Cerebellum, cerebrum, basal ganglia and limbic systems

3 main regions of the brain for motor control:

- Cerebellum – coordination of movement
- Basal ganglia – amplification of movement
- Motor association cortices – selection of right movement

Motor association cortices:

1) Premotor cortex
2) Broca's area
3) Prefrontal cortex

3 main regions of the brain for motor control:

- Damage to basal ganglia = Dyskinesia, hypokinesia, hyperkinesia
- Damage to cerebellum = ataxia
- Damage to motor association cortices = apraxia

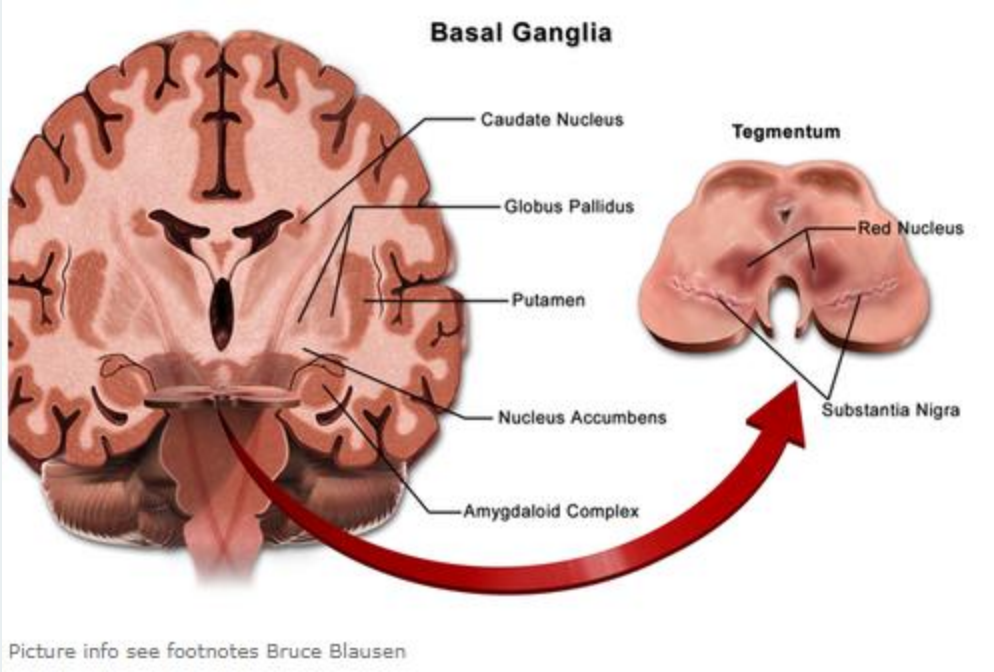
Basal ganglia:

- Group of nuclei (grey matter)

- **Excitatory signals** = glutamate neurotransmitter
- **Inhibitory signals** = GABA neurotransmitter

- **(Neo)Striatum** – caudate + putamen (biggest)
- **Pallidum** – GPI + GPE
- **Subthalamic nucleus**
- **Substantia nigra** – pars compacta + pars reticularis

