

The Neuromuscular System

Overview

The body is a complex machine.

Today's Goal:

1. morphological (form and structure) and mechanical review of the neuromuscular system
2. muscle mechanics

System Components

Bone

Primary Function:

- provide mechanical support (rigid links)
- act as lever system to transfer muscle forces (mechanical advantage)
- red blood cells and ion reservoir

Types:

- Cortical
- Trabecular

Wolf's Law: Bone adapts to the loads under which it is placed.

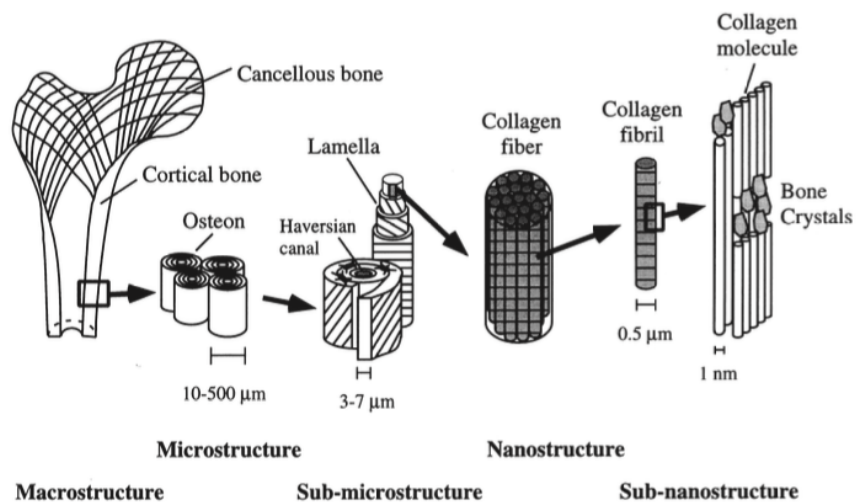
Example: tennis players, low-gravity

Composition:

- mostly collagen (35% wet weight)
- some water (20% wet weight)

Other Facts:

- basic unit is an osteon
- safety factor 2-5
- ~ 206 in body



Rho, 1998

Synovial Joint

Types of joints: fibrous (fetal sutures, long bones), cartilaginous (rib cage, spine), **synovial** (wrist, elbow, etc.)

Primary Function:

- provides mobility of the skeleton
- transmit forces from one segment to another

Composition:

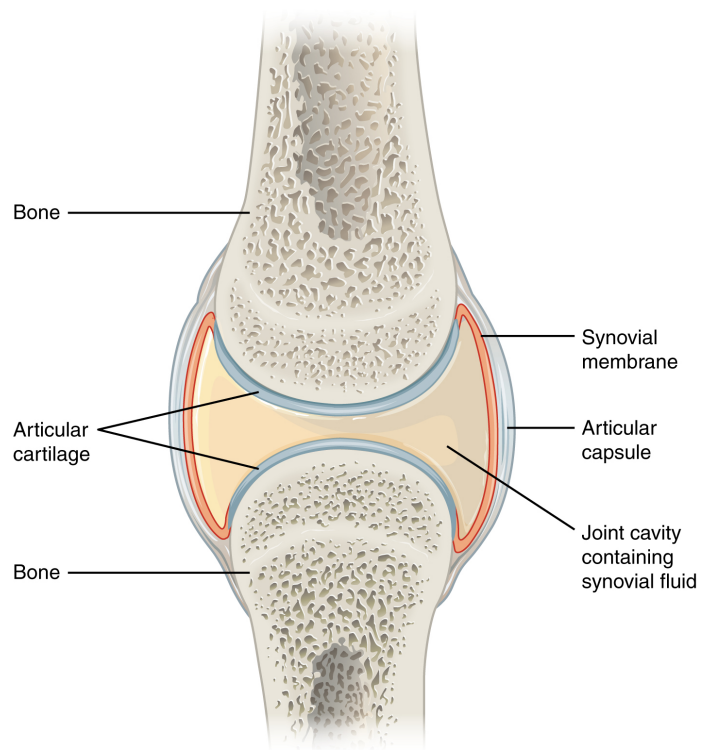
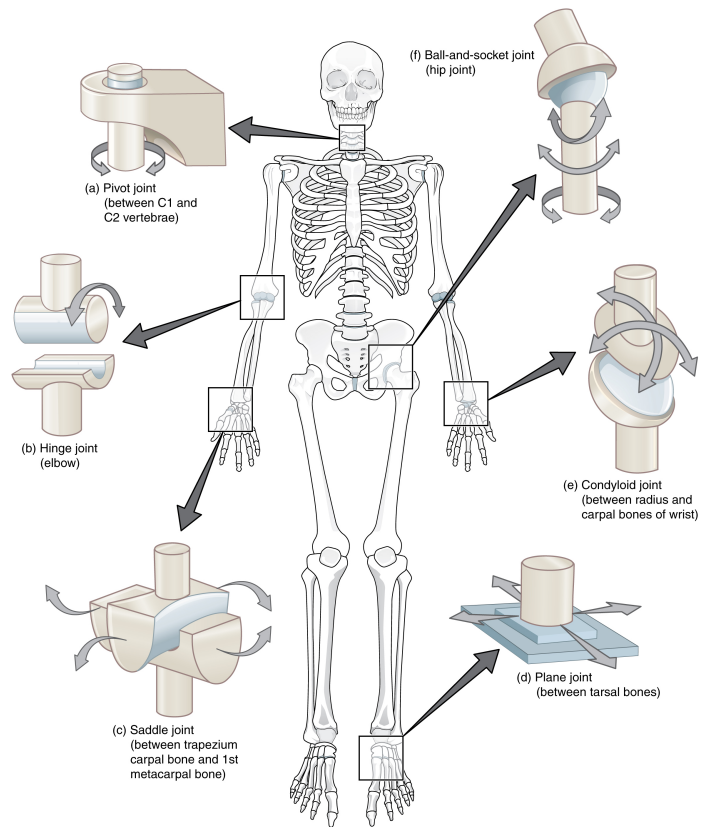
- surface of bones → articular cartilage
- enclosed in joint capsule
- synovial fluid

