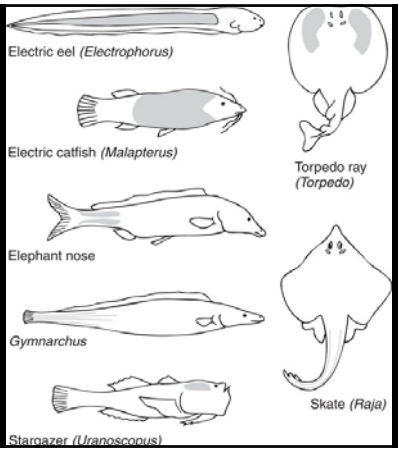
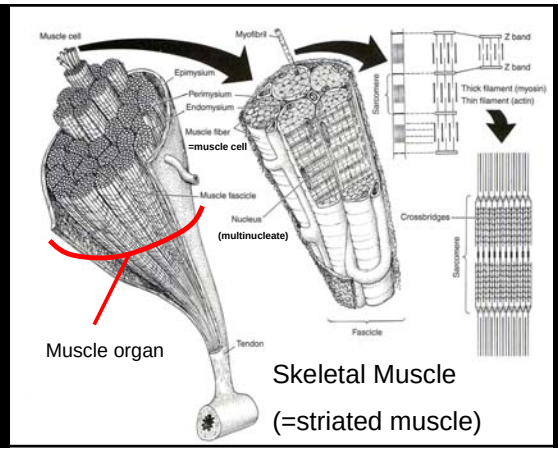
Muscles

