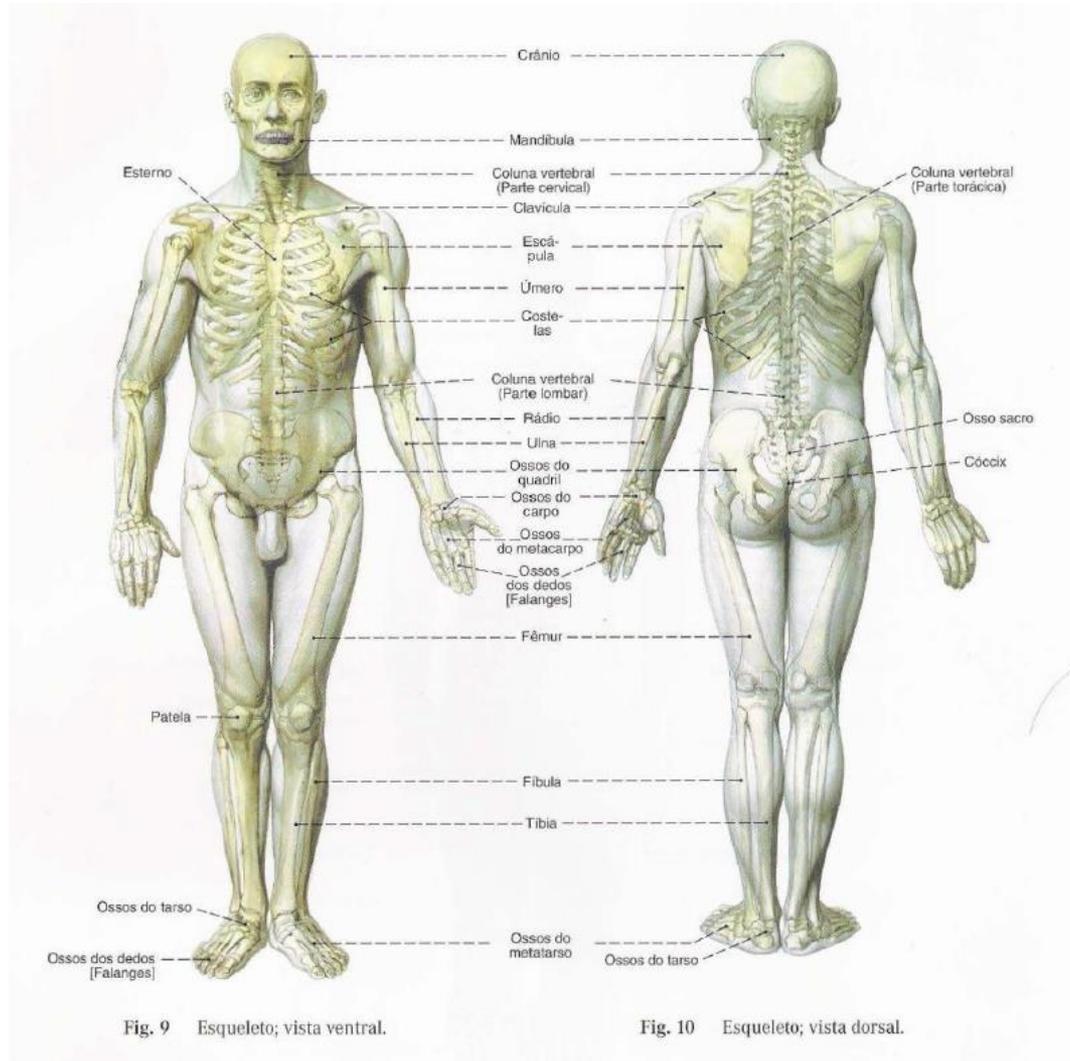
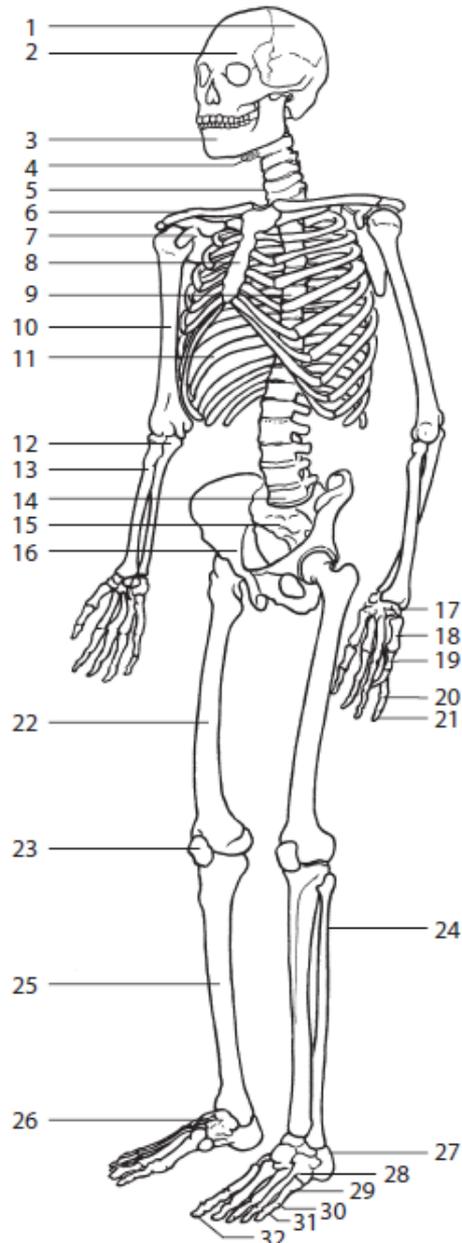


# MEA 0028 – Introdução à osteoarqueologia humana



# MEA 0028 – Introdução à osteoarqueologia humana



1. Paired cranial elements (22)
  2. Single cranial elements (5)
  3. Mandible (1)
  4. Hyoid (1)
  5. Cervical vertebrae (7)
  6. Clavicle (2)
  7. Scapula (2)
  8. Sternum (1)
  9. Thoracic vertebrae (12; var\*)
  10. Humerus (2)
  11. Ribs (24; var\*)
  12. Ulna (2)
  13. Radius (2)
  14. Lumbar vertebrae (5; var\*)
  15. Sacrum (1)
  16. Os coxae (2)
  17. Carpals (16)
  18. Metacarpals (10)
  19. Proximal hand phalanges (10)
  20. Intermediate hand phalanges (8)
  21. Distal hand phalanges (10)
  22. Femur (2)
  23. Patella (2)
  24. Fibula (2)
  25. Tibia (2)
  26. Talus (2)
  27. Calcaneus (2)
  28. Other tarsals (10)
  29. Metatarsals (10)
  30. Proximal foot phalanges (10)
  31. Intermediate foot phalanges (8)
  32. Distal foot phalanges (10)
- Coccyx (1; not visible)

TOTAL: 206 Adult

\* Commonly variable elements indicated by (var\*)

# 206

# Termos direcionais

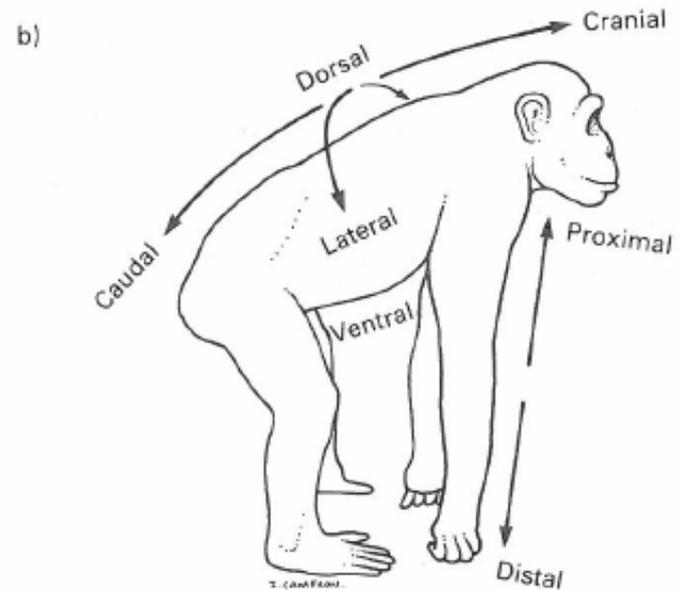
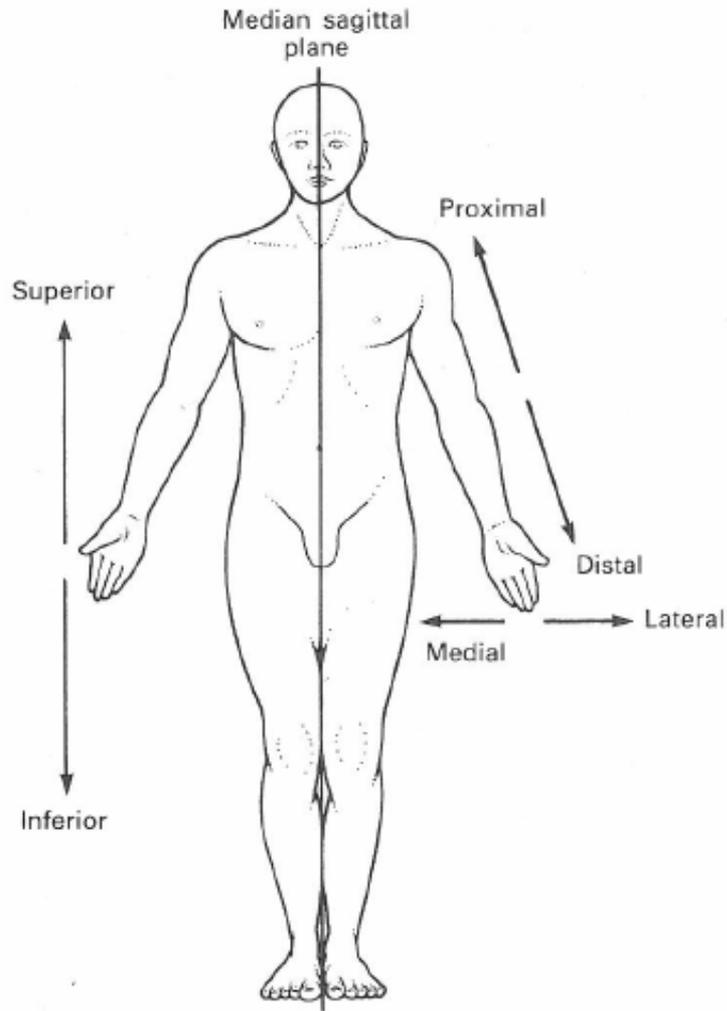
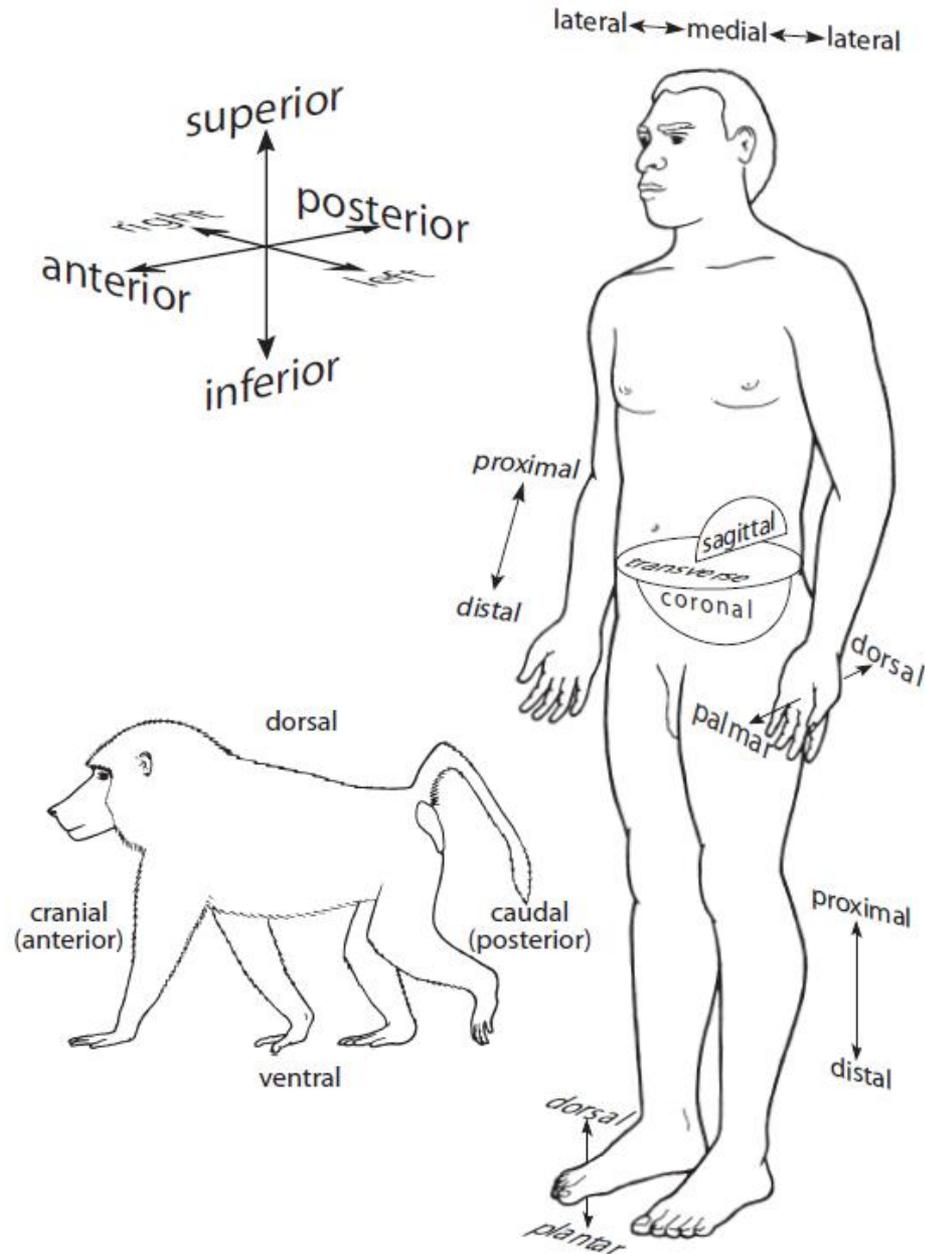


FIGURE 2.1 (a) *The anatomical position.* (b) *The habitual position in a quadrupedal primate with equivalent terms indicated.*

# Termos direcionais



# Termos direcionais

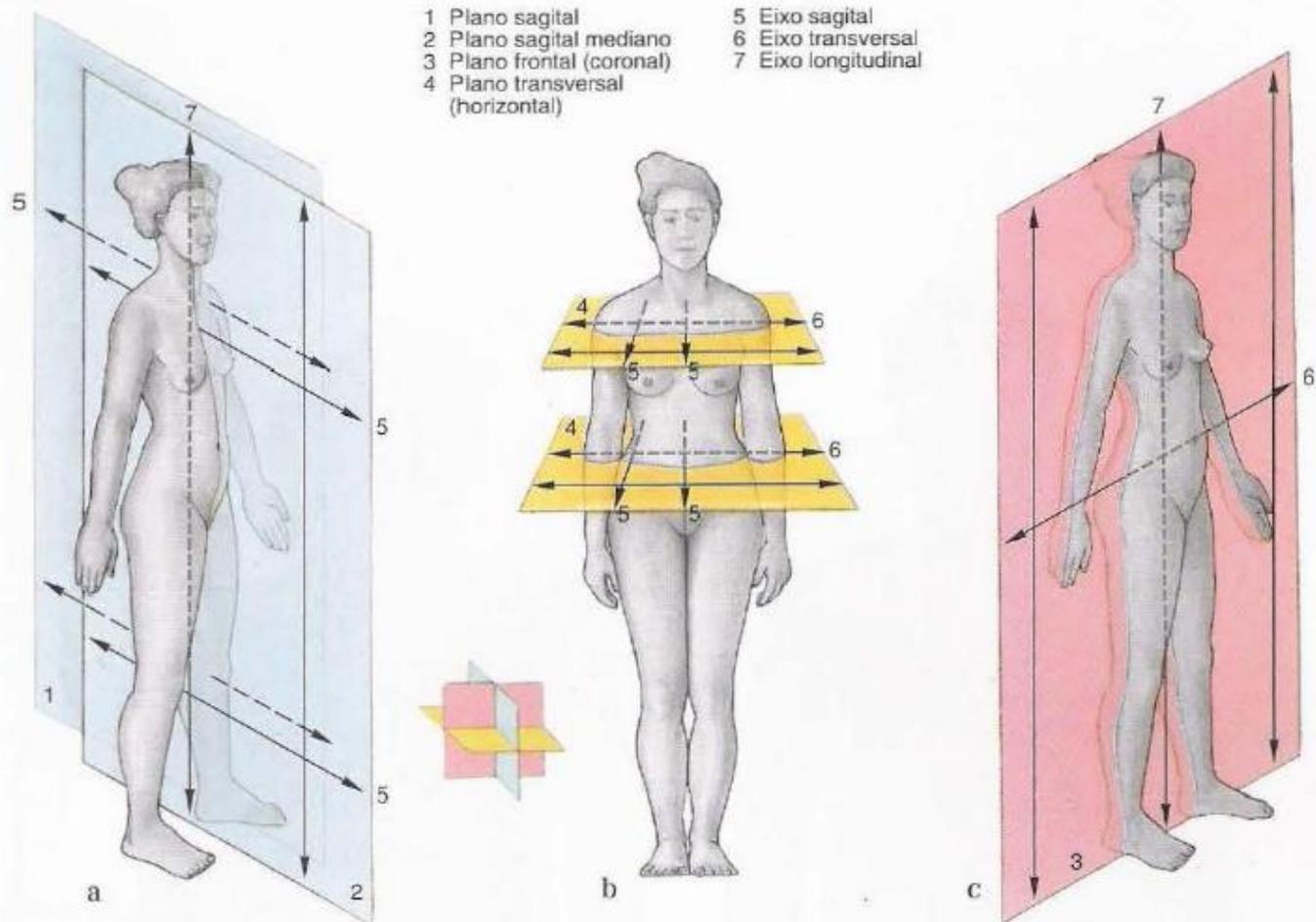


Fig. 1 a-c Planos e eixos do corpo humano.

a Plano sagital, eixos sagital e longitudinal

b Plano transversal (= plano horizontal), eixos transversal e sagital

c Plano frontal (= plano coronal), eixos longitudinal e transversal

# Termos direcionais

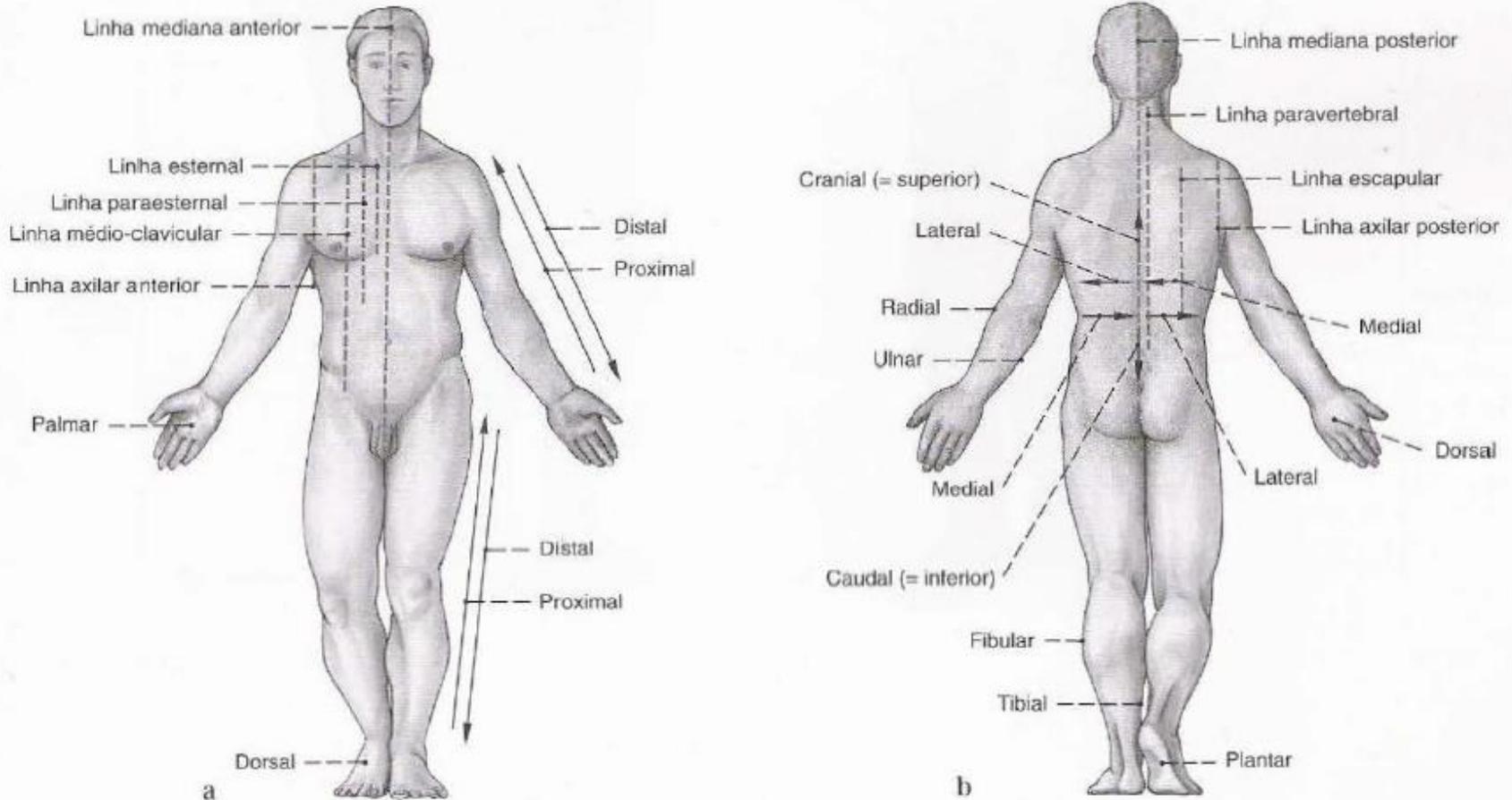


Fig. 2 a, b Linhas de orientação, bem como de direção e indicação de posição no corpo humano.  
a Vista ventral (= anterior)  
b Vista dorsal (= posterior)

# Termos direcionais

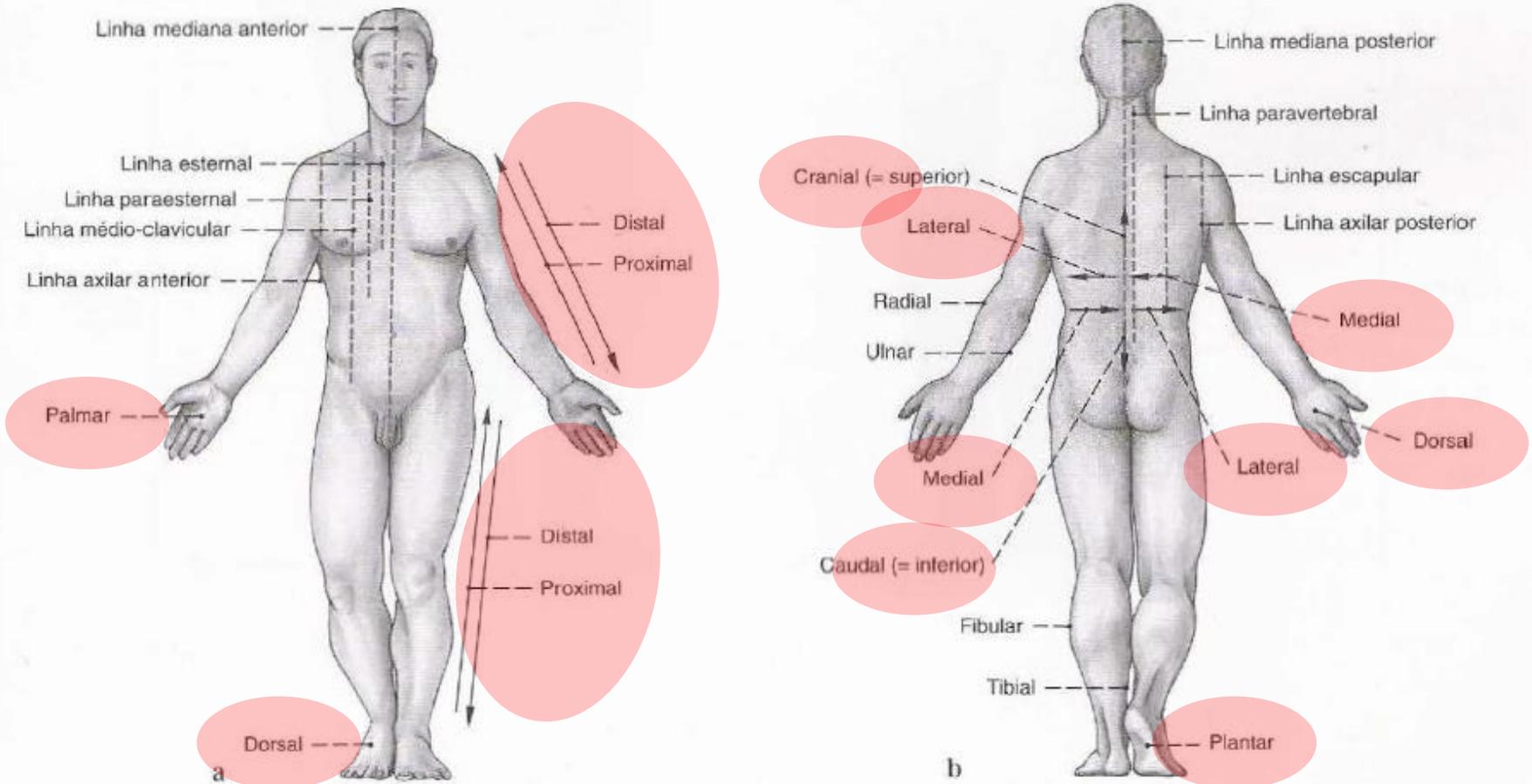


Fig. 2 a, b Linhas de orientação, bem como de direção e indicação de posição no corpo humano.  
a Vista ventral (= anterior)  
b Vista dorsal (= posterior)

# Termos direcionais

- a. **Superior:** toward the head end of the hominid body. The *superior* boundary of the human parietal bone is the sagittal suture. **Cephalic** and **cranial** are synonymous terms that may be used homologously for bipeds and quadrupeds.
- b. **Inferior:** opposite of superior; for hominids, body parts away from the head. The *inferior* surface of the calcaneus, or heel bone, is the part of the bone that rests nearest to, or lies in contact with, the ground. **Caudal**, toward the tail, is often used in the description of quadrupedal anatomy.
- c. **Anterior:** toward the front of the hominid body. The breastbone, or sternum, is located *anterior* to the backbone, or vertebral column. **Ventral**, toward the belly, may be used homologously for bipeds and quadrupeds.
- d. **Posterior:** opposite of anterior; for hominids, toward the back of the individual. The occipital bone is on the *posterior* and inferior end of the skull. **Dorsal** is often used for homologous parts of the quadruped anatomy.
- e. **Medial:** toward the midline. The left side of the tongue is *medial* to the left half of the mandible.
- f. **Lateral:** opposite of medial; away from the midline. The thumb occupies a *lateral* position relative to the little finger in standard anatomical position.
- g. **Proximal:** nearest the axial skeleton, usually used for limb bones. The *proximal* end of the upper arm bone, the humerus, is the end toward the shoulder.
- h. **Distal:** opposite of proximal; farthest from the axial skeleton. The *distal* end of the terminal foot phalanx fits into the front end of a shoe.

# Termos direcionais

- i. **External:** outer. The cranial vault is an *external* covering of the brain.
- j. **Internal:** opposite of external; inside. The *internal* surface of the parietal is marked by a set of grooves made by blood vessels that lie external to the brain.
- k. **Endocranial:** inner surface of the cranial vault. The brain fills the *endocranial* cavity.
- l. **Ectocranial:** outer surface of the cranial vault. The temporal line is on the *ectocranial* surface of the parietal.
- m. **Superficial:** close to the surface. The ribs are *superficial* to the heart.
- n. **Deep:** opposite of superficial; far from the surface. The dentine core of a tooth is *deep* to the enamel.
- o. **Subcutaneous:** just below the skin. The anteromedial surface of the tibia is *subcutaneous*.

# Termos direcionais

## 6.2.3 Hands and Feet

- a. **Palmar:** palm side of the hand. The *palmar* surface of the digits bears fingerprints.
- b. **Plantar:** sole of the foot. The *plantar* surface of the foot contacts the ground during normal walking.
- c. **Dorsal:** top of the foot or the back of the hand. The *dorsal* surfaces of hands and feet often bear hair, whereas the palmar and plantar surfaces do not.

# Termos direcionais

Os termos que se seguem designam a posição dos órgãos e partes do corpo e suas relações uns com os outros em referência à posição anatômica, i. é., o corpo humano na posição ereta, olhando para o horizonte, os pés juntos, os braços ao longo do corpo com as palmas das mãos voltadas para a frente. Estes termos não se referem somente à anatomia humana, mas também à prática médica e à anatomia comparativa.

## Termos gerais

*Anterior-posterior* = na frente-atrás (p. ex., Artérias tibiais anterior e posterior)

*Ventral-dorsal* = em direção ao ventre-em direção ao dorso (sinônimo de anterior-posterior)

*Superior-inferior* = acima-abaixo (p. ex., conchas nasais superior e inferior)

*Cranial-caudal* = em direção à cabeça-em direção à cauda

*Direito-esquerdo* (p. ex., Artérias ilíacas comuns direita e esquerda)

*Interno-externo* = situado dentro-situado fora (em relação a uma cavidade)

*Superficial-profundo* = localizado superficial ou profundamente em relação à superfície (p. ex., Músculos flexores superficial e profundo dos dedos)

*médio\** = que está entre duas estruturas, uma superior e outra inferior ou uma anterior e outra posterior, ou uma superficial e outra profunda (p. ex., concha nasal média, entre as conchas nasais superior e inferior)

*intermédio\** = que está entre duas estruturas, uma lateral e outra medial ou direita-esquerda (p. ex., V. hepática intermédia entre as Vv. hepáticas direita e esquerda)

*mediano* = localizado na linha mediana (p. ex., a fissura mediana anterior da medula espinal). O plano *mediano* é o plano que corta o corpo humano em metades direita e esquerda

*medial-lateral* = localizado próximo ou longe do plano mediano do corpo (p. ex., fossas inguinais medial e lateral)

*frontal* = localizado no plano frontal ou em relação à frente (p. ex., processo frontal da maxila)

*longitudinal* = que corre longitudinalmente, paralelo ao eixo longo (p. ex., M. longitudinal superior da língua)

*sagital* = localizado em um plano sagital

*transversal* = situado em um plano transversal (p. ex., fásia transversal)

*transverso* = que corre transversalmente (p. ex., processo transverso da vértebra torácica)

## Termos de direção e posição para os membros

*Proximal-distal* = localizado perto ou longe da raiz de um membro ou origem de uma estrutura (p. ex., Articulações rádio-ulnares proximal e distal)

para o membro superior:

*radial-ulnar* = situado no lado do rádio ou da ulna (p. ex., Artérias radial e ulnar)

para a mão:

*palmar-dorsal* = em relação à palma ou dorso da mão (p. ex., aponeurose palmar; M. interósseo dorsal)

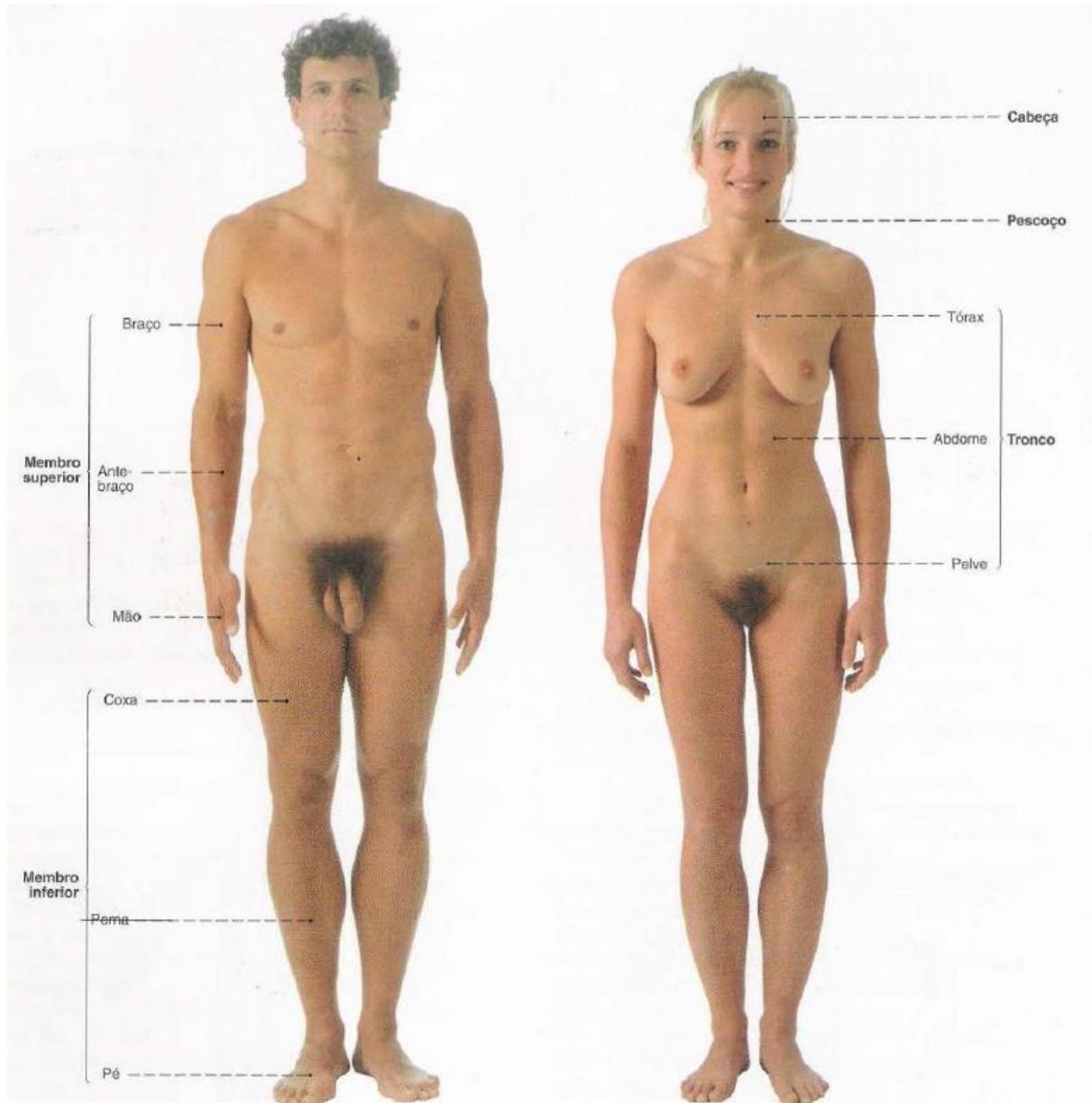
para o membro inferior:

*tibial-fibular* = situado no lado da tibia ou da fíbula (p. ex., A. tibial anterior)

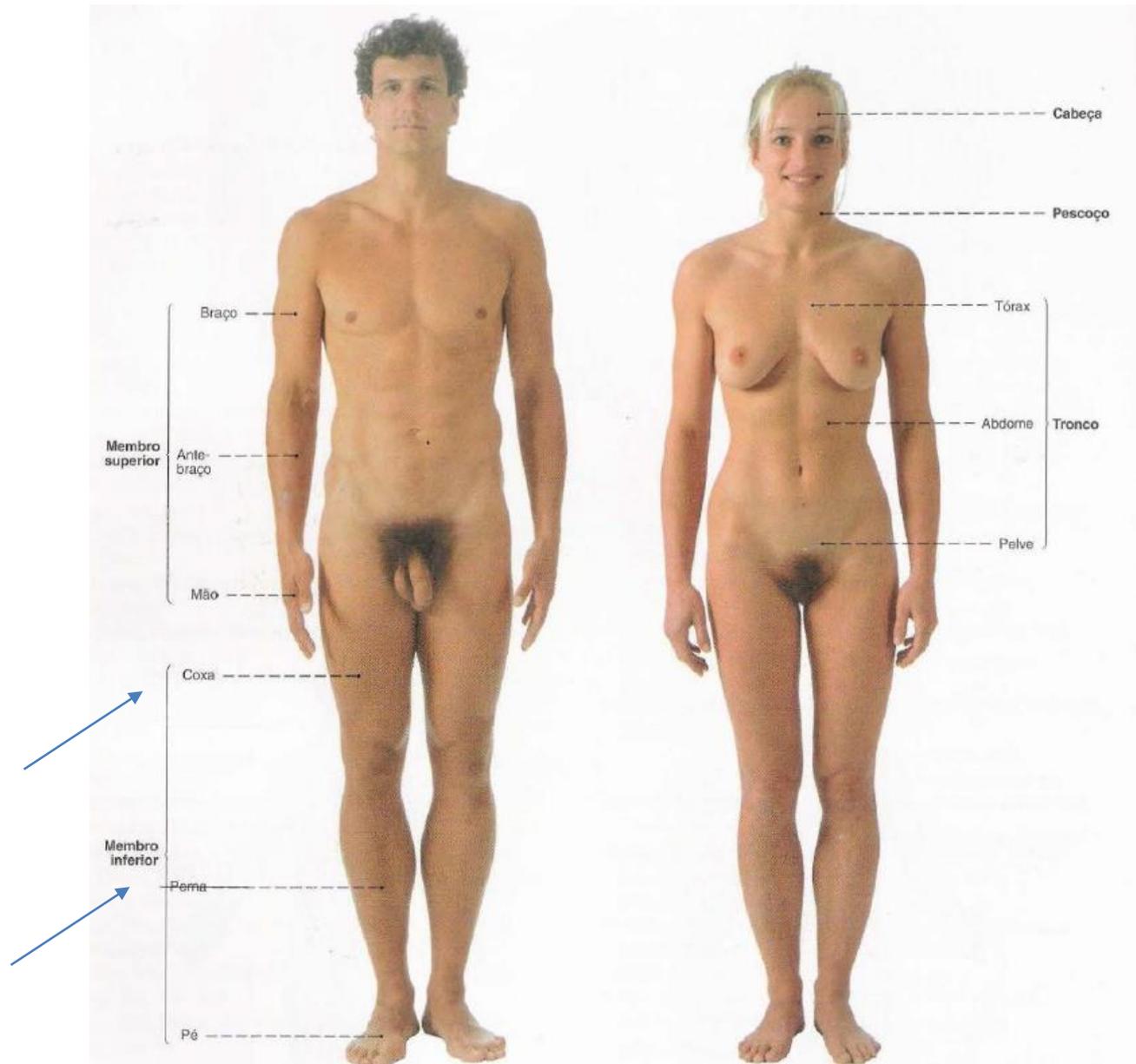
para o pé:

*plantar-dorsal* = em relação à planta ou dorso do pé (p. ex., Aa. plantares lateral e medial, A. dorsal do pé)

# Partes do corpo

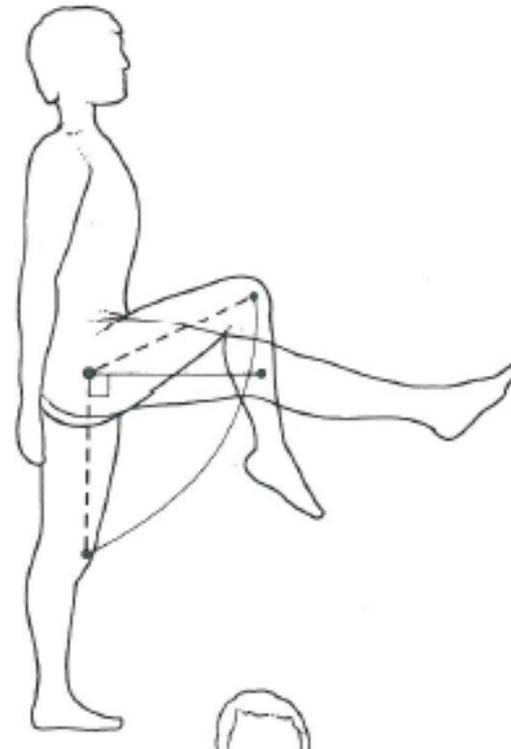
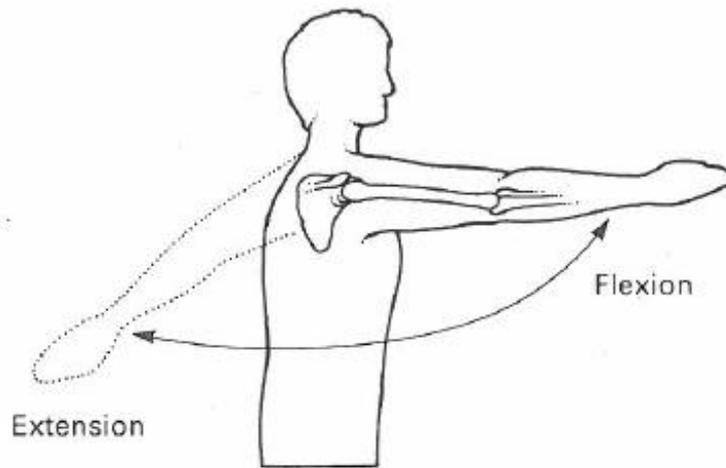


# Partes do corpo



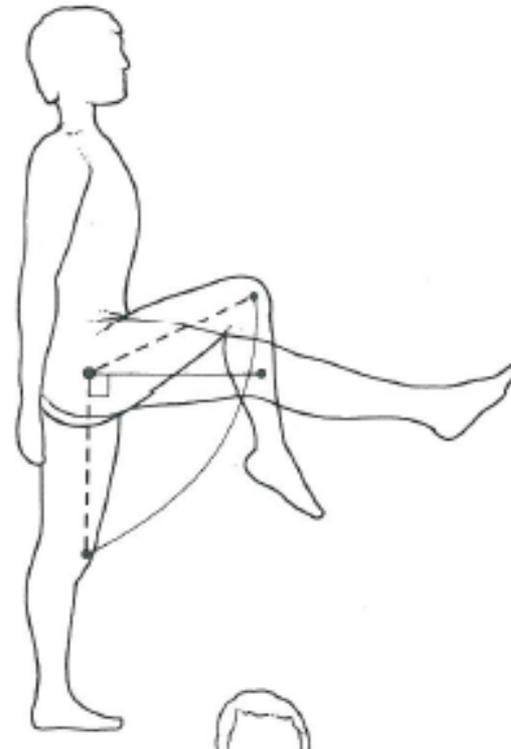
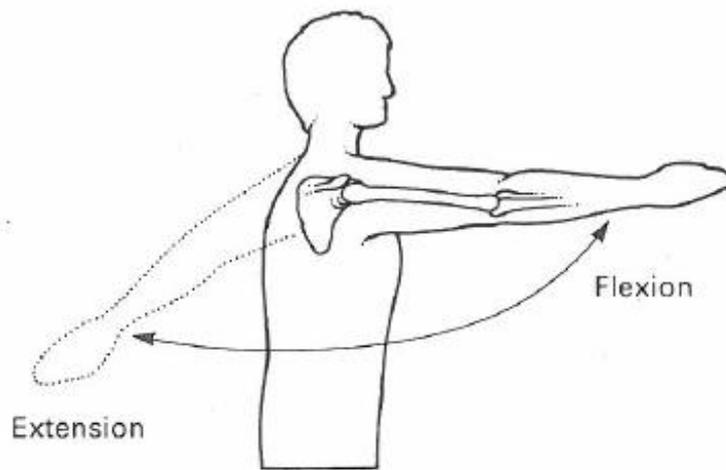
# Movimentos do corpo

**Flexion:** generally, a bending movement that decreases the angle between body parts. When a hand is clenched into a fist there is strong *flexion* of the phalanges on the metacarpal heads. By convention, flexion at the shoulder or hip joint refers to a ventral (forward) movement of the limb.



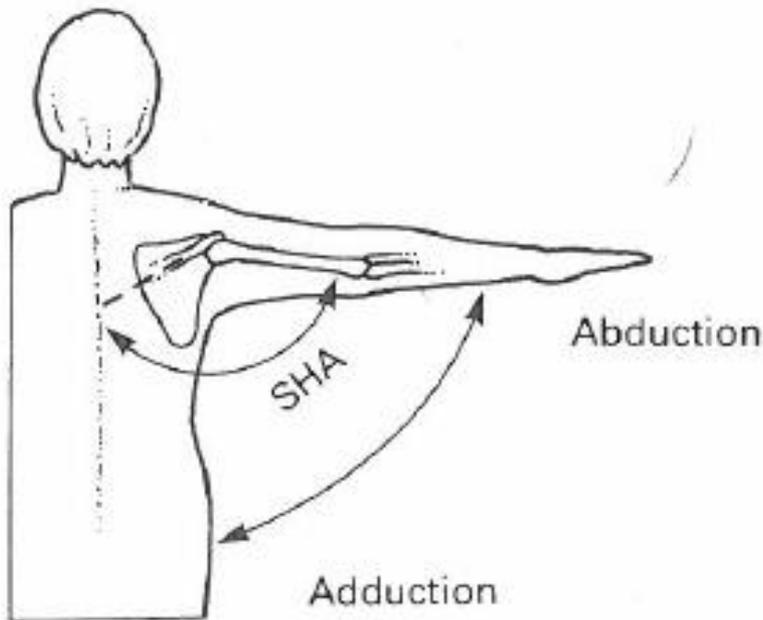
# Movimentos do corpo

**Extension:** opposite of flexion; a straightening movement that increases the angle between body parts. The classic karate chop is made by a rigid hand in which the fingers are extended. By convention, *extension* at the shoulder or hip joint is a dorsal (backward) swing of the limb.



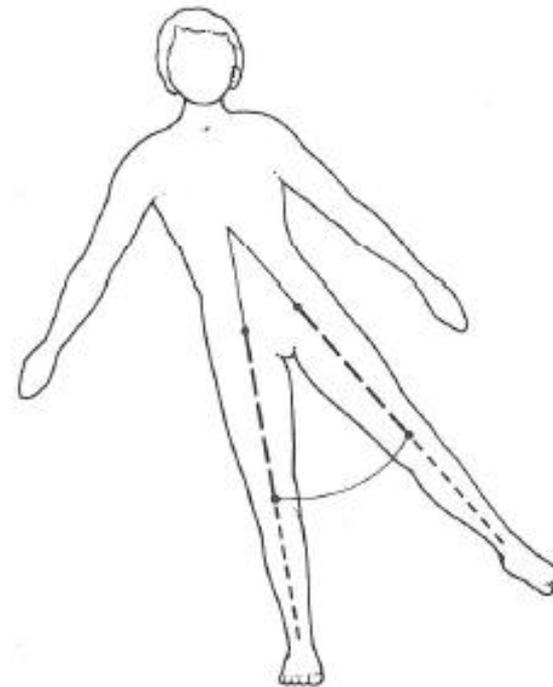
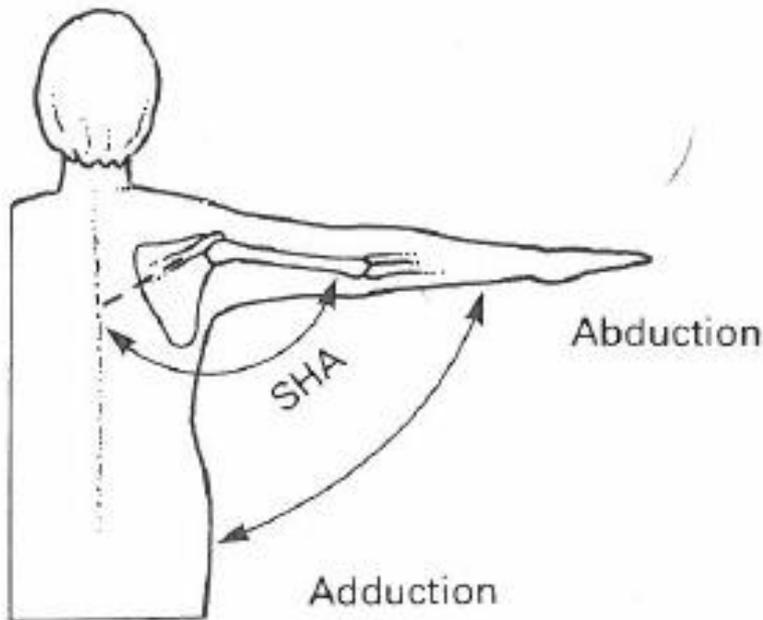
# Movimentos do corpo

**Abduction:** movement of a body part, usually a limb, away from the sagittal plane. When the arm is raised to the side from standard anatomical position, *abduction* of the arm occurs. For the special case of fingers and toes, *abduction* is movement of the digit away from the midline of the hand or foot (spreading the digits).



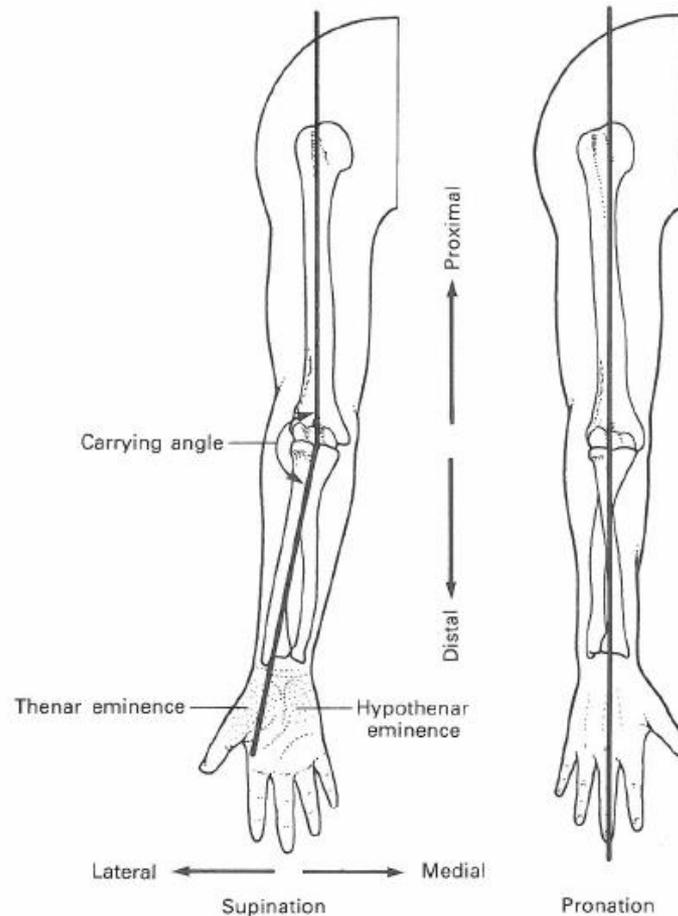
# Movimentos do corpo

**Adduction:** opposite of abduction; movement of a body part, usually a limb, toward the sagittal plane. Bringing the arm down to slap the side of the thigh is *adduction*. For the special case of fingers and toes, *adduction* is movement of the digit toward the midline of the hand or foot (closing the digits).



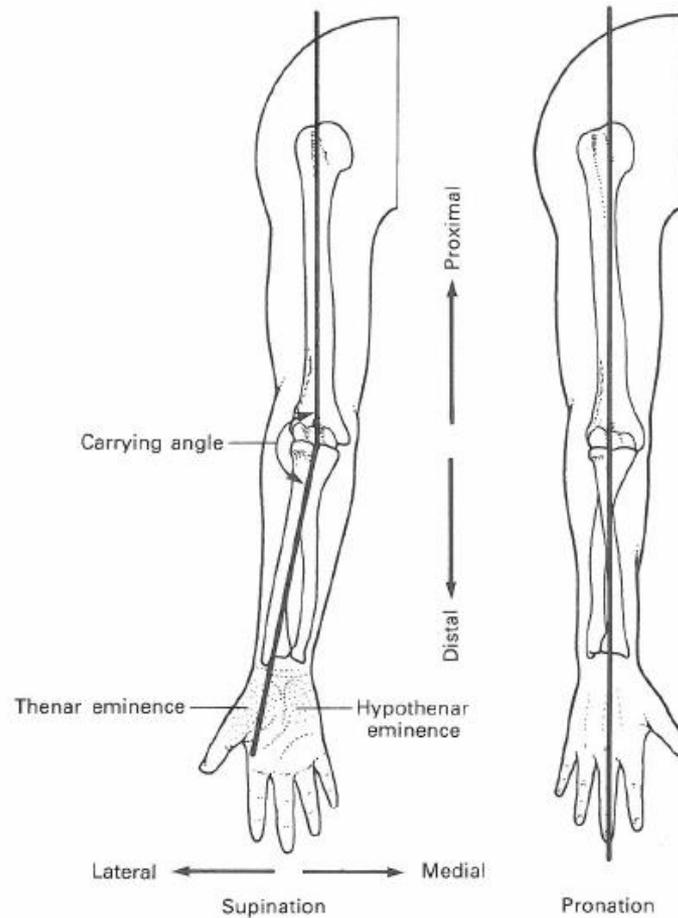
# Movimentos do corpo

**Pronation:** rotary motion of the forearm that turns the palm from anteriorly facing (thumb lateral) to posteriorly facing (thumb medial). Typewriters are used with the hand in *pronation*.

