

## Introduction to the Central Nervous System: Internal Structure

### Objective

- To understand, in general terms, the internal organization of the brain and spinal cord.
- To understand the 3-dimensional organization of several major deep structures (striatum, hippocampal formation and fornix, lateral ventricle) and cortical gyri  
NTA Ch 3, pgs. 61-82  
Key Figs: 3-3; 3-4; 3-6 to 3-8; 3-12; 3-13  
Table 3-1

As in lab one, all topics covered in this lab will be revisited in later labs, when we consider the functional organization of the different neural systems.

### Lab resources

- Brain slices, models, and whole brains

### Self evaluation

- Be able to identify all structures listed in key terms and describe briefly their principal functions
- Use neuroanatomy on the web to test your understanding

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### List of media

#### **Clastrum (movie)**

The claustrum is a gray matter structure located beneath the insular cortex. While it has connections with the cerebral cortex, its function is not know. The extreme and external capsules are two white matter regions that are located lateral and medial to the claustrum, respectively.

Key:

Clastrum=aqua

Insuar cortex=yellow

## **chorplex Choroid plexus (movie)**

The choroid plexus are intraventricular organs that produce cerebrospinal fluid (CSF). The choroid plexus in the lateral ventricle has a C-shaped configuration, as does the ventricle.

What is the “hole” in the third ventricle?

Key:

choroid plexus=red

fornix=white

third and fourth ventricles=aqua

hippocampal formation=purple

anterior commissure=gray

## **chorplexhippothal Choroid plexus, ventricles, and others (movie)**

Note the pre- and postcommissural fornix.

Key:

choroid plexus=red

fornix=white

third and fourth ventricles=aqua

hippocampal formation=purple

anterior commissure and corpus callosum=gray

thalamus and rest of brain=brown

accumbcaudput Striatum Key:

Caudate nucleus and putamen=green

Nucleus accumbens=yellow

amygdhiptrans Amygdala, caudate, and hippocampus Key:

Caudate nucleus=green

Amygdala=red

Hippocampal formation=purple

Anterior commissure=white

Ventricular system=aqua

## **SA-1 Medial brain surface**

Review the structures that can be seen on the medial surface of the cerebral hemisphere of the hemisected brain (NTA Fig. I-4). Locate the four major lobes of the brain in this medial view. Identify the 3 major subdivisions of the corpus callosum. (The 4<sup>th</sup>, the rostrum, is not present.) Inferior to the corpus callosum lies the third ventricle. The lateral walls of this single central cavity are composed of diencephalic structures, primarily the thalamus. The two thalami may be connected with one another in the midline by the thalamic adhesion or massa intermedia. (The thalamic adhesion is present in about 80% of human brains, but it is not present on this brain.) A bundle of fibers (fornix) passes dorsal to the thalamus and inferior to the corpus callosum and appears to be “connected” to the corpus callosum

anteriorly by the membranous septum pellucidum. Look for the interventricular foramen (the actual opening can not be seen in this view), the opening of the lateral ventricle into the third ventricle, just posterior and dorsal to the anterior commissure.

Identify the following structures surrounding the third ventricle: anteriorly is the anterior commissure; inferiorly the optic chiasm, and mammillary bodies; posteriorly the posterior commissure and the pineal gland. Follow the cerebral aqueduct (aqueduct of Sylvius) caudally into the fourth ventricle.

### **IS-1 Coronal, head of caudate nucleus**

Identify the genu of the corpus callosum. Identify the radiations of the corpus callosum. What is the function of these fibers in this region of the brain? In this same section also find the cingulate sulcus, the cingulate gyrus (including the cortex and the underlying association fibers). Lateral to the head of the caudate nucleus identify the anterior limb of the internal capsule and the putamen. Lateral to the putamen find the external capsule, the claustrum, the extreme capsule, and the insular cortex in that order.

### **IS-2 Coronal, anterior commissure**

Progressing caudally, two new major structures to identify are the anterior commissure and the globus pallidus. Continue to follow the structures identified in previous brain sections. To understand the three-dimensional extent of the anterior commissure note its position in the hemisected brain and follow it in subsequent coronal sections. What portion of the internal capsule is shown in this drawing?

### **IS-3 Coronal, mid thalamus and subthalamus**

Identify the internal capsule. What portion is shown on this drawing? (Hint: this is a drawing of a slice through the thalamus.) Identify the thalamus and caudate nucleus, which are medial to the internal capsule, and the putamen and globus pallidus, which are lateral. In the temporal lobe, identify the amygdala and hippocampal formation. Find the body and inferior horn of the lateral ventricle. Note that the space under the fornix is continuous with the subarachnoid space and not part of the ventricular system.

### **IS-4 Coronal, posterior thalamus**

Identify the internal capsule. What portion is shown on this drawing? Identify the lateral and medial geniculate nuclei. What are their functions? Note that this is a coronal slice through the diencephalon and telencephalon, but a longitudinal slice through the brain stem.

