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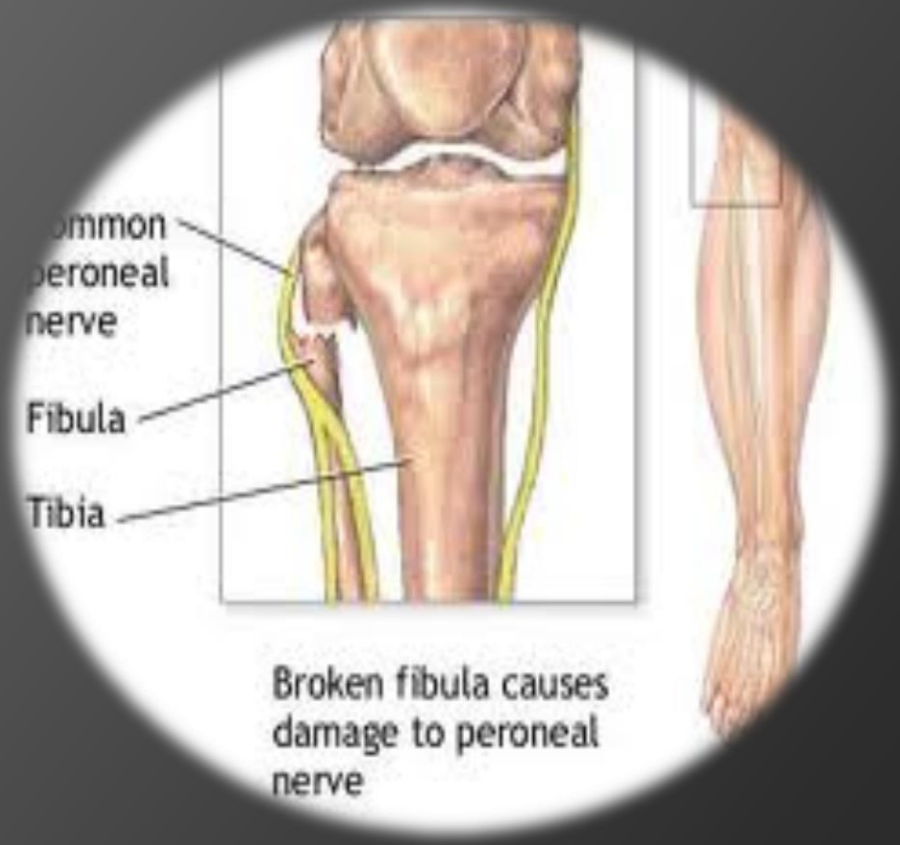
LOWER EXTREMITY IMPAIRMENTS – PERIPHERAL NERVE INJURIES



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- Upper Extremity Impairments due to Peripheral Nerve Entrapments

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21 Secrets of the Most Persuasive QME's

Topics Include:

- Preparatory Secrets
- Interview/Exam Secrets
- Report Writing Secrets
- Deposition Secrets
- 2 Bonus Secrets

PERSUASIVE

Merriam Webster – adj. – able to cause people to do or to believe something.

Wikipedia – adj. – tending to persuade, or to use persuasion:

- Persuasion: The influence of beliefs, attitudes, intentions, motivations, or behaviors. Persuasion is a process aimed at changing a person's (or a group's) attitude or behavior toward some event, idea, object, or other person(s), by using written or spoken words to convey information, feelings, or reasoning, or a combination of them.

Chinese Proverb:

"The tongue can paint what the eye cannot see."

21 Secrets of the Most Persuasive QME's

Topics:

- Section 1 - Preparatory Secrets of the Most Persuasive QME's
- Section 2 - Interview/Physical Examination Secrets of the Most Persuasive QME's
- Section 3 - Report Writing Secrets of the Most Persuasive QME's
- Section 4 - Deposition Secrets of the Most Persuasive QME's
- Section 5 – Final Thoughts

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LOWER EXTREMITY IMPAIRMENTS – PERIPHERAL NEUROPATHIES

Topics Include:

- Neurology 101
- Peripheral Nerve Lesions
- Exam Procedures
- Impairment Calculations
- Case Examples

LOWER EXTREMITY IMPAIRMENTS – PERIPHERAL NERVE INJURY

Topics:

- Neurology 101
  - Development of the Nervous System
  - Layout of the Nervous System
  - Differentiation of the Somites
  - Spinal Nerve Roots
  - Lumbar and Sacral Plexuses

LOWER EXTREMITY IMPAIRMENTS – PERIPHERAL NERVE INJURY

Topics:

- Entrapment Neuropathies
  - Femoral Nerve
  - Obturator Nerve
  - Sciatic Nerve (Tibial/Common Peroneal)

LOWER EXTREMITY IMPAIRMENTS – PERIPHERAL NERVE INJURY

Topics:

- Exam Procedures:
  - Sensory Exam:
    - Exam Procedures for 1) pain, 2) light touch, and 3) two point discrimination
    - Review of Sensory Receptors
      - Free Nerve Endings, Meissner's corpuscles, Krause end bulbs, golgi tendon organs, etc.

LOWER EXTREMITY IMPAIRMENTS – PERIPHERAL NERVE INJURY

Topics:

- Permanent Impairment Calculation
  - Determining Sensory Deficit
  - Determining Motor Deficit
  - Determining Final Whole Person Impairment Rating

LOWER EXTREMITY IMPAIRMENTS – PERIPHERAL NERVE INJURY

Topics:

- Case Examples

THE IMPORTANCE OF THE NEUROLOGIC EXAMINATION

AMA Guides References to the Neurologic Examination (page 524):

History:

"Discuss the quality, frequency, duration, and anatomic location of pain, numbness, paresthesias, and weakness in detail."

THE IMPORTANCE OF THE NEUROLOGIC EXAMINATION

AMA Guides References to the Neurologic Examination (page 524):

Examination:

"A targeted neurologic assessment is needed for individuals with lower extremity problems….they physician records physical findings such as range of motion, limb length discrepancy, deformity, reflexes, muscle strength and atrophy, ligamentous laxity, motor and sensory deficits, and specific diagnoses such as fractures and bursitis"

"Neurologic examination of the lower extremities includes measurement of the knee and ankle reflexes and motor and sensory functions."

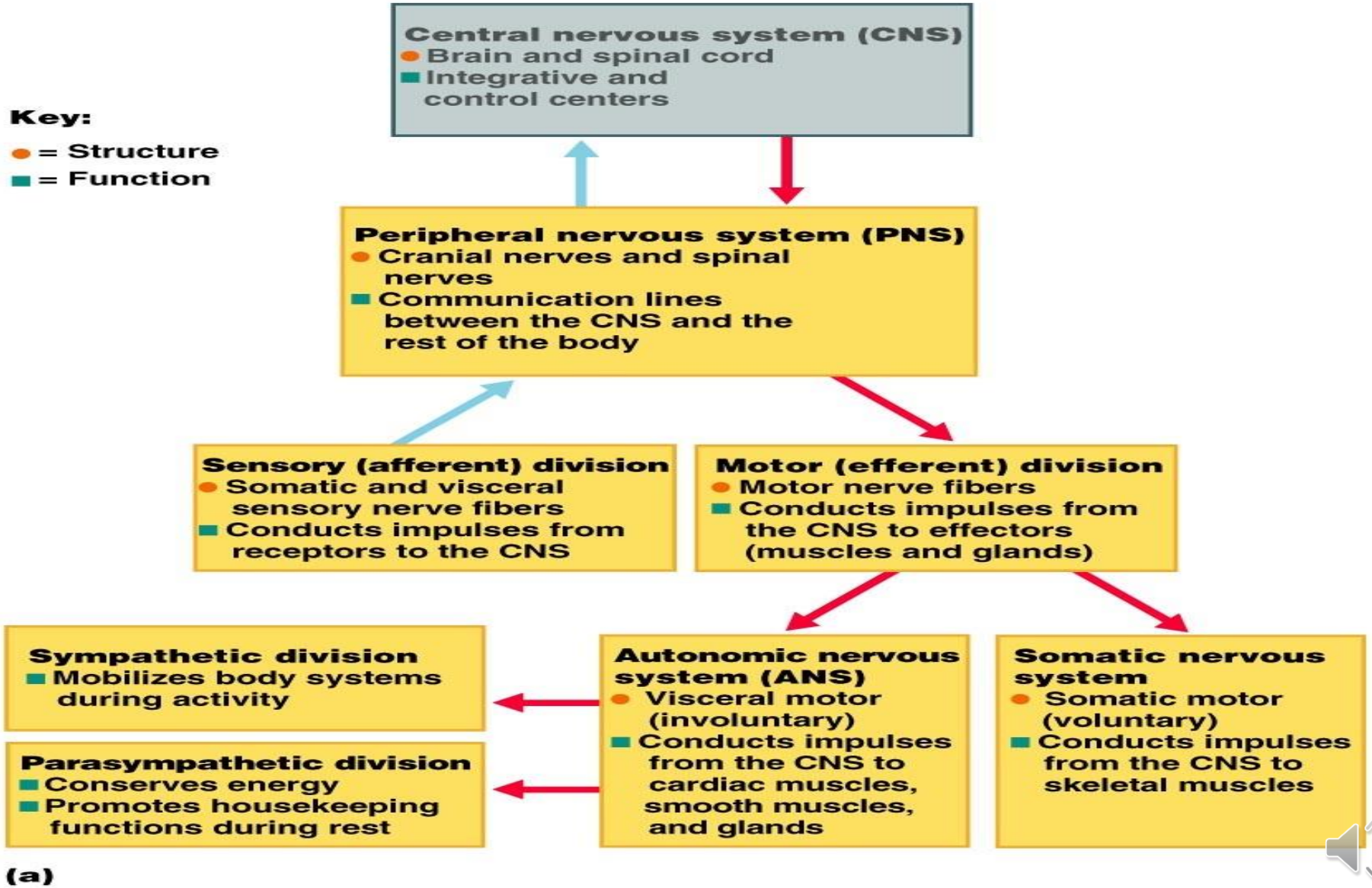
PERIPHERAL NEUROPATHIES

AMA Guides Chapter 16 – The Upper Extremities (page 480): “Excellent knowledge of the morphologic anatomy and physiology of the nervous system is a prerequisite.

The same would apply to the Lower Extremities - -

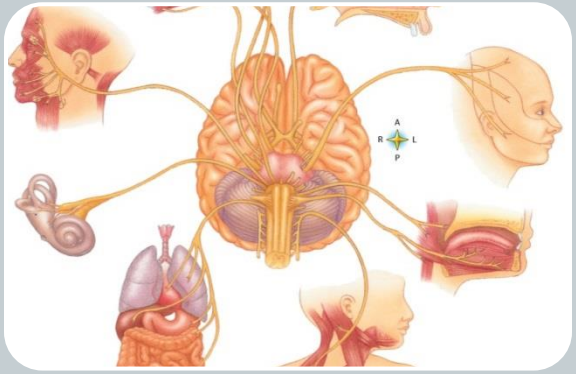
Brief Review of the Nervous System:

NERVOUS SYSTEM REVIEW

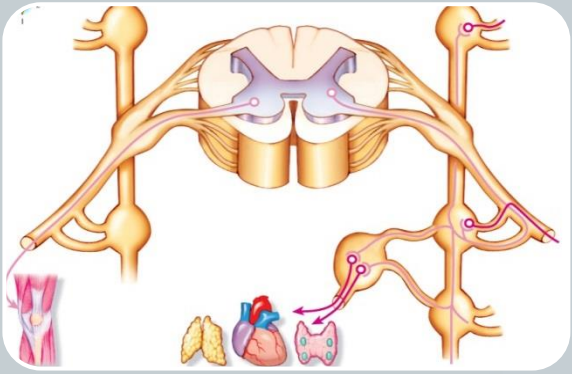


ENTRAPMENT NEUROPATHIES

Brief Review – So, we have the CNS and the PNS as the 2 major divisions of the nervous System.

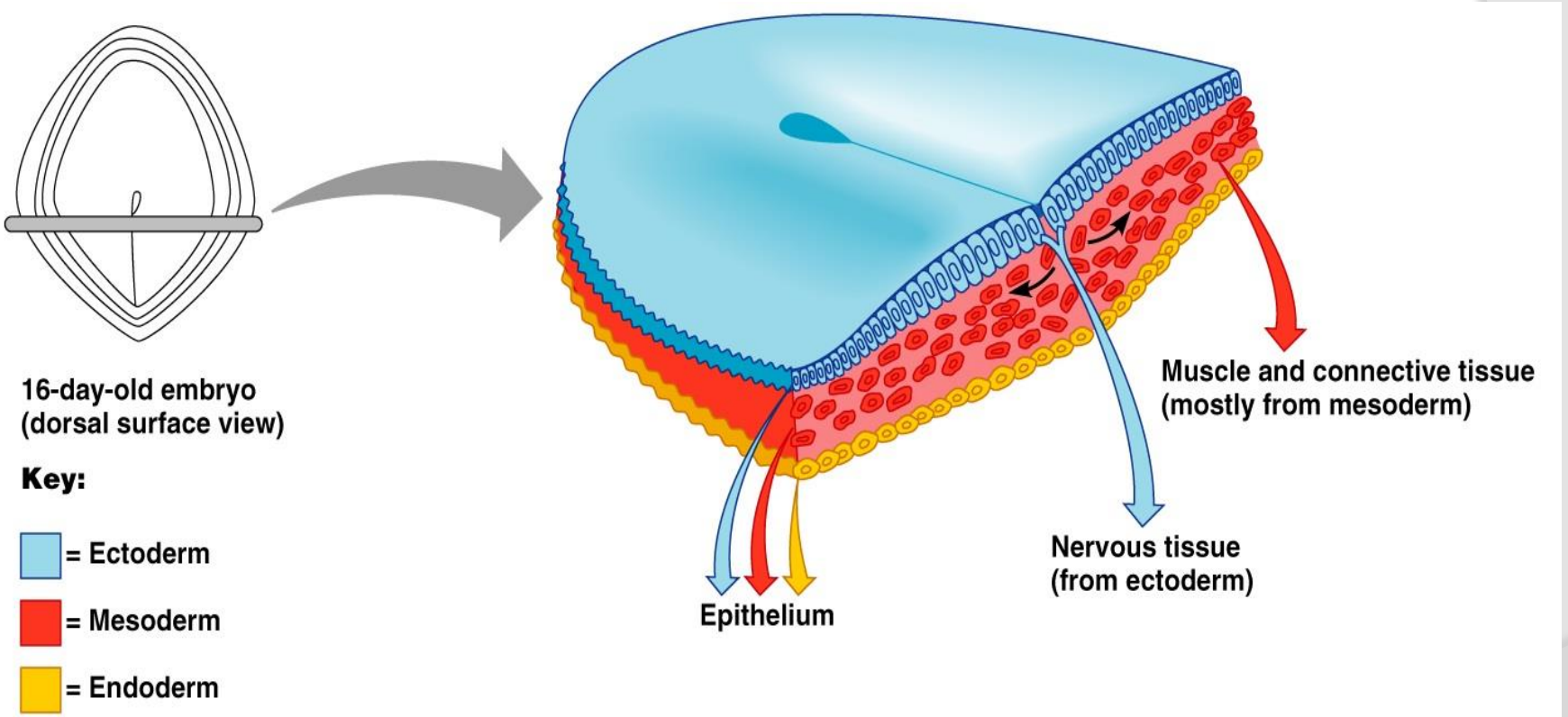


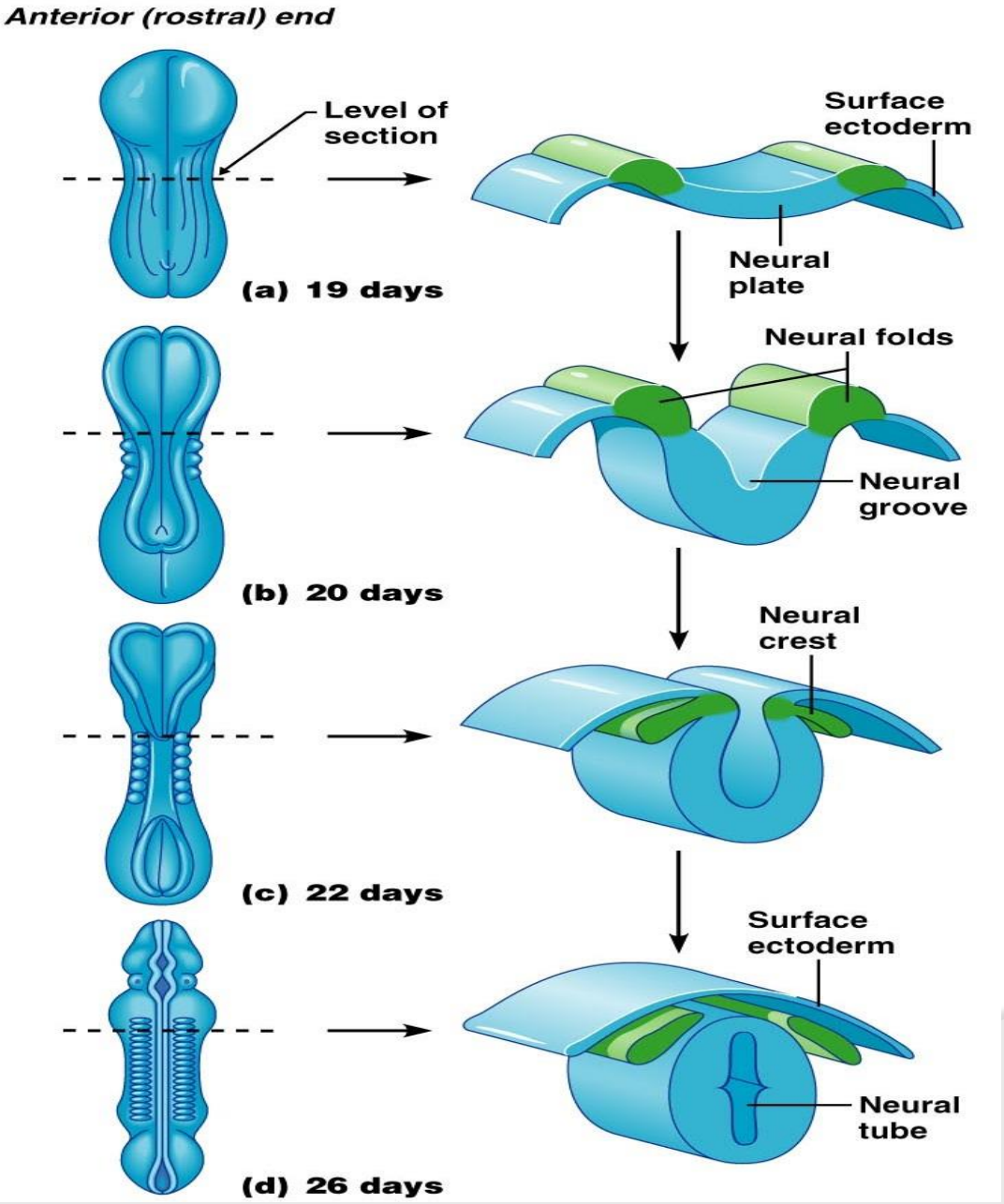
PNS Consists of the Cranial Nerves (12 pairs) and the Spinal Nerves (31 pairs)



PNS is divided into sensory (afferent) divisions and motor (efferent) divisions. Later on in the Program, we are going to discuss the examination procedures for both the sensory and motor divisions of the named lower extremity peripheral nerves.

Embryonic Development




Anterior (rostral) end
Level of section
Surface ectoderm
Neural plate
(a) 19 days
Neural folds
Neural groove
(b) 20 days
Neural crest
(c) 22 days
Surface ectoderm
Neural tube
(d) 26 days

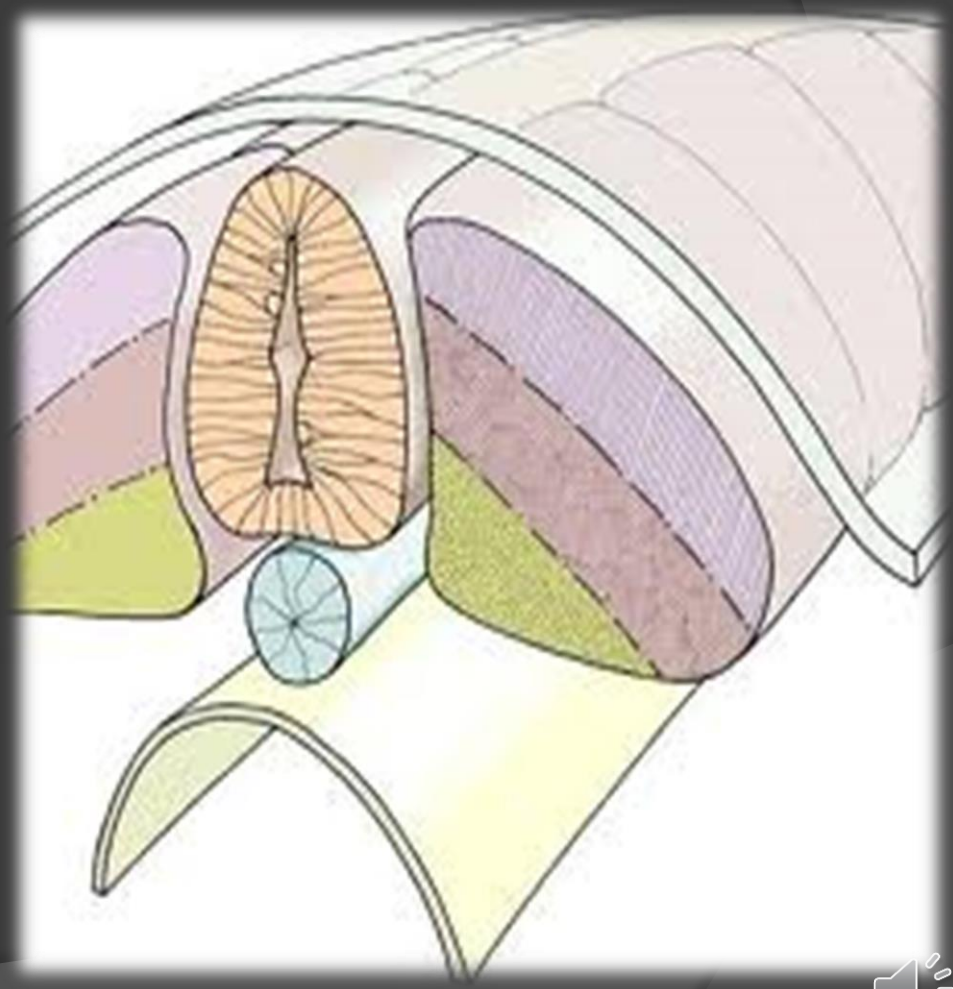
DEVELOPMENT OF MESODERM

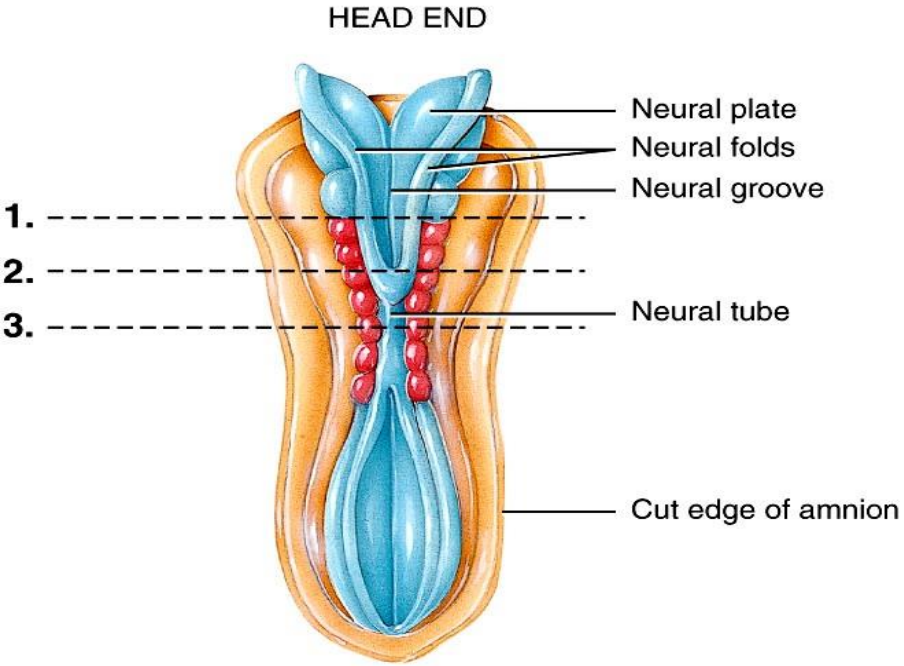
- Meanwhile (Simultaneously) - Ectodermal Cells proliferate and push downward and fill the middle layer of the trilaminar disc. Cells proliferate quickly and pile up on both sides of the neural tube. This becomes the mesoderm.
- Mesoderm separates out into 3 distinct areas:
  - Paraxial Mesoderm (Future somites)
  - Intermediate Mesoderm (Future kidneys)
  - Lateral Plate Mesoderm (Parietal and visceral layers of mesoderm). This forms the body wall lining and the viscera and heart respectively.

DERMATOMES AND MYOTOMES

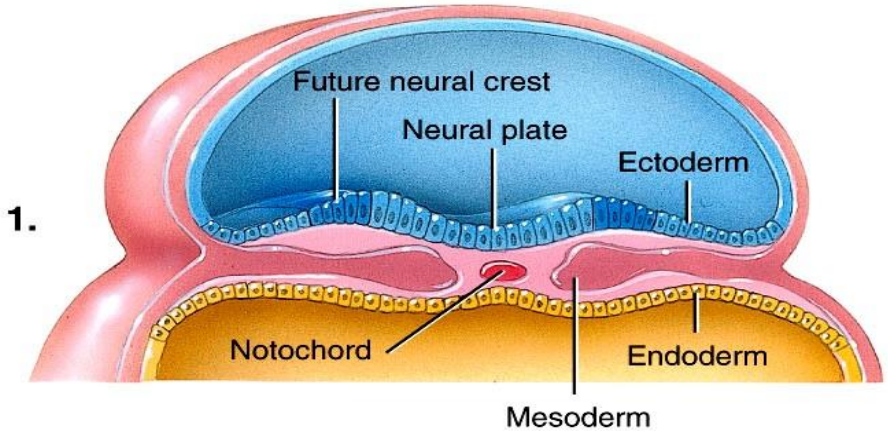
Embryonic Somites - Development of dermatomes and myotomes

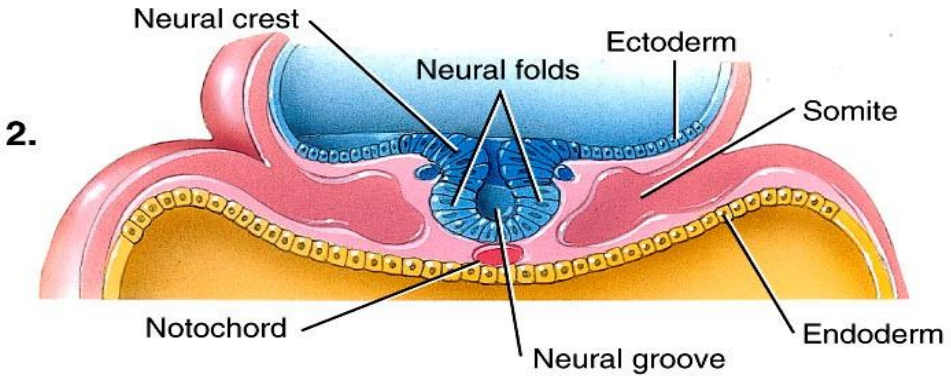
- Paraxial Mesoderm gives us the Somites:
- A Somite is a mass of mesoderm distributed along the two sides of the neural tube that will eventually differentiate and divide into the dermis (giving us the dermatomes), the skeletal muscle (giving us the myotomes), and the sclerotome (which becomes the vertebrae of the spine and bones of axial and appendicular skeleton)

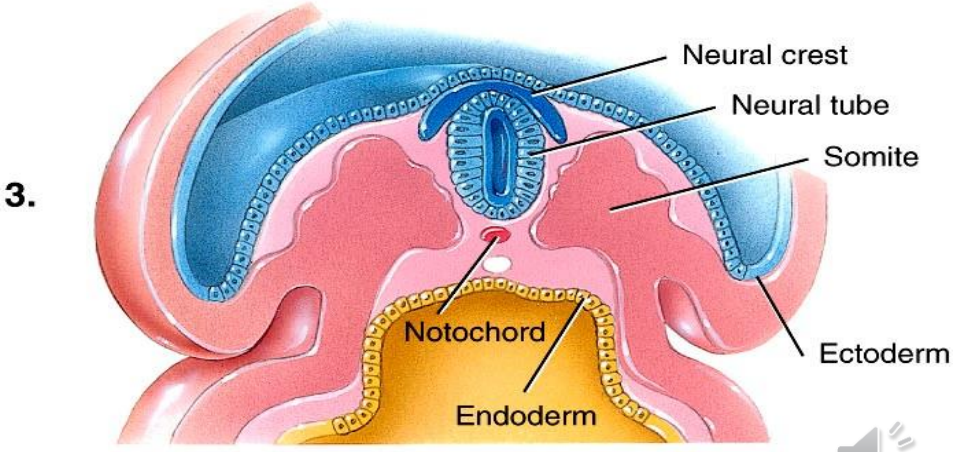




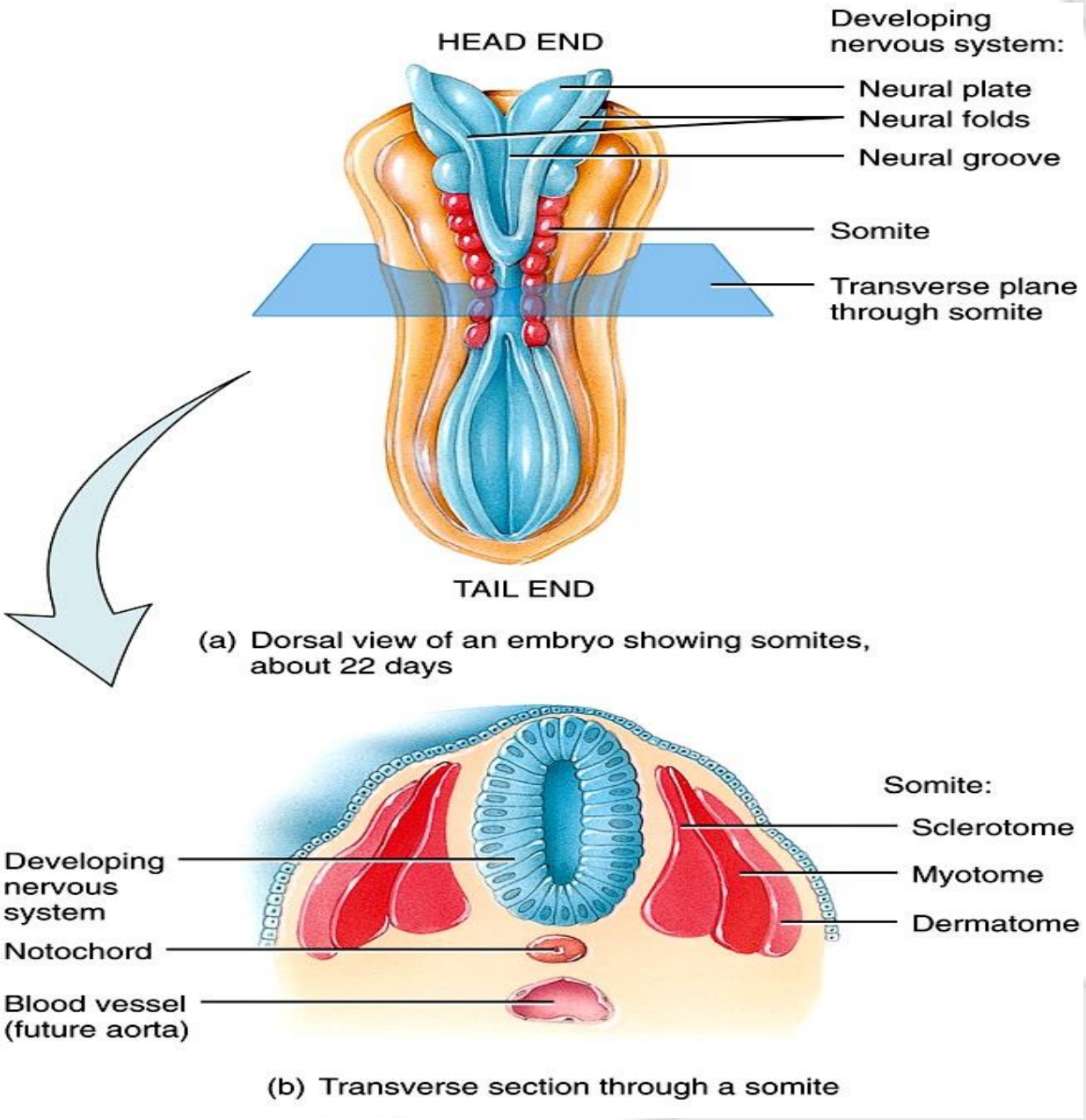
(a) Dorsal view







(b) Transverse sections


HEAD END
Developing nervous system:
Neural plate
Neural folds
Neural groove
Somite
Transverse plane through somite
TAIL END
(a) Dorsal view of an embryo showing somites, about 22 days
Somite:
Sclerotome
Myotome
Dermatome
Developing nervous system
Notochord
Blood vessel (future aorta)
(b) Transverse section through a somite

