

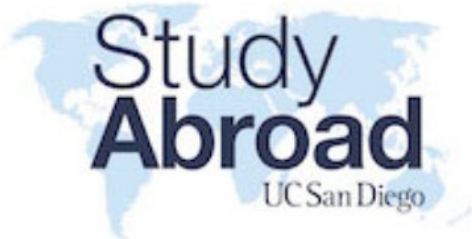
Professor Johnson's COGS17 as taught by Boyle

99% of the material is from Dr. Christine
Johnson's Course

The Origins of Mind



St Andrews, Scotland



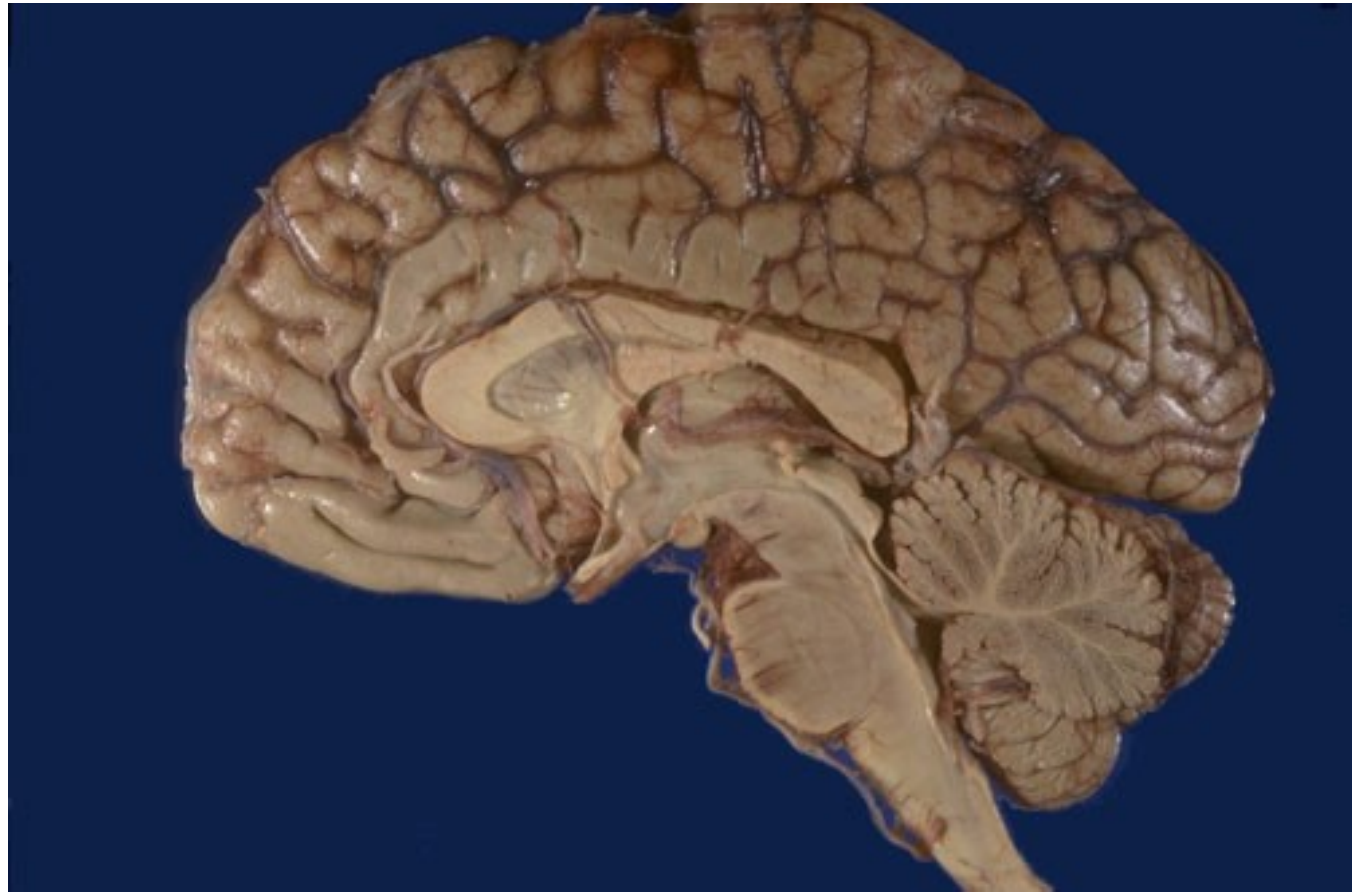
<https://studyabroad.ucsd.edu/students/programs/global-seminars/st-andrews/index.html>

Overview

Professor	<p>Christine Johnson c8johnson@ucsd.edu</p>  <p>Christine Johnson is a faculty member in the UC San Diego Cognitive Science Department. Her work focuses on the behavior and cognition of nonhumans, in the laboratory and in the field, largely in an effort to see what light a comparative perspective can shed on the origins and nature of the human mind. She regularly involves undergraduates in her research and believes in the value of intensive, cooperative, hands-on learning.</p>
Courses	<ul style="list-style-type: none">• COGS 143GS: Animal Cognition (PDF)• COGS 184GS: Modeling the Evolution of Cognition (PDF)• COGS 143GS + 184GS: Combined Schedule (PDF)

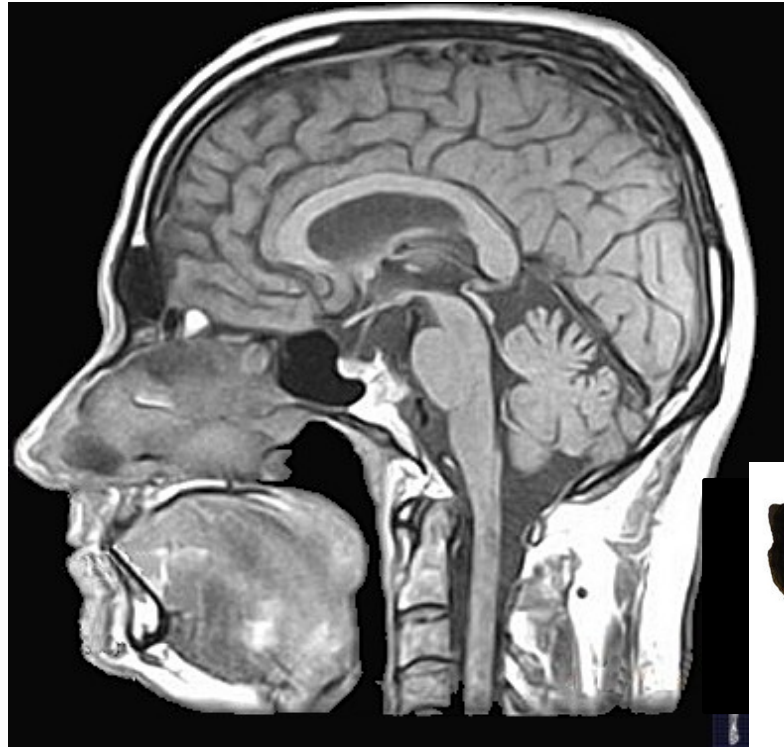
LEC 1A

ANATOMY OF THE NERVOUS SYSTEM

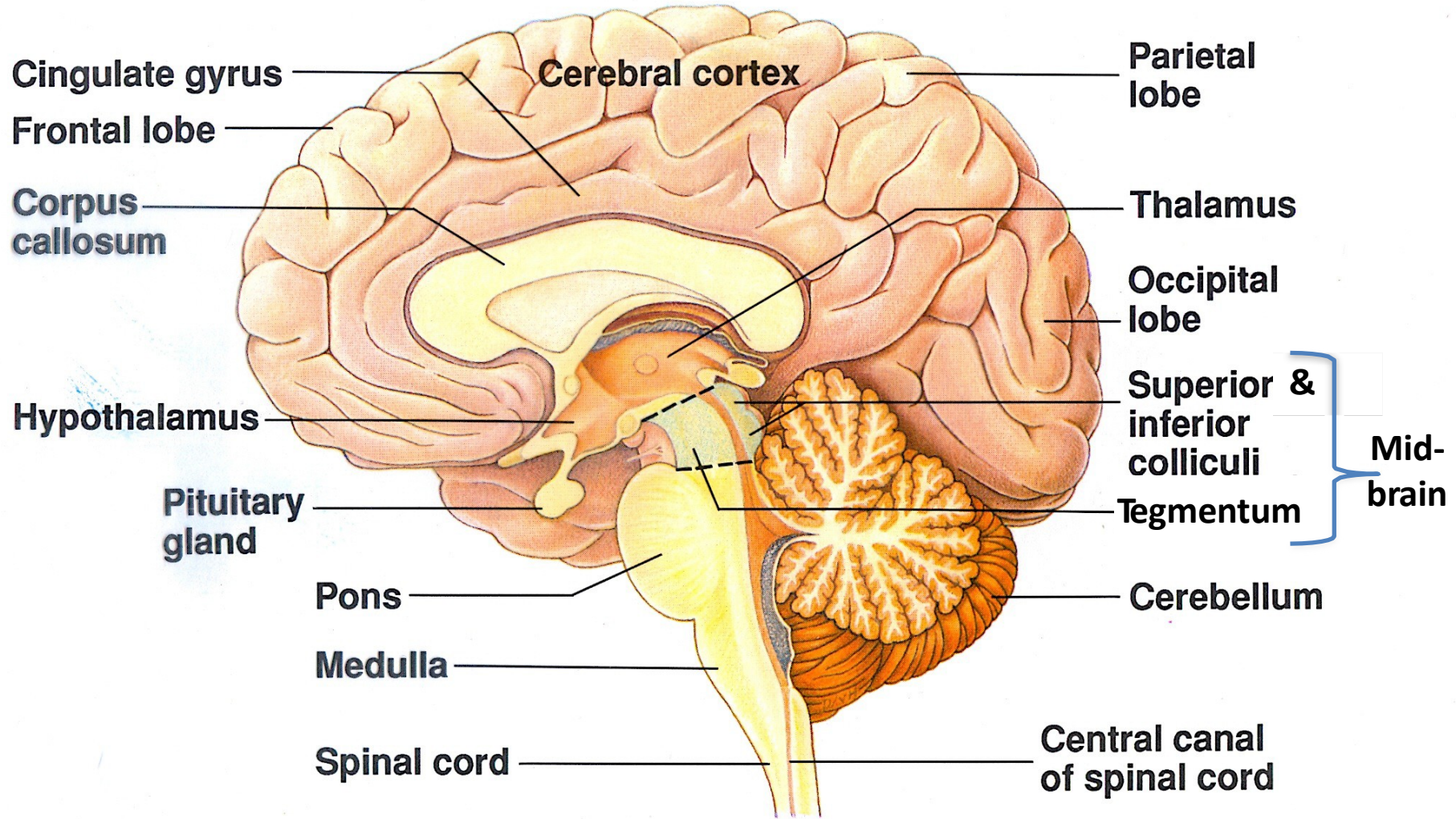


Cogs 17 * UCSD

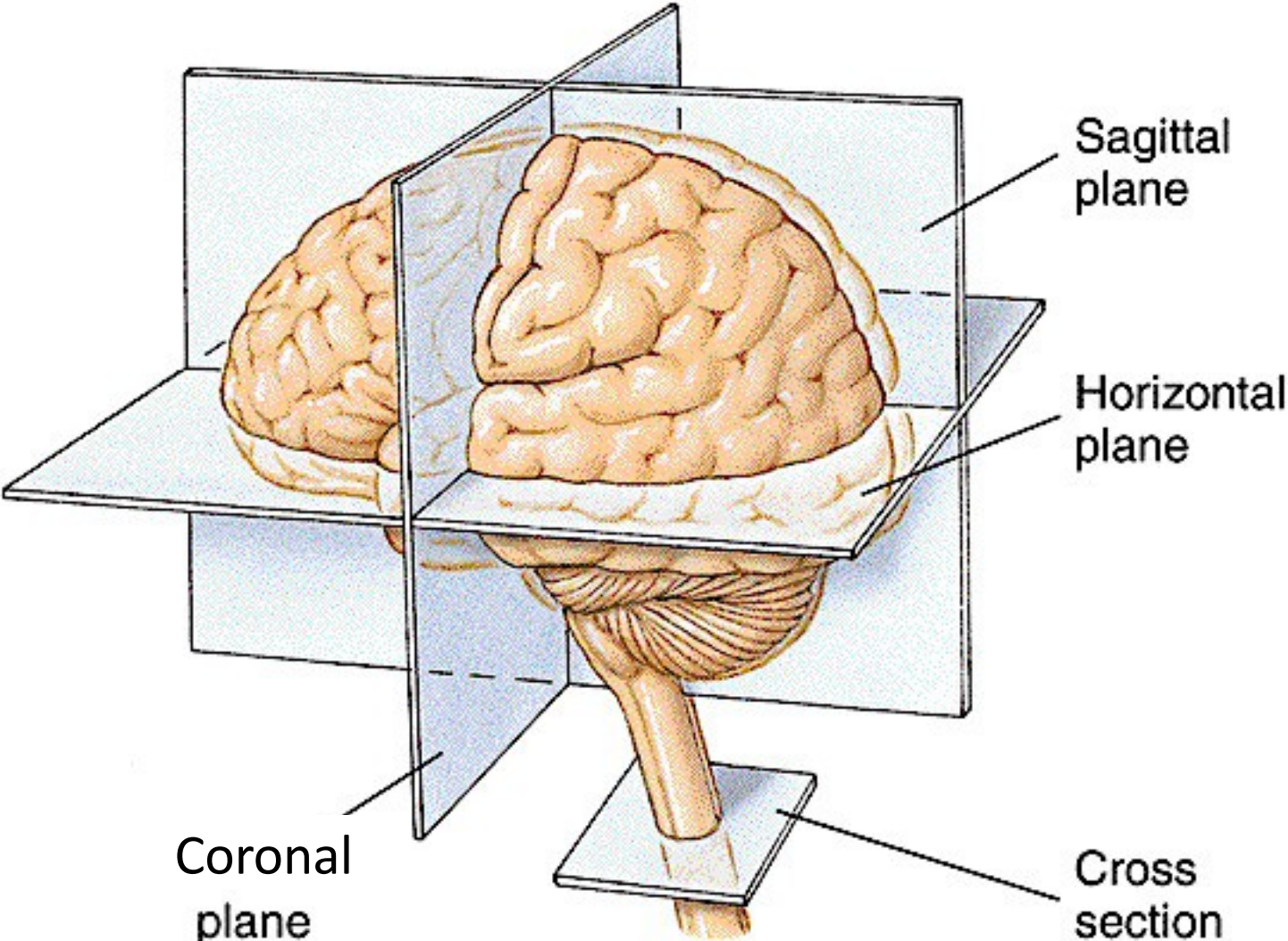
Consciousness – "The Hard Problem"



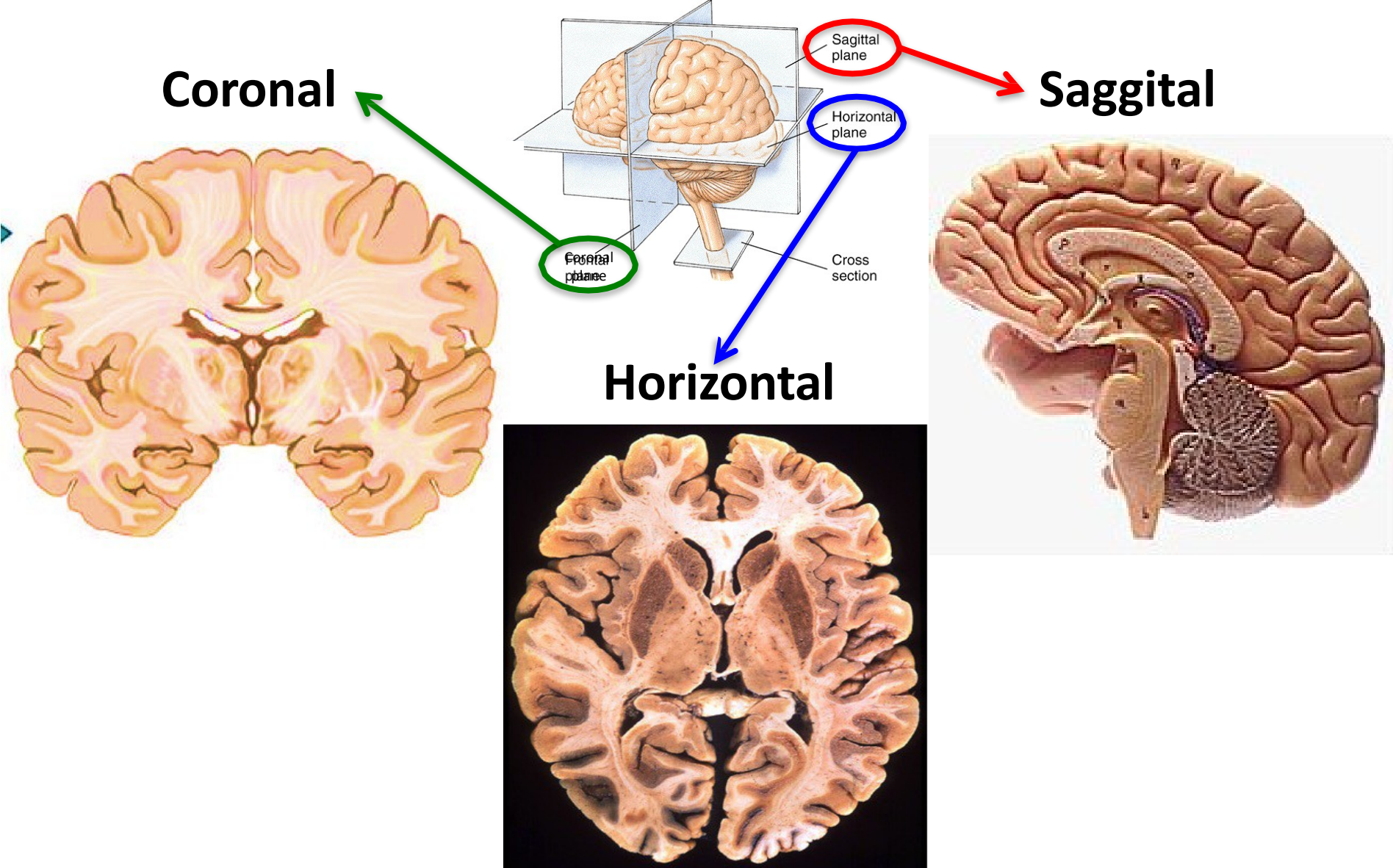
Mid-Sagittal Section



Planer Views of the Brain



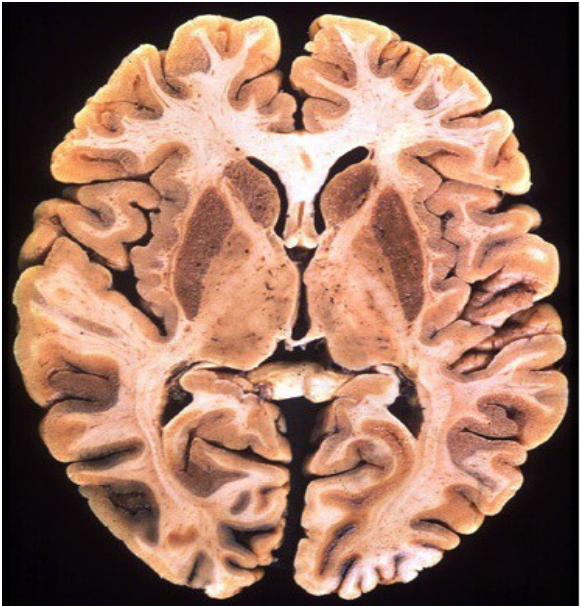
Planer Views of the Brain



Coronal



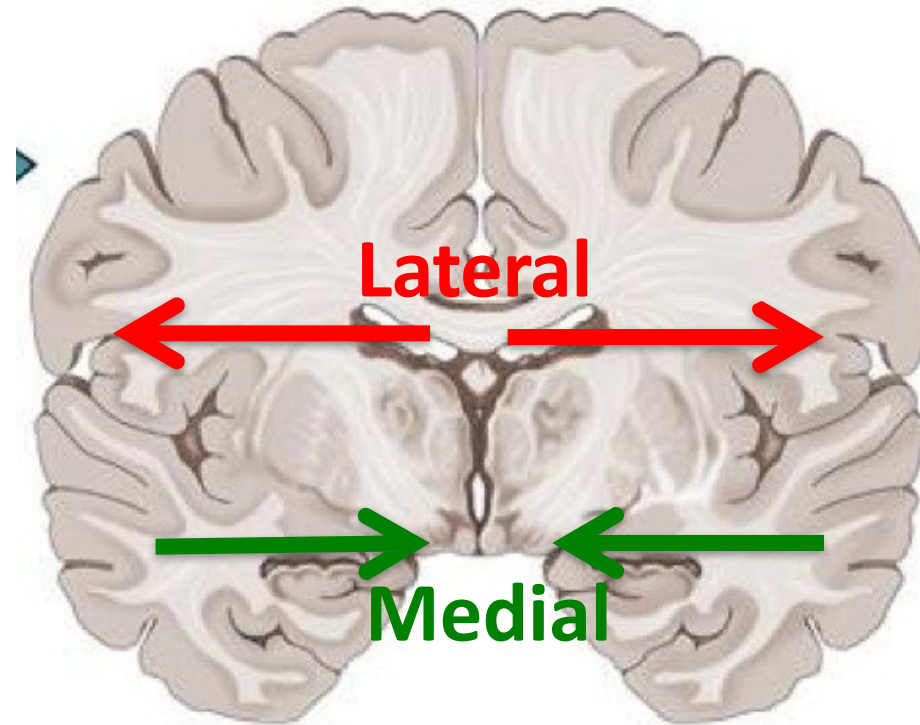
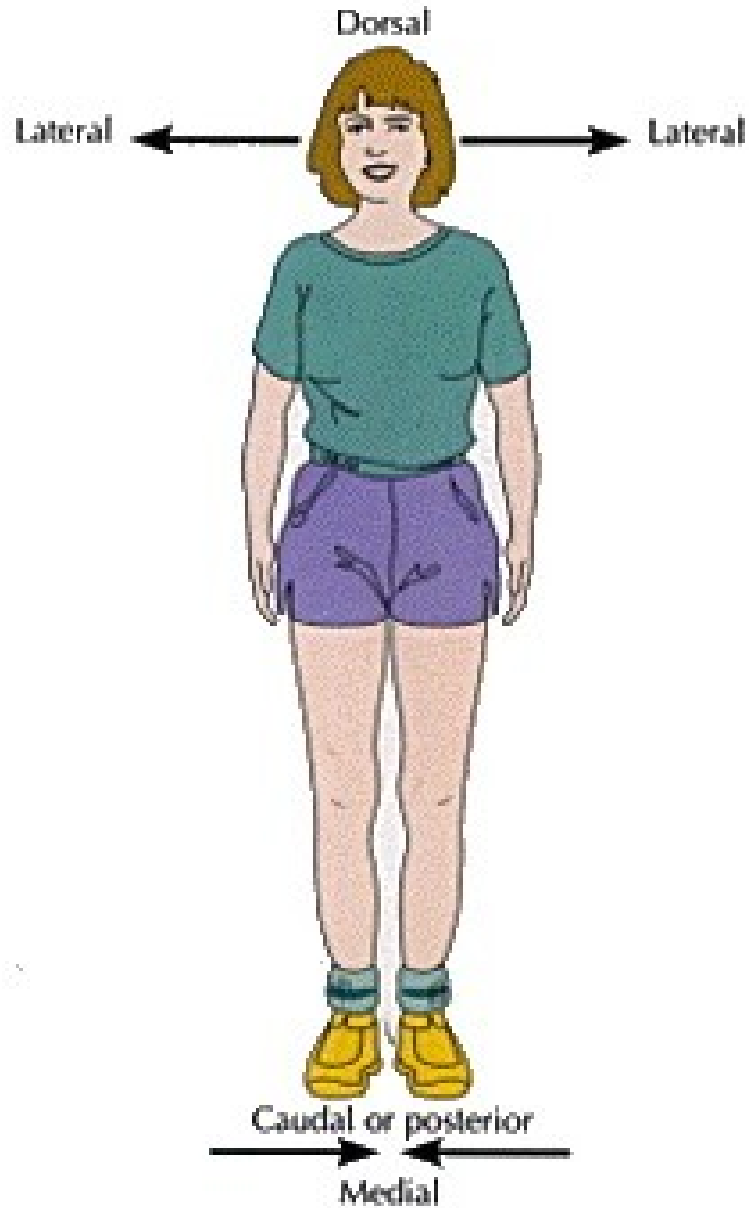
Horizontal



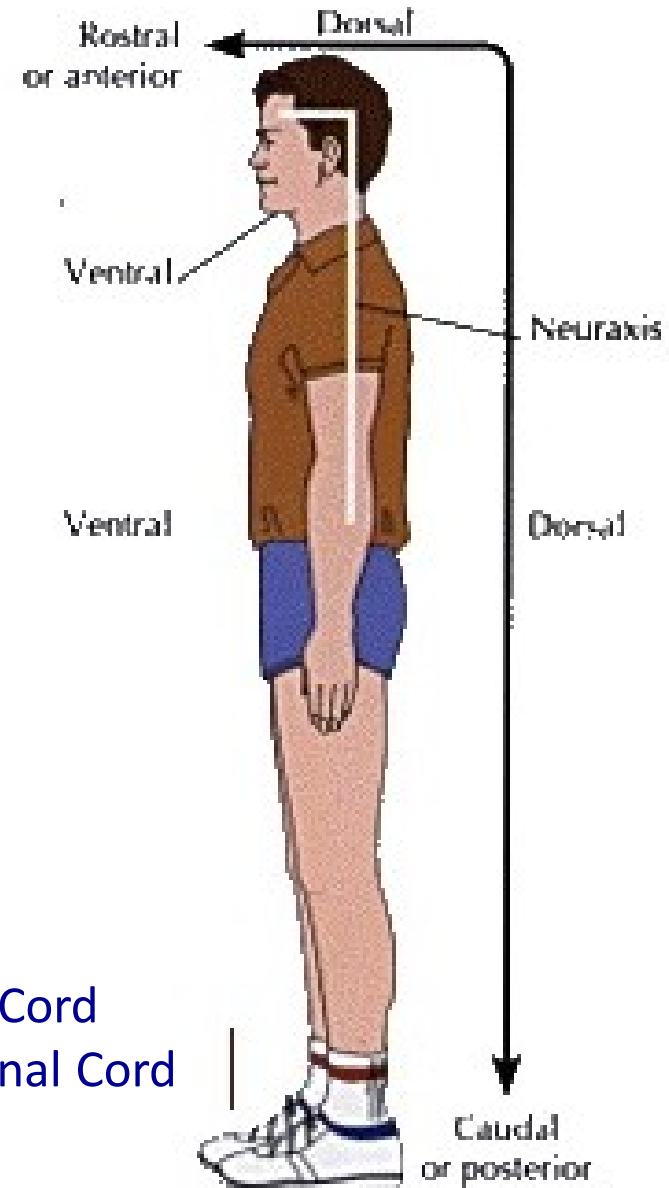
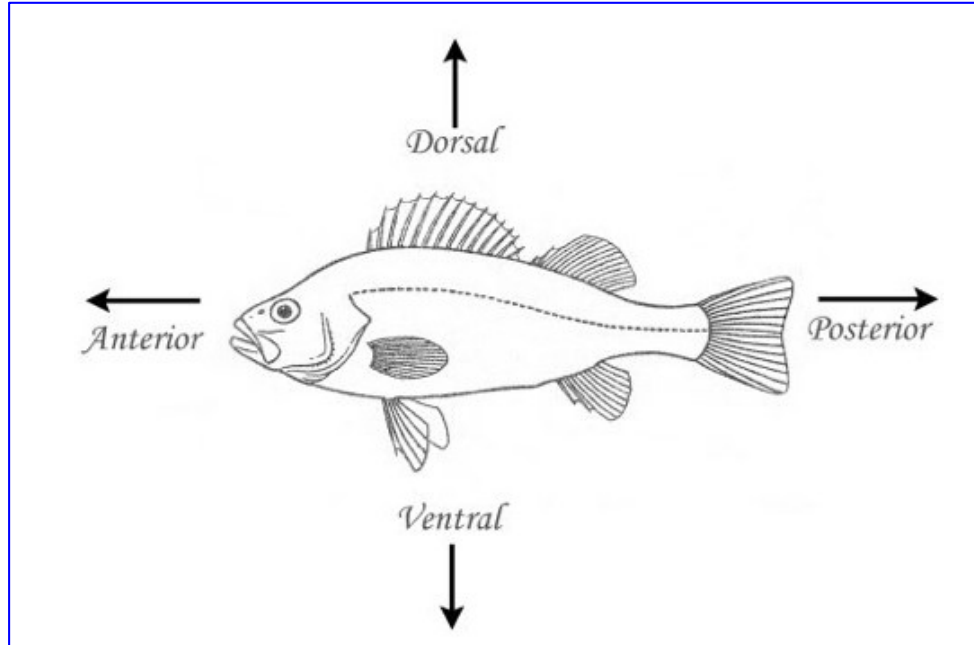
Saggital



