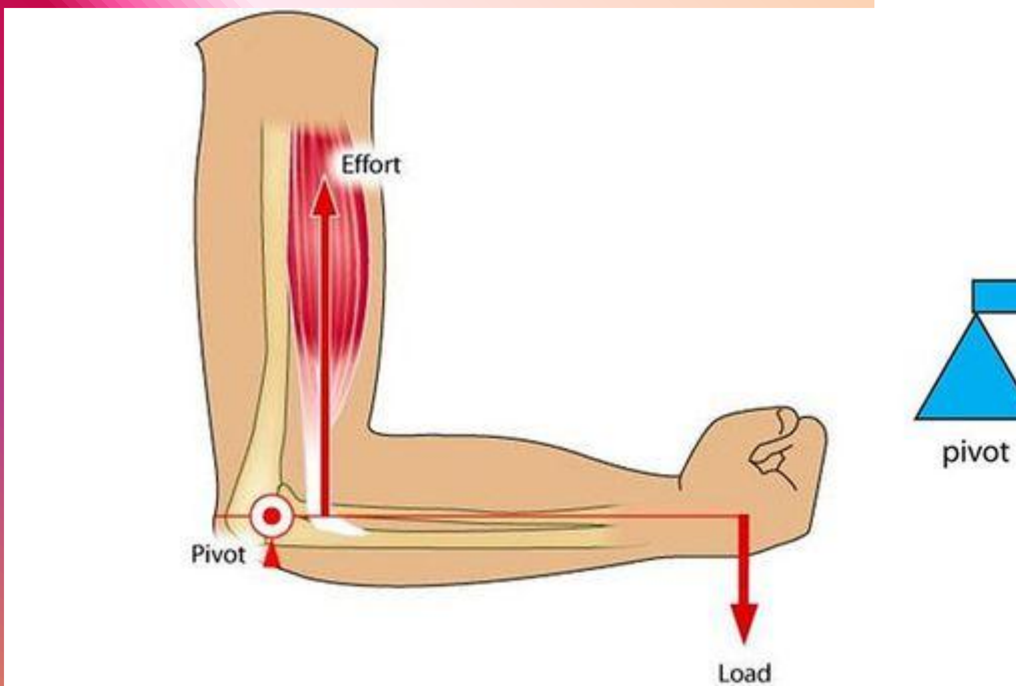
Standing on tip toes is a Class 2 lever. The pivot is at your toe joints and your foot acts as a lever arm. Your calf muscles and achilles tendon provide the effort when the calf muscle contracts. The load is your body weight and is lifted by the effort (muscle contraction).

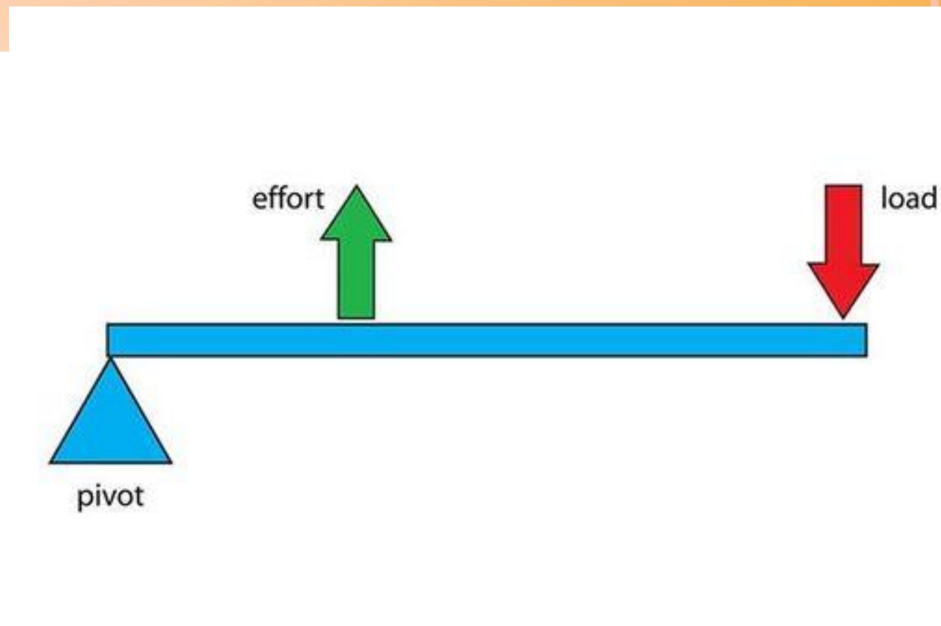




THIRD CLASS LEVER

For a Class 3 lever the load is further away from the pivot than the effort. There is no mechanical advantage because the effort is greater than the load. However this disadvantage is compensated with a larger movement. This type of lever system also gives us the advantage of a much greater speed of movement.
A bent arm is a Class 3 lever. The pivot is at the elbow and the forearm acts as the lever arm.
The *biceps* muscle provides the effort (force) and bends the forearm against the weight of the forearm and any weight that the hand might be holding.





