

**4**

# **Hierarchy and evolution of nervous system I**

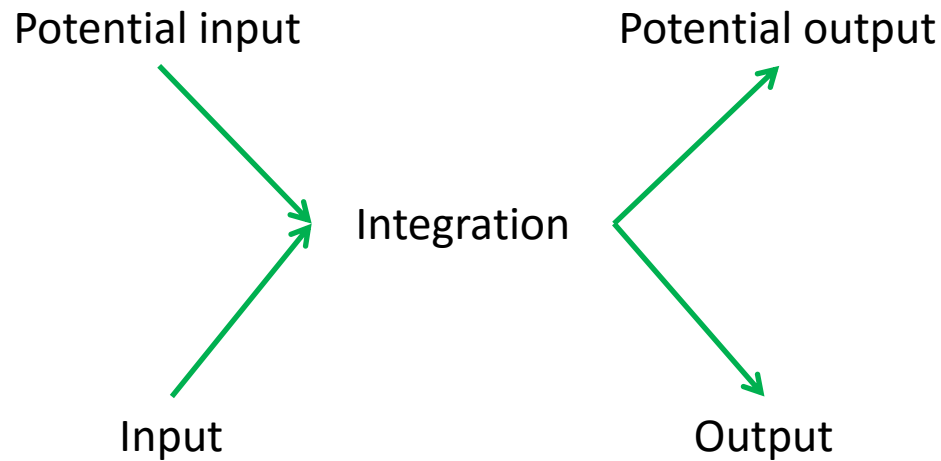
**Evolutionary approach**

**Evolution is not revolution**



# The role of nervous system

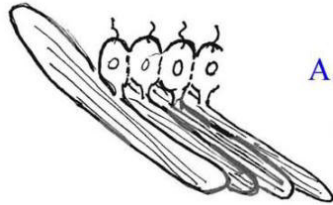
**ANTICIPATION**



**REGULATION**

# Evolution of the nervous system

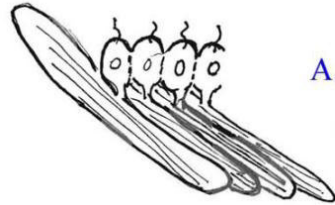
Input → Integration → Output



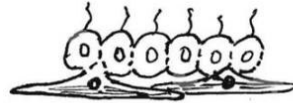
A. Myoepithelium:  
contractile epithelial cells  
responding to stimulation and  
interconnected by electrical  
synapses (gap junctions)

# Evolution of the nervous system

Input → Integration → Output



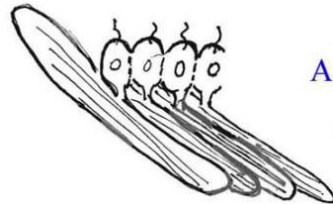
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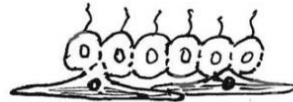
B. Protomyocytes separate  
from sensory epithelium,  
all connected by electrical  
synapses

# Evolution of the nervous system

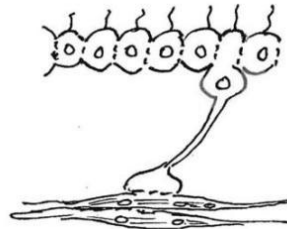
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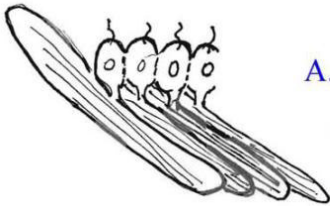
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C. Protoneurons appear,  
sensory and connected to  
separate contractile cells

# Evolution of the nervous system

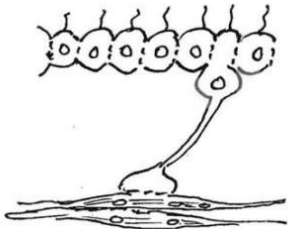
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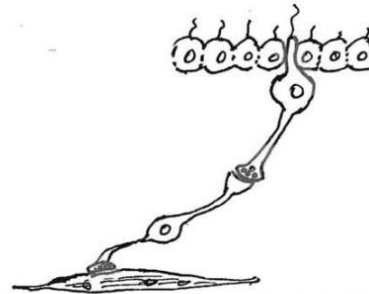
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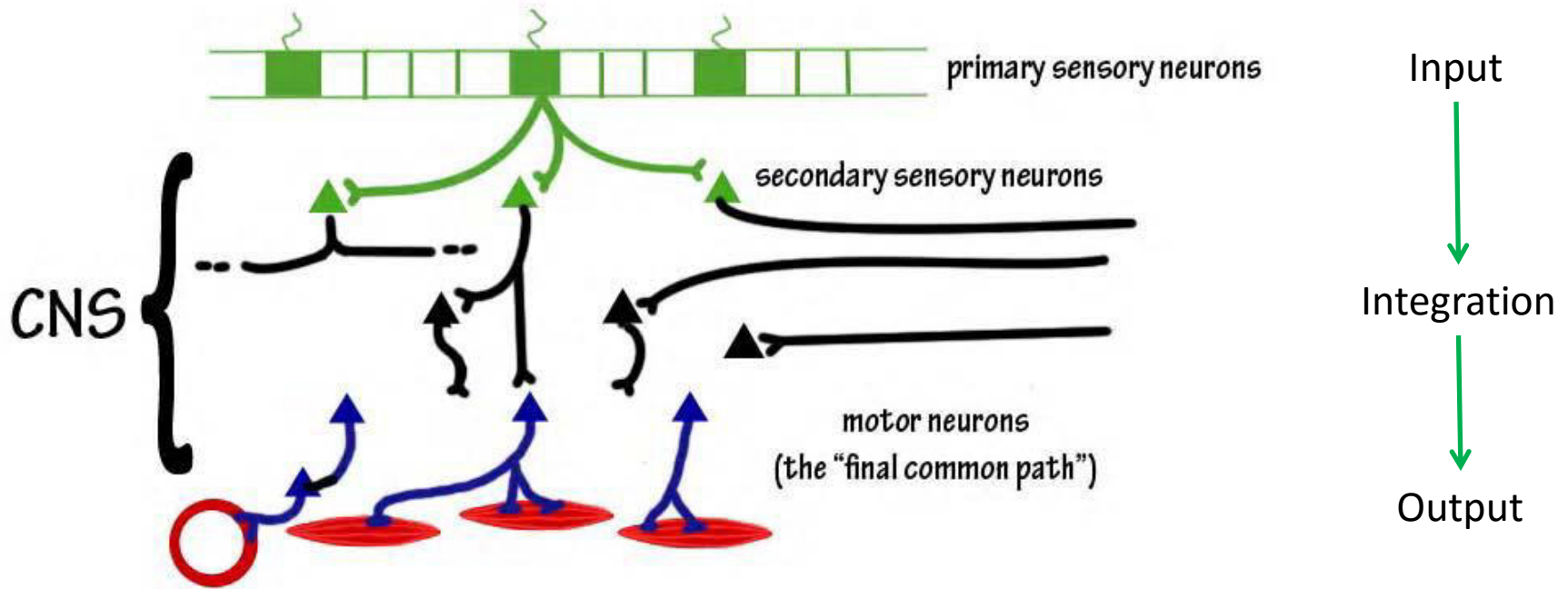


