



# Topographical anatomy of the lower limb, gait mechanism

Ph.D., Dr. Dávid Lendvai

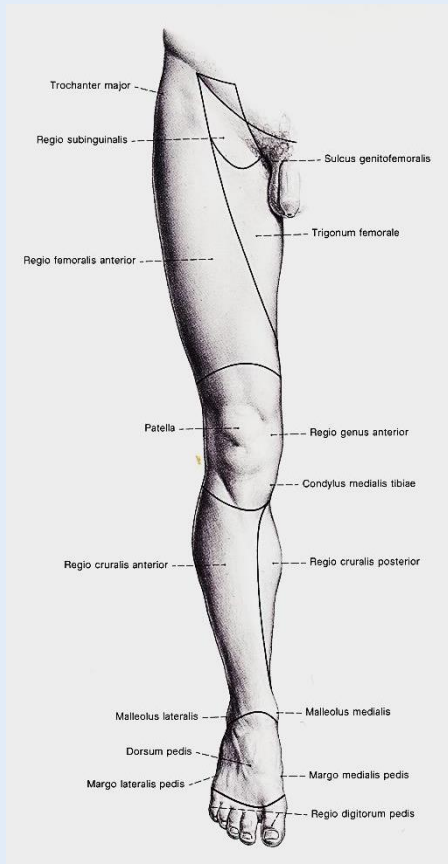
## Anatomical aspects

### Descriptive

Osteology,  
Syndesmology,  
Arthrology,  
Myology

### Angiology

### Neurology



### Topographic

#### Gluteal region

- ~ subinguinalis
- ~ ant. femoral

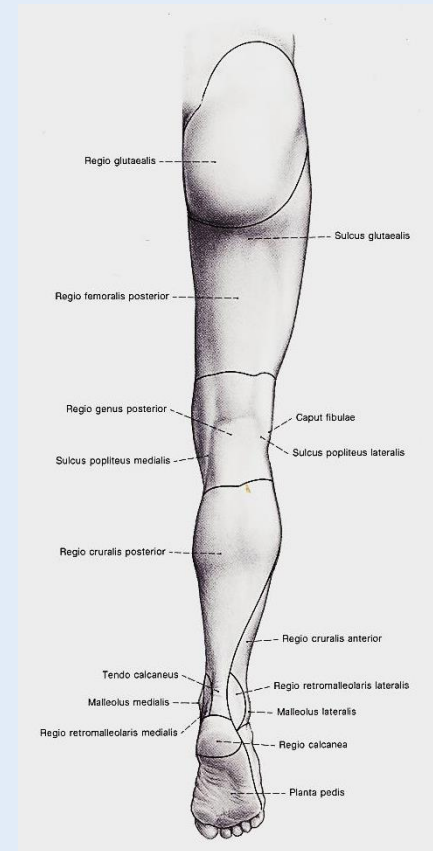
#### *Femoral Triagon*

- ~ posterior
- ~ genus anterior
- ~ posterior
- ~ cruralis anterior
- ~ posterior
- ~ malleolaris medialis
- ~ malleolaris lateralis
- ~ *retromalleolaris medialis*
- ~ *retromalleolaris lateralis*
- ~ *calcanea*
- ~ plantaris pedis
- ~ dorsalis pedis
- ~ *digitorum pedis*

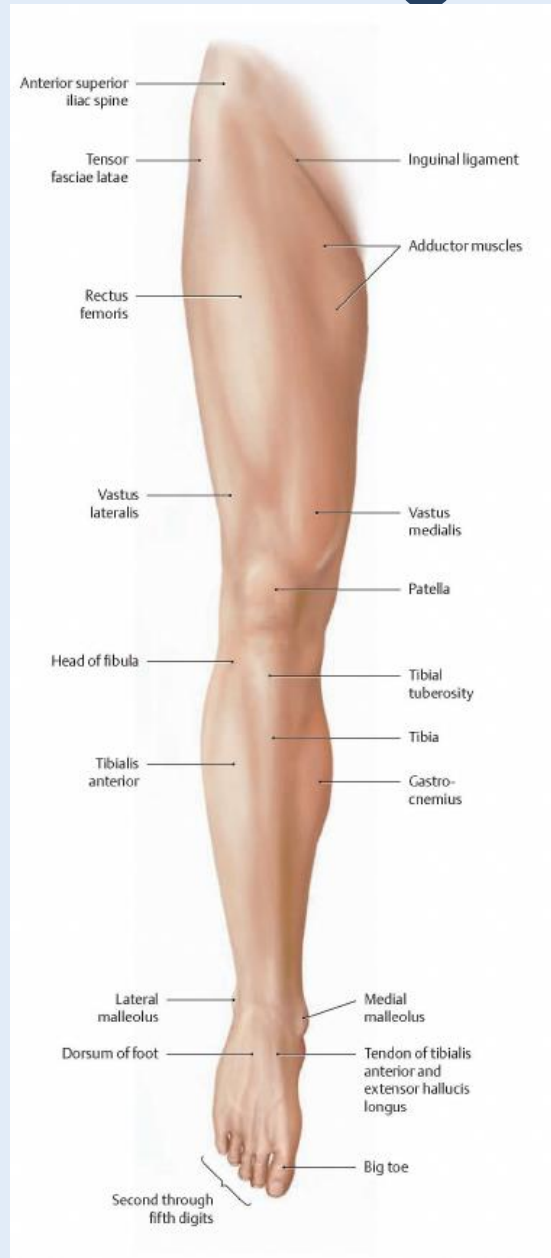
## Clinical / practical aspects

### Diseases and injuries

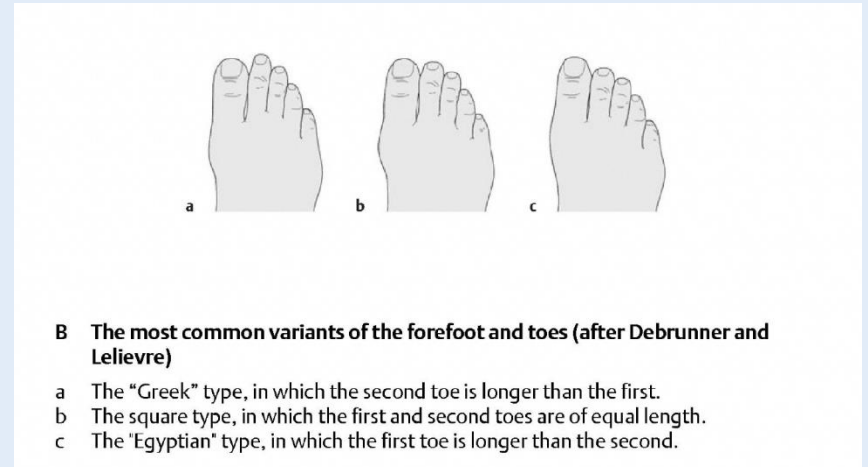
(Symptoms, Syndroms, Diagnostics,  
Intervention planning and intervention)



# Ventral regions

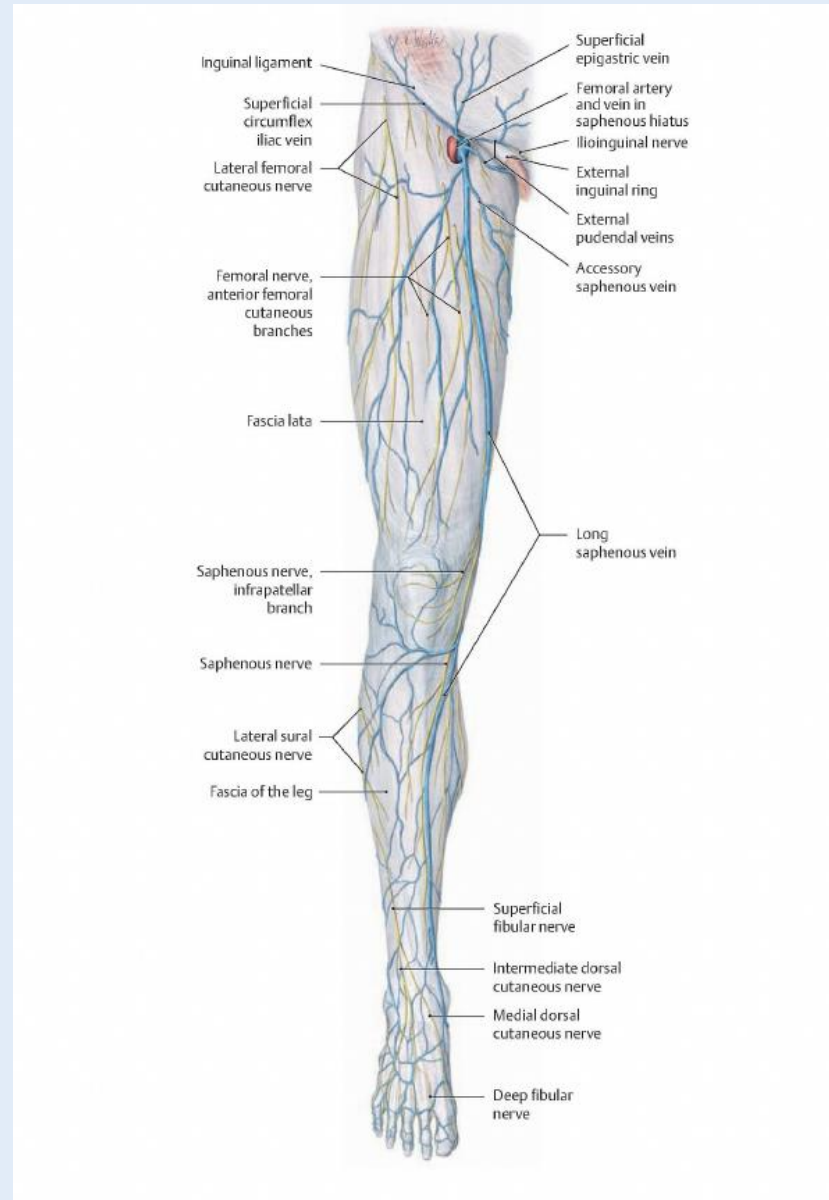


# Foot shapes

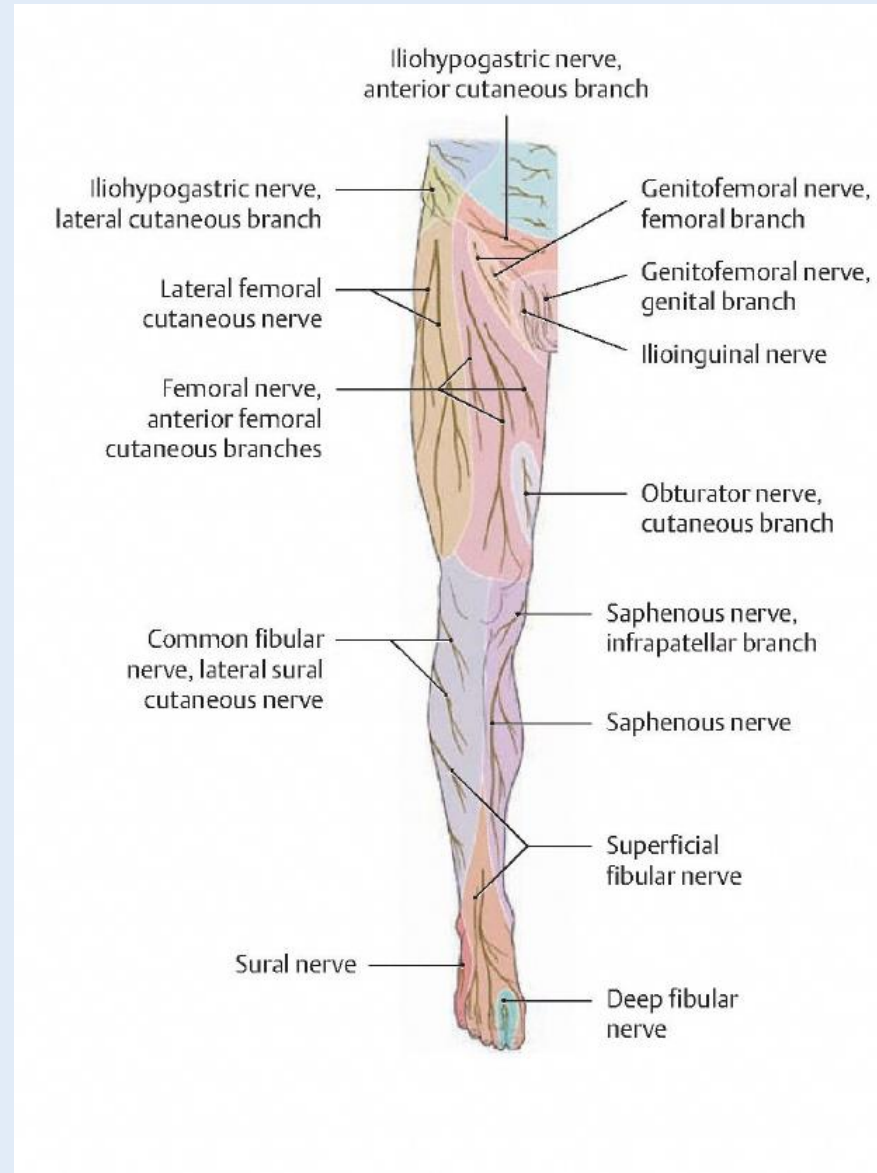
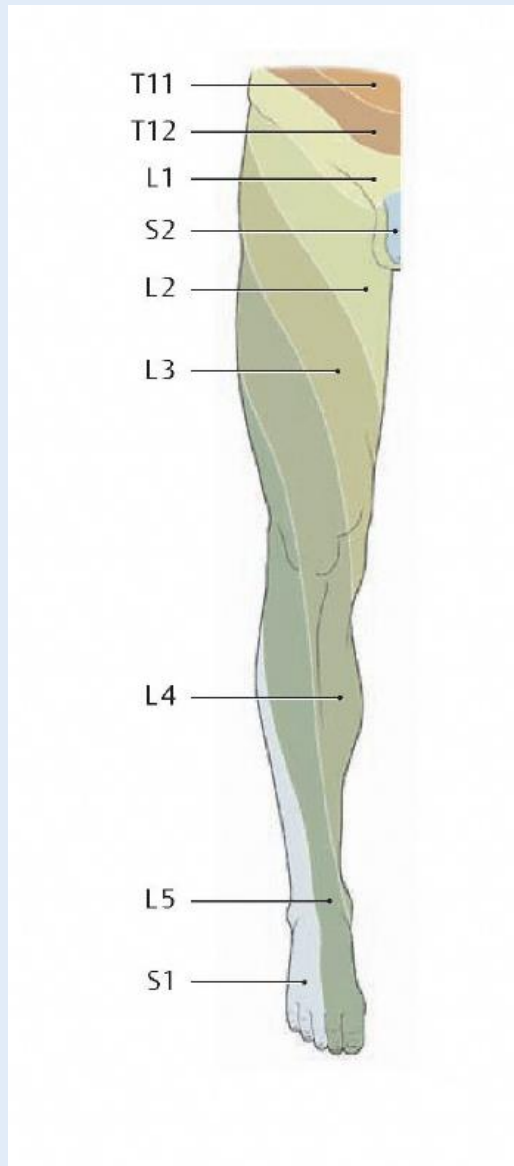


- a The "Greek" type, in which the second toe is longer than the first.
- b The square type, in which the first and second toes are of equal length.
- c The "Egyptian" type, in which the first toe is longer than the second.

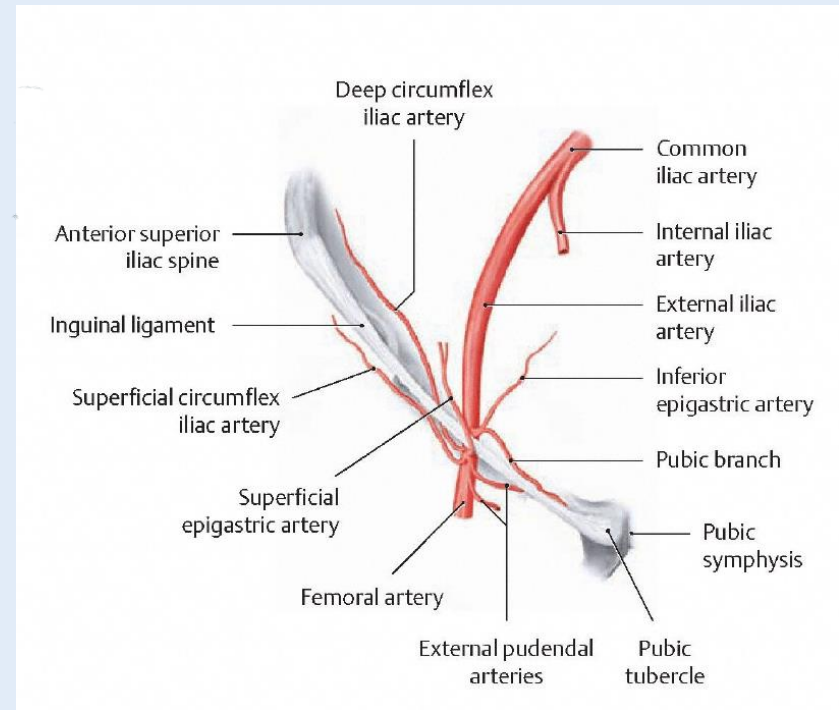
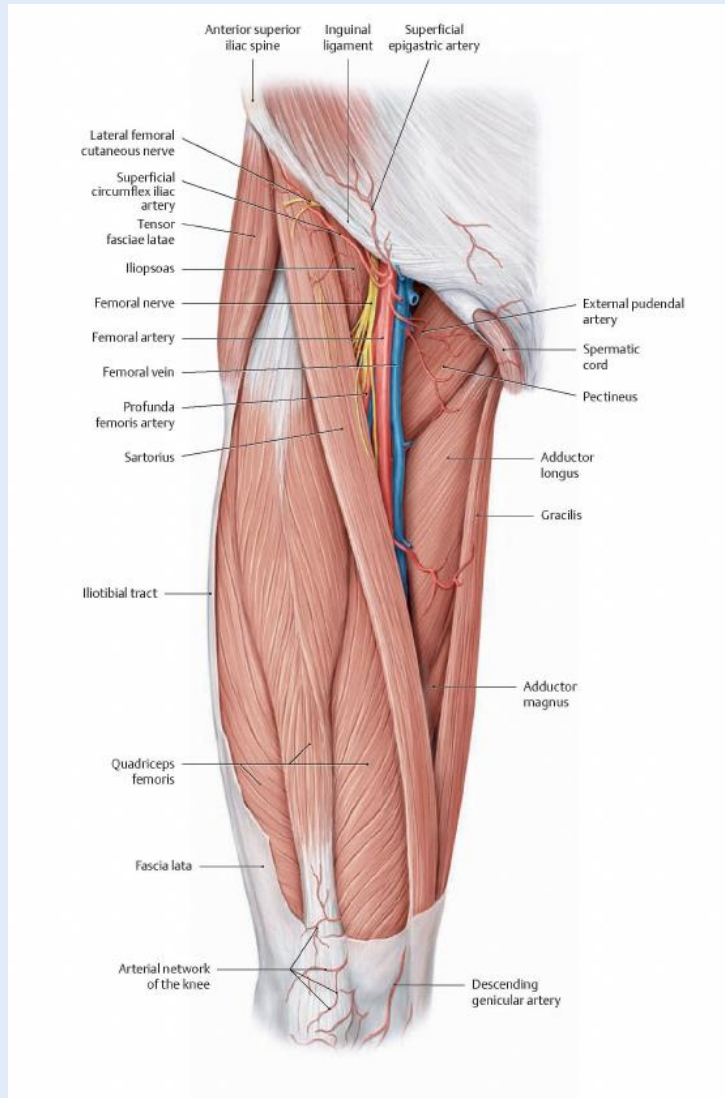
# Epifascial structures



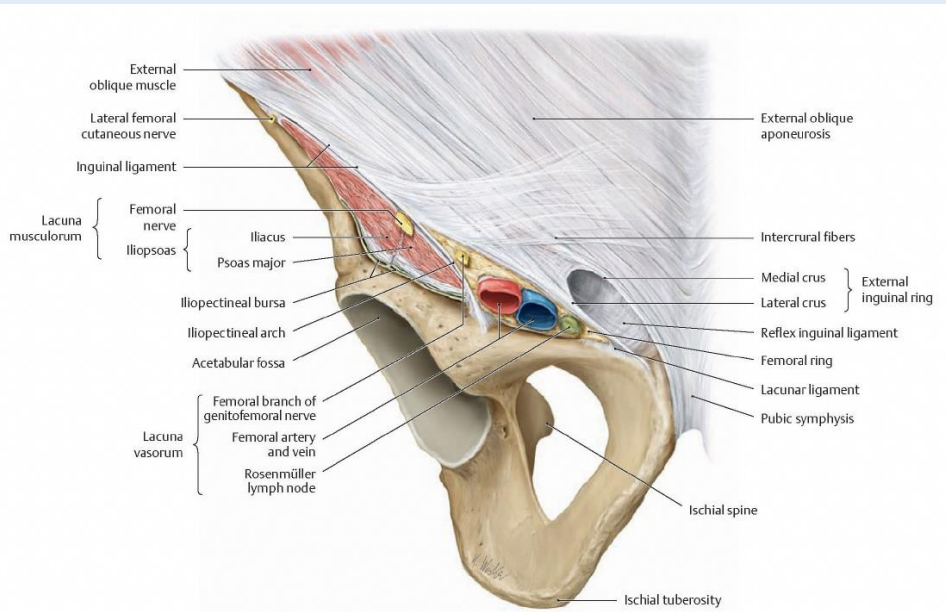
# Dermatomes, cutaneous nerves



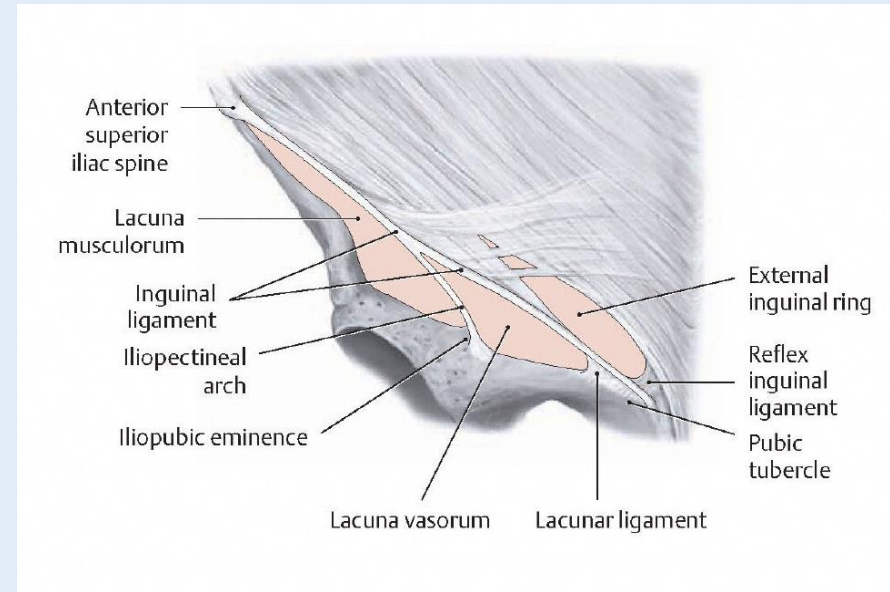
# Femoral triangle



# Subinguinalis hiatus



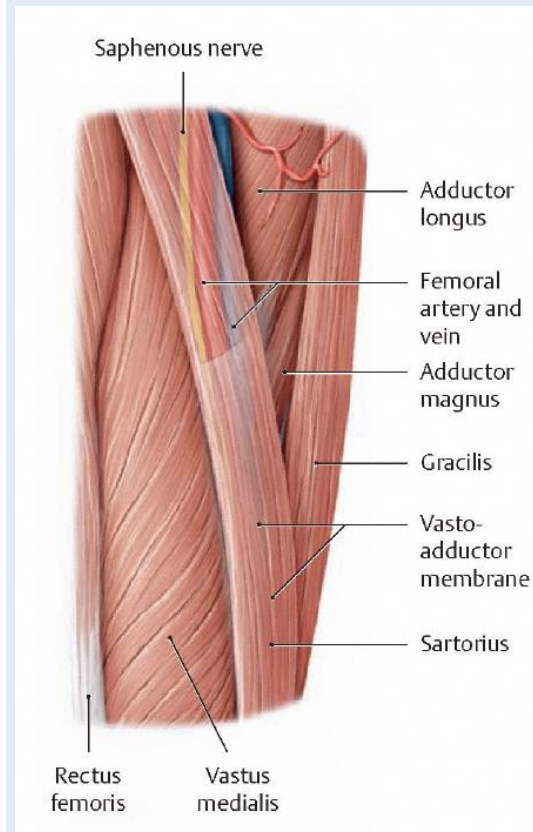
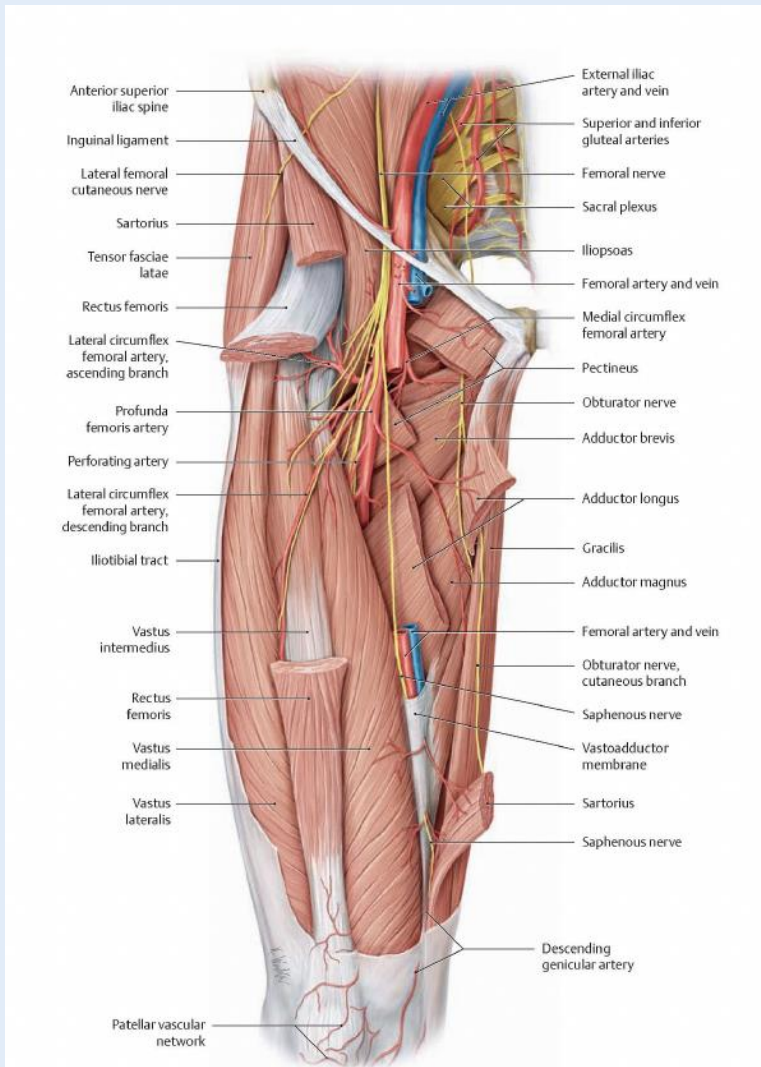
**C Inguinal region and the contents of the lacuna musculorum and lacuna vasorum**  
Anterior view.





