Lab 3 Gross and Intrinsic Anatomy of the Medulla B. Puder, Ph.D.

Objectives:
At the completion of this lab, you should be able to:

1. **Identify the gross structures of the medulla**
2. **Identify the intrinsic structures of the medulla**
3. **Describe the signs/symptoms in a patient with a lesion to the ALS, PC/ML, voluntary motor pathway, cranial nerve nuclei.**

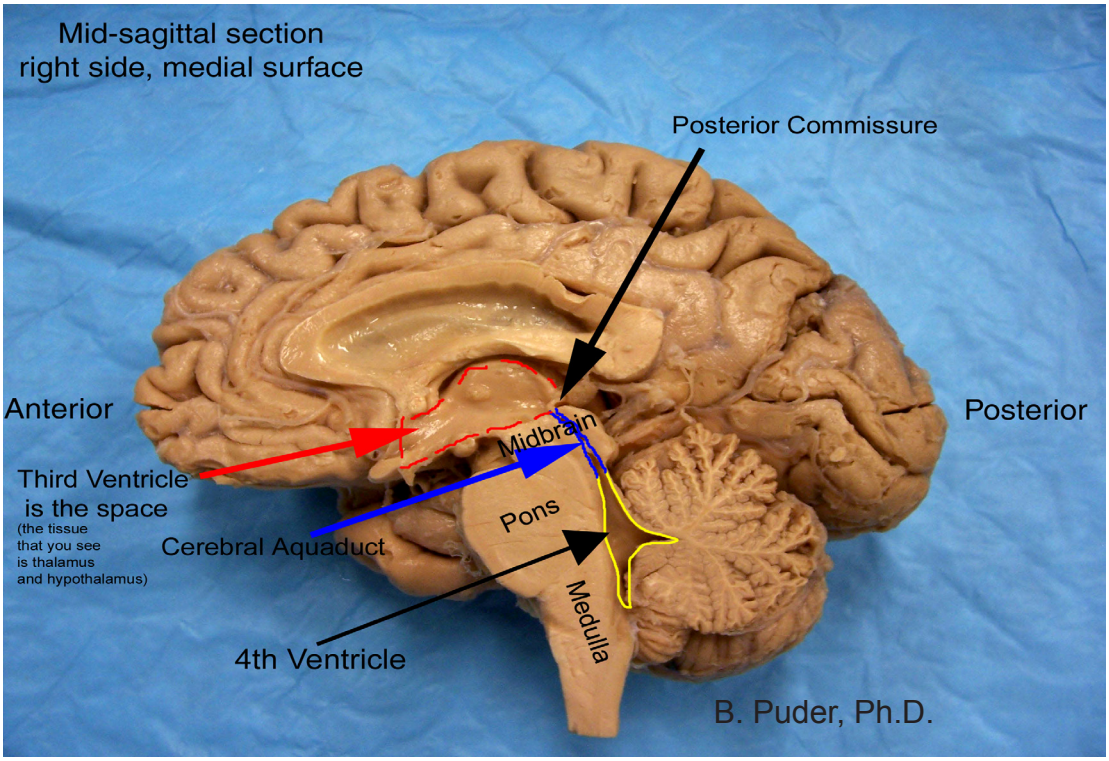
Gross Anatomy of the Medulla

Materials needed:

Whole and half brain specimens, lab atlas and lab manual

The ***medulla*** is the most caudal portion of the ***brainstem***. The medulla begins at the level of the foramen magnum at the exit point of the rootlets of the first cervical spinal nerve, and it extends rostralward to the inferior border of the middle cerebellar peduncle. At the level of the **spinal cord-medulla** transition, there are several structural changes which occur. The central canal of the spinal cord enlarges into the **fourth ventricle** in the **medulla**. Many of the long ascending and descending nerve tracts of the spinal cord change their anatomical positions in the neural axis with respect to one another. There is the appearance of numerous nuclei and other structures which give the **medulla** its characteristic morphology.

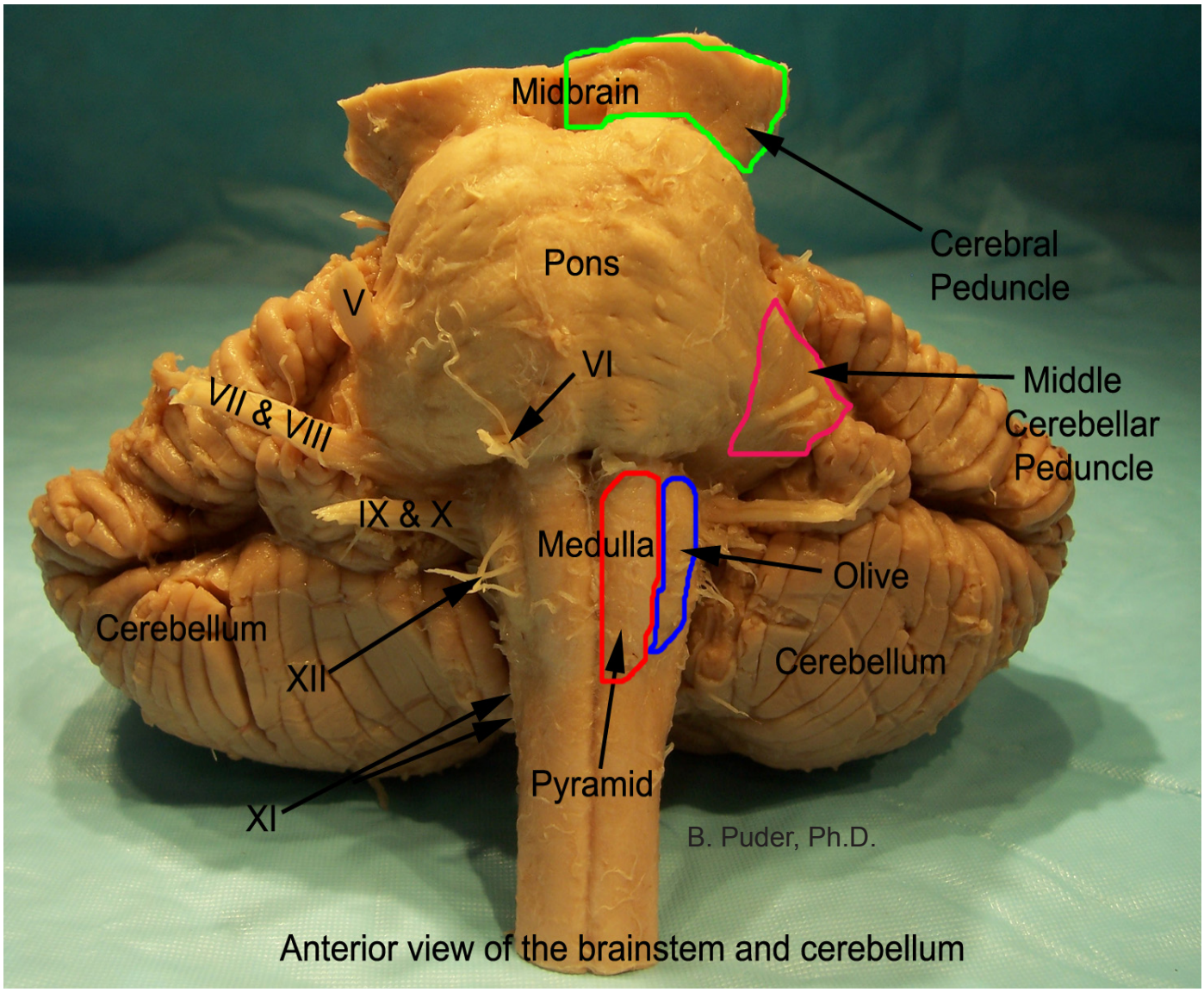
With respect to the ***fourth ventricle***, note that it is continuous above the ***pons*** with the ***cerebral aqueduct***. The lateral aperatures (of Luschka.) and the median aperature (of Magendie) permit the cerebrospinal fluid to pass from the **ventricular system** into the subarachnoid space. The lateral aperatures exit at the junction between the medulla and pons and course under the cerebellum. The median aperature lies between the nodule of the vermis of the cerebellum and the obex of the medulla. The median aperature will probably have been destroyed in your specimen by the removal of the overlying cerebellum or the sagittal sectioning of the brainstem.



