

M U N I

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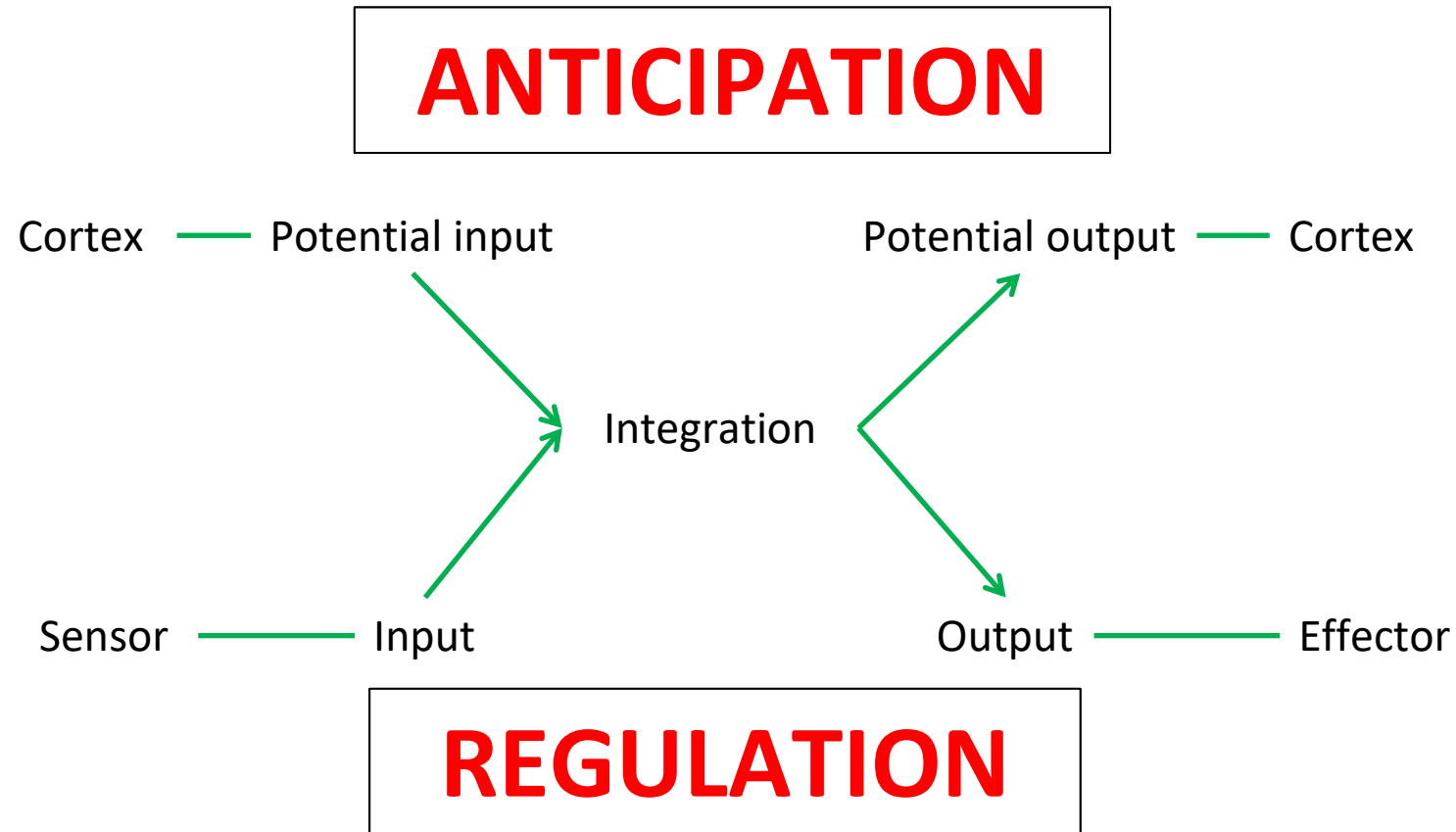
Hierarchy and evolution of nervous system

Evolutionary approach

Evolution is not revolution



The role of nervous system



Evolution of the nervous system

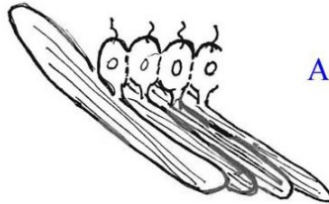
Input → Integration → Output

Four basic types of tissue

- ✓ Epithelial
- ✓ Connective
- ✓ Muscular
- ✓ Nervous

Evolution of the nervous system

Input → Integration → Output



A. Myoepithelium:
contractile epithelial cells
responding to stimulation and
interconnected by electrical
synapses (gap junctions)

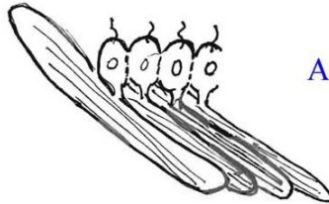
Gerald Schneider. *9.14 Brain Structure and Its Origins, Spring 2014*. (Massachusetts Institute of Technology: MIT OpenCourseWare), <http://ocw.mit.edu> (Accessed). License:Creative Commons BY-NC-SA

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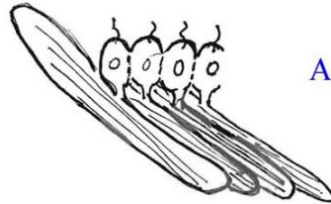


B. Protomyocytes separate
from sensory epithelium,
all connected by electrical
synapses

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Evolution of the nervous system

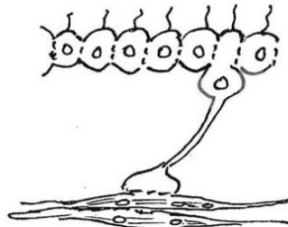
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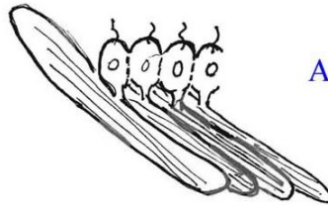


C. Protoneurons appear,
sensory and connected to
separate contractile cells

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Evolution of the nervous system

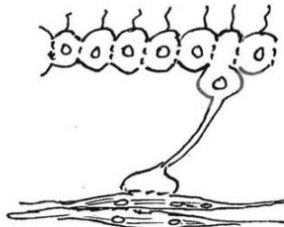
Input → Integration → Output



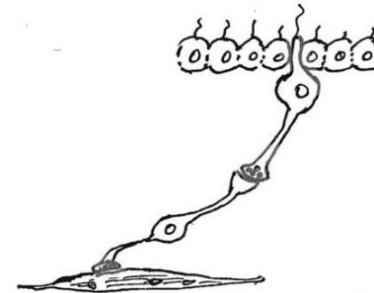
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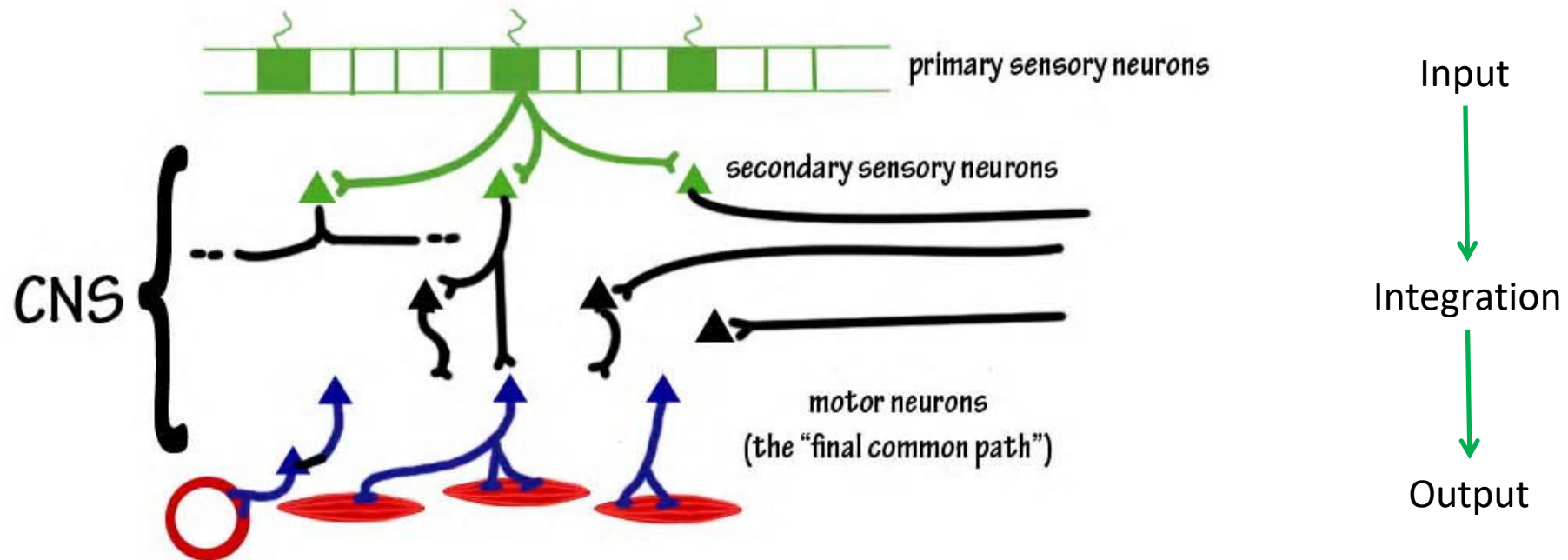
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D. Neurons appear, separate
from both neurosensory cells
and contractile cells.
Chemical synapses appear.

