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2

What Should I Expect

Level I questions

eg. phases of gait, Rancho vs. traditional terminology

Level II questions

Application of gait concepts, largely pathologic

"Hidden gait questions"

Often come under the guise of prosthetics and orthotics

3

4

What Resources Are Available to Me

- PT Exam book
- Content Prompts
- Clinical Application Templates
- Critical Work Activities
- Class Notes
- Textbooks

- Identification of close packed position
  - Upper extremity
  - Lower extremity
  - Spine and pelvis
- Definition of open packed
  - Amount of congruence
  - Amount of ligamentous stretch
  - Relationship to anatomical position
- Purpose of utilizing open packed position
- Identification of open packed position
  - Upper extremity
  - Lower extremity
  - Spine and pelvis

Dynamometry
- Definition
- Position
  - Subject
  - Limb
  - Dynamometer
- Stabilization
- Testing position
- Bilateral comparison
  - Upper extremity
  - Lower extremity
- Contraction type
  - Isometric
  - Concentric
  - Eccentric
- Muscle performance characteristics
  - Power
  - Endurance
- Isometric dynamometry
  - Procedures
  - Advantages-disadvantages
- Grip dynamometer
  - Adjustable hand spacing
  - Bell curve
  - Fatigue
  - Advantages-disadvantages
- Reliability
- Validity

End-Feel
- Type of range of motion
- Quality of range of motion
  - Capsular
  - Noncapsular
- Amount of range of motion
  - Hypermobility
  - Hypomobility
- Normal end-feel
  - Definition and example
    - Soft
    - Firm
    - Hard
- Abnormal end-feel
  - Definition and example
    - Soft
    - Firm
    - Hard
    - Empty
- Clinical relevance

Gait
- Rancho Los Amigos terminology
  - Weight acceptance
    - Initial contact
    - Loading response
  - Single limb support
    - Midstance
    - Terminal stance
  - Swing limb advancement
    - Pre-swing
  - Initial swing
    - Midswing
    - Terminal swing
- Traditional terminology
  - Stance phase
    - Heel strike
    - Foot flat
    - Midstance
    - Heel off
    - Toe off
  - Swing phase
    - Acceleration
    - Midswing
    - Deceleration

5

Where Are We Going

- Foundation
- Biomechanical approach to swing phase
- Biomechanical approach to stance phase
- Sample Questions

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Phases of Gait

Stance Phase				Swing Phase			
Weight Acceptance		**Single Limb Support**		**Swing Limb Advancement**			
Initial Contact	Loading Response	Mid-Stance	Terminal Stance	Pre-Swing	Initial Swing	Mid-Swing	Terminal Swing

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Foundational Concepts

Induced torque

- External torque upon a segment generated by gravity (with or without exernal load and/or GRF)

Reactionary torque

- Internal torque upon a segment generated by muscle forces in response to induced torque

8

Types of Muscle Contraction

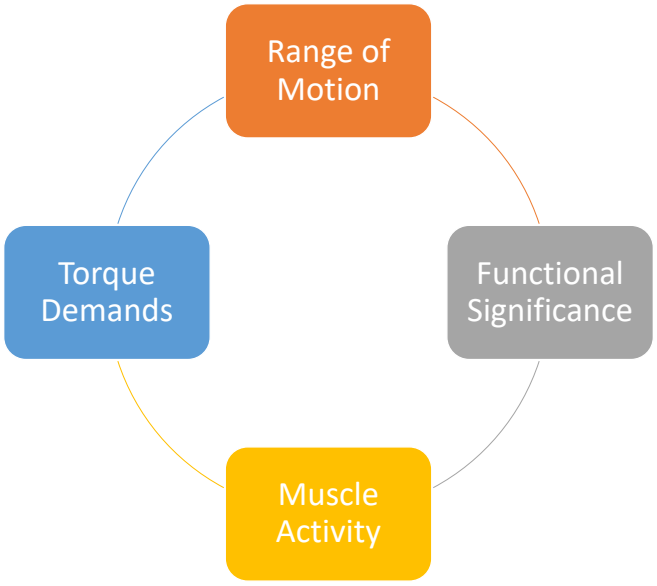
Isometric:
no movement

Concentric:
shortens (“moves”)

Eccentric: lengthens
(“controls/restrains”)

9

Biomechanical Considerations of the Hip, Knee & Ankle



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Pelvis and Foot Biomechanics

Nice to know but not **need** to know

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Stance Phase					Swing Phase		
Weight Acceptance		**Single Limb Support**		**Swing Limb Advancement**			
Initial Contact	Loading Response	Mid-Stance	Terminal Stance	Pre-Swing	Initial Swing	Mid-Swing	Terminal Swing
0%	0-12%	12-31%	31-50%	50-62%	62-75%	75-87%	87-100%

12

Initial Contact: Ankle Joint

Initial Contact: Ankle Joint	
Range of Motion	Neutral position
Torque Demand	Plantarflexion torque
Muscle Action	Isometric contraction of pretibial muscles
Functional Significance	Foot correctly positioned for heel rocker action in LR

