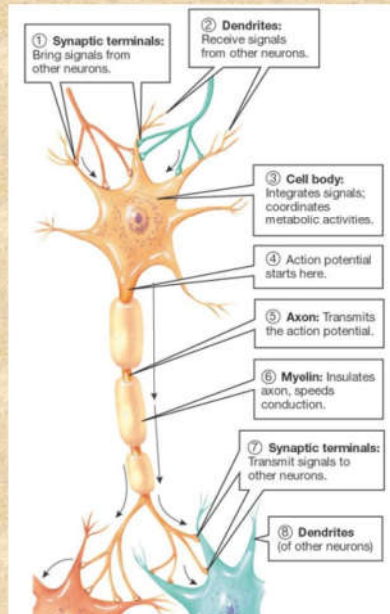


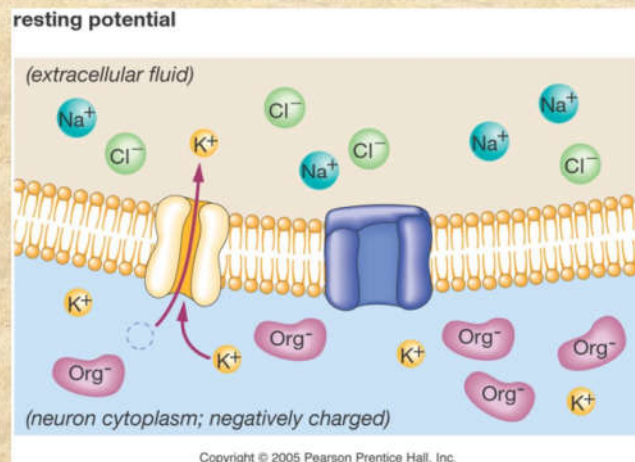
The Neuron

- Dendrites receive signals.
- The cell body integrates signals.
- The axon transmits action potential. The myelin sheath makes the signal travel faster.
- Synaptic terminals transmit signals.



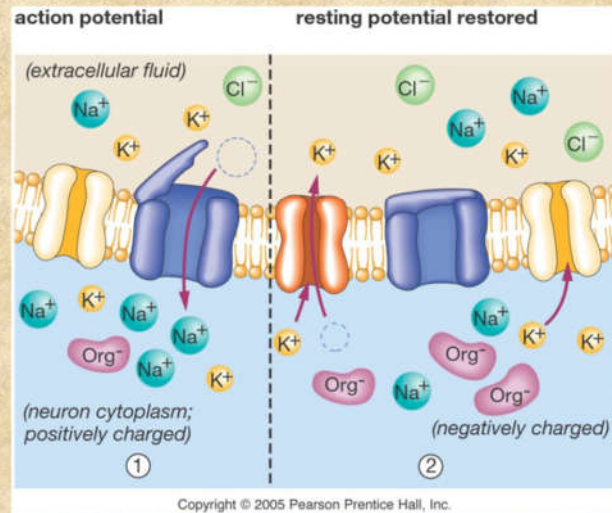
Resting potential

- Using active transport, the neuron moves Na^+ ions to the outside of the cell and K^+ ions to the inside of the cell.
- Large molecules in the cell maintain a negative charge.



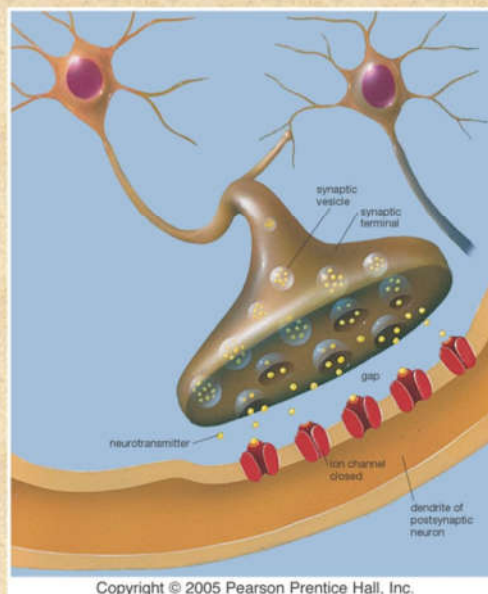
Action potential

- On receiving a stimulus, sodium gates and potassium channels open briefly, allowing these ions to diffuse.
- The gates close, and active transport restores the resting potential.



Synapse

- Neurons usually do not connect directly to one another. A gap called a synapse controls the transmission of signals.
- Neurotransmitters cross the synapse and stimulate the next neuron.



