Spinal cord - Tracts of spinal cord

Spinal cord tracts are neural pathways in the spinal cord's white matter that are classified as either ascending (sensory) or descending (motor). Ascending tracts transmit sensory information from the body's periphery to the brain for processing, while descending tracts carry motor commands from the brain to the body's muscles for movement. These tracts allow for communication between the brain and the rest of the body, enabling both sensory perception and motor control.

Ascending (Sensory) Tracts

These pathways carry sensory information from the body to the brain, including pain, temperature, touch, and proprioception (body position).

Dorsal Columns

(e.g., Fasciculus gracilis and Fasciculus cuneatus): Ascending tracts that carry fine touch, vibration, and proprioception from the lower and upper body, respectively, to the brain.

Spinothalamic Tract:

Carries information about pain and temperature (lateral spinothalamic) and crude touch (anterior spinothalamic) from the spinal cord to the thalamus in the brain.

Spinocerebellar Tracts:

Carry unconscious proprioceptive information from the muscles to the cerebellum, which helps coordinate and refine motor movements.

Descending (Motor) Tracts

These pathways transmit motor commands from the brain to the muscles, controlling voluntary and involuntary muscle movements.

- Corticospinal Tract **(Pyramidal Tract)**: Responsible for voluntary movements of the body.
- Extrapyramidal Tracts: A group of motor tracts (such as the rubrospinal, vestibulospinal, reticulospinal, and tectospinal tracts) that are under unconscious control and regulate and modulate motor activity.

Function of Spinal Cord Tracts

Beyond simply acting as conduits, spinal cord tracts also modify and integrate the information passing through them. This allows for more complex communication and processing between the central nervous system (brain and spinal cord) and the periphery of the body.

Anatomy

The spinal cord is part of the central nervous system (CNS). It is situated inside the vertebral canal of the vertebral column. During development, there’s a disproportion between spinal cord growth and vertebral column growth. The spinal cord finishes growing at the age of 4, while the vertebral column finishes growing at age 14-18. This is the reason why, in adults, the spinal cord occupies only the upper two thirds of the vertebral canal.

