

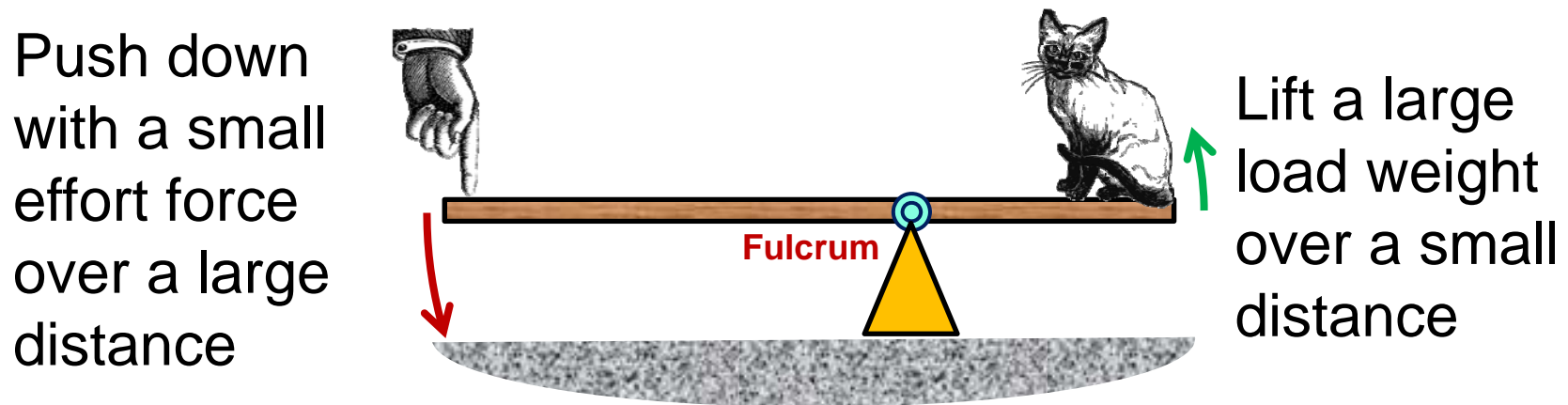
Levers & Limbs



National Science Foundation
WHERE DISCOVERIES BEGIN

Mechanical Lever

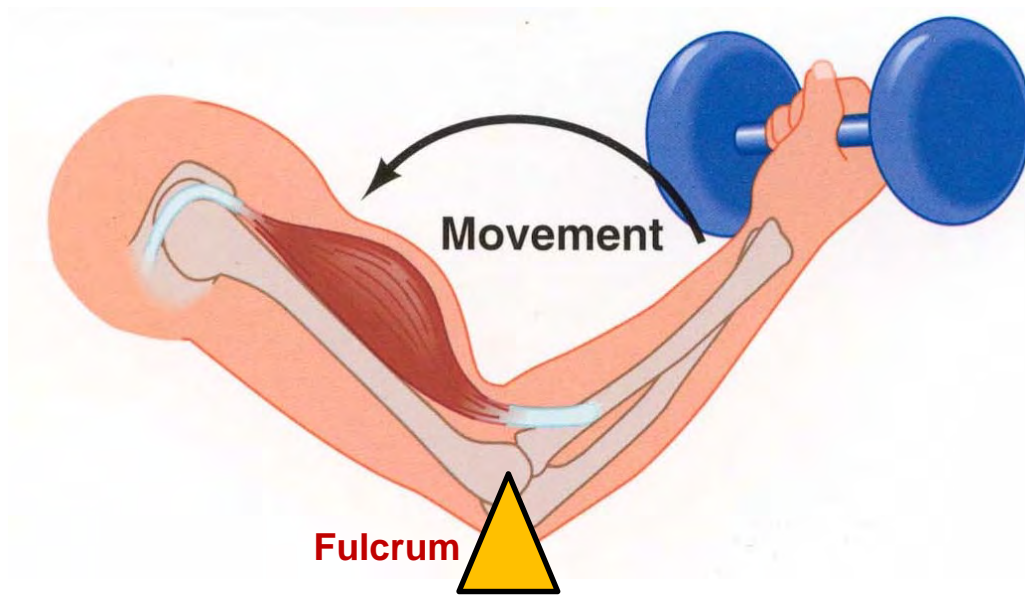
Lever converts an effort force into a load force by ratio of distances from fulcrum.



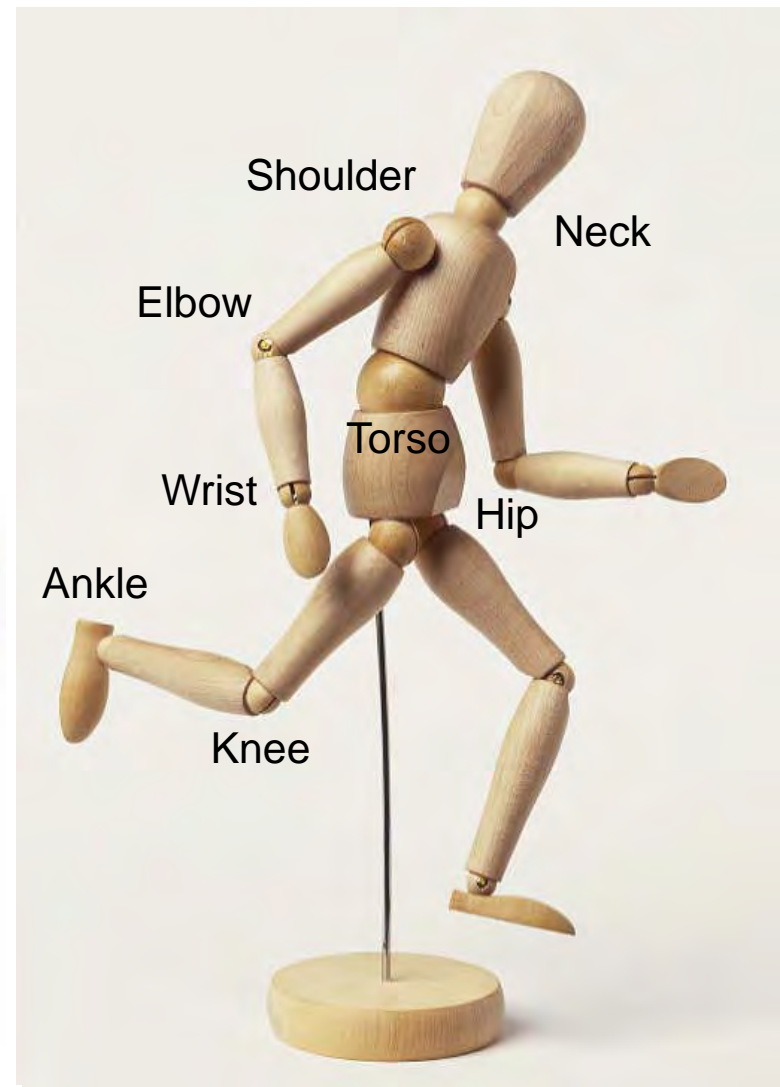
Axis of rotation goes through the fulcrum point.

