The Muscular System – General & Anatomy

**General Functions:**
1. **movement**
   voluntary – skeletal muscles

2. **internal movement** of substances through various tubes and passageways
   eg blood, food, urine
   heart pumps blood continuous through body (64,000 miles of vessels)

3. **Control of Body Openings and Passages**
   ringlike sphincter muscles around eyelids, pupils, mouth, urethra, anus

4. **Posture & Stability**
   sustained partial contractions
   resists gravity, prevents unwanted movements

5. **Communication**
   facial expression, hand gestures, body language, writing, speech

6. **Control of Body Temperature**
   muscles comprise 40% of body mass
   metabolism requires lots of energy (ATP)
   for movement
   ~25% = energy of movement
   ~75% = heat energy
   skeletal muscles generate up to 85% of our body heat

**Muscle Organs:**
almost 700 muscle organs in body
range from extremely small to broad flat sheets

muscle organs each consists of several kinds of tissue:
1. **fibrous connective tissue**
2. **nervous tissue**
3. **muscle tissue**
4. **blood vessels and blood**
1. **Fibrous Connective Tissue**

superficial fascia lies beneath skin
deep fascia below this is part of muscle organs

forms continuous sheath (series elastic components) of tissue from endomysium to bone matrix

arranged in overlapping layers:

individual cells = **endomysium**
fascicles = **perimysium**
whole organ = **epimysium**

epimysium also called **deep fascia**
as distinct from superficial fascia of skin

very tough and strong yet flexible, very elastic
‡ collagen fibers mostly

very strong, rarely separated from bone or muscle

extends beyond muscle and attaches muscle to bone or to other muscles (between each end is body of muscle)

  tough strap = **tendon**
broad sheet = **aponeurosis**

tendons are continuous with periosteum of bones

tendons are often surrounded by **tendon sheath** of synovial membrane
fluid lubricates tendons to reduce friction

also are synovial sacs = **bursae**
scattered between tendons and muscles
wherever there is lots of friction and tension

2. **Nervous Tissue**

almost all muscles in the body are under direct or indirect control of the CNS, esp skeletal muscles

skeletal muscles are innervated by **somatic motor neurons** (voluntary)
skeletal muscles will not contract without stimulation
each motor neuron branches into 200 or so **synaptic knobs**  
(within a **motor end plate**)  

each muscle cell in innervated by only one motor neuron  

each neuron typically innervates ~200 muscle cells  

connection between neuron and muscle cell = **neuromuscular junction**  

at **motor end plate**  

not a direct connection  

‡ has synapse or gap  

**neurotransmitter**, Acetylcholine, is released  

NT crosses synapse to trigger contraction  

3. **Muscle Tissue**  

close to half of body consists of muscle tissue  

elongated cells, spindle shaped, up to 1 ft long = muscle fibers  

very little matrix, instead embedded in framework of fibrous connective tissue  

highly **contractile** and **elastic**  

muscle cells stop dividing at birth (# fixed at birth)  

‡ but each cell can expand greatly in volume  

development is affected by sex hormones  

‡ males’ muscles respond better than females’ to exercise  

three types of muscle tissue:  

1. **striated**: most abundant, voluntary  

   most attached to two or more bones across a joint  

2. **smooth**: internal organs; arranged in two or more layers eg circular and longitudinal  

3. **cardiac**: heart only  

4. **Blood Supply**  

endomysium is full of capillaries that reach every muscle fiber  

all skeletal muscles receive ~1.25 liter of blood/min at rest  

(~1/4th total blood supply)
during heavy exercise they can use up to 11.6 liters/min
(>3/4th ‘s of all blood)

increased demand for oxygen and glucose

Some Basic Principles of Muscle Function

1. Muscles can only pull not push

any movement requires coordination of several muscles
(often opposing pairs, functional groups)

eg. prime mover,
synergist (including fixators)
antagonists

2. Bones act as levers and fulcrums

most skeletal muscles are arranged in bundles with ends attached to
two different bones

muscles pull across joints to produce movement

Each muscle must attach to at least two different bones on opposite
sides of an articulation:

origin – proximal, less mobile point of attachment
body – most muscle fibers grouped here
insertion – distal and more mobile point of attachment

*Usually the body of the muscle that moves a part does not lie over the part
it moves

