MEDICAL EDUCATION RESOURCE

Venous and Lymphatic Drainage; Segmental and Sympathetic Innervation

Introduction

- Venous drainage of the lower limb is arranged in **two systems:**
    1. **Superficial veins** — lie in superficial fascia.
    2. **Deep veins** — accompany arteries as *venae comitantes*.
- Both systems are interconnected by **perforating (communicating) veins**.
- Veins possess **valves** that ensure unidirectional flow of blood towards the heart.

1. Tributaries of Long (Great) Saphenous Vein

Mnemonic: *“3 S’s and 3 P’s”*
? **Superficial Epigastric**
? **Superficial Circumflex Iliac**
? **Superficial External Pudendal**
? **Posterior Arch Vein**
? **Parapatellar Vein**
? **Perforating Veins**

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2. Perforating Veins (Names and Locations)

Mnemonic: *“Do Boy’s Calf”*
? **Dodd’s** – in lower thigh (adductor canal).
? **Boyd’s** – just below knee (upper leg).
? **Cockett’s** – along lower leg (ankle region).

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3. Groups of Inguinal Lymph Nodes

Mnemonic: *“HIP LEG”*

- **H** – Horizontal group
- **I** – Inguinal ligament (location)
- **P** – Perineum and penis/vulva drainage
- **L** – Lower abdominal wall
- **E** – External genitalia and anal canal (below pectinate line)
- **G** – Gluteal region

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4. Deep Inguinal Node (Cloquet’s Node)

Mnemonic: *“Close to the Canal”*
? The **node of Cloquet** lies **close to the femoral canal** — the highest deep inguinal node.

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5. Superficial vs Deep Lymphatics

Mnemonic: *“Long and Short Stories”*
? Long saphenous ? superficial inguinal nodes
? Short saphenous ? popliteal nodes ? deep inguinal nodes

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6. Popliteal Lymph Node Drainage

Mnemonic: *“Deep Little Sock”*
? **D**eep tissues of leg and foot
? **L**ateral side of foot and heel
? **S**mall saphenous territory

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7. Root Value of Major Reflexes

Mnemonic: *“1, 2 — buckle my shoe; 3, 4 — kick the door; 5, 6 — pick up sticks.”*

- **L3–L4:** Knee jerk (kick)
- **S1–S2:** Ankle jerk (stand on toes)
- **L5–S1:** Plantar reflex (pick up)

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8. Myotomes of Lower Limb

Mnemonic: *“L2–3 flex the thigh; 3–4 extend the knee; 4–5 lift the foot; 5–S1 push down.”*
? L2–L3 – Hip flexion
? L3–L4 – Knee extension
? L4–L5 – Dorsiflexion
? S1–S2 – Plantar flexion

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9. Dermatomal Spiral

Mnemonic: *“From groin to heel, L1 to S1 feel.”*
? Dermatomes twist spirally from upper medial (L1) to lower lateral (S1) aspect of limb.

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10. Sympathetic Functions in Limb

Mnemonic: *“VSP Rule”*
? **V**asomotor – vessel tone
? **S**udomotor – sweat glands
? **P**ilomotor – hair erection

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11. Comparison of Limbs (Functional Summary)

Mnemonic: *“Hand Handles, Leg Lands.”*
? Upper limb = handles, manipulates, precise.
? Lower limb = lands, supports, propels.

Facts to Remember

- The **venous drainage of the lower limb** is arranged in **two systems** — superficial and deep — interconnected by **perforating veins** that allow blood flow only from superficial to deep veins.
- The **superficial veins** begin from the **dorsal venous arch of the foot** and include the **long (great) saphenous vein** and **short (small) saphenous vein**.
- The **long saphenous vein** runs in front of the **medial malleolus**, while the **short saphenous vein** passes **behind the lateral malleolus**.
- The **long saphenous vein** ends in the **femoral vein**, and the **short saphenous vein** ends in the **popliteal vein**.
- **Perforating veins** connect the superficial to the deep system and contain valves that prevent reverse flow; their incompetence leads to **varicose veins**.
- **Cockett’s, Boyd’s, and Dodd’s perforators** are the clinically important sets in the leg and thigh.
- The **calf muscles** act as a **musculovenous pump**, propelling venous blood upwards against gravity during walking.

