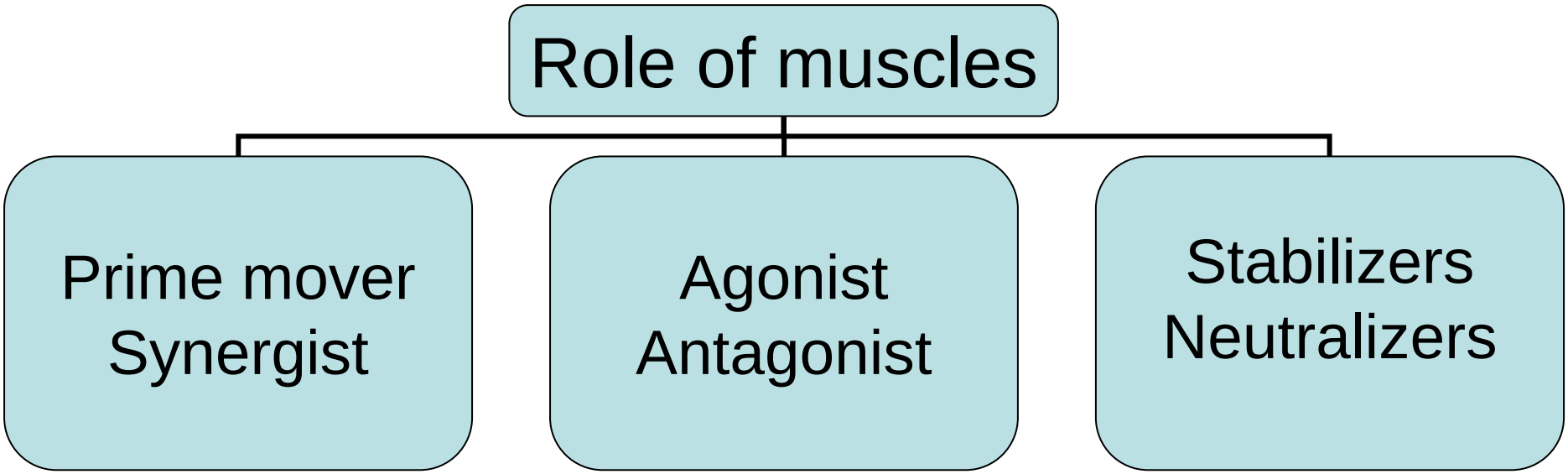
# Muscular Considerations for Movement

Kinesiology
RHS 341
Lecture **4**
**Dr. Einas Al-Eisa**


Role of muscles
Prime mover
Synergist
Agonist
Antagonist
Stabilizers
Neutralizers

# Role of muscles

- **Agonist:**
  - Muscles producing the movement
  - Primary or prime movers
  - Contract actively to produce a concentric, isometric, or eccentric contraction

