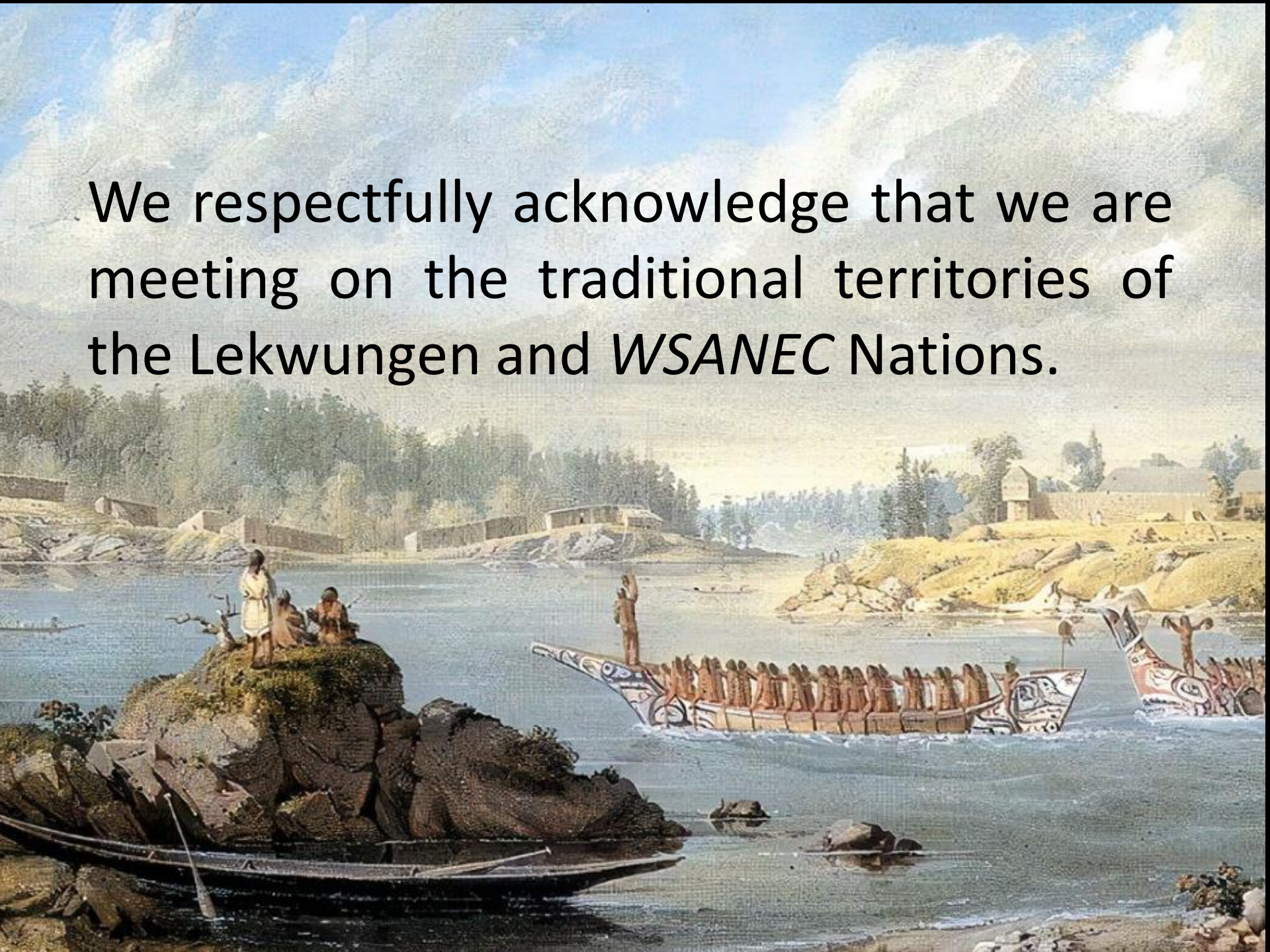
The Body Works?

Part of the UVic
Retirees Association (UVRA)
Elder Academy Program

Presenters: David Docherty, Ph.D., with Pat Gunton, M.D. and Chris Pengilly, M.D.


We respectfully acknowledge that we are meeting on the traditional territories of the Lekwungen and *WSANEC* Nations.

Overall approach:

Purpose: To provide some insight into how the body works and what can go wrong so you are able to understand what goes on in your body and communicate more effectively with medical professionals.

Presentations: two parts

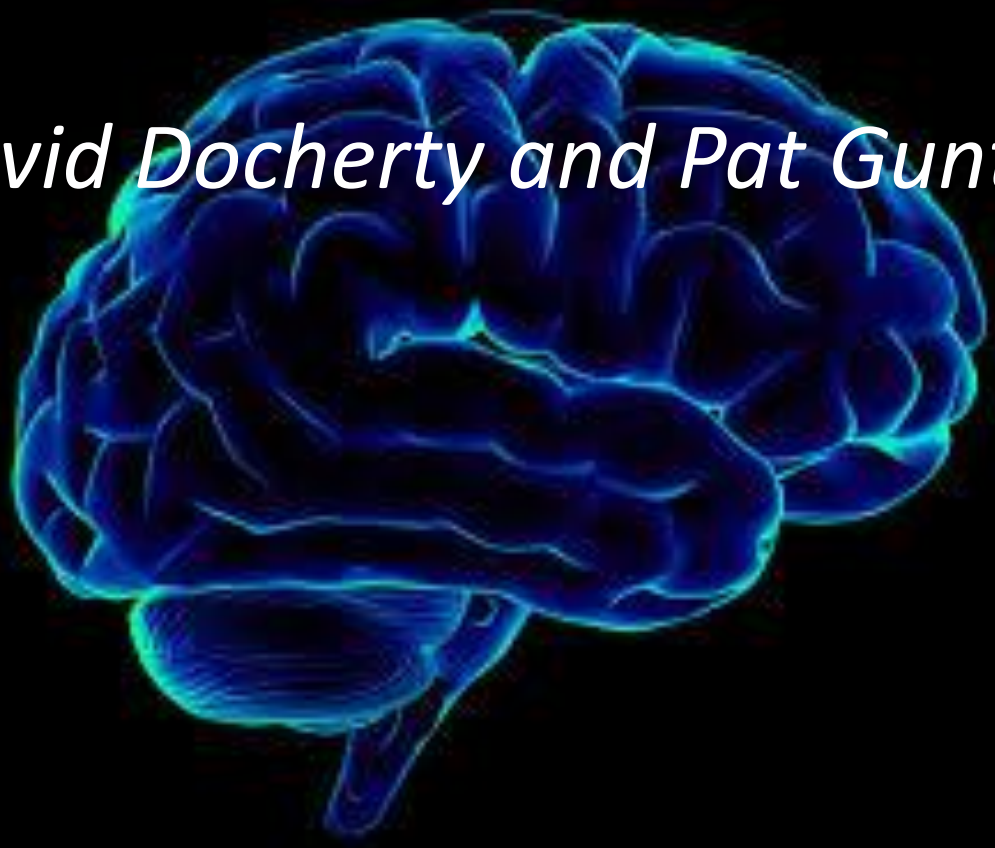
1. The anatomy and function of four selected systems
2. Things that can go wrong and the medical interventions commonly available

The Body Works?

- ~~The Heart (March 5th)~~
- ~~The Articulations, in particular the knee and hip joints (March 12th)~~
- **The Control Centre (March 19th)**
- *The Immune System (March 26th)*

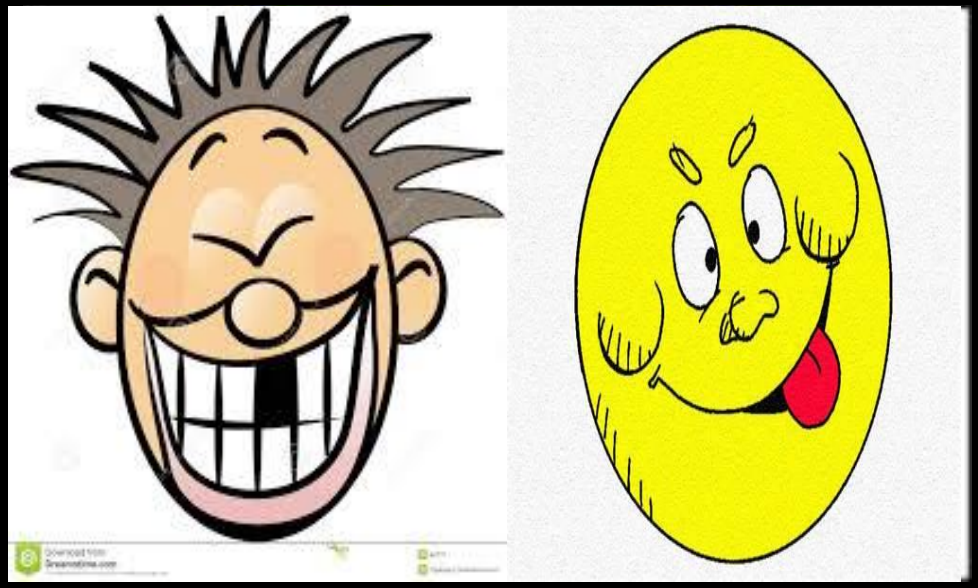
Presentation: The Brain (and associated parts!)

David Docherty and Pat Gunton



However, before we start.....

Differences between men's brains and women's brains with apologies to Mark Gungor (marriage expert)



Compared the two brains!

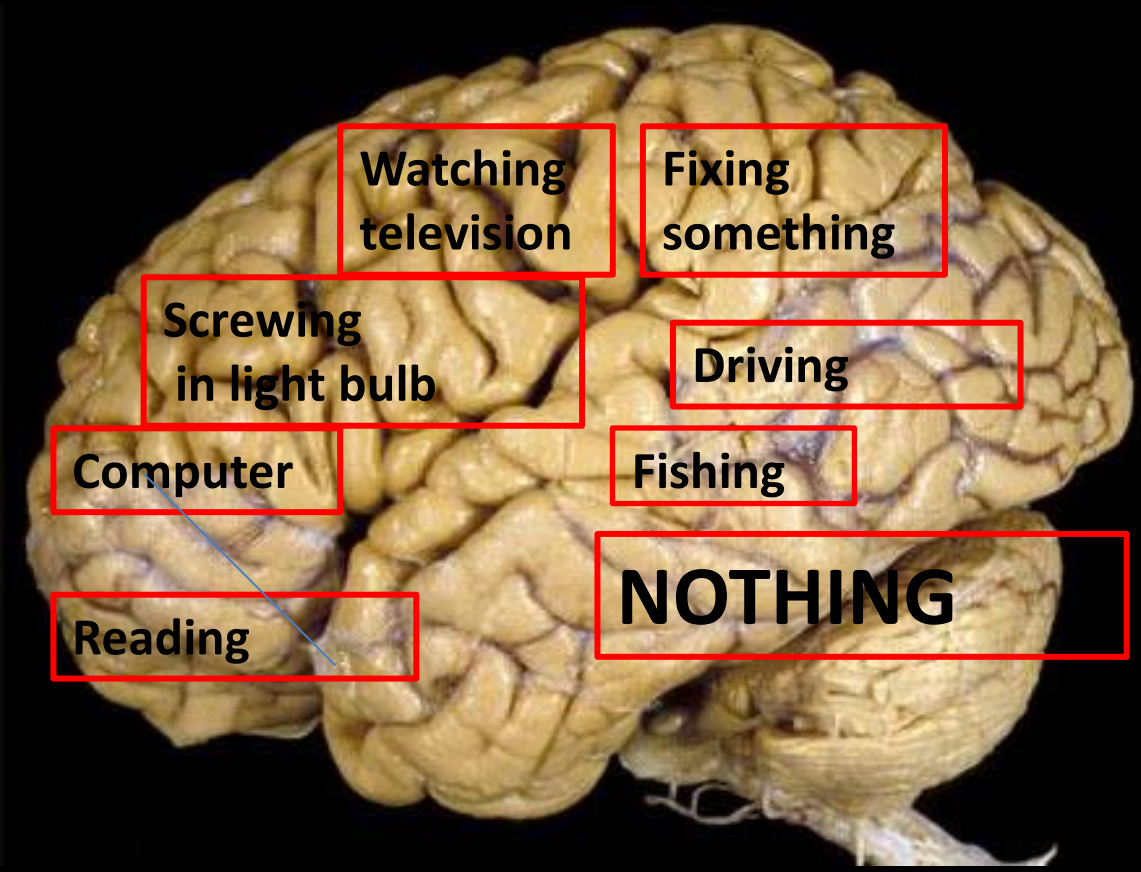
Woman's brain

Complex network

Man's brain

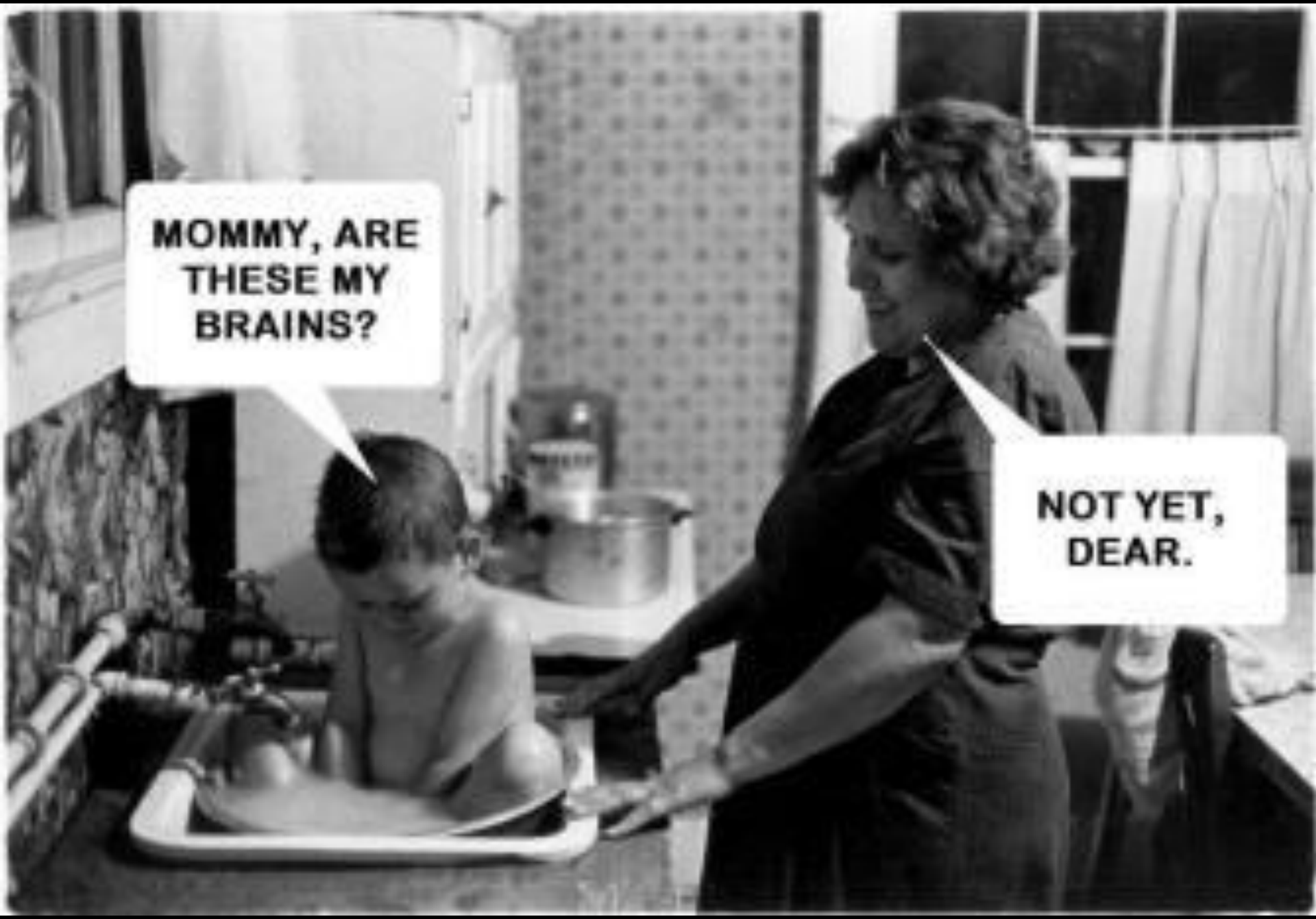
Boxes

Man's brain



Organized into boxes that do not touch or connect.

Note: There is no shopping box


MOMMY, ARE THESE MY BRAINS?
NOT YET, DEAR.

Outline of presentation (first part)

- Neurons and how they communicate
- Organization of the brain and nervous system
- How messages get to their targets and how information is relayed back.
- Brief mention of the Autonomic Nervous System
- How the brain is protected.
- Circulation of blood and CSF in the brain.

The real thing!

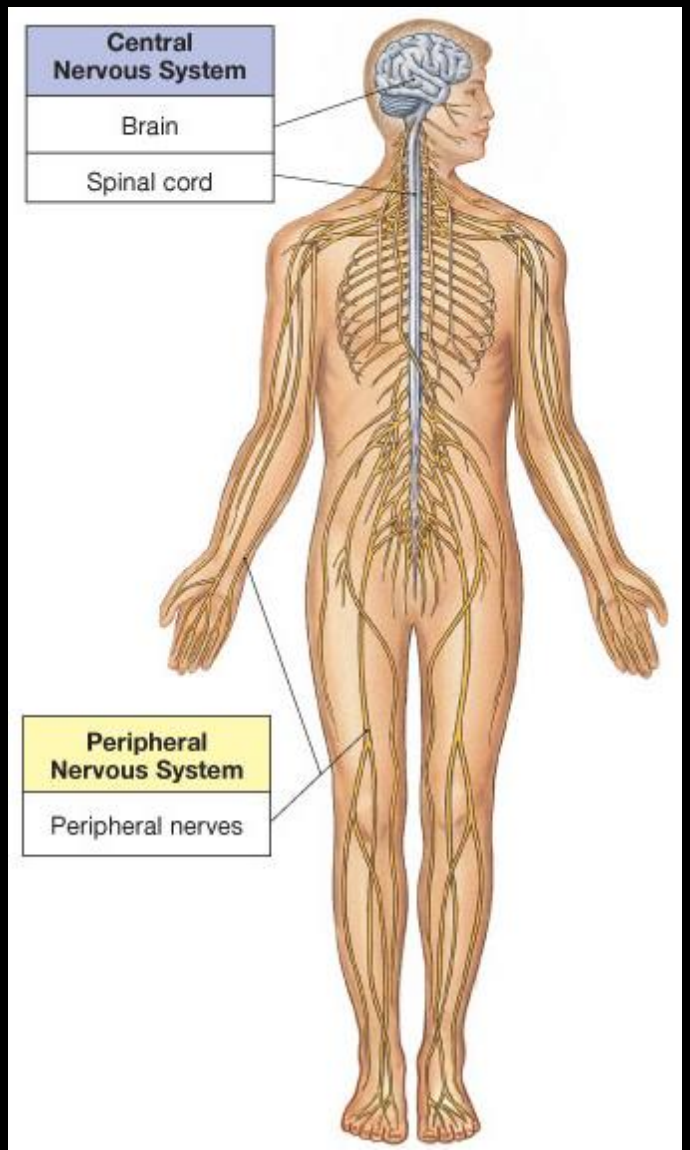
The brain

The nerve cells (neurons)

Would you believe 86-100 billion!

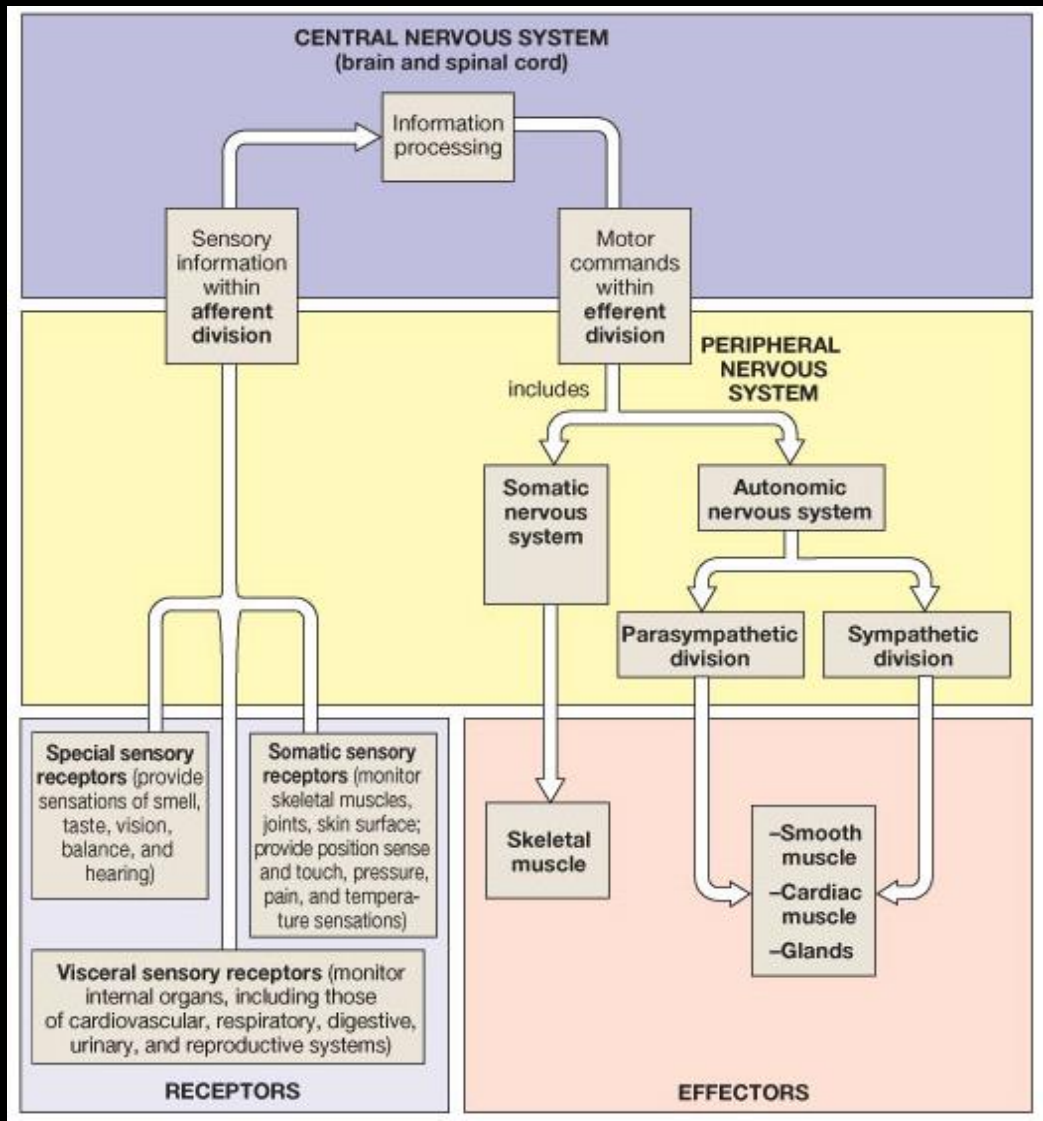
The Nervous System

- The nervous system includes all the neural tissue in the body.

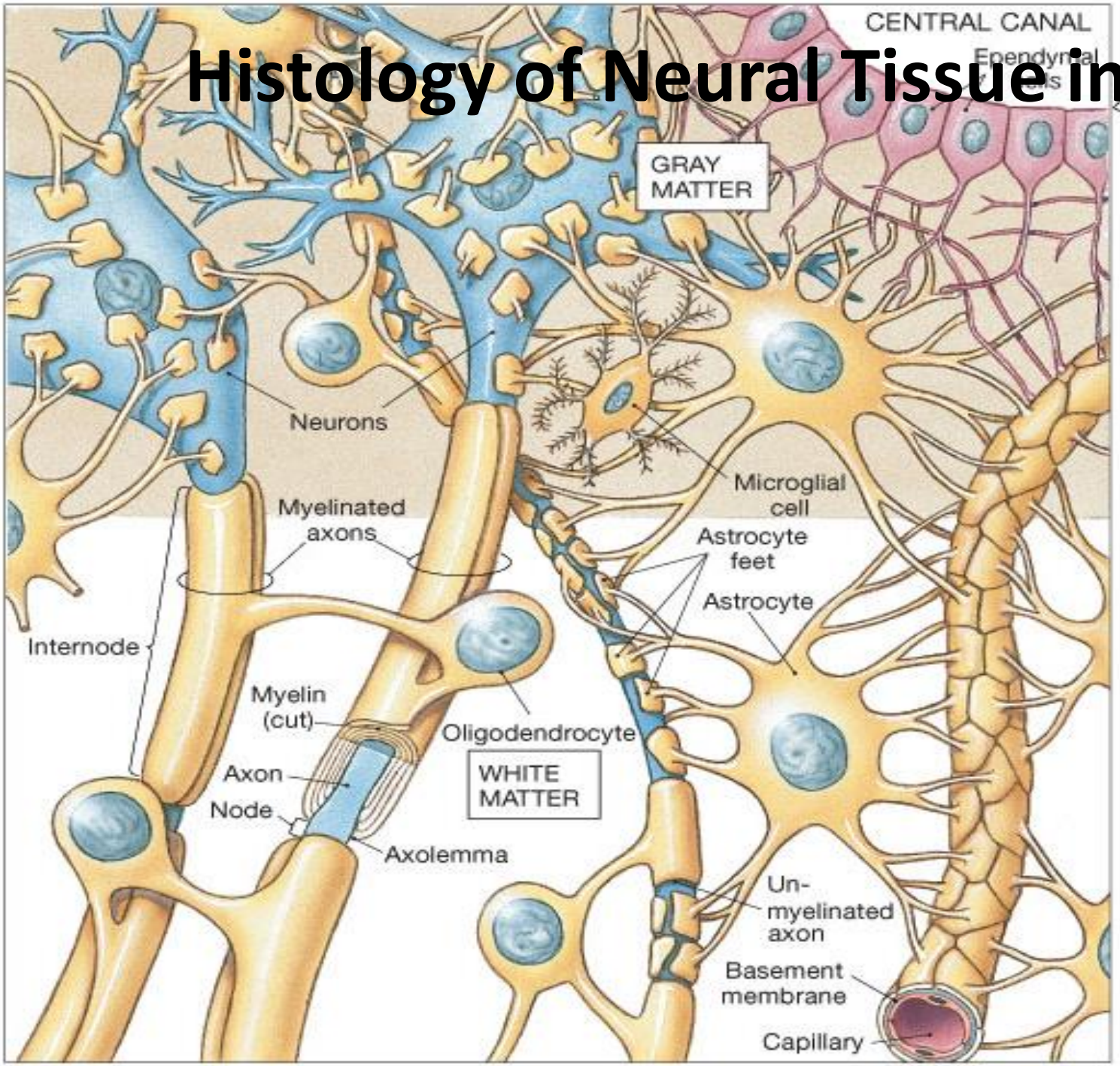


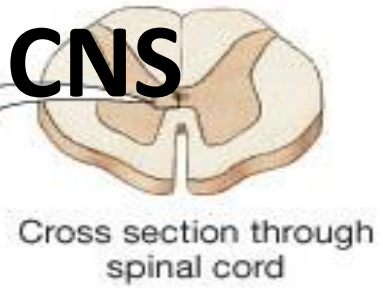
A Functional Overview of the Nervous System

- This diagram shows the relationship between the CNS and the PNS and the functions and components of the afferent and efferent divisions.



