

Chapter 6: The Muscular System

1. Muscles are responsible for all types of body movement.

2. Three basic muscle types are found in the body:

- a.
- b.
- c.

3. Characteristics of Muscles

- a. _____ & _____ muscle cells are elongated (muscle cell = muscle fiber)
- b. _____ of muscles is due to the movement of _____
- c. All muscles share some terminology
 - i. Prefixes *myo* and *mys* refer to “_____”
 - ii. Prefix *sarco* refers to “_____”

TABLE 6.1

Comparison of Skeletal, Cardiac, and Smooth Muscles




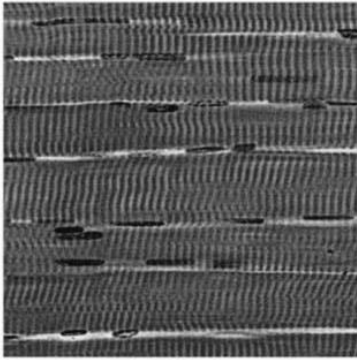

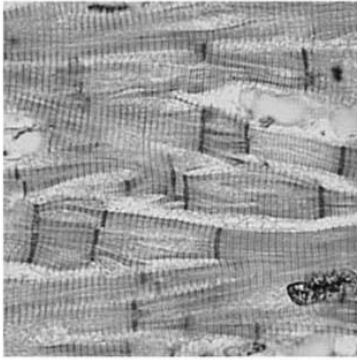

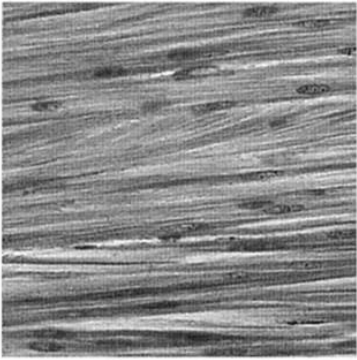

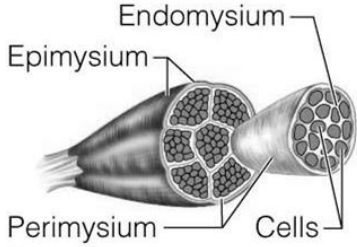
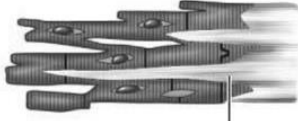

Characteristic	Skeletal	Cardiac	Smooth
Body location	Attached to bones or, for some facial muscles, to skin 	Walls of the heart 	Mostly in walls of hollow visceral organs (other than the heart) 
Cell shape and appearance	Single, very long, cylindrical, multinucleate cells with very obvious striations  	Branching chains of cells; uninucleate, striations; intercalated discs  	Single, fusiform, uninucleate; no striations  

TABLE 6.1

Comparison of Skeletal, Cardiac, and Smooth Muscles (*continued*)

Characteristic	Skeletal	Cardiac	Smooth
Connective tissue components	Epimysium, perimysium, and endomysium	Endomysium attached to the fibrous skeleton of the heart	Endomysium
Regulation of contraction	 <p>Voluntary; via nervous system controls</p>	 <p>Involuntary; the heart has a pacemaker; also nervous system controls; hormones</p>	 <p>Involuntary; nervous system controls; hormones, chemicals, stretch</p>
Speed of contraction	Slow to fast	Slow	Very slow
Rhythmic contraction	No	Yes	Yes, in some

Describe two **anatomical** (structural) differences between the 3 types of muscle based on table 6.1.

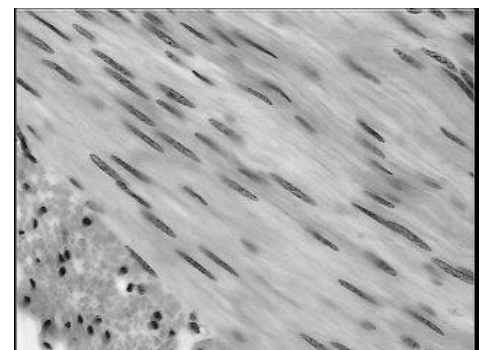
- 1.
- 2.

Describe two **physiological** (functional) differences between the 3 types of muscle based on table 6.1.

- 1.
- 2.

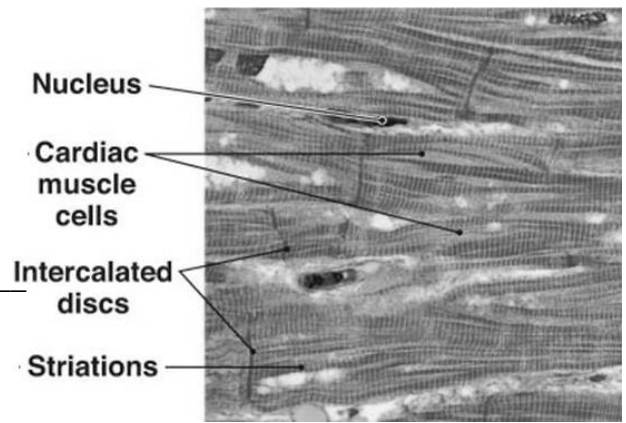
4. Smooth Muscle Characteristics

- a. Lack _____
- b. _____ shaped cells
- c. _____ (single nucleus)
- d. Involuntary: _____
- e. Found mainly in _____



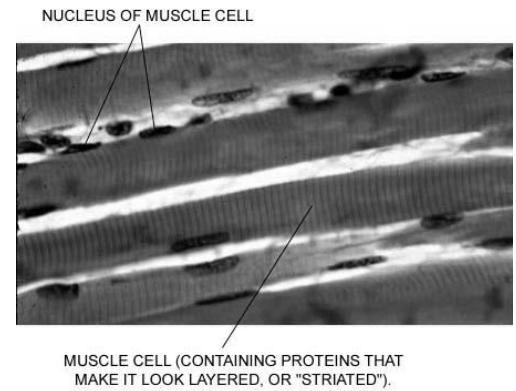
5. Cardiac Muscle Characteristics

- _____ – have visible banding
- Usually _____ - has single nucleus
- _____ cells
- Joined to another muscle cell at _____
- _____ - no conscious control
- Found only in the _____
- Arranged in _____ or _____ shaped bundles



6. Skeletal Muscle Characteristics

- Most are attached by _____ to bones
- Cells are _____ (more than one nucleus)
- _____ – have visible banding
- _____ – subject to conscious control



7. Skeletal Muscle Attachments

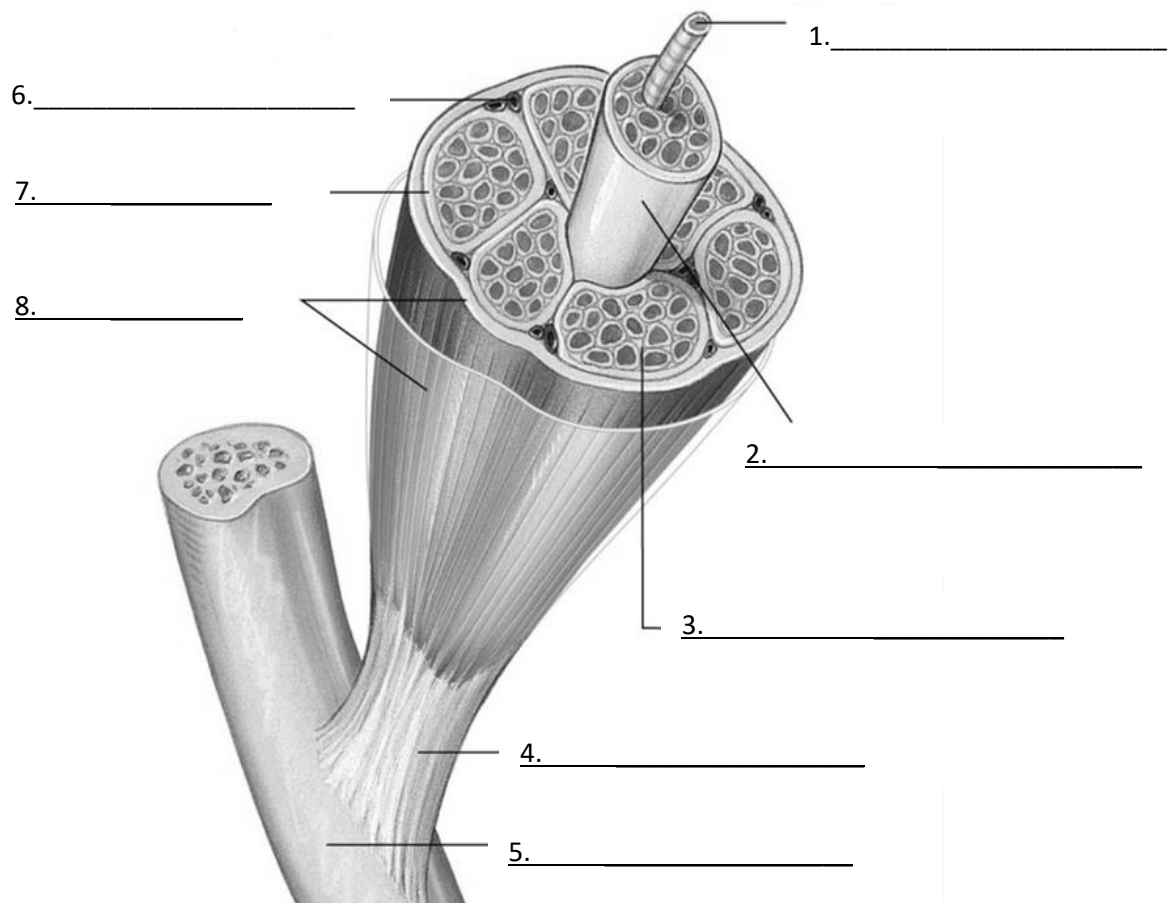
- Epimysium (outer covering of muscle) blends into a connective tissue attachment
 - Tendons: _____ structures that connect _____ to _____
 - Mostly _____ fibers
 - Often cross a joint due to toughness and small size
 - Aponeuroses: _____
 - Attach muscles indirectly to bones, cartilages, or connective tissue coverings
- Sites of muscle attachment
 -
 -
 -

8. Skeletal Muscle Functions

- _____ - allow us to respond quickly to changes in external environment
- _____ - remaining erect or seated despite the downward pull of gravity
- _____ - reinforcement of skeletal articulations
- _____ - by product of muscle activity as ATP is used to power muscle contraction

Connective Tissue Wrappings of Skeletal Muscle: How are muscles protected?

