



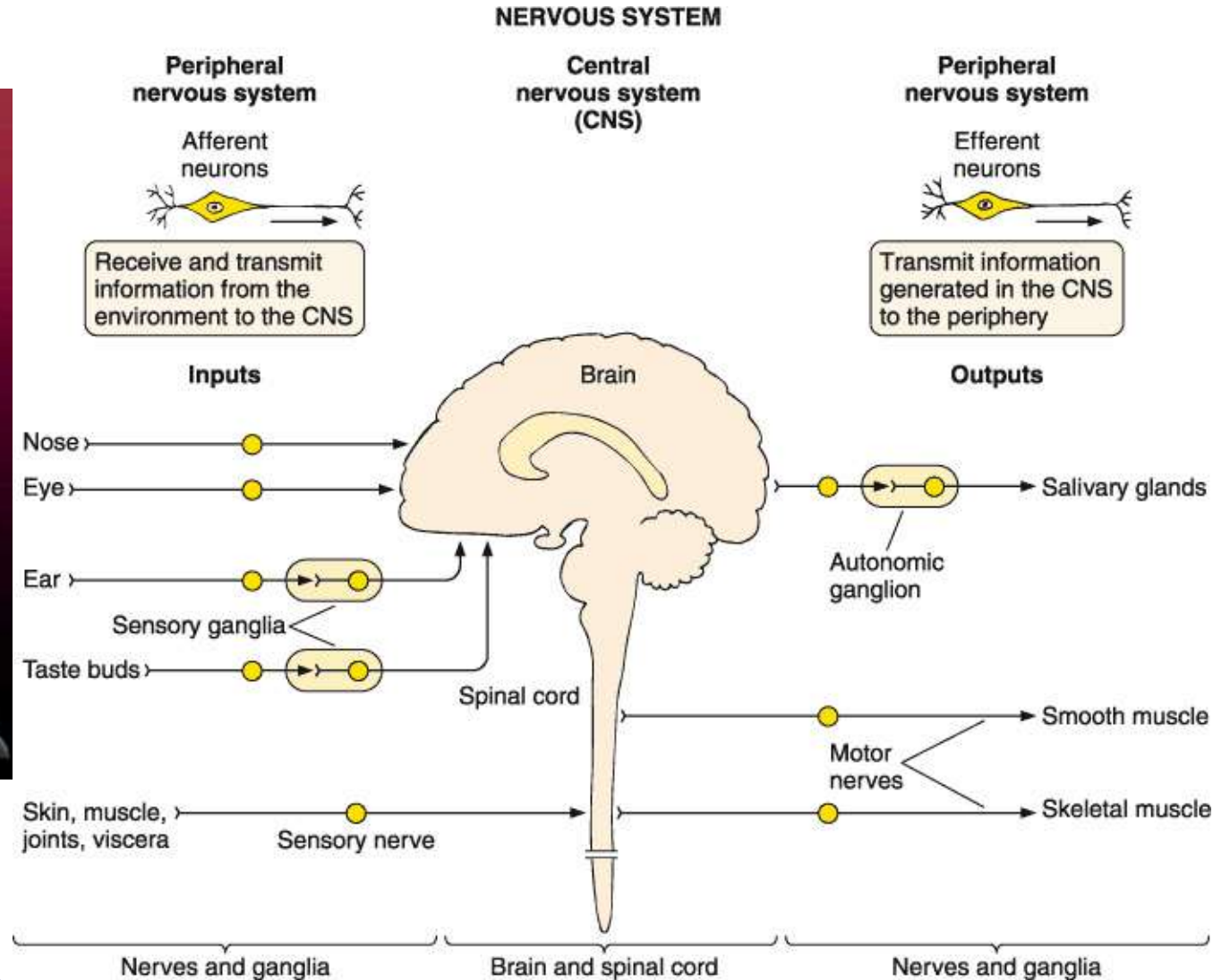
# Spinal nerves

1. Formation and general organization
2. Spinal ganglia
3. Zonal and segmental innervation
4. Dorsal rami of the spinal nerves
5. Ventral rami of the spinal nerves
6. The cervical plexus
7. The brachial plexus
8. Thoracic ventral rami – intercostal nerves
9. Lumbar ventral rami: the lumbar plexus
10. Sacral and coccygeal ventral rami
  - ✓ the sacral plexus
  - ✓ the coccygeal plexus



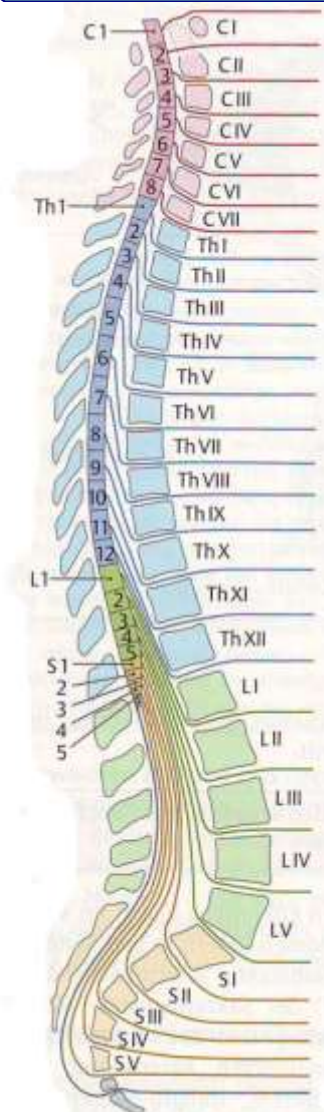
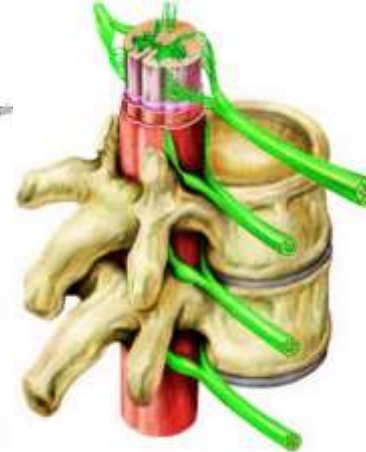
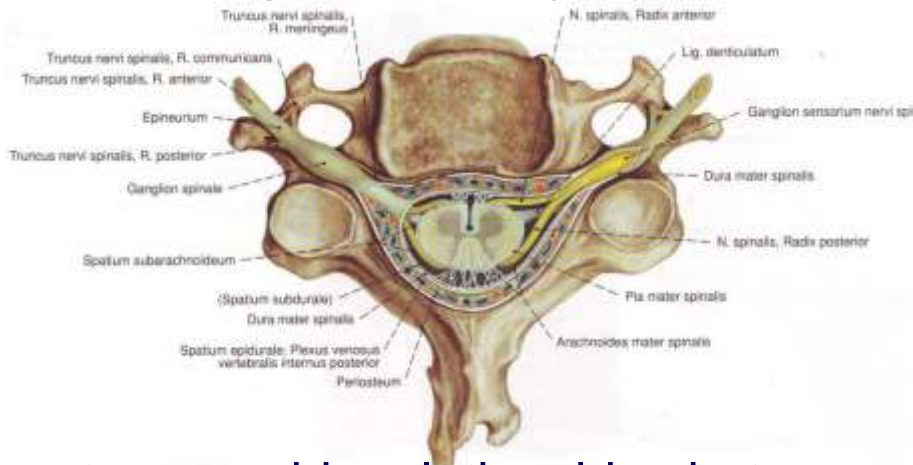


# Classification of the nervous system



# General organization

- 31 pairs of segmentally arranged nerves:
  - ✓ 8 cervical – C1-C8
  - ✓ 12 thoracic – Th1-Th12
  - ✓ 5 lumbar – L1-L5
  - ✓ 5 sacral – S1-S5
  - ✓ 1 coccygeal – Co1
- corresponds to a pair of embryonic somites
- emerges through the intervertebral foramen
- mixed spinal nerve (common nerve trunk)



- topographic relationships between spinal nerves, segments and vertebrae



# Segmental innervation

- **Segmental innervation:**
  - ✓ organs or muscles innervated by one spinal segment
  - ✓ corresponds to the general metamerism of the body
- **Embryonic somites (metamere):**
  - ✓ myotome ⇒ muscle
  - ✓ sclerotome ⇒ skeleton
  - ✓ dermatome ⇒ skin
- **Neuromere ⇒ somite**

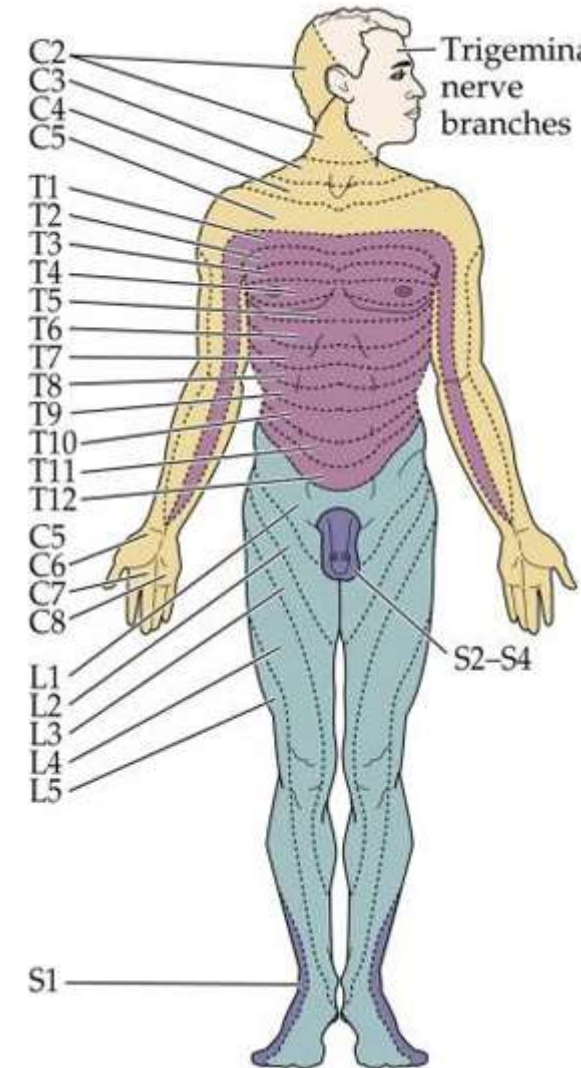
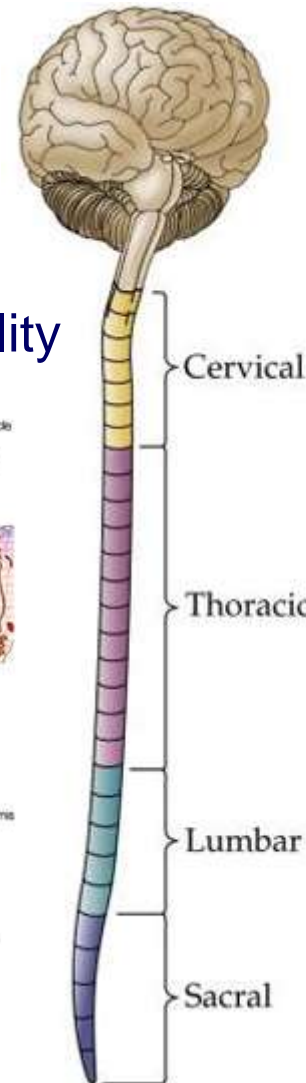
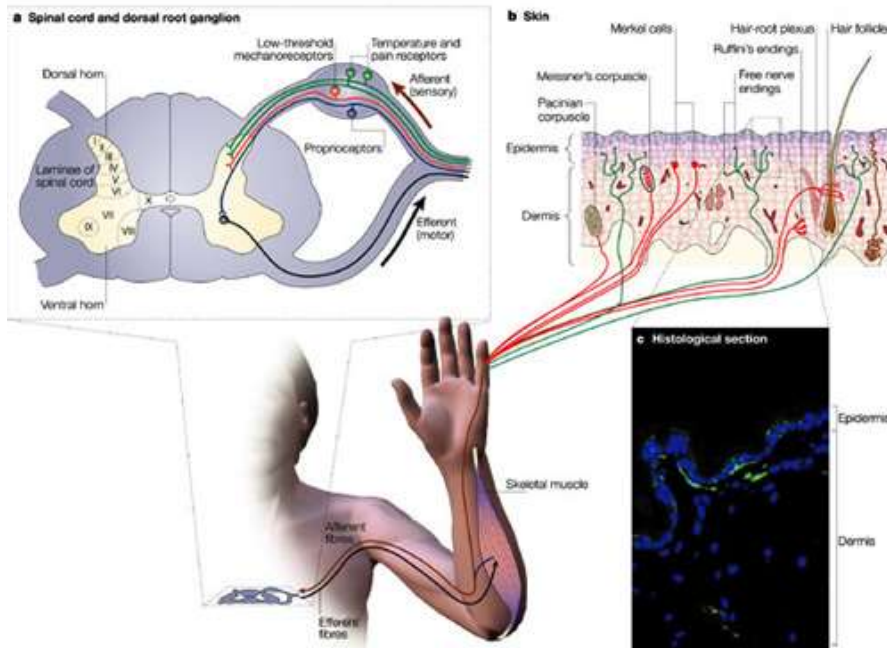


SEGMENTAL INNERVATION OF MUSCLES OF THE UPPER LIMB						
	CERVICAL SEGMENTS					THORACIC SEGMENTS
	4	5	6	7	8	1
SHOULDER	Supraspinatus					
	Teres minor					
	Deltoid					
	Infraspinatus					
ARM	Subscapular					
	Teres major					
	Biceps brachii					
	Brachialis					
	Coracobrachialis					
FOREARM	Triceps brachii					
	Anconeus					
	Brachioradialis					
	Supinator					
	Extensor carpi radialis					
	Pronator teres					
	Flexor carpi radialis					
	Flexor pollicis longus					
	Abductor pollicis longus					
	Extensor pollicis brev.					
	Extensor pollicis longus					
	Extensor digitorum communis					
	Extensor indicis proprius					
	Extensor carpi ulnaris					
	Extensor digiti minimi					
	Flexor digitorum sublimis					
	Flexor digitorum profundus					
	Pronator quadratus					
	Flexor carpi ulnaris					
	Palmaris longus					
HAND	Abductor pollicis brevis					
	Flexor pollicis brevis					
	Opponens pollicis					
	Flexor digiti minimi					
	Opponens digiti minimi					
	Abductor pollicis					
	Palmaris brevis					
	Abductor digiti minimi					
	Lumbricals					
	Interossei					

# Zonal innervation

## ■ Sensory nerve innervation regions:

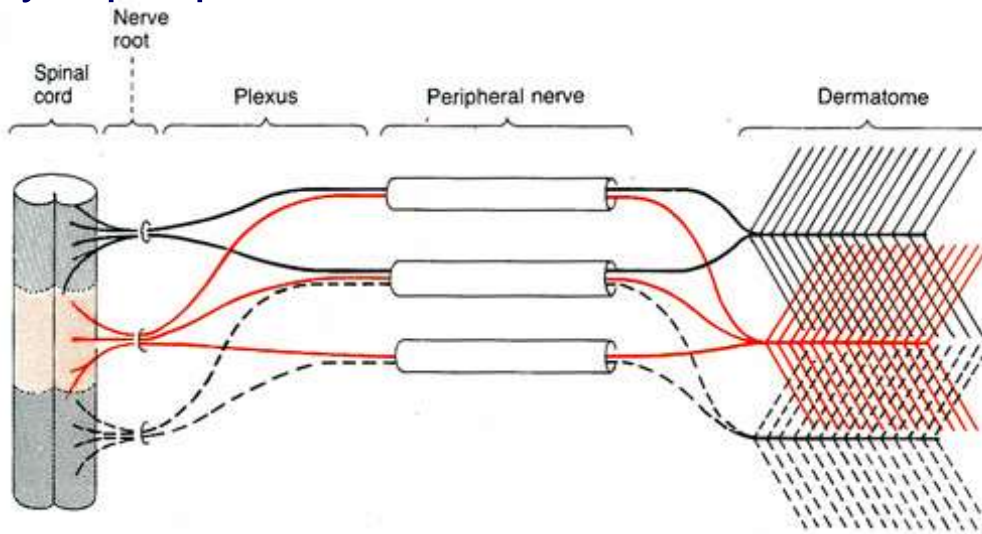
- ✓ autonomic  $\Rightarrow$  anesthesia
- ✓ mixed  $\Rightarrow$  hypoesthesia
- ✓ maximal  $\Rightarrow$  no loss in sensibility





