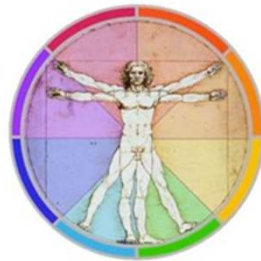


HUBS 191 Lecture Material

This pre-lecture material is to help you prepare for the lecture and to assist your note-taking within the lecture,
it is NOT a substitute for the lecture !



Please note that although every effort is made to ensure this pre-lecture material corresponds to the live-lecture there may be differences / additions.

HUBS191

Lecture 11: Musculoskeletal system: Complex movements (standing and gait)

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Department of Anatomy

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Lecture objectives

- Describe the anatomical features of the lower limb that allow us to stand with minimal energy expenditure
- Define the phases of the gait cycle
- Understand and describe the sequence of muscle activity that occurs during the gait cycle

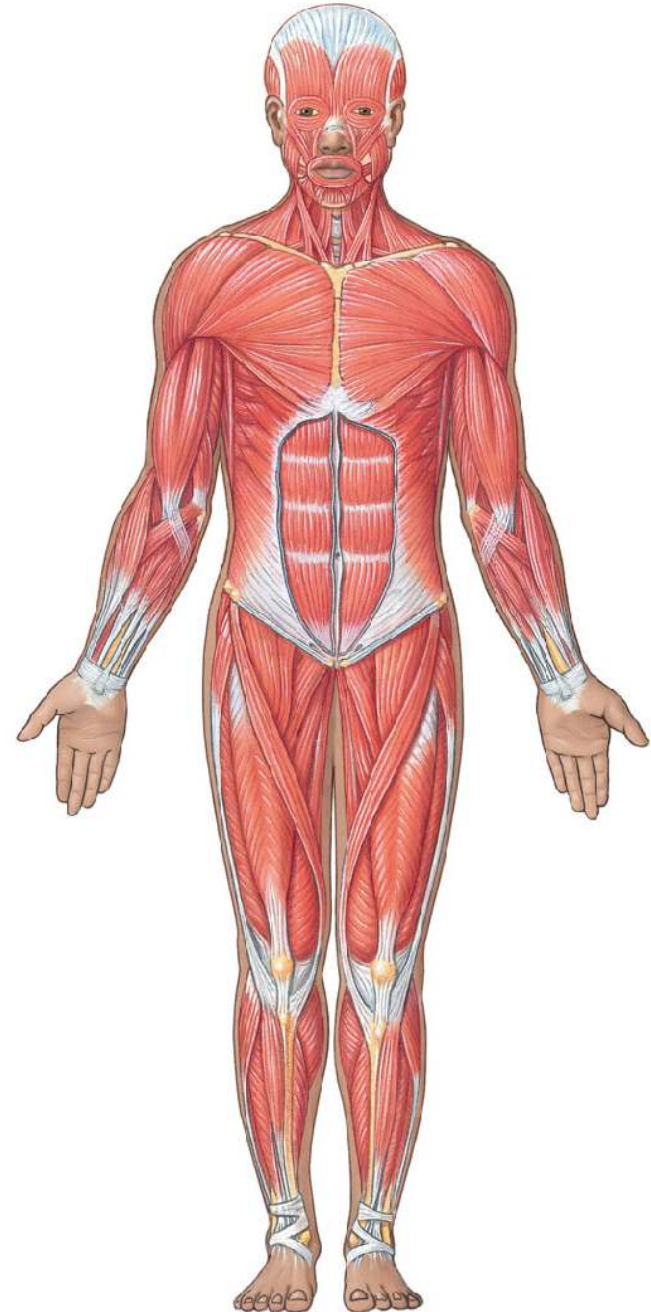
Quadrupedal standing

- Base of support
- Limbs active at many joints
- Demands energy



Bipedal standing

- Relatively small area of contact with ground
- Plantar surface of feet
- Energy efficient



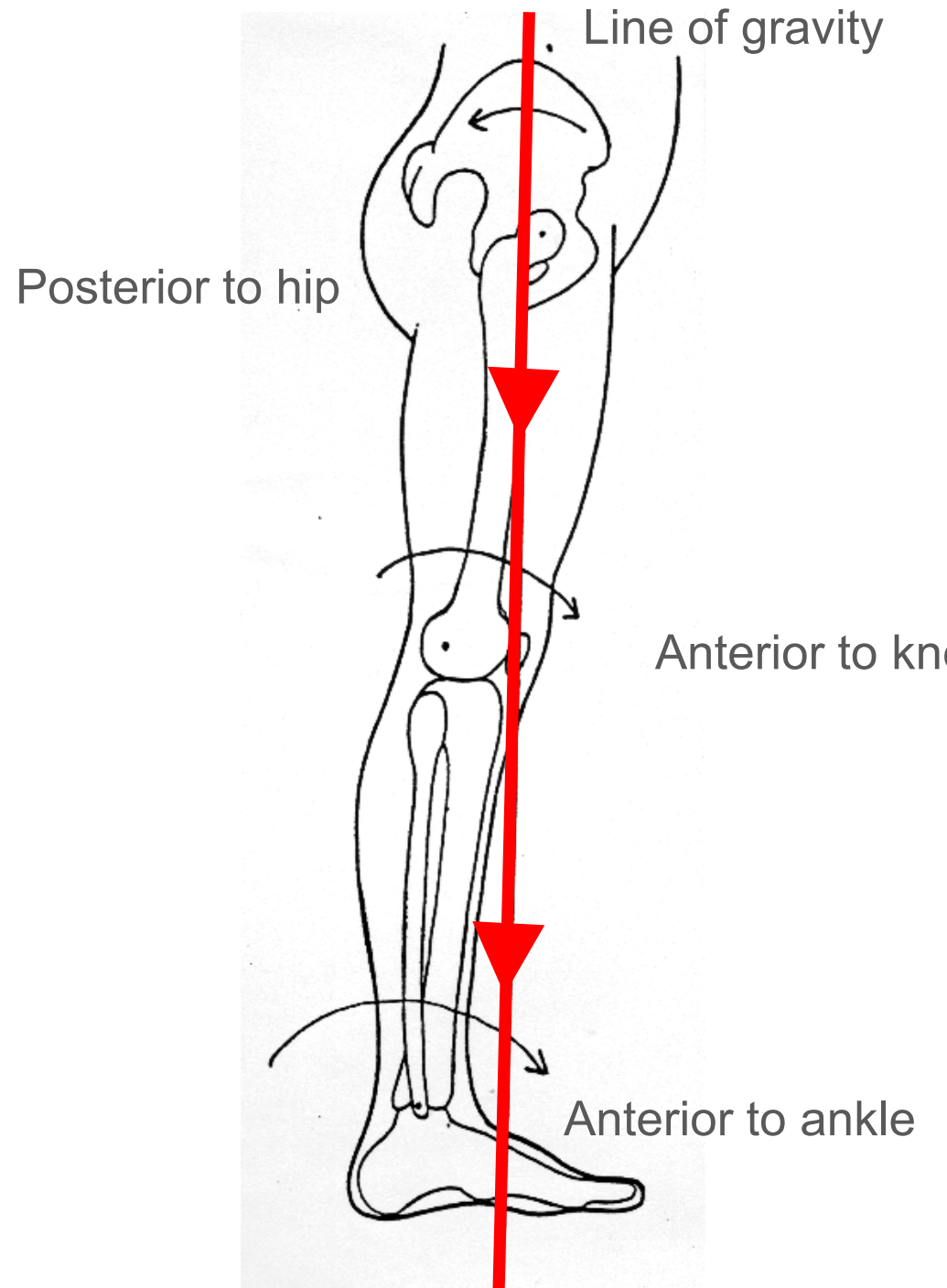
Recap of muscle roles

- Agonists act concentrically
- Antagonists act eccentrically
- Stabilisers act isometrically
- **Gravity** can act as an agonist or an antagonist