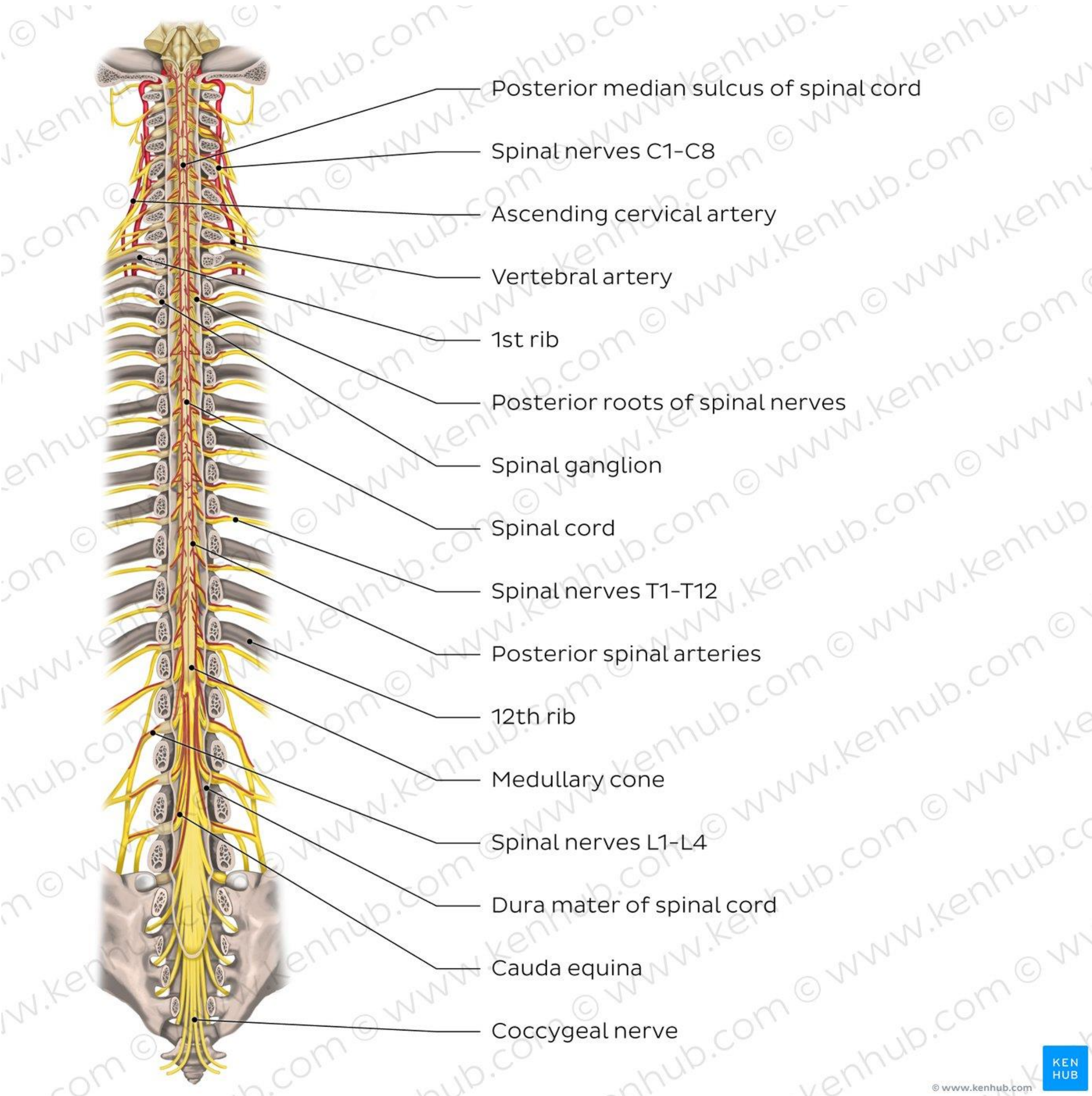


Fig: Spinal cord(diagram)

The spinal cord is a continuation of the brainstem. It extends from the foramen magnum at the base of the skull to the L1/L2 vertebra where it terminates as the conus medullaris (medullary cone). A thin thread called filum terminale extends from the tip of the conus medullaris all the way to the 1st coccygeal vertebra (Co1) and anchors the spinal cord in place.