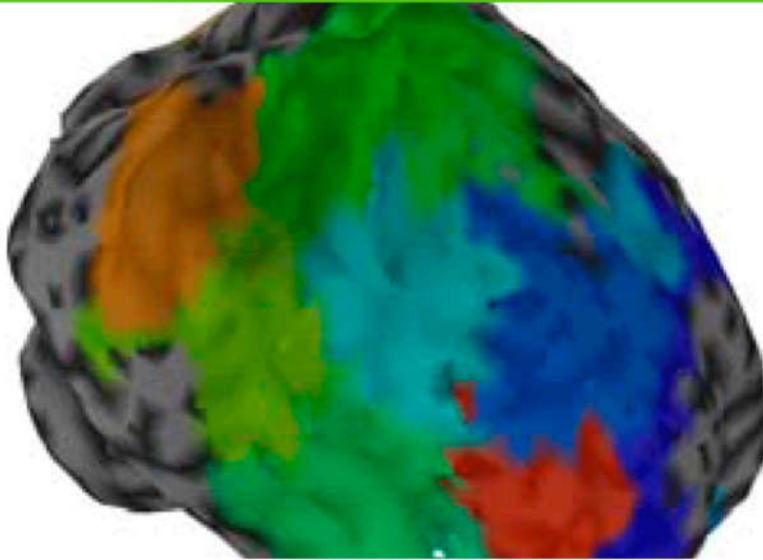
Web Address

<http://outreach.mcb.harvard.edu/animations/actionpotential.swf>

Some Neurotransmitters

Neurotransmitter	Location	Some Functions
Acetylcholine	Neuron-to-muscle synapse	Activates muscles
Dopamine	Mid-brain	Control of movement
Epinephrine	Sympathetic system	Stress response
Serotonin	Midbrain, pons, medulla	Mood, sleep
Endorphins	Brain, spine	Mood, pain reduction
Nitric Oxide	Brain	Memory storage

Information Processing



Four basic operations

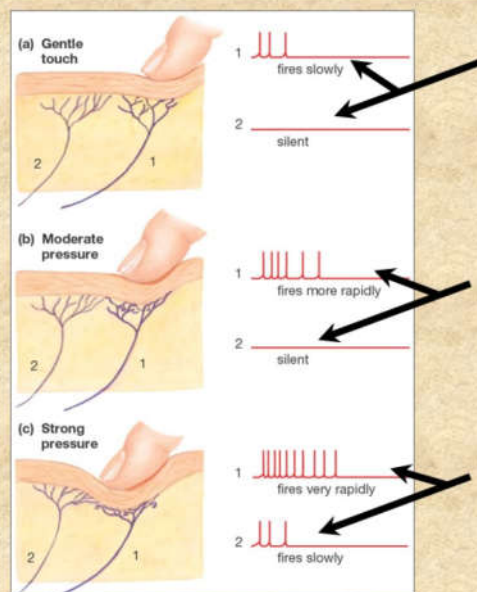
- • Determine type of stimulus
- • Signal the intensity of a stimulus
- • Integrate responses from many sources
- • Initiate and direct operations

Type of stimulus

- Wiring patterns in the brain determine the type of stimulus.
- Areas of the brain dedicated to specific sensory signals are connected to nerves that connect to specific sensory organs.
- “Cross-sensory” effects: a poke in the eye produces stimulates the optic nerve, producing visual effects.

Intensity of stimulus

- Intensity = frequency of action potentials



Integration of stimuli

- Convergence = Many signals arrive through many neurons, but several may pass their signal to a single connecting neuron.
- Such cells may be “decision-making” cells that may determine an appropriate output.

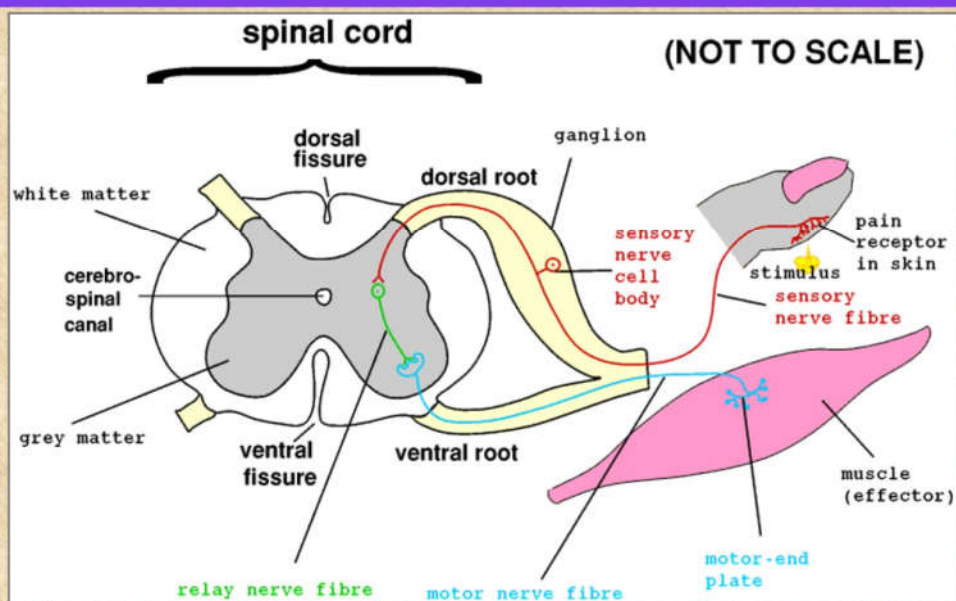
Directing operations

- **Neural pathways consist of:**
 - Sensory neurons
 - Association neurons, which receive signals from many sources
 - Motor neurons
 - Effectors: muscles, glands