Lateral & Medial



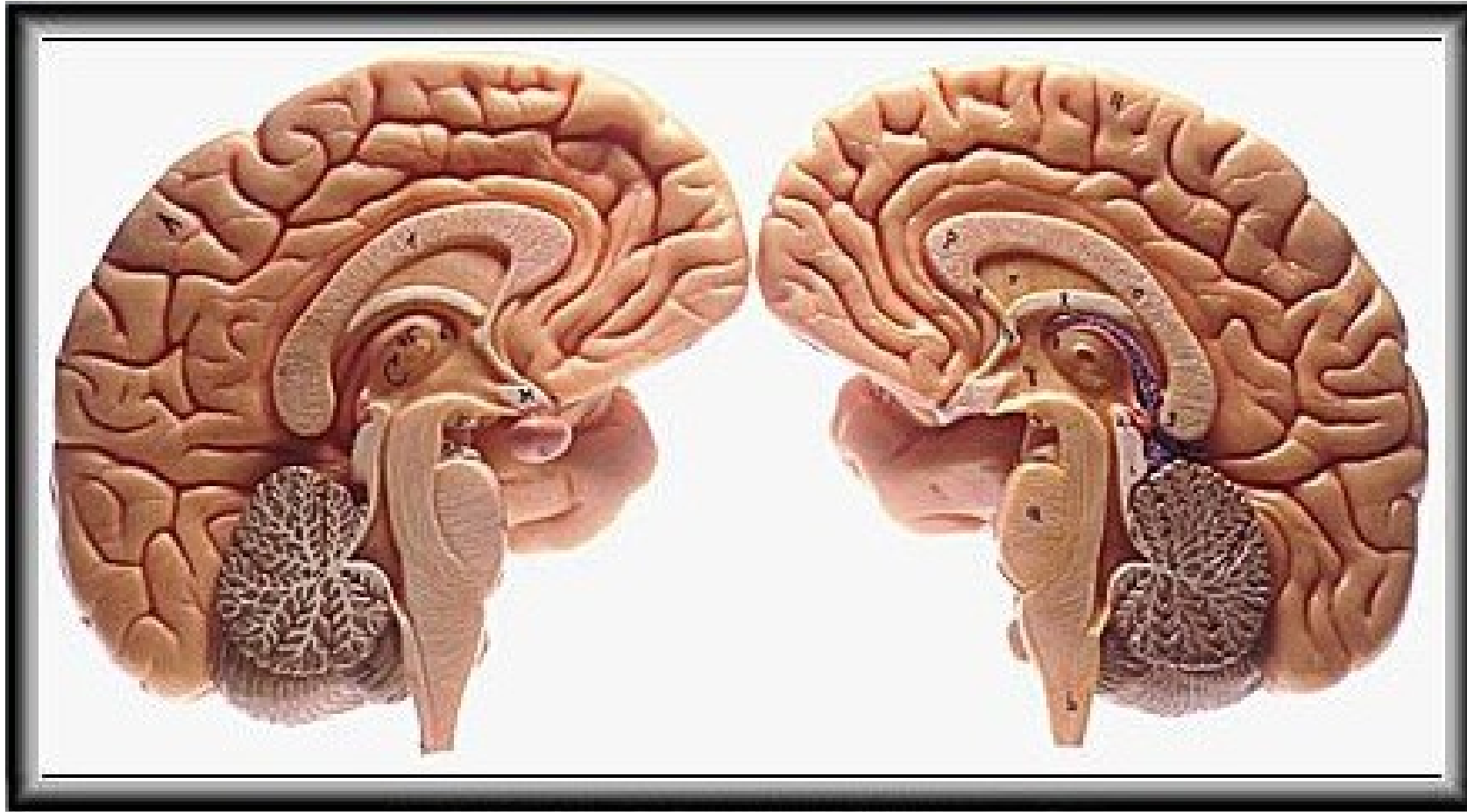
Dorsal & Ventral



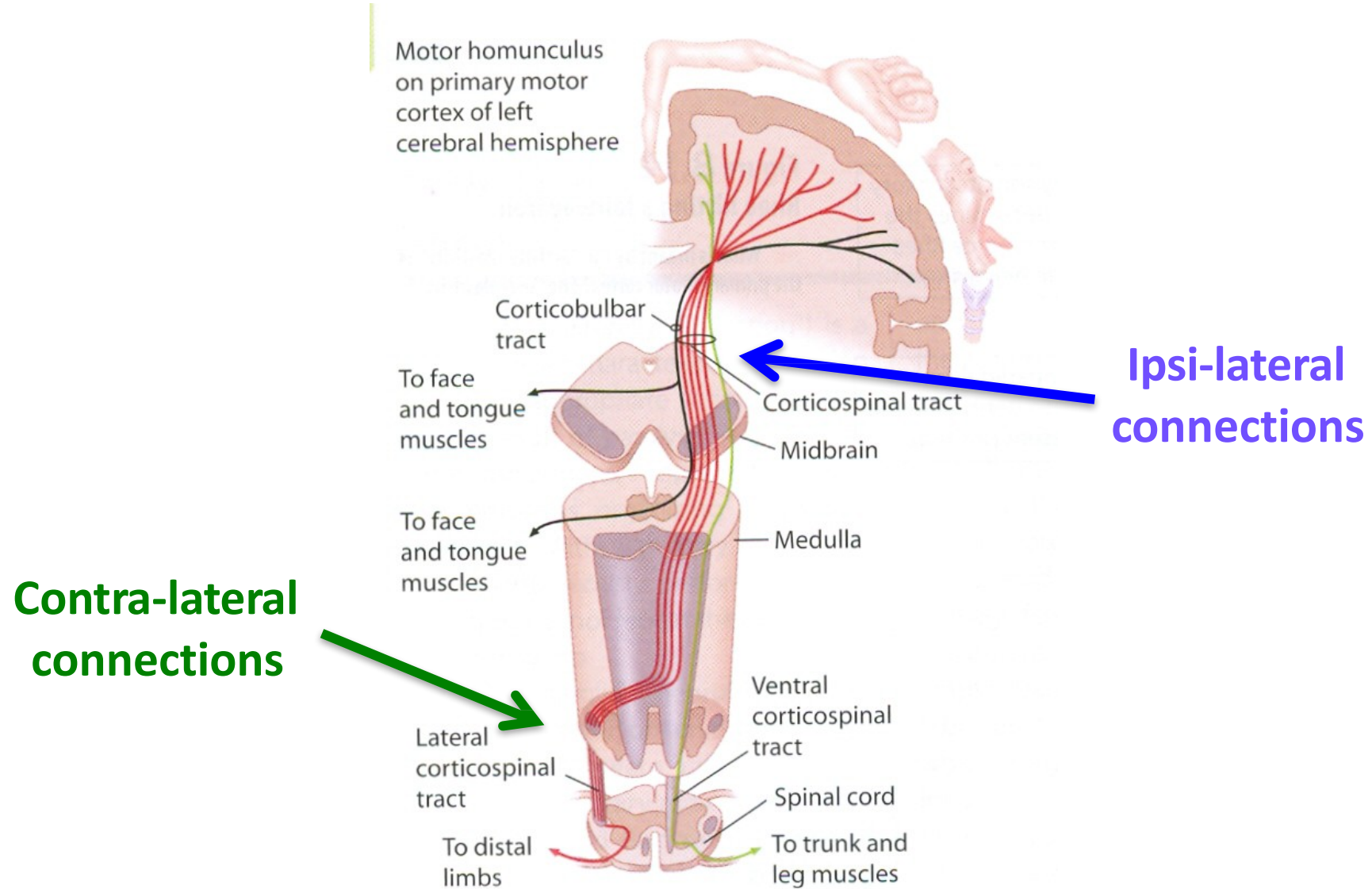
In Humans,
"Dorsal" = TOP of Brain & REAR of Spinal Cord
"Ventral" = BOTTOM of Brain & FRONT of Spinal Cord

Bilateral Structure

Nervous System duplicated on right & left



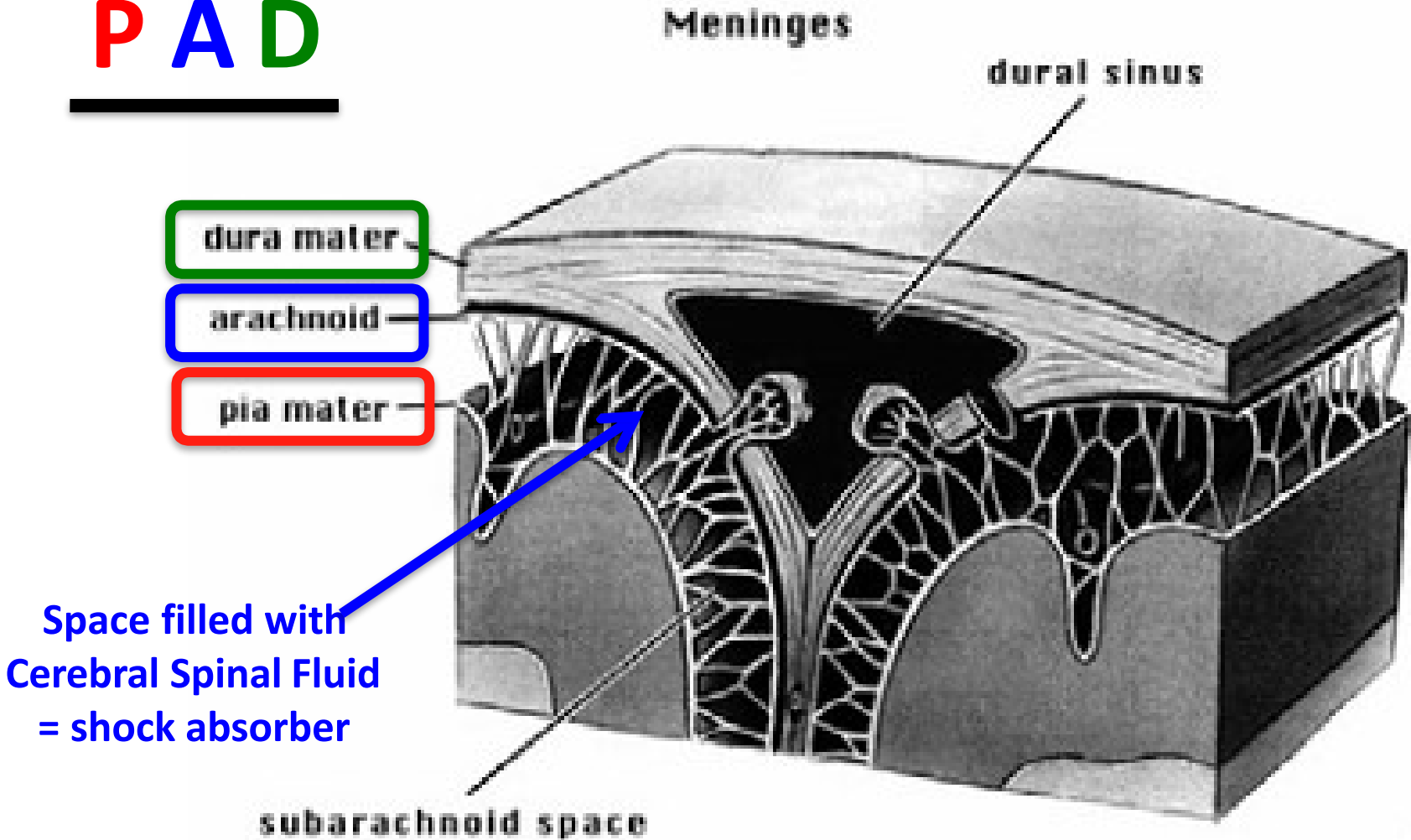
Ipsi-lateral (same side) and Contra-lateral (opposite side) Connections



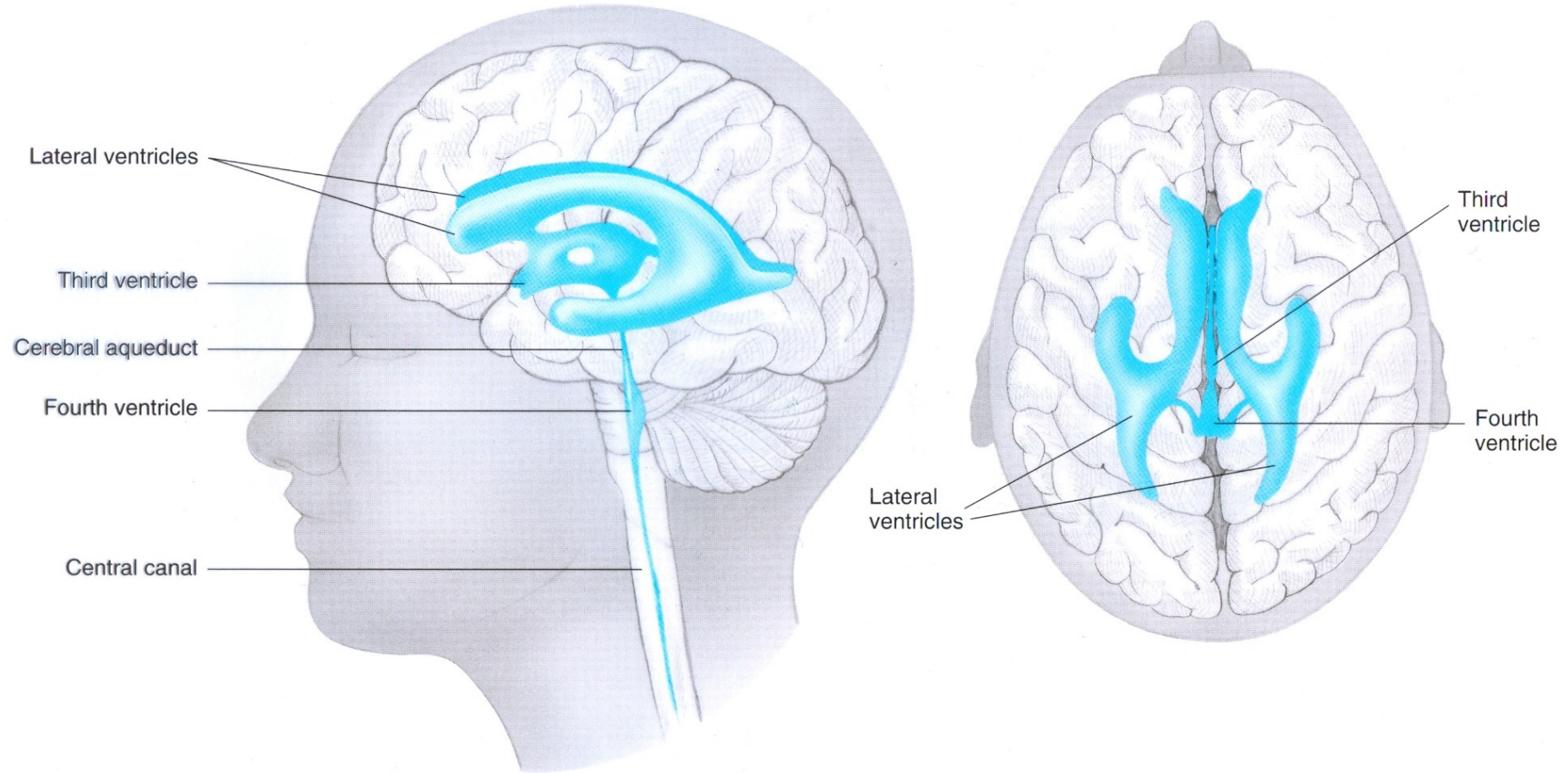
Support Structures: The **Meninges**

Surrounds CNS under bone

P A D

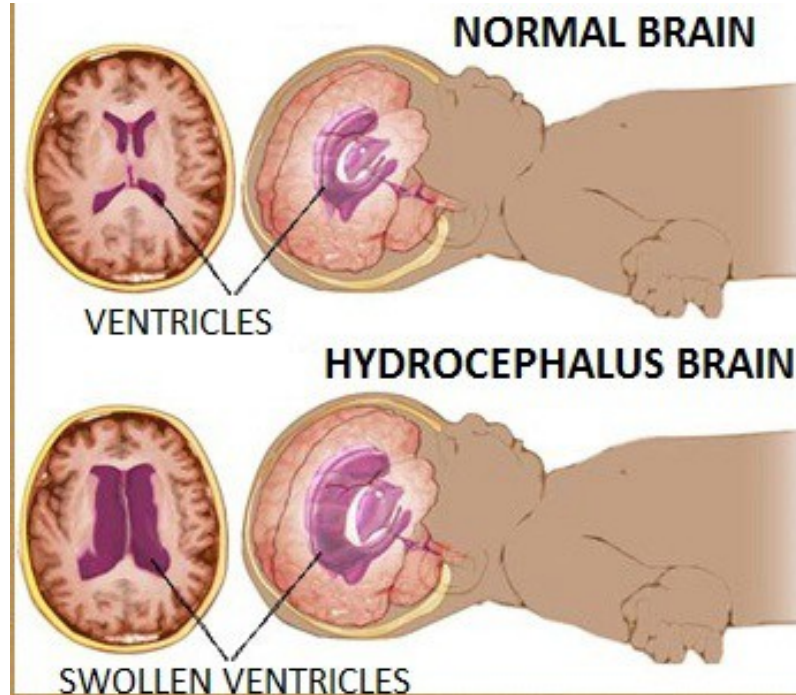


Ventricles

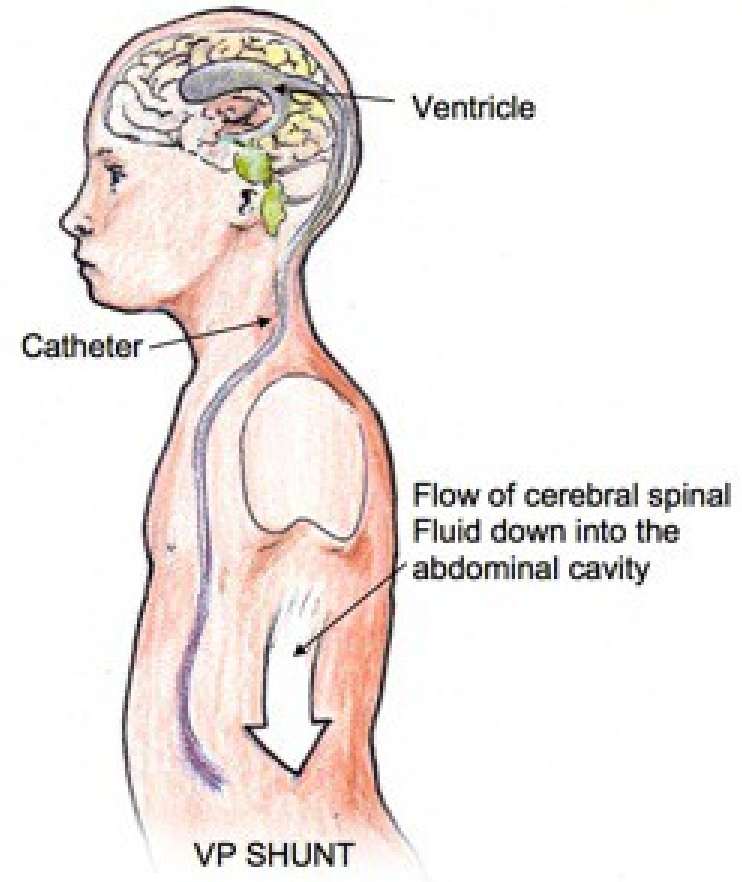


Produce, and filled with, Cerebral Spinal Fluid (CSF)

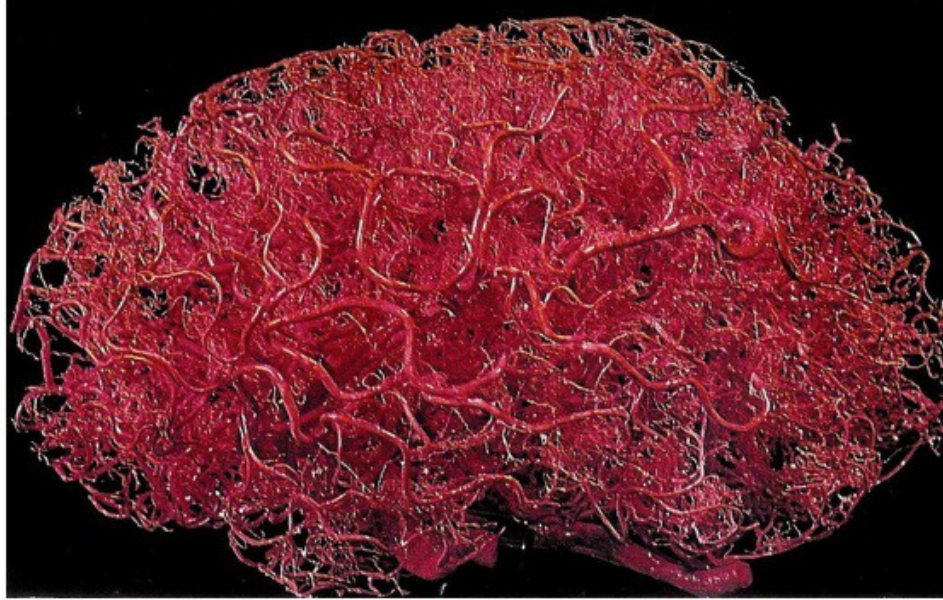
Hydrocephalus



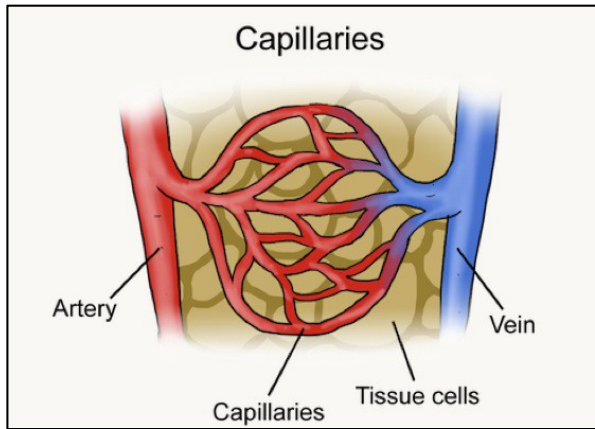
If CSF does not drain properly,
can build up in Ventricles



Blood Vessels in Brain



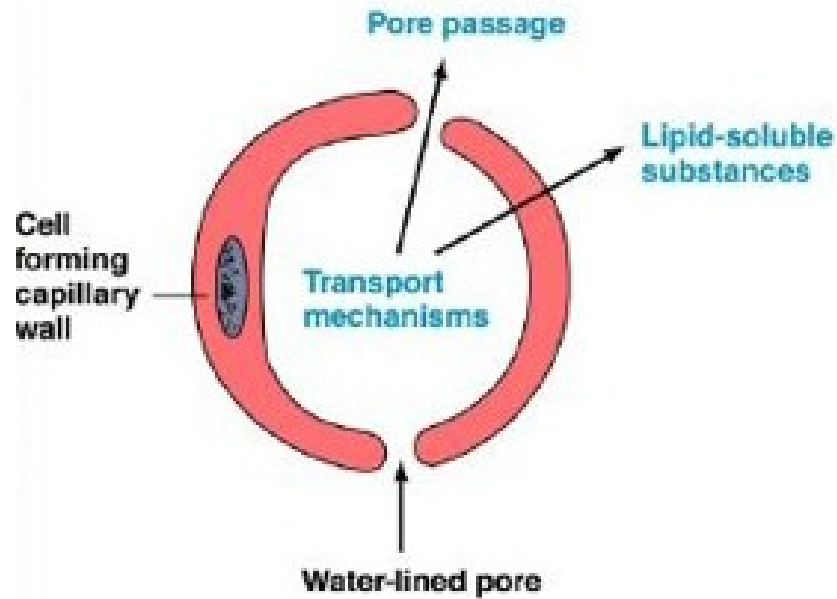
Brain = 2% of body weight,
uses 20% of blood supply!

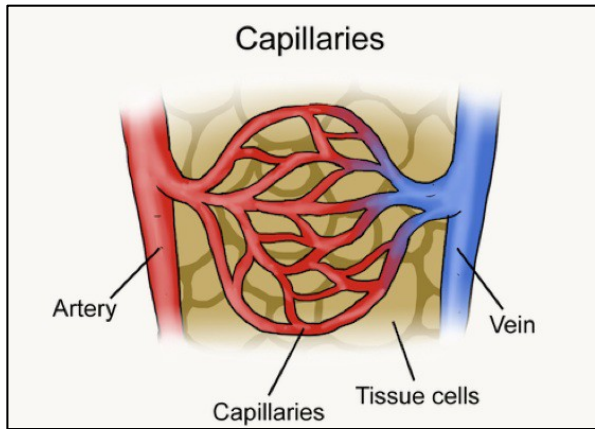


Blood-Brain Barrier

Exercising tight controls over what enters brain from bloodstream

Most capillaries in body

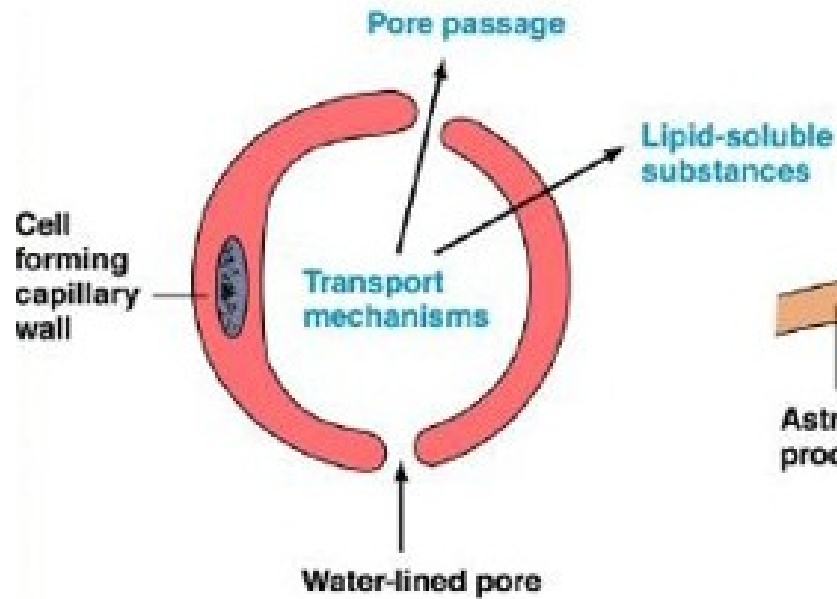




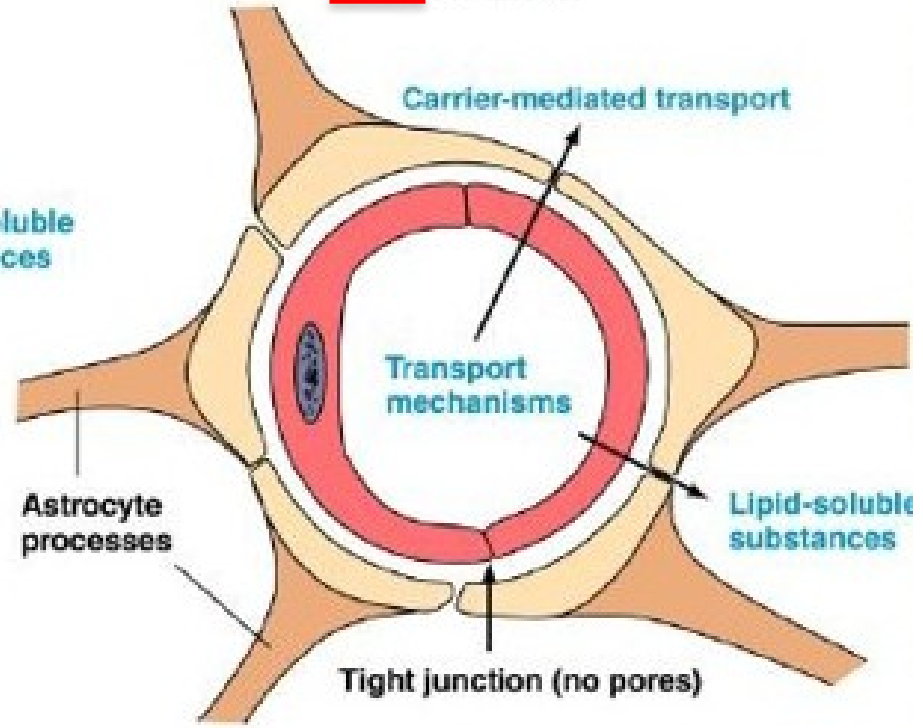
Blood-Brain Barrier

Exercising tight controls over what enters brain from bloodstream

Most capillaries in body



Brain capillaries



Capillaries in cross section

Blood Brain Barrier

BBB - studies done by Paul Ehrlich (1885, 1906)
Edwin Goldman (1909, 1913)



*vital dye
→ inject into living tissue w/o "obvious" damage



BLOOD BRAIN BARRIER

idea of a barrier surrounding CNS

What was discovered in the end was that the BBB -
protected

*not just "Brain"

- ① BRAIN
- ② SPINAL CORD
- ③ PERIPHERAL NERVES

Why do we want a BBB?

- need to protect neurons & their env.
- neurons are delicate
- need a stable environment

- neurons get nutrition from blood
- move waste into blood
- so why the barrier?
- the extracellular environment is "sacred" & should not be disturbed.
- hormones in blood fluctuate
 - fasting, eating, stress
 - ↳ these fluctuations should not disturb neurons*
 - ↳ or some of them
- the protection of the extracellular environment

- BBB's job is to keep the environment stable — not be at the mercy of changes in the blood
- metabolites in blood should not modify the microenvironment
- ionic levels need to be stable
 - sodium
 - potassium
 - magnesium

What exactly is the BBB ^{micro & macro level.}

- acts as a "stabilizer"

- acts as a "protector"

↳ exogenous] toxins
endogenous]

must have a mechanism
to protect ↳ even some
drugs

- microbes - bacteria

- virus

- HOLDER

↳ stores & caches neurotransmitters

eg Gln] store the
5HT] valuable

so they are XMITERS

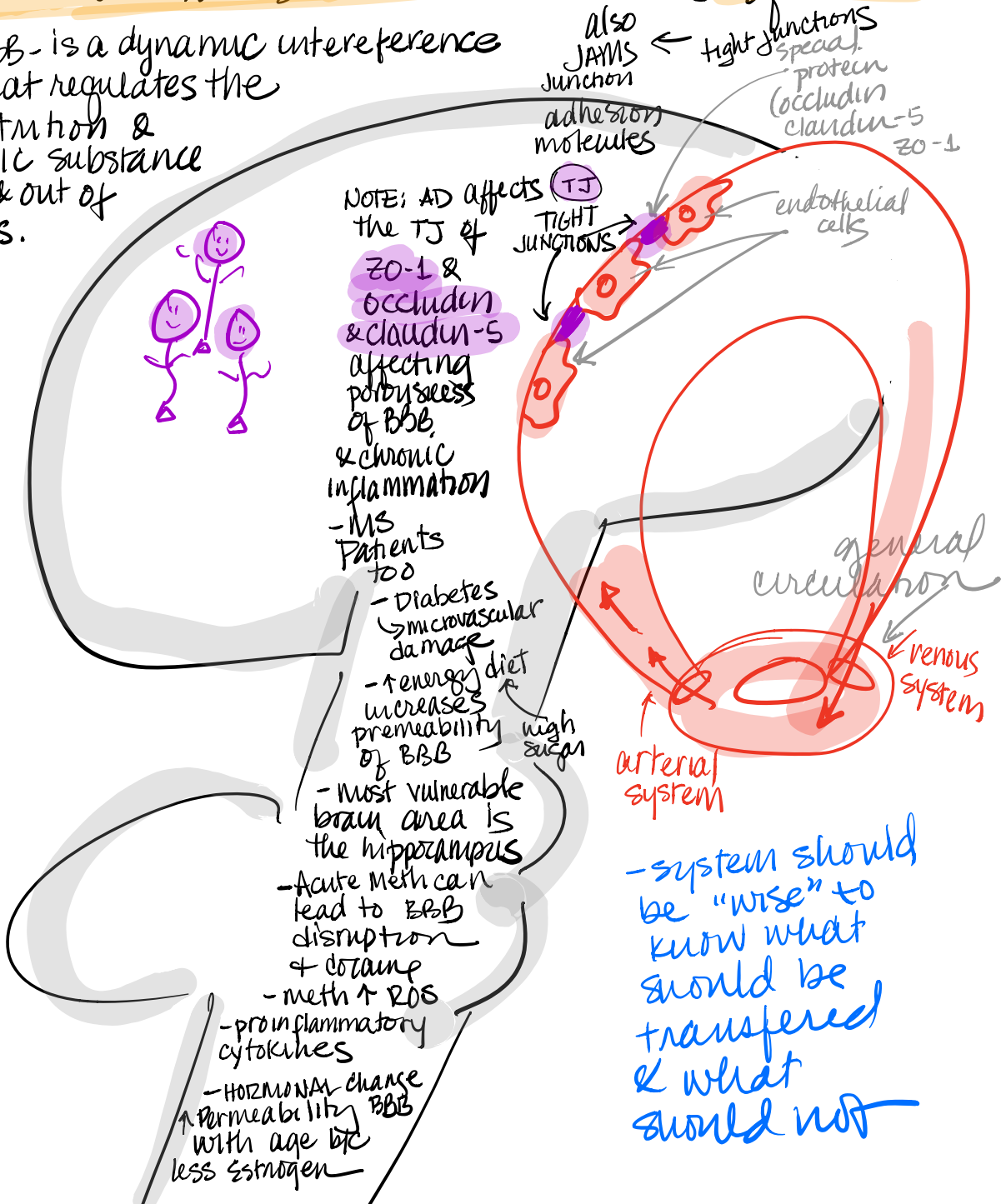
NOT flushed away

Q. How much blood is flushed through the brain?
about 15% of cardiac output goes to brain
700-800 ml blood/min
exercising - almost 1 l/min.

