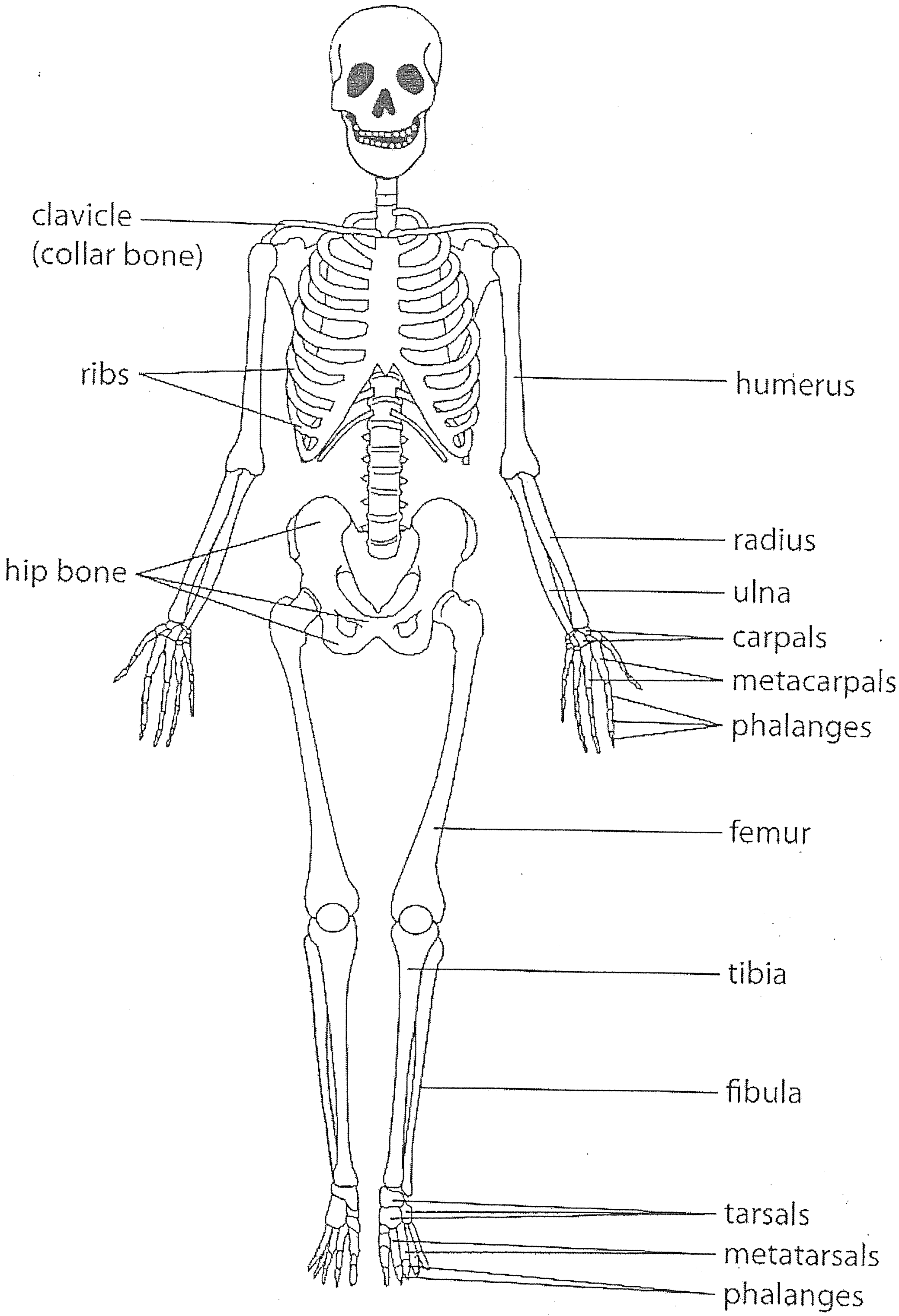
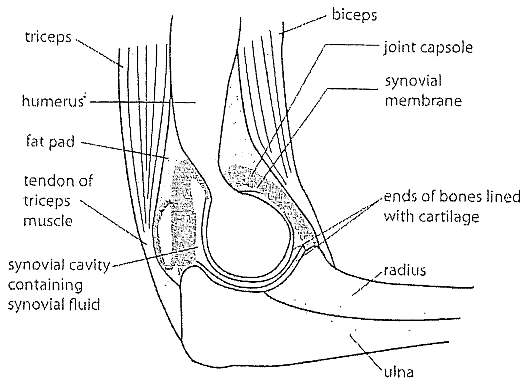
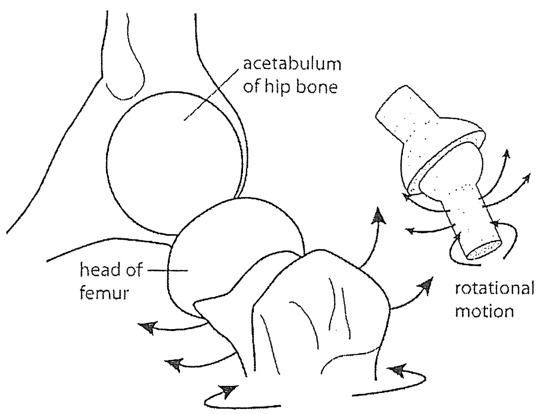
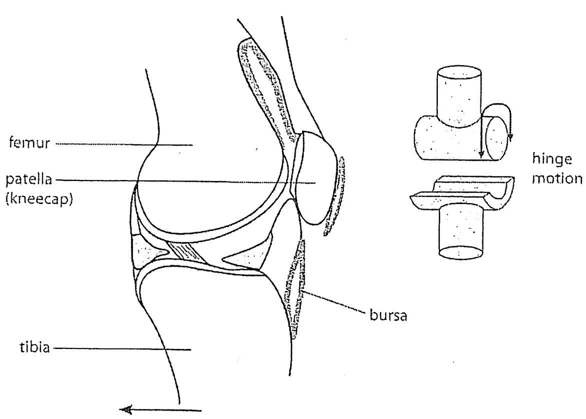