Sliding Filament Theory

The theory of how muscle contracts is the sliding filament theory. The contraction of a muscle occurs as the thin filament slide past the thick filaments. The sliding filament theory involves five different molecules plus calcium ions. The five molecules are: myosin, actin, tropomyosin, troponin, and ATP.

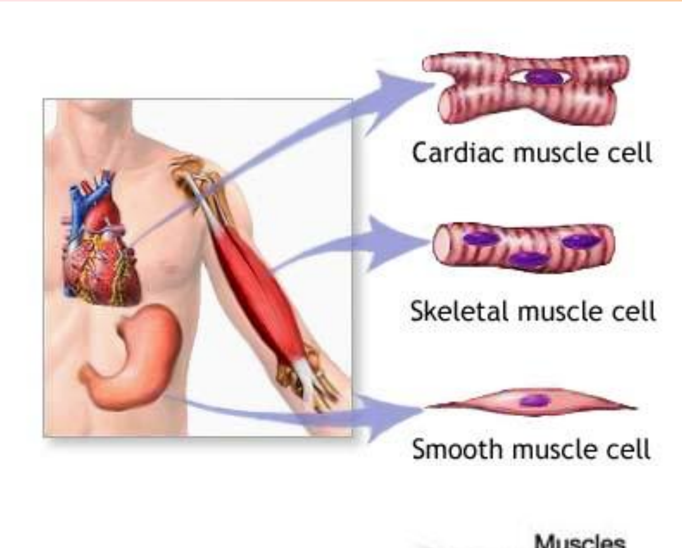
The myosin molecules are bundled together to form the thick filament. The head (cross bridge) of the myosin molecule has the ability to move back and forth. The flexing movement of the head provides the power stroke for muscle contraction. The hinge portion of linear tail allows vertical movement so that the cross bridge can bind to actin on the thin filament. The cross bridge has two important binding sites. One site specifically binds ATP, a high energy molecule.

This binding of ATP transfers energy to the myosin cross bridge as ATP is hydrolyzed into ADP and inorganic phosphate. The second binding site on the myosin cross bridge binds to actin.

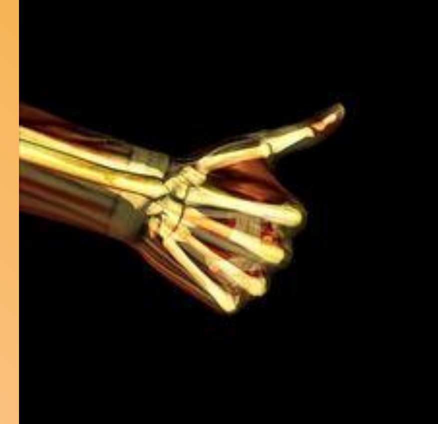
Actin is the major component of the thin filament. Tropomyosin entwines around the actin and covers the binding sites on the actin subunits and prevents myosin cross bridge binding.

Troponin is attached and spaced periodically along the tropomyosin strand. After an action potential calcium ions are released from the terminal cisternae and bind to troponin. This causes a conformational change in the tropomyosin-troponin complex, "dragging" the tropomyosin strands off the binding site.

