

# *Lab 2. Medulla*

## **A. Lesion Lessons**

### **Lesion 3.1. Mike Rowmeter**

*i) Location:*

*ii) Signs/symptoms:*

*iii) Cause:*

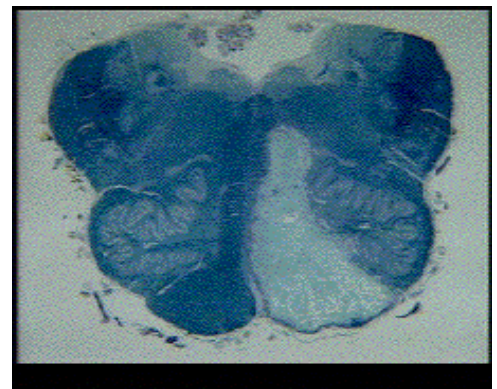


### **Lesion 3.2. Anne Chovee**

*i) Location:*

*ii) Signs/symptoms:*

*iii) Cause:*



## Spinomedullary junction.

### Locate and note the following:

- the enlarged *substantia gelatinosa* of the *dorsal horn* is a caudal extension of the *spinal trigeminal nucleus*.
- the *spinal trigeminal tract* is located superficially to the nucleus and is made up of *primary trigeminal afferent fibers* that entered the brain stem in the pons and then descended to this level.
- *MLF (medial longitudinal fasciculus)* is often considered to include these tracts:
  - *reticulospinal*
  - *tectospinal*
  - *medial vestibulospinal*

### hypothalamic autonomic tract

- also known as “*descending sympathetics*”
- *descends diffusely in the lateral brain stem*
- *projects to the intermediolateral nucleus of the spinal cord*
- **lesion** → *Horner’s syndrome (Ptosis, miosis, anhydrosis, and enophthalmos)*

### Label these structures on

#### Figure 1.

- *fasciculus gracilis*
- *fasciculus cuneatus*
- *spinal trigeminal nuc.*
- *spinal tract of V*
- *dorsal spinocerebellar tr.*
- *ventral spinocerebellar tr.*
- *spinothalamic tr.*
- *rubrospinal tract*
- *lat. corticospinal tr.*
- *ant. corticospinal tr.*
- *vestibulospinal tr.*

