BIOL/PHYS 438

Zoological Physics

- Logistics & USRA announcement
- Corrections & Review of Statics
- Ch. 3: Animal Mechanics
  - Muscles, Tendons & Bones

Logistics

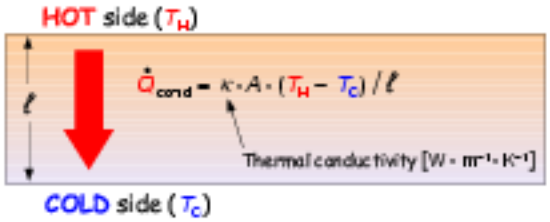
Assignment 1:

- Login and Update your Profile!
- Please Email us about yourself!

Assignment 2:

- Does not cover all of Ch. 3 (big): but you should *study* it all!
- Last question is nominally from Ch. 4, but requires mainly familiar Thermodynamics (Gas Law etc.).

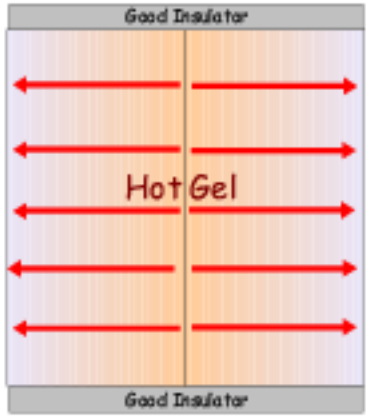
Conduction of Heat



For an infinitesimal region in a thermal gradient,

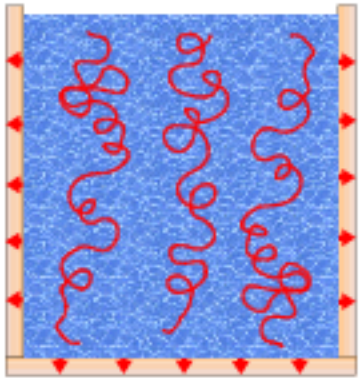
$$J_U = \kappa \cdot \vec{\nabla} T$$

Cylindrical Heat Conduction



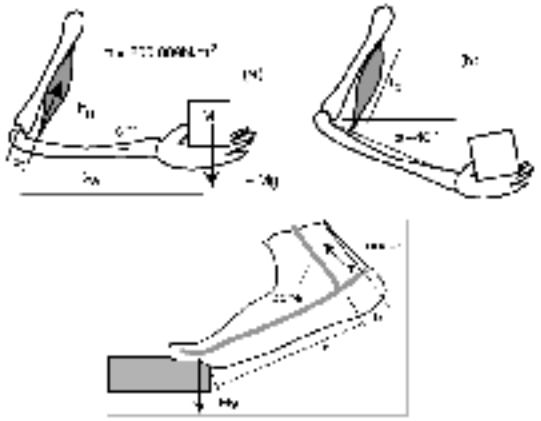
A cylindrical vessel is filled with a hot gel. As the gel cools, a thermal gradient is set up between the warm centre and the cool outer surface. To escape, heat must be *conducted* through the whole solid mass of the gel.

Convection: Mixing of Hot Fluids



Warm fluid rises, cool fluid sinks, setting up cells of **circulation** which *mix* hot & cold and thus deliver heat to the (thin) container walls much faster than it would get there *via* conduction through a solid.

Assignment 2



Statics: Rigid Bodies

- Newton's Second Law: $\Sigma F = m a$ with $a = 0$

  $\Sigma F = 0$ *(vectors!)*

- Cross Product with r: $r \times F \equiv \Gamma$ (torque) *changes*

  $r \times p = L$ (angular momentum)

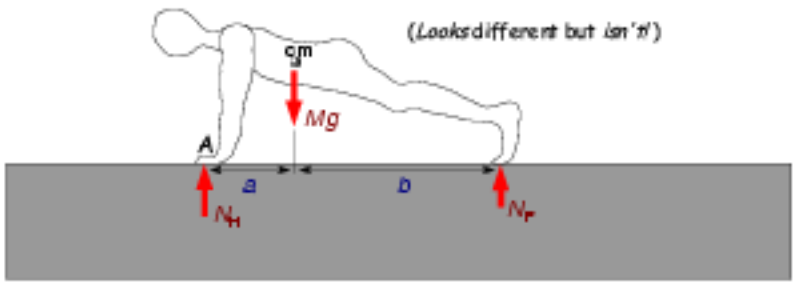
  but if L is constant, then $\Sigma \Gamma_A = 0$

Note: r is measured from same origin A so all torques Γ_A and angular momenta L_A are "about A".

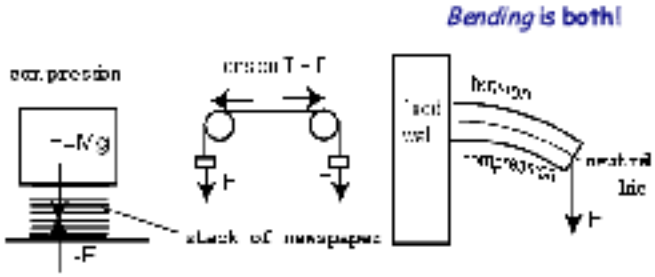
Rigid Body FBD

- $\Sigma F = 0$ (vectors!) $N_H + N_F = Mg$
- $\Sigma \Gamma_A = 0$ Use cm as origin: $a N_H = b N_F$