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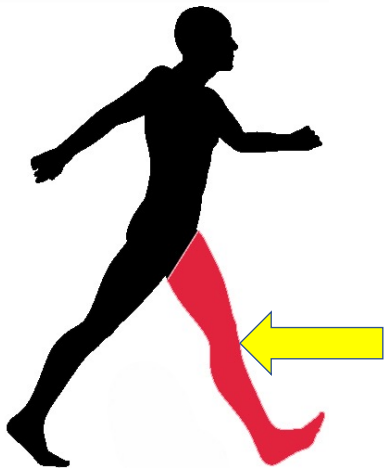
Initial Contact: Knee Joint

Initial Contact: Knee Joint	
Range of Motion	Positioned in neutral to 5º flexion
Torque Demand	Brief extension torque
Muscle Action	Quads prep for next phase Hamstrings counter extension torque
Functional Significance	Extension torque stabilizes knee



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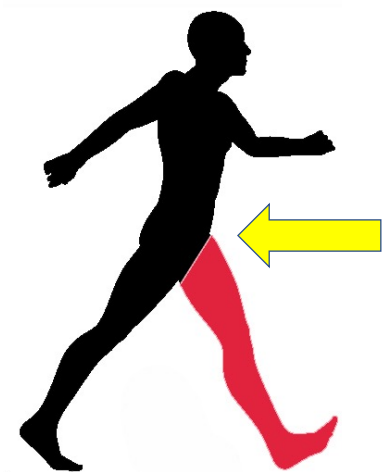
Initial Contact: Hip Joint

Initial Contact: Hip Joint	
Range of Motion	Flexed 20º
Torque Demand	Rapid, high intensity flexion torque
Muscle Action	All hip extensors active Semimembranosis and biceps femoris long head activity wanes
Functional Significance	Hip in position of forward reach



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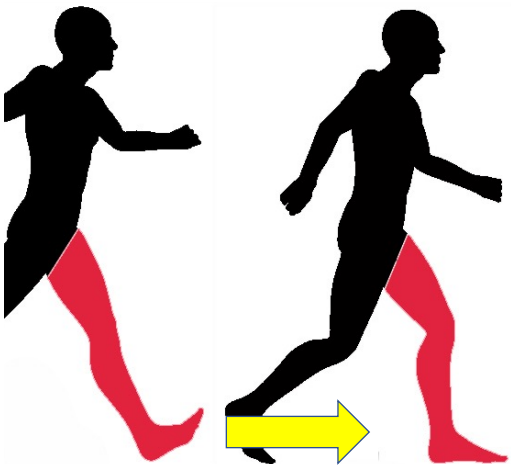
Loading Response: Ankle Joint

Loading Response: Ankle Joint	
Range of Motion	5º of rapid plantarflexion
Torque Demand	Plantarflexion torque forces foot to floor then diminishes
Muscle Action	Pretibials contract eccentrically Soleus and gastrocnemius act to control tibial advancement
Functional Significance	Heel rocker action created Momentum carried forward Knee flexion initiated



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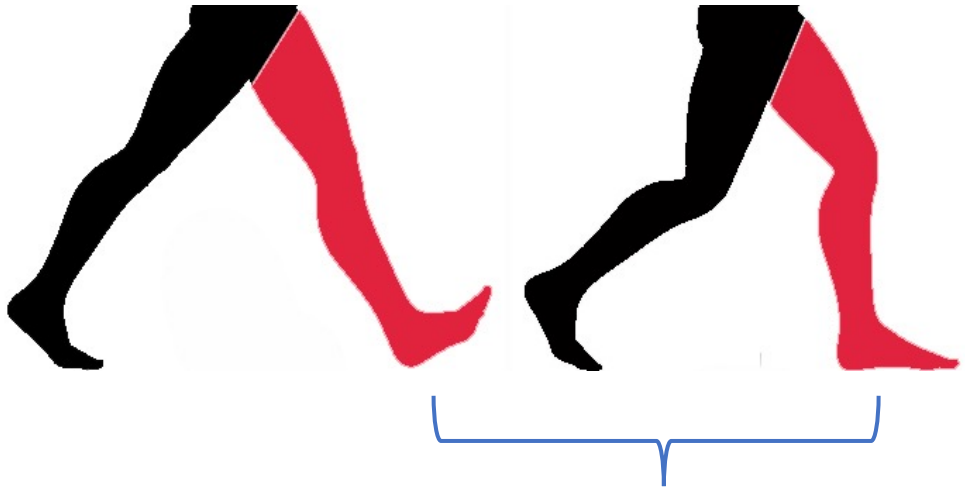
What is the Heel Rocker Action?