Levers & Limbs

Limbs operate as levers:
Effort Force – Muscle
Load – Weight of the Limb
Fulcrum Point – Joint

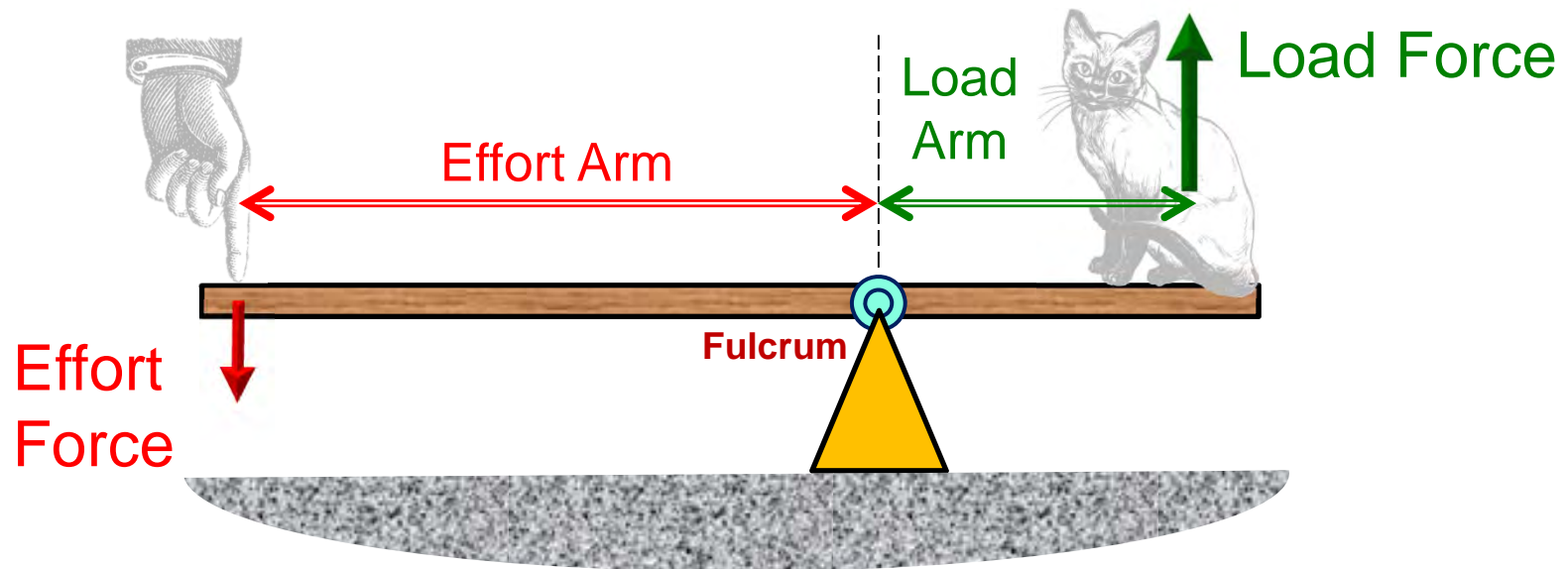


<http://www.phoenixrevolution.net/>



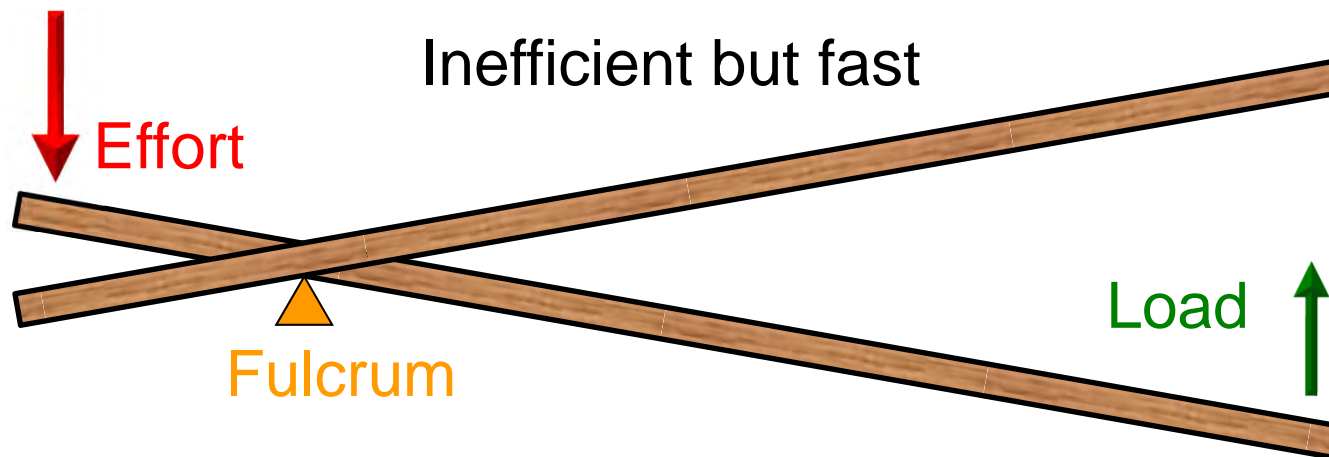