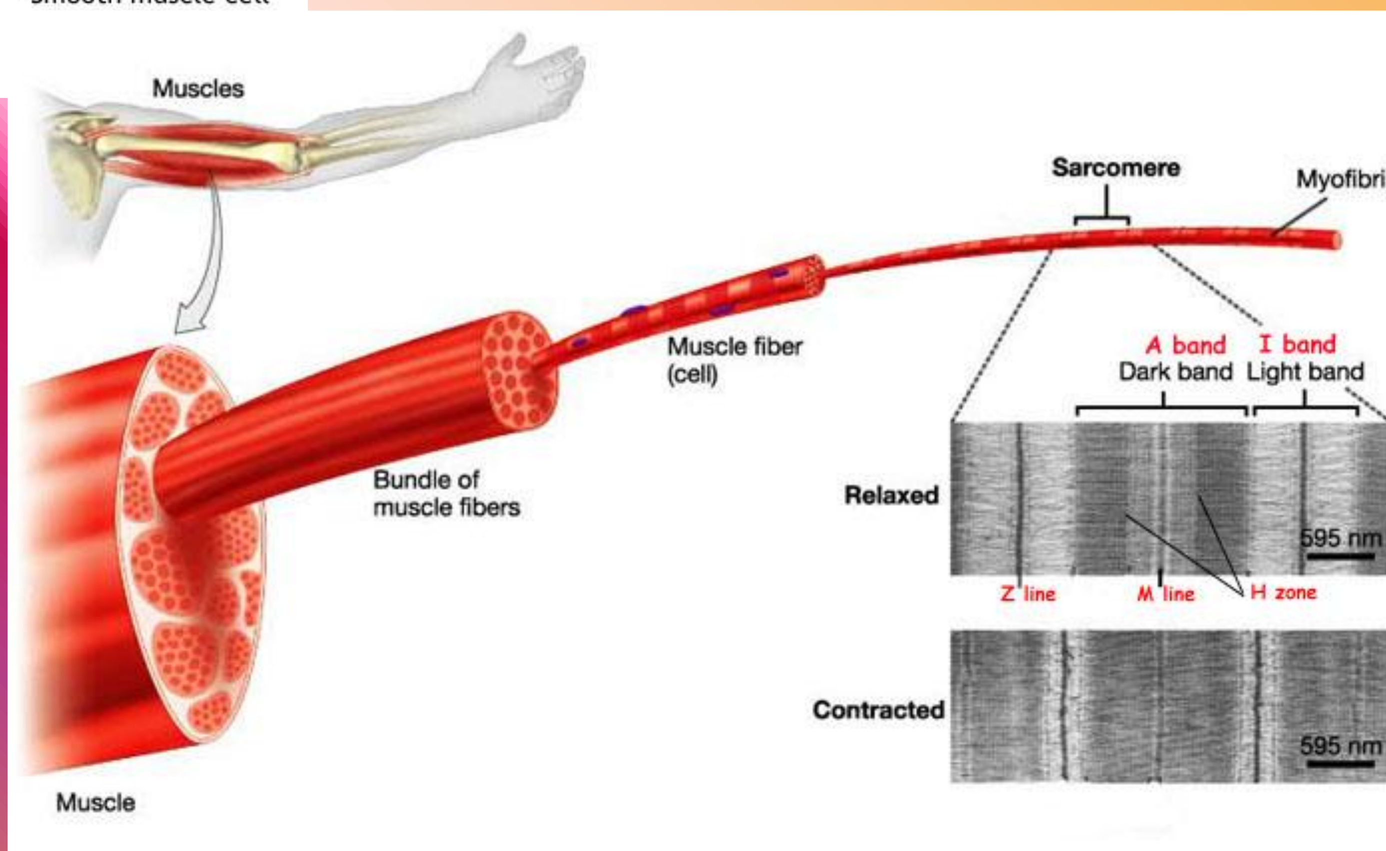
The five organic molecules and the calcium ions all work together in a coordinated maneuver to cause the thin filament to slide past the thick filament, and are illustrated here.



