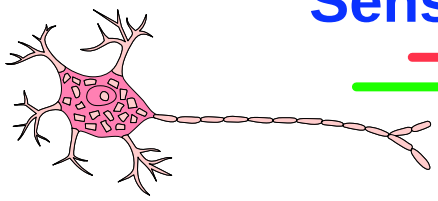
Sensory Physiology has 5 Components



Sensations & Perceptions

sensation - is an awareness of sensory stimuli in brain

perception - meaningful interpretation or conscious under-standing of sensory data

1. Sensory Receptors - structures that detect changes in external & internal environment modifeid neurons or epithelial cells eyes, ears, that respond to stimuli

Classes of Receptors

mechano-receptors : mechanical forces

(1) hair cell
(2) stretch receptors of muscles
(3) equilibrium receptor of inner ear
(4) touch receptors of skin

chemo-receptors : chemicals

sense solutes in solvents, taste, smell
osmo-receptors of hypothalmus which monitors blood osmotic pressure

photo-receptors : light

eye, eyespots, infrared receptors of snakes, etc...

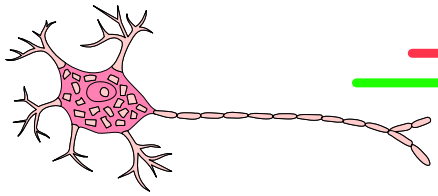
thermo-receptors : radiant energy

phono-receptors : sound

electro-receptors : detect currents... lateral line of fish, electric eels, etc..

noci-receptors : pain receptors... naked dendrites of skin

Sensory Physiology Components

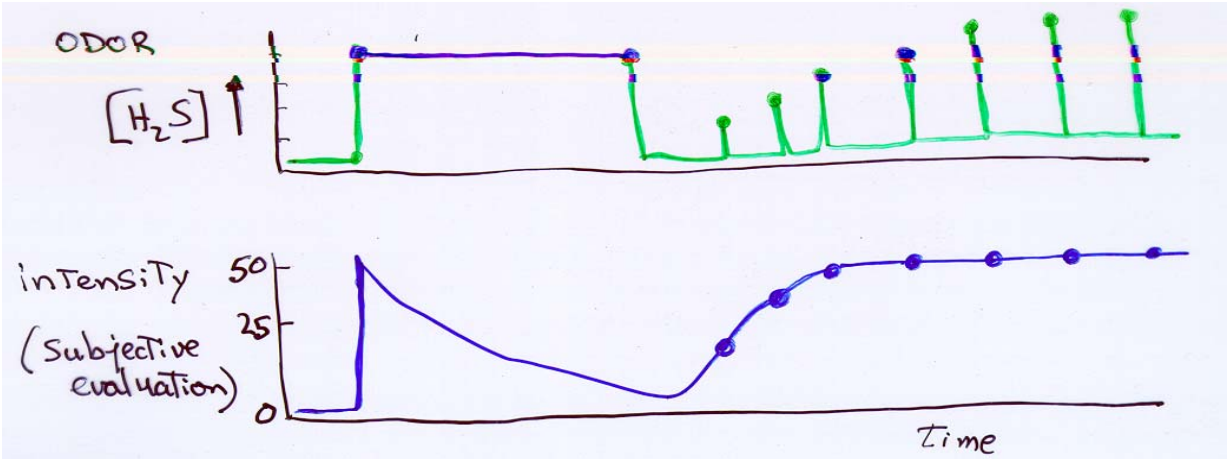


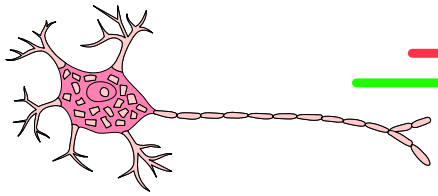
2. **Reception** -
   ability of receptor to absorb energy of a stimulus
3. **Transduction** -
   conversion of stimulus energy into membrane potential, i.e.,
   a Receptor Potential...
   - is a change in permeability of a post-synaptic membrane
   - is graded = proportional to strength of stimulus
   - may be amplified and may be summed
4. **Transmission** -
   receptor potential transmitted via Ap's to CNS
5. **Integration** -
   processing of the frequency of receptor potentials received via summation

Sensory Adaptation -

a decrease in responsiveness by receptor to continual stimulation

a uniformly maintained stimulus of constant intensity is perceived as progressively weaker with time, while a variable intensity stimulus of short duration is perceived as stonger





Vison & some Eye Disorders

Example of Sensory Organ - the Human Eye

structure (parts) - see next panel

vertebrate retina -

photoreceptors -

effect of light on rod & cones -

Some common disorders of vision - correctable by eye glasses

myopia (near-sightedness) -
lens' point of focus falls within the vitreous body,
so that when light reaches the retina it is out of focus

hyperopia (farsightedness) -
point of focus falls behind the retina (out of focus)

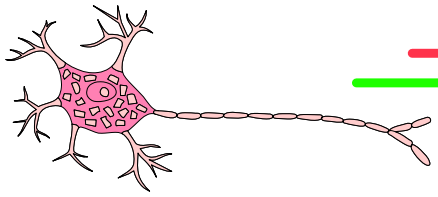
astigmatism - results from defects in the corneal curvature
rays of light don't form a point of focus on the retina.