Reflexes

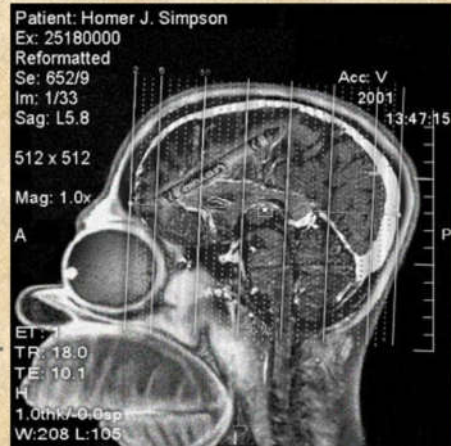
- The simplest neural pathway is the reflex arc.
- This involves one or more sensory neurons, association neurons in the spine, and motor neurons, which carry out the reflex entirely **before** the brain is aware of the response.

Reflex Arc



Why a Brain?

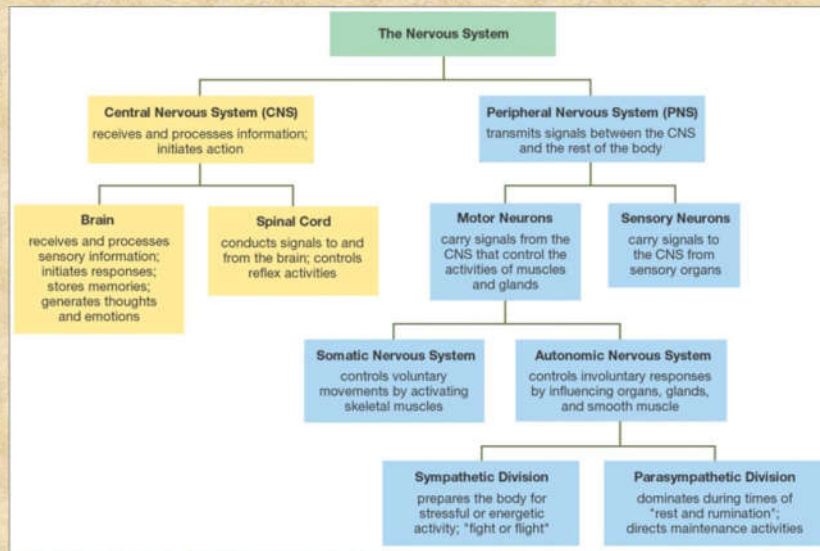
- Brains are the result of selection for centralization of the nervous system.
- Neurons control movement. The brain (or spine) interprets sensory signals and determines the appropriate movements (that is, behavior).
- Appropriate movement is critical to the survival of most animal species.



Organization



Neural Organization

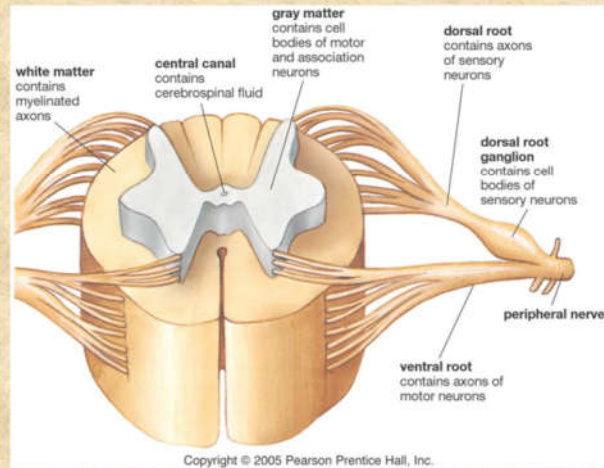


Central Nervous System

- Consists of brain and spine
- Functions:
 - Receives sensory signals and determines appropriate response
 - Stores memory
 - Carries out thought

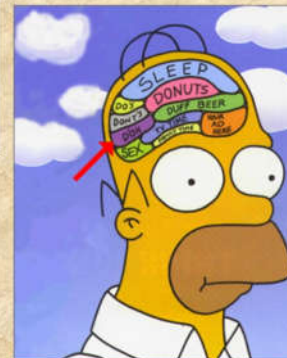
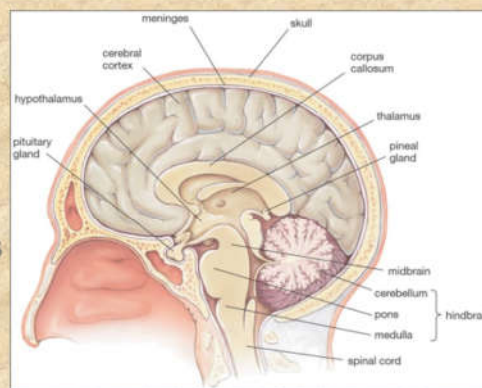
Spine: structure

- The spinal cord is protected by the vertebrae.
- Gray matter contains cell bodies; white matter contains myelinated fibers.
- PNS nerves extend outside of the vertebrae.



