Introduction to the Nervous System

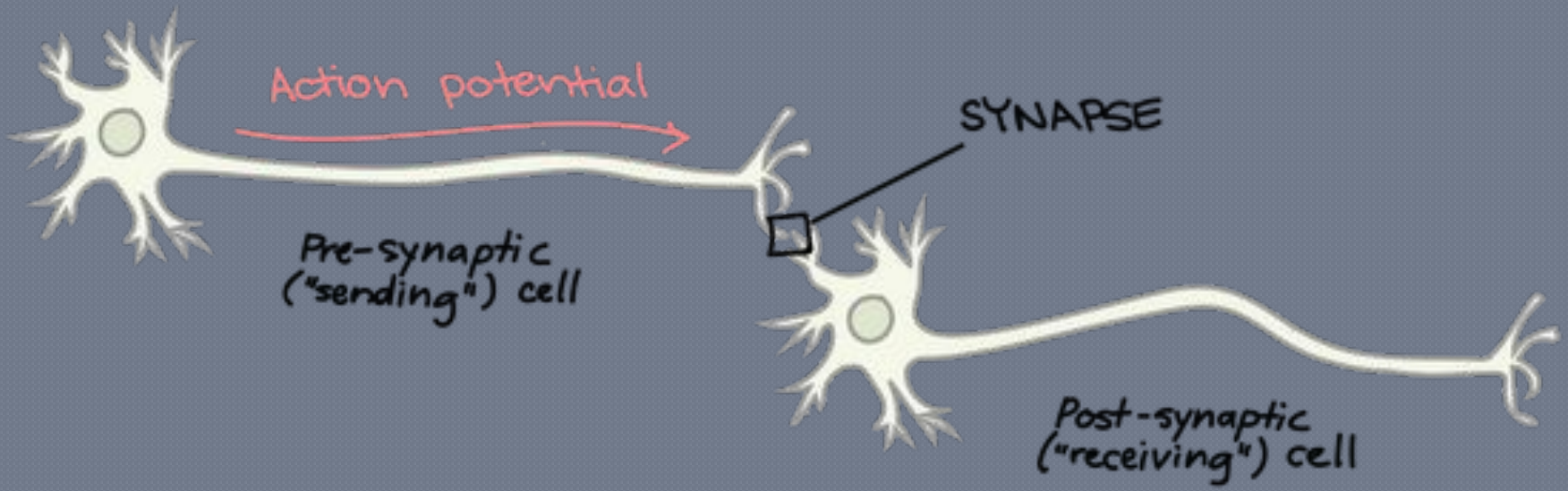
Neurons

What is a neuron?

- aka: nerve cells
  - a nerve is a group of neurons bundled together
- information processing units of the brain that function to:
  - receive signals from the environment
  - integrate incoming signals
  - communicate signals to target cells

How do neurons work?

- neurons lie adjacent to each other but **ARE NOT** connected
- They function to carry electrical impulses from one neuron to the next
- communication occurs via electrical impulses at gaps called **synapses**
- as a whole this process is called an **action potential**


Action potential
SYNAPSE
Pre-synaptic ("sending") cell
Post-synaptic ("receiving") cell

Process of an action potential

- electrical signal (AP) travels down a presynaptic neuron
- at the end of the neuron the AP causes the release of neurotransmitters into synaptic cleft
- neurotransmitters cross the synaptic cleft & bind to receptors on postsynaptic neuron
- the electrical signal is now triggered through the postsynaptic neuron

Parts of a neuron

- Dendrites
  - shaped like tree-roots
  - typically shorter but more numerous than axons
  - function:
    - Receive information from other neurons and transmit information to the cell body

Soma (Cell Body)

- Cell Body
  - considered the core of the neuron
  - enclosed by a protective membrane & contains the cell's nucelus
  - Function:
    - Mainain the cell

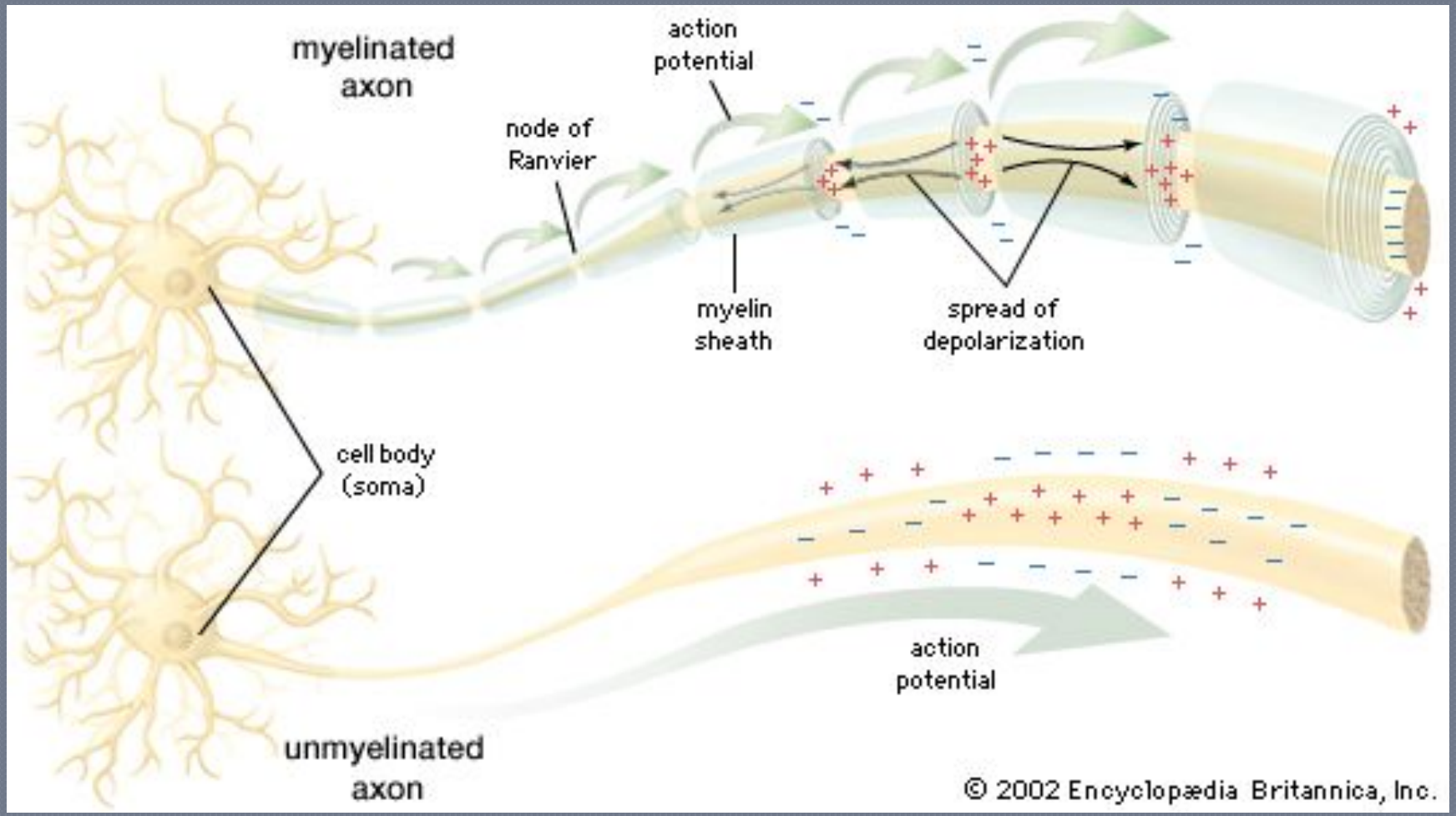
Axon

- Axon
  - aka: nerve fiber
  - tail-like structure; joins to the body @ a junciton called the axon hillock
  - may or may not be covered in myelin
  - function:
    - Carry signals away from the cell body to trasmit electrical signals to other neurons

Myelin

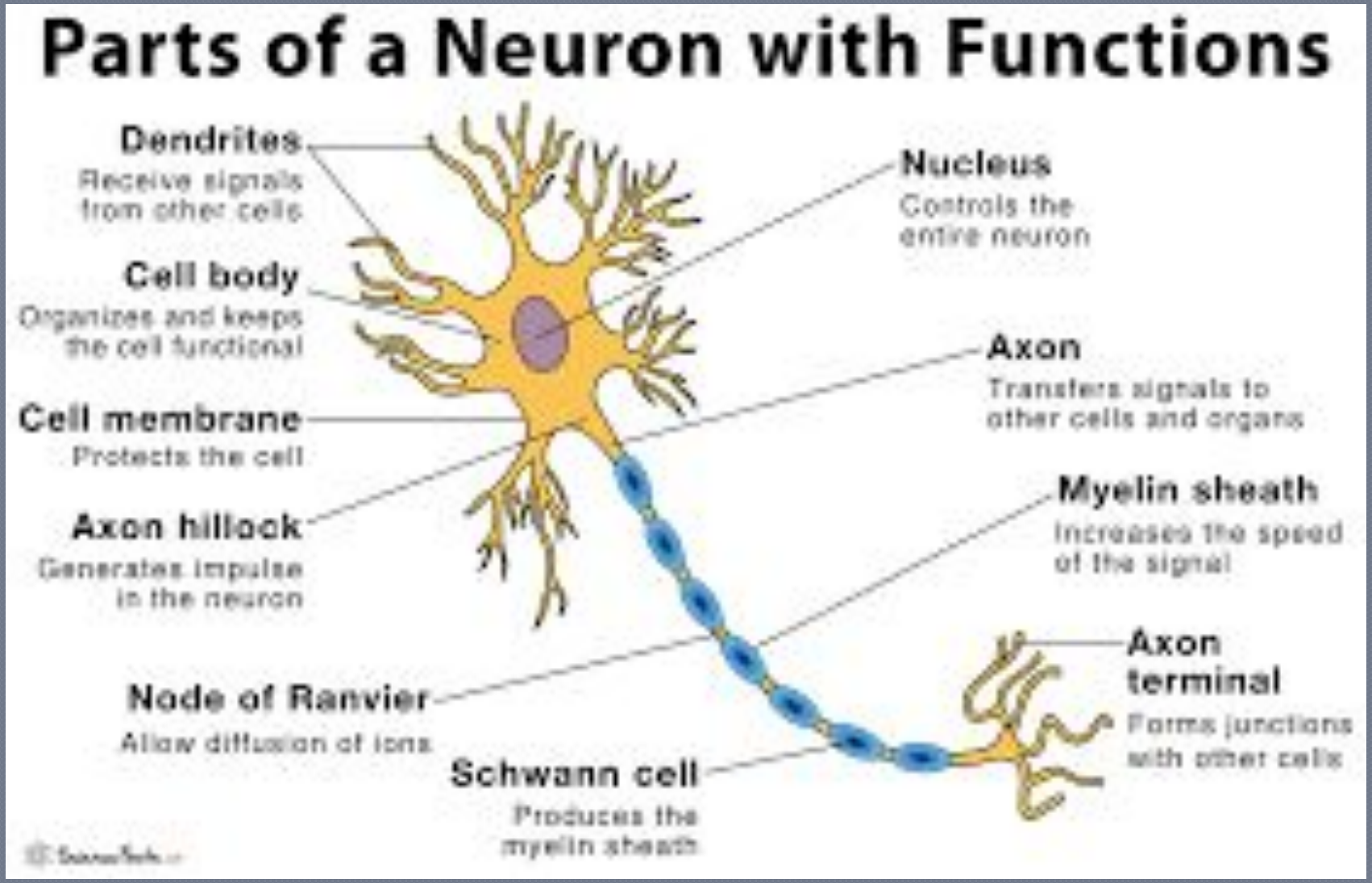
- Myelin
  - a sheath of fatty material that covers axons
  - function:
    - insulates one nerve cell from another to prevent impulses of adjacent neurons from interfering with each other
    - speeds up the conduction of the nerve impulses
  - myelinated axons are wrapped in glial cells that are responsible for forming the myelin sheath
    - Schwann Cells
    - oligodendrocytes
  - the myelin sheath is broken up by nodes of Ranvier - this orientation allows the impulse to move faster down the neuron

Myelinated and Unmyelinated



Axon Terminal

- Axon terminal
  - aka: terminal buttons
  - appears at the end of a neuron
  - function:
    - transmit signals to other neurons
    - release neurotransmitters across the synapse
    - reuptake any neurotransmitters that do not get passed on to the next neuron


Parts of a Neuron with Functions
Dendrites
Receive signals from other cells
Cell body
Organizes and keeps the cell functional
Cell membrane
Protects the cell
Axon hillock
Generates impulse in the neuron
Node of Ranvier
Allow diffusion of ions
Schwann cell
Produces the myelin sheath
Nucleus
Controls the entire neuron
Axon
Transfers signals to other cells and organs
Myelin sheath
Increases the speed of the signal
Axon terminal
Forms junctions with other cells

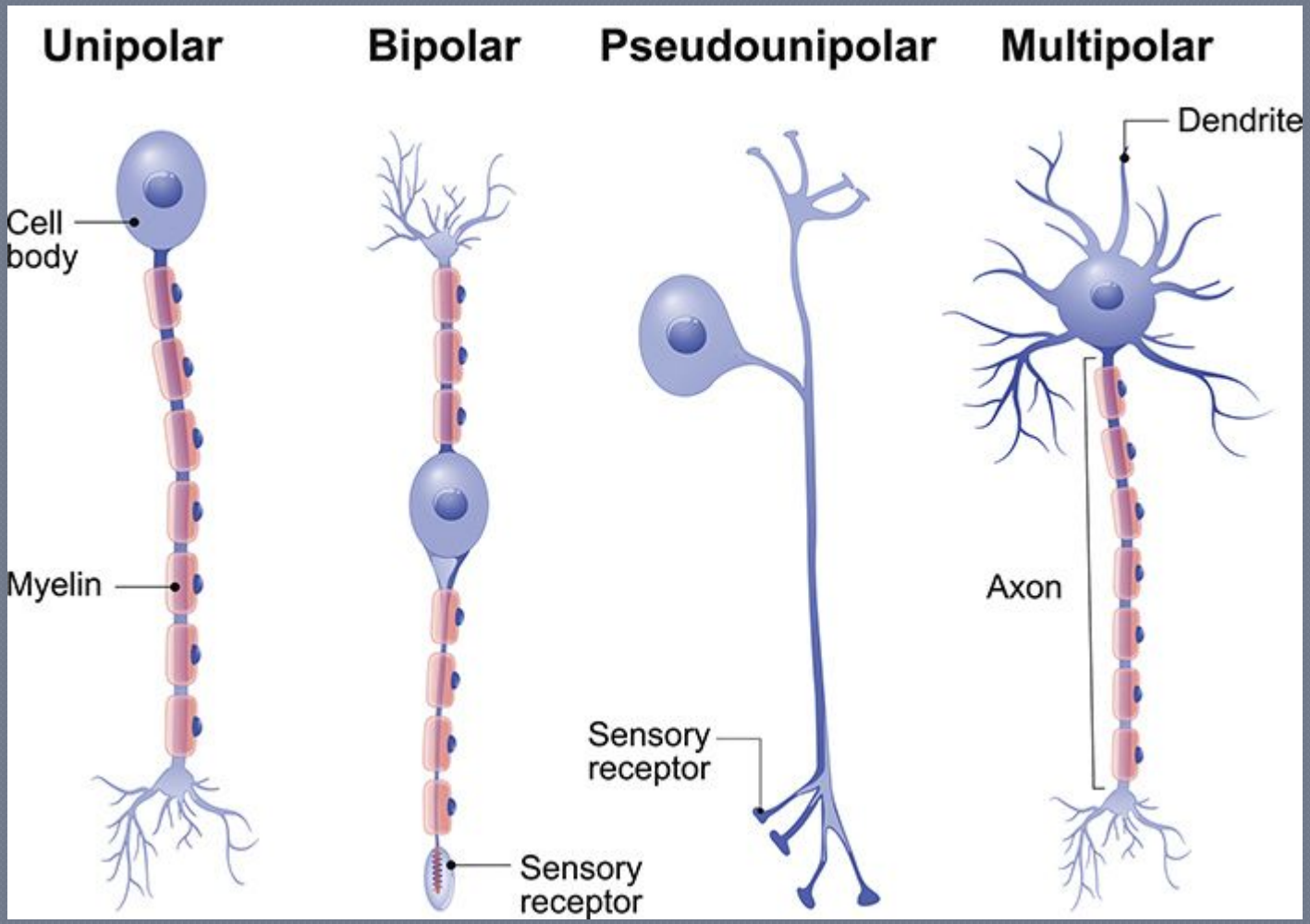
Classes of Neurons

Sensory Neurons

- Sensory neurons/nerves
  - aka: afferent neurons/nerves
  - brings information regarding what is happening inside and outside of the body to the central nervous system to be processed
  - information is transferred as nerve impulses, once it is processed, it is translated into sensations
    - vision, hearing, taste, touch
  - typically pseudounipolar; an axon split into two branches

Example:

touching hot stove → heat stimulus picked up by sensory neurons in fingers → information carried to the CNS

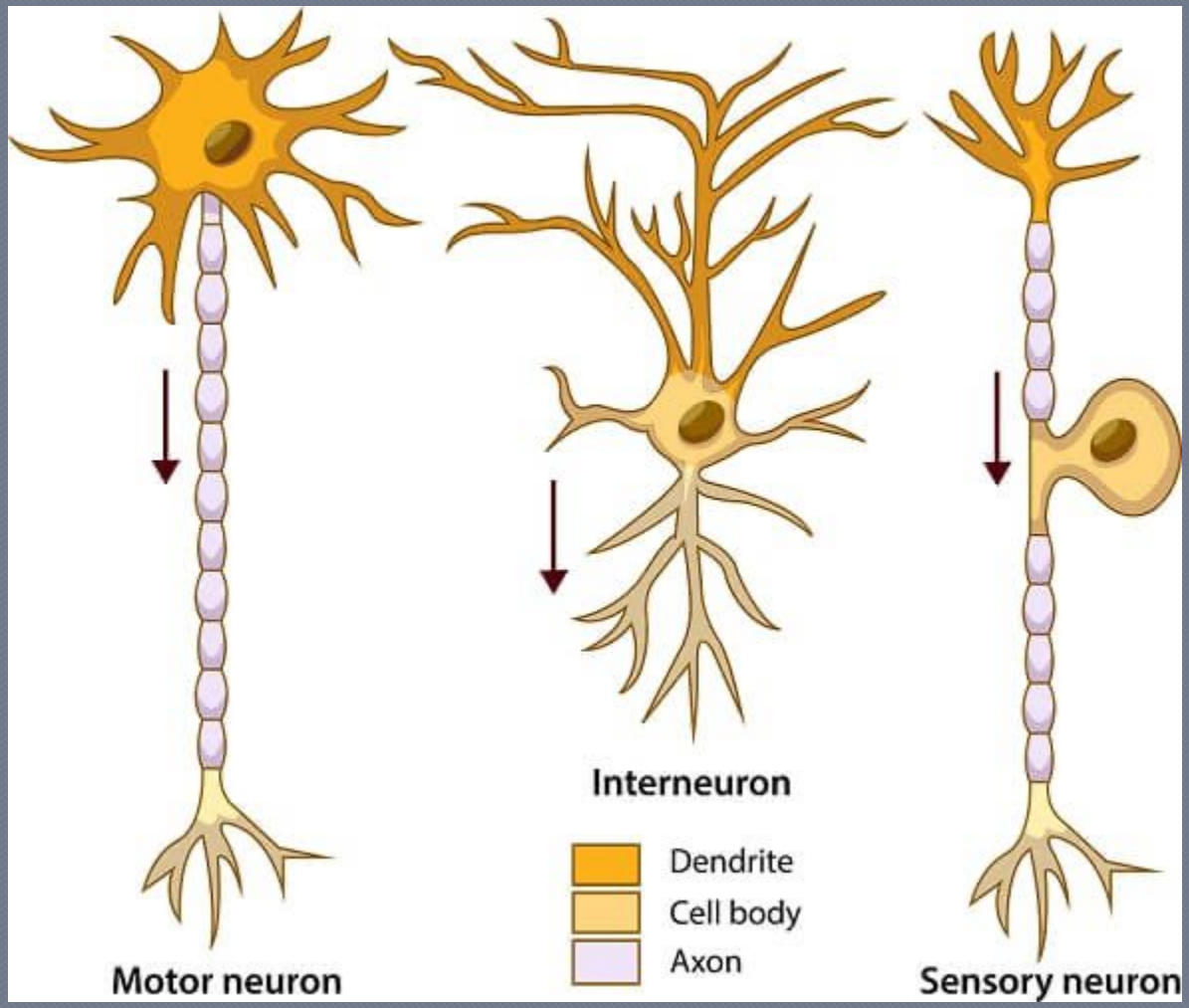

Unipolar
Bipolar
Pseudounipolar
Multipolar
Cell body
Myelin
Sensory receptor
Sensory receptor
Dendrite
Axon

Motor Neurons

- Motor neurons/nerves
  - aka: efferent neurons/nerves
  - carry signals away from the CNS to convey messages to target muscles, organs, tissues
  - two types:
    - lower motor neurons
      - travel from spinal cord → the rest of the body
    - upper motor neurons
      - Travel between the brain & spinal cord
  - typically multipolar; one axon with several dendrites projecting from the cell body

Example:

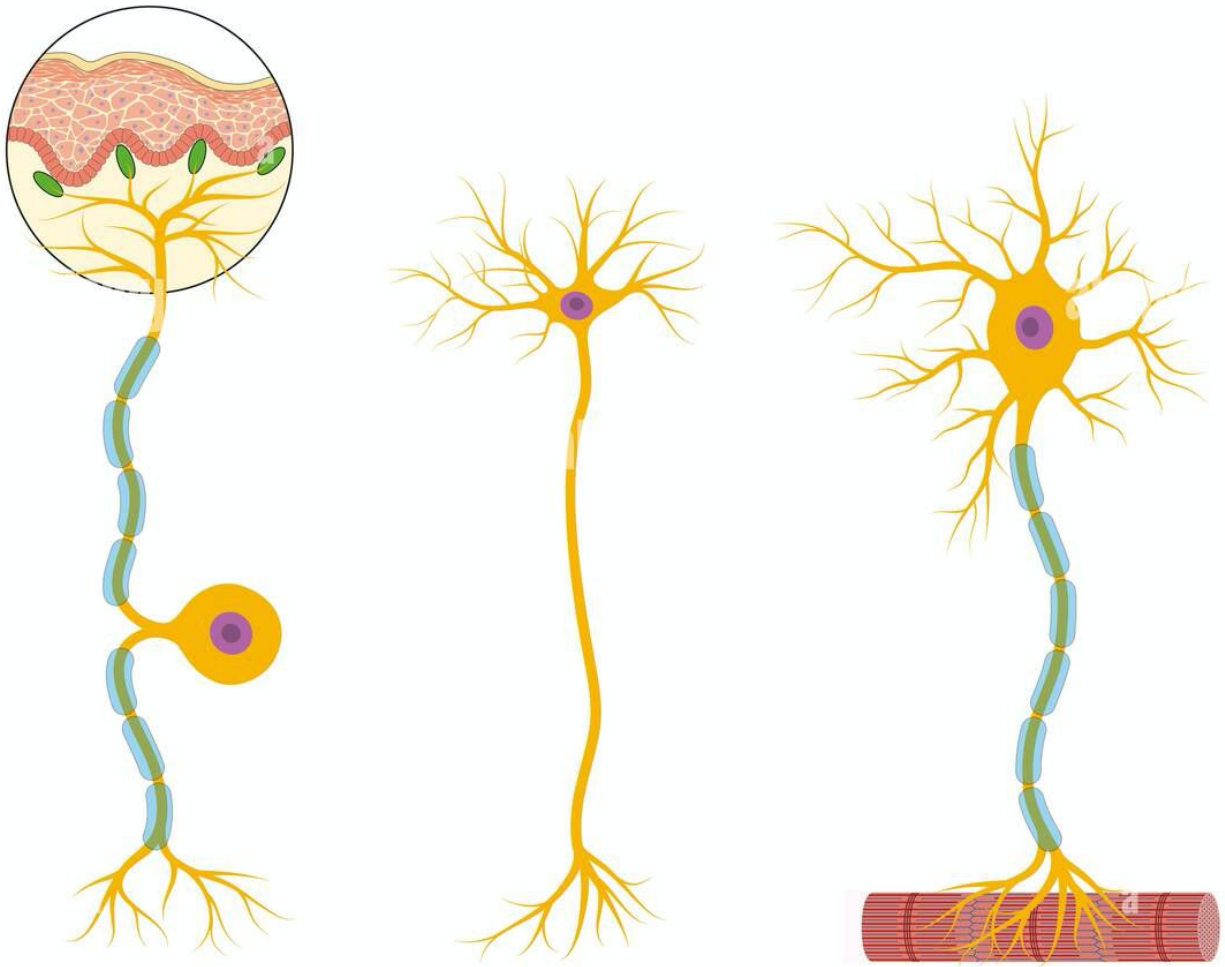
Heat stimulus processed by CNS → CNS makes decision → motor neurons send message to muscles in fingers → hand lifts from stove


Motor neuron
Interneuron
Dendrite
Cell body
Axon
Sensory neuron

Interneurons

- Interneurons
  - aka: relay neurons
  - found only in the CNS; the most abundant
  - allow sensory & motor neurons to communicate with each other
  - connect various neurons with the brain & spinal cord
  - assist the brain to complete complex functions:
    - learning, decision-making, reflexes, neuron regeneration

Types of neurons



Sensory neuron

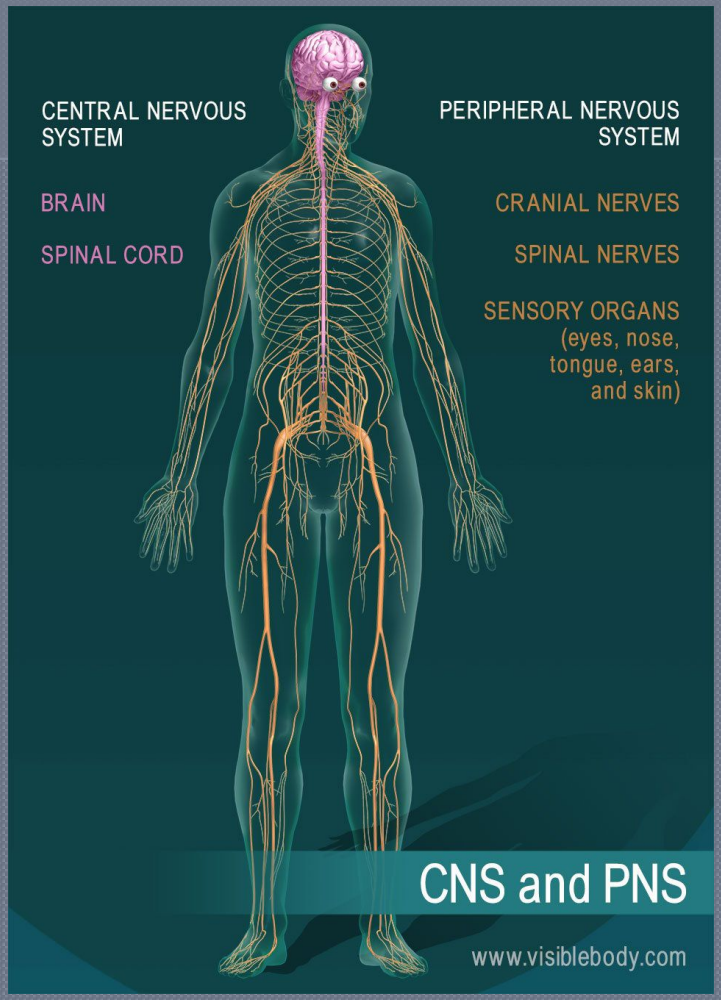
Interneuron

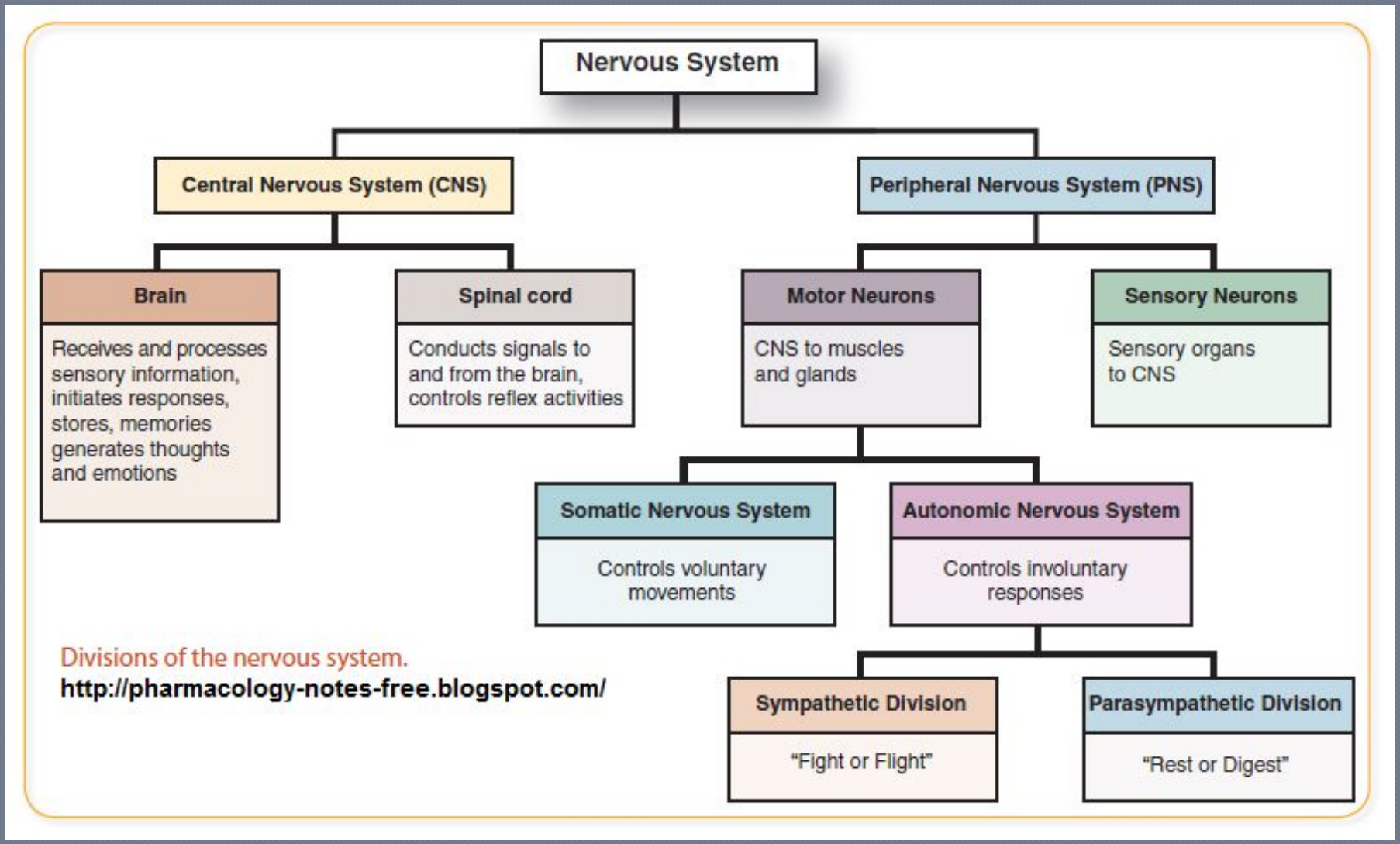
Motor neuron

Mixed Nerves

- **Mixed nerves**
  - contain both afferent (sensory) and efferent (motor) fibers
  - conduct both incoming sensory information and outgoing commands in the same bundle

Divisions of the Nervous System





Divisions of the nervous system.

http://pharmacology-notes-free.blogspot.com/

Central Nervous System

- includes the brain & the spinal cord
- the CNS is responsible for receiving & processing incoming information
- once information is processed, the CNS makes a decision & communicates it to target tissues in the body
- the "decision maker"

The Brain

- receives information
- processes information
  - from all the senses
- initiates the appropriate response
- makes decisions, stores memories, responsible for learning, understanding, etc.

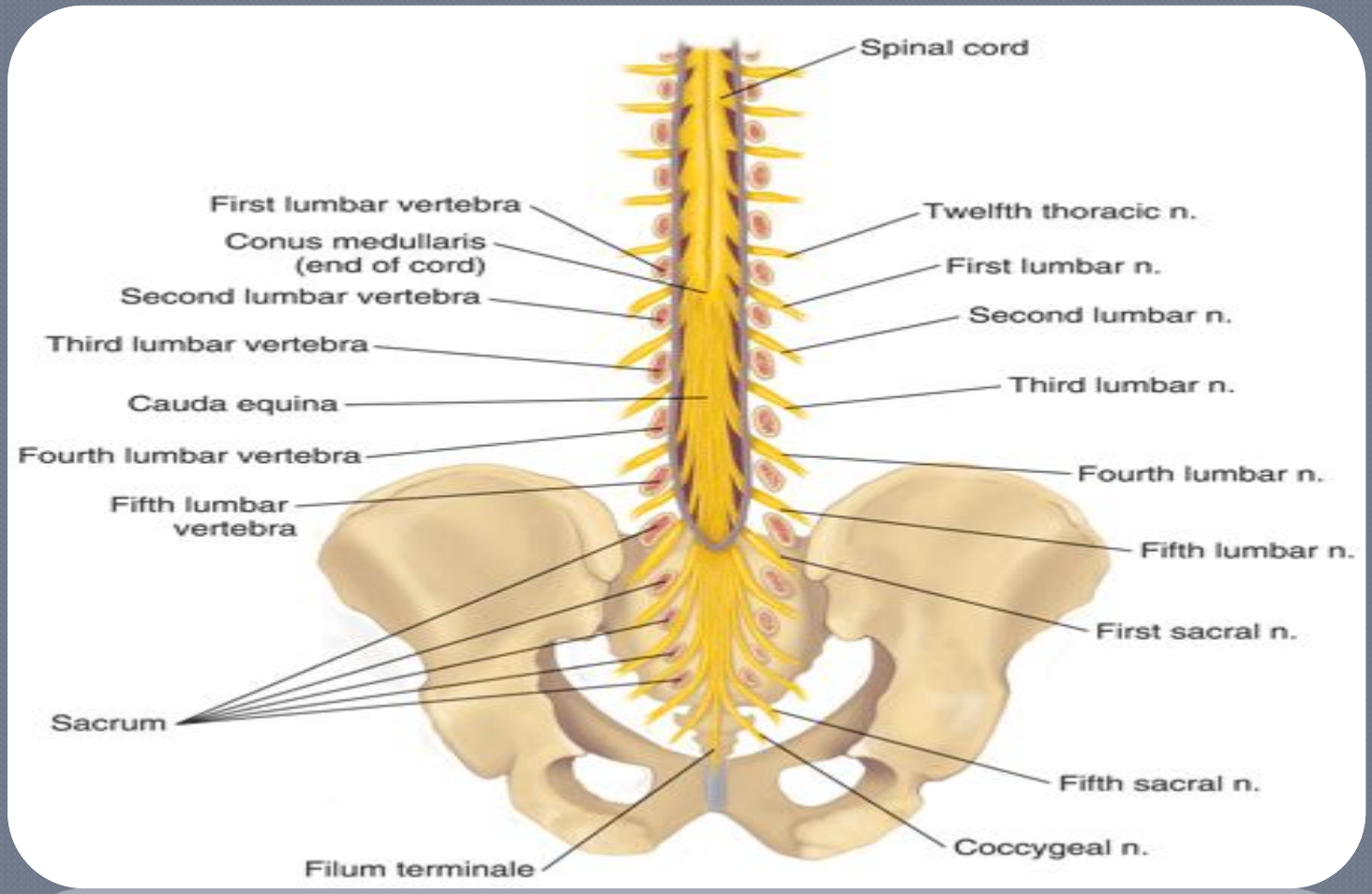
The Spinal Cord

- conducts signals to and from the brain
- comes off of the brainstem and runs through the C & T spines
- at the L & S regions of the spine; nerves branch into the cauda equina (horse's tail)

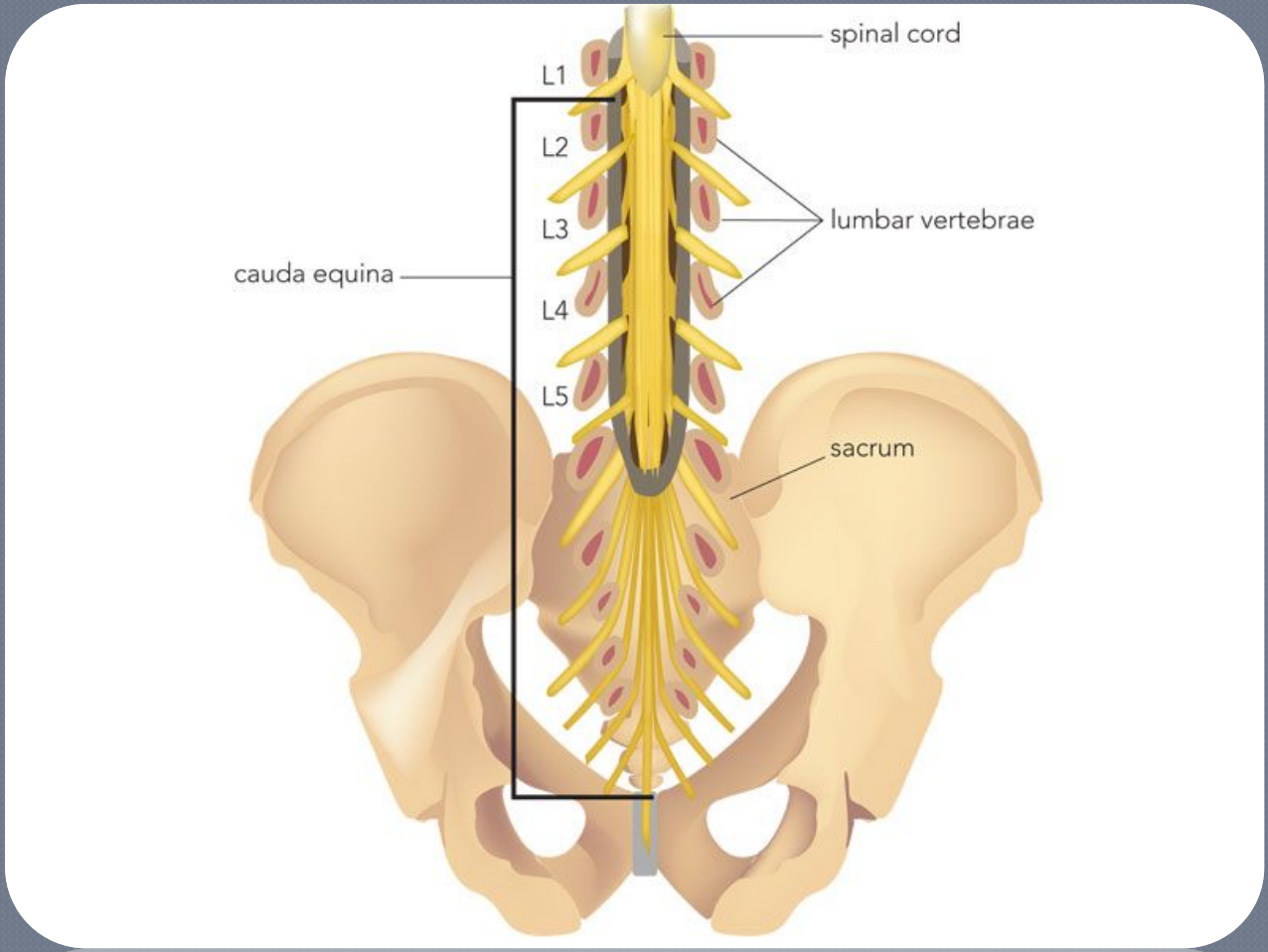
The Spinal Cord

- C-spine
  - sends signals to the face and neck
- T-spine
  - sends signals to the arms, chest & abdomen
- L & S spines
  - Sends signals to the lower body

Spinal Cord


Spinal cord
First lumbar vertebra
Conus medullaris (end of cord)
Second lumbar vertebra
Third lumbar vertebra
Cauda equina
Fourth lumbar vertebra
Fifth lumbar vertebra
Sacrum
Filum terminale
Twelfth thoracic n.
First lumbar n.
Second lumbar n.
Third lumbar n.
Fourth lumbar n.
Fifth lumbar n.
First sacral n.
Fifth sacral n.
Coccygeal n.

Cauda Equina



Peripheral Nervous System

- includes neurons & parts of neurons found outside of the CNS
- includes sensory & motor neurons
  - have individualized functions to either carry information to or from the CNS
- the "messenger"

Recall…

- Sensory functions
  - carry information from sensory receptors found all over the body → the CNS
- Motor functions
  - carry information from the CNS to targets in the body

Divisions of the PNS: Motor functions

- Somatic Nervous System
  - controls voluntary movements
- Autonomic Nervous System
  - controls involuntary responses
    - Sympathetic division
    - Parasympathetic division

Somatic Nervous System

- a subdivision of the PNS
- Function:
  - delivers information from the body to the brain
  - delivers information from the brain to the body
- involves things that we consciously do
  - ex: drinking a cup of coffee

Somatic continued…

What does it do?

- Sensory input
  - all of the senses (except sight) travel through the somatic nervous system
  - sound, smell, taste, touch use somatic NS to reach the brain
  - touch; below the neck
    - sends info to the brain via the spinal column before

Somatic continued…

What does it do?