# Formation of a dermatome

- **Dermatome** – a localized area of skin supplied by a single nerve from a single nerve root of the spinal cord
  - ✓ herringbone pattern – the width of the cutaneous field of innervation
  - ✓ thorax&abdomen – like a stack of discs
  - ✓ arms&legs – longitudinally along the limbs
- **Peripheral nerve field** – a territory supplied by a peripheral nerve from more than one somite



Cervical

C2  
C3  
C4  
C5  
C6  
C7  
C8



Lumbal

L1  
L2  
L3  
L4  
L5

Thoracal

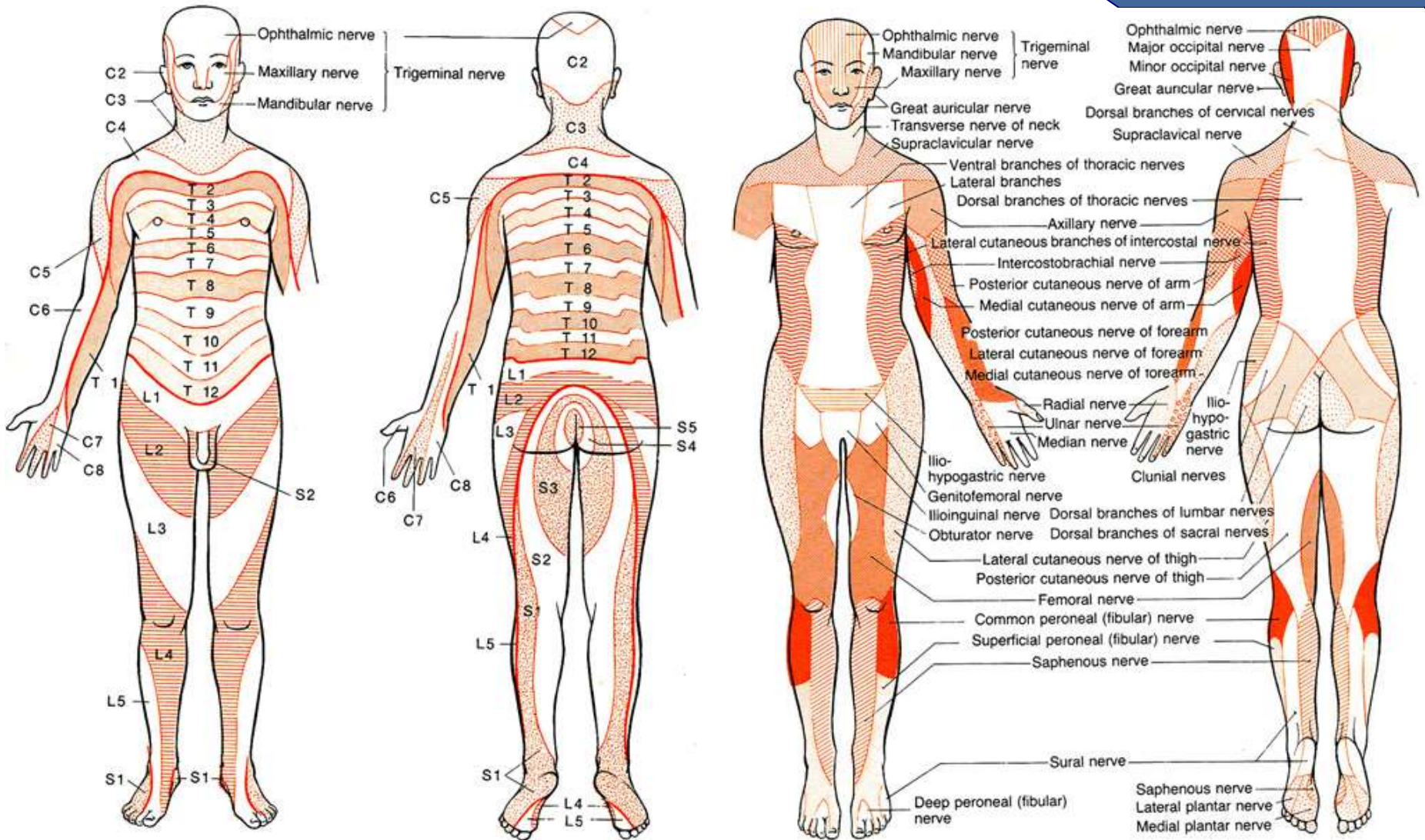
Th1  
Th2  
Th3  
Th4  
Th5  
Th6  
Th7  
Th8  
Th9  
Th10  
Th11  
Th12

Sacral

S1  
S2  
S3  
S4  
S5



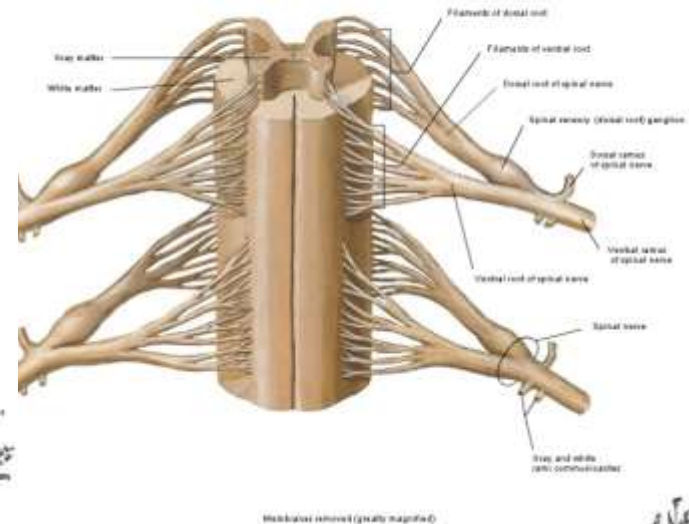
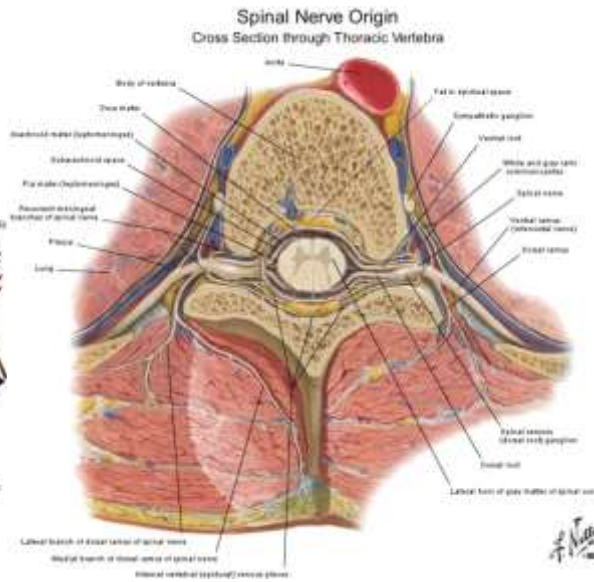
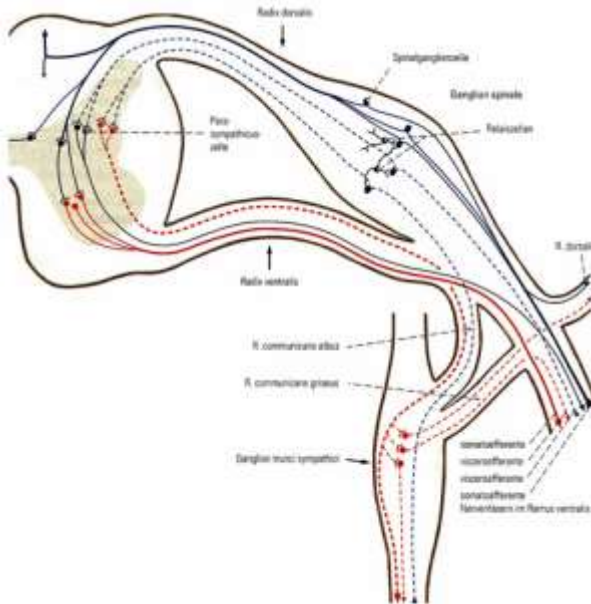
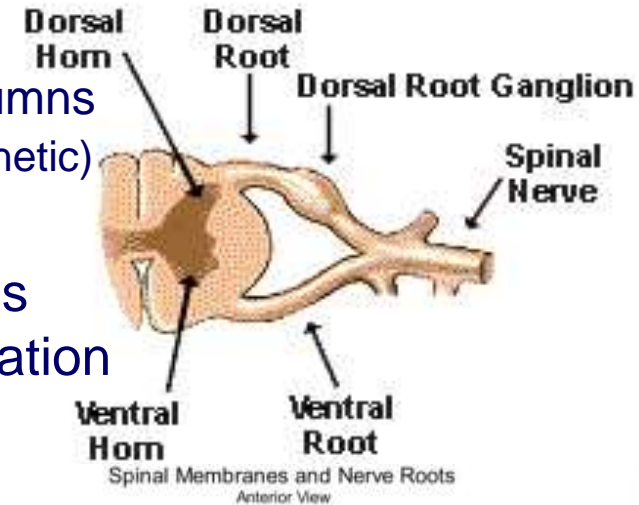
# Dermatome vs. skin innervation





# Spinal nerve formation

- **ventral (motor) root:**
  - ✓ axons of neurons in anterior and lateral grey columns
  - ✓ motor and autonomic (sympathetic and parasympathetic)
- **dorsal (sensory) root:**
  - ✓ central processes of the dorsal ganglion cells
  - ✓ convey somatic and visceral sensory information

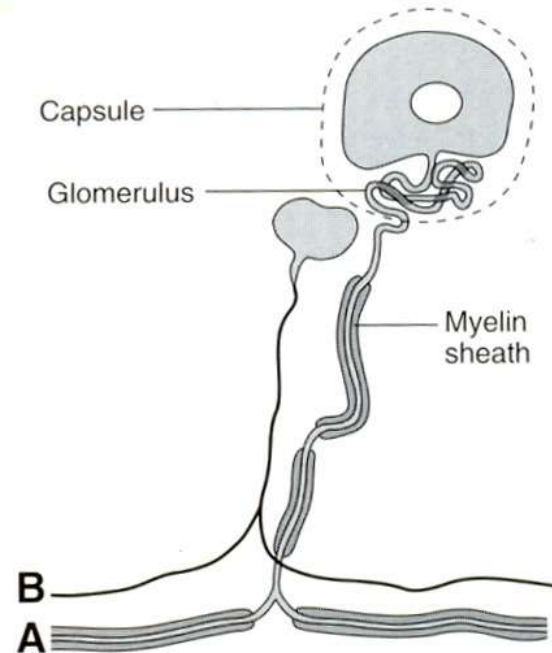
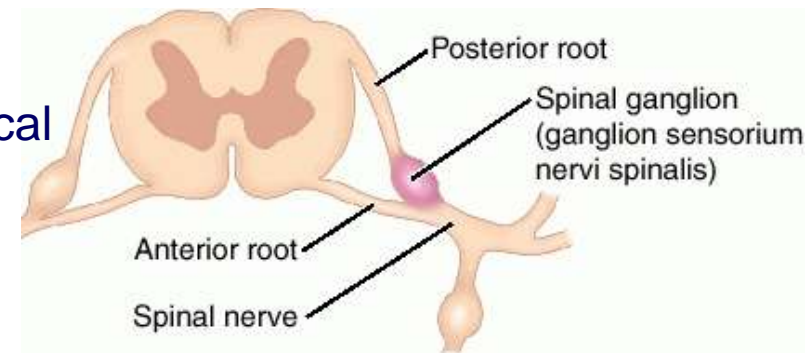
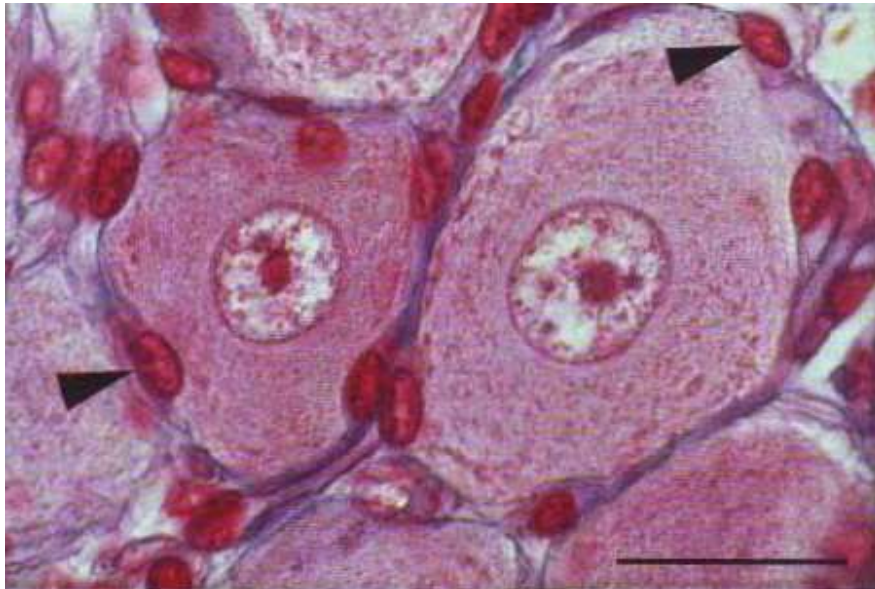






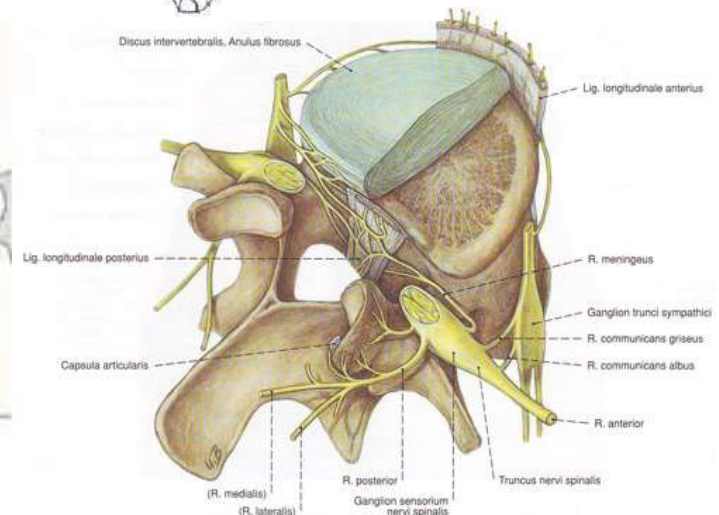
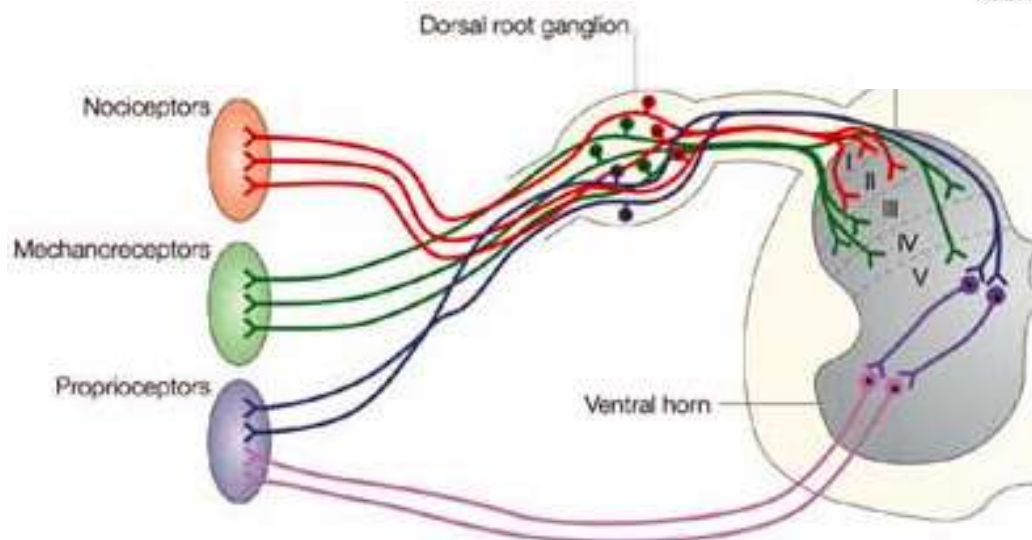
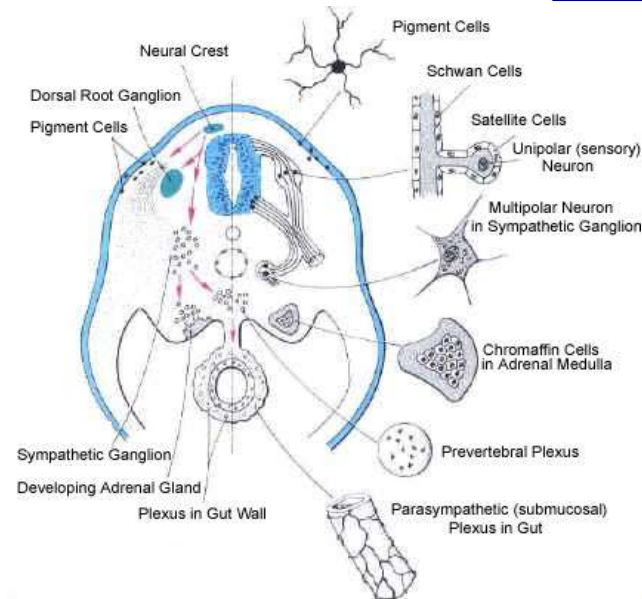
# Spinal ganglion