Brain: Structure

- Hindbrain carries out the most basic functions.
- Midbrain coordinates signals.
- Forebrain processes signals, stores memories, creates thought.



Peripheral Nervous System

- Nerves, neurons, and sensory organs outside the central nervous system
- Functions:
 - Sends signals to the CNS
 - Receives and transmits motor signals from the CNS
 - Stimulates effectors

Somatic Nervous System

- Motor neurons that control voluntary movements by activating skeletal muscles.
- Also involved in what we perceive as involuntary movements, such as reflexes (though voluntary control of the muscles involved, such as tensing them, can reduce the response).

Autonomic Nervous System

- Motor neurons that control involuntary responses involving the organs, glands, and smooth muscles.
- Some voluntary control over the responses can come from relaxation, meditation, etc., which reduce perceptions of stress and in turn reduce the stress response.

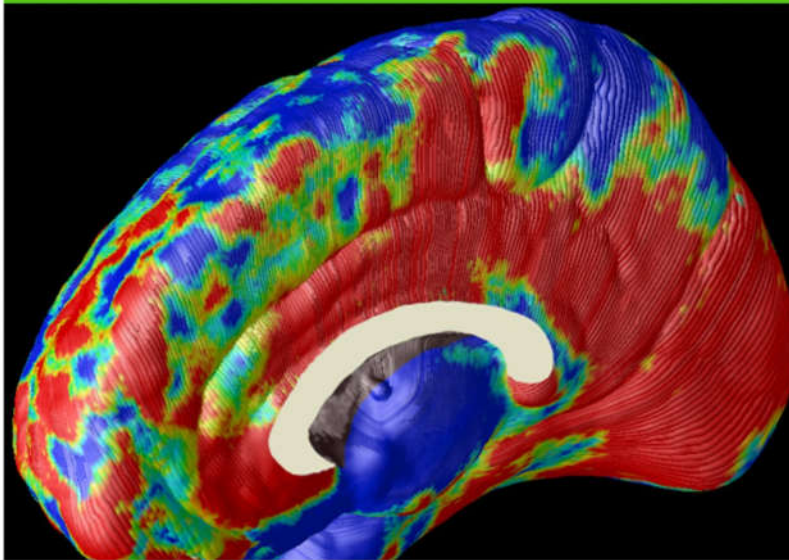
Sympathetic Division

- Portion of the autonomic nervous system that produces the “fight or flight” response:
 - Dilation of pupils
 - Increased heart and breathing rates
 - Constriction of blood vessels
 - Inhibits digestion

Parasympathetic Division

- Portion of the autonomic nervous system that produces the “rest and ruminate” response:
 - Constricts pupils
 - Dilates blood vessels
 - Reduces heart and breathing rates.
 - Stimulates digestion.

Brain and Mind

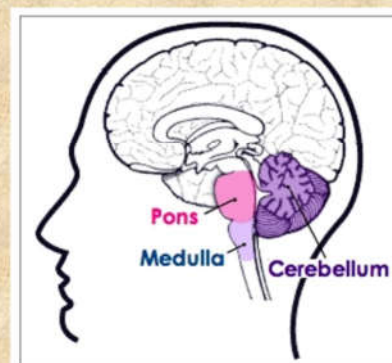


The Complex Brain

- The mammalian brain is highly complex, containing many specialized regions that carry out specific functions.
- Generally, the brain is divided into hindbrain, midbrain, and forebrain.

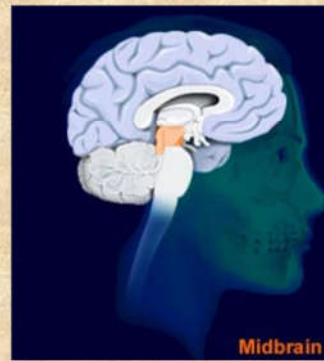
Hindbrain

- Medulla: controls autonomic functions.
- Pons: controls sleep stages.
- Cerebellum: coordinates movement, stores some motor memory.



Midbrain

- Reticular formation: the “traffic cops” of the brain.
- Filters sensory input, which allows us to concentrate.
- Filtering can be affected by higher thoughts.

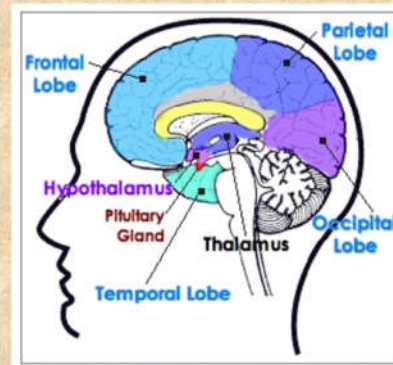


Try this:

- Stop and think: What have you been paying attention to for the last ten minutes?
- Pay attention to the feel of your shirt on your arms. Had you been noticing it during the last ten minutes? That's the reticular formation in action.
- What else have you *not* been paying attention to?

