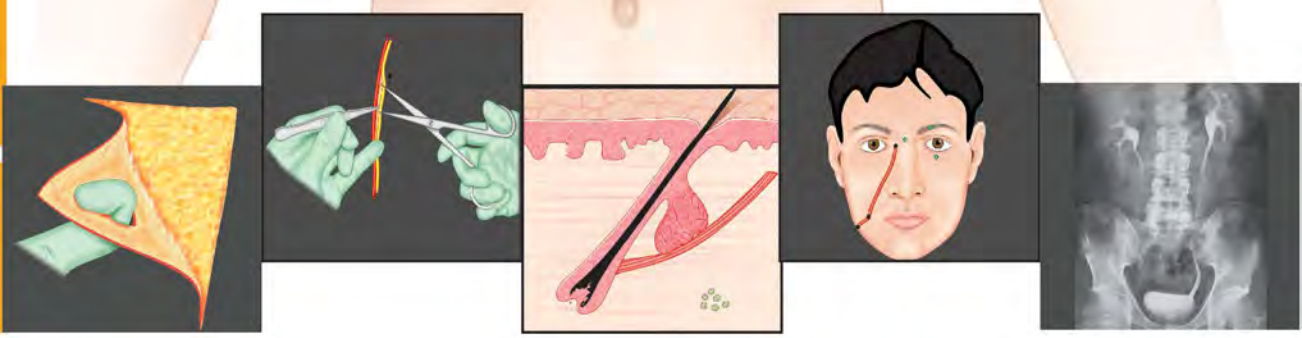
Exam-Oriented Practical ANATOMY

A Student's Manual

Window Dissections
Surface Anatomy
Histology
Radiological Anatomy



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LESSON 1: INTRODUCTION TO INFERIOR EXTREMITY

The inferior extremities or lower limbs of a human being are developed from the limb buds which appear as the outgrowths from the trunk at the fourth week of intrauterine life. The lower limb buds (one on each side) appear at the level between T_{12} to S_4 segments of spinal cord which provide innervations to the lower limb.

The lower limb is connected to the trunk and is used for carrying the body weight and for propulsion. The pelvic girdle which is formed by the two hip bones connects the lower limb with the trunk. The two hip bones articulate with each other in front at the symphysis pubis and separated from each other by the sacrum behind.

Axial line is said to be the line of junction of two dermatomes supplied from discontinuous spinal levels. Though adjacent dermatomes overlap, no overlapping occurs across the axial line. **The anterior axial line** (Fig. 3.1) of the lower limb extends from the root of the penis (male) or clitoris (female) → across the front of the scrotum (male)/labia majora (female) → then spirals to the middle of the back of the thigh and leg → almost up to the heel. **The posterior axial line** (Fig. 3.1) starts from the L_4 spine → then across the gluteal region which undergoes a convex curve → lateral side of the back of the thigh and leg → stops above the heel. **It is probable that posterior axial lines do not exist, but evidence of anterior axial line is more convincing** (RJ Last). So, the **preaxial** border means the medial border and the **postaxial** border means the lateral border of the foot. **Due to the medial rotation of the lower limb bud**, the hallux (great toe) becomes medial. The great saphenous vein and the tibia are preaxial in position, whereas the small saphenous vein and fibula are postaxial in position. Due to this rotation of the lower limb bud, the flexor surface of the lower limb becomes posterior and the extensor surface becomes anterior. This explains the nerve supply of the lower limb muscles where the anterior division of the lumbosacral plexus supplies the posterior surface and the posterior division supplies the anterior aspect of the lower limb.