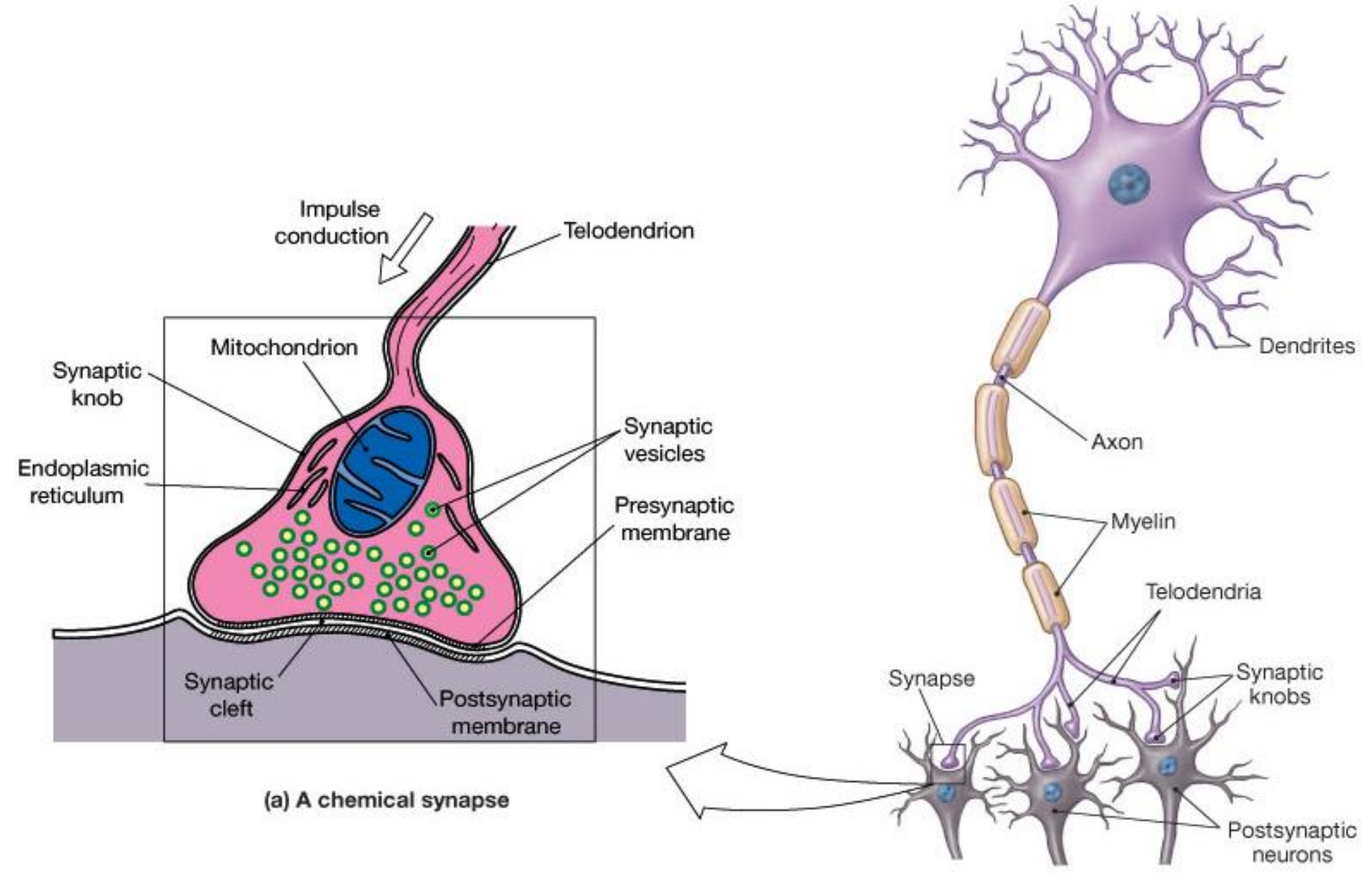
Histology of Neural Tissue in CNS





Cross section through spinal cord

The Structure of a Synapse



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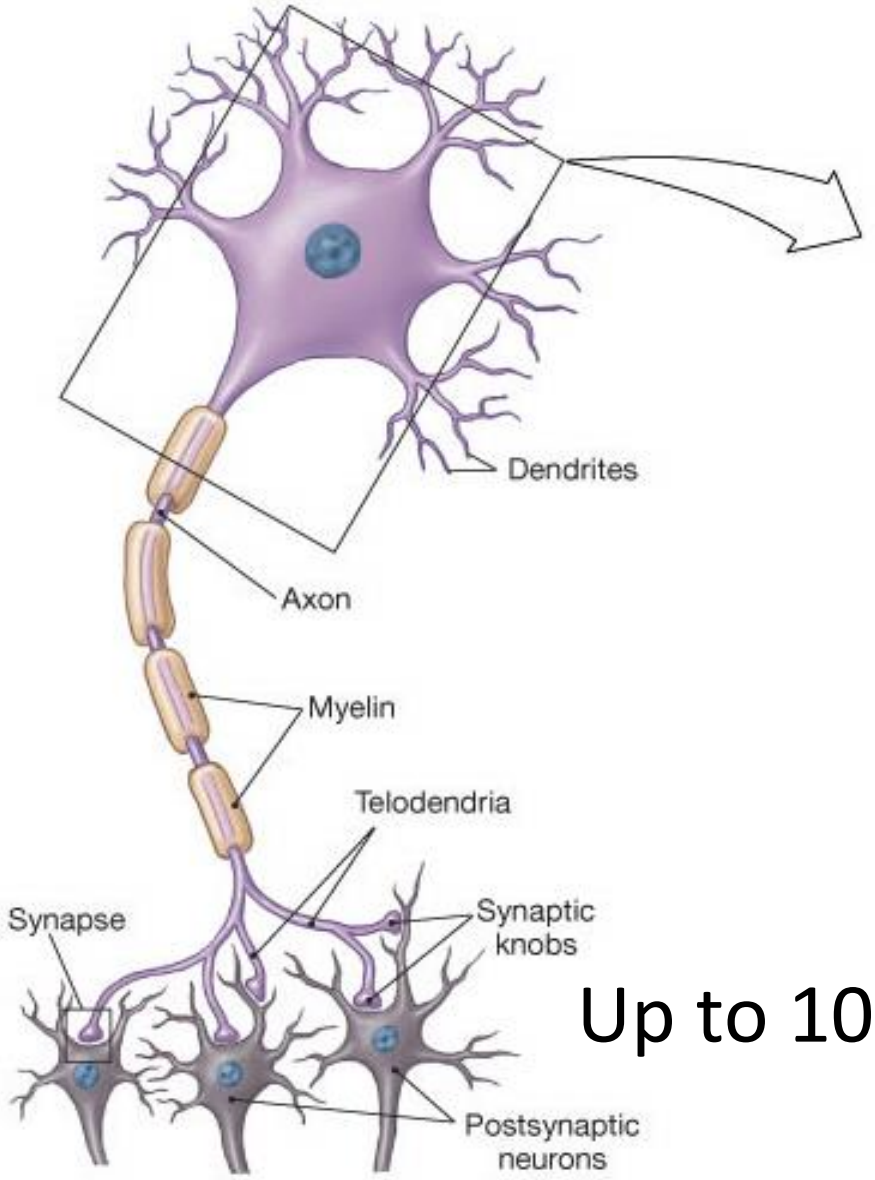
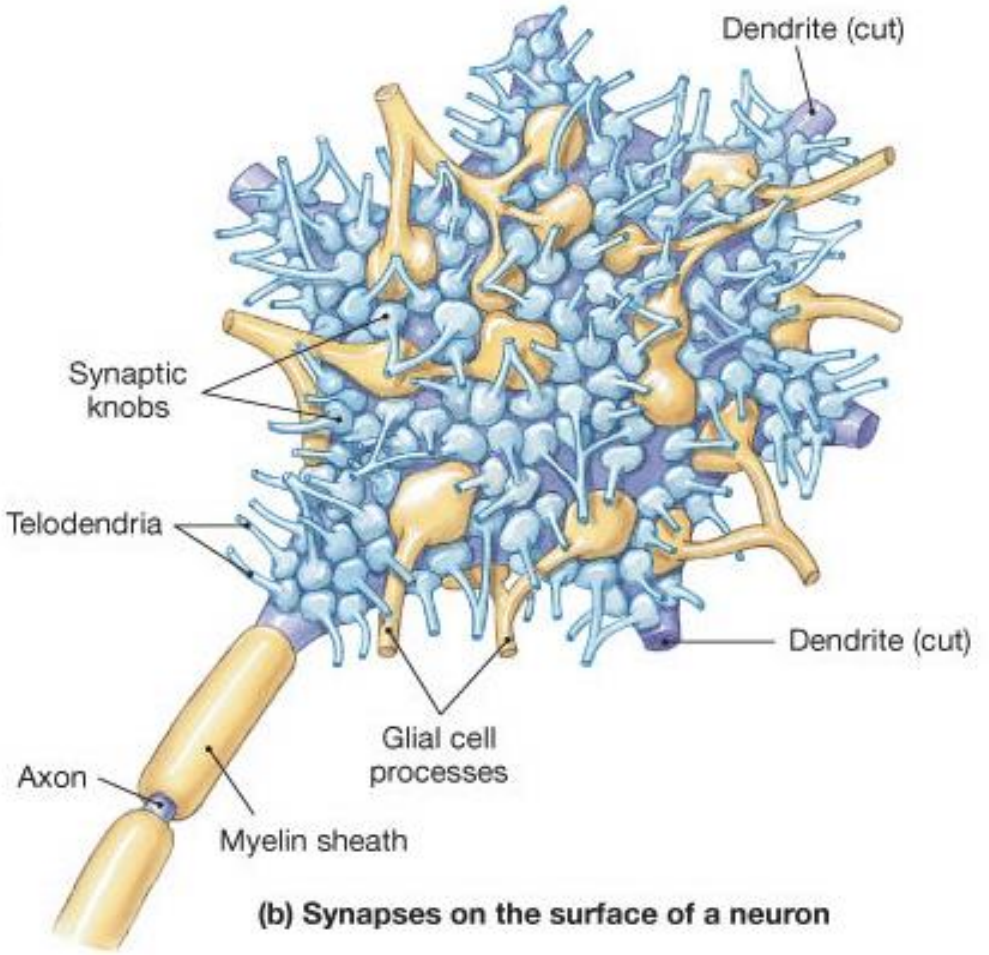


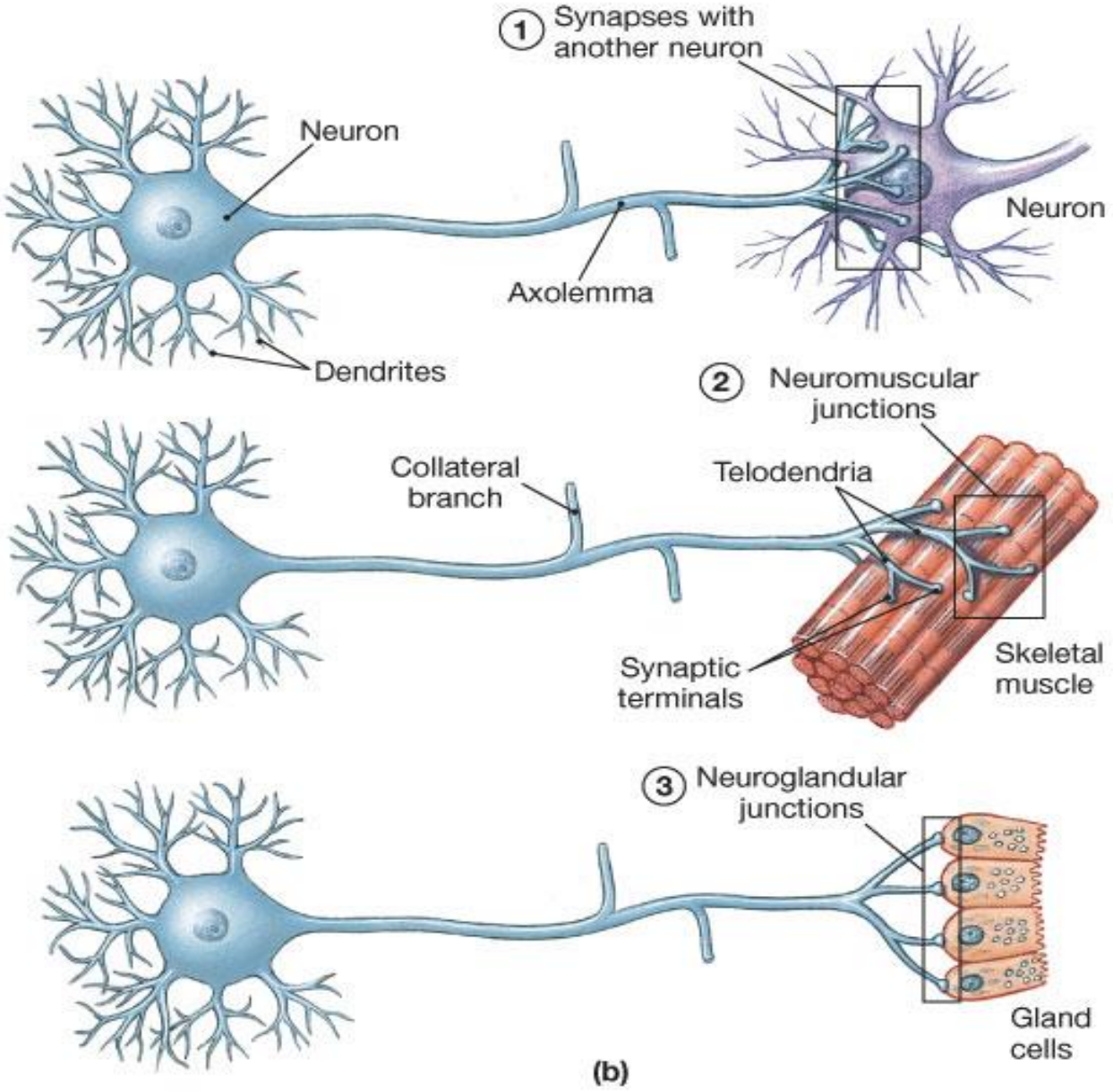


Up to 1000 connections!

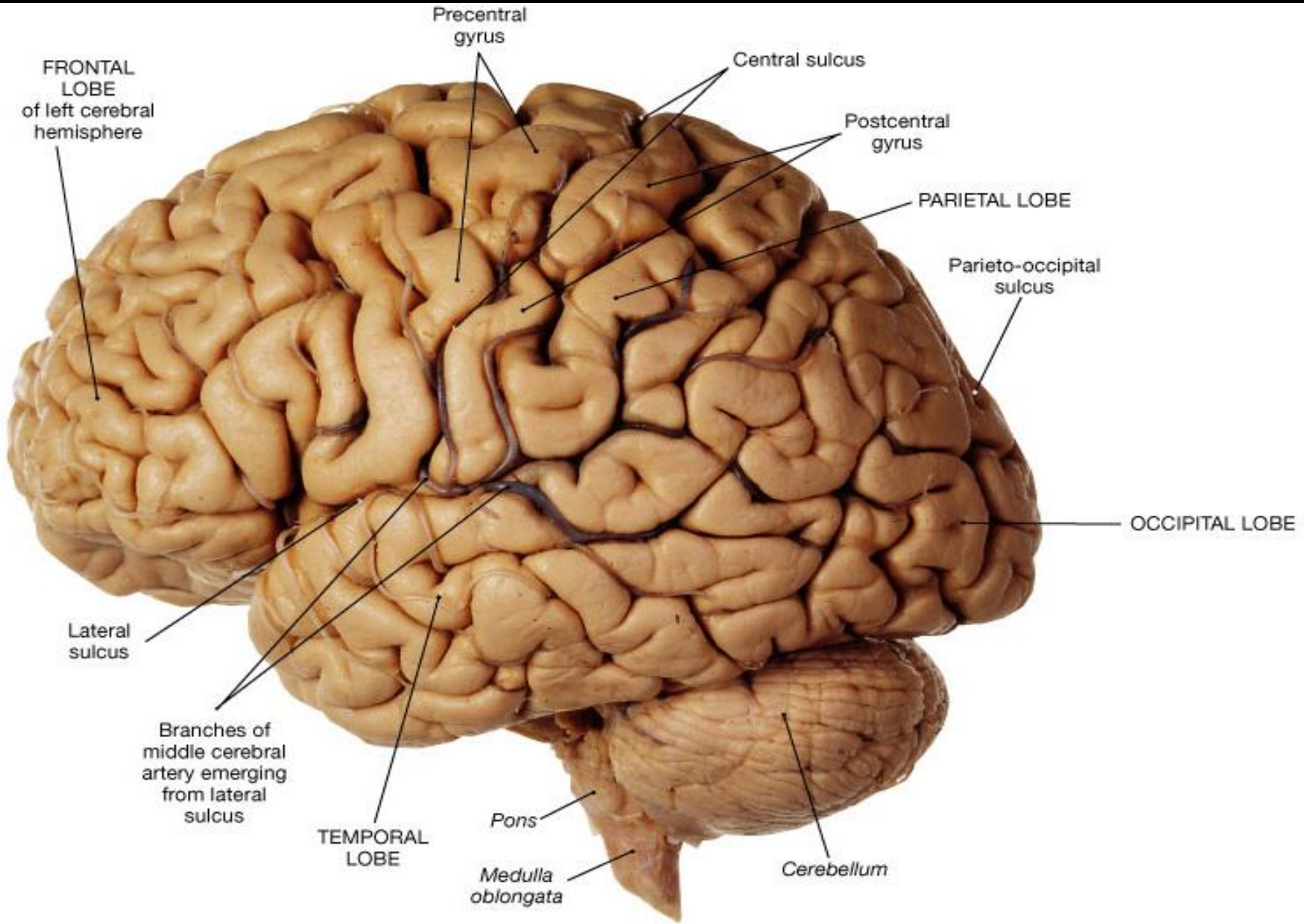
How neurons communicate

- https://www.youtube.com/watch?v=o9p2ou1IyC0

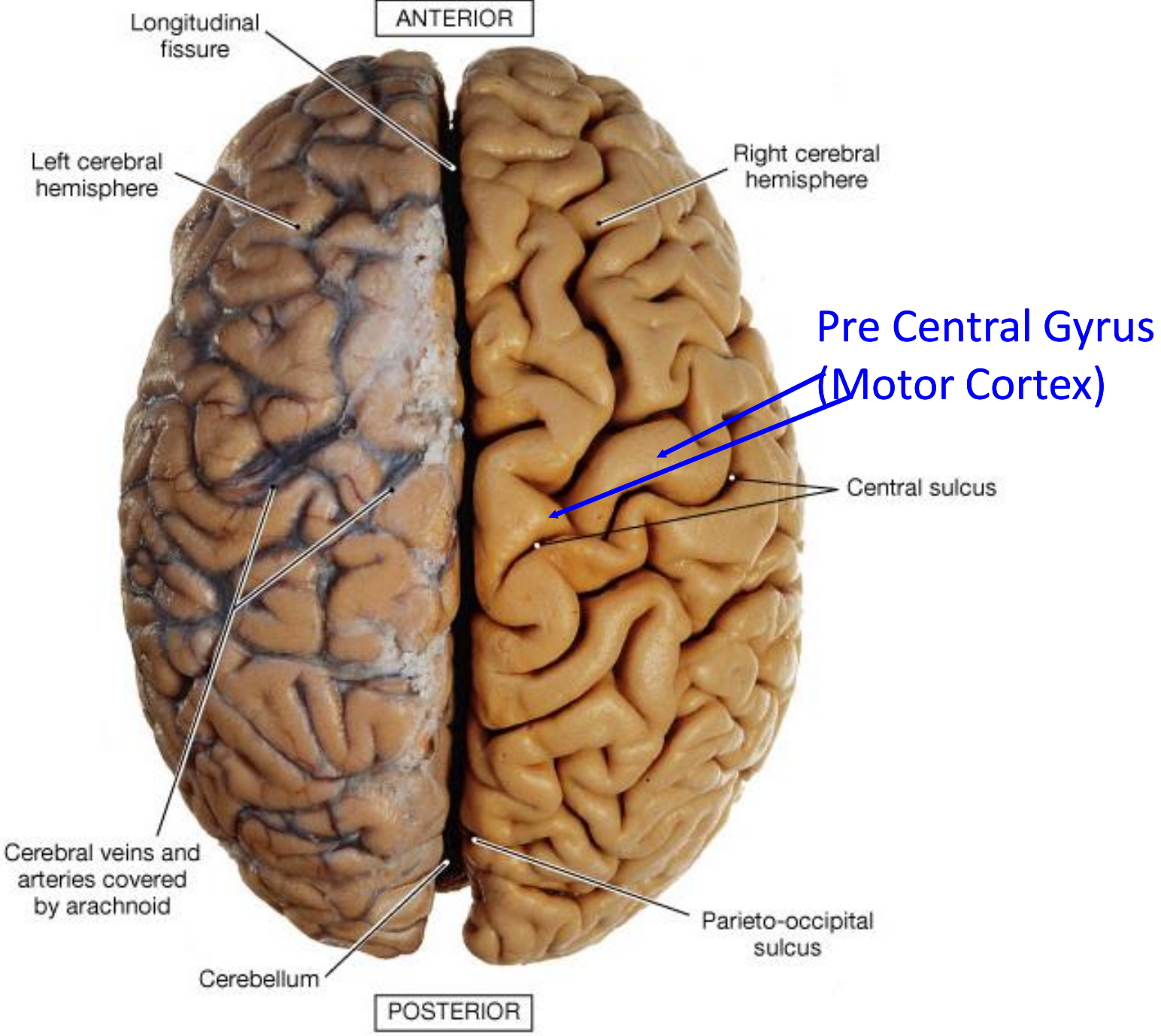
Neurons can connect with:



Cerebral hemispheres (lateral view)

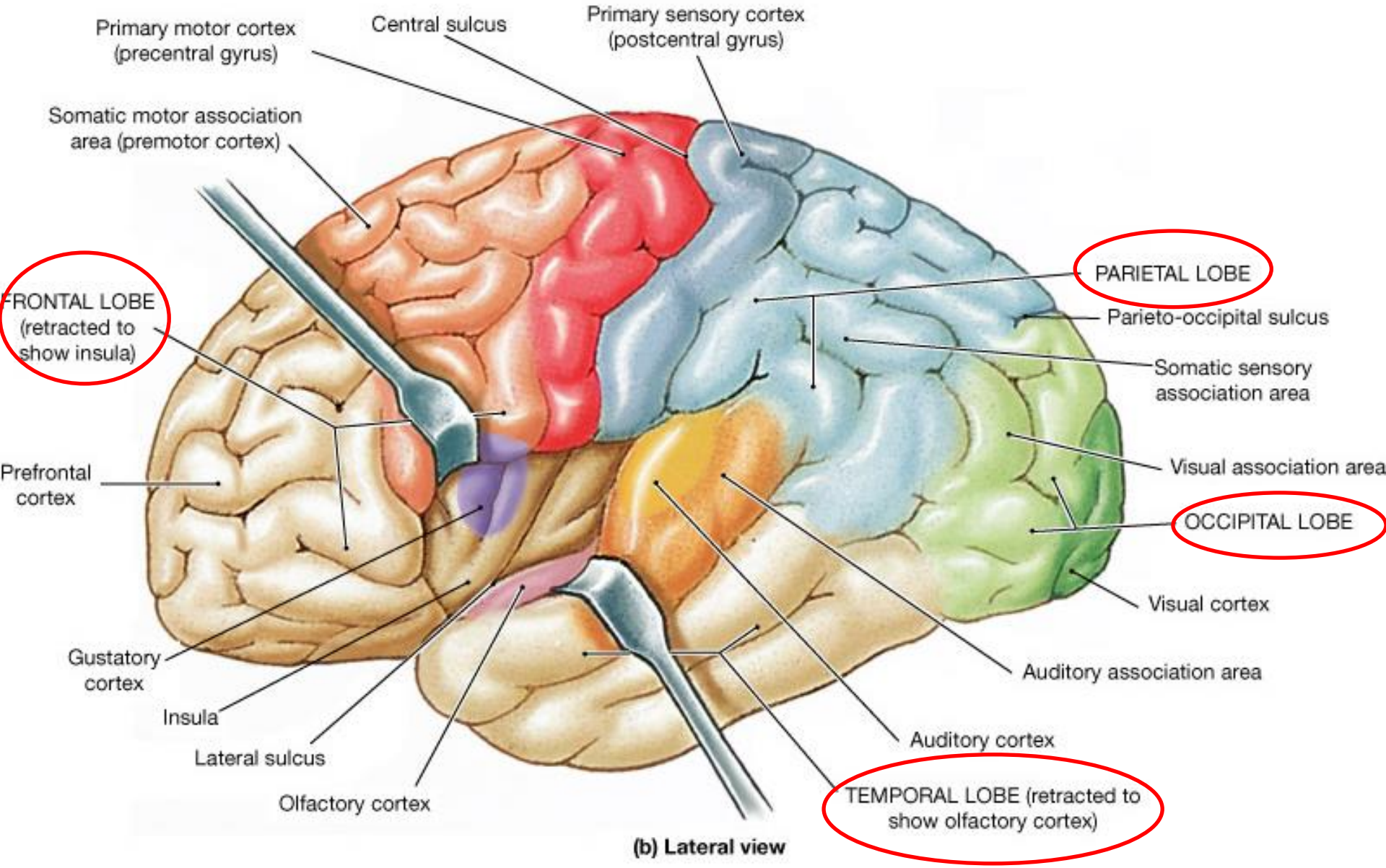


(a) Lateral view



(a) Superior view

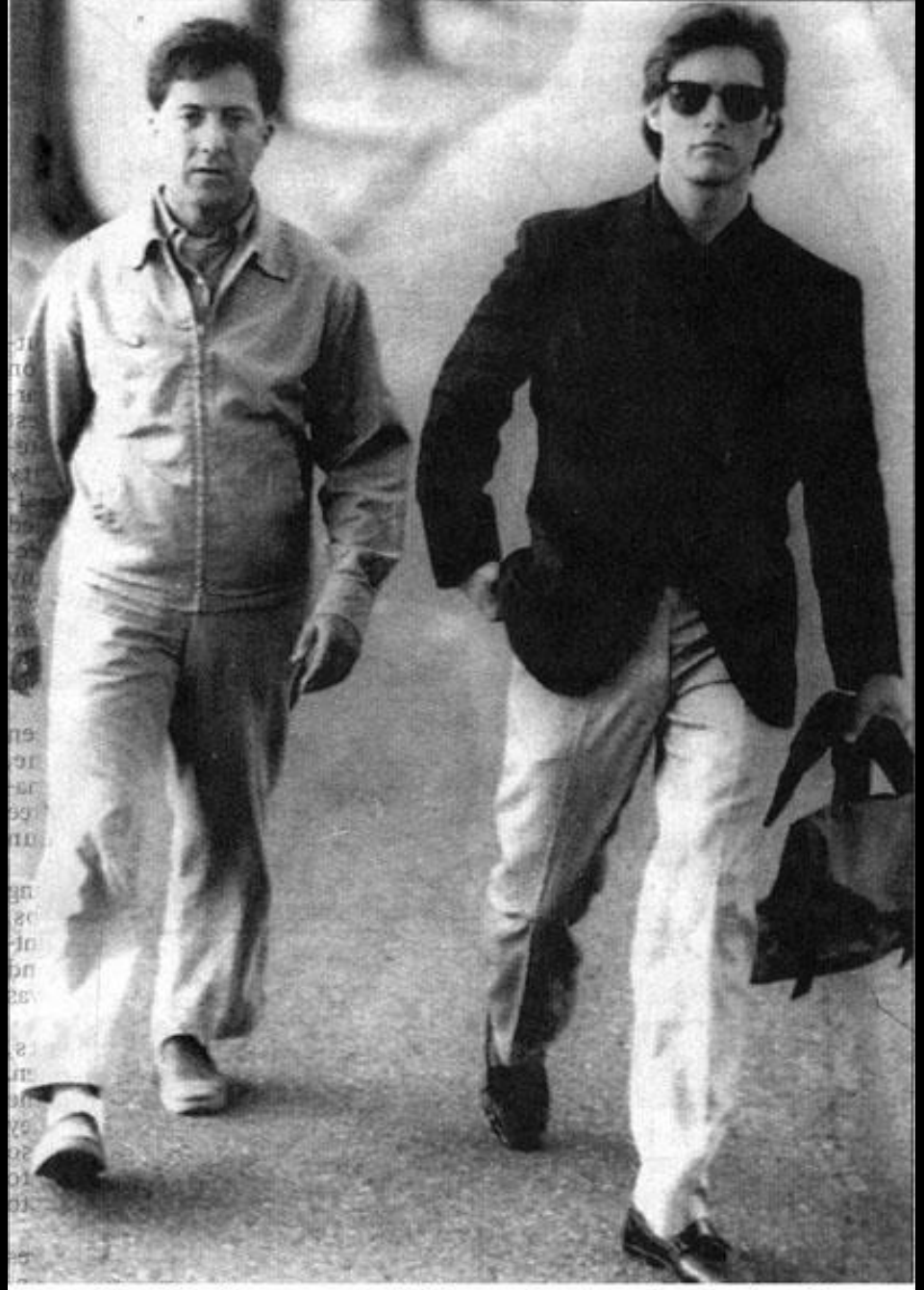
anatomical and functional landmarks



A Megasavant

Diagnostic imaging has shown Kim Peek's brain is a single hemisphere.