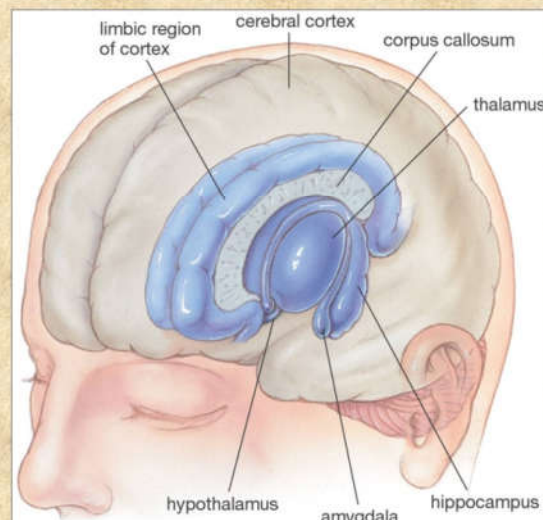
Forebrain

- Thalamus: relay station channeling sensory information.
- Limbic system: basic emotions, drives, and behaviors.
- Cortex: higher thought



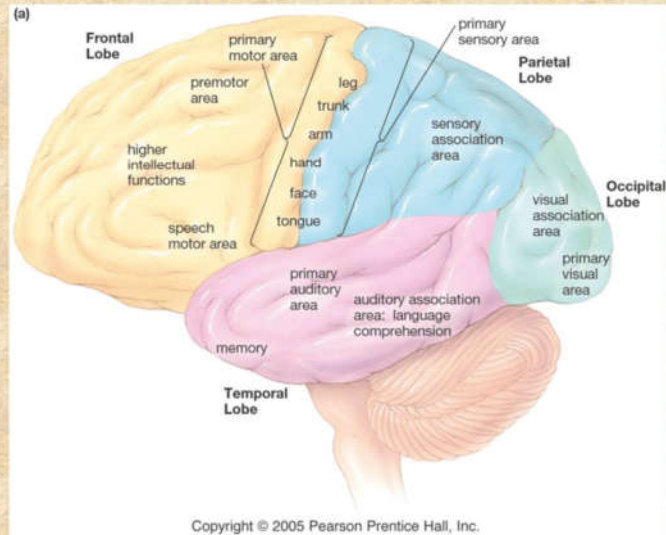
Limbic system

- Hypothalamus: master controller of the endocrine system.
- Amygdala: sensations of pleasure or fear, recognition of fear in others.
- Hippocampus: formation of memories.



Cortex

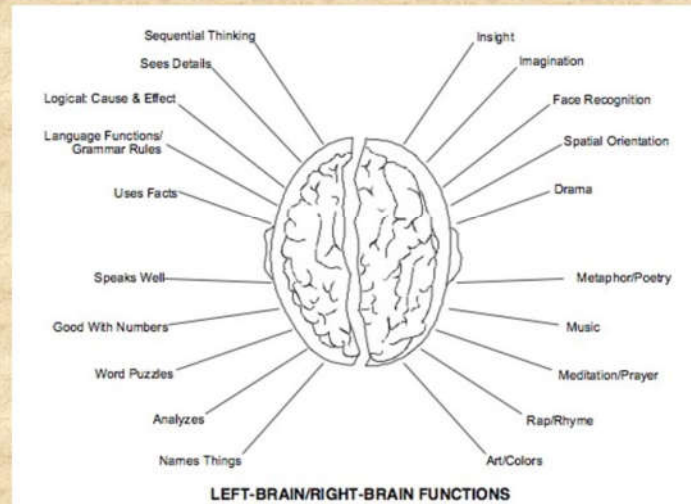
- Various areas control sensory processing, motor control, thought, memory.
- Wiring is plastic: people blind from birth, for example, use parts of the visual cortex to process auditory signals.



Left brain, right brain?

- While there is some specialization to each hemisphere, the idea has been oversimplified.
- The left brain controls the right half of the body; the right brain controls the left half of the body.
- However, “right brain” or “left brain” functions such as math, language, etc. produce activity on both sides of the brain, and processing of these may be different in different people (males vs. females, novices vs. experts, etc.).

Brain “maps”?



While hemispheric research shows some specialization between hemispheres, most “brain maps” like this are nonsense.

Memory

- How humans form memories is poorly understood.
- “Working memory” appears to be distinct from long-term memory. There may be short-term memory as well, things remembered for a few days. Is this because the memory disappears, or because it cannot be retrieved?