ECTODERMAL CELLS

- Central nervous system
- Peripheral nervous system
- Sensory epithelium of ear, nose and eye (Special Senses of hearing/balance, smell, and sight)
- Epidermis (including hair and nails)
- Subcutaneous glands (including breast)
- Pituitary gland
- Enamel of teeth

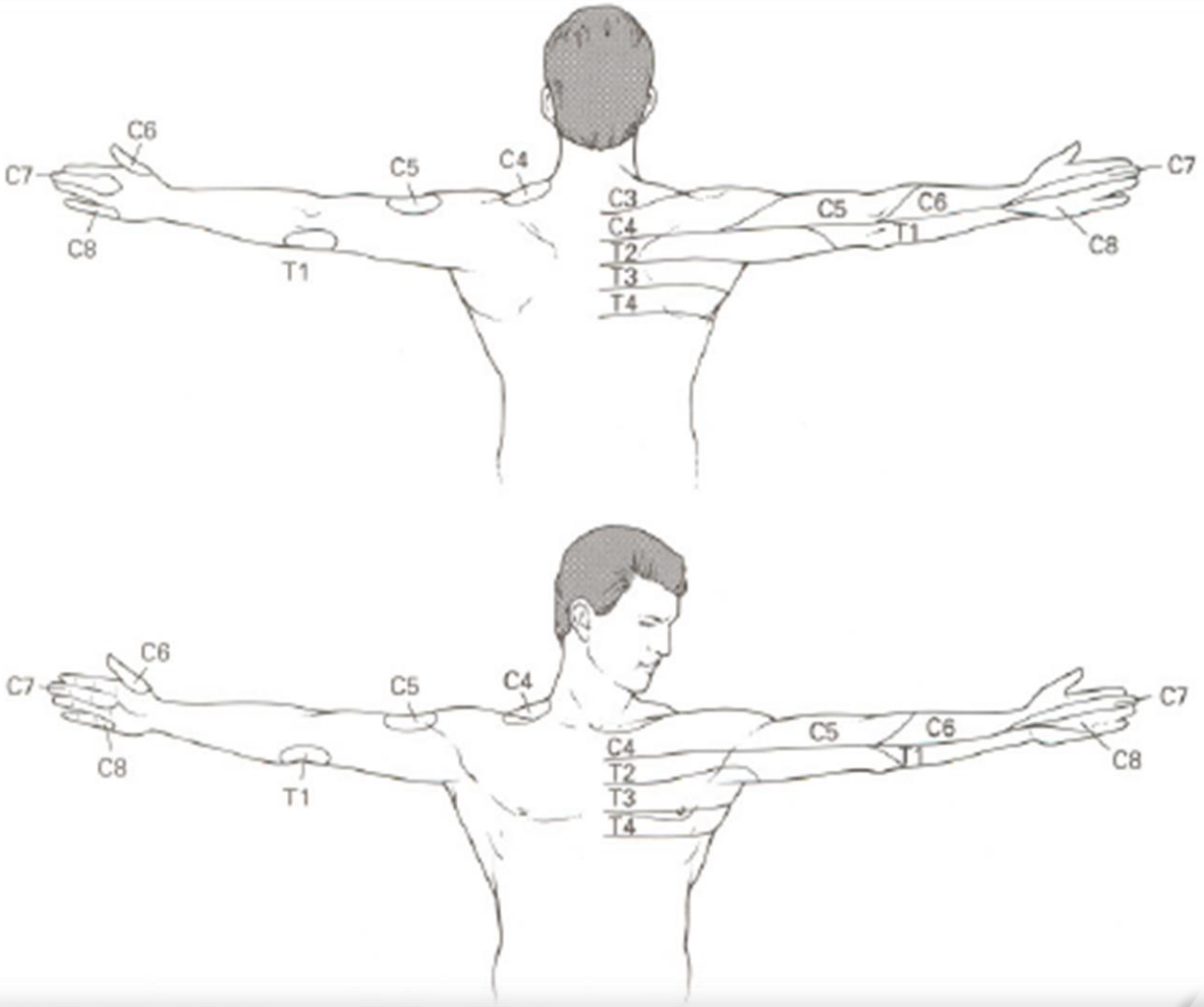
NEURAL CREST CELLS

- Dorsal Root Ganglia (sensory) – all spinal nerves and CN 5, 7, 9, 10 (not special sensory neurons CN 1, 2, 8)
- Sympathetic chain, peripheral ganglia, adrenal medulla
- Schwann cells and glial cells (astrocytes/microglial cells/ependymal cells/oligodendrocytes – CNS)
- Melanocytes (pigment) and C cells of the thyroid gland
- Meninges – dura, arachnoid, and pia mater
- Odontoblasts (teeth)
- Cartilages of pharyngeal arches
- Septum of truncus arteriosus
- Dermis of face and neck
- Connective tissue and bones of face and skull

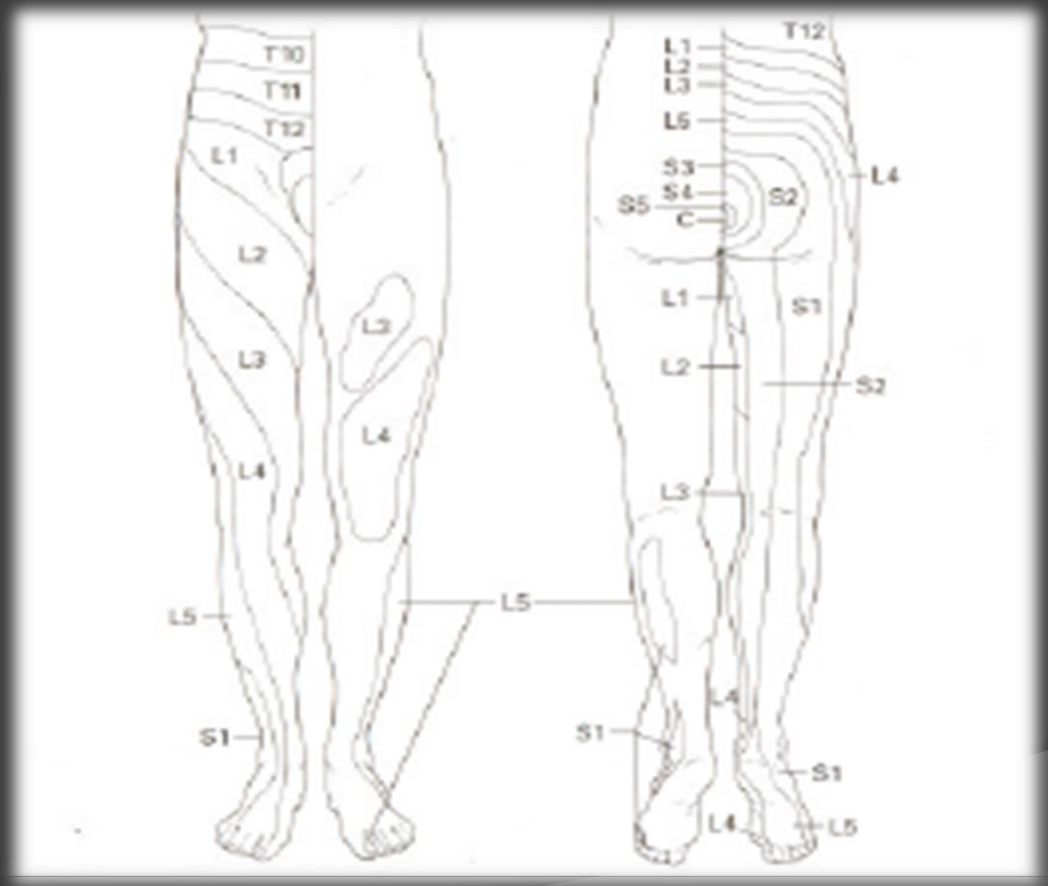
DERMATOMES

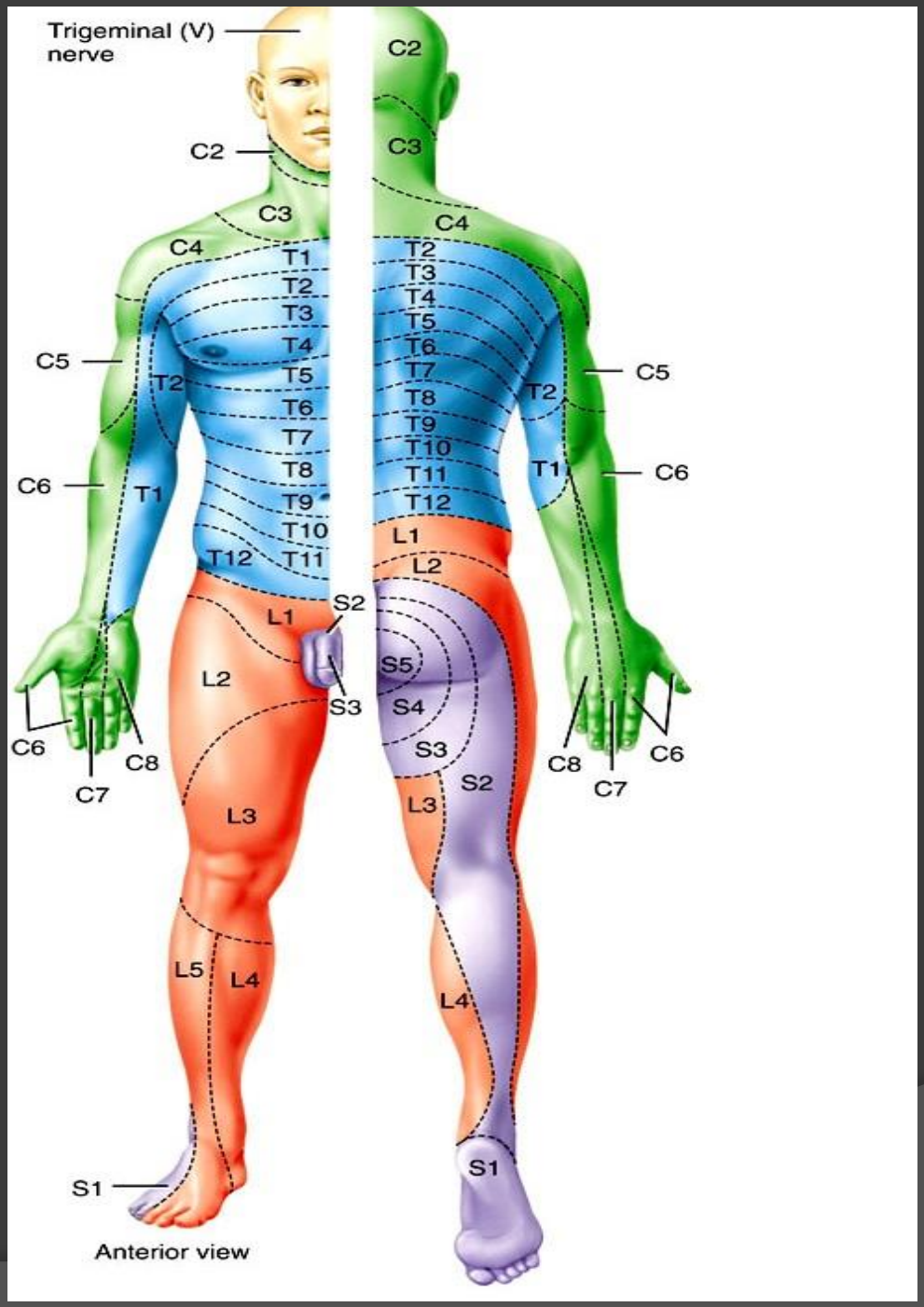
- A “**dermatome”** is an area of skin that is supplied by a single spinal nerve. There are eight cervical nerves, twelve thoracic nerves, five lumbar nerves and five sacral nerves. Each of these nerves relay sensations (including pain) from a particular region of skin to the brain.

UPPER EXTREMITY DERMATOMES (P. 377)

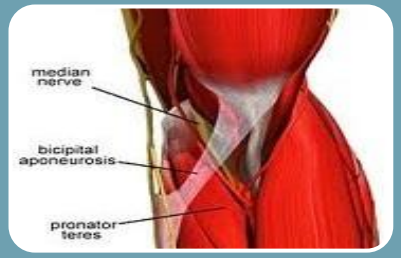


LOWER EXTREMITY DERMATOMES (P. 377)

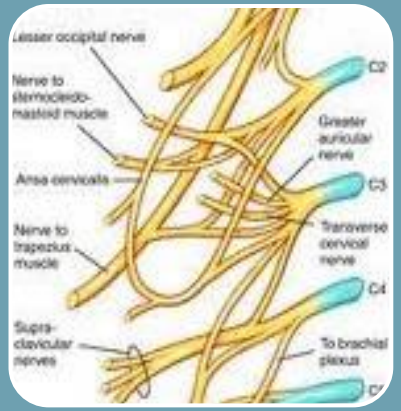



Trigeminal (V) nerve
C2
C3
C4
C5
C6
C7
C8
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
L1
L2
L3
L4
L5
S1
S2
S3
S4
S5
Anterior view

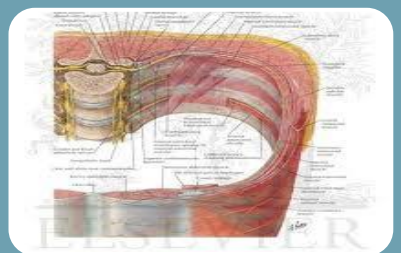
MYOTOMES



M**yotome -** In embryonic, a **myotome** is a group of tissues formed from SOMITES that develop into the body wall muscle. We use the term "myotome" to describe all the muscles served by a single spinal nerve root. It is the motor equivalent of a dermatome.



Law of Original Innervation: Wherever a somite derivative (dermatome/myotome/sclerotome) migrates it retains its original somite nerve (For example, the myotomes of cervical somites 3, 4, and 5 migrate and combine to form the *diaphragm – they migrate to the level of T12 and drag their somite nerves, united as the phrenic nerves along with them)* Even when a muscle or bone receives contributions from several somites, each spinal nerve continues to innervate only the tissue that derived directly from its original somite.



Because of a lack of limbs, the thoracoabdominal wall retains all the nerves, muscles, ribs, and intercostal vessels in their primordial somite sequences without migrating.

SPINAL NERVE ROOTS

Dermatomes transmit impulses to the spinal cord via the sensory neurons. Myotomes receive impulses from the spinal cord via motor neurons. Sensory and motor neurons travel in the same spinal nerve root.

Dermatomes – we test with the “sensory examination”

Myotomes – we test with our “motor examination”

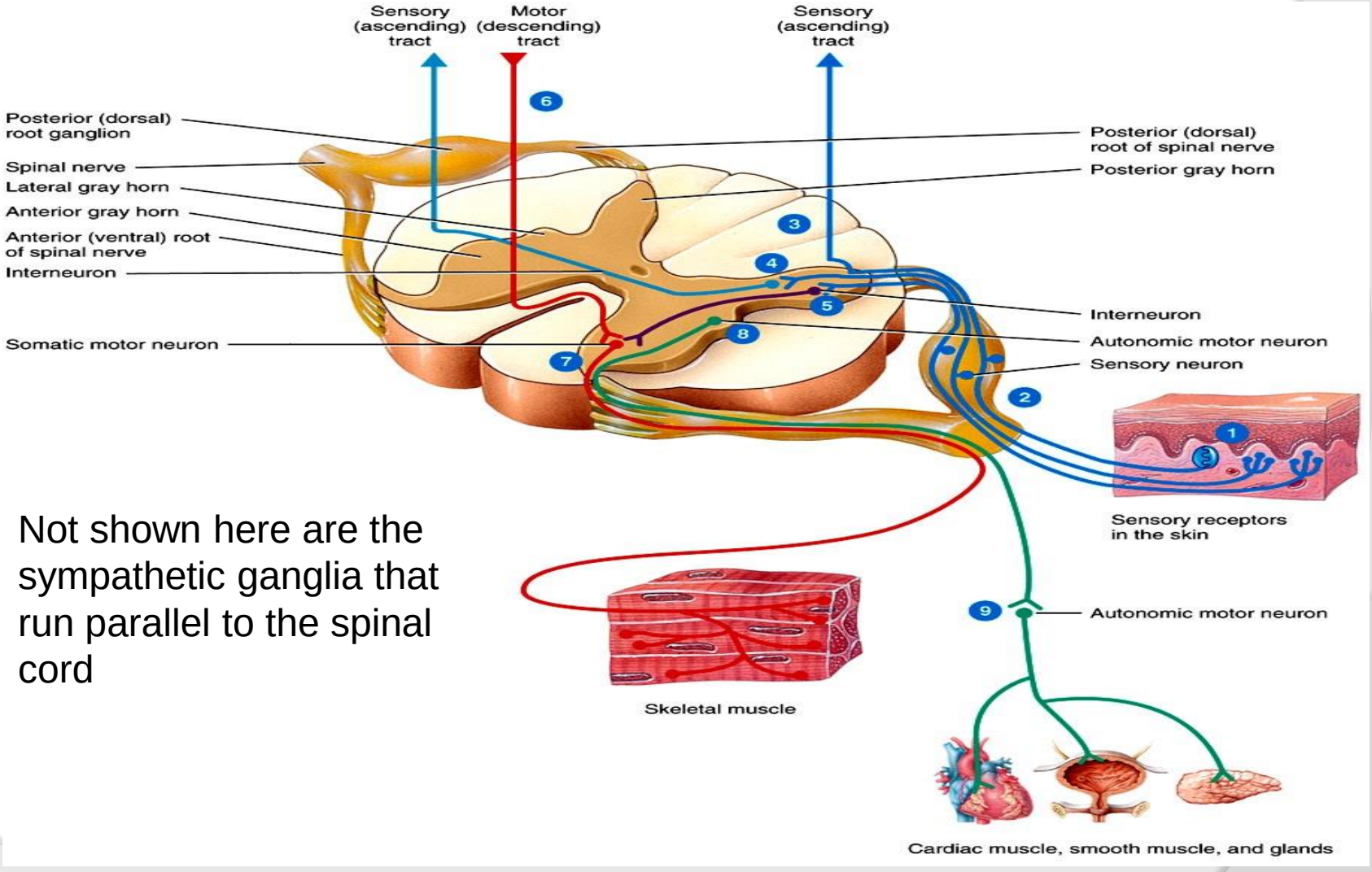
SPINAL NERVE ROOTS

- The spinal nerves (31 pairs) contain 3 main groups of fibers:
  - Sensory (afferent) fibers that carry to the CNS impulses arising from various receptors in the skin, muscles, tendons, ligaments, bones (periosteum/mineralized bone/bone marrow), and joints (mechanoreceptors). (These are "Afferent" fibers from the dermatome, myotome, and sclerotome - all cell bodies are located in the dorsal root ganglion). GSA = general somatic afferent.

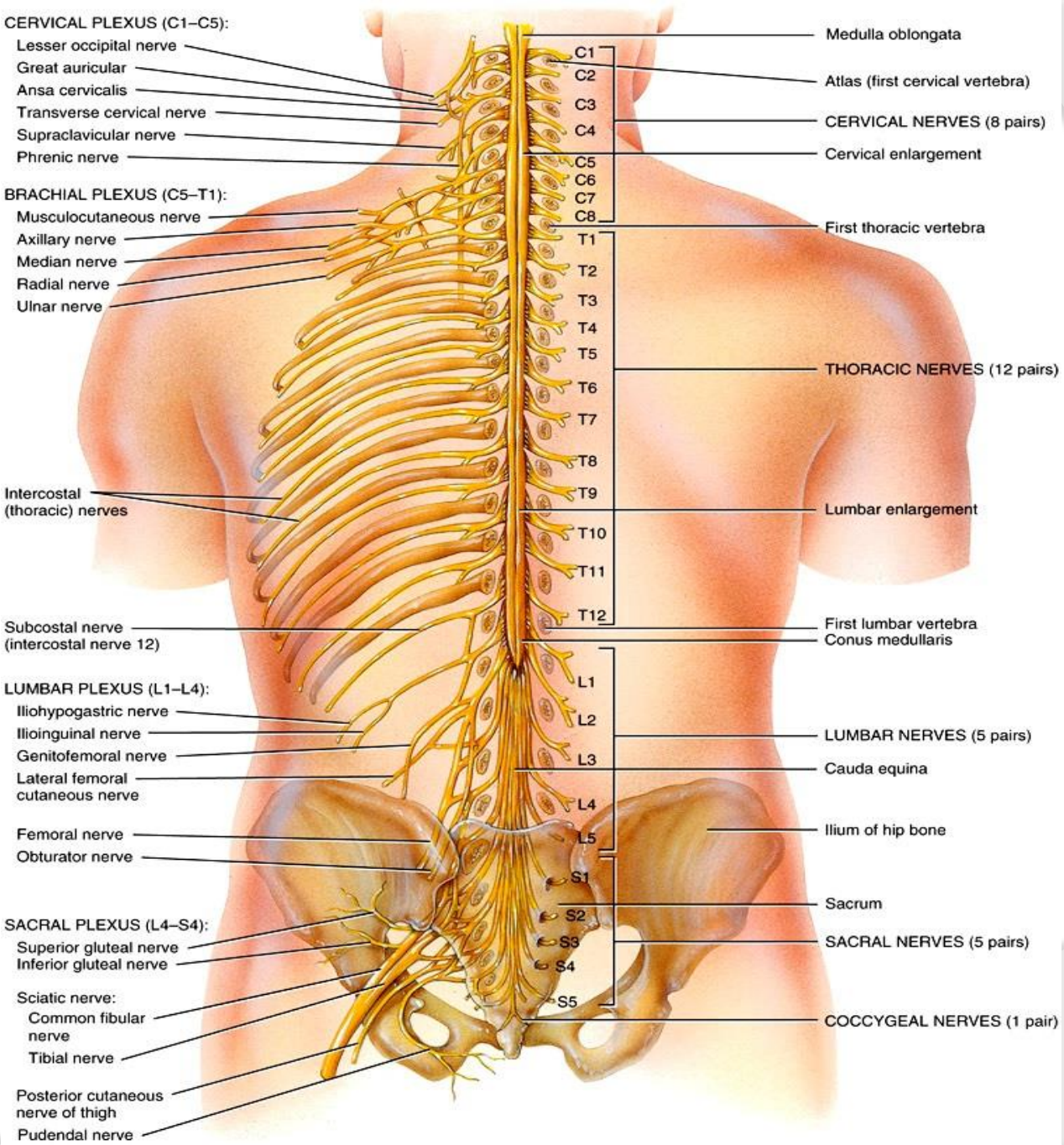
SPINAL NERVE ROOTS

- The spinal nerves (31 pairs) contain 3 main groups of fibers:
  - Motor (efferent) fibers, which include large *alpha* motor neuron fibers conducting impulses from the spinal cord to skeletal muscles fibers, and smaller *gamma* motor neuron fibers carrying impulses to muscle spindles for feedback control and,
  - Autonomic system fibers, which are efferent and are concerned with the control of smooth muscles and glands. (Not mentioned are that there are autonomic sensory fibers (GVA) from the viscera – GVE = general visceral efferent – either sympathetic or parasympathetic).

Spinal Nerve Root



Not shown here are the sympathetic ganglia that run parallel to the spinal cord

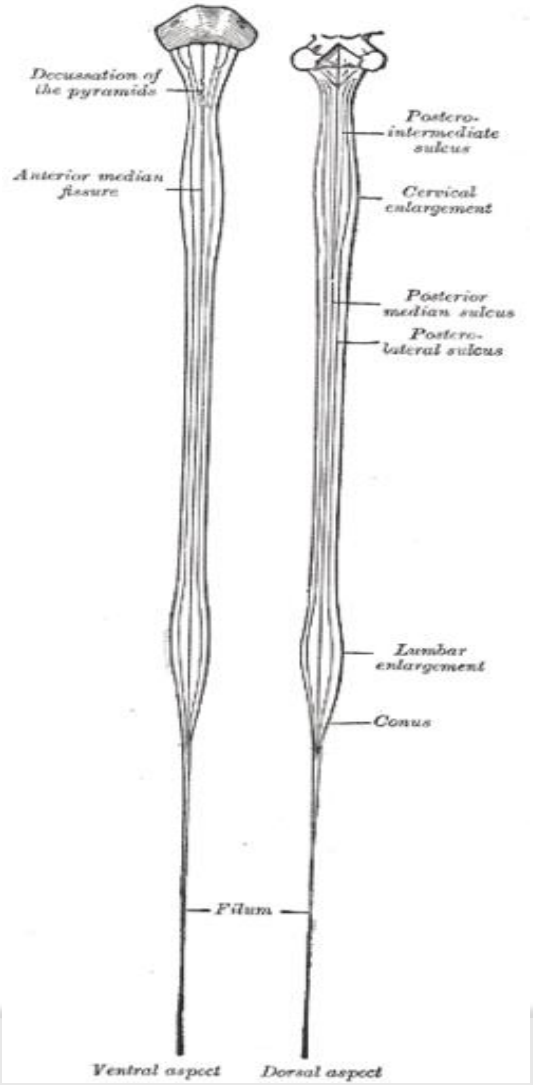


Posterior view of entire spinal cord and portions of spinal nerves

SPINAL NERVE ROOTS

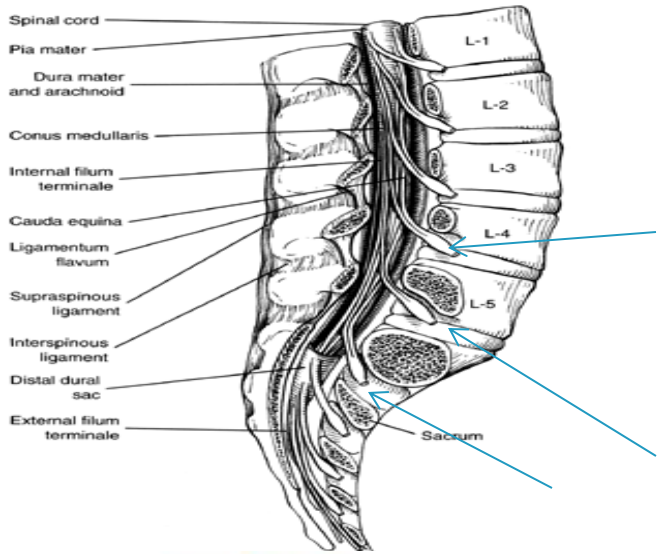
- Spinal Nerve Roots coalesce into the named Peripheral nerves of the Lower Extremities through either 1) the lumbar plexus (L1, L2, L3, L4), or 2) the sacral plexus (L4, L5, S1, and S2). All of these nerve roots are mixed in that they carry all 3 (or even 4) types of fibers (Somatic – sensory/motor, Autonomic – sensory/motor). Autonomic fibers carry impulses to 1) smooth muscle in arterial walls, 2) sweat glands, and 3) arrector pili muscles.

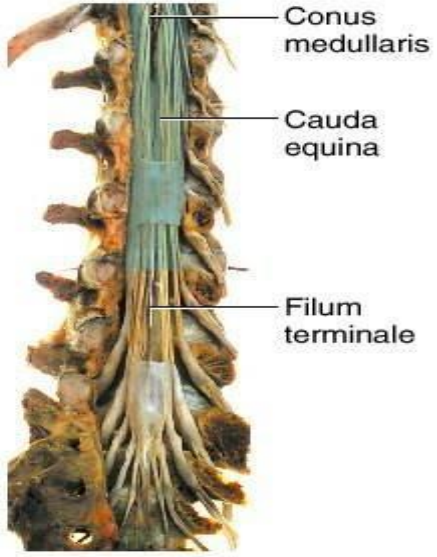
CONUS MEDULLARIS



- In the lumbar spine - the spinal cord ends at about the level of L1-L2 because the growth of the spinal column exceeds the growth of the spinal cord
- Lumbar enlargement: Commences about the level of T11, and reaches its maximum circumference, of about 33 mm., at L1, below which it tapers rapidly into the conus medullaris. Contains spinal nerve segments L1-S3.

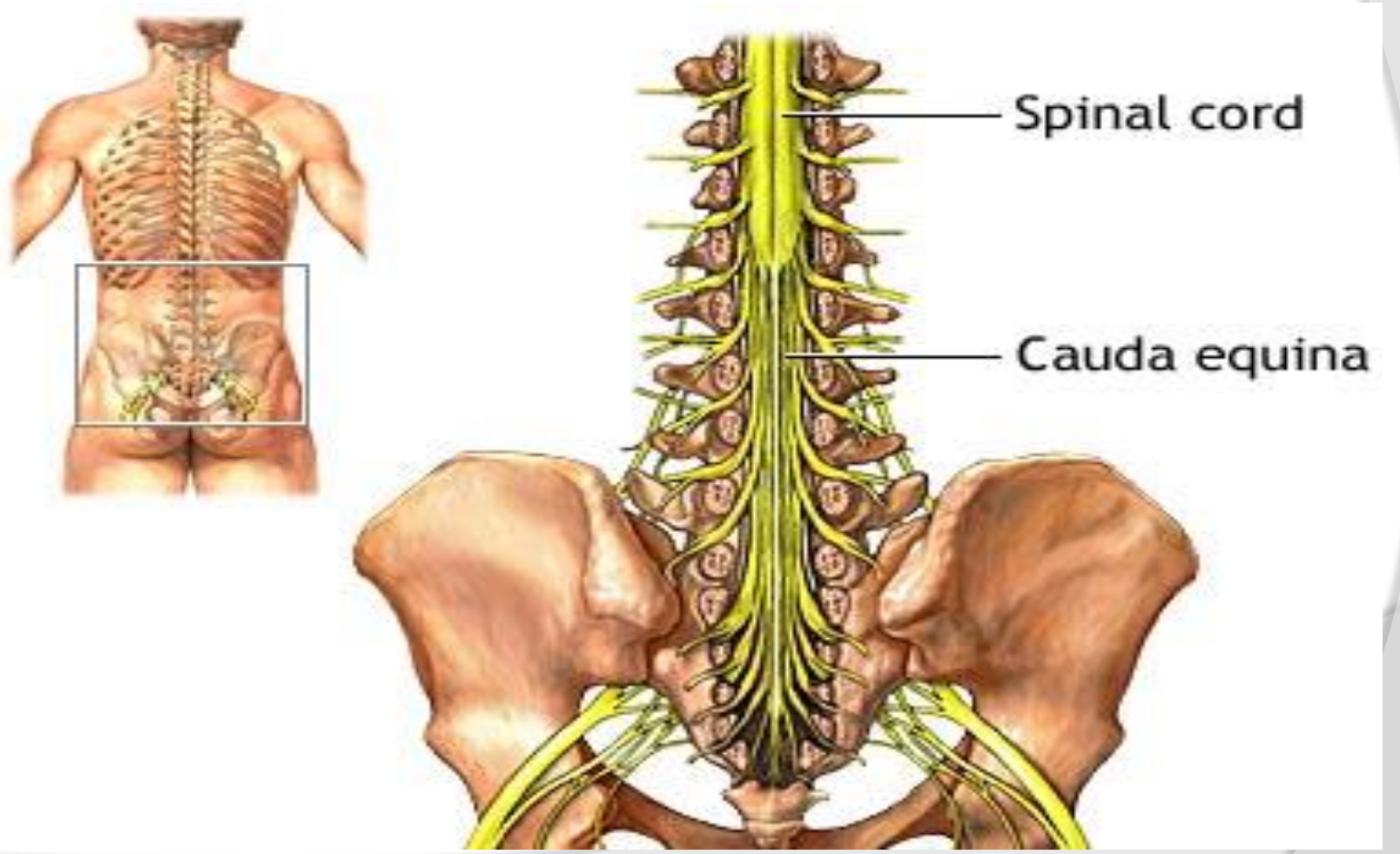
CONUS MEDULLARIS



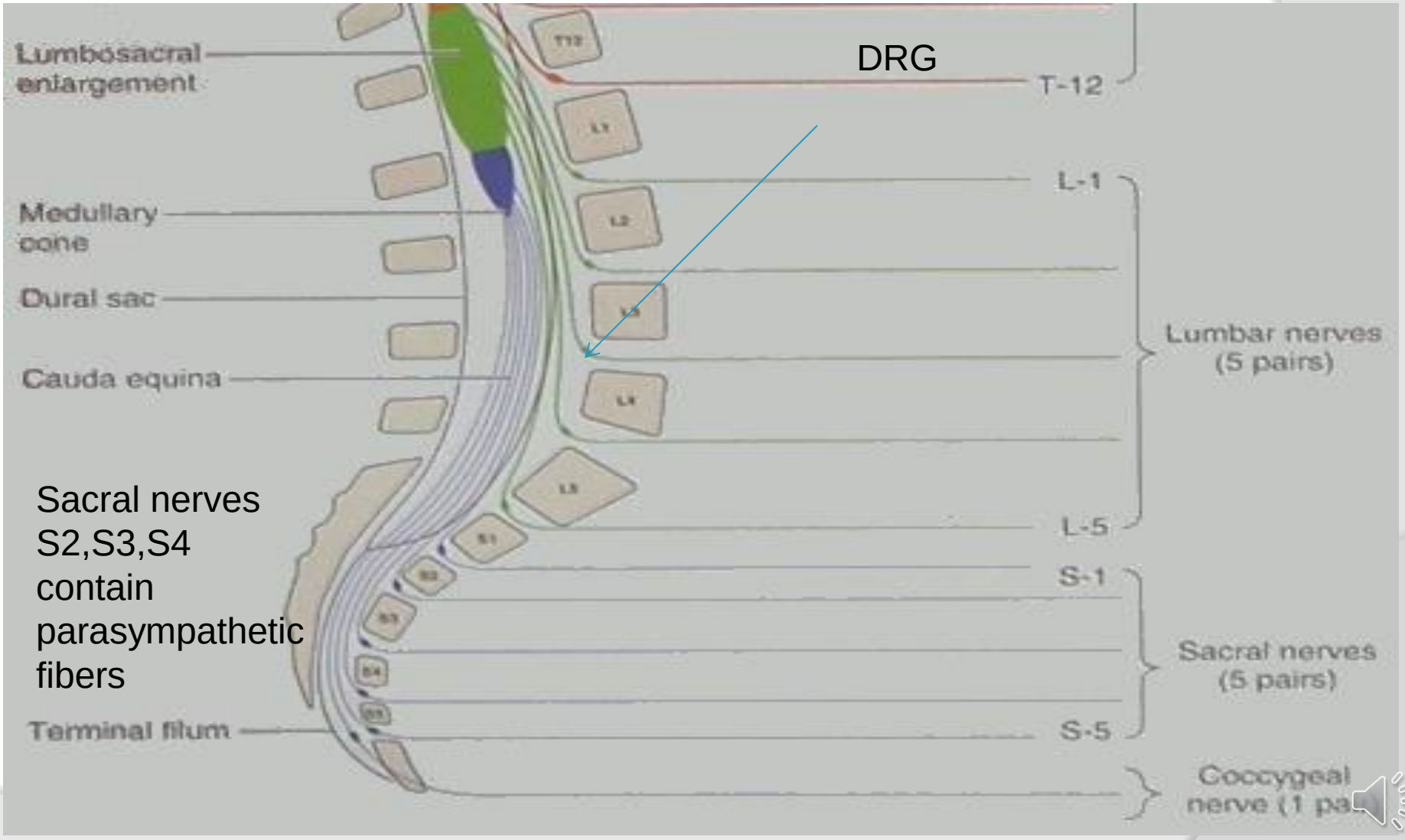


- The conus medullaris is the terminal end of the spinal cord. It occurs near L1 and L2. After the spinal cord terminates, the spinal nerves continue as dangling nerves called the “cauda equina.” Each root has to traverse several inches in the spinal canal before reaching its exit foramen. The root can be damaged anywhere along its intradural course. Most commonly it is damaged at its exit foramen by a disc lesion.