- so XMITs could get flushed away.

What are the structural details of BBB

BBB - is a dynamic interreference that regulates the nutrition & toxic substance in & out of CNS.



- system should be "wise" to know what should be transferred & what should not

control of flow

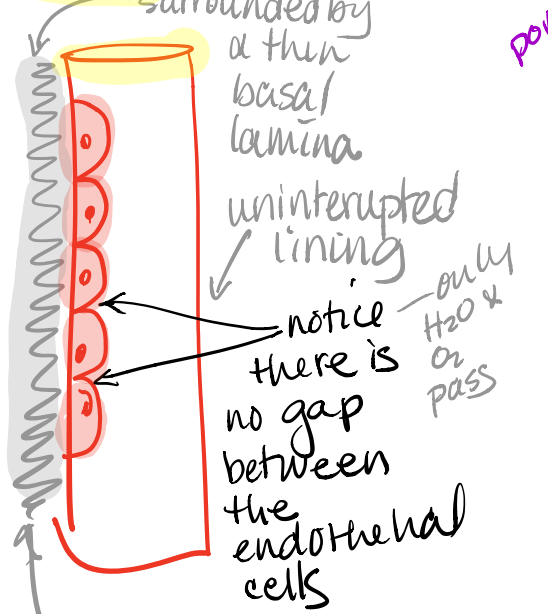
connect arterioles & venules to exchange...

measure 5-10µm diameter
 → exchange O₂, H₂O, CO₂, nut. + waste

part of microcirculation
 capillaries are the narrowest smallest blood vessels

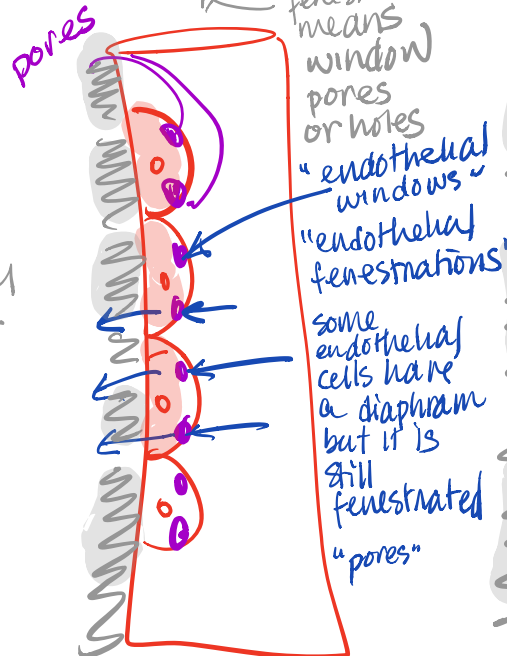
Types of capillaries

no gaps
Continuous/tight

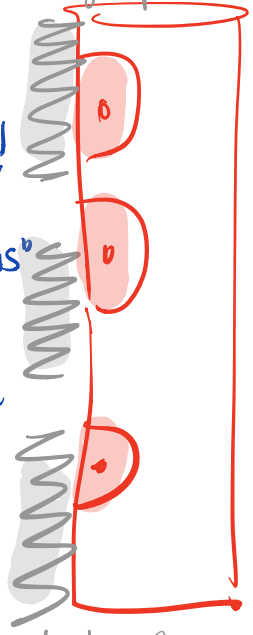


basal lamina is also continuous

Fenestrated



Sinusoidal
 lymph



adrenal
 liver & spleen

↓
find these in
CNS

& in periphery

- muscles (there are
some
endothelial
gaps here)

but
not
in CNS

↓
small
molecules
&
limited
proteins
to
pass

↓
enables
blood to
pass

special type
of "fenestrated"
capillaries

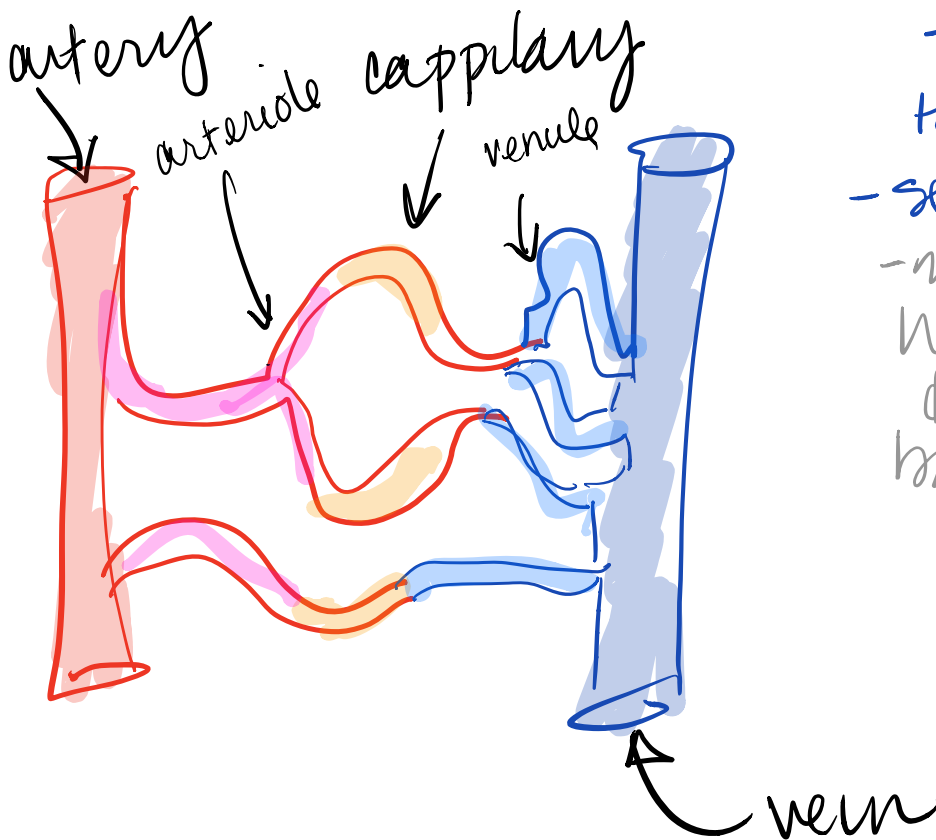
- larger
openings
20-40 μm

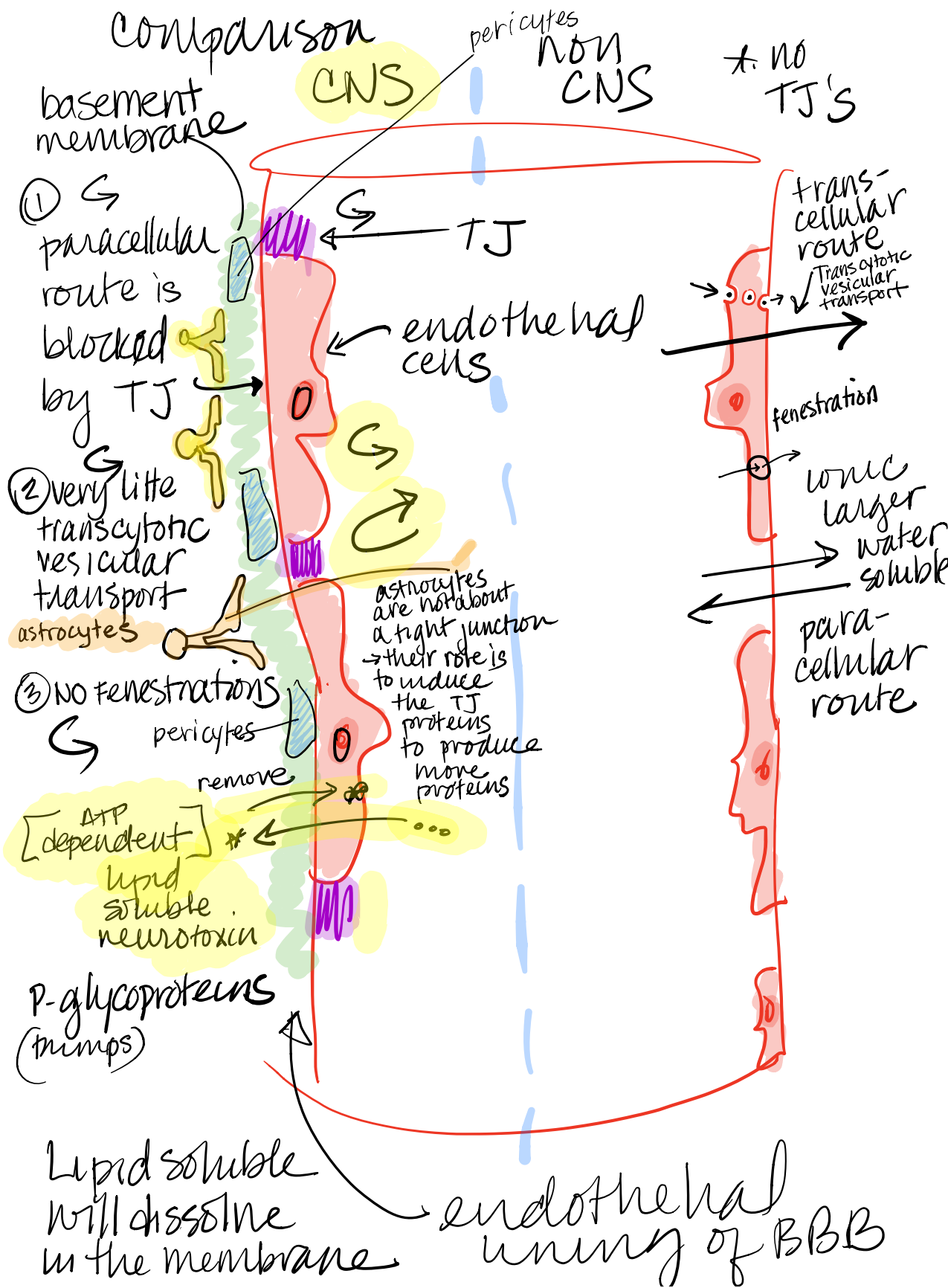
- allow R/W
blood cells

7.5-25 μm
to pass

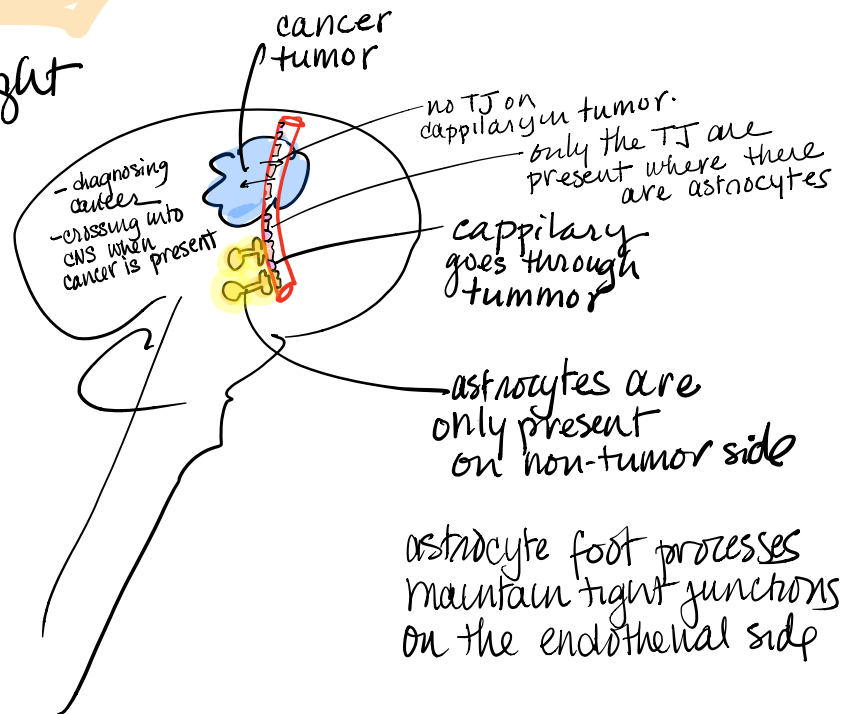
- serum

- may also
have
discontinuous
basal lamina





How do we know that
the astrocytes
induce the tight
junctions?



* The peripheral nerves
have an endoneurium
(no astrocytes, but it
does have the TJ,
no transcytotic vesicular transport
& no paracellular transport.

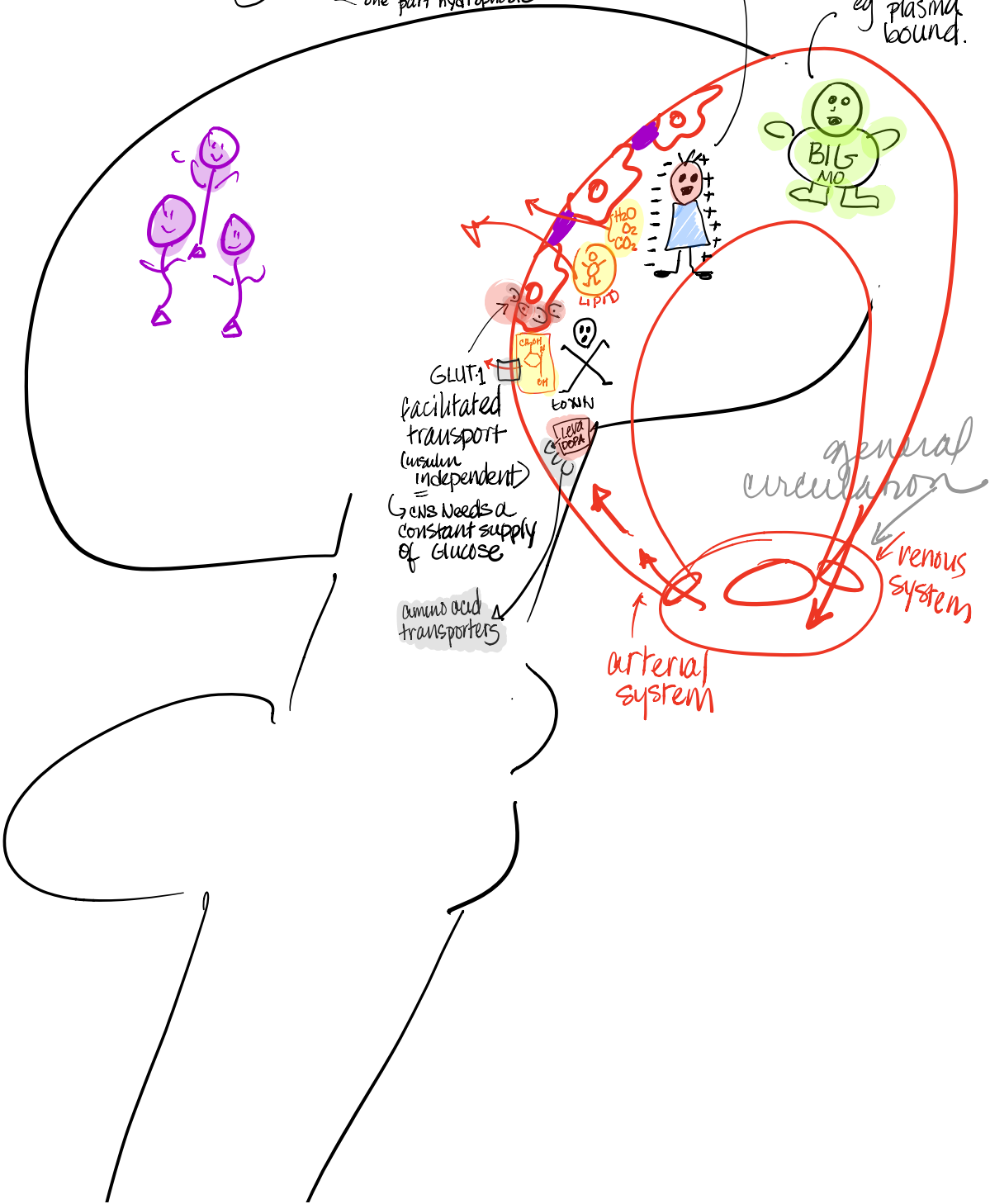
then which substances can pass?

none shall pass

Just like water ← it will be repelled one part hydrophilic one part hydrophobic

HIGHLY POLARIZED/CHARGED MOLECULES CANNOT PASS B/C OF LIPID BARRIER

BIG MOLECULES CANNOT PASS - eg plasma bound.



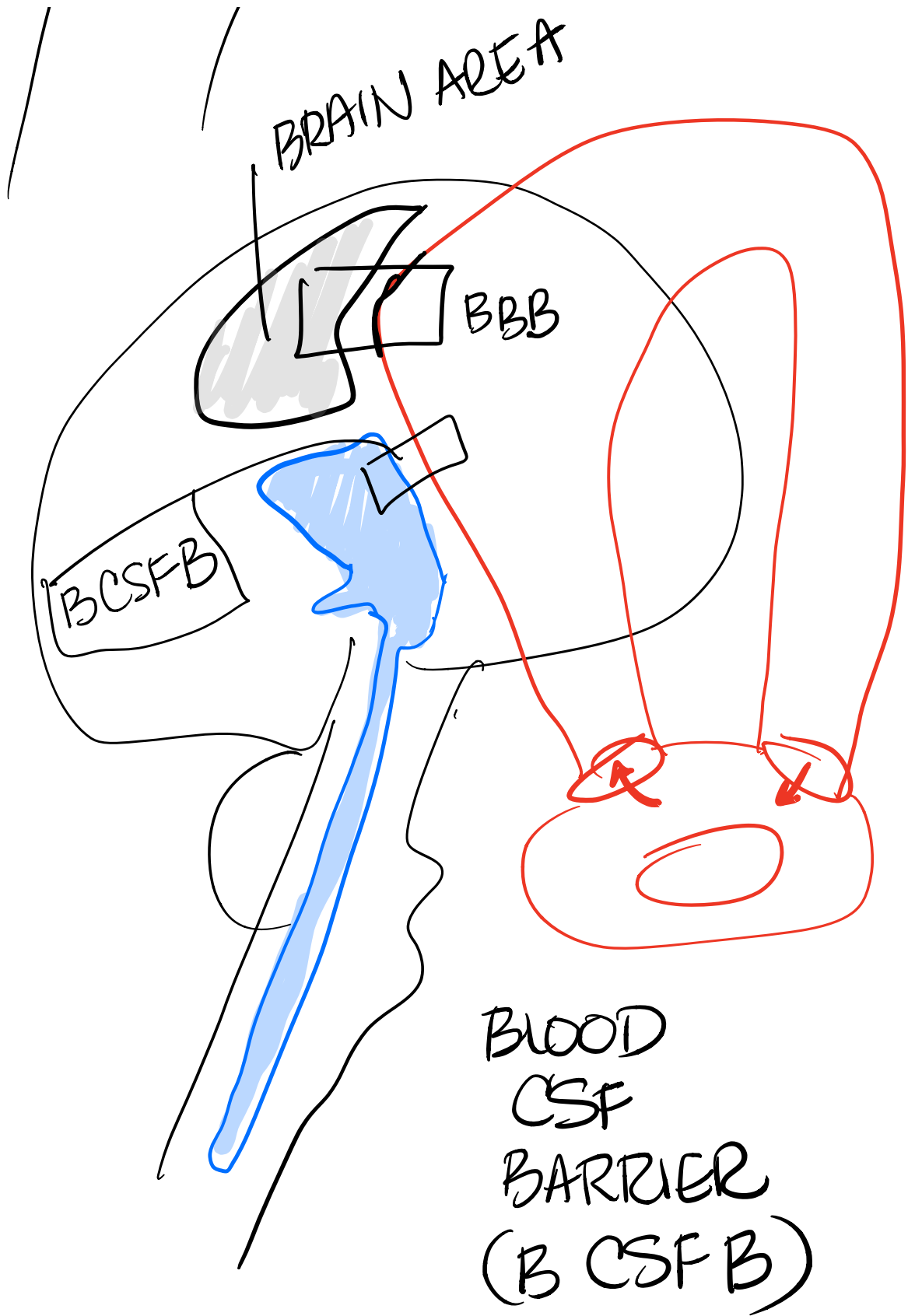
GLUT1 facilitated transport (insulin independent) = Needs a constant supply of glucose

amino acid transporters

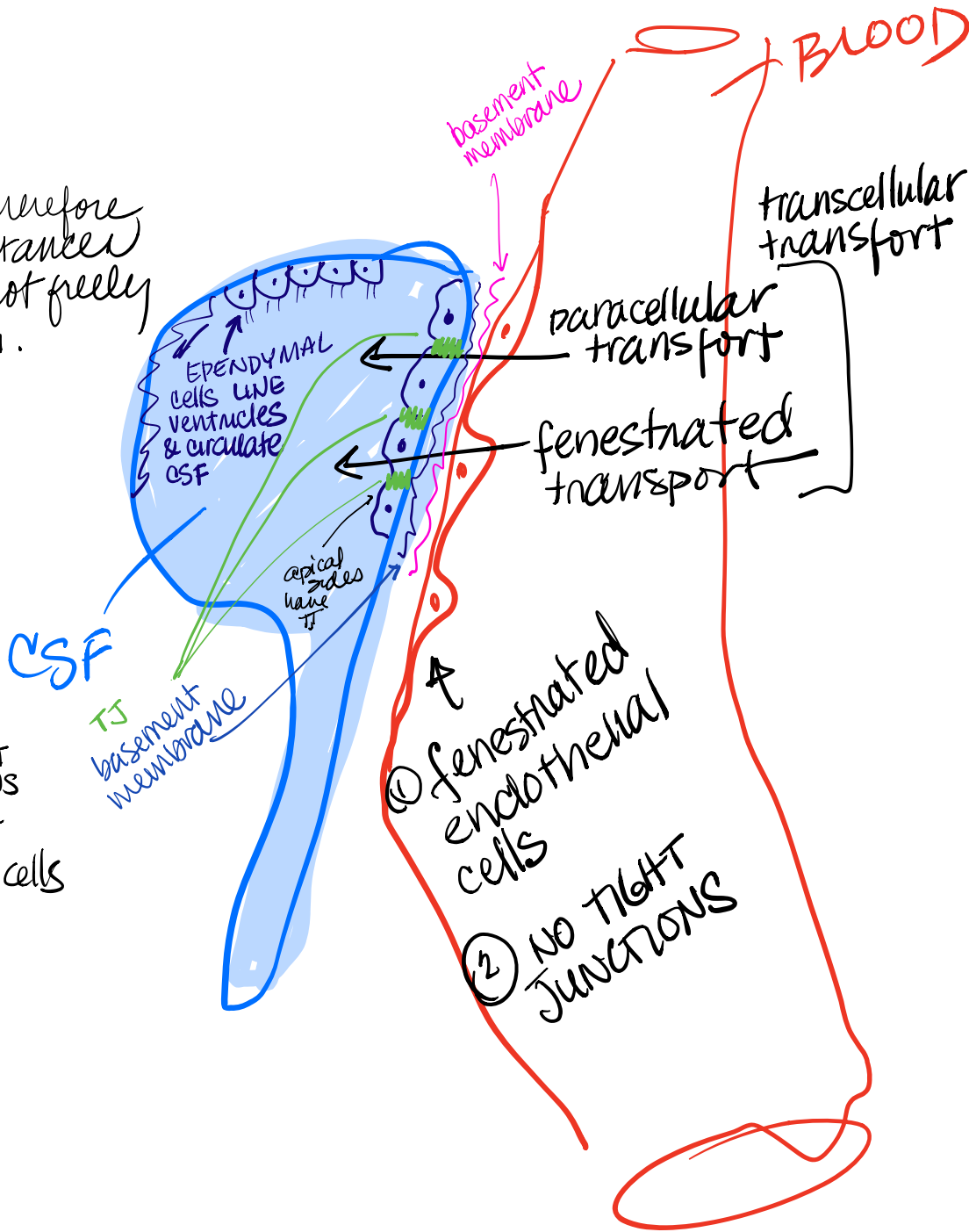
general circulation

arterial system

venous system



∴ therefore substances cannot freely enter.



THE TIGHT JUNCTIONS (TJ) are on the choroidal cells

Under what circumstances is BBB broken down?

- circumventricular organs

→ specialised areas where BBB is more permeable

PATHOLOGICAL PROCESS BBB destroyed

→ TRAUMA — TJ BREAK

INFLAMMATION

INFILTRATION

IRRADIATION

NEOPLASM

↑ HYPERTENSIVE CRISES

(HIGH BLOOD PRESSURE)

↑↑↑↑↑ altitude — low O₂ levels

HYPERTENSIVE ENCEPHALOPATHY

CONSEQUENCE?

→ inappropriate infiltration into CNS

→ water will follow

→ brain swelling

→ brain edema

↙
due to vascular problem
"vasogenic edema"
→ life threatening situation

NOTE: (BILIRUBIN) → neurotoxic
↙ orange-yellow pigment
formed in liver
breakdown of hemoglobin
secreted in bile

