

MUSCLES

I. GENERAL FUNCTIONS OF MUSCLES

The major function of muscle tissue is contraction (the ability to shorten and thus cause movement in the body), and relaxation (the ability to lengthen again and thus be ready to contract again).

II. FUNCTIONAL CHARACTERISTICS OF MUSCLE TISSUE

- A. IRRITABILITY = ability of the muscle cell to respond to a stimulus
- B. CONTRACTILITY = ability of the muscle or muscle cell to contract or shorten
- C. EXTENSIBILITY = ability of the muscle to be stretched beyond its normal length
- D. ELASTICITY = ability of the muscle to resume a normal length after first being stretched out

NOTE: Conductivity occurs in heart muscle only; it is the ability to transmit a nerve impulse through the Purkinje fibers from the right atrium to the left atrium and the right and left ventricles.

III. SPECIFIC FUNCTIONS OF MUSCLES

- A. Aids in locomotion = movement of the whole body from one place to another
- B. Movement of substances within the body
 - 1. Digestive tract
 - a. peristalsis
 - b. churning
 - c. defecation
 - 2. Respiratory tract
 - a. coughing
 - b. sneezing
 - 3. Urinary tract
 - a. peristalsis
 - 4. Reproductive tract
 - a. peristalsis in male and female tracts

b. labor in female's uterus at birth

5. Heart and Blood vessels

- a. systole of heart
 - b. contraction in arterioles increases resistance to blood flow

C. Maintenance of erect body posture

1. Action of extensor groups of muscles

- a. always oppose flexors on front
 - b. keeps body pulled backwards to an upright position

D. Body heat production

1. Heat produced through cellular respiration in muscle cells

NOTE: Heat is a form of energy but it is not used for energy purposes by cells

2. Location of most of heat production: contracting skeletal muscles

IV. TYPES OF MUSCLE TISSUE

There are three kinds of muscle tissue. Each is different from the others in its function, location and cell structure among other things. Study the summary table below:

MEMBRANE EVENTS OF CONTRACTION

I. FACTORS NECESSARY TO HAVE MUSCLE EXCITABILITY

- A. Cell membrane must be semipermeable
- B. High extracellular concentration of sodium ions (Na^+)
 - 1. extracellular sodium ions are 10 times greater than intracellular sodium ions.
- C. High intracellular concentration of potassium ions (K^+)
 - 1. intracellular potassium is 30 times higher than extracellular potassium
- D. Negative intracellular voltage

1. negatively charged protein ions are prevented from exiting muscle cell; combined with the positively charged potassium ions that slowly leak out of the cell, they provide an overall negative charge to the inside of the cell.

4) **SYNAPTIC CLEFT** = space between synaptic end bulb and motor end plate of muscle cell

3) **MOTOR END PLATE** = Portion of sarcolemma in contact with the terminal or synaptic end bulb

MUSCLE CONTRACTION

I. MUSCLES CONTRACT ONLY IF STIMULATED

A. stimulus provided by nerve impulse received from motor unit

Note: Makeup of motor unit = the motor neuron, all of its branches and all the muscle cells that it supplies or innervates

NOTE: All components of the motor unit must be intact in order for the muscle to contract.

ILLUSTRATION: Diagram of some major components of the central and peripheral nervous system; the lower left is a schematic drawing of a myoneural junction.

- a. To perform a voluntary muscular activity, neurons from cerebral cortex send an action potential down their axons in the spinal cord.
- b. The action potential is relayed over other motor neurons that lie in the spinal cord. Their axons carry the action potential to the neuromuscular or myoneural junction, at the muscle.

2. NERVE IMPULSE CAUSES CHANGES AT MYONEURAL JUNCTION

_____ a. Makeup of myoneural or neuromuscular junction

- 1) **MOTOR AXON** = that part of the motor neuron that conducts nerve impulses away from the cell body of the motor neuron in the CNS
- 2) **TERMINAL OR SYNAPTIC END BULB** = ballooned out end of the axon at the place where it meets the muscle cell
- 3) **SYNAPTIC VESICLE** = stores and releases neurotransmitter

3. ACETYLCHOLINE RELEASE

_____ a. action of acetylcholine

b. Acetylcholine makes the muscle cell membrane more permeable to sodium.

4. DEPOLARIZATION OF MUSCLE CELL OCCURS, producing

an "action potential" or charge to the inside of the cell.

a. Events in depolarization

1) Na⁺ moves to inside of cell changing the resting polarity

2) Depolarization causes production of the action potential or "charge" carried along the sarcolemma to the T-Tubules.

Note: As soon as the acetylcholine has initiated an action potential on the sarcolemma, the acetylcholine is destroyed by the enzyme, cholinesterase.

5. PATH OF ACTION POTENTIAL OR "CHARGE"

6. ACTION AT SARCOPLASMIC RETICULUM

7. EFFECTS OF CALCIUM WITHIN SARCOPLASM

a. calcium binds to troponin allowing it to change its shape; this removes the blocking action of tropomyosin and leaves active sites on actin exposed.

a. calcium activates the enzyme needed to breakdown ATP into ADP, + P + ENERGY, thus making available the energy for contraction (sliding of the filaments).

- b. calcium initiates the mechanism that allows the actin filaments to slide across the myosin filaments.

8. HOW SHORTENING OCCURS AT MOLECULAR LEVEL

NOTE: Myosin cross bridges alternately attach to actin and detach, pulling the actin filaments toward the center of the sarcomere. The whole process is powered by the breakdown (hydrolysis) of ATP to ADP plus high energy phosphate.

- a. Sliding of actin towards the center draws the "Z" lines toward each other;
 - 1) sarcomere shortens
 - 2) muscle fiber shortens
 - 3) whole muscle shortens

SEQUENCE OF EVENTS LEADING TO RELAXATION OF MUSCLE. FOLLOWING CONTRACTION

1. Calcium ions actively transported back into sarcoplasmic reticulum.
 - a. Action of Calsequestrin = promotes the calcium pump
2. Lack of calcium ions in cytoplasm stops enzymatic action of myosin.
 - a. No more ATP broken down by ATP-ASE so no energy available for further contraction.
3. Adenosine diphosphate (ADP) is converted back into Adenosine Triphosphate (ATP)
4. Once the Ca^{++} is gone from the filaments and the ATP is regenerated, the actin and myosin slide apart and the sarcomere lengthen again. When this happens throughout the muscle cell, the muscle cell is said to relax (regain its resting length).

