Ascending Tracts	Pathway in SC	Decussation	Sensations Mediated	Input receptors
Dorsal Column Medial Leminiscus	Dorsal root ganglia (fasciculus gracilis [LE] and fasciculus cuneatus [UE]) and then forms dorsal columns medial to dorsal roots ascends to medulla then decussates...	In medulla as internal arcuate fibers forming medial leminiscus terminates on VPL in thalamus TO internal capsule and project to somatosensory cortex of postcentral gyrus (Areas 3,1,2)	Tactile discrimination, vibration, stereognosis, joint muscle sensations, conscious proprioception	Pacini's & Meissner's Corpuscules, Joint Receptors, Muscle Spindles, Golgi Tendon Organs
Ventral Spinothalamic Tract	Dorsal root ganglia to dorsal horn the decussates...	At level in ventral white commissure and ascend in ventral funiculus to VPL in thalamus to internal capsule and corona radiate to postcentral gyrus	Light touch	Free nerve endings and Merkel's Tactile disks
Lateral Spinothalamic Tract	Dorsal root ganglia to dorsolateral tract of Lissauer to dorsal horn and decussates...	At level in ventral white commissure ascending in ventral half of lateral funiculus; some collaterals to reticular formation terminates in contralateral VPL and bilaterally in intralaminar nuclei of thalamus to internal capsule to somatesthetic cortex of postcentral gyrus (areas 3,1,2)	Pain and temperature	Free nerve endings, thermal receptors, A-δ (fast conducting) & C Fibers (slow conducting) pain fibers
Dorsal Spinocerebellar Tract	C8 – S3 Dorsal roots ganglia (afferent for muscle stretch reflexes), nucleus dorsalis of Clarke, ascend lateral funiculus to inferior cerebellar peduncle, terminate in cortex of rostral and caudal cerebellar vermis	**Does Not Decussate**	Unconscious proprioception to cerebellum (fine coordination of posture and movement **individual** LE muscles)	Muscle Spindles, Golgi Tendon Organs, Pressure Receptors
Ventral Spinocerebellar Tract	L1-S2 Dorsal Root Ganglia (afferent for muscle stretch reflexes), to spinal border cells in ventral horns and decussates...	At level in anterior white commissure ascending lateral to LSTT in lateral funiculus, and enter cerebellum via superior cerebellar peduncle and terminate in rostral cerebellar vermis	Unconscious proprioception (coordination of posture and movement of **entire** LE)	Muscle Spindles, Golgi Tendon Organs, Pressure Receptors
Cuneocerebellar Tract	(UE version of DSCT) C2 –T7 Dorsal root ganglia to fasciculus cuneatus to caudal medulla synapse on accessory cuneate nucleus to inferior cerebellar peduncle and terminate ipsilaterally in arm region of anterior lobe of cerebellum	**Does Not Decussate**	Unconscious proprioception to cerebellum (fine coordination of posture and movement **individual** UE muscles)	Muscle Spindles, Golgi Tendon Organs, Pressure Receptors

Descending Tracts	Pathway to SC	Decussation	Outputs Mediated
Lateral Corticospinal (pyramidal) Tract	Arises from Lamina V of cerebral cortex (premotor cortex [area 6], precentral cortex [area 4], and postcentral sensory cortex [areas 3,1,2], through internal capsule to crus cerebri (midbrain) to base of pons, and undergoes 90% decussation...	At pyramids of medulla, to dorsal aspect of lateral funiculus and terminates on ventral horn motor neurons and dorsal horn sensory neurons	Volitional skilled motor activity
Ventral Corticospinal Tract		Decussates at spinal cord levels in ventral white commissure	Control of axial muscles
Rubrospinal Tract		**Does Not Decussate**	Role in control of flexor tone
Vestibulospinal Tract			Role in control of extensor tone

Anatomy 234.3
Brainstem (III) - The Reticular Formation

Specific Objectives:
To be able to

1) describe the main components of the reticular formation and the function(s) of each component
2) describe the major ascending and descending efferent pathways from the reticular formation and indicate the type of information conveyed by each tract
3) list the main sources of afferent input to each component of the reticular formation
4) list the nuclei of the brainstem that project to the cerebellum and identify their location within the brainstem

What is the Reticular Formation?
It is that portion of the brainstem tegmentum which contains a net-like organization consisting of small groups of neurons, interspersed with fibres

- ✿ The dendritic field of the neurons of the RF are oriented at right angles to the axis of the brainstem - maximum synaptic connections
- ✿ The axons of RF neurons course over long distances throughout the brainstem, & even up into the cerebrum and down into the spinal cord

Can be considered as a rostral extension of the interneuronal network that surrounds the spinal cord

How is the Reticular Formation organized?
Can be arranged in 3 longitudinal medial - lateral zones on either side of the midline.