- Supply power (with skeletal system)
- Restrain
- Heat
- Viscera
- Specialized

Electric Organs

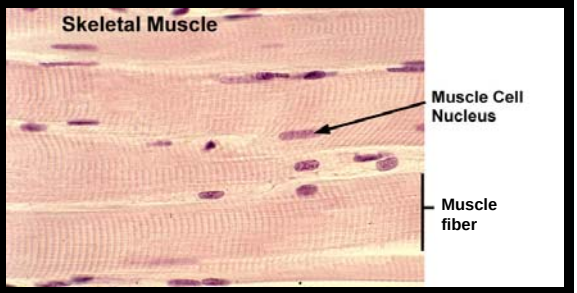


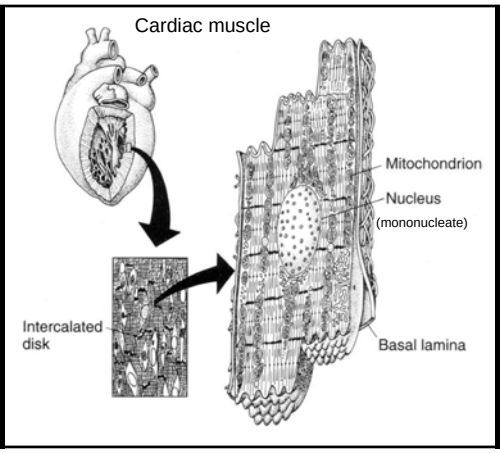


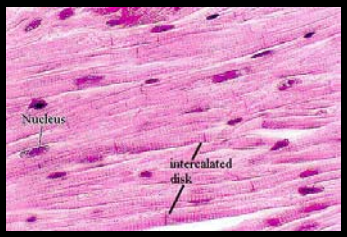
Muscle organ

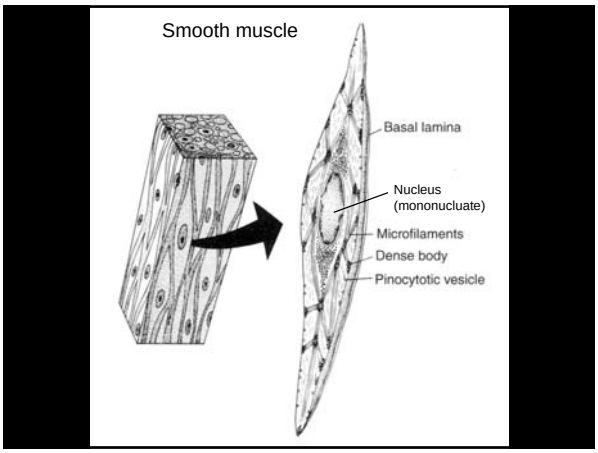
Skeletal Muscle

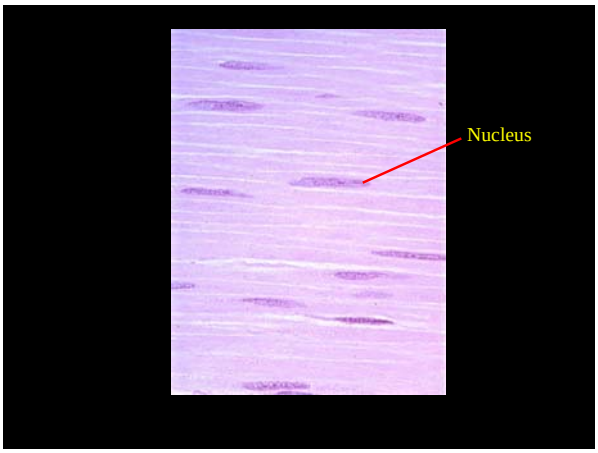
(=striated muscle)

