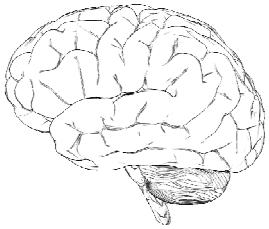
Psychology 101

Intro Bio Cog Psych
University of British Columbia
Dr. Michael Souza

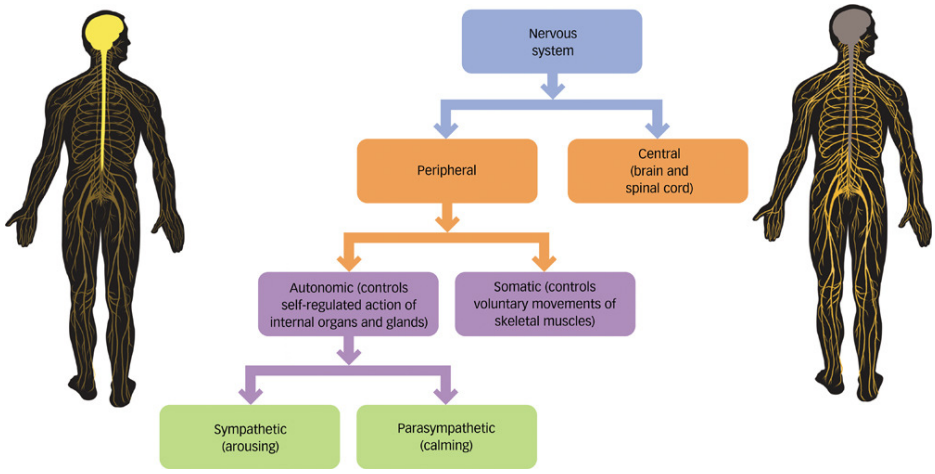


Lecture 03a (14 May 2012)

Neural anatomy and signal transmission

Please note: for the rest of this course, class will be held in Chem B250

Divisions of the nervous system



2

Picture: From Schacter's Psychology (2nd ed)

PNS: autonomic nervous system

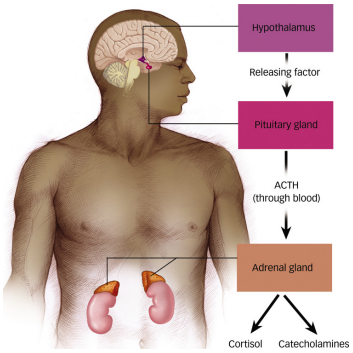
Sympathetic division

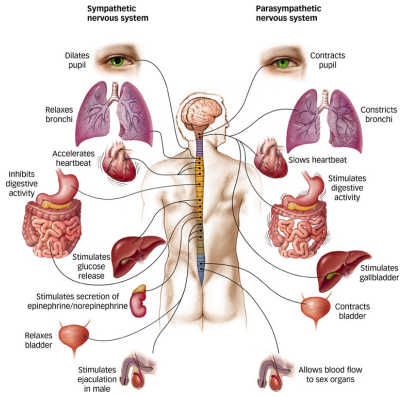
Cortisol

Catecholamines

> Epinephrine and norepinephrine

Parasympathetic division





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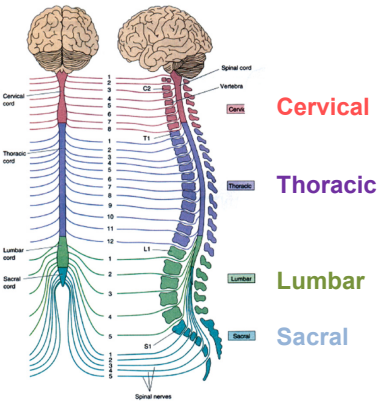
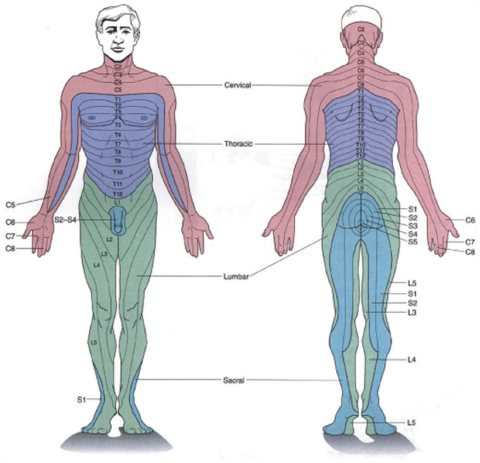
Picture: From Schacter's Psychology (2nd ed)

CNS: the spinal cord

Dermatomes

Paraplegia and quadriplegia





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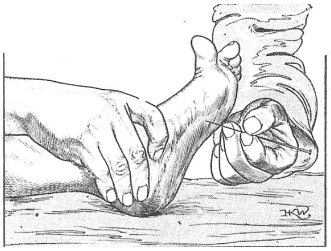
Picture: Courtesy of M. D'Esposito

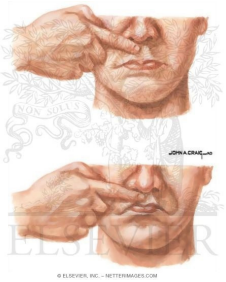
Examining reflexes

Reviewing the roles of the spine, brain

Babinski and snouting

Abnormal presentation of reflexes in brain injury





Picture: http://it.wikipedia.org/wiki/File:Babinski%27s_sign01.jpg
http://www.netterimages.com/image/12079.htm