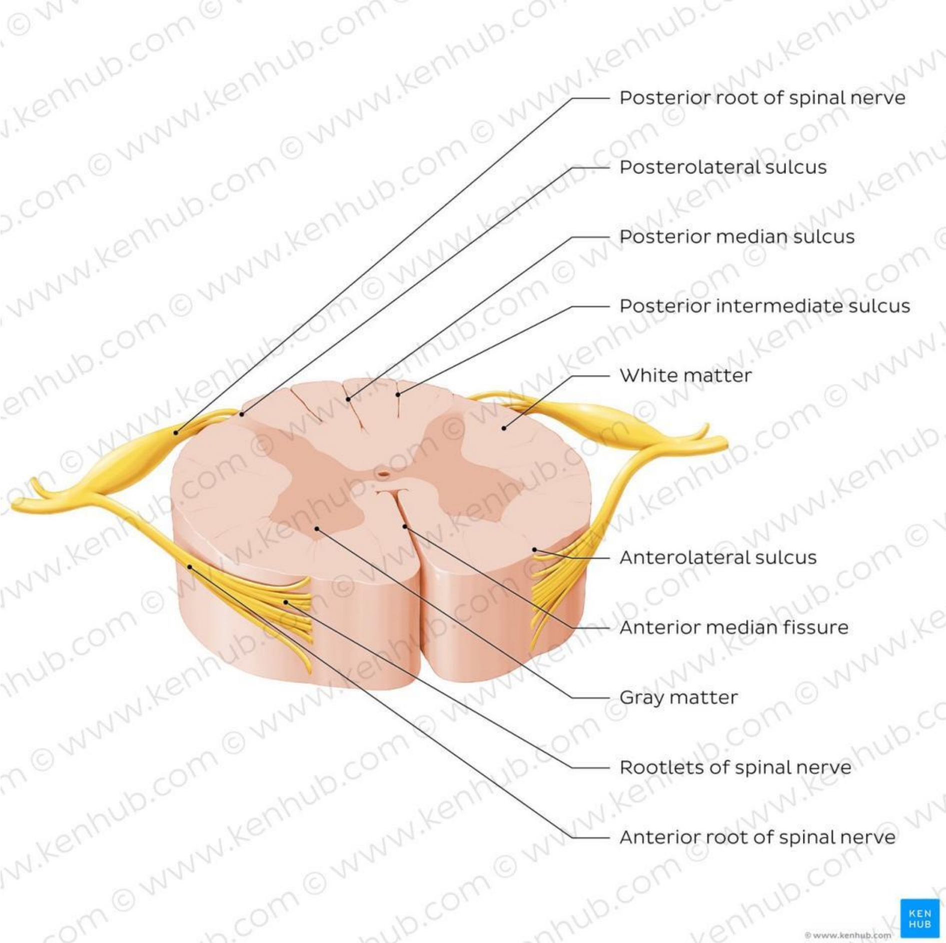
You can easy remember the extent of the spinal cord with a **mnemonic** '**SCULL**', which stands for ' **S**pinal **C**ord **U**ntil **L2** (LL)'.

It's important to master the basics of the nervous system before delving into the details of specific structures like the spinal cord. Check if your knowledge is up to par with our nervous system anatomy practice quizzes.

Throughout its length, the spinal cord shows two well defined enlargements to accommodate for innervation of the upper and lower limbs: one at the cervical level (upper limbs), and one at the lumbosacral level (lower limbs).

Like the vertebral column, the spinal cord is divided into **segments**: cervical, thoracic, lumbar, sacral, and coccygeal. Each segment of the spinal cord provides several pairs of spinal nerves, which exit from vertebral canal through the intervertebral foramina. There are 8 pairs of cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal pair of spinal nerves (a total of 31 pairs).

The spinal cord is made of gray and white matter just like other parts of the CNS. It shows four surfaces: anterior, posterior, and two lateral. They feature fissures (anterior) and sulci (anterolateral, posterolateral, and posterior).



Spinal cord: Cross section (External morphology)

The gray matter is the butterfly-shaped central part of the spinal cord and is comprised of neuronal cell bodies. It shows anterior, lateral, and posterior horns. White matter surrounds the gray matter and is made of axons. It contains pathways that connect the brain with the rest of the body.

Spinal meninges

The spinal cord and spinal nerve roots are wrapped within three layers called meninges. The outermost is the dura mater, underneath it is the arachnoid mater, and the deepest is the pia mater. Dura mater has two layers (periosteal and meningeal), between which is the epidural space. Between the arachnoid and pia mater is the subarachnoid space, it is filled with cerebrospinal fluid.
Interested to know everything about the spinal membranes? Sure, check out our study unit:

Blood supply

The spinal cord is supplied by branches of the vertebral and segmental arteries.