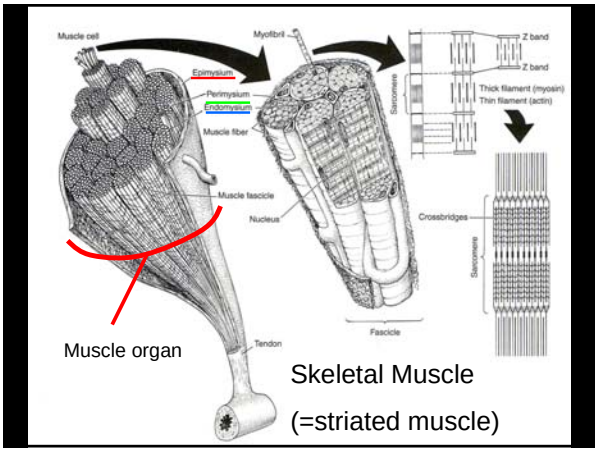


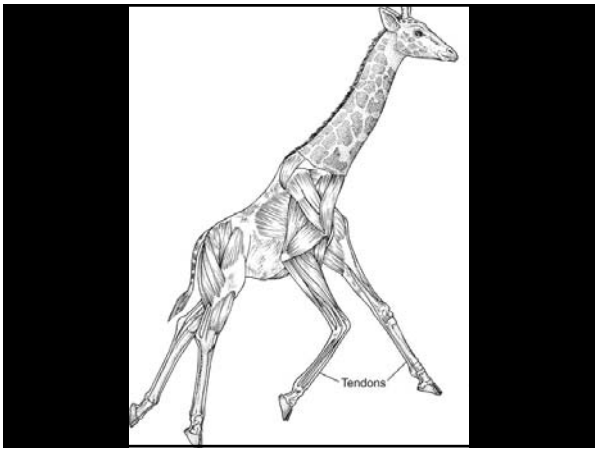


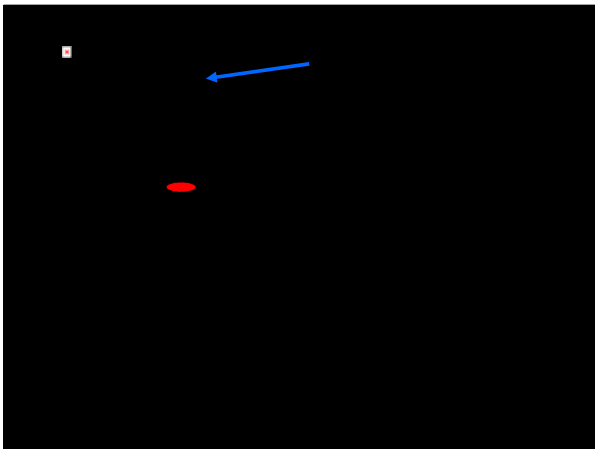








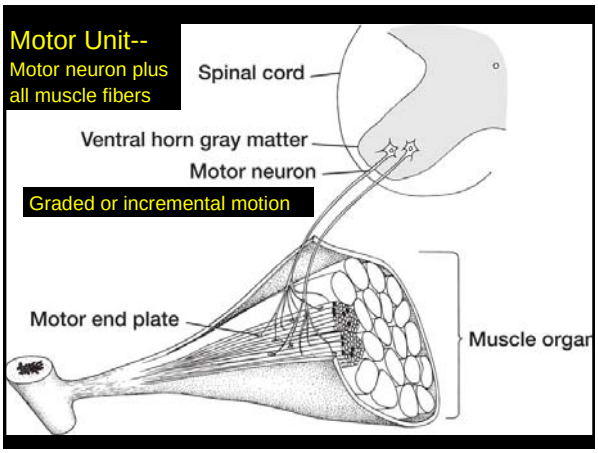


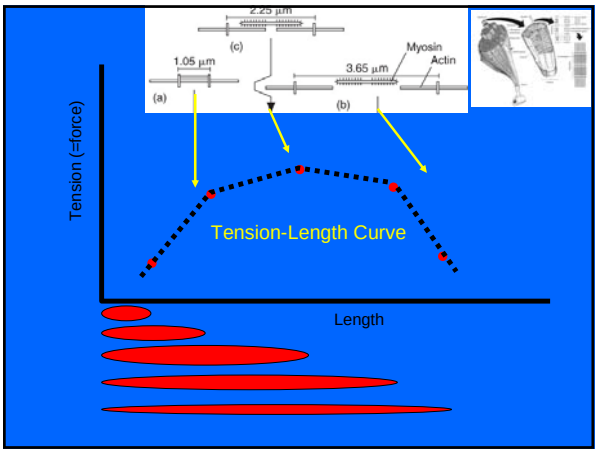


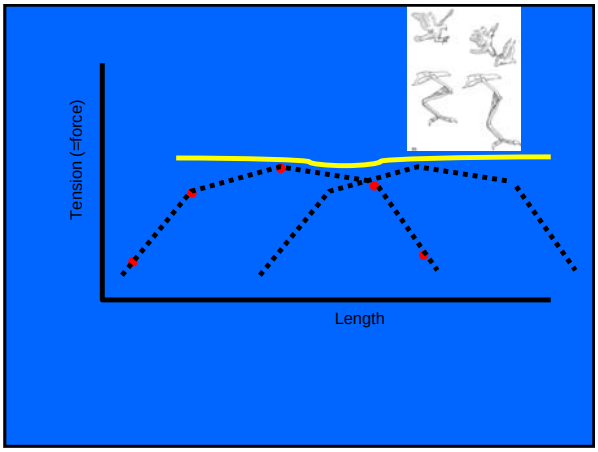
Muscle Action

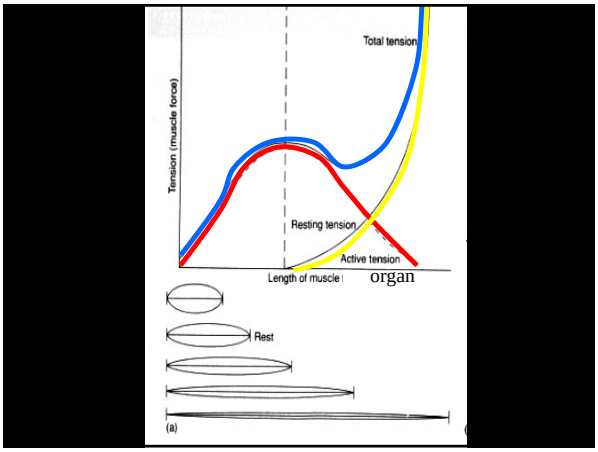
- Prime motion
- Synergists
- Antagonists
- Fixators