clavicle
(collar bone)
ribs
humerus
radius
hip bone
ulna
carpals
metacarpals
phalanges
femur
tibia
fibula
tarsals
metatarsals
phalanges



triceps
humerus
fat pad
tendon of
triceps
muscle
synovial cavity
containing
synovial fluid
biceps
joint capsole
synovial
membrane
ends of bones lined
with cartilage
radius
ulna



acetabulum
of hip bone
head of
femur
rotational
motion



femur
patella
(kneecap)
tibia
bursa
hinge
motion

SKELETAL SYSTEM
ANATOMY OF A BONE *
CN 7

1. Color the various structures of this long bone (humerus).
2. Red should be used for both cancellous bone (e) and nutrient artery (h).
3. The epiphysis (a) and diaphysis (b) are represented by a diagram to the far right, and are colored there.

Bones are the supportive framework (skeleton) of the body. The hardest of all living tissues, bone is a connective tissue consisting of a meshwork of fibers and cells (35% by weight) impregnated with calcium salts. Bones are connected at joints and make movement possible, provide sites of attachment for skeletal muscle, are a source of calcium ions for the blood, and form blood cells. Bones may be long (as shown here), short, flat or irregular in shape. Long bones are responsible for stature and reflect most dramatically the phenomenon of growth.

EPIPHYSIS (END) a EPIPHYSEAL LINE a'

The *epiphysis* is the end of a long bone; it is largely cancellous and capped with articular cartilage. It is separated from the diaphysis by a variably-sized cartilage plate for about the first 20 years of life. Most bones develop from cartilage models. Bone development occurs in the epiphysis and the diaphysis, and slowly advances toward the intervening cartilage from both ends. The cartilage progressively thins to a line and ultimately disappears and diaphyseal/epiphyseal bone centers meet (end of bone growth).

DIAPHYSIS (SHAFT) b

The *diaphysis* is the shaft of a large bone. It consists of compact bone with a central cavity. It resists bending forces. The epiphyseal line separates it from the epiphysis. Diaphyseal compact bone develops just before bone replacement of cartilage occurs within the interior of the shaft. It offers support to the developing bone during formation of the central (medullary) cavity.

