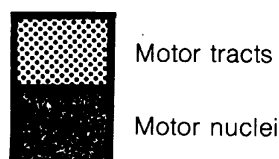
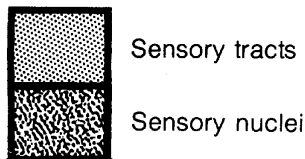


Figure 178 Transverse sections of the brainstem.

The levels of the transverse sections are shown in Figure 178a in relation to i) a dorsal and ii) a lateral view of the brainstem after removal of the cerebellum. In Figures 178b to 178j, sensory tracts and their associated nuclei are shaded and labelled on the left, motor on the right. Nuclei of the reticular formation are labelled in *italics*; their positions, but not their boundaries, are indicated. The sections are conventionally orientated with dorsal at the top.

Clues to the level of an isolated transverse section of the brainstem are provided by its outline and by the presence of either the central canal, fourth ventricle or cerebral aqueduct. The caudal medulla is approximately circular in outline, with a central canal. The cranial medulla has an increasingly scalloped outline, with the fourth ventricle extending dorsally. The pyramids are found ventrally throughout the medulla. In sections through the pons, the middle cerebellar peduncle is prominent laterally; dorsally, the fourth ventricle is enclosed by the cerebellum. Sections through the midbrain are characterised by the colliculi dorsally and the deep interpeduncular fossa ventrally; the cerebral aqueduct is surrounded by the peri-aqueductal grey. Knowledge of the external features of the brainstem is of considerable assistance in further identifying the level of a section and in understanding its internal topography.

Key for sections shown in Figures 178b to j



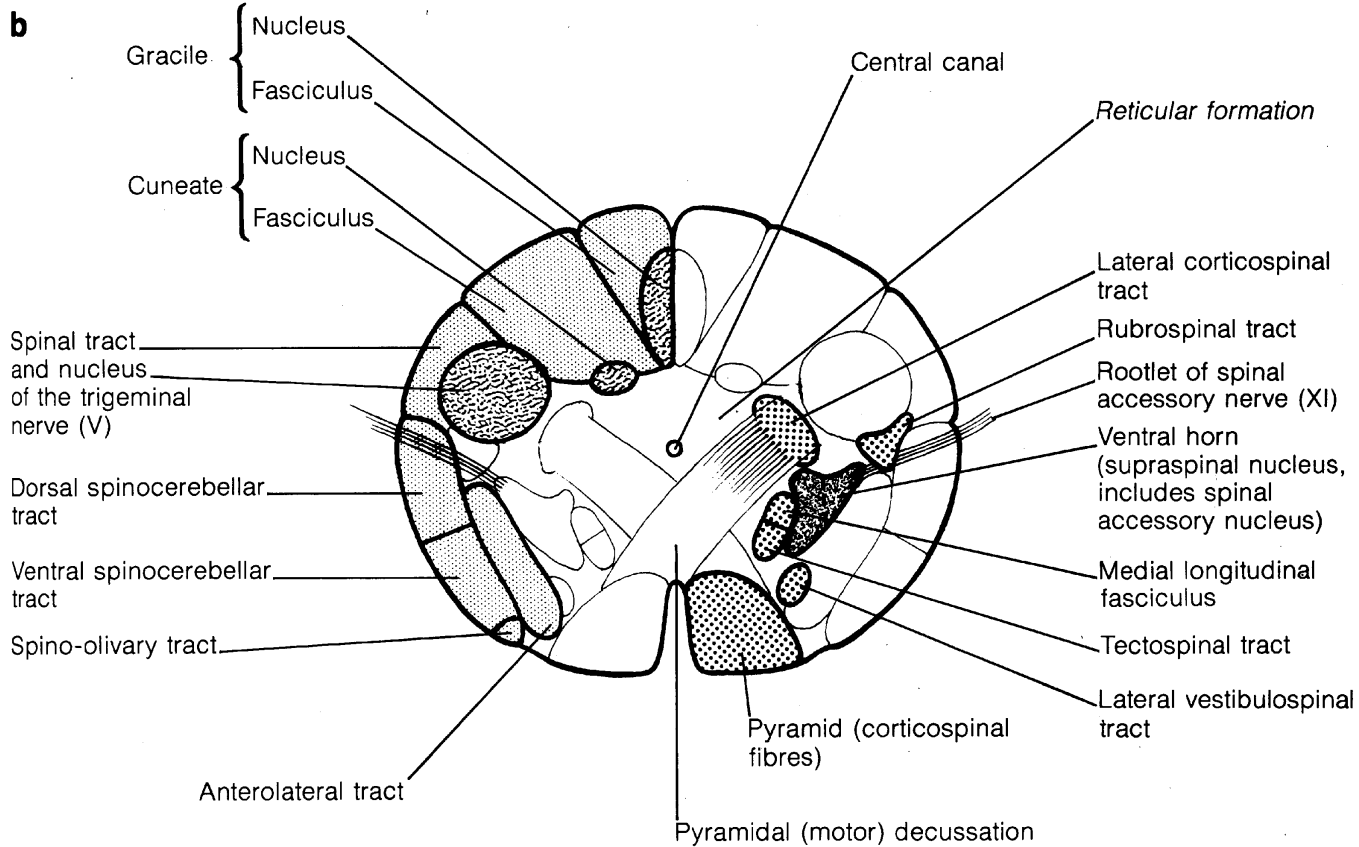


Figure 178b Junction of spinal cord and medulla oblongata (motor decussation).

Identifying features:

- 1 The outline is essentially circular. The canal is nearly central. Ventrally, small bundles of decussating fibres from the pyramids interrupt the ventral median sulcus.*
- 2 Ventrally are the pyramids. Their decussating fibres (the motor decussation) pass obliquely across the midline to form the lateral corticospinal tract.*
- 3 Dorsolateral to each pyramid is the cranial extension of the ventral horn of the spinal cord (supraspinal nucleus). Motoneurons found laterally in this region belong to the spinal nucleus of the accessory nerve. Fibres of the spinal part of the accessory nerve are shown emerging laterally.*
- 4 Dorsally, the gracile and cuneate fasciculi are prominent and the caudal ends of the gracile and cuneate nuclei are seen.*
- 5 Dorsolaterally is the spinal tract and nucleus (pars caudalis) of the trigeminal nerve. The nucleus forms a continuation of the dorsal horn of the spinal cord.*
- 6 The other ascending tracts (dorsal and ventral spinocerebellar, spino-olivary and anterolateral) and descending tracts (rubrospinal, medial longitudinal fasciculus and associated tectospinal tract, and lateral vestibulospinal) are located ventrolaterally, close to their positions within the spinal cord.*

