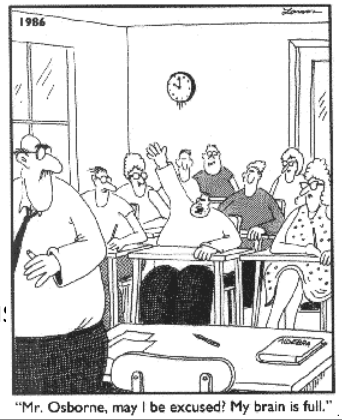
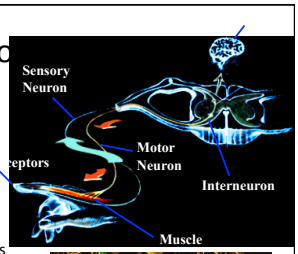
The Nervous System

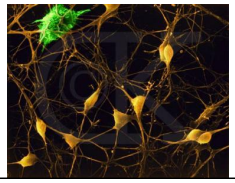


"Mr. Osborne, may I be excused? My brain is full."

Key Co

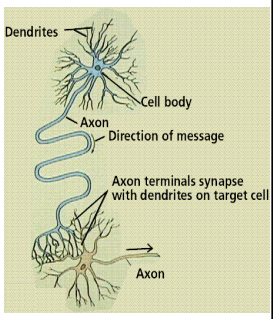
- Nervous systems function in sensory input, integration, and motor output.
- The nervous system is composed of neurons and supporting cells.
- Membrane potentials arise from differences in ion concentrations between a cell's contents and the extracellular fluid.
- An action potential is an all-or-none change in the membrane potential.



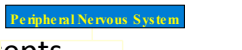


Key Concepts

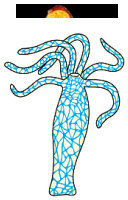
- Action potentials travel along an axon because they are self-propagating.
- Chemical or electrical communication between cells occurs at synapses.
- One neurotransmitter can produce different effects on different types of cells.



Key Concepts

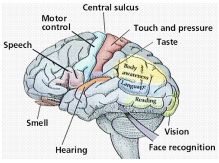


- The symmetry of the nervous system is correlated with body symmetry.
- Vertebrate nervous systems are highly centralized and cephalized.
- The vertebrate peripheral nervous system has several components differing in organization and function.

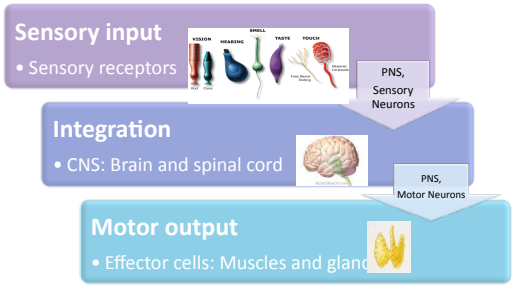


Key Conce

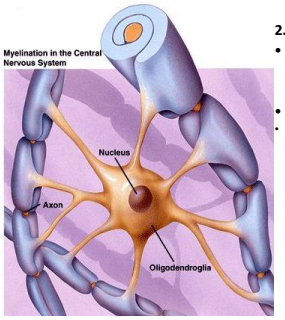
- The brainstem conducts data and controls automatic activities essential for survival.
- The cerebellum controls movement and balance.
- The thalamus and hypothalamus are prominent integrating centers of the forebrain.
- The cerebrum contains the most sophisticated integrating centers.



Functions of Nervous Systems



Cells of the Nerv



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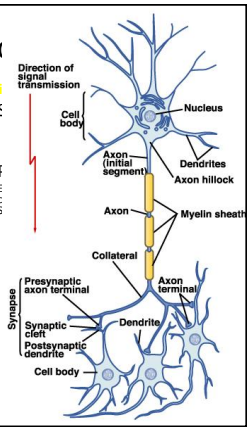
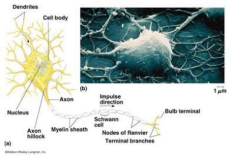


The Dendrite Song

(sung to the tune of "Clementine" sent in by Leah B., a graduate student in elementary education at Long Island Univ. Leah gives credit to Bruce Campbell for composing this song.)

Use your dendrites,
Use your dendrites,
To connect throughout your brain.
Take in info, analyze it,
Grow some new ones
Unrestrained.



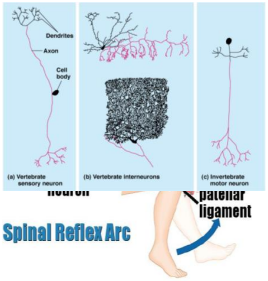
Axons send out
Neurotransmitters
To the dendrites all around
Across the synapse
Jumps the impulse
New ideas can now abound.

Stimulation
Is what the brain needs
To make dendrites stretch and grow.
New connections
Make us smarter
In what we think and what we know.

Use your dendrites,
Use your dendrites,
To connect throughout your brain
Take in info, analyze it,
Grow some new ones
Unrestrained.

