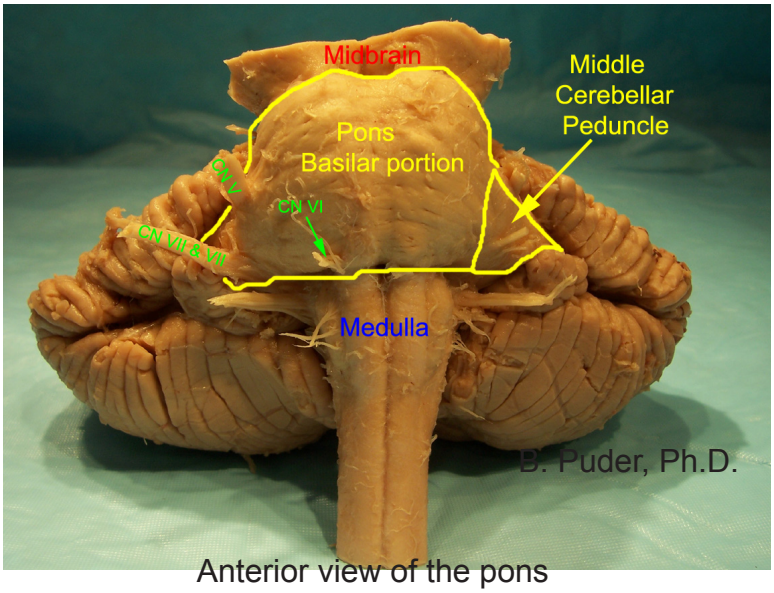
Objectives:
At the completion of this lab, you should be able to:

1. **Identify the gross structures of the pons**
2. **Identify the intrinsic structures of the pons**
3. **Describe the signs/symptoms you will see in patients with lesions to the ALS, PC/ML, voluntary motor pathway, and cranial nerve nuclei. Or if given the signs/symptoms, be able to describe/identify the location of the lesion in the pons**

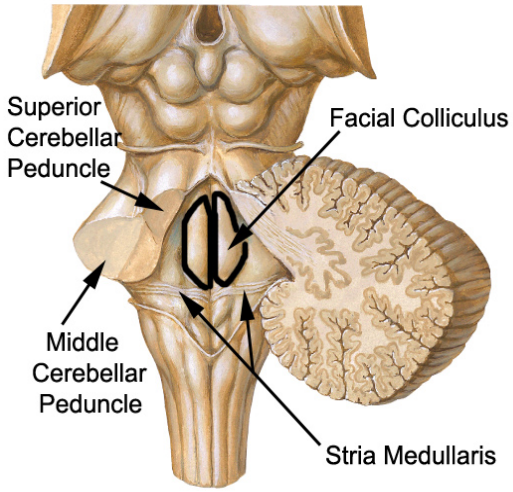
Gross Anatomy of the Pons

Materials required: Gross brainstem specimens, atlas, lab manual

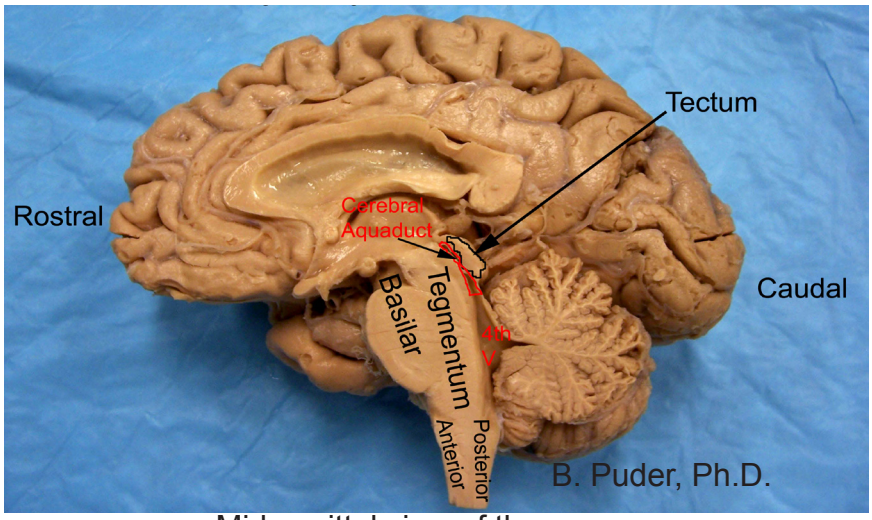
The major external morphological characteristic of the ***pons*** is the large ***middle cerebellar peduncle*** which forms the base of the pons. The tegmentum of the pons lies between the base of the pons and the floor of the ***fourth ventricle*** and contains the majority of the nuclei and fiber tracts passing through the pons. Examine the floor of the fourth ventricle and note that it is associated with the pons, and most of the medulla. Note that the floor of the fourth ventricle is rhomboid shaped, thus its designation as the rhomboid fossa. From a dorsal veiw, the ***striae medullaris*** marks the medulla-pons boundary. The ***middle and superior cerebellar peduncles*** can also be seen from the posterior aspect of the **pons** (if you remove the cerebellum so that you can see the posterior aspect of the pons.
Please don't actually do this to the brainstem specimens.)



Anterior view of the pons



Posterior view of the pons



Mid sagittal view of the pons

Intrinsic Morphology of the Pons

Materials required: 3 classic myelin stained transverse sections of the pons, lab manual and lab atlas

As described previously for the medulla, several classical levels can be identified in the pons. Two are most notable:

1. Lower pons, level of cranial nerves VI and VII
2. Mid-upper pons, level of cranial nerve V
3. A third level could be described as rostral pons where the locus ceruleus is evident.