NOTE: Troponin-tropomyosin binding reoccurs. Remember that calcium normally unbinds the Troponin-tropomyosin complex.

III. MUSCLE CELLS CONTRACT ACCORDING TO THE "ALL OR NONE" LAW

A. Principle

1. Muscle **cells** will contract with all force possible or they won't contract at all.
2. Law implies that the "charge" will reach all sarcomeres at the same time allowing each sarcomere to contract uniformly and completely with no delay in firing.
 - a. **NOTE:** Since t-tubules are really extensions of the cell membrane, they carry charge produced at cell membrane down to the individual sarcomeres all at the same time.

III. THE GROSS MUSCLE CONTRACTS ACCORDING TO THE "GRADED STRENGTH" PRINCIPLE

NOTE: Same as "summation of motor units", i.e., the greater the number of motor units acting, the greater is the amount of muscle tissue contraction.

A. Factors affecting strength of muscle tissue contraction.

1. **Tension and the initial length** of the muscle filaments.

NOTE: TENSION = force used to overcome resistance or load; It is produced by two forces -- the contracting force and the stretching force, applied in opposite directions.

- a. A muscle fiber develops its greatest tension when there is maximal overlap between the thick and thin myofilaments since it provides for the greatest number of cross-bridge attachments.

2. **Load (or resistance to be moved)**

- a. Slight load increases tension and makes contraction stronger.

NOTE: Muscles contract stronger when more tension is present

3. Number of fibers actually stimulated.

- a. The greater the number of fibers contracting, the greater the force of contraction.
- b. This explains why you can blink your eyes so gently that you can hardly feel them closing most of the time, but if you want to you can shut them so tightly that another person could not pry them open.

4. Metabolic conditions of the muscle fibers

- a. adequate food supply via glucose
- b. adequate oxygen supply
 - 1) importance of myoglobin = stores oxygen for ready use by muscle about to contract
 - 2) Note that disease situations can harm oxygen delivery

- i.e.
- c. poor circulation can cause problems,
 - 1) *atherosclerosis* = condition in which blood vessel lumens become narrowed due to build up of fatty plaques; when vessels narrowed, less oxygen reaches tissues including muscle tissue
 - 2) *anemia* = deficiency of oxygen carrying capacity by the blood; usually due to lack of hemoglobin or iron in red blood cells

IV. MUSCLES PRODUCE MOVEMENT BY PULLING ON BONES

NOTE: Action always occurs over joints and on the more distal bone, or the bone farthest away from the point of reference.

A. Examples

NOTE: Remember, muscles don't move joints but rather the bone or part distal to the joint over which the muscle acts.

V. MUSCLES THAT MOVE A PARTICULAR BONE DO NOT LIE OVER THE BONE MOVED.

- A. Examples - body or belly of the muscle lies proximal to the bone that is moved.
 1. Body of Biceps brachii lies over anterior surface of upper arm but moves the forearm.
 2. Body of Quadriceps femoris lies over anterior surface of thigh but moves the leg.
 3. Body of Latissimus dorsi lies over the lower back but moves the upper arm.

VI. MUSCLES ALMOST ALWAYS ACT IN GROUPS RATHER THAN INDIVIDUALLY

A. **AGONIST** or **PRIME MOVER** = muscle whose contraction produces the actual movement referred to.

1. Examples
 - a. Biceps brachii is prime mover for flexing the forearm.
 - b. Quadriceps femoris is agonist for extension of the leg.

2. **NOTE:** Every muscle is a prime mover for some action

B. **SYNERGIST** = muscle contracting at the same time as the prime mover and aids its action.

1. Examples
 - a. Brachialis and Brachioradialis are synergists to the Biceps brachii for flexion of the forearm.
 - b. Soleus and Tibialis posterior are synergists to the Gastrocnemius for plantar flexion of the foot

C. **ANTAGONIST** = muscle with an action opposite to the prime mover; it relaxes and stretches as the prime mover contracts.

1. Example

- a. Triceps brachii is the antagonist of biceps brachii because it relaxes and stretches when the biceps contracts.
- b. Hamstrings are antagonist of quadriceps femoris because it relaxes and stretches when the quadriceps contract.

D. **FIXATION** = When both the prime mover (agonist) and the antagonist contract at the same time and with equal force, then the opposite actions neutralize each other and no additional movement occurs.

1. At this point, the prime movers and antagonists are together acting as **"FIXATOR MUSCLES"**.

_____ 2. Stretch of opposing muscle increases tension greatly, and produces an **isometric contraction**. Energy is used up, but no work or movement is performed.

TYPES OF MUSCLE CONTRACTION

I. **TWITCH CONTRACTION** = the mechanical response of a muscle to a single action potential or nerve impulse.

ILLUSTRATION Myogram of a twitch contraction

- A. **LATENT PERIOD** - TIME during which depolarization and repolarization are occurring just before actual contraction.
- B. **CONTRACTION PERIOD** = TIME during which muscle actually shortens.
- C. **RELAXATION PERIOD** = TIME during which muscle relaxes and regains original length.

- a. phases of twitch contraction may vary with type of muscle, being shortest in muscles with least branching of the motor units.

- 1) Examples: shortest in rectus muscles of eyes and muscles that move the fingers

II. **WAVE SUMMATION** = when two stimuli are applied and the second stimulus is delayed until after refractory period of the first but before muscle relaxes, the second contraction will be stronger than the first.

NOTE: muscle still responds to both stimuli

ILLUSTRATION Myogram of summation of twitches.

A. Height of second twitch is added or summed with height of first twitch.

B. **INCOMPLETE or UNFUSED TETANUS** = a sustained contraction with some relaxation between ever increasing stimuli

A. **COMPLETE or FUSED TETANUS** = when the frequency of stimulations becomes so great that successive twitch contractions show no relaxation phase, then the peaks fuse together and cannot be distinguished from one another.

ILLUSTRATION Myogram of (a) incomplete and (b) complete tetanus.

NOTE: Tetanus represents a typical contraction, for example, a very smooth movement when skeletal muscles contract.

III. **TREPPE** - condition in which a skeletal muscle contracts more forcefully in response to the same strength of stimulus.

