

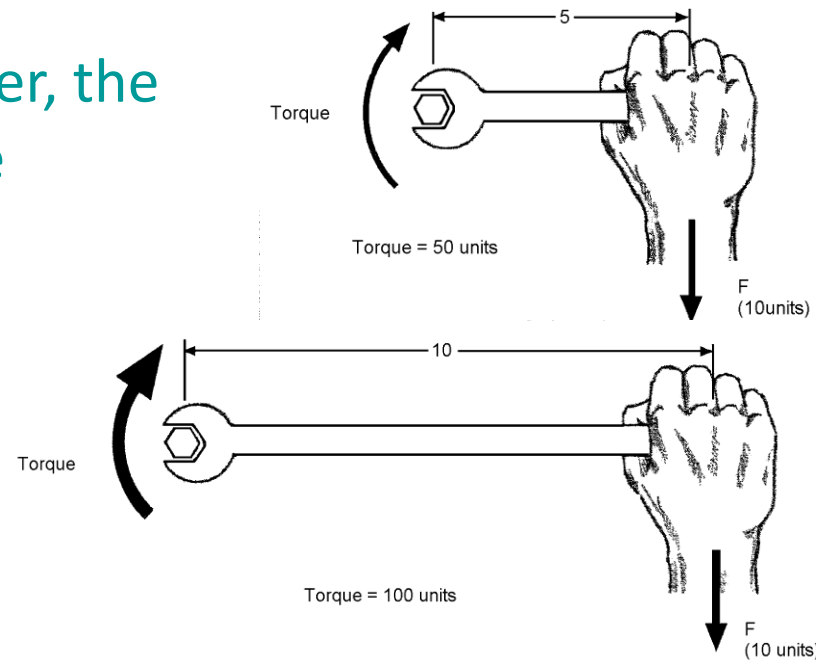
The Study of Levers

Movement of Force - Torque

The **movement of force** is the single most important concept in understanding human movement.

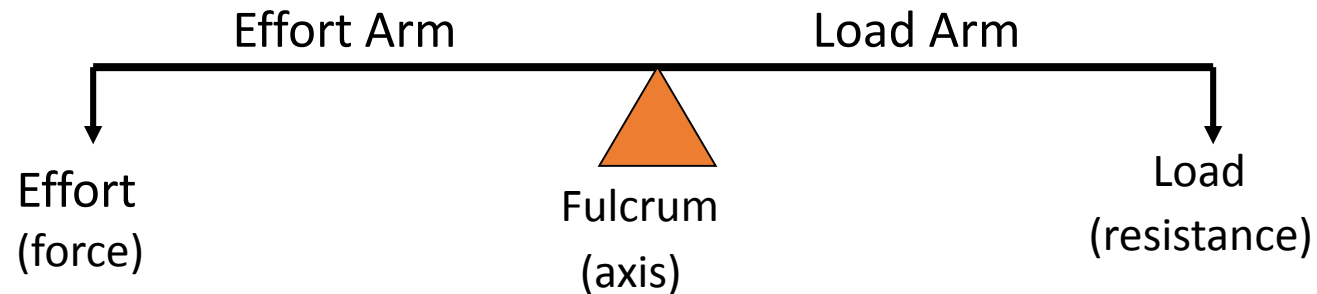
A movement of force in a lever causes **torque** (a rotation or turning).

The longer the lever, the greater the torque



Parts of a Lever

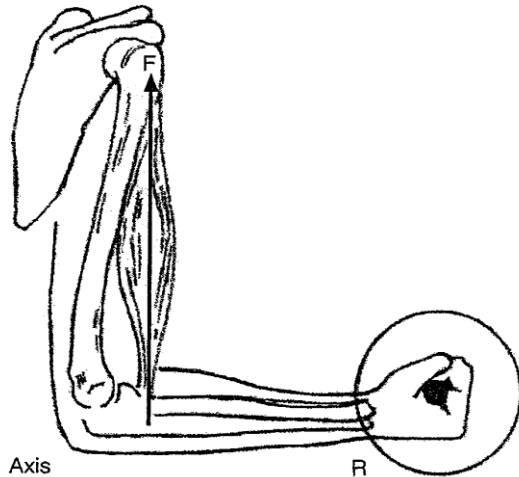
All levers have a rigid bar, a fulcrum, an effort arm which applies an application force or effort, and a load arm which moves the load.



