See 9, 10

V. MUSCULAR SYSTEM

INTRODUCTION

CN: Use light colors for A-E. (1) Begin with the muscle belly and tendons in the upper illustration. (2) When coloring the narrow borders of the endomysium (C) in the enlarged section, it is recommended that you also color over the muscle fiber ends (D) with the very light endomysium color, and then go back over the fiber ends with a darker color (D). Do not color the neurovascular bundle, or the cut ends of blood vessels and capillaries. (3) Color the lower illustration.

SKELETAL MUSCLE:
BELLY A

FASCIA:

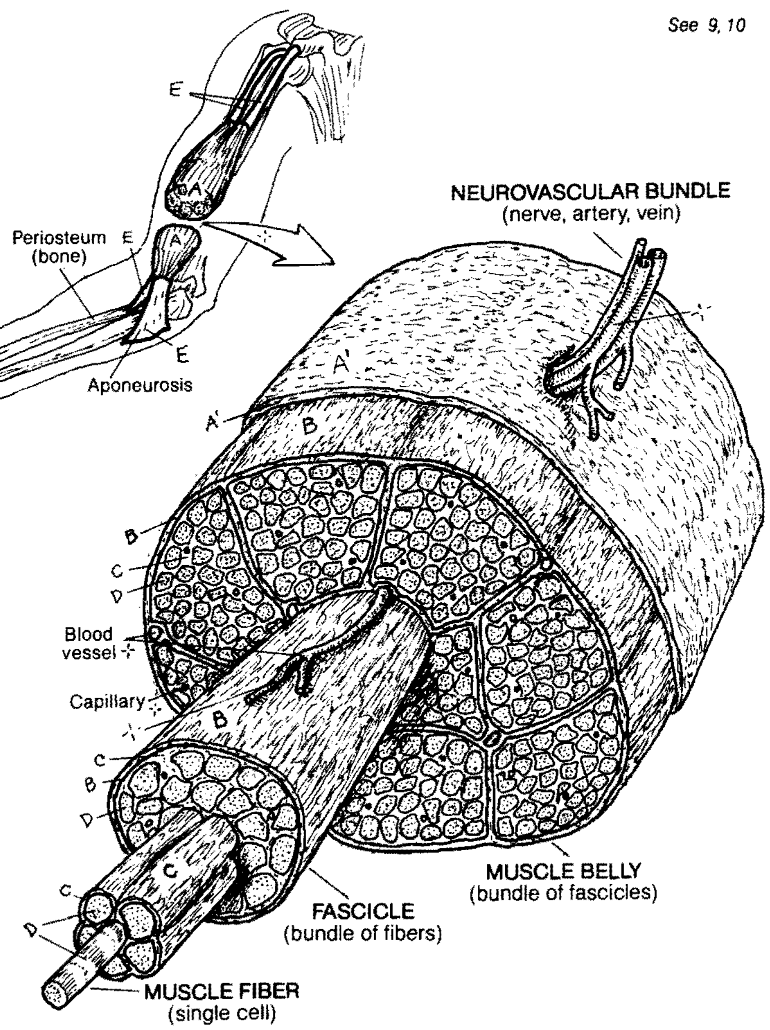
EPIMYSIUM A'

PERIMYSIUM B

ENDOMYSIUM C

MUSCLE FIBER (CELL) D

TENDON E



A named skeletal muscle (e.g., biceps brachii), surrounded by a layer of deep *fascia* (*epimysium*), consists of fascicles or bundles of muscle cells enveloped in thin fibrous tissue (*perimysium*). Each muscle cell is surrounded by a thin sheath of fibrous tissue (*endomysium*). Each of these fibrous layers is important to muscle structure and function, providing support for nerves and vessels (neurovascular bundles), ensuring uniform distribution of muscle tension during contraction, and maintaining the elasticity of muscle, permitting it to recoil to its resting length following stretching. It is the merging of these fibrous layers at the ends of the muscle fibers that form the *tendons* which integrate the muscle to its attachment site(s), such as periosteum or another tendon. Broad, flat tendons are called *aponeuroses*. The mass of the fasciae-enveloped contractile cells is called the *belly* of the muscle. It is the muscle belly that shortens during muscle contraction. The belly may be shaped one of a number of ways depending on its tendinous arrangement and attachments. Skeletal muscles are named in relation to their attachments (e.g., hyoglossus), shape (e.g., trapezius), number of heads (e.g., quadriceps), function (e.g., adductor magnus), and position (e.g., brachialis).

MECHANICS OF MOVEMENT:
FULCRUM F (JOINT) F'

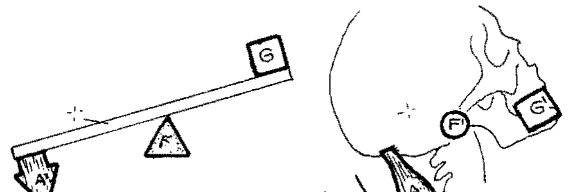
EFFORT A' (MUSCLE) A

RESISTANCE G (WEIGHT) G'

Skeletal muscles employ simple machines, such as levers, to increase the efficiency of their contractile work about a joint. Mechanically, the degree of *muscular effort* required to overcome *resistance* to movement at a *joint* (*fulcrum*) depends upon (1) the force of that resistance (*weight*, G); (2) the relative distances from the anatomical fulcrum to the anatomical sites of muscular effort (F^1-A); and the anatomical sites of resistance (F^1-G^1). The position of the joint relative to the site of muscle pull and the site of imposed load determines the class of the lever system in use.

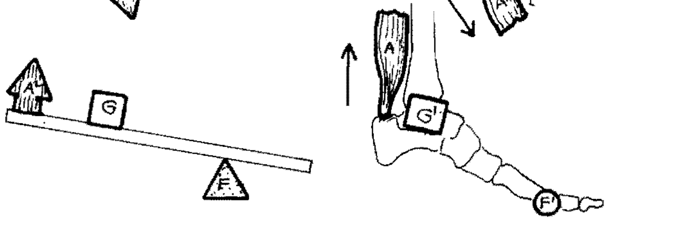
1ST CLASS LEVER

In a *1st class lever*, the joint lies between the muscle and the load. This is the most efficient class of lever. By flexing the neck and posturing the head forward and downward, the load (G^1) is appreciably increased, and the muscular effort (A) to hold that posture may induce muscle pain and stiffness/tightness (overuse).



2ND CLASS LEVER

In a *2nd class lever*, the load lies between the joint and the pulling muscle. This lever system operates in lifting a wheelbarrow (the wheel is the fulcrum) as well as lifting a 75 kg (165 lb) body onto the metatarsal heads at the metatarsophalangeal joints. This is a relatively easy task for the strong calf (triceps surae) muscles; but try standing on the heads of your middle phalanges (increasing the distance F^1-G^1)!



3RD CLASS LEVER

In a *3rd class lever*, the muscle lies between the joint and the load and has a poor mechanical advantage here. Consider the difference in muscular effort required to carry a 45 kg (100 lb) bag of cement in your hands with flexed elbows (elbow joint: 3rd class lever) and carrying your 75 kg (165 lb) body on the heads of your metatarsals (2nd class lever at the metatarsophalangeal joints). It is all a matter of leverage.