- e. Cells are surrounded and bundled by connective tissue
 - i. Endomysium:
 - ii. Perimysium:
 - iii. Epimysium:
 - iv. Fascia:

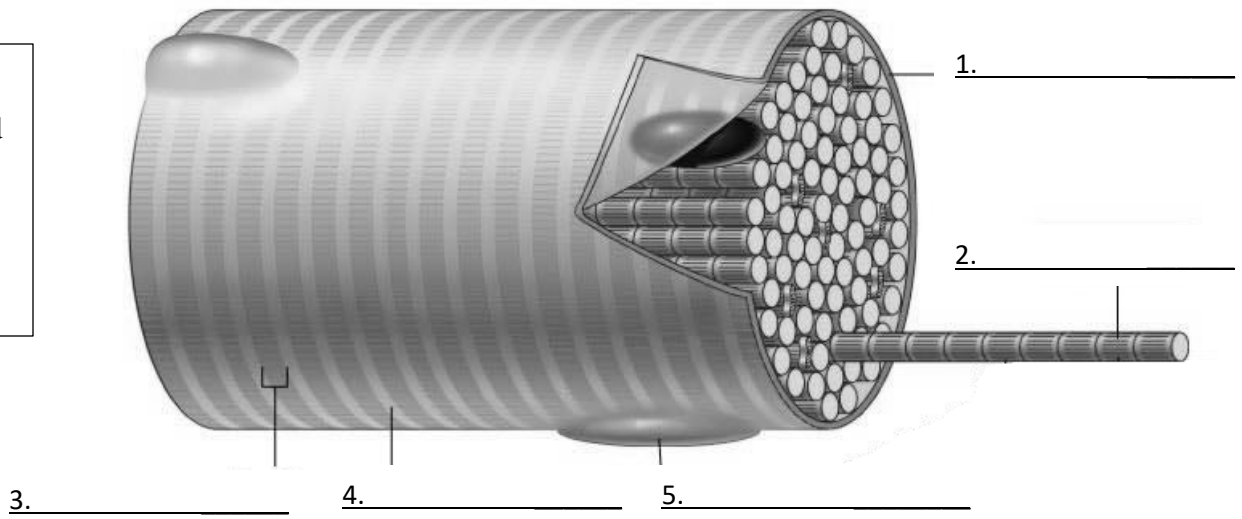


Word Bank			
Bone	Endomysium	Epimysium	Blood Vessel
Tendon	Fascicle	Perimysium	Muscle Fiber

9. Microscopic Anatomy of Skeletal Muscle

- a. Sarcolemma: _____
- b. Myofibrils: _____
- c. Sarcoplasmic Reticulum: _____

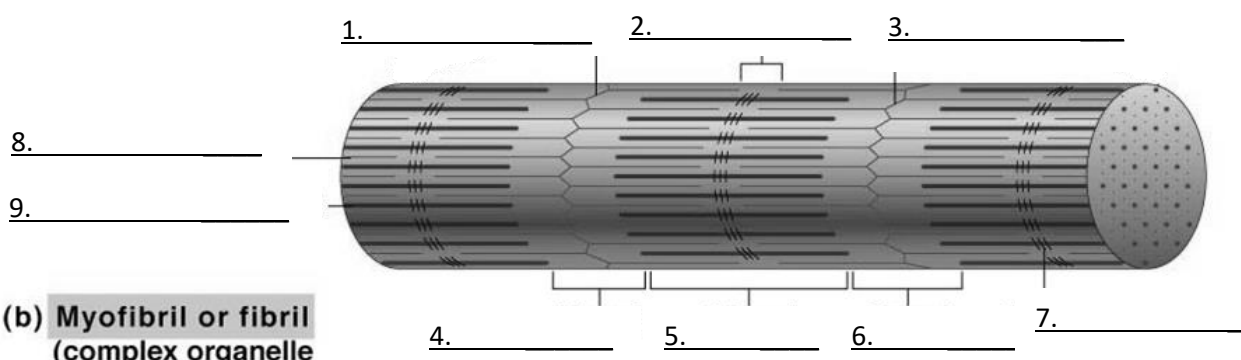
Word Bank
 Dark (A) band
 Nucleus
 Myofibril
 Sarcolemma
 Light (I) band



(a) Segment of a muscle fiber (cell)

- d. Myofibrils are aligned to give distinct bands
- i. I band = _____
 - 1. Contains only _____ filaments (actin)
 - ii. A band = _____
 - 1. Contains the entire length of the _____ filaments (myosin)

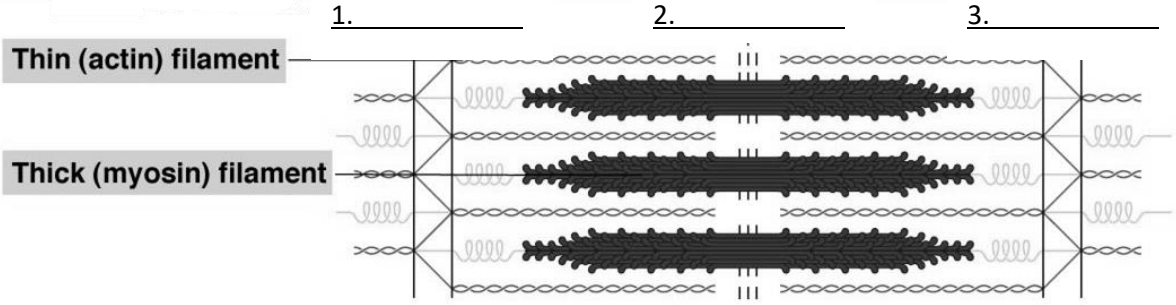
Word Bank
 Actin
 Myosin
 M line
 Z disc (2x)
 A band
 I band (2x)
 H zone



(b) Myofibril or fibril (complex organelle composed of bundles of myofilaments)

- e. Sarcomere: _____
- f. Organization of the sarcomere
- 1. _____ filaments
 - a. Composed of the protein _____
 - b. Have heads (extensions, or _____)
 - 2. _____ filaments
 - a. Composed of the protein _____
 - b. Anchored to the _____

Word Bank
M line
Z disc (2x)



(c) **Sarcomere (segment of a myofibril)**

- g. At rest, there is a bare zone that lacks actin filaments, called the _____
- h. Sarcoplasmic Reticulum (SR)
 - i. Stores and releases _____
 - ii. Surrounds the _____

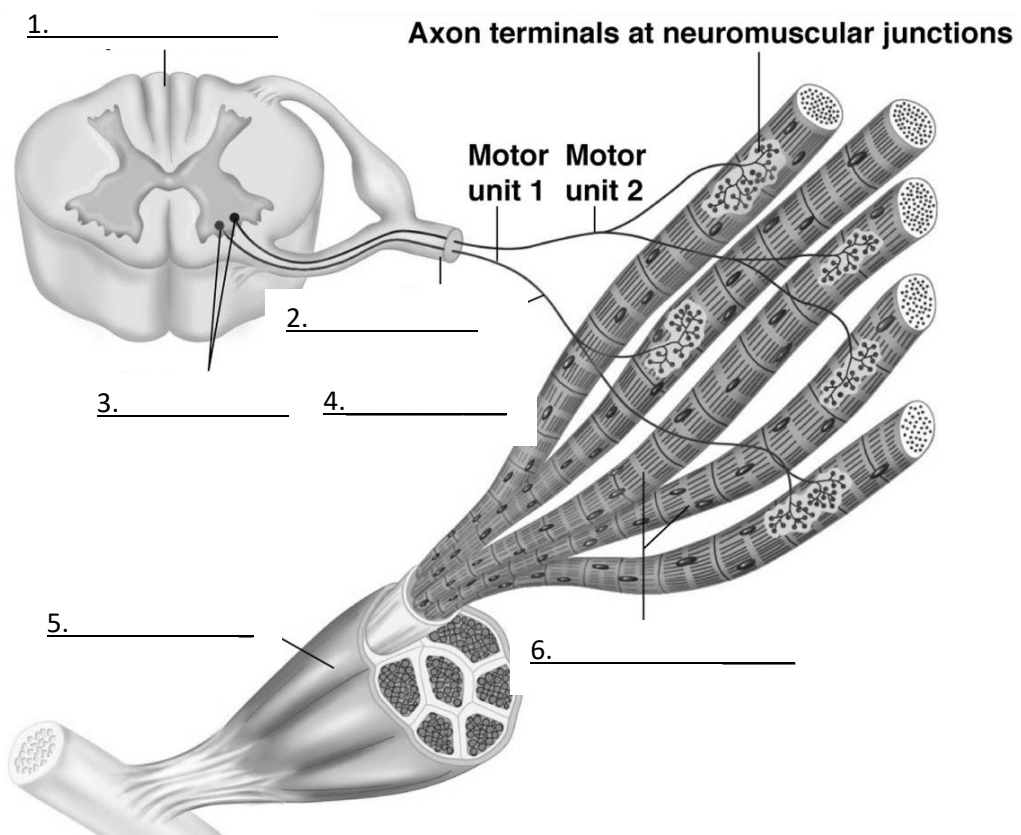
10. Stimulation and Contraction of Single Skeletal Muscle Cells