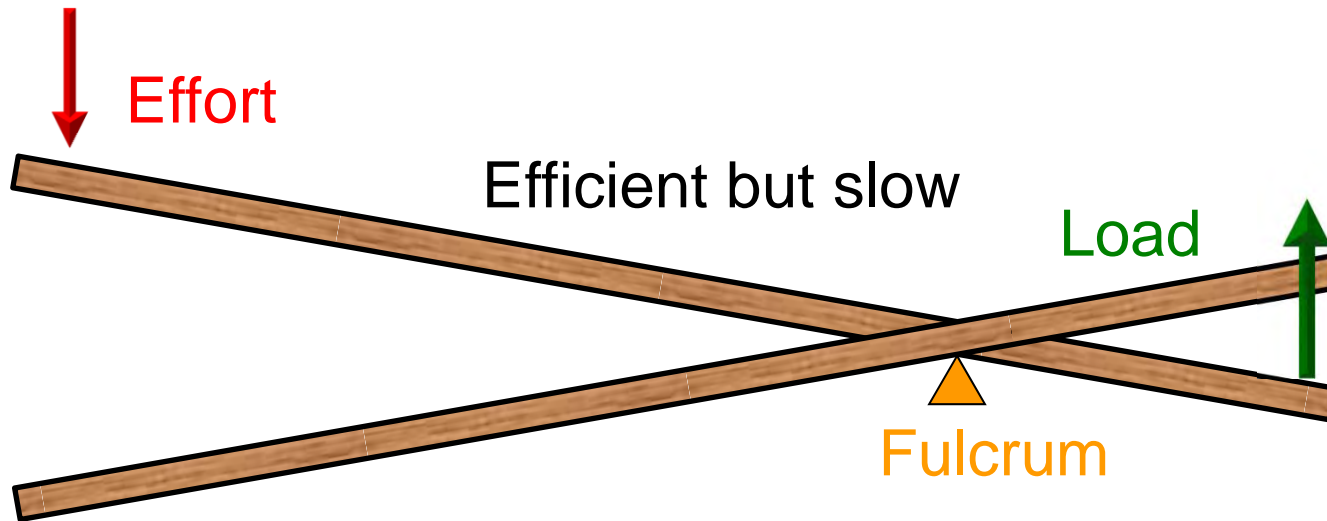
First Class Levers

First Class Lever: Fulcrum is located between the effort force and the load.

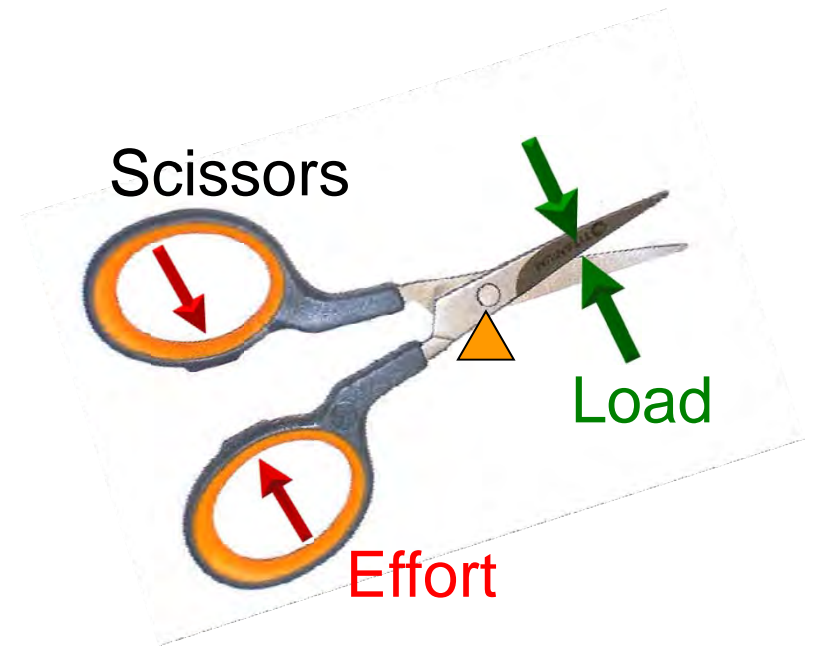


Lift a heavy load using small effort by having a long effort arm and/or short load arm.

