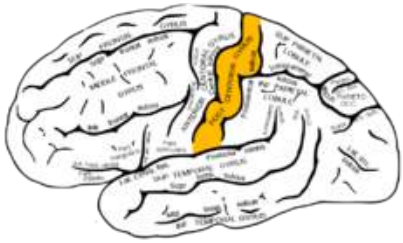
THE SOMATOSENSORY SYSTEM

"Somatosensory"



The somatosensory system uses AFFERENT pathways (afferent arrives)

3 types of sensory information:

1.
2.
3.

3 main pathways:

1.
2.
3.

RECEPTORS

Haptic Mechanoreceptors:

1. Meissner's corpuscles
2. **P**acinian corpuscles

   P
3. Merkel's receptors
4. Ruffini corpuscles

Rapid Adapting

Slow Adapting

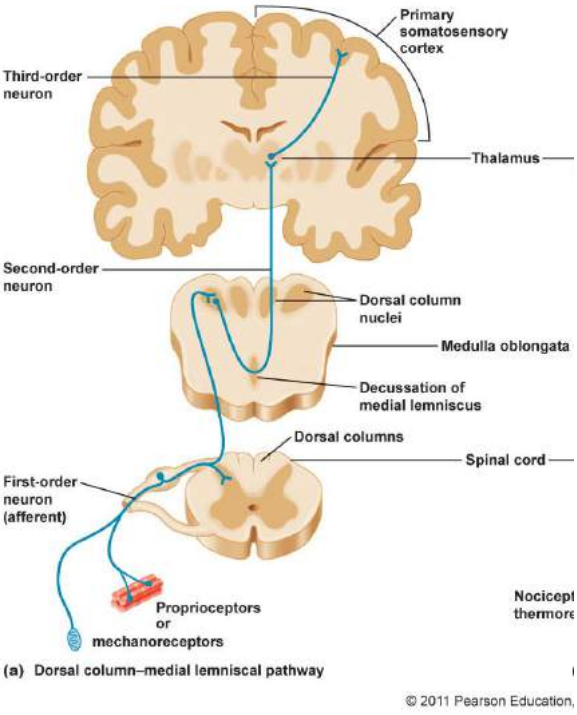
Nociceptors

Classified according to the type of fibre they innervate:

- **C fibres**
  Unmyelinated, slow
  Less specific, higher threshold
- **Aδ fibres**
  Faster, myelinated
  More specific, lower threshold
  First pain

DORSAL COLUMN-MEDIAL LEMNISCUS PATHWAY

Functions: Fine touch, 2-point discrimination, proprioception



1st order neurones:

Take information from the _____ to the _____.

Receptors

Spinal Cord

The cell bodies are in the _____

_____

ARMS =

LEGS =

Medulla

ARMS =

LEGS =

2nd order neurones

Gracile/Cuneate Nuclei

Decussate in _____

Ascend as the _____

_____

3rd order neurones

VPL

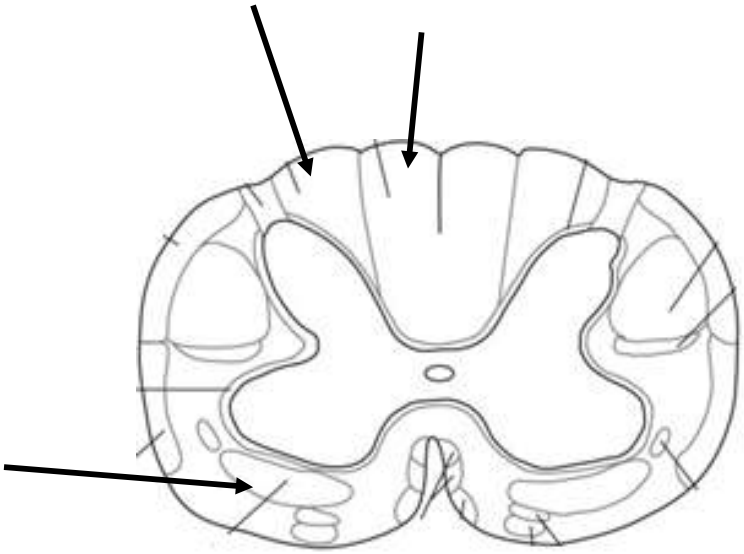
Through the internal capsule

_____

ANTEROLATERAL SYSTEM

Made up of 5 tracts of **C fibres**:

1. **Spinothalamic Tract (STT)**
2. Spinoreticular Tract (SRT)
3. Spinomesencephalic Tract
4. (Spinotectal Tract
5. Spinohypothalamic tract)