- **Varicose veins**, **venous ulcers**, and **deep vein thrombosis (DVT)** are common vascular disorders of the lower limb.
- The **long saphenous vein** is frequently used as a **graft in coronary artery bypass surgery** due to its suitable length and wall structure.
- The **lymphatic drainage of the lower limb** is divided into **superficial and deep lymphatics**, both ending in **inguinal lymph nodes**.
- The **superficial inguinal lymph nodes** are divided into **horizontal and vertical groups** and drain the lower limb, perineum, lower abdominal wall, and external genitalia.
- The **deep inguinal lymph nodes** lie along the **femoral vein**; the highest one is the **node of Cloquet**, situated in the **femoral canal**.
- **Superficial lymphatics** accompanying the **long saphenous vein** end in **superficial inguinal nodes**, while those along the **short saphenous vein** end in **popliteal nodes**.
- **Popliteal lymph nodes** drain the **deep tissues of leg and foot** and send efferents to **deep inguinal nodes**.
- **Sympathetic fibers to the lower limb** arise from **T10–L2** spinal segments and supply **vessels, sweat glands, and arrector pili muscles**.
- Sympathetic functions include **vasomotor, sudomotor, and pilomotor** control.
- The **segmental innervation** of the limb follows a **spiral dermatome pattern** due to embryological medial rotation of the lower limb.
- **Myotomes** correspond to major limb movements:
    - L2–L3 ? hip flexion,

- L3–L4 ? knee extension,
- L4–L5 ? dorsiflexion,
- S1–S2 ? plantar flexion.

- **Reflex levels:**
  - Knee jerk ? L3–L4,
  - Ankle jerk ? S1–S2,
  - Plantar reflex ? L5–S1.

- **Upper and lower limbs** are homologous in structure but functionally distinct — upper limb specialized for **mobility and manipulation**, lower limb for **support and locomotion** .

- During development, the **upper limb rotates laterally**, while the **lower limb rotates medially**, reversing the positions of flexor and extensor compartments.

- The **preaxial border** is **lateral in the upper limb** (thumb side) and **medial in the lower limb** (great toe side).

- The **arches of the foot** (absent in the hand) provide **elasticity, shock absorption, and weight distribution**.

- The **commonest deformity** of the upper limb is **wrist drop**, while that of the lower limb is **foot drop**.

? Clinicoanatomical Problems

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1. A 45-year-old shopkeeper complains of tortuous, bulging veins along the medial side of his leg after prolonged standing.
? **Diagnosis:** Varicose veins due to valve incompetence in the **long saphenous vein** and perforators.

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2. A patient presents with an ulcer above the medial malleolus with surrounding pigmentation and eczema.
? **Cause: Chronic venous insufficiency** from valvular failure in **superficial and perforating veins**.

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3. A 32-year-old woman develops sudden swelling and pain in her calf after surgery.
? **Diagnosis: Deep vein thrombosis (DVT)** involving **posterior tibial or popliteal veins**.

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4. An elderly patient has swelling in the groin just below the inguinal ligament, giving a cough impulse.
? **Differential: Saphenous varix** at the terminal part of the **long saphenous vein** mimicking a **femoral hernia**.

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5. After injury to the popliteal fossa, a patient develops localized venous dilation behind the knee.
? **Structure affected: Small saphenous vein** or its termination into **popliteal vein**.

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6. During coronary artery bypass surgery, the surgeon harvests a long superficial vein from the leg.
? **Vein used: Great saphenous vein** — easily accessible and of suitable diameter.

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7. A 25-year-old man shows prominent superficial veins in his leg but normal deep veins on Doppler scan.
? **Cause: Incompetent perforating veins** (especially Cockett's group) allowing backflow into superficial system.

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8. A patient with varicose veins undergoes the Trendelenburg test.
? **Observation:** Rapid filling of veins on standing indicates **incompetent saphenofemoral junction** valves.

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9. A diabetic patient develops a non-healing ulcer over the dorsum of foot with cold skin.
? **Cause: Ischemia** due to atherosclerosis and autonomic neuropathy affecting **sympathetic vasomotor control**.

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10. A woman presents with tender, enlarged lymph nodes below the inguinal ligament following a boil on the thigh.
? **Lymph nodes involved: Superficial inguinal lymph nodes** (horizontal and vertical groups).

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11. A chronic leg infection leads to swelling of the foot with thickened skin and loss of ankle contour.
? **Diagnosis: Lymphoedema** due to obstruction of **superficial and deep lymphatics**.