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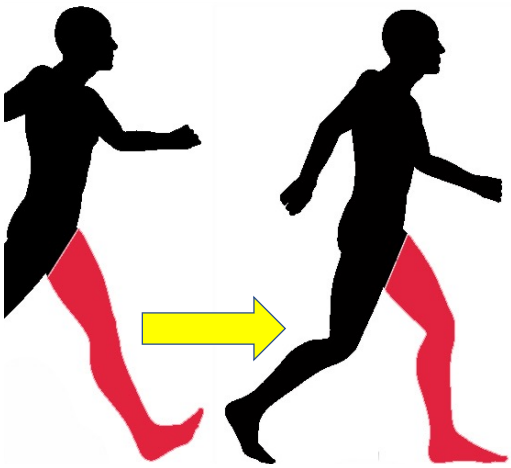
Loading Response: Knee Joint

Loading Response: Knee Joint	
Range of Motion	Moves to 15º flexion
Torque Demand	Rapid, moderate intensity flexion torque
Muscle Action	Eccentric quadriceps activity Diminished hamstring activity
Functional Significance	Shock absorption Limb stability maintained



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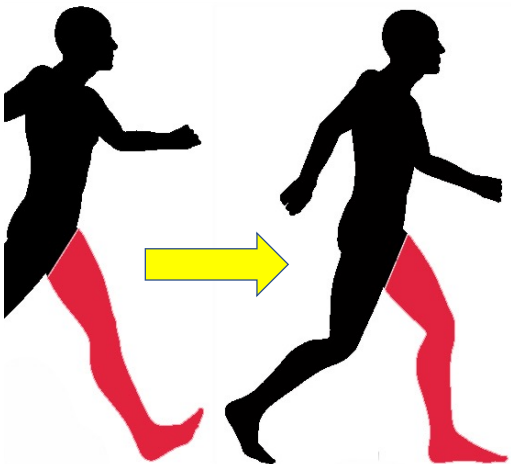
Loading Response: Hip Joint

Loading Response: Hip Joint	
Range of Motion	Remains in 20º of flexion
Torque Demand	Rapid, high intensity flexion torque Adduction torque begins
Muscle Action	Hip extensors and abductors active
Functional Significance	Hip, pelvis and trunk stabilized in sagittal and frontal planes



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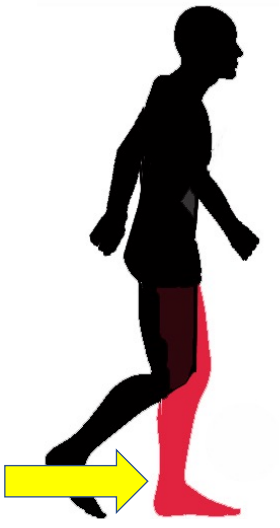
Mid-Stance: Ankle Joint

Mid-Stance: Ankle Joint	
Range of Motion	Moves into 5º of DF
Torque Demand	Markedly increasing DF torque
Muscle Action	Soleus & gastrocsoleus contract eccentrically to control forward progression of the tibia
Functional Significance	Calf muscles stabilize knee Ankle rocker action created Body progresses forward



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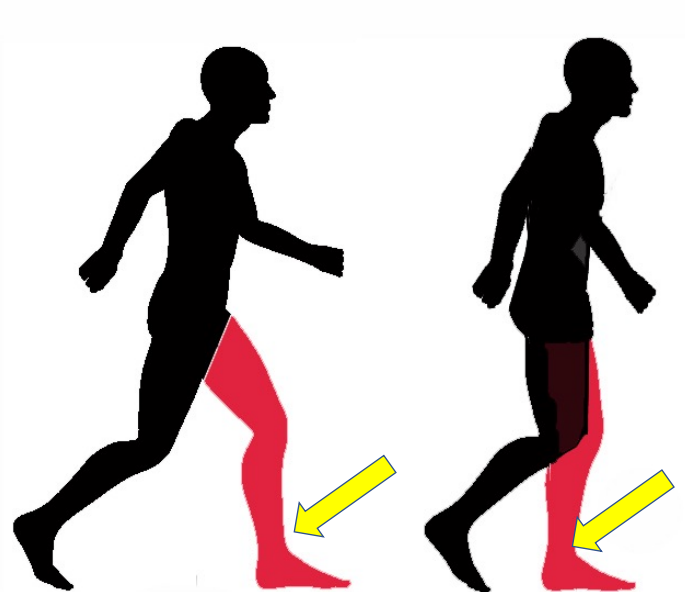
What Does the Ankle Rocker Provide?

Ankle becomes fulcrum for continued progression of limb over stationary foot



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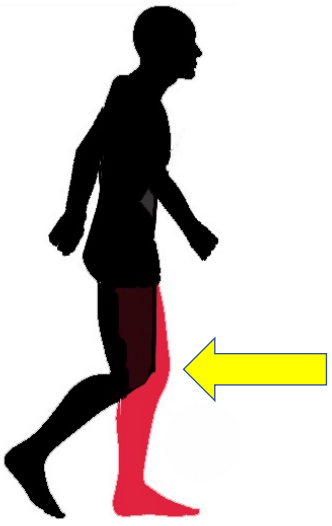
Mid-Stance: Knee Joint

Mid-Stance: Knee Joint	
Range of Motion	Extends to 5º flexion
Torque Demand	Extension torque
Muscle Action	Quads stabilize knee until knee extension torque begins Calf muscles restrain tibia allowing femur to advance faster
Functional Significance	Knee stability maintained by knee extension torque and calf activity