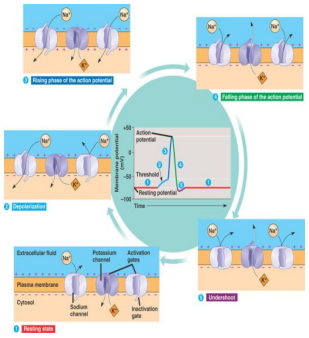
How are neurons organized?

- Three types of neurons
1. **Sensory** neurons
2. **Interneurons**
3. **Motor** neurons
- **Neural circuits** form from any combination of two or more of these
- **Convergent**: (many to one)
- **Divergent**: (one to many)
- **Reverberating**: (circular)
- Simplest: Sensory and motor neurons – **reflex arc**



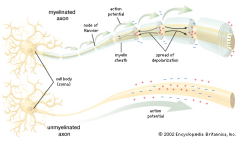
Electrical conduction of information

- **Membrane potential**
- **Resting potential**
- **Action potential/impulse**



Saltatory conduction – a faster way

- Depends on myelin sheaths coating an axon
- Impulses are carried from node to node instead of throughout the membrane of the axon
- Advantages
  - Saves on ATP/energy
  - Increases the speed of conduction
- Multiple sclerosis – neurological disorder causing the demyelination of axons in the CNS



Neurotransmitters: crossing the gap between neurons

- Chemicals that cross the synapse to relay the impulse to another neuron or an effector
- Examples: acetylcholine, norepinephrine, dopamine, serotonin, endorphins, amino acids, neuropeptides, gases

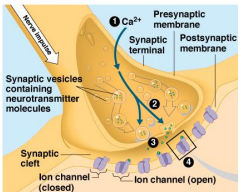
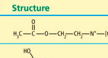
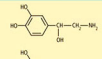
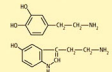
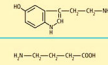
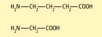
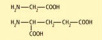
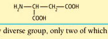
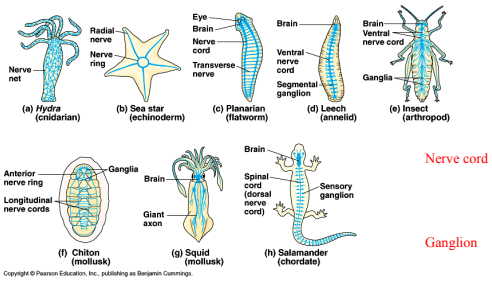


Table 48.1 Major Neurotransmitters

Neurotransmitter	Structure	Functional Class	Secretion Sites
Acetylcholine		Excitatory to vertebrate skeletal muscles; excitatory or inhibitory at other sites	CNS; PNS; vertebrate neuromuscular junction
Biogenic Amines			
Norepinephrine		Excitatory or inhibitory	CNS; PNS
Dopamine		Generally excitatory; may be inhibitory at some sites	CNS; PNS
Serotonin		Generally inhibitory	CNS
Amino Acids			
GABA (gamma aminobutyric acid)		Inhibitory	CNS; invertebrate neuromuscular junction
Glycine		Inhibitory	CNS
Glutamate		Excitatory	CNS; invertebrate neuromuscular junction
Aspartate		Excitatory	CNS
Neuropeptides (a very diverse group, only two of which are shown)			
Substance P	Arg—Pro—Lys—Pro—Gln—Gln—Phe—Phe—Gly—Leu—Met	Excitatory	CNS; PNS
Met-enkephalin (an endorphin)	Tyr—Gly—Gly—Phe—Met	Generally inhibitory	CNS

Diversity of nervous systems



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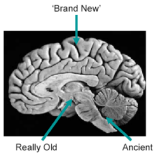
Vertebrate nervous systems

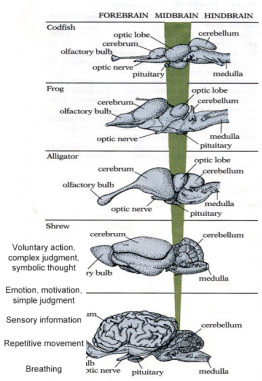
Evolutionary trends

1. Increase in overall brain size
2. Compartmentalization of functions
3. Increased development of the forebrain



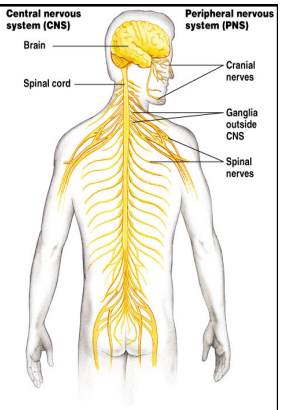
Luxuries ↑

Necessities



Vertebrate CNS

- Cephalized
- Centralized
- Integration and processing of information
- White matter – axons in the CNS
- Gray matter – cell bodies, dendrites, unmyelinated axons
- Central canal of the spinal cord
- Ventricles of the brain
- Cerebrospinal fluid (CSF)
- Meninges – protective connective tissue