Identify the followinng structures on the gross medulla specimen:
Anterior median fissure. Note that this fissure is interrupted by small bundles of nerve fibers crossing the midline at the level of the spinal cord-medulla junction. These fibers will form the corticospinal tract (lateral) of the spinal cord. This area is referred to as the motor decussation.

Pyramids (paired structures) are located on the anterior surface and consist of the corticospinal tracts.

Olives are located on the lateral surface. The ***olives*** are surface projections which contain the underlying inferior olivary nucleus. This structure is related to the motor system and the cerebellum and will be discussed later.
On the posterior surface, the fasciculus gracilis and fasciculus cuneatus of the posterior columns of the spinal cord continue into the dorsal medulla. The axons of fasciculus gracilis and cuneatus will synapse on the nuclei gracilus and cuneatus respectively. The gracilus and cuneatus nuclei are within the ***gracile and cuneate tubercles*** which can be seen on the posterior aspect of the medulla. The v-shaped edge of the caudal extent of the fourth ventricle is referred to as the obex.



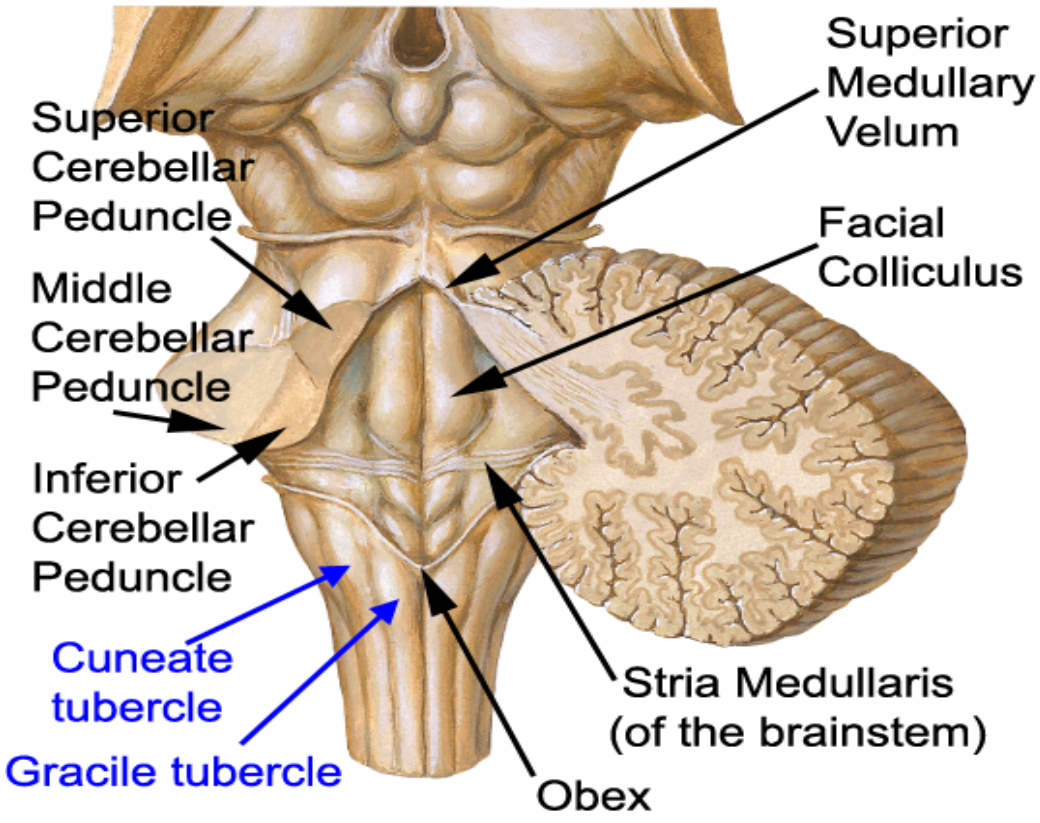
Cranial nerves
The rootlets of the accessory, vagus and glossopharyngeal nerves emerge from the medulla just dorsal to the **olive**. The ***rootlets of the hypoglossal nerve*** emerge along the ventral lateral sulcus between the ***pyramid*** and the ***olive.*** The rootlets of the glossopharyngeal and vagus nerves cannot be identified with certainty in these preparations. The most rostral few constitute the glossopharyngeal rootlets, the remainder, the vagus rootlets.

The ***vestibulocochlear*** and ***facial nerves*** exit from the ***brainstem*** at the junction between the ***pons*** and the ***medulla***. The ***facial nerve*** is the more medial of the two and has two roots--a motor and sensory; the motor root is the larger and the more medial of the two.

The ***abducens nerve*** exits from the brainstem ventrally at the level of the pons-medulla junction. The ***abducens nerve*** has a rather long and clinically important course. It courses forward between the clivus (bone at base of skull) and the ***pons*** and enters a sleeve of dura referred to as Dorello's canal. It then passes forward and, in company with several other cranial nerves, passes in the lateral wall of the cavernous sinus, and enters the orbit through the superior orbital fissure. Because of the long complex course of this nerve it is frequently injured in head trauma.

Examine the floor of the ***fourth ventricle*** at approximately the level of the ***vestibulocochlear nerve.*** Many specimens will show a group of transverse fibers crossing the floor of the **fourth ventricle** which are referred to as the ***striae medullaris.*** These fibers mark the rostral extent of the ***medulla*** on the dorsal surface. Their function is related to the motor system.

On the mid-sagittal section of the ***brainstem*** on the half brain specimen observe the roof of the ***fourth ventricle*** between the ***cerebellum*** and ***medulla.*** This thin, transparent portion of the meninges is referred to as the inferior (posterior) medullary velum. In life it is invaginated by blood vessels and forms part of the choroid plexus of the fourth ventricle.



Intrinsic Morphology of the Medulla
Materials required: Digital images of the 4 myelin stained medulla transverse sections, lab atlas and lab manual.

It is common to refer to four classical levels in the medulla oblongata where significant changes occur. These are:

1. Level of the Pyramidal (Motor) Decussation (most caudal)
2. Level of the Sensory Decussation
3. Level of the Vagus Nerve
4. Level of the Nerves VIII and IX (most rostral)

Caudal Medulla - Level of the Motor Decussation

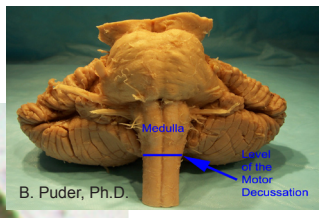
Identify the following nuclei and tracts in this section:
Motor (pyramidal) decussation - Corticospinal axons of descending upper motor neurons have been descending within the pyramids. At the decussation, these axons cross over to the contralateral side and change names to be the lateral corticospinal tracts in the lateral funiculus of the spinal cord.