- a. Excitability / responsiveness / irritability: ability to receive and _____ to a stimulus
- b. Contractibility: ability to _____ when an adequate _____ is received
- c. Extensibility: ability of muscle cells to be _____
- d. Elasticity: ability to _____ and resume _____ after stretching

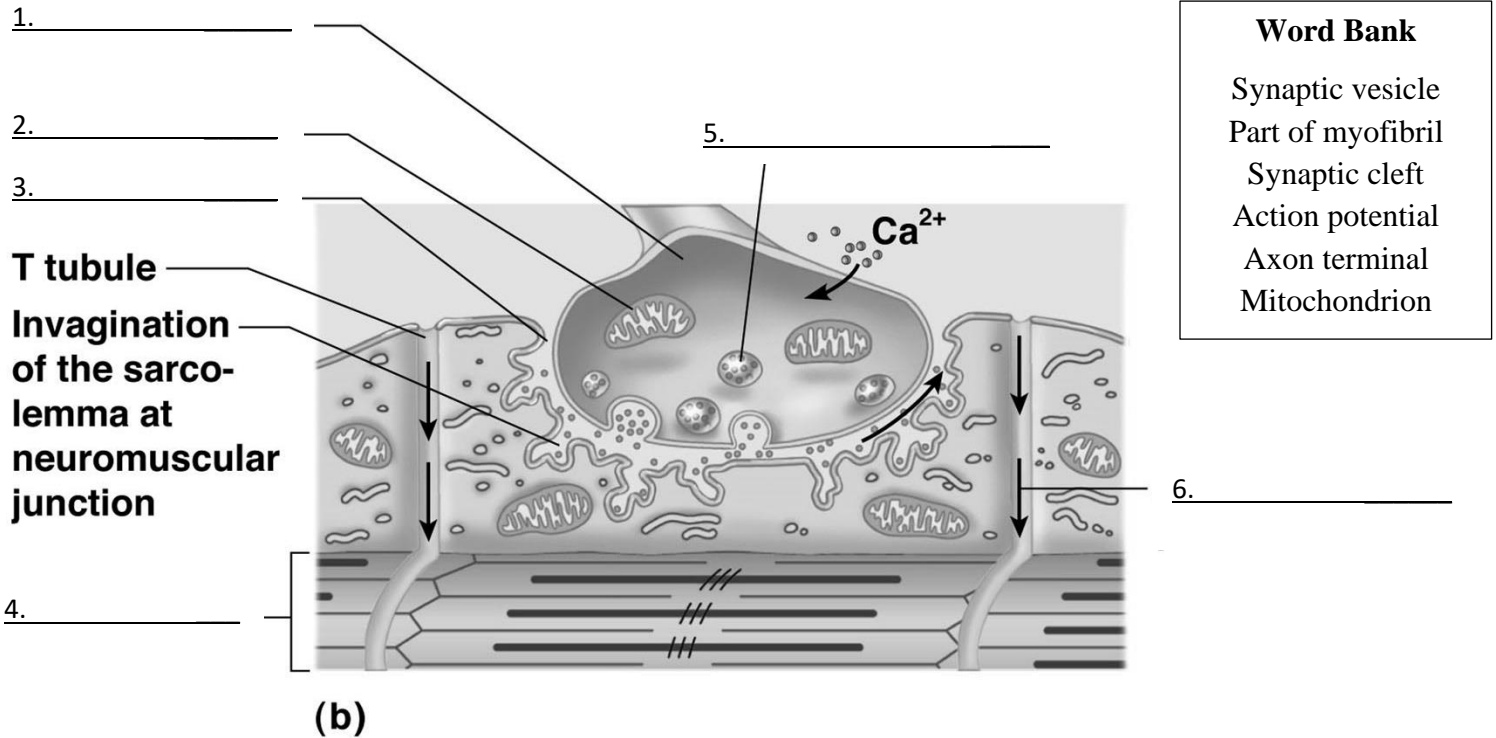
11. The Nerve Stimulus and Action Potential

- a. Skeletal muscles must be stimulated by a _____ (type of nerve cell) to contract
- b. Motor Unit: one motor neuron and all the _____ cells stimulated by it

Word Bank
Spinal cord
Nerve
Muscle
Muscle fibers
Motor neuron
Axon of motor neuron



- c. Neuromuscular junction:
 i. Association site of _____ of the motor neuron and _____
- d. Synaptic Cleft (a.k.a. synapse)
 i. _____ between _____ and _____
 ii. Nerve and muscle do _____ make contact
 iii. Area between nerve and muscle is filled with _____



12. Transmission of Nerve Impulse to Muscle

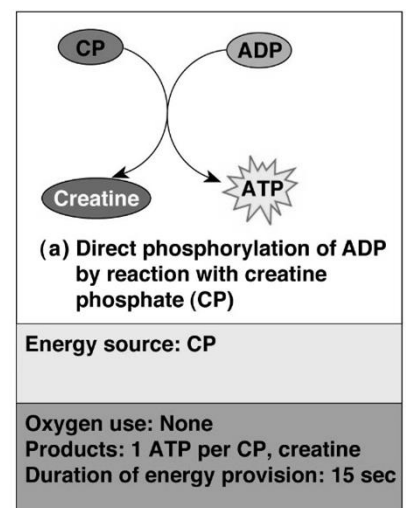
- a. Neurotransmitter: _____ by nerve upon arrival of nerve impulse
 i. Carries the impulse _____ the _____
 ii. The neurotransmitter for skeletal muscle is _____ (ACh)
- b. Acetylcholine attaches to _____ on the _____ of the muscle cells
- c. Sarcolemma becomes permeable to _____ (Na^+)
- d. Sodium rushes into the cell generating an _____
- e. Once started, muscle contraction cannot be stopped

13. The Sliding Filament Theory of Muscle Contraction

- a. Activation by nerve causes _____ heads (cross bridges) to _____ to binding sites on the _____ filament; requires _____ in the form of ATP
- b. Myosin heads then _____ the thin filaments toward the center of the _____
- c. This causes a _____ of the actin past the myosin
- d. The result is that the muscle is _____ (contracted)

14. Contraction of Skeletal Muscle

- a. Muscle fiber contraction is “all or none”
- b. Within a skeletal muscle, not all fibers may be _____ during the same interval
- c. Different _____ of muscle fiber contractions may give differing responses
- d. _____: different degrees of skeletal muscle shortening
- e. Graded responses can be produced by changing:
 - i. The _____ of muscle stimulation
 - ii. The _____ of muscle cells being stimulated at one time
- f. Types of Graded Responses:
 - i. Twitch
 1. _____, _____ contraction
 2. Not a normal muscle function
 - ii. Tetanus (summing of contractions)
 1. One contraction is immediately _____ by another
 2. Muscle does not completely return to a _____ state
 3. The effects are added
 4. **Unfused** (incomplete) tetanus
 - a. _____ relaxation occurs _____ contractions
 - b. The results are summed
 5. **Fused** (complete) tetanus
 - a. _____ relaxation before the following contractions
 - b. Result is a _____ muscle contraction
 - g. Muscle response to Strong Stimuli
 - i. Muscle force depends upon the _____ of fibers stimulated
 1. _____ fibers _____ results in _____ muscle tension
 2. Muscles can continue to contract unless they run out of _____
 - h. Energy for Muscle Contraction
 - i. Initially, muscles use _____ ATP for energy
 1. ATP bonds are broken to _____ energy
 2. Only _____ worth of ATP is stored by muscles
 - ii. After this initial time, other pathways must be utilized to produce ATP.
 - iii. Direct phosphorylation of ADP by creatine phosphate (CP)
 1. Muscle cells store _____
 - a. CP is a high-energy molecule
 2. After ATP is depleted, ADP is left
 3. CP _____ energy to ADP, to regenerate ATP



4. CP supplies are exhausted in less than _____
- iv. Aerobic respiration (oxidative phosphorylation)
 1. _____ is broken down to carbon dioxide and water, releasing energy (ATP)
 2. This is a _____ reaction that requires continuous _____
 3. A series of metabolic pathways occur in the cell's _____
 - v. Anaerobic glycolysis and lactic acid formation
 1. Reaction that breaks down glucose without _____
 2. Glucose is broken down into _____ to produce small amount of ATP
 3. Pyruvic acid is converted into _____ (waste product)
 - vi. This reaction is _____, but is _____
 1. Huge amounts of glucose are needed
 2. Lactic acid produces _____
 - i. Muscle Fatigue and Oxygen Deficit
 - i. When a muscle is fatigued, it is unable to _____ even with a stimulus
 - ii. Common cause for muscle fatigue is oxygen _____
 1. Oxygen is required to get rid of accumulated _____
 - iii. Increasing acidity (from lactic acid) and lack of ATP causes the muscle to contract _____
 - j. Types of Muscle Contractions
 - i. _____ Contractions
 1. Myofilaments are able to slide past each other during contractions
 2. The muscle shortens and movement occurs
 - ii. _____ Contractions
 1. Tension in the muscles increases
 2. The muscle is unable to shorten or produce movement
 - iii. Muscle Tone
 1. Some fibers are contracted even in a _____ muscle
 2. Different fibers _____ at different _____ to provide muscle tone
 3. The process of stimulating various fibers is under _____ control

15. Effect of Exercise on Muscles

- a. Exercise increases muscle _____, _____, and _____
 - i. _____ exercise (biking, jogging) results in stronger, more flexible muscles with greater resistance to _____
 1. Makes body metabolism more _____
 2. Improves digestion and coordination
 - ii. _____ exercise (weight lifting) increases muscle size and strength