Efficiency vs. Speed



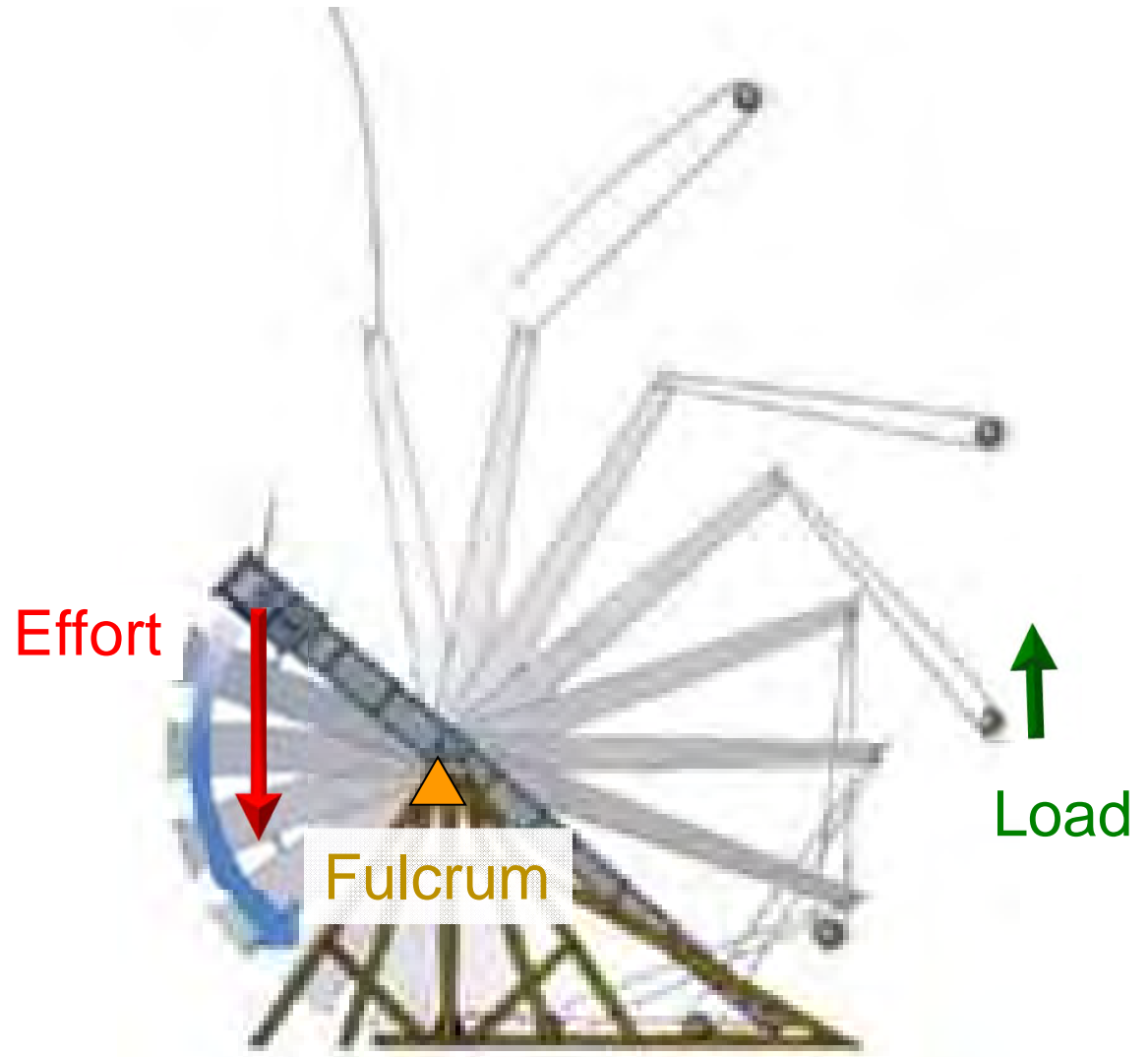
Examples of First Class Levers



Crowbar and scissors are efficient (big load force) but slow (long effort distance).

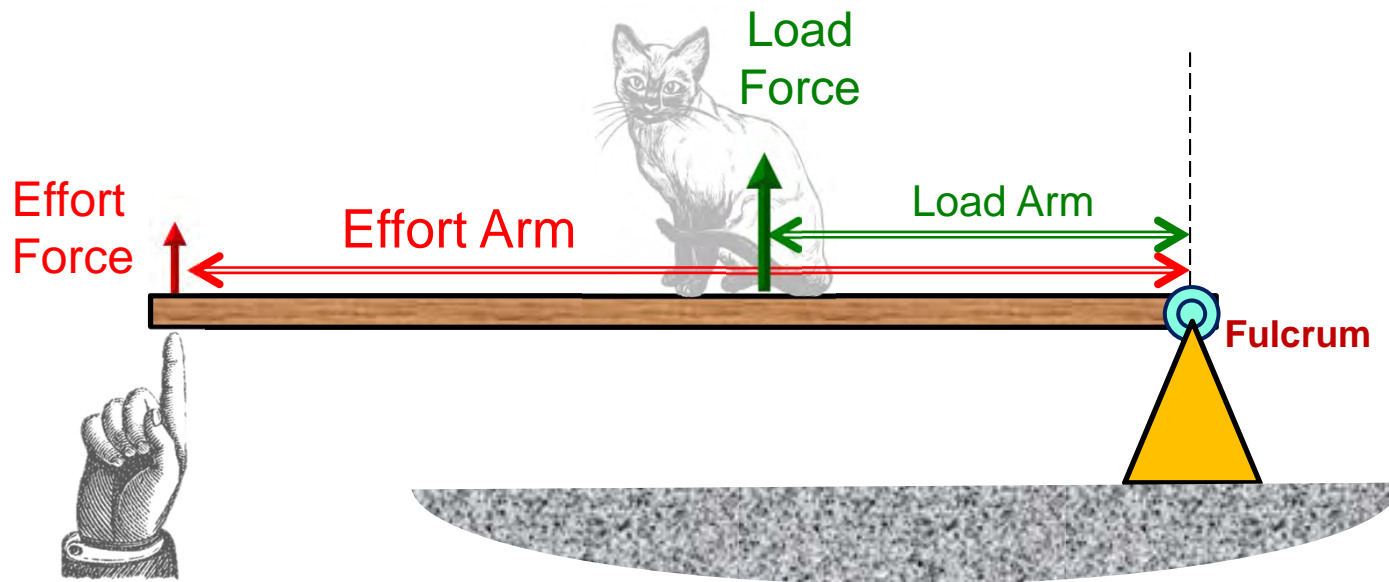
Examples of First Class Levers

A trebuchet is inefficient but fast.



