# Diencephalon
# Study Objectives



1. State the 4 components of the diencephalon: dorsal thalamus, hypothalamus, epithalamus, and subthalamus and list the specific nuclei belonging to each region.

2. Explain the relationship of the dorsal thalamus to the caudate nucleus, internal capsule, third ventricle and lateral ventricle. Be able to identify these structures on gross specimens or computer images.

3. Describe the relationship of the nuclei of the dorsal thalamus to the motor, visual, auditory, and reticular activating systems. List the thalamic nuclei that are involved in these systems and describe the pathways.

4. Describe how the dorsal thalamus is related to personality, moods, and emotions. List the thalamic nuclei that are involved in these systems.

5. Explain the pattern of inputs to, and outputs from the major thalamic nuclei.

6. Explain the blood supply to the thalamus and hypothalamus.

7. Recognize the symptoms expressed by lesions in thalamic nuclei and their connections.

8. Relate the structural and functional relationship of the hypothalamus to other parts of the diencephalon and to the pituitary gland.

9. Differentiate between the sympathetic and parasympathetic areas of the hypothalamus and the effects produced by their discharge.

10. Describe the role of the hypothalamus in temperature regulation, food intake, and sleep/wake cycles.

11. Explain the hypothalamic discharge to lower centers for the overt expression of visceral activity, i.e. via the DLF, median forebrain bundle, and mammillotegmental tracts through the reticular formation.

12. Describe the function of the supraoptic and paraventricular nuclei and list their hormone products and functional relationship to the posterior pituitary.

13. Explain the origin and describe the transport and function of releasing factors secreted by the hypothalamus and their relationship to the anterior pituitary gland.

14. List the components of the subthalamus.

15. Explain the basic function of the subthalamic nucleus and the the signs or symptoms that arise from a lesion to this area.

16. List and explain the function of the components of the epithalamus.

## The Diencephalon Outline

I. Location of the Diencephalon
   A. Deep in cerebral hemispheres, bilateral, caps the brainstem
   B. Bordered superiorly by the fornix and corpus callosum and in part by the body of the lateral ventricles
   C. In horizontal section, it is medial to the lentiform nucleus and caudal to the head of the caudate nucleus. Lies medial to the posterior limb of the internal capsule.

II. Organization
   A. There are 4 Main parts to the diencephalon (plus 1 minor part):
      1. Dorsal thalamus = thalamus
      2. Hypothalamus
      3. Epithalamus = stria medullaris, habenula, pineal gland
      4. Subthalamus (ventral thalamus)
      5. Metathalamus = medial and lateral geniculate nuclei

III. 3-D position of thalamus in the brain. Relationship to the corpus callosum, body of the lateral ventricle, caudate nucleus, and cortex.
   A. Thalamic nuclei
      1. Lateral cell mass
         a. Dorsal tier: Lateral Dorsal, Lateral Posterior, Pulvinar
         b. Ventral tier: Ventral Anterior, Ventral Lateral, Ventral Posterior (medial and lateral parts), centromedial (part of the intralaminar nuclei and reticular formation). Medial and lateral geniculate nuclei are oftern placed in this group.
      2. Medial cell mass
         a. Mediodorsal (dorsomedial) nucleus, and medioventral (midline) nuclei
      3. Anterior cell mass
         a. Anterior nucleus
   B. Functional Interactions of thalamic nuclei – 3 functional groups
      1. Specific nuclei (relay): receive/project specific information to/from specific areas
         a. Ventral Anterior and Ventral Lateral Nuclei – Motor
         b. Ventral Posterior (Medial and Lateral) Nuclei – Somatosensory
         c. Medial Geniculate Nucleus – special sensory, auditory
         d. Lateral Geniculate Nucleus – special sensory, visual
         e. Anterior nuclei – limbic, memory, and behavior
      2. Specific Nuclei (associational): Receive/project information to/from widespread areas that are non-specific
         a. Lateral dorsal nuclei – limbic, memory, and behavior
         b. Mediodorsal Nucleus – prefrontal and temporal cortex, amygdala and limbic system – personality, behavior, memory
         c. Lateral Posterior and Pulvinar Nuclei – parietal, occipital and temporal cortex – functions with general intellect. Pulvinar has connections with the visual system.

3. Non-specific
   Intralaminar Nuclei – associated with the ARAS
   a. Centromedian nucleus – input from reticular formation and other thalamic nuclei and project to widespread areas of the cortex – arousal, alertness, and consciousness.

4. Reticular Nuclei – connections from thalamocortical fibers, corticothalamic fibers and other thalamic nuclei

IV. The hypothalamus: Landmarks for the hypothalamus: Optic chiasm. lamina terminalis, subthalamus, thalamus

V. Hypothalamic Nuclei: contains many nuclei, we will focus on only a few and also some hypothalamic areas
   A. Supraoptic and Paraventricular Nuclei – Hormones: Oxytocin and Vasopressin
   B. Suprachiasmatic Nucleus – receives light input, circadian rhythms
   C. Lateral Hypothalamus and ventromedian nucleus – feeding and satiety
   D. Preoptic area – reproduction
   E. Mammillary bodies – limbic
   F. Median eminence, arcuate nucleus, tuberal nucleus – releasing factors

VI. Integration of input and output of hypothalamus for overt expression of visceral activity
   A. Input from cortex
   B. Other afferents, e.g. pain, olfaction, light, blood elements etc…
   C. Output from hypothalamus
      1. to brainstem reticular formation, cranial nerve nuclei, parasympathetic and sympathetic centers
      2. Dorsal longitudinal fasciculus
      3. Mammillotegmental tract

VII. Sympathetic and Parasympathetic centers - function in output

VIII. Hypothalamic Functional Centers
   A. Temperature Regulation
   B. Food intake
   C. Sleep
   D. Water balance
   E. Pituitary function
   F. Reproduction and Growth

IX. Hypothalamic Lesions
    A. Relationships of hypothalamus, cavernous sinus, pituitary, optic chiasm

X. Subthalamus
    A. Components of subthalamus
        1. Subthalamic nucleus
            a. Lesion causes contralateral hemiballism
        2. Prerubral fields
        3. Zona Incerta

XI. Epithalamus
    A. Components of epithalamus
        1. Habenular nuclei
        2. Habenular commissure
        3. Posterior commissure
        4. Pineal gland

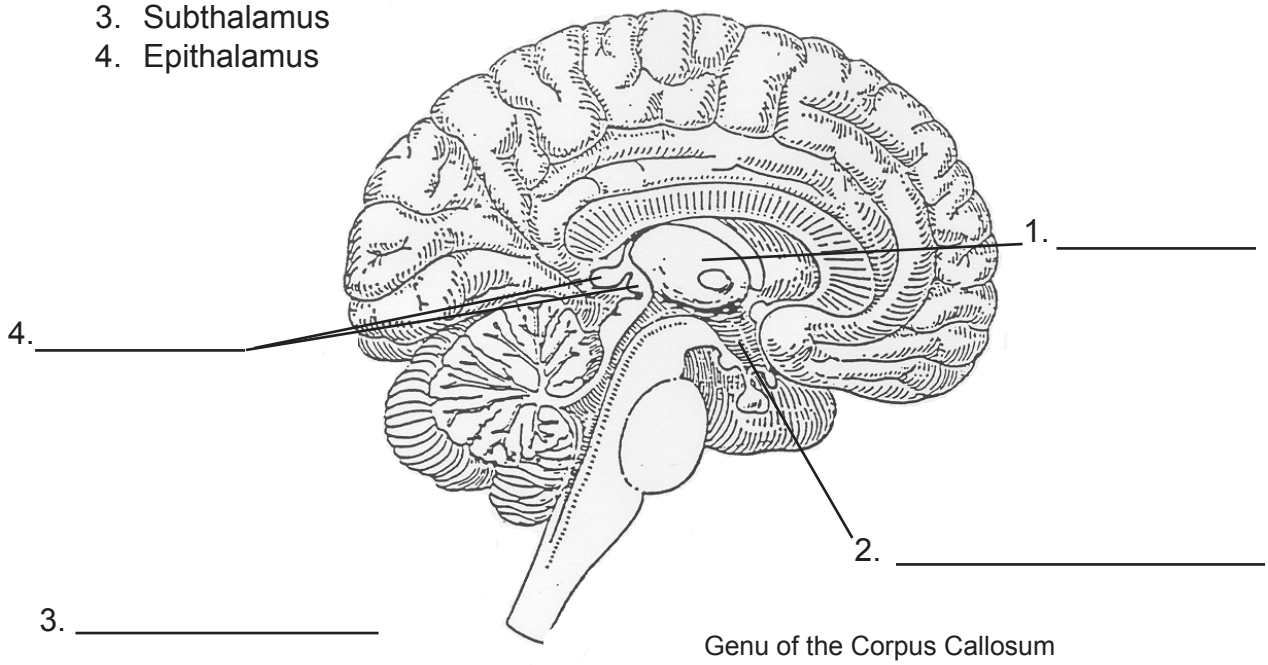
XII. Blood supply to the diencephalon

# The Diencephalon

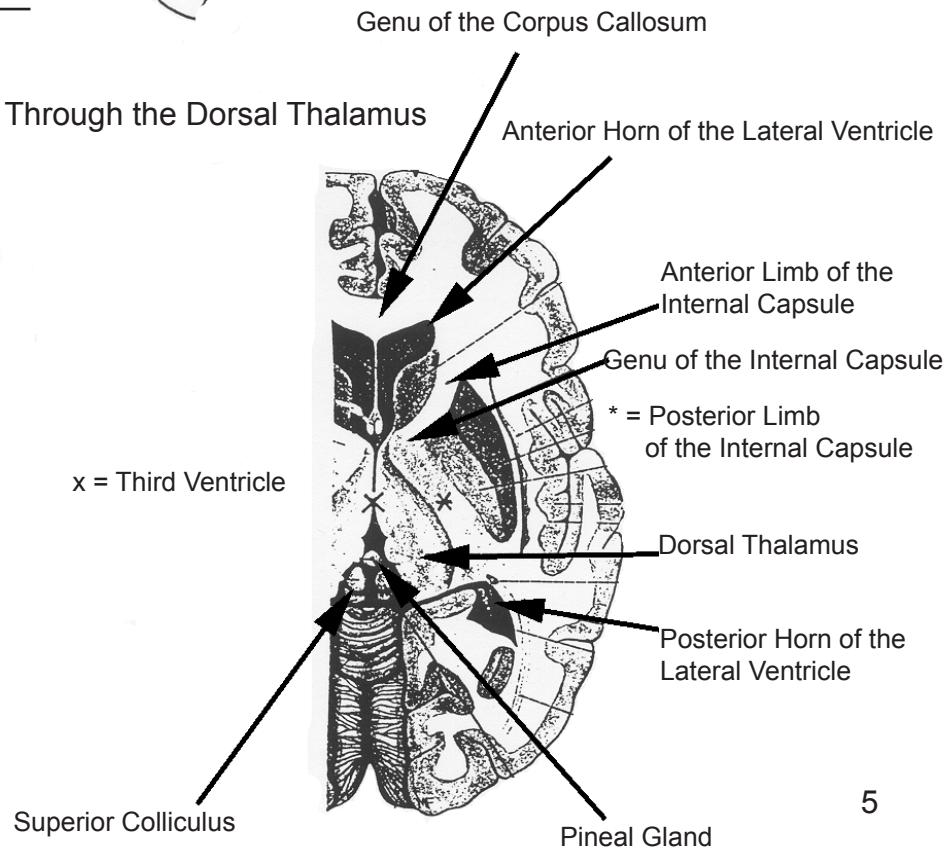
I. General Information

The diencephalon is a bilateral and symmetrical structure. The diencephalon can be divided into 4 major components:

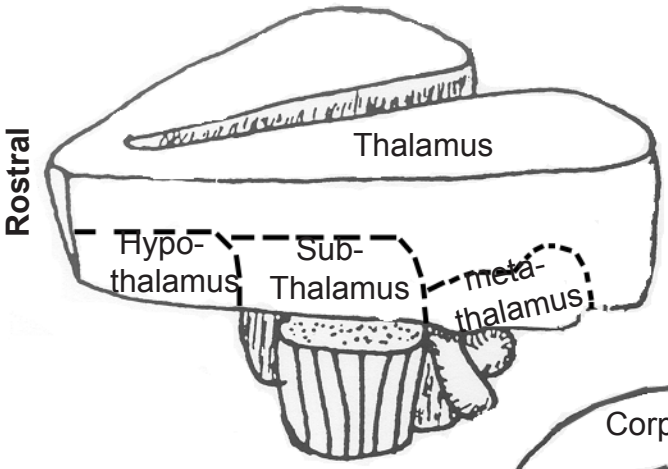
1. Thalamus or dorsal thalamus
2. Hypothalamus
3. Subthalamus
4. Epithalamus



