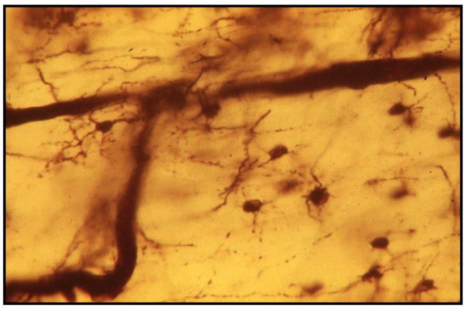
Oligodendrocytes

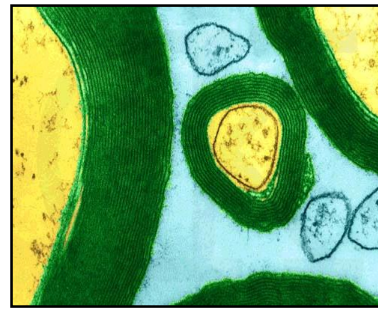
Form myelin sheaths in CNS



http://cti.itc.virginia.edu/~psyc220/astro2.gif

Schwann Cells - form myelin sheaths in PNS

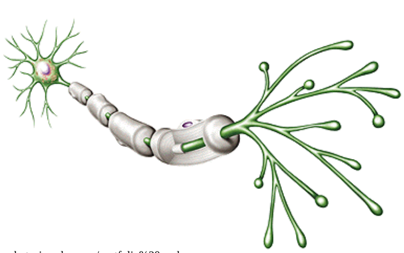
Cross section of myelin sheaths that surround axons



http://www.emc.maricopa.edu/faculty/farabee/BIOBK/BioBookNERV.html
This image is copyright Dennis Kunkel at www.DennisKunkel.com

Oligodendrocytes - envelop an average of 15 axonal internodes each

Schwann cells - envelop only one internode



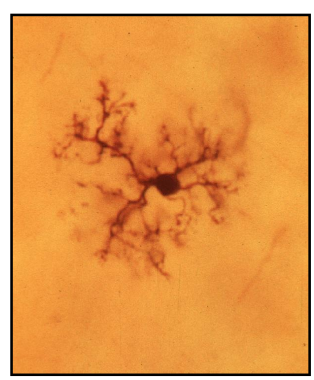
http://www.zoobotanica.plus.com/portfolio%20medicine%20pages/neuronst.htm

Microglia

-phagocytes

- mobilized after injury, infection or disease

- arise from macrophages outside of NS



http://cti.itc.virginia.edu/~psyc220/oligo.gif

Contact with axons essential for induction and maintenance of myelin sheath.

Myelin Forming Schwann Cells	Non-Myelin Forming Schwann Cells
↓	↓
Expresses major myelin proteins	Expresses NCAM L1, NGF

What triggers myelination?

In Schwann cells, axon diameter (only largest myelinated) and total axonal surface area important.

cAMP triggers expression of some myelin proteins and suppresses expression of NCAM and NGF receptors.

In oligodendrocytes, myelin expression dependent upon presence of astrocytes.

Myelin Components

MAG- myelin associated glycoprotein

- minor component of myelin
- expressed early and next to axon
- structurally similar to other surface recognition molecules (NCAM, T cell surface antigens)

Thought to be important for myelin initiation

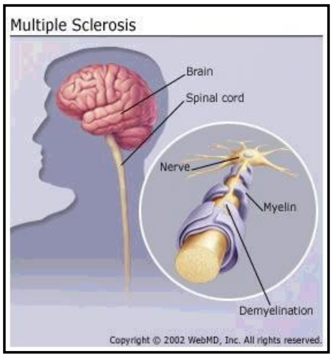
Myelin Components

Central and peripheral myelin also contain myelin basic proteins.

Seven related proteins produced from a single gene by alternative splicing.

Proteins are highly antigenic.

Inject into animals → autoimmune response called experimental allergic encephalitis (demyelination in CNS)



http://content.health.msn.com/content/article/57/66104

Used as a model for **multiple sclerosis** - impaired sensory or motor performance

Demyelination interferes with impulse conduction, sensory perception and motor coordination.

