The Peripheral Nervous System

- Nervous structures outside brain & spinal cord
- Nerves allow the CNS to receive information and take action
- *Functional components of the PNS*
  - Sensory inputs and motor outputs
    - Categorized as somatic or visceral
  - Sensory inputs also classified as *general* or *special*

1

The Peripheral Nervous System

- Autonomic nervous system (ANS)
  - General **visceral motor part** of the PNS
  - ANS has two divisions
    - **Parasympathetic**
    - **Sympathetic**

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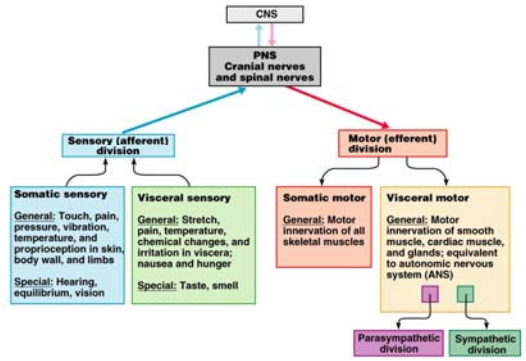
Functional Organization of the PNS



Basic Structural Components of PNS

- **Sensory receptors** – pick up stimuli from inside or outside the body
- **Motor endings** – axon terminals of motor neurons
  - Innervate effectors (muscle fibers and glands)
- Nerves and ganglia
  - **Nerves** – bundles of peripheral axons
  - **Ganglia** – clusters of peripheral neuronal cell bodies

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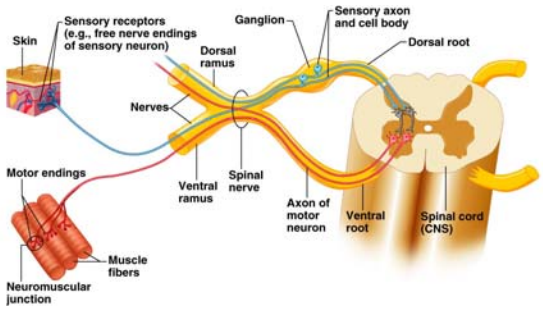
Basic Anatomical Scheme of the PNS in the Region of a Spinal Nerve



Peripheral Sensory Receptors

- Structures that pick up sensory stimuli
  - Initiate signals in sensory axons
- Two main categories of sensory receptors
  - **Complete receptor cells** – specialized epithelial cells or small neurons
    - Monitor most types of *special sensory information*
      - *Taste, vision, hearing, equilibrium*
  - **Free nerve endings of sensory neurons**
    - Monitor general sensory information

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Classification by *Location*

- **3 classes based on location**
  1. Exteroceptors – At or near body surface
     - Touch, pressure, pain and temperature in skin and special senses
  2. Interoceptors – "Viscероceptors" – in the visera
     - Chemical concentration, taste, stretch and temperature
  3. Proprioceptors – Musculoskeletal organs
     - Stretch (position of body part)

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Classification by *Stimulus*

- **5 classes based on Stimulus**
  1. Mechanoreceptors – Mechanical forces
     - Touch, pressure, stretch, vibrations and itch
  2. Thermoreceptors – temperature changes
  3. Chemoreceptors – Chemicals in solution
     - Taste, smell, blood chemistry
  4. Photoreceptors – Respond to light (eye)
  5. Nociceptors – Harmful stimuli (pain)

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Classification by *Structure*

- **General sensory receptors**
  - Widely distributed
  - Two types: Free & Encapsulated nerve endings
  - Nerve endings of sensory neurons monitor
    - Touch
    - Pressure
    - Vibration
    - Stretch
    - Pain
    - Temperature
    - Proprioception

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Spinal Nerves

- 31 pairs – contain thousands of nerve fibers
- Connect to the spinal cord
- Named for point of issue from the spinal cord
  - 8 pairs of cervical nerves (C_1–C_8)
  - 12 pairs of thoracic nerves (T_1–T_{12})
  - 5 pairs of lumbar nerves (L_1–L_5)
  - 5 pairs of sacral nerves (S_1–S_5)
  - 1 pair of coccygeal nerves (Co_1)

