Sensations & Perceptions

**sensation** - is an awareness of sensory stimuli in brain

**perception** - meaningful interpretation or conscious understanding of sensory data

1. **Sensory Receptors** - structures that detect changes in external & internal environment modified 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
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 stronger
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 - a specialized sensory organ capable of light reception &,
in vertebrate animals, formed visual 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)
Model: **skeletal neuromuscular 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 gets feeblaler, 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

<table>
<thead>
<tr>
<th>TYPE I</th>
<th>TYPE II</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLOW TWITCH</td>
<td>FAST TWITCH</td>
</tr>
<tr>
<td>Tonic muscles (red)</td>
<td>Tetanic muscles (white)</td>
</tr>
<tr>
<td>Leg muscles</td>
<td>Pectoral muscles</td>
</tr>
</tbody>
</table>

- Slower contraction times (110 msec) vs. faster contraction times (50 msec)
- Continuous use muscles vs. one time use muscles
- For endurance performance (marathoners) vs. for power & speed (sprinters)
- Good for long slow sustained contractions and prolonged performance vs. good in rapid contraction short time and brief performance
- Not easily fatigued vs. easily fatigued

-含 myoglobin (red) vs. no myoglobin (white)
- More capillary beds greater max VO₂ vs. less capillary beds
- Smaller in size vs. larger in size
- Lower glycogen content vs. higher glycogen content
- Poor anaerobic glycolysis vs. predominant anaerobic glycolysis
- Predominant aerobic enzymes & aerobic metabolism vs. some aerobic capacity
- Higher fat content vs. lower fat content
- More mitochondria-Beta Oxidation high vs. fewer mitochondria-Beta Oxidation low
- Poorly formed sarcoplasmic reticulum vs. well formed sarcoplasmic reticulum
- Slower release of Ca = slow contractions vs. quick release of Ca = rapid contractions
- Tropinin has lower affinity for Ca vs. 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 center of sarcomere 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 \( \text{Ca}^{+2} \)

Muscle Contraction Cycle & Role of Ca
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