Infant with [↑↑ Bilirubin]
↙ damage to Basal ganglia
Kernicterus

NERVOUS SYSTEM

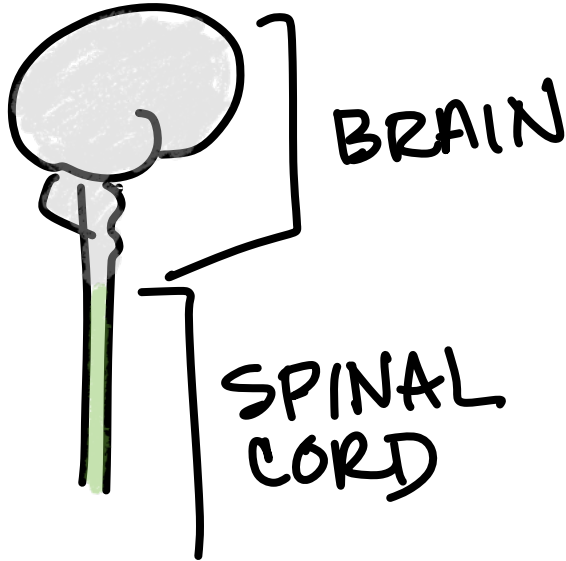
CNS

PNS

NERVOUS SYSTEM

CNS

PNS



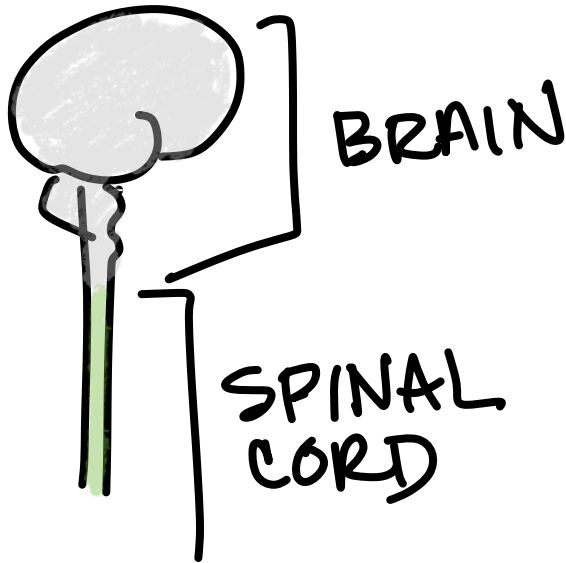
NERVOUS SYSTEM

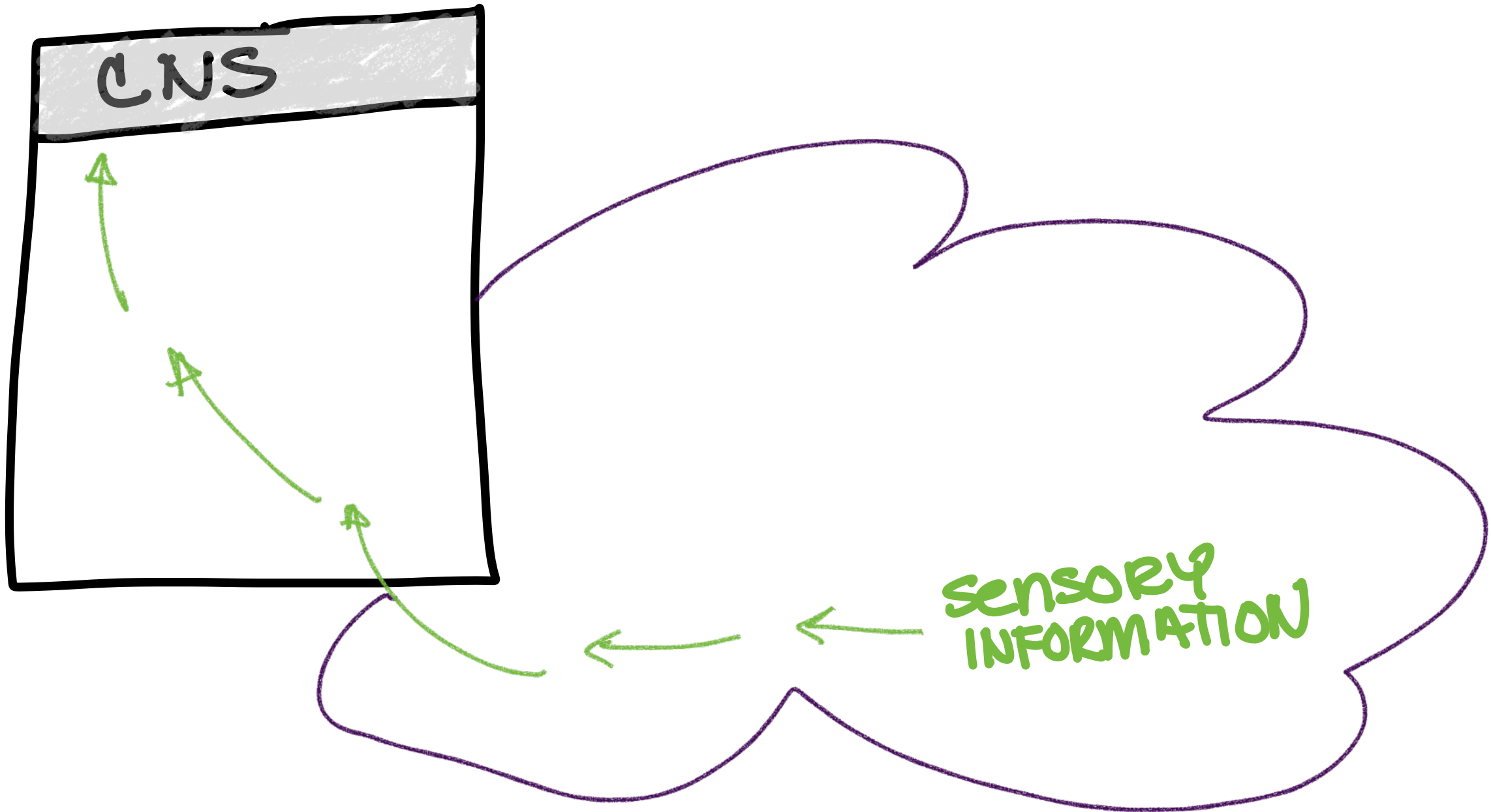
CNS

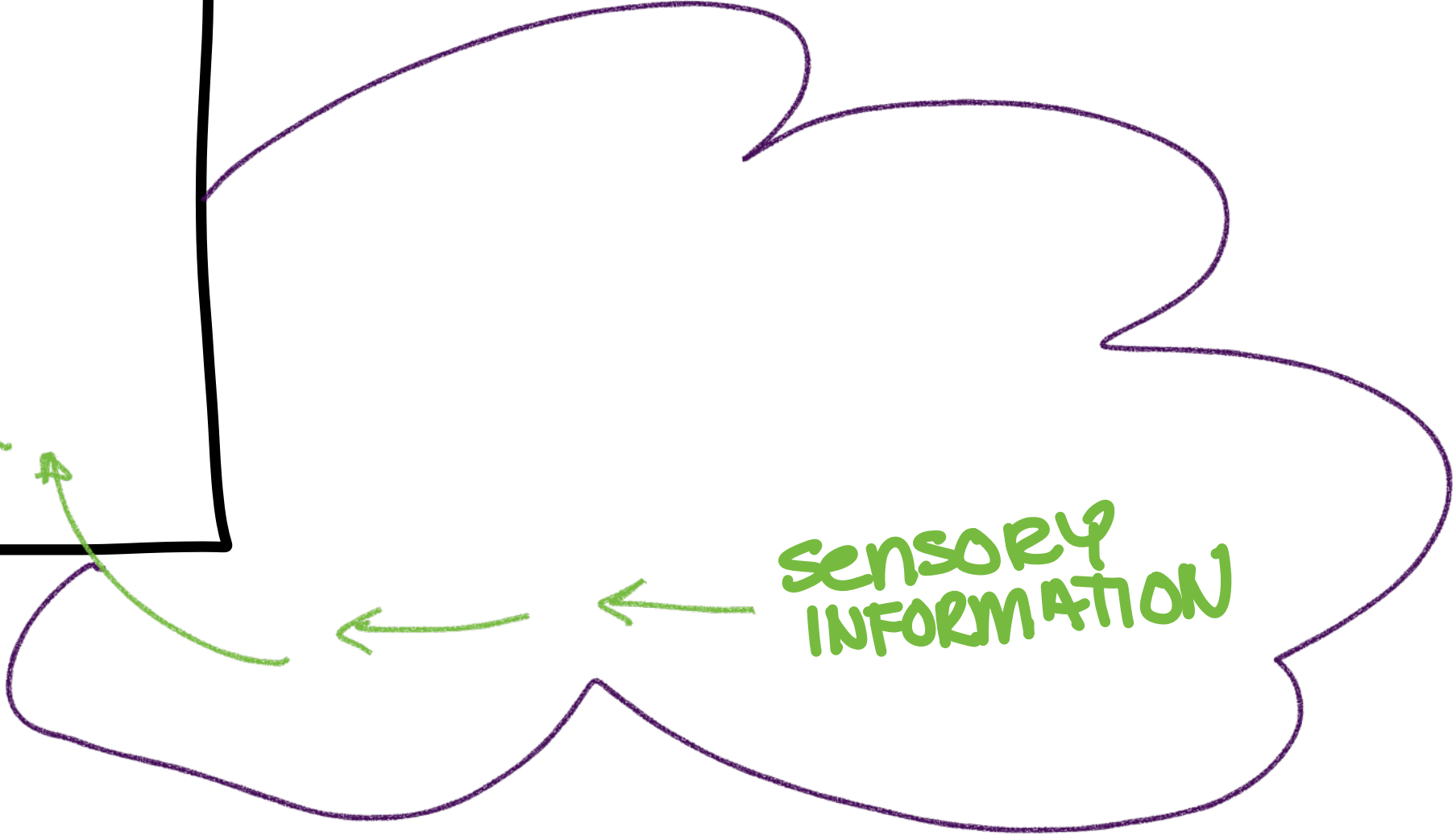
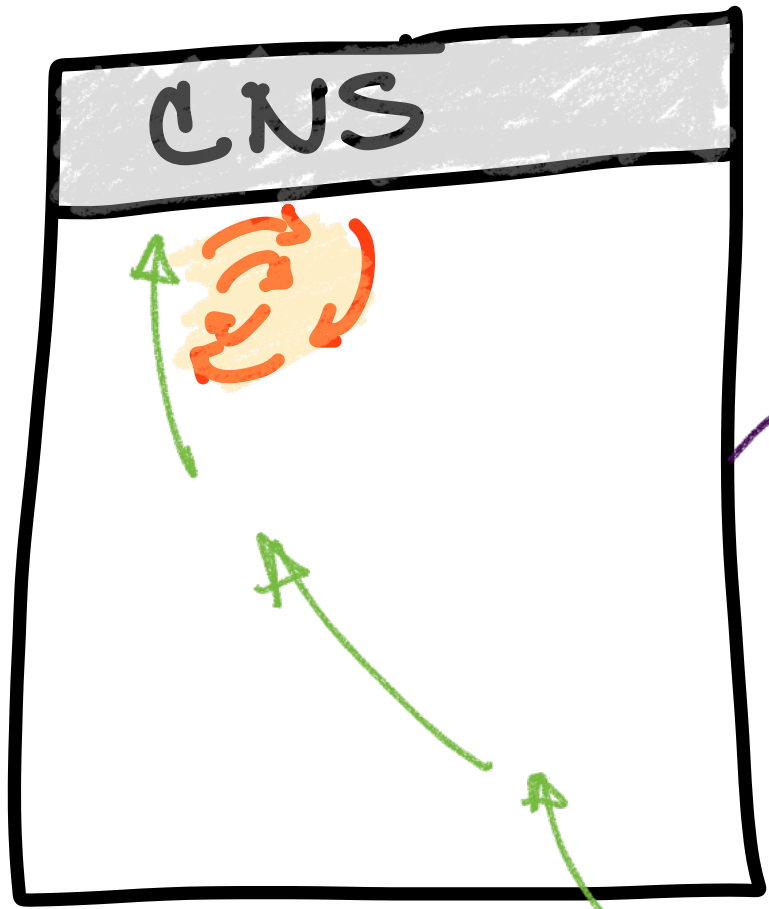
PNS

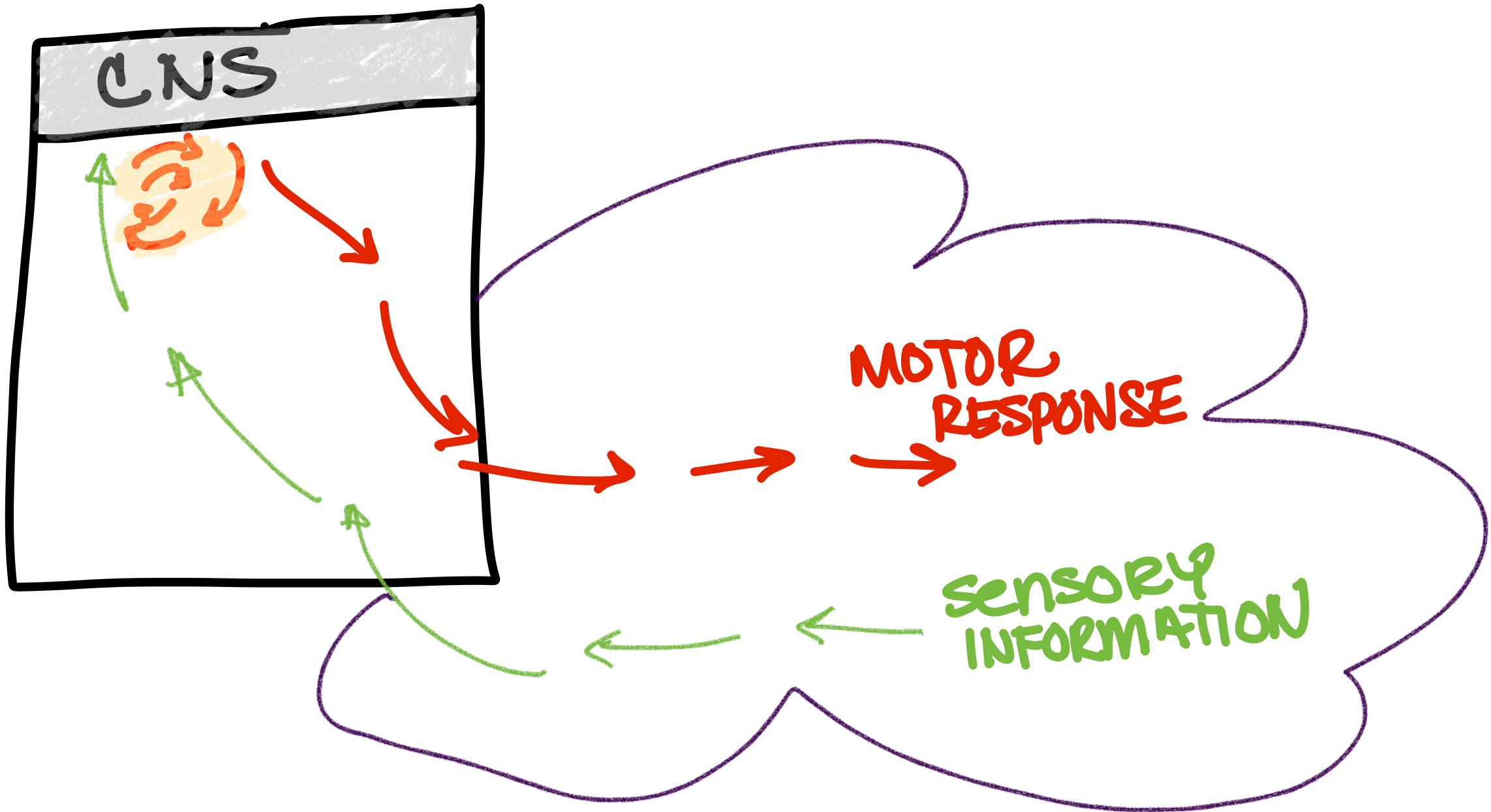
DISCUSSION

↳ what does the CNS do?









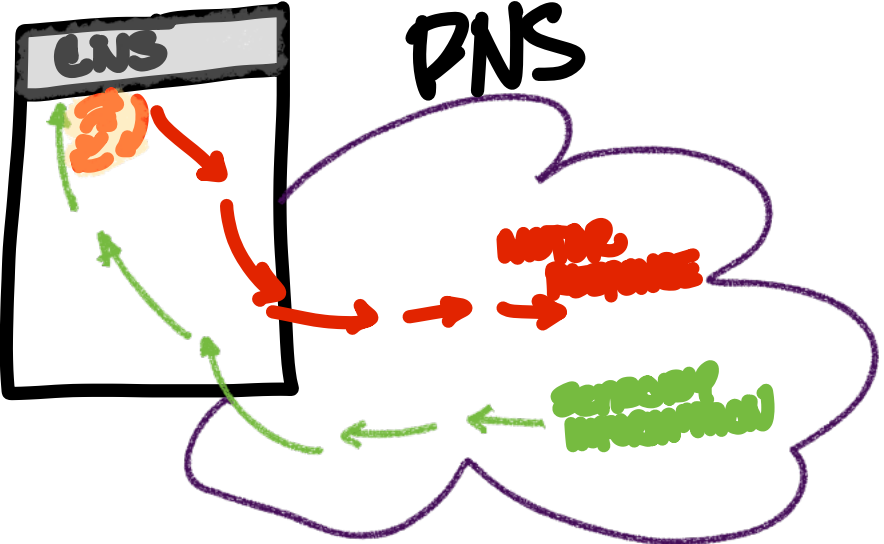
NERVOUS SYSTEM

CNS

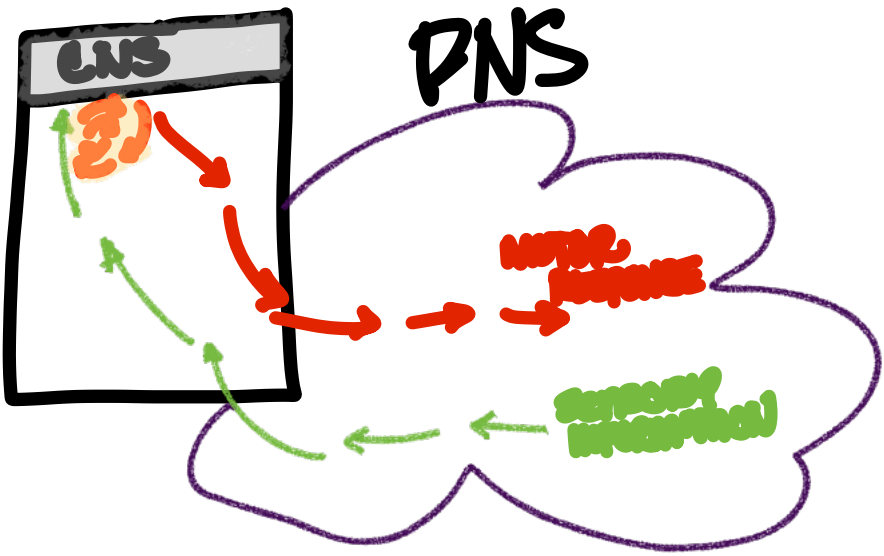
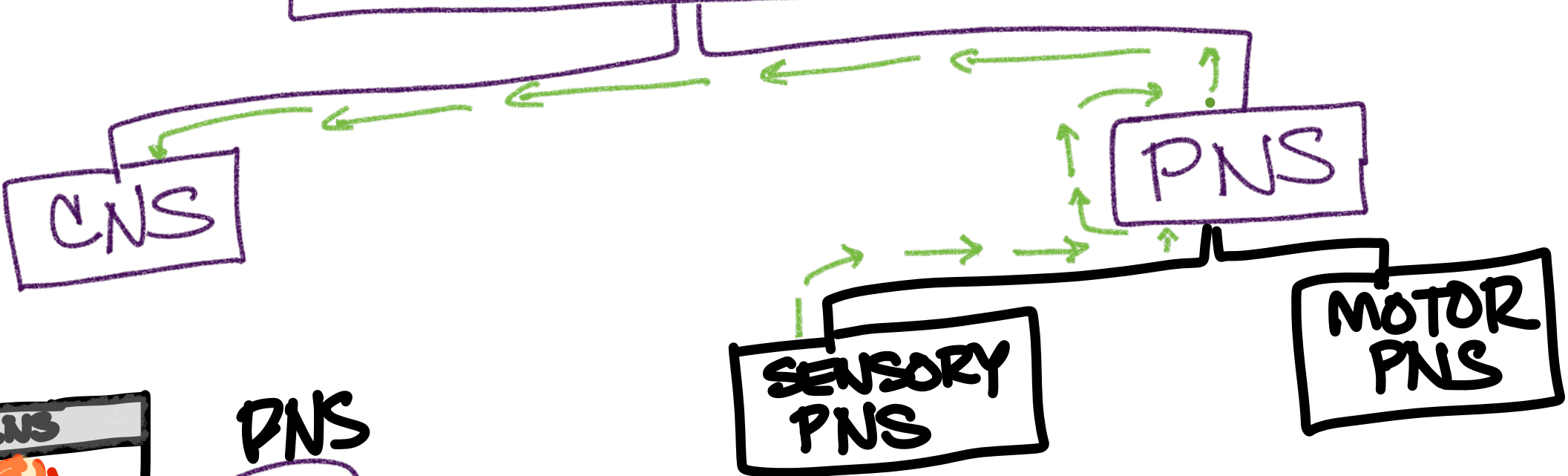
PNS