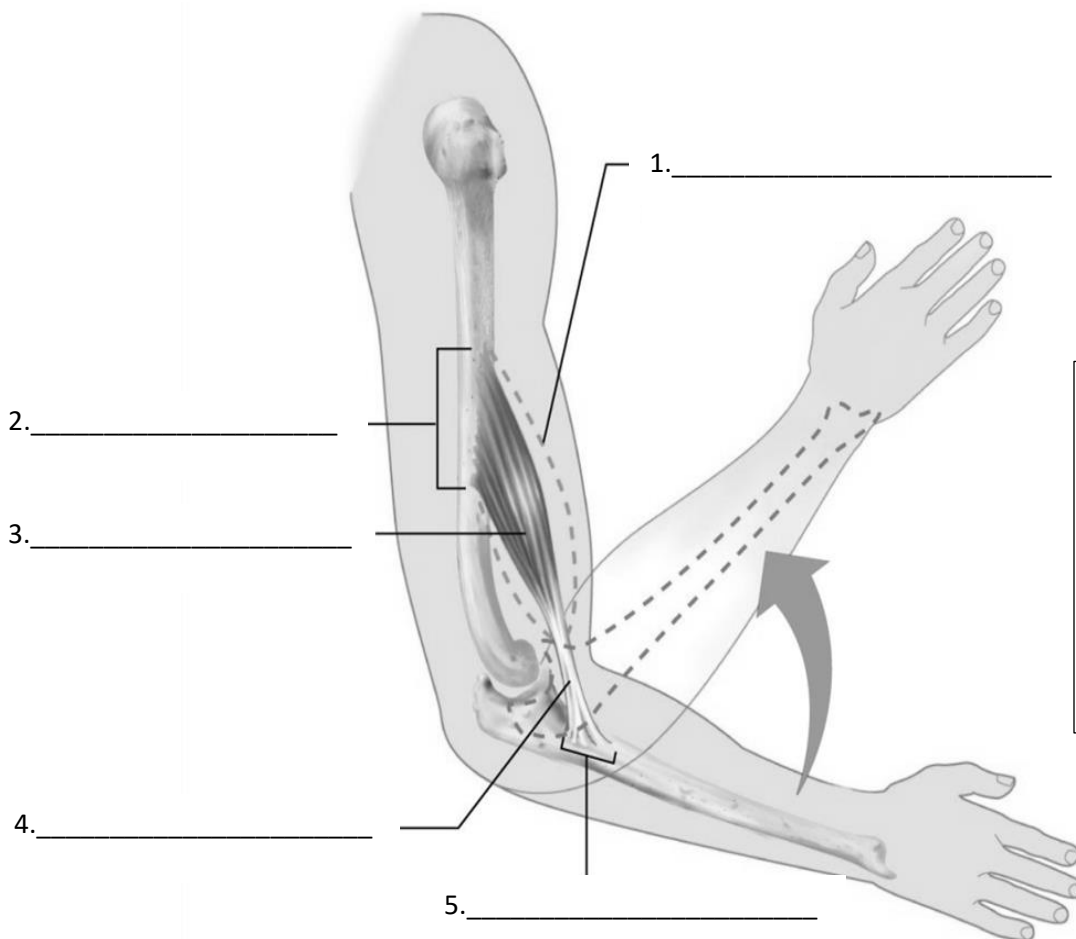
16. Muscles and Body Movements

- a. Movement is due to a _____ pulling an attached _____
- b. Muscles are attached to at least two points:
 - i. Origin – attachment to the _____ bone
 - ii. Insertion – attachment to the _____ bone

TABLE 6.2

The Five Golden Rules of Skeletal Muscle Activity

1. With a few exceptions, all skeletal muscles cross at least one joint.
2. Typically, the bulk of a skeletal muscle lies proximal to the joint crossed.
3. All skeletal muscles have at least two attachments: the origin and the insertion.
4. Skeletal muscles can only pull; they never push.
5. During contraction, a skeletal muscle insertion moves toward the origin.



Word Bank

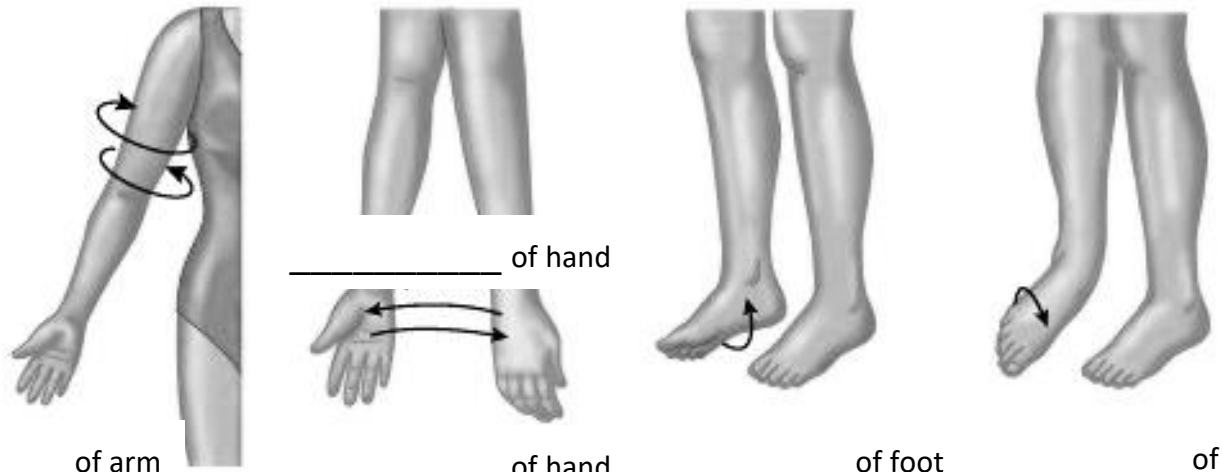
Origin
 Insertion
 Bicep Brachialis
 Tendon
 Muscle Contracting

17. Types of Ordinary & Special Body Movements

- a. Flexion
 - i. _____ the angle of the joint
 - ii. Brings two bones _____
 - iii. Typical of hinge joints like _____ and _____
- b. Extension
 - i. Opposite of flexion
 - ii. _____ the angle between two bones
 - iii. _____: increases the angle of a joint more than 180 degrees
- c. Rotation
 - i. Movement of a bone around its _____ axis
 - ii. Common in _____ joints
 - iii. Ex. Moving the _____ around the _____ of the _____ (shake your head “no”)
- d. Abduction
 - i. Movement of a limb _____ the midline of the body
- e. Adduction
 - i. Opposite of abduction
 - ii. Movement of a limb _____ the midline of the body
- f. Circumduction
 - i. Combination of _____, _____, _____, _____
 - ii. Common in _____ joints
- g. Dorsiflexion
 - i. Lifting the _____ so that the superior surface approaches the _____
- h. Plantar flexion
 - i. Depressing the _____ (pointing the _____)
- i. Inversion
 - i. Turn _____ of the foot _____
- j. Eversion
 - i. Turn _____ of the foot _____
- k. Supination
 - i. _____ rotates _____ so _____ faces _____
- l. Pronation
 - i. _____ rotates _____ so _____ faces _____
- m. Opposition
 - i. Move _____ to touch the tips of _____ _____ on the same hand



_____ of leg _____ of leg _____ of thigh _____ of thigh
a. Angular movements



_____ of arm _____ of hand _____ of foot _____ of foot
b. Circular movements **c. Special movements**

18. Types of Muscles

- a. Prime mover- muscle with the _____ for a certain movement
- b. Antagonist- muscle that _____ or _____ a prime mover
- c. Synergist- aids a prime mover in a movement and helps _____
- d. Fixator- _____ the _____ of a prime mover

19. Naming Skeletal Muscles

- a. By _____ of muscle fibers
 - i. Example: _____
- b. By relative _____ of the muscle
 - i. Example: _____
- c. By _____ of the muscle
 - i. Example: _____

- d. By number of _____
 i. Example: _____
- e. By location of the muscle's _____ and _____
 i. Example: _____
- f. By _____ of the muscle
 i. Example: _____
- g. By _____ of the muscle
 i. Example: _____

Word Bank for diagram below (arrangement of fascicles)

Convergent
 Fusiform
 Parallel
 Circular
 Unipennate
 Bipennate
 Multipennate

Pectoralis major



a. _____

Orbicularis oris



d. _____

Deltoid

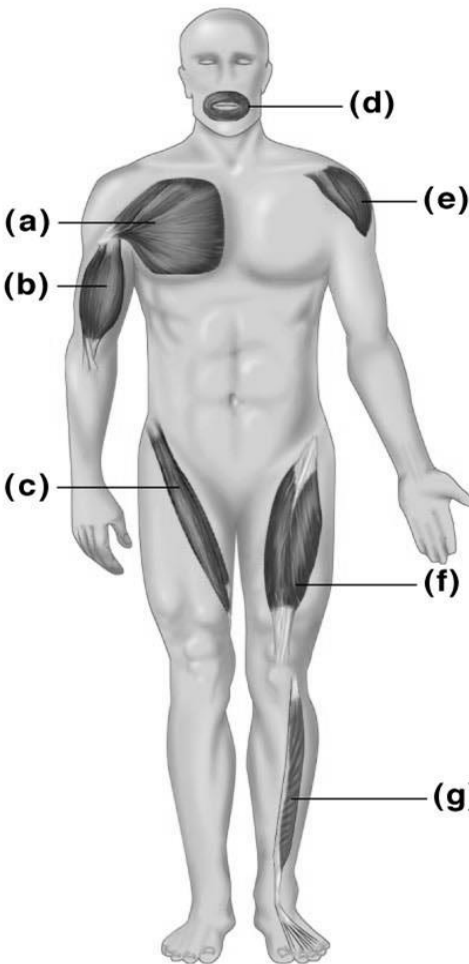


e. _____

Biceps brachii



b. _____



Rectus femoris



f. _____

Sartorius



c. _____

Extensor digitorum longus



g. _____

20. Head and Neck Muscles

a. Facial muscles

- i. Frontalis: raises _____
- ii. Orbicularis oculi: closes _____, _____, _____, _____
- iii. Orbicularis oris: closes _____ and _____ the lips
- iv. Buccinator: flattens the _____, _____
- v. Zygomaticus: raises corners of the _____

b. Chewing muscles

- i. Masseter: _____ the _____ raising the mandible
- ii. Temporalis: _____ of the masseter, aids in closing the jaw

c. Neck muscles

- i. Platysma: pulls the corners of the mouth _____
- ii. Sternocleidomastoid: flexes the _____, rotates the _____