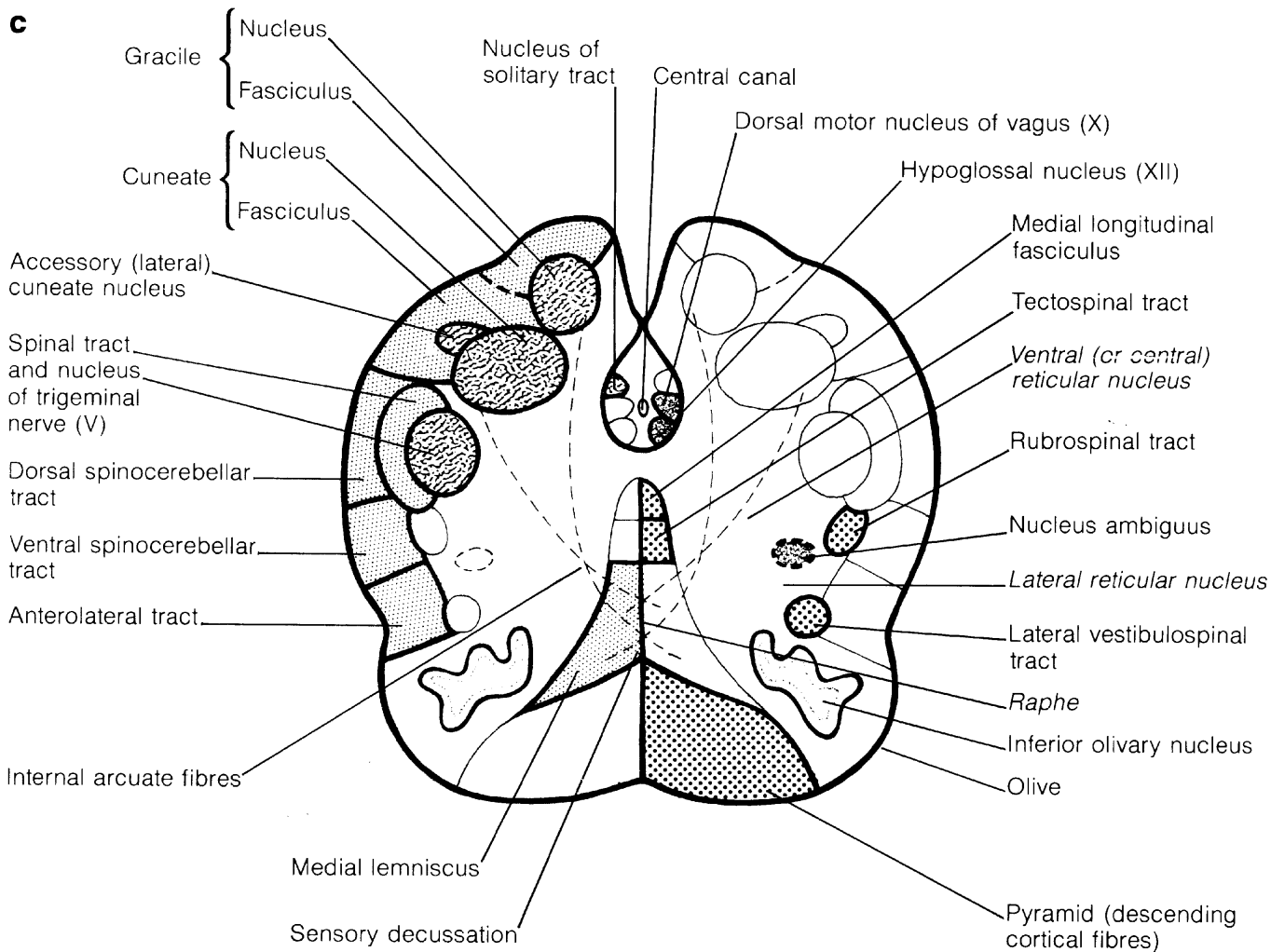


Figure 178c Caudal medulla oblongata (sensory decussation).

Identifying features:

- 1 The outline is nearly square. The central canal is more dorsal than central.
- 2 Ventrally, the pyramids are well formed.
- 3 Dorsally are the gracile and cuneate fasciculi and their nuclei. Internal arcuate fibres leave the nuclei, cross the midline as the sensory decussation, and form the medial lemniscus of the opposite side.
- 4 The medial lemniscus is located medially, dorsal to each pyramid. Dorsal to this lemniscus are the tectospinal tract and medial longitudinal fasciculus.
- 5 Immediately lateral to the main cuneate nucleus is the accessory (lateral) cuneate nucleus. Its axons form the cuneocerebellar tract.
- 6 Dorsolateral to each pyramid is the caudal end of the inferior olivary nucleus.
- 7 Surrounding the central canal is grey matter. Ventromedially within this grey area is the hypoglossal nucleus, one of the five long cranial nerve nuclei of the medulla. Dorsolateral to the hypoglossal nucleus is the dorsal motor nucleus of the vagus. Dorsal to the dorsal motor nucleus of the vagus is the solitary tract and its nucleus.
- 8 Laterally, within the reticular formation dorsal to the inferior olivary nucleus, is the (indistinct) nucleus ambiguus.
- 9 Dorsolaterally are the spinal tract and nucleus (pars caudalis) of the trigeminal nerve.
- 10 Other ascending and descending tracts lie laterally.