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12. A farmer from an endemic area shows gross enlargement of the lower limb with rough skin and non-pitting edema.
? **Diagnosis: Elephantiasis** caused by *Wuchereria bancrofti* blocking the lymphatic channels.

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13. A small swelling is detected in the femoral canal during groin dissection.
? **Structure: Node of Cloquet** (highest deep inguinal lymph node).

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14. After fracture of the femur, the patient develops severe pain and swelling of the thigh; Doppler shows blocked deep veins.
? **Diagnosis: Post-traumatic DVT**, risking **pulmonary embolism**.

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15. A patient with a wound on the lateral side of the foot shows lymph node enlargement in the popliteal fossa.
? **Explanation:** Lymph from the **lateral foot and heel** drains first into **popliteal lymph nodes**.

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16. A patient presents with cold, pale foot after lumbar sympathectomy.
? **Explanation:** Removal of sympathetic tone ? loss of **vasoconstrictor control** ? dilated

vessels and warm, dry skin.

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17. A man has loss of sweating and hair over his leg following a sciatic nerve injury.
? **Reason:** Interruption of **sympathetic fibers** traveling in peripheral nerves.

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18. A patient experiences severe burning pain after tibial nerve injury in the leg.
? **Condition: Causalgia** due to sympathetic overactivity.

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19. A clinician tests sensory loss over the dorsum and lateral aspect of the foot.
? **Findings:** Diminished sensation corresponds to **L5 and S1 dermatomes** ? possible **nerve root compression** at **L4–L5 or L5–S1**.

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20. A patient complains of foot drop after prolonged squatting.
? **Cause:** Compression of **common peroneal nerve** at the fibular neck; corresponds to **L4–S1 motor fibers**.

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21. A spinal disc prolapse at L5 compresses nerve roots in the canal.
? **Effect:** Pain radiating along dorsum of foot with weakness of **toe extension** (extensor hallucis longus, L5 myotome).

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22. A patient with carcinoma of penis presents with enlarged groin nodes.
? **Spread:** Metastatic involvement of **superficial inguinal lymph nodes** via lymphatic drainage of external genitalia.

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23. A neurologist notes absence of knee jerk reflex in a patient.
? **Root level affected: L3–L4** — suggests lesion in **femoral nerve** or **corresponding spinal roots**.

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24. Another patient shows absent ankle jerk but normal knee jerk.
? **Root level involved: S1–S2**, affecting **tibial nerve**.

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25. A person suffers loss of sensation around the perianal region after spinal injury.
? **Dermatomes affected: S3–S5** — indicating **cauda equina involvement** (saddle anesthesia)

- The lower limb veins play a vital role in **venous return against gravity** during standing and walking.

Venous Drainage

1. Superficial veins

- Begin in the **dorsal venous arch** on dorsum of foot.
- Drain into:
  - **Long (great) saphenous vein** ? ascends medially.
  - **Short (small) saphenous vein** ? ascends posteriorly.

2. Deep veins

- **Venae comitantes** accompany arteries and bear the same names.
- Major deep veins: *anterior tibial, posterior tibial, peroneal, popliteal,* and *femoral veins*.
- Join with superficial veins through perforators.

Factors Helping Venous Return

1. **Muscle Pump:**

- Calf muscles contract ? compress deep veins ? propel blood upward.
- Valves prevent backflow (“musculovenous pump”).

2. **Venous Valves:**
   - Numerous and strong in lower limb.
   - Permit upward flow and close to prevent retrograde movement.
3. **Respiratory Movements:**
   - During inspiration, decreased thoracic pressure aids venous suction.
4. **Arterial Pulsation:**
   - Arteries pulsate alongside deep veins, helping venous propulsion.
5. **Gravity & Negative Pressure:**
   - Postural changes and walking activate venous flow by alternate contraction and relaxation.
6. **Fascial Compression:**
   - Deep fascia and septa compress veins during muscle activity, aiding return.

Veins of Lower Limb

- **Superficial veins** drain skin and superficial fascia.

- **Deep veins** drain deeper structures (muscles, bones).
- **Perforating veins** connect the two and direct blood from **superficial ? deep** systems.
- All ultimately drain into the **femoral vein** ? **external iliac vein** ? **inferior vena cava**.