C. Protoneurons appear,  
sensory and connected to  
separate contractile cells



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

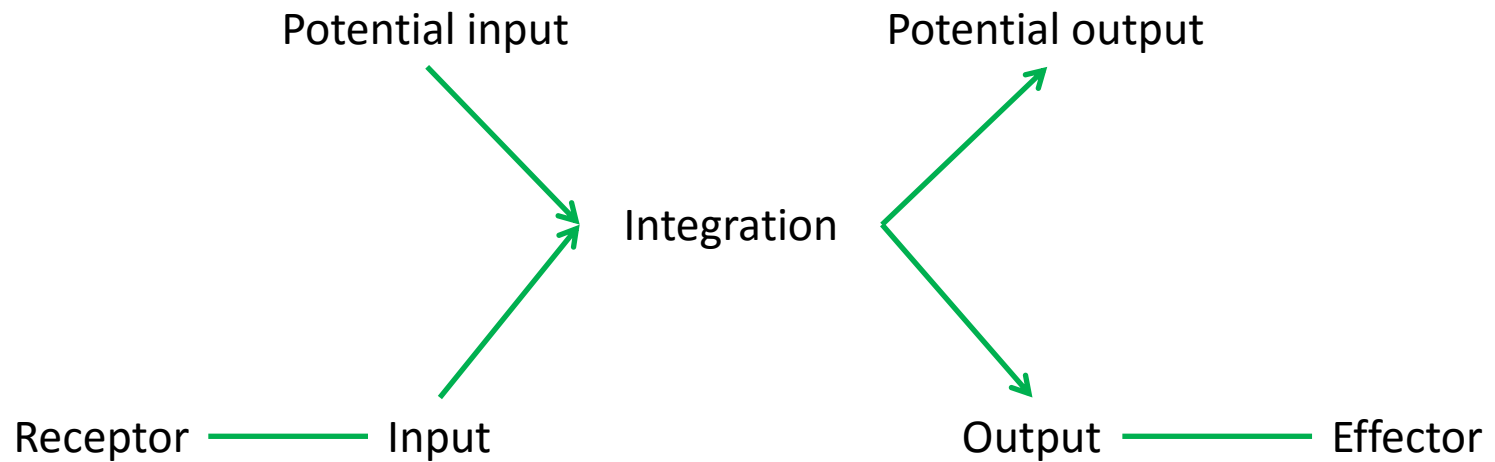
# Evolution of the nervous system





# The role of nervous system

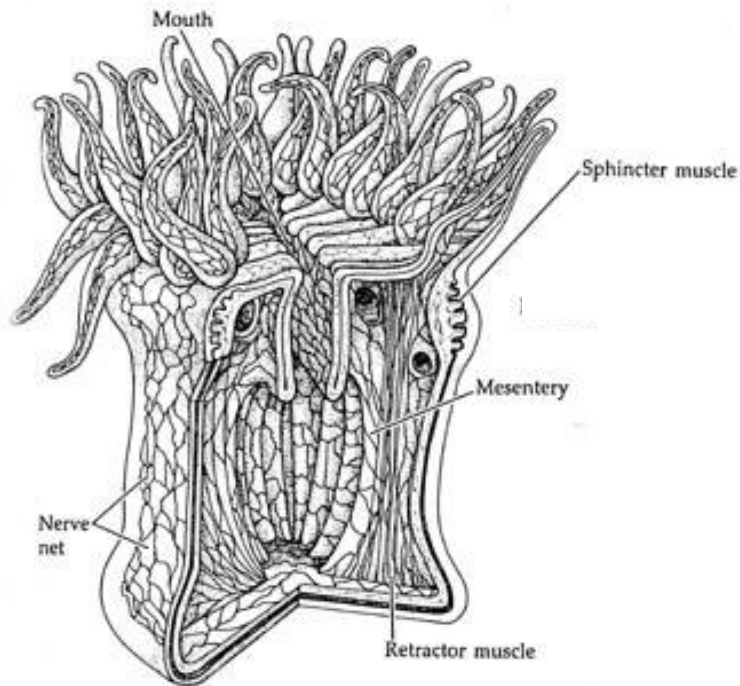
**ANTICIPATION**



**REGULATION**

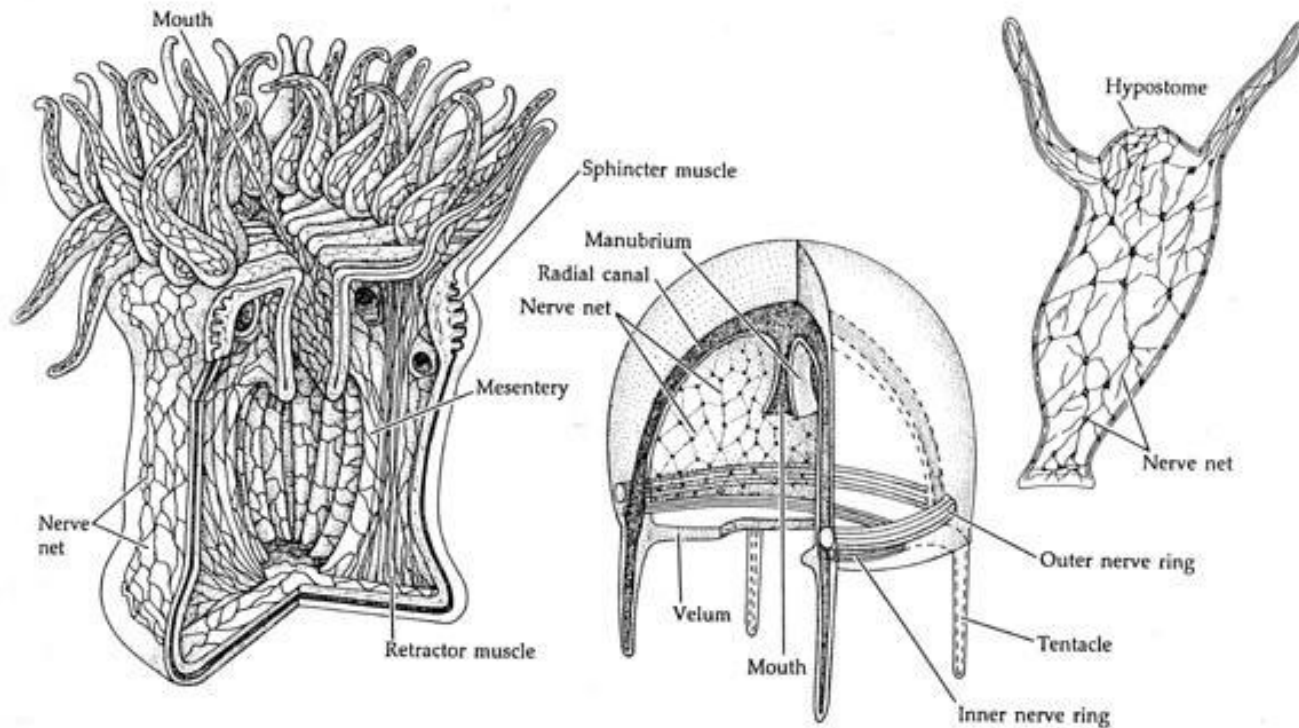
# Evolution of the nervous system

- Polyp