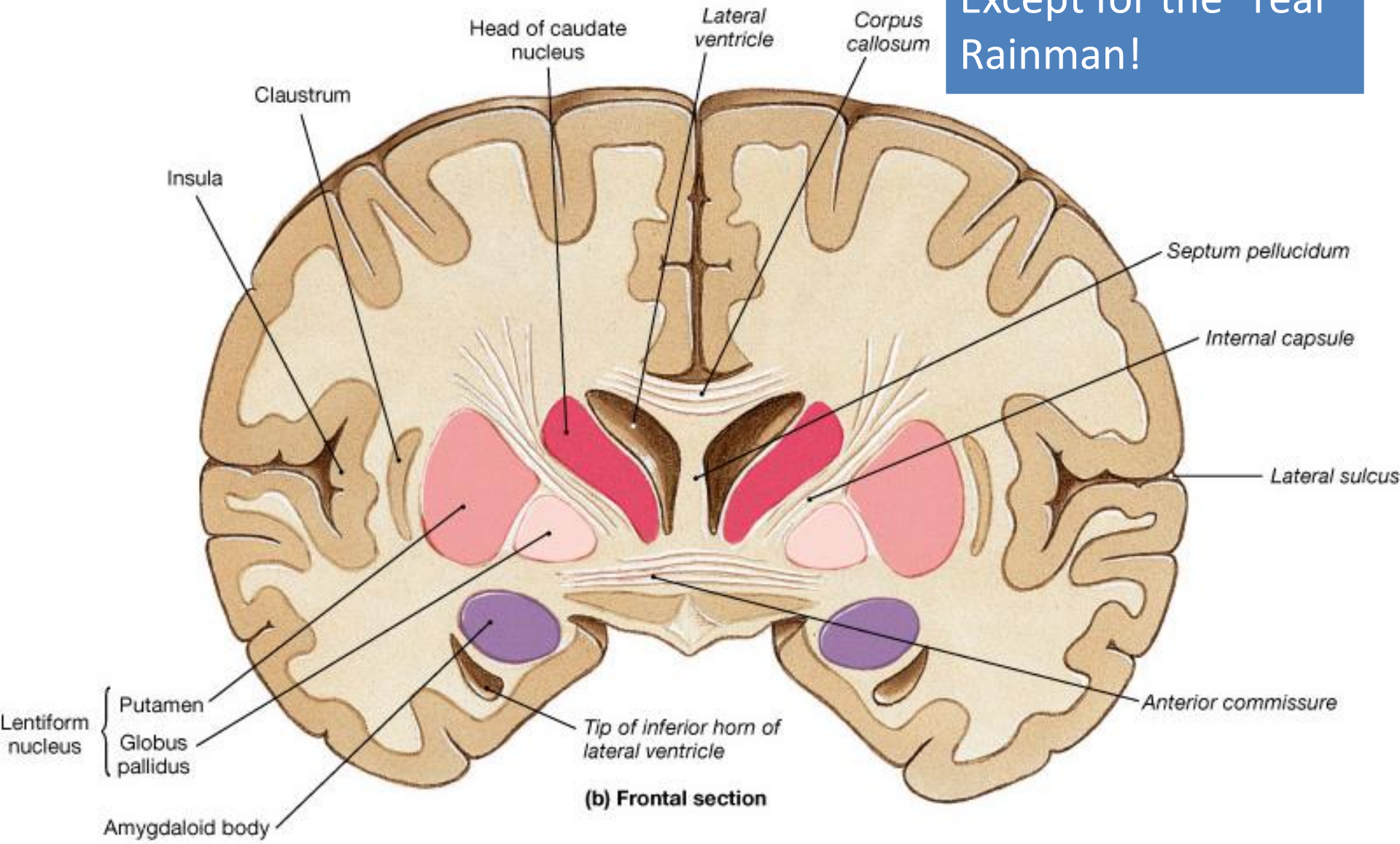
He is able to read two pages simultaneously. The left eye reads the left page and the right eye the right page in a matter of SECONDS!!!!!

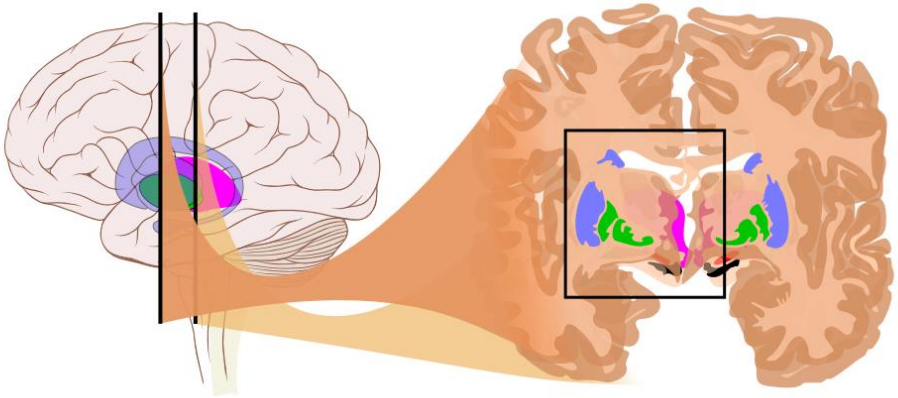


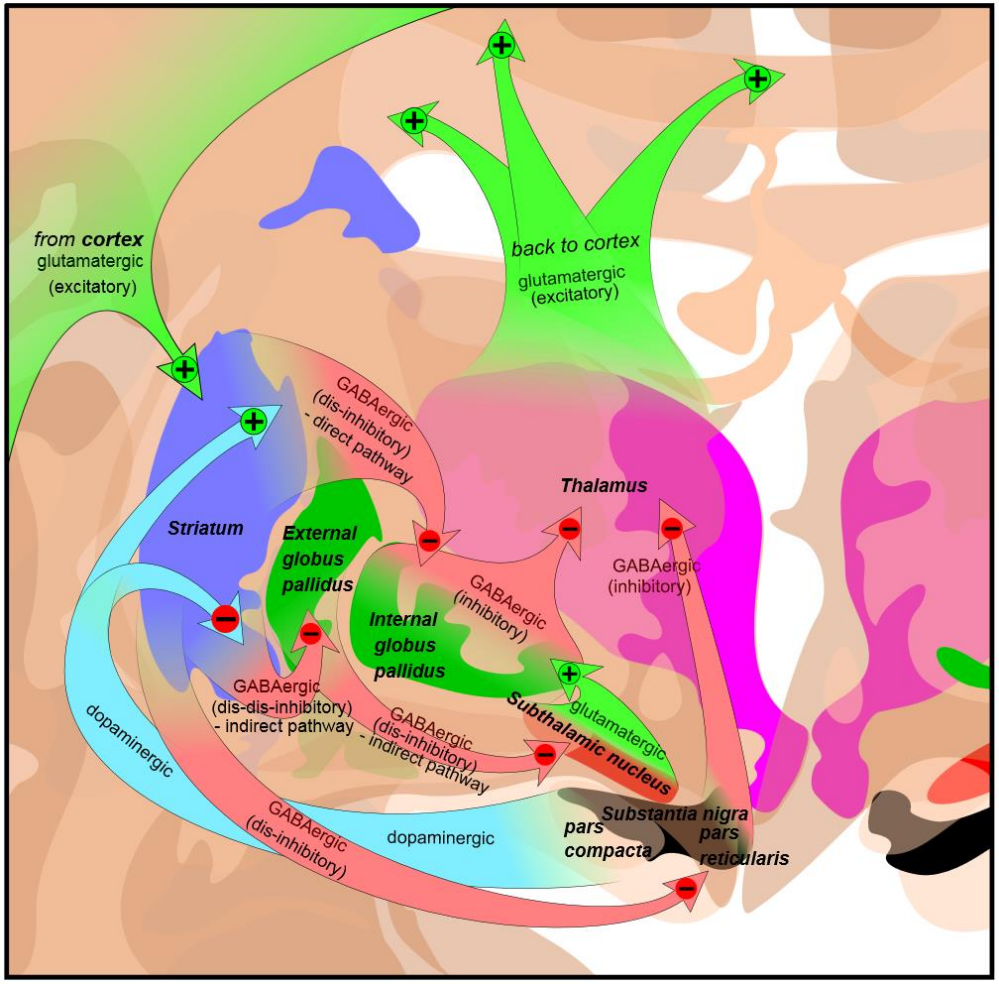
Dustin Hoffman and Tom Cruise in Rain Man, based loosely on Kim Peek's life.

Cerebral Cortex

Except for the "real" Rainman!

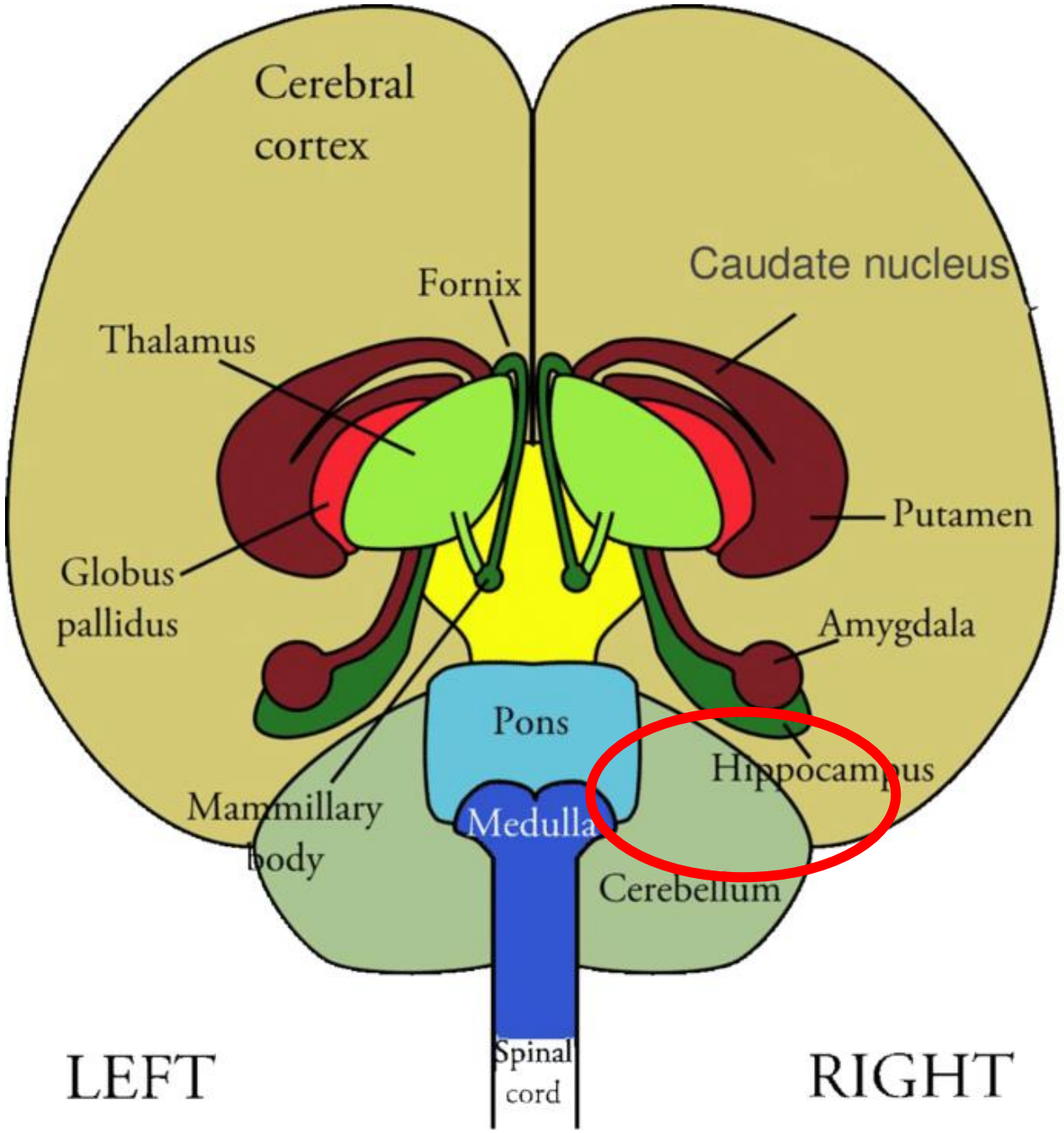


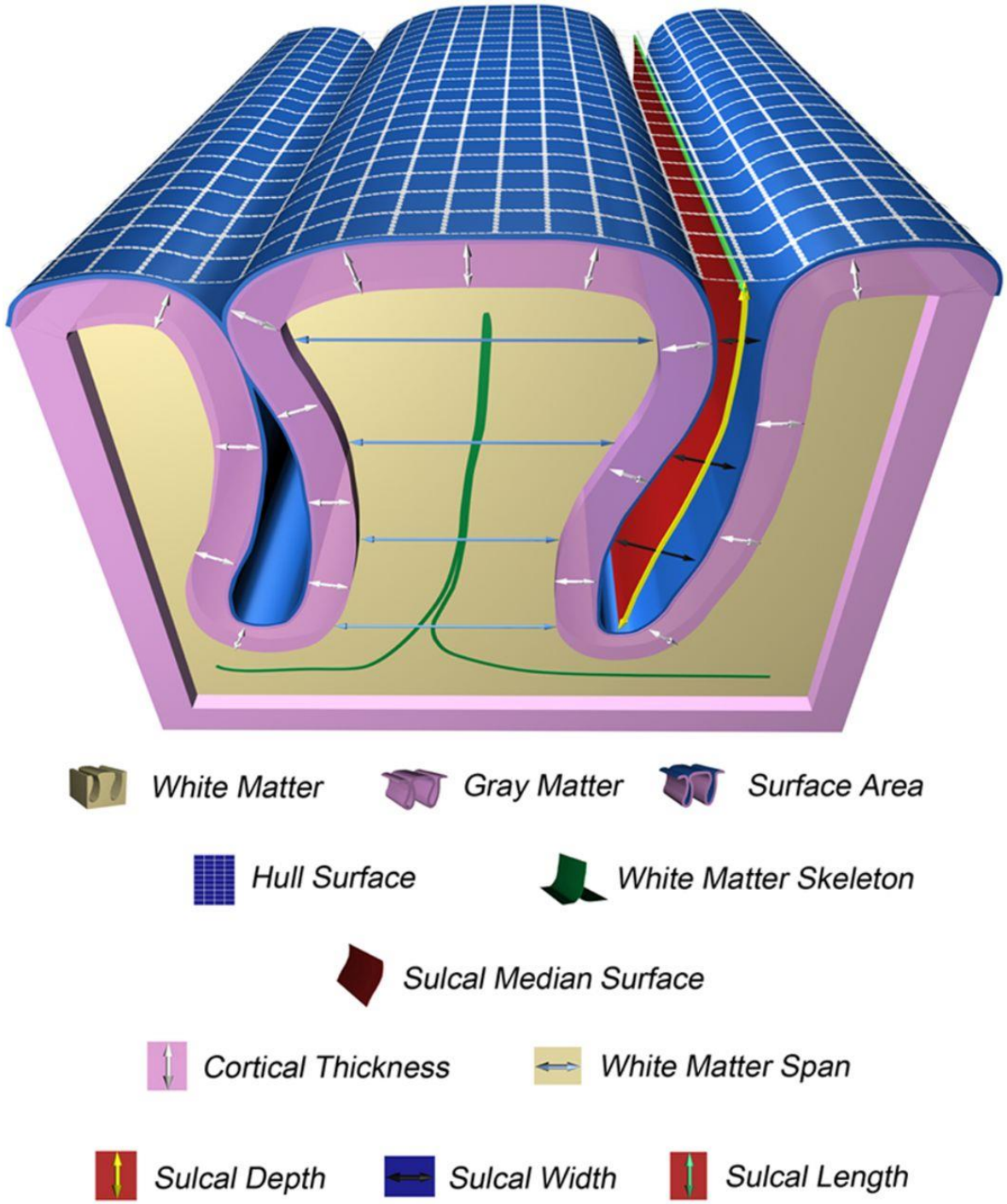




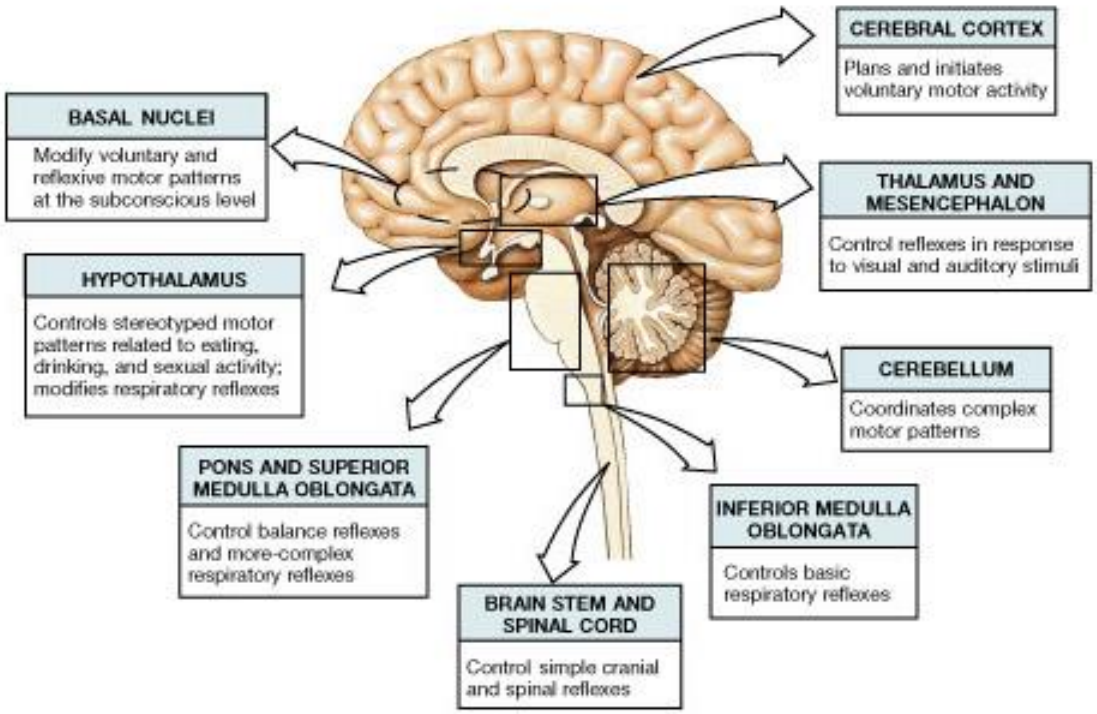
- The basal ganglia are responsible for voluntary motor control, procedural learning, and eye movement, as well as cognitive and emotional functions.

Source: Boundless. “The Role of the Basal Ganglia in Movement.” *Boundless Anatomy and Physiology*. Boundless, 12 Oct. 2016. Retrieved 09 Nov. 2016 from https://www.boundless.com/physiology/textbooks/boundless-anatomy-and-physiology-textbook/peripheral-nervous-system-13/motor-pathways-135/the-role-of-the-basal-ganglia-in-movement-724-8216/


Cerebral cortex
Fornix
Caudate nucleus
Thalamus
Putamen
Globus pallidus
Amygdala
Pons
Hippocampus
Mammillary body
Medulla
Cerebellum
Spinal cord
LEFT
RIGHT

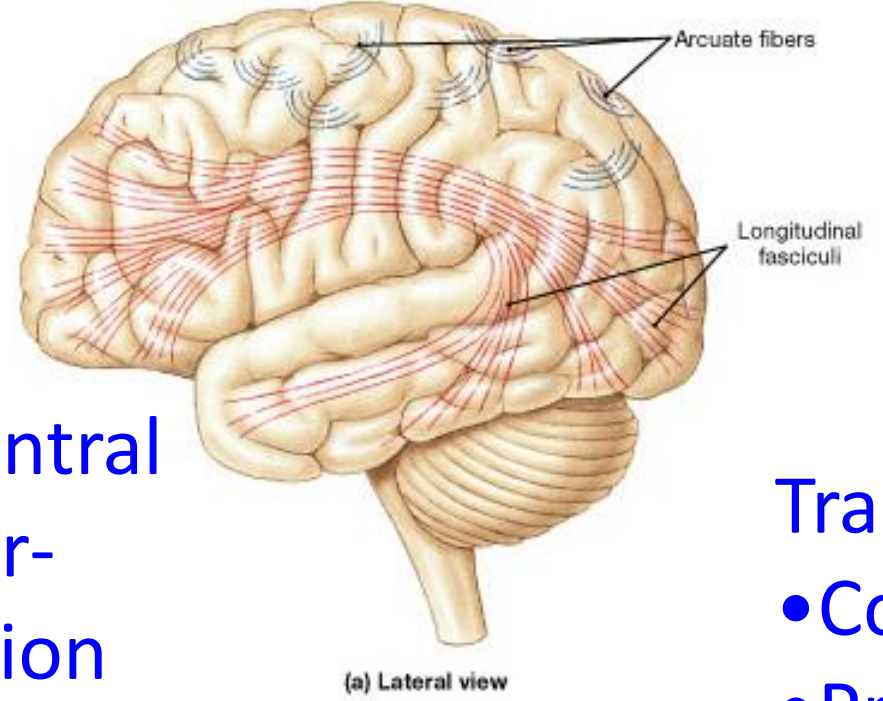

White Matter
Gray Matter
Surface Area
Hull Surface
White Matter Skeleton
Sulcal Median Surface
Cortical Thickness
White Matter Span
Sulcal Depth
Sulcal Width
Sulcal Length