CONUS MEDULLARIS

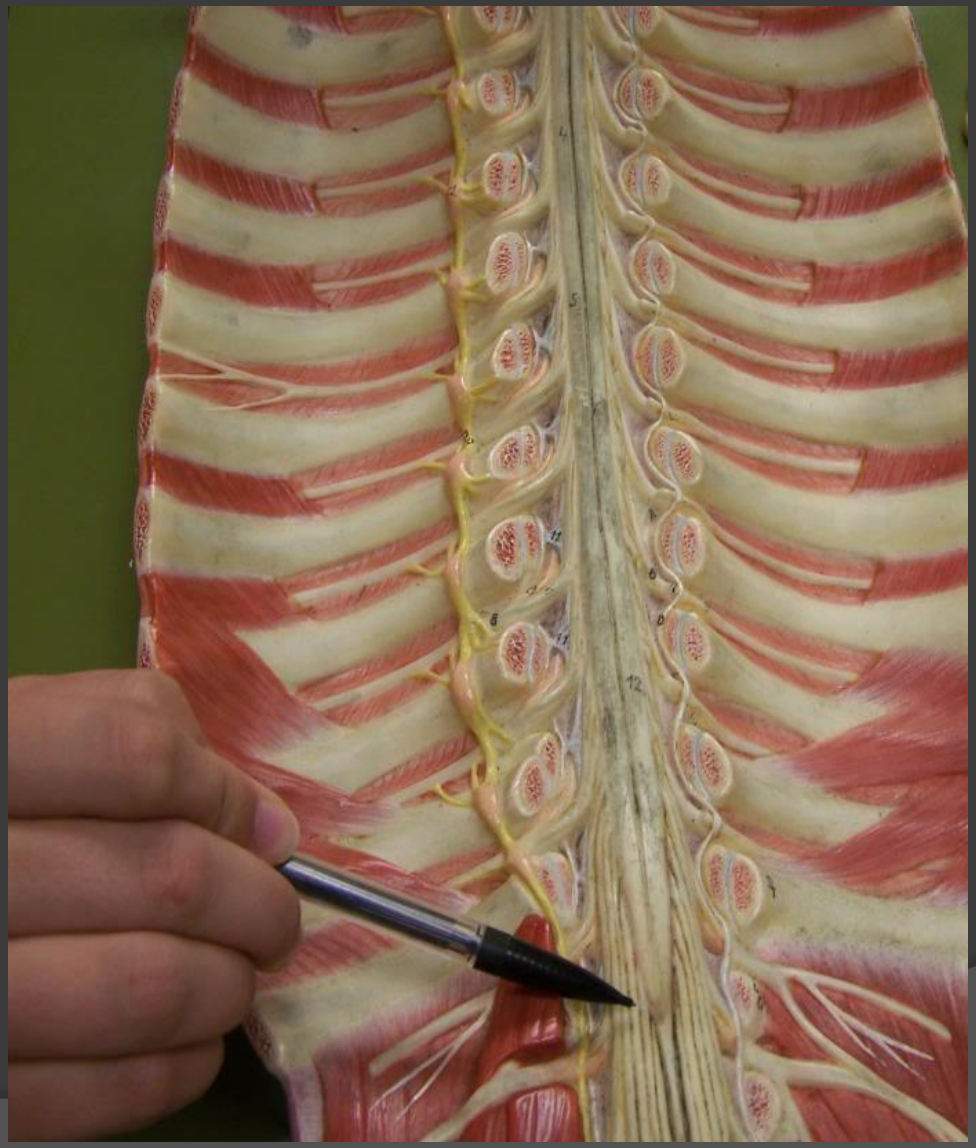


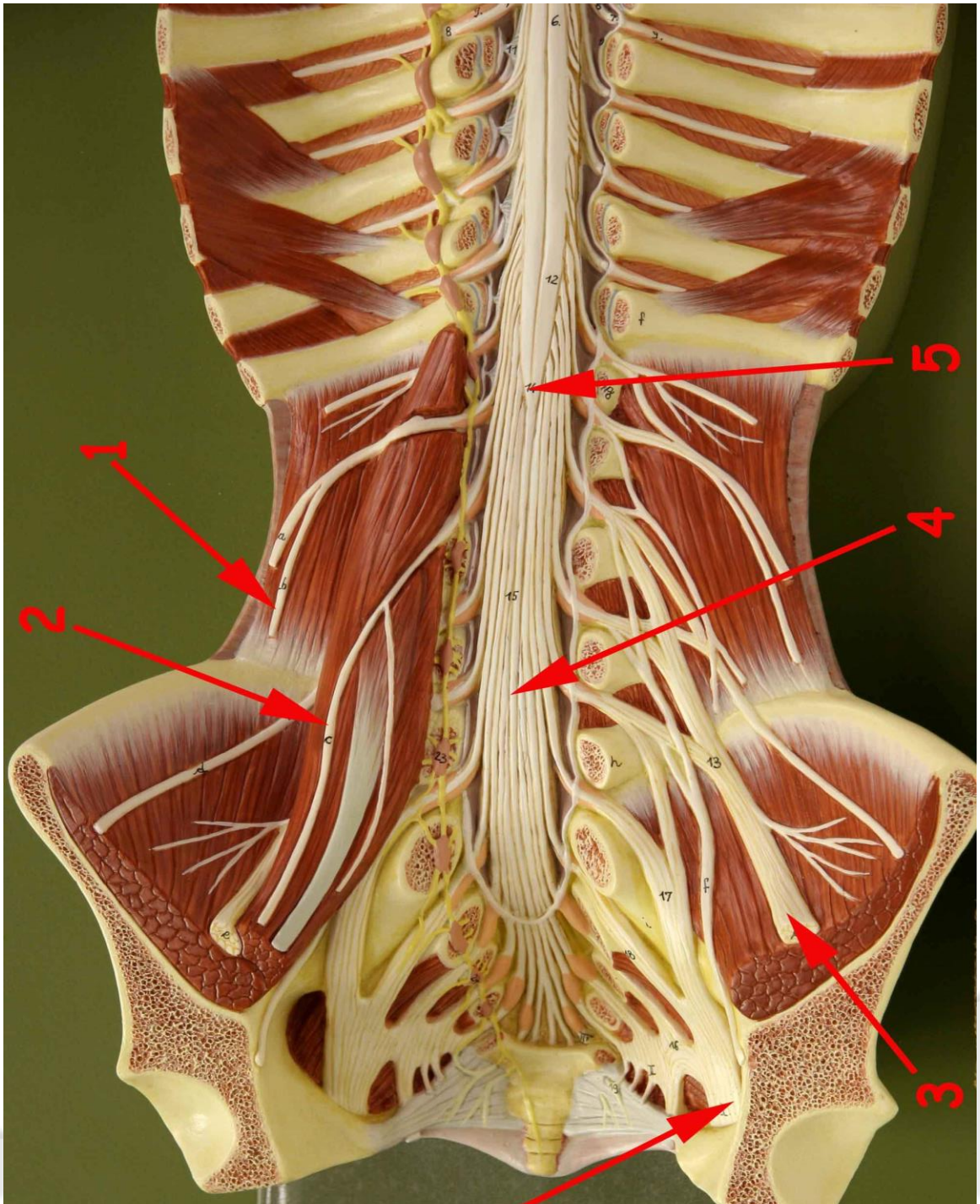
CONUS MEDULLARIS



Sacral nerves S2,S3,S4 contain parasympathetic fibers

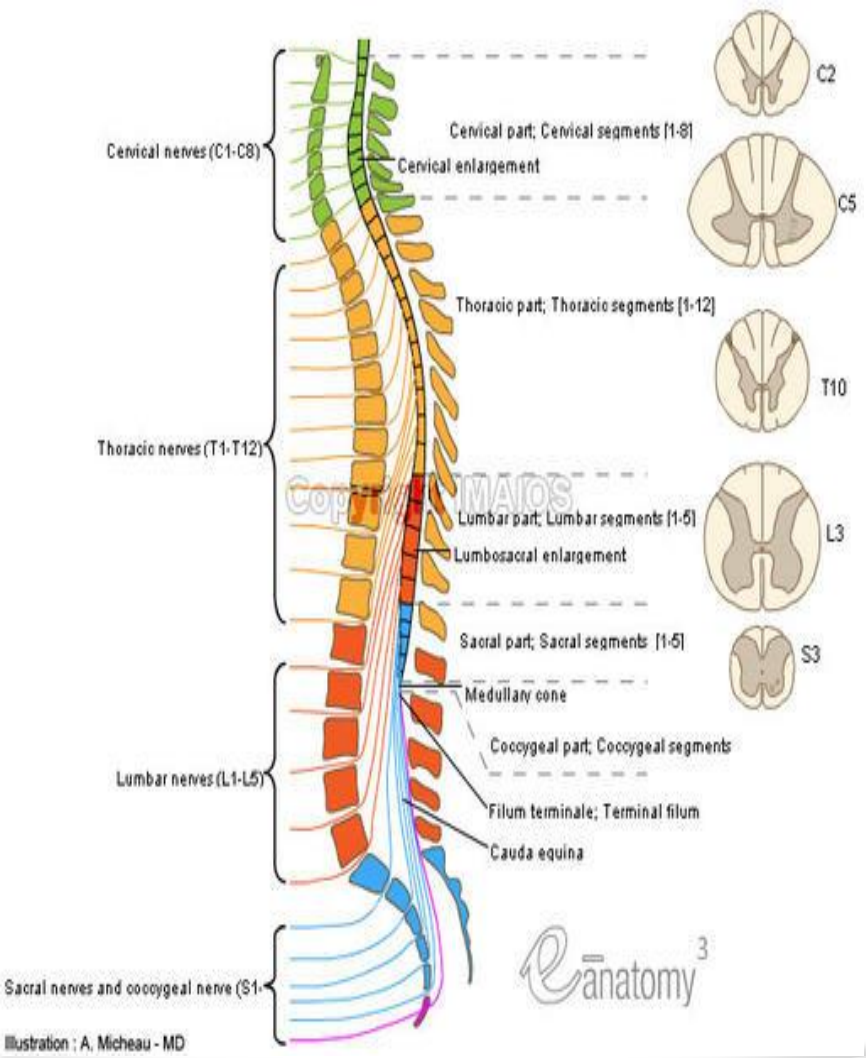
CONUS MEDULLARIS





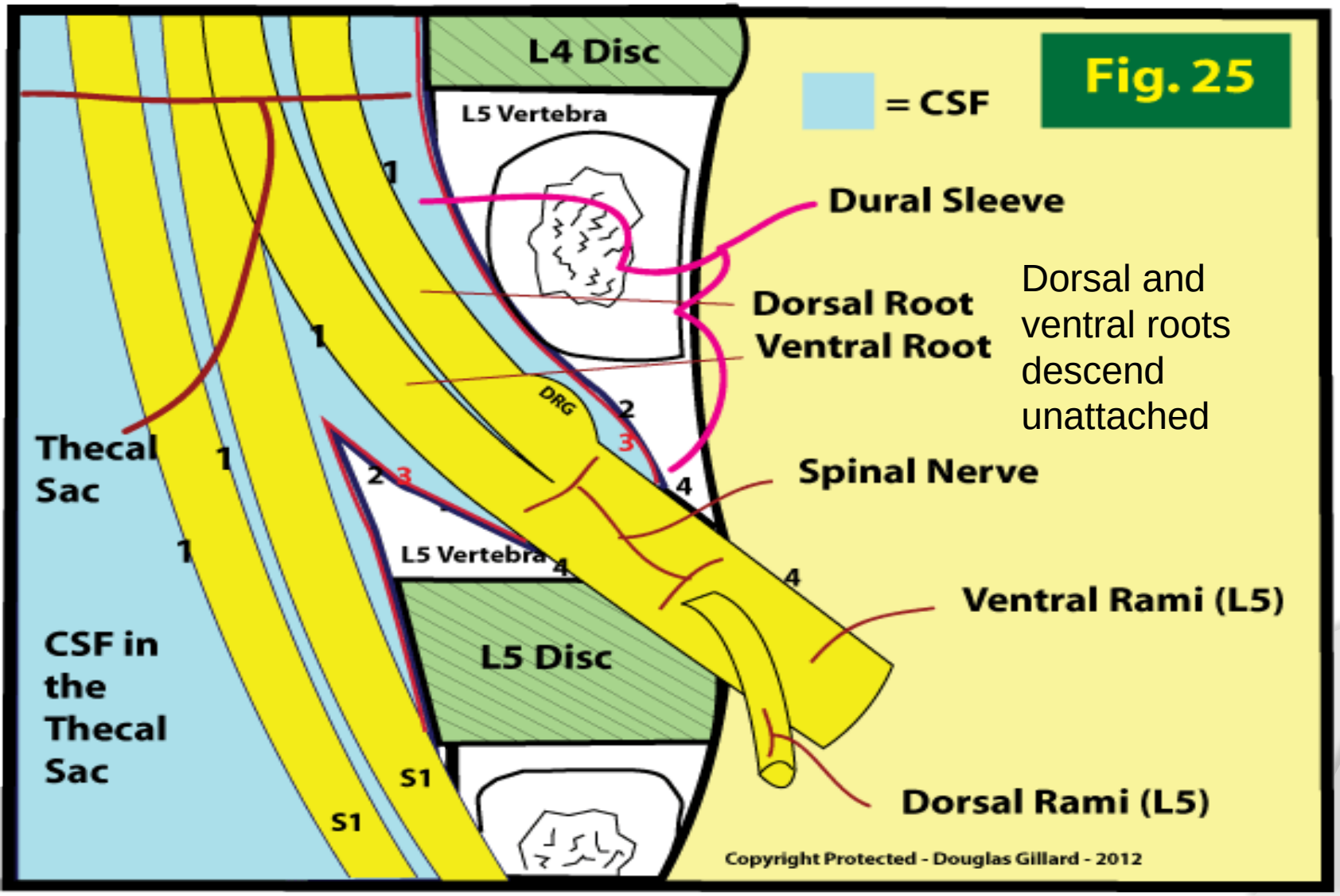
Note location of all of the dorsal root ganglia = extradural

CONUS MEDULLARIS



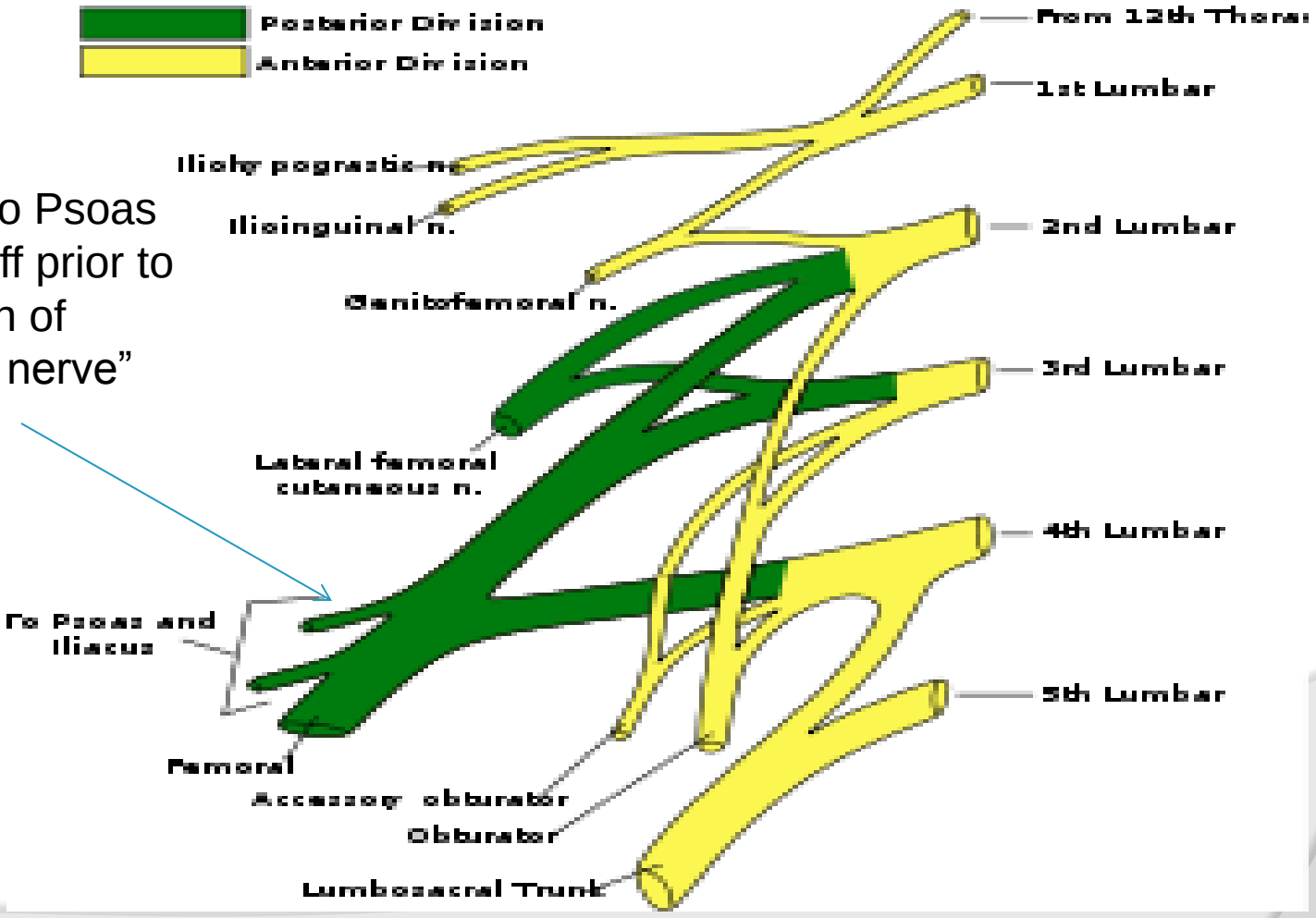
- At Lumbosacral enlargement:
  - Gray matter increases
  - Least amount of white matter
  - Intermediolateral cell column is present only from T1-L2 (or L3)

CONUS MEDULLARIS



LUMBAR PLEXUS

Branch to Psoas comes off prior to formation of "femoral nerve"



BRANCHES OF LUMBAR PLEXUS

- L1 ROOT has 2 named branches:
  - Iliohypogastric: Sensory to pubis and medial inguinal ligament
  - Ilioinguinal: Sensory to penis and scrotum – or labia
- L1 & L2 roots combine to form the genitofemoral nerve:
  - Sensory to skin over femoral triangle
  - Motor to cremaster muscle in spermatic cord

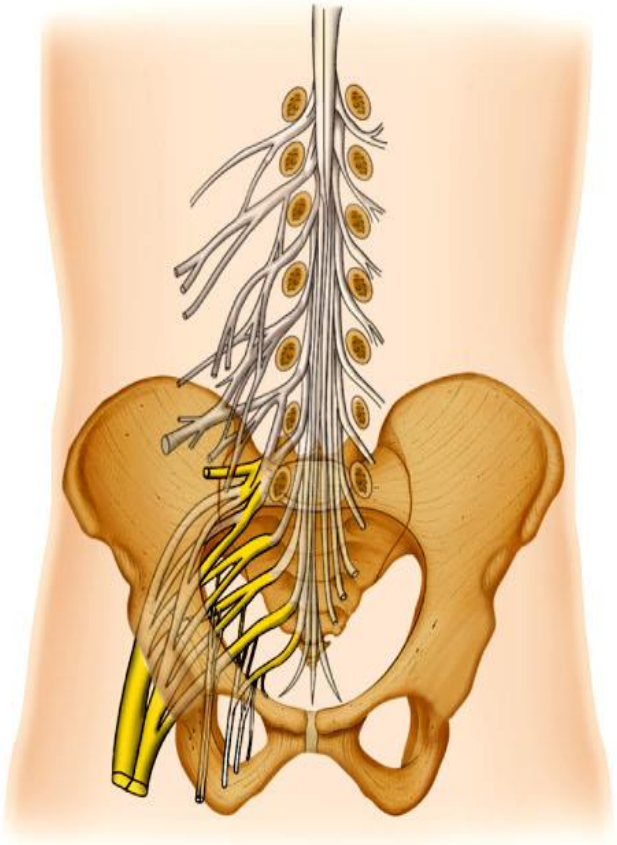
BRANCHES OF LUMBAR PLEXUS

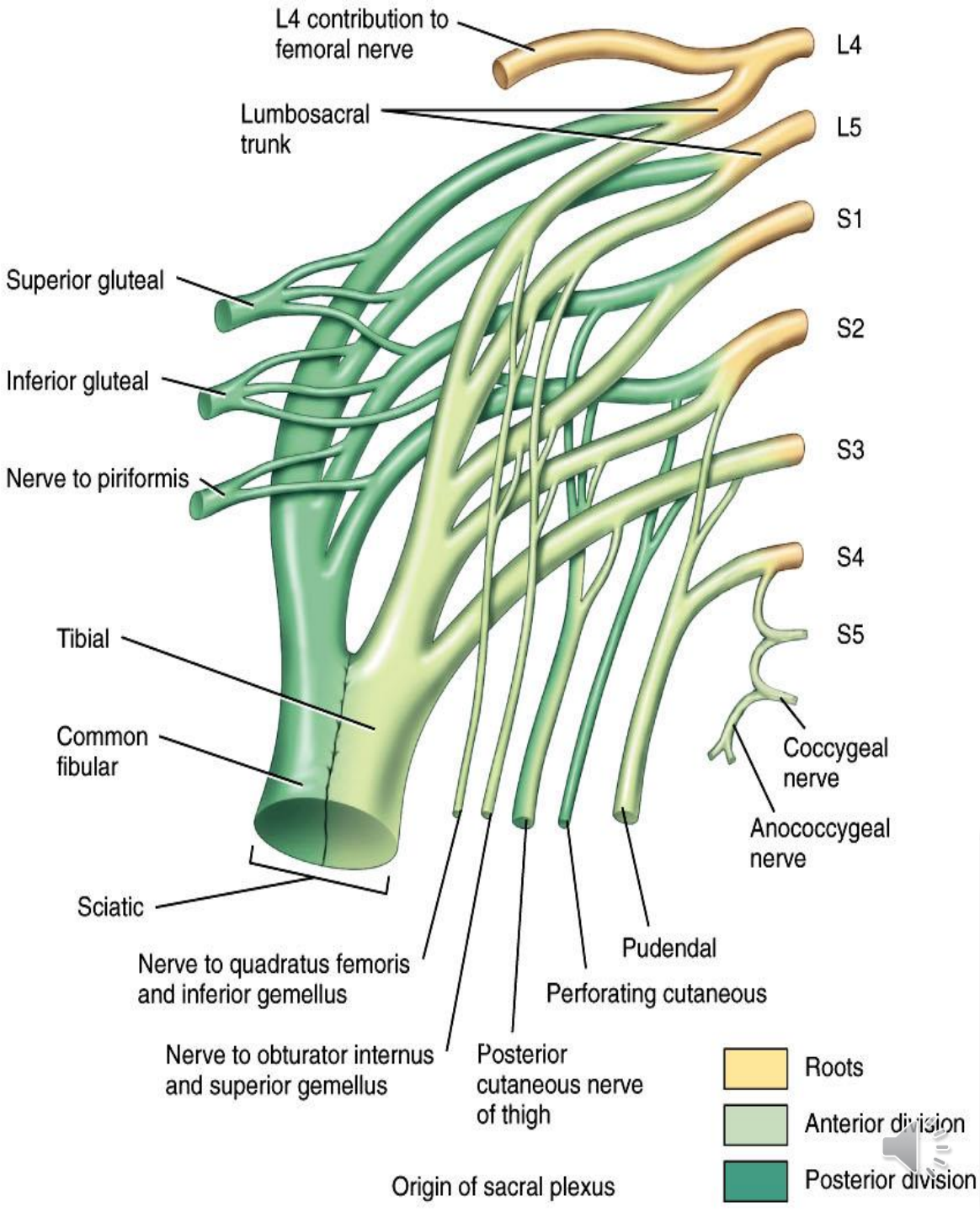
- L2 & L3 (Posterior Divisions) – Lateral femoral cutaneous nerve:
  - Enters thigh under lateral part of the inguinal ligament
  - Sensory to lateral thigh down as low as the knee
- L2, L3, and L4 (Posterior Divisions) – Femoral Nerve:
  - Sensory to anteromedial thigh (anterior cutaneous nerve
  - Sensory to medial leg (saphenous nerve) to include the medial malleolus
  - Motor to 1) iliopsoas, 2) rectus femoris, 3) sartorius, 4) vastus lateralis/intermedius

BRANCHES OF LUMBAR PLEXUS

- L2, L3, and L4 (Anterior Divisions) – Obturator Nerve:
  - Sensory to medial aspect of knee
  - Motor to 1) pectineus, 2) adductor brevis, 3) adductor longus, 4) adductor magnus, 5) gracilis (hip adductors)

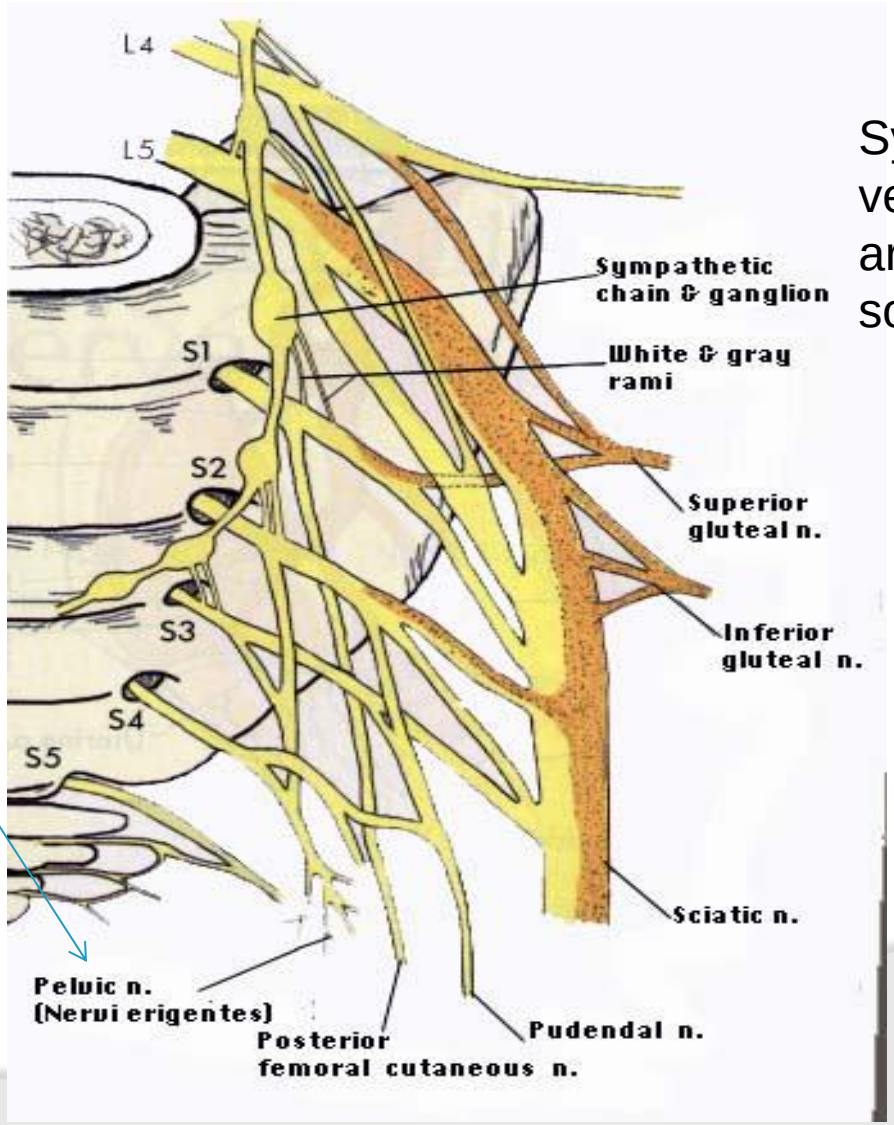
SACRAL PLEXUS



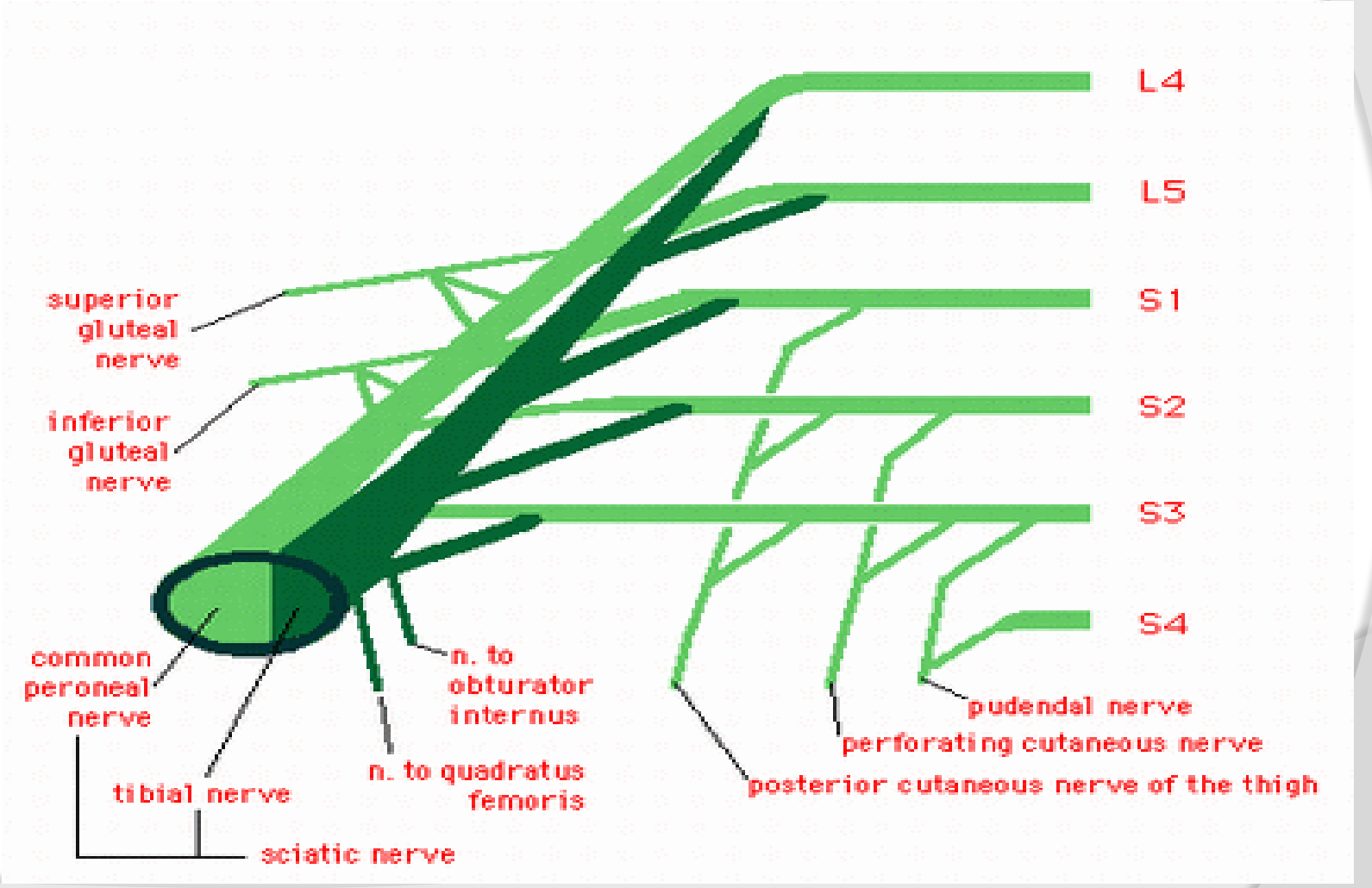

L4 contribution to femoral nerve
L4
Lumbosacral trunk
L5
S1
Superior gluteal
S2
Inferior gluteal
S3
Nerve to piriformis
S4
S5
Tibial
Common fibular
Coccygeal nerve
Anococcygeal nerve
Sciatic
Nerve to quadratus femoris and inferior gemellus
Pudendal
Perforating cutaneous
Nerve to obturator internus and superior gemellus
Posterior cutaneous nerve of thigh
Roots
Anterior division
Posterior division
Origin of sacral plexus