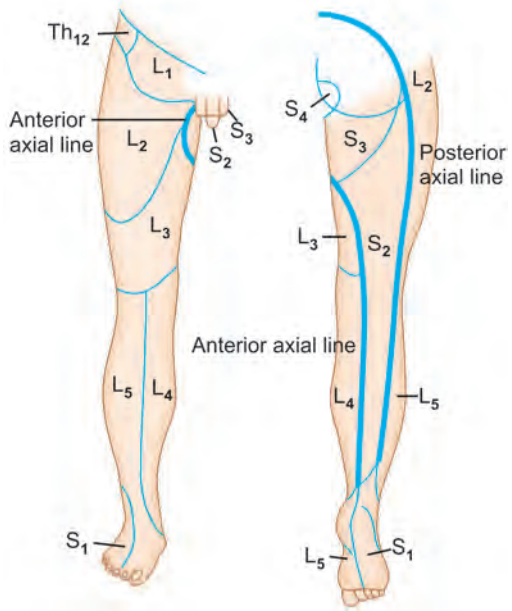


Fig. 3.1: Anterior and posterior axial lines

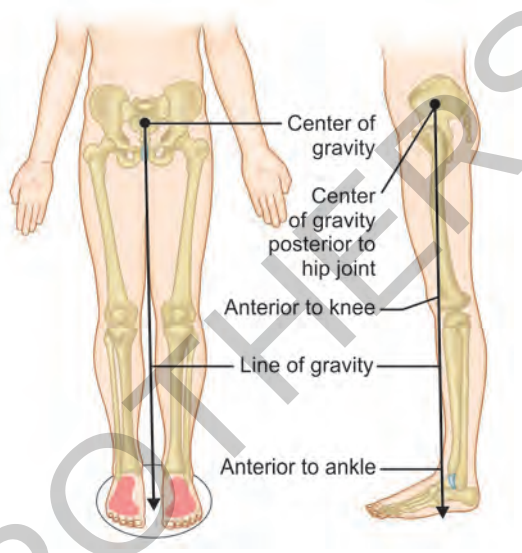


Fig. 3.2: Center of gravity and line of gravity

On the other hand, it is to be noted that **the upper limb bud rotates laterally** bringing the palm to face anteriorly so that the thumb is placed laterally. The preaxial border of the upper limb is lateral and the postaxial border is medial in position. The cephalic vein and radius become preaxial and the basilic vein and ulna become postaxial. Consequently, the flexor surface becomes anterior and the extensor surface becomes posterior due to this lateral rotation.

In upright posture, the body weight is transmitted through the acetabulum of the hip bone → Femur → Tibia → Foot. **In sitting posture,** the weight is transmitted to the ischial tuberosities. **So, we stand on S_1 and we sit on S_3 spinal nerves** (RJ Last). It is also observed that the line of center of gravity passes behind the hip joint and in front of the knee and ankle joints (Fig. 3.2). So, there is a natural tendency of backward tilting of the pelvis at the hip joint, hyper-extension of the knee joint and forward dislocation of the leg bones at the ankle joints. But these are prevented by the strong ligaments, antagonistic muscles and the bony configuration of the foot (**talus**).

For descriptive purpose, **the lower limb is divided into the following regions:**

i. **Thigh** which extends from the hip to knee joint is having only one bone called femur (Fig. 3.3). The thigh can be divided into three compartments (Fig. 3.4)**:** (a) Anterior or extensor, (b) Posterior or flexor and (c) Medial or adductor.

ii. **Gluteal region** which lies above the posterior compartment of the thigh and behind the pelvis and hip.

iii. **Leg** is the region between the knee and foot. It is having two bones called tibia and fibula (Fig. 3.5). The leg can be divided into three compartments (Fig. 3.6): (a) Anterior or extensor, (b) Posterior or flexor and (c) Lateral or peroneal.