  - Reticular NS
  - Nonspecific reaction on irritation



# Evolution of the nervous system

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

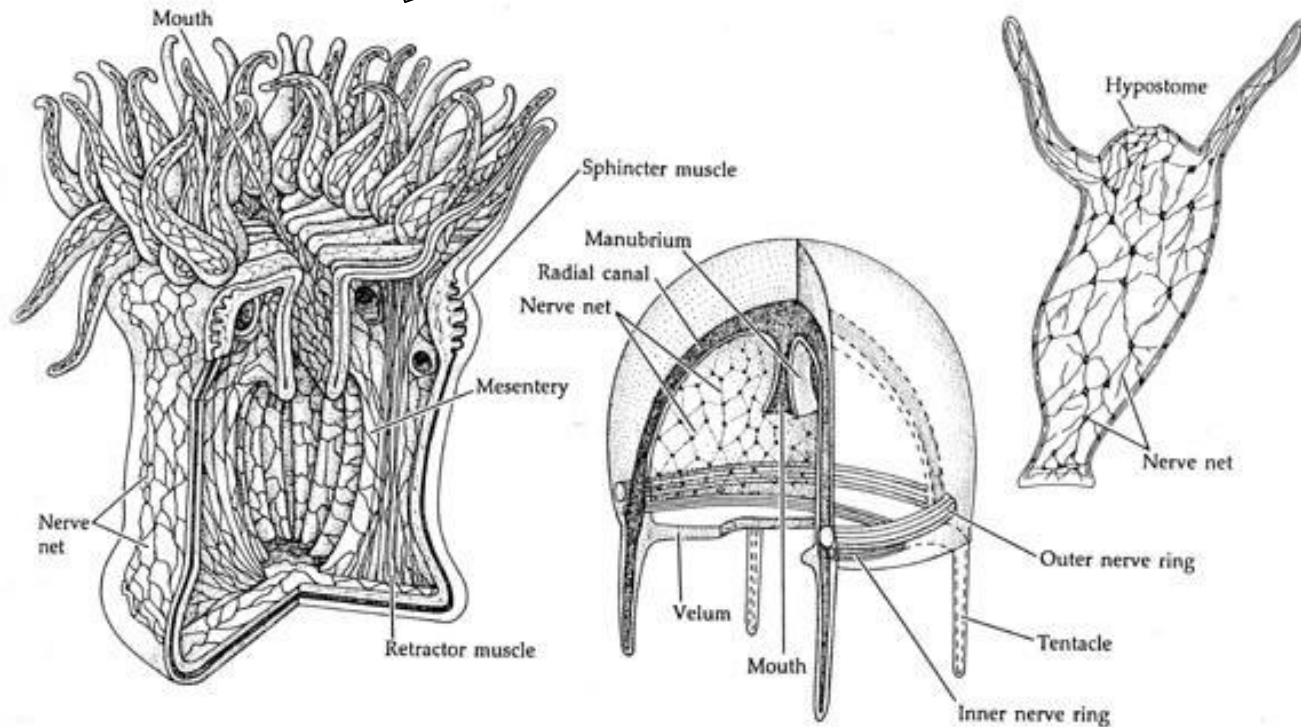


# Evolution of the nervous system

- Jellyfish

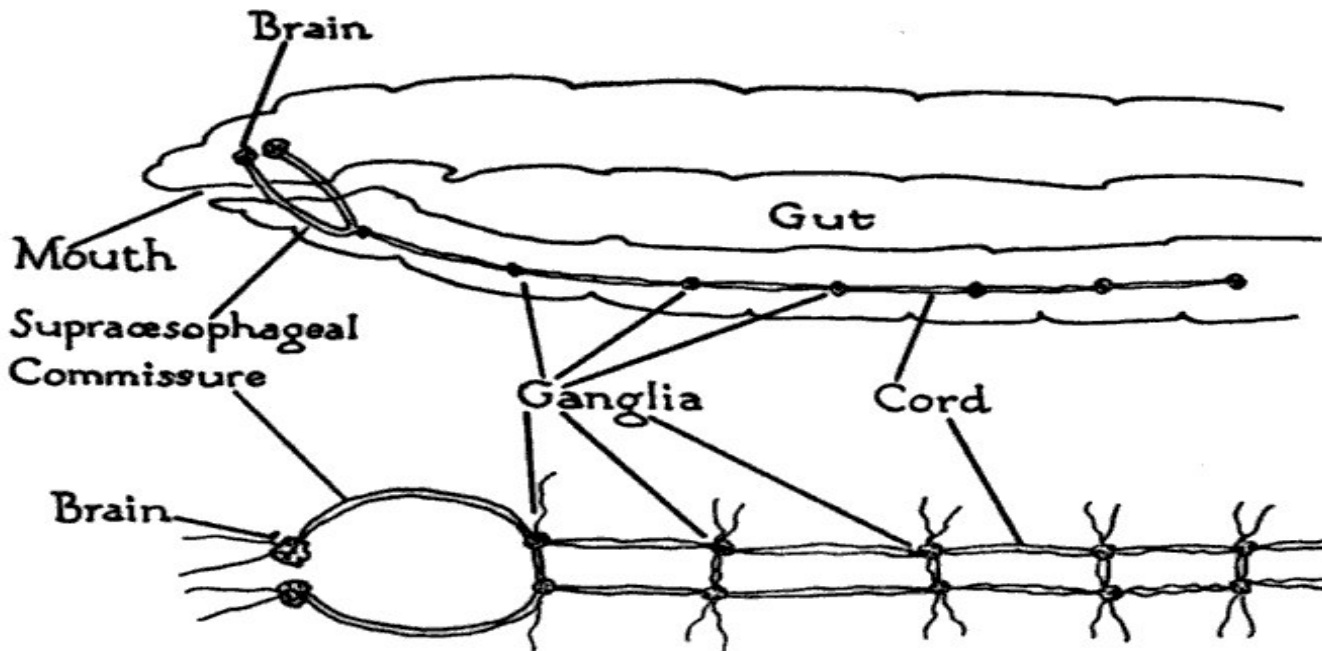
- Around propulsion part of nervous system into the ring
- Coordinated contraction of body for coordinated movement