ARTICULAR CARTILAGE c

The only remaining evidence of an adult bone's cartilaginous past, *articular cartilage* is smooth, slippery, and bloodless, kept moist by the egg-white-like fluid from the synovial lining of the joint cavity. Bones of a synovial joint make physical contact at their cartilaginous ends.

PERIOSTEUM d

Periosteum is a fibrous, cellular, vascular, and highly sensitive life support sheath for bone, providing nutrient blood for bone cells and a source of bone-developing cells during growth and after fracture. It does not cover articular cartilage.

CANCELLOUS (SPONGY) BONE e
RED MARROW e

Tiny beams of bone forming a latticed truss capable of reorientation, *cancellous bone* resists the stresses of weight and postural changes as well as muscular development. *Red marrow* packs the spaces between beams of certain bony epiphyses and elsewhere. It consists of masses of developing and mature red/white blood cells supported by an array of loose, fine fibers.

COMPACT BONE f

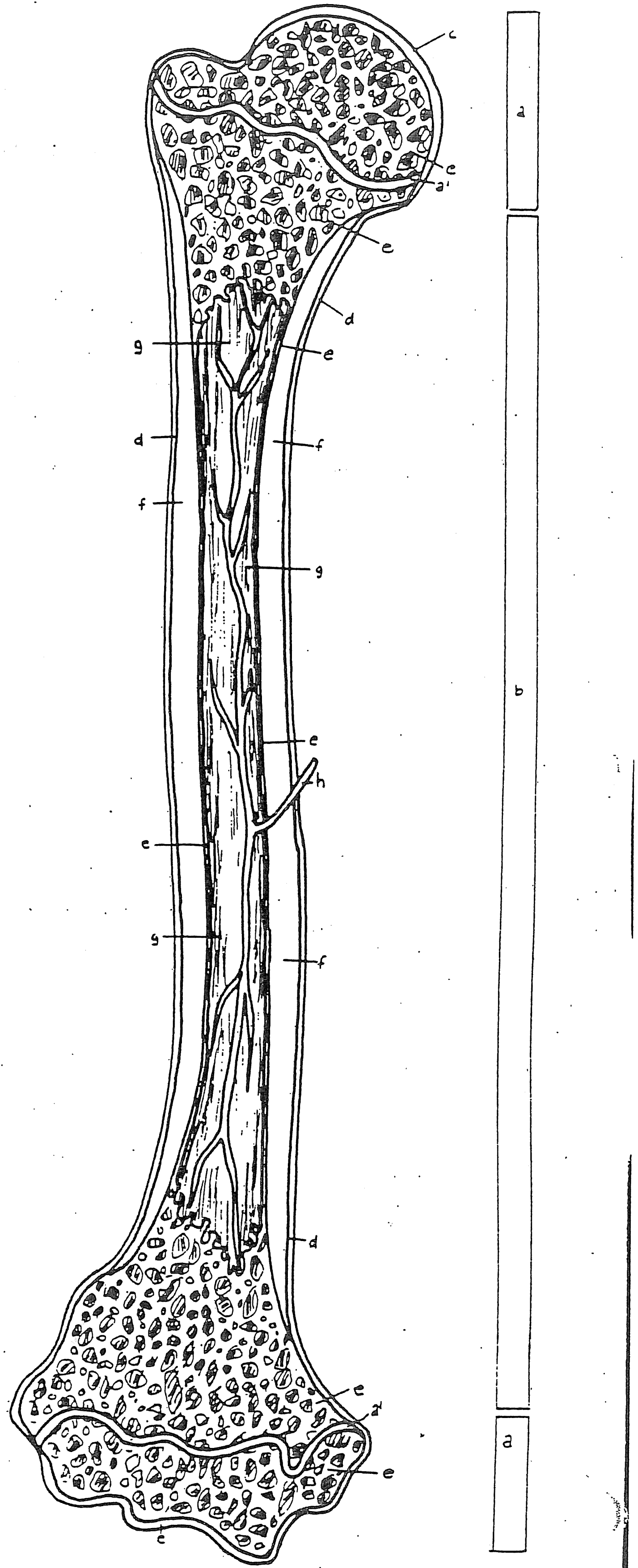
The dense bone of the diaphysis, *compact bone* consists of repeating patterns of solid bone tissue organized into concentric layers. Nutrient blood reaches the bone cells by a system of integrated canals. Cancellous bone is too porous to reflect such regular arrangement.

