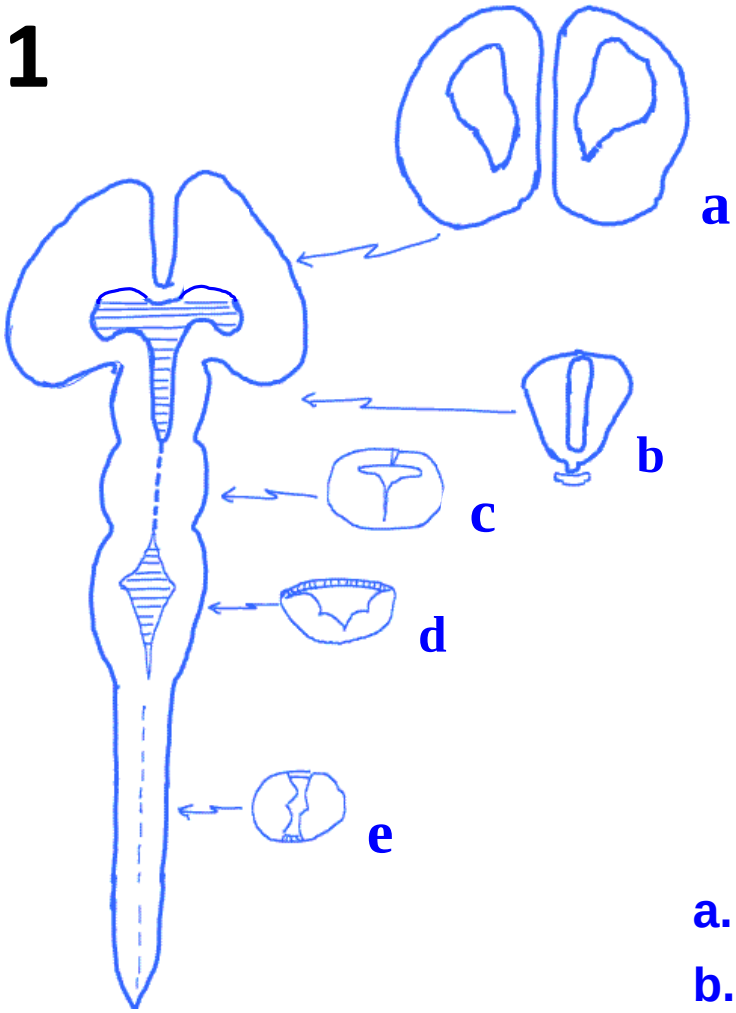
9.14 Worksheets

Schneider, G. E. *Brain structure and its origins: In the Development and in Evolution of Behavior and the Mind*. MIT Press, 2014. ISBN: 9780262026734.

1



The thickening embryonic neural tube

a. **Endbrain** (telencephalon)
b. **'Tweenbrain** (diencephalon)

} Forebrain (prosencephalon)

c. **Midbrain** (mesencephalon)
d. **Hindbrain** (rhombencephalon)
e. **Spinal cord**

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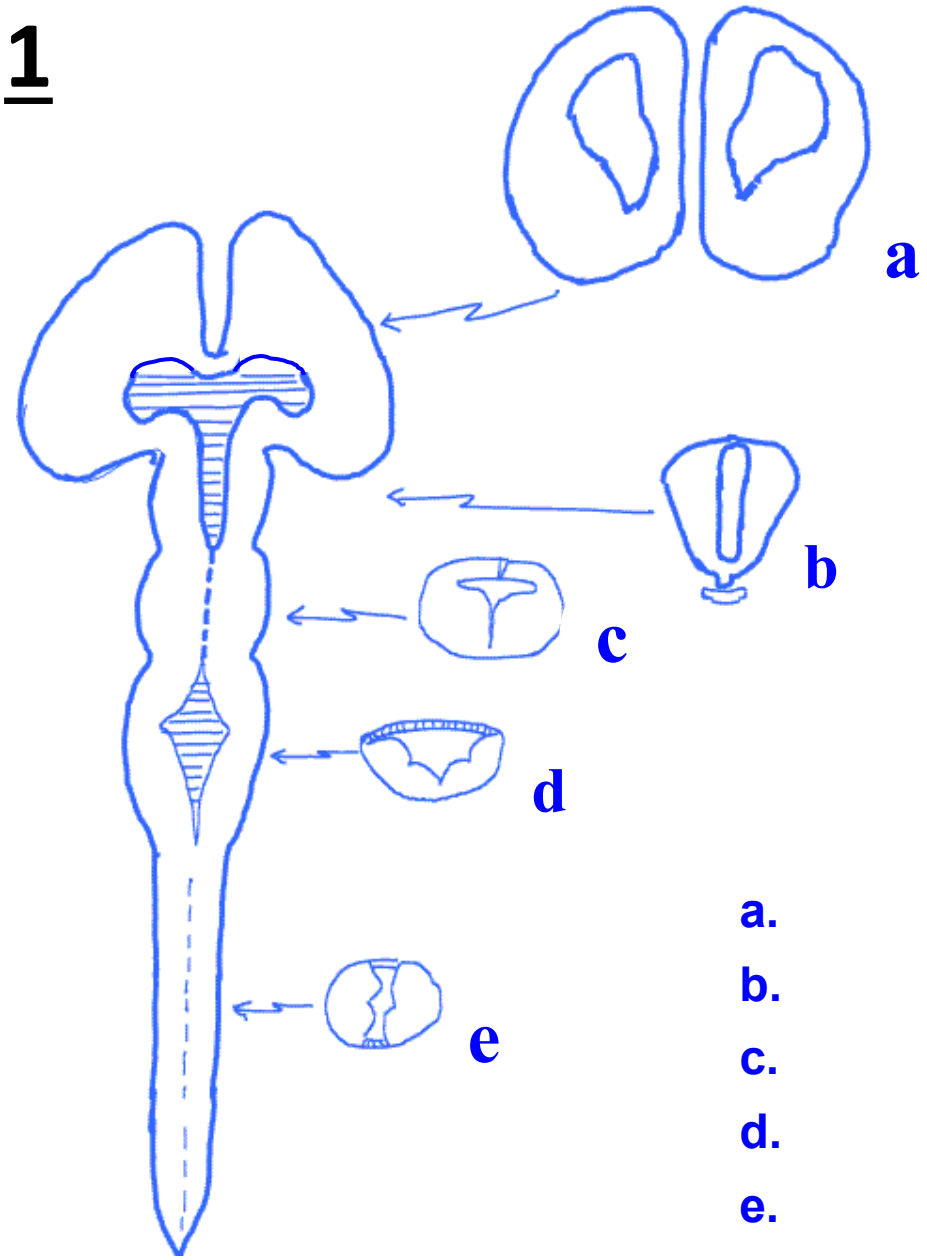
Fig 1.3

1



The thickening embryonic neural tube

a.

b.

c.

d.

e.

2

Synapses: varied structural arrangements:

Consider the functional possibilities

1. **Axo-somatic**
2. **Axo-dendritic**
   (to dendritic shaft or dendritic spine)

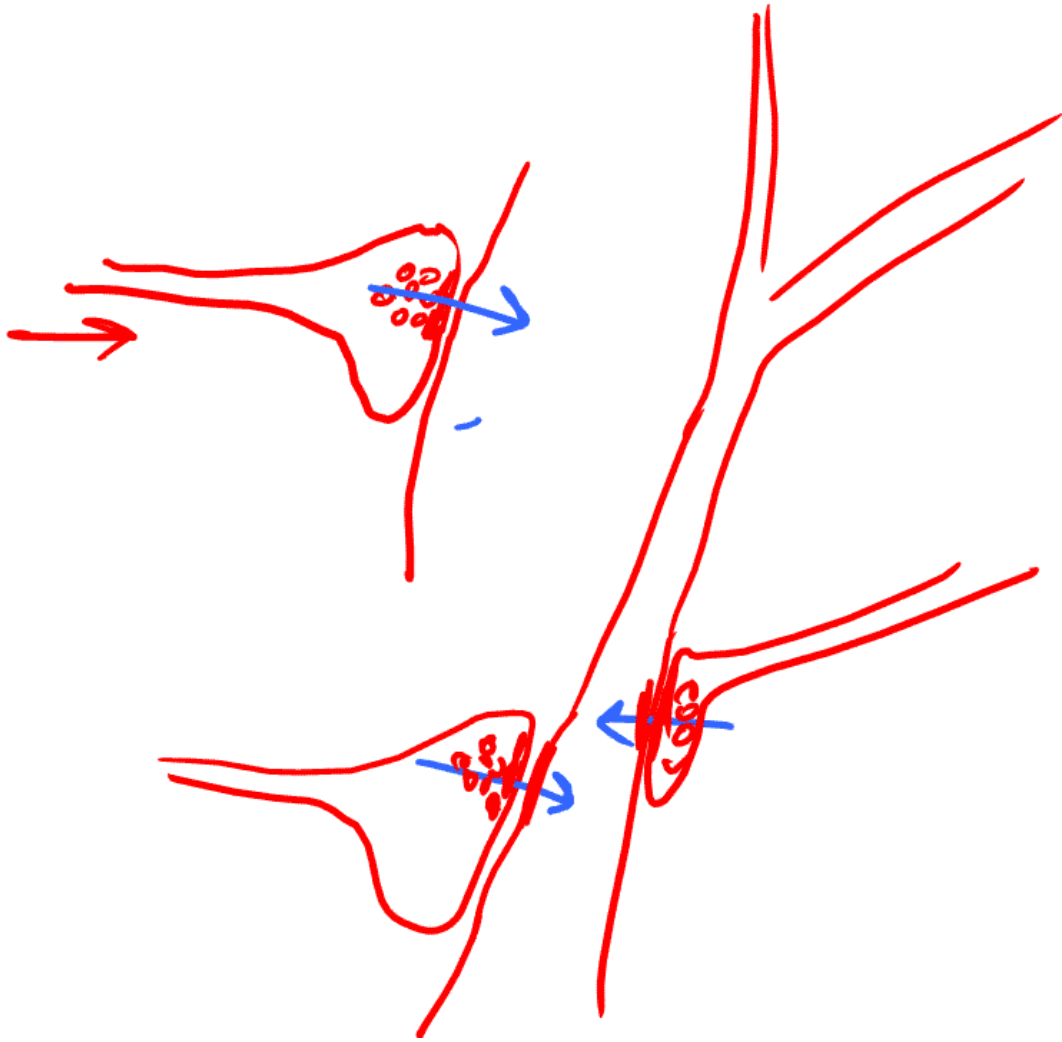


Fig 1-13a

3

Synapses: varied structural arrangements:

Consider the functional possibilities

6. Serial synapses

   Gating mechanisms…

7. Synapses without a postsynaptic site (not illustrated)

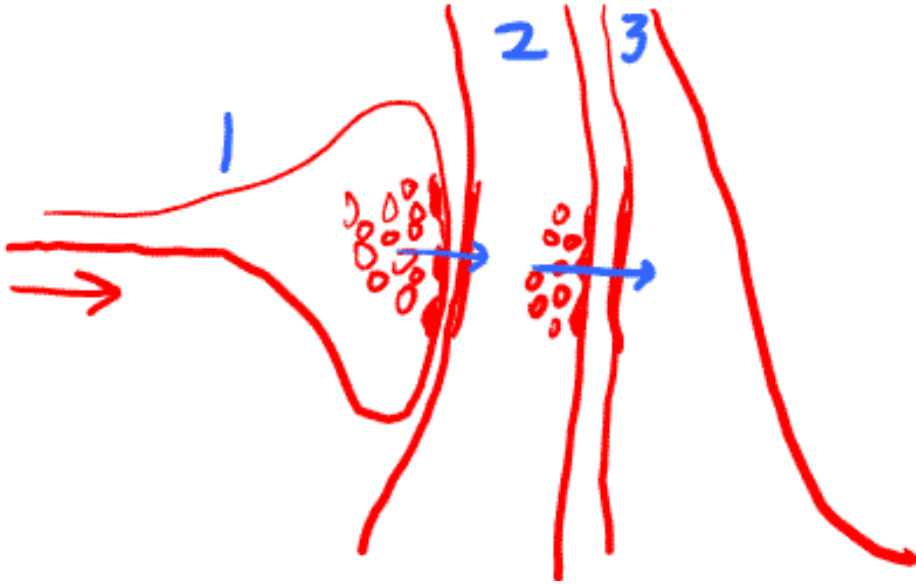


Fig 1-13c

Synapses: varied structural arrangements:

Consider the functional possibilities

3. **Axo-axonal**
   Presynaptic inhibition and facilitation
4. (Also: dendro-dendritic, dendro-axonal…)
5. Reciprocal synapses

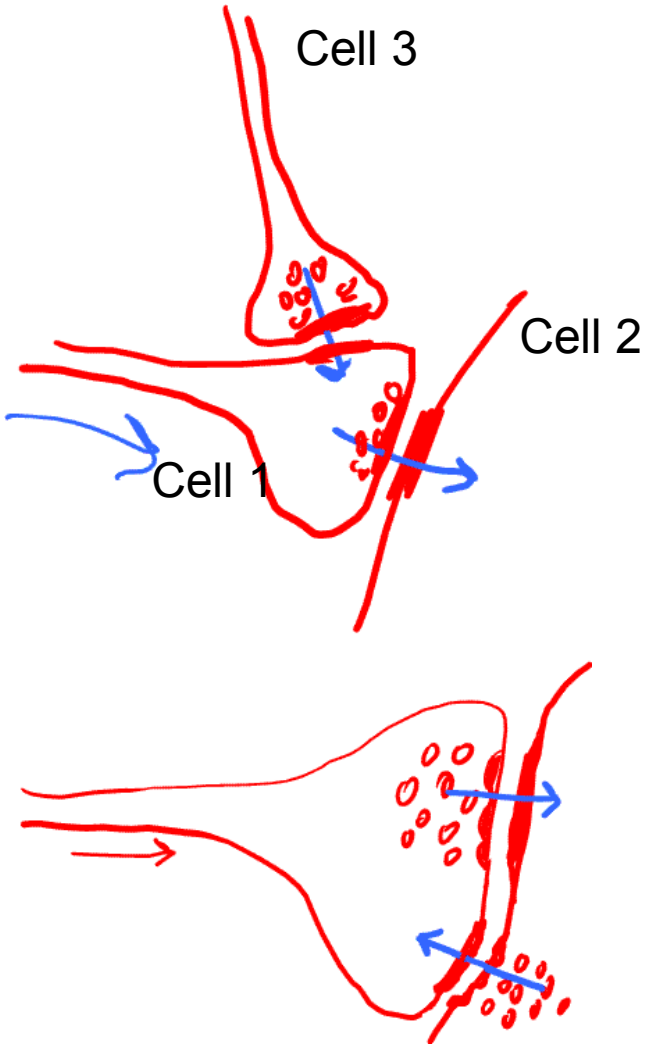


Fig 1-13b

5

Hamster Brain (similar to rat)

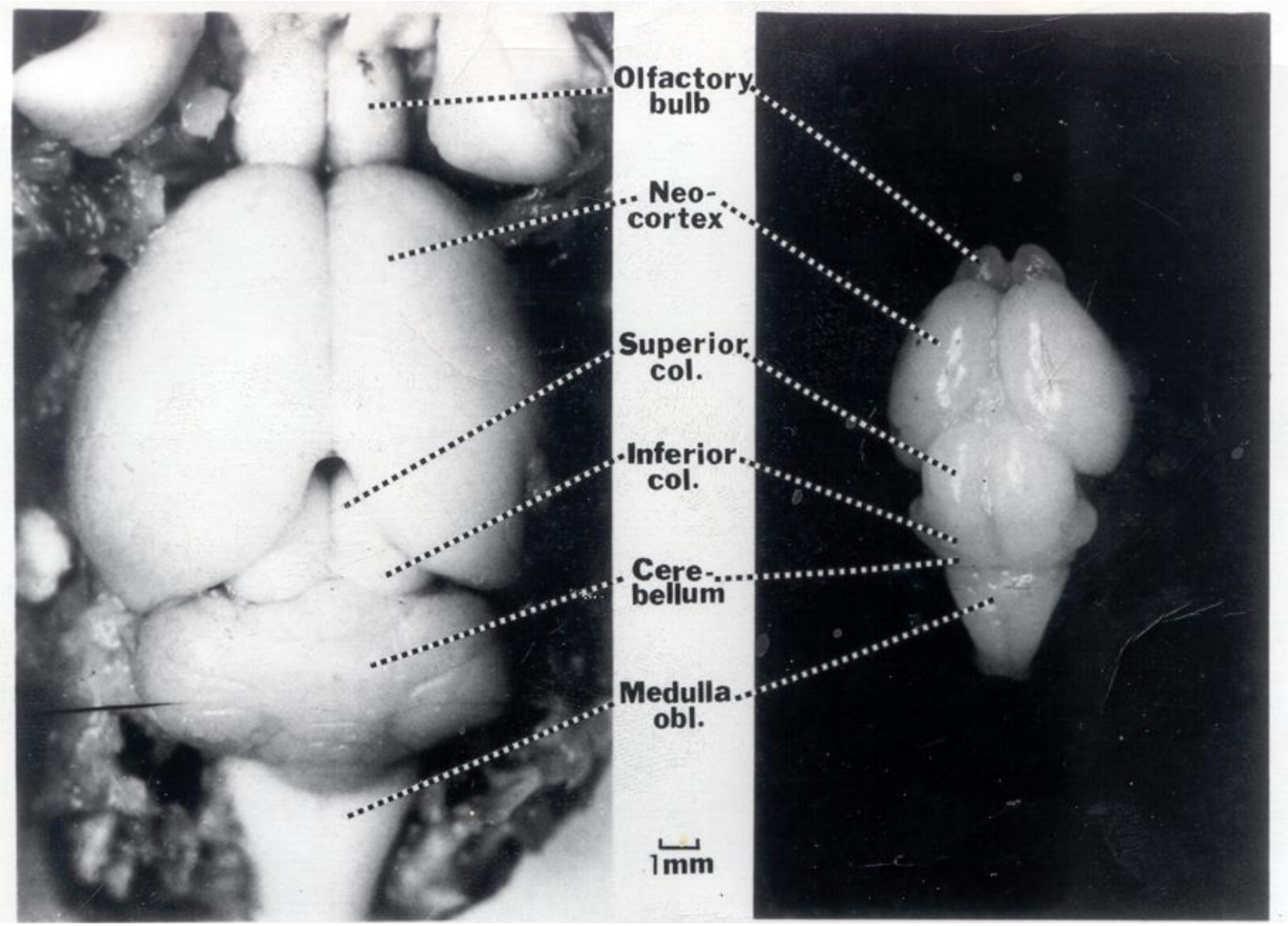


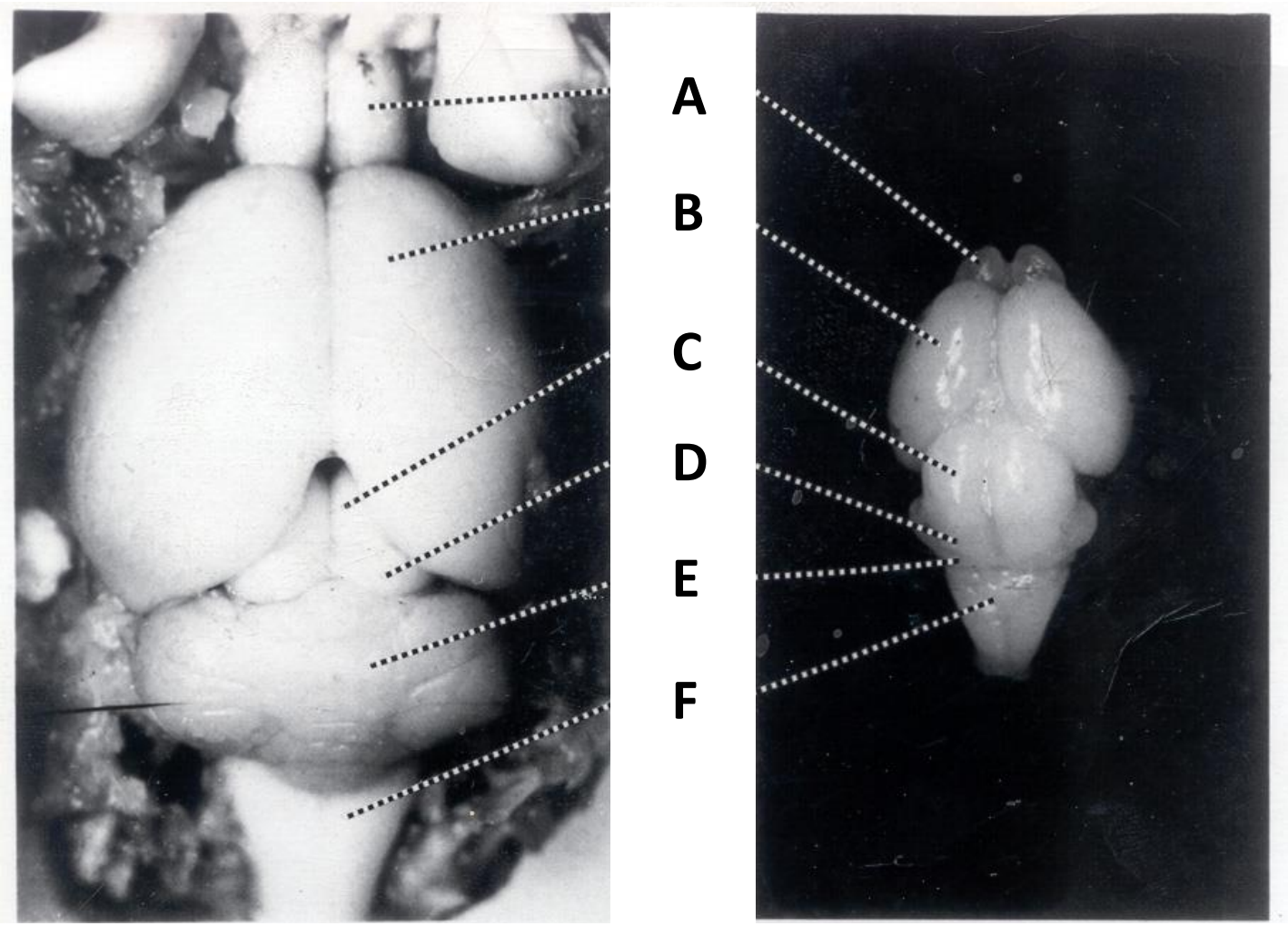
Fig.1-5

Adult

Newborn

5

Hamster Brain (similar to rat)



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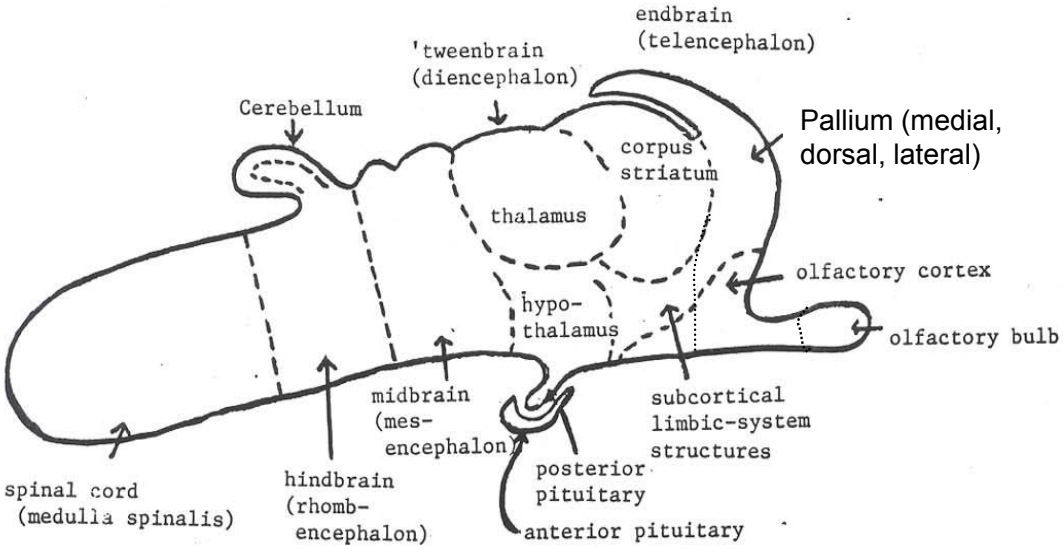
Adult

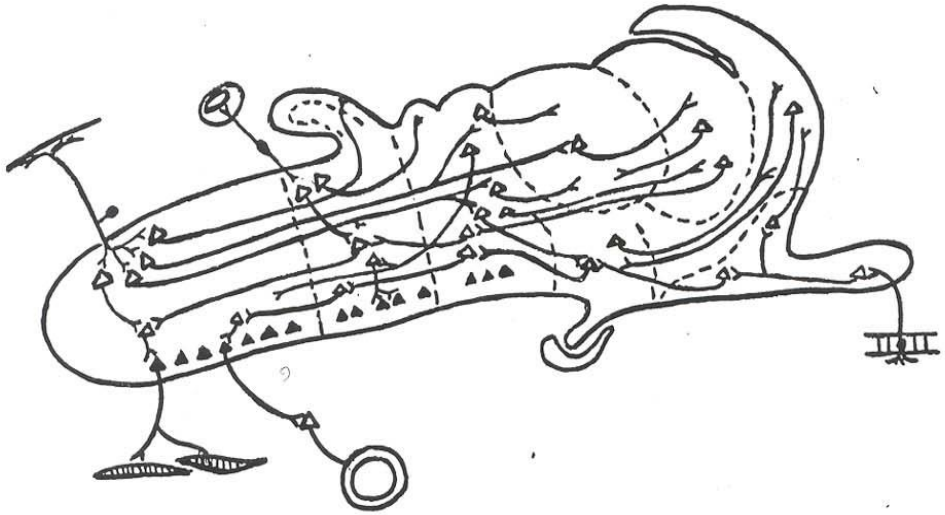
Newborn

6

Study the names of these subdivisions. Learn which is which.