# Role of muscles

- **Antagonist:**

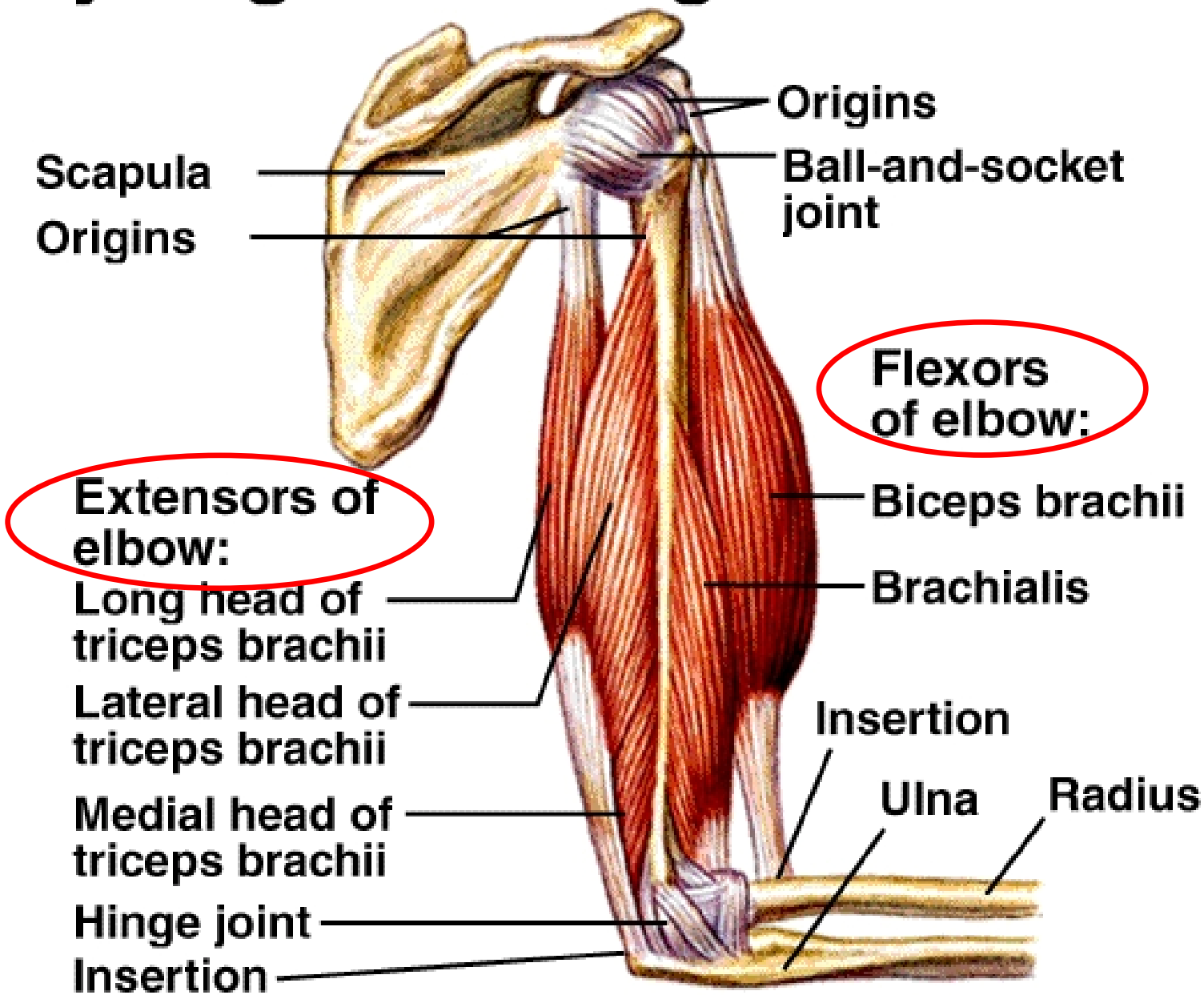
  - More susceptible to injury because the muscle contracts to slow the limb (or control the movement) while being stretched

# Example

When the thigh swings forward:

- **Agonists:** hip flexors (iliopsoas, rectus femoris, sartorius, pectineus, gracilis)
- **Antagonists:** hip extensors (hamstrings & gluteus maximus)

# Synergistic/Antagonistic Muscles



# Role of muscles

- **Synergists:**
  - Neutralizers
  - Stabilizers / Fixators

# Role of muscles

- **Synergists** (Neutralizers):

Muscles that contract to assist the prime movers, either by:

- adding force to the movement and making it more refined

Or

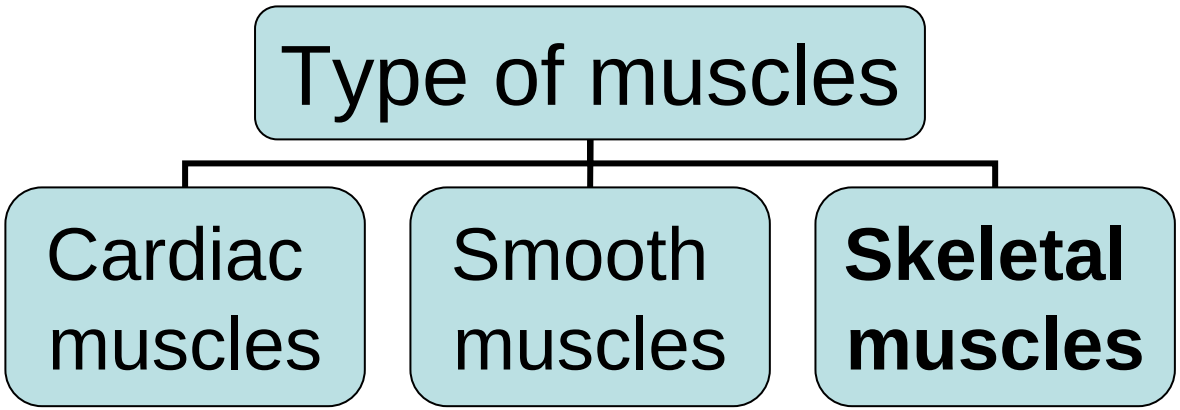
- eliminating undesired movement

# Role of muscles

- **Synergists (Neutralizers):**
  - Some prime movers cross several joints and cause movements at all those joints, but synergists act to cancel some of these movements.
  - Example: making a fist without flexing the wrist, although the muscles that flex the fingers also flex the wrist.

# Role of muscles

- **Stabilizers** (Fixators):
  - Muscles that fix or stabilize one segment to allow another segment to move smoothly & efficiently
  - Example: muscles that fix the scapula when the arm moves


Type of muscles
Cardiac muscles
Smooth muscles
Skeletal muscles

## Table 10.1 Comparison of Skeletal, Cardiac, and Smooth Muscle

| Characteristic | Skeletal | Cardiac | Smooth |
|---|---|---|---|
| Body location |  Attached to bones or (some facial muscles) to skin |  Walls of the heart |  Mostly in walls of hollow organs, such as the stomach, respiratory tubes, bladder, blood vessels, and uterus |
| Cell shape and appearance |  Single, very long, cylindrical, multinucleate cells with very obvious striations |  Branching chains of cells; uni- or binucleate; striations |  Single, fusiform, uninucleate; no striations |

# Skeletal muscles

- Attach to and move the skeleton
- Makes up 40% of the total body weight
- Under voluntary control
- Cells show stripes or striations
- The cells are elongated and called fibers
- Contraction depends on myofilaments which fill most of the cytoplasm:
  - actin & myosin = proteins generating contractile force

# Skeletal muscles

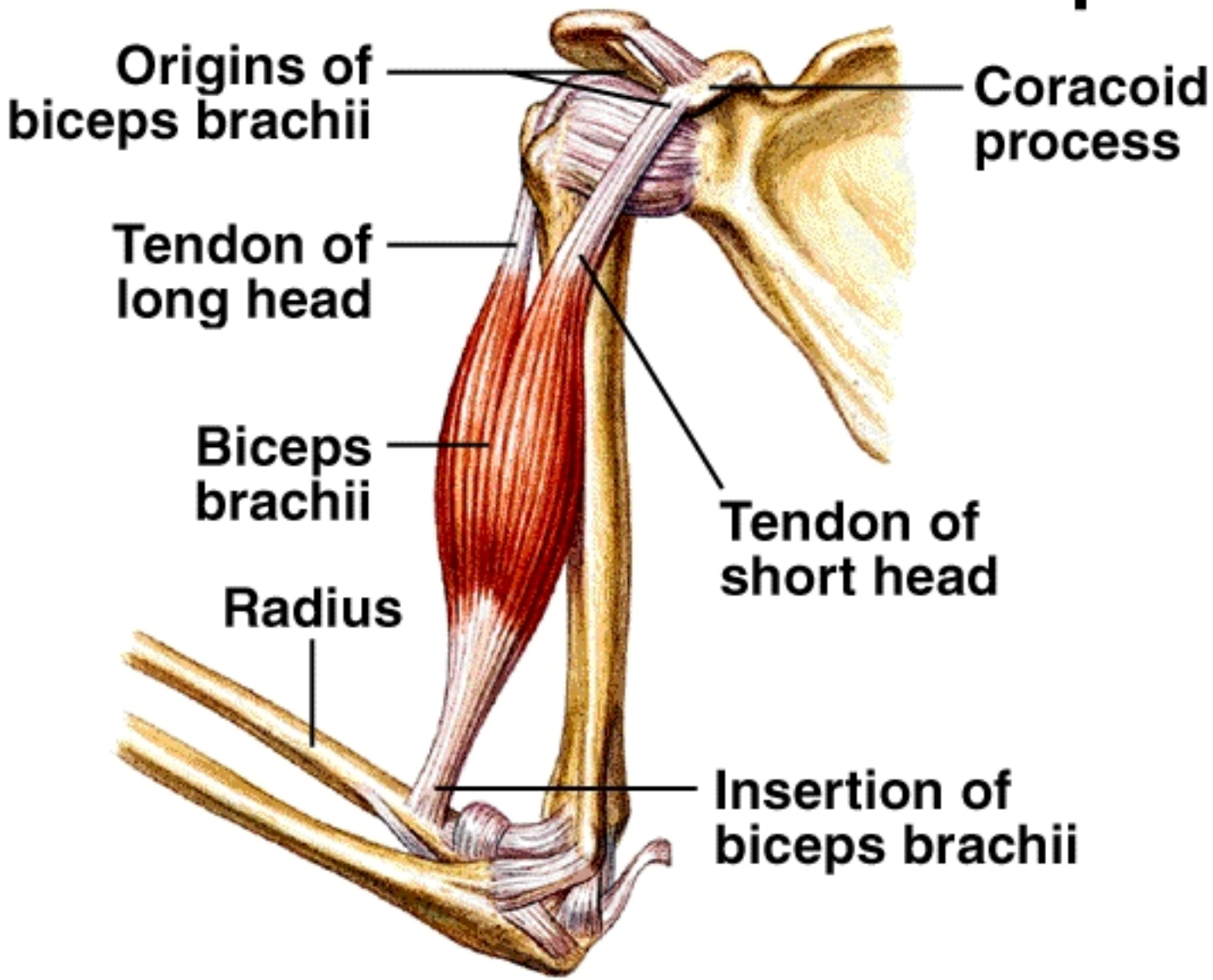
- Several sheaths of **connective tissue** surround the muscle **fibers** within a muscle