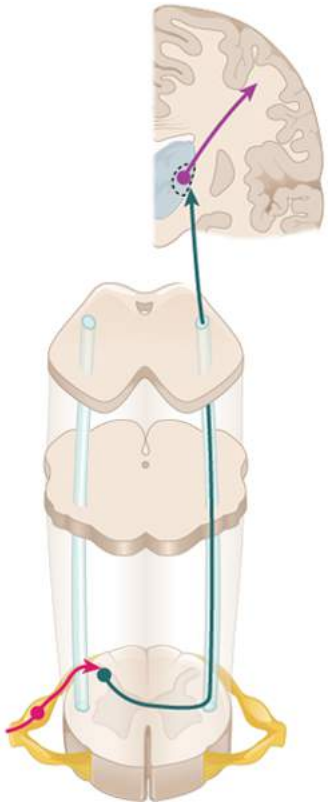
1. Spinothalamic Tract

- Main pathway
- Function = crude touch, localisation of pain, temperature

1st order neurones: Nociceptors → Spinal cord (Substantia gelatinosa, Lamina I/II)

2nd order neurones: Substantia gelatinosa → decussates at the level of the spinal cord → VPL

3rd order neurones: VPL → Post-central gyrus



2. Spinoreticular Tract

Function = Unclear, emotional component of pain?

Goes via the **reticular formation – INDIRECT**

3. Spinomesencephalic Tract

Synapses in the Peri-Aqueductal Grey Matter (PAG).

The PAG allows endogenous opiods to be produced, part of the descending inhibitory control of pain pathway.

SPINOCEREBELLAR TRACTS = the odds ones out!!

No 3rd order neurones

Ipsilateral

Function =

1. Dorsal tract

Receives information from the _____

Rises on the _____ side, parallel to the _____

Synapses in _____

Continues to the cerebellum

2. Ventral tract

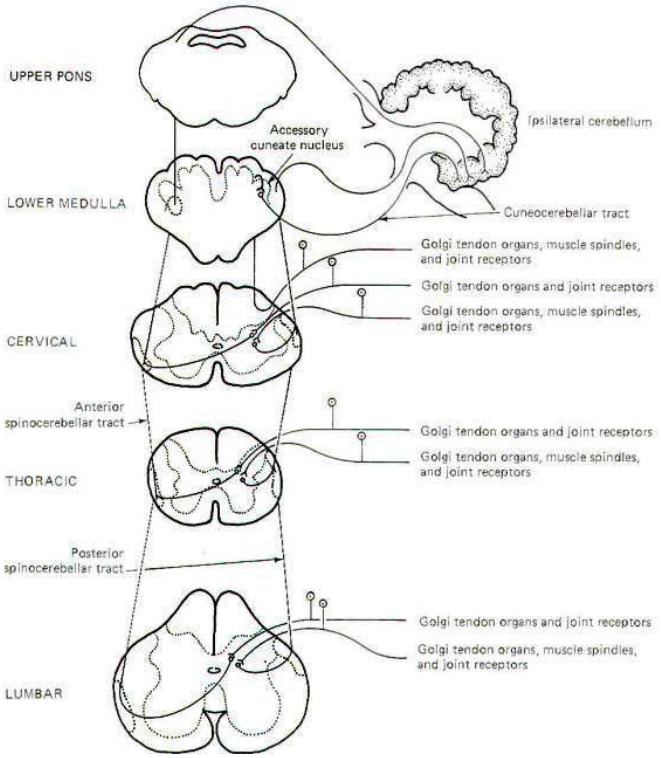
Receives information from the _____

Decussates at the _____

Decussates again at the

_____

Continues to the cerebellum



3. Cuneocerebellar Tract

Receives information from the

_____

Runs parallel to the _____

Synapses in the _____

Continues to the cerebellum

THINGS TO REMEMBER!!!

The DCML and anterolateral systems have 3 neurones, spinocerebellar has 2

DCML/anterolateral take information to the contralateral side of the brain

DCML decussates at the medulla, anterolateral system decussates at the level of the SC

Gracile is medial to cuneate

Pain Pathways

1 Some Definitions

NoCiception = _____

_____

Pain = a sensory and emotional experience affected by psychological factors such as past experiences, beliefs about pain, fear or anxiety

2 Pathways of Pain

PS3

Ascending Pain Pathways

- Post synaptic dorsal column
- Spinoreticular
- Spinomesencephalic (PAG of midbrain)
-

Spine → Thalamus (VPL)

- LATERAL spinothalamic tract detects _____.
- ANTERIOR spinothalamic tract detects _____