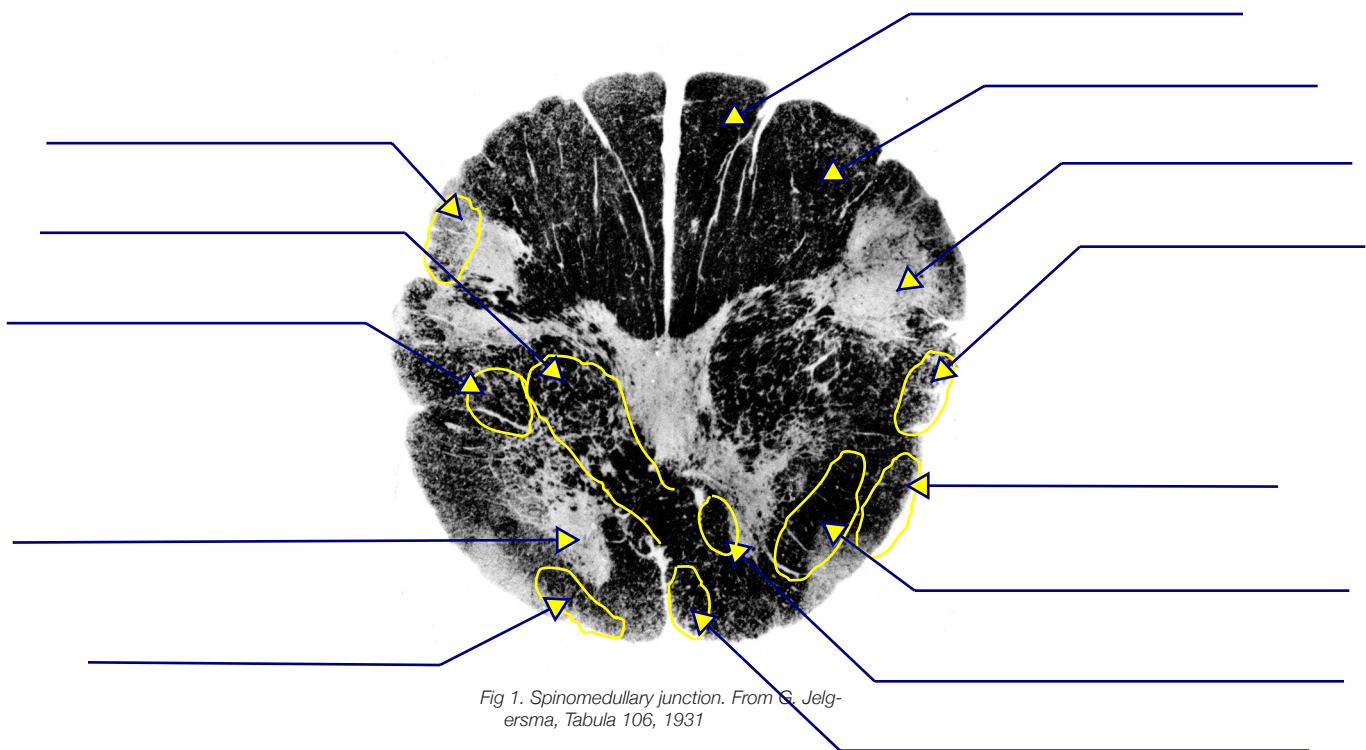


Fig 1. Spinomedullary junction. From G. Jellgersma, Tabula 106, 1931

## Medullary Level of the Pyramidal (Motor) Decussation

### Locate and note the following:

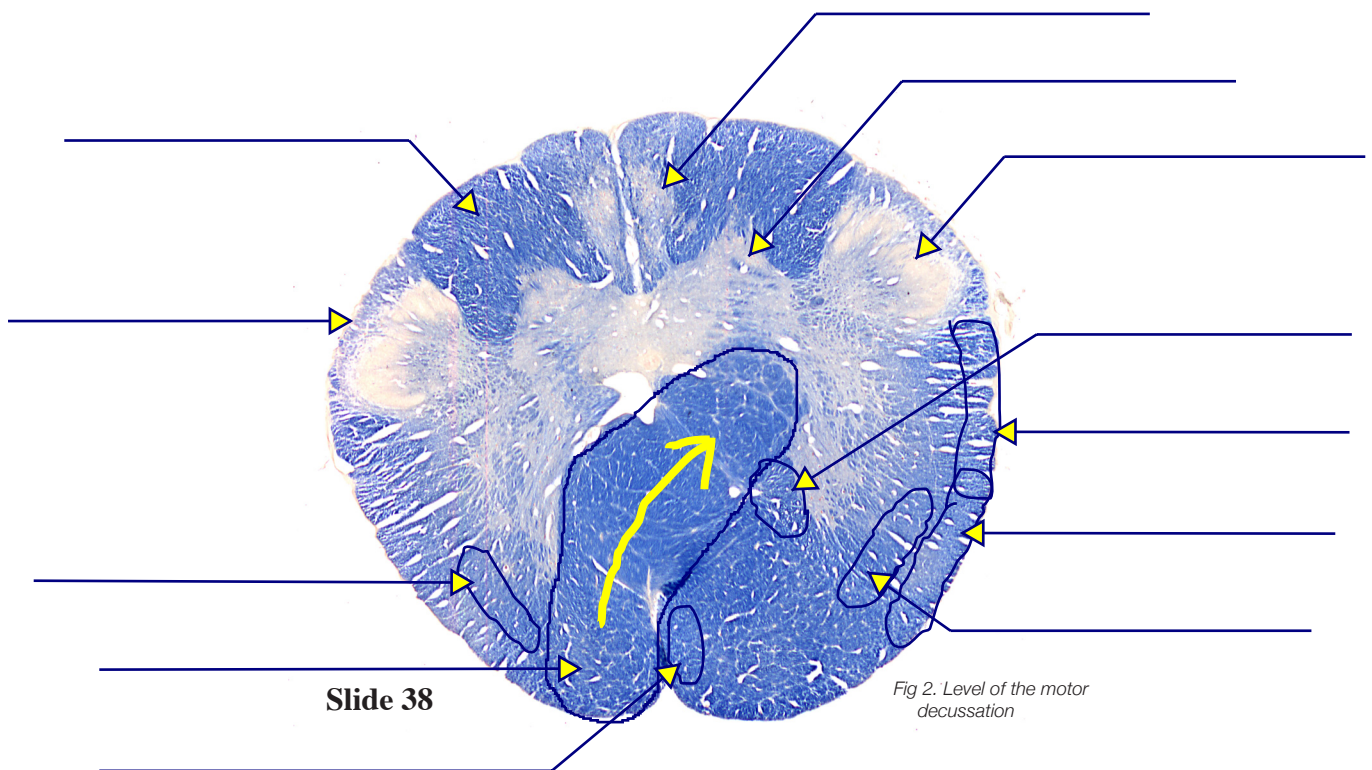
- *pyramidal decussation* – obvious in the ventral midline.
  - *pyramidal tract* - fibers arise in cerebral cortex, descend to the lower medulla, and cross here to the contralateral spinal cord where they form the *lateral corticospinal tract* that runs in the *lateral funiculus*.
- *spinal trigeminal nucleus* replaces the *dorsal horn* in function.
  - a rostral continuation of the *substantia gelatinosa* of the spinal cord
  - the actual transition occurs at the lower levels of C2-3, below which the *substantia gelatinosa* becomes much smaller.
- *posterior intermediate sulcus* – between the *fasciculus cuneatus* and *fasciculus gracilis* is now deeper
- *nucleus gracilis* and *fasciculus cuneatus* – are now visible.
  - these *dorsal column nuclei* are synaptic stations for the long “dorsal root” fibers that have passed up the *dorsal columns*.