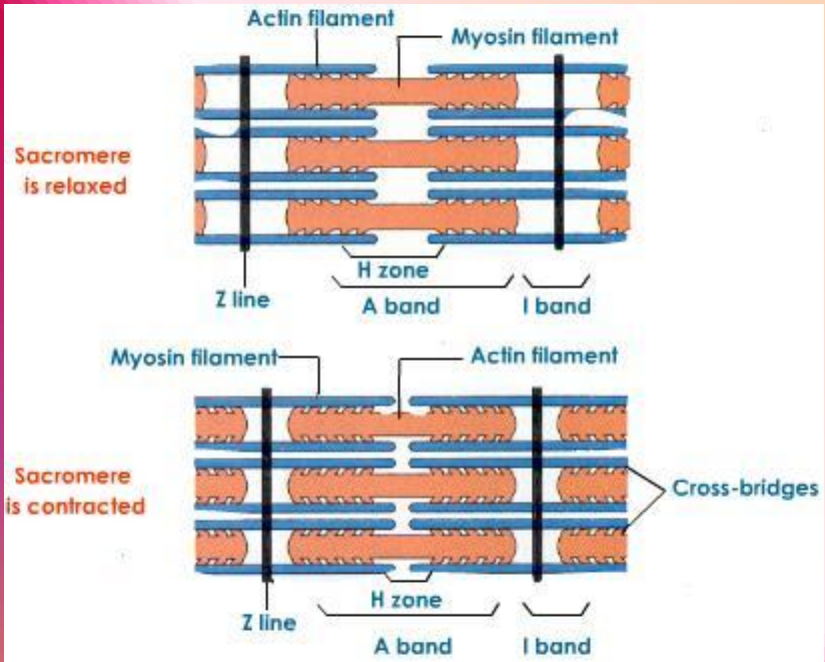
Kinds of muscles



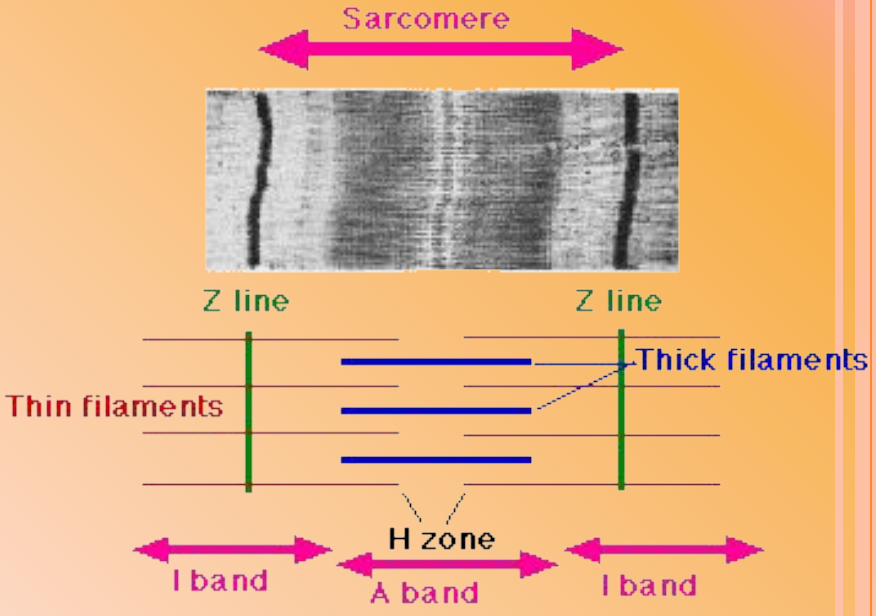
Skeletal muscle structure



SARCOMERE

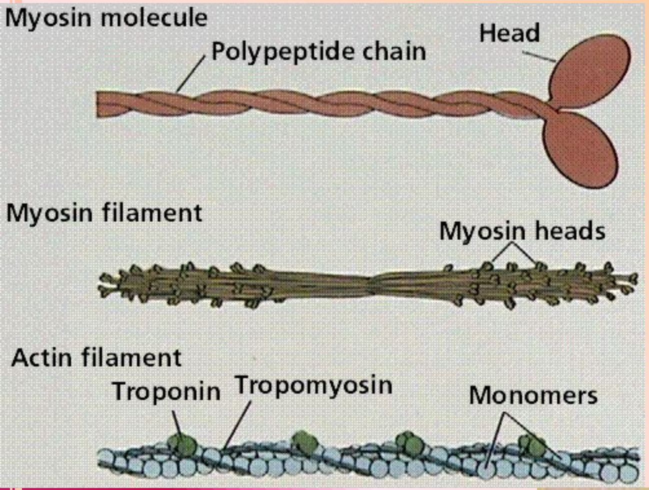


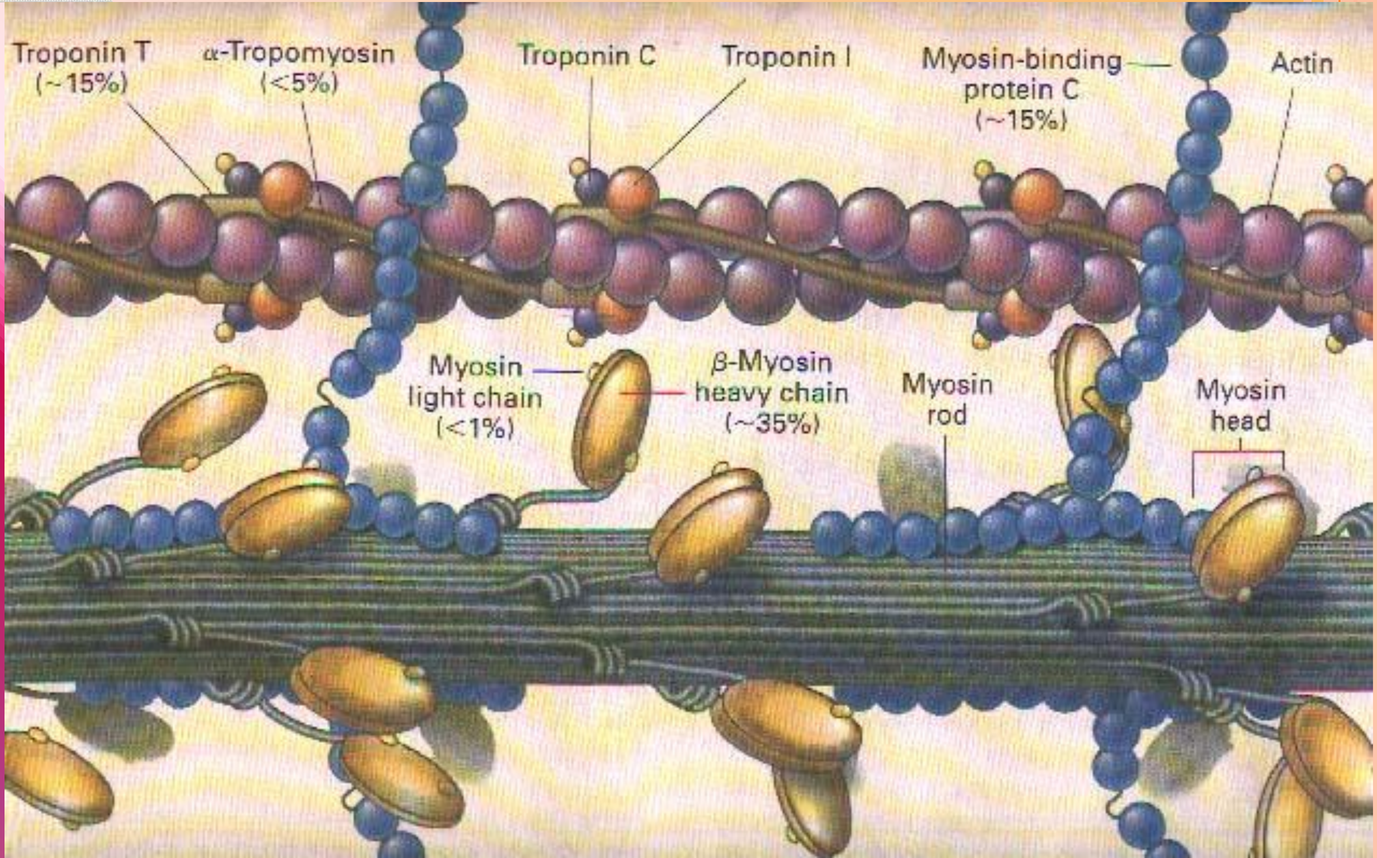
Actin filament
Myosin filament
Sacromere
is relaxed
H zone
Z line
A band
I band
Myosin filament
Actin filament
Sacromere
is contracted
Cross-bridges
H zone
Z line
A band
I band