MEDULLARY CAVITY g
YELLOW MARROW g

The *medullary cavity* of the diaphysis serves to lighten bone weight and provide space for its marrow. After childhood, blood cell production largely ceases in the marrow of the shaft; such cells are replaced by fat, which is yellow in color.

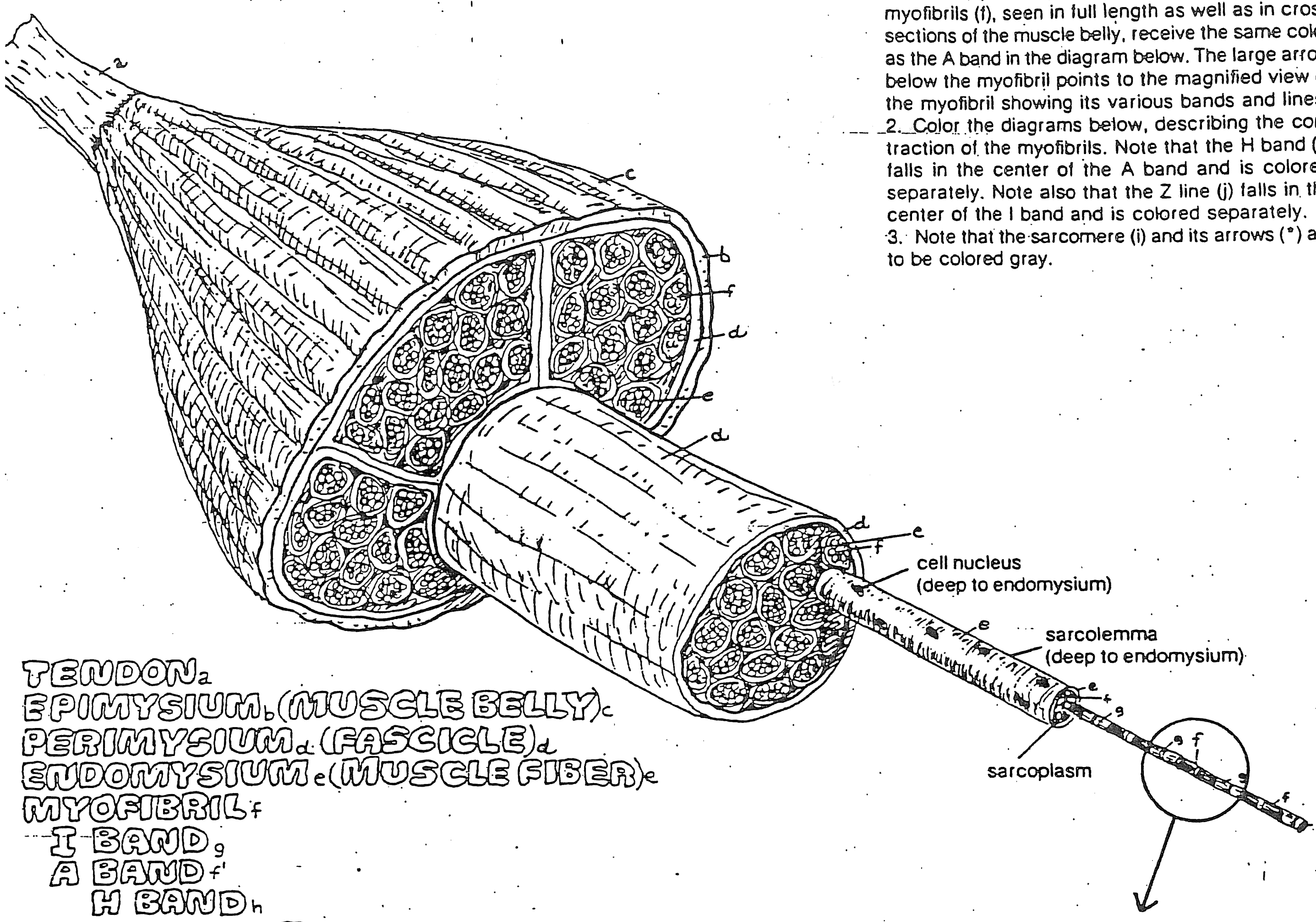
NUTRIENT ARTERY h

Each long bone contains an oblique tunnel in its shaft for the passage of a *nutrient artery*, which enters the medullary cavity and branches throughout, supplying the shaft. Arteries to the epiphyses generally arise from the joint capsule.