SACRAL PLEXUS

Pelvic Splanchnic Nerves – Parasympathetics



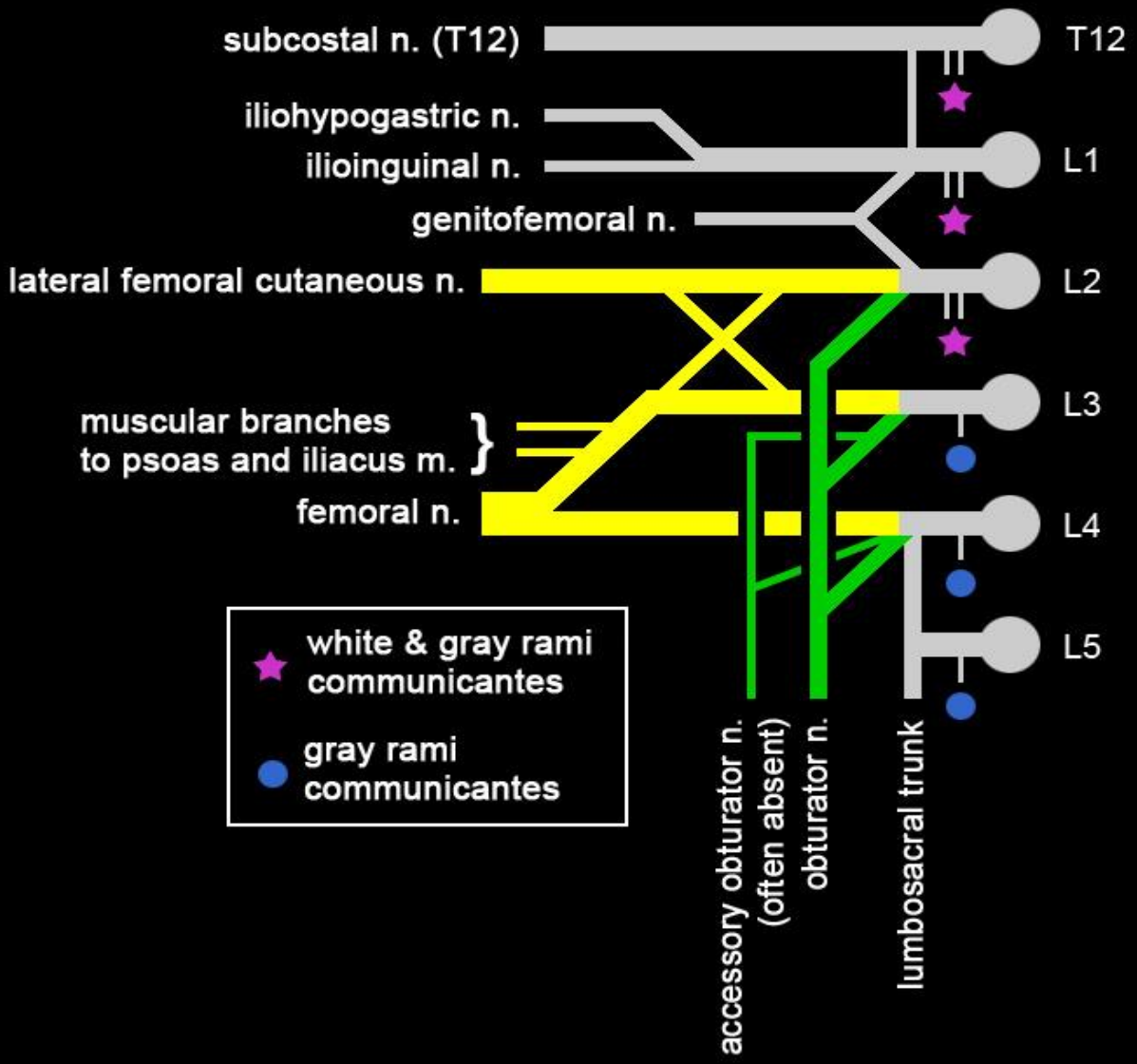
Sympathetics to blood vessels, sweat glands, arrector pili muscles of the somatic structures.


L4
L5
S1
S2
S3
S4
superior gluteal nerve
inferior gluteal nerve
common peroneal nerve
tibial nerve
sciatic nerve
n. to obturator internus
n. to quadratus femoris
pudendal nerve
perforating cutaneous nerve
posterior cutaneous nerve of the thigh

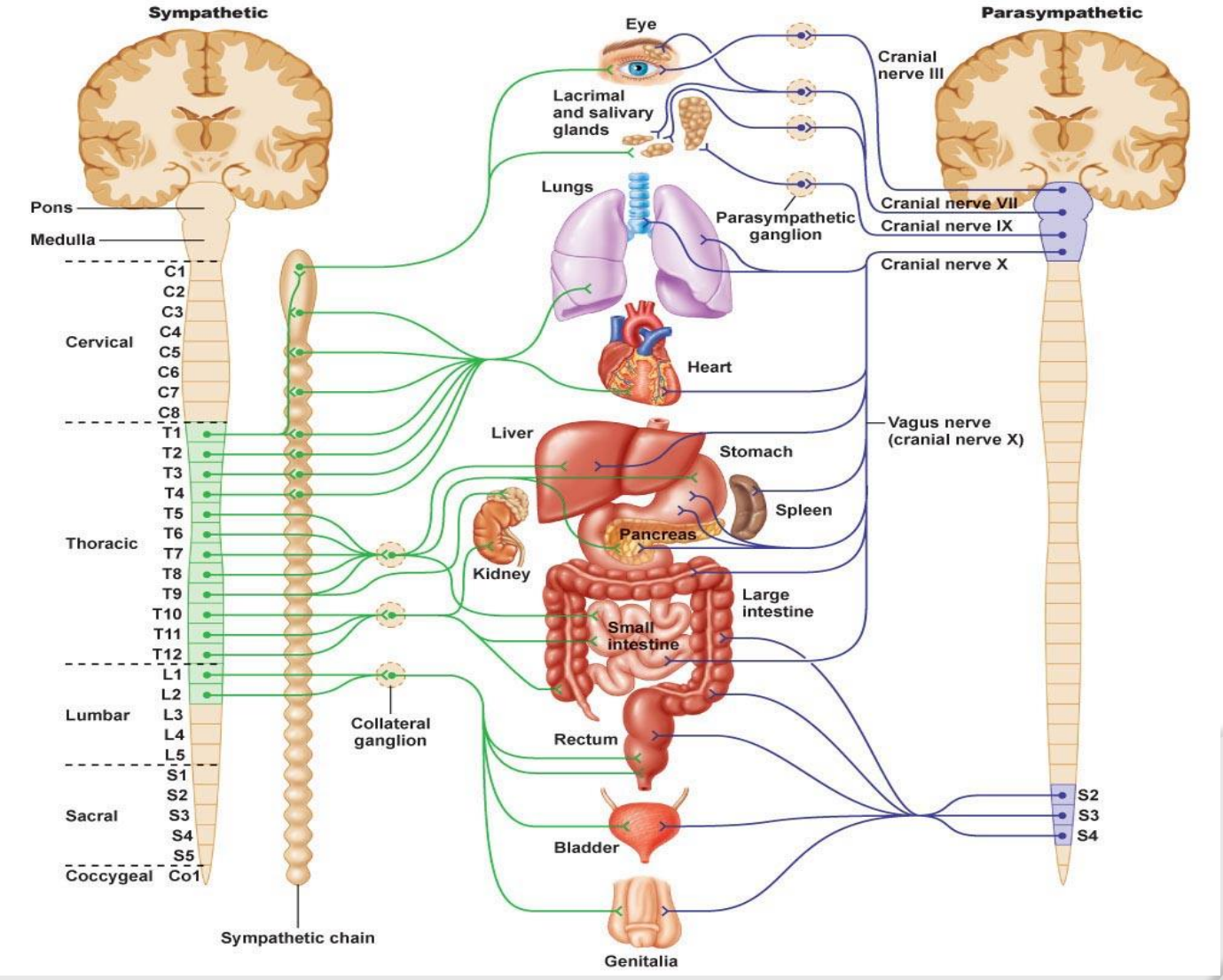
BRANCHES OF SACRAL PLEXUS

- Leaves the pelvis by way of the greater sciatic foramen
- Main Branches:
  - L4, L5, S1, S2 Gluteal Nerves (3)
  - L4, L5, S1, S2 (Posterior Division) Peroneal Nerve (a.k.a. “Common Fibular Nerve” or “Lateral Popliteal Nerve”)
  - L4, L5, S1, S2, (and S3) (Anterior Division) Tibial Nerve
  - Peroneal and Tibial are invested in the same fascia – Peroneal component 6 times more likely to be damaged than the tibial component
  - S1, S2, S3 Posterior Cutaneous Nerve
  - S2, S3, S4 Pudendal Nerve

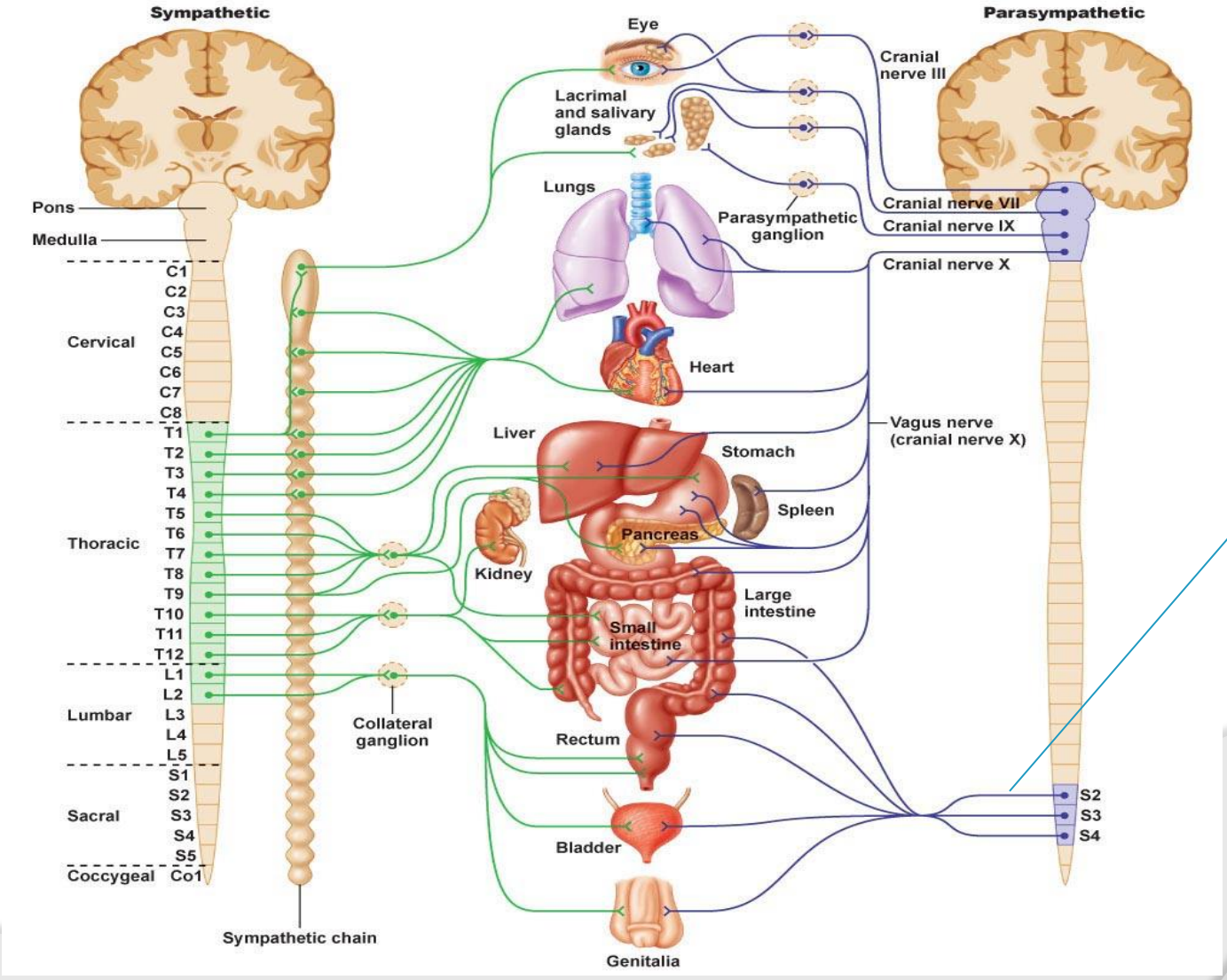
SYMPATHETIC TRUNK



SYMPATHETIC TRUNK



PARASYMPATHETIC TRUNK

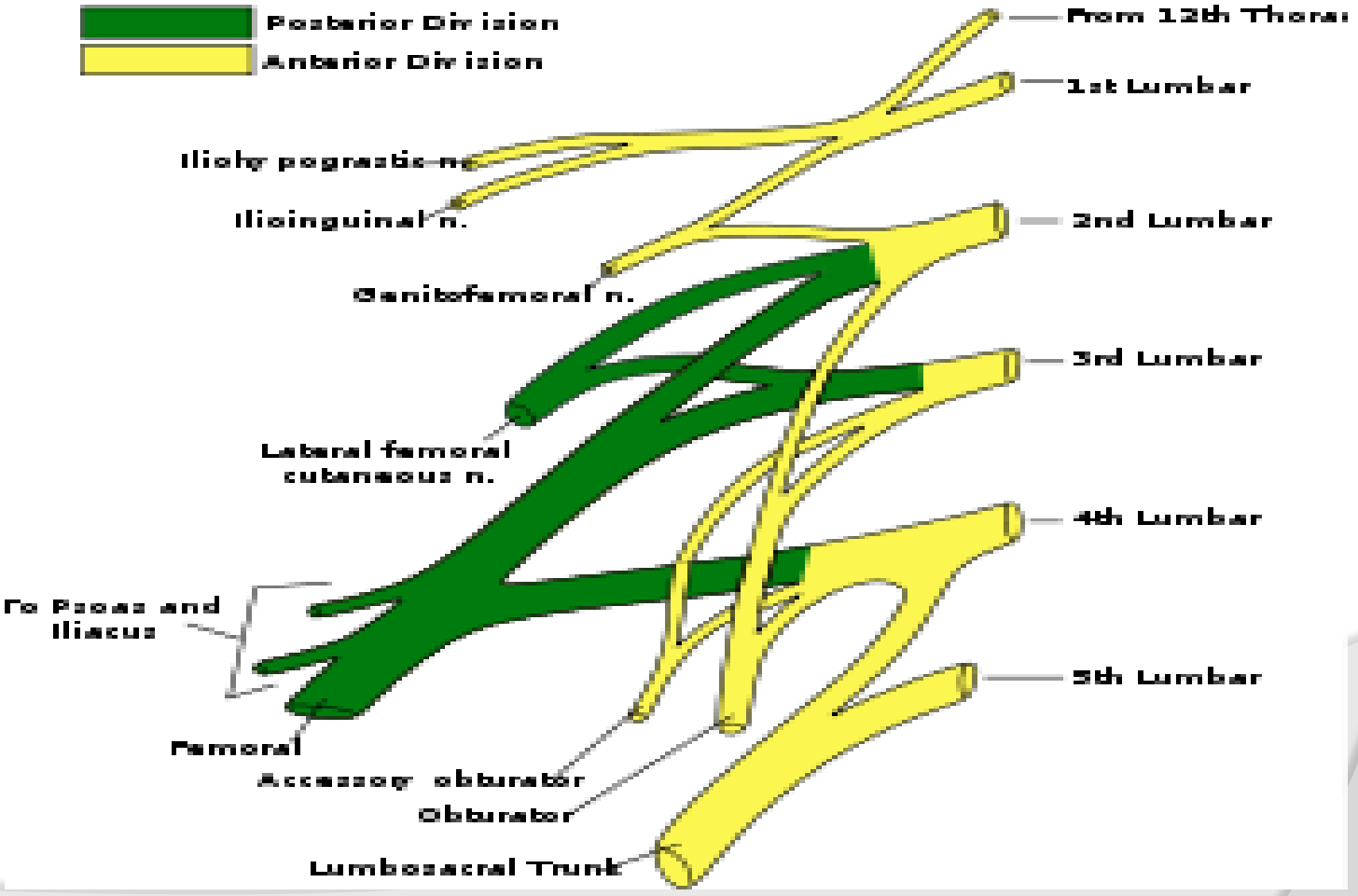


Nervi Erigentes

ENTRAPMENT NEUROPATHIES

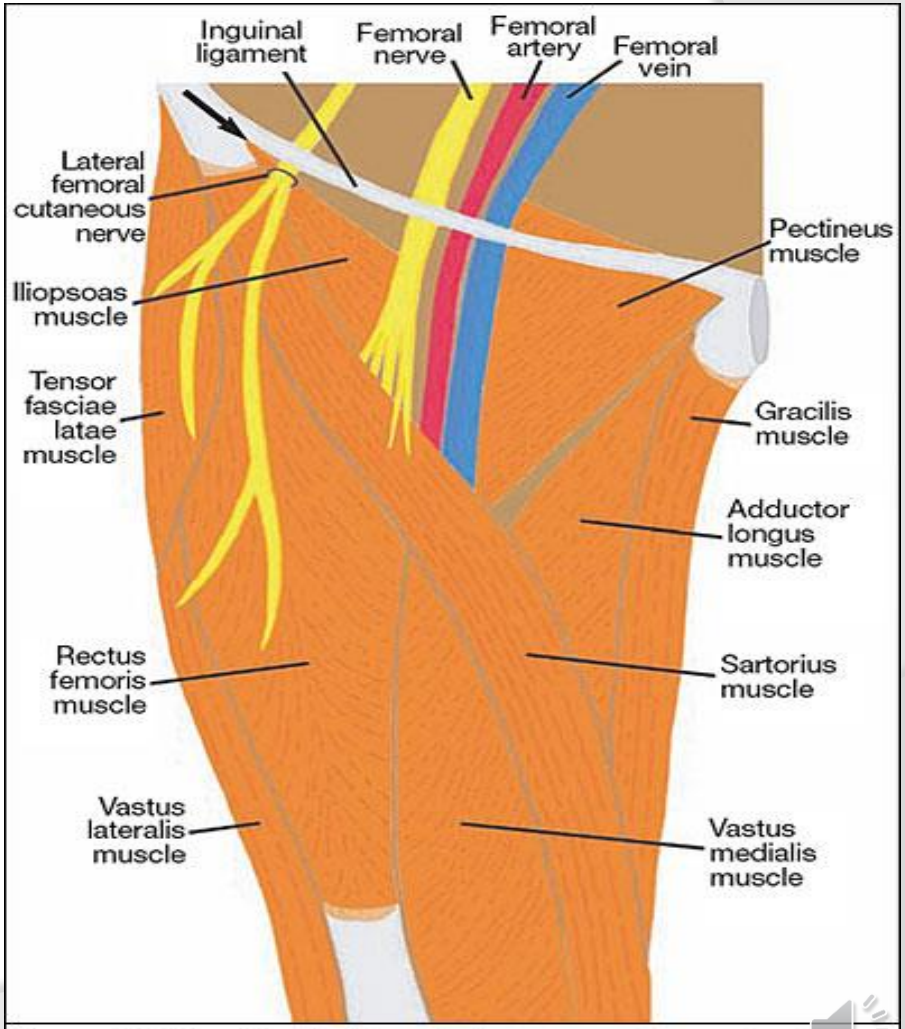
- Most Common Nerves Affected:
  - Lateral Femoral Cutaneous Nerve – L2, L3
  - Femoral Nerve – L2, L3, L4 (posterior divisions)
  - Obturator Nerve – L2, L3, L4 (anterior divisions)
  - Sciatic Nerve – L4, L5, S1, S2, S2
  - Peroneal Nerve – L4, L5, S1, S2, S3 (anterior divisions)
  - Tibial Nerve – L4, L5, S1, S2, S3 (posterior divisions) Tarsal Tunnel Syndrome

LATERAL FEMORAL CUTANEOUS NERVE



LATERAL FEMORAL CUTANEOUS NERVE

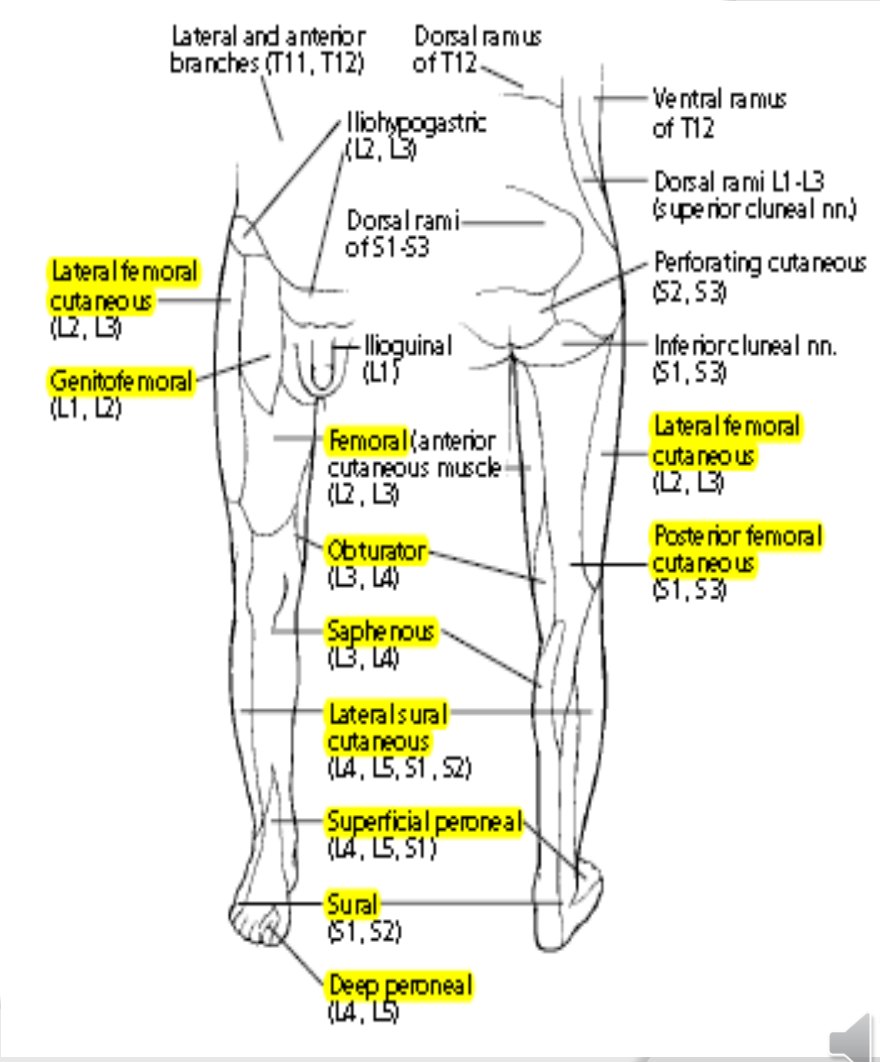
- Primarily sensory (GSA) but also carries sympathetic efferent (GSE) fibers for vasomotor, pilomotor, and sudomotor impulses (in other words, it innervates 1) smooth muscle of a) blood vessels and b) hair follicles, and 2) sweat glands.



Figure—Distribution of the lateral femoral cutaneous nerve. Compression of the nerve often occurs between the inguinal ligament and the sartorius muscle (arrow).

LATERAL FEMORAL CUTANEOUS NERVE

- ANATOMIC COURSE (AMA GUIDES pg. 551)
- Posterior Divisions of L2 and L3:
- It emerges from the lateral border of the psoas major at about its middle, and crosses the iliacus muscle obliquely, toward the anterior superior iliac spine. It then passes under the inguinal ligament and over the sartorius muscle into the thigh, where it divides into an anterior and a posterior branch.

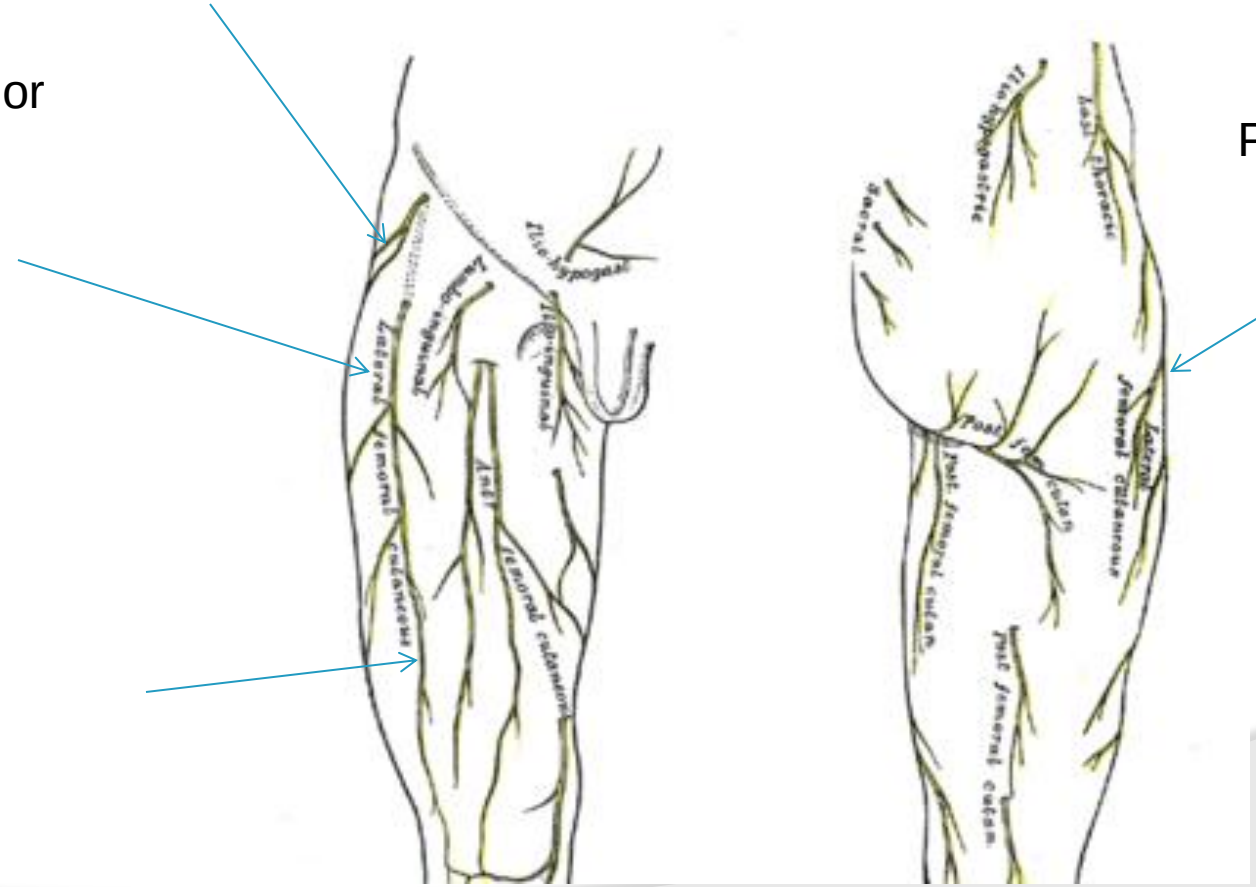


Peripheral Nerve	Branch	Skin Supplied
Lateral Femoral Cutaneous Nerve	Anterior Branch	The anterior branch becomes superficial about 10 cm below the inguinal ligament, and gives off branches which are distributed to the skin of the anterior and lateral parts of the thigh, as far as the knee. The terminal filaments of this nerve frequently communicate with the anterior cutaneous branches of the femoral nerve, and with the infrapatellar branch of the saphenous nerve, forming with them the peripatellar plexus.
	Posterior Branch	The posterior branch pierces the fascia lata, and subdivides into filaments which pass backward across the lateral and posterior surfaces of the thigh, supplying the skin from the level of the greater trochanter to the middle of the thigh.