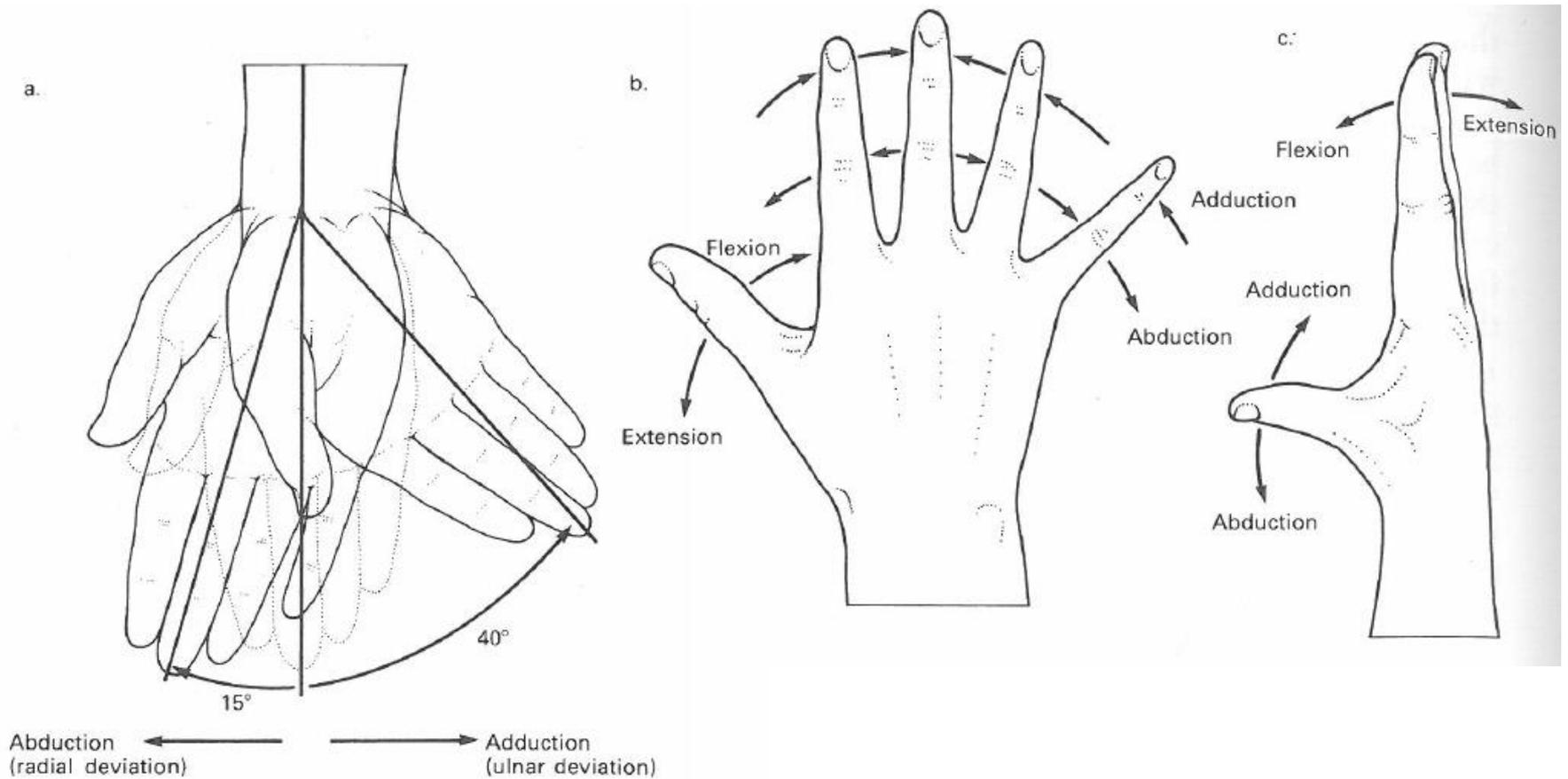


# Movimentos do corpo

**Supination:** opposite of pronation; rotary motion of the forearm that returns the palm to a position in which the thumb is lateral. When chimpanzees beg for food the hand is often held in *supination*.



# Movimentos do corpo



# Movimentos do corpo

**Eversion:** turning the sole of the foot outward so that it faces away from the midline of the body. Also known as **pronation** of the foot.

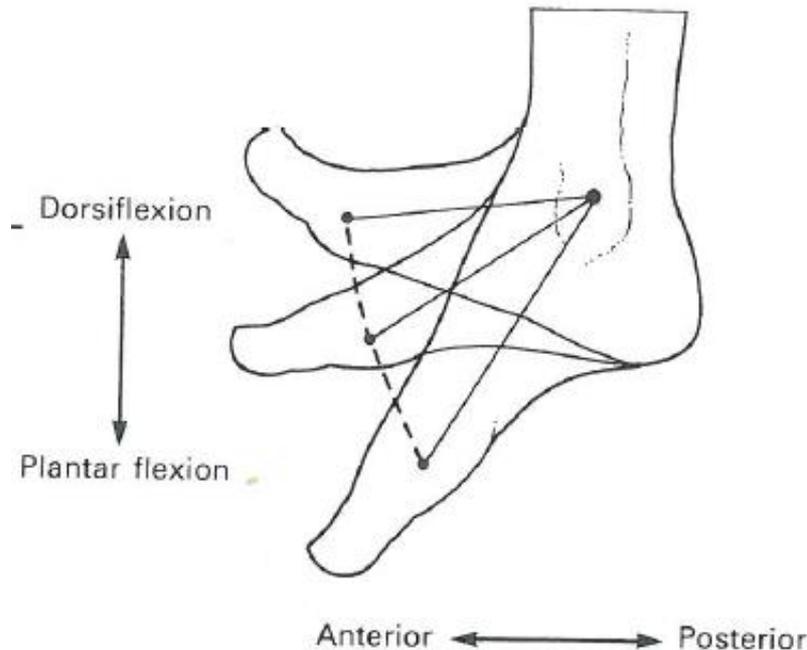
**Inversion:** turning the sole of the foot inward so that it faces toward the midline of the body. Also known as **supination** of the foot.



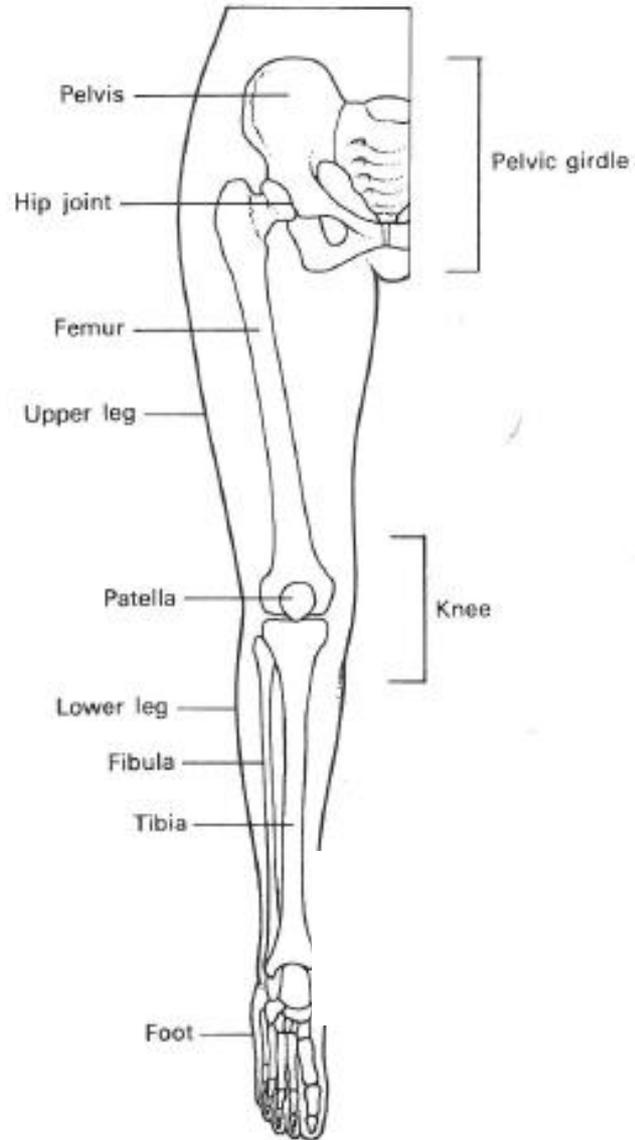
# Movimentos do corpo

**Dorsiflexion:** flexion of the entire foot away from the ground. When a mime walks on her heels, her feet are *dorsiflexed*.

**Plantarflexion (volarflexion):** opposite of dorsiflexion; flexing of the entire foot inferiorly, toward the ground at the ankle. Action in both dorsiflexion and plantar flexion occurs at the ankle. When a ballerina walks on her toes, her feet are strongly *plantarflexed*.



# O membro inferior



# Human anatomy

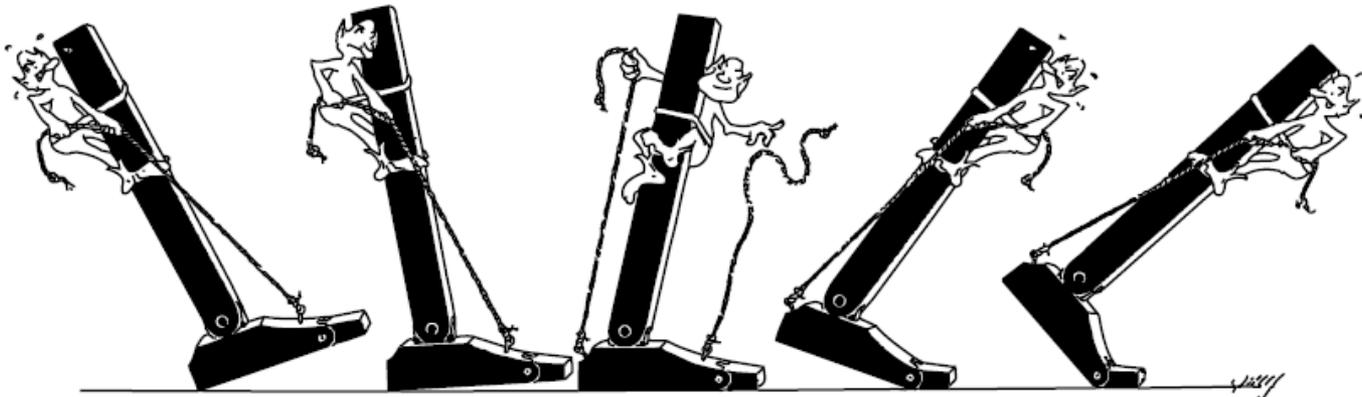
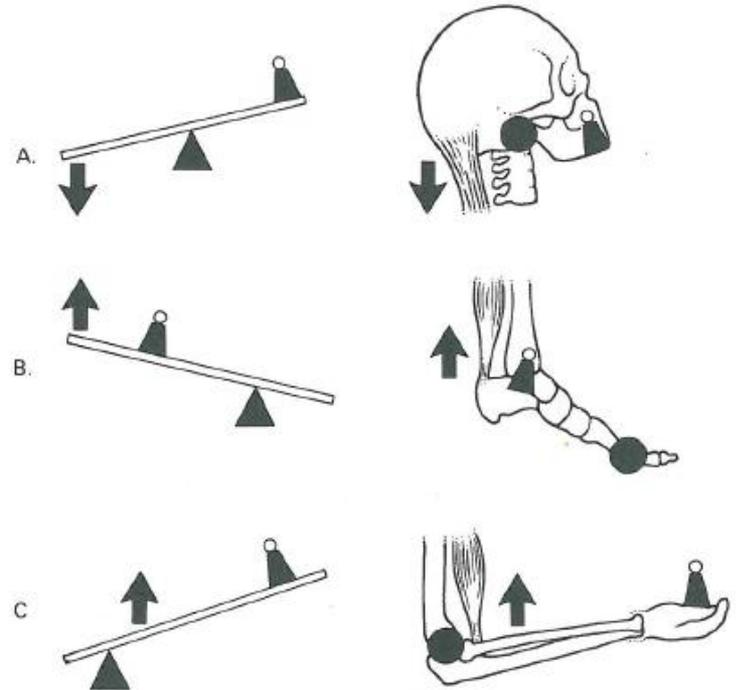
## Lever systems

**Lever** – a rigid bar with no account taken on its shape or structure.

**Fulcrum** – the point around which the lever rotates

**Force arm** – Part between the fulcrum and the point where force is applied.

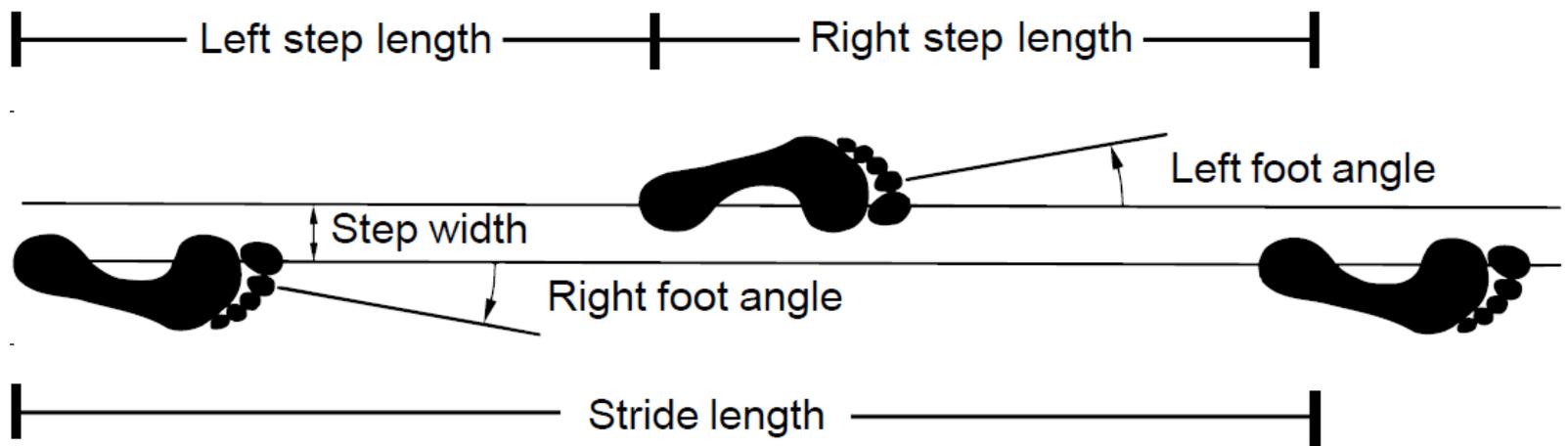
**Load arm** – Part between the fulcrum and the point where load takes place



# Bipedal locomotion

**Gait** – Is the term use to describe the walking cycle.

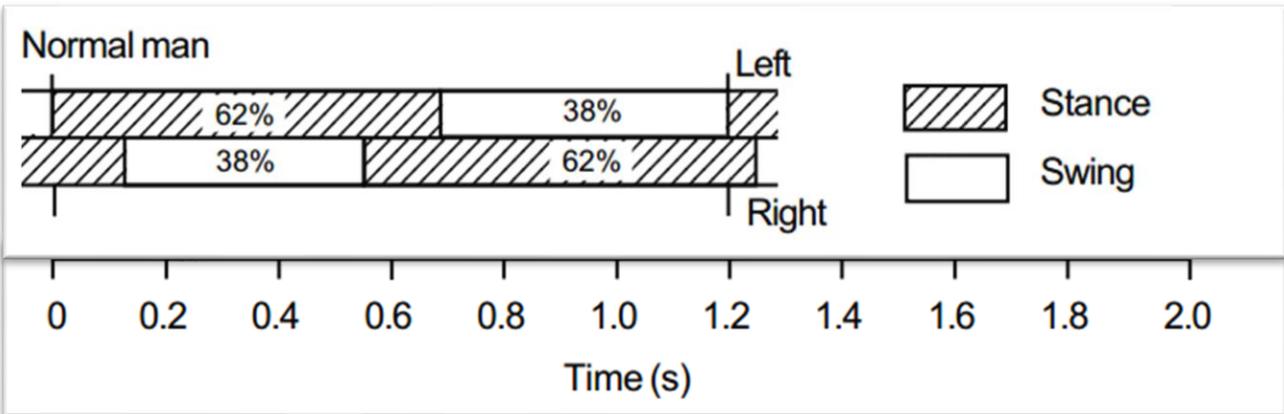
**Stride versus step** – A stride begins when the heel strikes on the floor and it lasts until that same foot contact the ground again.



# Bipedal locomotion

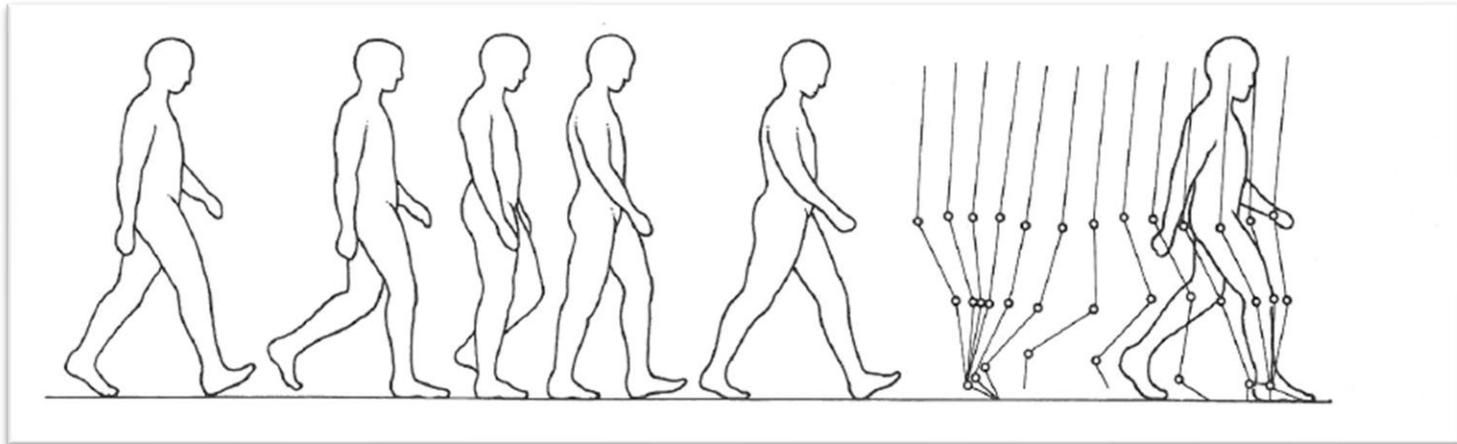
**Stance phase (fase de apoio) of the stride (marcha)** - The leg is holding the weight of the body.

**Swing phase (fase de balanço) of the stride** - The leg moves forward to begin next stride.



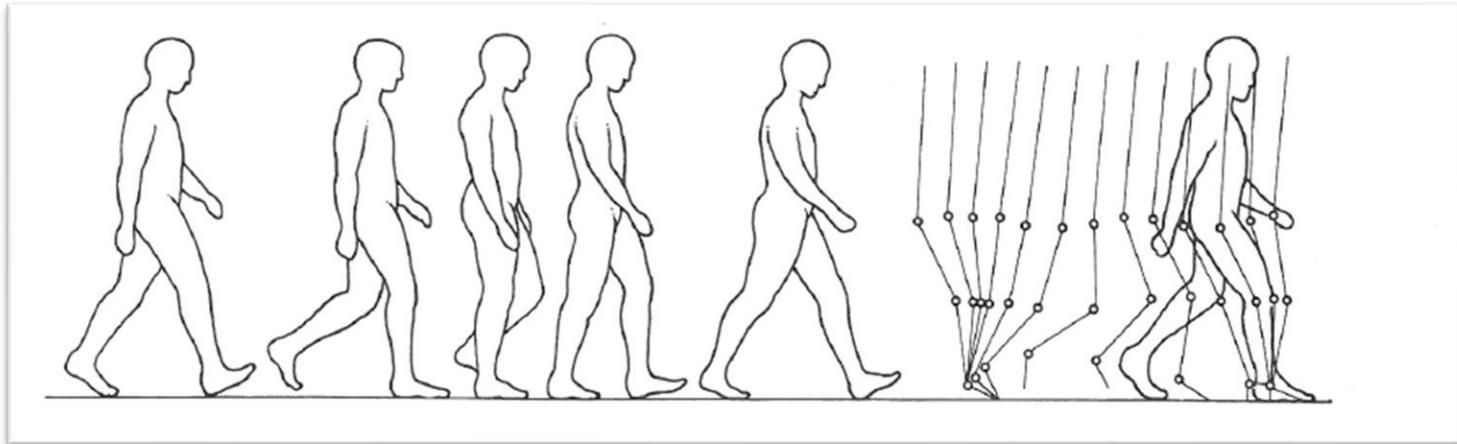
## Bipedal locomotion

1. The walking stride starts with the heel strike. At this point the hip is flexed, the knee extended and the leg laterally rotated.
2. **Adductor muscles** then pull the weight of the body over the supporting leg.
3. At the **mid-stance** phase of the stride the whole weight of the body is over the supporting foot and both the **knee and hip joints are extended**.



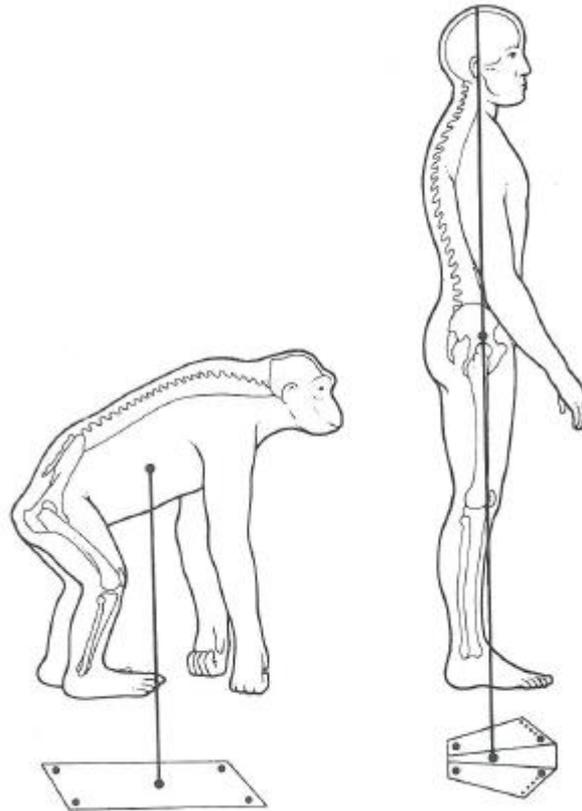
## Bipedal locomotion

4. As the **stance phase** progresses the **ankle dorsiflexes** and both the hip joint and the knee joint pass over the supporting foot. This is the propulsive phase.
5. At final stage of the **stance phase** (toe-off) the body weight passes over the great toe, while the hip joint is hyperextended, the knee **extended** and the foot **dorsiflexed**.
6. As the **swing phase** starts both the hip and knee joints **flex**. As the swing leg passes the supporting leg the knee joint starts to **extend**.
7. During the final stage of the **swing phase** the leg rotates laterally in preparation for heel strike.



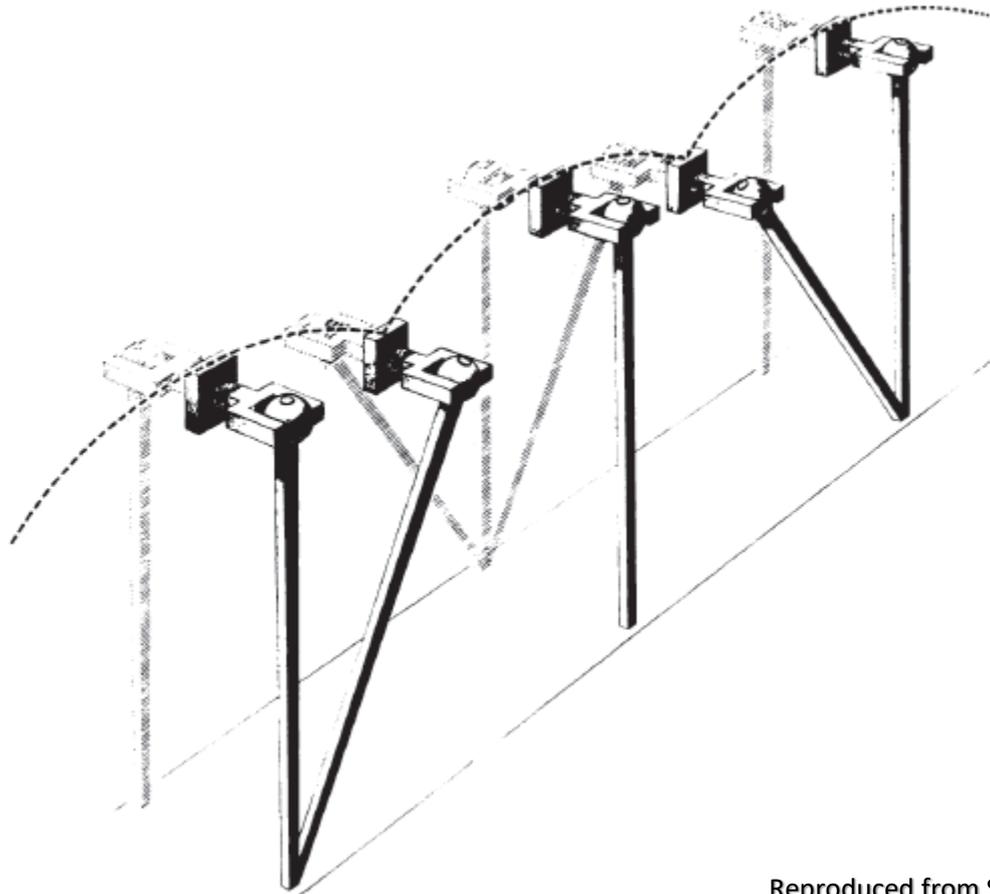
# Bipedal locomotion

- The “six determinants of gait”: minimizing the dislocation of the centre of gravity.
- **The supporting rectangle and the centre of gravity.**



# Bipedal locomotion

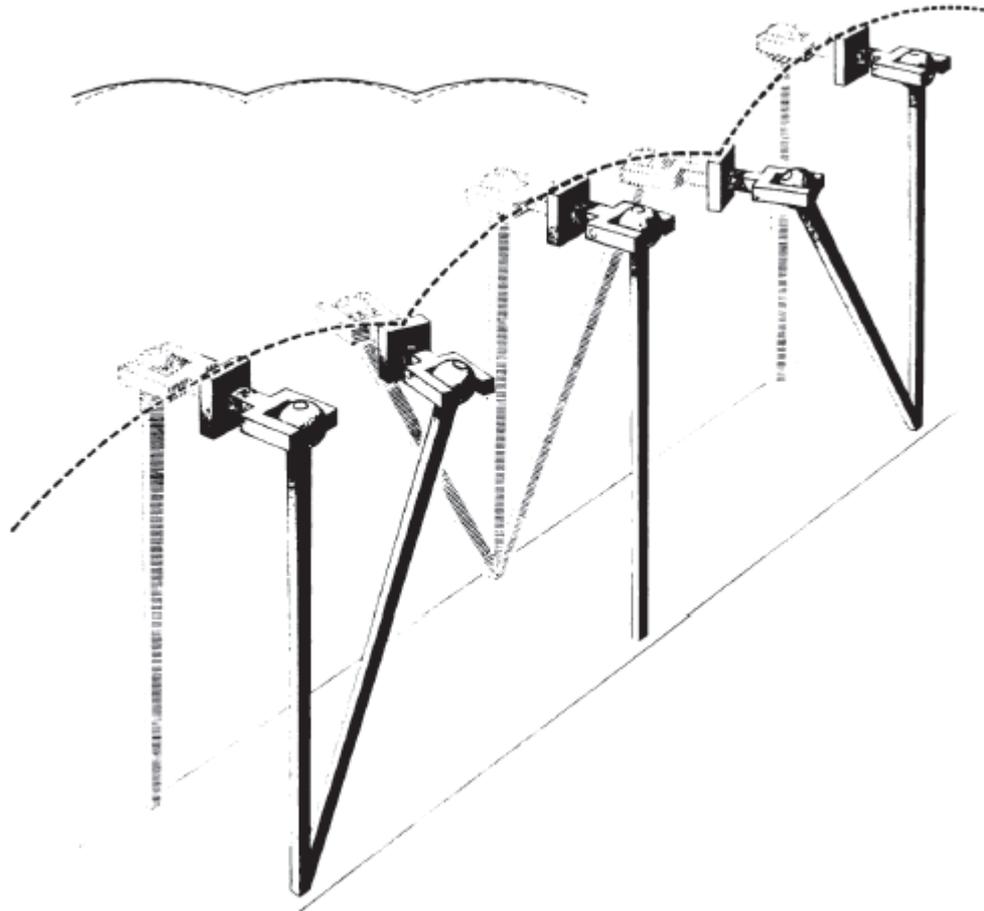
- The “six determinants of gait”: minimizing the dislocation of the centre of gravity.
- The “null model” (compass gait)



Reproduced from Saunders et al., 1953

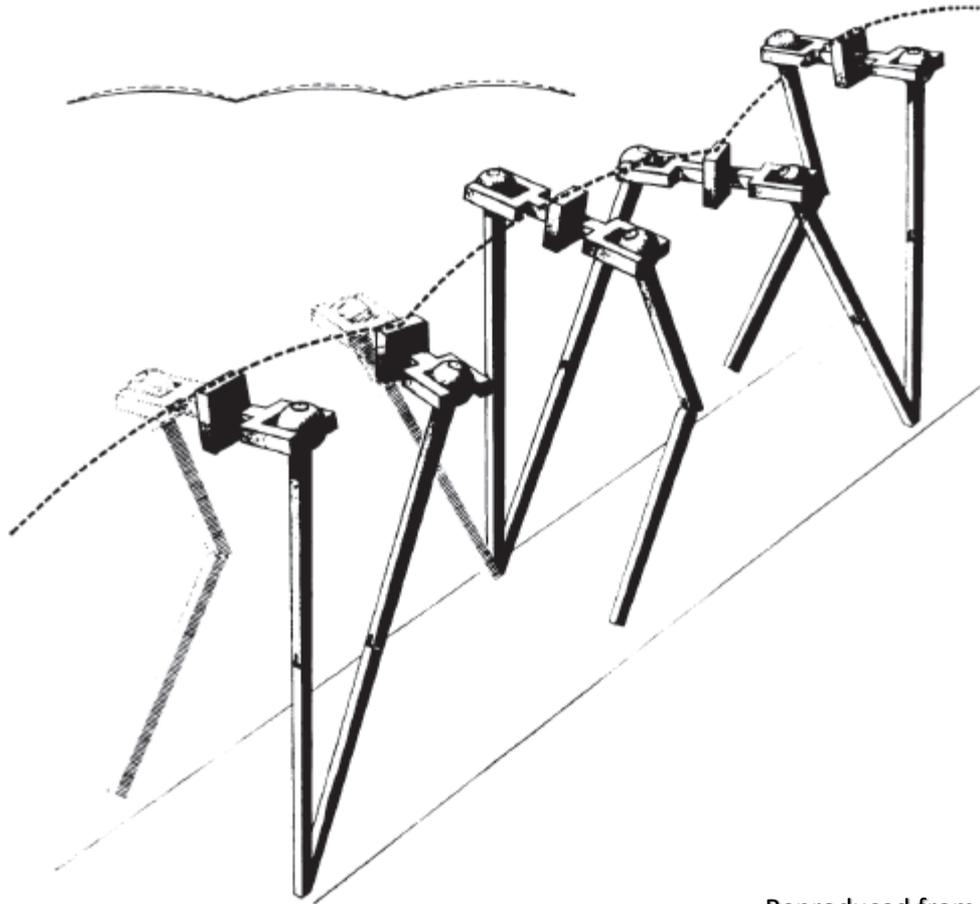
# Bipedal locomotion

- The “six determinants of gait”: minimizing the dislocation of the centre of gravity.
- **Pelvic rotation (ca. 8 degrees)**



# Bipedal locomotion

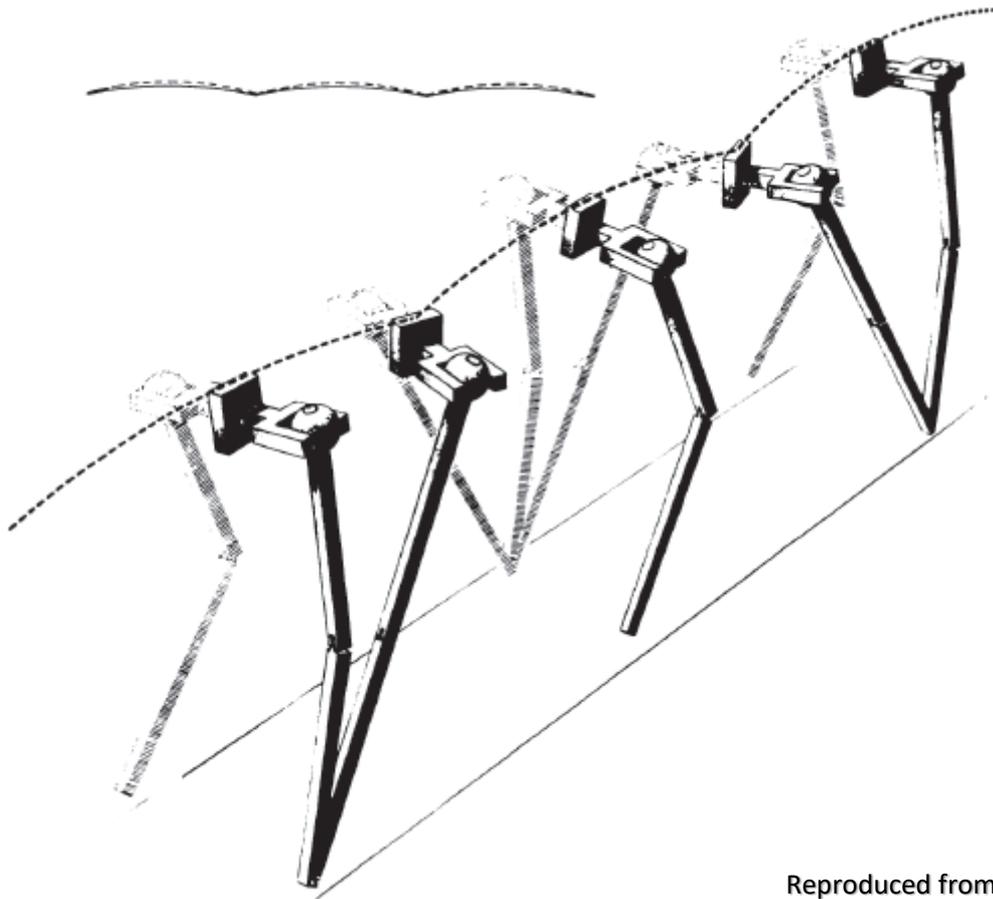
- The “six determinants of gait”: minimizing the dislocation of the centre of gravity.
- **Pelvic tilting (ca. 5 degrees)**



Reproduced from Saunders et al., 1953

# Bipedal locomotion

- The “six determinants of gait”: minimizing the dislocation of the centre of gravity.
- **Knee flexion in the stance phase (ca. 5 degrees)**



Reproduced from Saunders et al., 1953

# Bipedal locomotion

- The “six determinants of gait”: minimizing the dislocation of the centre of gravity.
- **Valgus knee:** minimal horizontal displacement is achieved.

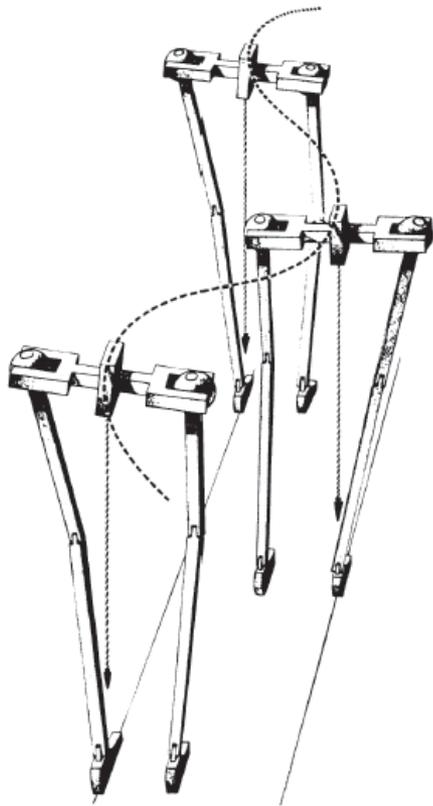
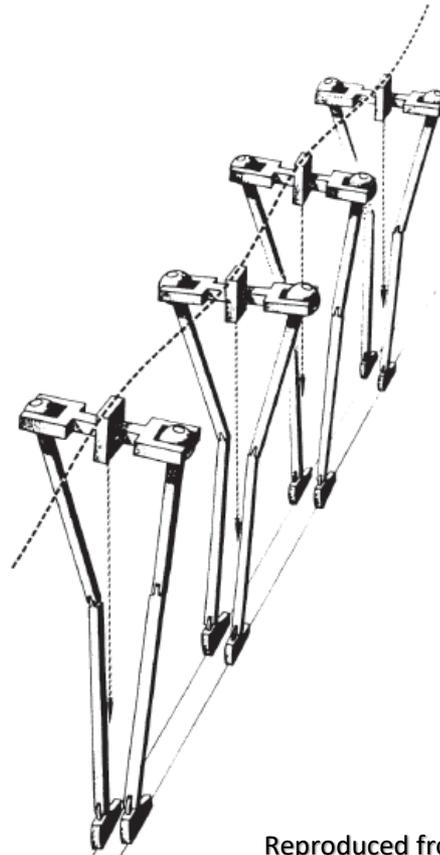


FIG. 10



Reproduced from Saunders et al., 1953

# Bipedal locomotion

## The bipedalism in the chimpanzee

- Chimpanzees are ripe fruit specialist foragers.
- Most of the food they need are found in tree canopies.
- They need to find the trees and climb them
- They walk 2-5 km per day.
- **Predominantly knuckle-walking (i.e. Quadrupedal locomotion).**



# Bipedal locomotion



## The bipedalism in the chimpanzee

- Apes comfortably and habitually employ a diverse range of gaits.
- Bipedalism among hominoids is simply one, rather unremarkable, aspect of their locomotor versatility (Pontzer et al., 2014 ).
- “Rather than being confined to a limited and well-defined set of stereotyped gaits, apes comfortably and habitually employ a diverse and variable range of gaits and movement patterns as they navigate terrestrial and arboreal environments” (Pontzer et al., 2014).



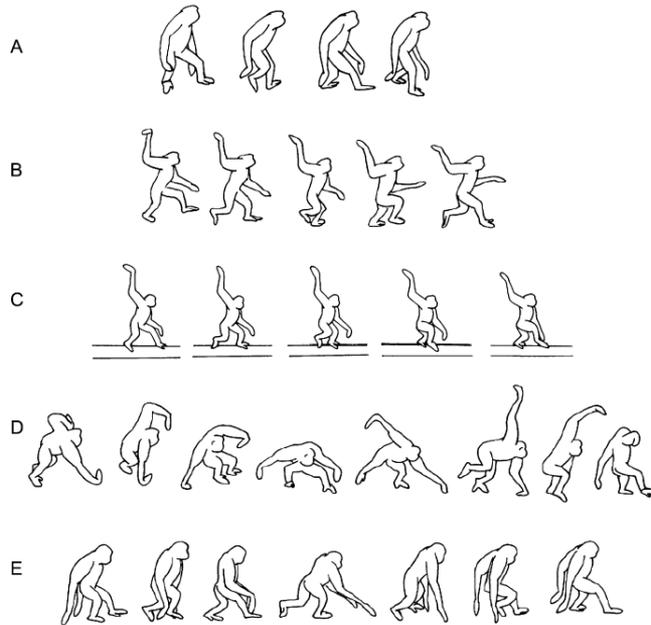
Show Video

# Bipedal locomotion



**NEXT YEAR... Add a slide on hylobates bipedalism!**

**See paper Vereeck 2006**

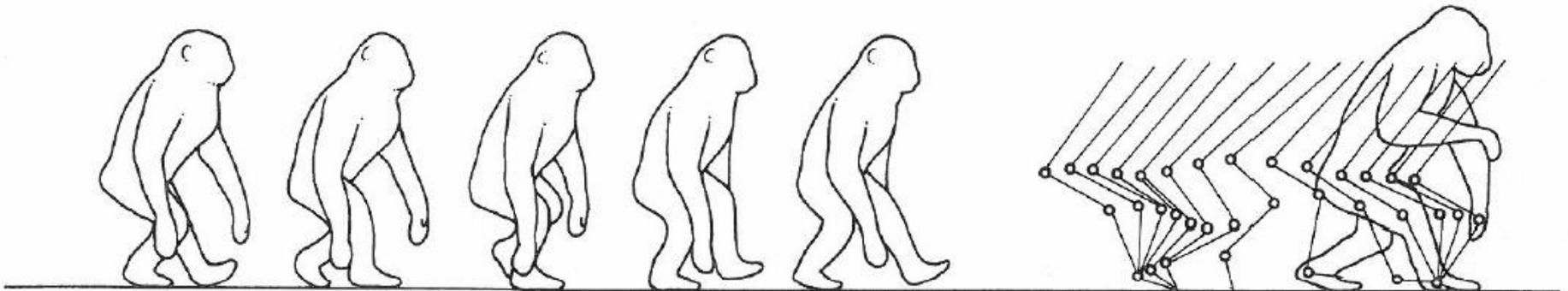


Show Video

# Bipedal locomotion

## The **BHBK** posture

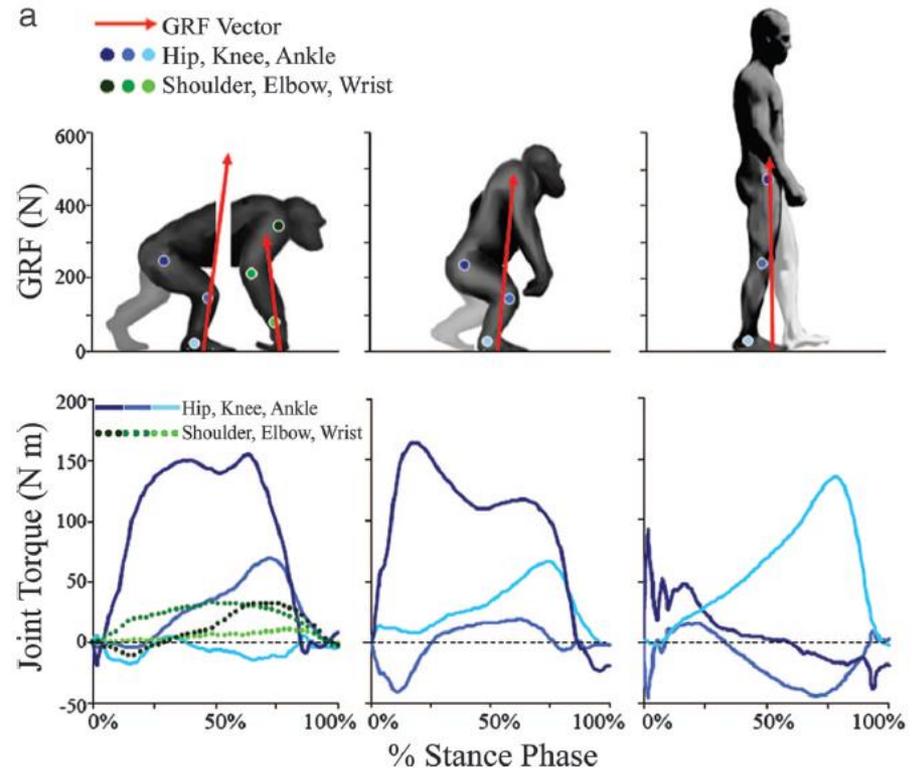
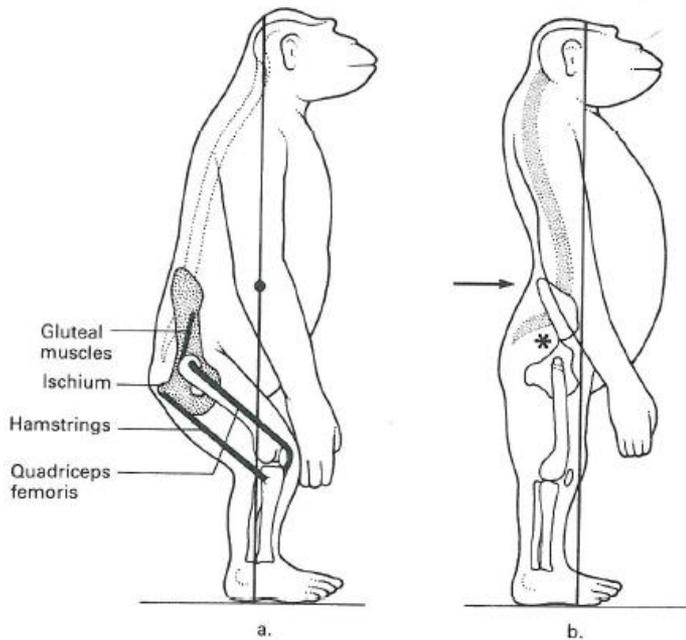
- Chimpanzee always have a **bent hip and bent knee (BKBH)** both in bipedal and quadrupedal walking.
- The primary kinematic differences between them are a more extended hip and shorter, more frequent steps when walking bipedally.
- Neither the knee joint nor the ankle joint pass behind the hip joint during stance phase. -> Less energy for the propulsive phase.
- The femur lacks the the human **bycondilar angle**. Therefore, there is a much greater lateral movement of the gravity centre.
- Reversed sequence of **pelvic tilt**.



# Bipedal locomotion

## The **BKBH** posture

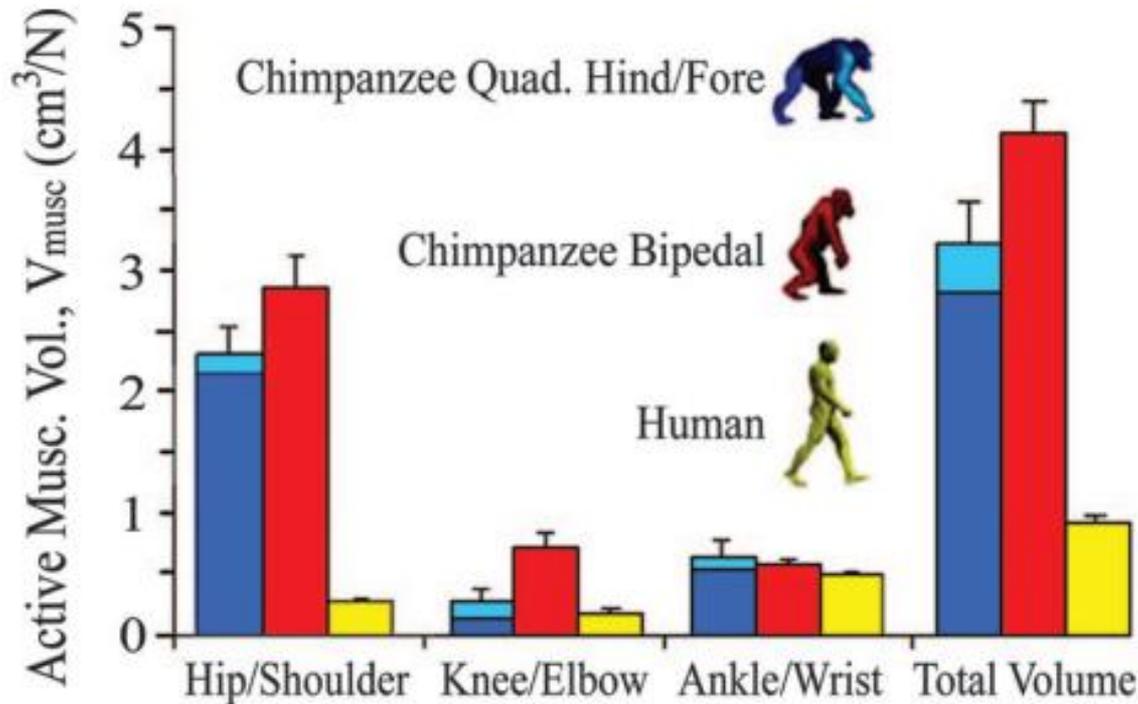
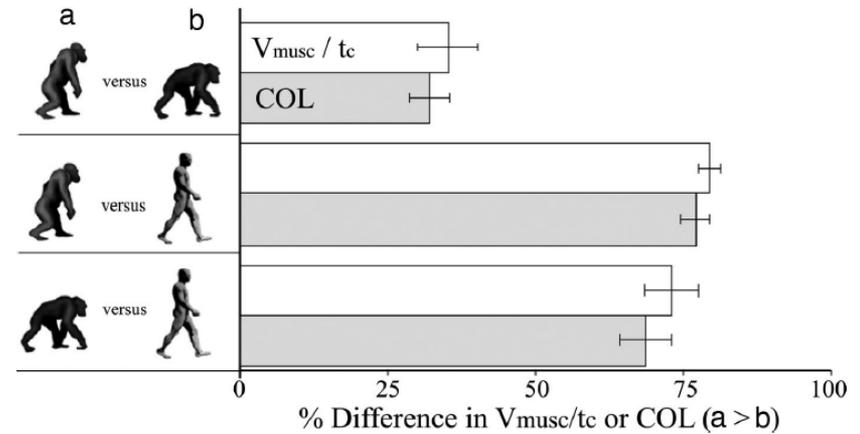
- The main difference between human and chimpanzee bipedal locomotion resides in the flexion of the hip.
- In humans it is the ankle joint instead that concentrate the efforts resulting from locomotion.



# Bipedal locomotion

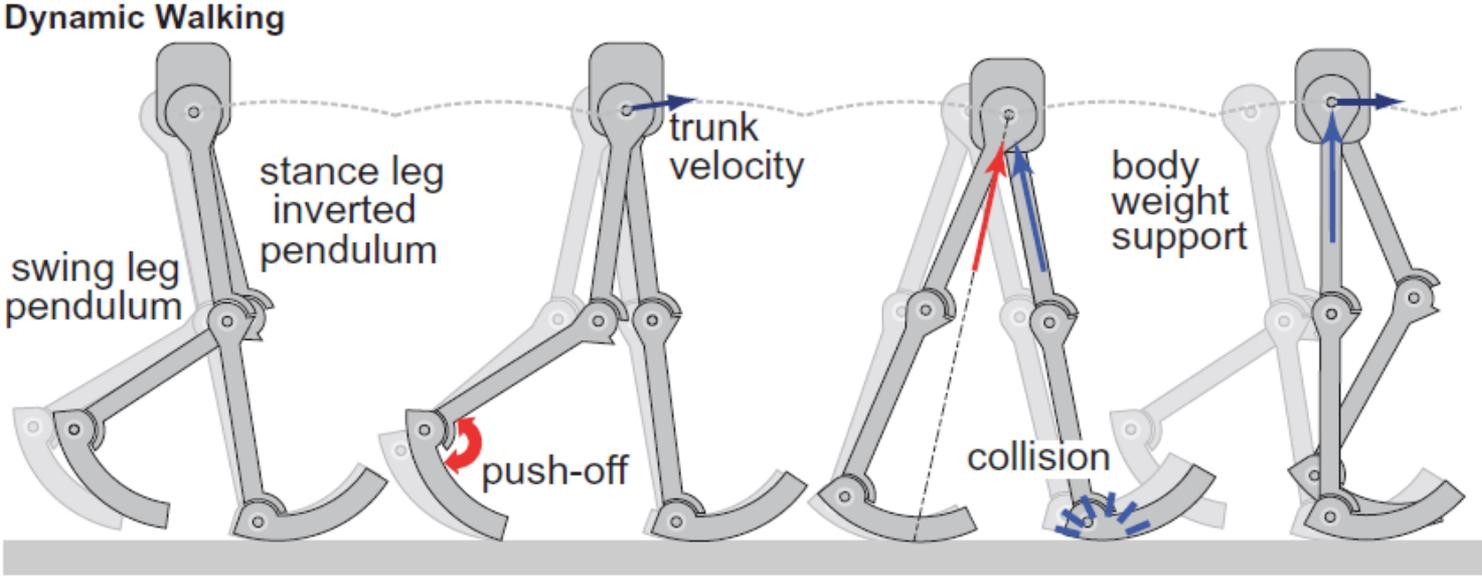
## Human versus chimpanzee locomotion

- Humans are 75% more efficient.



# The human gait as an inverted pendulum (dynamic walking)

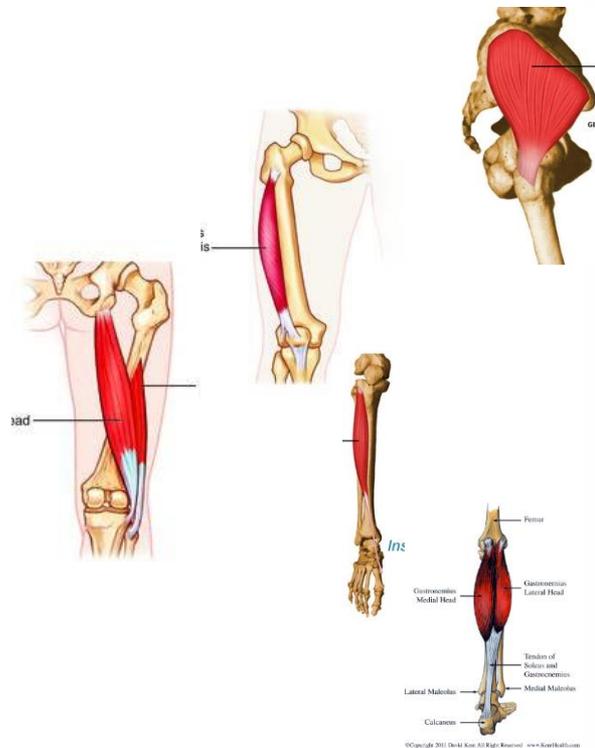
- During human bipedal locomotion the lower limbs work as a compound pendulum.
- Extended leg in midstance important to minimize muscle activity.
- Energy is focused on the step-step transition.