Mice - shiverer mutation (recessive) - Deletion 5 of 6 exons for myelin basic protein on chromosome 18

cause tremors, frequent convulsions and die young

Homozygous - less than 10% normal myelination

Inject wild type gene into fertilized eggs - transgenic mice express gene at right time

produce about 20% of normal amount of proteins

much more myelination

occasional tremors but do not convulse and have normal life span

Glia and Axon Regeneration

If peripheral axons severed, they grow back because:

- axons and associated myelin break down

- axonal and myelin debri, removed by surviving Schwann cells and macrophages.

- tubular structures defined by basal lamina retained. Components contained in basal lamina potent promoters of neurite growth

Schwann cells secrete their own growth factors and have membrane proteins that aid neuron growth

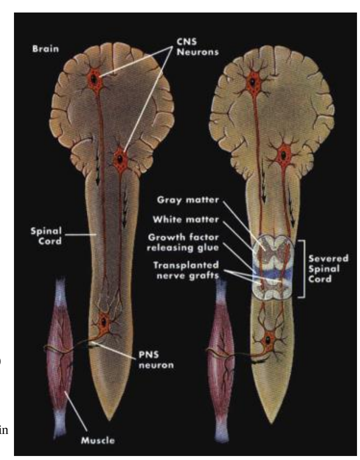
Make natural tubes to "guide" axons

peripheral grafts containing support cells and cut axons

Also use of embryonic cells which are not subject to regeneration limitations

Inject Schwann cells into area

http://web.sfn.org/content/Publications/Brain Briefings/spinal_cord.html



Myelin in the brain and spinal cord gets in the way of axon regeneration

Interfering with myelin can aid axon repair and restore some function in rodents with spinal cord injuries.

- a vaccine against myelin prompted axons regrowth and treated animals regained some movement in their hind legs

Other possible approaches?

Identify specific molecules signaling macrophages to ingest and remove myelin from the damaged spinal cord.

Target specific components of myelin, instead of whole sheath

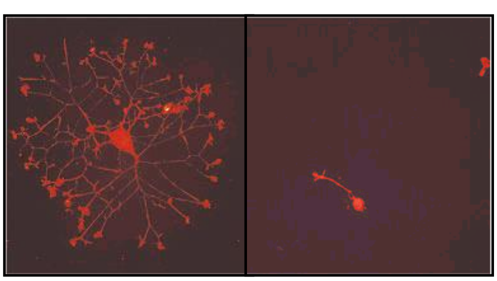
http://web.sfn.org/content/Publications/BrainBriefings/brain_spinalcord.html

Some proteins present in CNS myelin:

At least MAG and Nogo are capable of causing growth cone collapse and inhibiting neurite outgrowth in vitro.

Have a common receptor (NgR).

Nogo, may be partly responsible for the inability of damaged axon fibers to repair.



Normal neuron **Neuron treated with synthesized Nogo**

The Nervous System

1) **Central Nervous System**

Brain, spinal cord, retina

2) **Peripheral Nervous System**

Everything (except the retina) outside of the brain and spinal cord

Peripheral Nervous System

1) Somatic - carries voluntary motor and sensory information both to and from the CNS.

2) Autonomic

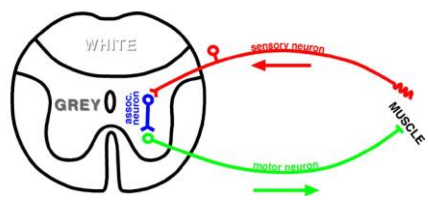
a. sympathetic

b. parasympathetic

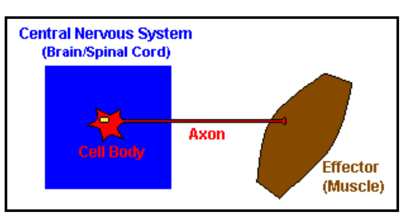
3) Enteric - meshwork of nerve fibers that innervate the viscera (gastrointestinal tract, pancreas, gall bladder).