LATERAL FEMORAL CUTANEOUS NERVE

Posterior

Anterior



Posterior

LATERAL FEMORAL CUTANEOUS NERVE COMPRESSION

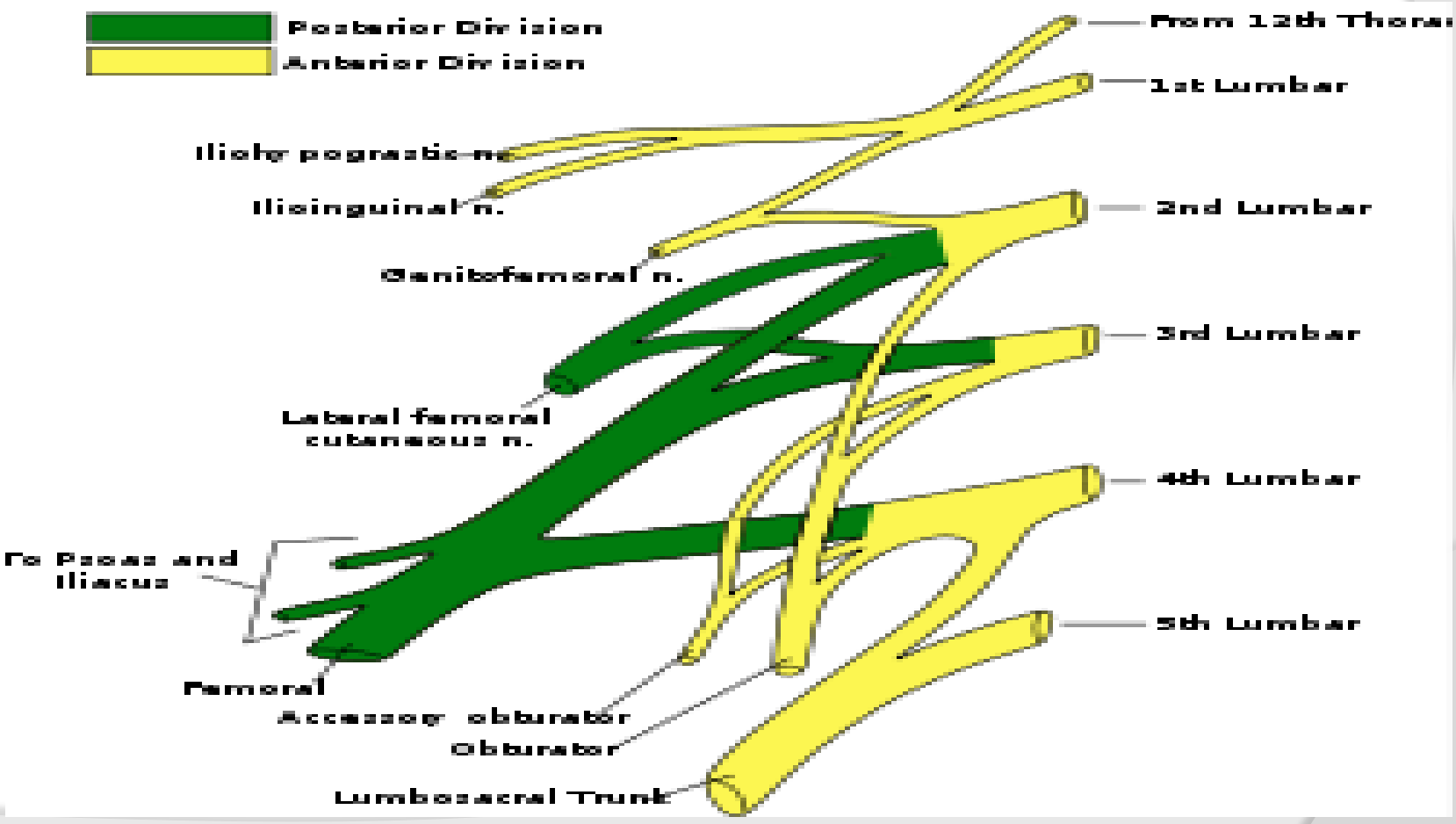
- At Spine:
  - Hypertrophic arthritis of the upper lumbar spine causes nerve root compression
- At Psoas:
  - Nerve emerges at lateral border of psoas and can be affected by psoas abcess (secondary to infection)
- At Inguinal Ligament:
  - Traction Neuritis causes stretching and angulation of the nerve as the examinee moves from sitting to standing (“Meralgia Paresthetica”)
  - Local trauma such as from wearing a tool belt, prolonged sitting with knee higher than the hip, tight work pants, etc.
  - Pendulous abdomen/use of brace and corsets are risk factors – frequent in pregnancy/”beer belly”

LATERAL FEMORAL CUTANEOUS NERVE COMPRESSION

- Meralgia Paresthetica:
  - Signs: Numb, tingling, burning hypersensitivity over the anterolateral thigh
  - Commonly noted by putting hands in pockets, carrying keys in the pockets

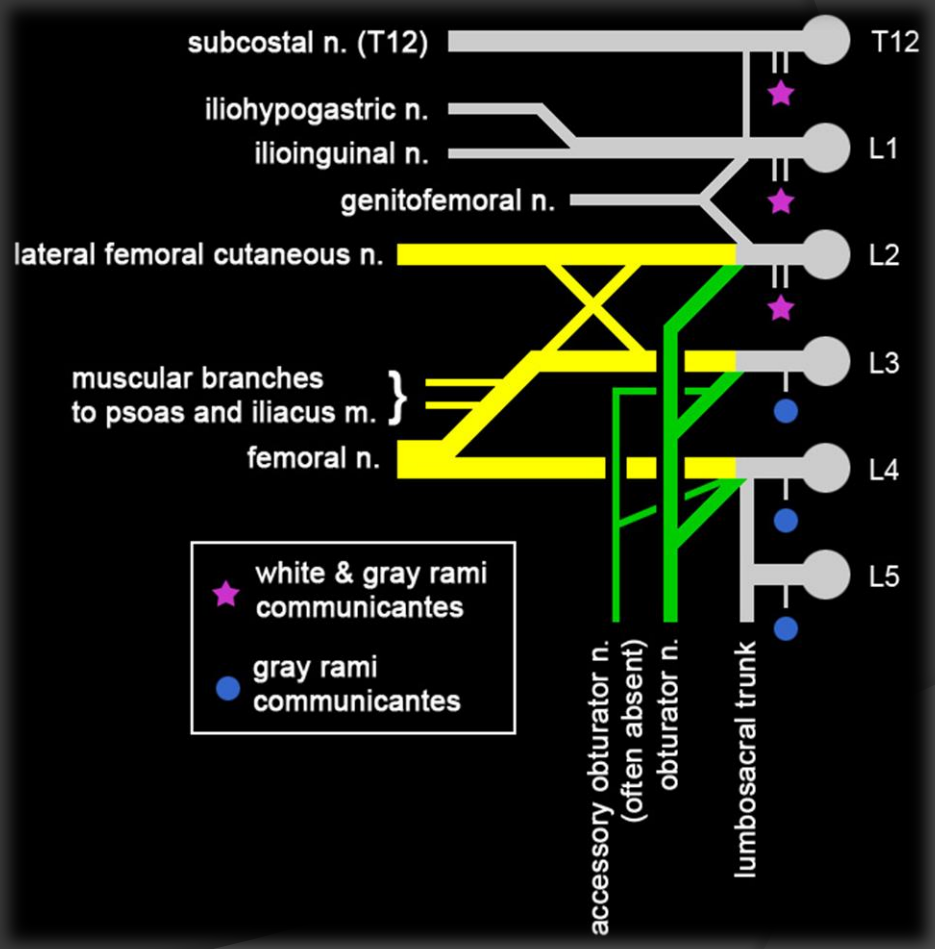
Location of Entrapment	Physical Exam Finding	Explanation
Spine	In the case of herniated disc or osteoarthritis in the upper lumbar region: • Weakness and atrophy of the quadriceps muscle • Patellar reflex probably preserved (L4 reflex)	High lesions affect the L2 and L3 nerve roots which comprise the femoral nerve.
Psoas/Inguinal Ligament	Dysesthesia to light touch/stroking over the anterolateral thigh. No motor findings.	

FEMORAL NERVE



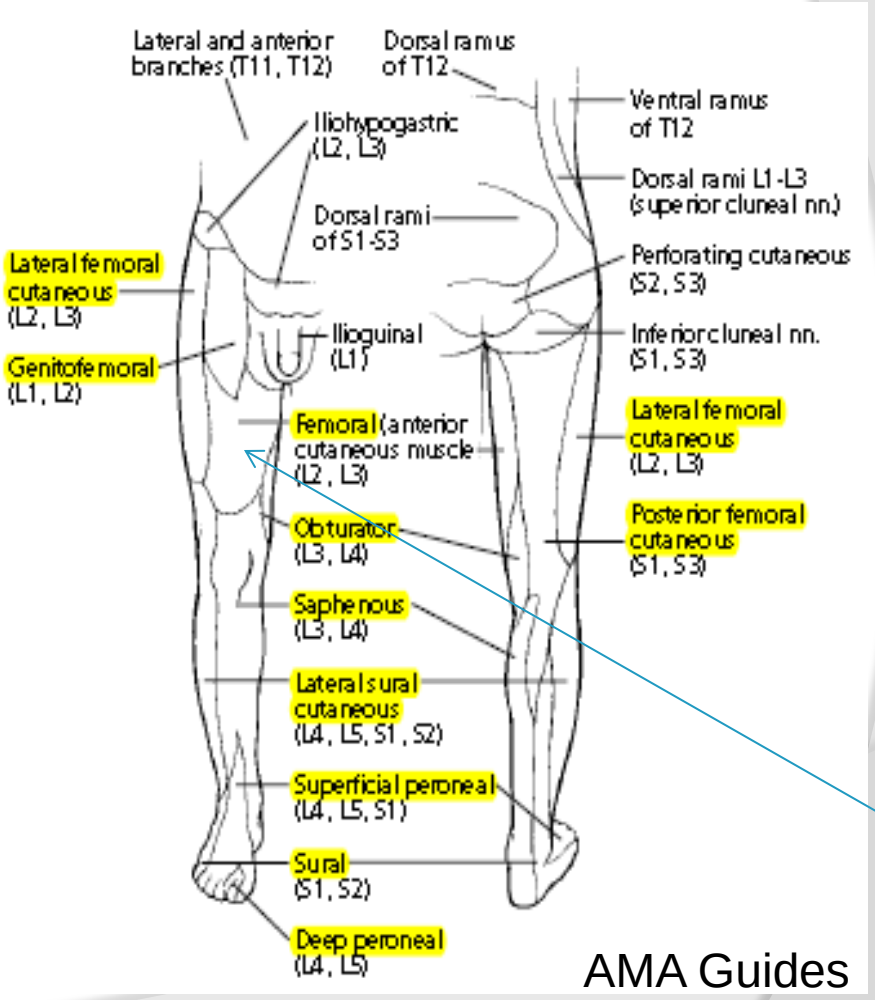
FEMORAL NERVE

- Largest branch of the lumbar plexus
- Posterior divisions of L2, L3, and L4
- It descends through the fibers of the psoas major muscle, emerging from the muscle at the lower part of its lateral border, and passes down between it and the iliacus muscle, behind the iliac fascia; it then runs beneath the inguinal ligament, into the thigh, and splits into an anterior and a posterior division.



FEMORAL NERVE

- Within the abdomen the femoral nerve gives off small branches to the iliacus muscle, and a branch which is distributed upon the upper part of the femoral artery (a continuation of the external iliac artery).
- In the thigh the anterior division of the femoral nerve gives off anterior cutaneous and muscular branches.
  - Cutaneous Branches: The anterior cutaneous branches comprise the following nerves: *intermediate femoral cutaneous nerve* and *medial femoral cutaneous nerve. The AMA Guides* simply group these two branches into a distribution described as the “anterior cutaneous nerve.” (Note the “lateral” femoral cutaneous nerve is a branch from the lumbar plexus.)



AMA Guides Figure 17-8

FEMORAL NERVE

- Muscular branches (rami musculares): The nerve to the pectineus arises immediately below the inguinal ligament, and passes behind the femoral sheath to enter the anterior surface of the muscle. The nerve to the sartorius arises in common with the intermediate cutaneous nerve.

FEMORAL NERVE

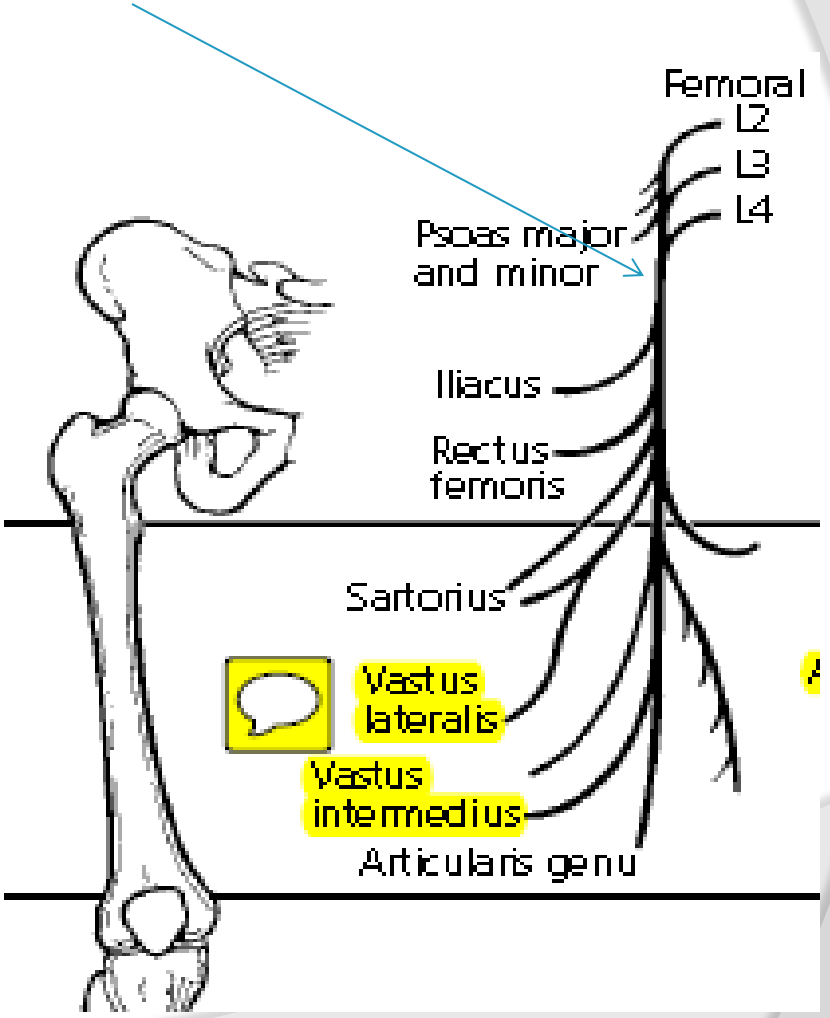
- Posterior Division:
- Muscular branches supply the four parts of the quadriceps femoris.
  - Rectus Femoris - enters the upper part of the deep surface of the muscle. Supplies an articular branch to the hip-joint.
  - Vastus Lateralis – also supplies an articular branch to the knee-joint.
  - Vastus Medialis – also supplies an articular branch to the knee-joint.
  - Vastus Intermedius - two or three in number, enter the anterior surface of the muscle about the middle of the thigh; a filament from one of these descends through the muscle to the ARTICULARIS GENU and the KNEE JOINT.

Peripheral Nerve	Associated Nerve Roots	Muscles Supplied	Muscle Action
Femoral Nerve	L2/L3/L4	Iliacus	Hip Flexion
	L2/L3/L4	Sartorius	Combined movement of flexion, adduction/abduction (weak), and lateral rotation of hip, Knee flexion (weak) – attaches below knee to tibial along with 1) gracilis, and 2) semitendinosus = “pes anserine”
	L2/L3/L4	Quadriceps (all 4)	Knee extension

Peripheral Nerve	Branch	Skin Supplied
Femoral Nerve	AMA Guides (Anterior Cutaneous Nerve – L2/L3)	Anterior upper thigh to include the top of the knee Communicates with infrapatellar branch of saphenous to form the patellar plexus
	Saphenous – L3/L4	Anterior medial lower leg from the crest of the tibial medialward Posterior medial lower leg from the division between the two heads of the gastrocnemius muscle medialward

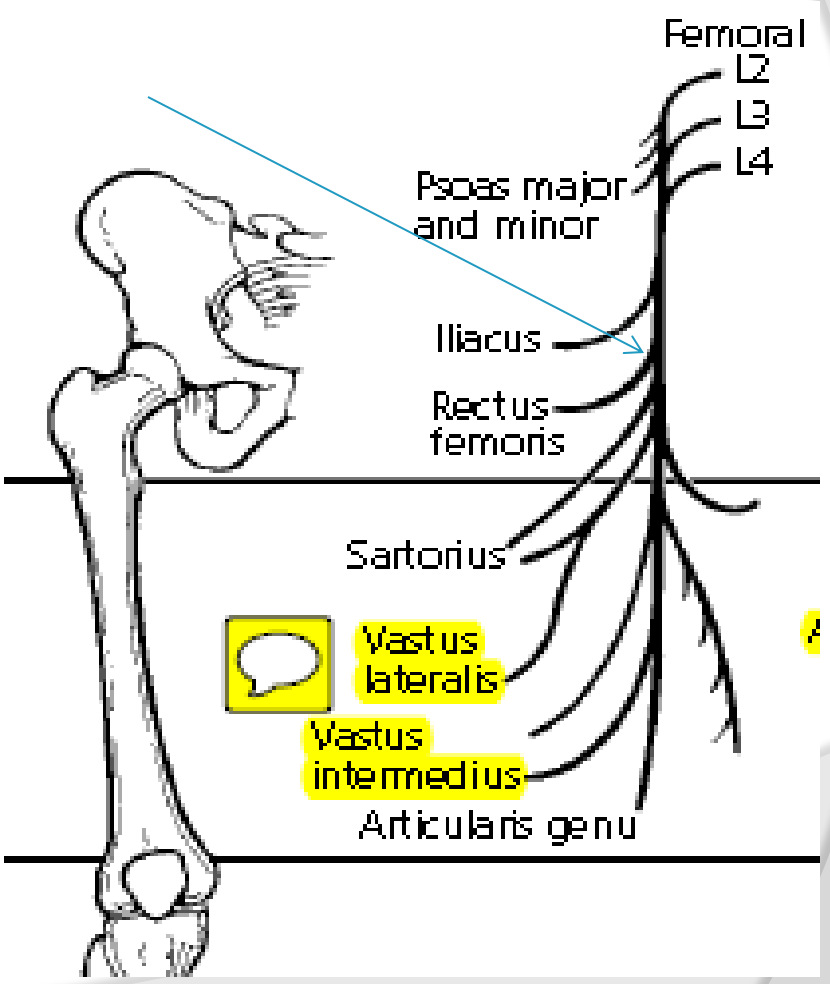
FEMORAL NERVE COMPRESSION

- Intrapelvic Injury/Inguinal injury:
  - Diabetic Amyotrophy:
  - Open Injuries from gunshots, knife wounds, glass shards, needle puncture



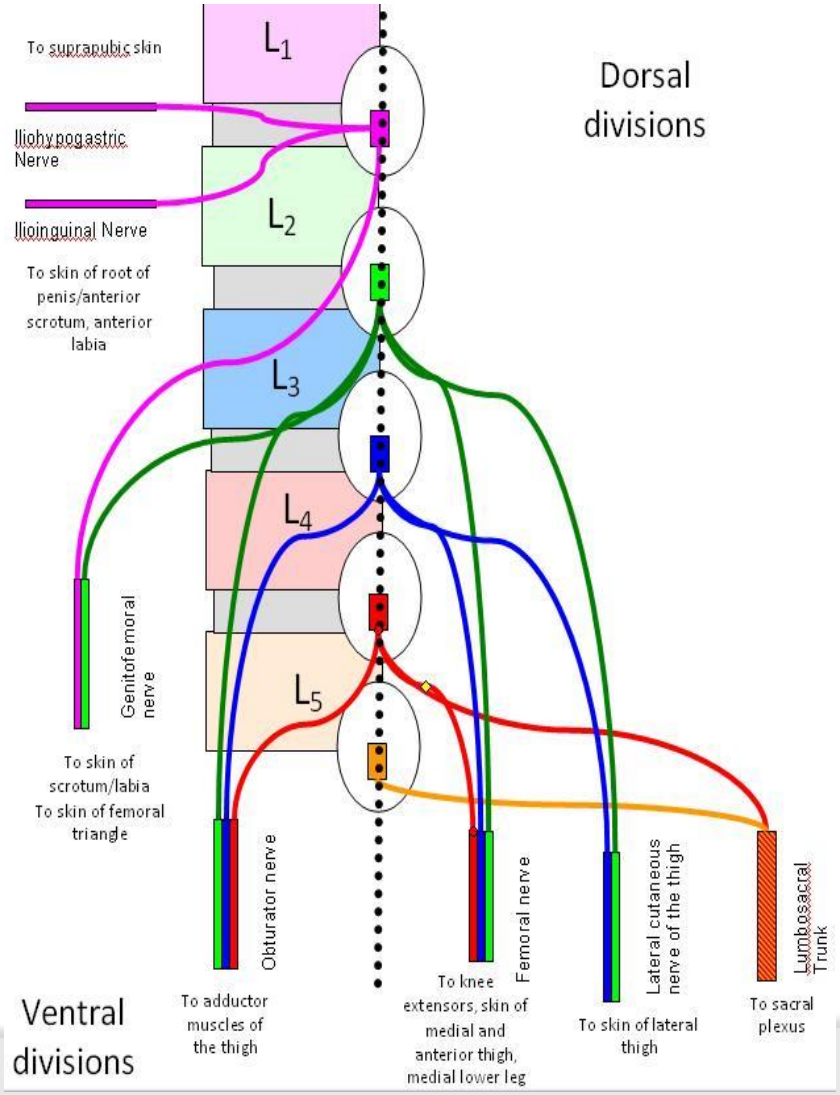
FEMORAL NERVE COMPRESSION

- Below Inguinal Ligament:
  - Any pathology with the hip joint (capsule/femoral head), psoas tendon, or tendon of vastus intermedius
  - Prolonged position of hip flexion with leg abducted and externally rotated with compress the nerve beneath the inguinal ligament
  - Acute hyperextension of the thigh



Location of Entrapment	Physical Exam Finding	Explanation
Intrapelvic Lesion	Sensory: Decreased light touch, numbness, tingling in the anterior thigh to include the knee cap, sensory loss may occur along the medial aspect of the leg below the knee in the distribution of the saphenous nerve (sensory continuation of the femoral nerve) Motor: Decreased strength of hip flexion (psoas/iliacus), decreased strength of knee extension. Probably no finding for the sartorius Reflex: Decreased patellar reflex	High lesions affect both the hip flexors and knee extensors
Inguinal Ligament	Hip flexion strength preserved	Low lesion does not affect the branch to the iliacus and the branches to the psoas are from the L2 and L3 nerves roots prior to the formation of the femoral nerve

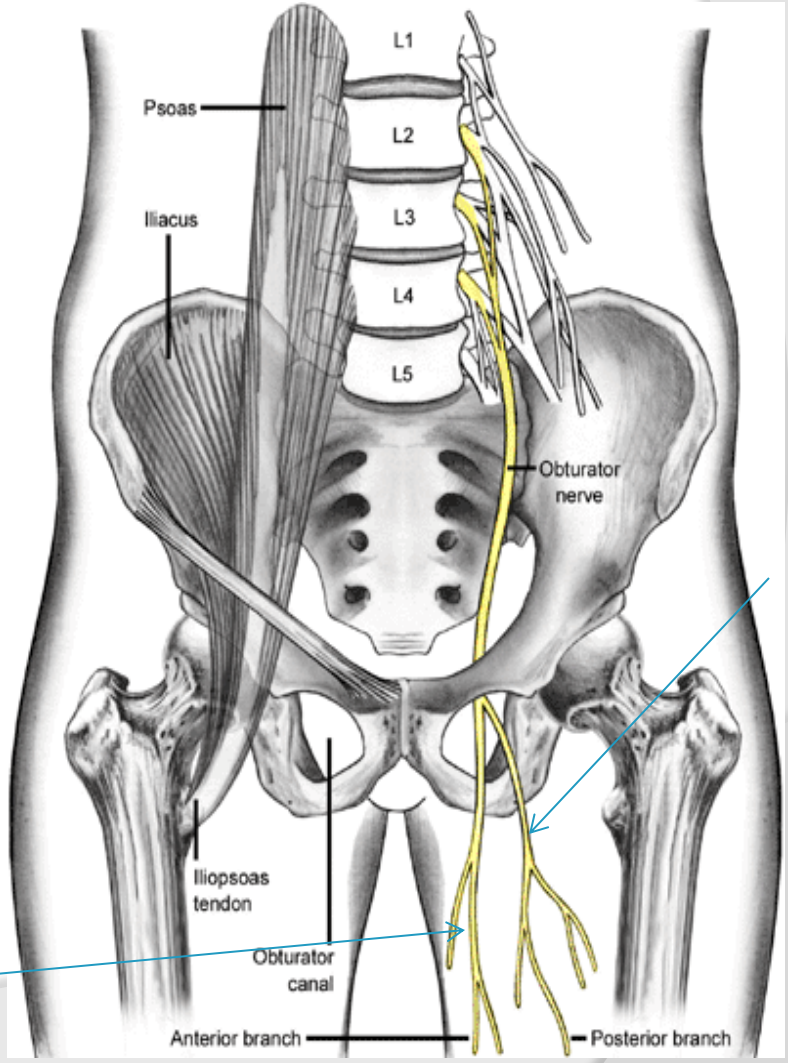
OBTURATOR NERVE



- L2, L3, and L4 (Ventral Divisions) with the greatest contribution coming from L3.

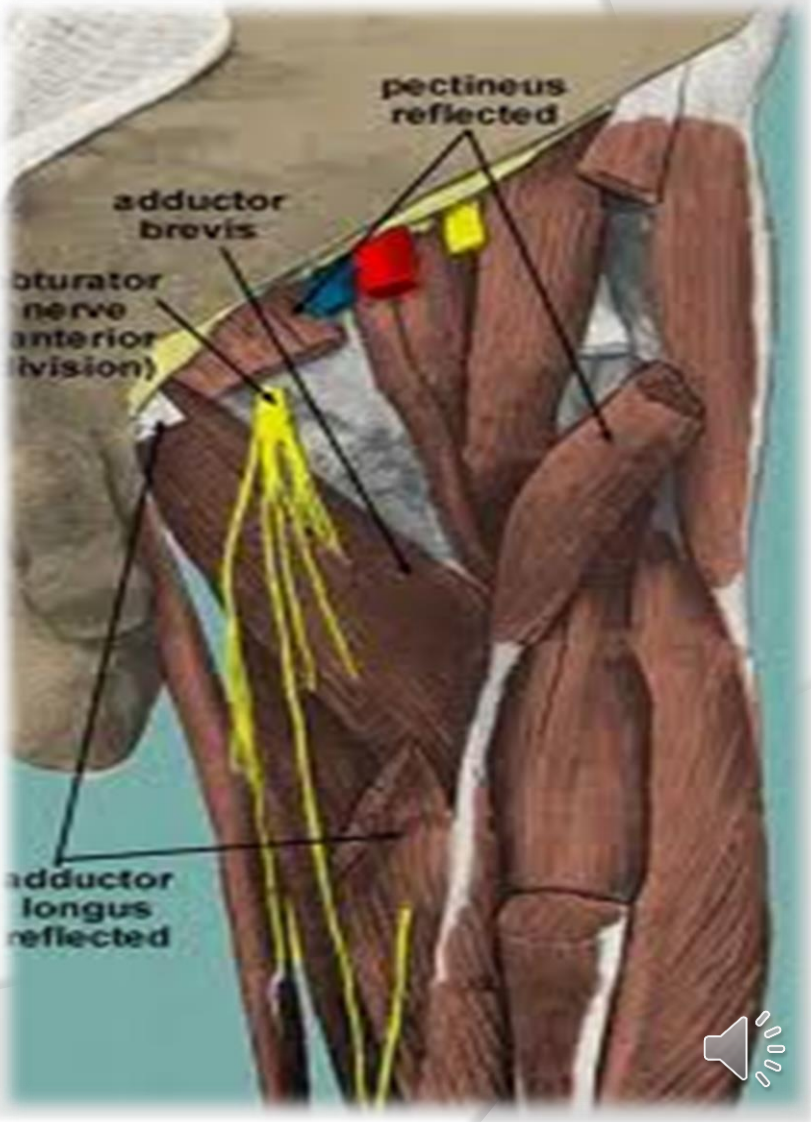
OBTURATOR NERVE

- Course: It descends through the fibers of the psoas major, and emerges from its medial border near the brim of the pelvis; it then passes behind the common iliac arteries, and on the lateral side of the internal iliac artery and ureter , and runs along the lateral wall of the lesser pelvis, to the upper part of the obturator foramen.
- Here it enters the thigh, through the “obturator canal”, and divides into an anterior and a posterior branch - which are separated at first by some of the fibers of the obturator externus, and lower down by the adductor brevis.



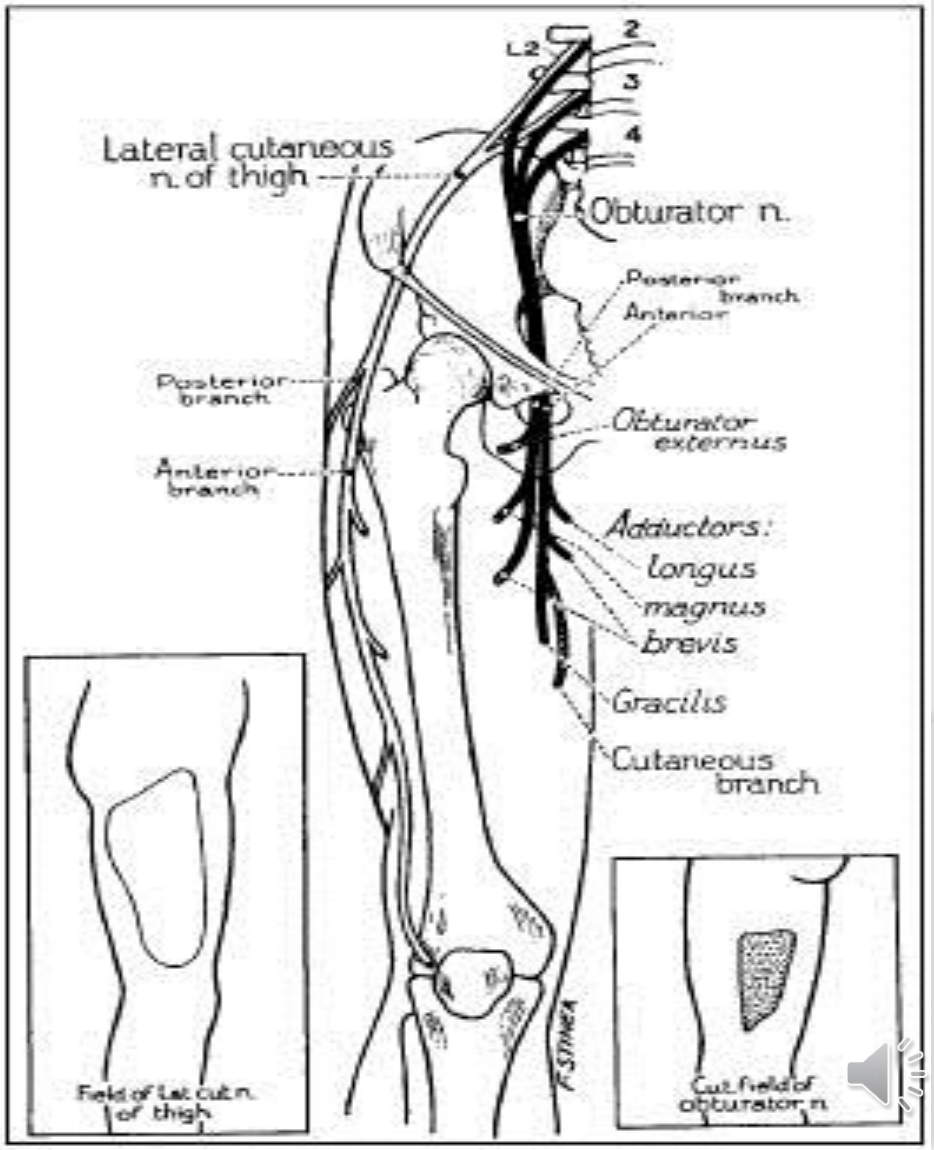
OBTURATOR NERVE

- Anterior Branch: It leaves the pelvis in front of the obturator externus and descends in front of the adductor brevis, and behind the pectineus and adductor longus; at the lower border of the adductor longus it communicates with the “anterior cutaneous” and “saphenous” branches of the femoral nerve, forming the “peripatellar plexus.”
- Near the obturator foramen the nerve gives off an articular branch to the hip joint.
- Behind the pectineus, it distributes branches to the adductor longus and gracilis, and usually to the adductor brevis, and in occasional cases, to the pectineus (pectineus usually innervated by femoral nerve).
- It then descends upon the femoral artery, to which it distributes autonomic function branches.



OBTURATOR NERVE

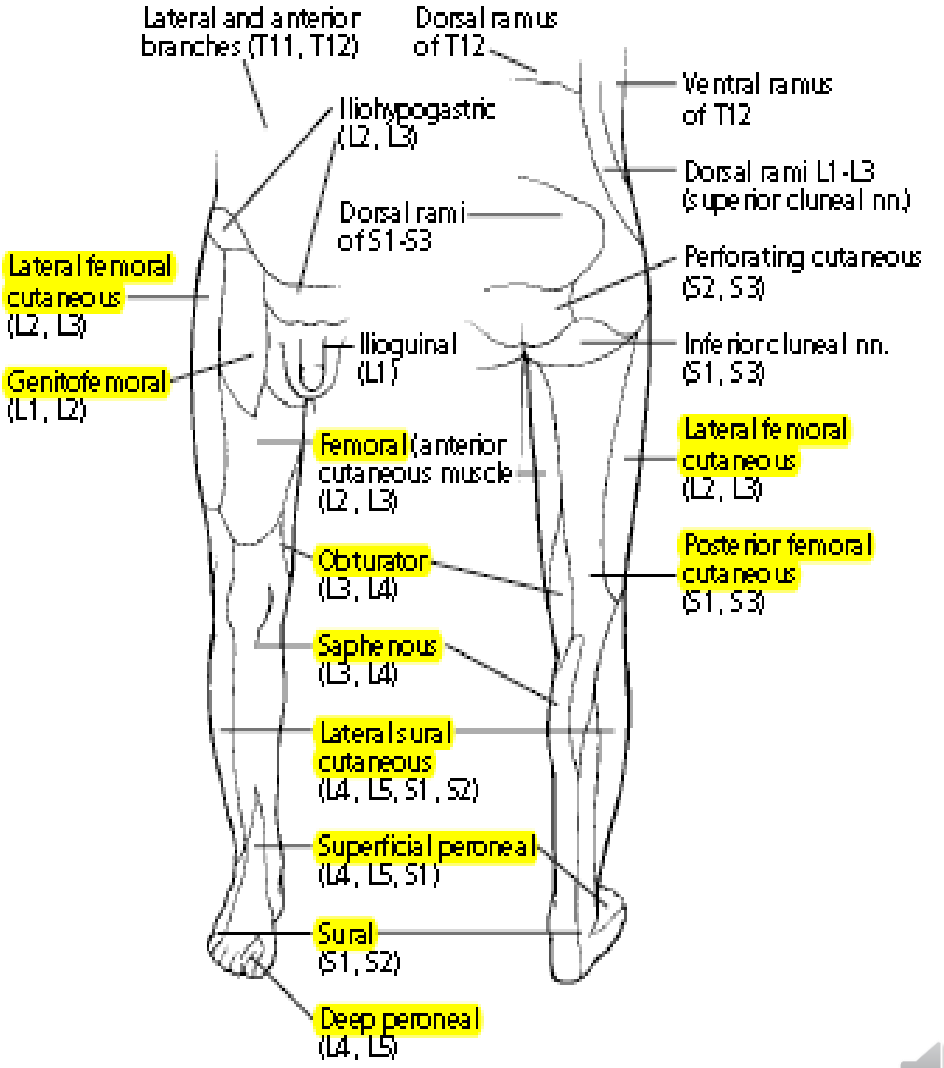
- Posterior Branch: The **posterior branch of the obturator nerve** pierces the anterior part of the obturator externus muscle, and supplies this muscle; it then passes behind the adductor brevis on the front of the adductor magnus, where it divides into numerous muscular branches - which are distributed to the adductor magnus and the adductor brevis.
- It usually gives off an articular filament to the knee joint.



OBTURATOR NERVE

- Sensory: Occasionally the communicating branch to the anterior cutaneous and saphenous branches of the femoral nerve is continued down, as a cutaneous branch, to the thigh and leg, as the **cutaneous branch of the obturator nerve**.

- When this is so, it emerges from beneath the lower border of the adductor longus, descends along the posterior margin of the sartorius to the medial side of the knee, where it pierces the deep fascia, communicates with the saphenous nerve, and is distributed to the skin of the tibial side of the leg as low down as its middle.