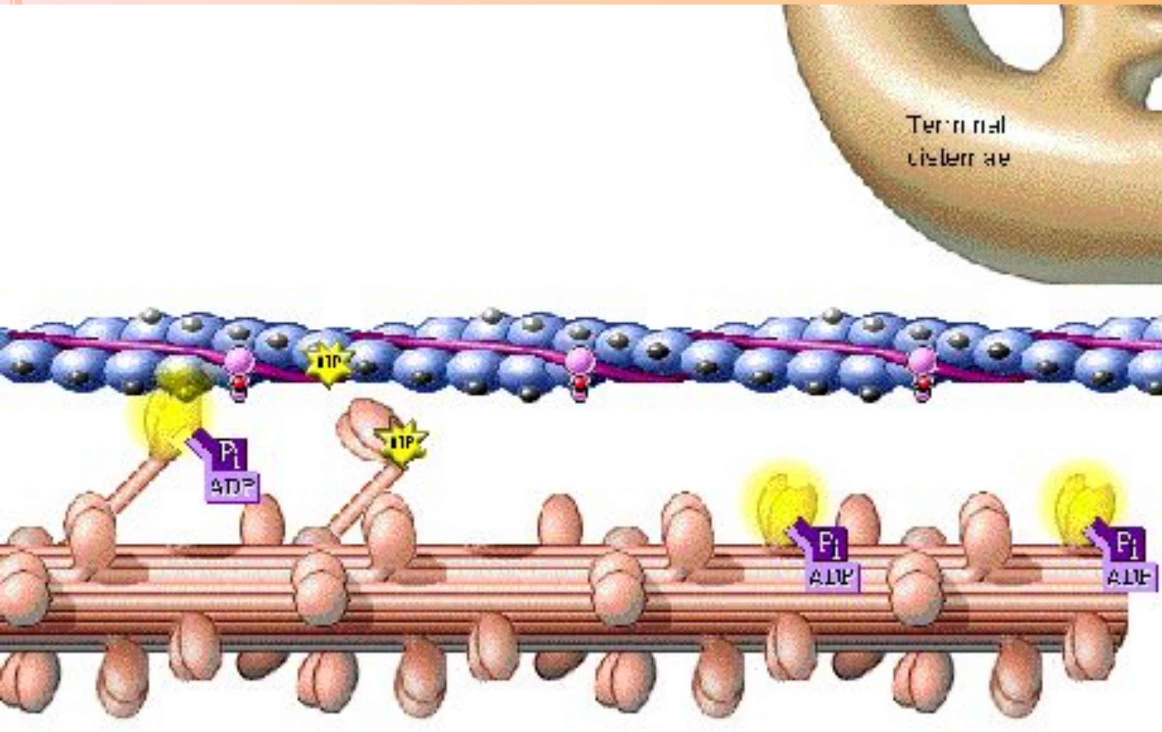
Sarcomere
Z line
Z line
Thick filaments
Thin filaments
H zone
I band
A band
I band