Fig. 3.3: Femur

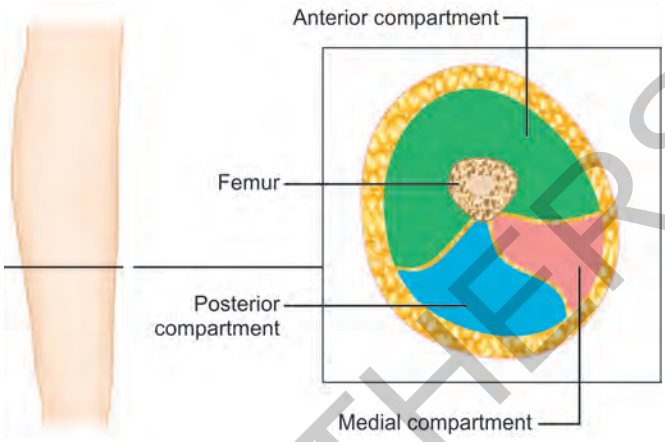


Fig. 3.4: Compartments of thigh

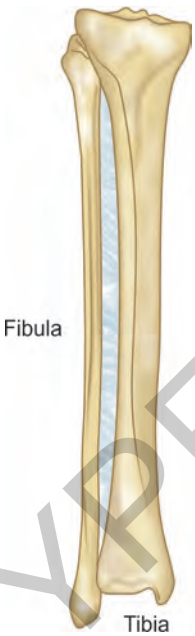


Fig. 3.5: Tibia and fibula

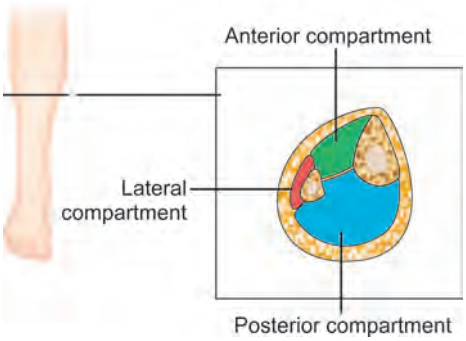


Fig. 3.6: Compartments of leg

iv. **Foot:** Skeleton of the foot consists of the following bones (Fig. 3.7):

a. **Tarsal bones** (7): Calcaneum, talus, navicular, cuboid and 3 cuneiforms (medial, intermediate and lateral)
b. **Metatarsal bones** (5): Named as 1st, 2nd,3rd,4th and 5th (from medial to lateral)
c. **Phalanges** (14): 3 for each toe (proximal, middle and distal) except the great toe which has two phalanges (proximal and distal).

Fig. 3.7: Bones of the foot

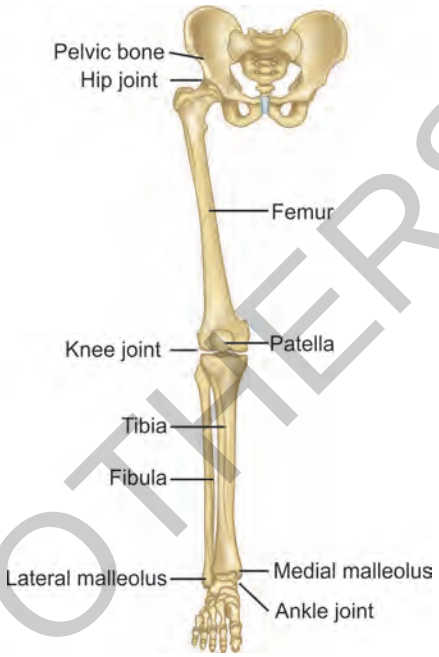


Fig. 3.8: Bones and joints of lower limb

The foot has an upper surface called dorsum of the foot and a plantar surface called sole of the foot.

The joints of the lower limb are as follows:

i. Hip joints
ii. Knee joints
iii. Ankle joints
iv. Tibiofibular joint (superior, intermediate and inferior)
v. Subtalar and midtarsal joints
vi. Other intertarsal joints
vii. Tarsometatarsal joints (5)
viii. Metatarsophalangeal joints (5)
ix. Interphalangeal joints (proximal and distal). **Great toe is having only one interphalangeal joint.**

The bones and joints of the lower limb are shown in Figure 3.8.