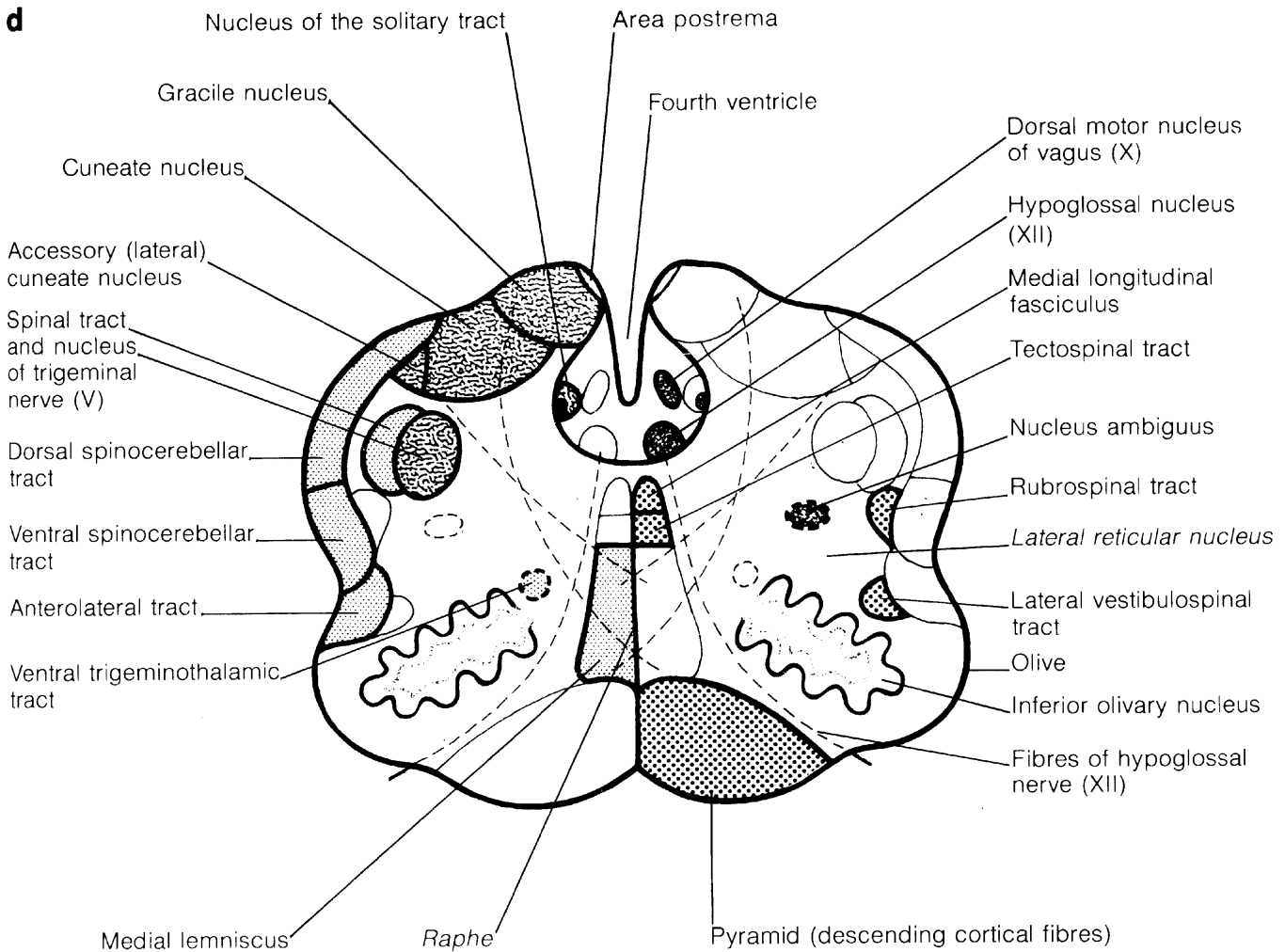
d

Figure 178d *Mid-medulla oblongata (obex or caudal calamus scriptorius).*

Identifying features:

- 1 *The outline is indented and dorsally the gracile and cuneate tubercles raised by the underlying nuclei are conspicuous. In the midline dorsally, a deep groove marks the most caudal part of the fourth ventricle (at the boundary of the closed and open parts of the medulla). The median aperture of the fourth ventricle lies above this point.*
- 2 *The pyramids are prominent ventrally.*
- 3 *Dorsal to each pyramid, the medial lemniscus is now large. Associated with it, but represented by scattered bundles of fibres rather than a discrete tract, is the ventral trigeminothalamic tract. This tract remains close to the medial lemniscus throughout the brainstem and forms the trigeminal lemniscus. The tectospinal tract and the medial longitudinal fasciculus lie immediately above the medial lemniscus.*
- 4 *The inferior olivary nucleus is large and lies beneath the olive. The medial and dorsal accessory olivary nuclei are not shown.*
- 5 *The five long cranial nerve nuclei of the medulla (hypoglossal nucleus, dorsal motor nucleus of the vagus, nucleus of the solitary tract, nucleus ambiguus and nucleus [pars interpolaris] of the spinal tract of the trigeminal nerve) are all in the same relative positions as in Figure 178c. Fascicles of the hypoglossal nerve are illustrated.*
- 6 *The dorsal spinocerebellar tract is now dorsolateral. The remaining sensory and motor tracts are found laterally.*
- 7 *The reticular formation occupies large, mainly paramedian areas of the section. The area postrema is found dorsally, in the walls of the ventricle.*

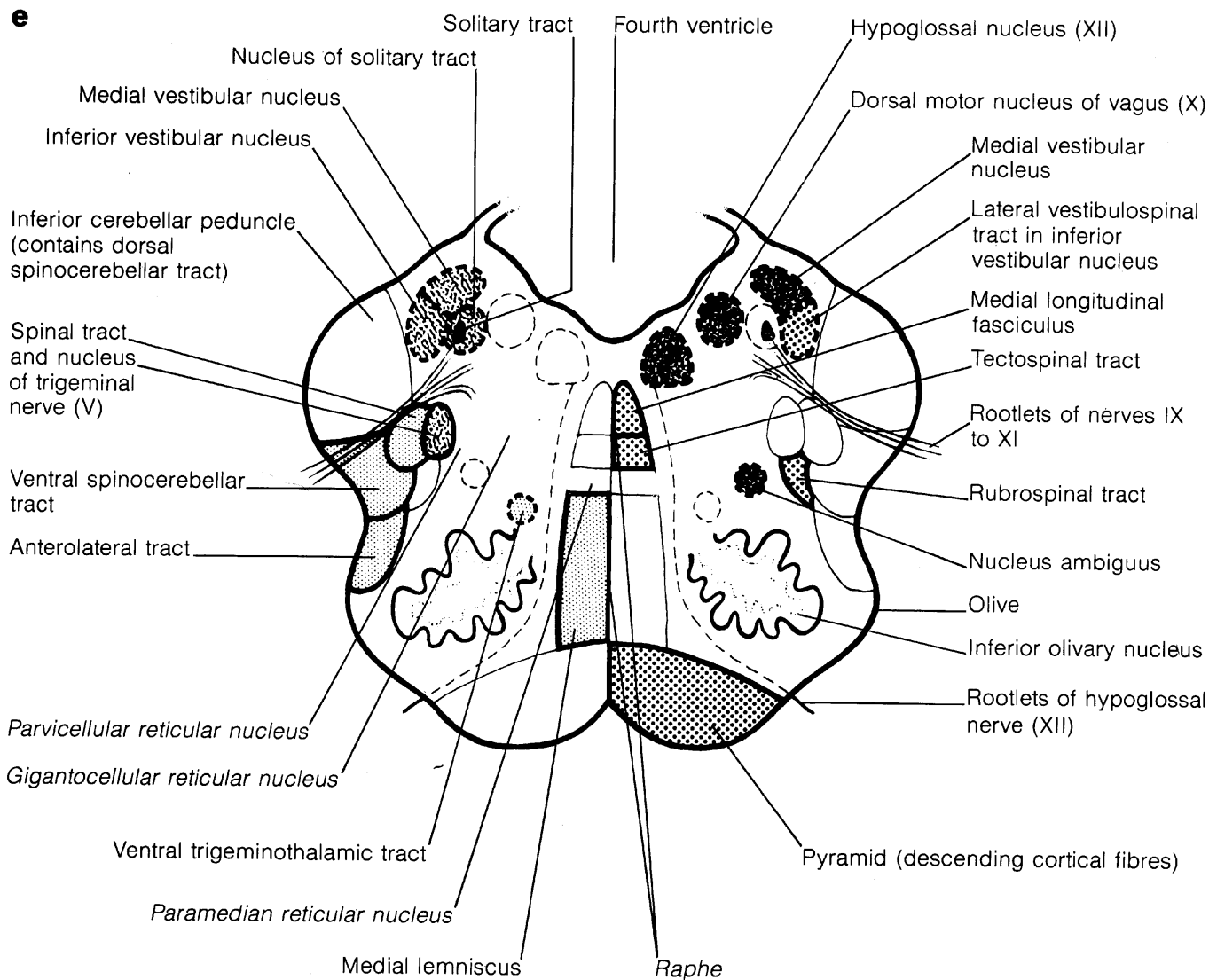


Figure 178e Cranial medulla oblongata (open part of medulla).