- INPUT – caudate + putamen
- OUTPUT – GPI + pars reticularis

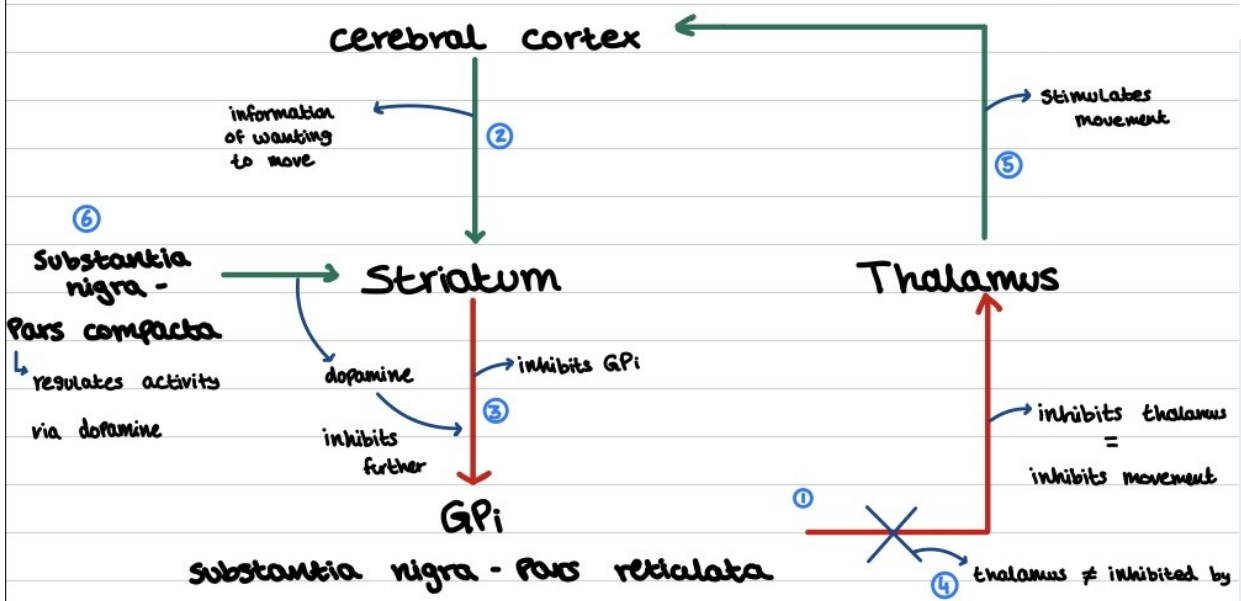


Picture info see footnotes Bruce Blausen

Direct pathway: allows **wanted movement**

1) GPI + pars reticularis inhibit thalamus = NO MOVEMENT
2) However, when the cerebral cortex receives information for desired movement = EXCITATION of STRIATUM
3) Striatum INHIBITS GPI + pars reticularis = NO INHIBITION of thalamus
4) Thalamus EXCITATES cerebral cortex
5) Pars compacta = dopamine – acts on DA1 RECEPTORS
6) This causes FURTHER INHIBITION of GPI + pars reticularis

Direct Pathway: DA1 receptors, wanted movement



= inhibitory - GABA

= excitatory - Glutamate, dopamine

1) GPi + Pars reticulata inhibit thalamus ≠ movement
2) however, when cerebral cortex receives information for desired movement it excitates the striatum
3) striatum inhibits GPi + Pars reticulata ≠ inhibits thalamus
4) thalamus excitates cerebral cortex
5) Pars compacta = dopaminergic cells
   ↑ dopamine acts on DA1 receptors on neostriatum
   ↑ further inhibition of GPi + pars reticulata

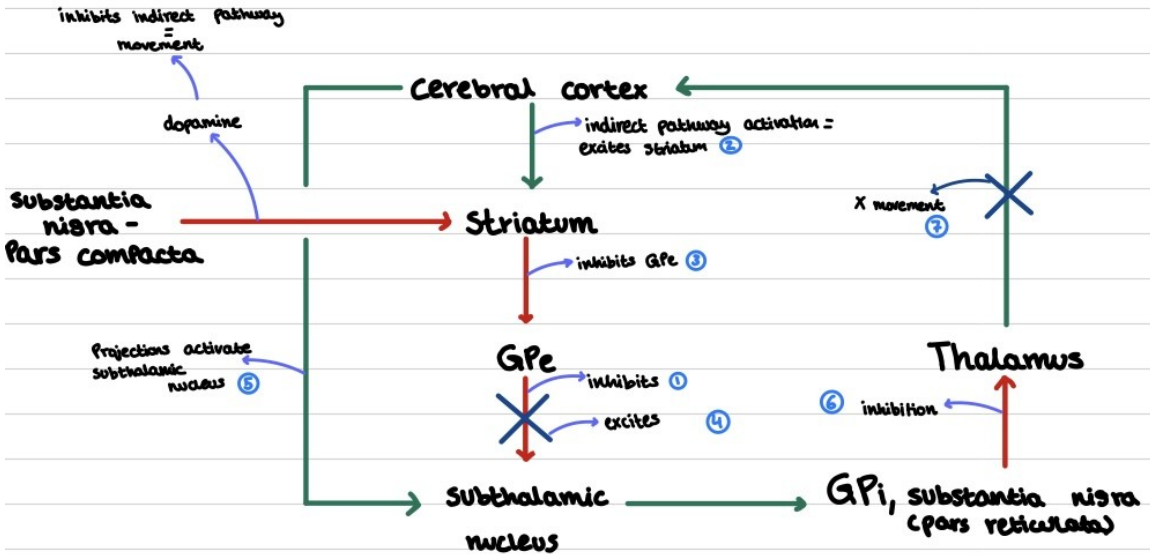
Indirect pathway: Prevents **unwanted movement** – antagonises direct pathway

1) GPE INHIBITS subthalamic nucleus
2) When the indirect pathway is activated, cerebral cortex EXCITATES the striatum
3) Striatum INHIBITS GPE
4) GPE NO LONGER INHIBITS subthalamic nucleus
5) Subthalamic nucleus EXCITATES GPI + pars reticulata
6) This causes INHIBITION of the thalamus – preventing unwanted movement

release of dopamine inhibits indirect pathway = movement via DA2 receptors

antagonises direct pathway

Indirect Pathway: DA2, Prevents unwanted movement



= inhibitory - GABA, Dopamine

= excitatory - Glutamate

Substantia nigra: Pars compacta

* release dopamine
  - ↳ acts on DA2 receptors - striatum
    - ↳ causes movement
      - ↳ X inhibition of GPe,
        GPe inhibits subthalamic nucleus,
        Subthalamic nucleus inhibits GPi + Pars reticulata,
        GPi + Pars reticulata X inhibit thalamus,
        thalamus = free to fire → cortex = movement

Cerebellum:

Function:

- coordination, balance and fine movement = **‘fine tuner’**

Anatomy:

- **Anterior** = subconscious skeletal movement
- **Posterior** = subconscious skeletal movement
- **Floculonodular** = equilibrium and balance

