Gait And Gait Cycle

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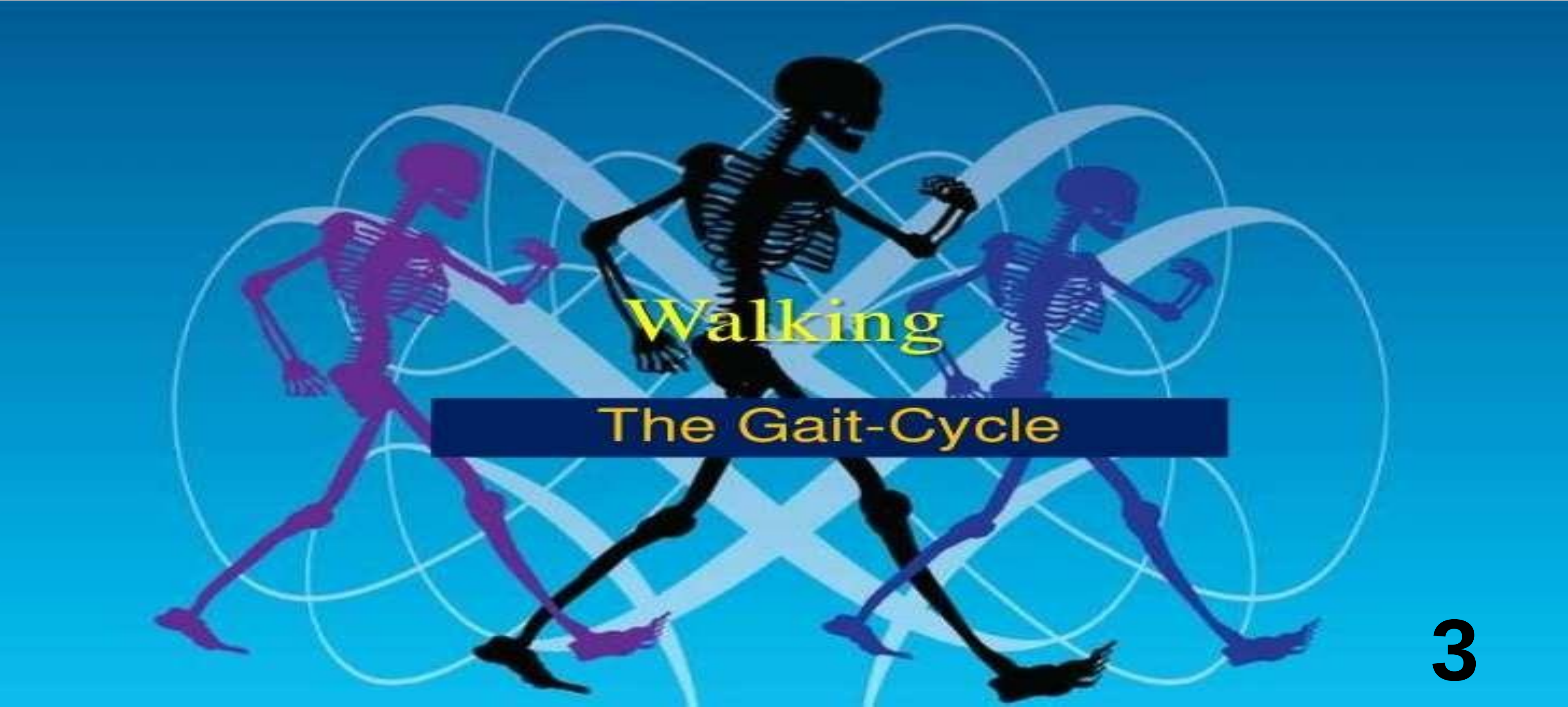
Gait

<u>Normal Gait</u>

Series of rhythmical , alternating movements of the trunk & limbs which result in the forward progression of the center of gravity…

- Gait is style , manner or a pattern of walking.
- Walking pattern may differ from individual to individual



Gait Cycle

- Defined as the period of time from one heel strike to the next heel strike of the same limb