Levels of somatic motor control

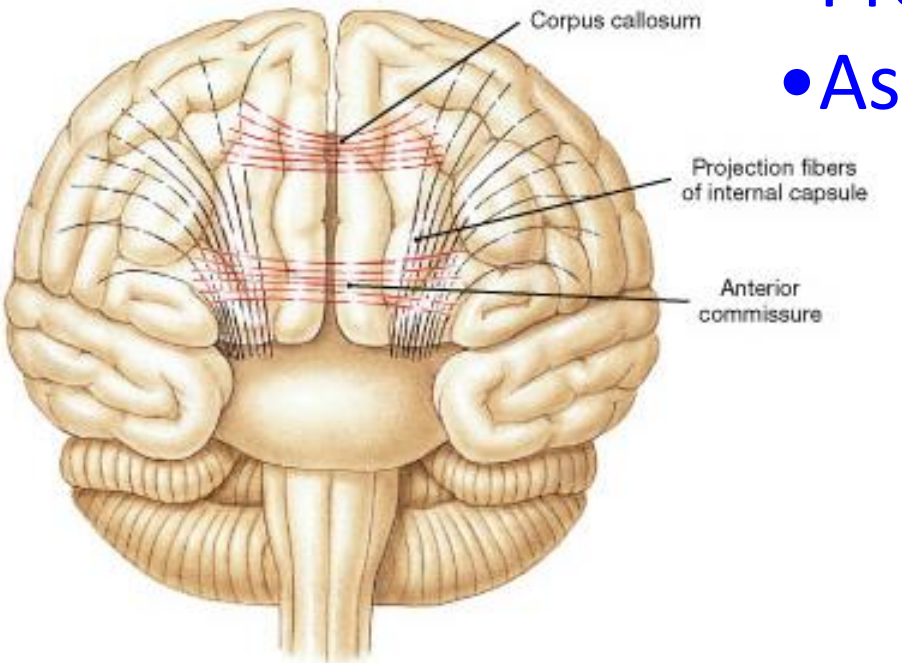


(a) Levels of somatic motor control

Fig 15.10: Central White Matter- Communication Tracts



(a) Lateral view

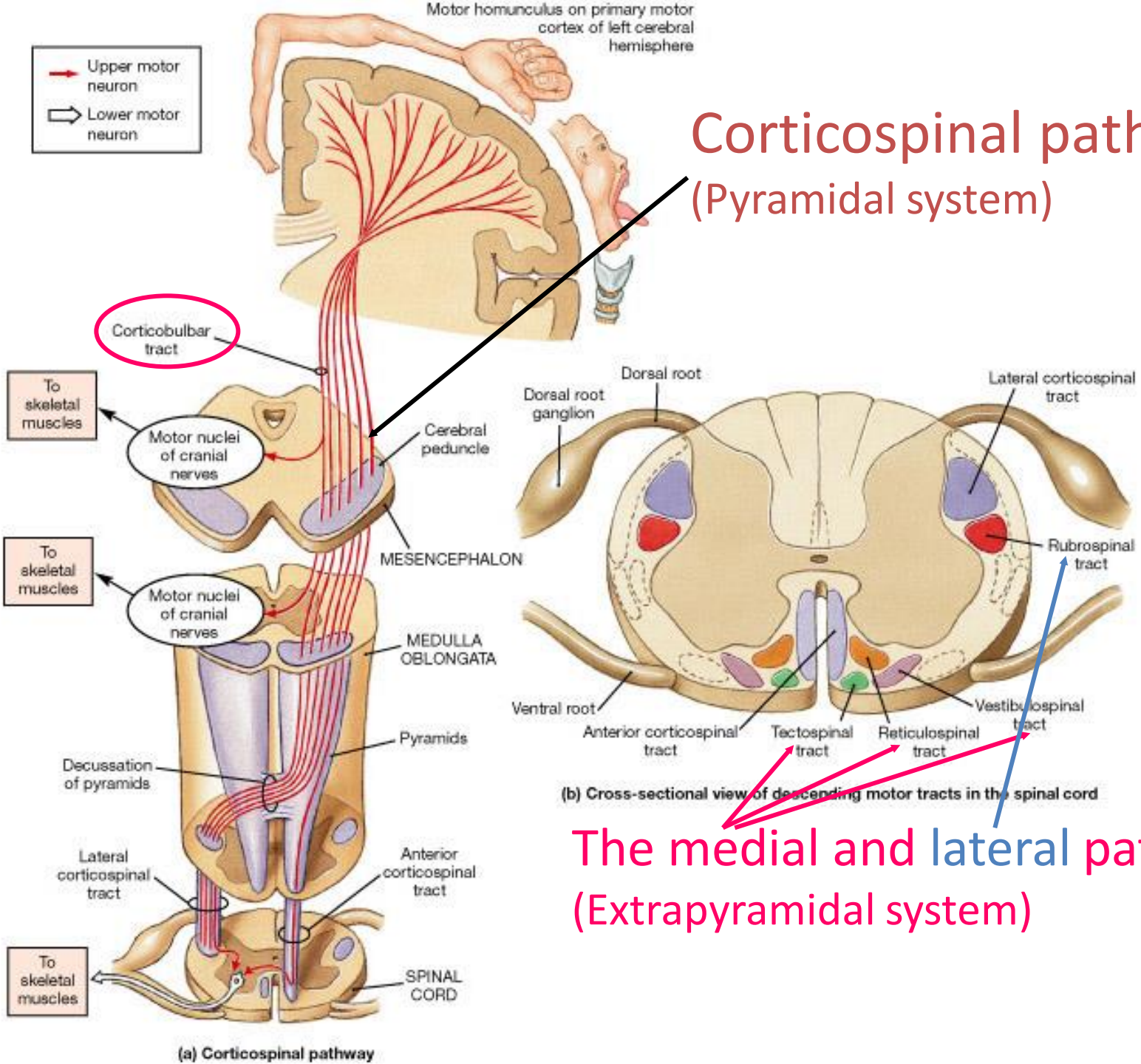


(b) Anterior view

Tracts:

- Commisural
- Projection
- Association

Corticospinal pathway
(Pyramidal system)



The medial and lateral pathways
(Extrapyramidal system)

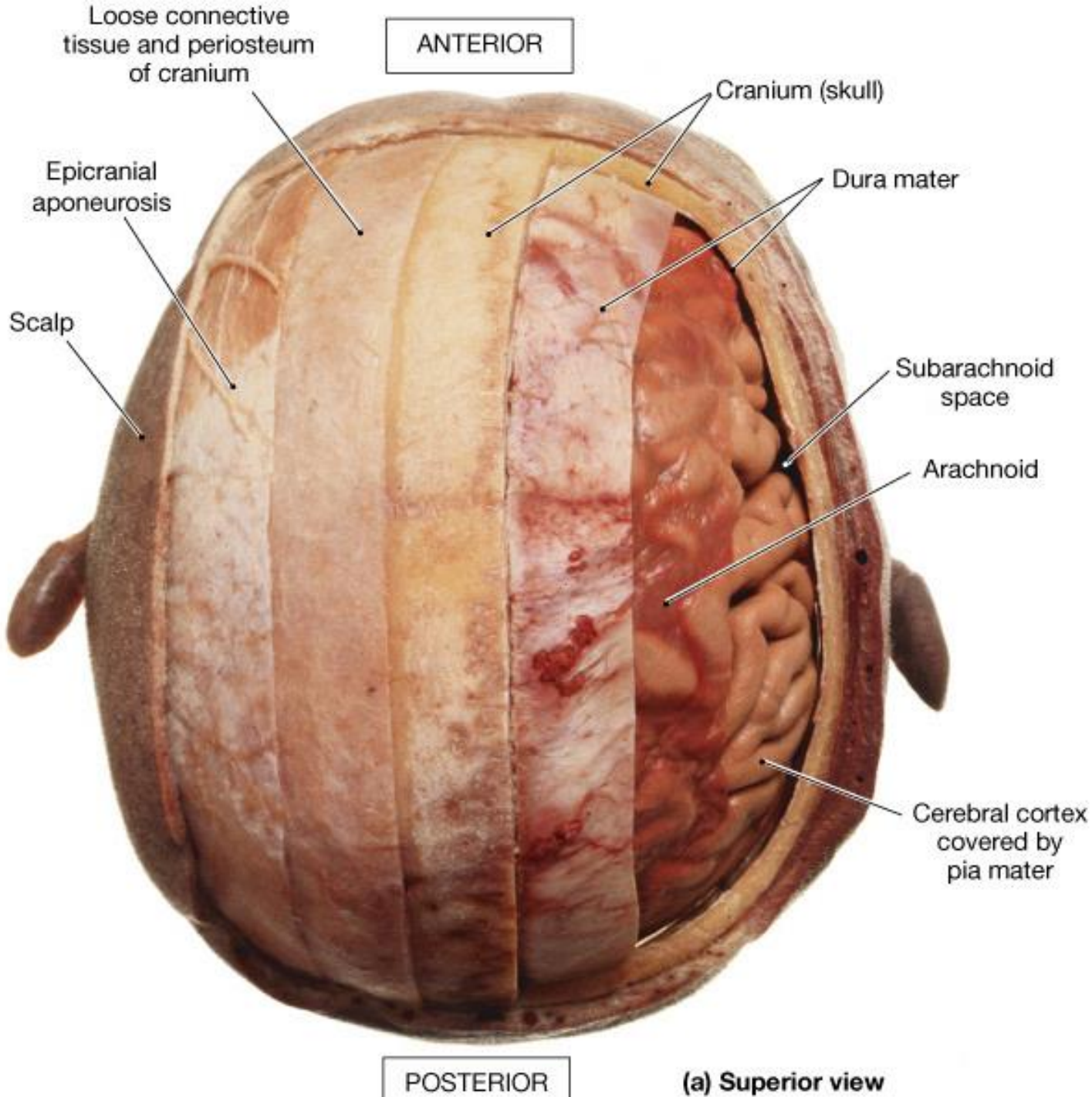
Homunculus

Protection of the brain

Bone (Skull)

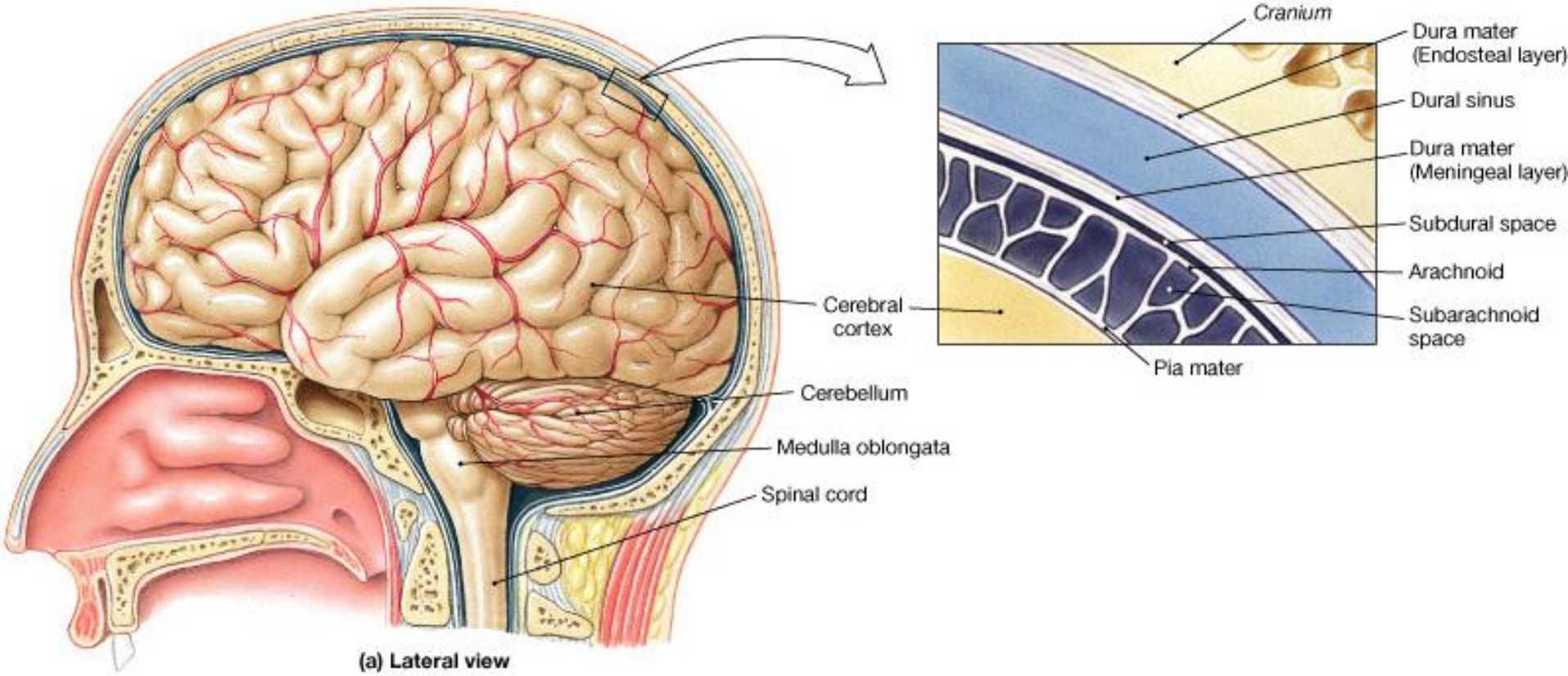
Connective tissue (meninges)

Fluid (CSF)

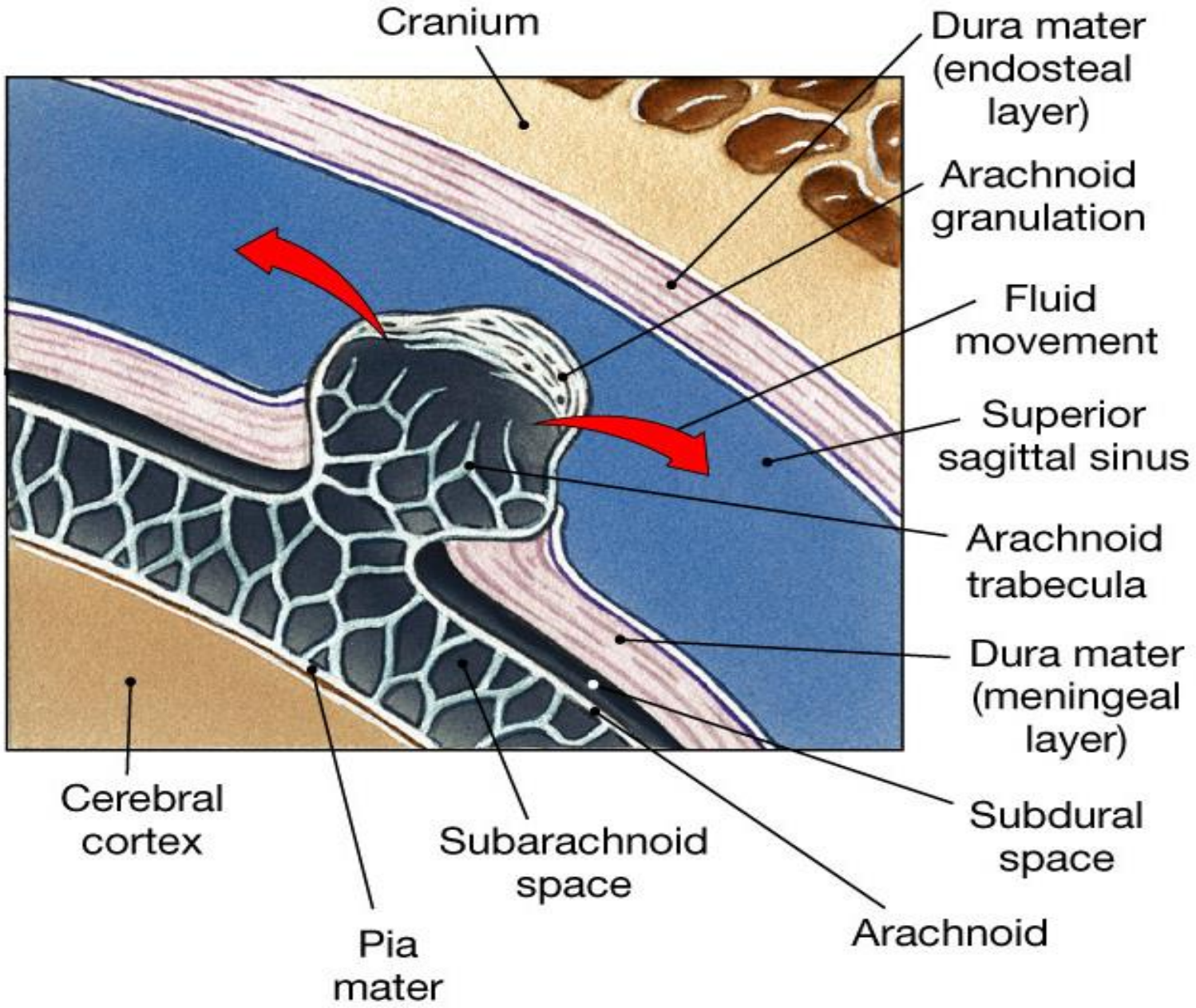


(a) Superior view

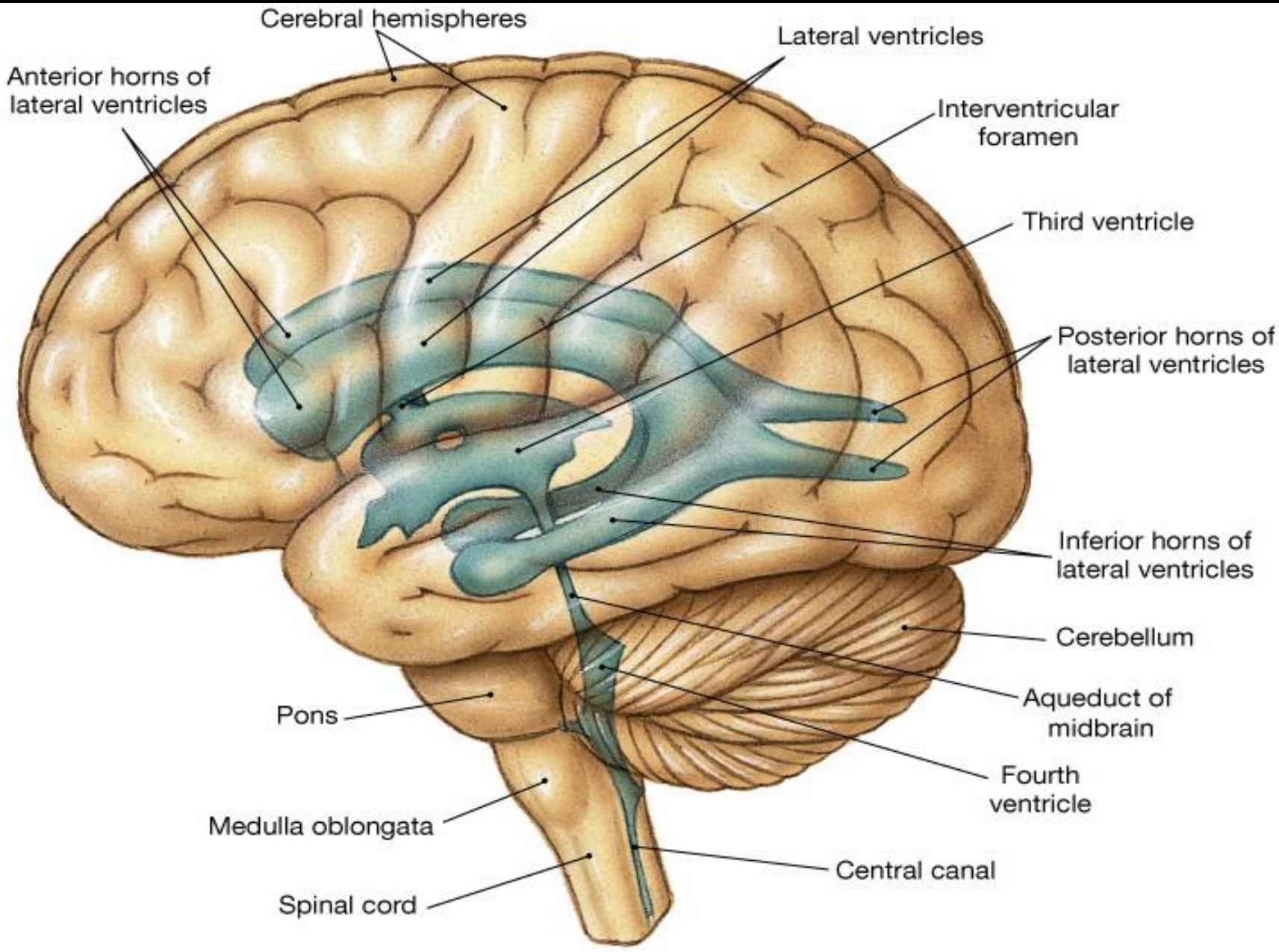
Brain, cranium & meninges



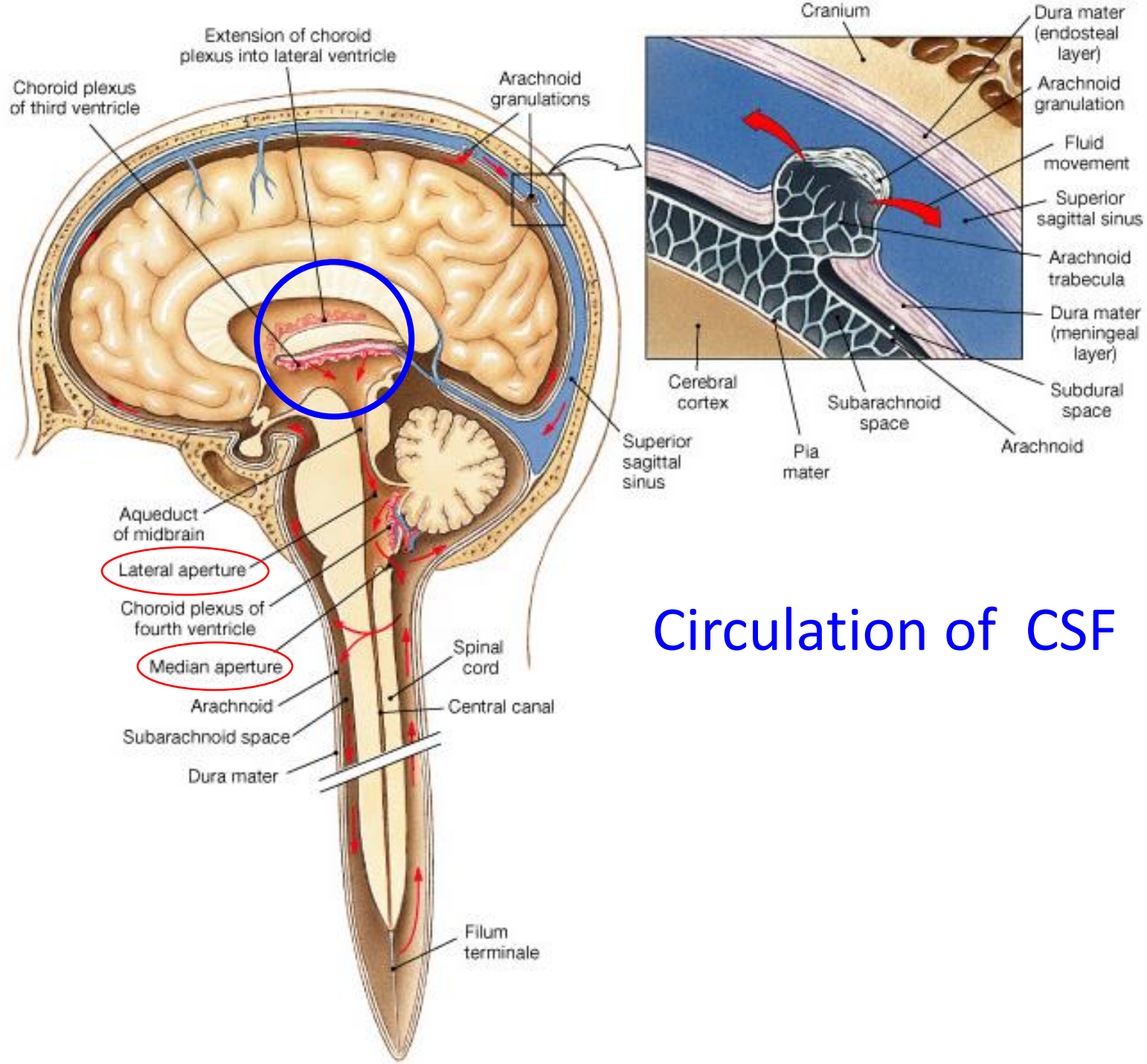
Arachnoid granulation & CSF



Ventricles of the brain



(a) Lateral view



Circulation of CSF

Hydrocephalus

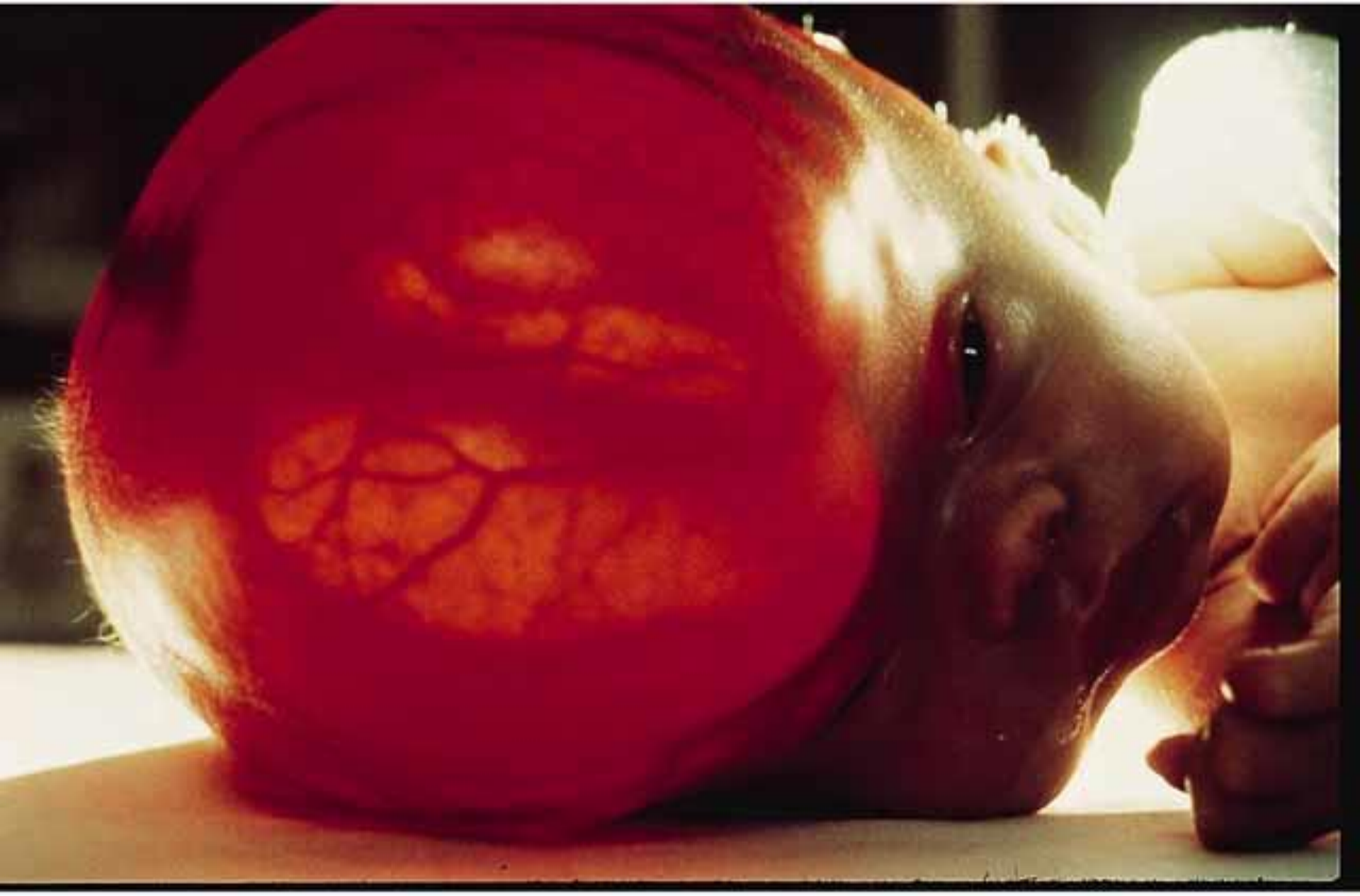
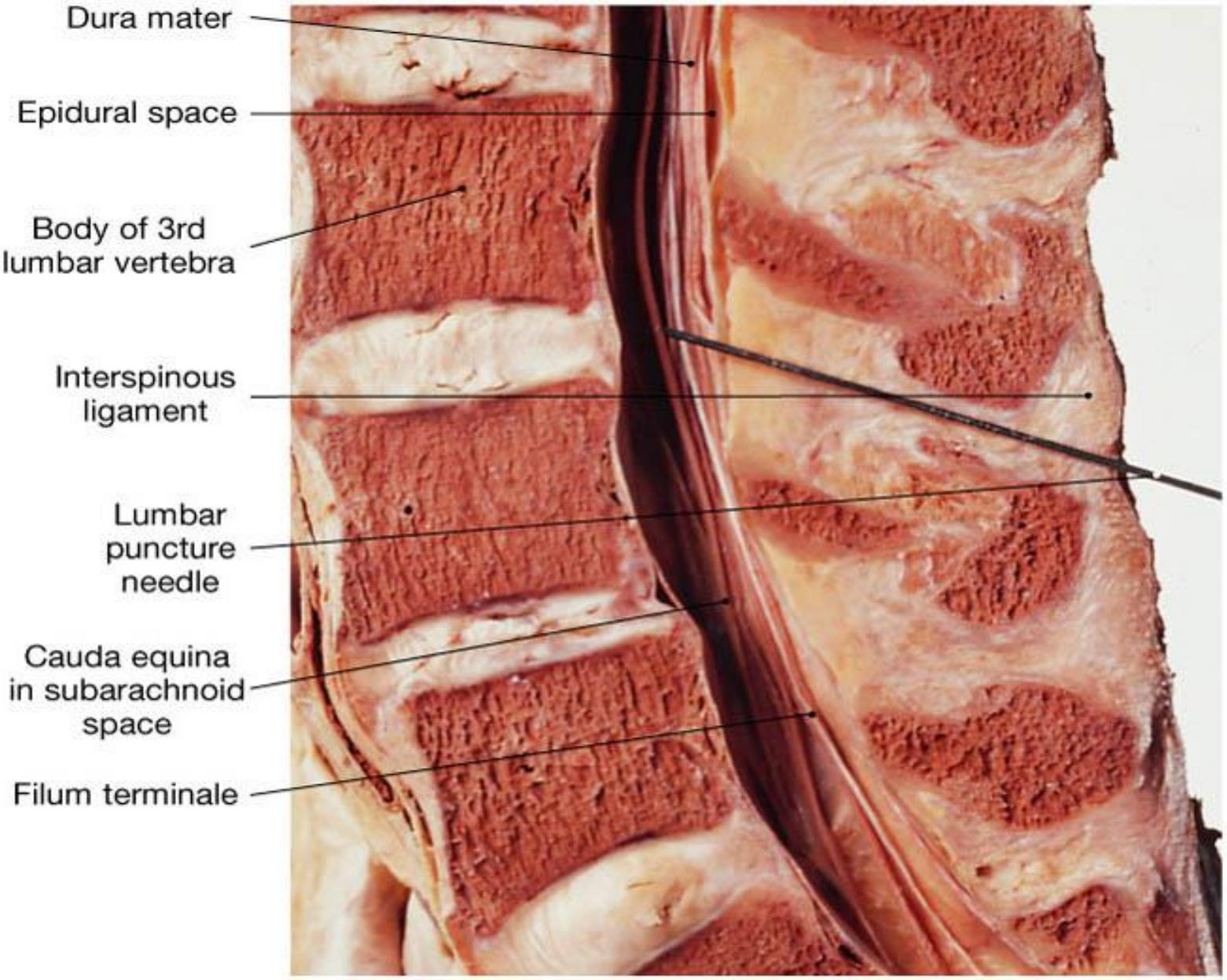
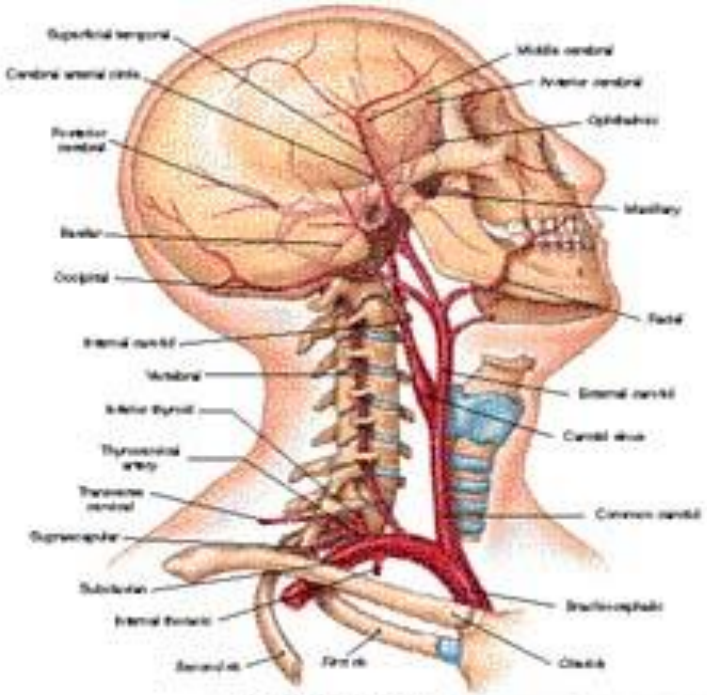