Peripheral Nervous System

1) Somatic - peripheral nerve fibers that send sensory information to the central nervous system AND motor nerve fibers that project to skeletal muscle.



Somatic Nervous System



http://faculty.washington.edu/chudler/nsdivide.html

The cell body is located in either the brain or spinal cord and projects directly to a skeletal muscle.

Peripheral Nervous System

1) Somatic

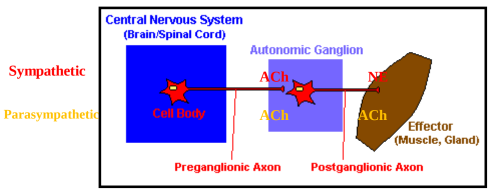
2) Autonomic - controls smooth muscle of the viscera (internal organs) and glands.

a. sympathetic - "fight" or take "flight" (run away)

b. parasympathetic - "rest" and "digest"

3) Enteric

Autonomic Nervous System

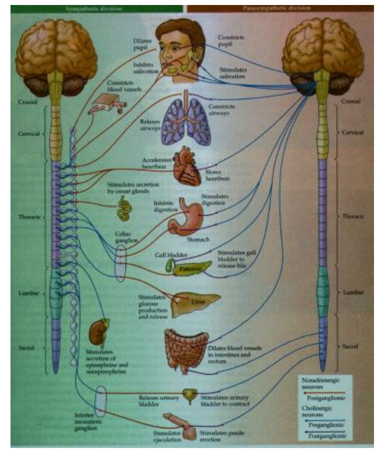


http://faculty.washington.edu/chudler/nsdivide.html

Preganglionic neuron -located in either the brain or the spinal cord and projects to an autonomic ganglion.

Postganglionic neuron - projects to the target organ.

ACh → NE



ACh → ACh

http://home.swipnet.se/sympatiska/nervous.htm

Ways of Characterizing Peripheral Nervous System Nerves

1	Sensory (afferent) - carry information INTO the central nervous system from sense organs. OR Motor (efferent) - carry information away from the central nervous system (for muscle control)
2	Cranial Nerve - connects the brain with the periphery. OR Spinal Nerve - connects the spinal cord with the periphery.
3	Somatic - connects the skin or muscle with the central nervous system. OR Visceral - connects the internal organs with the central nervous system.

Central Nervous System

1) **Spinal Cord**

2) **Cerebral Hemispheres** - cerebral cortex and 3 deep lying nuclei: basal ganglia, hippocampus and the amygdala.

3) **Diencephalon** - thalamus and hypothalamus

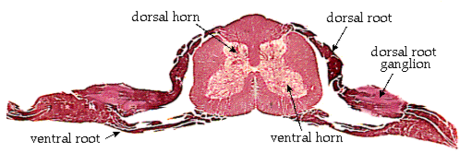
4) **Midbrain** - superior and inferior colliculi

5) **Medulla**

6) **Pons**

7) **Cerebellum**

The Spinal Cord

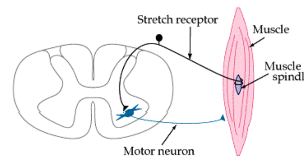


http://thalamus.wustl.edu/course/spinal.html

The spinal cord runs from the base of the skull to the first lumbar vertebrae.

31 pairs of spinal nerves

A Simple Reflex

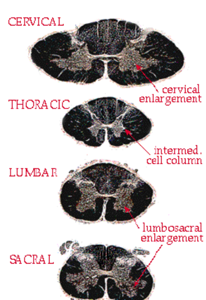


http://thalamus.wustl.edu/course/spinal.html

Afferent - sensory input.

Efferent - motor output.

Levels of the Spinal Cord



http://thalamus.wustl.edu/course/spinal.html

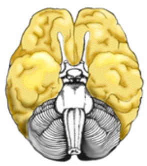
Dorsal Columns - contains primary afferent axons.

Ventral Columns - descending motor axons controlling posture.