NOTE: rate of stimulation not fast enough to produce tetanus.

ILLUSTRATION Myogram of a treppe contraction. Each contraction is slightly stronger than the prior one. Notice that the muscle relaxes completely between successive contractions.

A. Result:

1. Muscle contracts more forcefully in response to same stimulus.

- a. Response due to increased availability of calcium ions in the sarcomere to relieve tropomyosin - troponin inhibition of actin.

IV. **ISOTONIC CONTRACTIONS** = a muscle shortens and moves a load

A. Characteristics of isotonic contractions

1. The length of the muscle changes (so that a bone can be lifted) but the tension or tightness (tone) within the muscle stays

the SAME, thus ISOTONIC = same tone.

2. Represents typical tetanus type muscle contraction.

decreases oxygen delivery to the blood

3. **lack of food sources**, for example, glucose, to the muscle

V. **ISOMETRIC CONTRACTION** = muscle develops considerable tension but no movement of the load occurs

a. *hypoglycemia* = very low blood glucose levels

A. Characteristics

1. Occurs when muscle supports a load in a fixed position or attempts to move a load that is greater than the tension (contraction force) developed by the muscle.

b. *diabetes mellitus* = inability to get glucose into the cells

c. *starvation* or prolonged fasting = decreases all food supply, including glucose, to the tissues

NOTE: ISOMETRIC contractions occur if both ends of the muscle are tied down and it is stimulated, the length of the muscle can NOT change (same length = isometric) but the tension tightness, or tone of the muscle, increases.

TONUS

Ex: When you hold a heavy book or just hold your body upright without moving, you are doing isometric contractions.

I. **DEFINITION** = continuous state of partial contraction of muscle due to stretch of antagonistic muscles.

A. Example of stretch reflex producing tonus (using Biceps muscle)

VI. **FATIGUE** = lack of excitability in a muscle

NOTE: When muscle tension declines even though nerve impulses (innervations) are still being supplied to the muscle, fatigue sets in and contraction stops.

1. Agonist (Biceps brachii) contracts to flex the forearm.

2. Stretch receptors in antagonist (Triceps brachii) are stimulated.

3. Nerve impulse produced in stretch receptors (or proprioceptors).

4. Impulse passes over sensory nerves to spinal cord and then to cerebellum of brain (latter not shown in illustration above).

A. Characteristics of fatigue

1. **Lack of resynthesis of ATP** following muscle contraction.

5. Cerebellum interprets signal and relays it to cerebral cortex;

2. **Lack of oxygen** availability to the muscle, for example, due to:

6. Cerebral cortex sends out impulses over motor neurons down the brainstem to the cerebellum.

a. *anemia* = decreased oxygen supply because of blood oxygen insufficiency

7. Cerebellum sends out motor impulses down brainstem to spinal cord and then to the stretched muscle (triceps brachii).

b. *hypoxia* = decreased in oxygen to the tissues (muscles)

8. Triceps contracts, extending the forearm, and overcoming the stretch. Only a small number of fibers in the triceps contract.

c. at temporary *high altitudes* (low atmospheric pressure)

B. Importance of Tonus

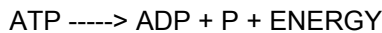
d. *pneumonia* = inflammation of alveoli of the lung where oxygen is picked up by the blood; pneumonia

1. It gives the muscle slight tension, and tautness.

- It provides for a better overall contraction when an appropriate stimulus is present.
 - It aids the movement of blood through the body.
- MUSCLE METABOLISM

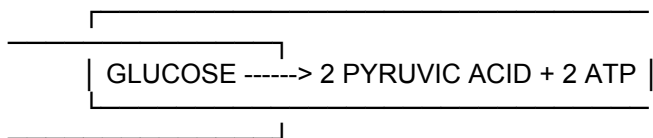
I. ENERGY PRODUCTION FOR AND BY SKELETAL MUSCLES

- A. For the work of muscle contraction to occur, energy is needed. This energy comes directly from the breakdown of ATP, the energy storage molecule of living cells.



The energy stored in ATP comes originally from glucose that is ingested. Recall, when glucose is ingested and not all of it is needed at the moment by the body, the excess glucose can be stored as a large molecule, glycogen. Glycogen is simply a long chain of glucose molecules linked together, to store the glucose. During muscle contraction, the glycogen can be broken down again into glucose, which in turn, is broken down further to yield energy.

- B. If glucose needed for energy then:

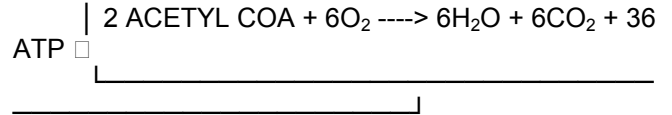
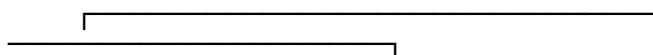


NOTE: This is called "anaerobic glycolysis".

- Regardless of the amount of oxygen available, glucose is first broken down into molecules of pyruvic acid (which are essentially two half glucose molecules) - this produces enough energy to make two ATP molecules.

NOTE: Anaerobic respiration used in SHORT bursts of exercise, since not enough oxygen available, thus individual fatigues faster as lactic acid accumulates.

- C. Next, Pyruvic acid broken down to acetylcoenzymeA A with the following results:



- This is aerobic respiration.
- If there is a shortage of oxygen, the pyruvic acid will be converted into lactic acid and no more ATP can be produced. If there is lots of oxygen present, the pyruvic acid will enter into the mitochondria and be broken down further into carbon dioxide (CO₂) and water (H₂O) with the production of a total of 38 ATP.

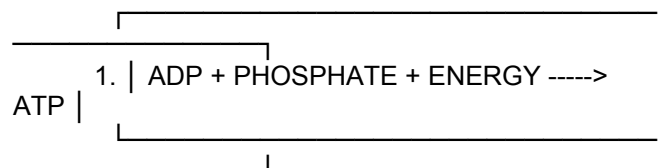
NOTE: Aerobic respiration is used mainly in long term exercise, such as running, brisk walking, or jogging.

NOTE: Myoglobin (modified hemoglobin) present in skeletal muscles; used to hold on to oxygen and make it readily available for aerobic respiration.