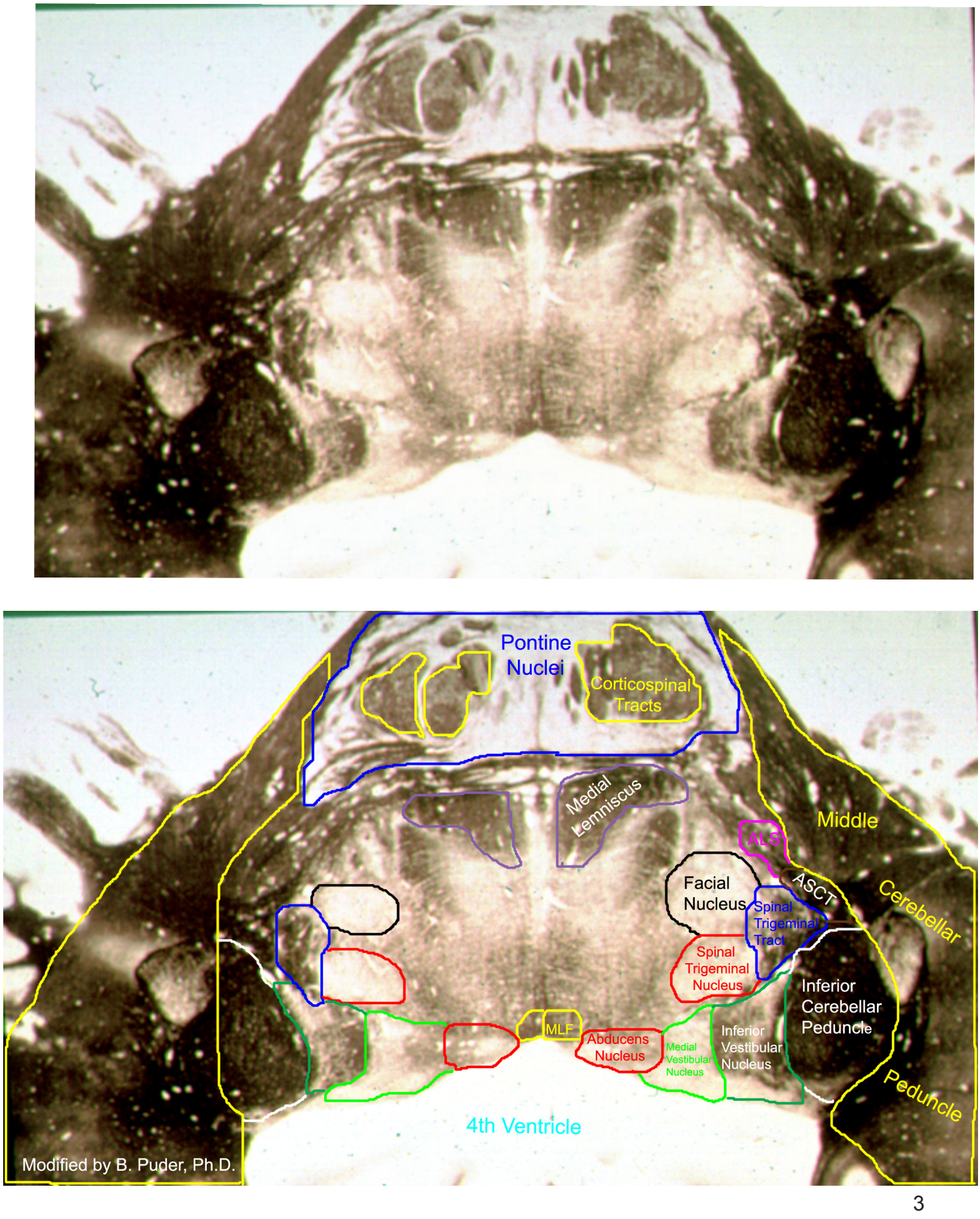
1. Lower Pons - level of cranial nerve nuclei VI and VII

Study a section of the brainstem at the level of the medulla-pons boundary.
Notice that the most caudal portion of the ***middle cerebellar peduncle*** is continuous with the white matter of the cerebellum.
The fibers of the ***medial lemniscus*** are shifting their orientation from a anterior-posterior to a medial-lateral position.
The ***inferior cerebellar peduncle*** at this level is medial to the ***middle cerebellar peduncle***.
The ***spinal trigeminal tract and nucleus*** are medial to the ***inferior cerebellar peduncle.***
The ***corticospinal fibers*** are broken up into many small fascicles as they pass through the base of the pons.
Within the base of the pons, you will see clusters of cells (gray matter) which are the ***pontine nuclei*****,** and the transverse fibers in the base of the pons are the ***pontocerebellar tracts.***
The ***inferior olivary nucleus***, which was so prominent in the ***medulla,*** is barely vbisible in this section.

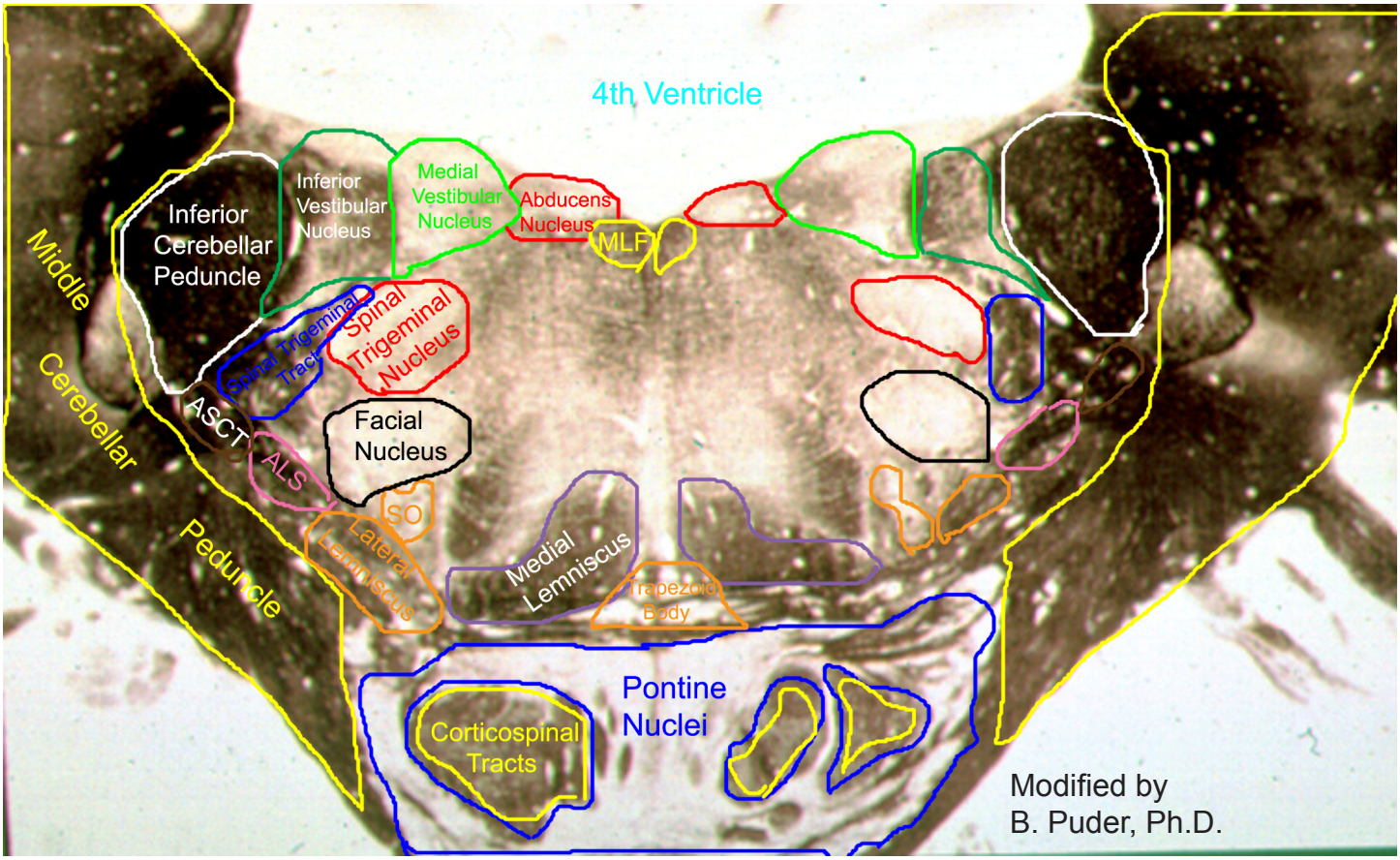
Identify the following items on this section
New Structures in this section:
Abducens nucleus - cell bodies of CN VI whose axons will innervate the lateral rectus extraocular muscle
Facial nucleus - cell bodies of CN VII whose axons will innervate the ipsilateral facial expression muscles
Middle Cerebellar peduncle - axons from various locations entering the cerebellum
Pontine nuclei - cell bodies, some of the axons will project into the cerebellum via the middle cerebellar peduncle
Corticospinal tracts - axons of upper motor cortical neurons that will descend into the medullary pyramids

Previous structures:
Medial Lemniscus - this tract is starting to bend laterally
ALS
ASCT
Inferior cerebellar peduncle
Spinal trigeminal nucleus and tract
MLF
Medial and Inferior Vestibular nuclei
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 Pons
Clinical Orientation



Caudal Pons
Anatomical Orientation



Mid level Pons
Examine a section through the pons at the Level of the Nuclei and Roots of the Trigeminal Nerve. The nuclei associated with the facial and abducens nerves are not present at this level. With these exceptions most of the structures listed for the lower pons level can be identified and, in addition, three new structures appear at this level. The spinal nucleus and tract of the trigeminal nerve are replaced at this level by the ***chief sensory trigeminal nucleus*** and the ***trigeminal motor nucleus***. Your sections may show the root fibers of the trigeminal nerve passing between these two nuclei. The ***mesencephalic nucleus*** is medial to the superior cerebellar peduncles.