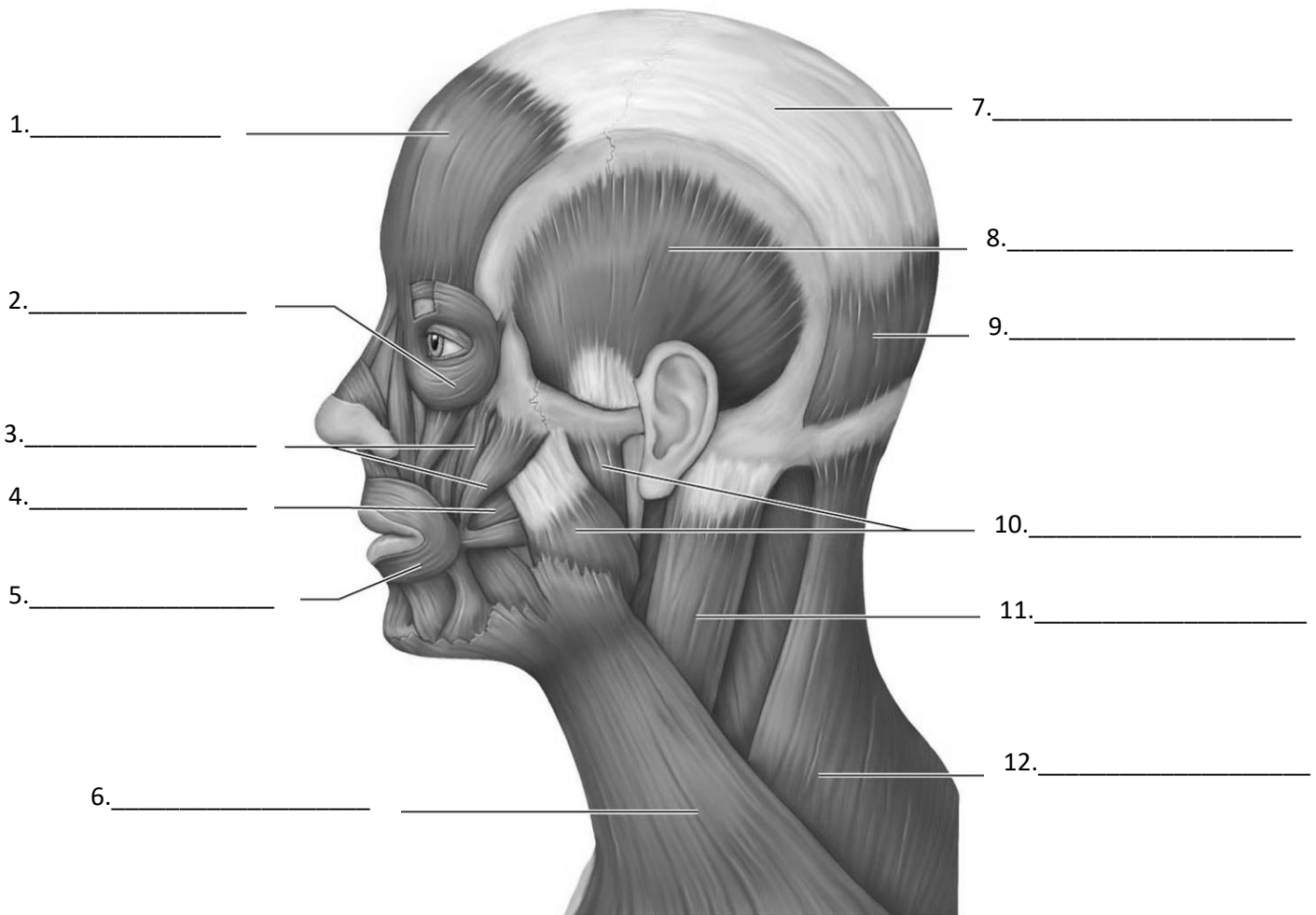
Word Bank – Head and Neck Muscles

Cranial aponeurosis
Masseter
Frontalis

Zygomaticus
Sternocleidomastoid
Temporalis

Orbicularis oculi
Orbicularis oris
Buccinator

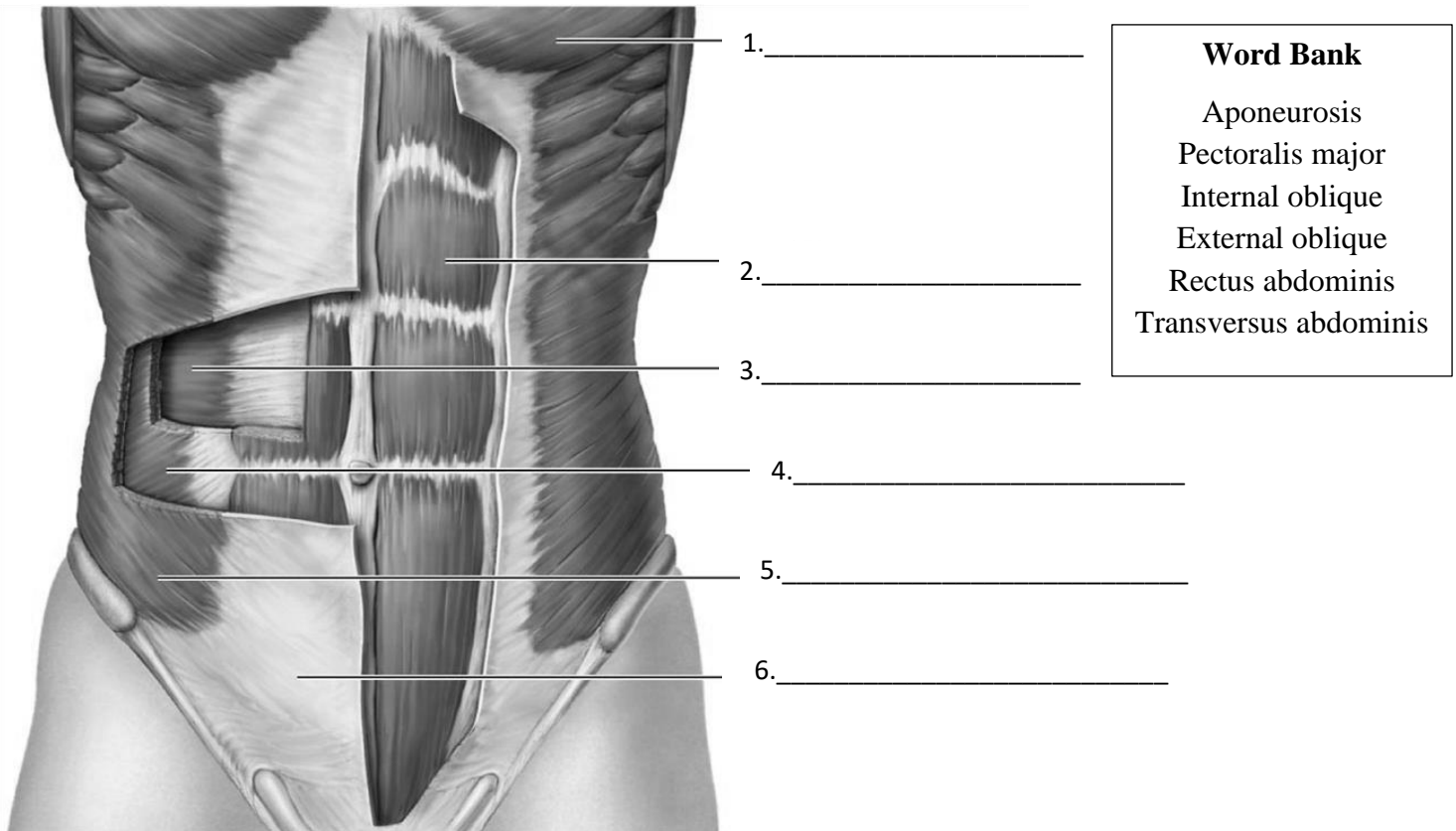
Trapezius
Occipitalis
Platysma



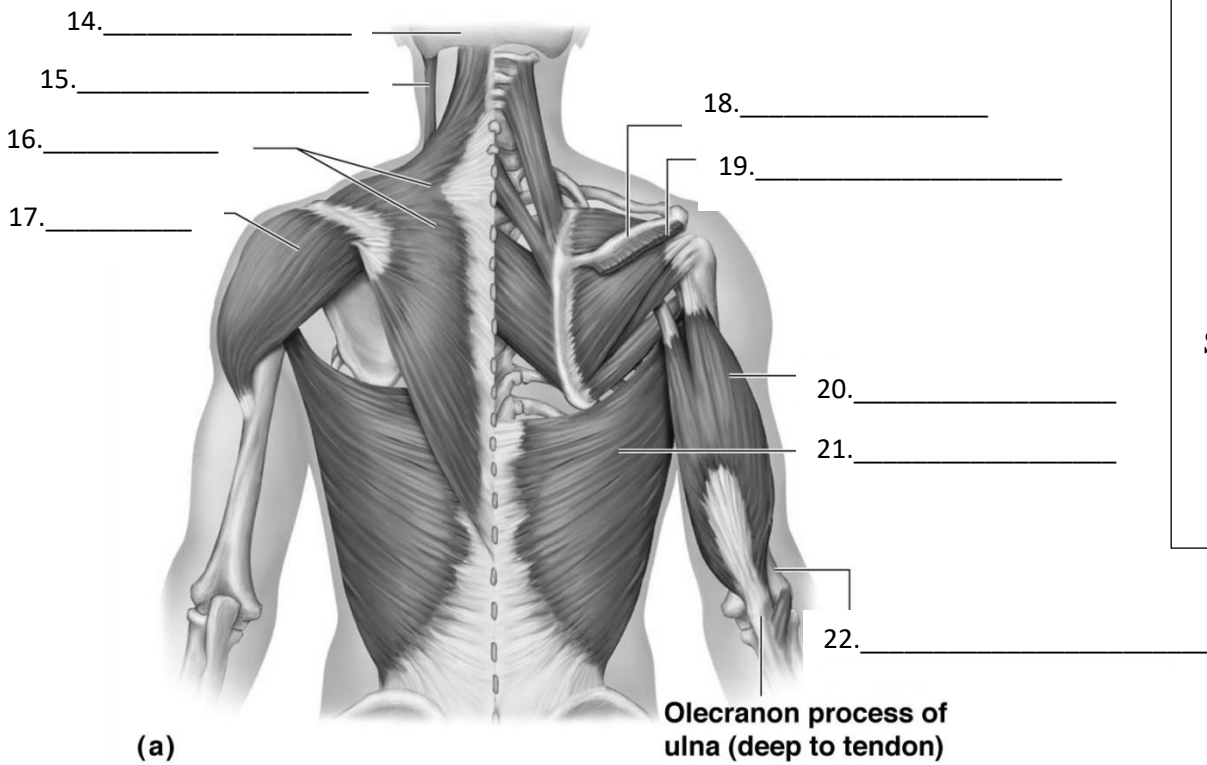
21. Muscles of Trunk, Shoulder & Limbs

- a. Anterior Muscles
 - i. Pectoralis major: _____ and _____ the humerus
 - ii. Intercostal muscles (rib cage)
 1. External intercostals: _____ rib cage during _____
 2. Internal intercostals: _____ rib cage during _____
- b. Muscles of the abdominal girdle
 - i. Rectus abdominis: flexes _____ and compresses abdominal contents (defecation, childbirth, forced breathing)
 - ii. External and internal obliques: flex vertebral column; _____ trunk and bend it _____
 - iii. Transversus abdominis: compresses abdominal contents