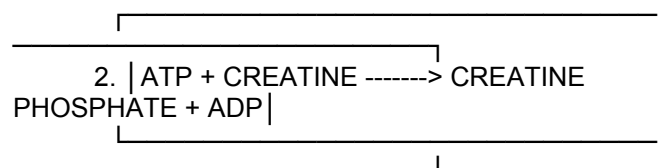
II. PRODUCTION OF ADENOSINE TRIPHOSPHATE (ATP)

During the time that is muscle is resting, it also stores energy as the high energy storage molecule **CREATINE PHOSPHATE**. When energy is needed quickly (before glucose breakdown starts supplying enough energy), creatine phosphate can remake ATP from ADP as follows:

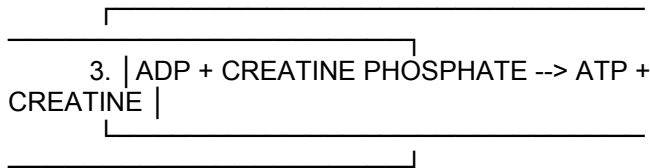
- A. Chemical reactions in production of ATP and usable energy.



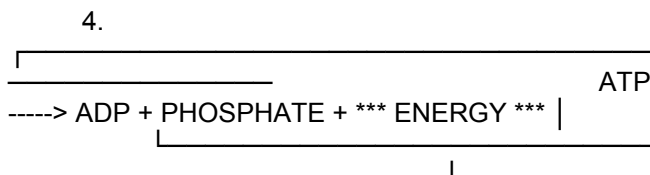
- a. This is normal way to store energy in any cell.



- a. Mechanism to store excess energy via creatine phosphate; provides temporary storage site for energy



- a. This is how creatine phosphate gets incorporated into ATP.



- a. This reaction catalyzed (speeded up) by ATP-ASE, or activated myosin.

NOTE: This is only way usable energy can be gotten in glycolysis

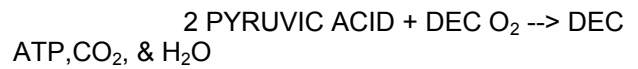
- b. Energy used for following:

- 1) to allow actin to slide across myosin in a ratchet-like movement.
- 2) sodium pump = used to provide resting conditions in muscle cell so it can again be depolarized leading to additional contractions
- 3) calcium pump = used to get calcium back into sarcoplasmic reticulum following contraction
- 4) ADP build up to ATP again

III. OXYGEN DEBT (Also see summary at end of this sequence of events)

- A. Sequence of events in production of an "oxygen debt".

1. "Stimulus" = Strenuous exercise
2. Oxygen is used up faster than rebreathing can replenish it.
3. Muscles cells are deprived of oxygen.
4. Aerobic respiration slowed down since it is dependent on oxygen.



- a. Pyruvic acid accumulates as less of it is oxidized.

- b. Lactic acid accumulation causes the pain of "fatigue" in muscle in oxygen debt.

5. Amount of oxygen needed to burn up the excess lactic acid is called the OXYGEN DEBT.

6. If exercise is continued anyway, muscle fatigue will result making contraction almost impossible. **Fatigue** is due to lack of ATP and the accumulation of lactic acid which changes the normal environment of the cell enough that the enzymes that break down glucose cannot work very fast, thus energy collects too slowly to do a contraction.

SUMMARY OF PRODUCTION OF OXYGEN DEBT:

As you can see, with oxygen (O₂) present, glucose can be broken down completely to produce lots of ATP to be used as source of energy to do muscle contraction. But, in the absence of O₂, glucose can only be broken in half with the release of only enough energy to produce a few ATP. Thus, when O₂ is insufficient, the amount of muscle contraction is limited. The lactic acid present in this case collects in the muscle. Some of it can then be transported via the blood to the liver to be resynthesized into glucose. The rest of it stays in the muscle causing discomfort until enough O₂ is supplied to allow it to enter the mitochondria. **THE AMOUNT OF O₂ NEEDED TO REACT WITH THE LACTIC ACID ACCUMULATED IN THE MUSCLE IS CALLED THE OXYGEN DEBT.** The oxygen debt must be repaid before strenuous exercise can be resumed - that is why we have to stop to catch our breath.

PATHOLOGY OF MUSCLES

- I. **PARALYSIS** = lack of contraction due to disruption of some part of the motor unit.

- A. Diseases with paralysis

1. **MYASTHENIA GRAVIS** - type of autoimmune disease

- a. disease due to blockage of acetylcholine over the myoneural junction.
- b. Antibodies occupy receptor sites reserved for acetylcholine.
- c. Result = acetylcholine cannot enlarge pores in muscle cell membrane and depolarization leading to contraction cannot occur.

2. **MUSCULAR DYSTROPHY**

- a. disease due to degeneration of individual muscle cells.
- b. Fat deposits between muscle cells.
- c. Muscle fibers atrophy.
- d. Cause = lack of Dystrophin
 - 1) Frequent tears in muscle, due to stretch, is ordinarily repaired by dystrophin. In its absence, injury and scar tissue formation occurs. When it affects the heart muscle, death occurs.

II. **OTHER MUSCULAR DISORDERS**

A. **SPASM** = sudden, involuntary and painful muscle contraction

B. **TIC** = an involuntary, brief and recurrent twitching of a group of muscles, usually involving the face, neck and feet.

C. **CONVULSIONS** = a violent, involuntary muscle contraction, or a series of contractions producing jerky movements, and often life-threatening conditions.

1. Examples

- a. Epileptic seizures
- b. Hypoglycemic shock

D. **CRAMP** = a sudden, involuntary, complete tetanic muscular contraction causing severe pain and temporary paralysis, often occurring in the leg or shoulder as the result of a strain or a pull.

E. **CHARLEY HORSE** = a cramp or stiffness of various muscles in the body, especially in the arm or leg, caused by injury or excessive exertion.

F. **TETANUS** = a disease of the nervous system that produces spasms and painful convulsions of skeletal muscles. It is caused by a bacterial exotoxin.

G. **FIBRILLATIONS** = the rapid contraction of individual myofibrils of a muscle cell; it usually occurs in a muscle deprived of oxygen and produces no movement.

NOTE: In myocardial ischemia, blood flow to heart muscle is severely reduced causing a lack of oxygen; fibrillations of heart muscle ensue.