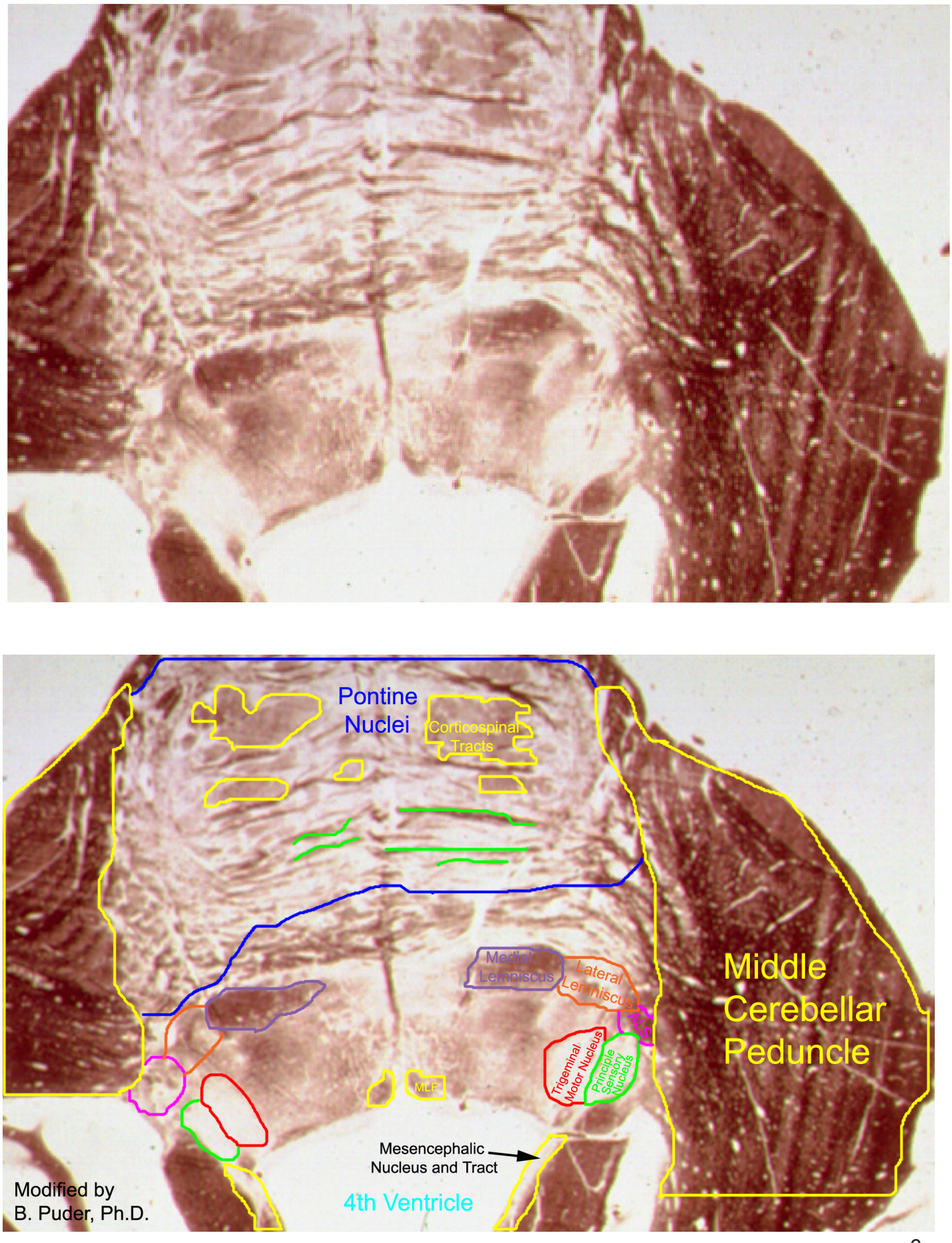
Identify the following nuclei and tracts on this section.

New Structures in this section:
Trigeminal motor nucleus - Cell bodies whose axons will innervate the muscles of mastication
Principal sensory nucleus - Cell bodies receiving tactile, vibratory sense from the face
Mesencephalic nucleus and tract - pseudounipolar neurons relaying proprioceptive information from the mastication muscles
Transverse fibers in the pontine nuclei represent pontocerebellar fibers

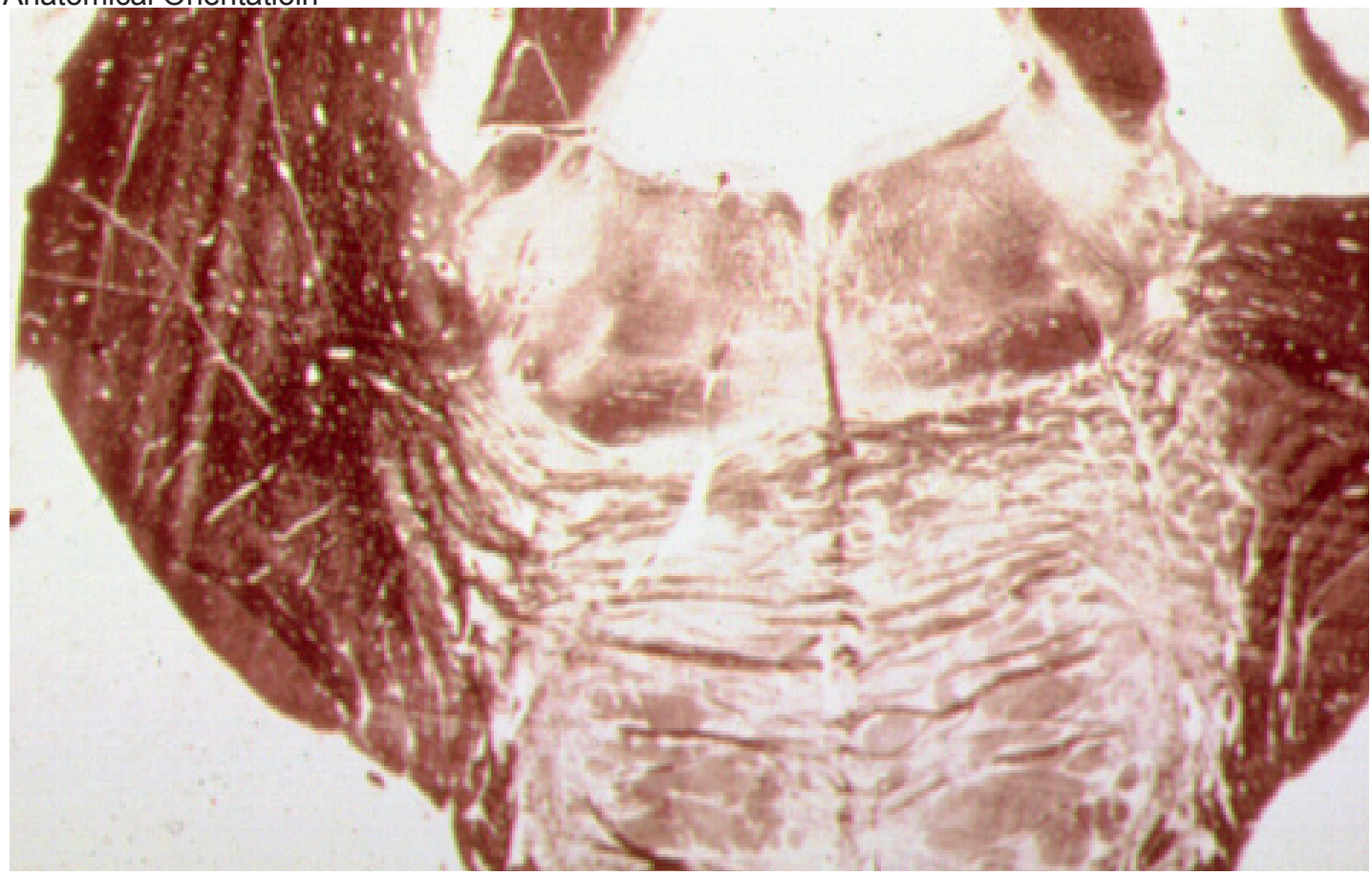
Previous Structures:
MLF
Middle Cerebellar peduncle
Medial Lemniscus
ALS (anterolateral system)
Pontine nuclei
CST (corticospinal tract)