3rd order neurons of LST

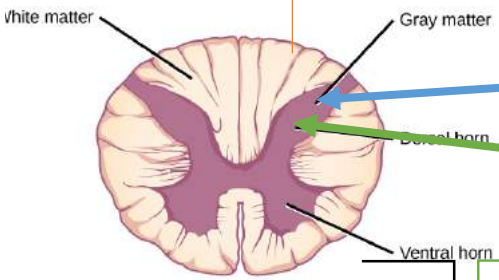
2nd order neurons of LST

Reticular Formation in the **brainstem**

- Involved in respiratory and cardiovascular response to pain

Aδ fibres

- Myelinated
- Fast Pain
- Sharp, stabbing
- Synapse in rexed layers, 2,3, 4 – deeper than C fibres
- A for Acute Pain
- D for synapsing deeper



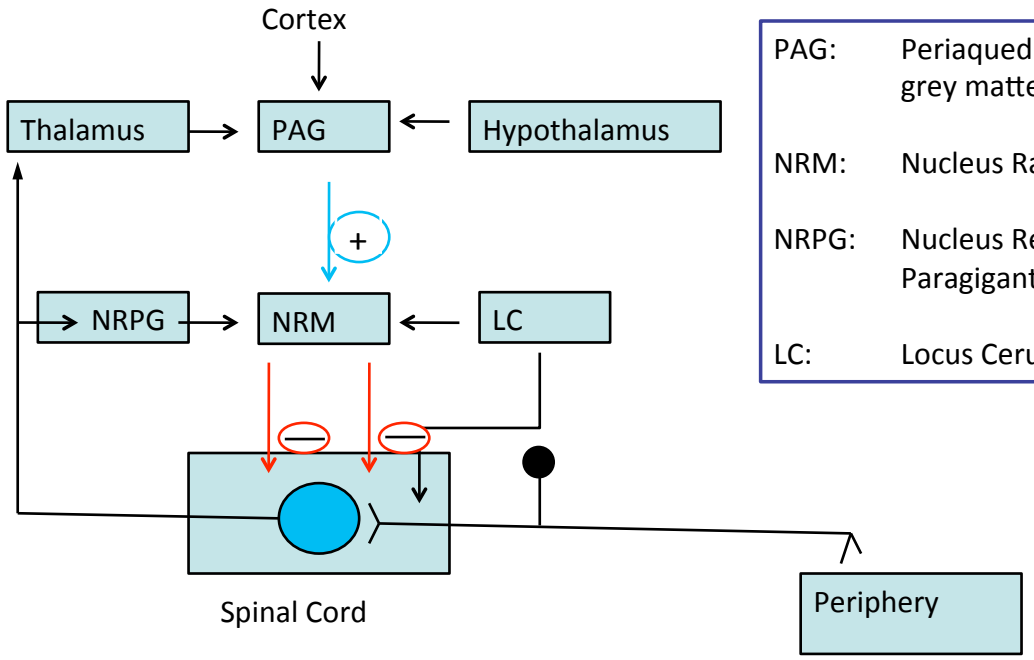
1st order neurons of LST

C fibres

- Non-myelinated
- SLOW pain – burning sensation
- Synapse in rexed layer 2 of the substantia gelatinosa

Withdrawal Reflex

3 Inhibitory Control of Pain



PAG:	Periaqueductal grey matter
NRM:	Nucleus Raphe Magnus
NRPG:	Nucleus Reticularis Paragigantocellaris
LC:	Locus Ceruleus

4 Opioids

Opioids = _____

_____

Effects of opioids:

- S
- E
- A

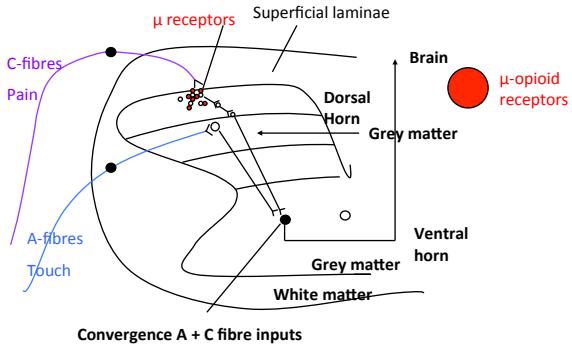
Opioids act on three classes of receptors:

-
-
-

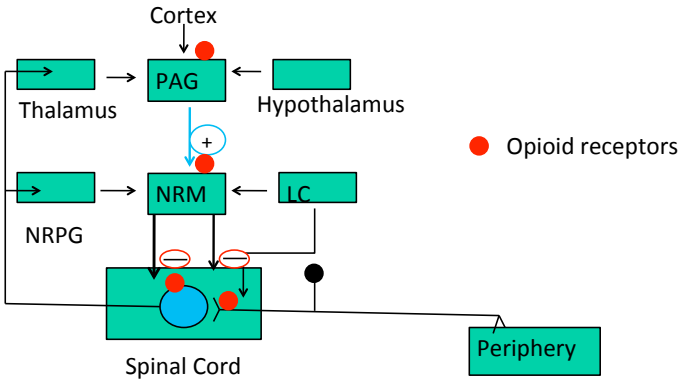
Features of opioid receptors:

- 7 transmembrane spanning
- G protein coupled receptor
- Inhibit adenylate cyclase and reduce cAMP production
- Alter ion channels through G-protein coupling to channel
  - Open K^+ channels
  - Close Ca^{2+} voltage-gated channels
- Hyperpolarization of neurone – action potential inhibition

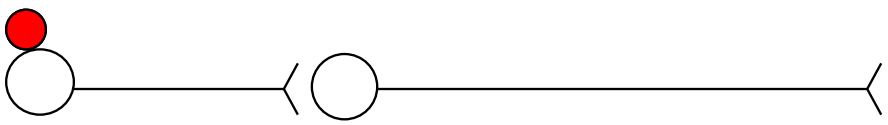
- μ-opioid receptors are superficial in the dorsal _____.
- _____% are located pre-synaptically
- _____% are located post-synaptically
- Mainly located on _____
- A-fibres can be blocked at higher doses



- In pregnancy – the dose of epidurals are titrated:
  - It does act on μ-opioid receptors on c fibres
  - Doesn't act on A-fibres to ensure sensation isn't lost – mother pushes out child without excessive pain

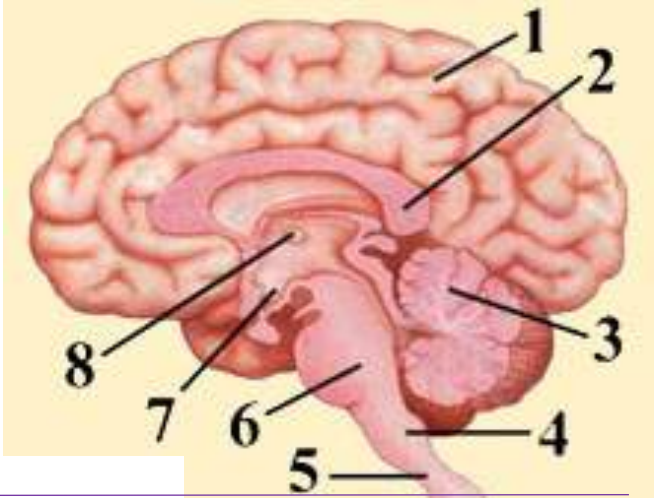


- Opioid receptors are also located within the _____ and the _____
- Opioids drive the descending inhibitory pain pathway by _____

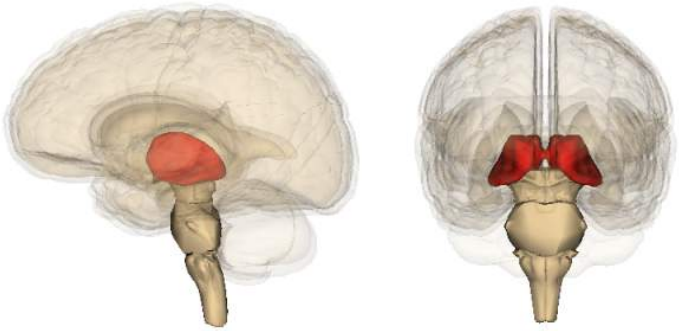


THALAMUS

Which number is the thalamus??



The thalamus is part of the _____ which also comprises of the hypothalamus, the epithalamus and the subthalamus.



The thalamus is located just above the _____and below the cerebral cortex.

The upper surface occupies the floor of the lateral ventricle

It is located at the base of the cerebral hemispheres on either side of the 3rd ventricle