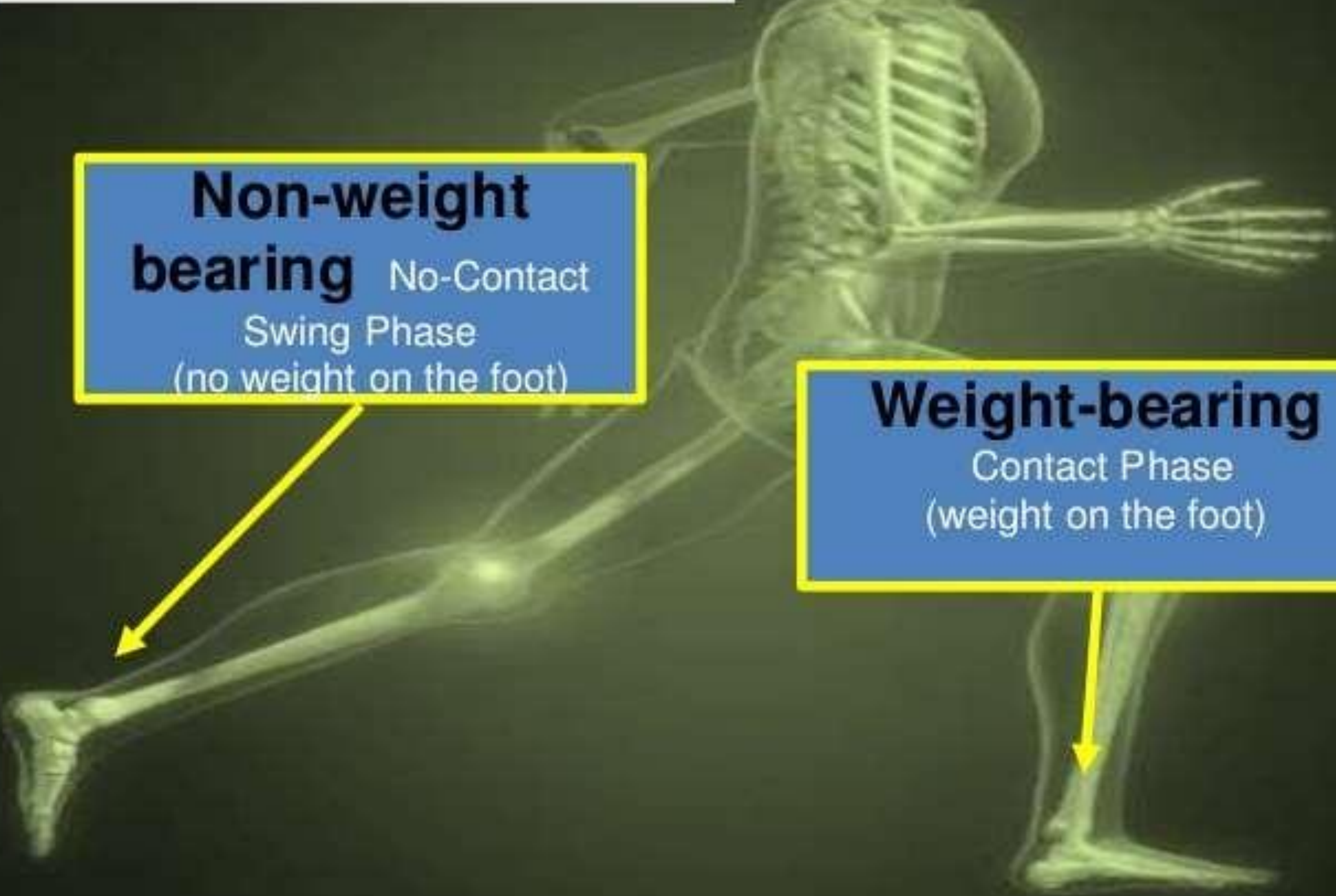
Gait Cycle

The gait cycle consists of two phases…

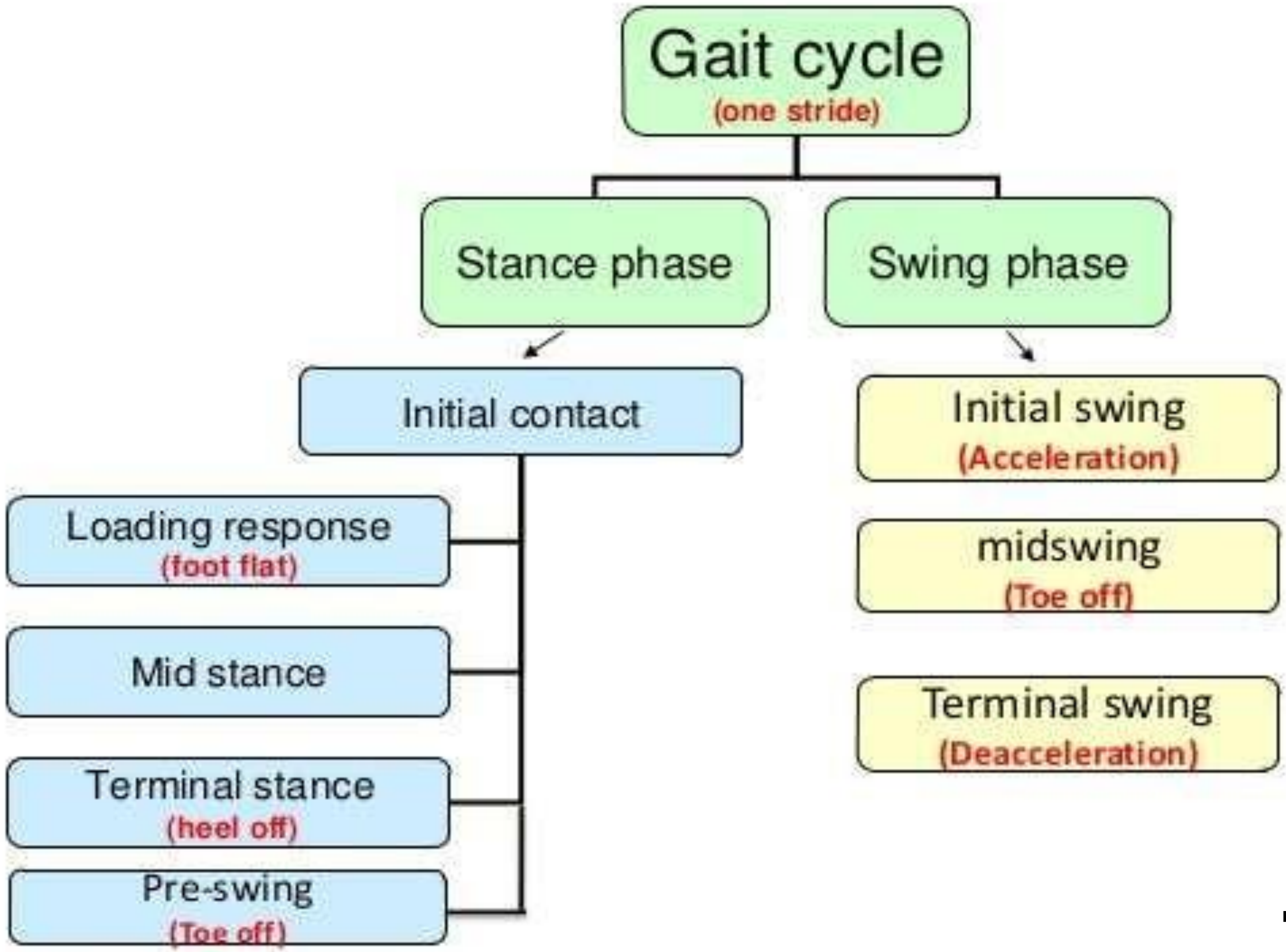
1) ***STANCE PHASE***

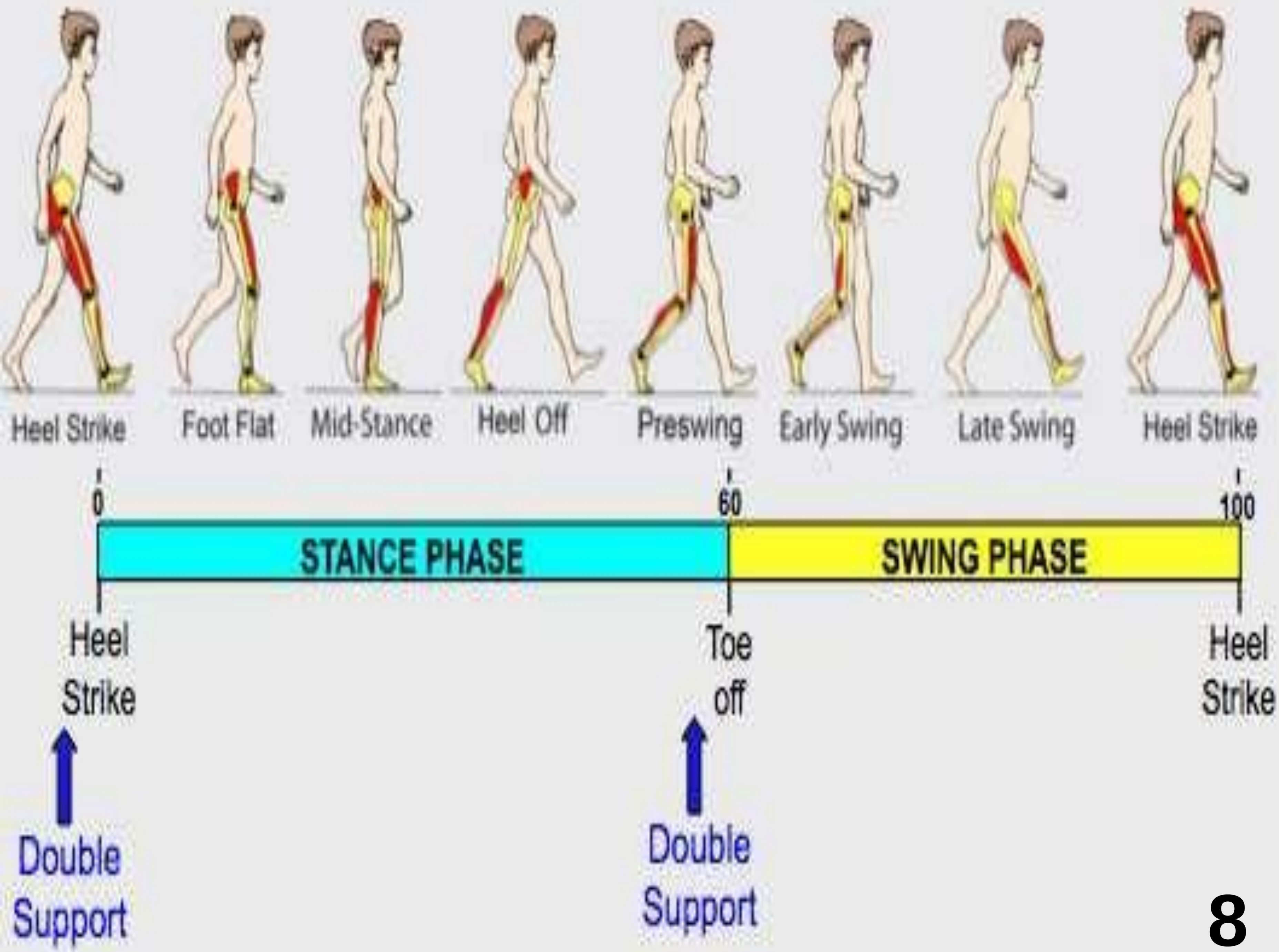
2) ***SWING PHASE***

There are 2 main phases of walking.



PHASES OF GAIT CYCLE

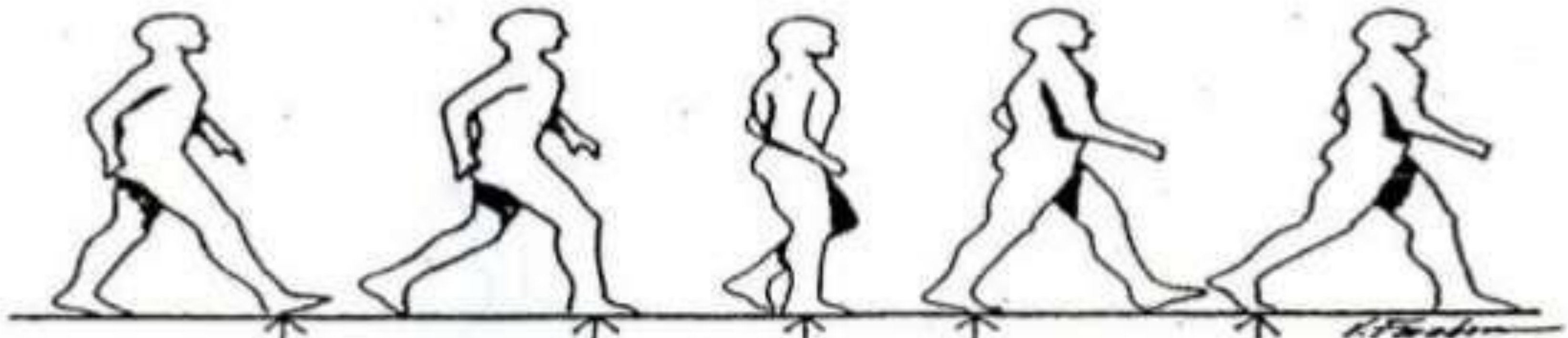



Heel Strike
Foot Flat
Mid-Stance
Heel Off
Preswing
Early Swing
Late Swing
Heel Strike
0
60
100
STANCE PHASE
SWING PHASE
Heel Strike
Toe off
Heel Strike
Double Support
Double Support

STANCE PHASE

- Begins when the heel of one leg strikes the ground and ends when the toe of the same leg lifts off.
- Constitutes approximately 60% of the gait cycle.

Gait Cycle - Subdivisions:



The five subphases of stance phase.

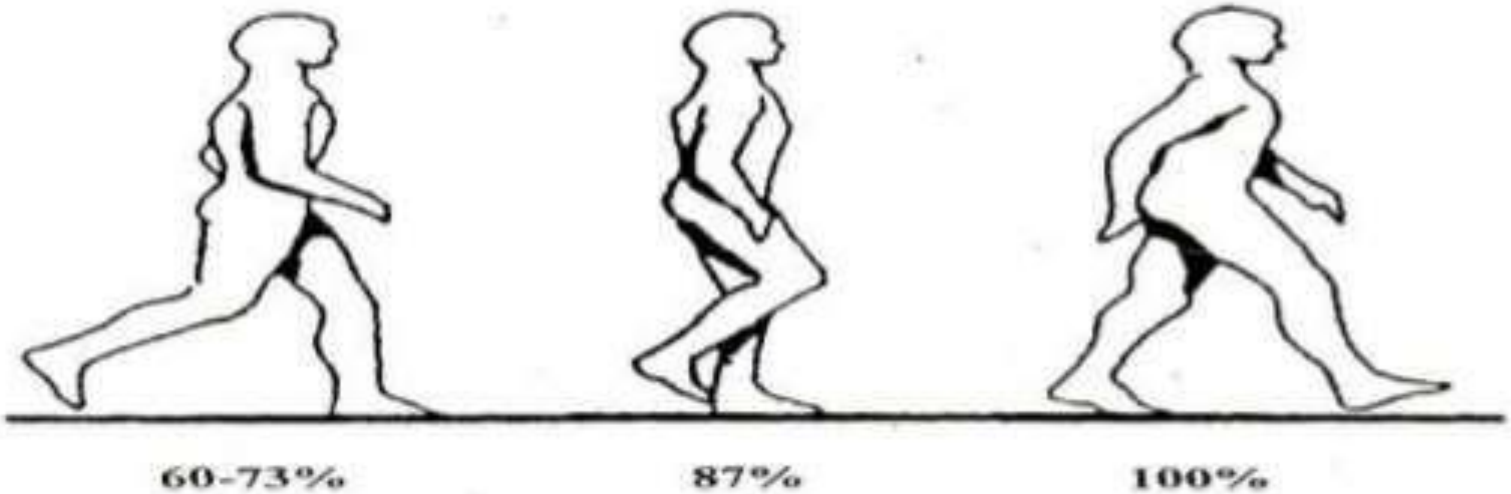
A. Stance phase:

1. **Heel contact**: 'Initial contact'
2. **Foot-flat**: 'Loading response', initial contact of forefoot w. ground
3. **Midstance**: greater trochanter in alignment w. vertical bisector of foot
4. **Heel-off**: 'Terminal stance'
5. **Toe-off**: 'Pre-swing'

SWING PHASE

- Swing phase represents the period between a toe off on one foot ad heel contact on the same foot.
- Constitutes approximately 40% of the gait cycle.

Gait Cycle - Subdivisions:



The three subphases of swing phase.

B. Swing phase:

1. **Acceleration**: 'Initial swing'
2. **Midswing**: Swinging limb overtakes the limb in stance
3. **Deceleration**: 'Terminal swing'

GAIT TERMINOLOGIES

GAIT TERMINOLOGIES

- Time and distances are two basic parameters of motion.

1. **Temporal (Time) variables**
2. **Distance (Spatial) variables**

TEMPORAL VARIABLES

1. Single limb support time
2. Double support time
3. Cadence
4. Speed

Single Limb Support Time

Amount of time that spent during the period when only one extremity is on the supporting surface is a gait cycle.

Double Support Time

Amount of the time spent with both feet on the ground during one gait cycle.