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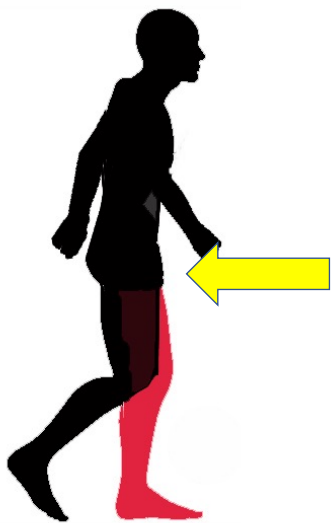
Mid-Stance: Hip Joint

Mid-Stance: Hip Joint	
Range of Motion	Extension to neutral
Torque Demand	Change from flexion to extension torque Adduction torque continues
Muscle Action	No hip muscle activity in sagittal plane Hip abductors active
Functional Significance	Stable hip joint position achieved in sagittal plane Pelvis stabilized in frontal plane



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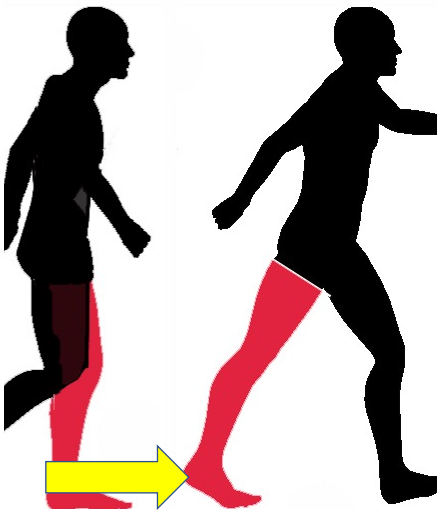
Terminal Stance: Ankle Joint

Terminal Stance: Ankle Joint	
Range of Motion	Moves into 10º of DF
Torque Demand	Dorsiflexion torque peaks
Muscle Action	Calf muscle activity peaks
Functional Significance	Maximal forward progression of the tibia Heel allowed to rise

Don't forget about the great toe here!



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What Does the Forefoot Rocker Provide?

Metatarsal heads serve to facilitate forward progression of tibia

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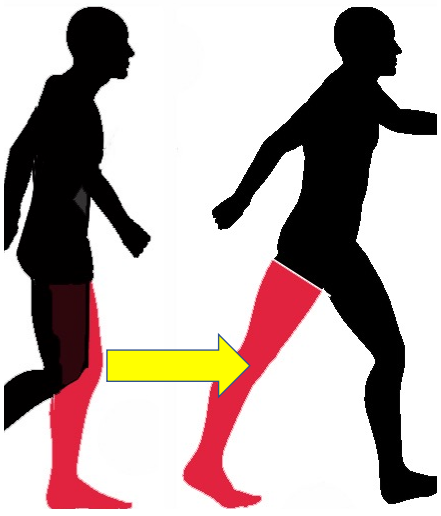
Terminal Stance: Knee Joint

Terminal Stance: Knee Joint	
Range of Motion	Unchanged from MSt in 5º of flexion
Torque Demand	Extension torque peaks and then diminishes
Muscle Action	Calf muscles continue to stabilize knee by restraining tibia Biceps femoris may be active
Functional Significance	Joint mobility maintained Biceps femoris may act to prevent recurvatum



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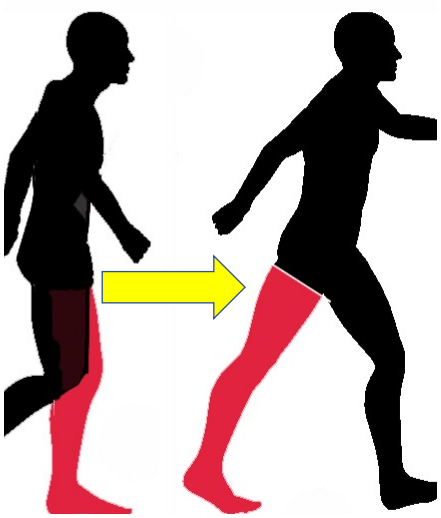
Terminal Stance: Hip Joint

Terminal Stance: Hip Joint	
Range of Motion	Thigh moves to trailing position of 20º extension
Torque Demand	Hip extension torque Adduction torque rapidly diminishes
Muscle Action	Posterior fibers of TFL cease Anterior fibers of TFL may become active
Functional Significance	Body allowed to advance past foot to maximize step length while limb remains stable



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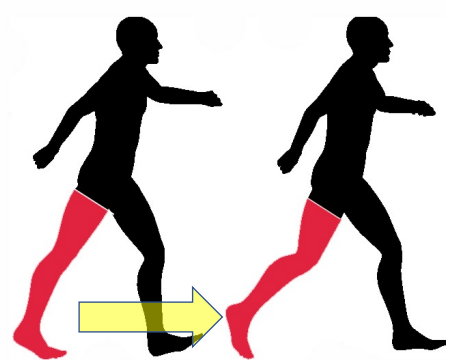
Stance Phase				Swing Phase			
Weight Acceptance		**Single Limb Support**		**Swing Limb Advancement**			
Initial Contact	Loading Response	Mid-Stance	Terminal Stance	Pre-Swing	Initial Swing	Mid-Swing	Terminal Swing
0%	0-12%	12-31%	31-50%	50-62%	62-75%	75-87%	87-100%

28

Pre-Swing: Ankle Joint

Pre-Swing: Ankle Joint	
Range of Motion	Moves into 15º of plantarflexion
Torque Demand	Dorsiflexion torque rapidly decreases
Muscle Action	Calf muscle activity ceases Pretibial muscle activity initiated
Functional Significance	Forefoot on floor assists balance Plantarflexion assists knee flexion and limb advancement



Don't forget about the great toe here!