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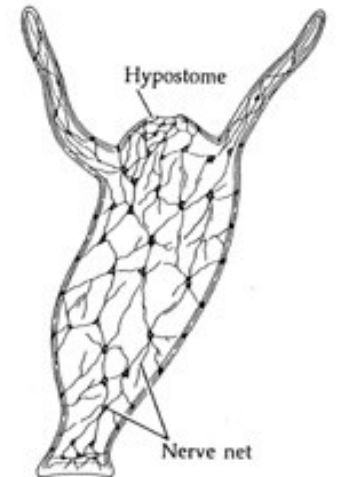
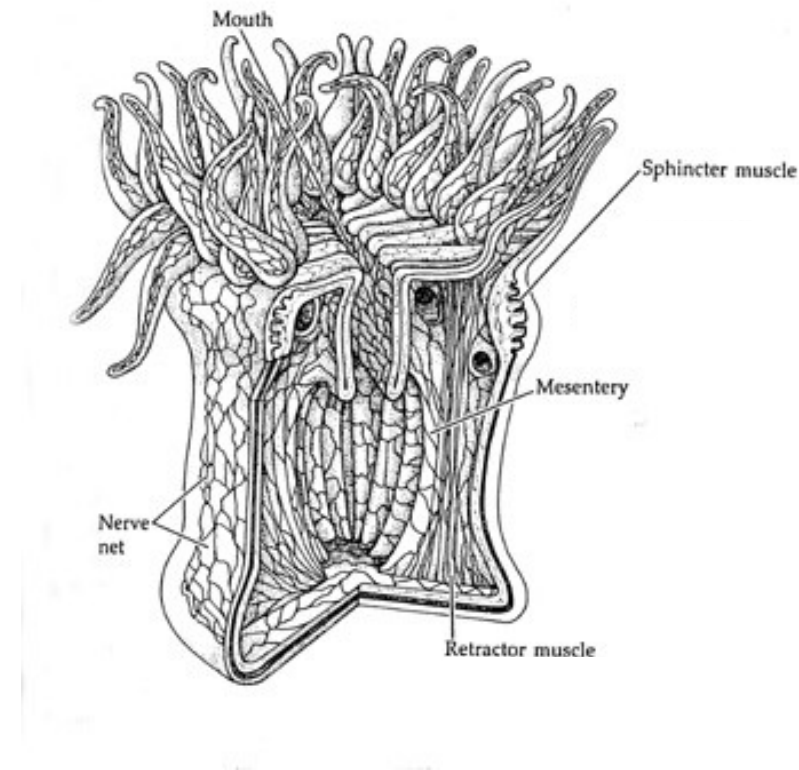
Evolution of the nervous system



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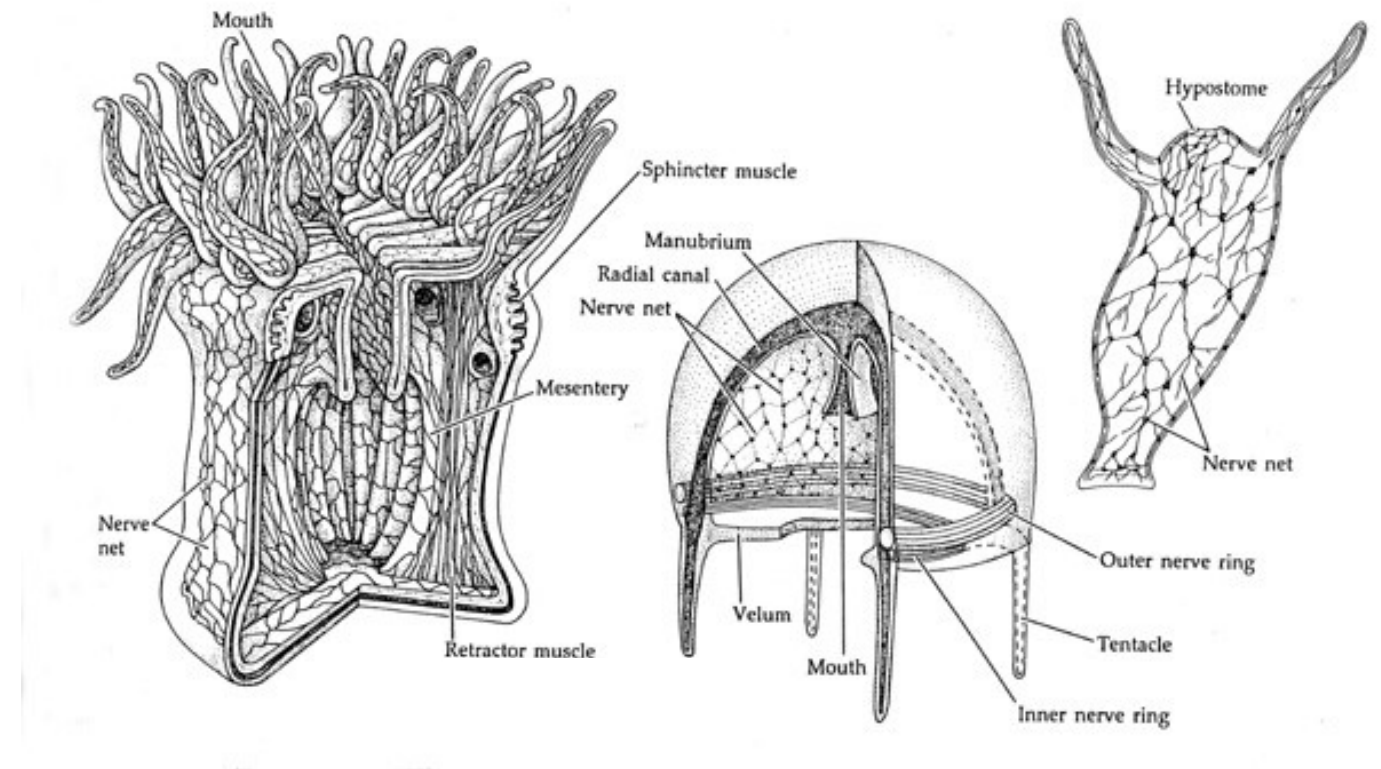
Evolution of the nervous system

- Polyp
 - Reticular NS
 - Nonspecific reaction on irritation



Evolution of the nervous system

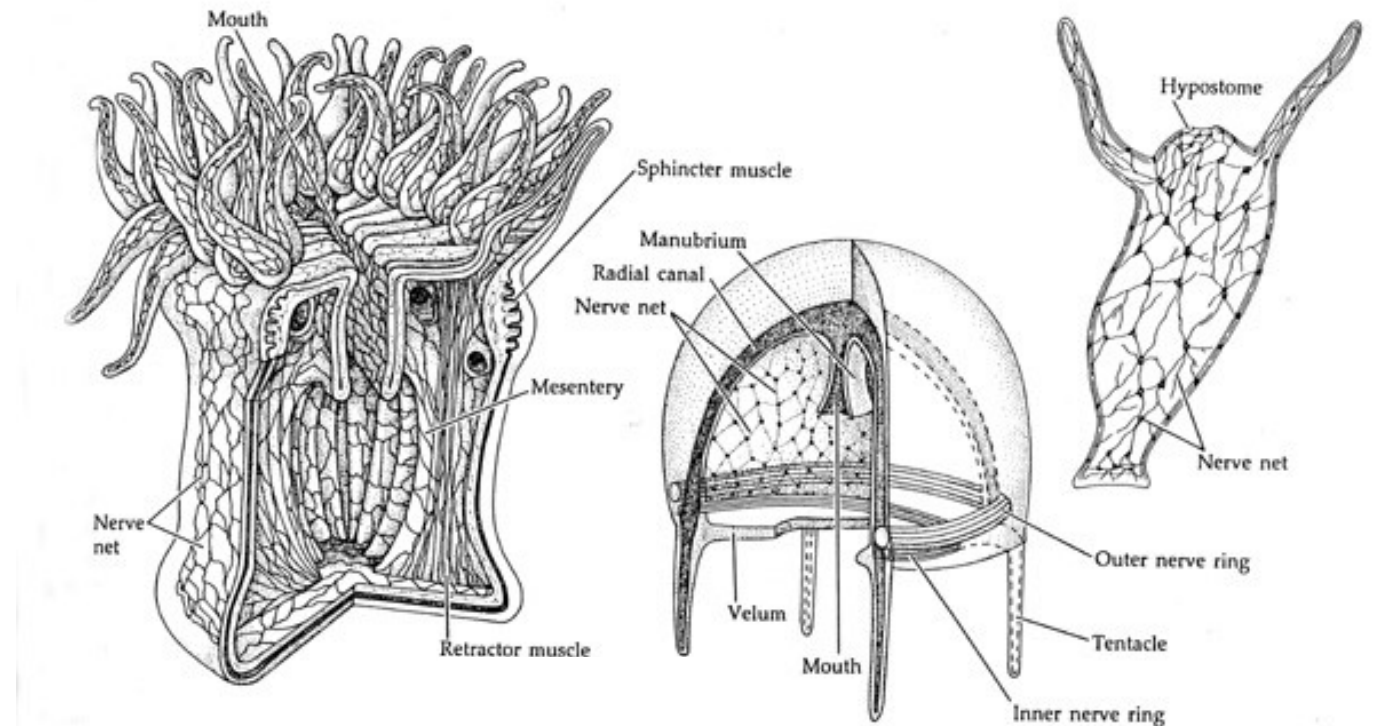
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 - Nonspecific reaction on irritation
- Jellyfish
 - Around propulsion part is nervous system into the ring
 - Coordinated contraction – coordinated movement