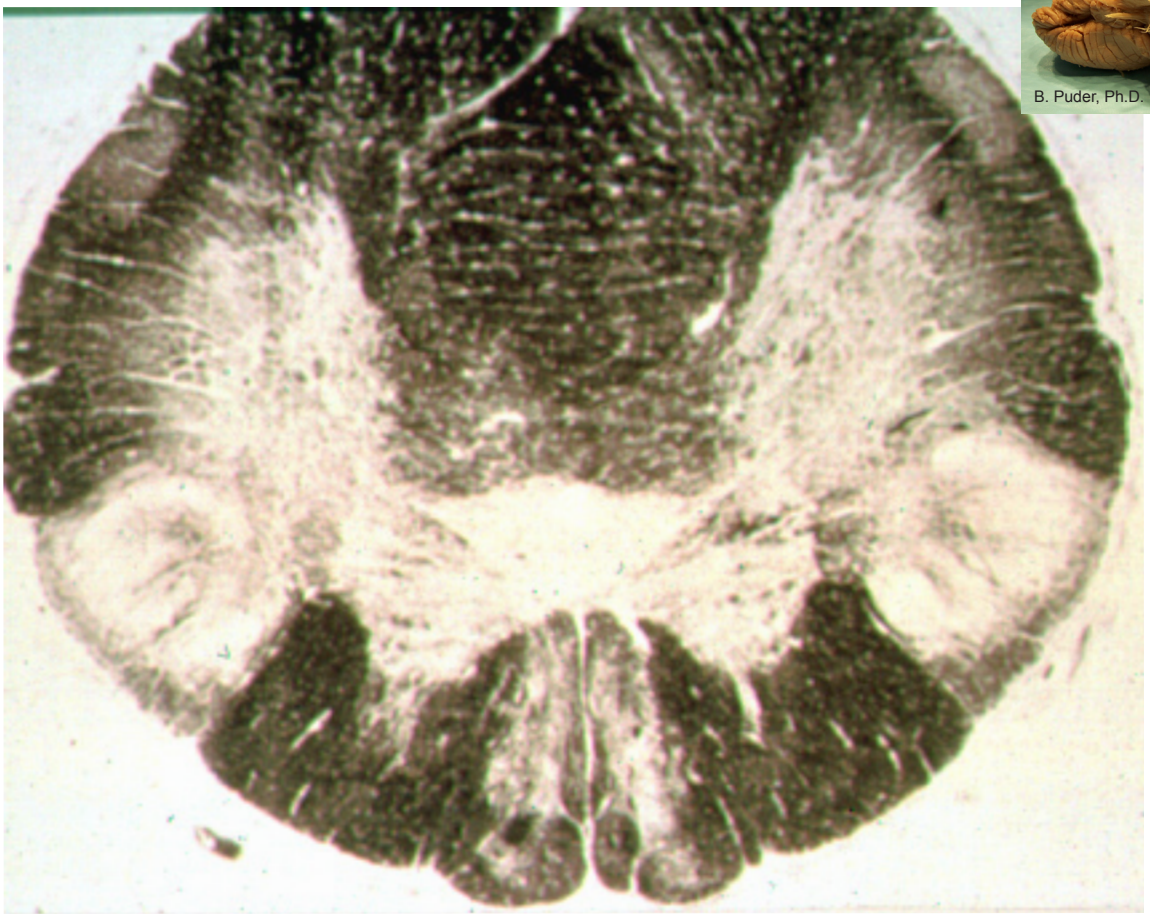
The substantia gelatinosa and posterolateral fasciculus (Lissauer) structures are overlapped by the ***spinal nucleus*** **and the** ***spinal tract of the trigeminal nerve*** which carry sensation from the ipsilateral face.
Spinal trigeminal tract - axons relaying sensory information (pain and temperature)from the face
Spinal trigeminal nucleus - cell bodies: The spinal trigeminal tract axons will synapse upon the spinal trigeminal nucleus and pain and temp information from the face will decussate and be relayed to thalamus and cortical areas.

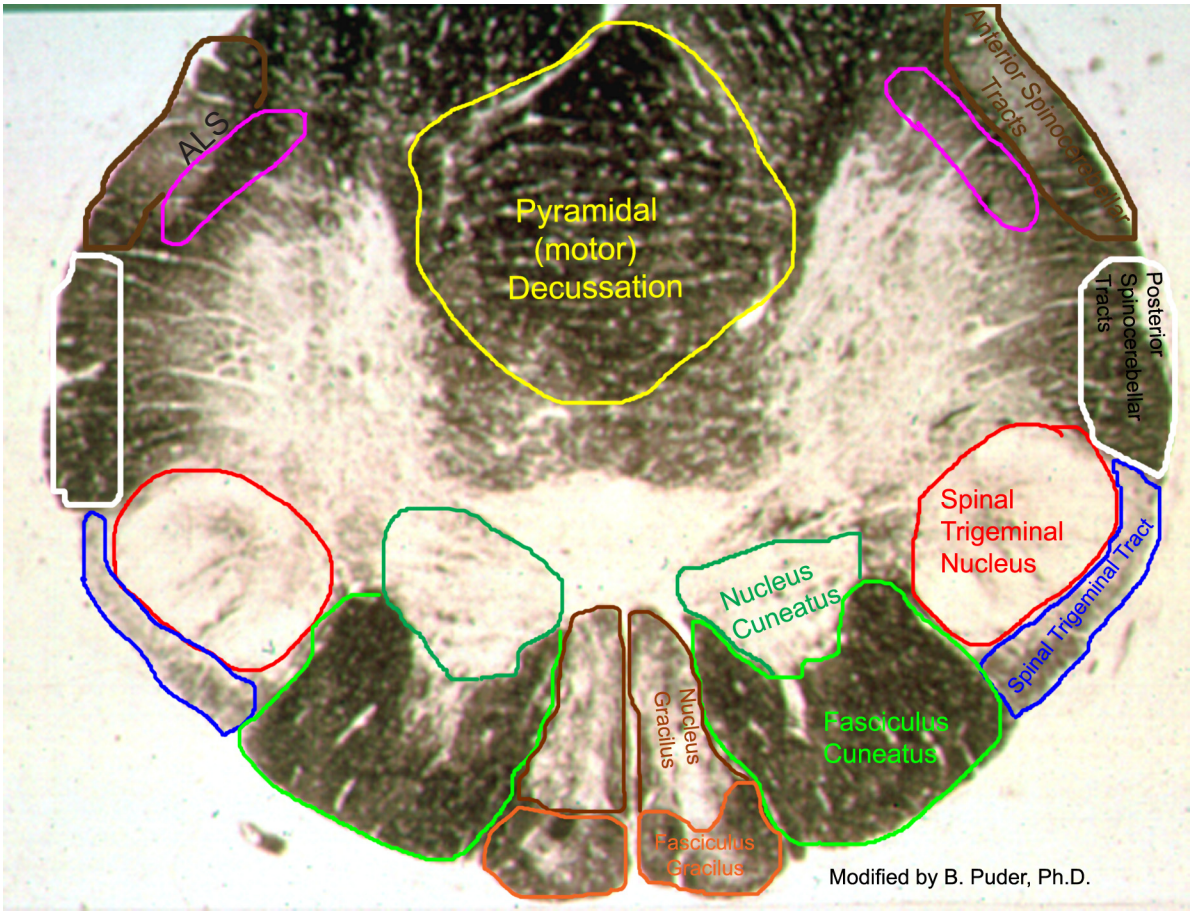
Previous structures (seen in the spinal cord):
Fasciculus cuneatus - sensory axons relaying tactile,vibratory sense from the upper half or the body
Fasciculus gracilus - sensory axons relaying tactile, vibratory sense from the lower half of the body
Note: Nucleus cuneatus and nucleus gracilus are beginning to become visible in this section, but will be seen more prominently in the next section.
ALS - Anterolateral system - contains the spinothalamic axons that are relaying pain and temp information from the contralateral body to the thalamus
Anterior & Posterior spinocerebellar tracts - relay muscle proprioceptive information to cerebellum

As you identify these nuclei and tracts, discuss what would happen if one of these nuclei or tracts was lesioned. What signs,symptoms would you see in the patient? Would these signs/ symptoms be ipsilateral or contralateral to the lesion?