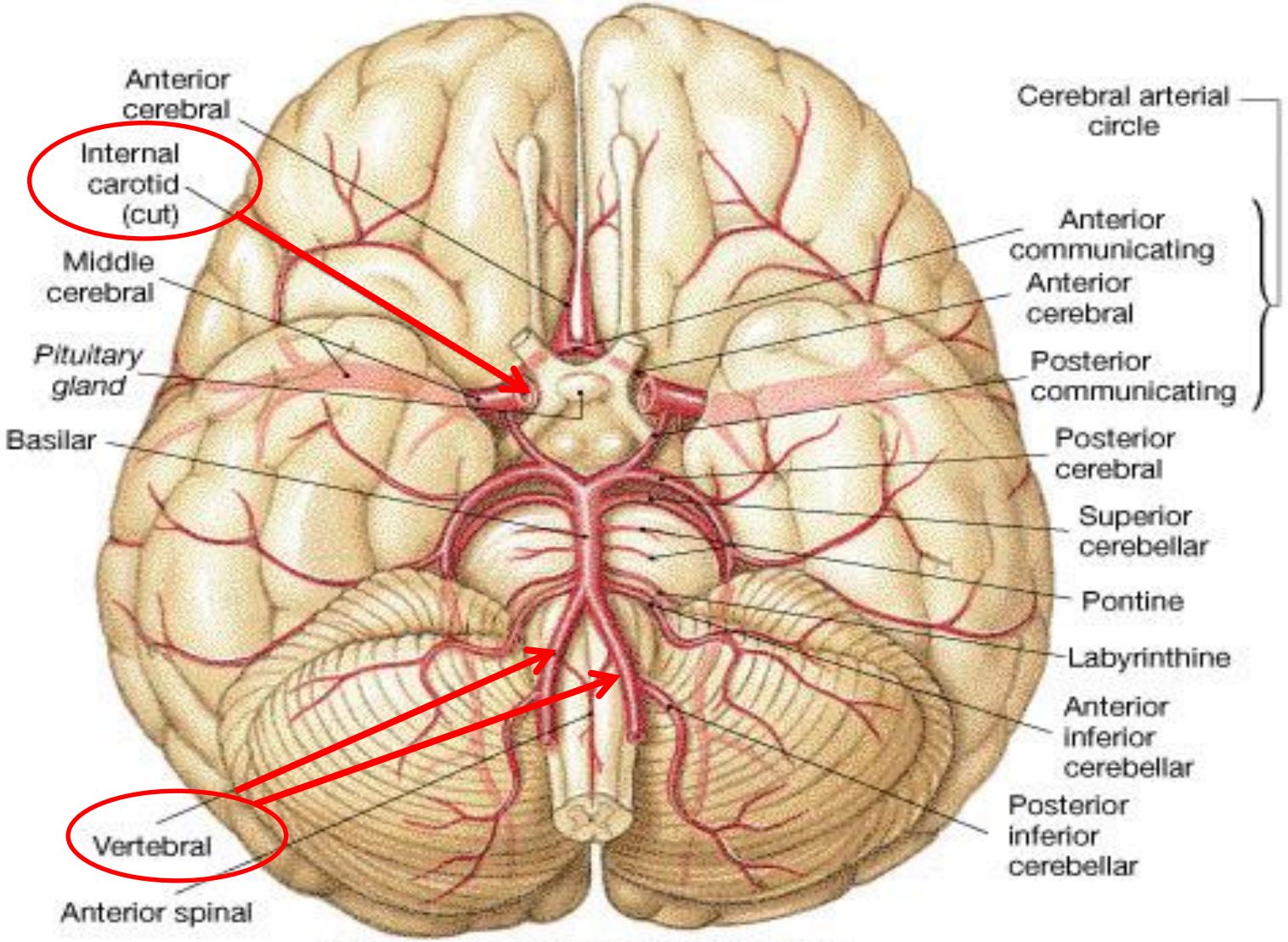
Fig 14.4 Lumbar Puncture (Spinal tap)



Blood flow to the brain

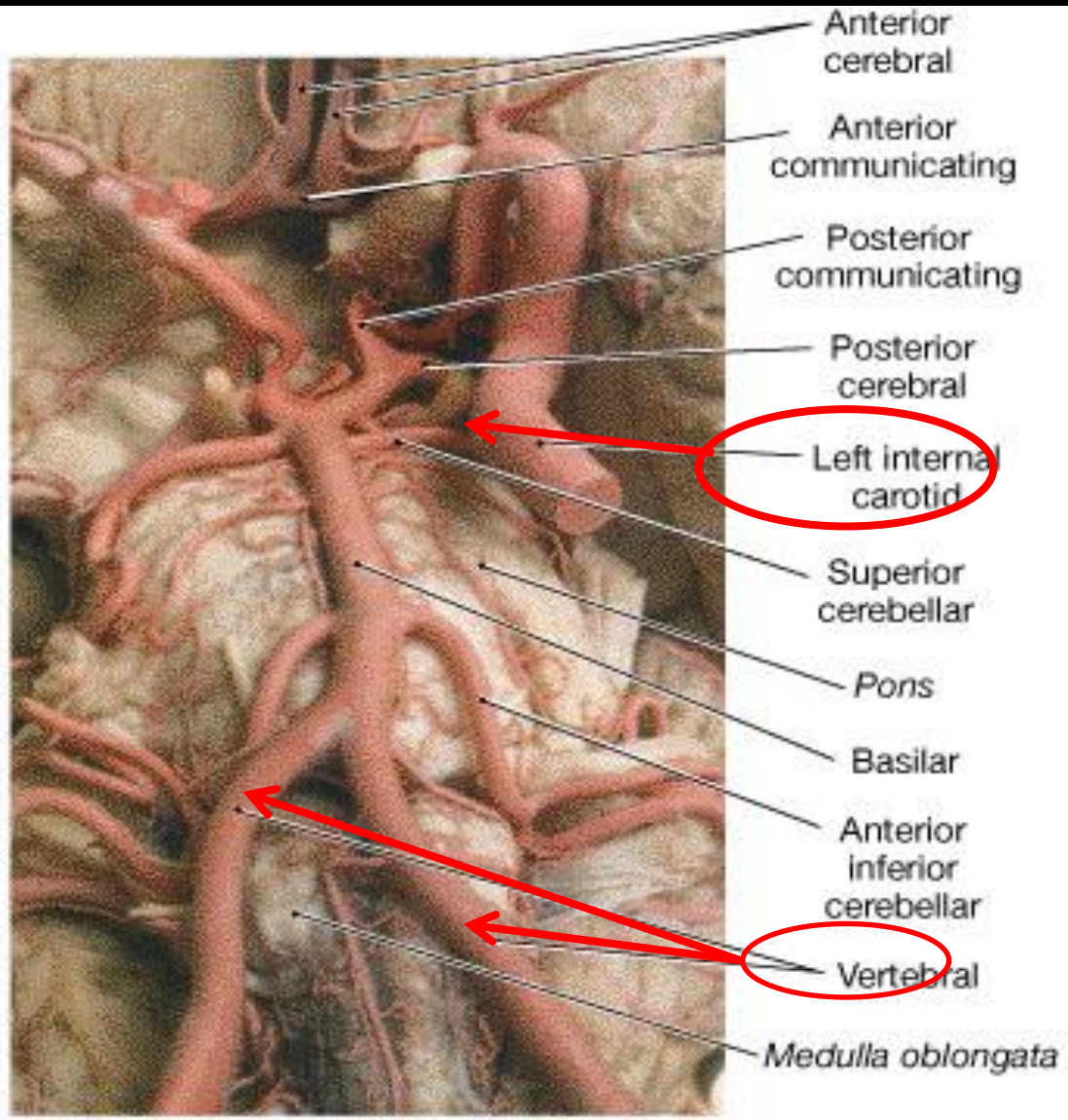


The Circle of Willis



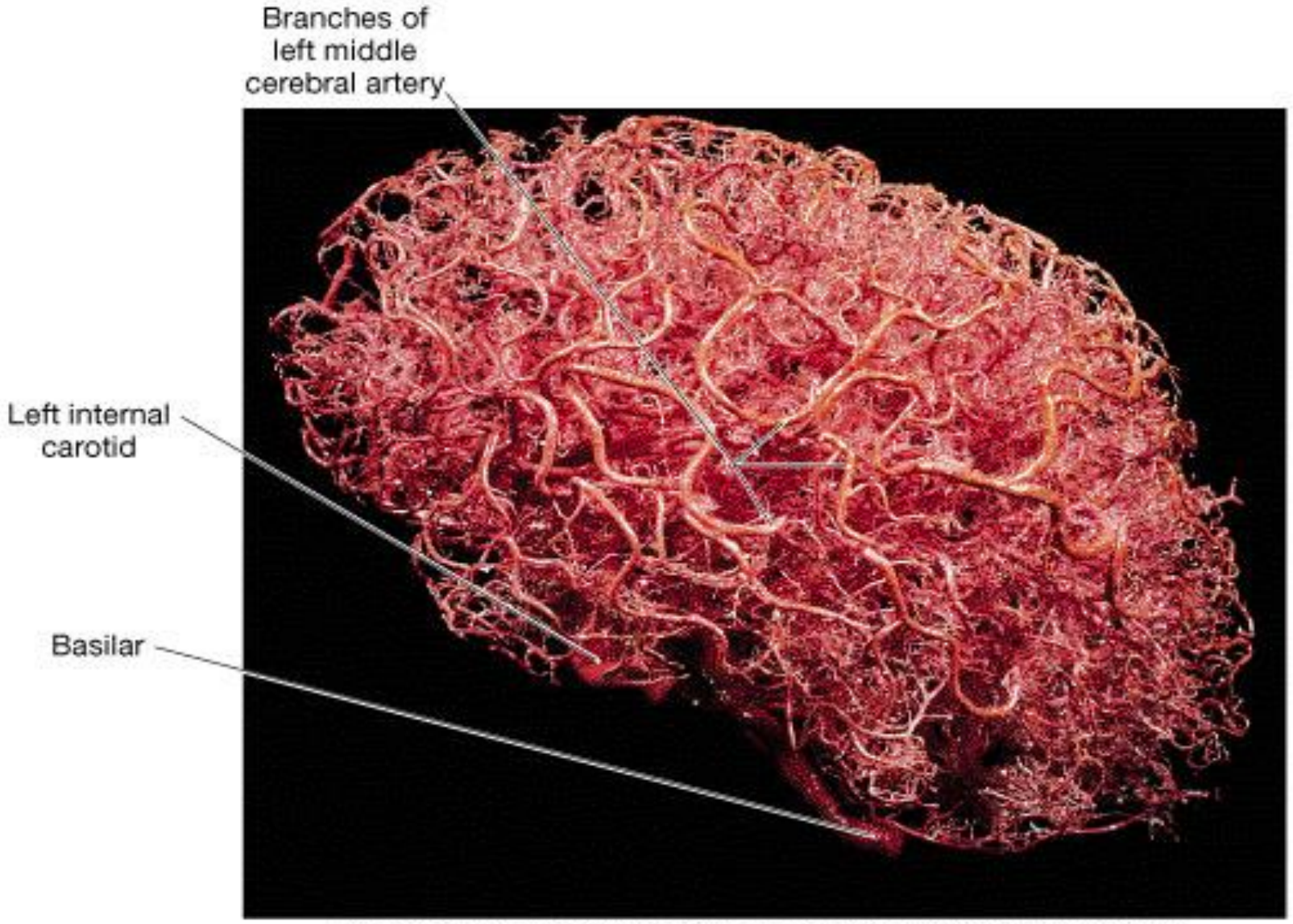
(a) Arteries of the brain, inferior view

Circle of Willis (up close)



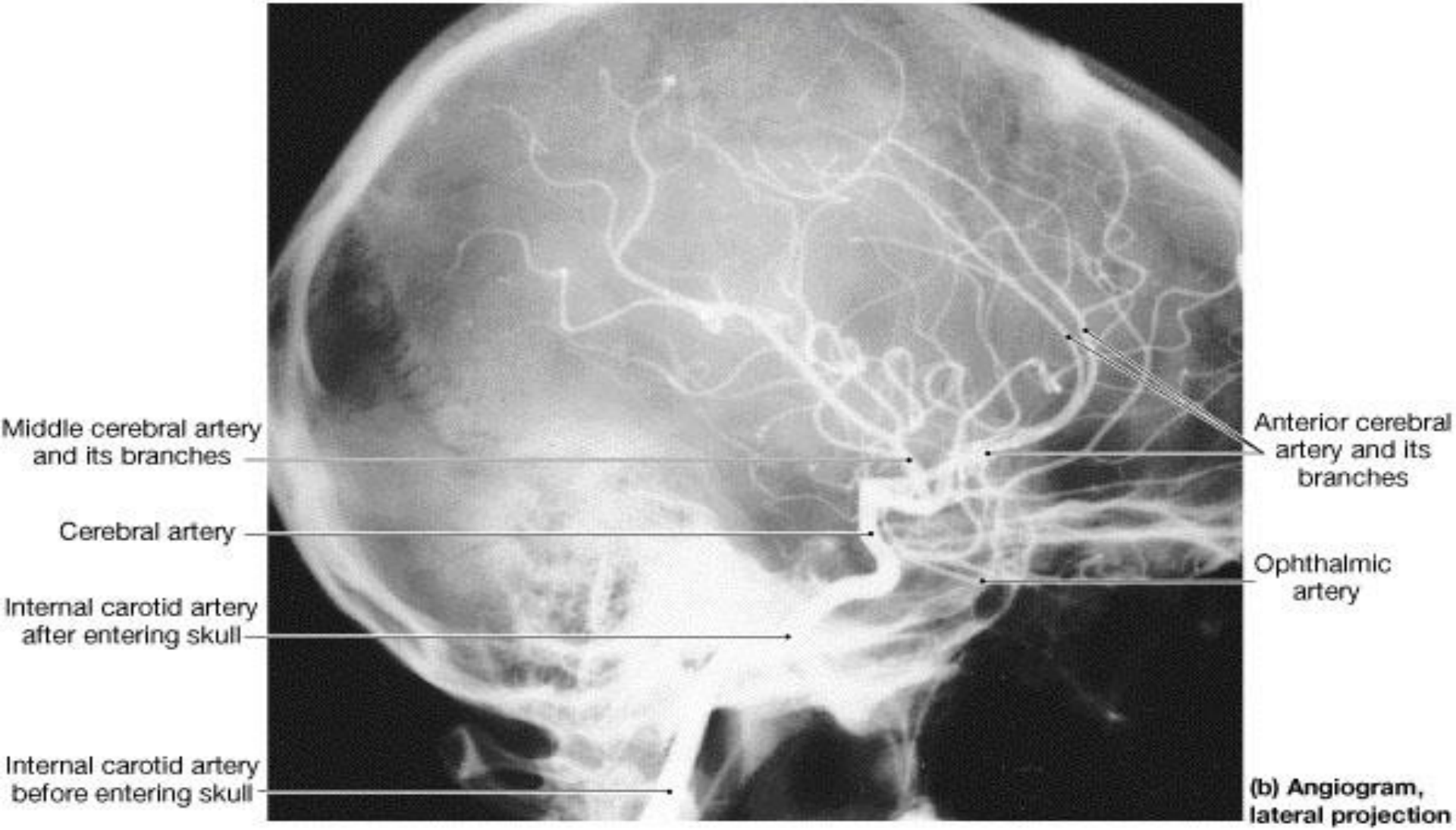
(b) Arteries injected to show cerebral arterial circle

That’s a lot of blood vessels!



(c) Corrosion cast of cerebral arteries, left cerebral hemisphere

Angiogram of blood flow to the brain



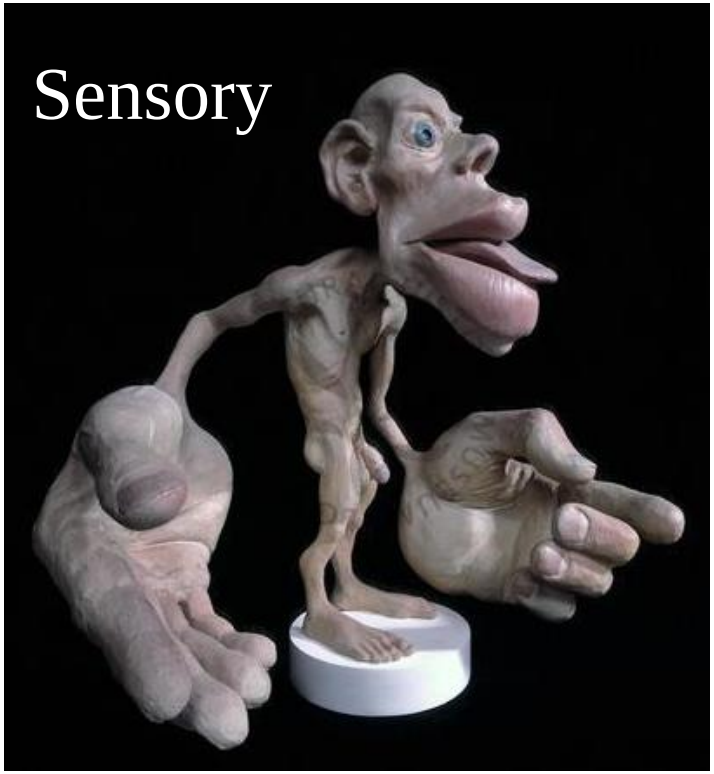

Next!
Some medical conditions associated with aging!
But first a short break

The Brain

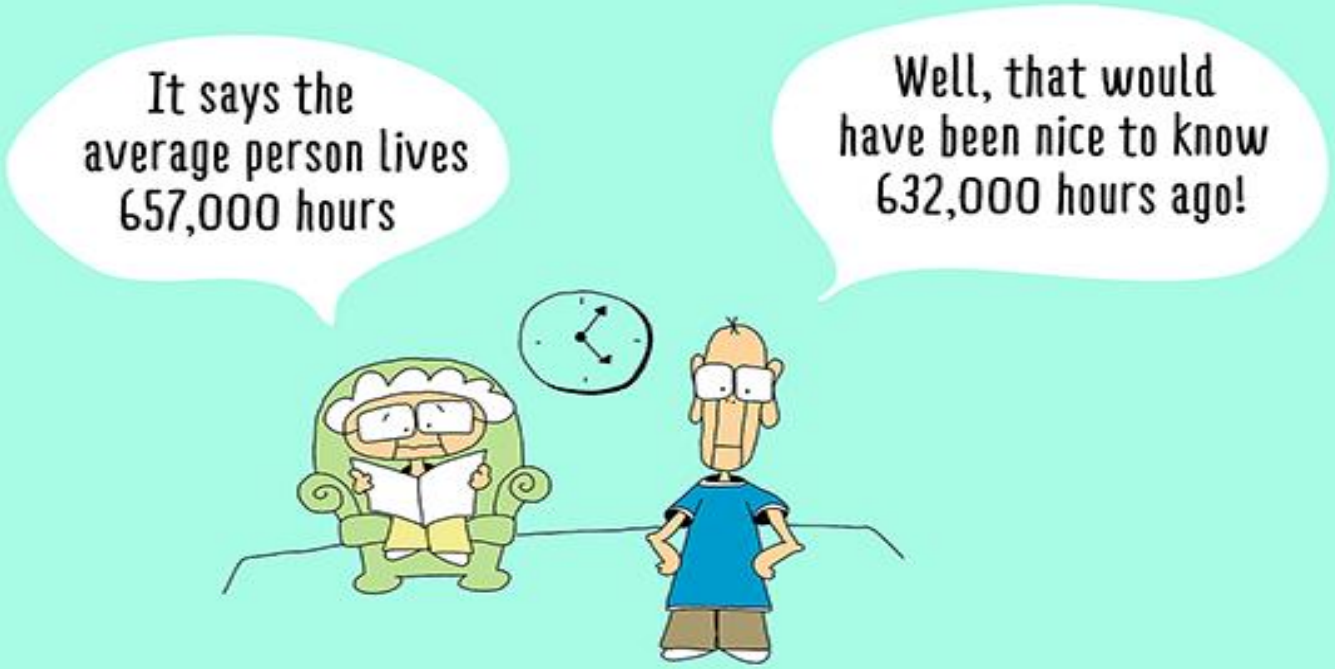
MEDICAL ISSUES & FIXES

Dr. Pat Gunton

March 19, 2022



WHAT THE BODY LOOKS LIKE TO THE BRAIN


It says the average person lives 657,000 hours
Well, that would have been nice to know 632,000 hours ago!
UNDER CARDIAC ARREST
©JOHN DONAGHUE

Presentation Outline

Medical Issues	Medical Condition
Viral or bacterial **INFECTION**	Meningitis, Encephalitis
Acute or chronic **CIRCULATION**	Stroke, Aneurysms, Hemorrhage
Benign or malignant **TUMOURS**	Glioma, Meningioma,
Acute or chronic **TRAUMA**	Subdural or Epidural Hematoma
Acute or chronic **DEGENERATION**	Dementia, Parkinsons, CTE, ALS
Acute or chronic **INFLAMMATION**	Multiple Sclerosis

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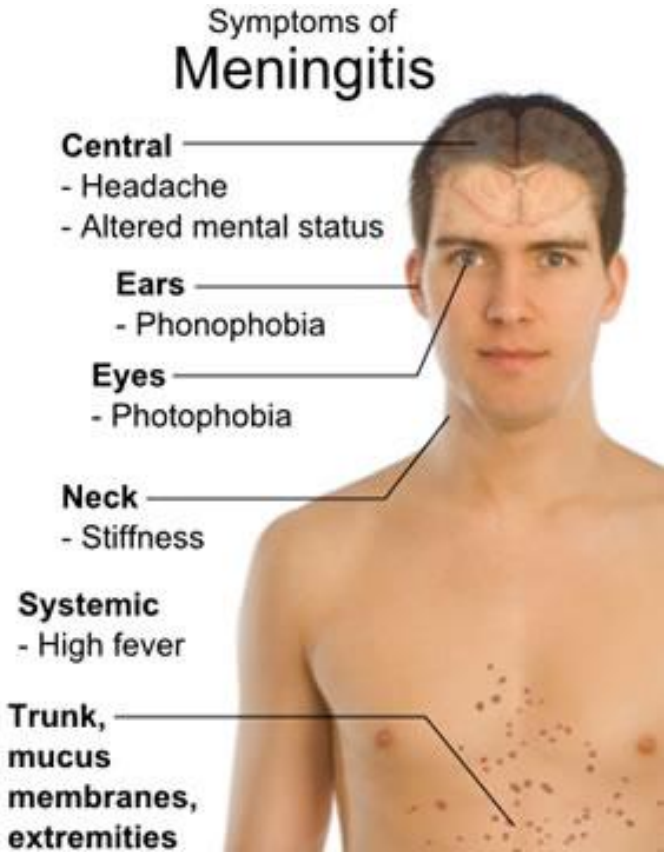
Meningitis



