BOOKLET #3

The Autonomic Nervous System

Learner outcomes…

What you need to know!

- identify the principal structures of the central and peripheral nervous systems and explain their functions in regulating the voluntary (somatic) and involuntary (autonomic) systems of the human organism; i.e., cerebral hemispheres and lobes, cerebellum, pons, medulla oblongata, hypothalamus, spinal cord, sympathetic and parasympathetic nervous systems, and the sensory-somatic nervous system

Outcomes continued…

- describe the structure and function of the parts of the human eye; i.e., the cornea, lens, sclera, choroid, retina, rods and cones, fovea centralis, pupil, iris and optic nerve
- describe the structure and function of the parts of the human ear, including the pinna, auditory canal, tympanum, ossicles, cochlea, organ of Corti, auditory nerve, semicircular canals and Eustachian tube
- explain other ways that humans sense their environment and their spatial orientation in it; *e.g., olfactory receptors, proprioceptors, taste receptors, receptors in the skin.*

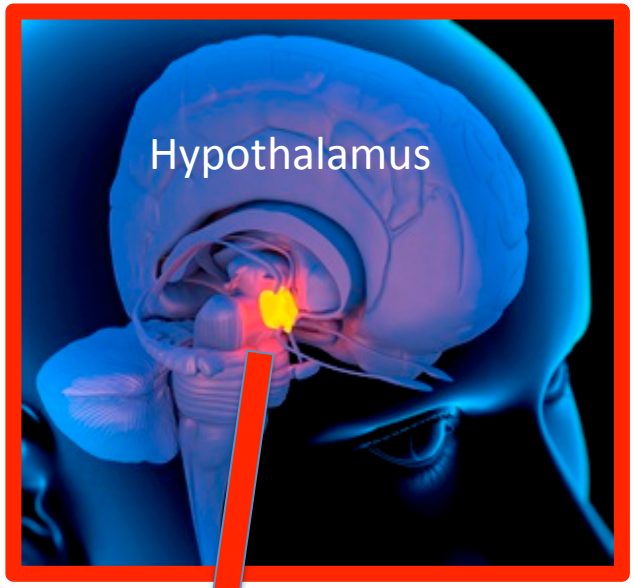
Terms you need to know…

- Somatic Nervous System
- Autonomic Nervous System
- Sympathetic Nervous System
- Parasympathetic Nervous System
- Hypothalamus
- Medulla Oblongata
- Meninges
- White Matter
- Grey Matter
- Cerebrospinal fluid
- Dorsal
- Ventral

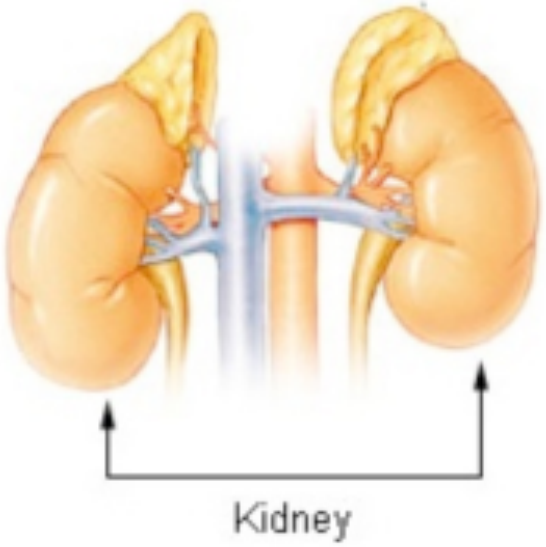
FIGHT or FLIGHT Response

What made this guy get out of the way?
Then what want on in his body?

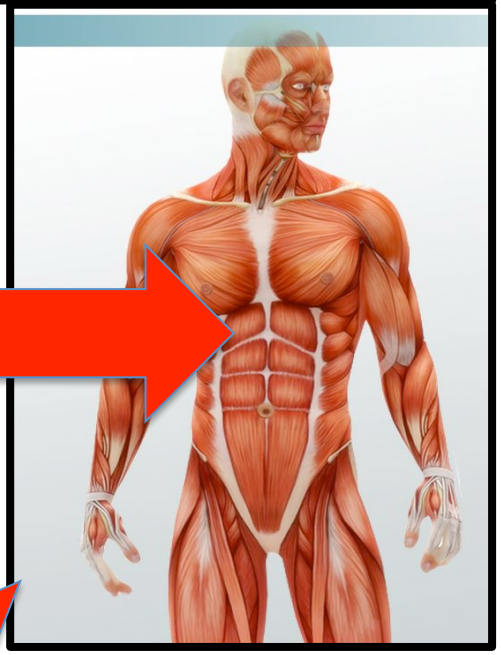
Wholly _____!
A car almost hit me!!

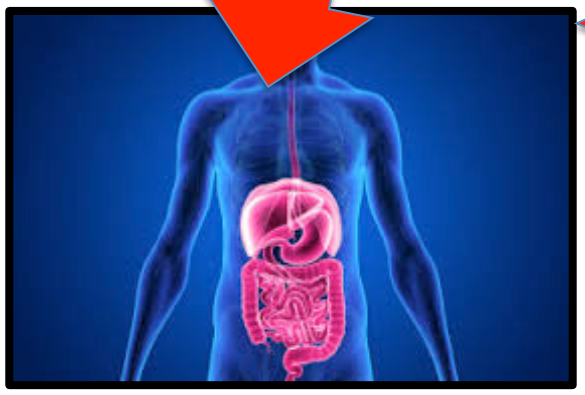


Adrenal Gland



Epinephrine





The Autonomic Nervous System

Divided into the:

-SYMPATHETIC nervous system

-PARASYMPATHETIC nervous system

- **Involuntary control (not under conscious control)**

  CONTROLLED BY:

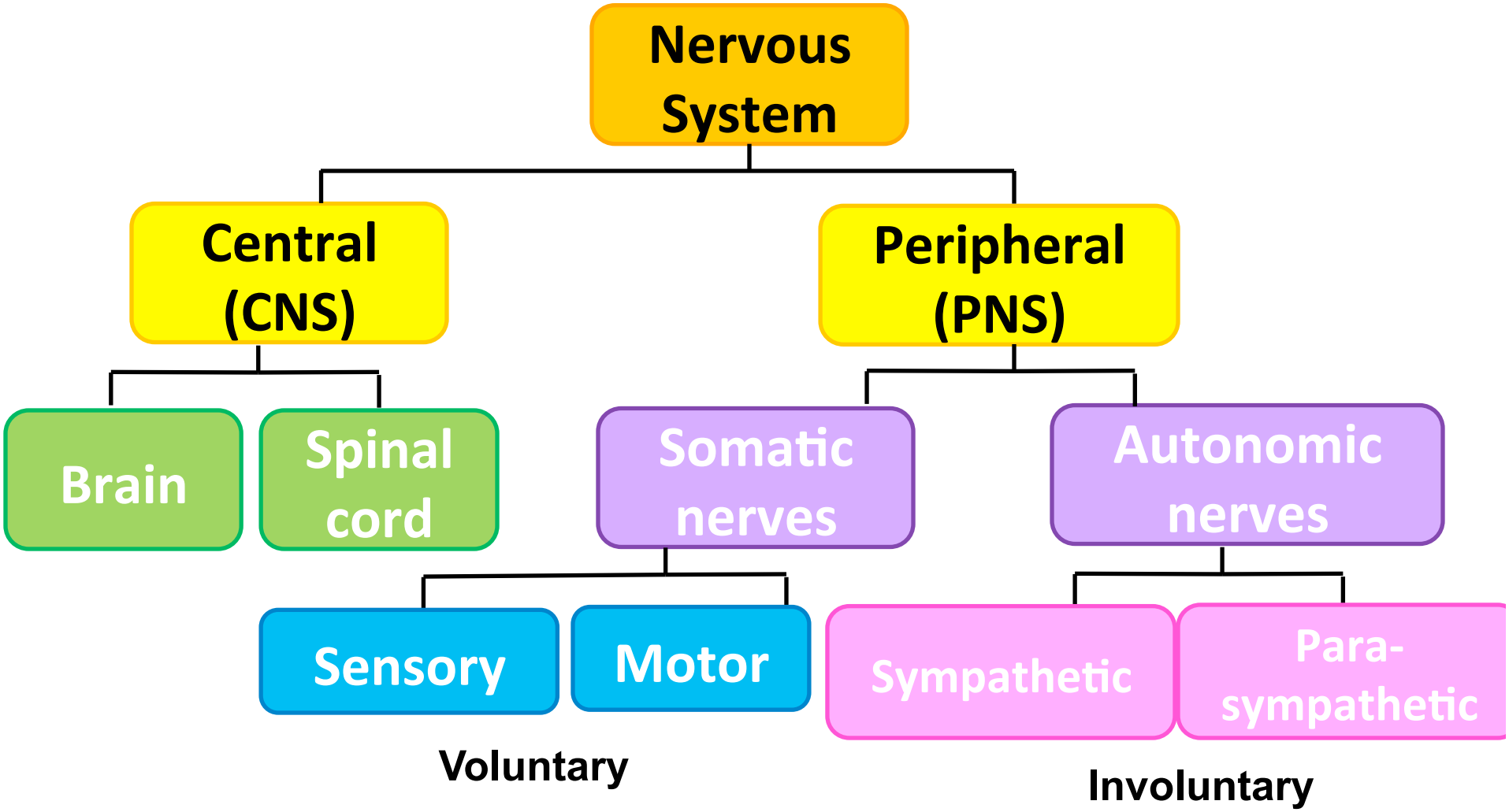
  -HYPOTHALAMUS

  -MEDULLA OBLONGATA

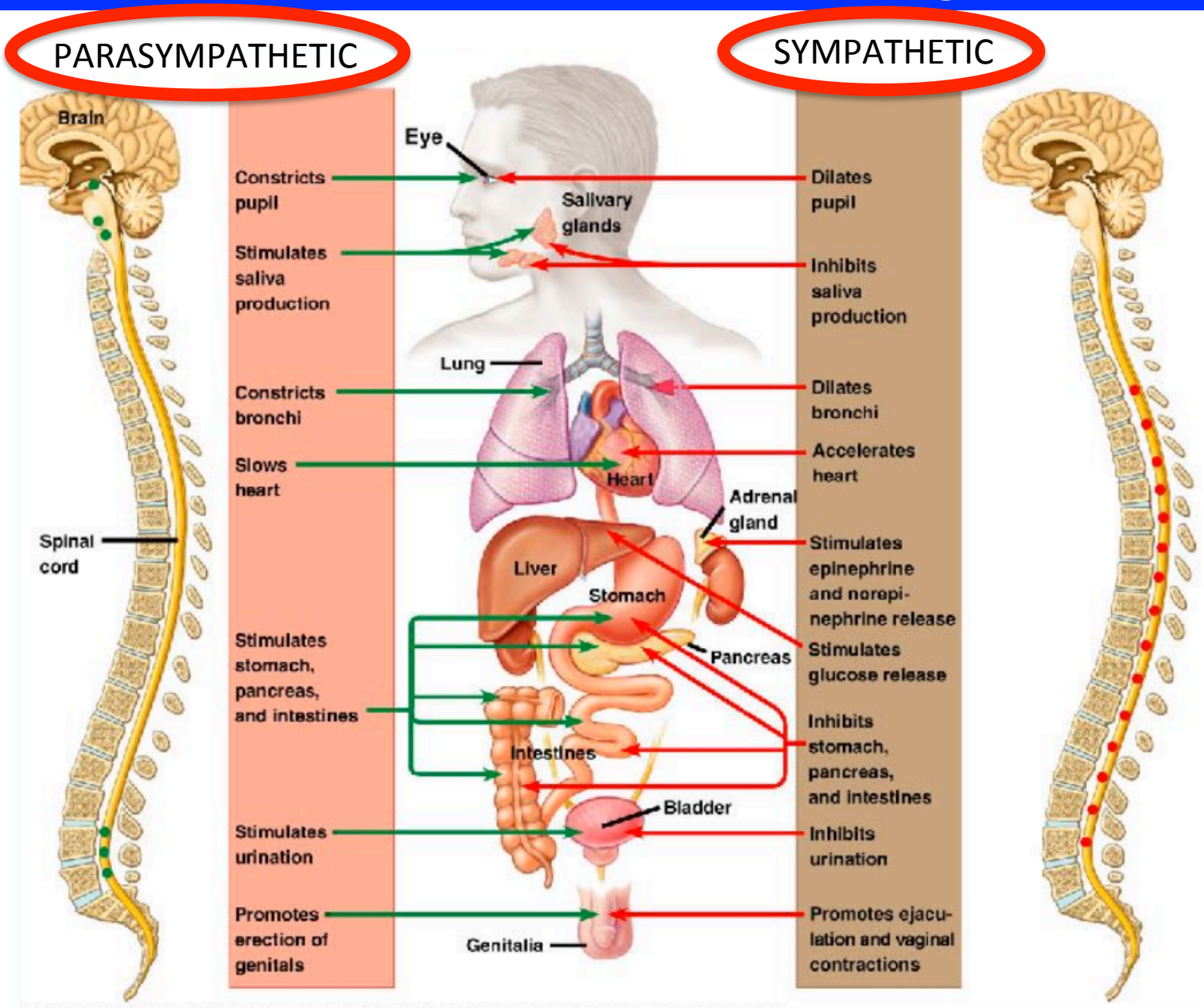
- **Part of the peripheral nervous system**

- **Important in maintaining homeostasis**
  - **Ex. Breathing (O_2 and CO_2)**
  - **Maintaining Blood sugar levels**
  - **Hormones**

Divisions of the Nervous System



Autonomic Nervous System



Divisions of the Autonomic System

Parasympathetic

- Returns the body to normal levels

(rest and digest)

Sympathetic (Stress)

- Prepares the body for stress

(flight-or-fight response)

Parasympathetic	Sympathetic
No effect	Releases epinephrine (adrenaline)
↓ Heart rate	↑ Heart rate
↑Peristalsis	↓ Peristalsis
↑Glucose to glycogen	↑Glycogen to glucose
Constricts pupils	Dilates pupils
Contracts bladder	inhibits bladder contraction
↑ Blood flow to skin	↓Blood flow to skin
constrict bronchioles	dilate bronchioles

These 2 systems balance each other out!

Videos to Check Out!

Autonomic Nervous System: Crash Course

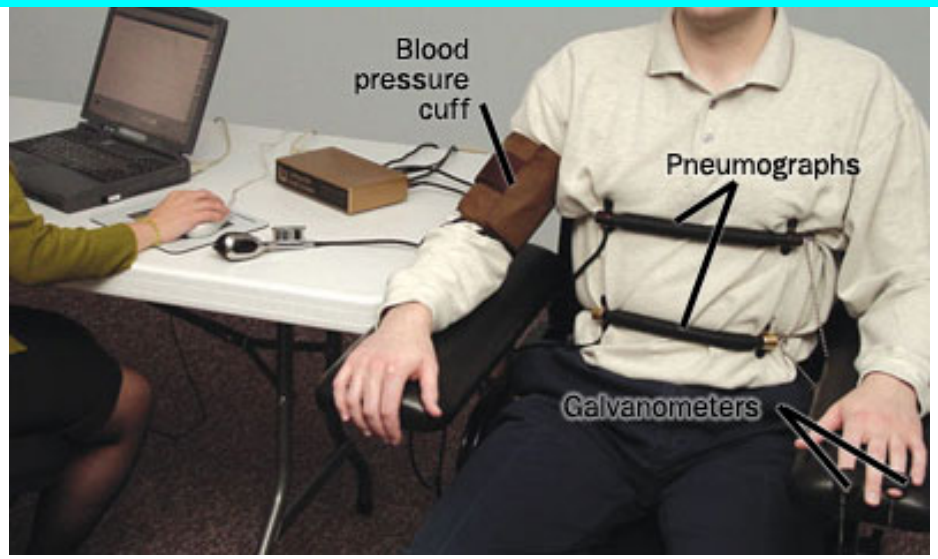
PARASYMPATHETIC Nervous System: Crash Course

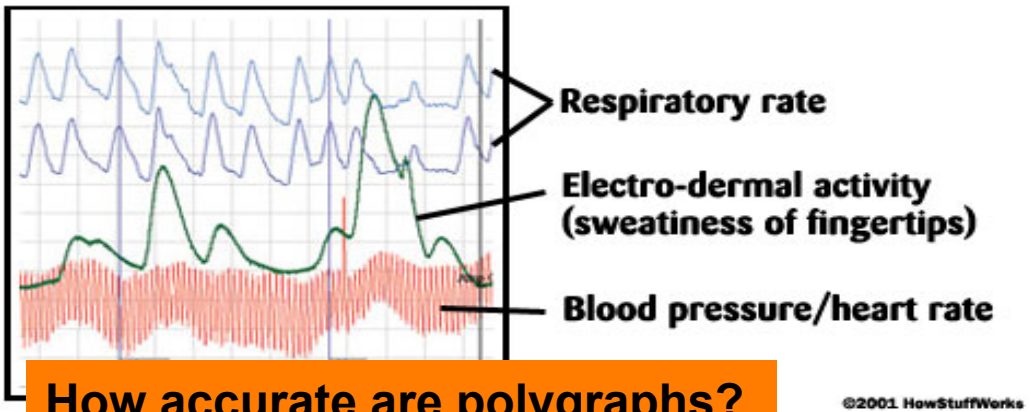
SYMPATHETIC Nervous System: Crash Course

Lie Detector

How do lie detectors work?

- **Polygraph**
- Monitors changes in the sympathetic system
- Monitors changes in perspiration (sweating)
- Why? Sweat contains salt = ↑ in current flow
- It also monitors breathing and pulse rate



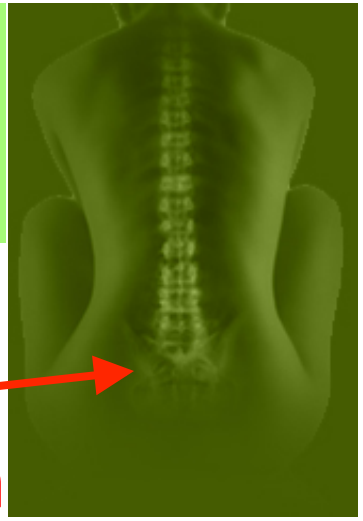


How accurate are polygraphs?