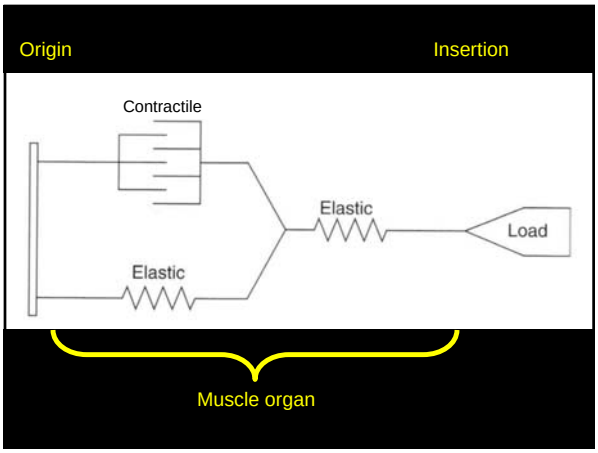
geniohyoid

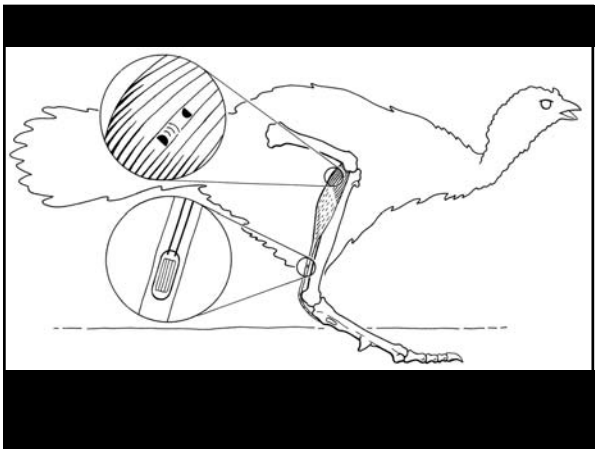

Motor Unit--
Motor neuron plus all muscle fibers
Spinal cord
Ventral horn gray matter
Motor neuron
Graded or incremental motion
Motor end plate
Muscle organ

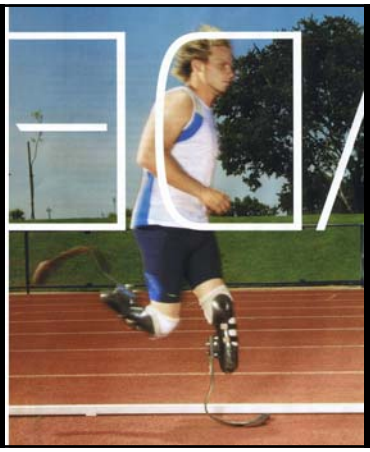

2.25 µm
(c)
1.05 µm
3.65 µm
Myosin
Actin
(a)
(b)
Tension (–force)
Tension-Length Curve
Length

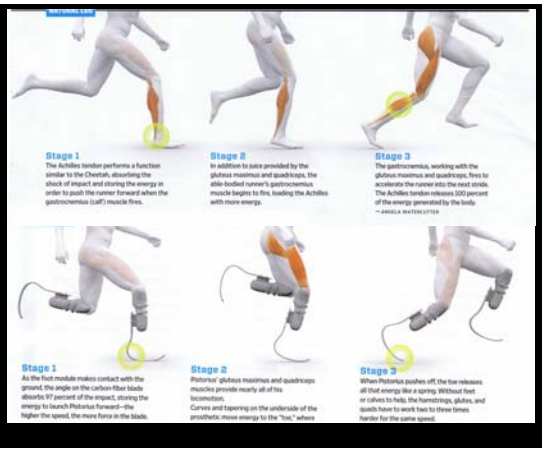

Tension (–force)
Length


Total tension
Tension (muscle force)
Resting tension
Active tension
Length of muscle
organ
Rest
(a)