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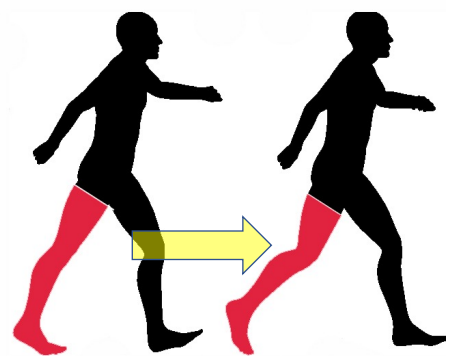
Pre-Swing: Knee Joint

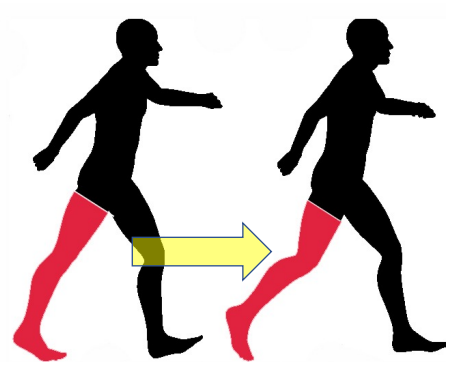
Pre-Swing: Knee Joint	
Range of Motion	Rapid flexion to 40º
Torque Demand	Flexion torque demand
Muscle Action	Minimal knee flexor activity from gracilis Rectus femoris may be active
Functional Significance	Contributes significantly to knee flexion for limb clearance Rectus femoris may restrain speed of knee flexion



30

Pre-Swing: Hip Joint

Pre-Swing: Hip Joint	
Range of Motion	Thigh flexes forward by falling to position of 10º of extension
Torque Demand	Hip extension torque diminishes
Muscle Action	Adductor longus contracts concentrically Rectus femoris may be active
Functional Significance	Limb advancement begins Hip flexion motion contributes to knee flexion



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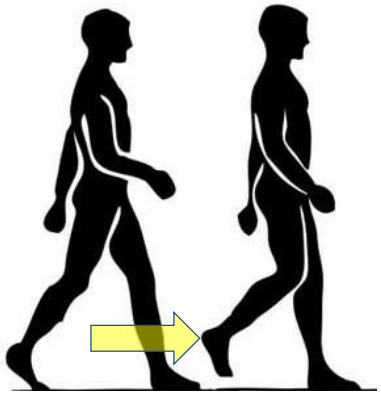
Initial Swing: Ankle Joint

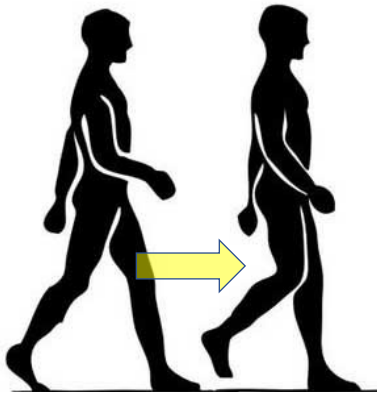
Initial Swing: Ankle Joint	
Range of Motion	Moves into 5º of PF
Torque Demand	Very low level of PF torque
Muscle Action	Pretibial muscles contract concentrically to initiate DF
Functional Significance	Dorsiflexion needed to clear foot as the next phase begins



32

Initial Swing: Knee Joint

Initial Swing: Knee Joint	
Range of Motion	Further rapid flexion to 60º
Torque Demand	Knee flexion torque
Muscle Action	Peak in activity of biceps femoris short head, sartorius, and gracilis
Functional Significance	Foot clears floor as thigh begins to advance



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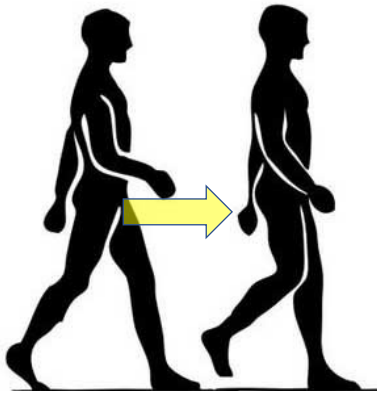
Initial Swing: Hip Joint

Initial Swing: Hip Joint	
Range of Motion	Moves to position of 15º flexion
Torque Demand	Hip extension torque initially, moving to neutral by end of phase
Muscle Action	Iliacus, gracilis, sartorius, and adductor longus active
Functional Significance	Limb advancement continues