70 – 87.5 % accurate

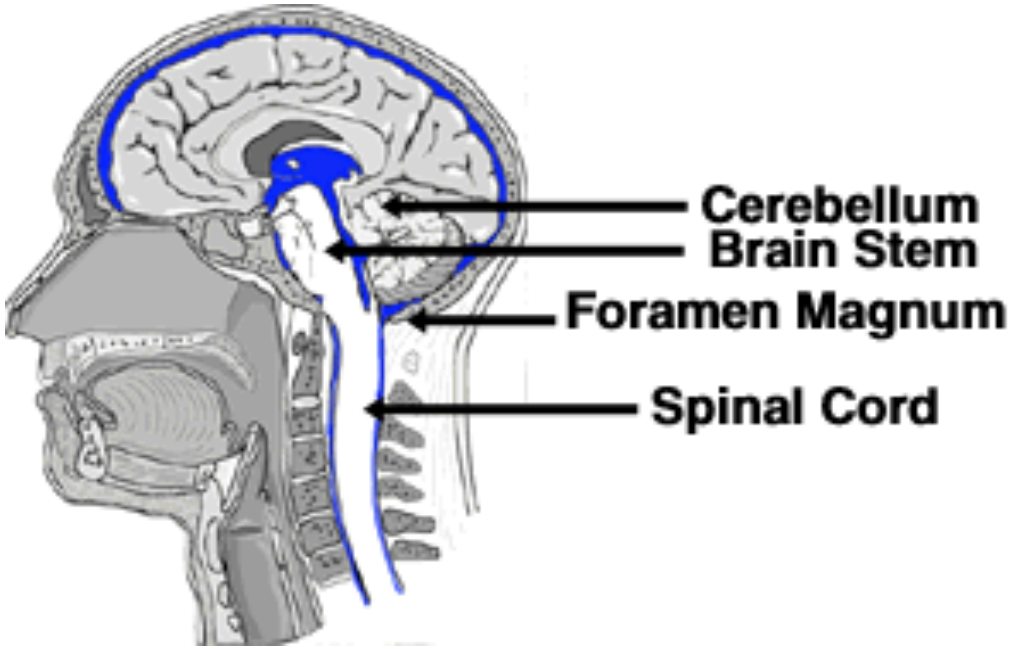

The Spinal Cord

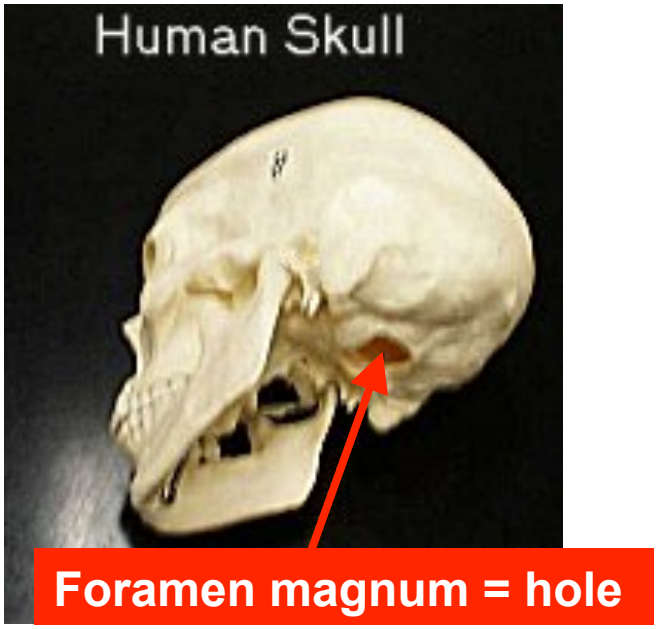
Spinal Cord and the brain



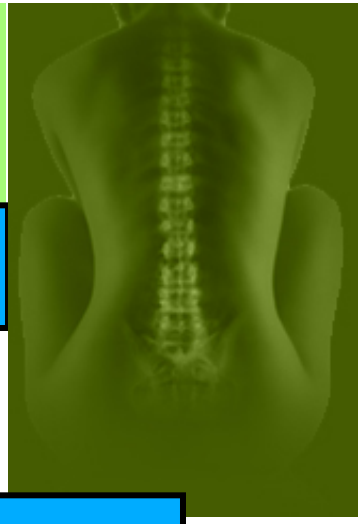
- Runs from the base of the **sacrum**

  into the brain through the **foramen magn**
  (hole in the bottom of the skull)

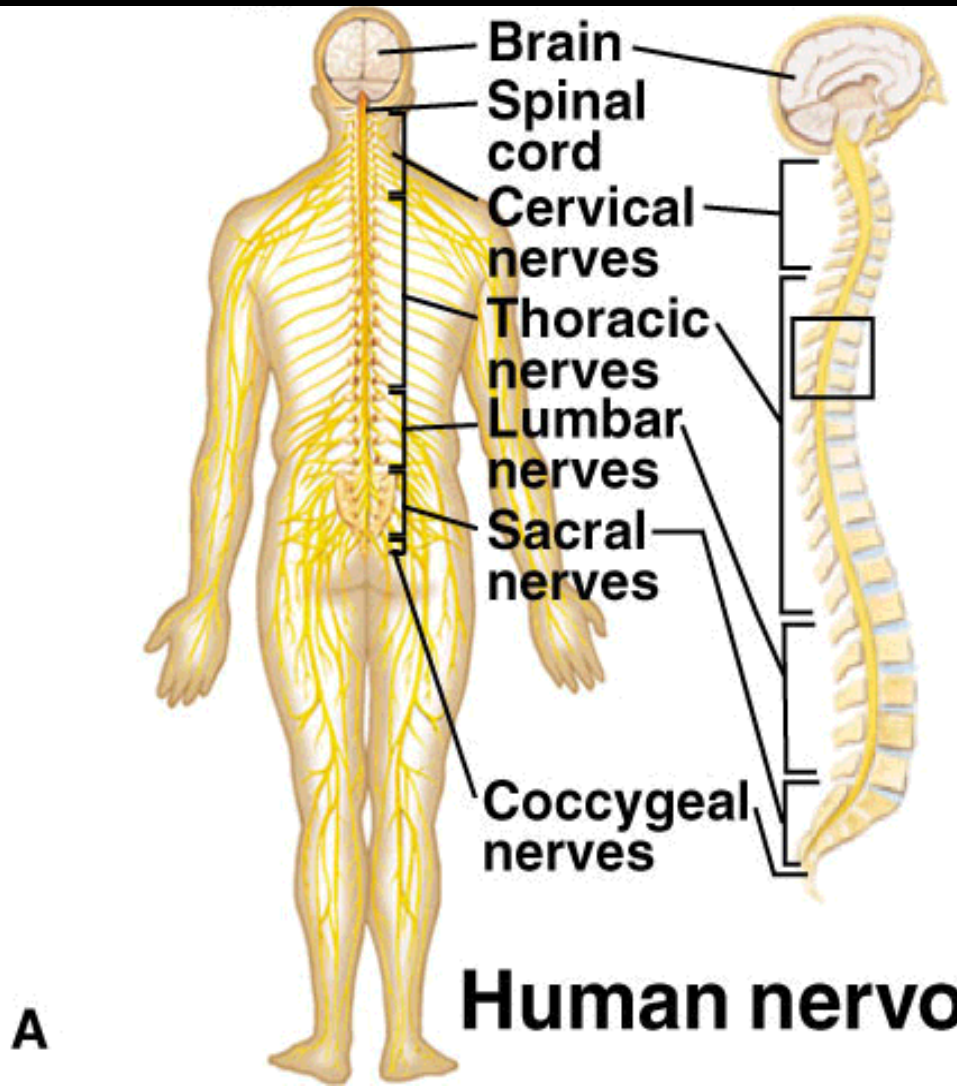




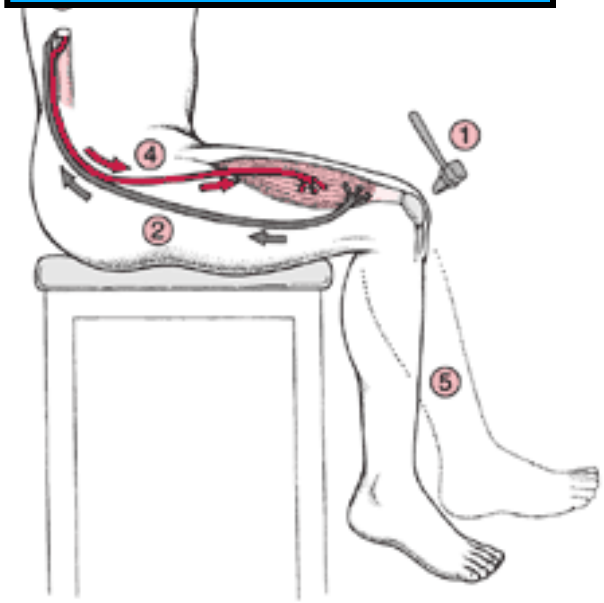
Functions



1. Connects the brain and the PNS

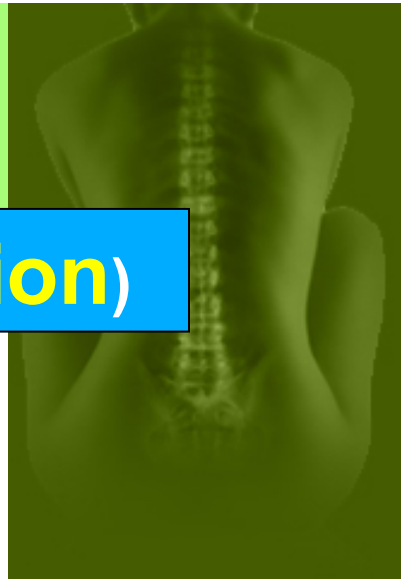


2. Reflex arc

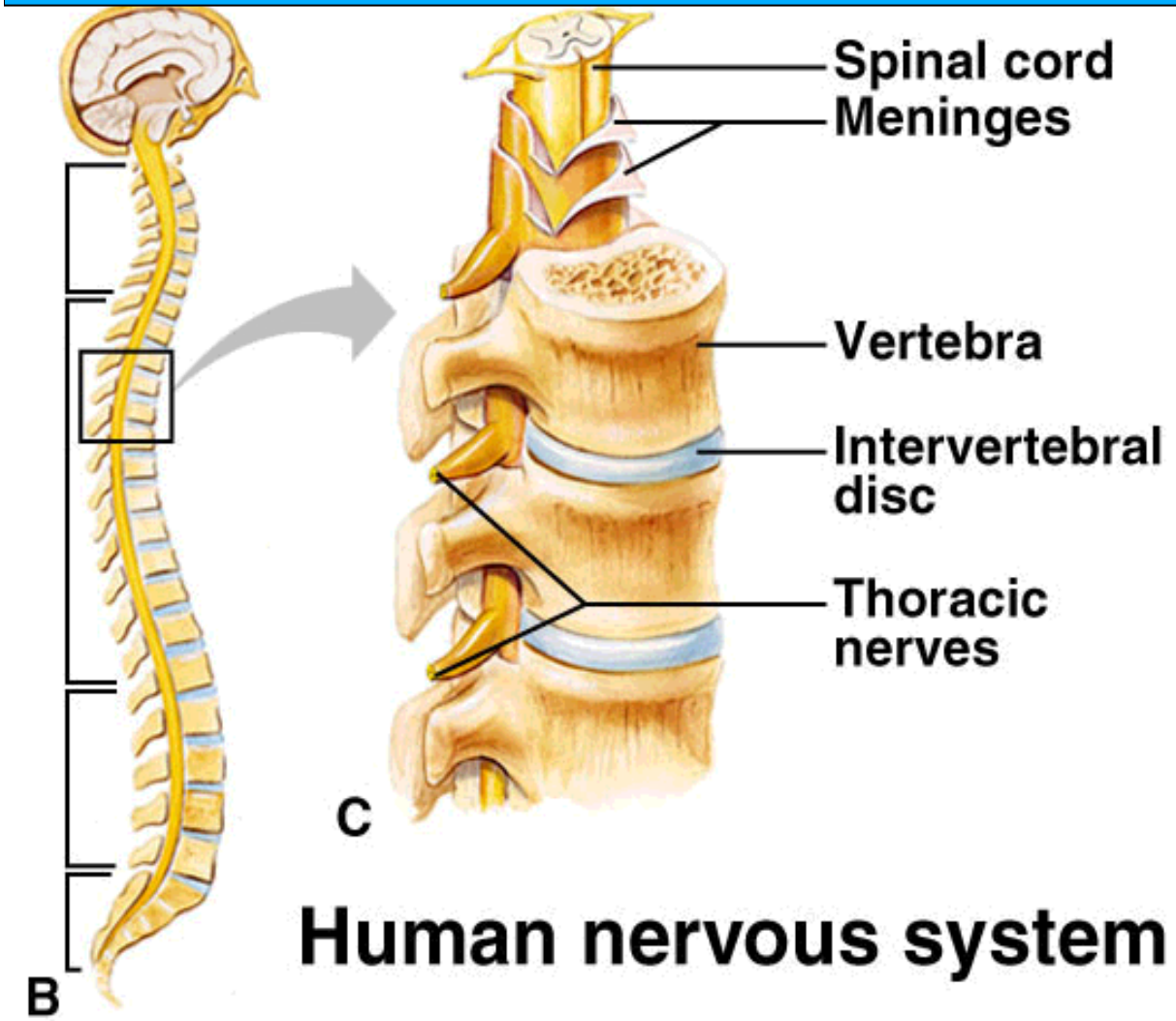


Human nervous system

Location



Inside the vertebral column (bone = protection)



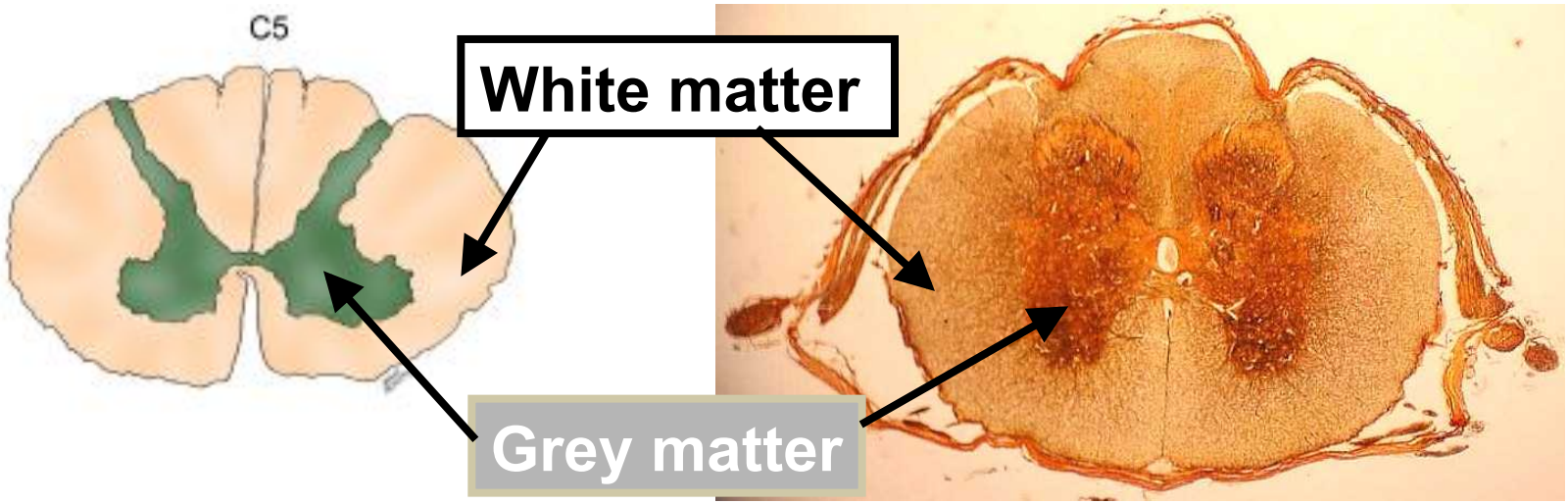
Protected by the meninges

White and Grey matter

The spinal cord contains 2 types of tissue:

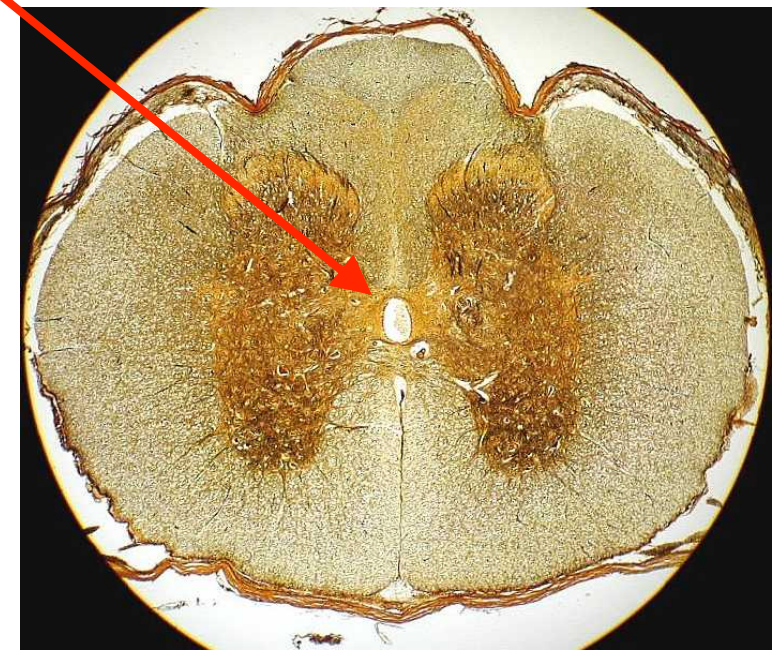
- **WHITE MATTER = outer portion**
  - **Myelinated (carry information up and down spinal cord)**

  -although myelinated, it is formed by different cells and do not have a neurilemma layer
- **GREY MATTER = butterfly shaped center portion**
  - **Unmyelinated (carry sensory and motor information)**

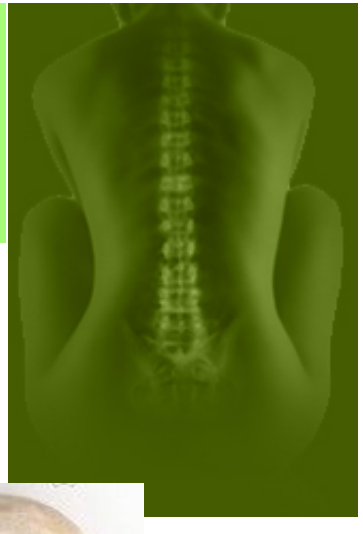


Did you notice the small hole?