# Ant. femoral region

## Adductorian canal



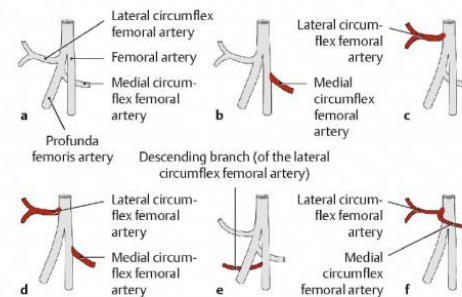
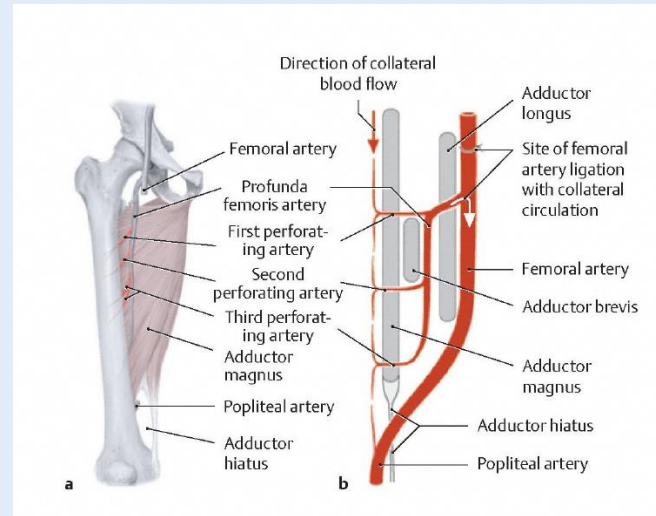
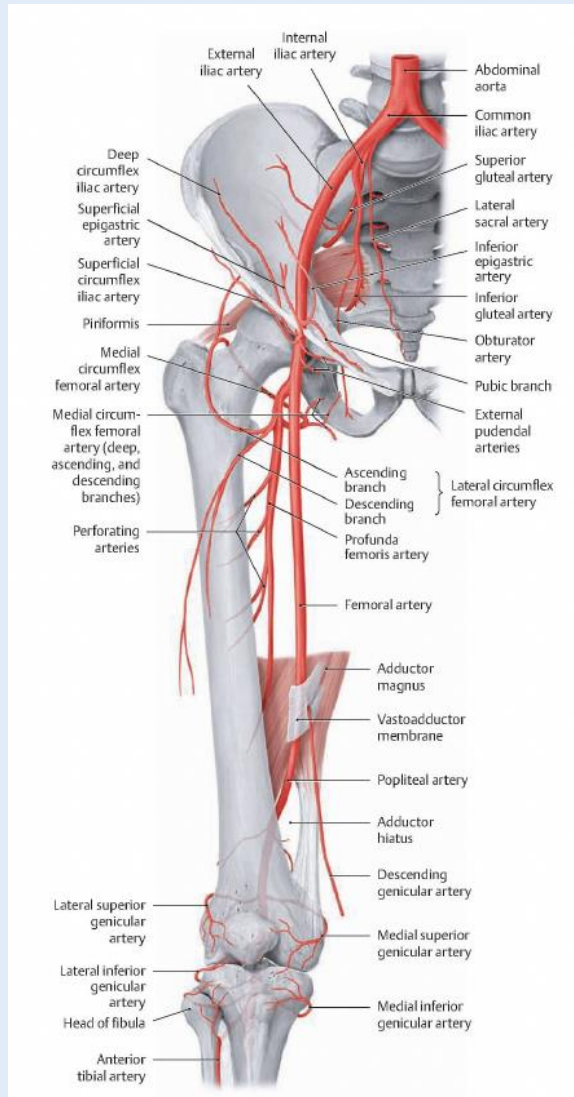
### Boundaries

- Adductor longus and magnus (posterior)
- Sartorius (medial)
- Vastoadductor membrane (anterior)
- Vastus medialis (lateral and anterior)

### Contents

- Femoral artery
  - Femoral vein
  - Saphenous nerve
  - Descending genicular artery
- pierce the vastoadductor membrane

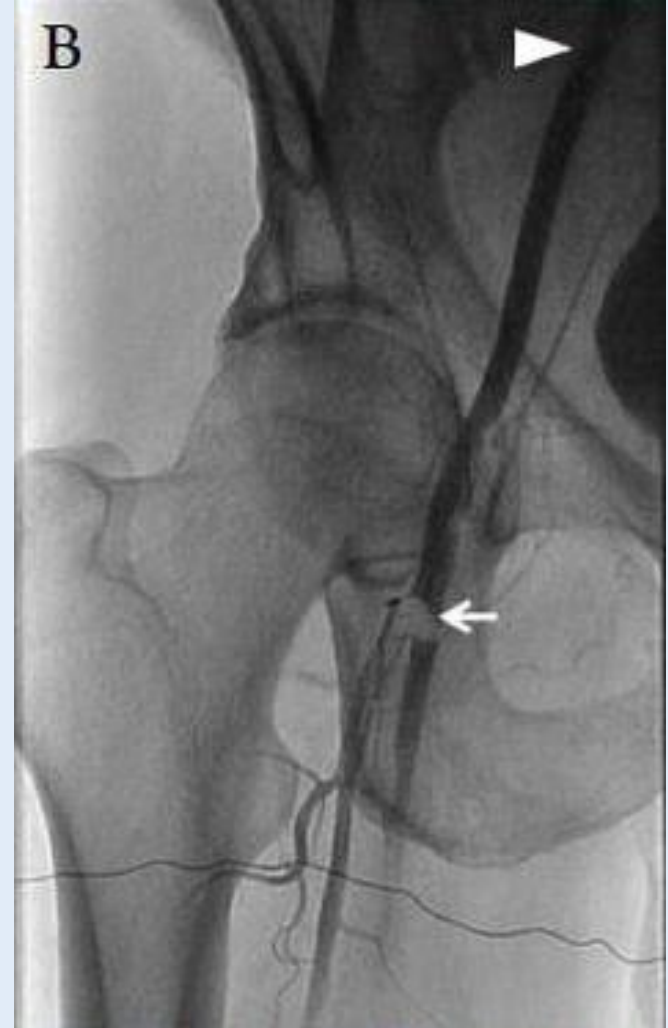
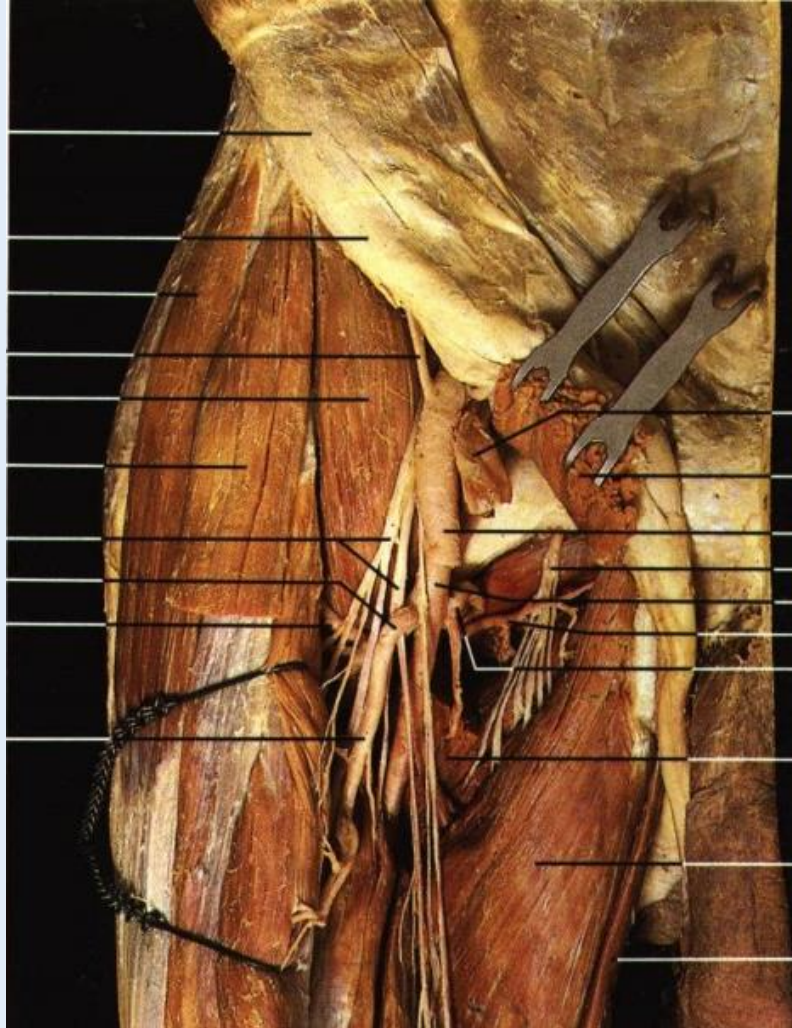
# Femoral artery



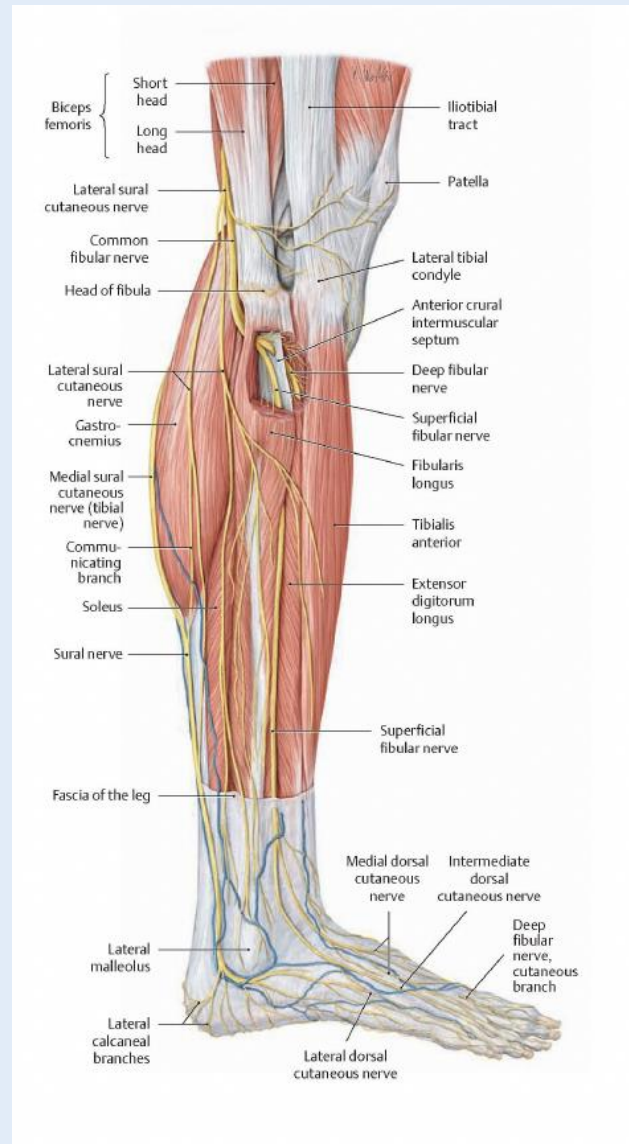
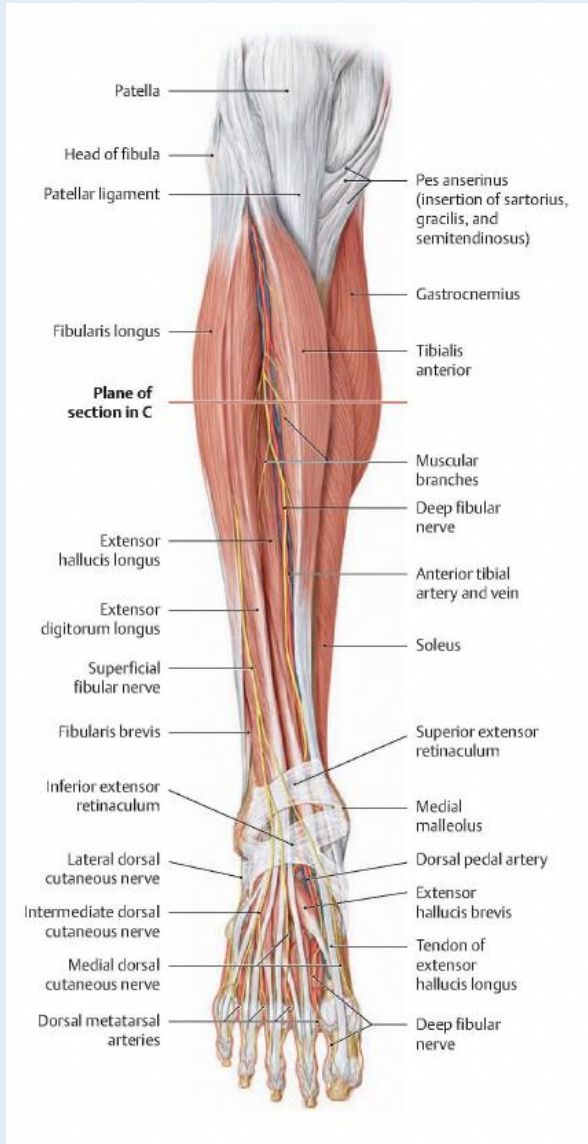
## C Variants in the femoral artery branching pattern (after Lippert and Pabst)

- a 58 % of cases.
- b 18 % of cases.
- c 15 % of cases.
- d 4 % of cases.
- e 3 % of cases.
- f 1 % of cases.

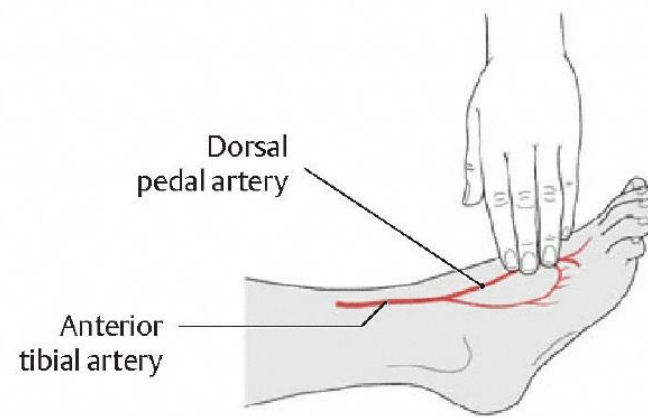
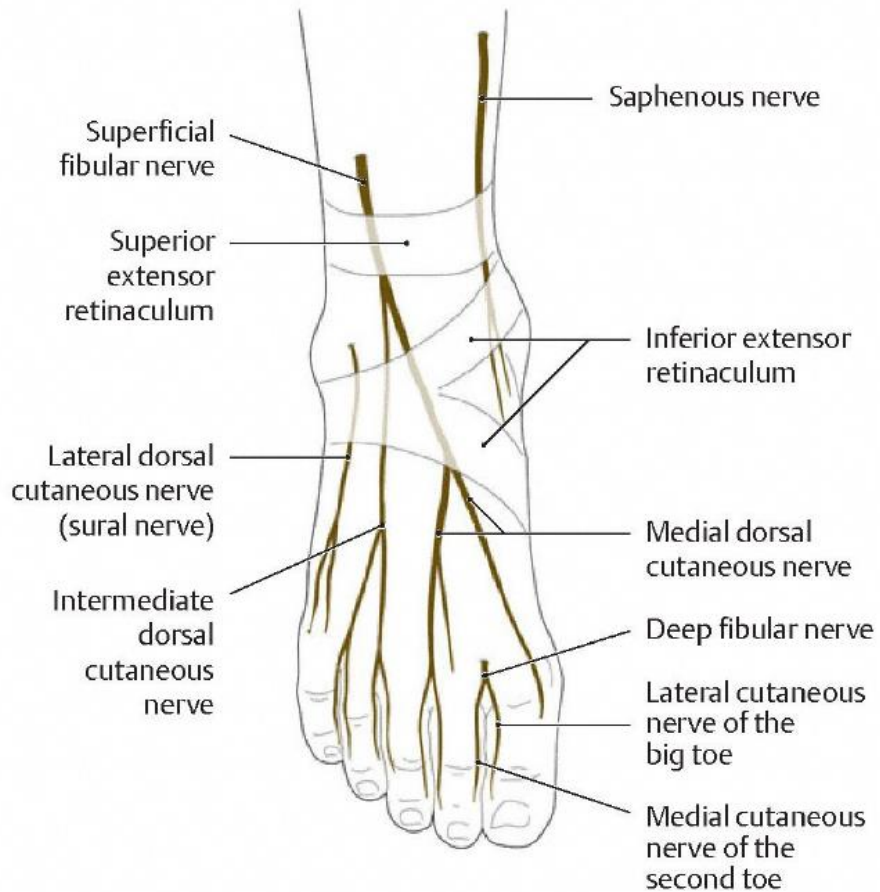
# Arteries



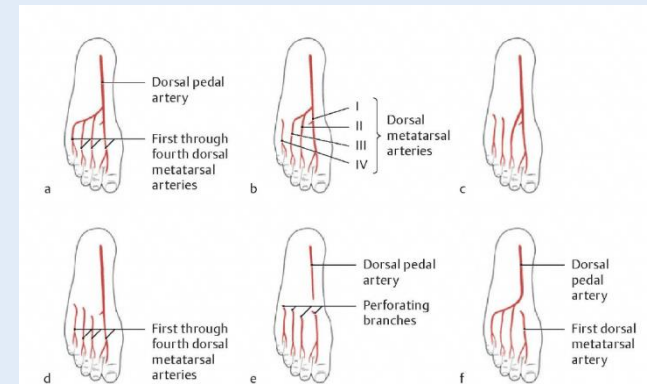
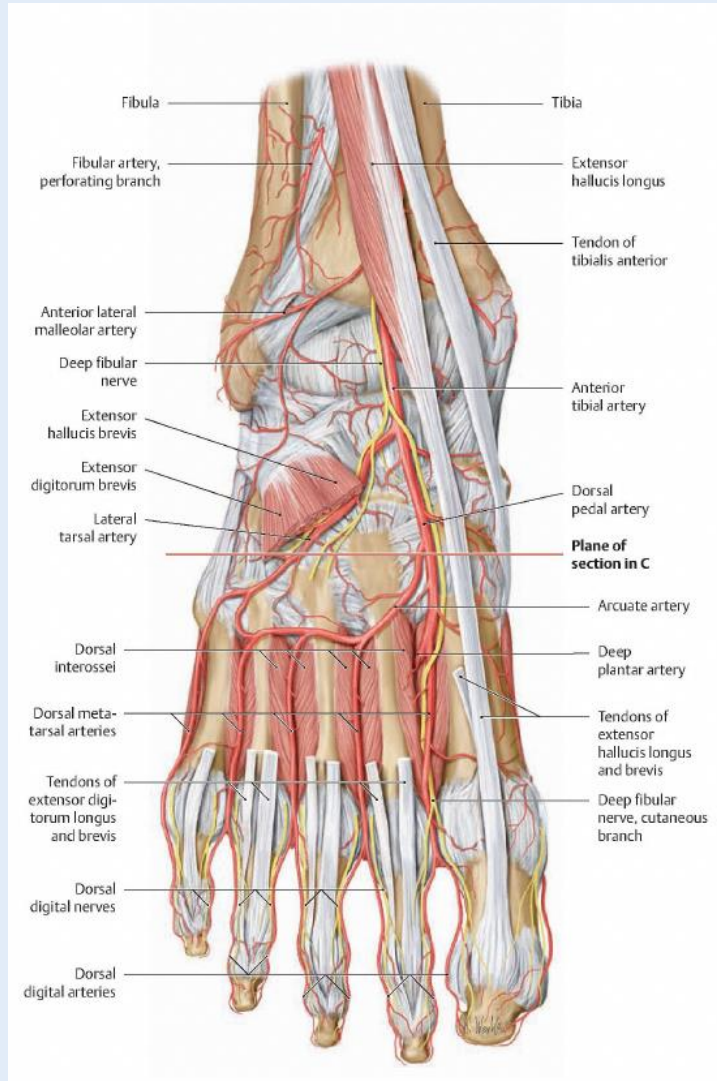
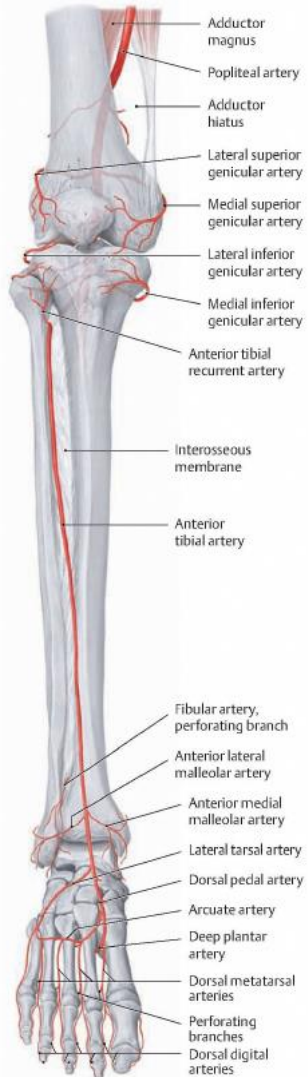
# Ant. and med. crural regions