Evolution of the nervous system

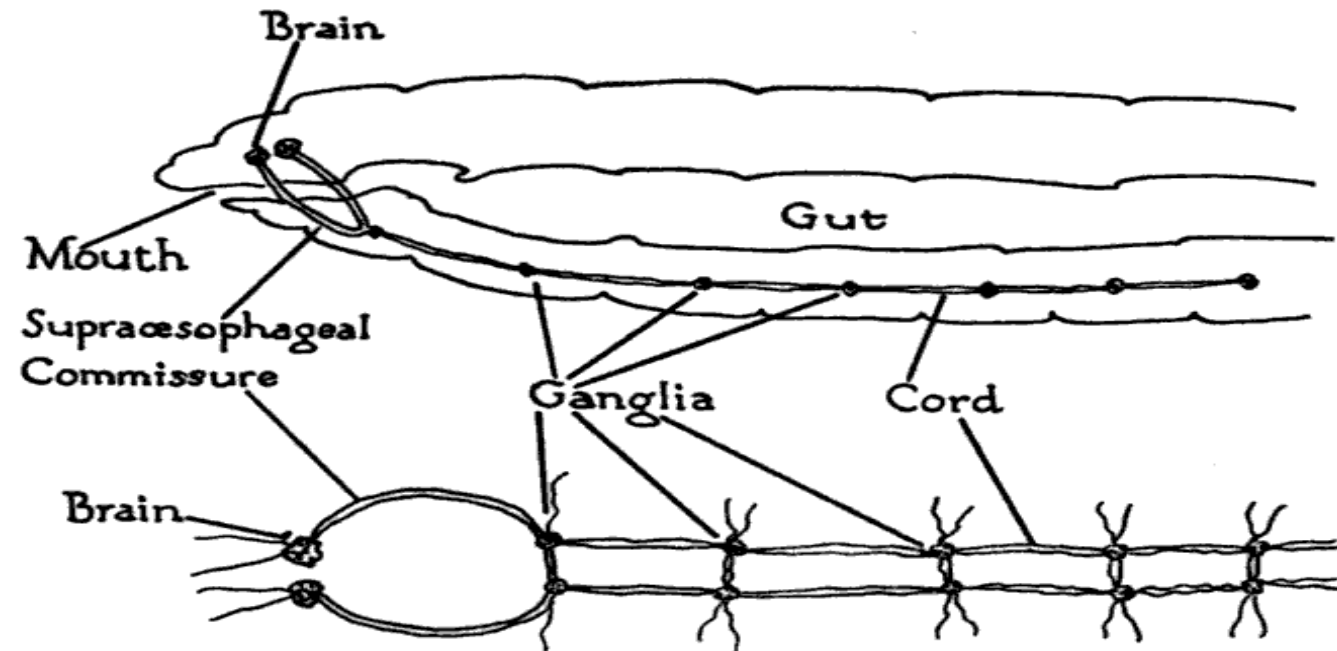
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FOTORECEPTION



Evolution of the nervous system

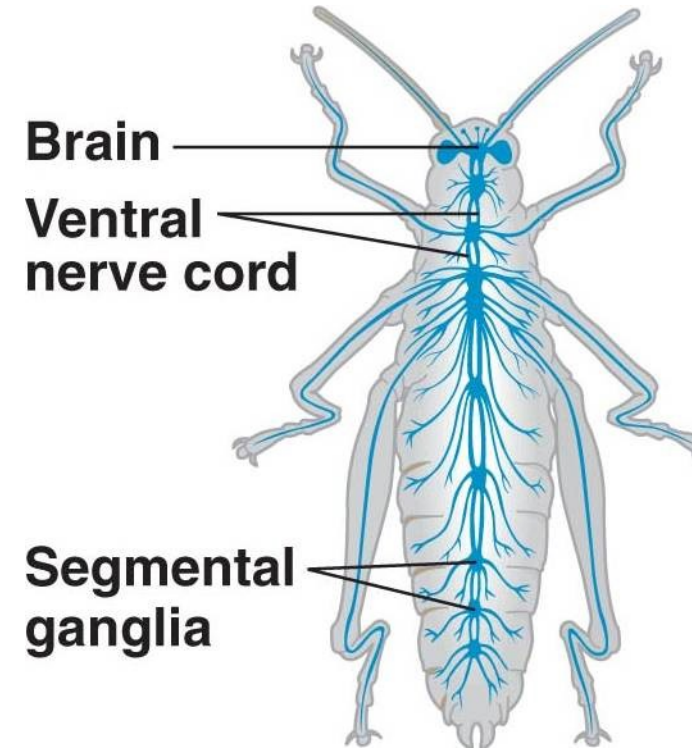
- Worms
 - Segmented nervous system
 - Left – right coordination
 - Ganglia
 - „Brain“ ganglion – head – forward locomotion – food intake



<https://en.wikipedia.org/wiki/Earthworm>

Evolution of the nervous system

- Insect
 - „Sophisticated“ NS
 - Coordinated movement
 - „Developed“ senses
 - Communication skills (bee)



<http://bilingualbiology10.blogspot.cz/2013/08/topic-11b-arthropods-izeltlabuak.html>

Basics of behavior enabling survival

- **Multipurpose movements**
 - The most basic actions of individual organisms
 - **Locomotion**: to approach or to avoid something
 - **Orienting**: towards or away from something
 - **Exploring/foraging/seeking** (includes the first two plus motivation)

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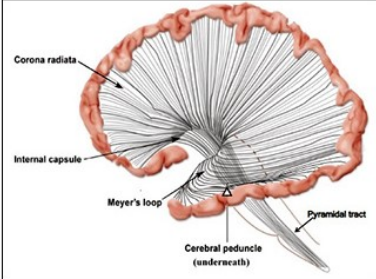
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EXAMS

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Instructor(s)
Prof. Gerald E. Schneider

MIT Course Number
9.14

As Taught In
Spring 2014

Level
Undergraduate

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Drawing of the left hemisphere of the human brain together with the brainstem, dissected to reveal the course of axons that descend to the brainstem and spinal cord. (Courtesy of MIT Press. Used with permission. Figure 22.8 from Schneider, G. E. [Brain Structure and Its Origins: In the Development and in Evolution of Behavior and the Mind](#). MIT Press, 2014.)

Course Features

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- > [Subtitles/transcript](#)
- > [Lecture notes](#)
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<http://ocw.mit.edu/courses/brain-and-cognitive-sciences/9-14-brain-structure-and-its-origins-spring-2014/#>

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 - respiration, temperature regulation, postural reflexes

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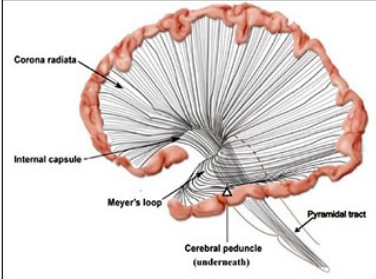
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- **Motivation**

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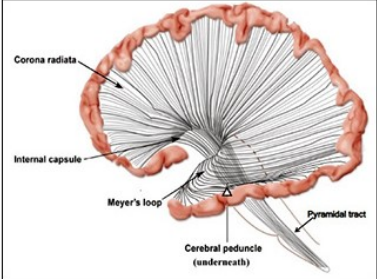
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Basics of behavior enabling survival

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- **Orienting:** towards

- **Exploring**
plus movements

- **Background**

- respiration
reflexes

- **Motivation**

Locomotion influenced development of

- **Sensory analyzing mechanisms**

- Connected to inputs from cranial nerves

- **Associated motor apparatus**

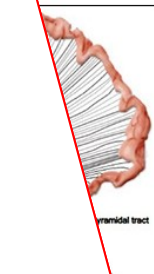
- For directing the receptors (orienting movements)
- For controlling alterations in posture and locomotion under guidance from these receptors