Long (Great) Saphenous Vein

- **Origin:** Medial end of *dorsal venous arch* of foot.
- **Course:**
  - Passes **anterior to medial malleolus**,
  - Ascends along **medial side of leg and thigh**,
  - Pierces **cribriform fascia in saphenous opening**,
  - Terminates in **femoral vein** about 3.5 cm below and lateral to pubic tubercle.
- **Tributaries:**
  - *From leg:* Posterior arch vein, accessory saphenous veins.
  - *From thigh:* Superficial circumflex iliac, superficial epigastric, and superficial external pudendal veins.
- **Valves:** 10–20 in number, prevent backflow.
- **Clinical relevance:** Commonly used for **coronary artery bypass grafting (CABG)** and **intravenous access**.

Small (Short) Saphenous Vein

- **Origin:** Lateral end of *dorsal venous arch* of foot.
- **Course:**
  - Passes **behind lateral malleolus**,
  - Ascends along the **midline of back of leg**,
  - Pierces deep fascia at lower popliteal fossa,
  - Ends in the **popliteal vein**.
- **Tributaries:** Communicating veins from great saphenous and deep veins of leg.
- **Valves:** Fewer than long saphenous vein.
- **Clinical relevance:** Used for **venous cut-down** and prone to **varicosities**.

Perforating Veins

- Connect **superficial veins to deep veins** and contain **valves** allowing flow only from superficial ? deep system.
- Common groups of perforators:
  1. **Upper thigh** (connecting great saphenous ? femoral vein).
  2. **Lower thigh** (near adductor canal).

3. **Leg perforators:**
    - *Cockett's perforators* (between posterior arch vein and posterior tibial veins).
    - *Boyd's perforator* (connects great saphenous ? posterior tibial veins).
    - *Dodd's perforator* (above knee, near adductor canal).

- **Clinical significance:** Incompetent valves in these veins cause **varicose veins and venous ulcers**.

Clinical Anatomy

Varicose Veins

- Dilated, tortuous superficial veins due to valve incompetence.
- Most common in **long saphenous vein** territory.
- Predisposing factors: prolonged standing, obesity, pregnancy, hereditary weakness of vein wall.
- Complications: eczema, pigmentation, ulceration, thrombophlebitis.

Venous Ulcers

- Occur over **medial malleolus** due to chronic venous stasis and tissue hypoxia.
- Poor healing because of sluggish circulation.

Deep Vein Thrombosis (DVT)

- Clot formation in deep veins (posterior tibial or popliteal).
- May cause pulmonary embolism if clot dislodges.
- Risk factors: immobility, dehydration, surgery, malignancy.

Saphenous Varix

- Localized dilation of terminal part of long saphenous vein at saphenous opening; may give rise to swelling in groin with cough impulse (can mimic femoral hernia).

Coronary Bypass Use

- Long saphenous vein is ideal for CABG because of its length, superficial location, and muscular wall.

Venous Cut-down

- Small saphenous or long saphenous vein used for emergency intravenous access (commonly anterior to medial malleolus).

Trendelenburg Test

- Used to assess competence of saphenofemoral and perforator valves in cases of varicose veins.

? Lymphatic Drainage of the Lower Limb

Introduction

- The lymphatic system drains tissue fluid, proteins, and cellular debris from the **skin, fascia, and deeper tissues** of the lower limb.
- It is divided into two main sets of vessels and nodes:
    1. **Superficial lymphatics** (in superficial fascia).
    2. **Deep lymphatics** (accompany deep veins).
- All lymph ultimately drains into **inguinal lymph nodes** ? **external iliac nodes** ? **lumbar (para-aortic) nodes** ? **cisterna chyli** ? **thoracic duct**.

Classification of Lymph Nodes in Lower Limb

1. **Superficial inguinal lymph nodes**
2. **Deep inguinal lymph nodes**

Both are located in the **femoral triangle** region, forming the principal lymphatic filter stations for the limb.

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1. Superficial Inguinal Lymph Nodes

- **Number:** 10–20 nodes.
- **Location:** In the **superficial fascia** of the femoral triangle, just below the **inguinal ligament**.
- **Divisions:**

- **Horizontal group:**
  - Lies parallel and just below inguinal ligament.
  - **Receives lymph from:**
    - Lower anterior abdominal wall (below umbilicus).
    - Perineum and external genitalia (excluding testes).
    - Gluteal region.
    - Lower part of vagina, anal canal (below pectinate line).
    - Medial side of lower limb (via long saphenous lymphatics).
- **Vertical group:**
  - Lies along terminal part of **long saphenous vein**.
  - **Receives lymph from:**
    - Superficial lymphatics of most of the **lower limb**, except lateral side of foot and heel (which drain to popliteal nodes).