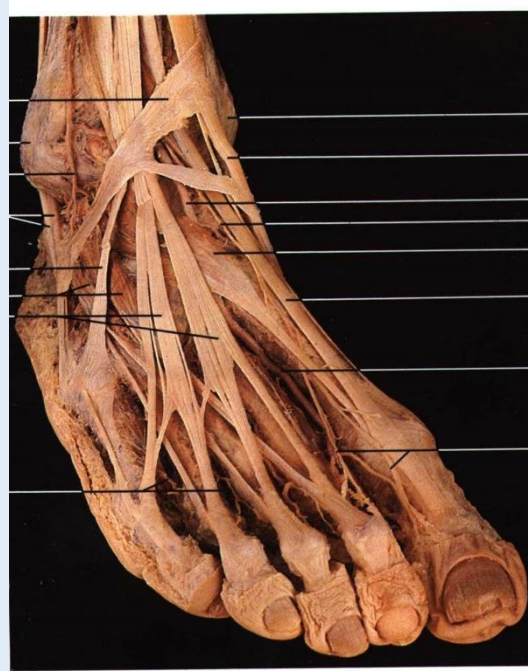
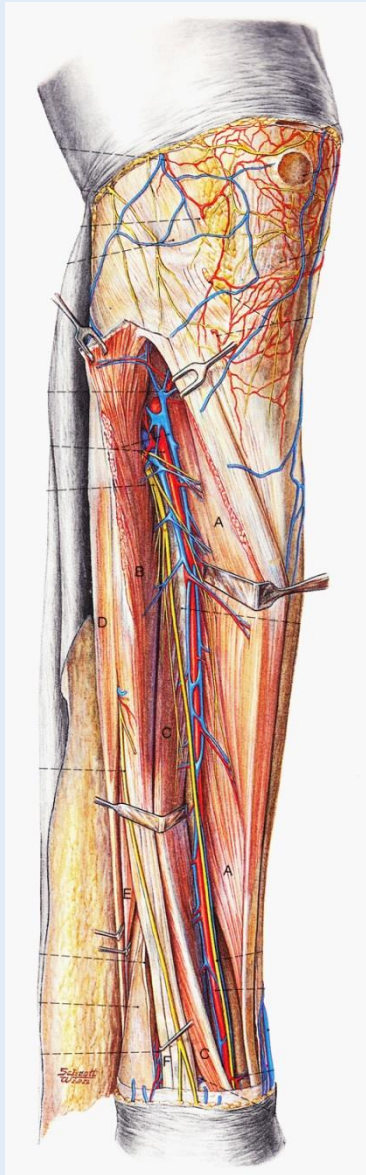
# Cutaneous nerves, palpation



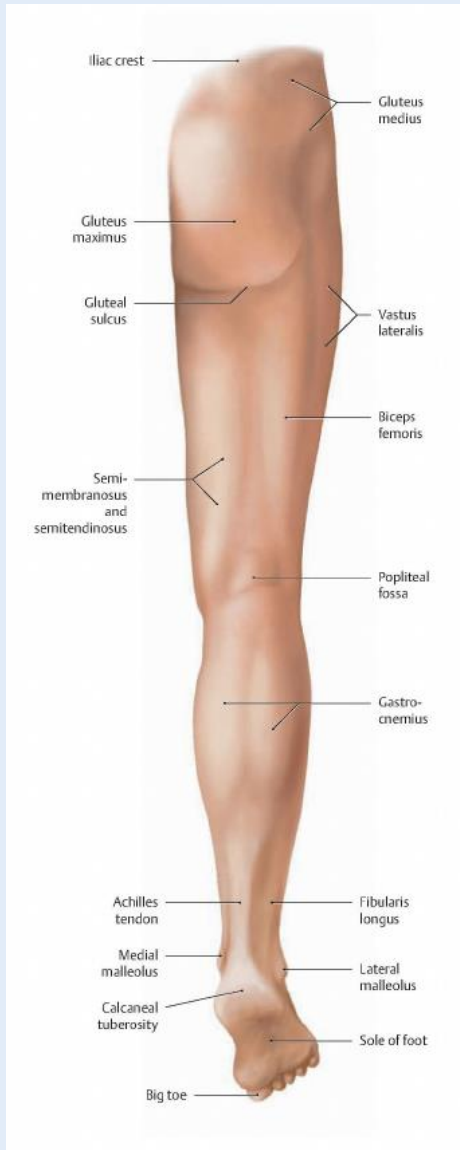
# Nerves and blood vessels



# Arteries

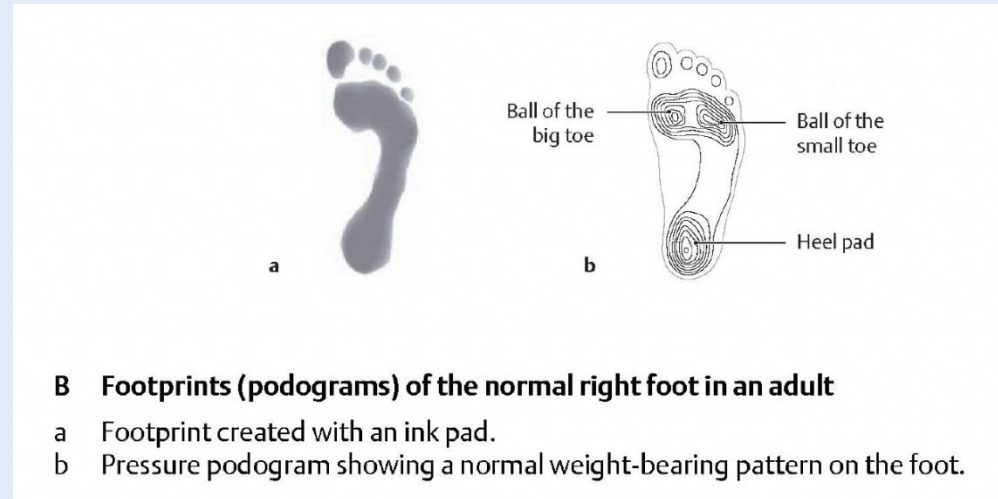
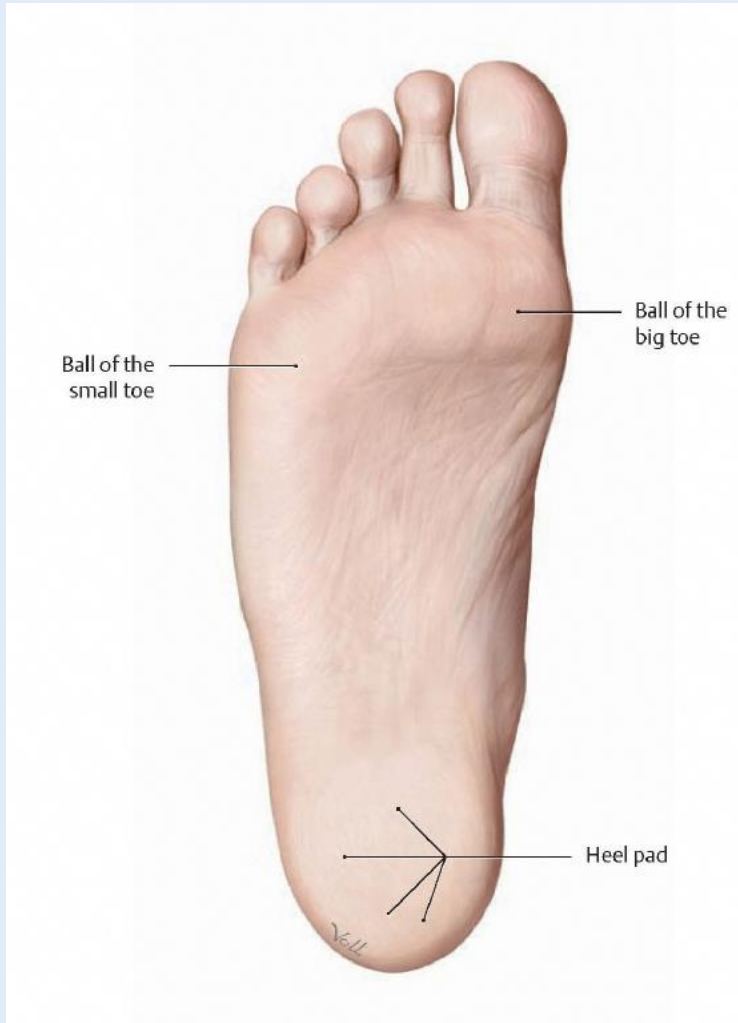


# Dorsal regions

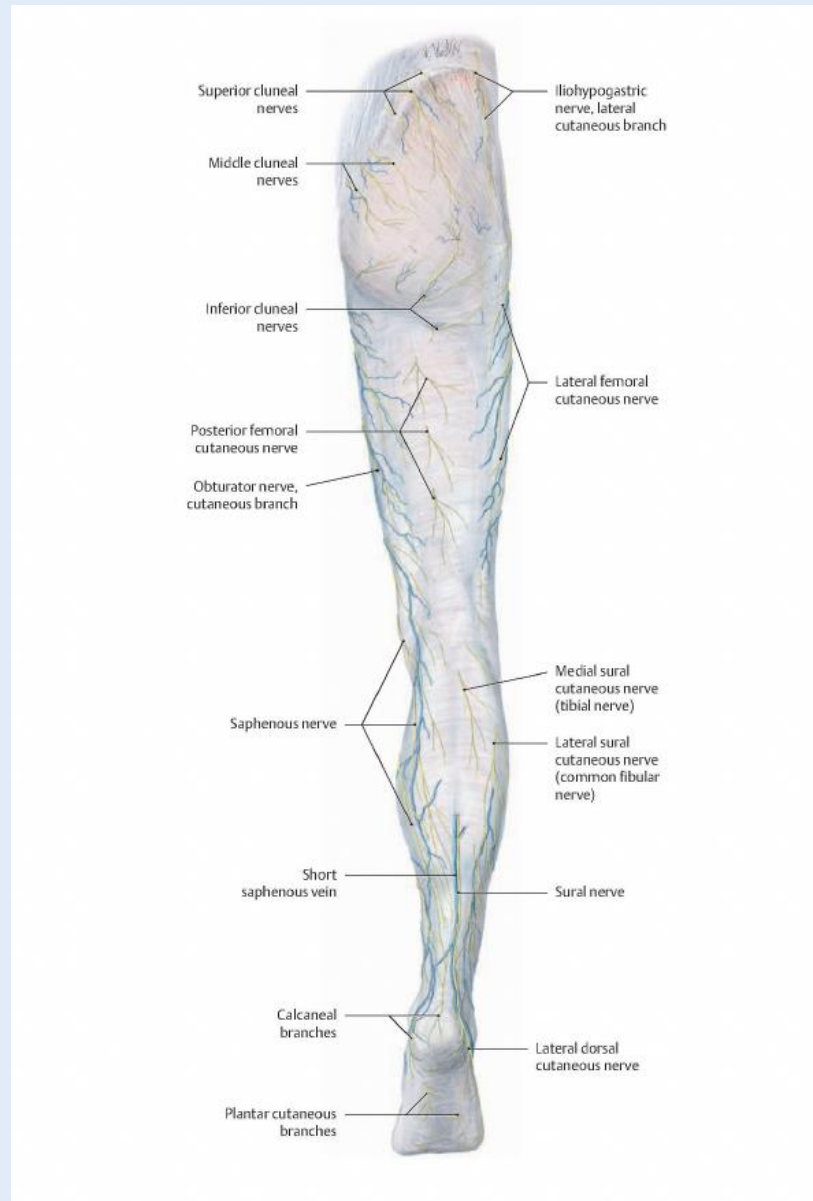




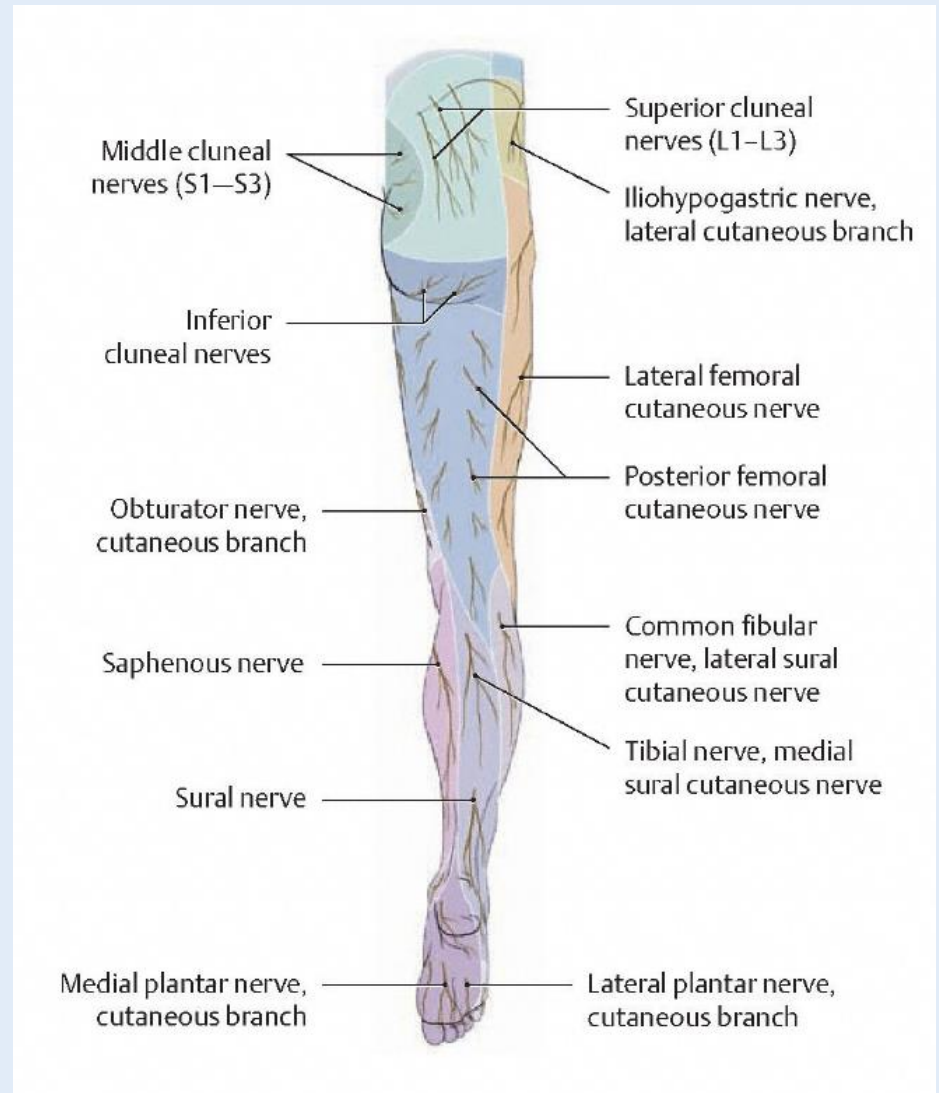
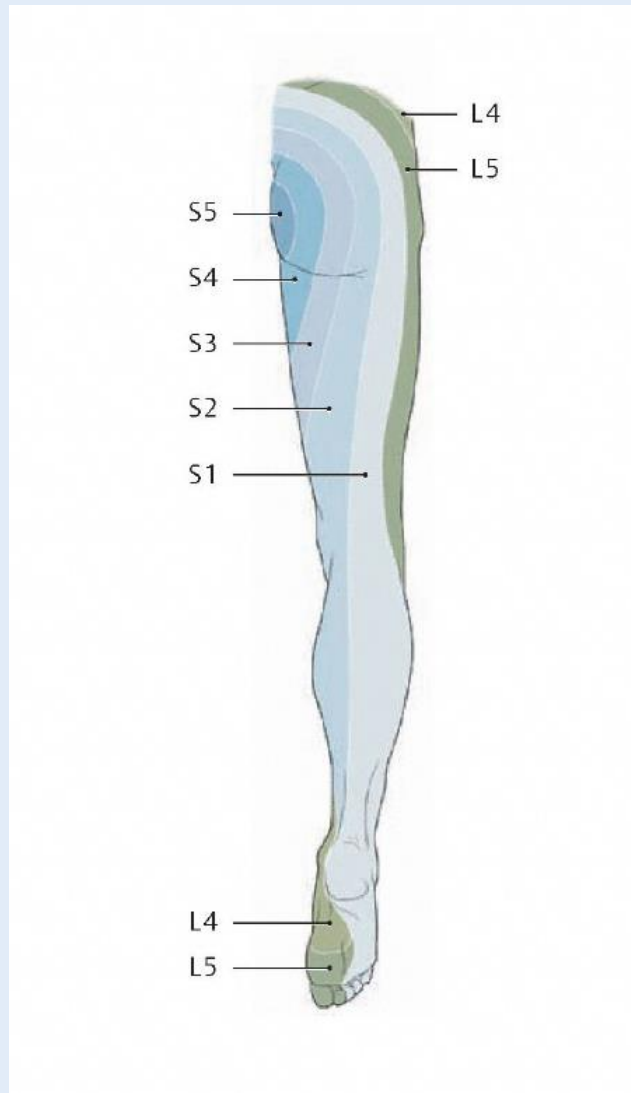
# podogram



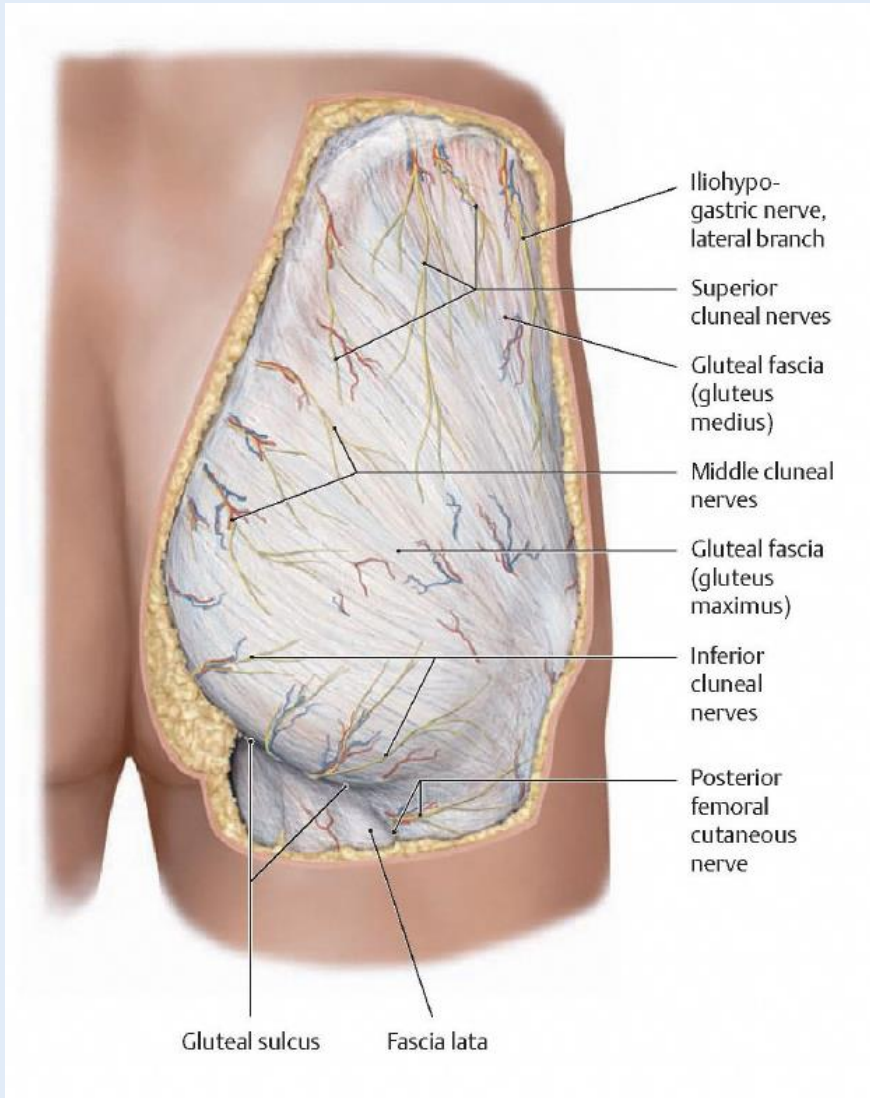
# Epifascial Structures



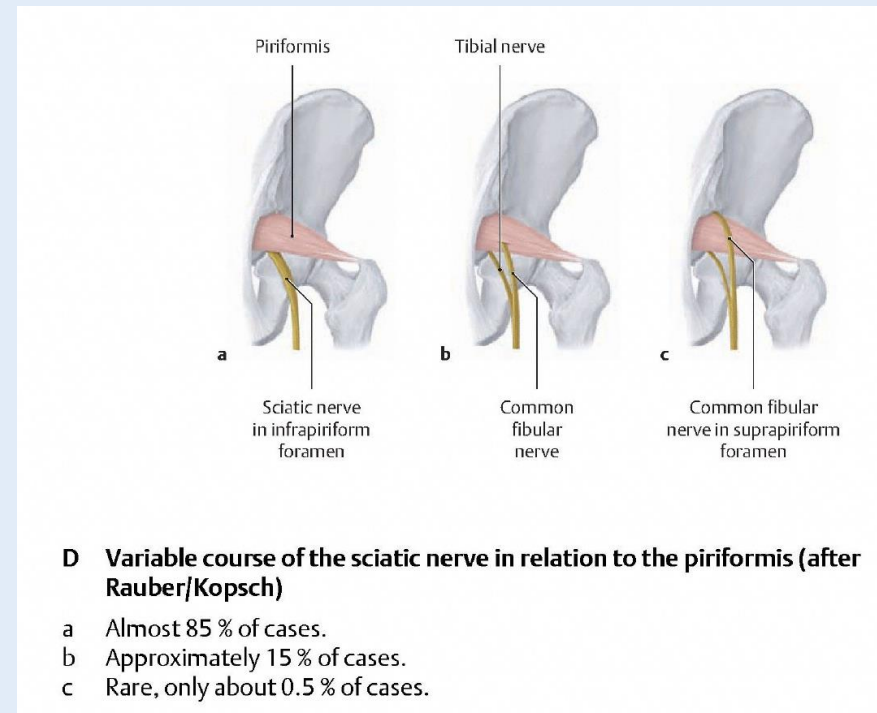
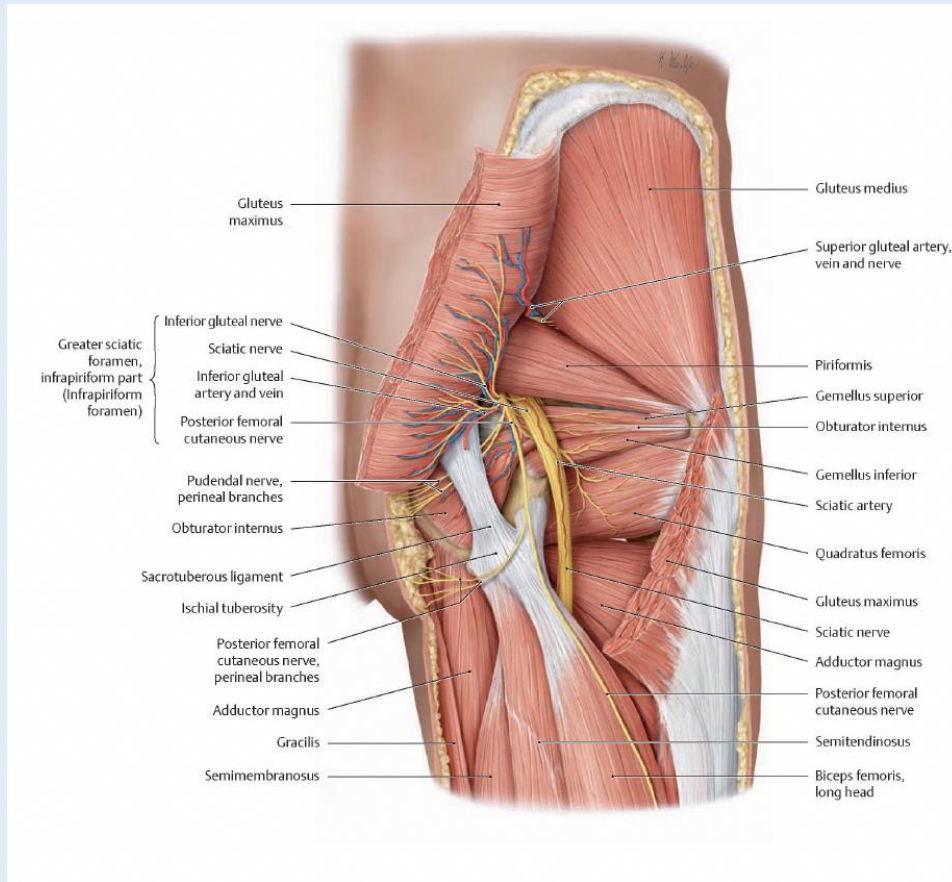
# Dermatomes, cutaneous nerves