- Movement control
  - the brain uses the somatic nervous system to send signals to muscles regarding movement

Referred pain

- The somatic NS can help indicate pain for internal organs
  - ex: heart attack or breathing
    - pain in left arm, jaw, abdomen
    - breathing is typically involuntary, however we can control when we take a breath/hold our breath
      - Ex: swimming underwater

Somatic NS Location

- spreads outward from your brain to the rest of the body
  - occurs through our cranial nerves
    - except CN II
  - also has connections further down in the spinal nerves
  - both sets of nerves will continue to branch off into many smaller nerves
  - nerves in these groups can be both sensory and motor

#	Name	Nerve type	Function
I	Olfactory	Sensory	Smell
II	Optic	Sensory	Vision
III	Oculomotor	Motor	Most eye movement
IV	Trochlear	Motor	Moves eye to look at nose
V	Trigeminal	Both	Face sensation, mastication
VI	Abducens	Motor	Abducts the eye
VII	Facial	Both	Facial expression, taste
VII	Vestibulocochlear	Sensory	Hearing, balance
IX	Glossopharyngeal	Both	Taste, gag reflex
X	Vagus	Both	Gag reflex, parasympathetic innervation
XI	Accessory	Motor	Shoulder shrug
XII	Hypoglossal	Motor	Swallowing, speech

Autonomic Nervous System

- second subdivision of the CNS
- the ANS is always active; even at rest
- key to survival; the autonomic nervous system is responsible for all of the functions the body does without thinking about them
  - involuntary control
  - breathing, heart rate, blood pressure

Autonomic Nervous System

- the goal of the ANS is to maintain homeostasis
  - temperature
  - salt concentration
  - blood sugar
  - O_2 and CO_2 in the blood
- also plays a part in our emotional experience
  - what happens when you get excited?
    - increase heart beat
    - dry mouth
    - butterfly feeling in the stomach

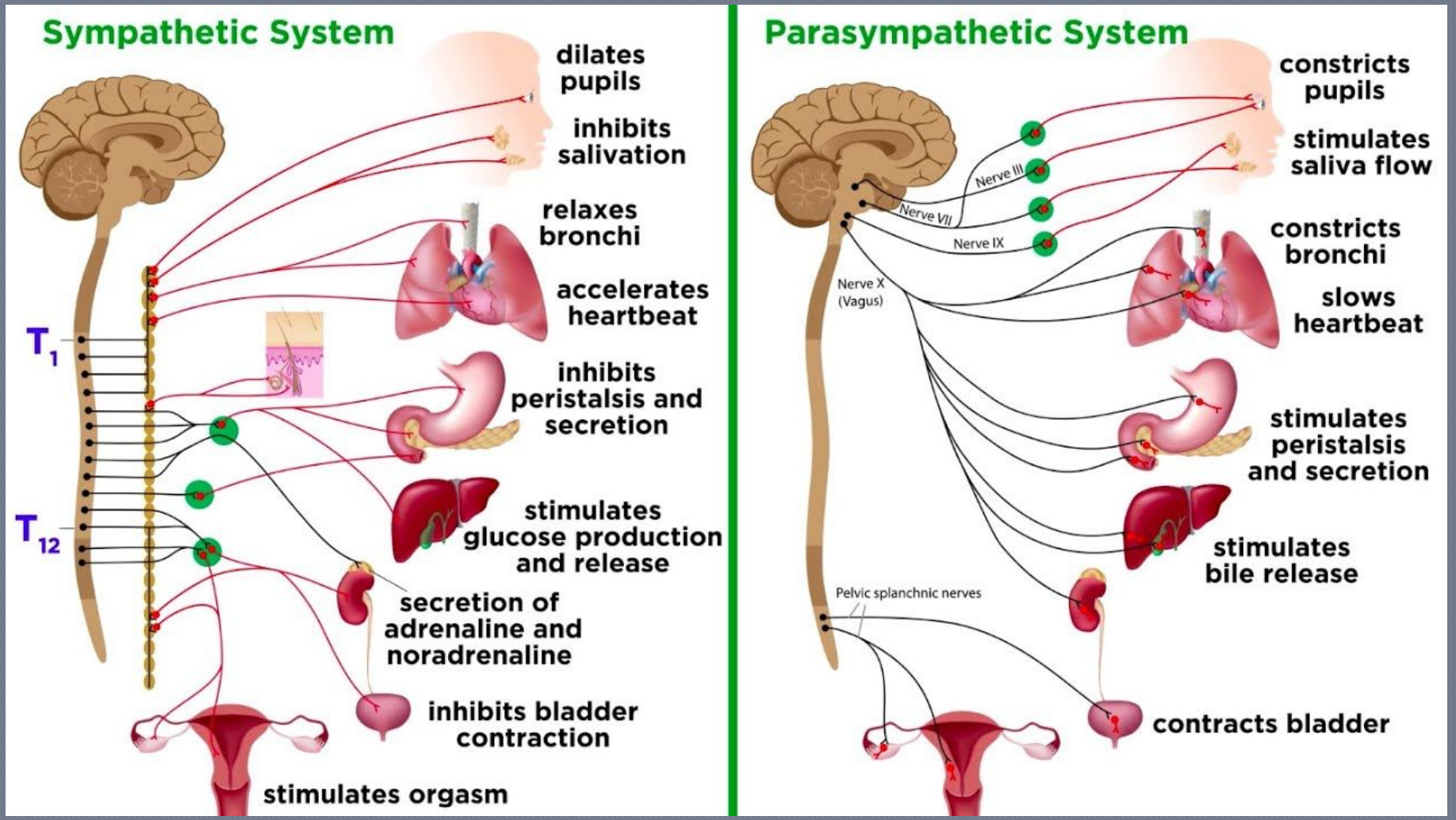
Autonomic Nervous System

- connects the brain to the internal organs
  - nerves serve as a network to connect our organs to the brain

- Examples of organ control by ANS:
  - Eyes, heart, immune system, skin
    - width of pupils, heart beat & width of blood vessels, allergic reactions, ability to sweat

Divisions of ANS

- Sympathetic Nervous System
  - activates the body processes that help a person in times of need
  - ex: stress or danger
    - fight or flight response
- Parasympathetic Nervous System
  - Opposite to the SNS → rest & digest
    - RMTs*
- Enteric Nervous System
  - solely responsible for digestion


Sympathetic System
dilates pupils
inhibits salivation
relaxes bronchi
accelerates heartbeat
T1
inhibits peristalsis and secretion
T12
stimulates glucose production and release
secretion of adrenaline and noradrenaline
inhibits bladder contraction
stimulates orgasm
Parasympathetic System
constricts pupils
stimulates saliva flow
Nerve III
Nerve VII
Nerve IX
Nerve X (Vagus)
constricts bronchi
slows heartbeat
stimulates peristalsis and secretion
stimulates bile release
Pelvic splanchnic nerves
contracts bladder

Location of ANS

- networks of nerves that extend throughout the head & body
- presence in the cranial nerves
  - ANS has nerve fibers in four of them
    - III, VII, IX, X
- most of the 31 spinal nerves
  - T-spine, lumbar, sacral
  - Important for controlling:
    - heart, lungs, liver, pancreas, spleen, stomach, intestines, colon, kidney, bladder, sexual organs
- The hypothalamus has a huge role in the function of the ANS

Crash Course Nervous System Videos

- The Nervous System, Part 1: Crash Course Anatomy & Physiology #8
- The Nervous System, Part 2 - Action! Potential!: Crash Course Anatomy & Physiology #9
- Peripheral Nervous System: Crash Course Anatomy & Physiology #12

Spinal Nerves

Spinal Nerves

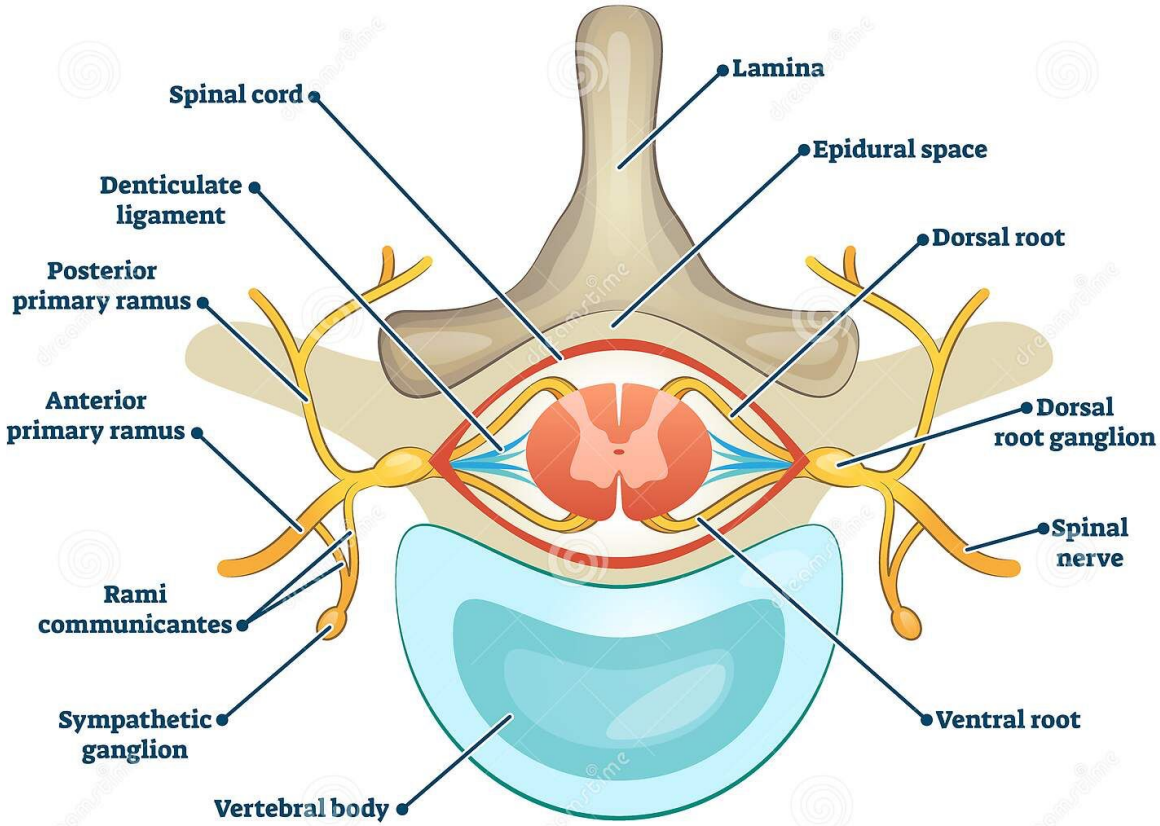
- The spinal cord is divided into segments according to the nerve roots that branch off of it

- Spinal nerves
  - are part of your PNS & are responsible for voluntary movement & sensation
  - total of 31 pairs that emerge from each segment of the spine
  - contain sensory & motor nerves
  - relatively large

Structure

- Nerve roots
  - made up of a sensory nerve root & motor nerve root
  - an area where the two merge
  - the roots meet and connect laterally to the spinal cord
- Sensory nerve root
  - emerge from the back of the spinal cord
  - receives information from sensory nerves in the posterior part of the spinal cord
- Motor nerve root
  - emerge from the front of the spinal cord
  - sends nerve message to spinal nerves

NERVE ROOT



Spinal Nerve Pairs & Location

- Cervical Spine
  - C1-C8
- Thoracic Spine
  - T1-T12
- Lumbar Spine
  - L1-L5
- Sacral Spine
  - S1-S5
- Coccygeal
  - Co1

Main plexus' of spinal nerves:

- Plexus
  - When spinal nerves merge with each other to form a network of interlacing nerves
- Cervical plexus
  - merging of C1-C5
  - divide into smaller nerves that carry sensory messages & provide motor control to the muscles of the neck & shoulders

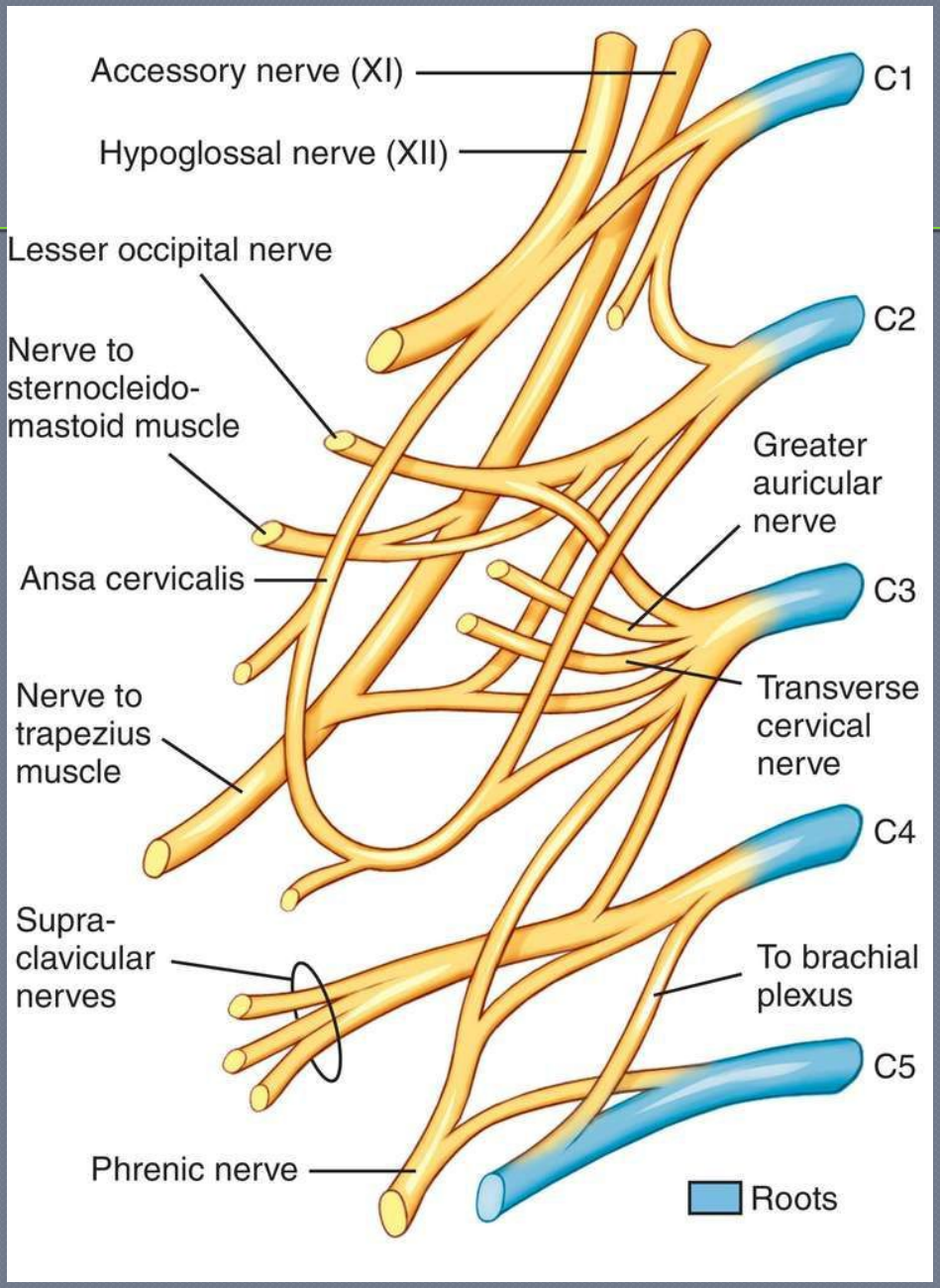
Plexus' continued…

- Brachial plexus
  - merging of C5-T1
  - branches into nerves that carry sensory messages & provide motor control to the muscles of the arm & upper back
- Lumbar plexus
  - Merging of L1-L4
  - Splits into nerves that carry sensory messages & provide motor control to the muscles of the abdomen & leg

Plexus' continued

- Sacral plexus
  - merging of L4-S4
  - branch into nerves that carry sensory messages & provide motor control to the muscles of the legs
- Coccygeal plexus
  - merging of S4-C01
  - Supplies motor & sensory control of genitalia & muscles that control defecation

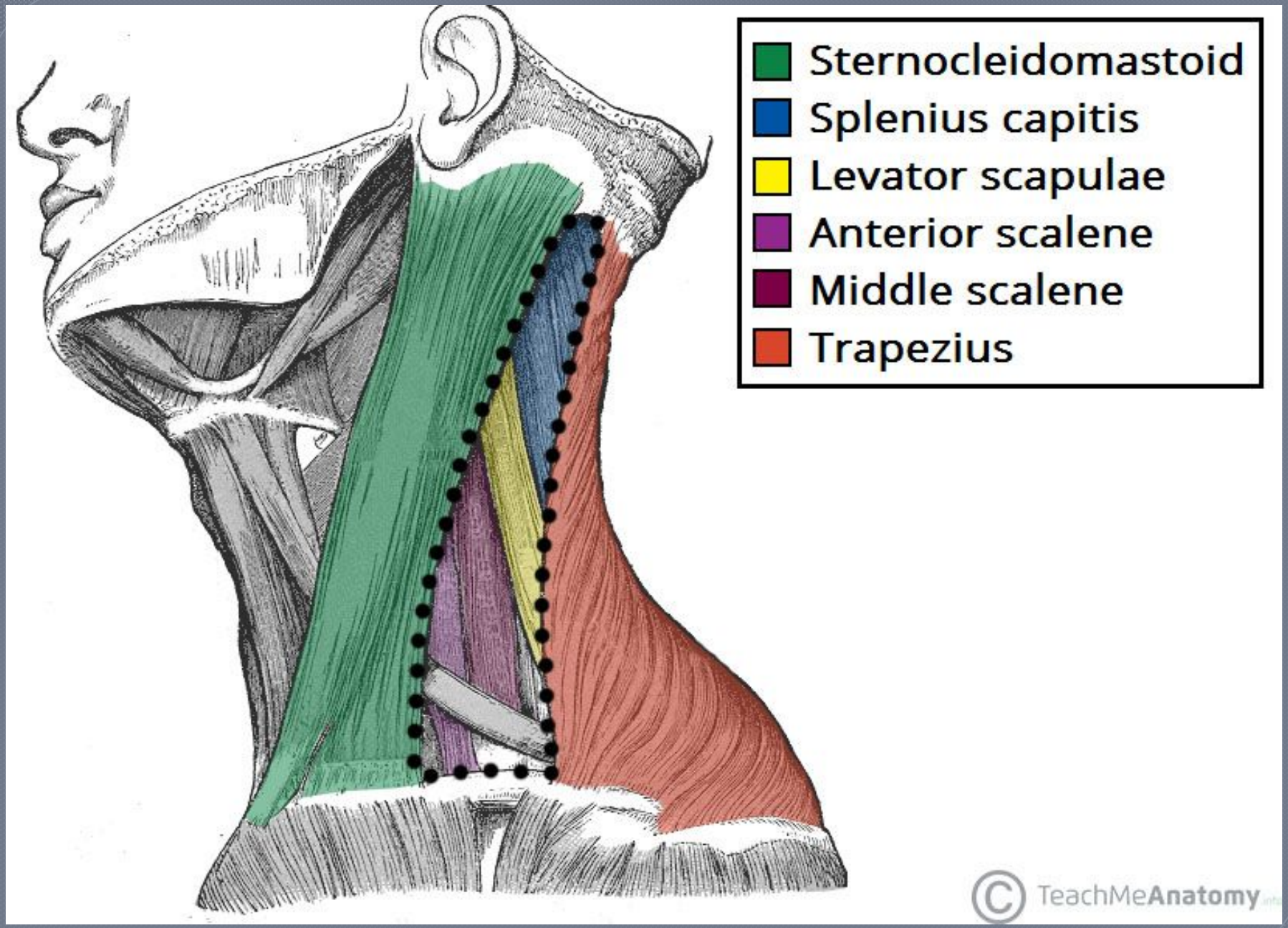
Cervical Plexus



Cervical Plexus

- supplies innervation to some of the structures in the neck & trunk

- location:
  - posterior triangle of the neck
    - halfway up the sternocleidomastoid muscle
    - within the prevertebral layer of cervical fascia


Sternocleidomastoid
Splenius capitis
Levator scapulae
Anterior scalene
Middle scalene
Trapezius
© TeachMeAnatomy

Cervical Plexus

- C1 – C4 form the basis of the cervical plexus

General rule:

- paired spinal nerves leave the spinal cord via the intervertebral foramina of the vertebral column
- each nerve then divides into anterior and posterior nerve fibres

Cervical plexus:

- the cervical plexus begins as the **anterior fibres** of the spinal nerves C1, C2, C3 and C4

Branches

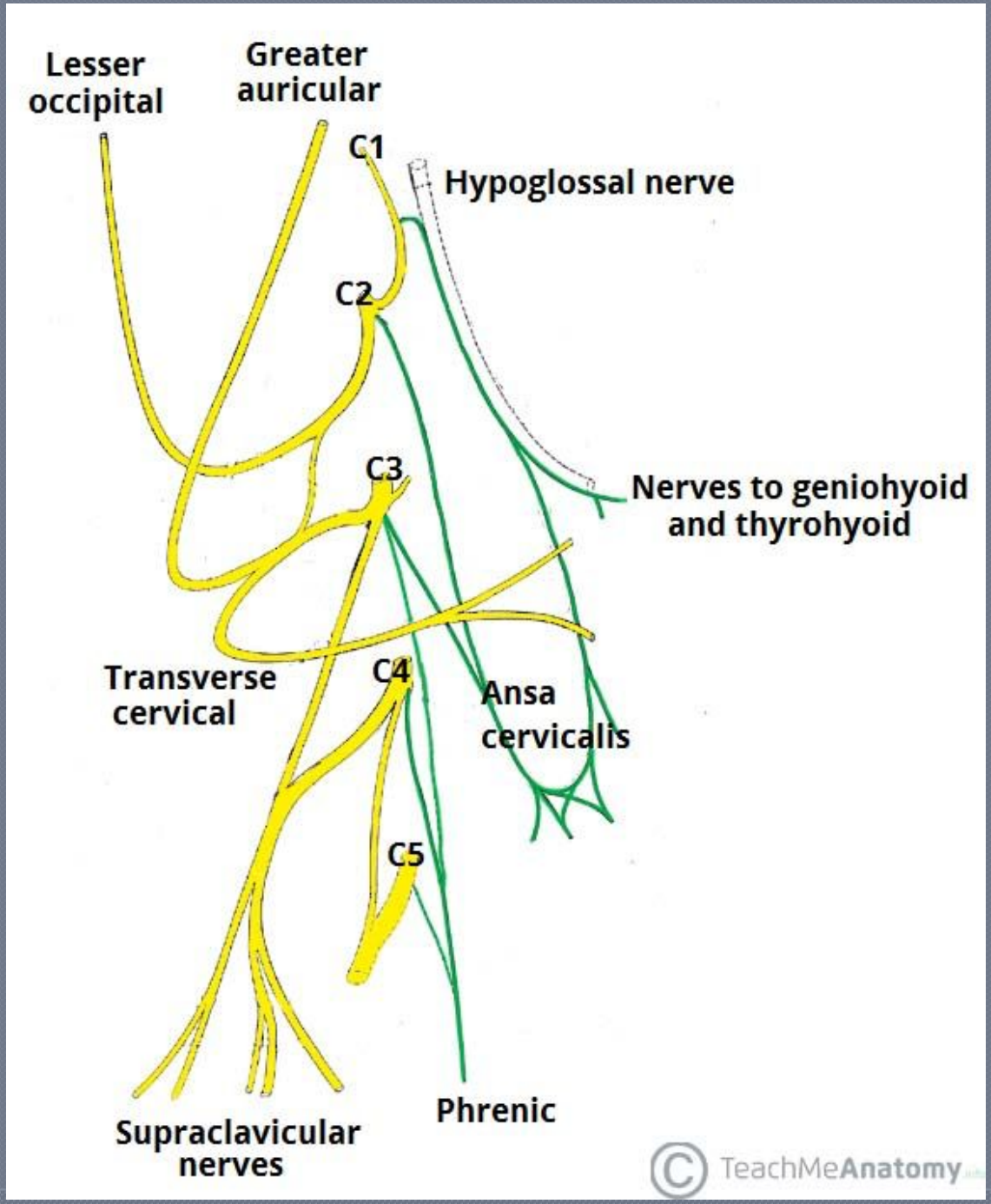
- Branches
  - sensory & motor nerves that extend to supply peripheral structures
    - Muscles, glands, tissues, organs, etc.
  - in the cervical plexus they supply head & neck
- Phrenic Nerve
  - the phrenic nerve arises from the anterior rami of C3-C5
  - it provides motor innervation to the diaphragm
- C1 spinal nerve
  - gives rise to nerves to the geniohyoid (moves the hyoid bone anteriorly and upwards, expanding the airway)
  - the thyrohyoid (which depresses the hyoid bone and elevates the larynx)
  - these nerves travel with the hypoglossal nerve to reach their respective muscles