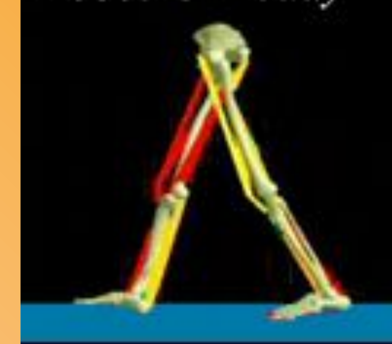
Myofilaments

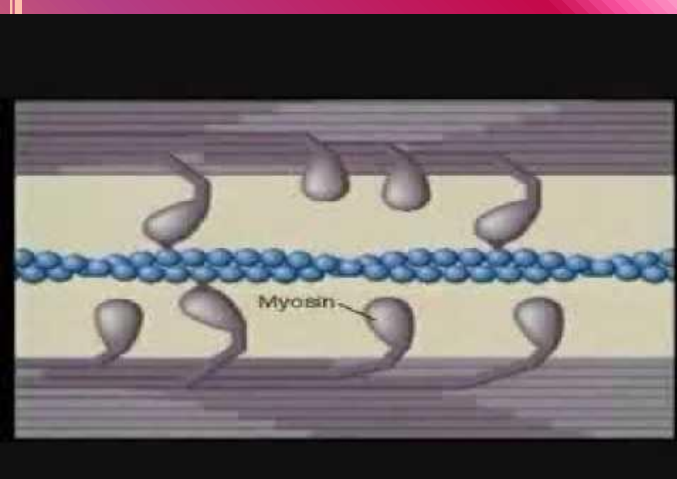


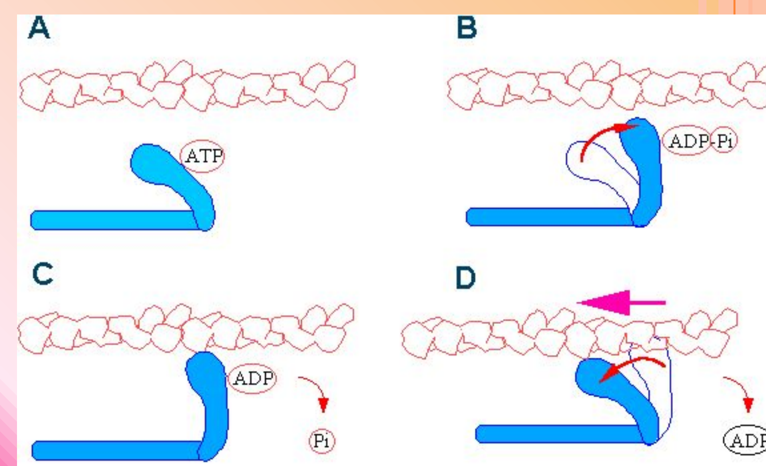