Reproduced from Kuo 2007

# Bipedal locomotion

The human gait is very efficient and demands minimal muscle activity



Gluteus medius

Vastus lateralis

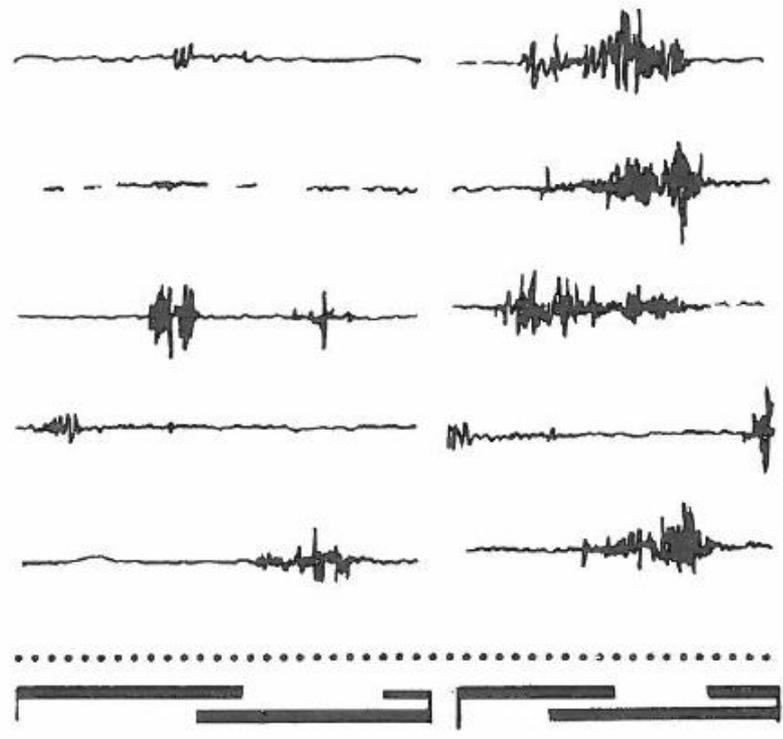
Biceps femoris long head

Tibialis anterior

Gastrocnemius lateralis

Human

Chimpanzee

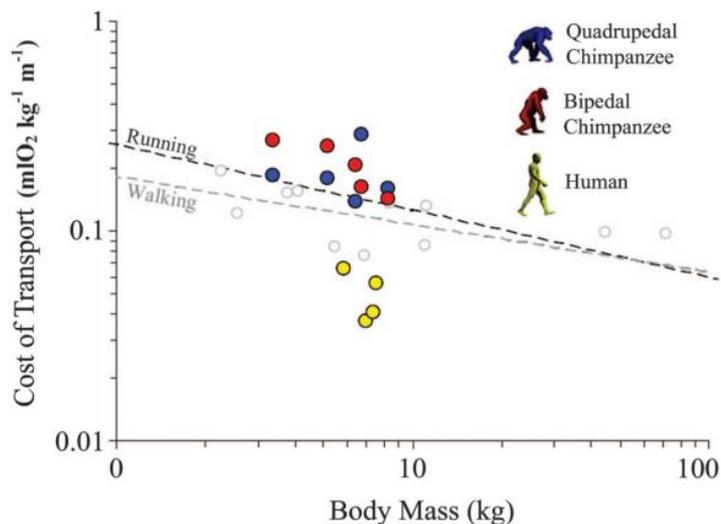


Foot Contact  
L  
R

# Bipedal locomotion

## The bipedalism in the chimpanzee

- **IMPORTANT** -> The comparison here is with between chimpanzee and human BKBH and fully extended bipedalism. Empirical studies show that the energy cost is the same for biped and quadruped locomotion in chimpanzee. But BHBK indeed is more costly for humans.
- **BHBK** (either quadrupedal or bidped) result in higher terrestrial cost. But it also result in increased safety in three canopy.



# Bipedal locomotion

## The Laetoli footprints

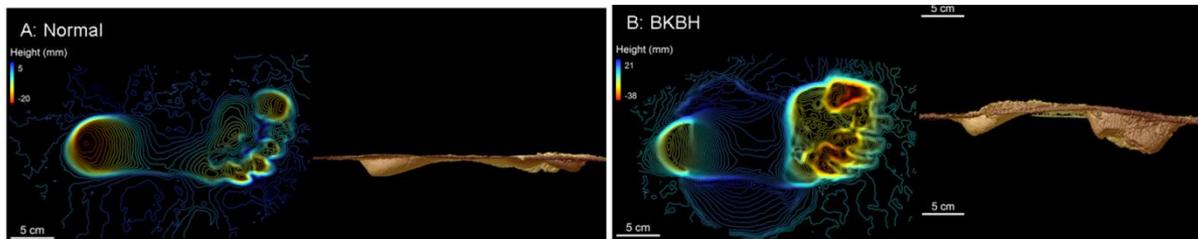
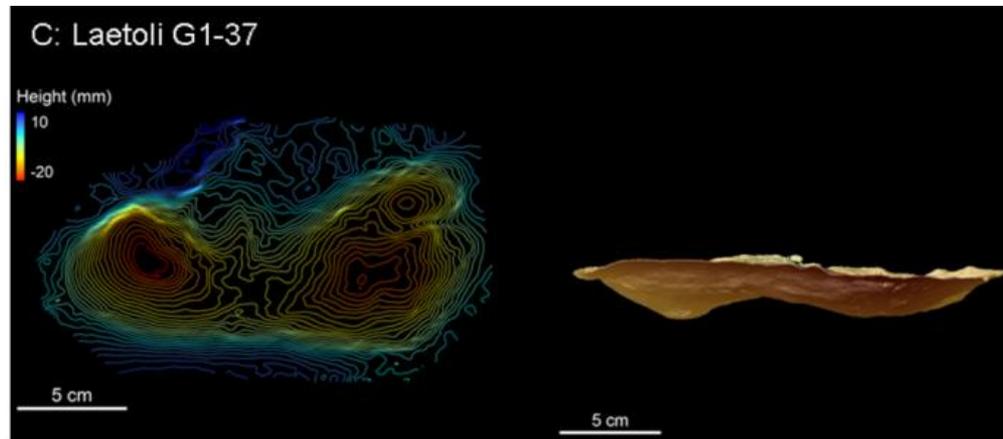
- Discovered in 1976 by Mary Leakey's team
- Made in volcanic ashes and dated to 3.66 Mya
- Trail G1 made by a small individual walking to the left of trail G2/3
- Trail G2/3 consist of larger prints made either by one individuals whose feet slipped, or two individuals, the second treading in the footprint of the first.
- Made by *A. afarensis*



# Bipedal locomotion

## The Laetoli footprints

- Consensus that it was produced by biped gait (BHBK or Extended?).
- Contradictory interpretations concerning the presence of a longitudinal arch, lateral-to-medial force transfer and push-off by the hallux.

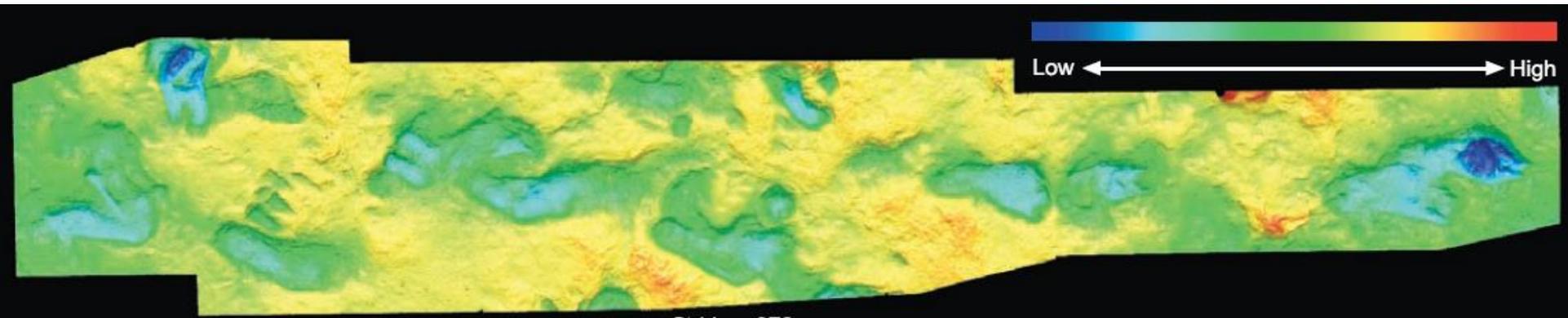


Reproduced from Raichlen 2010

# Bipedal locomotion

## The Ileret footprints (1.51-1.53 ky)

- Found in the Okote Member of the Koobi Fora Formation.
- In association with other animals footprints.
- Two layers separated by a 5 meters interval.
- On the top one there are three hominin footprint trails.
- The lower one is poorer with only 3 footprints.
- Made by *H. erectus*

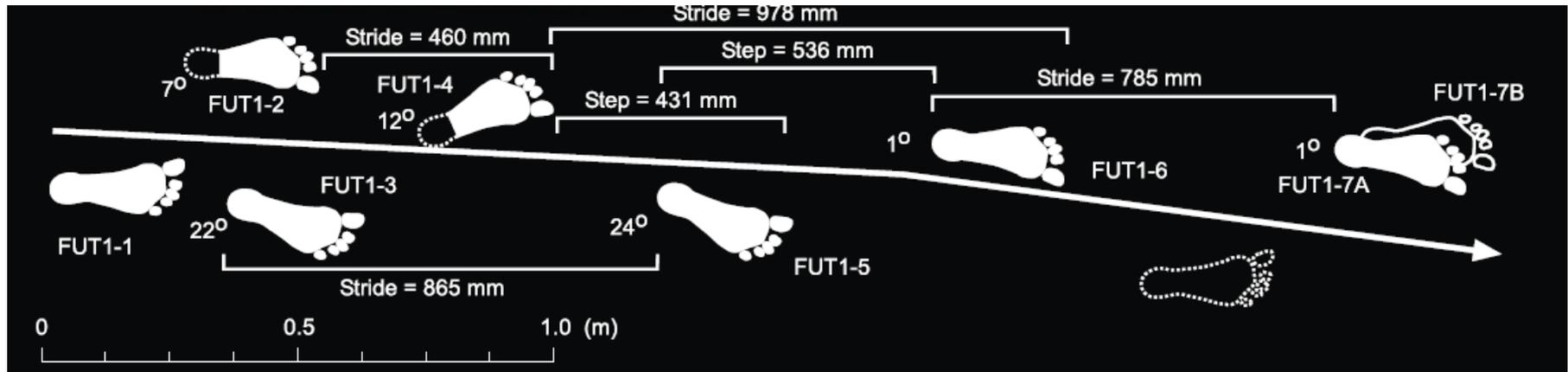


Reproduced from Bennett 2009

# Bipedal locomotion

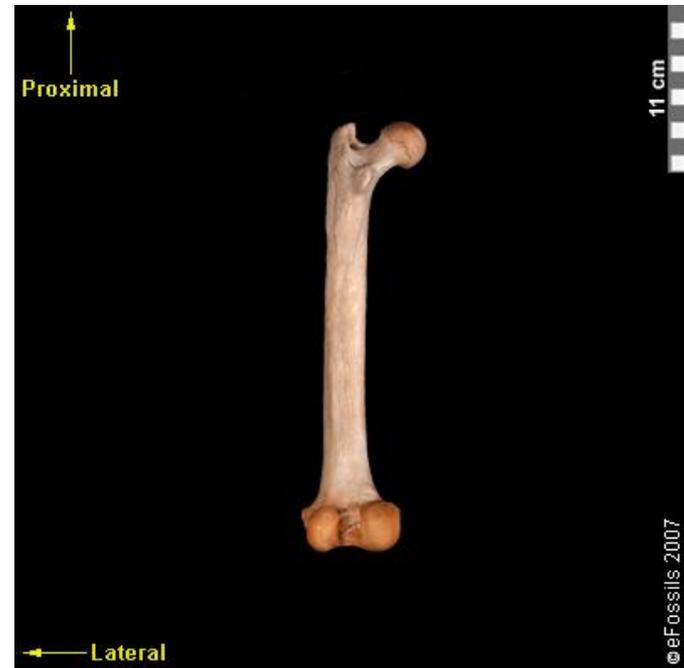
## The Ileret footprints (1.51-1.53 ky)

- Using the average of the last **three strides (876mm)** and a **hip height of 860 mm** estimated from a **foot length (258mm)** a velocity of **0.63m/s** was estimated. Slow velocity compatible with the initial phase of gait.
- Stature was estimated to be 1.75m and 1.76m



# The femur in humans and apes

- The human femur is both absolutely and relatively longer than the ape femur.
- Chimp's femur ca. 75% of human femur of the same body weight.
- The degree of obliquity of the femoral shaft, the **bicondylar angle**, also serves to distinguish human and ape femora. Humans have a more **valgus angle** (larger angle).

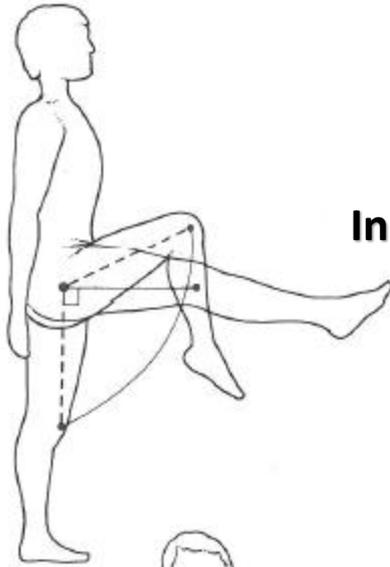


# The femur in humans and apes

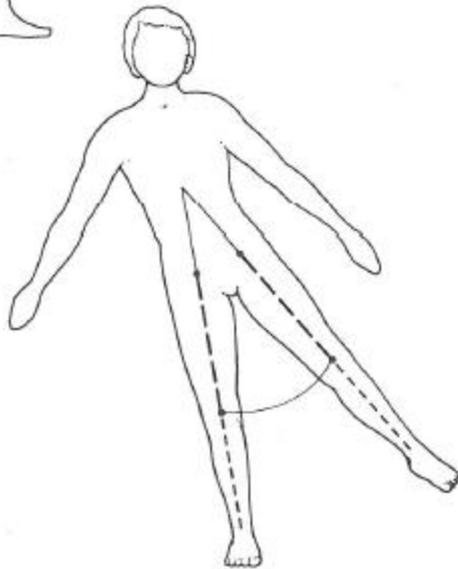
- A long femur indeed....



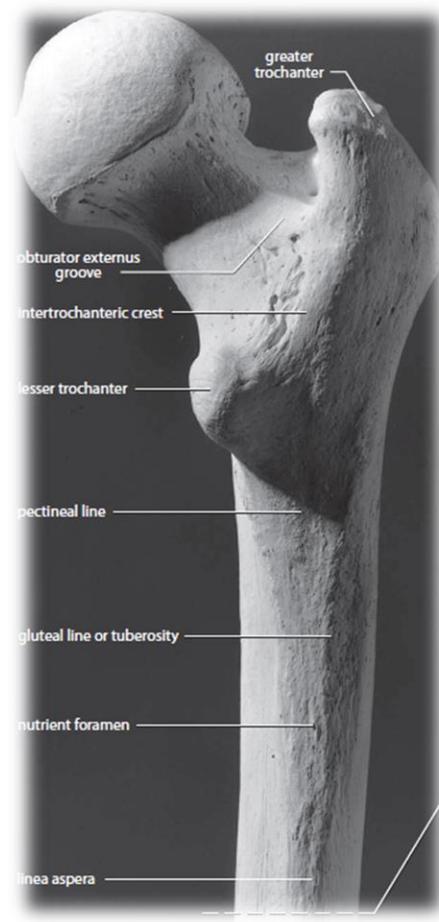
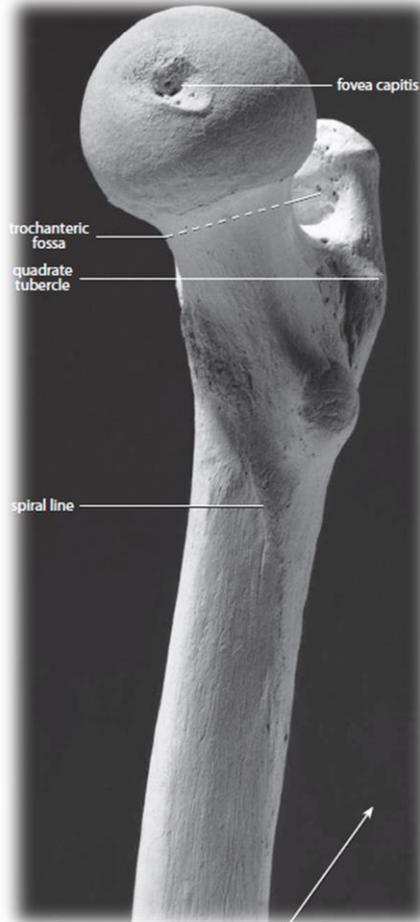
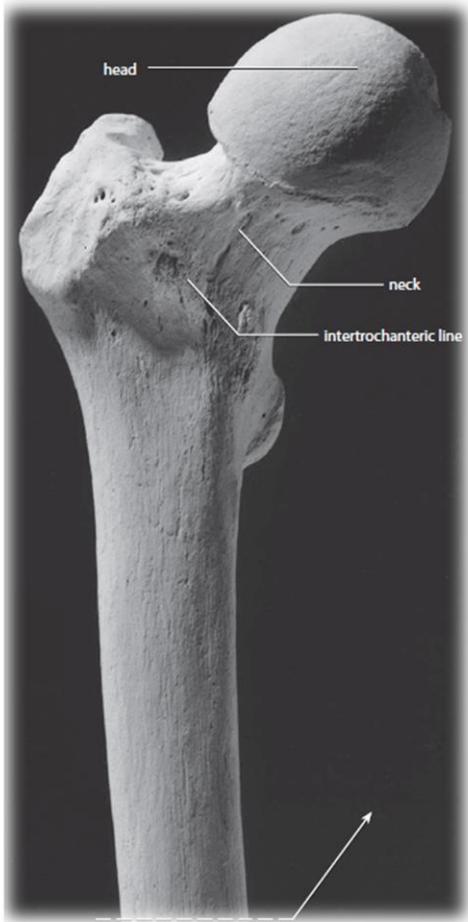
# Human anatomy



**In the lower leg a “inverted pattern” is observed for flexion**

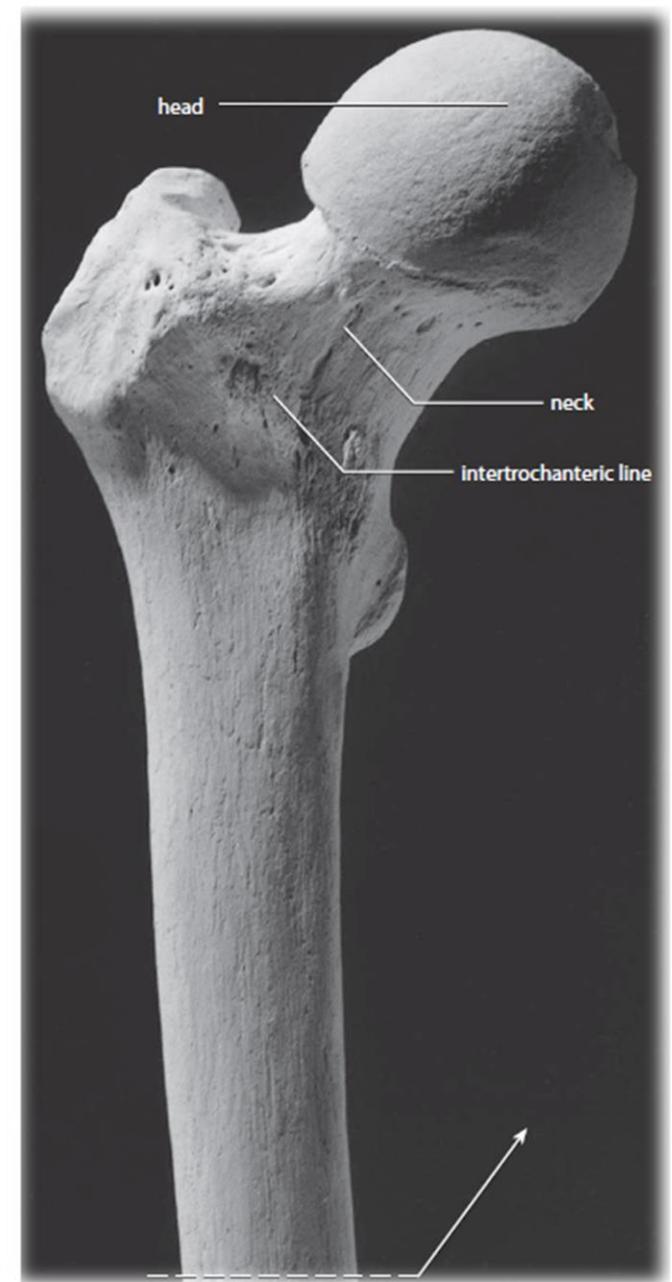


# The proximal femur – human



# The fêmur – proximal end

- **Head (Cabeça)**
  - The round proximal part of the bone that fits into the acetabulum. It constitutes more of a sphere than the hemispherical humeral head.
- **Neck (Colo do / Pescoço do)**
  - Connects the head with the shaft.
- **Greater trochanter**
  - The large, blunt, nonarticular prominence on the lateral, proximal part of the fêmur. It is the insertion site for the *gluteus minimus* and *gluteus medius* muscles – crucial in stabilizing the trunk when the leg is lifted from the ground.
- **Intertrochanteric line**
  - Roughened vertical line that passes between the lesser and greater trochanters on the anterior surface of the base of the neck of the femur. Superiorly, this line anchors the *iliofemoral ligament*, which is the largest ligament in the human body.



# The fêmur – proximal end

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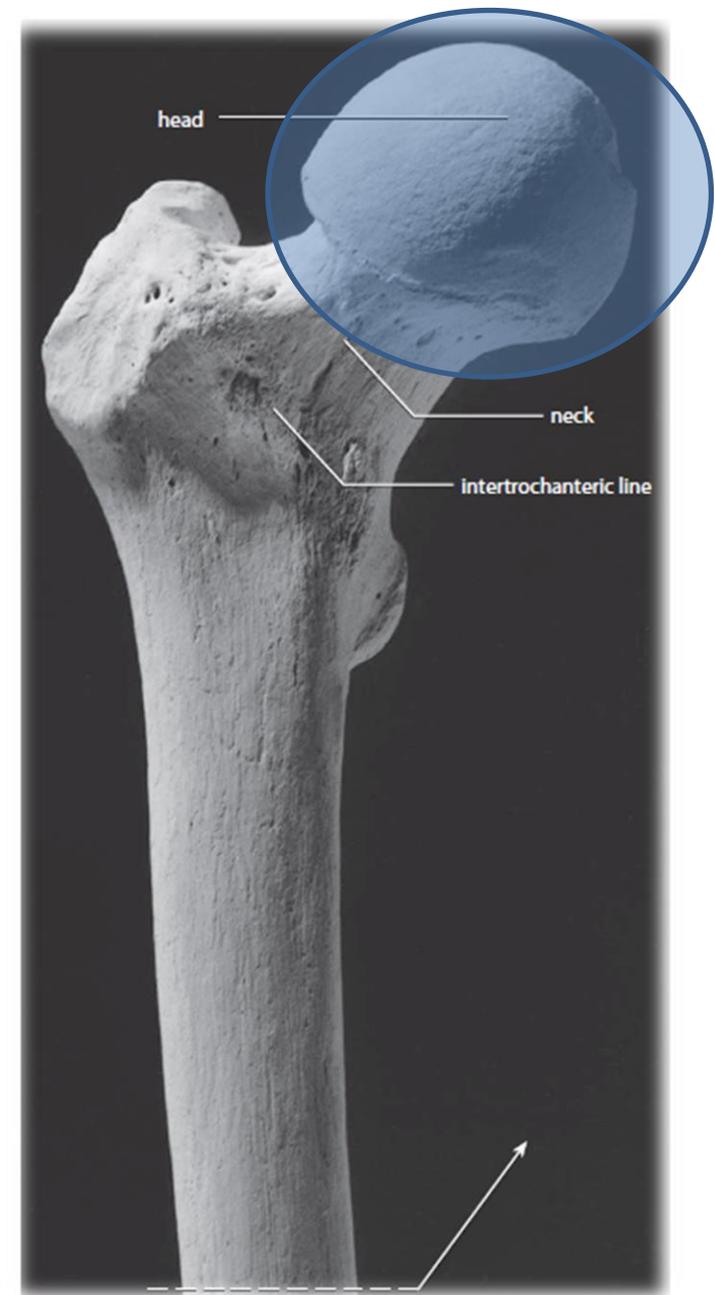
- Connects the head with the shaft.

## • Greater trochanter

- The large, blunt, nonarticular prominence on the lateral, proximal part of the fêmur. It is the insertion site for the *gluteus minimus* and *gluteus medius* muscles – crucial in stabilizing the trunk when the leg is lifted from the ground.

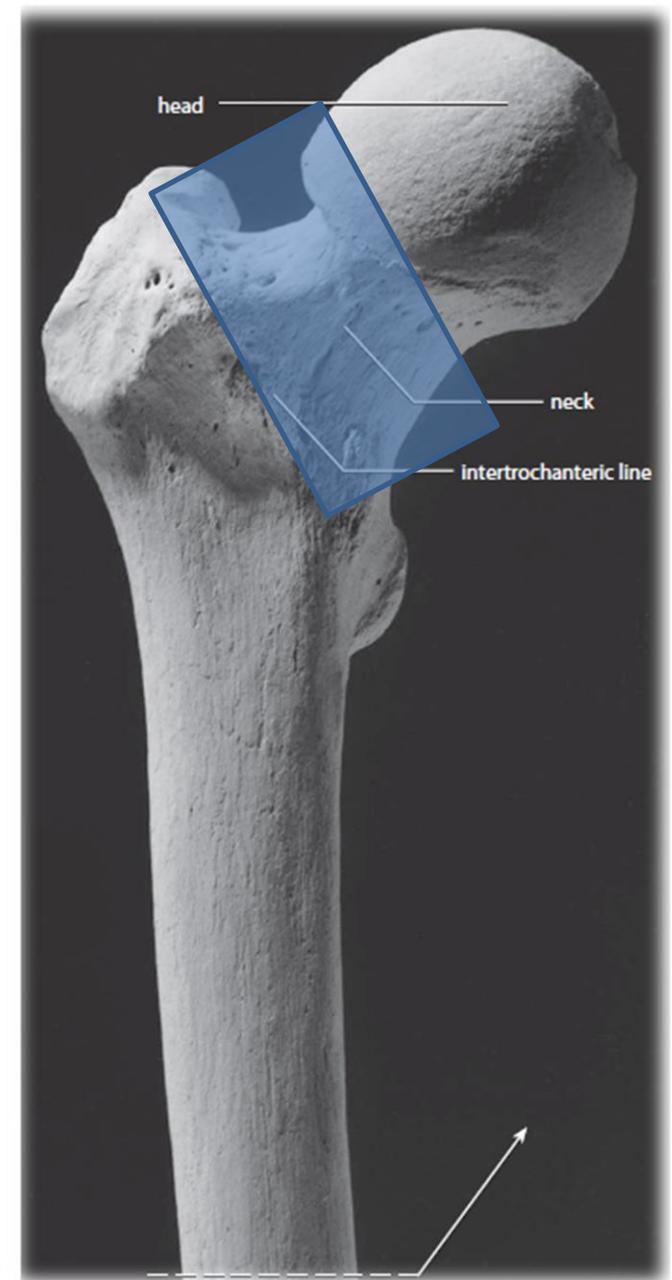
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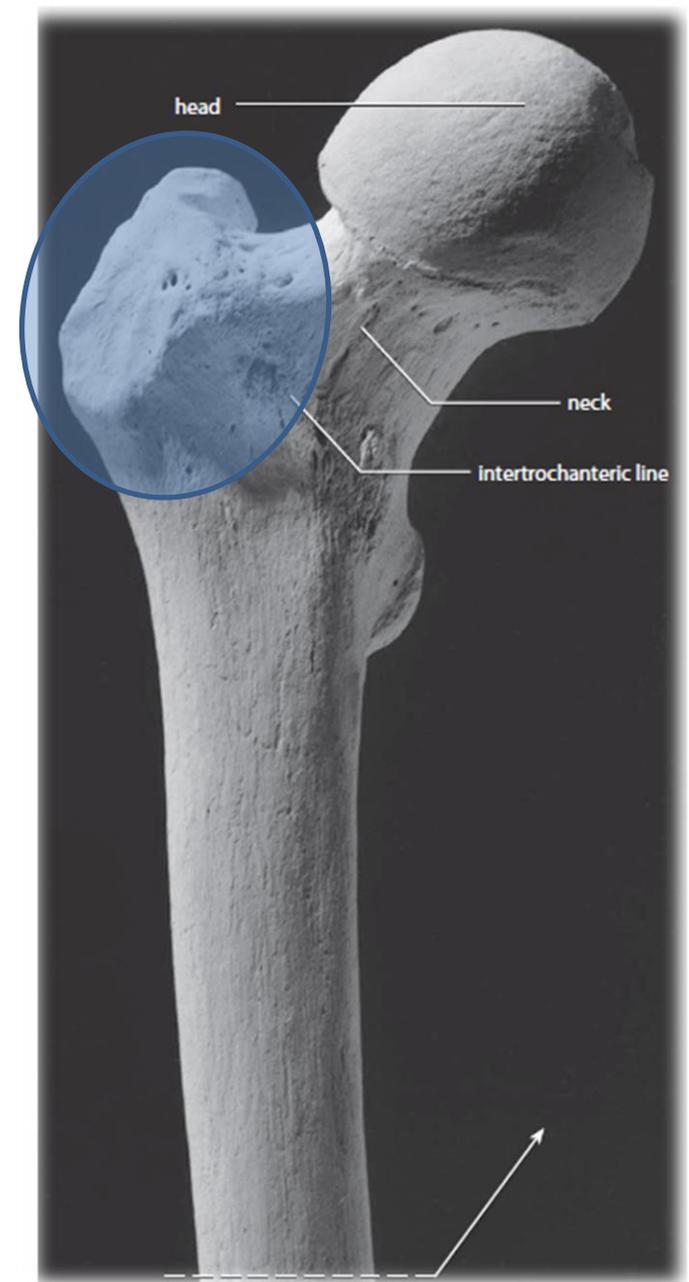
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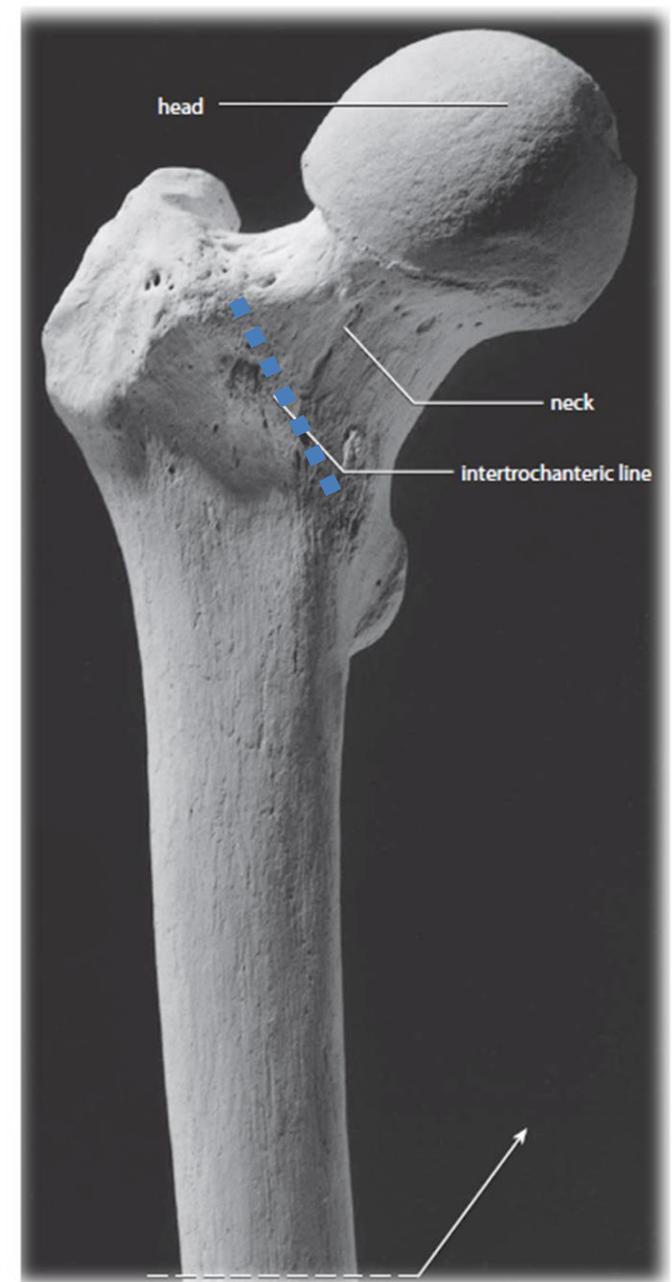
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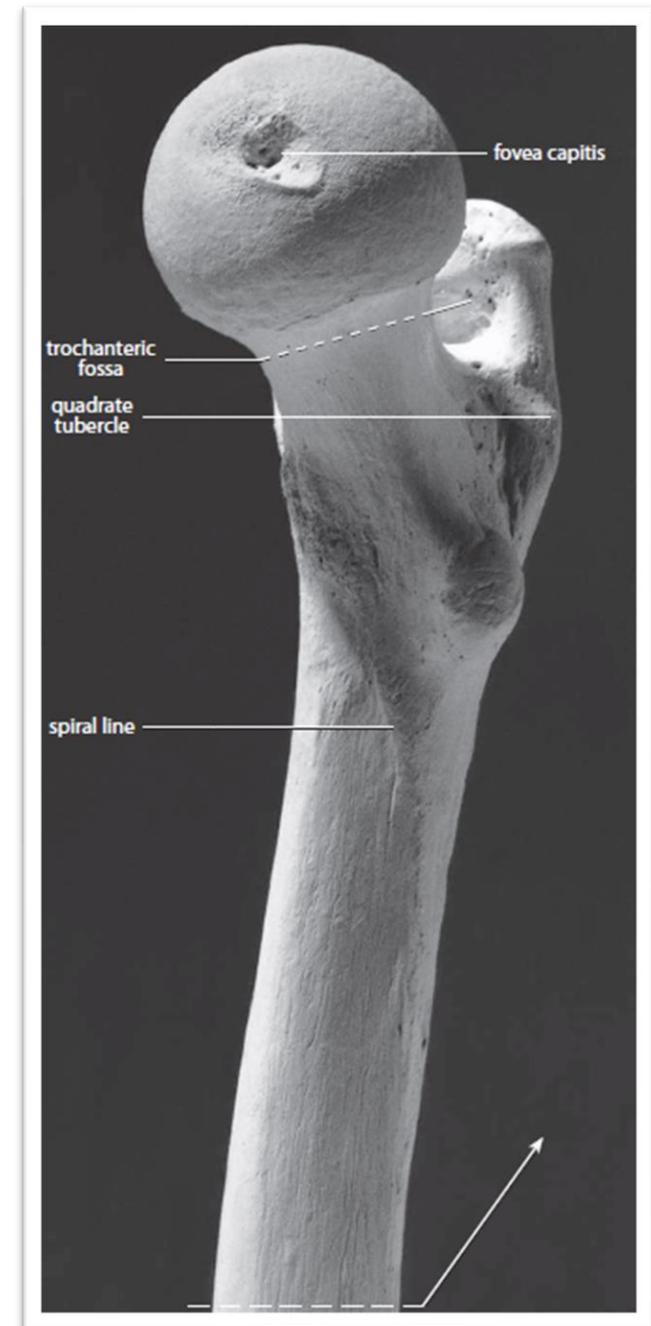
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# The fêmur – proximal end

- **Fovea capitis (Fóvea da cabeça do fêmur)**
  - Small, nonarticular depression near the center of the head of the femur. It receives the *ligamentum teres* from the acetabular notch of the os coxae.
- **Trochanteric fossa (Fossa trocantérica)**
  - The pit excavated into the posteromedial wall of the greater trochanter for insertion of the *tendon of obturator externus*, a muscle that originates around and across the membrane that stretches across the obturator foramen of the os coxae. This muscle acts to rotate the thigh laterally at the hip. Just above its insertion, the medial tip of the greater trochanter receives several hip muscles: the *superior* and *inferior gemelli*, the *obturator internus*, and the *piriformis*. The latter two are important abductors, and all of these muscles can rotate the fêmur laterally.
- **Spiral line (?)**
  - Spiraling inferior to the lesser trochanter, connects the inferior end of the intertrochanteric line with the medial lip of the *linea áspera*. It is the origin of the *vastus medialis muscle*, a part of the *quadriceps femoris muscle*, a knee extensor that inserts on the anterior tibia via the patella.



# The fêmur – proximal end

## • Fovea capitis (Fóvea da cabeça do fêmur)

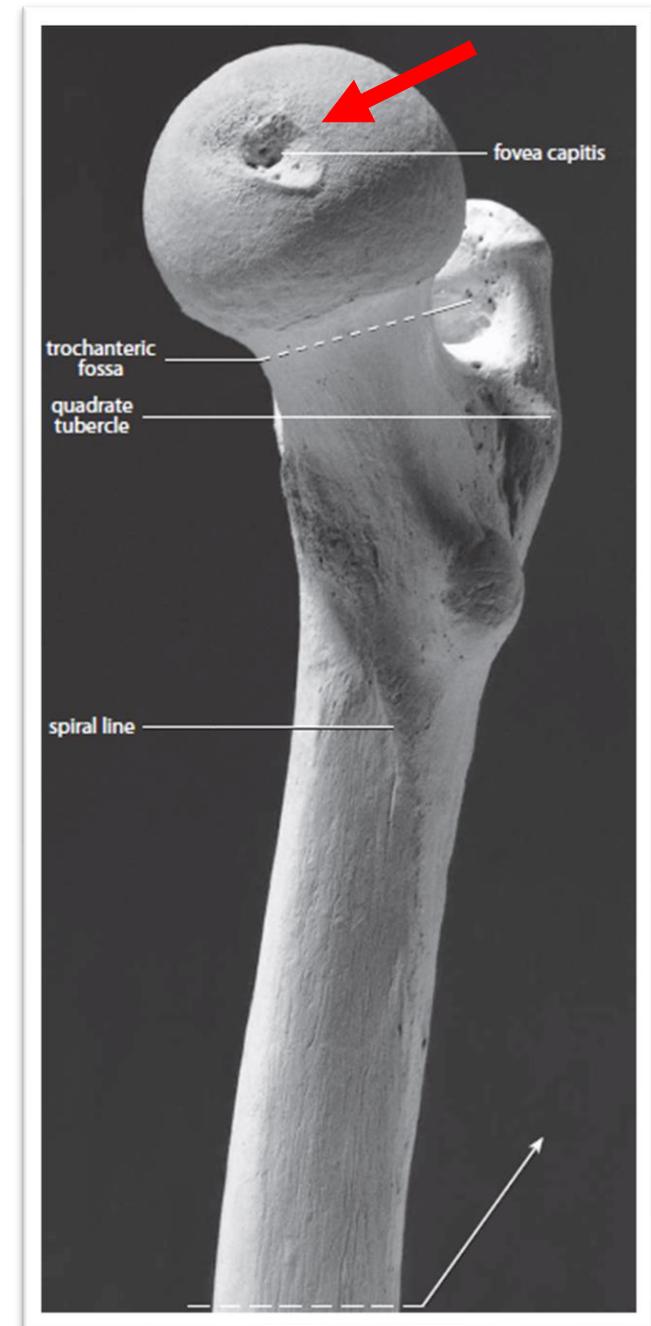
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## • Trochanteric fossa (Fossa trocantérica)

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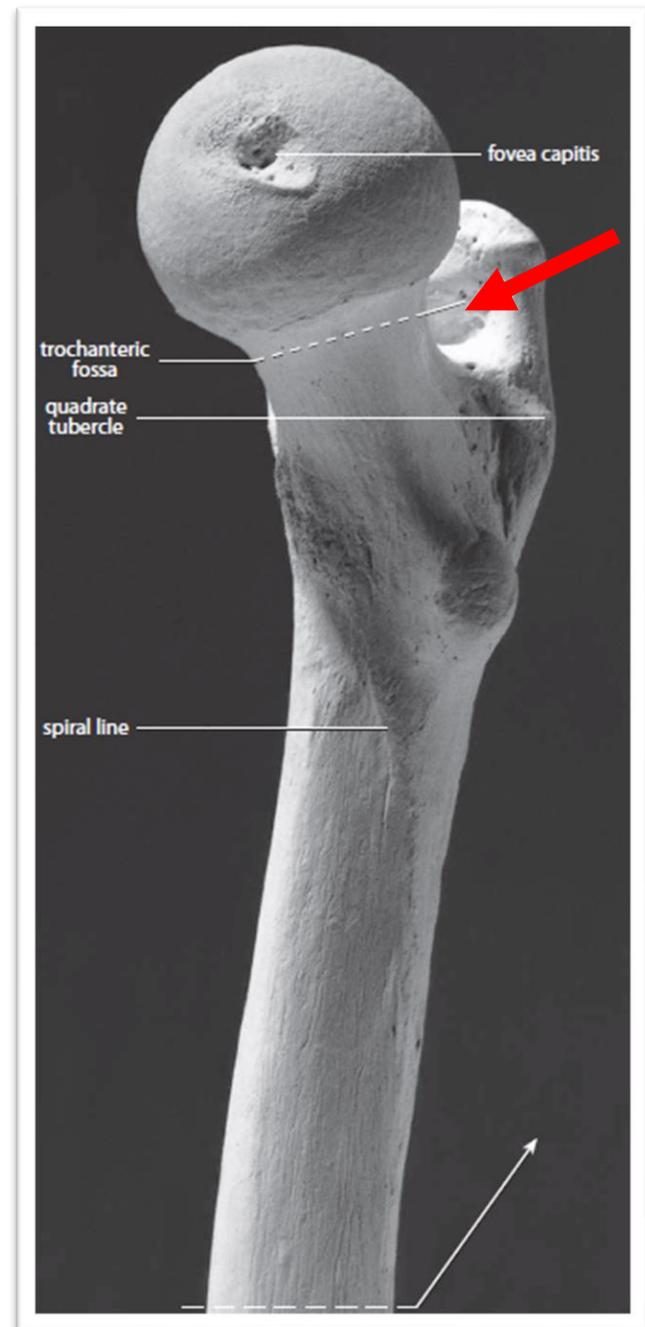
## • Spiral line (?)

- Spiraling inferior to the lesser trochanter, connects the inferior end of the intertrochanteric line with the medial lip of the linea áspera. It is the origin of the *vastus medialis muscle*, a part of the *quadriceps femoris muscle*, a knee extensor that inserts on the anterior tibia via the patella.



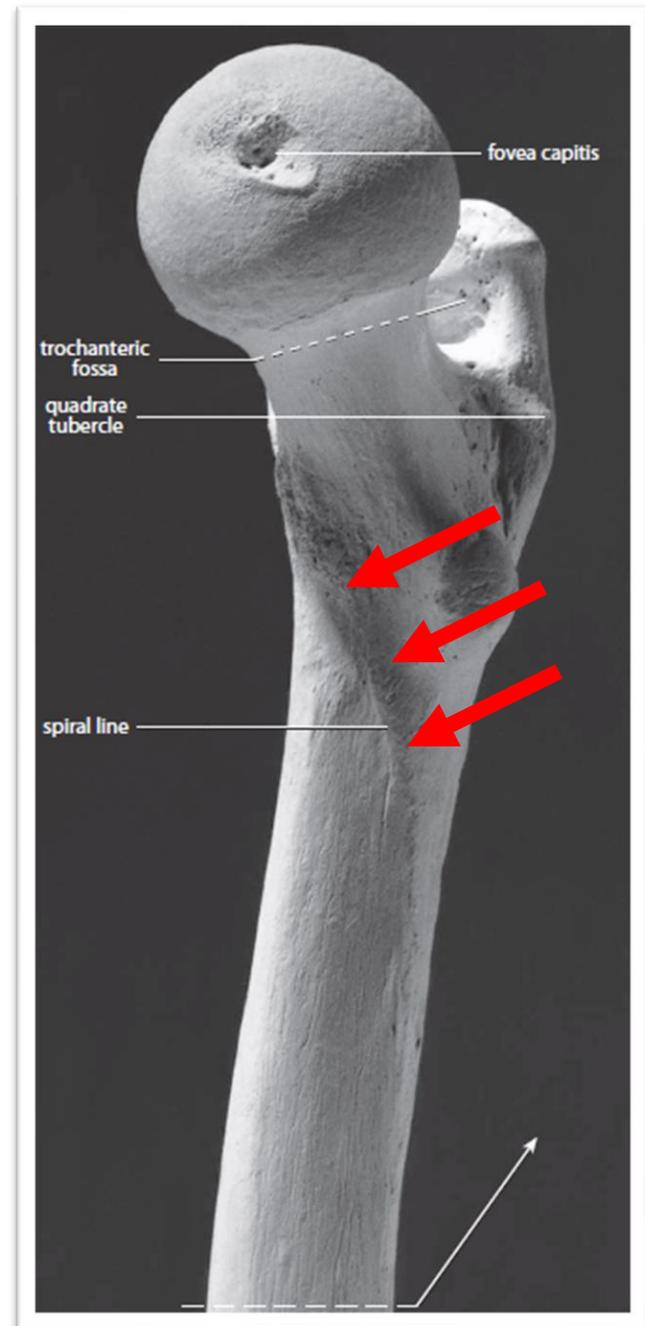
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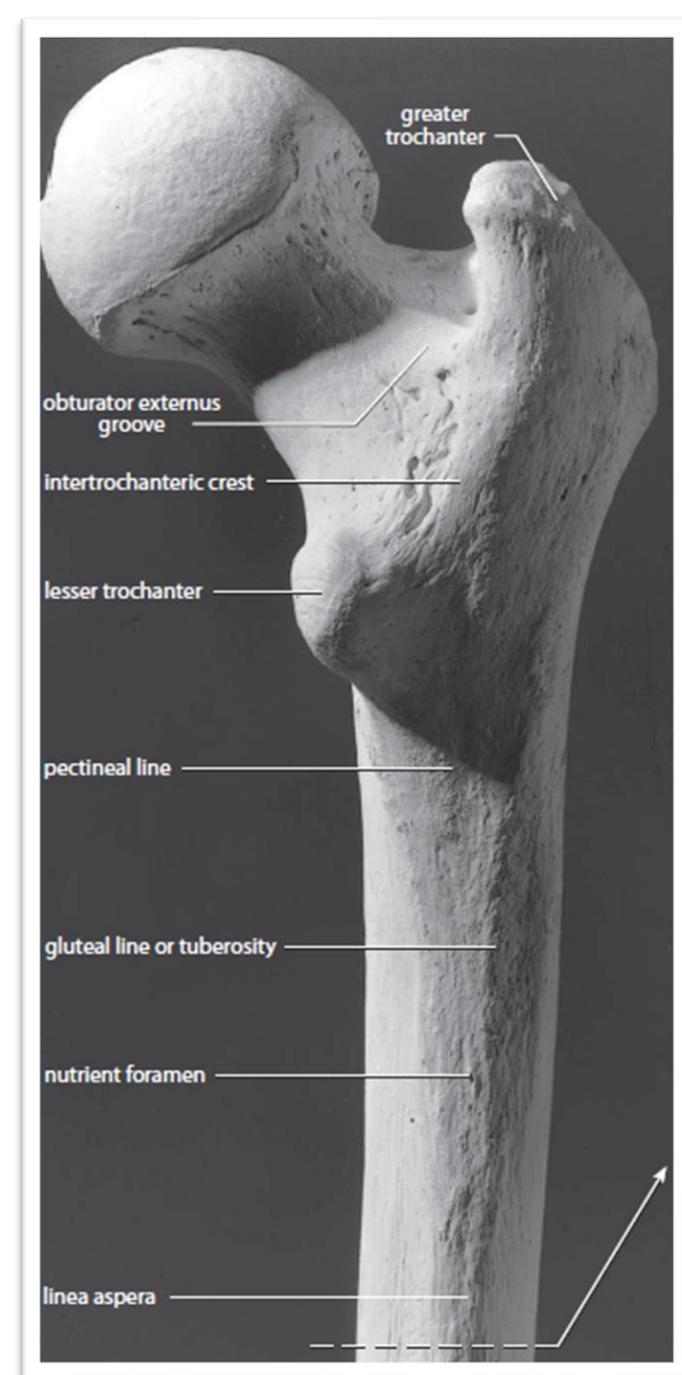
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# The fêmur – proximal end

- **Lesser trochanter (Trocanter menor)**
  - Blunt, prominent tubercle on the posterior femoral surface just inferior to the point where the neck joins the shaft. This is the point of insertion of the *iliopsoas tendon* (the common tendon of the *iliacus muscle*, originating in the iliac fossa, and the *psaos major muscle*, originating from the lumbar vertebrae and their disks). These muscles are major flexors of the thigh and the hip.
- **Intertrochanteric crest (Crista intertrocantérica)**
  - Elevated line on the posterior surface of the proximal fêmur between the greater and lesser trochanters. It passes from superolateral to inferomedial. Just above its midpoint is a small tubercle (the quadrate tubercle).
- **Quadrate tubercle (Tubérculo quadrado)**
  - Small tubercle located above the midpoint of the intertrochanteric crest. It is the insertion site for the *quadratus femoris muscle*, a lateral rotator of the femur.



# The fêmur – proximal end

## Lesser trochanter (Trocanter menor)

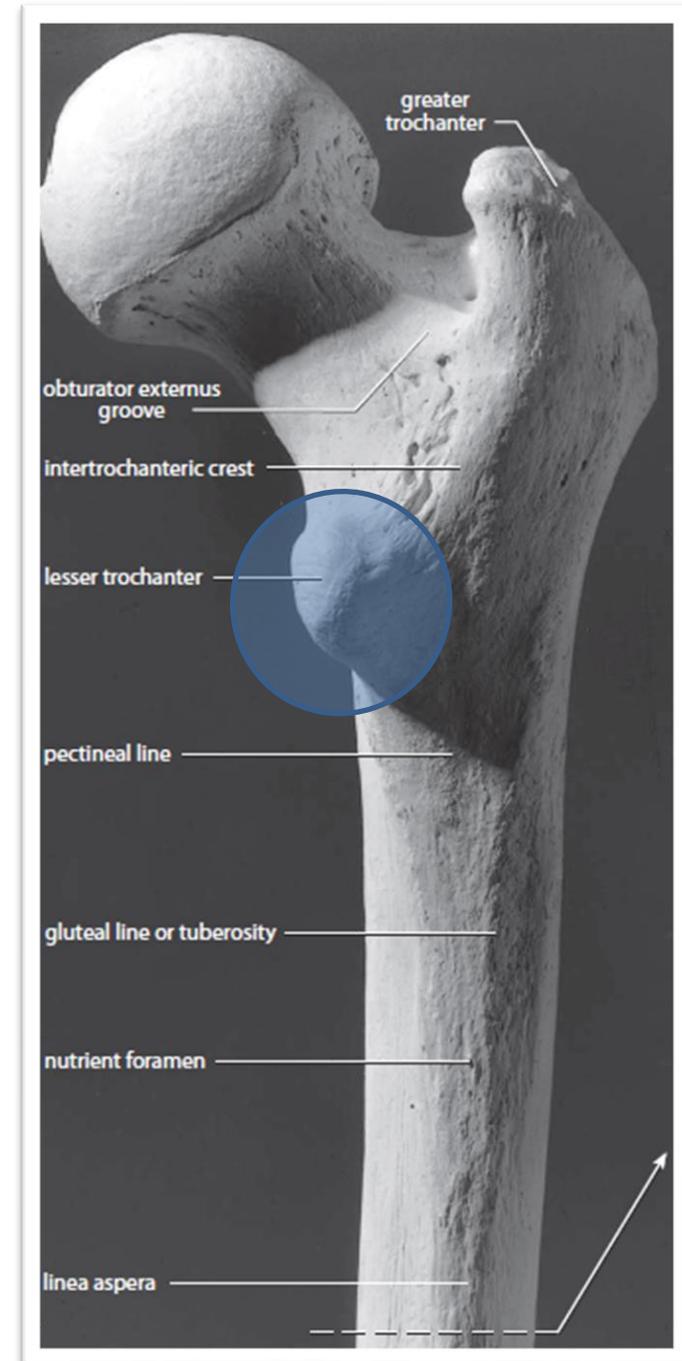
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## Intertrochanteric crest (Crista intertrocantérica)

- Elevated line on the posterior surface of the proximal fêmur between the greater and lesser trochanters. It passes from superolateral to inferomedial. Just above its midpoint is a small tubercle (the quadrate tubercle).

## Quadrate tubercle (Tubérculo quadrado)

- Small tubercle located above the midpoint of the intertrochanteric crest. It is the insertion site for the *quadratus femoris muscle*, a lateral rotator of the femur.