Branches

- Nerve roots C1-C3
  - aka: the ansa cervicalis (goose's neck) is a loop of nerves
  - provides four muscular branches
    - superior and inferior omohyoid, sternohyoid and sternothyroid
- Several other minor branches arise from the nerve roots to supply muscles of the neck and back:
  - C1-C2: rectus capitis anterior and lateralis
  - C1-C3: longus capitis
  - C2-C3: prevertebral muscles and sternocleidomastoid
  - C3-C4: Levator scapulae, trapezius and scalenus medius
  - The middle and anterior scalene muscles also receive innervation directly from the cervical plexus

Continued

- Sensory Branches
  - Greater Auricular Nerve
  - Transverse cervical Nerve
  - Lesser Occipital Nerve
  - Supraclavicular nerve


Lesser occipital
Greater auricular
C1
Hypoglossal nerve
C2
C3
Nerves to geniohyoid and thyrohyoid
Transverse cervical
C4
Ansa cervicalis
C5
Phrenic
Supraclavicular nerves
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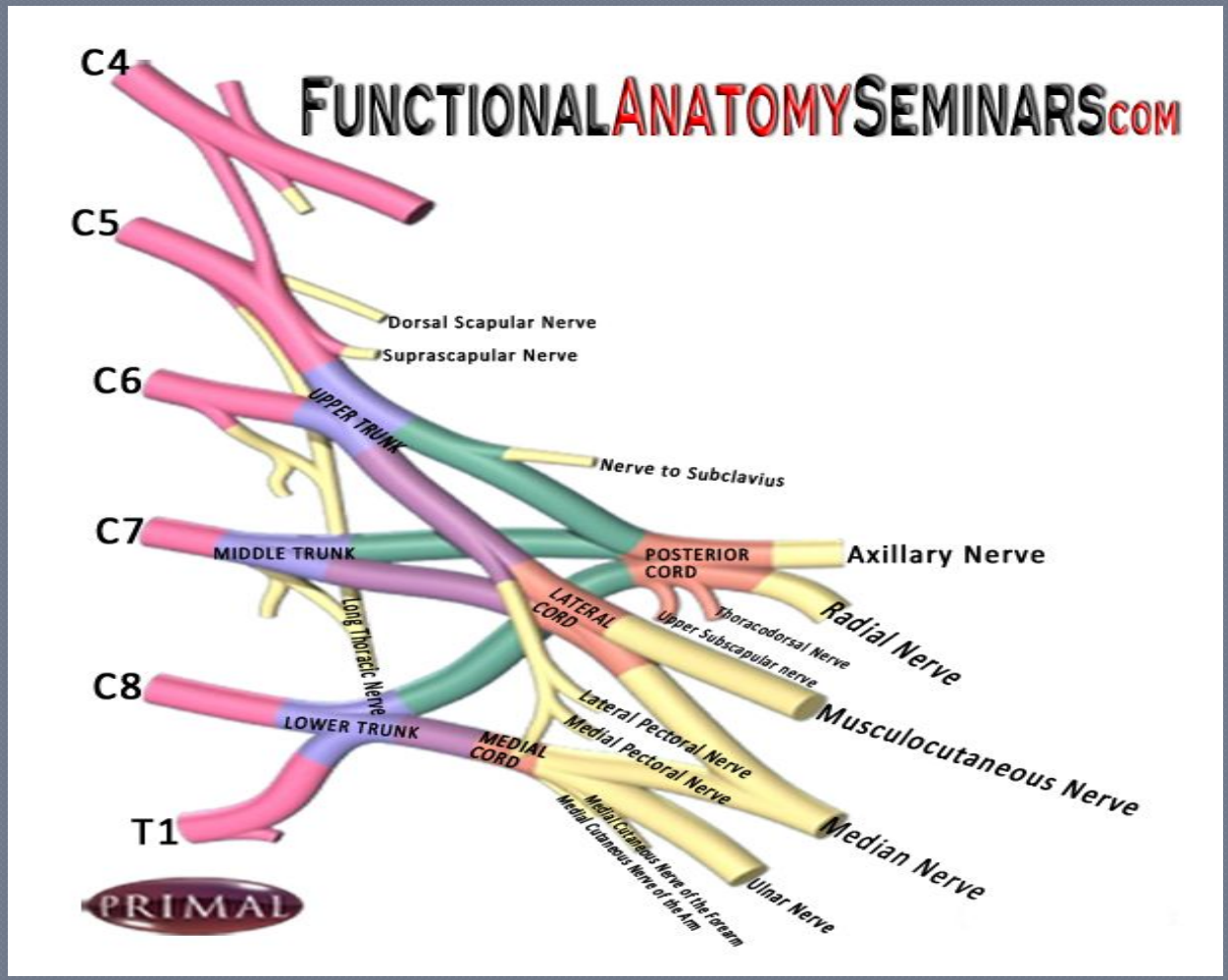
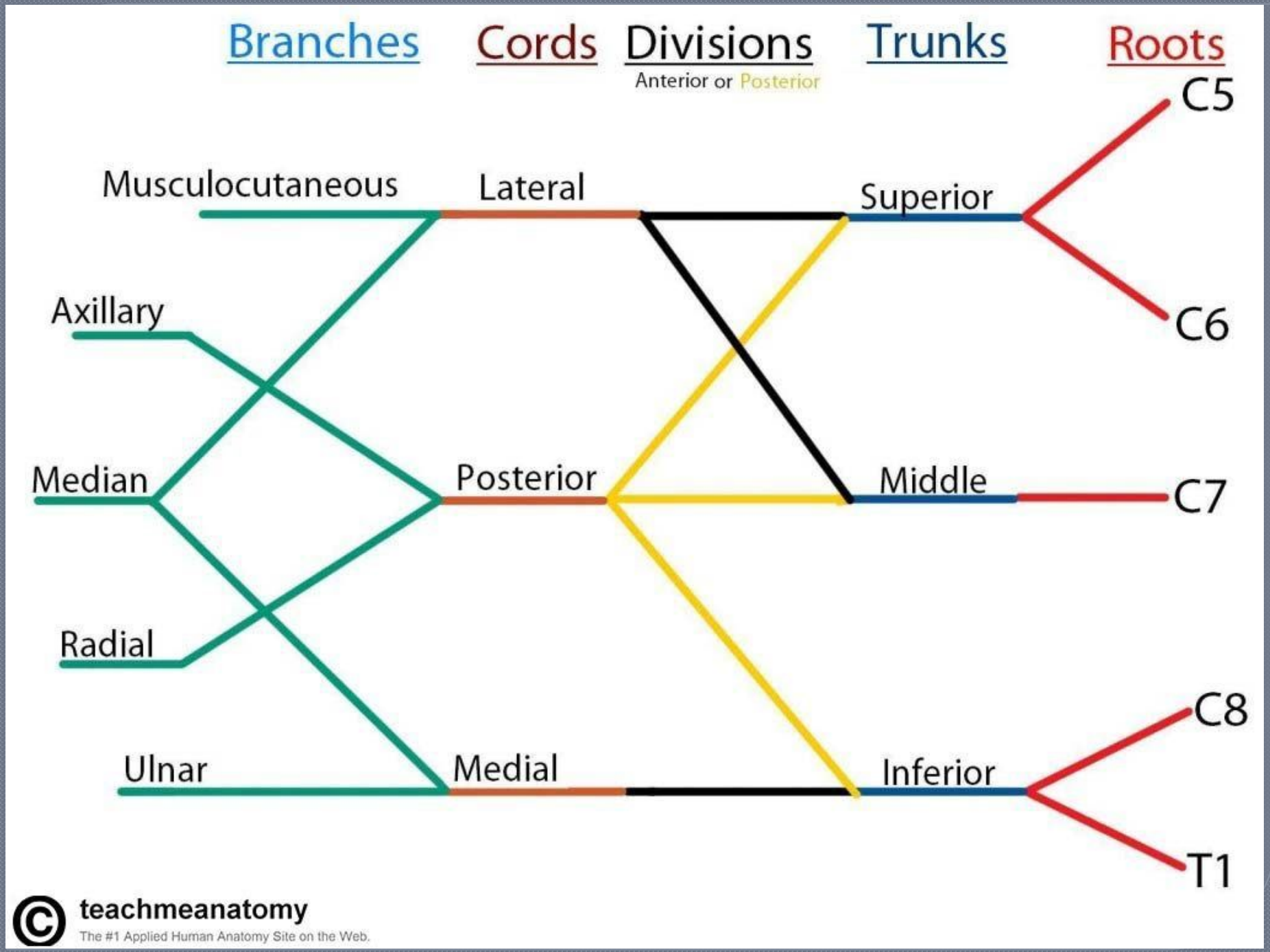
Brachial Plexus





Brachial Plexus

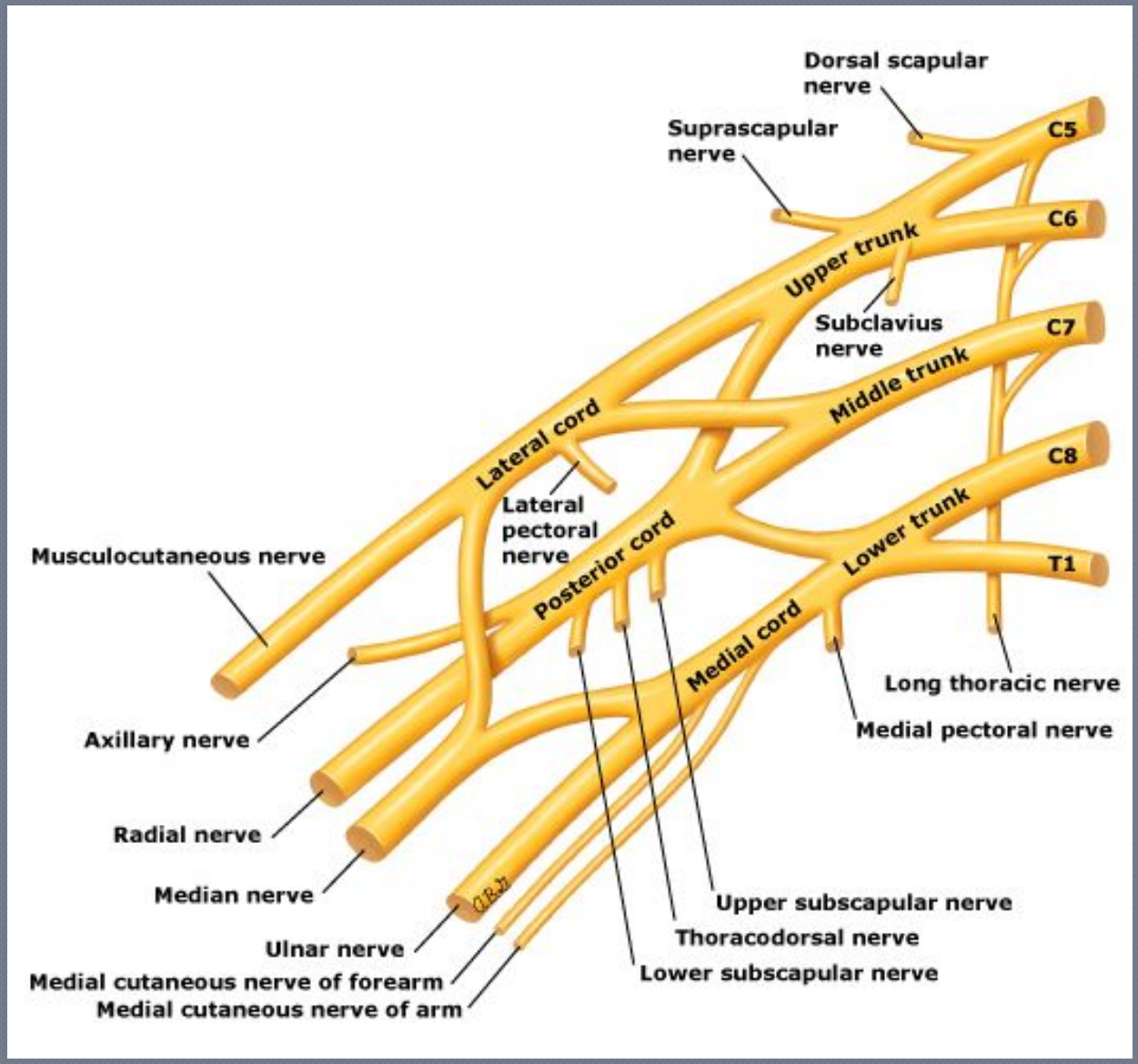
- a network of nerve fibers that run:
  - from the spine
  - passes through the cervico-axillary canal to reach axill
  - it is formed by the ventral rami of the lower four cervical and first thoracic nerve roots (C5-C8, T1)
- responsible for cutaneous and muscular innervation of the entire upper limb, with two exceptions:
  - the trapezius muscle innervated by the spinal accessory nerve (CN XI)
  - an area of skin near the axilla innervated by the intercostobrachial nerve

Brachial Plexus

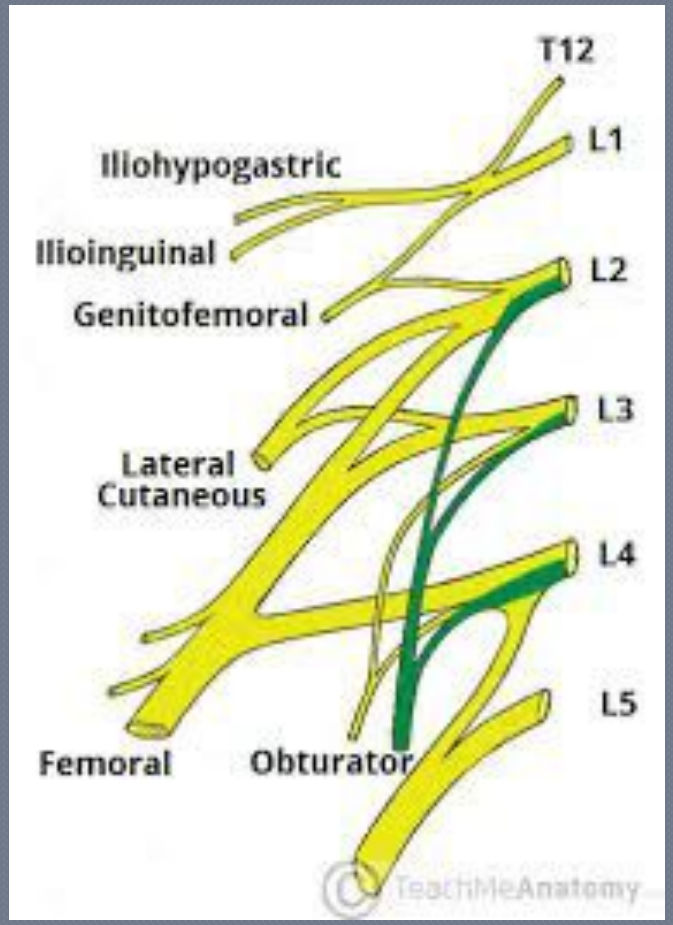
- divided into:
  - Roots, Trunks, Divisions, Cords, and Branches
    - "Reach, To, Drink, Cold, Beer"
  - there are five "terminal" branches and numerous other "pre-terminal" or "collateral" branches that leave the plexus at various points along its length
- Roots:
  - are the five anterior rami of the of the lower four cervical and first thoracic nerve roots (C5-C8, T1)
  - after they have given off their segmental supply to the muscles of the neck roots merge → trunks
- Trunks:
  - Upper Trunk (C5-C6)
  - Middle Trunk (C7)
  - Lower Trunk (C8, T1)
    - trunks split into anterior and posterior divisions called divisions

Brachial Plexus

- Divisions
  - there are 6 anterior & posterior divisions; they function ot innervate flexor & extensor groups
  - anterior divisions of the upper, middle, and lower trunks
  - posterior divisions of the upper, middle, and lower trunks
  - divisions will regroup to become three cords
- Cords
  - are named by their position with respect to the axillary artery
  - posterior Cord
    - formed from the three posterior divisions of the trunks (C5-C8,T1)
  - lateral Cord
    - formed from the anterior divisions from the upper and middle trunks (C5-C7)
  - medial cord
    - is simply a continuation of the anterior division of the lower trunk (C8,T1)
- Branches
  - There are six specific branches
    - Musculocutaneous
    - Axillary
    - Median
    - Radial
    - Ulnar


Dorsal scapular nerve
Suprascapular nerve
C5
C6
Upper trunk
Subclavius nerve
C7
Middle trunk
Lateral cord
C8
Lateral pectoral nerve
Lower trunk
Musculocutaneous nerve
Posterior cord
T1
Medial cord
Long thoracic nerve
Axillary nerve
Medial pectoral nerve
Radial nerve
Median nerve
Upper subscapular nerve
Thoracodorsal nerve
Ulnar nerve
Lower subscapular nerve
Medial cutaneous nerve of forearm
Medial cutaneous nerve of arm

Lumbosacral Plexus



Lumbosacral Plexus

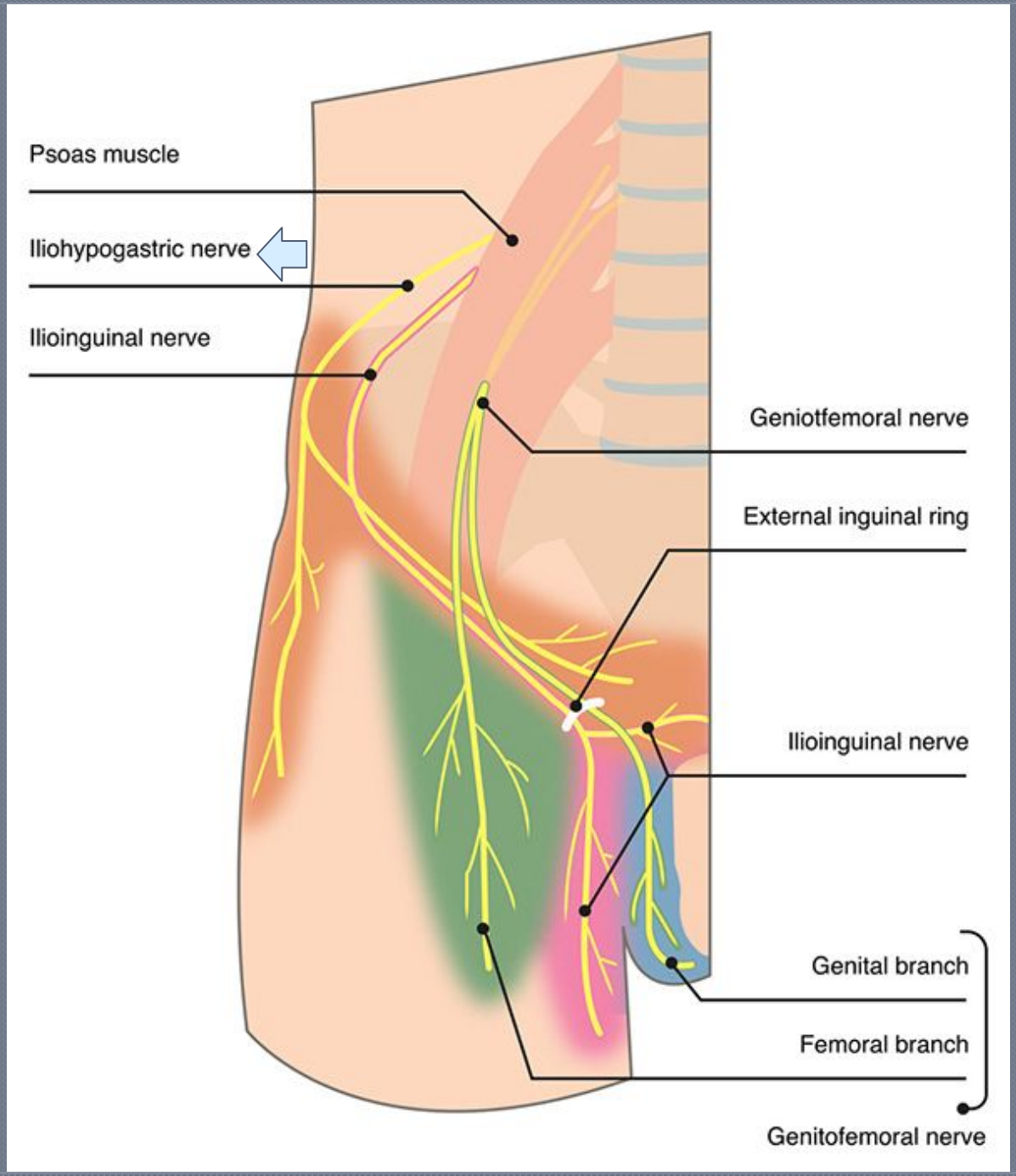
- a web of nerves in the lumbar region of the body
- forms part of the larger lumbosacral plexus
- formed by the divisions of the first four lumbar nerves (L1-L4) and from contributions of the subcostal nerve (T12) which is the last thoracic nerve.