Second Class Levers

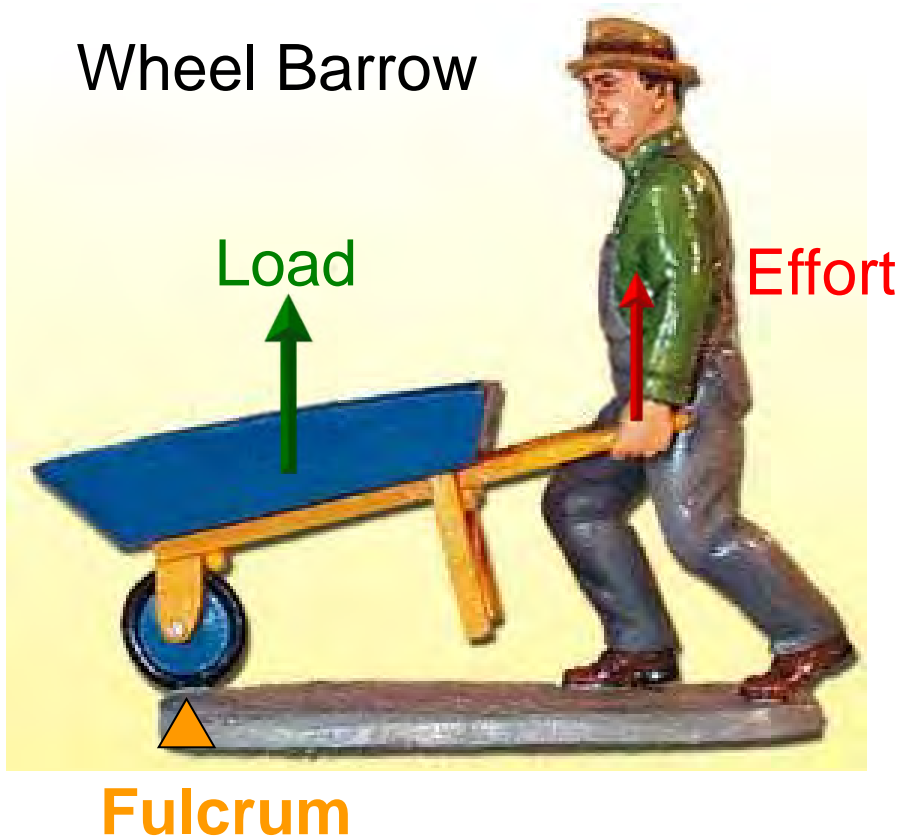
Second Class Lever: Load is located in between the effort force and the fulcrum.



Lift a heavy load using small effort by having a long effort arm and/or short load arm.

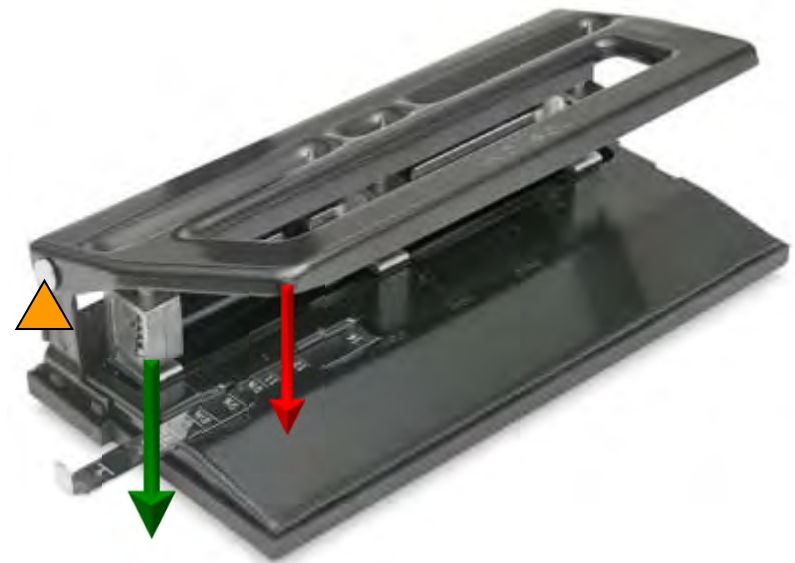
Examples of Second Class Levers

Wheel Barrow



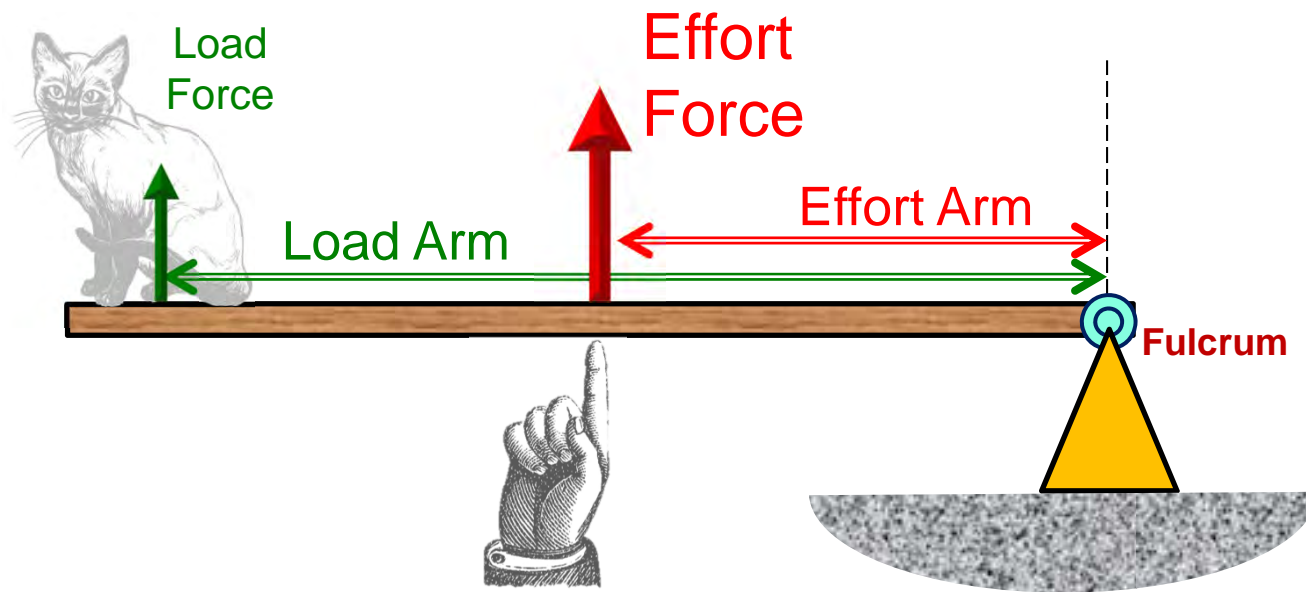
Second class levers are always efficient and slow.