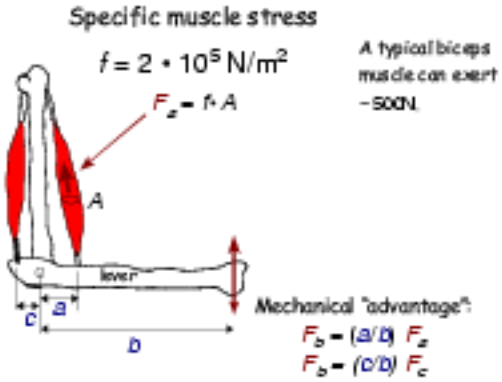
  OR use A as origin: $a Mg = (a + b) N_F$



Compression *vs.* Tension

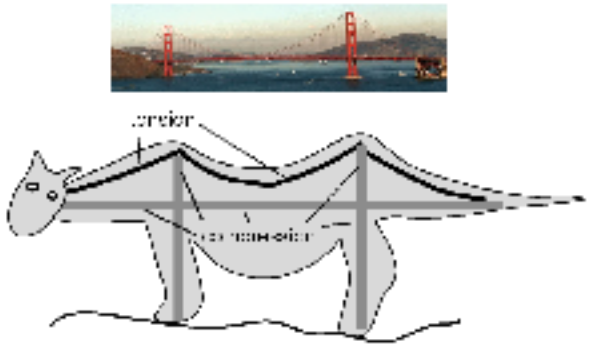


More complex machine

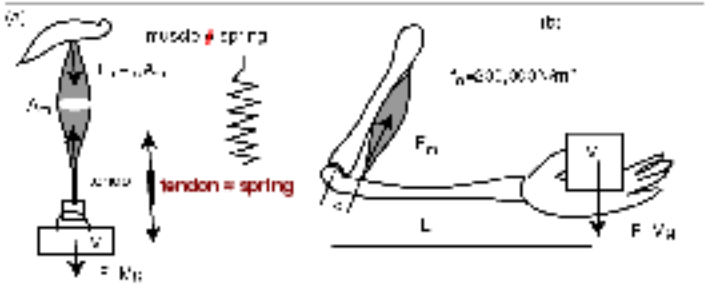


Much more complex machines

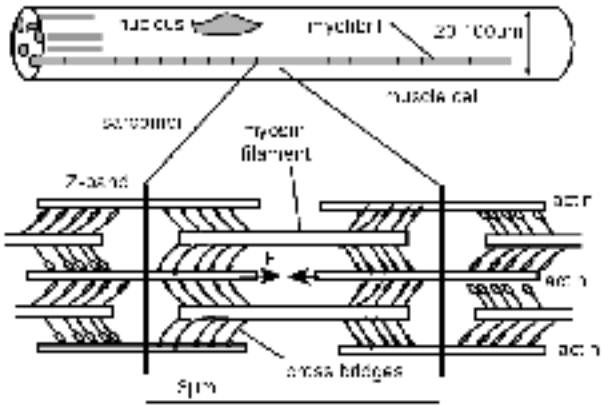
Much, *much* more complex machines



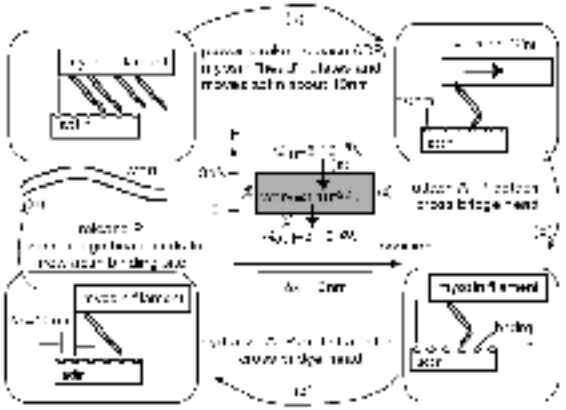
Muscles & Tendons



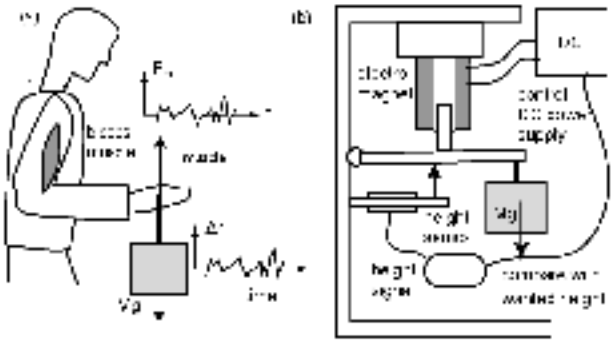
What is a muscle, anyway?



$$ATP + H_2O \rightarrow ADP + Pi + 6x10^{-20}\ J$$



Why holding up a weight *seems* like work even though **no** "*useful work*" is being done:



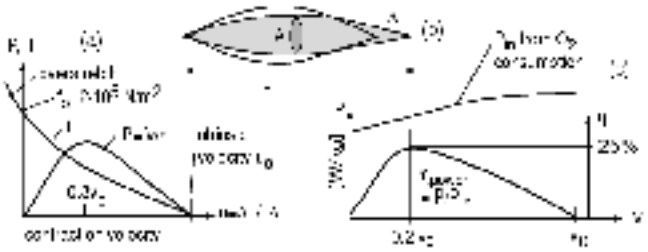
Maximum Force *vs.* Maximum Power

$P = v \cdot F$

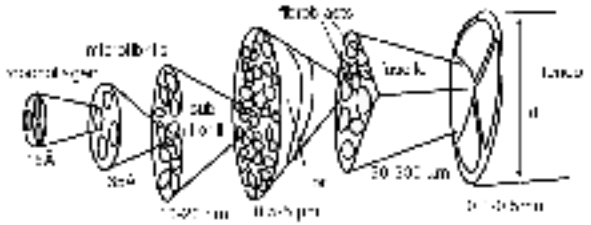
$F = Af$

$v = Lu$

Power per unit Volume:



Microstructure of a **Tendon**:



Elastic Forces & Energy Storage