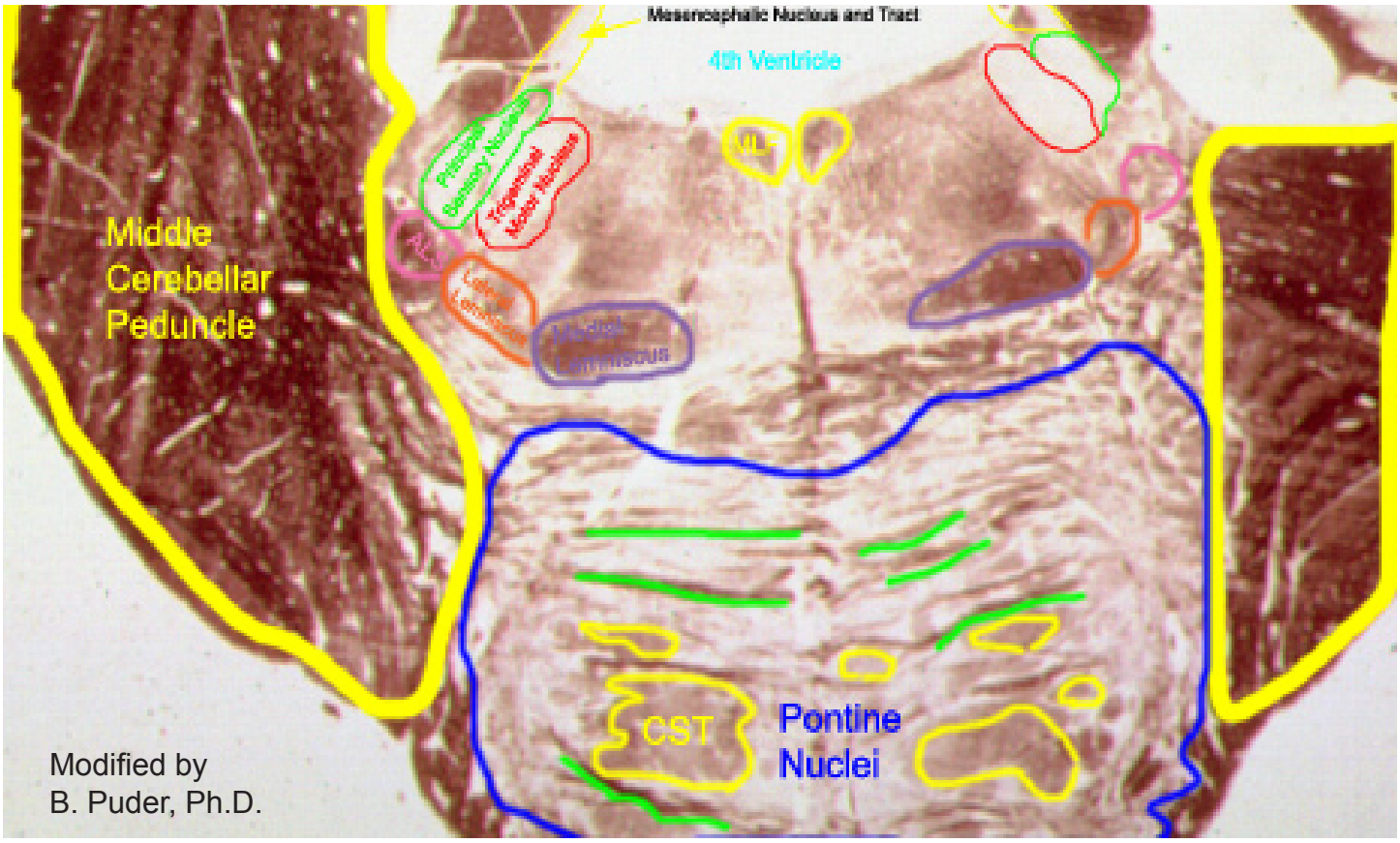
As you identify these nuclei and tracts, discuss what would happen if one of these nuclei or tracts was lesioned. What signs,symptoms would you see in the patient? Would these signs/ symptoms be ipsilateral or contralateral to the lesion?

Mid Pons
Clinical Orientation



Mid Pons
Anatomical Orientatioin





Modified by
B. Puder, Ph.D.