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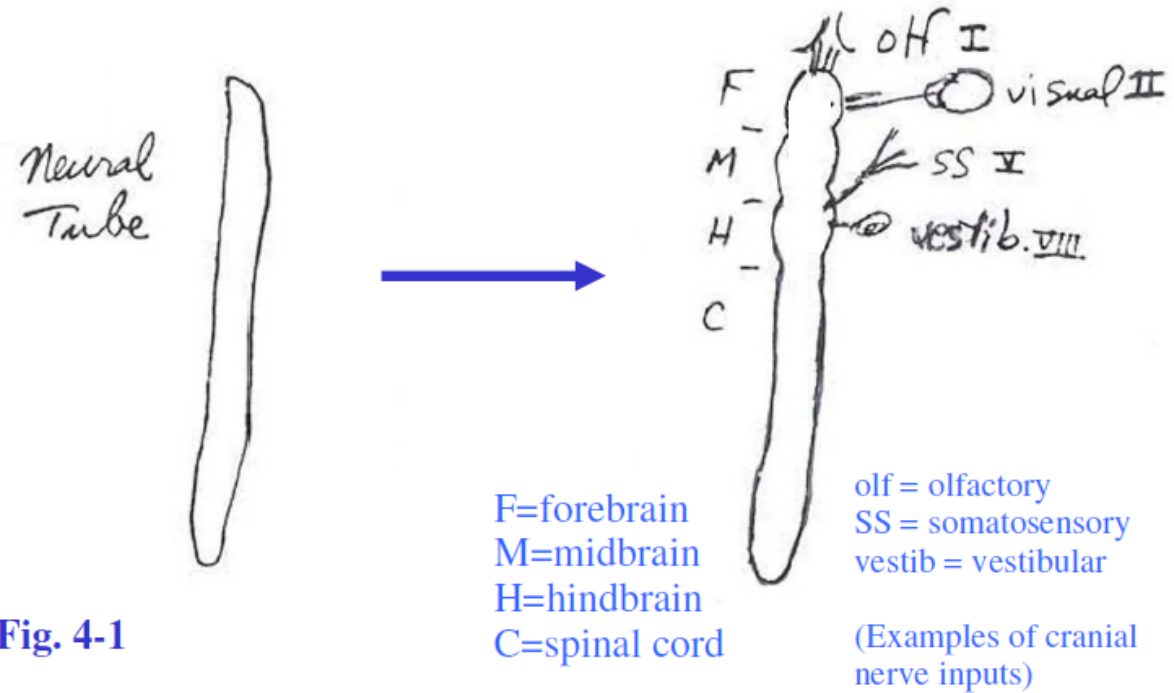


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Evolution of the brain

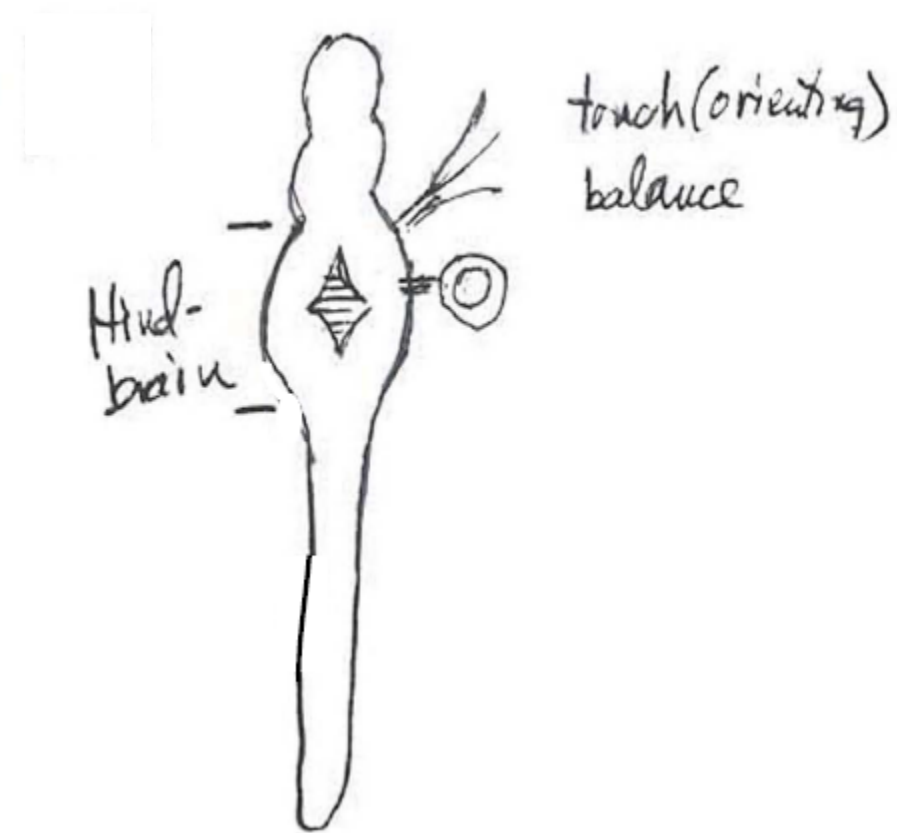
- Neural tube
- Locomotion
- Rostral receptors



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Evolution of the brain

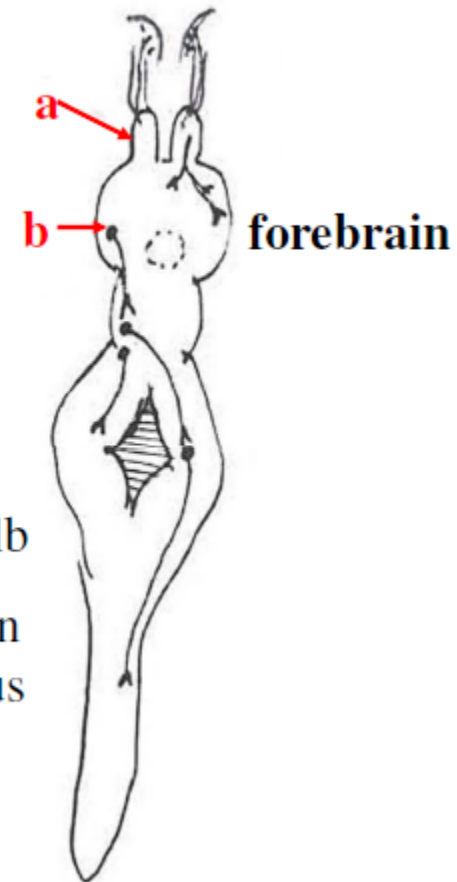
- **Expansion of hindbrain**
(Rhombencefalon - Medula oblongata, pons Varoli, cerebellum)
- **Input**
 - Information from head sensors
- **Output**
 - Motor system
(Fixed action pattern - reflex/instinct behavior)



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Evolution of the brain

- **Expansion of forebrain 1**
(Prosencephalon - diencephalon, telencephalon)
(simultaneously with hindbrain)
- **Input**
 - Olfaction (Approach/avoidance)
- **Output**
 - Motor system
(via corpus striatum)