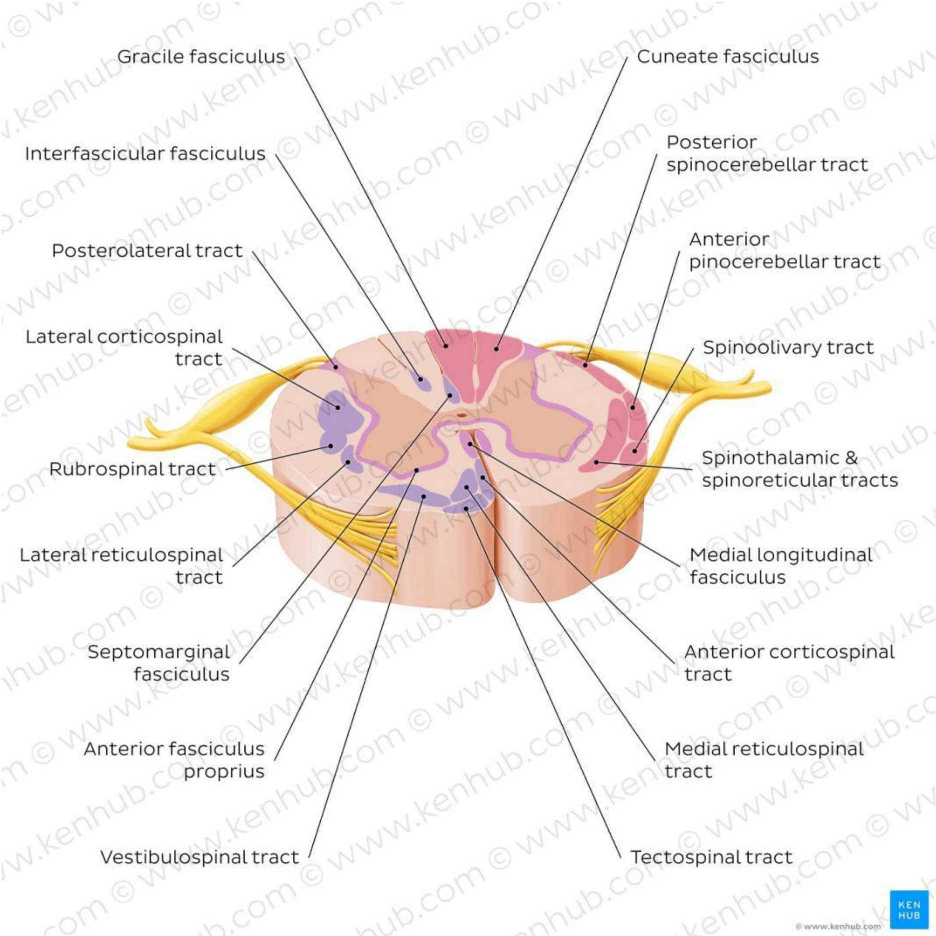
The **vertebral artery** gives rise to anterior and posterior **spinal arteries**. Segmental arteries, such as the deep cervical, ascending cervical, and posterior intercostal give rise to 31 pairs of radicular arterial branches which supply the roots of spinal nerves.

Similar named veins accompany the arteries. Anterior and posterior **spinal veins** drain into radicular veins, which then empty into the (internal and external) vertebral venous plexus. This network eventually empties into the vertebral (neck) and segmental (trunk) veins. Blood supply is always an inevitable part of any anatomy study unit.

Spinal cord tracts

Spinal cord neural pathways are found within the spinal cord white matter. On each side, the white matter is divided into three funiculi: anterior, lateral, and posterior.

Ascending tracts convey information from the periphery to the brain. On the other hand, the descending tracts carry information from the brain to the periphery. The spinal cord is more than just a conduit, as it also modifies and integrates the information that pass through it.



Spinal cord: Cross section (ascending and descending tracts)