- The time of double support may be increased in elder patients and in those having balance disorders
- The time of double support decreases when speed of walking increases

Cadence =

- Number of steps per unit time
- Normal: 100 – 115 **steps/min**
- Cultural/social variations

Speed (Velocity)=

- **Distance covered by the body in unit time**
- **Usually measured in m/s**
- **Instantaneous velocity varies during the gait cycle**
- **Average velocity (m/min) = step length (m) x cadence (steps/min). Average walking speed= 80m/minute.**

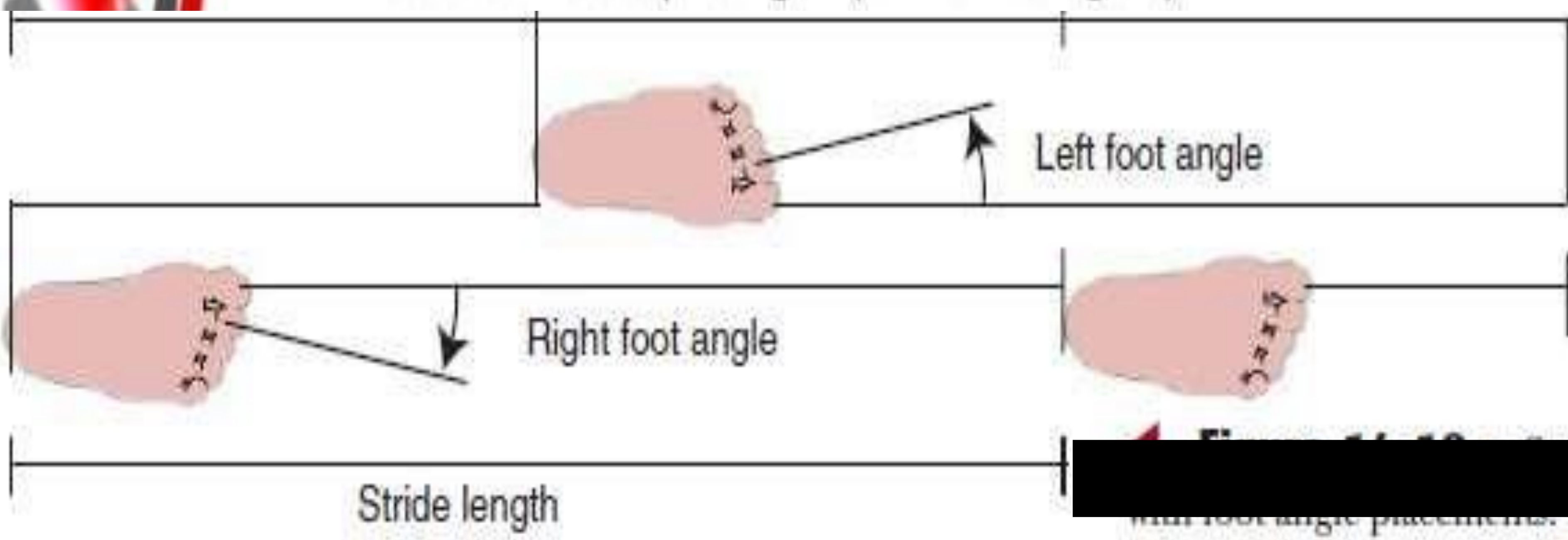
Distance Variables

1. Stride length
2. Step length
3. Degree of toe out

Stride length

Stride length

- Distance between successive points of heel contact of the **same foot**
- Double the step length (in normal gait)



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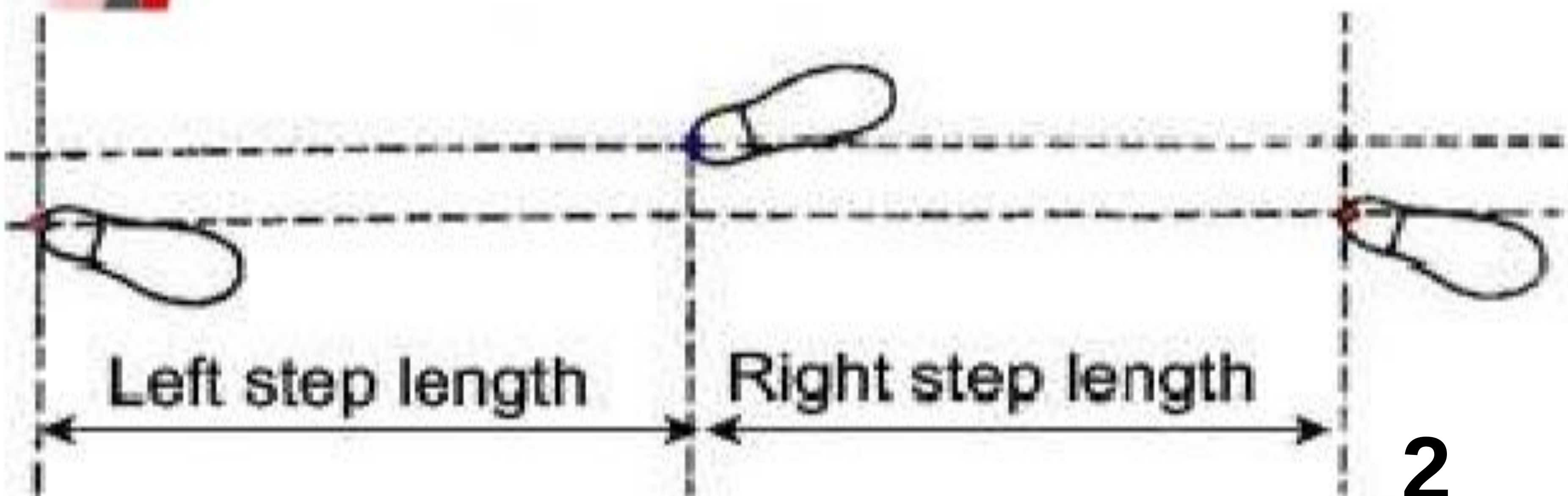
Step length

Step length

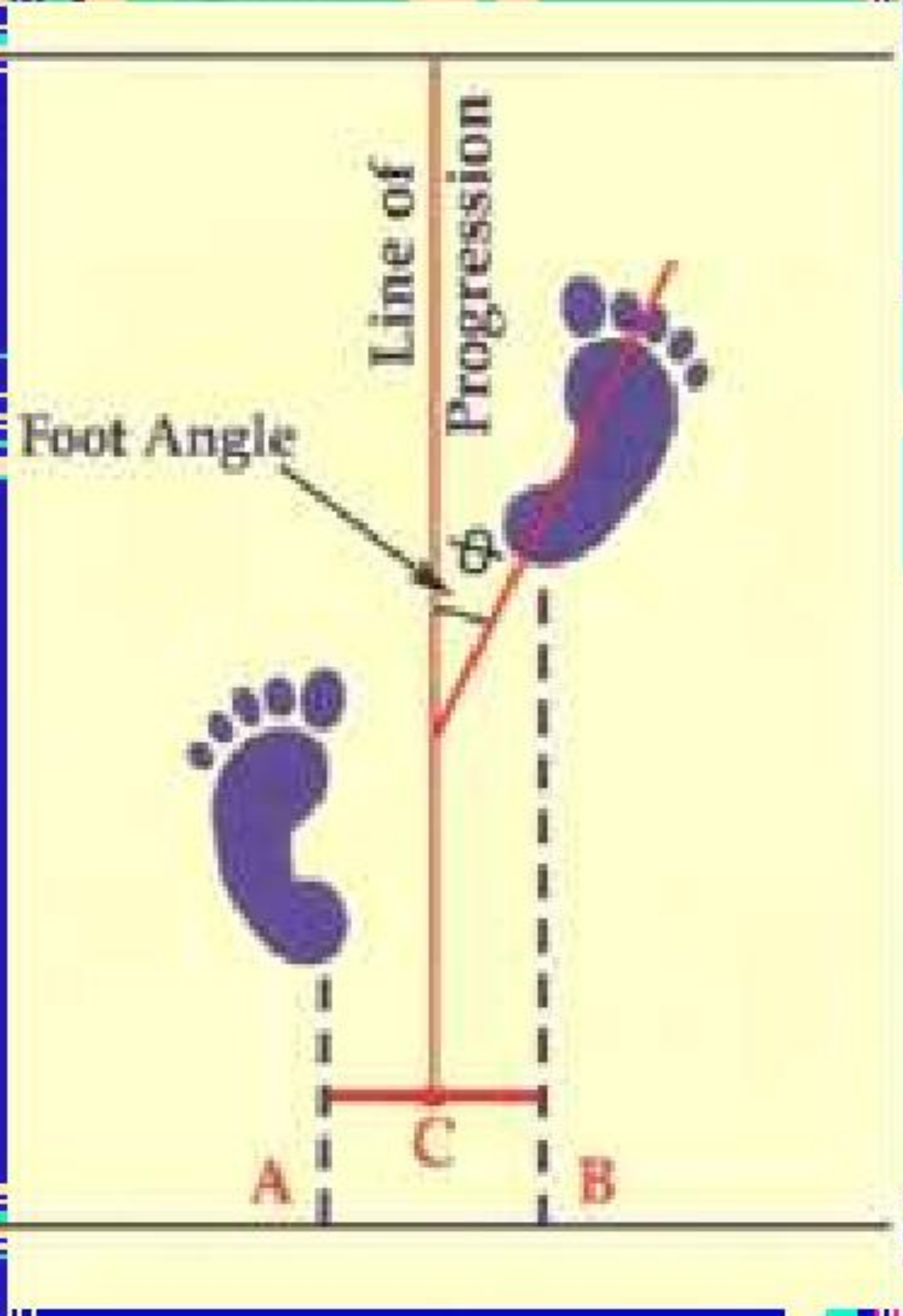
- Distance between corresponding successive **points of heel contact of the opposite feet.**
- Rt step length = Lt step length (in normal gait).