Lumbar plexus

- begins as the anterior fibres of the spinal nerves L1, L2, L3, and L4
- the anterior rami of the L1-L4 spinal roots divide into several cords
- the cords then combine together to form the **six** major peripheral nerves of the lumbar plexus
- nerves then descend down the posterior abdominal wall and innervate structures in the lower limb

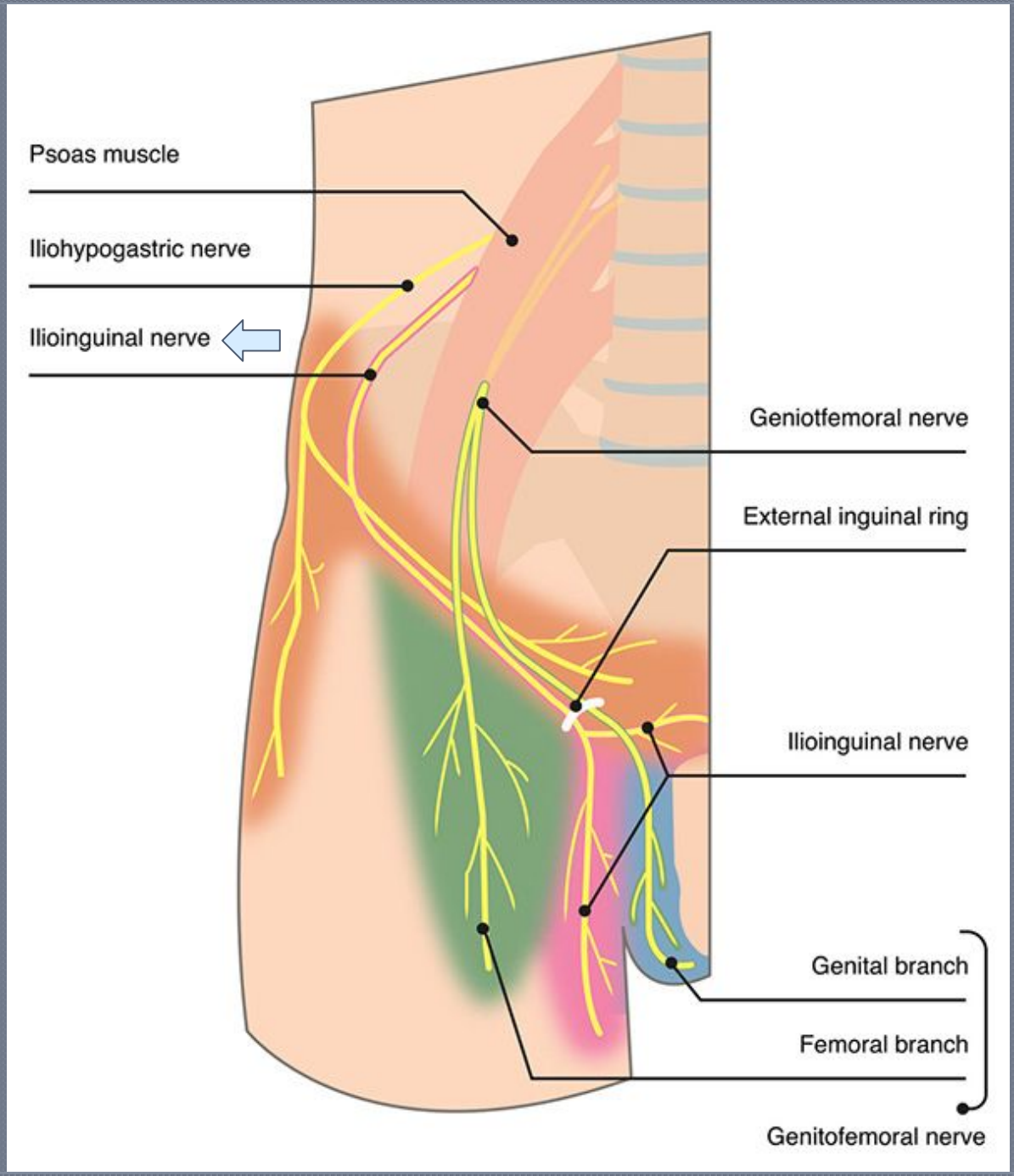
Nerves of the lumbar plexus

- iliohypogastric nerve
  - is the first major branch of the lumbar plexus
  - runs to the iliac crest & across the quadratus lumborum muscle of the posterior abdominal wall
  - then perforates the transversus abdominis, and divides into its terminal branches
- Roots: L1 (with contributions from T12)
- Motor Functions
  - innervates the internal oblique and transversus abdominis.
- Sensory Functions:
  - Innervates the posterolateral gluteal skin in the pubic region


Psoas muscle
Iliohypogastric nerve
Ilioinguinal nerve
Geniotfemoral nerve
External inguinal ring
Ilioinguinal nerve
Genital branch
Femoral branch
Genitofemoral nerve

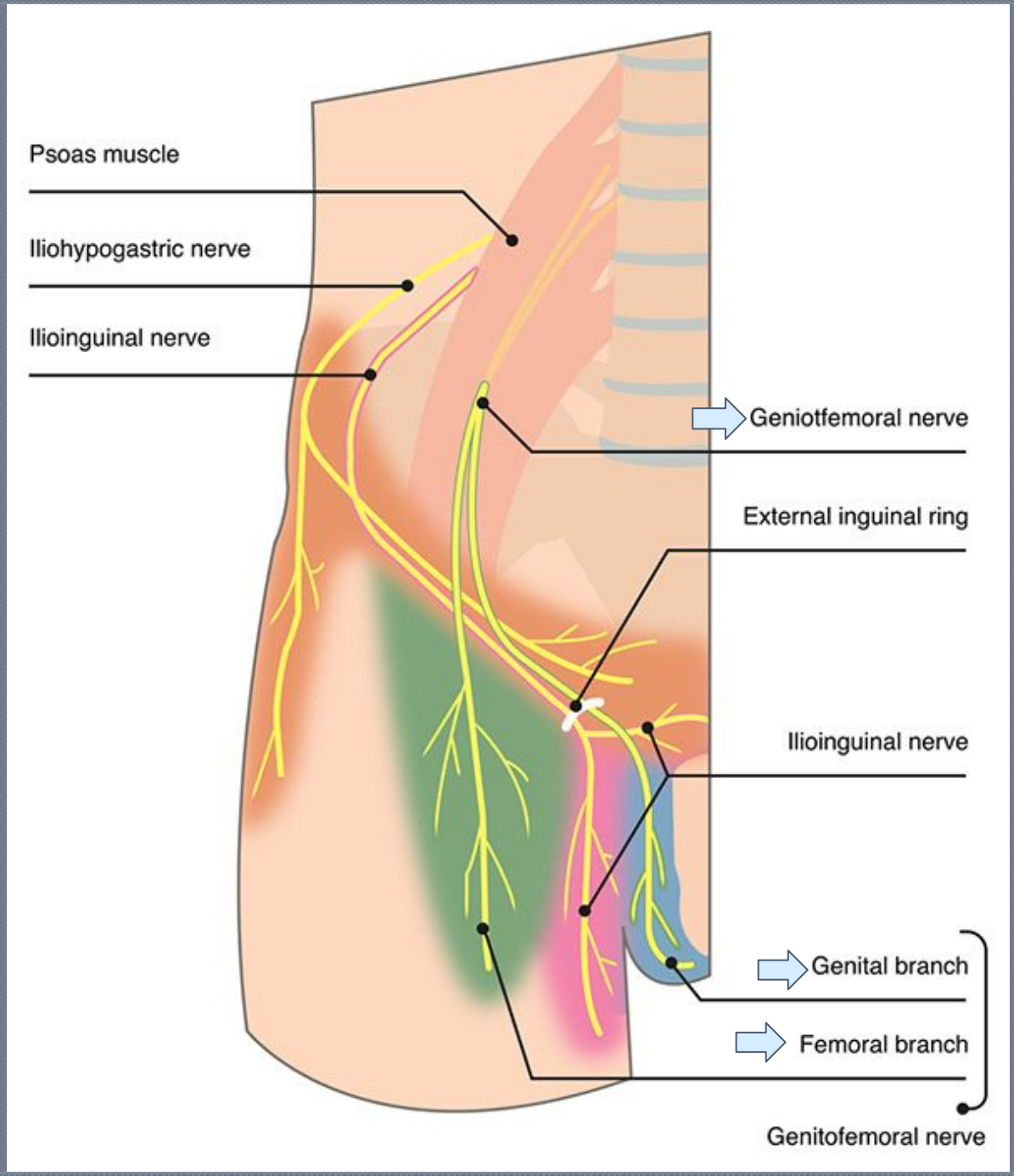
Nerves of the lumbar plexus

- ilioinguinal nerve
  - follows the same anatomical course as the larger iliohypogastric nerve
  - after innervating the muscles of the anterior abdominal wall, it passes through the superficial inguinal ring to innervate the skin of the genitalia and middle thigh
- Roots: L1.
- Motor Functions:
  - innervates the internal oblique and transversus abdominis.
- Sensory Functions:
  - innervates the skin on the upper middle thigh
  - in males; supplies the skin over the root of the penis and anterior scrotum
  - in females; supplies the skin over mons pubis and labia majora


Psoas muscle
Iliohypogastric nerve
Ilioinguinal nerve
Geniotfemoral nerve
External inguinal ring
Ilioinguinal nerve
Genital branch
Femoral branch
Genitofemoral nerve

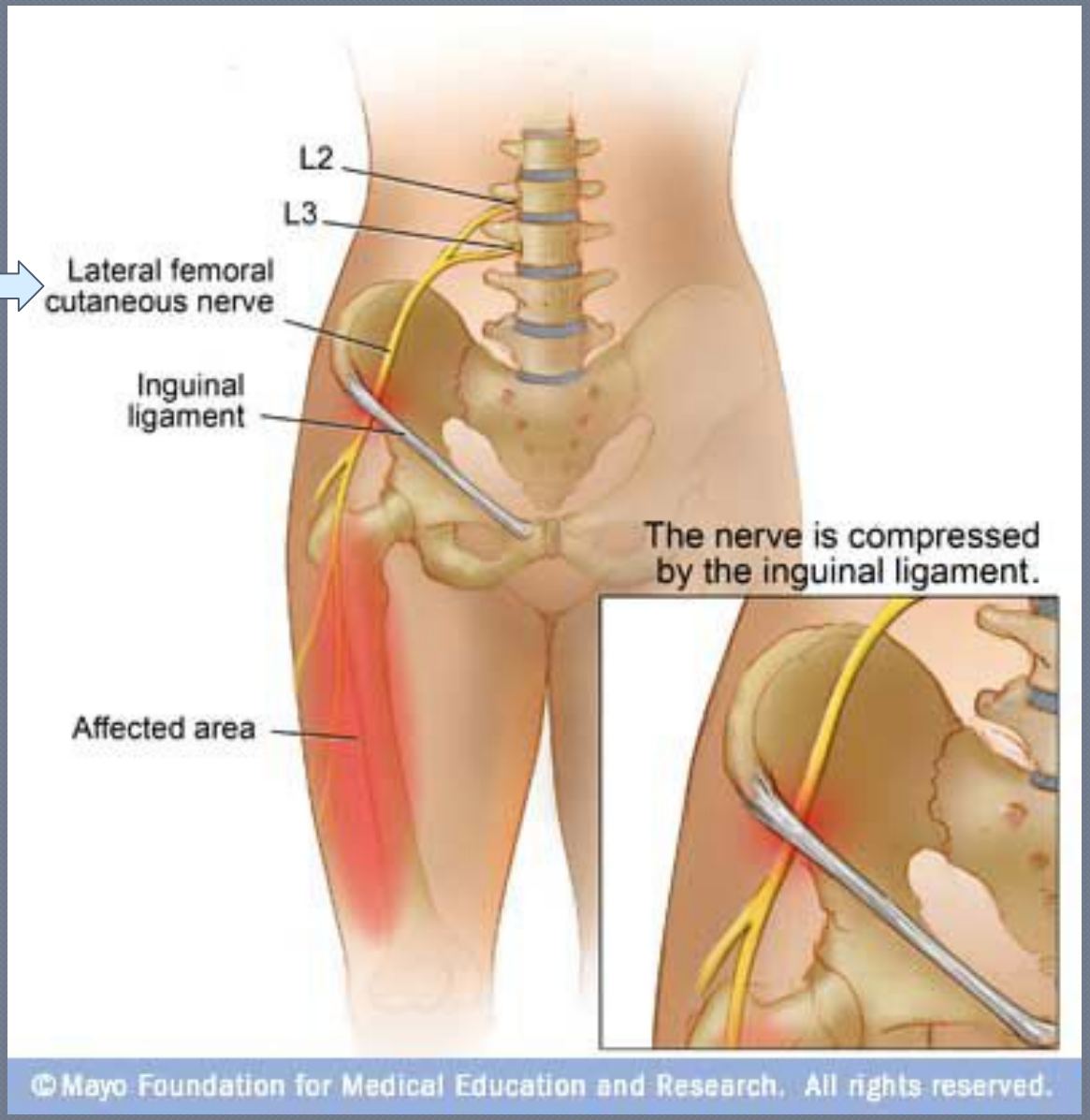
Nerves of the lumbar plexus

- Genitofemoral nerve
  - leaves the psoas major muscle & divides into a genital branch, and a femoral branch
- Roots: L1, L2.
- Motor Functions:
  - The genital branch innervates the cremaster muscle
- Sensory Functions:
  - the genital branch innervates the skin of the anterior scrotum (in males)
  - Innervates the skin over mons pubis and labia majora (in females)
  - The femoral branch innervates the skin on the upper anterior thigh


Psoas muscle
Iliohypogastric nerve
Ilioinguinal nerve
Geniotfemoral nerve
External inguinal ring
Ilioinguinal nerve
Genital branch
Femoral branch
Genitofemoral nerve

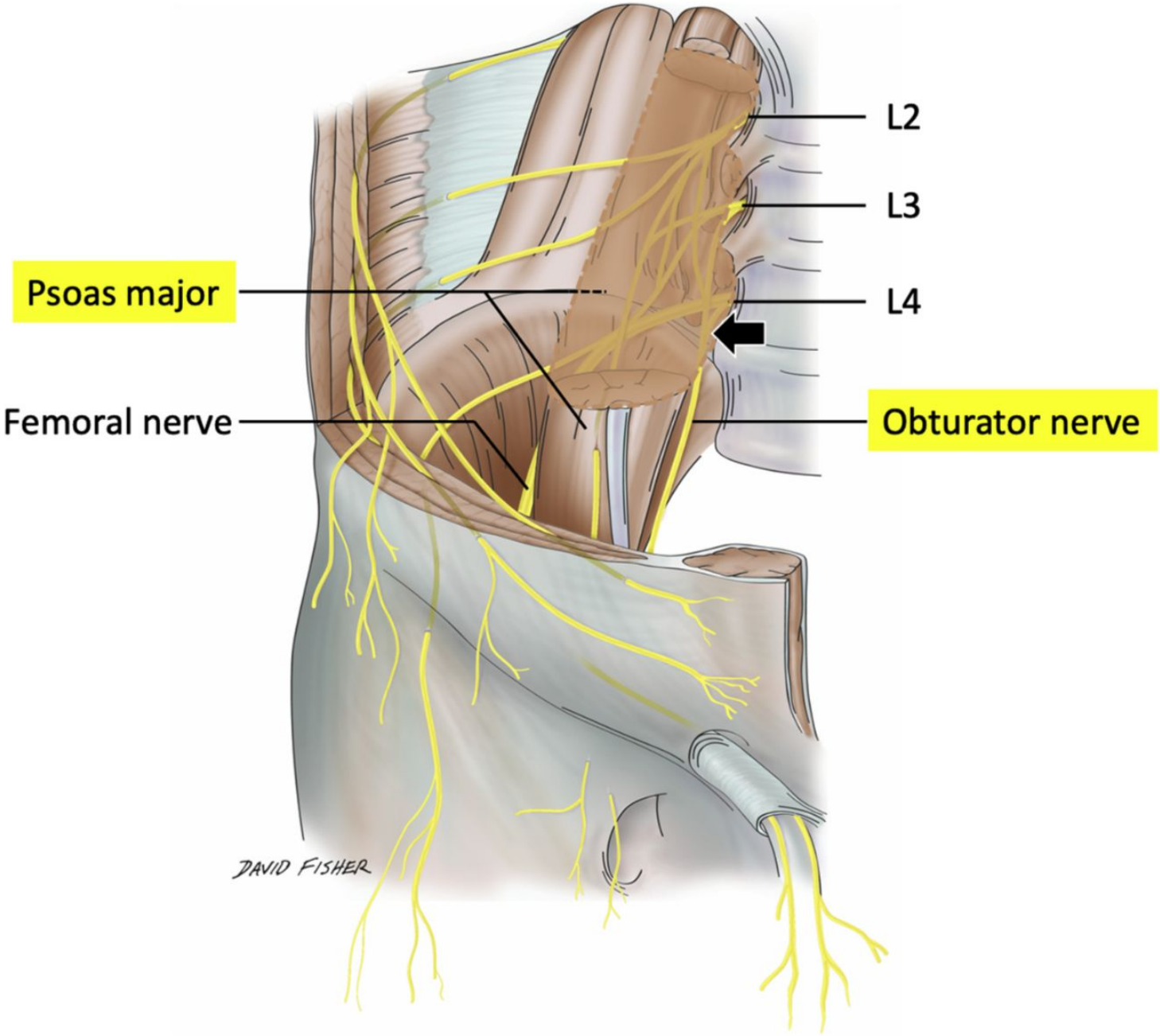
Nerves of the lumbar plexus

- Lateral cutaneous nerve of the thigh
  - purely sensory function
  - it enters the thigh at the lateral aspect of the inguinal ligament
  - it provides cutaneous innervation to the skin there
- Roots: L2, L3
- Motor Functions:
  - None
- Sensory Functions:
  - innervates the anterior and lateral thigh down to the level of the knee



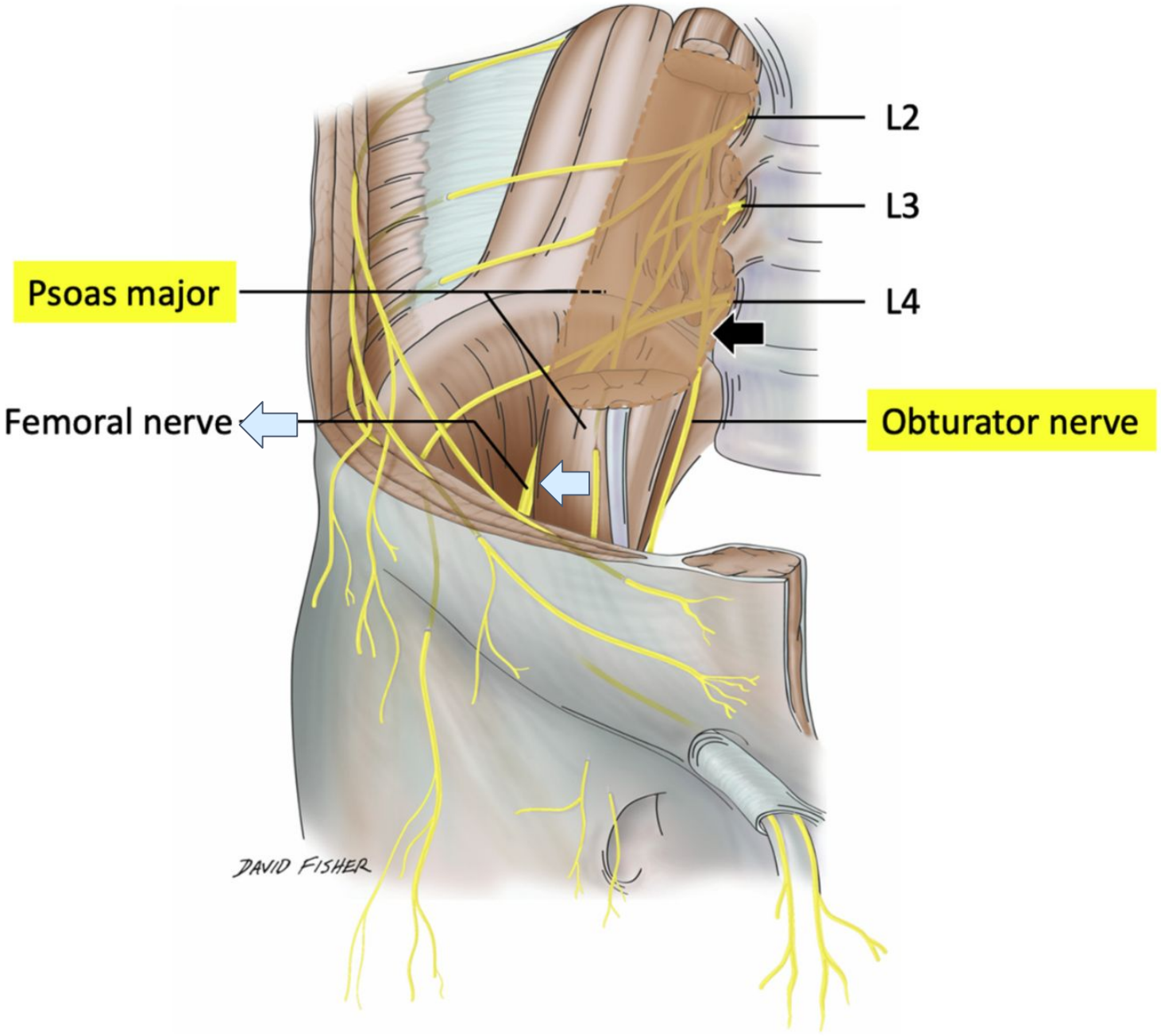
Nerves of the lumbar plexus

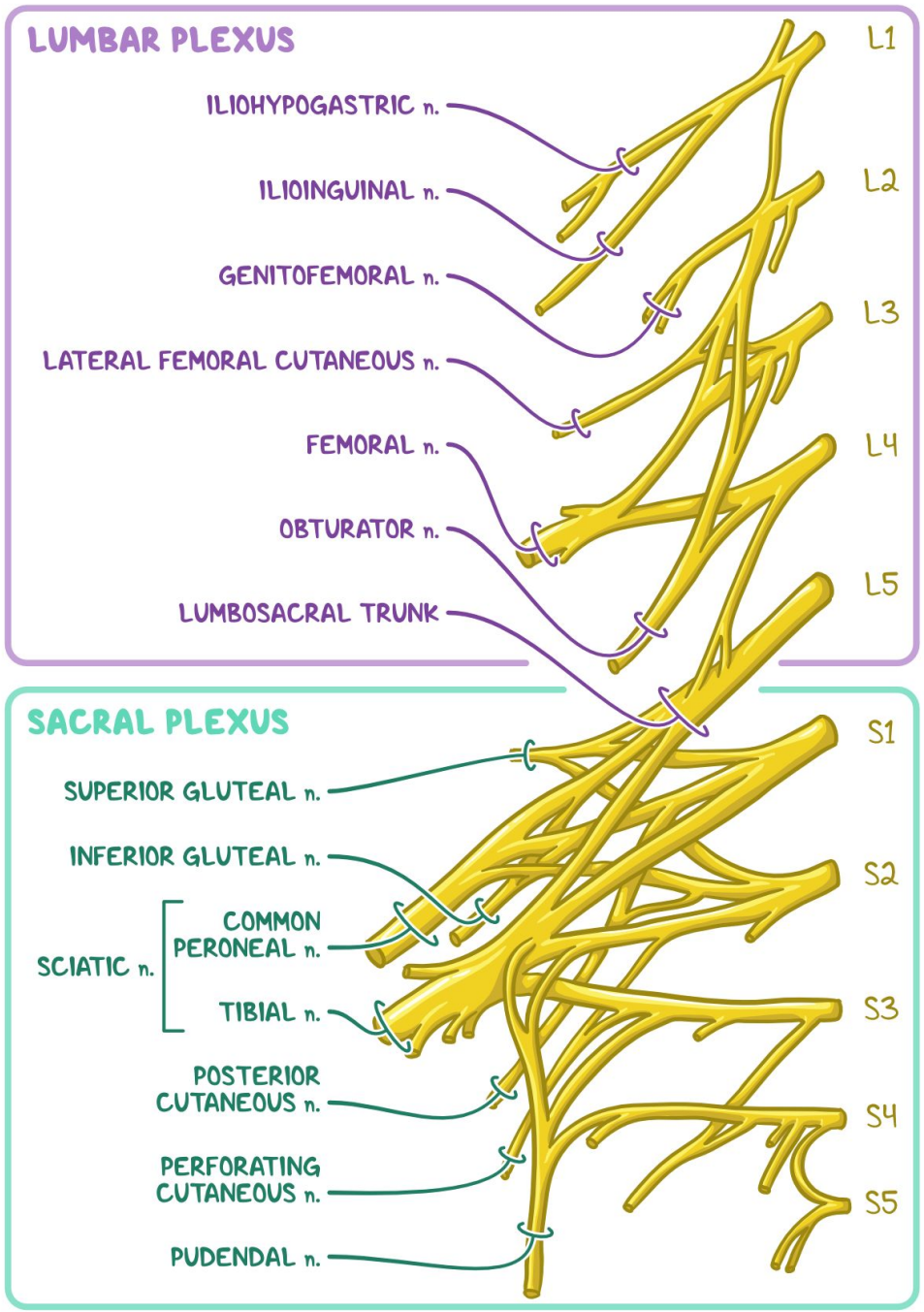
- obturator nerve
- Roots: L2, L3, L4.
- Motor Functions
  - innervates the muscles:
    - obturator externus, pectineus, adductor longus, adductor brevis, adductor magnus, gracilis
- Sensory Functions:
  - innervates the skin over the medial thigh