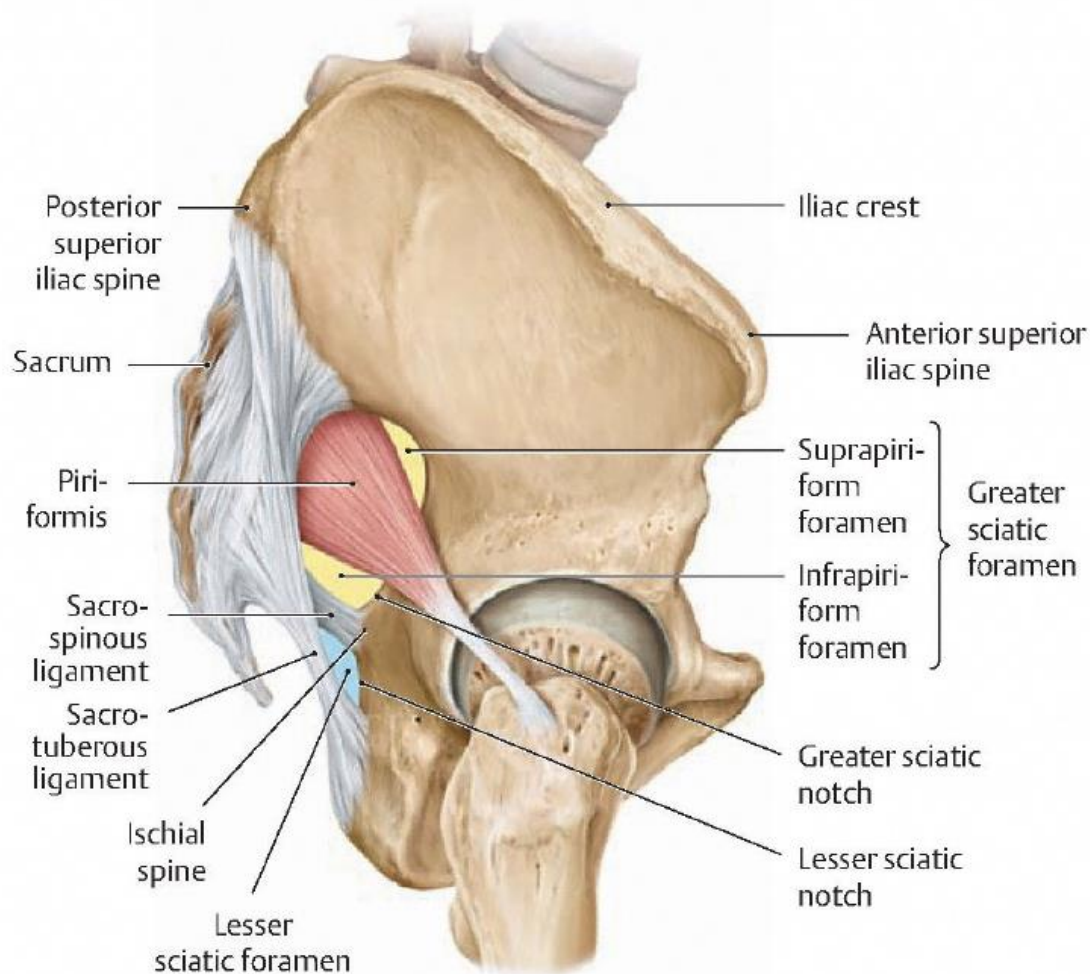
# Gluteal region



# Gluteal region

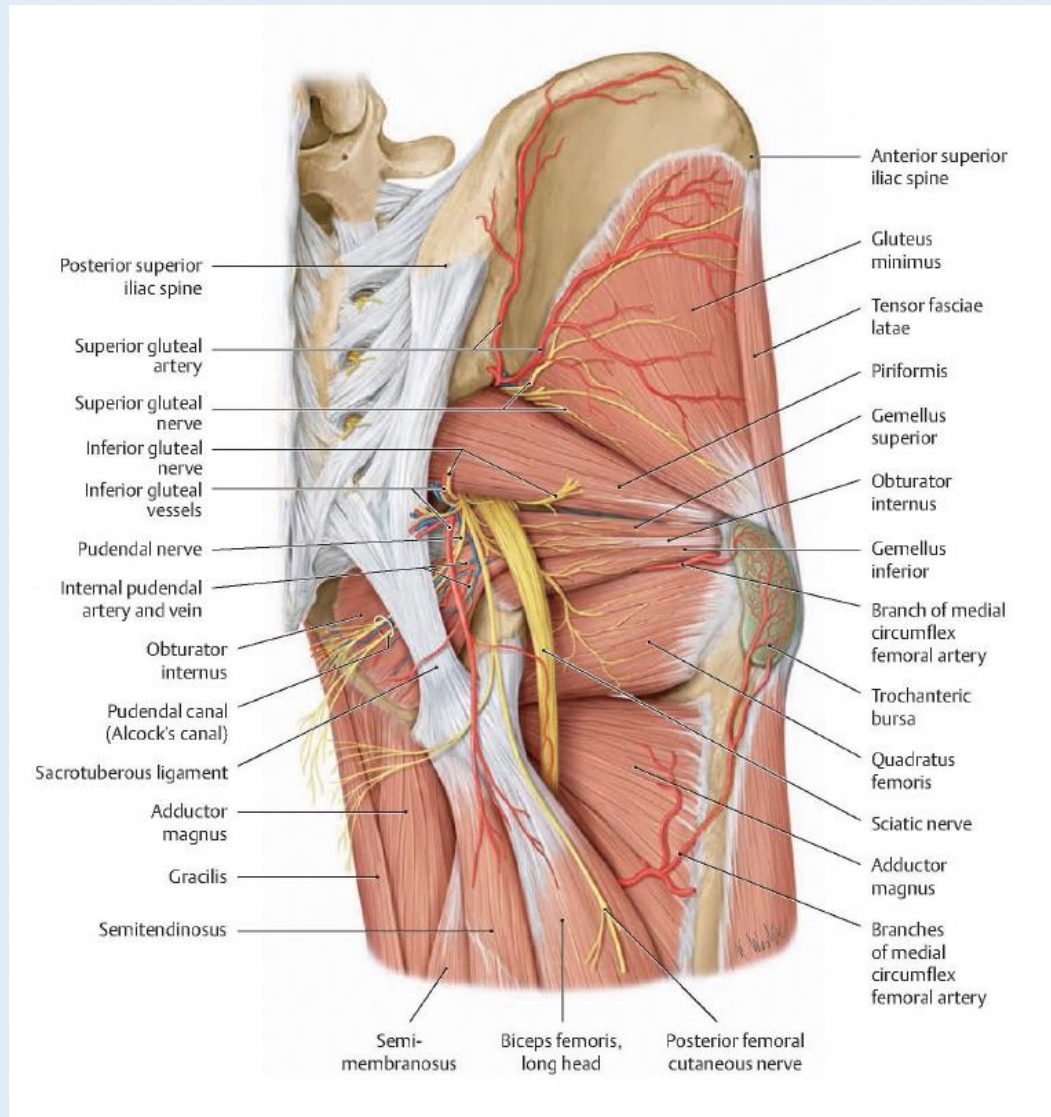


# Greater and lesser sciatic foramen

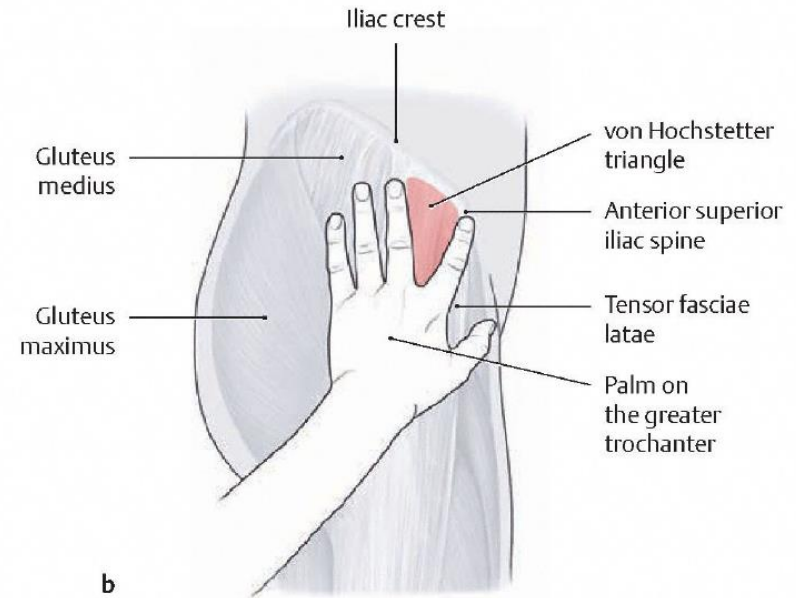
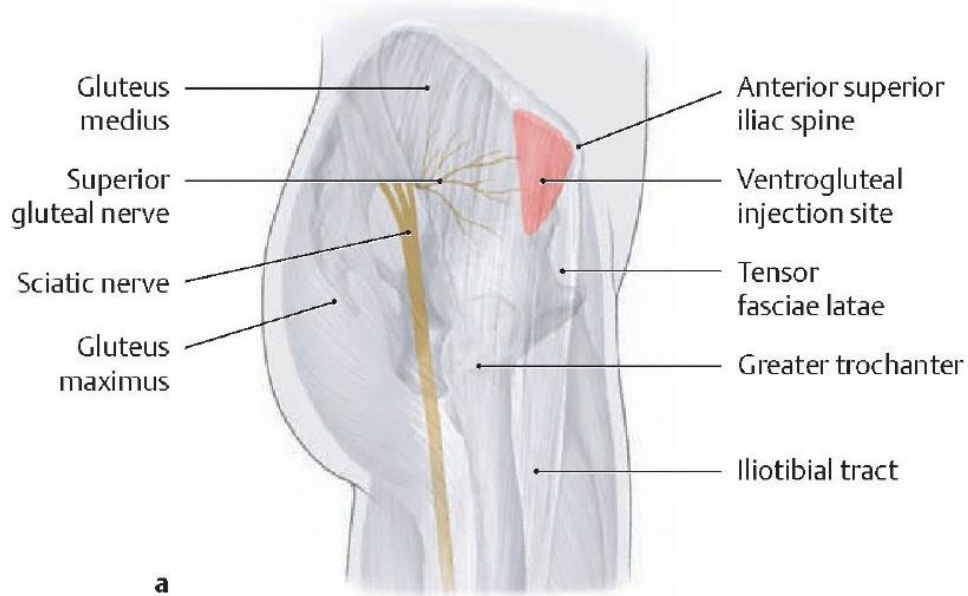


Foramen	Boundaries	Transmitted structures
<ul style="list-style-type: none"> <li>Greater sciatic foramen</li> </ul>	<ul style="list-style-type: none"> <li>Greater sciatic notch</li> <li>Sacrospinous ligament</li> <li>Sacrum</li> </ul>	<ul style="list-style-type: none"> <li>Suprapiriform portion                             <ul style="list-style-type: none"> <li>Superior gluteal artery and vein</li> <li>Superior gluteal nerve</li> </ul> </li> <li>Infrapiriform portion                             <ul style="list-style-type: none"> <li>Inferior gluteal artery and vein</li> <li>Inferior gluteal nerve</li> <li>Internal pudendal artery and vein</li> <li>Pudendal nerve</li> <li>Sciatic nerve</li> <li>Posterior femoral cutaneous nerve</li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>Lesser sciatic foramen</li> </ul>	<ul style="list-style-type: none"> <li>Lesser sciatic notch</li> <li>Sacrospinous ligament</li> <li>Sacro-tuberous ligament</li> </ul>	<ul style="list-style-type: none"> <li>Internal pudendal artery and vein</li> <li>Pudendal nerve</li> <li>Obturator internus</li> </ul>

# Blood vessels and nerves

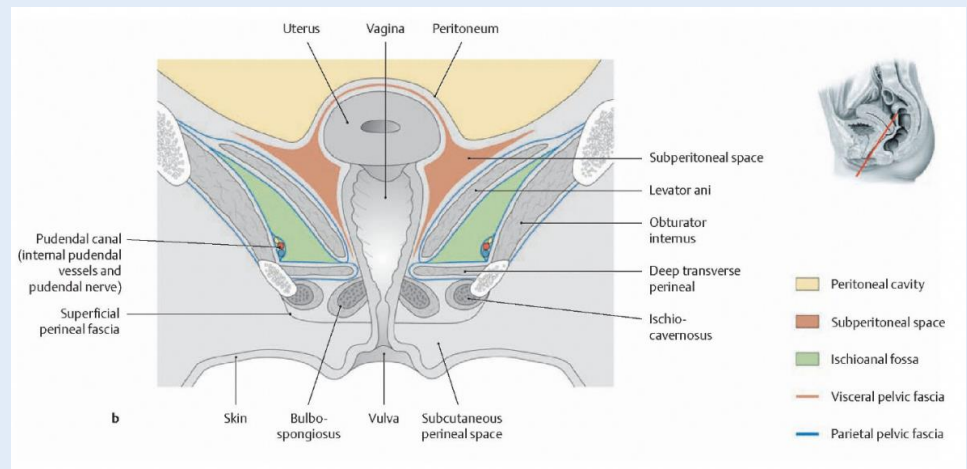
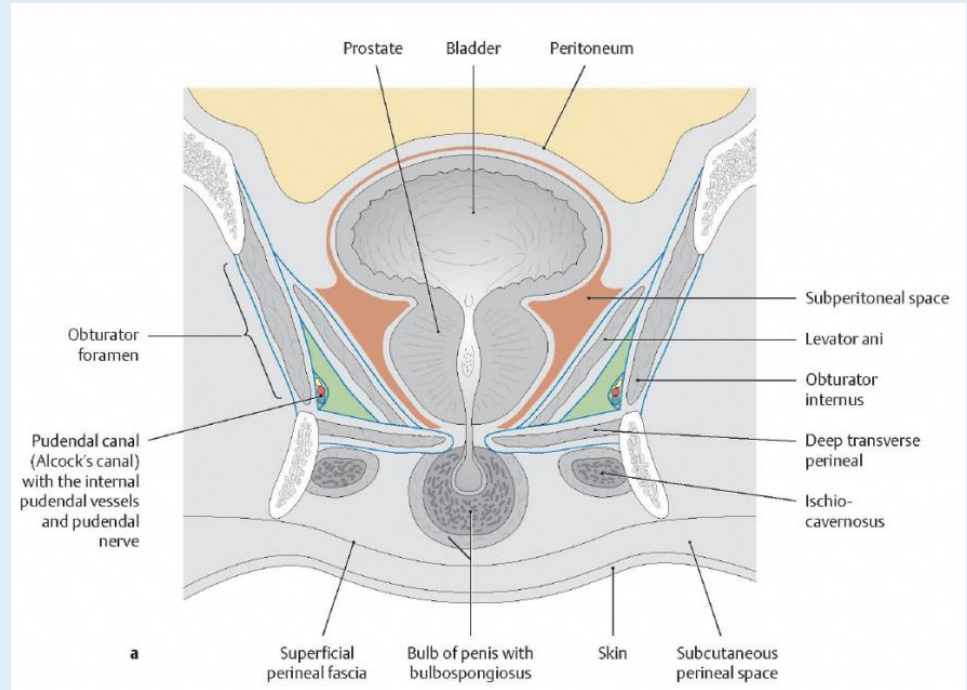
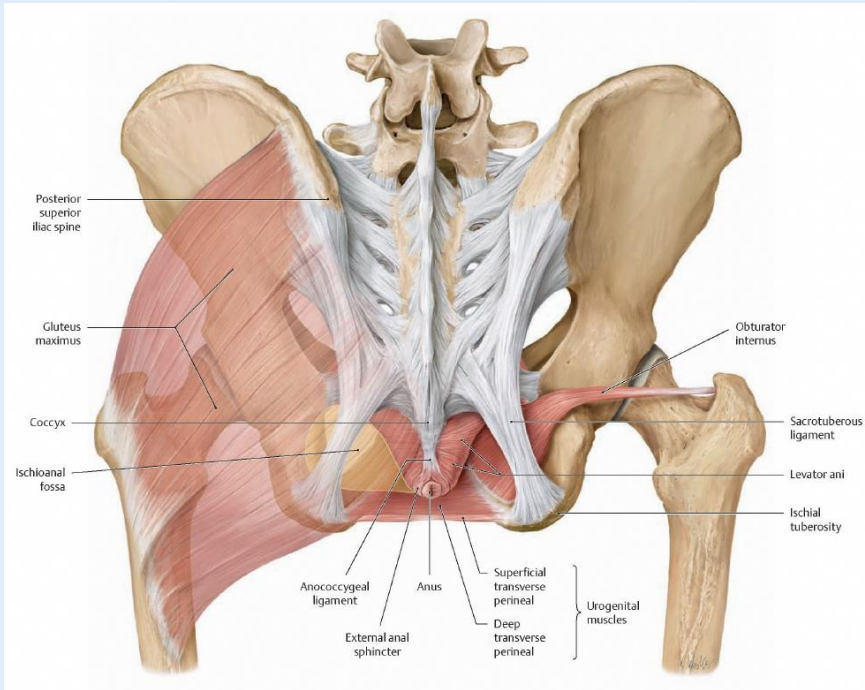


# IM injection



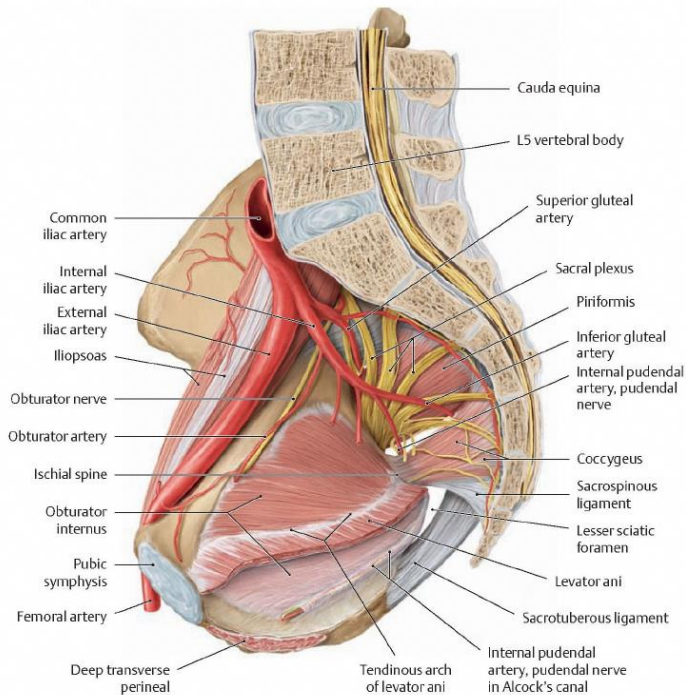


# Ischio-anal fossa



Pudendal canal (Alcock's canal)

# Pudendal canal

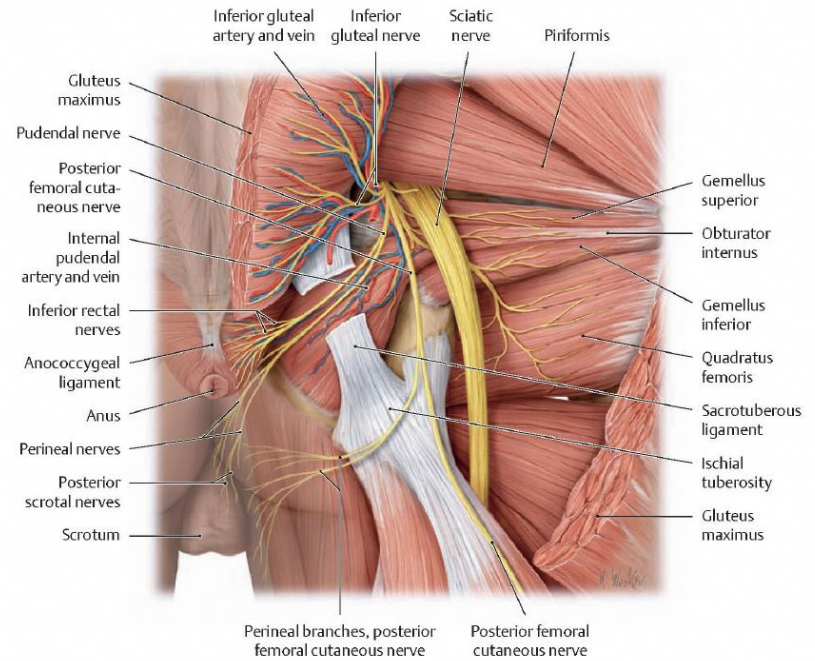


**A Location of the pudendal canal (Alcock's canal) and the neurovascular structures it contains**  
Right half of the pelvis, medial view.

Illustrator: Karl Wesker

pp. 498-499

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**B Distribution of the pudendal nerve and internal pudendal vessels to the anus, perineum, and external genitalia**  
Gluteal region and ischioanal fossa on the right side, posterior view.

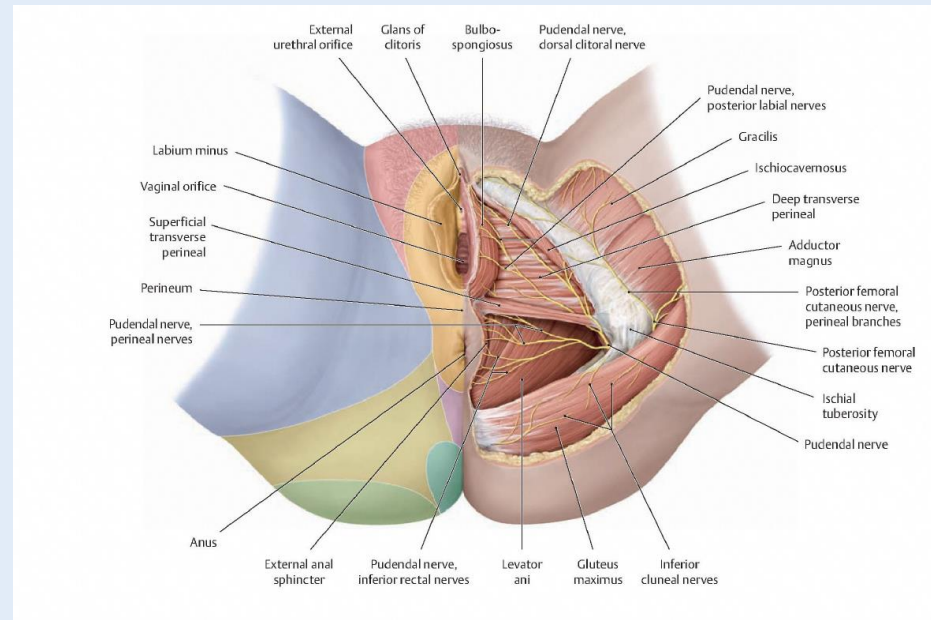
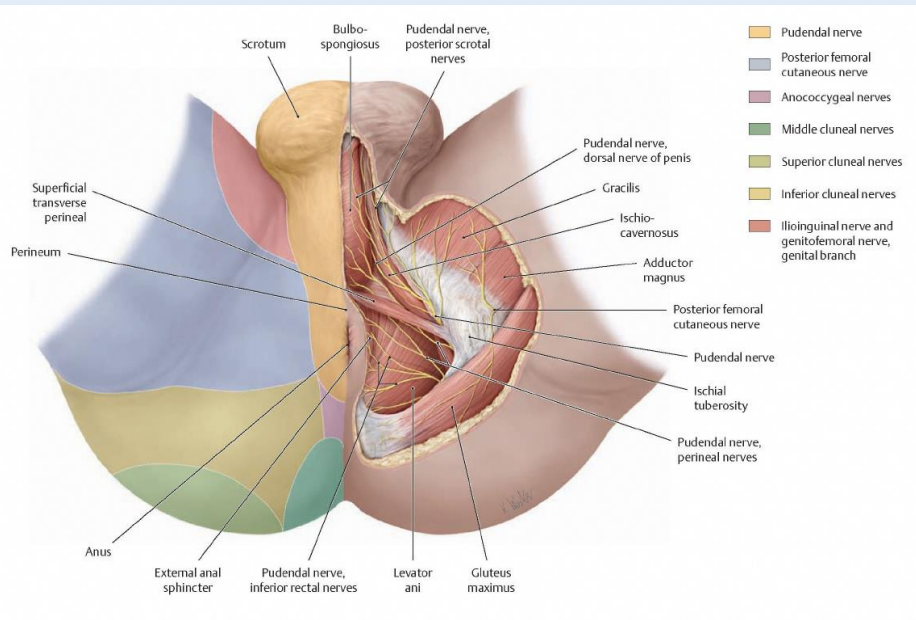
Illustrator: Karl Wesker