### Question classic

Which types of sensory modalities are conveyed by the dorsal columns?

### Label these structures on Figure 2.

- nucleus gracilis
- fasciculus cuneatus
- nucleus cuneatus
- spinal trigeminal nuc.
- spinal tract of V
- dorsal spinocerebellar tr.
- ventral spinocerebellar tr
- spinothalamic tr.
- descending MLF
- lat. corticospinal tr.
- ant. corticospinal tr.
- vestibulospinal tr.



## Medullary Level of the Sensory Decussation

### Note the following:

- *internal arcuate fibers* - course ventrally from the *nucleus gracilis* and *nucleus cuneatus*.
  - these fibers cross the midline and then turn rostrally to form the *medial lemniscus* that ascends to the *thalamus*.
- *solitary nucleus* - receives input from the very darkly stained, compact fiber tract known as the *solitary tract*.
- *solitary tract* - is composed of primary visceral afferent fibers carried into the brain in the *vagus*, *glossopharyngeal*, and *facial* nerves.
- *hypoglossal nucleus* - is located just dorsal to the MLF
  - innervates the intrinsic muscles of the tongue.
  - axons course ventrally from each the nucleus to exit from the anterior aspect of the medulla in the *anterior lateral sulcus* (preolivary sulcus) between the *pyramid* and the *inferior olive*.
- *dorsal motor nucleus of the vagus* - seen on an enlarged view just dorsal to the hypoglossal nucleus
  - gives rise to GVE preganglionic parasympathetic axons that supply the thoracic and abdominal viscera, i.e., the heart, lungs and gastrointestinal system (stomach, intestine, liver, pancreas).
- *obex* - the caudal part of the *fourth ventricle* where it is continuous the *central canal* of the spinal cord.
- *lateral cuneate nucleus* - is homologous to the *dorsal nucleus of Clarke* of the spinal cord.
  - receives afferent, sensory fibers conveying muscle stretch information from cervical and upper thoracic roots via the *dorsal columns*.
- *cuneocerebellar tract* - originates from the *lateral cuneate nucleus* and courses through the *inferior cerebellar peduncle* into the *cerebellum*.

The *ventral spinocerebellar tract* and *hypothalamo-autonomic tract* remain in about the same locations as in previous slides, as do the *spinothalamic tract* and *rubrospinal tract*.
- *inferior olivary complex* - includes a most distinctive, convoluted nucleus identified as the *principal olive*.
- *olivocerebellar projections* - cross the midline and course to their termination as “*climbing fibers*” in the contralateral *cerebellar cortex* via the *inferior cerebellar peduncle*.

### **This is important**

*The dorsal column somato-sensory pathway crosses via the internal arcuate fibers.*

*Recall that the spinothalamic tract, the other somatosensory pathway, crosses at spinal levels*

### **This is important**

*The region of the solitary nucleus and tract is part of the “medullary respiratory center.”*

### **Question classic**

*Which spinocerebellar tract does not course through the inferior cerebellar peduncle?*



**Label these structures on Figure 3.**

• obex	• nucleus gracilis	• nucleus cuneatus
• spinal trigeminal nuc.	• spinal tract of V	• lateral cuneate nuc.
• dorsal motor nucleus	• hypoglossal nucleus	• solitary tract
• descending MLF	• tectospinal tract	• medial lemniscus
• dorsal spinocerebellar tr.	• ventral spinocerebellar tr	• spinothalamic tr.
• lat. vestibulospinal tr.	• lat. corticospinal tr.	• inferior olive