- c. Posterior muscles
 - i. Trapezius: elevates, depresses, adducts, and stabilizes the _____
 - ii. Latissimus dorsi: extends and adducts the _____
 - iii. Erector spinae: _____ of back
 - iv. Quadratus lumborum: flexes the spine _____
 - v. Deltoid: arm _____

Anterior Abdominal Region



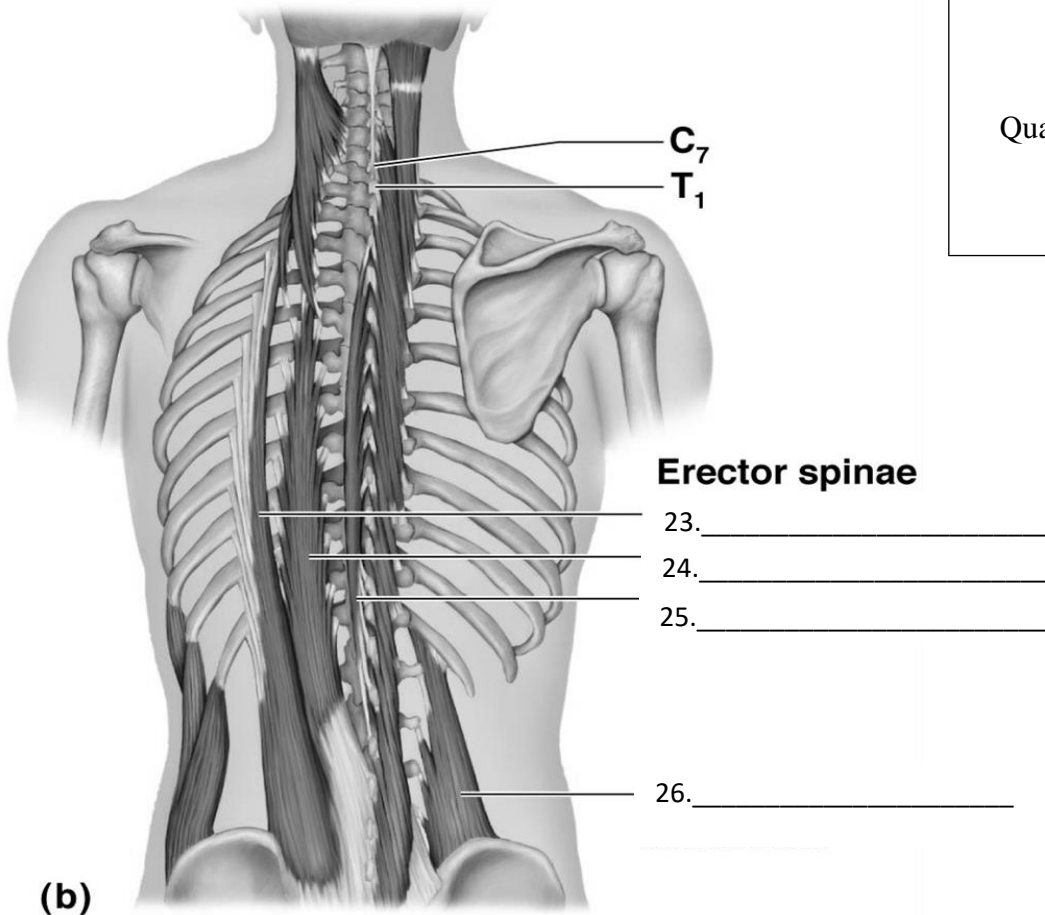
Muscles of the Back



Word Bank

- Deltoid
- Deltoid (cut)
- Latissimus dorsi
- Humerus
- Trapezius
- Occipital bone
- Sternocleidomastoid
- Triceps brachii
- Spine of scapula

Deep muscles of the back



Word Bank

- Spinalis
- Quadratus lumborum
- Iliocostalis
- Longissimus

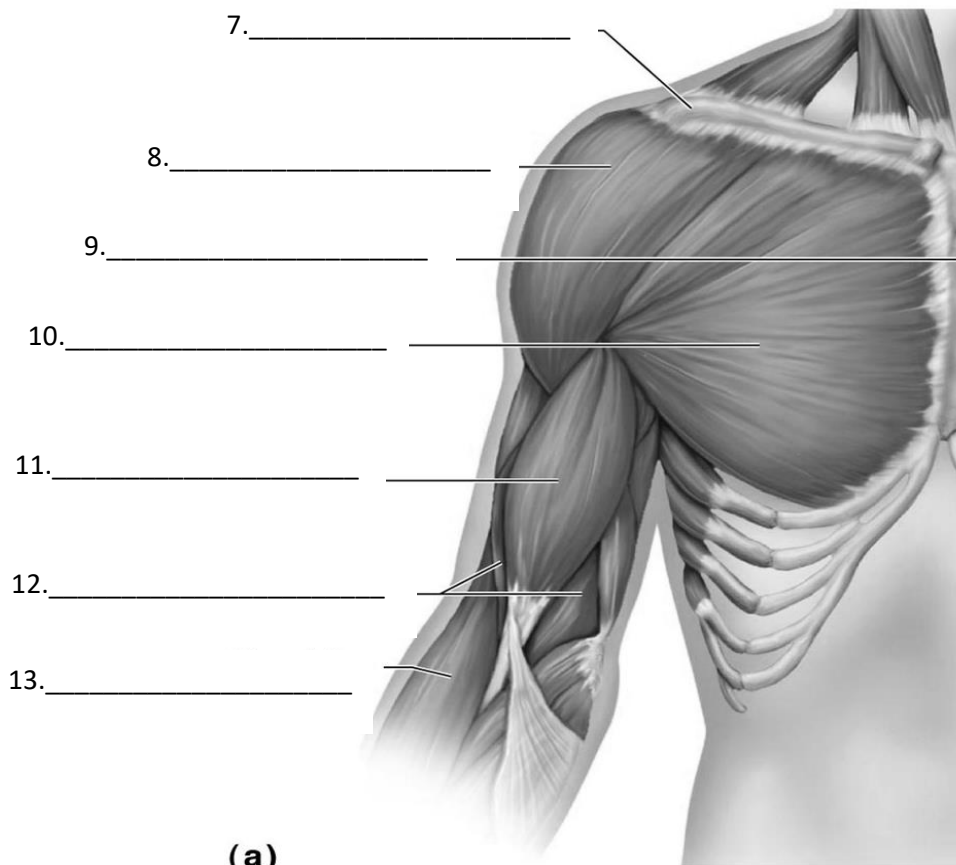
d. Muscles of the Upper Limb

- i. Biceps brachii: _____ of forearm, _____ of elbow
- ii. Brachialis: _____ flexion
- iii. Brachioradialis: weak muscle of forearm
- iv. Triceps brachii: elbow _____ (antagonist to _____)