pp. 498-499

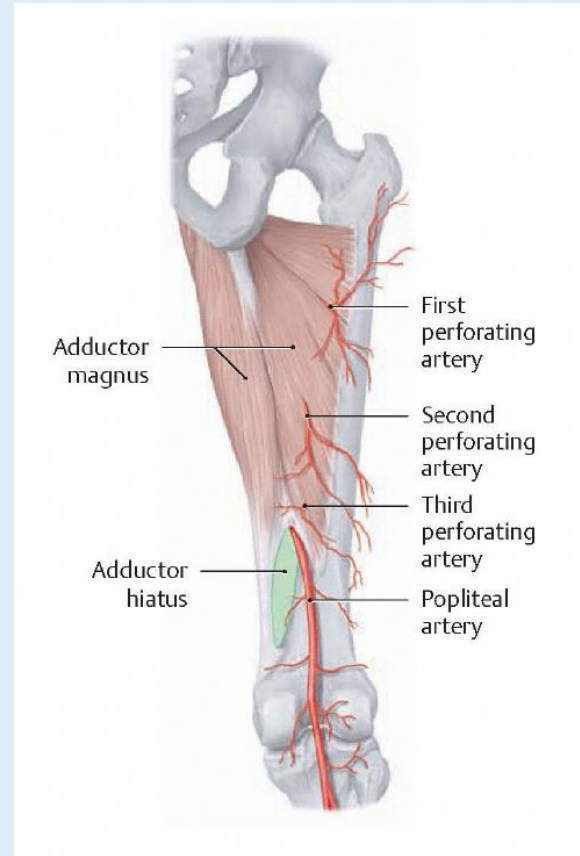
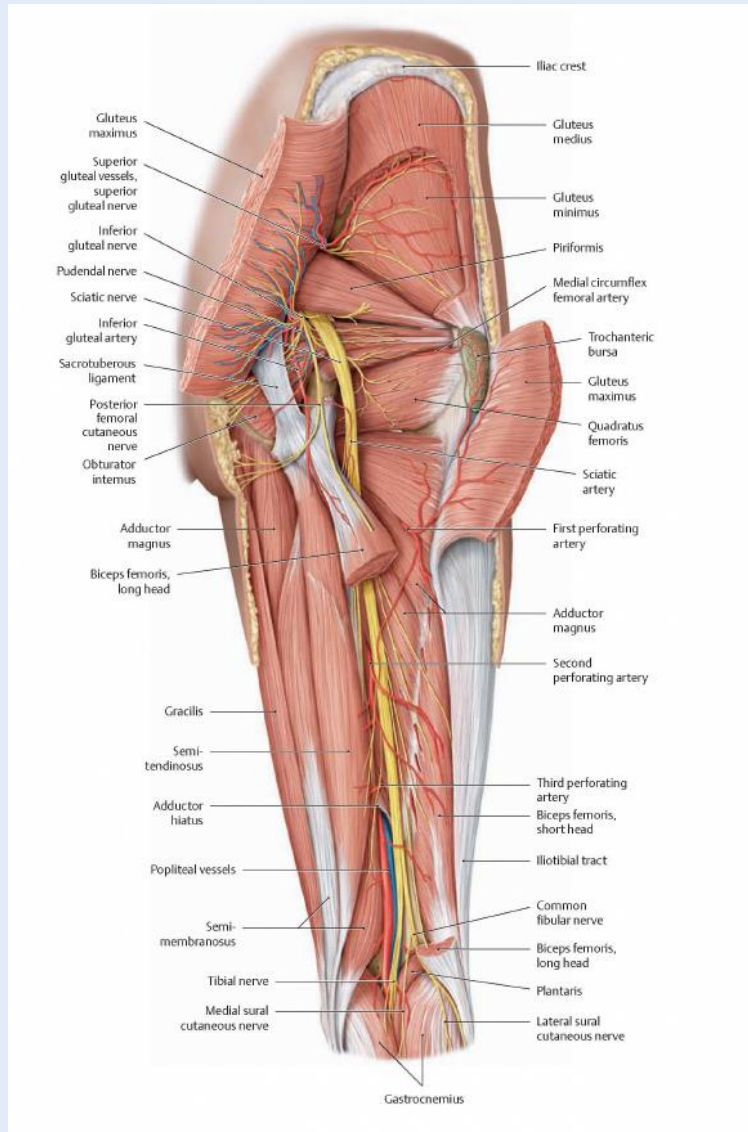
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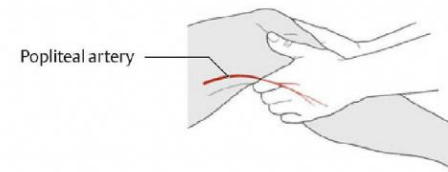
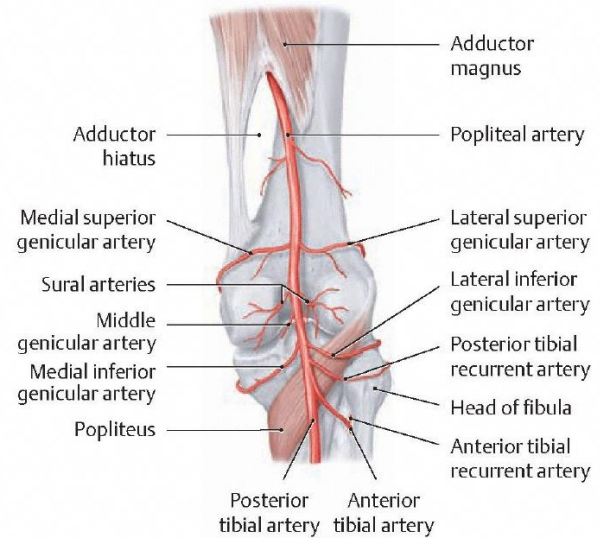
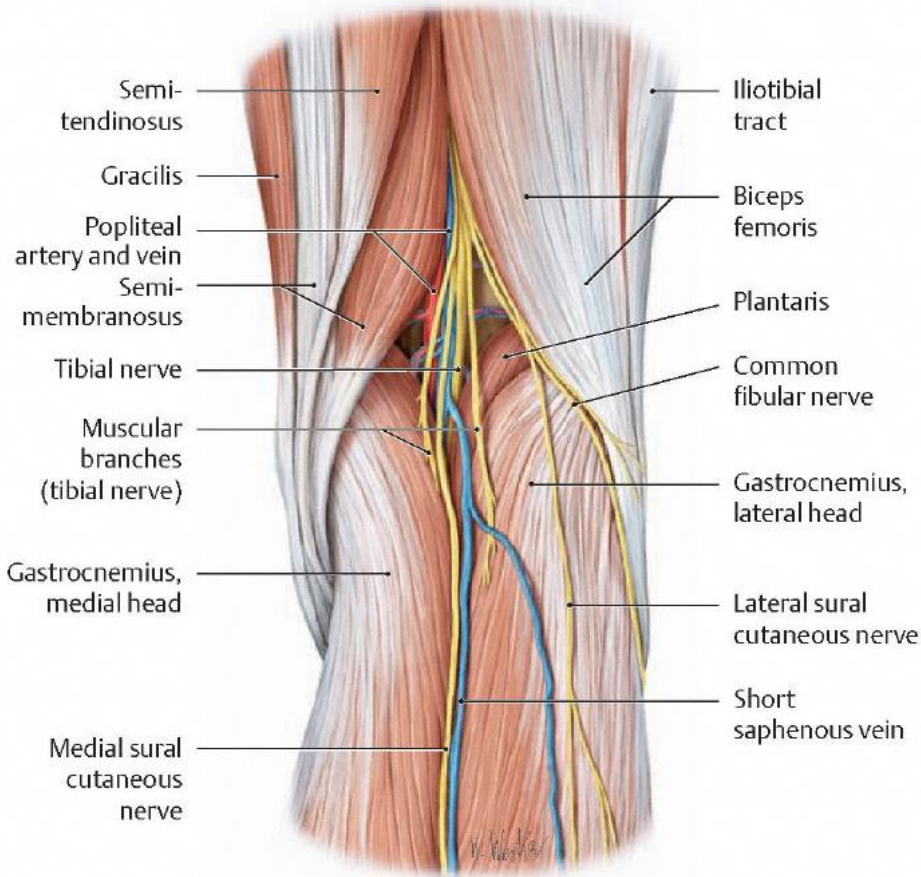
# Pudendal region



# Post. femoral region

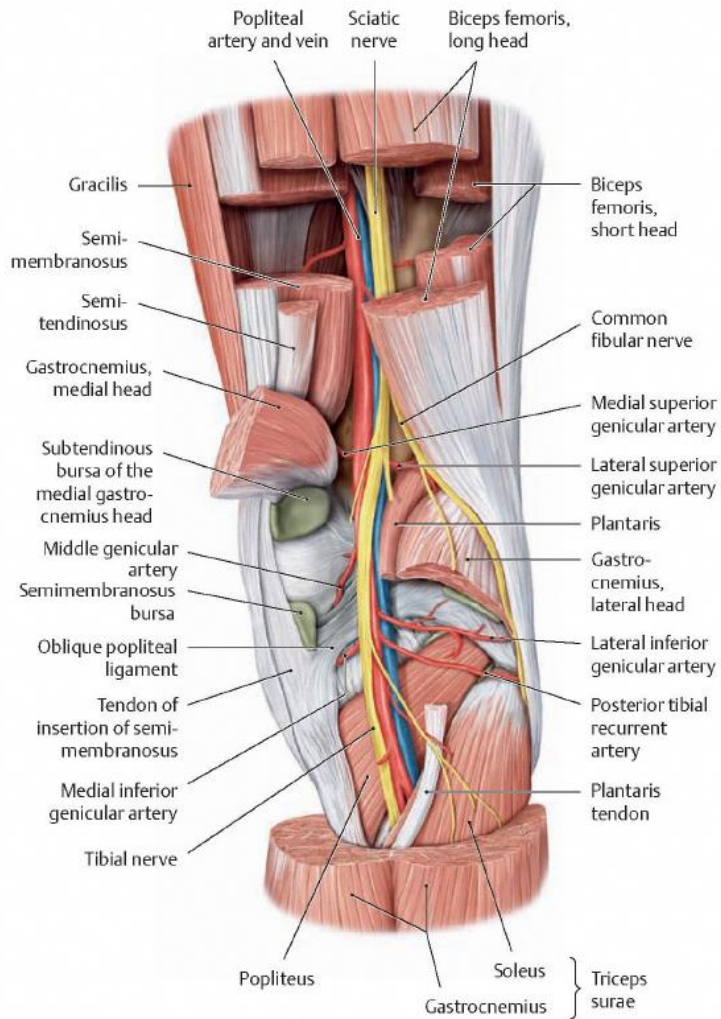


# Popliteal region

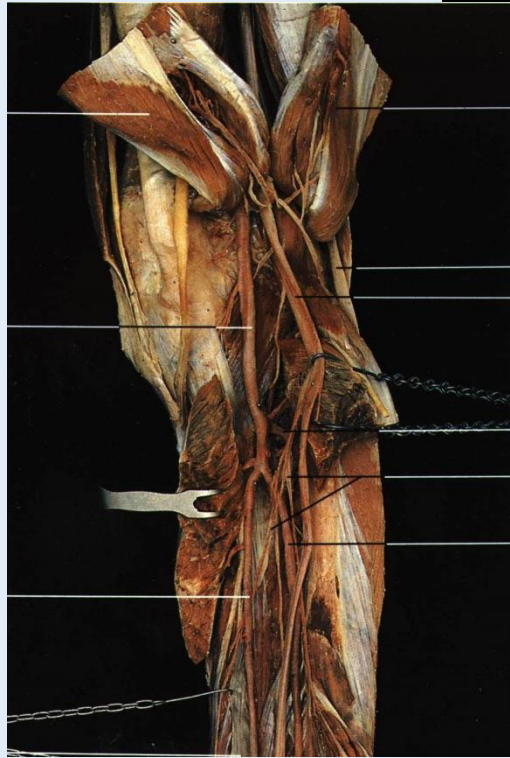
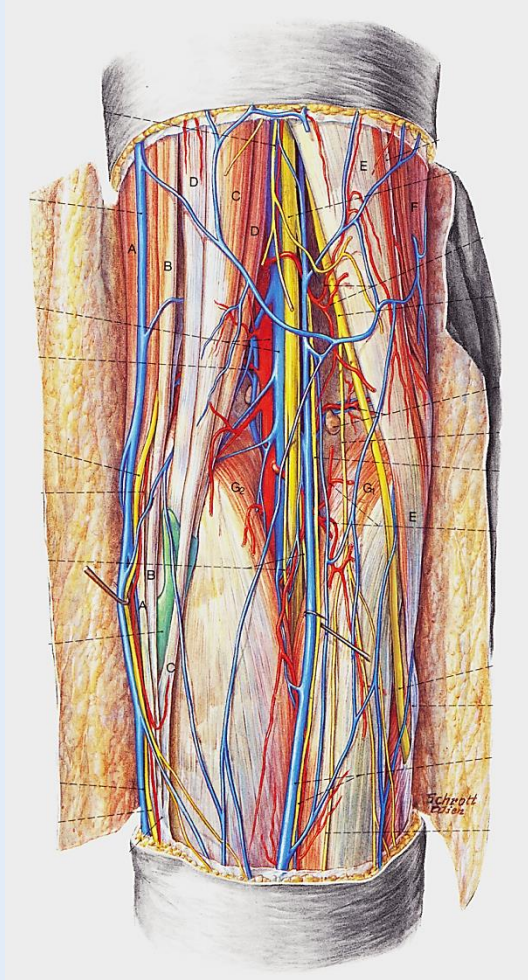


**E Palpation of the popliteal artery in the popliteal fossa**

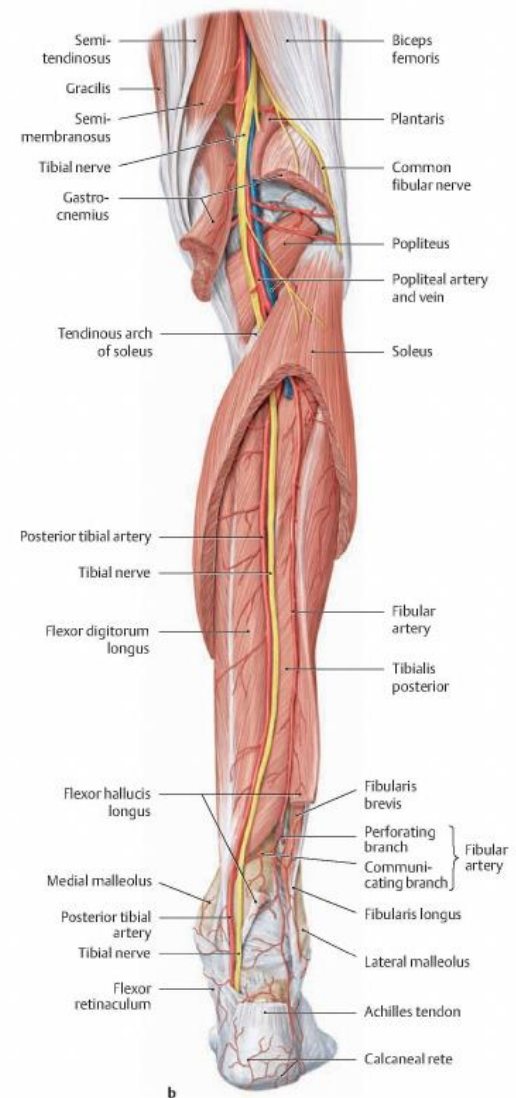
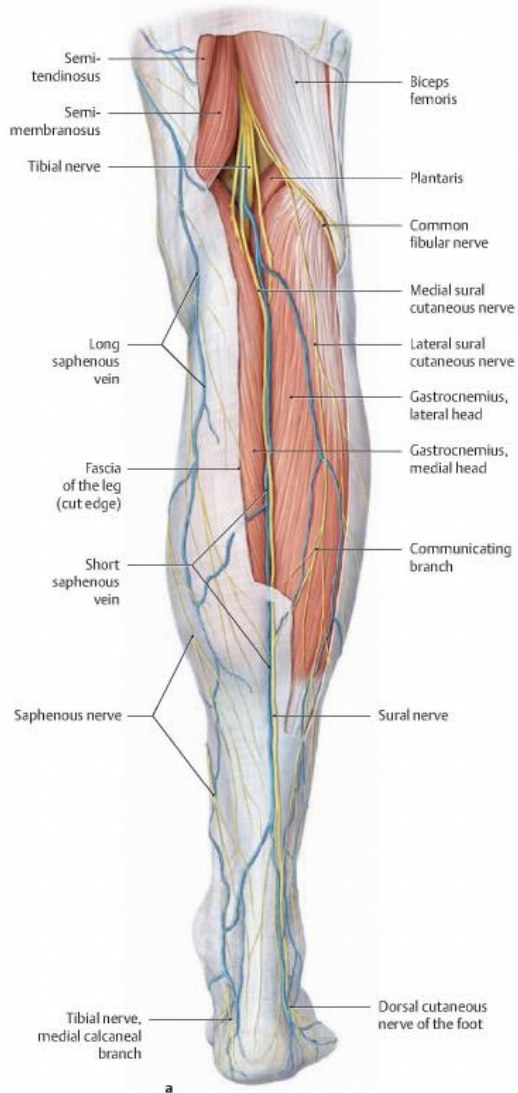
# Popliteal fossa



# Arteries



# Post. crural region

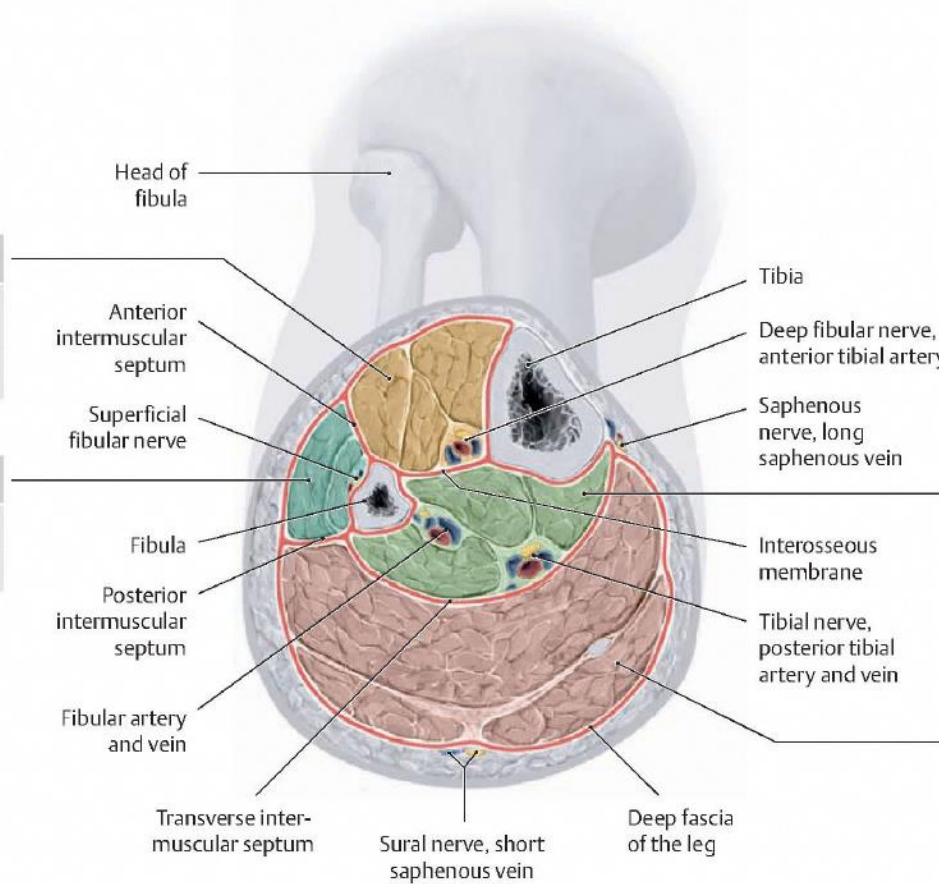




# Compartments

- Anterior compartment**
- Tibialis anterior
  - Extensor digitorum longus
  - Extensor hallucis longus

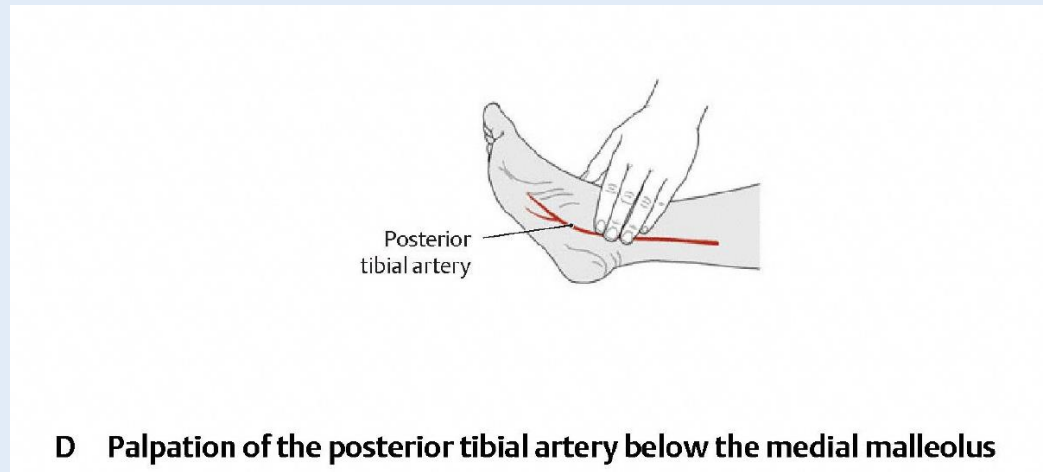
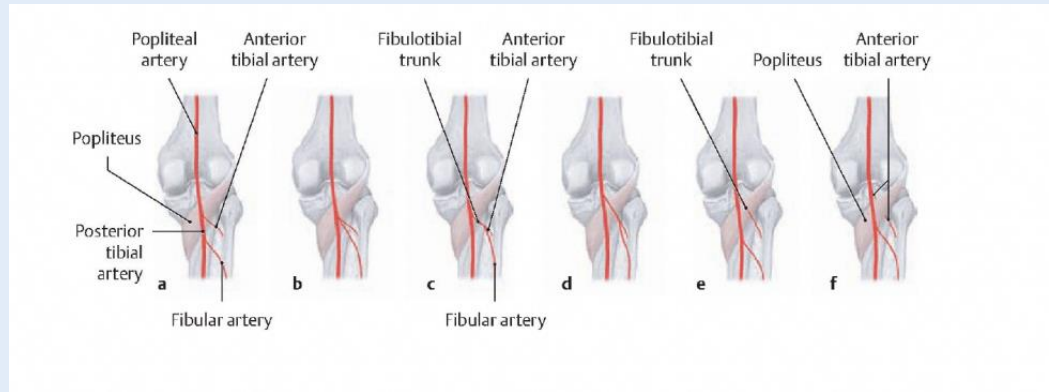
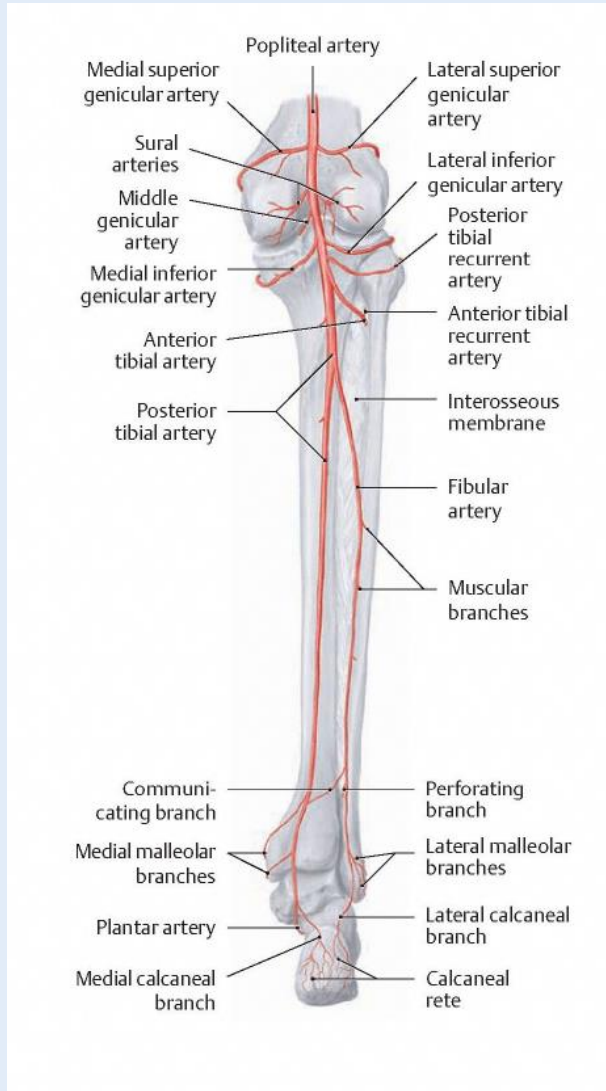
- Lateral compartment**
- Fibularis longus
  - Fibularis brevis