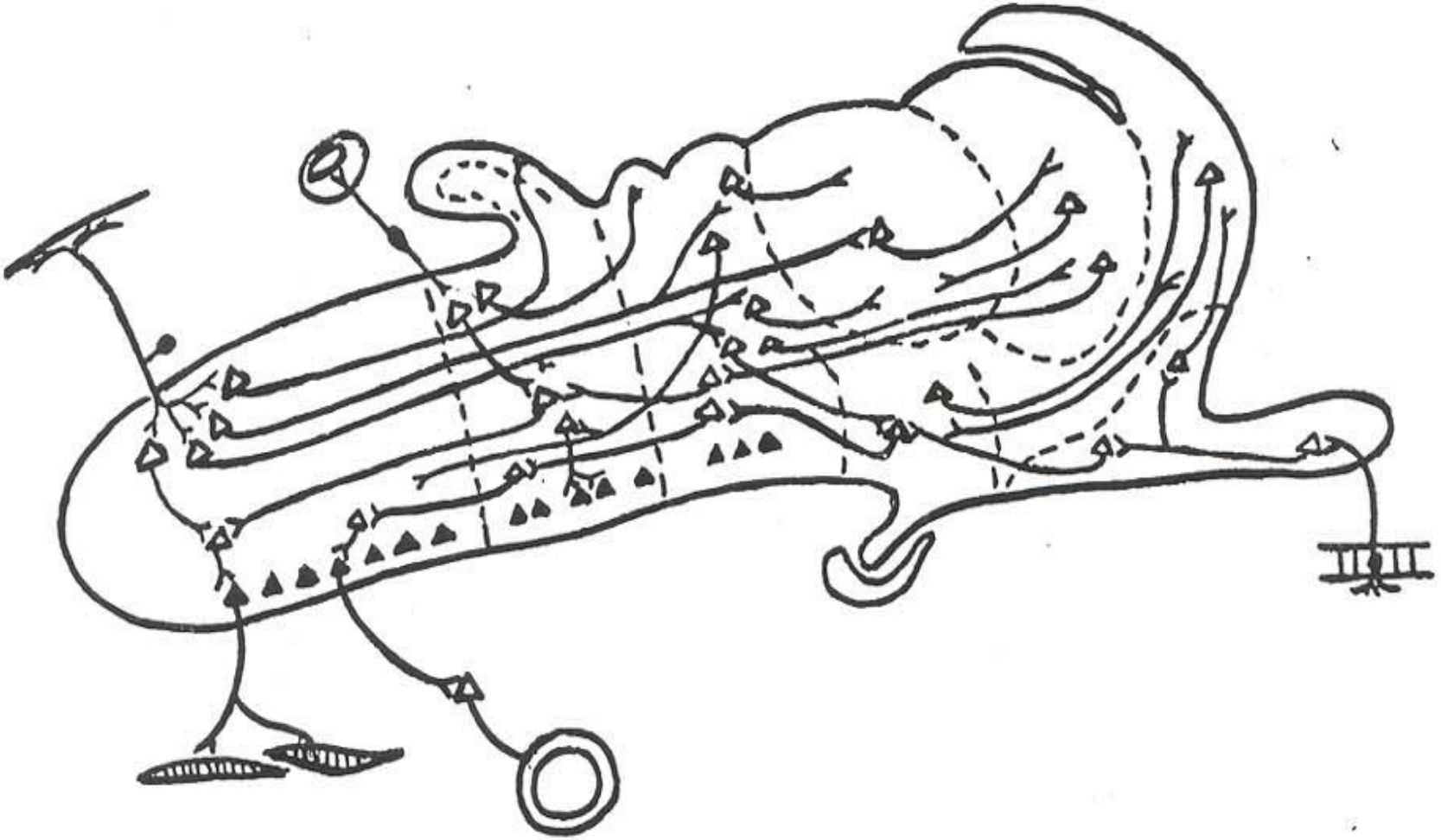
Schematic of pre-mammalian brain





7

Sketch of a pre-mammalian brain



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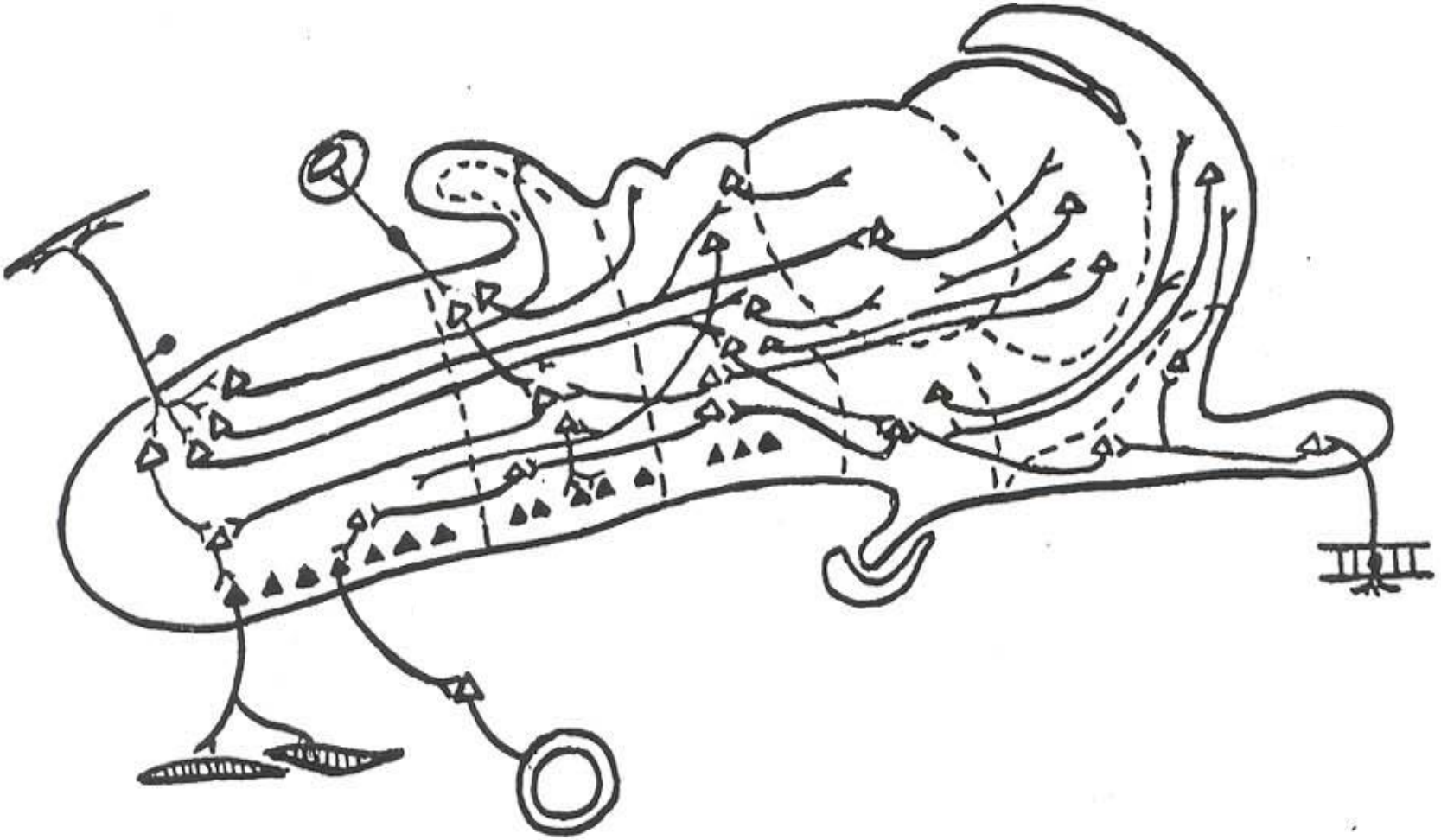
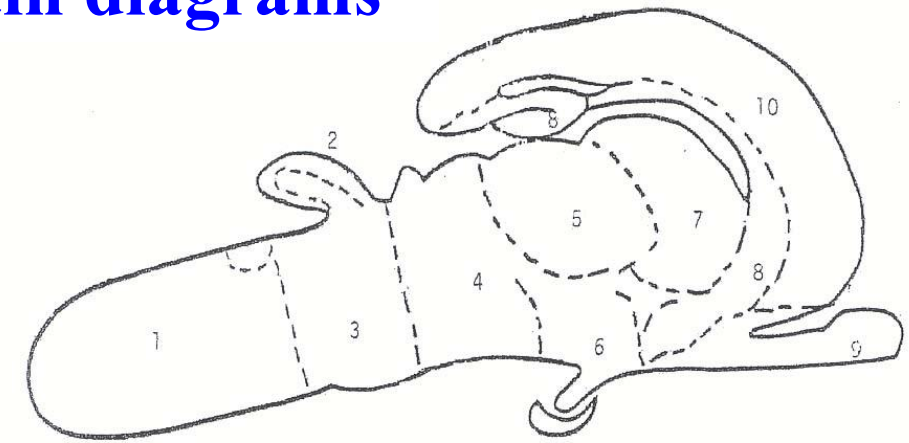
7 Locate a local reflex channel. What function might such a pathway serve?

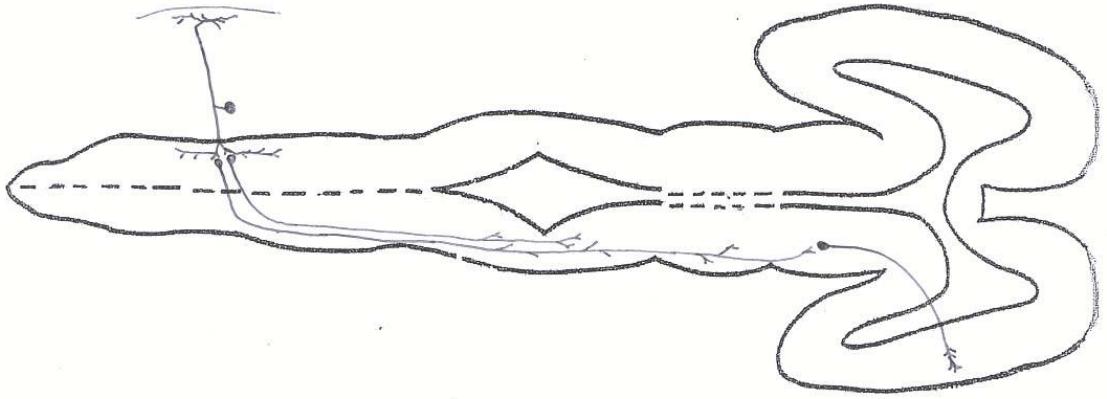


8 Mammalian brain diagrams

Schematic side view

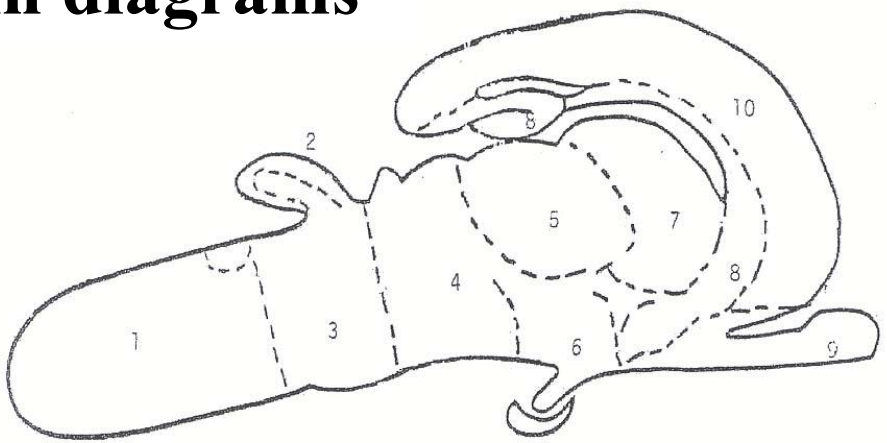


Top view, embryonic brain (with spinothalamic tract)

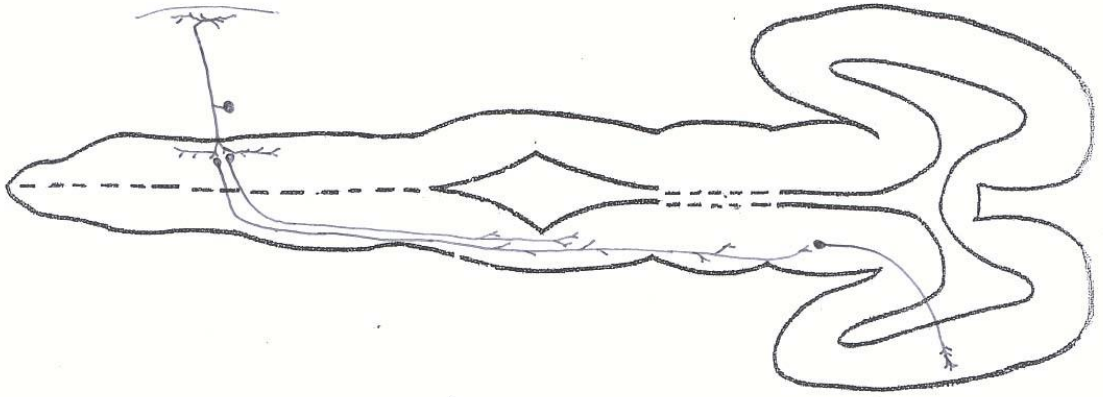


8 Mammalian brain diagrams

Schematic side view

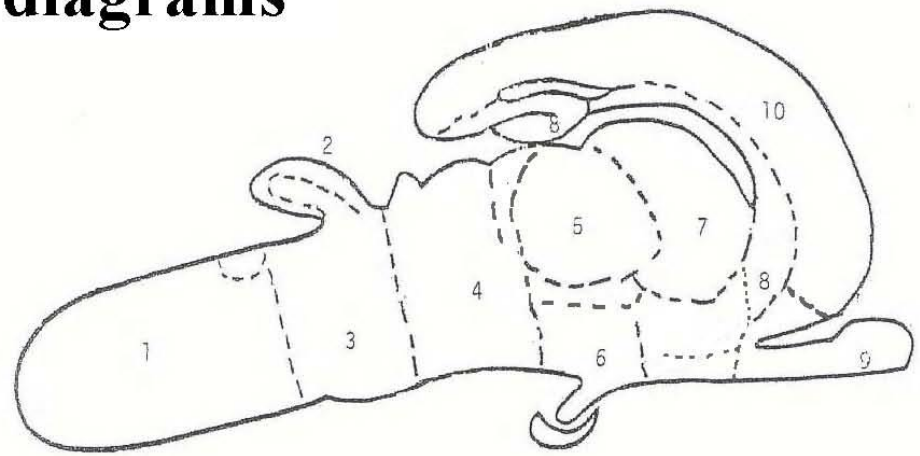


Top view, embryonic brain (with dorsal root axon)

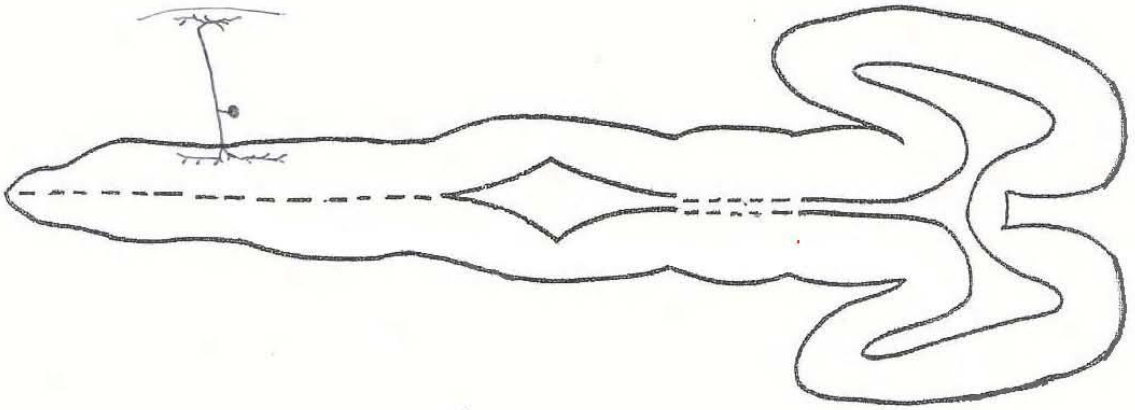


Mammalian brain diagrams

Schematic side view



Top view, embryonic brain (with dorsal root axon)



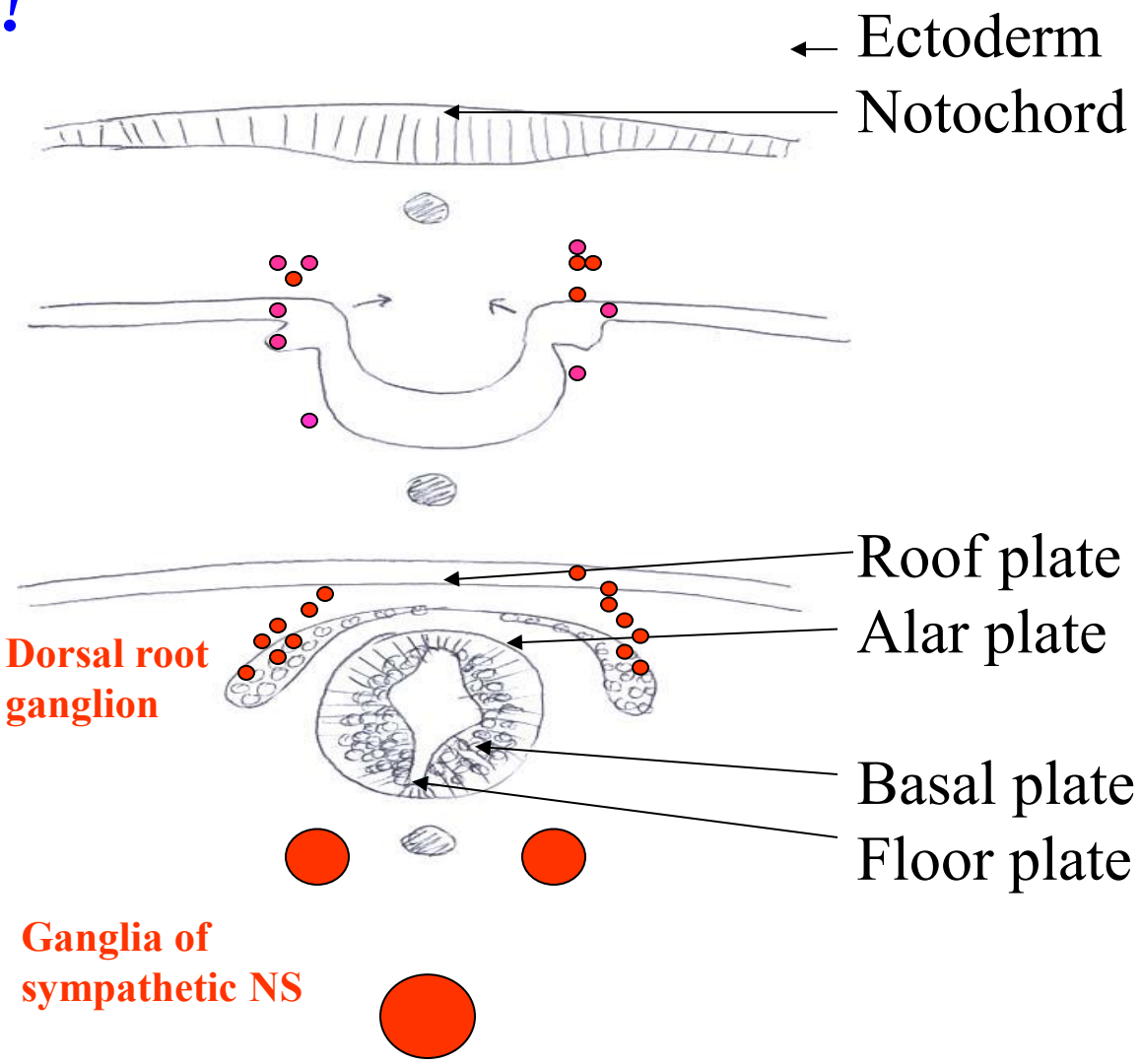
9 Closure of neural tube with formation of sympathetic ganglia:

Learn the terms!