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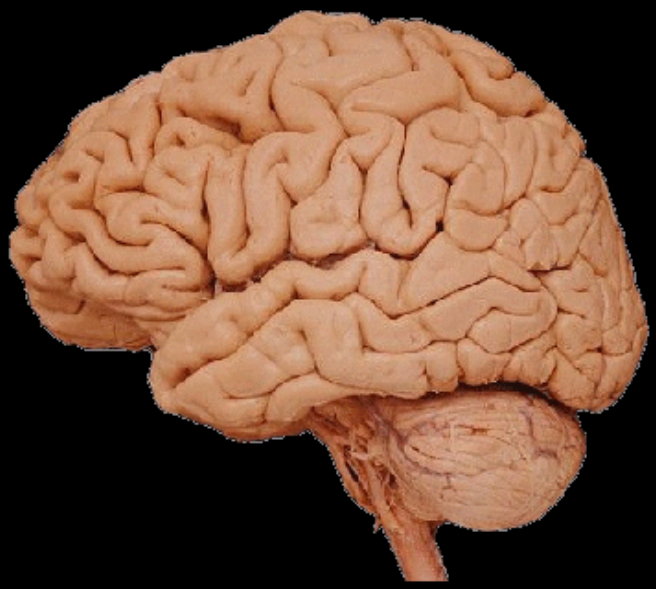
CNS: the brain



Picture: http://www.thenanoage.com/cryonics.htm

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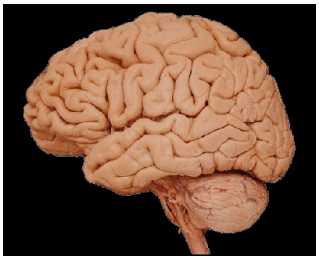
A couple of thought questions

How do neurons represent information (e.g. memories) and support mental abilities (e.g. language, reasoning)?

Sensory neurons - how do they represent variation?

What happens to cognitive abilities when neurons supporting their function are compromised?



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Picture: http://www.thenanoage.com/cryonics.htm

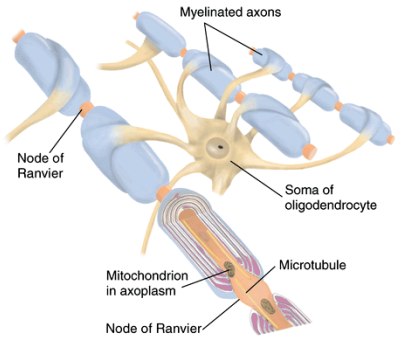
Glial cells

Astrocytes

Microglia

Schwann cells

Oligodendrocytes



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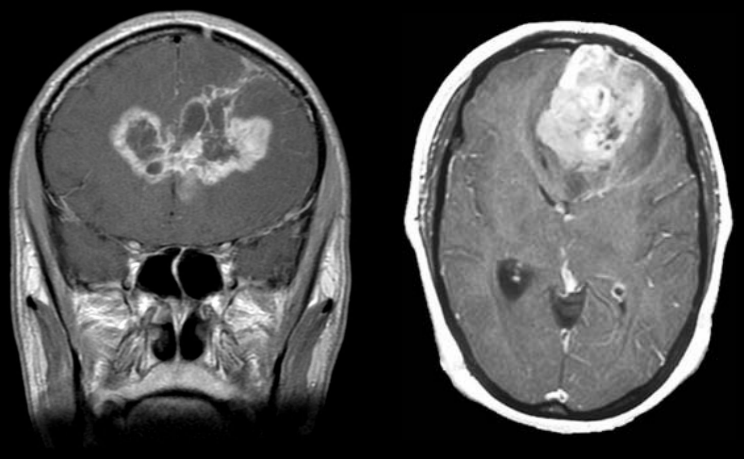
Picture: http://course1.winona.edu/sberg/308s10/Lec-note/NervesA.htm

Glial cells and brain tumours



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Images courtesy of M. D'Esposito

Types of neurons

Sensory neurons

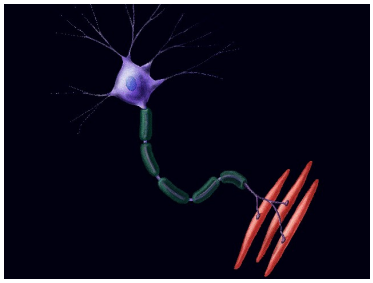
Visual, auditory, tactile, gustatory, olfactory

Motor neurons

Relay of movement commands

Interneurons

Types of information processed



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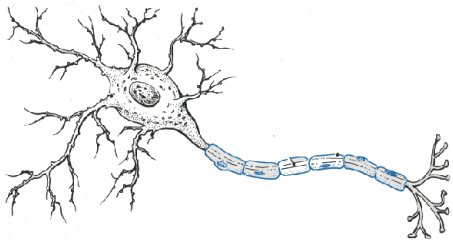
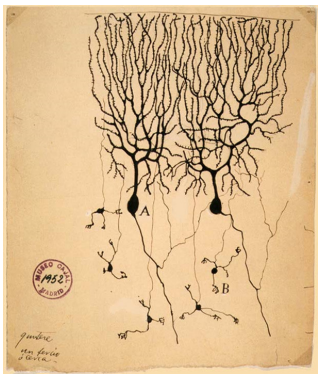
Picture: http://www.uofaweb.ualberta.ca/compneurolab/news.cfm?story=49462

Neuronal morphology





Purkinje cell (cerebellum)

Picture: http://www.mindcreators.com/NeuronBasics.htm
http://en.wikipedia.org/wiki/Purkinje_cell

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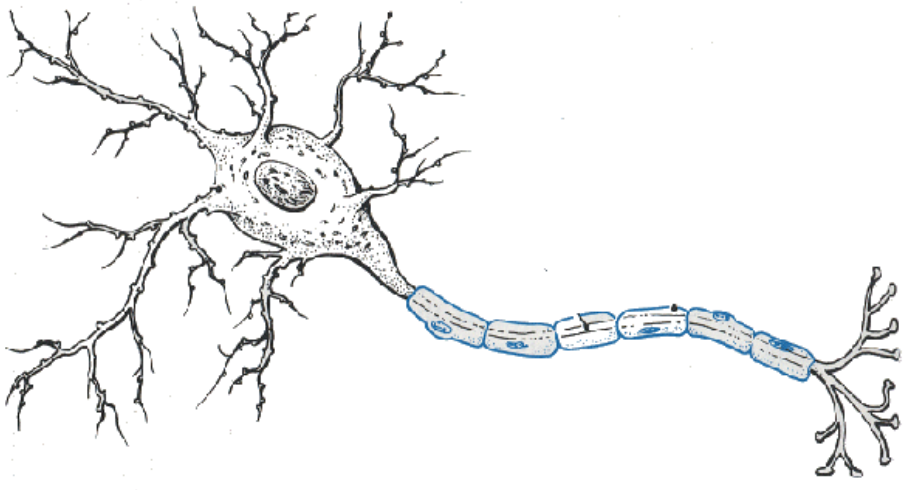
Anatomy of a basic neuron