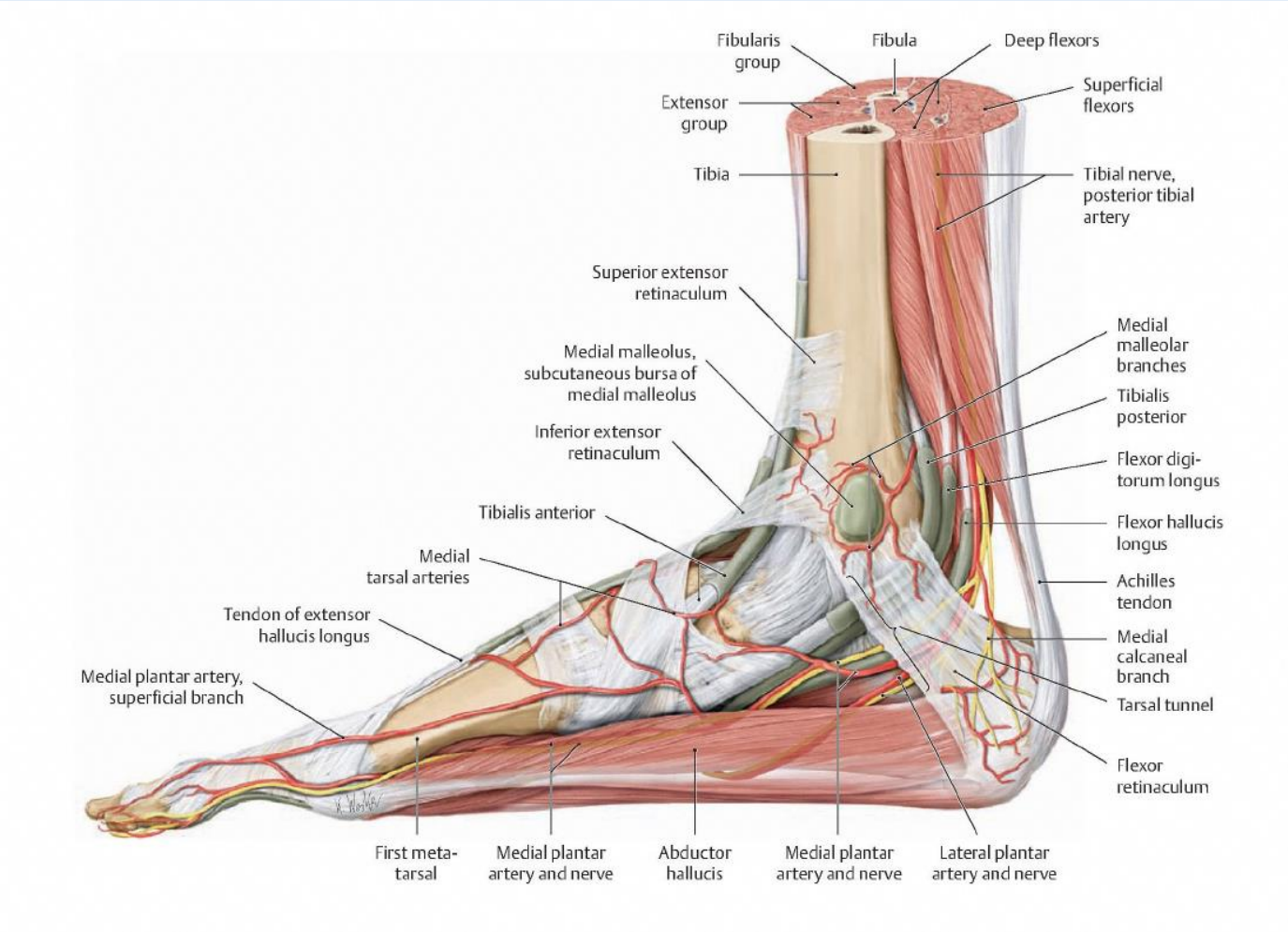
- Posterior compartment, deep part**
- Tibialis posterior
  - Flexor digitorum longus
  - Flexor hallucis longus

- Posterior compartment, superficial part**
- Triceps surae
  - Plantaris

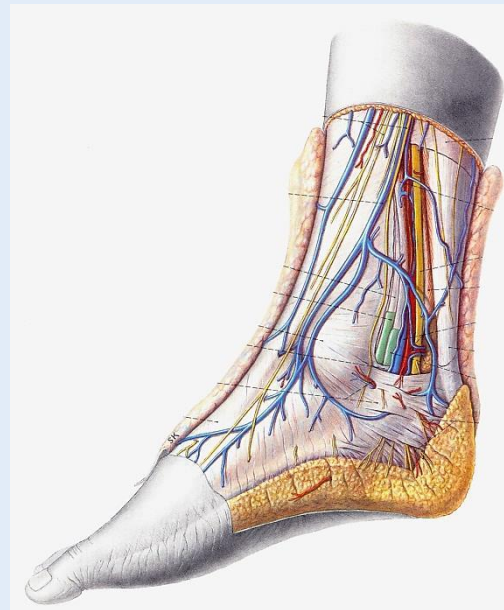
# Blood supply



# Tarsal canal



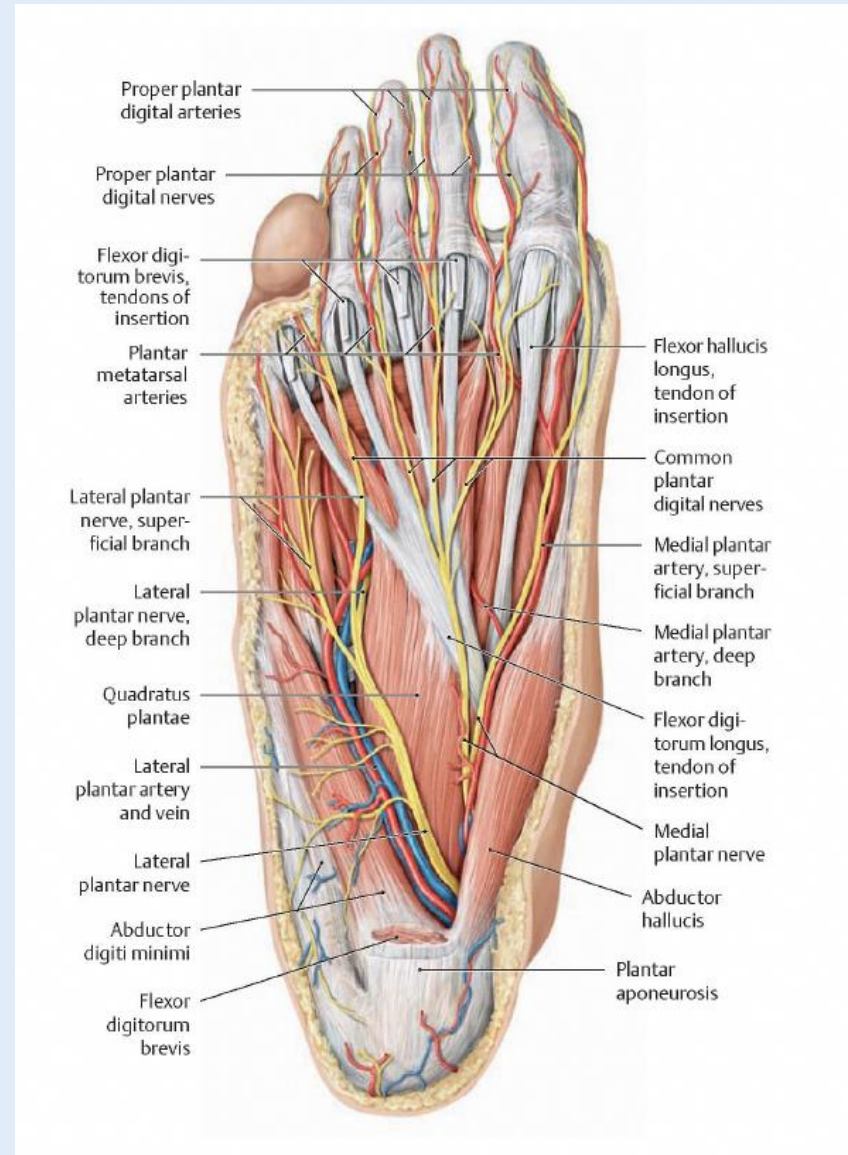
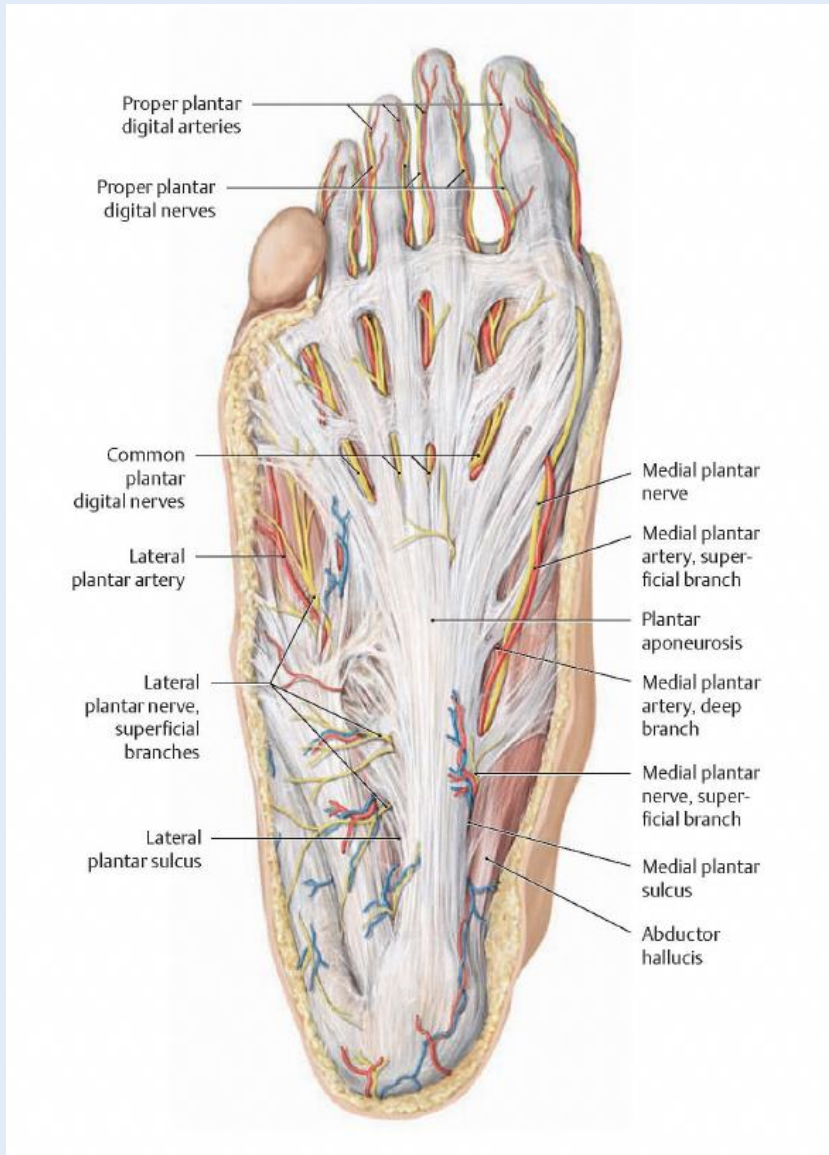
# Arteries



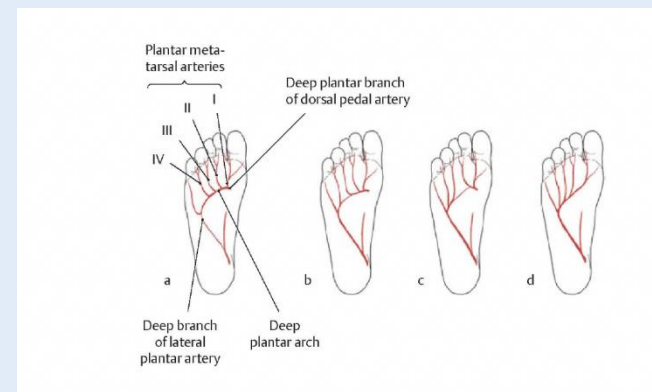
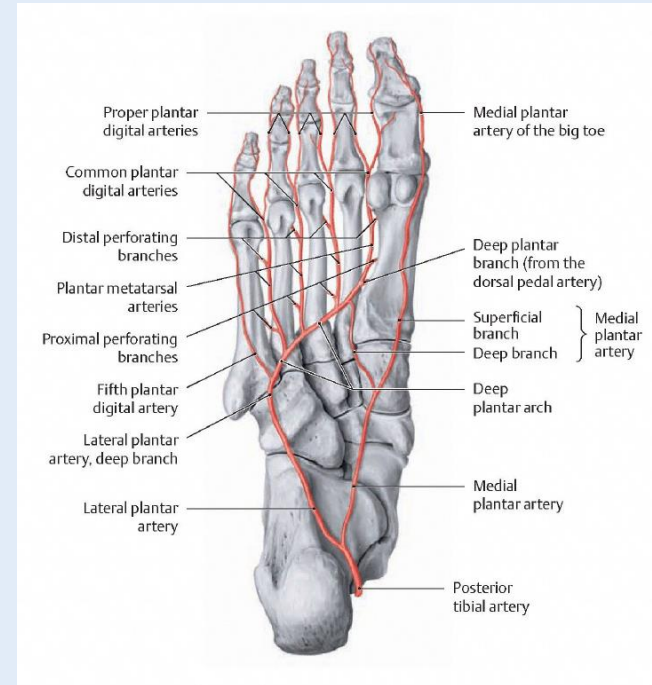
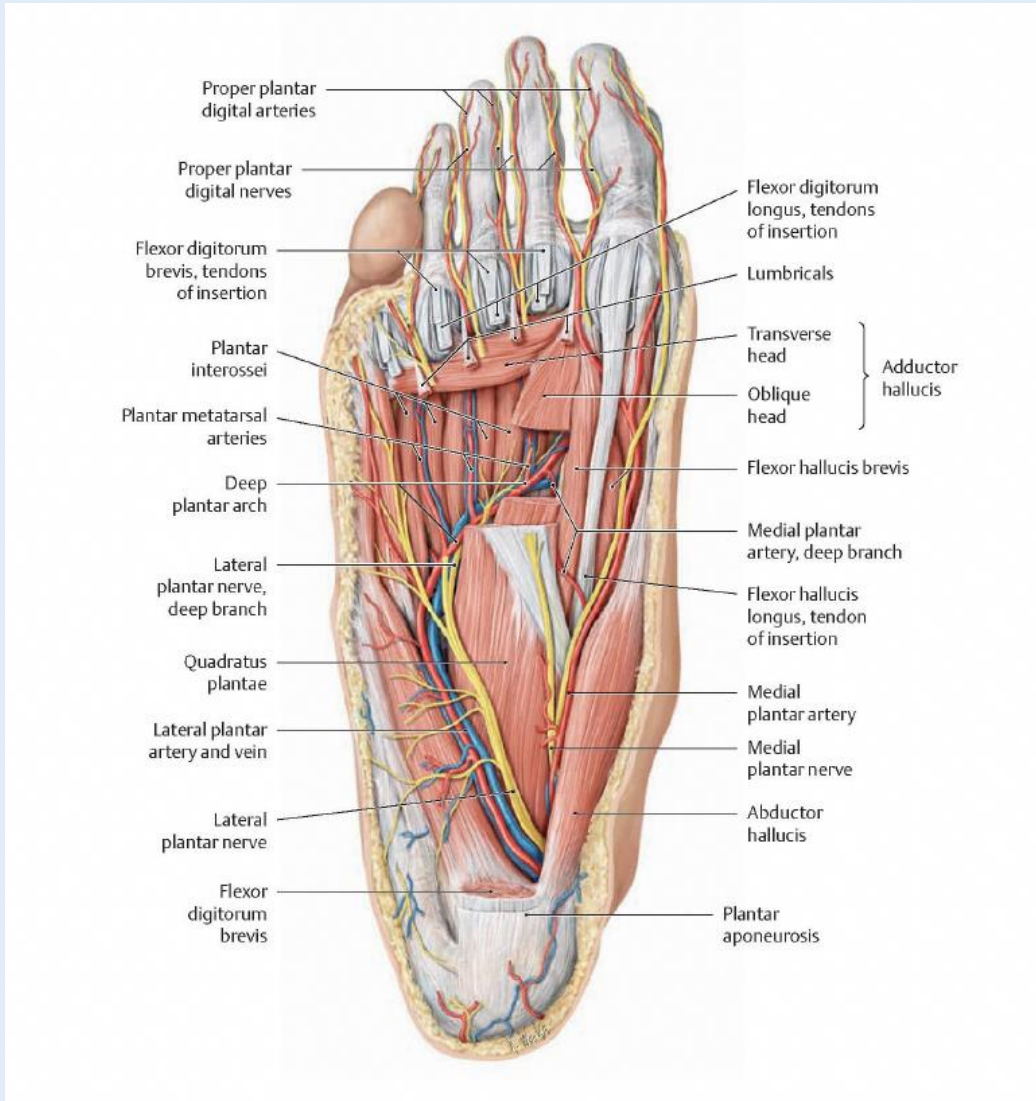
Most important pulse artery called ATP in clinics.

Palpating: behind the medial Malleolus

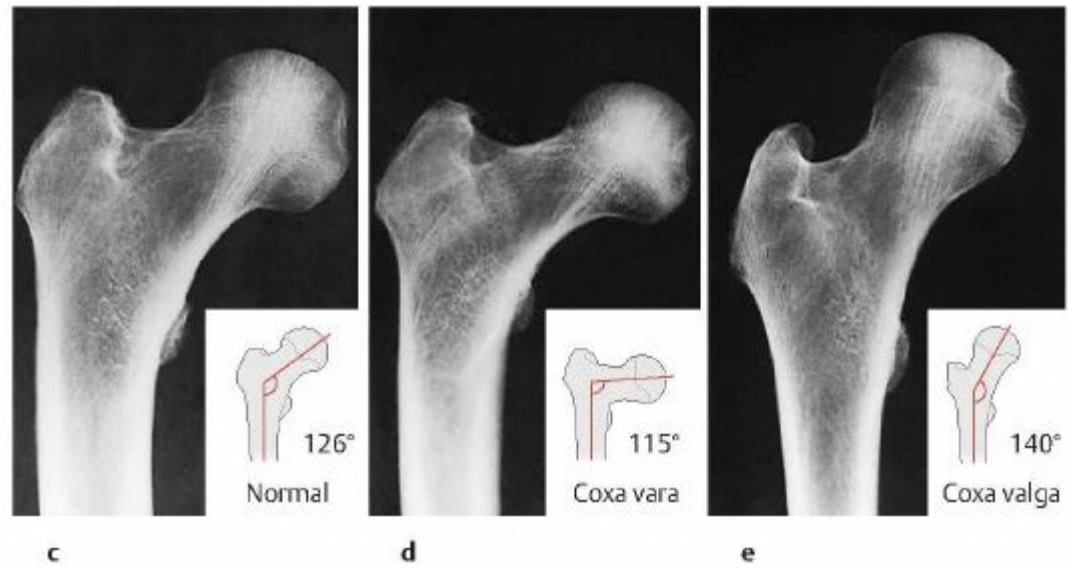
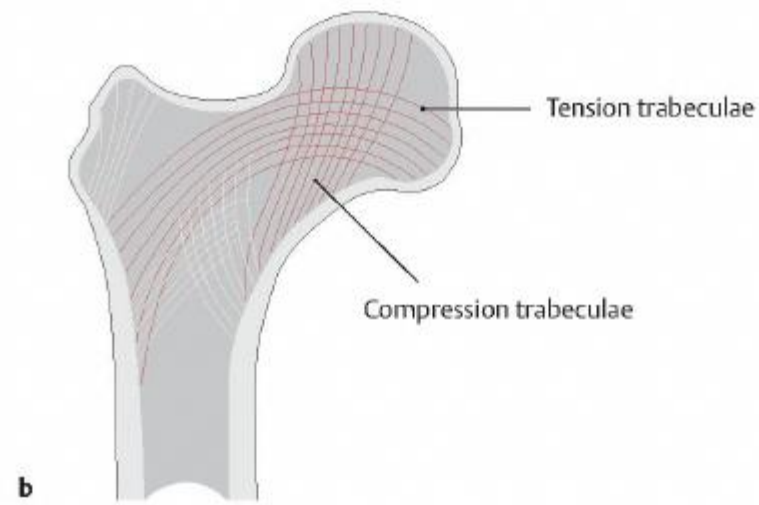
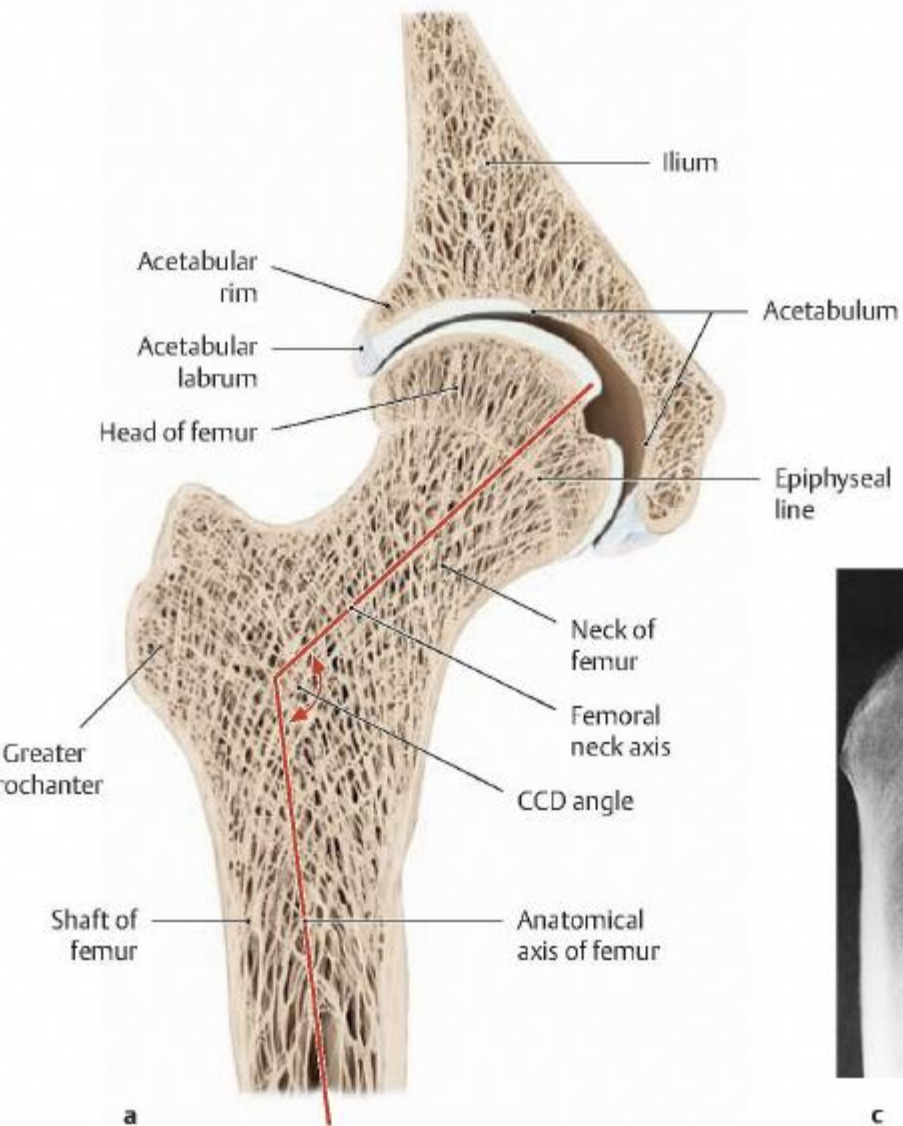
# Plantar region



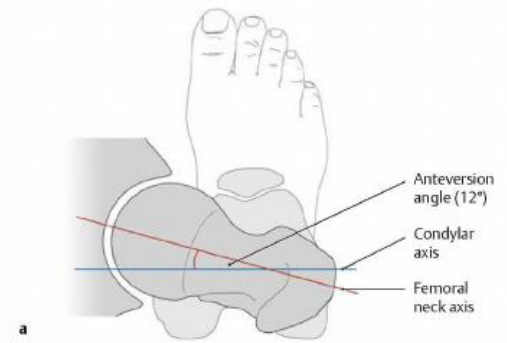
# Plantar region



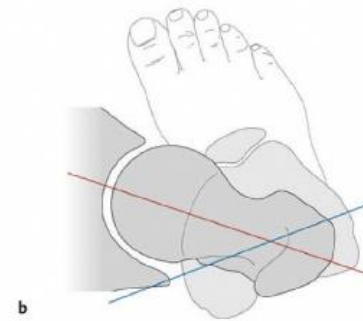
# Clinical aspects



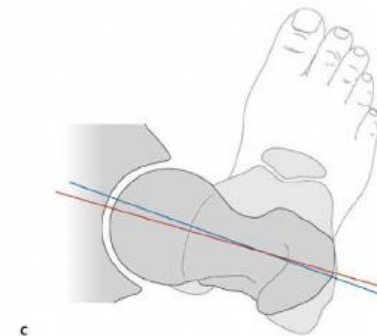




a



b



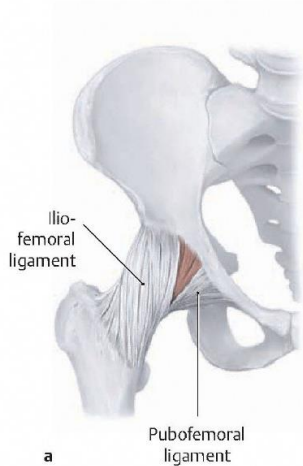
c

#### D Rotational deformities of the femoral neck

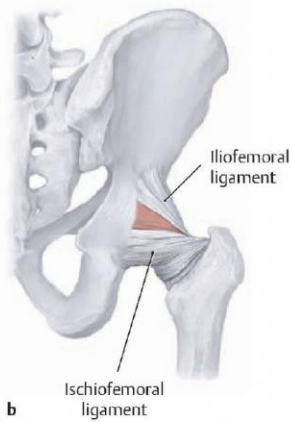
Right hip joint, superior view.