# The fêmur – proximal end

- **Lesser trochanter (Trocanter menor)**

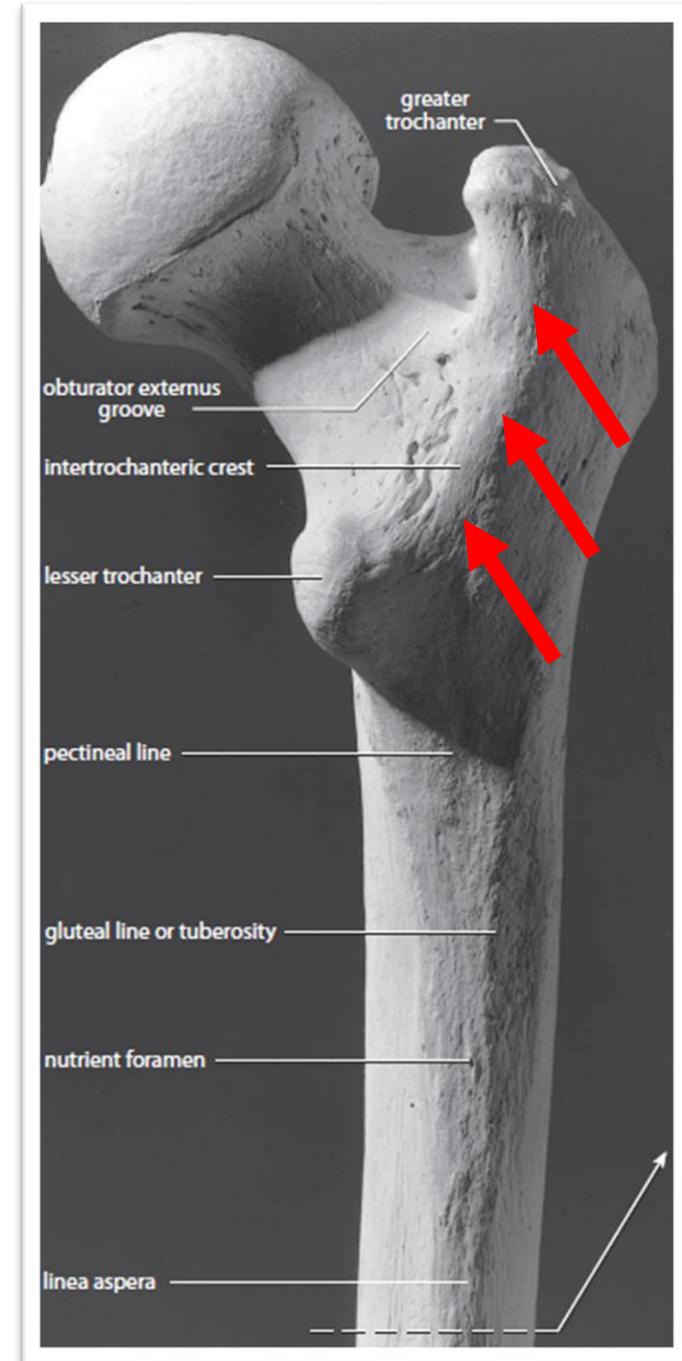
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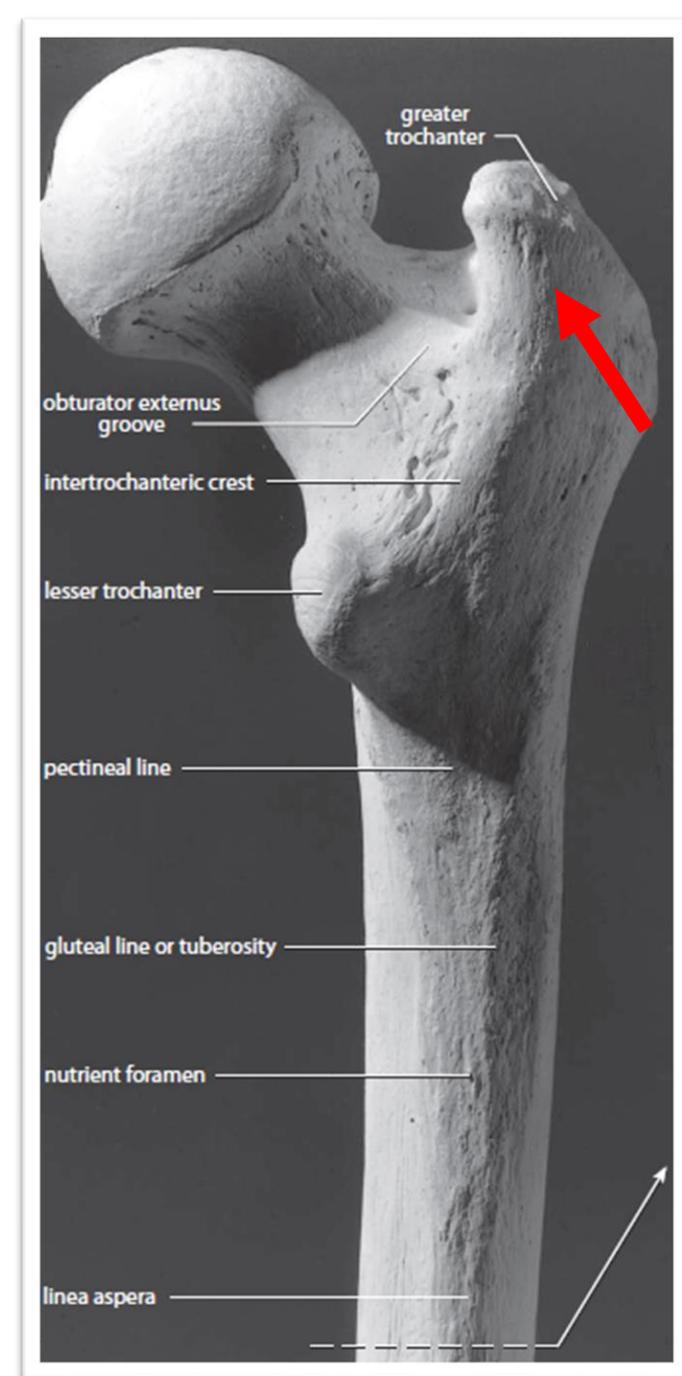
- **Quadrate tubercle (Tubérculo quadrado)**

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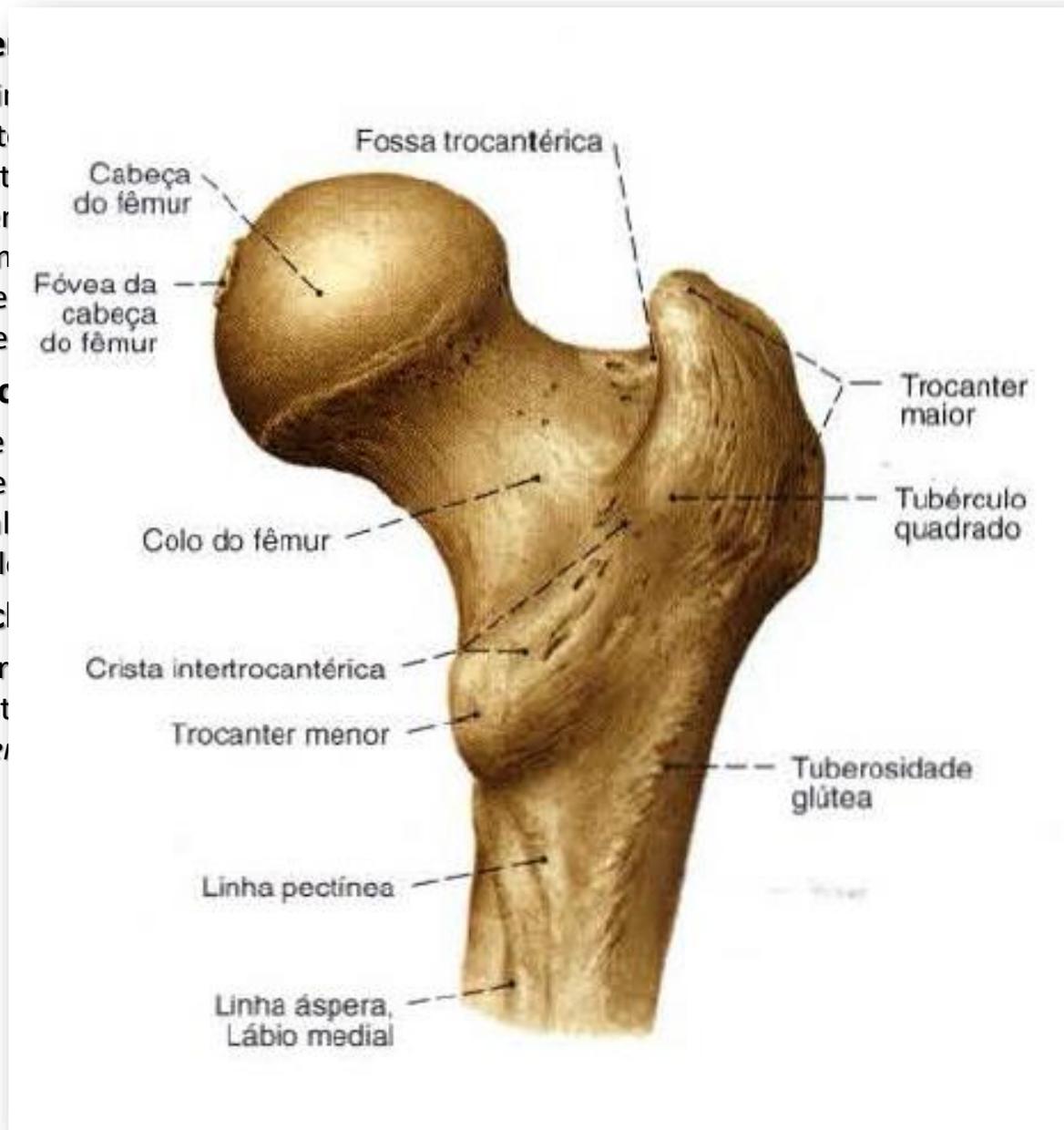
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  - Small tubercle located above the midpoint of the intertrochanteric crest. It is the insertion site for the *quadratus femoris muscle*, a lateral rotator of the femur.



# The fêmur – proximal end

- **Lesser trochanter**
  - Blunt, prominent just inferior to the greater trochanter. It is the point of attachment of the iliac fossa, and the lumbar vertebral flexors of the trunk.
- **Intertrochanteric crest**
  - Elevated line between the greater and lesser trochanters. The superolateral part is the small tubercle of the lesser trochanter.
- **Quadratus femoris tubercle**
  - Small tubercle on the lesser trochanter. The *quadratus femoris* muscle is attached to it.



# The fêmur – proximal end

- **Gluteal line and/or tuberosity (Linha glútea)**

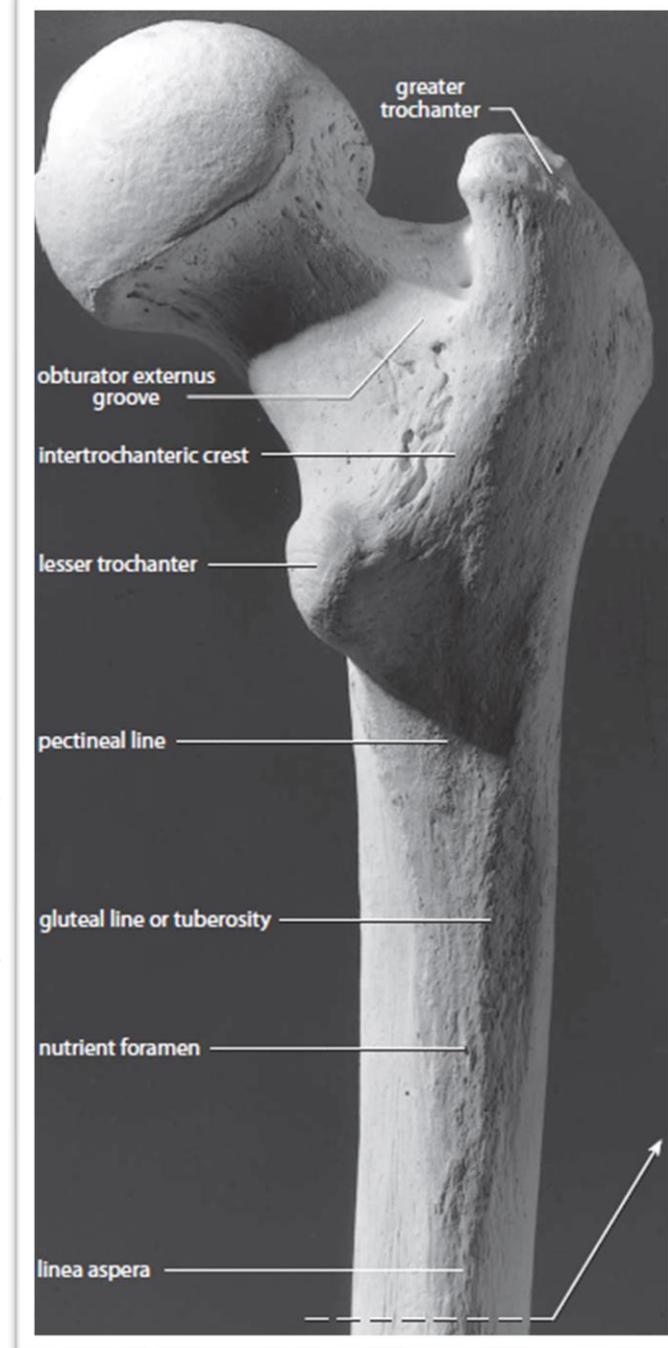
- A long, wide, roughened, posterolaterally placed feature that extends from the base of greater trochanter to the lip of the linea áspera. It can be a depression or it can assume the form of a true tuberosity. If the latter is present, it is often referred to as the **third trochanter**. It is the insertion for part of the *gluteus maximus muscle*, na extensor, abductor, and lateral rotator of the thigh at the hip that originates on the posterior Half of the os coxae, the sacrum and the coccyx.

- **Pectineal line (Linha pectínea)**

- A short, curved line that passes inferolaterally from the base of the lesser trochanter, between the spiral line and gluteal tuberosity/line. It is the insertion of the *pectineus muscle*, which originates from the pubic part of the ox coxae and acts to adduct, laterally rotate, and flex the thigh at the hip. long, wide, roughened, posterolaterally placed feature that extends from **Gluteal line and/or tuberosity (Linha glútea)**

- **Spiral line (?)**

- Spiraling inferior to the lesser trochanter, connects the inferior end of the intertrochanteric line with the medial lip of the linea áspera. It is the origin of the *vastus medialis muscle*, a part of the *quadriceps femoris muscle*, a knee extensor that inserts on the anterior tibia via the patella.



# The fêmur – proximal end

## Gluteal line and/or tuberosity (Linha glútea)

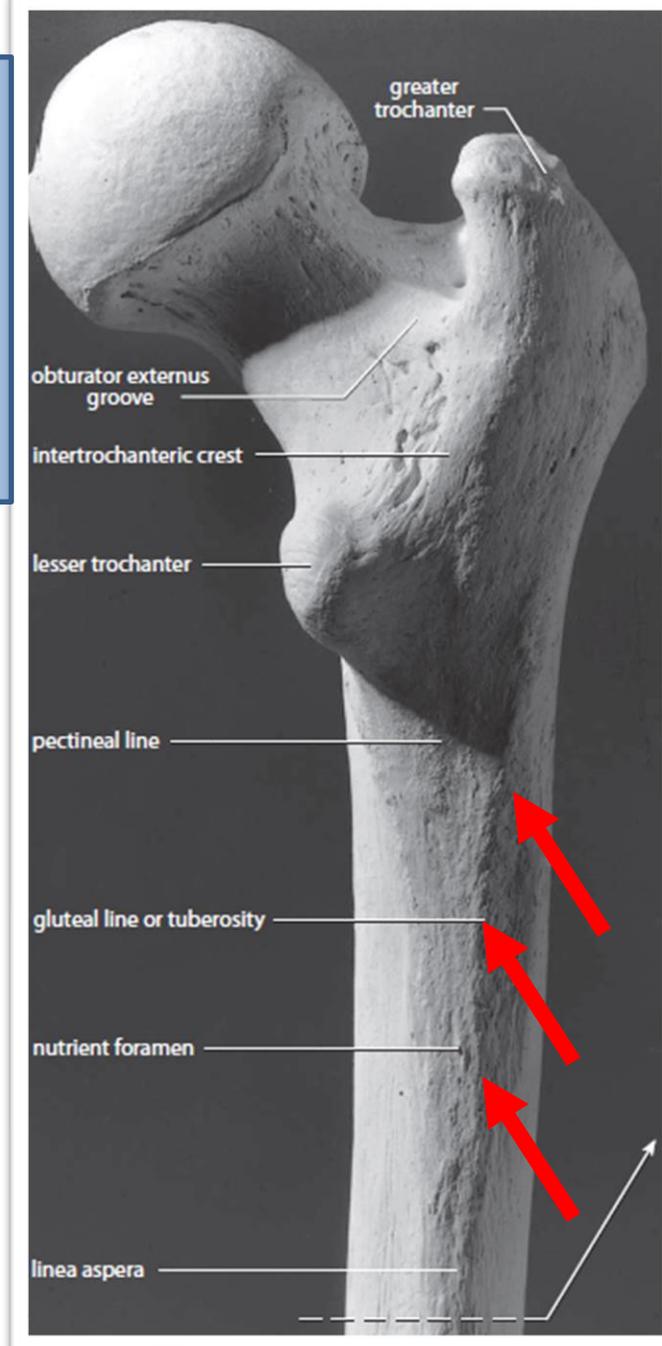
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# The fêmur – proximal end

- **Gluteal line and/or tuberosity (Linha glútea)**

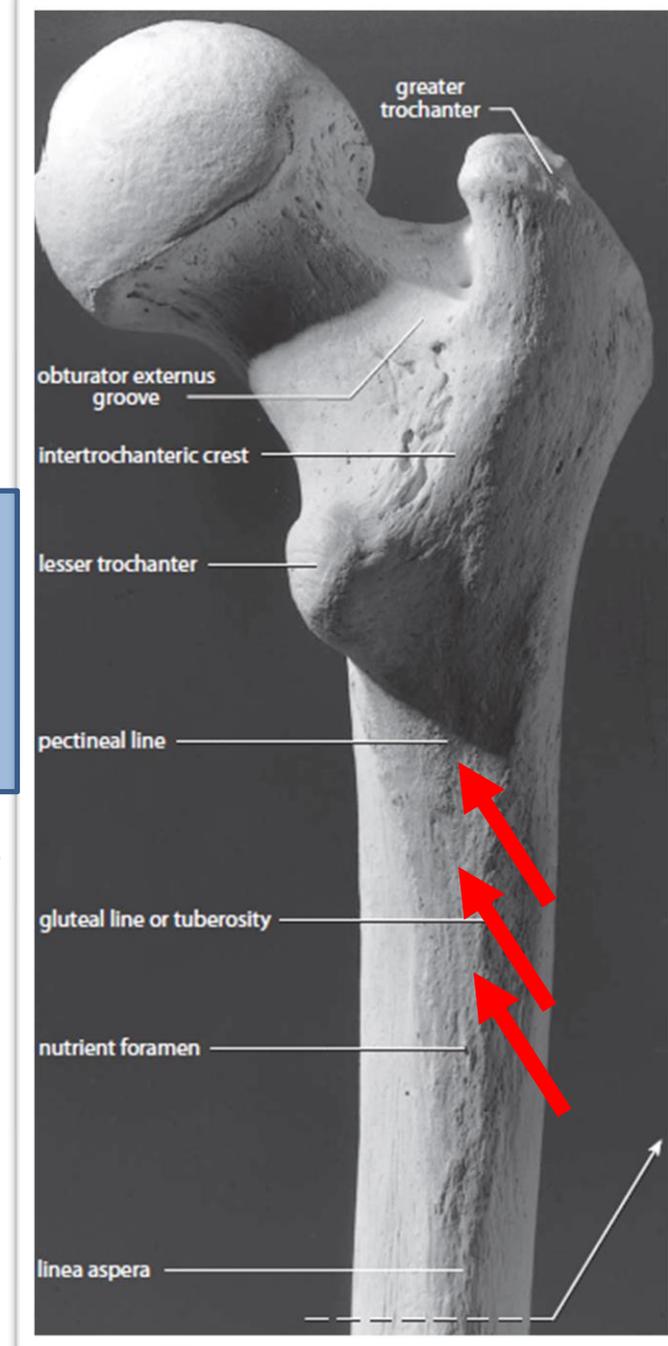
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# The fêmur – proximal end

- **Gluteal line and/or tuberosity (Linha glútea)**

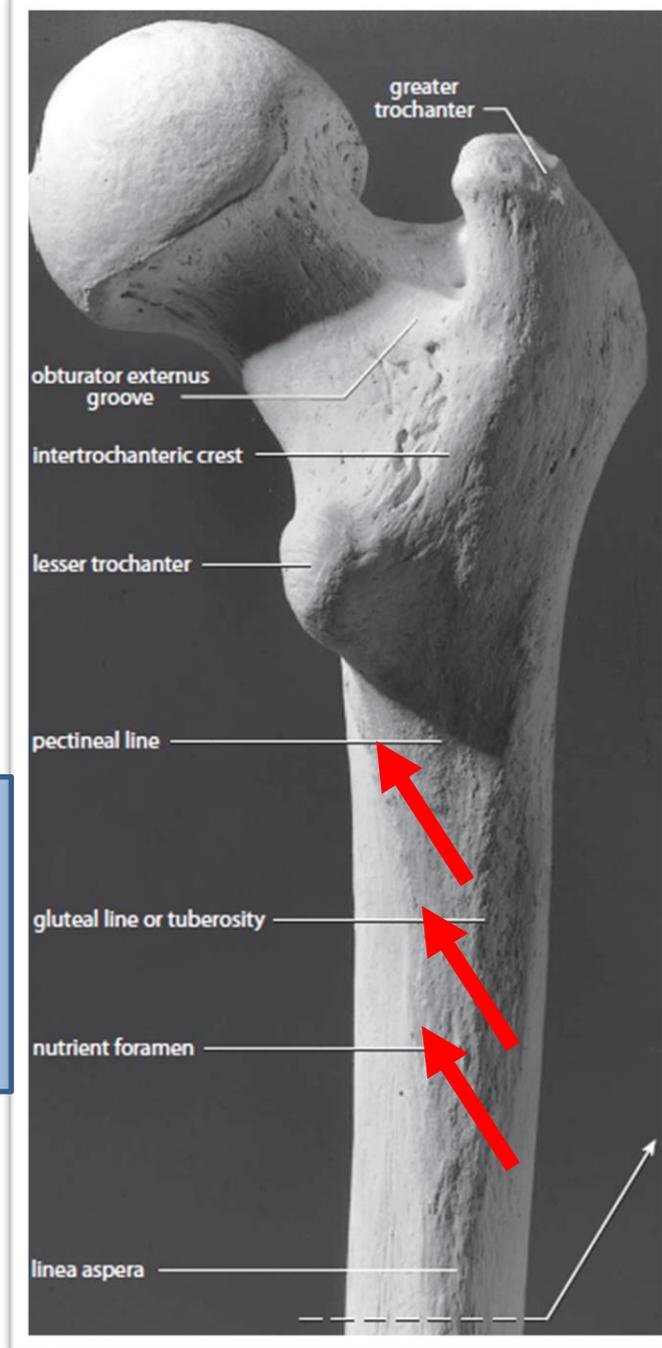
- A long, wide, roughened, posterolaterally placed feature that extends from the base of greater trochanter to the lip of the linea áspera. It can be a depression or it can assume the form of a true tuberosity. If the latter is present, it is often referred to as the **third trochanter**. It is the insertion for part of the *gluteus maximus muscle*, na extensor, abductor, and lateral rotator of the thigh at the hip that originates on the posterior Half of the os coxae, the sacrum and the coccyx.

- **Pectineal line (Linha pectínea)**

- A short, curved line that passes inferolaterally from the base of the lesser trochanter, between the spiral line and gluteal tuberosity/line. It is the insertion of the *pectineus muscle*, which originates from the pubic part of the ox coxae and acts to adduct, laterally rotate, and flex the thigh at the hip.

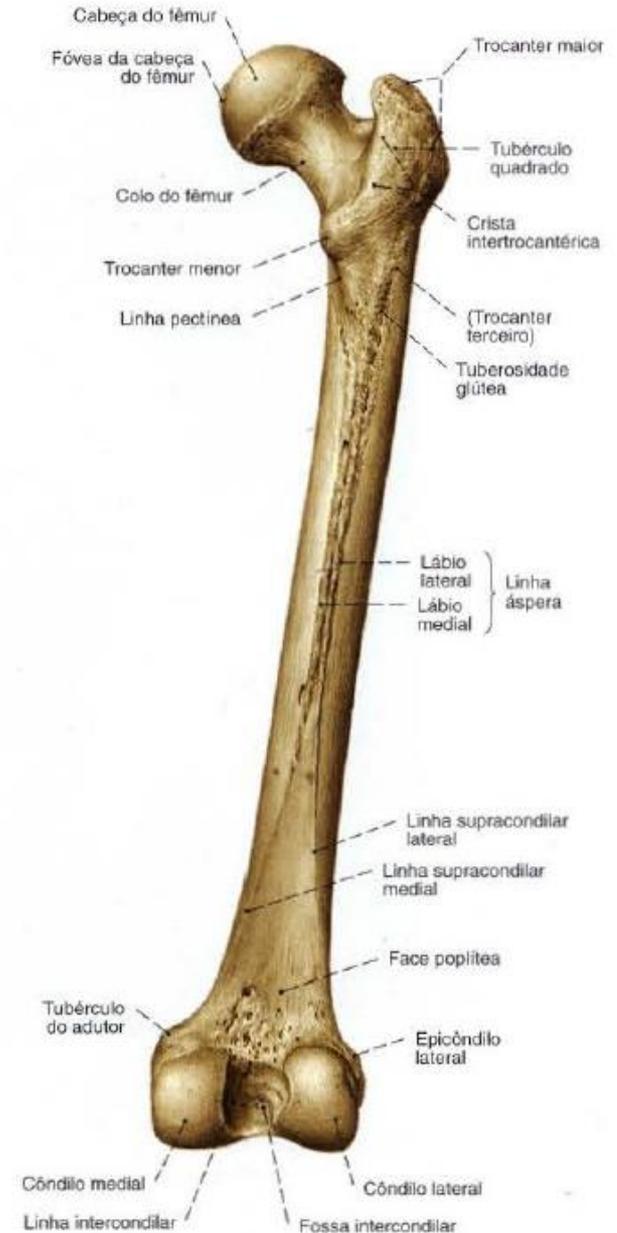
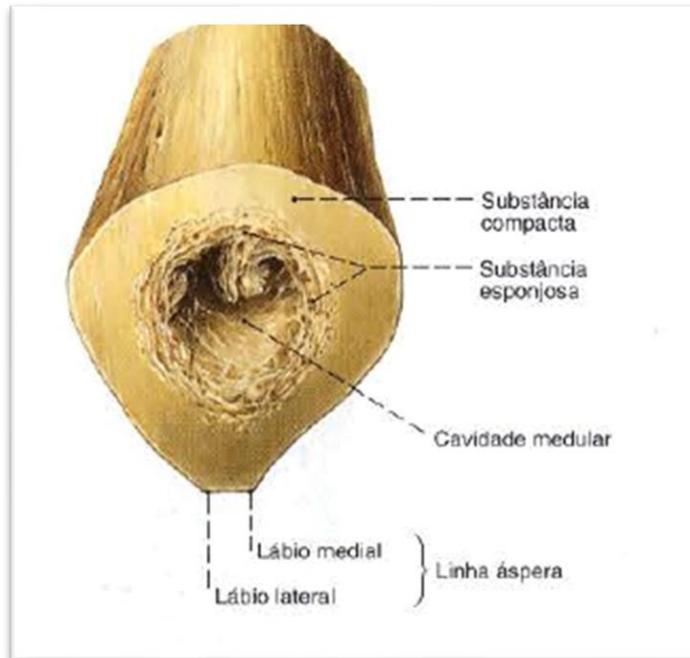
- **Spiral line (?)**

- Spiraling inferior to the lesser trochanter, connects the inferior end of the intertrochanteric line with the medial lip of the linea áspera. It is the origin of the *vastus medialis muscle*, a part of the *quadriceps femoris muscle*, a knee extensor that inserts on the anterior tibia via the patella.



# The fêmur – Femoral shaft

- **Femoral shaft (Corpo do fêmur)**
  - O corpo do fêmur é a longa seção entre as terminações expandidas do osso.
- **Linea aspera**
  - Long, wide, roughened, and elevated ridge that runs along the posterior shaft surface. It collects the spiral, pectineal and gluteal lines proximally and divides into the supracondylar ridges distally. Is the origin for the *vastus muscles* and insertion of the adductors of the hip (*longis, brevis, and mafnus*)



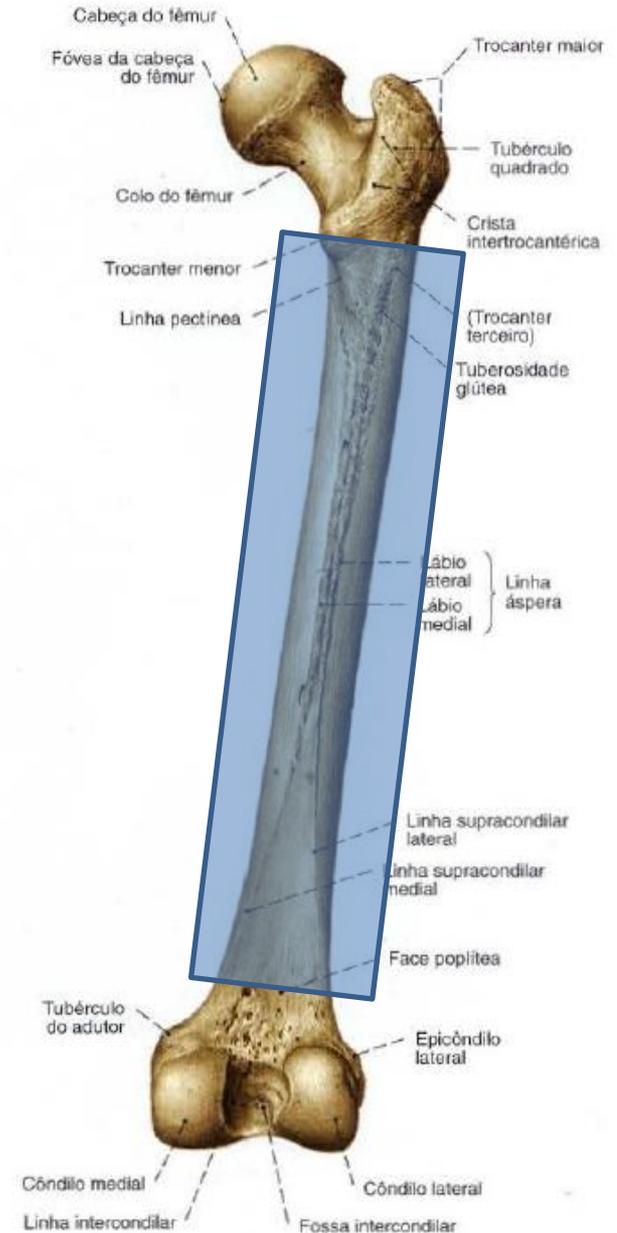
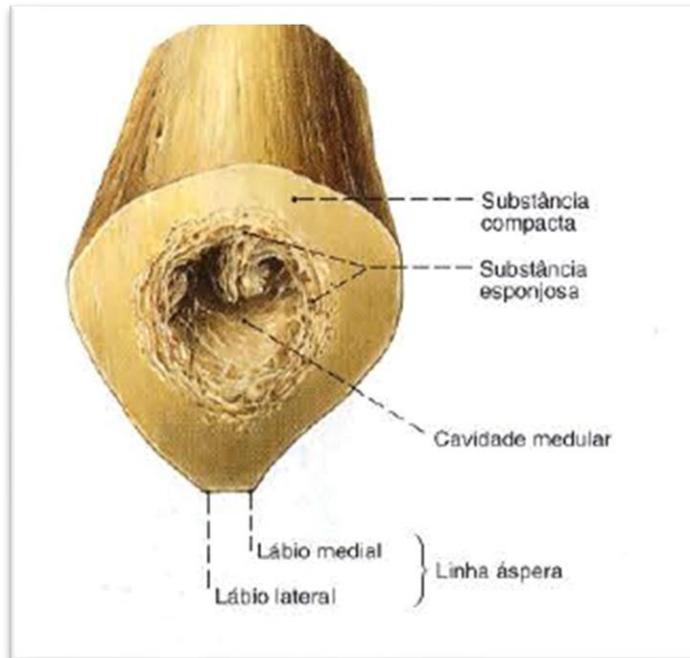
# The fêmur – Femoral shaft

## Femoral shaft (Corpo do fêmur)

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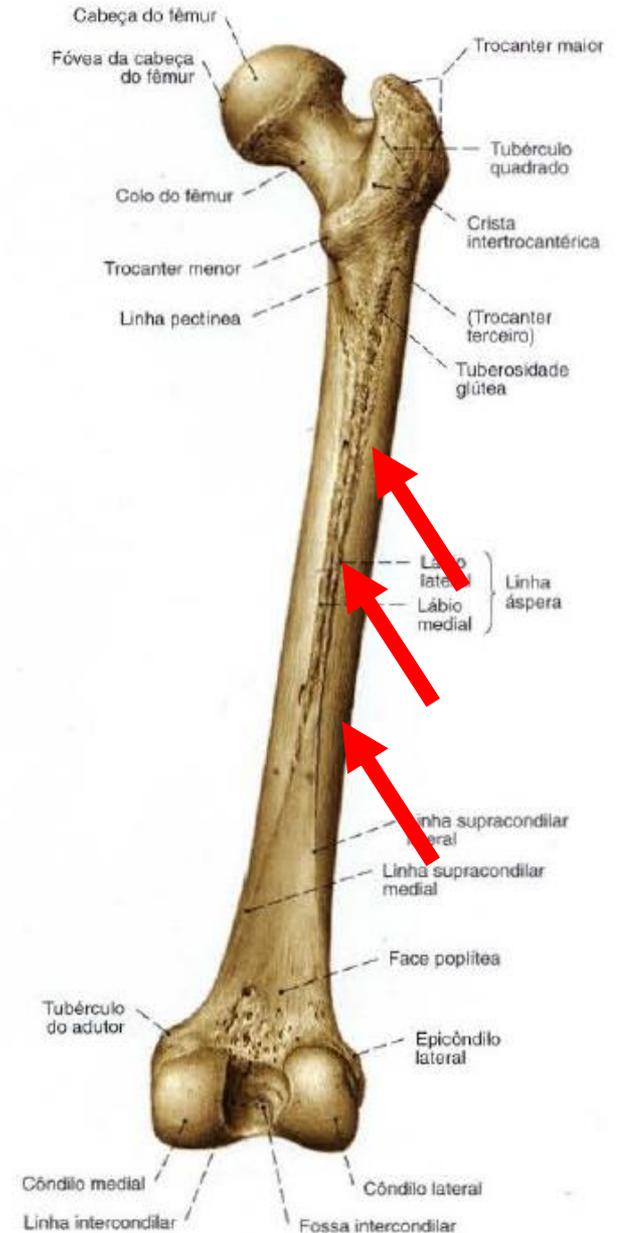
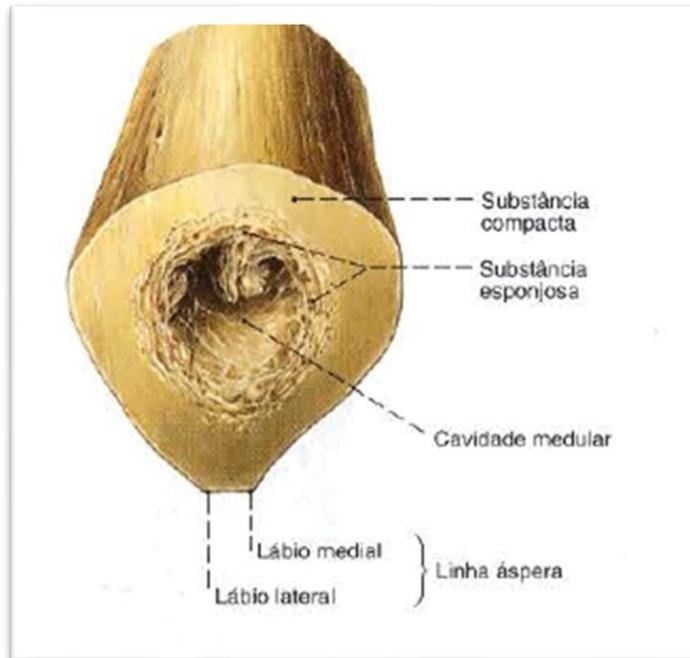
# The fêmur – Femoral shaft

- **Femoral shaft (Corpo do fêmur)**

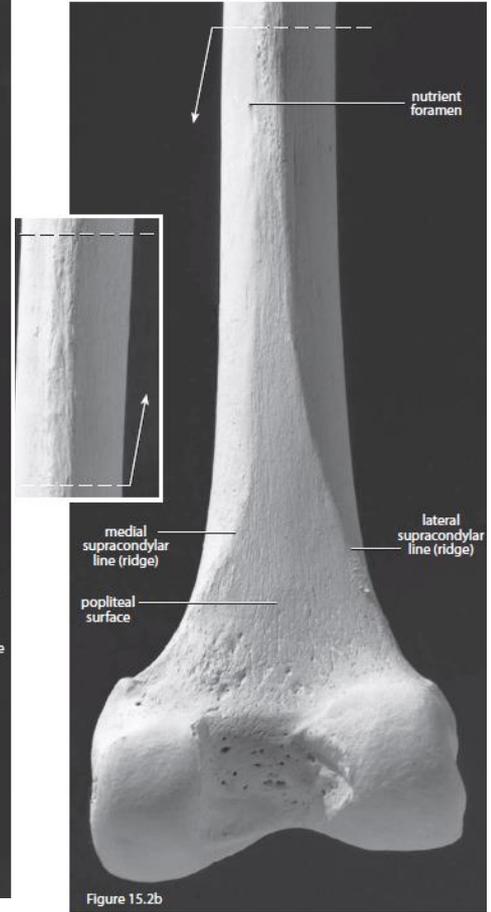
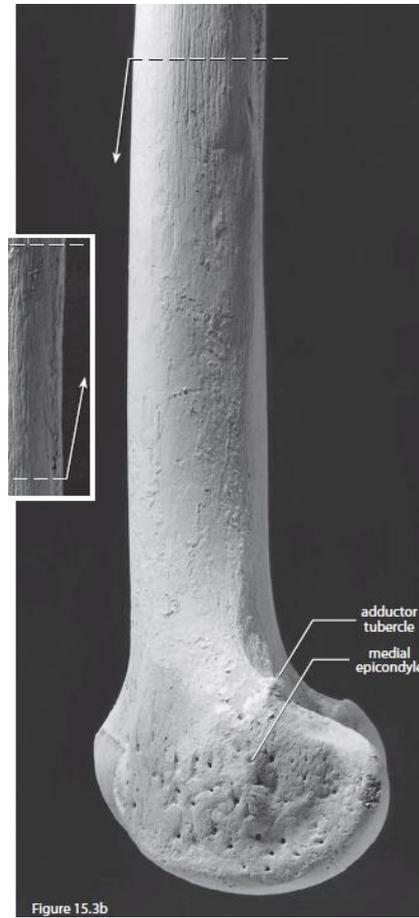
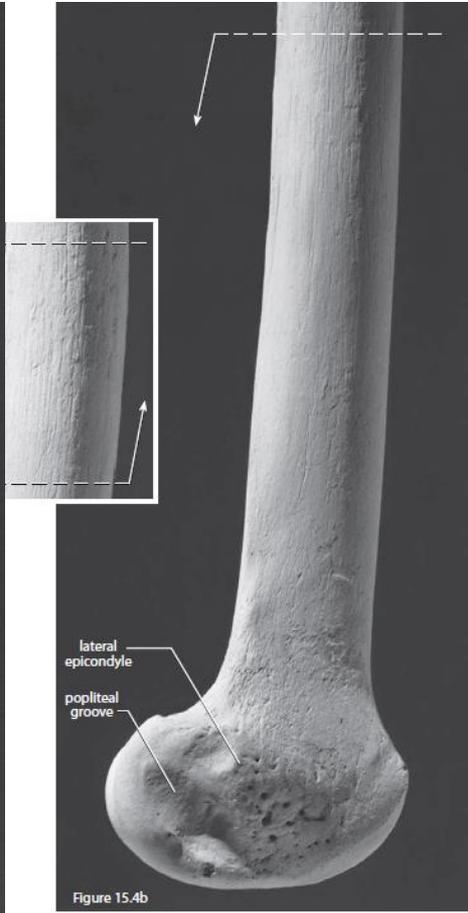
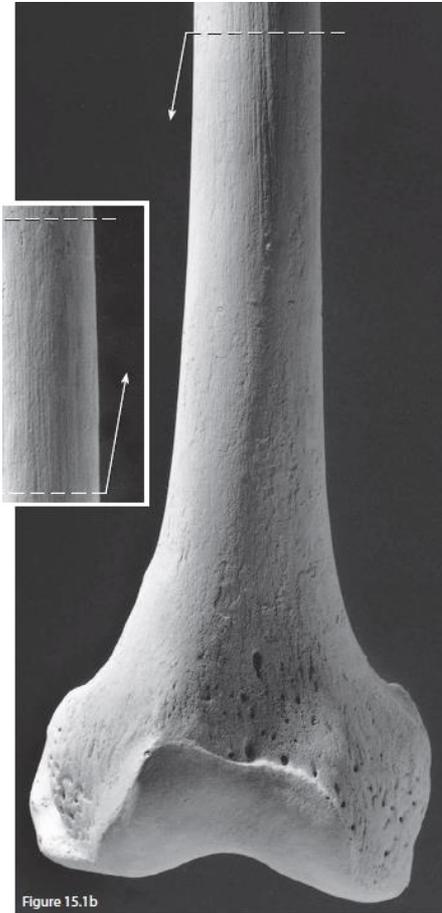
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- **Linea aspera**

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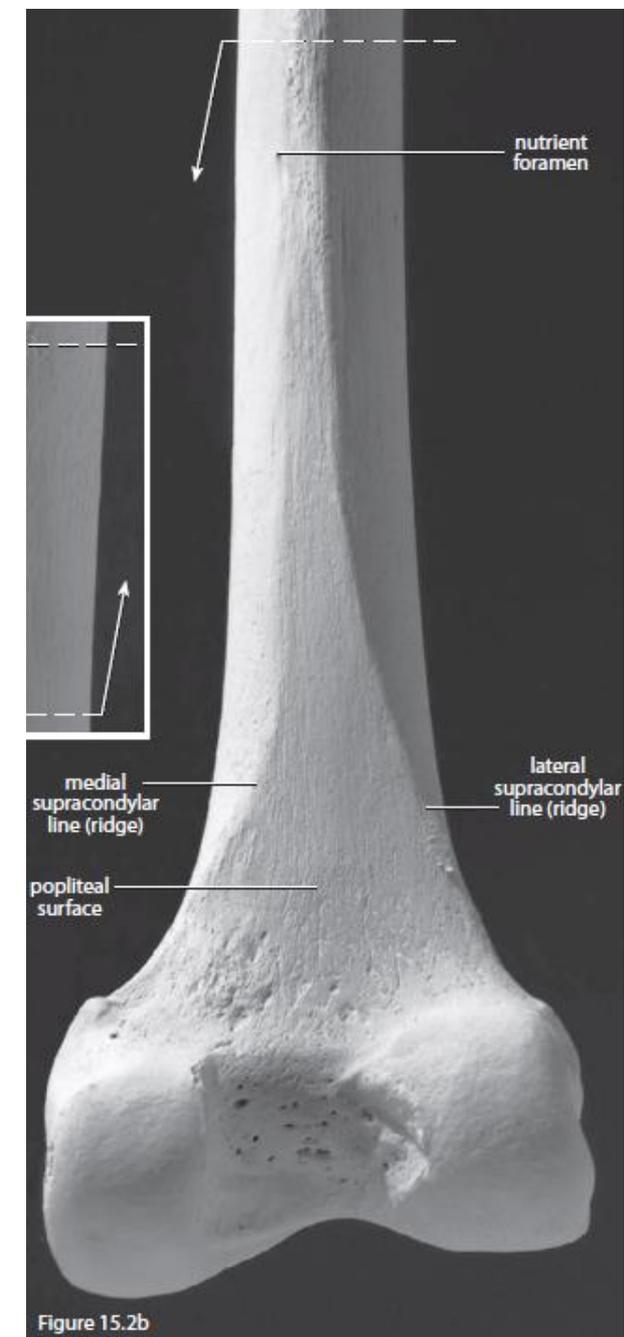


# The fêmur – distal end



# The fêmur – distal end

- **Medial supracondylar line/ridge (Linha supracondilar medial)**
  - The inferior (distal), medial extension of the linea áspera, marking the distal, medial corner of the shaft. It is fainter than the lateral supracondylar ridge.
- **Lateral supracondylar line/ridge (Linha supracondilar lateral)**
  - The inferior (distal), lateral extension of the linea áspera. It is more pronounced than the medial supracondylar ridge.
- **Popliteal surface (Face poplítea)**
  - Wide, flat, triangular area of the posterior, distal femur. It is bounded by the condyles inferiorly and by the supracondylar lines medially and laterally.



# The fêmur – distal end

- **Medial supracondylar line/ridge (Linha supracondilar medial)**

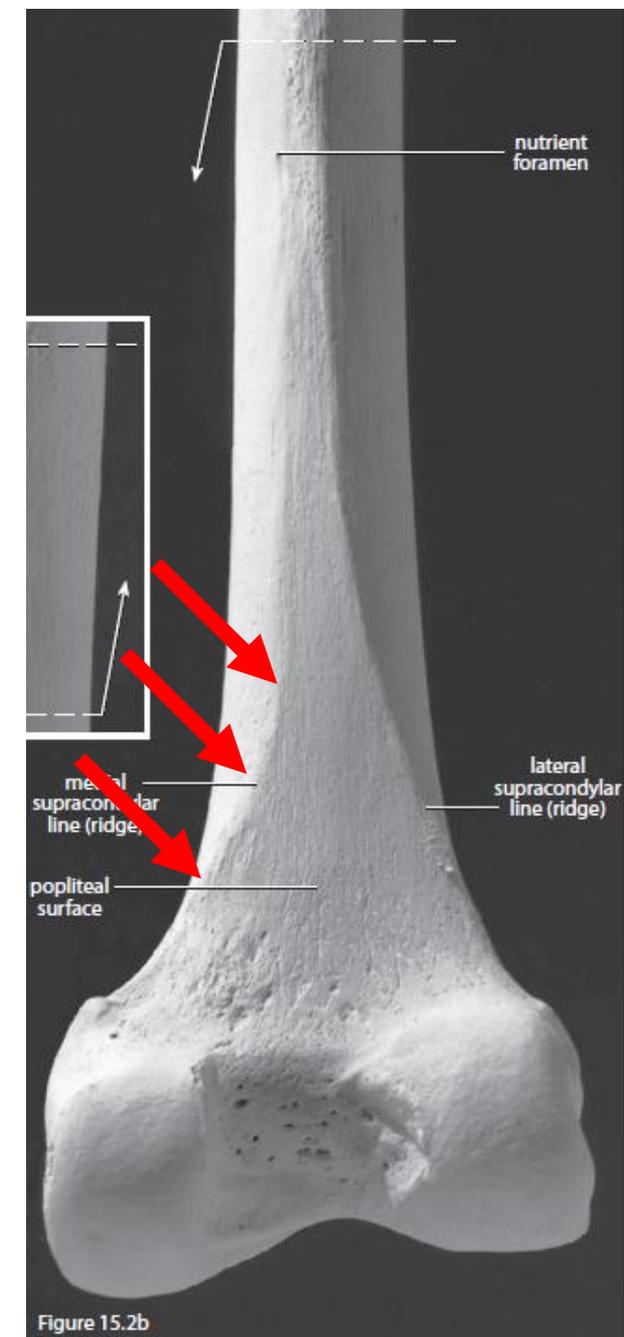
- The inferior (distal), medial extension of the linea áspera, marking the distal, medial corner of the shaft. It is fainter than the lateral supracondylar ridge.

- **Lateral supracondylar line/ridge (Linha supracondilar lateral)**

- The inferior (distal), lateral extension of the linea áspera. It is more pronounced than the medial supracondylar ridge.

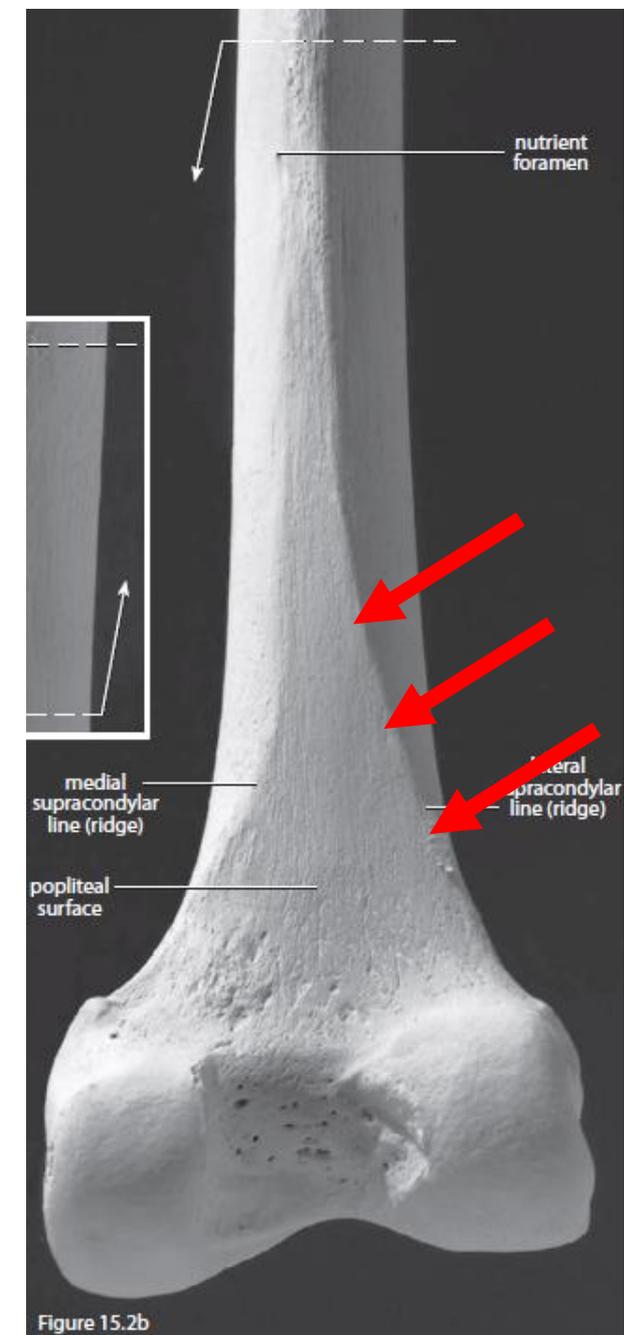
- **Popliteal surface (Face poplítea)**

- Wide, flat, triangular area of the posterior, distal femur. It is bounded by the condyles inferiorly and by the supracondylar lines medially and laterally.



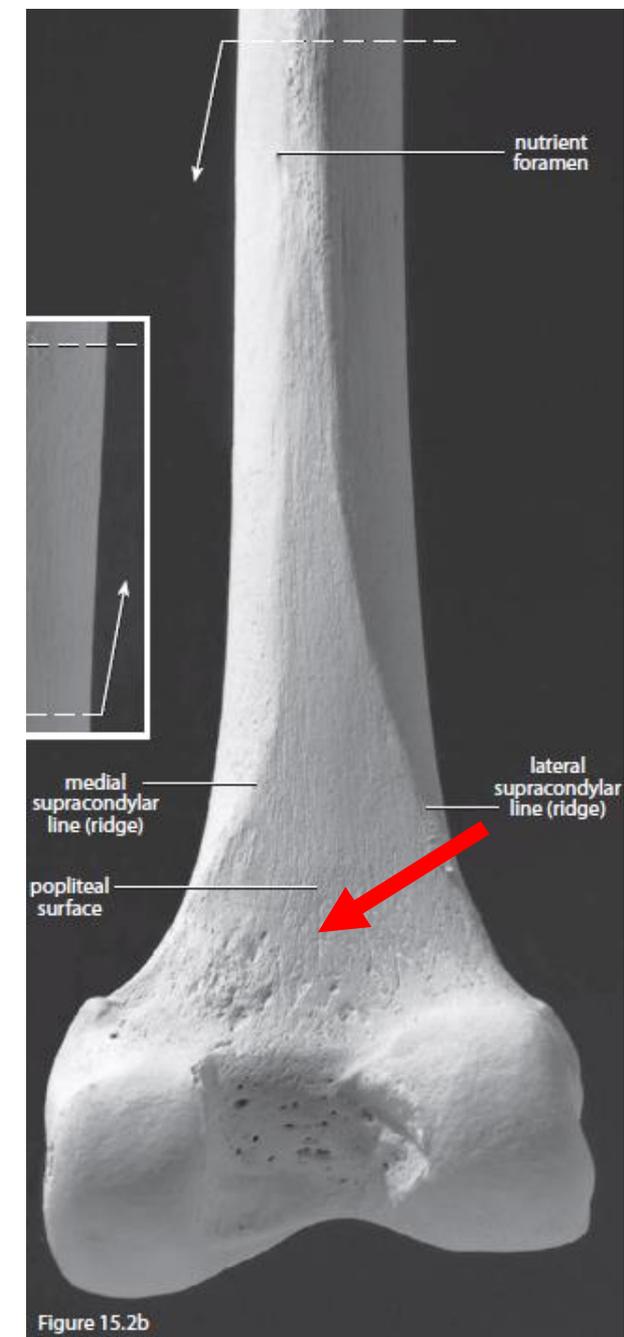
# The fêmur – distal end

- **Medial supracondylar line/ridge (Linha supracondilar medial)**
  - The inferior (distal), medial extension of the linea áspera, marking the distal, medial corner of the shaft. It is fainter than the lateral supracondylar ridge.
- **Lateral supracondylar line/ridge (Linha supracondilar lateral)**
  - The inferior (distal), lateral extension of the linea áspera. It is more pronounced than the medial supracondylar ridge.
- **Popliteal surface (Face poplítea)**
  - Wide, flat, triangular area of the posterior, distal femur. It is bounded by the condyles inferiorly and by the supracondylar lines medially and laterally.