Surface (grey matter) = many folds = folia -> INCREASE SURFACE AREA

White matter = Arbor vitae = cerebellar nuclei

Most important nuclei = dentate nucleus – allows motor planning

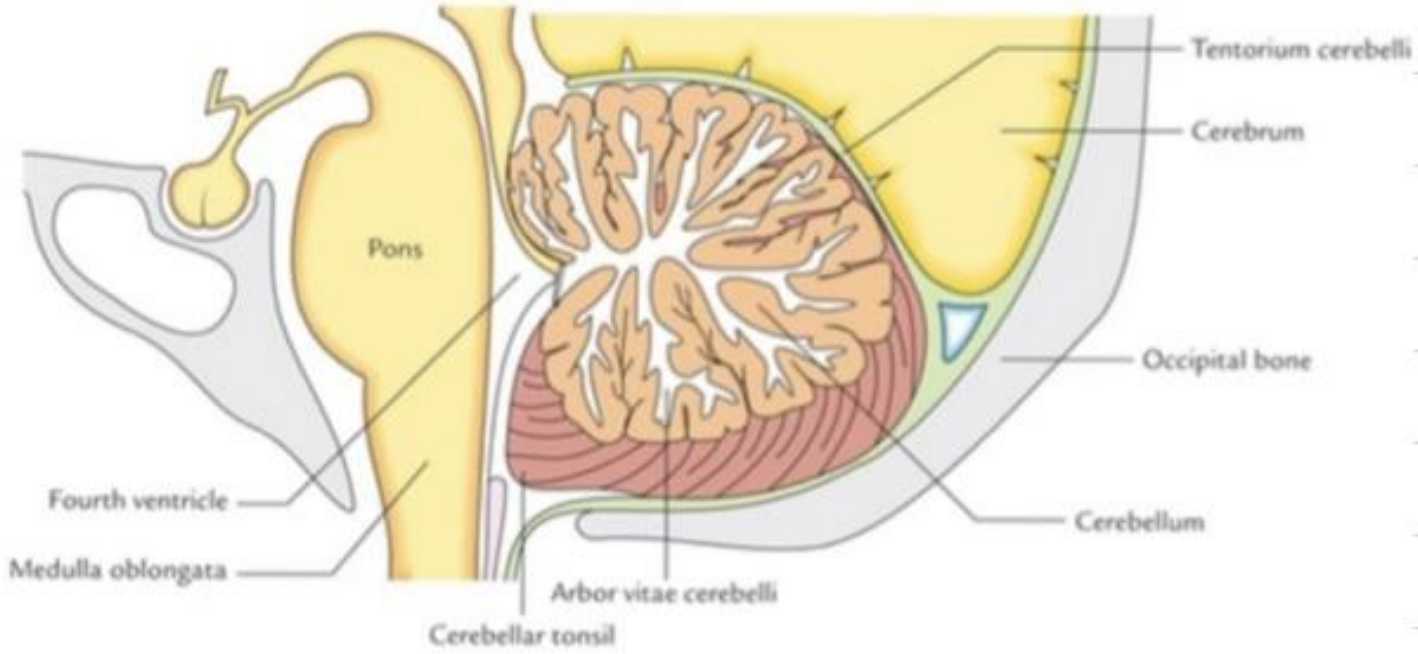
EXTRA!!

Cerebellum:

Grey matter — folia (folds) — manages sensory inputs

↓ inferior

cerebellar nuclei — arbor vitae — White matter



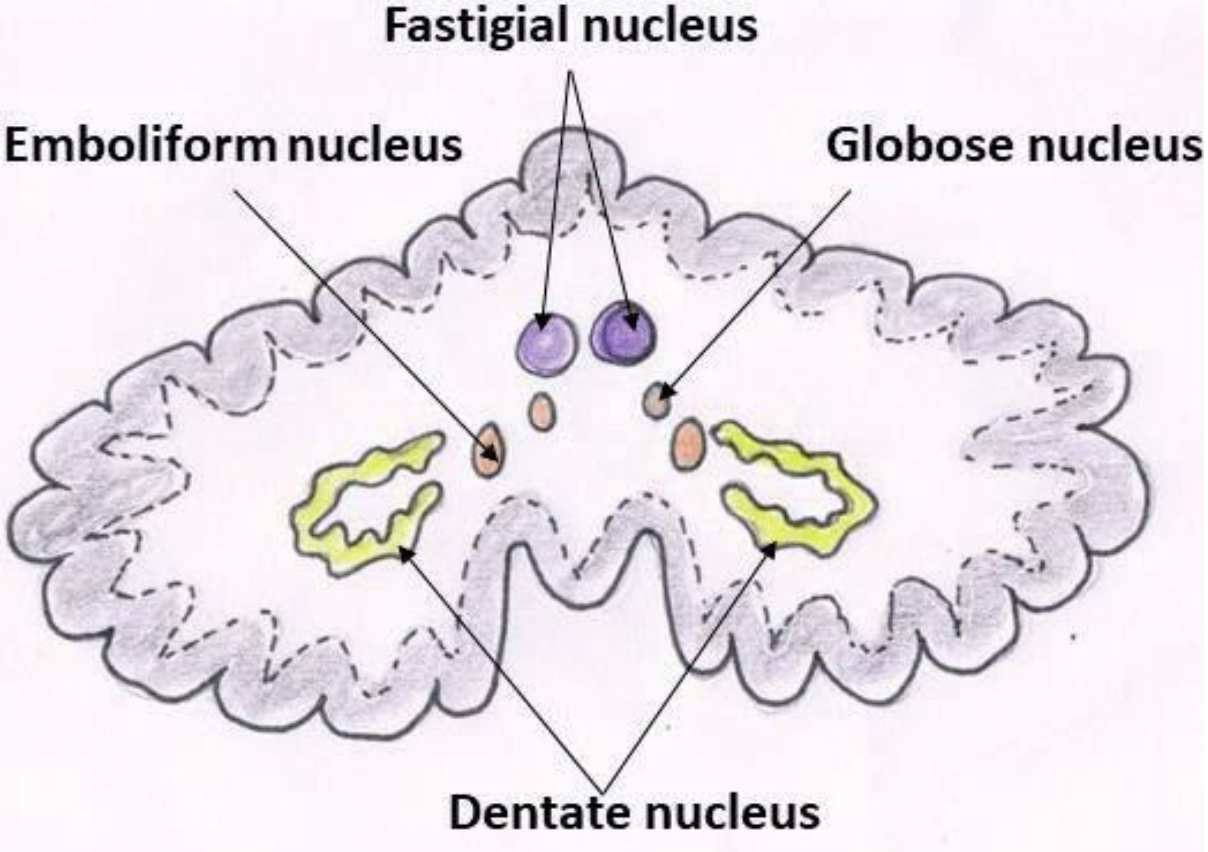
Cerebellar output:

Cerebellar nuclei:

- Collection of cell bodies + modulate different outputs

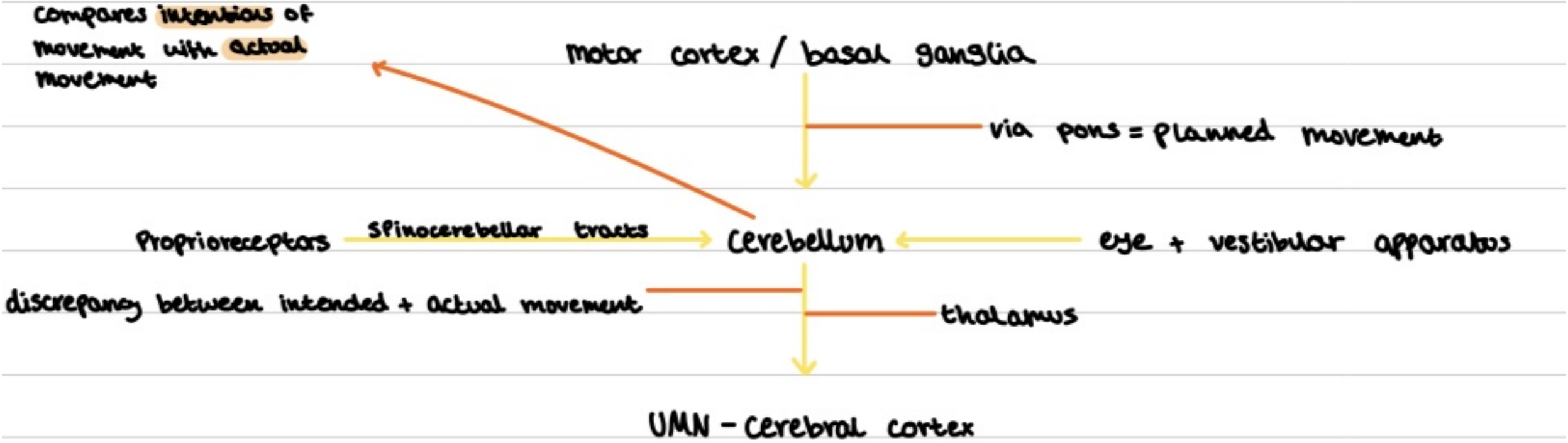
Functional divisions:

1) **Vestibulocerebellum** – vestibular nuclei
2) **Spinocerebellum** – fastigial, globose, emboliform nuclei outputs
3) **Cerebrocerebellar** – dentate nucleus



EXTRA!!