Origin
Insertion
Contractile
Elastic
Load
Elastic
Muscle organ

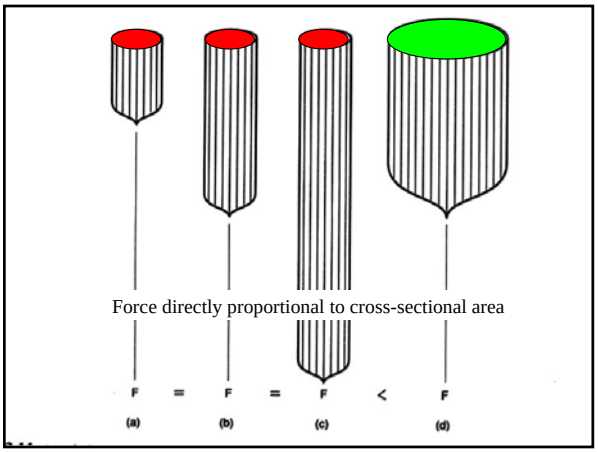




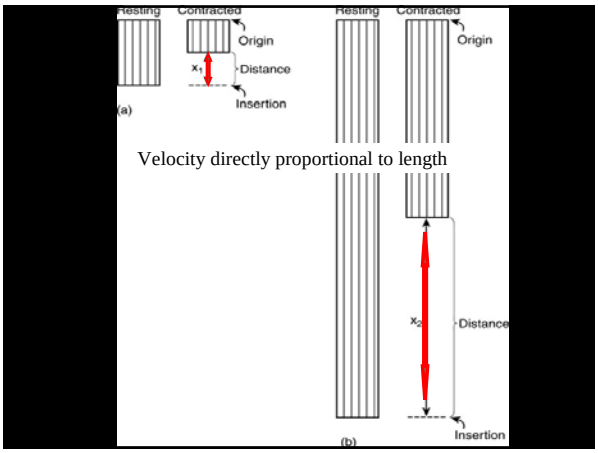


- Motor units
  - recruitment
- T-L curve
  - two or more

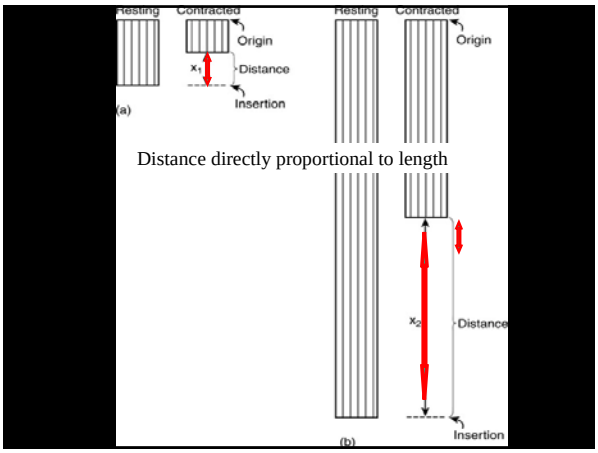
Functional Properties of Muscle as a Tissue



Force directly proportional to cross-sectional area



Velocity directly proportional to length

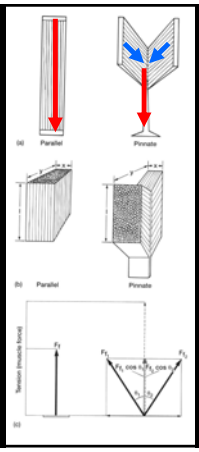


Distance directly proportional to length

Functional Properties of Muscle Varies with Fiber Orientation

Parallel

light weight,
long distance



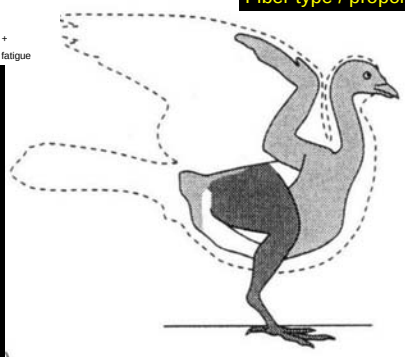
Pinnate

heavy weight,
short distance

Fiber type / proportion

Red

Myoglobin +
Vascularization +
Slow – / resists fatigue



White

Myoglobin –
Vascularization –
Rapid + / fatigable

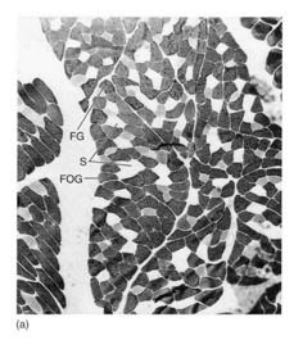
Fiber Types

1) Tonic--Slow contracting
   Low force
   Sustained contraction

2) Twitch--Fast contracting

Fiber Types:

Speed—	***slow twitch***	***fast twitch***
Fatigue—	***resistant***	***fatigable***