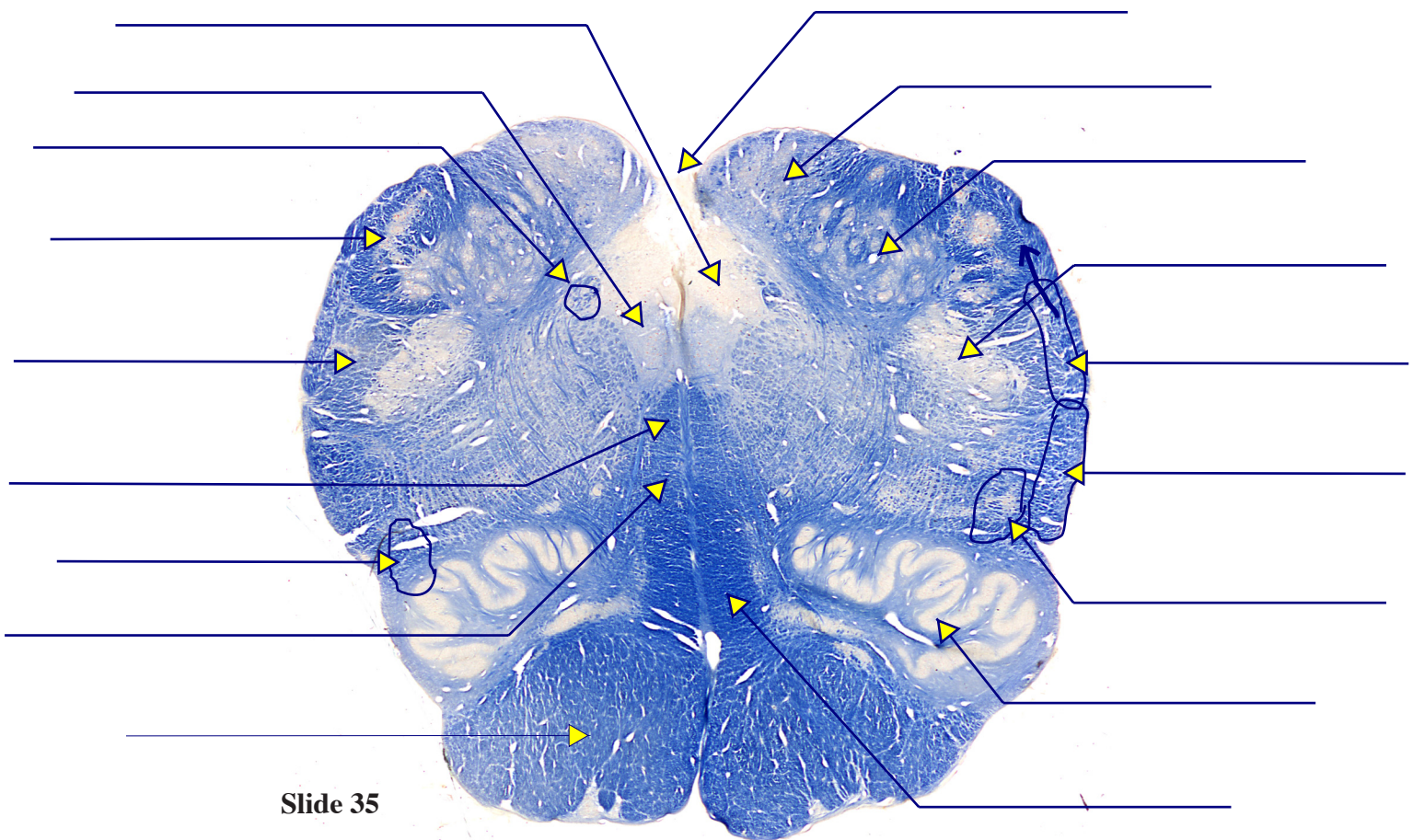


Fig 3. Level of the sensory decussation.

## Medullary Level of the Vagus Nerve

### Locate and note the following:

- *inferior olivary complex* - the large and characteristic *principal olive* is easily identified.
  - *dorsal accessory olive* and *medial accessory olive* are small and found as their names imply.
- *lateral reticular nucleus* – located dorsal to the *principal olive*
  - projects ipsilaterally to the *cerebellum* via the *inferior cerebellar peduncle*.
- *fourth ventricle* – has opened up at this level.
- *medial and spinal vestibular nuclei*- have “replaced” the *gracile* and *cuneate nuclei*
  - *spinal vestibular nucleus* - has a peppered appearance due to the vestibulospinal tract axons running through it.
  - both receive incoming sensory input from the semicircular canals carried by CN VIII as well as *olivocerebellar* and *spinocerebellar* inputs.
- *inferior cerebellar peduncle* – has greatly increased in size and now contains the *dorsal spino-cerebellar tract*.
- *nucleus ambiguus* - a third nucleus associated with the vagus nerve can be seen on an enlarged view as a small cluster of red-stained neurons located directly under the *solitary tract* and just dorsomedial to some *olivocerebellar fibers*.
  - primarily innervates branchial arch musculature of the pharynx, esophagus and larynx via SVE fibers that travel in the vagus and then form the recurrent laryngeal nerve.
  - also gives rise to some vagal GVE preganglionic parasympathetic projections to the heart.

### Question classic

***What is the origin of the cerebellar climbing fibers?***

**Label these structures on Figure 4.**

• hypoglossal nucleus	• lateral cuneate nuc	• medial vestibular nuc.
• dorsal motor nucleus	• spinal tract of V	• spinal (inf) vestibular nuc.
• descending MLF	• spinal nuc of V	• inferior cerebellar peduncle
• solitary tract	• medial lemniscus	• corticospinal tr.
• solitary nucleus	• ventral spinocerebellar tr	• spinothalamic tr.
• lat. vestibulospinal tr.	• tectospinal tract	• inferior olive
• fourth ventricle	• nucleus ambiguus	• sulcus limitans