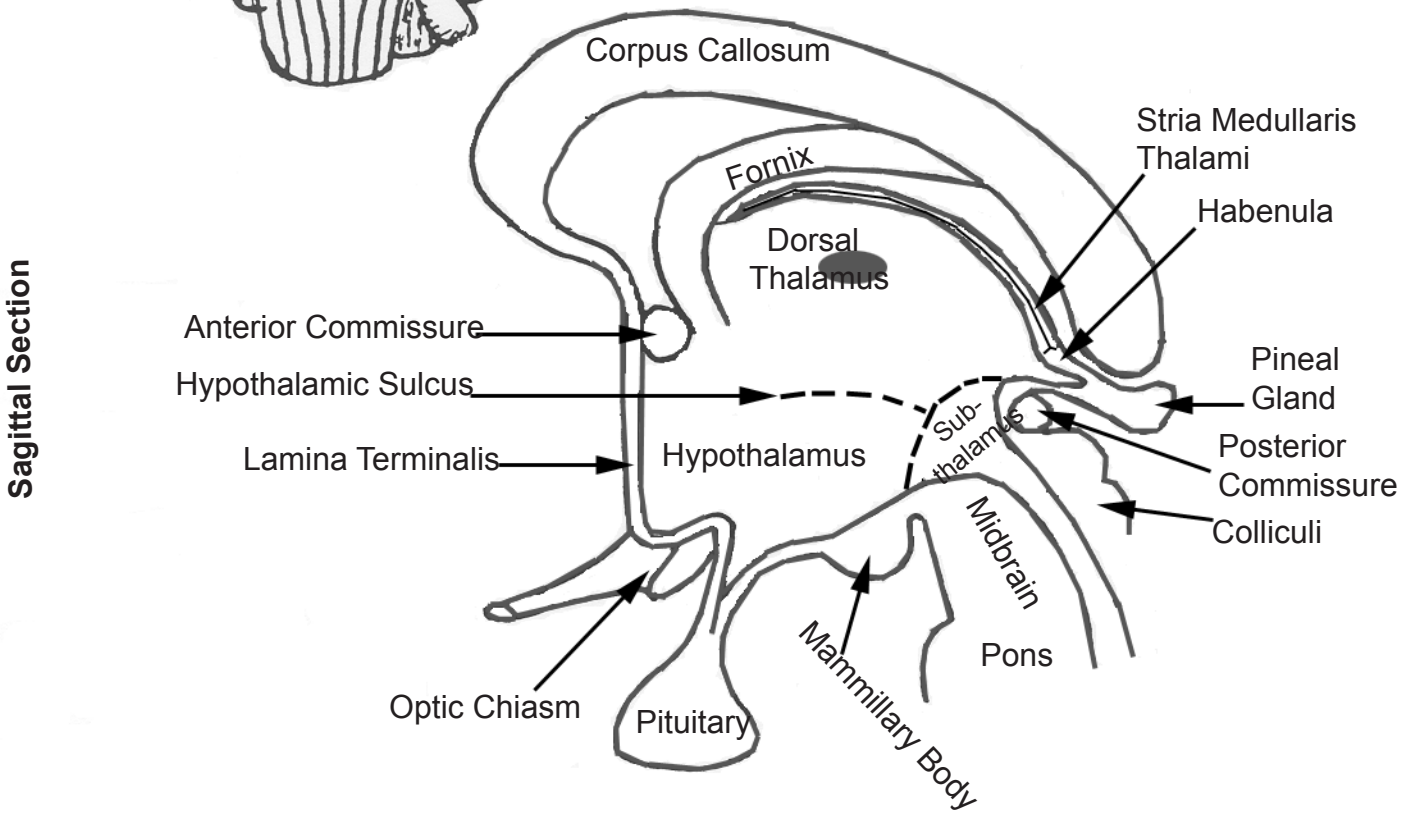

Horizontal Section Through the Dorsal Thalamus

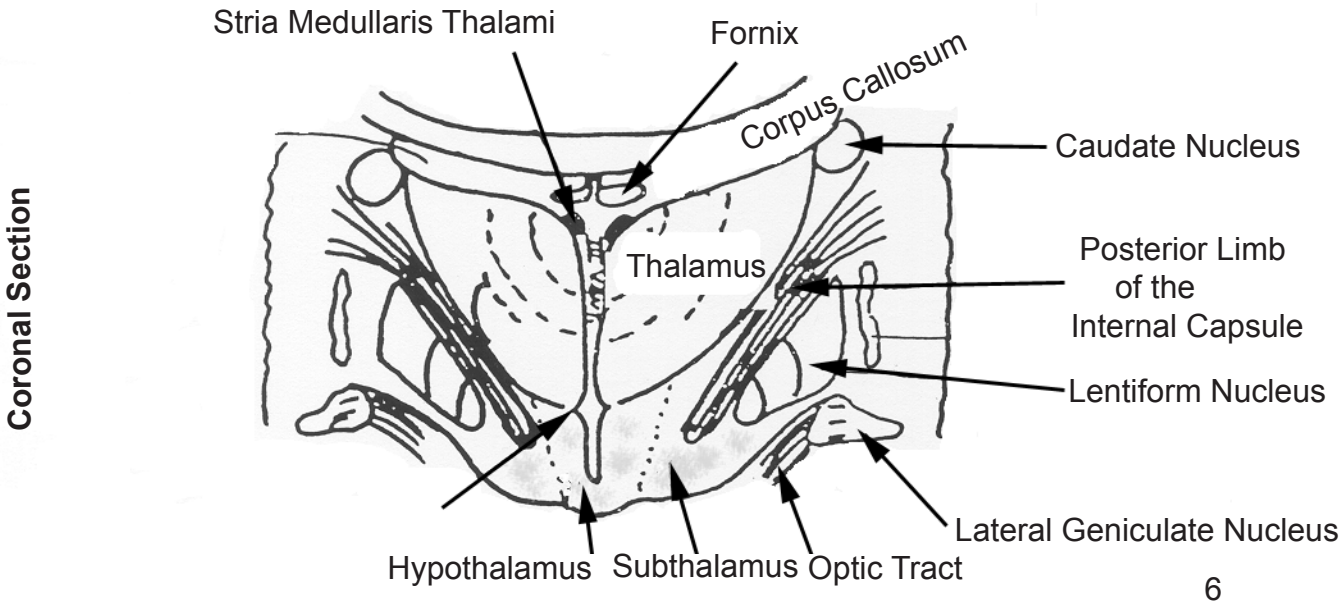


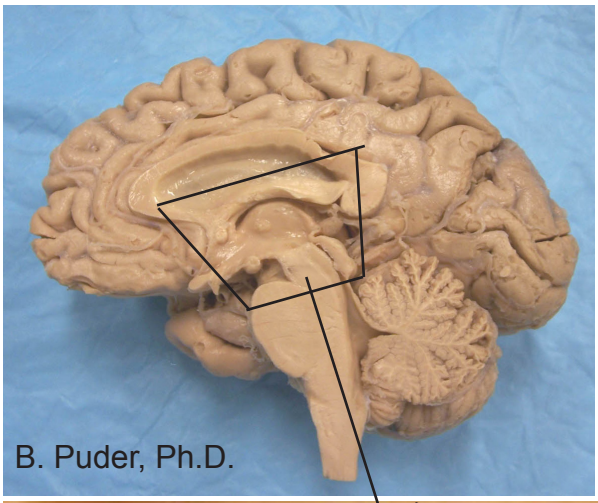
**Organization of the 4 parts of the Diencephalon**



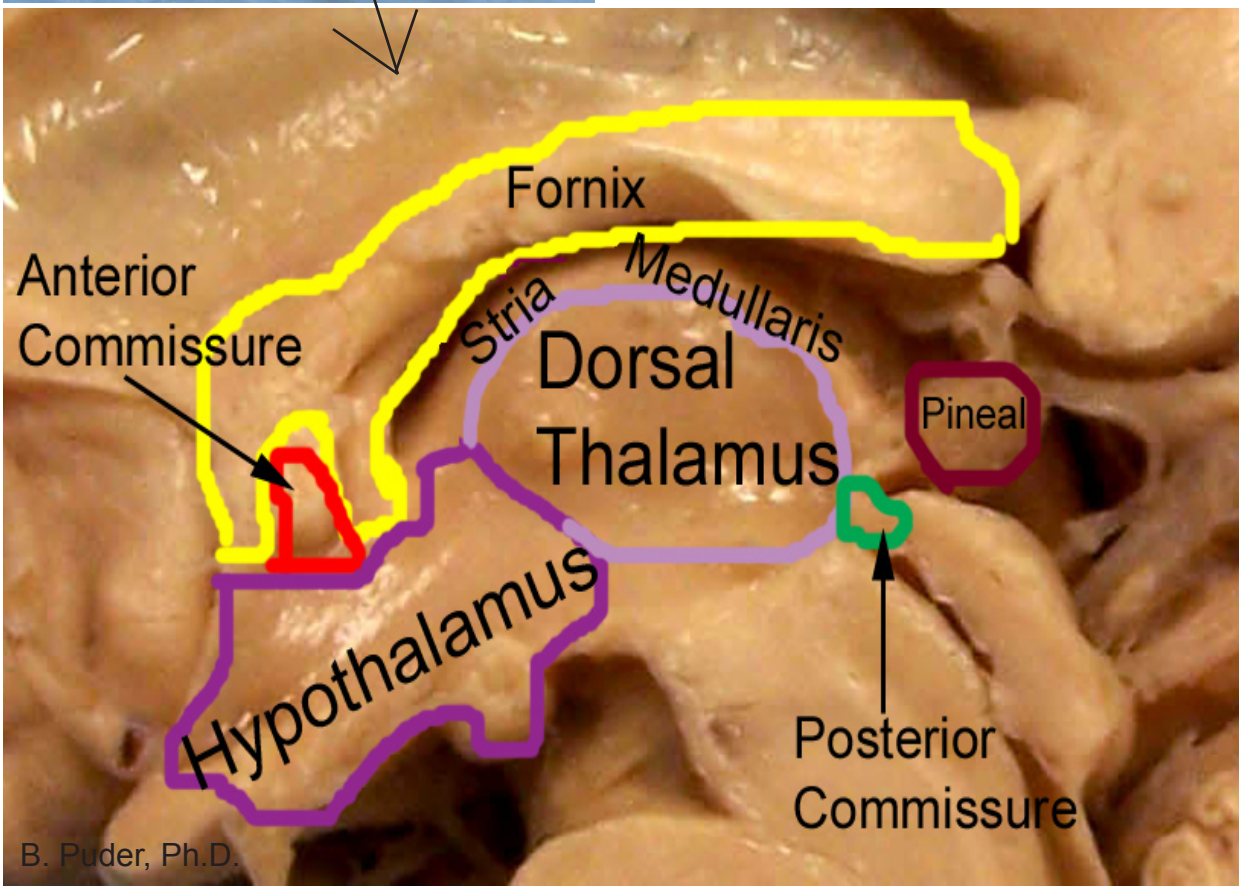

Metathalamus =
medial geniculate nucleus (MGN)
and lateral geniculate nucleus (LGN)



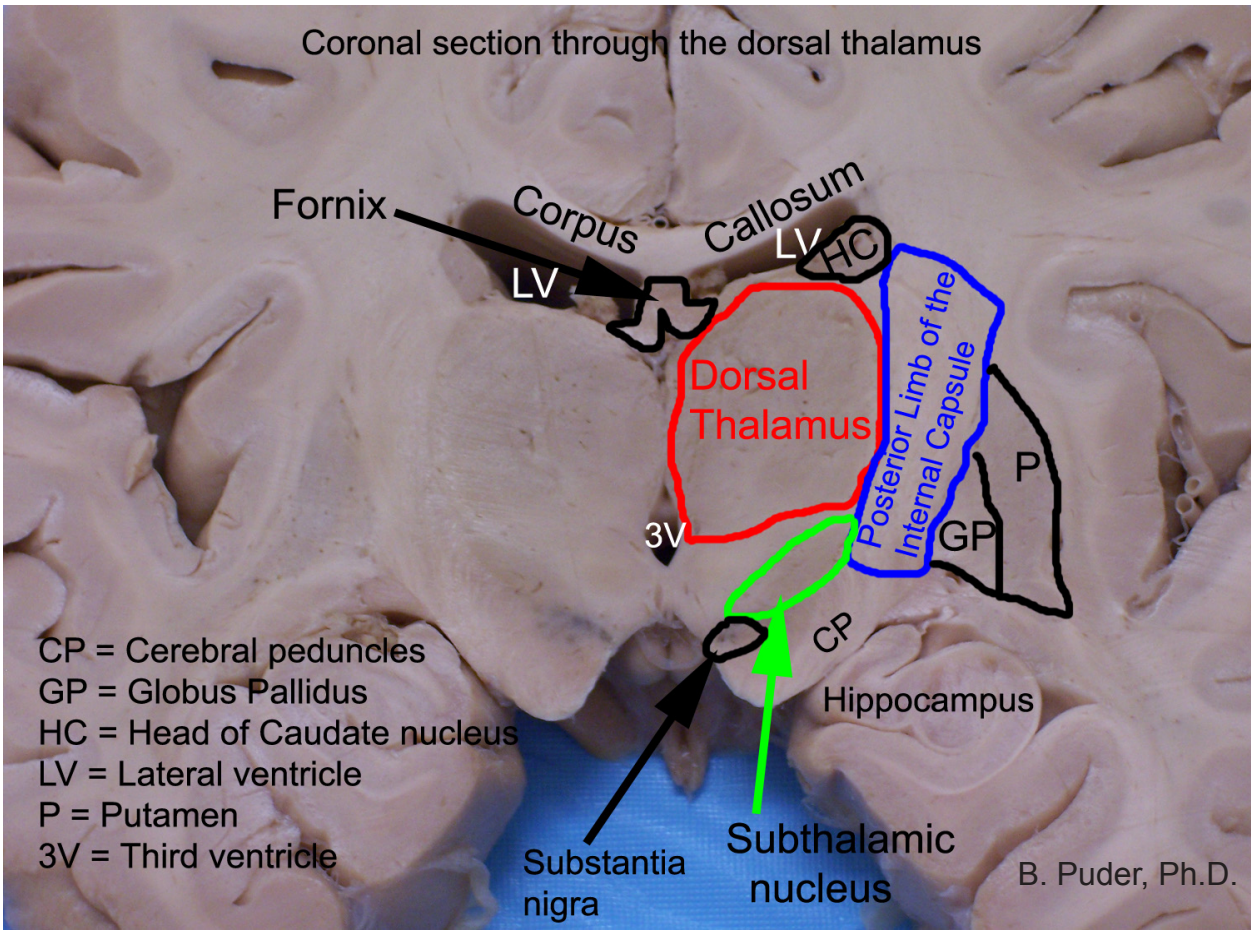



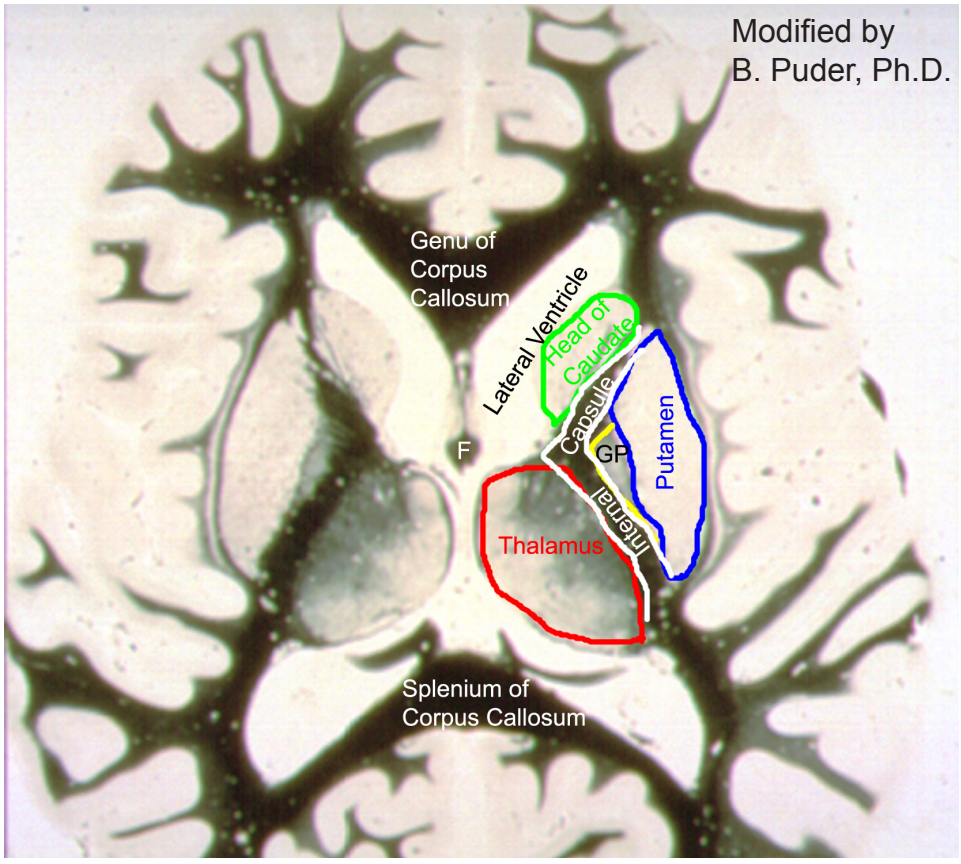



The area highlighted by the black lines on the mid-sagittal brain section on the left is depicted in the high magnification image below.