- Those sheaths of connective tissue are continuous with the **tendons** that join muscles to bones

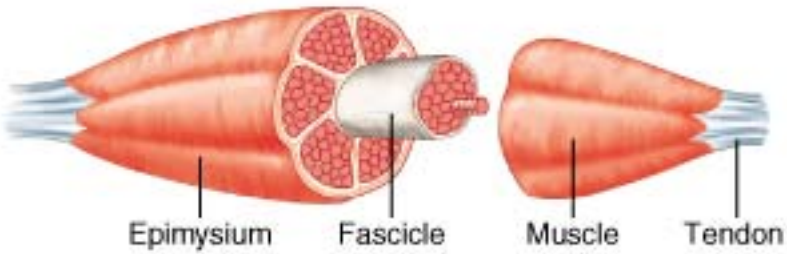
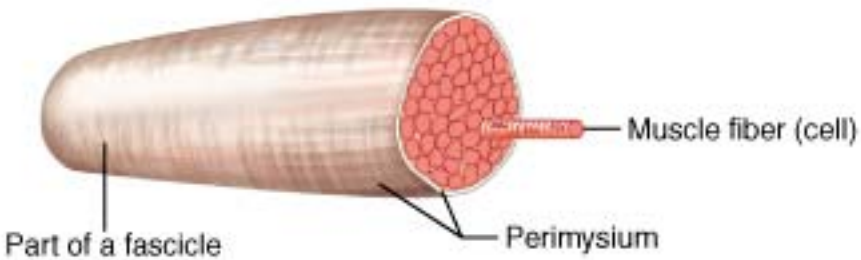
# Skeletal muscles