**FOTORECEPTION**



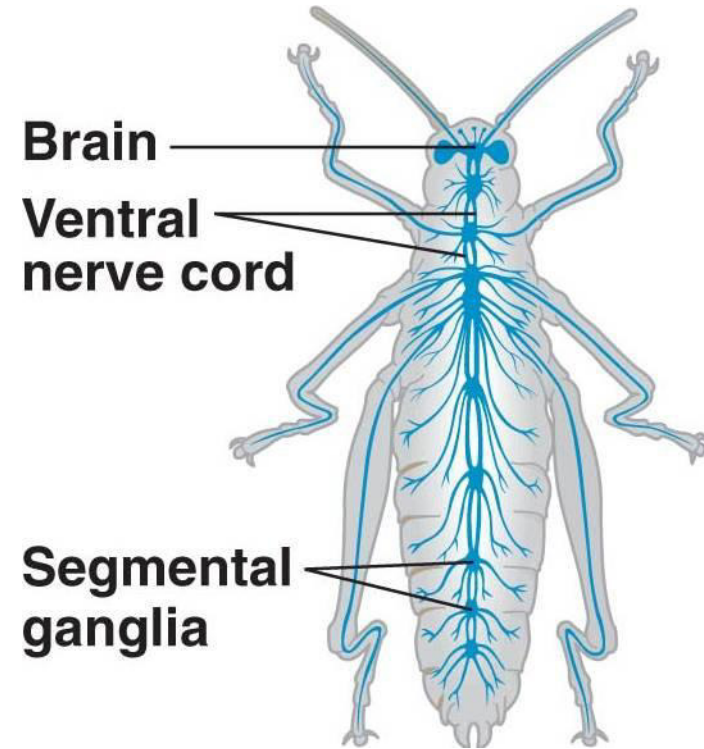
# Evolution of the nervous system

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



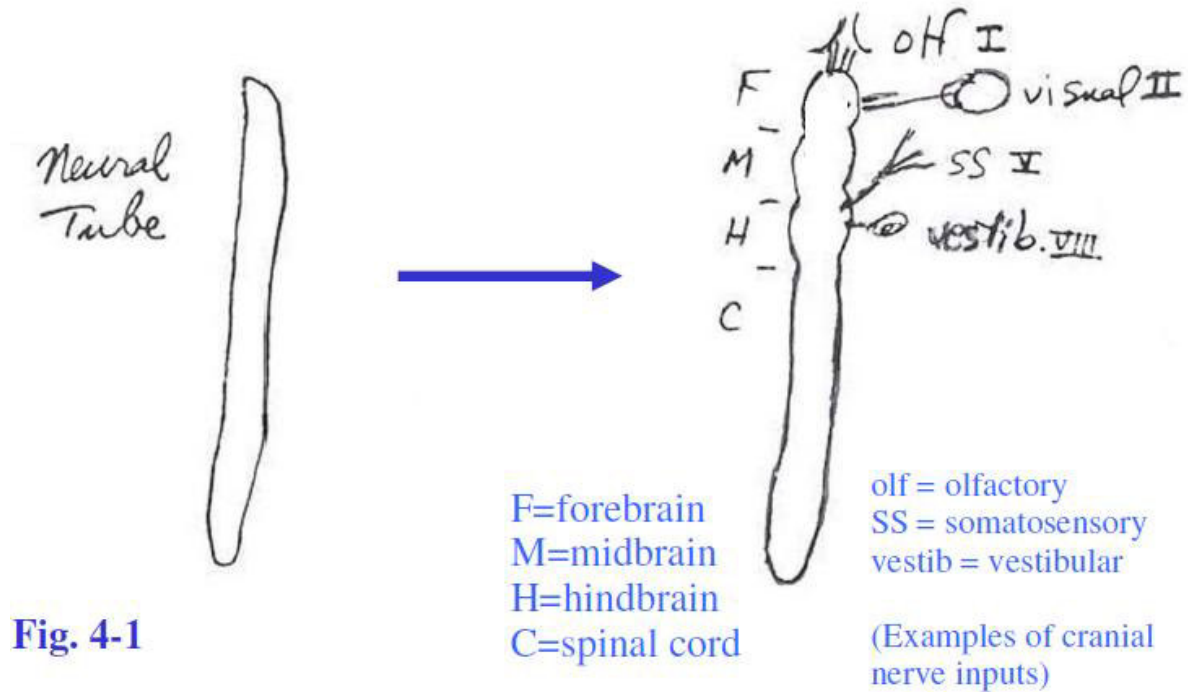
# Evolution of the nervous system

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



# Evolution of the brain

- Neural tube
- Locomotion
- Rostral receptors



# Evolution of the brain

- **Expansion of hindbrain**

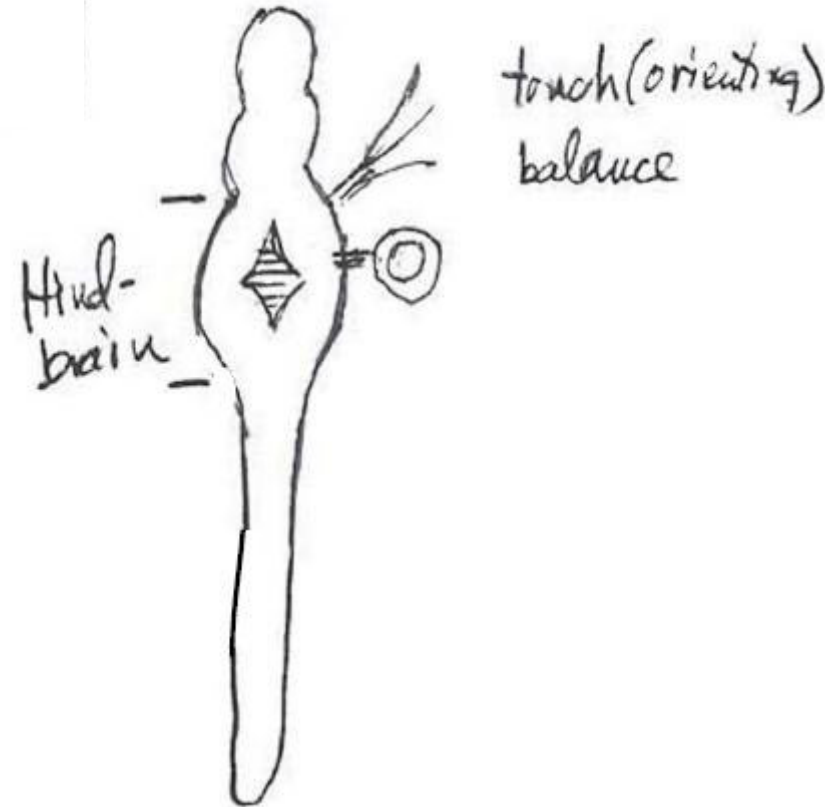