Structures in the above image that are part of the diencephalon include:
Dorsal thalamus
Hypothalamus
Posterior commissure (part of epithalamus)
Pineal gland (part of epithalamus)

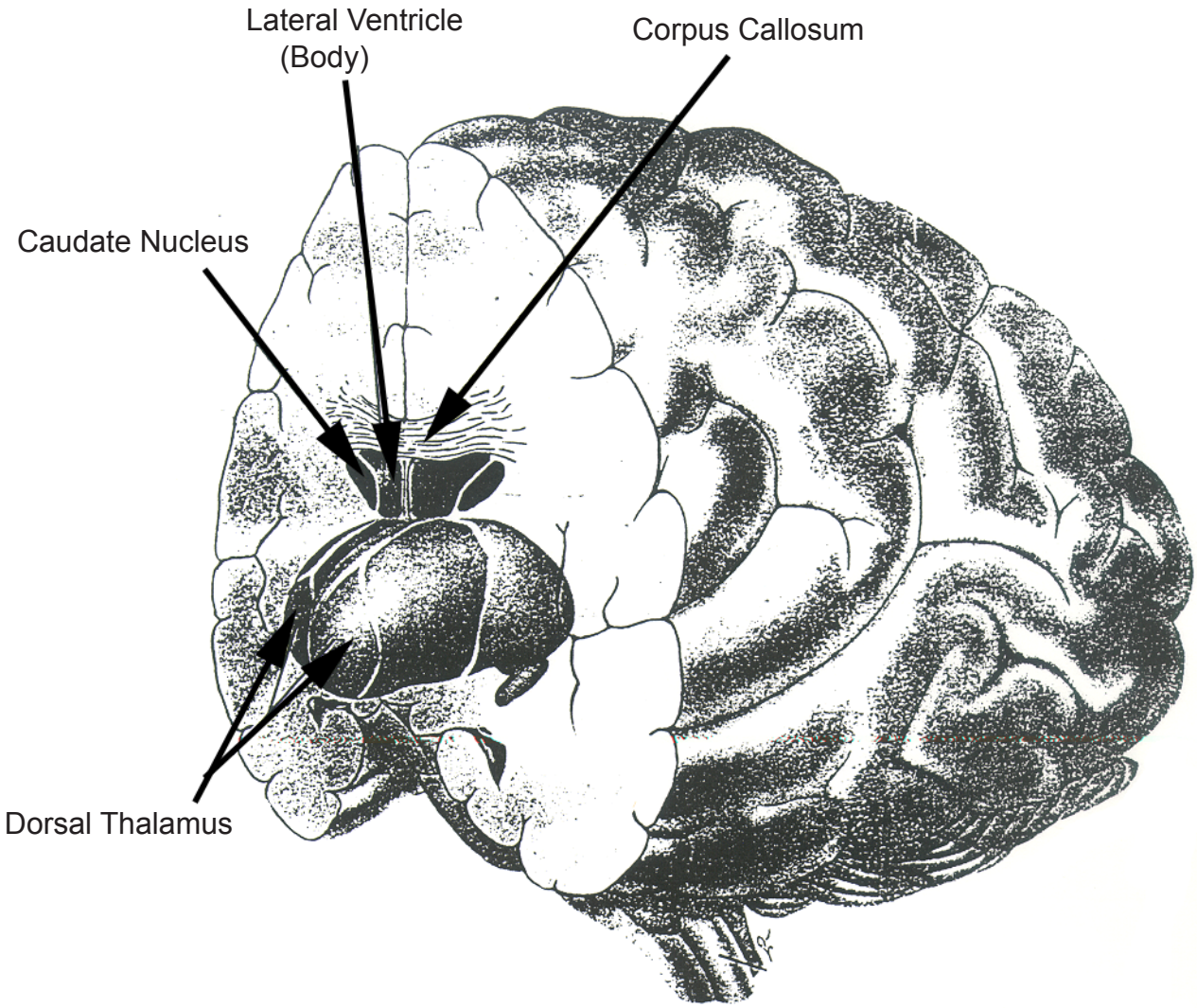



Horizontal section through the thalamus and internal capsule

## The 4 Major Components of the Diencephalon

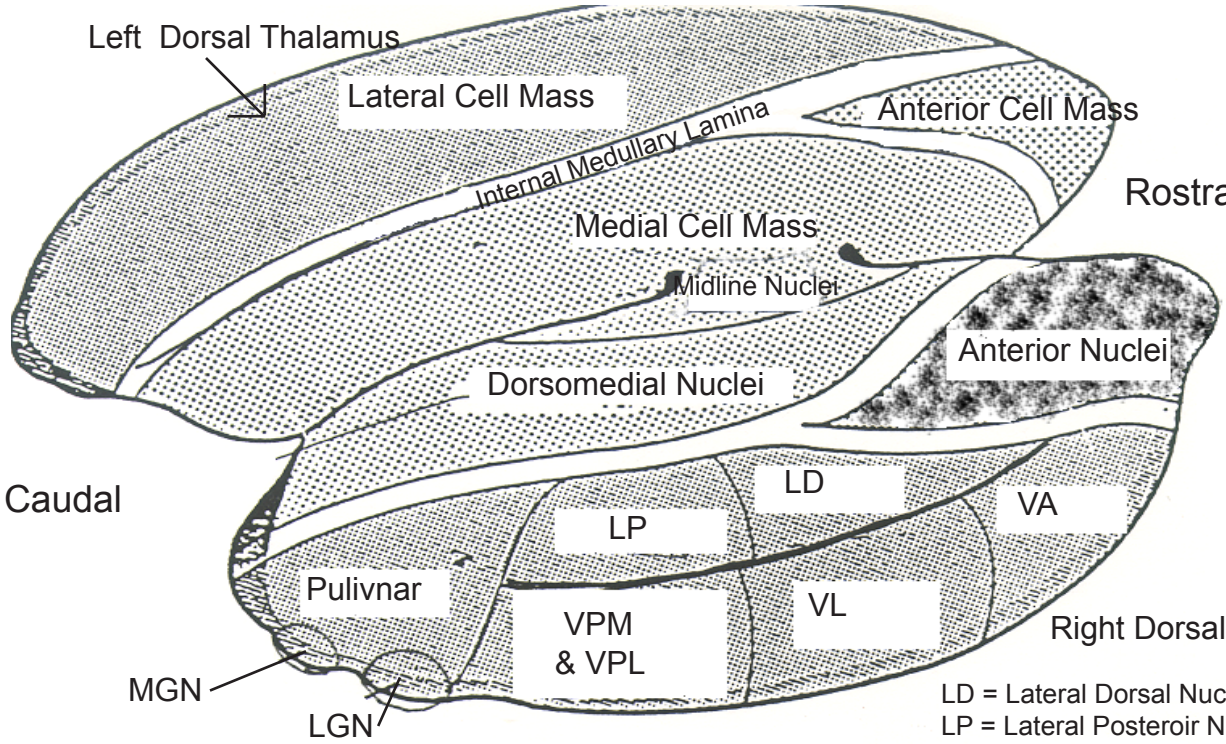
1. The Thalamus - "The Gateway to the Cortex"
   General Information
   - largest part of the diencephalon
   - is composed of several nuclei – each nuclei has distinct afferent and efferent connections. The thalamic nuclei integrate sensory, motor and limbic (emotion and memory) information.




**A. Location of the Thalamus**

- extends anterior-posteriorly from the interventricular foramen to the posterior commissure and transversely from the internal capsule to the 3rd ventricle
- the anterior end is narrow and right behind the interventricular foramen
- the posterior end goes to the pulvinar (which overhangs the superior colliculus)
- the 2 thalami are attached by the massa intermedia
- the superior thalamus is grooved by the fornix and the stria medullaris thalami runs along the medial aspect of the thalamus
- there is extensive reciprocal input from the thalamus to the cortex

**The Dorsal Thalamus (both left and right sides) and its respective nuclei**




LD = Lateral Dorsal Nuclei
LP = Lateral Posteroir Nuclei
VA = Ventral Anterior Nuclei
VL = Ventral Lateral Nuclei
VPL = Ventral Posteior Lateral
VPM = Ventral Posterior Medial
MGN = Medial Geniculate Nuclei
LGN = Lateral Geniculate Nuclei

**B. Thalamic nuclei**

The thalamic nuclei can be divided up into areas by:

1. Location
2. Function

**1. Location Nuclei**

- nuclei are divided into **medial**, **lateral** and **central** regions by the internal medullary lamina (the internal medullary lamina splits to enclose the anterior nucleus, and central intralaminar nuclei

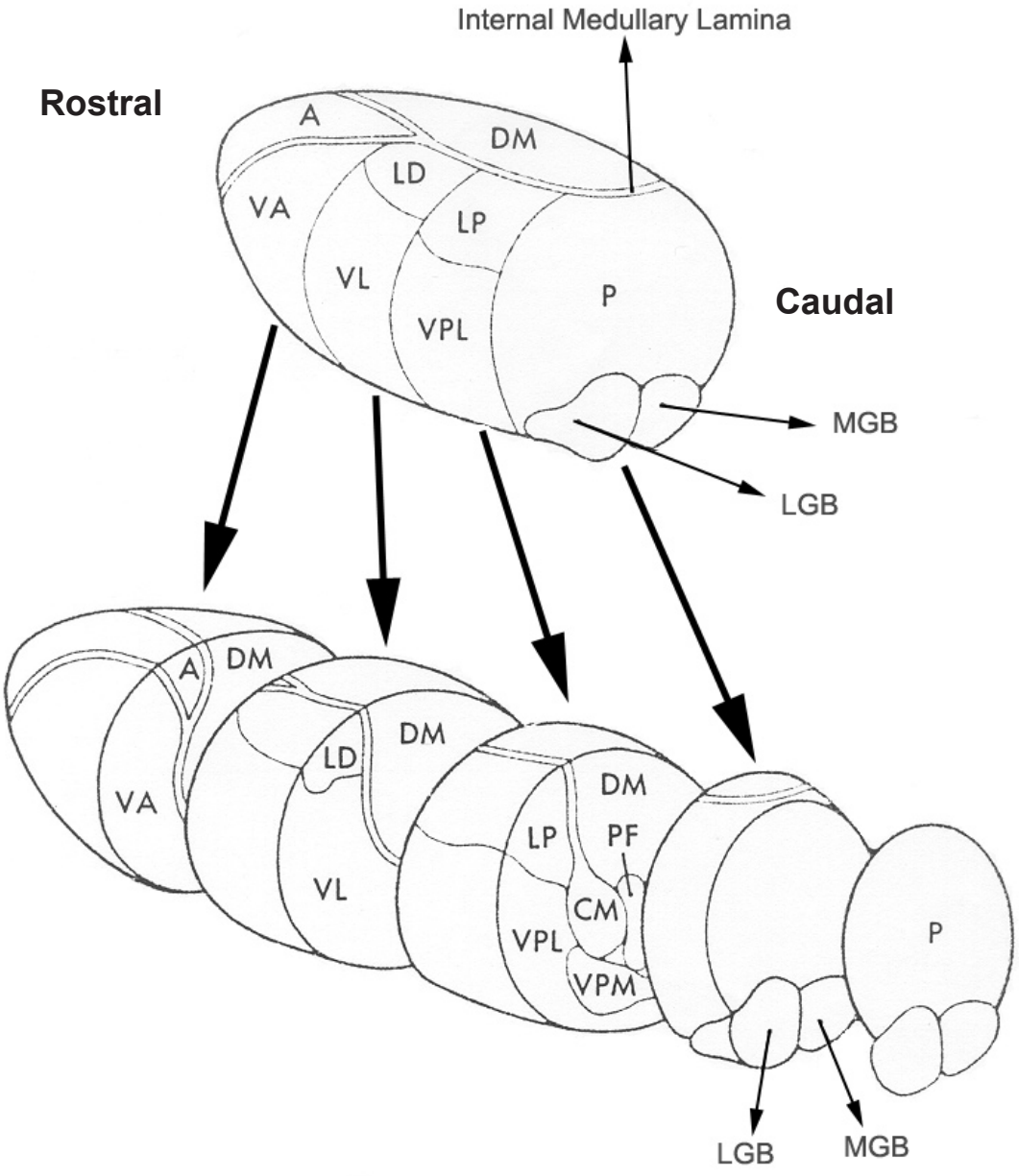
A. The **medial** thalamic nuclei
   1. **Dorsomedial (mediodorsal)** nucleus
   2. small midline nucleus

B. The **lateral** thalamic nuclei
   can be divided into **dorsal** and **ventral** tiers
   1. The dorsal tier
      **Lateral Dorsal** (LD)
      **Lateral Posterior** (LP)
      **Pulvinar**
      **Medial and Lateral Geniculate Nuclei** = Metathalamus
   2. The ventral tier
      **Ventral Anterior (VA)**
      **Ventral Lateral (VL)**
      **Ventral Posterior** - Includes ventral posteromedial (**VPM**) and ventral posterolateral (**VPL**)

C. The central intralaminar nuclei
   1. Centromedial nucleus

## Coronal Sections through the Left Dorsal Thalamus

Adapted from Fundamental Neuroscience, D.E. Haines 2002



**2. Thalamic nuclei** can be categorized functionally:

A. **Specific**
   **i. Relay**
   **ii. Associational**
B. **Non-Specific**
   **i. Intralaminar**
C. **Reticular**

**A. Specific Nuclei**

General Information

- evoke a sharp, localized response in ipsilateral hemishere

i. Relay nuclei

- receive specific ascending tracts and project to specific cortical areas

**Specific Relay nuclei include:**
**VPL, VPM, MGN, LGN, VA, VL, Anterior nuclei**
**Ventral Posterior Nuclei**

- receive ascending somatic sensory fibers
- there are **2 divisions** to the VP:

1. **VPL** – receives **somatosensory** from the **contralateral body** (from the DC/ML and ALS)
2. **VPM** – **receives trigeminalthalamic** fibers from the spinal trigeminal tract (P&T from face) and Chief sensory nucleus of V, and also gustatory fibers from the nucleus solitarius

Both the **VPL and VPM project** to the **primary sensory area** in the **postcentral** and **paracentral gyrus.**

There are connections with the dorsal tier nuclei for integration and the mediodorsal nucleus (emotional response).