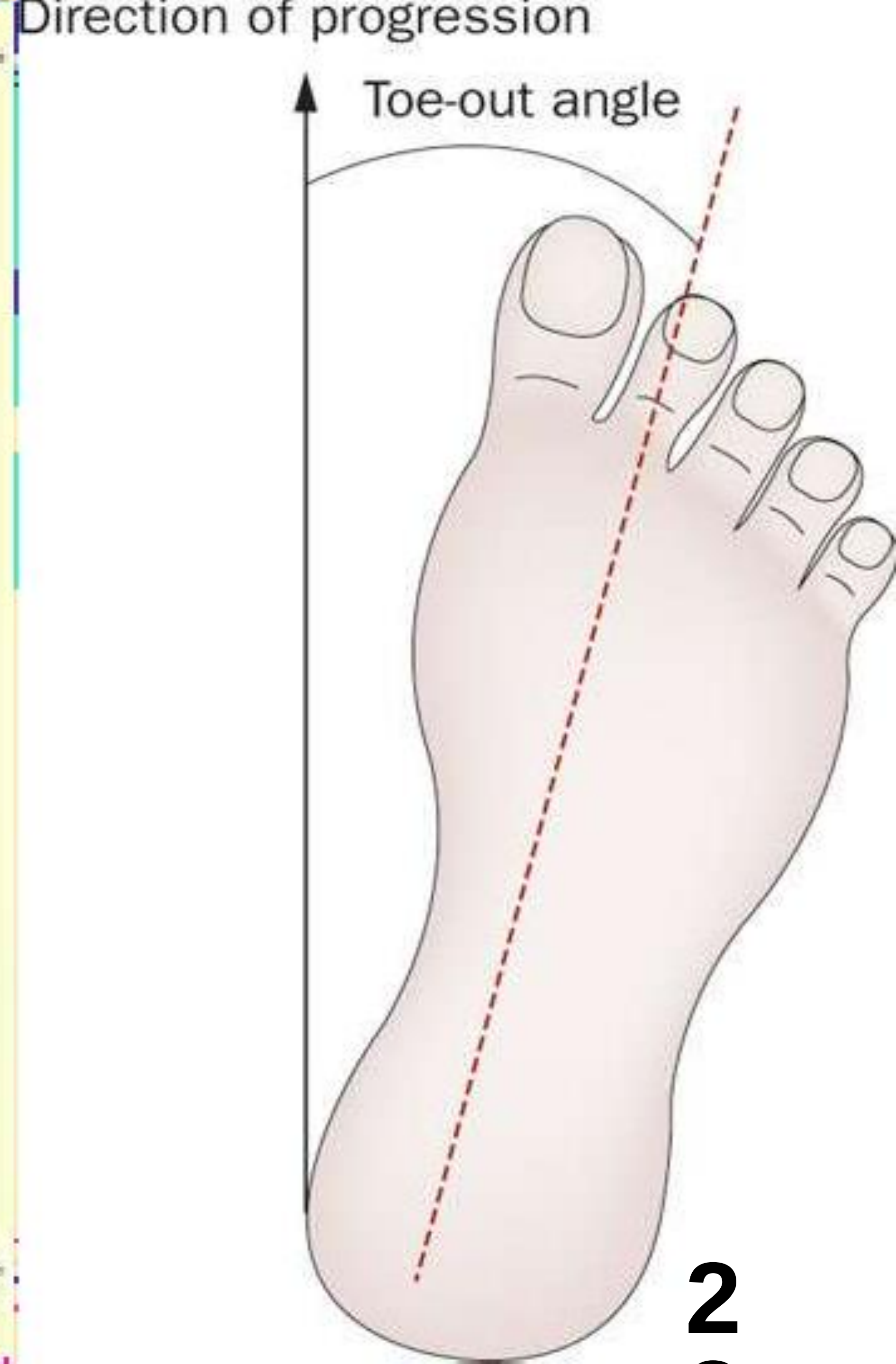
Degree of toe out

It represents the angle of foot placement and may be found by measuring the angle formed by each foot's line of progression and a line intersecting the center of heel and second toe.

The angle for men is about 7 degree. the degree of toe out decreases as the speed of walking increases in normal men.



Line of Progression
Foot Angle
θ
A
C
B



Direction of progression
Toe-out angle

KINEMATICS AND KINETICS OF GAIT

- Path of Center of Gravity
  - midway between the hips
  - Few cm in front of S2
  - Least energy consumption if CG travels in straight line

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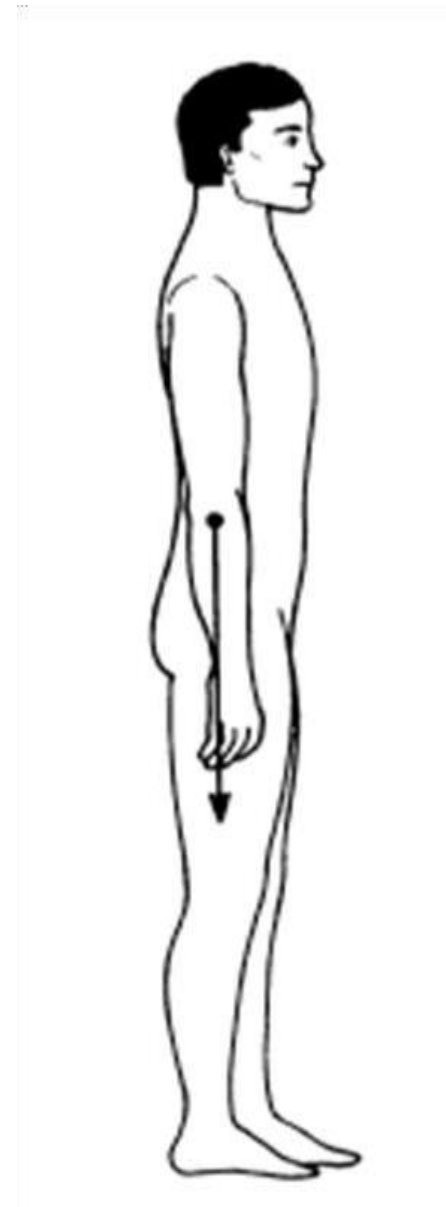
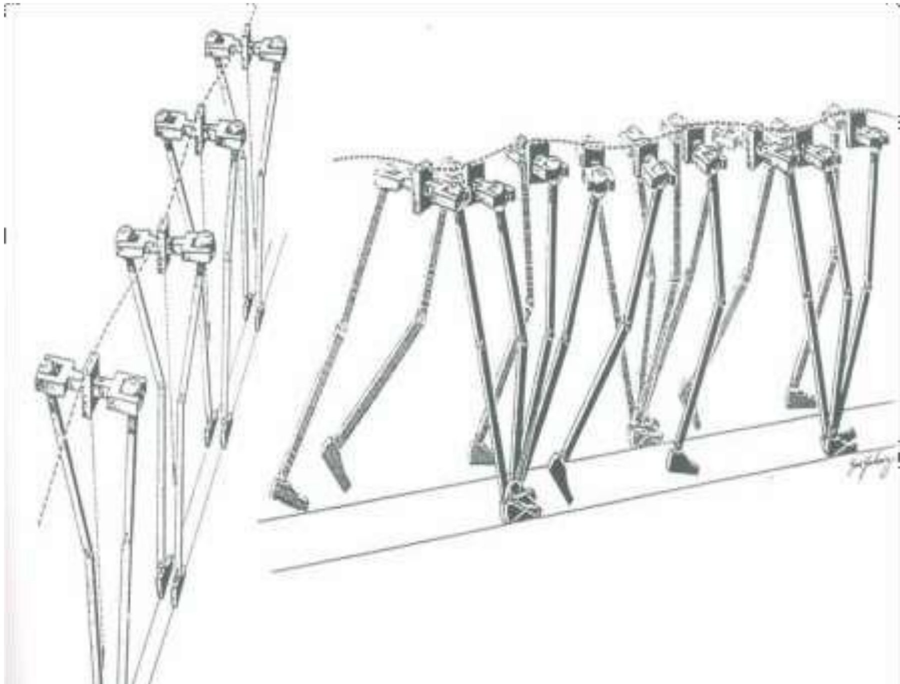


Path of Center of Gravity

A. <u>Vertical displacement:</u>

- Rhythmic up & down movement
- Highest point: midstance
- Lowest point: double support
- Average displacement: 5cm
- Path: extremely smooth sinusoidal curve

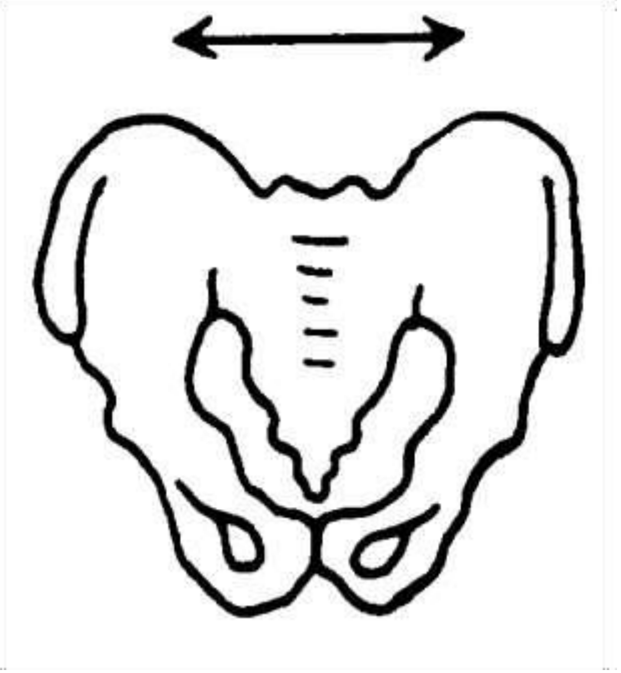


Effect of dampening mechanisms on body center of gravity movement

Path of Center of Gravity

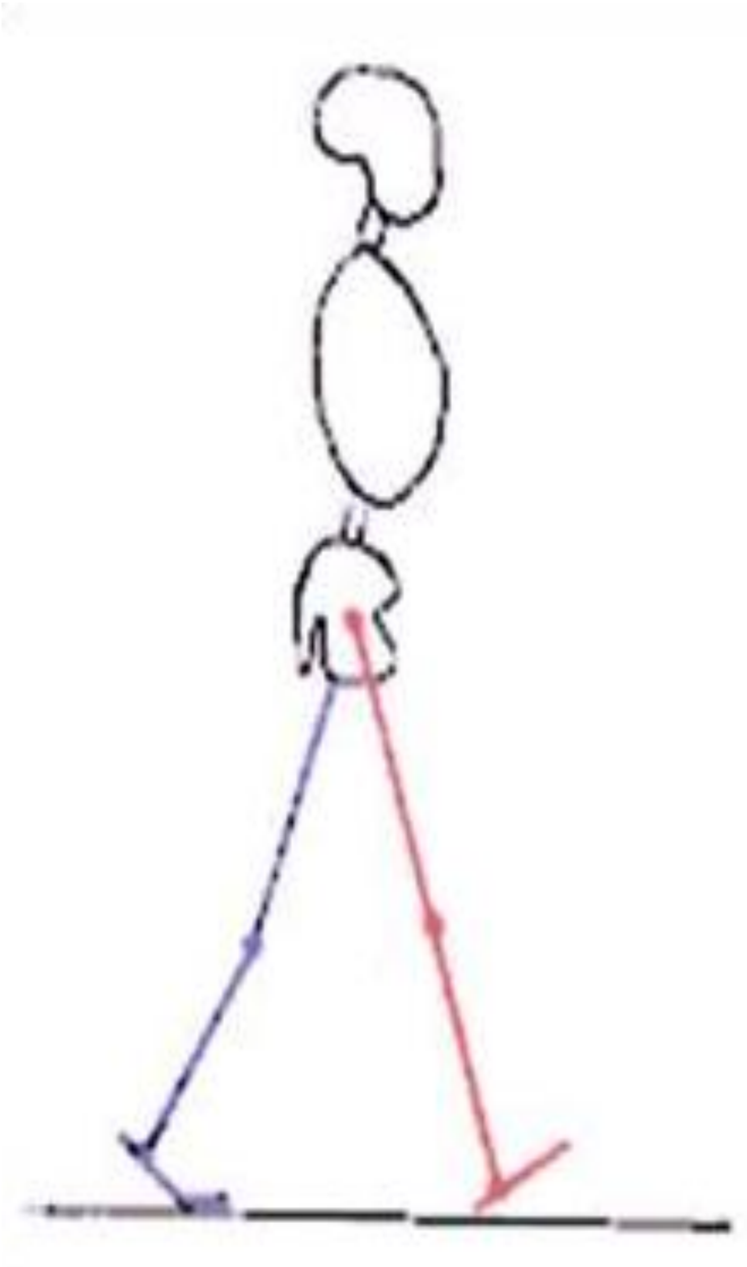
B. Lateral displacement:

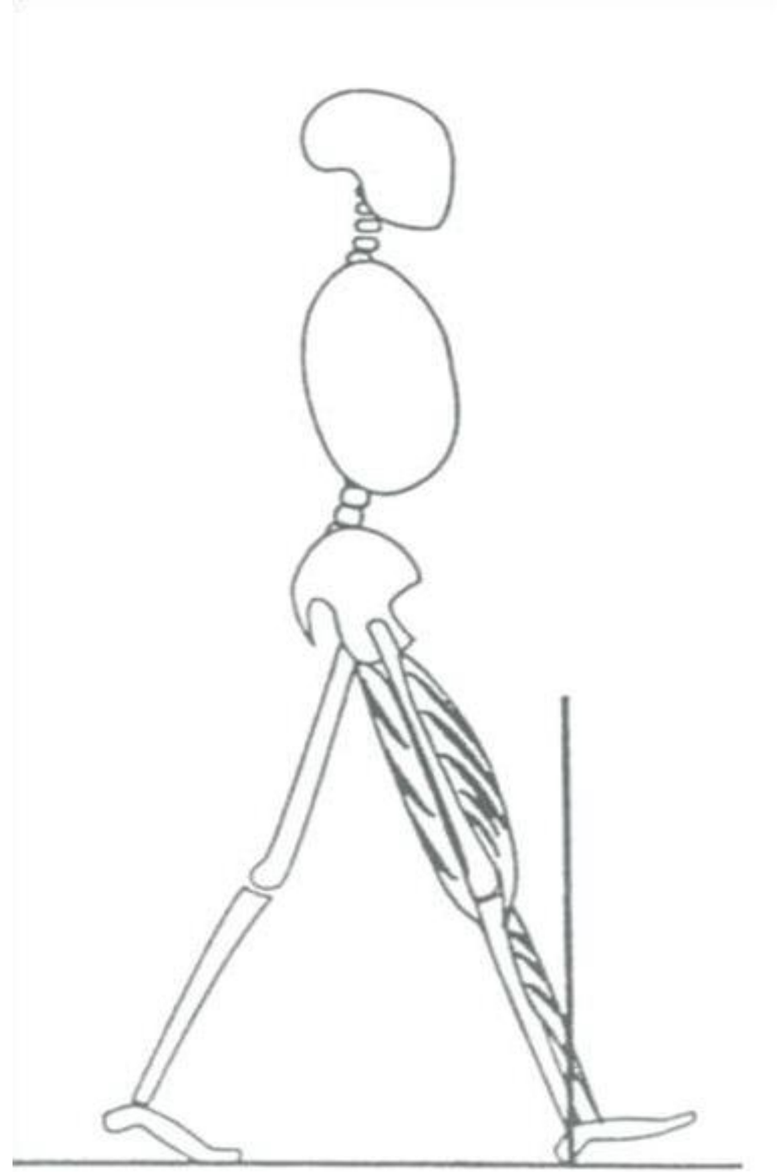
- Rhythmic side-to-side movement
- Lateral limit: midstance
- Average displacement: 5cm
- Path: extremely smooth sinusoidal curve



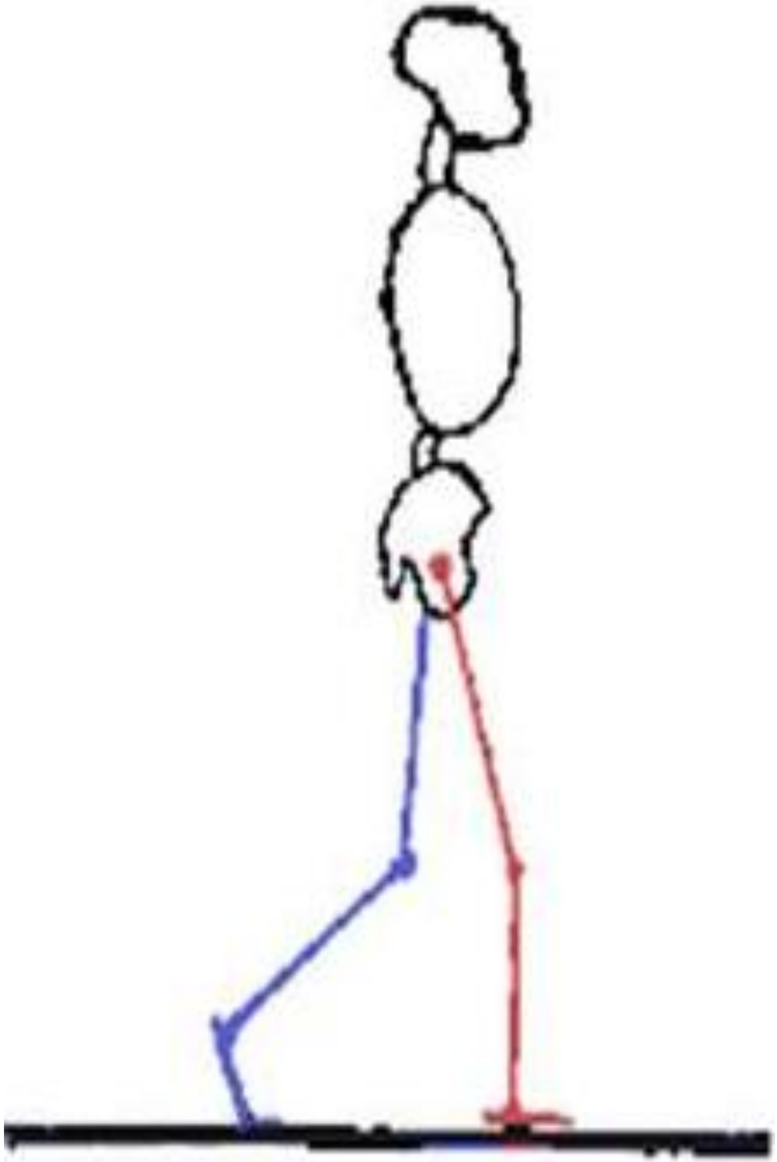
HEEL STRIKE TO FOOT FLAT

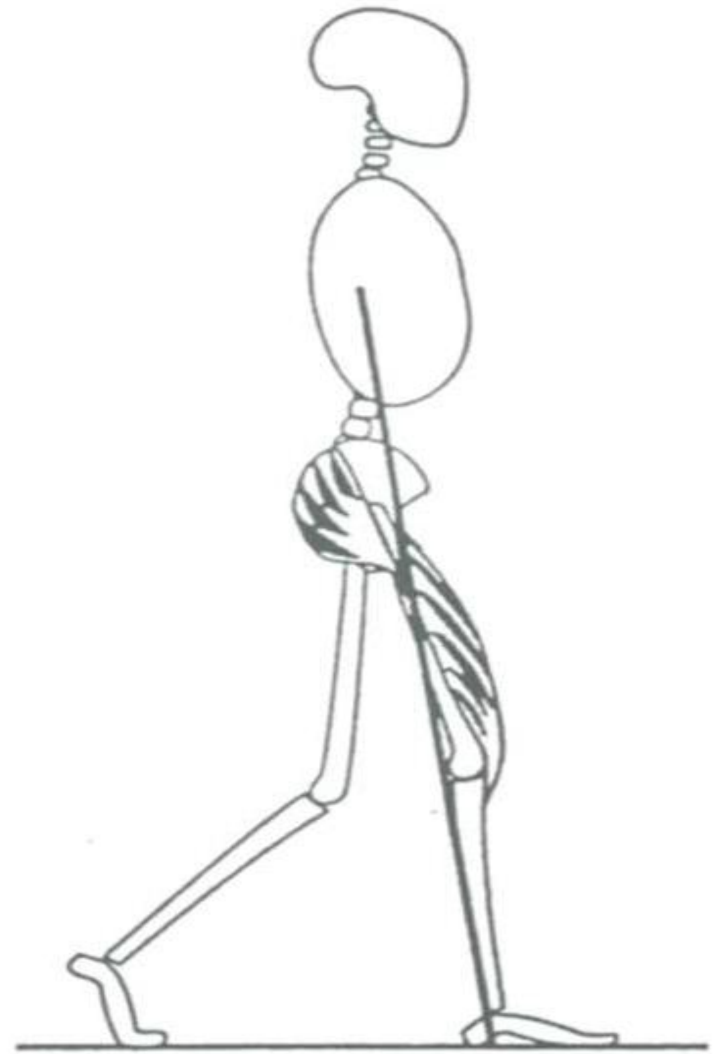
- Heel strike to forefoot loading
- Foot pronates at subtalar joint
- Only time (stance phase) normal pronation occurs
- This absorbs shock & adapts foot to uneven surfaces
- Ground reaction forces peak
- Leg is internally rotating
- Ends with metatarsal heads contacting ground