- **Efferents:**
  - Pass through **cribriform fascia** ? drain into **deep inguinal nodes** ? **external iliac nodes**.

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2. Deep Inguinal Lymph Nodes

- **Number:** 3–5 nodes.
- **Location:** Deep to the fascia lata, **medial to femoral vein** (within femoral canal).
- The most superior node is the **node of Cloquet (Rosenmüller)** — located in the femoral canal beneath the inguinal ligament.
- **Receives lymph from:**
    - Superficial inguinal nodes.
    - Deep lymphatics accompanying femoral vein (from entire lower limb).
    - Glans penis and glans clitoris (through deep perineal channels).
- **Efferents:**
    - Pass through femoral canal ? **external iliac nodes** ? **common iliac ? para-aortic nodes**.

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3. Superficial Lymphatics of the Lower Limb

Divided into two sets:

(a) Medial (larger) set

- Follows the **long saphenous vein**.
- **Drains:**

- Skin and superficial fascia of the entire limb except the lateral part of foot and heel.

- **Termination:**
  - Ends in **vertical group of superficial inguinal nodes**.

(b) Lateral (smaller) set

- Follows the **small saphenous vein**.
- **Drains:**
  - Lateral side of foot, heel, and posterior leg.
- **Termination:**
  - Ends in **popliteal lymph nodes**, whose efferents reach **deep inguinal nodes**.

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4. Deep Lymphatics of the Lower Limb

- Accompany **deep veins** (anterior tibial, posterior tibial, peroneal, popliteal, and femoral).
- **Popliteal lymph nodes:**
  - Located in popliteal fossa (5–7 in number).
  - Receive lymph from:
    - Deep tissues of leg and foot.
    - Superficial lymphatics accompanying small saphenous vein.

- **Efferents** ? ascend along femoral vein ? **deep inguinal nodes**.

- Deep lymphatics of thigh ? direct drainage to **deep inguinal nodes**.

Clinical Anatomy

1. Lymphadenopathy

- Enlargement of lymph nodes due to infection, inflammation, or malignancy.
- **Superficial inguinal lymphadenopathy**:
  - Commonly due to infections in leg, foot, perineum, or external genitalia.
  - Nodes may be enlarged, firm, and tender.
- **Deep inguinal lymphadenopathy:**
  - Often secondary to malignancy or chronic deep infection of limb.

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2. Lymphangitis

- Inflammation of lymphatic vessels, producing red streaks along the limb (usually due to *Staphylococcus* or *Streptococcus* infection).
- May lead to abscess formation and secondary lymph node enlargement.

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3. Elephantiasis (Filariasis)

- Caused by *Wuchereria bancrofti* infection blocking lymphatics ? severe lymphoedema of leg and scrotum.
- Chronic cases produce thickened, fibrotic skin and gross enlargement of limb.

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4. Pitting Edema of Foot

- Occurs in chronic venous insufficiency or lymphatic obstruction.
- Pressing leaves a depression (“pitting”) due to accumulation of lymph and interstitial fluid.

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5. Metastatic Spread

- Carcinoma of **penis, vulva, anal canal (below pectinate line), or perineum** spreads first to **superficial inguinal nodes**, then to deep and external iliac nodes.
- Carcinoma of **glans penis or clitoris** may directly reach **deep inguinal nodes** bypassing the superficial group.

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6. Palpation of Nodes

- **Superficial inguinal nodes**: easily palpable just below inguinal ligament.
- **Deep inguinal nodes**: not palpable; detected by imaging (ultrasound/CT).

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7. Surgical Relevance

- During **femoral hernia repair**, the **node of Cloquet** is an important landmark.

- **Radical groin dissection** for malignancy involves removal of both superficial and deep groups.

? Segmental Innervation of the Lower Limb

Introduction

- The nerves of the lower limb are derived from the **lumbosacral plexus (L1–S4)**.
- Each spinal segment contributes both **sensory (dermatomal)** and **motor (myotomal)** fibers.
- Segmental innervation helps in localizing **spinal cord or root lesions** during neurological examination.