Fast twitch—dark

Slow twitch—light

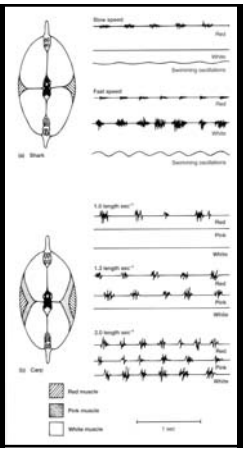
Fiber Types

1) Tonic--Slow contracting
   - Low force
   - Sustained contraction

2) Twitch--Fast contracting

		Fiber Types:
Speed—	***slow twitch***	***fast twitch***
Fatigue—	***resistant***	***fatigable***

3) Recruitment



Recruitment

Fiber Types

1) Tonic--Slow contracting
   - Low force
   - Sustained contraction

2) Twitch—Fast contracting

	Fiber Types:	
Speed—	***slow twitch***	***fast twitch***
Fatigue—	***resistant***	***fatigable***

3) Recruitment

4) Training
   - Capillaries
   - Increase size
   - NO change fiber types

Training

Chronic overload → muscle hypertrophy
Strength training → increase muscle mass
Immobilization → atrophy
increased strength

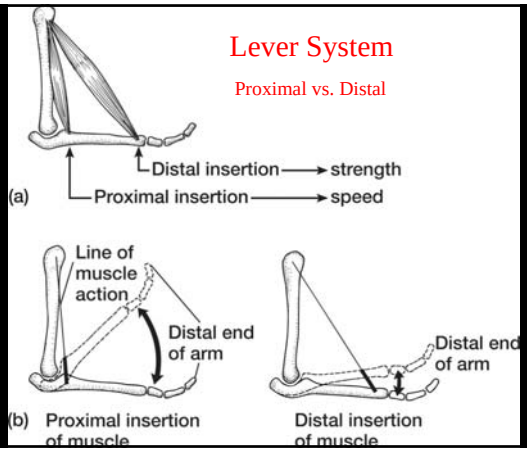
Endurance training → increase efficiency O_2
fatigue resistence

Each at expense of the other

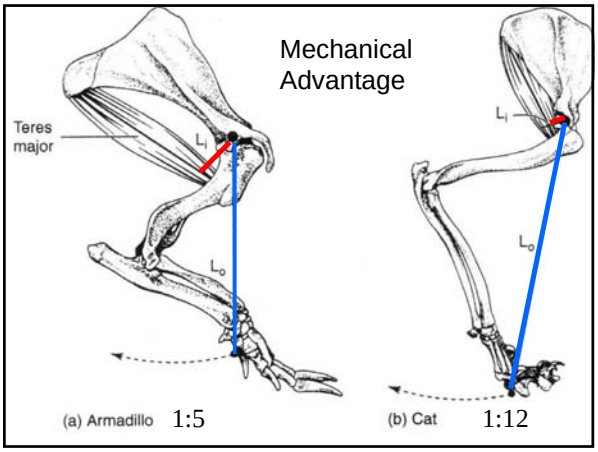
Functional Properties of Muscle as Part of a Lever System