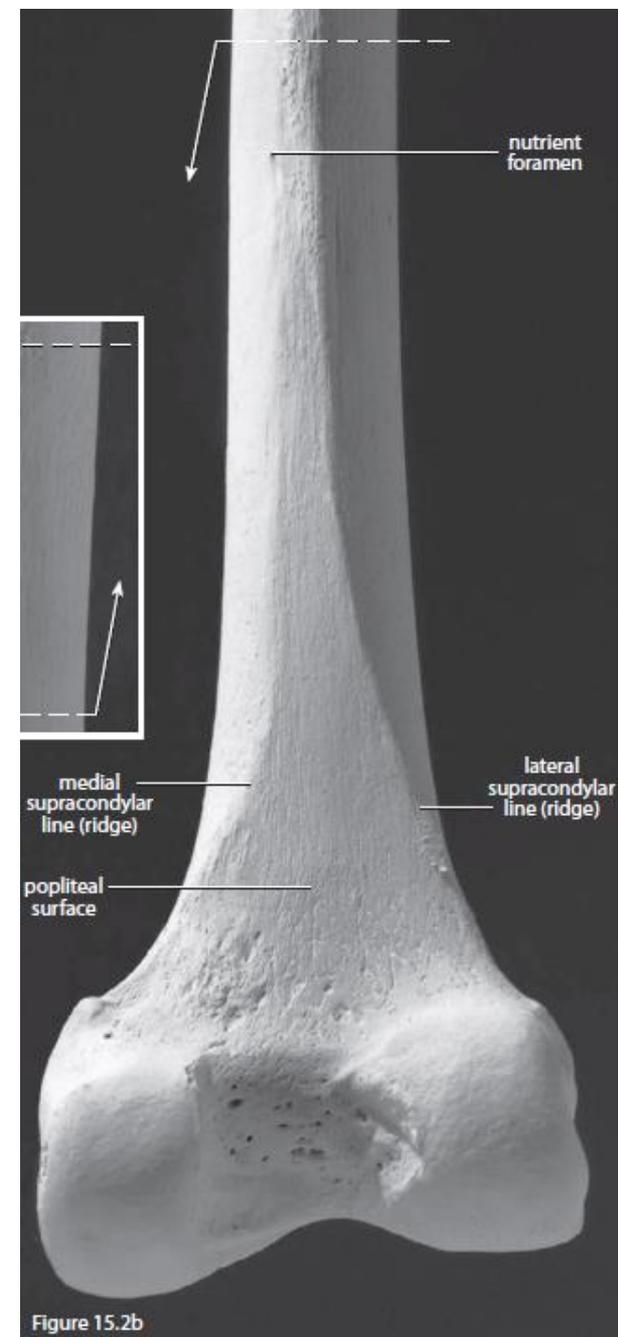
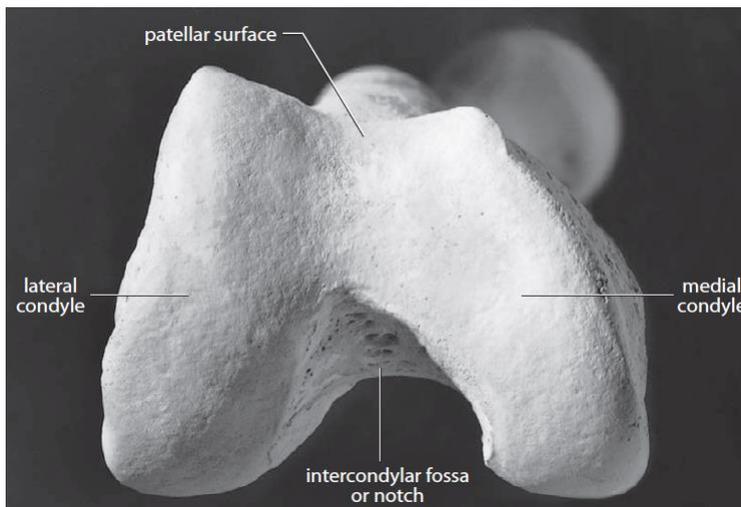
# The fêmur – distal end

- **Medial supracondylar line/ridge (Linha supracondilar medial)**
  - The inferior (distal), medial extension of the linea áspera, marking the distal, medial corner of the shaft. It is fainter than the lateral supracondylar ridge.
- **Lateral supracondylar line/ridge (Linha supracondilar lateral)**
  - The inferior (distal), lateral extension of the linea áspera. It is more pronounced than the medial supracondylar ridge.
- **Popliteal surface (Face poplítea)**
  - Wide, flat, triangular area of the posterior, distal femur. It is bounded by the condyles inferiorly and by the supracondylar lines medially and laterally.



# The fêmur – distal end

- **Medial condyle (Côndilo medial)**
  - The large, articular knob on the medial side of the distal fêmur. Its medial surface bulges away from the axis of the shaft. The medial condyle extends more distally than the lateral condyle.
- **Lateral condyle (Côndilo lateral)**
  - The large, protruding, articular knob on the lateral side of the distal fêmur.
- **Medial epicondyle (Epicôndilo medial)**
  - Is the convexity on the medial side of the medial condyle. It is a point of attachment for the *medial collateral ligament* of the knee.
- **Lateral epicondyle (Epicôndilo lateral)**
  - Is the convexity on the lateral side of the lateral condyle. It is an attachment point for the *lateral collateral ligament* of the knee. Its upper surface bears a facet that is an attachment point for one head of the *gastrocnemius muscle*, a flexor of the knee and plantar flexor of the foot at the ankle.



# The fêmur – distal end

## • Medial condyle (Côndilo medial)

- The large, articular knob on the medial side of the distal fêmur. Its medial surface bulges away from the axis of the shaft. The medial condyle extends more distally than the lateral condyle.

## • Lateral condyle (Côndilo lateral)

- The large, protruding, articular knob on the lateral side of the distal fêmur.

## • Medial epicondyle (Epicôndilo medial)

- Is the convexity on the medial side of the medial condyle. It is a point of attachment for the *medial colateral ligament* of the knee.

## • Lateral epicondyle (Epicôndilo lateral)

- Is the convexity on the lateral side of the lateral condyle. It is an attachment point for the *lateral colateral ligament* of the knee. Its upper surface bears a facet that is an attachment point for one head of the *gastrocnemius muscle*, a flexor of the knee and plantar flexor of the foot at the ankle.

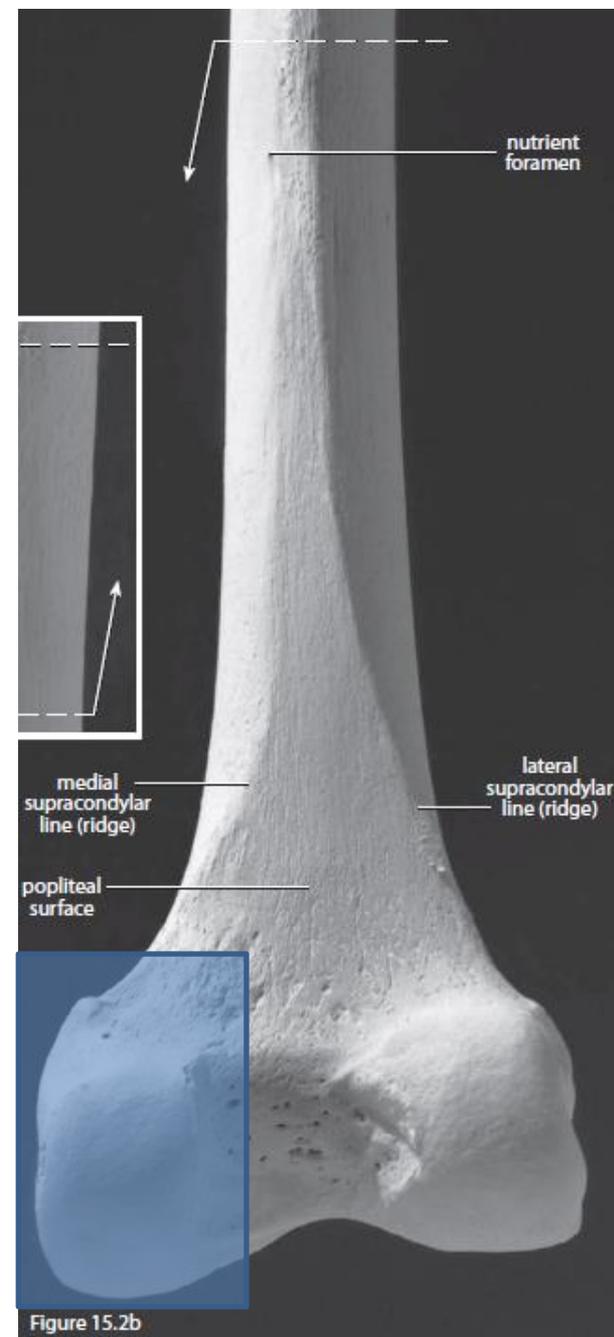
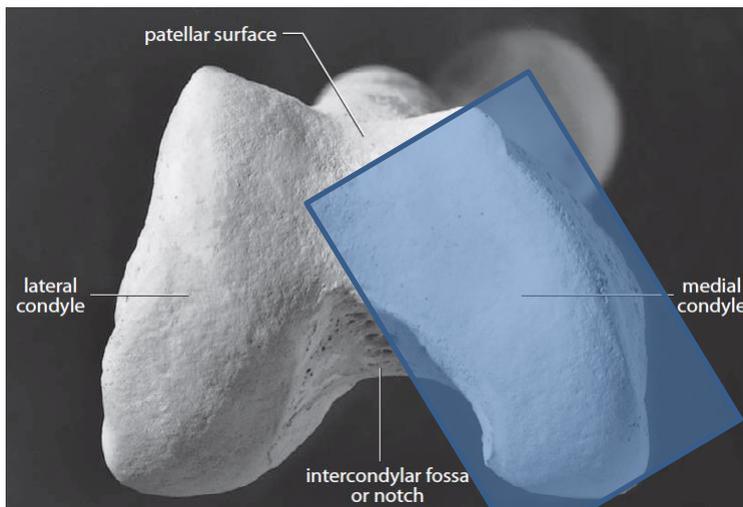


Figure 15.2b

# The fêmur – distal end

- **Medial condyle (Côndilo medial)**

- The large, articular knob on the medial side of the distal fêmur. Its medial surface bulges away from the axis of the shaft. The medial condyle extends more distally than the lateral condyle.

- **Lateral condyle (Côndilo lateral)**

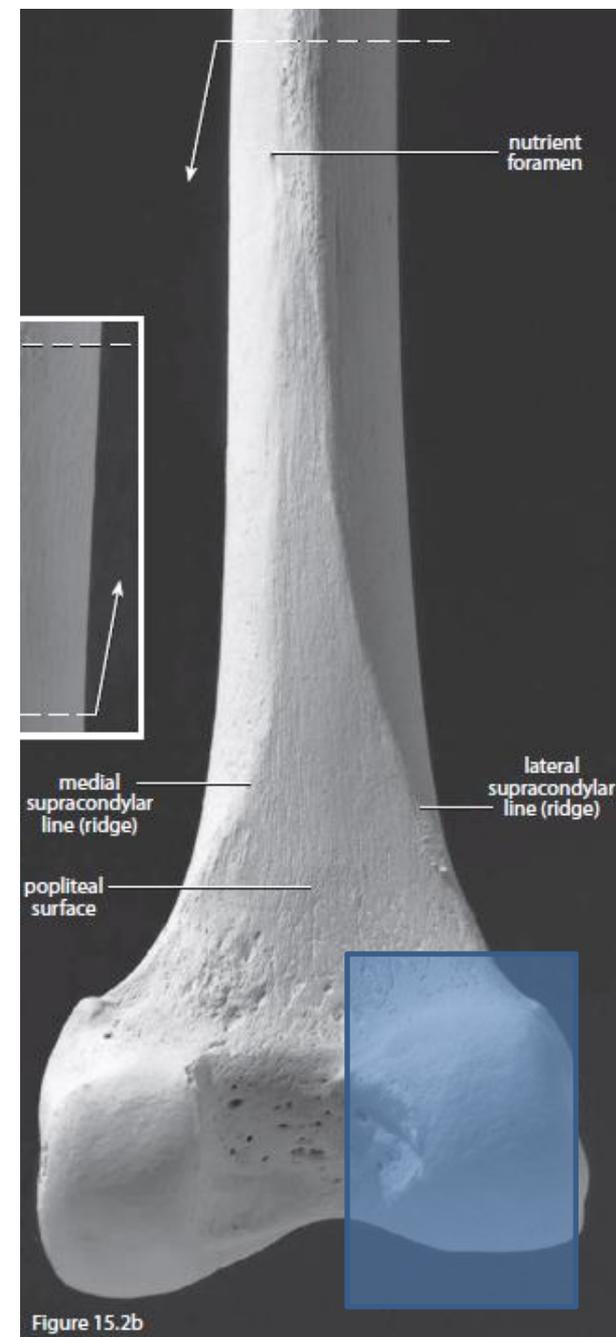
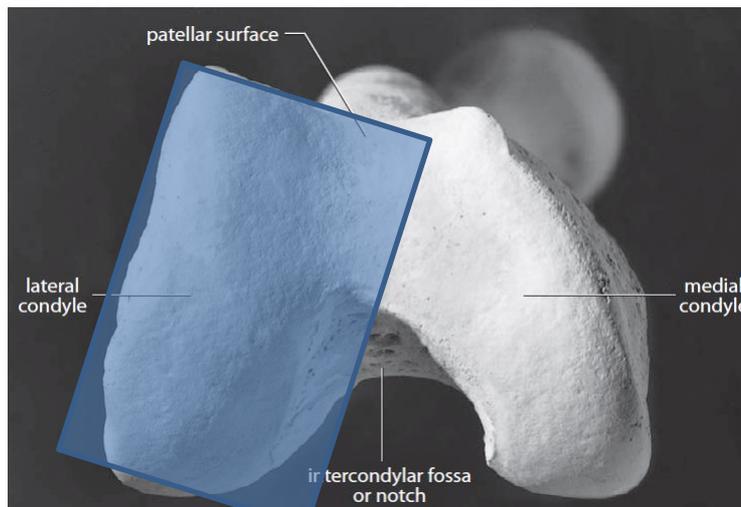
- The large, protruding, articular knob on the lateral side of the distal fêmur.

- **Medial epicondyle (Epicôndilo medial)**

- Is the convexity on the medial side of the medial condyle. It is a point of attachment for the *medial collateral ligament* of the knee.

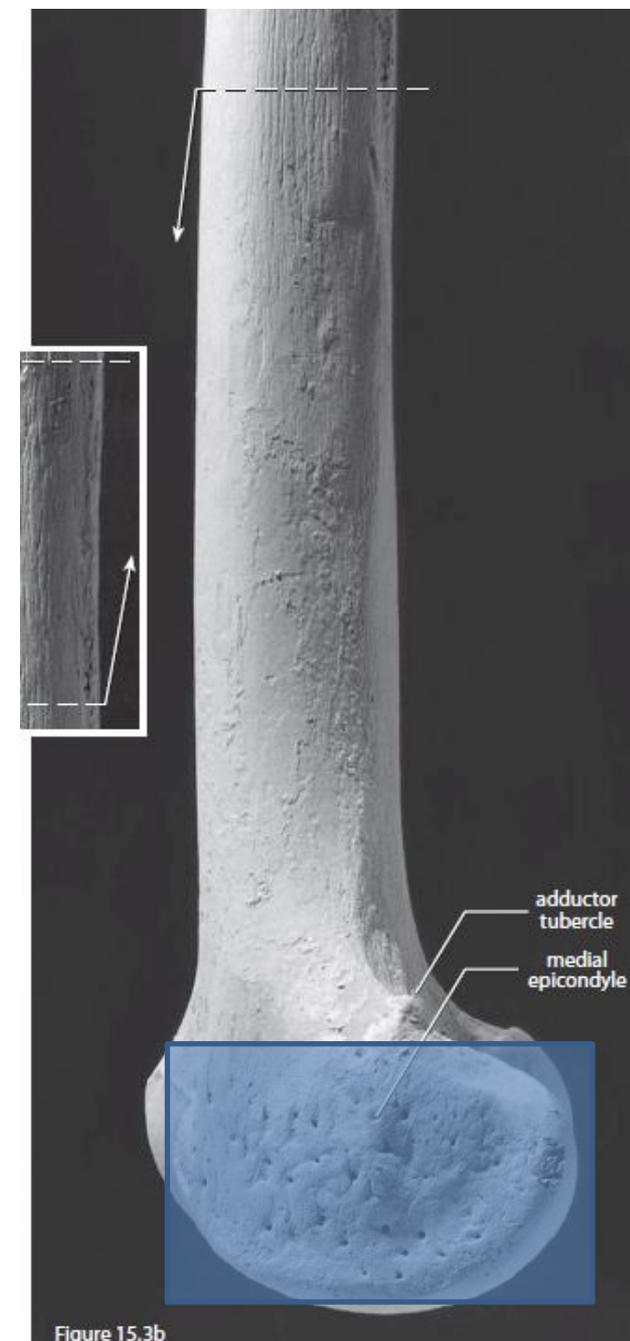
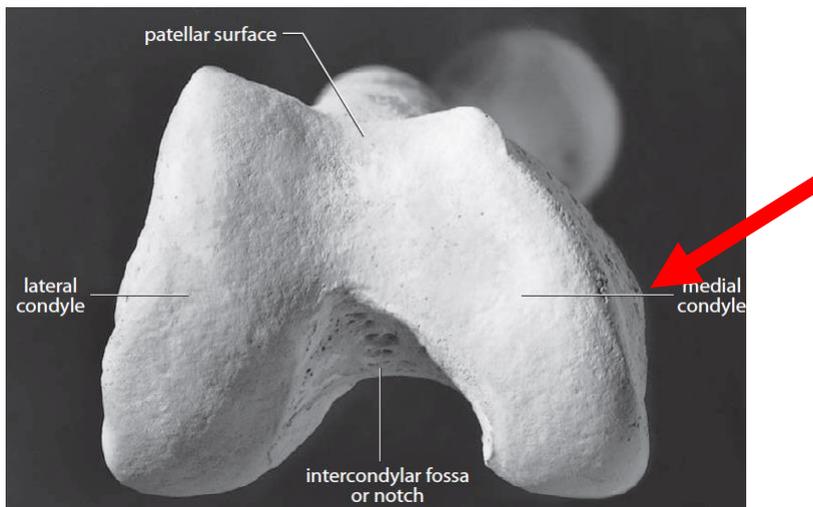
- **Lateral epicondyle (Epicôndilo lateral)**

- Is the convexity on the lateral side of the lateral condyle. It is an attachment point for the *lateral collateral ligament* of the knee. Its upper surface bears a facet that is an attachment point for one head of the *gastrocnemius muscle*, a flexor of the knee and plantar flexor of the foot at the ankle.



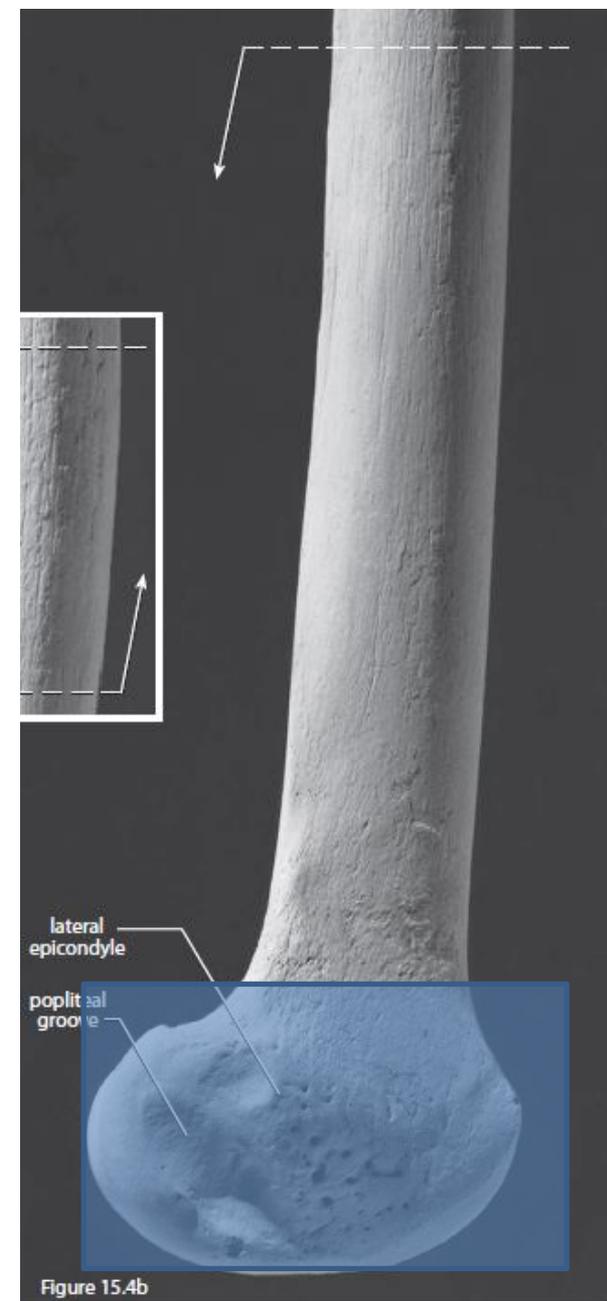
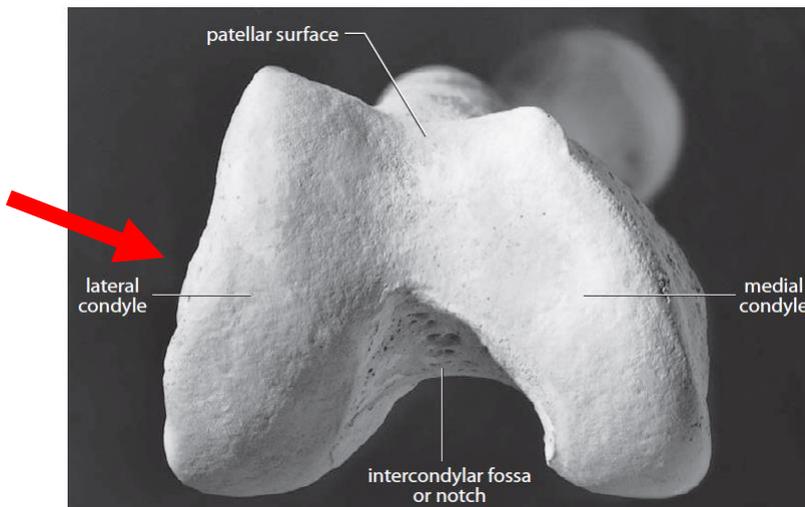
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  - Is the convexity on the medial side of the medial condyle. It is a point of attachment for the *medial colateral ligament* of the knee.
- **Lateral epicondyle (Epicôndilo lateral)**
  - Is the convexity on the lateral side of the lateral condyle. It is not an attachment point for the *lateral colateral ligament* of the knee. Its upper surface bears a facet that is an attachment point for one head of the *gastrocnemius muscle*, a flexor of the knee and plantar flexor of the foot at the ankle.



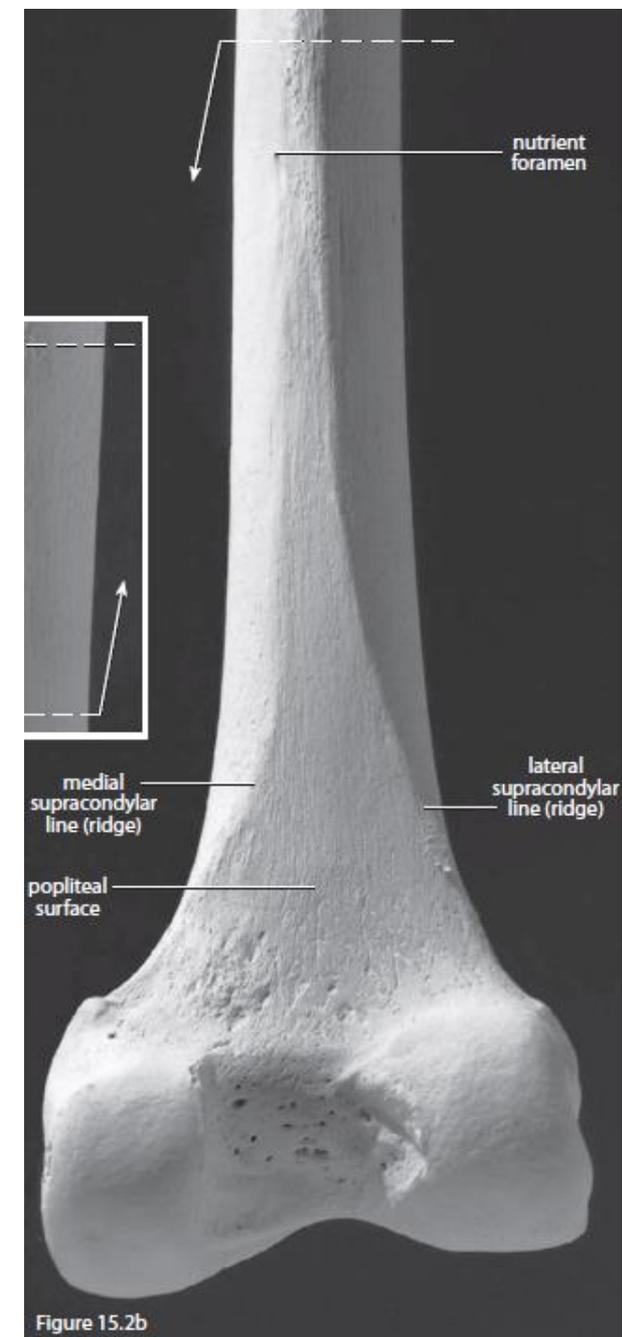
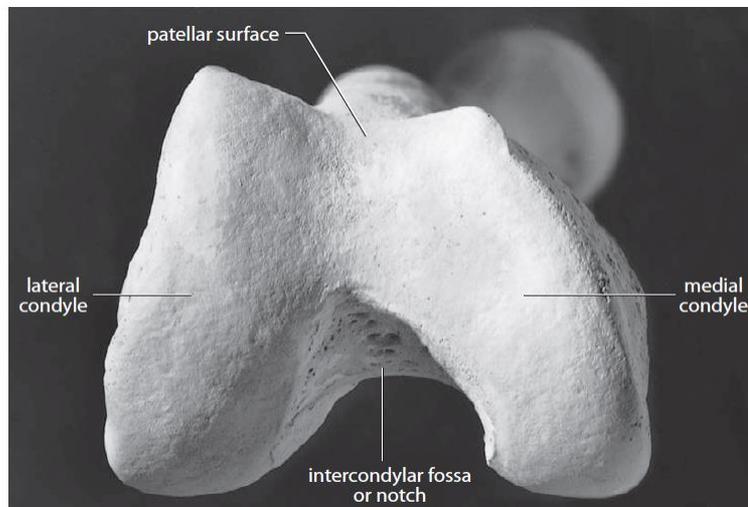
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# The fêmur – distal end

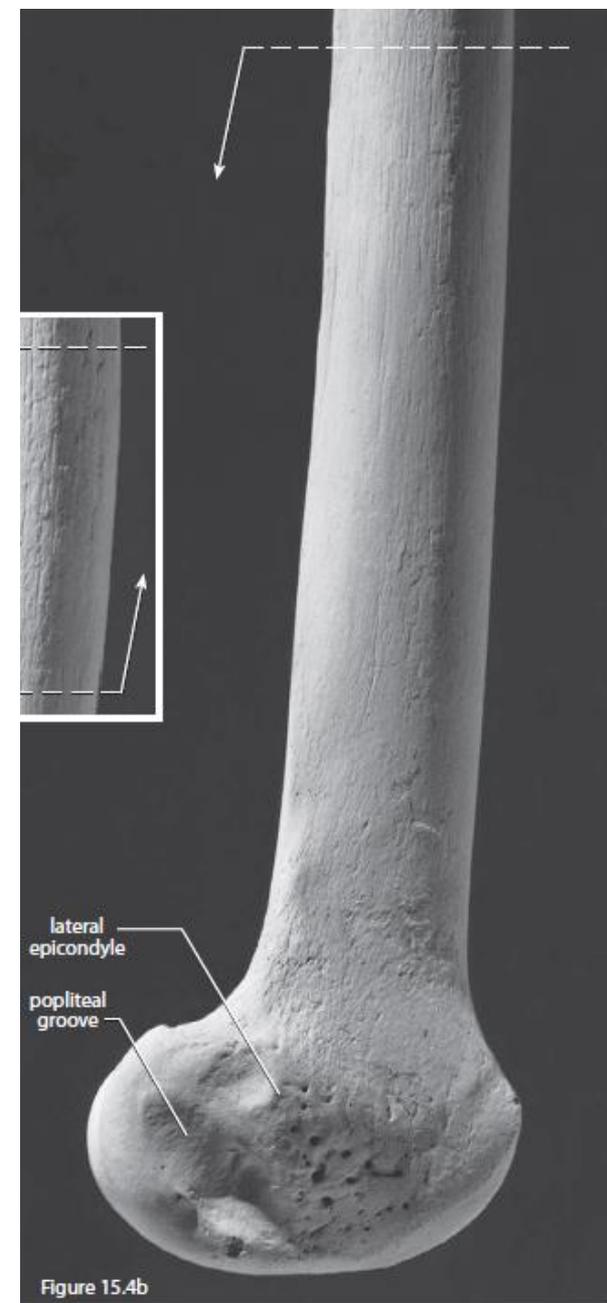
- **Intercondylar fossa or notch (Fossa intercondilar)**
  - Nonarticular, excavated surface between the distal and posterior surfaces of the condyles. Within the fossa are two facets that are the femoral attachment sites of the *anterior* and *posterior cruciate ligaments*, a pair of crossed ligaments linking the fêmur and tibia. These ligaments strengthen the knee joint.
- **Patellar surface (Face patelar)**
  - Is a notched, articular área on the anterior surface of the distal fêmur, over which the patella glides during flexion and extension of the knee. The lateral surface of this notch is elevated, projecting more anteriorly than the medial boundary of the notch. Nonarticular, excavated surface between the distal and posterior surfaces of the condyles. Within the fossa are two facets that are the femoral attachment sites of t



# The fêmur – distal end

- **Popliteal groove ( )**

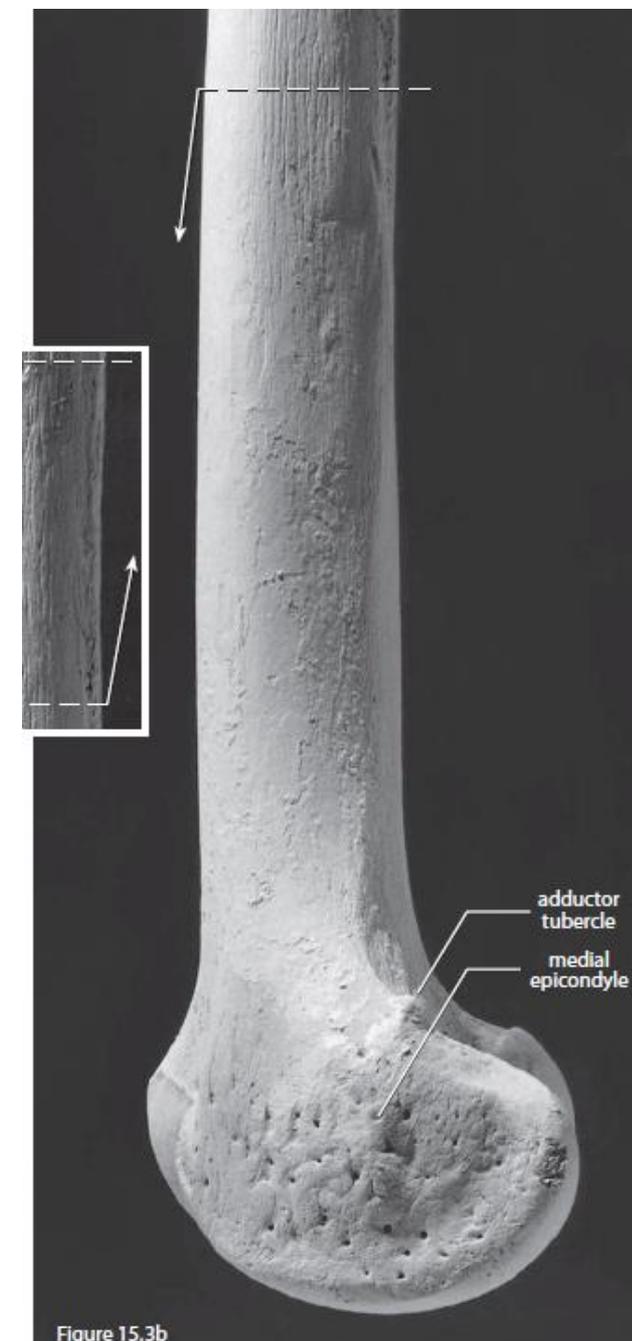
- A smooth hollow on the posterolateral side of the lateral condyle, is a groove for the *tendo of the popliteus muscle*. This muscle inserts on the posterior tibial surface and is a medialrotator of the tibia at the knee.



# The fêmur – distal end

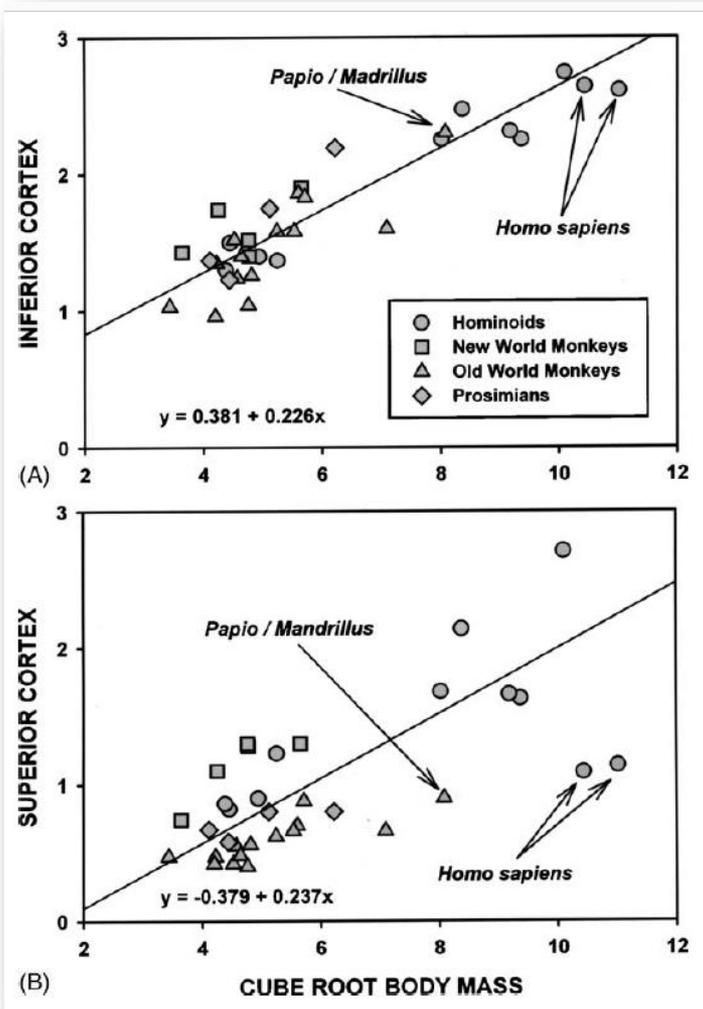
- **Adductor tubercle (Tubérculo do adutor)**

- A smooth hollow on the posterolateral side of the lateral condyle, is a groove for the *tendo of the popliteus muscle*. This muscle inserts on the posterior tibial surface and is a medialrotator of the tibia at the knee.

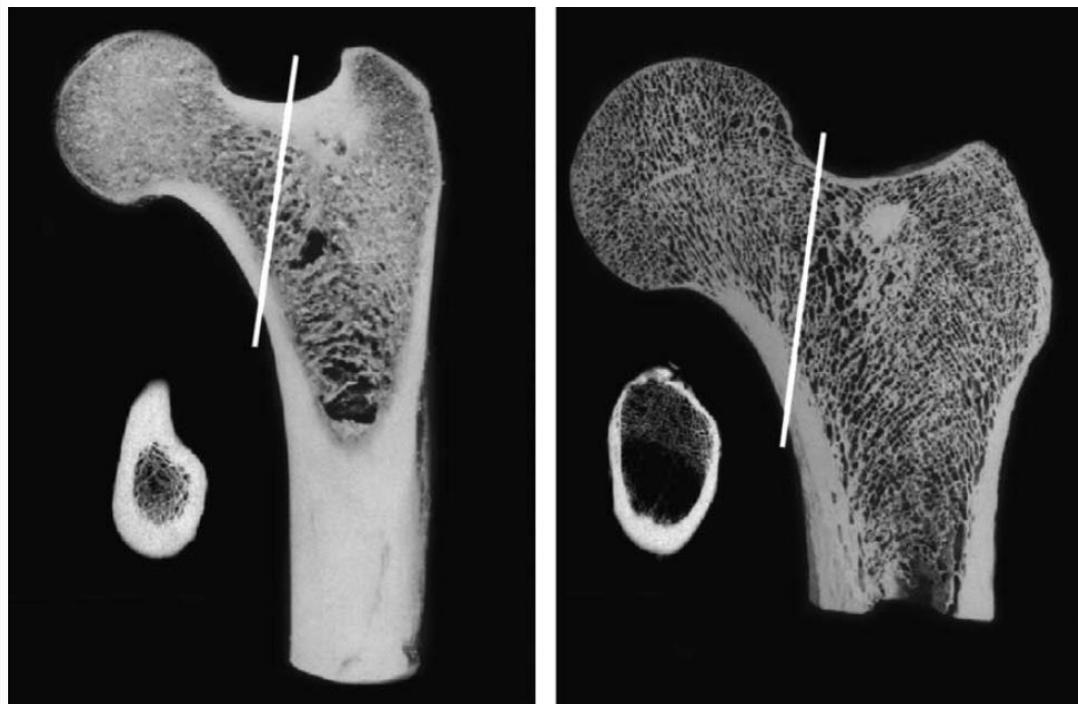


# The proximal femur – Cortical bone distribution on the neck

- Apes exhibit a complete ring of cortex at its neck/shaft juncture.
- Humans bear a distinctly thickened cortex only near the interior portion of the neck.
- In humans the superior cortex is very thin and sometimes even absent.

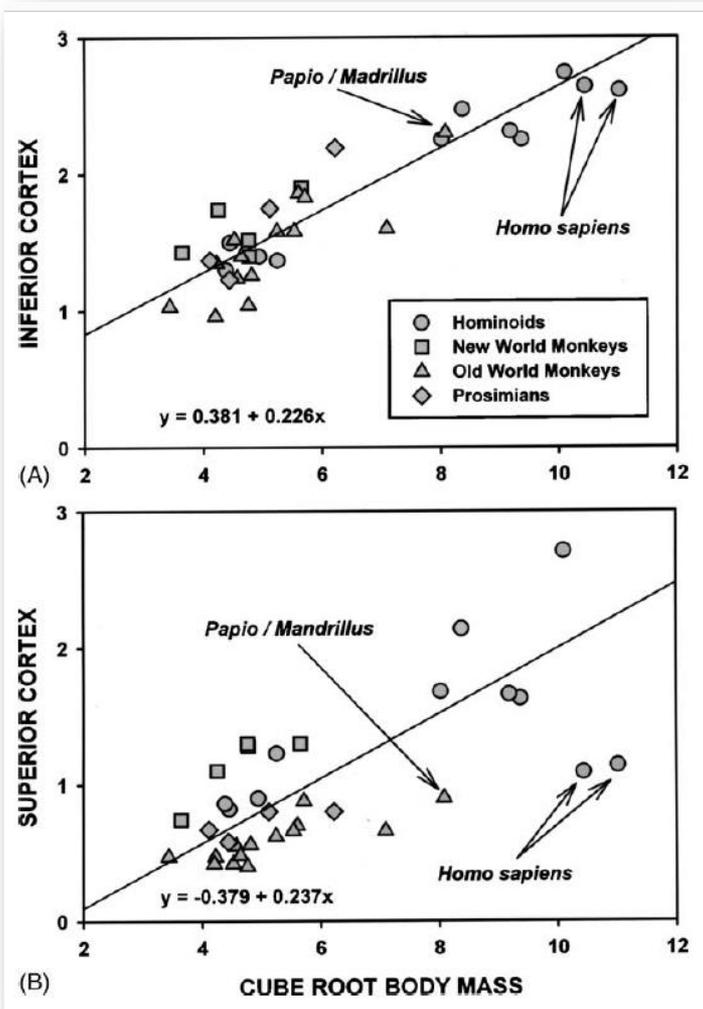


A presença de um conjunto de músculos adutores alivia o pescoço do fêmur do estresse compressivo durante a stance phase.

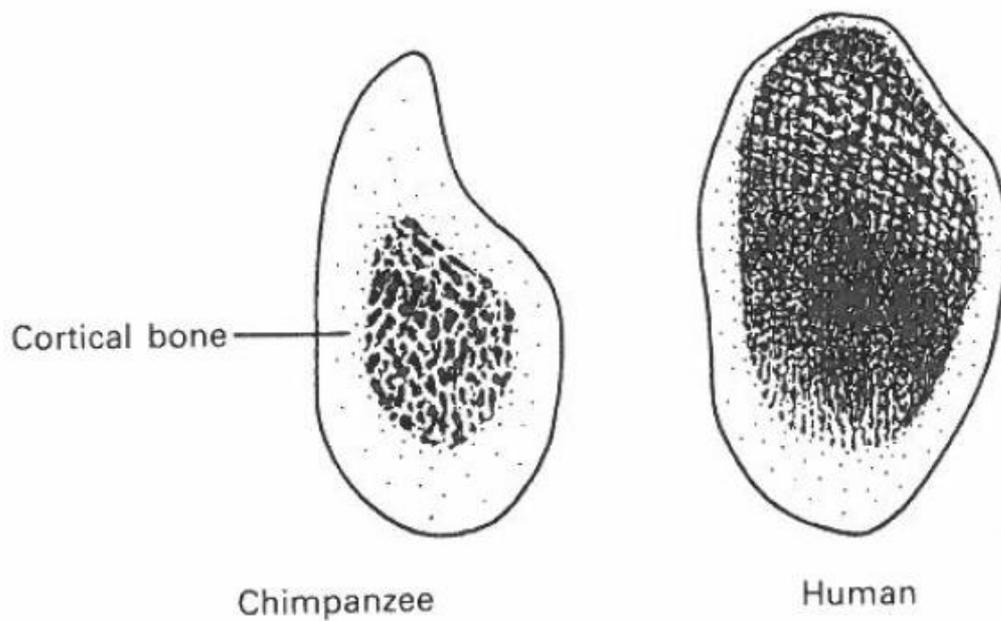


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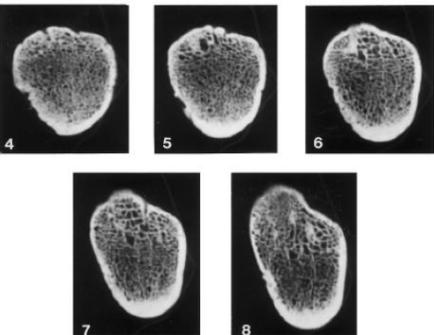
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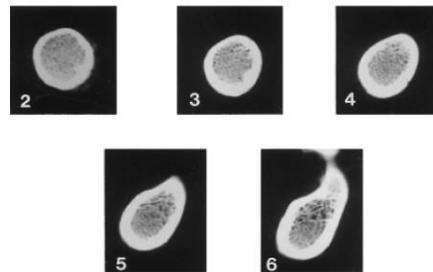
# The proximal femur – Cortical bone distribution on the neck

- Hominoid diversity.

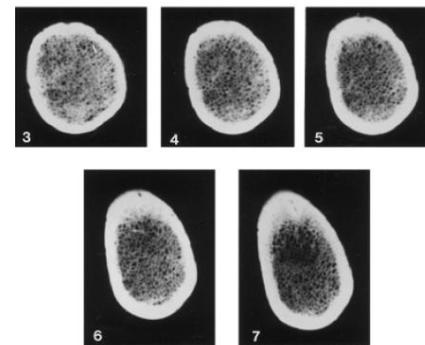
## Humans (male)



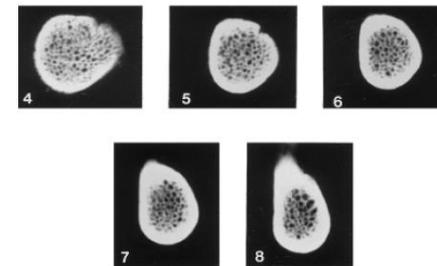
## Chimp (female)



## Gorilla (male)



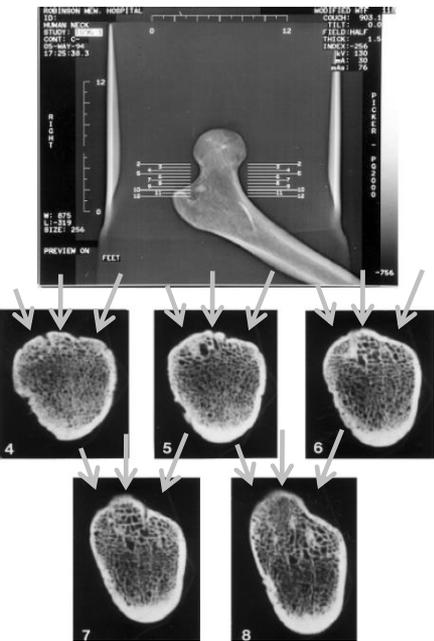
## Orang (male)



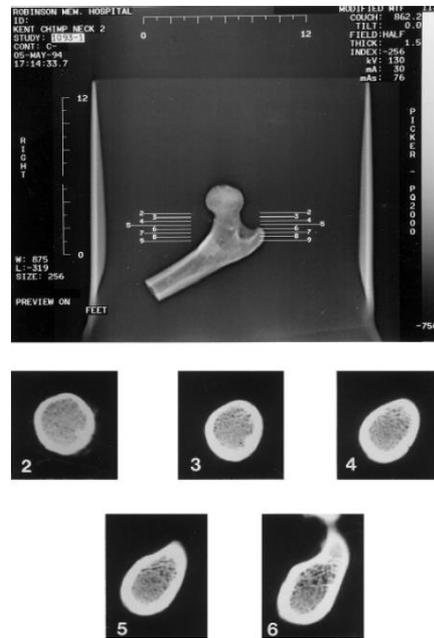
# The proximal femur – Cortical bone distribution on the neck

- Hominoid diversity.

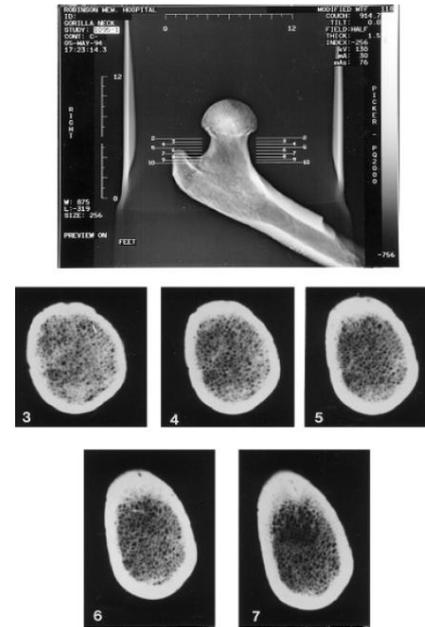
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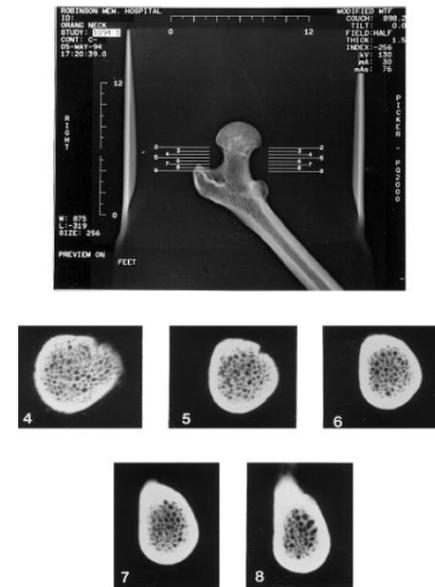
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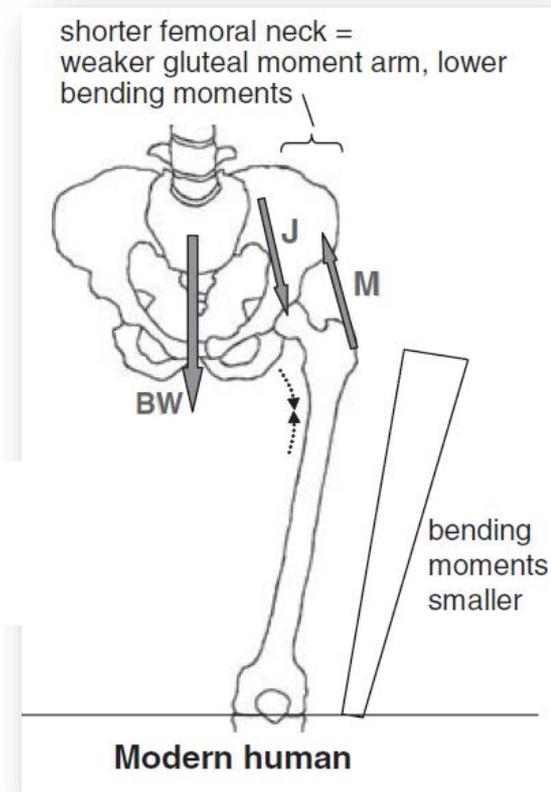
# The proximal femur – Biomechanics

- Balance... over one leg...