Key features:
Dendrites, soma, nucleus, axon hillock, axon, myelin sheath, Node of Ranvier, terminal buttons

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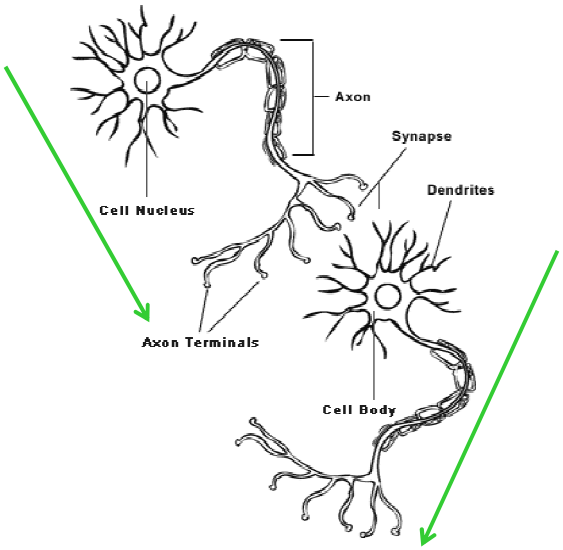
Picture: http://www.mindcreators.com/NeuronBasics.htm

Flow of information



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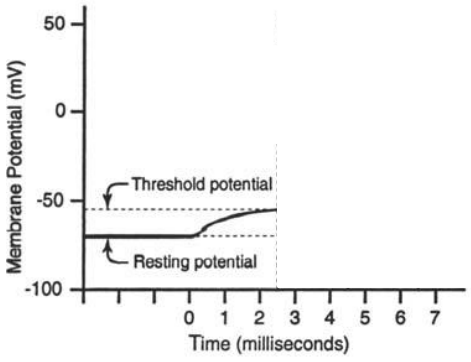
Picture: http://mybrainnotes.com/memory-brain-stress.html

Electrical transmission (1)

Resting potential: -70 mV

1. Receive incoming signals (+/-)
2. If threshold met,
   an action potential occurs

   "All or none" principle



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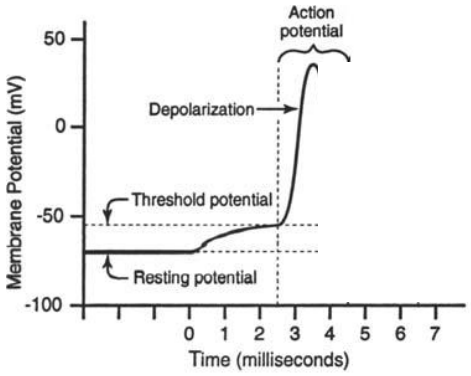
Picture: http://www.dummies.com/how-to/content/understanding-the-transmission-of-nerve-impulses.html

Electrical transmission (2)

3. Depolarization
4. Repolarization
5. Hyperpolarization
6. Return to resting potential



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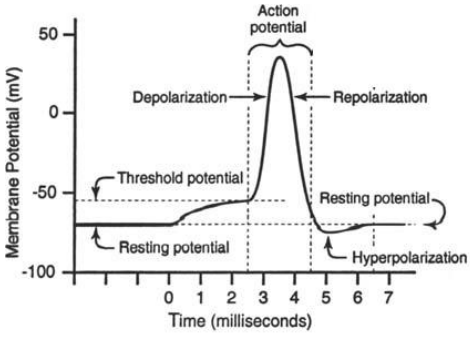
Picture: http://www.dummies.com/how-to/content/understanding-the-transmission-of-nerve-impulses.html

Electrical transmission: review

1. Receive incoming signals
2. Action potential initiation
3. Depolarization
4. Repolarization
5. Hyperpolarization
6. Return to resting potential



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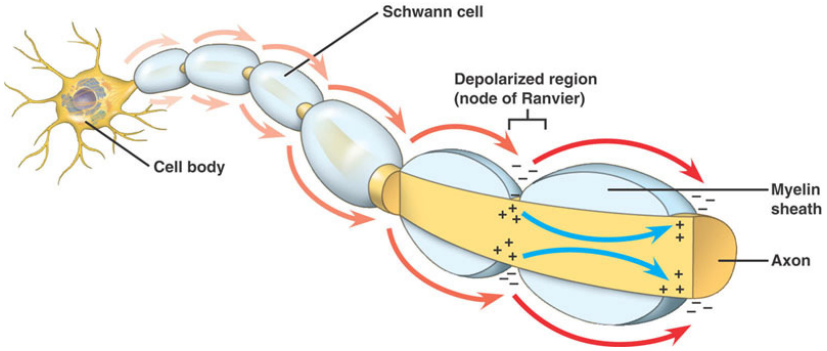
Picture: http://www.dummies.com/how-to/content/understanding-the-transmission-of-nerve-impulses.html

Signal propagation

Electrical signal travels down the axon via saltatory conduction

Regeneration of action potential signal



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Picture: http://www.tokresource.org/tok_classes/biobiobio/biomenu/nerves_hormones_homeostasis/index.htm

Multiple Sclerosis (MS)

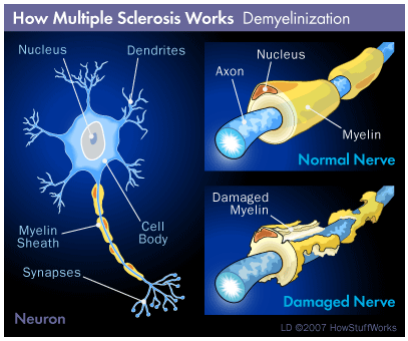
Progressive damage to the myelin

55-75K in Canada (3 new/day)