L2
L3
Psoas major
L4
Femoral nerve
Obturator nerve
DAVID FISHER

Nerves of the lumbar plexus

- femoral nerve
- Roots: L2, L3, L4
- Motor Functions:
  - innervates the muscles:
    - iliacus, pectineus, sartorius, all the muscles of quadriceps femoris
- Sensory Functions:
  - innervates the skin on the anterior thigh and the medial leg


L2
L3
L4
Psoas major
Femoral nerve
Obturator nerve
DAVID FISHER

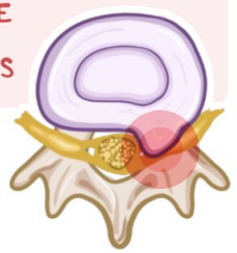


BACKGROUND

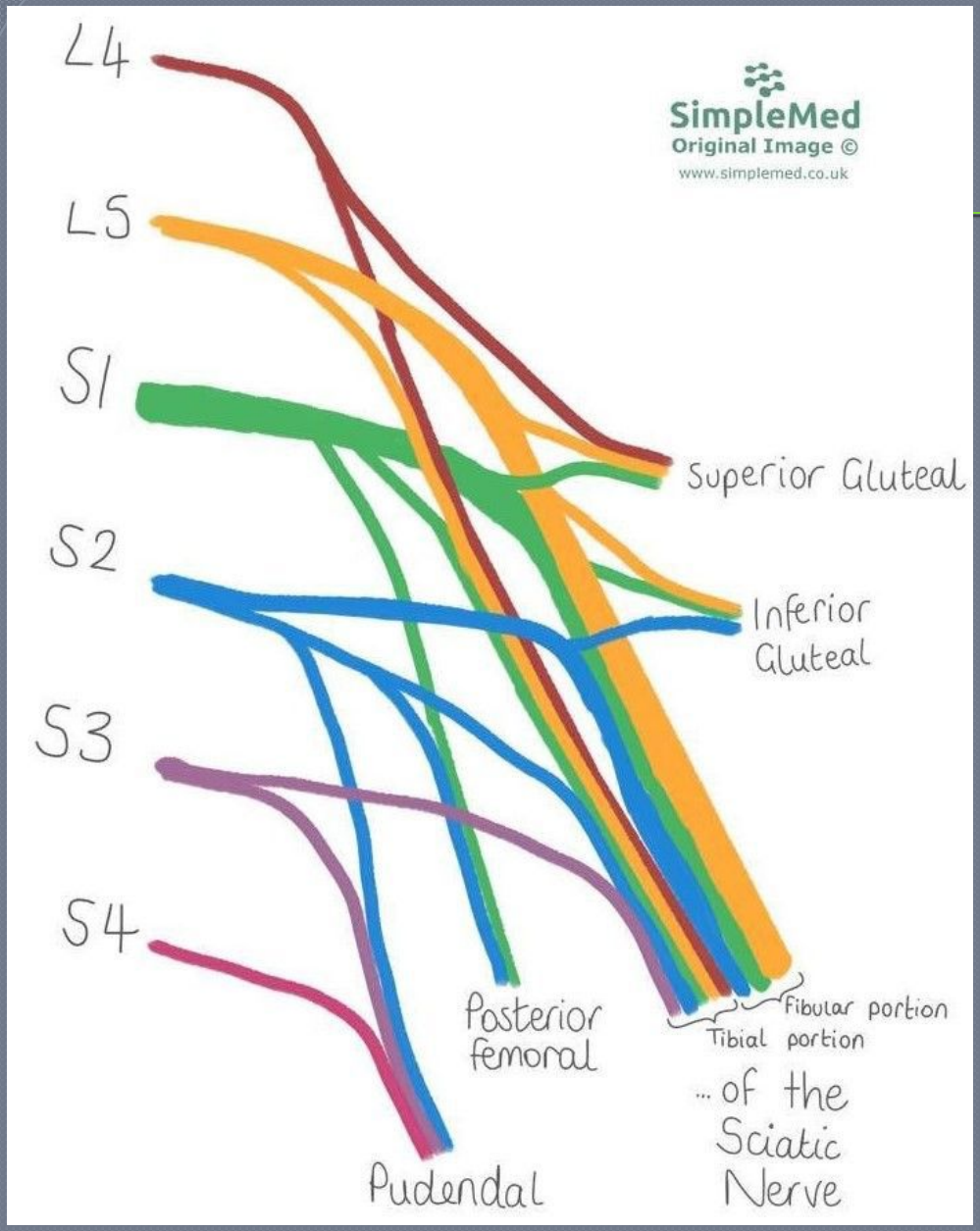
* NETWORK of NERVE FIBERS that BRANCH OUT to INNERVATE the LOWER LIMBS
  - ~ DERIVED from ROOTS of LUMBAR & SACRAL SPINAL NERVES

CLINICAL SIGNIFICANCE

* SPINAL DISC HERNIATION is MOST COMMON CAUSE of DAMAGE
* COMPRESSION of LOCAL SPINAL NERVES
  - ~ SHOOTING PAIN DOWN LEG
  - ~ NUMBNESS & MUSCLE WEAKNESS in AREAS of AFFECTED NERVES



Sacral Plexus



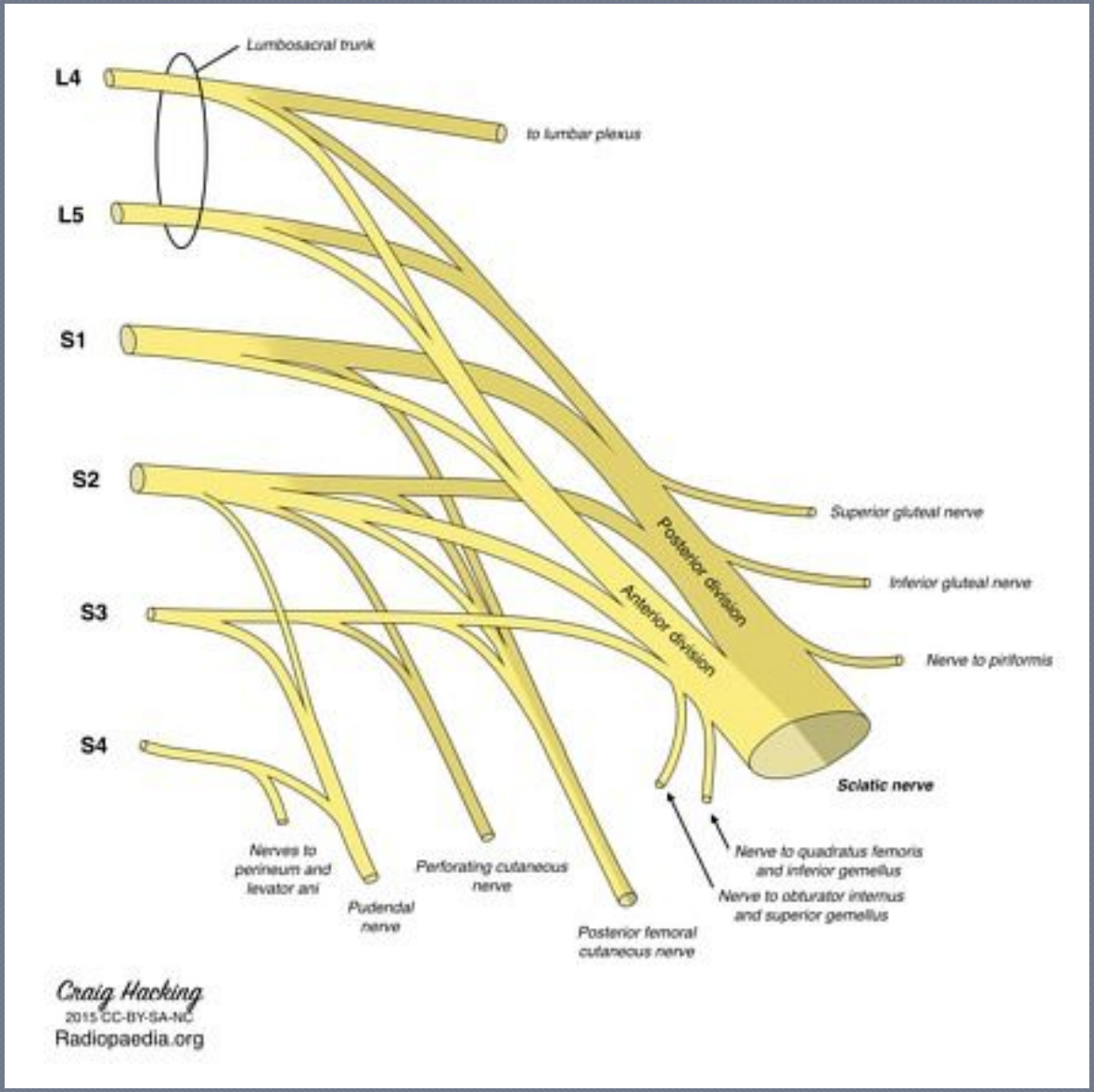
Sacral Plexus

- a nerve plexus that provides motor and sensory nerves for the posterior thigh, most of the lower leg, the entire foot, & part of the pelvis

- derived from the anterior rami of spinal nerves L4, L5, S1, S2, S3, and S4

Sacral Plexus Spinal Nerves

- the spinal nerves S1 – S4 form the basis of the sacral plexus
- each nerve divides into anterior and posterior nerve fibres
- the sacral plexus begins as the anterior fibres of the spinal nerves S1, S2, S3, and S4 & are joined by the 4th and 5th lumbar roots
  - combined = lumbosacral trunk
  - together they descend into the pelvis to meet the sacral roots as they emerge from the spinal cord


Lumbosacral trunk
L4
L5
S1
S2
S3
S4
to lumbar plexus
Superior gluteal nerve
Inferior gluteal nerve
Nerve to piriformis
Posterior division
Anterior division
Sciatic nerve
Nerves to perineum and levator ani
Pudendal nerve
Perforating cutaneous nerve
Posterior femoral cutaneous nerve
Nerve to quadratus femoris and inferior gemellus
Nerve to obturator internus and superior gemellus
Craig Hacking
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Nerves of the sacral plexus

- The anterior rami of the S1-S4 spinal roots (and the lumbosacral trunk) divide into several cords
- cords then combine together to form the five major peripheral nerves of the sacral plexus
- these nerves then descend down the posterior pelvic wall
- two main destinations:
  - leave the pelvis via the greater sciatic foramen
    - these nerves enter the gluteal region of the lower limb, innervating the structures there
  - remain in the pelvis
    - these nerves innervate the pelvic muscles, organs and perineum

The Sacral Plexus

- Provides motor and sensory nerves for the posterior thigh, most of the lower leg, the entire foot, and part of the pelvis

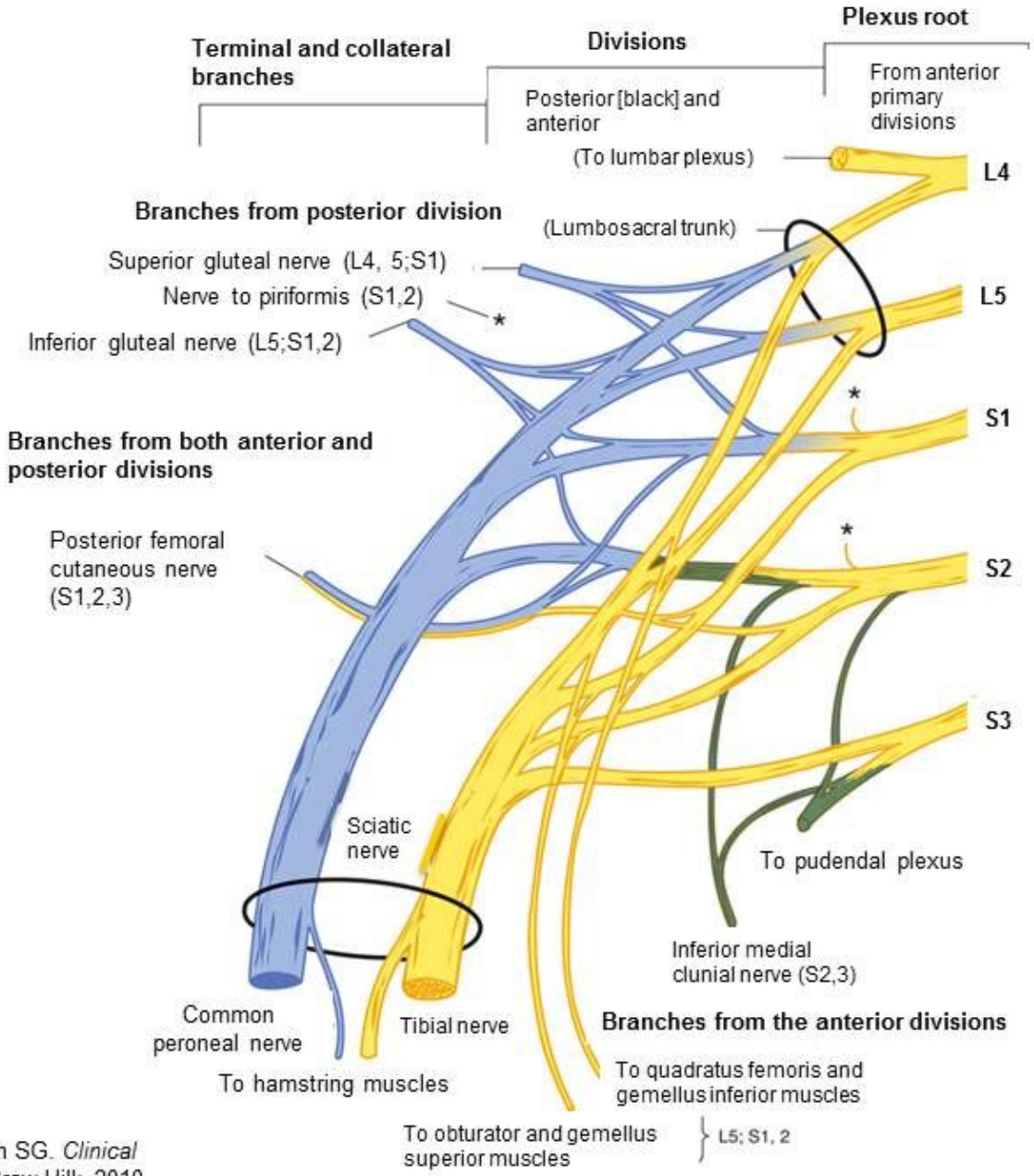
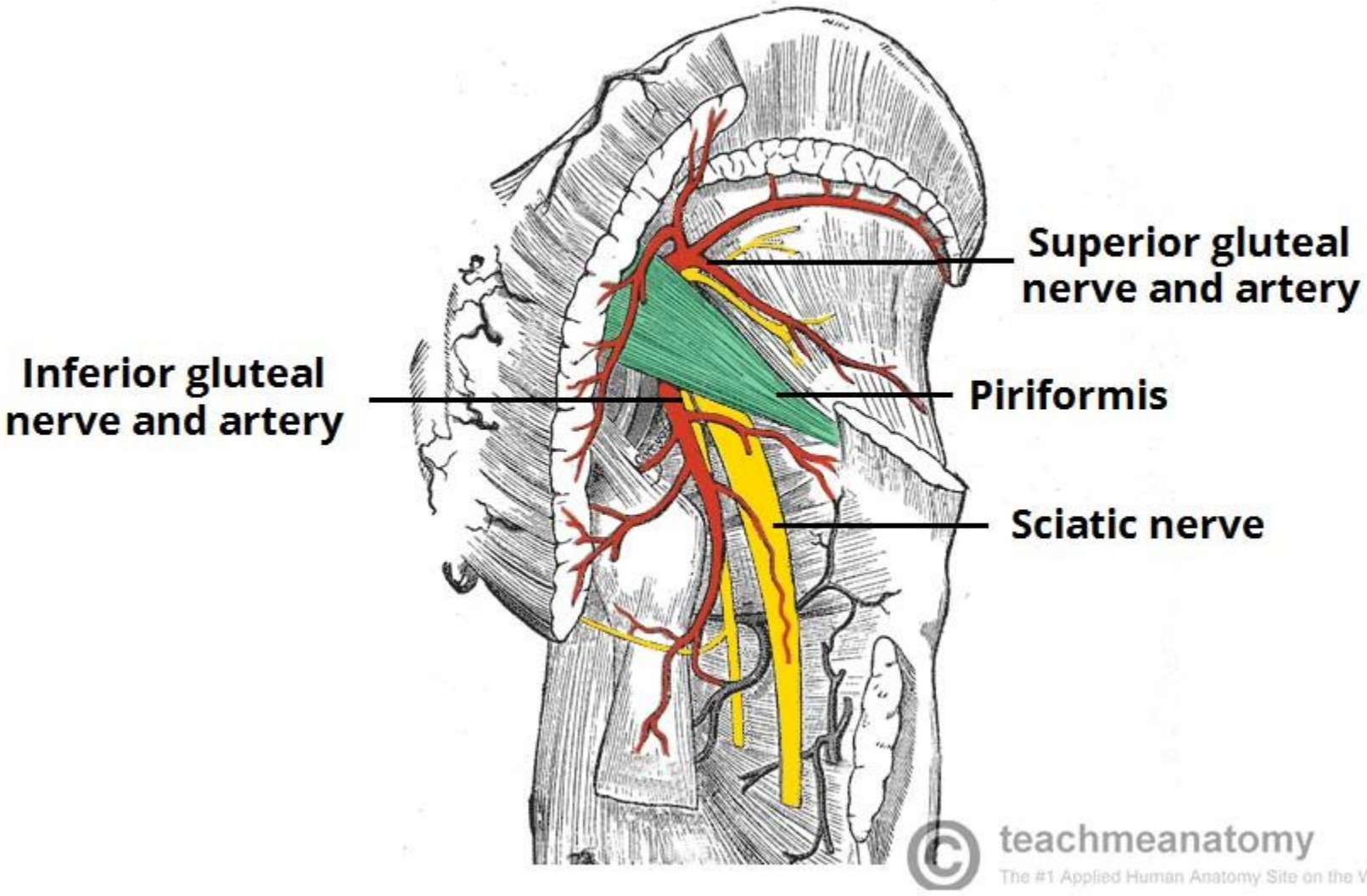


Figure 28-12. The sacral plexus. In: Waxman SG. *Clinical Neuroanatomy*. 26th ed. New York, NY: McGraw-Hill; 2010. http://www.accessphysiotherapy.com. Accessed March 22, 2012.