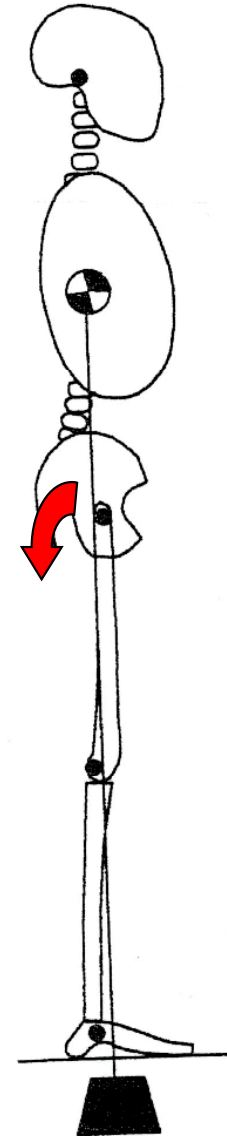
Line of gravity

- How do we maintain a stable, upright stance?
- Needs to be energy efficient
- Requires anatomical solutions

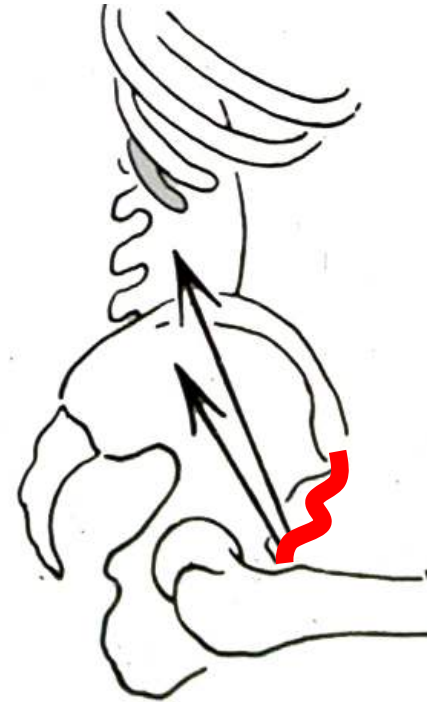
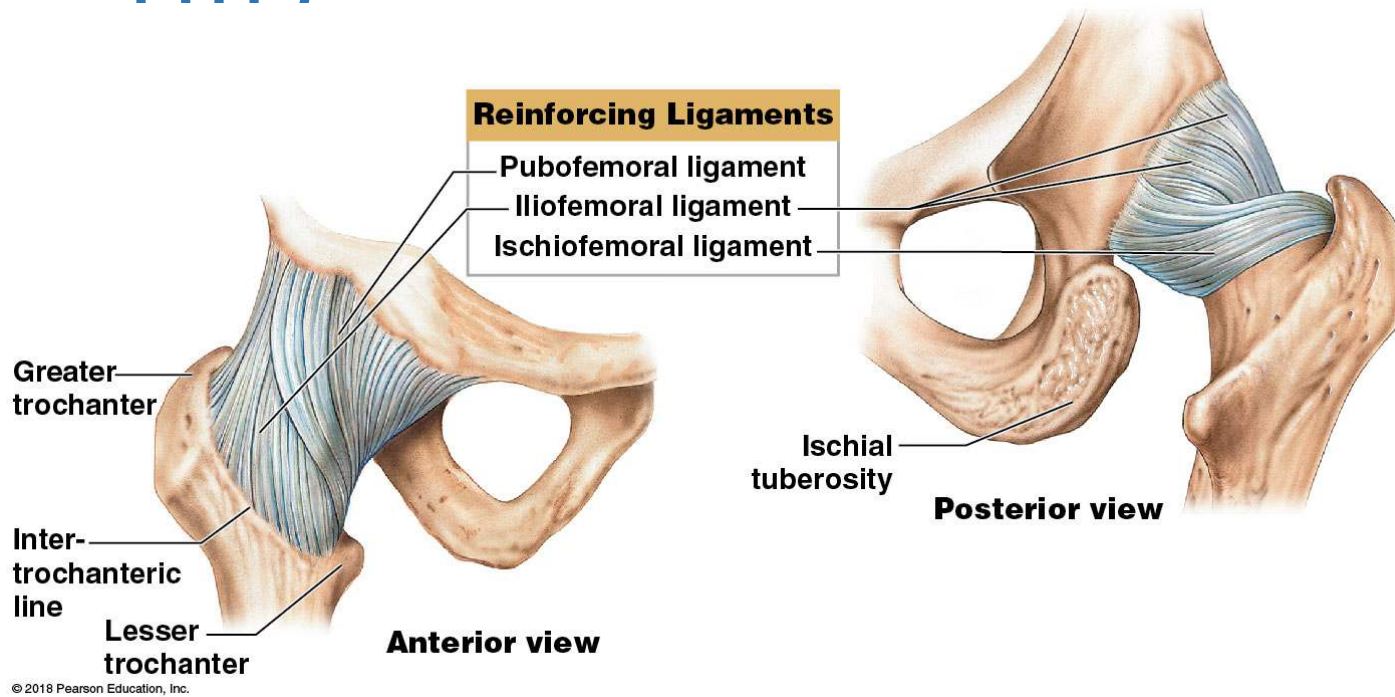


Bipedal standing - Hip

- Line of gravity = posterior to joint
- 'Pushes' joint into extension
- Ligaments are tight
- Joint is locked
- No energy spent



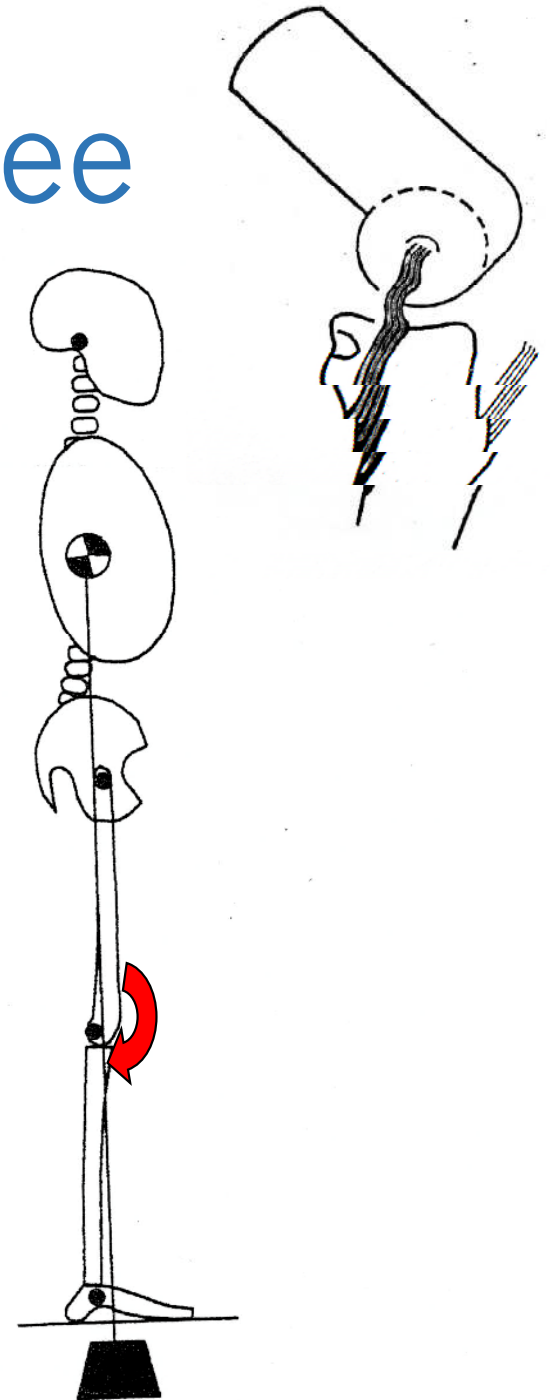
Capsular ligaments of the hip



- Hip in flexion: lax anteriorly; taut posteriorly
- Hip in extension: taut anteriorly; lax posteriorly