- The small hole is called the **cerebrospinal canal** or **central canal**
- Filled with **cerebrospinal fluid**
- It absorbs shocks and transports nutrients and wastes
- Sample may be taken from central canal to diagnose bacterial/viral infections



The Reflex Arc



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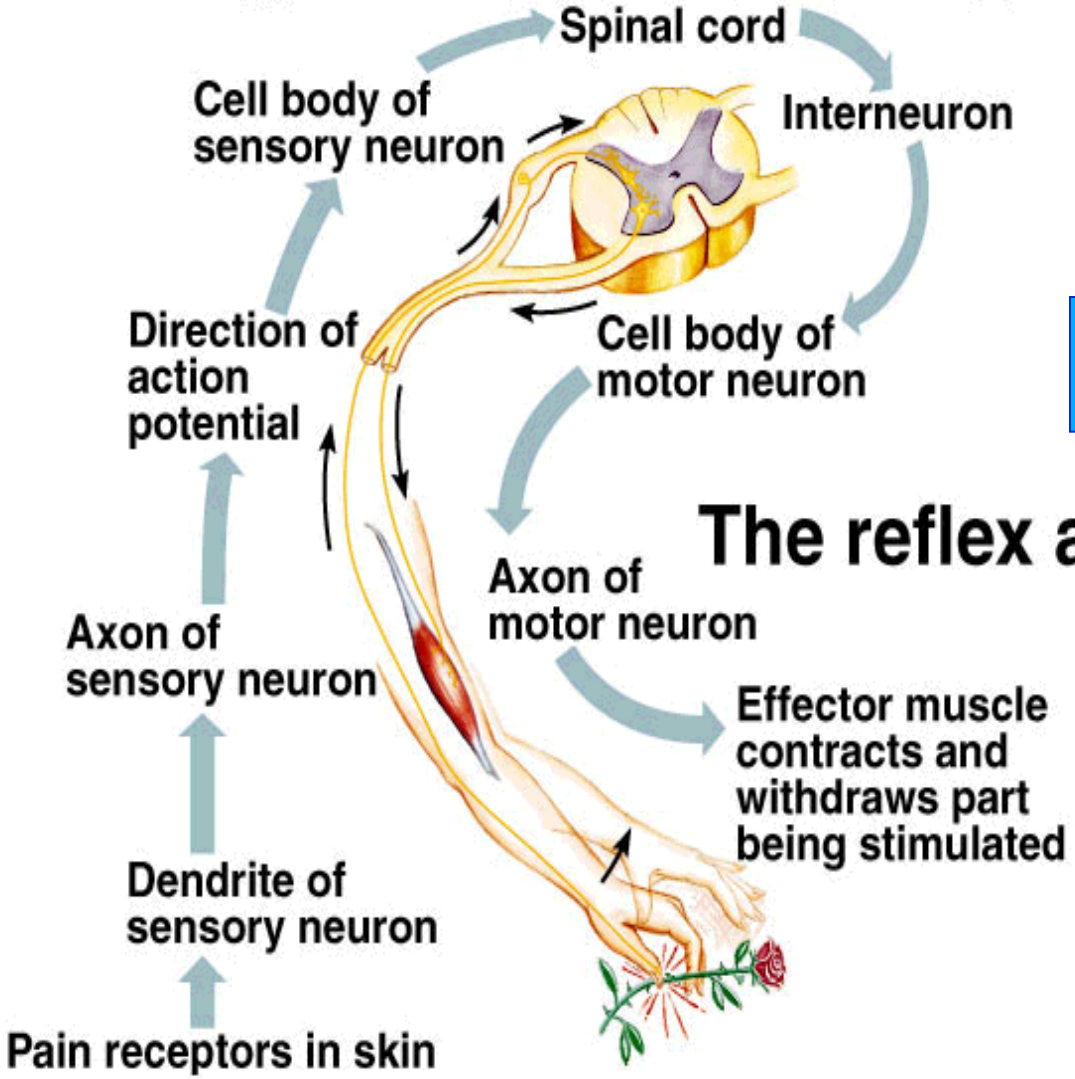
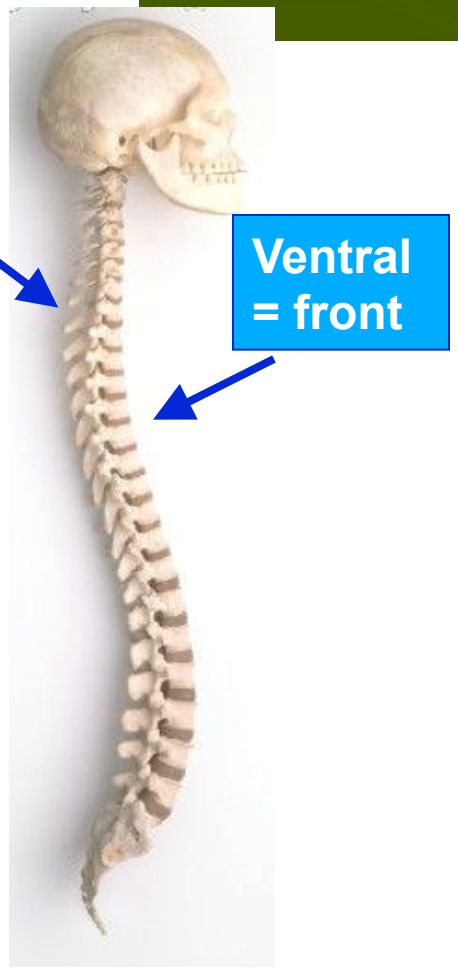
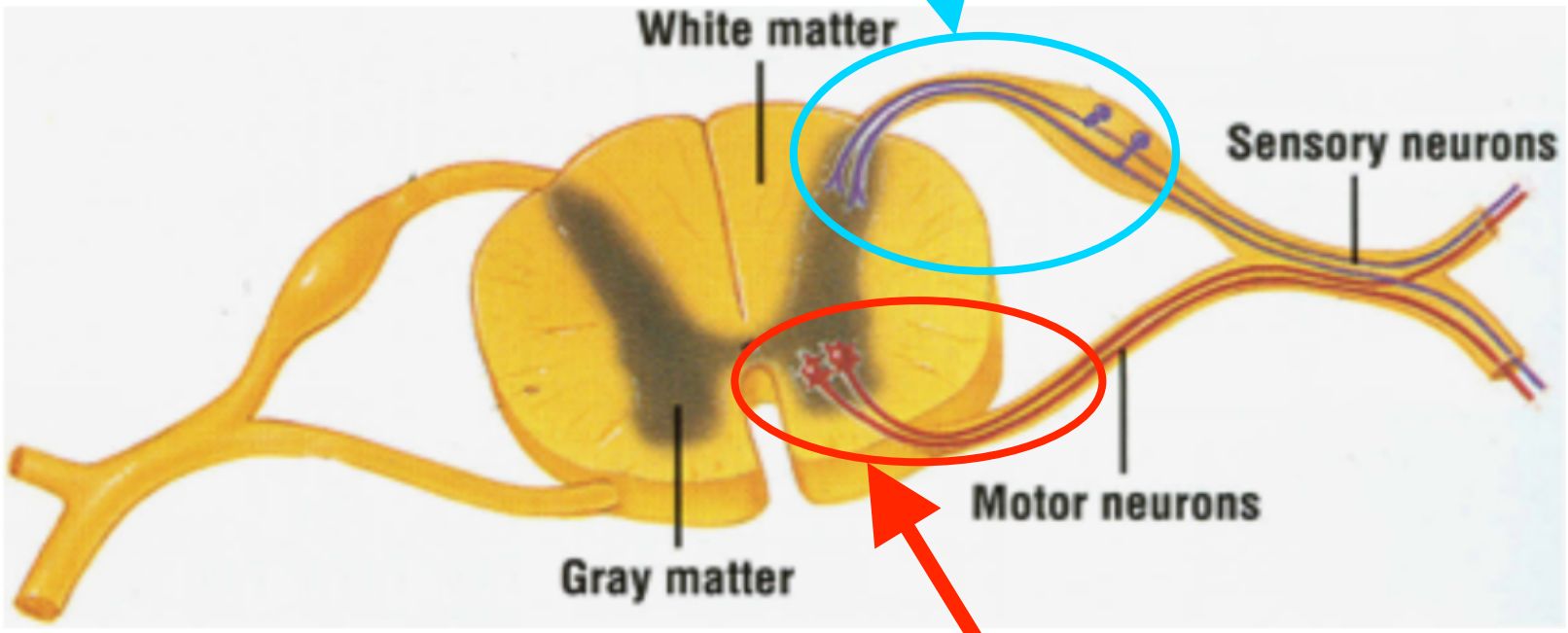




Dorsal and Ventral Roots

Dorsal root (BACK)
allows sensory neurons to enter

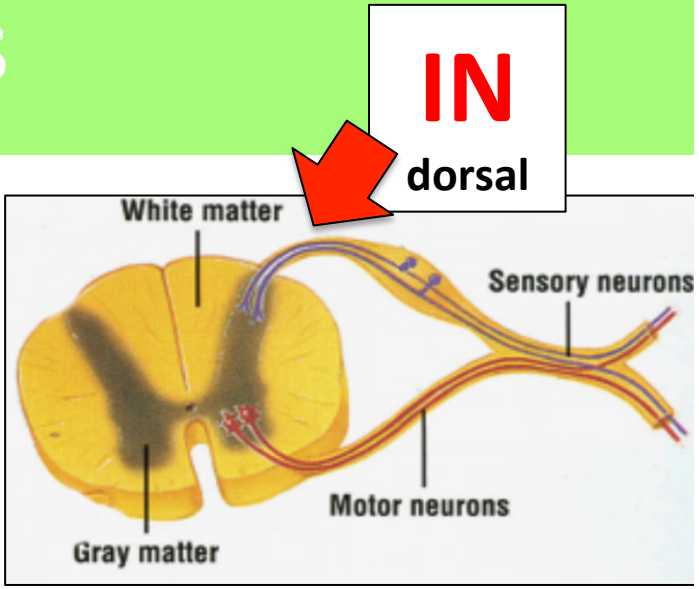


Ventral root (FRONT)
Allows motor neurons to exit

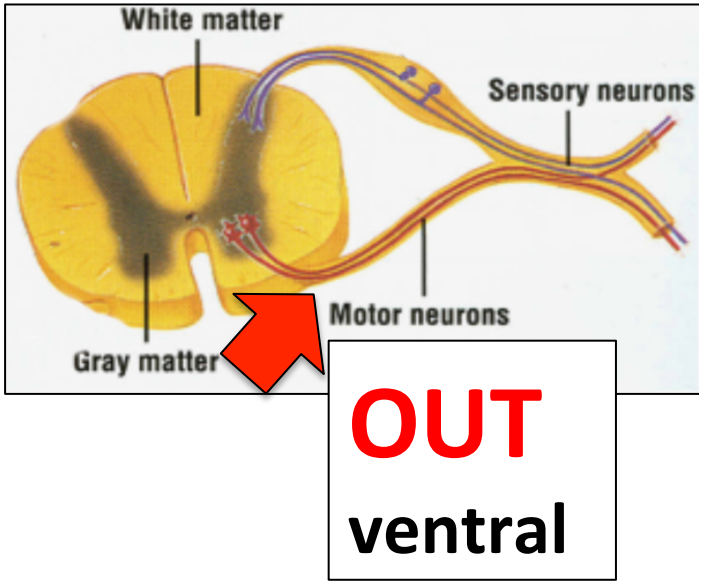
Dorsal and Ventral Roots

SUMMARY

1) Sensory information comes in through the BACK side (dorsal) of spinal cord GREY MATTER

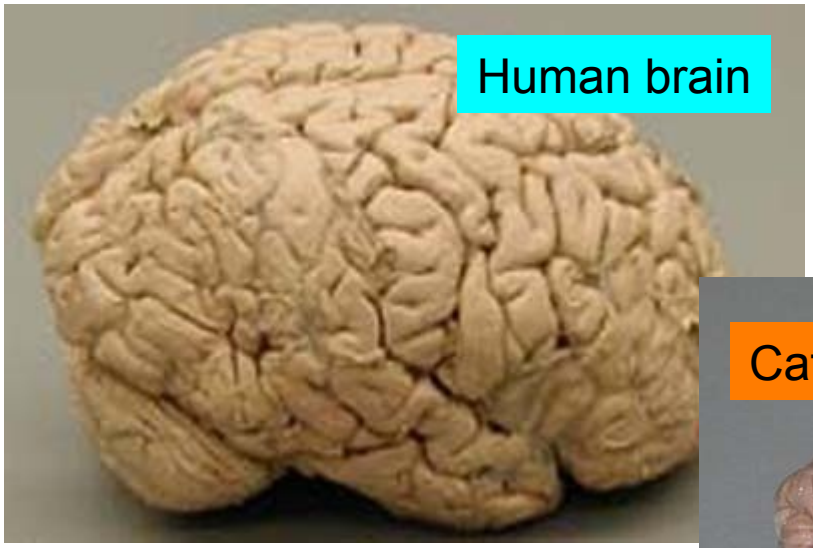


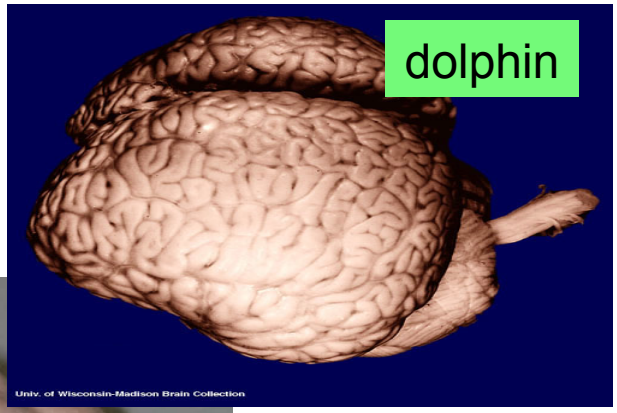
2) Motor information leaves through the FRONT side (ventral) of spinal cord GREY MATTER

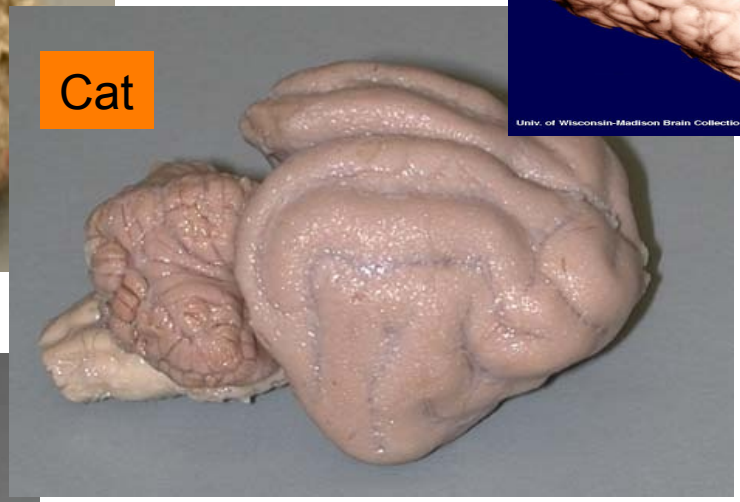


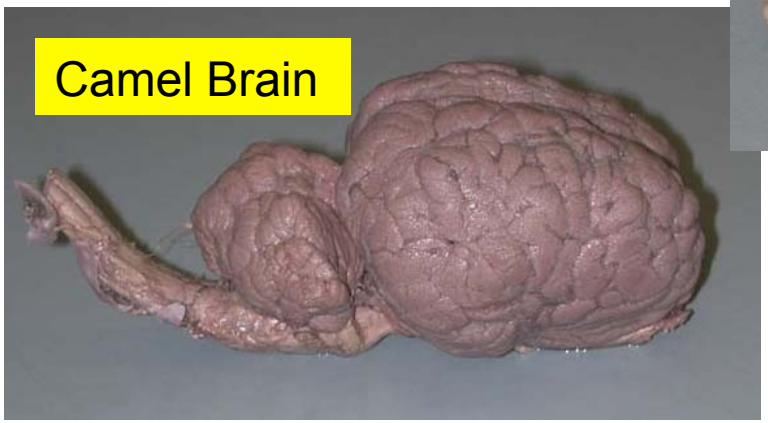
3) Sensations like pain, pressure, temperature are then sent up the spinal cord through WHITE MATTER

The Brain


Human brain

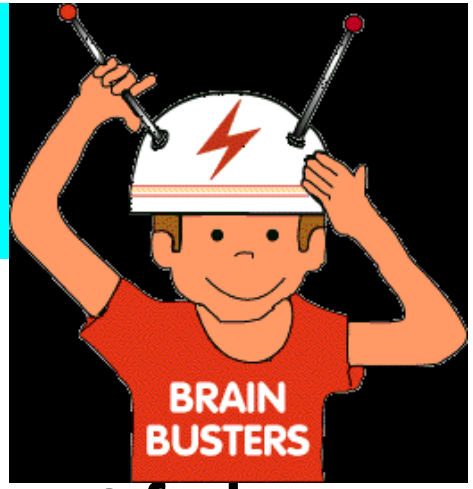

dolphin
Univ. of Wisconsin-Madison Brain Collection


Cat


Camel Brain


frog

Interesting facts about the human brain!



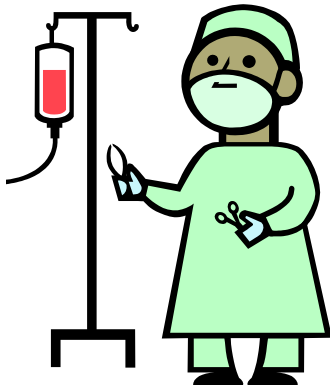
- The human brain is made up

  of **85% water.**
- Studies have shown that children who are **breast fed** display IQ's up to 10 points higher by the age of three.
- Do you know why a doctor can operate on your brain while you are awake but you don't

  feel a thing?

  Your brain is full of nerve cells, but

  it has **no** pain receptors.



[Awake Brain Surgery]

What you may or may not know…

- Preservatives, coloring, dyes and artificial flavors affect IQ
  - When they were removed from the cafeteria menu researchers found that 70,000 students performed two or more IQ grade levels higher than before
- The smell of **rosemary** is said to enhance brain functioning
- Try and remember as many numbers as possible

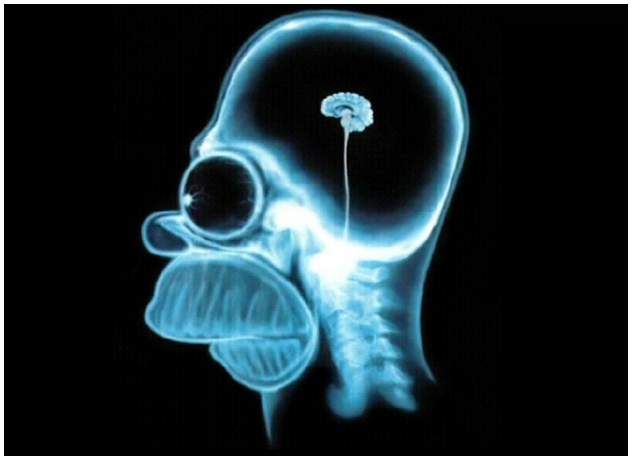
375919047392

  - Our working memory, short-term memory, can hold on average a maximum of seven digits.