Rostral Pons

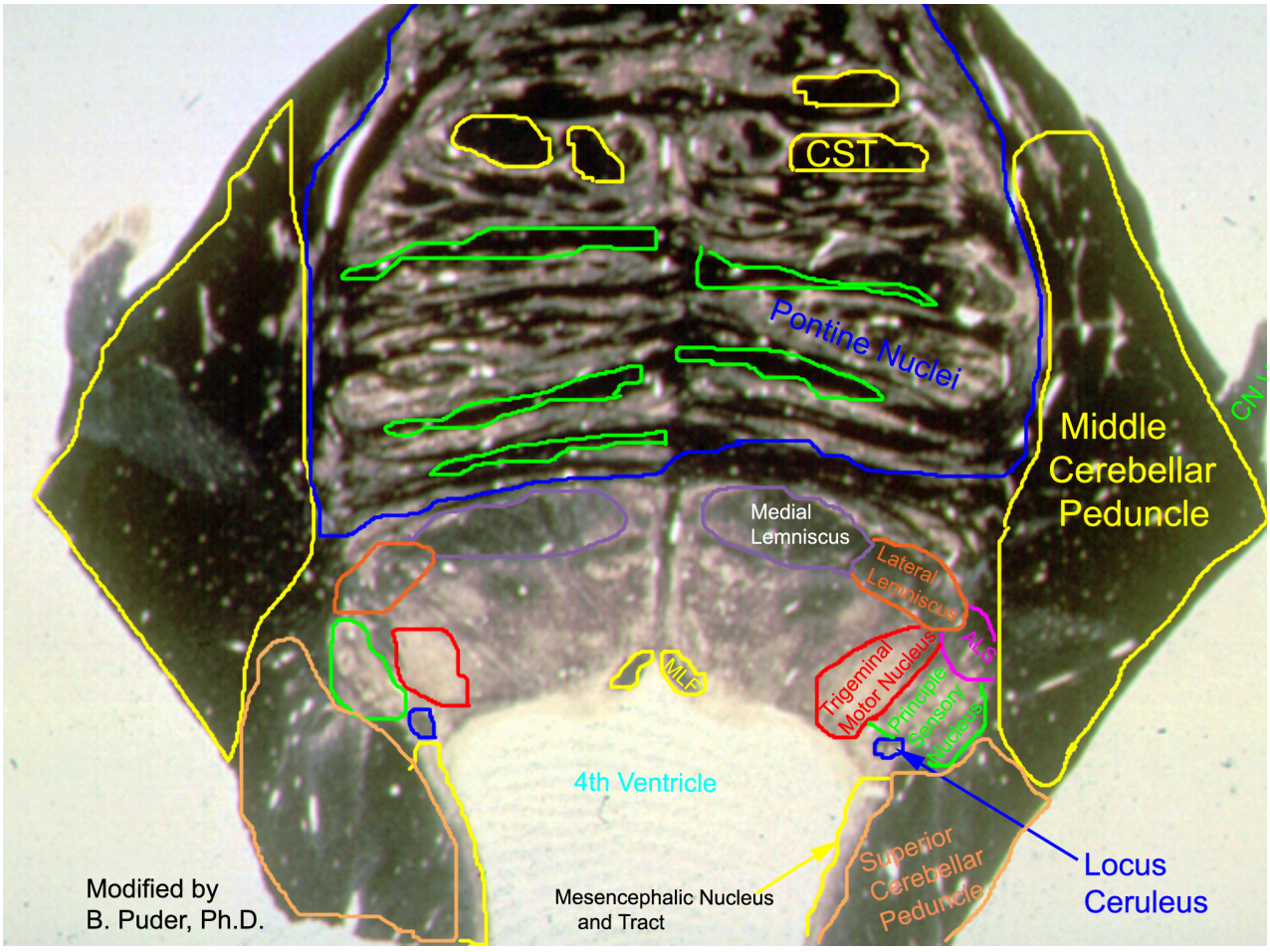
The ***locus ceruleus*** is a nucleus located just under the floor of the ***fourth ventricle*** in the mid to upper pons. It belongs to the reticular formation and is unique because its neurons contain melanin pigment and utilize norepinephrine (a catecholamine) as a transmitter. The axons of these neurons project throughout the brain - especially to the cerebral cortex and reticular formation of the brain-stem. It is thought to play a role in sleep/wake cycles and maintaining an appropriate level of consciousness.

Identify the following nuclei and tracts in this section:
New Structures in this section:
Superior Cerebellar Peduncle - axons entering and leaving the cerebellum
Locus Ceruleus - cell bodies here have smokey blue appearance. They contain **Noradrenaline/Norepinephrine** and their axons project throughout the CNS including the cortex, diencephalon, limbic system, brainstem, cerebellum and spinal cord. These cell bodies have l**ow discharge rates during sleep and high discharge rates during stress.**

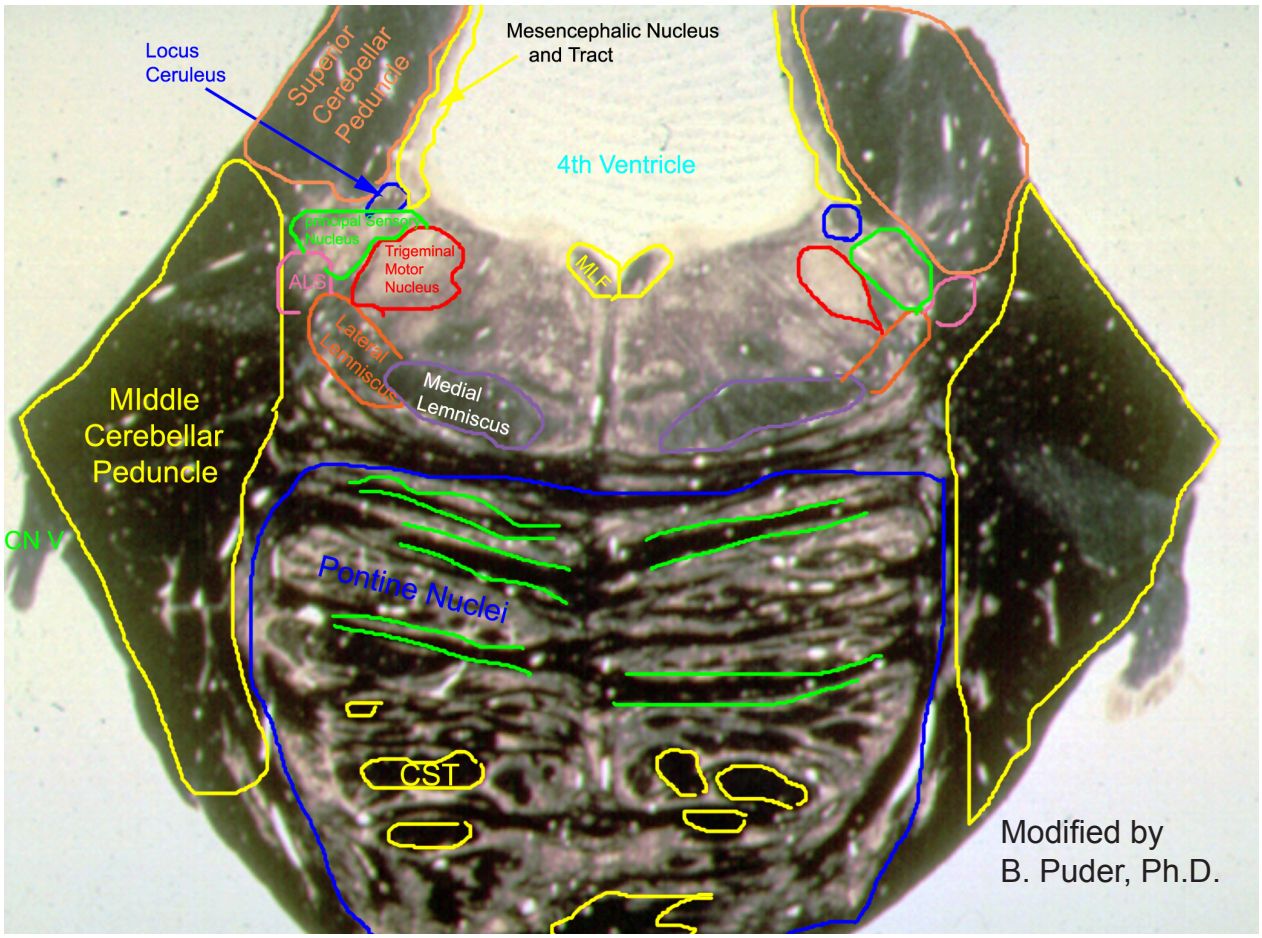
Structures from Previous sections:
Mesencephalic nucleus and tract
MLF
Trigeminal Motor nucleus
Principal Sensory nucleus
ALS
Medial Lemniscus
Pontine nuclei
CST corticospinal tract
Middle cerebellar peduncle