- spindle-shaped aggregations on the dorsal roots
  - **dorsal root ganglion**
    - ✓ (pseudo)unipolar neurons – ovoid or spherical (primary afferent neurons)
    - ✓ satellite cells (capsular cells, amphicytes)
    - ✓ Schwann cells and blood vessels



# Spinal ganglion

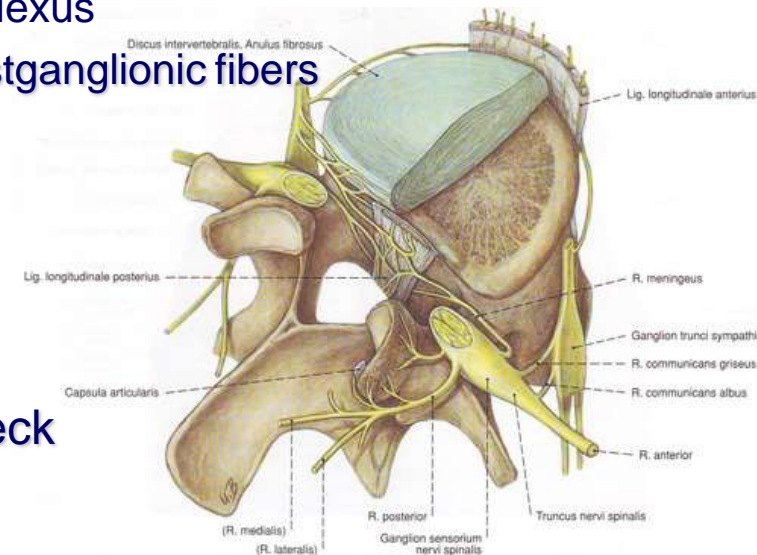
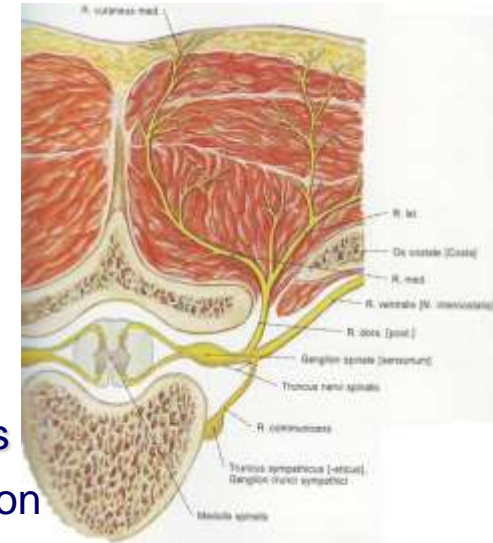
- embryonic origin – neural crest cells
- location – in intervertebral foramina
- axons (afferents) – proximal and distal processes
- functional modalities:
  - ✓ mechanoreception
  - ✓ nociception
  - ✓ proprioception





# Spinal nerve trunks

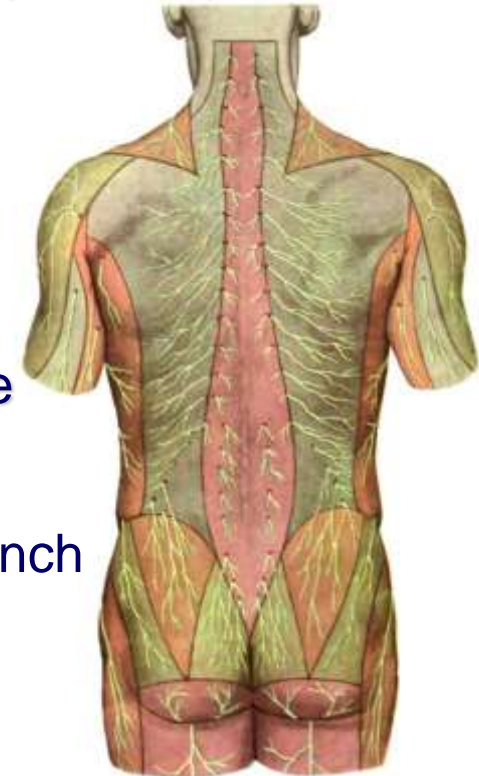
- Spinal nerve functional components:
  - ✓ somatic components – efferent and afferent fibers
  - ✓ visceral components – sympathetic or parasympathetic
- Spinal nerve branches:
  - ✓ meningeal branch – at all vertebral levels (recurrent meningeal nerve)
  - ✓ white ramus communicans – myelinated preganglionic fibers
    - all thoracic and L1-L2 to corresponding sympathetic ganglion
    - S2-S4 nerves to the parasympathetic pelvic plexus
  - ✓ grey ramus communicans – unmyelinated postganglionic fibers
    - from paravertebral sympathetic ganglia
  - ✓ ventral (anterior) ramus – thicker
    - ventrolateral muscles
    - skin of the trunk and extremities
  - ✓ dorsal (posterior) ramus – thinner
    - intrinsic dorsal muscles of the back and neck
    - overlying skin from vertex to coccyx





# Dorsal rami of the spinal nerves

- divide into medial and lateral branches (exception C1)
- have a typical segmental distribution
- cervical dorsal rami:
  - ✓ suboccipital nerve (C1) – purely motor
  - ✓ greater occipital nerve (C2) – mixed
  - ✓ C3 medial cutaneous branch, third occipital nerve
- thoracic dorsal rami:
  - ✓ Th1-Th6 – medial (mixed) and lateral (motor) branch
  - ✓ Th7-Th12 – medial (motor) and lateral (mixed)
- lumbar dorsal rami:
  - ✓ L1-L3 lateral cutaneous branches – superior clunial nerves
- sacral dorsal rami:
  - ✓ S1-S3 lateral cutaneous branches – medial clunial nerves





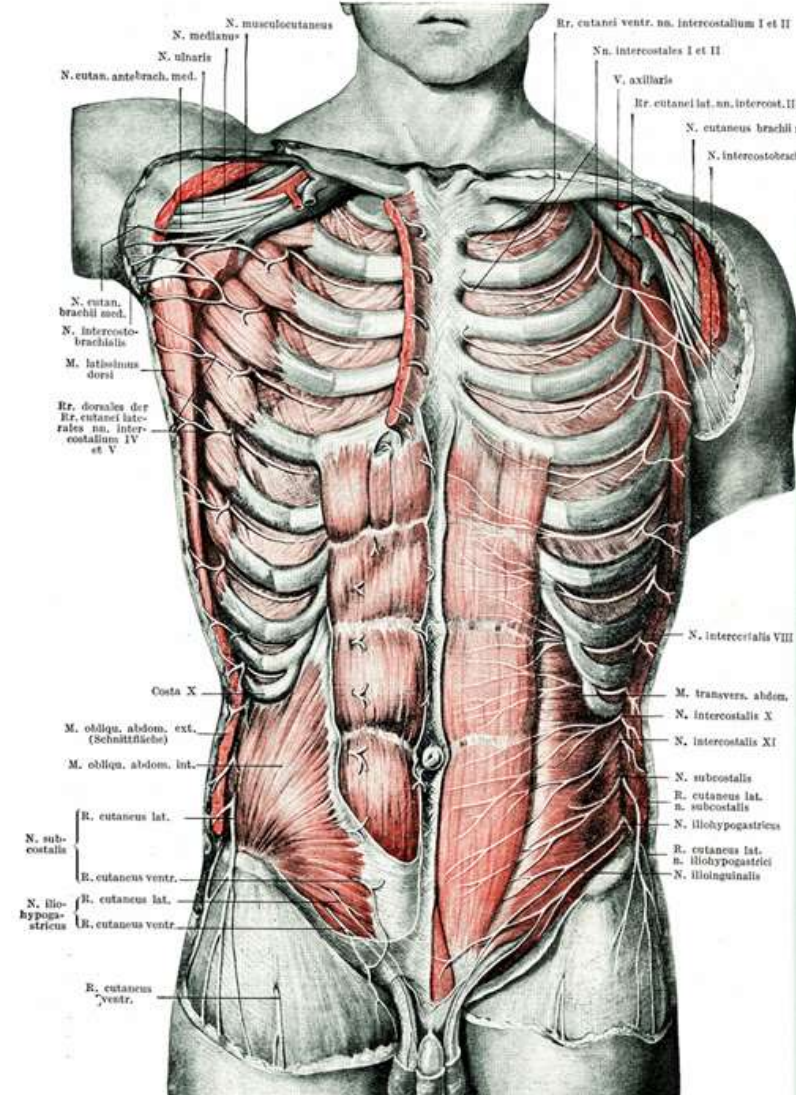
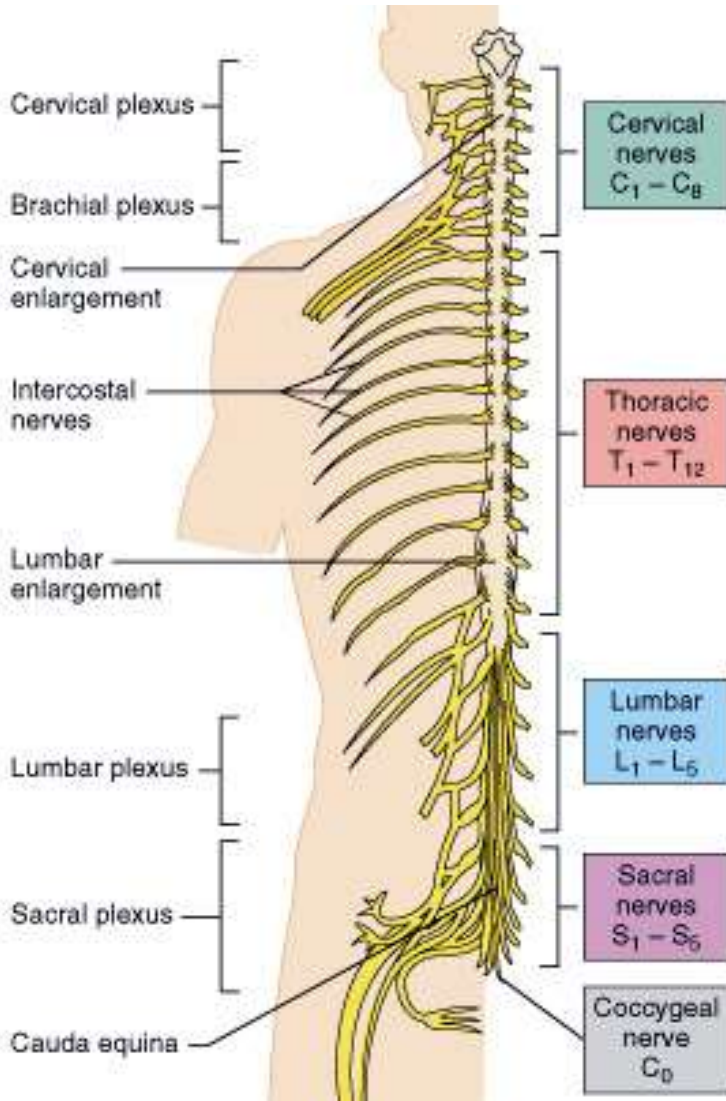
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# Ventral rami of the spinal nerves

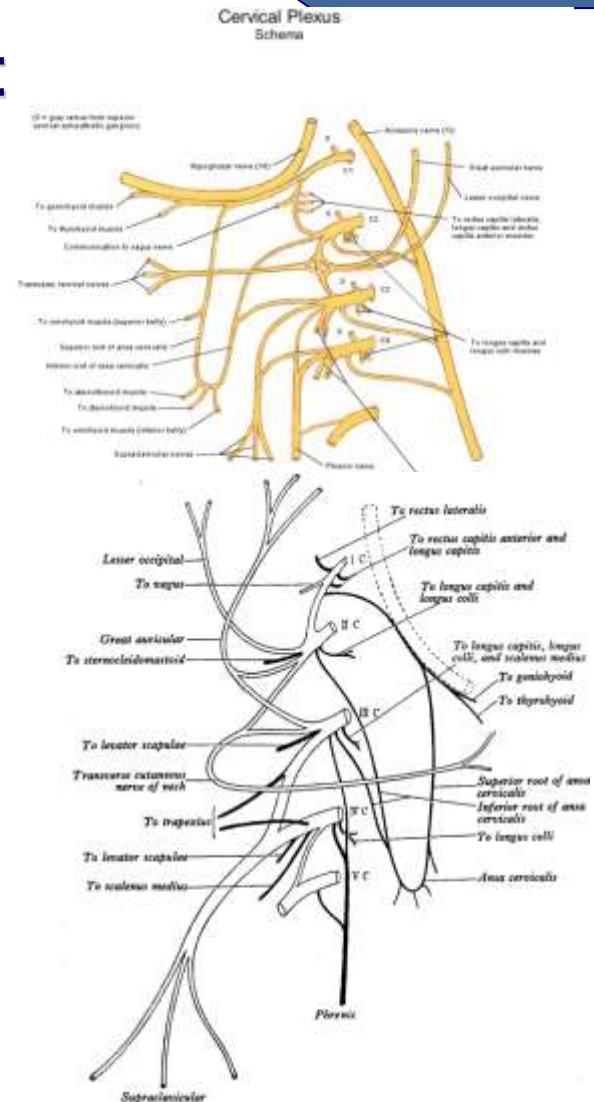




# Cervical plexus, *plexus cervicalis*

## ■ Formation and segmental origin:

- ✓ a loop of nerves
- ✓ ventral rami of C1-C4 nerves
- ✓ three arcuate loops
  - *ansae cervicales*
- ✓ communicating branches with:
  - ✓ *hypoglossal nerve* ⇒ *ansa cervicalis*
  - ✓ *accessory nerve (ramus externus)*
  - ✓ *sympathetic trunk*