# The proximal femur – Biomechanics

- Human bipedality: very little lateral displacement and a slight drop in the contralateral hip.
- Flared, short iliac blade - not this class ;-)
- **Recruitment of the lesser gluteal muscles on the ipsilateral side, which counteract the tendency of the body weight force to lower.**

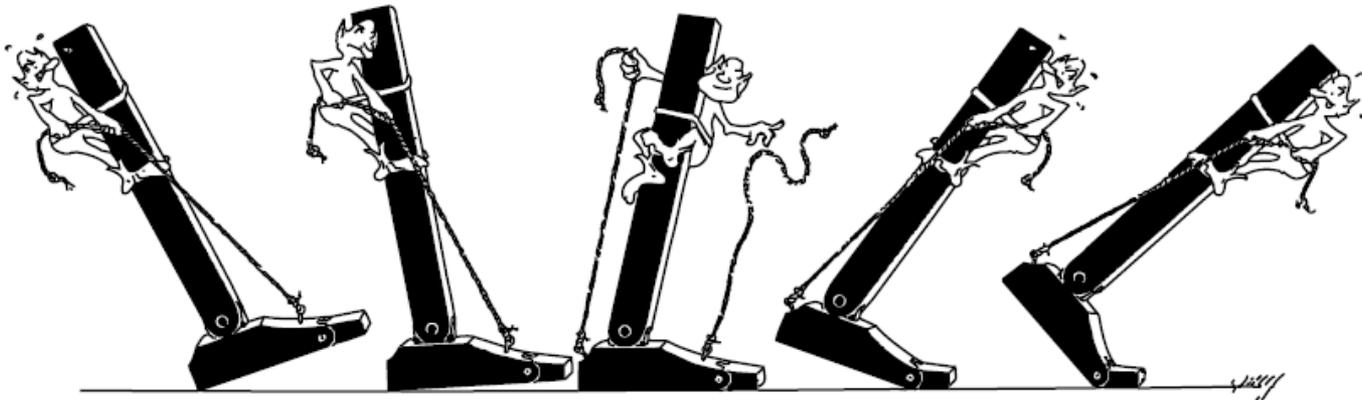
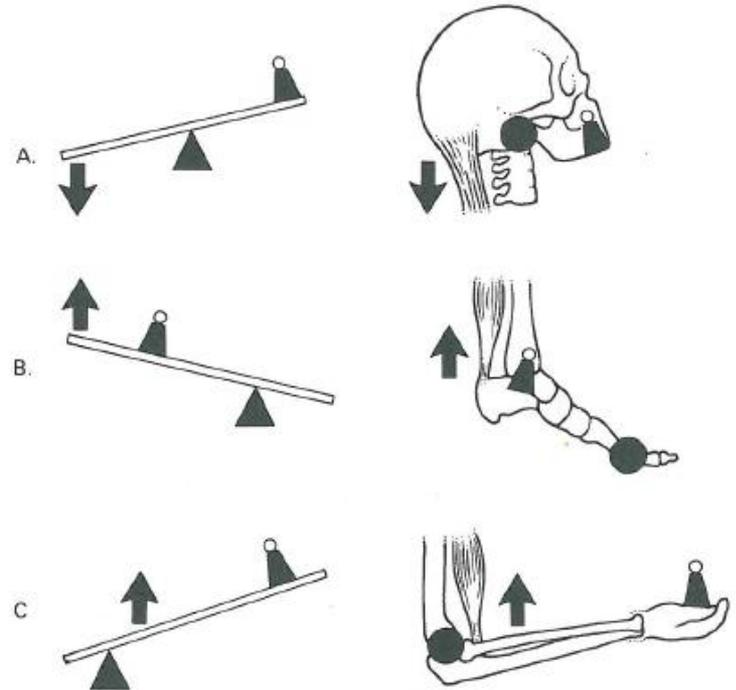


**Lever** – a rigid bar with no account taken on its shape or structure.

**Fulcrum** – the point around which the lever rotates

**Force arm** – Part between the fulcrum and the point where force is applied.

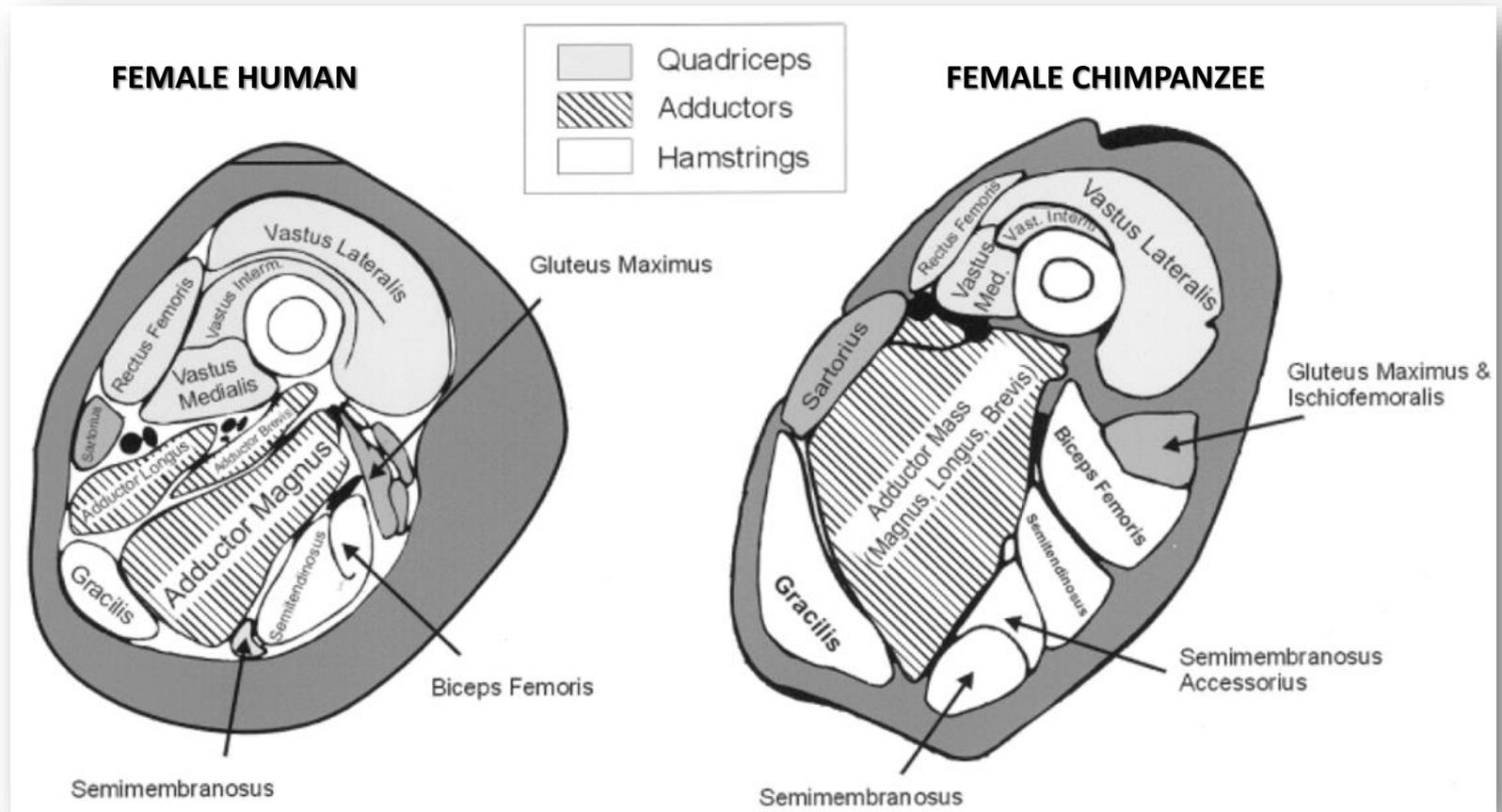
**Load arm** – Part between the fulcrum and the point where load takes place





# The proximal femur – Biomechanics

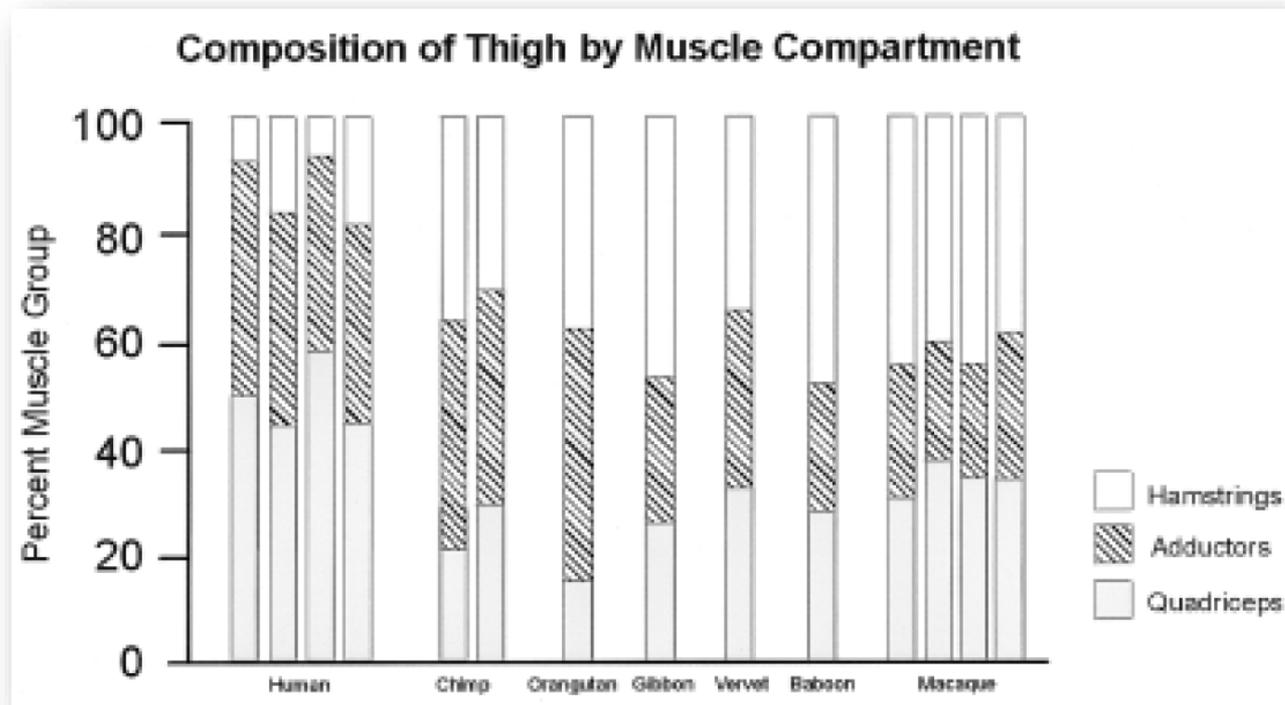
- Humans differ dramatically from apes with respect to the disposition of their hip and thigh musculatur.
- Humans evince clear **quadriceps dominance**, while primate quadrupeds, including the African hominoids, exhibit a comparatively **striking hamstring/adductor dominance**.
- Improve a biped's **knee extensor capacity** but to **reduce the ability of the posterior thigh compartment to effect hip extension**.



Section of the thigh immediately below the lesser trochanter

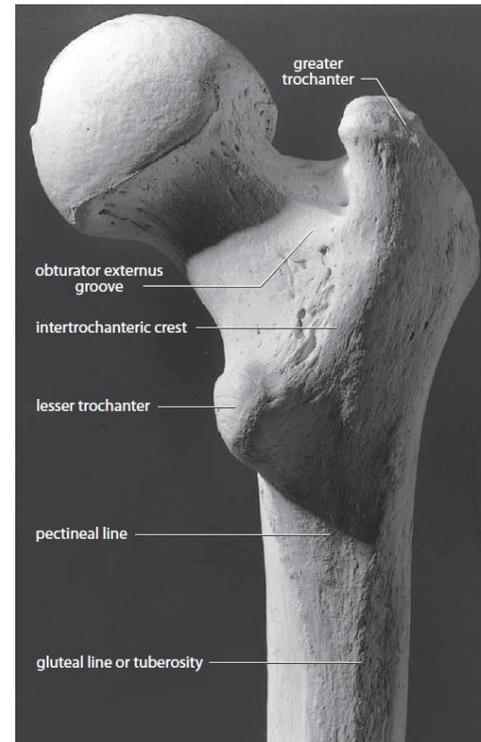
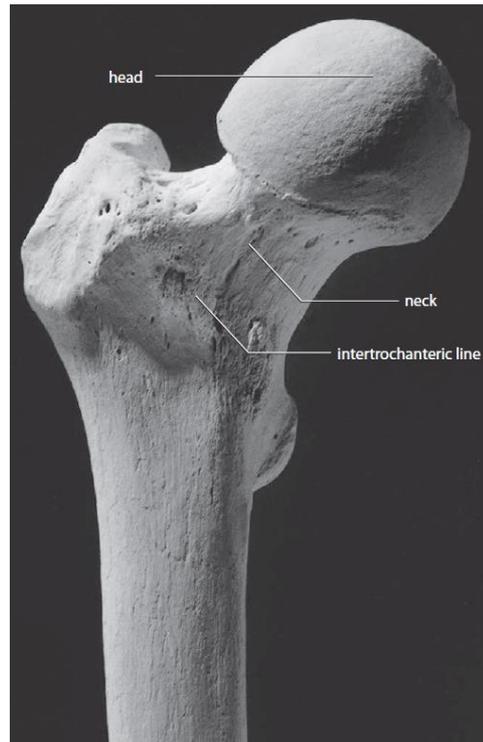
# The proximal femur – Biomechanics

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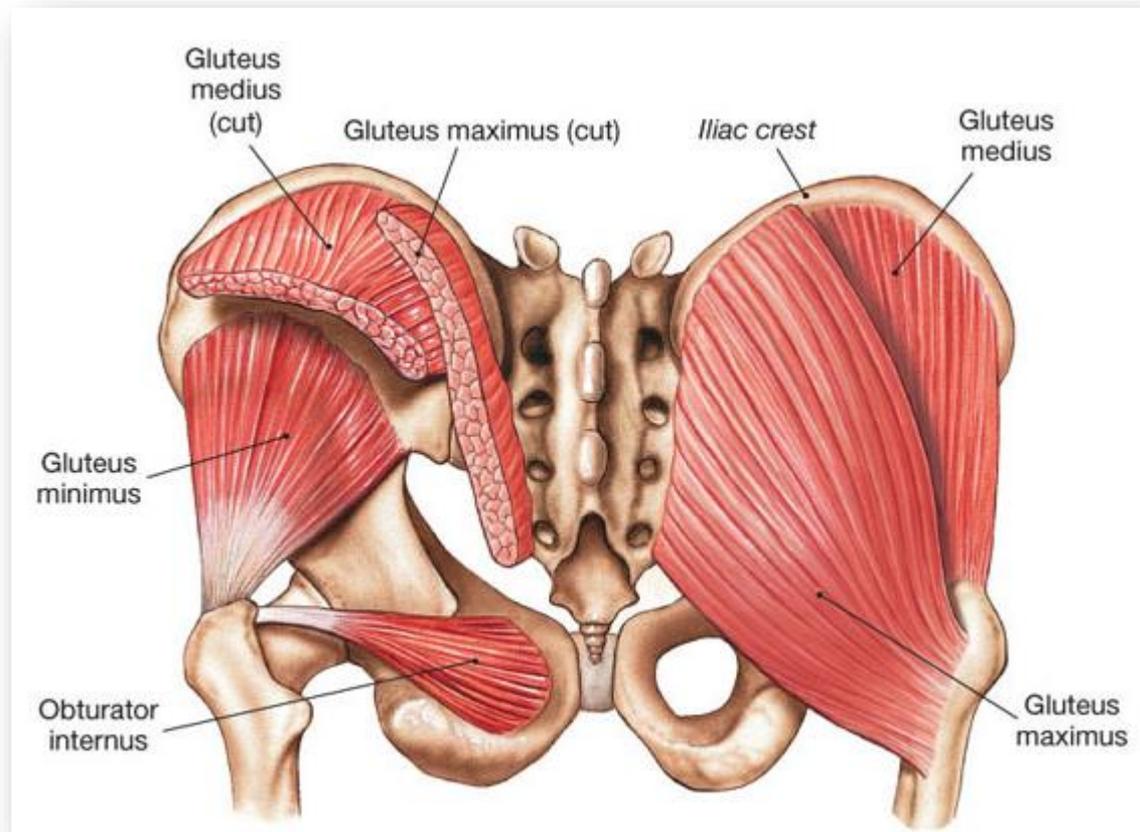
# The proximal femur – Greater trochanter

- Large, blunt, nonarticular prominence on the lateral proximal part of the femur.
- Gluteus minimus (anterior aspect of the trochanter) and gluteus medius (posterior aspect)
- Both **major abductors** of the thigh and **stabilizers of the hip in humans** (orig. from flaring iliac blades).
- Trunk stabilization when one leg is left from the ground during bipedal locomotion.



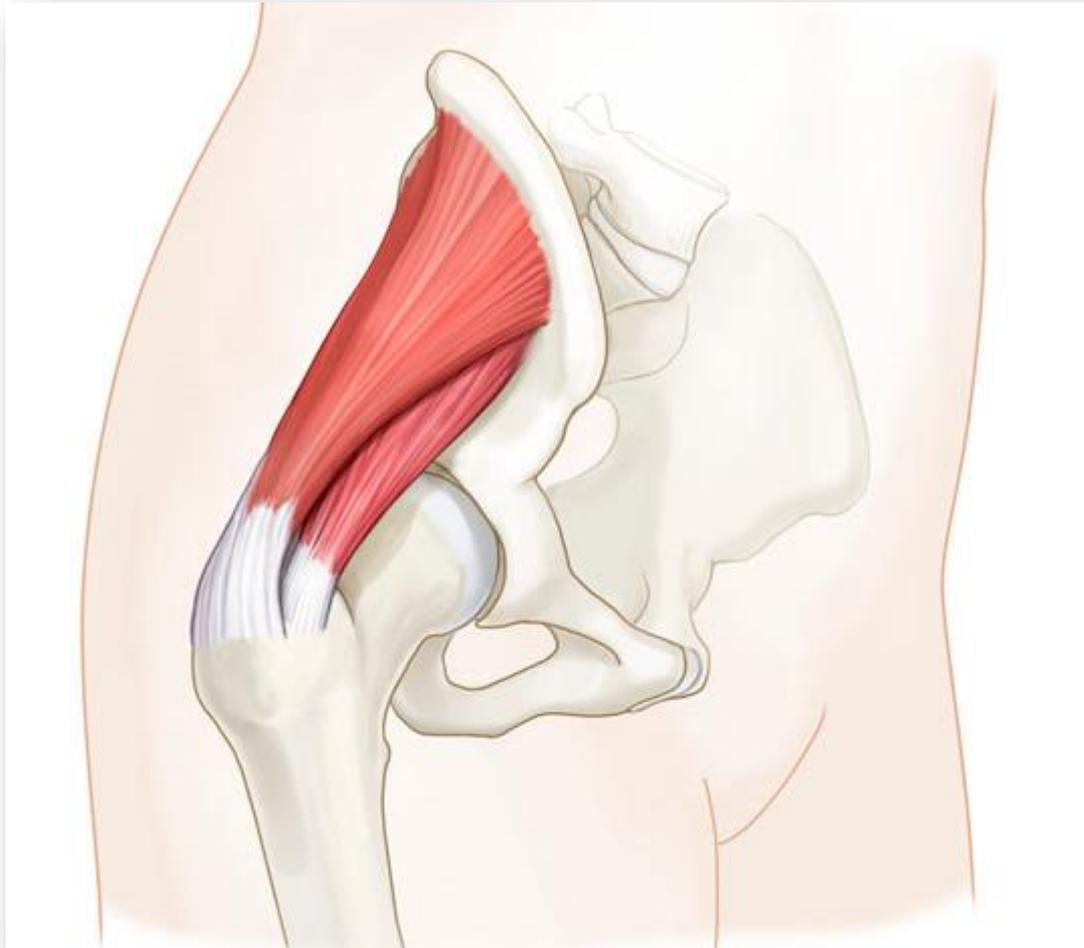
## The proximal femur – Greater trochanter

- Large, blunt, nonarticular prominence on the lateral proximal part of the femur.
- Gluteus minimus (anterior aspect of the trochanter) and gluteus medius (posterior aspect)
- Both **major abductors** of the thigh and **stabilizers of the hip** in humans (orig. from flaring iliac blades).
- Trunk stabilization when one leg is left from the ground during bipedal locomotion.



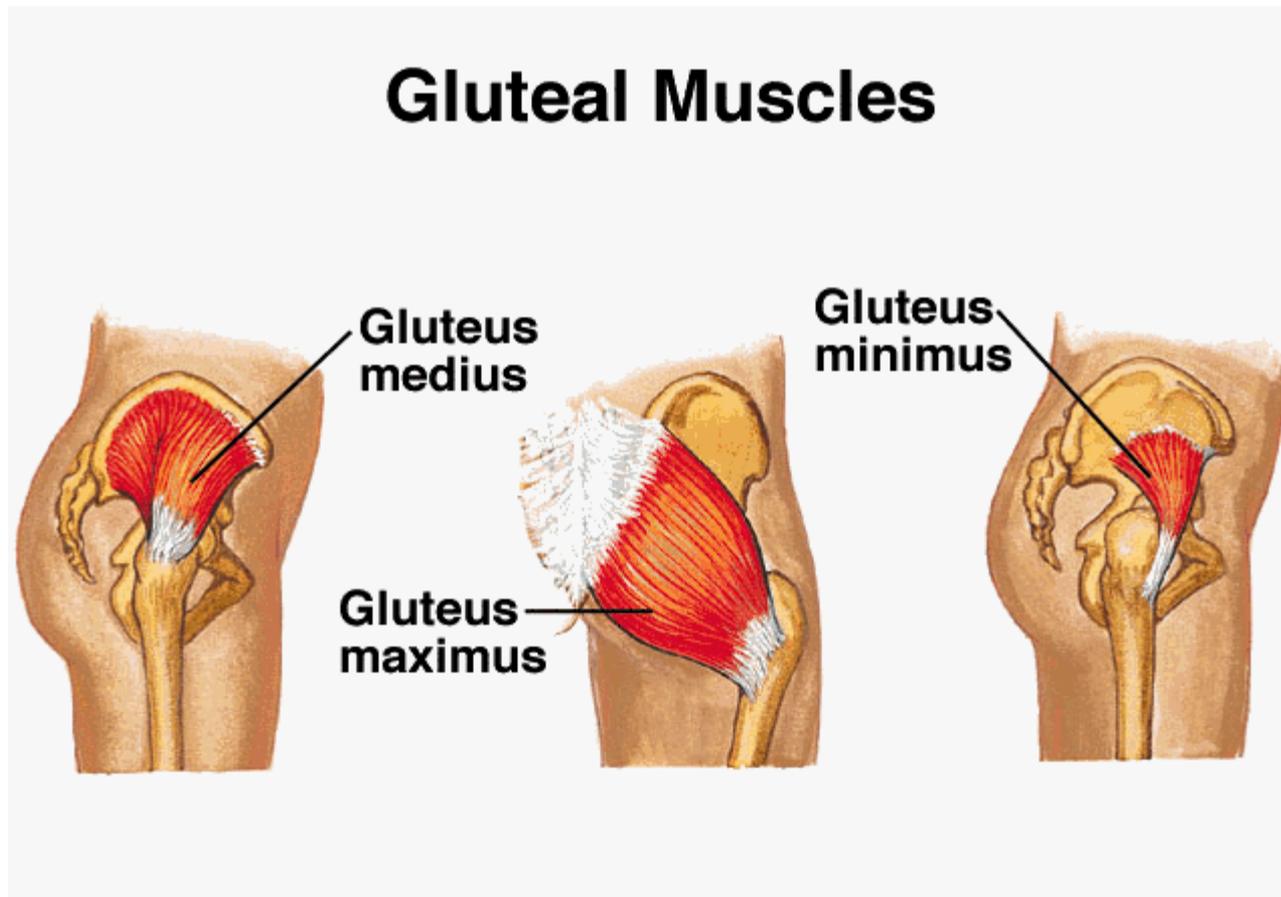
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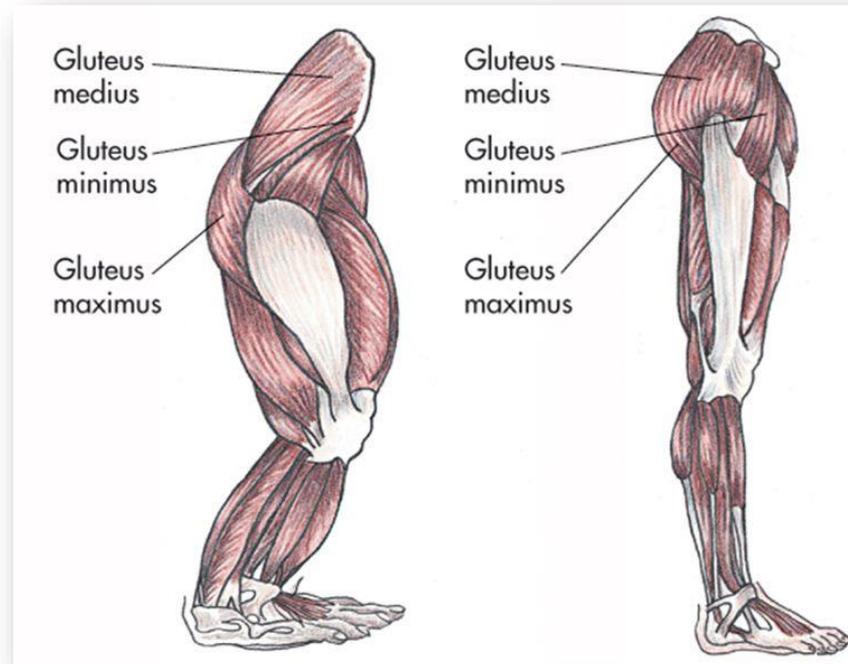
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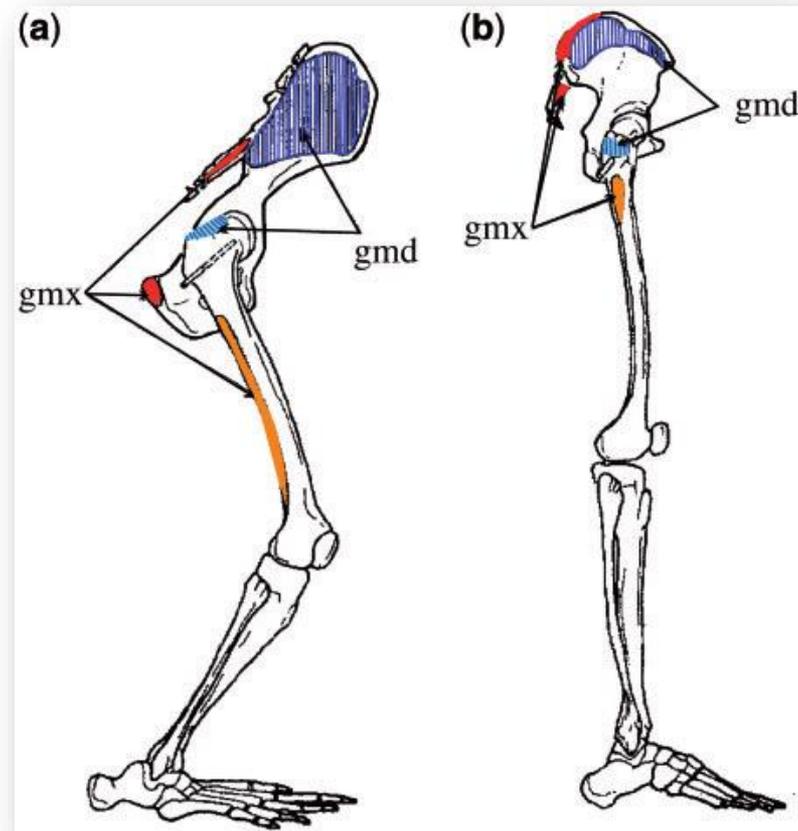
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- Both **major abductors** of the thigh and **stabilizers of the hip in humans** (orig. from flaring iliac blades).
- Trunk stabilization when one leg is left from the ground during bipedal locomotion.
- **In chimpanzees gluteus medius and gluteus minimus are not abductors.**



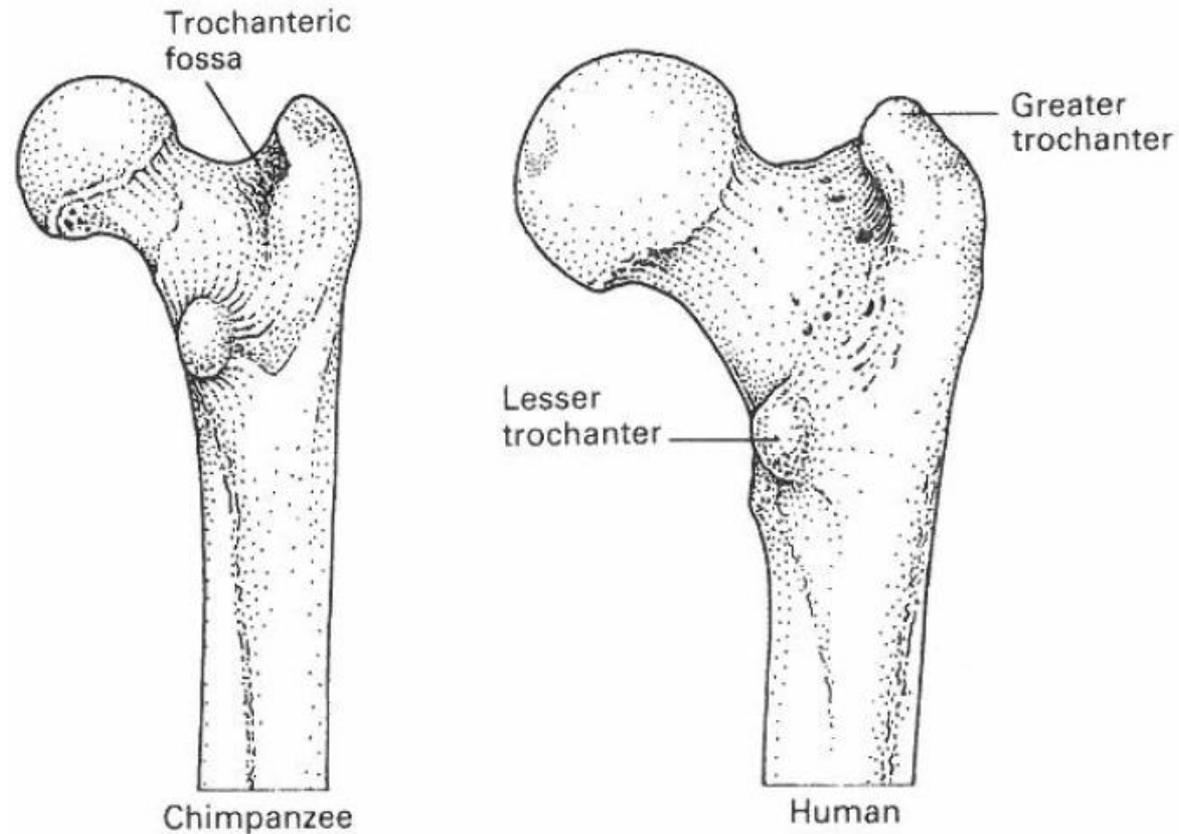
# The proximal femur – Greater trochanter

- Both **major abductors** of the thigh and **stabilizers of the hip** in humans (orig. from flaring iliac blades).
- Trunk stabilization when one leg is lifted from the ground during bipedal locomotion.
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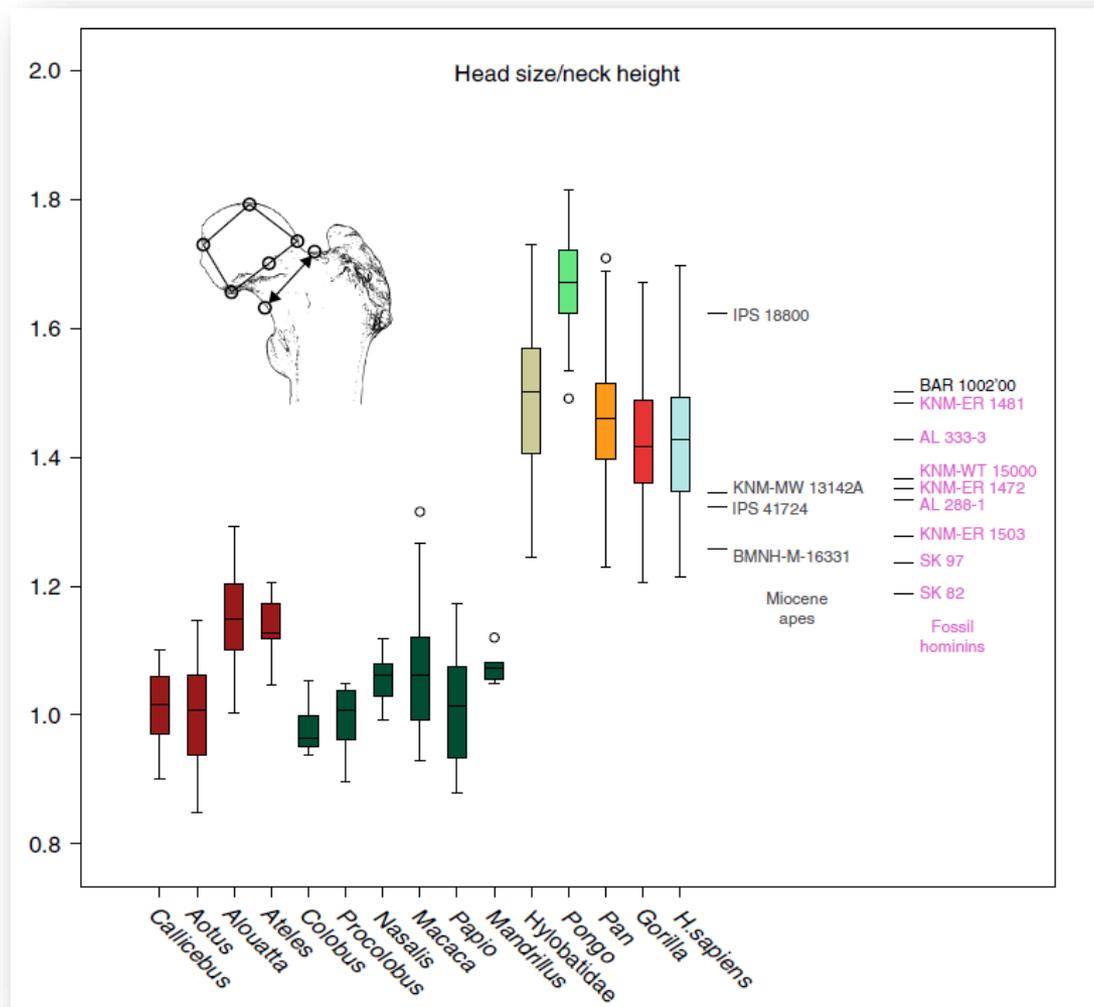
## The proximal femur – Greater trochanter

- The human great trochanter is **low in relation to the superior border of the neck** in comparison with the apes.
- The ape great trochanter **lacks the flared laterally projecting aspect of humans**.
- The **trochanteric fossa is much deeper in chimpanzees** (providing large area for the insertion of obturator externus muscles? responsible for rotating the thigh at the hip).



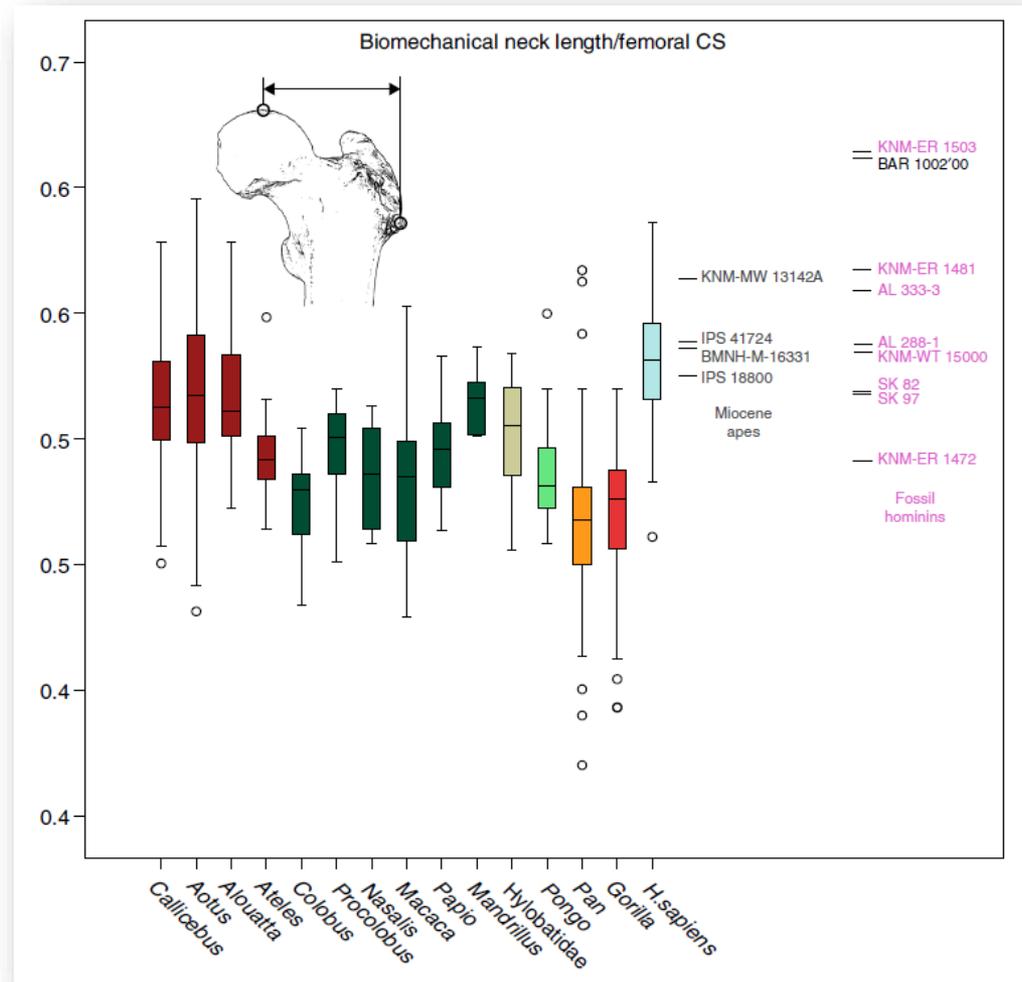
# The proximal femur – Head size / neck height

- Hominoids have absolute and relatively larger heads.
- Humans have absolutely larger heads than chimpanzees, but not relatively larger.



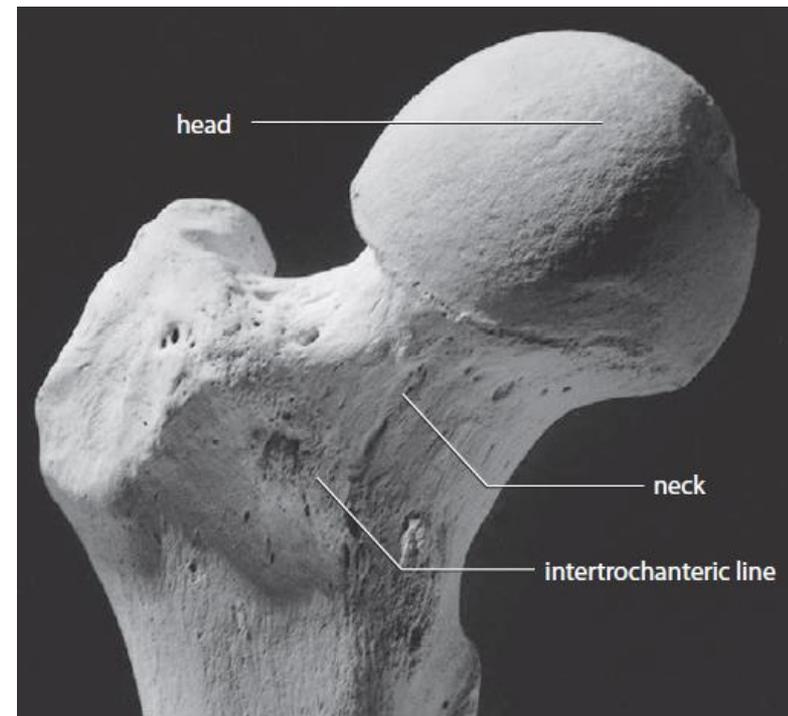
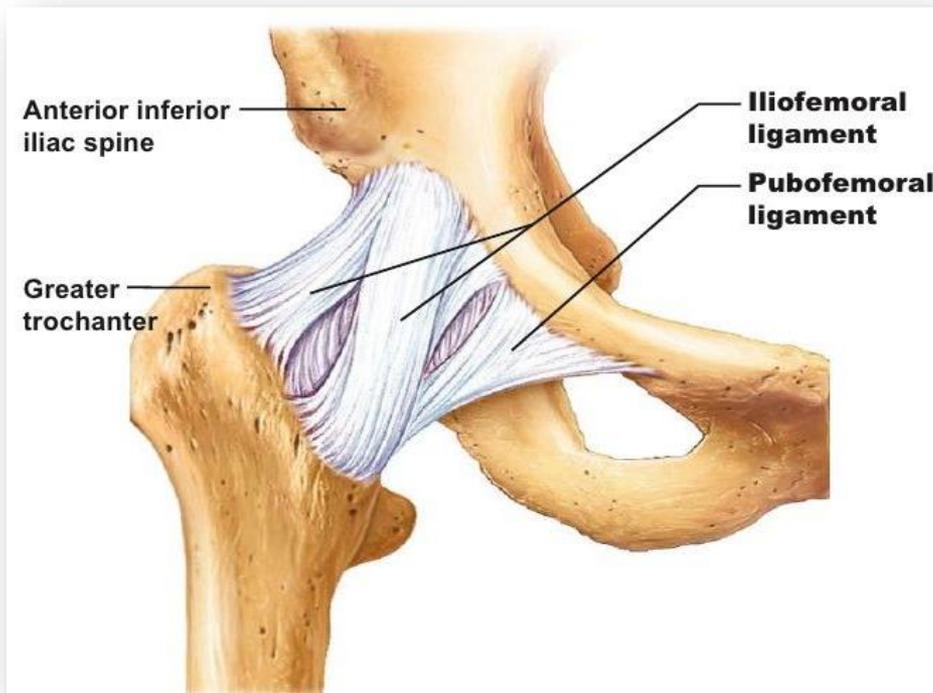
# The proximal femur – Head size / neck height

- Humans have relatively longer 'biomechanical neck length'



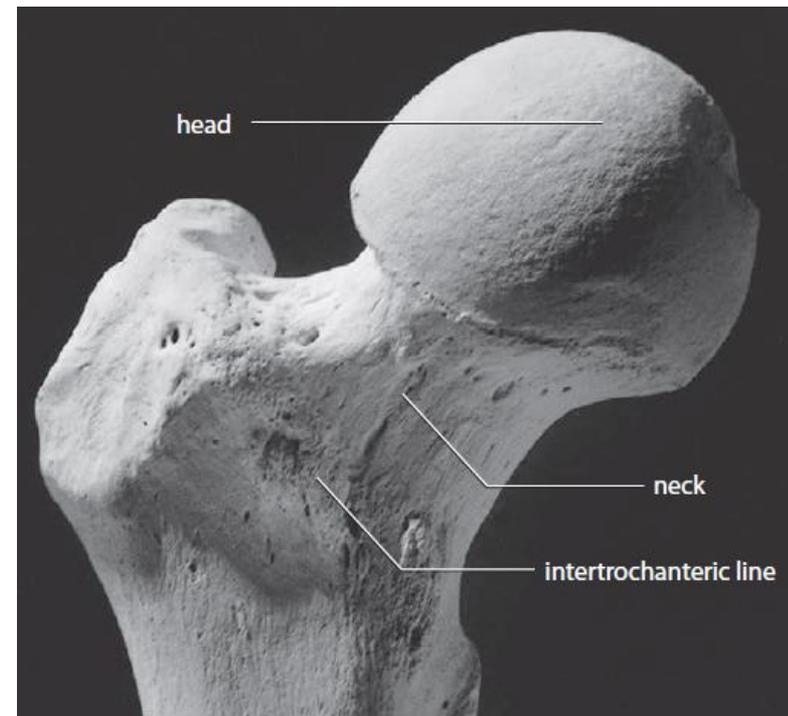
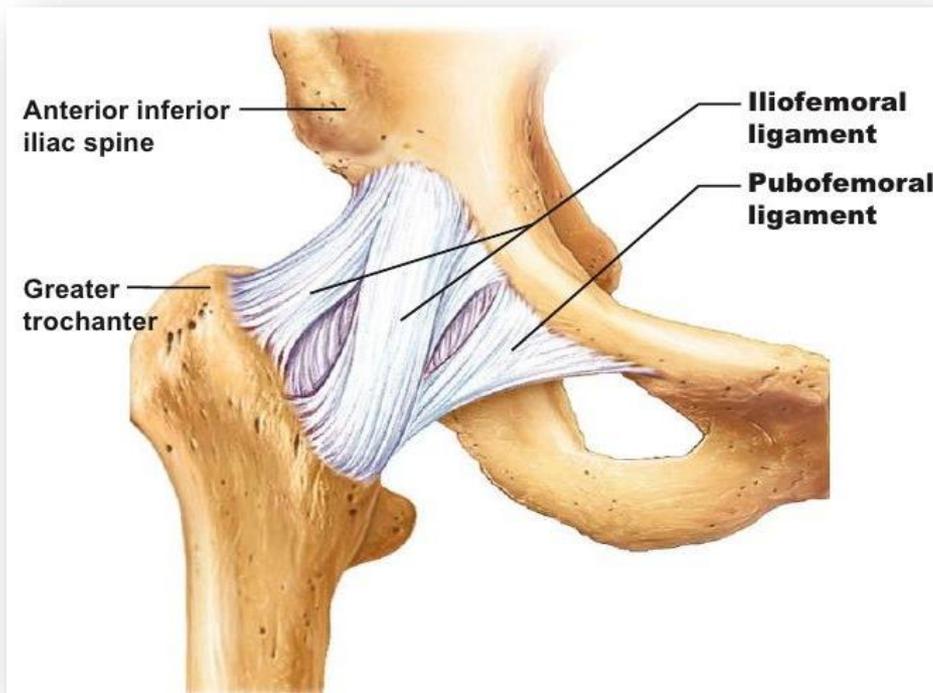
## The proximal femur – Intertrochanteric line/crest

- A variable, fairly vertical, roughened line that passes between the lesser and greater trochanters.
- Superiorly, this line anchors the **iliofemoral ligament**, which is the largest ligament in the human frame. It acts to strengthen the joint capsule of the hip.
- Because this ligament is shaped like a Z the intertrochanteric line is most strongly developed inferiorly and superiorly.
- In humans this ligament is **very strong** and functions to **maintain upright posture**.
- Because the centre of gravity passes behind the hip joint, the strength of this ligament prevents the trunk from falling backwards at the hipjoint.



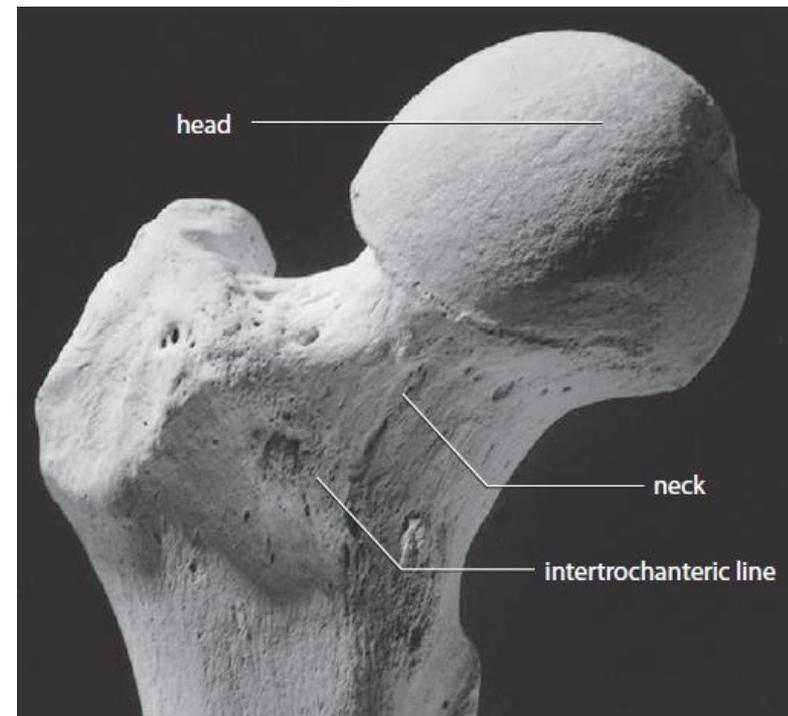
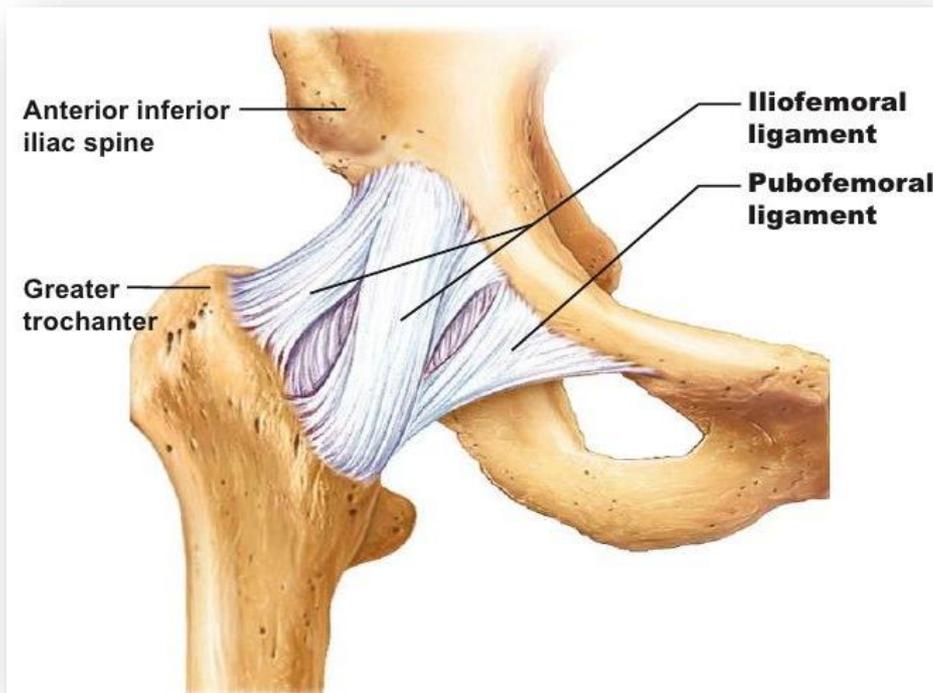
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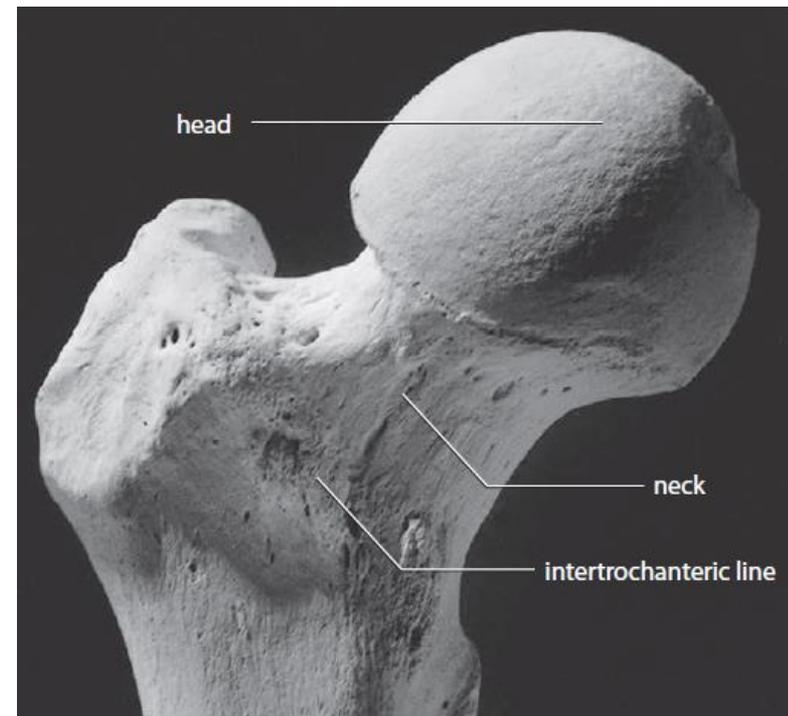
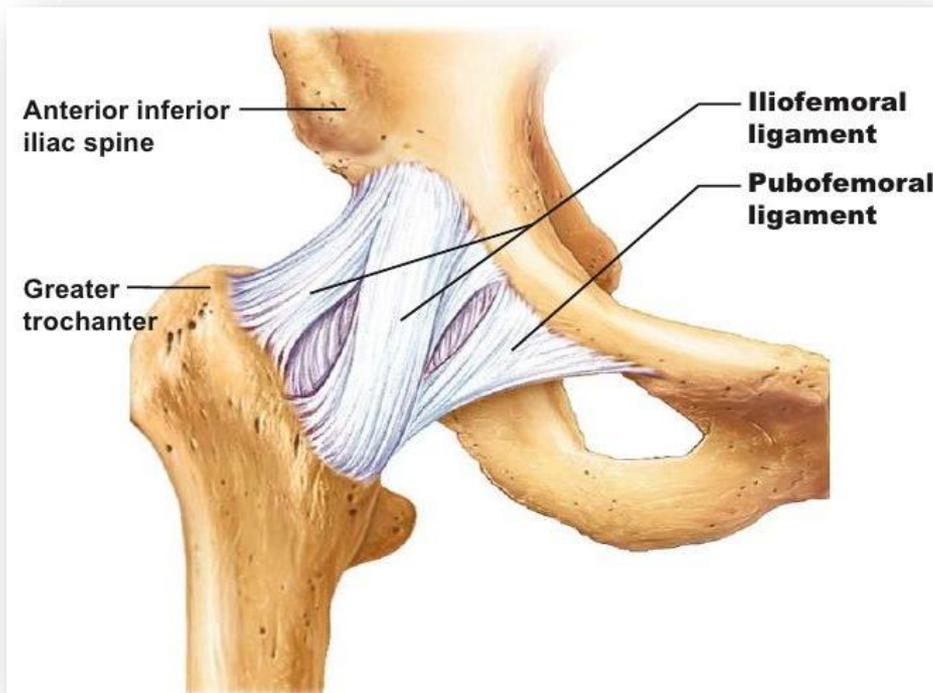
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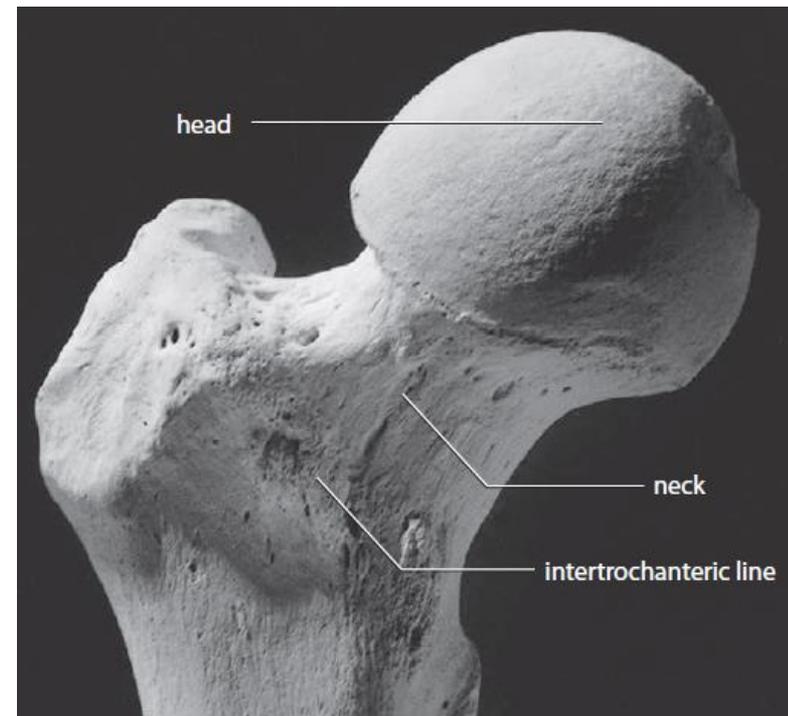
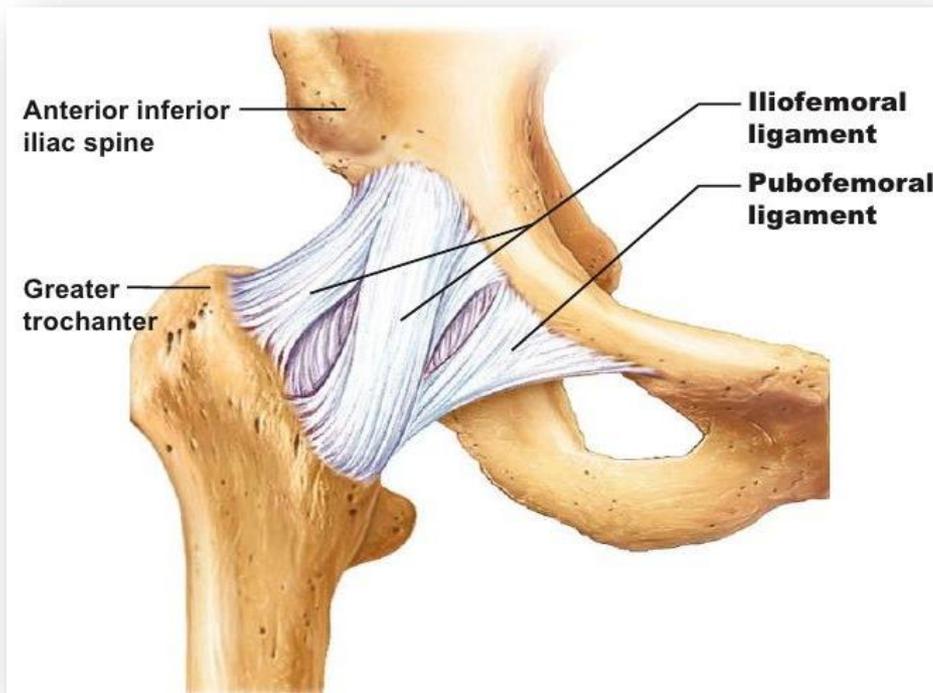
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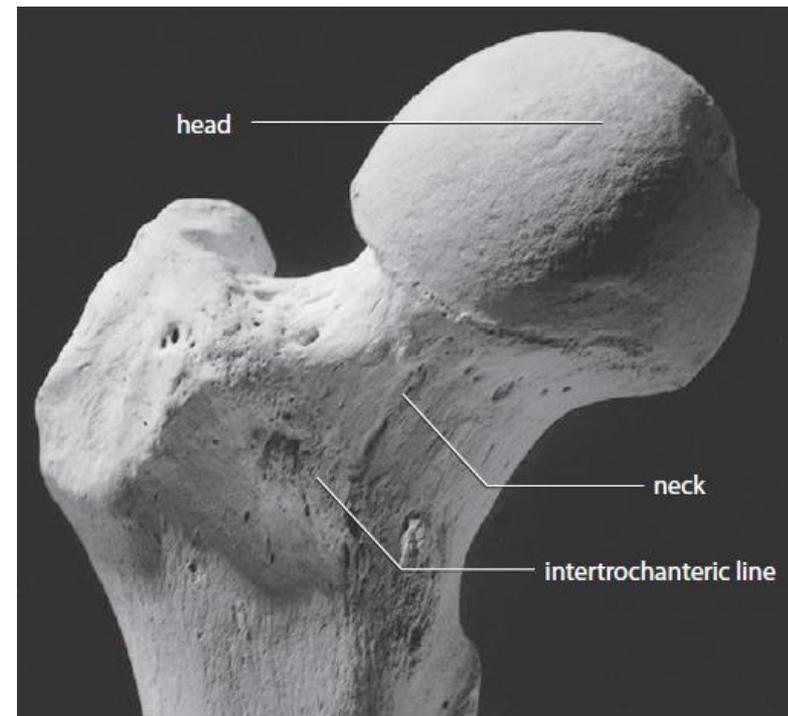
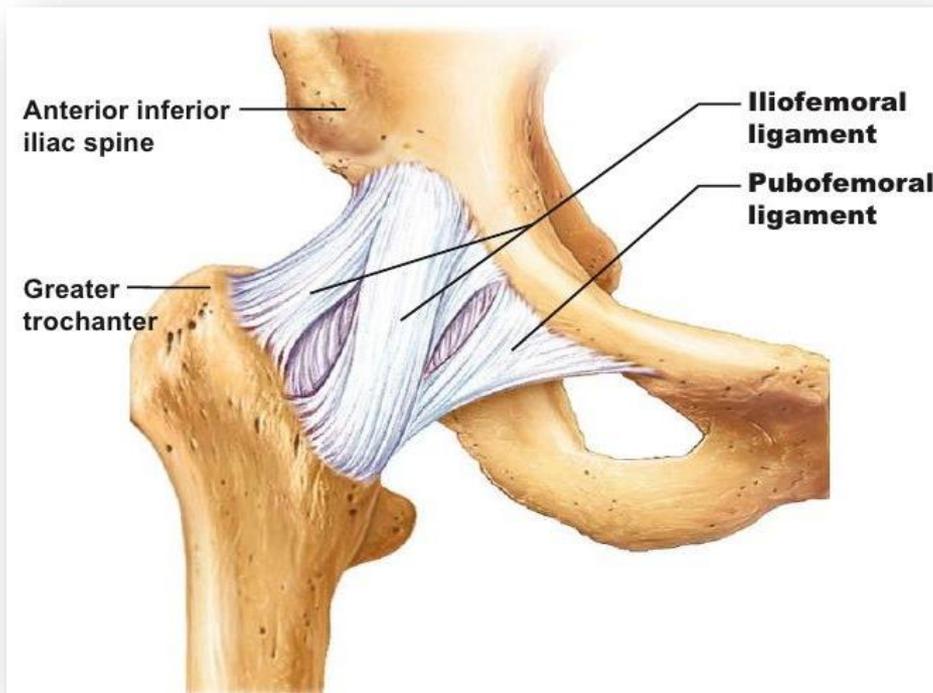
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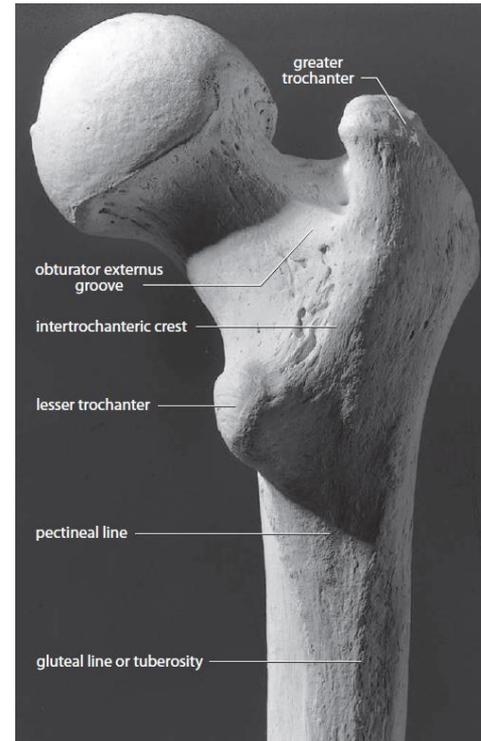
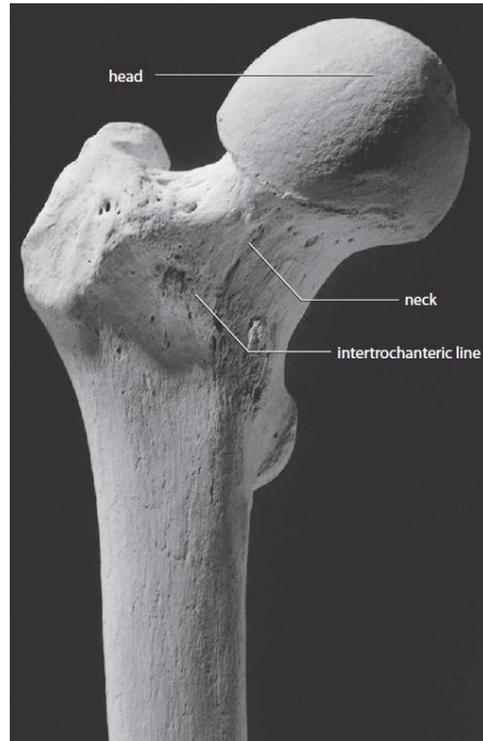
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# The proximal femur – Lesser trochanter

- The **lesser trochanter** is the prominent **tubercle** on the **posterior femoral surface**.
- Just inferior to the point where the neck joins the shaft.
- Insertion of the **iliopsoas tendon** .
  - The common tendon of the **iliacus muscles**, originating in the iliac fossa, and the **psoas major** muscle, originating from the lumbar vertebrae and their disks).
- These muscles are **major flexors** of the thigh and hip.