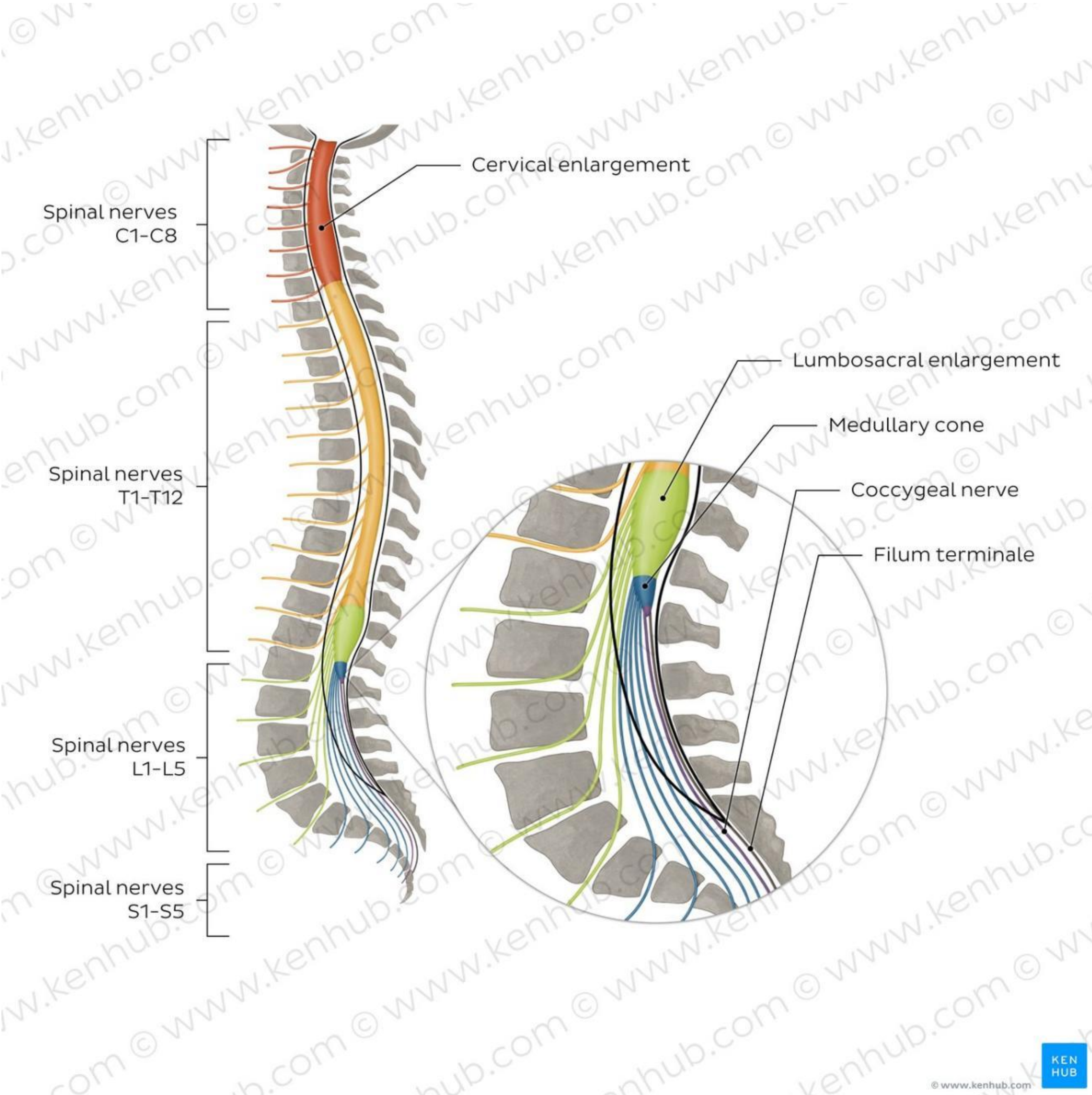
Anterior funiculus	**Ascending tract:** - Anterior spinothalamic tract **Descending tracts:** - Anterior corticospinal tract - Vestibulospinal tract - Tectospinal tract - Reticulospinal tract
Lateral funiculus	**Ascending tracts:** - Posterior spinocerebellar tract - Anterior spinocerebellar tract - Lateral spinothalamic tract - Spinotectal tract - Posterolateral tract of Lissauer - Spinoreticular tract - Spino-olivary tract **Descending tracts:** - Lateral corticospinal tract - Rubrospinal tract

	- Lateral reticulospinal tract - Descending autonomic tracts - Olivospinal tract
Posterior funiculus	**Ascending tracts:** - Gracile fasciculus of Gol - Cuneate fasciculus of Burdach

Master spinal cord anatomy and fortify your understanding of the nervous system by going through this study content.