Identifying features:

- 1 The outline is scalloped, with bulges formed ventrally by the pyramids, ventrolaterally by the olives, and dorsolaterally by the inferior cerebellar peduncles. Dorsally, the floor of the fourth ventricle is divided into the hypoglossal and vagal triangles which lie above the respective cranial nerve nuclei.
- 2 Medially, the pyramids are prominent ventrally. The medial lemniscus, tectospinal tract and medial longitudinal fasciculus continue to be found dorsal to each pyramid. Other sensory and motor tracts lie laterally.
- 3 Ventrolaterally, the inferior olivary nucleus is large, deep to the olive. Axons leaving the nucleus pass diagonally to the contralateral inferior cerebellar peduncle.
- 4 The five long cranial nerve nuclei of the medulla occupy the same relative positions as they do more caudally, but are now spread out mediolaterally. The hypoglossal nucleus is dorsal and near to the midline. Fibres from it pass ventrally before emerging between the olive and pyramid. The dorsal motor nucleus of the vagus is lateral to the hypoglossal nucleus; some fibres from it are shown passing into the vagus nerve which emerges, along with the glossopharyngeal and cranial part to the accessory nerves, ventral to the inferior cerebellar peduncle. The solitary tract lies within its nucleus lateral to the dorsal motor nucleus of the vagus. Ventrally is the spinal tract of the trigeminal; it lies lateral to its nucleus (pars interpolaris). The position of the nucleus ambiguus within the reticular formation dorsal to the inferior olivary nucleus is indicated.
- 5 The inferior and medial vestibular nuclei are located between the nucleus of the solitary tract and the inferior cerebellar peduncle.
- 6 The large remaining, intermediate areas of the section are occupied by the reticular formation.

f

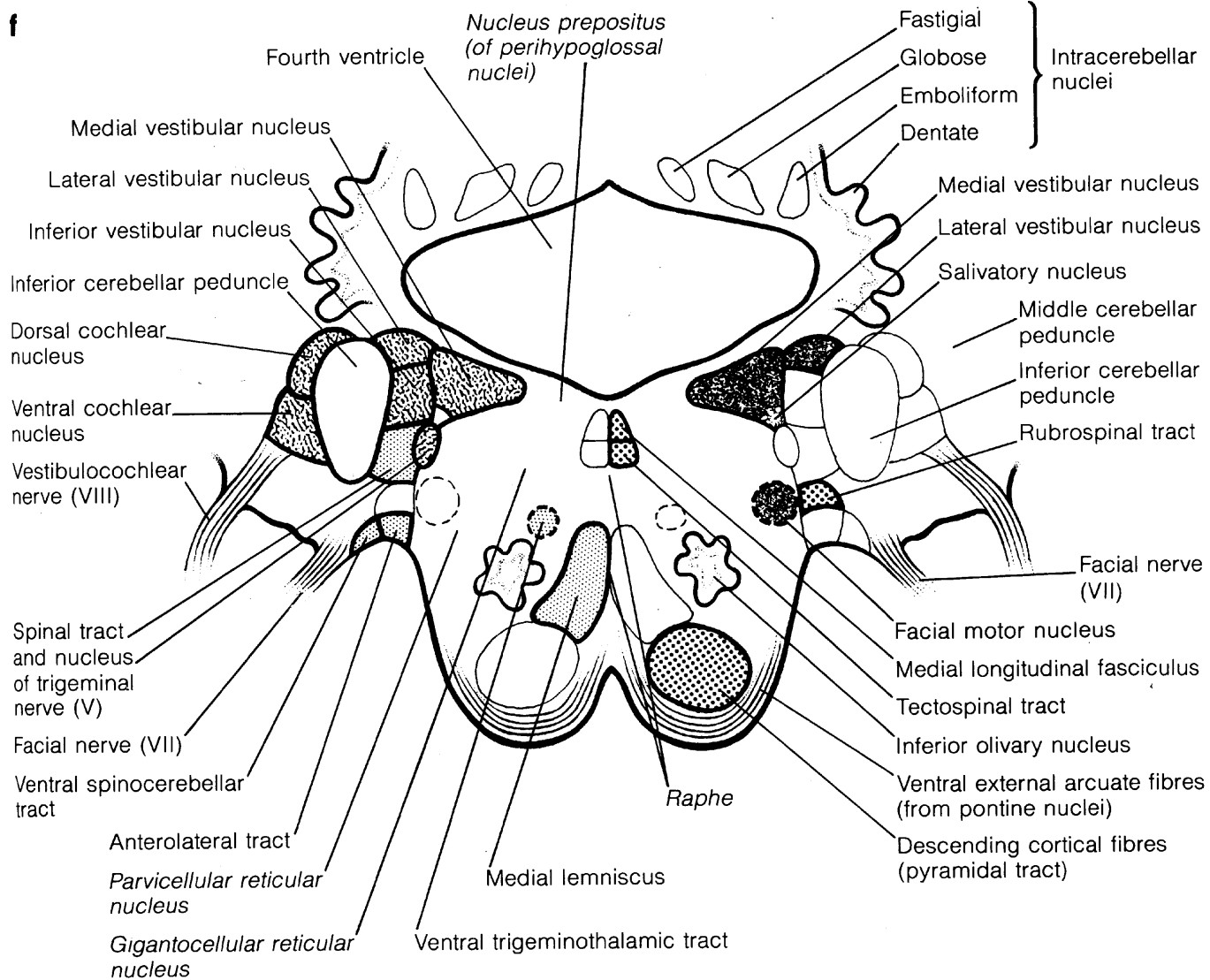


Figure 178f Junction of medulla oblongata and pons.

Identifying features:

- 1** *Ventrally, the section's outline is relatively smooth, being formed by ventral external arcuate fibres from the pontine nuclei. These fibres pass dorsolaterally into the middle cerebellar peduncle. Laterally and dorsally, the brainstem is continuous with the cerebellum. Dorsal to the fourth ventricle, the four pairs of intracerebellar nuclei are visible within the medullary core of the cerebellum. The fourth ventricle is close to its widest. Just caudal to this level, the lateral apertures of the fourth ventricle are at the ends of its lateral recesses.*
- 2** *Ventrally are the corticospinal and corticonuclear fibres that form the medullary pyramids.*
- 3** *Medially, the medial lemniscus broadens out as it passes cranially, while the laterally adjacent inferior olivary nucleus diminishes in size. The medial longitudinal fasciculus and tectospinal tract are dorsal.*
- 4** *Most laterally are fibres of the middle cerebellar peduncle. The inferior cerebellar peduncle is medial to it and is surrounded by nuclei.*
- 5** *Ventrolaterally, the vestibulocochlear nerve is seen entering the brain from the cerebellopontine angle. Its nuclei are found on both sides of the inferior cerebellar peduncle. The dorsal and ventral cochlear nuclei are lateral to the peduncle. The medial, inferior and lateral vestibular nuclei are medial to it, beneath the vestibular area of the floor of the ventricle.*
- 6** *Ventromedial to the inferior cerebellar peduncle are the spinal tract of the trigeminal nerve and its nucleus (pars oralis). Other sensory and motor tracts are found more ventrally.*
- 7** *In the region just dorsal to the trigeminal nucleus are the scattered cells of the salivatory nucleus.*
- 8** *Ventromedial to the trigeminal nucleus is the motor nucleus of the facial nerve. The facial nerve may be seen ventrolateral to its motor nucleus where it enters the cerebellopontine angle, medial to the vestibulocochlear nerve.*