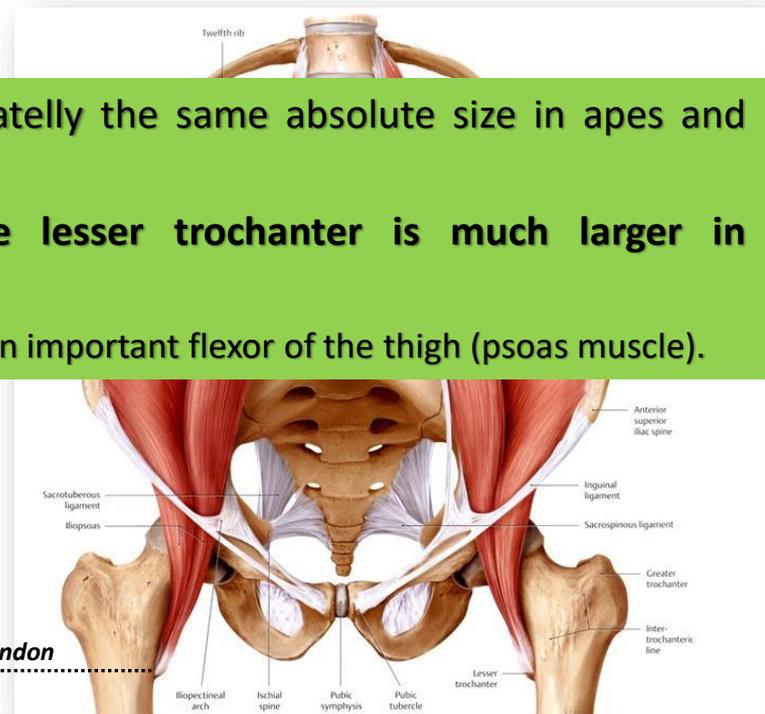
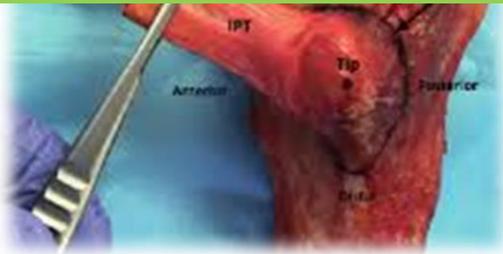
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The lesser trochanter is of the approximately the same absolute size in apes and humans.

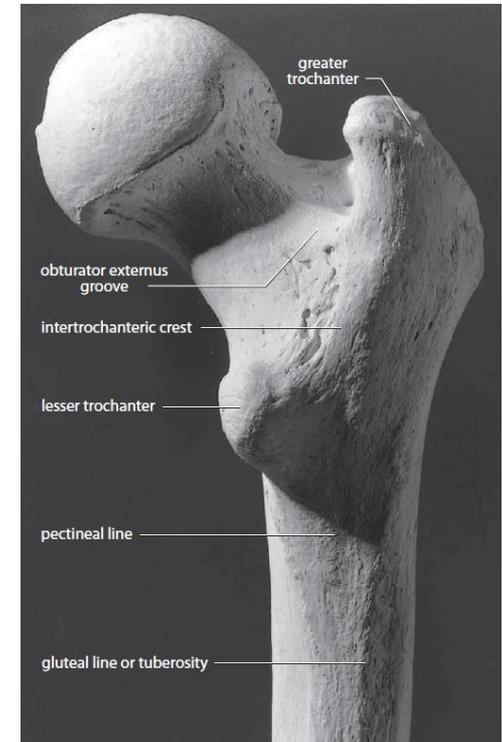
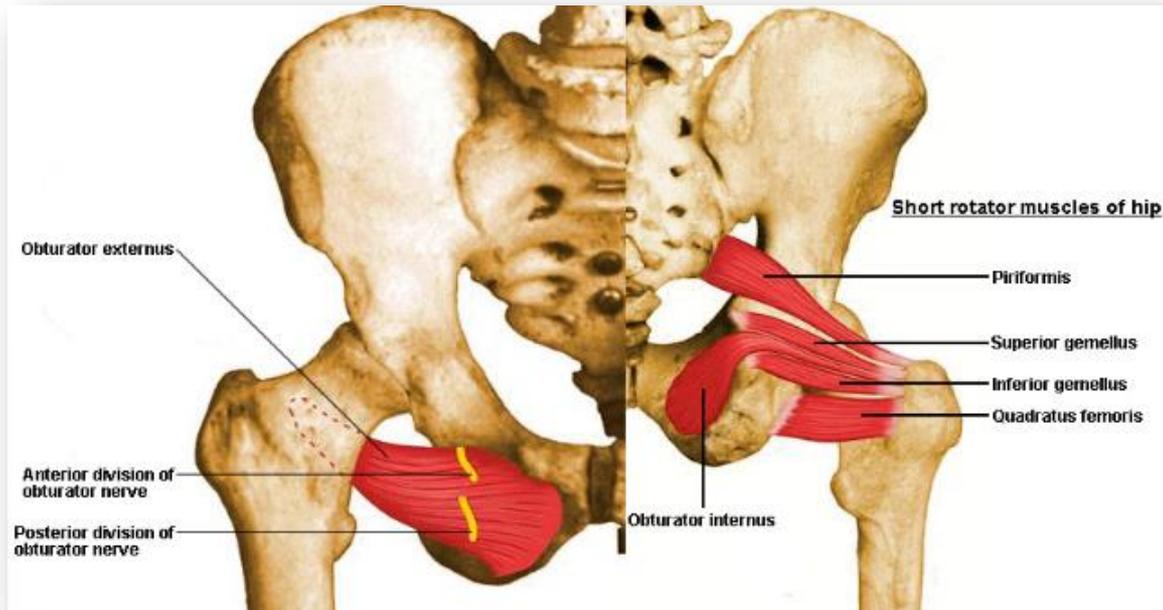
Therefore, **relative to femur size the lesser trochanter is much larger in chimpanzees.**

*Iliop* The lesser trochanter is the insertion of an important flexor of the thigh (psaos muscle).



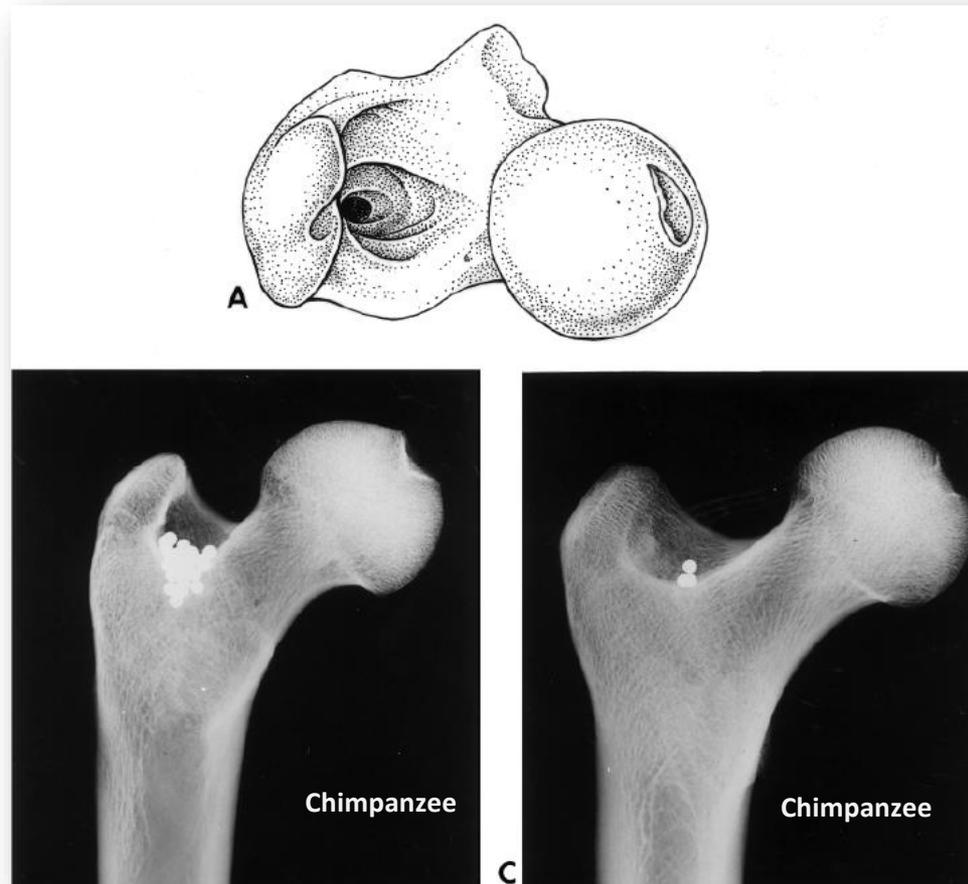
# The proximal femur – Trochanteric fossa

- The pit excavated into the posteromedial wall of the greater trochanter.
- The insertion of the tendon of ***obturator externus***, a muscle that originates around and across the membrane that stretches across the obturator foramen of the os coxae.
- This muscle acts to rotate the thigh laterally at the hip.



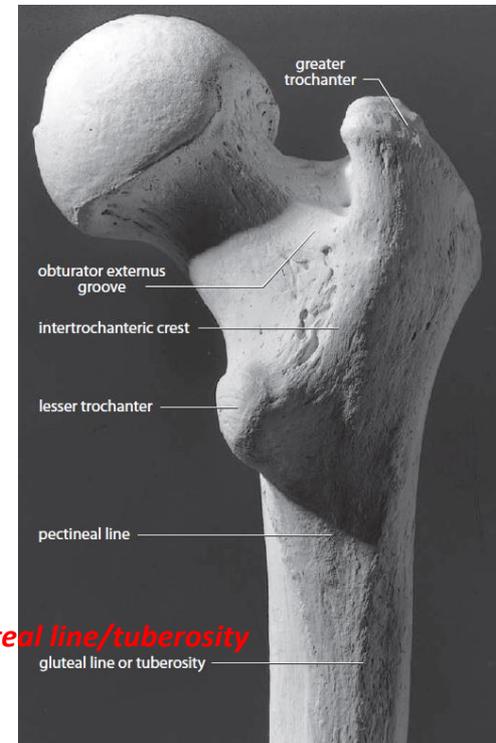
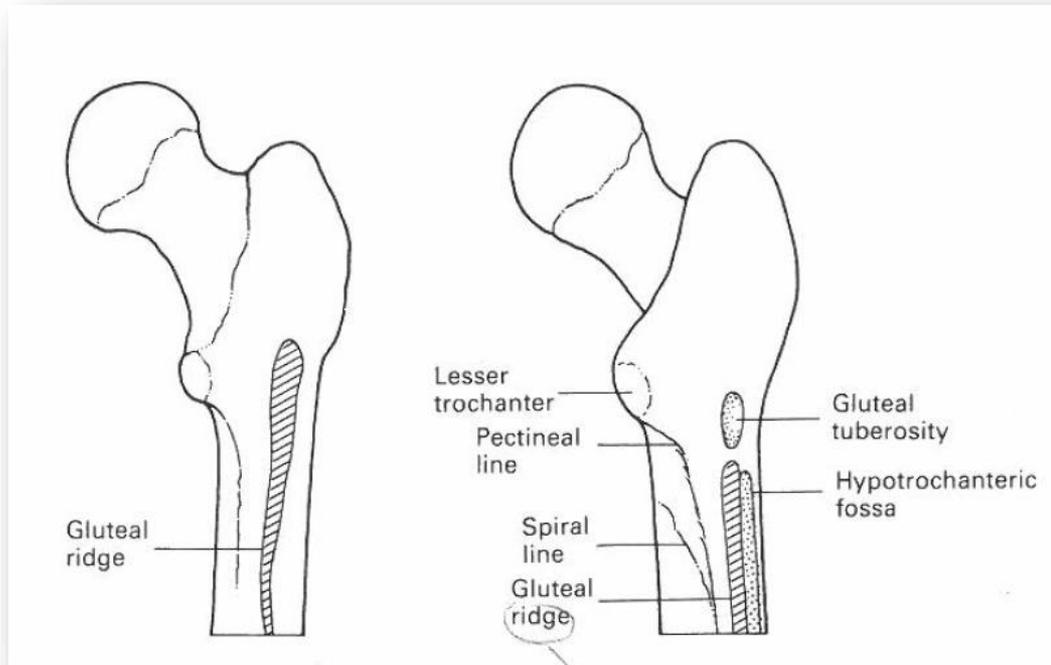
## The proximal femur – Trochanteric fossa/cavity

- The **trochanteric fossa is much deeper in chimpanzees** (providing large area for the insertion of obturator externus muscles? responsible for rotating the thigh at the hip).
- The trochanteric 'canal' is also occasionally present in *Pongo*, but appears virtually never to be present in *Homo* or *Gorilla*.



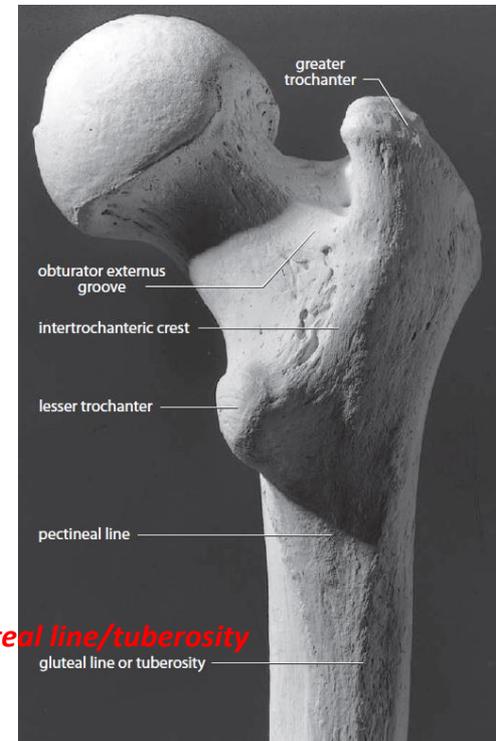
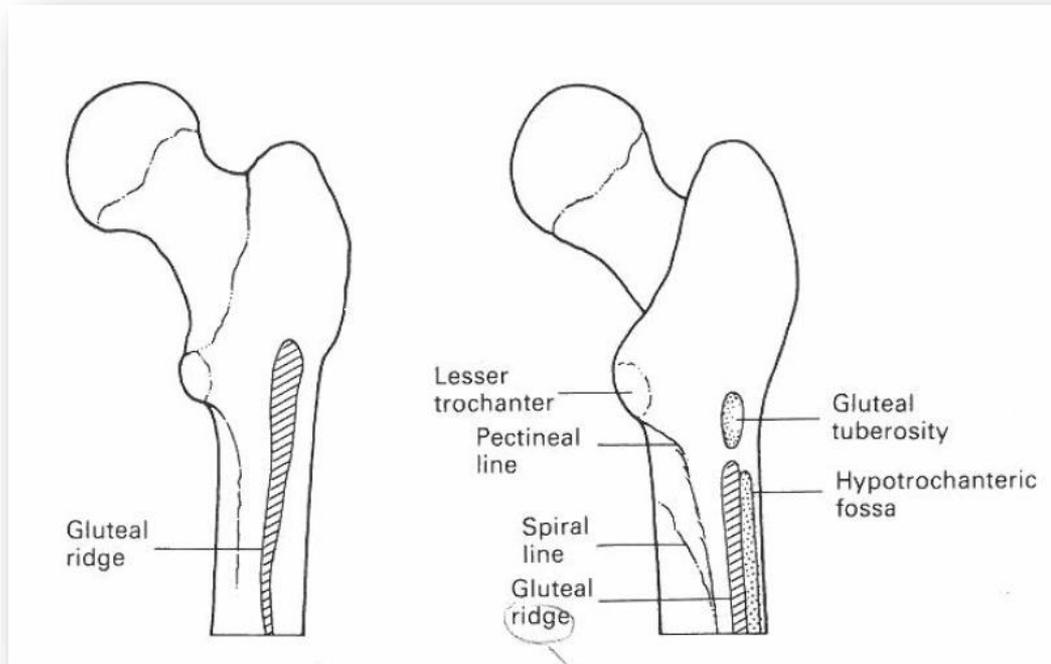
# The proximal femur – Gluteal line/tuberosity and Third trochanter

- The gluteal line, gluteal ridge, or gluteal tuberosity is a long, wide, roughened, posterolaterally placed feature that extends from the base of the greater trochanter to the tip of the linea aspera.
- It is the insertion for part of the **gluteus maximus muscle**, an **extensor, abductor and lateral rotator** of the thigh at the hip that originates on the posterior half of the os coxae, the sacrum and coccyx.
- It can be a depression or it can assume the form of a true tuberosity. If the latter is present, it is often referred to as the **third trochanter**.



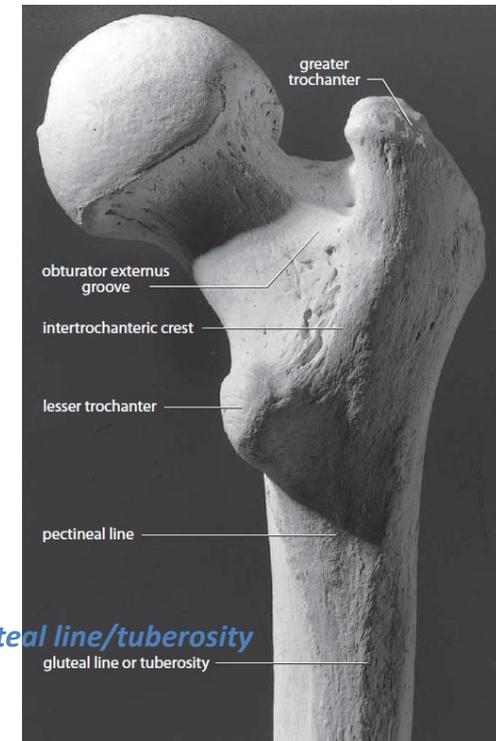
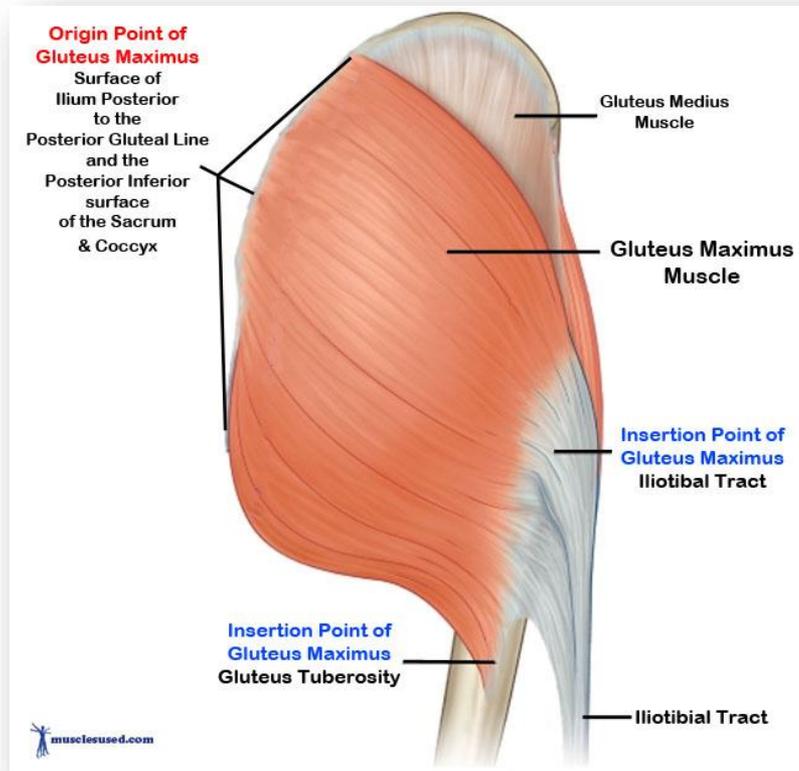
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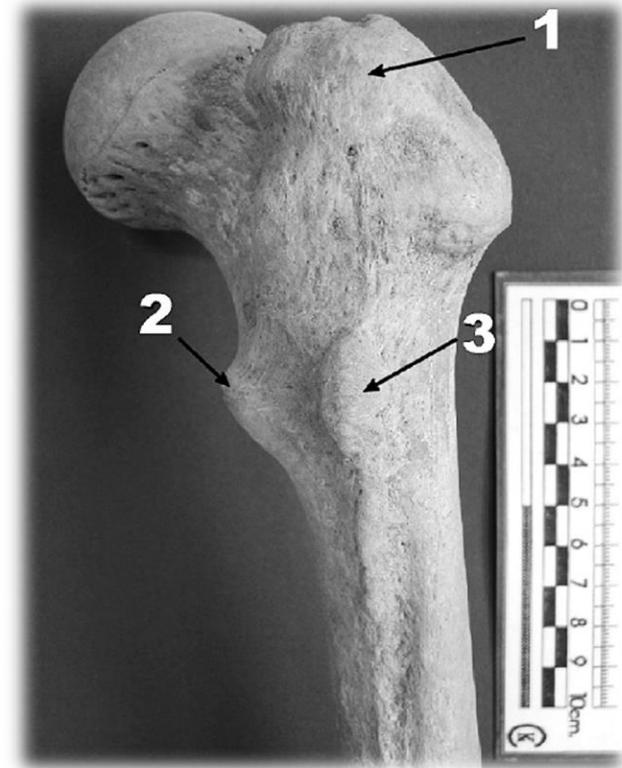
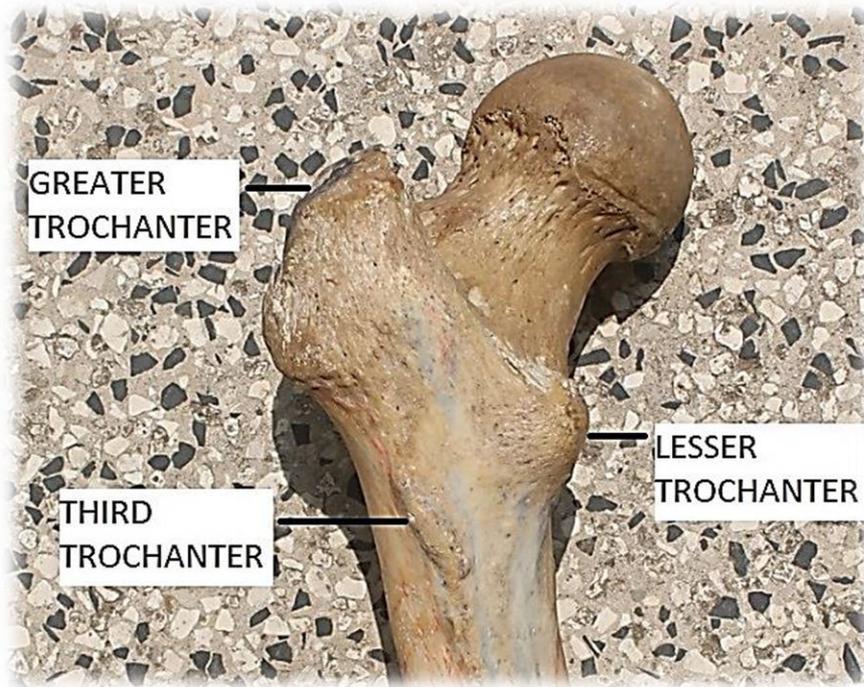
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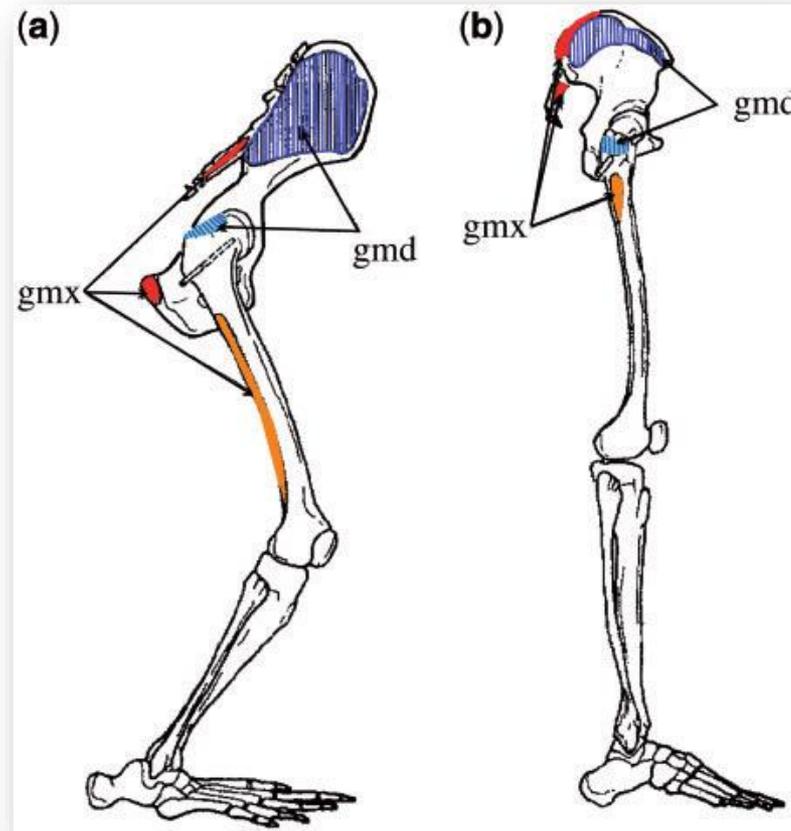
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# The proximal femur – Gluteal line/tuberosity and Third trochanter

- Occurs in low frequencies in humans (ca. 10-40%), lower frequency in chimpanzees (ca. 9%) and is absent from gorilla and orang-utans.



# The proximal femur – Hypotrochanteric fossa

- Elongated groove that is variably found in primate femora but has not been observed to occur in other mammals. Exact location and relation with adjacent features can also vary.
- Modern humans the frequency of occurrence of the hypotrochanteric fossa varies from high of 89% in Eskimos to a low of 61% in Cantonese Chinese.
- In humans it lies between the gluteal ridge and the lateral border of the shaft while in the apes it involves the lateral border of the shaft.



Humans



# The proximal femur – Hypotrochanteric fossa

- In the great apes the fossa is normally well developed and is present in 74% of gorillas, 76% of chimpanzees and 80% of orangs.
- In the African apes it is normally situated lower on the shaft than in humans, has an oblique orientation and is placed more laterally on the shaft.
- In the African apes the fossa is also 'spacious and rough' rather than relatively narrow and linear as is normally the case in humans.



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**Orang**

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Chimpanzee

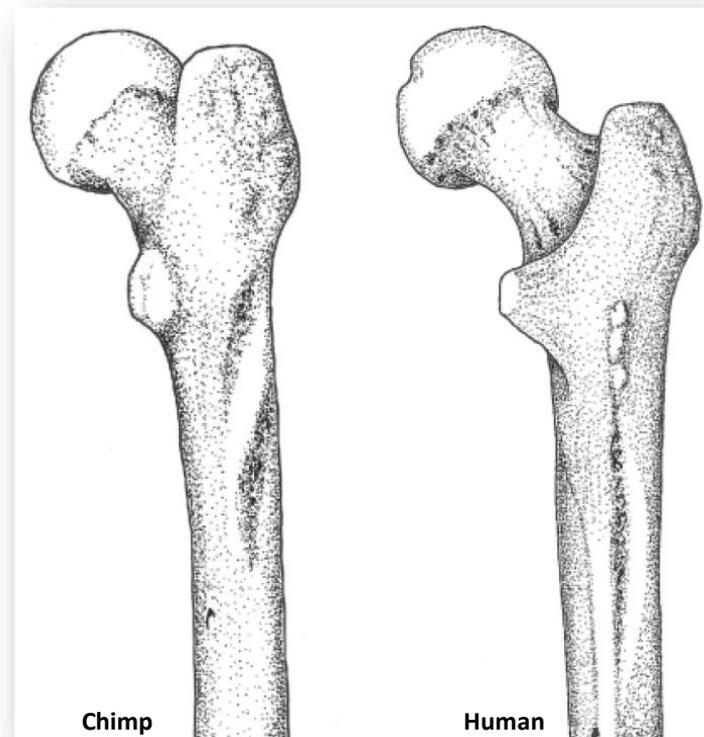
## The proximal femur – Hypotrochanteric fossa

- The morphological 'complex' related to gluteus maximus is already present in humans at very early stages of development.



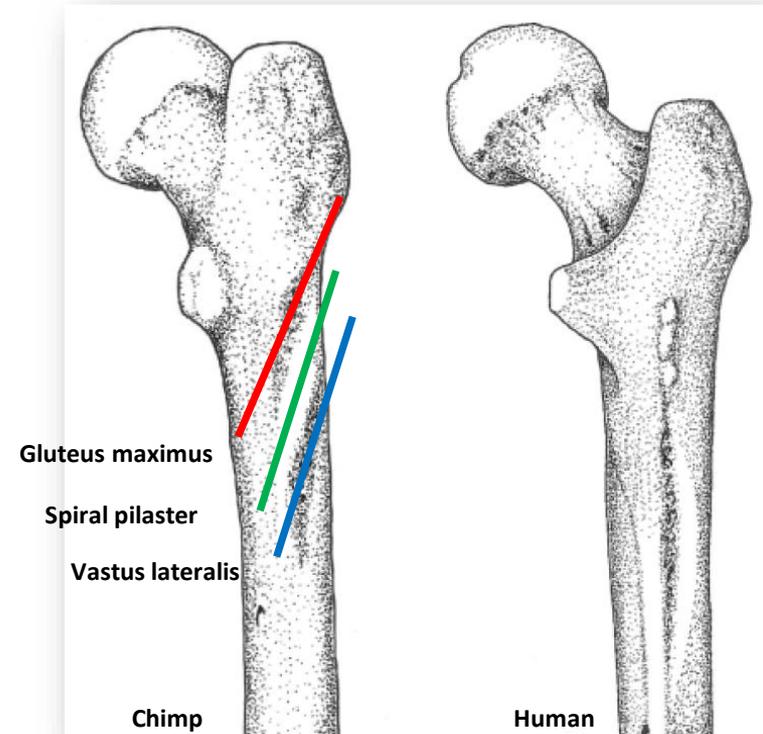
## The proximal femur – Lateral spiral pilaster

- The lateral surface of the femoral shaft of the African apes, immediately inferior to the termination of the greater trochanter, regularly exhibits an elevated, invariably palpable, local pilaster (often originating as an uninterrupted continuation of the midlateral lower border of the greater trochanter).
- It descends inferomedially for several centimeters as a smooth-surfaced promontory, usually in a spiral fashion separating **two areas of muscle attachment** on the proximolateral aspect of the femur.
- One, which lies more superiorly and posteromedial to the pilaster, is a rough, reticulated surface whose upper portion is often a continuation of the trochanteric origin of the *vastus lateralis*.
- The second is the area of rugosity for the insertion of the gluteus maximus.
- It reflects the relative position of these muscle



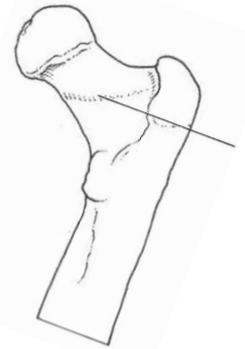
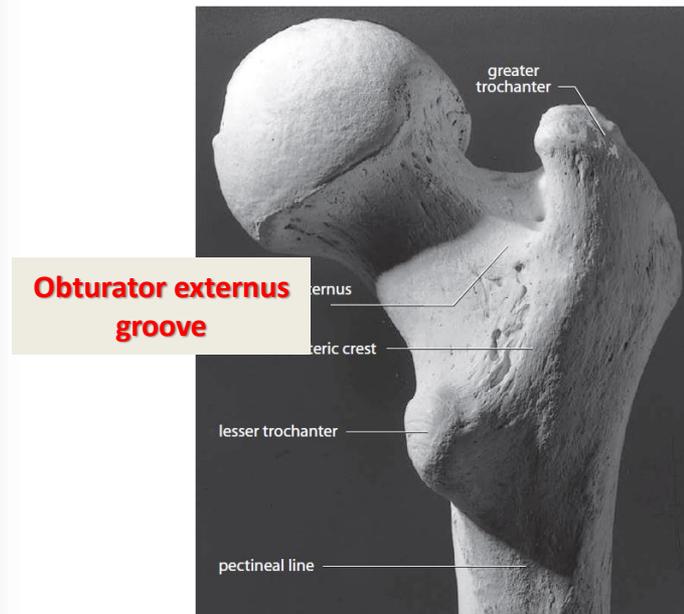
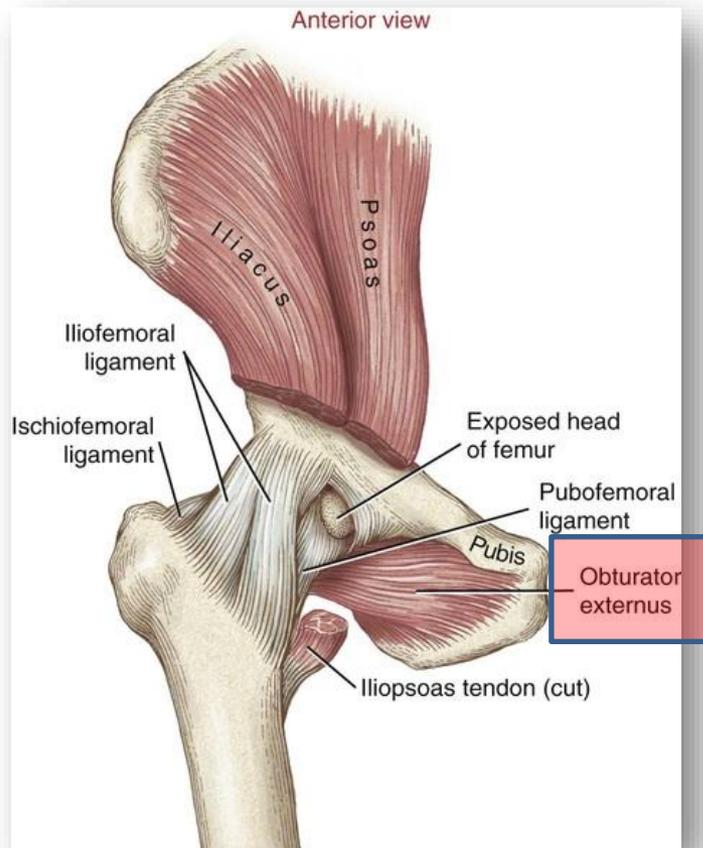
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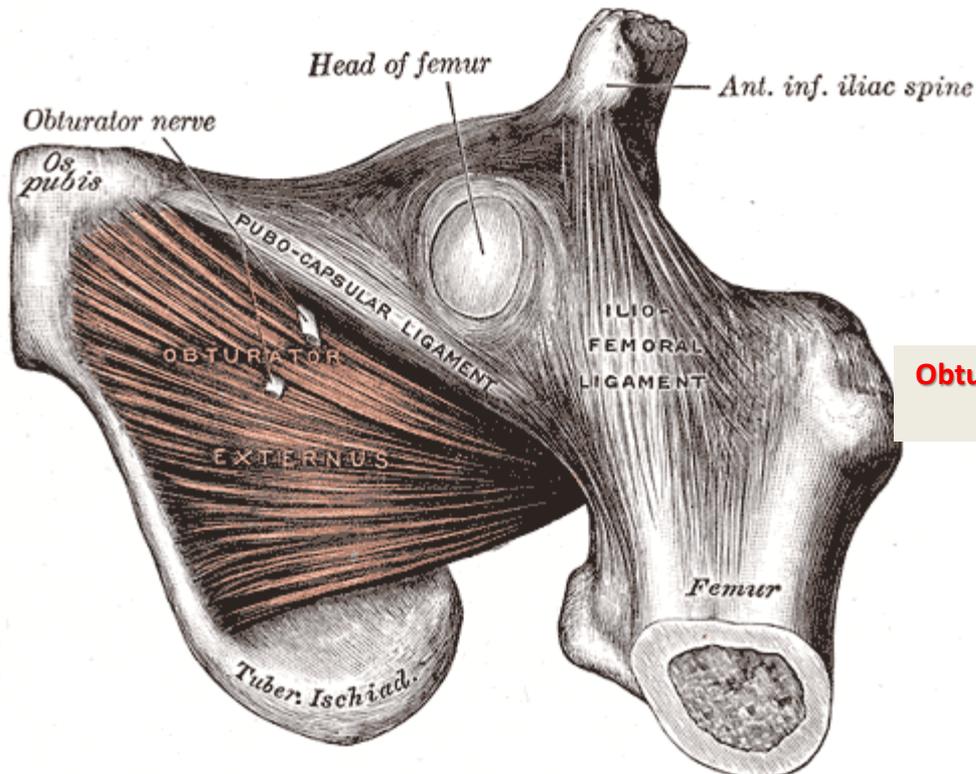
# The proximal femur – Obturator externus groove

- It is a diagonal groove variably left on the posterior surface of the neck of the femur produced by the tendon of **the obturator externus muscle**.
- This muscle originates from the body of the pubis, ischiopubic ramus and the membrane that closes the obturator foramen. It **passes behind the femur neck inserting into the trochanteric fossa**.
- Due to the habitual flexed-hip posture of chimpanzees the tendon does not wrap the femoral neck. As a result **there is no obturator externus groove in chimpanzees**.

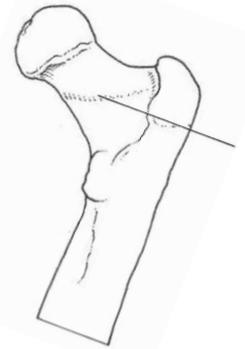
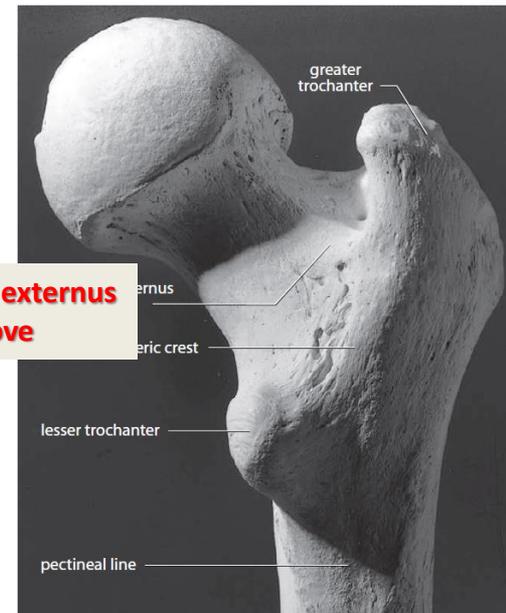


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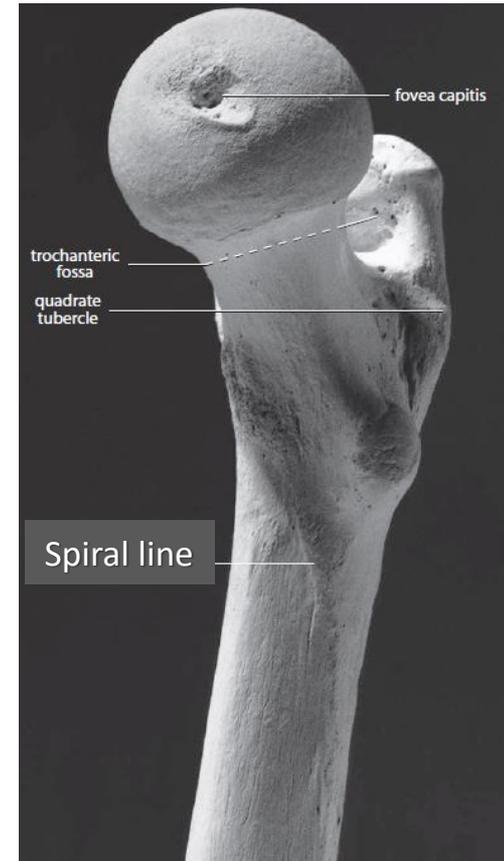
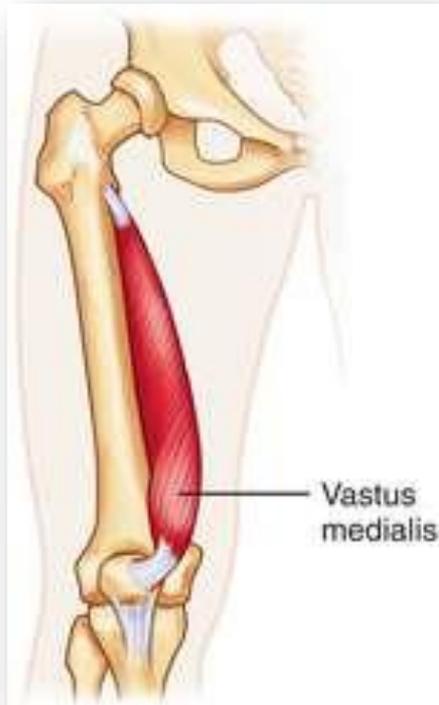


**Obturator externus groove**



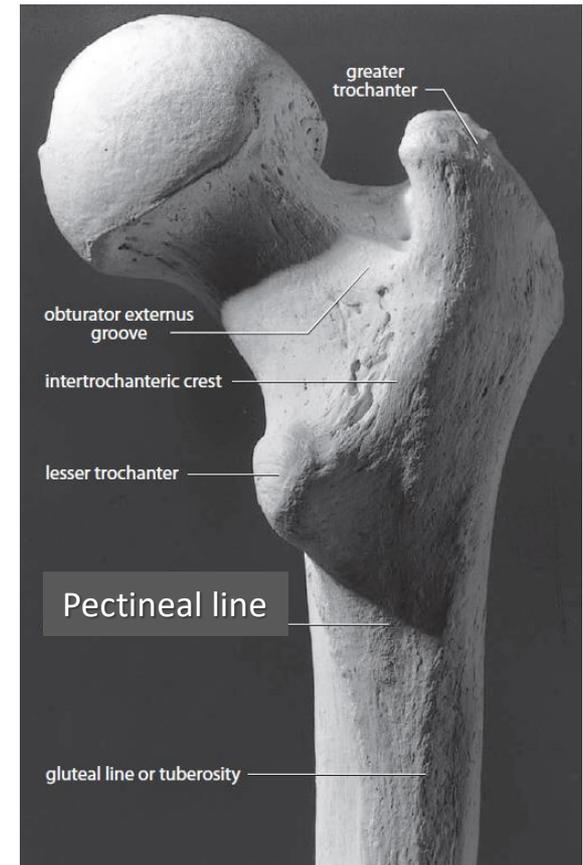
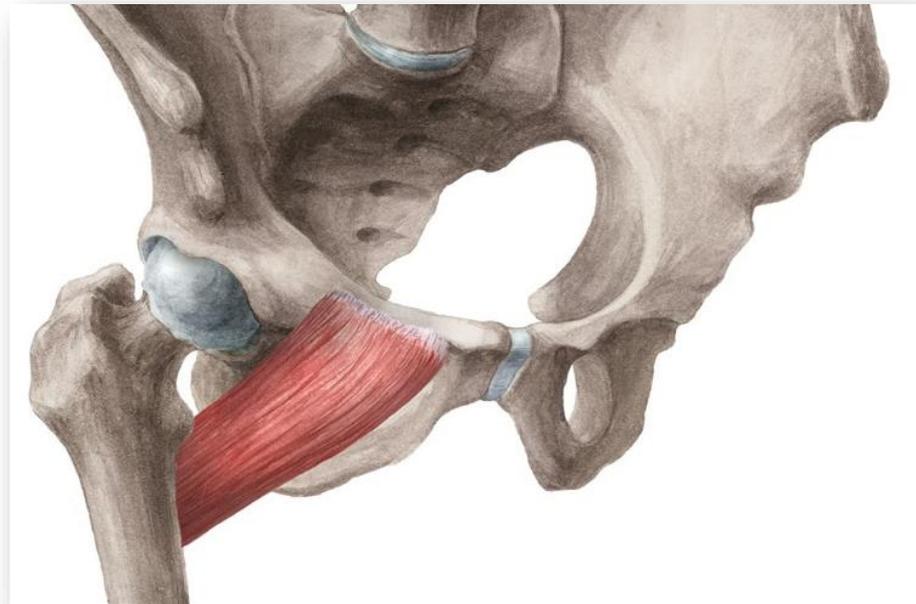
# The proximal femur – Spiral line

- It spiraling inferior to the lesser trochanter, connects the inferior end of the intertrochanteric line with the medial lip of the linea aspera.
- It is the origin of the ***vastus medialis muscles*** – a part of the *quadriceps femoris muscles*, a **knee extensor** that inserts on the anterior tibia via the patella.



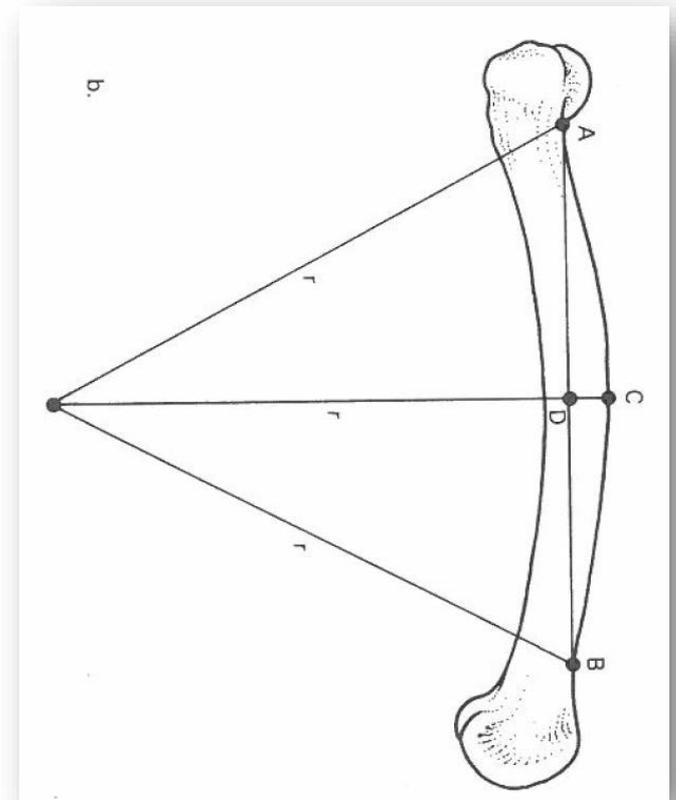
# The proximal femur – Pectineal line

- It is a short, curved line that passes inferolaterally from the base of the lesser trochanter, between the spiral line and gluteal tuberosity.
- It is the insertion of the *pectineous muscle*, which **originates from the pubic part of the os coxae**.
- Acts to **adduct, laterally rotate, and flex the thigh at the hip**.