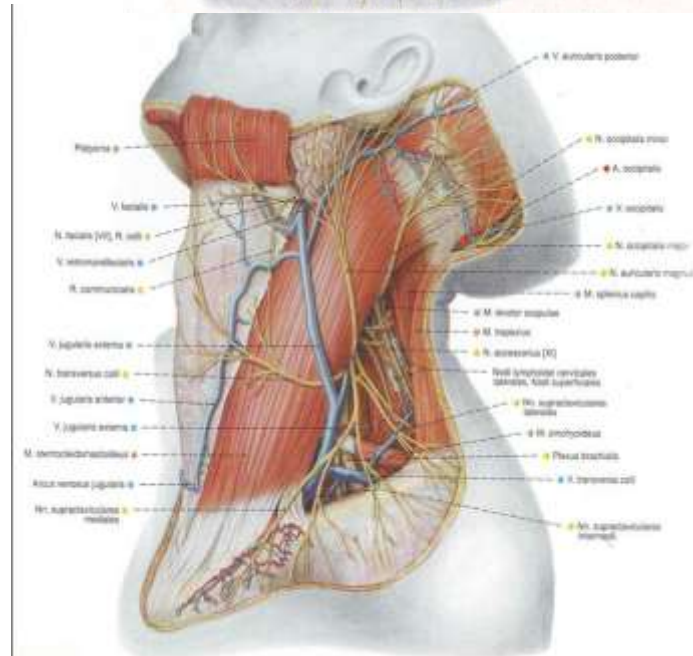
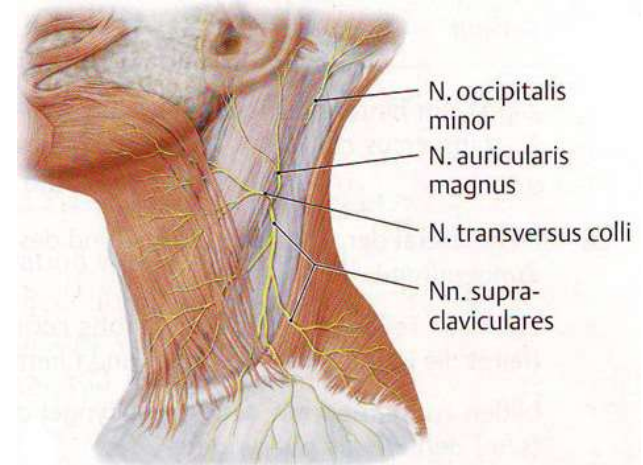
# Cervical plexus, *plexus cervicalis*

## ■ Branches:

### ✓ superficial (sensory) branches:

- lesser occipital nerve,  
*n. occipitalis minor*
- great auricular nerve,  
*n. auricularis magnus*
- transverse colli nerve,  
*n. transversus colli*
- supraclavicular nerves,  
*nn. supraclaviculares*

### ✓ deep (motor) branches

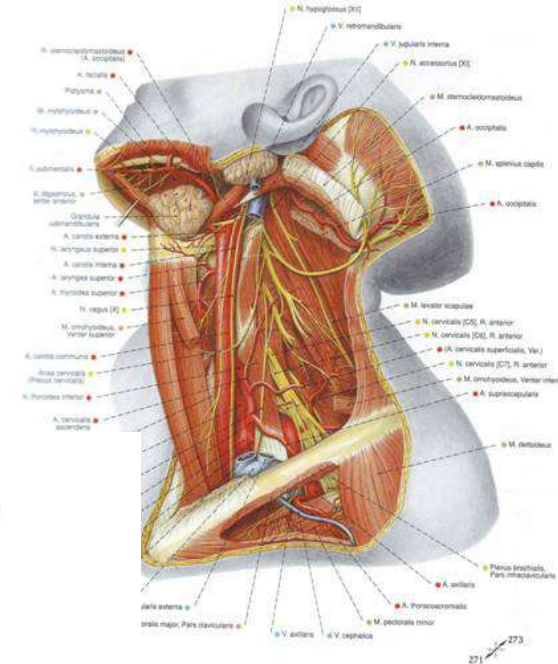
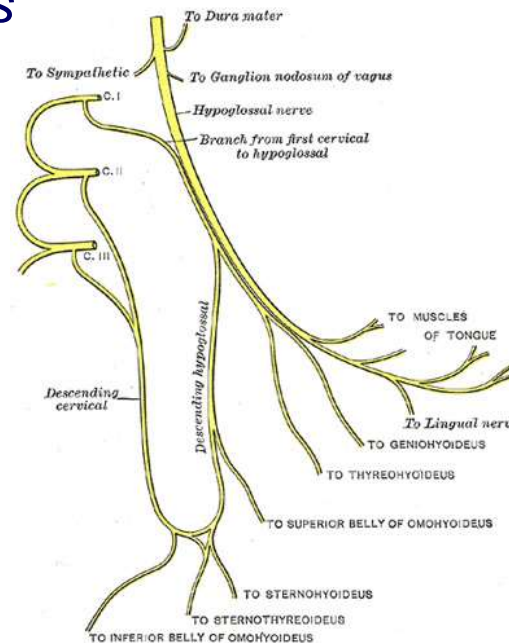






# Cervical plexus, *plexus cervicalis*

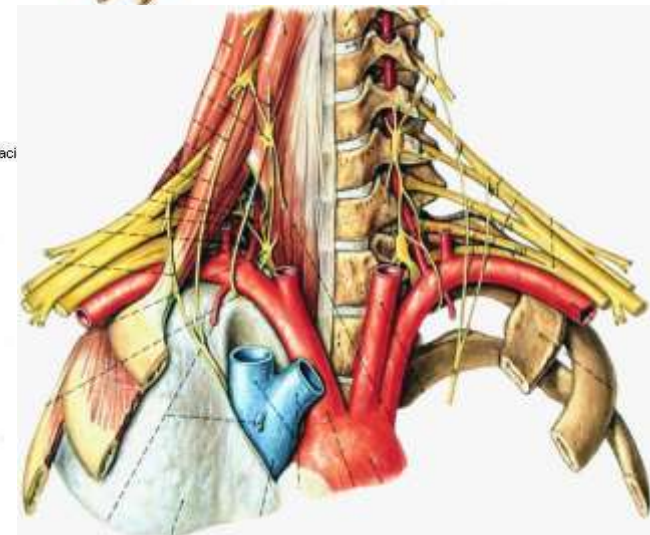
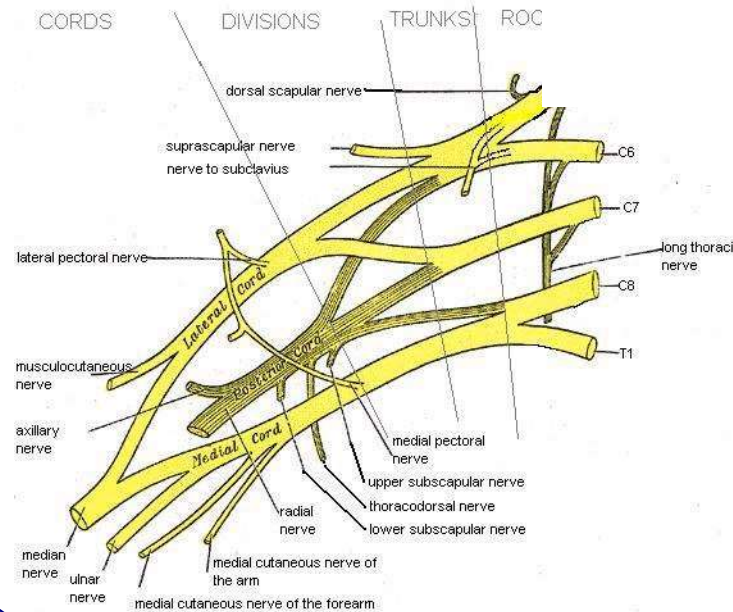
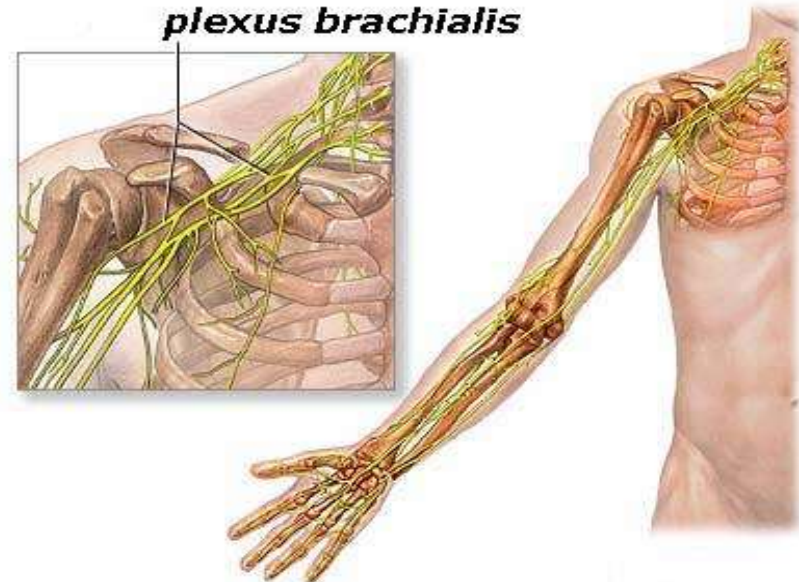
- Branches:
  - ✓ superficial (sensory) branches:
  - ✓ deep (motor) branches:
    - muscular branches, *rr. musculares*
    - inferior root of the ansa cervicalis, *radix inferior ansae cervicalis*
    - trapezius root, *ramus trapezius*
    - sternocleidomastoid root, *r. sternocleidomastoideus*
    - phrenic nerve, *n. phrenicus*





# Brachial plexus, *plexus brachialis*

- Formation and segmental origin:
  - ✓ ventral rami of C5-C8, Th1 nerves
- Three primary trunks:
  - ✓ superior (upper) trunk – C5-C6
  - ✓ middle trunk – C7
  - ✓ inferior (lower) trunk – C8-Th1



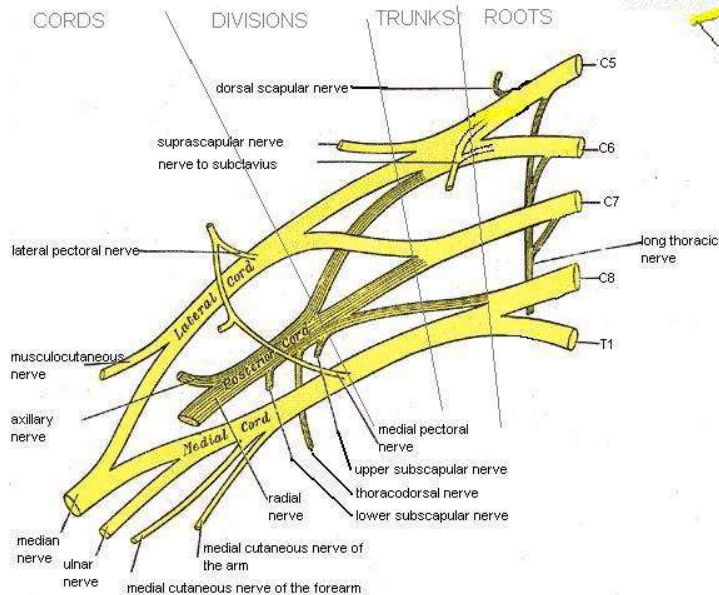
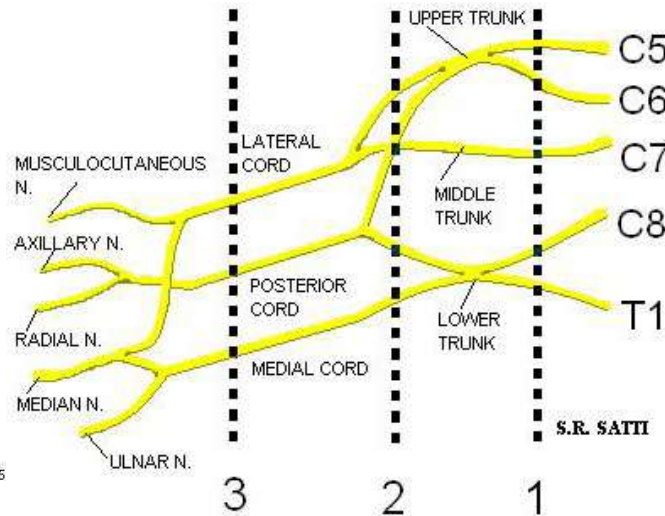


# Brachial plexus, *plexus brachialis*

## Divisions:

- ✓ posterior division
  - posterior cord
- ✓ anterior
  - lateral cord
  - medial cord

## BRACHIAL PLEXUS DIVISIONS

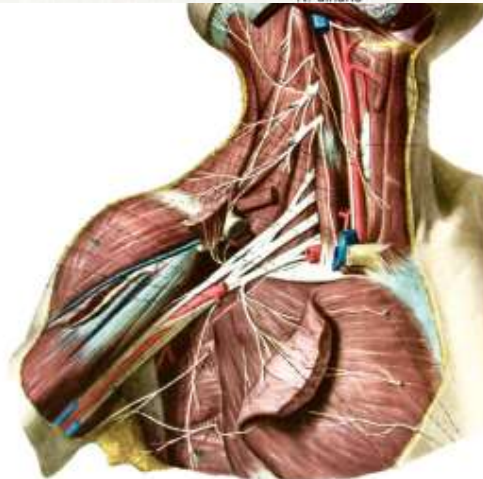
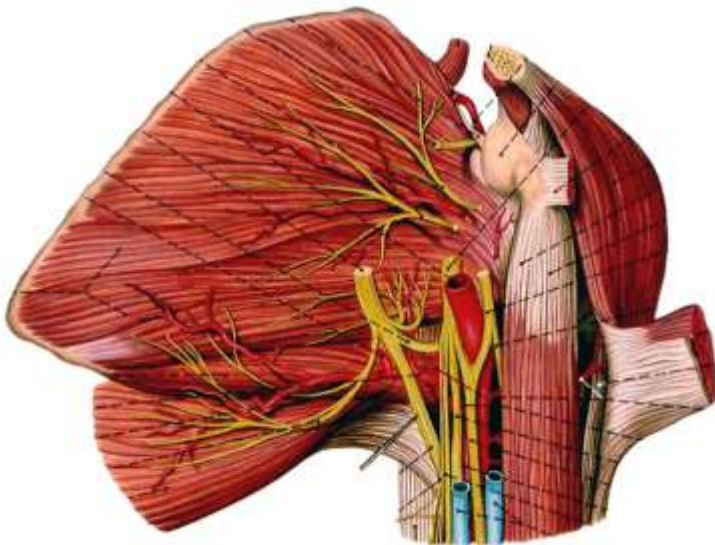
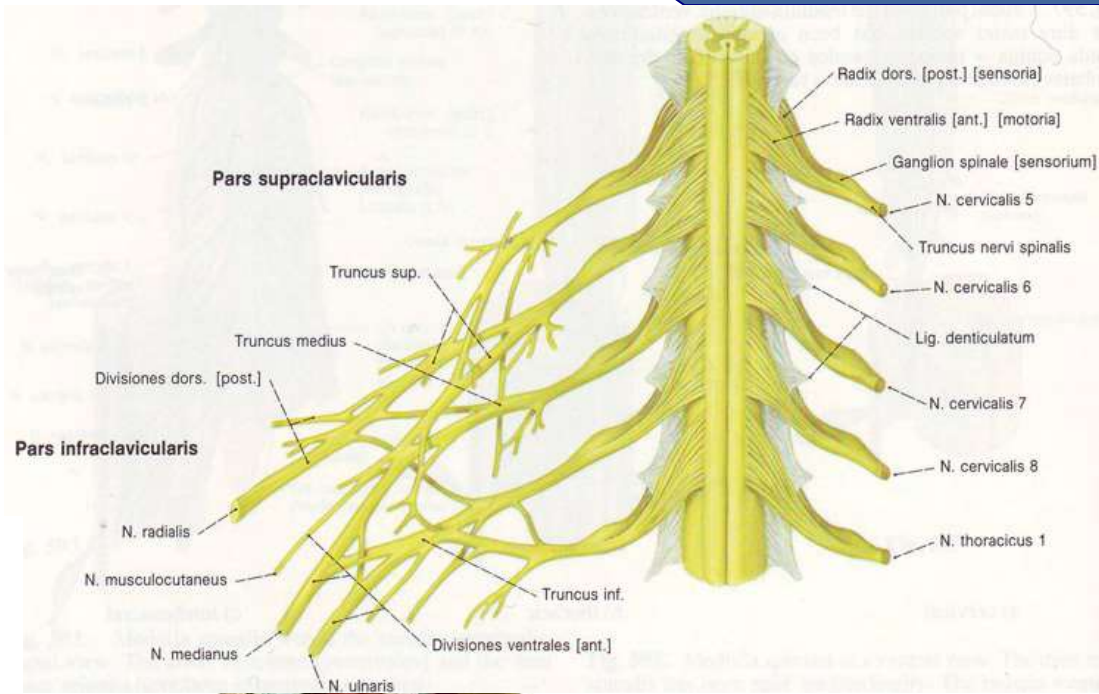


	TRUNKS	DIVISIONS	CORDS	MAIN BRANCHES
C5	Upper	Ant.	Lateral	Musculo-cutaneous Radial Median Axillary Ulnar
C6				
C7	Middle	Post.	Posterior	
C8				
T1	Lower	Ant.	Medial	