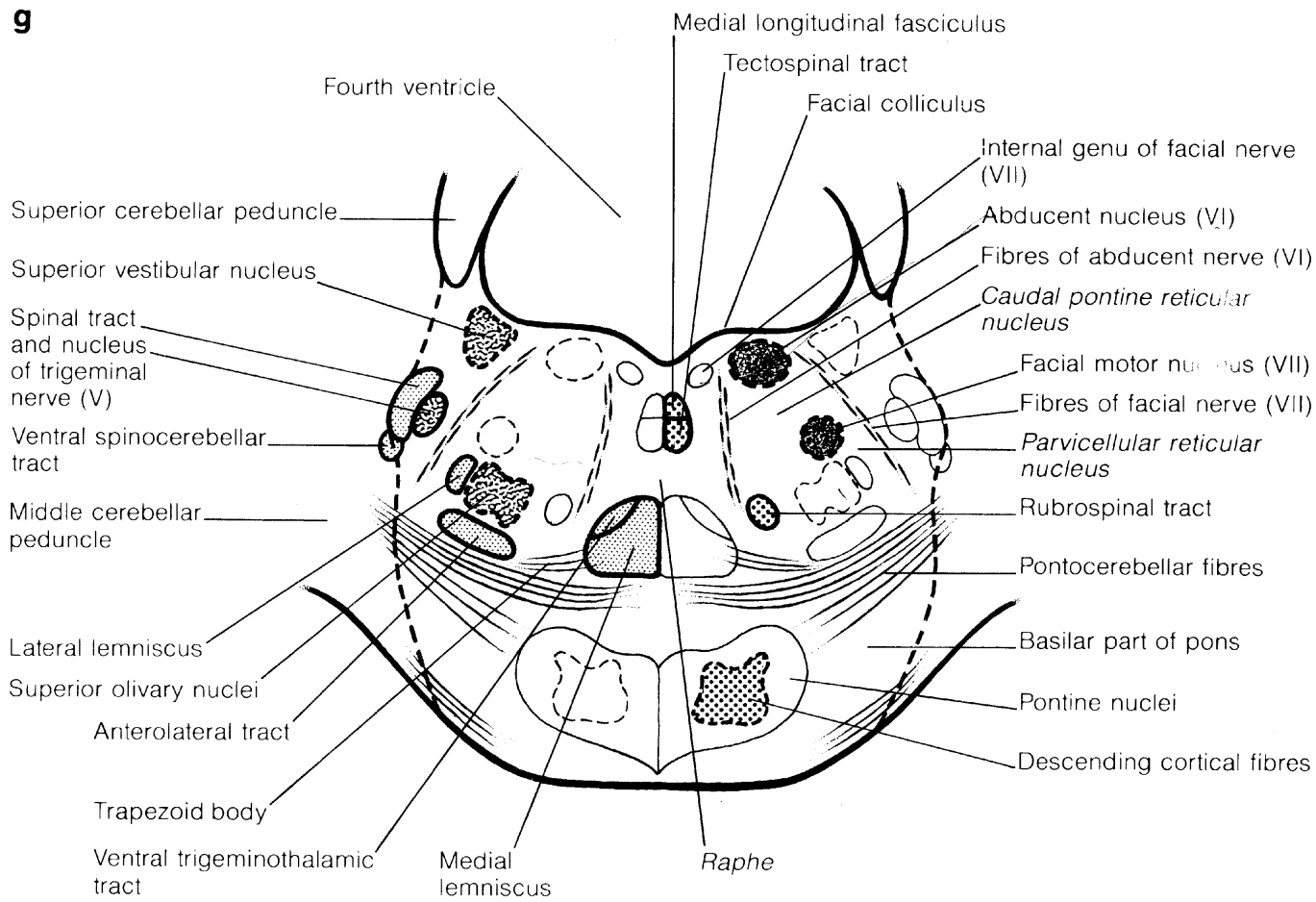


Figure 178g Caudal pons (facial colliculus).

Identifying features:

- 1 Laterally, the pons is continuous through the massive middle cerebellar peduncle with the cerebellum. Dorsally, the fourth ventricle is enclosed by the pons and cerebellum. The superior cerebellar peduncles form its dorsolateral walls. In its floor is the facial colliculus.
- 2 The pons is divided into a dorsal, tegmental part and a ventral, basilar part. The basilar part of the pons consists of caudally running fibres of cerebral cortical origin (cortico-pontine, -nuclear, -spinal fibres), broken up into irregular bundles by scattered pontine nuclei and by transversely running pontocerebellar fibres. Pontocerebellar fibres pass from the pontine nuclei to the contralateral middle cerebellar peduncle.
- 3 Each side of the pontine tegmentum is divided into three regions (medial, intermediate, lateral) by fibres of the abducent and facial nerves.
- 4 In the floor of the fourth ventricle is an elevation, the facial colliculus, caused by the underlying abducent nucleus. Fibres from the abducent nucleus pass ventrally, caudally and slightly laterally to their point of emergence as the abducent nerve near the pontine-medullary junction.
- 5 Immediately medial to the abducent nucleus is the internal genu of the facial nerve. Fibres from the motor facial nucleus pass dorsomedially and cranially, gather into a compact bundle which runs cranially (medial to the abducent nucleus), before turning laterally (dorsal to the abducent nucleus), and then passing ventrolaterally and caudally to emerge in the facial nerve (see Figure 178f). These fibres give the facial colliculus its name.
- 6 In the medial pontine tegmentum, the medial lemniscus lies ventrally with the ventral trigeminothalamic tract or trigeminal lemniscus. These lemnisci are crossed by decussating fibres of the auditory pathway, the fibres forming the trapezoid body. Dorsally, the tectospinal tract and medial longitudinal fasciculus are close to the abducent nucleus.
- 7 In the intermediate part of the tegmentum are the abducent, motor facial and superior olivary nuclei. Ventrally, above fibres of the anterolateral system (tract) and cranial to the inferior olivary nucleus, are the superior olivary nuclei of the auditory pathway. The lateral lemniscus commences just lateral to the superior olivary nuclei.
- 8 In the lateral tegmentum are the spinal tract of the trigeminal nerve and its nucleus (pars oralis) and, dorsally, the superior vestibular nucleus.
- 9 Much of the tegmentum is occupied by the pontine reticular formation.