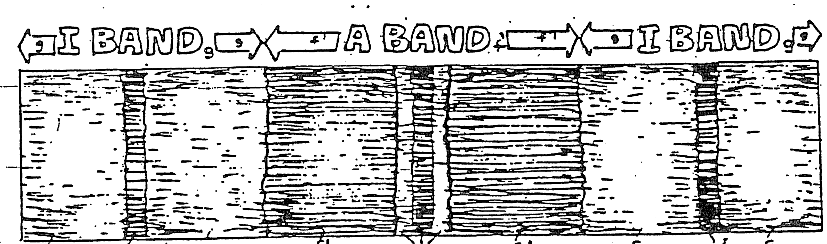
MUSCULAR SYSTEM
STRUCTURE OF SKELETAL MUSCLE*

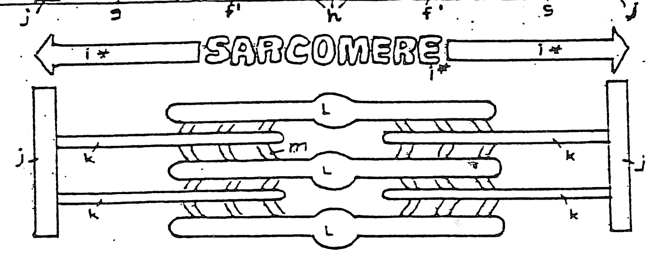
CN 12
1. Color (b) and (c) the same color. Note that the myofibrils (f), seen in full length as well as in cross sections of the muscle belly, receive the same color as the A band in the diagram below. The large arrow below the myofibril points to the magnified view of the myofibril showing its various bands and lines.
2. Color the diagrams below, describing the contraction of the myofibrils. Note that the H band (h) falls in the center of the A band and is colored separately. Note also that the Z line (j) falls in the center of the I band and is colored separately.
3. Note that the sarcomere (i) and its arrows (*) are to be colored gray.

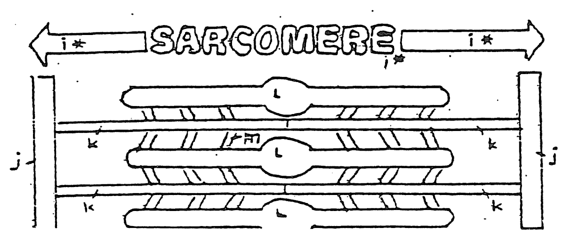


TENDON a
EPIMYSIUM b (MUSCLE BELLY) c
PERIMYSIUM d (FASCICLE) d
ENDOMYSIUM e (MUSCLE FIBER) e
MYOFIBRIL f
I BAND g
A BAND f'
H BAND h
SARCOMERE i*
Z LINE j
ACTIN k
MYOSIN L
CROSS BRIDGES m

A *skeletal muscle* consists of bundles (*fascicles*) of muscle cells (*fibers*) each wrapped in their connective tissue sheath (*epimysium, perimysium, endomysium,* respectively). As the skeletal muscle approaches its attachment site, the muscle fibers end; and connective tissue continues on as the *tendon.* A muscle cell consists of several nuclei administering a mass of myofibrils in the cytoplasm (sarcoplasm) within the boundaries of a cell membrane (sarcolemma). *Myofibrils* have been shown to be a collection of *myofilaments* arranged in a pattern. The basic unit of this pattern is the *sarcomere* (*). Within the sarcomere, the dark and light areas are called *bands* (I, A, H), and these are created by the relative arrangements of the filaments *actin* (j) and *myosin* (k). When a skeletal muscle fiber contracts, the actin filaments within a sarcomere slide toward each other, past the myosin filaments, breaking and remaking *cross bridges.* The myosin filaments do not move. Therefore, one would expect the A bands to have a constant length during contraction, while the I and H bands would shorten. In this way, the *Z lines* are brought closer together, and the overall muscle cell length shortens by about one-third of its resting length.







