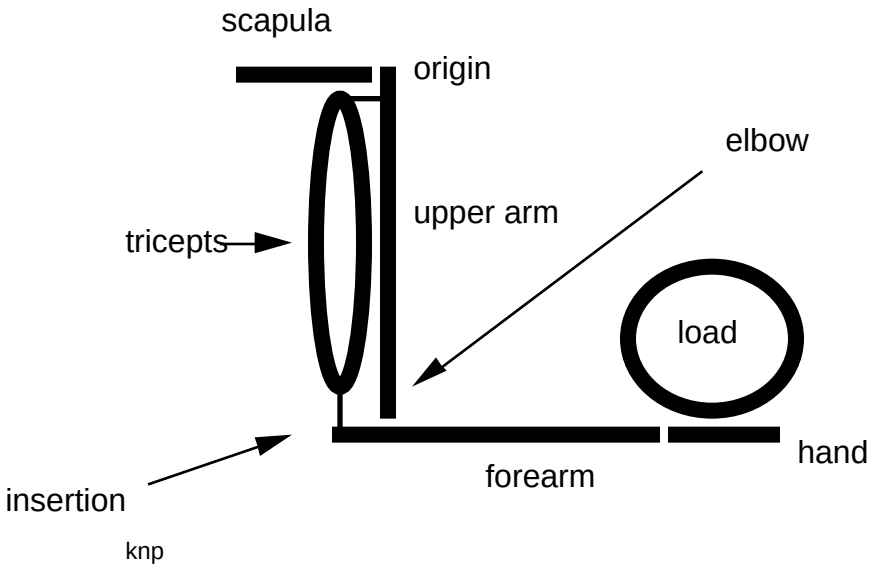
Exercise Physiology Problems: Skeletal Levers
Spring 2003

1. Suppose that we are dealing with the following system:



Here are some additional data, not all of which you will need:
(a) the distance from the muscle's origin to insertion is **0.25 m**.
(b) the distance from the muscle's origin to the joint is **0.251 m**.
(c) the distance from the triceps insertion to the center of the joint is **0.015** m.
(d) the distance from the center of the joint to where the center of the load touches the hand is **0.38** m.
(e) the distance from the where the center of the load touches the hand to the triceps insertion is **0.395 m**
(f) the mass of the load is **25 kG**
(g) assume the acceleration due to gravity acting on the load is **10 m/s^2**.

Questions:
1. Which choices above correctly describe the length of the:

IN - ARM _____ OUT -ARM _____

2. Calculate the force (N) exerted by the load at the hand:
3. Does the elbow-forearm lever that is operated by the triceps transform direction? Explain.
4. Calculate the mechanical advantage of this lever.
5. What is the exact amount of force that must be applied by the triceps to hold the load (Q#2) steadily in the position shown in the figure?
6. If the triceps shortens 0.03 m (3 cm -- a bit over 1") in 0.5 s., what is the velocity of the triceps (in m/s)?

7. For the same movement as described in Q#6, how far (m) does the load move? How fast (m/s) does it move?
8. Now assume that the same joint is involved except this time the triceps are resisting a 500 N force applied to the hand. How much force must the triceps supply in order not be stretched? (this question is essentially the same as Q#5.)
9. What does your answer to question 8 tell you about the importance of the parallel elastic elements in muscles?
10. Summarize the most important ways this lever system modifies the output of the triceps muscle. How do skeletal levers get around the constraints imposed on muscles in terms of changes in length and direction? Is the power produced at the load and input ends of the lever any different?
11. Could the system be viewed in reverse -- where the input arm is the load and work is being done on the muscle? Is this ever important (or is it totally unreasonable and eminently ignorable)? If the system can be viewed in reverse, what is true about the force on the muscle as compared to the load?