# Brachial plexus, *plexus brachialis*

- Main branches:
  - ✓ supraclavicular part:
    - dorsal scapular nerve, *n. dorsalis scapulae*
    - long thoracic nerve, *n. thoracicus longus*
    - nerve to the subclavius, *n. subclavius*
    - suprascapular nerve, *n. suprascapularis*





# Brachial plexus, *plexus brachialis*

## ■ Main branches:

### ✓ infraclavicular part:

#### ➤ lateral cord, *fasciculus lateralis*:

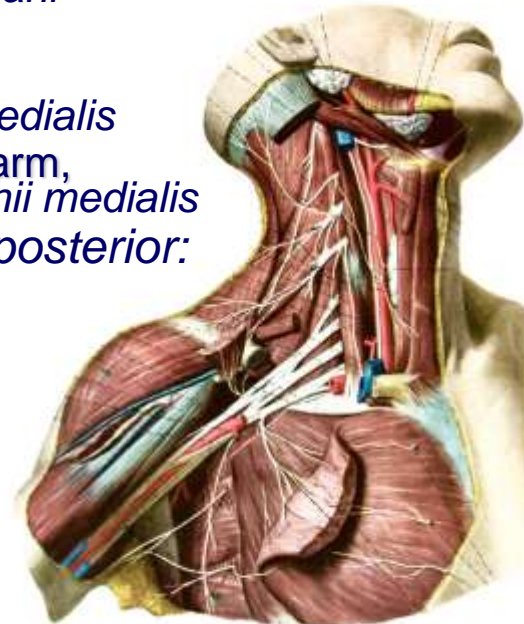
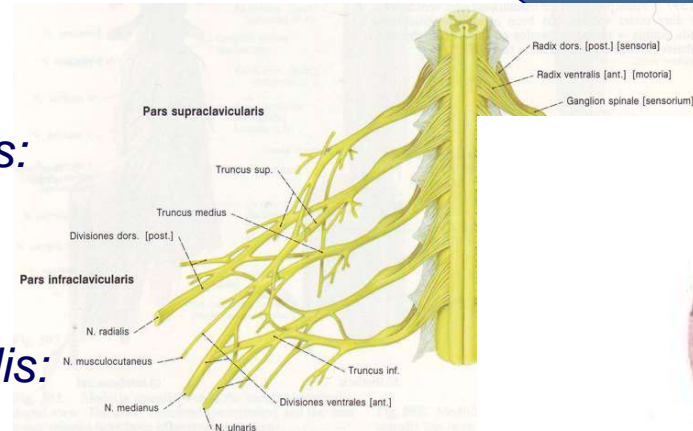
- musculocutaneous nerve, *n. musculocutaneus*
- lateral root of median, *radix lateralis n. mediani*

#### ➤ medial cord, *fasciculus medialis*:

- medial root of median, *radix medialis n. mediani*
- ulnar nerve, *n. ulnaris*
- medial cutaneous of arm, *n. cutaneus brachii medialis*
- medial cutaneous of forearm, *n. cutaneus antebrachii medialis*

#### ➤ posterior cord, *fasciculus posterior*:

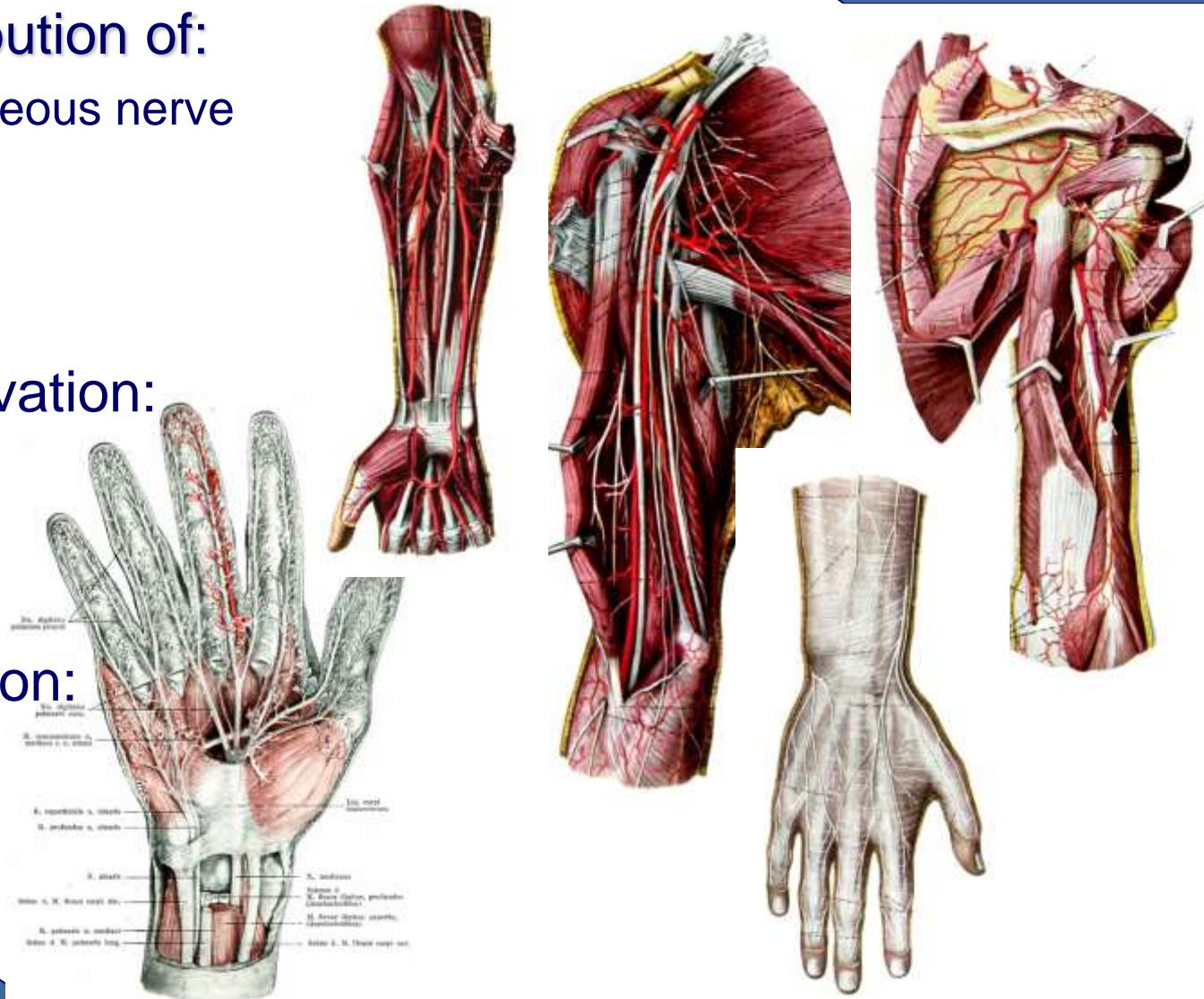
- axillary nerve, *n. axillaris*
- radial nerve, *n. radialis*





# Brachial plexus, *plexus brachialis*

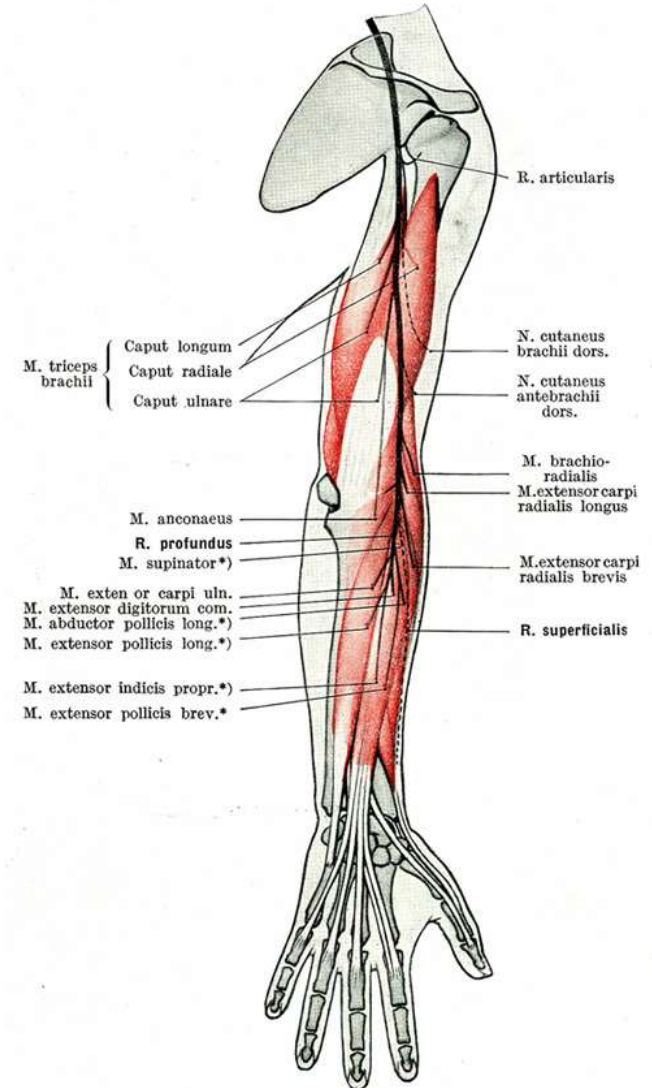
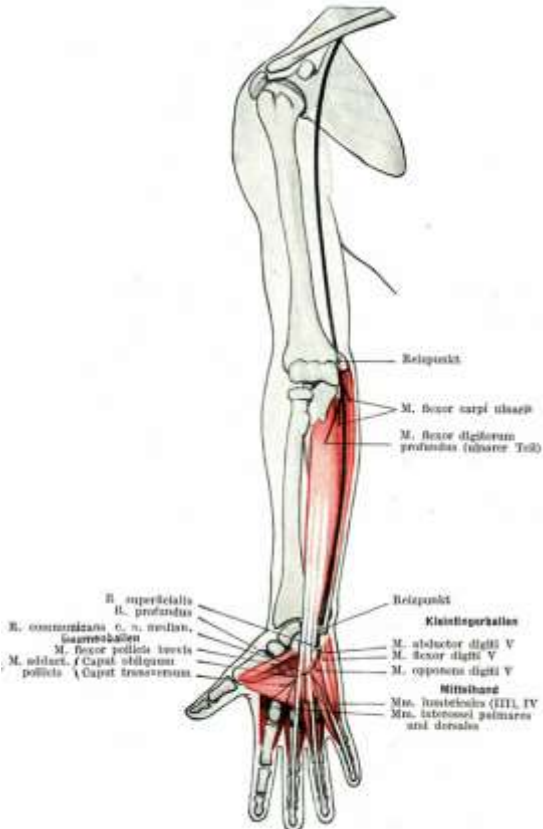
- Brachial distribution of:
  - ✓ musculocutaneous nerve
  - ✓ median nerve
  - ✓ ulnar nerve
  - ✓ radial nerve
- Forearm innervation:
  - ✓ median nerve
  - ✓ ulnar nerve
  - ✓ radial nerve
- Hand innervation:
  - ✓ median nerve
  - ✓ ulnar nerve





# Muscle innervation of the upper limb

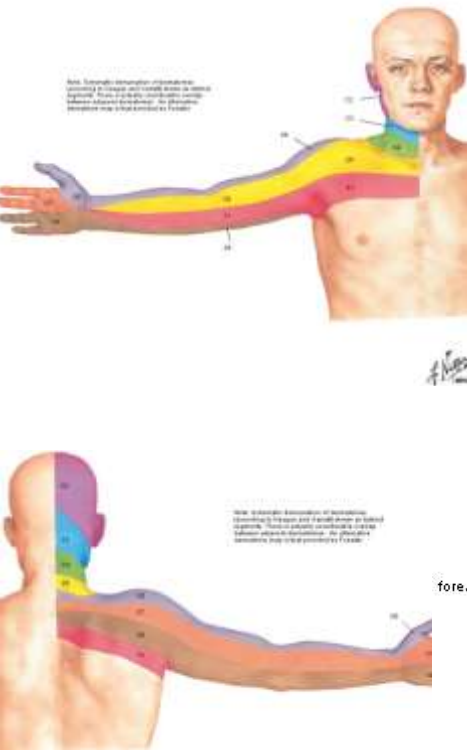
- Muscular branches of:
  - ✓ median nerve
  - ✓ ulnar nerve
  - ✓ radial nerve