Axons relaying info about pain and thermal sensation to higher levels

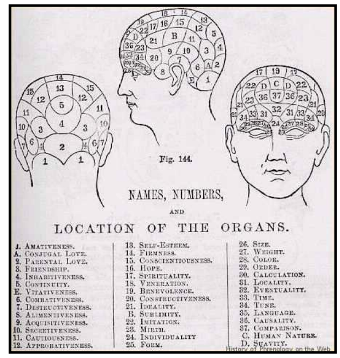
Lateral Columns - axons that ascend to higher levels and axons from nuclei in brain stem to motorneurons and interneurons in spinal cord.

The Cerebral Cortex



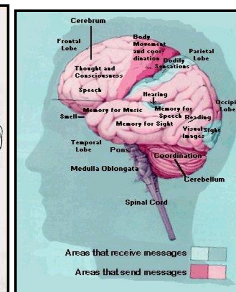
- Outermost layer of the cerebral hemisphere.
- Composed of gray matter.
- Cortices are asymmetrical. Both analyze sensory data, perform memory functions, learn new information, form thoughts and make decisions.

Then:

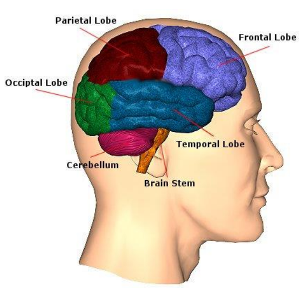


http://pages.britishlibrary.net/phrenology/images.html

and **Now:**



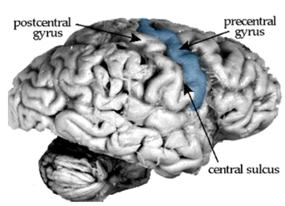
http://www.niehs.nih.gov/kids/brain.htm



Sulci - grooves

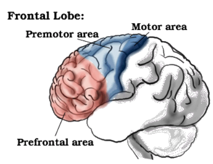
Gyri -elevated regions

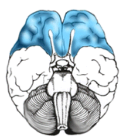
http://www.neuroskills.com/index.html?main=tbi/brain.shtml



http://thalamus.wustl.edu/course/basmot.html

The Frontal Lobes





Divided into:

a) **prefrontal area**- emotional control center and home to our personality. Involved in motor function, problem solving, spontaneity, memory, language, initiation, judgement, impulse control, and social and sexual behavior.

b) **premotor area** -contains neurons that produce movements.

The Parietal Lobes

Two functional regions:

1) Involves **sensation** and **perception**. Integrates sensory information to form a single perception (cognition).

2) Integrates **sensory input**, primarily with the **visual system** to construct a spatial coordinate system to represent the world around us.

The Occipital Lobes

http://www.neuroskills.com/index.html?main=tbi/brain.shtml

Center of our visual perception system.

Disorders of this lobe can cause visual hallucinations (visual images with no external stimuli) and illusions.

The Temporal Lobes

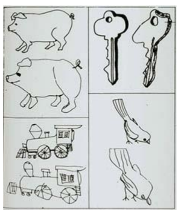
http://www.neuroskills.com/index.html?main=tbi/brain.shtml

Involved in the primary organization of sensory input and also highly associated with memory skills. Left temporal lesions result in impaired memory for verbal material. Right side lesions result in impaired recall of non-verbal material, such as music and drawings.

Language can also be affected by temporal lobe damage. Left lesions disturb recognition of words. Right damage can cause a loss of inhibition of talking.

http://www.cquest.utoronto.ca/psych/psy280f/ch4/agnosia.html

•**agnosia:** inability to recognize familiar objects, persons, sounds, shapes, or smells while the specific sense is not defective

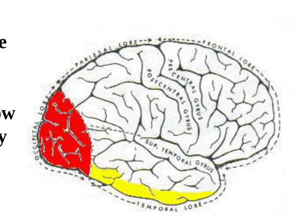


Drawing abilities of two agnosic patients asked to copy pictures

1) visual agnosia is not due to poor acuity

2) although they copied the pictures, the patients could not IDENTIFY the pictures.

In patients with object agnosia, the occipital (the red area) or the inferotemporal cortex (the yellow area) are usually damaged.