Spinal nerves

Spinal nerves are grouped as cervical (C1-C8), thoracic (T1-T12), lumbar (L1-L5), sacral (S1-S5), and coccygeal (Co1), depending from which segment of the spinal cord they extend.



Vertebral column and spinal nerves

Segmentation of the spinal cord corresponds to the intrauterine period in which the spinal cord occupies the entire vertebral canal. For this reason in adulthood, where the vertebral column is longer than the cord, each spinal cord segment is located higher than its corresponding vertebra. These differences become more obvious distally towards the lumbar and sacral segments of the spinal cord–for example spinal cord segment L5 is at the level of the L1 vertebra.

Spinal nerves, however, exit the vertebral column at their correspondly numbered vertebrae. Cervical spinal nerves exit through the intervertebral foramina directly above their corresponding vertebrae, whilst thoracic, lumbar and sacral spinal nerves exit directly below.

In order for the more distal spinal nerves to exit they must first descend through the vertebral canal. Since the lumbar and sacral spinal nerves are the farthest from their intervertebral foramina, they are the longest. While descending towards their corresponding intervertebral foramina, lumbosacral spinal nerves form a bundle called the cauda equina (meaning horse's tail).

Each spinal nerve has an anterior and posterior root. **Anterior roots** transmit motor information, and they originate from the anterior horns of the gray matter and exit the spinal cord through the anterolateral sulcus. The **posterior roots** transmit sensory information and have sensory ganglion attached to them. They originate from the posterior horns of gray matter and exit through the posterolateral sulcus of the spinal cord.

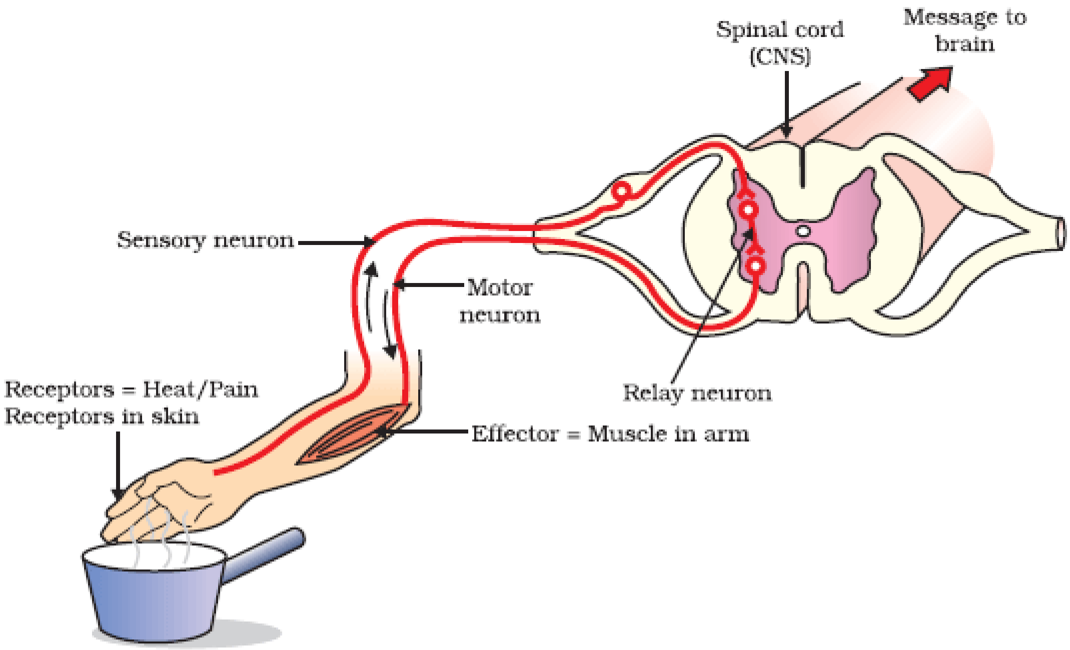
The anterior and posterior roots merge just before the intervertebral foramen, and form the trunk of the spinal nerve. The trunk is very short, and soon after exiting the vertebral column, it divides into four branches: anterior ramus, posterior ramus, communicating ramus, and meningeal ramus.