Neural plate

Neural groove

Neural tube and **neural crest**



9 Closure of neural tube with formation of peripheral ganglia:

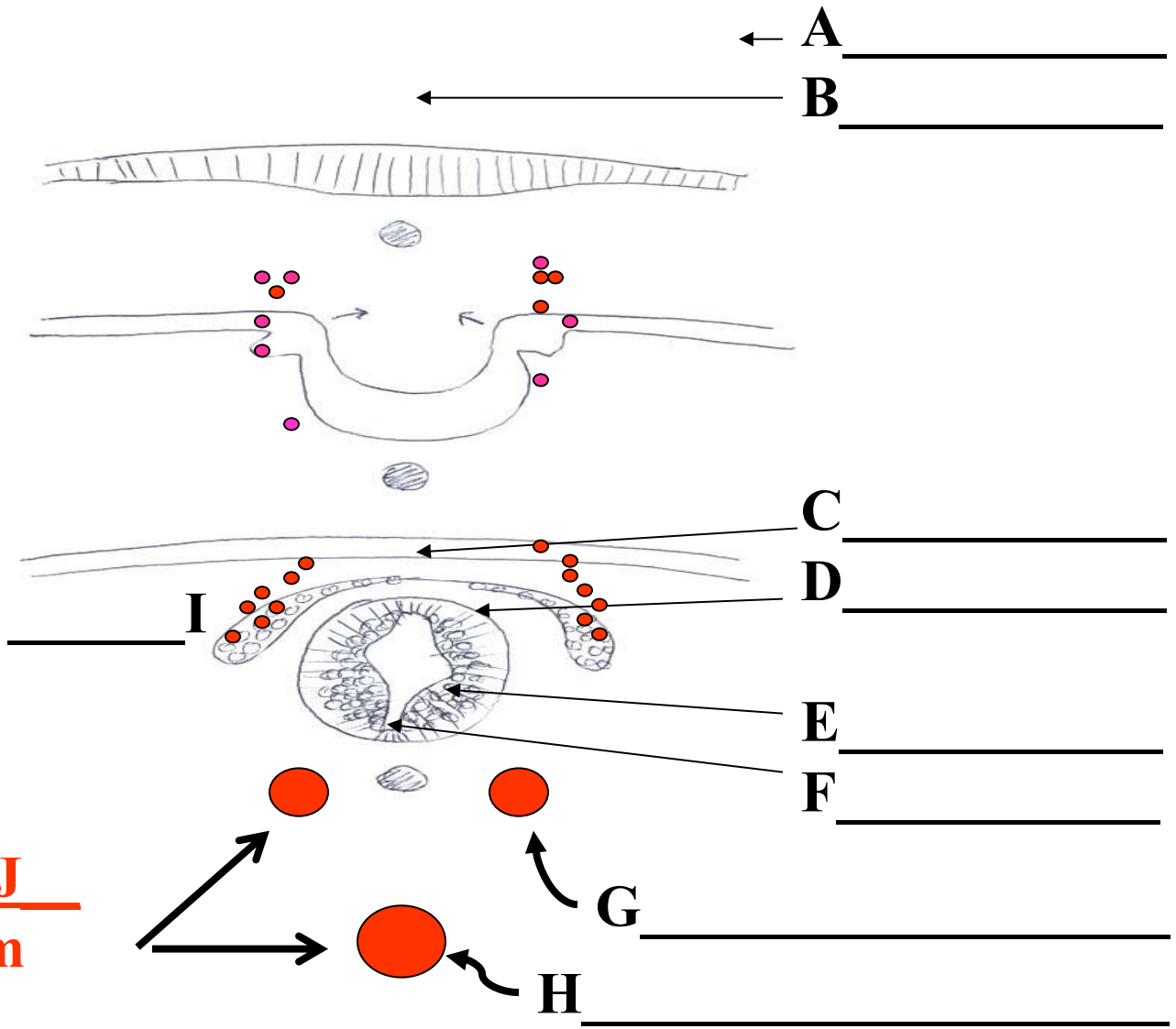
Neural **X** stage

Neural **Y** stage

Neural **Z** and

neural ZZ

Ganglia of J nervous system



REVIEW

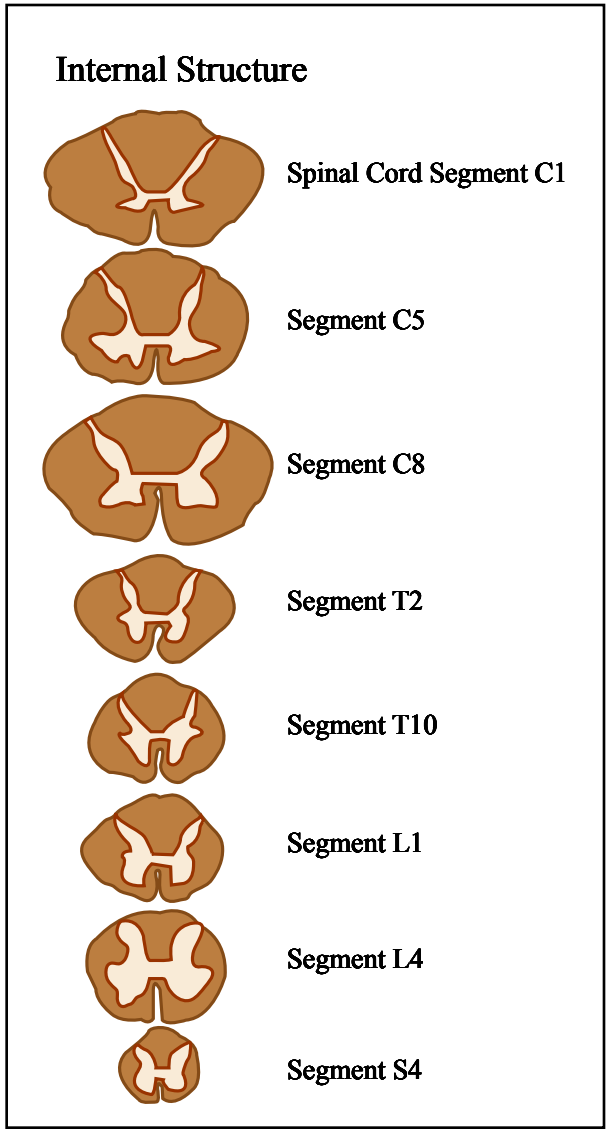
Some neurodevelopment terms to be familiar with

- ectoderm (*vs.* mesoderm and endoderm),
- ventricular layer, intermediate layer, marginal layer (= matrix layer, mantle layer, zonal layer)
- modes of migration,
- radial glia (radial astrocytes),
- ependyma,
- sulcus limitans, separating alar and basal plates,
- neural crest,
- dorsal and ventral roots and rootlets.

See Nauta & Feirtag, ch.10, and other texts

10

Internal structure of spinal cord:
Note the lateral horn



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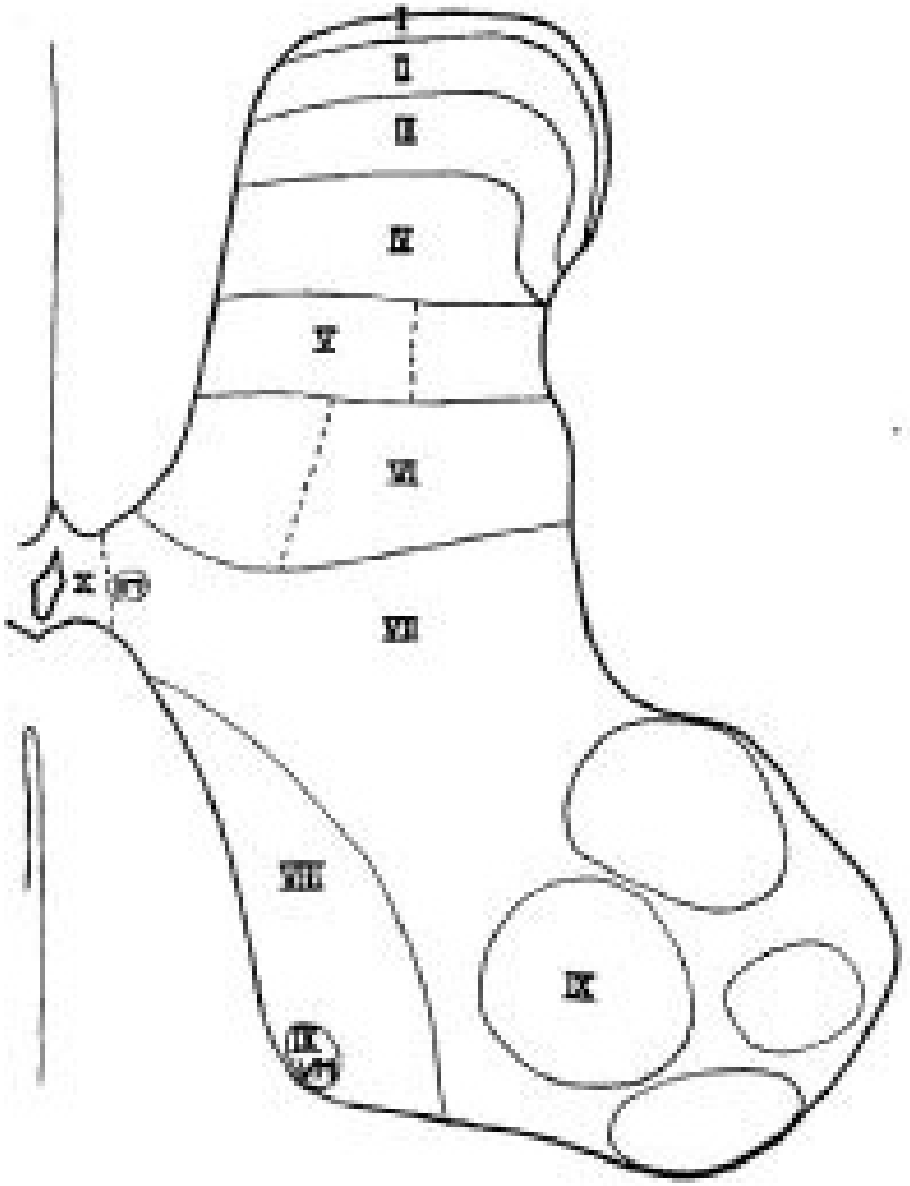
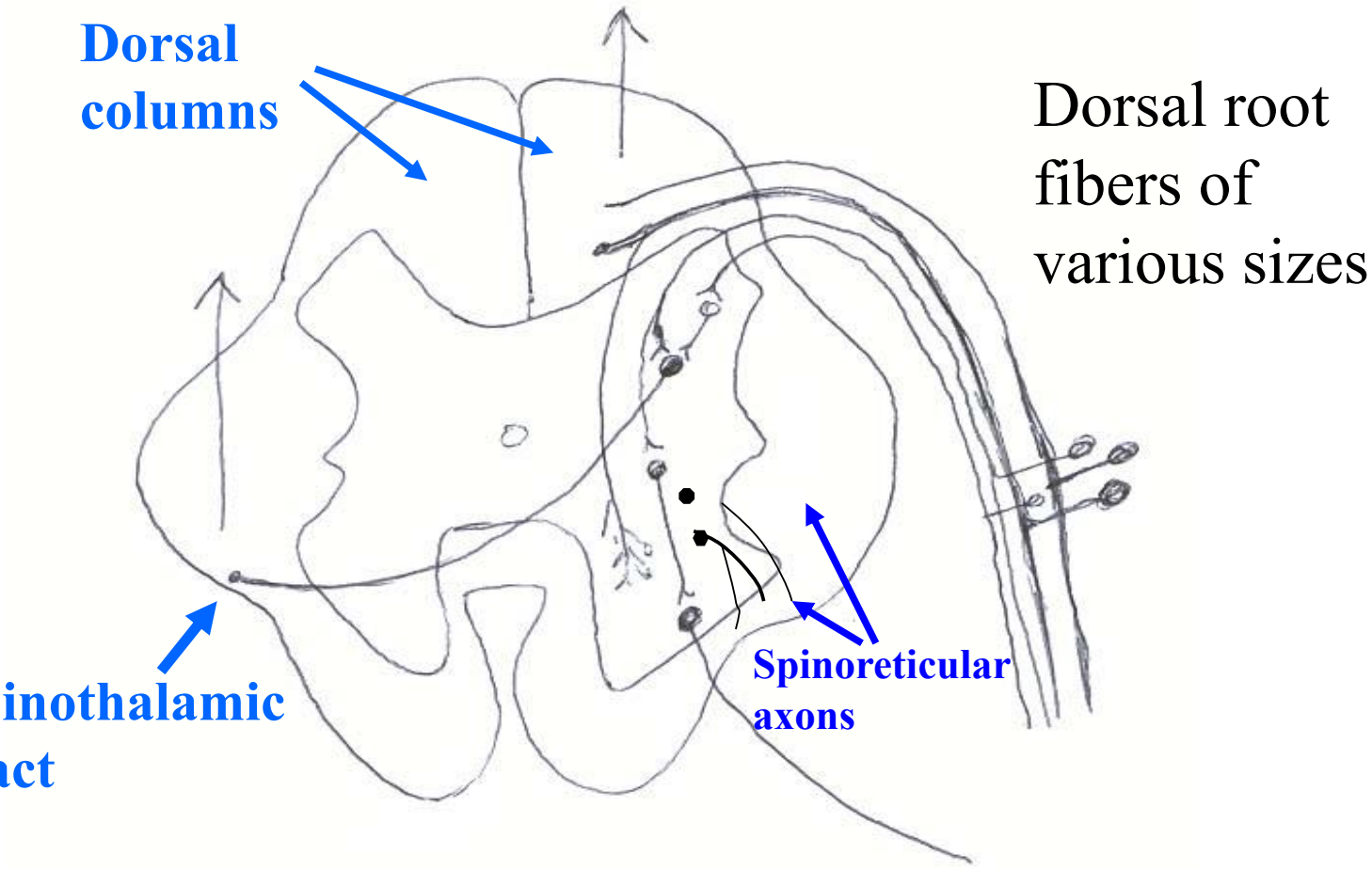
11

Termination of dorsal root fibers

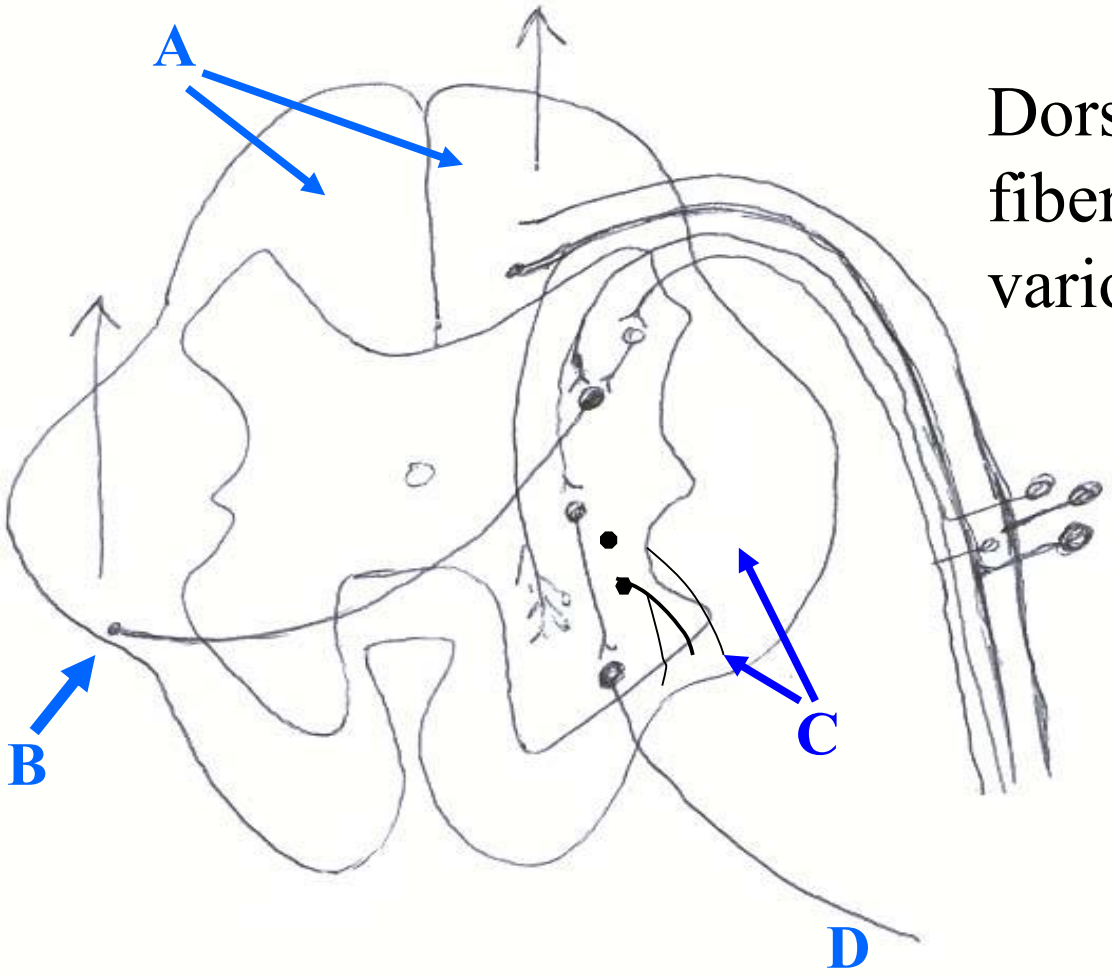


Figures removed due to copyright restrictions.
Please see course textbook or: Rexed, Bror. "A Cytoarchitectonic Atlas of the Spinal Coed in the Cat." *Journal of Comparative Neurology* 100, no. 2 (1954): 297-379.

Adult spinal cord, schematic frontal section: reflex and lemniscal channels



Adult spinal cord, schematic frontal section: reflex and lemniscal channels



Dorsal root fibers of various sizes

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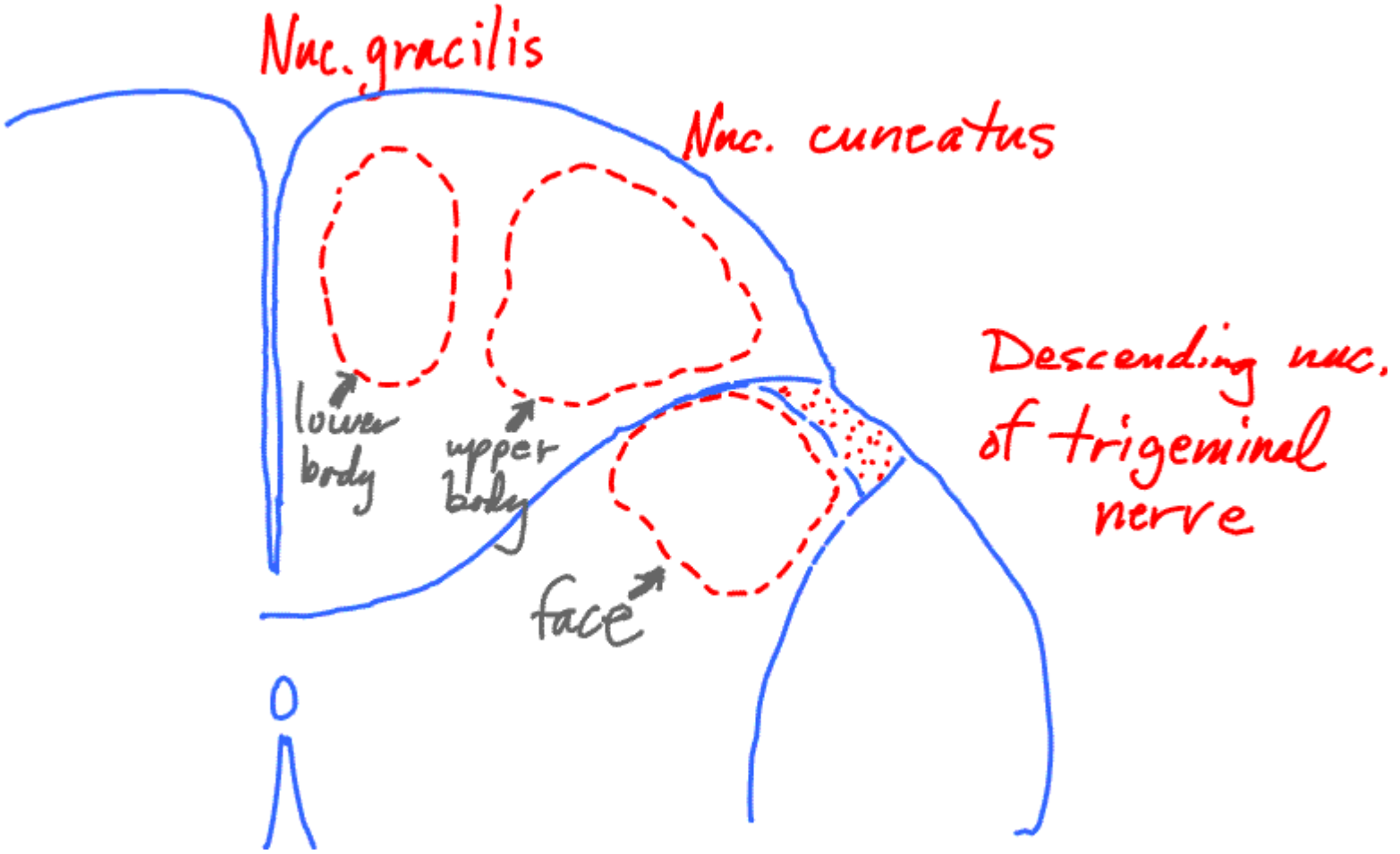
The body surface represented at the hindbrain-spinal cord boundary