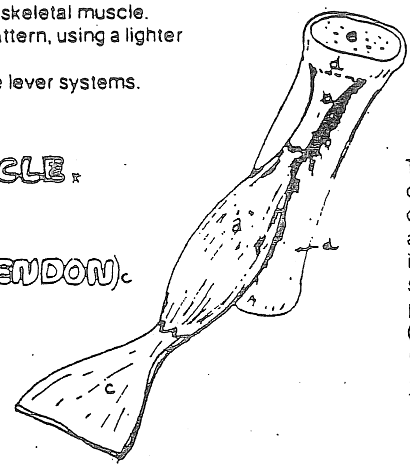
MUSCULAR SYSTEM / AN INTRODUCTION

CN 14

1. Color the five parts of a typical skeletal muscle.
2. Color the six types of muscle pattern, using a lighter shade for the tendons.
3. Color the elements of the three lever systems.

A SKELETAL MUSCLE *

BELLY a
TENDON b
APONEUROSIS c (TENDON) c
PERIOSTEUM d
BONE e

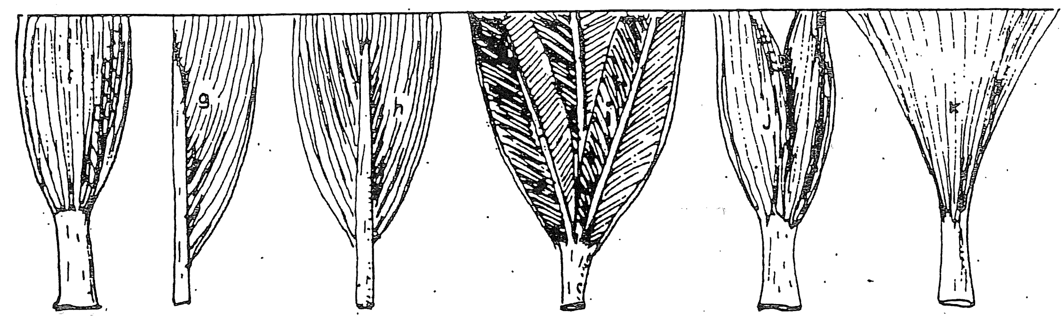


The form of the body is largely due to *skeletal muscle*— the voluntary contractile tissue that moves our skeleton about. Skeletal muscle demands large amounts of oxygen and nutrients to sustain itself, and will spasm in their absence. The skeletal muscle you are coloring is a collection of many microscopic muscle cells (fibers) each ensheathed in a delicate fibrous envelope. As a skeletal muscle approaches its attachment site, the mass of contractile elements (*belly*) ends rather abruptly, while the connective tissue fibers continue on as the *tendon* of attachment, offering astounding resistance to pulling tension. Flat tendons are called *aponeuroses*. The collagen fibers of the tendon integrate with those of the *periosteum* and the *bone* itself to form a unit construction—a blend resistant to all but the most traumatic forces.

TYPES OF MUSCLES *

FUSIFORM f
UNIPENNATE g
BIPENNATE h
MULTIPENNATE i
BICIPITAL j
TRIANGULAR k

The contractile force of a muscle is partly attributable to the architecture of its fibers. Variations in range and power relate to the configuration of muscle and tendon fibers Short range but great power and resistance to tension are characteristics of *multipennate* muscle where many short muscle fibers attach to shoots of tendon within a small space. In *fusiform* types, the longer the muscle fibers, the greater the range of movement.



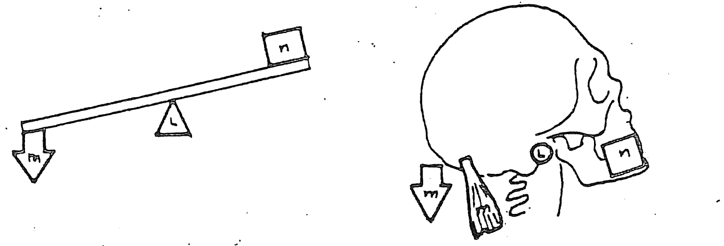
MECHANICS OF MOVEMENT *

FULCRUM L (JOINT) L
EFFORT m (MUSCLE) m
RESISTANCE n (WEIGHT) n

Skeletal muscles employ simple machines, such as *levers*, to increase the efficiency of their contractile work. The degree of *muscular effort* required to overcome *resistance* depends upon the force of resistance (weight), and the relative distances from fulcrum to point of resistance (L–n) and from fulcrum to point of muscular effort (L–m). The position of the *fulcrum* (L) relative to points (m) and (n) determines the class of the lever system in use.