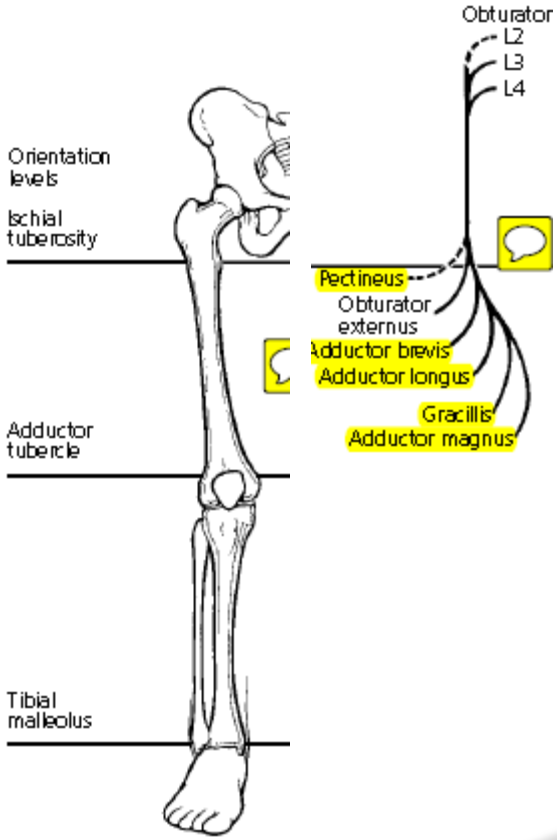


Peripheral Nerve	Associated Nerve Roots	Muscles Supplied	Muscle Action
Obturator Nerve	L2/**L3**/L4	Pectineus (occasional – generally innvervated by femoral nerve) Obturator externus Adductor brevis Adductor longus Gracilis Adductor magnus	Resisted hip adduction Resisted hip adduction

Peripheral Nerve	Branch	Skin Supplied
Obturator Nerve	Anterior branch joins with the 1) anterior cutaneous and 2) saphenous branches of the femoral nerve	Sensation to the medial aspect of the lower thigh and medial knee.

OBTURATOR NERVE COMPRESSION

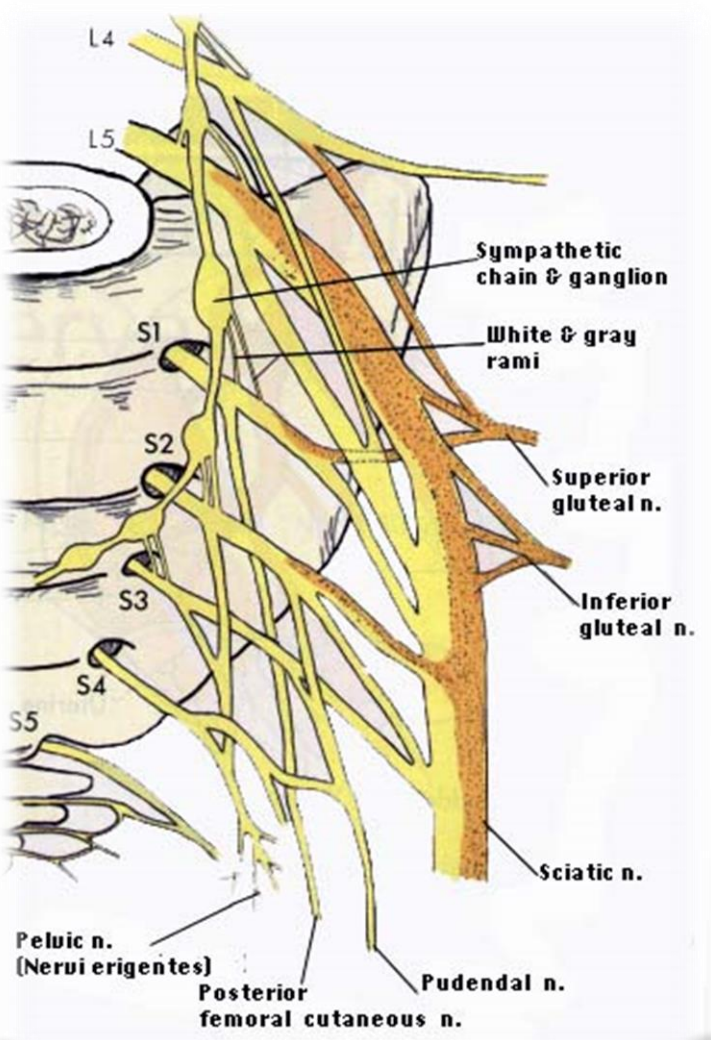
- The obturator nerve is rarely injured in isolation. However, injury can occur with pelvic trauma and associated fractures (affects both anterior and posterior branches), during delivery as a result of compression of the nerve between the head of the fetus and the bony structures of the pelvis, or as a consequence of compression of the nerve between a tumor and the bony pelvis.
- Entrapment may occur in the obturator canal during surgery or with total hip arthroplasties.
- Other potential causes include malposition of the lower limb for prolonged periods, entrapment in the adductor magnus in athletes, and abnormal positioning of the lower limb of a newborn during a difficult delivery. Finally, the anterior branch may be entrapped in the fascia as it passes over the adductor brevis muscle, owing to an inflammatory process.



- Entrapped in either the adductor brevis or adductor magnus -

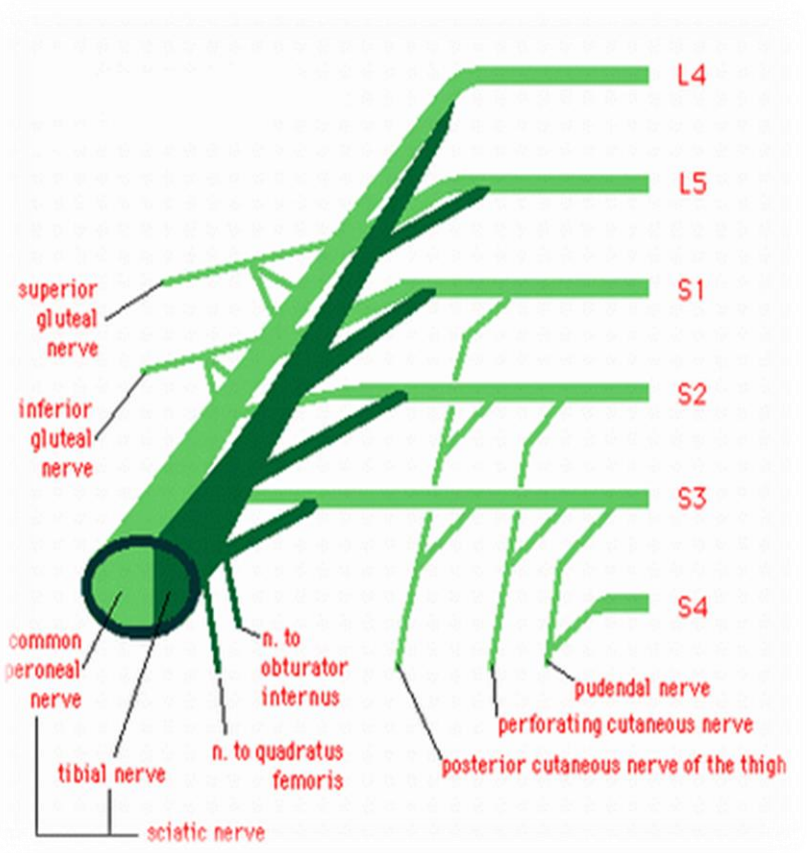
Location of Obturator Nerve Entrapment	Physical Exam Finding	Explanation
All locations	Difficulty with ambulation, unstable leg on the side of involvement (gait disturbance). With anterior branch entrapment, symptoms include groin pain exacerbated by activity. Pain may radiate down the medial aspect of the thigh toward the knee. Inability to jump and weakness worsens with exercise. Late Finding - Loss of hip adduction and hip internal rotation Gait - Externally rotated foot. Motor Findings - Wasting of the adductor muscles of the thigh	Due to multiple overlap and muscles that contribute to hip adduction, a precise determination of the location of lesion is difficult – however all lesions will affect hip adduction.

SCIATIC NERVE



- Actually consists of 2 nerves:
  - Tibial Nerve
  - Peroneal Nerve
  - Both invested in the same fascia (Perineurium)
  - Is the longest and widest single nerve in the body stretching from the top of the leg to the foot on the posterior aspect. The sciatic supplies nearly the whole of the skin of the lower, the muscles of the back of the thigh, and those of the leg and foot.

SCIATIC NERVE



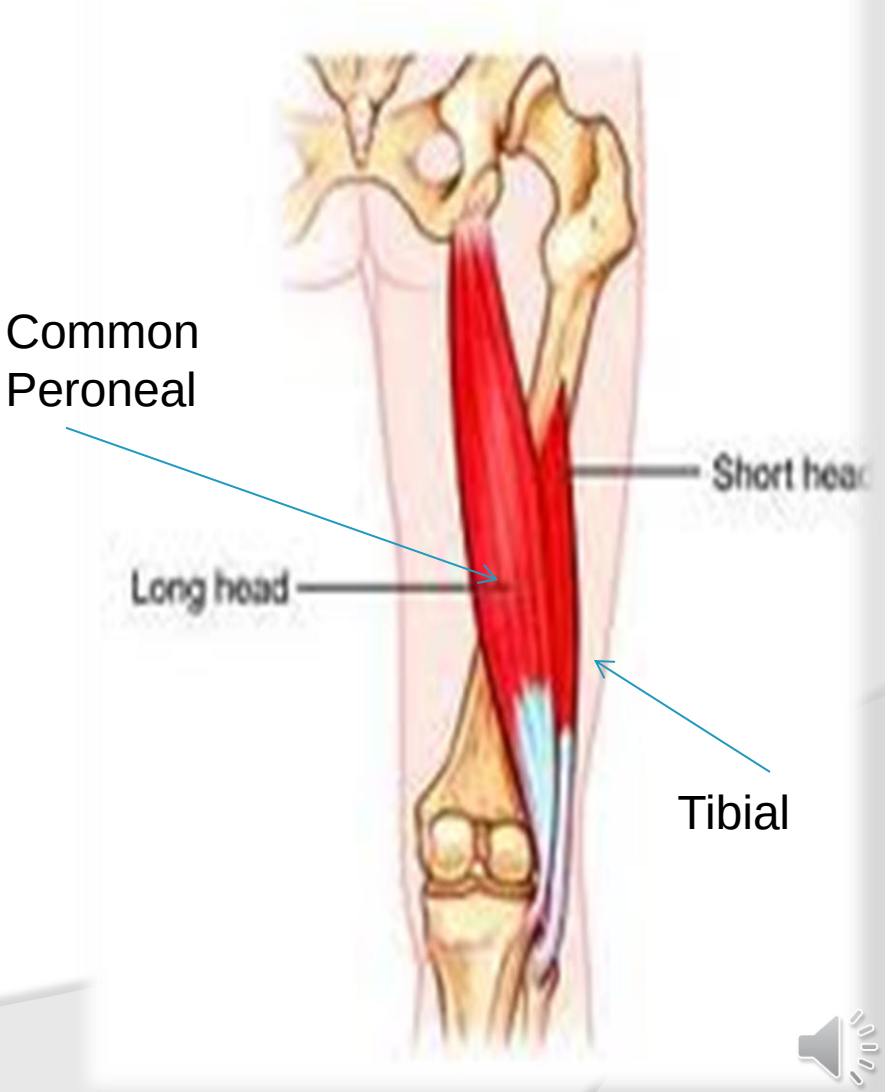
- L4, L5, S1, S2, and S3 and contains fibers from both the anterior division (common peroneal nerve) and posterior division (tibial nerve) of the sacral plexus.

SCIATIC NERVE

- The nerve gives off articular and muscular branches.
- The **articular branches** (*rami articulares*) arise from the upper part of the nerve and supply the HIP JOINT, perforating the posterior part of its capsule.
- The **muscular branches** (*rami musculares*) are distributed to the following muscles of the lower limb: biceps femoris (ong and short heads), semitendinosus, semimembranosus, and portions of the adductor magnus.

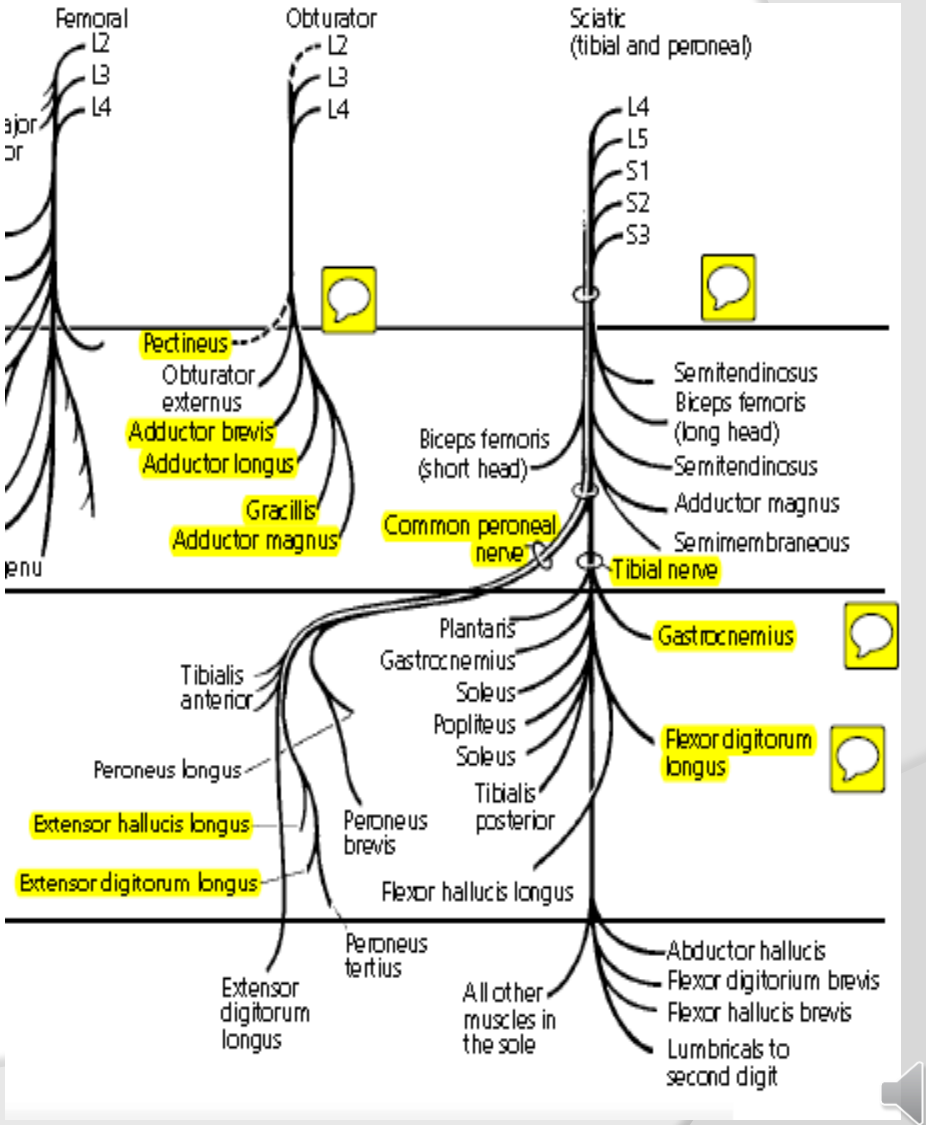
SCIATIC NERVE

- The nerve to the short head (the more laterally placed head) of the biceps femoris comes from the common fibular part of the sciatic (see below), while all other muscular branches arise from the tibial portion.
- Thus, the common peroneal gives off only 1 muscular branch above the knee – all other muscles are served by the tibial portion of the nerve.



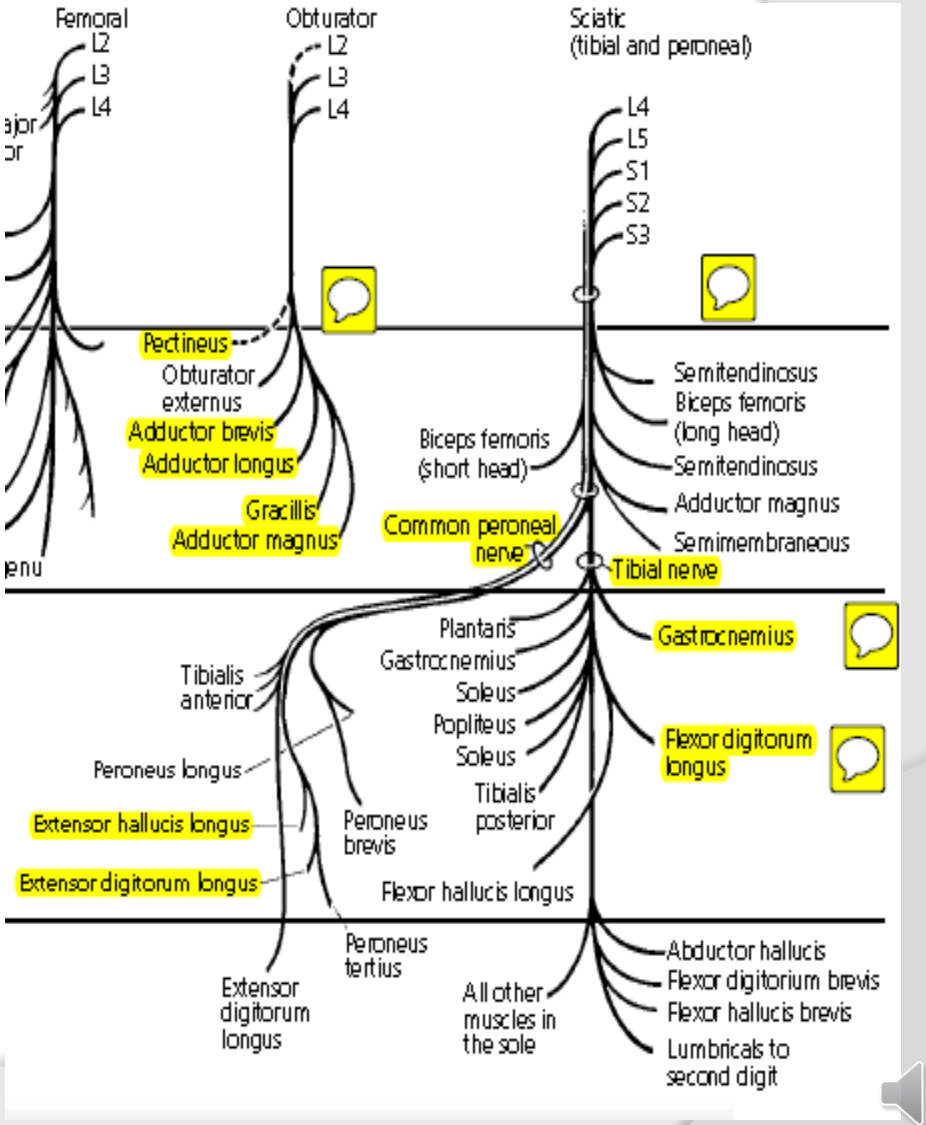
SCIATIC NERVE

- Muscular Branch:
- Just above the knee, the muscular branch divides out into the tibial nerve and the common peroneal nerve. These two innervate all muscles of the lower leg. The tibial nerve goes on to innervate all intrinsic muscles of the foot except the extensor digitorum brevis and the extensor hallucis brevis (which are innervated by the deep fibular nerve).



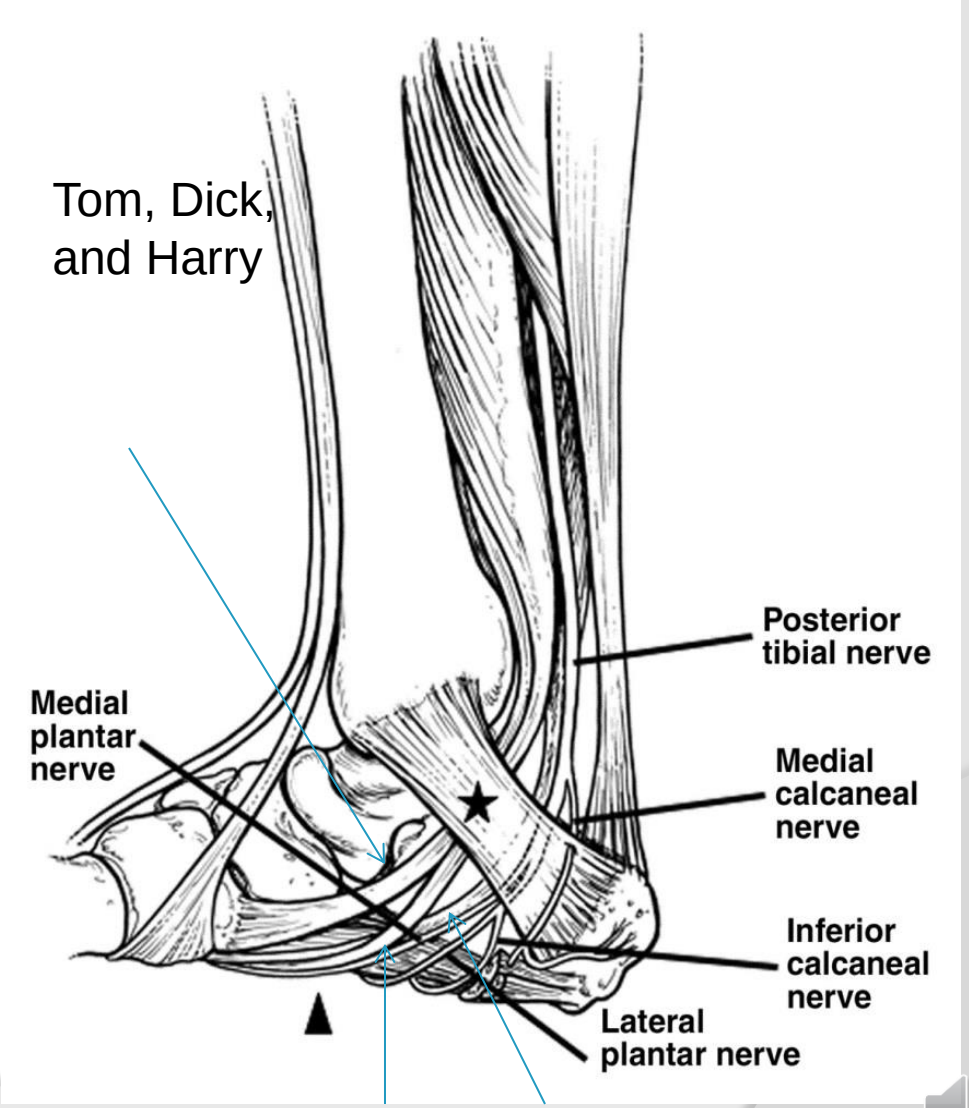
SCIATIC NERVE

- Below Knee:
  - Tibial Nerve: Passes between the tibialis posterior and the FDL, and then between the FDL and FHL. Travels behind the medial malleolus where it is bound down with the posterior tibial artery (proximal tarsal tunnel) and then divides into terminal branches – the medial and lateral plantar nerves.



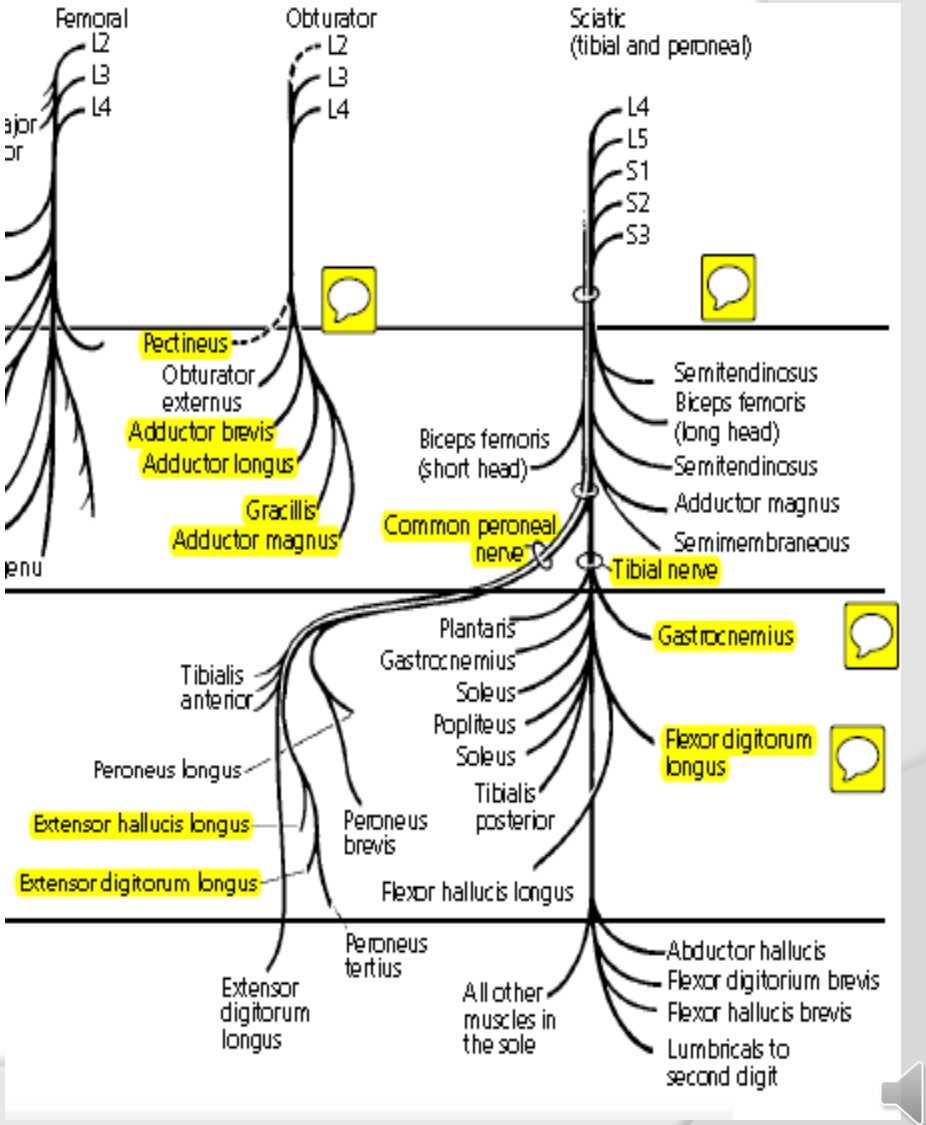
SCIATIC NERVE

- Tarsal Tunnel:
  - Formed by medial surface of the talus, the inferomedial navicular, the sustentaculum tali, and the curved medial surface of the calcaneus. The fibrous portion of the canal is the flexor retinaculum – which is formed by the deep and superficial aponeurosis of the leg and is attached closely to the sheaths of the tibialis posterior, FDL, and FHL tendons.
  - :



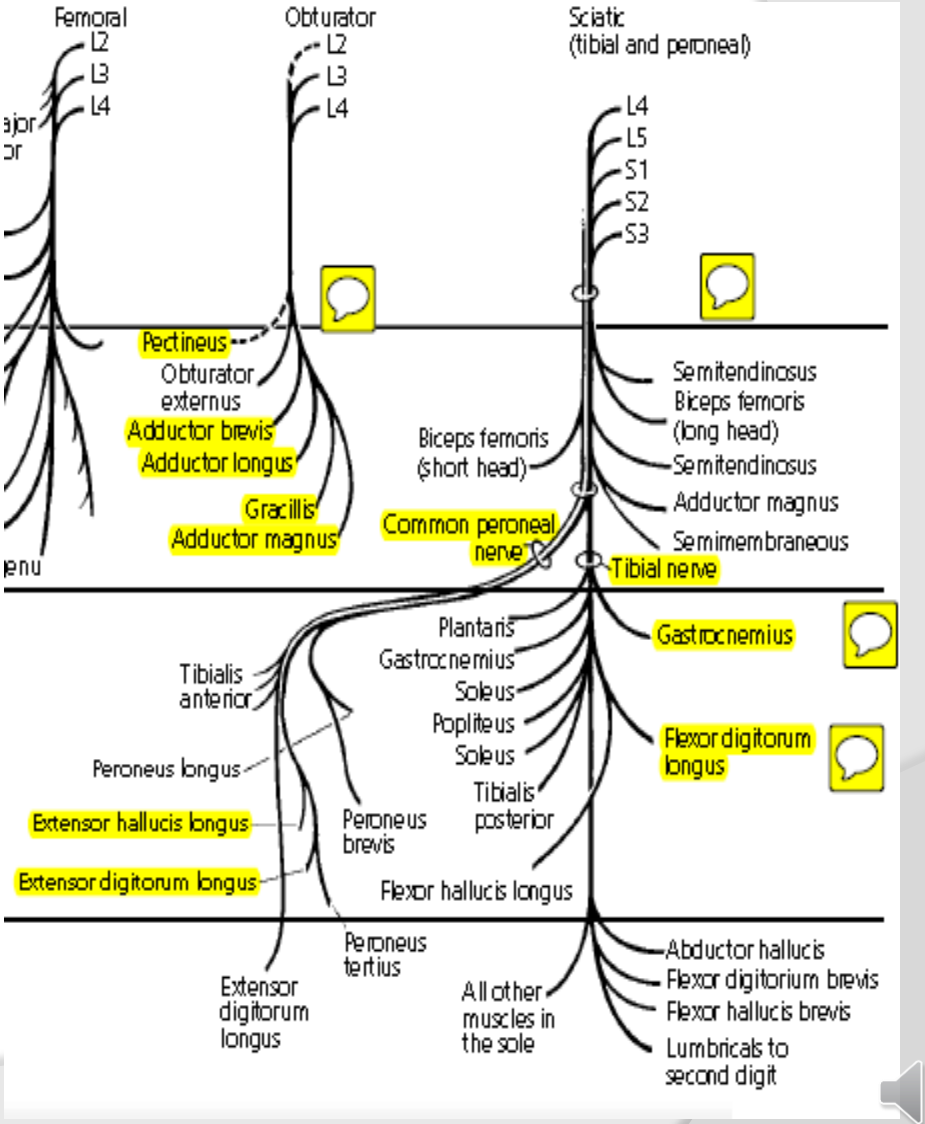
SCIATIC NERVE

- Below Knee:
  - Common Peroneal Nerve – Courses around the fibular neck and passes through the fibro-osseous (fibular tunnel) opening in the superficial head of the peroneus longus muscle. – can be a site of angulation of the nerve.
  - From here, it divides into the superficial and deep peroneal nerves.



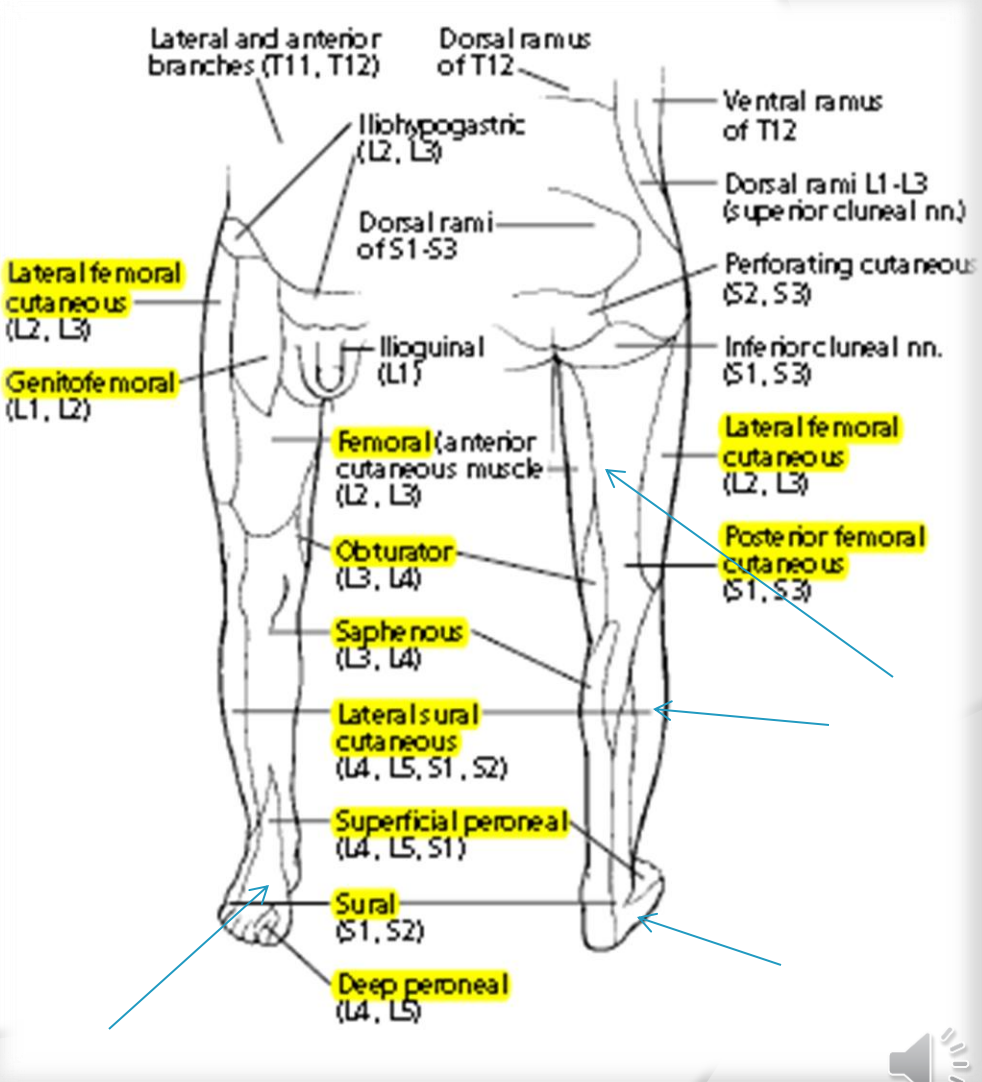
SCIATIC NERVE

- Superficial Peroneal Nerve (Sensory/Motor):
  - Innervates the peroneus long and peroneus brevis muscles. Travels down the leg to pierce the deep fascia at about the distal third of the anterior leg.
  - Here it splits into 2 terminal branches, passes anterior to the ankle to provide sensory innervation to the dorsum of the foot.
- Deep Peroneal Nerve (Motor):
  - Descends between the anterior tibialis and the EHL – innervating those as well as EDL and peroneus tertius.