H. **TREMOR** = a trembling or quivering of muscles.

I. **HYPERTROPHY** = increase in bulk of the muscle without increase in number of muscle fibers.

J. **ATROPHY** = decrease in bulk of the muscle without decrease in the number of muscle fibers.

K. **FLACCID MUSCLE** = muscles are weak and soft. In most cases, the motor units continue to function but they do not operate with a good degree of coordination.

Exercise: do not do the joints one we covered them in bone.

11. Which of these is not characteristic of a synovial joint?

- a. articular cartilage
- b. epiphyseal cartilage
- c. synovial membrane
- d. fibrous capsule

12. Which of these is not an angular movement?

- a. flexion
- b. abduction
- c. rotation
- d. hyperextension

13. The movement of the sole of the foot laterally is called

- a. inversion
- b. protraction
- c. eversion
- d. retraction

14. The ability of muscle tissue to receive and respond to a stimulus is referred to as

- a. contractility b. excitability c. elasticity d. extensibility
15. Which of the following groupings is incorrect?
- a. skeletal, striated, voluntary b. smooth, unstriated, involuntary
- c. cardiac, striated, voluntary d. cardiac, striated, involuntary
16. The connective tissue component of a skeletal muscle that surrounds fasciculi is called the
- a. perimysium b. epimysium c. endomysium d. tendomysium
17. The ability of a muscle to return to its original shape after contraction or extension is called
- a. extensibility b. elasticity c. contractility d. excitability
18. The layer of fibrous connective tissue that covers the entire muscle is the
- a. endomysium b. perimysium c. epimysium d. sarcolemma
19. A muscle in a group that performs the desired action is referred to as the
- a. antagonist b. synergist c. fixator d. agonist
20. An injection into the lateral side of the thigh is given in which muscle?
- a. adductor longus b. peroneus longus c. vastus lateralis d. deltoid

Answers: 11-b, 12-c, 13-c, 14-b, 15-c, 16-a, 17-b, 18-c, 19-d, 20-c

21. Because the biceps brachii muscle flexes the forearm when it contracts, most of the muscle lies
- a. anterior to the humerus b. posterior to the humerus c. anterior to the ulna and radius
- d. posterior to the ulna and radius
22. The trapezius muscle is named on the basis of
- a. shape b. size c. location d. action
23. The muscle that turns the palm upward or anterior is the

- a. tibialis anterior b. plantaris c. adductor longus d. supinator
24. The facial muscle that is used to wrinkle the forehead is the
- a. orbicularis oculi b. frontalis c. temporalis d. masseter
25. A major muscle used to abduct the arm is the
- a. teres minor b. teres major c. pectoralis major d. deltoid
26. All of the following are flexors of the leg except the
- a. biceps femoris b. rectus femoris c. semitendinosus d. semimembranosus
27. All of the following flex the forearm except the
- a. brachialis b. brachioradialis c. biceps brachii d. triceps brachii
28. The latissimus dorsi, triceps brachii, and sacrospinalis all
- a. are located on the posterior surface of the body
- b. serve as extensors of some part of the body
- c. serve as extensors of one part but flexors of another
- d. none of the above
- e. both a and b
29. Which movements are possible at both the shoulder and elbow joint?
- a. abduction and flexion b. circumduction and flexion c. abduction, circumduction and flexion
- d. extension and flexion
30. Which is not a diarthrotic type of joint?
- a. between vertebral articular processes b. intercarpal c. distal tibio-fibular joint d. elbow
- e. all are diarthrotic

Answers: 21-a, 22-a, 23-d, 24-b, 25-d, 26-b, 27-d, 28-e, 29-d, 30-c

31. A muscle that originates on both the spine of the scapula and the clavicle is the

a. pectoralis major b. trapezius c. deltoid d. sternocleidomastoid

32. The functional relationship between the tibialis anterior and the soleus is comparable to that between

the:

a. deltoid and biceps brachii b. pectoralis major and serratus anterior

c. pectoralis major and trapezius d. sternocleidomastoid and semispinalis

33. Which of the following is a functional joint classification?

a. fibrous b. synarthrosis c. synovial d. cartilaginous

34. A joint cavity is present in

a. fibrous joints b. amphiarthrotic joints c. cartilaginous joints d. synovial joints

35. Motion that increases the joint angle anteriorly is

a. abduction b. extension c. eversion d. flexion

36. Structurally, diarthroses are

a. fibrous joints b. synovial joints c. cartilaginous joints d. slightly movable

37. The circular, conelike movement of a body segment is

a. rotation b. pronation c. circumduction d. eversion

38. Which of the following is not characteristic of all diarthroses?

a. articular surfaces of hyaline cartilage b. joint capsule c. synovial membrane d. meniscus

39. In the cervical region all of the following movements are possible except

a. flexion b. hyperextension c. dorsiflexion d. lateral rotation

40. Which of the following joints can be readily and comfortably hyperextended?

a. tibiofemoral b. interphalangeal c. atlantooccipital d. elbow

Answers: 31-c, 32-d, 33-b, 34-d, 35-b, 36-b, 37-c, 38-d, 39-c, 40-c

41. Which of the following word pairs is incorrect?

a. syndesmosis - synarthrosis b. pivot - diarthrosis

c. symphysis - amphiarthrosis d. suture - synarthrosis

42. Which of the following is an agonist along with the supinator of the forearm?

a. brachioradialis b. flexor carpi radialis c. brachialis d. biceps brachii

43. Contraction of which of the following muscles would never result in an extension movement?

a. sacrospinalis b. biceps femoris c. rectus abdominis d. latissimus dorsi

44. The muscle tissue that can be consciously controlled is

a. smooth b. skeletal c. intercalated d. cardiac

45. Cardiac muscle is found in the wall of the

a. stomach b. intestine c. urinary bladder d. none of the above

46. The innermost layer of connective tissue in a skeletal muscle is called the

a. epimysium b. perimysium c. endomysium d. sarcomysium

47. Intercalated discs are found in

a. cardiac muscle b. smooth muscle c. skeletal muscle d. a and c

48. Which of the following is under voluntary control?

a. skeletal muscle b. smooth muscle c. cardiac muscle d. a and c

49. Which of the following connective tissues is in direct contact with individual skeletal muscle fibers?

a. periosteum b. epimysium c. perimysium d. endomysium

50. The extensor carpi ulnaris contracts to

- a. supinate the forearm
- b. flex the thumb
- c. extend the arm
- d. adduct the hand

Answers: 41-a, 42-d, 43-c, 44-b, 45-d, 46-c, 47-a, 48-a, 49-d, 50-d

51. The latissimus dorsi originates primarily on the

- a. humerus
- b. linea alba
- c. vertebral column
- d. clavicle

52. Which pair of muscles would not function as antagonists to one another?

- a. biceps brachii and triceps brachii
- b. anterior deltoid and latissimus dorsi

- c. rectus abdominis and sacrospinalis
- d. biceps femoris and gastrocnemius

53. Which of the following is not a rotator cuff muscle?

- a. supraspinatus
- b. subscapularis
- c. teres minor
- d. deltoid

54. Which one of the following is located entirely or mostly on the posterior surface of some part of the

body?