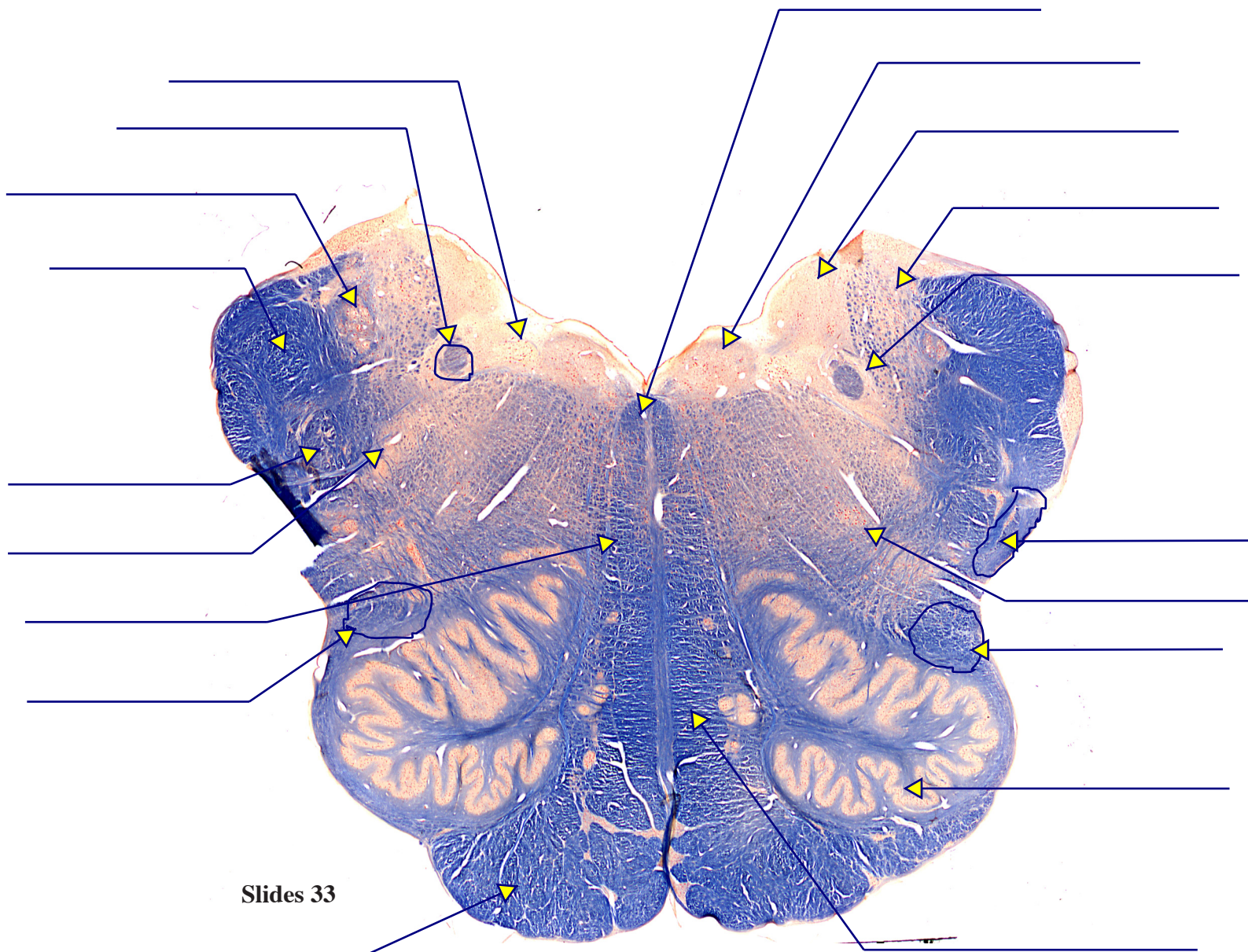


Fig 4. Level of the vagus nerve.