**Geniculate Nuclei:**

**Medial Geniculate Nucleus**

- **receives auditory fibers** from the inferior colliculus (via the brachium of the inferior colliculus)
- **projects** to **primary auditory cortex** ( in the temporal lobe)

**Lateral Geniculate Nucleus**

- **receives optic tract** from retina
- **projects** via optic radiations to the **primary visual area** (occipital lobe)

**Ventral Anterior Nuclei (VA)**

- **receive** from the **corpus striatum**

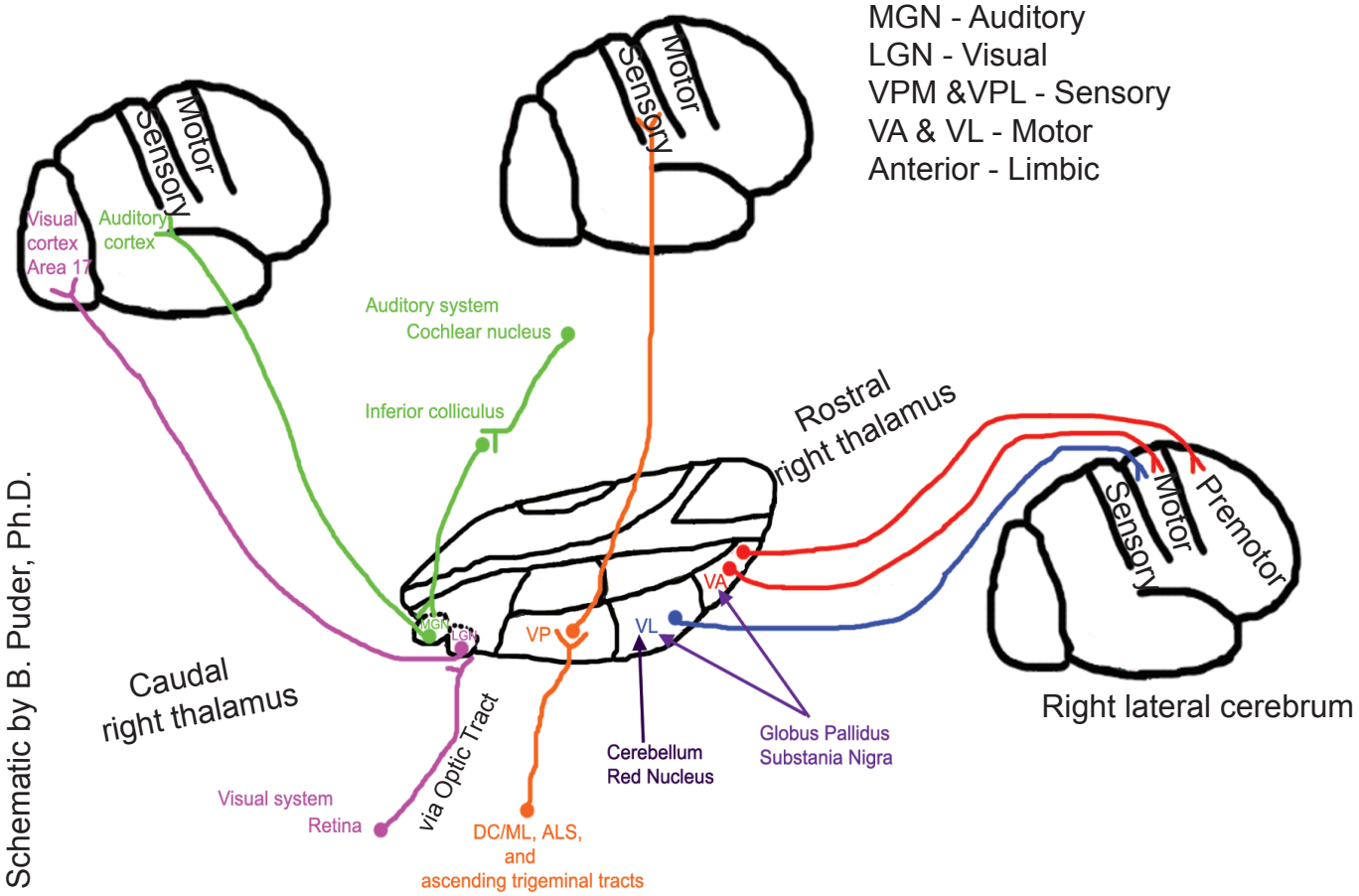
**Ventral Lateral Nuclei (VL)**

- **receive** from the **cerebellum** via the dentato-rubro-thalamic tract

Both the **VA and VL project to the motor cortex** (**precentral gyrus** and **premotor area** and contribute to initiation, organizaton and control of movement.

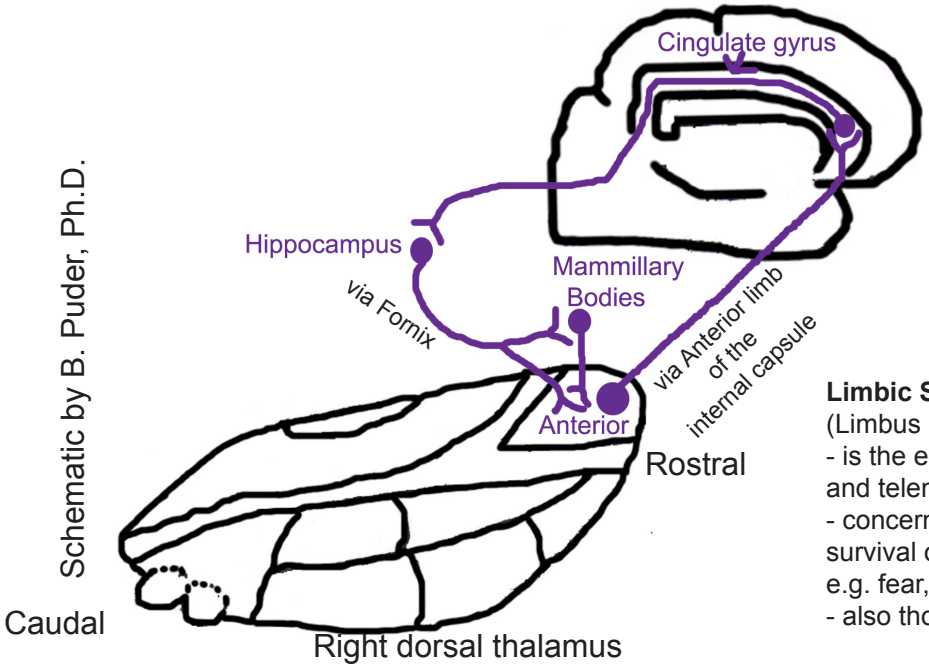
**Specific Relay Nuclei** - receive /project specific information to/from specific areas

**Specific Relay Nuclei include:**
MGN - Auditory
LGN - Visual
VPM &VPL - Sensory
VA & VL - Motor
Anterior - Limbic




Schematic by B. Puder, Ph.D.

Diagram depicting inputs into the right dorsal thalamus and projections to higher cortical centers




Schematic by B. Puder, Ph.D.

**Limbic System:**
(Limbus = edge)
- is the edge between the diencephalon and telencephalon
- concerned with basic emotions related to survival of the species,
e.g. fear, anger, reproduction, feeding
- also thought to be involved in memory

Diagram depicting projections from,and inputs into the anterior nucleus of the thalamus (Papez circuit)

**Anterior nucleus**

- **receives** from **hippocampus** (via the fornix) and **hypothalamus** (via the mammillothalamic tract)
- **projects** through anterior limb of the internal capsule to the **cingulate gyrus**
- involved in emotional drives, instinctive behavior, memorization
- part of the limbic system

ii. **Specific Association nuclei**

- Receives input from numerous areas
- Projects to many cortical areas

**Specific Association nuclei include:**
**DM, Pulvinar, LP, LD**
**Dorsomedial Nuclei**

- largest nucleus in the medial thalamic region
- highly developed
- **receives** afferents from **other thalamic** and **hypothalamic nuclei**
- **integrates somatic and visceral afferents**
- has **reciprocal connections** with **prefrontal cortex**
- associated with mood and emotional balance
- feelings of euphoria or depression may result from stimulation of this nuclei
- through its hypothalamic connection – visceral response to emotion may result – e.g. an unpleasant experience may cause vomiting
- **damage** here results in **personality change,** affects **intelligence**, **emotional drive, memory, psychological reactions to pain** (similar to damage to prefrontal cortex)

**Clinical Aspect :** Frontal **lobotomy cuts connections** between the **prefrontal cortex** and the **dorsomedial nucleus.**

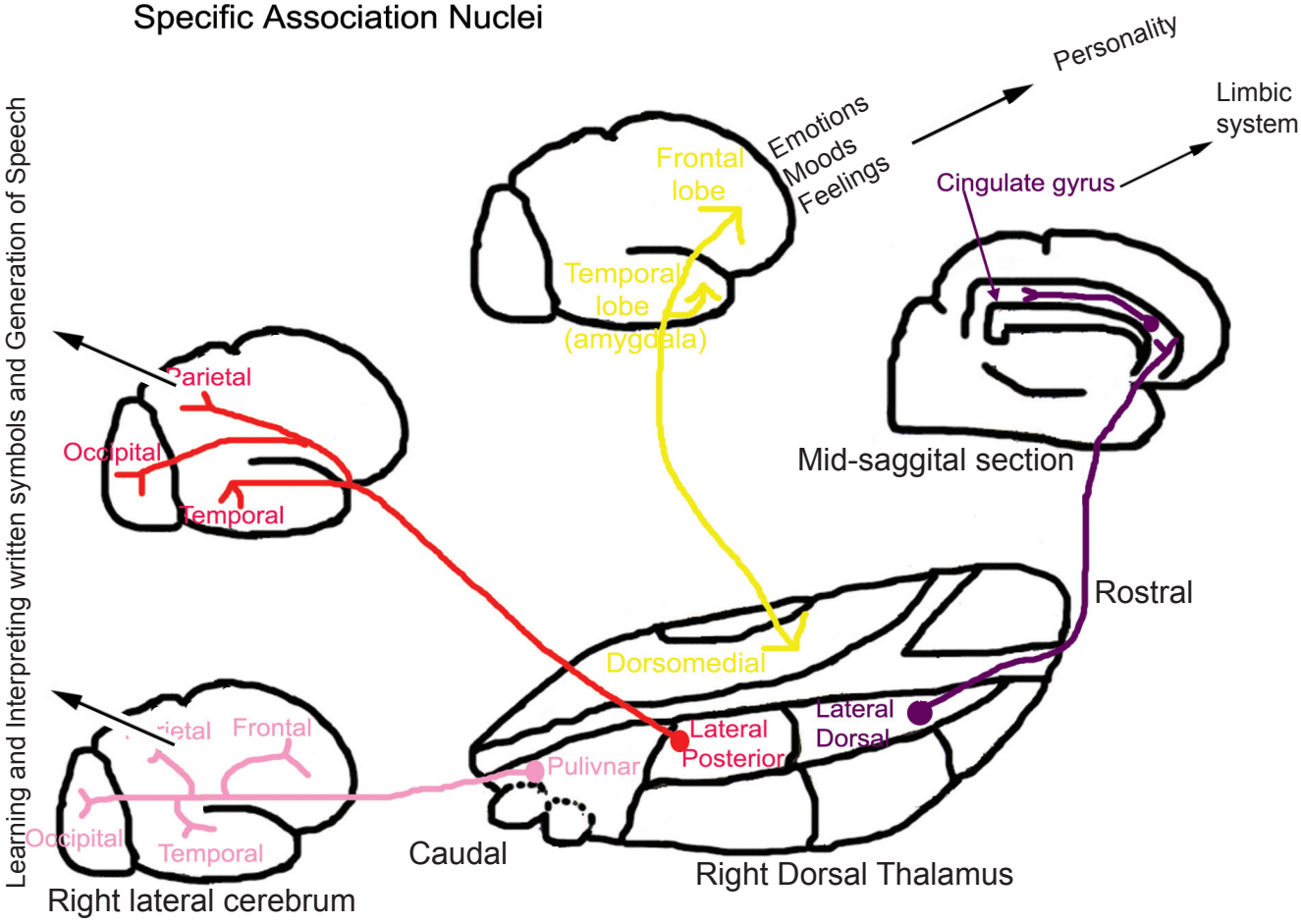
**Dorsal tier of the Lateral Nuclei**

- **receives** from the **ventral tier**
- has **reciprocal connections** in **parietal, occipital and temporal lobes**
- involved in **analysis and integration of sensory input**

1. **Pulvinar**
   - receives from the LGN and SC
   - projects to visual association cortex
   - important for **visual discrimination** and ability to interpret **written symbols**
   - projects to temporal,parietal, and frontal lobes for visual function and eye movements

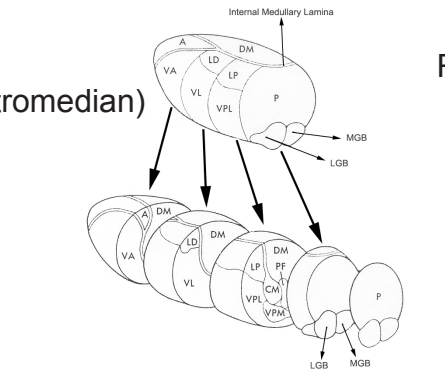
Schematics by B. Puder, Ph.D.