- Inflammation of fluid & membranes (meninges) surrounding the brain & spinal chord
- Symptoms:
  - Fever
  - Rash
  - Headache
  - **Stiff neck**
- Cause: usually viral & bacterial infection due to meningococcus, hemophilus & pneumococcus
- Prevention/treatment:
  - by childhood vaccines & antibiotics.
  - Life threatening condition and classified as a medical emergency

Encephalitis (aseptic meningitis)

- Infections of the brain
- Many forms of encephalitis which are usually rare.
- Mostly present as a mild infection which is self-limiting.
- Some fatal forms
- Symptoms:
  - Mild to severe flu-like signs and symptoms — such as fatigue, weakness, aching muscles & joints, fever or headache
  - Or, no symptoms at all.
  - Confused thinking, seizures, or problems with movement or with senses such as sight or hearing, stiffness, swelling
- Causes:
  - Several causes but commonly inflammation of the brain by viral infection (rabies, tick, mosquito, herpes, measles)
- Prevention/treatment: Vaccinations. Can be life threatening

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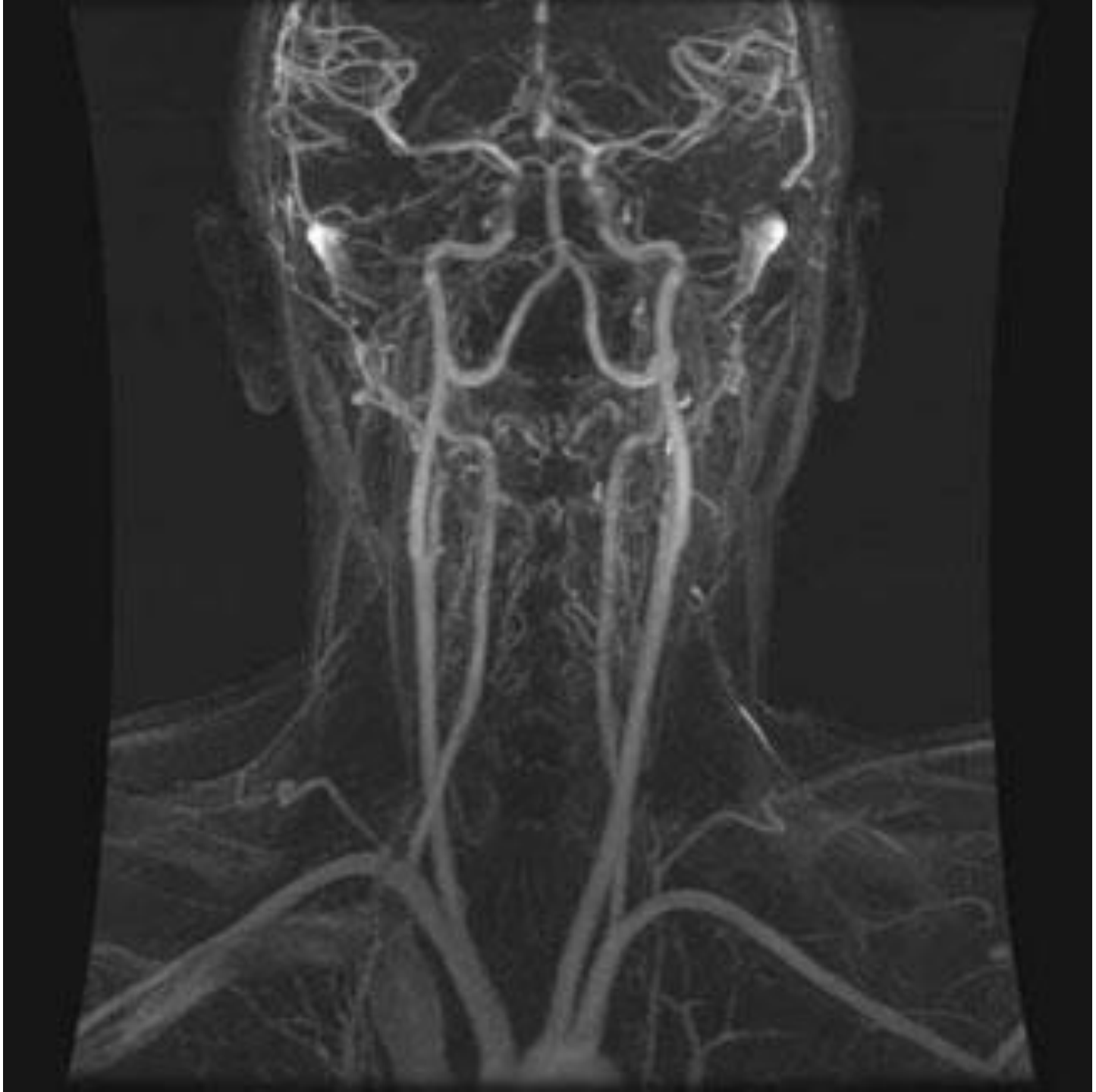
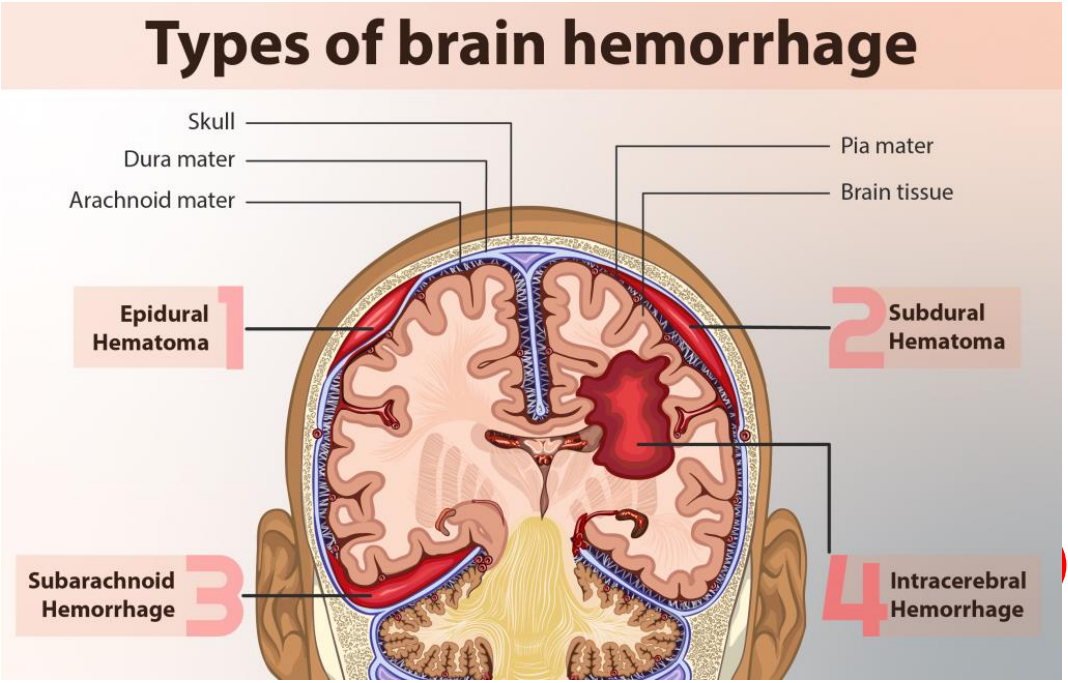


CIRCULATION
A Vascular
Organ

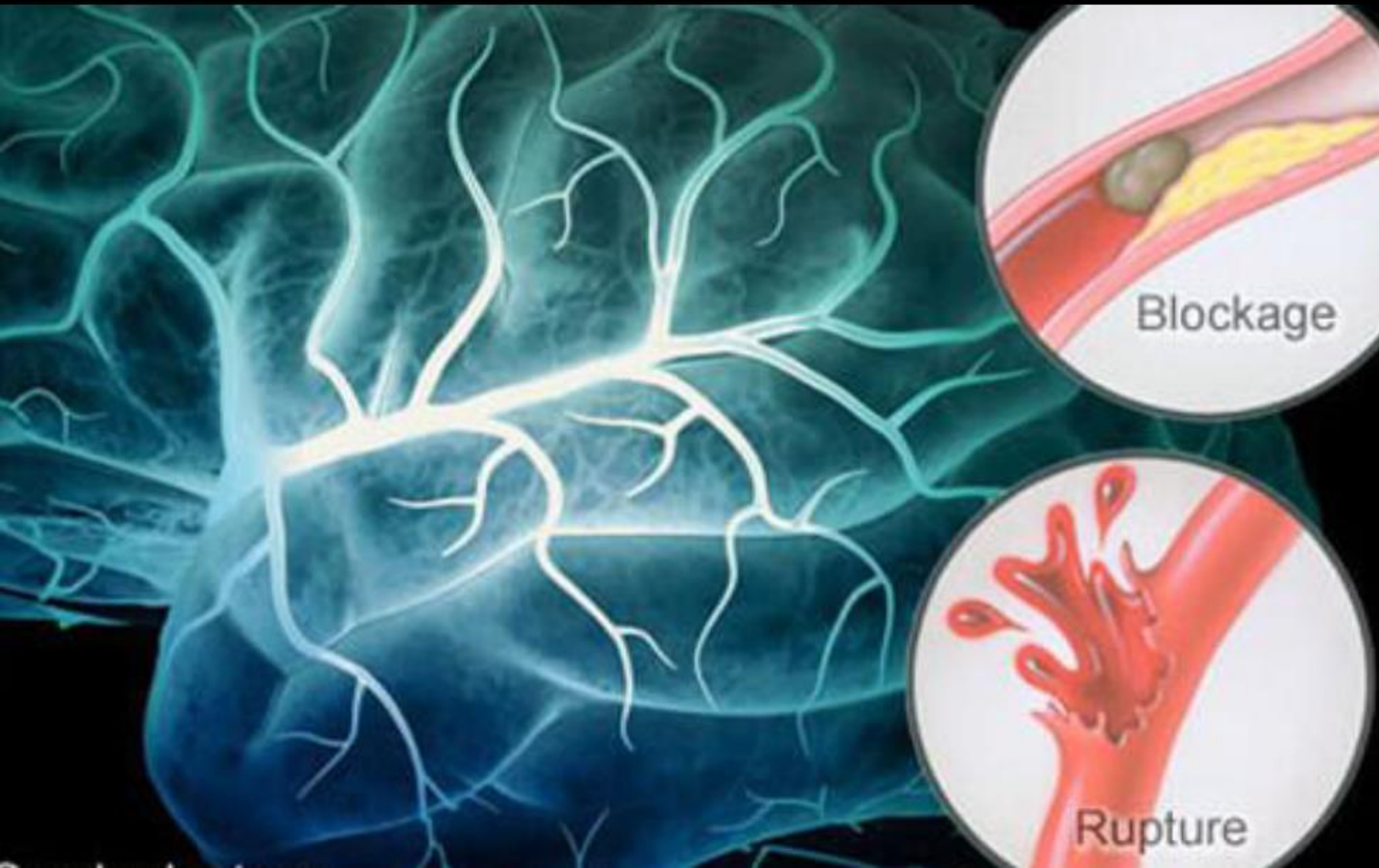
STROKE

"Brain Attack"

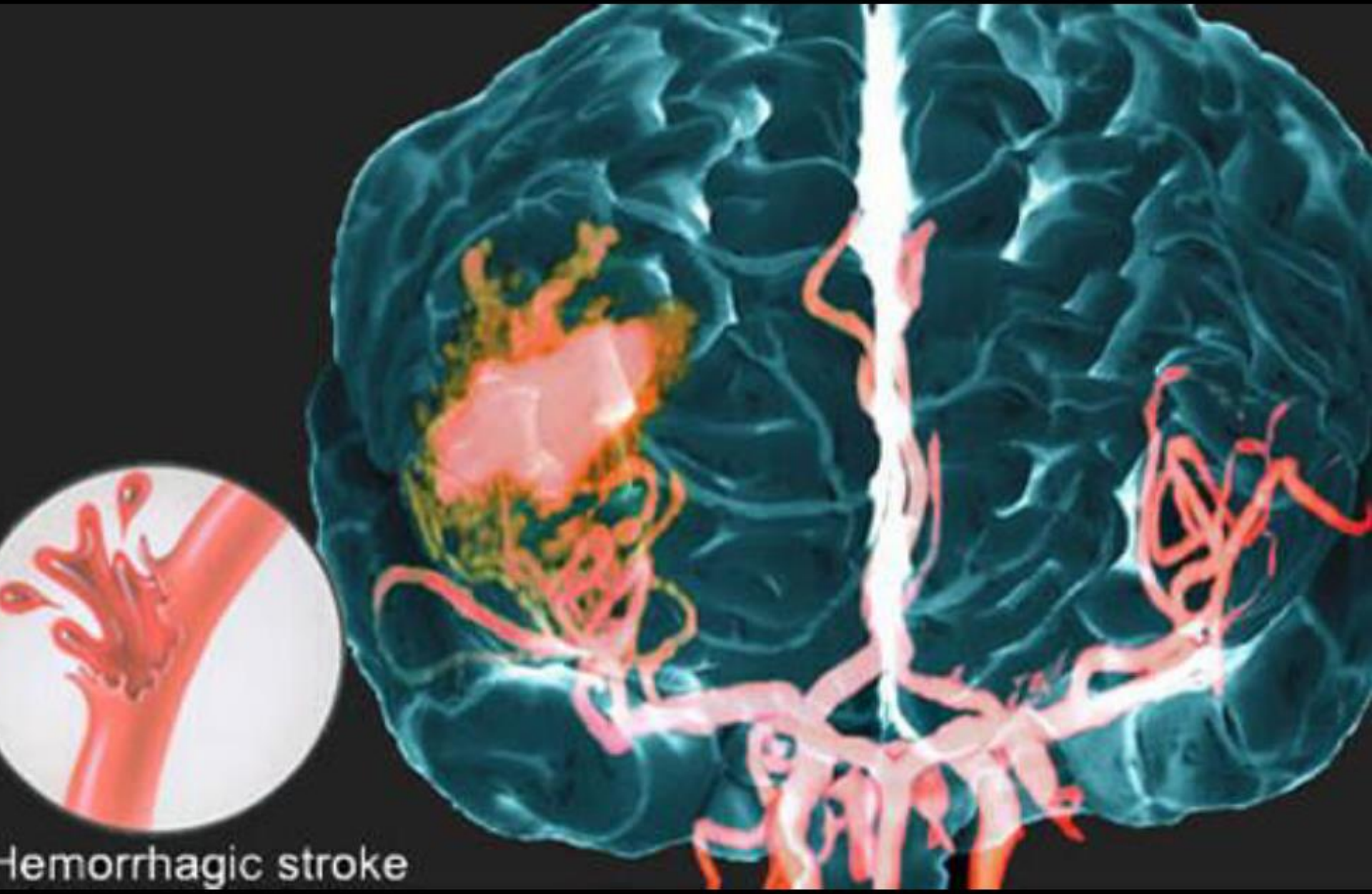
- Sudden onset of neurological problems due to either blockage or rupture of blood vessels in the brain.
- Symptoms: paralysis (unilateral), slurred speech, confusion
- Causes: blockage (blood clot) from heart (Afib) or carotid artery or blood vessel rupture (aneurysm)
- Prevention/treatments: control blood pressure, cholesterol, medications (anticoagulants), tPA. (tissue plasminogen activator)

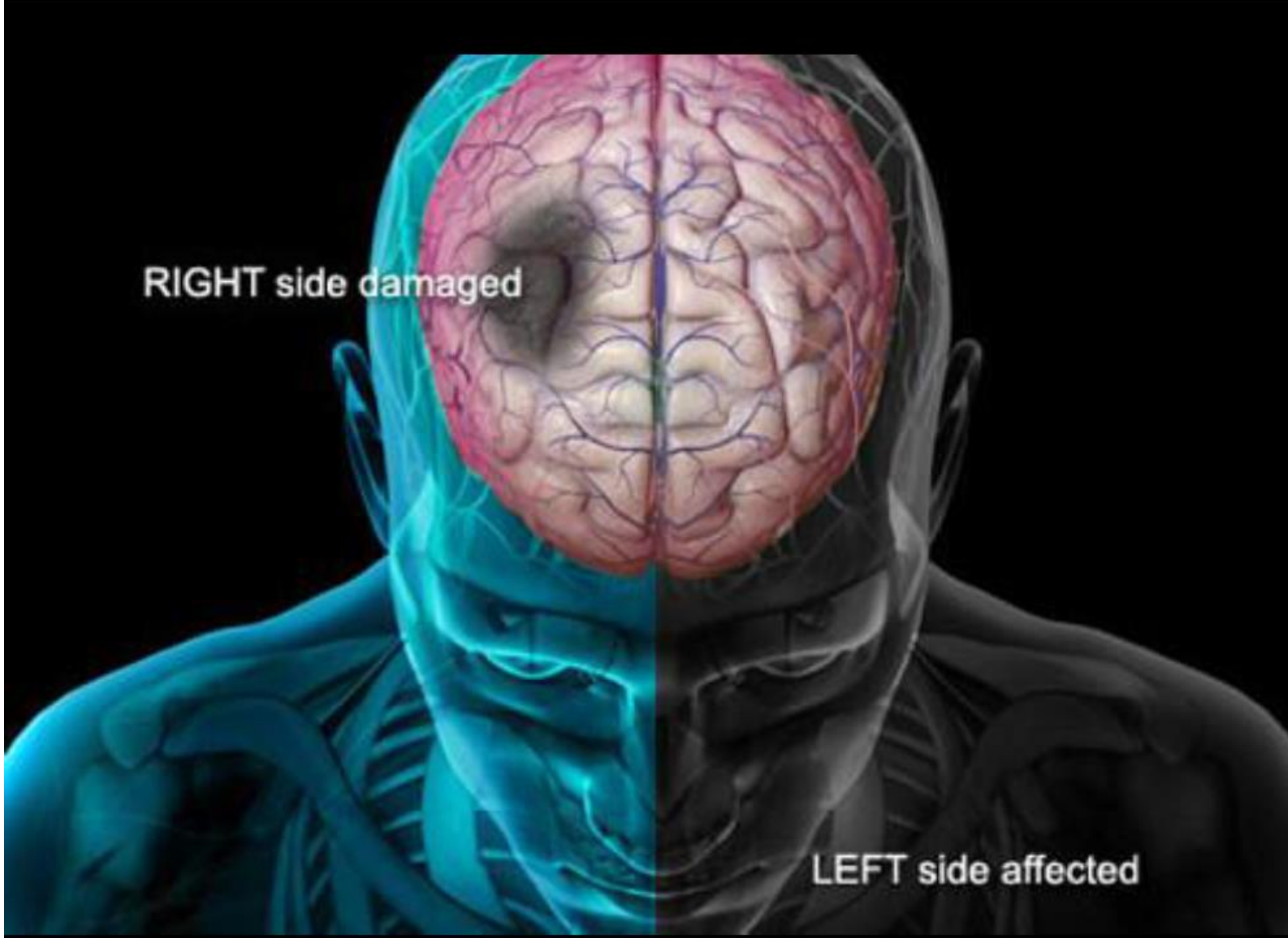


Causes of Stroke!

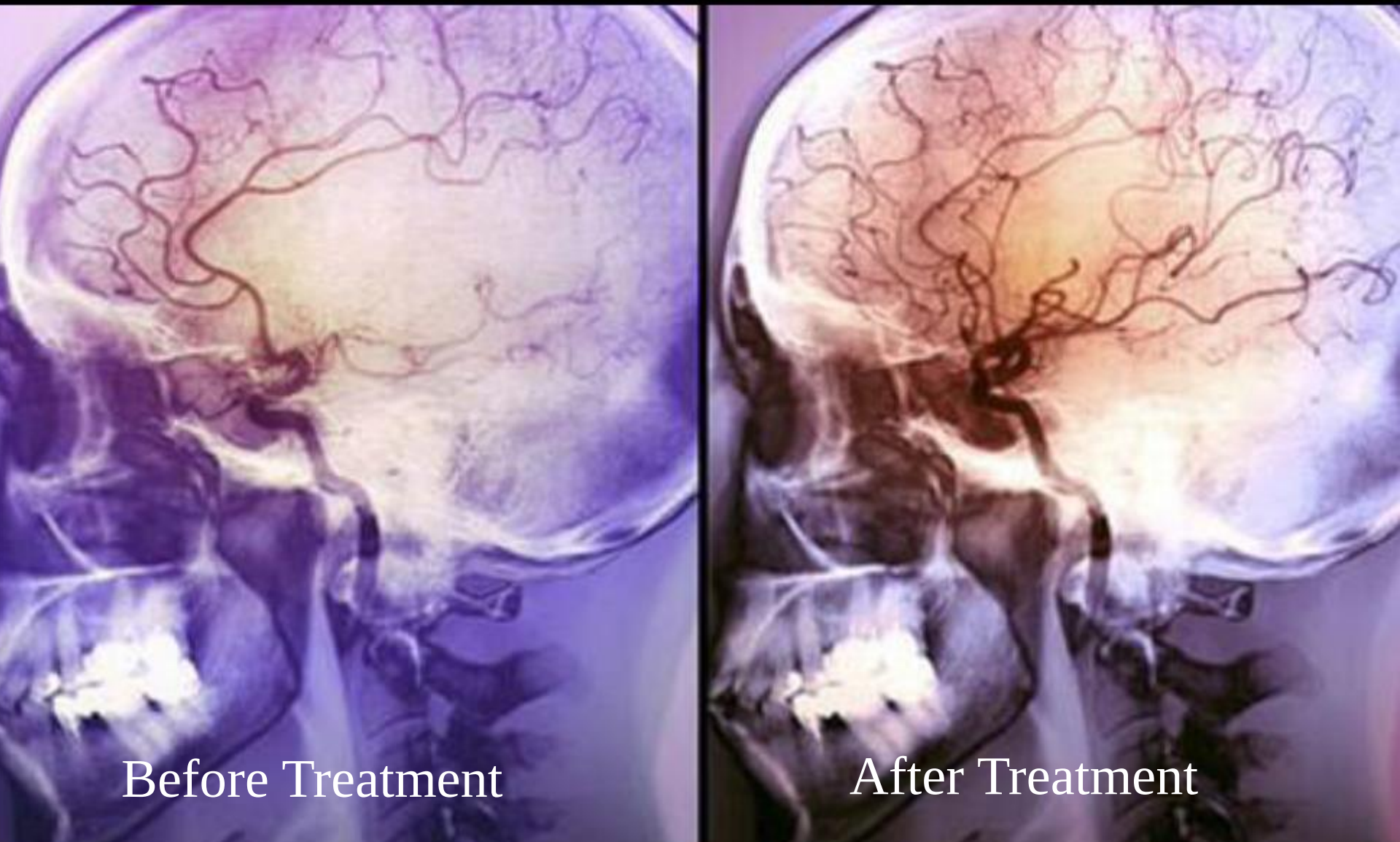


Hemorrhagic Stroke

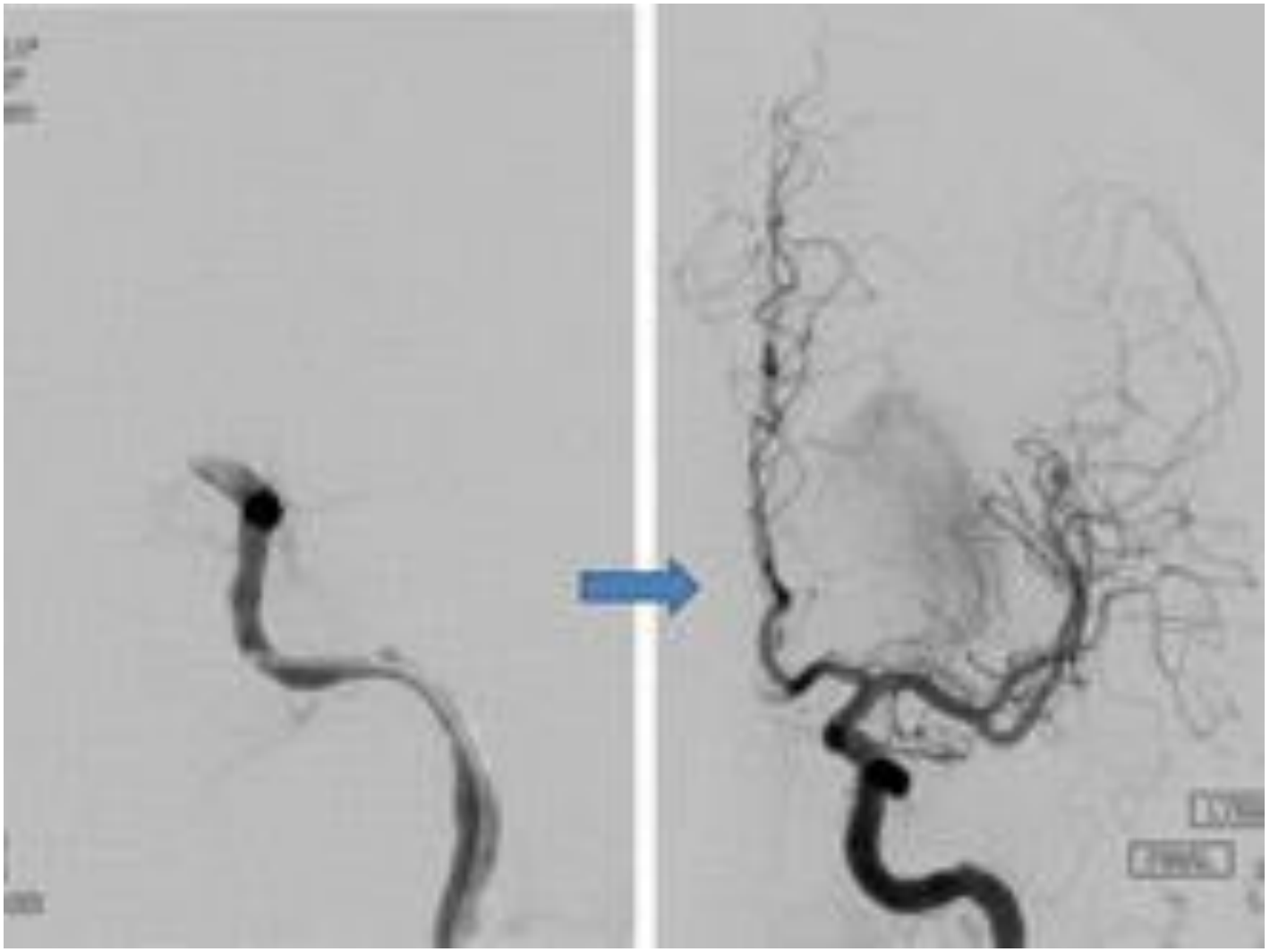



RIGHT side damaged
LEFT side affected

Treatment With tPA



tPA
(tissue plasminogen activator) at work

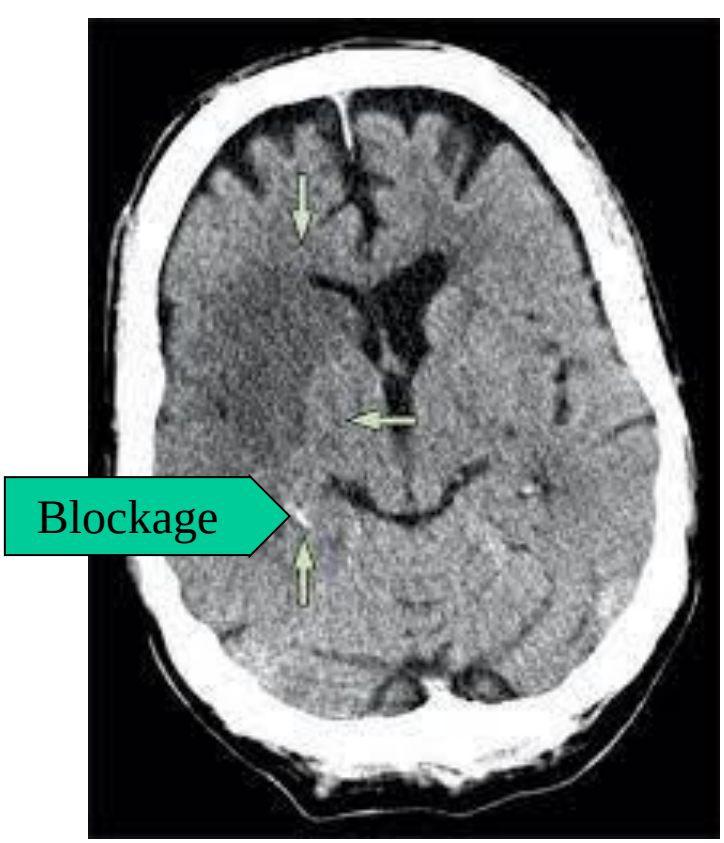


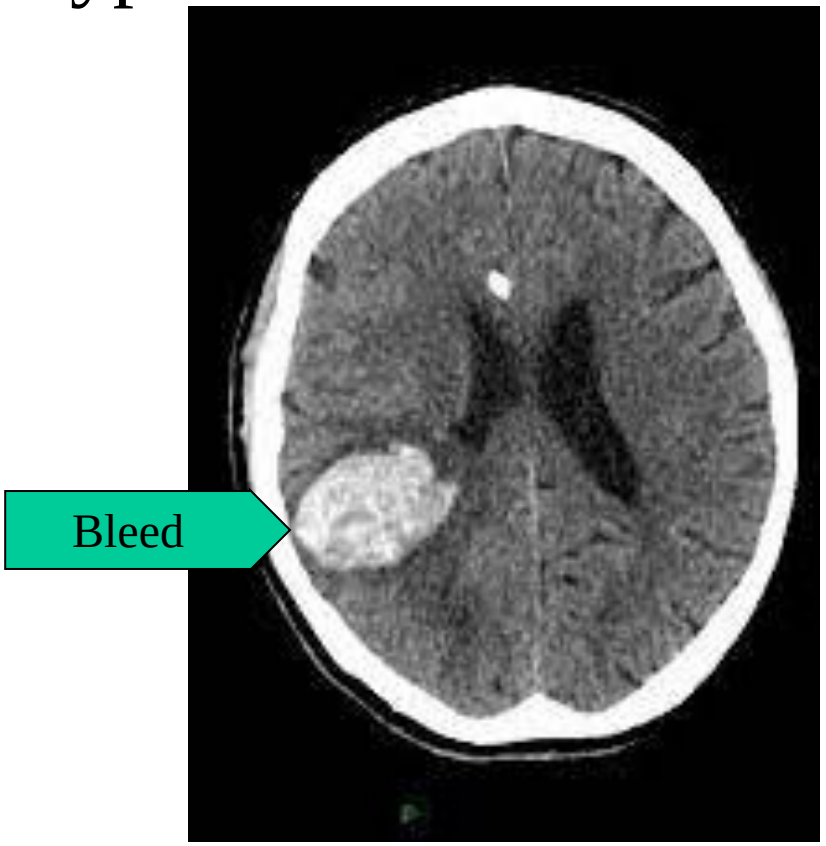
Stroke vs Transient Ischemic Attack ("mini-stroke": TIA)