Joint Stability

- ability of joint to maintain functional position under external force
- most stable joint? (hip?)

Joint Mobility

- ability to move through full anatomical range of motion
- 3 factors determine DOF (degrees of freedom)
 - shape
 - restraint (ligaments)
 - action of muscles across joint
- most mobile joint?



OpenStax College - Anatomy & Physiology, Connexions Web site.

Ligament

Primary Function:

- attach articulating bones to one another across a joint

Example: Knee joint

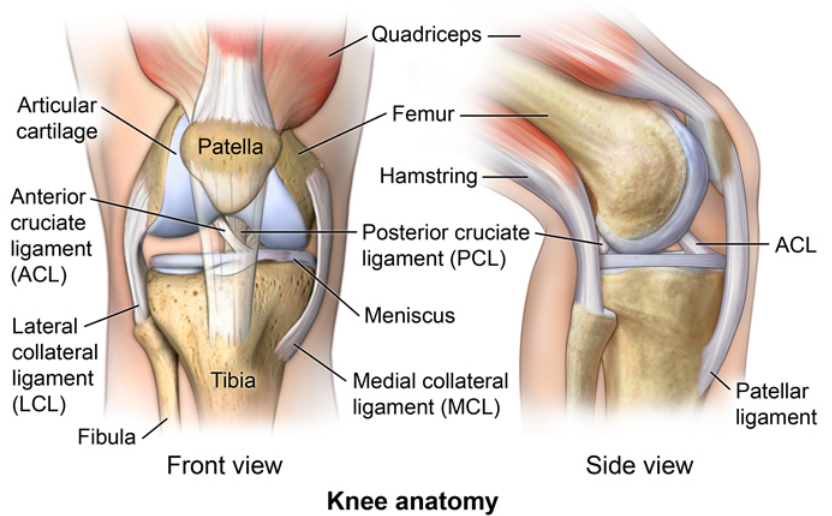
- ACL (anterior cruciate ligament)
- PCL (posterior cruciate ligament)
- MCL (medial collateral ligament)

Composition:

- 75% collagen

Viscoelasticity:

- creep
- force relaxation



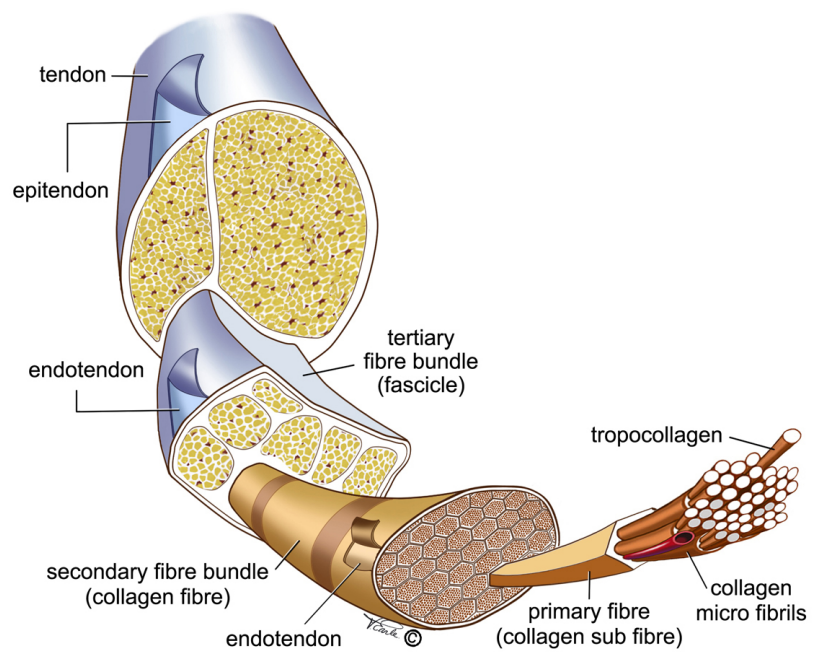
<http://healthcare.utah.edu>

Tendon

Primary Function:

- connect muscles to bone
- transmit forces from muscle to bone
- store elastic energy

Composition: similar to ligament



Vicky Earle (vearlemedicalart.com)

Muscle

Primary Function: generate force

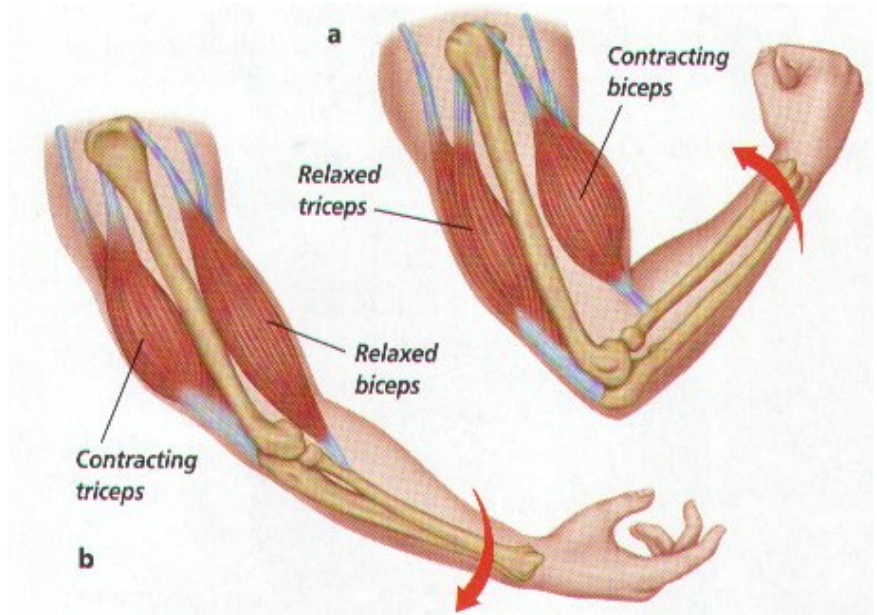
Types: cardiac (heart), smooth (gut), **skeletal**

Muscle's are molecular machines that convert chemical energy into force.

Most skeletal acts across joints.