## Specific Association Nuclei

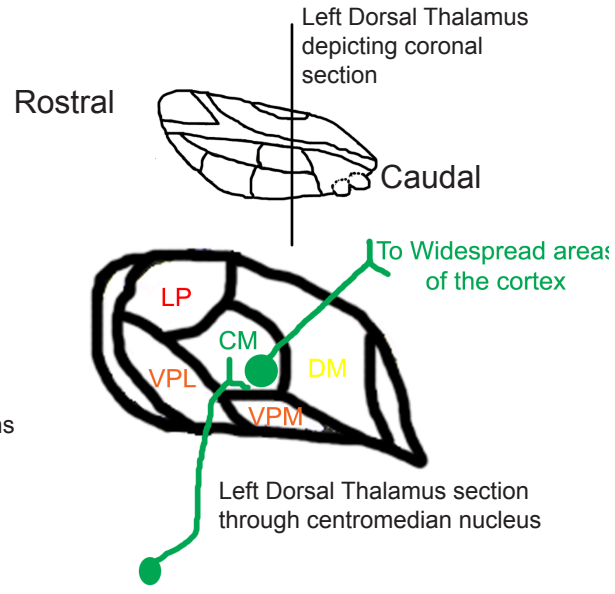



**Specific Association Nuclei include:**
Lateral Dorsal Nuclei - Limbic System
Dorsomedial,Pulvinar, and Lateral Posterior Nuclei - other thalamic nuclei and cortex

**Non Specific Nuclei**
Include:
Intralaminar nuclei (centromedian)
midline nuclei



Left Dorsal Thalamus in coronal sections



2. **Lateral Posterior**
   - projects to parietal, occipital and temporal cortex
   - important for **visual discrimination** and ability to interpret written symbols
3. **Lateral dorsal nuclei**
   - projects to the cingulate gyrus

**B. Non-Specific Nuclei**

- evoke widespread activity in both hemispheres
- project to widespread cortical areas in both hemispheres
- concerned with correlation and interpretation of information

**Intralaminar Nuclei**

- internal medullary lamina encloses several nuclei – the largest is the **centromedian**
- **receive** afferents from the **reticular activating system** and from ascending **pain pathways**
- project to other thalamic nuclei and corpus striatum
- **evoke arousal response**, **consciousness**, and **alertness and awareness** of **pain**

**Midline Nuclei**

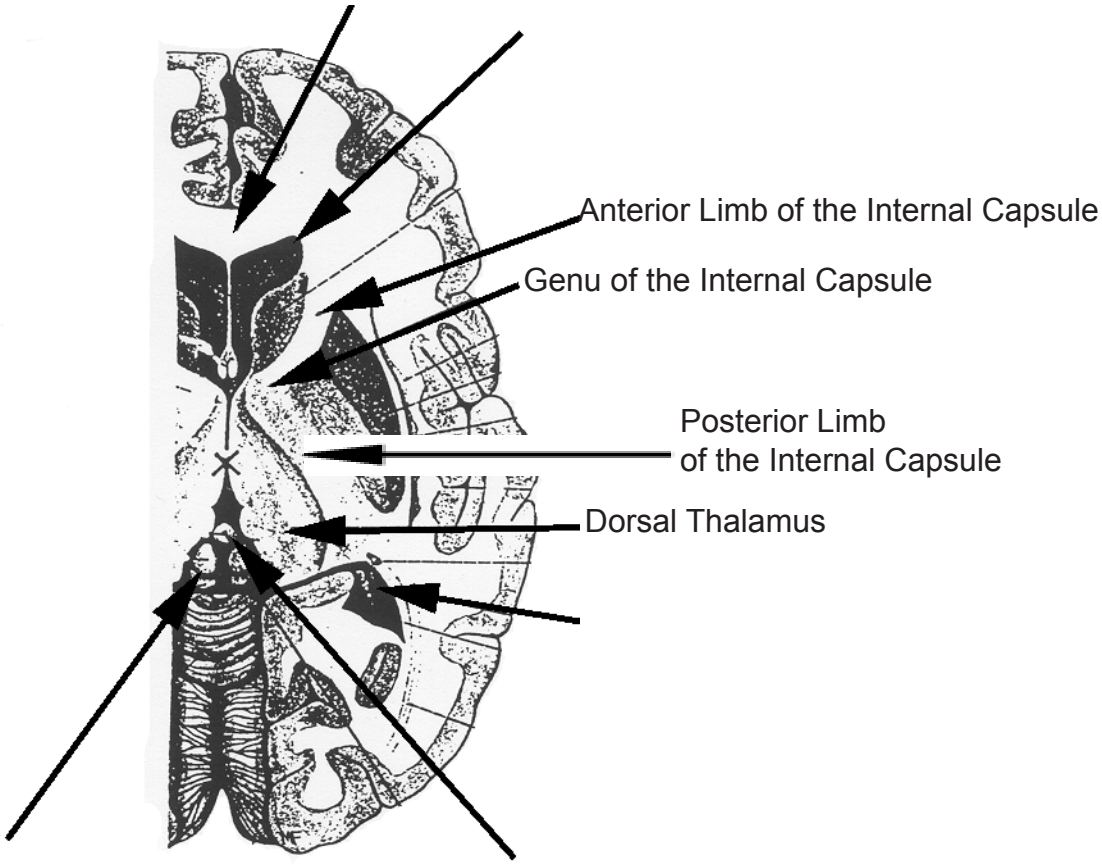
- small in humans
- located on wall of 3rd ventricle
- receive visceral afferents and projects to the hypothalamus

**C. Reticular Nuclei**

- Thin sheet between the external medullary lamina and the internal capsule
- gates responses of thalamic neurons to cortical input
- **modulates thalamic input**

**II. Thalamic Projections and the Internal Capsule**

- The internal capsule **consists of ascending and descending tracts** (motor and sensory) that **connect the thalamus and the cerebral cortex.**
- It **consists** of an **anterior limb, genu, and posterior limb.**
- Ascending fibers leave the thalamus, go through the internal capsule to the corona radiata to the cortex. Descending fibers from the cortex travel through these same areas, but in opposite direction.



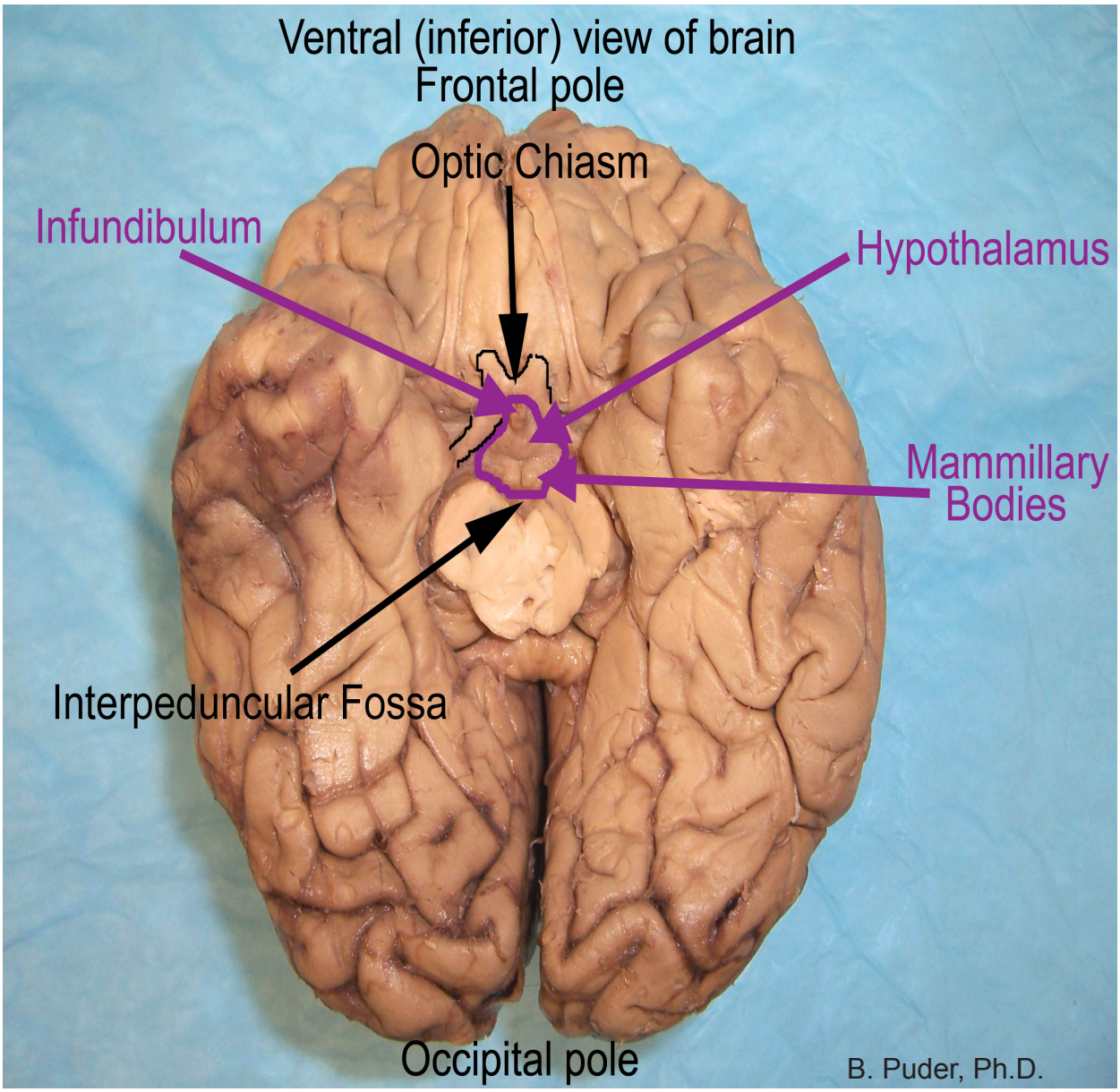

Horizontal section through the dorsal thalamus showing the relationship of the dorsal thalamus to the internal capsule.

We have spent a considerable amount of time on the dorsal thalamus, but there are still 3 other components to the diencephalon that we need to discuss. These 3 areas are the hypothalamus , subthalamus, and epithalamus

## The Hypothalamus

### I. General Information

The hypothalamus is composed of several nuclei, each nuclei has specific afferent and efferent connections as well as distinct functions. In addition to their neuronal connections, the hypothalamic neurons are also influenced by factors such as osmotic pressure, temperature, and hormones as conveyed by the circulatory system.


Ventral (inferior) view of brain
Frontal pole
Optic Chiasm
Infundibulum
Hypothalamus
Mammillary Bodies
Interpeduncular Fossa
Occipital pole
B. Puder, Ph.D.

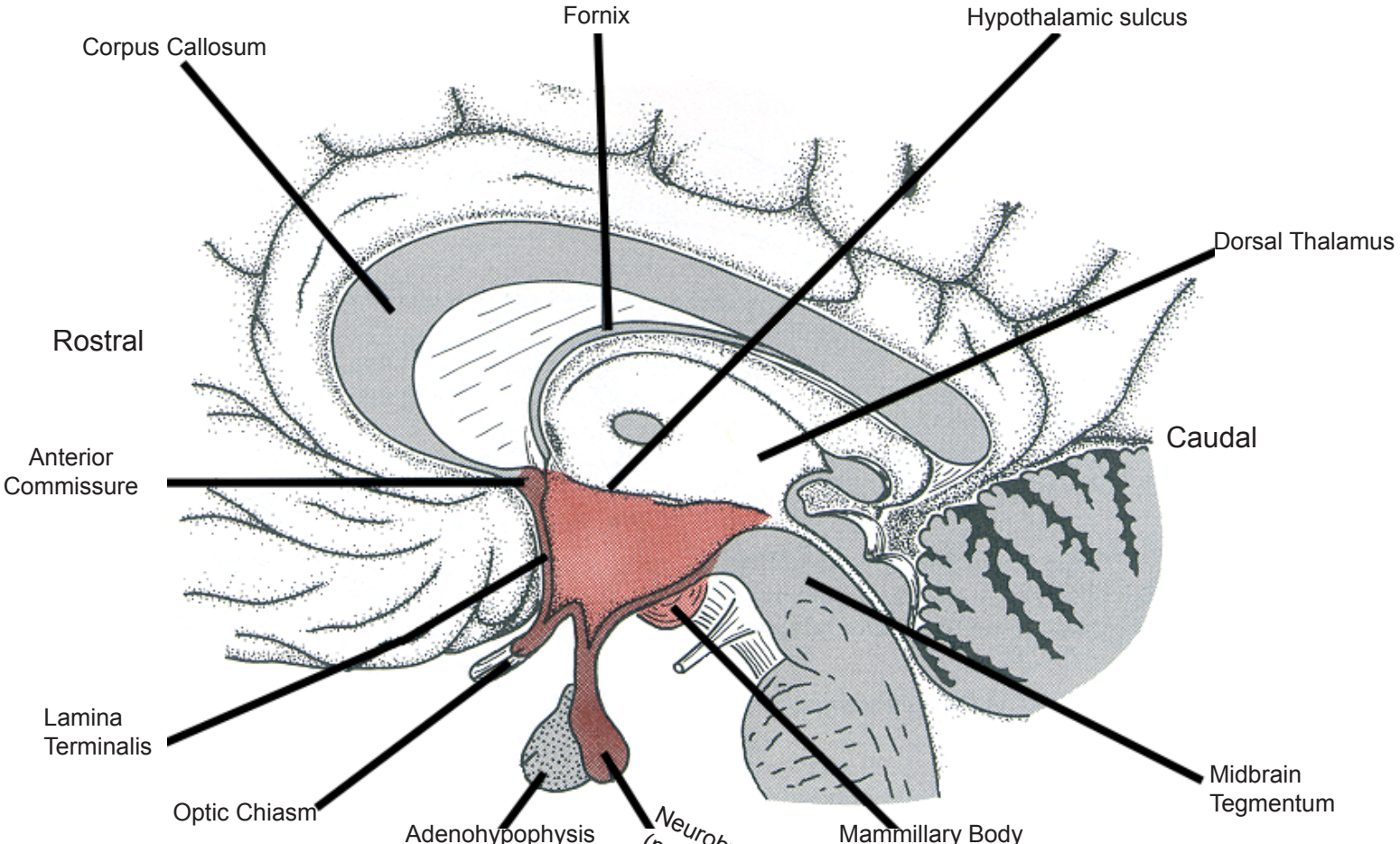
## II. Functions of the Hypothalamus

The Hypothalamus:

1. **Synthesizes hormones**
2. **Regulates** the **autonomic nervous system**
3. **Regulates body temperature**
4. **Regulates the biological clock** (circadian rhythms)
5. **Controls electrolyte balance**
6. **Controls emotional behavior** (anger, fear, euphoria)
7. **Controls motivational arousal** (hunger, thirst, aggression, sexual arousal)
8. **Regulates anterior pituitary by** production of **releasing factors**
9. Has a **endocrine function** by releasing **Oxytocin** and **Vasopressin** to general circulation **via the posterior pituitary**