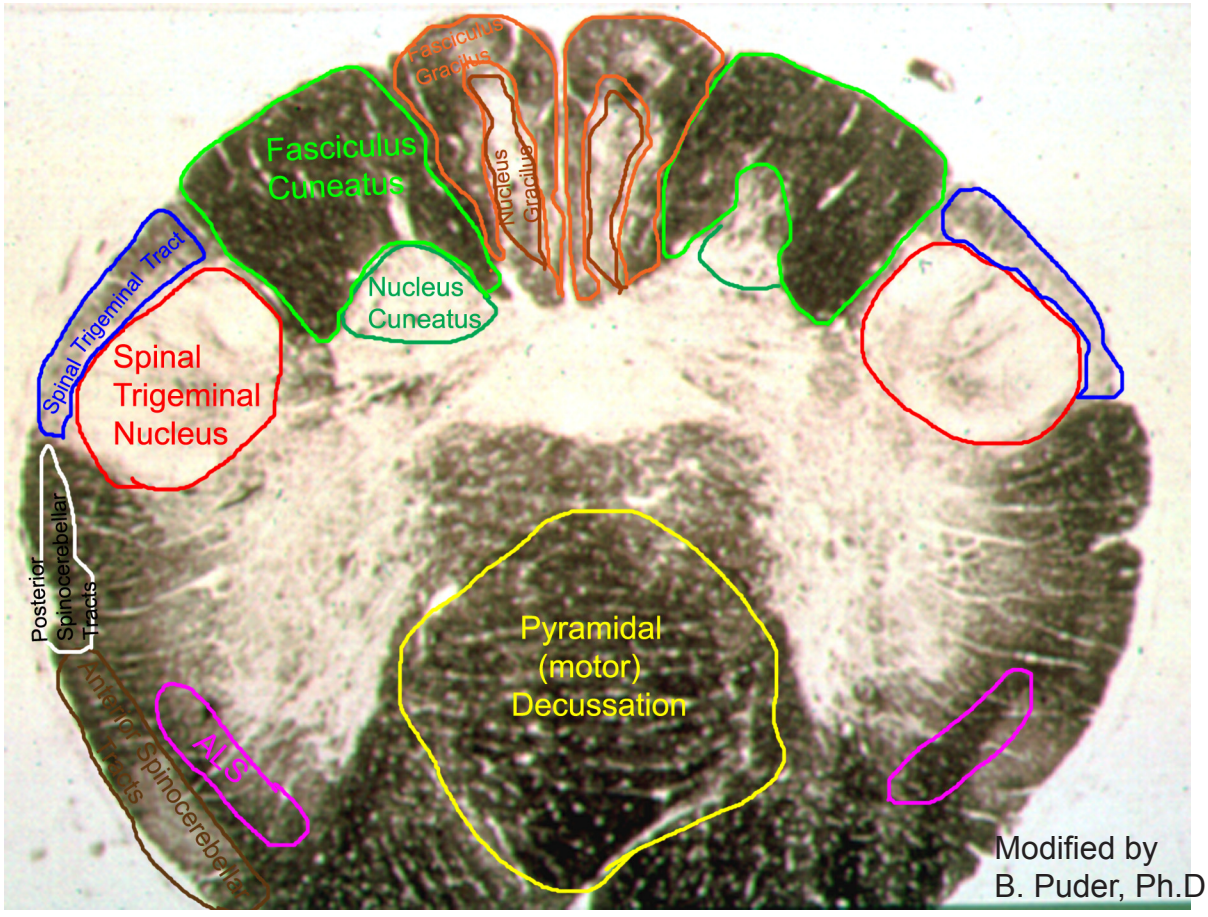
Caudal Medulla
Level of the
Motor Decussation
Clinical Orientation







Caudal Medulla
Level of the
Motor Decussation
Anatomical Orientation



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Caudal Medulla - Level of the Sensory Decussation

A section slightly more rostral (**Level of Sensory Decussation**) shows several morphological changes. ***Fasciculus gracilis*** (axons of the first order neuron carrying tactile,vibratory sensation from the lower half of the body) will synapse on the ***nucleus gracilis*** (cell bodies of the 2nd order neuron), and ***fasciculus cuneatus*** (axons of the 1st order neuron carrying tactile,vibratory snesation from the upper half of the body) will synapse on the ***nucleus cuneatus***. The axons of the cells of the ***nuclei gracilis and cuneatus*** sweep ventrally as the ***internal arcuate fibers*** (sensory decussation), cross the midline and turn rostralward forming the ***medial lemniscus.***

Identify the following structures on this section:

New Structures at this level:

Nucleus Cuneatus and Nucleus Gracilus - cell bodies whose axons will travel through as the ***Internal Arcuate Fibers*** and cross to the contralateral side and then the axons change their name to ***medial lemniscus*****.** This is an ascending tract carrying tactile, vibratory sensation from the body to the cortex

Pyramids **-** corticospinal axons are descending through here

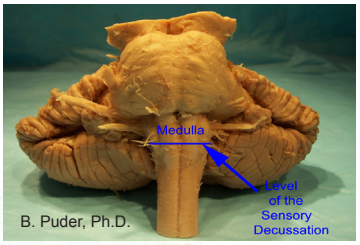
Previous Structures:

Spinal Trigeminal Tract and Nucleus

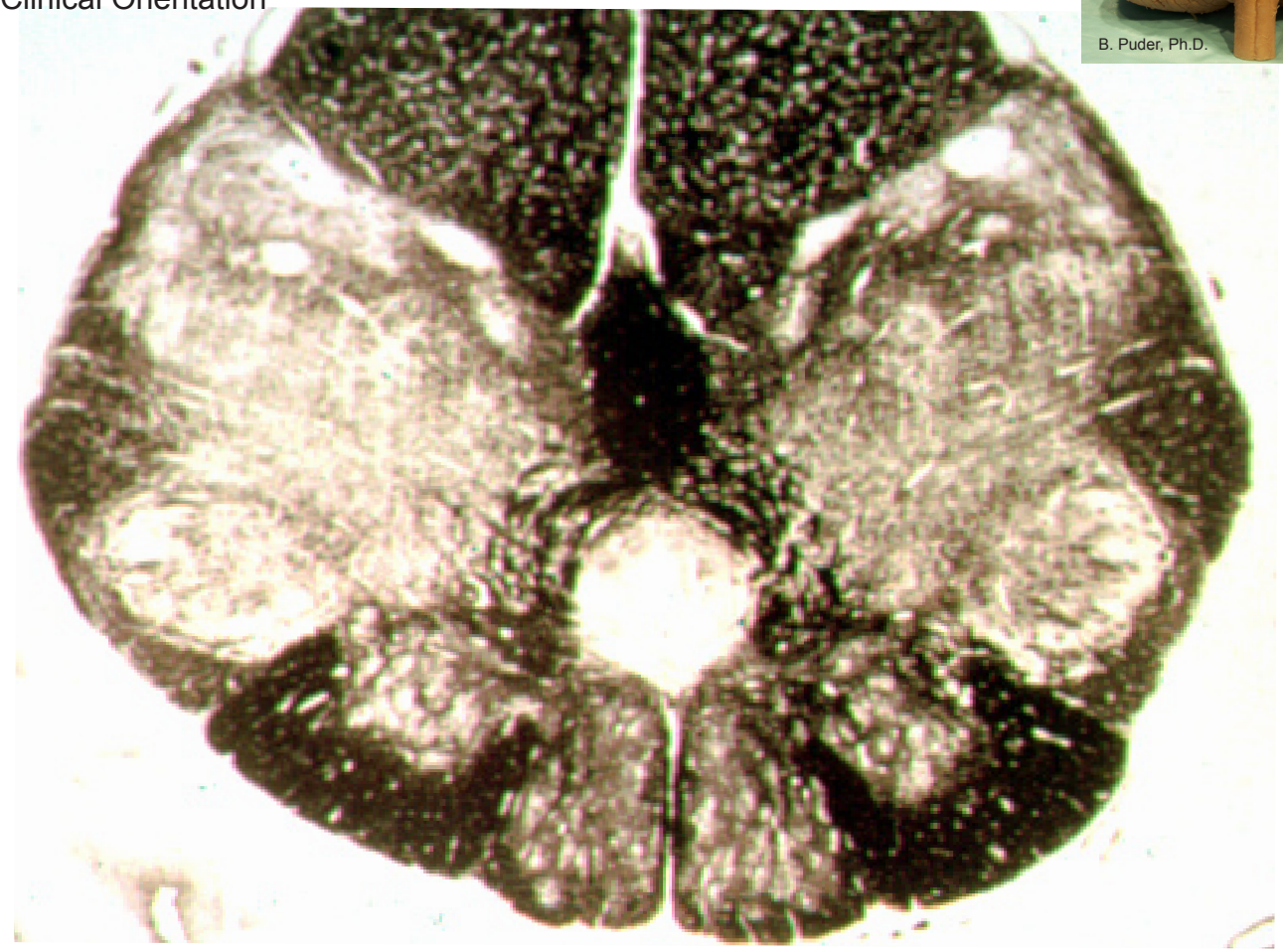
Anterior and Posterior Spinocerebellar tracts