The purpose of a lever is to gain a **mechanical advantage**

Anatomical Levers

Levers can be found at all joints of the human body



Rigid bar – bones of the body

Fulcrum (axis) – joints

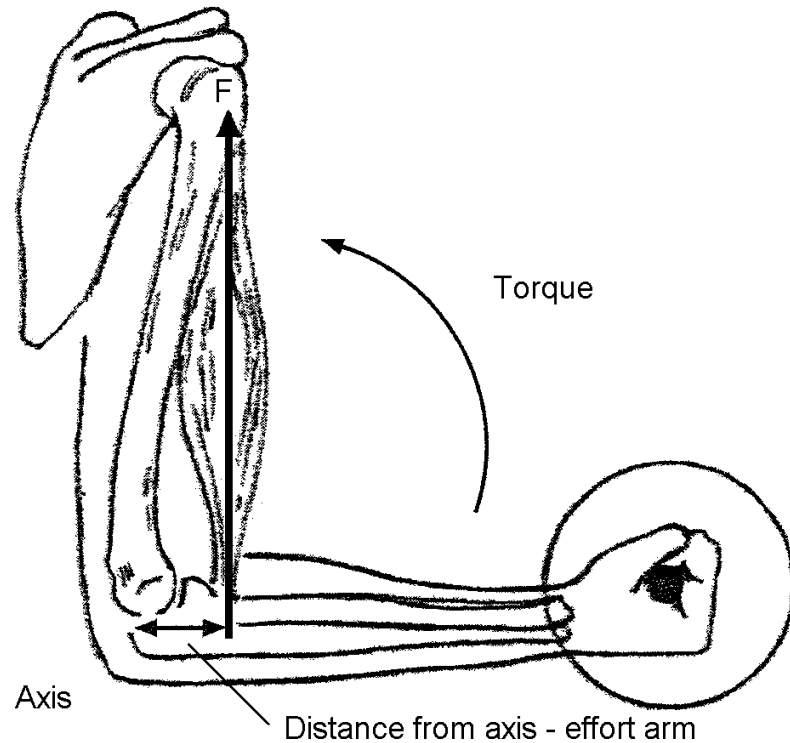
Effort Arm (force)- distance between the fulcrum and the effort

Load Arm (resistance) – distance between the fulcrum and the load

Application Force – attachment of the muscle by the tendon to the bone

Mechanical Advantage

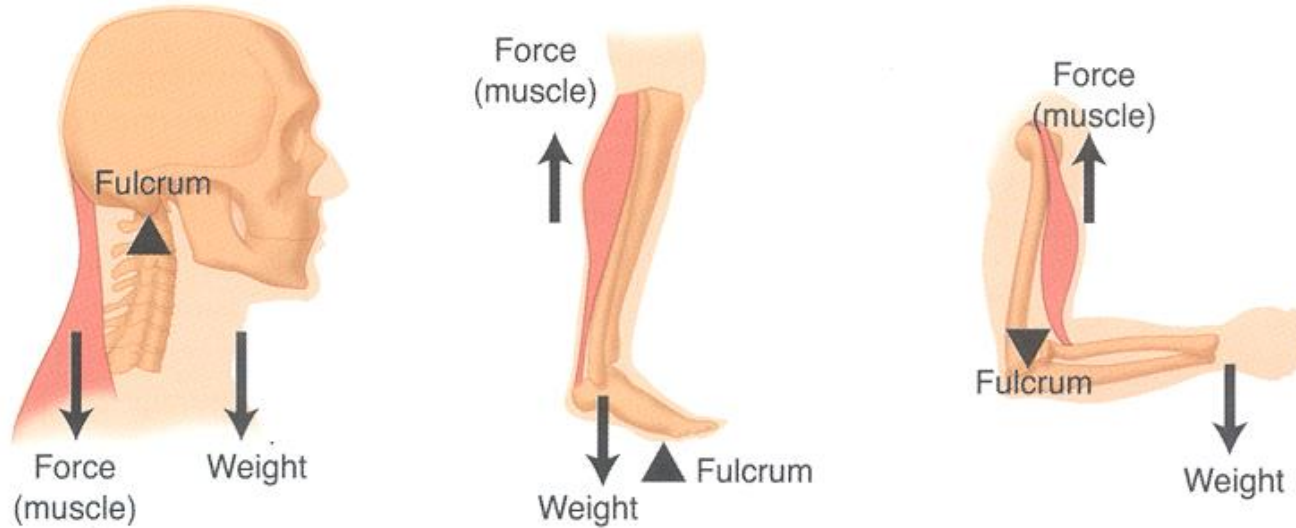
Completing a biceps curl produces torque.