## Medullary Level of the Glossopharyngeal Nerve

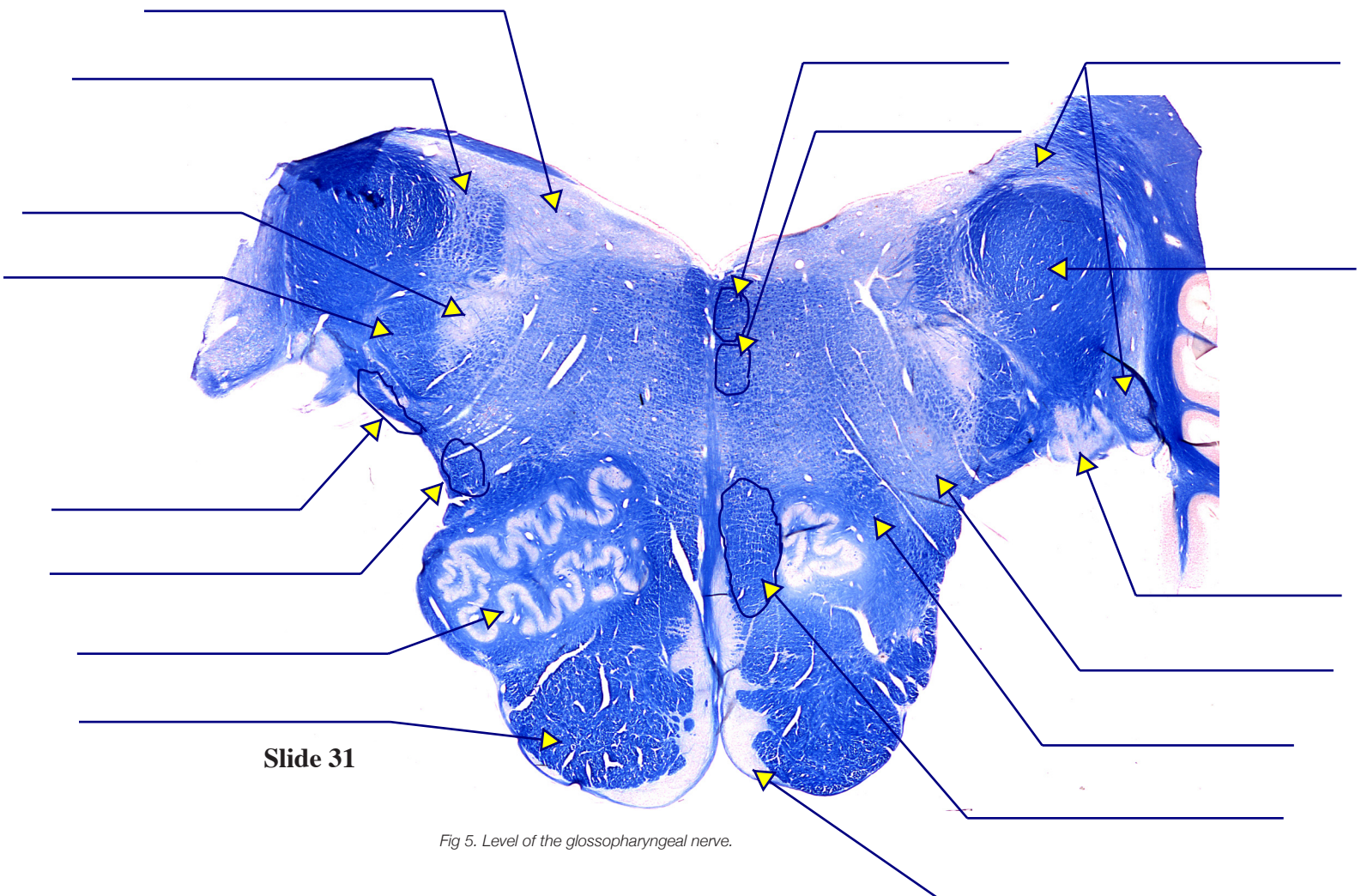
### Note the following

- *Slide 31* - is near the medullary-pontine junction.
- *inferior olivary complex* – disappearing on the right.
- *central tegmental tract* – a major descending input to the olive as the can be seen surrounding the remaining right *principal olive nucleus*.
- *nucleus prepositus* –has replaced *hypoglossal nucleus* and is located lateral to the MLF and medial to the *medial vestibular nucleus*.
  - concerned with horizontal eye movement via its connections with the *abducens nucleus*, which is found more rostrally.
- *facial nucleus* – visible on the right side as a pale staining area filled with red specks (facial motor neurons) about 1/3 of the distance from the *spinal trigeminal nucleus* to the remnant of the *inferior olive*.
- *dorsal and ventral cochlear nuclei* – seen the right side arching over the *inferior cerebellar peduncle*.
  - receive auditory input from the *cochlea* carried by CN VIII.
- *pontobulbar body* – a patch of gray matter located immediately ventral to the *inferior cerebellar peduncle*
  - appears to be a caudal extension of *pontine gray* and sends projections to the *cerebellum*.
- *arcuate nucleus* – another “misplaced piece” of pontine gray seen as a thin coating of gray matter around the *pyramids*.
  - gives rise to axons that travel up the midline and then course laterally across the floor of the fourth ventricle as the *striae medullares of the fourth ventricle* on their way to the *cerebellum*.



**Label these structures on Figure 5.**

• <i>nucleus prepositus</i>	• <i>inf. cerebellar peduncle</i>	• <i>corticospinal tr.</i>
• <i>medial vestibular nuc.</i>	• <i>dorsal cochlear nuc.</i>	• <i>pontobulbar body</i>
• <i>spinal (inf) vestibular nuc.</i>	• <i>ventral cochlear nuc.</i>	• <i>facial nucleus</i>
• <i>descending MLF</i>	• <i>medial lemniscus</i>	• <i>arcuate nucleus</i>
• <i>tectospinal tract</i>	• <i>ventral spinocerebellar tr</i>	• <i>spinothalamic tr.</i>
• <i>fourth ventricle</i>	• <i>spinal trigeminal nerve &amp; tract</i>	• <i>inferior olive</i>



## Case Break

*(As you continue on with this lab, the answers to this case break will become more clear.)*