TIA	Stroke
• Interruption of blood flow is transient	• Interruption of blood flow is long-lasting
• No brain damage	• Brain damage ensues

Bleeds vs Blockages

CT of the two types of stroke

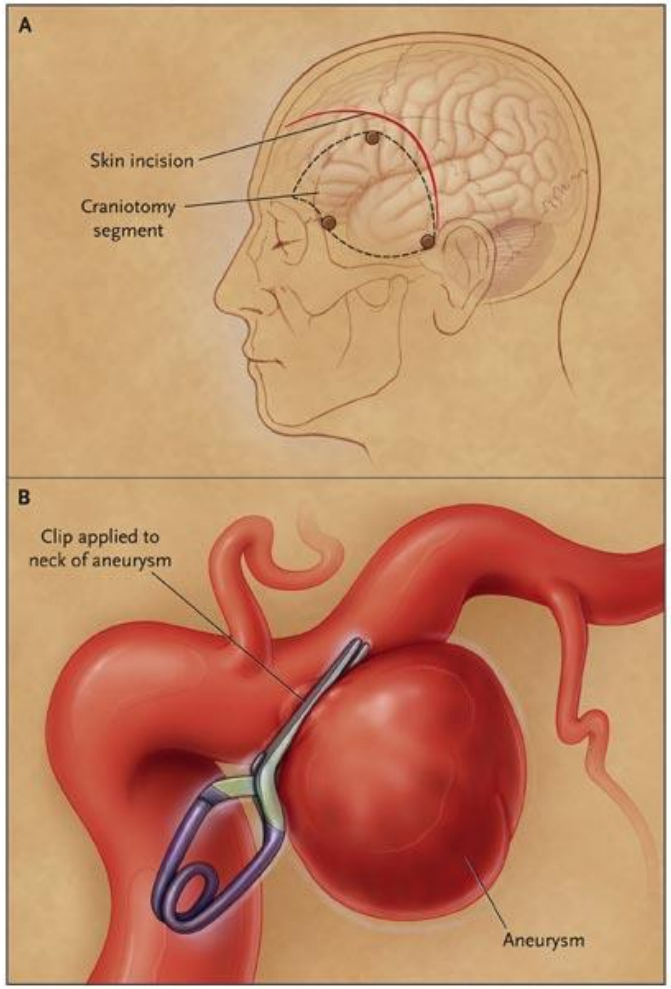




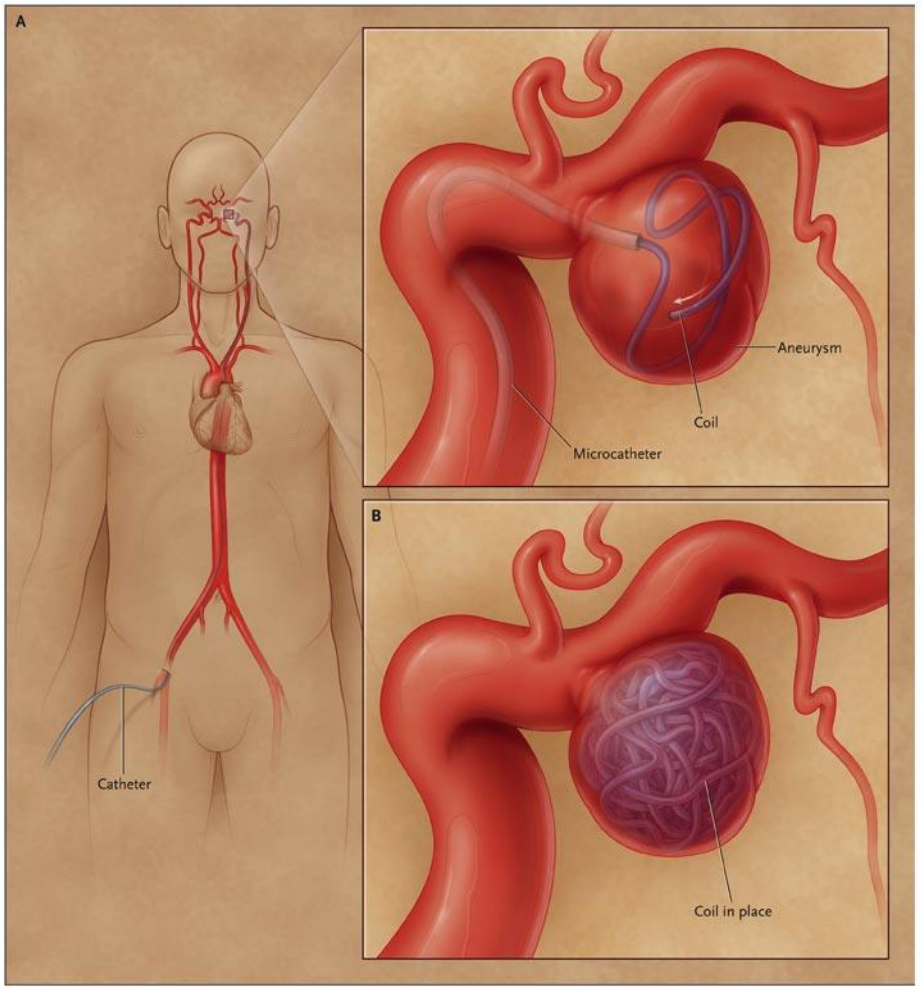
Cerebral Aneurysm

- Occurs in 1 to 5% of adult autopsies
- Rupture is 1 in 10,000 per year
- Unruptured: Size matters <7mm good >10mm bad
- In the US more unruptured aneurysms are treated than ruptured ones.
- Peak age 55 to 60
- Symptoms: Dramatic sudden headache (“Thunder Clap”), stiff neck, neurologic symptoms are none to brain dead
- Causes:
  - Underlying Disorders: Polycystic kidneys, Marfan, Ehlers Danlos
  - Risk in family members may be doubled
- Prevention/treatments:
  - >10% do not make it to hospital
  - Rebleed 4% in 48 hours, 30% in 2 weeks
  - Untreated mortality 45% in 30 days

Aneurysm Treatment

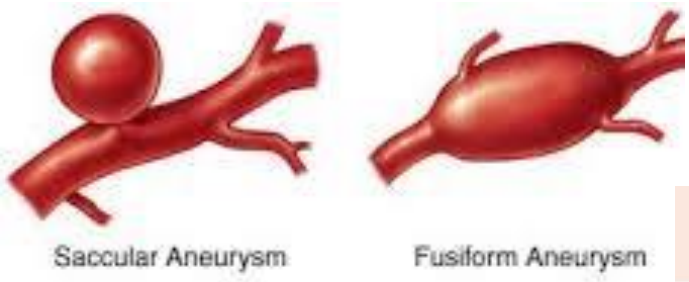


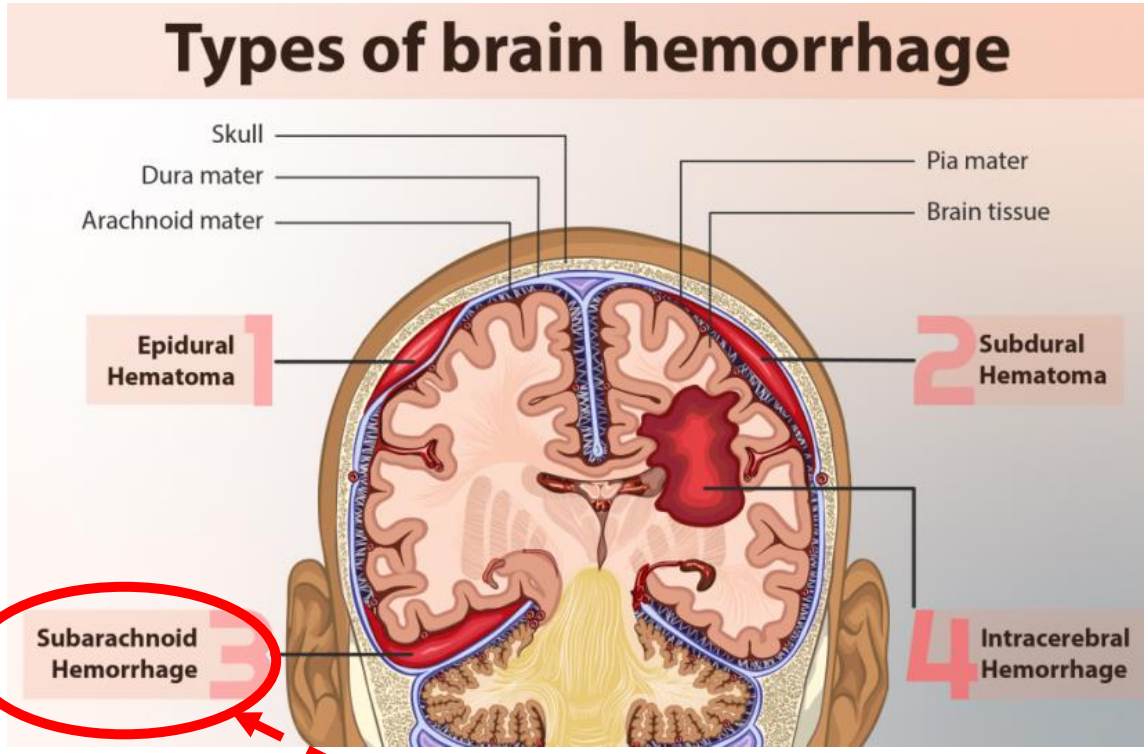
Clip



Coil

Berry Aneurysm





This type of aneurysm will burst and cause a subarachnoid hemorrhage

Aneurysm Diagnosis

- CT scan
- Lumbar Puncture
- Cerebral Angiogram
  - MRA
  - CT Angio
  - Conventional (traditional) angiography
- 10% of SAH no cause on angio

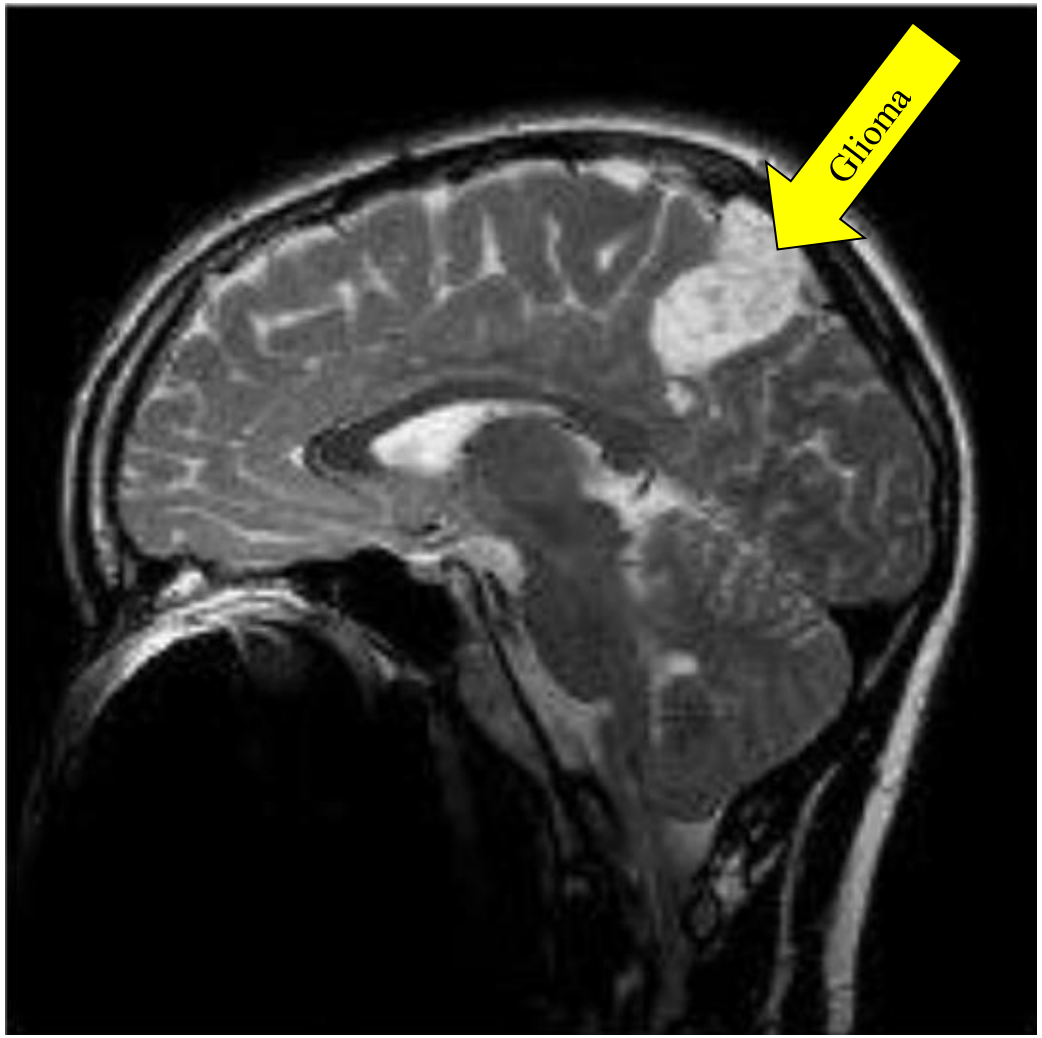
Presentation Outline

Medical Issues	Medical Condition
Viral or bacterial **INFECTION**	Meningitis, Encephalitis
Acute or chronic **CIRCULATION**	Stroke, Aneurysms, Hemorrhage
Benign or malignant **TUMOURS**	Glioma, Meningioma,
Acute or chronic **TRAUMA**	Subdural or Epidural Hematoma
Acute or chronic **DEGENERATION**	Dementia, Parkinsons, CTE, ALS
Acute or chronic **INFLAMMATION**	Multiple Sclerosis

Brain Tumours

- Mass or growth of abnormal cells in the brain
- 150 different types
- Malignant or benign
- Localized or invasive
- Primary or Secondary (metastatic)
  - Primary eg: 80% gliomas (malignant)
  - Secondary eg: 10-15% meningiomas (benign)
- Symptoms: pattern of headaches, nausea/vomiting, vision & balance difficulties, tired, confused, seizures
- Causes: often not clear but exposure to radiation and family history seem important
- Prevention/treatment: surgery, brachytherapy, radiotherapy, gamma knife, chemotherapy

Glioma
Cat Scan Image



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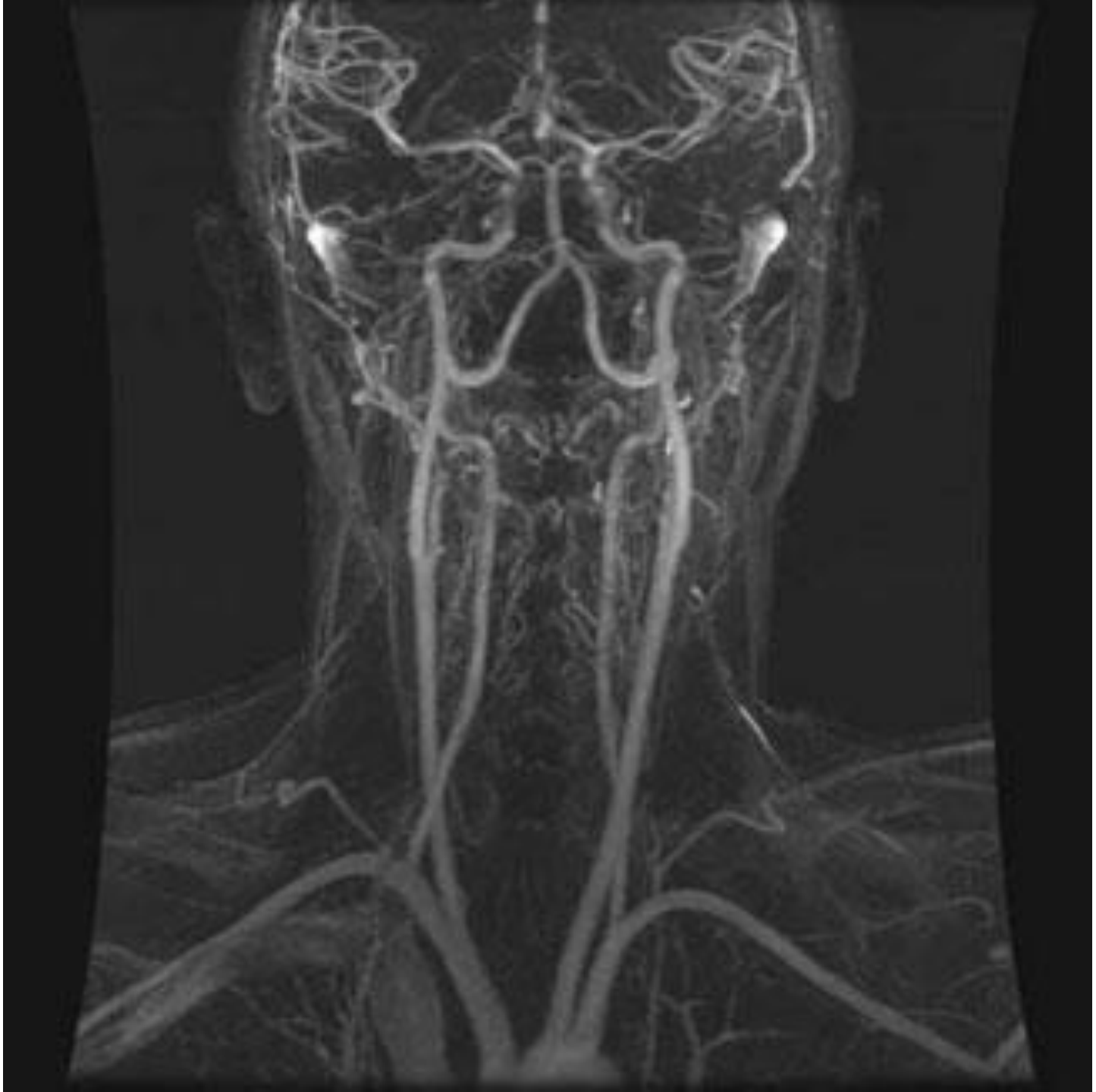
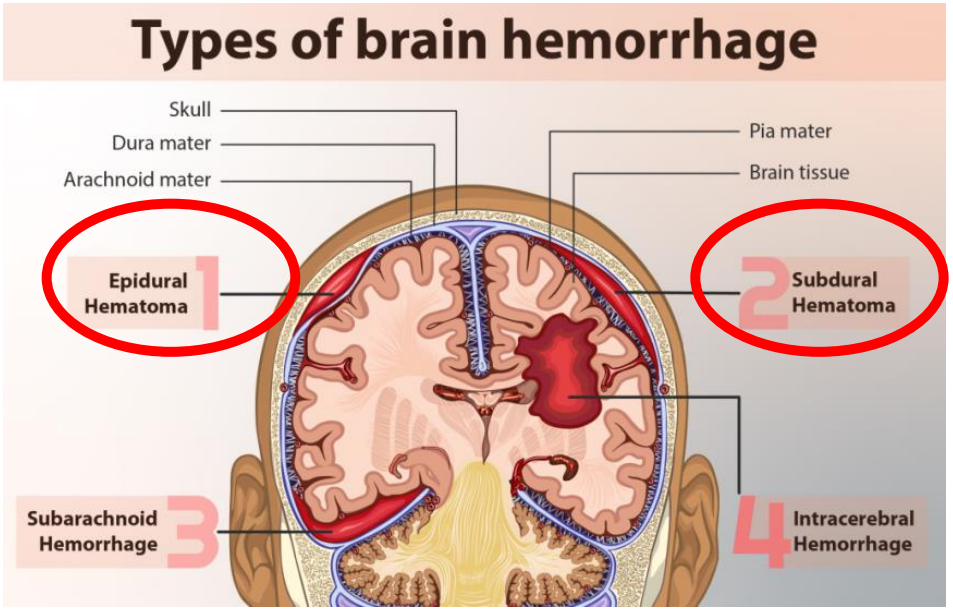


CIRCULATION
A Vascular
Organ

Epidural and Subdural hemorrhages

- Bleeds on the outside of the brain
- Symptoms: Headache, loss of consciousness, confusion
- Causes: Both of these are traumatic.
  - The subdural hematoma occurs relatively rapidly after the trauma,
  - The epidural is much more insidious and can continue to expand and exert symptoms for weeks.
- Treatment: drilling a borehole through the skull into the hematoma and draining



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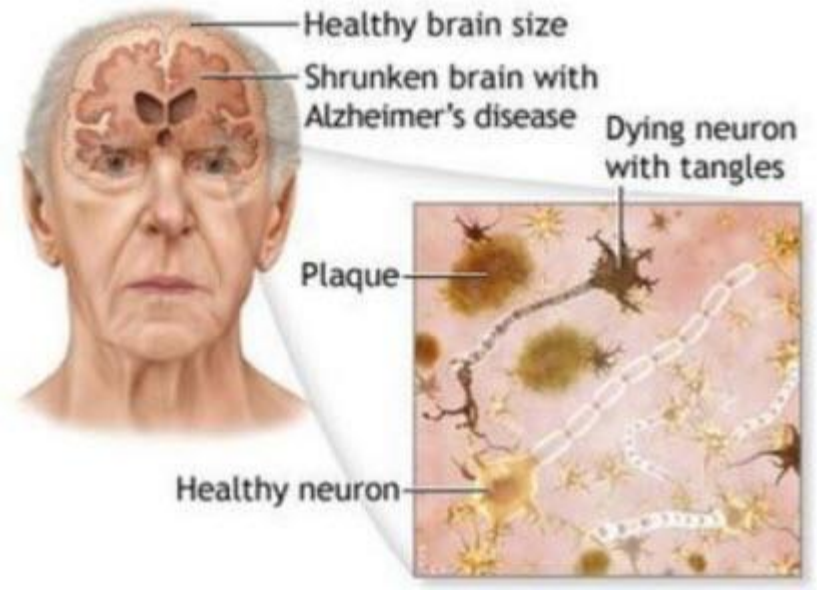
Dementia: Alzheimers

- Plaque & tangle buildup damaging healthy neurons
  - Plaque – clumps of protein (amyloid)
  - Tangles -fibrous tissue made up of tau protein
- Symptoms: Shrunken brain size, loss of communication skills & recognition, memory loss etc. Avg life expectancy 4 – 8 yrs after diagnosis
- Causes: ???High blood pressure & decreased blood supply
- Prevention/treatment: medications:
  - Aricept
  - Memantine
  - Exelon
  - Reminyl



Definition of Dementia
(Canadian Government Dementia Statement)

"Dementia is a progressive and incurable disease for which a complete understanding of it's pathophysiology and effective therapies to stop the progression are lacking."