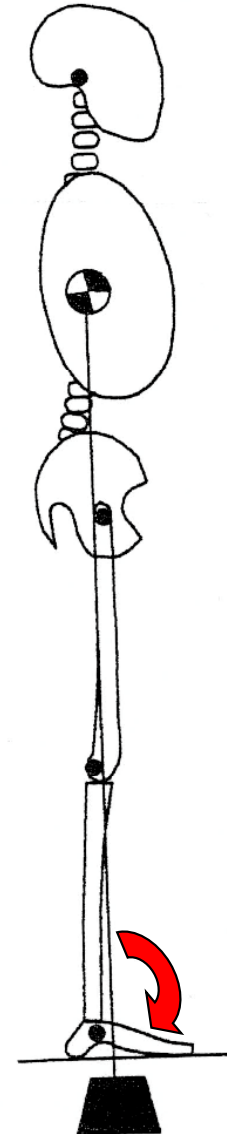
Bipedal standing - Knee

- Line of gravity = anterior to joint
- 'Pushes' into extension
- Ligaments are tight
- Joint is locked
- No energy spent



Bipedal standing - Ankle

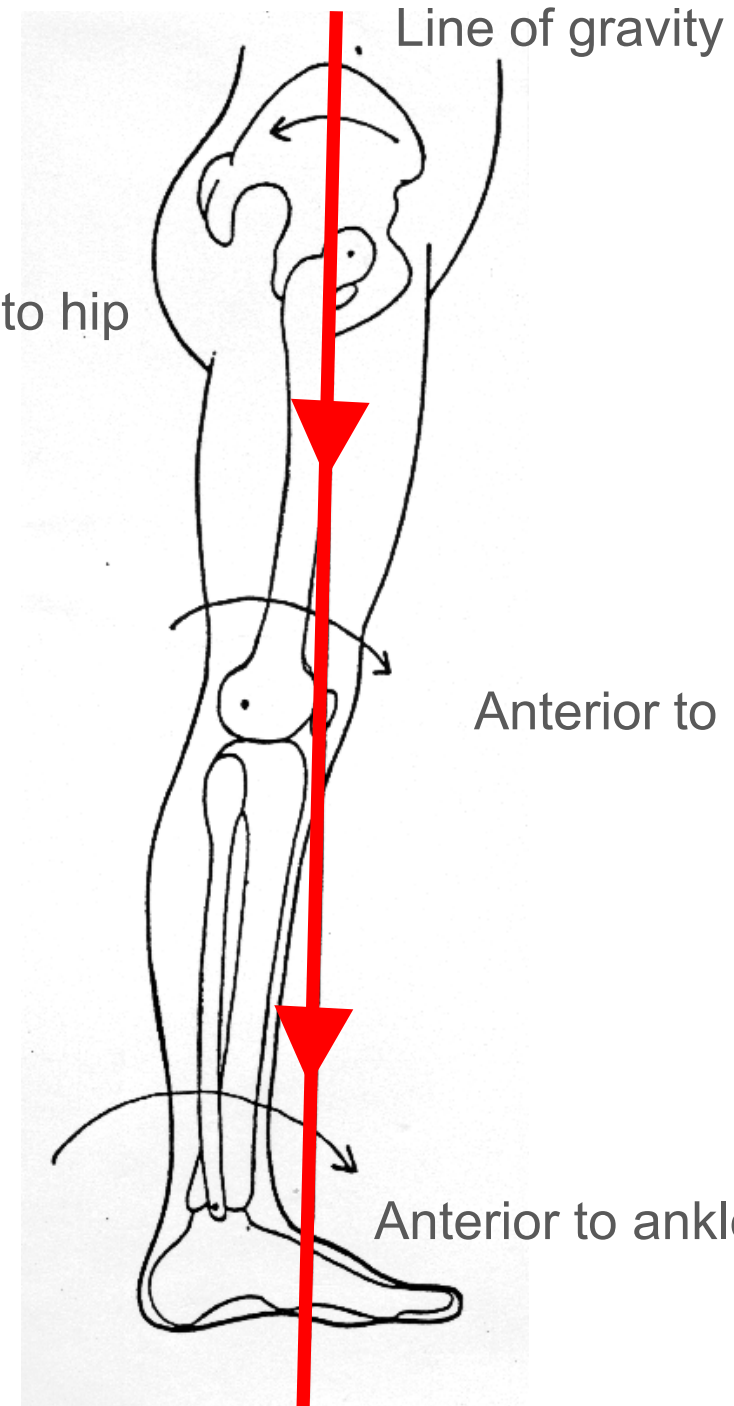
- Line of gravity = anterior to joint
- 'Pushes' into dorsiflexion
- Joint is NOT locked
- Plantarflexors needed to stabilize
- Energy consumed



Bipedal standing

- Unique to humans
- Feet form base of support, but insufficient size to be only balance option
- Special anatomical features at joints to assist balance
- Standing achieved with very little muscular support – mostly at ankle joint

Posterior to hip

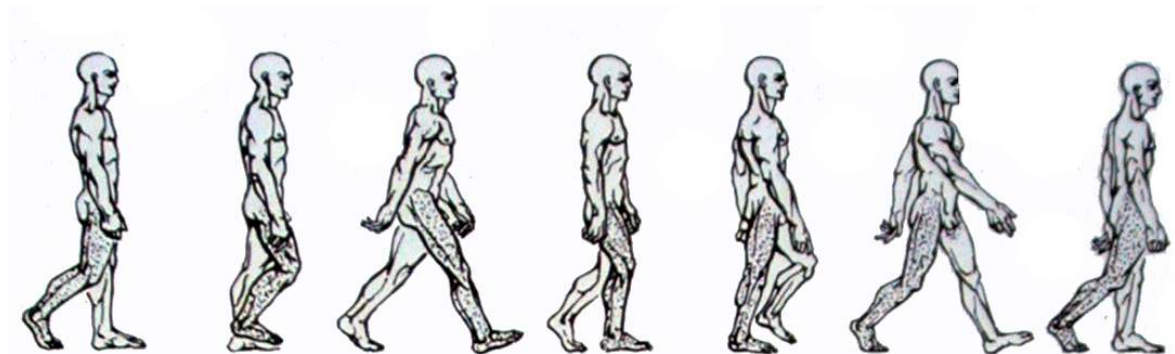


True or False?