The deep structures of these above regions are ensheathed by a jacket of common tubular connective tissue membrane called **deep fascia**. This deep fascia only changes its name from region to region such as **fascia lata in thigh, fascia cruris in leg and plantar aponeurosis in the sole of the foot.**

LESSON 2: FEMORAL TRIANGLE

Femoral triangle is a triangular area in front of the upper part of the thigh bounded **superiorly** by the **inguinal ligament, laterally** by the medial border of **sartorius muscle**, **medially** by the medial border **of adductor longus muscle** and its apex is the meeting point of medial border of sartorius and medial border of adductor longus (Fig. 3.9).

STEPS OF DISSECTION

1. **Position of the cadaver:** Body supine, thigh extended and laterally rotated.
2. **Skin incisions (Fig. 3.10):**
   i. An oblique incision from the anterior superior iliac spine to pubic tubercle (A–B)
   ii. Another transverse incision at the junction of upper 1/3rd and lower 2/3rd of the thigh (C–D)
   iii. A vertical incision from the midpoint of (A–B) to the midpoint of (C–D) which is indicated by the line (E–F)

   Now, reflect the skin flaps laterally and medially.
   Superficial fascia is exposed.
3. **Superficial fascia:** In the superficial fascia, the following structures are identified (Fig. 3.11)
   i. **Blood vessels:**
      a. Great saphenous vein (on the medial aspect).
      b. Superficial external pudendal vessels.
      c. Superficial epigastric vessels.
      d. Superficial circumflex iliac vessels.
   ii. **Cutaneous nerves:**
      a. Lateral femoral cutaneous nerve of thigh.
      b. Intermediate femoral cutaneous nerve of thigh.

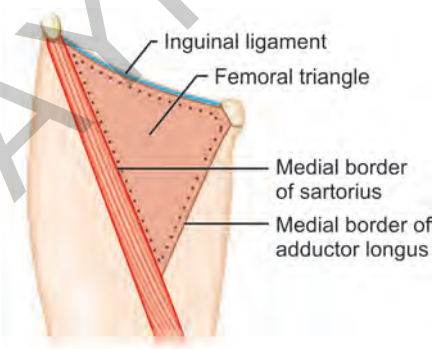


Fig. 3.9: Boundaries of femoral triangle

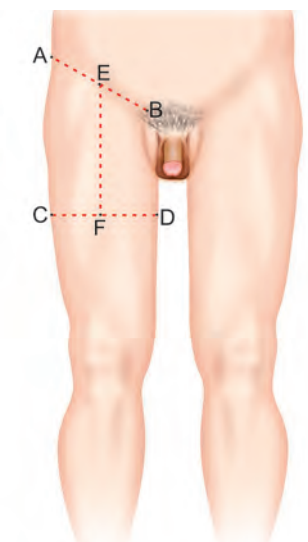


Fig. 3.10: Dissection of femoral triangle (skin incision)

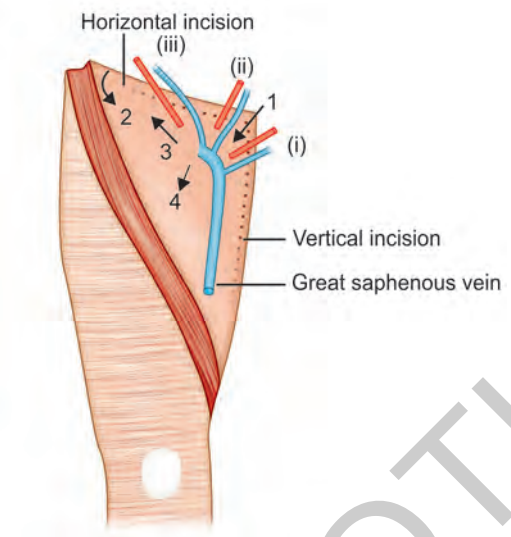


Fig. 3.11: Structures in superficial fascia: (i) Superficial external pudendal vessels; (ii) Superficial epigastric vessels; (iii) Superficial circumflex iliac vessels; (1) Branch of ilioinguinal nerve; (2) Branch of subcostal nerve; (3) Femoral branch of genitofemoral nerve; (4) Branch of medial femoral cutaneous nerve

c. Medial femoral cutaneous nerve.
d. Femoral branch of genitofemoral nerve.
e. A twig from ilioinguinal nerve.

iii. **Lymphatics:**
a. Superficial group of inguinal lymph nodes.
b. Superficial lymph vessels.