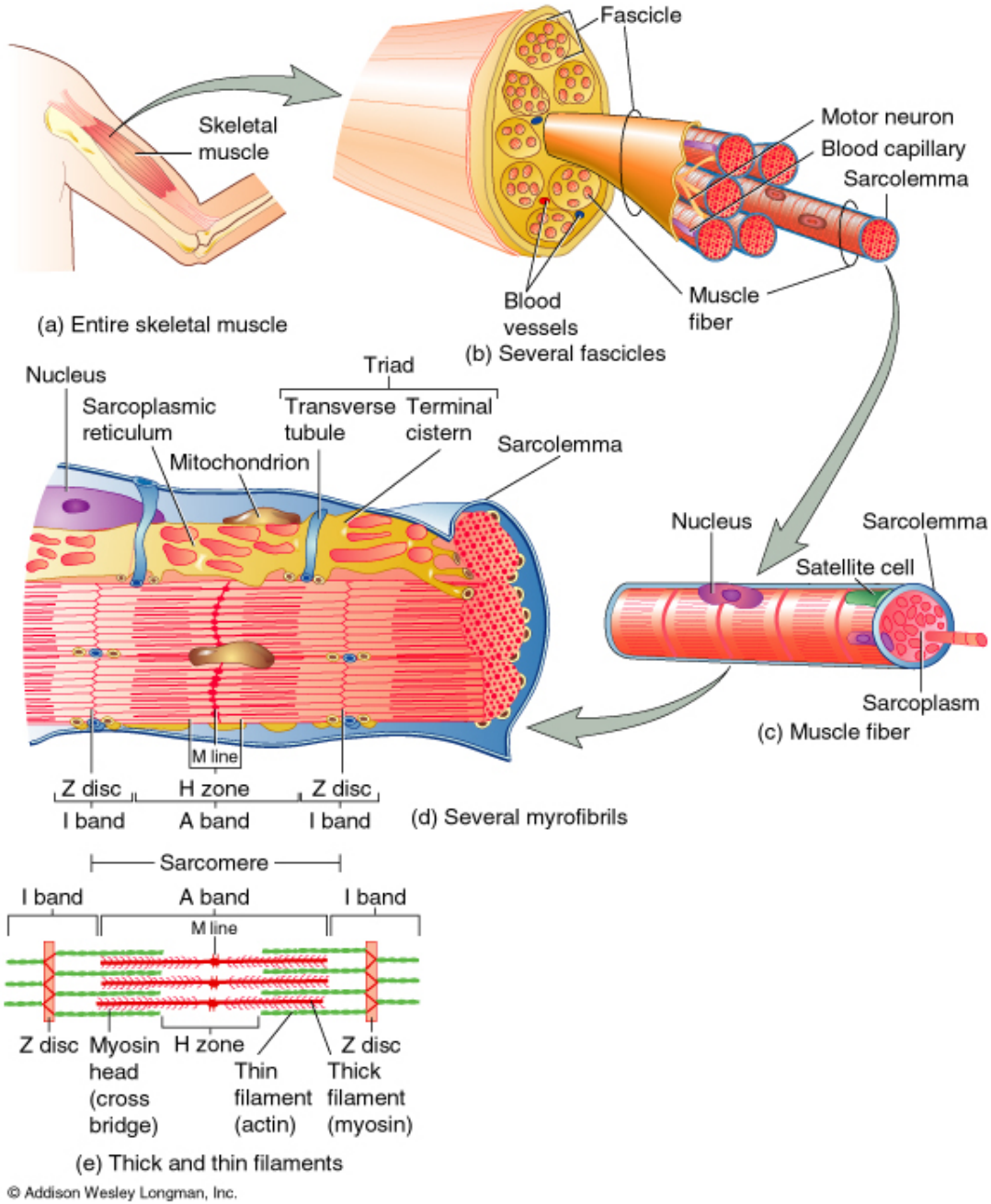
- When muscle fibers contract → pull on the connective tissue sheaths → transmit the force to the bone being moved

# Skeletomuscular Relationship



## Table 10.2 Structure and Organization Levels of Skeletal Muscle

| Structure and organizational level | Description | Connective tissue wrappings |
|---|---|---|
|   | Consists of hundreds to thousands of muscle cells, plus connective tissue wrappings, blood vessels, and nerve fibers | Covered externally by the epimysium |
|   | Discrete bundle of muscle cells, segregated from the rest of the muscle by a connective tissue sheath | Surrounded by a perimysium |



# Muscle strength

- = the maximum amount of force produced by a muscle at the site of attachment on the skeleton
- Usually measured by moving the heaviest possible external load through one repetition of a specific range of motion
- Affected by the size & structure of the muscle

# Muscle strength

- Affected by the **physiologic cross-section** (PCS) = the perpendicular section that cuts all muscle fibers at its thickest part while the muscle is in midway between complete contraction and complete stretch