Dermatomes of Lower Limb

Definition:
A dermatome is an area of skin supplied by sensory fibers from a **single spinal nerve root**.

Key Dermatomal Distribution (remember spiral pattern)

- **L1:** Groin region, upper medial thigh.
- **L2:** Middle of anterior thigh.
- **L3:** Medial side of knee and lower thigh.
- **L4:** Medial side of leg and foot (including great toe).

- **L5:** Dorsum of foot and middle three toes, lateral leg.
- **S1:** Lateral margin of foot and little toe, posterior leg.
- **S2:** Back of thigh and popliteal fossa.
- **S3:** Perineum and ischial region.
- **S4–S5:** Perianal skin and anal canal.

? **Mnemonic for spiral arrangement:**
During limb development, dermatomes spiral — so the **preaxial border (medial)** is supplied by **L4**, and **postaxial border (lateral)** by **S1**.

Myotomes of Lower Limb

Definition:
A myotome is a group of muscles supplied by motor fibers of a **single spinal nerve root**.

Major Myotomes and Their Actions

SPINAL SEGMENT	MAIN MUSCLES / MOVEMENTS
L1–L2	Hip flexion (Iliopsoas)
L3	Knee extension (Quadriceps femoris)
L4	Ankle dorsiflexion (Tibialis anterior)
L5	Toe extension (Extensor hallucis longus) & hip abduction (Gluteus medius)

SPINAL SEGMENT	MAIN MUSCLES / MOVEMENTS
S1	Ankle plantar flexion (Gastrocnemius, Soleus) & foot eversion (Peroneus longus, brevis)
S2	Knee flexion (Hamstrings)
S3–S5	Sphincter control, perineal muscles

? **Functional mnemonic:**

- "**L2, 3, 4 — kick the door**" (leg extension).
- "**L5 — lift the toes**."
- "**S1, 2 — stand on tiptoes**."

Clinical Anatomy

1. Dermatomal Testing

- **L4:** Sensation over medial malleolus.
- **L5:** Sensation over dorsum of foot and middle toes.
- **S1:** Sensation over lateral border of foot.
  ? Used to localize **nerve root compression** in lumbar disc herniation.

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2. Motor (Myotomal) Testing

- **L3–L4 lesion:** Weak quadriceps ? difficulty in knee extension.
- **L4–L5 lesion:** Foot drop due to loss of dorsiflexion.
- **S1 lesion:** Weak plantar flexion ? difficulty standing on toes.

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3. Reflex Testing and Root Levels

REFLEX	SPINAL SEGMENT	SIGNIFICANCE
Knee jerk	L3–L4	Tests femoral nerve integrity
Ankle jerk	S1–S2	Tests tibial nerve integrity
Plantar reflex	L5–S1	Corticospinal tract lesion if Babinski sign present

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4. Radiculopathy and Disc Prolapse

- **L4 root compression:** Pain along medial leg ? weak dorsiflexion of foot.
- **L5 root compression:** Pain along dorsum of foot ? weak toe extension.
- **S1 root compression:** Pain along lateral foot ? loss of ankle jerk and plantar flexion.

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5. Saddle Anesthesia

- Loss of sensation over **S3–S5 dermatomes** (perineum) ? indicates **cauda equina syndrome** (a neurosurgical emergency).

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6. Upper vs Lower Motor Neuron Lesions

- **Upper motor neuron lesion (UMN):** Spasticity, hyperreflexia, Babinski sign positive.
- **Lower motor neuron lesion (LMN):** Flaccid paralysis, atrophy, fasciculations.

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7. Segmental Overlap

- Each area of skin or muscle is supplied by more than one spinal segment ? partial sparing occurs in isolated root injuries.

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8. Clinical Mapping in Surgery and Orthopedics

- In **hip or knee surgeries**, knowing segmental innervation prevents iatrogenic nerve injury (e.g., L3–L4 for quadriceps, L5–S1 for calf muscles).
- In **nerve block anesthesia**, understanding dermatomes ensures complete sensory blockade.

? Sympathetic Innervation of the Lower Limb

Origin

- Sympathetic fibers for the lower limb arise from **T10–L2 spinal segments**.
- These fibers descend in the **sympathetic chain** to **lumbar and sacral ganglia** before joining **spinal nerves** that supply the limb.