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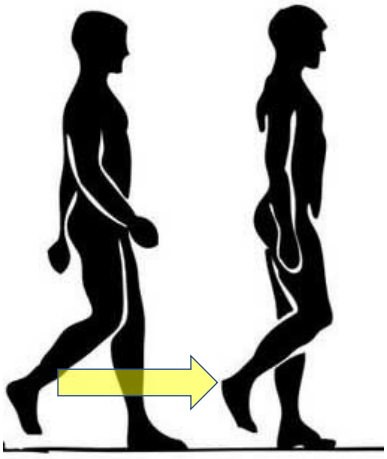
Mid-Swing: Ankle Joint

Mid-Swing: Ankle Joint	
Range of Motion	Dorsiflexion to neutral
Torque Demand	Very low level of PF torque
Muscle Action	Pretibial muscles contract concentrically
Functional Significance	Foot clears the ground by 1cm



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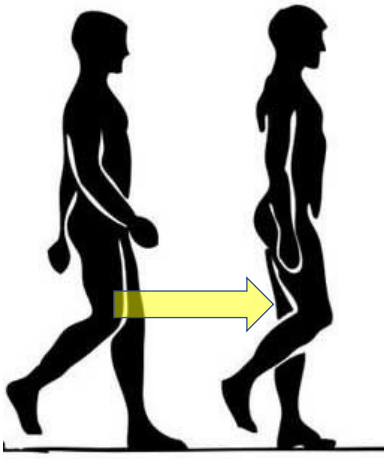
Mid-Swing: Knee Joint

Mid-Swing: Knee Joint	
Range of Motion	Rapidly extends to 25° of flexion
Torque Demand	Transition to knee extension torque late in phase
Muscle Action	Short head of biceps femoris may control rate of extension Hamstrings active late in phase
Functional Significance	Extension necessary for step length begins in this phase



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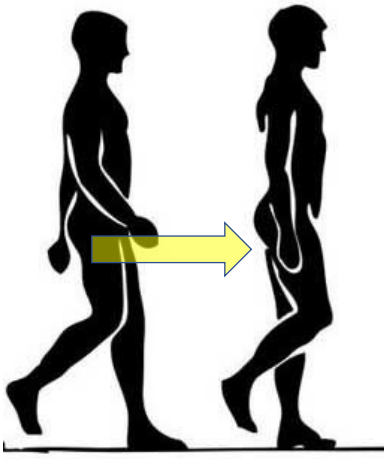
Mid-Swing: Hip Joint

Mid-Swing: Hip Joint	
Range of Motion	Moves to position of 25º flexion
Torque Demand	Gradually increasing hip flexion torque
Muscle Action	Hamstrings become active late in phase
Functional Significance	Thigh advancement slows Momentum of swing limb helps carry body past stance limb



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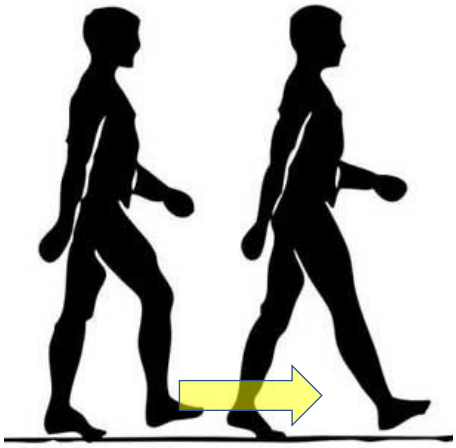
Terminal Swing: Ankle Joint

Terminal Swing: Ankle Joint	
Range of Motion	Remains in neutral
Torque Demand	Plantarflexion torque diminishes to 0º
Muscle Action	Pretibial muscles contract isometrically
Functional Significance	Neutral position assures heel contact for initial contact



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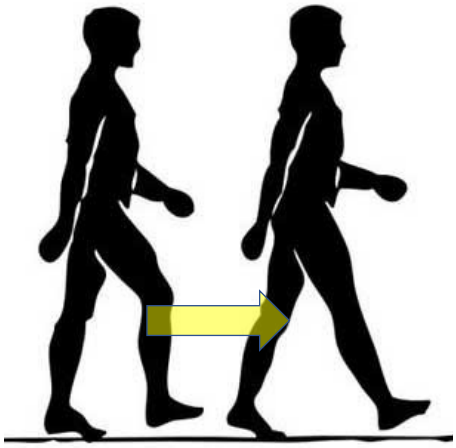
Terminal Swing: Knee Joint

Terminal Swing: Knee Joint	
Range of Motion	Extends to neutral, but then may move into 5º flexion
Torque Demand	Extension torque
Muscle Action	Flexion torque (restraining extension)
Functional Significance	Step length optimized by leg reaching out



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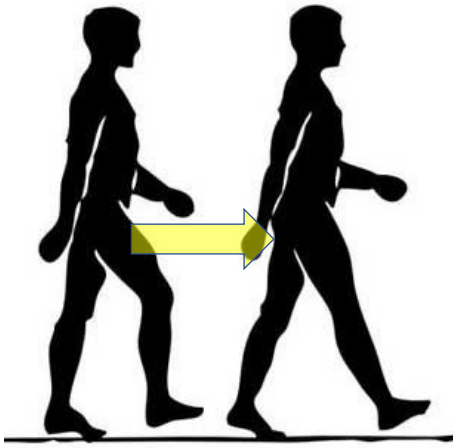
Terminal Swing: Hip Joint

Terminal Swing: Hip Joint	
Range of Motion	Falls slightly to position of 20º flexion
Torque Demand	Hip flexion torque diminishes at end of phase
Muscle Action	Hamstrings peak in activity Adductor magnus, gluteus maximus & medius, and TFL become active
Functional Significance	Limb positioned for heel first initial contact



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We Did It!