- Raphe nuclei
- Medial zone nuclei
- Lateral zone nuclei

Raphe Nuclei
Midline - bilaterally
Found at all 3 levels of brainstem
Neurotransmitter used is serotinin

Projections
Rostrally - active in sleep program
Caudally - modulates pain perception

Medial Zone Nuclei - (central group)
Lateral to Raphe nuclei

- ✿ mixture of large & small neurons
- ✿ Medullary Medial zone called the gigantocellular reticular nucleus because neurons so large
- ✿ Paramedian Pontine Reticular Formation (PPRF)
- ✿ Precerebellar Reticular Nuclei
- ✿ Locus Coeruleus

Lateral Zone Nuclei
Lateral to Medial Zone nuclei

- ✿ mostly located in the ponto/medullary tegmentum - Parvocellular Reticular nucleus (these are mainly small neurons)
- ✿ Parabrachial area - midbrain
- ✿ Lateral Reticular Nucleus - medulla

What input does the Reticular Formation receive?
Derived from many sources

- ✿ from spinal cord - anterolateral system
- ✿ from all sensory cranial nerves - GSA (V)
- ✿ from visceral sources
  Nucl. Solitarius; Vestibular Nucl.;
- ✿ from cerebral centres (motor & visceral);
- ✿ from cerebellum

Note about inputs:
The lateral group is primarily considered an "associative or sensory zone", receiving the input as shown

What about output from the Reticular Formation to other areas?
Extensive output - axons have diffuse projections throughout CNS

- ✿ back to spinal cord
  - modulating pain
  - integrating motor activity
  - controlling autonomic nuclei
- ✿ integration of cranial nerves- GSE, SVE, GVE 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
- ✿ back to cerebral centres via Ascending Reticular Activating System (ARAS)
- ✿ back to cerebellum

✿integration of cranial nerves- GSE, SVE, GVE 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

Eye movements; Mastication; Salivation; Facial Expresion; Lacrimation; Swallowing; Sneezing; Respiration; Circulation

Note about outputs:
The medial group is primarily considered the "effector or motor zone", sending the information back out

Functional Organization of the Reticular Formation
Can be subdivided into several groupings:

- ✿ Control of Consciousness
- ✿ Motor Control
  - Cerebral centres
  - Cerebellar
  - Cranial nerves
  - Spinal cord
- ✿ Sensory Control

Control of Consciousness – ARAS
Controlled through the Central Tegmental Tract (reticulo-reticulo pathway)

✿ There are areas that increase alertness when active - locus coeruleus; central group of reticular nuclei (silent in sleep)
Important for maintenance of consciousness
✿ The Raphe nuclei are v. active in sleep
See Fig 22 - 25

Motor Control - to Cerebral Centres

Largely directed to basal ganglia through the intralaminar nuclei (thalamus), & to hypothalamus and the septal area (MFB)

✿Outflow to basal ganglia comes from pedunculopontine nucl (lateral group),

✿Outflow to intralaminar nuclei comes from locus coeruleus, parabrachial area & central reticular nuclei

Motor Control - Cerebellum

✿Outflow to cerebellum comes from the central reticular nuclear group (medial zone) and the lateral reticular nucleus (lat. zone)

Largely responsible for integration of "motor programs"

Motor Control - Cranial Nerve Motor Nucl.

✿Examples of outflow to cranial nerves are

1) from the parvocellular reticular area (lateral zone) to control feeding reflexes
and
2) the Paramedian Pontine Reticular Formation (medial zone) to control horizontal conjugate gaze

Responsible for integration of "motor programs"

Motor Control - Spinal Cord

✿Outflow to spinal cord comes from the central reticular nuclear group (medial zone)

✿Largely responsible for additional "motor programs" responsible for complex patterns of movement

- pontine reticulospinal tract (medial) (ipsilateral- to all cord levels; runs in MLF)
- medullary reticulospinal tract (lateral) (1° ipsilateral - runs with Rubrospinal; all cord)

Sensory Control - descending Pain control

✿Largely directed by periaqueductal gray and Raphe nucleus Magnus (Fig 11 - 17)

✿Stimulation of periaqueductal gray activates Raphe nuclei - Outflow to spinal cord, synapses on interneurons in Lamina II (substantia gelatinosa) & III

Use of endorphins at these neurons to regulate pain perception & induce analgesia

Visceral Control - Autonomic outflow

✿Respiratory centers

acts with influences from "other" regions (pneumotaxic center in pons) to control inhibitory (ventromedial medulla) and excitatory (dorsolateral pons/medulla) rhythms

✿Cardiovascular centers

- ✿ Also has inhibitory (ventromedial tegmentum of the medulla) and excitatory (lateral medulla) sites that regulate heart beat and blood pressure

Input is from pressoreceptors & chemoreceptors (eg., in heart and carotid sinus)

Nuclei of the brainstem that project to the cerebellum

Tegmental:

Vestibular nuclei in the pons/medulla
Groups of lateral reticular nuclei in pons/medulla
Red Nucleus - midbrain

Ventral nuclei

Inferior olive - medulla
pontine nuclei - basis pontis
arcuate nucleus -(stria medularis) - covers pyramid