400K in US (200 new/day)

Canadians have one of the highest rates of multiple sclerosis in the world

Symptoms



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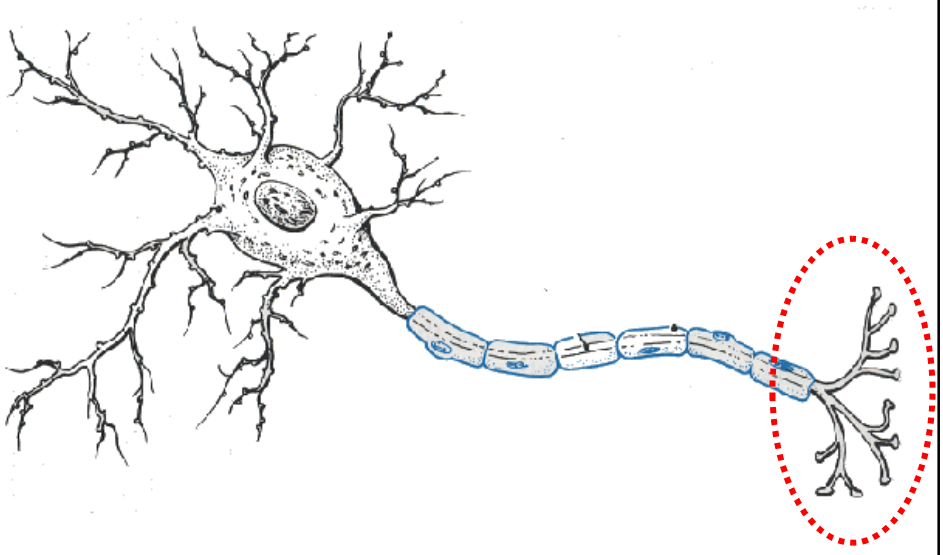
Picture: http://www.articlesweb.org/health/multiple-sclerosis

From electrical to chemical transmission



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Picture: http://www.mindcreators.com/NeuronBasics.htm

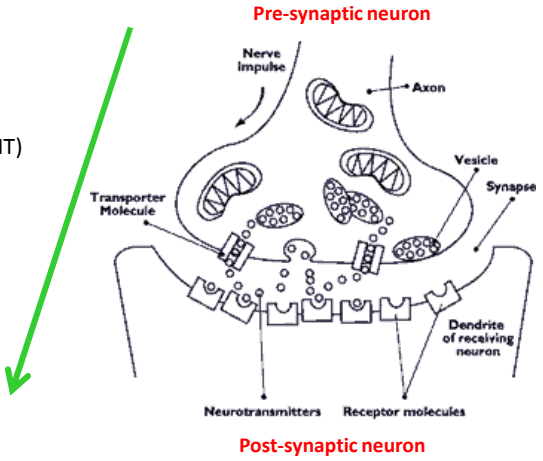
Anatomy of the synapse

The synapse

Pre-synaptic neuron
Vesicles and neurotransmitter (NT)

Synaptic cleft

Post-synaptic neuron
Receptors



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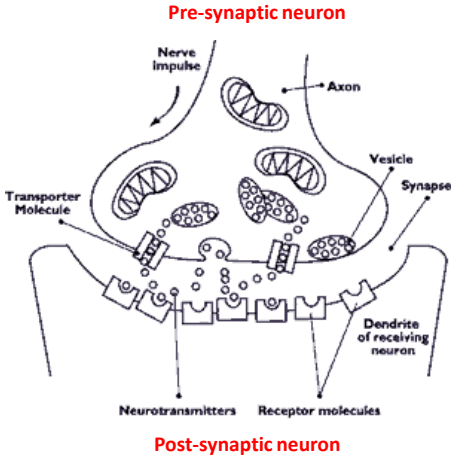
Picture: http://wiki.answers.com/Q/Is_there_A_labelled_diagram_of_a_synapse

Chemical transmission (1)

1. Action potential reaches the terminal buttons
2. Ca^{+} ions flood in terminal, cause vesicles to go to membrane
3. Vesicles release neurotransmitter (NT) into the synaptic cleft



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Picture: http://wiki.answers.com/Q/Is_there_A_labelled_diagram_of_a_synapse

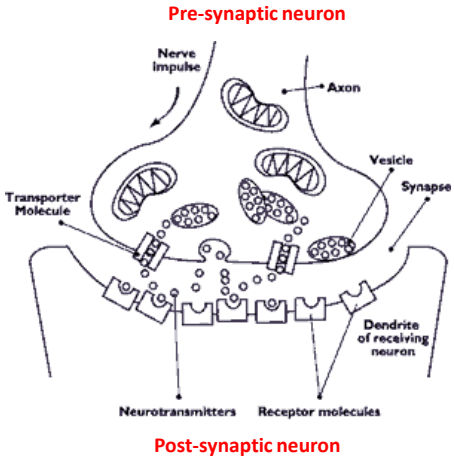
Chemical transmission (2)

4. NT travels across the cleft to post-synaptic neuron
5. NT binds with appropriate receptor, results in change of membrane potential

   EPSPs and IPSPs

   Excitatory post-synaptic potential

   Inhibitory post-synaptic potential



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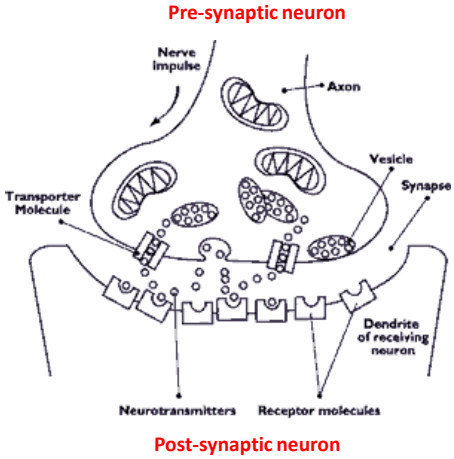
Picture: http://wiki.answers.com/Q/Is_there_A_labelled_diagram_of_a_synapse