(Rhombencefalon - Medula oblongata, pons Varoli, cerebellum)

- **Input**

– Information from head sensors

- **Output**

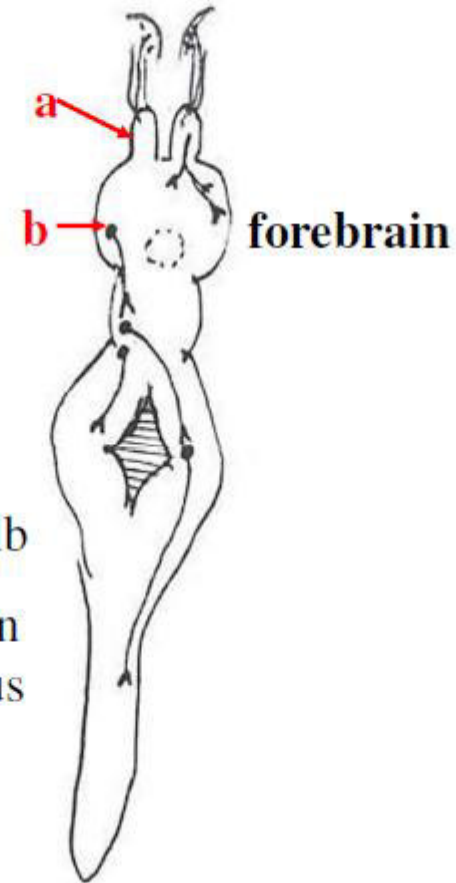
– Motor system  
(Fixed action pattern - reflex/instinct behavior)





# Evolution of the brain

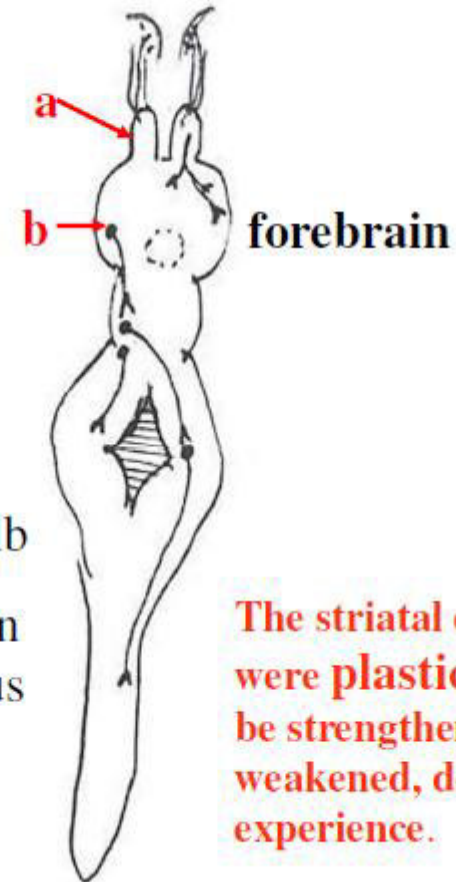
- **Expansion of forebrain 1**  
(Prosencephalon - diencephalon, telencephalon)  
(simultaneously with hindbrain)
- **Input**
  - Olfaction  
(Approach/avoidance)
- **Output**
  - Motor system  
(via corpus striatum)