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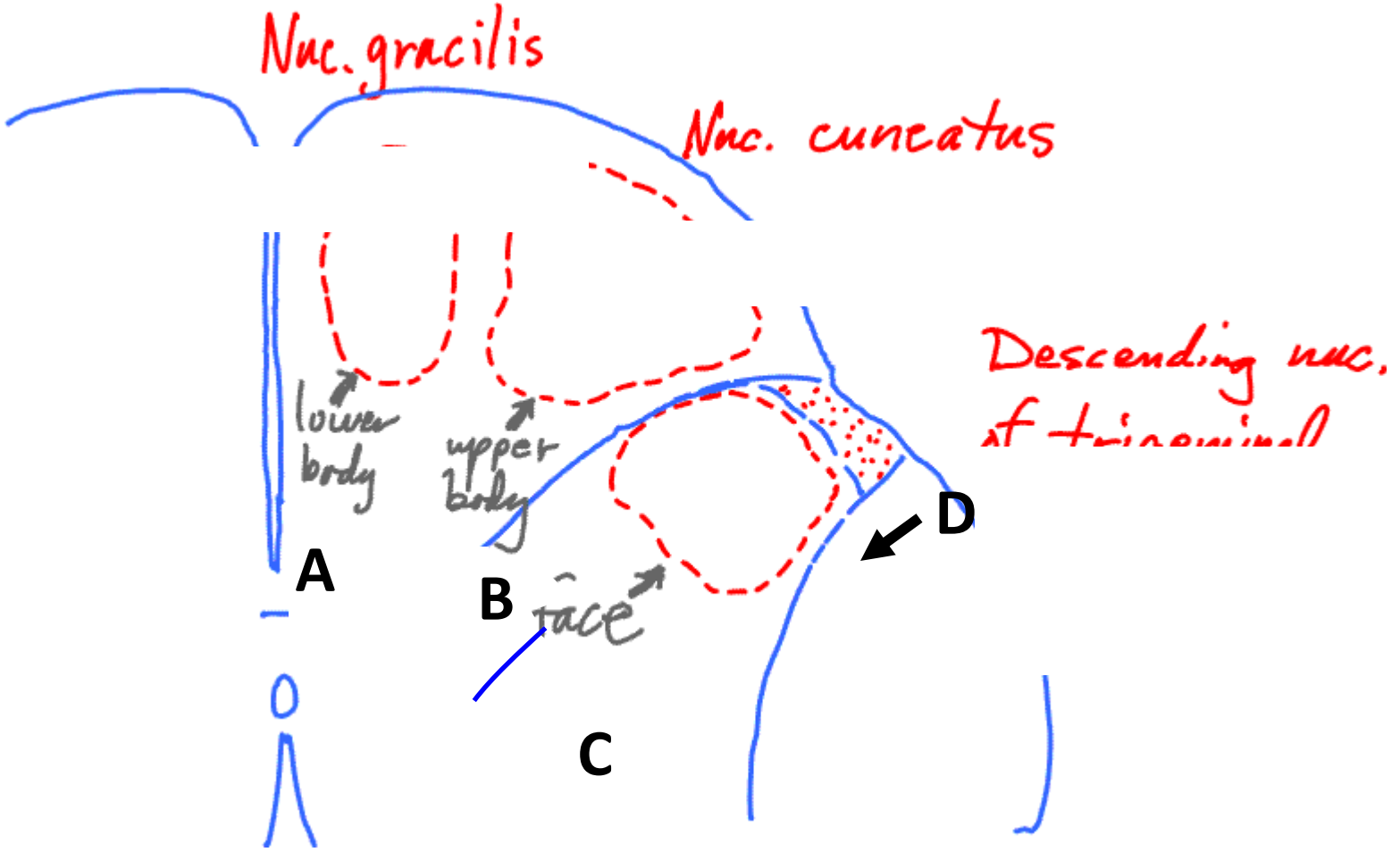
13

The rostral-most end of the spinal cord



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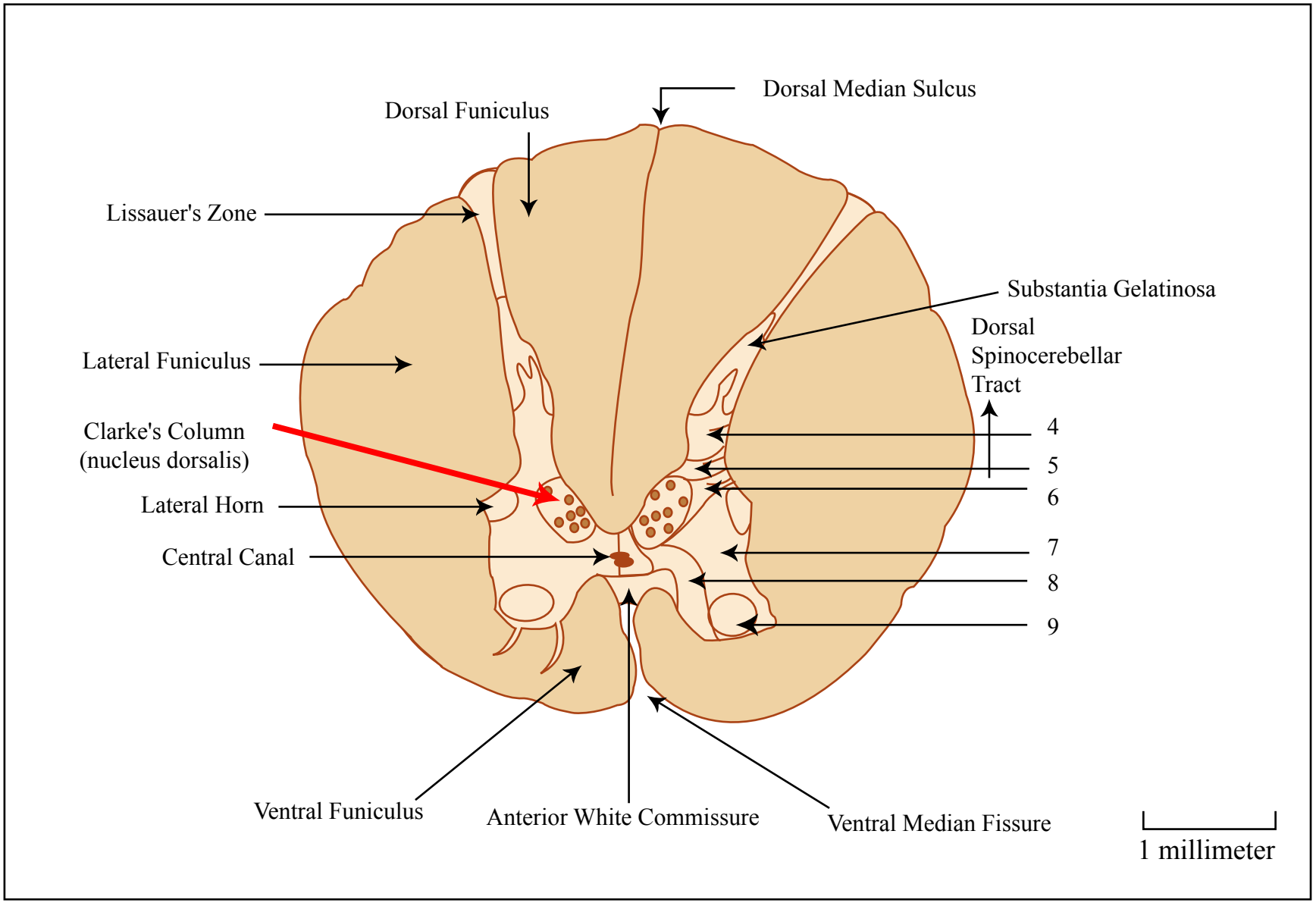
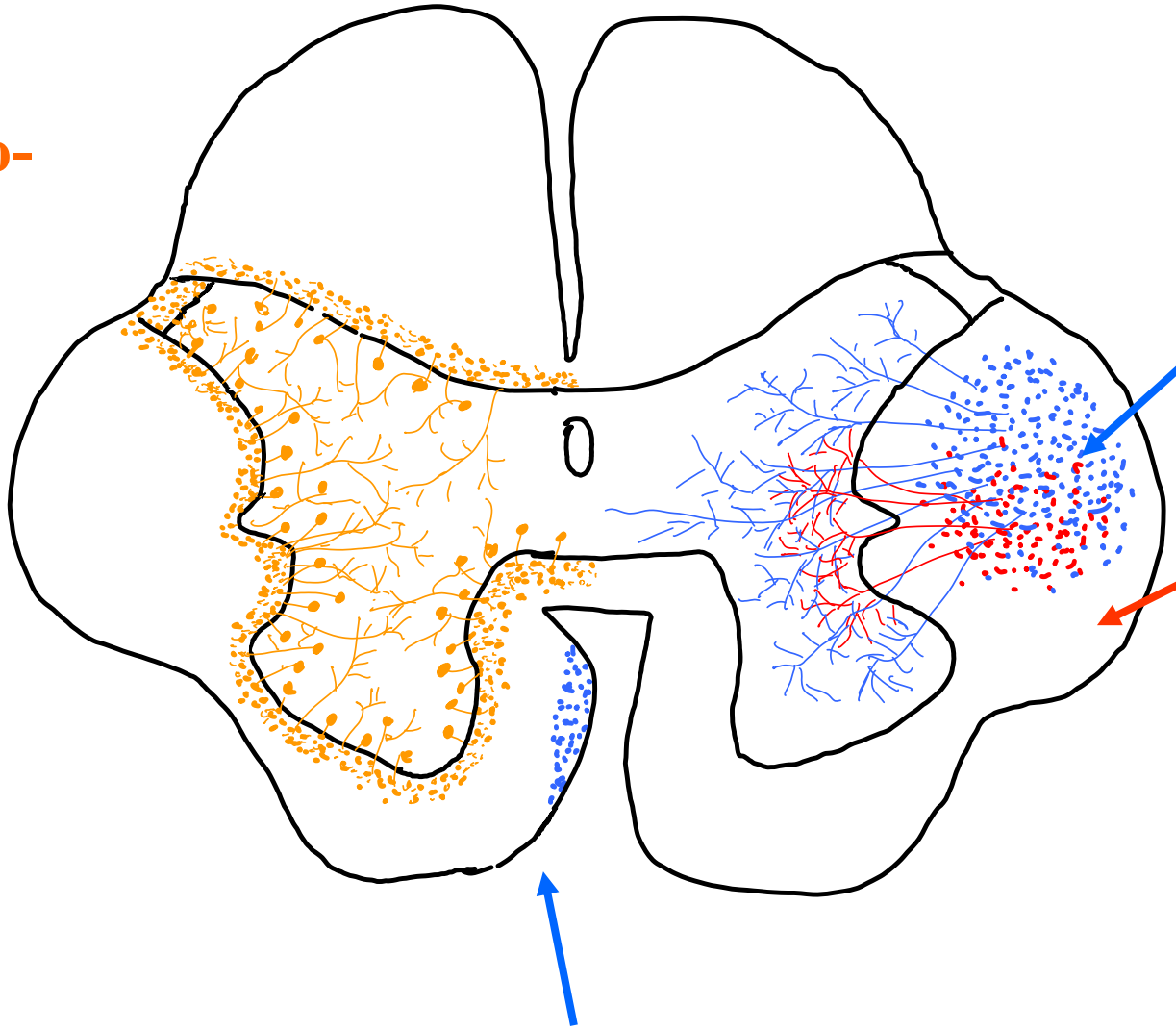


Fig 9-9 **Clarke's Column and dorsal spino-cerebellar tract**

Adult spinal cord: some descending and intrinsic axons



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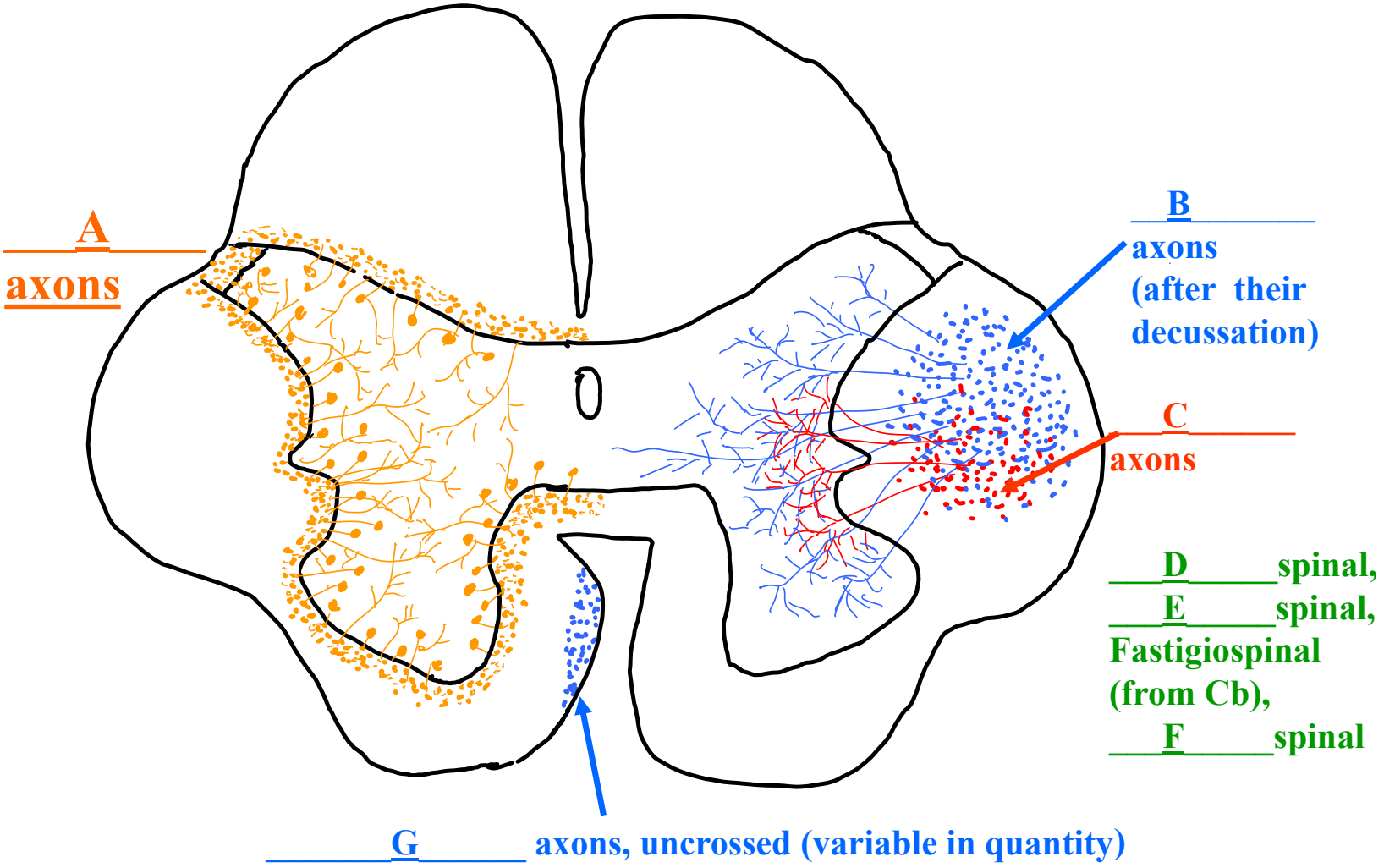
Adult spinal cord: some descending and intrinsic axons (fill in the blanks)



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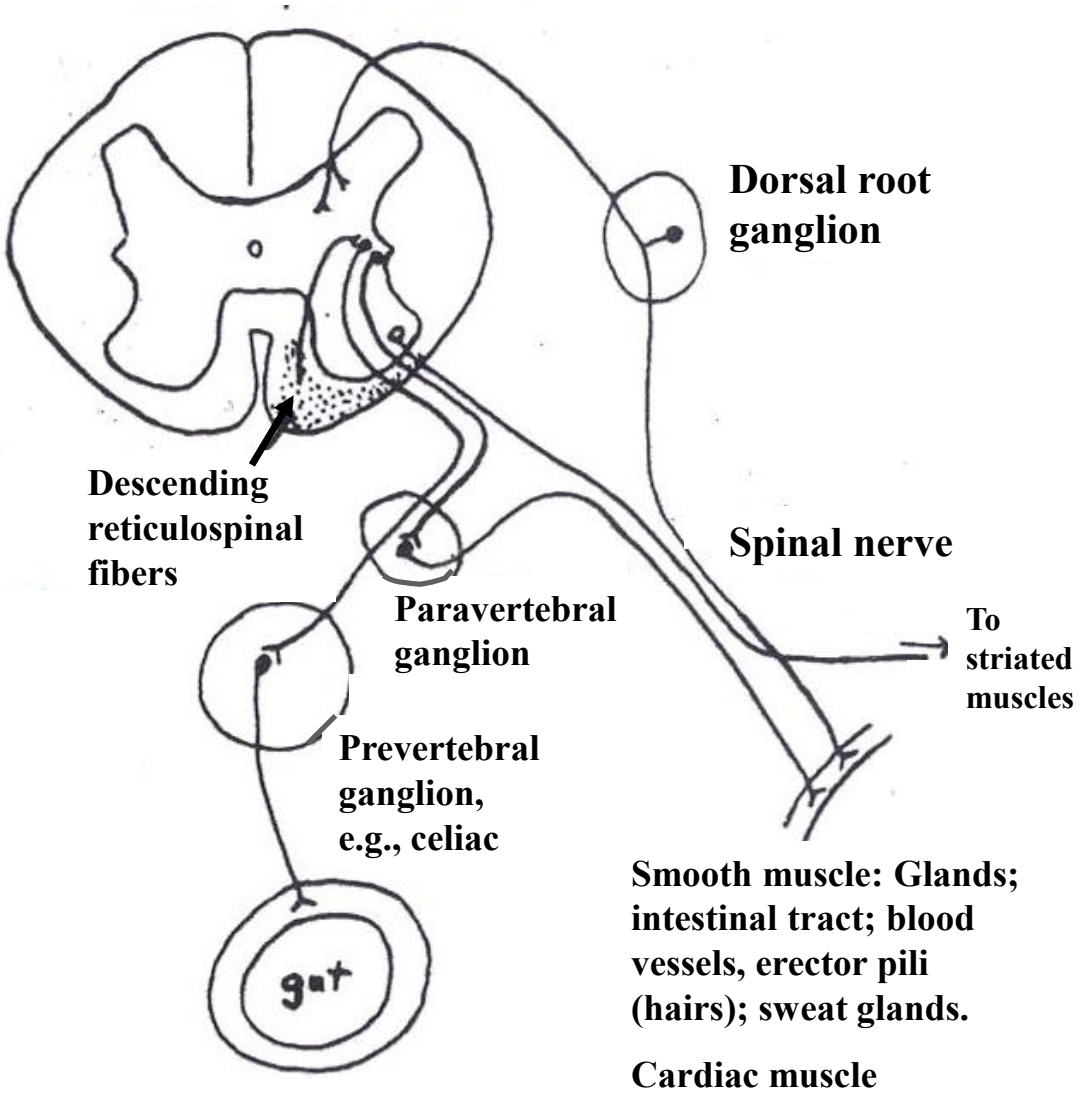
Sympathetic nervous system axons, schematic section of spinal cord, thoracic level



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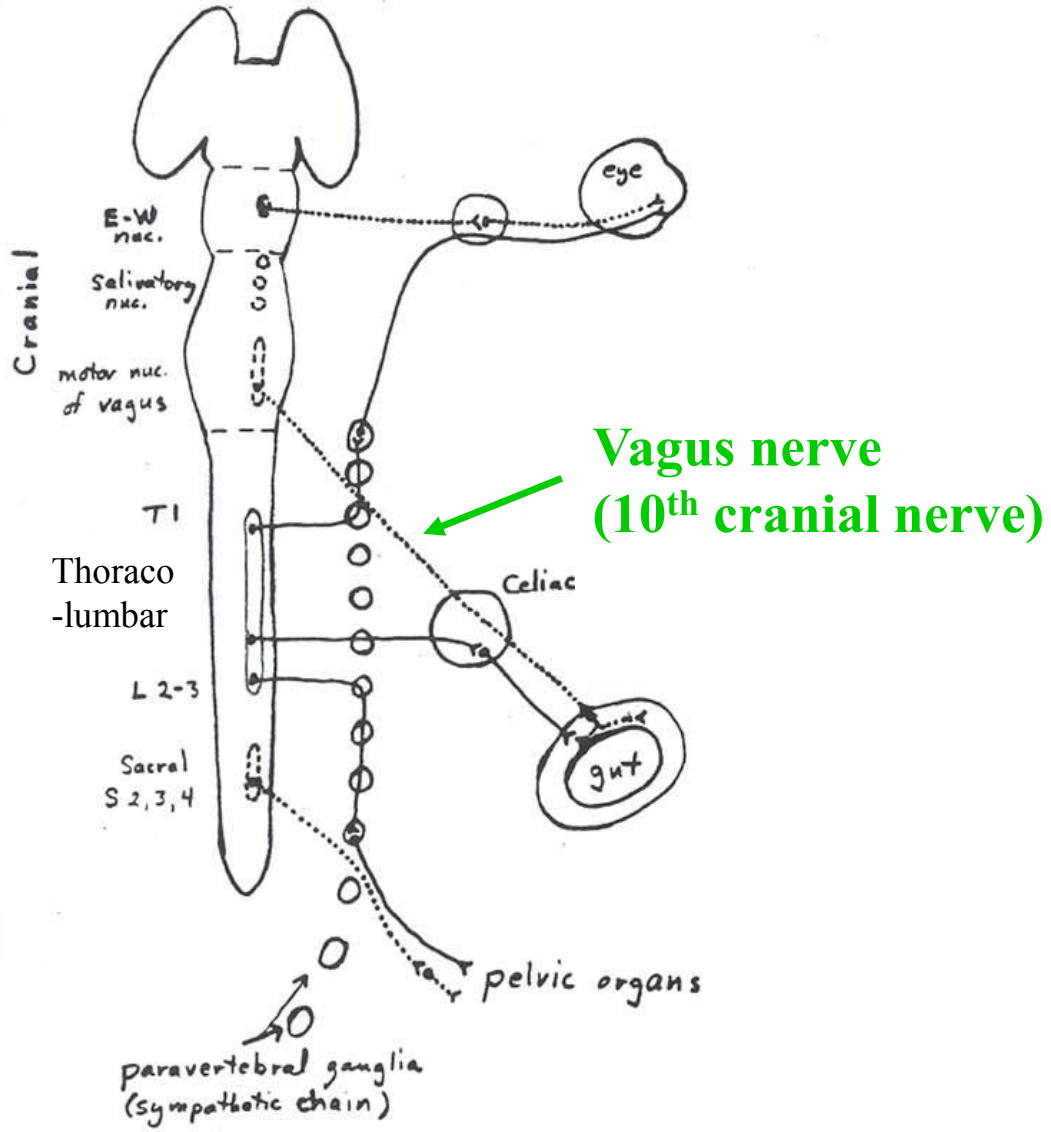