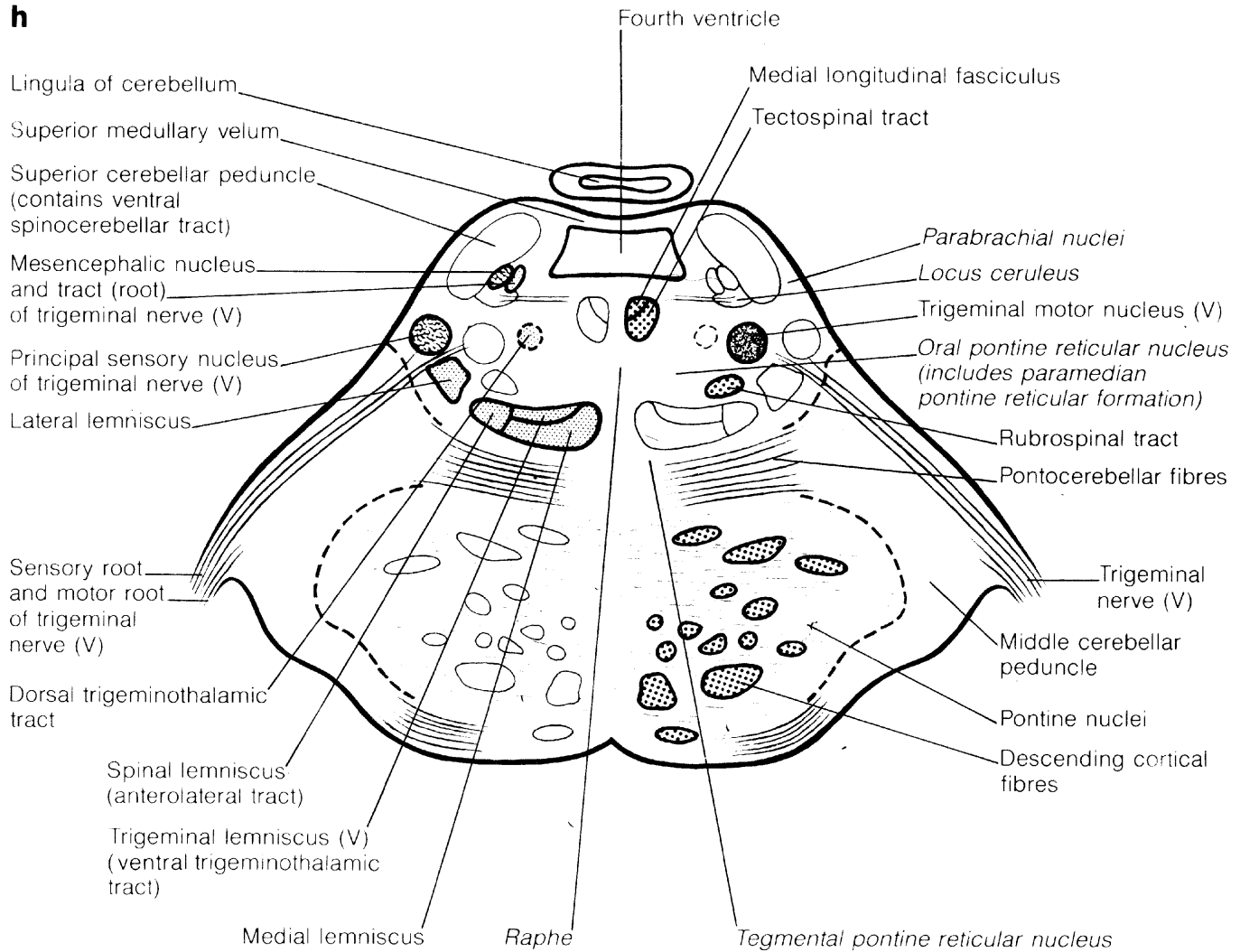
h

Figure 178h Cranial pons (level of trigeminal nerve).

Identifying features:

1 The large, ventral portion of the section is of the basilar part of the pons. Laterally, the trigeminal nerve emerges through the middle cerebellar peduncle. Dorsally, the fourth ventricle narrows as it approaches the cerebral aqueduct of the midbrain.

2 The medial, trigeminal and spinal (somatosensory), and lateral (auditory) lemnisci form a band across the ventral pontine tegmentum. The dorsal trigeminothalamic tract is found more dorsally. The medial longitudinal fasciculus and tectospinal tract are dorsomedial.

3 Fibres of the trigeminal nerve may be traced centrally to its laterally located, principal sensory nucleus and more medial, motor nucleus. The principal sensory nucleus is continuous caudally with the nucleus of the spinal tract. The mesencephalic nucleus of the trigeminal nerve is a thin column of cells lying ventrolateral to the fourth ventricle.

4 Large, melatonin-pigmented cells of the nucleus of the locus ceruleus are found just ventral to the mesencephalic nucleus of the trigeminal nerve.

5 The superior cerebellar peduncles are conspicuous lateral to the fourth ventricle. The lingula of the cerebellum is immediately dorsal to the superior medullary velum which roofs the ventricle.

6 Large areas of the tegmentum are occupied by the pontine reticular formation.

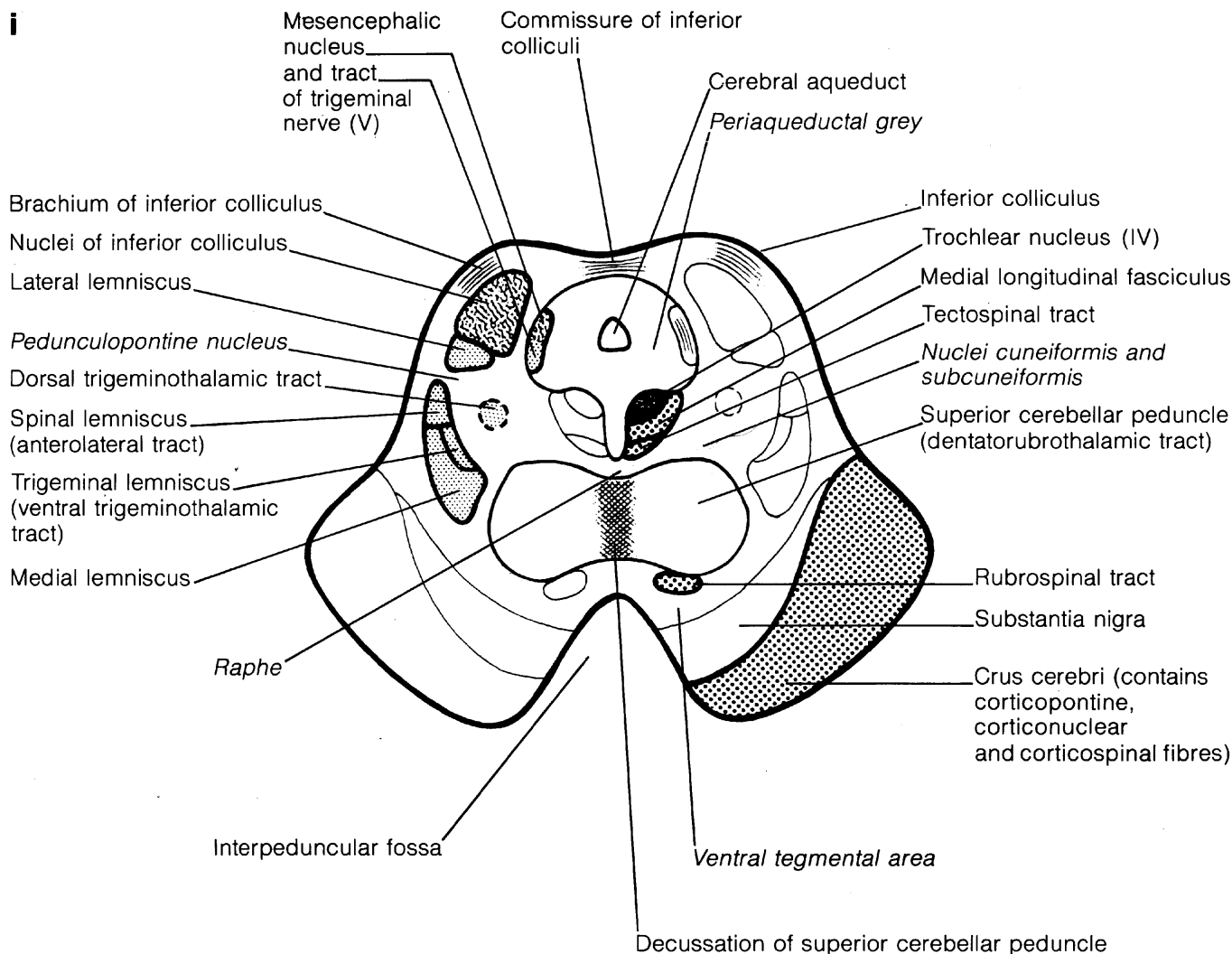


Figure 178i Caudal midbrain (level of inferior colliculus).