**a** olfactory bulb  
**b** connection in primitive corpus striatum

# Evolution of the brain

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

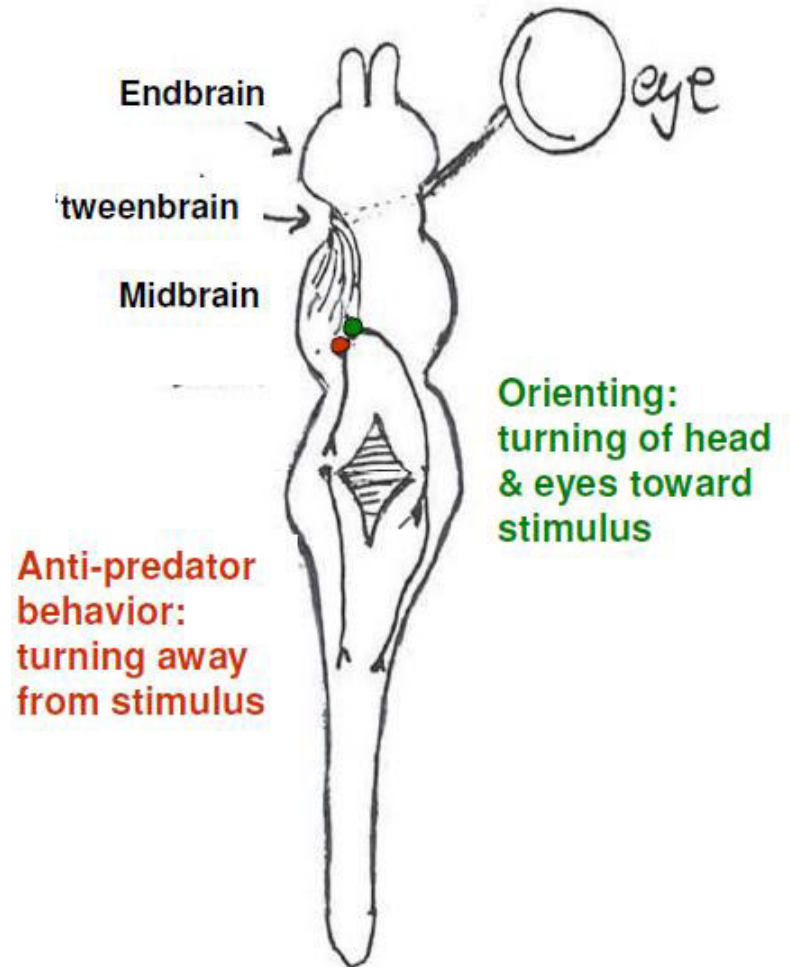


**a** olfactory bulb  
**b** connection in primitive corpus striatum

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

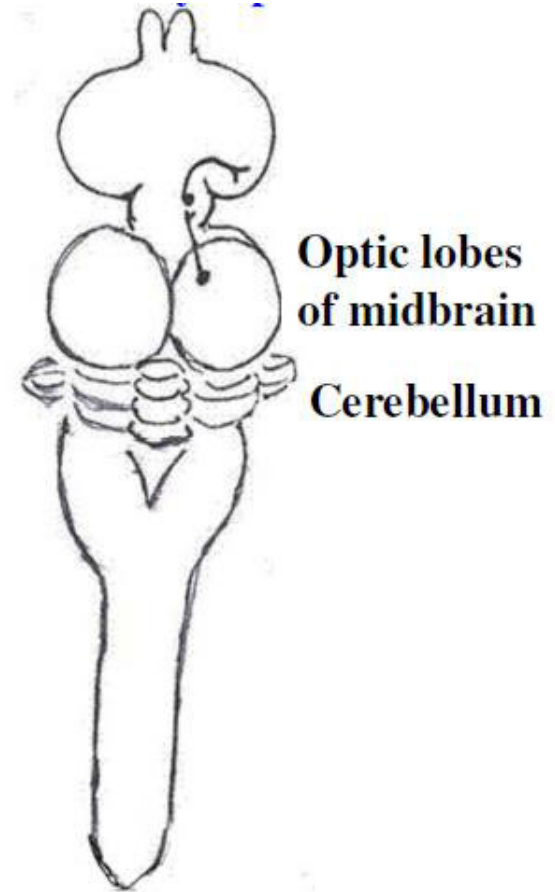
# Evolution of the brain

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