Hole Punch



Third Class Levers

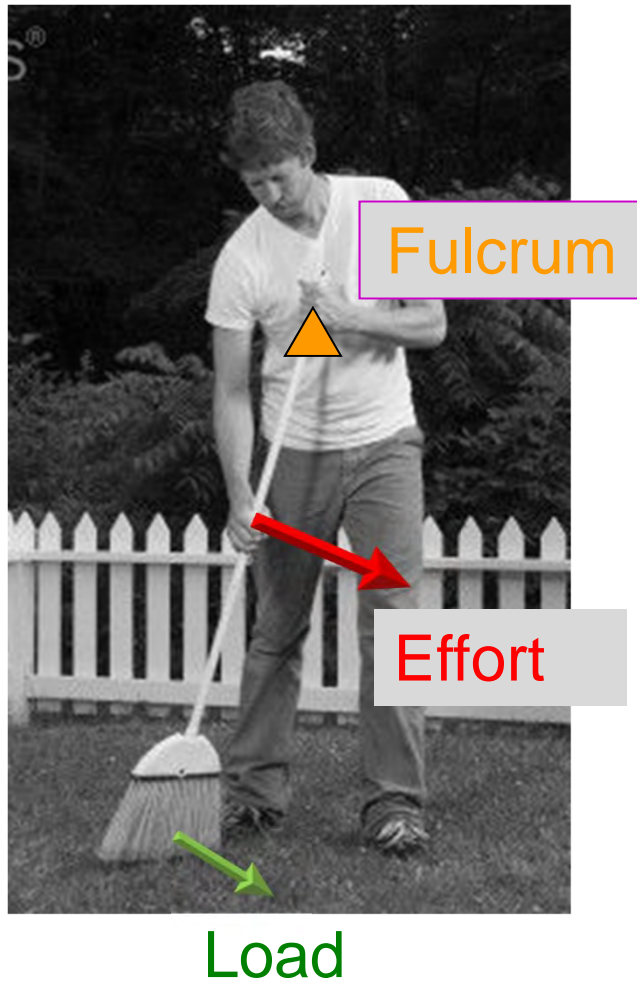
Third Class Lever: Effort force is located in between the load and the fulcrum.



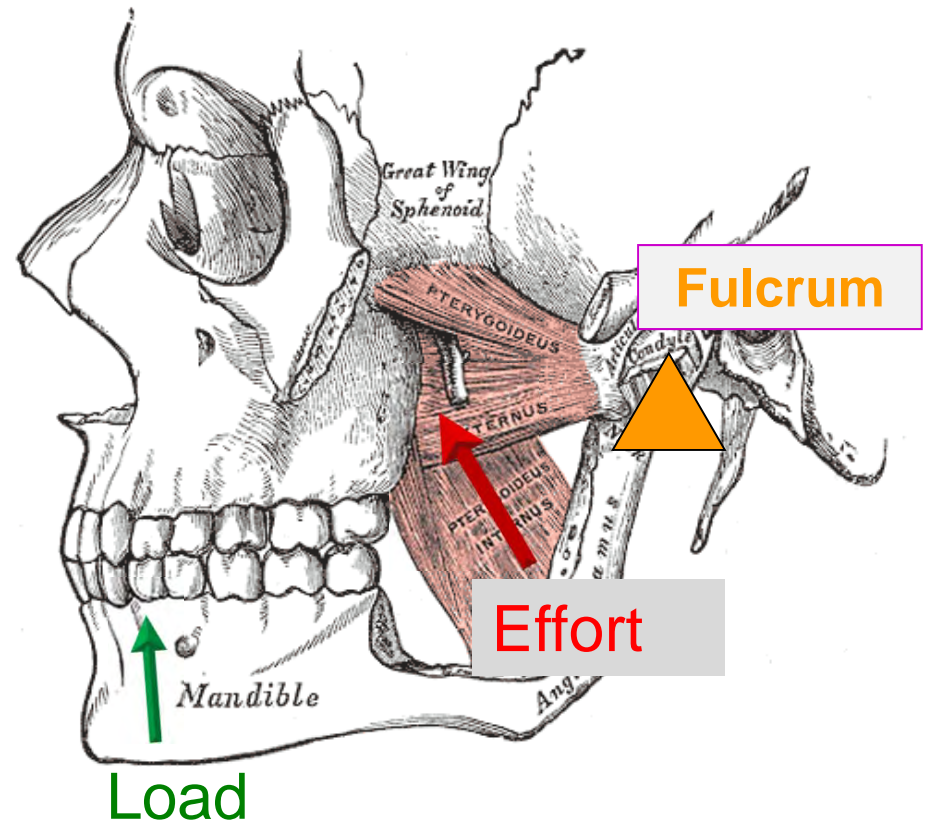
Third class levers are always inefficient but fast (since load arm is longer than the effort arm).

Examples of Third Class Levers

Broom

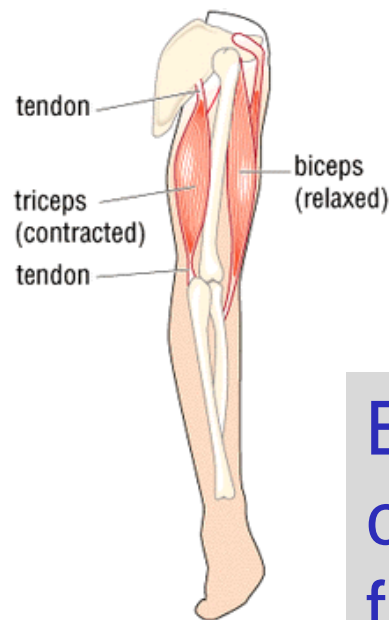
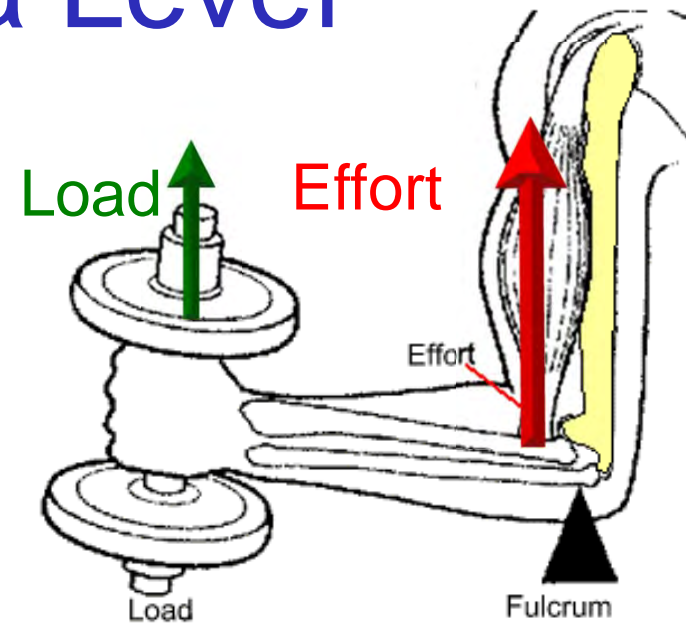