e. Muscles of the Lower Limb

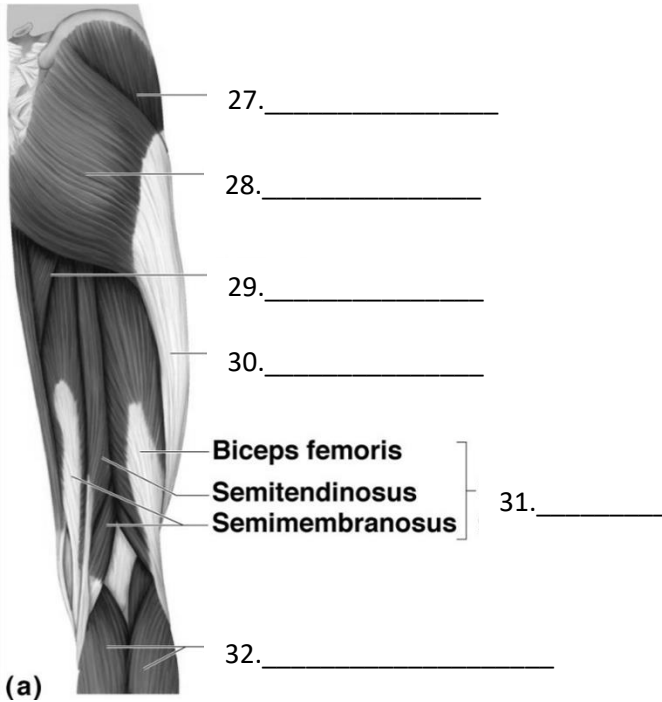
- i. Gluteus maximus: hip _____
- ii. Gluteus medius: hip _____, steadies pelvis when walking
- iii. Iliopsoas: hip flexion, keeps the upper body from falling backward when standing erect
- iv. Adductor muscles: adduct the _____

Anterior Thoracic & Brachial Region



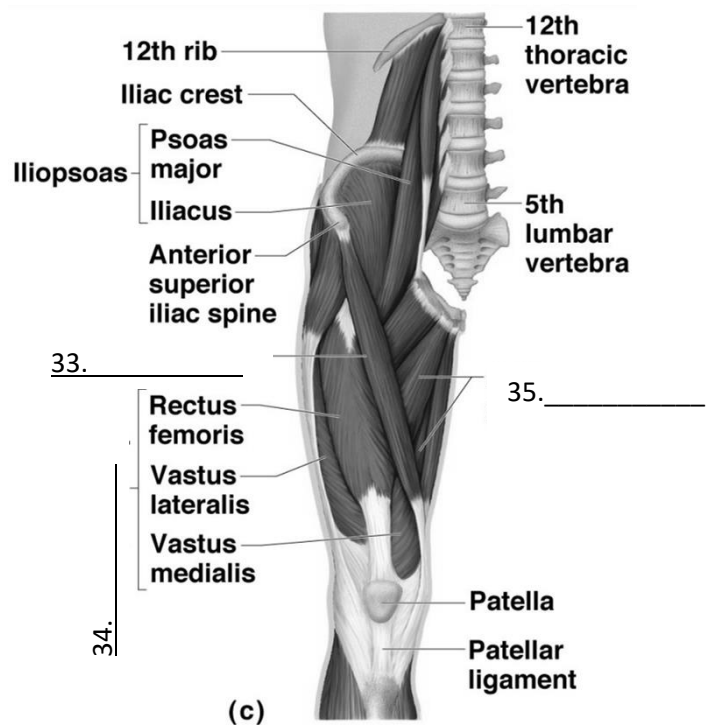
<p>Word Bank</p> <p>Deltoid</p> <p>Pectoralis major</p> <p>Brachioradialis</p> <p>Brachialis</p> <p>Sternum</p> <p>Clavicle</p> <p>Biceps brachii</p>
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Posterior lower limb muscles



Word Bank	
Hamstring group	Iliotibial tract
Gluteus maximus	Gluteus medius
Gastrocnemius	Adductor magnus

Anterior lower limb muscles



Word Bank	
Adductor group	Quadriceps
Sartorius	

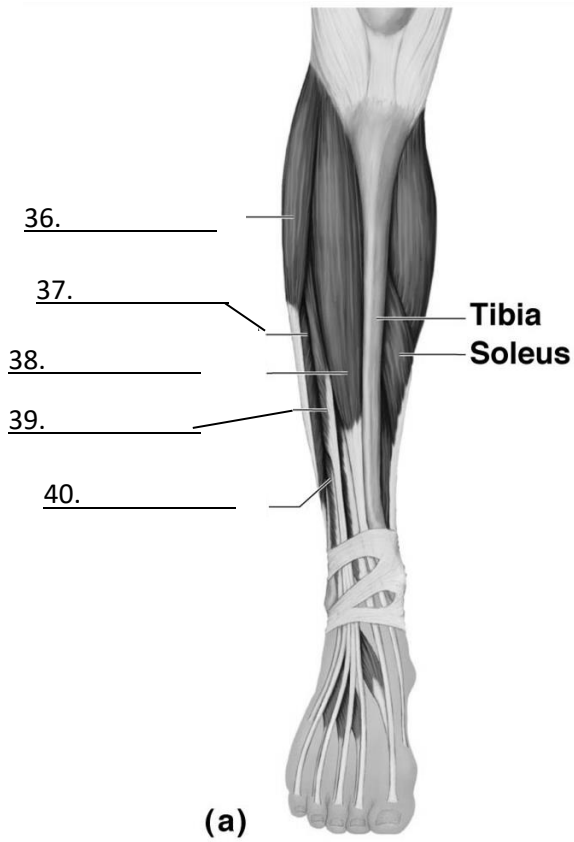
v. Muscles causing movement at the knee joint

1. Hamstring group: thigh _____ and knee _____
 - a. Biceps femoris
 - b. Semimembranosus
 - c. Semitendinosus
2. Sartorius: _____ the thigh
3. Quadriceps group _____ the knee
 - a. Rectus femoris (also _____ hip on thigh)
 - b. Vastus muscles (three)
 - i. Vastus medialis, vastus lateralis, vastus intermedius

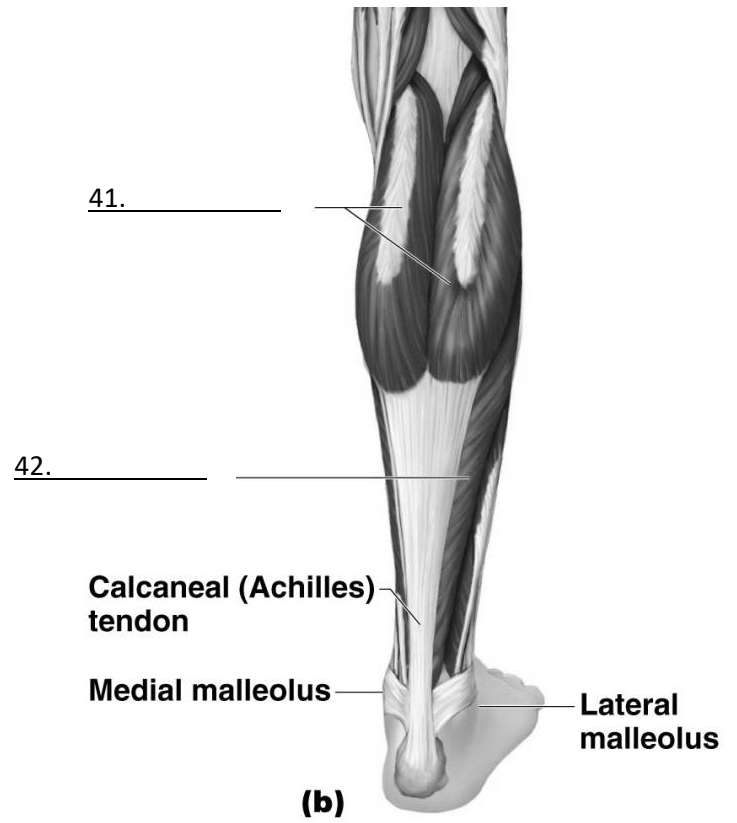
vi. Muscles causing movement at ankle and foot

1. Tibialis anterior: _____ and foot inversion
2. Extensor digitorum longus: toe _____ and dorsiflexion of the foot
3. Fibularis muscles: _____ and _____ of the foot
4. Soleus: _____ of foot