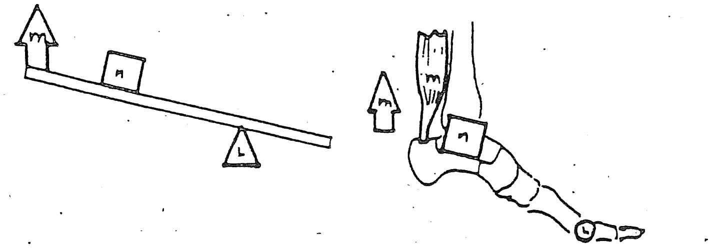
1ST CLASS LEVER *

The fulcrum (joint) always lies between the effort (muscle) and the resistance (weight). This is the most efficient class of lever. With a constant weight, the longer the distance L—m, relative to the distance L—n, the less muscle effort required.



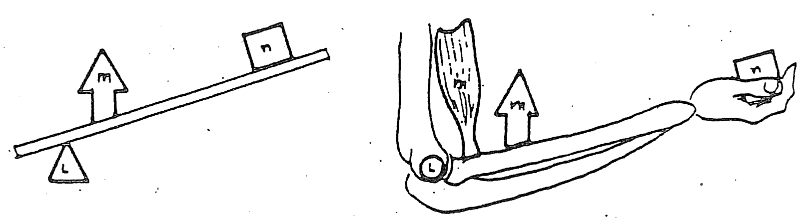
2ND CLASS LEVER *

The resistance always lies between the fulcrum (joint) and the effort (muscle), such as when pushing/lifting a wheelbarrow. In this case, the longer L—m distance relative to the shorter L—n distance provides a good mechanical advantage for the muscle lifting the body weight onto the heads of the metatarsals.



3RD CLASS LEVER *

The muscular effort is placed between the weight and the joint, providing the least efficient mechanical advantage. To compare 3rd and 2nd class levers: lifting a 50-lb box with your arms takes significantly more muscular effort than lifting your 150-lb body by standing on the heads of your metatarsals.



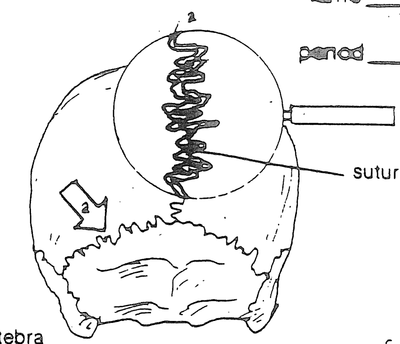
Name ________________

period ____ date ______

SKELETAL SYSTEM
CLASSIFICATION OF JOINTS*

CN 13
1. Color all lettered structures on the plate.
2. Use a dark color for the synovial cavity (f).

Bones are connected at joints (articulations). Joint movements are determined by joint structure. Joint structure is classified as *fibrous*, *cartilaginous*, or *synovial*.

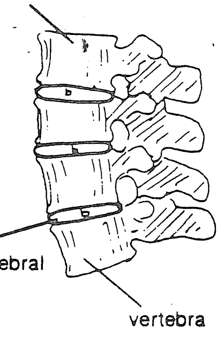


FIBROUS JOINT a

The bones are attached by *fibrous* connective tissue providing little or no movement. Examples: sutures between flat bones of the skull (immovable); interosseous ligaments between bones of the leg and between bones of the forearm (partly movable).