- a A normal anteversion angle of approximately 12 degree with the foot directed forward.
- b An increased anteversion angle (coxa anteverta).
- c The femoral neck is retroverted (coxa retroverta).

# Dislocation (Luxation)

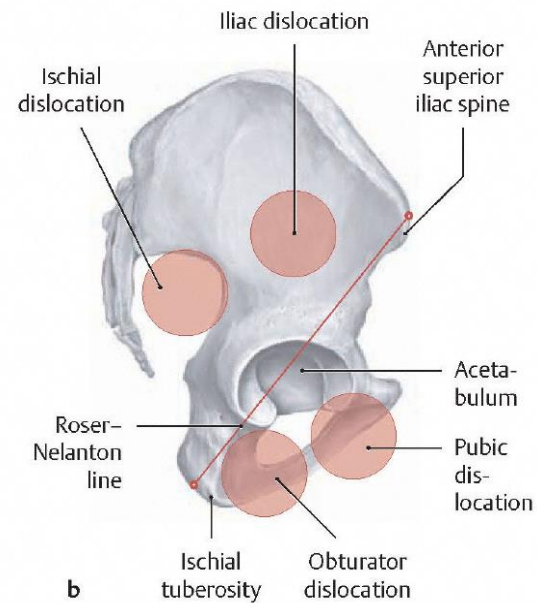


**D Weak spots in the capsule of the right hip joint**



**D Weak spots in the capsule of the right hip joint**

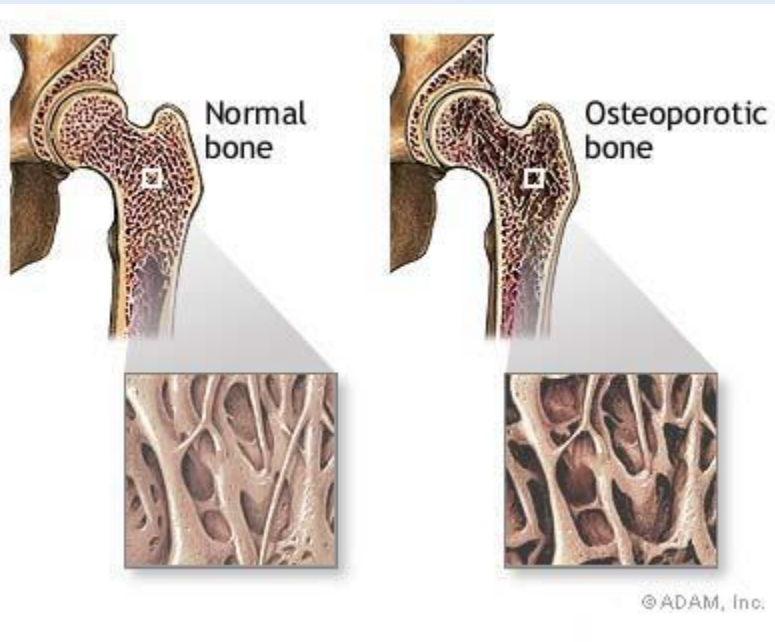
b Posterior view.



**E Traumatic dislocation of the hip**

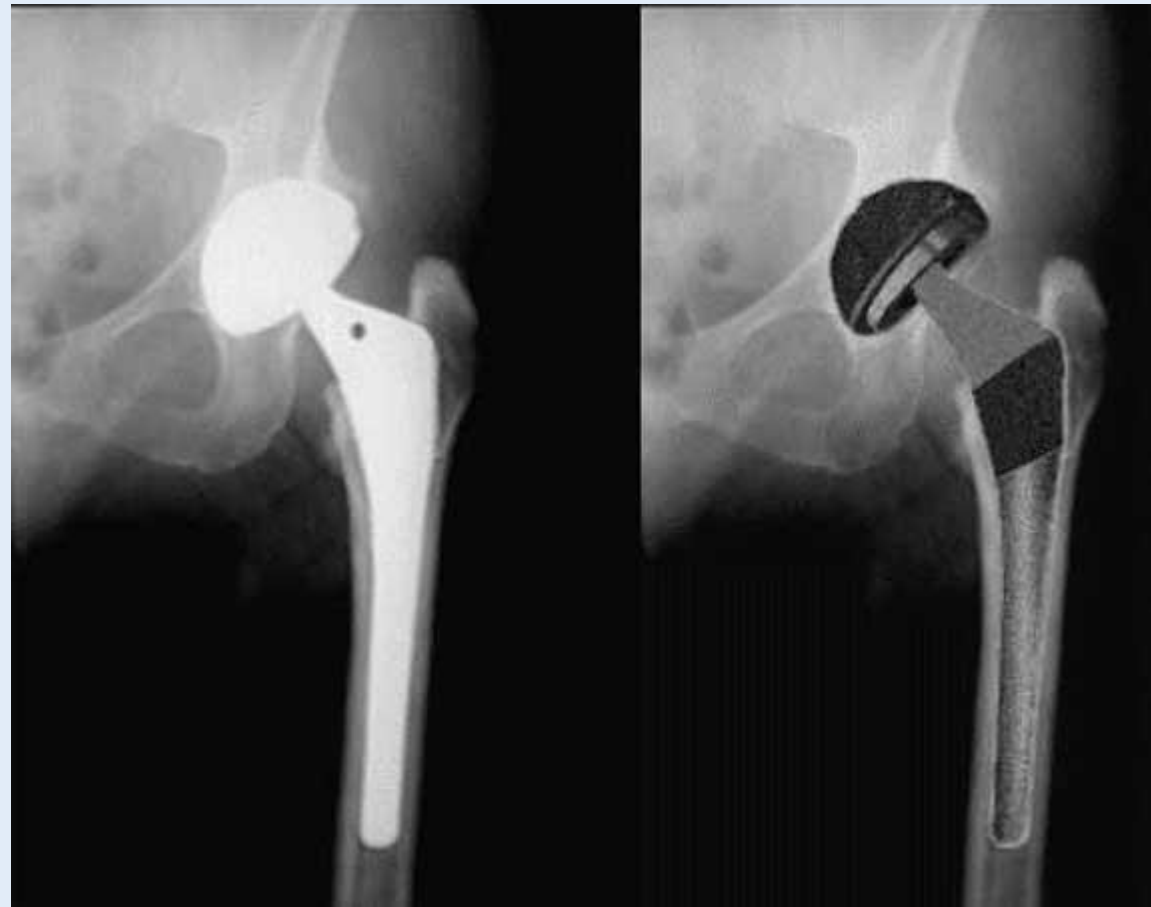
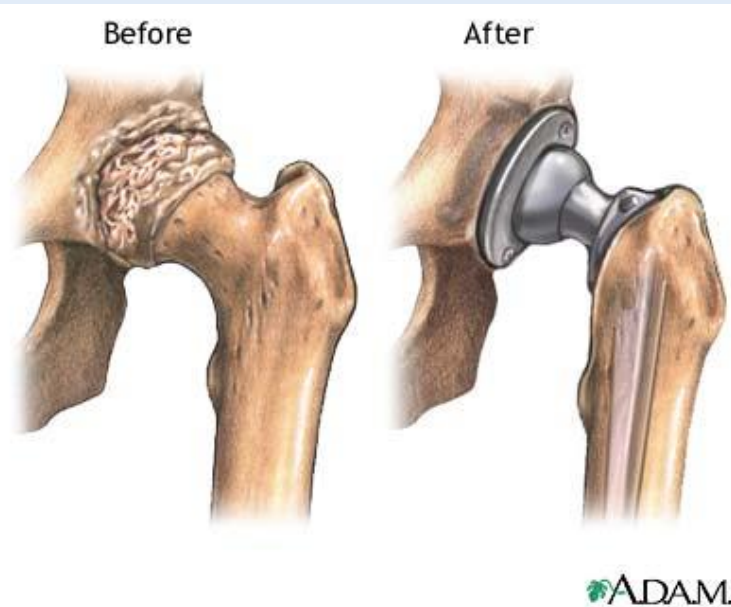


# Osteoporosis, fracture

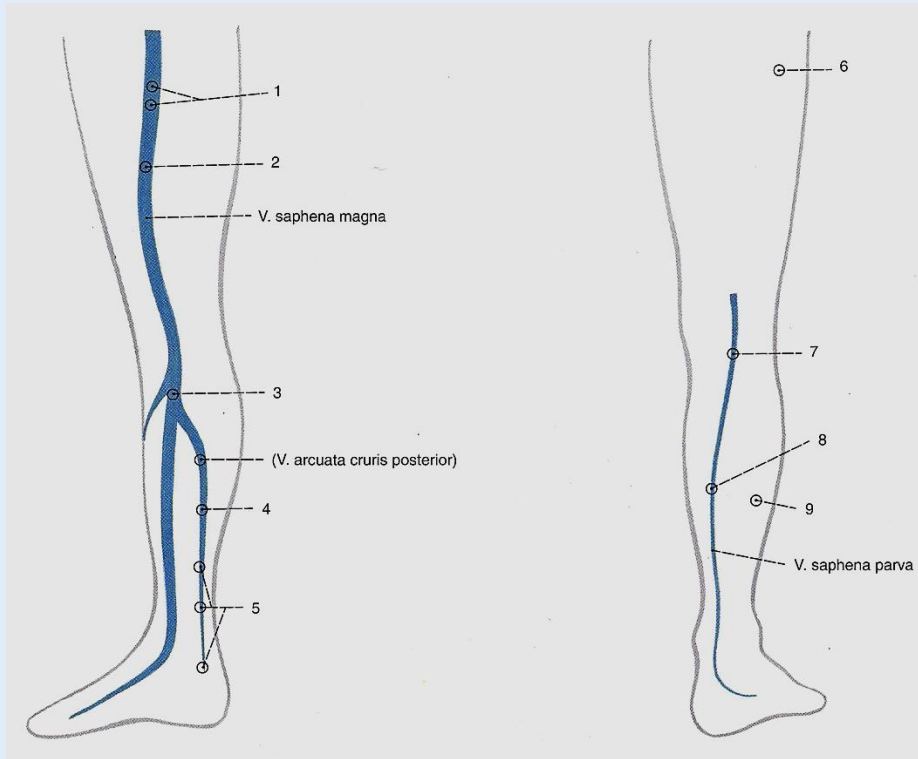


pregnancy, substitution of  $\text{Ca}^{++}$ !!!

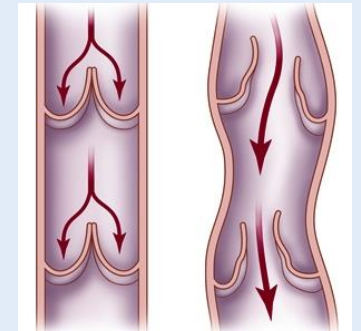
# Coxarthrosis, hip replacement



# Venous drainage

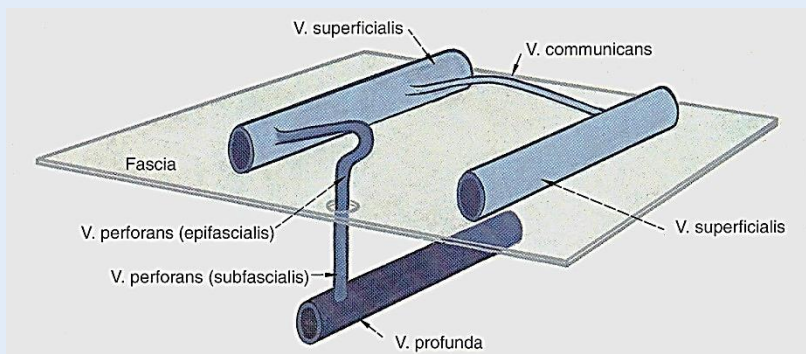


- Venous reflux conditioned by:
1. Anastomosis between e.g. skin- and deep Veins (Perforating)
  2. Muscelpumps
  3. Valves



## Perforating (e.g.):

1. Dodd
2. Hunter
3. Boyd
4. Sherman
5. Cocket



# Veins

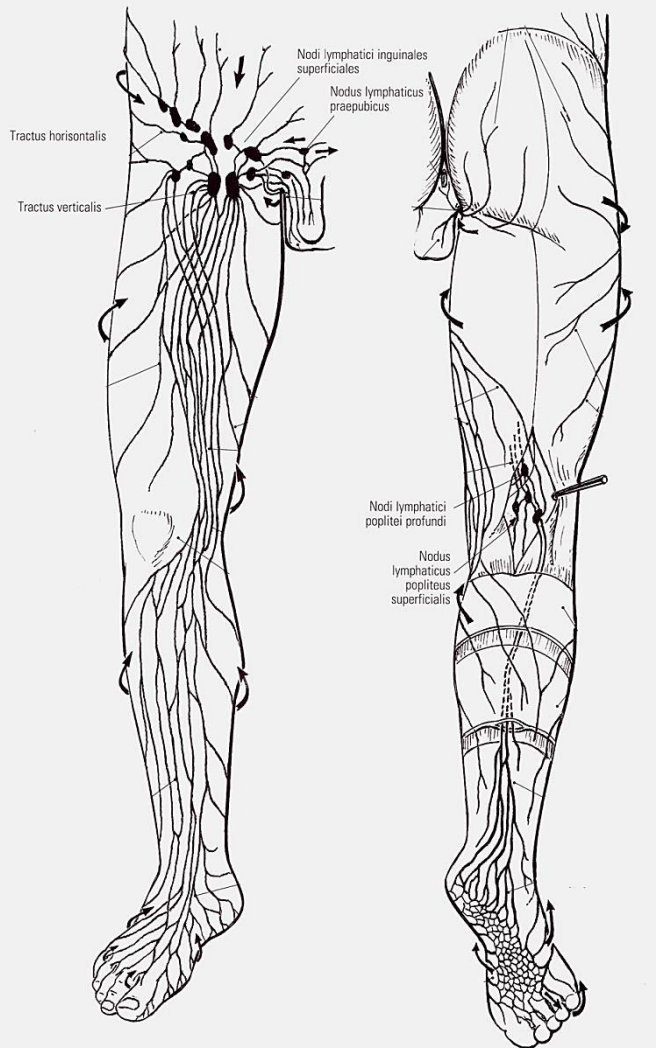


# Varicosity





# Lymphatic vessels

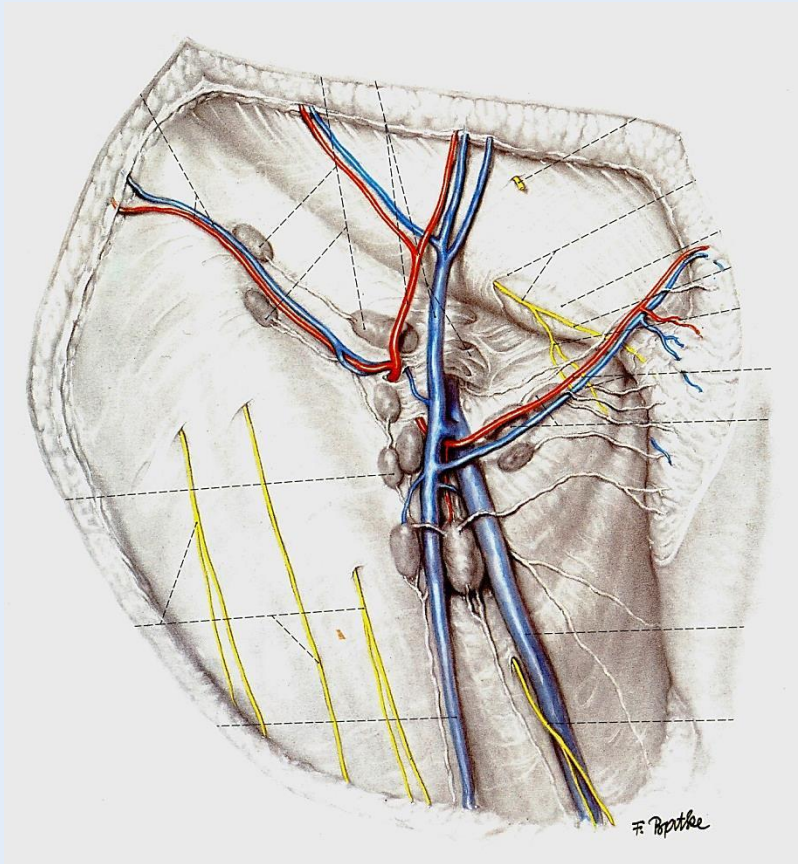


Deep (for Muscles, Tendons and Joints)  
and superficial (for subcutaneous tissues and skin)  
Lymphatic vessels

Below the knee: dorsolateraler and ventromedialer flow  
To the sup. and deep popliteal lymphnodes

Above the knee: dorsolateraler, dorsomedialer and ventro-  
medialer flow  
to the sup. and deep inguinal lymphnodes

# Lymphatic flow



Characteristic T-shape of the inguinal lymph nodes:

*Tractus horizontalis* (drainage from the outer genitals, perineum, anal part of the rectum, lower part of the rectus abdominis muscle, abdominal wall below the navel!!!)

*Tractus verticalis* (beside the rectus abdominis muscle and the outer genitals: lower limb)