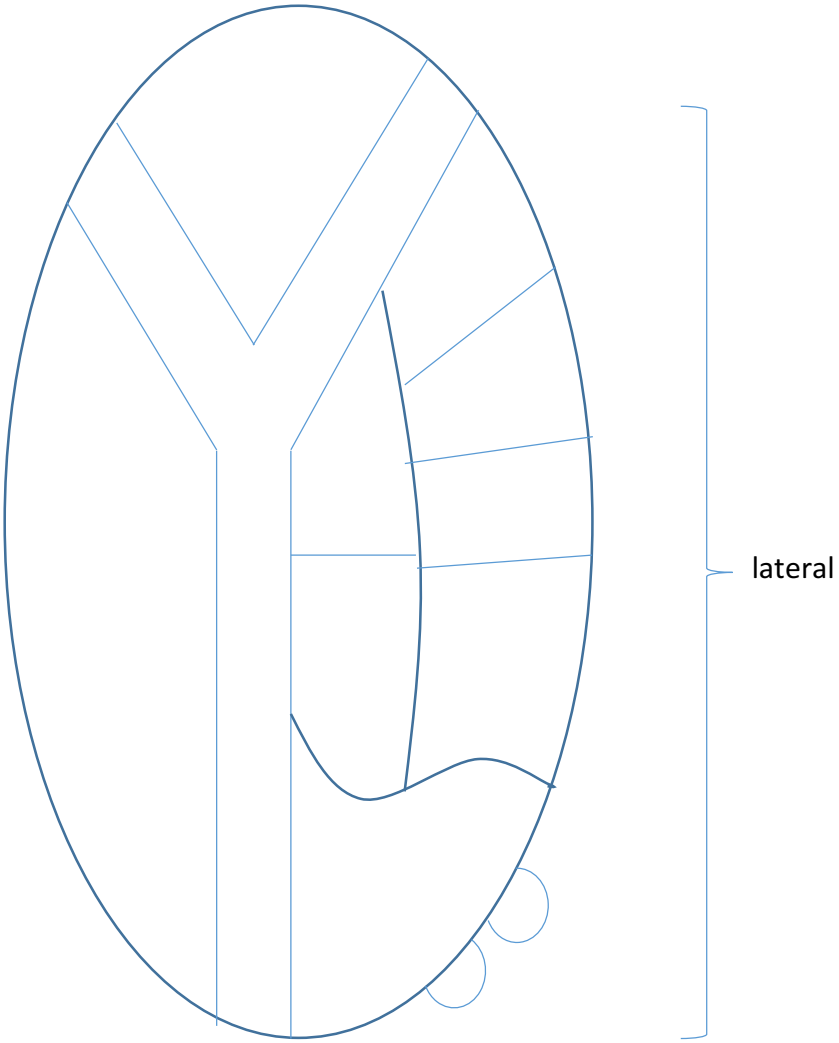
The thalamus is divided into three parts: _____, _____ _____ and lateral by the Y shaped internal medullary _____.

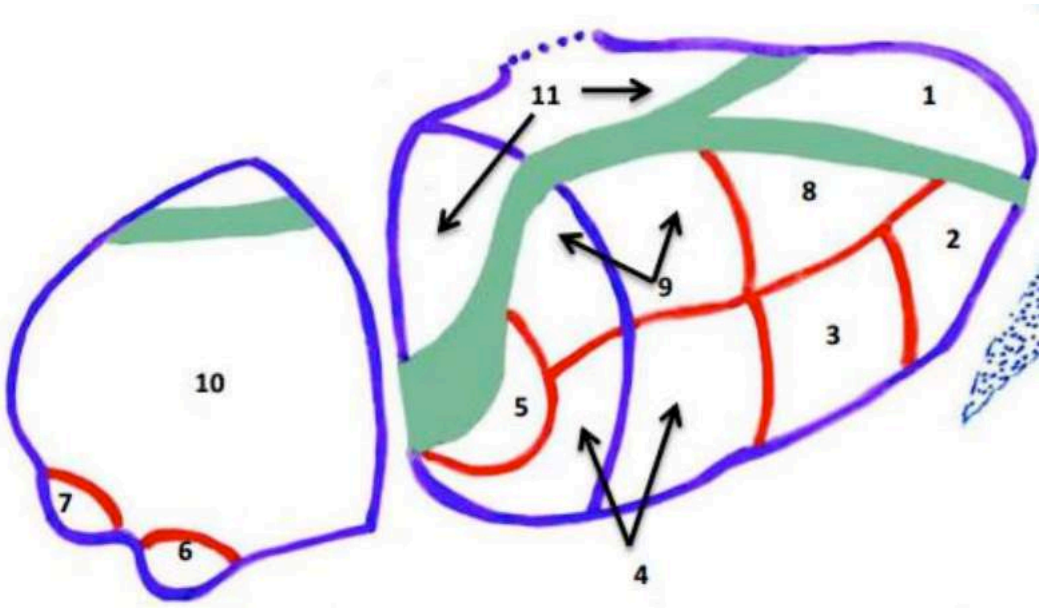
The thalamus' job is to relay sensory impulses to the cerebral cortex. The only sensory information that is not sent to the thalamus to be relayed to the cortex is _____.

The thalamus is thought to filter sensory signals that can reach the brain.

There are many nuclei found the the thalamus which receive information from different sources.