ALS - anterolateral system

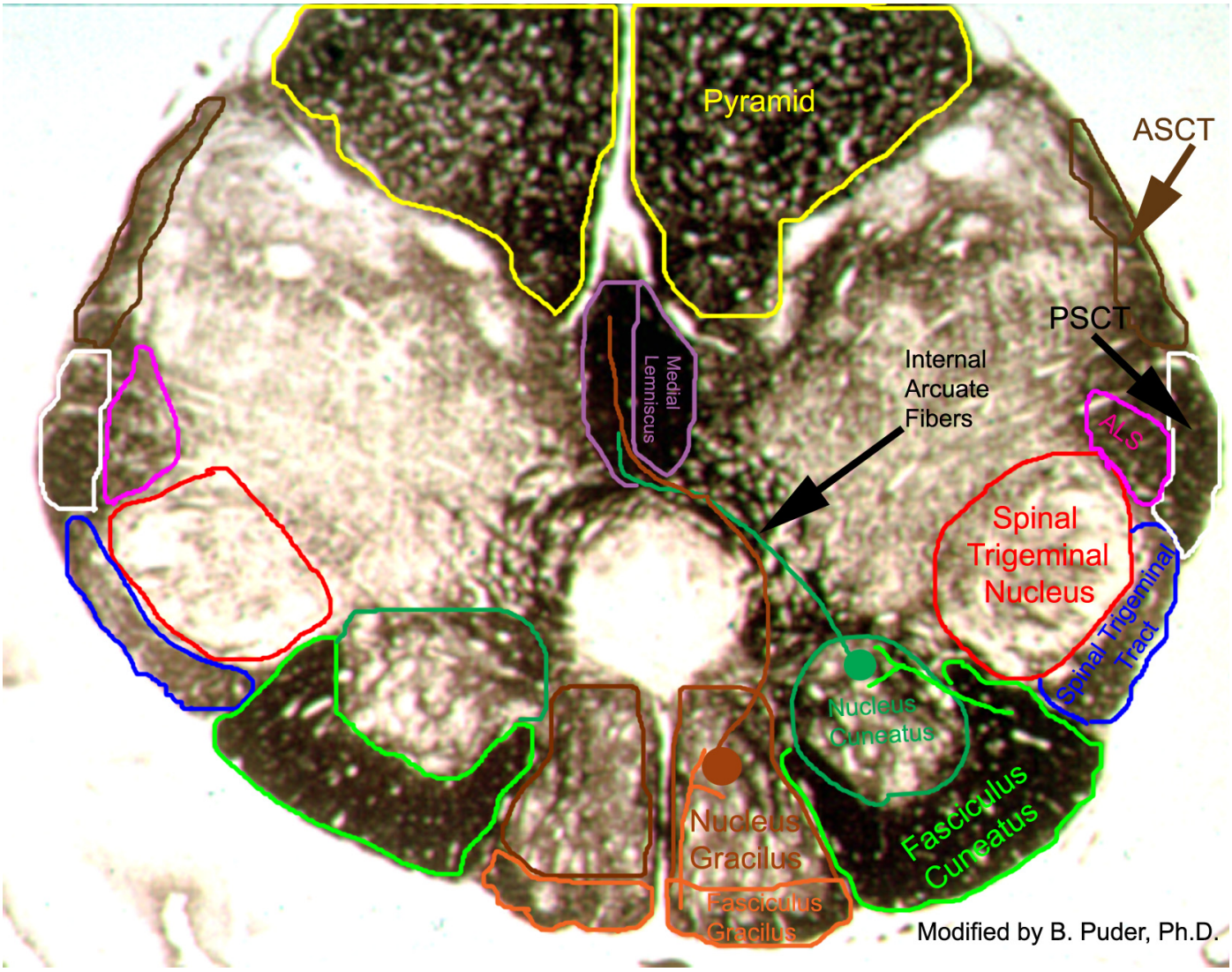
As you identify these nuclei and tracts, discuss what would happen if one of these nuclei or tracts was lesioned. What signs,symptoms would you see in the patient? Would these signs/ symptoms be ipsilateral or contralateral to the lesion?



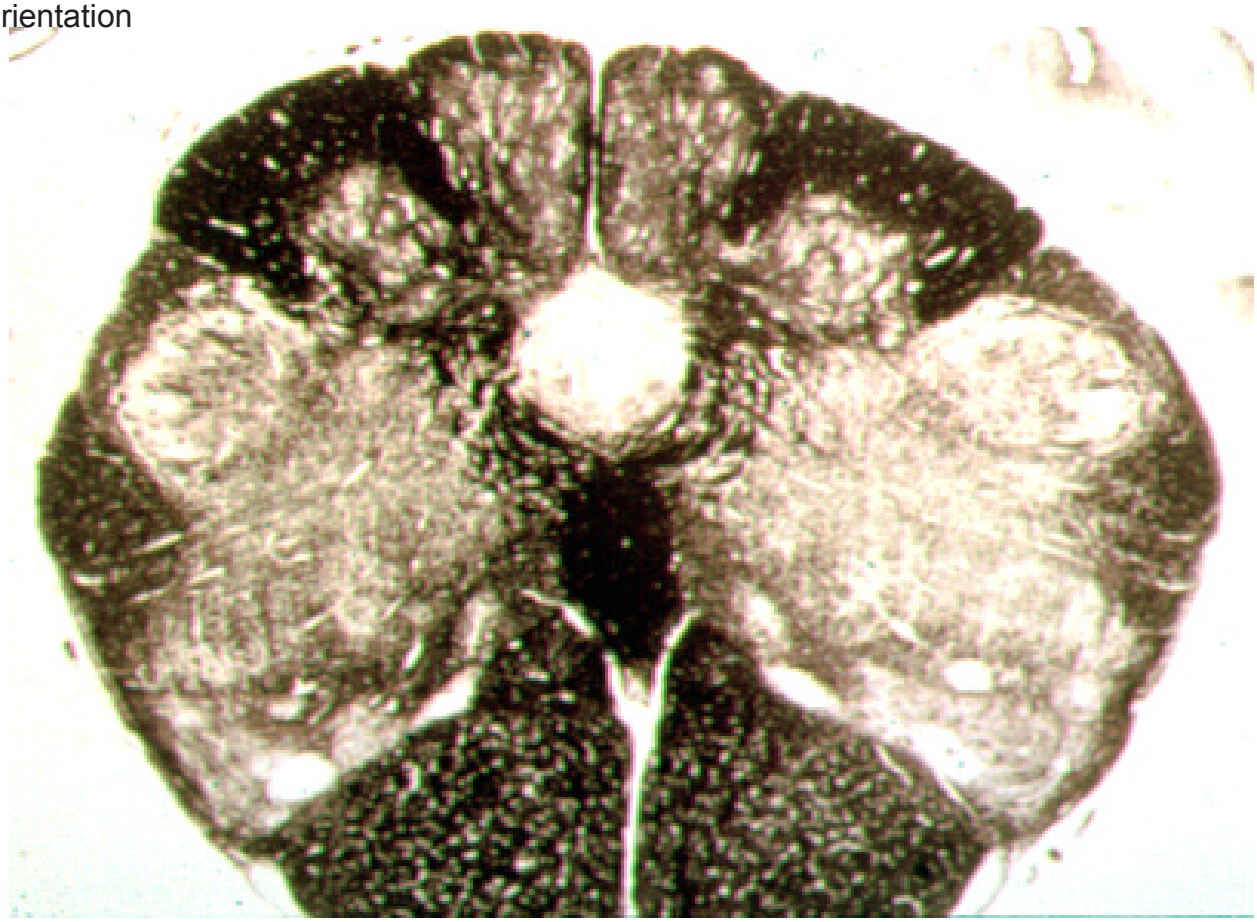
Caudal Medulla
Level of the
Sensory Decussation
Clinical Orientation