Nerves of the sacral plexus

- superior gluteal nerve
  - leaves the pelvis via the greater sciatic foramen, entering the gluteal region superiorly to the piriformis muscle
  - it is accompanied by the superior gluteal artery and vein for much of its course
- Roots: L4, L5, S1.
- Motor Functions:
  - innervates the gluteus minimus, gluteus medius and tensor fascia lata
- Sensory Functions:
  - none


Superior gluteal nerve and artery
Inferior gluteal nerve and artery
Piriformis
Sciatic nerve
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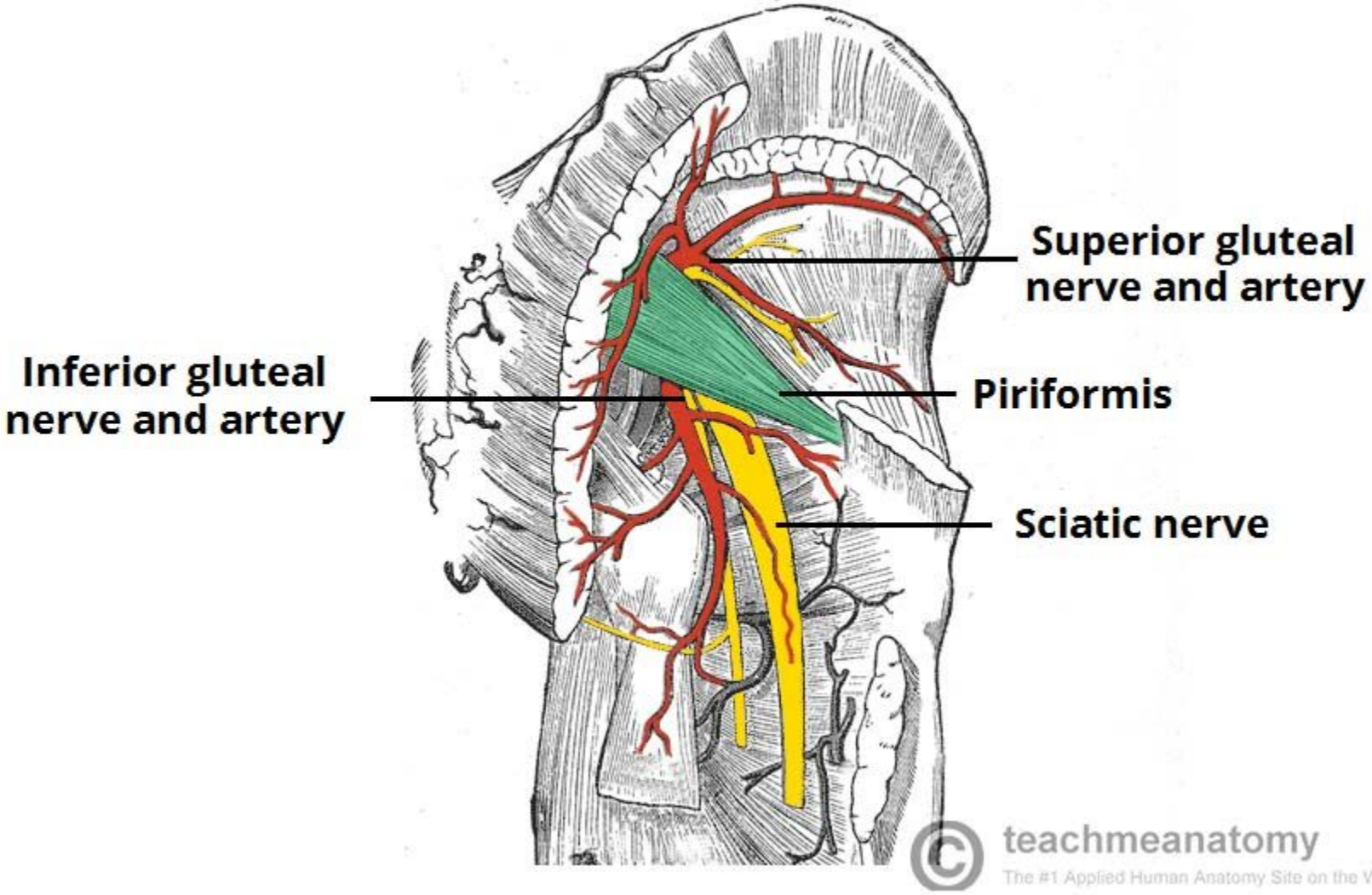
The #1 Applied Human Anatomy Site on the Web.

Nerves of the sacral plexus

- inferior gluteal nerve
  - leaves the pelvis via the greater sciatic foramen
  - enters the gluteal region inferiorly to the piriformis muscle
  - accompanied by the inferior gluteal artery and vein for much of its course.
- Roots: L5, S1, S2
- Motor Functions:
  - innervates gluteus maximus
- Sensory Functions:
  - none


Superior gluteal nerve and artery
Inferior gluteal nerve and artery
Piriformis
Sciatic nerve
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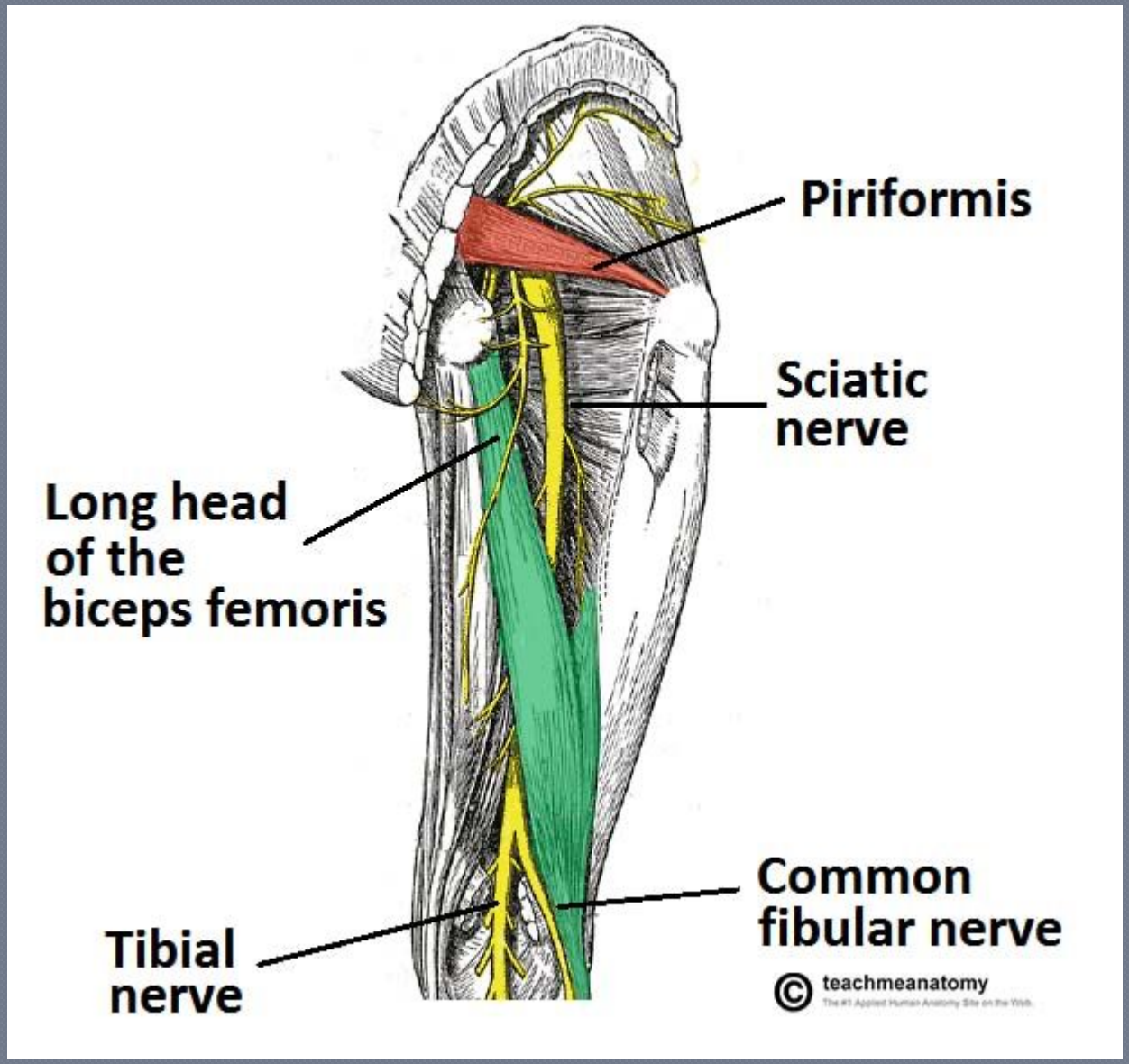
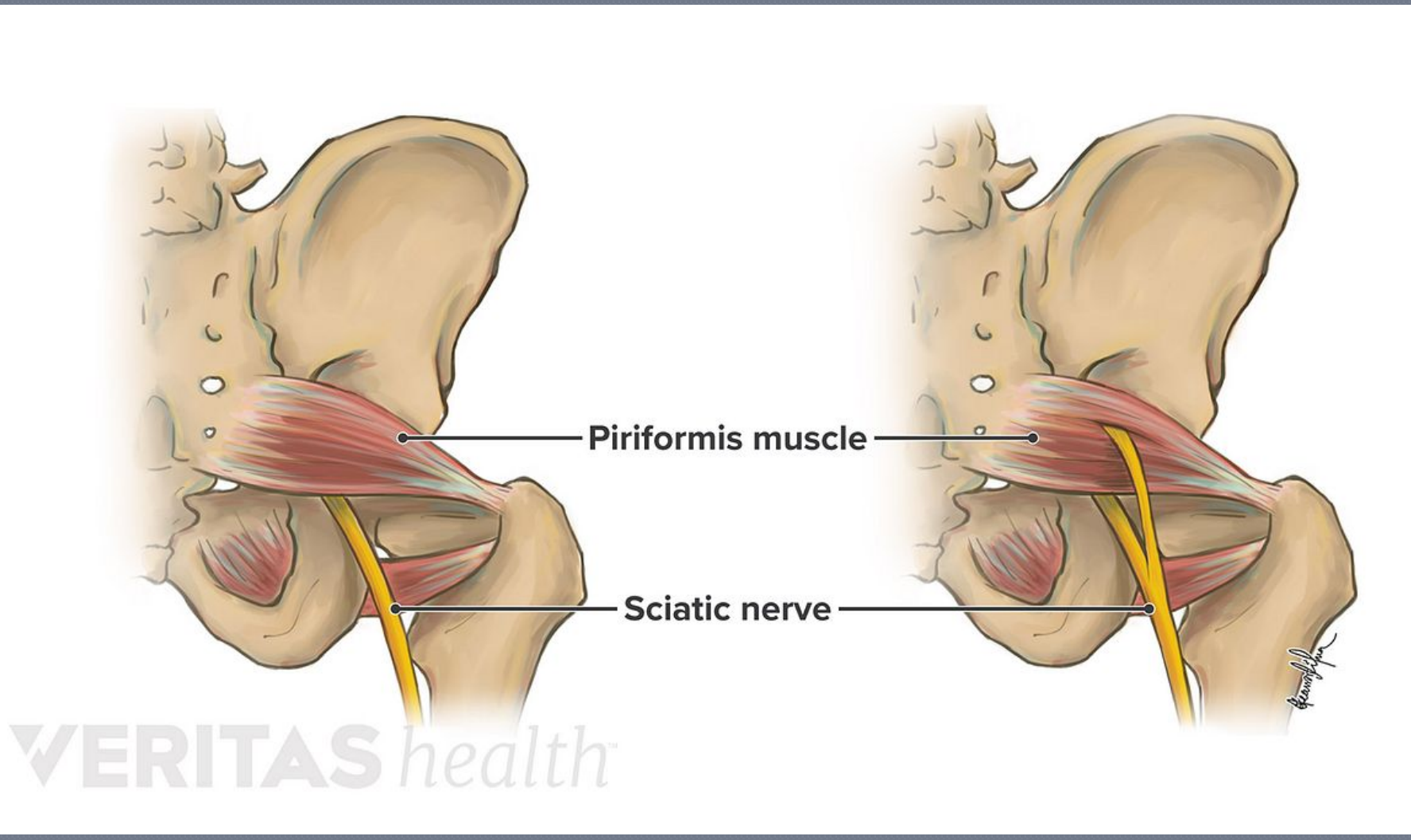
Nerves of the sacral plexus

- Sciatic nerve
- Roots: L4, L5, S1, S2, S3
- Motor Functions:
  - tibial Portion
    - innervates all of the muscles in the posterior compartment of the thigh, including the hamstring portion of adductor magnus, apart from the short head of the biceps femoris
    - all muscles in the posterior compartment of the leg
    - all muscles in the sole of the foot
  - common Fibular Portion
    - short head of biceps femoris
    - all muscles in the anterior and lateral compartments of the leg and extensor digitorum brevis

Nerves of the sacral plexus

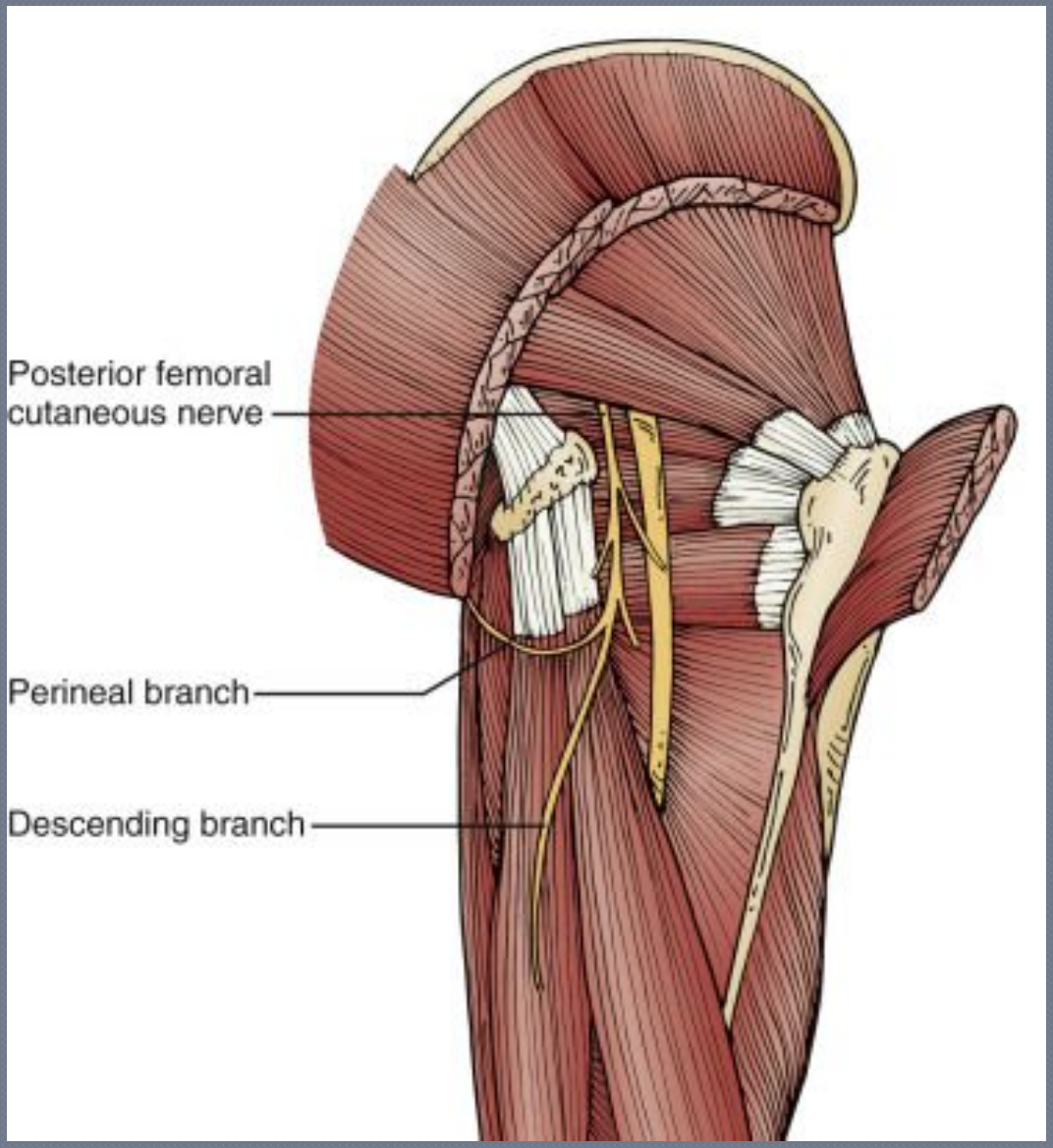
- Sensory Functions:
  - tibial portion:
    - innervates the skin on the posterolateral and medial surfaces of the foot as well as the sole of the foot
  - common fibular portion:
    - innervates the skin on the anterolateral surface of the leg and the dorsal aspect of the foot


Piriformis
Sciatic nerve
Long head of the biceps femoris
Common fibular nerve
Tibial nerve
© teachmeanatomy


Piriformis muscle
Sciatic nerve
VERITAS health

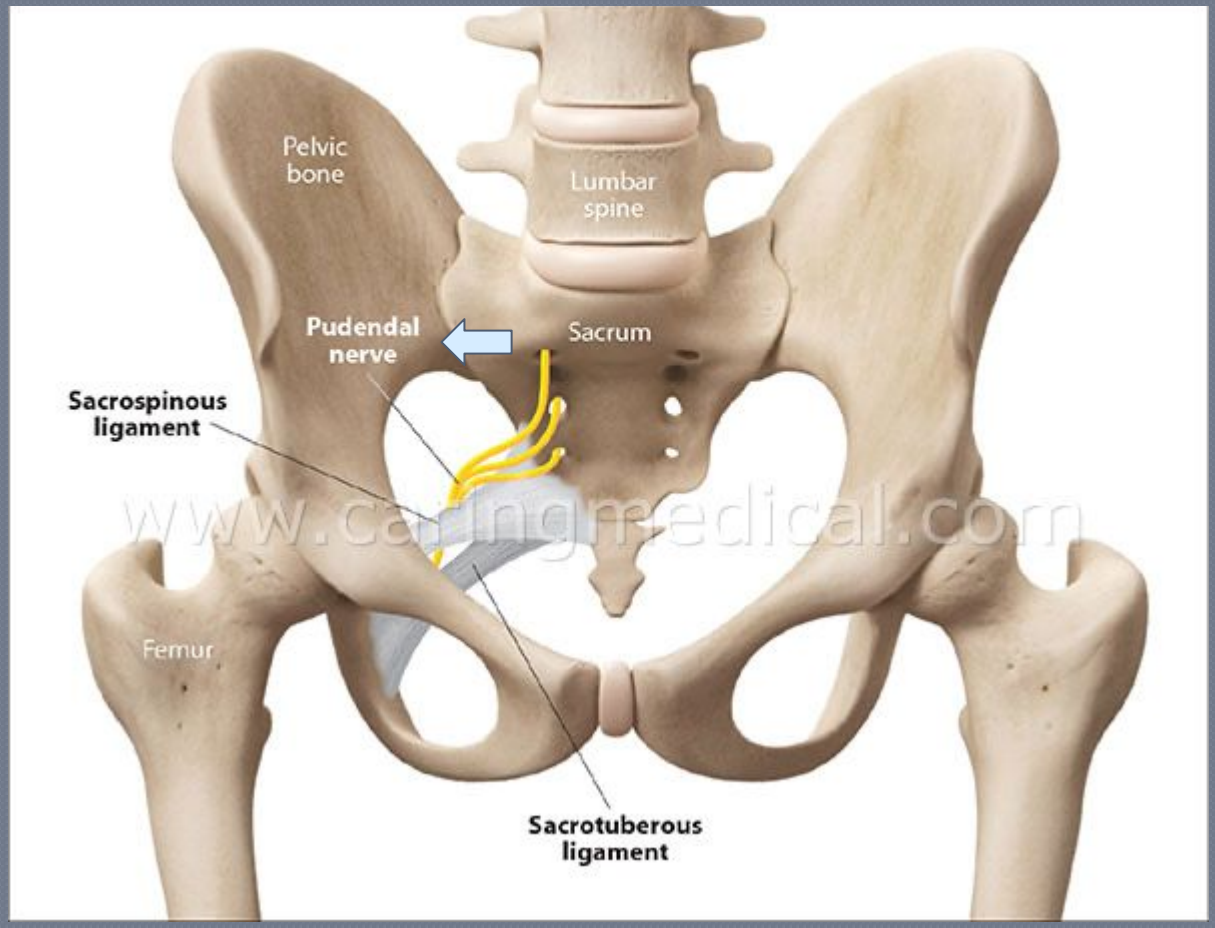
Nerves of the sacral plexus

- posterior cutaneous nerve of thigh
  - leaves the pelvis via the greater sciatic foramen
  - enters the gluteal region inferiorly to the piriformis muscle
  - it descends deep to the gluteus maximus and runs down the back of the thigh to the knee
- Roots: S1, S2, S3
- Motor Functions:
  - none
- Sensory Functions:
  - innervates the skin on the posterior surface of the thigh and leg
  - also innervates the skin of the perineum


Posterior femoral cutaneous nerve
Perineal branch
Descending branch

Sacral Plexus Nerve Continued

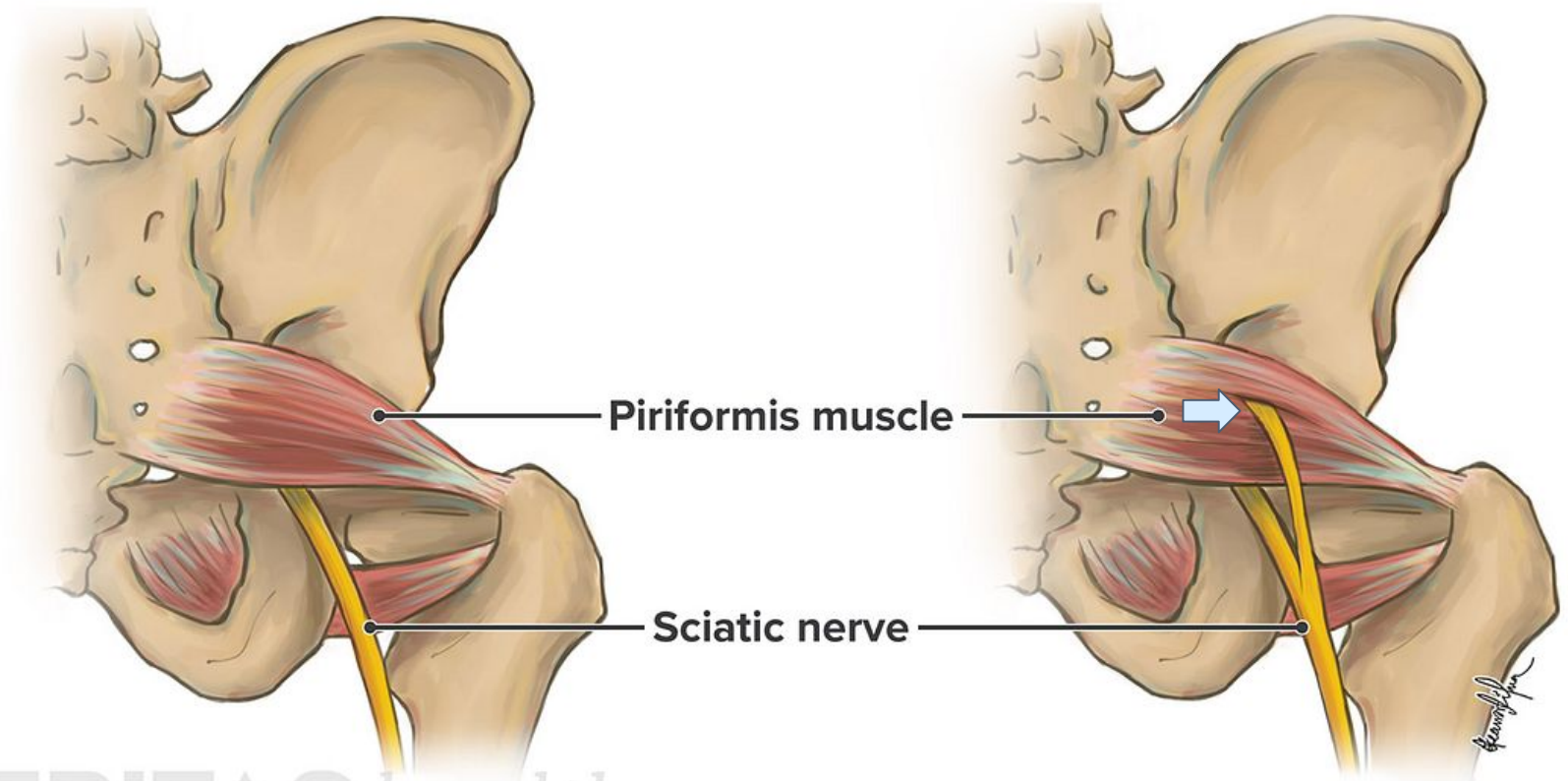
- pudendal nerve
  - leaves the pelvis via the greater sciatic foramen
  - re-enters via the lesser sciatic foramen
  - it moves anterosuperiorly along the lateral wall of the ischiorectal fossa
  - terminates by dividing into several branches
- Roots: S2, S3, S4
- Motor Functions
  - innervates the skeletal muscles in the perineum, the external urethral sphincter, the external anal sphincter, levator ani
- Sensory Functions:
  - innervates the penis and the clitoris and most of the skin of the perineum