Some Properties:

- come in pairs
 - flexor: bends limb
 - extensor: straightens limb
- irritability (response to stimulus)
- conductivity (propagate excitation wave, action-potential)
- contractility (modify length)



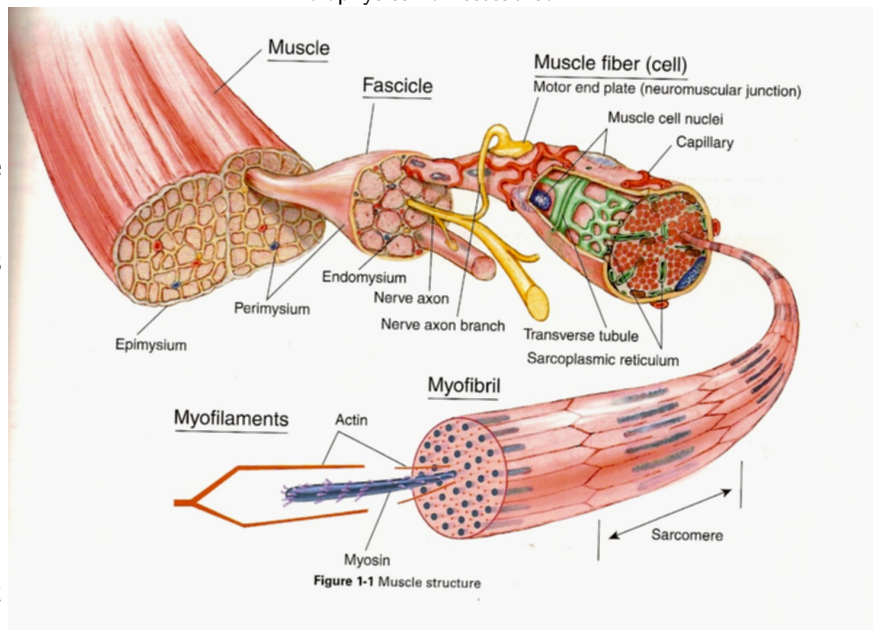
biophysics.homestead.com

Important Elements:

- sarcomere: basic contractile unit
- sarcolemma: muscle fiber excitable membrane
- sarcoplasmic reticulum: membranous system linked to sarcolemma
- motor end plate: innervation location

Critical Processes:

1. relationship of sarcolemma and sarcoplasmic reticulum (action potentials)
2. sarcomere mechanics – sliding filament theory



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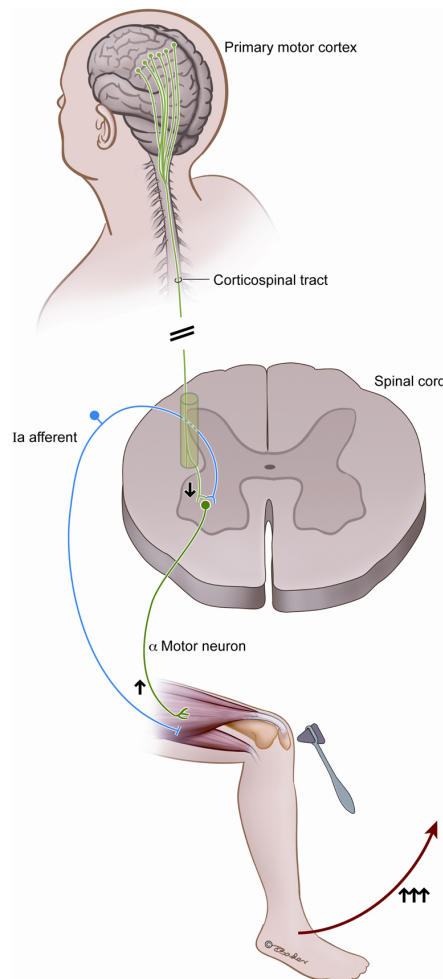
Neuron

Primary Function:

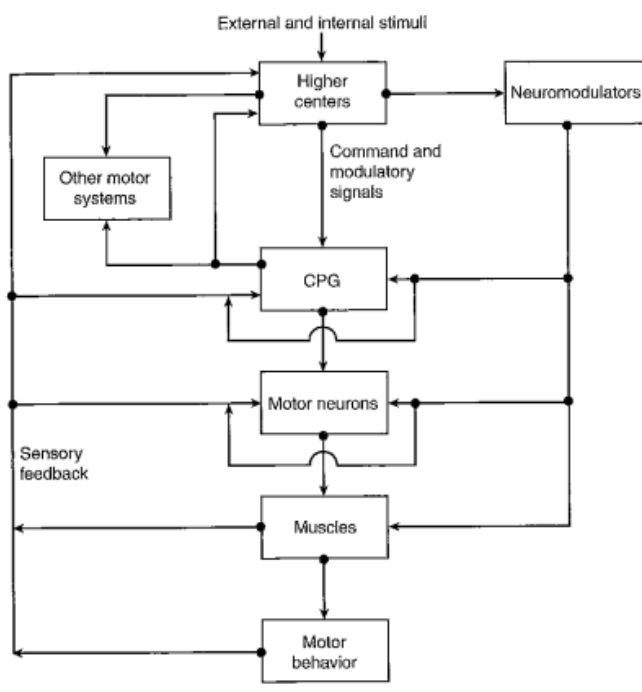
- controls the neuromuscular system
 - reception of information (input)
 - evaluation of information (computation)
 - transmission of motor signal (output)