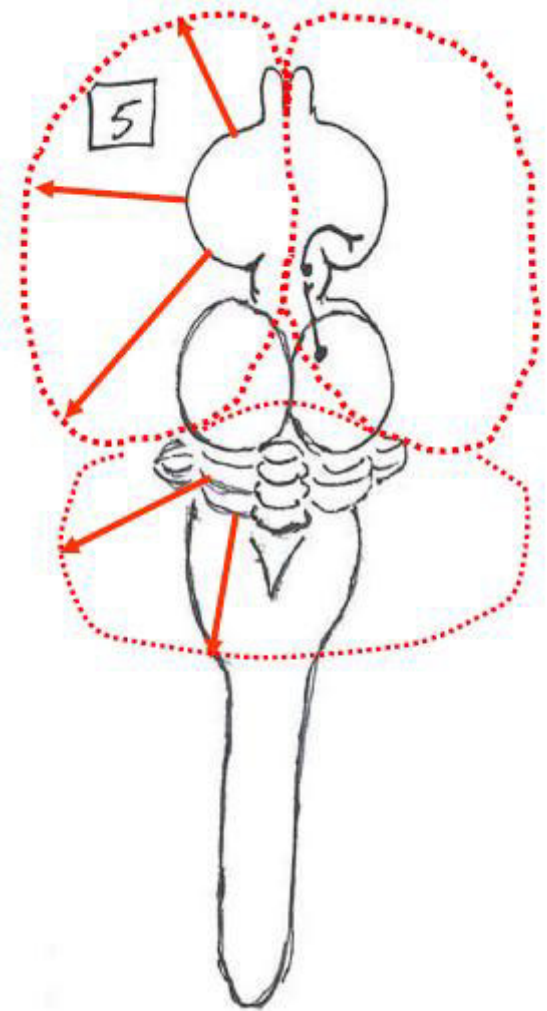
# Evolution of the brain

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



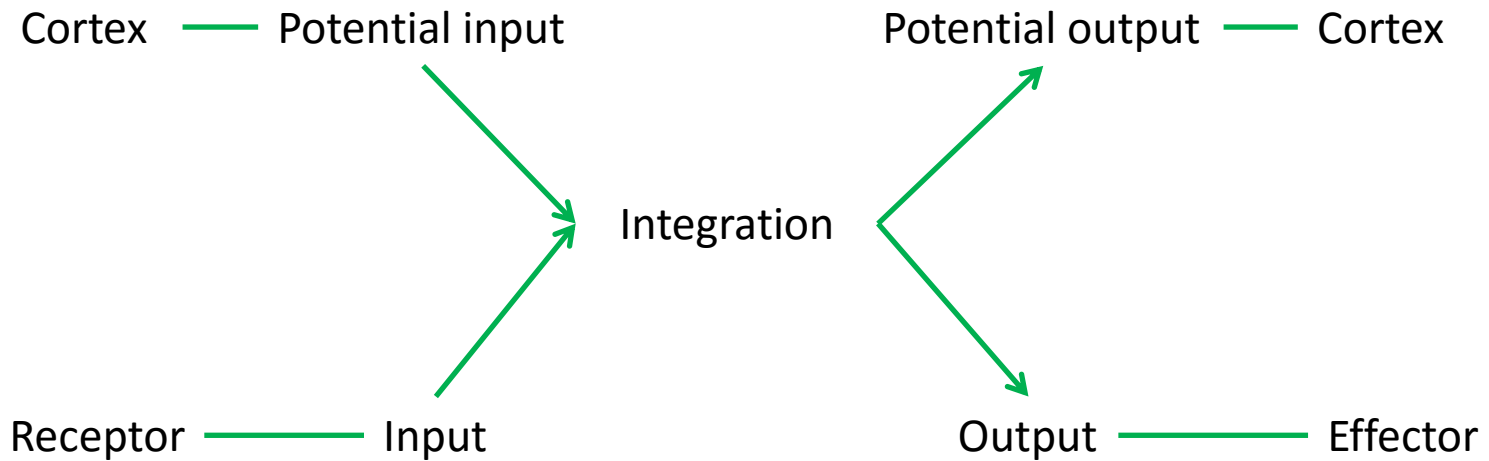
# Evolution of the brain

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



# The role of nervous system

**ANTICIPATION**

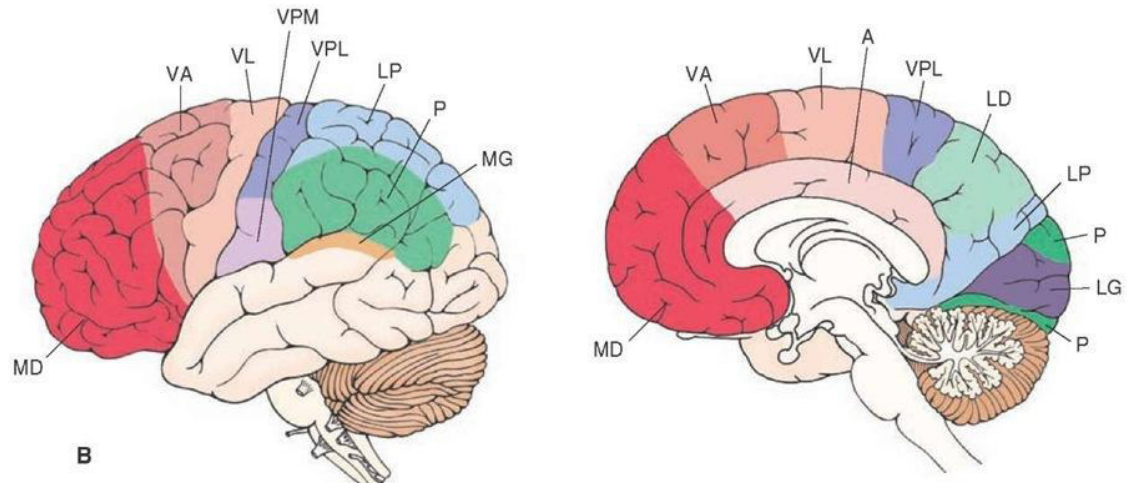
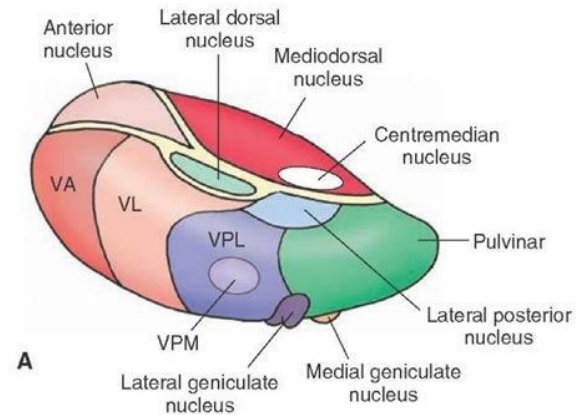