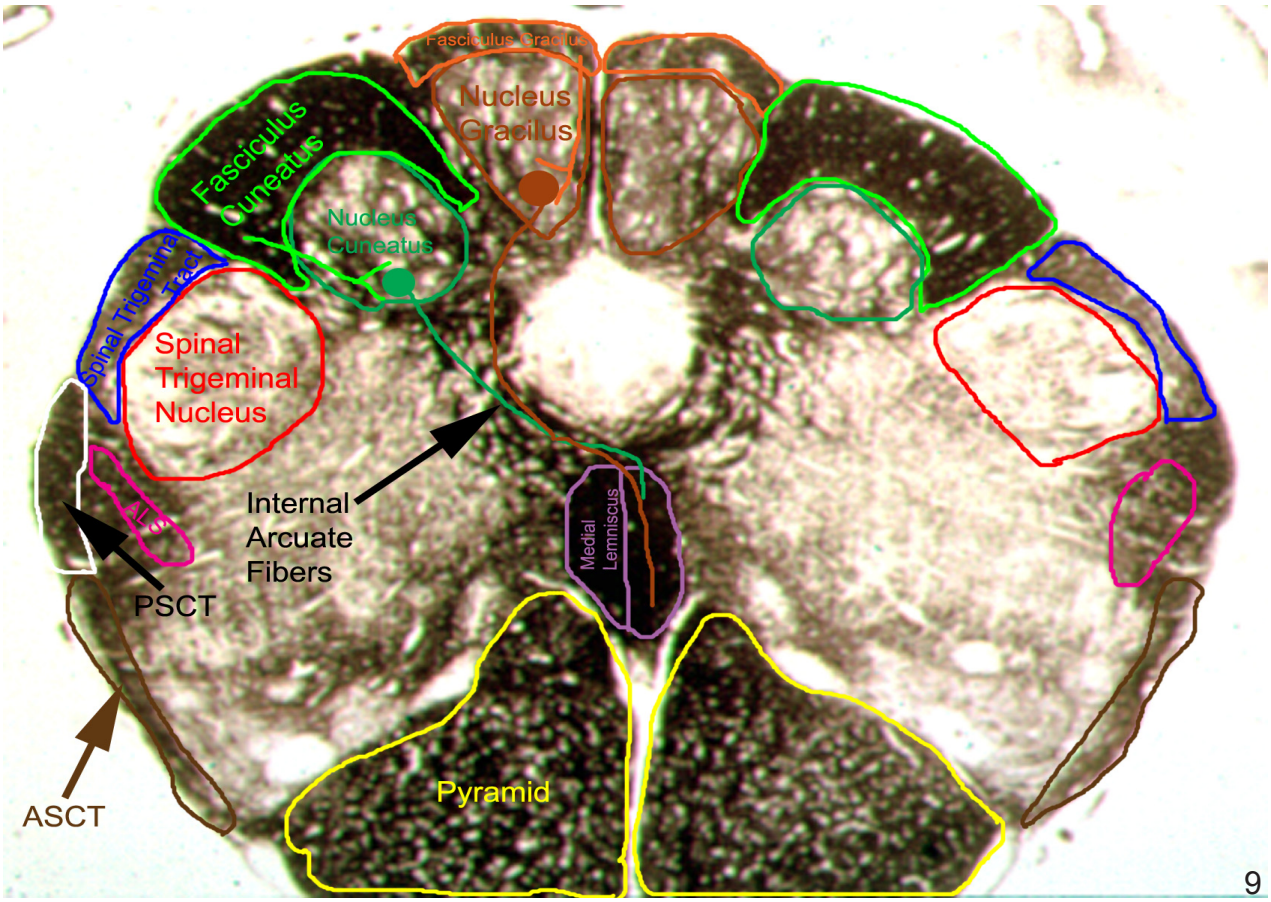


Caudal Medulla
Level of the
Sensory Decussation
Labeled
Clinical Orientation



Caudal Medulla
Level of the
Sensory Decussation
Anatomical Orientation





At about mid-medulla is the **Level of the Vagus (nerve X)**, which shows the beginning of the **fourth ventricle** posteriorly.

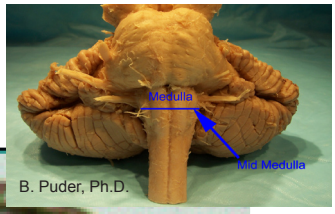
Identify the following structures:
New Structures at this level:
Hypoglossal nucleus - cell bodies of CN XII that innervate the ipsilateral tongue muscles
Hypoglossal nerves - Notice how the hypoglossal nerve exits between the pyramid and olive.
Dorsal Motor nucleus of the Vagus - Preganglionic parasympathetic cell bodies for CN X
Solitary nucleus and solitary tract (center) - receives sensory input from CN VII, IX & X
MLF - medial longitudinal fasciculus - long axonal tract that coordinates eye movements
NA - nucleus ambiguus - Cell bodies of the part of CN IX & X whose axons innervate larynx and pharynx muscles
Inferior cerebellar peduncle - the axons that were in the posterior spinocerebellar tract are now in the inferior cerebellar peduncle and will enter the cerebellum. Embedded in the inferior cerebellar peduncle is the accessory (lateral) cuneate nucleus. This nucleus is homologous in morphology and function to the dorsal nucleus (of Clarke) of the spinal cord.

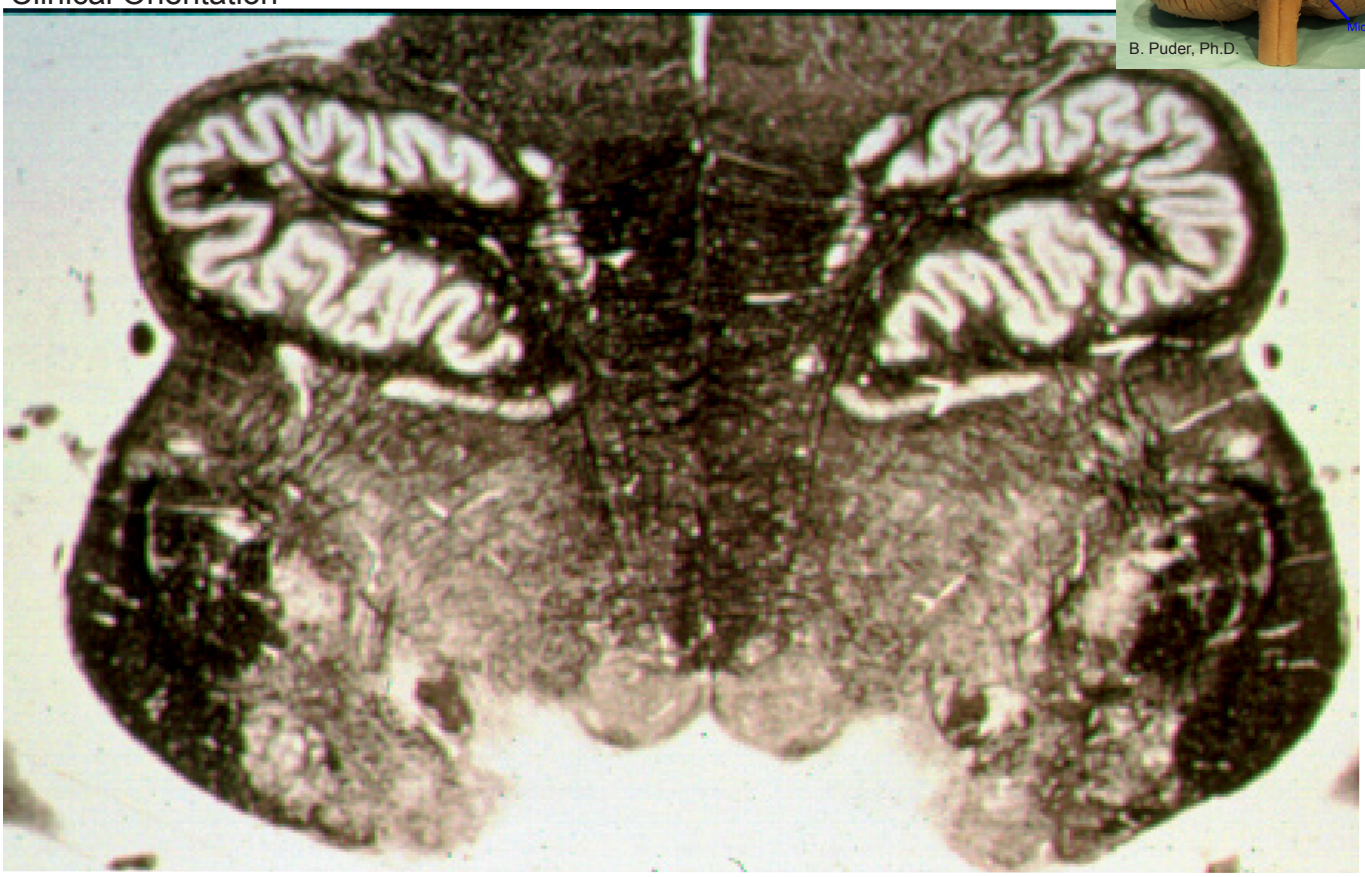
Inferior Olivary nucleus - cell bodies here receive information from several sources and its axons project to the cerebellum