Other disorders include :

night blindness (lack of chromophore retinal)

color blindness - lack of trichromatic pigments

glaucoma - result of increased pressure of fluids in the eye,
produces defects in field of vision & can lead to vision loss



EYE as a model sensory organ

EYE - a specialized sensory organ capable of light reception &, in vertebrate animals, formed isual images are then carried to the visual center of the brain = perception.

Parts - of a simple eye -

roughly spherical w opaque sides & back,
w transparent front & interior

lens - focuses light on rod & cone cell of retina - cuboidal epithelia

retina - layer of nerve tissue of millions of light receptor cells
rod & cone cells - transmits signals of varying light intensity

fovea - structure near center of retina, where cone cells give max sharpness of vision

optic nerve - retinal cells record light images & transmit to optic nerve, which exits eyeball behind the optic disk (blind spot) to the visual centers of brain.

sclera - tough outer shell of eyeball, made of dense fibrous tissue

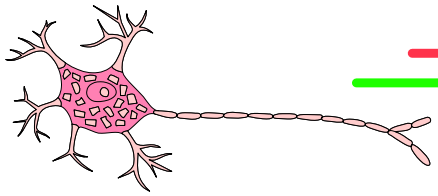
cornea - stratified squamous epithelia, chief refractory part of eye allows light to pass & aids in focusing.

vitreous humour - transparent jellylike material, helps eye keep its spheroid shape.

aqueous humour - anterior chamber, filled with a watery fluid

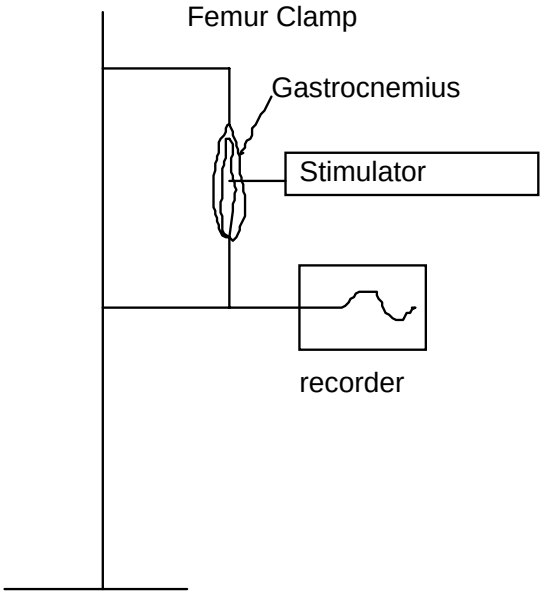
iris - muscular curtain that opens/closes to regulate amount of light entering eye through the **pupil** (opening of iris into eye)

MUSCLE PHYSIOLOGY



Model: **skeletal neuromusclar junction** (see web fig)

innervated muscle fiber
muscles can only contract (pull)



4 parts of a Muscle twitch

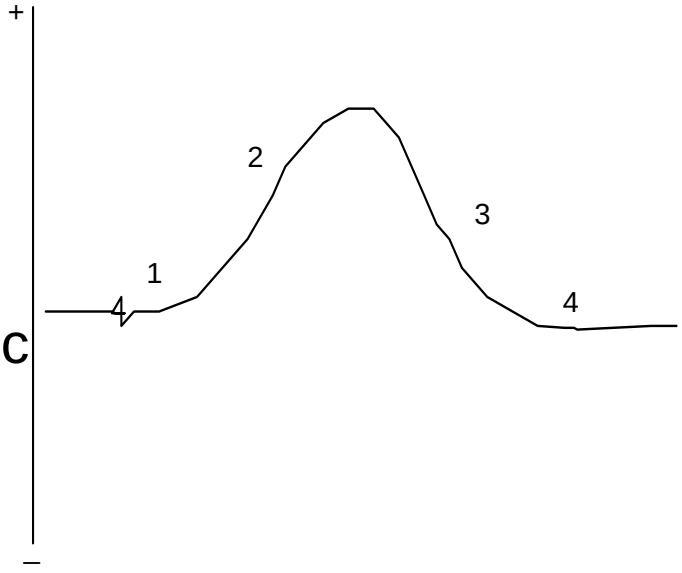
[CONTRACTION]