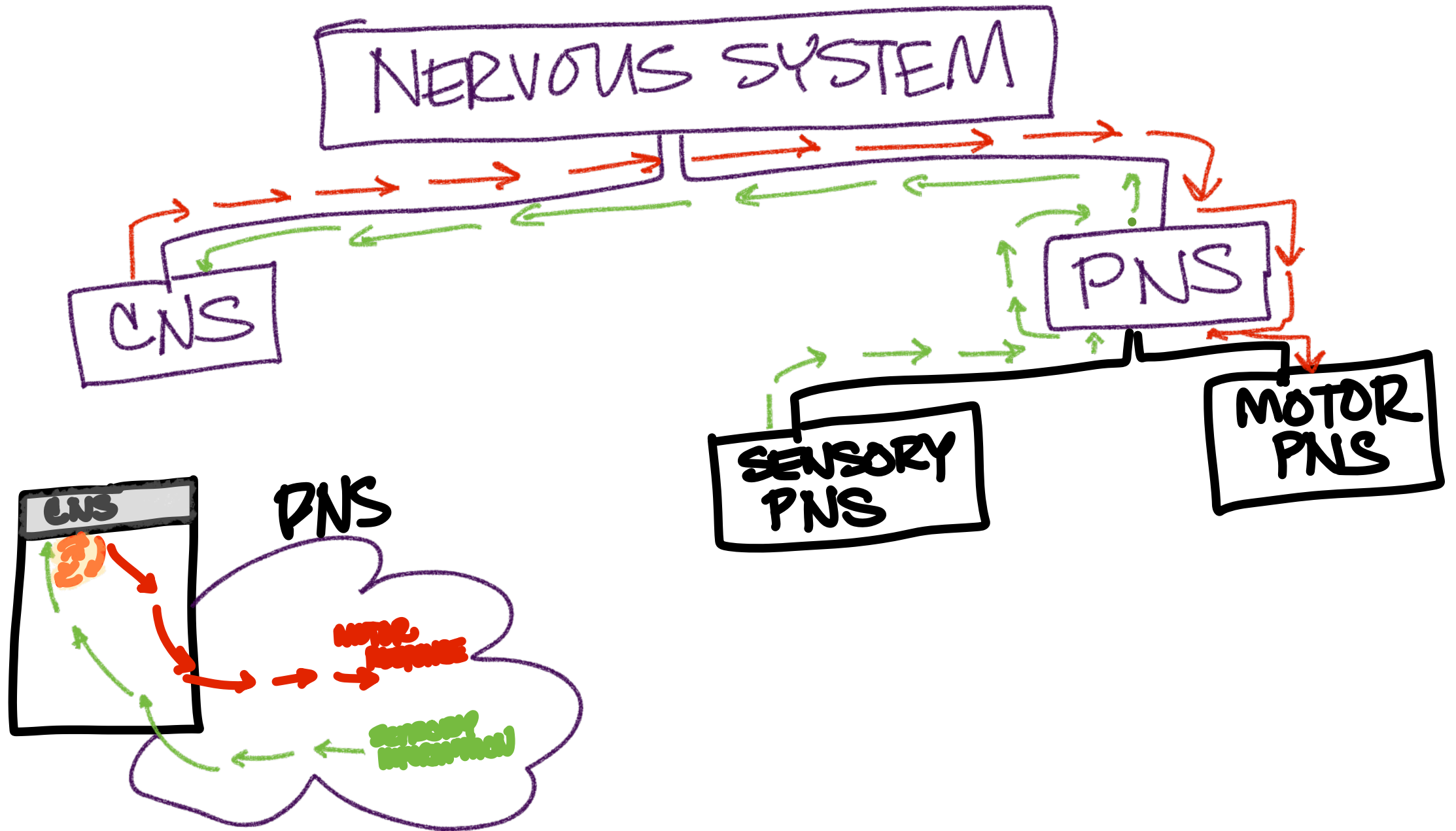
SENSORY
PNS

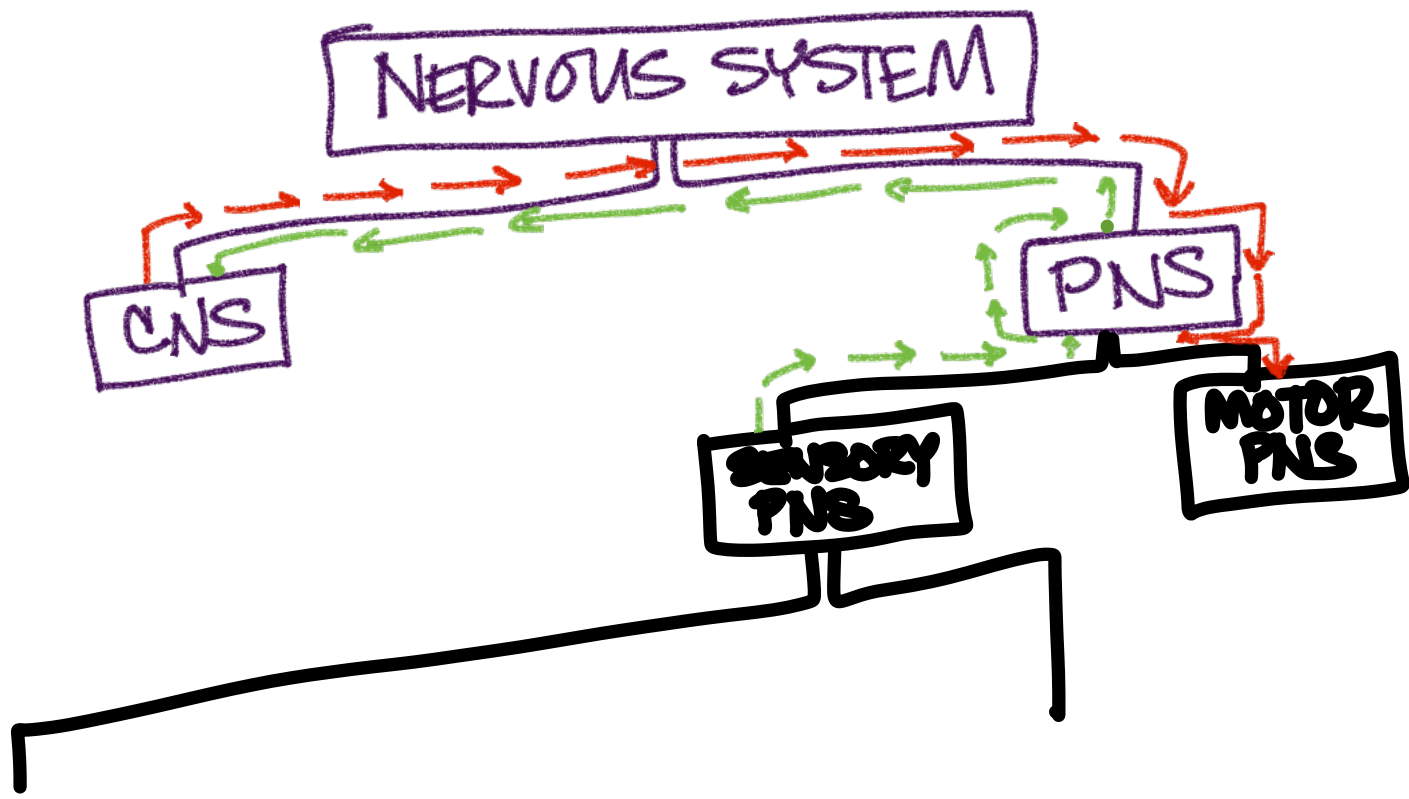
MOTOR
PNS

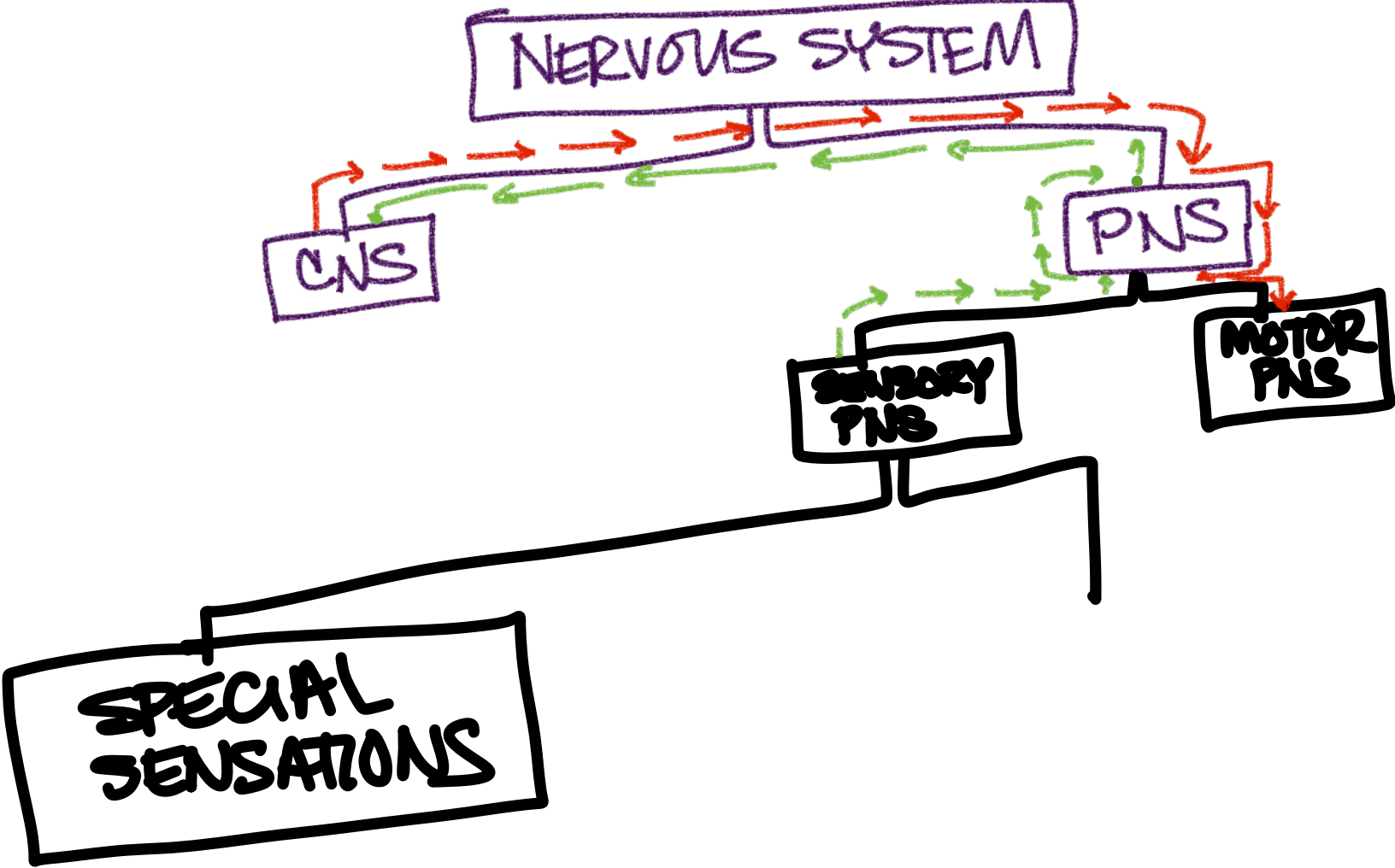


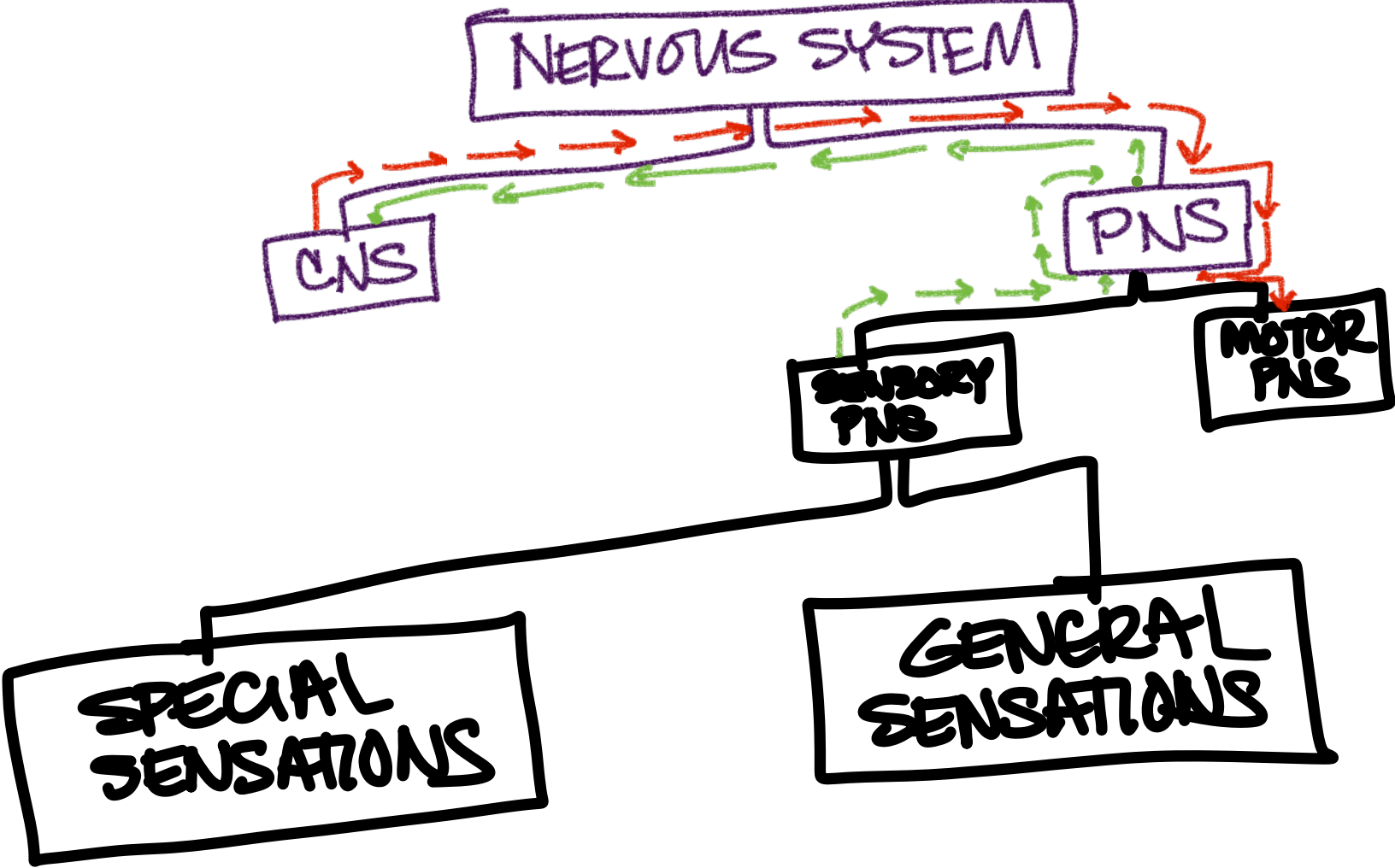
NERVOUS SYSTEM

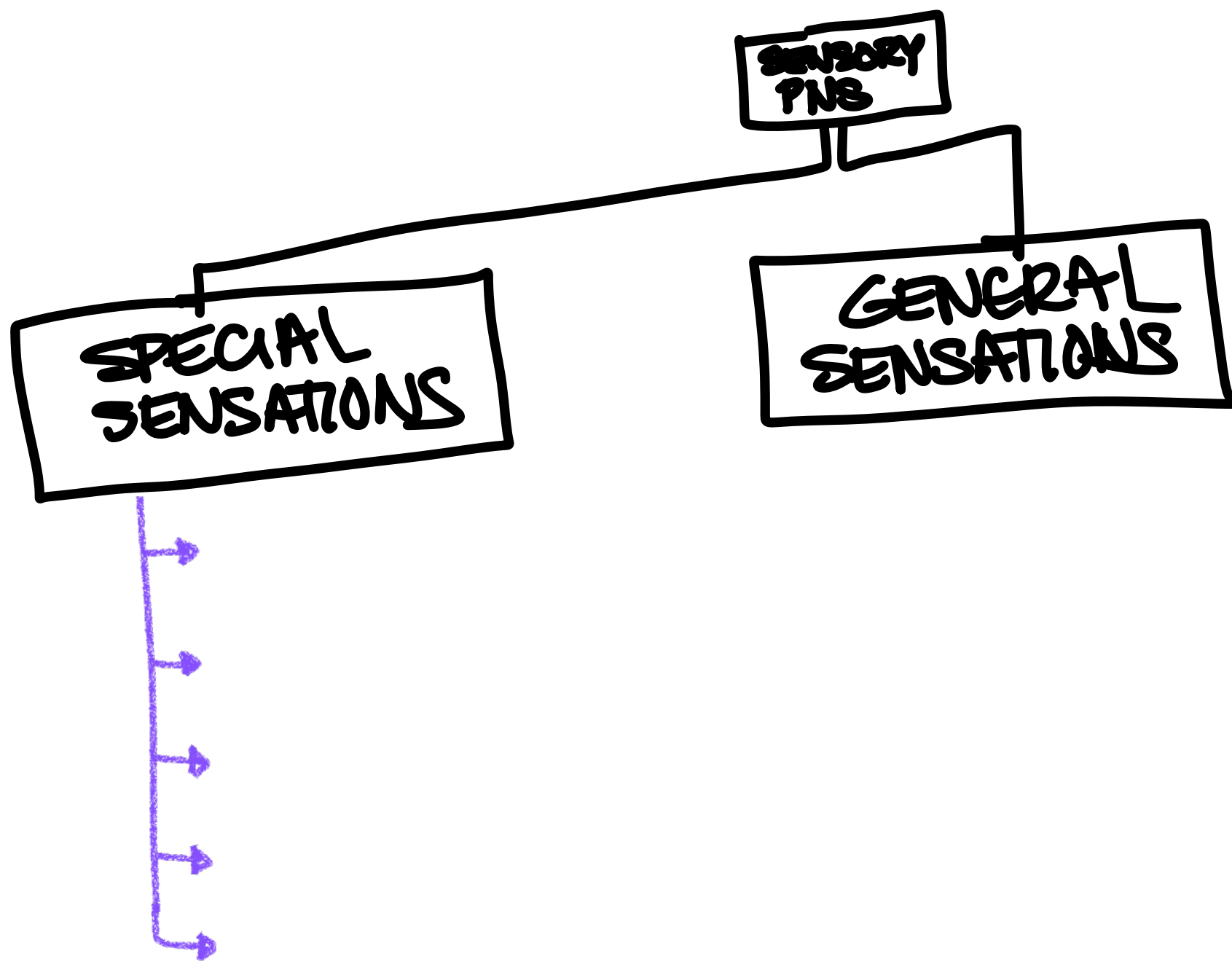


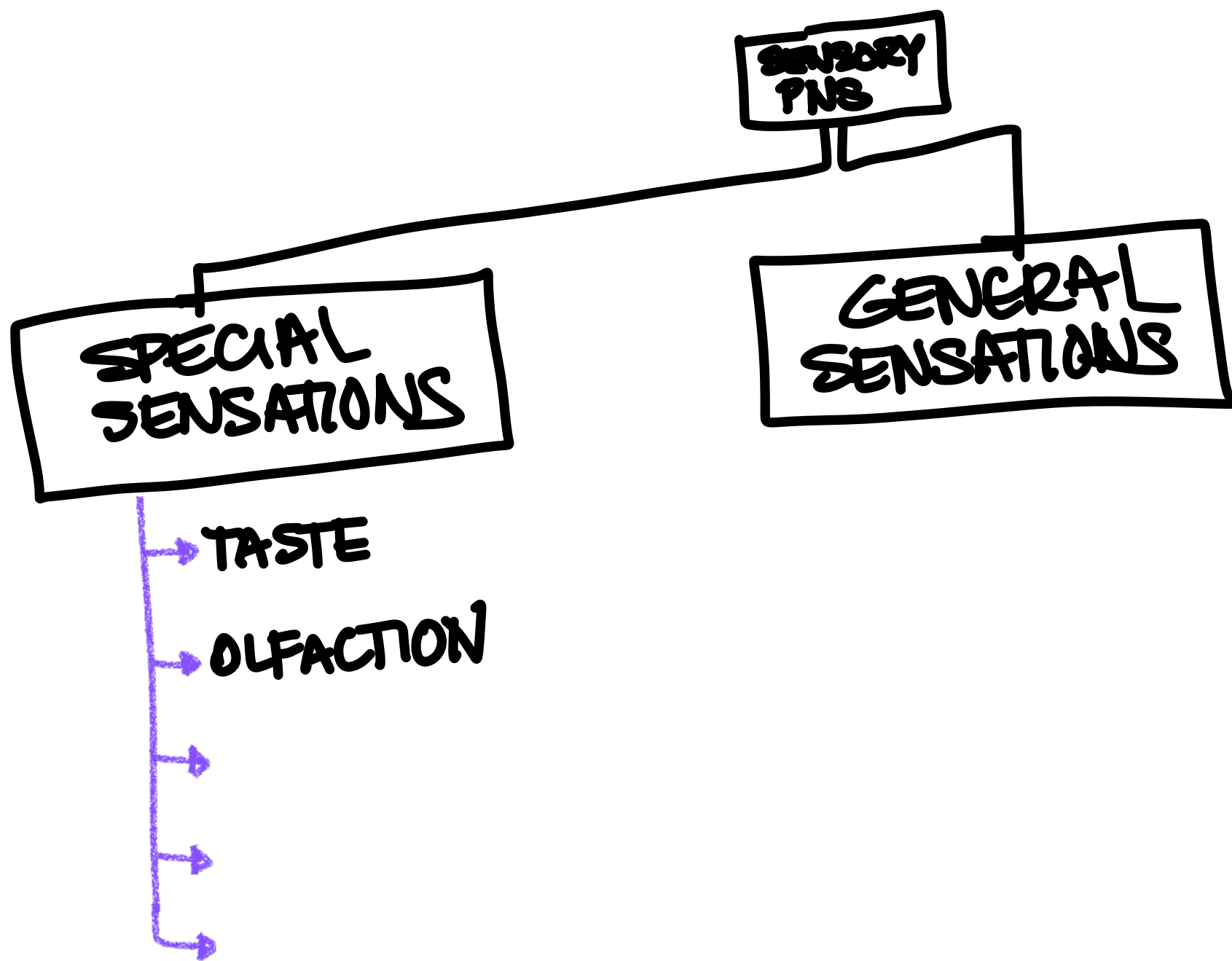


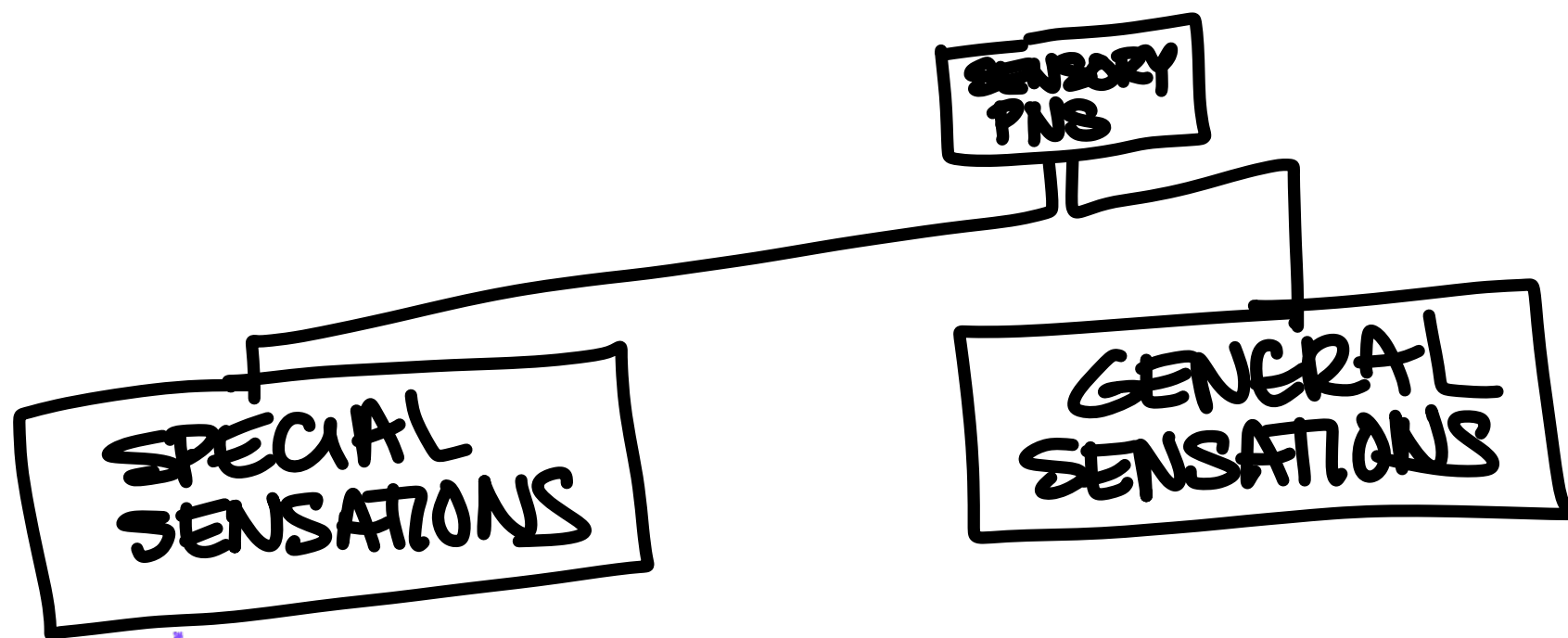




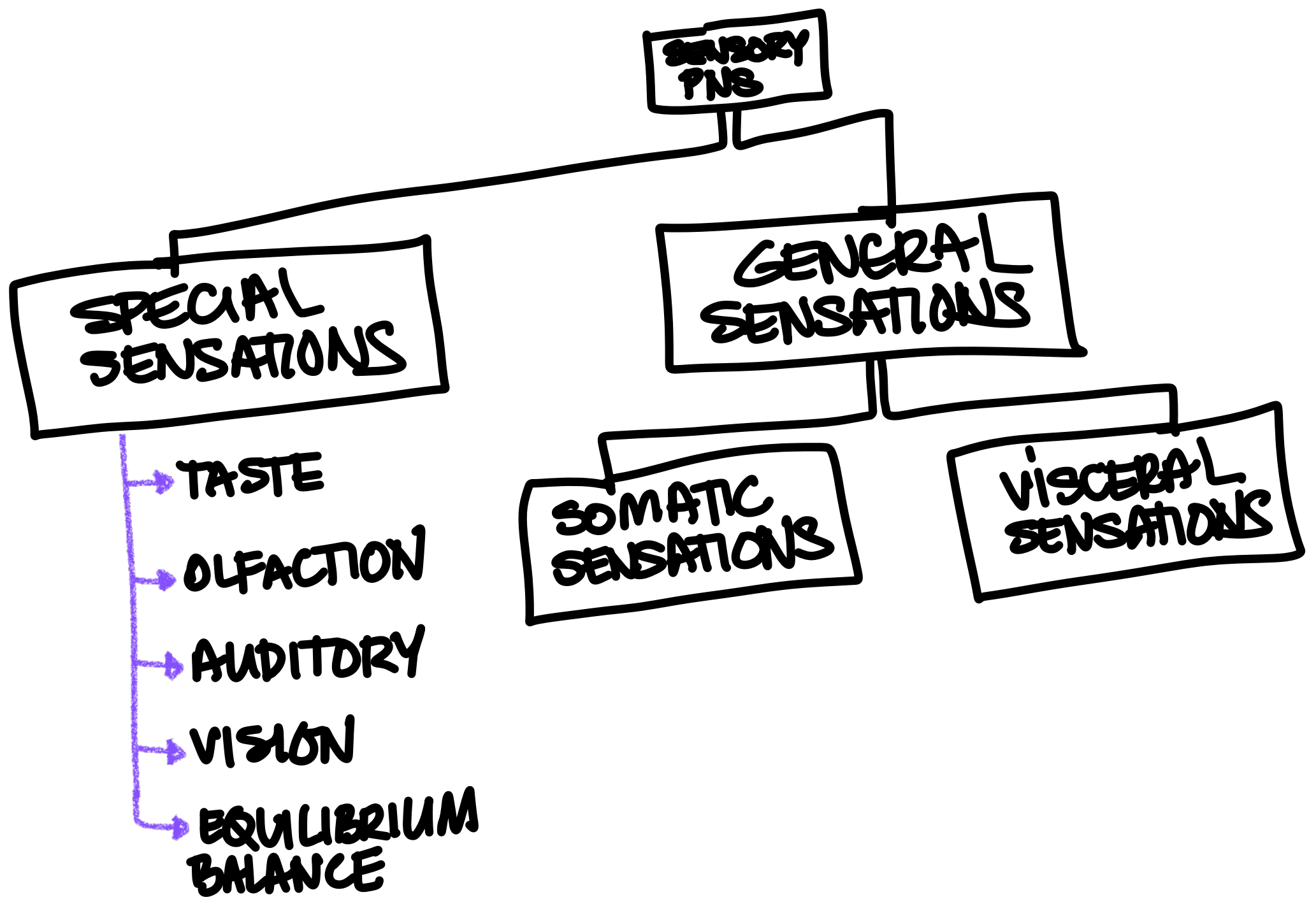


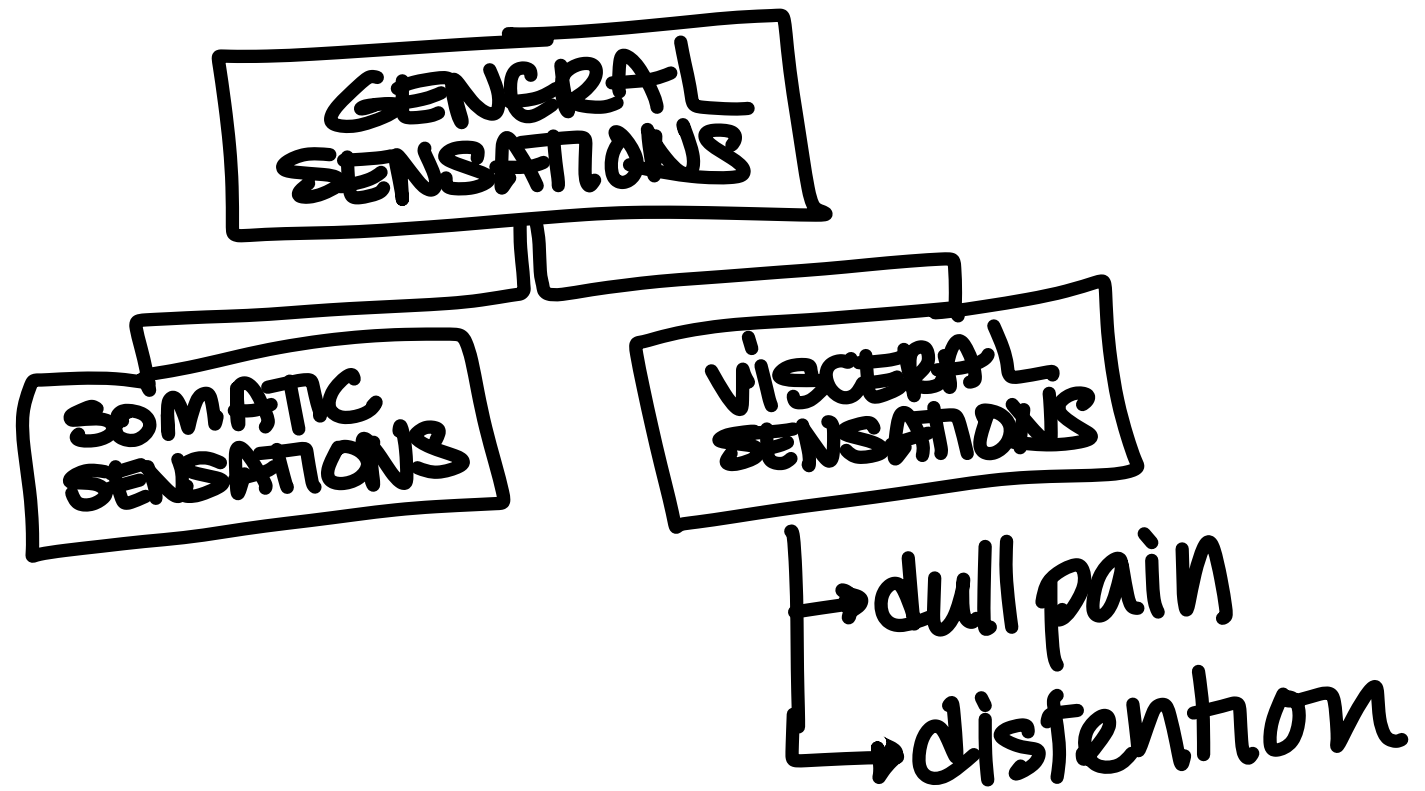






- TASTE
- OLFACTION
- AUDITORY
- VISION
- EQUILIBRIUM
BALANCE



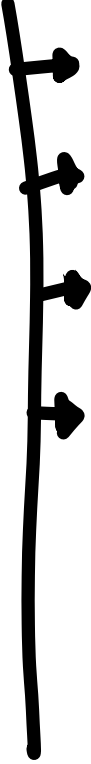


GENERAL SENSATIONS

SOMATIC SENSATIONS

VISCERAL SENSATIONS

dull pain
distention



GENERAL SENSATIONS

SOMATIC SENSATIONS

- SKIN
- TOUCH
- PAIN
-
-
-

VISCERAL SENSATIONS

- dull pain
- distention

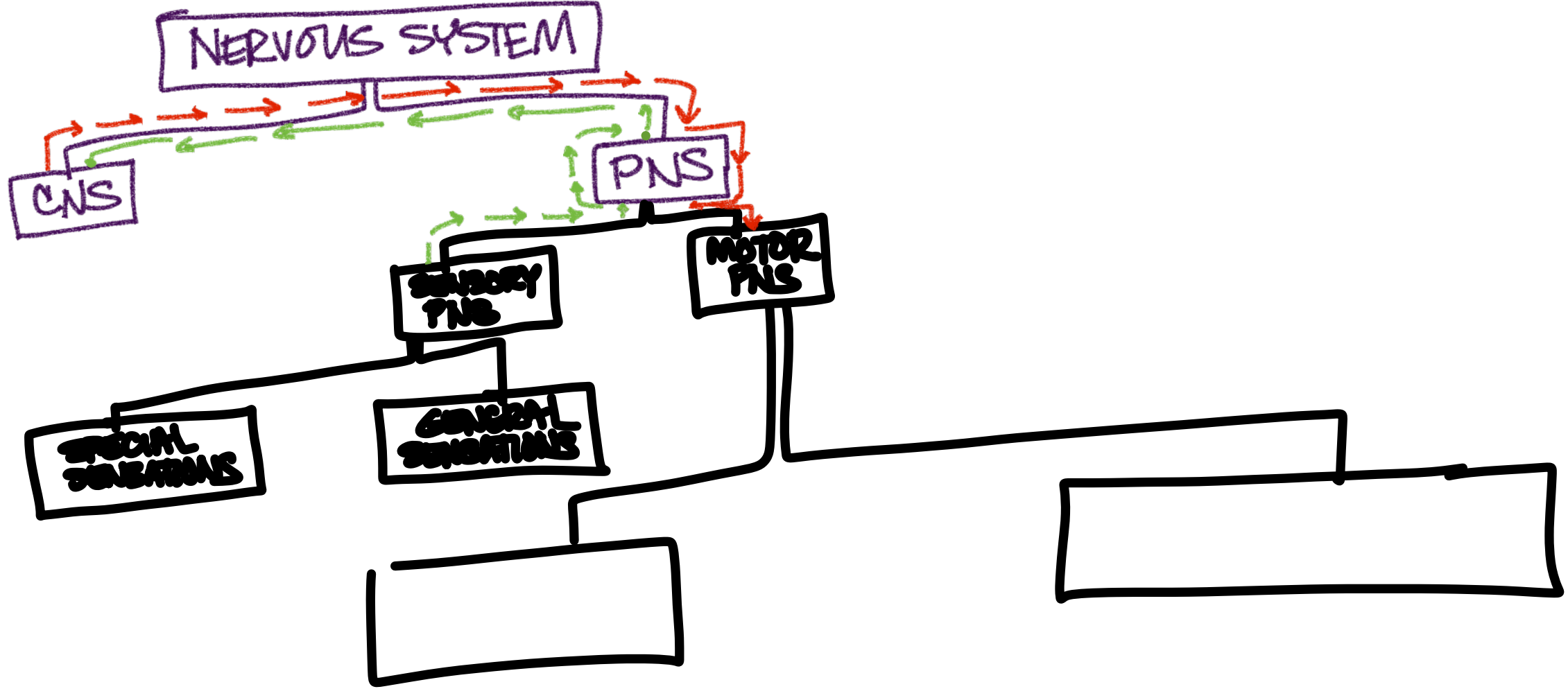
GENERAL SENSATIONS

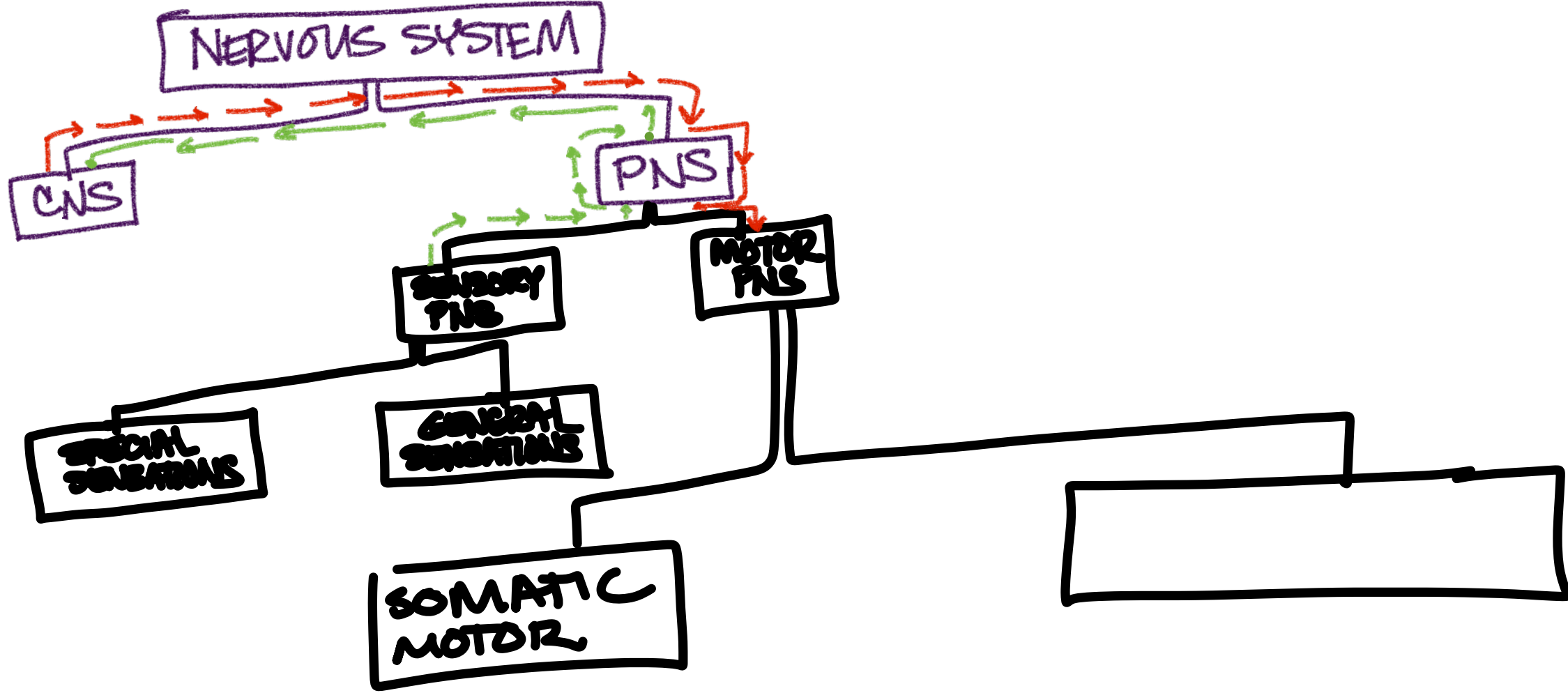
SOMATIC SENSATIONS

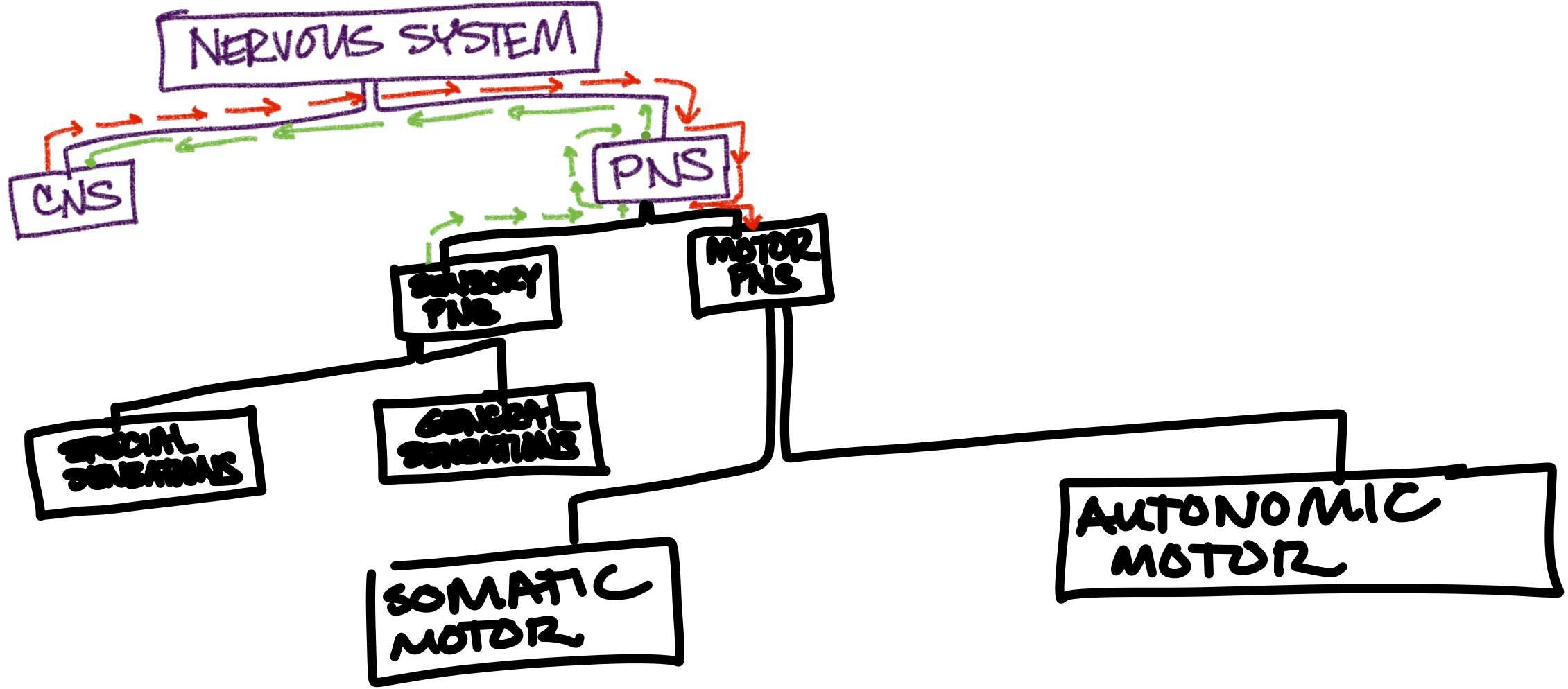
- SKIN
- TOUCH
- PAIN
- TEMPERATURE