Models of Memory

The Atkinson-Shiffrin Model

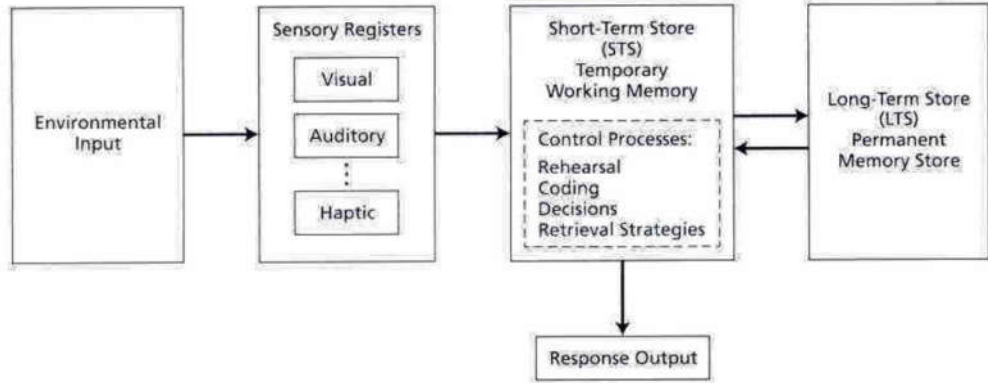
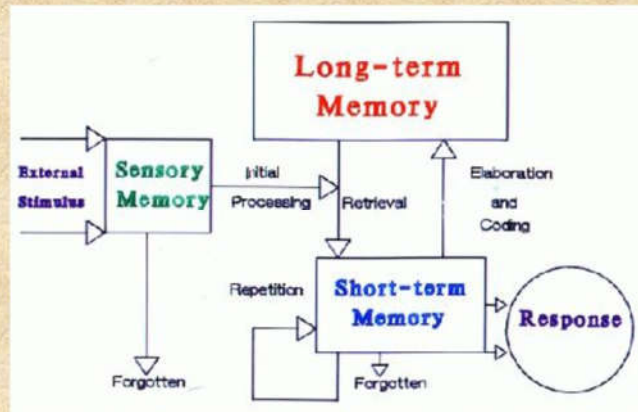


FIGURE 8.2 The Atkinson-Shiffrin Information Processing Model. (From Atkinson and Shiffrin, 1971.) © 1971 Scientific American.

Models of Memory



Craik & Lockhart, 1972

What is mind?

- Many traditions, including psychology, separate “brain” from “mind.”
- What we perceive as “mind” (thought, will, self-perception) does produce evidence of brain activity in brain scans.
- That “brain” influences “mind” is well-established; but some evidence shows “mind” can influence “brain”; as cognitive therapy for depression can physically change the brain.
- Neurology is a very young science, and there is still much to learn about the brain-mind connection.

Senses

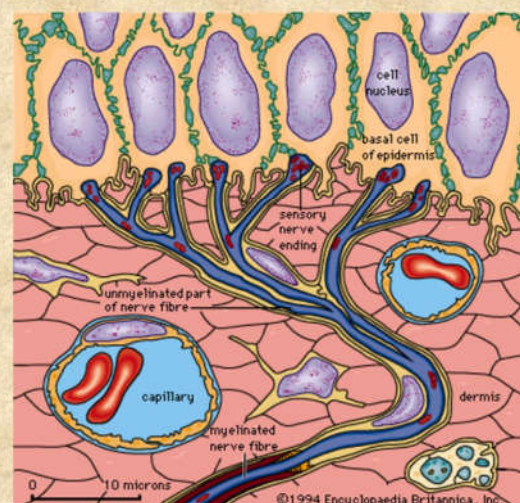


Sensory receptors

- Receptors are found in the sense organs. They receive stimuli from the environment and transmit stimuli to neurons.
- Primary human senses: photoreception, chemoreception, mechanoreception, thermoreception.

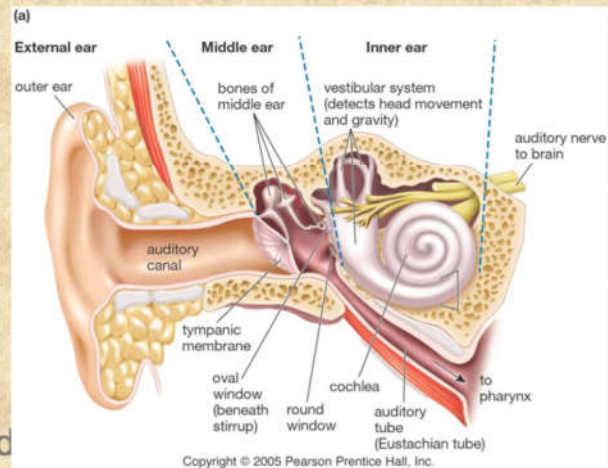
Thermoreception

- Free nerve endings in the skin sense changes in temperature (differences rather than absolutes).
- These are directly transmitted through the PNS.



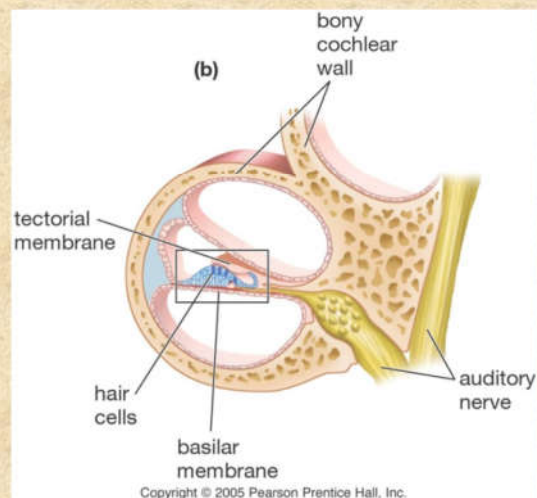
Mechanoreception

- Hearing is a form of mechanoreception.
- Ears gather sound waves from the environment.
- The inner ear bones amplify sounds.
- Sounds are transmitted to the cochlea.