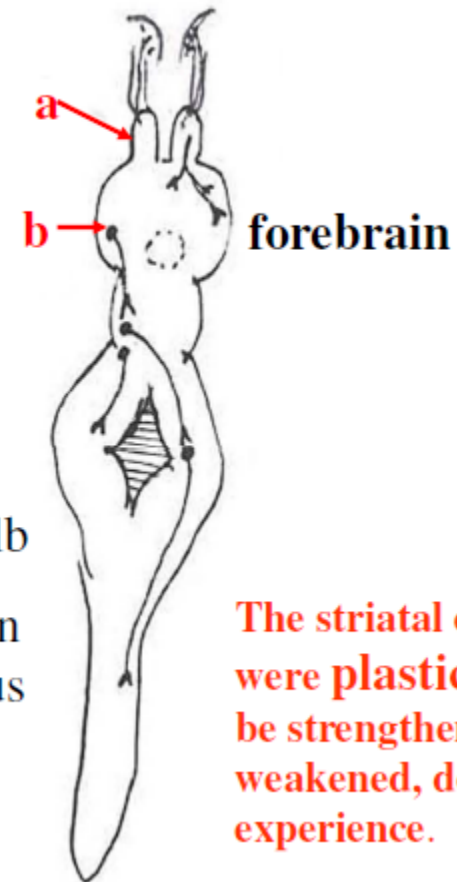


a olfactory bulb
b connection in primitive corpus striatum

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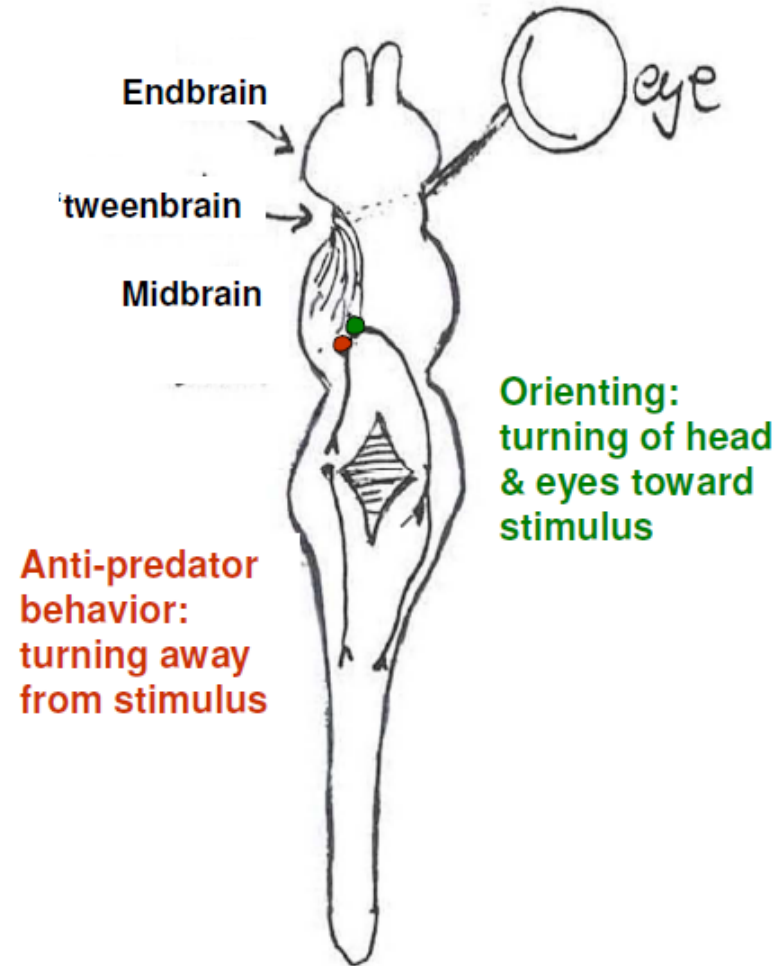
a olfactory bulb
b connection in primitive corpus striatum

The striatal connections were plastic: They could be strengthened or weakened, depending on experience.

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Evolution of the brain

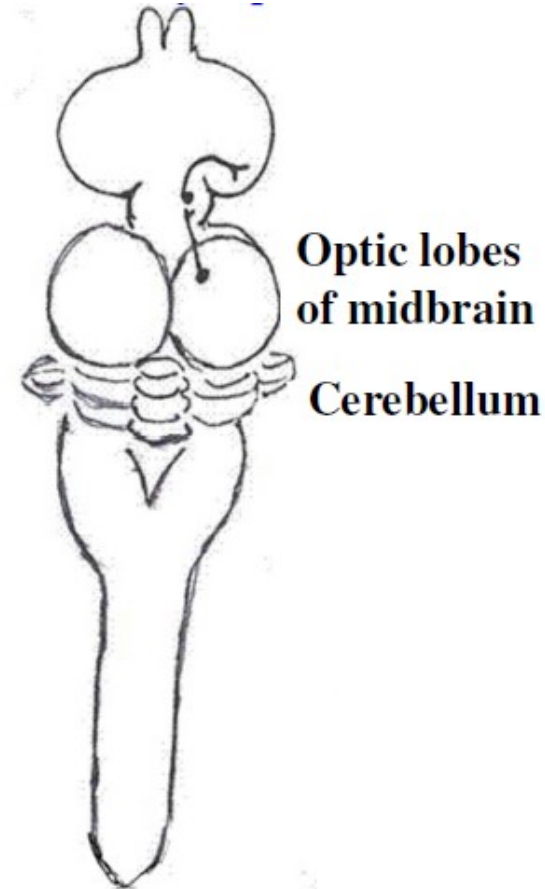
- **Expansion of midbrain**
- **Input**
 - Vision, sense of hearing (distant senses)
- **Output**
 - Motor system
(Approach – contralateral m.)
(Avoidance – ipsilateral m.)
- **Advantage**
 - Speed
 - Acuity



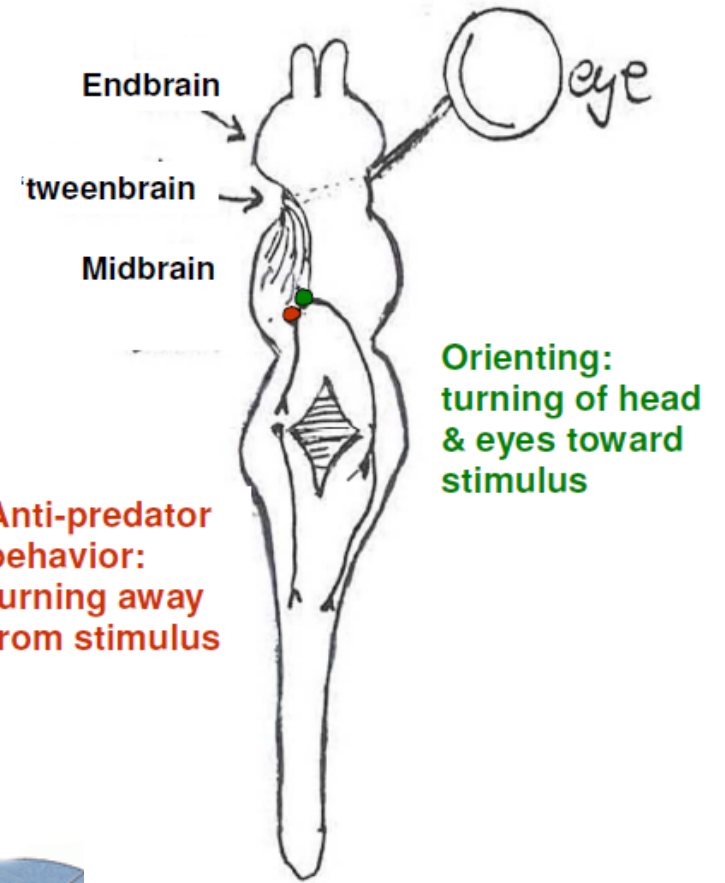
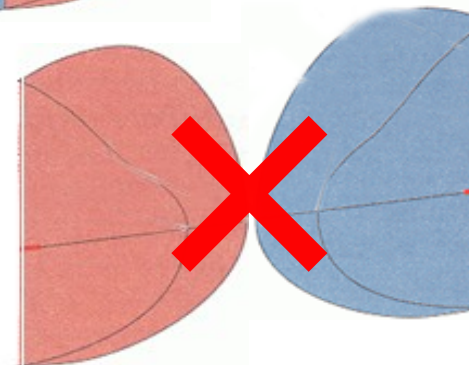
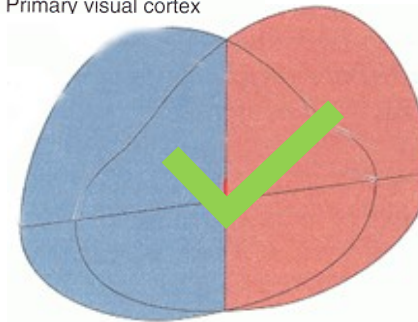
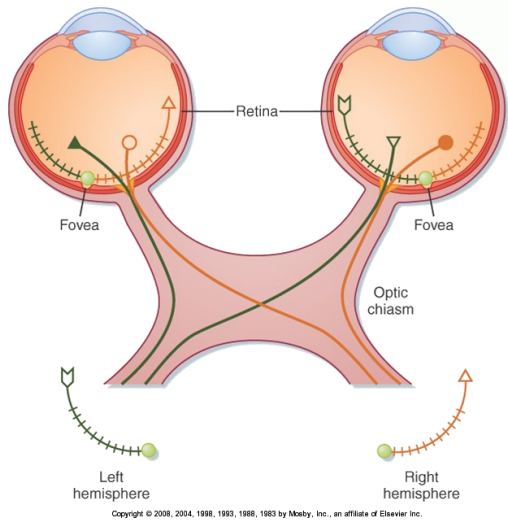
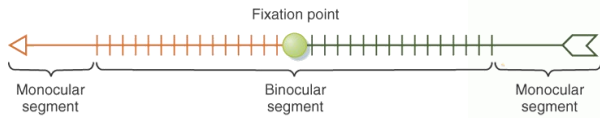
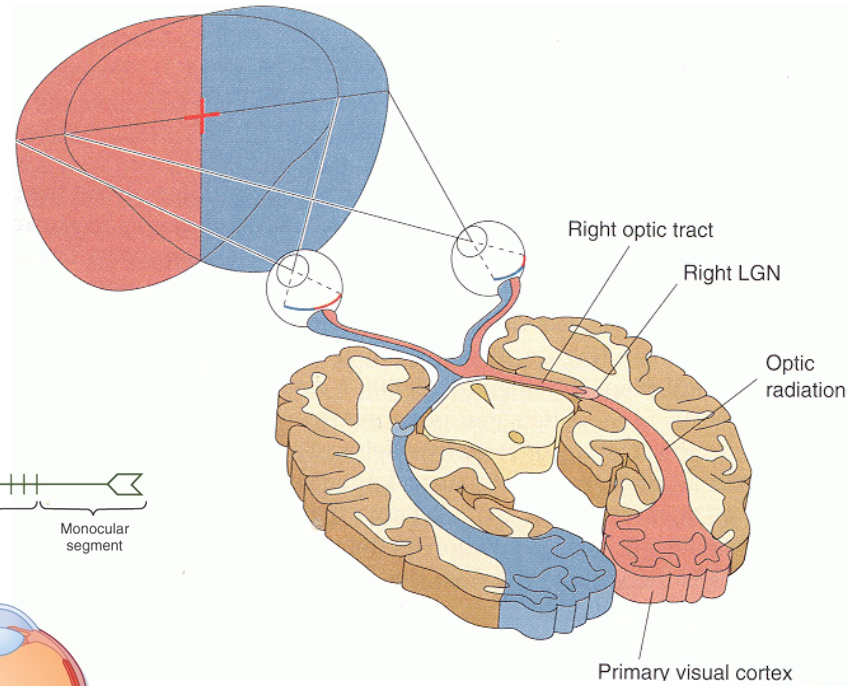
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Evolution of the brain