- a. biceps brachii
- b. external oblique
- c. triceps brachii
- d. quadriceps femoris

55. Paralysis of which of the following would make an individual unable to flex his thigh?

- a. iliopsoas
- b. biceps femoris
- c. semitendinosus
- d. vastus medialis

56. Paralysis of which of the following muscles would make an individual unable to flex his leg?

- a. gastrocnemius
- b. soleus
- c. rectus femoris
- d. gluteus medius

57. An injection in the rump would be given in which muscle?

- a. gluteus medius
- b. tensor fascia latae
- c. gluteus minimus
- d. gluteus maximus

58. A pulled hamstring would include which muscle?

- a. semitendinosus
- b. rectus femoris
- c. iliopsoas
- d. vastus medialis

59. Which muscle elevates the ribs?

- a. serratus anterior
- b. pectoralis minor
- c. scalene
- d. transversus thoracis

60. Which muscle is a synergist in adduction of the arm?

- a. pectoralis major
- b. deltoid
- c. supraspinatus
- d. rhomboid

Answers: 51-c, 52-d, 53-d, 54-c, 55-a, 56-a, 57-d, 58-a, 59-c, 60-d

71. The shoulder joint is

- a. triaxial
- b. ball and socket
- c. synovial
- d. all of the above

72. Which joint would not allow circumduction?

- a. metacarpal/phalangeal II
- b. radioulnar/carpals
- c. carpometacarpal of the thumb
- d. interphalangeal

73. Which muscle could elevate the ribs as well as flex the neck?

- a. sternocleidomastoid
- b. scalene
- c. splenius
- d. semispinalis

74. Which muscle is an antagonist to the action(s) provided by the pectoralis major?

- a. pectoralis minor
- b. subscapularis
- c. serratus anterior
- d. supraspinatus

75. Which muscle is not a rotator of the arm?

- a. subscapularis
- b. infraspinatus
- c. supraspinatus
- d. latissimus dorsi

76. Which muscle is not superficial in the body, seen just below the skin?

- a. latissimus dorsi
- b. gastrocnemius
- c. internal oblique
- d. pectoralis major

77. A sphincter muscle includes the

- a. temporalis
- b. platysma
- c. occipitofrontalis
- d. orbicularis oculi

78. Which action(s) does the soleus and gastrocnemius have in common?

- a. plantar flexion of the foot
- b. dorsiflexion of the foot
- c. flexion of the leg
- d. a and c

79. Which muscle is involved in chewing?

- a. temporalis
- b. orbicularis oculi
- c. occipitofrontalis
- d. sternocleidomastoid

80. Which of the following characterizes all cartilaginous joints?

- a. contain plates of hyaline cartilage
- b. lack joint cavities
- c. are immovable
- d. all of the above do

Answers: 71-d, 72-d, 73-b, 74-d, 75-c, 76-c, 77-d, 78-a, 79-a, 80-b

81. When the movement at a joint is limited to rotation around only one axis, the joint is said to be

- a. uniaxial
- b. biaxial
- c. nonaxial
- d. amphiarthrotic

82. Which of the following tends to form septa within the skeletal muscle, to reinforce the muscle?

- a. fasciculus
- b. epimysium
- c. perimysium
- d. endomysium

83. Which action(s) would the brachialis and biceps brachii have in common?

- a. supination of the forearm
- b. flexion of the arm
- c. flexion of the forearm
- d. a and c

84. Which action occurs for the rectus femoris but not the vastus muscles?

- a. extension of the thigh
- b. extension of the leg
- c. flexion of the thigh
- d. flexion of the leg

85. If a pin enters a skeletal muscle, which of the following layers would be encountered secondly?

- a. deep fascia
- b. endomysium
- c. perimysium
- d. epimysium

86. Which muscle name indicates the relative size of the muscle in its name?

- a. transversus abdominis
- b. pectoralis major
- c. trapezius
- d. sartorius

87. Which muscle might act as a synergist in plantar flexion of the foot?

- a. tibialis anterior
- b. quadriceps femoris
- c. flexor digitorum longus
- d. extensor digitorum longus

88. Which muscle name indicates the shape of the muscle?

- a. gluteus maximus
- b. rectus abdominis
- c. rhomboid
- d. biceps brachii

89. All synovial joints possess all of the following features except:

- a. articular cartilage
- b. a joint capsule
- c. a synovial membrane
- d. an articular disc

90. Flexion and extension movements at the wrist take place at

- a. the joint between radius and ulna and the proximal row of carpals

- b. the joint between the proximal and distal rows of carpals

- c. the joints between carpals and metacarpals

- d. the joint between the distal radius and distal ulna

Answers: 81-a, 82-b, 83-c, 84-c, 85-d, 86-b, 87-b, 88-c, 89-d, 90-a

91. Which of the following would not be under the control of the autonomic nervous system?

- a. iris of the eye
- b. muscular layer of the uterus
- c. muscular layer of the pharynx

- d. muscular layer of a small artery

92. Which muscle is an agonist for adduction of the arm?

- a. pectoralis major
- b. pectoralis minor
- c. teres minor
- d. supraspinatus

93. Which muscle does not form part of the abdominal wall musculature?

- a. external oblique
- b. rectus abdominis
- c. transversus abdominis
- d. transversus thoracis