Also:

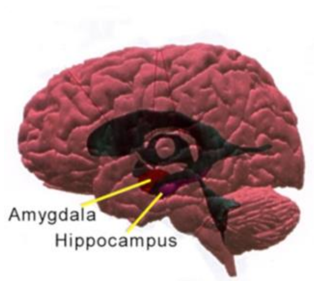
Prosopagnosia

Neglect agnosia

http://ahsmail.uwaterloo.ca/kin356/agnosia/agnosia.htm

Hippocampus - Learning and memory

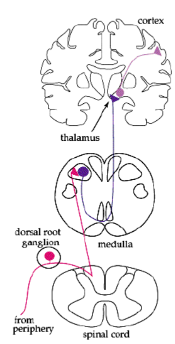
Amygdala -Associated with emotions and coordinates actions of autonomic and endocrine systems.



http://ahs.uwaterloo.ca/kin356/ltm/hippocampus_amygdala.html

http://www.waiting.com/brainfunction.html

Basal ganglia - Initiation and direction of voluntary movement. Balance (inhibitory), Postural reflexes.



http://thalamus.wustl.edu/course/bassens.html

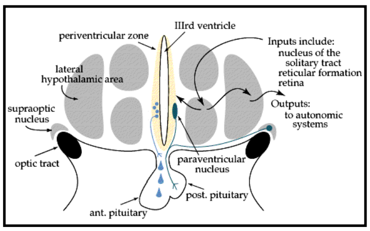
Thalamus - processes and distributes almost all sensory and motor info going to and out of, the cerebral cortex.

Regulates levels of awareness and emotional aspects of sensory experiences through wide variety of effects on cortex.

Hypothalamus - Main function is **homeostasis**. Factors such as blood pressure, body temperature, fluid and electrolyte balance, and body weight are held to set-points.

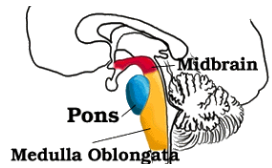
- Receives inputs about the state of the body, and initiates compensatory changes.

- Extensive afferent and efferent connections with thalamus, midbrain and some cortical areas.



http://thalamus.wustl.edu/course/hypoANS.html

The Brainstem



- Lower extension of the brain where it connects to the spinal cord.

- Functions include those necessary for survival (breathing, digestion, heart rate, blood pressure) and for arousal (being awake and alert).

- Consists of:

1) medulla oblongata

2) pons

3) cerebellum

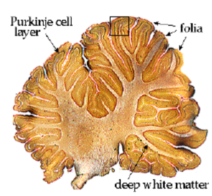
4) midbrain

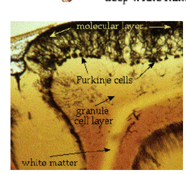
medulla oblongata - primarily a relay station for the crossing of motor tracts between the spinal cord and the brain. It also contains the respiratory, vasomotor and cardiac centers, as well as many mechanisms for controlling reflex activities such as coughing, gagging, swallowing and vomiting.

pons - links different parts of the brain and serves as a relay station from the medulla to the higher cortical structures of the brain. It contains the respiratory center.

Midbrain - serves as the nerve pathway of the cerebral hemispheres and contains auditory and visual reflex centers.

The Cerebellum





- Involved in the coordination of voluntary motor movement, balance and equilibrium and muscle tone.

- Located just above the brain stem and toward the back of the brain.

- Cerebellar injury results in movements that are slow and uncoordinated.

http://thalamus.wustl.edu/course/cerebell.html http://www.hark.com/clips/sfpbhcvhzh-jeopardy-theme

Jeopardy Show #6297 - Tuesday, January 24, 2012

INSIDE THE BRAIN OF MEGAN FOX

400 Megan's corpus callosum connects the right & left halves of her brain, also called these, like halves of the earth

hemispheres

800 A 2010 paper shows Megan's amygdala maintains her "loss aversion" when faced with decisions about risking this

money

1200 When Megan enjoys a fine meal, she's employing the parietal these, right behind the frontal ones

lobes

1600 The thalamus, part of this botanical-sounding part of Megan's brain, receives all sensory input except smell

brainstem ???