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 Pons
Clinical Orientation



Rostral Pons
Anatomical Orientation



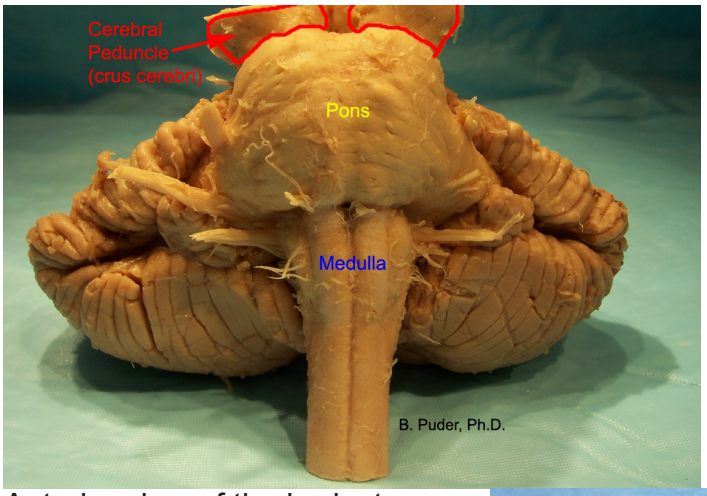
Objectives:
At the completion of this lab, you should be able to:

1. **Identify the gross structures of the midbrain**
2. **Identify the intrinsic structures of the midbrain**
3. **Describe the signs/symptoms you will see in patients with lesions to the ALS, PC/ML, voluntary motor pathway, and cranial nerve nuclei. Or if given the signs/symptoms, be able to describe/identify the location of the lesion in the midbrain.**

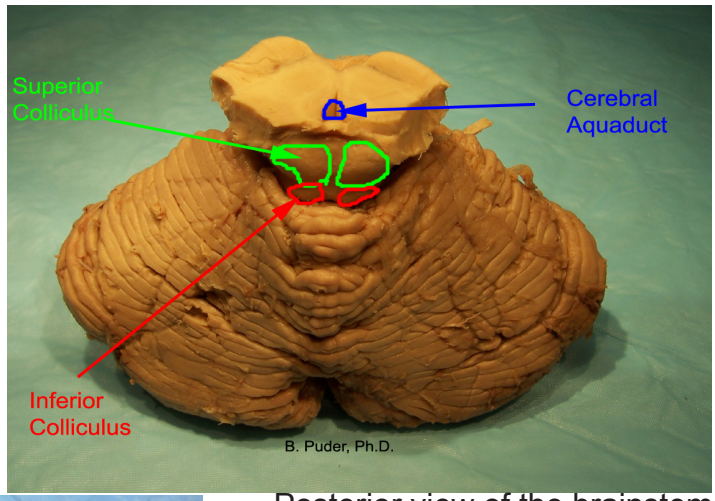
Gross Anatomy of the Midbrain
Materials required: Gross brain stem specimens and half-brain specimen.

The ventral surface of the ***midbrain*** extends from the most superior fibers of the middle cerebellar peduncle to the mammillary bodies of the diencephalon. The ventral surface of the ***midbrain*** is characterized by the paired ***cerebral peduncles (crus cerebri)*** and the interpeduncular fossa which lies between them. The floor of this fossa is known as the posterior perforated substance. Note the oculomotor nerves emerging from the lateral aspects of the interpeduncular fossa.

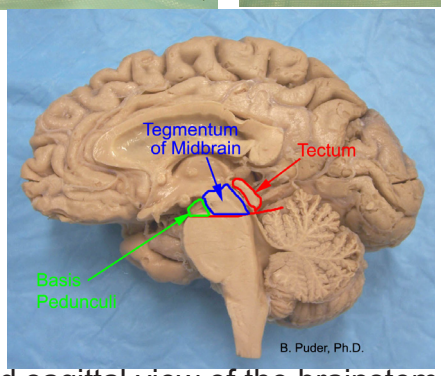
The posterior surface of the ***midbrain*** is characterized by the ***superior and inferior colliculi*** which constitute the ***tectum of the midbrain.*** Note that the ***cerebral aqueduct*** lies anterior to the colliculi (also called, collectively, the quadrigeminal plate). In addition, some specimens may show the peduncles (brachium) of the superior and inferior colliculi. These bundles of fibers interconnect the colliculi with the lateral and medial geniculate nuclei of the dorsal thalamus. Recall from your lecture notes how all of the above named structures of the midbrain are related to the tentorium cerebelli, incisura, clivus, medial portion of the temporal lobe, pineal gland, and the Great cerebral vein of Galen.



Anterior view of the brainstem



Posterior view of the brainstem



Mid sagittal view of the brainstem

Intrinsic anatomy of the Midbrain

Materials required: 2 myelin stained transverse midbrain sections, lab atlas, and lab manual

The two levels of the **midbrain** are generally distinguished by two characteristic prominent structures in the tegmentum.

1. **Level of the Inferior Colliculus**, the ***decussation of the superior cerebellar peduncles*** can be clearly seen.
2. **Level of the Superior Colliculus** is characterized by the ***red nucleus*** **(Nucleus Ruber)** in the tegmentum.

Caudal Midbrain - Level of the Inferior Colliculus

Examine a section of the caudal ***midbrain*** at the **Level of the Inferior Colliculus**. Fibers of the ***lateral lemniscus*** can be seen entering the ***inferior colliculus***. The ***cerebral aqueduct,*** is associated with the ***midbrain*** and is small compared with the fourth ventricle.

The ***corticospinal (pyramidal) tract fibers*** identified in the medulla and pons form part of the ***cerebral peduncles*** of the **midbrain**. The ***corticospinal tracts*** which ultimately form the ***lateral*** and ventral ***corticospinal tracts*** **of the spinal cord** lie in a ***central position in the cerebral peduncle.*** The fibers that compose the most medial and most lateral areas of the cerebral peduncle originate in other motor areas of the cerebral cortex and ultimately synapse on the neurons of the pontine nuclei. Subsequently, the axons of the neurons of the pontine nuclei form the middle cerebellar peduncle.

The nuclear mass immediately dorsal to the ***cerebral peduncle*** is the ***substantia nigra***. The ***substantia nigra*** is part of the motor system which projects to the basal nuclei of the telencephalon.

The ***decussation of the superior cerebellar peduncles*** occurs in the central tegmentum of the ***midbrain.*** The crescent-shaped bands of fibers that lie lateral to the decussation of the superior cerebellar peduncles contain fibers of the ***medial lemnisci, anterolateral system (spinothalamic tracts), and lateral lemnisci.***

In the posteromedial portion of the tegmentum identify the ***medial longitudinal fasciculus*** which is very large at this level because it contains a great number of fibers that interconnect the ***vestibular nuclei*** with the ***abducens, trochlear and oculomotor nuclei.***

In the posterior surface of the ***medial longitudinal fasciculus*** is the small ***trochlear nucleus.*** The bundles of root fibers from this nucleus encircle the ***cerebral aqueduct.*** These root fibers cross the midline just caudal to the ***inferior colliculi*** before emerging from the posterior surface of the ***midbrain*** on course to the orbit.