Superficial fascia is reflected like skin.

Deep fascia is exposed.

4. **Deep fascia (fascia lata):** There is an oval and twisted gap in the upper and medial part of deep fascia. This opening is called **saphenous opening** which is closed by an areolar membrane called **cribriform fascia**. A number of structures are seen piercing the cribriform fascia. These structures are as follows (Fig. 3.12):
   i. Great (long) saphenous vein.
   ii. Superficial external pudendal artery.
   iii. Superficial epigastric artery.
   iv. Few branches of medial femoral cutaneous nerve.
   v. Few lymph vessels connecting the superficial and deep inguinal lymph nodes.

Remember that the superficial external pudenal **vein** and superficial epigastric **vein** do not pass through the saphenous opening. They accompany their corresponding arteries and drain into the great saphenous vein just before it pierces the cribriform fascia.

Now, insert your index finger into the **saphenous opening** beside the great saphenous vein. Then, you move your finger around the vein to define the margins of the saphenous opening. Trace the great saphenous vein up to its termination into the femoral vein.

Then, again insert your finger into the saphenous opening and push it inferiorly deep to the deep fascia until the fingertip touches the sartorius muscle.

Cut the deep fascia vertically downwards by using scissors from the lower margin of saphenous opening up to the sartorius muscle (Fig. 3.13, incision 1).

A second incision is made through the fascia lata from the upper margin of the saphenous opening. This incision extends laterally below and parallel to the inguinal ligament up to a point just below the anterior superior iliac spine (Fig. 3.13, incision 2).

A third incision is made through the fascia lata from the upper margin of the saphenous opening which extends medially below and parallel to the medial part of inguinal ligament up to a point just below the pubic tubercle (Fig. 3.13, incision 3).

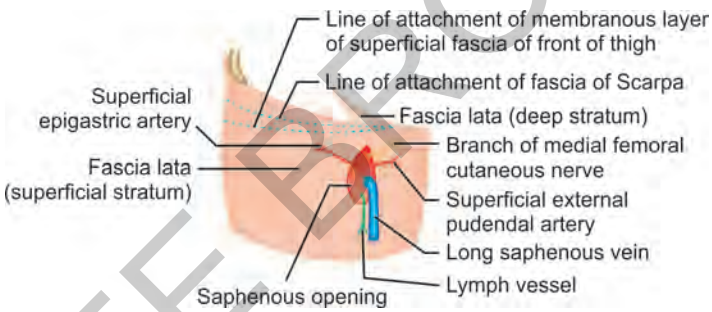


Fig. 3.12: Structures passing through the saphenous opening

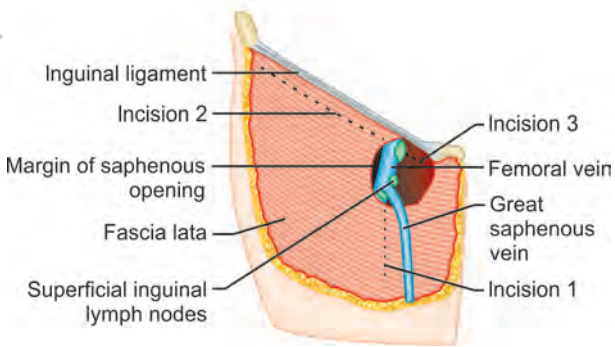


Fig. 3.13: Incisions on deep fascia

Then push your finger through these cuts and move them deep to the fascia lata to separate the deeper structure from the fascia lata.

Then reflect the flaps of fascia lata medially and laterally. Now the roof of the femoral triangle which is formed by the fascia lata (deep fascia of the thigh) is opened.

5. **Identify and clean the boundaries of the femoral triangle**.