Assuming that your muscular strength is identical, who in this class can produce the most torque?

Types of Levers

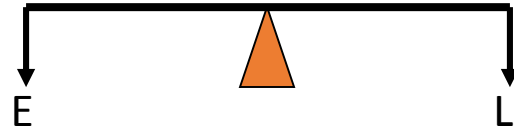
There are three types of levers.



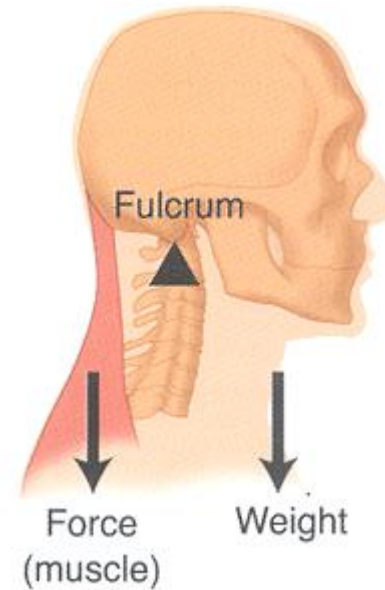
- The classification of a lever is based on the way the load, effort, and fulcrum are positioned in relation to each other
- The result will be a mechanical advantage of either **increased speed and range of motion** or **increased force**

Class 1 Lever

In a Class I lever the fulcrum is always positioned **between** load and effort.



The closeness of the fulcrum to either the effort or the load dictates the type of mechanical advantage gained.



When the fulcrum is midway between the effort and the load **no mechanical advantage** is gained.

Class 1 Lever

When the fulcrum is closer to the effort



The effort must be greater than the resistance of the load

The distance that the effort moves is less than the distance that the load moves

The effort arm is shorter than the load arm



Mechanical Advantage
Increased Speed and Range of Motion

Class 1 Lever

When the fulcrum is nearer to the load



The effort is less than the resistance

The effort moves farther than the load moves

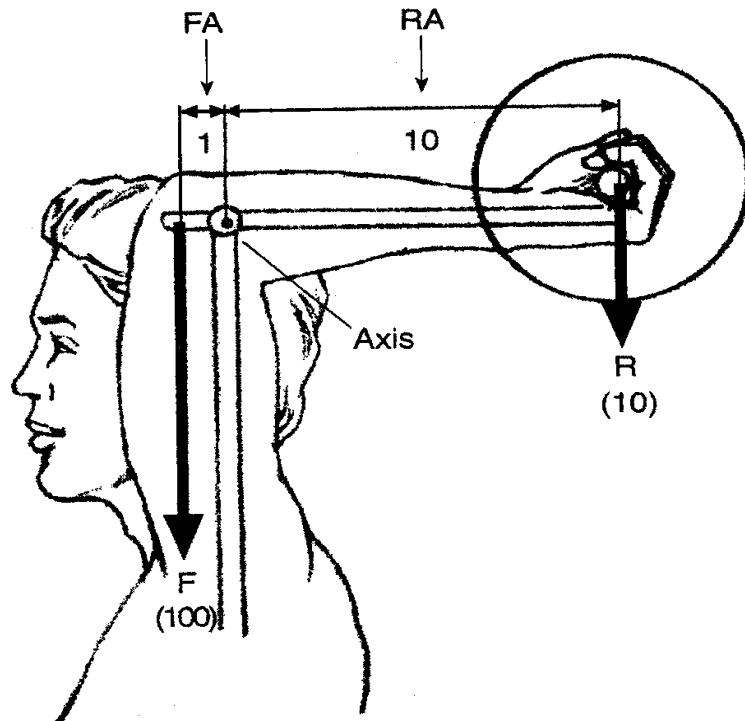
The effort arm is longer than the load arm

The lever favors force which means that the athlete can get more force out than they put in