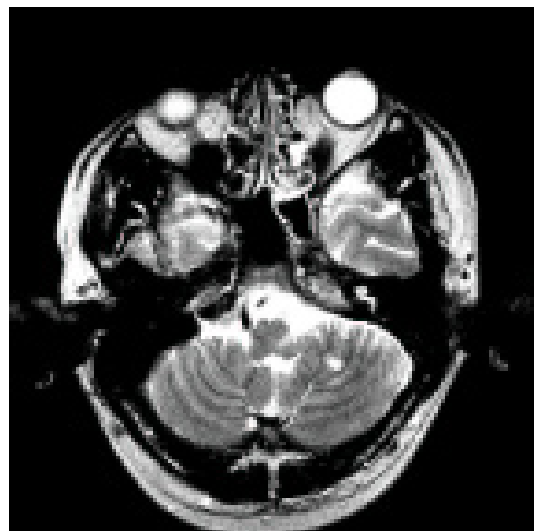
### ***An Old Man is Spinning***

A 70 year-old man, Dewey Dessmul, feels unsteady, “spinning” with a tendency to fall and veer to the right when he gets up to go to the bathroom one morning. When calling his wife, he notes he sounds hoarse and later feels nauseated. On examination, his right palate droops, and there is mild ptosis, with a smaller but reactive pupil on the right side. Pinprick and temperature sensation are decreased on the right face and left limbs and trunk. Finger-nose-finger and heel-shin-knee testing are impaired in the right limbs. Strength, reflexes, and vision are normal.

- 1. Why is his balance affected?***
- 2. Why are finger-nose-finger and heel-shin-bone movements affected?***
- 3. Explain the sensory abnormalities in pinprick and temperature sensation (position sense or proprioception and vibration are normal).***
- 4. Why is he hoarse?***
- 5. Why is there a mild right ptosis with smaller pupil?***
- 6. What lesion accounts for this syndrome?***

**Here's his MRI. Find the lesion**

*(<http://mcns10.med.nyu.edu/vascular/cases/vertdiss/MC.html>)*



## Medullary Level Showing the Deep Cerebellar Nuclei

### Note the following:

- *deep cerebellar nuclei* - receive inputs from the cerebellar cortex and give rise to cerebellar outputs to the brain stem and thalamus
  - most cerebellar efferents course through the *superior cerebellar peduncle*.
  - medial-lateral they are the *fastigial nucleus*, the *globose nucleus*, the *emboliform nucleus* and the *dentate nucleus*. (Fat Guys Eat Donuts.)
- *dorsal cochlear nucleus* - arches over the *inferior cerebellar peduncle* on the left.

### Question classic

Which cerebellar cortical neuron projects to the deep cerebellar nuclei?

### Label these structures on Figure 6.

• <i>fastigial nucleus</i>	• <i>inf. cerebellar peduncle</i>	• <i>corticospinal tr.</i>
• <i>globose nucleus</i>	• <i>dorsal cochlear nuc.</i>	• <i>CN VIII</i>
• <i>emboliform nucleus</i>	• <i>descending MLF</i>	• <i>inferior olive</i>
• <i>dentate nucleus</i>	• <i>medial lemniscus</i>	• <i>tectospinal tract</i>
• <i>fourth ventricle</i>	• <i>cerebellar cortex</i>	• <i>vestibular nuclei</i>