- LOCOMOTOR SYSTEM
- PROPRIOCEPTION

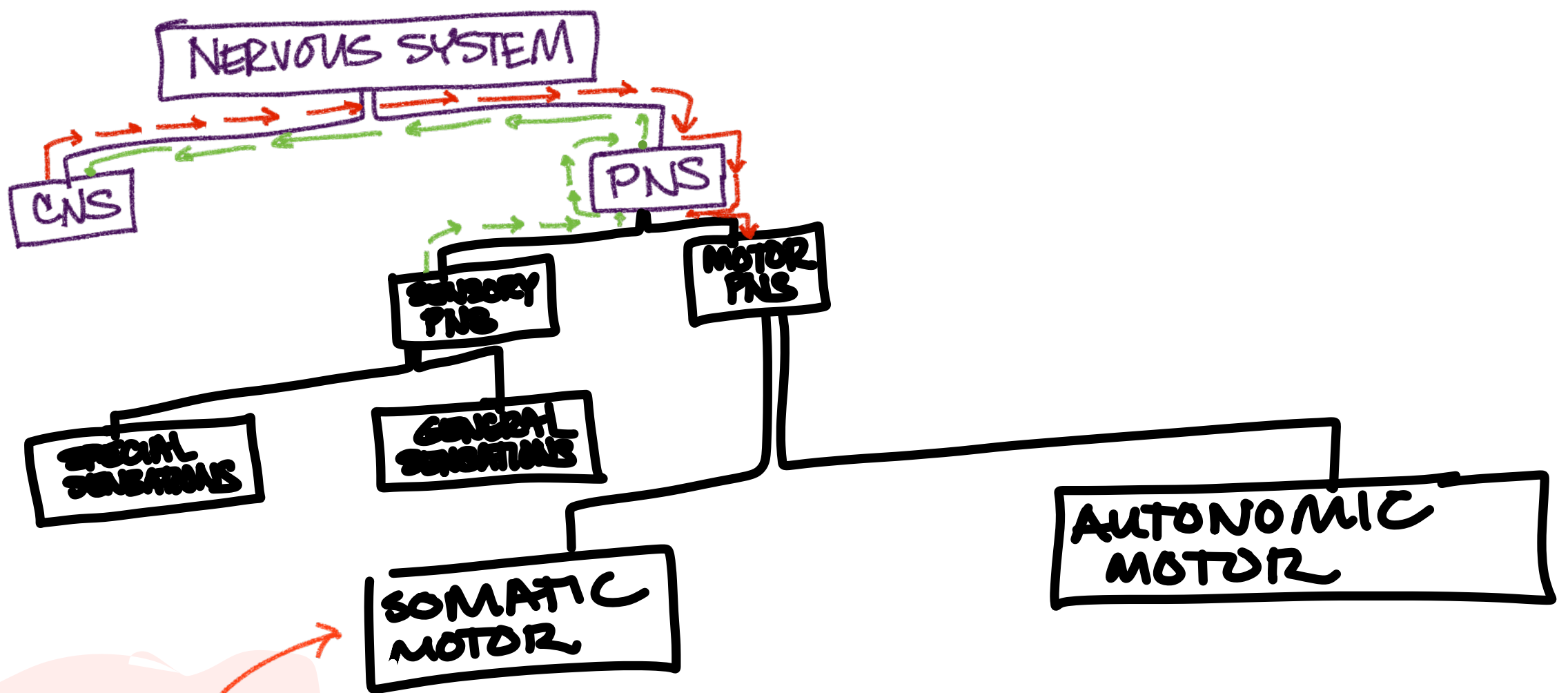
VISCERAL SENSATIONS

- dull pain
- distention

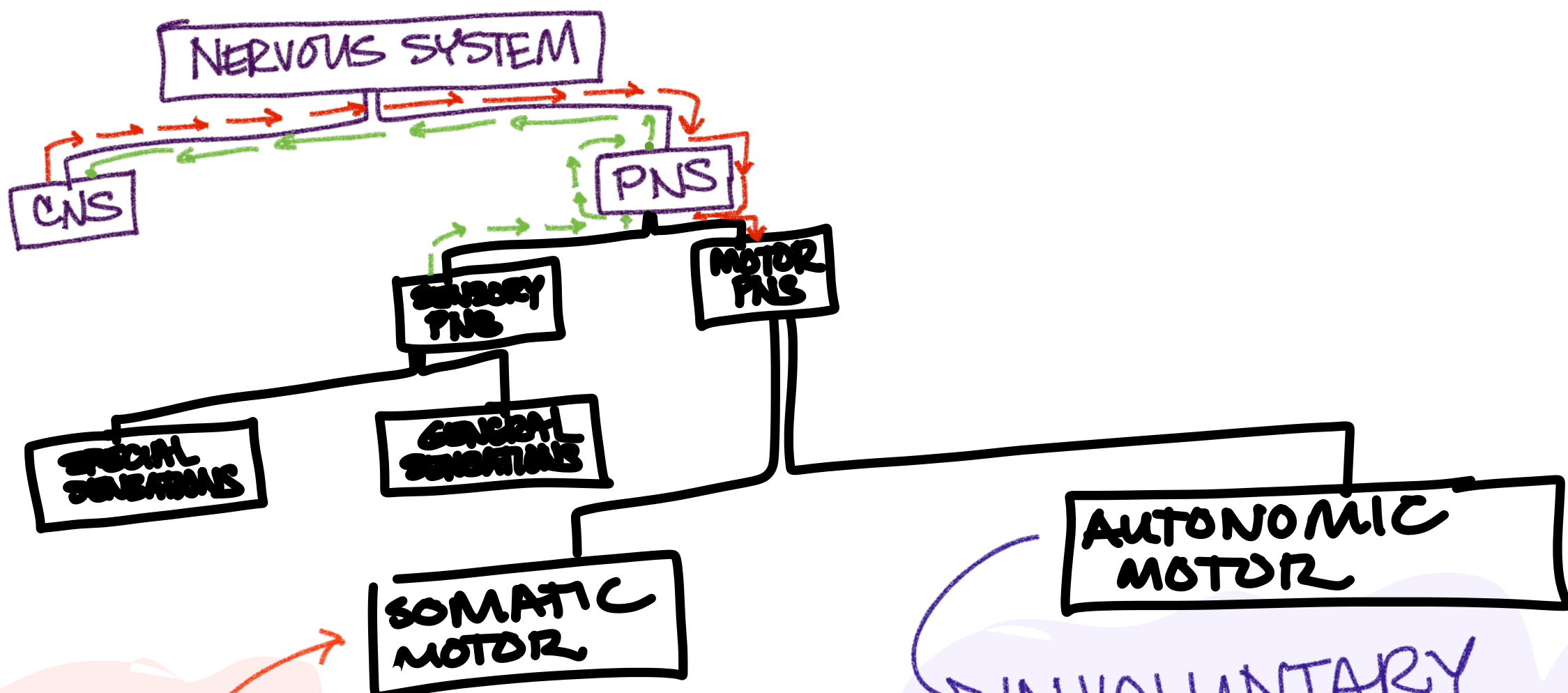






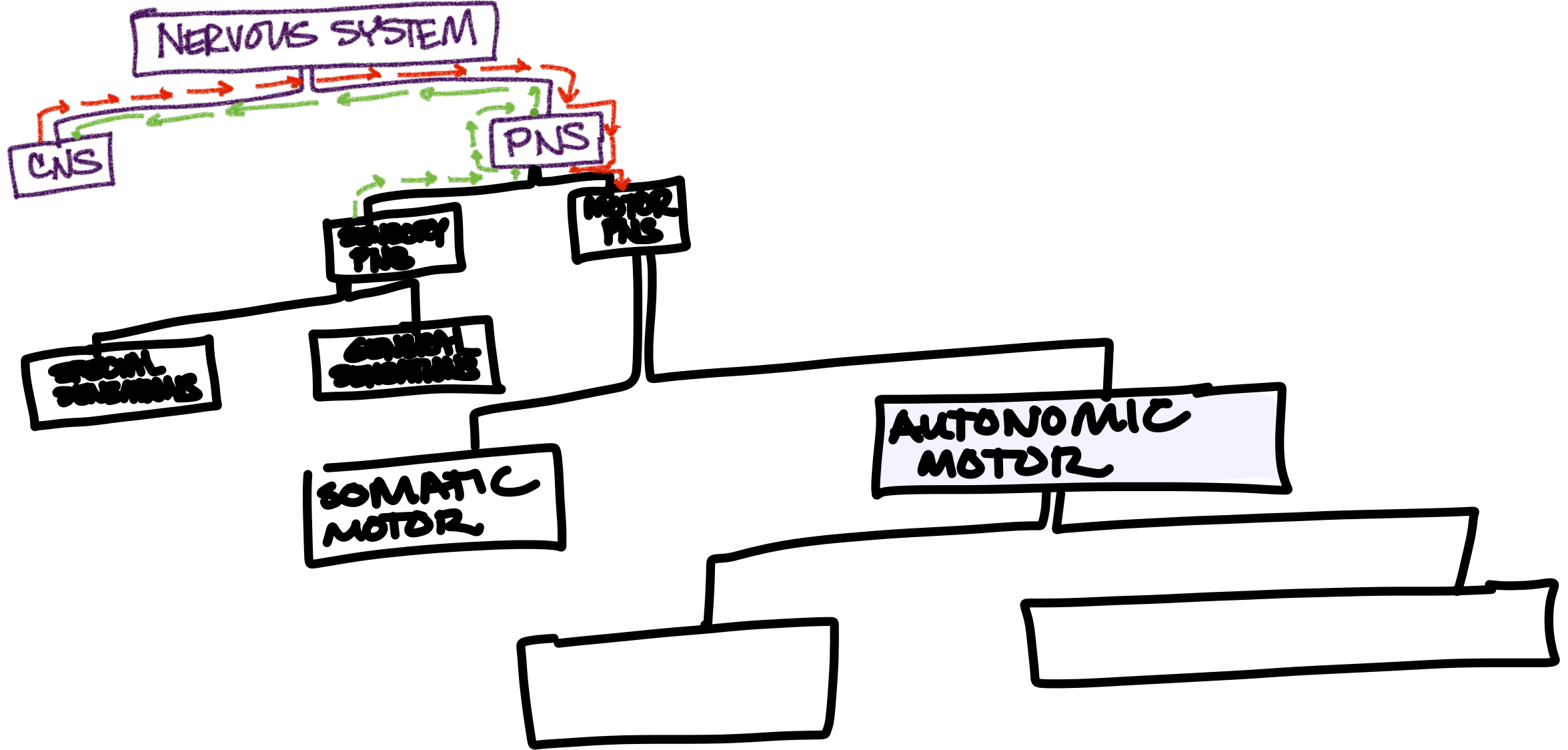


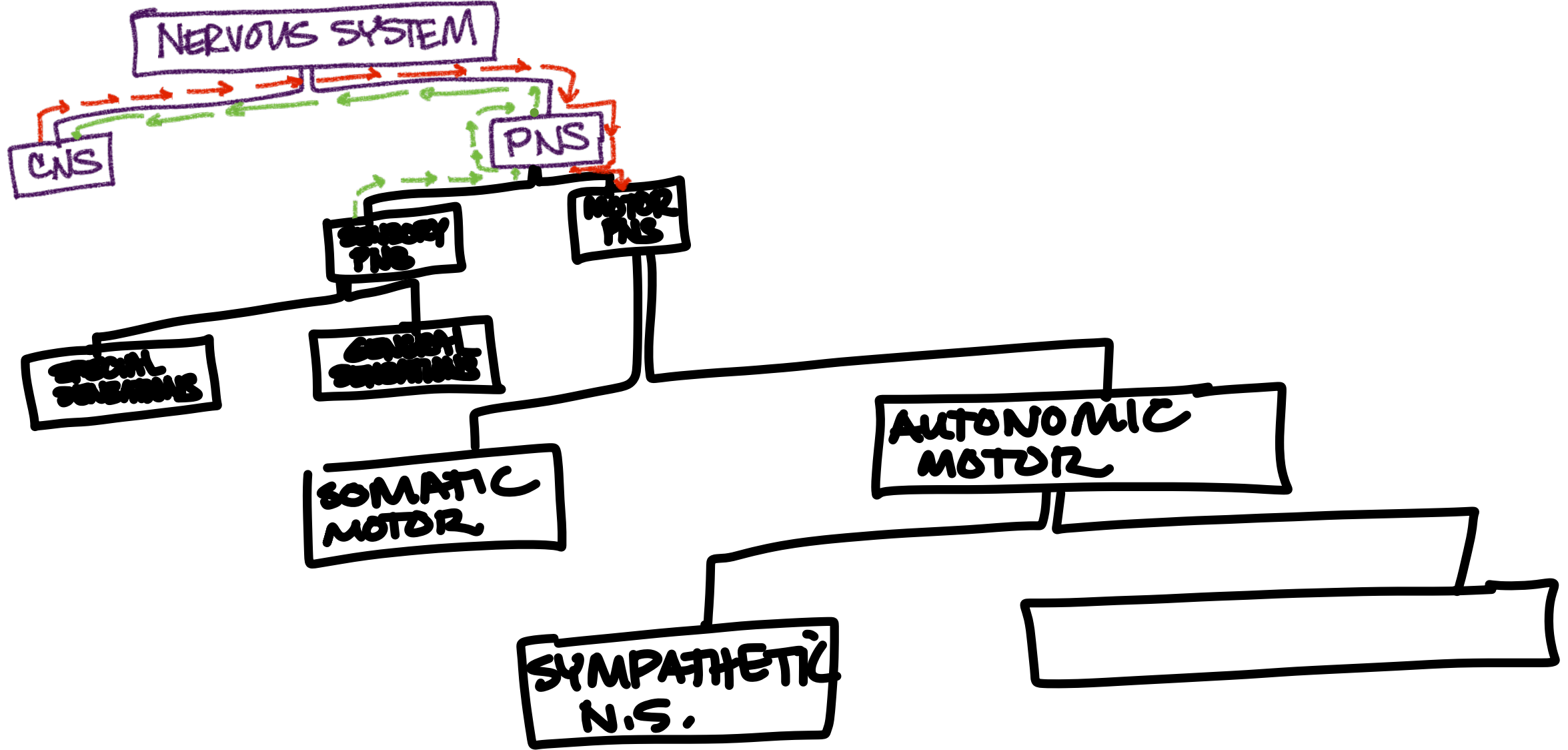
- voluntary control
- throw a ball
- sit down
- text

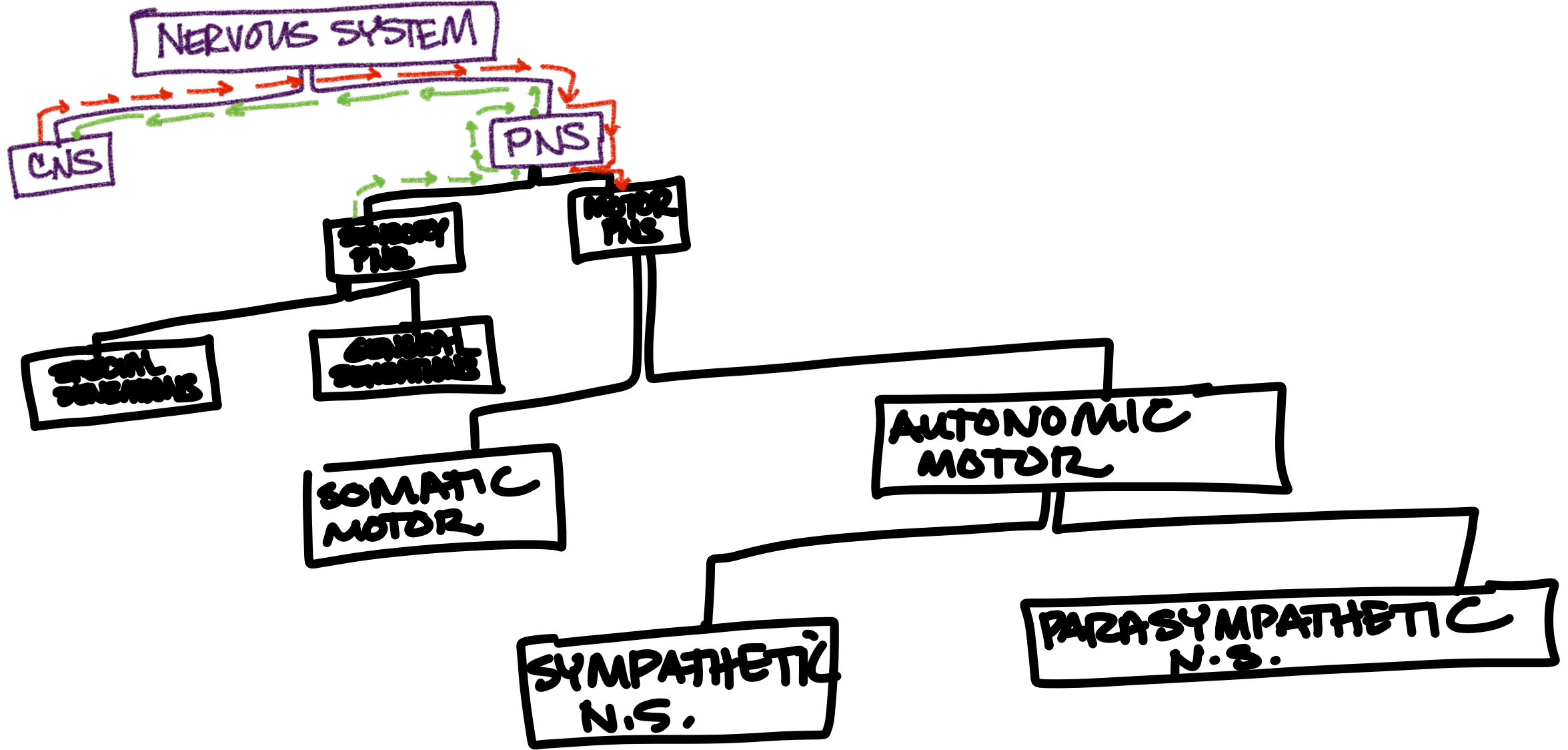


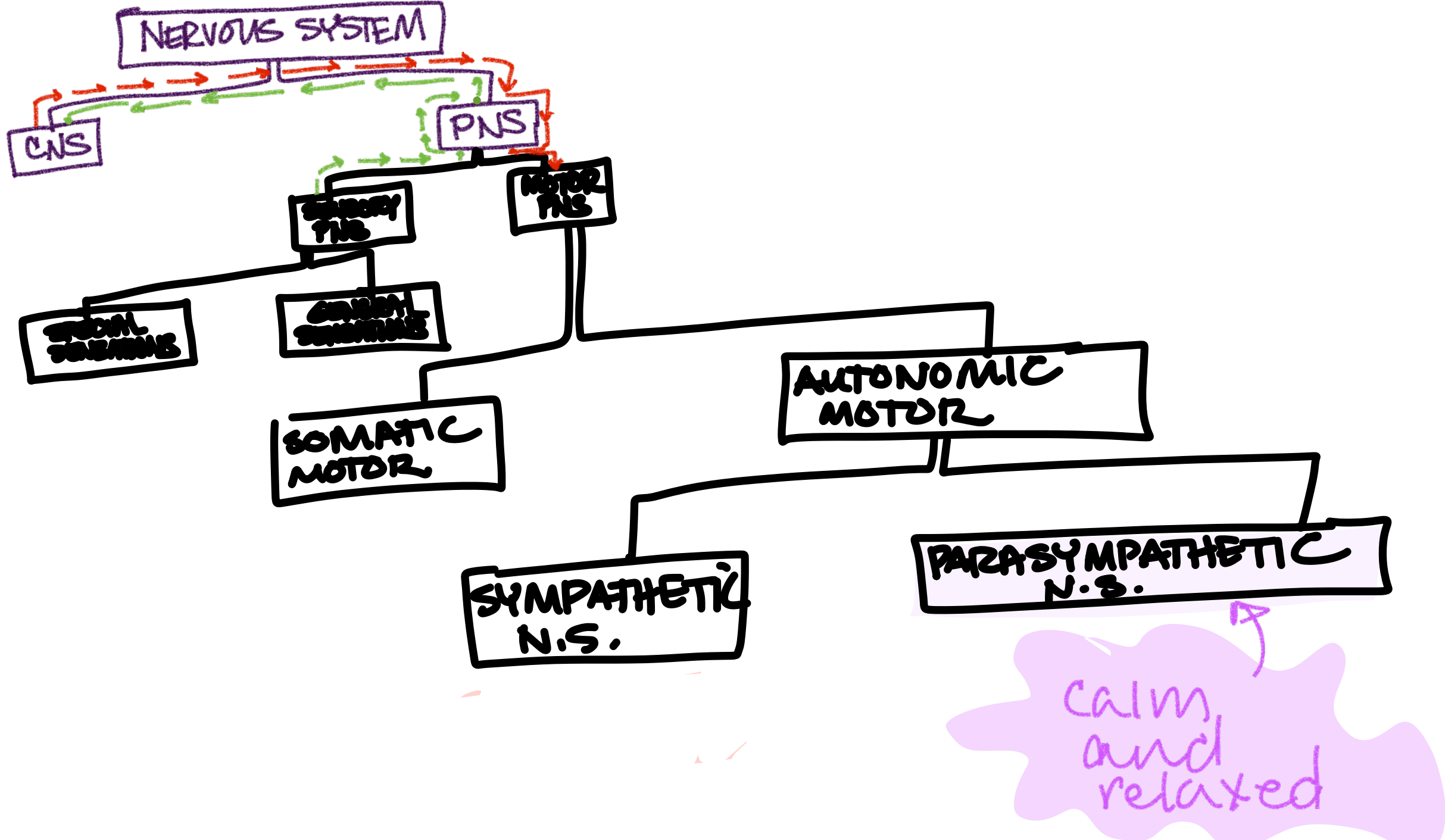
- voluntary control
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- text

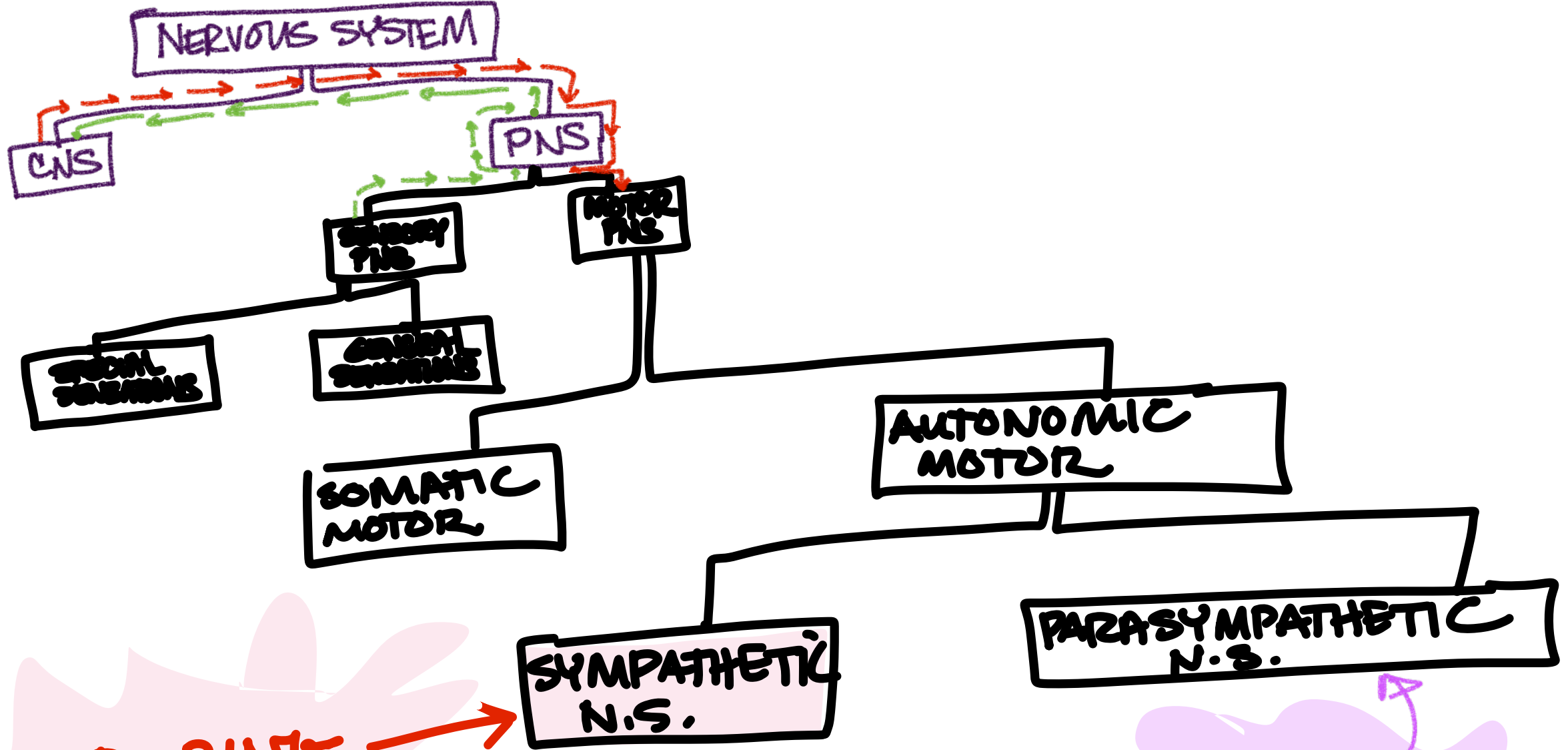
- INVOLUNTARY CONTROL
- eg. Heart rate
- digestion







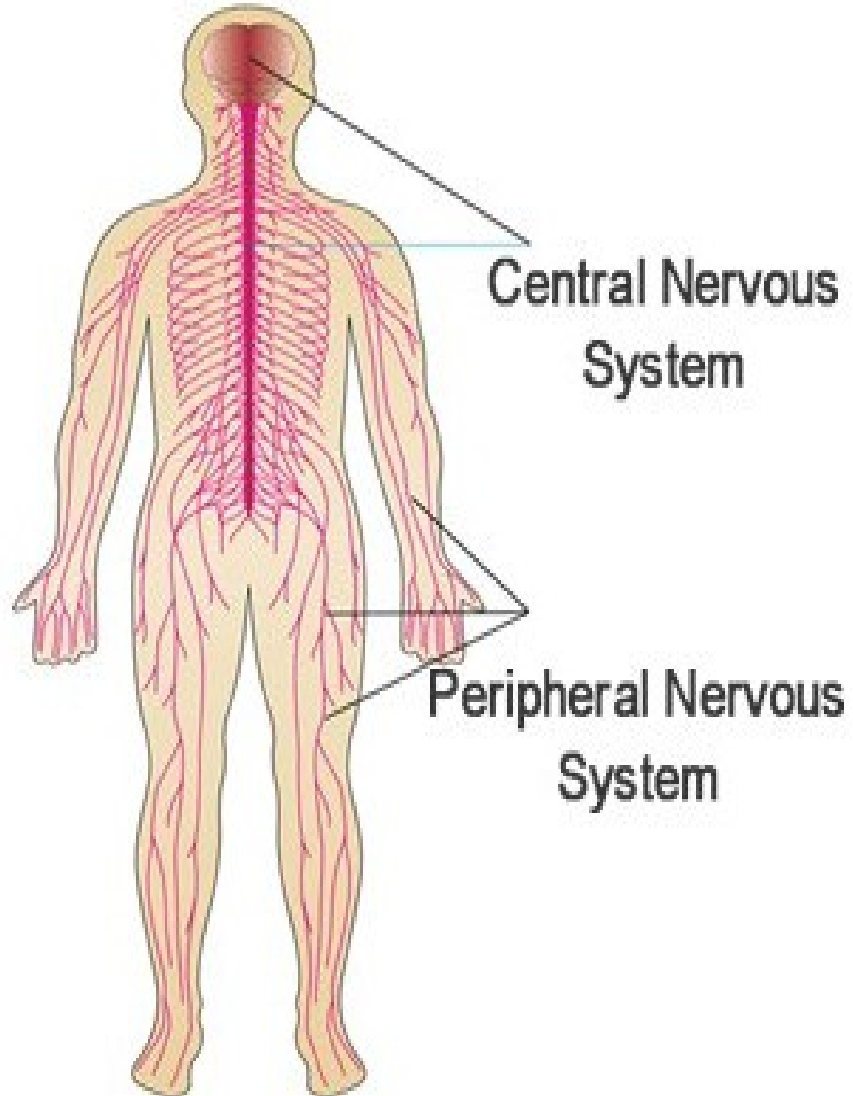




DURING STRESSFUL CONDITIONS →

calm and relaxed ↗

CNS & PNS



CNS

Central Nervous System

= Brain & Spinal Cord

Surrounded by bone
and meninges

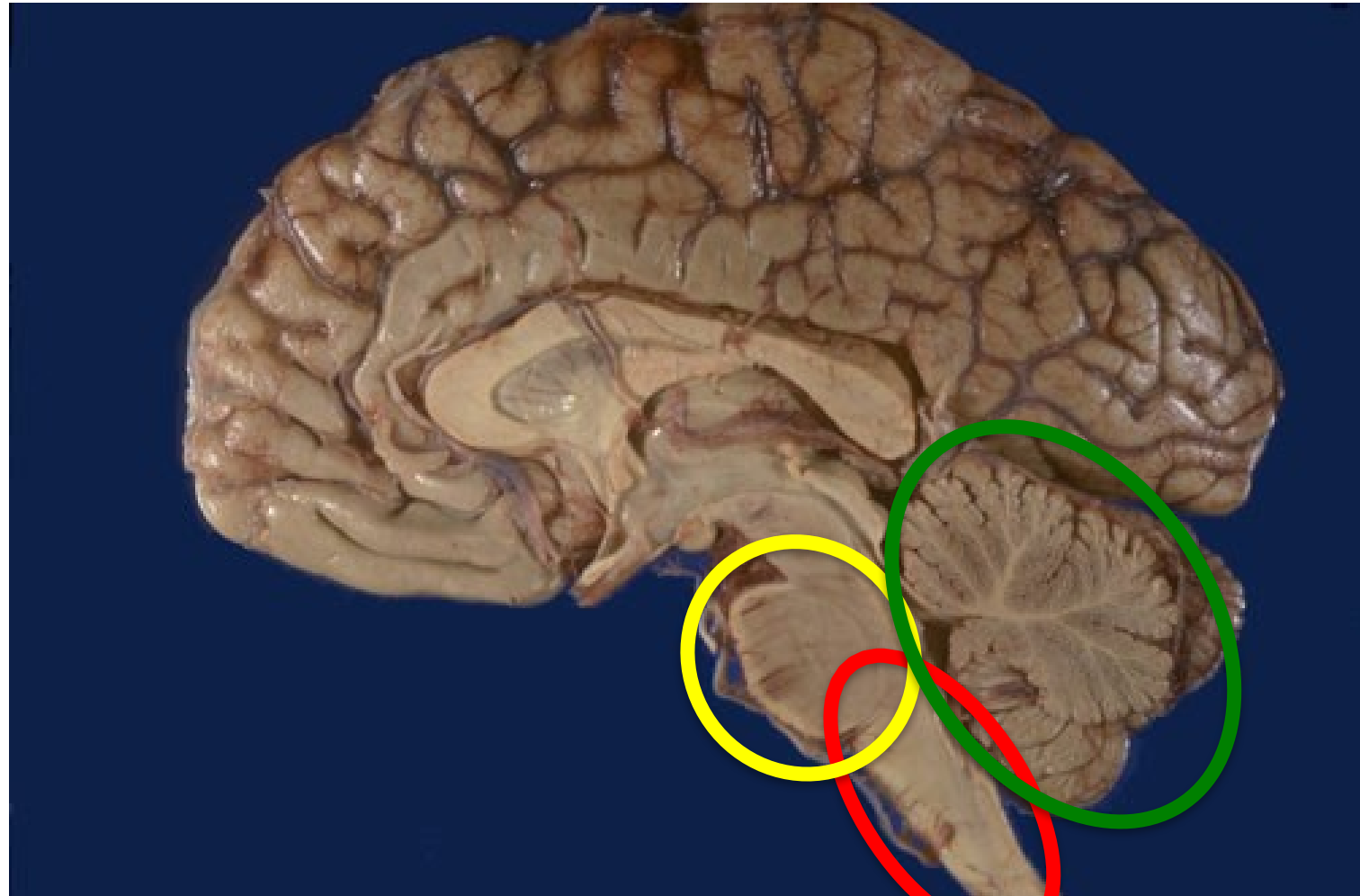
PNS

Peripheral Nervous System

SOMATIC System
= Interaction w/external env.

AUTONOMIC System
= Regulates internal env.