## III. Location of the Hypothalamus

- Forms lower and lateral wall and floor of the 3rd ventricle
- Located posterior to lamina terminalis and extends posterior to and includes the mammillary bodies
- Median eminence is right behind optic chiasm and attaches the infundibulum to the pituitary gland



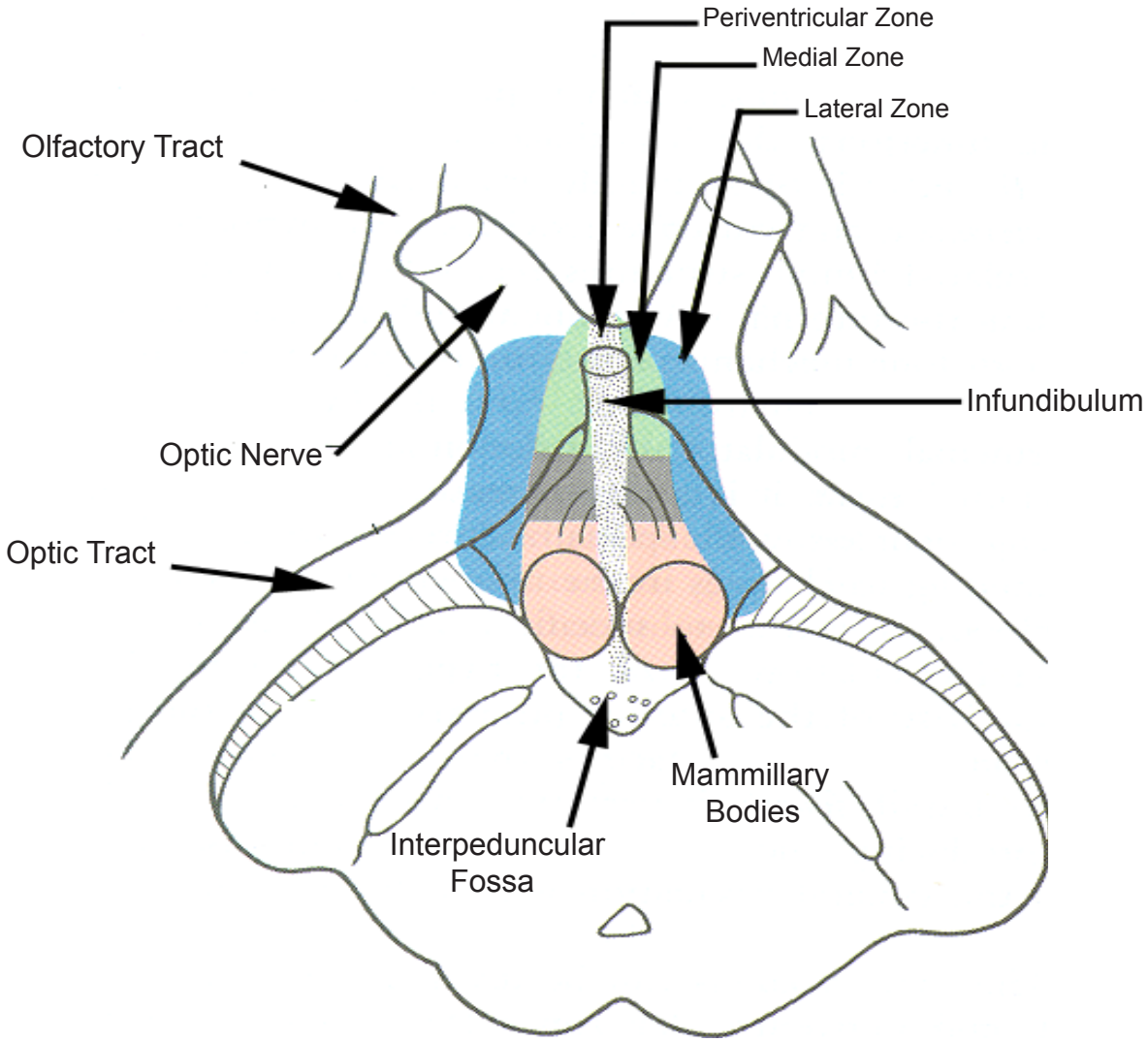

Adapted from Textbook of Neuroanatomy, A.M. Burt, 1993

Mid-sagittal section through the hypothalamus

## Location of the Hypothalamus and its Nuclei

The **Hypothalamus** contains **3 Zones:**

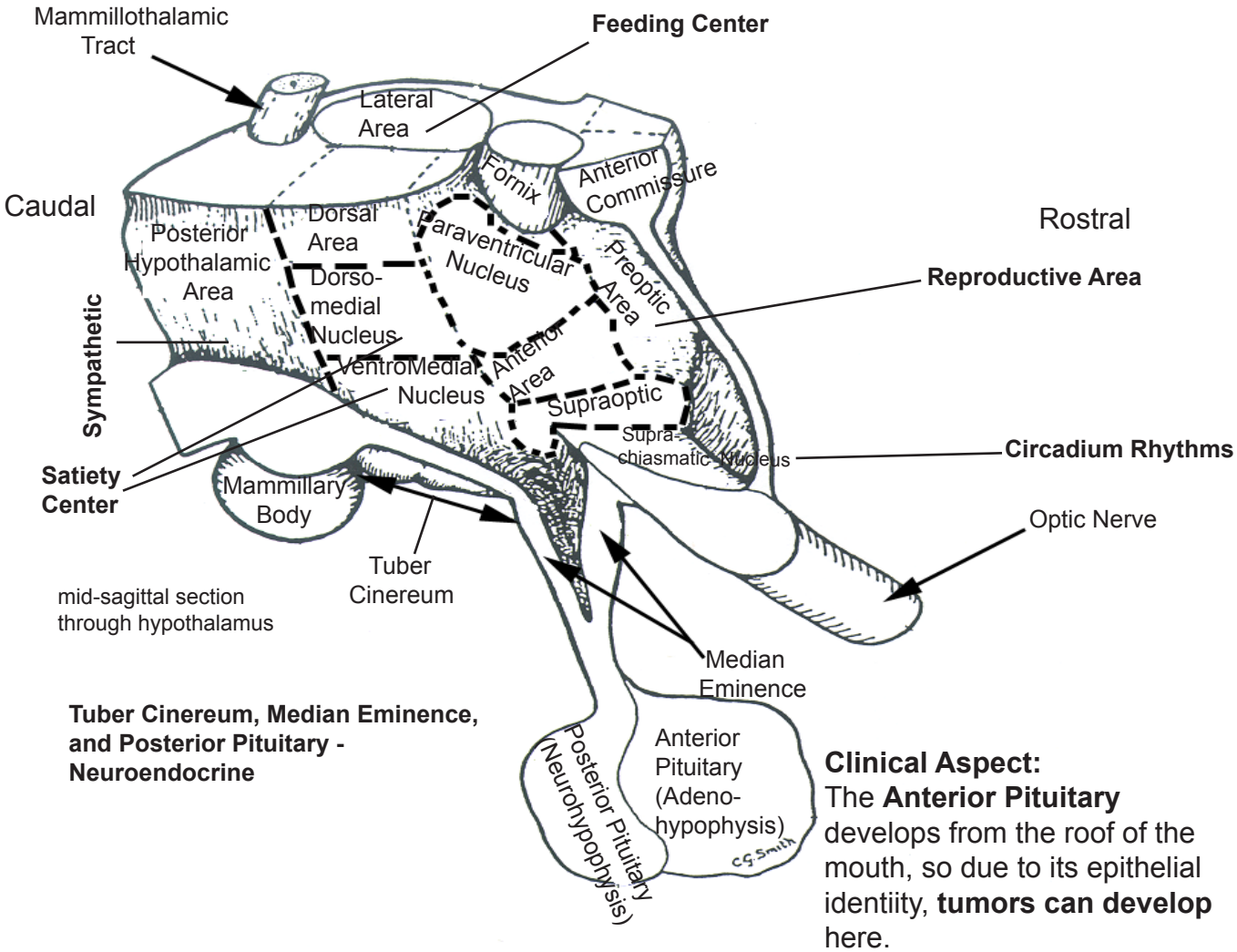
1. **Lateral** - extends rostral /caudal and is separated from the medial zone by the fornix
2. **Medial** - From rostral to caudal , it contain 3 zones:
   i. **Chiasmatic**
   ii. **Tuberal**
   iii. **Mammillary**
3. **Periventricular** – are neurons that border the ependymal surfaces of the 3rd ventricle




Anterior view of the diencephalon depicting the ventral portion of the hypothalamus

Adapted from Fundamental Neuroscience, D.E. Haines, 2002

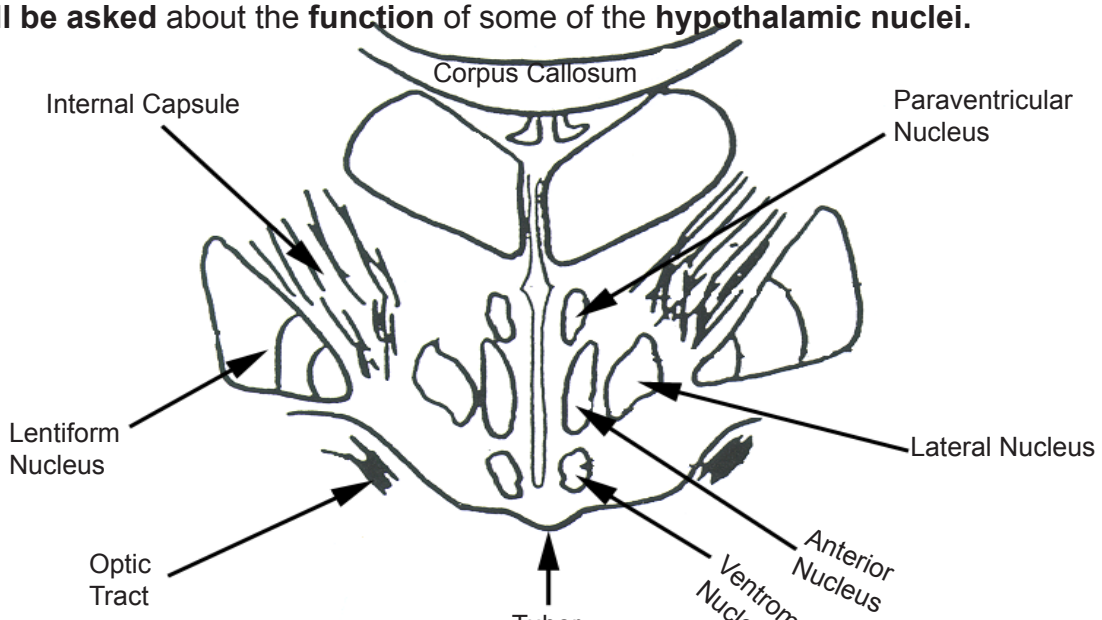
# The Hypothalamus and its Nuclei




**Tuber Cinereum, Median Eminence, and Posterior Pituitary - Neuroendocrine**

**Clinical Aspect:**
The **Anterior Pituitary** develops from the roof of the mouth, so due to its epithelial identiity, **tumors can develop** here.

You will not be asked to identify the location of the various hypothalamic nuclei.
You **will be asked to identify** the **hypothalamus** and the **mammillary bodies**.
You **will be asked** about the **function** of some of the **hypothalamic nuclei.**




Coronal Section through the hypothalamus

## IV. Afferent and Efferent Connections to the Hypothalamus

A. **Major Afferent connections to the Hypothalamus**

A. **Olfactory**

B. **Limbic** cortical centers: **Hippocampus** → Fornix → Hypothalamus
**Amygdala** → Stria terminalis → Hypothalamus

C. **Frontal cortex: Septal** area → Medial Forebrain Bundle → Hypothalamus

D. Environmental **Light**: drives metabolic and hormonal activity

E. **Peripheral influences**: e.g. **osmotic pressure**, plasma **glucose levels**, gonadal **steroid levels**, blood **temperature**

F. **Sensory Input**: via spinal cord and brainstem (reticular formation), afferent pathways (e.g. taste, pain, general tactile)

B. **Major Efferent Connections from the Hypothalamus**

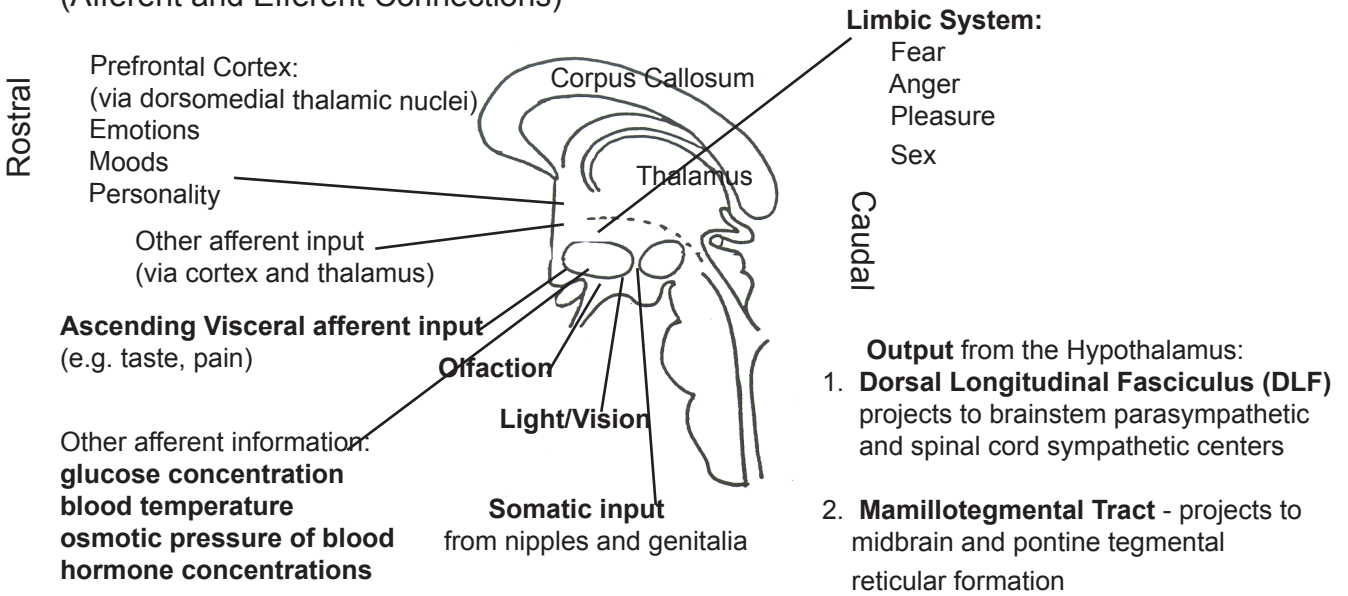
There are **2 Major descending pathways:**

1. **Dorsal Longitudinal Fasciculus** -runs beneath the ventricular system through the brainstem. Some fibers may **innervate brainstem nuclei** (e.g. dorsal nucleus of the vagus) and some fibers continue into the **spinal cord** to terminate in the **intermediolateral cell column** (these fibers are preganglionic neurons of the sympathetic nervous system).
2. **Mammillotegmental Fasciculus** - are collateral branches of the mammillothalamic tract that descend and **terminate in reticular formation** nuclei in the **midbrain and pons**.