SAVANT SYNDROME

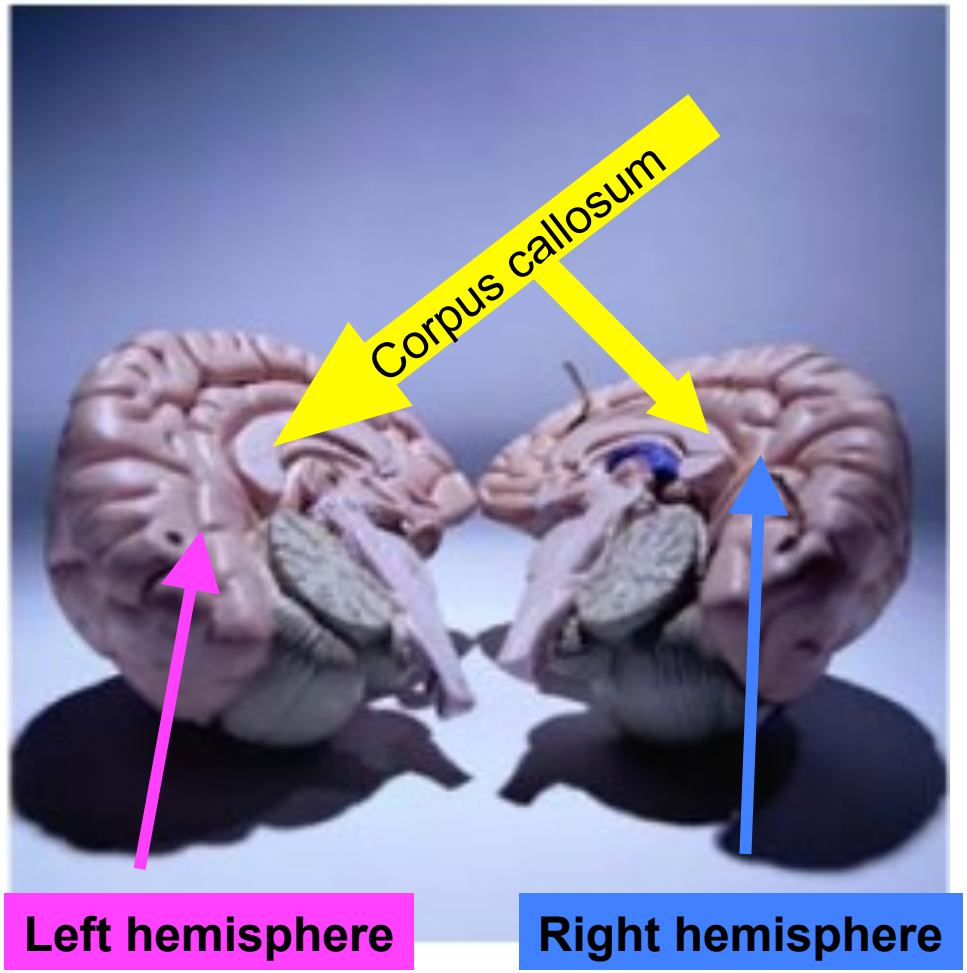
The Central Nervous System

- 2 parts: **brain** and **spinal cord**
- Simply put, the brain is a **concentration** of nerve tissue
- **Location:** inside the skull
- **Purpose:** Coordinating center

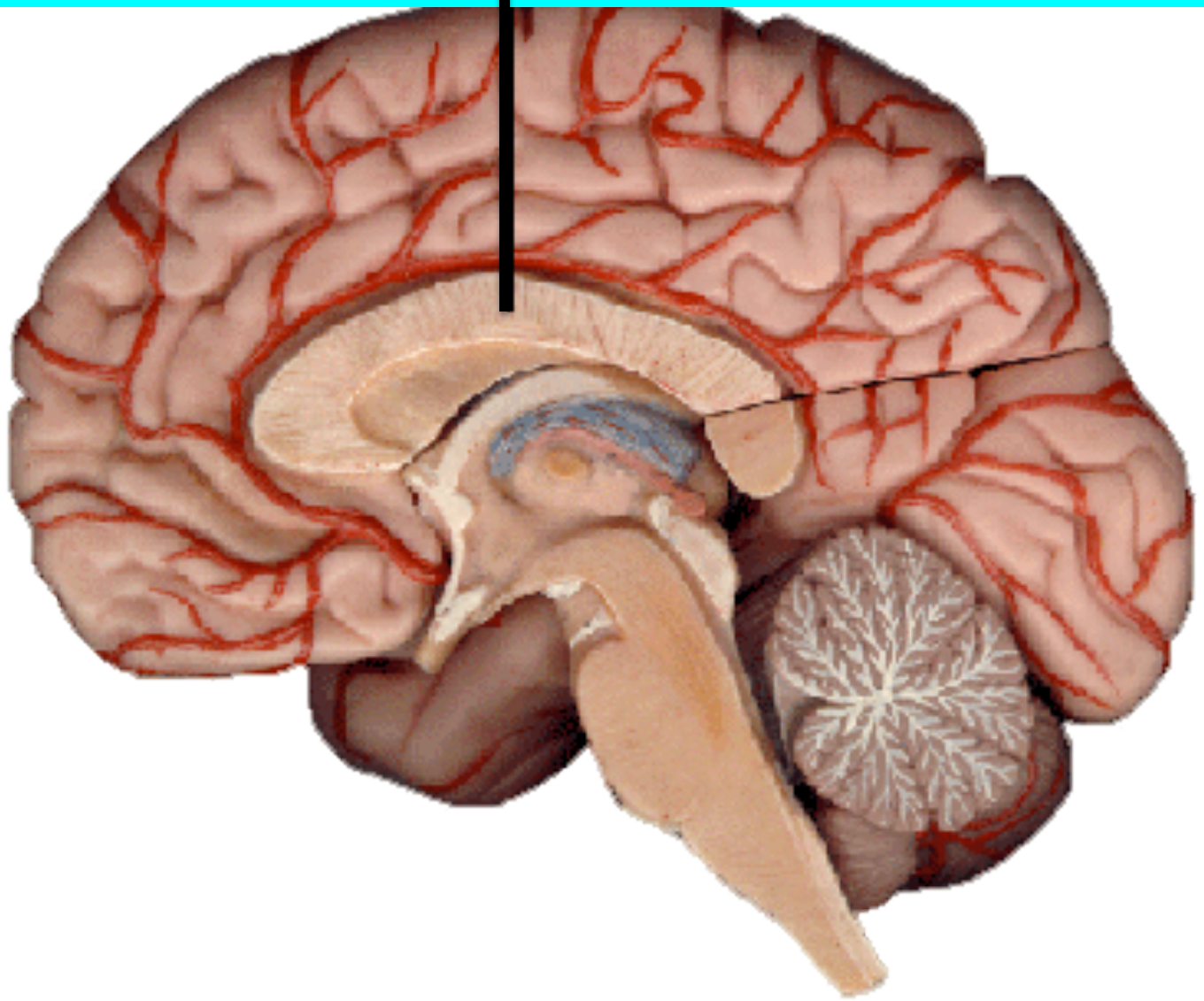


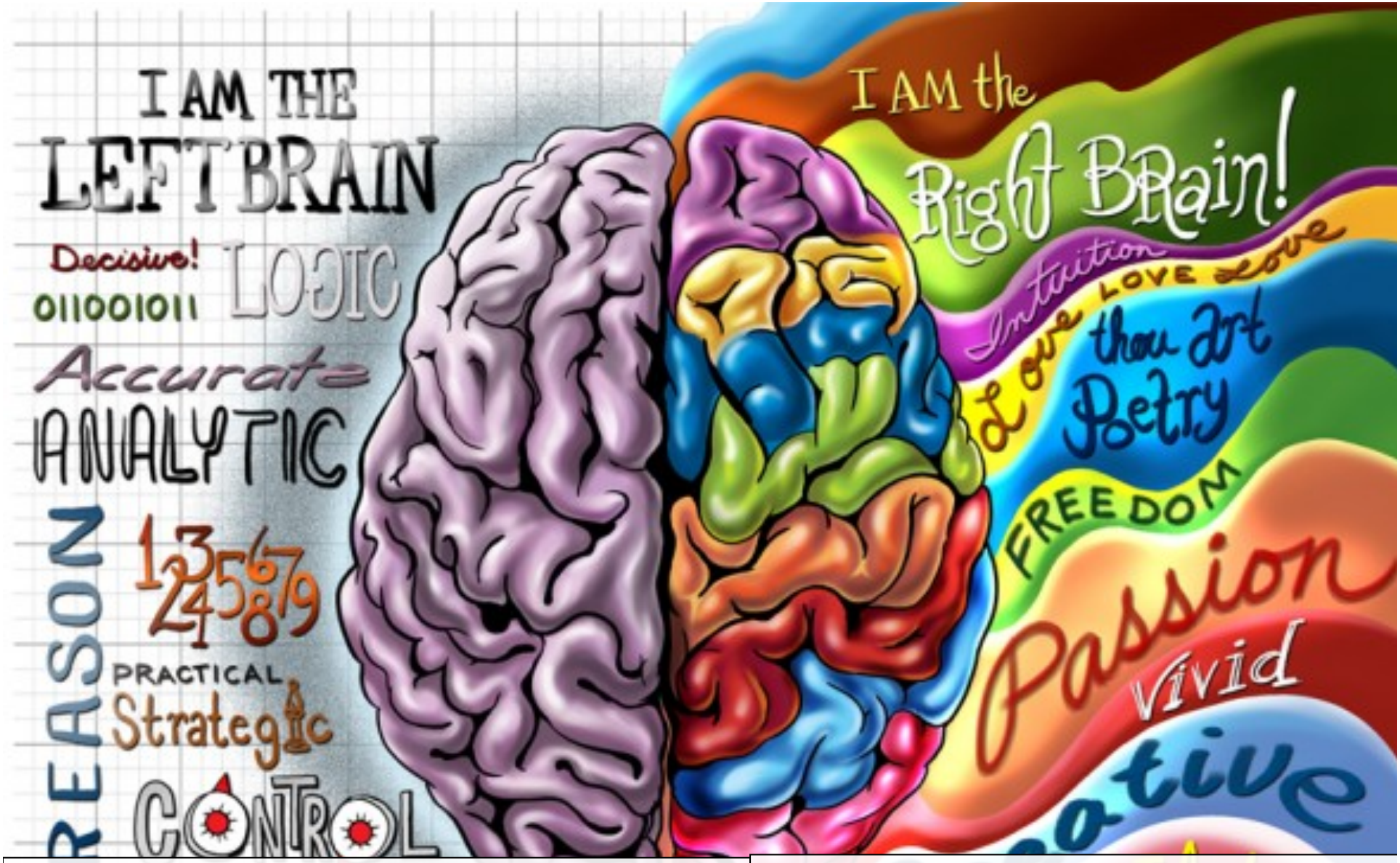
Cerebral Hemispheres

- The brain is divided into two sides, called hemispheres. They are called the left and the right hemispheres.
- The corpus callosum joins the two hemispheres, allowing them to communicate with each other



Corpus Callosum





Males tend to be more left brained, while females have greater access to both sides.

ARE YOU RIGHT or LEFT BRAINED?
http://en.sommer-sommer.com/braintest/

COLOR TEST

CONFLICT:

The right side of the brain wants to pick the color that matches the word, the left wants to choose the word written. When you make a mistake, that's the left side of the brain in action.

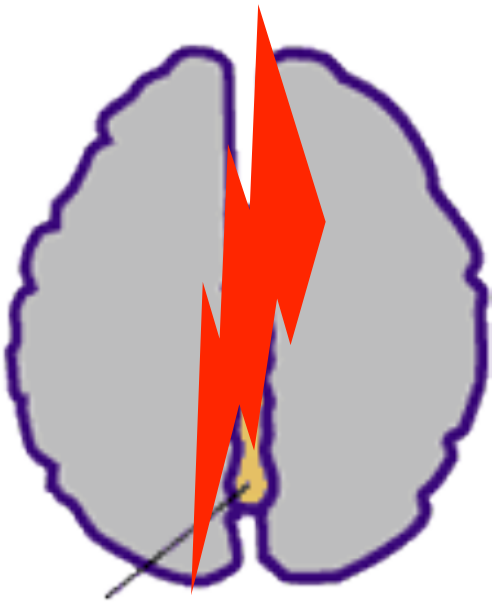
Left is right, right is left

- The **left side** of your **brain** controls the **right side** of your **body** and vice versa
- But, your brain combines information from both sides of your body due to communication via the **corpus callosum.**

How do we know what each hemisphere does?

- People who suffered from **epilepsy** ("brain storm" of excessive neuronal activity) had their corpus callosum cut to prevent the spread of the **"epileptic seizure"** from one hemisphere to the other.
- What happened to communication between the two halves?

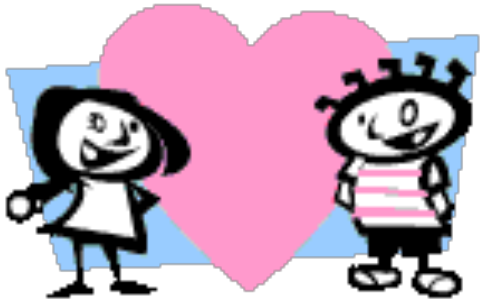
It stopped.



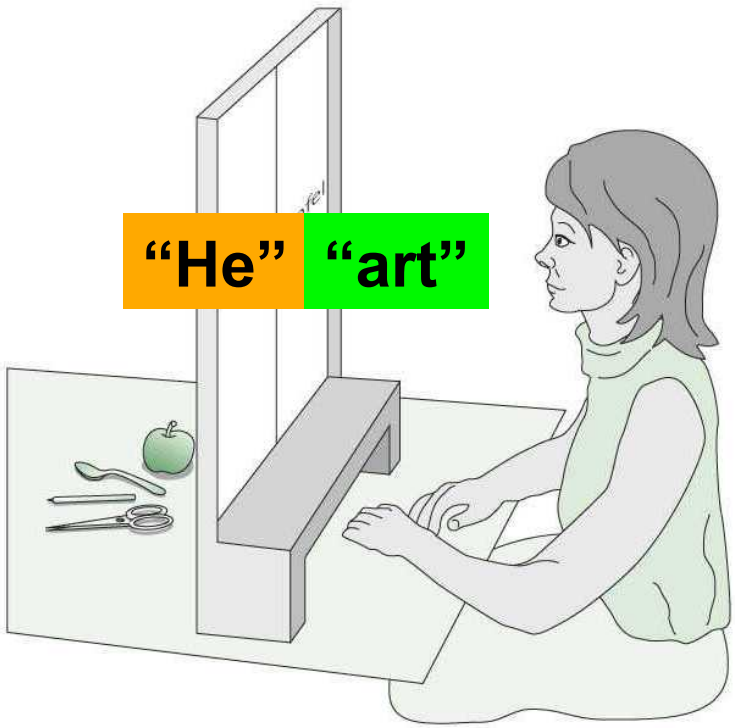
The Great Split-Brain Experiment

- **Roger Sperry** was awarded the Nobel Prize in Physiology or Medicine in 1981 for the discovery of **cerebral dominance**
- He studied patients who had the surgery
- At first he noticed that the patients could walk, talk and looked normal
- **BUT……..**

http://www.nobelprize.org/educational/medicine/split-brain/splitbrainexp.html



“He” “art”



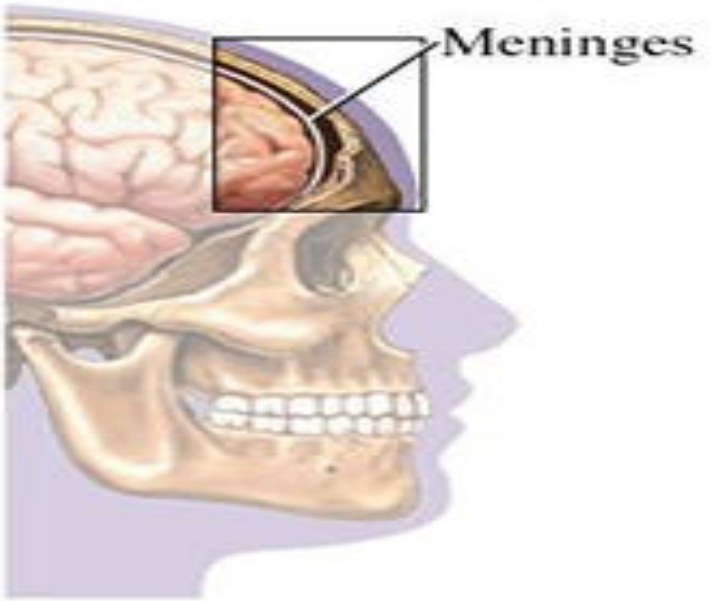
- The patient could only see **“he”** with her **left eye** and **“art”** with the **right eye**
- The word **“he”** went to the **right side** of the brain and **“art”** went to the **left side** of the brain
- When asked what the patient saw, she said….**“art”**

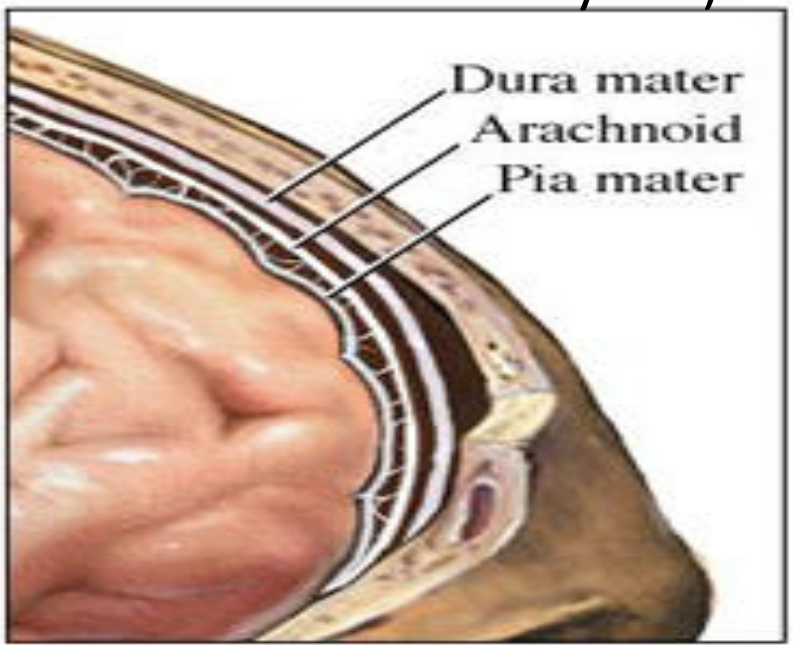
  When asked to write down what she saw, she wrote “he”.

FUN THING TO DO!!! Student Left brain / right brain rope knot

Meninges? What are they?

- **Location:** Between the **brain** and the **skull**
- **Make up: 3 layers** (Don't memorize names of layers!)