- **Expansion of forebrain 2**
(Prosencephalon - diencephalon, telencephalon)
- **Input**
 - Nonolfactory systems connected to forebrain
 - Mainly vision and hearing
- **Advantage**
 - Plastic connections of forebrain
- **Thalamus**
 - Gating
(Corpus striatum and cortex)

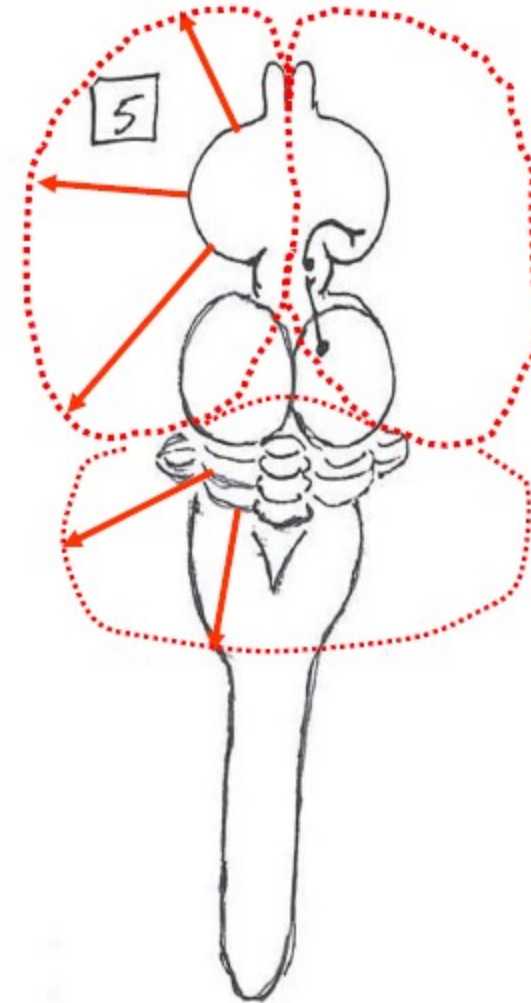


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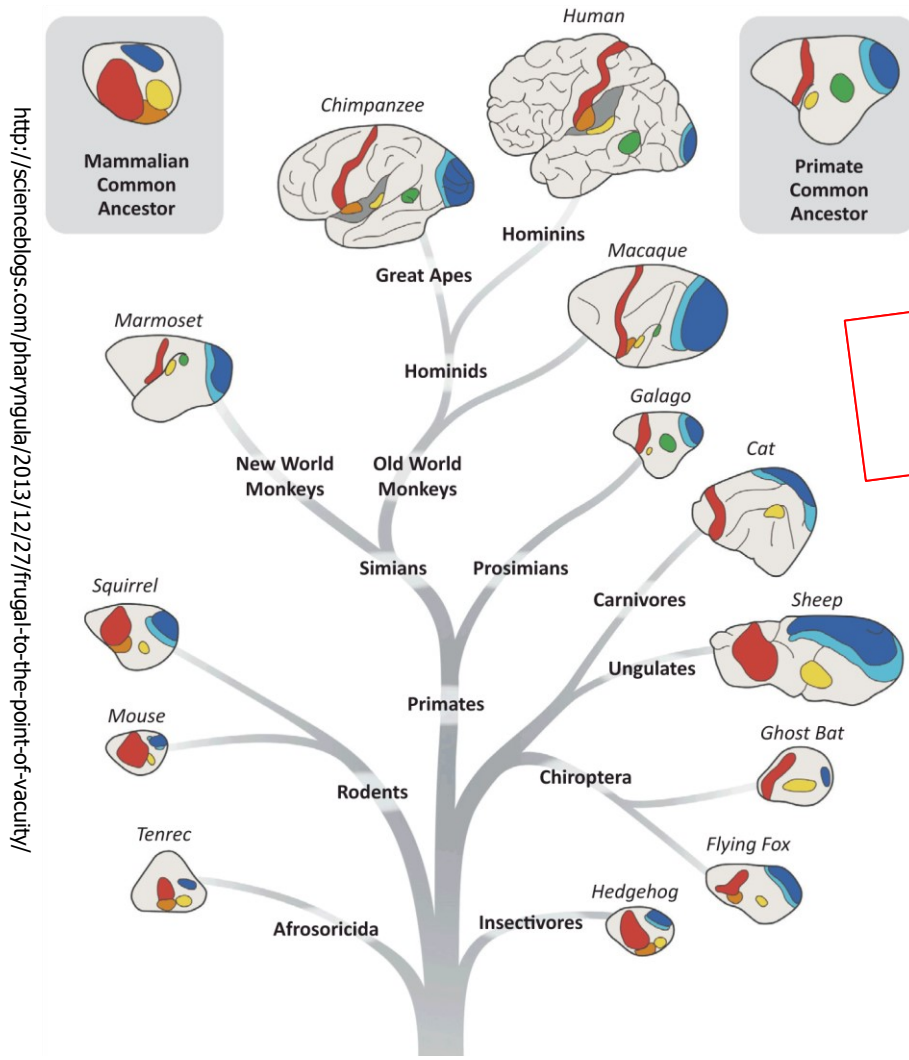
Evolution of the brain

- **Expansion of forebrain 3**
- Neocortical expansion
- Simultaneous expansion of
 - Neostriatum
 - Neocerebellum
- Advantage
 - „High resolution“ information processing
 - Anticipation



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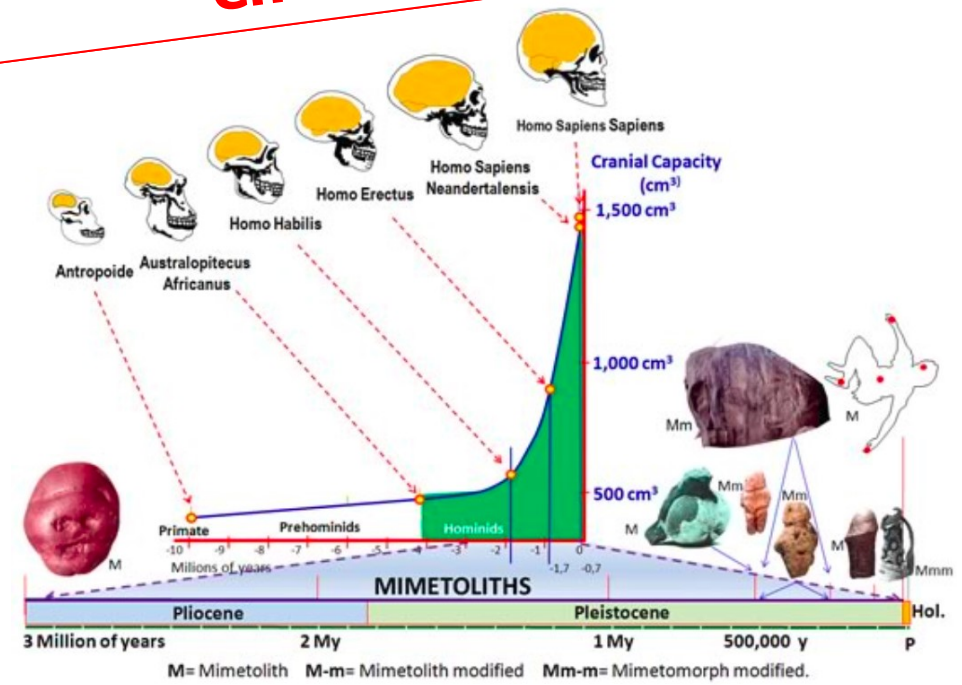
Evolution of the brain