Reflex arc

A huge part of spinal cord function is under the influence of the brain, as it functions to relay information to and from the periphery. But there are many reflexes that are generated in the spinal cord independently from the brain. Spinal reflexes are either monosynaptic or polysynaptic.

Monosynaptic reflexes play out with only two neurons participating in the reflex arc, one sensory and one motor. The first-order neuron (sensory) is in the spinal ganglion, while the second-order neuron (motor) is in the anterior horn of the spinal cord). The sensory neuron gathers impulses from the muscle and sends this information to the motor neuron which innervates the same muscle. The motor neuron then causes contraction of the innervated muscle. An example of a monosynaptic reflex is the stretch reflex.

Polysynaptic reflexes on the other hand have multiple neurons participating. Besides one sensory and one motor neuron, there are also one or more interneurons between them making this communication indirect. They are more complex than monosynaptic reflexes as they involve muscle groups instead of a single muscle. An example is the withdrawal reflex.



Reflexes are rapid, involuntary responses to stimuli, categorized by the involvement of skeletal or internal organs and their complexity. Types include somatic (muscle/skin-related) and autonomic (internal organ) reflexes, with somatic examples like the stretch reflex and withdrawal reflex, and autonomic examples including digestive and cardiovascular reflexes. Reflexes are also classified by complexity, as monosynaptic (two neurons) or polysynaptic (more than two neurons), and can be inborn (innate) or learned (acquired) through experience.

Classification by Involvement

Somatic Reflexes:

These reflexes involve skeletal muscles, skin, and other external stimuli, and are often conscious.

Stretch Reflex: A monosynaptic reflex that regulates muscle length, like the patellar (knee-jerk) reflex.

Withdrawal Reflex: A polysynaptic reflex that pulls a limb away from a painful stimulus, such as touching a hot surface.

Golgi Tendon Reflex: Protects muscles from excessive stretch by causing relaxation.

Autonomic Reflexes:

These reflexes involve internal organs and processes, often below the level of conscious awareness.

Cardiovascular Reflexes**:** Regulate heart rate and blood pressure.

Digestive Reflexes**:** Control internal digestive processes.

Excretory Reflexes**:** Manage bodily waste removal.

Classification by Complexity

Monosynaptic Reflexes**:**

These involve a reflex arc with a single synapse and just two neurons: a sensory neuron and a motor neuron. The stretch reflex is an example.

Polysynaptic Reflexes**:**

These reflex arcs contain one or more interneurons connecting the sensory and motor neurons, making them more complex. The withdrawal reflex is a common example.

Classification by Origin

Innate (Intrinsic) Reflexes**:**

These are pre-programmed, involuntary, and unlearned responses present at birth.

Moro Reflex**:** The "startle reflex" in infants, which includes an arm-spreading response.

Rooting and Sucking Reflexes**:** Facilitate feeding in newborns.

Learned (Acquired) Reflexes**:**

These are developed through practice, repetition, and experience, such as learning to drive a car.

Classification by Function

Flexor Reflexes**:** Muscle contraction to flex a limb.

Extensor Reflexes**:** Muscle contraction to extend a limb.

Locomotor Reflexes**:** Involve coordinated movements like stepping or standing.

Statokinetic Reflexes**:** Help maintain body position and balance.