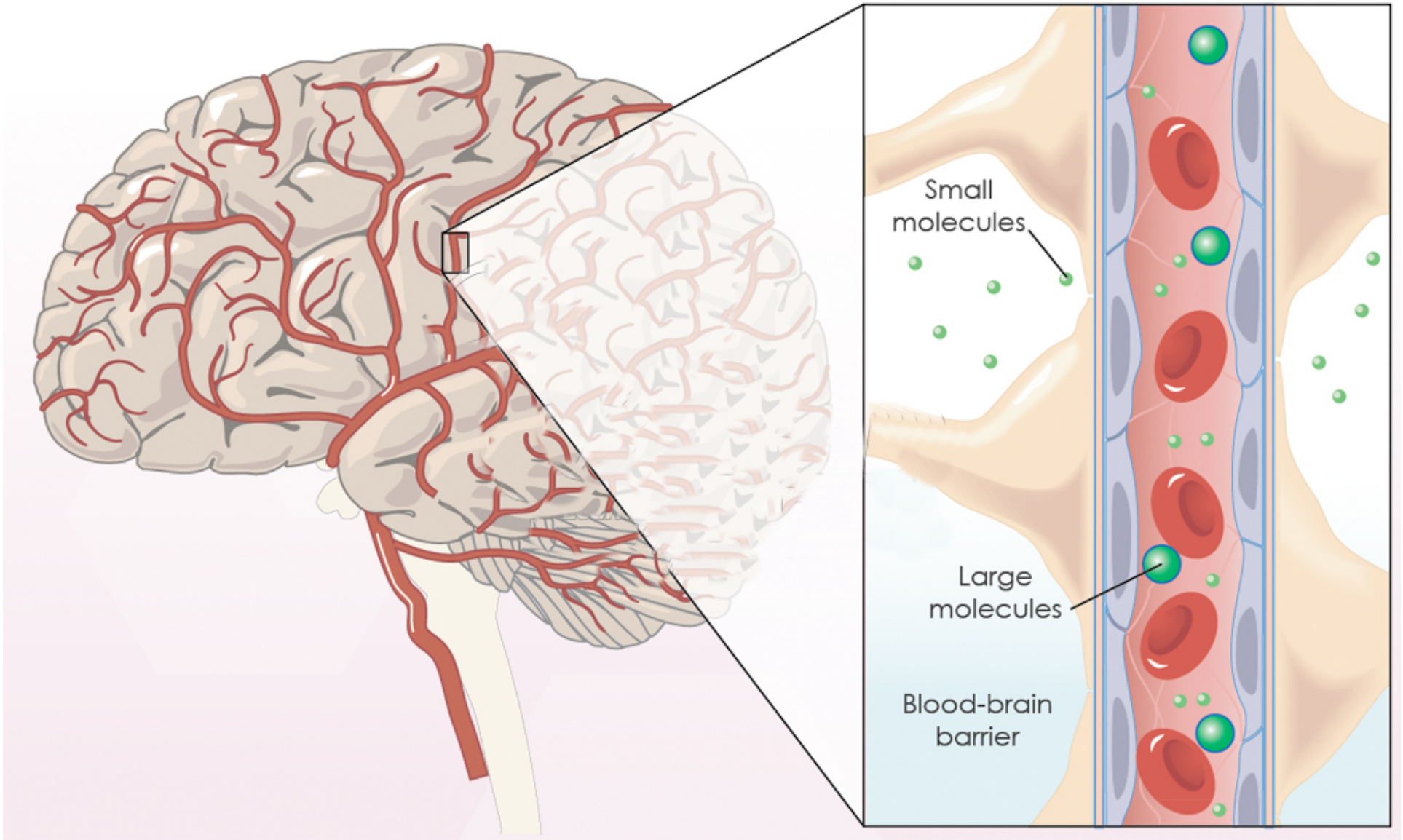


The meninges are 3 layers of tough, elastic tissue that directly enclose the brain and spinal cord. They act as a shock absorber and protect your brain!

Meningitis

- **Inflammation of the meninges**
- Meningitis is caused by **bacterial or viral infection** of the meninges
- **"Meningitis Belt"** in Africa is where meningitis is very common

Blood Brain Barrier



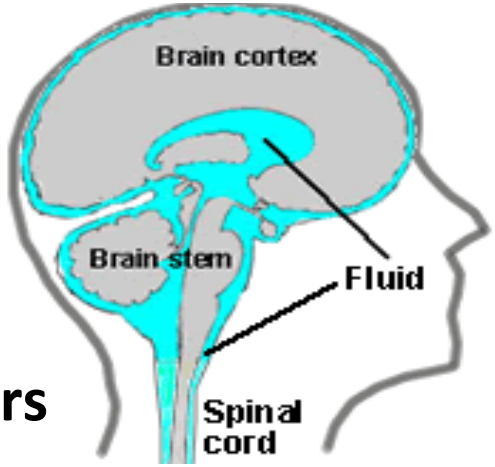
Blood Brain Barrier

More than 100 years ago it was discovered that if blue dye was injected into the bloodstream of an animal, that tissues of the whole body EXCEPT the brain and spinal cord would turn blue. To explain this, scientists thought that a "Blood-Brain-Barrier" (BBB) which prevents materials from the blood from entering the brain existed.

1) **Protects the brain from "foreign substances"** in the blood that may injure the brain.
2) **Protects the brain from hormones and neurotransmitters** in the rest of the body.
3) **Maintains a constant environment** for the brain.

THE PROBLEM…many medications are prevented from helping many neurological and mental disorders

Cerebrospinal Fluid

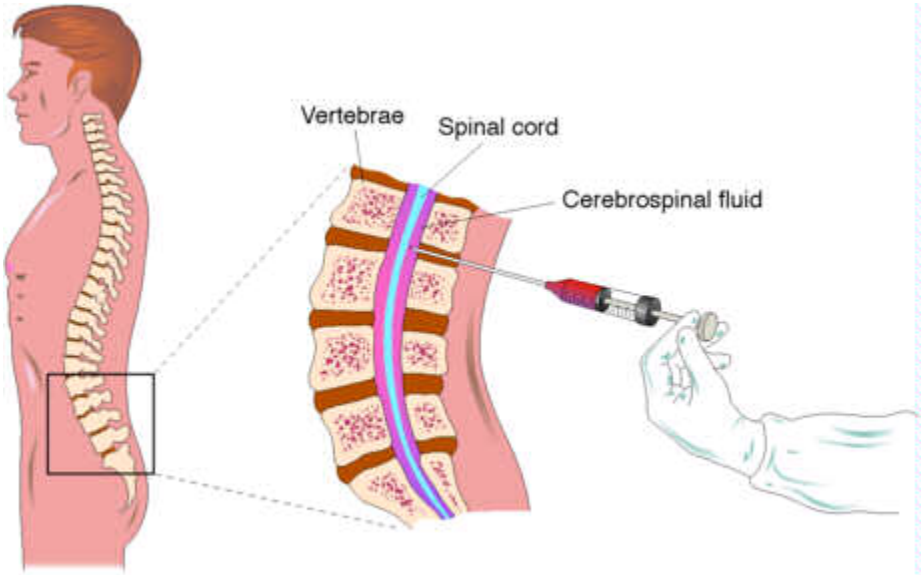


- **Location:** Circulates between the **Meninges layers**

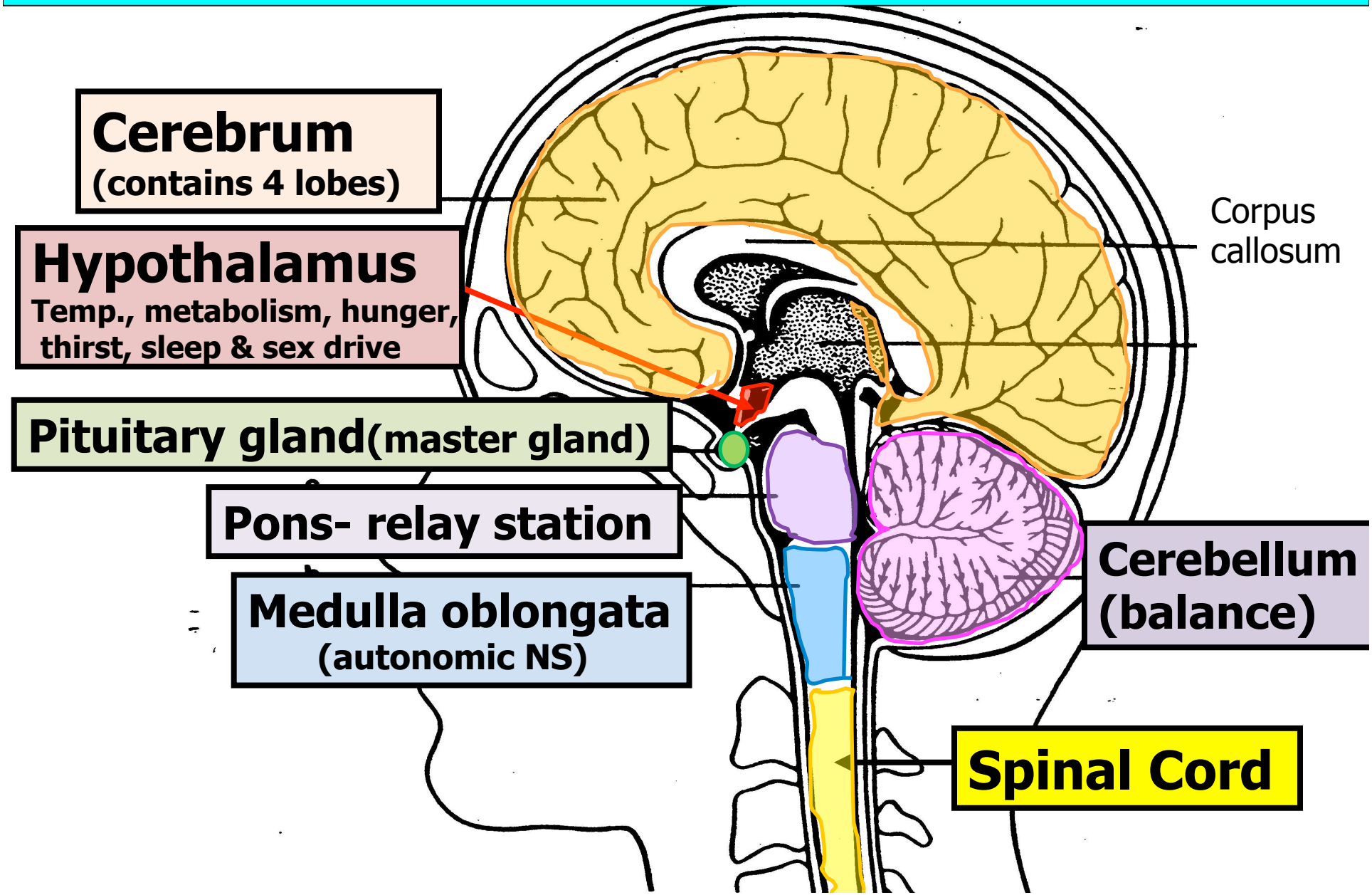
- **Function:** **acts as a shock absorber and helps to transport nutrients to the brain and wastes away from the brain**

Spinal tap? This is when a doctor extracts cerebrospinal fluid for examination

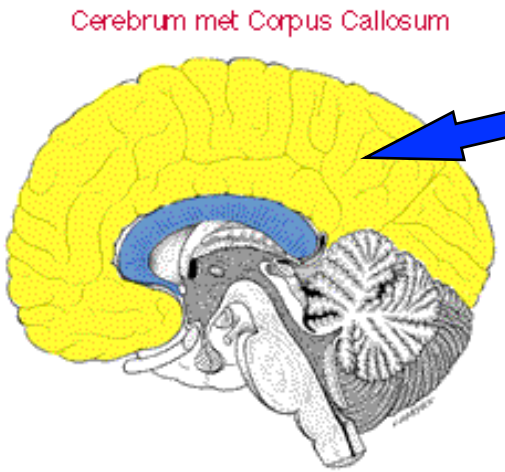
- Also found in the **spinal cord**



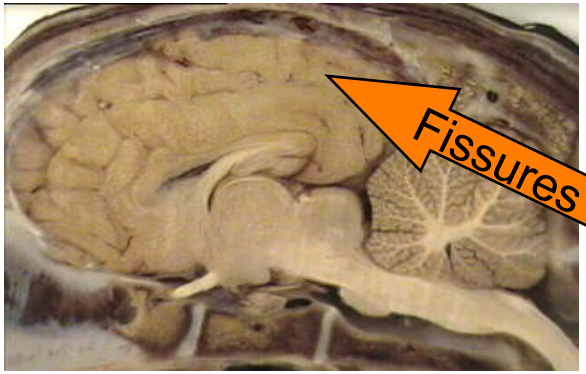
PARTS OF THE BRAIN



Cerebrum



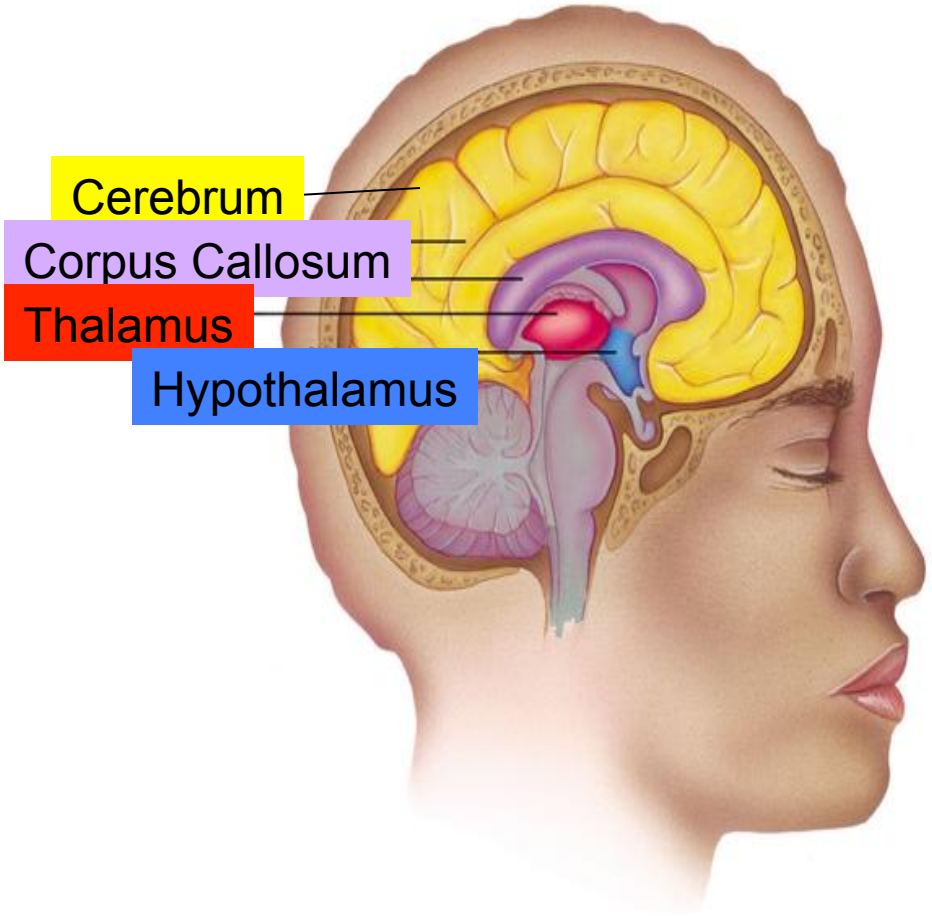
- Largest part of the brain
- Most highly developed part of the brain
- Role: **speech, reasoning, memory, personality**
- **4 lobes: occipital, temporal, parietal and frontal**
- Is divided into **2 cerebral hemispheres**



Cerebral cortex: surface of the cerebrum

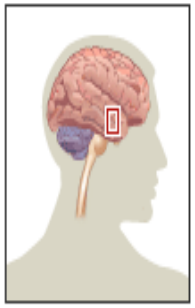
- **Grey matter**
- Lots of folds **(fissures/folds)** to increase surface area

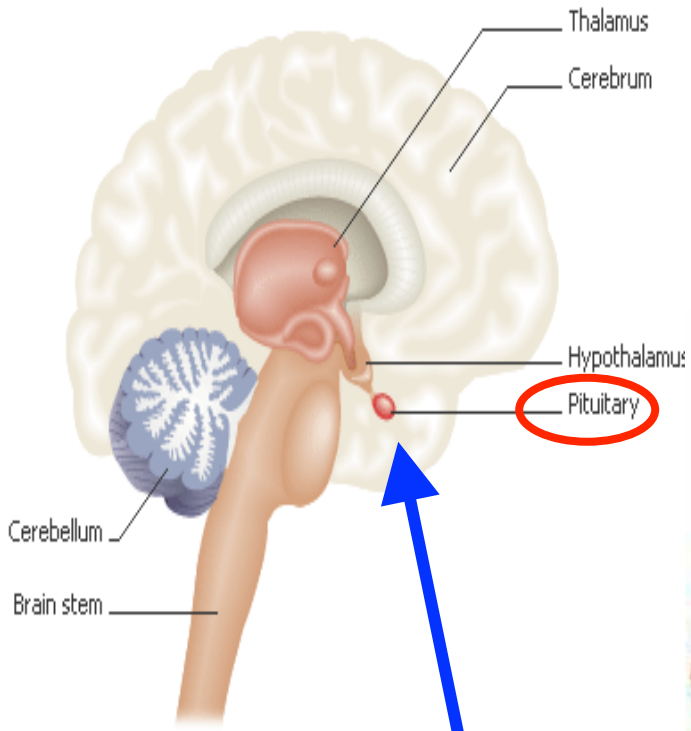
Hypothalamus



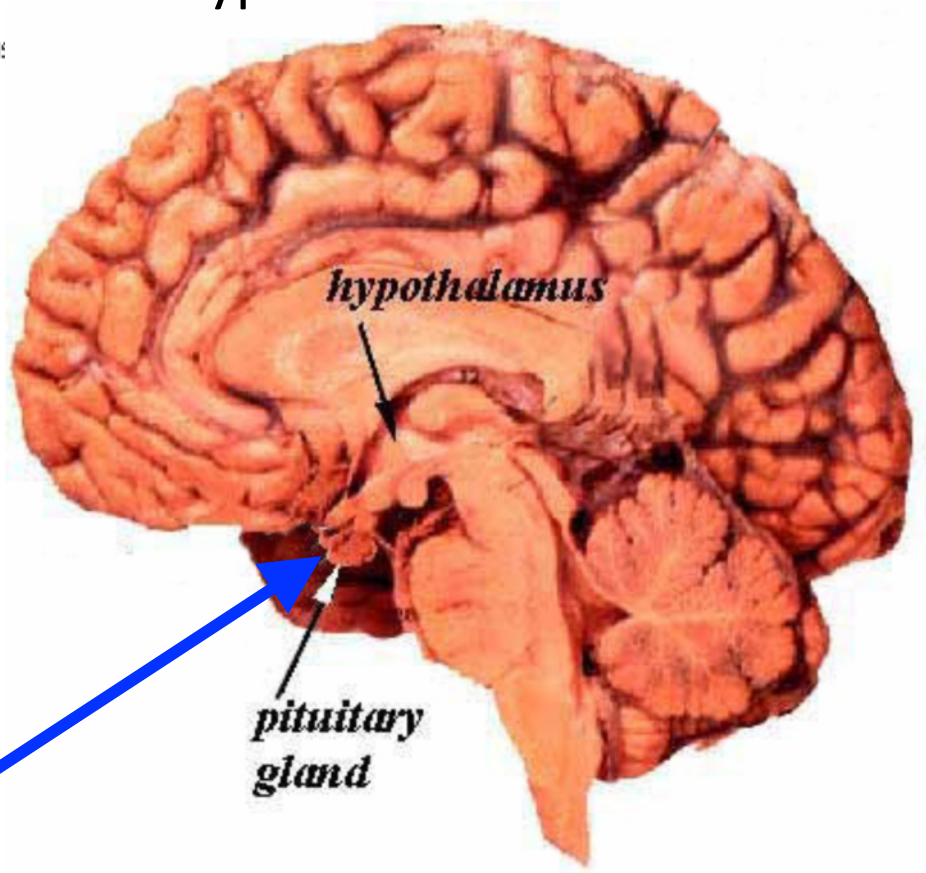
- **Hypothalamus**
  - **Regulates body temperature and metabolism**
  - **Controls hunger, thirst, sleep and sex drive**
  - **Controls the pituitary gland**
  - **Links nervous system with endocrine system**

