Ch 10: **Skeletal** Muscle Tissue (Myology)

*main objectives:*

1) Describe the distinguishing characteristics of the different muscle tissues
2) Discuss the organization of skeletal muscle
3) Explain the micro-anatomy of a skeletal muscle fiber
4) Describe the fascicle arrangement in different types of muscle
5) Review general muscle terminology

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Types of Muscle Tissue

One of the 4 primary tissue types

- **Skeletal** = **Striated** = **Voluntary**
  - 40% of weight
- **Cardiac** (involuntary)
- **Smooth** (involuntary, nonstriated)

Made up of many tissue types.

> 700 skeletal muscles

Word roots:
- sarco
- myo

Musculus = little mouse
Function of Skeletal Muscles

1. Skeletal movement
2. Posture and body position
3. Support of soft tissues
4. Joint Stabilization
5. Guarding of entrances & exits
6. Maintenance of body temperature
7. Protection
8. Facial expression
Each skeletal muscle cell (fiber) is wrapped by 3 layers of connective tissue.
Epi-, Peri-, and Endomysium

Are interwoven - Continuous with tendon, and eventually the periosteum

Distinguish between:
- **Tendon**
- **Aponeurosis**
- **Ligament**

Function:
- Protection
- Blood supply
- Innervation

**Epimysium** = On top of the muscle
**Perimysium** = Around a bundle of myofibers
**Endomysium** = Surrounds each myofiber
Nerve and Blood Supply

Skeletal muscles are rich in nerves and blood vessels.

Chemical communication at neuromuscular junction

Synaptic terminal of axon meets motor end plate of muscle cell

Coiled capillaries are able to adapt to changes in length of muscle fiber
Coiled Capillaries

Large blood vessels
Origin and Insertion

- **Origin:**
  - The part that stays still
  - Usually proximal

- **Insertion:**
  - The part that moves
  - Usually distal
Microanatomy of Skeletal Muscle Fibers

**Some vocabulary:**

Skeletal muscle cell = fiber or myofiber
Sarcolemma
Sarcoplasm
Sarcoplasmic reticulum
Myofibril
Myofilaments
T-tubules

Multiple nuclei on periphery
Microanatomy

Myofiber (= cell)
Myofibrils
Myofilaments

Fig. 10.4
Myofiber (cell) → Myofibrils → Myofilaments

Actin & Myosin
Sarcomere (= thick + thin filaments)

Thick and Thin Filaments are organized in repeating functional units

Each myofibril has linear arrangement of up to 10,000 sarcomeres

Banded appearance (striation) due to arrangement of thick and thin filaments

Interaction of thick and thin filaments responsible for skeletal muscle fiber contraction
Sarcomere Structure

- **Z-line**
- **A-bands**
- **I-bands**
- **H-zone**

Thin filaments

Thick filaments

I-band = **Light band**  

A-band = **Dark band**

Z-line
Thin Filament: Actin

(a) Z line and thin filaments

(b) Thin filament

Sarcomere

Myofibril

Z line  M line  H zone
Thick Filament: Myosin
Motor Unit

All muscle fibers that are controlled by a single motor neuron (axon)

The lower the ratio of muscle fibers to neurons, the more precise the movement can be.

Ratio is from 1:1 to 1:2000

Acetylcholine is the neurotransmitter at the motor end plate

Contraction of a motor unit is “all or none.”
Muscle Control

Muscle tone = Resting tension of skeletal muscles
(continuous contraction of some motor units to maintain some muscle tension)

Recruitment or Multiple motor unit summation for greater force

Some directional control depending on which motor units are stimulated
Muscle Hypertrophy vs. Atrophy

**Hypertrophy** due to anaerobic exercise
Leads to increased muscle size - *how*?

**Atrophy** if supply of myofilaments exceeds demand. Muscle fibers become smaller and weaker.

Eventual death of muscle fibers is irreversible!

Importance of Physical Therapy
Three Types of Skeletal Muscle Fibers (fast, slow, intermediate)

1. Slow (or Red) Oxidative Fibers
   Type I
2. Fast Glycolytic Fibers
   Type IIX
3. Fast Oxidative Fibers
   Type IIa

Most skeletal muscles contain a mixture of fiber types. *Proportion of fast to slow depends on training and development.*

One motor unit only contains one fiber type.
1. Slow (or Red) Oxidative Fibers
Type I

Slow but continuous contraction for extended periods

Smaller diameter (~ half)
contain myoglobin
more capillaries
more mitochondria

Do not fatigue as fast due to aerobic production of ATP
2. Fast Glycolytic Fibers
Type IIx

Fast contraction after nervous stimulation
Large diameter
  large glycogen reserve
  fewer mitochondria
  densely packed myofibrils
Fatigue fast due to mainly anaerobic respiration
3. Fast Oxidative Fibers
Type IIa

Have attributes in between fast and slow types
Organization (shape) of Skeletal Muscle Fibers

Effect of individual muscle contraction determined by:
1. arrangement of muscle fibers
2. method of attachment to skeleton

 Bundles of muscle fibers = fascicle

Muscle fibers within 1 fascicle are parallel
Parallel Muscles

Extensor vs. flexor

Origin vs. Insertion

Spindle shaped with cord-like tendons

Some flat bands with broad attachments on each end
Convergent muscles

Broad origin, pointed insertion

Direction of pull can be varied: versatility!!

Example = deltoid
Pennate Muscles: Unipennate

One or more tendons run through muscle body

Fascicles in oblique angle to tendon

Can generate more tension

**Example** = biceps brachii
Pennate Muscles: **Bipennate & Multipennate**

Example

- Tendons
- Cross section

Example
Muscle Terminology

Flexor → Extensor
Origin → Insertion
Agonist → Antagonist
Synergist

♦ Possible: multiple origins
♦ Note: Agonist = Prime Mover
Grouping of Muscles according to Primary Action

Agonist = Prime Mover

Antagonist (action opposes agonist)

Synergists = Assistants of prime mover
Cardiac Muscle

- Form the Myocardium
- Striated, involuntary
- Single cells
  - Branched extensively
  - Joined with Intercalated Disks (provide communication with gap junctions)
- Similar filament structure to Skeletal M.
  - Not as organized
  - Nuclei in the middle of the cells
Smooth Muscle

- Nonstriated, involuntary
- Internal organs (mostly)
- Single Cells called fibers
- Often in opposing layers
  - Gut, bladder