Mechanical Advantage
Increased Force

Class 1 Lever

Triceps extension



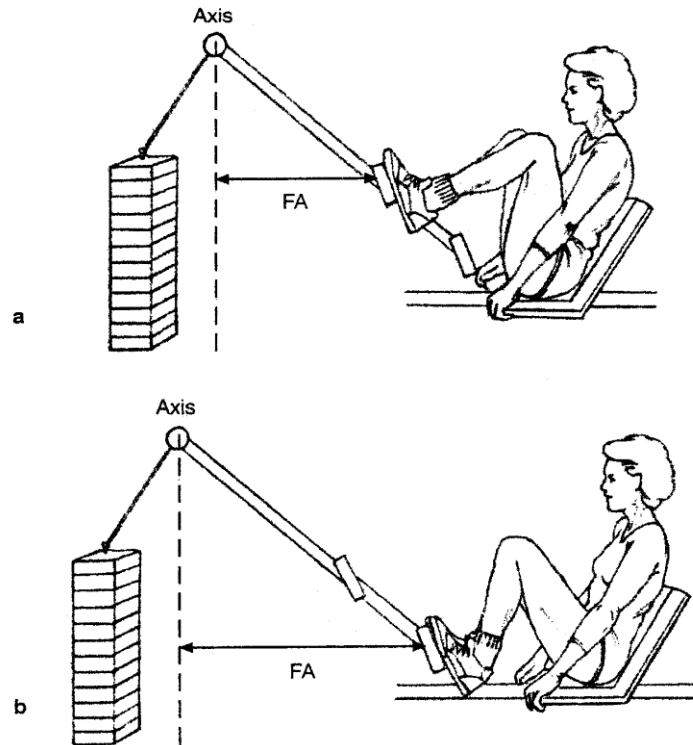
The axis of rotation occurs at the elbow joint.

Muscular force is produced by the contraction of the triceps.

The load is the weight of the dumbbell and the lifter's arms

Class 1 Lever

Triceps extension



The axis of rotation occurs at the pulley;

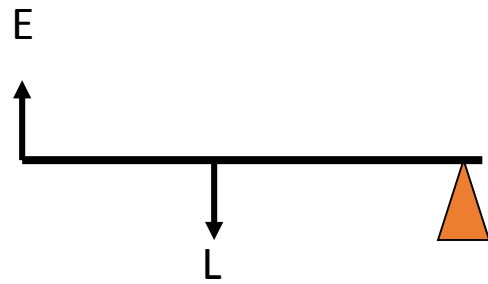
Muscular force is produced by the extension of the quads;

The load is the weight stack on the machine;

When the lower pedals are used (b) the effort arm is lengthened and the effort decreases.

Class 2 Lever

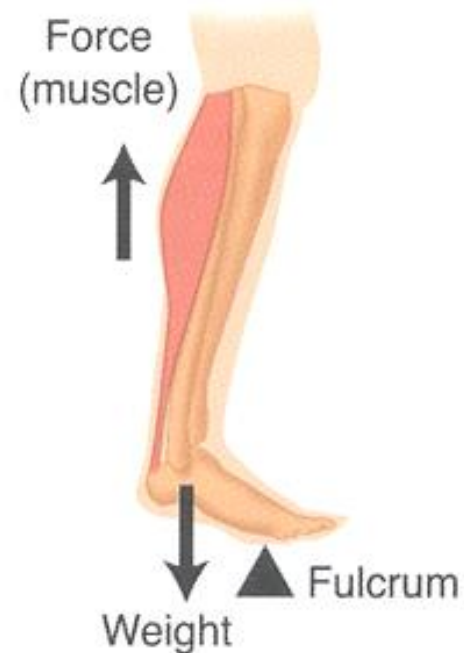
In a Class II lever the load and the effort are on the same side of the fulcrum



The load is always between the fulcrum and the effort

The effort arm is always longer than the load arm.

The effort and the load move in the same direction.



Class 2 Lever

Class II levers always favor force at the expense of speed or range of motion.

The effort will always increase the force applied.

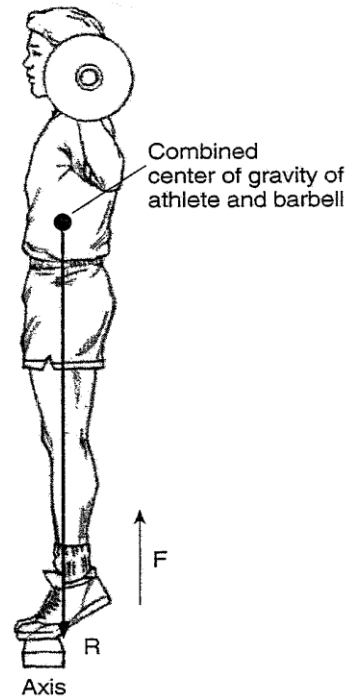
The longer the effort arm in relation to the load arm the greater the force output.