The thalamus is like a train station and each nuclei is a platform. Different trains will stop at different platforms according to their allocated destination.


lateral

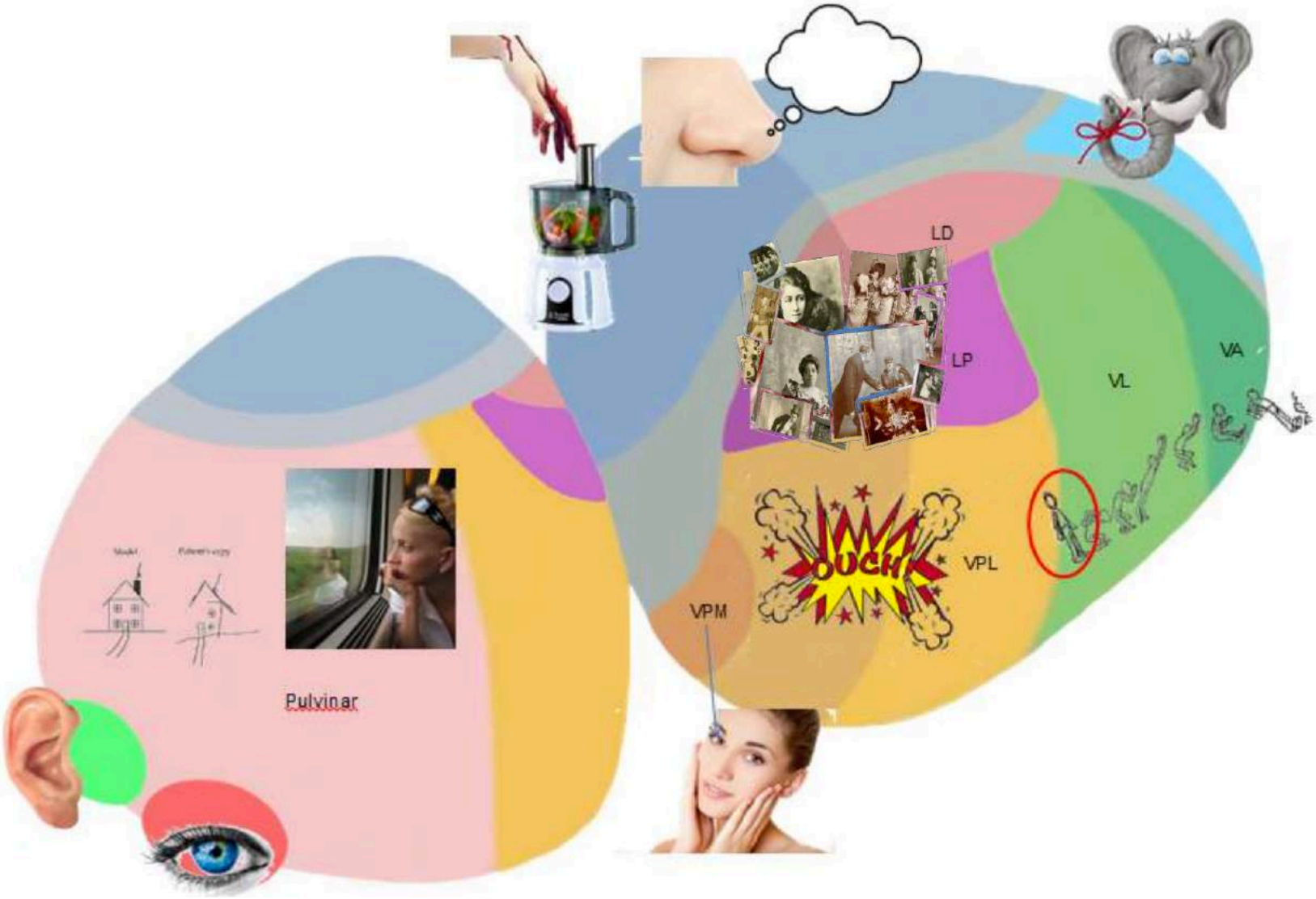

11
1
8
2
9
3
10
5
7
6
4

Nucleus	Receives fibres from	Projects to	Outcome
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			

2 types of nuclei

Specific/relay (numbers 1-7): these nuclei have reciprocal connections to a specific motor or sensory area of the cortex. E.g. there is a precise, point-to-point connection between the anterior nucleus and the cingulate gyrus of the cerebral cortex. They are found in the anterior and ventral portions of the thalamus, and also the geniculate bodies.

Association (8-11): these project to association (rather than primary) areas of cerebral cortex. They are found in the medial and dorsal parts of the thalamus.