Mid-Saggital Section
including... **HINDBRAIN**

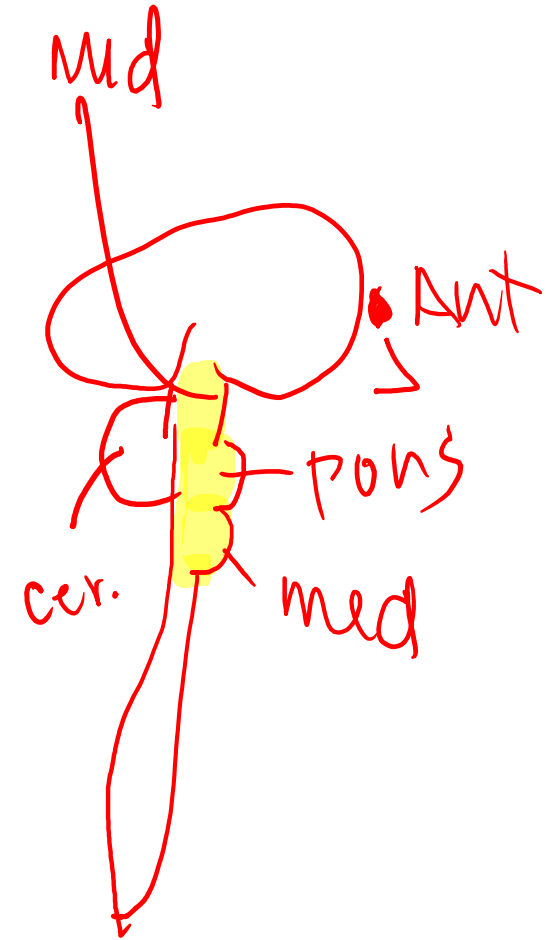
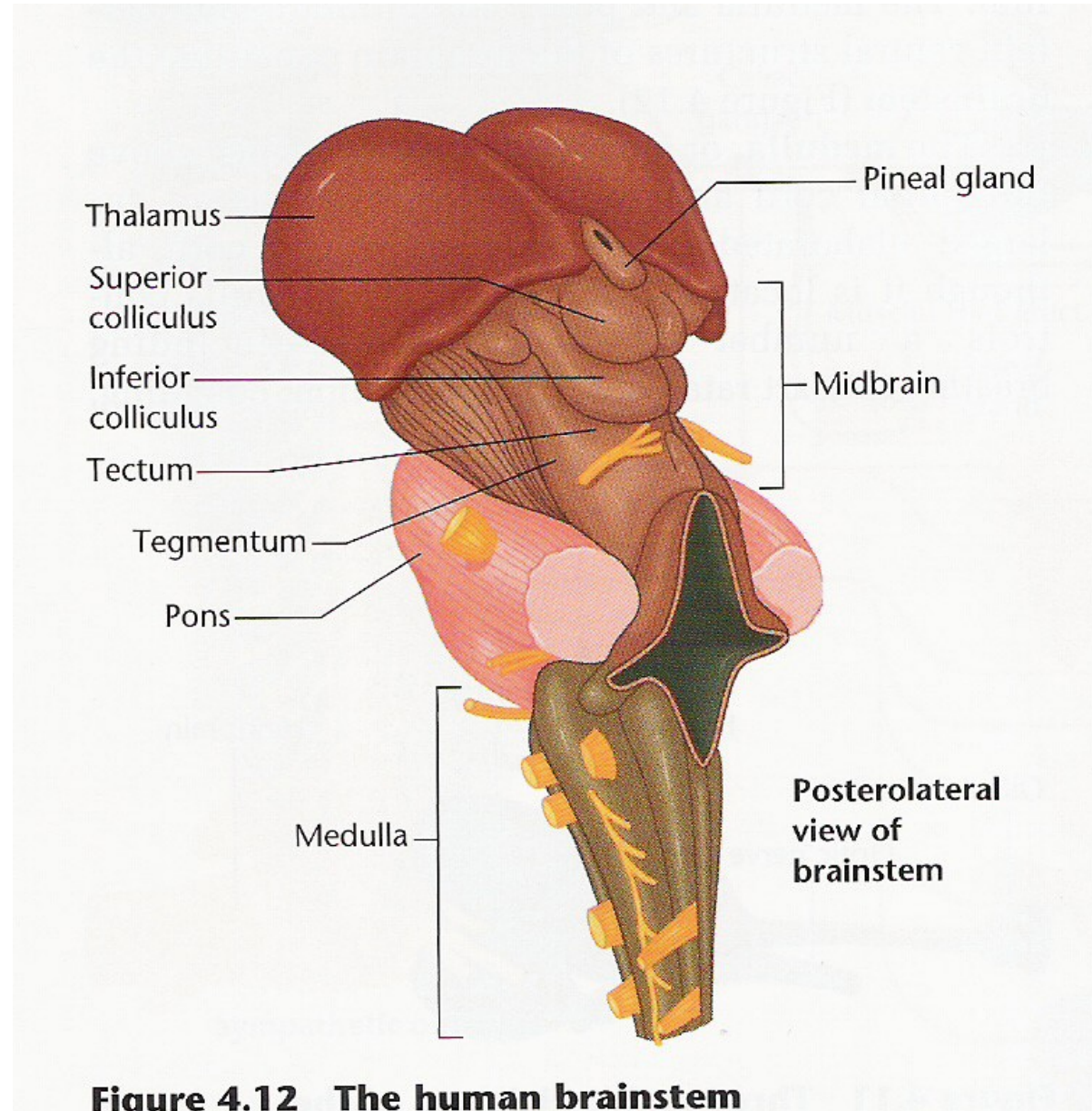


Medulla oblongata

Pons

Cerebellum

Brainstem



HINDBRAIN: Medulla

Medulla oblongata
- Primal reflexes

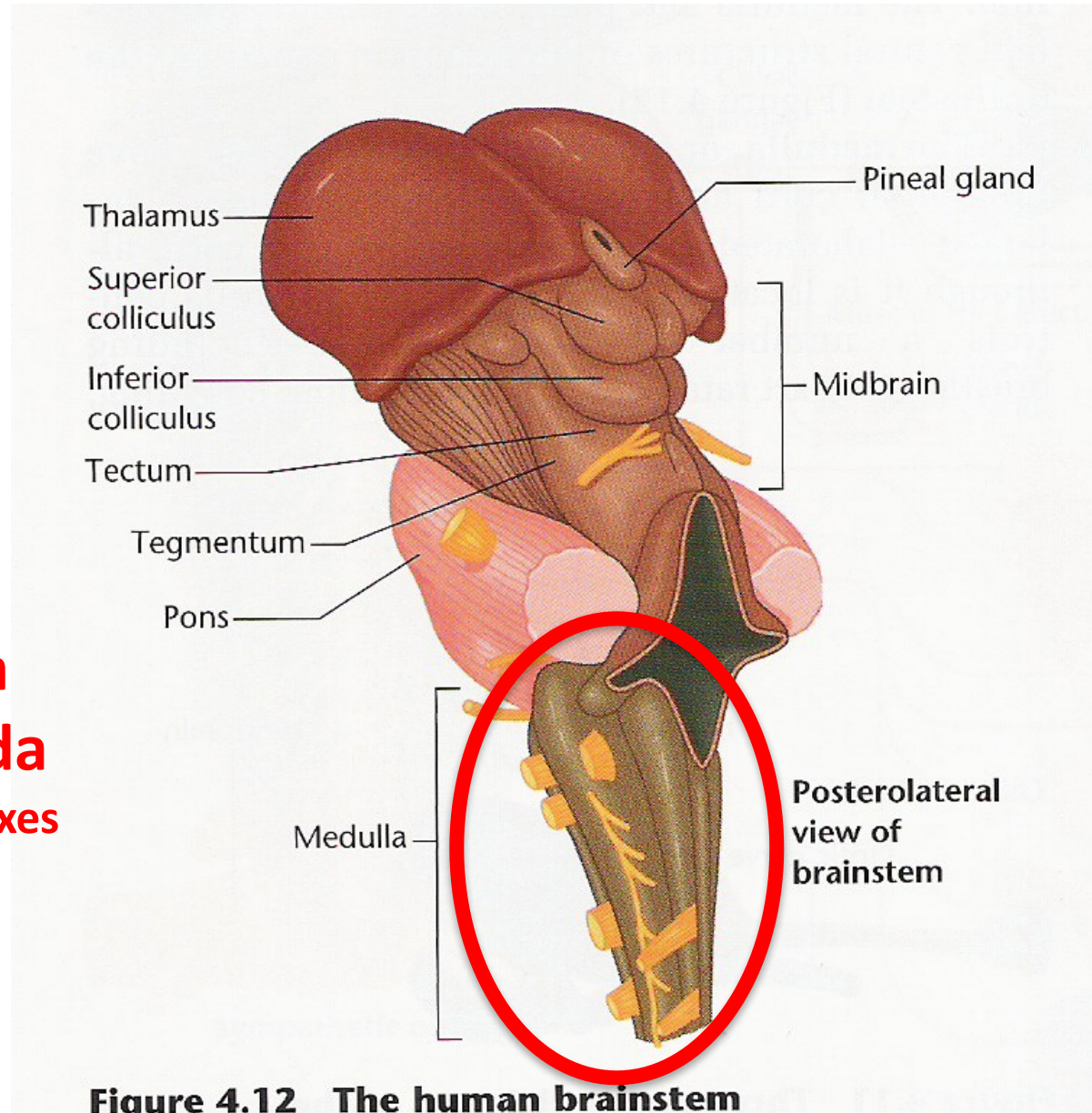
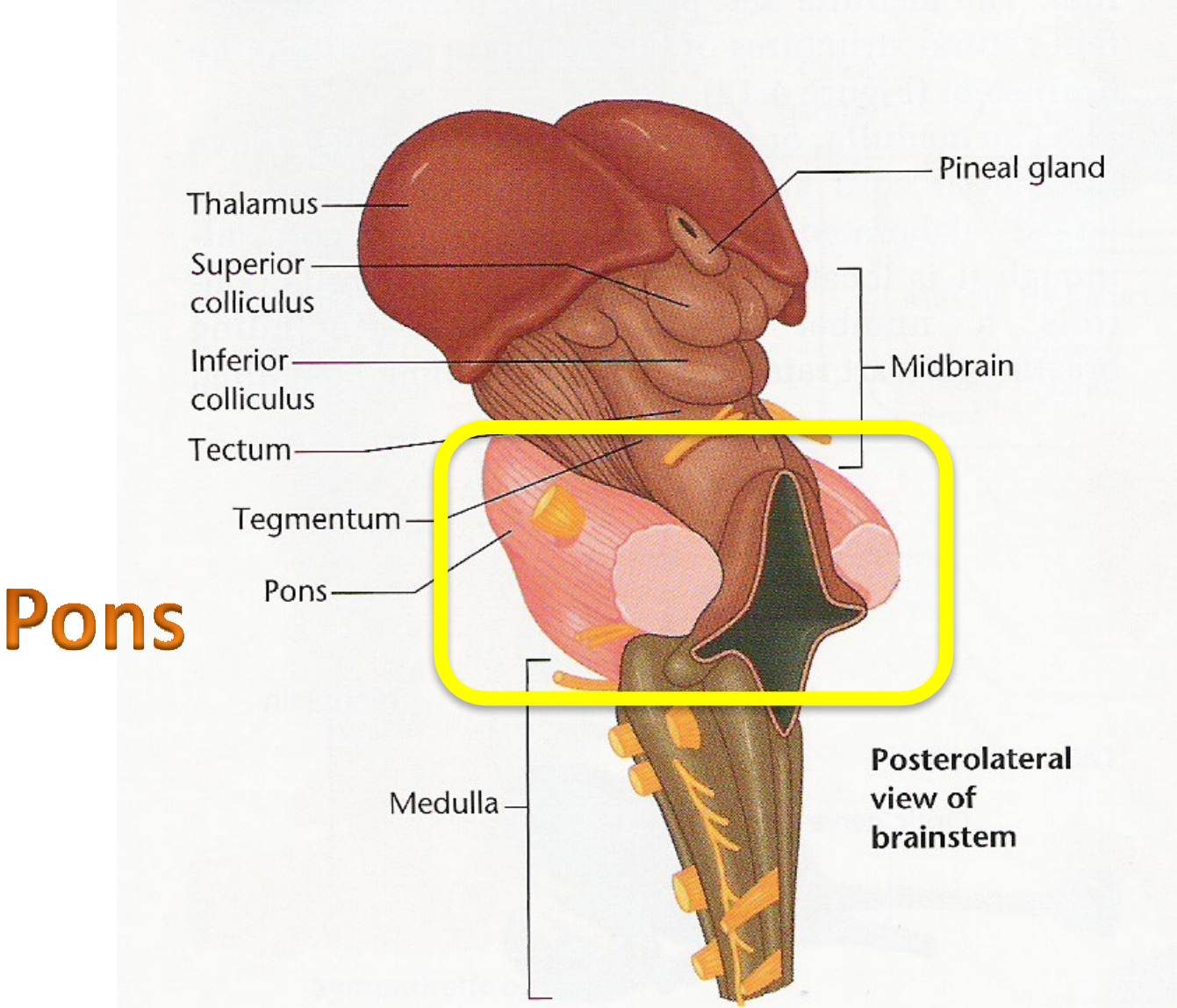


Figure 4.12 The human brainstem

HINDBRAIN: Pons



Pons

Figure 4.12 The human brainstem

Cranial Nerves

Most
Cranial Nerves
also enter/exit
Medulla & Pons

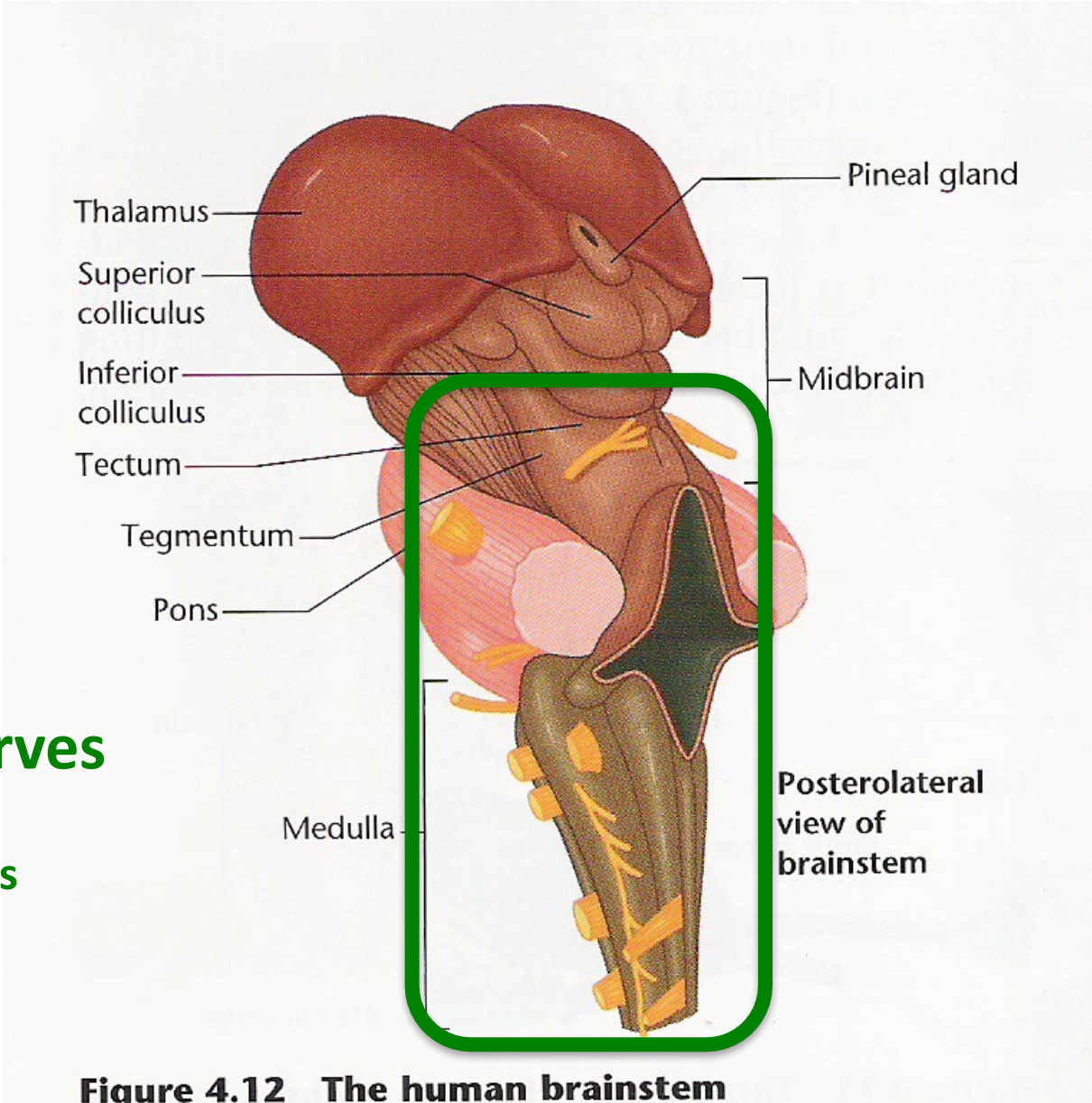
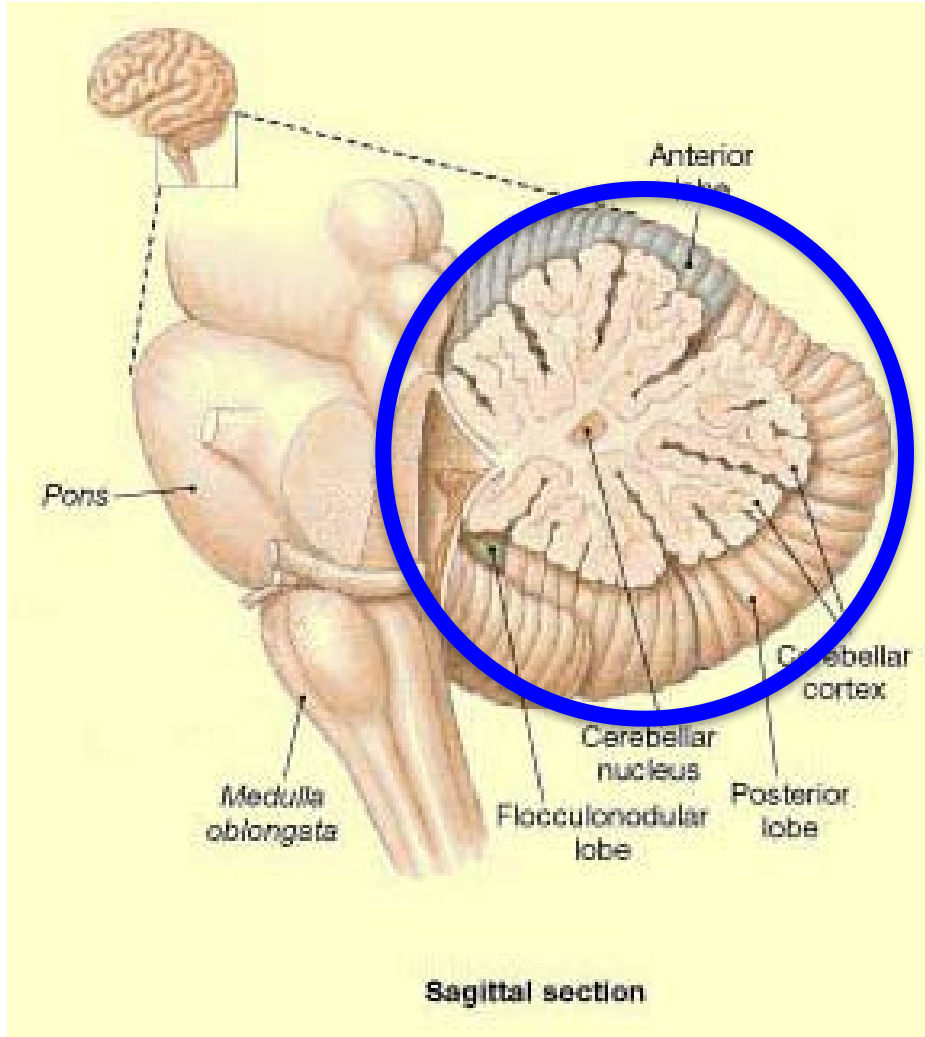


Figure 4.12 The human brainstem

HINDBRAIN: Cerebellum



**Motor Programs
w/realtime sensory coordination**

HINDBRAIN: Cerebellum

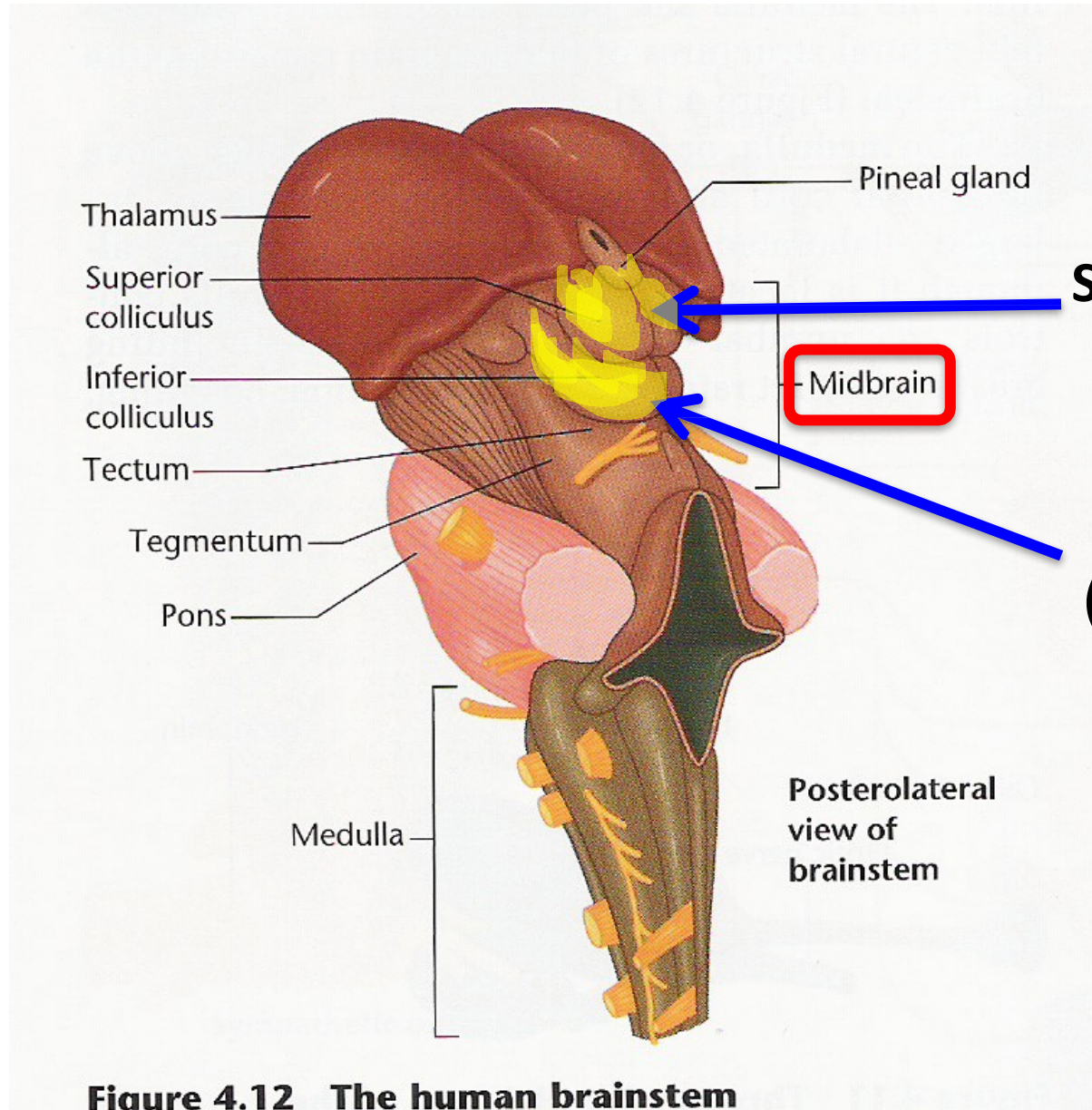
MNEMONIC:

**Sarah the ballerina
has a hell of a cerebellum!**



MIDBRAIN

TECTUM

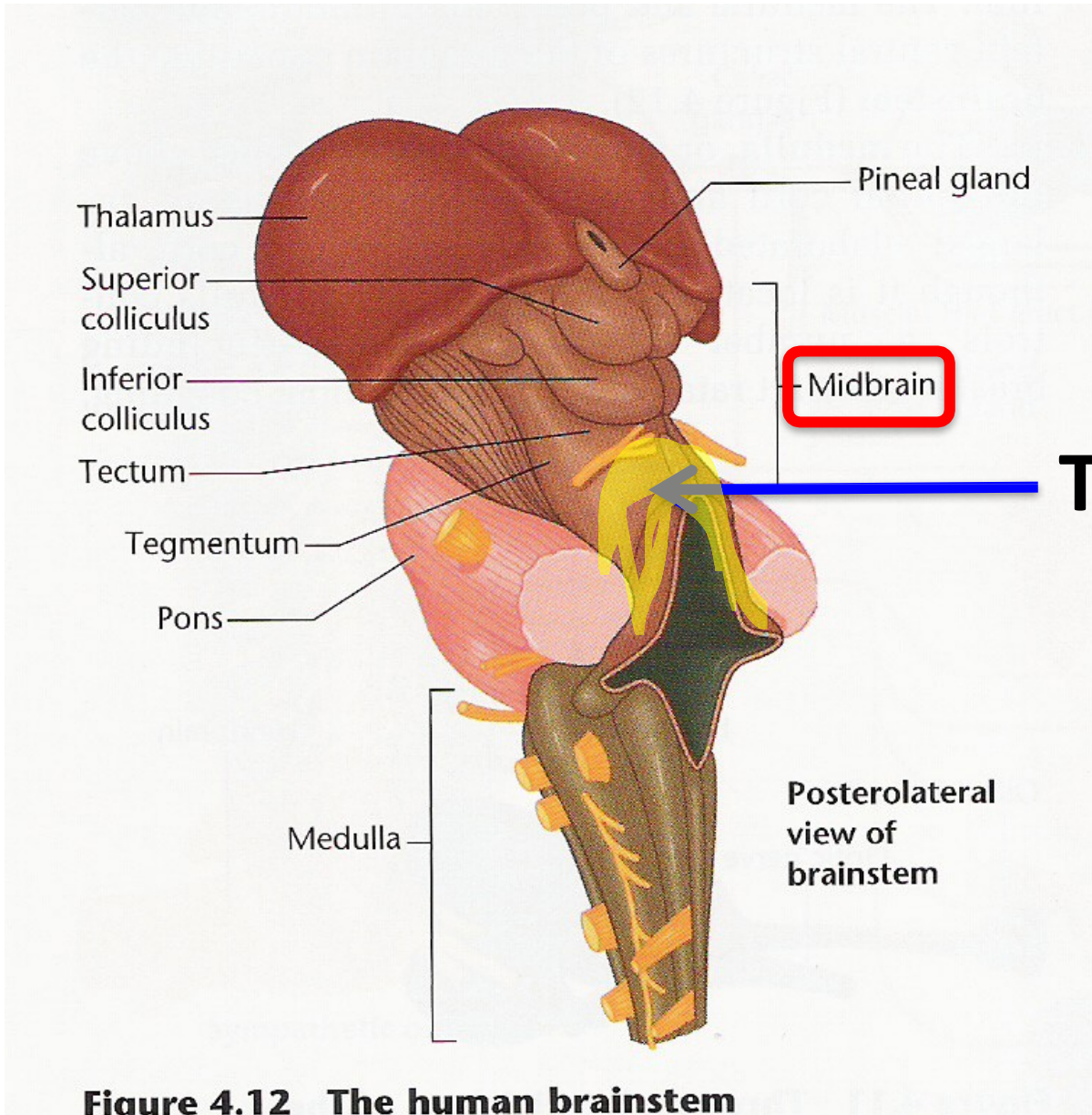


Superior Colliculus
(Visual Motion)

Inferior Colliculus
(Auditory Motion)

Figure 4.12 The human brainstem

MIDBRAIN

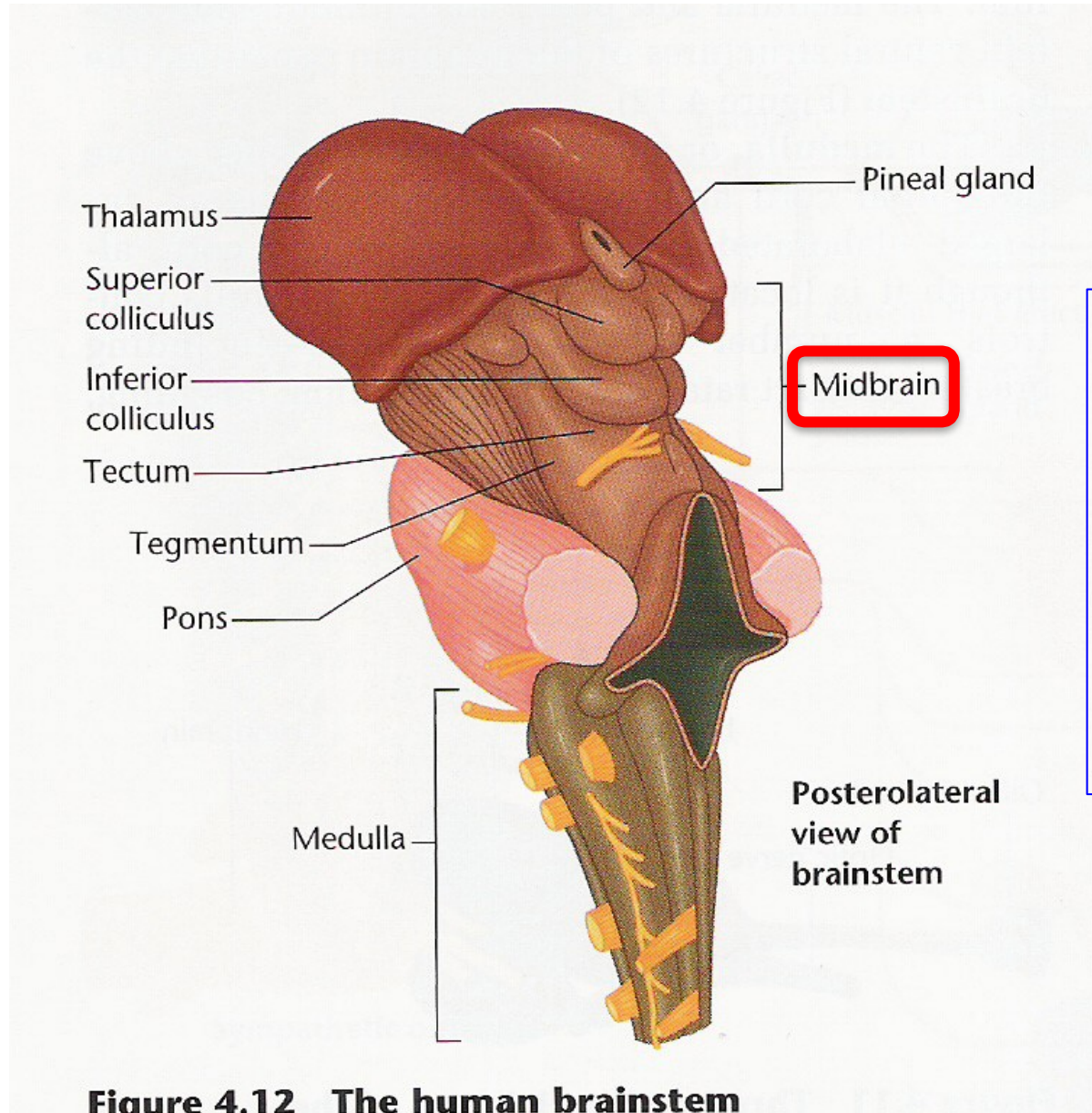


TEGMENTUM

**Motor Pathways
& some
Cranial Nerves**

Figure 4.12 The human brainstem

MIDBRAIN

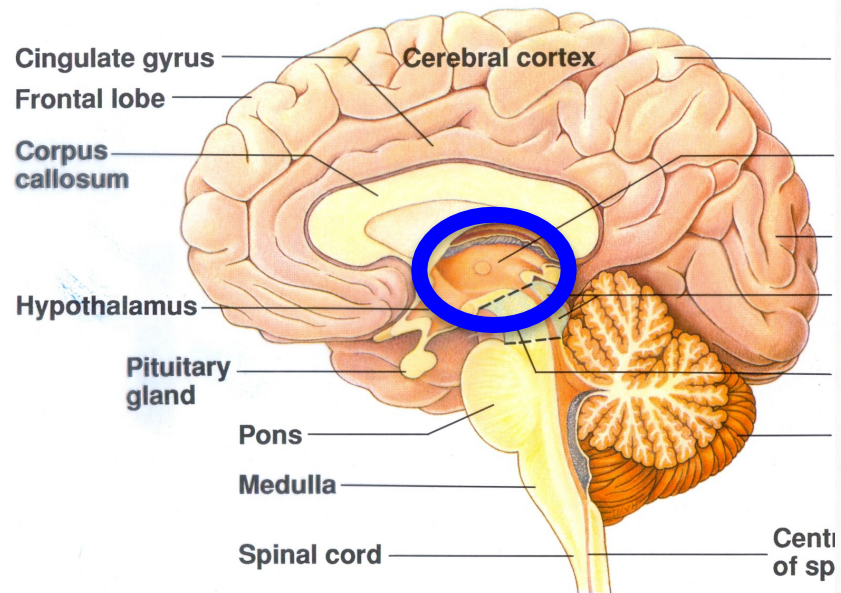


MIDBRAIN MNEMONIC:

**Tectum
to detect 'em,
Tegmentum
for momentum**

Figure 4.12 The human brainstem

Diencephalon of Forebrain: **THALAMUS**



**Projects to/Receives from
Sensory, Motor & Arousal systems**

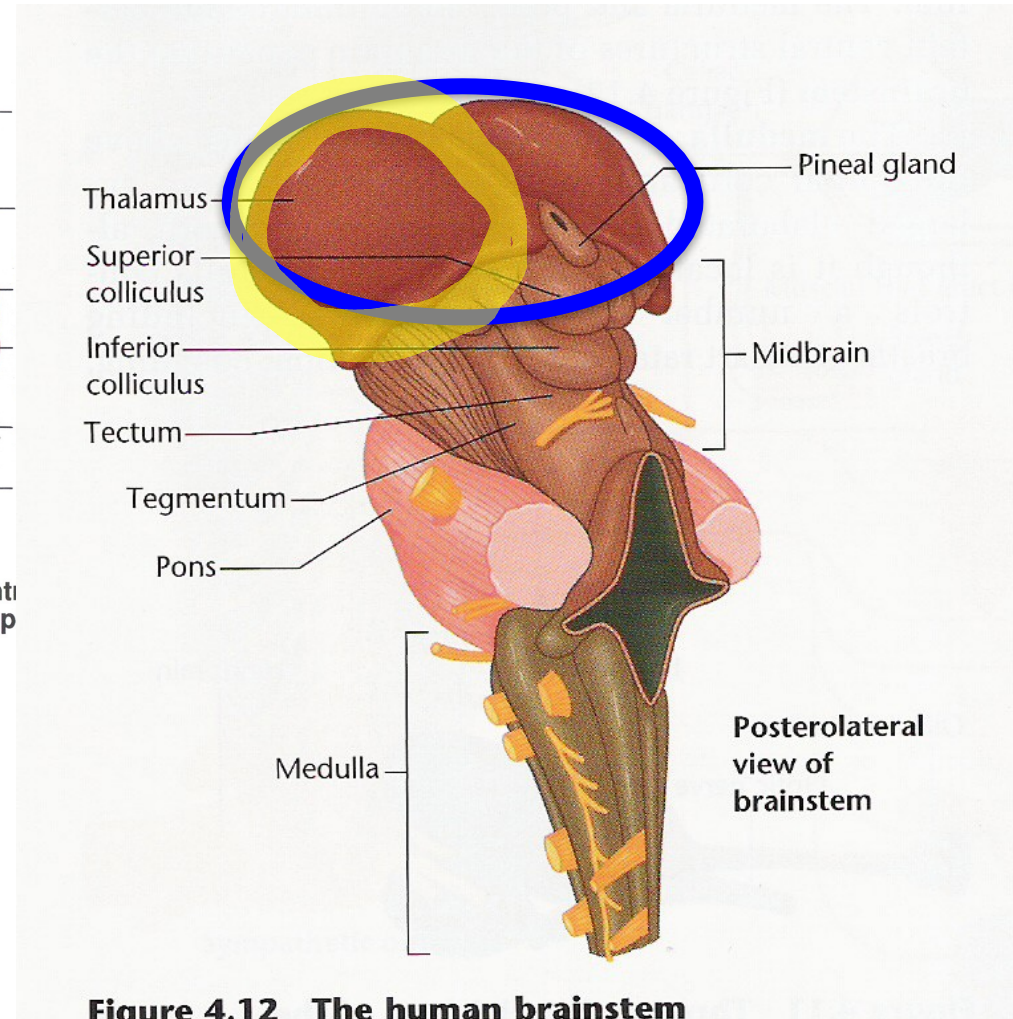
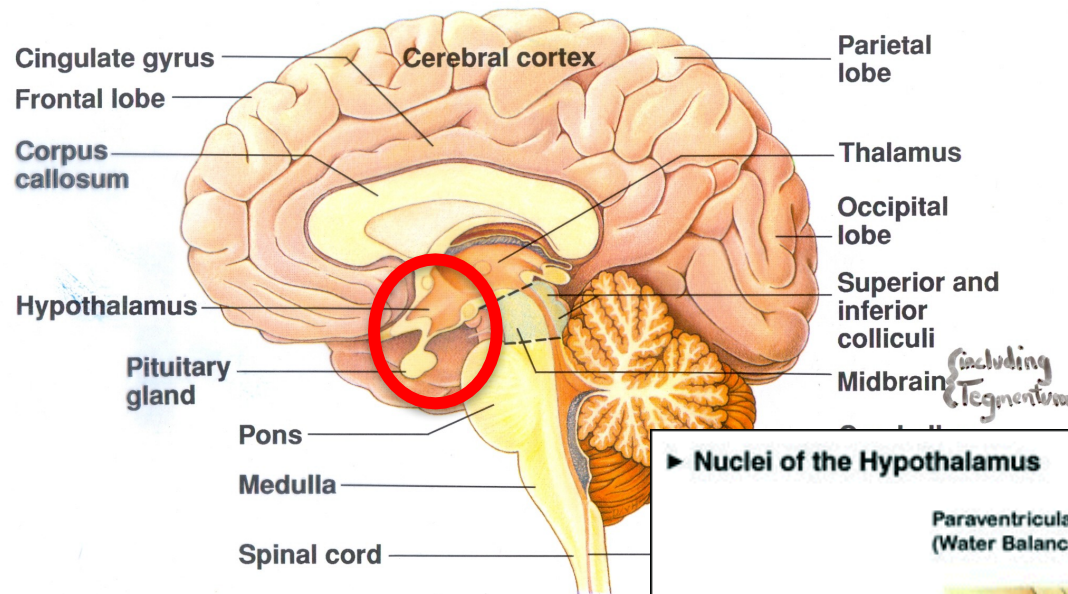


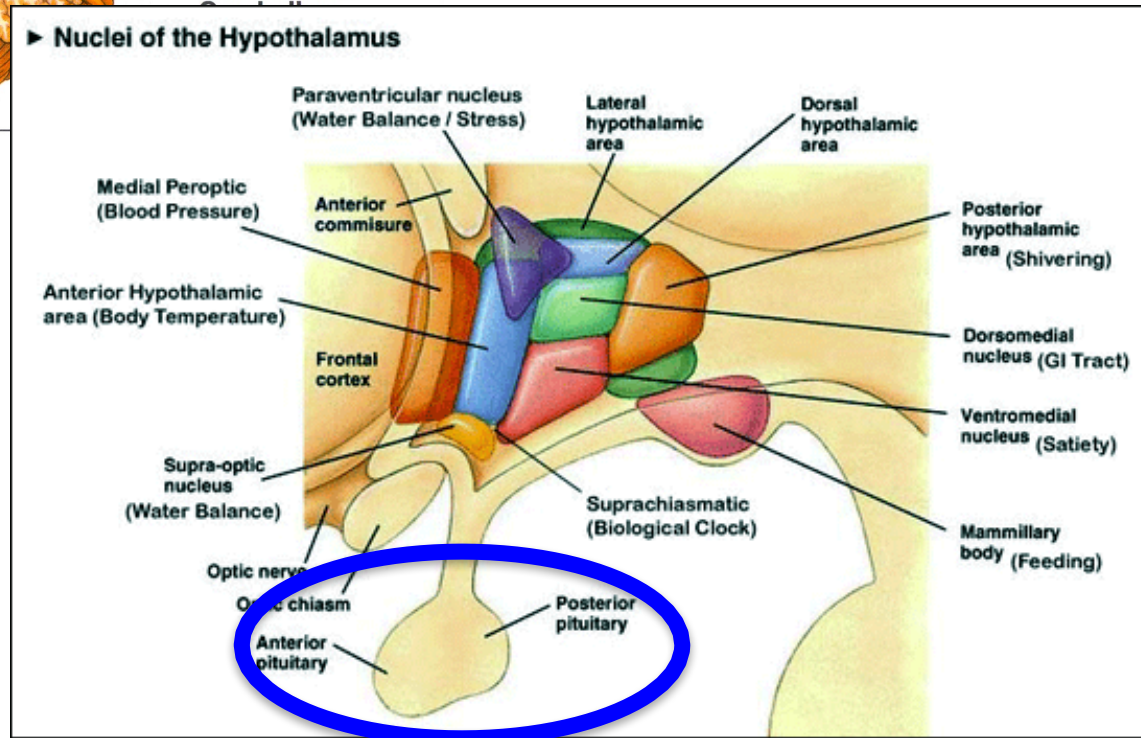
Figure 4.12 The human brainstem



Diencephalon of Forebrain: **Hypothalamus**

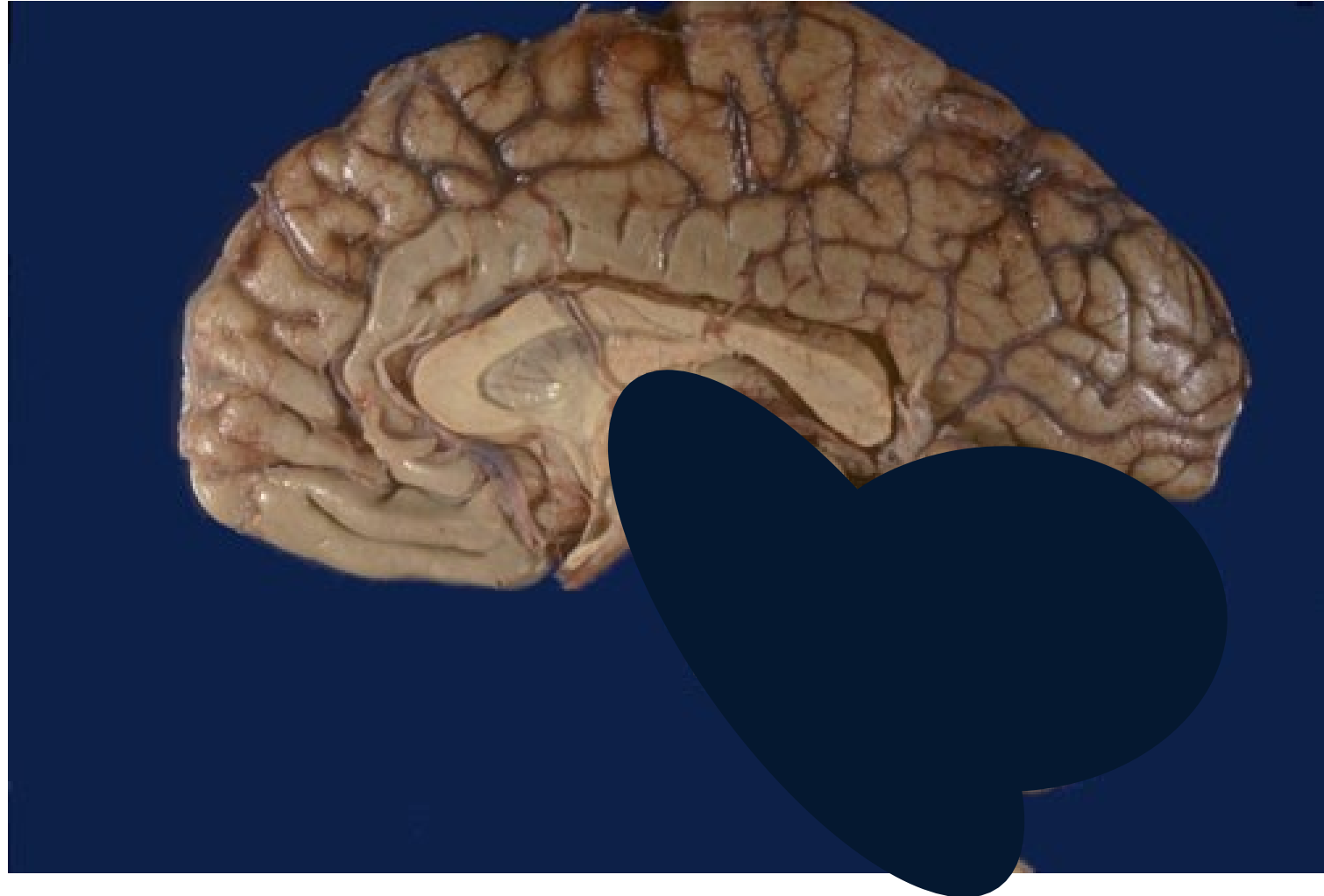
Neuro-Endocrine
(Brain+Hormone)
System

Oversees
4Fs + Temp + Clock



**Communicates to PITUITARY GLAND
(the "master" gland)**

Telencephalon: All other Forebrain Structures



Limbic System - Motivation

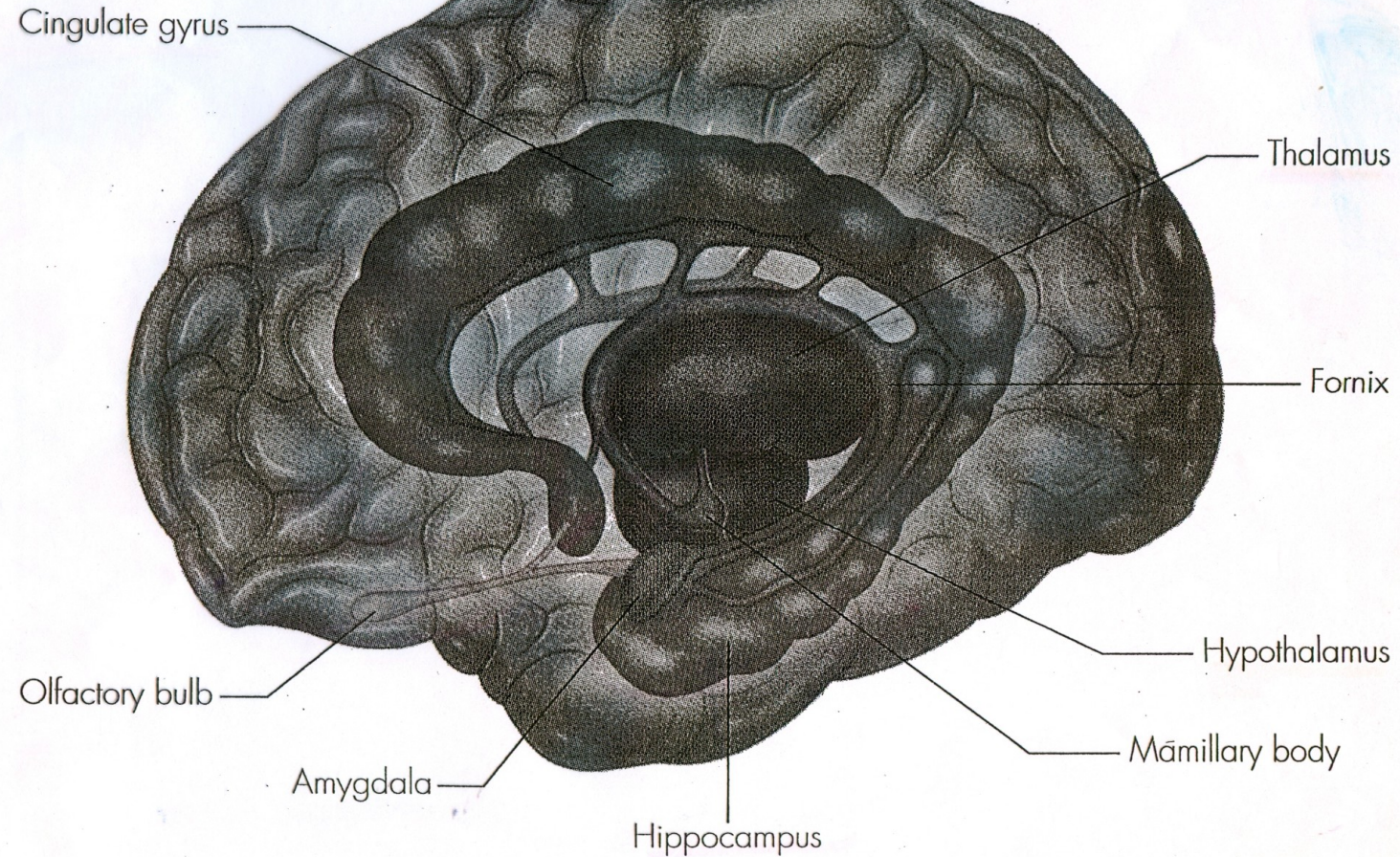


Figure 4.10 The limbic system is a set of subcortical structures that form a border (or limbus) around the brain stem.

Limbic System - Motivation

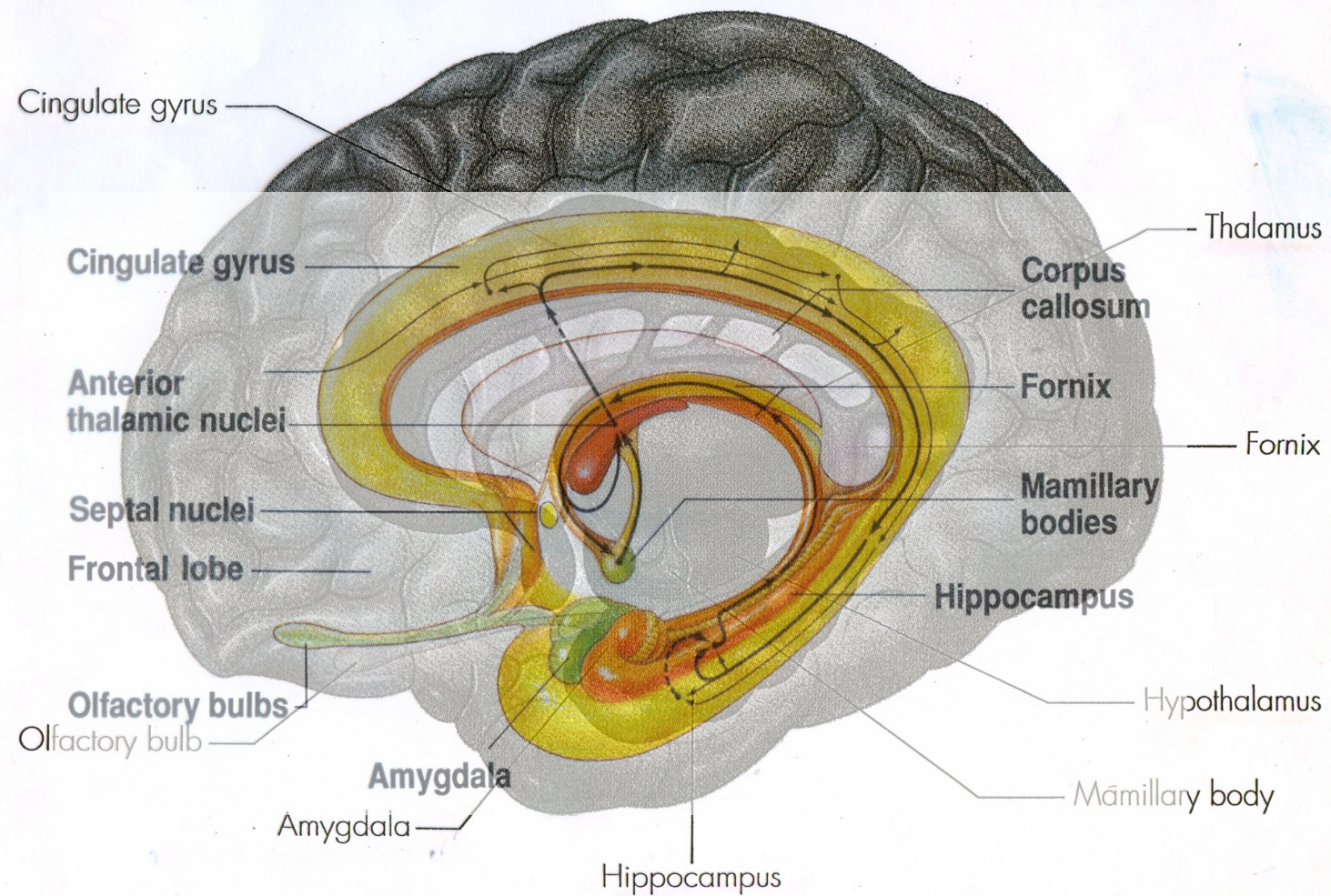
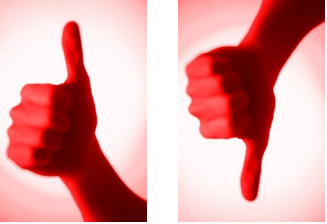


Figure 4.10 The limbic system is a set of subcortical structures that form a border (or limbus) around the brain stem.

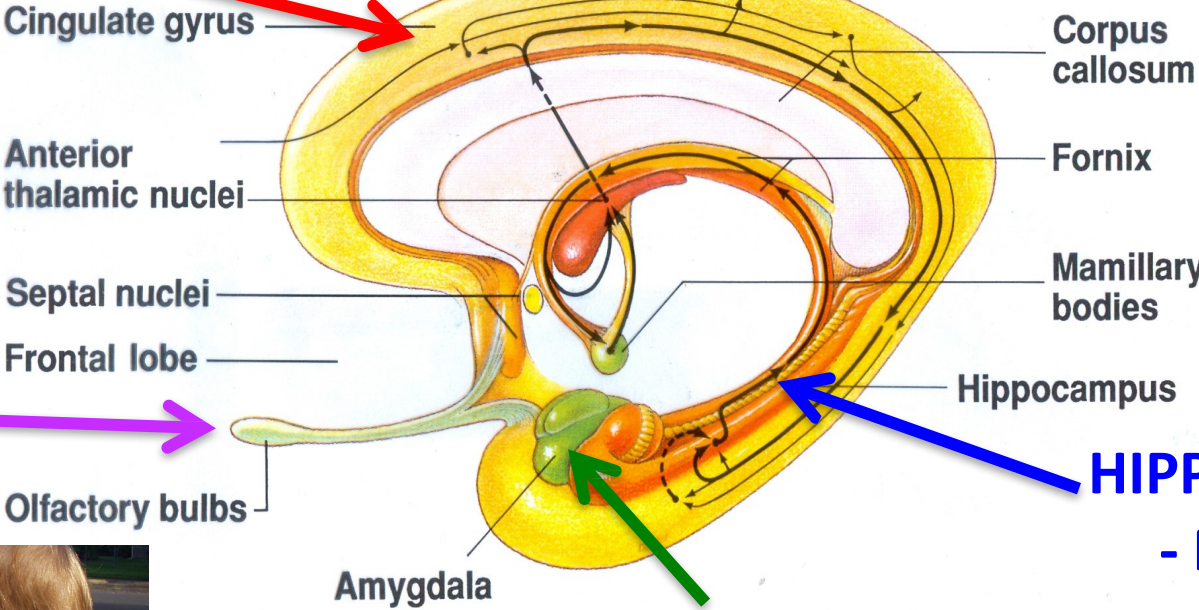
Limbic System - Motivation

CINGULATE GYRUS
+/- Evaluator
A "Re-Entrant" System



...and MORE!

OLFACTORY BULB
- Smell

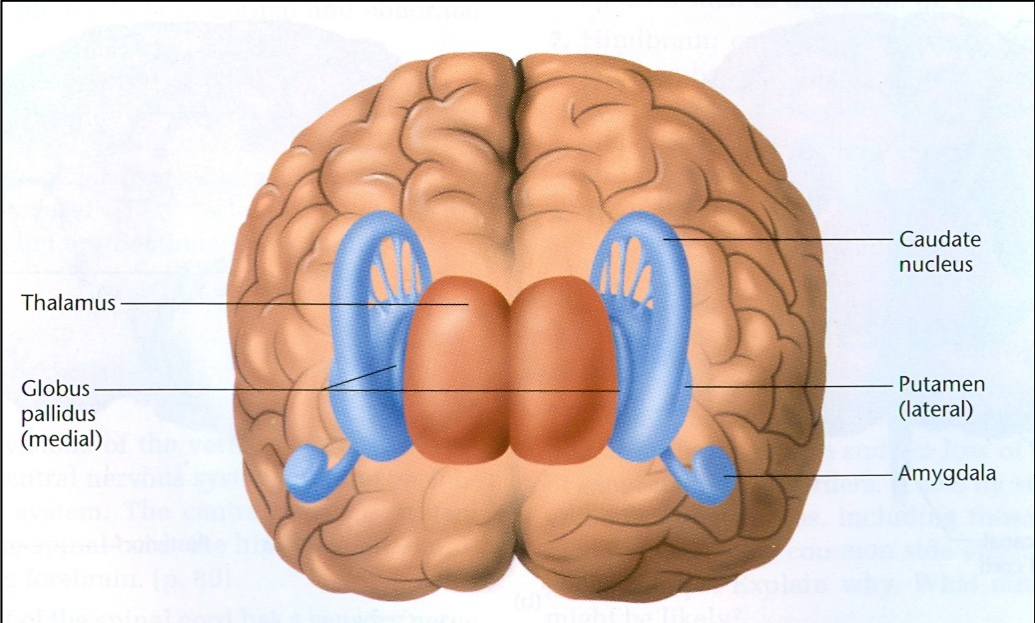


HIPPOCAMPUS
- Memory

AMYGDALA
- Emotion

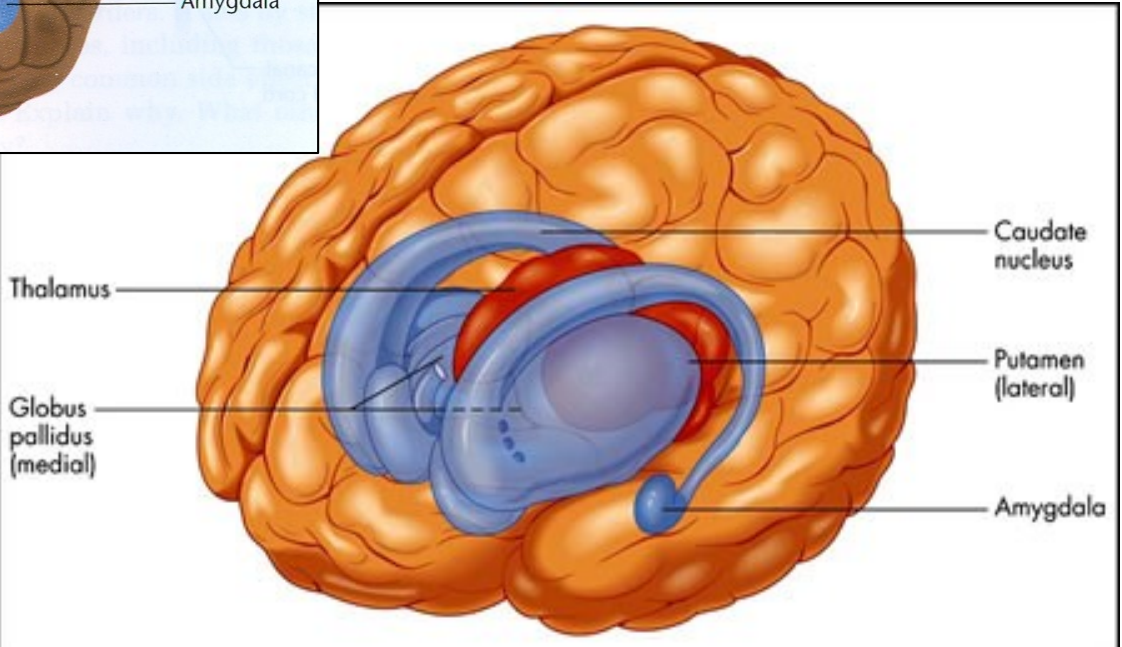


Basal Ganglion

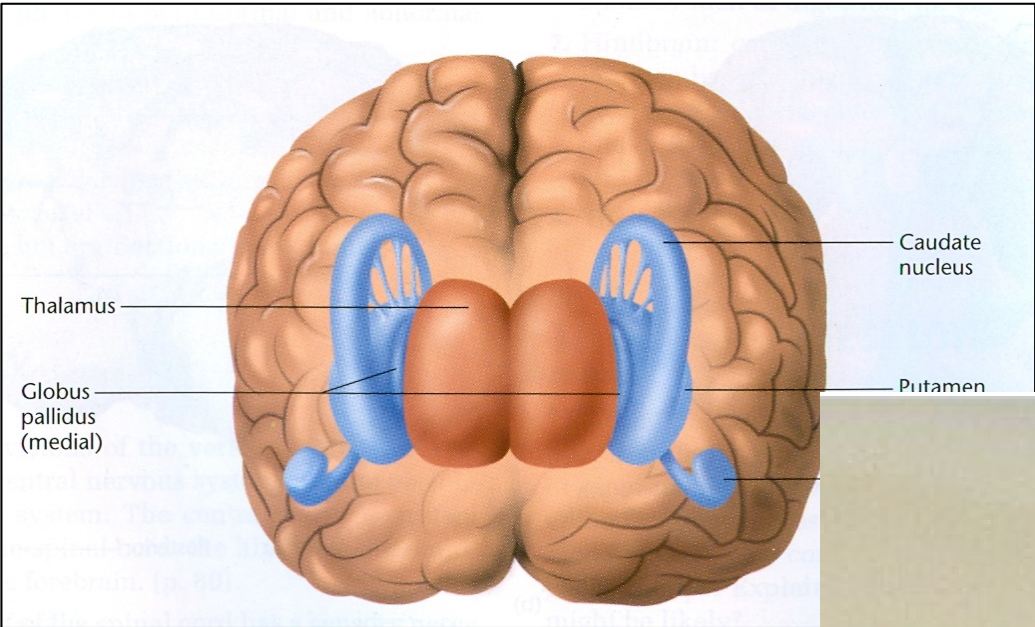


Organizing activity into
TASKS

Another
RE-ENTRANT
System



Basal Ganglion



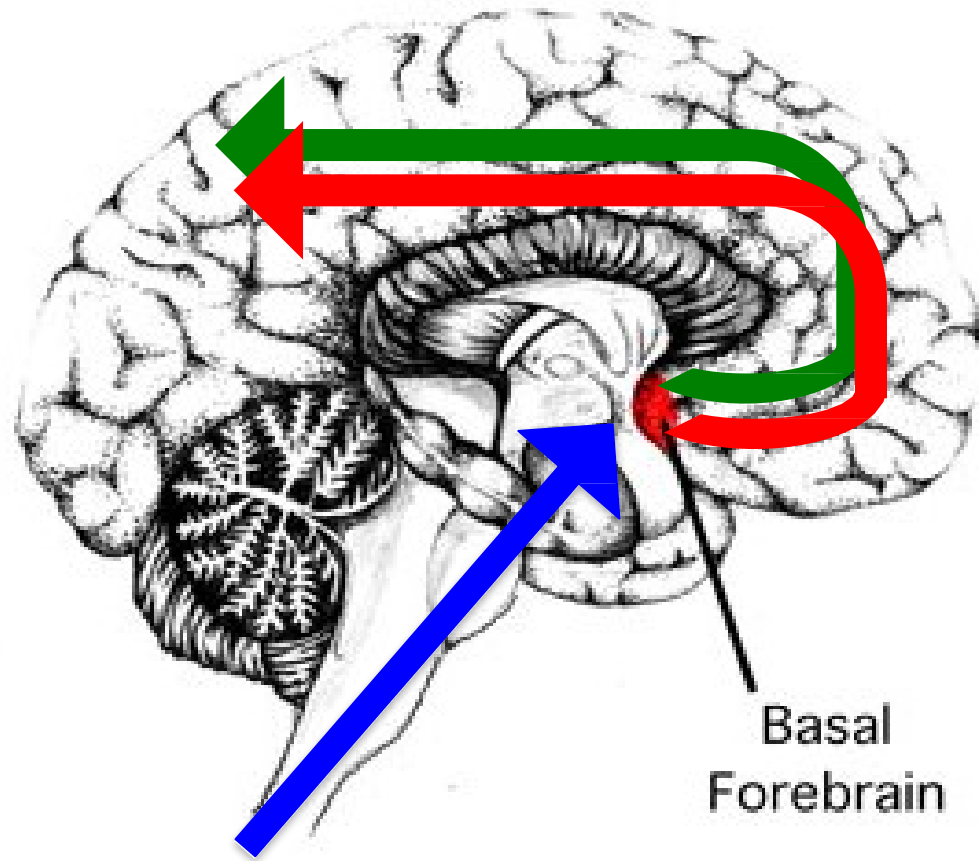
Substantia nigra

Parkinsons Disease:
 Compromised connections
 from Tegmentum to Basal Ganglia
 >>Motor deficits



Michael J. Fox is curing Parkinson's because it's there.

Basal Forebrain



ACh arouses Cortex

GABA de-arouses
Cortex

Receives from Raphe/Reticular Arousal System in Brainstem