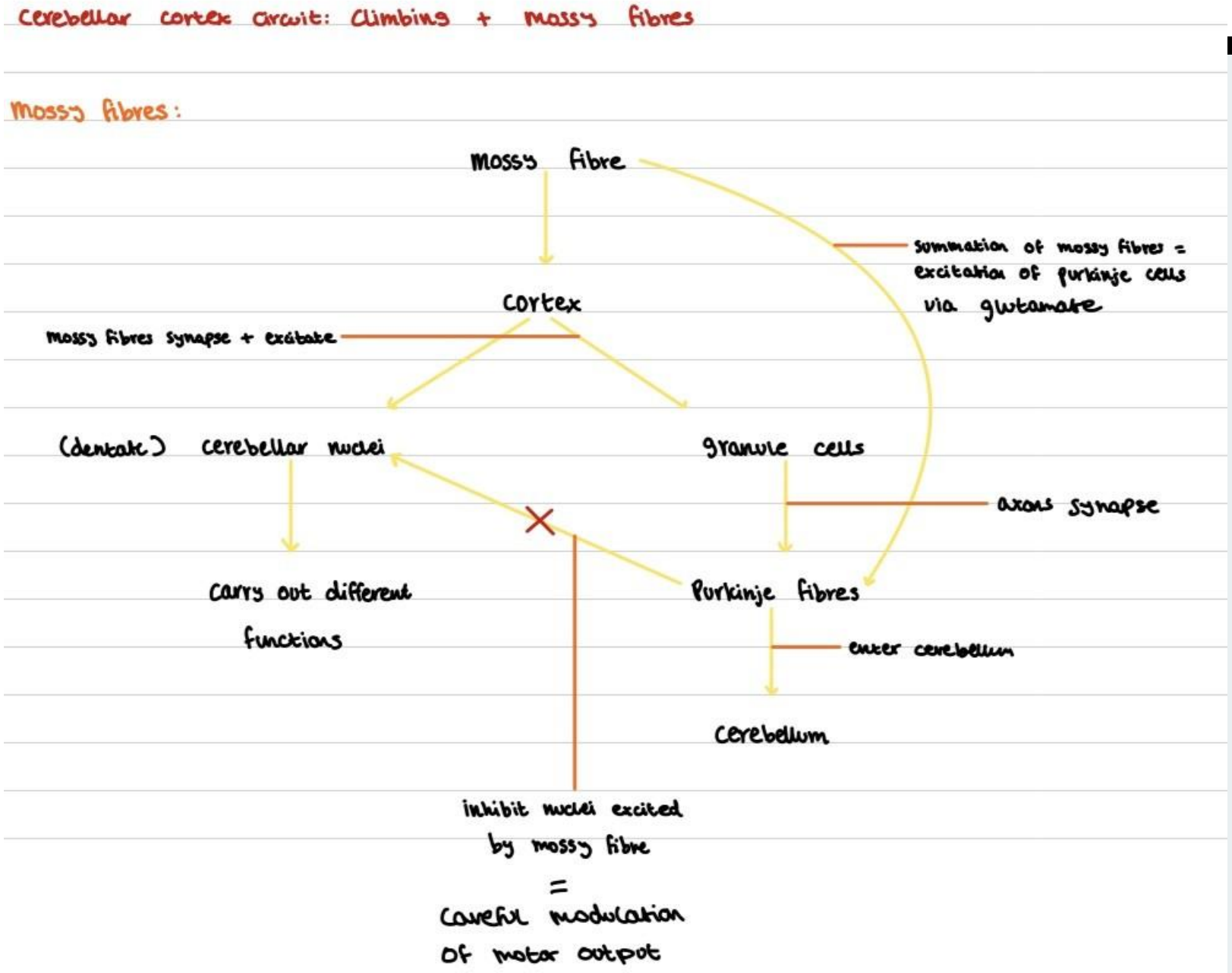
Modulation + movement of cerebellum:



Mossy fibres:

1) Mossy fibres branch in the cortex and synapse on to the CEREBELLAR NUCLEI + GRANULE CELLS
2) Mossy fibres EXCITE both via GLUTAMATE
3) Axons of these granule cells travel to the cortical surface + divides and synapse on to PURKINJE CELLS
4) One mossy fibre = small input, a SUMMATION of these excite the Purkinje cells
5) Purkinje cells leave the cortex and INHIBIT the nuclei that the mossy fibre initially excited
6) This results in a careful modulation of motor output