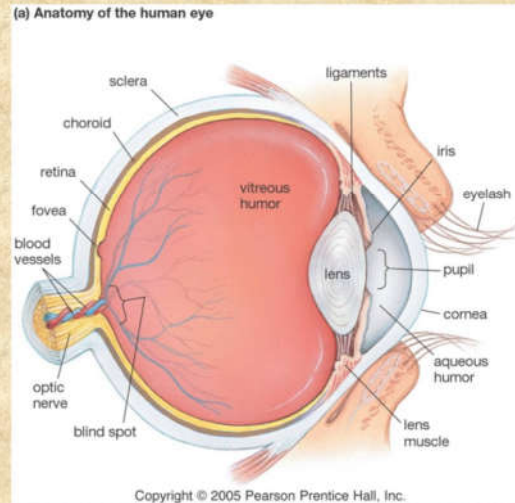
Sound transmission

- Within the cochlea, hair cells on the basilar membrane vibrate to certain frequencies, and send signals down the auditory nerve.
- Loud sounds can damage these sensitive hairs permanently.



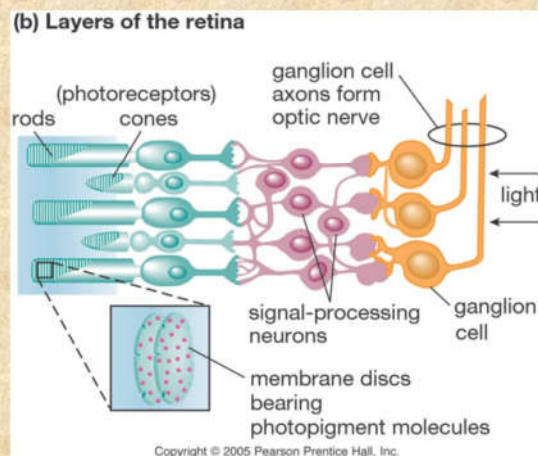
Photoreception

- Sight is photoreception.
- Light enters the eye through the cornea and pupil.
- Light is focused by the lens.
- Light strikes the retina, and stimulates receptors.



Photoreceptors

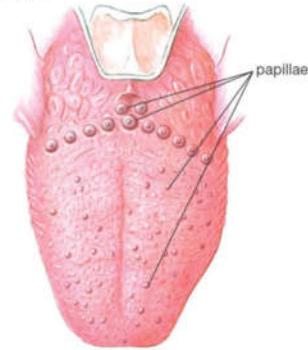
- Light breaks pigments in the receptor cells, releasing energy that stimulates neurons connecting to the optic nerve.
- Rod cells detect amount of light, cone cells distinguish colors.



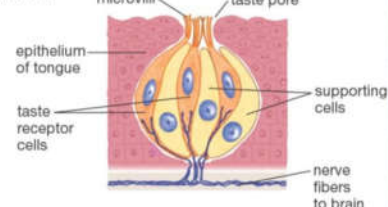
Chemoreception

- Taste is one form of chemoreception.
- Taste buds detect certain ions dissolved in saliva.
- Tastes: salty, sweet, sour, bitter, "umami."

(a) The human tongue

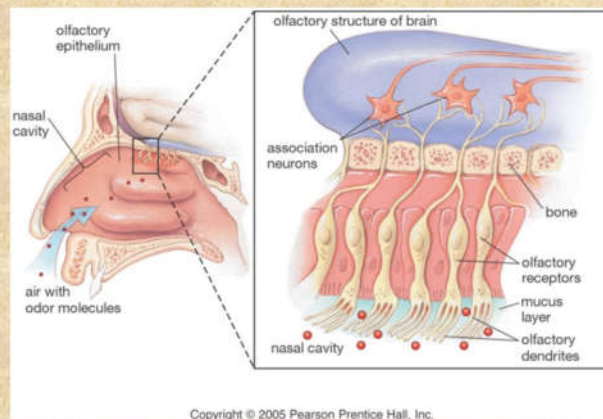


(b) Taste bud



Chemoreception

- Smell is another form of chemoreception.
- Receptors in the olfactory patch in the human nose can distinguish between about 1000 different chemicals in the air.

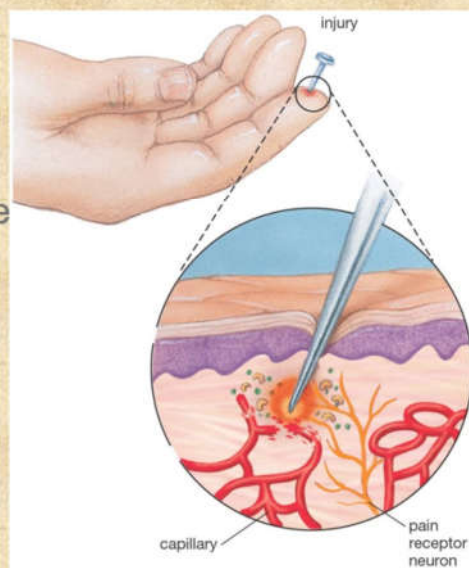


“Flavor”

- What we sense as the “flavor” of food is not taste alone. Smell and taste together create the sensation of “flavor.”
- This is why things don’t “taste” good when we have a cold; we lose the sense of “flavor.”