Intramuscular Injections: muscles with thick
bellies commonly used when drug must be
absorbed more slowly or is given in large doses
eg. deltoid, gluteus medius, vastus lateralis

3. Kinds of body movements:

the synovial joints of the body each allow specific kinds of voluntary
movements, such as:

flexion/extension
= decrease vs increase angle
(inc. hyperextension (beyond anatomical position)
supination/pronation = rotate outward vs inward
adduction/abduction = toward vs away from median
levator/depressor = produces upward vs downward movement
rotation/circumduction = pivot vs describe cone
eversion/inversion = turns sole outward vs inward
dorsiflexion/plantarflexion = toes up vs toes down
flexes foot vs extends foot at ankle joint

other kinds of muscle movements:
tensor = makes body part more rigid
sphincter = decreases size of opening
orbicularis; voluntary or smooth muscles
peristalsis = slow wavelike contractions that are used to push
materials down a “tube” within the body
segmentation = a mixing motion made by smooth muscle lining
the digestive tract
systole/diastole = coordinated contraction and relaxation of the
chambers of the heart

4. Skeletal muscle are named in several ways:
direction of muscle fibers (rectus, transverse, oblique)
location (temporalis, orbicularis oris)
size (maximus, minimus)
origin and insertion (sternocleidomastoid)
number of origins (biceps, triceps)
shape (deltoid, trapezius)
action (flexors, extensors)
Examples of Human Muscle Groups:

Muscles of the Appendages

A. Muscles that move the pectoral girdle

levate/depress
trapezius
latissimus dorsi

B. Muscles that move the upper arm

adduct/abduct
abduct arm   deltoid
adduct arm   pectoralis major
            latissimus dorsi

flex/extend
flexors       pectoralis major
extensors     latissimus dorsi

rotate

Compartments

muscles of the limbs are arranged into tightly packed “compartments”

fascia surround and enclose the muscles, nerves and blood vessels within each compartment

if the blood vessels within a compartment are damaged blood and tissue fluid accumulate

‡ fascia prevent swelling and relief of pressure

‡ blood vessels and nerves are compressed and obstructed

if pressure persists for >2-4 hrs nerves begin to die

C. Muscles that move forearm
**D. Muscles that move wrist and fingers**

- **Flexes wrist**
  - Flexor carpi radialis
  - Flexor carpi ulnaris

- **Extends wrist**
  - Extensor carpi radialis
  - Extensor carpi ulnaris

- **Flexes fingers**
  - Flexor digitorum

- **Extends fingers**
  - Extensor digitorum

**E. Muscles that move thigh**

- **Abduct/adduct**
  - Abduct thigh
    - Tensor fascia latae
  - Adduct thigh
    - Adductor longus
    - Adductor magnus
    - Gracilis

- **Flex/extend**
  - Flexors
    - Sartorius
    - Rectus femoris
    - Tensor fascia latae
  - Extensors
    - Gluteus maximus
    - Biceps femoris
    - Semitendinosus
    - Semimembranosus

- **Rotate**

**F. Muscles that move lower leg**

- **Flexors**
  - Biceps femoris
  - Semitendinosus
  - Semimembranosus
  - Sartorius

- **Extensors**
  - Rectus femoris
  - Vastus lateralis
  - Vastus medialis
G. Muscles that move foot

- **evert/invert**
- **dorsiflex/plantarflex**
  - dorsiflexors: tibialis anterior
  - plantarflexors: gastrocnemius, soleus

**Head and Trunk Muscles**

A. Muscles of the head and neck

- **sphincters:**
  - orbicularis oculi (close eye)
  - orbicularis oris (close mouth)

- **chewing:**
  - closes jaw: masseter, temporalis, orbicularis oris
  - opens jaw: platysma

- **facial expression:**
  - frontalis (raise eyebrows)
  - orbicularis oculi (squint)
    - orbicularis oris (purse lips, pout, kiss)

- **extrinsic eye muscles**

- **head movement**
  - sternocleidomastoid (flexes neck, turns head)
  - trapezius (extends neck)

B. Muscles that move rib cage

- **elevates rib cage**
  - external intercostals (inspiration)

- **depresses rib cage**
  - internal intercostals (expiration)

- **breathing**
  - diaphragm

C. Muscles of the Abdominal Wall

- **layers**
  - external oblique
  - internal oblique
  - transversus abdominis
  - rectus abdominis (linea alba)