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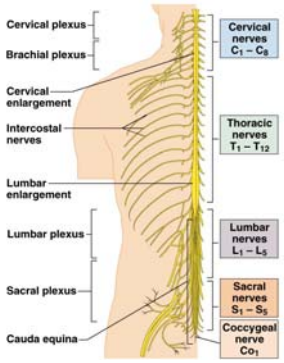
Spinal Nerves Posterior View



Spinal Nerves

- Connect to the spinal cord by the dorsal root and ventral root
  - **Dorsal root** – contains sensory fibers
    - Cell bodies – located in the dorsal root ganglion
  - **Ventral root** – contains motor fibers arising from anterior gray column
  - When an anterior root and a posterior root unite, they form a spinal nerve (motor and sensory)

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Spinal Nerves

- Spinal nerves split into two main branches
  1. **Posterior (dorsal) ramus**
     - Innervates skin of back and deep back muscles
  2. **Anterior (ventral) ramus**
     - Innervates everything from neck inferiorly
     - Also forms nerve plexuses
       - Nerve plexus – a network of converging and/or diverging nerve fibers

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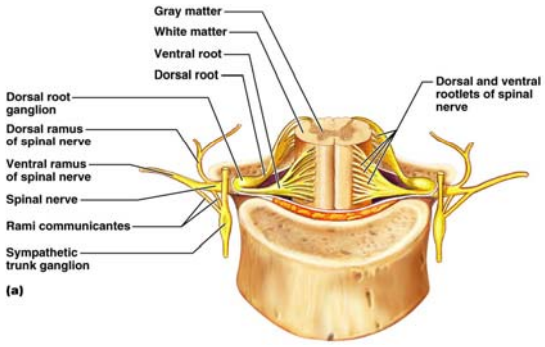
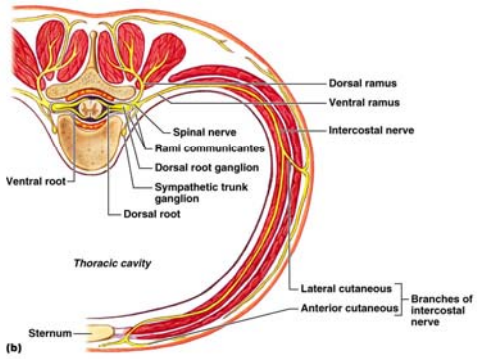
Spinal Nerves



Spinal Nerves



Introduction to Nerve Plexuses

- **Nerve plexus** – a network of nerves
- **Ventral rami** (except $T_2 – T_{12}$)
  - Branch and join with one another
  - Form nerve plexuses
    - In cervical, brachial, lumbar, and sacral regions
  - Primarily serve the limbs
  - Fibers from ventral rami crisscross

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The Cervical Plexus

- Buried deep in the neck
  - Under the **sternocleidomastoid muscle**
- Formed by ventral rami of first four cervical nerves (C1 – 4)
- Some innervate muscles of the anterior neck
- **Phrenic nerve** – the most important nerve of the cervical plexus
  - Innervates the diaphragm

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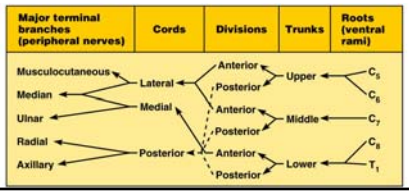
The Brachial Plexus and Innervation of the Upper Limb

- Brachial plexus lies in the neck and axilla
- Formed by ventral rami of $C_5 – C_8$
- Cords give rise to main nerves of upper limb



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Nerves from the Lateral and Medial Cords

- **Musculocutaneous Nerve**
  - Innervates the biceps brachii and brachialis
- **Median Nerve**
  - Innervates anterior forearm muscles & lateral palm
- **Ulnar Nerve**
  - Innervates intrinsic hand muscles and skin of the medial hand