Pituitary Gland





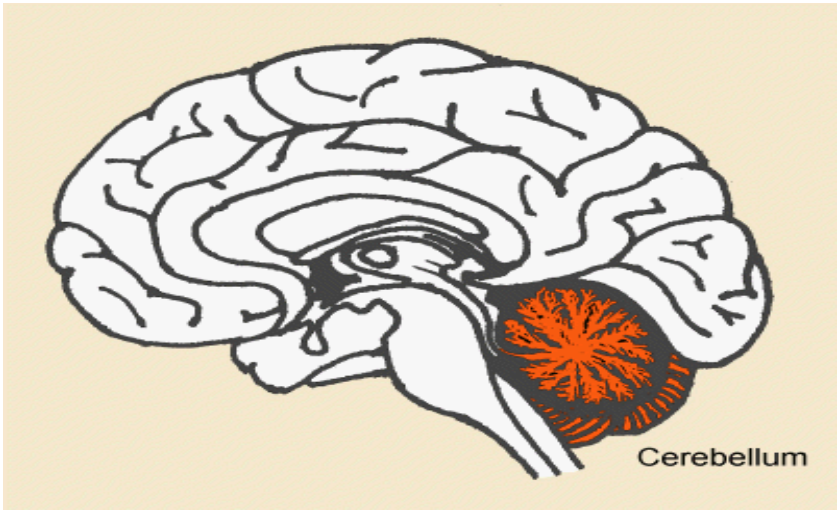
- **"Master gland"** of the body
- **It controls most other glands (tropic hormones)**
- Controlled by the hypothalamus



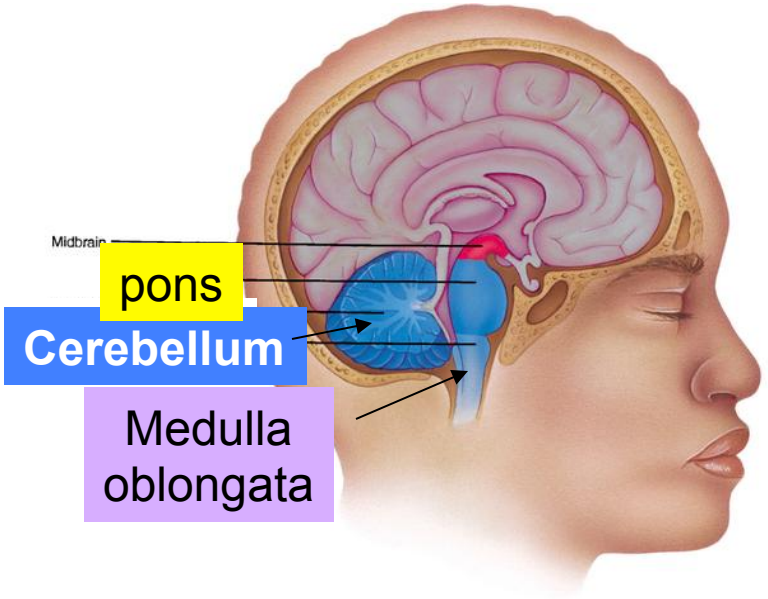
Shape and size of a pea

Cerebellum

- **Controls involuntary limb movement, balance, and muscle tone**
- **Repetitive movements improve its effectiveness**
- **Largest section** of the hindbrain
- **dubbed "Little brain"**
- Only **10% of the mass** of the brain, but contains **50% of the neurons**
- **Has "the tree of life" appearance**



Pons and Medulla Oblongata



Pons – relay station between

- A) two sides of the cerebellum and
- B) the cerebellum and the medulla oblongata

- **Medulla oblongata**
  - **autonomic nervous system**
  - **sympathetic and parasympathetic nervous system**
  - **heart rate, breathing, blood pressure**

The Cerebral Cortex: 4 lobes!

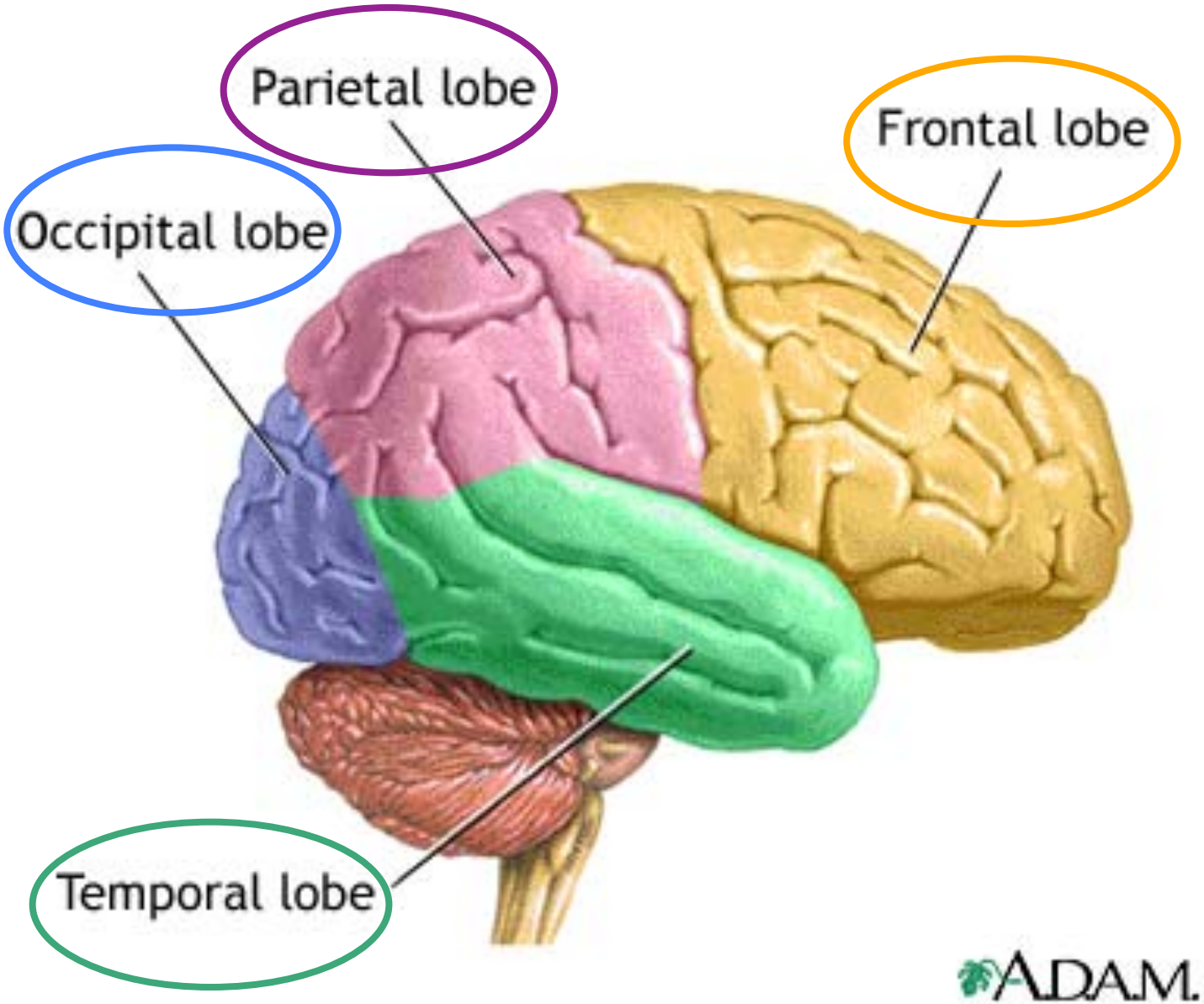
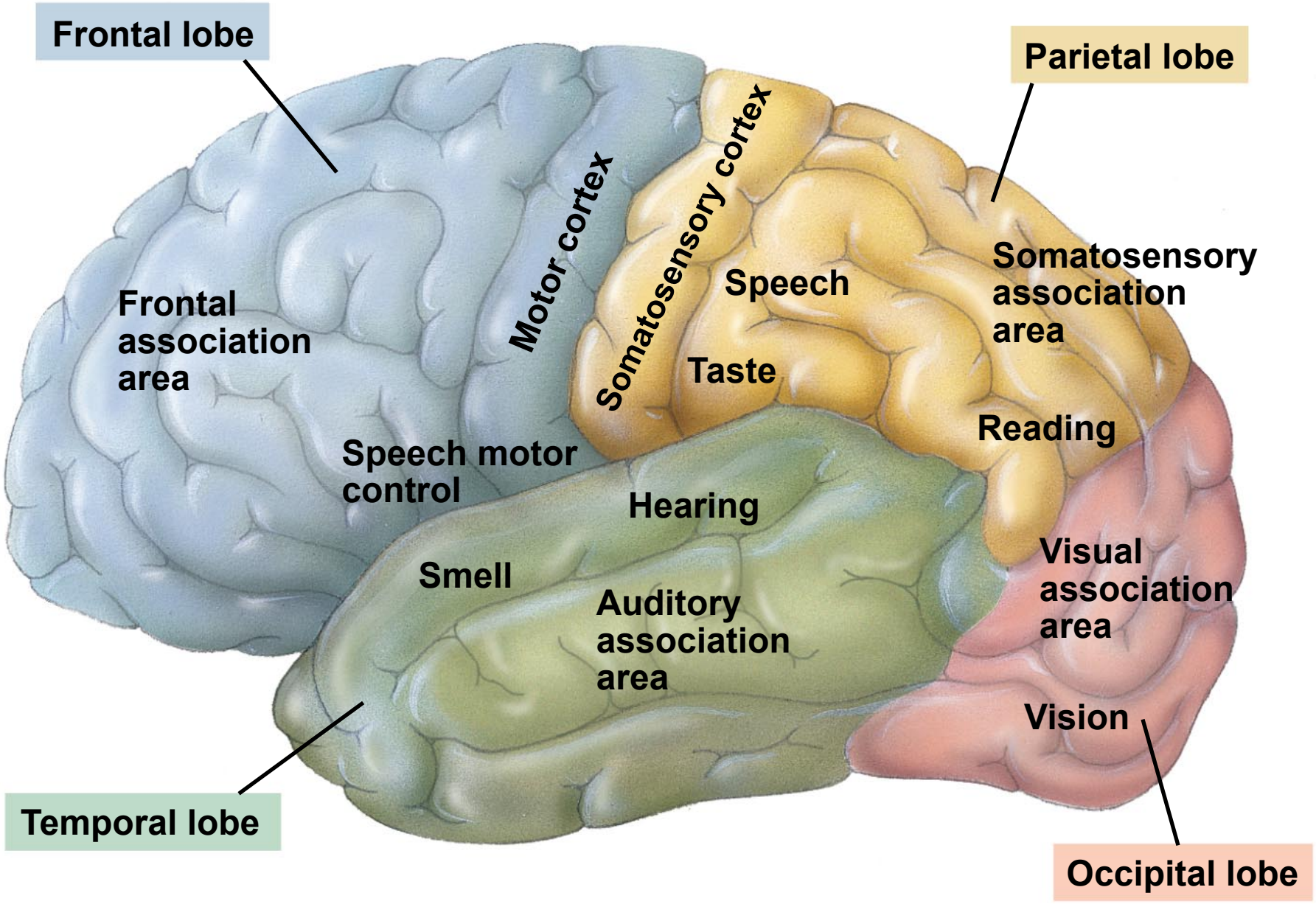


Fig. 49-15



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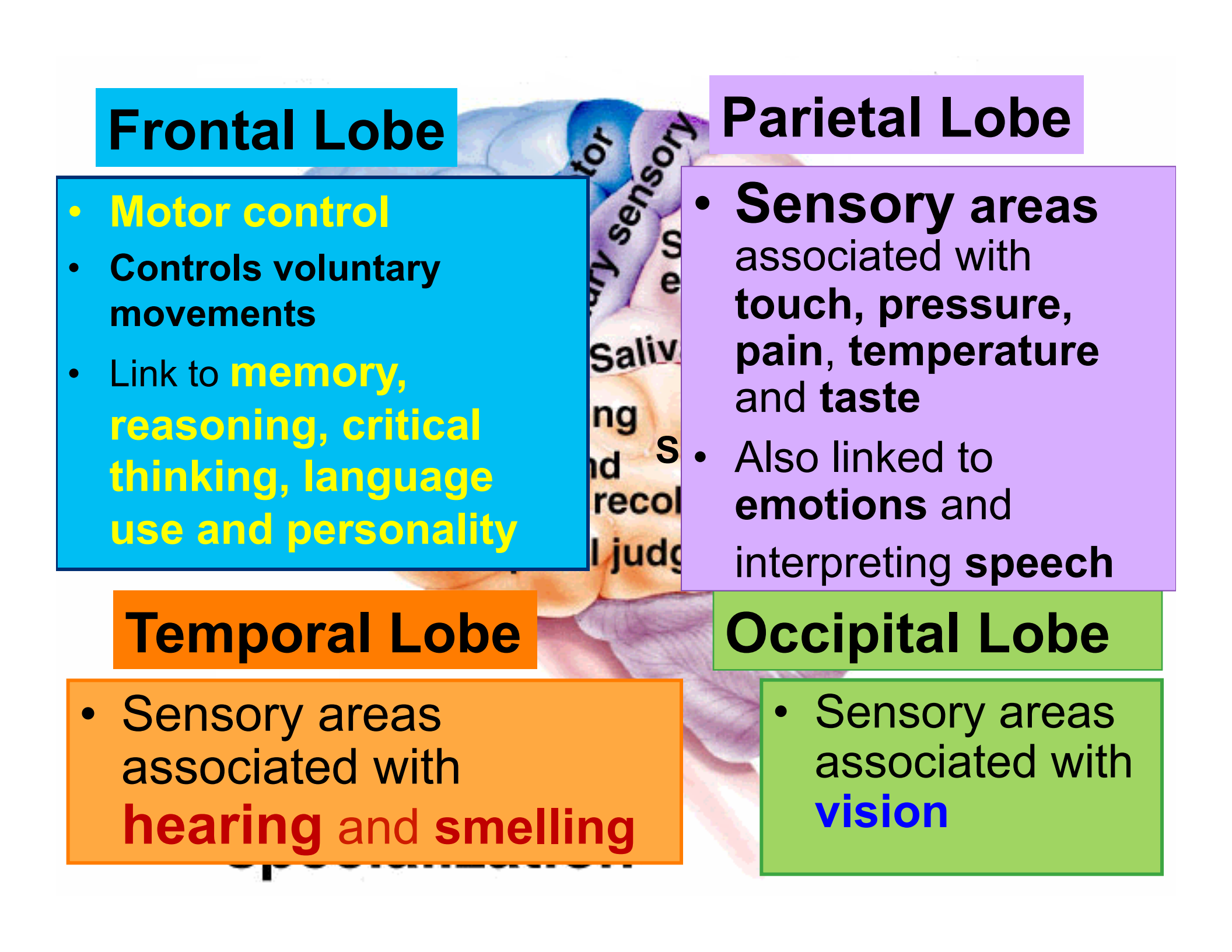


Frontal Lobe

- **Motor control**
- **Controls voluntary movements**
- Link to **memory, reasoning, critical thinking, language use and personality**

Parietal Lobe

- **Sensory areas** associated with **touch, pressure, pain**, **temperature** and **taste**
- Also linked to **emotions** and interpreting **speech**

Temporal Lobe

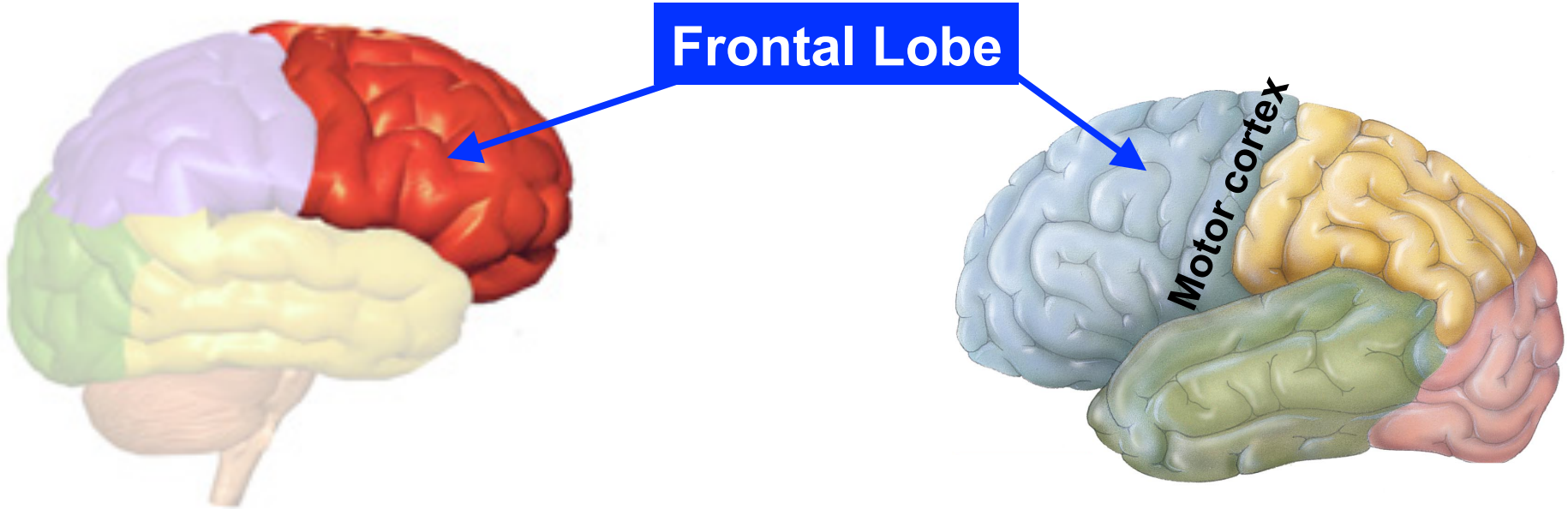
- Sensory areas associated with **hearing** and **smelling**