- Weight training ⟶

  Greater cross-sectional area (hypertrophy) associated with an increase in the size of the muscle fibers

# Muscle strength

Affected by the following factors:

- Arrangement of the muscle fibers
- Width of the muscle (circumference)
- Gender (muscle force is greater in males?)
- Age (muscle force decreases with age)

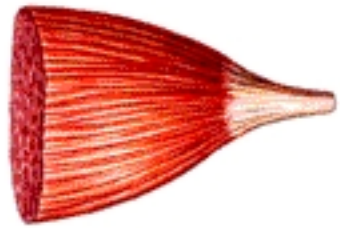
# Arrangement of **fascicles** in muscles

- **Fascicles** = bundles of fibers enclosed in a sheath of connective tissue
- The action of each muscles is dependent (in part) on the arrangement of its fascicles
- The power of a muscle depends on the total number of fibers it contains

# Muscle Architecture

**Parallel—**
**straplike**

**Convergent—**
**fan-shaped**



**Sphincteral**

**Pennate—**
**(a) unipennate**
**(b) bipennate**
**(c) multipennate**

# Muscle Architecture

**Parallel—**
**straplike**

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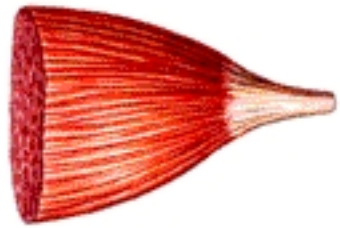


**Sphincteral**

**Pennate—**
**(a) unipennate**
**(b) bipennate**
**(c) multipennate**

# Arrangement of **fascicles**

- **Parallel** arrangement:
  - The long axes of the fascicles run parallel to the long axis of the muscle itself
  - *Strap-like*; e.g., sternocleidomastoid

Or:

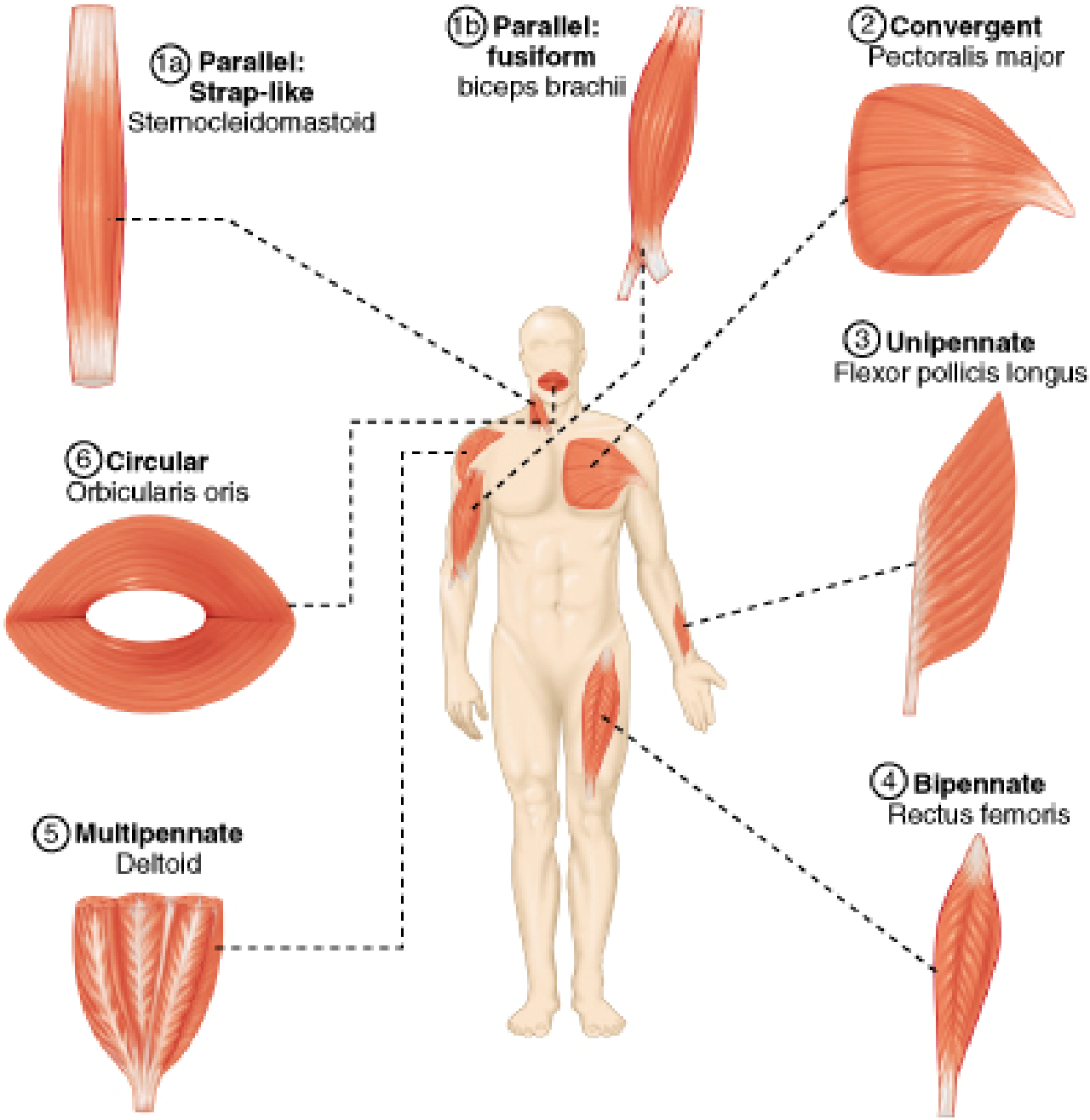
  - *Spindle-shape* (fusiform) with an expanded central belly, e.g., biceps brachii