Athletes who use second class levers apply less effort over a longer distance to shift a heavier load a small distance

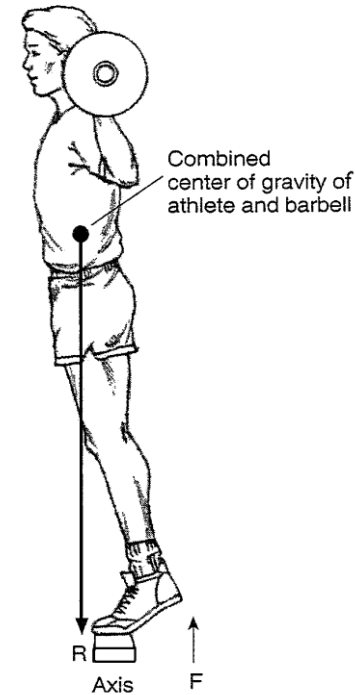
Mechanical Advantage
Increased Force

Class 2 Lever In the Human Body

Changes in body position can change the type of lever that the body uses

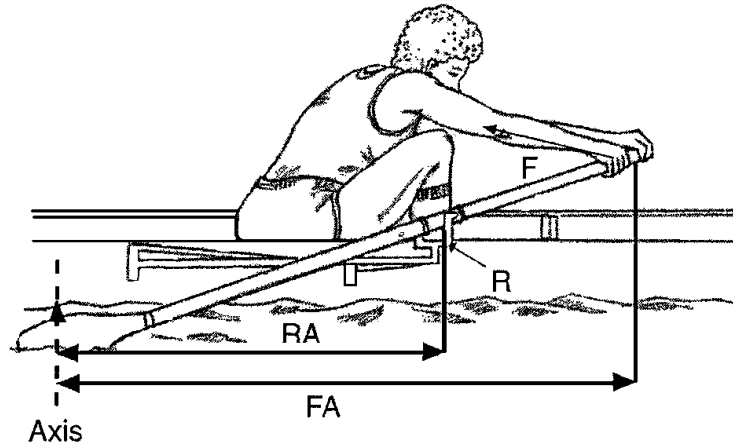


A calf raise as a
Class II lever



Leaning forward
produces a
Class I lever

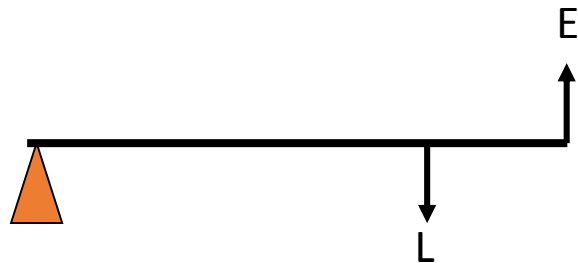
Rowing as a Class 2 Lever



The axis of rotation occurs where the oar contact the water.

Muscular force is produced by the contraction and pull of the rowers arm and leg muscles.

The load is the point where the oar contacts the oar lock.



Class 3 Lever

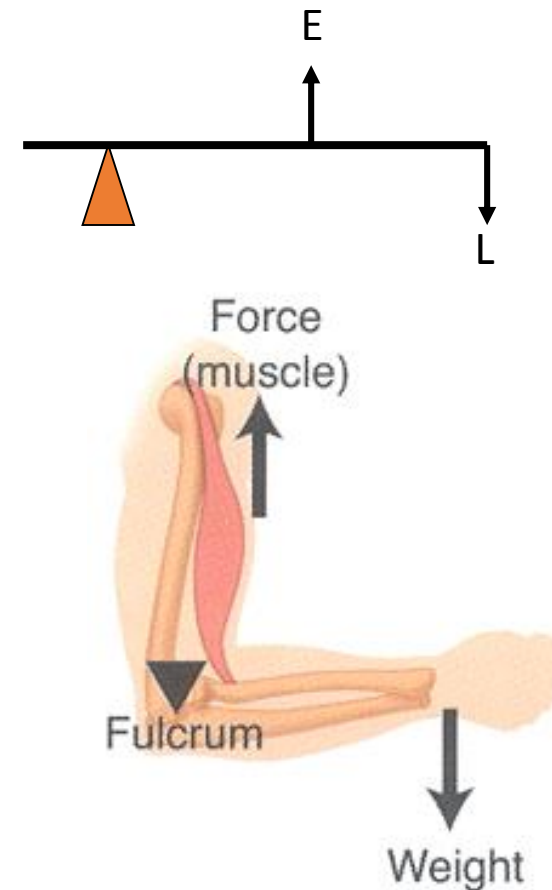
In a Class III lever the load and the effort are on the same side of the fulcrum. However,

The effort acts between the fulcrum and the load.