94. Which muscle is not a hamstring?

- a. semitendinosus
- b. gastrocnemius
- c. biceps femoris
- d. semimembranosus

95. The agonist for jaw closure is the

- a. platysma
- b. sternocleidomastoid
- c. masseter
- d. orbicularis oris

96. Which muscle moves the ribs?

a. diaphragm b. serratus anterior c. serratus posterior inferior d. splenius

97. Which of the following is not a fibrous joint?

a. suture b. syndesmosis c. synchondrosis d. interosseus membrane

98. Which muscle is not involved in a medial or lateral rotational movement within the forearm?

a. supinator b. biceps brachii c. pronator teres d. palmaris longus

99. Which of the following is not a synovial joint?

a. odontoid process and atlas b. between vertebral articular facets

c. joint between bodies of two vertebrae d. joint between two tarsals

100. A synergist in abduction of the arm would be

a. rhomboideus b. anterior deltoid c. biceps brachii d. pectoralis major

Answers: 91-c, 92-a, 93-d, 94-b, 95-c, 96-c, 97-c, 98-d, 99-c, 100-a

101. Examples of pivot joints include

a. wrist (distal radius/proximal carpals) b. atlas/dens of axis

c. humerus head/glenoid cavity d. radial head/ulna e. b and d

102. A joint united by dense fibrous tissue that permits a slight degree of movement is a(an)

a. suture b. syndesmosis c. synarthrosis d. amphiarthrosis e. b and d

103. Which types of joint provides triaxial movement?

a. hinge b. ball and socket c. saddle d. condyloid e. none do

104. Which of the following is an example of a hinge joint?

a. elbow b. knee c. interphalangeal d. tibia/talus e. all are

105. Which of the following is an antagonist in flexion of the forearm?

a. biceps brachii b. brachialis c. pronator teres d. coracobrachialis e. none are

106. Which of the following is an example of a diarthrodial joint?

a. knee b. gomphosis c. sagittal suture d. interosseus membrane of radius/ulna e. a and b

107. Which muscle is an antagonist in flexion of the thigh?

a. rectus femoris b. sartorius c. biceps femoris d. vastus intermedius e. b and c

108. Which muscle is involved in moving the vertebral column?

a. scaleni b. sacrospinalis c. sartorius d. diaphragm e. a and b

109. Which of the following movements would be permitted in a saddle joint?

a. medial rotation b. adduction c. circumduction d. all are e. all but a

110. Which muscle might act as synergist during extension of the arm?

a. trapezius b. anterior deltoid c. biceps brachii d. posterior deloid e. a and d

Answers: 101. e, 102. e, 103. b, 104. e, 105. e, 106. a, 107. c, 108. e, 109. e, 110. a

MATCHING. Match muscle on left with action on the right.

- | | |
|------------------------|-----------------------|
| 1. sternocleidomastoid | a. extension of thigh |
| 2. temporalis | b. flexion of head |
| 3. orbicularis oris | c. abduction of arm |

- | | |
|------------------------|--------------------------------|
| 4. rhomboideus | d. close eyelids |
| 5. deltoid | e. flexion of leg |
| 6. brachialis | f. puckers lips |
| 7. supinator | g. flexion of thigh |
| 8. serratus anterior | h. flexion of forearm |
| 9. palmaris longus | i. lateral rotation of forearm |
| 10. adductor femoris | j. elevation of mandible |
| 11. quadriceps femoris | k. retraction of scapula |
| 12. gastrocnemius | l. protraction of scapula |
| 13. gluteus maximus | m. flexion of hand |
| | n. extension of leg |

Answers: 1-b, 2-j, 3-f, 4-k, 5-c, 6-h, 7-i, 8-l, 9-m, 10-g, 11-n, 12-e, 13-a

MATCHING. Match term on left with joint(s) on right.

- | | |
|---------------------|------------------------------|
| 14. synarthrosis | a. carpometacarpal of thumb |
| 15. amphiarthrosis | b. shoulder and hip joints |
| 16. gliding | c. intervertebral discs |
| 17. pivot | d. radiocarpal joint |
| 18. condyloid | e. proximal radioulnar joint |
| 19. ball and socket | f. intertarsal joints |
| | g. suture |
| | h. knee, elbow |

Answers: 14-g, 15-c, 16-f, 17-e, 18-d, 19-b

MATCHING. Match movement term with appropriate description.

- | | |
|---------------------|--|
| 20. flexion | a. arching the back |
| 21. hyperextension | b. moving a limb away from the midline |
| 22. abduction | of the body |
| 23. adduction | c. moving a bone in an anterior- |
| 24. plantar flexion | posterior plane;decreasing the |
| 25. dorsiflexion | angle between the two bones |
| | d. lowering the toe region of the foot |
| | toward the floor |
| | e. raising the toe region of the foot |
| | toward the shin |
| | f. moving the fingers toward the |
| | midline of the hand |

Answers: 20-c, 21-a, 22-b, 23-f, 24-d , 25-e

MATCHING. Match statement on left with muscle tissue on the right.

- | | |
|----------------------------|---------------------------|
| 26. greatest blood supply | a. cardiac muscle |
| 27. striated | b. skeletal muscle |
| 28. intercalated discs | c. smooth muscle |
| 29. tongue muscles | d. more than one of these |
| 30. diaphragm | |
| 31. unstriated | |
| 32. involuntary | |
| 33. many peripheral nuclei | |
| 34. voluntary | |

Answers: 26-a, 27-d, 28-a, 29-b, 30-b, 31-c, 32-d, 33-b, 34-b

TRUE/FALSE

1. In order to move a bone, a muscle must have its origin on that bone.
2. The rectus femoris muscle may function as a flexor of the thigh, trunk, or leg.
3. The sartorius is one of the hamstrings.
4. The hamstring muscles function as leg flexors, as does the gastrocnemius.
5. Muscles of the back (posterior trunk) function as extensors of the trunk.
6. Extensor muscles play a more important part in the maintenance of upright posture than do flexors.
7. The gastrocnemius and the tibialis anterior are examples of antagonists.
8. All diarthroses permit free movement, but not necessarily the same kinds of movements, between
articulating bones.
9. The term synarthroses is another name for synovial joints.
10. A large majority of joints in the body are synovial in type.