Chemical transmission (3)

6. After NT binds and has its effect, it falls off the receptor
7. Removing the NT
   Reuptake
   Enzyme deactivation



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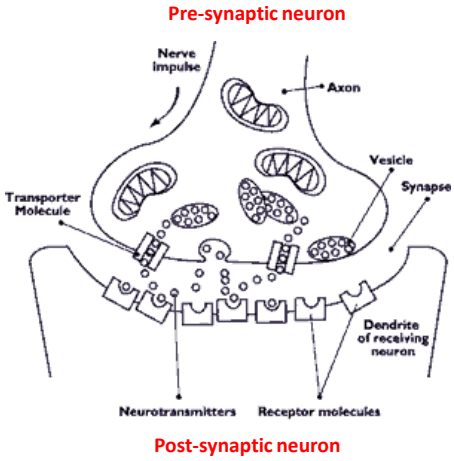
Picture: http://wiki.answers.com/Q/Is_there_A_labelled_diagram_of_a_synapse

Summary of chemical transmission

1. AP arrives at terminal
2. Vesicles go to membrane
3. NT dumped into cleft
4. NT to post-synaptic neuron
5. Receptor binding
6. NT falls off of receptor
7. NT resolved



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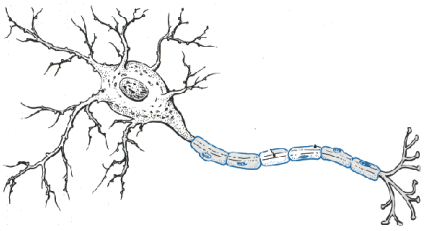
Picture: http://wiki.answers.com/Q/Is_there_A_labelled_diagram_of_a_synapse

Information transmission

How do neurons have different functions?

Connectivity (location)

Neurotransmitters



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Picture: http://www.mindcreators.com/NeuronBasics.htm

Some key neurotransmitters

Glutamate
Primary excitatory NT
Learning/memory

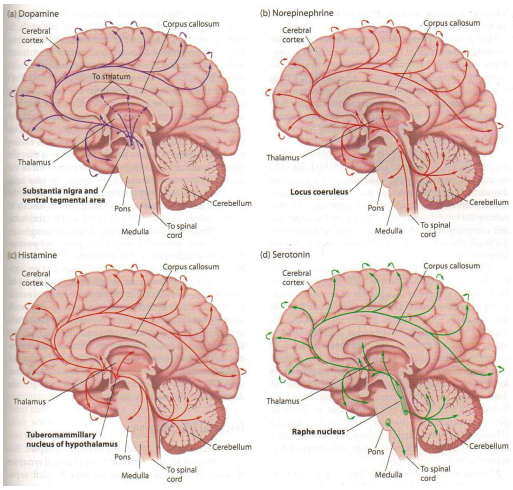
GABA
Primary inhibitory NT

Dopamine
Reward, movement, working memory
> Substantia nigra (tegmentum)

Serotonin
Mood
> Raphe nucleus

Norepinephrine
Arousal
> Locus coeruleus

Acetylcholine
Memory, attention
> Basal forebrain



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Picture: Cog Neuro: Bio of the Mind (3rd ed), Gazzaniga

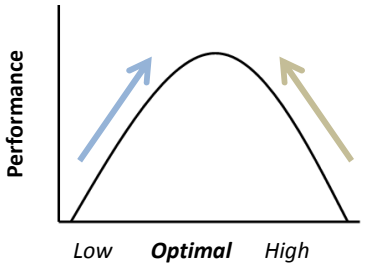
Modulating NT levels with drugs

NT imbalances may result in cognitive and/or behavioral problems or impairment

Agonists increase the level of NT available in the synapse

Antagonists reduce the level of NT available in the synapse

The key challenge is to find the person's optimal level….



Yerkes-Dodson curve

ARICEPT (donepezil HCl) Zoloft (sertraline HCl) Clozaril (clozapine) PROZAC fluoxetine hydrochloride

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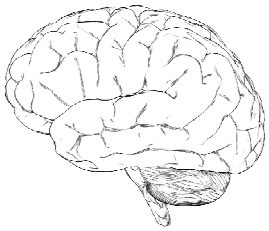
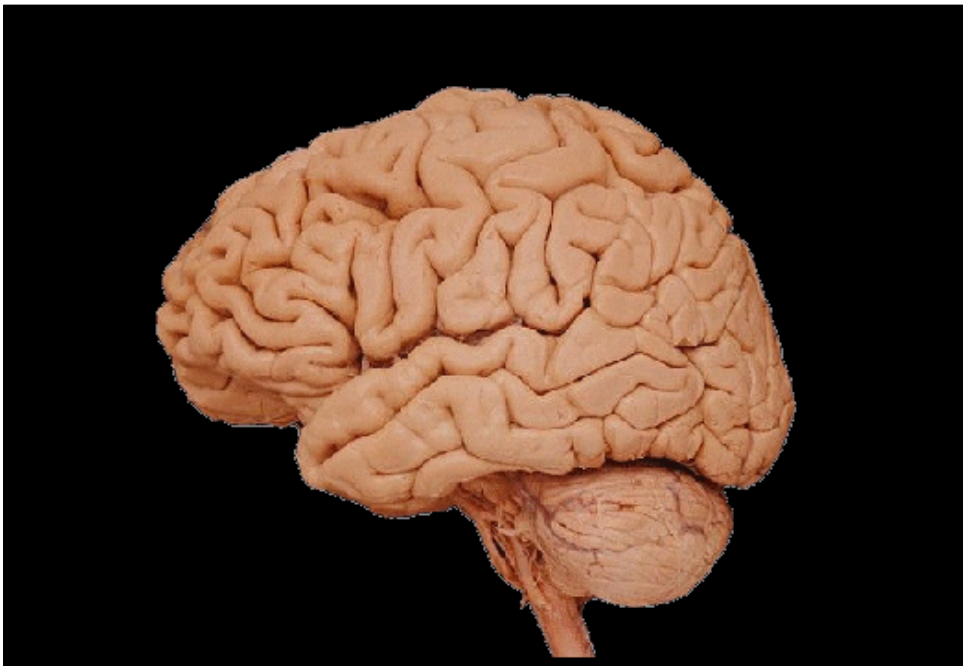