Types of Interest:

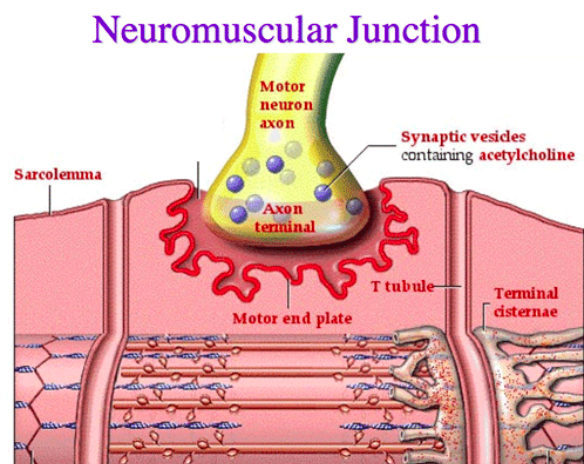
- afferent
 - convey sensor info to CNS
- afferent
 - modulates interactions between neurons
- efferent
 - output motor signal



Florman, 2013



Enoka



newhealthadvisor.com

Sensory Receptors

Primary Function:

- provide information to the CNS about the it's own state and the state of the surroundings

Transducers: convert some type of energy into another form energy (electro-chemical)

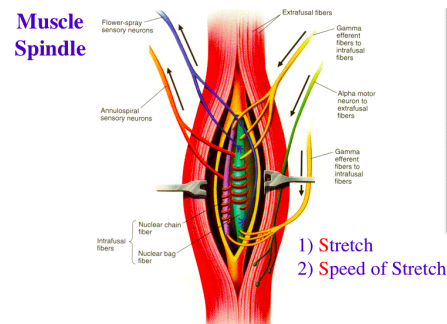
Types of Interest:

- Proprioceptors
 - detect stimuli with in system
- Exteroceptors
 - detect external stimuli

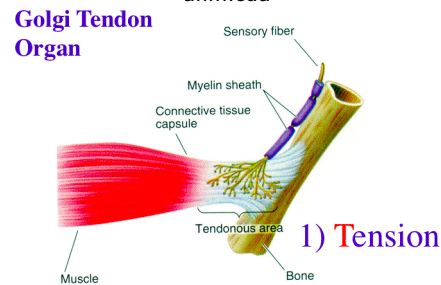
Why? Feedback!

Examples:

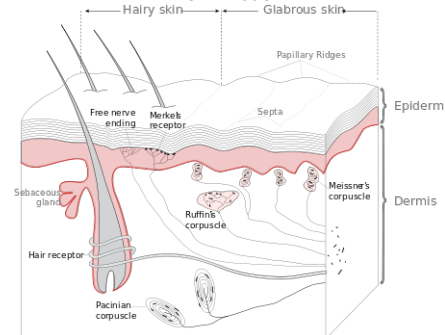
- Muscle Spindles
 - miniature skeletal muscle fibers enclosed in connective tissue
 - afferent neuron supply
 - provide muscle length feedback
- Tendon Organ
 - monitors muscle forces
- Joint receptors
 - angular rates
 - pressure
- Cutaneous Mechanoreceptors
 - interaction forces



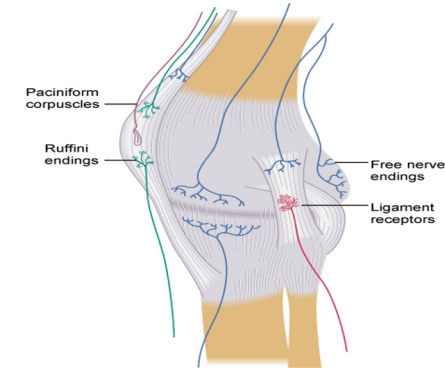
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