Mechanism of muscle contraction









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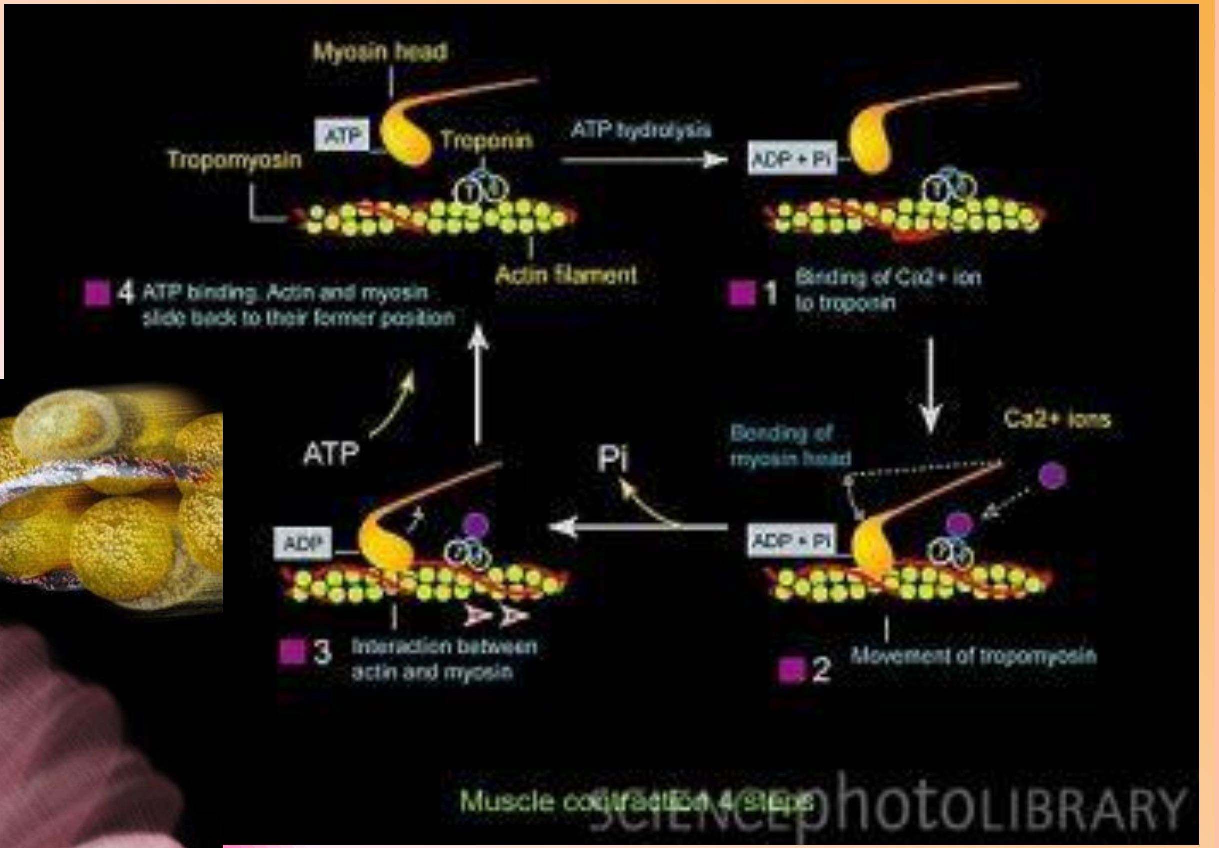
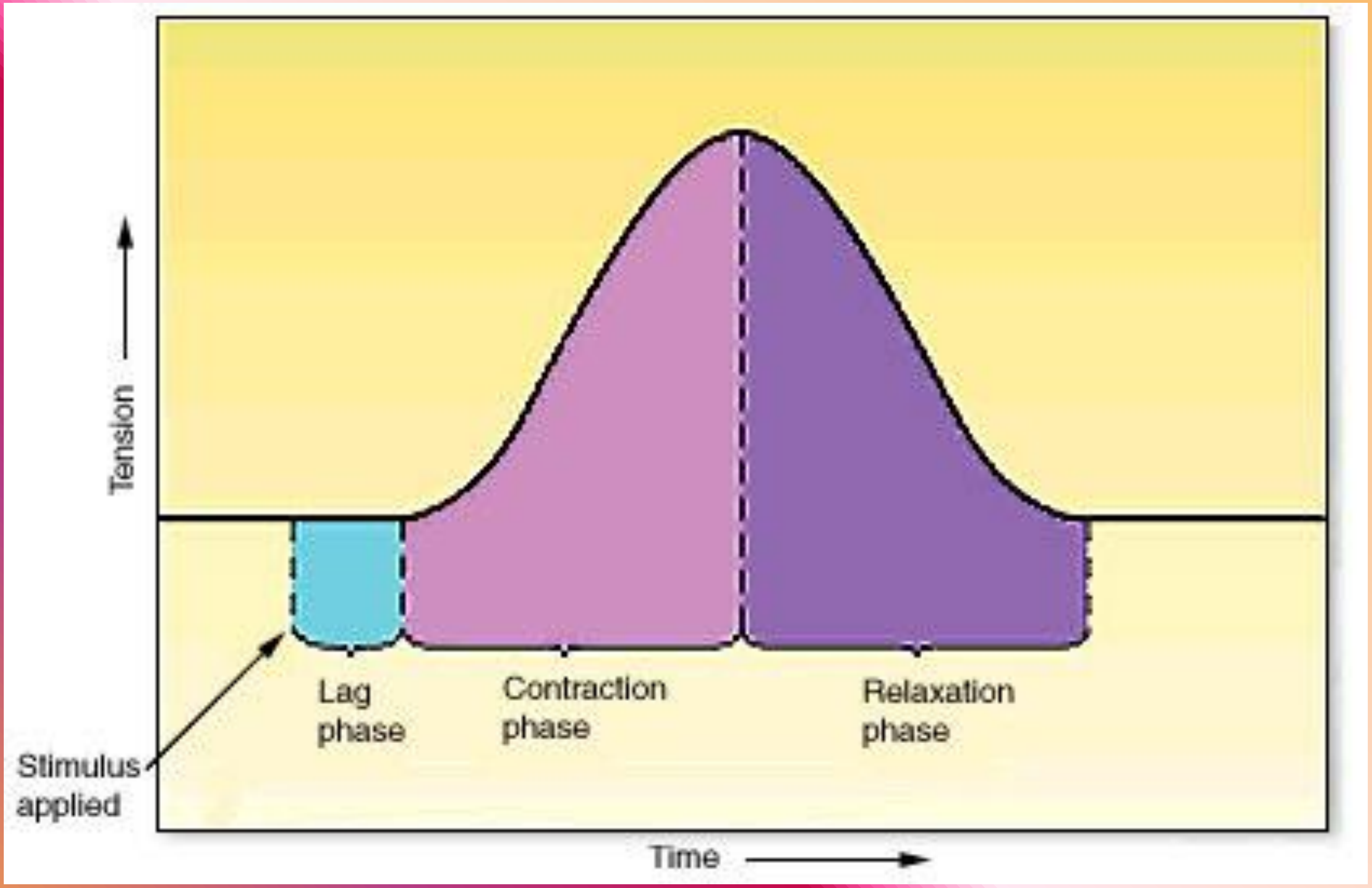