Lecture 03b (14 May 2012)
Gross brain anatomy
Traumatic brain injury (briefly)



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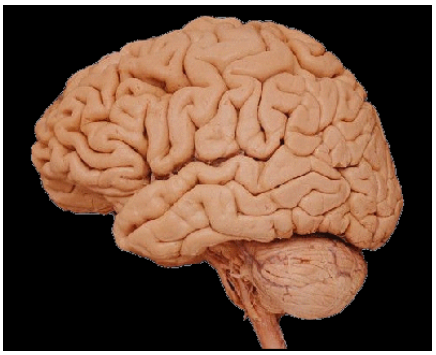
Picture: http://www.thenanoage.com/cryonics.htm

Surface of the brain

Gyrus (plural = gyri)

Sulcus (plural = sulci)
Fissure



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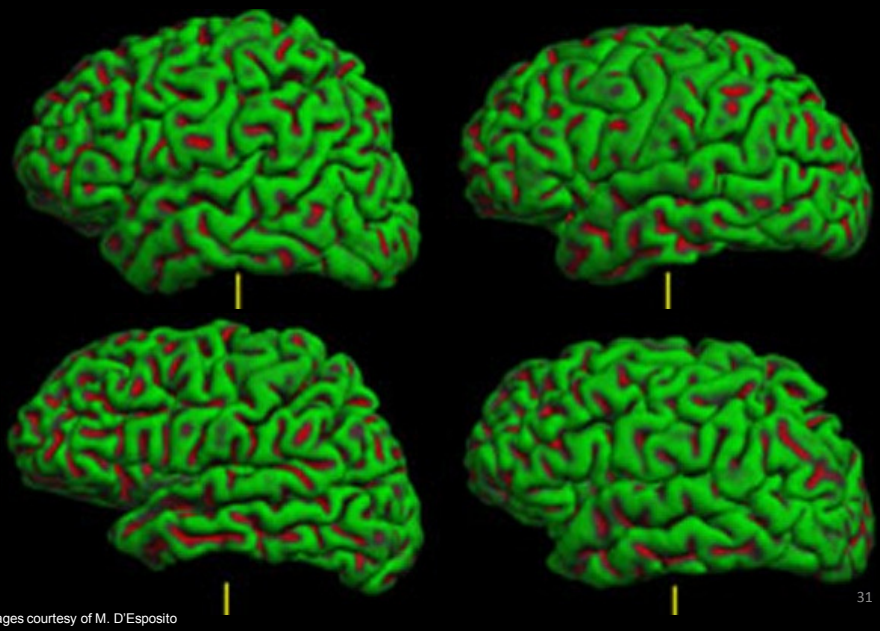
Picture: http://www.thenanoage.com/cryonics.htm

Inter-individual cortical variability



Images courtesy of M. D'Esposito

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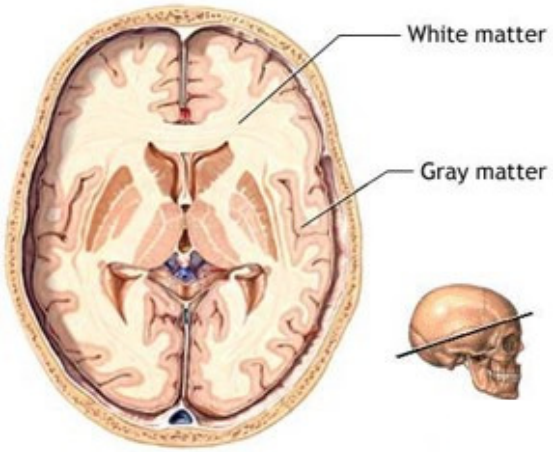
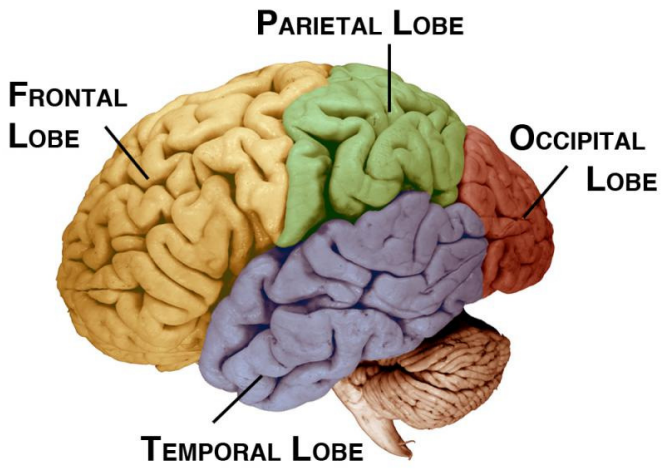
Gray and white matter distribution in the cortex