Answers: 1-F, 2-F, 3-F, 4-T, 5-T, 6-T, 7-T, 8-T, 9-F, 10-T

11. Most diarthroses are ball and socket type joints.
12. Both the knee joint and the elbow joint are classified as hinge type synovial joints.
13. Cartilaginous joints permit no movement between the articulating bones.
14. The head of the humerus articulates with the acetabulum at the shoulder joint.
15. No diarthroses permit all of the following movements: flexion, extension, abduction, adduction, rotation,
and circumduction.
16. Moving the forearm so as to turn the palm forward, as it is in the anatomical position, is called
supination.
17. The humerus/ulna joint is an example of a fibrous joint.
18. Synovial joints, like fibrous and cartilaginous joints, are classified according to the material that

connects the bones.

19. The temporalis muscle depresses the mandible.

20. The diaphragm has an action on the ribs.

Answers: 11-F, 12-T, 13-F, 14-F, 15-F, 16-T, 17-F, 18-T, 19-F, 20-F

21. Condyloid joints are biaxial.

22. The rectus abdominis muscle flexes the vertebral column.

23. Most joints in the body are diarthroses.

24. All joints in the skull are forms of sutures.

25. Hinge joints are uniaxial.

Answers: 21-T, 22-T, 23-T, 24-F, 25-T

If the second item in each of the following pairs of items is in some way part of the first item, circle the T. Otherwise, circle the F.

1. T F cartilaginous joints

syndesmosis

2. T F cartilaginous joints

symphysis

3. T F fibrous joints

synchondrosis

4. T F diarthrosis

synovial membrane

5. T F diarthrosis

articular cartilage

6. T F synovial joints

sutures

7. T F knee joint

medial and lateral menisci

8. T F symphysis

intervertebral disc

9. T F diarthrosis

pubic symphysis

10. T F synovial joint

articular capsule

11. T F amphiarthrosis

suture

Answers: 1-F, 2-T, 3-F, 4-T, 5-T, 6-F, 7-T, 8-T, 9-F, 10-T, 11-F

FILL IN

1. The band that occurs where two cardiac muscle cells join together is called a (an) _____.

2. A movement of a limb away from the midline is _____.

3. The circular movement of the end of a limb is _____.

4. The more stationary attachment of a muscle is known as the _____.

5. A _____ is a type of synarthrosis found between a diaphysis and an epiphysis at the epiphyseal

plate.

6. _____ are the tough cartilaginous pads located in the knee joint that cushion and guide the

articulating bones.

7. A _____ is a synovial fluid sac located near a joint between muscles or where a tendon passes over a

bone.

8. Intercarpal and intertarsal joints are of the _____ type of diarthrosis.

9. The radiocarpal joint is an example of a _____ type of synovial joint.

10. _____ is a movement that decreases the joint angle on an anteroposterior plane.

Answers: 1-intercalated disc, 2-abduction, 3-circumduction, 4-origin, 5-synchondrosis, 6-menisci,

7-bursa, 8-gliding, 9-condyloid, 10-flexion

11. The quadriceps femoris group inserts on what structure? _____

12. The abdominal muscle running lengthwise along the midventral region is the _____.

13. The skeletal muscle separating the thoracic and abdominopelvic cavities is the _____.

14. _____ muscle tissue is located in the tongue.

15. _____ muscle tissue is located in the wall of the small intestine.

16. The tibialis anterior _____ the foot.

17. A muscle that performs the opposing action in a body movement is called the _____.

18. The main posterior muscle in the arm is the _____.

19. The large superficial muscle in the rump is the _____.

20. The pectoralis minor has what action on the scapula?

Answers: 11-tibial tuberosity, 12-rectus abdominis, 13-diaphragm, 14-skeletal, 15-smooth,

16-dorsiflexes/inverts, 17-antagonist, 18-triceps brachii, 19-gluteus maximus,

20-protraction

21. The insertion of the biceps brachii is the _____.

22. An example of a symphysis joint would be _____.

23. Give an example of a gliding joint. _____

24. The hamstrings all originate from what common structure? _____

25. Name a muscle that extends the trunk. _____

26. Give an action for the platysma muscle. _____

27. The deepest layer of connective tissue of a skeletal muscle is the _____.

28. A bundle of muscle fibers within a skeletal muscle is called the _____.

29. You have just touched your chin to your chest; this is _____ of the neck.

30. Standing on your toes as in ballet requires _____ (movement) of the foot.

Answers: 21-radial tuberosity of the radius, 22-pubic symphysis, 23-intertarsal joint, 24-ischial

tuberosity, 25-sacrospinalis, 26-depression of the corner of the mouth, 27-endomysium,

28-fasciculus, 29-flexion, 30-plantar flexion

31. The superficial calf muscles all insert on what bone? _____

32. Name the muscle used in raising your eyebrows. _____

33. The white, flat tendinous sheet attaching the external oblique to the linea alba is called a(an) _____.

34. The ankle joint is what type of synovial joint? _____

35. Give an action for the posterior deltoid. _____

36. Name a muscle that retracts the scapula. _____

37. When kicking a football, the action of the leg at the knee is _____.

38. The action that moves the distal end of the radius across the ulna, as in criss-crossing the bones, is _____.

39. Raising the arms laterally away from the body is called _____ of the arms.

40. Name a muscle that inserts on the coracoid process. _____

Answers: 31-calcaneus, 32-occipitofrontalis, 33-aponeurosis, 34-hinge, 35-extension of arm,

36-rhomboid, 37-extension, 38-pronation, 39-abduction, 40-pectoralis minor

41. The muscle that inserts on the olecranon process is the _____.

42. Name one head of the quadriceps femoris muscle. _____

43. Give an action for the triceps brachii muscle. _____

44. Name a muscle that elevates the scapula. _____

45. Give an action for the gluteus maximus. _____

46. Name a muscle that abducts the thigh. _____

47. The insertion tendon of what muscle group contains the large sesamoid bone, the patella? _____

48. The common tendon for insertion of the gastrocnemius and soleus is called the _____ tendon.

49. The basic shape of the articular surface in a gliding joint is _____.

50. The inner layer of the articular capsule of a synovial joint is the _____.

Answers: 41-triceps brachii, 42-vastus lateralis, rectus femoris, 43-extension of arm, forearm,

44-levator scapulae, upper trapezius, 45-laterally rotate, extend thigh, 46-gluteus

medius, minimus, 47-quadriceps femoris, 48-calcaneal, 49-flat, 50-synovial membrane