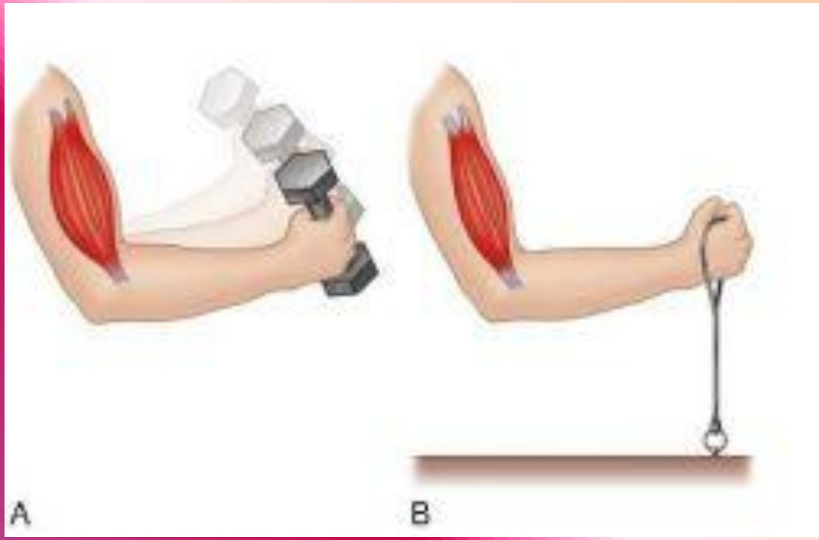
Phases of a Muscle Twitch

A muscle twitch is contraction of a muscle in response to a stimulus that causes an action potential in one or more muscle fibers. Even though the normal function of muscles is more complex, an understanding of the muscle twitch makes the function of muscles in living organisms easier to comprehend.



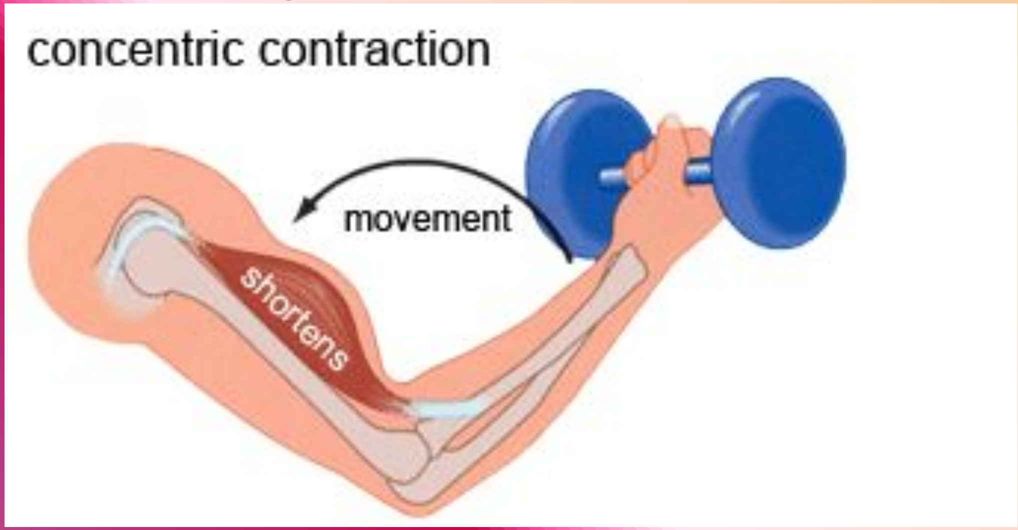
ISOTONIC AND ISOMETRIC TWITCH

A - isotonic contraction muscle contraction without appreciable change in the force of contraction; the distance between the muscle's origin and insertion becomes lessened



B - isometric contraction muscle contraction without appreciable shortening or change in distance between its origin and insertion.

concentric contraction contraction resulting in shortening of a muscle, used to perform positive work or to accelerate a body part. It is metabolically more demanding than an eccentric contraction. Called also shortening contraction.



eccentric contraction contraction in the presence of a resistive force that results in elongation of a muscle, used to perform negative work or to decelerate a body part. It is less metabolically demanding than aconcentric contraction but may cause disruption of associated connective tissue with delayed soreness or frank injury if it occurs in an unaccustomed manner. Called also lengthening contraction.