   The triangle is bounded **above** (base) by the **inguinal ligament,** laterally by the medial border of **sartorius muscle, medially** by the medial border of **adductor longus muscle** and the **apex** is formed by the junction of these above two muscles.

   The contents of femoral triangle are as follows (**Fig. 3.14**)**:**

   i. Femoral nerve and its branches.
   ii. Femoral sheath with its contents.
   iii. Terminal part of great saphenous vein.
   iv. Femoral branch of genitofemoral nerve.
   v. Lateral femoral cutaneous nerve (L_2,L_3).

6. **Femoral nerve** is seen to lie on the floor of the femoral triangle in the grove between the **iliacus** and **psoas major** muscle. It lies on the lateral side of the femoral artery and outside the femoral sheath. Clean and trace the femoral nerve inferiorly to expose its branches. It sends a branch to pectineus muscle called **nerve to pectineus** which passes medially behind the femoral sheath before the femoral nerve divides into anterior and posterior branches.

   Identify the **branches of anterior division** of femoral nerve which are as follows:

   i. **Muscular** (1): Nerve to sartorius.
   ii. **Cutaneous**:
      a. Medial femoral cutaneous nerve.
      b. Intermediate femoral cutaneous nerve.

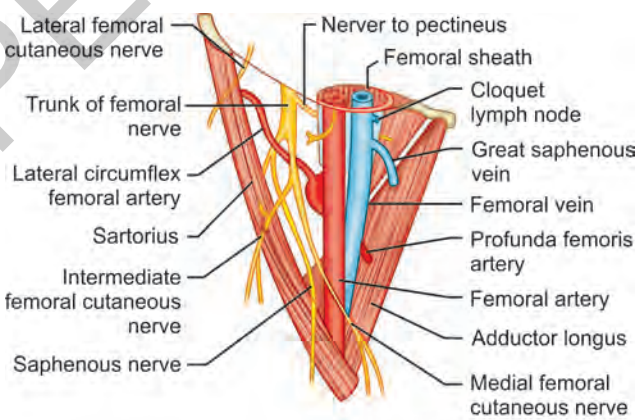


Fig. 3.14: Contents of femoral triangle

Identify the branches of **posterior division of femoral** nerve:

i. **Muscular (4):**
   a. Nerve to rectus femoris.
   b. Nerve to vastus lateralis.
   c. Nerve to vastus medialis.
   d. Nerve to vastus intermedius.

ii. **Cutaneous (1): Saphenous nerve.**

Remember that the lateral circumflex femoral vessels pass between the two divisions of femoral nerve.

7. **Femoral sheath** is identified.

Femoral Sheath (Figs 3.15A and B)

Definition: It is a funnel-shaped fibrous sheath around the proximal part of femoral vessels.

Formation:

i. Anterior wall by fascia transversalis.
ii. Posterior wall by fascia iliaca.

Shape: Funnel-shaped.

Lateral wall is vertical but the medial wall is oblique directing laterally and downwards.

Dimension:

i. Length—about 3–4 cm.
ii. Breadth—about 2 cm.

Compartments: **Three,** separated by two vertical septa.

a. Lateral (**arterial**) compartment containing
   i. Femoral artery.
   ii. Femoral branch of genitofemoral nerve.
b. Intermediate (**venous**) compartment containing
   i. Femoral vein.
c. Medial compartment (**femoral canal**) containing
   i. Loose areolar tissue.
   ii. Lymph node and lymph vessels.