**REGULATION**

# Thalamus and neocortex

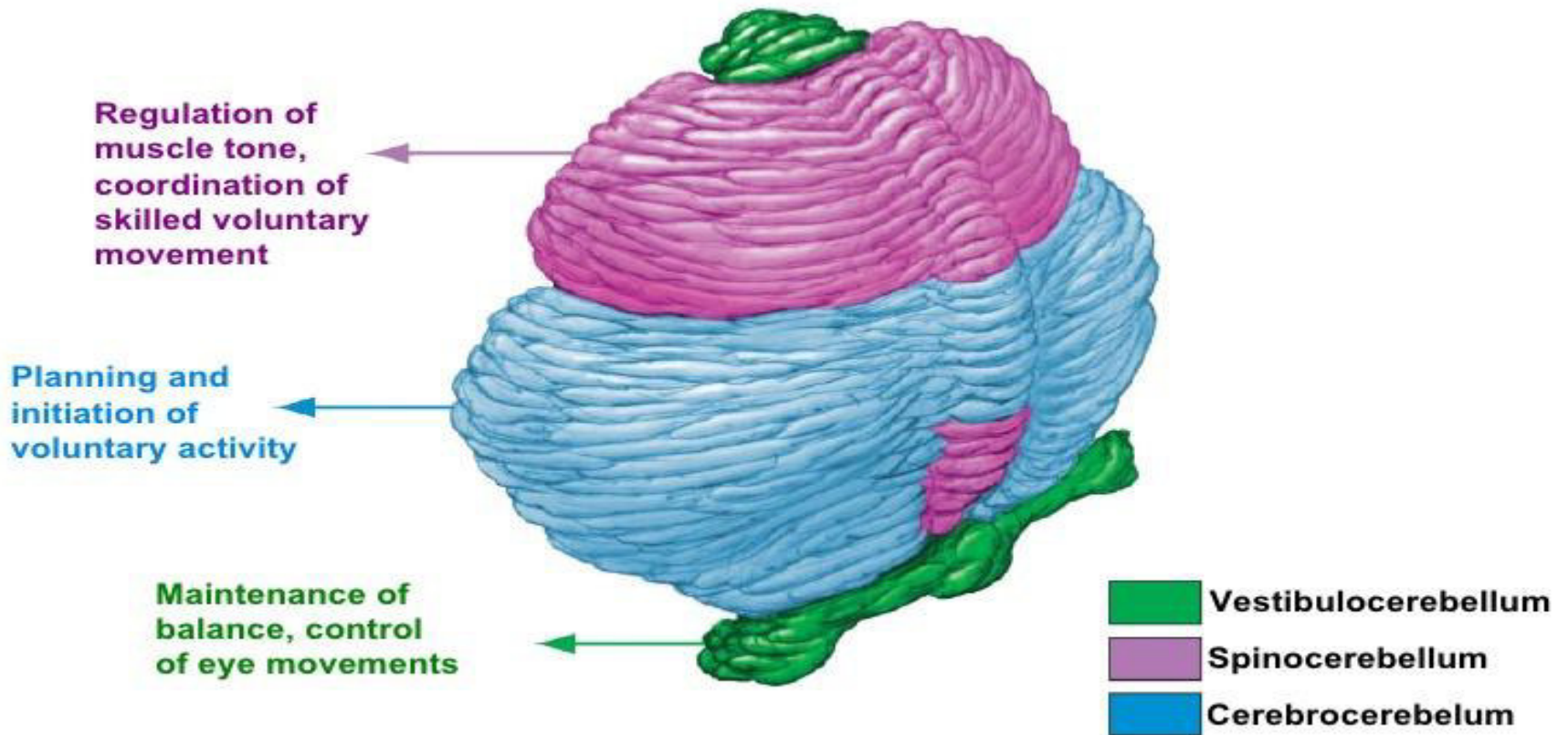
## Gating

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



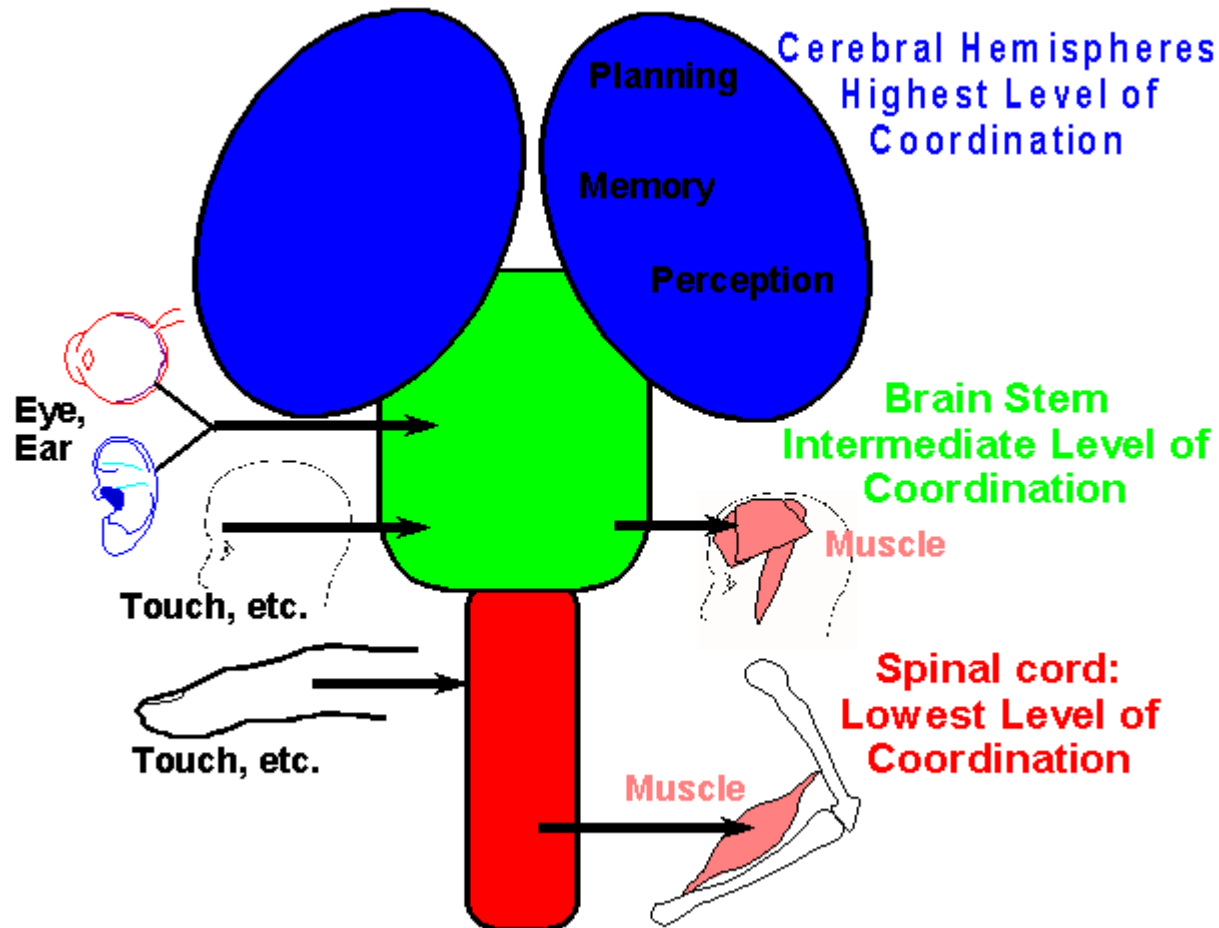
# Cerebellum

## Coordination

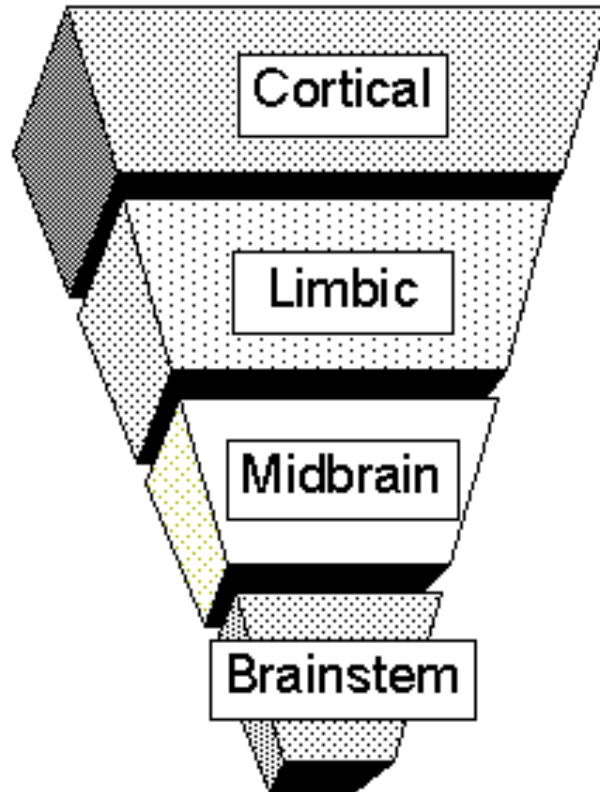




# Hierarchy of central nervous system



# Hierarchy of central nervous system



Abstract Thought  
Concrete Thought  
Affiliation  
Attachment  
Sexual Behavior  
Emotional Reactivity  
Motor Regulation  
"Arousal"  
Appetite/Satiety  
Sleep  
Blood Pressure  
Heart Rate  
Body Temperature