Pathway

1. **Preganglionic fibers:**
    - Originate from *lateral horn cells (intermediolateral column)* of T10–L2.
    - Pass through **white rami communicantes** ? enter **sympathetic chain**.
2. **Postganglionic fibers:**
    - Synapse in **lumbar and sacral ganglia**.
    - Leave via **gray rami communicantes** to join **ventral rami of spinal nerves (L1–S3)** ? travel with **femoral, obturator, and sciatic nerves**.
3. **Distribution:**
    - Supply **blood vessels, sweat glands, and arrector pili muscles** of the lower limb.
    - Vasomotor fibers: regulate constriction and dilation of arteries.
    - Sudomotor fibers: stimulate sweat secretion.
    - Pilomotor fibers: cause hair erection.

Functions

- **Vasomotor control:** Maintains arterial tone and controls skin temperature.
- **Sudomotor function:** Promotes sweating for thermoregulation.
- **Pilomotor function:** Erection of hair follicles.
- **Trophic effect:** Maintains nutrition of skin, nails, and vessels through vascular regulation.

Clinical Anatomy

1. **Peripheral Vasoconstriction:**
    - Sympathetic hyperactivity produces cold, pale skin in emotional stress or fear.
2. **Sympathectomy:**
    - Surgical interruption of sympathetic chain (e.g., for **Raynaud's disease**) causes warm, dry skin and vasodilatation in limb.
3. **Causalgia:**
    - Persistent burning pain after peripheral nerve injury due to sympathetic overactivity.
4. **Peripheral Vascular Disease:**
    - Sympathetic tone contributes to chronic vasospasm and ischemic pain; treated with lumbar sympathectomy.
5. **Autonomic Neuropathy (in diabetes):**
    - Leads to loss of vasomotor and sudomotor control ? dry, fissured skin and trophic ulcers.

?? Comparison between Upper and Lower Limbs

The upper limb is adapted for **mobility and manipulation**, whereas the lower limb is designed for **support and locomotion**.

FEATURE	UPPER LIMB	LOWER LIMB

Primary Function	Manipulation, grasping, precision	Support, weight-bearing, locomotion
Attachment to Trunk	Via **pectoral girdle** (mobile)	Via **pelvic girdle** (rigid and strong)
Girdle Mobility	Highly mobile scapular girdle	Pelvic girdle fixed to vertebral column
Bone Structure	Light and slender	Heavy and strong
Joint Stability	Sacrificed for mobility	Sacrificed mobility for stability
Main Movements	Wide range at shoulder	Limited, but powerful at hip and knee
Long Axis of Limb	Directed laterally and inferiorly	Directed vertically
Rotation during Development	Lateral rotation (extensors lateral)	Medial rotation (extensors anterior)
Preaxial Border	Lateral (thumb side)	Medial (great toe side)
Postaxial Border	Medial (little finger side)	Lateral (little toe side)
Main Artery	Axillary ? Brachial ? Radial/Ulnar	Femoral ? Popliteal ? Tibial arteries
Superficial Vein	Cephalic and Basilic veins	Long and Short saphenous veins
Main Nerves	Median, Ulnar, Radial	Femoral, Obturator, Sciatic
Dermatomes	Run longitudinally	Spiral around the limb
Digits	Prehensile (for grasping)	Weight-bearing (for balance)

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Thumb/Great Toe	Thumb is free and opposable	Great toe is fixed and non-opposable
Arches	None	Longitudinal and transverse arches for shock absorption
Reflexes	Biceps, Triceps, Supinator	Knee jerk, Ankle jerk, Plantar reflex
Common Deformity	Wrist drop (radial nerve palsy)	Foot drop (common peroneal nerve palsy)

Summary of Functional Contrast

- **Upper Limb ? Dexterity and Expression.**
  - Prioritizes fine control (e.g., writing, grasping).
- **Lower Limb ? Power and Endurance.**
  - Built for strength, posture, and gait stability.

Clinical Highlights

- **Evolutionary Adaptation:**
  - Both limbs are homologous in origin but specialized in function.
  - Their rotation during development explains opposite orientation of flexor/extensor surfaces.
- **Injury Patterns:**

- Upper limb nerve injuries ? loss of fine movement.
- Lower limb nerve injuries ? loss of stability or locomotion (e.g., foot drop, gait imbalance).

- **Comparative Reflex Testing:**
  - Upper limb: C5–C7 roots.
  - Lower limb: L3–S2 roots.