### **IS-5 Horizontal**

First identify the anterior limb, genu, and posterior limb of the internal capsule, and next, the caudate, putamen, and thalamus (shown with several component nuclei). Try to approximate the levels of the coronal slices shown up till now (slides IS 1-4). Note that only slices through the thalamus cut through the posterior limb of the internal capsule. What portion of the corpus callosum is shown in this drawing?

## **X-5 Spinal cord**

This image contains views of 4 levels of the spinal cord. This is an example of a myelin-stained section: myelinated tracts stain black and nuclear regions stain gray. Note that there are also myelin-stained axons within the gray matter.

First locate the cervical, thoracic, lumbar, and sacral segment on the slide.

Next identify the following features of the general organization of the spinal cord:

1. central region=gray matter; contains mostly neuronal cell bodies
2. surrounding region=white matter; contains mostly myelinated axons

## **X-10 Spinal cord-medulla junction**

In this and the following 5 images, which are all myelin-stained sections through the brain stem, identify key structures, some of which are specific to the level shown and others are common to several/all levels. Identify these structures common to all brain stem levels:

- descending cortical fibers (pyramidal decussation)
- ventricular system (region of central canal; not labeled – can be seen at higher magnification only)

## **X-15 Caudal medulla**

Identify structures common to all brain stem levels:

- ventricular system (central canal)
- medial lemniscus
- descending cortical fibers (pyramids)

Identify structures specific to the medulla:

- dorsal column nuclei and tracts
- olive (Inferior olivary nuclei)

## **X-20 Rostral medulla**

Identify structures common to all brain stem levels:

- ventricular system (IVth ventricle)
- medial lemniscus
- descending cortical fibers (pyramids)

Identify structures specific to the medulla:

- various cranial nerve nuclei - eg., V, VIII, X, XII
- inferior cerebellar peduncle
- inferior olivary nucleus (olive)
- reticular formation

## **X-30 Pons, at level of facial colliculus**

Identify structures common to all brain stem levels:

- ventricular system (IVth ventricle)
- medial lemniscus
- descending cortical fibers (corticospinal and corticobulbar fibers)

Identify structures specific to the pons:

- Facial nerve genu and abducens nucleus (facial colliculus)
- pontine nuclei
- deep cerebellar nuclei
- middle cerebellar peduncle
- reticular formation

#### **X-40 Midbrain, at level of inferior colliculus**

Identify structures common to all brain stem levels:

- ventricular system (cerebral aqueduct)
- medial lemniscus
- descending cortical fibers

Identify structures specific to the midbrain:

- inferior colliculus
- substantia nigra
- superior cerebellar peduncle (decussation)

#### **X-45 Midbrain, at level of superior colliculus**

Identify structures common to all brain stem levels:

- ventricular system (cerebral aqueduct)
- medial lemniscus
- descending cortical fibers (basis pedunculi)

Identify structures specific to the midbrain:

- IIIrd nerve fascicles exiting to interpeduncular fossa
- superior colliculus
- substantia nigra
- red nucleus

#### **X-120 Horizontal section through the thalamus.**

Contrast this myelin-stained section through the thalamus and internal capsule with that shown in image IS05. While there are many subtle differences, for now just focus on the thalamus, caudate nucleus (head and tail; Where is the BODY?), putamen, globus pallidus (don't worry for now that there are two components), and the three parts of the internal capsule.

## Key Structures and Terms

### SPINAL CORD:

Gray matter/white matter  
Dorsal horn; ventral horn  
Dorsal column; ventral column;  
lateral column

### BRAINSTEM:

Pyramids (descending cortical fibers)  
Pyramidal decussation  
Medial lemniscus  
Dorsal column nuclei and tracts  
Olives  
IVth ventricle, central canal, and cerebral aqueduct  
Cerebellar peduncle  
Facial colliculus (facial nerve genu and abducens nucleus)  
Pontine nuclei  
Inferior and superior colliculi  
Substantia nigra  
Red nucleus  
IIIrd nerve fascicles exiting to interpeduncular fossa  
Basis Pedunculi

### CEREBELLUM:

Deep cerebellar nuclei

### DIENCEPHALON:

Thalamus:  
Thalamic adhesion\*  
Pulvinar  
Optic Radiation  
Hypothalamus:  
Infundibulum \*  
Mammillary Bodies\*  
Subthalamic Nucleus  
Pineal Gland

### TELENCEPHALON:

Corpus Callosum:  
Splenum  
Body  
Genu  
Ventricles:  
Third Ventricle

Fourth Ventricle  
Inter-ventricular Foramen (of Monro)\*  
Lateral Ventricle\*\*  
Anterior Horn  
Body  
Collateral Trigone (Atrium)  
Inferior (temporal) Horn  
Posterior (occipital) Horn  
Septum Pellucidum  
Anterior Commissure\*  
Basal Ganglia  
Caudate Nucleus\*\*  
Putamen\*\*  
Globus Pallidus\*\*  
Amygdala\*  
Clastrum  
Extreme Capsule  
External Capsule  
Internal Capsule:  
Anterior Limb  
Posterior Limb  
Genu

\*Important landmark for recognizing planes of sections.

\*\*Important structure with complex three dimensional shape. Appreciation of the shape is also important for recognizing planes of sections.