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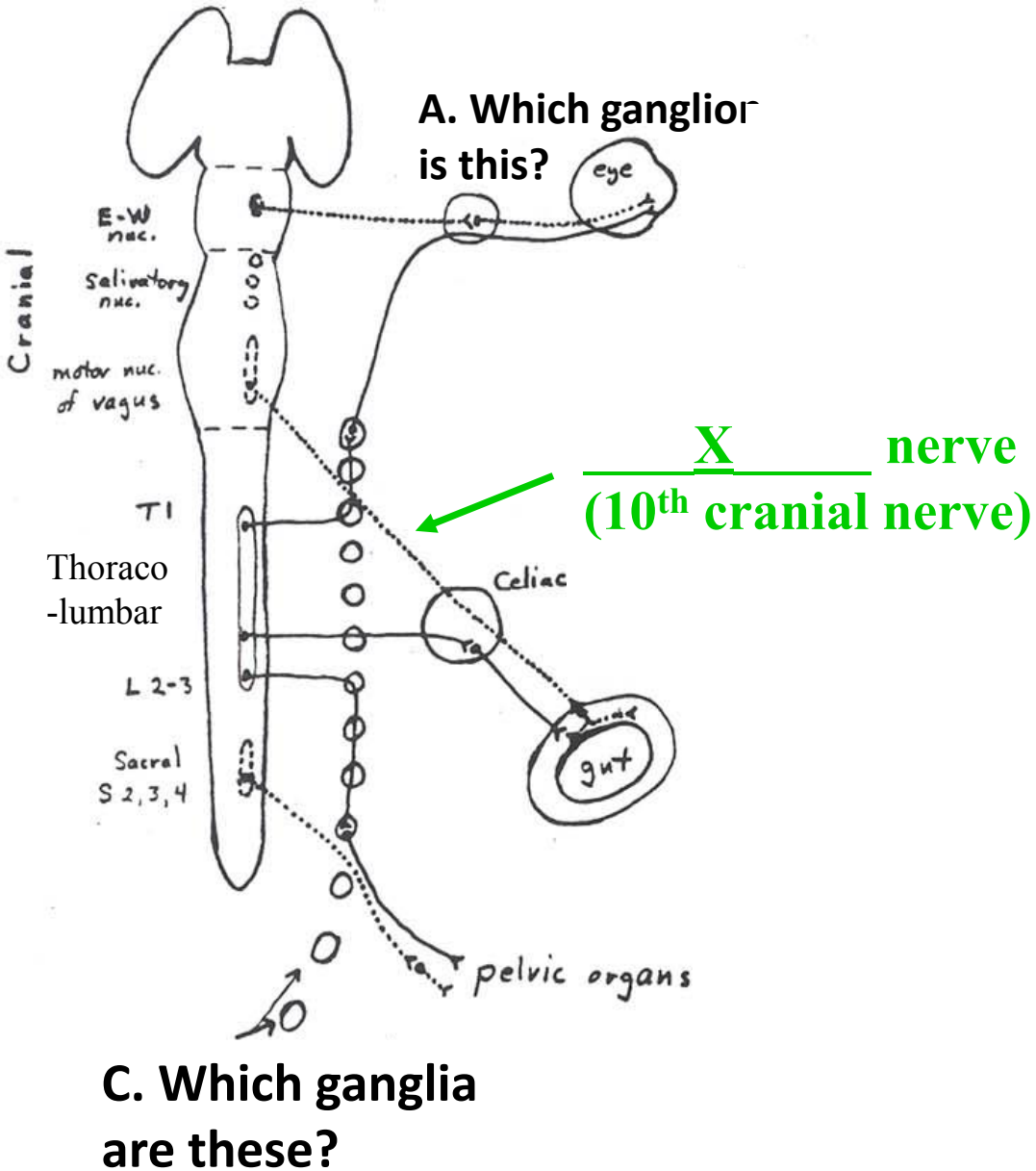

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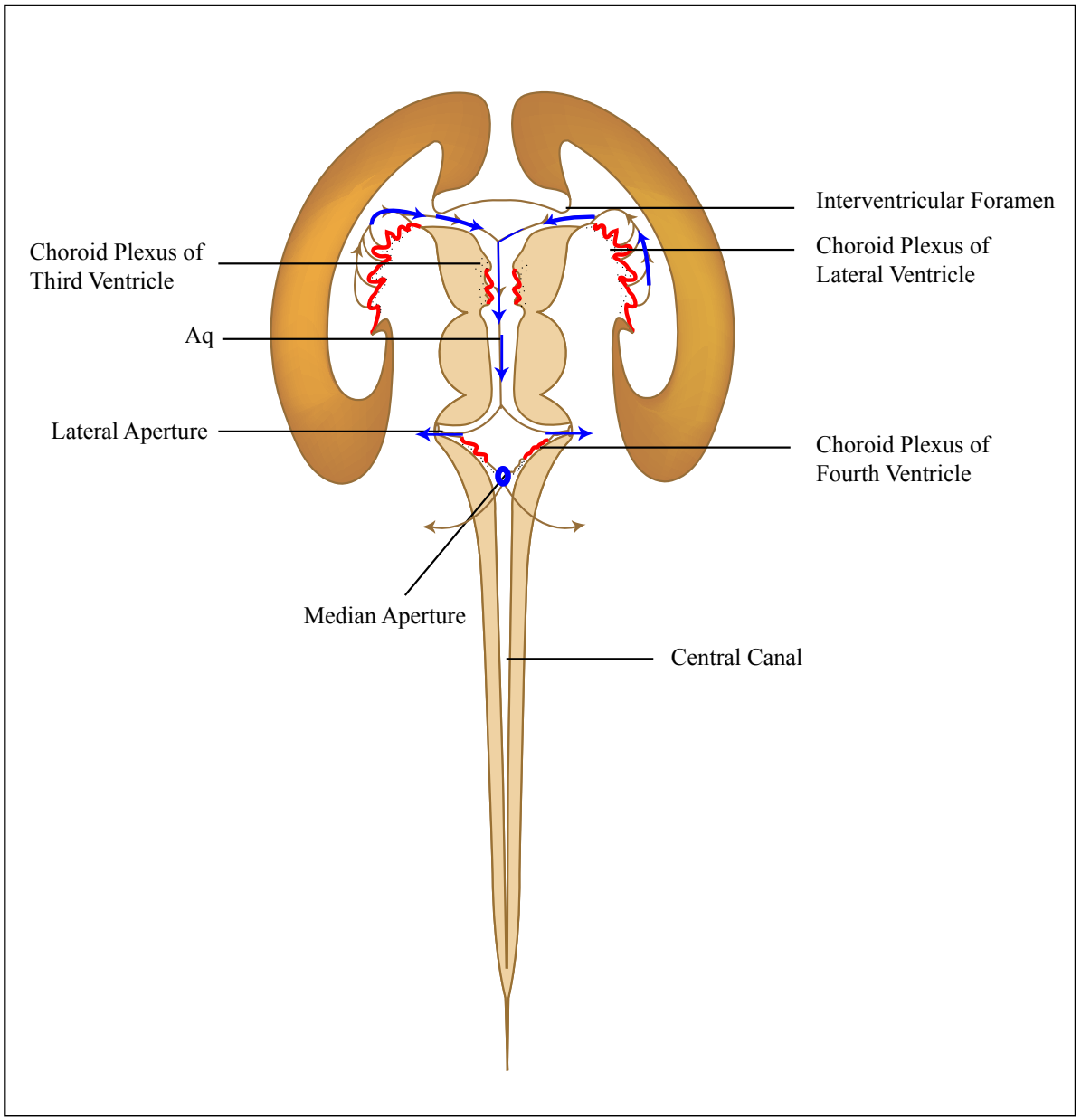

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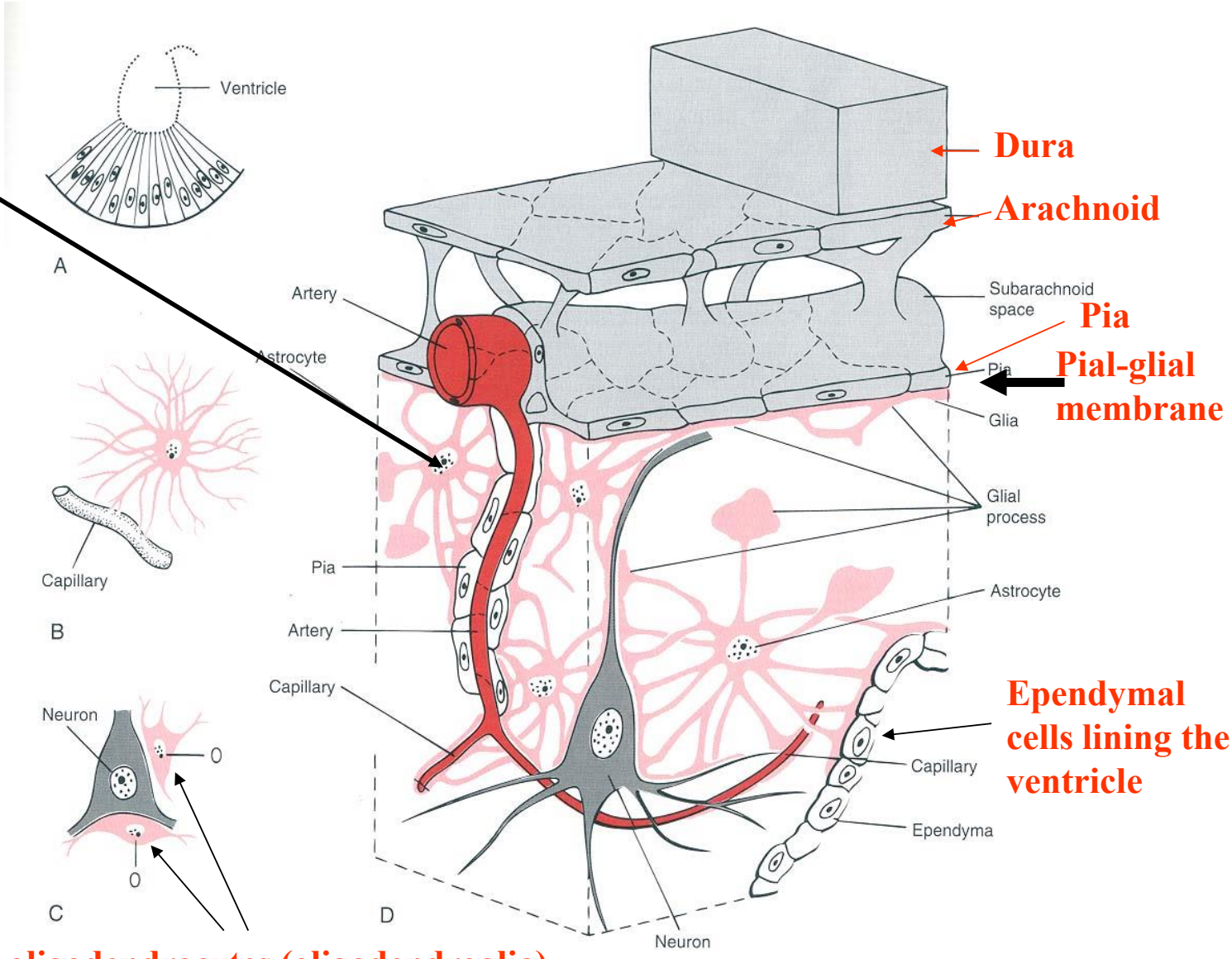
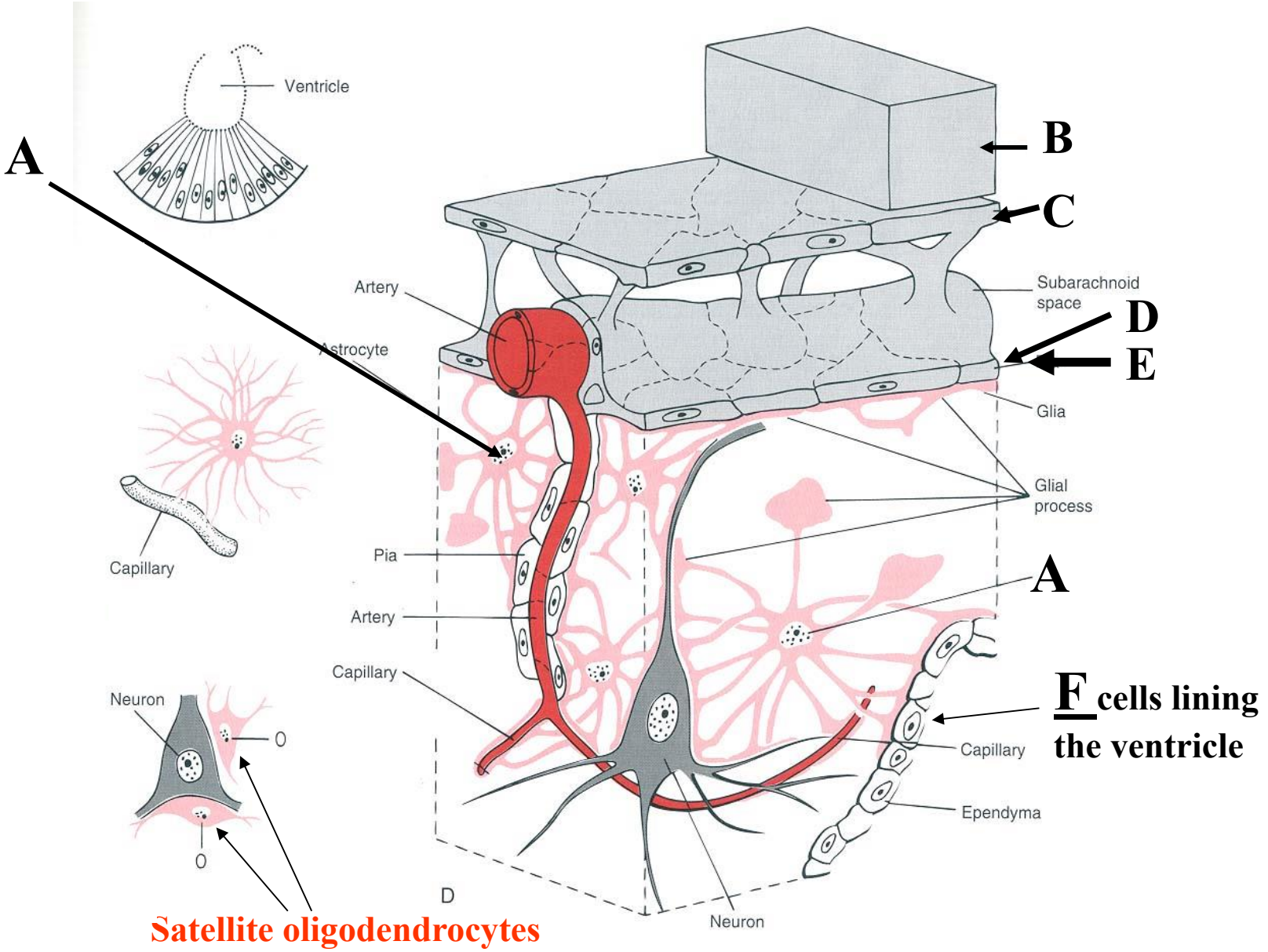
Ventricular system

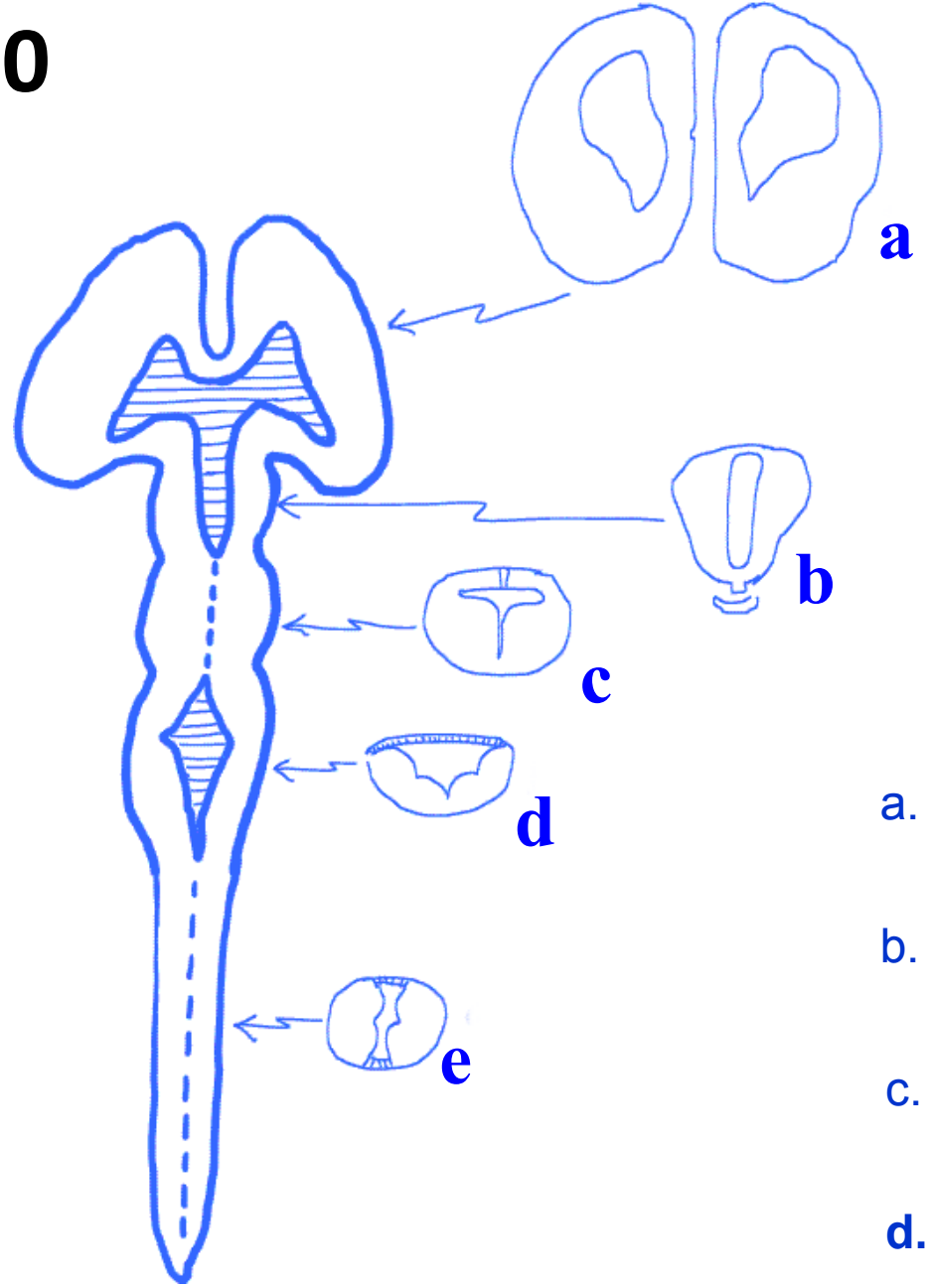
Fig 9a-1

Meninges & Glia



19 Meninges & Glia (Identify structures indicated)





Basic subdivisions, embryonic neural tube:

Where is the rhombus? What is it?

a. Endbrain (telencephalon)
b. 'Tweenbrain (diencephalon)

} Forebrain (prosencephalon)

c. Midbrain (mesencephalon)

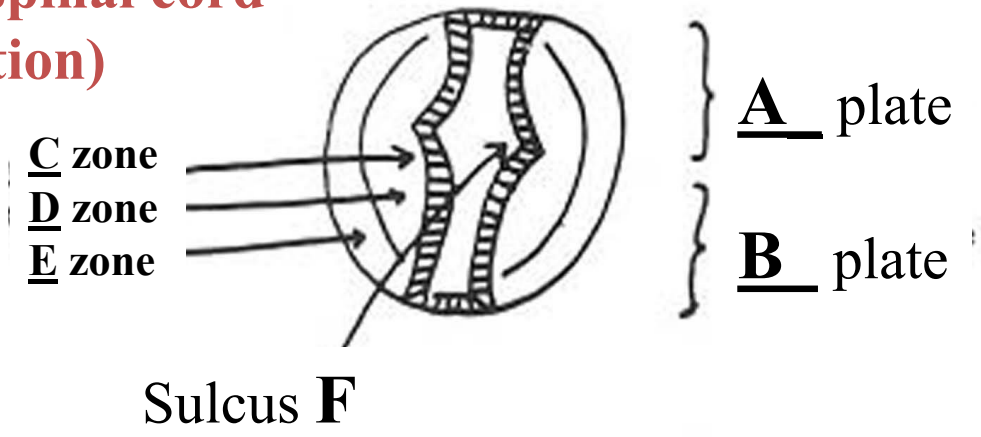
d. Hindbrain (rhombencephalon

e. Spinal cord

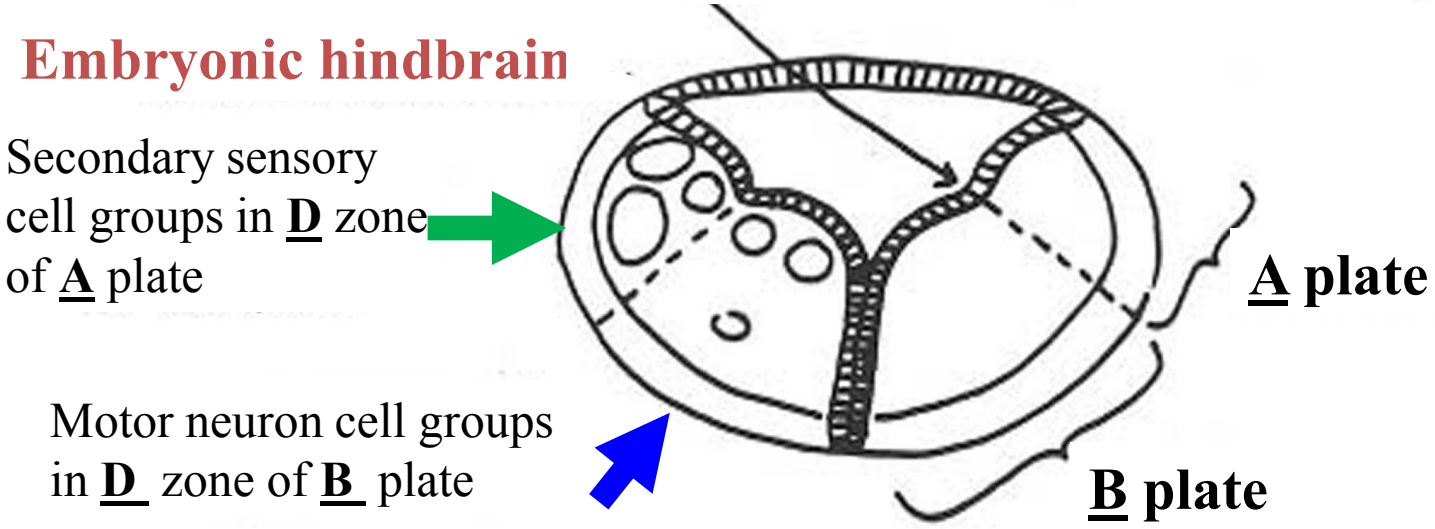
Reminder: Students should understand and know this figure!