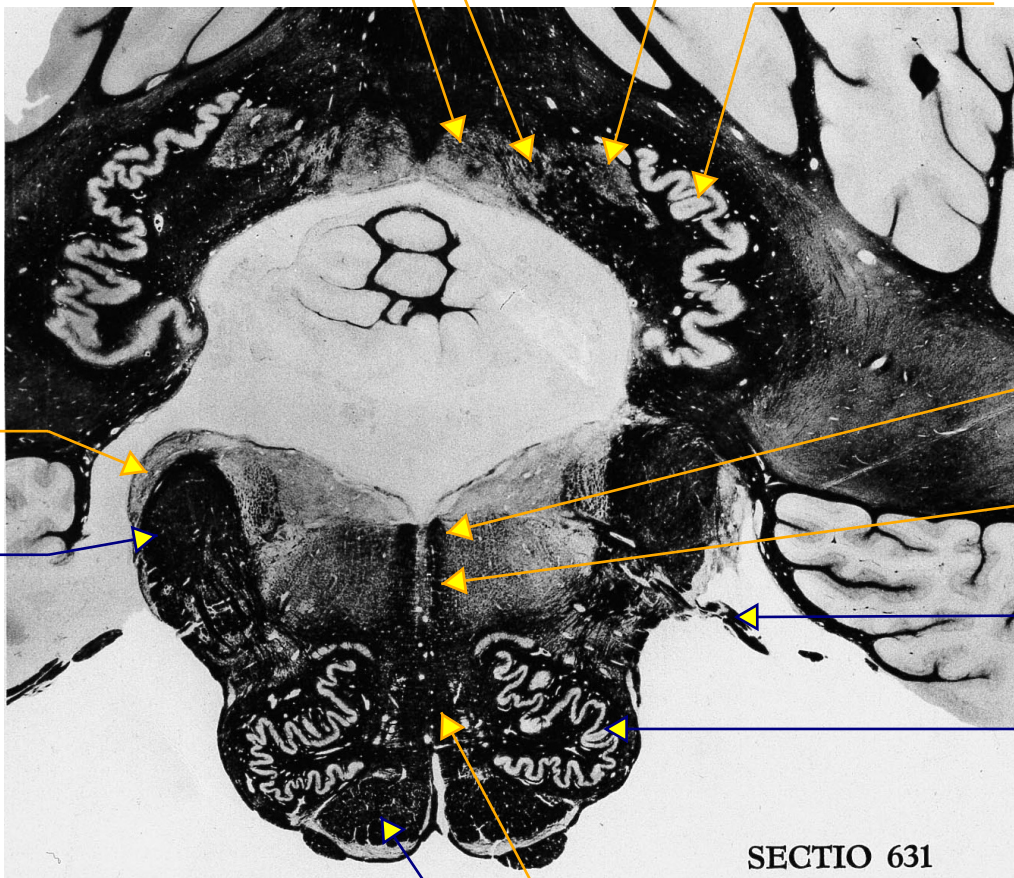


Fig 6. Medulla with cerebellar nuclei. From G. Jellgersma, Tabula 92, 1931

## C. Review Questions

1. What sensory modalities are found in the spinal trigeminal tract?
2. What is the relationship of the spinal trigeminal nucleus to the substantia gelatinosa?
3. What are the dorsal column tracts and nuclei?
4. Describe the somatotopy in the *medial lemniscus* in the *medulla*.
5. What cranial nerve nuclei are found in the *medulla*?
6. Relate the embryonic alar and basal plates to the cranial nerve nuclei in the floor of the fourth ventricle.
7. What functional components are found in the vagus nerve? . . . hypoglossal nerve?
8. Where do the *pyramids* come from? Where do they go?



## D. MRI Correlation

**Label these structures  
on Figure 7.**

- pyramid
- vertebral artery
- olive
- inf. cerebellar peduncle
- cerebellar hemisphere

**What brain  
stem level is  
this?**

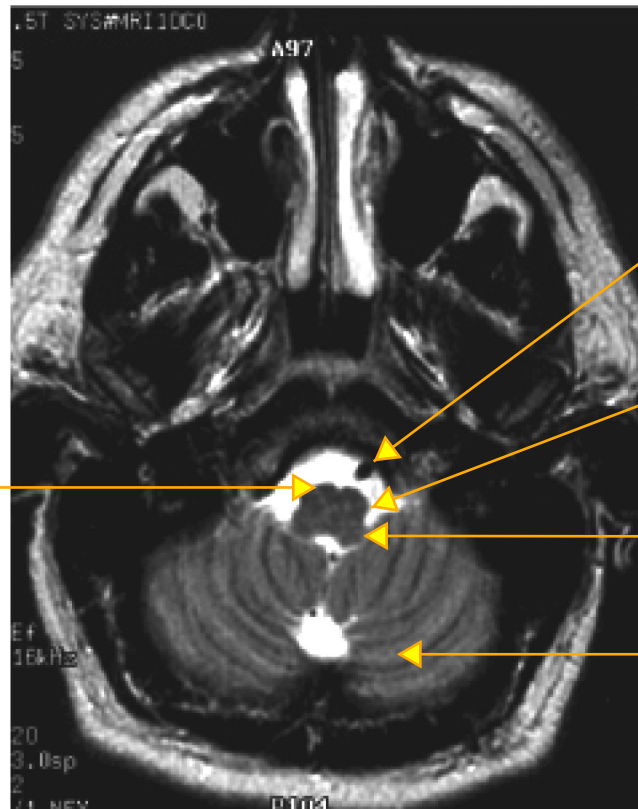


Fig 7. Axial MRI - T2. From Rand Swenson,  
Dartmouth Medical School.

## Patient Puzzle

### Patient 3.1. Case of the unsteady young boy.

Patient: Rusty Bell    Age: 7    Occupation: Student

*(This case contributed by a graduate of the Stritch School of Medicine.)*

#### **Signs and Symptoms:**

- This young boy complained of dizziness, headaches and double vision.
- His mother said that he sometimes “saw things that weren’t there” over the past few months
- Your examination revealed a mild nystagmus and left sided cerebellar signs, including ataxia and dysdiadochokinesis.
- You note that he is unsteady when he walks.

#### **Diagnosis:**

1. What should immediately come to mind considering the patient’s age and symptoms?

2. Here is his MRI. What do you conclude?

3. From this image can you explain the symptoms?

4. Is the rapid development of symptoms helpful in the diagnosis?



#### **Related questions:**

1. Identify the descending pathways involved in reflex righting movements.
2. What do the laterality of cerebellar deficits signify?
3. Why isn't the cerebellum displaced upward in this case?
4. What is dysdiadochokinesis?