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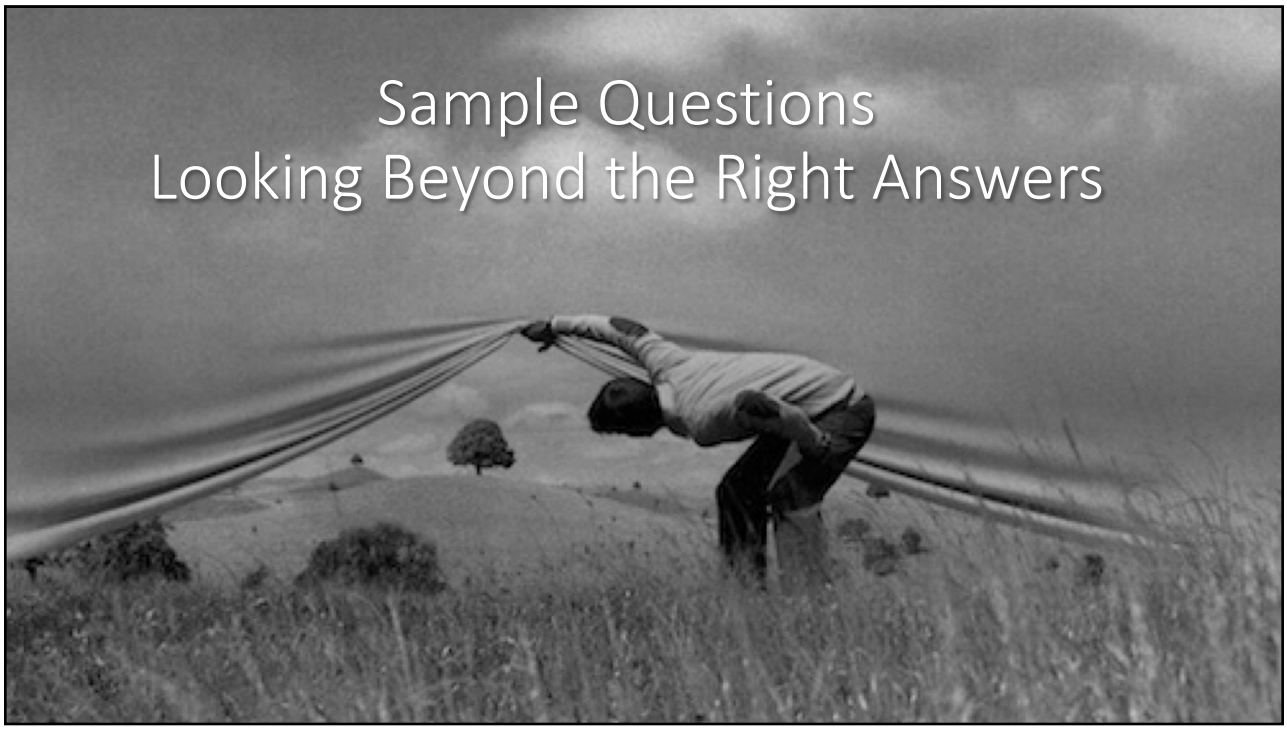

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QUESTION 1

With which phase of gait would hypertonicity of the hamstrings following a stroke be MOST likely to interfere?

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QUESTION 1

With which phase of gait would hypertonicity of the hamstrings following a stroke be MOST likely to interfere?

1. Terminal swing
2. Pre-swing
3. Initial swing
4. Mid swing

44

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45

QUESTION 1

Looking Beyond the Right Answer

- Describe the physiology that contributes to tone.
- How would you grade tone?
- What manual therapy or exercise techniques can be used to inhibit tone?
- What pharmacologic agents are used to reduce tone?

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QUESTION 2

During which phase of the gait cycle is the greatest amount of metatarsophalangeal extension needed?

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QUESTION 2

During which phase of the gait cycle is the greatest amount of metatarsophalangeal extension needed?

1. Pre-swing
2. Terminal stance
3. Initial swing
4. Mid-swing

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QUESTION 2

During which phase of the gait cycle is the greatest amount of metatarsophalangeal extension needed?

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3. Initial swing
4. Mid-swing

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QUESTION 2

Looking Beyond the Right Answer

- What are the landmarks used when measuring MTP extension?
- What is considered normal MTP extension ROM?
- What muscle is largely responsible for MTP extension strength?
- A lesion to what nerve root would lead to a loss of 1st MTP extension strength?
- What grade and direction of mobilization would you use to increase MTP extension ROM?

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QUESTION 3

During which phase of the gait does the highest flexion torque occur upon the hip joint?