Occipital Lobe

- Sensory areas associated with **vision**

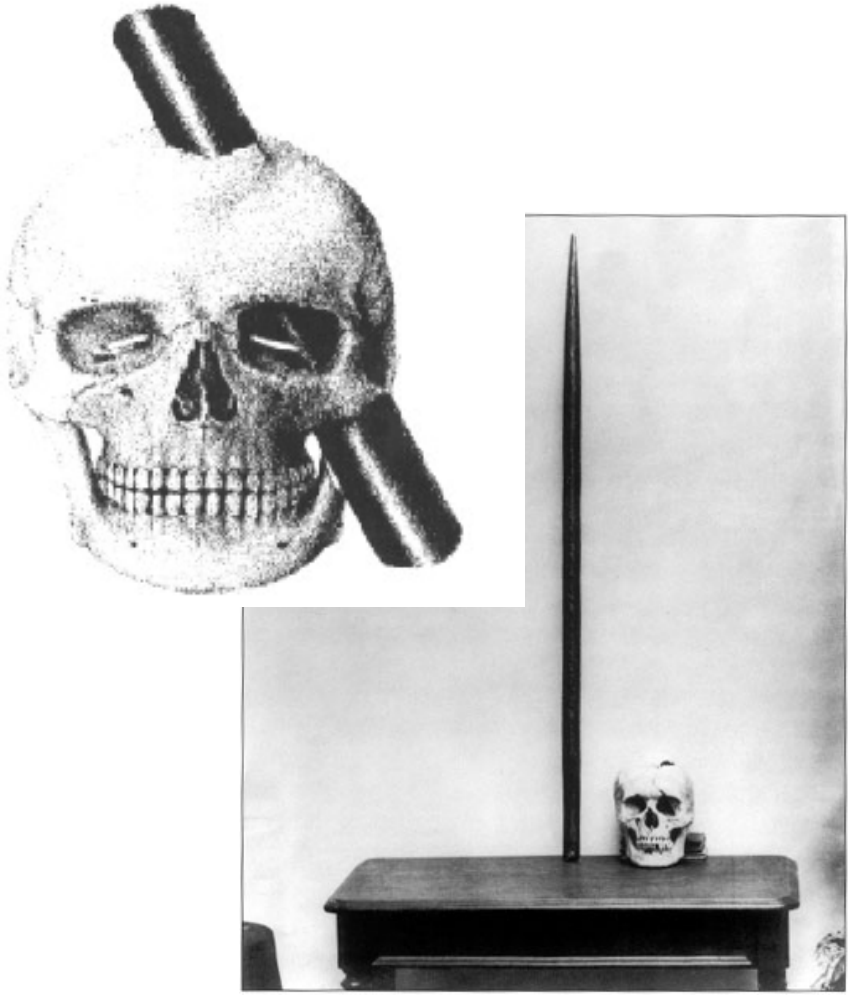
Frontal lobe

- **Motor control**
- **Motor Cortex: planning, control and execution of movements**
- **Controls voluntary movements**
- Link to **memory, reasoning, critical thinking, language use and personality**

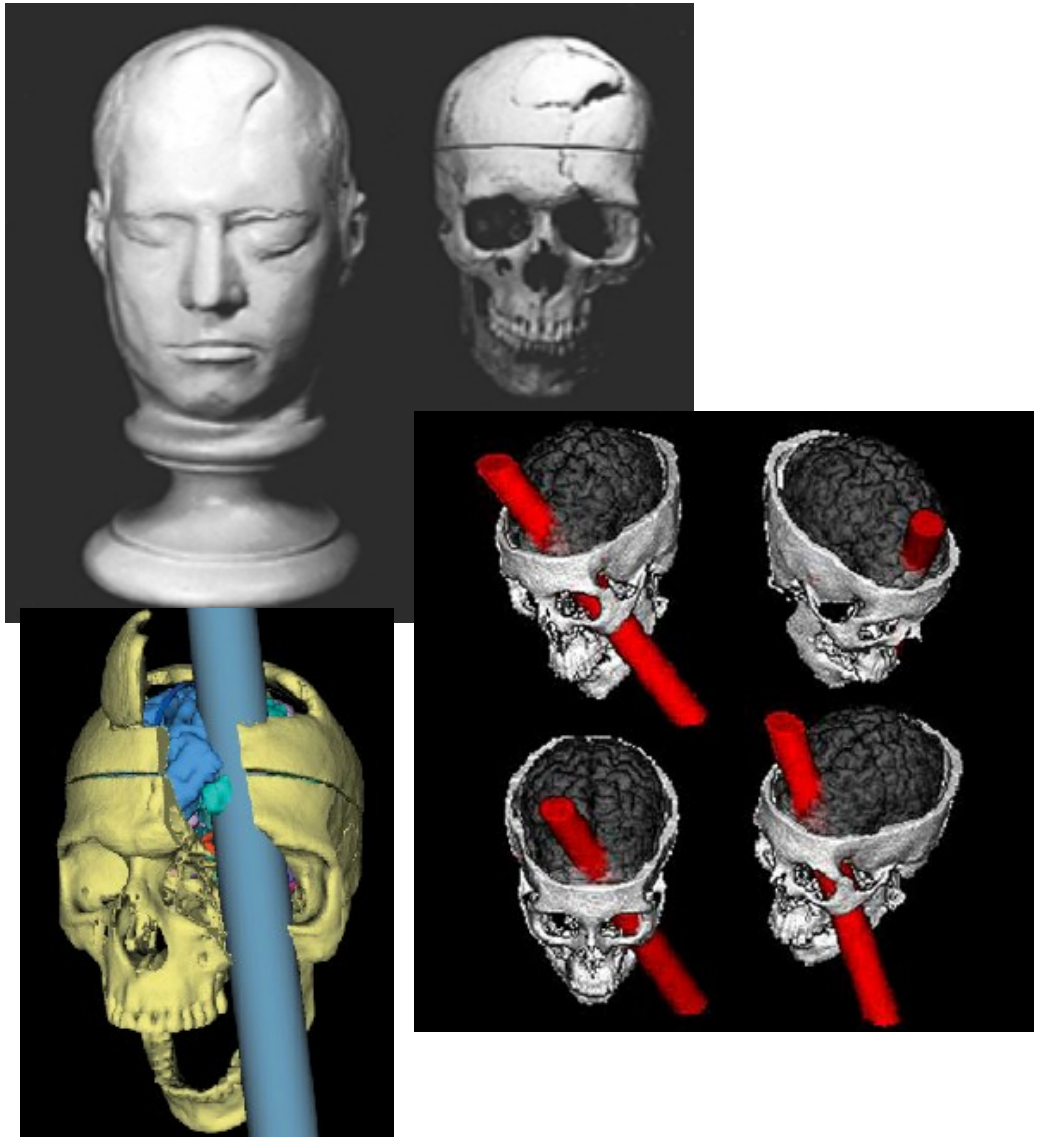


Phineas Gage (1823 – 1860)

- Construction foreman
- Blasted a 13 pound tamping rod through his head
- Not only did he live, but he lived for 12 more years AND even walked to the oxcart taking him to the hospital
- Damage to the frontal lobe and his left eye



Did anything bad come out of his accident?



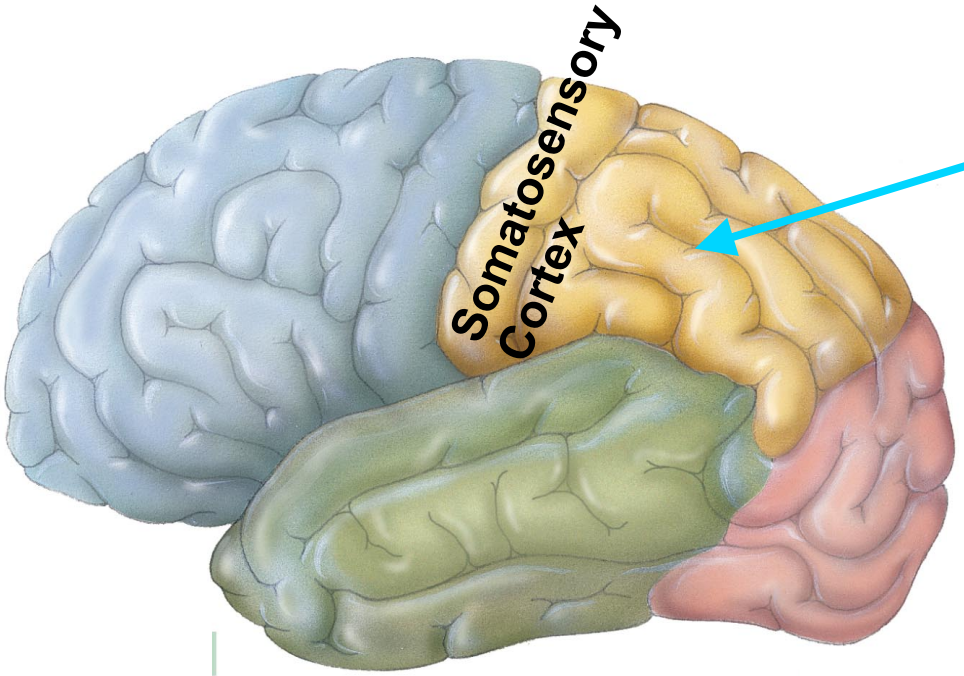
- Underwent drastic personality change (polite and well liked to short tempered and rude)
- Lead to greater understanding of the brain
- Idea later used for lobotomies

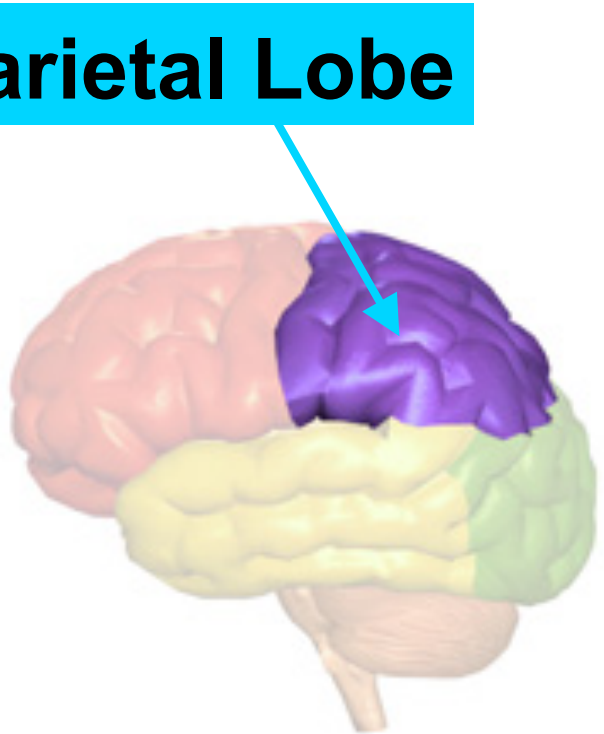
https://www.youtube.com/watch?v=yXbAMHzYGJ0

https://www.youtube.com/watch?v=FrULrWRlGBA

Parietal Lobe

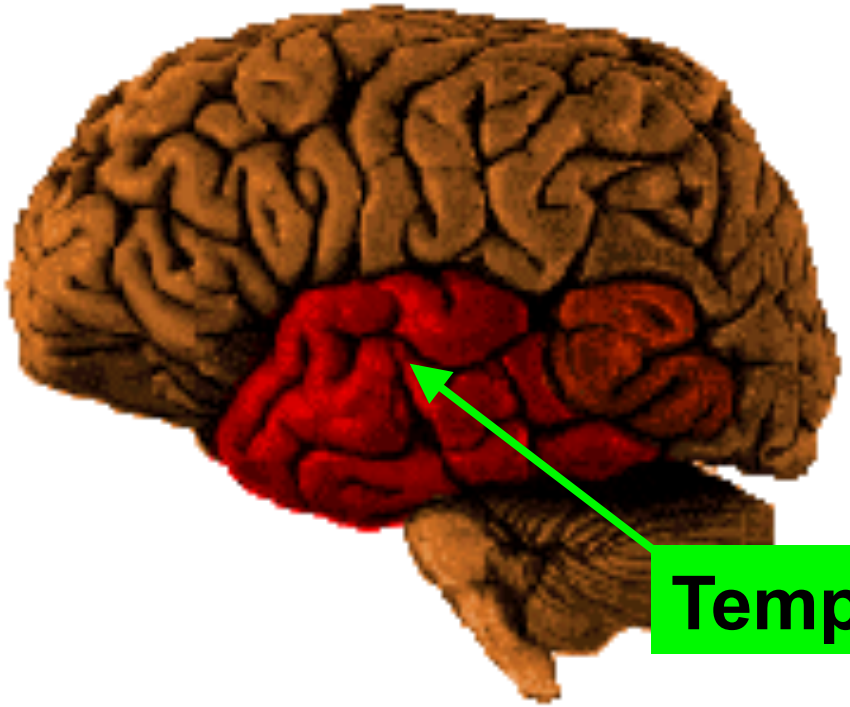
- **Somatosensory Cortex: main sense of touch**
- **Sensory areas** associated with **touch, pressure, pain**, **temperature** and **taste**
- Also linked to **emotions** and interpreting **speech**

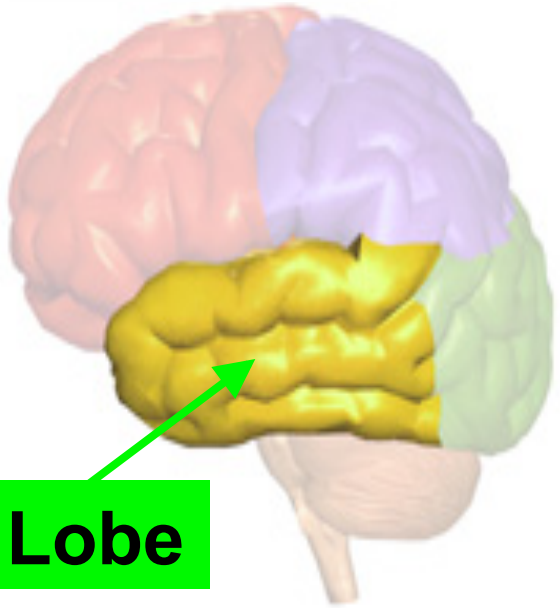




Temporal Lobe

- Sensory areas associated with **hearing** and **smelling**

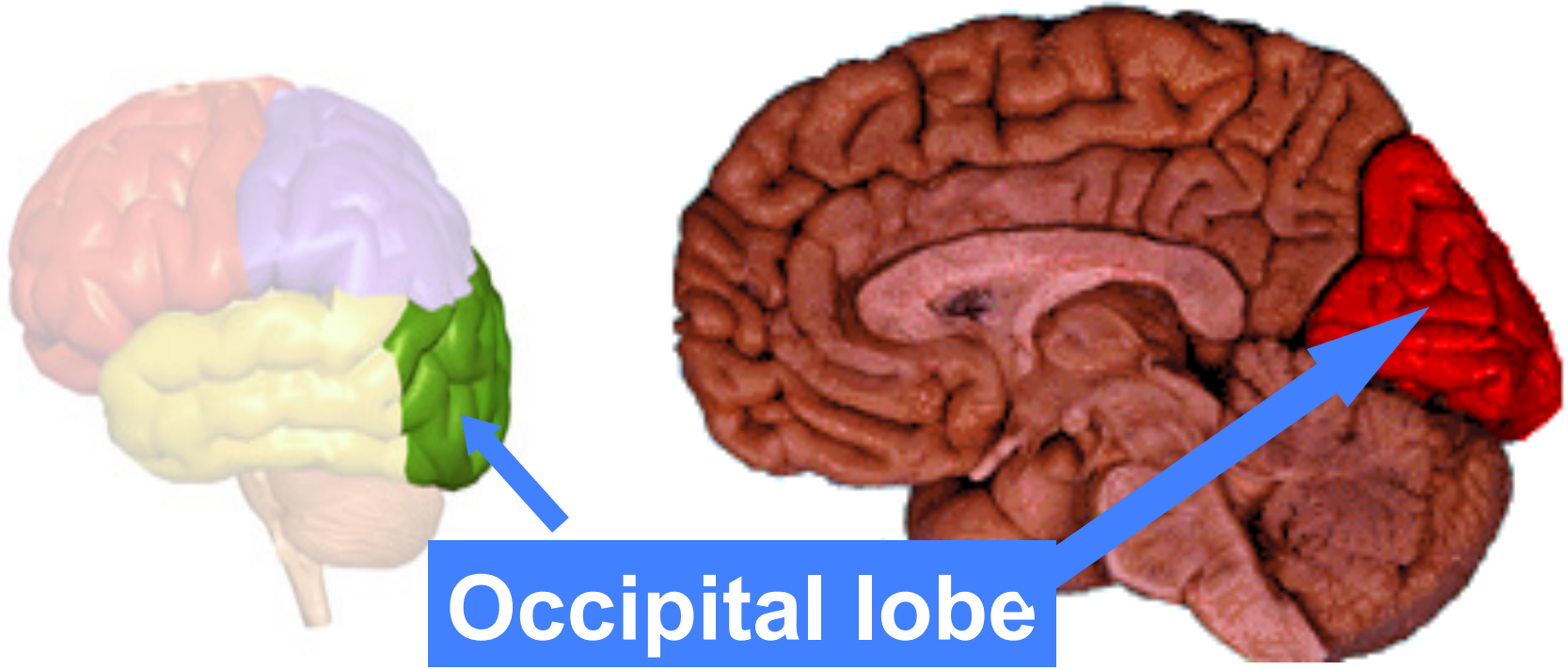




Temporal Lobe

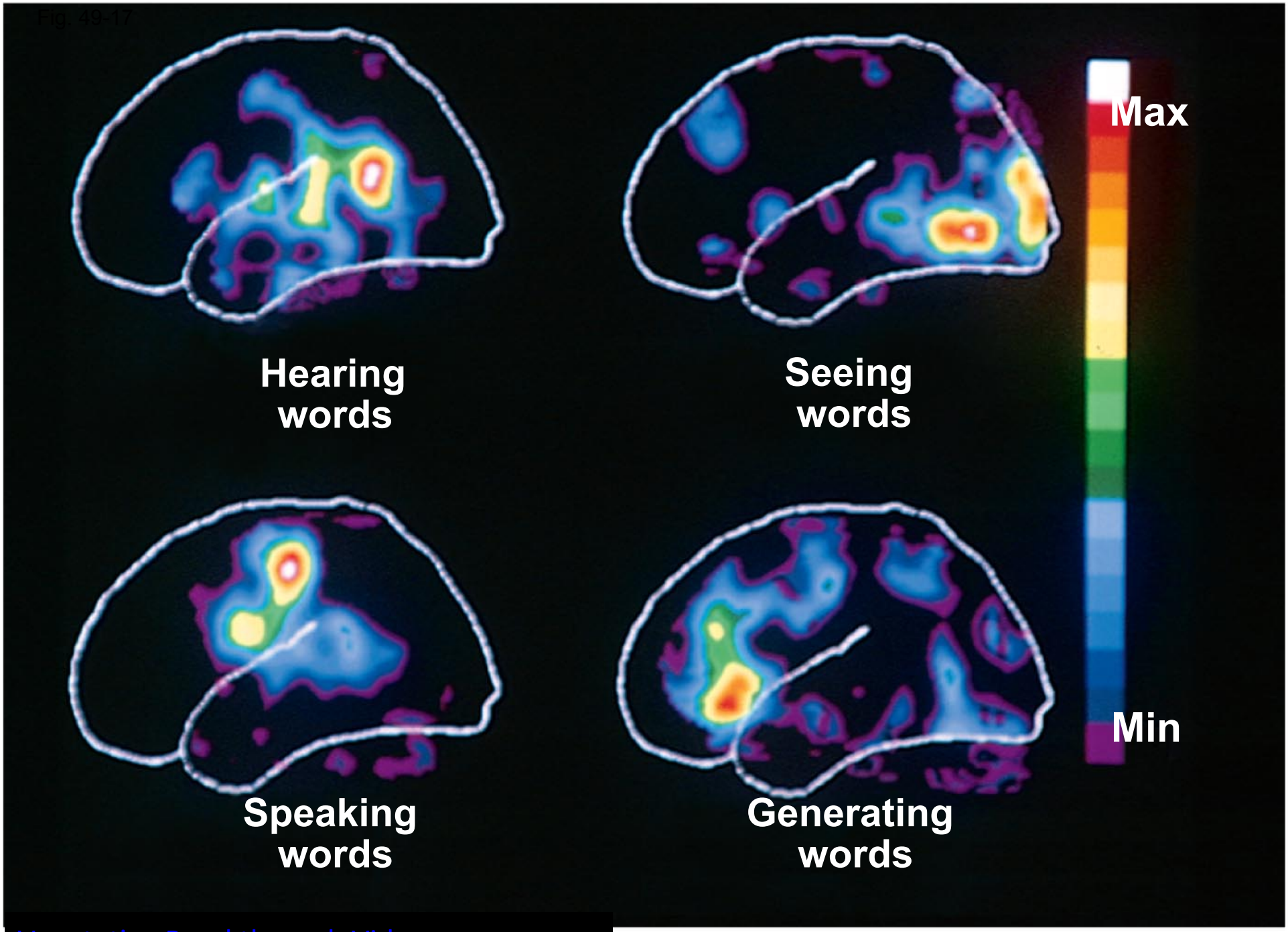
Occipital lobe

- Located at the back of the brain
- Sensory areas associated with **vision**
- Damage may cause loss of vision