Anterior lower leg muscles



Posterior lower leg muscles



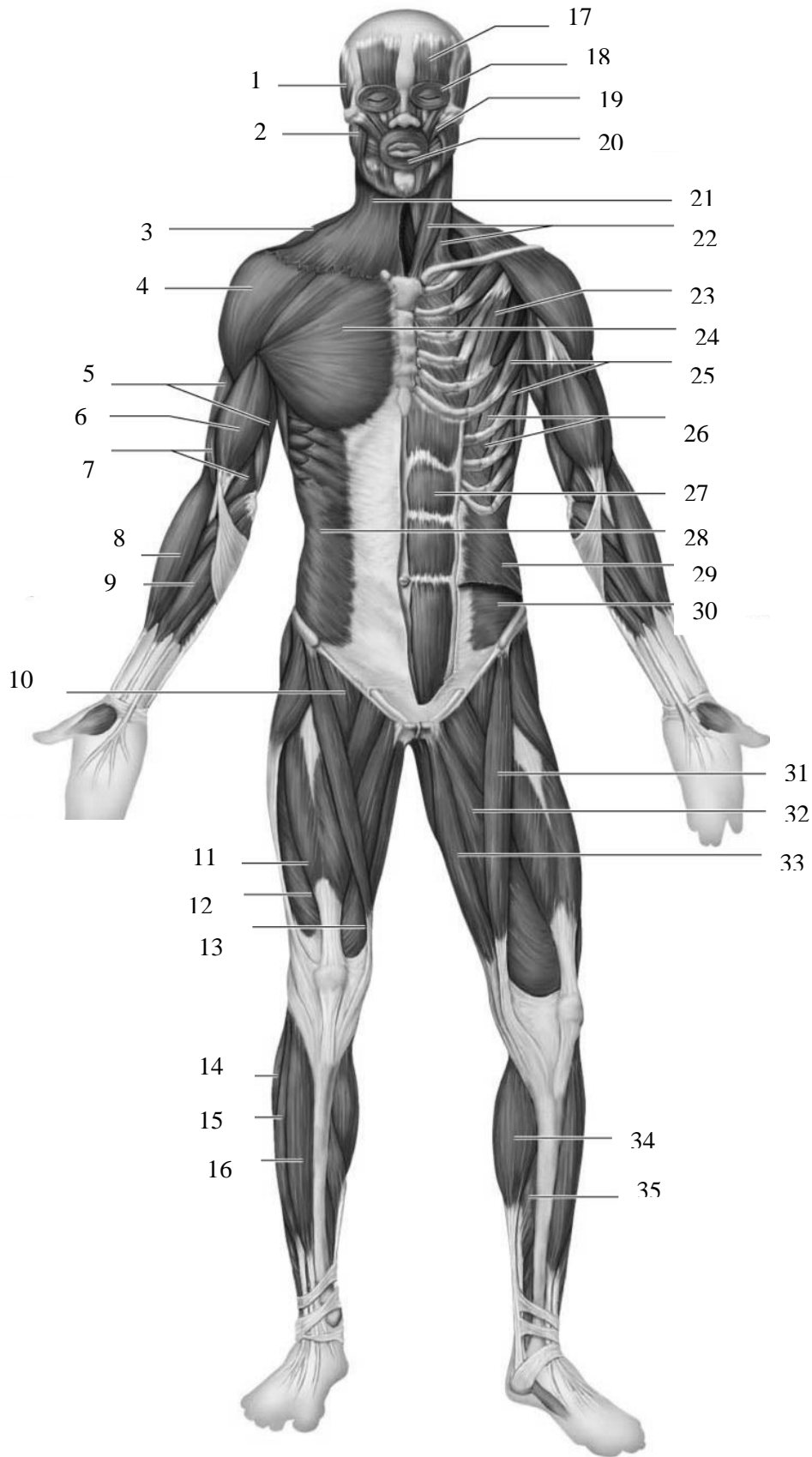
Word Bank

Fibularis tertius
Fibularis brevis

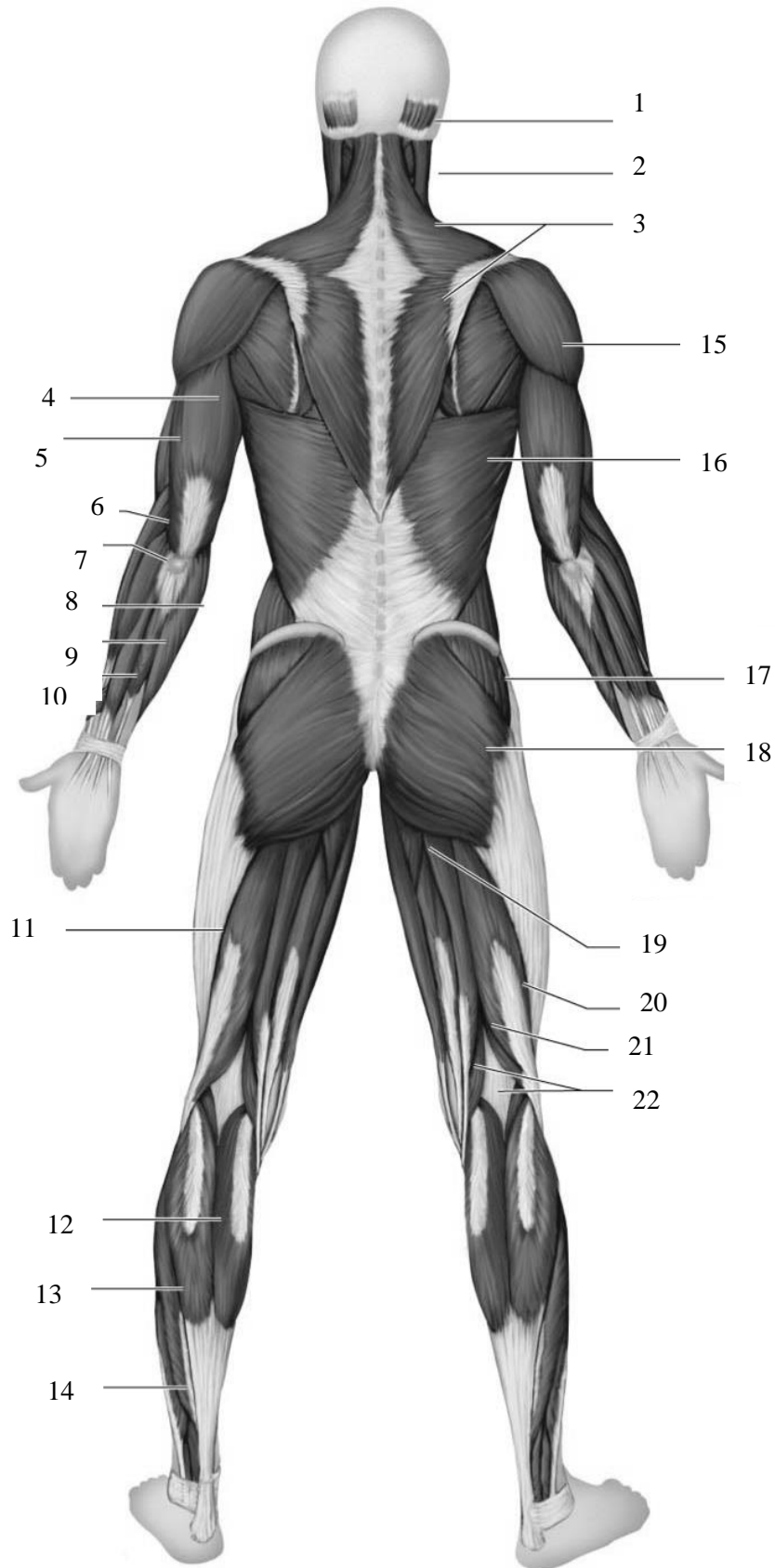
Fibularis longus
Tibialis anterior
Soleus

Extensor digitorum longus
Gastrocnemius

Anterior Muscles: Use the word bank at the end of this packet identify each muscle's name.



Posterior Muscles: Use the word bank at the end of this packet identify each muscle's name.



22. Developmental Aspects of the Muscular System

- a. Embryo development
 - i. Muscular system is laid down in segments
 - ii. Develops early in pregnancy
 - iii. First movements of the fetus, called _____, occur by the _____ week of pregnancy
- b. Infancy
 - i. Initial movements of baby are _____
 - ii. _____ system must mature before baby can control muscles
 - iii. Development proceeds in a _____ (head) to _____ (tail) direction
 - iv. Gross muscular movements _____ fine motor movements
 1. Can raise their heads before they _____
 2. Can sit up before they can _____
 - v. Development also proceeds in a _____ to _____ direction
 1. Can wave bye-bye before can use pincher grasp
- c. As we age
 - i. Amount of connective tissue in muscle _____ while amount of muscle tissue _____
 - ii. Body weight begins to decline in an older person due to loss of _____
 - iii. Muscle strength decreases by _____% by age of 80
 - iv. _____ can rebuild muscle mass and increase strength in older people
- d. Homeostatic Imbalances
 - i. Duchenne's Muscular Dystrophy
 1. Muscle destroying disease that progresses from the extremities _____, with final effects on the head and _____ muscles
 2. Caused by lack of muscle protein called _____ that helps maintain the sarcolemma
 3. Almost exclusively in _____ (a sex-linked genetic disorder)
 4. Diagnosed between ages of 2 – 7
 5. Active normal children become clumsy and fall frequently as muscles _____
 6. Rarely live beyond their 20s
 7. Die of _____ failure
 - ii. Myasthenia Gravis
 1. Rare disease that affects muscles during adulthood, may be an _____ disease
 2. Drooping of upper _____, difficulty swallowing & talking, generalized muscle weakness and fatigue
 3. Shortage of acetylcholine _____ at neuromuscular junctions
 4. Death usually due to _____ failure

You may detach this page when you use it to label the diagrams on pages 20 and 21.

ANTERIOR Muscles Word Bank

Vastus medialis	Brachialis	Trapezius
Fibularis longus	Iliopsoas	Biceps brachii
Tibialis anterior	Deltoid	Temporalis
Soleus	Masseter	Triceps brachii
Sartorius	Vastus lateralis	Rectus femoris
Pectoralis minor	Pectoralis major	Frontalis
Gastrocnemius	Gracilis	Platysma
Extensor digitorum longus	Adductor muscle	Sternocleidomastoid
Zygomaticus	Brachioradialis	Internal oblique
Intercostals	External oblique	Orbicularis oris
Flexor carpi radialis	Orbicularis oculi	Serratus Anterior
Transverse abdominis	Rectus abdominis	

POSTERIOR Word Bank

Trapezius	Semimembranosus	Iliotibial tract
Fibularis longus	Deltoid	Brachialis
Sternocleidomastoid	Triceps brachii	Occipitalis
Gluteus medius	Brachioradialis	Gastrocnemius
Gluteus maximus	Semitendinosus	Soleus
Latissimus dorsi	Extensor digitorum	Biceps femoris
Adductor muscle	Flexor carpi ulnaris	Extensor carpi ulnaris
Extensor carpi radialis longus		