SCIATIC NERVE

- Sensory Branches:
  - S1,S3 – Posterior femoral cutaneous nerve: Posterior aspect of thigh from gluteal crease to behind the knee to central upper calf
  - L4, L5, S1, S2 – Lateral sural cutaneous nerve: Lateral aspect of lower leg from lateral knee to lateral malleolus to lateral two toes
  - S1, S2 – Sural Cutaneous nerve: Posterolateral aspect of calf (posteromedial is served by saphenous nerve)
  - L4, L5, S1 (Superficial peroneal) and L4, L5 (Deep peroneal) dorsum of foot



Peripheral Nerve	Associated Nerve Roots	Muscles Supplied	Muscle Action
Sciatic Nerve (above knee)	L4/L5/S1/S2/ S3	Biceps femoris Semitendinosus Adductor Magnus Semimembranosus	Knee flexion Knee flexion/hip extension Hip adduction Knee flexion/hip extension
Sciatic Nerve – Tibial division (below knee)		Plantaris Gastrocnemius (both heads) Soleus Popliteus Tibialis Posterior Flexor digitorum longus Flexor hallucis longus	Weak ankle plantarflexion Ankle plantarflexion and weak knee flexion Ankle plantarflexion Medial rotation of an unweighted tibia Ankle plantarflexion with inversion Flexion of distal phalanges of 2-5 Flexion of distal phalanx of big toe
Sciatic Nerve – Tibial division (below ankle)		Abductor hallucis Flexor digitorum brevis Flexor hallucis brevis Lumbricals to 2nd digit Muscles in sole of foot	Abduction of proximal phalanx of big toe Flexion of interphalangeal joints of 2-4 Flexion of proximal phalanx of big toe Flexion of MTP joint and extension of PIP and DIP of 2nd toe

Peripheral Nerve	Associated Nerve Roots	Muscles Supplied	Muscle Action
Sciatic Nerve – Common Peroneal division (below knee) – deep peroneal nerve		Tibialis anterior Extensor digitorum longus	Ankle dorsiflexion and inversion (along with tibialis posterior) Extension of phalanges of 2-5 toes
Sciatic Nerve – Common Peroneal division (below knee) – deep peroneal nerve		Extensor hallucis longus Extensor digitorum longus Peroneus tertius	Extension of distal phalanx of big toe Extension of phalanges of 2-5 toes Ankle eversion and weak dorsiflexion
Sciatic Nerve – Common Peroneal division (below knee) – superficial nerve		Peroneus longus Peroneus brevis	Ankle eversion and plantar flexion Ankle eversion and plantar flexion

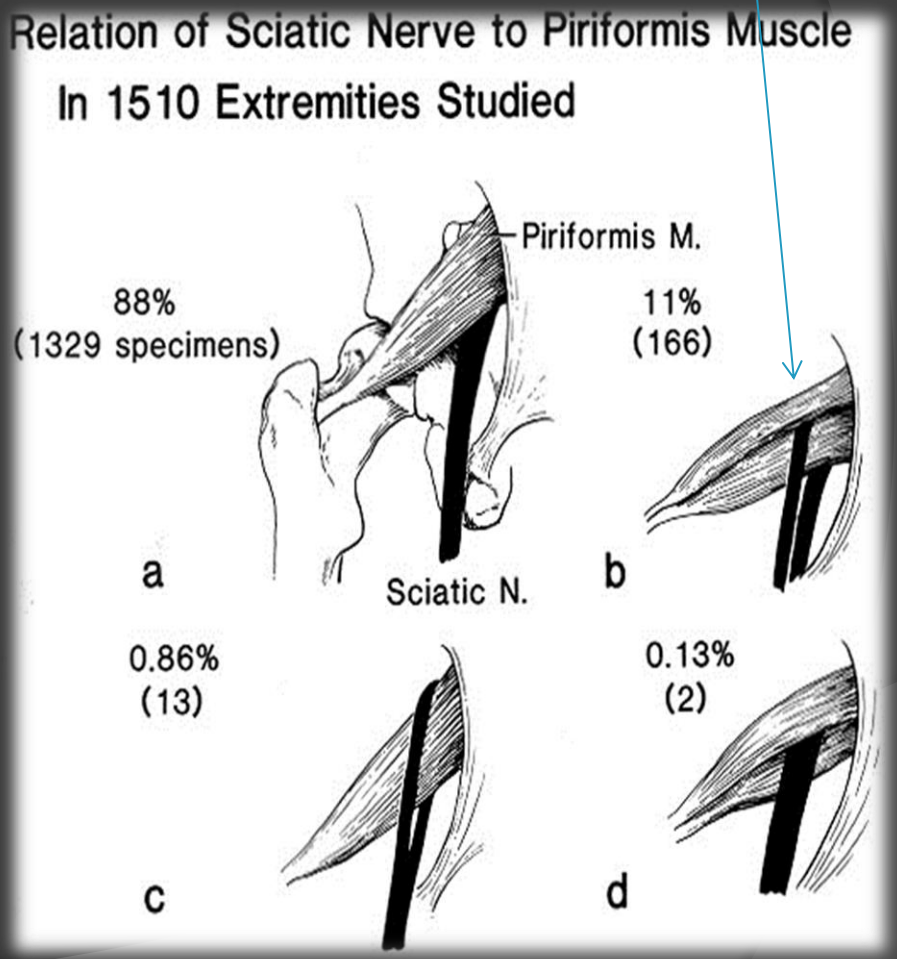
Peripheral Nerve	Branch	Skin Supplied
Sciatic Nerve	Posterior femoral cutaneous nerve: Lateral sural cutaneous nerve: Sural Cutaneous nerve: Superficial peroneal deep peroneal nerve:	Posterior aspect of thigh from gluteal crease to behind the knee to central upper calf Lateral aspect of lower leg from lateral knee to lateral malleolus to lateral two toes Posterolateral aspect of calf (posteromedial is served by saphenous nerve) Dorsum of foot
Sciatic Nerve (foot)	Medial Calcaneal Lateral Plantar Medial Plantar	Bottom of heel Sole of foot along lateral two metatarsals Sole of foot along 1st-4th metatarsals

SCIATIC NERVE COMPRESSION/IRRITATION

- Spine: Not discussed in this program
- Buttock: Hip fractures or penetrating trauma (such as due to gunshot or knife wound)
  - Peroneal division 6 times more commonly damaged than tibial division (in addition to a foot drop, this person will have weakness of the short head of the biceps femoris muscle)

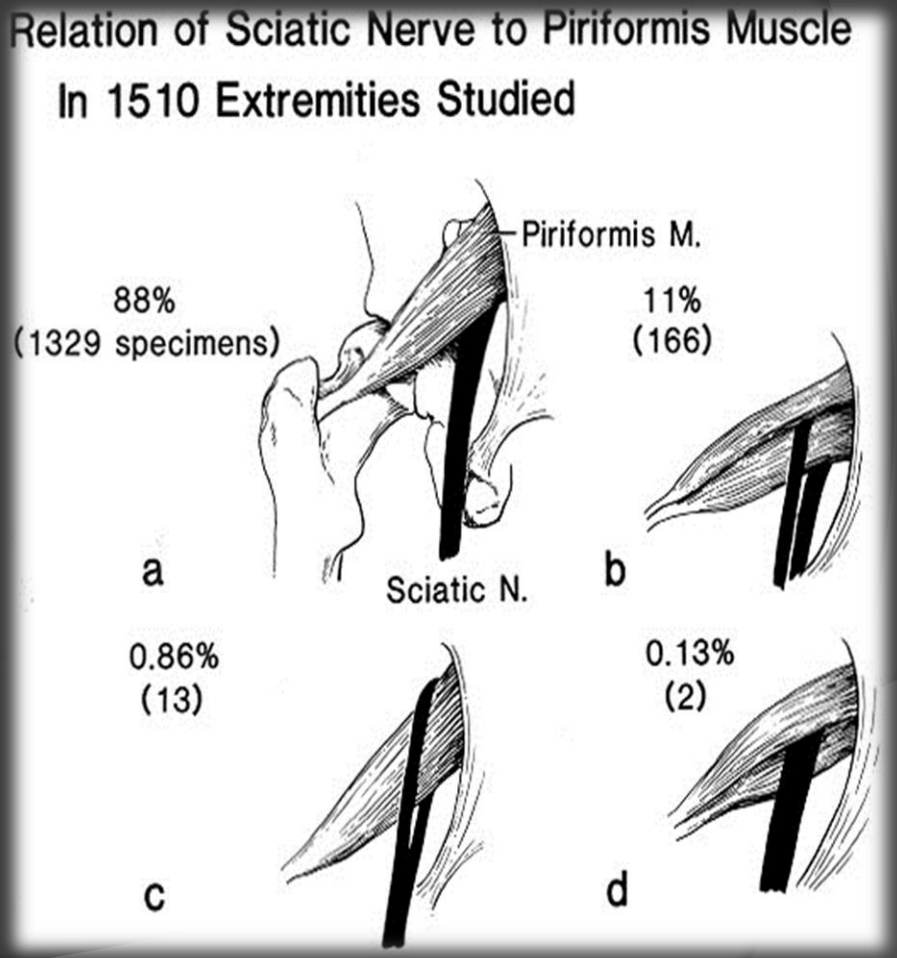
SCIATIC NERVE COMPRESSION/IRRITATION

- Piriformis Syndrome:
  - Both divisions of the sciatic nerve pass the piriformis muscle – various configurations exist:
  - In 17% of people, the piriformis muscle is pierced by parts or all of the sciatic nerve. Several variations occur, but the most common type of anomaly (81% of anomalies) is the Beaton's type B which is when the common peroneal nerve pierces the piriformis muscle.[



SCIATIC NERVE COMPRESSION/IRRITATION

- Piriformis Syndrome:
  - In the vast majority (90%) the nerve exits the greater sciatic foramen below the muscle. But in 7.1% the nerve demonstrated anterior and posterior divisions which passed through a divided piriformis muscle. In 2.1% the divided nerve passed above and below an undivided muscle, and in .8% an undivided nerve passed though the 2 heads of a divided muscle. The nerve can also pass undivided along the anterior superior surface of the muscle.
  - Examinee will report deep gluteal pain, sciatic neuralgia, and may walk with the foot everted.



COMMON PERONEAL NERVE COMPRESSION/IRRITATION

- Fibular Head: Most common form of peripheral nerve injury of the lower extremity.
- Habitual leg crossing
- Direct trauma/external compression
- Contusions/wounds/fractures involing the lateral knee/lacerations
- Ankle sprains with proximal fibular fracture
- Knee dislocations
- Prolonged squatting (strawberry picker's palsy)

POSTERIOR TIBIAL NERVE COMPRESSION/IRRITATION

- Most common location is distal to ankle due to intrinsic neural abnormalities and/or external compression (fibrosis, neurilemomas, ganglion cysts, lipomas, tight tarsal canal, hypertrohpic abductor hallucis, anomalous artery, tenosynovitis, partial or complete rupture of the medial tendons.
- Other risk factors include diabetes, rheumatoid arthritis, heel varus or valgus, varicose posterior tibial veins (common)

Location of Entrapment	Physical Exam Finding	Explanation
Pelvic trauma	Weakness and wasting of the short head of the biceps femoris muscle differentiates this from a lesion lower down – such as in the back of the leg	The branch to the short head of the biceps femoris comes off prior
Piriformis Syndrome	Six classic (Robinson 1947) diagnostic findings: 1. History of trauma to the sacroiliac and gluteal areas. 2. Pain at the sacroiliac joint, greater sciatic notch, and piriformis muscle that radiates down the limb and causes difficulty walking. 3. Acute exacerbation of pain by stooping or lifting and moderate relief of pain by traction in a supine position.	

Location of Entrapment	Physical Exam Finding	Explanation
Piriformis Syndrome	4. Palpable sausage-shaped tender mass over the piriformis muscle on the painful side. 5. Positive Lasegue's sign. 6. Gluteal atrophy, depending upon duration of the affliction. Exam: • Spasm Test – With patient supine on examining table – firmly invert the feet • Internal Rotation of femur with SLR or internal Rotation of femur with hips and knees flexed to 90 degrees • Piriformis Strength test reproduces pain • Passive hip abduction test	
Fibular Head	Short head of biceps femoris spared Pain not always present Gait disturbance (stepage gait) due to paretic or paralyzed ankle dorsiflexors (drop foot) (slappage foot) Weakness of EDB Loss of sensation to dorsum of foot	

Location of Entrapment	Physical Exam Finding	Explanation
Tarsal Tunnel	Diffuse, vague discomfort – or pain Burning/tingling/numbness of plantar foot Possible proximal radiation of pain to the medial leg Worse with prolonged standing and walking Night Pain Pain with extreme dorsiflexion Pain unrelated to weight bearing (differentiates it from plantar fasciitis) Symptoms may correlate with onset of use of orthotics Exam: Possible hindfoot varus/valgus Possible varicosities, swelling, skin changes-	

Location of Entrapment	Physical Exam Finding	Explanation
Tarsal Tunnel	Pulses – may be involved due to compression of posterior tibial artery Patchy numbness in distribution of medial or lateral plantar nerves, or of calcaneal nerve(s) Increased pain with dorsiflexion, inversion, or eversion Possible weakness of ADM or Abductor Hallucis Palpable ganglia, tenosynovitis (or other space occupying lesion) in tarsal tunnel. Positive Tinel's or Durkan's compression (60 seconds)	These movements increase tarsal compartment pressure Innervated by lateral plantar nerve and medial plantar nerve respectively

SUMMARY

- Summary of Nerve Functions:
  - Femoral Nerve
  - Obturator Nerve
  - Sciatic Nerve

Summary of Function of Femoral, Obturator, and Sciatic Nerves	Muscle Actions/Sensory Distribution	Simplified Tests of Muscle Action
Femoral Nerve	Hip Flexion (iliacus/rectus femoris and also psoas – but remember, psoas is innervated by L2/L3 nerve roots prior to contribution of L4 Knee Extension (quadriceps) Sensory to front of thigh	Best: Resisted Knee Extension (supine on exam table, repetitive squat maneuver, rising from sitting to stand), observe for atrophy Monofilament to front/medial thigh above knee
Obturator	Hip Adduction (pectineus, adductor brevis, adductor longus, adductor magnus, and gracilis) Sensory to small patch at medial knee (slightly posterior)	Resisted hip adduction Monofilament to medial knee (slightly posterior)

Summary of Function of Femoral, Obturator, and Sciatic Nerves	Muscle Actions/Sensory Distribution	Simplified Tests of Muscle Action
Sciatic Nerve (Tibial Division)	Knee Flexion (through 3 of 4 hamstring muscles (exception is short head of biceps femoris) Ankle Plantarflexion (through soleus/gastrocnemius/plantaris) Sensory: Lateral foot (sural nerve), entire sole of foot (medial and lateral plantar nerves)	Resisted knee flexion (patient prone) Toe walk Monofilament to lateral foot or sole of foot
Sciatic Nerve (Common Peroneal Division)	Ankle Dorsiflexion (through tibialis anterior) Sensory to dorsum of foot and particularly, dorsal 1st web space	Heel walk Resisted dorsiflexion (patient supine) Dorsiflexion “reps” Monofilament testing

Gait Disturbances	Antalgic Gait	Foot Drop	Heel Drop
Nerve Involved	Posterior Tibial (either of medial plantar, lateral plantar, or medial calcaneal nerve)	Deep Peroneal (branch of common peroneal, division of sciatic, from anterior divisions of L4/L5)	Tibial (division of sciatic, from posterior divisions of S1/S2)
Typical Presentation	Takes short strides (shortened stance phase) and immediately “gets off” the painful foot – as if walking on hot cement	High steppage gait, may be slapping of foot on impact due to loss of eccentric dorsiflexion	Shortened stance phase due to inability of gastrocnemius to contribute to propulsion
Muscles Paralyzed	N/A	Anterior tibialis	Gastrocnemius/soleus/plantaris
Movements Involved	N/A	Loss of function of ankle dorsiflexion	Loss of ankle plantarflexion

QME EXAM PROCEDURES

- Lower Extremity Examination:
  - Neurologic Components
    - Sensory Exam – light touch, pain, two point discrimination
    - Motor Exam – manual muscle testing of the muscles innervated by the named peripheral nerves
    - Reflex Exam – adductor/knee/medial and lateral hamstrings/ posterior tibial/achilles
    - Girth measurements – 10 cm. above and 10 cm. below the knee joint.

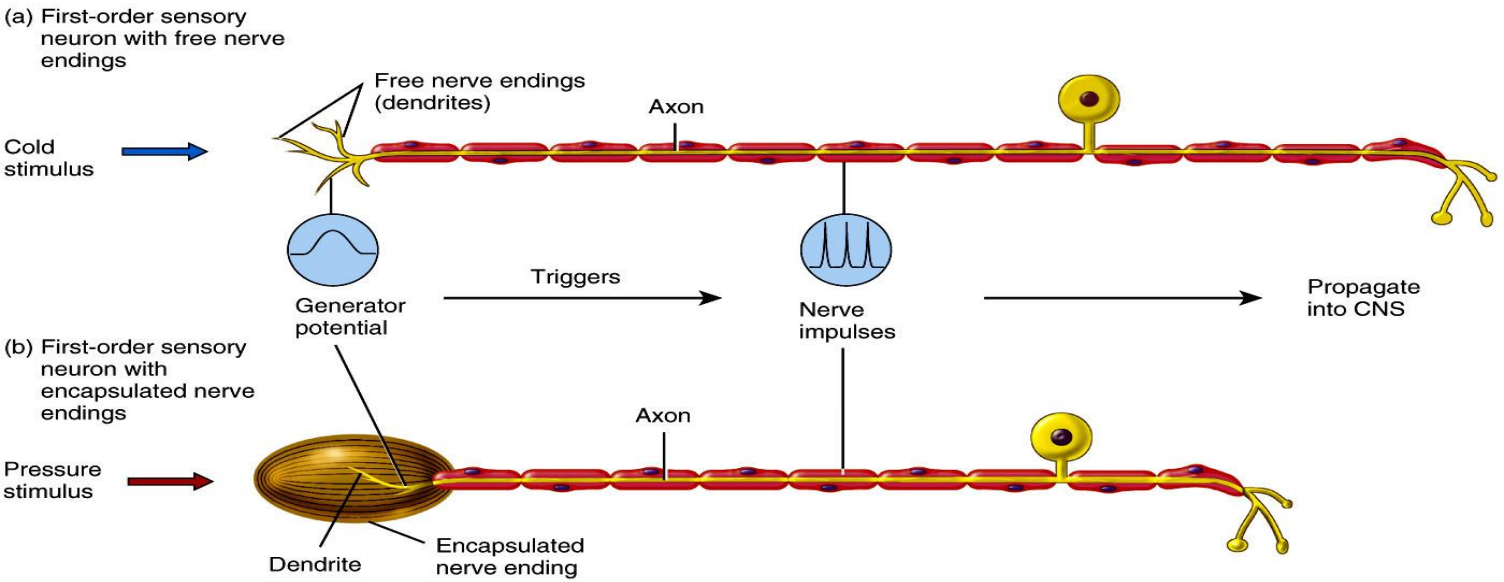
QME EXAM PROCEDURES – SENSORY EXAM

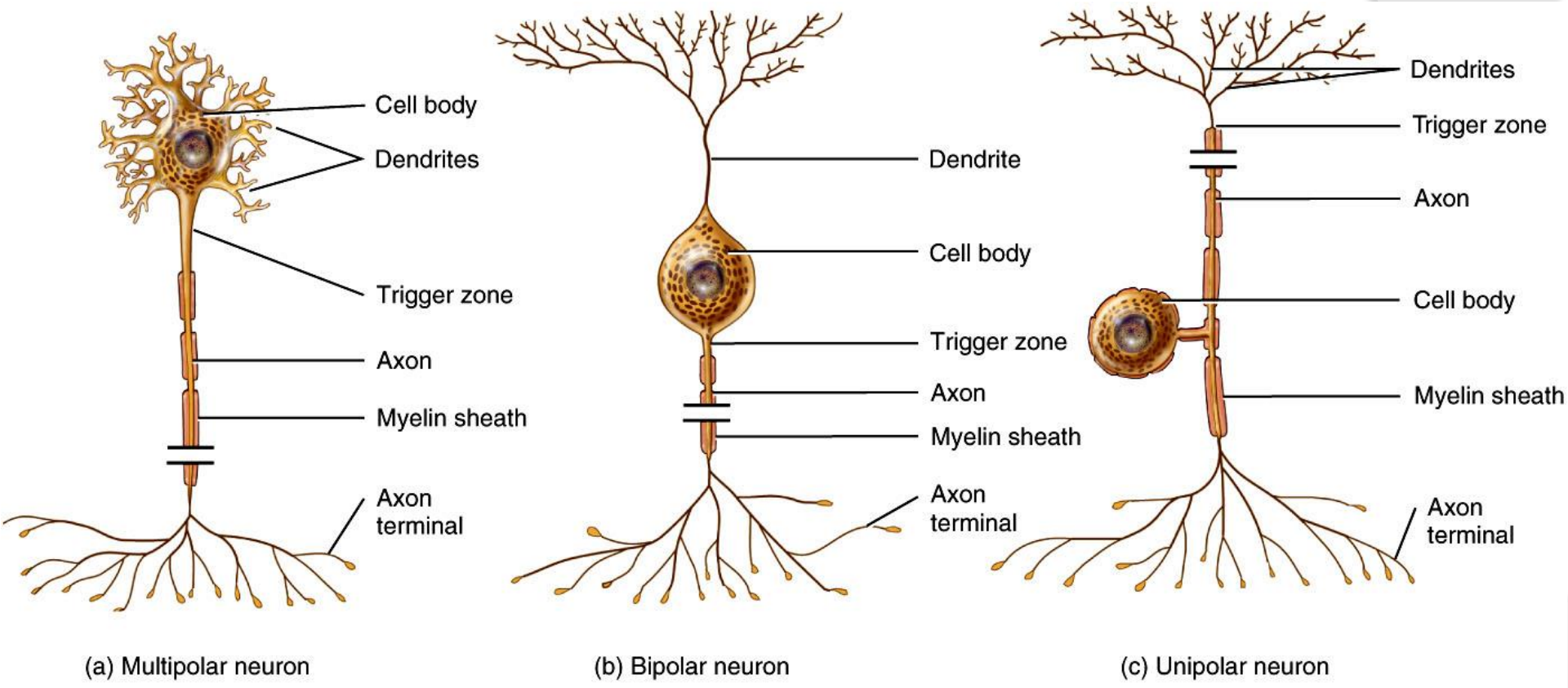
- Sensory examination:
- 2 basic classifications of sensory receptors that we will be involved with –

1. Unencapsulated Receptors
2. Encapsulated Receptors

QME EXAM PROCEDURES – SENSORY EXAM

- Brief Review of Sensory receptors
  - Unencapsulated Receptors
    - Free Nerve Endings
  - Encapsulated Receptors
    - Meissner corpuscles
    - Ruffini corpuscles
    - Pacini corpuscles
    - Krause end bulbs
    - Golgi tendon organs
    - Muscle spindles


(a) First-order sensory neuron with free nerve endings
Free nerve endings (dendrites)
Axon
Cold stimulus
Generator potential
Triggers
Nerve impulses
Propagate into CNS
(b) First-order sensory neuron with encapsulated nerve endings
Axon
Pressure stimulus
Dendrite
Encapsulated nerve ending



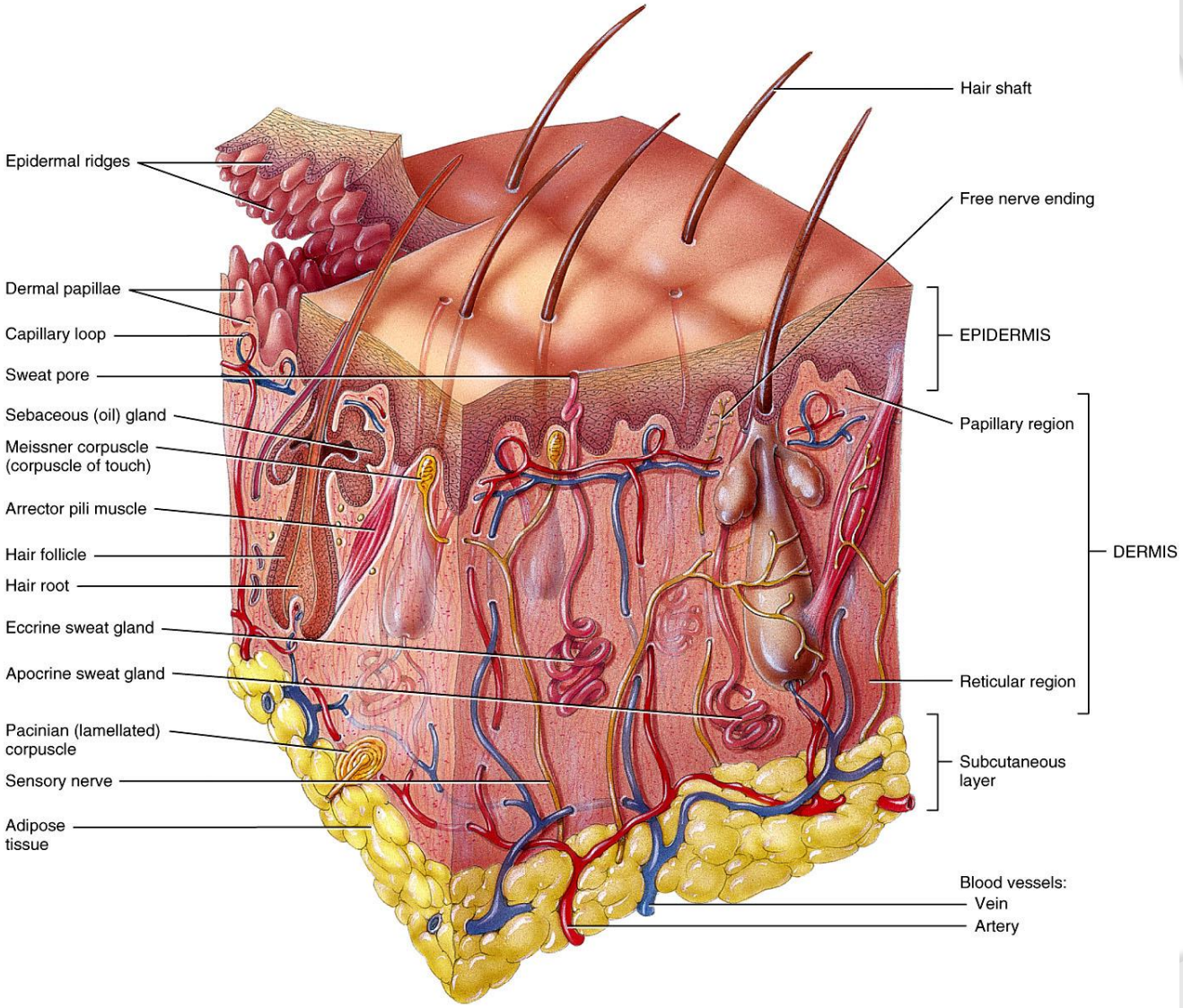
(a) Multipolar neuron

(b) Bipolar neuron

(c) Unipolar neuron

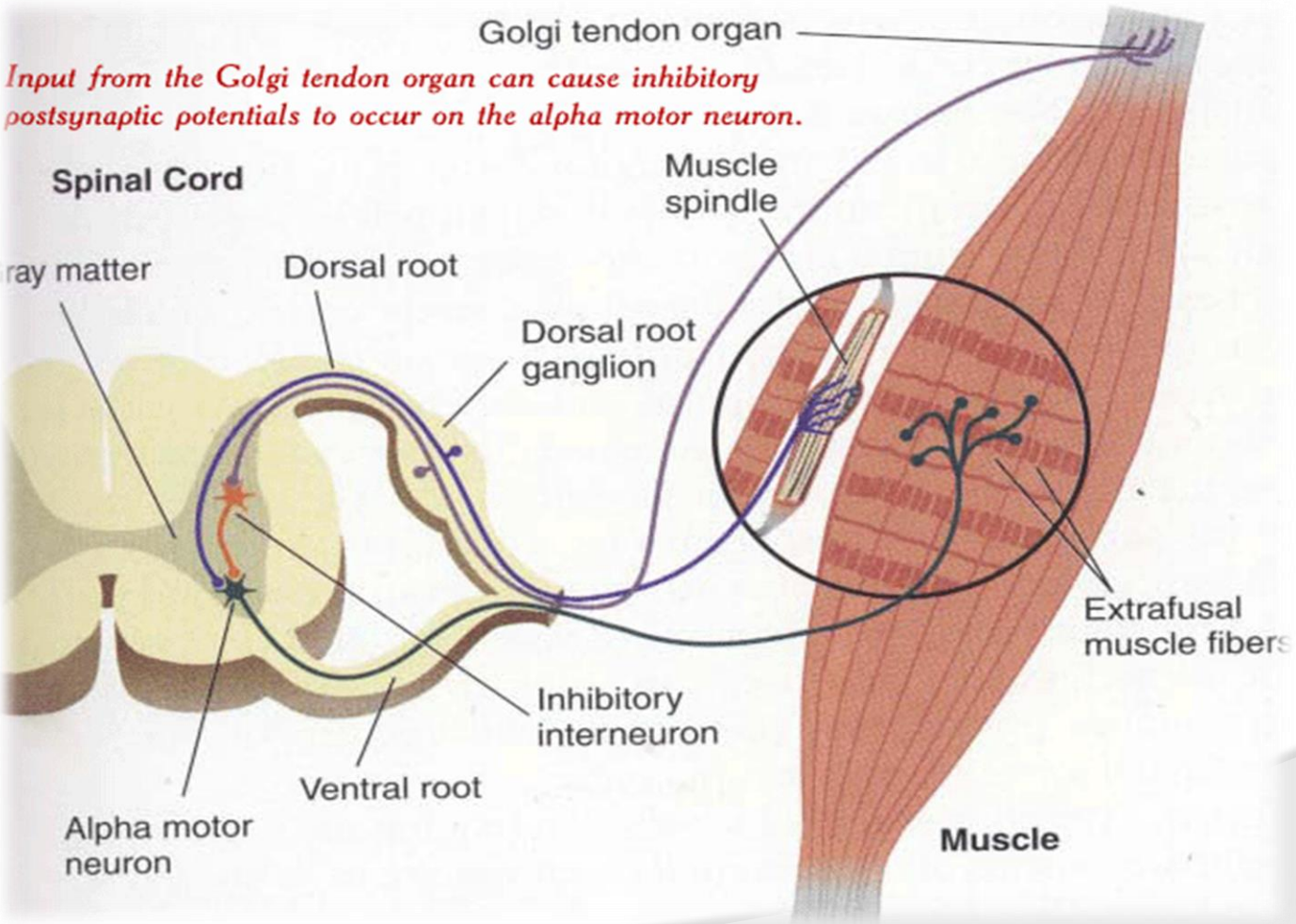
Free NN. Endings (unencapsulated)	Skin & Mucosa (Epithelial layer)	Pain, crude touch, temp., itch, tickle
Meissner Corpuscles (encapsulated)	Skin (papillae of dermis), fingertips/lips	Fine touch, low freq. vibration
Ruffini corpuscles (encapsulated)	Skin (dermis) and subcutaneous tissue of fingertips	Touch and pressure
Pacini corpuscles (encapsulated)	Subcutaneous tissues, around joints	Pressure and high freq. vibration

Krause End Bulbs (encapsulated)	Skin (dermis), subcutaneous tissue, mucosa of lips, eyelids, external genitals	Touch
Golgi Tendon Organs	Musculotendinous junction	Proprioception (sense of muscle tension)
Muscle Spindles	Skeletal muscles	Proprioception (sense of muscle length and sense of rate of change of length)



(a) Sectional view of skin and subcutaneous layer

Figure 05.01a Tortora - PAP 12/e


Golgi tendon organ
Input from the Golgi tendon organ can cause inhibitory postsynaptic potentials to occur on the alpha motor neuron.
Spinal Cord
Muscle spindle
ray matter
Dorsal root
Dorsal root ganglion
Extrafusal muscle fibers
Inhibitory interneuron
Ventral root
Alpha motor neuron
Muscle

QME EXAM PROCEDURES – SENSORY EXAM

The Sensory Examination consists of procedures to test the sensory modalities of light touch, pain, two point discrimination, and joint position sense as follows:

Superficial Tactile Sensibility (Light Touch) – This Sensory Exam was performed using a Semmes Weinstein monofilament.