- The line of gravity falls posterior to the knee
- Dorsiflexors stabilize the ankle during upright standing
- The agonists of hip flexion are iliopsoas and rectus femoris

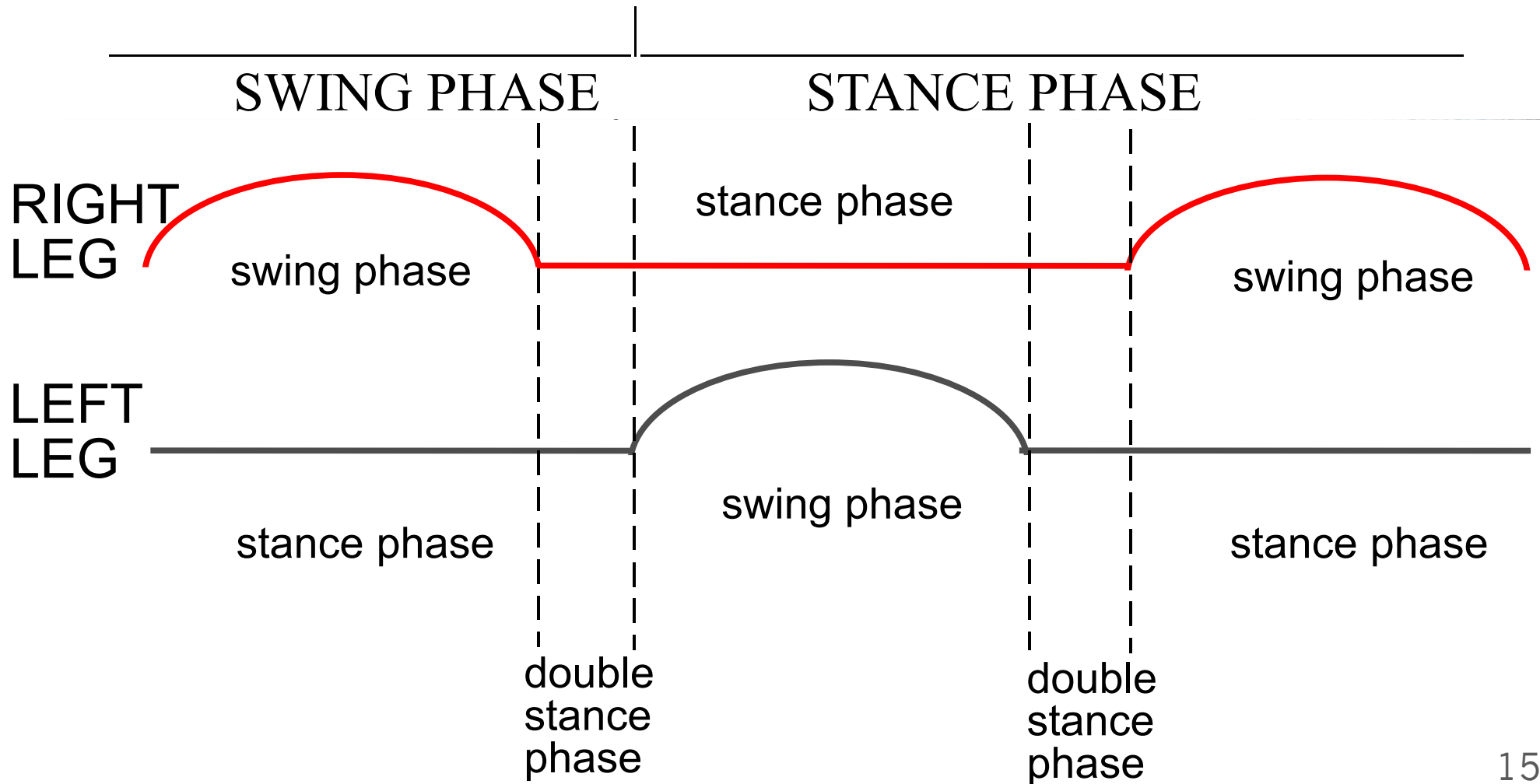
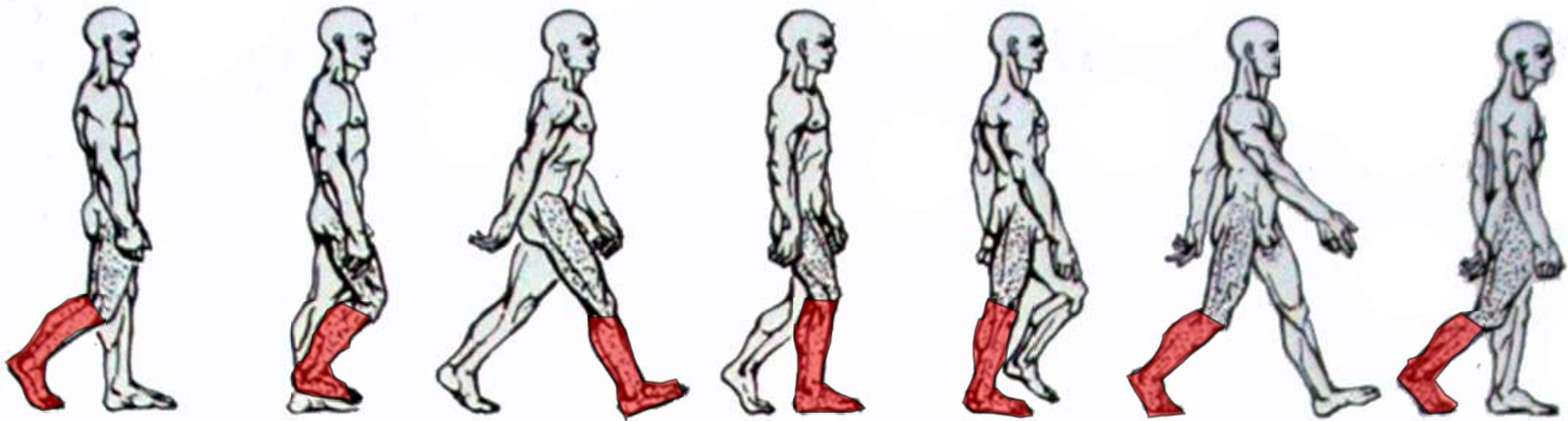
Bipedal walking

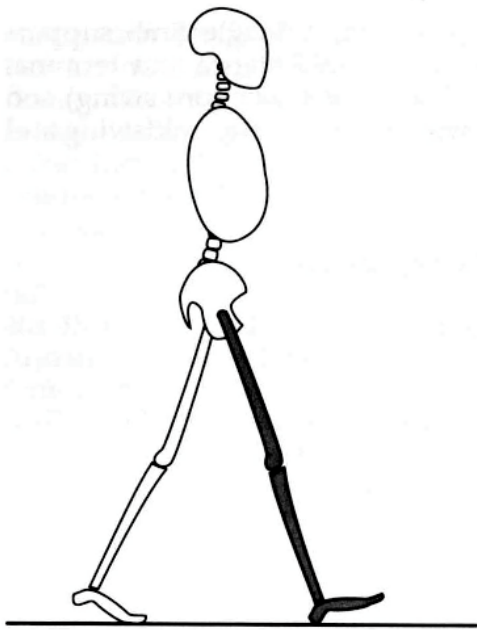
- Learned movement strategy
- Gait is characteristic
- Basic pattern = gait cycle
- Complex series of movements
 - STANCE
 - SWING
 - Transition phases between these
 - Heel strike
 - Toe off



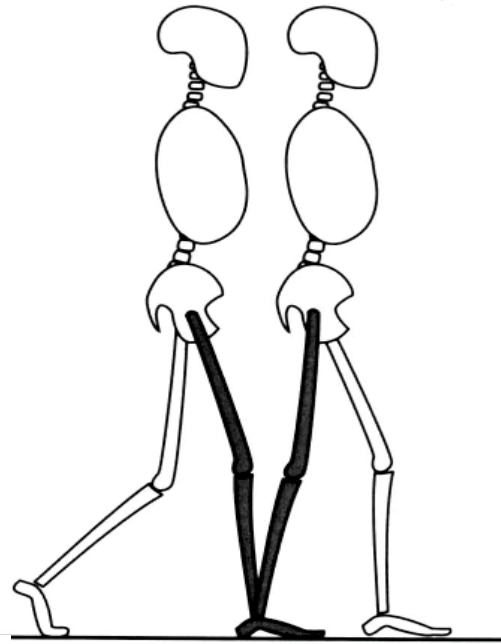
The gait cycle

- Is complex and dynamic
- Involves lots of movements and muscles
 - we will focus on flexion and extension, and only using muscles we learnt yesterday
- Many phases = how many depends on where you look
 - We will focus on 6 key parts
- Images show 'snapshots' in time.
 - Cycle is continuous and in motion
 - Joints may be in one position, but moving into another- the muscle action will reflect where we want the joint to end up
- Don't overthink this. Cannot be easily rote learnt.
Need to understand muscle roles, then practice, while thinking about what you're doing