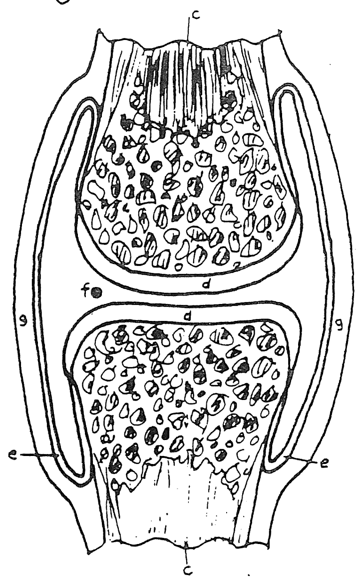
CARTILAGINOUS JOINT b

The bones are connected by *cartilage* connective tissue reinforced by fibrous tissue, permitting little or no movement. Example: fibrocartilage discs between vertebral bodies (partly movable); cartilage between epiphysis and diaphysis of developing bone (immovable).



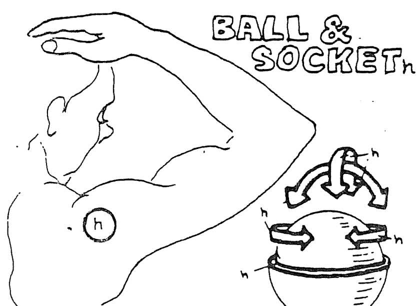
SYNOVIAL JOINT (TYPICAL)*
ARTICULATING BONES c
ARTICULAR CARTILAGE d
SYNOVIAL MEMBRANE e
SYNOVIAL CAVITY (FLUID) f
JOINT CAPSULE (LIGAMENT) g

The bones, capped with cartilage, articulate within a *cavity* lined by a *membrane* secreting a viscous *fluid* that absorbs the heat of friction during movement. The *synovial joint* is surrounded by a fibrous *capsule* interlaced with ligaments and tendons.



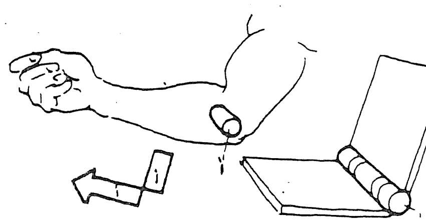
TYPES OF SYNOVIAL JOINTS*

BALL & SOCKET h



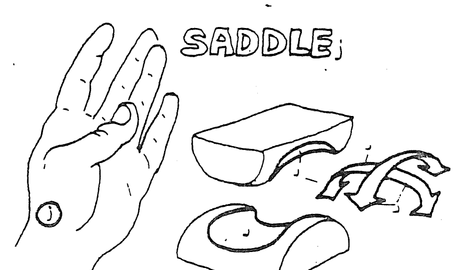
The ball-like head of one bone fits into the socket-like head of another, permitting all movements. Examples: shoulder and hip joints.

HINGE i



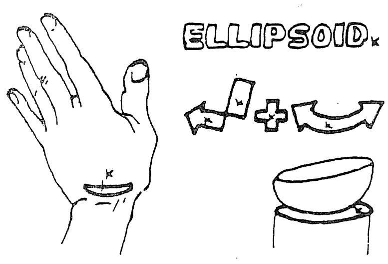
The C-shaped surface of one bone swings about the rounded surface of another. Movement is limited to flexion/extension. Examples: elbow, ankle, interphalangeal joints.

SADDLE j



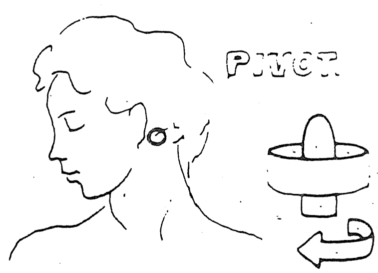
The concave surfaces of two bones articulate with one another. All movements are possible, but rotation is limited. Example: carpometacarpal joint of thumb.

ELLIPSOID k



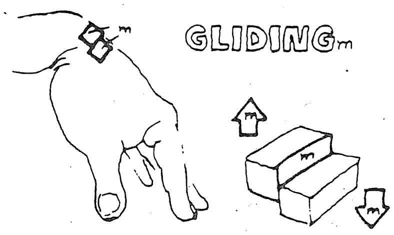
This is a reduced ball and socket configuration in which rotation is not permitted. Example: radiocarpal (wrist) joint.

PIVOT



A ring of bone rotates about a process of bone. Movement is limited to rotation. Example: skull on its atlas (1st cervical vertebra) rotates about the odontoid process of the 2nd cervical vertebra.

GLIDING m



Two opposed flat surfaces of bone glide across one another. Movement is limited to gliding. Examples: intercarpal joints.