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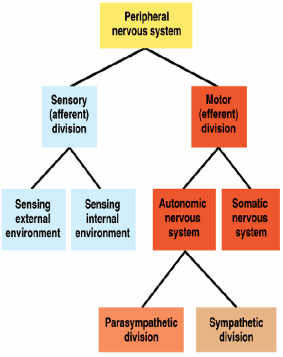
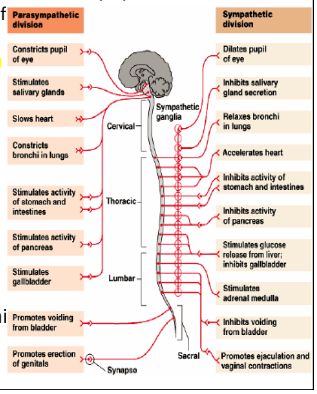
Vertebrate PNS



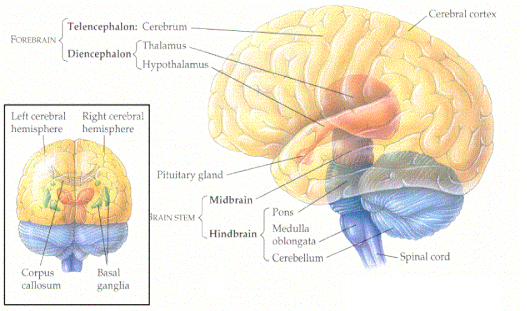
- Transmits information to and from the CNS
- Components
  - Both sensory and motor functions
  - Paired cranial nerves (12)
  - Paired spinal nerves (31)
  - Ganglia
- Motor division
  - Somatic nervous system
    - Voluntary - signals to and from skeletal muscles
    - Respond to external stimuli
  - Autonomic nervous system
    - Involuntary - Internal environment, smooth and cardiac muscles
    - Sympathetic and parasympathetic

Actions of the parasympathetic and sympathetic divisions of

- Sympathetic division
  - Stimulation
  - Energy generation
- Parasympathetic division
  - Calming
  - Rest and repair
- Often have *antagonistic* actions
- Cooperate to maintai homeostasis



Structure and function of the vertebrate brain



Forebrain
- **Cerebrum** – complex integrating center of the CNS, memory storage, "seat of consciousness"
- **Thalamus** – sorts and relays sensory information to cerebrum, regulates emotion and arousal
- **Hypothalamus** – regulator of homeostasis: hormones, thermostat, hunger and thirst, sexual response, fight or flight, pleasure, biological clock

Midbrain
- **Inferior colliculi** – auditory system
- **Superior colliculi** – visual system

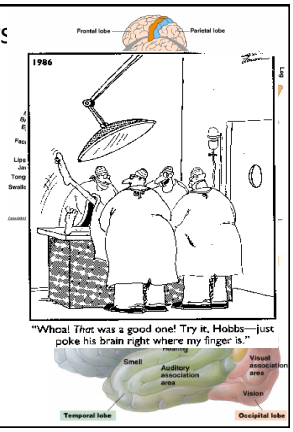
Hindbrain
- **Pons** - bridge between halves of cerebellum; coordinates activity of muscles on both sides; aids medulla; causes sleep
- **Medulla oblongata** - respiratory and cardiac center; vomiting, sweating, gastric secretion, heartbeat
- **Cerebellum** - regulates and controls muscle contractions; coordination, balance, equilibrium
- **Reticular formation** – regulates sleep and arousal

Spinal cord – receives information from skin and muscles and sends out motor commands for movement

Other structures
- **Corpus callosum** – band of fibers transferring information between cerebral hemispheres
- **Pituitary gland** – "master gland," releases hormones that regulate homeostasis

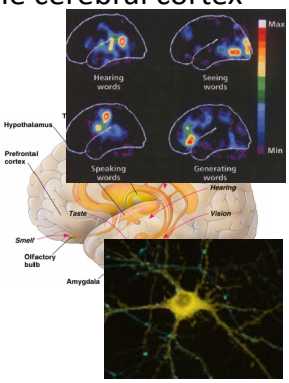
Integrating centers

Right and left cerebral hemispheres
- **Cerebral cortex**
  - Highly developed and convoluted in mammals
  - Lobes with sensory areas and association areas, frontal lobe with motor cortex
- **Basal nuclei** – planning and learning movement sequences



Other roles of the cerebral cortex

- **Language and speech**
  - Broca's area
  - Wernicke's area
- **Emotions**
  - Limbic system – amygdala, hippocampus, and olfactory bulb
  - Laughing, crying, aggression, feeding, and sexuality
- **Memory and learning**
  - Short-term: frontal lobe
  - Long-term: amygdala and hippocampus
  - Neurons may make new connections
- **Consciousness**
  - Emergent property based on activity in many areas of the cortex



Drugs and the Nervous System

Drug	Effect on the NS	Effect o
Alcohol (ethanol)	CNS depressant	Depends on dosage, FAS in babies
[redacted]		
Depressants ● **Barbiturates**	CNS depressant, action potentials cannot be produced	Reduce respiration, bp, heart rate, anesthetic
[redacted]		
Hallucinogens /psychedelics	Mimics the effects of serotonin	Vivid colors, heightened emotions, increase in heart rate and bp
[redacted]