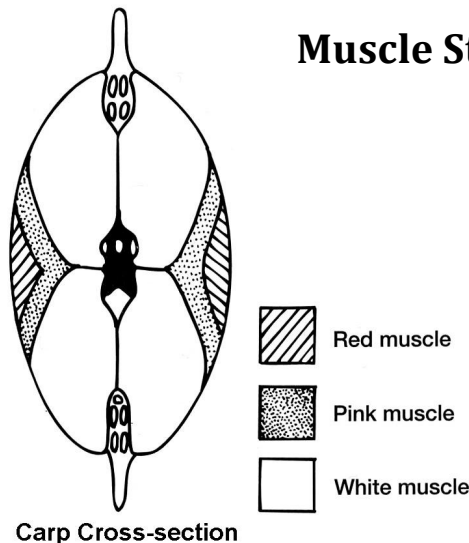


## Muscle Study Question Solutions



**Study Question 1:** Consider this cross-section of a carp (Actinopterygii).

a) Imagine that this carp is swimming slowly through the water looking for food. Now imagine that the carp senses a predator and swims rapidly away to escape. Would you predict that the carp would be using mainly its white muscles or its red muscles while swimming slowly? What about when it swims rapidly away to escape a predator? Explain your choice, based on the metabolic properties of red and white muscle fibers. (4 marks)

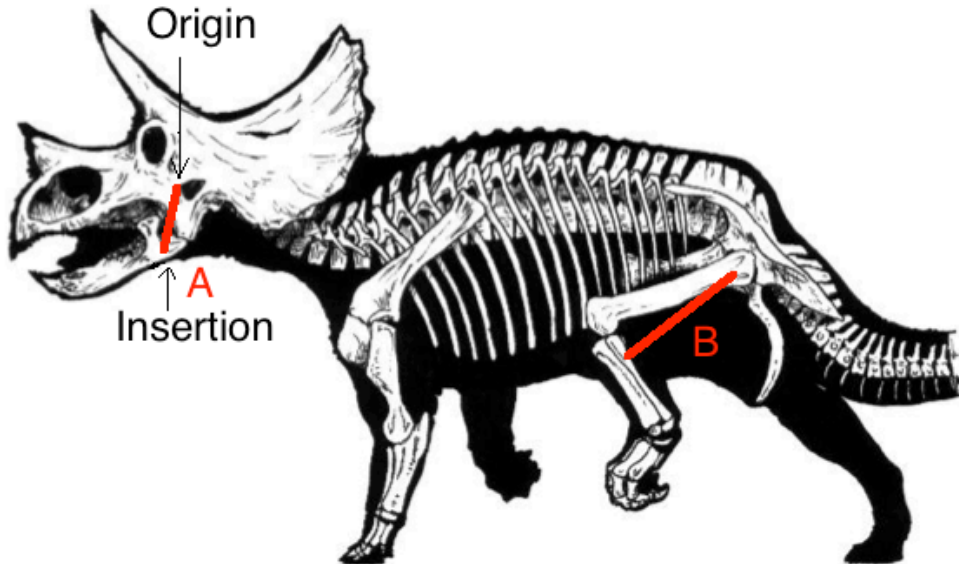
- Red muscle fibers are oxidative (0.5)
- White muscle fibers are glycolytic (0.5)
- Glycolysis produces ATP faster (0.5)
- So white muscles can contract faster / white muscle fibers can generate more force (0.5)
- To escape a predator the carp must swim as fast as it possibly can, so uses white muscles (0.5)
- But oxidation produces more ATP per molecule of fuel (0.5)
- So red muscles are fatigue resistant / white muscle fibers fatigue faster (0.5)
- To look for food the carp must swim for a long time without fatiguing, so uses red muscles (0.5)

b) In fish like this carp, why are the axial muscles relatively large compared to the appendicular muscles? Explain (make sure to consider the general functions of these two muscle groups). (3 marks)