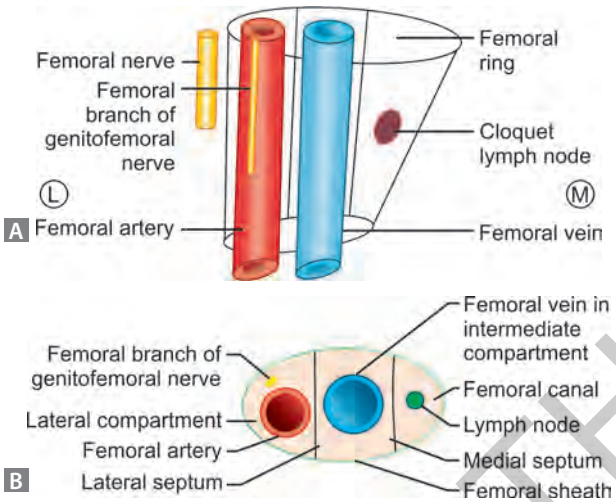
Function: It helps in free gliding of the femoral vessels in and out behind the inguinal ligament during the movements of the hip joint.

Changes with age: Femoral sheath is rudimentary in newborn and prolonged below the inguinal ligament after one year.

Structures piercing the sheath:

a. **In front**:
   i. Superficial external pudendal artery.
   ii. Superficial epigastric artery.
   iii. Superficial circumflex iliac artery.
   iv. Deep external pudendal artery.
b. **Laterally**: Femoral branch of genitofemoral nerve.
c. **Medially**: Great saphenous vein.

Applied: Femoral hernia may occur through the femoral ring into the femoral canal.



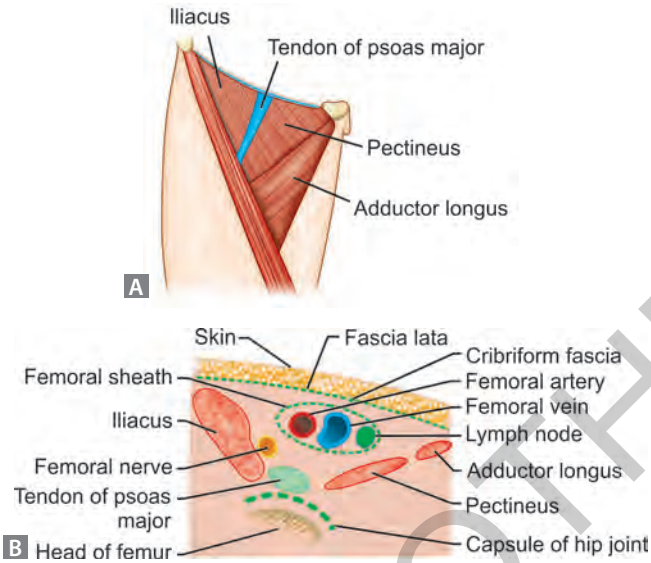
Figs 3.15A and B: Femoral sheath with its contents

The lateral compartment of the femoral sheath contains femoral artery. This artery is cleaned by using blunt dissection. **Three superficial branches** of femoral artery (**superficial external pudendal, superficial epigastric** and **superficial circumflex iliac**) arise just distal to the inguinal ligament. But do not attempt to follow these vessels.

The **largest** branch of femoral artery is the **arteria profunda femoris** which arises from the lateral side of the femoral artery about 3.5 cm below the inguinal ligament. Retract the femoral artery medially and identify the arteria profunda femoris. Very close to the femoral artery the profunda femoris artery gives off lateral and medial circumflex femoral artery. Identify these circumflex branches. The profunda femoris artery leaves the femoral triangle between pectineus and adductor longus muscle. Finally, this artery pierces the adductor magnus muscle as **the fourth perforating artery**. The femoral artery courses distally between the sartorius and adductor longus muscles.

Clean and identify the femoral vein and terminal part of great saphenous vein. Preserve this major vein but remove their tributaries to clear the dissection field.

8. **Floor of the femoral triangle** is cleaned by using blunt dissection. The floor of the triangle is formed by the following muscles from lateral to medial side (Figs 3.16A and B):
   i. Iliacus.
   ii. Psoas major.
   iii. Pectineus.
   iv. Adductor longus.