Picture: http://www.nlm.nih.gov/medlineplus/ency/imagepages/18117.htm

Forebrain: Cerebral cortex



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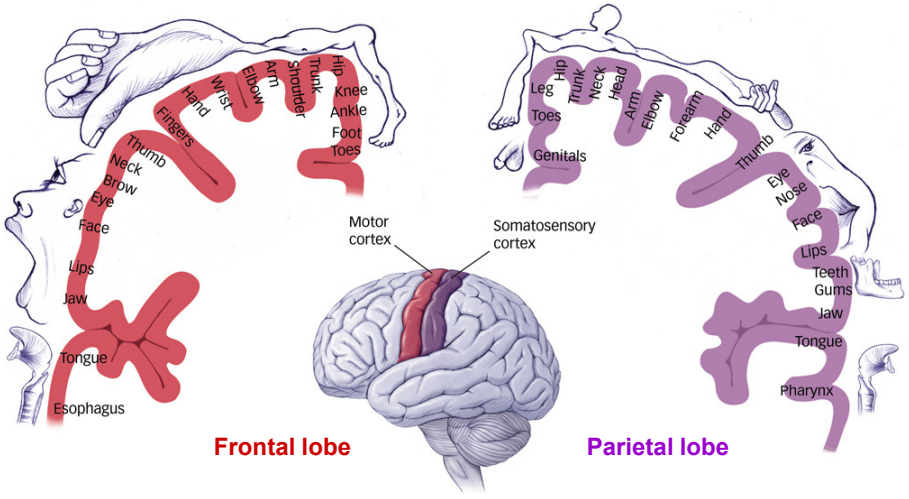
Picture: http://serendip.brynmawr.edu/exchange/brains/definitions/def-occlobe

Motor and sensory homunculi



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Picture: From Schacter's et al.'s *Psychology*, 2nd ed.

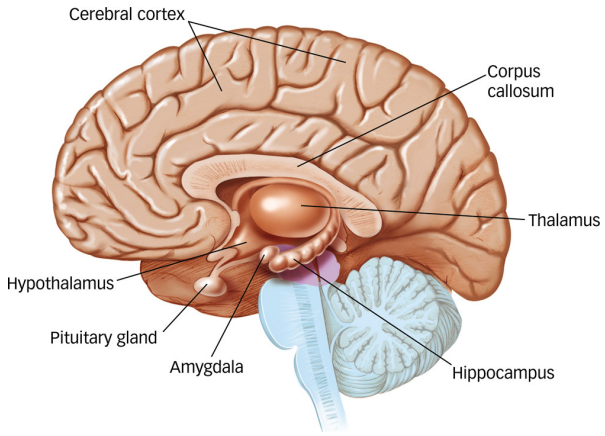
Forebrain: Medial view

Thalamus

Hippocampus

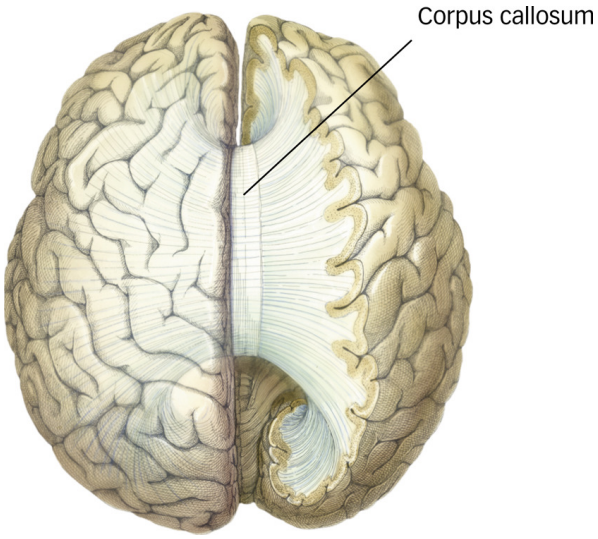
Amygdala

Corpus callosum



Picture: From Schacter's Psychology (2nd ed)

Close-up of the corpus callosum



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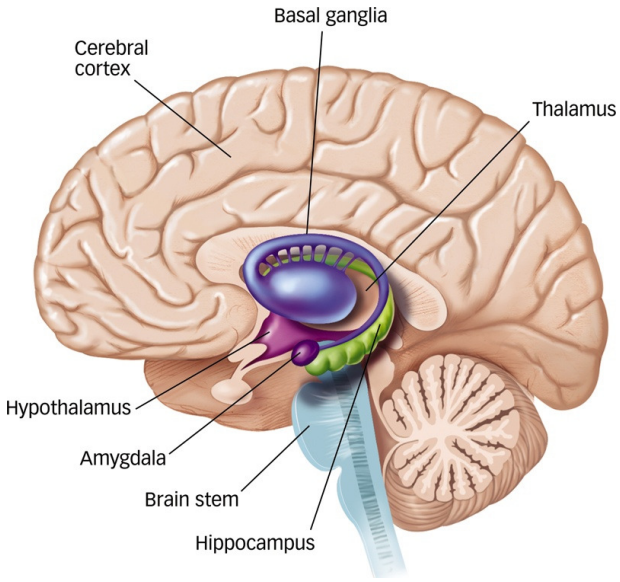
Picture: From Schacter's Psychology (2nd ed)

Forebrain: Basal ganglia (subcortical)



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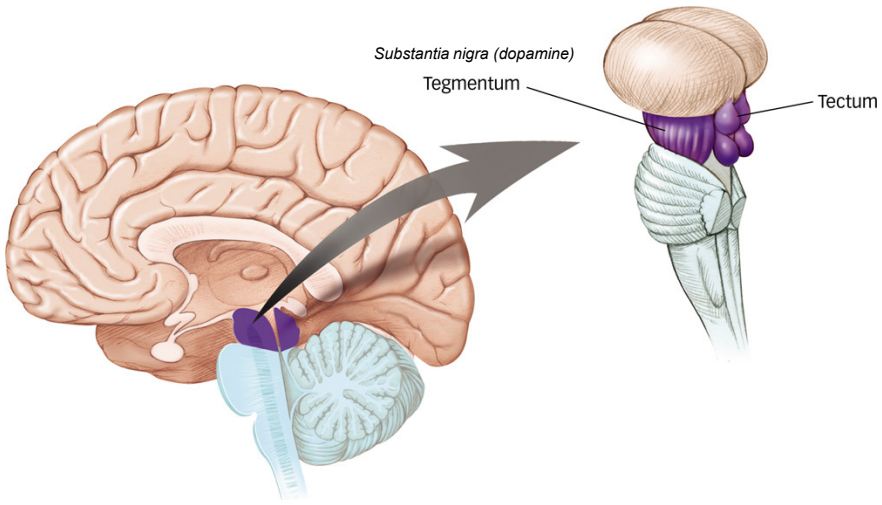
Picture: From Schacter's Psychology (2nd ed)