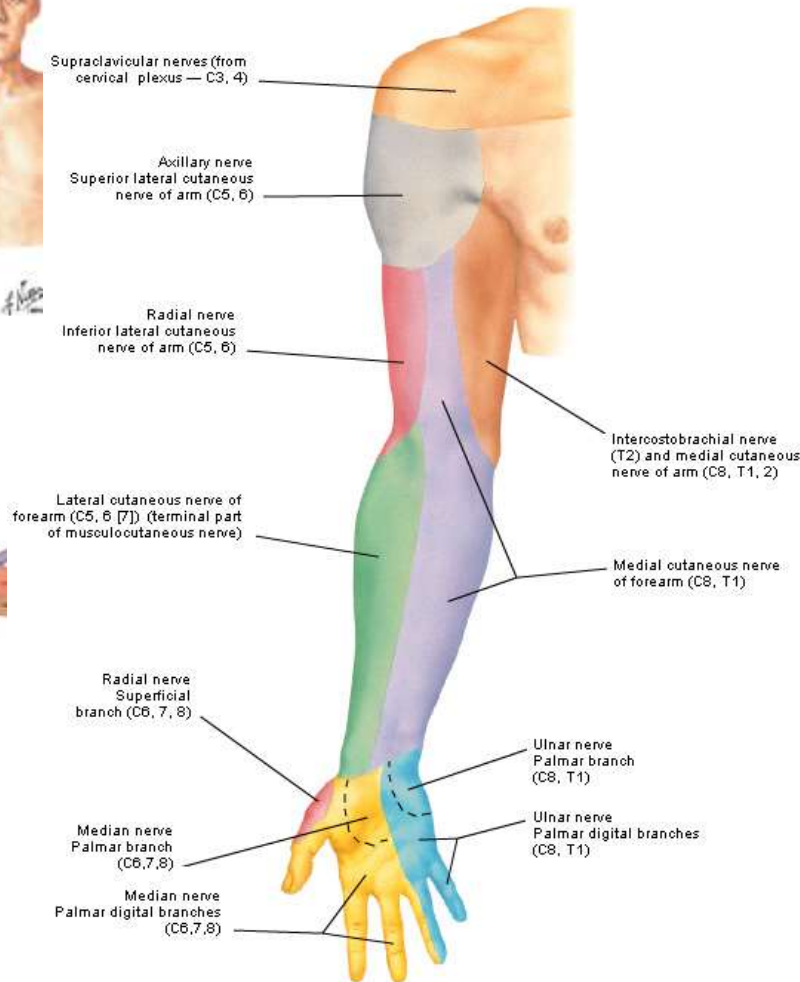


# Cutaneous innervation of the upper limb

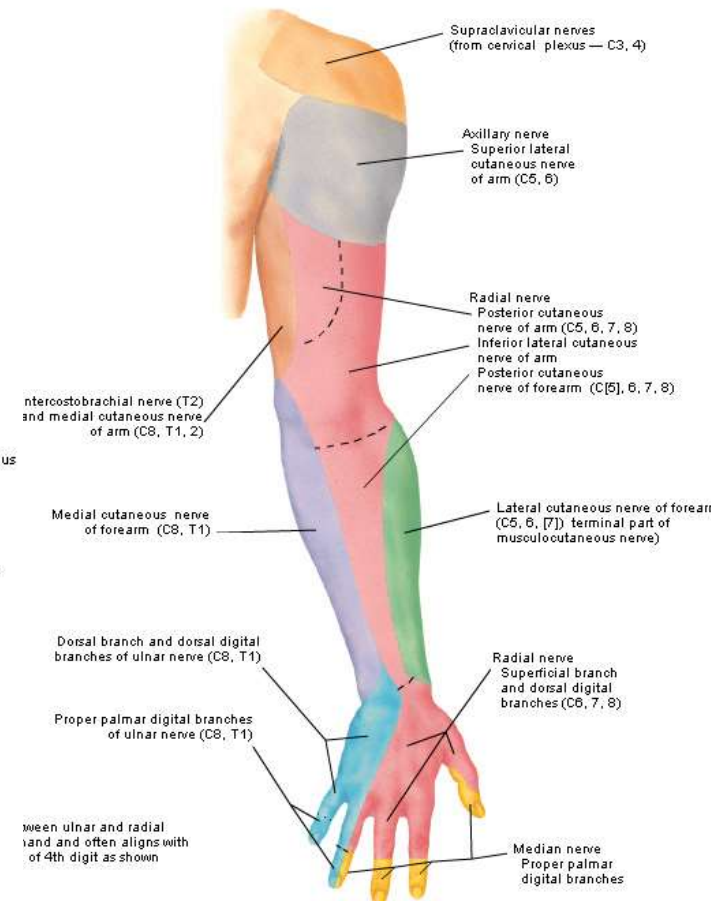
Dermatomes of Upper Limb



Cutaneous Innervation of Upper Limb  
Anterior (Palmar) View



Cutaneous Innervation of Upper Limb  
Posterior (Dorsal) view

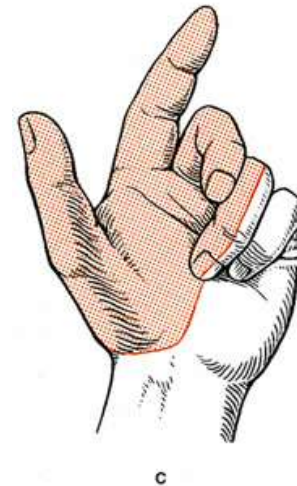
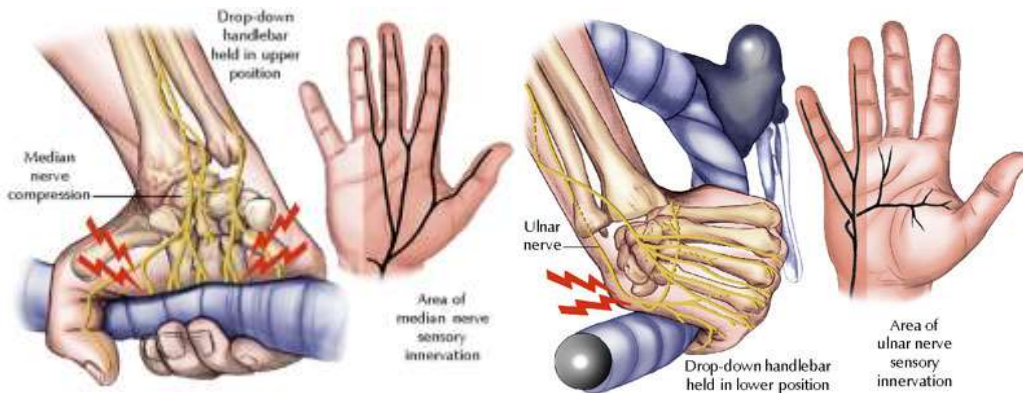
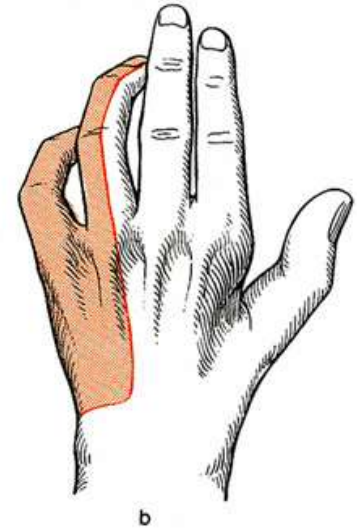
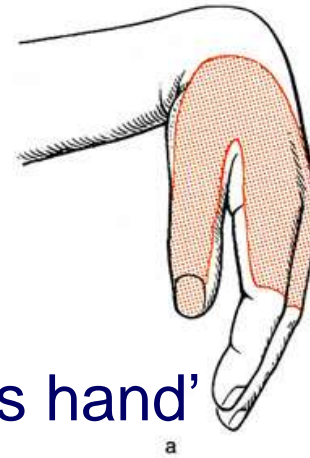






# Peripheral neuropathies

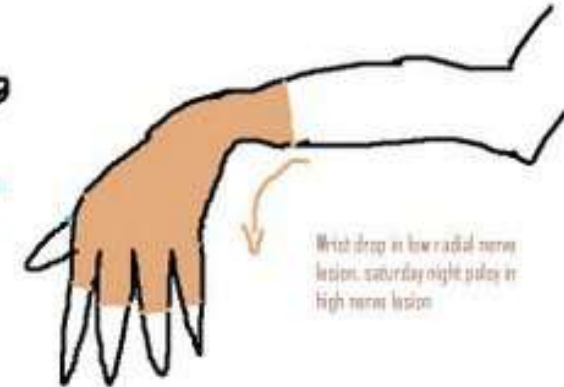
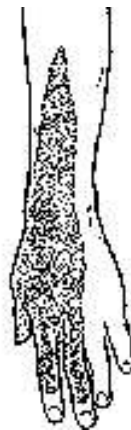
- Radial nerve palsy, wrist drop (Saturday night palsy)
- Ulnar nerve palsy, 'claw hand' handlebar palsy – cyclist's hands
- Median nerve palsy, 'accoucheur's hand' median neuropathy (Carpal tunnel syndrome)





# Saturday night palsy

= park bench paralysis,





# Saturday night palsy



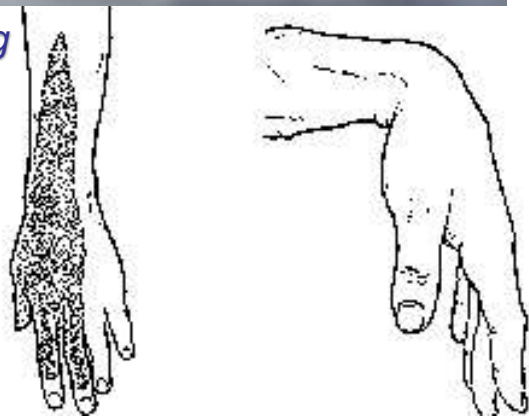
*Saturday night palsy victim in the making*  
[Dmytro Zinkevych/Shutterstock](#)

= park bench paralysis,  
= honeymoon palsy

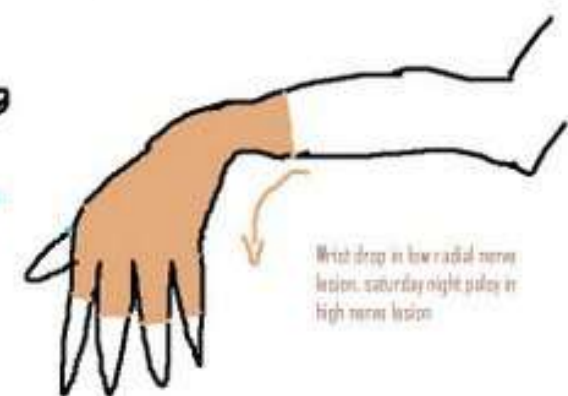


[wordpress.utoledo.edu](http://wordpress.utoledo.edu)

*Physician warns cuddling while sleeping can get on your nerves*



radial nerve area of sensory loss

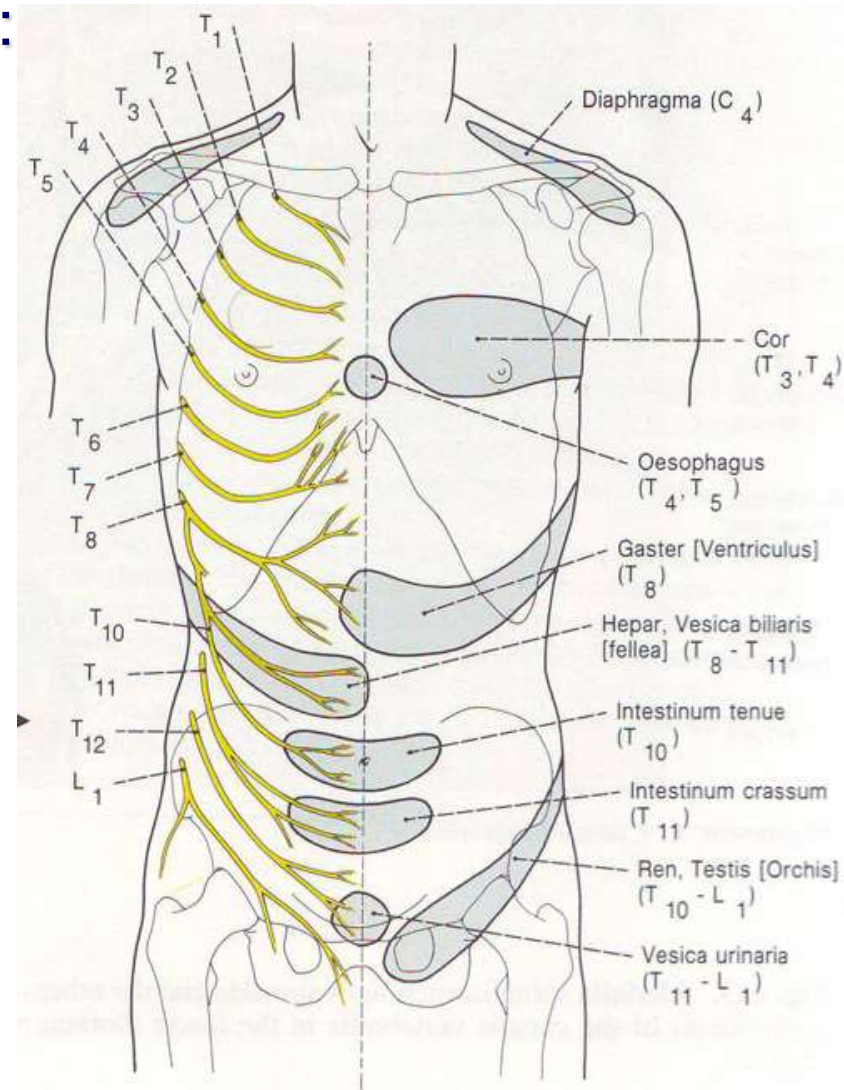
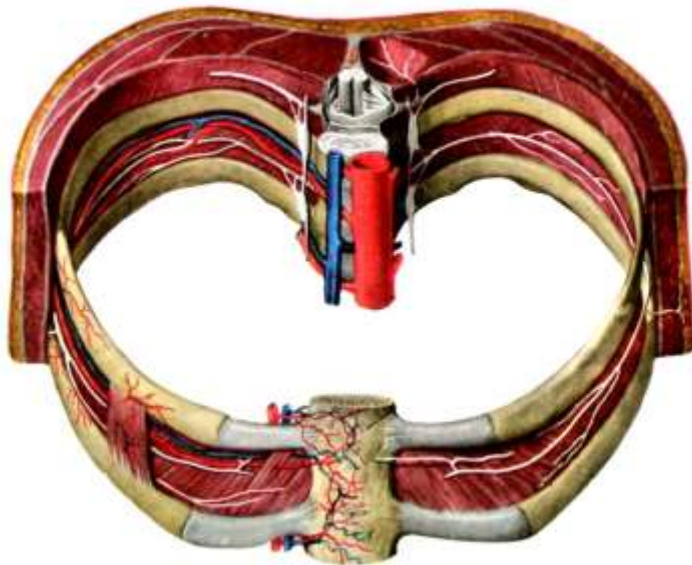


Wrist drop in low radial nerve lesion, Saturday night palsy in high nerve lesion



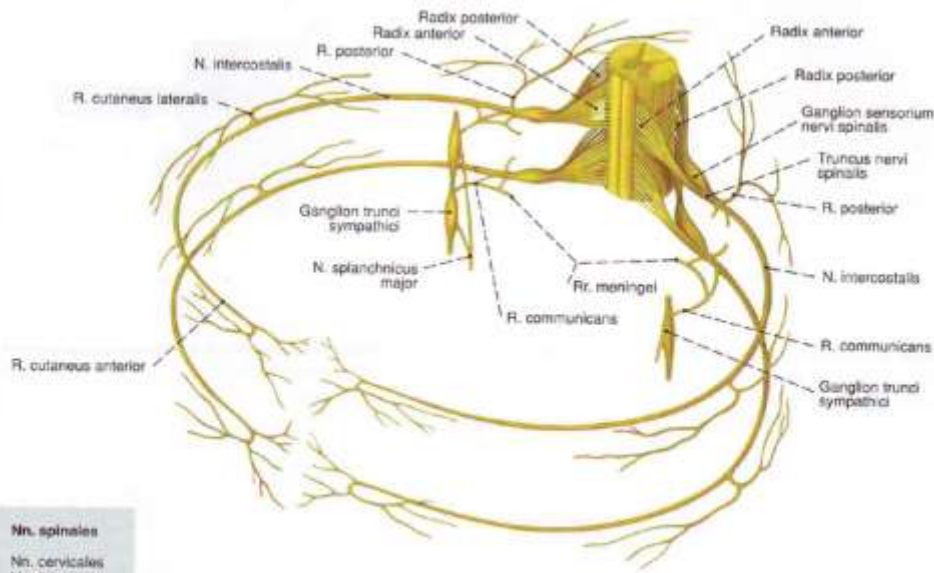
# Ventral rami of the spinal nerves

- Thoracic ventral rami – 12 pairs:
  - ✓ segmental distribution – **intercostal nerves**
  - ✓ Th12 – subcostal nerve
  - ✓ anterior cutaneous branches
  - ✓ lateral cutaneous branches

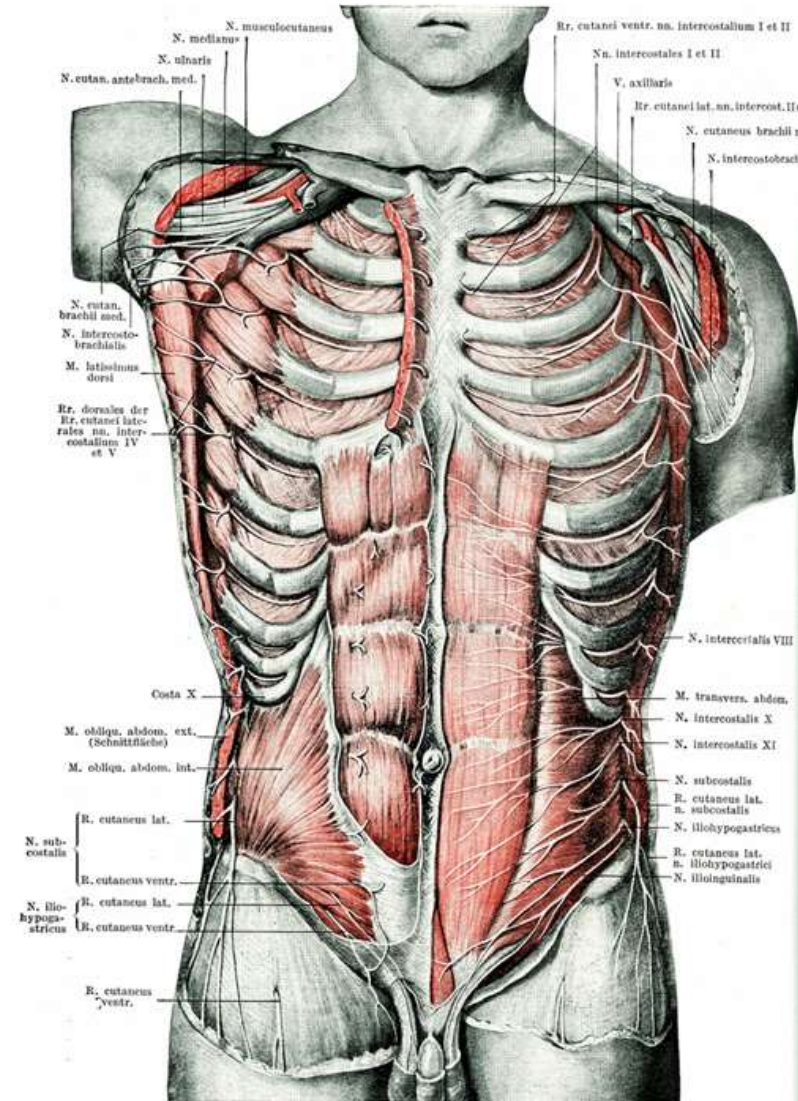


# Ventral rami of the spinal nerves

- Thoracic ventral rami – 12 pairs:
  - ✓ segmental distribution – **intercostal nerves**
  - ✓ Th12 – subcostal nerve
  - ✓ anterior cutaneous branches
  - ✓ lateral cutaneous branches