<http://scienceblogs.com/pharyngula/2013/12/27/frugal-to-the-point-of-vaquity/>

- Mammalians and humans
- Peak of NS development

Evolution is shaped by environment

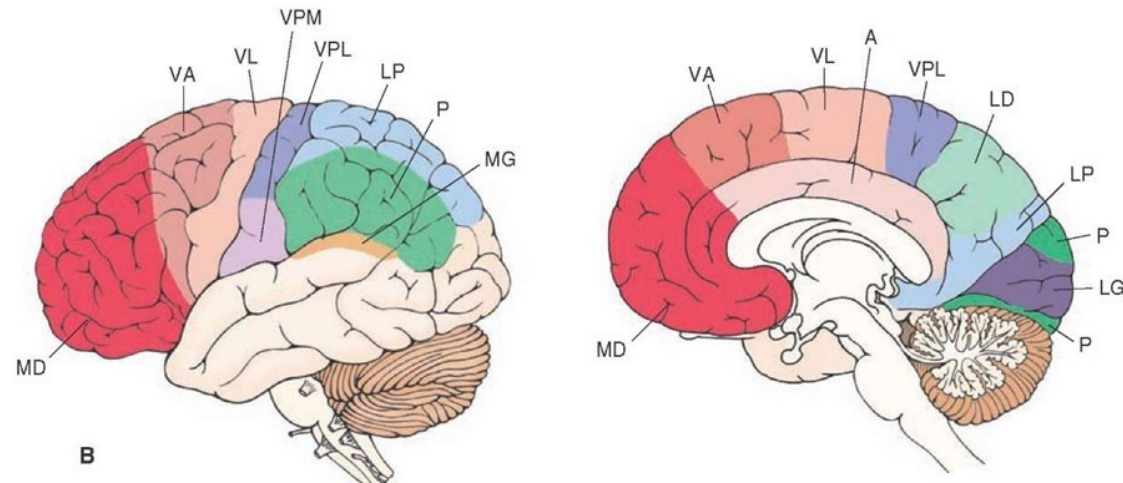
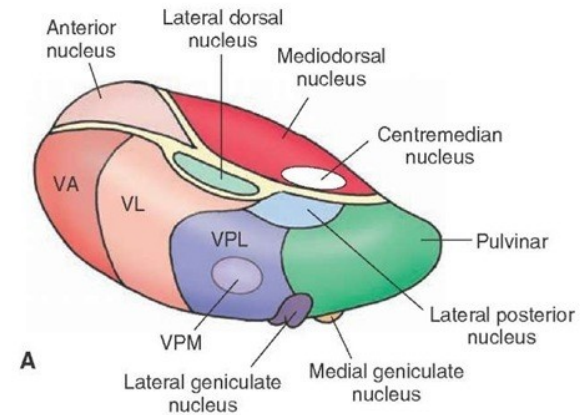


<http://www.rupestreweb.info/mimesis.html>

Thalamus and neocortex

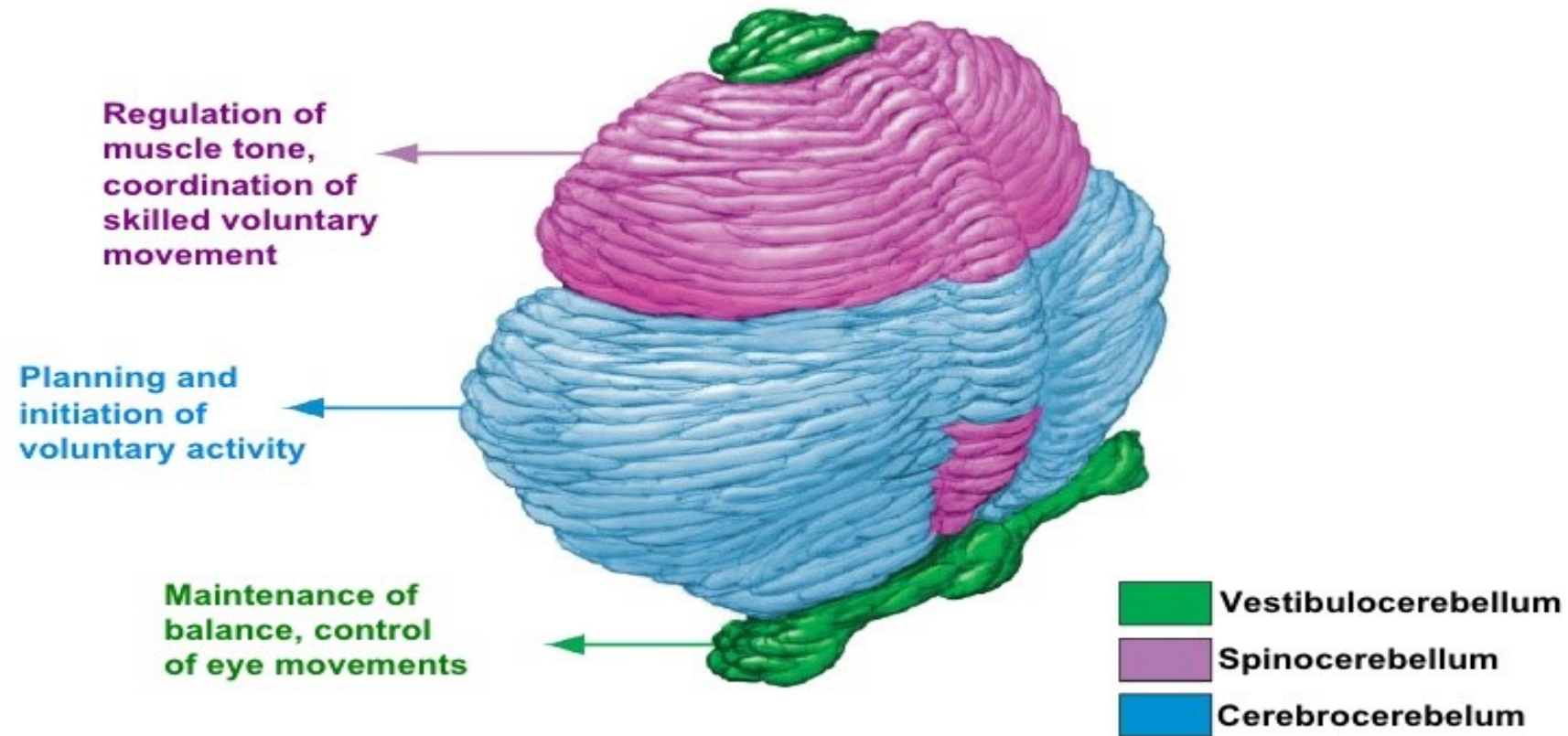
Gating

- Thalamic nuclei
 - Nonspecific
 - Specific
- Reciprocal connections between thalamus and neocortex