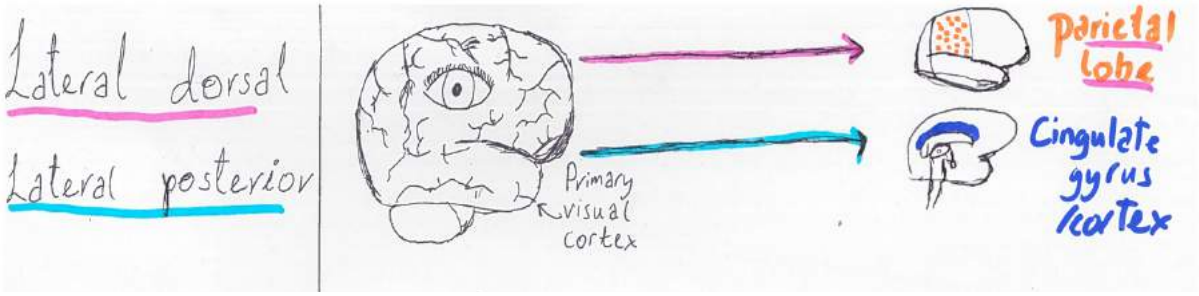

LD
LP
VA
VL
VPL
VPM
OUCH
Pulvinar

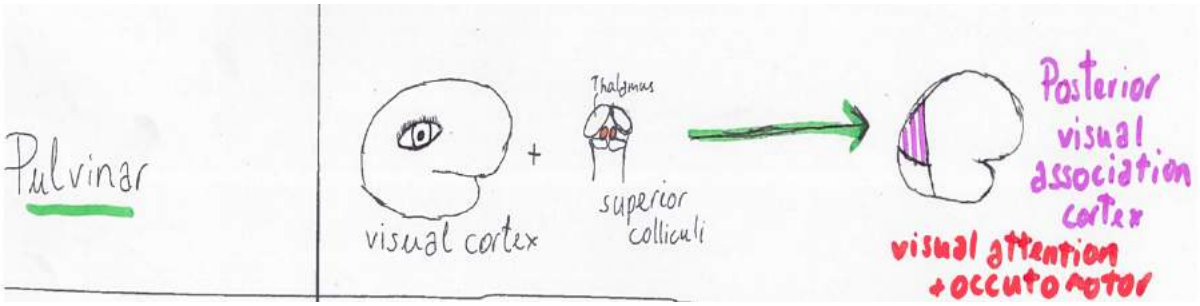
Memory aid:
Anterior nucleus:
Elephant memory (episodic memory) goes from madly busy (mammillary bodies) to
completely gone (cingulate gyrus).

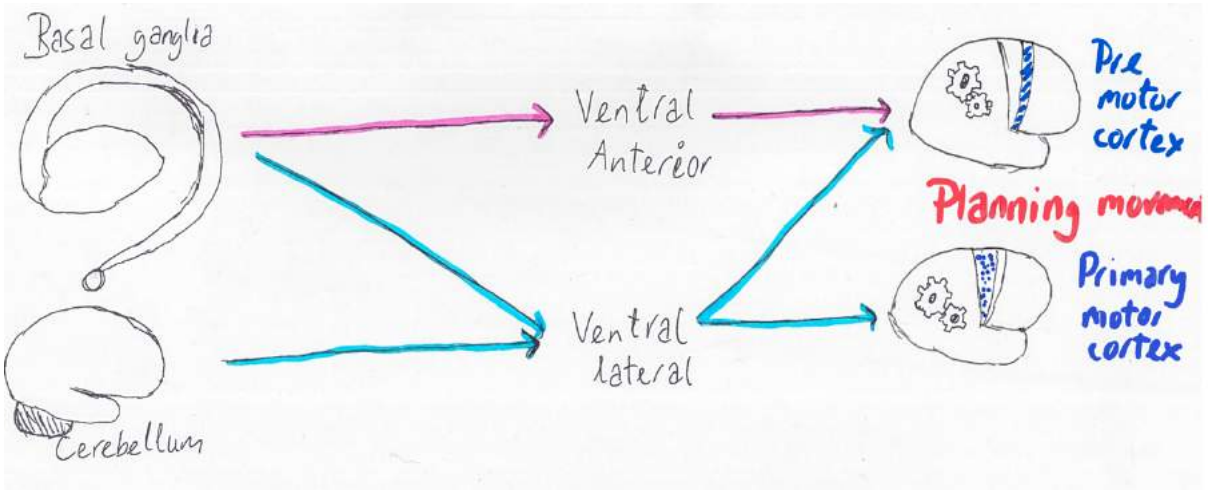
Memory aid
Medial dorsal nucleus
Painful penny, judgy Judy and moody Mona (pain, judgement and mood)
took logs from the old lake (olfactory, lateral spinothalamic tract)
to fix the parish church (prefrontal cortex).