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Nerves from the Posterior Cord

- **Radial Nerve**
  - Largest branch of the brachial plexus
  - Innervates muscles of the posterior upper limb
- **Axillary Nerve**
  - Innervates the deltoid and teres minor

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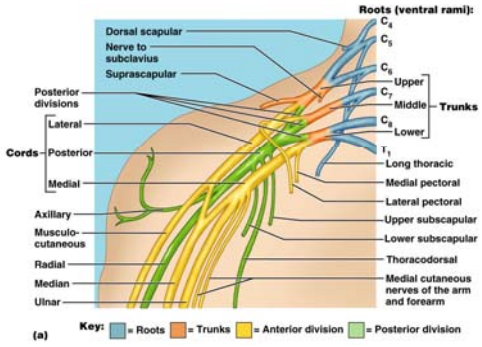
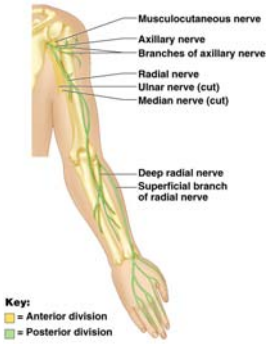
The Brachial Plexus



Axillary and Radial Nerves



The Lumbar Plexus and Innervation of the Lower Limb

- **Lumbar plexus**
  - Arises from L_1– L_4
  - Smaller branches innervate the posterior abdominal wall and psoas muscle
  - Main branches innervate the anterior thigh
    - Femoral nerve – innervates anterior thigh muscles
    - Obturator nerve – innervates adductor muscles

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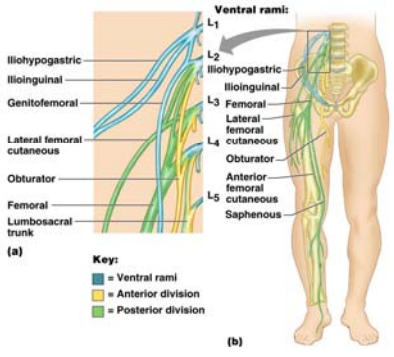
The Lumbar Plexus



The Sacral Plexus

- Arises from spinal nerves L_4–S_4
- Caudal to the lumbar plexus
- Often considered with the lumbar plexus
  - **Lumbosacral plexus**

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Innervation of the Lower Limb

- **Sciatic nerve** – the largest nerve of the sacral plexus
  - Actually two nerves in one sheath
    - Tibial nerve – innervates most of the posterior lower limb
    - Common fibular (peroneal) nerve – innervates muscles of the anterolateral leg

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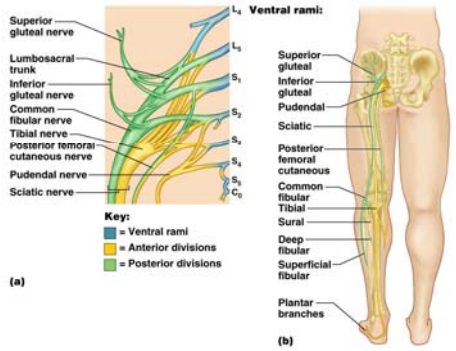
The Sacral Plexus



Innervation of the Skin: Dermatomes

- **Dermatome** – an area of skin
  - Innervated by cutaneous branches of a spinal nerve
- Upper limb
  - Skin is supplied by nerves of the **brachial plexus**
- Lower limb
  - Lumbar nerves – anterior surface
  - Sacral nerves – posterior surface

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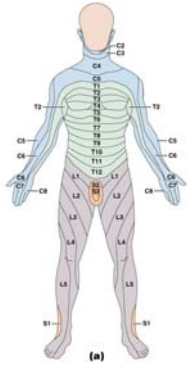
Map of Dermatomes – Anterior View



Map of Dermatomes – Posterior View