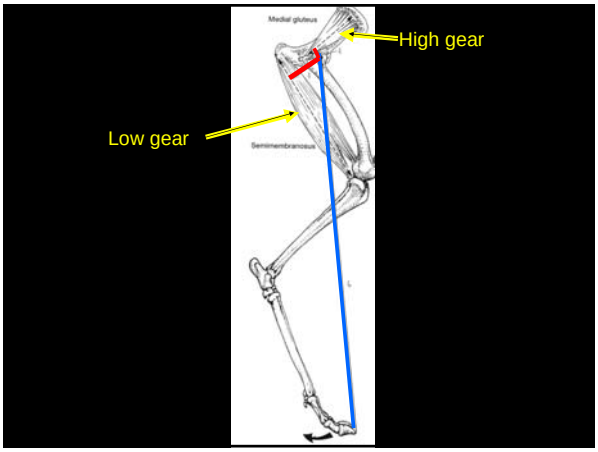
Lever System

Proximal vs. Distal



Mechanical Advantage





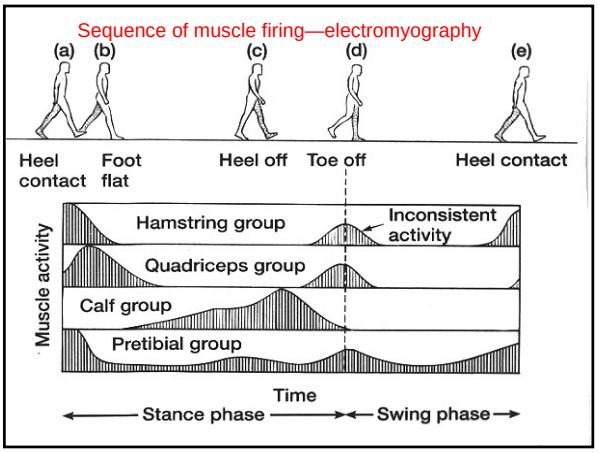
Muscles

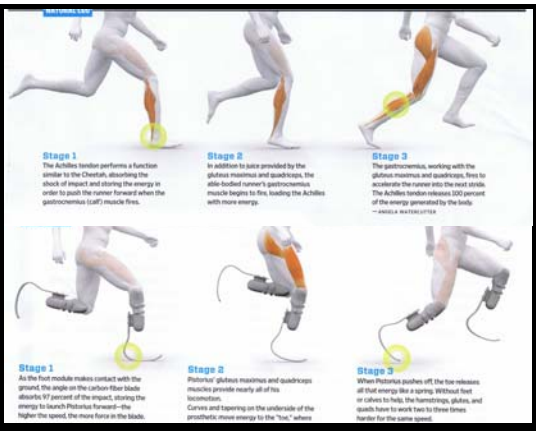
- Cell type
  - skeletal, cardiac, smooth
  - fast, slow twitch
- Tissue
- Lever system

Functional Properties of Muscles in Sequence

Electromyography

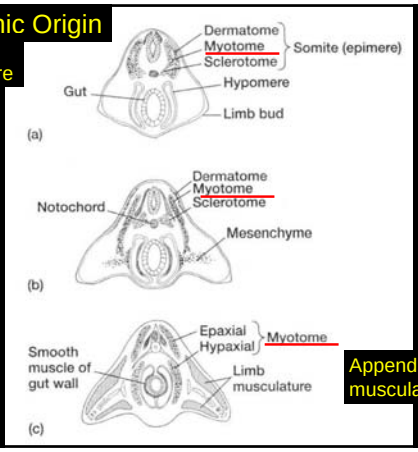
Sequence of muscle firing—electromyography



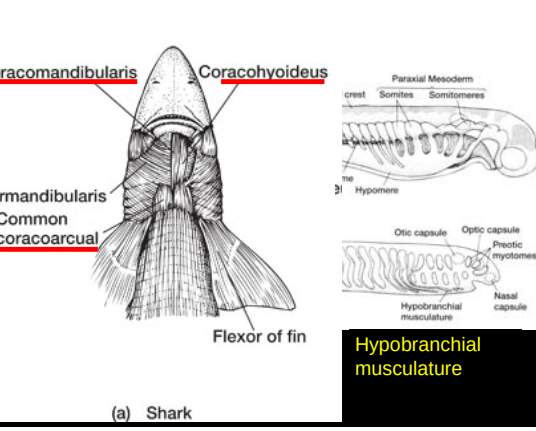


Embrvonic Origin

Somatic musculature



Appendicular musculature



Hypobranchial musculature

Body

- **Somatic**
  - **myotomes (somites)**
  - **spinal nerves**
- **Appendicular**
  - **trunk myotomes**
  - **spinal nerves**

Head

- **Hypobranchial—throat**
  - **trunk myotomes**
  - **spinal nerves**
- **Branchiomeric—jaw muscles**
  - **somitomeres**
  - **cranial nerves**

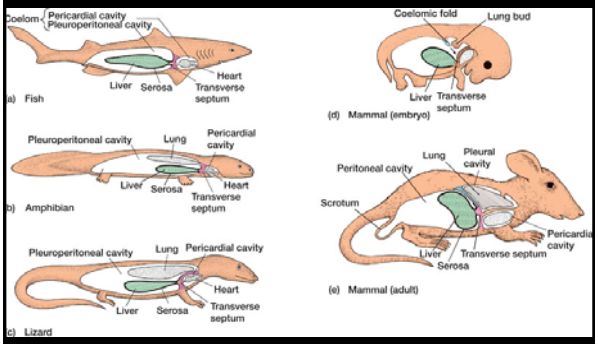
Muscle Differentiation

1) Change in direction (external obliques, etc)