Embyonic spinal cord & hindbrain compared:
identify the indicated structures

Embryonic spinal cord (in cross section)

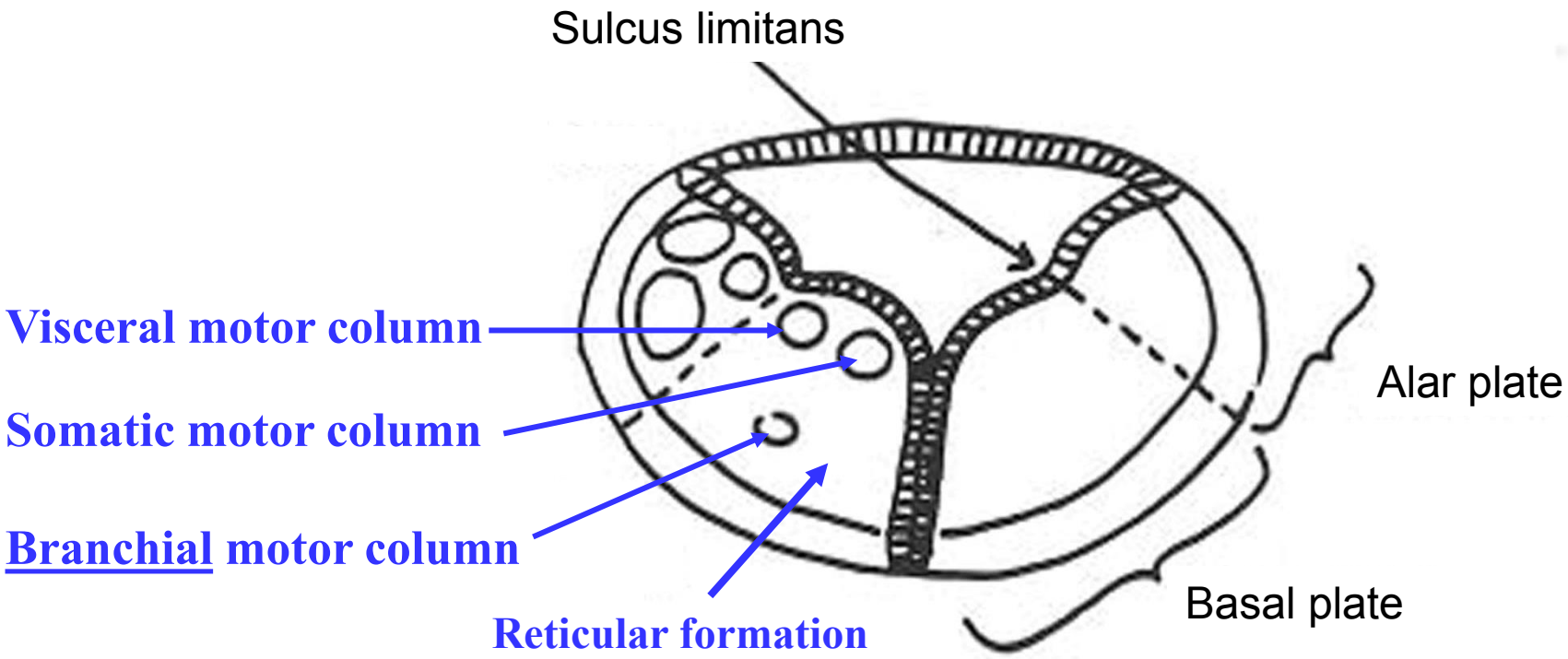


Embryonic hindbrain



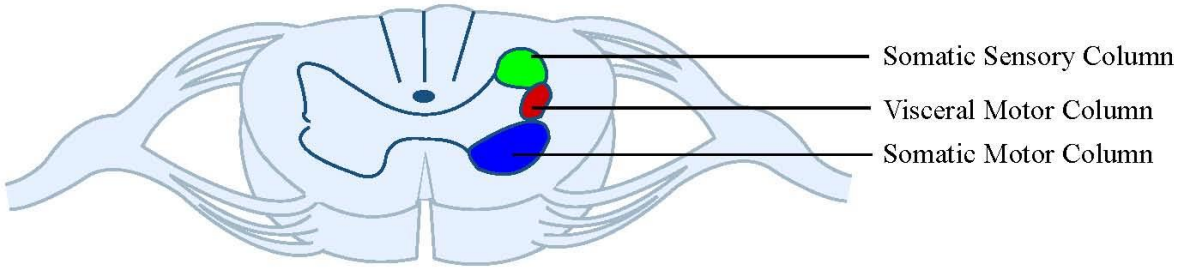
22 Notes on hindbrain origins: *definitions*

- Segmentation above the segments of the spinal cord: The somitomeres & **branchial arches in the mesoderm,** and the **rhombomeres** **of the CNS**
- *See Nauta & Feirtag, ch.11, p. 170, on the "**branchial motor column**" -- in addition to the **somatic and visceral motor columns**.*



23

Columns in spinal cord



Columns in Hindbrain

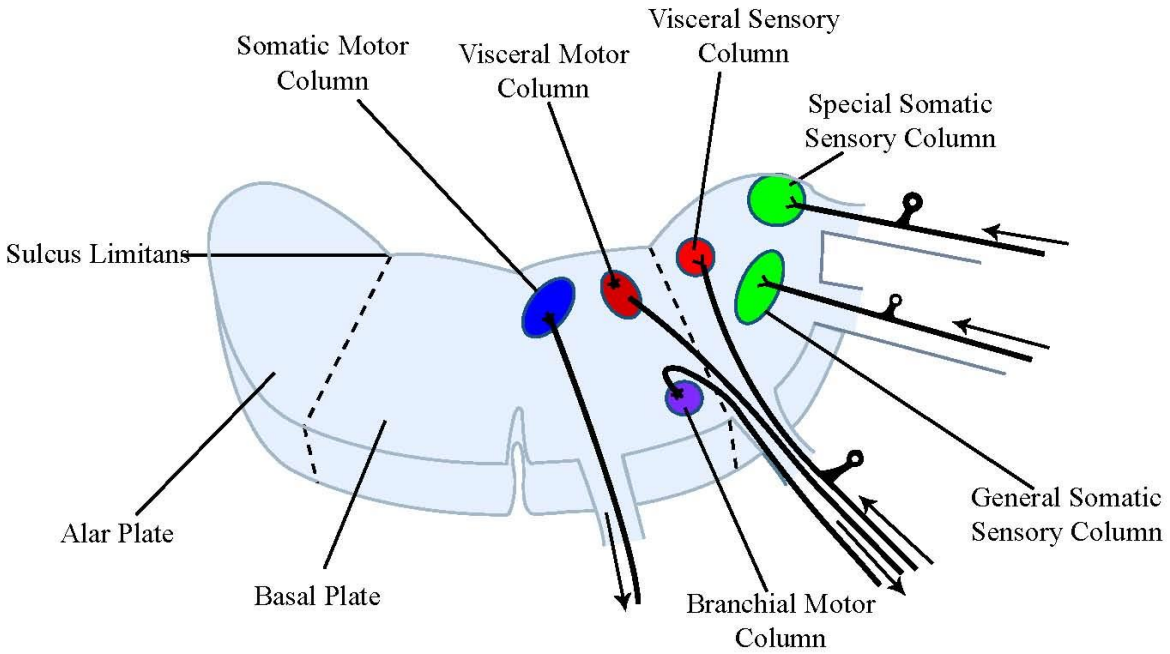
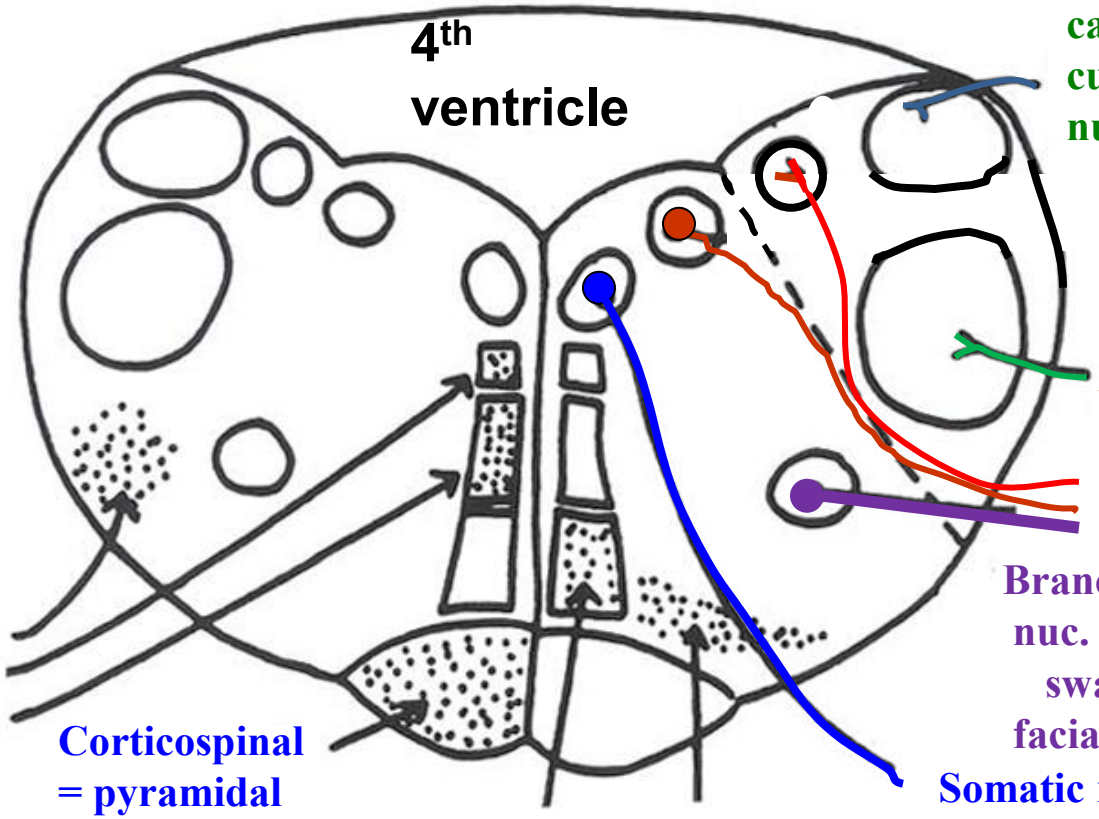


Fig 10-9

Adult caudal hindbrain of mammal

principle cell columns and fiber tracts (schematic)



Vestibular, auditory (VIII); caudally—nuc. gracilis & cuneatus (dorsal column nuclei)

Trigeminal (V, sensory from face)

Visceral sensory & motor (III in midbrain; VII, IX & X – parasympathetic

Branchial motor column: nuc. ambiguus (IX, X – swallowing & vocalization) facial (VII), masticatory (V)

Somatic motor column: III, IV (midbrain) & VI – eye movements XII – tongue movements

Descending pathways: Rubrospinal Vestibulospinal Tectospinal

Corticospinal = pyramidal tract

Medial lemniscus

Spinothalamic tract

Reticulospinal: not shown

Fig 10-10

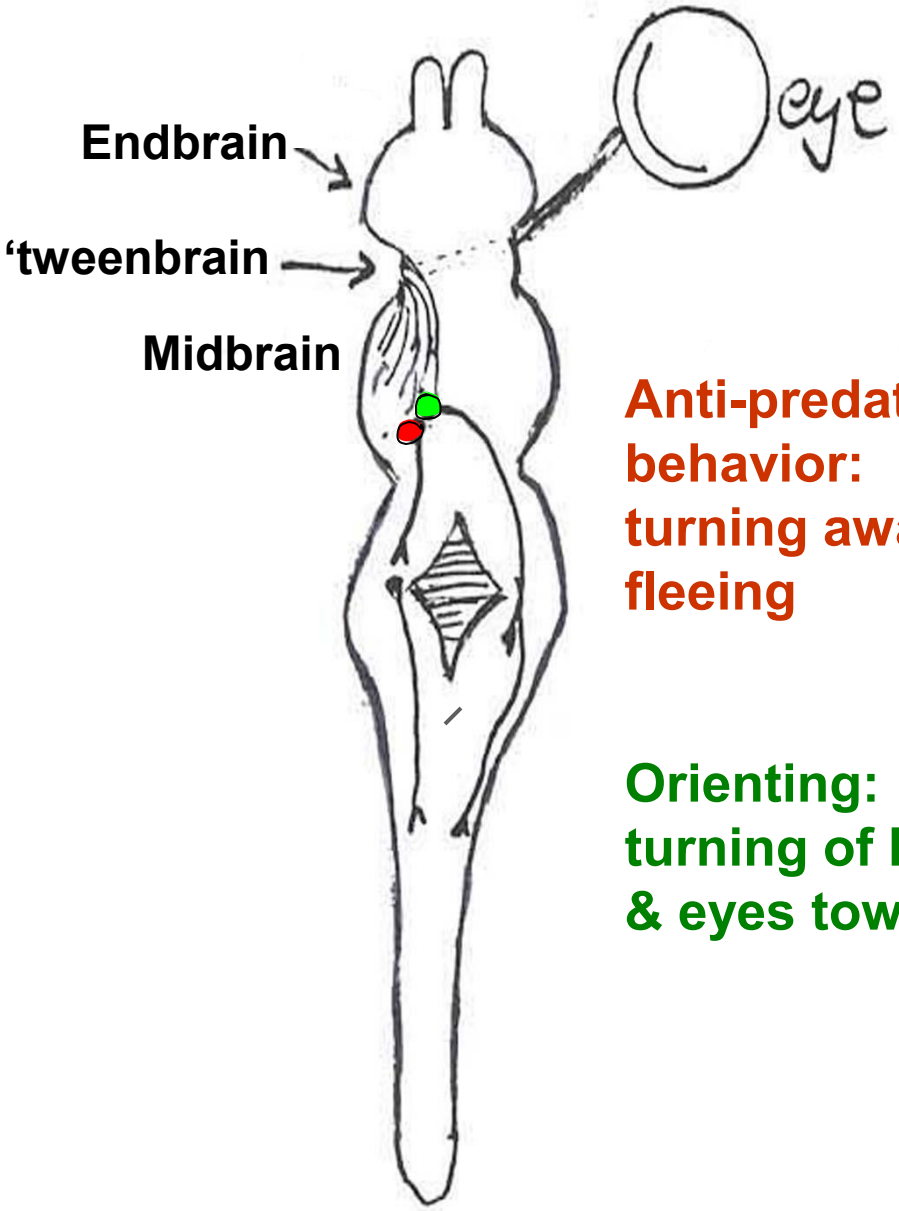
25

Evolution of Brain 4

Expansion of midbrain with evolution of distance-receptor senses: visual and auditory, receptors with advantages over olfaction for speed and sensory acuity, for early warning and for anticipation of events.

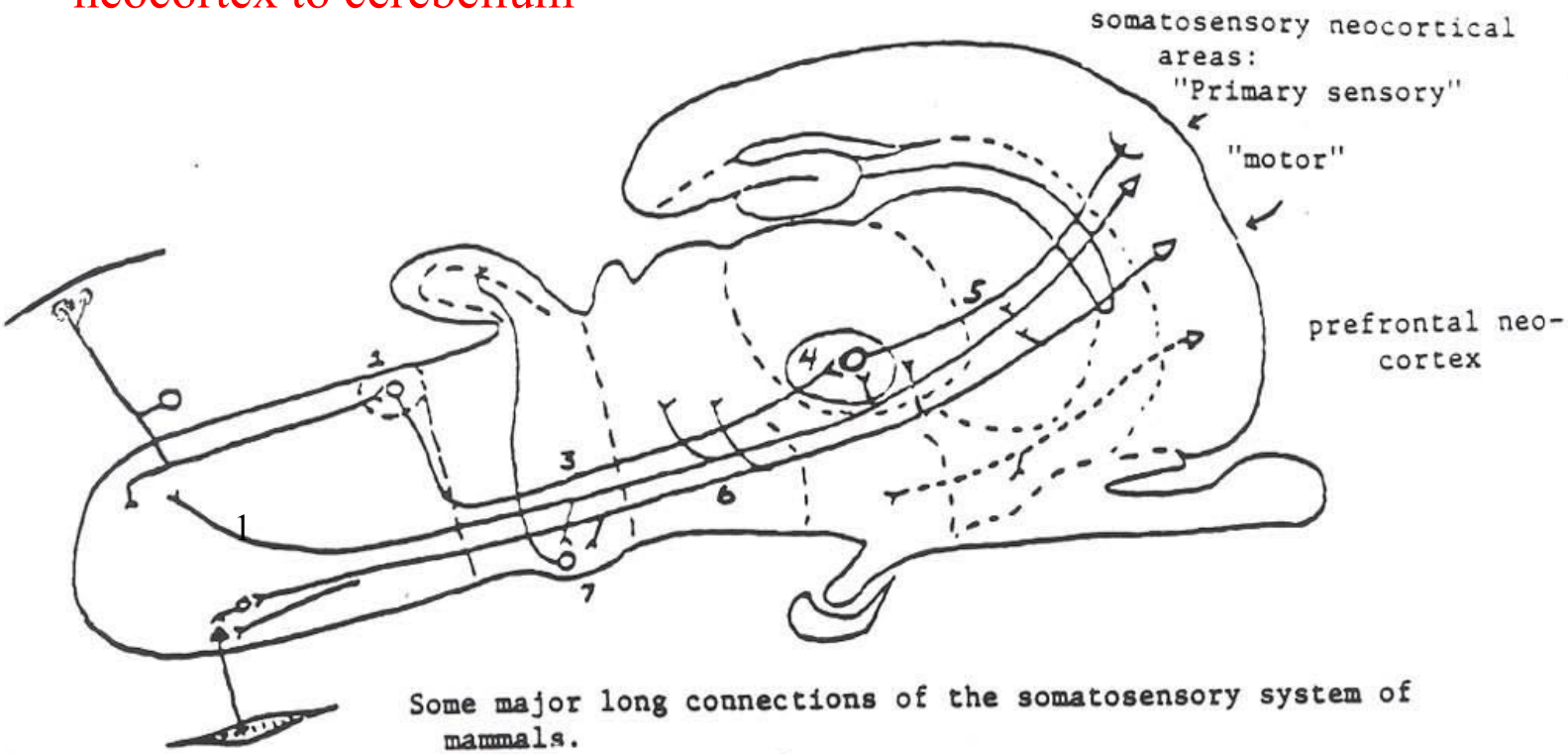
.....

Motor side: 1) escape loco-motion; 2) turning of head and eyes with modulation by motivational states, including those triggered by olfactory sense.



26 **Review** of earlier figure:

Note the pathway from neocortex to cerebellum



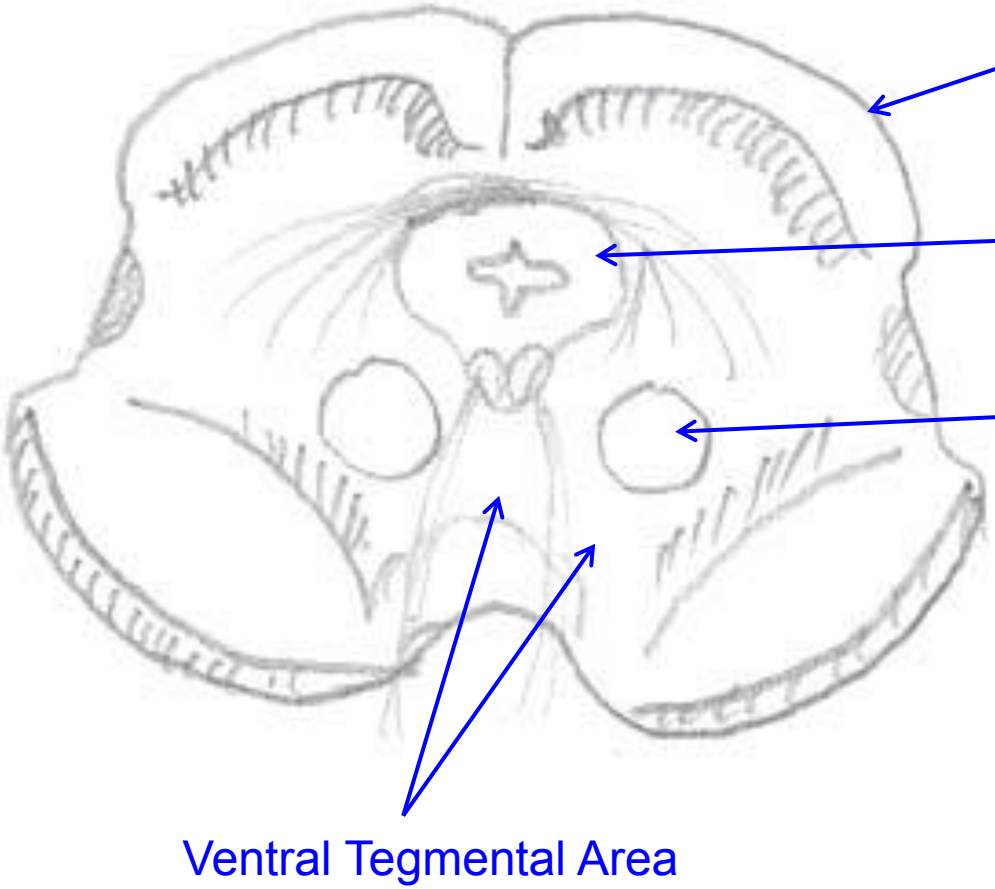
Some major long connections of the somatosensory system of mammals.