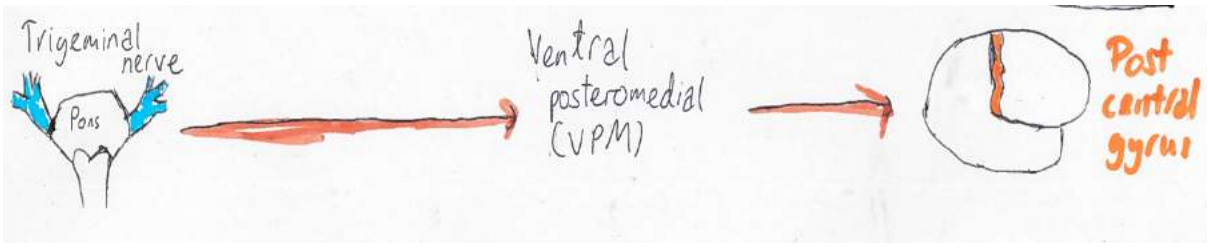
Medial geniculate body
Heath (Hearing) went from dating
icky Collette (inferior colliculus)
to awesome Courtney (auditory cortex).

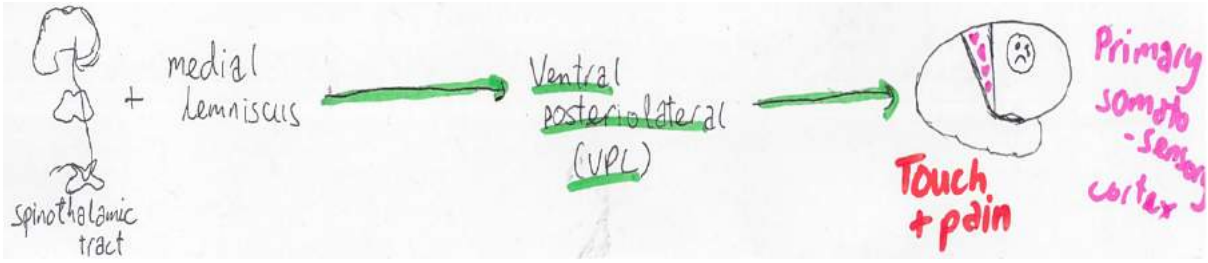
Lateral geniculate body
Visors (vision) used to be retro (retina)
but now they are very common (visual Cortex)

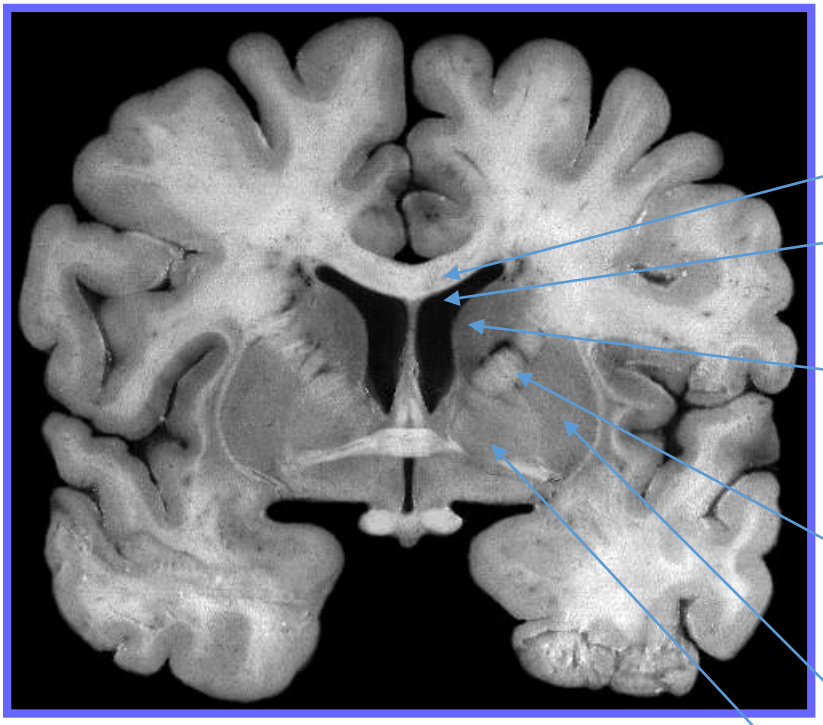

Lateral dorsal
Lateral posterior
Primary visual cortex
Parietal lobe
Cingulate gyrus cortex


Pulvinar
Thalamus
visual cortex
superior colliculi
Posterior visual association cortex
visual attention
+occuto motor


Basal ganglia
Ventral Anterior
Ventral lateral
Cerebellum
Pre motor cortex
Planning
Primary motor cortex


Trigeminal nerve
Pons
Ventral posteromedial (VPM)
Post central gyrus


medial lemniscus
Ventral posteriolateral (VPL)
spinothalamic tract
Touch + pain
Primary somato-sensory cortex



Corpus callosum:

3rd ventricle

Caudate nucleus: part of the basal ganglia which follows the ventricles

Internal capsule- bundle of axonal projections to and from cerebral cortex

Putamen

Globus pallidum