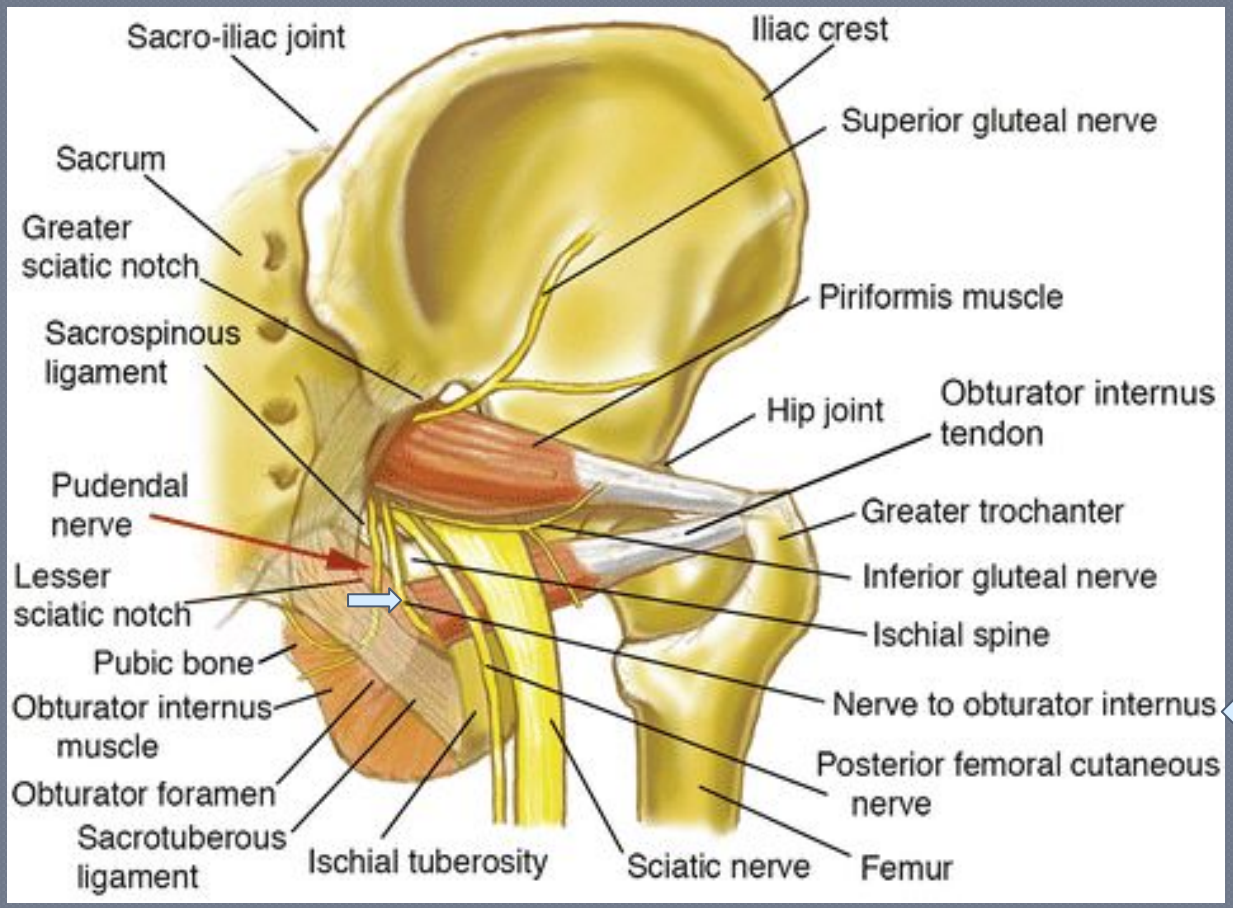

Pelvic bone
Lumbar spine
Pudendal nerve
Sacrum
Sacrospinous ligament
Femur
Sacrotuberous ligament

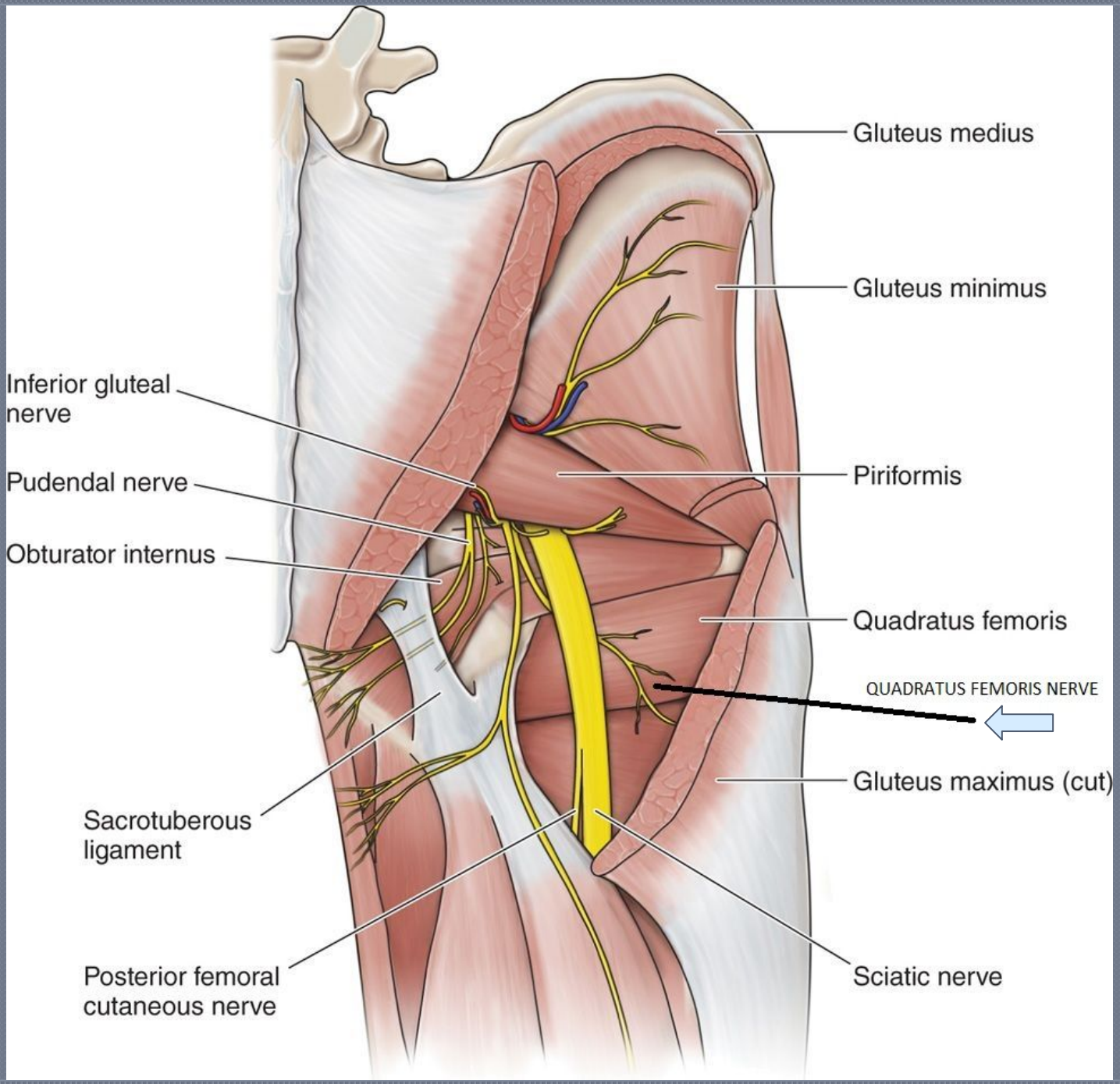
Other branches of the sacral plexus

- tend to be nerves that directly supplying muscles

- Nerve to piriformis
- Nerve to obturator internus
- Nerve to quadratus femoris


Piriformis muscle
Sciatic nerve


Sacro-iliac joint
Iliac crest
Superior gluteal nerve
Sacrum
Greater sciatic notch
Piriformis muscle
Sacrospinous ligament
Hip joint
Obturator internus tendon
Pudendal nerve
Greater trochanter
Inferior gluteal nerve
Lesser sciatic notch
Ischial spine
Pubic bone
Nerve to obturator internus
Obturator internus muscle
Posterior femoral cutaneous nerve
Obturator foramen
Sacrotuberous ligament
Ischial tuberosity
Sciatic nerve
Femur


Gluteus medius
Gluteus minimus
Inferior gluteal nerve
Pudendal nerve
Obturator internus
Piriformis
Quadratus femoris
QUADRATUS FEMORIS NERVE
Gluteus maximus (cut)
Sacrotuberous ligament
Posterior femoral cutaneous nerve
Sciatic nerve

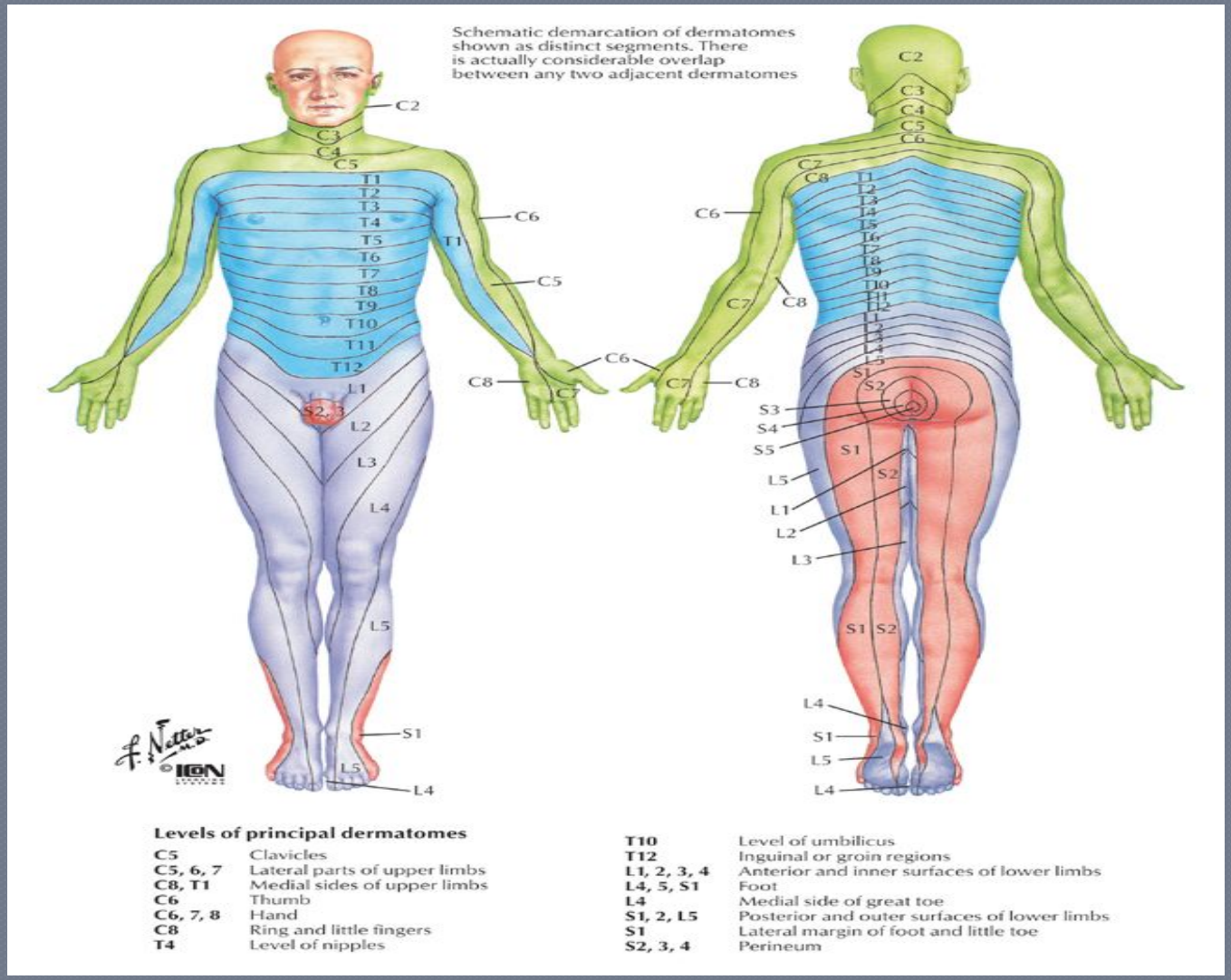
Dermatomes

- Each of the spinal nerves exits the spinal canal between two of the vertebra
- each then goes to a particular area of the body

Dermatome:

- The area of **skin** served by each of these nerves is called its dermatome

Dermatome Map of the Body



Levels of principal dermatomes

C5	Clavicles
C5, 6, 7	Lateral parts of upper limbs
C8, T1	Medial sides of upper limbs
C6	Thumb
C6, 7, 8	Hand
C8	Ring and little fingers
T4	Level of nipples
T10	Level of umbilicus
T12	Inguinal or groin regions
L1, 2, 3, 4	Anterior and inner surfaces of lower limbs
L4, 5, S1	Foot
L4	Medial side of great toe
S1, 2, L5	Posterior and outer surfaces of lower limbs
S1	Lateral margin of foot and little toe
S2, 3, 4	Perineum

Main Dermatome Levels

- C5
  - Clavicles
- C5/C6
  - Lateral sides of upper limbs
- C8/T1
  - Medial Sides of Upper Limbs
- C6
  - Thumb
- C6/C7/C8
  - Hand
- C8
  - Ring and little finger
- T4
  - Level of nipples
- T10
  - Level of umbilicus

Dermatome Levels continued

- L1
  - Inguinal region
- L1/2/3,/5
  - Anterior and inner surfaces of lower limbs
- L4/5/S1
  - Foot
- L4
  - Medial side of the Great Toe
- L5/S1/2
  - Lateral and posterior side of lower limbs
- S1
  - Lateral margin of Foot and Baby toe
- S2/3/4
  - Perineum

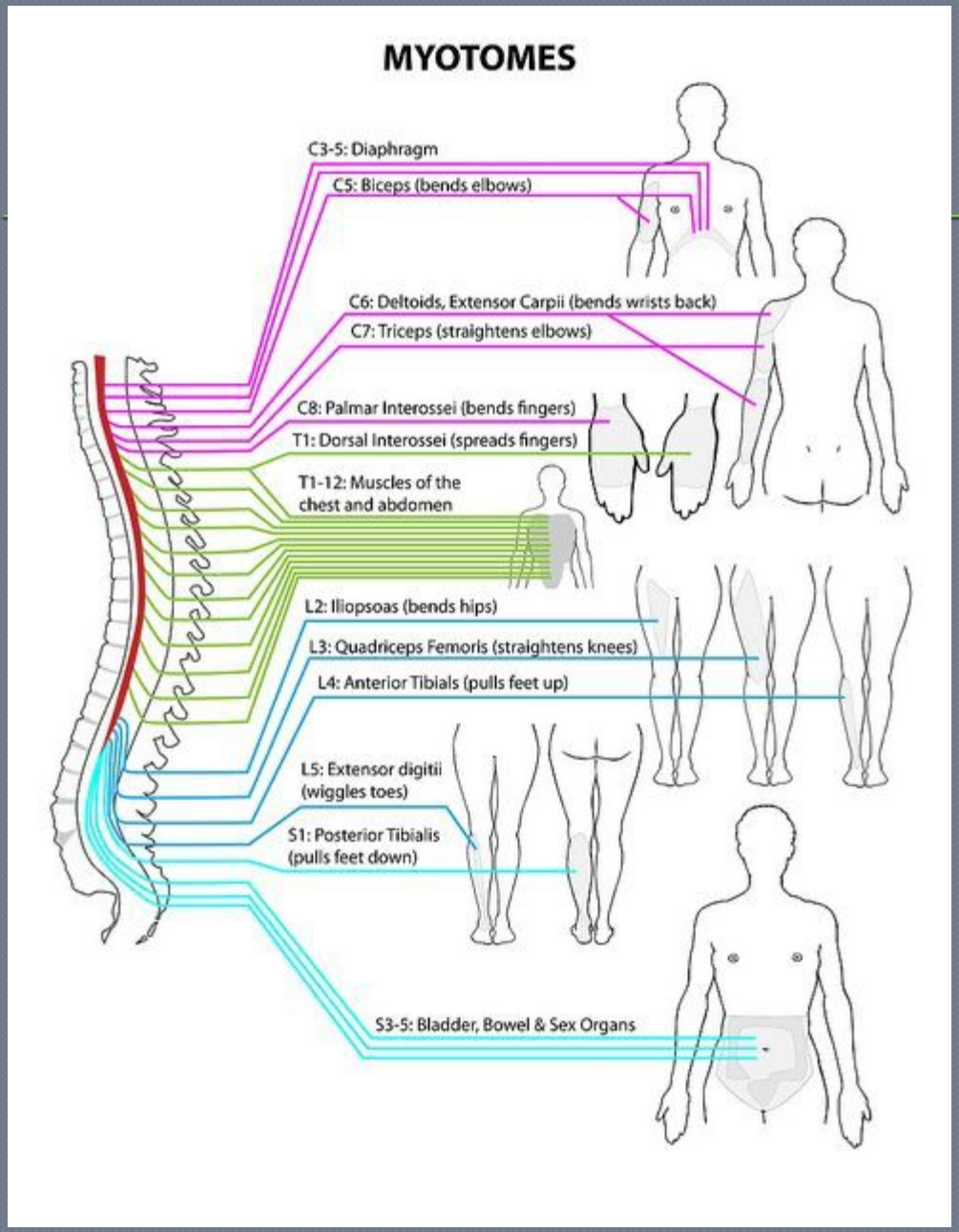
Myotomes

- each of the spinal nerves exits the spinal canal between two of the vertebra
- each then goes to a particular area of the body

Myotome:

- the area of **muscle** served by each of these nerves is called its dermatome

Myotomes


MYOTOMES
C3-5: Diaphragm
C5: Biceps (bends elbows)
C6: Deltoids, Extensor Carpii (bends wrists back)
C7: Triceps (straightens elbows)
C8: Palmar Interossei (bends fingers)
T1: Dorsal Interossei (spreads fingers)
T1-12: Muscles of the chest and abdomen
L2: Iliopsoas (bends hips)
L3: Quadriceps Femoris (straightens knees)
L4: Anterior Tibials (pulls feet up)
L5: Extensor digitii (wiggles toes)
S1: Posterior Tibialis (pulls feet down)
S3-5: Bladder, Bowel & Sex Organs

Myotomes and Differentiating Nerve Lesions

C1 Myotome Upper cervical flexion
C2 Myotome Upper cervical extension/ Neck Rotation
C3 Myotome Cervical lateral flexion
C4 Myotome Shoulder shrugs (upper trapezious)
C5 Myotome Shoulder abduction and external rotation (infraspinatus)
C6 Myotome Elbow flexion and wrist extension
C7 Myotome Elbow extension and wrist flexion
C8 Myotome Thumb extension and ulnar deviation
T1 Myotome Finger adduction and abduction
L1 Myotome Hip flexion
L2 Myotome Hip flexion (also adduction and medial rotation)
L3 Myotome Leg/knee extension
L4 Myotome Dorsiflexion
L5 Myotome Great/Big toe extension
S1 Myotome Ankle plantar flexion and eversion/knee flexion
S2 Myotome Ankle plantar flexion and knee flexion
S3 Myotome None
S4 Myotome Bladdar and rectum

When to use myotome testing

- paralysis or weakness of a muscle
  - shows when the client takes on abnormal positions
- muscle wasting or atrophy
- decreased/abnormal muscle tone

DERMATOME VERSUS MYOTOME

DERMATOME	MYOTOME
A dermatome refers to an area of skin innervated by the nerves from a single spinal root	A myotome refers to a group of muscles innervated by the nerves of a single spinal root
A region of the skin innervated by a single spinal nerve	A group of muscles innervated by a single spinal nerve
Some consists of overlapping regions innervated by more than one spinal nerve	Some are innervated by more than one spinal nerve
Responsible for the coordination of senses	Responsible for the coordination of voluntary muscular movements

Myotome Tests

Upper Extremity Nerve Routes

C4 tested with resisted shoulder shrugs/elevation
C5 tested with resisted shoulder abduction
C6 tested with resisted elbow flexion/ wrist extension
C7 tested with resisted wrist flexion
C8 tested with resisted thumb extension
T1 fingers abduction & adduction

Lower Extremity Nerve Routes

The quick test for the lower extremity, to rule out a nerve root injury is to have the athlete do a squat.

L1-L2 tested with resisted hip flexion
L3 tested with resisted knee extension
L4 tested with resisted foot dorsi flexion
L5 tested with resisted great toe extension
S1/S2 tested with plantar flexion