There is **1 Major Ascending pathway** involved in the Limbic system

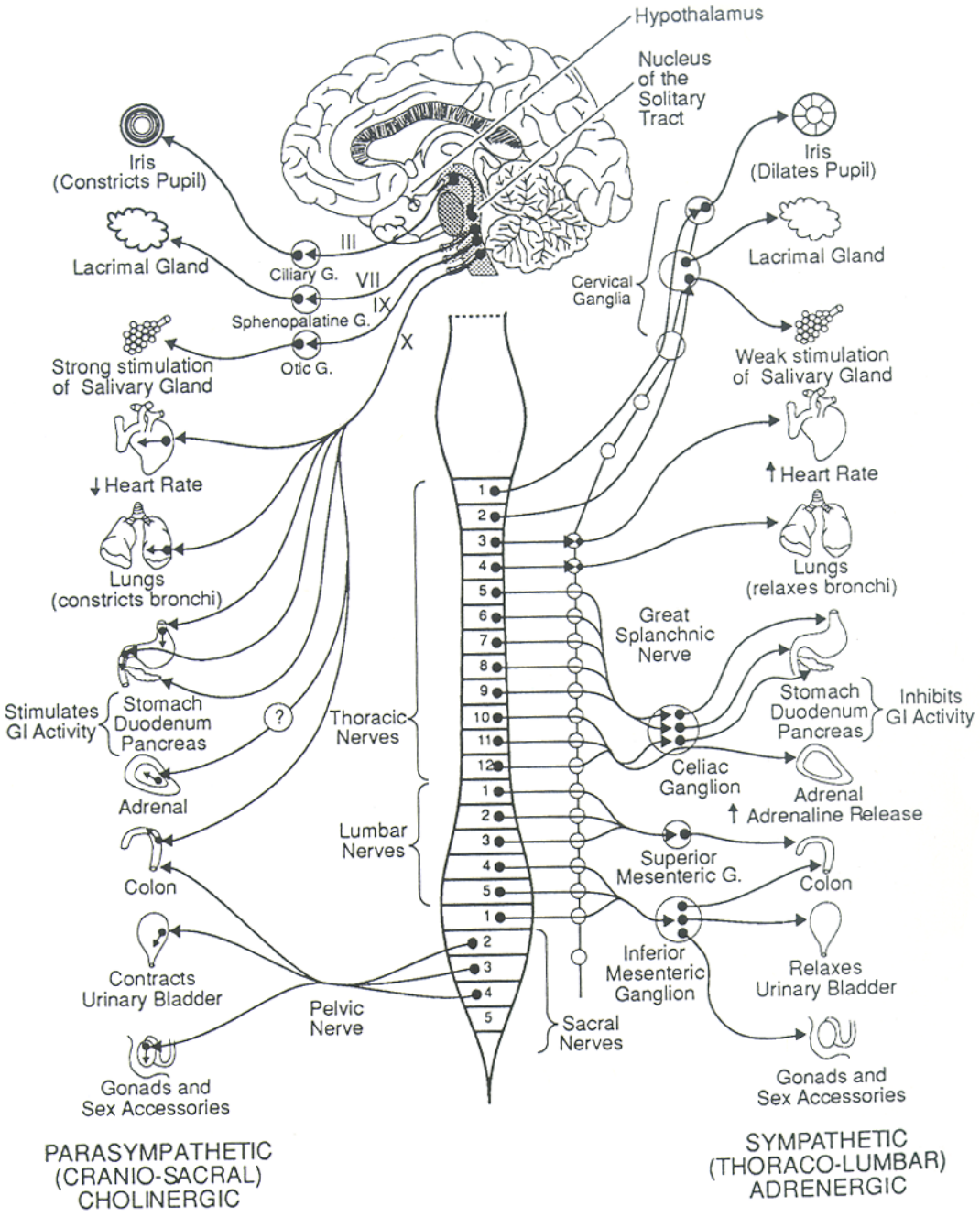
1. **Mammillothalamic Tract** - projects from **mammillary bodies** to the **anterior nucleus of the dorsal thalamus**.

**Involvement of the Hypothalamus in the Expression of Visceral Activity**
(Afferent and Efferent Connections)



**Examples of projections from the hypothalamus:**
Edinger-Westphal Nucleus (CN III) - pupillary constriction
IML - to superior cervical ganglion - pupillary dilation
Facial Nucleus (CN VII) - facial expressions
Superior Salivatory Nucleus - lacrimation (tearing)
Inferior Salivatory Nucleus - salivation
Brainstem respiratory centers
Brainstem cardiac centers - Dorsal Motor Nucleus of Vagus (CN X) and Nucleus Ambiguous - parasympathetic pressor and depressor centers
Spinal Cardiac Centers - IML - sympathetic preganglionic
Dorsal Motor Nucleus of Vagus (CN X) - parasympathetic for gut and other viscera
Spinal Cord IML - sympathetic for gut and other viscera

## Overview of the Autonomic Nervous System



## V. Hypothalamic Control of Visceral Function

The Hypothalamus is the highest center for co-ordination of visceral activity of the Autonomic Nervous System.

There are Two Principal Centers:

1. **Parasympathetic** Nervous System - **Anterior** and **Medial** parts of the **Hypothalamus**
2. **Sympathetic** Nervous System - **Posterior** and **Lateral** parts of the **Hypothalamus**

These 2 components of the autonomic nervous system overlap and communicate with each other.

**Parasympathetic** Center

Stimulation causes:

1. Reduced heart rate
2. Peripheral vasodilation
3. Reduced blood pressure
4. Pupillary constriction
5. Increased peristalsis
6. Increased secretion of digestive enzymes
7. Increased salivation

**Sympathetic** Center

Stimulation causes:

1. Increased heart rate
2. Peripheral vasoconstriction
3. Increased blood pressure
4. Pupillary dilation
5. Decreased peristalsis
6. Decreased secretion of digestive enzymes
7. Piloerection

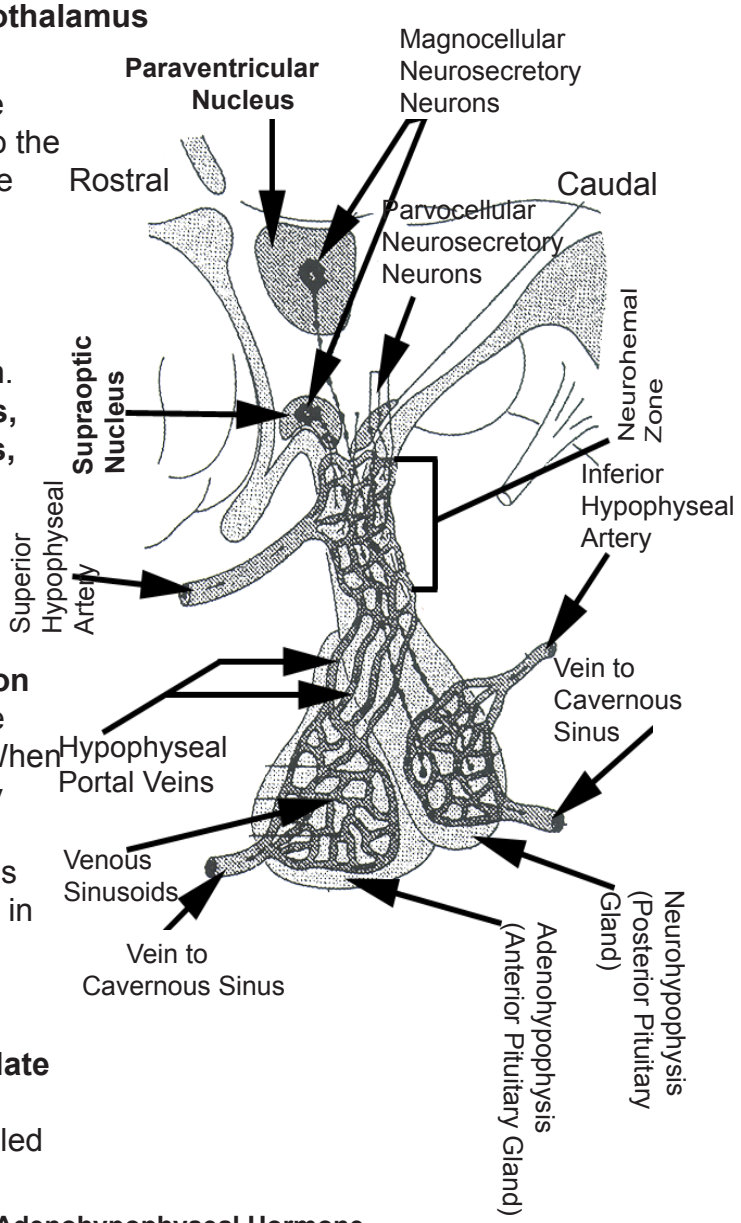
**Functional Centers in the Hypothalamus**

1. **Temperature regulation**
   a. **Anterior** Hypothalamus - **heat dissipation center** - Rise in temperature of blood causes cells in the anterior hypothalamus to discharge to lower brain centers to initiate sweating and cutaneous vasodilation.
   b. **Posterior** Hypothalamus - **heat conservation center** - Decrease in blood temperature causes cells here to discharge to lower centers to initiate vasoconstriction, shivering, and increase visceral activity to promote heat production and conservation.
2. **Food Intake**
   a. In or near the **Ventromedial nucleus** - **satiety center** - lesion here causes hyperphagia (overeating) - obesity
   b. **Lateral hypothalamus** - **feeding center** - lesion here abolishes the desire to eat (anorexia)
3. **Sleep/Wake Cycle**
   a. **Anterior** hypothalamus - **sleep** cycle
   b. **Posterior hypothalamus and mammillary bodies** - **wake** cycle
4. **Water Balance**
   a. **Supraoptic** and **Paraventricular Nuclei**
5. Regulation of **Pituitary function** and **Hormone regulation**
   a. **Median Eminence** - female cyclicity and onset of puberty
6. **Reproduction and Growth** - **Preoptic nucleus** controls the release of LH and FSH

(Interesting note: cell size differs in the medial preoptic area (MPOA) between males and females, thus making this a sexually dimorphic area. Studies performed on male homosexuals has shown that cell size in the MPOA falls somewhere between the male and female MPOA.)

## VI. Hormone Producing Neurons in the Hypothalamus

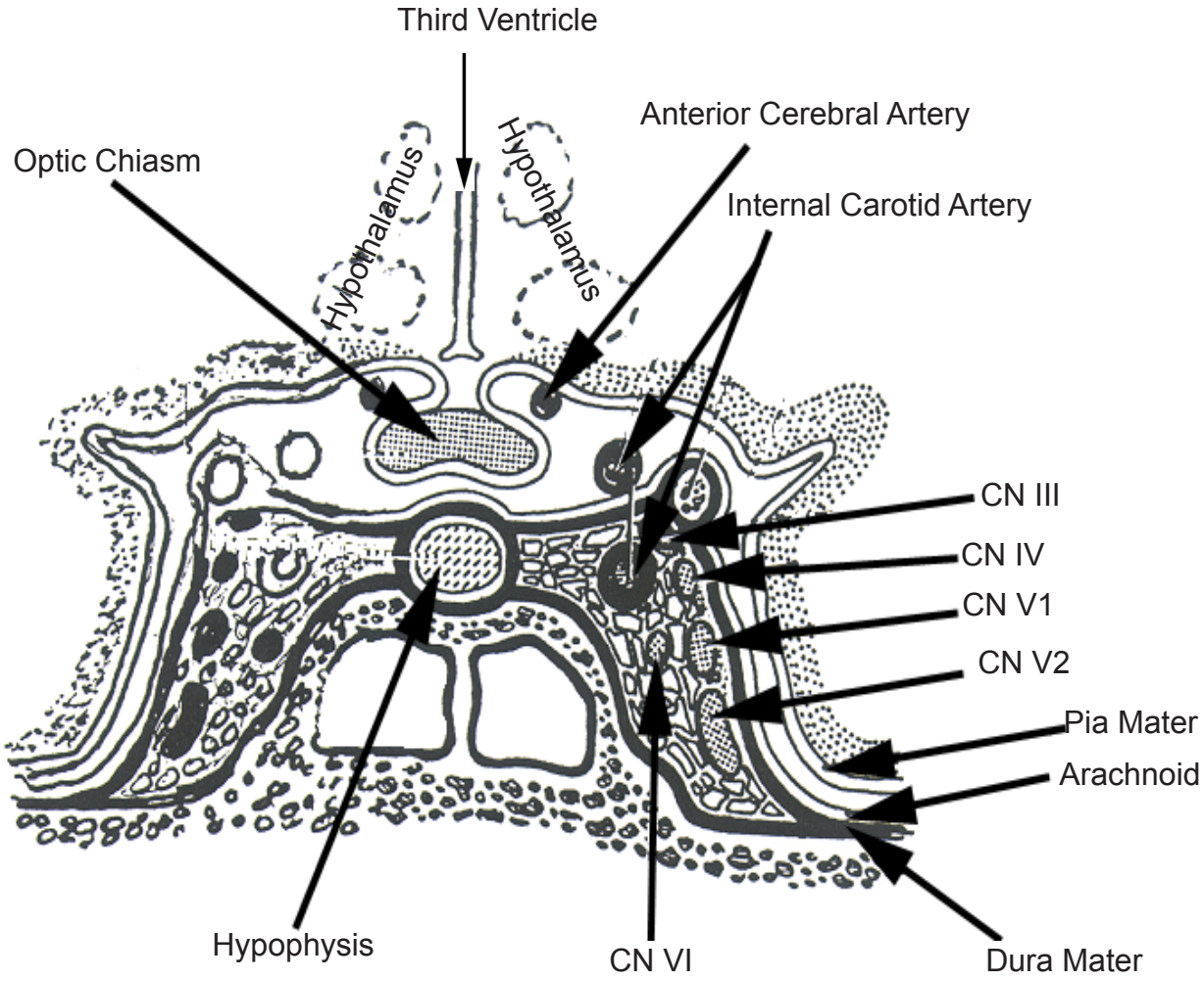
The **magnocellular neurons** are located in the **paraventricular** and **supraoptic nuclei**. These neurons have **varicosed axons** that **project** to the **neurohypophysis**. The varicosities **contain** the neurosecretory **hormones oxytocin** or **vasopressin** and when these neurons are **stimulated**, they **release** either **oxytocin or vasopressin** into the **capillary beds** in the **neurohypophysis** and into **general circulation**.
**Oxytocin** is necessary for **uterine contractions, milk ejection, maternal and mating behaviors, penile erection,and orgasm.**
**Vasopressin** (also called anti-diuretic hormone, ADH) is necessary for **water resorption** in the kidneys.