Jaw



Human Arm as a Lever

Biceps is a **third class lever** so a large effort force acts over a small distance to move a small load over a large distance.



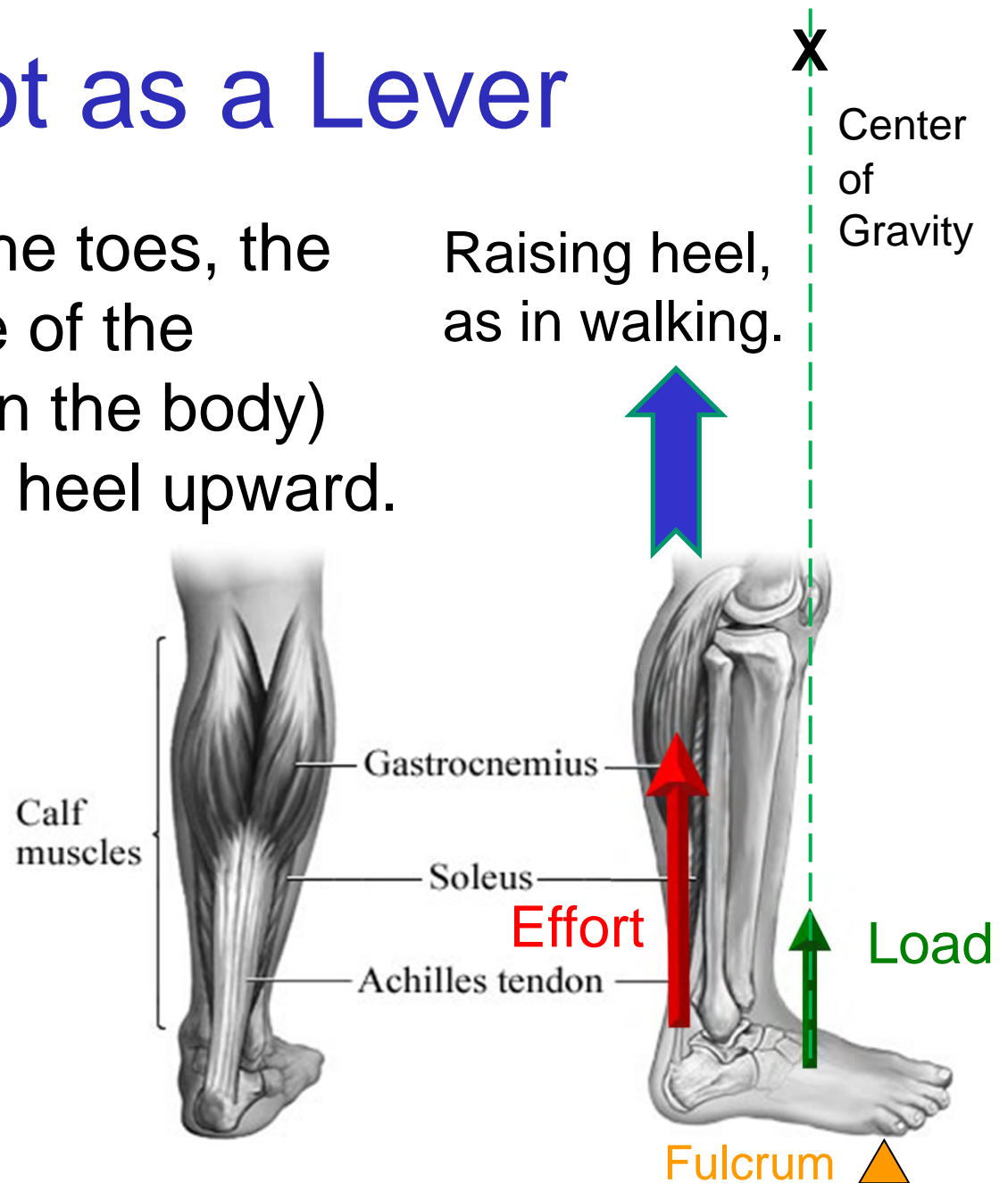
Triceps is also a third class lever, which pulls the arm in the opposite direction.

Because muscles can only contract, they're almost always found in pairs, like biceps/triceps.