# Arrangement of **fascicles**

- **Convergent** pattern:
  - The origin of the muscle is broad and the fascicles converge toward the tendon of insertion
  - Can be triangular or fan-shaped
  - Example: pectoralis major

# Arrangement of **fascicles**

- **Pennate** pattern:
  - Fascicles are short and attach obliquely to a tendon that runs the whole length of the muscle
  - **Unipennate**: if the muscle inserts into only one side of the tendon; e.g., flexor pollicis longus
  - **Bipennate**: if the fascicles insert into the tendon from both sides; e.g., rectus femoris
  - **Multipennate**: looks like many feathers situated side by side, with all their quills inserting into one large tendon; e.g., deltiod



# Arrangement of **fascicles**

- **Circular** (sphincter) pattern:
  - Surround external body openings, which the muscle closes by contraction
  - Example: Orbicularis oris (mouth), Orbicularis oculi (eye)

# Muscle strength

- = magnitude of the muscle force
- Changes according to the PCS of the muscle
- Force exerted by multipennate muscle is more than fusiform (because it has greater PCS?..)

# Effect of muscle structure on force

- The force a muscle can exert is proportional to its PCS
- A broad, thick, longitudinal muscle exerts more force than a thin one

# Effect of muscle structure on force

- A penniform (pennate) muscle of the same thickness as a longitudinal muscle can exert greater force (because the oblique arrangement of the fibers allows for a larger number of fibers in comparable sizes of the other classifications)

- Pennate muscles are the most common type of skeletal muscles & predominate when forceful movements are needed

# Muscle length-tension relationship

- The greatest amount of tension can be developed when a muscle is stretched (between 100-130% of its resting length)

- The amount of force that can be exerted by the muscle if it is shortened or if it is **over** stretched (beyond 100-130% of its resting length)

# Stretch-shortening cycle

- = proceeding a concentric contraction phase with an eccentric phase
- Putting the muscle under stretch in the eccentric phase enables the muscle to store potential energy
- Example: vertical jumps

# Electromyography (EMG)

- = the study of electrical activity of muscles

- Provides insight into:
  - which muscles are active during a task
  - when the muscles initiate and stop their activity

# EMG: Ergonomic application

- Effect of sitting posture on the activity of the neck and shoulder muscles
- Effect of carrying a load (with respect to magnitude & duration) on the activity of the shoulder, back, and leg muscles to develop proper lifting techniques
- Effect of exercises on back muscles in rehabilitation of low back pain