Identifying features:

1 *Ventrally is the deep interpeduncular fossa. Ventrolaterally are large protuberances containing the fibre tracts of the crus cerebri. Dorsally are the eminences produced by the inferior colliculi. The cerebral aqueduct is surrounded by the peri-aqueductal grey. Above the crus cerebri on each side are darkly pigmented cells of the substantia nigra. The ventral tegmentum is dominated by the continuations of the superior cerebellar peduncles.*

2 *Ventrolaterally, the crus cerebri contains cortico-pontine, -nuclear and -spinal fibres of the internal capsule of the cerebral hemisphere.*

3 *The substantia nigra occupies the region dorsomedial to the crus cerebri. Its pars reticulata is the cell-poor part adjacent to the crus cerebri. Its darkly pigmented, dorsal region is its pars compacta.*

4 *Medial to the substantia nigra is the ventral tegmental area (of Tsai).*

5 *Ventromedially, much of the tegmentum is taken up by the superior cerebellar peduncles (dentatorubrothalamic tracts) and their decussation.*

6 *Dorsal to each superior cerebellar peduncle and ventromedial to the peri-aqueductal grey, the medial longitudinal fasciculus lies close to the trochlear nucleus. Axons from the trochlear nucleus pass dorsally and caudally, describing a semicircle round the edge of the peri-aqueductal grey and decussating in the superior medullary velum, before emerging just caudal to the inferior colliculus as the trochlear nerve.*

7 *Laterally, in the peri-aqueductal grey, is the mesencephalic nucleus of the trigeminal nerve.*

8 *Laterally, in the tegmentum, are grouped the somatosensory fibres of the medial, trigeminal and spinal lemnisci.*

9 *More dorsally, the auditory fibres of the lateral lemniscus form a capsule ventral to the inferior colliculus before terminating there. Dorsally, the inferior colliculi are linked by their commissure. Dorsolaterally, axons pass from the inferior colliculus to the medial geniculate body via the brachium of the inferior colliculus.*

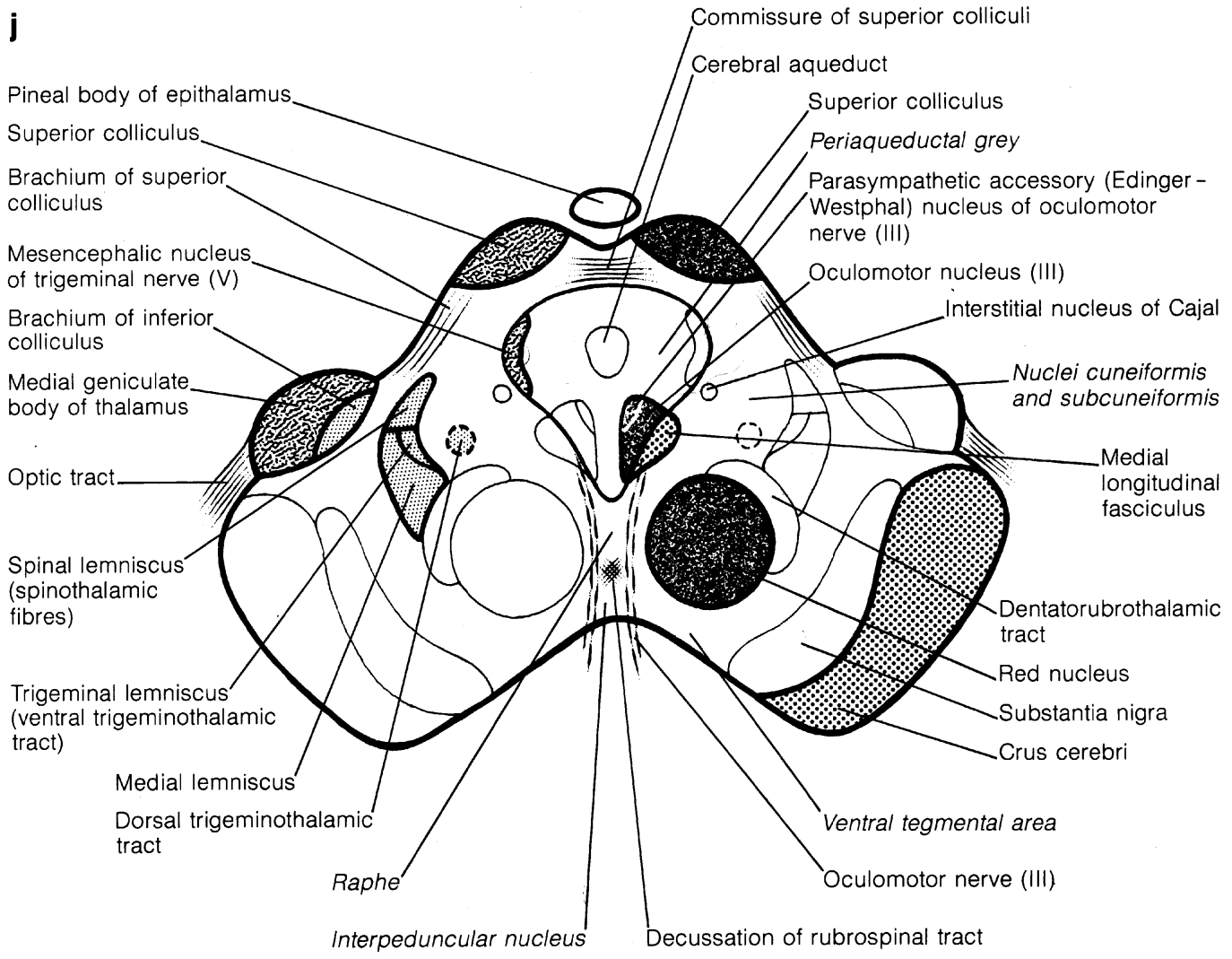
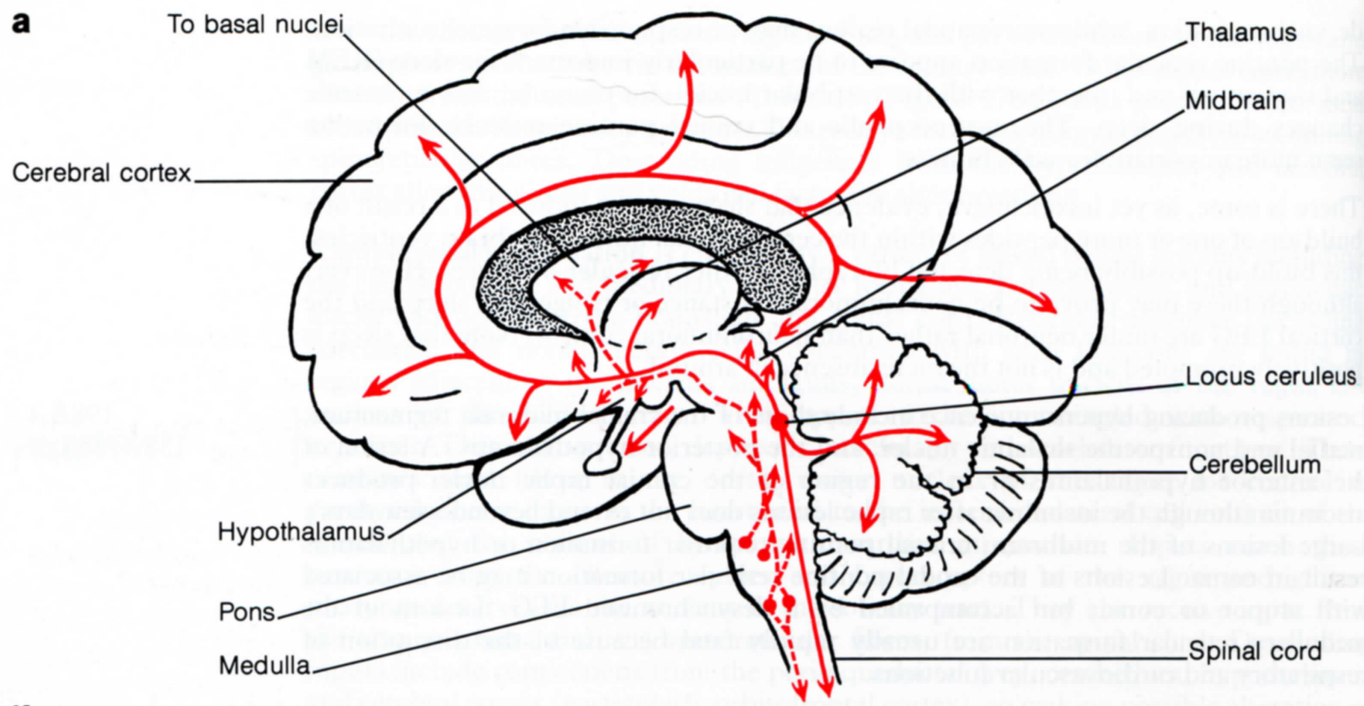
j