Bozeman: The Brain 13:55 http://www.youtube.com/watch?v=kMKc8nfPATI

Fig. 49-17



Vegetative Breakthrough Video

1 Which part of the brain would be damaged, and what would the symptoms be?

	Frontal Lobe	Impaired Judgement
B	Frontal Lobe	Hearing loss
C	Temporal Lobe	Reduced motor control
D	Temporal Lobe	Hearing loss

2 Which part of the brain would most likely be damaged, and what would the symptoms be?

A	Sensory Cortex	Reduced pain sensitivity
B	Sensory Cortex	Hearing loss
	Motor Cortex	Reduced motor control
D	Frontal Lobe	Loss of smell

3 Which part of the brain would be damaged, and what would the symptoms be?

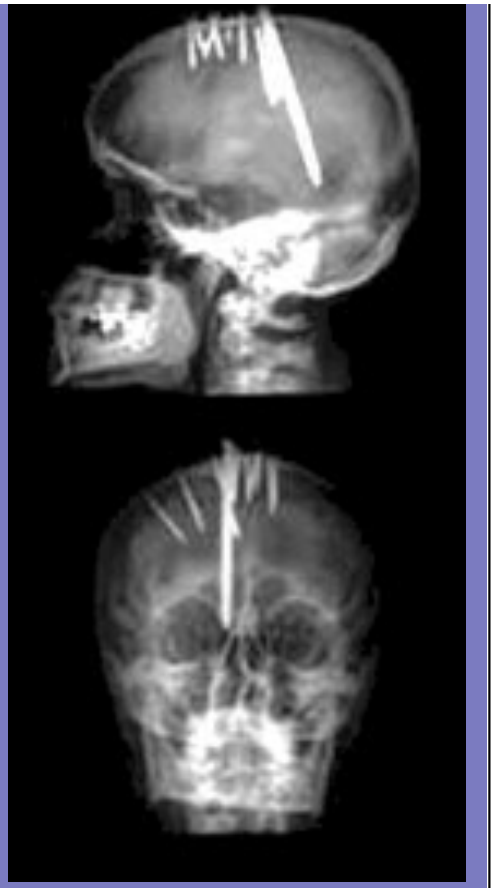
A	Parietal Lobe	Vision loss
B	Parietal Lobe	Hearing loss
C	Temporal Lobe	Vision loss
	Temporal Lobe	Hearing loss

4 Which part of the brain would be most affected, and what would the symptoms be?

	Cerebellum	Loss of Balance
B	Cerebrum	Personality change
C	Medulla	Emotional instability
D	Parietal Lobe	Reduced touch sensitivity

5 Which part of the brain would be most affected, and what would the symptoms be?

	Parietal Lobe	Reduced touch sensitivity
B	Parietal Lobe	Personality changes
C	Frontal Lobe	Personality changes
D	Frontal Lobe	Reduced touch sensitivity



7 The person whose brain this belonged to would have died because their heart and lungs, and well lets face it, everything else, would have quit working after the zombie ate their brain. Which part of the brain would be most **directly** responsible for the stopping of the heart & lungs?

A Frontal Lobe

B Parietal Lobe

C Temporal Lobe

D Occipital Lobe

E Hypothalamus

F Pituitary

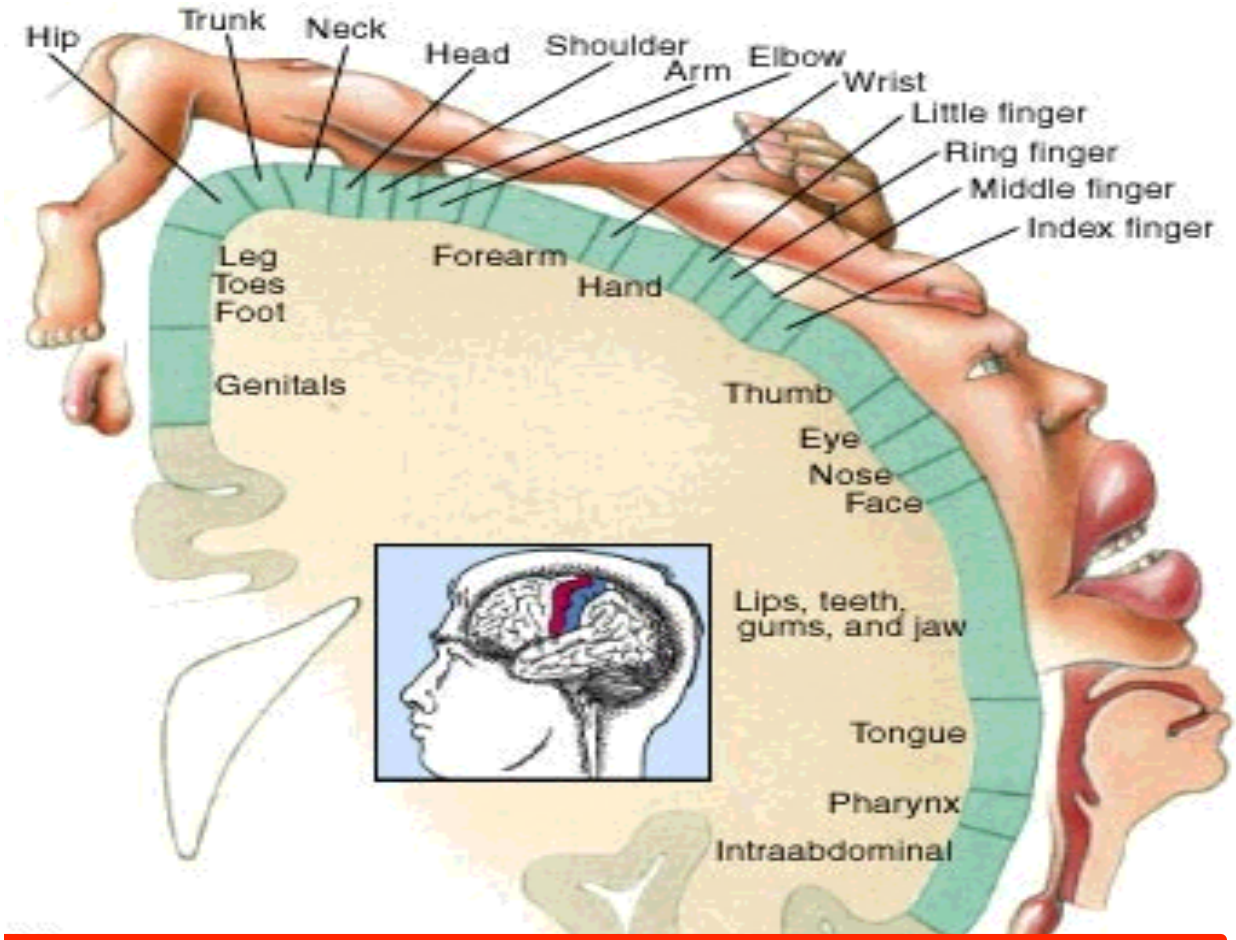
G Cerebellum

H Pons

Medulla Oblongata

J Corpus Callosum

What the body would look like according to the cerebral cortex? cortical homunculus

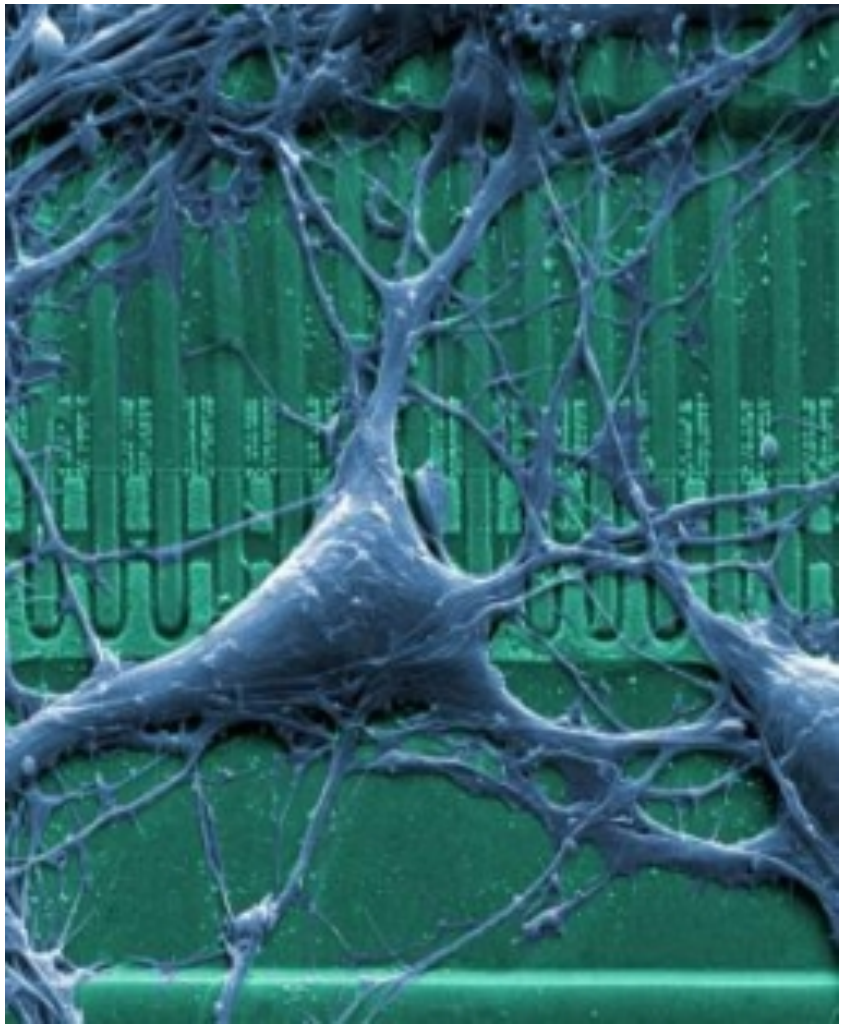


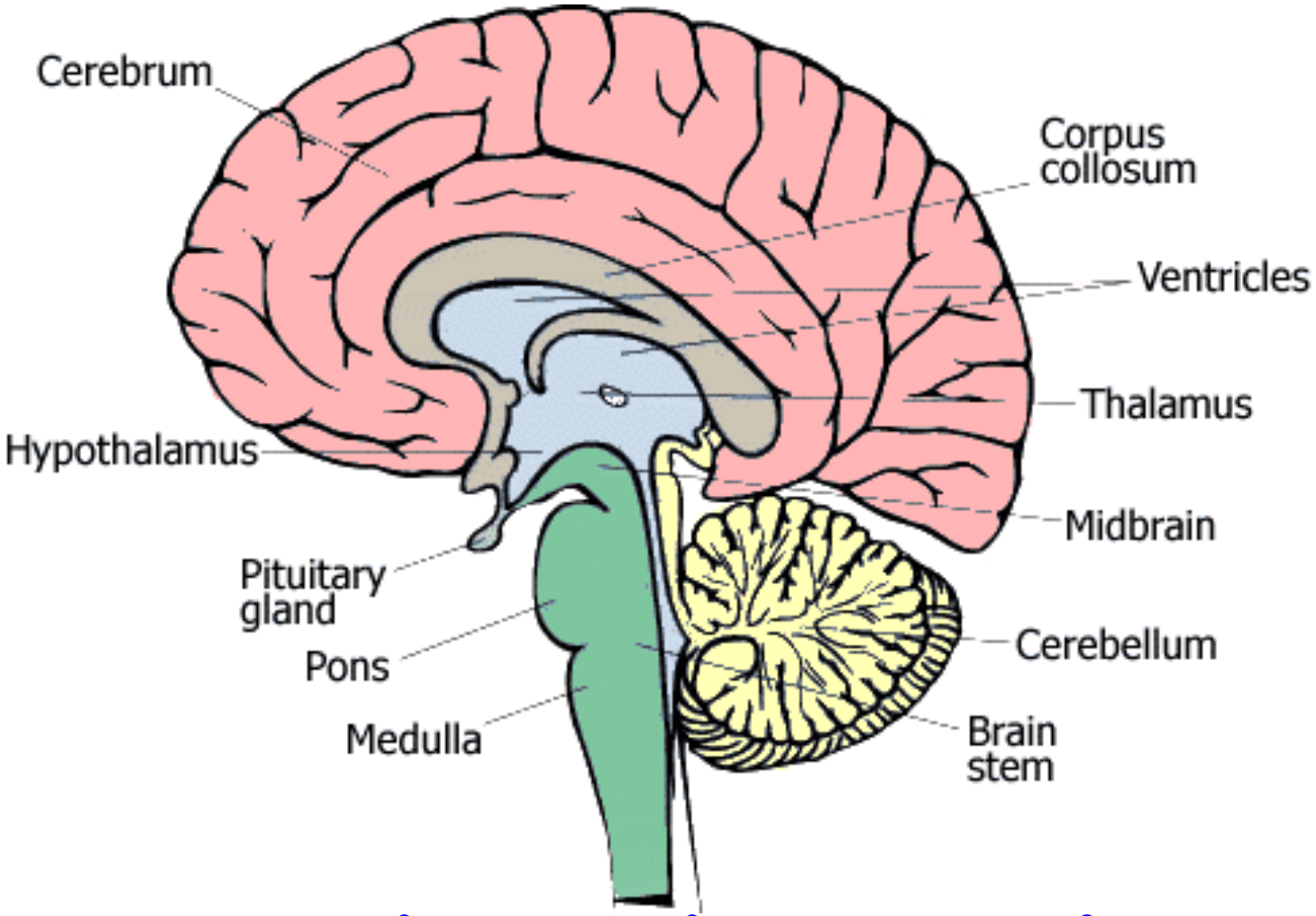
This model shows what a man's body would look like if each part grew in proportion to the area of the cortex of the brain concerned with its sensory perception. The hands and lips dominate – but the feet are also disproportionately large, indicating their sensory importance.

How Much of the Brain Do We Use? VIDEO

Brain Chip Implants Video

FYI: Researchers have interfaced actual living neurons with microchip transistors, as shown in photo. They succeeded in sending a signal from a microchip, through two neurons, to another microchip that turned on a silicon switch





Brain Review Page!

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

Brain Song

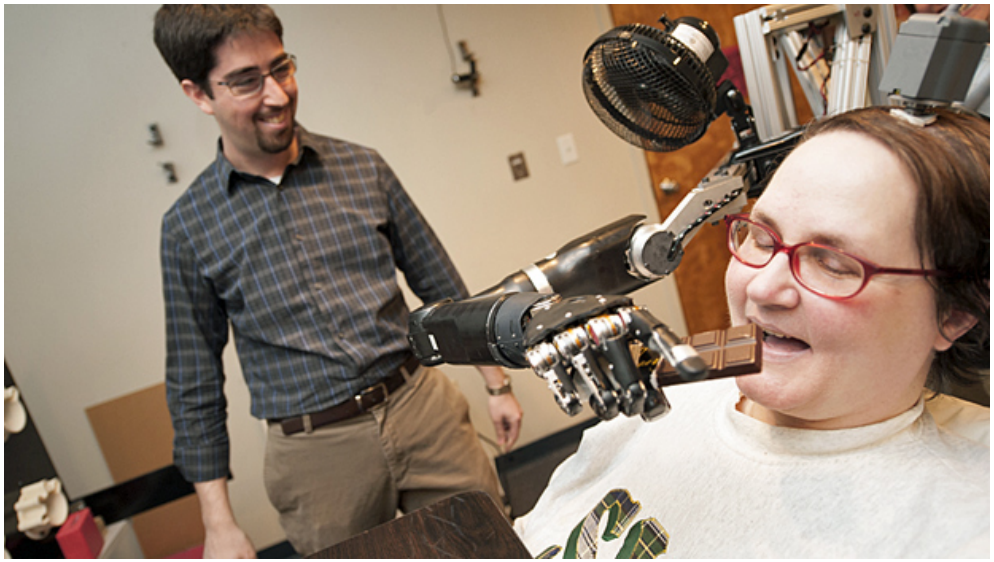
News reporter has stroke on air?

Tan Le: A headset that reads your brainwaves 10 min

Skateboard of Awesomeness- headset controlled

Thought-controlled robotic arm moves with skill and speed

- **http://www.cbc.ca/news/health/story/2012/12/14/robotic-arm-thought-controlled-pittsburgh.html**
- **Prosthetic arm approaches human equivalent in flexibility of movement**



Jan Scheuermann, who has quadriplegia, takes a bite out of a chocolate bar she has guided into her mouth with a thought-controlled robotic arm, as research assistant Brian Wodlinger looks on. (Courtesy UPMC)

http://www.youtube.com/watch?feature=player_embedded&v=76lIQtE8oDY&safety_mode=true&safe=active

Brain, Eye, Ear Assignment

-to be completed for marks