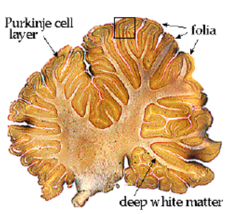
2000 Megan's higher functions use her cerebral this; when she "hears" a song in her head, she's using her brain's auditory this

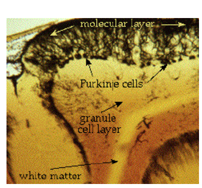
cortex

The cerebellum ("little brain")

convolutions similar to those of cerebral cortex

Has an outer cortex, an inner white matter, and deep nuclei below the white matter.





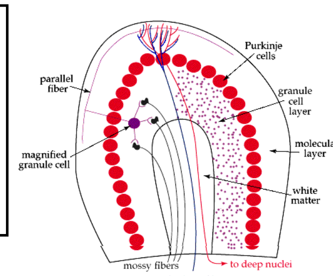
http://thalamus.wustl.edu/course/cerebell.html

molecular layer- outermost layer and is nearly cell-free.

Purkinje cell- monolayer of large cells

granule cells- dense layer of tiny neurons.

In the center of each folium is the white matter.



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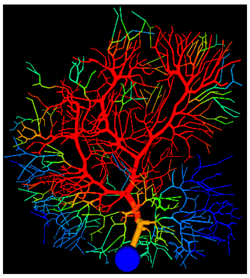
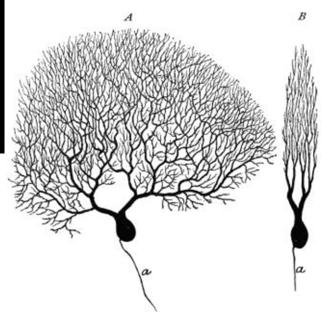
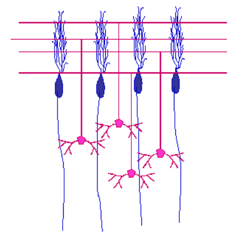


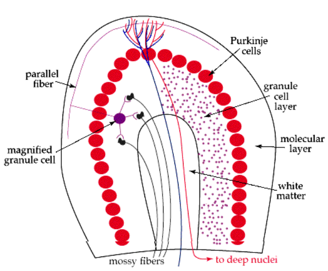
Purkinje Cells

Sole output from cerebellum



Receive input from granule cells





http://thalamus.wustl.edu/course/cerebell.html

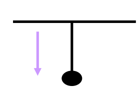
Purkinje cells arise from ventricular zone

Granule cells born in external germinal zone

Migration of granule cells arises late in development.

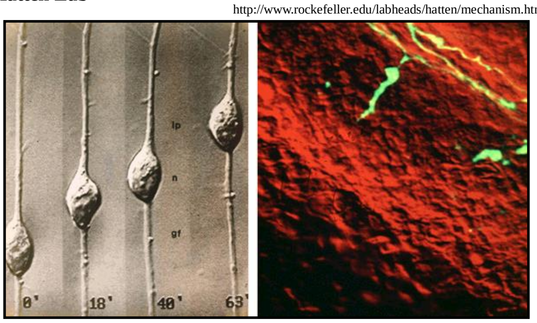
Must migrate along paths apparently blocked by obstacles.

Follow radial path because of Bergmann glia.



Hatten Lab

http://www.rockefeller.edu/labheads/hatten/mechanism.html



Migration of cerebellar granule cells along glial fibers imaged in real time in vitro (left). Extension of parallel fibers in tissue slices, after implantation of dye-labeled cells into early postnatal cerebellar cortex (right). In both cases, the migrating cell extends a leading process along the glial fiber, moving at speeds of 20-50 microns/h.

For cell migration movies:

http://www.rockefeller.edu/labheads/hatten/hattenhome.html

Alternatively search for Hatten and cerebellum and go to lab projects

Development of cerebellum at birth correlated with a newborn animal's powers of locomotion

altricial - animals are relatively undeveloped at hatching or birth; rodents, carnivores and humans are examples of animals with altricial young.

precocial - come out running; no extended period of parental care needed. Example: the Killdeer.

http://www.birdwatching.com/stories/killdeer.html