Nn. spinales  
 Nn. cervicales  
 Nn. thoracici  
 Nn. lumbales  
 Nn. sacrales  
 N. coccygeus





# Lumbosacral plexus, *plexus lumbosacralis*

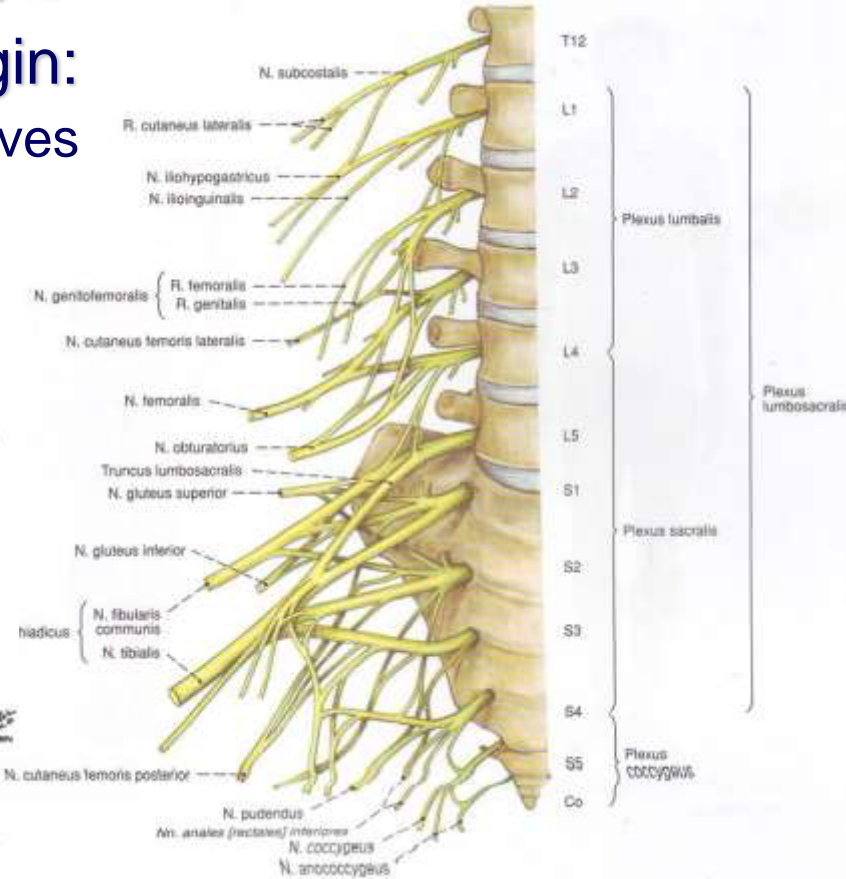
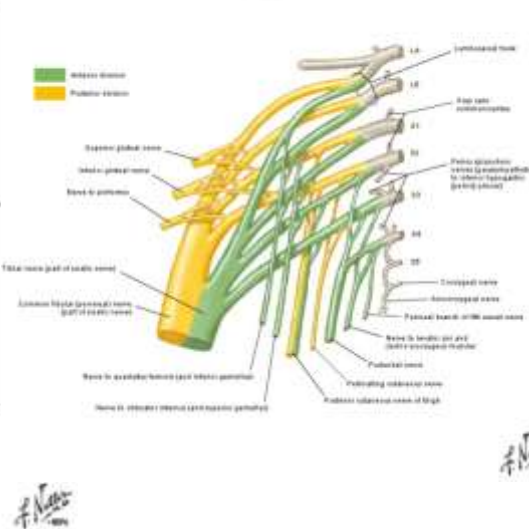
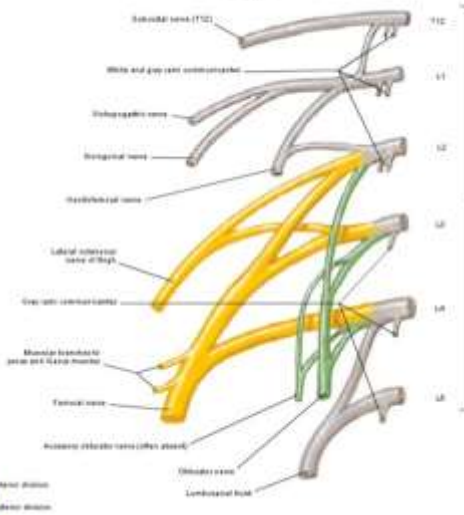
- Lumbar plexus, *plexus lumbalis*:

- ✓ formation and segmental origin:

- ventral rami of Th12, L1-L4 nerves

Lumbar Plexus Schema

Sacral and Coccygeal Plexuses Schema



- Sacral plexus, *plexus sacralis*:

- ✓ formation and segmental origin:

- ventral rami of L5, S1-S5, Co1 nerves

- Coccygeal plexus, *plexus coccygeus*:

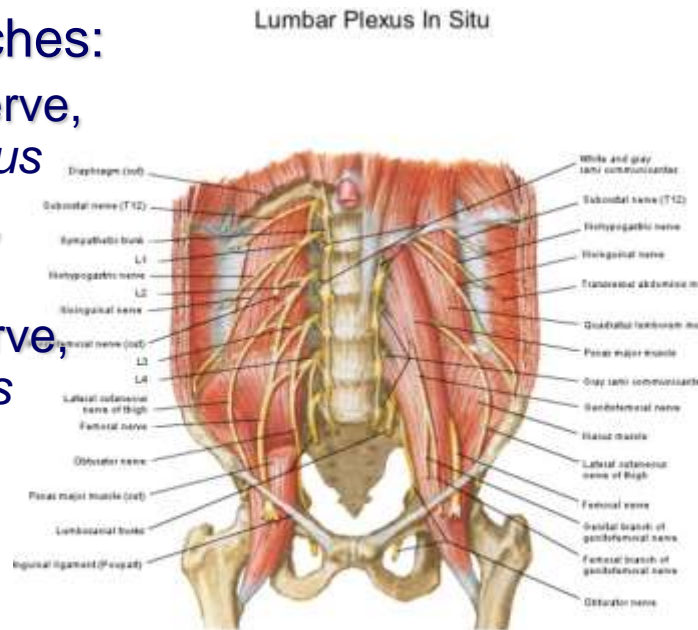
- ✓ ventral rami of S5, Co1



# Lumbar plexus, *plexus lumbalis*

## ■ Branches:

- ✓ muscular branches,  
*rr. musculares*
- ✓ purely sensory branch:
  - lateral femoral cutaneous nerve,  
*n. cutaneus femoris lateralis*
- ✓ sensorimotor branches:
  - iliohypogastric nerve,  
*n. iliohypogastricus*
  - ilioinguinal nerve,  
*n. ilioinguinalis*
  - genitofemoral nerve,  
*n. genitofemoralis*
  - obturator nerve,  
*n. obturatorius*
  - femoral nerve,  
*n. femoralis*

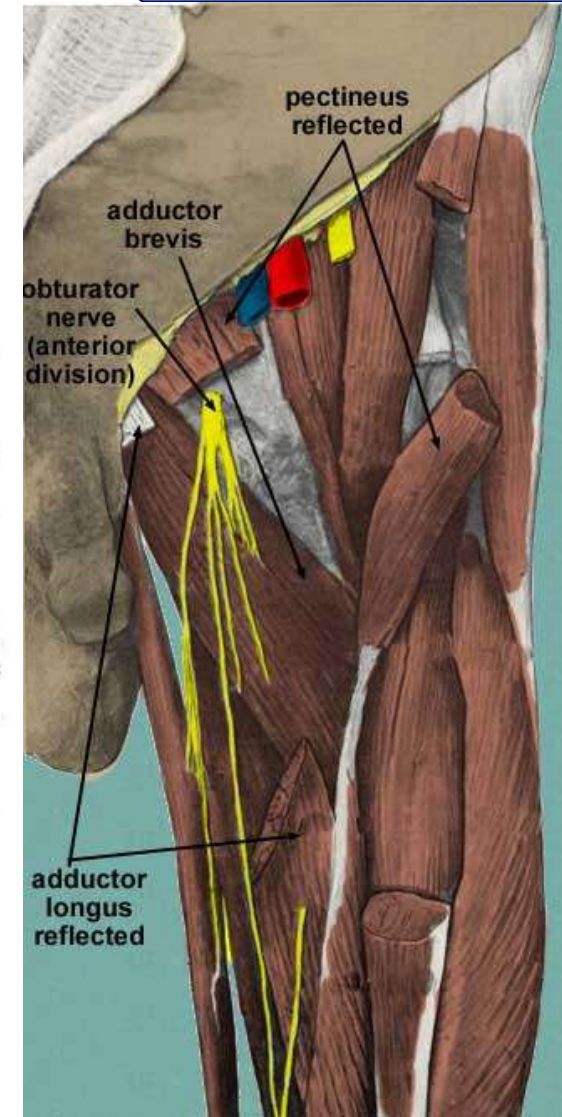
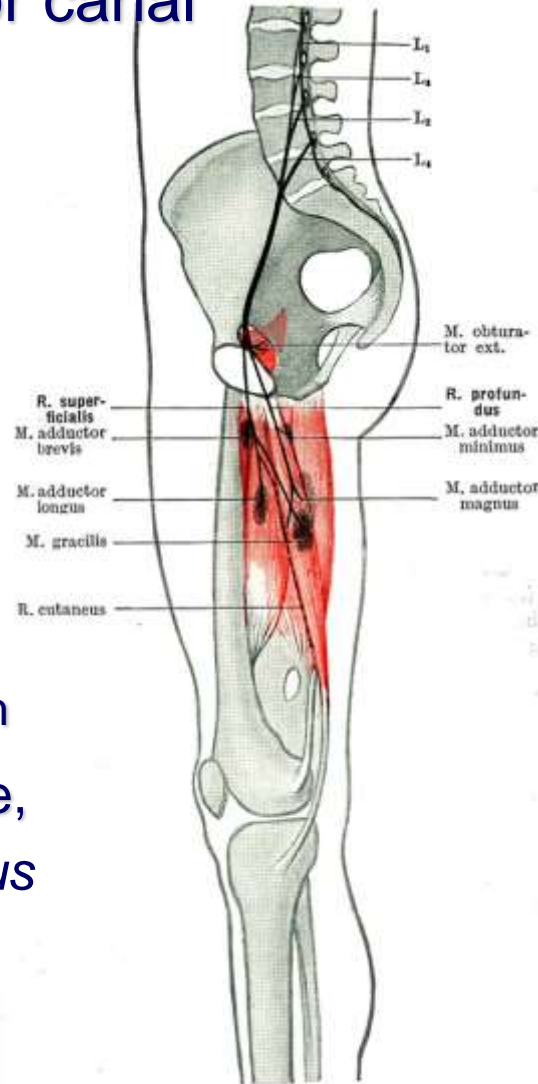


F. N. Lazarov



# Obturator nerve, *n. obturatorius*

- passes through obturator canal
- branches – L2-L4:
  - ✓ anterior division
    - adductor muscles
    - gracilis muscle
  - ✓ posterior division
    - inner surface of the thigh
  - ✓ accessory obturator nerve, *n. obturatorius accessorius*

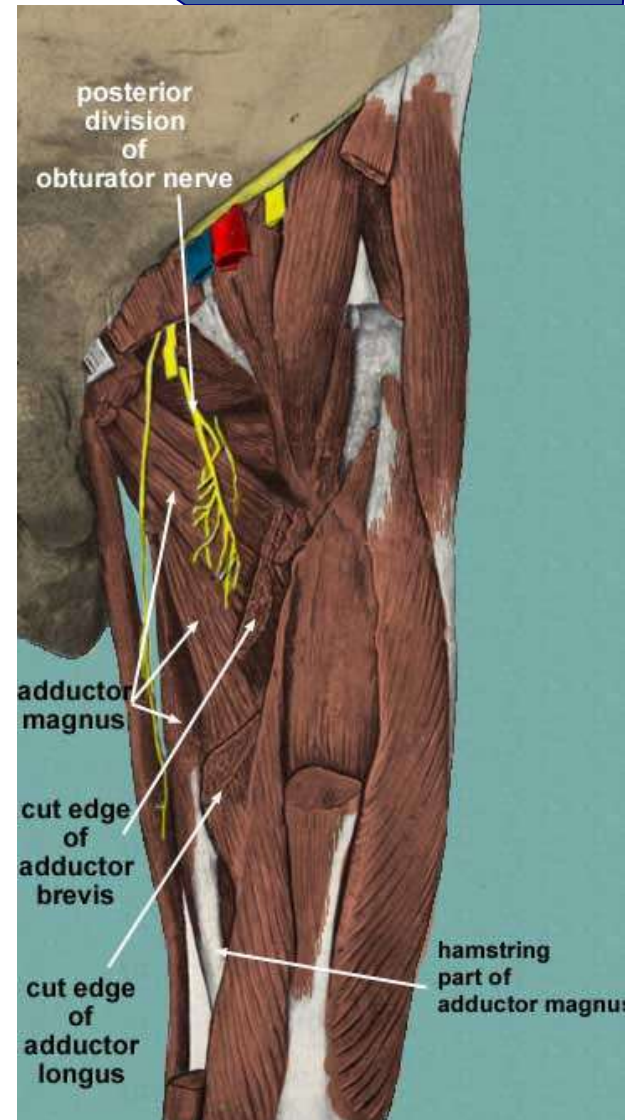
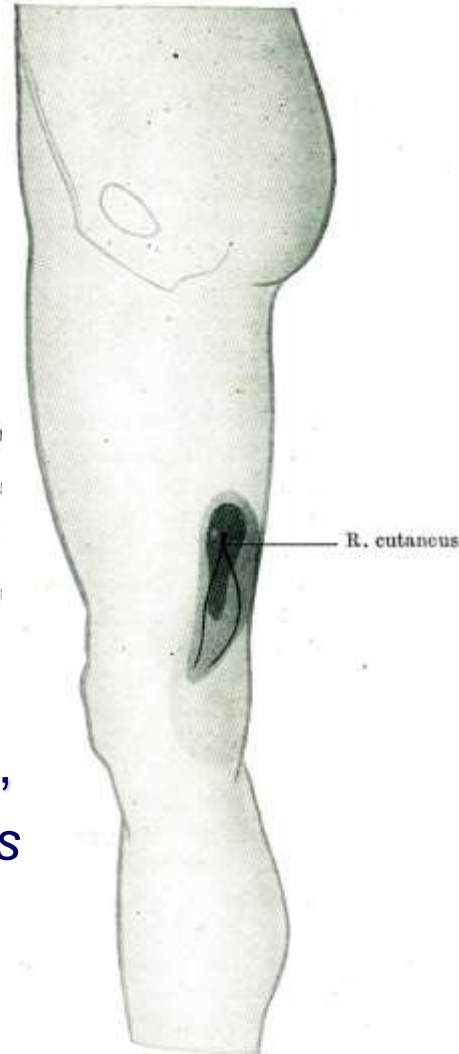






# Obturator nerve, *n. obturatorius*

- passes through obturator canal
- branches – L2-L4:
  - ✓ anterior division
  - ✓ posterior division
  - ✓ motor branches:
    - adductor muscles
    - gracilis muscle
  - ✓ sensory branches:
    - inner surface of the thigh
  - ✓ accessory obturator nerve, *n. obturatorius accessorius*