By adults 1,5-2 cm large lymph nodes

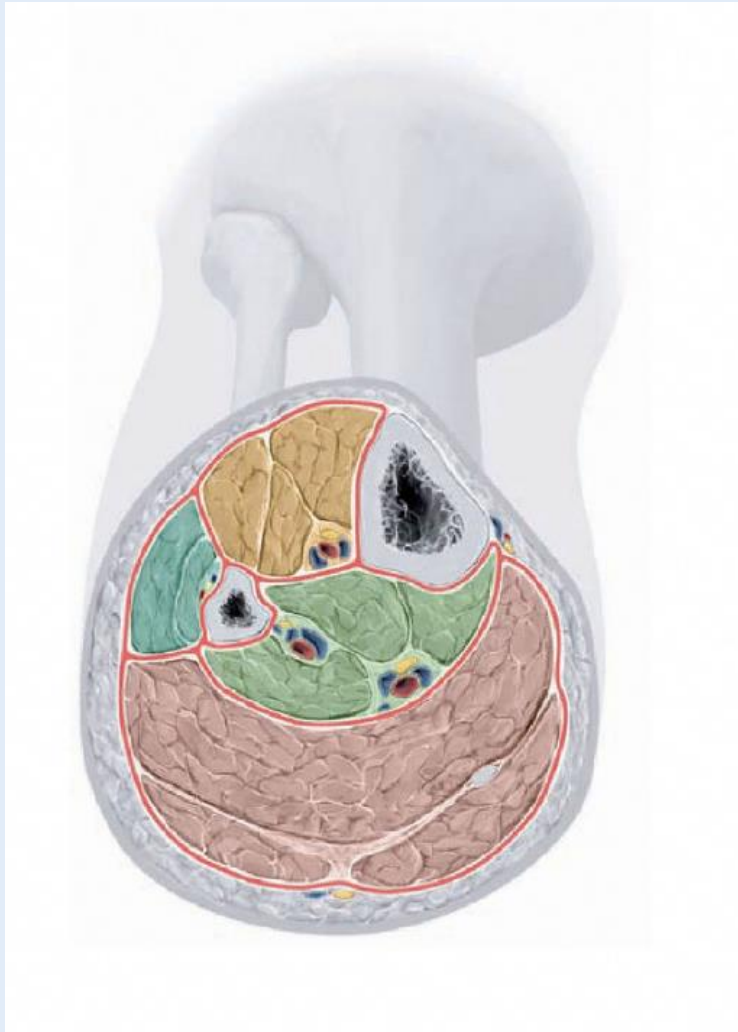
# Lymphatic flow



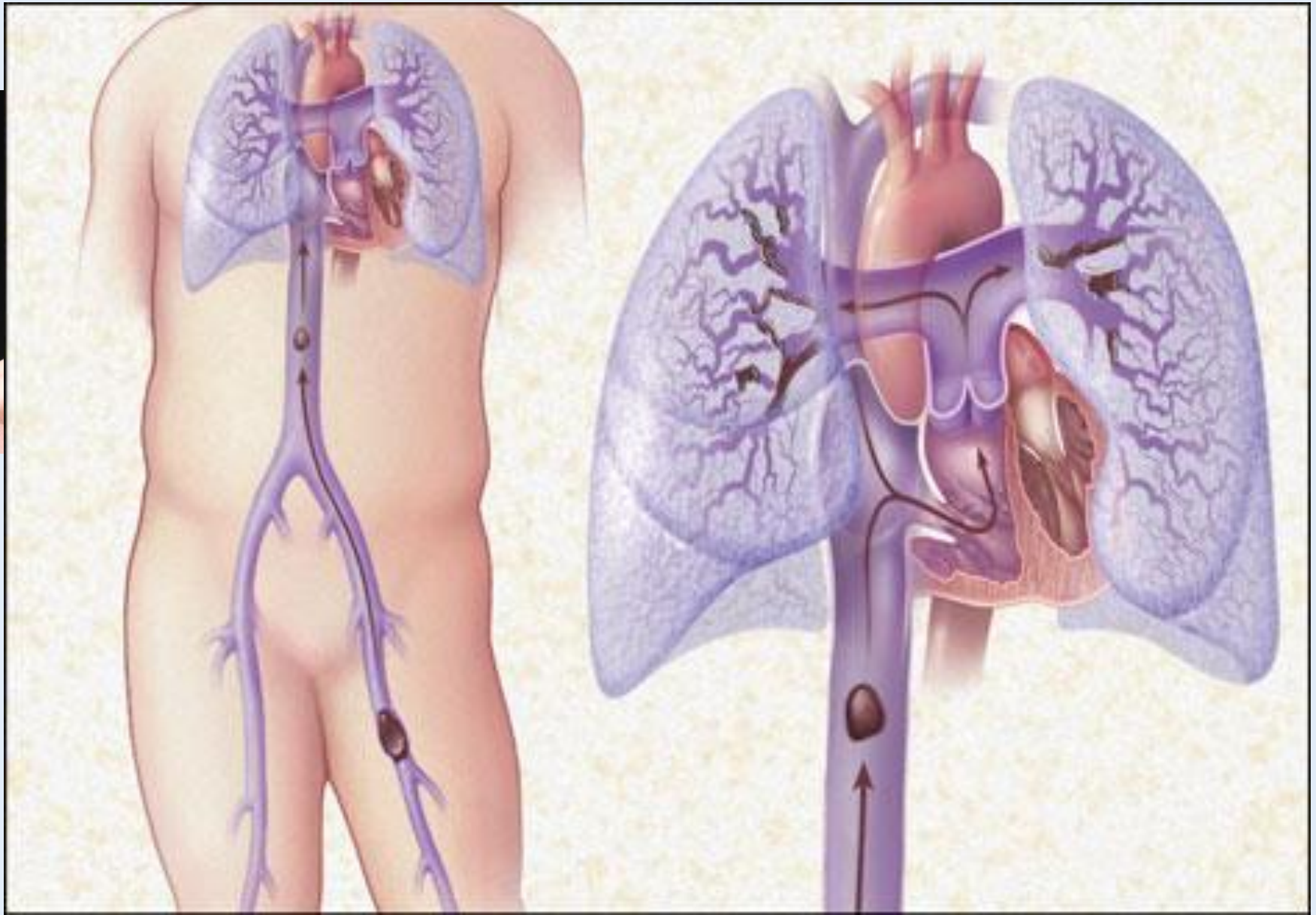
Extreme Lymphoedema:  
*Elephantiasis*



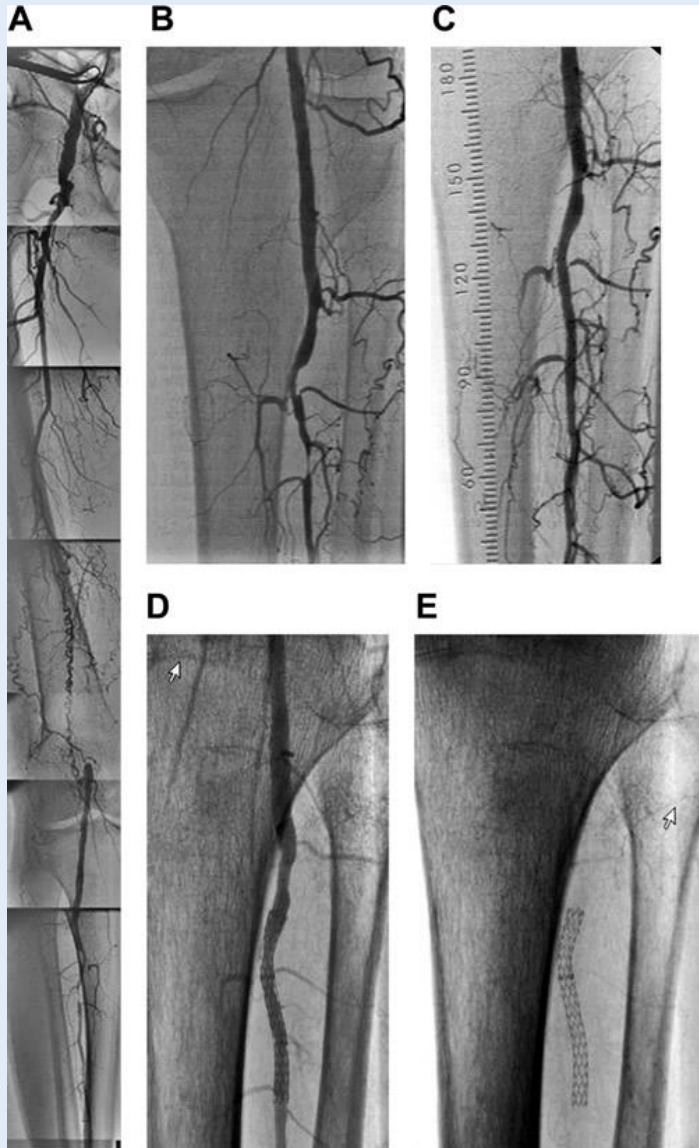
# Compartment syndrome



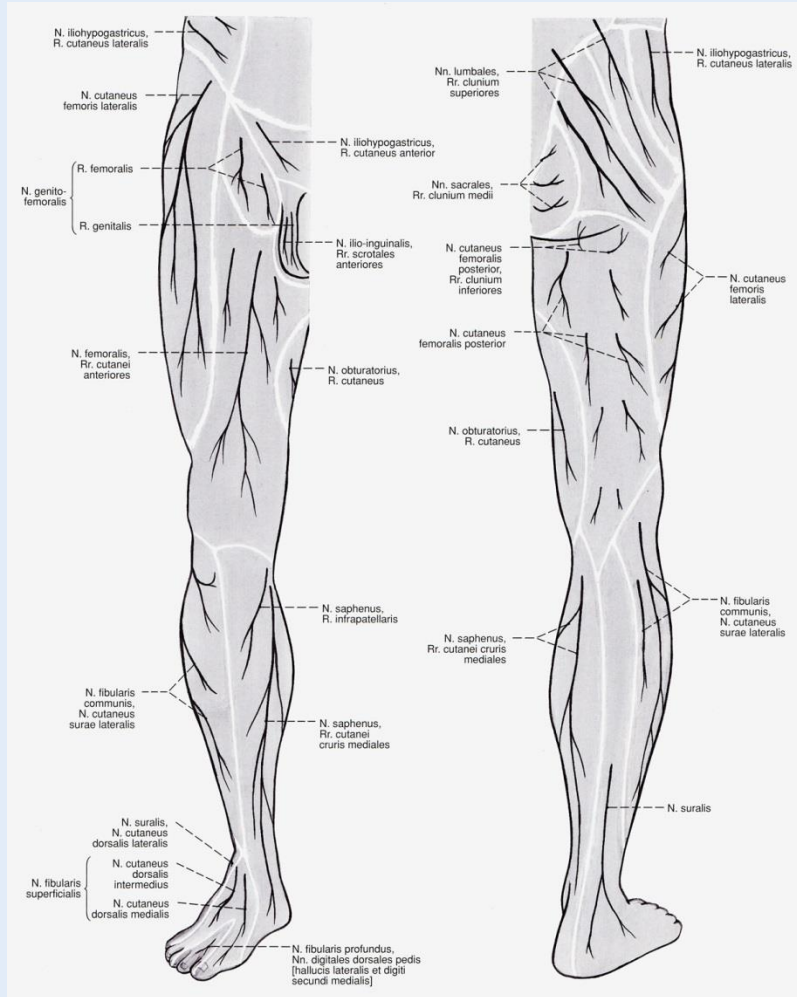
# Deep venomous thrombosis



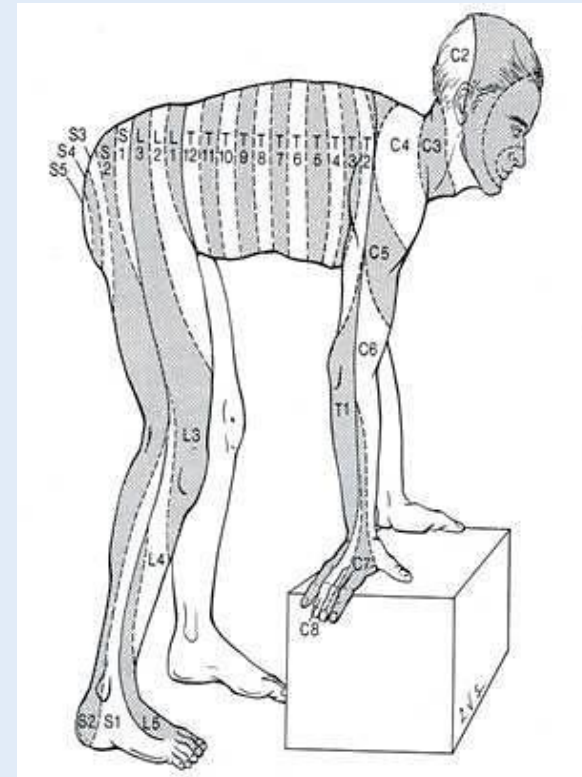
# Stenosis, diabetes



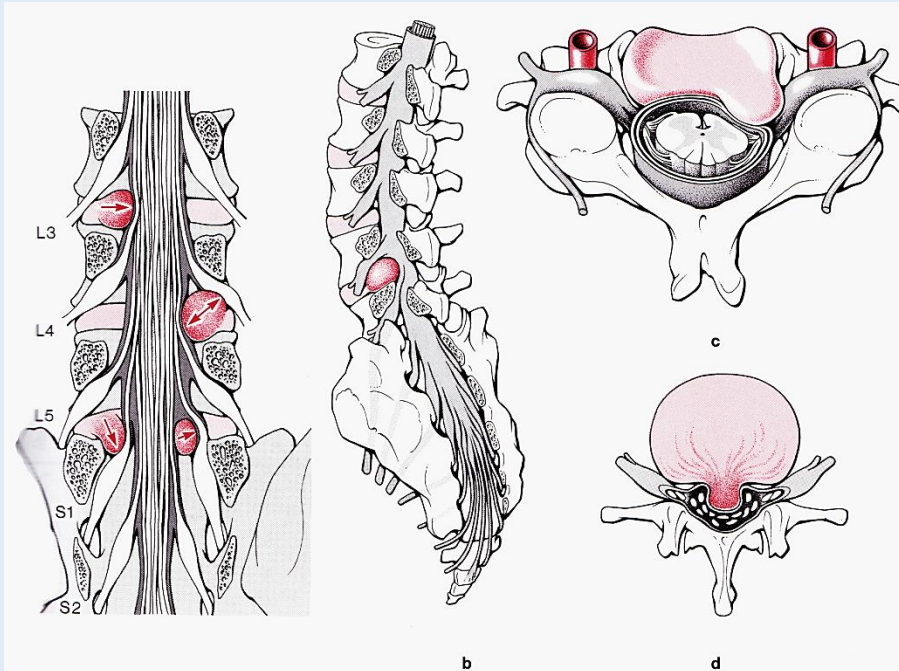
# Innervation







# Dermatoms



# Innervation

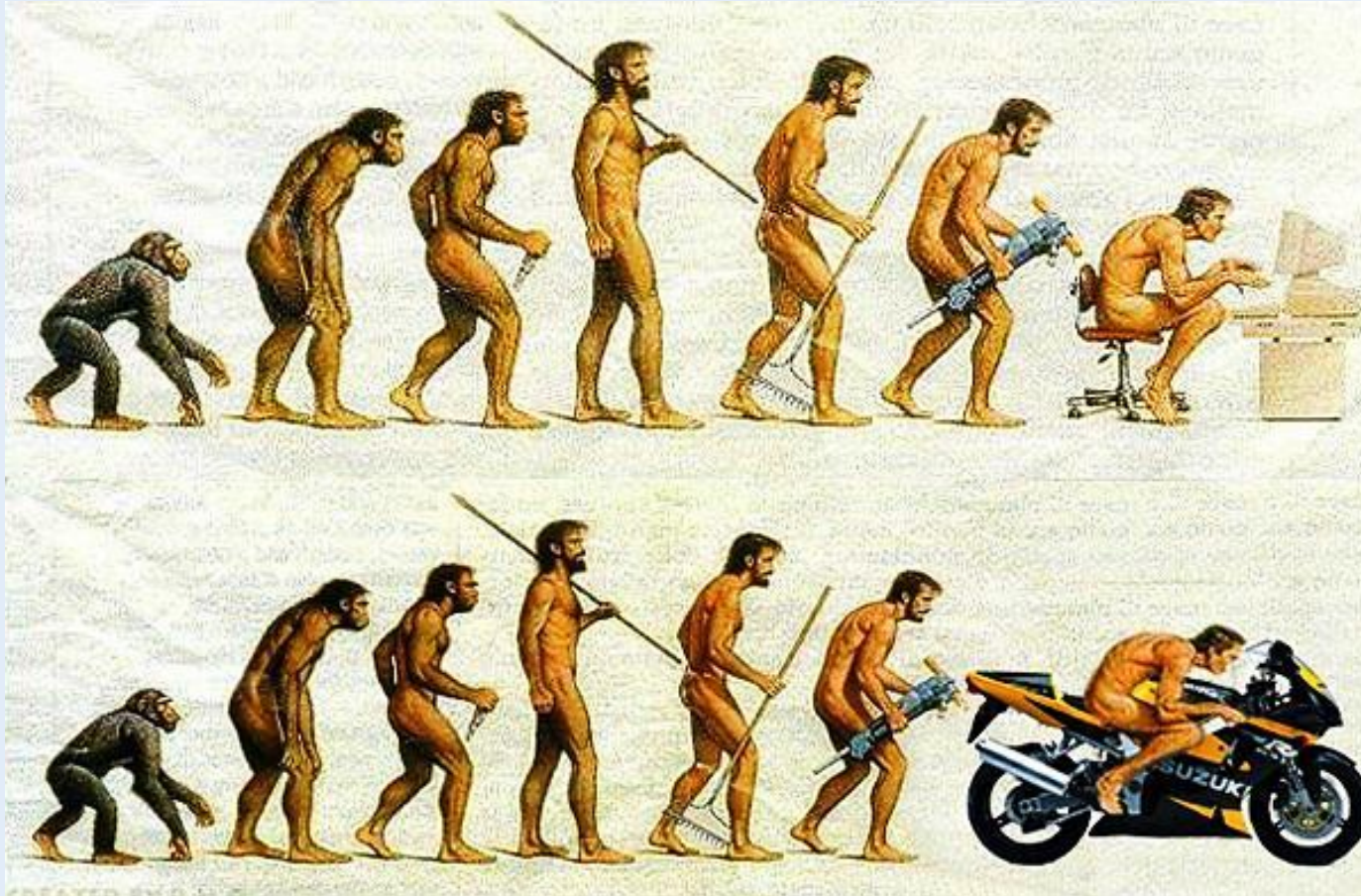


Syndrom	Parese	Neurologische Ausfälle		
		Reflexverlust	Dermatom	
L 3	M. quadriceps femoris, auch M. iliopsoas	PSR	Vom Trochanter major über den Oberschenkel nach medial bis zum Knie	
L 4	Mm. quadriceps und tibialis anterior	PSR	Über die Hüfte und den lateralen Oberschenkel auf den medialen Knöchel zu	
L 5	Mm. extensor hallucis longus und extensor digitorum brevis	TPR	Vom Oberschenkel zum Kniegelenk lateral, entlang der Schienbeinkante über die Dorsalseite des Fußes bis zur Großzehe und folgenden Zehe	
S 1	Mm. peronei triceps surae gluteus maximus	ASR	Hinterseite von Ober- und Unterschenkel zum äußeren Knöchel und Fußrand, Kleinzehenbereich und Fußsohle lateral	



# Gait mechanism

Walking: ca. 5 million years ago



# The mechanism of walking

Walk ↔ Run

Human: bipeder

Quadrupets: quadrupeder a) amble

b) cloister

Average walking speed:  $\sim 5 \text{ km/h} = 1,4 \text{ m/s}$

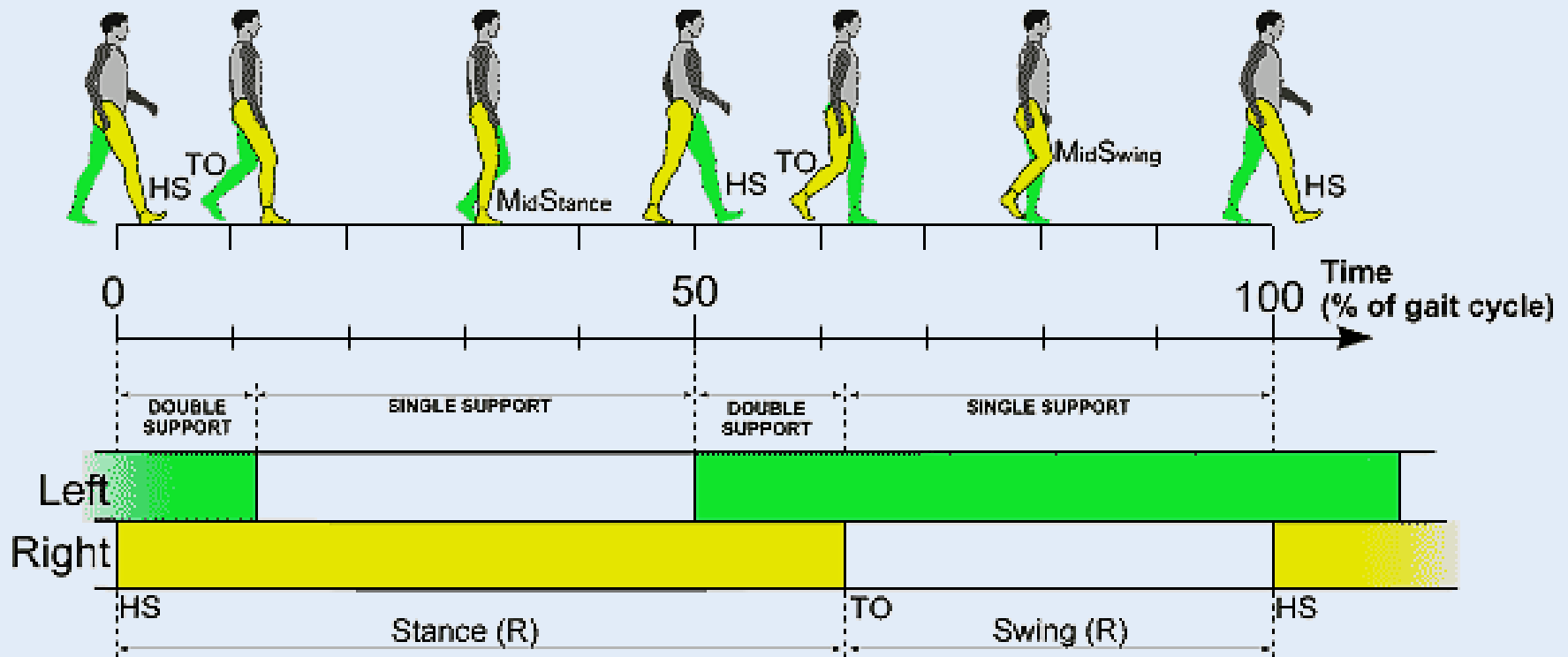
Embrional and learned elements must work automatically together

Syncro of the ipsi- and kontralateral movements through the contractionthe corresponding muscle groups::

Autochtone mucleles of the back

Muscles of the upper and lower limbs

# The mechanism of walking



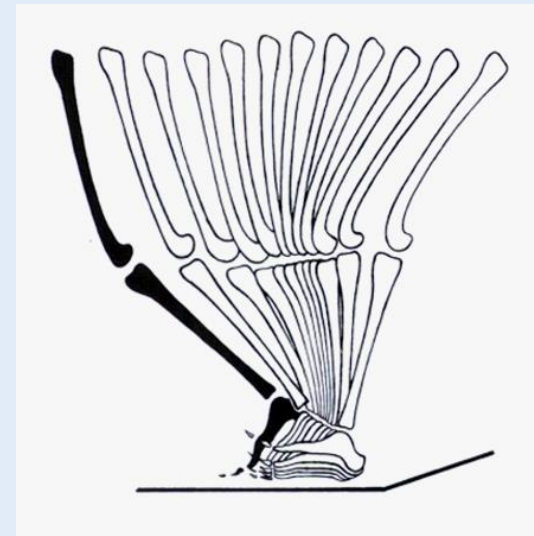
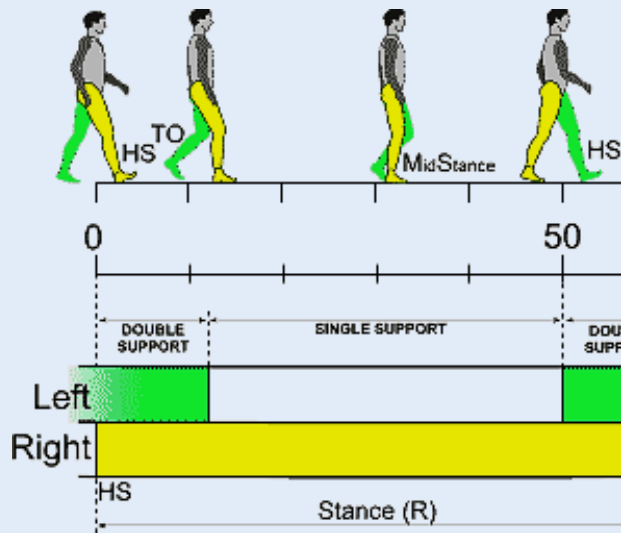
Walking glides in cycles (gait cycle), which can be divided into phases. A gait cycle means the repetitive sections of walking.

Phases of the gait cycle: Stance and Swing.

# The mechanism of walking

Stance phase (about 60% of the gait cycle) is divided into:

1. Weight transfer: from first contact to lifting the other leg
2. Medium stance phase: from standing on the whole foot to raising the heel
3. End phase: the other leg touches the ground



Standing leg: yellow

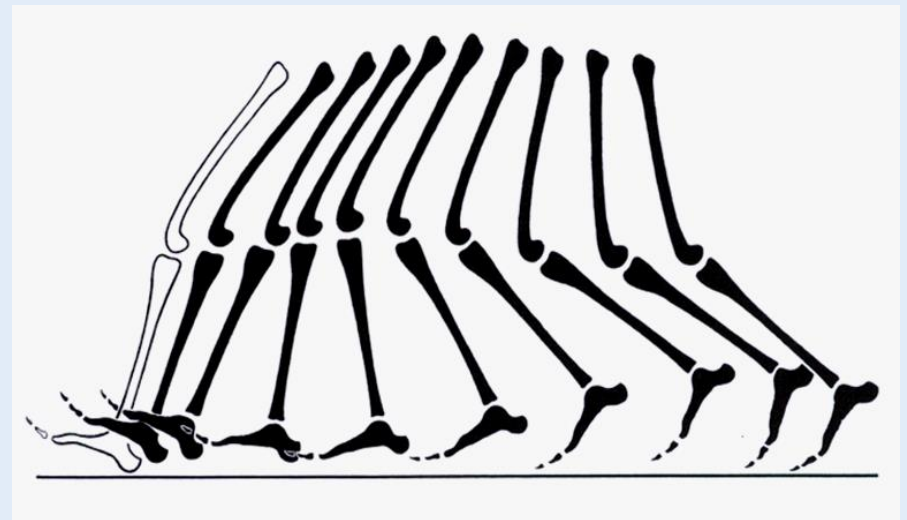
# The mechanism of walking

Swing phase (about 40% of the gait cycle) is divided into:

1. Start of swing: the swing leg passes the leg
2. Mid swing (mid swing): the lower leg is vertical above the ground
3. Final swing: lasts until the heel is put on

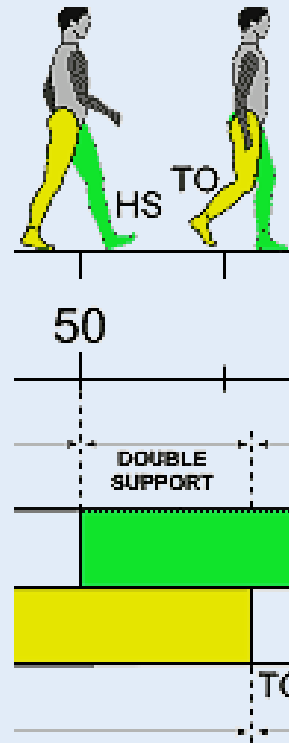


Walking leg: yellow



# The mechanism of walking

Phase of double support: both legs are on the floor  
(Overlap between stance and swing phase)



ca. 10% of the walking cycle

# The mechanism of walking

Muscle and joint activities while walking:

Standing leg:

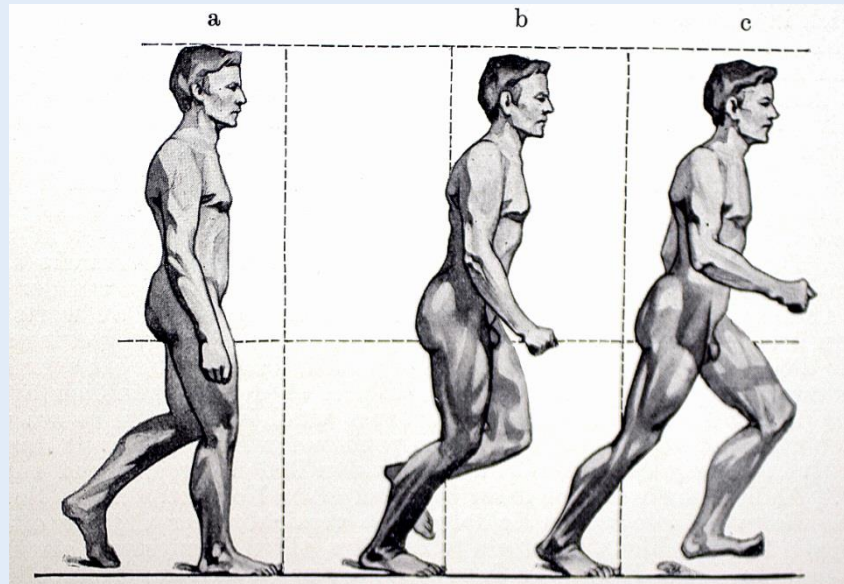
extension (hip and knee), plantar flexion in the upper ankle joint (flexor hallucis longus muscle)

Swing leg:

Anteflexion in hip and flexion in the knee joint;

at the end dorsiflexion of the upper ankle joint (tibialis anterior muscle)

Upper ankle joint is now stabilized by the geometry of the trochlea tali.



# The mechanism of walking

further events:

1. The lumbar lordosis is strengthened (assisting the hip flexion)
2. Weight transfer from the side of the walking leg to the supporting leg (M. gluteus medius and minimus see „waddle gear")
3. Upper extremities make an opposite pendulum motion