Dementia Types

- Alzheimers (70%)
- Vascular (15-20%)
- Lewy Body
- Frontotemporal
- Alcohol related
- Down Syndrome progresses to Alzheimers

Dementia Trajectory Outline

Dr Trevor Janz

Teen	Having hobbies, driving a car, getting a job Planning and organizing tasks, preparing a meal, grocery shopping, laundry	**Early Dementia**
School age child	Able to be left unsupervised Simple math and managing money. Reading. Being able to understand & follow instructions	**Middle Dementia**
Preschool child	Grooming: Hair, teeth, shaving, makeup, dressing Toilet training: Continent bowels and bladder Talking: Able to express needs in words	
Baby	Walking (sitting up, crawling, standing, walking) Feeding (spoon fed, finger foods, spoon & fork) Rolling over, sitting up and looking at the world Sleeping and eating Swallowing	**Late Dementia** **Actively Dying**

Dementia Risk & Prediction

- The most sensitive predictor of early Dementia is a
  "change in gait".
- Unable to predict progress as brain is affected at random
- Progressive decline can be slow or occur in abrupt "falling off a cliff" episodes
- Terminal Disease

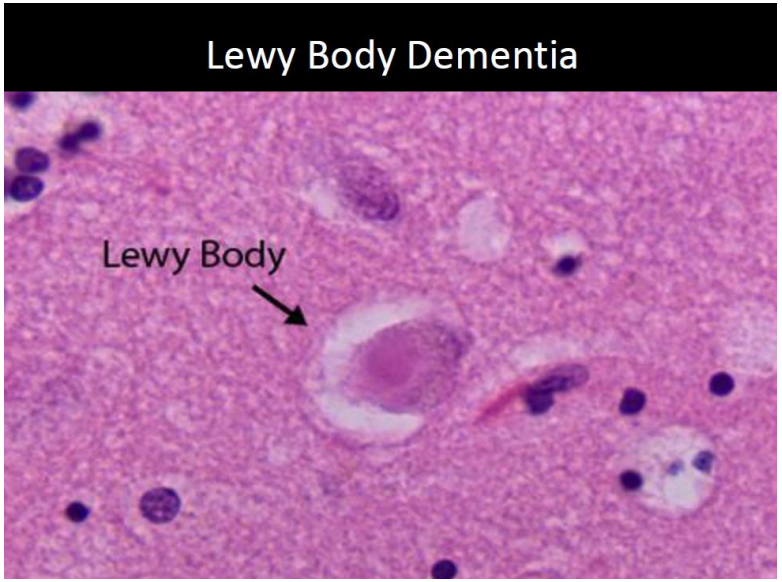
Dementia: New Medication

Aduhelm (Aducanumab)

- Reduces Amyloid build-up
- 40% of patients have side effects (brain swelling & bleeds)
- Cost: US$28,000 per yr.

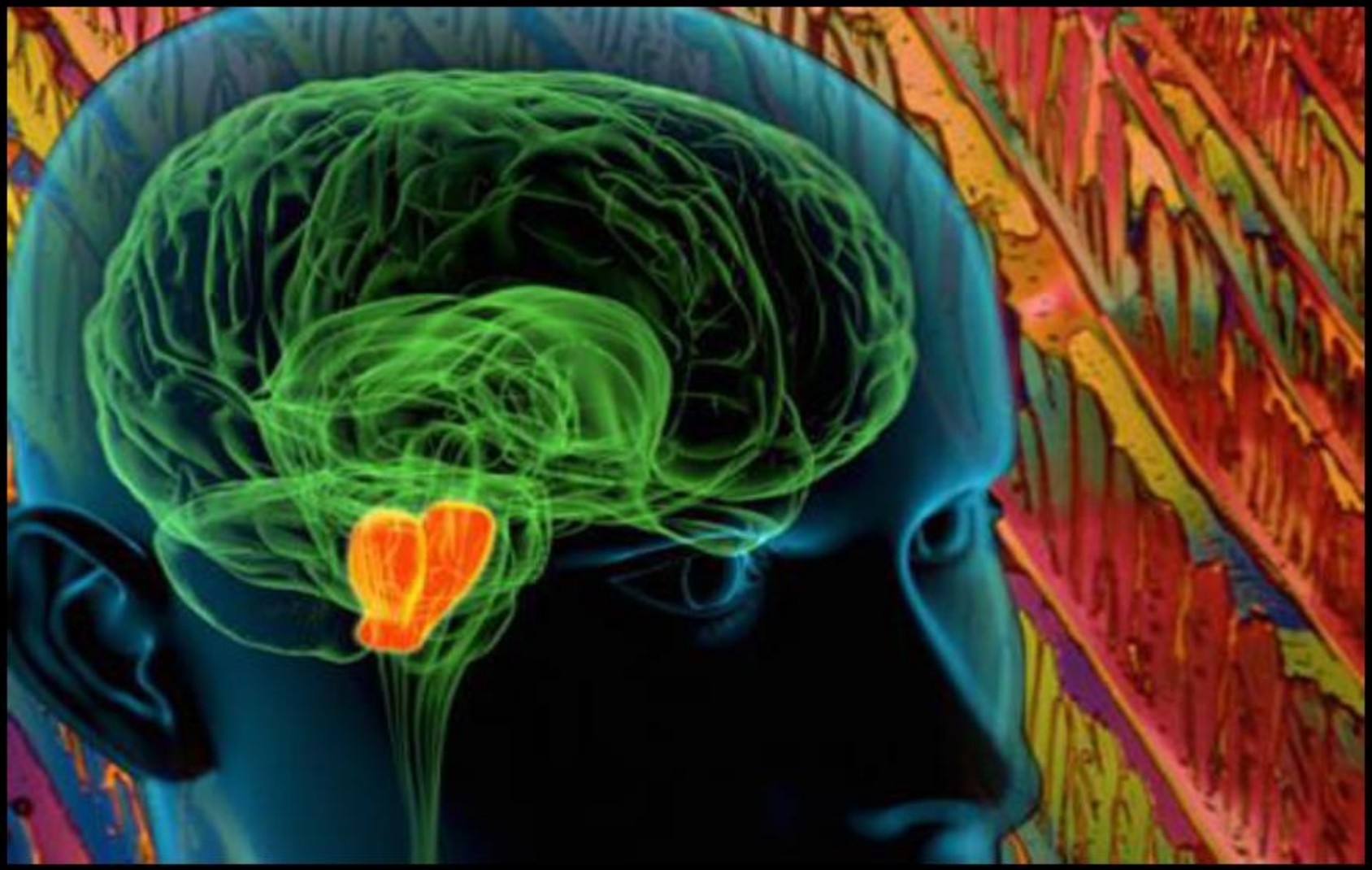
Parkinsons

- Death of cells in substantia nigra
- Leads to dopamine deficit
- Can cause Lewy Body Dementia
- Affects motor system
- Symptoms:
  - tremor,
  - rigidity,
  - slowness of movement



- Cause: unknown
  - Genetic? Toxic substances? Pesticides? Drugs? Head injuries?
- Prevention/Treatment:
  - Deep brain stimulation.
  - Medication: Levodopa/carbidopa combined in a single tablet. The brain tissue converts this drug to dopamine.
  - Utilization of Aptamers to prevent protein aggregation

Parkinson's Disease Causes



Substantia Nigra → dopamine

Famous Parkinson's Patients

Muhammad Ali & Michael J. Fox

THE MICHAEL J. FOX FOUNDATION
FOR PARKINSON'S RESEARCH

At age 61 yr, Michael J Fox has
lived with Parkinson's for over 30 years

Utilization of Aptamers to Prevent Protein Aggregation in Parkinson's Disease

- The abnormal aggregation of a protein known as alpha-synuclein appears to play a critical role in Parkinson's disease.
- This project will explore a new type of biomolecule, known as an aptamer, as a potential inhibitor of alpha-synuclein aggregation.
- Aim is to discover an aptamer with anti-aggregation properties and then test its ability to thwart alpha-synuclein aggregation.
- If these preliminary tests are promising, future work could explore how this aptamer could be used as a disease-modifying therapy.
- **Project Description:**
  Aptamers are short strands of DNA or RNA that fold up into 3D shapes that are capable of binding to a target molecule with remarkable specificity and affinity.
- Goal is to find a DNA aptamer that can bind tightly to alpha-synuclein and prevent it from aggregating.

"The Study and Treatment of Parkinson's Disease"

UVRA ZOOM Invitation via CURAC:

Date and time:

WEDNESDAY March 23, 2022; 7pm Eastern Time

Speaker:

Professor Maria DeRosa, Interim Dean, Faculty of Science, Carlton University, Ottawa Maria.DeRosa@carleton.ca

Short Overview:

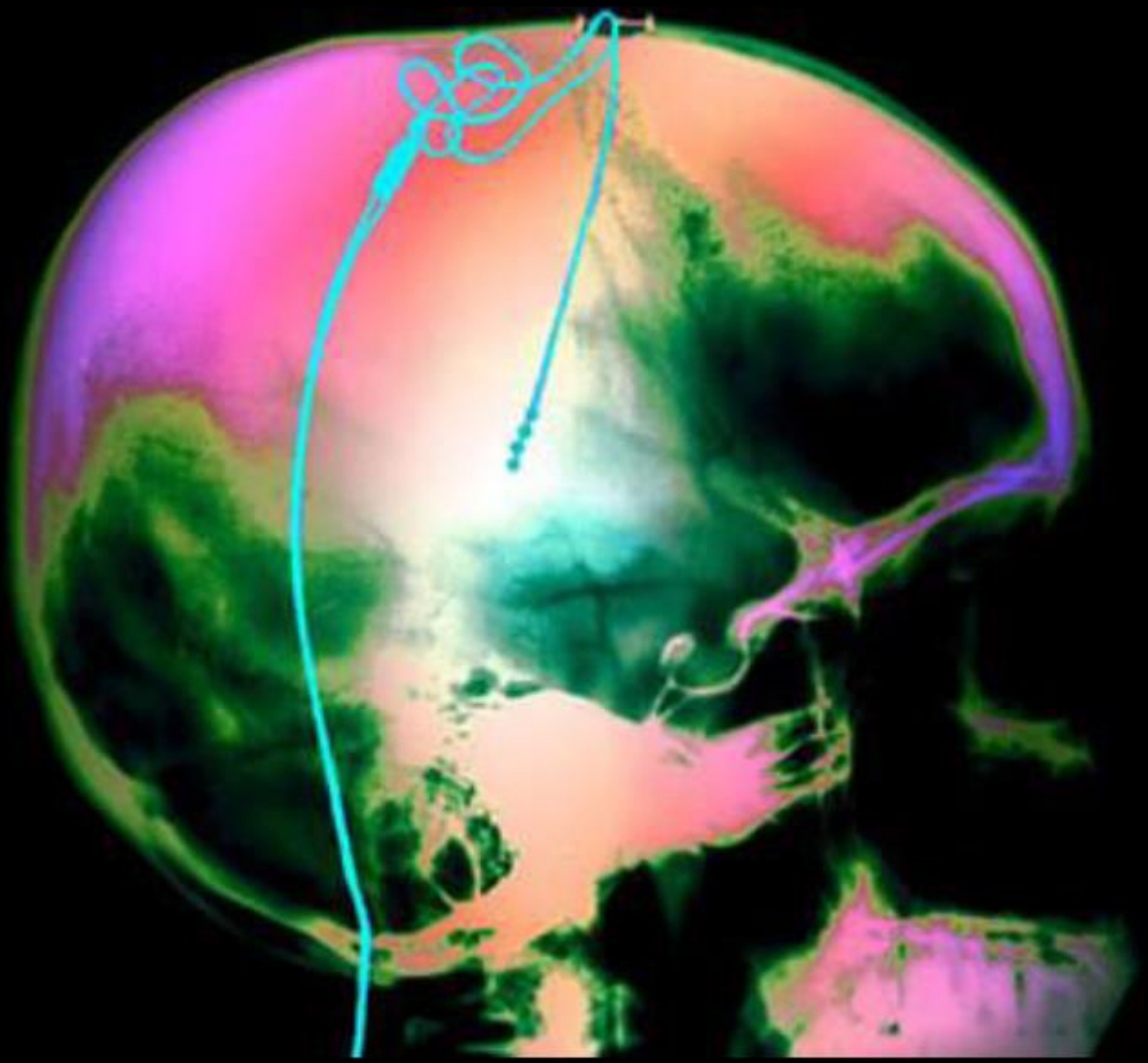
Dr. DeRosa will describe:

1. the science of aptamers,
2. how the aptamers were discovered and characterized
3. their applications for the treatment of Parkinson's

Registration:

Contact **Susan Nesrallah** susannesrallah@cunet.carleton.ca for a zoom invitation to this free event.

Parkinson's Surgery: Deep Brain Stimulation



Chronic Traumatic Encephalopathy (CTE)

- Diagnosis at autopsy
- 2 to 4.5 times increased risk of Alzheimers in later life
- ?? small number of mild trauma incidents or fewer severe incidents.
- Symptoms: Loss of consciousness, vision impairment, disorientation, repeated vomiting
- Causes: recurrent brain injury – concussion
- Prevention:
  - concussion protocols
  - head restraints: sports & aeronautics
  - helmet design: sports, cycling, skating, skiing etc.

Amyotrophic Lateral Sclerosis (ALS) Lou Gehrig's Disease

- A progressive nervous system disease
- Affects nerve cells (motor neurons) in the brain and spinal chord
- Symptoms: Loss of voluntary muscle control, weakness, muscle wasting, eventual paralysis
- Causes :
  - 5 – 10% genetic
  - 90 – 95% unknown
- Prevention : Death 2 to 5 yrs from diagnosis

Stephen Hawking lived >50yrs (76)

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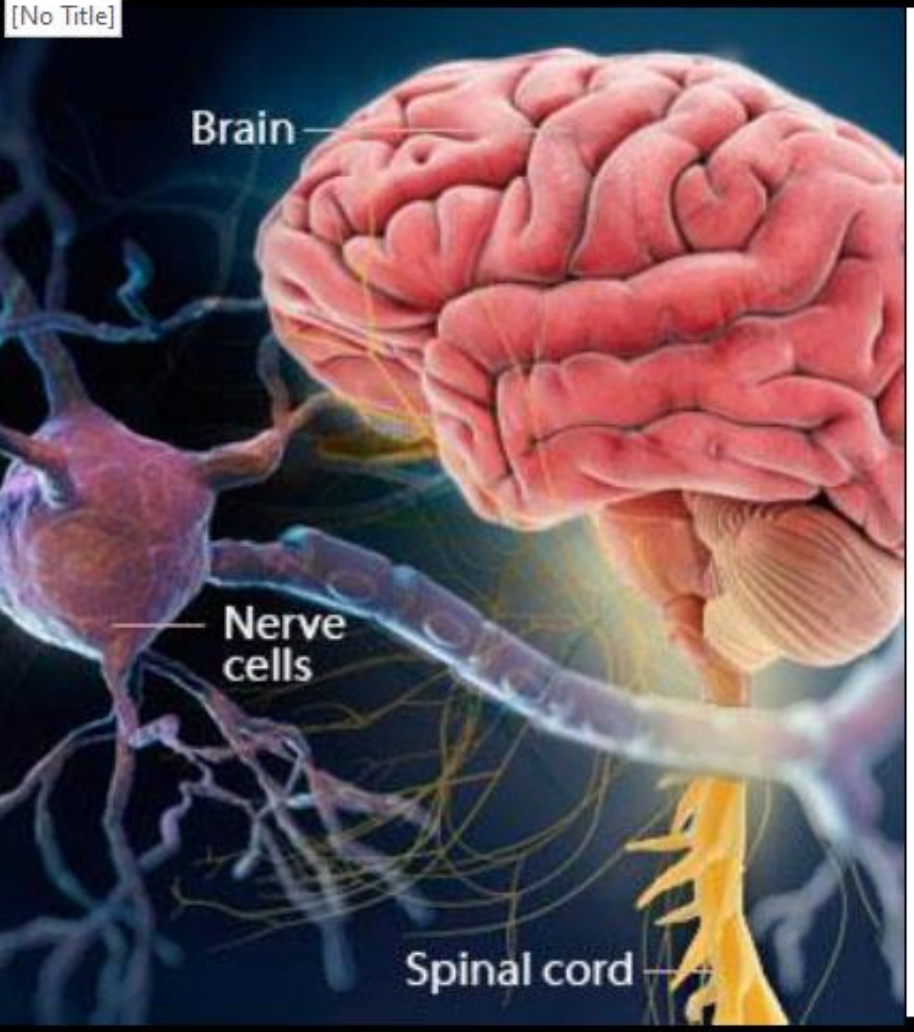
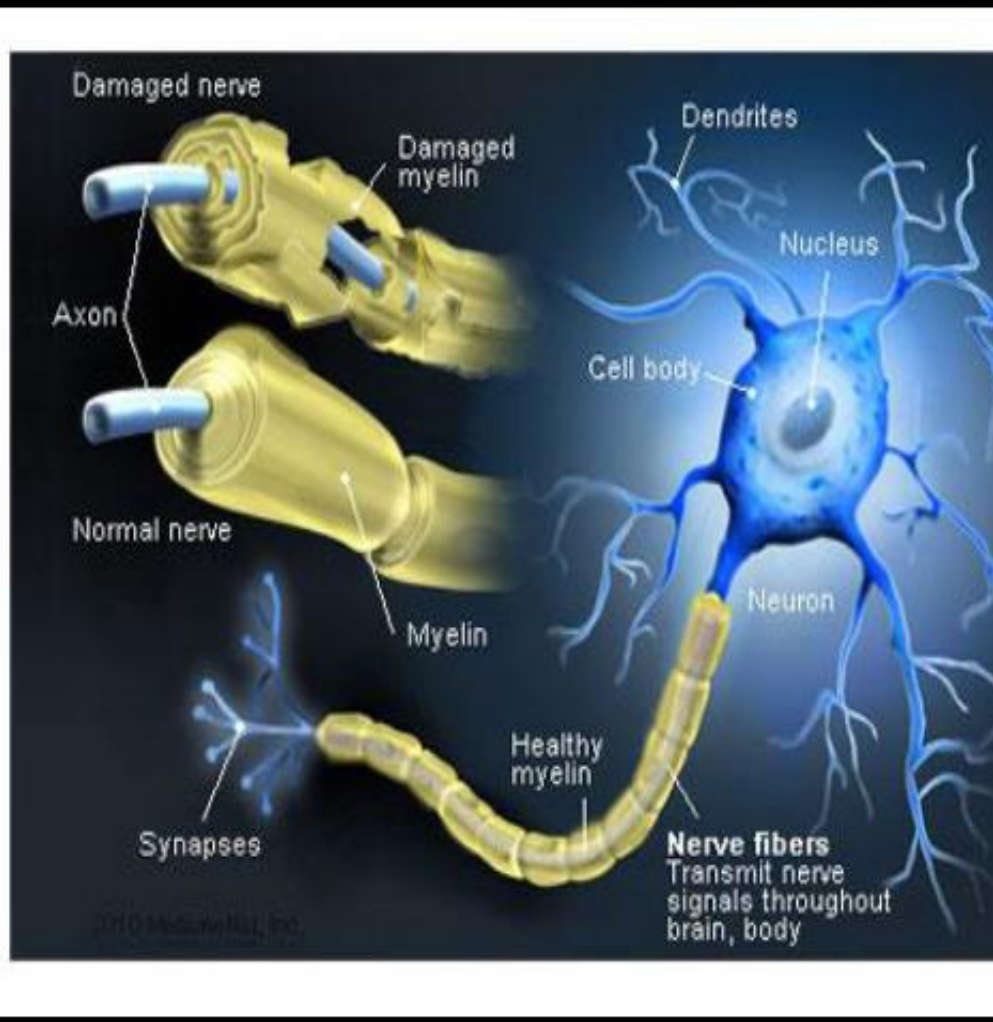
Multiple Sclerosis

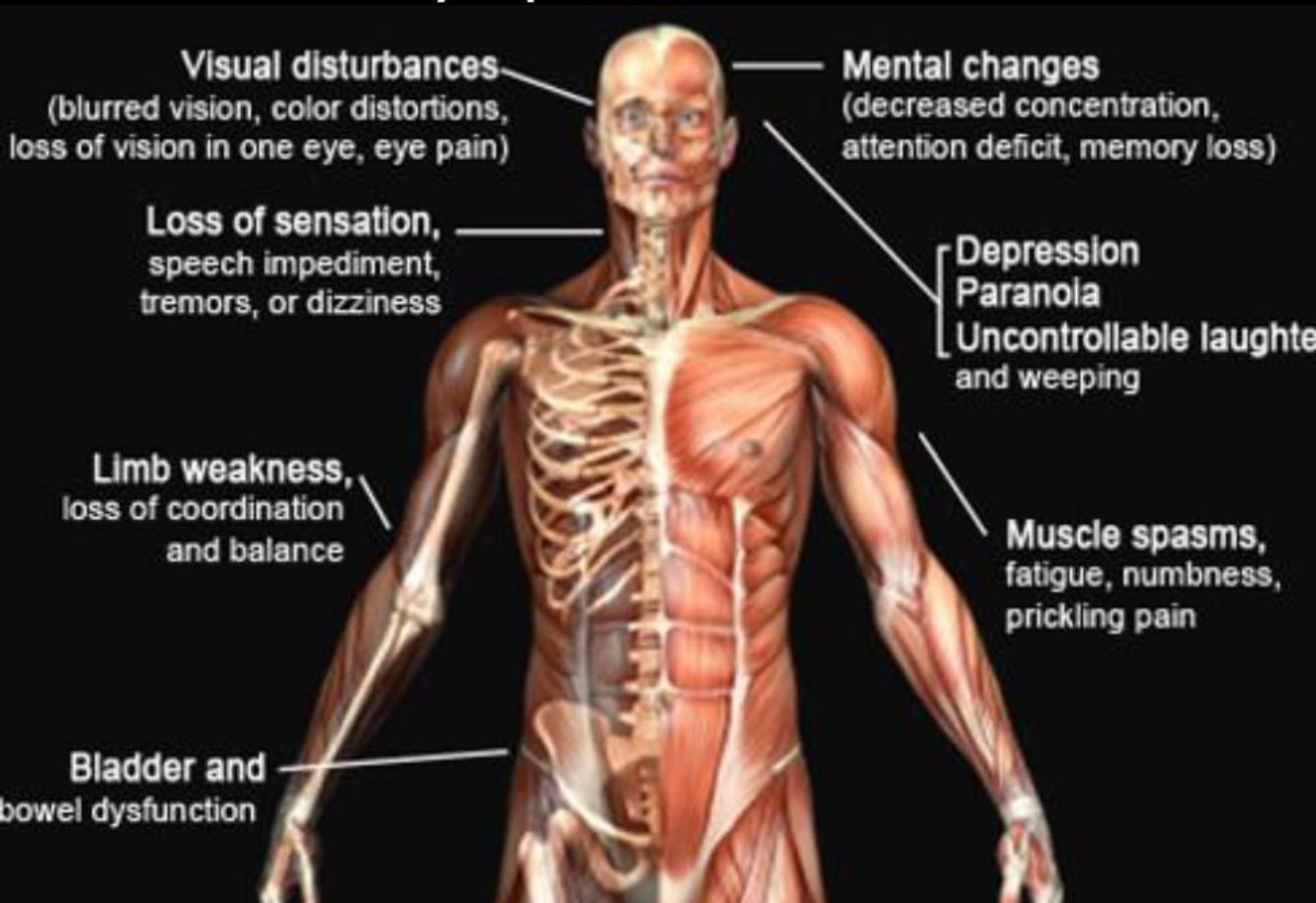
What is MS?

[No Title]





Symptoms of MS



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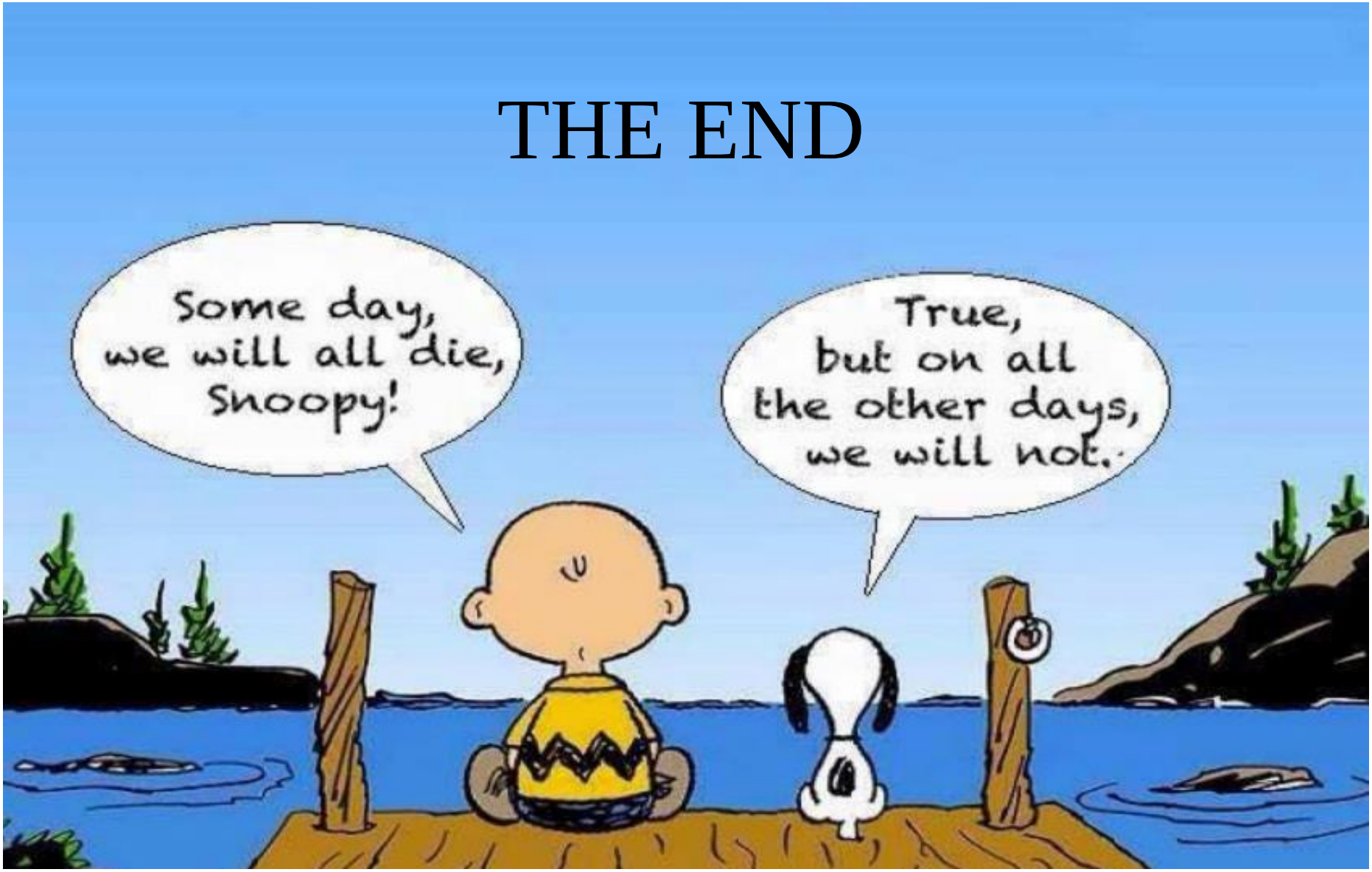
THE END


Some day, we will all die, Snoopy!
True, but on all the other days, we will not.