Terms:

1. **Dorsal columns**
2. **Nuclei of the dorsal columns**
3. **Medial lemniscus**

4. **Ventrobasal nucleus of thalamus (n. ventralis posterior)**
5. **Thalamocortical axon in the "internal capsule"**
6. **Corticofugal axons, including corticospinal components. Called "pyramidal tract" in hindbrain below pons.**
7. **Pons**

27 Frontal section, middle of mammalian midbrain:



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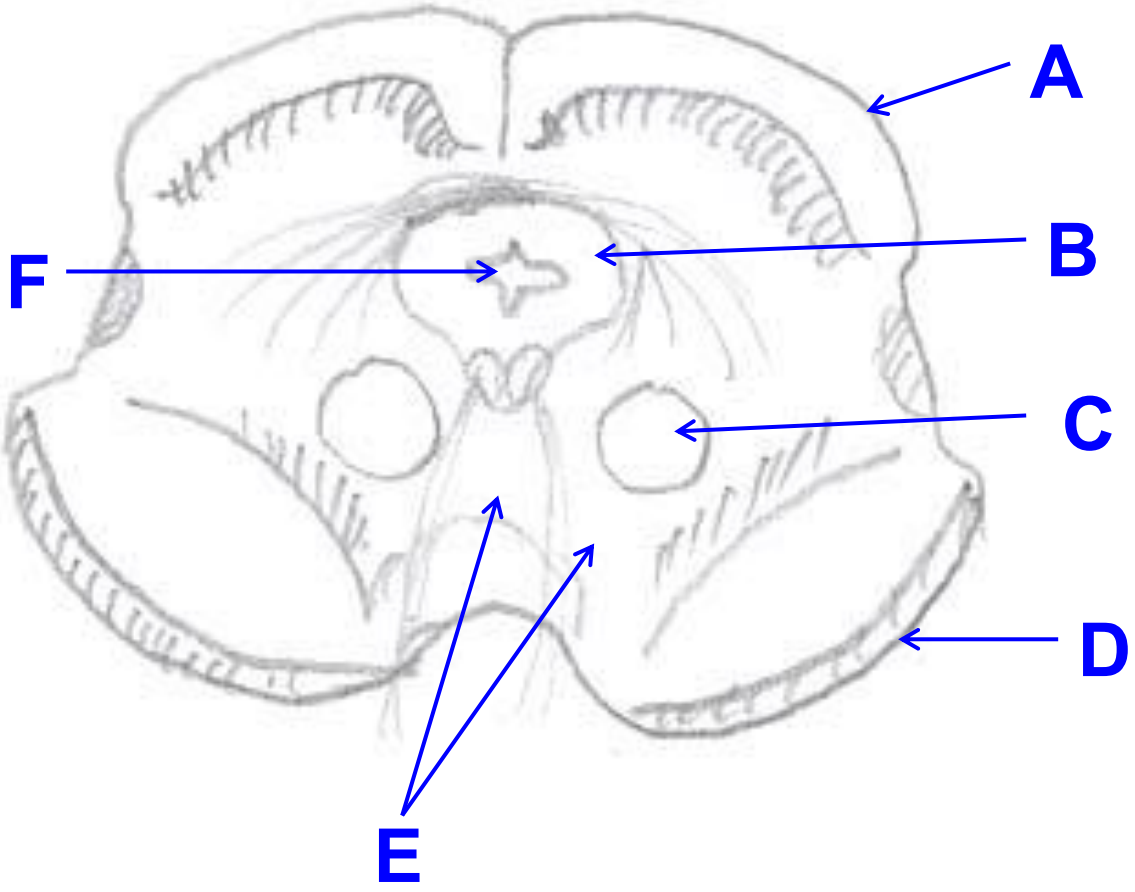
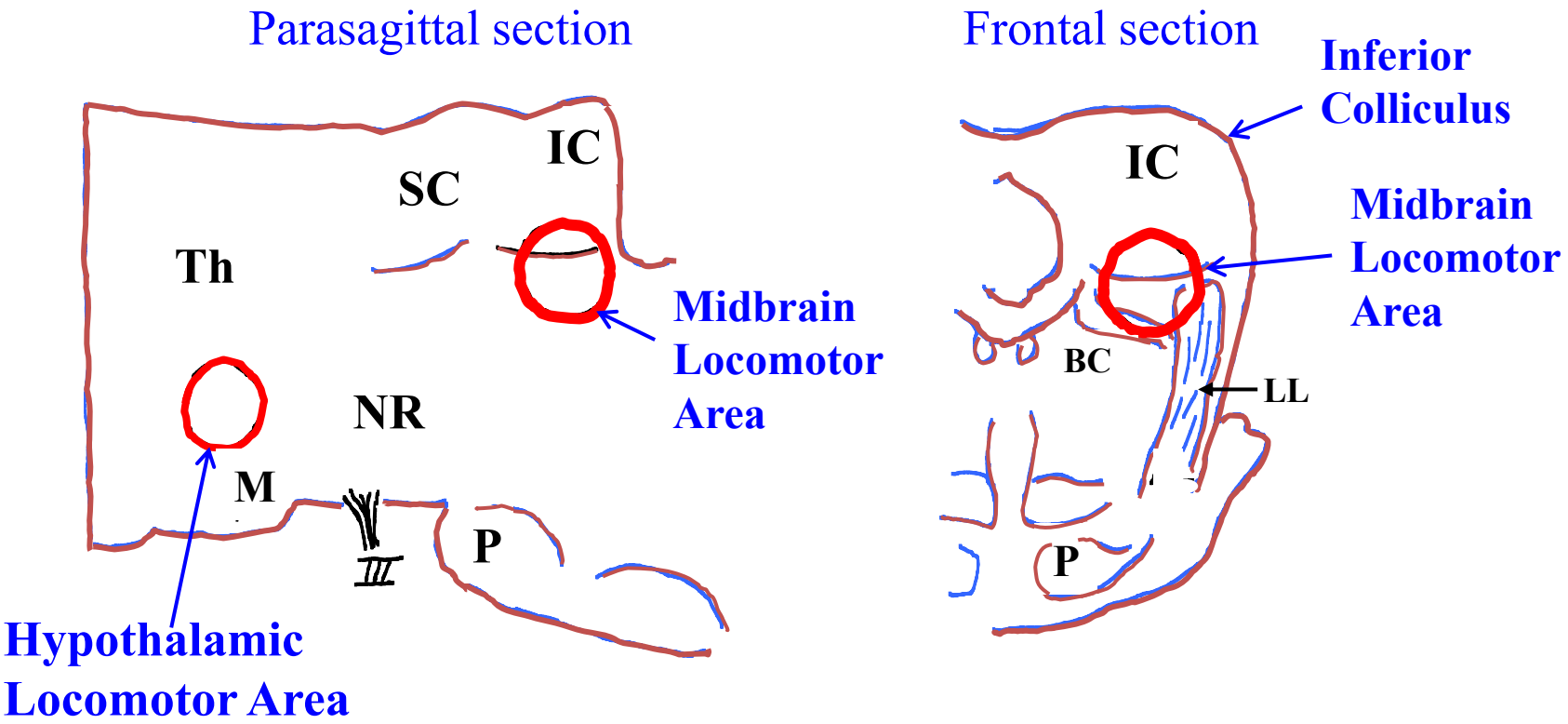
27

Frontal section, middle of mammalian midbrain: Identify the indicated structures



Midbrain Locomotor Region (MLR):

Localization in cat by electrical stimulation studies

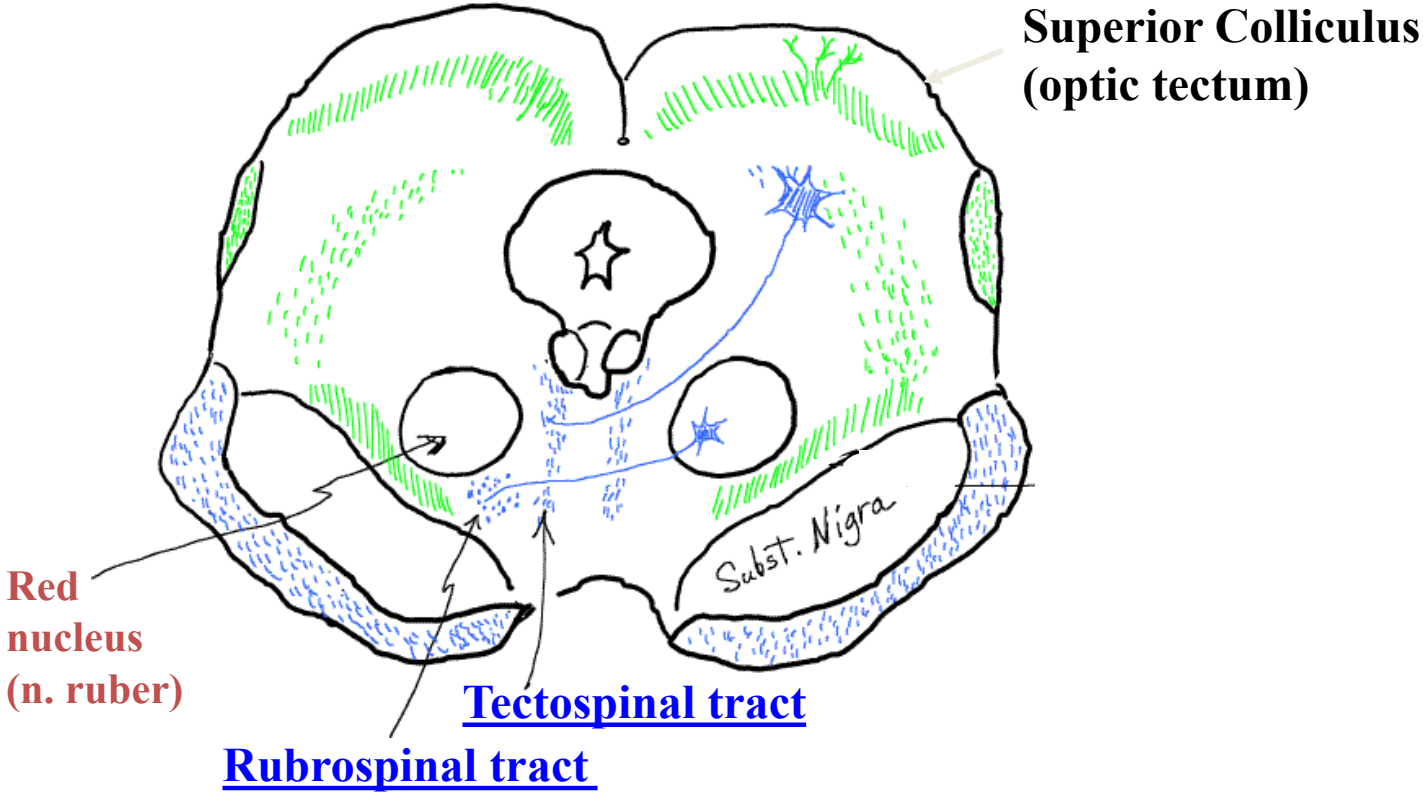


Th = thalamus
M = mammillary body
NR = nuc. ruber (red nuc.)
III = oculomotor nerve
P = pons
SC = superior colliculus

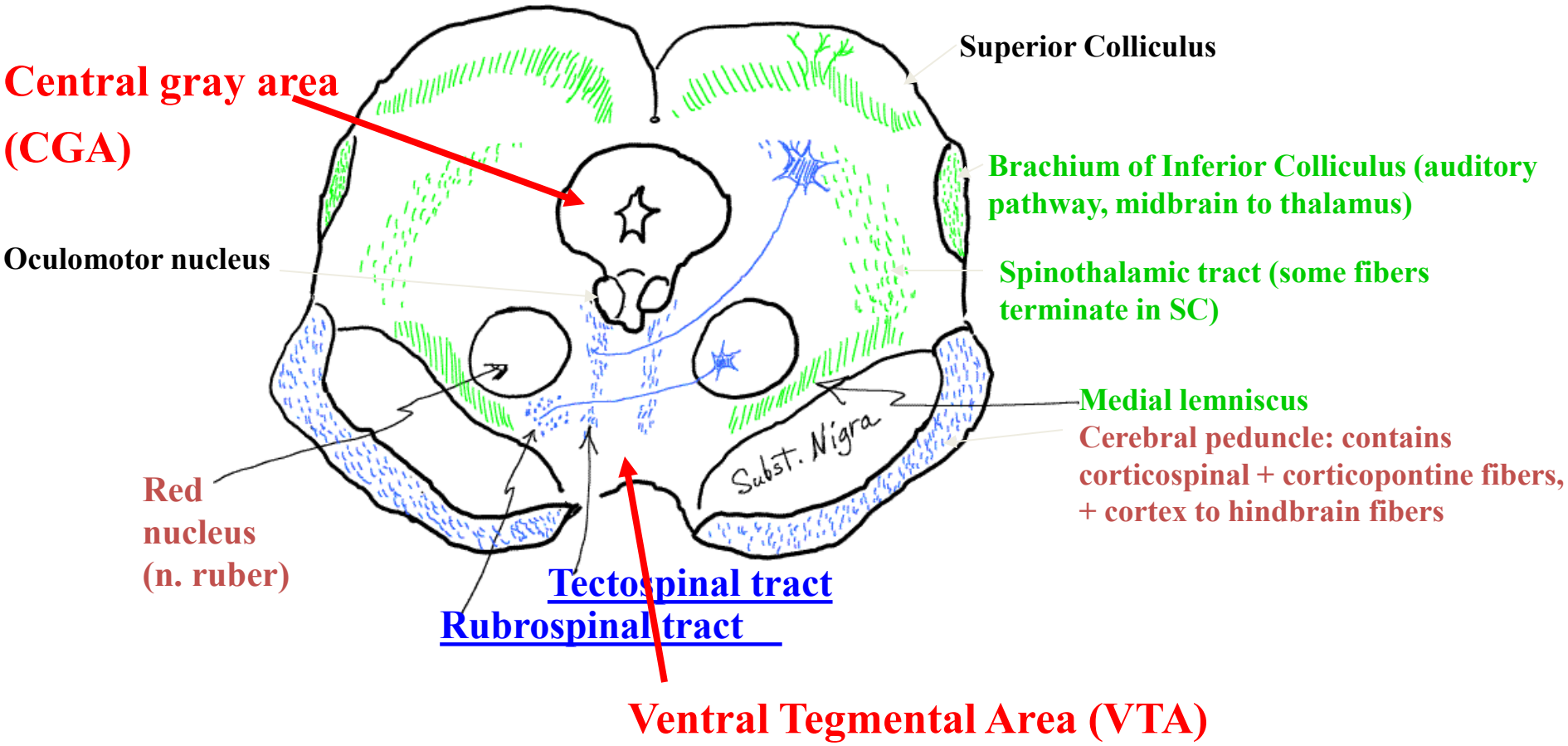
BC = brachium conjunctivum (axons from cb)
LL = lateral lemniscus (auditory)

Fig 14-1

Midbrain neurons projecting to spinal cord and hindbrain for motor control



30 Midbrain areas that influence moods and motivational states:



Connections to the CGA, also called the Periaquaductal Gray (PAG), and to the VTA enabled control of or influence on moods/motivations crucial for survival: **defensive, aggressive, sexual**. Activation of these areas is accompanied by **feelings of pain (CGA) or pleasure (VTA)**.

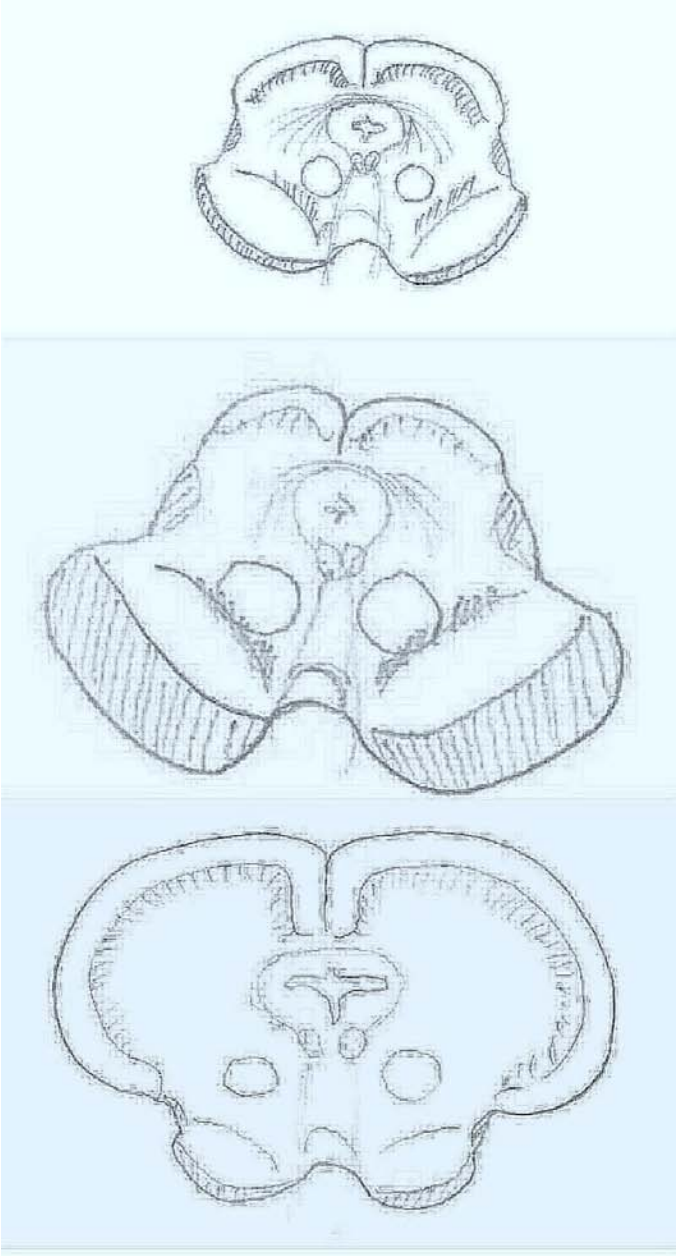
31

Midbrain:

Species comparisons

Note the great differences in the size of the cerebral peduncles at the base of the brain

(Sections are not drawn to the same scale)



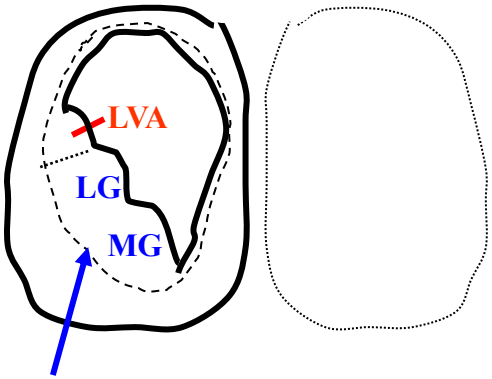
Rodent

Human

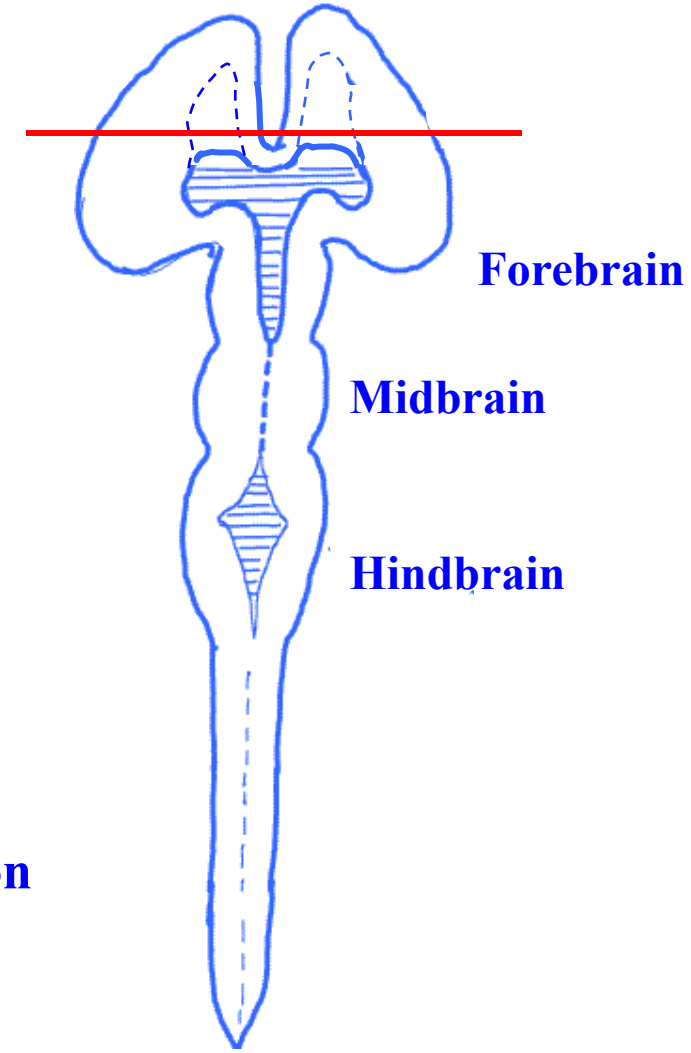
Tree Shrew
(Squirrel is similar)