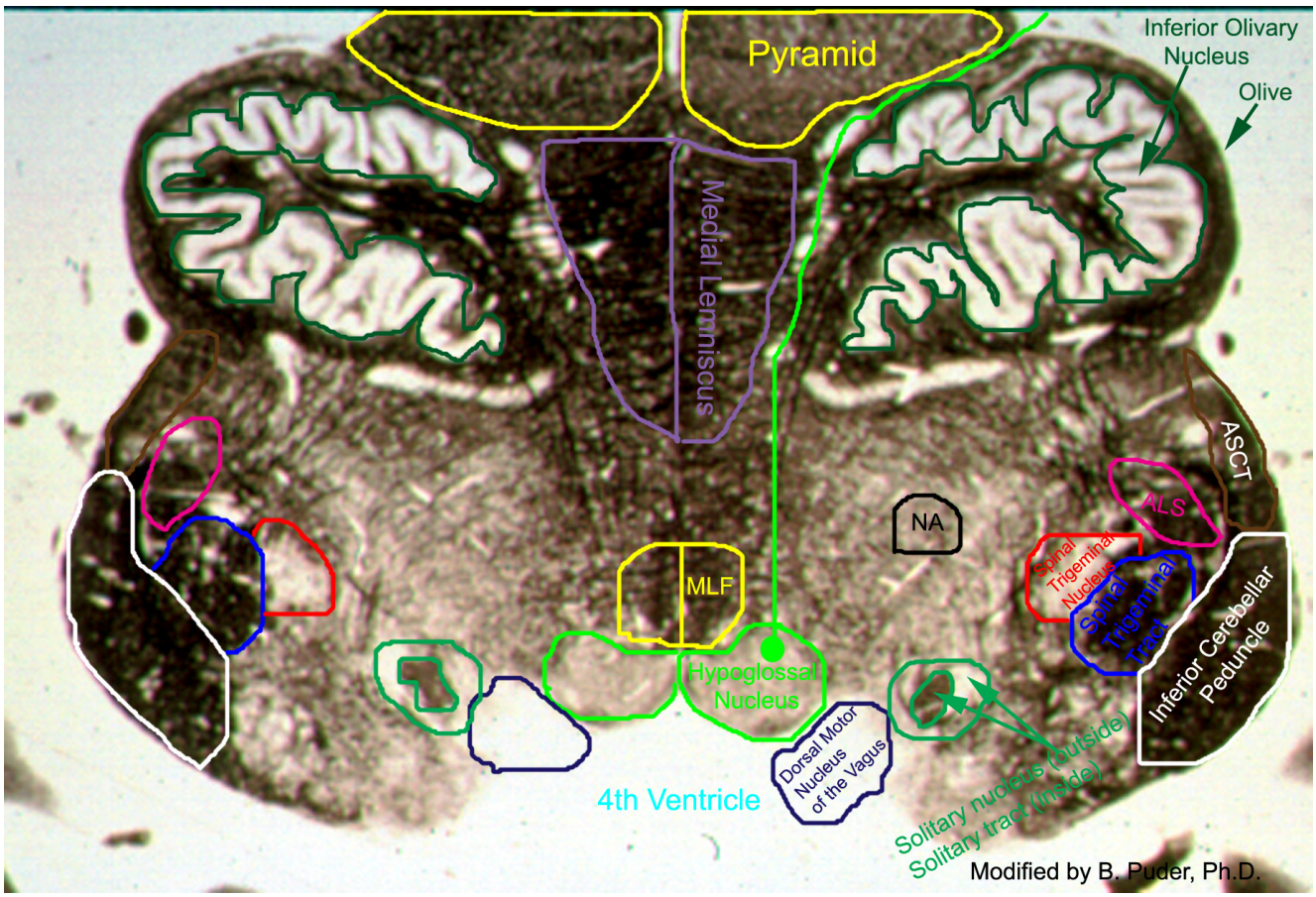
Previous structures :
Spinal trigeminal nucleus and tract
Anterolateral system
Anterior spinocerebellar tract
Medial Lemniscus
Pyramids

As you identify these nuclei and tracts, discuss what would happen if one of these nuclei or tracts was lesioned. What signs,symptoms would you see in the patient? Would these signs/ symptoms be ipsilateral or contralateral to the lesion?

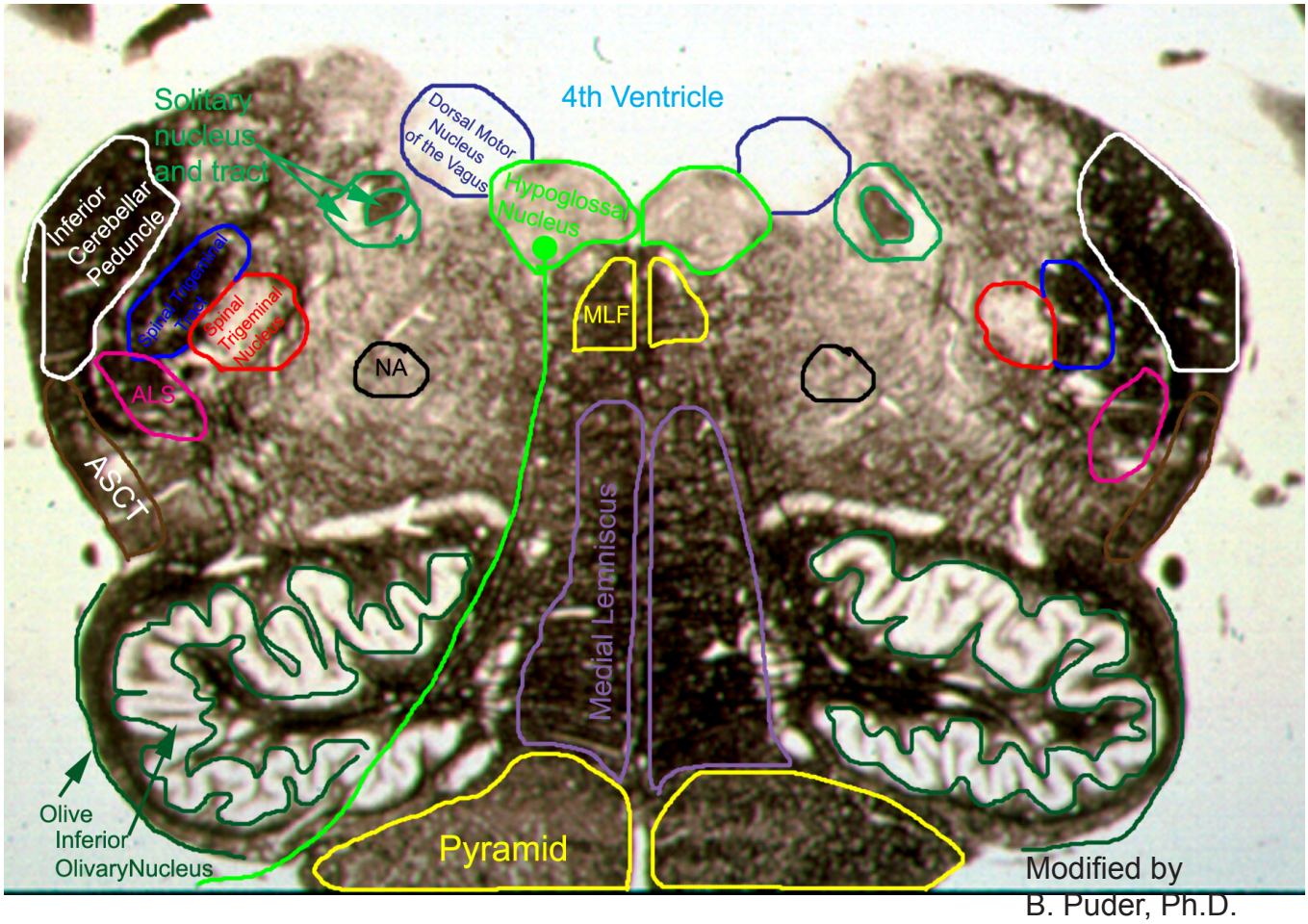
Mid Medulla
Level of Cranial nerve nuclei
IX, X, and XII
Clinical Orientation