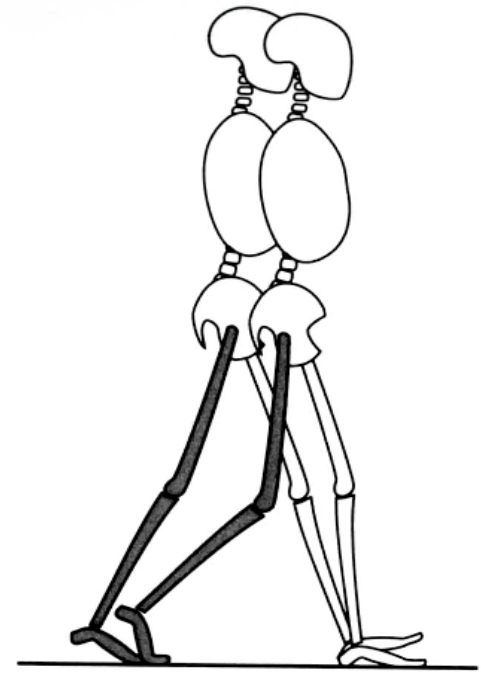




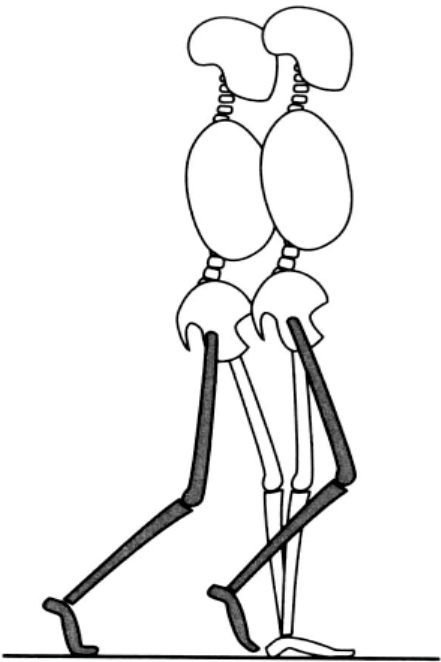
Early stance + heel strike



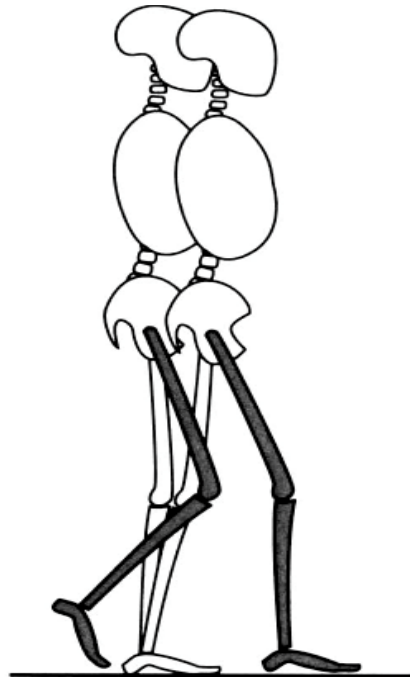
Mid stance



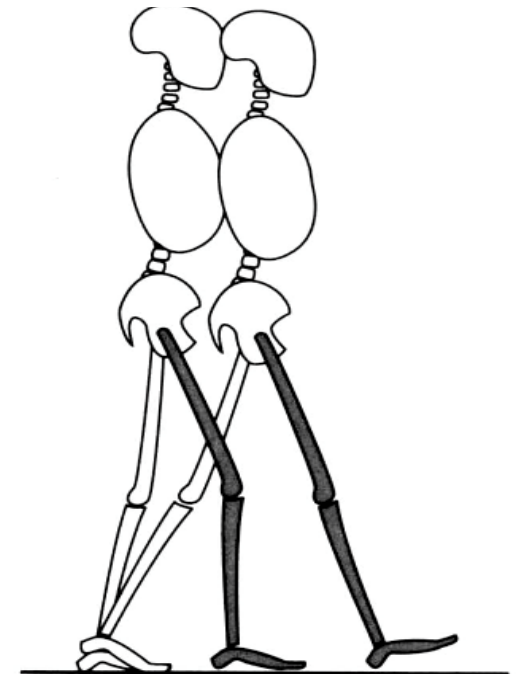
Late stance + toe off



Early swing

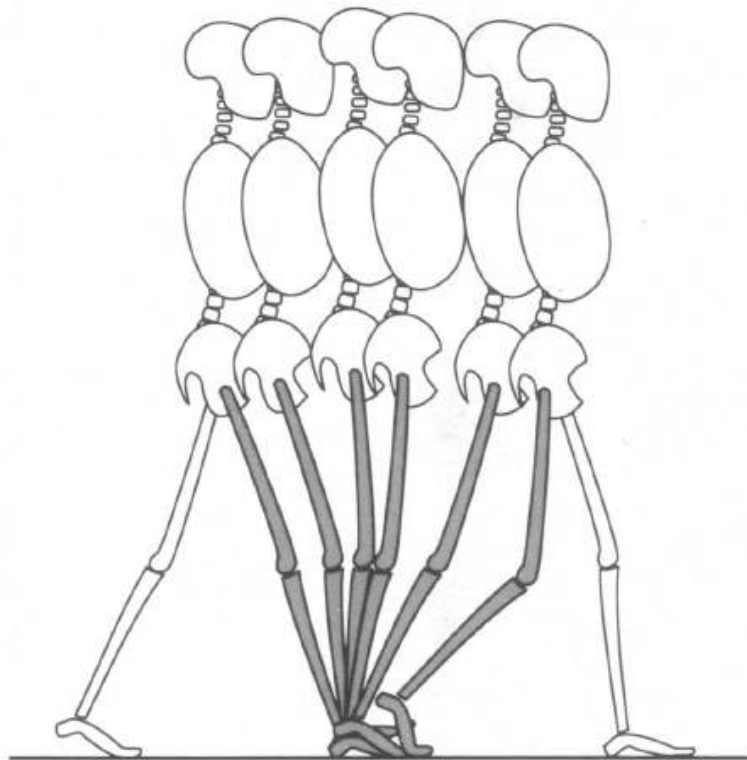


Mid swing

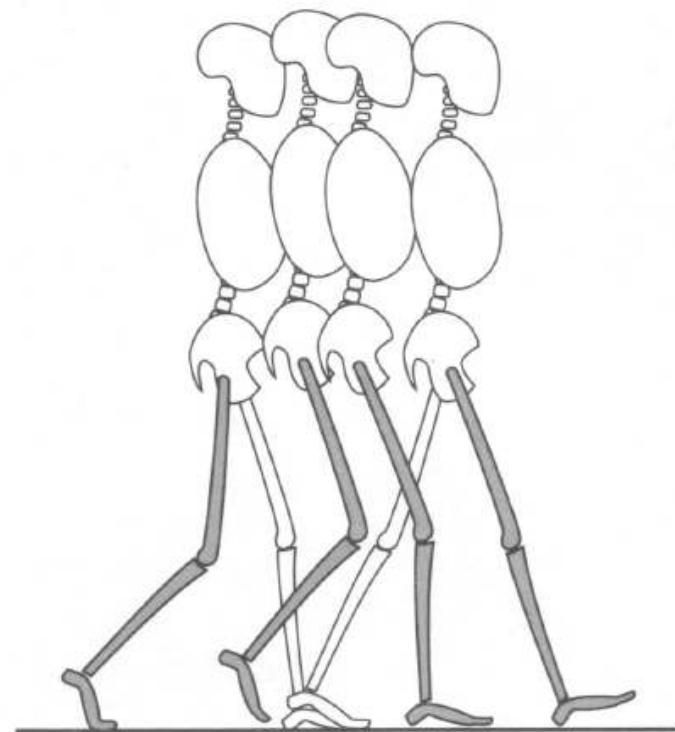


Late swing

Gait is dynamic



Stance Phase (shaded limb)