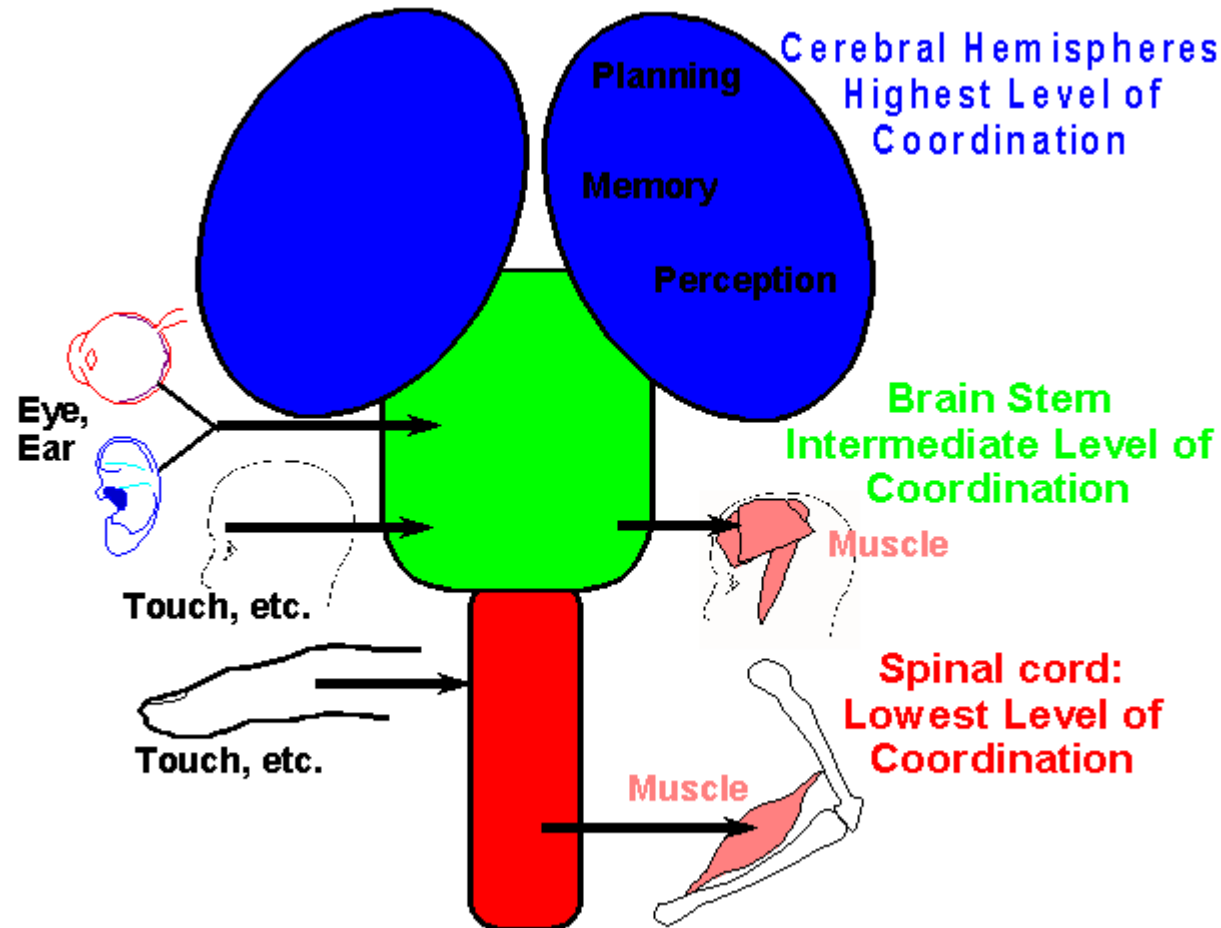
Cerebellum

Coordination

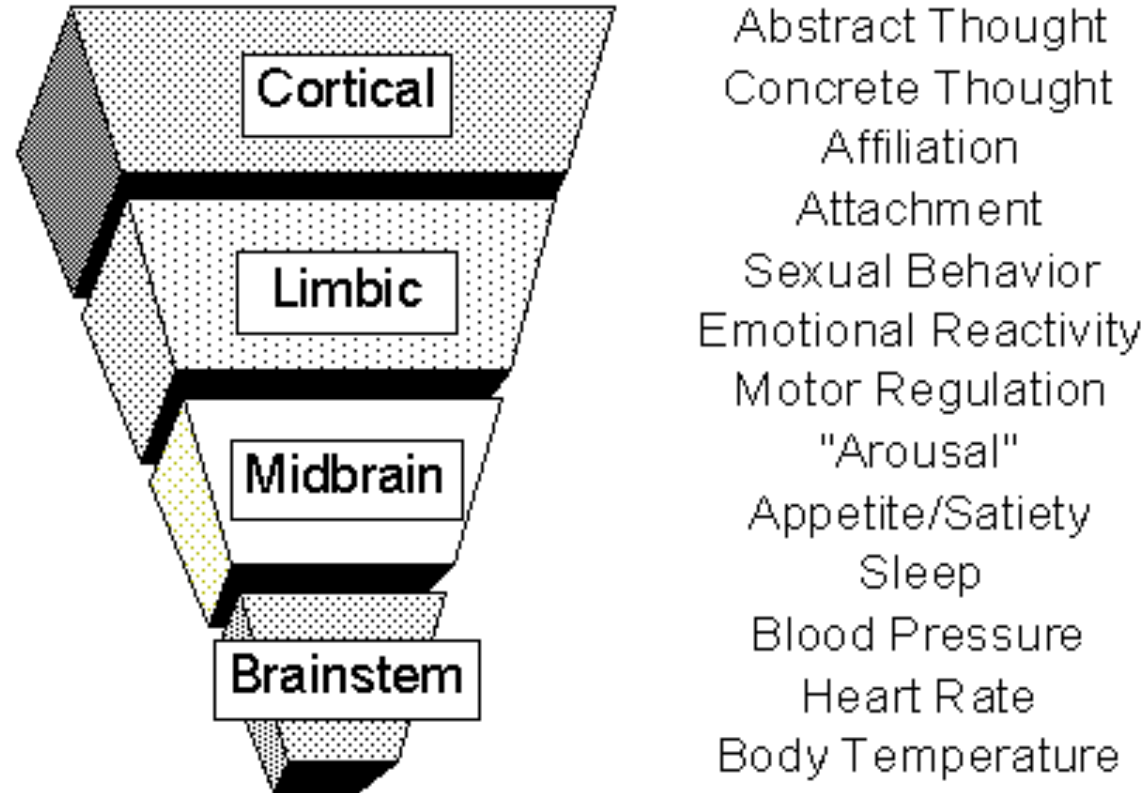


<http://www.slideshare.net/Harshshah103/cerebellum-its-function-and-relevance-in-psychiatry>

Hierarchy of central nervous system

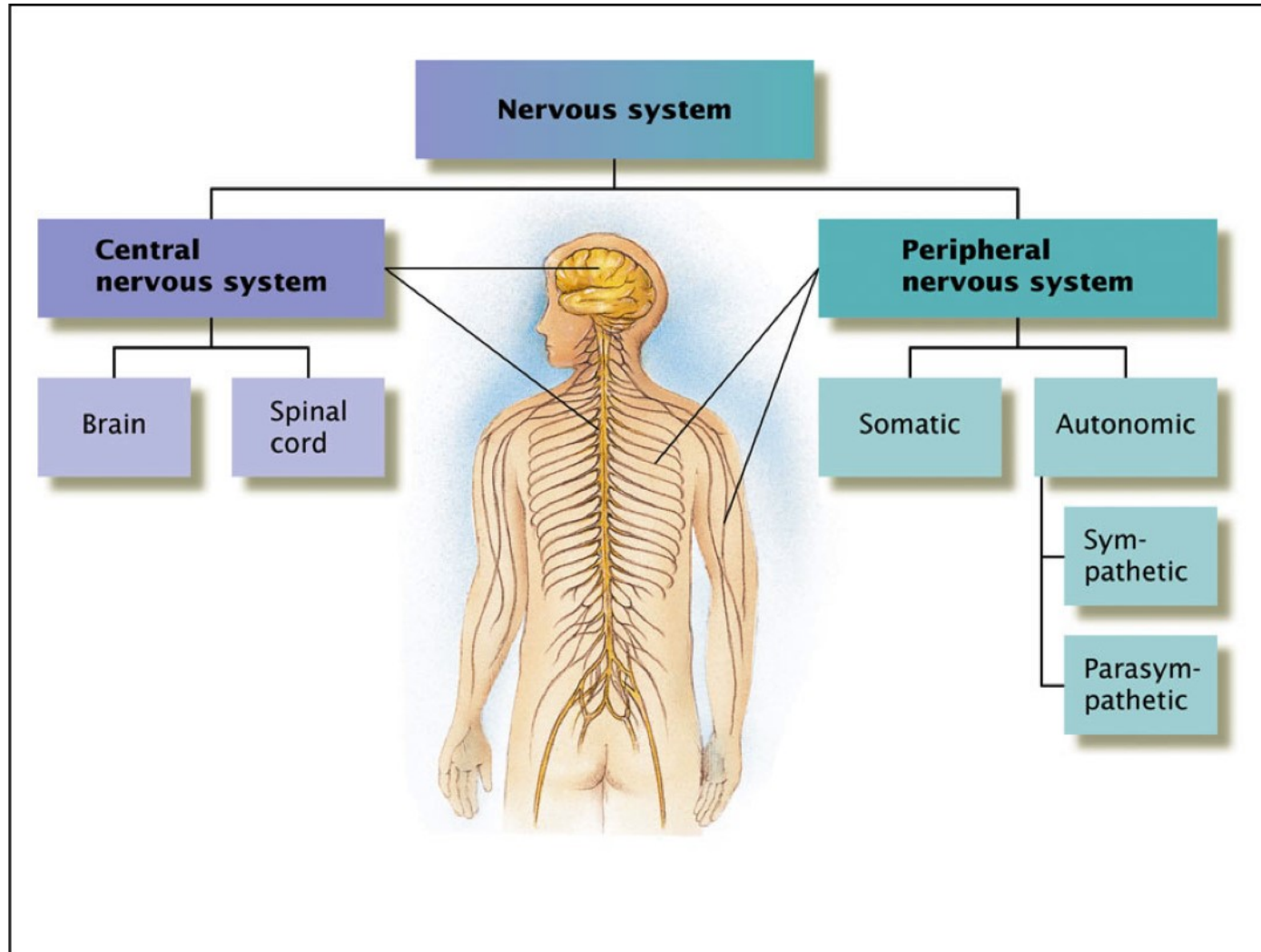


Hierarchy of central nervous system



<https://rajugurusamy.files.wordpress.com/2007/11/memories1.gif?w=497>

Hierarchy of nervous system



<https://userscontent2.emaze.com/images/be175f0a-afae-4c7c-944c-f6376cf09ba/60c3e8a3-a6b9-4a3d-943d-1841136a9ccf.png>

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