Pain - This Sensory Exam was performed using the Whartenburg pinwheel with sharp and dull sides.

Two Point Discrimination –The AMA Guides do not describe two point discrimination findings in the lower extremity.

QME EXAM PROCEDURES – SENSORY EXAM

- Lateral Femoral Cutaneous Nerve: Sensory
  - Normal sensation to light touch at the lateral aspect of the thigh from the greater trochanter to the knee.
- Genitofemoral Nerve: Sensory
  - Normal sensation to light touch at the anterior aspect of the thigh over the hip joint and to halfway down to the knee.
- Femoral Nerve: Sensory
  - Normal sensation to light touch at the medial and anterior aspect of the thigh above the knee.
- Posterior Femoral Cutaneous Nerve: Sensory
  - Normal sensation to light touch at the posterior aspect of the thigh from the buttock crease to the back of the knee.
- Obturator Nerve: Sensory
  - Normal sensation to light touch at the medial aspect of the knee to a point approximately 6 inches above the knee medially.
- Saphenous Nerve: Sensory
  - Normal sensation to light touch at the medial aspect of the leg extending from the knee to the medial malleolus bilaterally.
- Lateral Sural Cutaneous Nerve: Sensory
  - Normal sensation to light touch at the lateral aspect of the leg extending from the knee to the lateral malleolus bilaterally.
- Superficial Peroneal Nerve: Sensory
  - Normal sensation to light touch at the dorsum of the foot and over the anterior ankle bilaterally.
- Deep Peroneal Nerve: Sensory
  - Normal sensation to light touch at the dorsal web space between the great toe and second toe bilaterally.
- Sural Nerve: Sensory
  - Normal sensation to light touch at the lateral aspect of the foot and along the fifth metatarsal bone bilaterally.

QME EXAM PROCEDURES – SENSORY EXAM

At the foot:

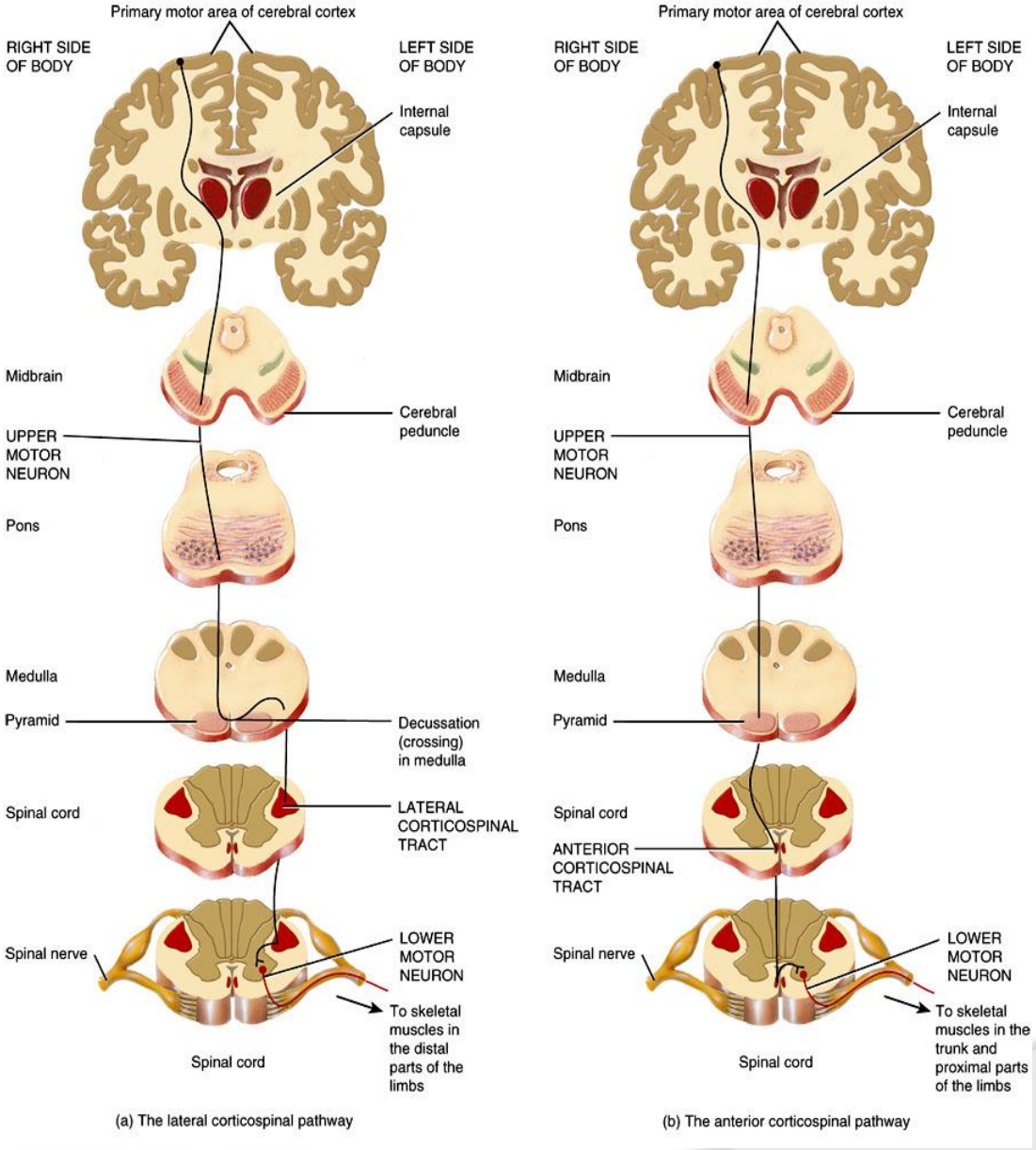
- Medial Calcaneal Nerve: Sensory
  - Normal sensation to light touch across the bottom of the heel.
- Medial Plantar Nerve: Sensory
  - Normal sensation to light touch over the bases of the 1st, 2nd, and 3rd metatarsal-phalangeal joints and back to the heel.
- Sural Nerve: Sensory
  - Normal sensation to light touch at the lateral aspect of the heel up to the lateral malleolus.
- Saphenous Nerve: Sensory
  - Normal sensation to light touch at the medial aspect of the arch of the foot up to the medial malleolus.
- Lateral Plantar Nerve: Sensory
  - Normal sensation to light touch at the bases of the 4th and 5th metatarsal-phalangeal joints and back to the heel.

QME EXAM PROCEDURES – MOTOR EXAM

- Motor Examination – consists of:
  - Manual muscle testing
  - Reflexes
  - Girth measurements.

QME EXAM PROCEDURES – MOTOR EXAM

- Manual muscle testing
  - AMA Guides: No specific mention of the technique for manual muscle testing
  - References:
  - Technique of the Neurologic Examination - DeMeyer
  - Fundamentals of Musculoskeletal Assessment Techniques – Palmer & Epler
  - Muscles: Testing and Function, with Posture and Pain – Florence Kendall (2005)
  - Muscle Testing – Techniques of Manual Examination – Daniels and Worthingham


Primary motor area of cerebral cortex
RIGHT SIDE OF BODY
LEFT SIDE OF BODY
Internal capsule
Midbrain
Cerebral peduncle
UPPER MOTOR NEURON
Pons
Medulla
Pyramid
Decussation (crossing) in medulla
Spinal cord
LATERAL CORTICOSPINAL TRACT
Spinal nerve
LOWER MOTOR NEURON
To skeletal muscles in the distal parts of the limbs
Spinal cord
(a) The lateral corticospinal pathway
Primary motor area of cerebral cortex
RIGHT SIDE OF BODY
LEFT SIDE OF BODY
Internal capsule
Midbrain
Cerebral peduncle
UPPER MOTOR NEURON
Pons
Medulla
Pyramid
Spinal cord
ANTERIOR CORTICOSPINAL TRACT
Spinal nerve
LOWER MOTOR NEURON
To skeletal muscles in the trunk and proximal parts of the limbs
Spinal cord
(b) The anterior corticospinal pathway

QME EXAM PROCEDURES – MOTOR EXAM

- Procedures for Manual Muscle Testing:
- General Principles:
  1. Select movements for the examinee to resist that would just about match your arm and hand strength. Select movements that are neither too strong for you to possibly overcome nor too weak for you to judge their resistance.

QME EXAM PROCEDURES – MOTOR EXAM

- Manual Muscle Testing (cont.):

  2. Understand that muscles are strongest when acting from their shortest length, and have little or no strength when acting from their longest position. Therefore, to test muscle of weak or modest strength, start with the muscle in a position of strength. To test very strong muscles, place the muscle in a position of disadvantage to bring them within your own range of strength.

Technique of the QME Examination

- Manual Muscle Testing (cont.):

3. Engage the examinee and get their competitive spirit into the game. Encourage them to put forth their best effort.
4. Test in a repeatable superior to inferior direction.
5. Always stabilize the proximal joint to prevent muscle substitution.
6. Specific manual muscle tests for the spine and for the upper and lower extremity examinations and their methods are described in another module.

REPORTING YOUR FINDINGS

- Obturator Nerve - Motor:
  - Resisted hip adduction using the pectineus, adductor brevis, adductor longus, adductor magnus, and gracilis muscles was strong and symmetric bilaterally with no evidence of weakness or give way of the knee. This tests the motor portion of peripheral obturator nerve – and indicates normal function.
- Femoral Nerve: Motor
  - Resisted knee extension using the vastus lateralis and vastus intermedius muscles was strong and symmetric bilaterally with no evidence of weakness of give way of the knee. The tests the motor portion of the peripheral femoral nerve – and indicates normal function.

REPORTING YOUR FINDINGS

- Sciatic – Tibial Nerve: Motor
  - Resisted ankle/foot plantar flexion using the gastrocnemius muscles were strong and symmetric bilaterally with no evidence of weakness or give way. This tests the motor portion of the peripheral tibial nerve.
  - Resisted toe flexion using the flexor digitorum longus muscles were strong and symmetric bilaterally with no evidence of weakness or give way. This tests the motor portion of the peripheral tibial nerve.

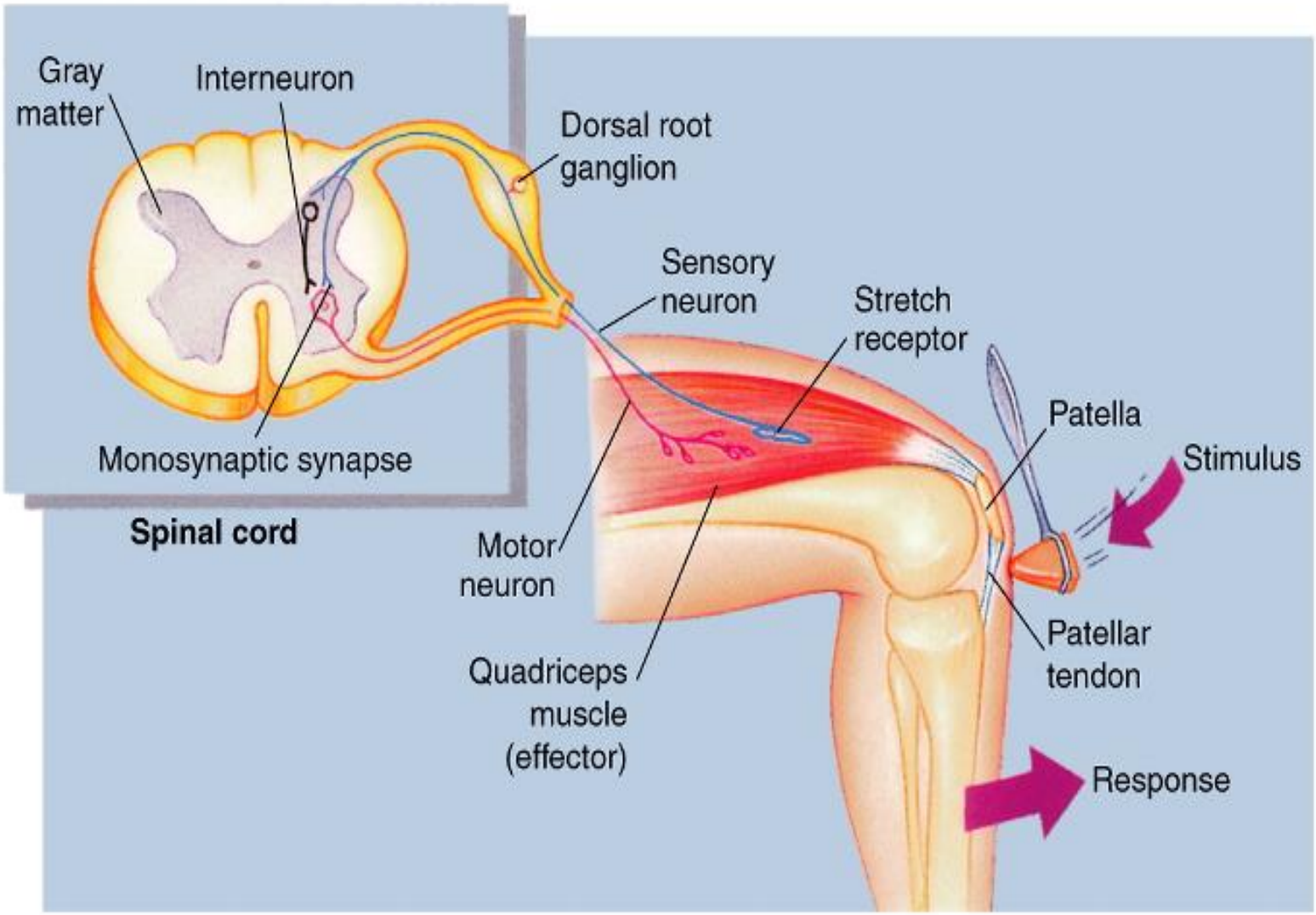
- Sciatic – Common Peroneal Nerve:
  - Resisted great toe extension using the extensor hallucis longus muscles were strong and symmetric bilaterally with no evidence of weakness or give way. This tests the motor portion of the deep peroneal nerve, a branch of the peripheral common peroneal nerve.
  - Resisted toe extension using the extensor digitorum longus muscles were strong and symmetric bilaterally with no evidence of weakness or give way. This tests the motor portion of the deep peroneal nerve, a branch of the peripheral common peroneal nerve.

QME EXAM PROCEDURES – MOTOR EXAM

- Lower Extremity Reflexes (Adductor/Knee/Ankle/Medial and Lateral Hamstrings)
- Components of a Reflex Arc:
  - 1. Stimulus – rapid stretch of muscle/tendon
  - 2. Receptors – muscle spindle in muscle (specialized dendrite)
    - Detect stimulus

Technique of the QME Examination

- 3. Sensory Nerve – impulses travel up dendrite to the nerve cell body – located (???) – axon ends in the spinal cord
- 4. Control center (brain or spinal cord) - Decides the correct response
- 5. Motor nerve – carries impulse back to the effector (muscle) – chemicals released from NMJ
- 6. Effector - A muscle or gland that carries out the response (quadricep – in the case of the knee reflex - muscle shortens)


Gray matter
Interneuron
Dorsal root ganglion
Sensory neuron
Stretch receptor
Patella
Stimulus
Monosynaptic synapse
Spinal cord
Motor neuron
Quadriceps muscle (effector)
Patellar tendon
Response
S
P
D
I

REFLEX	LEFT	RIGHT
Adductor Jerk (L3 through obturator nerve)	+2 (normal)	+2 (normal)
Knee Jerk (L4 through femoral nerve)	+2 (normal)	+2 (normal)
Ankle Jerk (S1 through tibial nerve)	+2 (normal)	+2 (normal)
Medial and lateral hamstring jerks (Both S1 but medial is tibial and lateral (biceps femoris) is peroneal)	+2 (normal)	+2 (normal)

REPORTING YOUR FINDINGS

- The lower extremity reflexes were normal and symmetric bilaterally. This indicates preserved function of:

- Left and right quadriceps muscle spindles (stretch receptors)
- Left and right gastrocnemius muscle spindles (stretch receptors)
- Left and right femoral (L2, L3, and **L4** nerve roots) nerve sensory function
- Left and right tibial (L4, L5, **S1**, S2, and S3 nerve roots) nerve sensory function
- Left and right femoral (L2, L3, and L4 nerve roots) nerve motor function
- Left and right tibial (L4, L5, S1, S2, S3 nerve roots) nerve motor function
- Left and right quadriceps muscle function
- Left and right gastrocnemius muscle function.
- Fill in blanks for “obturator nerve” and “peroneal nerve” reflexes

QME EXAM PROCEDURES – MOTOR EXAM

- Girth Measurements:
- 10 cm. above and 10 cm. below knee -

QME EXAM PROCEDURES

- Observation:
  - Gait (see also QME Continuing Education Program “Gait Disturbances and Assistive Devices”) – various named gait signs (steppage gait/slapping foot/etc.). This is the single most important part of the neurologic evaluation.
  - Atrophy

The Neurologic Examination

- Necessary Tools:
- Cloth Measuring Tape – for measuring circumferences, length of extremities, etc.
- Tuning Fork (256 cps) – for testing vibratory sensation, for testing temperature discrimination, for testing hearing
- Semmes-Weinstein Filaments – 2.36 gauge, and others up to 6.31 gauge
- Pinwheel – for testing pain sensation
- Aesthesiometer – for testing 2 point discrimination
- Reflex hammer – for testing muscle stretch reflexes

DETERMINING PERMANENT IMPAIRMENT DUE TO UPPER EXTREMITY PERIPHERAL NEUROPATHIES

PERMANENT IMPAIRMENT DUE TO ENTRAPMENT NEUROPATHIES

- AMA Guides (page 493):
  - “Only individuals with an objectively verifiable diagnosis should qualify for a permanent impairment rating. The diagnosis is made not only on believable symptoms but, more important, and on the presence of positive clinical findings and loss of function.
  - The diagnosis should be documented by electromyography as well as sensory and motor nerve conduction studies.
  - …There is no correlation between the severity of conduction delay on nerve conduction velocity testing and the severity of either symptoms or impairment rating.”

PERMANENT IMPAIRMENT DUE TO ENTRAPMENT NEUROPATHIES

- AMA Guides (page 550):
- “Peripheral nerve injuries are divided into two components: motor deficits and sensory deficits….
- All estimates listed in Table 17-37 (page 552) are for complete motor or sensory loss for the named peripheral nerves. Partial sensory and motor deficits shoulder be rated as in the upper extremity (Tables 16-10 and 16-11).

Table 17-37

Table 17-37 Impairments Due to Nerve Deficits

	Whole Person (Lower Extremity) [Foot] Impairment (%)		
Nerve	Motor	Sensory	Dysesthesia
Femoral	15 (37)	1 (2)	3 (7)
Obturator	3 (7)	0	0
Superior gluteal	25 (62)	0	0
Inferior gluteal	15 (37)	0	0
Lateral femoral cutaneous	0	1 (2)	3 (7)
Sciatic	30 (75)	7 (17)	5 (12)
Common peroneal	15 (42)	2 (5)	2 (5)
Superficial peroneal	0	2 (5)	2 (5)
Sural	0	1 (2)	2 (5)
Medial plantar	2 (5) [7]	2 (5) [7]	2 (5) [7]
Lateral plantar	2 (5) [7]	2 (5) [7]	2 (5) [7]

Table 16-10

Table 16-10 Determining Impairment of the Upper Extremity Due to Sensory Deficits or Pain Resulting From Peripheral Nerve Disorders

a. Classification

Grade	Description of Sensory Deficit or Pain	% Sensory Deficit
5	No loss of sensibility, abnormal sensation, or pain	0
4	Distorted superficial tactile sensibility (diminished light touch), with or without minimal abnormal sensations or pain, that is forgotten during activity	1-25
3	Distorted superficial tactile sensibility (diminished light touch and two-point discrimination), with some abnormal sensations or slight pain, that interferes with some activities	26-60
2	Decreased superficial cutaneous pain and tactile sensibility (decreased protective sensibility), with abnormal sensations or moderate pain, that may prevent some activities	61-80
1	Deep cutaneous pain sensibility present; absent superficial pain and tactile sensibility (absent protective sensibility), with abnormal sensations or severe pain, that prevents most activity	81-99
0	Absent sensibility, abnormal sensations, or severe pain that prevents all activity	100

Table 16-11

Table 16-11 Determining Impairment of the Upper Extremity Due to Motor and Loss-of-Power Deficits Resulting From Peripheral Nerve Disorders Based on Individual Muscle Rating

a. Classification

Grade	Description of Muscle Function	% Motor Deficit
5	Complete active range of motion against gravity with full resistance	0
4	Complete active range of motion against gravity with some resistance	1- 25
3	Complete active range of motion against gravity only, without resistance	26- 50
2	Complete active range of motion with gravity eliminated	51- 75
1	Evidence of slight contractility; no joint movement	76- 99
0	No evidence of contractility	100

PERMANENT IMPAIRMENT DUE TO ENTRAPMENT NEUROPATHIES

- AMA Guides (page 552):
- Estimates for peripheral nerve impairments may be combined with those for other types of lower extremity impairments, except those for muscle weakness, atrophy, and gait derangement.

Table 17-2 Guide to the Appropriate Combination of Evaluation Methods

Open boxes indicate impairment ratings derived from these methods can be combined.

	Limb Length Discrepancy	Gait Derangement	Muscle Atrophy	Muscle Strength	ROM Ankylosis	Arthritis (DJD)	Amputation	Diagnosis-Based Estimates (DBE)	Skin Loss	Peripheral Nerve Injury	Complex Regional Pain Syndrome (CRPS)	Vascular
Limb Length Discrepancy		X					X					
Gait Derangement	X		X	X	X	X	X	X	X	X	X	X
Muscle Atrophy		X		X	X	X	X	X		X	X	
Muscle Strength		X	X		X	X		X		X	0	
ROM Ankylosis		X	X	X		X		X			0	
Arthritis (DJD)		X	X	X	X							
Amputation	X	X	X	X								
Diagnosis-Based Estimates (DBE)		X	X	X	X							
Skin Loss		X										
Peripheral Nerve Injury		X	X	X							X	
Complex Regional Pain Syndrome (CRPS)		X	X	0	0					X		X
Vascular		X									X	

X = Do not use these methods together for evaluating a single impairment.

0 = See specific instructions for CRPS of the lower extremity.

PERMANENT IMPAIRMENT CALCULATION

- AMA Guides page 550:
  - Identify the injured nerve(s) – determine if there is a sensory and/or motor component
  - Grade severity of motor deficit (Table 16-11a on page 484). Values range from 0 (no deficit) to 100% (no evidence of contractility)
  - Grade severity of sensory deficit (Table 16-10a on page 482). Values range from 0 (normal) to 100% (complete loss of all sensibility or *severe* pain
  - Combine Impairments (using Combined Values Chart on page 604):
    - Combine 1) Sensory Impairments with 2) Motor Impairments for nerves with motor & sensory fibers
    - Combine Sensory and/or motor impairments of one nerve with sensory and/or motor impairments of another nerve in the event of multiple nerve involvements
  - Note: Table 17-37 already contains the conversion to Whole Person Impairment.

GRADING SENSORY DEFICIT

- Steps 1&2: Identify area of involvement (Figure 17-8). Identify the nerve structure(s) innervating that area.
  - Anterior aspect of lower extremity:
    - Lateral femoral cutaneous nerve/genitofemoral nerve/femoral/obturator/lateral sural cutaneous/saphenous/superficial peroneal/deep peroneal
  - Posterior aspect of lower extremity:
    - Femoral/posterior femoral cutaneous/lateral femoral cutaneous/obturator/saphenous/sural/superficial peroneal
  - At the Foot:
    - Sural/saphenous/medial plantar/lateral plantar/medial calcaneal

GRADING SENSORY DEFICIT

- Step 3: Grade *severity* of the sensory deficit – or pain – according to Table 16-10a on page 482

Grade	Description of Sensory Deficit, or Pain – Table 16-10a	% Sensory Deficit
5	No loss of sensibility, abnormal sensation, or pain	0%
4	Distorted superficial tactile sensibility (diminished light touch), with or without minimal abnormal sensations or pain, that is forgotten during activity.	1-25%
3	Distorted superficial tactile sensibility (diminished light touch and diminished two point discrimination), with some abnormal sensations, or slight pain, that interferes with some activities. AMA Guides do not discuss two point discrimination in the lower extremity.	26-60%
2	Decreased superficial cutaneous pain and tactile sensibility (decreased protective sensibility), with abnormal sensations or moderate pain, that may prevent some activities.	61-80%
1	Deep cutaneous pain sensibility present, absent superficial pain and tactile sensibility (absent protective sensibility), with abnormal sensations or severe pain, that prevents most activity.	81-99%
0	Absent sensibility, abnormal sensations, or severe pain that prevents all activity.	100%

GRADING SENSORY DEFICIT

- Step 4: Determine the maximum lower extremity impairment value (for the particular nerve(s) involved) due to sensory deficit or *pain* according to Table 17-37. Example – Superficial Peroneal Nerve = 2% Whole Person Impairment

Table 17-37 Impairments Due to Nerve Deficits

	Whole Person (Lower Extremity) [Foot] Impairment (%)		
Nerve	Motor	Sensory	Dysesthesia
Femoral	15 (37)	1 (2)	3 (7)
Obturator	3 (7)	0	0
Superior gluteal	25 (62)	0	0
Inferior gluteal	15 (37)	0	0
Lateral femoral cutaneous	0	1 (2)	3 (7)
Sciatic	30 (75)	7 (17)	5 (12)
Common peroneal	15 (42)	2 (5)	2 (5)
Superficial peroneal	0	2 (5)	2 (5)
Sural	0	1 (2)	2 (5)
Medial plantar	2 (5) [7]	2 (5) [7]	2 (5) [7]
Lateral plantar	2 (5) [7]	2 (5) [7]	2 (5) [7]

Nerves with Sensory Impairment only	Nerves with Motor Impairment only	Nerves with Combined Sensory and Motor Impairment
Lateral femoral cutaneous nerve	Obturator!!**	Femoral
Superficial peroneal**	Superior Gluteal Nerve	Sciatic
Sural	Inferior Gluteal Nerve	Common Peroneal
		Medial Plantar
		Lateral Plantar
AMA Guides do not Provide Impairment for:		
	Total loss of ankle eversion through the peronei	Superficial peroneal
	Total loss of sensation to the medial knee	Obturator

GRADING SENSORY DEFICIT

- Step 5: Multiple the % *severity deficit* (Step 3) by the maximum Whole Person Impairment value (Step 4) to obtain the final Whole Person Impairment.
- Step 6: Do this for each nerve structure involved. Record your numbers

GRADING MOTOR DEFICIT

Steps 1&2: Identify the *Motor Deficit.* "Identify the injured nerve….."

For Upper Extremities we use Table 16-12 to determine which muscle is weak, and therefore, which nerve is involved.

No such Table in Chapter 17. Therefore, use the following Table:

Muscle Weakness	Associated Nerve from Table 17-37
Weakness in 1) resisted knee extension and/or 2) resisted hip flexion	Femoral Nerve
Weakness in 1) resisted hip adduction	Obturator Nerve
Weakness of gluteus medius/gluteus minimus/tensor fascia lata (weakness of resisted hip abduction by manual muscle testing or, when the hip is fixed – loss of coronal plane stabilization of the pelvis – known as “trendelenburg sign”). If bilateral this results in “waddling gait.”	Superior Gluteal Nerve (named peripheral nerve of the sacral plexus arising from dorsal divisions of L4/L5/S1 prior to formation of common peroneal nerve)
Weakness of gluteus maximus (weakness of resisted hip extension by manual muscle testing or, when the hip is fixed – loss of sagital plane stabilization of the pelvis – known as the “gluteus maximus lurch” – a compensation for lack of hip extension during the stance phase of gait). If bilateral, results in “	Inferior Gluteal Nerve (named peripheral nerve of the sacral plexus arising from dorsal divisions of L5/S1/S2 prior to formation of common peroneal nerve)

Muscle Weakness	Associated Nerve from Table 17-37
Already discussed this at length with regard to the Tibial and Common Peroneal Divisions of the Sciatic nerve – this probably refers to all muscle innervations above the knee (semitendinosis/biceps femoris long head/semimembranosus/adductor magnus) and all innervations of the tibial nerve below the knee (excluding the foot)	Sciatic Nerve
Already discussed this at length as well. Because the AMA Guides break out the common peroneal nerve from the sciatic nerve – it appears that the AMA Guides provide for Impairment for weakness of all innervations (short head of biceps femoris/tibialis anterior/peroneus longus/peroneus brevis/peroneus tertius/ EHL/EDL	Common Peroneal

Muscle Weakness	Associated Nerve from Table 17-37
Weakness of AH, FDB, FHB, and 1st lumbrical (big toe abduction/flexion of proximal phalanx of toes 2-5/flexion of proximal phalanx of big toe/flexion of 2nd MTP with extension of 2nd IP	Medial Plantar
Weakness of ADM (abduction of little toe)	Lateral Plantar

GRADING MOTOR DEFICIT

Step 3:

- Grade the *severity* of the motor deficit of each of the individual muscles involved.

Grade	Description of Muscle Function	% Motor Deficit
5	“Complete active range of motion” against gravity with full resistance (may be modified in cases where ROM is not “full” although the restriction to ROM is not due to dysfunction of the nerve.	0%
4	“Complete active range of motion” against gravity with some resistance	1-25%
3	“Complete active range of motion” against gravity only, without resistance	26-50%
2	“Complete active range of motion” with gravity eliminated	51-75%
1	Evidence of slight contractility: no joint movement	76-99%
0	No evidence of contractility	100%

PERMANENT IMPAIRMENT RATINGS DUE TO ENTRAPMENT NEUROPATHIES

- AMA Guides page 484 (Chapter 16):
  - “The examiner must use clinical judgment to estimate the appropriate percentage of motor deficits and loss of power within the range of values shown for each severity grade. It is important to ascertain that weakness is due to loss of nerve function before using these Tables. Weakness may be due to many causes, including pain, and Table 16-11 is not to be used for rating weakness that is not due to a diagnosed injury of a specific nerve or nerves. A diagnosis of nerve injury can usually be made by a careful physical examination done by an examiner who has sufficient knowledge of the anatomy and function of the part. …Note that Grade 4 covers a wide range of weakness, from minimal detectable weakness to severe weakness in which the muscles are functional through a full range with only very slight resistance. The degree of weakness should be rated from 1% to 25% depending on the degree within this grade.”

GRADING MOTOR DEFICIT

- Step 4:
  - Determine the maximum Whole Person Impairment value (for the particular nerve(s) involved) due to motor deficit (loss of power) according to Table 17-37. Example – Superior Gluteal Nerve = 25% Whole Person Impairment

Table 17-37 Impairments Due to Nerve Deficits

	Whole Person (Lower Extremity) [Foot] Impairment (%)		
Nerve	Motor	Sensory	Dysesthesia
Femoral	15 (37)	1 (2)	3 (7)
Obturator	3 (7)	0	0
Superior gluteal	25 (62)	0	0
Inferior gluteal	15 (37)	0	0
Lateral femoral cutaneous	0	1 (2)	3 (7)
Sciatic	30 (75)	7 (17)	5 (12)
Common peroneal	15 (42)	2 (5)	2 (5)
Superficial peroneal	0	2 (5)	2 (5)
Sural	0	1 (2)	2 (5)
Medial plantar	2 (5) [7]	2 (5) [7]	2 (5) [7]
Lateral plantar	2 (5) [7]	2 (5) [7]	2 (5) [7]

Nerves with Sensory Impairment only	Nerves with Motor Impairment only	Nerves with Combined Sensory and Motor Impairment
Lateral femoral cutaneous nerve	Obturator!!**	Femoral
Superficial peroneal**	Superior Gluteal Nerve	Sciatic
Sural	Inferior Gluteal Nerve	Common Peroneal
		Medial Plantar
		Lateral Plantar
AMA Guides do not Provide Impairment for:		
	Total loss of ankle eversion through the peronei	Superficial peroneal
	Total loss of sensation to the medial knee	Obturator

GRADING MOTOR DEFICIT

- Step 5:
  - Multiply the % *severity of the motor deficit* (Step 3) by the maximum impairment value (Step 4) to obtain the Whole Person Impairment.
- Step 6: Do this for each nerve structure involved. Record your numbers.

TOTAL UPPER EXTREMITY IMPAIRMENT

- Combine Impairments (using Combined Values Chart on page 604):
  - Combine 1) Sensory Impairments with 2) Motor Impairments for nerves with motor & sensory fibers
  - Combine Sensory and/or motor impairments of one nerve with sensory and/or motor impairments of another nerve in the event of multiple nerve involvements
- Determine Final Whole Person Impairment due to “Peripheral Nerve Lesion”
- Combine with other Impairments according to Combined Values Chart (Table 17-2)

FINAL REMINDER

- This is Dr. Perry Carpenter. I want to thank you for joining me. I hope you enjoyed the course and I look forward to being with you again for a future course. If ever our paths shall met, I look forward to speaking with you and learning some of your best QME Secrets. For now, I have 2 final instructions:
- 1. When you are done with your Course Examination, fax (530-295-9196) or email (admin@ezqmeceu.com) your Examination and your credit for the course will be immediately processed.
- 2. Remember to visit www.ezqmeceu.com for products designed to make your QME Reports more powerful and persuasive.