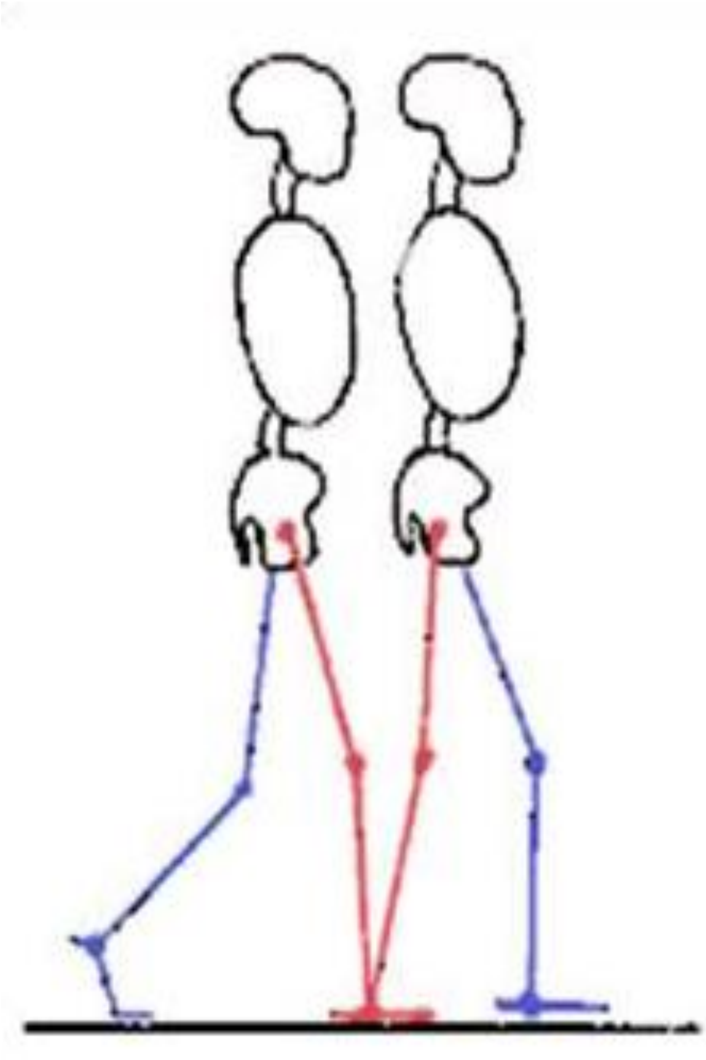
Initial Contact

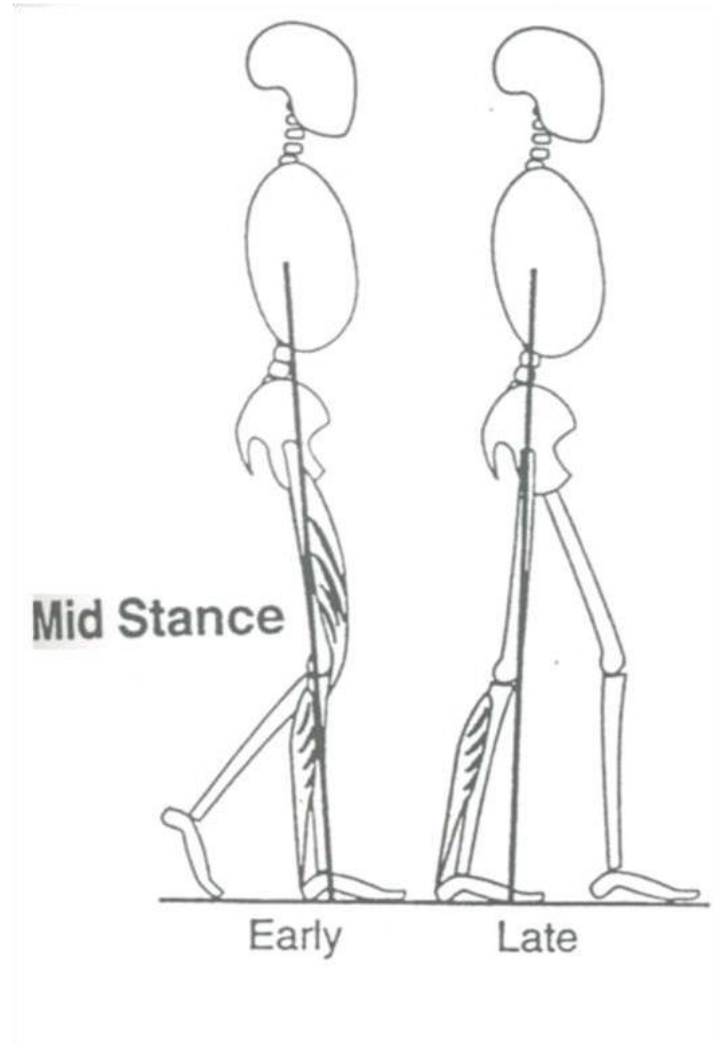




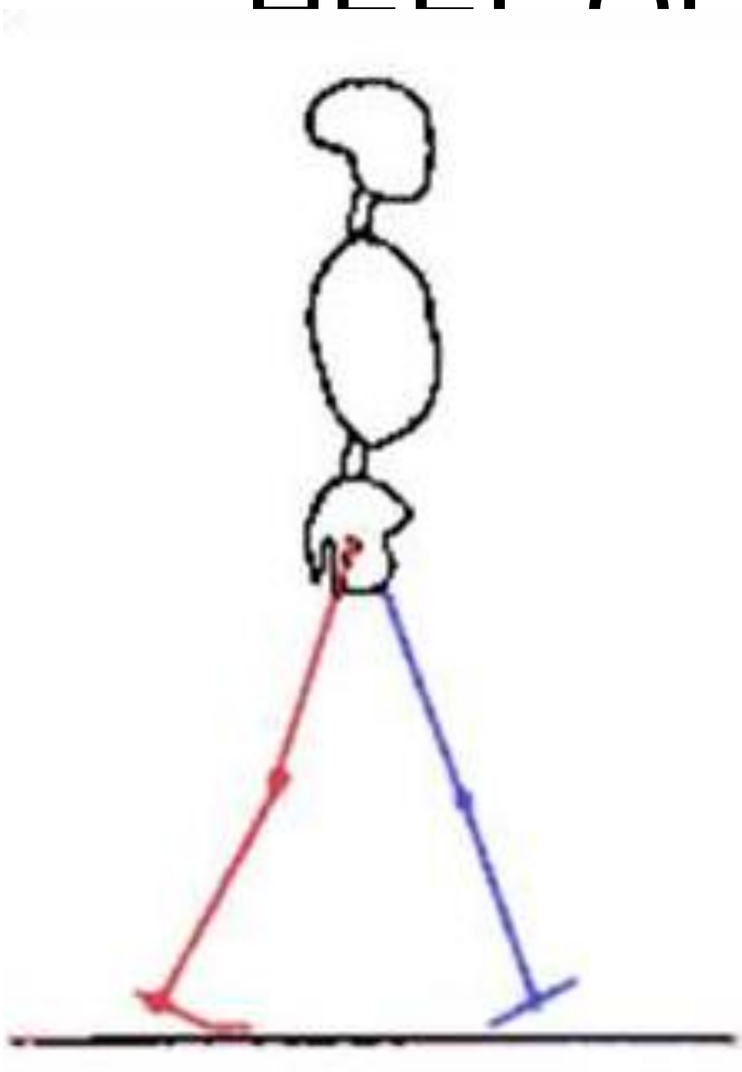
Loading Response

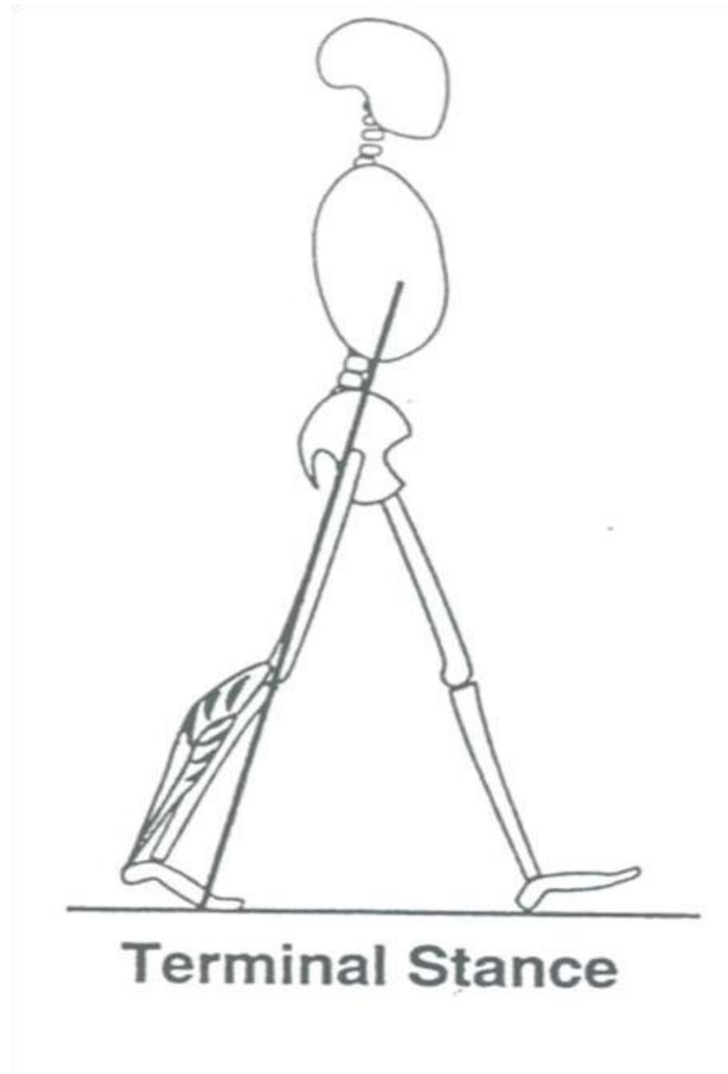
FOOT FLAT TO MIDSTANCE



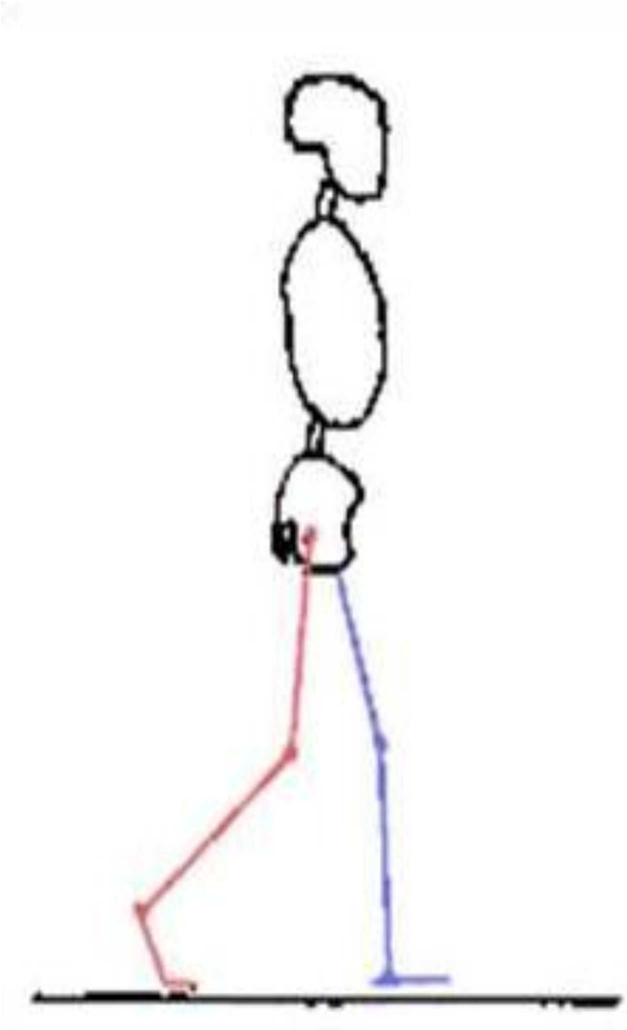


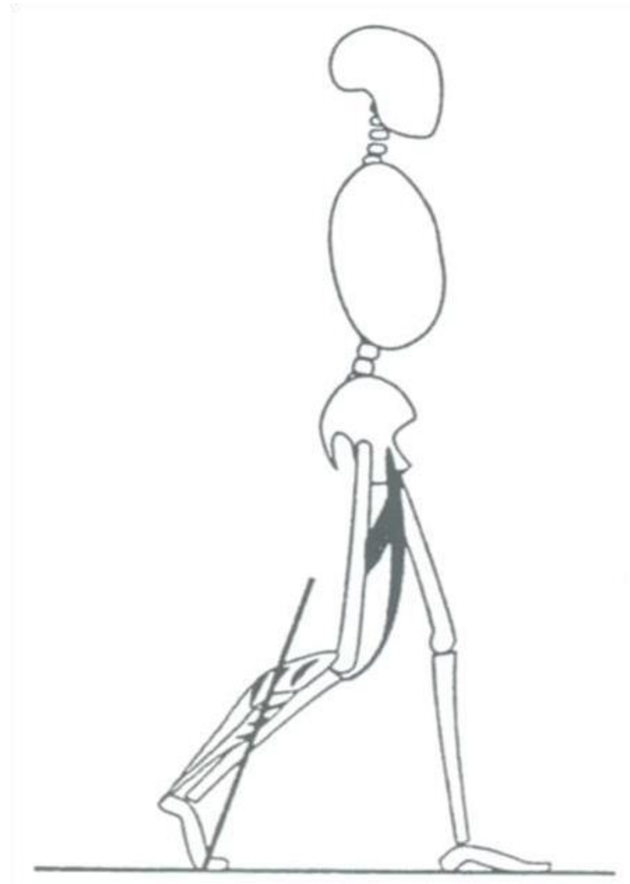
MIDSTANCE TO HEEL OFF





HEEL OFF TO TOE OFF





Pre-Swing

DETERMINANTS OF GAIT

- Six optimizations used to minimize excursion of CG in vertical & horizontal planes
- Reduce significantly energy consumption of ambulation
- The six determinants are
  - Lateral pelvis tilt
  - Knee flexion
  - Knee, ankle and foot interactions
  - Forward and backward rotation of pelvis
  - Physiological valgus of knee

