

Muscular System

The Muscles: Each muscle is an organ, comprised of skeletal _____ tissue, several _____ tissue coverings, _____ tissue to cause it to contract, and _____ to nourish it.

Connective Tissue Coverings:

The muscle has several dense connective coverings.

Layers of dense connective tissue, called _____, surround and separate each muscle.

This connective tissue extends beyond the ends of the muscle and gives rise to cord like _____ that are fused to the periosteum of bones.

Sometimes muscles are connected to each other by broad sheets of connective tissue called _____.

Under the outer layer another layer of connective tissue around each whole muscle is called the _____.

The _____ surrounds individual bundles of fibers called _____ within each muscle.

Each muscle cell (fiber) is covered by a connective tissue layer called _____.

Study Analogy

Pretend you are going to play a joke on someone and give them 100 pencils. The pencils will represent muscle fibers. First you wrap each individual pencil in tissue paper (dense tissue paper of course!). This would be endomysium. Then you take about 10 pencils in a bundle (a fascicle) and wrap them in paper (Perimysium). Then you take all the bundles and wrap them in gift wrap (epimysium). But you are going to mail this joke, so you also have to wrap it in brown paper representing the fascia.

Skeletal Muscle Fibers Structure:

The muscle fiber membrane is called the _____ which contains the cytoplasm called _____.

Within the sarcoplasm are many perpendicular _____ composed of smaller filaments called _____.

These myofilaments are actually two types of filaments, a thicker filament composed of the protein _____ and a thinner mostly made of the protein _____.

The dark stripes are called _____ bands and the light bands are called _____.

A _____ is defined as a unit extending from one _____ line to the next (center of the light band).

T tubules = transverse tubules. Where are they located?

Are they open or closed to the outside?

What other tubular structure are they associated with?

What ion does this other tubular structure contain?

Neuromuscular Interaction:

Neuromuscular junction: The site where the motor neuron and muscle fiber meet is the neuromuscular junction.

The muscle fiber membrane forms a _____ in which the sarcolemma is tightly folded and where nuclei and mitochondria are abundant.

acetylcholine – neurotransmitter released from the _____ of the neuron.

Acetylcholinesterase – what is its function?

Where is it found?

Motor unit: A _____ neuron and the muscle _____ it controls make up a motor unit; when stimulated to do so, the muscle fibers of the motor unit contract all at once.

Skeletal Muscle Contraction:

Muscle contraction involves several components that result in the shortening of sarcomeres, and the pulling of the muscle against its attachments.

- The protein _____ consists of two twisted strands with globular cross-bridges projected outward along the strands.
- _____ is a globular protein with myosin binding sites. What two proteins are associated with it?
- According to the sliding filament theory of muscle contraction, if allowed to, the myosin crossbridge attaches to the binding site on the actin filament and bends, pulling on the actin filament; it then releases and attaches to the next binding site on the actin, pulling again. What is preventing this from happening continuously?
- Energy from the conversion of ATP to ADP is provided to the cross-bridges from the enzyme ATPase, causing them to be in a “cocked” position.

Stimulus for Contraction

- The motor neuron must release the neurotransmitter _____ from its synaptic _____ into the _____ cleft in order to initiate a muscle contraction.
- Protein receptors in the motor end plate detect the neurotransmitters, and a muscle impulse spreads over the surface of the sarcolemma and into the _____ tubules, where it reaches the _____ reticulum.
- Upon receipt of the muscle impulse, the sarcoplasmic reticulum releases its stored _____ to the sarcoplasm of the muscle fiber.
- The high concentration of calcium in the sarcoplasm interacts with the _____ and _____ molecules, which move aside, exposing the myosin binding sites on the actin filaments.
- Myosin _____ now bind and pull on the _____ filaments, causing the _____ to shorten.
- After the nervous impulse has been received, the enzyme _____ rapidly decomposes the acetylcholine.
- Then, calcium is returned to the sarcoplasmic reticulum, and the linkages between myosin and actin are broken.

Study Analogy: Think of a very familiar love story. The actin and myosin are in love and would love to bind (keep it clean, think kiss). However, the actin is being guarded by the troponin and tropomyosin (T-T complex), perhaps they are her parents or guardians? But someone is looking out for the love birds, maybe a fairy godmother? They send a messenger in the form of a nerve impulse. This messenger isn't someone allowed in the house, so they send a second messenger (acetylcholinesterase) by way of the trusty T-tubules. This messenger releases a distracter (aka calcium). Pretend this is a belly dancer or someone from Publisher's clearing house or some other such distraction. While the T-T complex is so occupied, actin and myosin are free to bind. Of course this takes a lot of energy (who said love was easy?) But the messenger has only been paid for so long (destroyed by acetylcholinesterase) and the distracter can only dance (or whatever) for so long and has to leave. (calcium returns to sarcoplasmic reticulum). Thus the linkages are broken and they cannot live happily every after. But wait, another impulse may come along at any time!

Energy Sources for Contraction:

ATP: Energy for contraction comes from molecules of ATP.

This chemical is in limited supply and so must often be regenerated.

Creatine phosphate - As ATP decomposes, the energy from creatine phosphate can be transferred to ADP molecules, converting them back to ATP.

Cellular respiration: The early phase of cellular respiration yields few molecules of ATP, so muscle has a high requirement for oxygen, which enables the complete breakdown of glucose in the mitochondria

The pigment _____ stores oxygen in muscle tissue.

What happens to respiration rate during exercise?

Oxygen debt:

Oxygen deficiency may develop during strenuous exercise,

and _____ acid accumulates as an end product of anaerobic respiration.

This acid diffuses out of muscle cells and is carried in the bloodstream to the liver.