Human Foot as a Lever

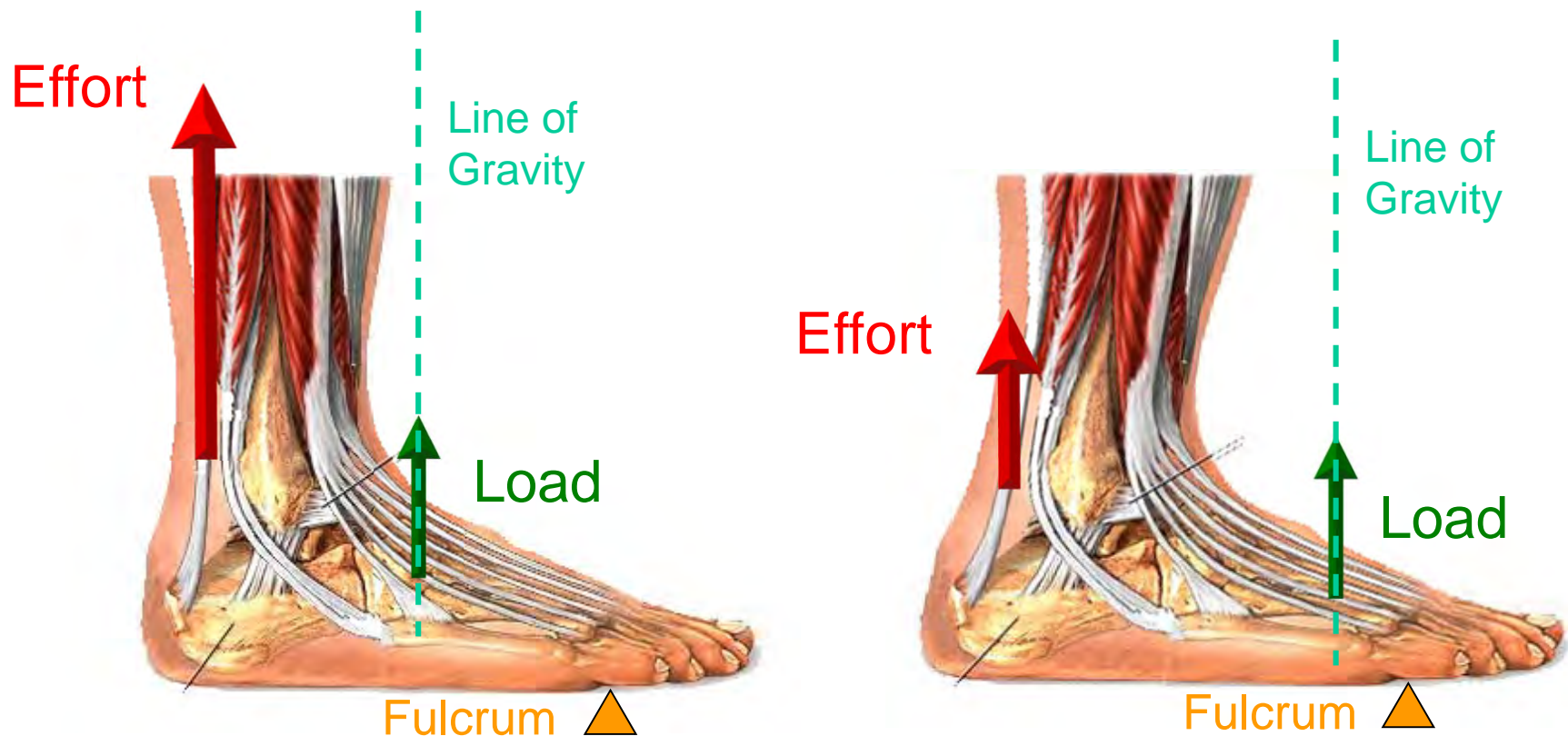
To lift the body on the toes, the gastrocnemius (one of the strongest muscles in the body) contracts, lifting the heel upward.

This is an example of a second class lever.



Weight Shift

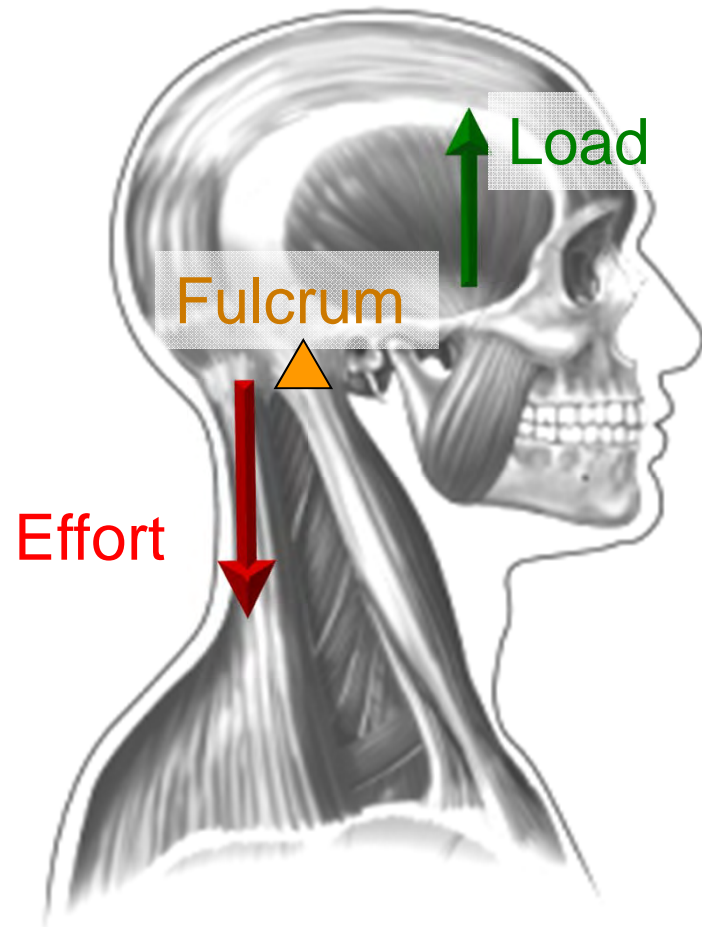
Weight shift forward shortens the load arm, reducing the required effort to lift the heel.



Human Neck as a Lever

The neck muscles are the body's only first class lever. This lever is not efficient since the effort arm is shorter than the load arm.

In general, the levers in animals' bodies sacrifice efficiency for speed and to keep a compact body form.



Summary

- Lever converts an effort force into a load force by ratio of distances to the fulcrum.
- Three classes of levers, depending on the positions of the fulcrum, effort and load.
- Limbs operate as levers with the fulcrum at the joint and muscles exerting effort.
- Most levers in the body are inefficient (large effort force) but fast (small muscle contraction moves load by large distance).