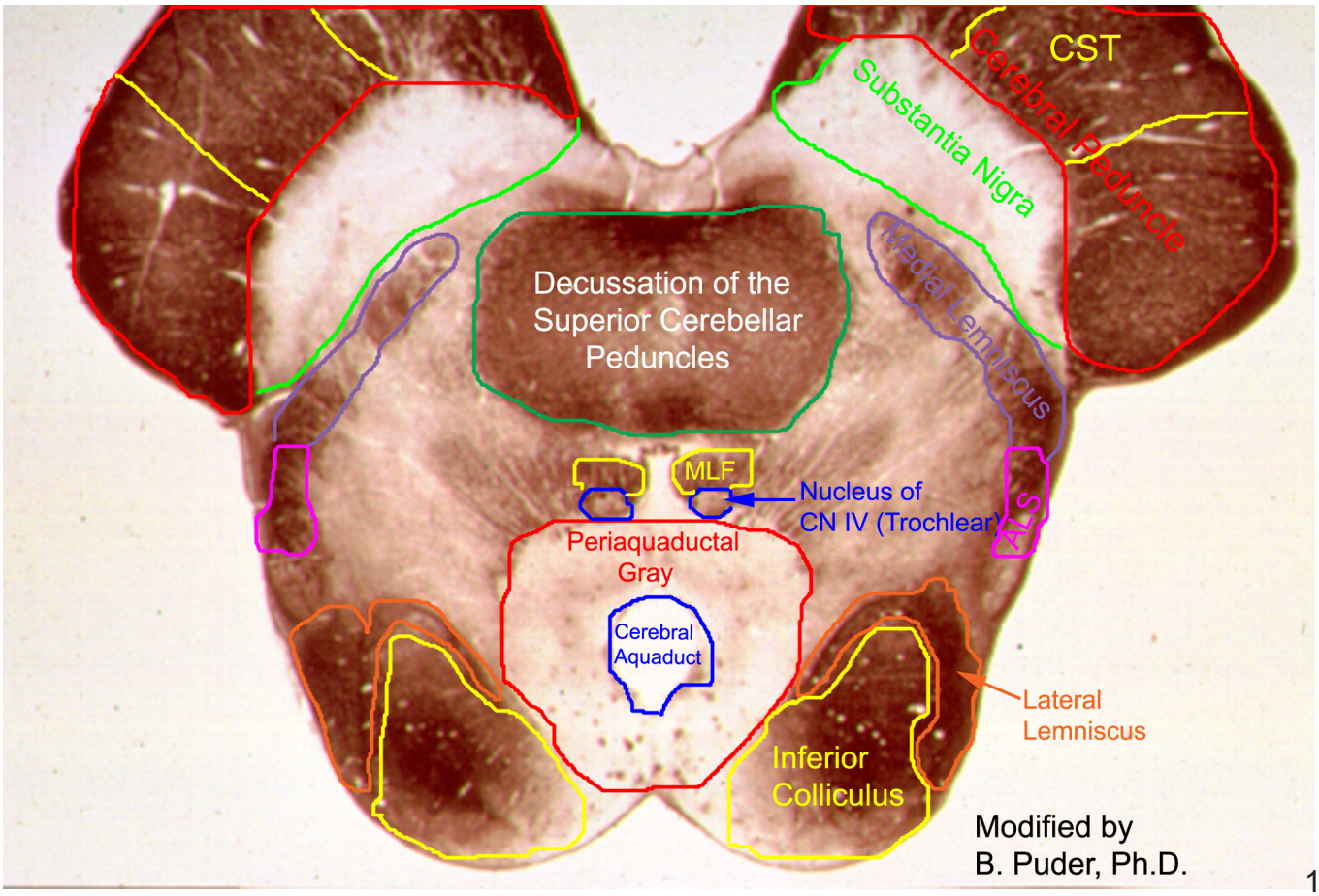
The nucleus of the ***inferior colliculus*** can be observed and often fibers of the ***lateral lemniscus*** are seen entering it.

Identify the following nuclei and traacts in this section:
New Structures:
Inferior colliculus - part of the auditory pathway
Cerebral aquaduct - part of the ventricular system
Periaquaductal gray - cell bodies here contain enkephalins that block pain transmission
Trochlear nucleus (nucleus of CN IV)- cell bodies of CN IV that innervate the superior oblique m.
Decussation of the Superior cerebellar peduncles - axons exiting the cerebellum via the superior cerebellar peduncles will cross here and ascend to the cortex, or synapse in the red nucleus
Substantia nigra - part of the basal nuclei (ganglia), cell bodies here contain dopamine and when these cell die, the disease is called **Parkinson's disease**
Cerebral Peduncles - carries axons from many sources, however the ***middle 3/5 of each peduncle contain the corticospinal tracts*** which are the axons of the upper motor neurons of the cortex which are descending to the spinal cord
Lateral lemniscus - are actually in the pons, but we didn't identify them there. These axons are now synapsing on the inferior colliculus (part of the auditory pathway)

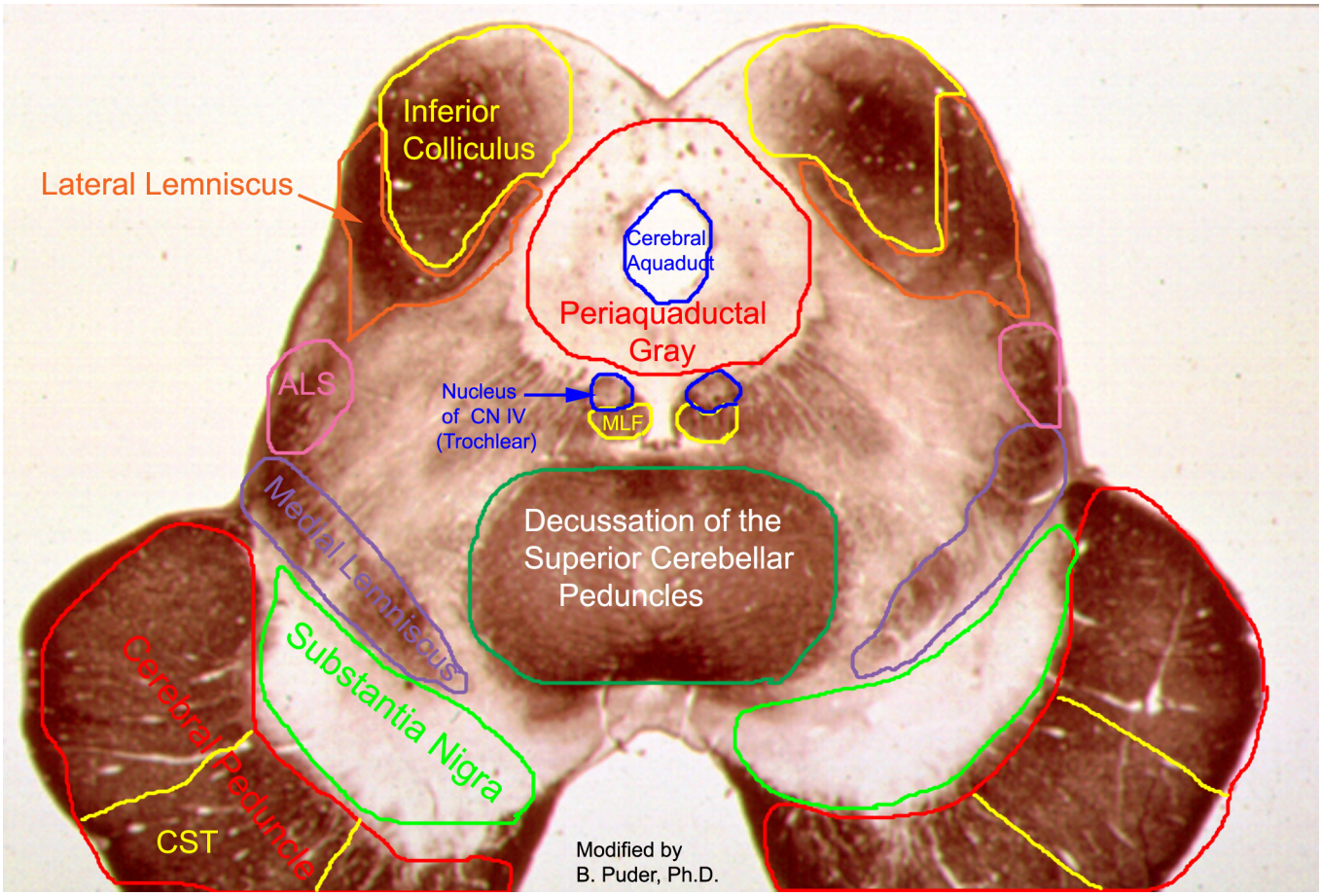
Previous structures:
MLF
ALS
Medial Lemniscus

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?