# Femoral nerve, *n. femoralis*

- passes through *lacuna musculorum*

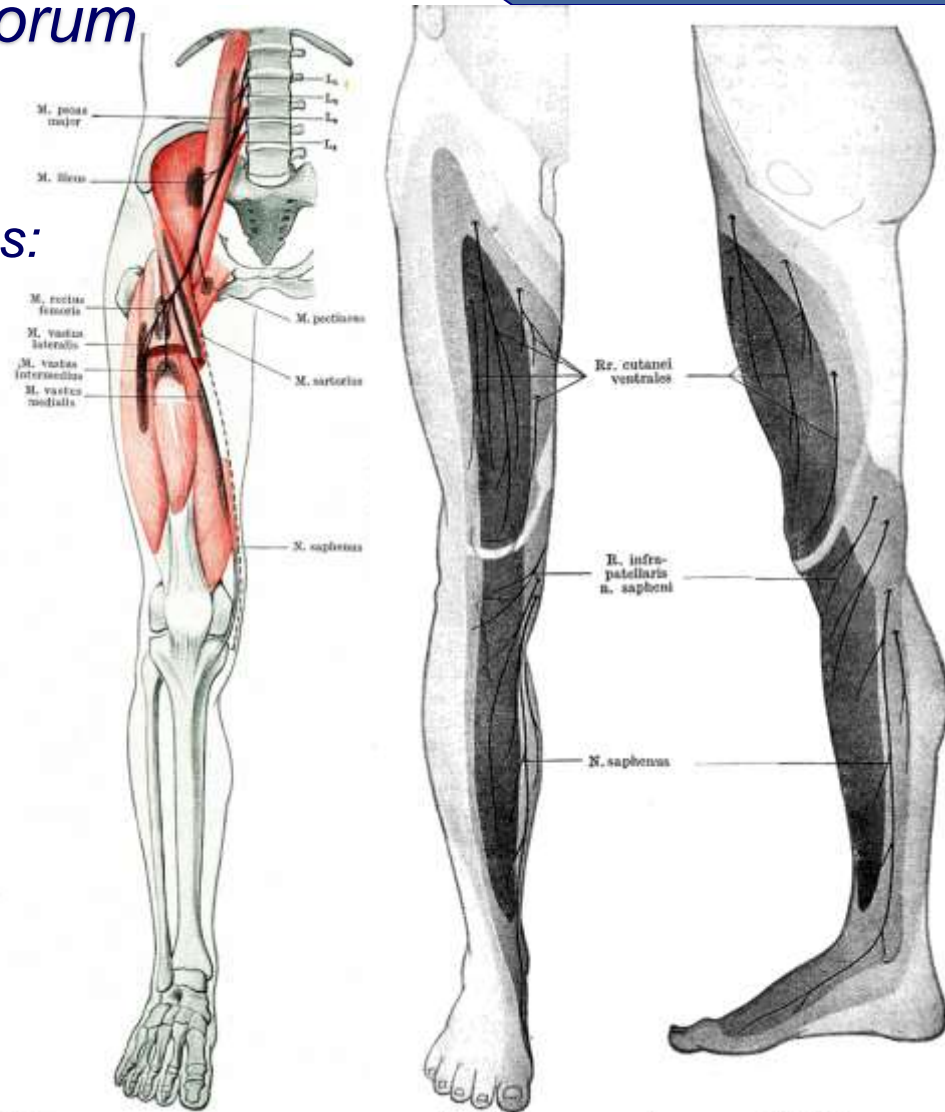
- branches – L2-L4:

- ✓ muscular branches, *rr. musculares*:

- iliopsoas
- pectineus
- sartorius
- extensor muscles of the knee – quadriceps femoris

- ✓ sensory branches:

- anterior femoral cutaneous nerve
- saphenous nerve





# Sacral plexus, *plexus sacralis*

## Branches:

### ✓ motor branches:

- muscular branches, *rr. musculares*
- superior gluteal nerve, *n. gluteus superior*
- inferior gluteal nerve, *n. gluteus inferior*

### ✓ purely sensory branch:

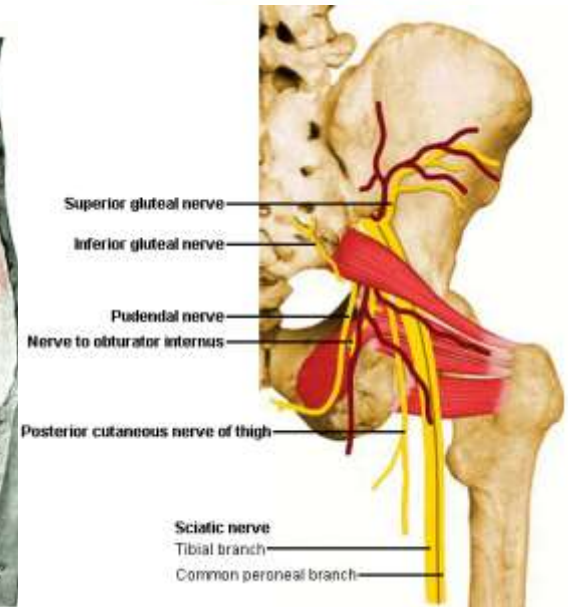
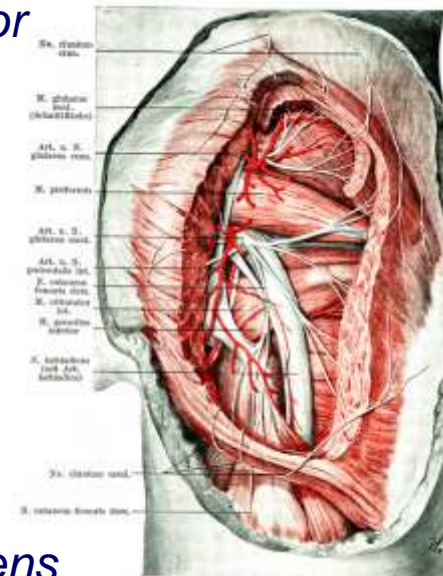
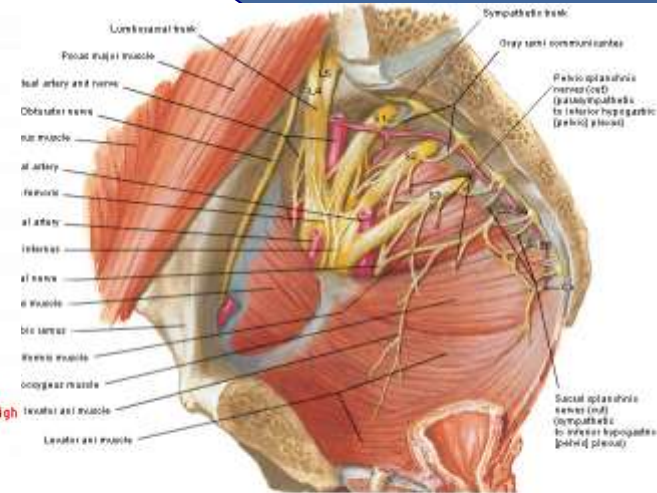
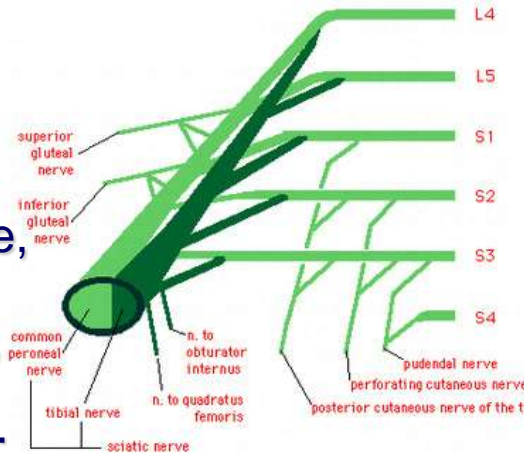
- posterior femoral cutaneous nerve  
*n. cutaneus femoris posterior*

### ✓ sensorimotor branches:

- pudendal nerve, *n. pudendus*
- coccygeal nerve, *n. coccygeus*
- sciatic nerve, *n. ischiadicus*

### ✓ visceral branch:

- pelvic splanchnic nerve,  
*nervus erigens*





# Sciatic nerve, *n. ischiadicus*

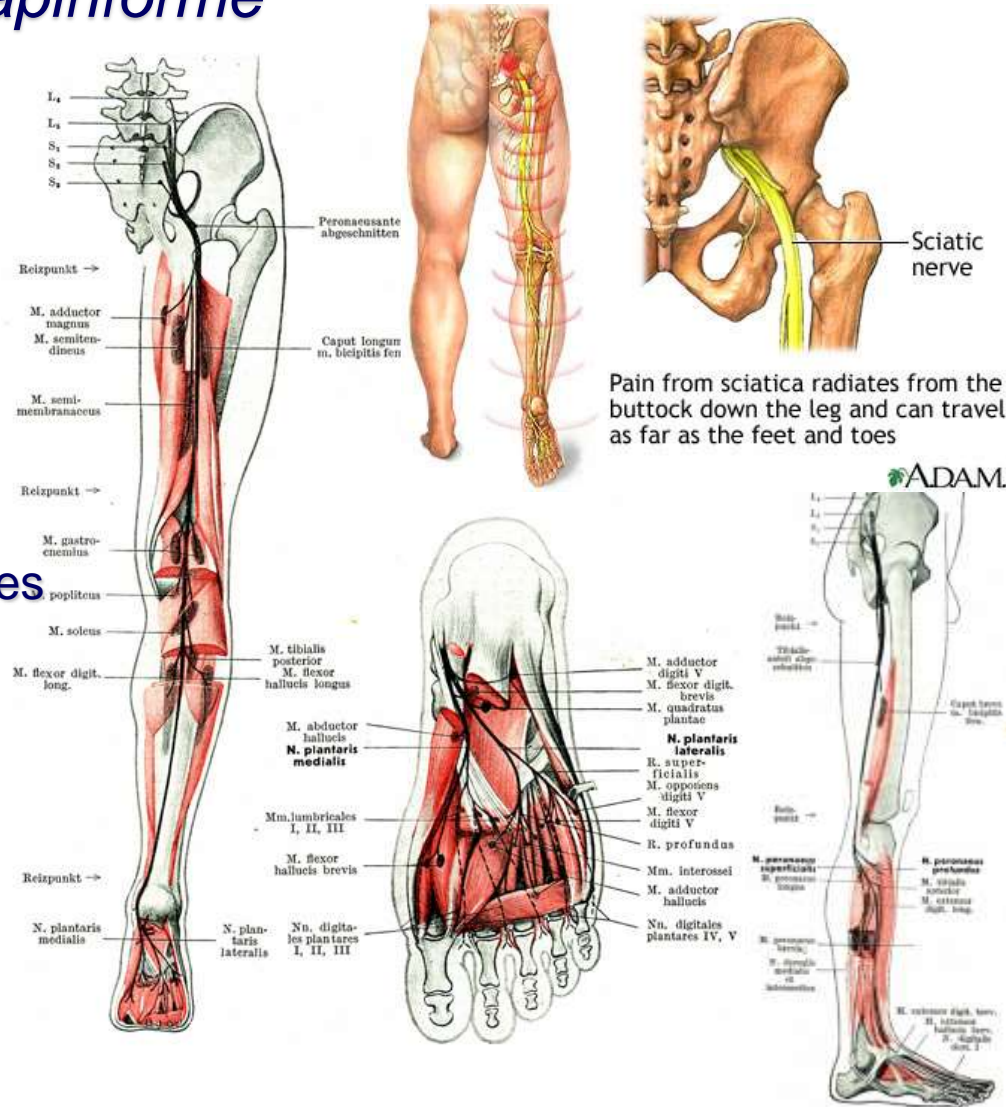
- passes through *foramen infrapiriforme*
- Main branches:

- ✓ tibial nerve, *n. tibialis*:

- articular branches
    - muscular branches
    - sural nerve
    - medial and lateral calcaneal
    - medial and lateral plantar nerves

- ✓ common peroneal nerve, *n. peroneus communis*:

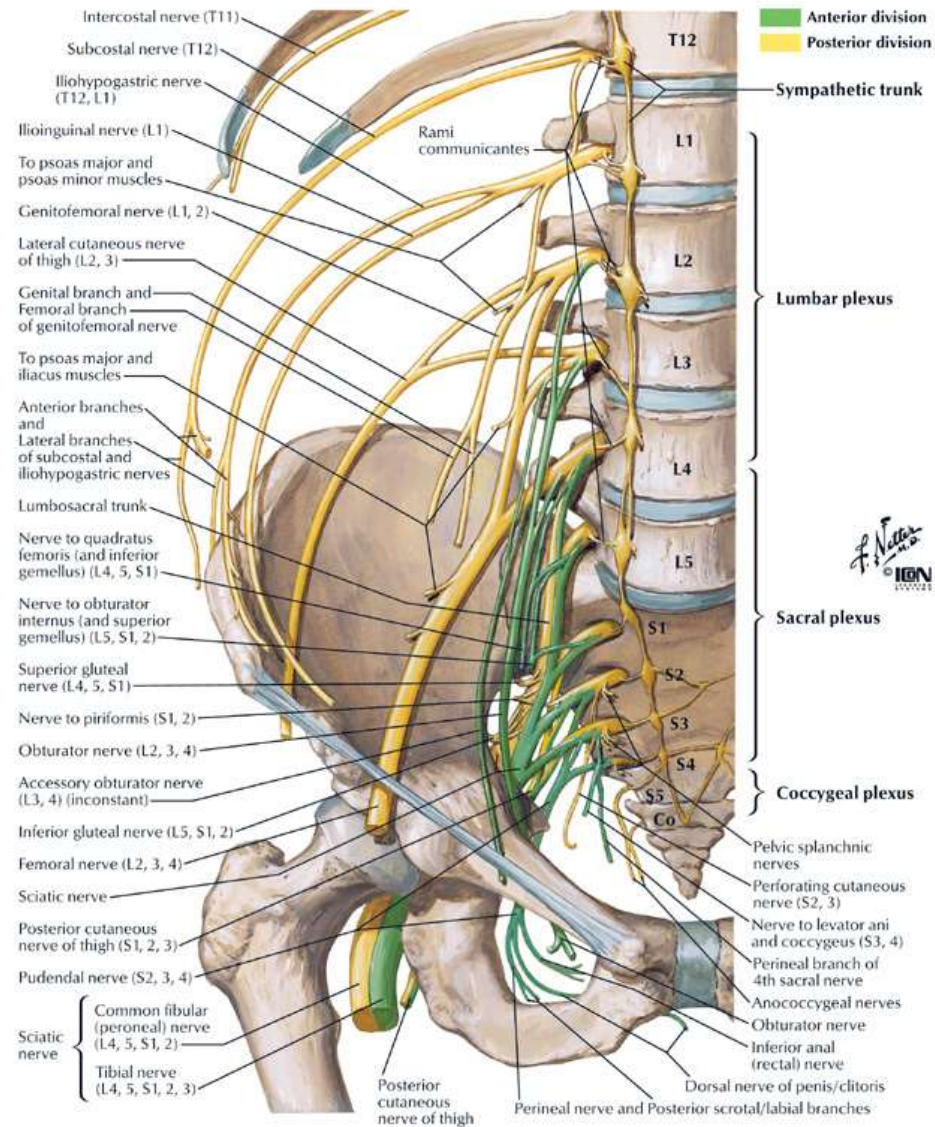
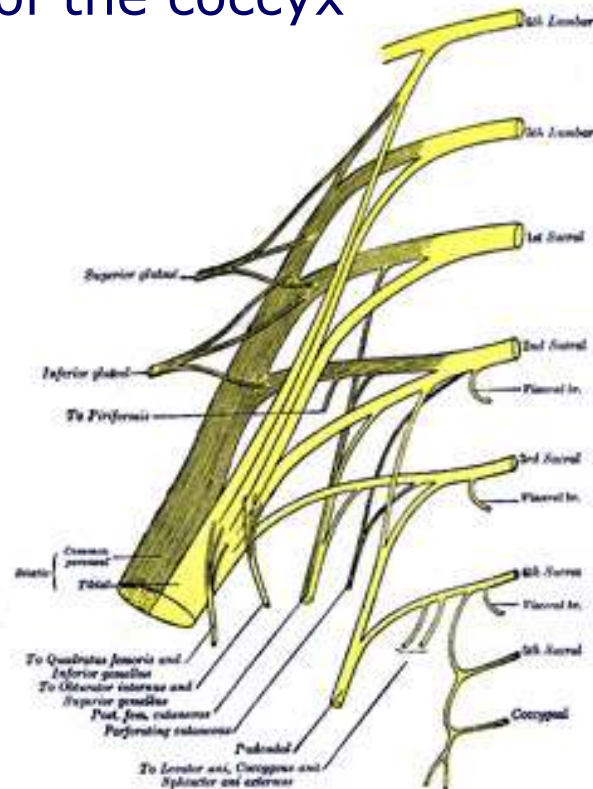
- superficial peroneal nerve (musculocutaneous)
    - deep peroneal nerve (anterior tibial nerve)





# Coccygeal plexus, *plexus coccygeus*

- part of the sacral plexus
- sensory branches:
  - ✓ anococcygeal nerves – the skin in the region of the coccyx





# *Happy Saint Valentine's Day and ...*



*Thank you ...*