DETERMINANTS OF GAIT

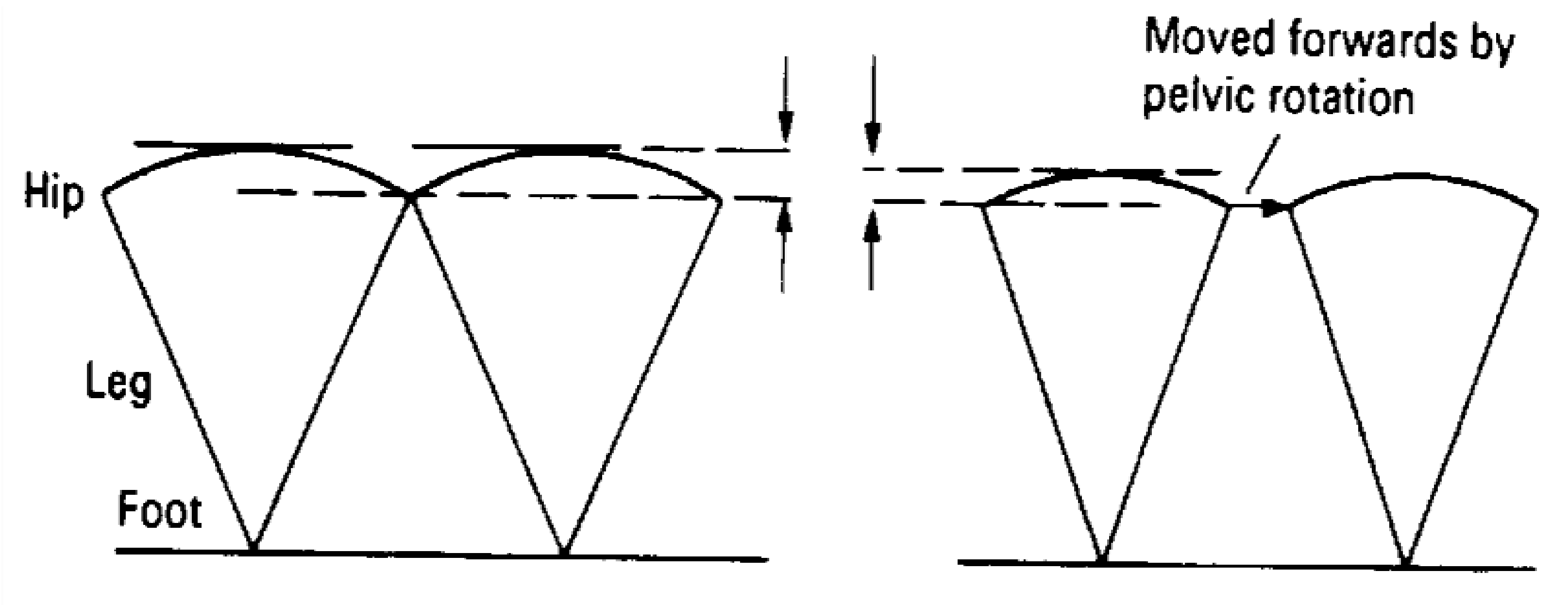
DETERMINANTS OF GAIT

1) <u>Pelvic rotation</u>:

– Forward rotation of the pelvis in the horizontal plane approx. 8o on the swing-phase side

– Reduces the angle of hip flexion & extension

– Enables a slightly longer step-length w/o further lowering of CG

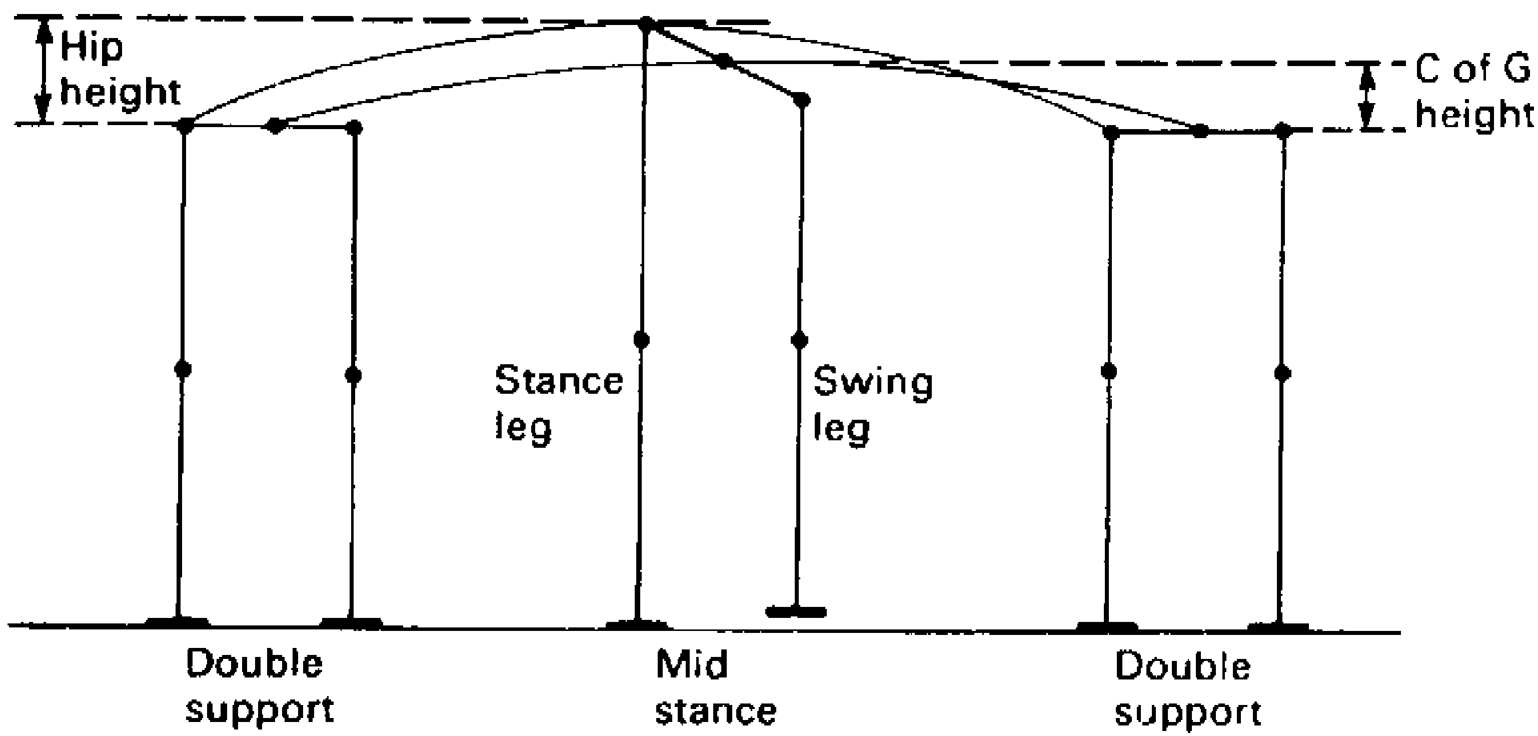


(2) <u>Pelvic tilt</u>:

– 5 degree dip of the swinging side (i.e. hip adduction)

– In standing, this dip is a positive Trendelenberg sign

– Reduces the height of the apex of the curve of CG

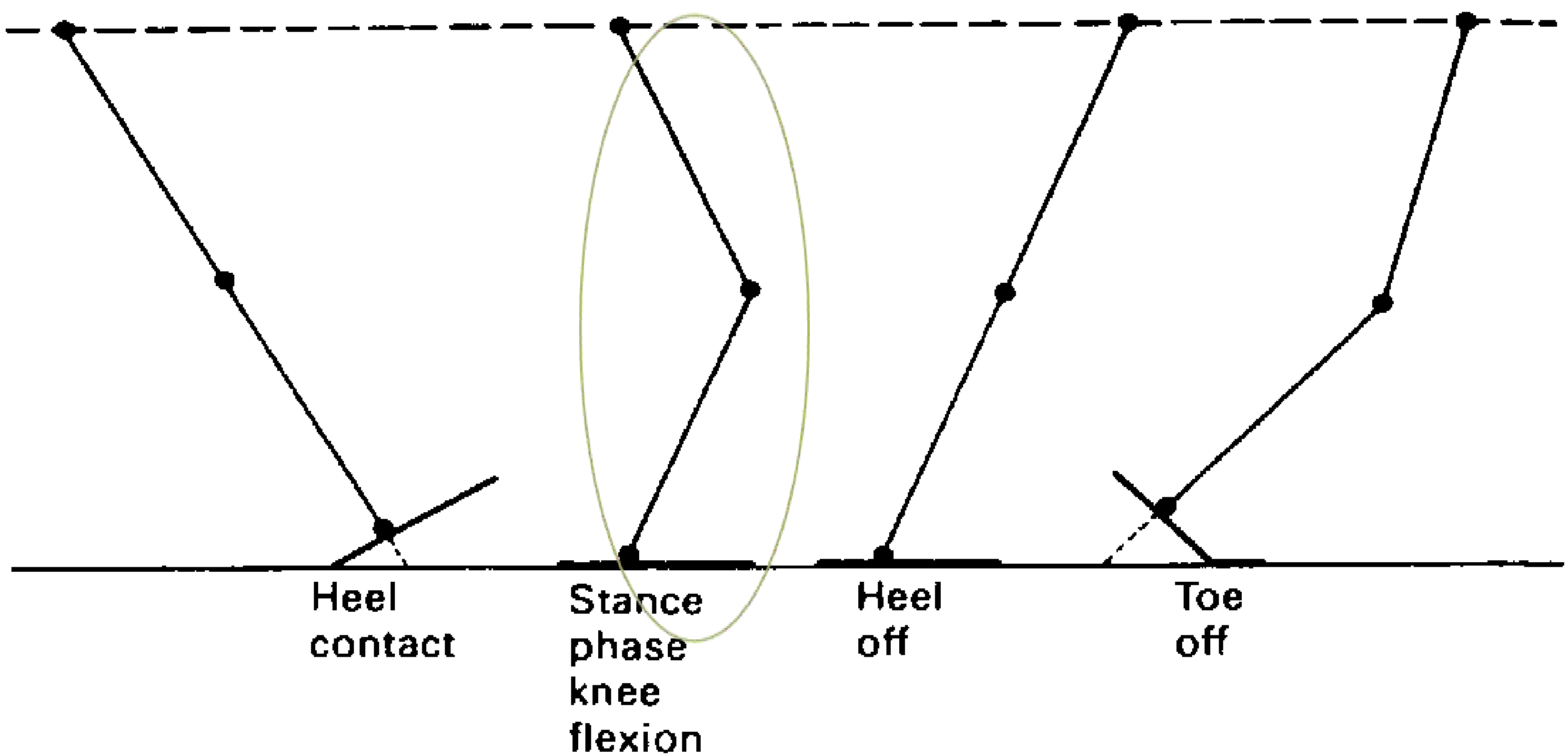


(3) <u>Knee flexion in stance phase</u>:

– Approx. 20o dip

– Shortens the leg in the middle of stance phase

– Reduces the height of the apex of the curve of CG



(4) Ankle mechanism:

- Lengthens the leg at heel contact
- Smoothens the curve of CG
- Reduces the lowering of CG

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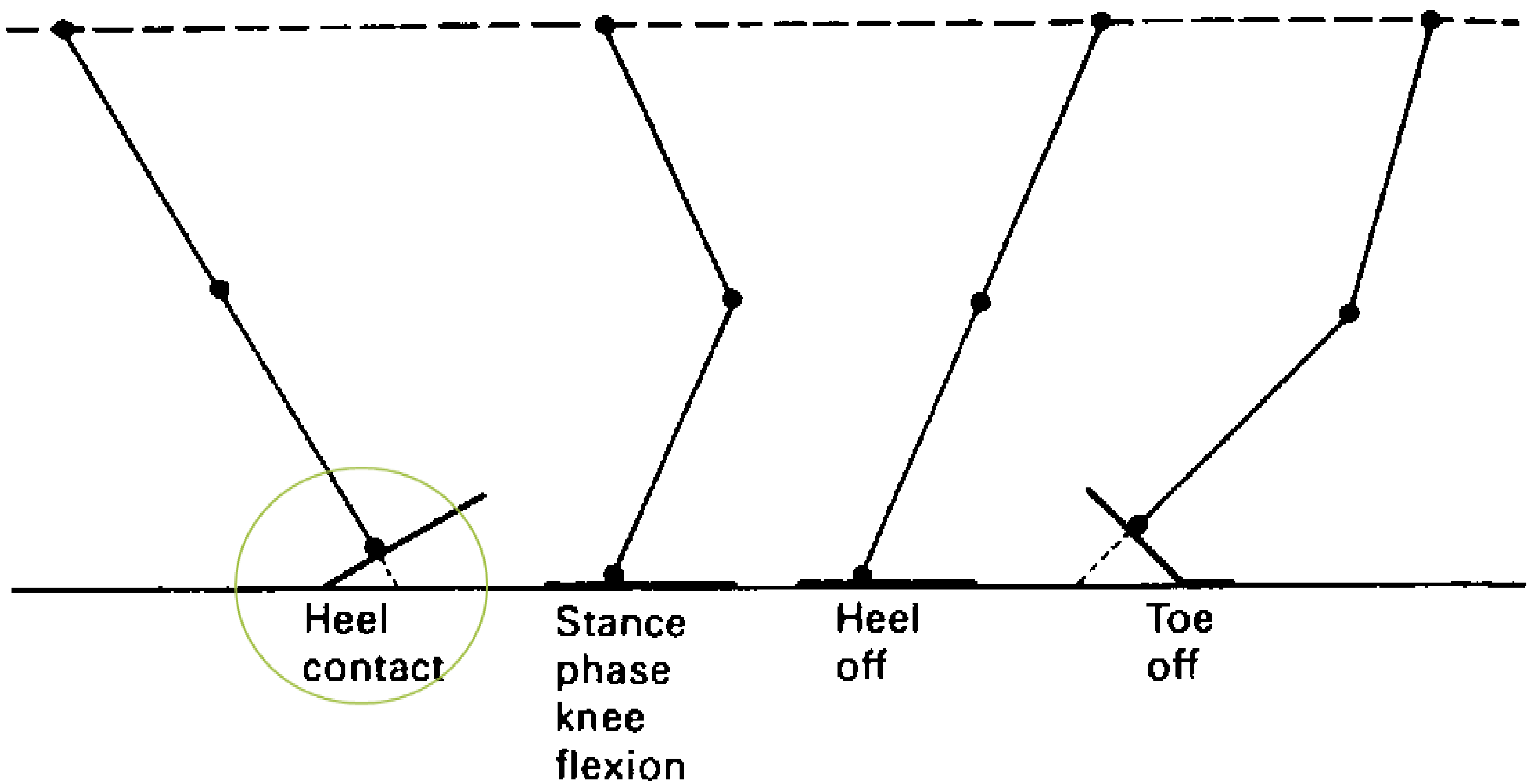
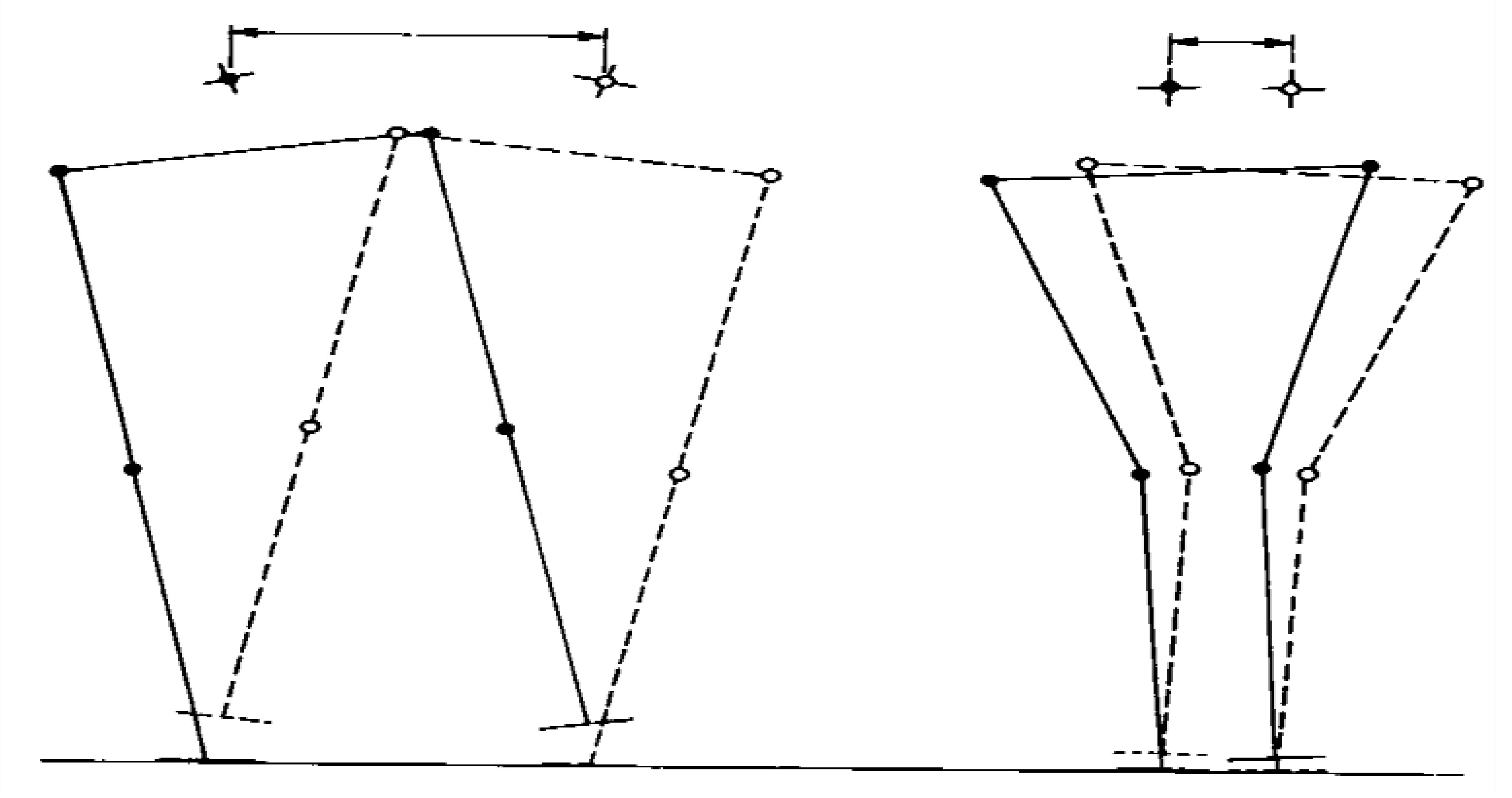


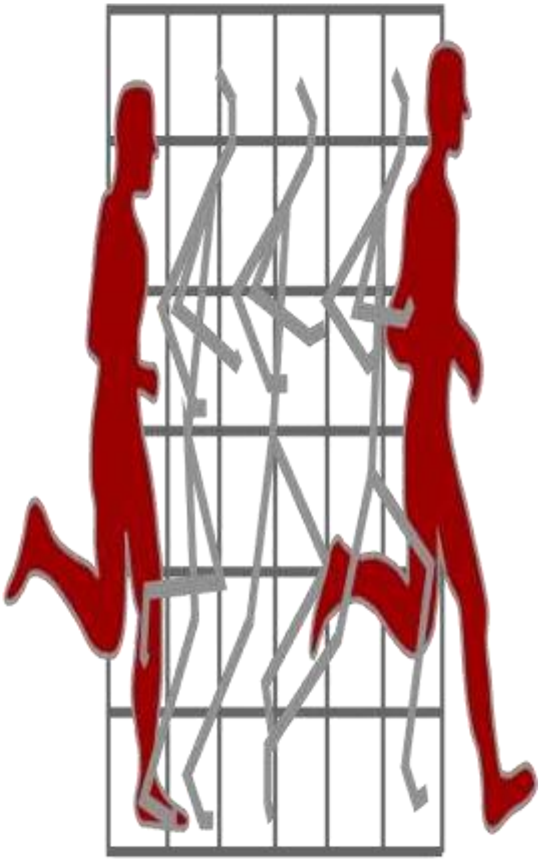
- Physiological valgus of knee

  Reduces the base of support, so only little lateral motion of pelvis is necessary.



RUNNING GAIT

- Require greater balance, muscle strength, ROM than normal walking.
- Difference b/w running and walking
- Reduced BOS
- Absence of double support
- More coordination and strength needed
- Muscle must generate higher energy bout to raise HAT higher than in normal walking.
- Divided into flight and support phase.



Box 2. Differences between running and walking

Increased velocity
Increased ground reaction forces
Float phase
No double stance phase
Decreased stance phase and increased swing phase
Overlap of swing phase rather than stance phase
Requires more range of motion of all lower limb joints
Requires greater eccentric muscle contraction
Initial contact varies, depending on speed
Decreased center of gravity with increased speed
Decreased base of support

STAIR GAIT

- Ascending and descending stairs is a basic body movement required for ADL

- Stair gait involved stance and swing phase

kinematics

- STANCE PHASE(64%)
- Weight acceptance
- Pull up
- Forward continuance

- SWING PHASE(36%)
- Foot clearance
- Foot placement


THANK
YOU