The effort and load pull or push in the same direction.

The movement of the effort results in movement of the load in the same direction.

The load arm is always longer than the effort arm



Class 3 Lever

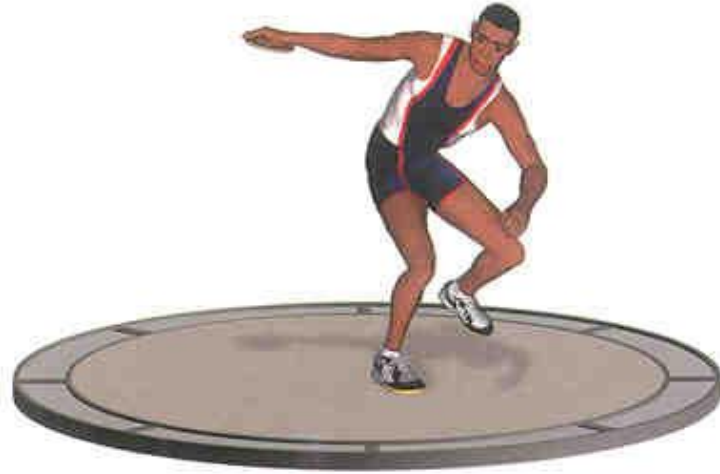
Class III levers always move the load through a larger range of motion than the effort

The effort will always increase the speed at which the load moves.

The effort is always greater than the load resulting in an increase in speed.

Mechanical Advantage
Increased Speed and Range of Motion

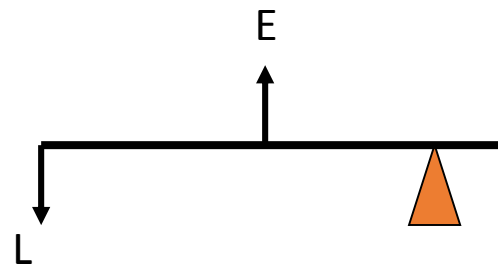
Discus as a Class 3 Lever



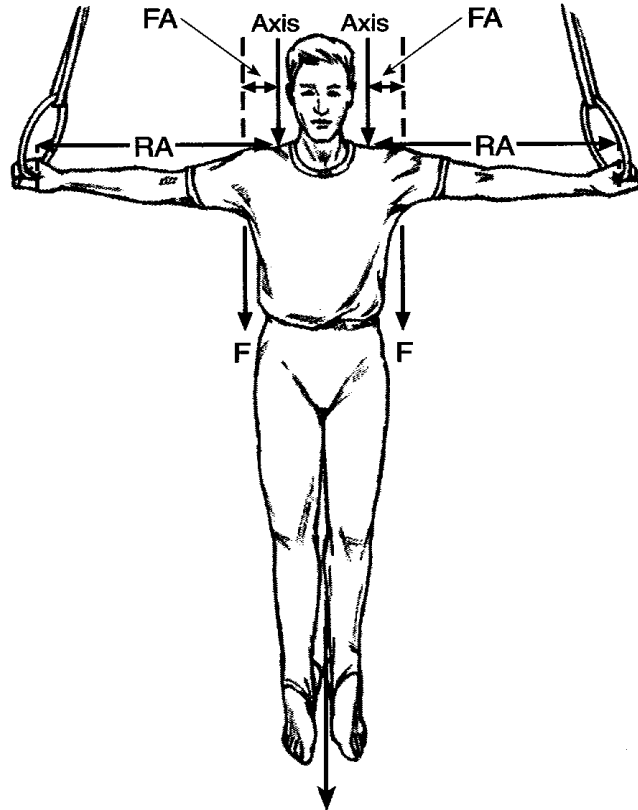
The axis of rotation runs from the left foot up through the body.

Force is produced by the contraction and pull of the thrower's pectoral muscles.

The load is the discus together with the weight of the thrower's arm



Advantages and Disadvantages of Limb Length



Effort arms and load arms
in the iron cross

Imagine that you all have similar strength in your pectoral, deltoid and latissimus muscles.

Who is at the greatest advantage in performing the iron cross? Who is at the greatest disadvantage?