The **parvocellular neurons** in the **tuberal region** of the hypothalamus **project** their axons into the **neurohemal zone** of the **median eminence**. When these parvocellular neurons are stimulated, they **release hypothalamic hypophysiotropic hormones** (HHH) into the **capillary bed** which is **formed by the superior hypophyseal arteries** in the neurohemal zone. These **hormones** are **transported by portal veins to** the venous sinusoids of the **adenohypophysis.**
Once in the adenohypophysis the **HHH's stimulate or inhibit** the **release** of **adenohypophysial trophic hormones**. This vascular system is called the hypothalamohypophysial portal system.

| **Hypothalamic Hypophysiotropic Hormone** | | **Adenohypophyseal Hormone** |
|---|---|---|
| Corticotropin-releasing hormone (CRH ) | → | Adrenocorticotropic hormone (ACTH) |
| Growth hormone-release-inhibiting hormone (GHRIH) (somatostatin)<br>Growth hormone-releasing hormone (GHRH) | → | Growth Hormone (somatotropin) |
| Thyrotropin-releasing hormone (TRH) | → | Thyrotropic Hormone (TSH) |
| Prolactin-inhibiting hormone (PIH) (Dopamine)<br>Prolactin-releasing hormone (PRH) | → | Prolactin |
| Gonadotropin-releasing hormone:<br>follicle-stimulating hormone releasing-hormone (FSHRH) | → | Follicle-stimulating Hormone(FSH) |
| lutenizing hormone-releasing hormone (LHRH) | → | Luteinizing Hormone (LH) |

## VII. Cavernous Sinus, Cranial Nerves, Pituitary, and Hypothalamic Relationships




**Clinical Aspect:** Due to its location to the optic chiasm, carotid arteries, and cranial nerves III, IV,and V, a growing pituitary tumor can expand into areas to cause visual deficits, problems with eye movements, and sensory loss to the face. This is in addition to problems due to lack of hormonal release. As stated on an earlier page, **pituitary tumors** usually **originate from the anterior pituitary** (adenohypophysis) due to its epithelial nature. The **triad of symptoms** with a pituitary tumor includes **diabetes insipidus, visual deficits**, and **panhypopituitarism**. **Obstructive hydocephalus** can also be present.

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The last 2 divisions of the diencephalon include the subthalamus and epithalamus.

**Subthalamus** (Ventral Thalamus)

- includes the **subthalamic nucleus, prerubral field, and zona incerta**
- is a zone between the midbrain and diencephalon
- located ventral and caudal to the dorsal thalamus
- the red nucleus extends into it
- is functionally related to the **motor system**

**Subthalamic Nucleus**

- is shaped like a biconvex lens
- has an excitatory effect on the globus pallidus
- posterior cerebral and posterior communicating arteries supply the subthalamus

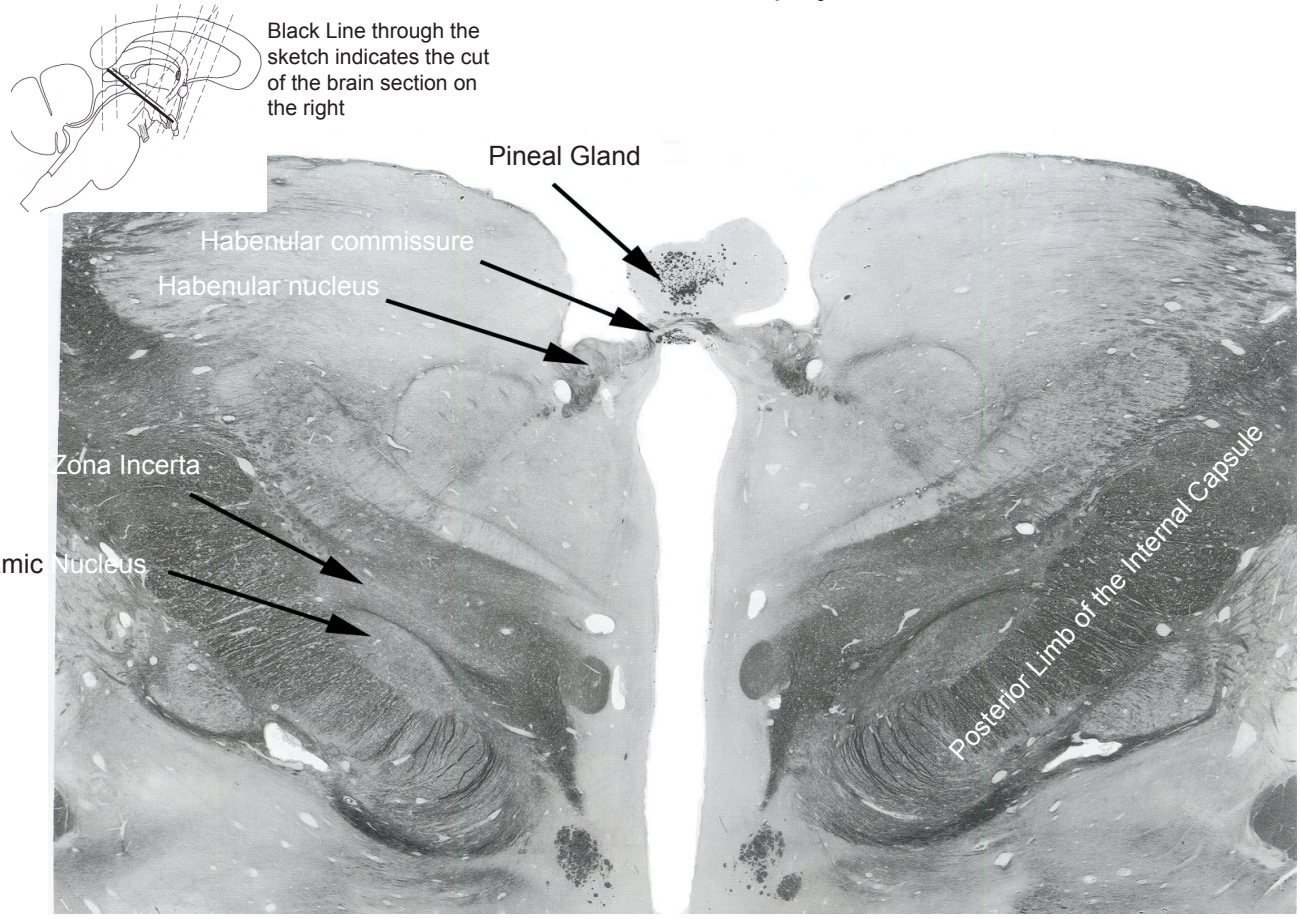
**Clinical Aspect:** A **lesion** to the **subthalamus** causes **contralateral hemiballism**

**Prerubral area**

- located rostral to the red nucleus
- fibers from the lenticular and thalamic fasciculus traverse through here

**Zona Incerta**

- located posterior to the subthalamic nucleus
- receives motor information and sends projections to cortex and brainstem




Adapted from Neuroanatomy: An Atlas of Structures, Sections, and Systems D.E. Haines 2000

**Epithalamus**

- located posteriorly in the diencephalon roof
- includes the habenular nuclei, pineal gland, and 3 fiber tracts: habenular commissure, stria medullaris thalami, and posterior commissure

**Habenular Nuclei**

- associated with **olfactory and limbic system**

**Habenular Commissure**

- allows for crossing of fiber tracts (stria medullaris thalami) from one habenular nuclei to another

**Stria Medullaris Thalami**

- fiber tract that originates in the **septal area**(olfactory and limbic) and projects to the **habenular nuclei**

**Posterior Commissure**

- Consists of connections of the medial longitudinal fasciculus, interstitial nuclei, superior colliculus, and pretectal nuclei

**Pineal Gland**

- overhangs superior colliculus
- located below the splenium of the corpus callosum
- the great cerebral vein is located between the spenium and the pineal gland
- has 2 stalks – the lower stalk connects to the posterior commissure and the upper stalk connect to the habenular commissure
- consists of glial cells and pinealocytes (no true neurons)
- **produces melatonin from serotonin** - maximal secretion is in darkness
- the effect of light is via retina to SCN of hypothalamus to IML to Superior cervical ganglion to pineal

**Clinical Aspects:** The **Pineal gland** is an endocrine gland which exerts **anti-gonadotrophic** effects the hypothalamus, and anterior and posterior pituitary.

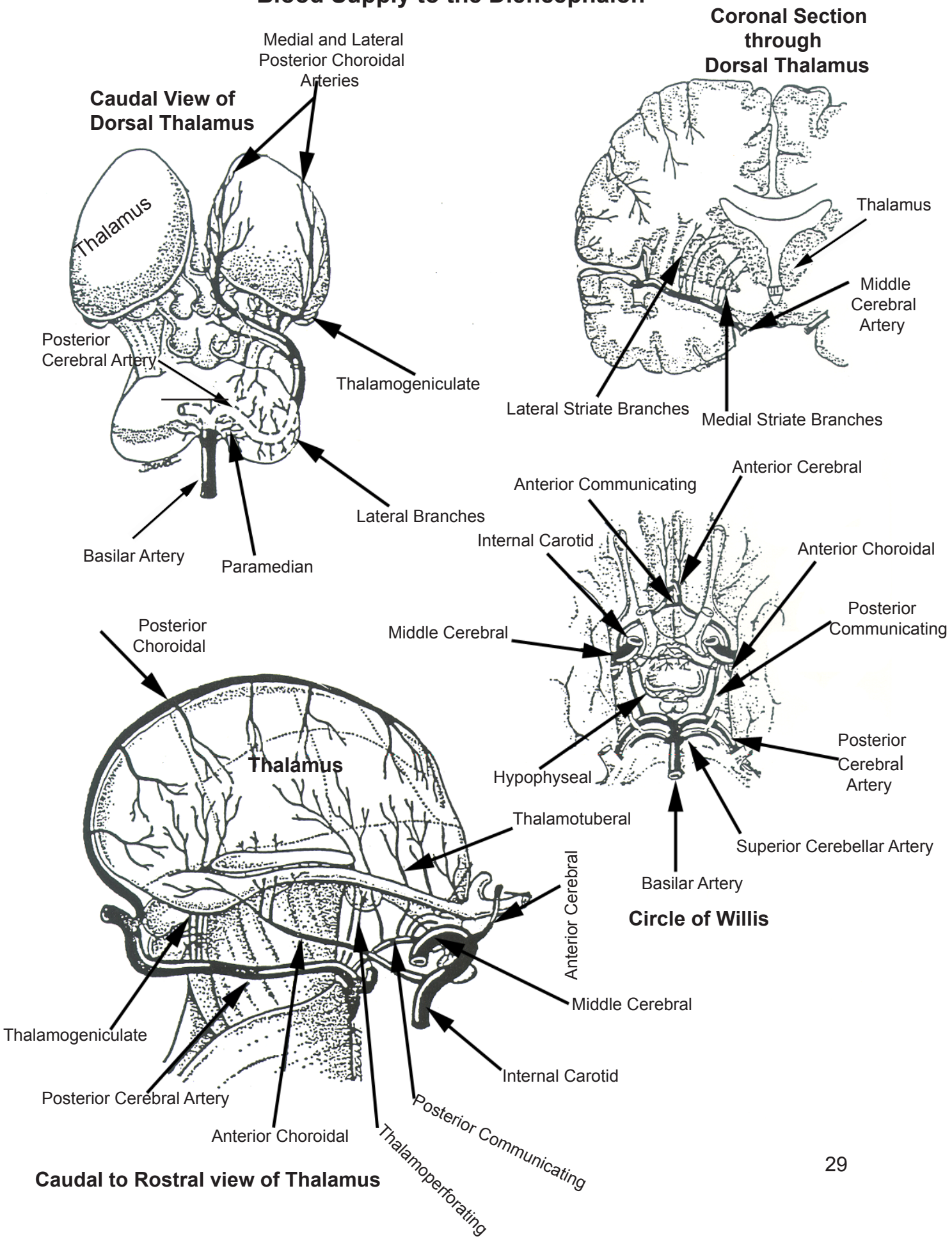
**Pinealomas** are **tumors** with large numbers of pinealocytes, this decreases gonadal function and results in **delayed puberty**.

A lesion to the pineal gland would cause a **loss of pineal cells** and result in **precocious puberty**.

An **expanding pineal tumor** may compress the pretectal region and superior colliculi which would produce **fixed, dilated pupils** and **paralysis of upward gaze**.

**After puberty**, calcareous deposits called **"brain sand"** (which are a by-product of secretory activity) are present in the pineal gland. This allows for the pineal to be seen on a radiogram and is **used as a midline marker by radiologists**.

# Blood Supply to the Diencephalon



## Blood Supply to Diencephalon

Blood supply to the diencephalon is from the middle and posterior cerebral arteries which branch into **medial** and l**ateral posterior choroidal arteries** to supply the dorsal thalamus.

The **Hypothalamus** is supplied by branches of the **circle of Willis** and **posterior cerebral artery.**
**Anterior** hypothalamus – central branches of **anterior communicating artery, anterior cerebral artery,** proximal part of **posterior communicating artery**
**Caudal** and **Ventral** hypothalamus– from **posterior communicating artery**, **posterior cerebral artery**

**Clinical Aspects:** **Thalamic Syndrome** is a **vascular lesion** in the thalamus -usually in the **VPL or VPM** and can involve the posterior limb of the internal capsule. Symptoms include a **loss of sensation on the contralateral side**. As **recovery** occurs, **pain** is very **diffuse** and can be constant (on the **contralateral body**), or if patient is touched with a wisp of cotton , it is perceived as very painful.

The **blood supply** to the **internal capsule** is from the **lateral striate arteries** which are branches of the middle cerebral artery. A **lesion** in the **posterior limb of the internal capsule** produces an **upper motor lesion of the contralateral body** (hemiplegia), and sometimes with partial sensory loss.