Oxygen debt refers to the amount of oxygen that liver cells require to convert the accumulated lactic acid into glucose, plus the amount that muscle cells need to resynthesize ATP and creatine phosphate to their original concentrations.

Repaying oxygen debt may take several hours.

When a muscle loses its ability to contract during strenuous exercise, it is referred to as _____.

This usually arises from the accumulation of lactic acid in the muscle causing a lowered _____.

A muscle _____ occurs due to a lack of ATP required to return calcium ions back to the sarcoplasmic reticulum so muscle fibers can relax.

Heat: Why does muscle contraction cause so much heat?

Muscle Responses:

A muscle fiber remains unresponsive to stimulation unless the stimulus is of a certain strength, called the _____.

When a muscle fiber contracts, it contracts to its full extent, it cannot contract partially.

This is called the _____ response.

Muscle twitch: A single, short contraction involving only a few motor units is referred to as a twitch. Is this considered a very useful contraction?

A muscle fiber receiving a series of stimuli of increasing frequency reaches a point when it is unable to relax completely and the force of individual twitches combine by the process of _____.

If the sustained contraction lacks any relaxation, it is called a _____ contraction.

An increase in the number of activated motor units within a muscle at higher intensities of stimulation is called _____. How is this done?

Muscle _____ is achieved by a continuous state of sustained contraction of motor units within a muscle.

Why would this be useful?

Smooth Muscles:

Describe the smooth muscle cells.

Are they voluntary or involuntary?

There are two types of smooth muscle: multi unit and visceral.

In _____ smooth muscle, such as in the blood vessels and iris of the eye, fibers occur separately rather than as sheets.

_____ smooth muscle occurs in sheets and is found in the walls of hollow organs; these fibers can stimulate one another and display rhythmicity, and are thus responsible for peristalsis in hollow organs and tubes.

Smooth muscle contraction: How is it like skeletal muscle?

How many neurotransmitters are there that act on smooth muscle?

How is it unlike skeletal muscle?

Cardiac Muscles:

Describe the cardiac muscle cells.

Cardiac Muscle Contraction: How is it like skeletal muscle contraction?

What are the three ways it differs from skeletal muscle contraction?

Muscle Terminology

Origin and insertion: The immovable end of a muscle is the _____, while the movable end is the _____. What does contraction do?

Prime mover, synergists and antagonists: Define these terms as they refer to muscles

Muscles Associated with the Head: Tables 8.3- 8.5)

Muscles of facial expression attach to underlying bones and overlying connective tissue of skin, and are

responsible for the variety of facial expressions possible in the human face. Be able to locate and identify the epicranium, orbicularis oculi, orbicularis oris, buccinator, zygomaticus, and platysma.

Muscles of mastication are used for chewing movements include up and down as well as side-to-side grinding motions of muscles attached to the skull and lower jaw. Be able to locate and identify the masseter and temporalis.

Muscles that move the head. Identify and locate the sternocleidomastoid, splenius capitis, and semispinalis capitis.

Muscles that Move the Pectoral Girdle and Arm

Pectoral Girdle Major muscles include trapezius, rhomboideus major, levator scapulae, serratus anterior, and pectoralis minor. Be able to locate and identify them.

Muscles that Move the Arm are separated into categories according to their movement. Be able to locate, identify and indicate the movement for the following:

Flexors include the coracobrachialis and pectoralis major.

Extensors include the teres major and latissimus dorsi.

Abductors include the supraspinatus and the deltoid.

Rotators are the subscapularis, infraspinatus, and teres minor.

Muscles that Move the Forearm are also separated by movement. Be able to locate, identify and describe them.

Flexors are the biceps brachii, brachialis, and brachioradialis.

An extensor is the triceps brachii muscle.

Rotators include the supinator, pronator teres, and pronator quadratus.

Muscles that Move the Wrist, Hand, and Fingers like the others, are organized by movement.

Be able to identify, locate and indicate the type of movement for these muscles.

Flexors include the flexor carpi radialis, flexor carpi ulnaris, palmaris longus, and flexor digitorum profundus.

Extensors include the extensor carpi radialis longus, extensor carpi radialis brevis, extensor carpi ulnaris, and extensor digitorum.

Muscles of the Abdominal Wall and Pelvic Outlet:

Muscles of the Abdominal Wall connect the rib cage and vertebral column to the pelvic girdle. Recognize and locate them.

A band of tough connective tissue called the _____, extends from the xiphoid process to the symphysis pubis and serves as an attachment for certain abdominal wall muscles.

These four muscles include external oblique, internal oblique, transverse abdominis, and rectus abdominis.

Muscles of the Pelvic Outlet : Recognize and locate these muscles.

The levator ani, the superficial transversus perinei, bulbospongiosus, and ischiocavernosus.

Muscles of the Leg: Be able to locate and identify these muscles.

Muscles that Move the Thigh are attached to the femur and to the pelvic girdle.

They are organized by location.

Anterior group includes the psoas major and iliacus.

Posterior group is made up of the gluteus maximus, gluteus medius, gluteus minimus, and tensor fasciae latae.

Thigh adductors include the adductor longus, adductor magnus, and gracilis.

Muscles that Move the Leg connect the tibia or fibula to the femur or pelvic girdle.

They are organized by movement.

Flexors are the biceps femoris, semitendinosus, semimembranosus, and sartorius.

An extensor is the quadriceps femoris group made up of four parts: rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius.

Muscles that Move the Ankle, Foot, and Toes

Dorsal flexors include the tibialis anterior, peroneus tertius, and extensor digitorum longus.

Plantar flexors are the gastrocnemius, soleus, and flexor digitorum longus.

An invertor is the tibialis posterior.

An evertor is the peroneus longus.