Figs 3.16A and B: Floor of femoral triangle

To expose of the obturator nerve the following steps of dissection are to be adopted.

i. Adductor longus muscle is divided transversely 2–3 cm below its origin and turn the distal part towards the femur. **Anterior division** of obturator nerve is exposed lying on the adductor brevis.

ii. Then, adductor brevis is also cut transversely and reflected. **Posterior division** of the obturator nerve is exposed lying on the adductor magnus muscle.

MUSCLES RELATED TO FEMORAL TRIANGLE

Muscles	*Origin*	*Insertion*	*Nerve supply*	*Action*
Sartorius (Longest strap muscle)	i. Anterior superior iliac spine (ASIS) ii. Notch below ASIS	Upper part of the medial surface of the shaft of tibia	Anterior division of femoral nerve	i. Flexion, abduction and lateral rotation of the hip joint ii. Flexion and medial rotation of the knee in semiflexed position
Iliacus (Triangular muscle)	Upper 2/3rd of iliac fossa	About 2.5 cm below and in front of lesser trochanter of femur	From the trunk of femoral nerve (L_2,L_3)	Flexor of the hip joint

Contd...

Contd...

Muscles	***Origin***	***Insertion***	***Nerve supply***	***Action***
Psoas major (Fusiform muscle)	Medial part of anterior surface of transverse process and sides of bodies of all lumbar vertebrae (L_1-L_5)	Anterior surface of lesser trochanter of femur	Directly from lumbar plexus (L_2,L_3)	Chief flexor of the hip
Pectineus (Quadrilateral muscle)	i. Pectin pubis ii. Superior ramus of pubis	**Pectineal line** of the femur (line extending from the lesser trochanter to linea aspera)	i. Ventral stratum (lateral part) by the branch from trunk of femoral nerve ii. Dorsal stratum (medial part) by the anterior division of obturator nerve and accessory obturator nerve (if present)	Flexor and adductor of the hip
Adductor longus (Triangular in outline)	Anterior surface of symphysis pubis below the pubic tubercle.	Medial lip of **linea aspera** of the shaft of femur	Anterior division of obturator nerve	Adductor of thigh

Summary

1. Position of the cadaver: Supine, thigh extended and rotated laterally.
2. Skin incision as in Figure 3.10.
3. Superficial fascia and deep fascia are incised and reflected like skin.
4. **Boundaries** of the triangle are identified.
   i. Base (above): Inguinal ligament.
   ii. Laterally: Sartorius (medial border)
   iii. Medially: Adductor longus (medial border)
   iv. Apex: Junction of sartorius and adductor longus.
5. **Contents**:
   i. Femoral nerve and its branches.
   ii. Femoral sheath with its contents (femoral artery, femoral vein, lymphatics).
   iii. Terminal part of great saphenous vein.
   iv. Femoral branch of genitofemoral nerve.
   v. Lateral femoral cutaneous nerve.

PROBABLE QUESTIONS AND ANSWERS

1. What are the boundaries of femoral triangle?

Ans. **Laterally:** Medial border of sartorius.
Medially: Medial border of adductor longus.

Exam-Oriented Practical **ANATOMY**
A Student's Manual

The present volume showcases the essential information required by undergraduate students in preparing for the anatomy practical examinations. All sections of this book contain a summary of the relevant information along with probable questions that the students may have to face and their appropriate answers. The book will be a useful companion both in the practical classes and at examination time. The sections are organized as follows:

- **Window dissections:** For cadaveric dissections, the description follows the classroom pattern of incisions, superficial structures, deeper structures, neurovascular bundles and probable questions to be faced in the viva examination.
- **Surface anatomy:** Clear instructions for drawing both lines and points are given along with accurate descriptions of the structures to be examined and drawn.
- **Histology:** Salient features for identification of slides are presented in order of importance. This is accompanied by detailed questions and answers covering further aspects of the tissues examined.
- **Radiological anatomy:** All normal anatomical landmarks and features are mentioned with regard to plain and special radiographs. Further questions on finer structures are mentioned as additional information.

The overall planning of the book attempts to present all anatomical information in a pleasant and palatable format to make the study of anatomy a pleasant and memorable experience.

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