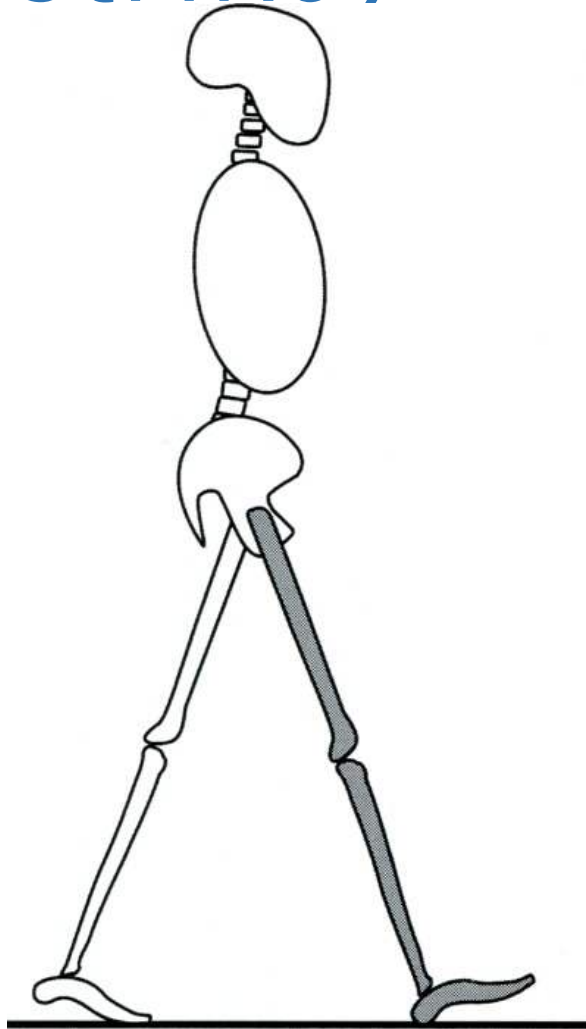


Swing Phase (shaded limb)

For each phase consider:

- Position joint starts in
- Position joint needs to be for next phase
- What muscle & type of contraction will bring the joint to the next phase

Early stance (includes heel strike)



Initial Contact

Hip

- In flexion, but moving into extension
- Agonists = gluteus maximus & hamstrings

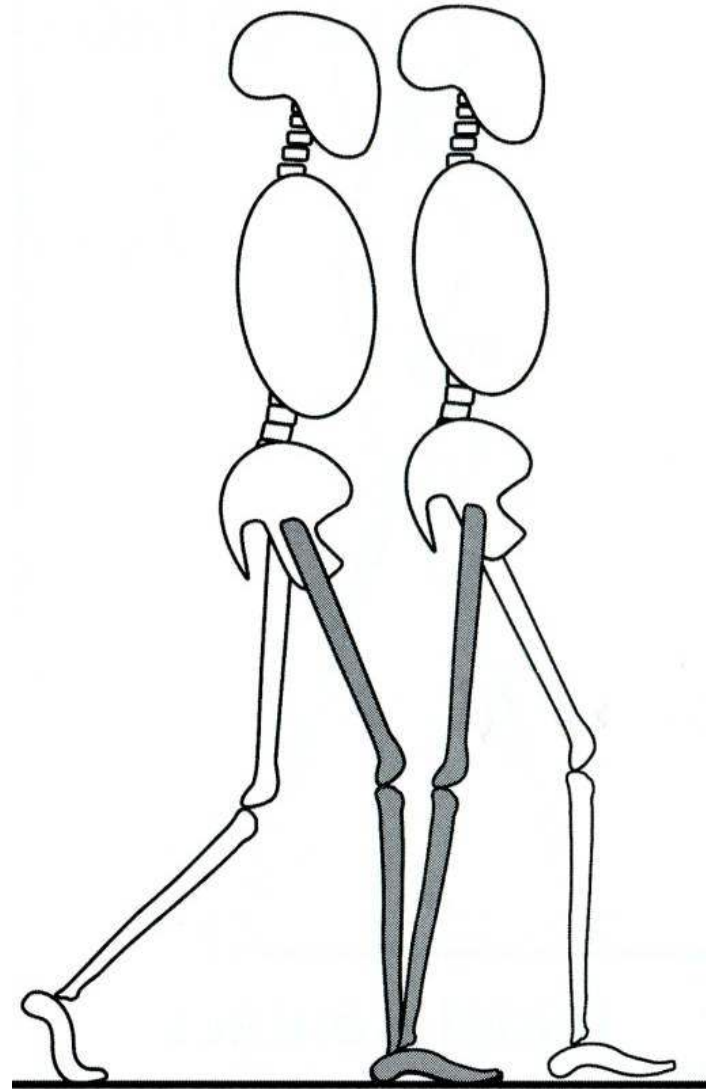
Knee

- In extension (locked for stability)
- Stabilisers: quadriceps femoris & hamstrings & gastrocnemius

Ankle

- In dorsiflexion (stable – best bony congruence), but moving into plantarflexion
- Agonist = triceps surae
- Antagonist = tibialis anterior needed to control rate of foot drop to ground

Mid stance



Mid Stance

Hip

- Continuing moving into extension
- Agonists = gluteus maximus & hamstrings

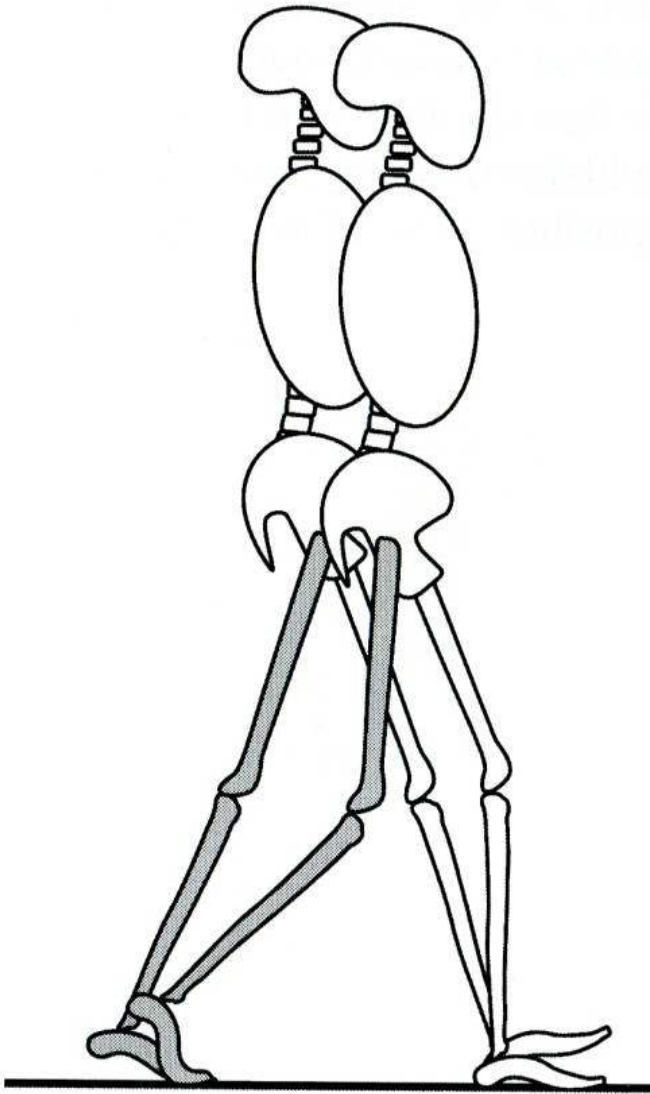
Knee

- Moving from extension into slight flexion
- Agonists = hamstrings & gastrocnemius