Caudal Midbrain
Clinical Orientation



Caudal Midbrain
Anatomical Orientation



Rostral Midbrain - Level of the Superior Colliculus
Examine a section at the upper **midbrain** at the **Level of the Superior Colliculus of the midbrain.** The major difference in morphology, compared to the level of the ***inferior colliculus***, is related to the layered appearance of the ***superior colliculus***, the appearance of the ***oculomotor nucleus*** anterior to the ***cerebral aqueduct*** and the characteristic ***red nucleus***. Note that the fibers which form the ***decussation of the superior cerebellar peduncle*** either end in the ***red nucleus*** or bypass it on their course to the dorsal thalamus. This fiber system, which forms most of the superior cerebellar peduncle, is referred to as the dentatorubrothalamic tract or sometimes the cerebellorubrothalamic tract. "Dentato" because the fibers originate in the dentate nucleus of the cerebellum; "rubro" because some of them end in the red nucleus of the midbrain and "thalamic" because the remaining fibers end in the ventrolateral nucleus (and possibly ventral anterior nucleus) of dorsal thalamus. This is part of the cerebellar feedback loop which provides coordination for the motor centers of the midbrain, diencephalon, cerebral cortex and cerebellum.

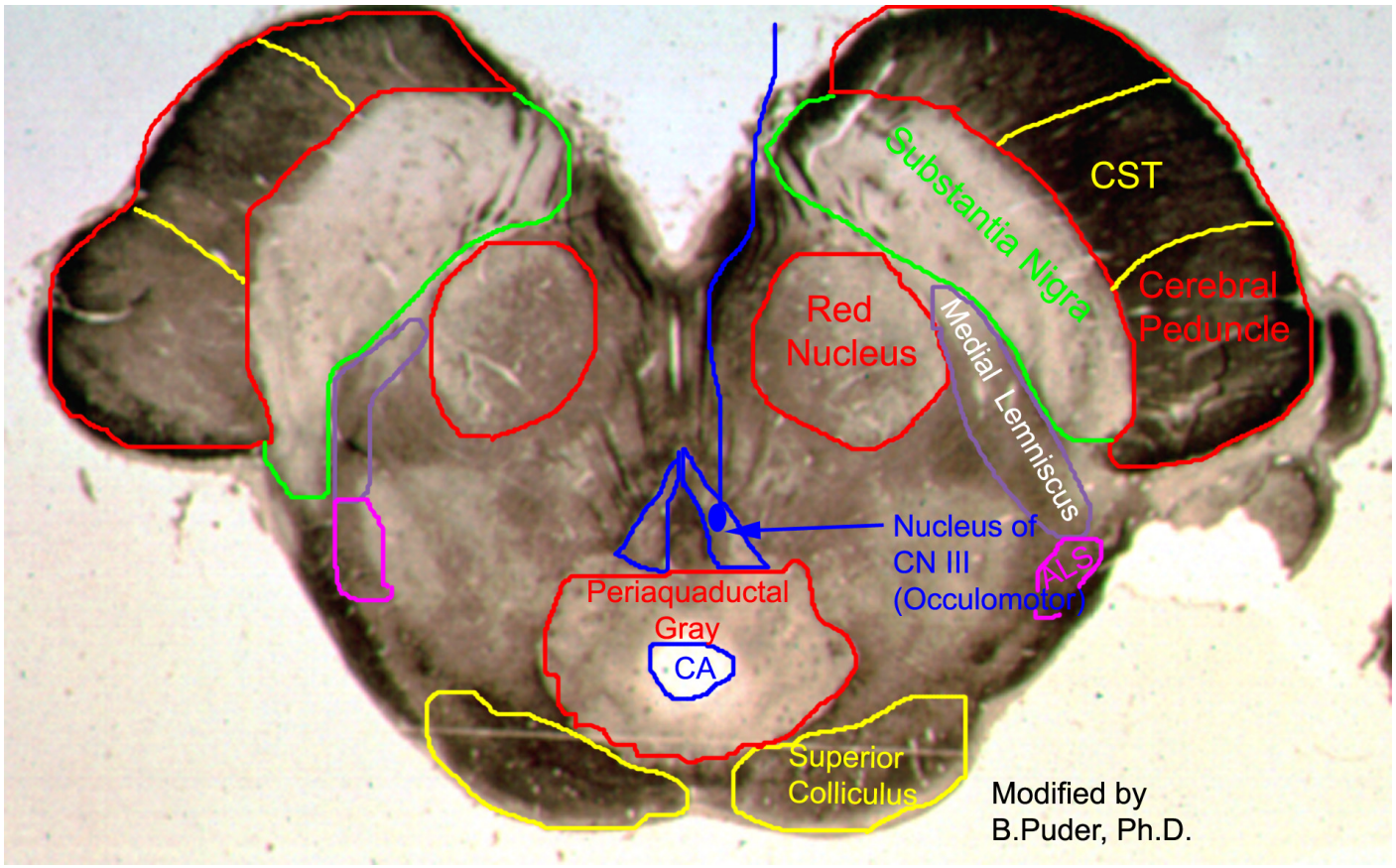
In the dorsomedial area of the tegmentum identify the ***oculomotor nucleus***. Anterolateral to the ***oculomotor nucleus***, fibers of the ***medial longitudinal fasciculus*** can be identified. Identify the **root fibers of the oculomotor nerve** as they leave the nucleus and swing through the tegmentum of the midbrain before exiting from the ventral surface in the interpeduncular fossa.

Identify the following nuclei and tracts in this section:
New Structures:
Superior colliculus - part of the visual system
Occulomotor nucleus (CN III nucleus) - cell bodies here project their axons to innervate 4 extraocular muscles
(There's also a parasympathetic nucleus to CN III called the Edinger-Westphal nucleus - it would appear as some tiny specks near the middle of the occulomotor nuclei. The Edinger-Westphal nucleus contains preganglionic parasympathetic cell bodies whose axons will synapse on the ciliary ganglion and will cause pupillary constriction.
Also note that the **axons of the occulomotor nuclei exit between the 2 cerebral peduncles (in the interpeduncular fossa). This will be of importance when we discuss lesions.**
Red Nucleus - cell bodies here project their axons as the rubrospinal tract wihich will influence lower motor neurons in the spinal cord.

Previous structures:
Cerebral aquaduct
Periaquaductal gray
ALS
Medial Lemniscus
Substantia nigra
Cerebral peduncles
There's also the **reticular formation** in the tegmental area of the midbrrain

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 Midbrain
Clinical Orientation



Rostral Midbrain
Anatomical Orientation