- Axial muscles are used to produce lateral undulations for locomotion (0.5)
- Appendicular muscles are used to move the fins for: steering / precise maneuvering / braking / stabilizing the body while swimming (0.5)
- Propelling the body through the dense water requires much more force (0.5)
- The larger the cross-sectional area of a muscle, the more force it can produce (1)
- So the axial muscles must be larger to generate sufficient force (0.5)

**Study Question 2:** Consider this triceratops skeleton.

a) Draw a muscle (represented as a straight line) that would elevate the lower jaw. Label the insertion and origin on your muscle drawing. (2 marks)



b) Draw a muscle (represented as a straight line) that would flex the left hindlimb. (1 mark)

c) Would you predict that this muscle would be composed mainly of glycolytic muscle fibers, mainly of oxidative muscle fibers, or of some of each type of muscle fiber? Explain. (3 marks)

- The triceratops would use this hindlimb flexor muscle for walking / running (0.5)
- Glycolytic muscle fibers (GMF) contract faster and with greater force (0.5)
- But they also fatigue more quickly (0.5)
- To run quickly (for example, to escape from a predator), this muscle would require some GMF (0.5)
- To prevent fatigue during prolonged activity (such as walking around for long periods of time to look for food) this muscle would require some OMF (0.5)
- So to allow for both speed and prolonged locomotion, this muscle requires some of each type (0.5)

**Study Question 3: Consider legs of the golden eagle (Aves), a flying predator that catches prey with its talons.**

**a) Predict the function of the gastrocnemius. (1 mark)**

Any of: extends the leg (around the joint between the tibiotarsus and the tarsometatarsus) / extends the hindlimb / flexes the digits / flexes the phalanges / flexes the toes

**b) The gastrocnemius is a short muscle that is attached to its insertion via a long tendon. Explain two reasons why having a short muscle and a long tendon is advantageous for the eagle. (6 marks)**

EXCELLENT (6 marks)

1. Muscles are more energetically expensive to maintain than tendons **(0.5)** and muscles require a direct blood supply while tendons do not **(0.5)**. The gastrocnemius is only as long as necessary for its function **(0.5)**. Covering the rest of the distance between origin and insertion with tendon minimizes the amount of muscle tissue that must be maintained **(0.5)** so saves the eagle energy **(0.5)**.

2. Muscles are heavier than tendons **(0.5)**. Having a short muscle and a long tendon means that the muscle can be located near the body's centre of gravity **(0.5)**, which allows the body to remain stable and balanced during flight **(0.5)**. This also makes the distal ends of the limbs lighter **(0.5)**, allowing for less resistance to limb movement (less inertia to overcome when moving the limb) **(0.5)** and therefore faster movement of the legs/digits for rapid capture of prey **(0.5)**. Also minimizing excess muscle tissue reduces overall body weight to save energy during flight **(0.5)**.

SATISFACTORY (4 marks)

1. Muscles require a lot more energy to maintain than tendons **(0.5)**, so covering a lot of the distance between origin and insertion with tendon rather than muscle **(0.5)** saves energy **(0.5)**.

2. Muscles are heavy while tendons are light **(0.5)**. The short muscle is located close to the eagle's centre of mass **(0.5)**. If the muscle were longer, that means it would extend farther into the leg so the distal end of the leg would be heavier **(0.5)** so the leg could not move fast enough to catch prey with the talons **(0.5)** and the heavy legs would also make the body unbalanced and unstable when flying **(0.5)**.

NEEDS IMPROVEMENT (2.5 marks)

1. Muscles take more energy to maintain than tendons **(0.5)**, so having a short muscle and a long tendon saves energy **(0.5)**.

2. Tendons are lighter than muscles **(0.5)**, so a short muscle and a long tendon means that the eagle weighs less than it would if it had a longer muscle and a shorter tendon, and reducing weight helps the eagle to be able to fly **(0.5)**. Also a short muscle and a long tendon helps to prevent the eagle from being unbalanced when it is flying **(0.5)**.