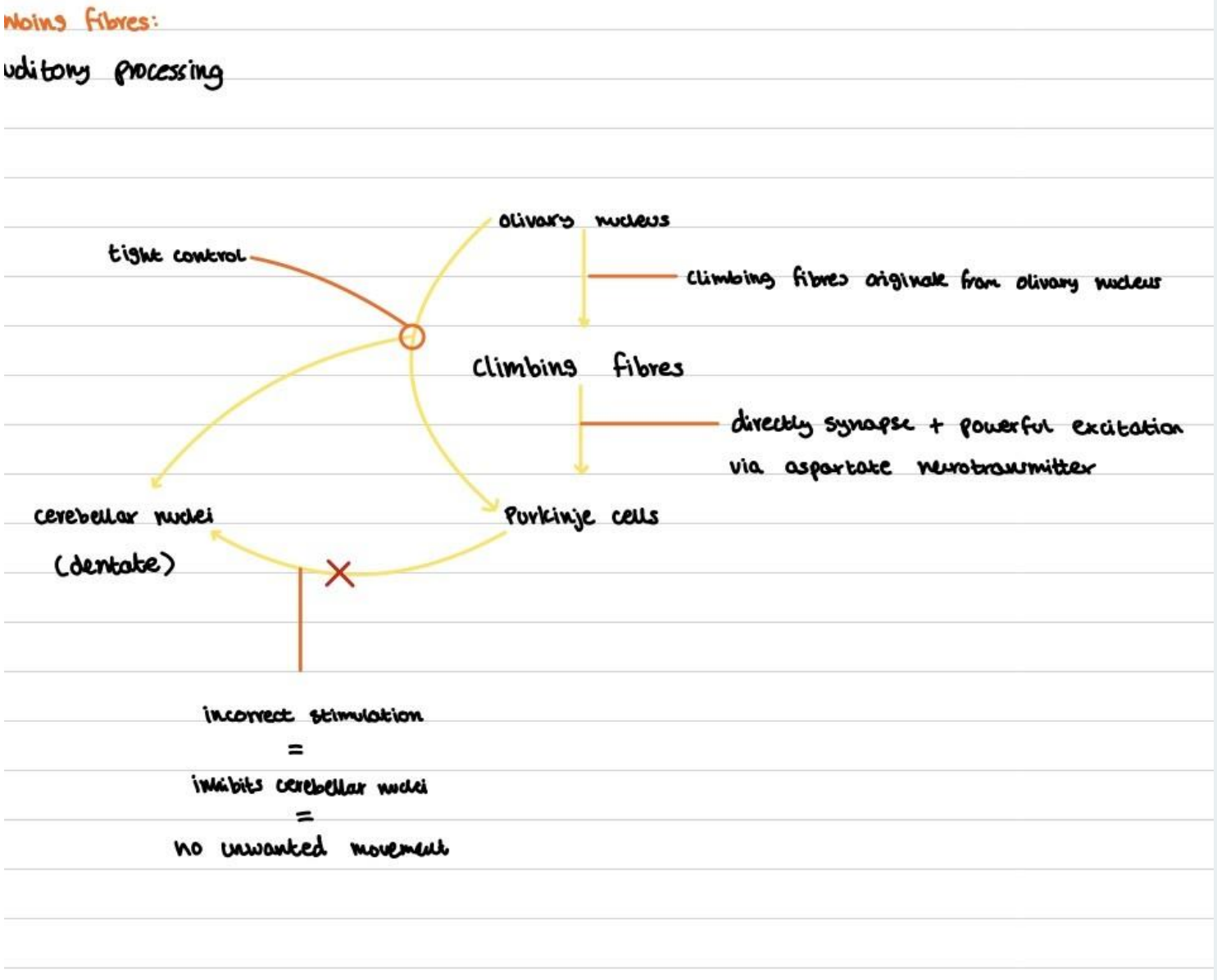
Mossy fibres:



Climbing fibres:

1) Climbing fibres from the OLIVARY NUCLEUS synapse DIRECTLY on to Purkinje cells = powerful excitement via ASPARTATE (one climbing fibre is ENOUGH to excite a Purkinje cell)
2) Olivary nucleus = TIGHT CONTROL on Purkinje cells
3) Process acts like 'error control' – if a nucleus has been incorrectly stimulated, the olivary climbing fibres are activated and excite Purkinje cells
4) They powerfully inhibit cerebellar nuclei if incorrectly stimulated
5) This STOPS UNWANTED MOVEMENT

Climbing fibres:



Cerebrum:

Frontal lobe:

- Primary motor cortex, Broca's area

Temporal lobe:

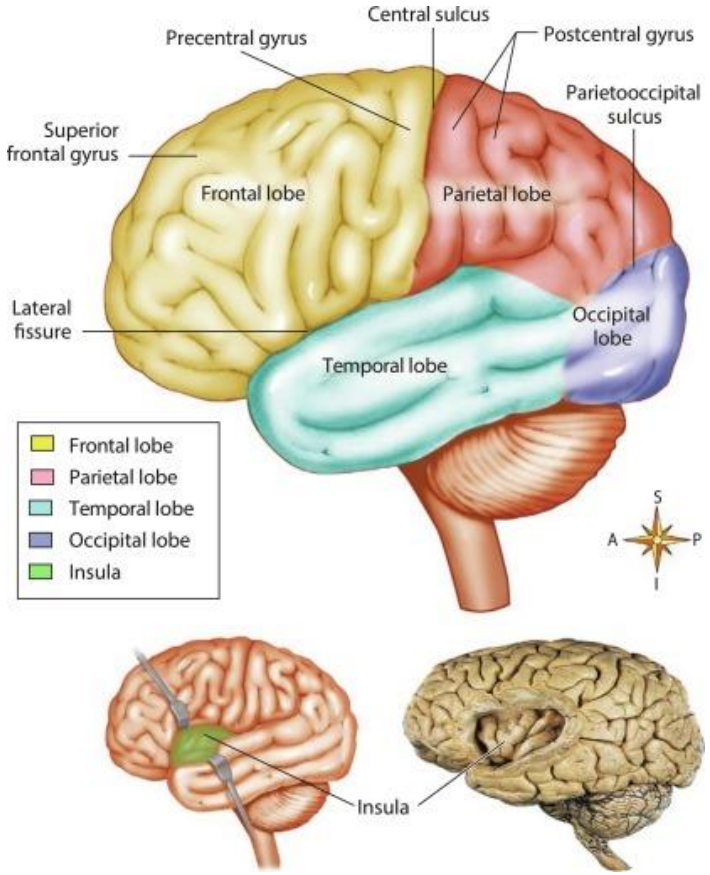
- Primary auditory area, hippocampus

Parietal lobe:

- Somatosensory cortex, auditory processing

Occipital lobe:

- vision



Language:

Broca's area:

- Speech production
- Frontal lobe = motor area

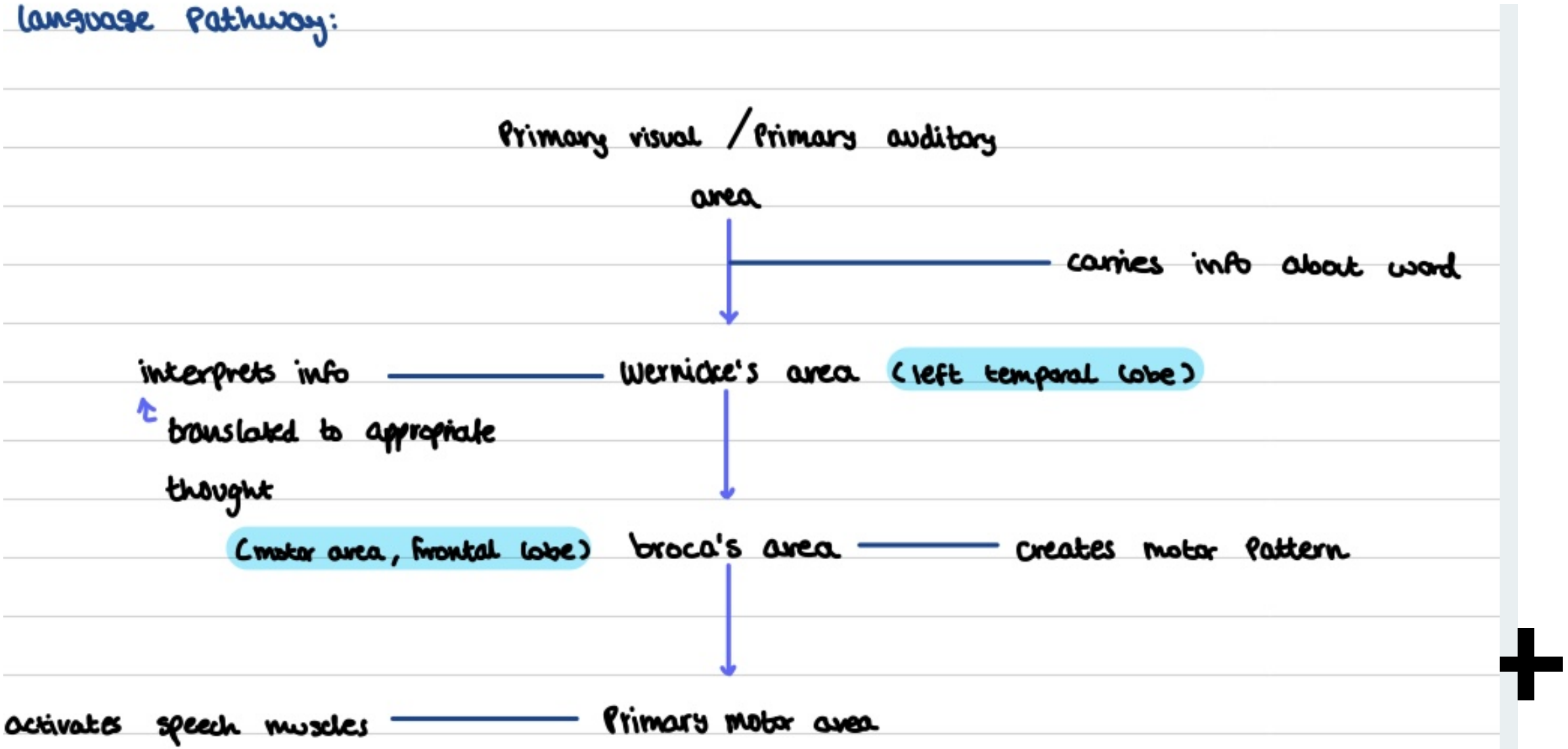
Wernicke's area:

- Speech comprehension
- Left temporal lobe

Language pathway:

1) **Primary visual area/primary auditory area** brings information to Wernicke's area
2) Wernicke's area – **interprets information and translates it into an appropriate thought**
3) Information is carried to **Broca's area** which creates a **motor pattern**
4) This is taken to the **primary motor area which activates speech muscles**

Language:


language Pathway:
Primary visual / Primary auditory area
carries info about word
interprets info
Wernicke's area (left temporal lobe)
translated to appropriate thought
(motor area, frontal lobe)
broca's area
creates motor pattern
activates speech muscles
Primary motor area

Limbic system:

- Found in cerebrum

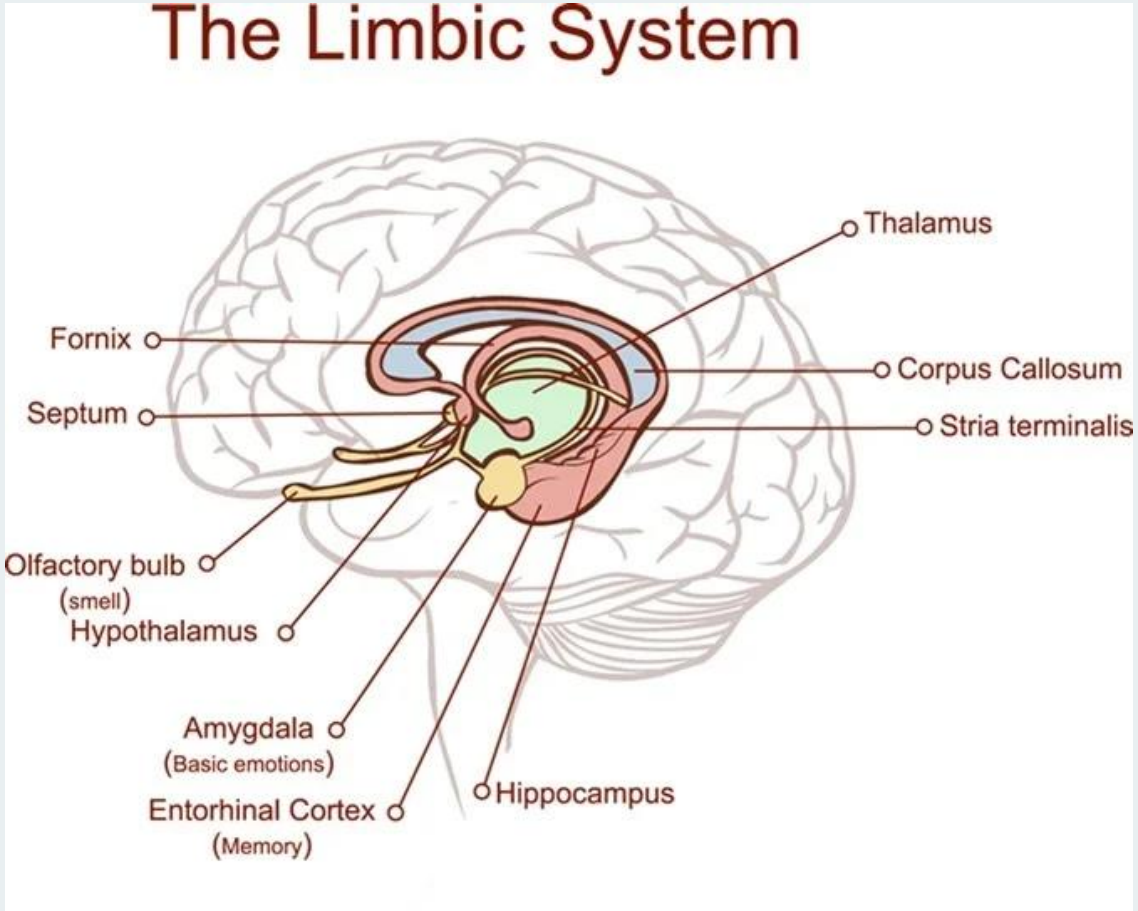
- Olfaction
- Emotions
- Memory

Amygdala:

- Emotional memories

Hippocampus:

- Long term memory/spatial memory
- Fornix = output



EXTRA!!

- Aphasia = language impairment
- Conduction aphasia = repetition impairment
- Agnosia = high order sensory dysfunction
- Associative agnosia = problems with understanding
- Apperceptual agnosia = problems with perception

Neurotransmitters:

- Noradrenaline – mood/arousal
- Serotonin – mood/attention
- Dopamine – motivation/reward
- Acetylcholine – sleep/attentiveness

QUESTIONS!!!!!

1) What is the function of the cerebellum?

- Amplification
- Selection
- Coordination

2) What is the biggest part of the basal ganglia?

- Striatum
- GPI
- Subthalamic nucleus

3) What receptors does dopamine bind to in the indirect pathway?

- D1
- M3
- DA2

QUESTIONS!!!!!

1) What is the cerebellum alternatively known as?

- Motor controller
- Fine tuner
- Speech talker

2) What fibres directly synapse to Purkinje cells?

- Mossy fibres
- Climbing fibres
- Neurotransmitter fibres

3) Where is Wernicke's area located?

- Right frontal lobe
- Inferior occipital lobe
- Left temporal lobe

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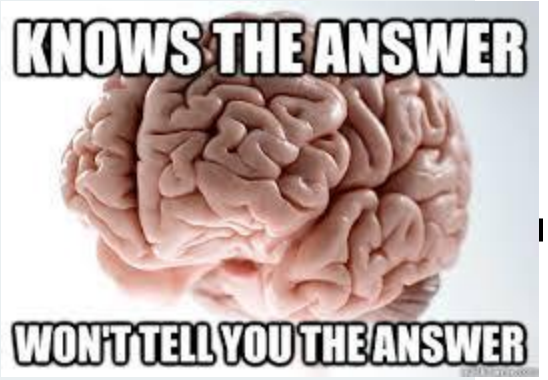
THANK YOU!!!


"The brain is the most important organ of the human body" - Brain


releases
dope-a-meme


KNOWS THE ANSWER
WON'T TELL YOU THE ANSWER