1) **latent period** - 5 msec
   time between application of AP
   & initiation of contraction

2) **contraction** - 40 msec
   muscle shortens
   & does its work

3) **relaxation** - 50 msec
   muscle elongates
   & returns to original position

4) **refractory period** - 2 msec
   time of recovery
   between stimulations

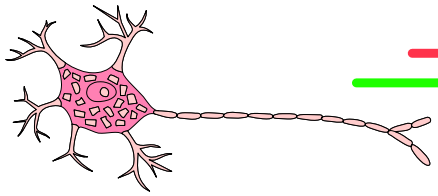


Summation - a 2nd contraction before the 1st subsides

Tetany - sustained contractions

Fatigue - under repeat stimulation, contraction get feebler, lactate accumulates, fatigue, contractions stop

Shivers - involuntary-summed muscle contractions which release waste heat, that warms body



2 TYPES of MUSCLE FIBERS

determined both genetically and functionally
based upon how fast they can produce a contractile twitch
Every muscle composed of varying % composition of two types

TYPE I

SLOW TWITCH

Tonic muscles (red)
Leg muscles

slower contraction times (110 msec)
continuous use muscles
for endurance performance(marathoners)
good for long slow sustained contractions and prolonged performance
not easily fatigued

contain myoglobin (red)
more capillary beds greater max VO_2
smaller in size
lower glycogen content
poor anaerobic glycolysis

predominant aerobic enzymes & aerobic metabolism
higher fat content
more miotchondria-Beta Oxidation high
poorly formed sarcoplasmic reticulum
slower release of Ca = slow contractions
tropinin has lower affinity for Ca

TYPE II

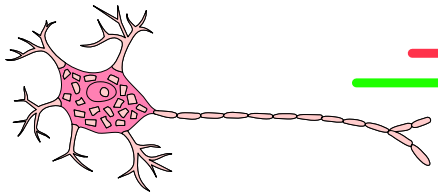
FAST TWITCH

Tetanic muscles (white)
Pectoral muscles

faster contraction times (50 msec)
one time use muslces
for power & speed (sprinters)
good in rapid contraction short time and brief performance
easily fatigued

no myoglobin (white)
less capillary beds
larger in size
higher glycogen content
predominant anaerobic glycolysis
easily converts glycogen to lac w/o O_2
some aerobic capacity

lower fat content
fewer mitochondria- Beta Oxidation low
well formed sacroplasmic reticulum
quick release of Ca =rapid contractions
troponin - higher affinity for Ca



Vertebrate Skeletal Muscle - structure

sarcomere - repeat unit of striated muscle, delimited by Z-lines

- **I band** - "clear zone around Z-line (isotropic)
- **A band** - dark region in center of sarcomere (anisotropic)
- **M line** - mid point of sarcomere
- **H zone** - clear region in cnter of sarcomer around M line

SLIDING FILAMENT THEORY of Muscle Contraction

A band remains constant in size
H Zone becomes denser
I band varies in length becoming shorter

Muscle Cell Proteins

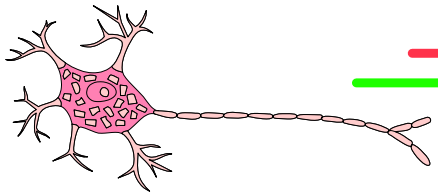
myosin - 2 polypeptides forming a helix with globular end, which has ATPase activity & an affinity to bind to actin
THICK FILAMENT

G-actin - globular protein which polymerizes into THIN FILAMENT, contains a myosin binding site

tropomyosin - fiberlike protein which helically wraps around actin thin filament

troponin - globular protein which binds Ca^{+2}

Muscle Contraction Cycle & Role of Ca



Muscle Performance & Doping

Disuse of a muscle, as in space travel (weightlessness), or couch potato shrinks muscle by 20% in 2 weeks. Weight Training increases muscle - 150% of normal size

How? by making more muscle proteins...

nuclei of muscle control translation, but muscle nuclei don't divide. New nuclei come from independent adjacent stem cells called Satellite cells.

rigorous exercise "tears", attracting satellite cells depositing more nuclei... heterotrophy of muscles.

more nuclei = more protein synthesis =muscle enlargement

Recruitment of Muscle Fibers?

neural input (electrical stimulation) is necessary for the proper genetic expression of the Slow-Type I isoform. Electrical stimulation boosts slow fiber in paralyzed muscles but slow ---> fast ? maybe... but no good evidence to date for slow to fast recruitments.

Gene & Drug Doping:

IGF-I* (insulin-like growth factor)

viral vectors (AAV) infuse IGF-I gene into muscle cells = increases: 15% to 30% in size & 2x in strength

MYOSTATIN - promotes atrophy & slow muscle cell growth thus inhibition of myostatin promotes muscle growth