51

QUESTION 3

During which phase of the gait does the highest flexion torque occur upon the hip joint?

1. Initial contact
2. Loading response
3. Terminal swing
4. Mid-swing

52

QUESTION 3

During which phase of the gait does the highest flexion torque occur upon the hip joint?

1. Initial contact
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3. Terminal swing
4. Mid-swing

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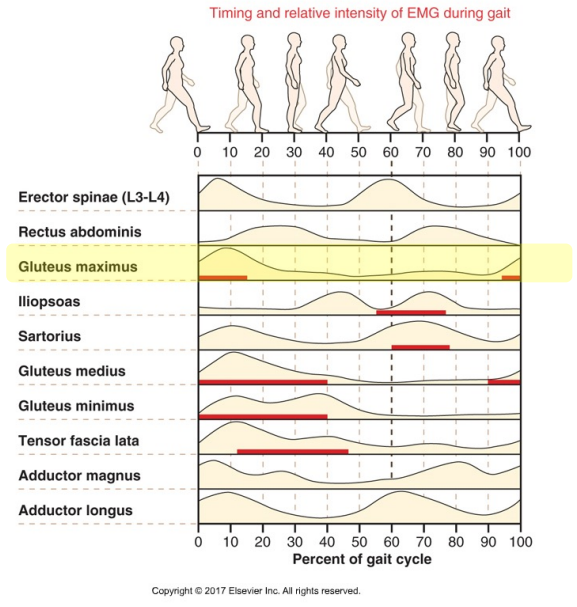
Brutal Casey. Absolutely brutal.



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QUESTION 3

Looking Beyond the Right Answer

- What is an induced torque? What is a reactionary torque?
- Why would someone have a loss of glute max strength?
- What specific exercises could I utilize in order to strengthen the glute max?
- What is the procedure and setup for MMT of the gluteus maximus?
- What type of gait compensation would a patient demonstrate who has a marked weakness of the gluteus maximus?

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QUESTION 4

Which of the following critical events is crucial for shock absorption during the loading response phase of gait?

56

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1. Ankle rocker
2. Restrained knee flexion
3. Restrained ankle dorsiflexion
4. Forefoot rocker

57

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1. Ankle rocker
2. Restrained knee flexion
3. Restrained ankle dorsiflexion
4. Forefoot rocker

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QUESTION 4

Looking Beyond the Right Answer

- What muscle is largely responsible for restraining this induced torque?
- What type of contraction is being elicited in this example?
- A lesion to which peripheral nerve could lead to an inability to restrain knee flexion?
- How can the clinician tease out a peripheral nerve lesion vs. a nerve root dysfunction?

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QUESTION 5

A patient presents to you with a ruptured posterior tibialis tendon. Which phase of the gait cycle is most likely to demonstrate dysfunction?

60

QUESTION 5

A patient presents to you with a ruptured posterior tibialis tendon. Which phase of the gait cycle is most likely to demonstrate dysfunction?

1. Mid-stance
2. Pre-swing
3. Initial contact
4. Mid-swing

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QUESTION 5

A patient presents to you with a ruptured posterior tibialis tendon. Which phase of the gait cycle is most likely to demonstrate dysfunction?

1. Mid-stance
2. Pre-swing
3. Initial contact
4. Mid-swing

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QUESTION 5

Looking Beyond the Right Answer

- What is the origin and insertion of the tibialis posterior?
- What comorbidities put a patient at risk for rupturing their tibialis posterior?
- What type of taping technique can help to reduce symptoms?
- What type of brace or boot could help with long-term pain and mobility dysfunction?

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QUESTION 6

A patient demonstrates an abnormal gait pattern during mid-swing. Which of the following options is most likely to contribute to this dysfunction?

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A patient demonstrates an abnormal gait pattern during mid-swing. Which of the following options is most likely to contribute to this dysfunction?

1. Limitation of hip extension range of motion
2. Weakness of the hamstring muscles
3. Limitation of subtalar eversion range of motion
4. Weakness of the pretibial muscles

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QUESTION 6

Looking Beyond the Right Answer

- What abnormal gait pattern is consistent with a 1/5 MMT for the pretibials? What type of AFO could help to accommodate for this?
- What abnormal gait pattern is consistent with a 3/5 MMT for the pretibials? What type of AFO could help to accommodate for this?
- What myotome is largely responsible for dorsiflexion?

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QUESTION 7

A patient demonstrates difficulty maintaining single limb support. Which of the following muscles is most likely contributing to the dysfunction?

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QUESTION 7

A patient demonstrates difficulty maintaining single limb support. Which of the following muscles is most likely contributing to the dysfunction?

1. Weakness of the quadriceps
2. Weakness of the hamstring
3. Weakness of the gluteus medius
4. Weakness of the gluteus maximus

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2. Weakness of the hamstring
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4. Weakness of the gluteus maximus

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QUESTION 7

Looking Beyond the Right Answer

- Demonstrate a compensated Trendelenburg gait pattern.
- Demonstrate an uncompensated Trendelenburg gait pattern.
- A lesion to which nerve root will often contribute to gluteus medius weakness?
- What closed chain interventions are most appropriate to address mid-stance gluteus medius weakness?

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