**Dynamic, moving bridge**

**Locomotion modes**
- **Cursorial** - running
- **Arboreal** - in trees
- **Saltatorial** - hopping
- **Fossorial** - digging
- **Aerial** – flying
- **Bipedal** – us!

**Cursorial**
Increasing speed is due to increasing:

1. **Stride length** - distance between footfalls during a whole stride
   and / or
2. **Stride frequency** - number of strides per unit time

**Increasing stride length**
- **Limb length**
Posture changes

- Drop scapula down to add to limb length – clavicle becomes reduced

Cursorial stride length

- Extension of vertebral column

- Add a suspension phase to gait

- Tradeoff of stability vs. speed
**Cursorial stride length**

- D. Fast gallop
  - Left hind
  - Left front
  - Right hind
  - Right front

- E. Half bound
  - Left hind
  - Left front
  - Right hind
  - Right front

**Increasing stride frequency**

- Shortened limb length, decreased limb weight

**What is the tradeoff?**

**Influence of in-lever vs out-lever**

- A. Design for speed (SLow)
  - Line of action of out force = F_out
  - Line of action of in force = F_in
  - Out-lever = L_out
  - In-lever = L_in

- B. Design for power (amplitude)
  - Line of action of out force = F_out
  - Line of action of in force = F_in
  - Out-lever = L_out
  - In-lever = L_in
**In-lever**

- Stronger out force
- Slower movement

**Out-lever**

- Weaker out force
- Faster movement

**Insertion close to joint**

**Insertion far from joint**

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**Increasing stride frequency**

- Compare in-levers and out-levers

**Fossorial limb**

- Added joints increases flexion

**Summation of movement of each bone during a stride**
Increasing stride frequency
Distal ends of limb have less muscle weight

More extreme cursorial adaptations
- Grooved joints, tendon recoil
- Tendon arranged for elastic recoil

Effect of body size
- With an increase in body size, cursorial adaptations must get more extreme to still have speed

Arboreal locomotion
- Cling and leap
- Arm swingers
Arboreal

Arm swingers

Becoming bipedal

Bipedalism
- Structural changes to appendicular and axial skeleton
- Center of gravity much higher
Bipedalism

- Vertebrae hold weight of those above
- Change in hip musculature to stabilize trunk

Pelvis tilted so acetabulum is in line with illio-sacral joint
Illium flares out - pelvis tilt to adjust center of mass
**Bipedalism**

- Angle of femur – a result of bipedal walking

**Our big butt**

Gluteus muscles stabilize hip when one foot is swinging, supporting body weight

**Issues**

- Lumbar region - weight distribution unbalanced along centrum
  - Brain size

**Bipedalism vs. big baby heads**

- Tradeoff of locomotion efficiency and big brains
Saltatorial locomotion

- Lengthening & fusion of hind limb bones
- Weight distributed at sacrum

- Frogs
  - Flexion at sacroiliac joint to allow legs to extend and rotate under body
  - Urostyle helps rotate pelvis
  - Fusions in fore and hind limbs
Limbs for flight

Wing shape and lift

Varying properties along wing

Adding a “slot” to enhance lift