Mid Medulla
Level of Cranial nerve nuclei
IX, X, and XII
Anatomical Orientation



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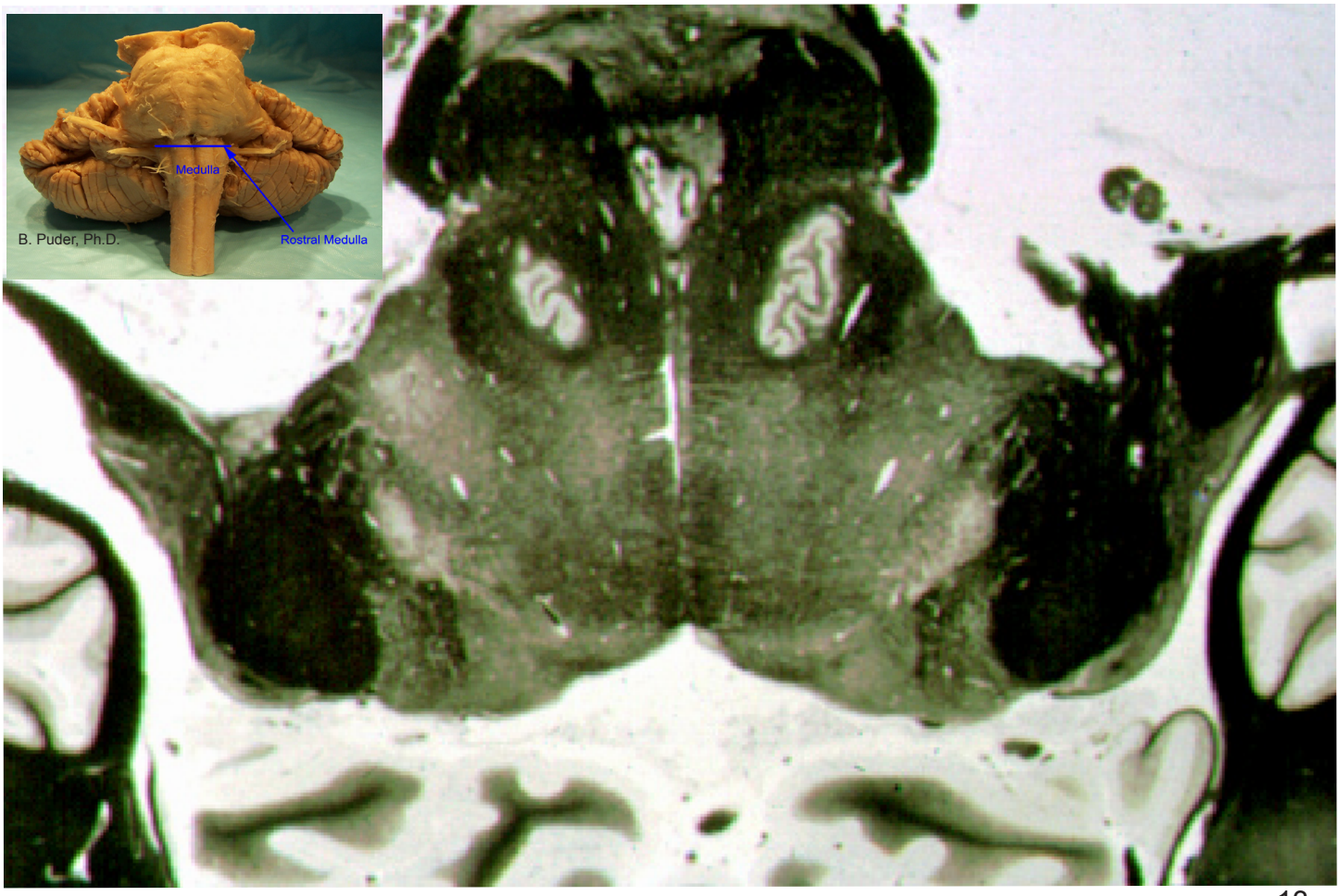
At the **rostal level of the medulla,** the **Level of Nerves VIII and IX**, note that the dorsal motor nucleus of the vagus and the hypoglossal nucleus are no longer present.

Identify the following structures:
New Structures on this section:
Inferior and Medial Vestibular nuclei - cell bodies that are part of CN VIII vestibular portion
Dorsal and ventral cochlear nuclei - cell bodies that are part of CN VIII auditory portion

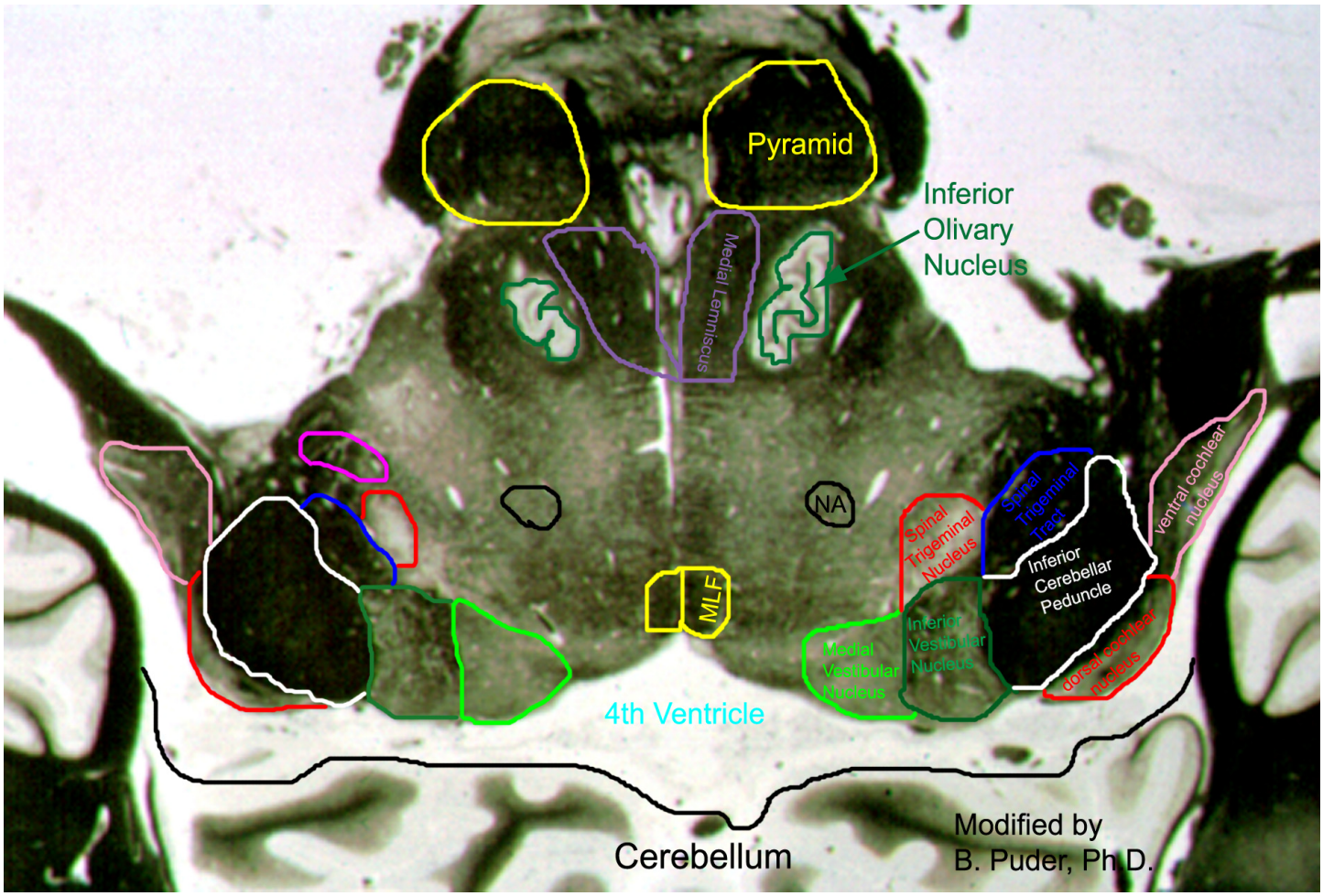
Structures from previous sections:
MLF, medial longitudinal fasciculus
Spinal trigeminal nucleus and tract
NA, Nucleus ambiguus
ALS, anterolateral system
Inferior cerebellar peduncle
Anterior spinocerebellar tract
Inferior Olivary nucleus
Pyramids
Medial Lemniscus

As you identify these nuclei and tracts, discuss what would happen if one of these nuclei or tracts was lesioned. What signs,symptoms would you see in the patient? Would these signs/ symptoms be ipsilateral or contralateral to the lesion?

Rostral Medulla
Level of Cranial nerve nuclei IX and VIII
Clinical Orientation



Rostral Medulla
Level of Cranial nerve nuclei IX and VIII
Labeled
Clinical Orientation



Rostral Medulla
Level of Cranial nerve nuclei IX and VIII
Anatomical Orientation