Figure 178j Cranial midbrain (level of the superior colliculus).

Identifying features:

- 1 The shape of the section is similar to that through the caudal midbrain. Many structures are continuations of those of the caudal midbrain and occupy similar positions (see Figure 178i). However, the superior colliculi are dorsal, and the red nuclei are conspicuous in the tegmentum.
- 2 Ventromedially on each side is the red nucleus. It gives rise to the rubrospinal tract which decussates in the ventromedial tegmentum.
- 3 Dorsomedial to the red nucleus and ventromedial to the peri-aqueductal grey is the medial longitudinal fasciculus.
- 4 Medially, adjacent to the medial longitudinal fasciculus, is the oculomotor nucleus. Dorsomedial to this nucleus is the parasympathetic accessory nucleus of the oculomotor nerve. Fibres run ventrally from the nuclei through the tegmentum to emerge in the interpeduncular fossa as the oculomotor nerve.
- 5 Dorsally are the superior colliculi, interconnected by their commissure. The pineal body of the epithalamus lies between them. Ventrolateral to each superior colliculus is its brachium. The brachium contains corticotectal fibres plus fibres of the medial division of the optic tract. The superior colliculus gives rise to the tectospinal tract. The tectospinal tract decussates immediately, ventral to the peri-aqueductal grey, and runs caudally, ventral to the medial longitudinal fasciculus.
- 6 Laterally, the medial geniculate body of the thalamus is near to the crus cerebri and the superior colliculus. It receives the auditory fibres of the brachium of the inferior colliculus. Fibres of the medial division of the optic tract pass close to it on their way to the superior colliculus.



Key

- Location of noradrenergic cell groups
- Projections of lateral tegmental system
- Projections of locus ceruleus

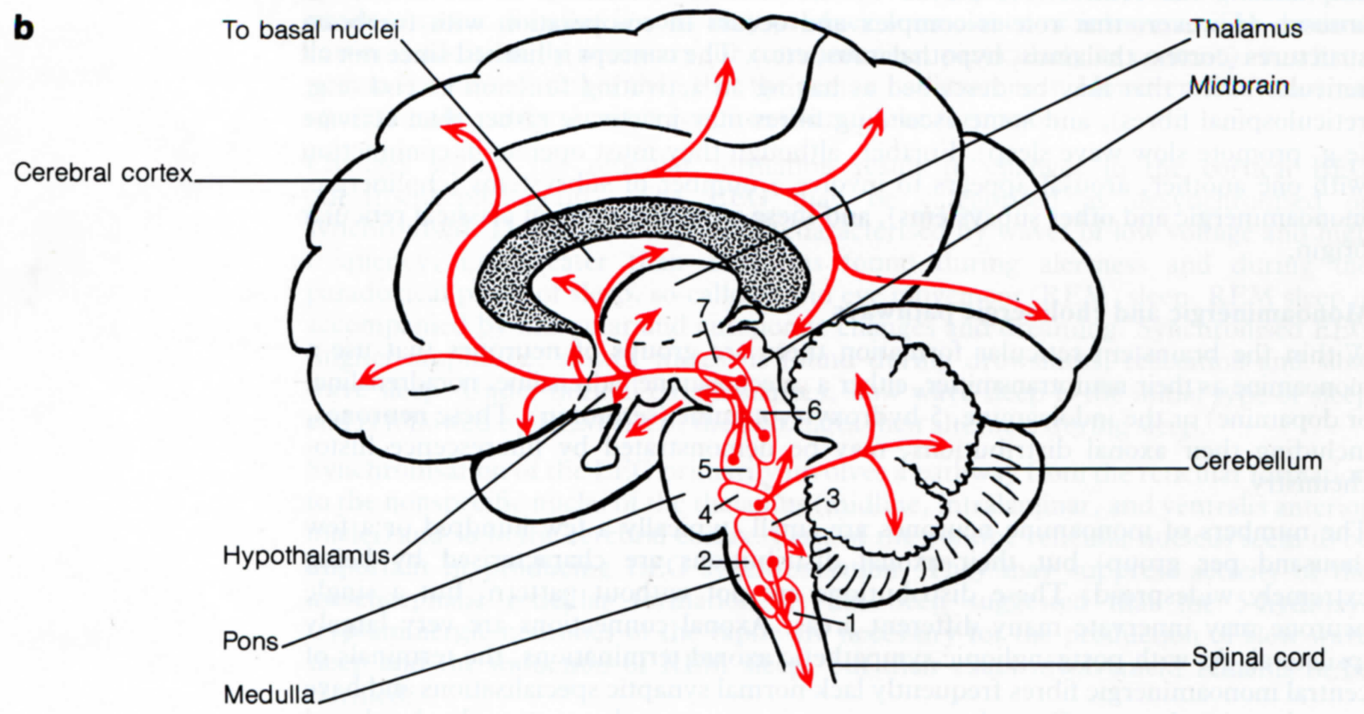


Figure 179 Monoaminergic and cholinergic pathways of the reticular formation (projected on to a median sagittal section of the brain). a) Noradrenergic pathways. b) 5-hydroxytryptaminergic pathways and the raphe nuclei: 1 = nucleus raphe obscurus, 2 = nucleus raphe pallidus, 3 = nucleus raphe magnus, 4 = nucleus raphe pontis, 5 = nucleus raphe medialis, 6 = nucleus raphe dorsalis, 7 = nucleus raphe linearis. c) Adrenergic and dopaminergic pathways. d) Cholinergic reticular pathways.