# The femoral shaft – gross morphology (stature)

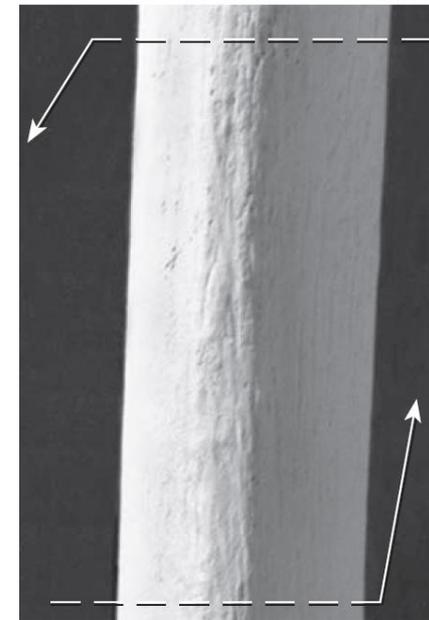
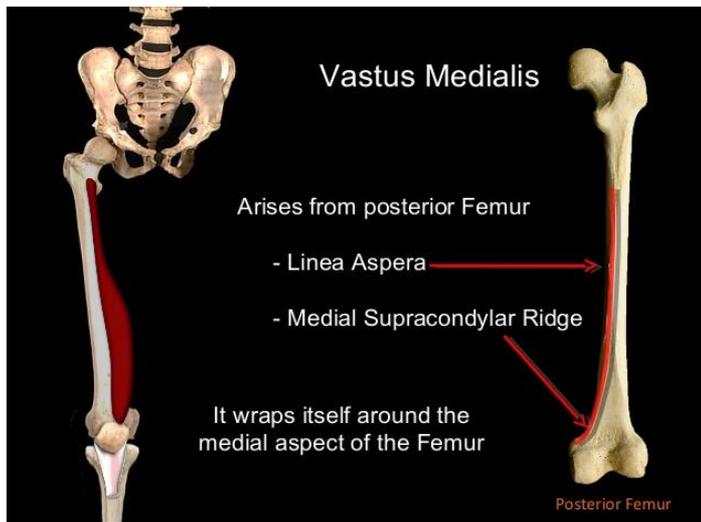
- Human have considerably larger femur.
- Femoral shaft anteroposterior curvature
  - African great apes have more anteroposterior curved midshafts.



# The femoral shaft – Linea aspera

- The long, wide, roughened, and elevated ridge that runs along the posterior shaft surface.
- It collects the spiral, pectineal and gluteal lines proximally and divides into the supracondylar ridges distally.
- Is a primary origin site for the *vastus medialis muscles* (part of *quadriceps*: extensor of the knee)
- A primary insertion site of the adductors (*longis, brevis, and magnus*) of the hip.

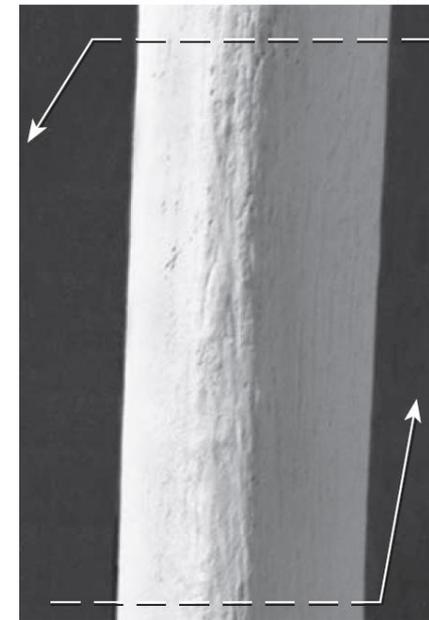
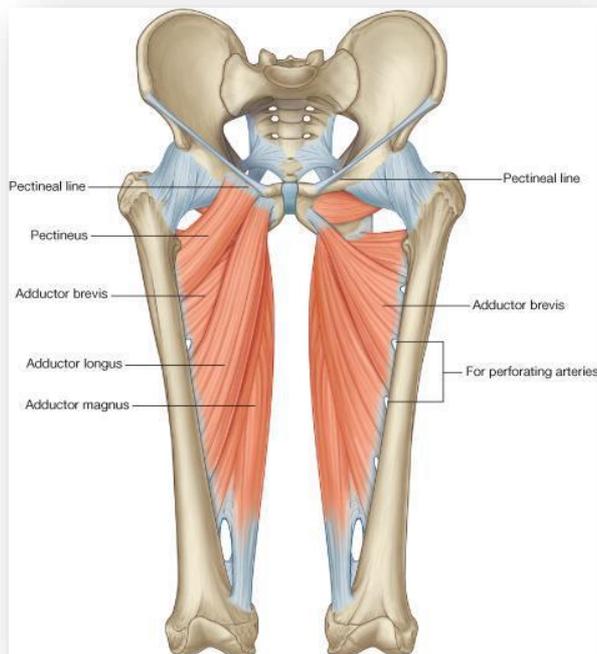
## *Vastus medialis*



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## Adductors



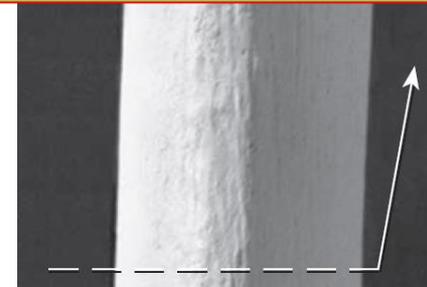
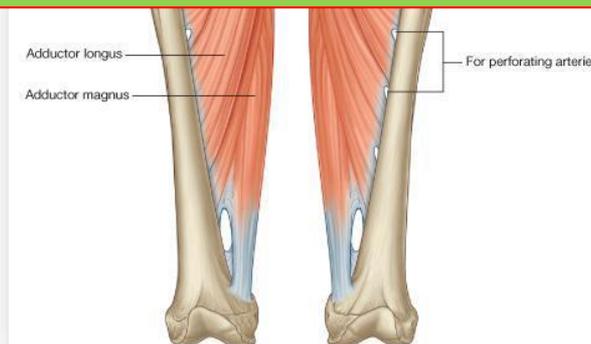
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## Adductors

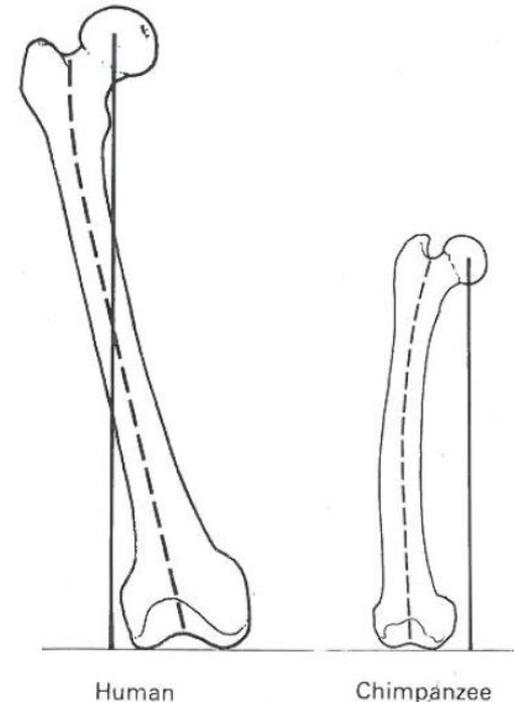
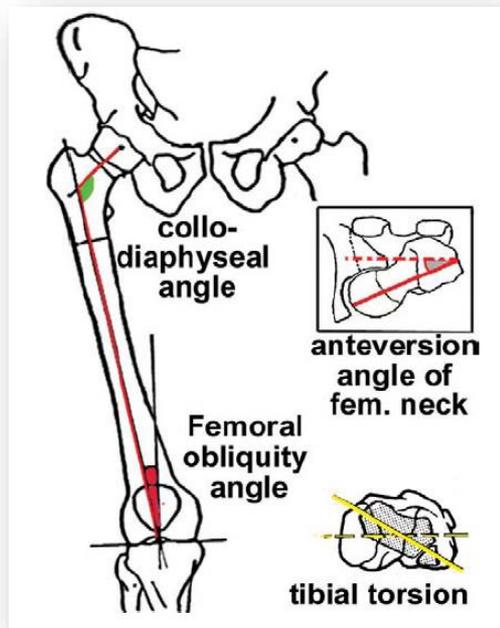


The linea aspera is present in African apes in a slight to moderate development.



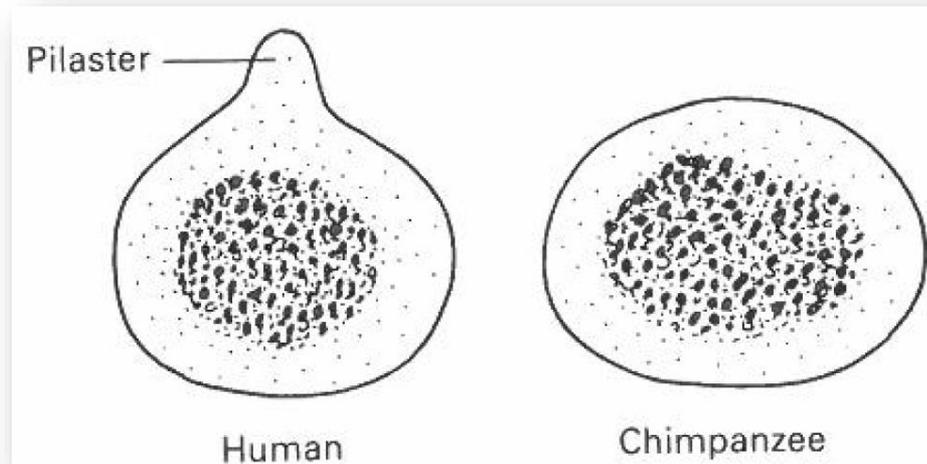
# The femoral shaft – location of reaction force / vertical inclination

- Another consequence is that in humans the **load axis intersects the axis of the shaft of the femur**. In apes this is not the case.
- Anatomical differences resulting from this difference in weight transferring:
  - ❖ **Curvature of the shaft:** In African apes the femora are **laterally convex** throughout their lengths.
  - ❖ **Cortical thickness:** In humans the **thickness of the cortex on the lateral side** generally exceeds the thickness in the medial side of the shaft.
  - ❖ **Bycondilar angle (valgus knee):** Humans have elevated bycondilar angle (valgus angle). PS: Broader pelvis.
  - ❖ **Relative size of femur condyles:** In the African apes the medial condyle is considerably larger than the lateral condyle. In humans both condyles of similar size.



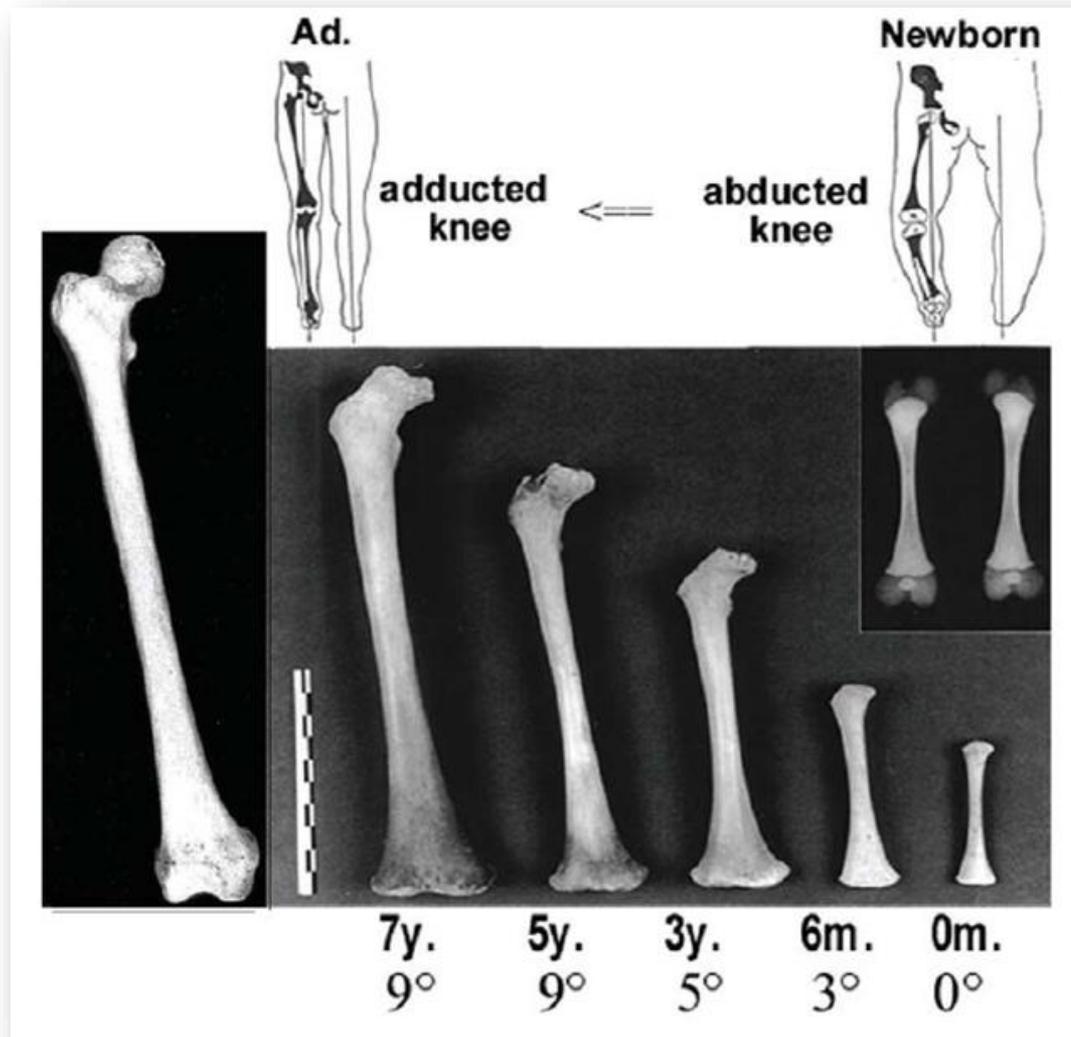
# The femoral shaft – transversal location of reaction force

- The femoral shaft of humans and apes are also different in that the later commonly have a **pilaster** while this is absent in the last.
  - ❖ The pilaster is a **beam-like structure which supports the linea aspera** and extends down back the femoral shaft. It is not the linea aspera.
  - ❖ The presence of the pilaster results in very different cross-section morphology for the femur midshaft of human and apes. In humans the antero-posterior diameter of the cross-section is, on average, considerably larger in relation to the transverse diameter in apes.



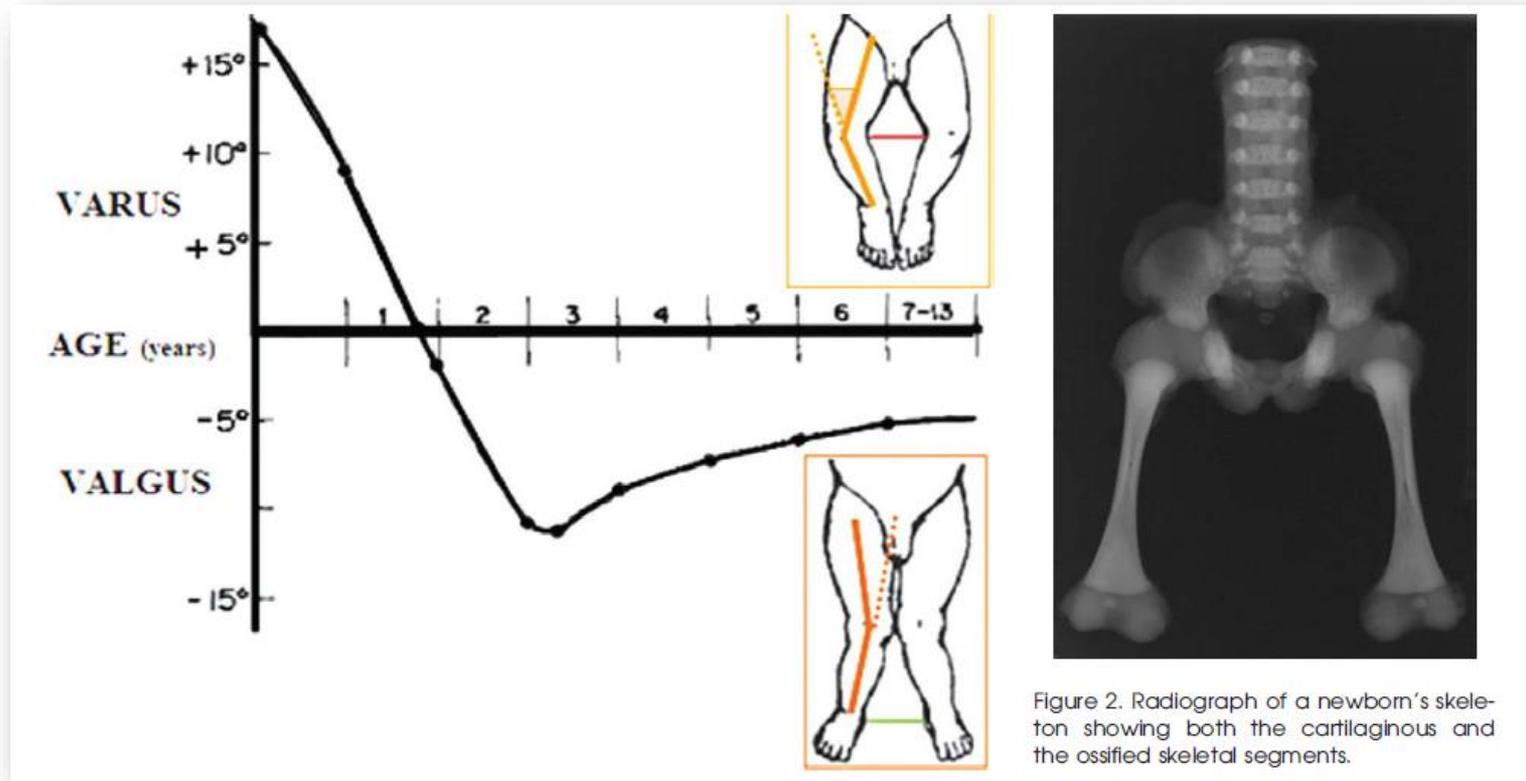
# The femoral shaft – location of reaction force / vertical inclination

- The valgus knee is absent in newborns and is gradually established through out ontogeny.



# The femoral shaft – location of reaction force / vertical inclination

- The valgus knee is **absent in newborns** and is gradually established through out ontogeny.



# The femoral shaft – location of reaction force / vertical inclination

- Radiograph of a 7 years old boy who **never walked**.
- The **valgus knee never developed** and super broad neck angle.



# The femoral shaft – location of reaction force / vertical inclination

- Valgus knee....



# The femoral shaft – location of reaction force / vertical inclination

- Valgus knee....



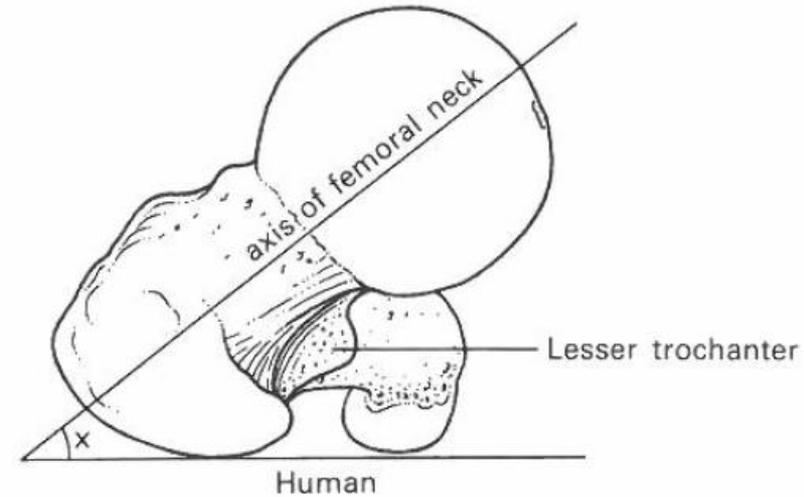
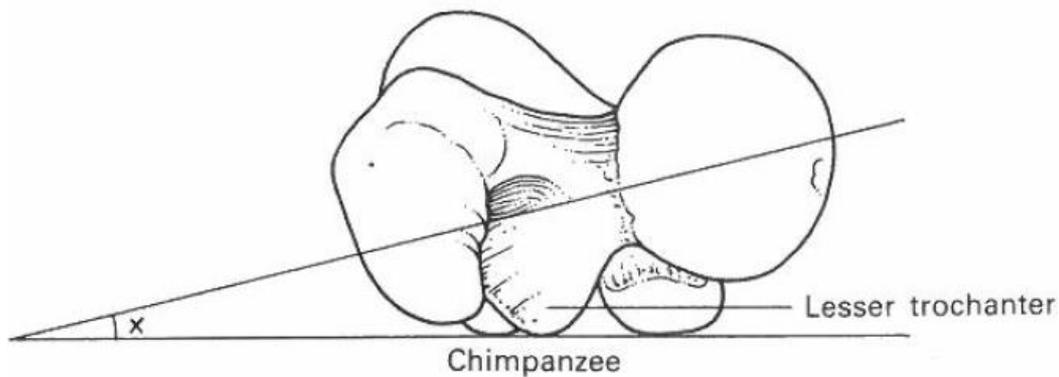
# The femoral shaft – location of reaction force / vertical inclination

- Valgus knee....



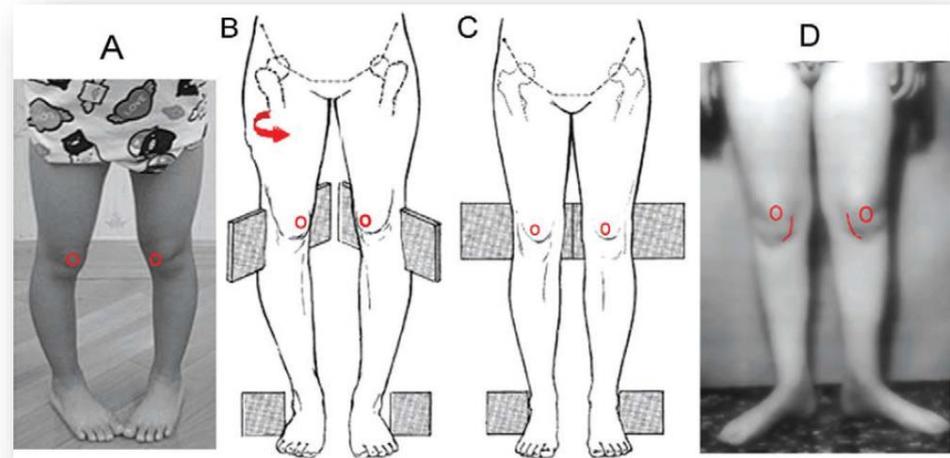
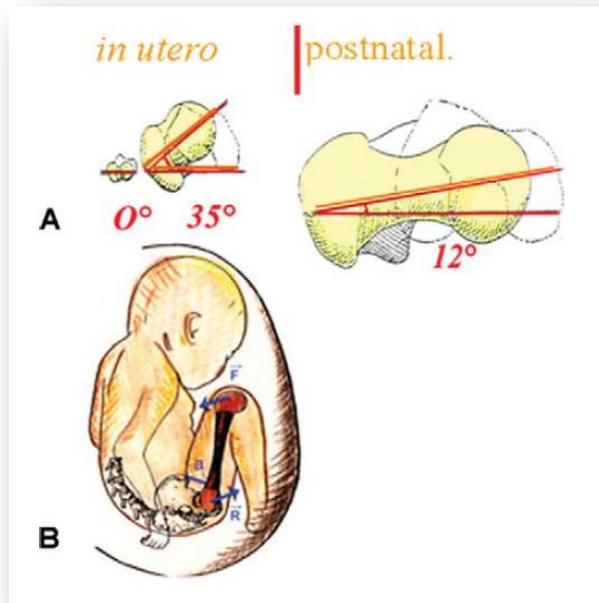
# The femoral shaft – Lesser trochanter and femoral torsion

- When resting on its two condyles the ape proximal femur is supported by its lesser trochanter, while in humans the femur is supported by the greater trochanter.
  - This reflects a difference in the **angle of femoral torsion**.



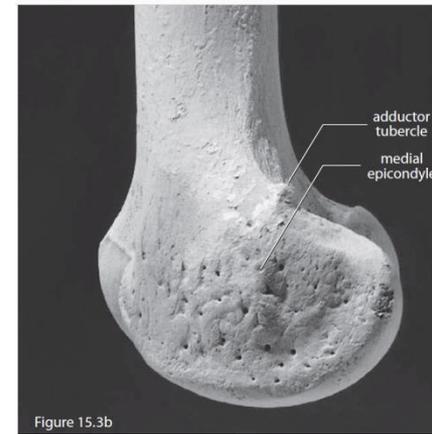
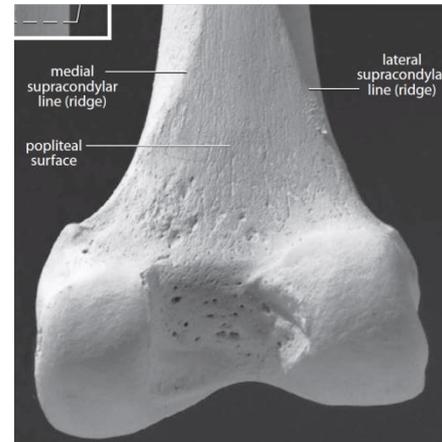
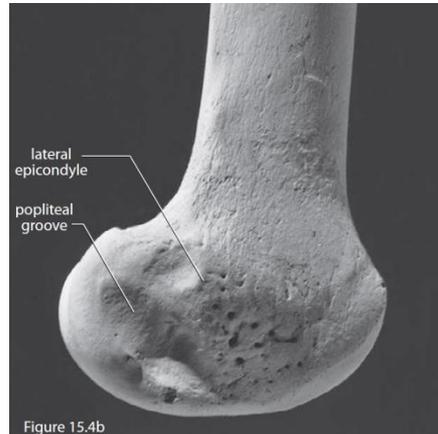
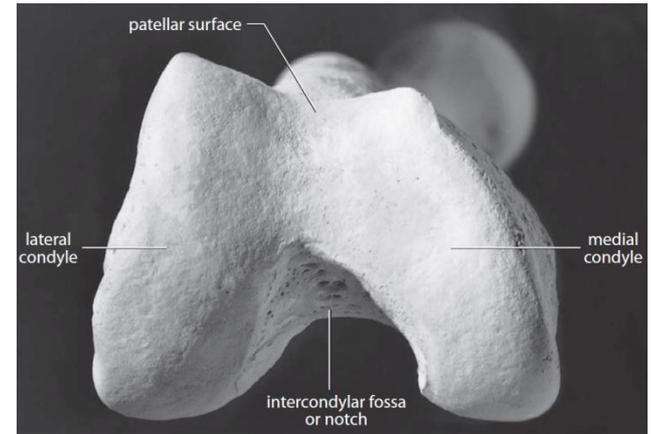
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# The distal femur - overview

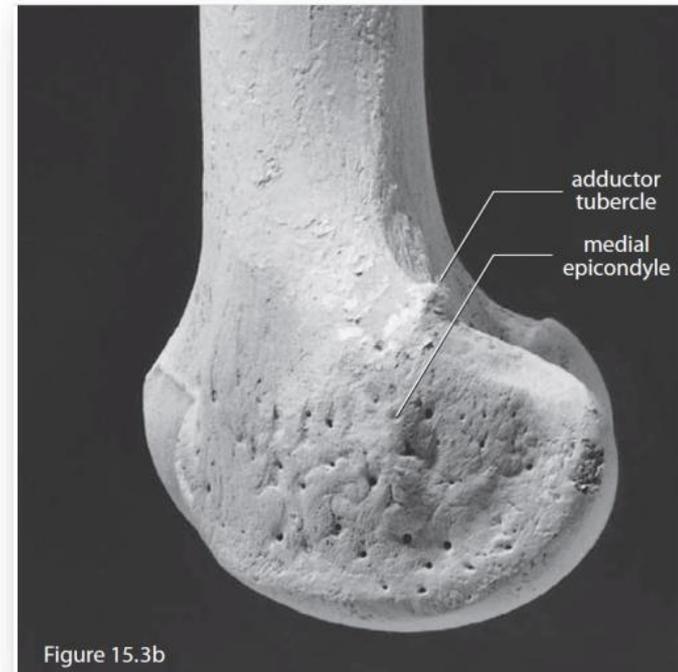
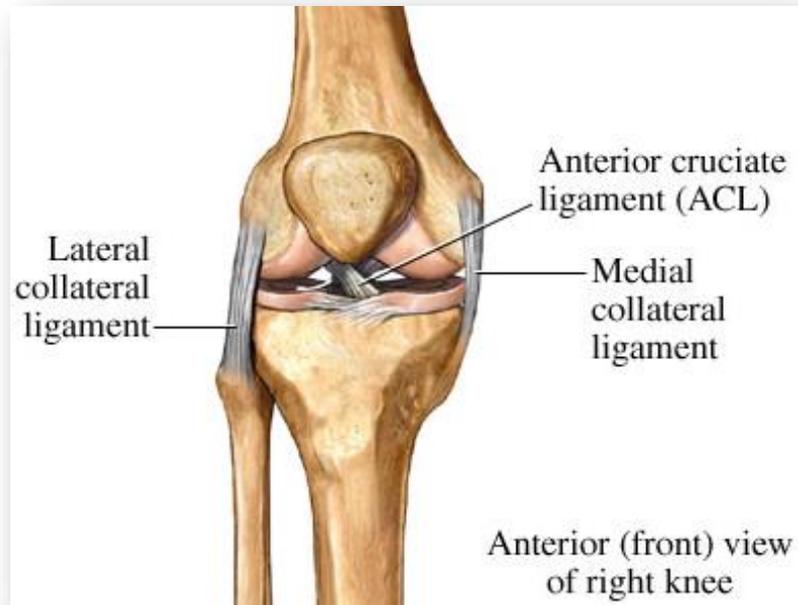
- Lateral and medial condyles and epicondyles
- Intercondylar fossa
- Patellar surface
- Popliteal surface and popliteal groove
- Lateral and medial supracondylar lines
- Adductor tubercle



# The distal femur – medial epicondyle

- The convexity on the medial side of the medial condyle.
- Attachment point for **medial collateral ligament** of the knee.

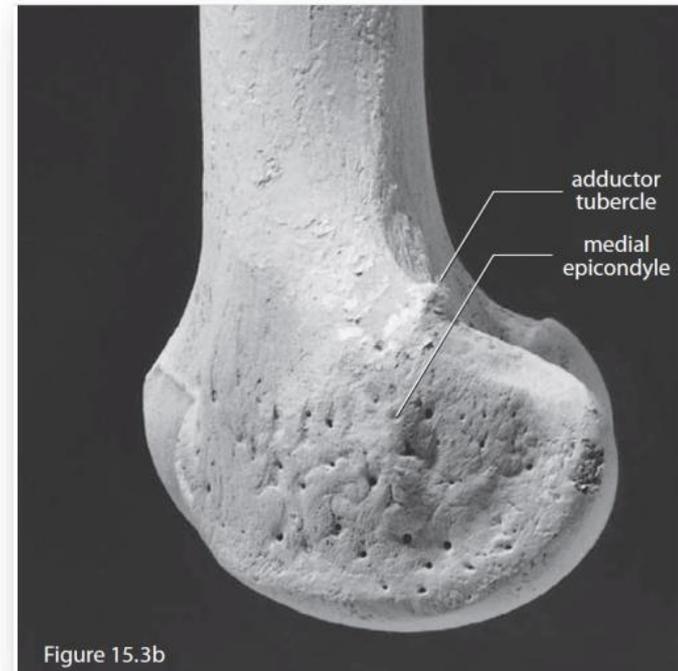
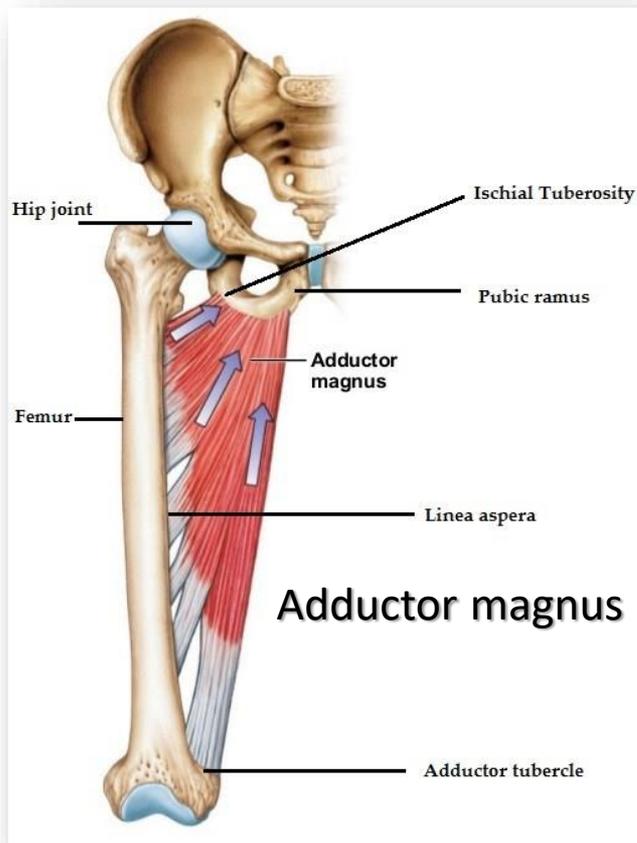
## *Medial collateral ligament*



# The distal femur – adductor tubercle

- A variable, raised tubercle on the medial supracondylar ridge just superior to the medial epicondyle.
- Attachment for the *adductor magnus*, a muscle originating on the lower edge of the ischiopubic ramus and ischial tuberosity.
  - This muscles adducts the thigh at the hip.

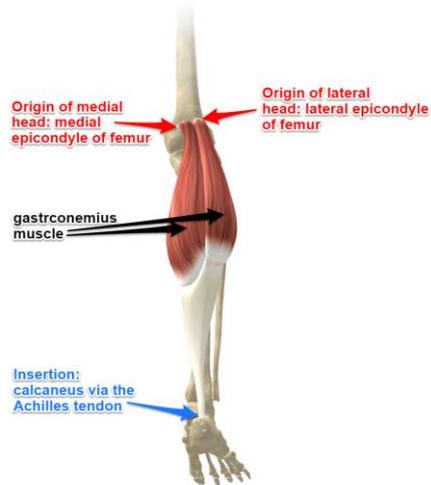
## *Adductor magnus*



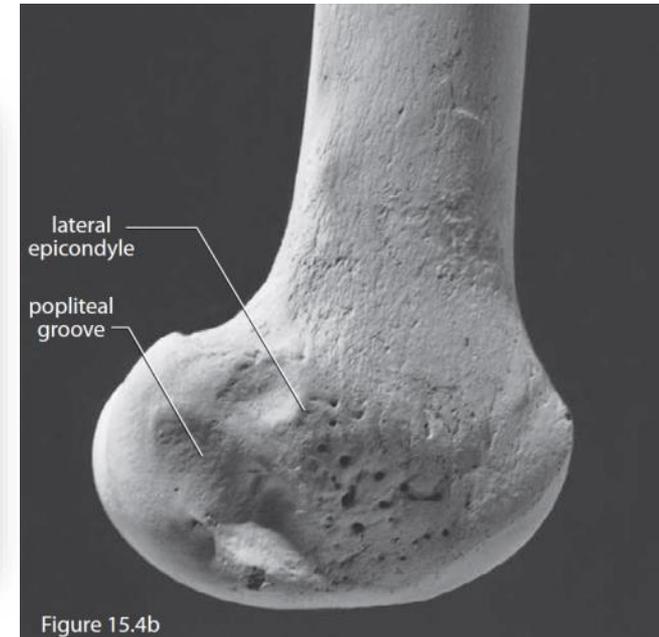
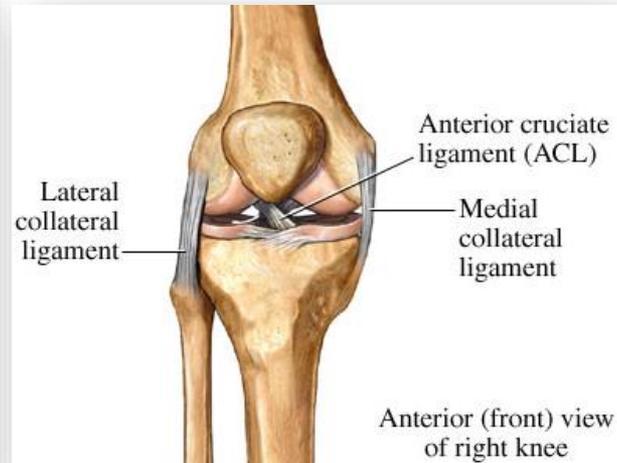
# The distal femur – lateral epicondyle

- The convexity on the lateral side of the lateral condyle.
- Its upper surface bears a facet that is an attachment point for one head of the ***gastrocnemius muscle***
  - Flexor of the knee and plantarflexor of the foot at the ankle.

## *Gastrocnemius*



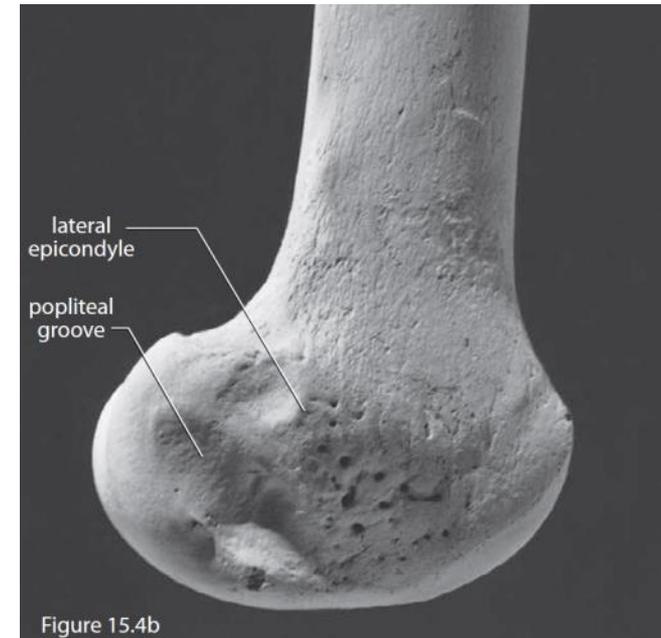
## *Lateral collateral ligament*



## The distal femur – Popliteal groove

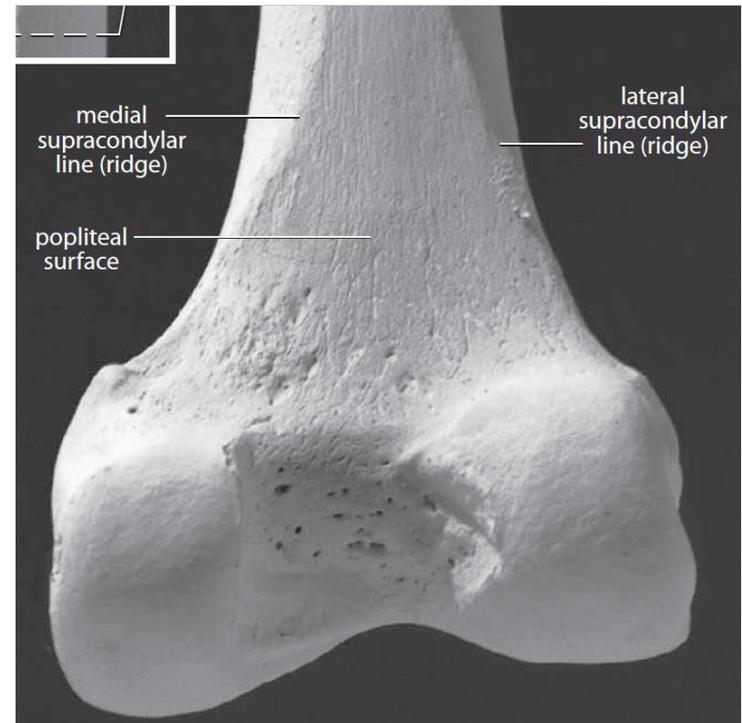
- A smooth hollow on the posterolateral side of the lateral condyle.
- Groove for the *tendon of the popliteus muscle*.
- This muscle inserts on the posterior tibial surface and is a medial rotator of the tibia at the knee.

### *Popliteus muscle*



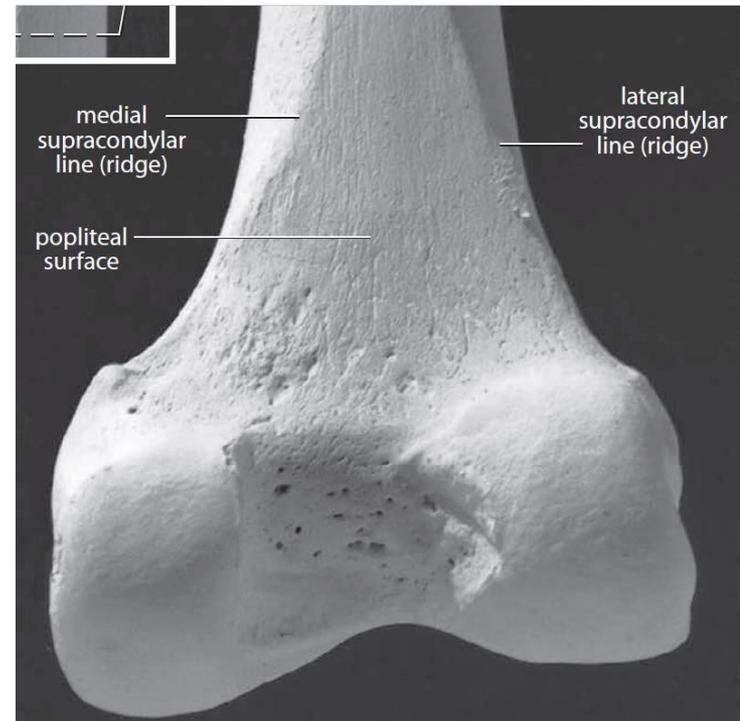
# The distal femur – Popliteal surface

- The popliteal surface is the wide, flat, triangular area of the posterior, distal femur.
- It is bounded by the condyles inferiorly and by the supracondylar lines medially and laterally.
- There are no muscles or ligament attachments in this area.



## The distal femur – Supracondylar lines/ridges

- Medial: Inferior, medial extension of the linea aspera, marking the distal, medial corner of the shaft. It is fainter than the lateral supracondylar ridge. and by the supracondylar linas medially and laterally.
- Lateral: Inferior, lateral extension of the linea aspera. It is more pronounced than the medial supracondylar ridge.



# The distal femur – lateral profile

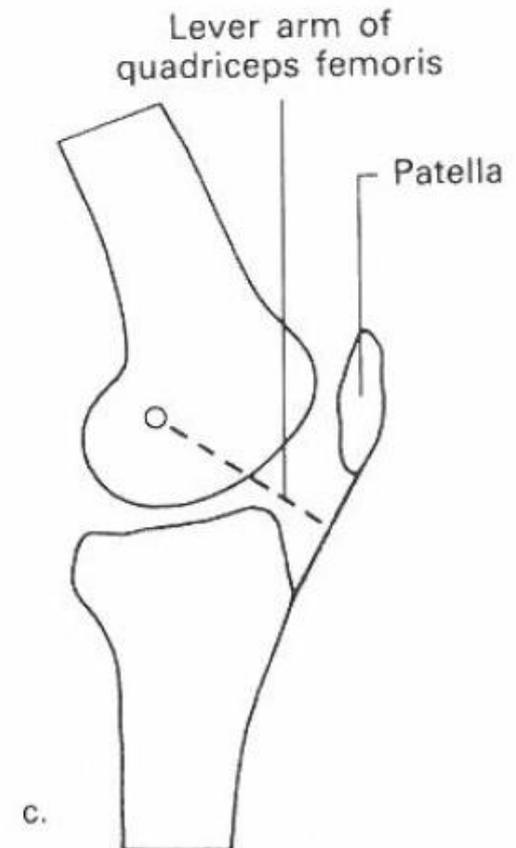
- Lateral and medial profile of the condyles
- Both the lateral and the medial **condyles in humans have an elliptical profile** when viewed from the side. This **maximizes the area of contact at the knee joint when the knee is in extension minimizing the load of the knee.**
- It also **dislocates patella anteriorly** increasing the lever arm of the main extensor of the knee (*quadriceps femoris*)



Chimpanzee



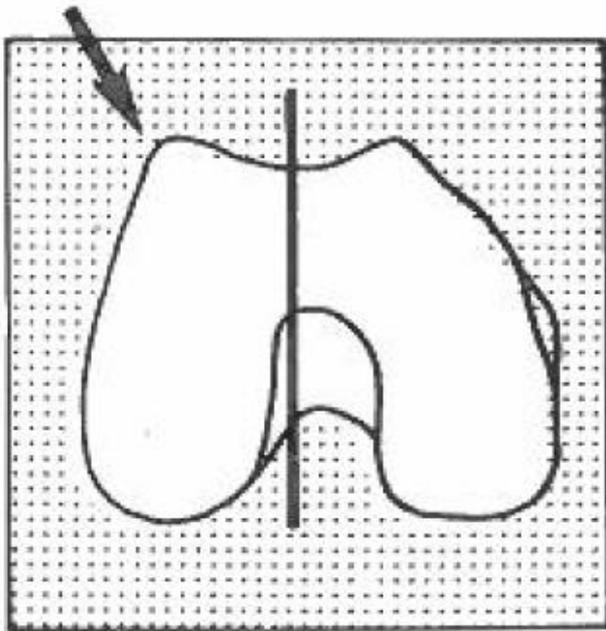
Humans



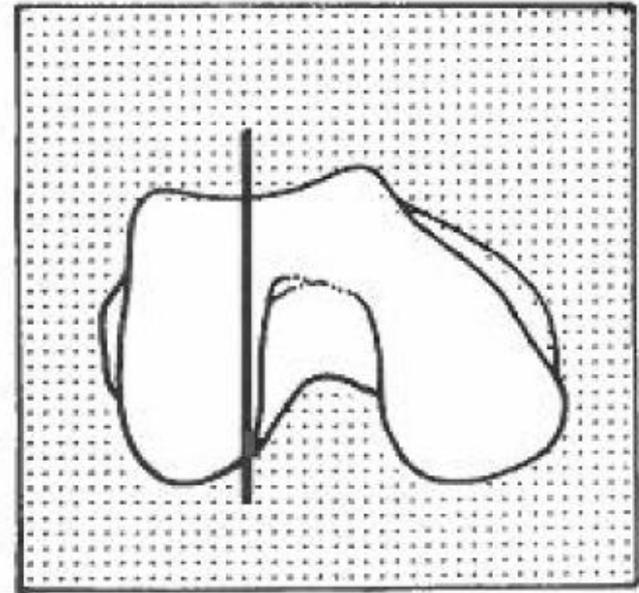
c.

## The distal femur – Condyles

- The distal surface of the human femur has a **square outline** while the ape one has a **rectangular outline**.
- The distal surface of the human femur is more symmetrical around the parasagittal plane.



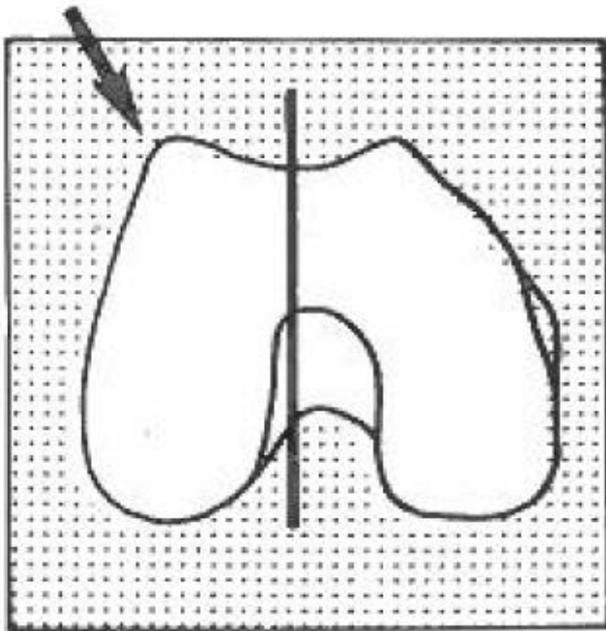
Human



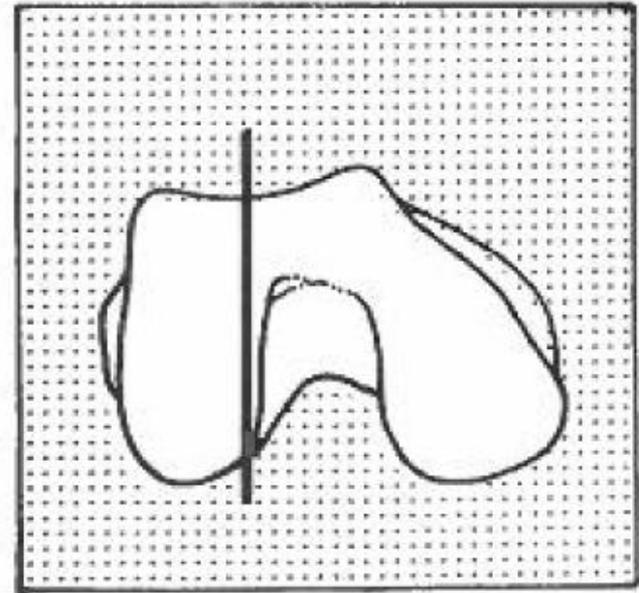
Chimpanzee

## The distal femur – Patellar groove

- In humans the **patellar groove is deeper** than it is in apes and the **lateral lip of the groove projects anteriorly** to a greater extent than does the medial lip. The distance from the lateral lip to the deepest part of the groove is longer than the distance from the medial lip.
- Debates over functional interpretation. Adaptation to bipedalism?



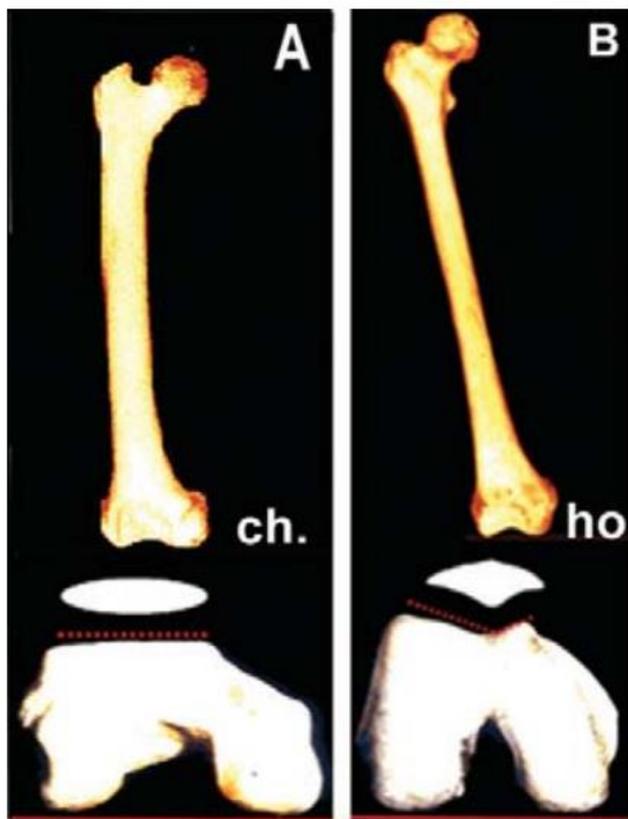
Human



Chimpanzee

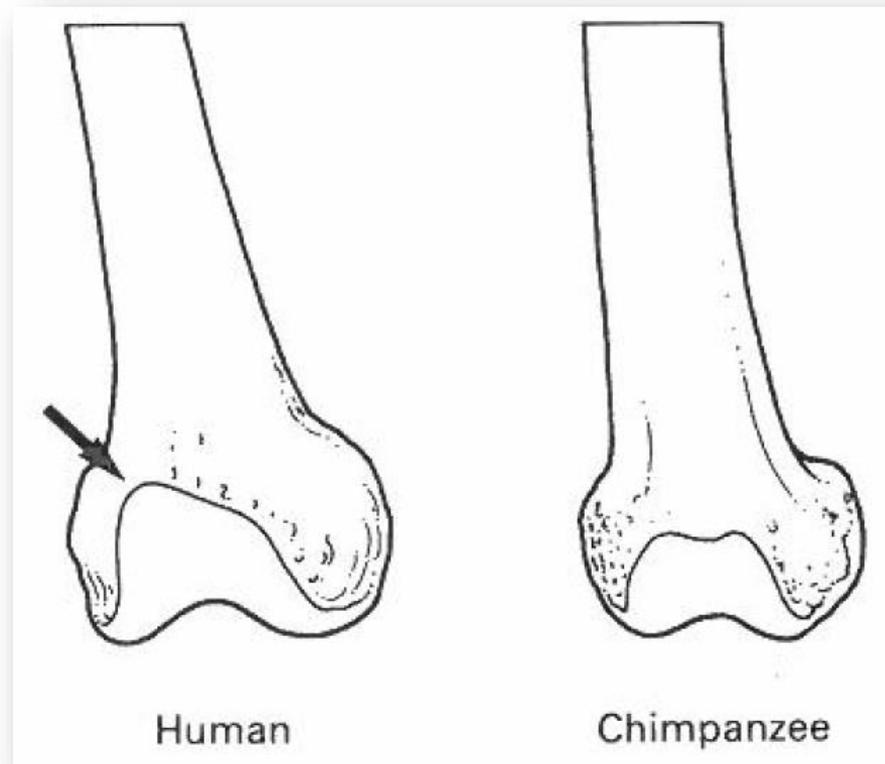
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  - The human angle of femoral obliquity implies an oblique direction of the quadriceps muscle, inserted on the proximal tibia so that a lateral force is applied to the patella.



## The distal femur – Patellar surface

- In humans the lateral side of the patellar surface extends more proximally than does the medial border.



## The distal femur – Patellar surface

- The **sustrochlear hollow** (from 17) is a palpable indentation just superior to the patellar articular surface.
- It receives the patella during full leg extension and is evidence for an extended leg during bipedal gait.