Ankle

- Continuing to move into plantarflexion
- Agonist = triceps surae

Late stance (includes toe off)



Hip

- In extension
- Agonists = gluteus maximus & hamstrings

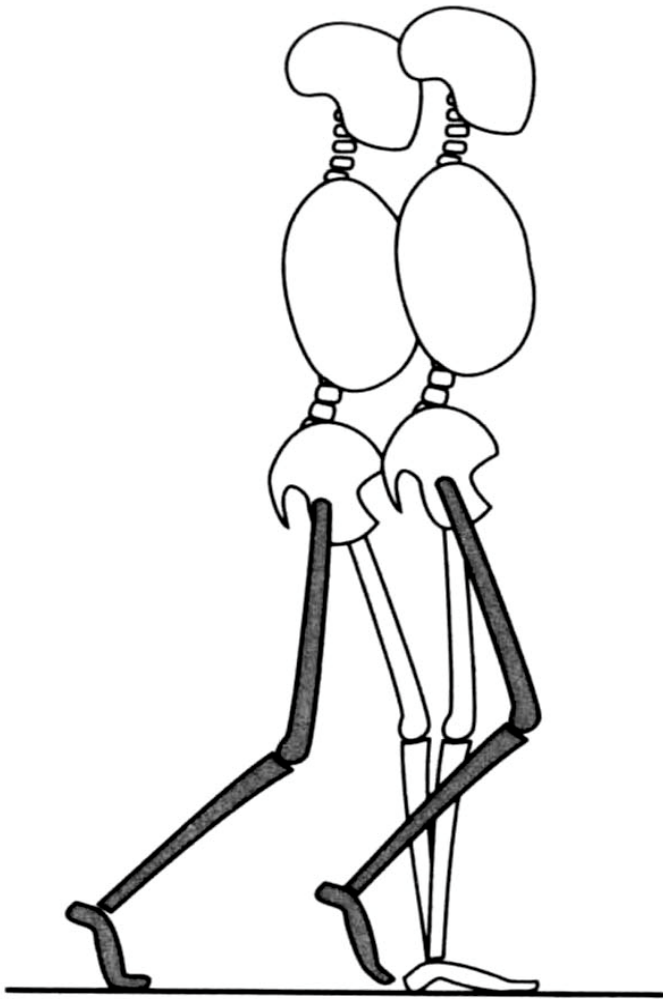
Knee

- In extension due to position of body
- hamstrings & gastrocnemius contracting ready for next movement

Ankle

- In full plantarflexion
- Agonist = triceps surae (strong for propulsion)

Early swing



Initial Swing

Hip

- In extension, moving into flexion
- Agonists = iliopsoas & rectus femoris
- Antagonists = gluteus maximus & hamstrings control rate of swing

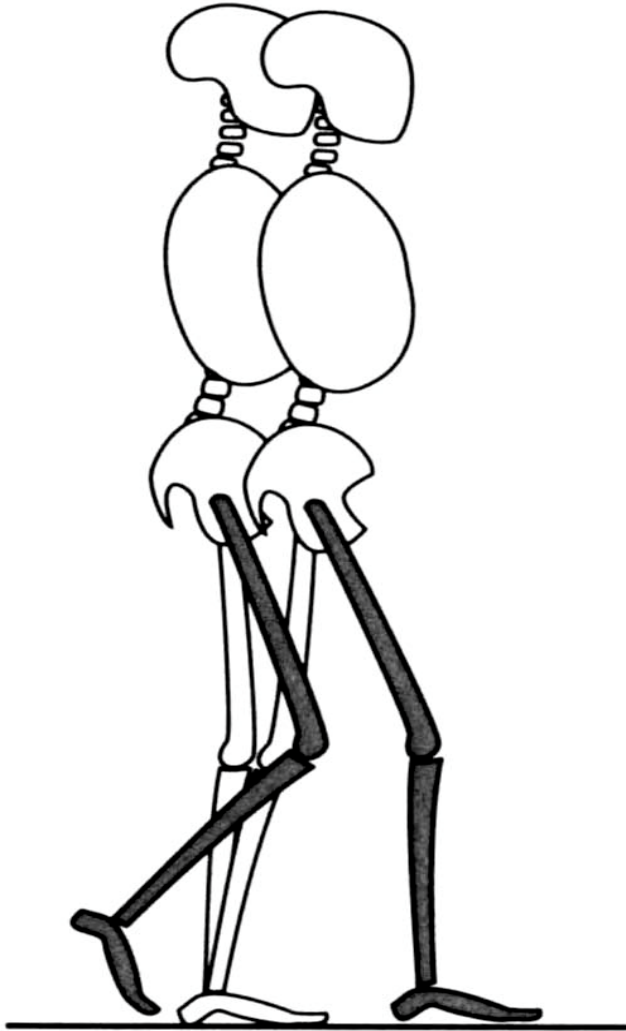
Knee

- In flexion to lift foot from ground
- Agonists = hamstrings & gastrocnemius

Ankle

- In dorsiflexion to allow clearance of toes during swing
- Agonist = tibialis anterior

Mid swing



Mid Swing

Hip

- In flexion
- Agonists = iliopsoas & rectus femoris
- Antagonists = gluteus maximus & hamstrings control rate of swing

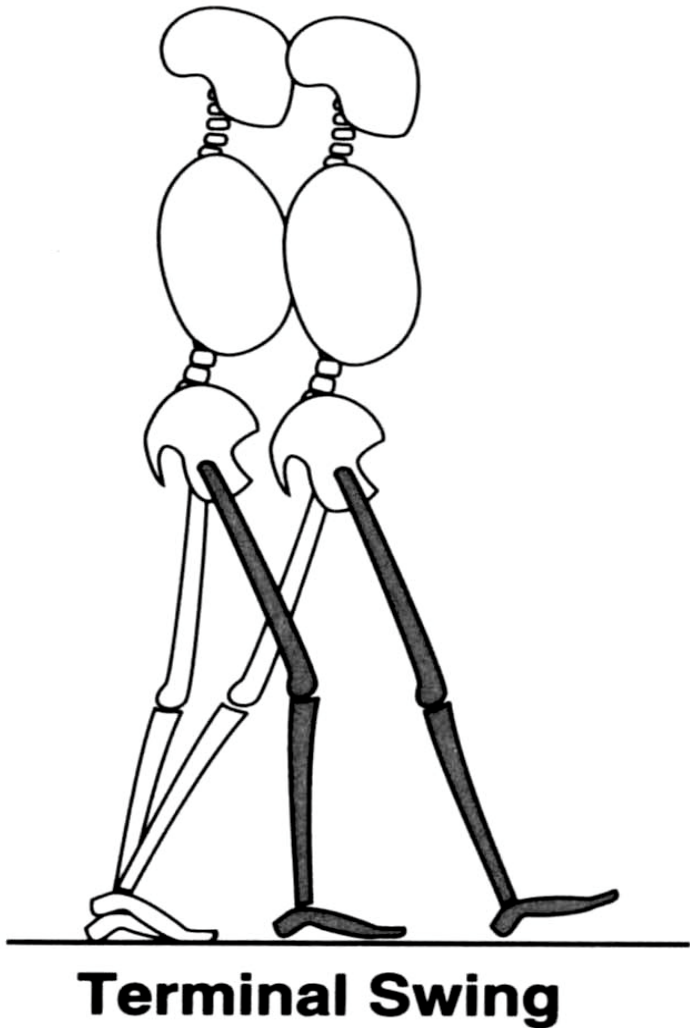
Knee

- In flexion to lift foot from ground
- Agonists = hamstrings & gastrocnemius

Ankle

- In dorsiflexion to allow clearance of toes during swing
- Agonist = tibialis anterior