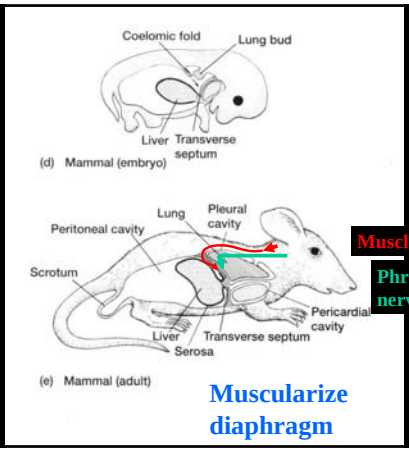
Muscle Differentiation

1) Change in direction (external obliques, etc)
2) Migration of muscle primordia

Migration



Migration



Muscle anlaga

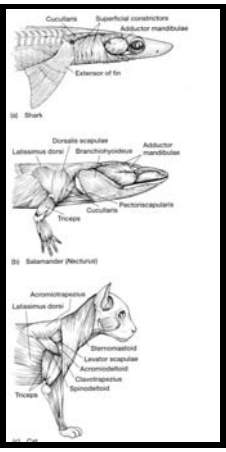
Phrenic nerve

Muscularize diaphragm

Muscle Differentiation

1) Change in direction
2) Migration of muscle primordia
3) Fusion

Fusion

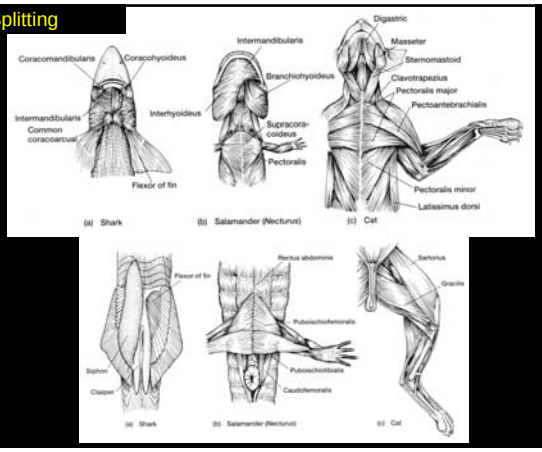


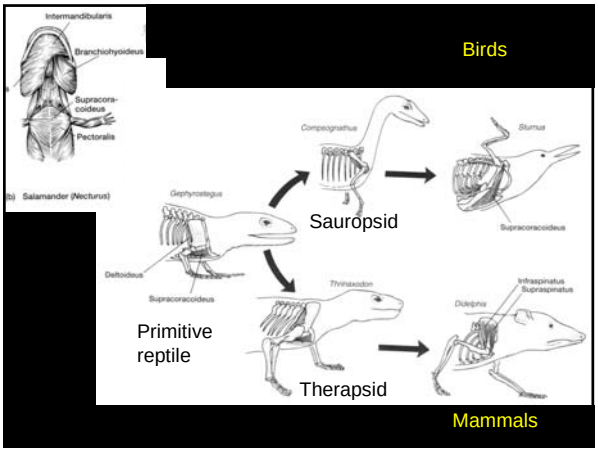
Fusion

Muscle Differentiation

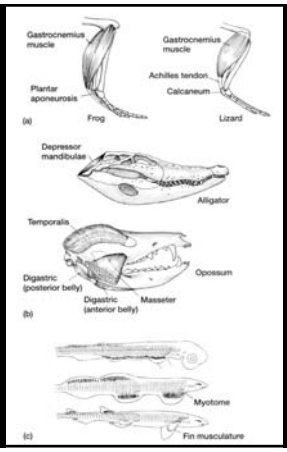
1) Change in direction
2) Migration of muscle primordia
3) Fusion
4) Splitting

Splitting





Muscle Homology



Attachments

Action (Innervation)

Embryology