The Midbrain



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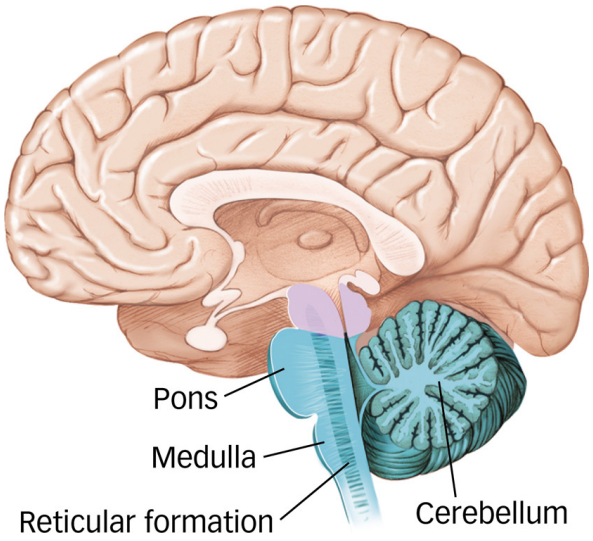
Picture: From Schacter's Psychology (2nd ed)

The Hindbrain



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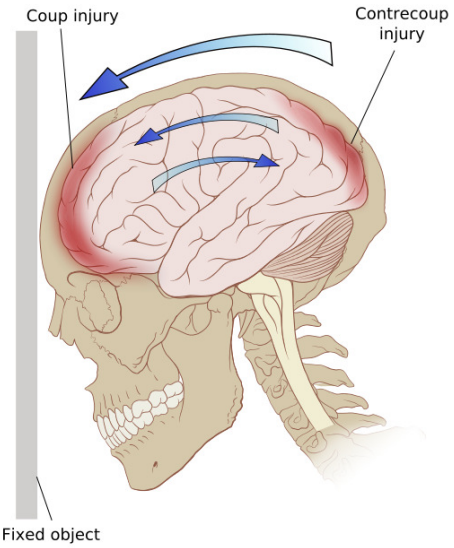
Picture: From Schacter's Psychology (2nd ed)

Traumatic brain injury



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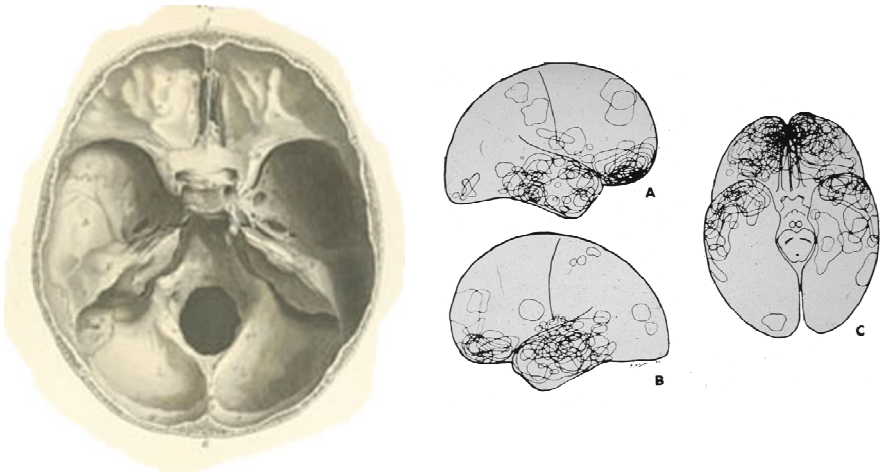
Picture: http://en.wikipedia.org/wiki/Coup_contrecoup_injury

Key challenges in skull design



Picture: http://www.biologycorner.com/anatomy/skeletal/printables.html
Courtesy of M. D'Esposito

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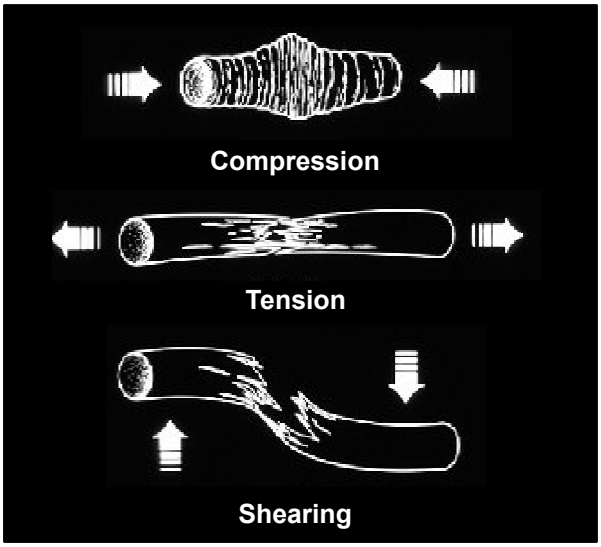
Diffuse Axonal Injury (DAI)



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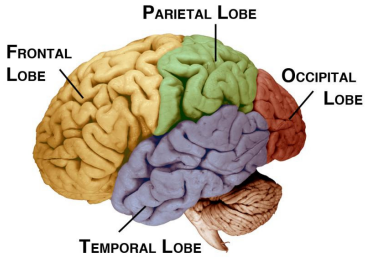
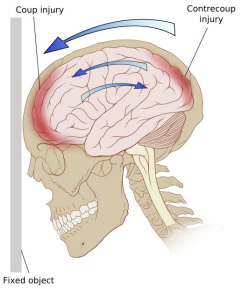
Picture: Courtesy of M. D'Esposito

Lecture summary

Regions near to (and including) the brain stem serve critical life functions while the cerebral cortex carries out higher-level motor, sensory and cognitive functions

Traumatic brain injury can damage neurons in a number of ways. One of those ways is by stressing the connections between brain regions (axonal injury)





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Next lecture: Midterm Examination 1 (BRING A PENCIL for the scantron!)