Chemoreception


- The sense of pain is another form of chemoreception.
- Injured tissues release chemicals as a response. These chemicals stimulate free nerve endings in the skin and the stimulation is perceived as pain.



Copyright © 2005 Pearson Prentice Hall, Inc.

Strange perceptions

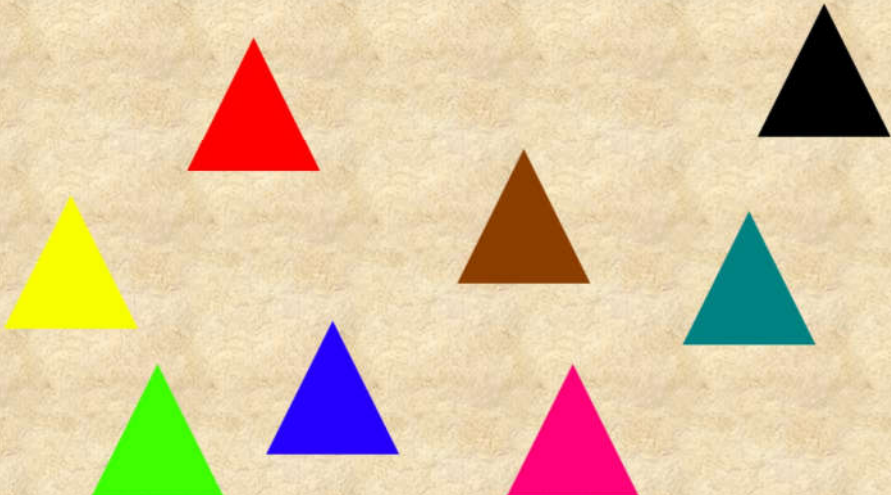
Which one of these, if any, is the right color for this letter?



The image shows seven capital letters 'A' scattered on a textured tan background. The colors of the letters are: yellow, brown, blue, purple, green, orange, and red.

Strange perceptions

Which of these, if any, is the right color for this shape?



The image shows eight equilateral triangles scattered on a textured tan background. The colors of the triangles are: red, black, yellow, brown, teal, green, blue, and pink.

Synesthesia

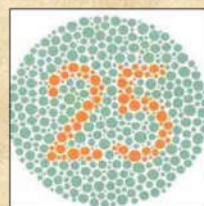
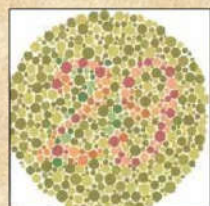
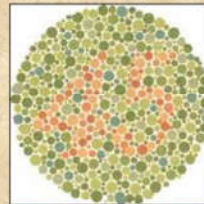
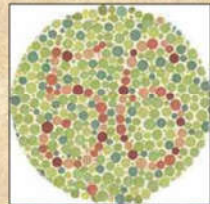
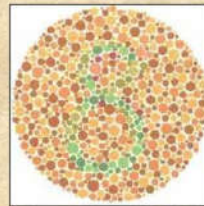
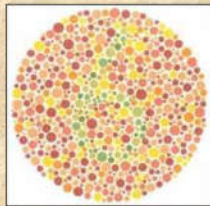
- Synesthesia can be described as “cross-sensory perceptions.”
- Synesthetes experience more than one sensory perception for a single sensory reception, such as experiencing flashes of particular colors or textures when hearing certain sounds.

Synesthesia

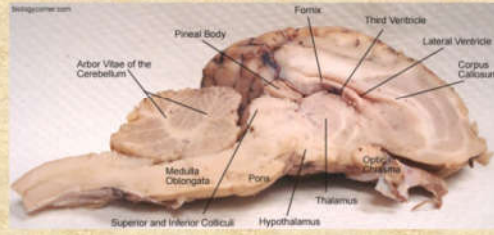
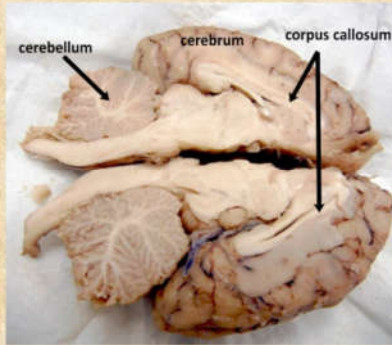
- The cause of synesthesia is unknown. Some speculate that all infants are synesthetic, and neural “pruning” during early years separates the senses. In some individuals, the pruning may not be complete. The evidence on this is mixed.
- The experiences are unique to each individual (i.e. there is no universal association between a certain letter or a certain color), are not made up or learned, and usually remain the same throughout life.

One Synesthete's Alphabet

A B C D E F G H I
J K L M N O P Q R
S T U V W X Y Z



Application: Dissection of the Sheep Brain For Gross Anatomical Examination



Source: https://www.biologycorner.com/anatomy/sheepbrain/sheep_dissection.html

Source: <https://slideplayer.com/slide/4951224/>