Late swing



Hip

- In flexion
- Agonists = iliopsoas & rectus femoris

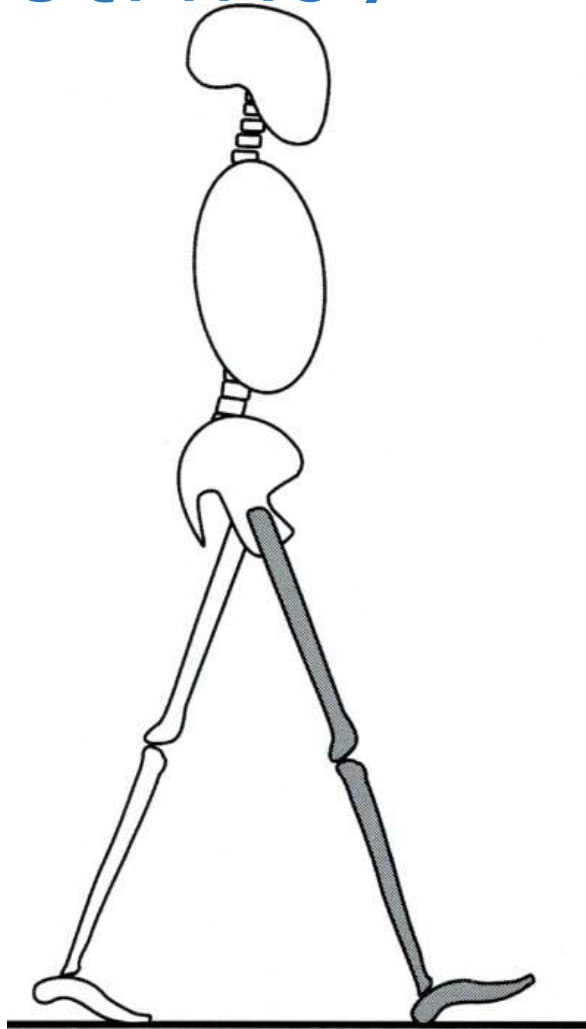
Knee

- Moving from flexion into extension to prepare for heel strike
- Agonists = quadriceps femoris

Ankle

- In dorsiflexion for most stable joint position for heel strike
- Agonist = tibialis anterior to pull into dorsiflexion then
- Stabiliser = triceps surae to keep ankle stable

Early stance (includes heel strike)



Hip

- In flexion, but moving into extension
- Agonists = gluteus maximus & hamstrings

Knee

- In extension (locked for stability)
- Stabilisers: quadriceps femoris & hamstrings & gastrocnemius

Ankle

- In dorsiflexion (stable – best bony congruence), but moving into plantarflexion
- Agonist = triceps surae
- Antagonist = tibialis anterior needed to control rate of foot drop to ground

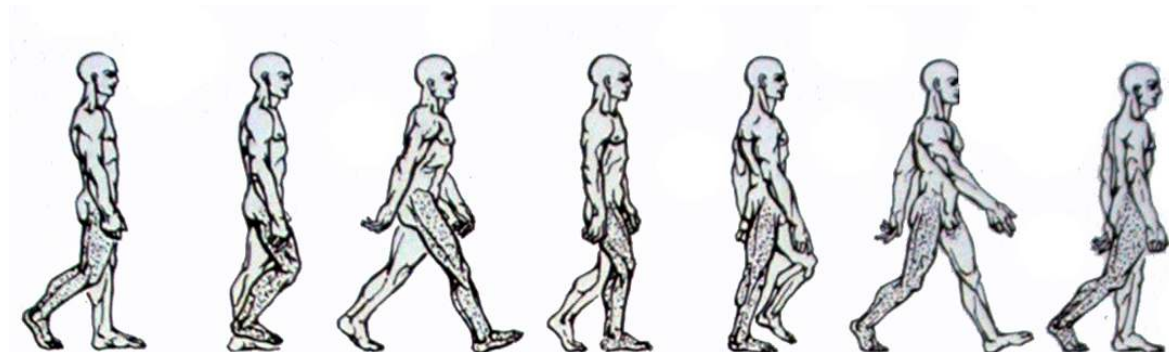
Initial Contact

Fill this in yourself, using the information on previous slides

Joint	Early stance	Mid stance	Late stance	Early swing	Mid swing	Late swing
HIP						
KNEE						
ANKLE						

Tips for learning gait cycle

- You must learn muscle position and action first
- Remember that each phase isn't a snapshot- it's moving!
- How do you get from where the joint was from where it needs to be? What muscles must contract? What type of contraction?
- Practice walking and thinking about each joint



Practice essay

The ankle is an important region of the lower limb. Write an essay on the structure and function of the knee, including the following components:

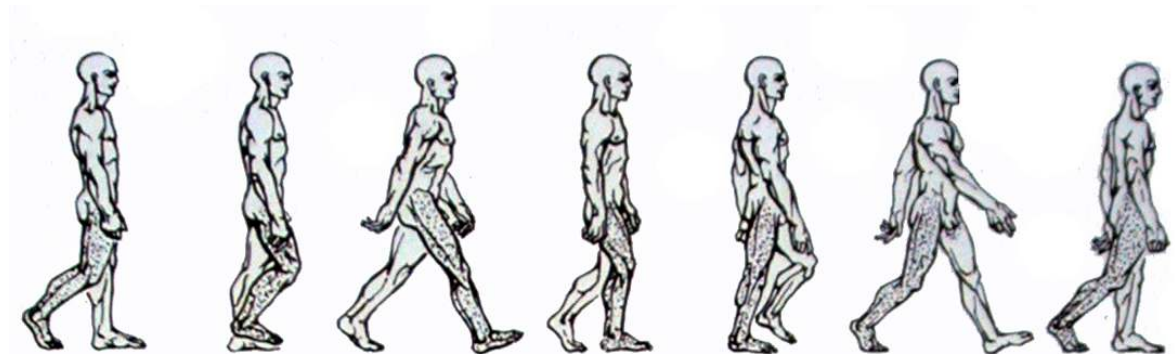
- i) Compare the structure of the ankle to the hip joint, noting differences in bones, muscles and movement. (3)

- ii) Outline the changes in position of the ankle joint throughout both swing and stance phases of the gait cycle, including the roles of muscles. (3)

- iii) Describe how severe damage to the tibialis anterior would impact the normal gait cycle. (2)

Thank you!

- This is my last lecture with you for the semester
- Make good use of resources and ask questions
 - Discussion board
 - Drop in sessions each week
 - Pre-test/exam drop in sessions
 - In your labs
- You've got this- good luck for the upcoming test!



HUBS191

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