Fig 11-3

32 Rostral end of the thickening neural tube in mammals: descriptive terms



Thickened Ventricular Layer



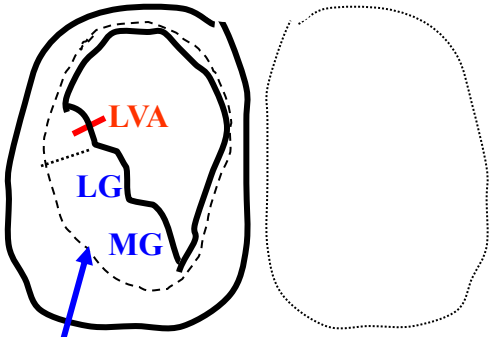
LVA = Lateral ventricular angle region

LG = Lateral Ganglionic Eminence

MG = Medial Ganglionic Eminence

32 Rostral end of the thickening neural tube in mammals:

identify the abbreviations shown

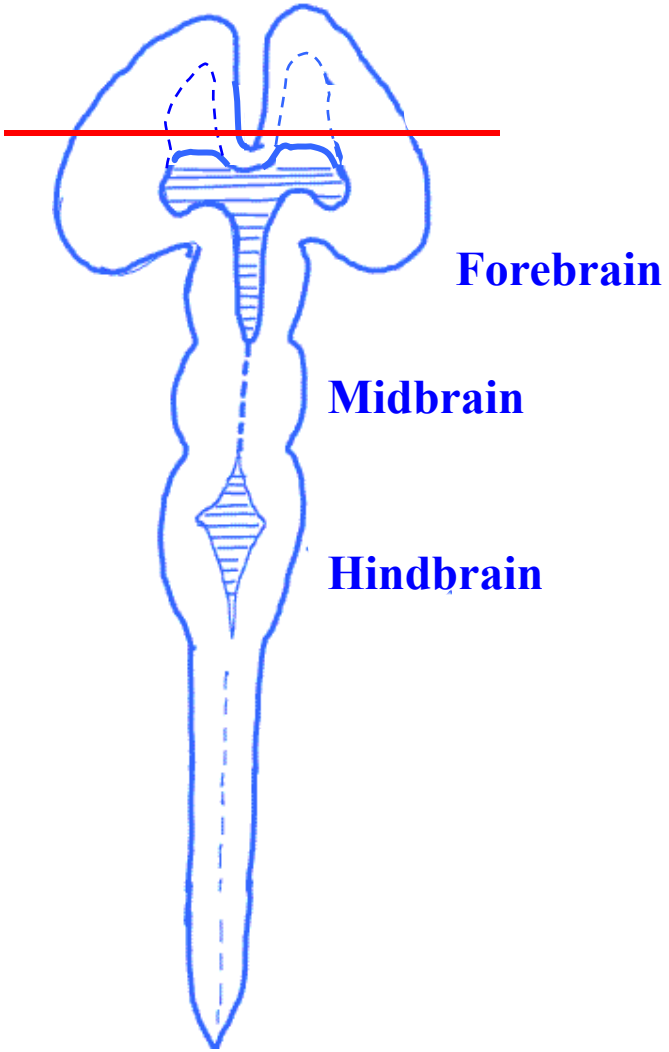


Thickened Ventricular Layer

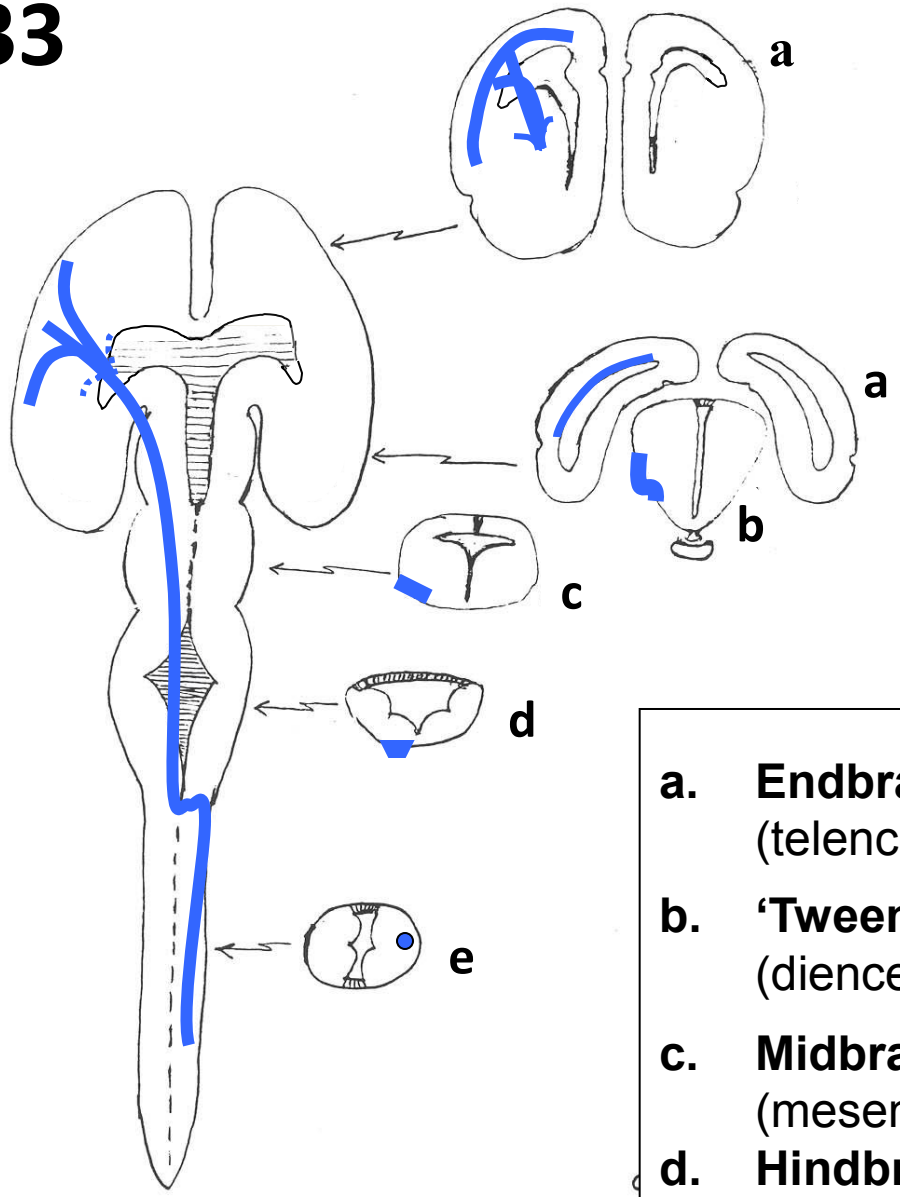
LVA = X

LG = Y

MG = Z



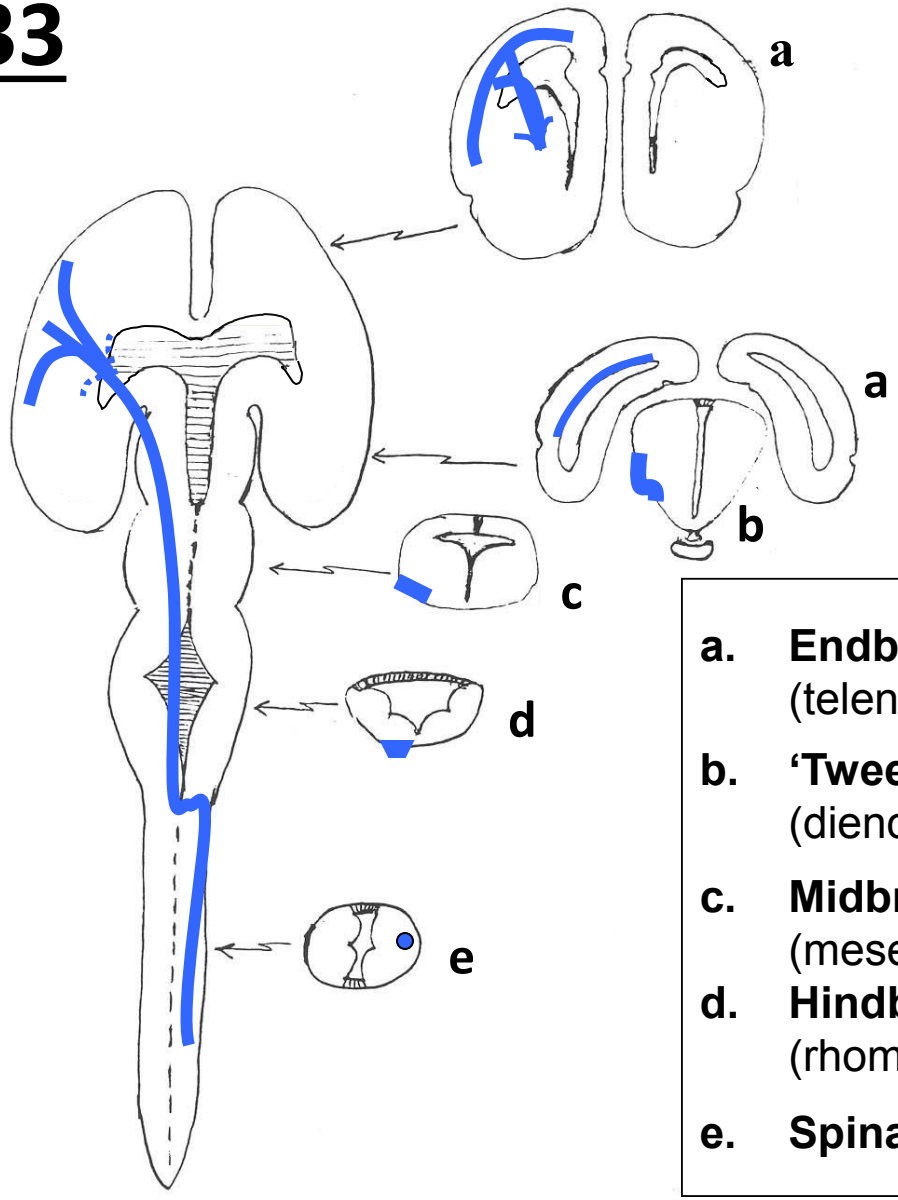
The lateral forebrain bundle: major origins and course



Note the different names at different levels. All these names occur frequently in discussions of brain structure and connections

a.	**Endbrain** (telencephalon)	Cortical white matter to Internal capsule
b.	**'Tweenbrain** (diencephalon)	Cerebral peduncles (includes fibers to 'tweenbrain, midbrain, pons, remainder of hindbrain, spinal cord)
c.	**Midbrain** (mesencephalon)	
d.	**Hindbrain** (rhombencephalon)	Pyramidal tract
e.	**Spinal cord**	Corticospinal tract

Fig 12-6



Descending axons from somatosensory and motor cortical areas:

Note the different names at different levels. **Fill in the blanks.**

a. **Endbrain** (telencephalon)

b. **'Tweenbrain** (diencephalon)

c. **Midbrain** (mesencephalon)

d. **Hindbrain** (rhombencephalon)

e. **Spinal cord**

Cortical white matter to ___A___ capsule

Cerebral ___B___ (includes fibers to 'tweenbrain, midbrain, pons, remainder of hindbrain, spinal cord)

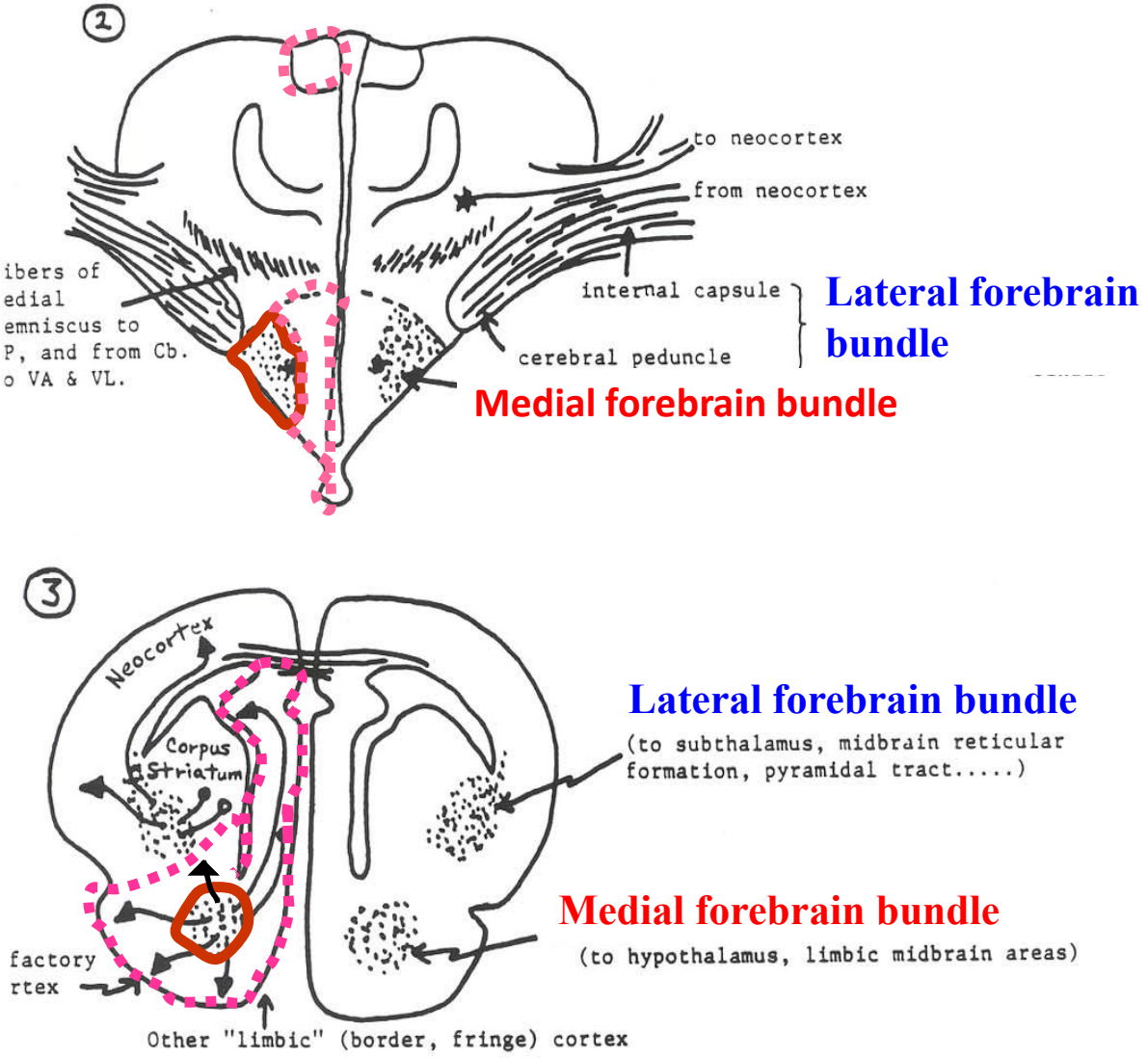
___C___ tract

___D___ tract

Fig 12-6

34

‘Tween-brain and Endbrain limbic & MFB

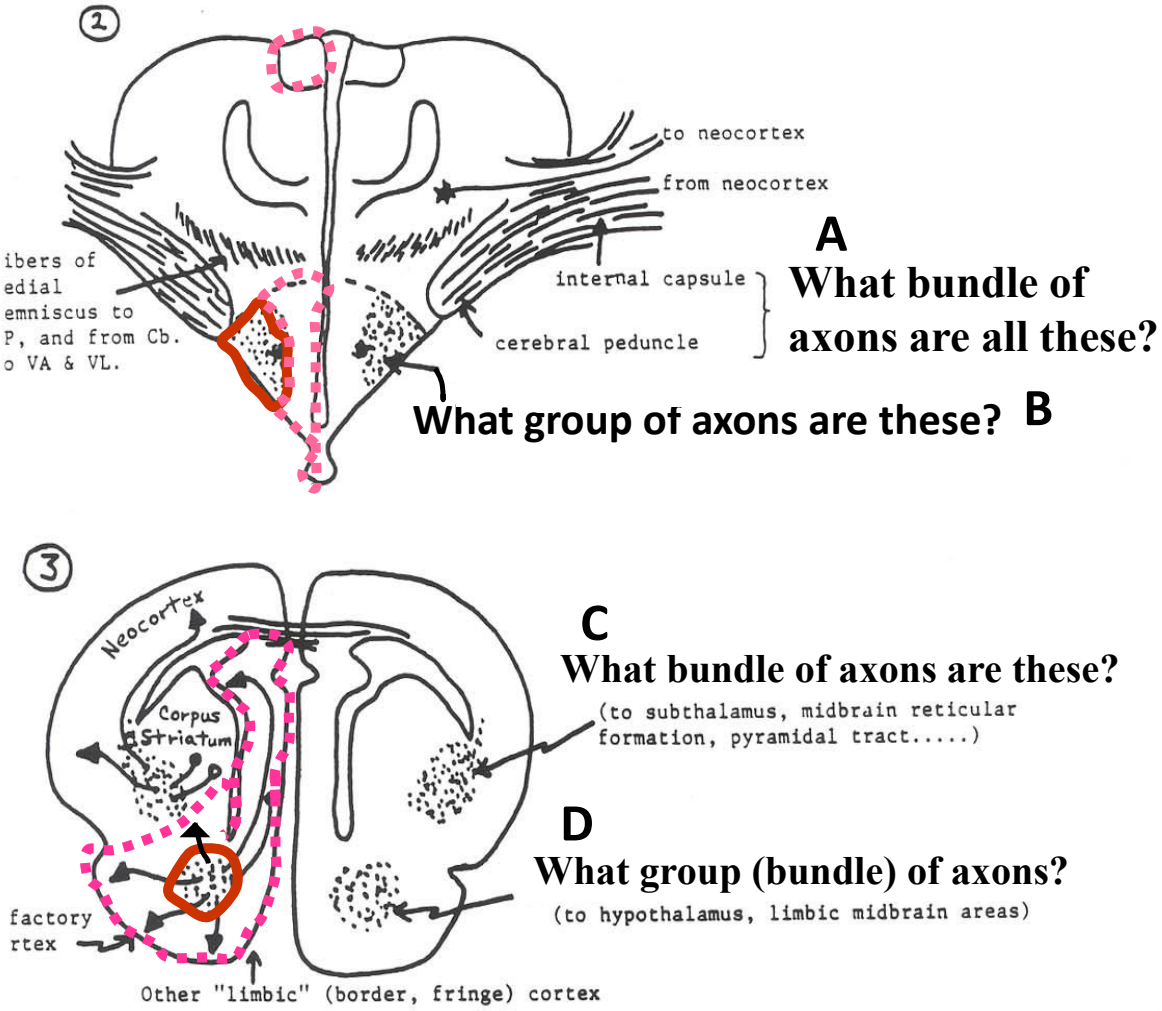


Schneider, G. E. Brain structure and its origins: in the development and in evolution of behavior and the mind. MIT Press, 2014. ISBN:9780262026734.

34

‘Tween-brain and Endbrain

--Identify the axon groups indicated



Schneider, G. E. Brain structure and its origins: in the development and in evolution of behavior and the mind. MIT Press, 2014. ISBN:9780262026734.

Check your knowledge of brain structures:

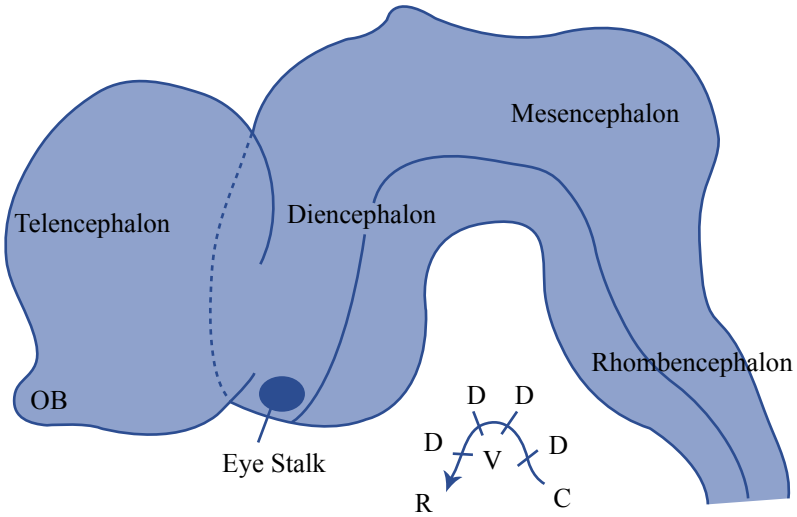
Neuroanatomy review

- Subdivisions of CNS; definitions of cell types
  - Shapes of the neural tube at various levels
- Sensory channels of conduction; dermatomes
- Diaschisis: lesion-produced deafferentation causes a functional depression of neurons
- Evolution of neocortex with major ascending and descending pathways to it and from it
- Spinal cord structure; differences between levels
- Propriospinal system
- Autonomic N.S. and its components
- Hindbrain organization; distortions of the basic plan
- Cranial nerves: the 5^{th} (trigeminal nerve)

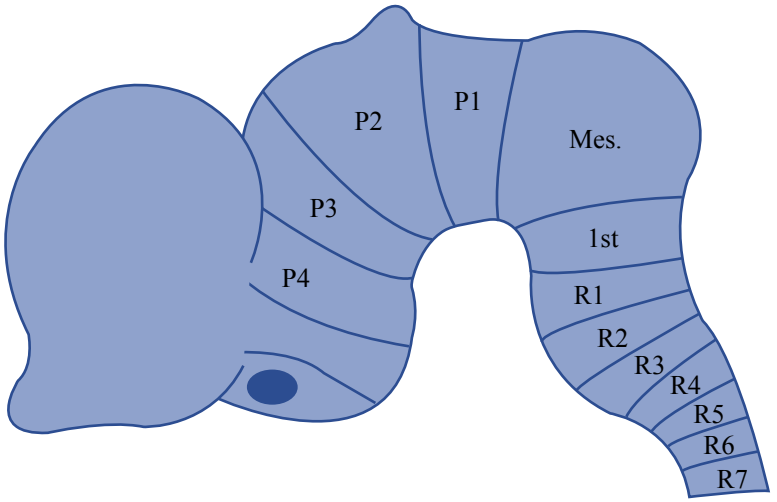
Neuroanatomy review continued

- Midbrain: tectum and tegmentum; species differences; outputs for three major types of movement
- Diencephalon: two major and two additional subdivisions (functional/structural)
- Telencephalon: the endbrain (cerebral hemispheres and basal forebrain); origins of two major pathways for descending axons (Both contain some ascending axons also.)
- Some major axonal pathways in mammals:
  - *Spinoreticular, trigeminoreticular tracts (mostly ipsilateral)*
  - *Spinothalamic tract*; longest axons reach the ventrobasal nuc. of thalamus (VB = VPM and VPL)
  - Dorsal columns, connecting to the medial lemniscus pathway, which projects to the ventrobasal nuc. of thalamus
  - Corticospinal & corticopontine pathways (the former connect to all levels of CNS, the latter connecting to the pons, hence to cerebellum)

35

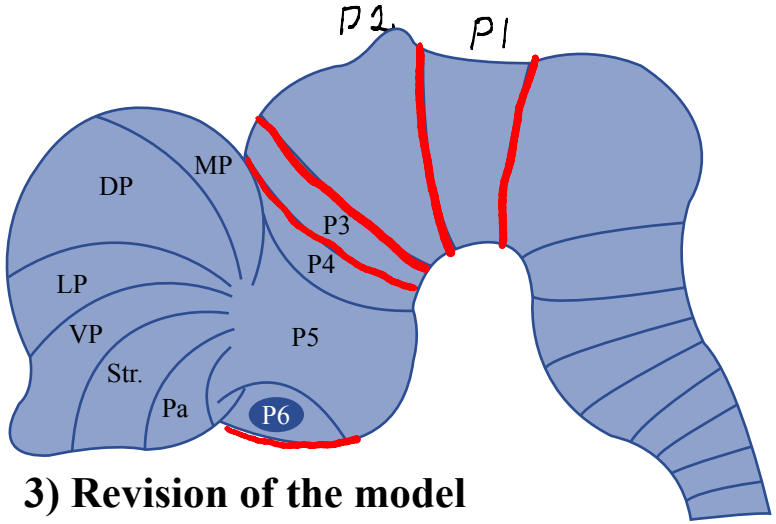


1) Embryonic brain with curved longitudinal axis



2) Puelles & Rubenstein,'93

Neuromeric models of embryonic mammalian brain



3) Revision of the model

Fig 12-8

9.14 Brain Structure and Its Origins

Spring 2014