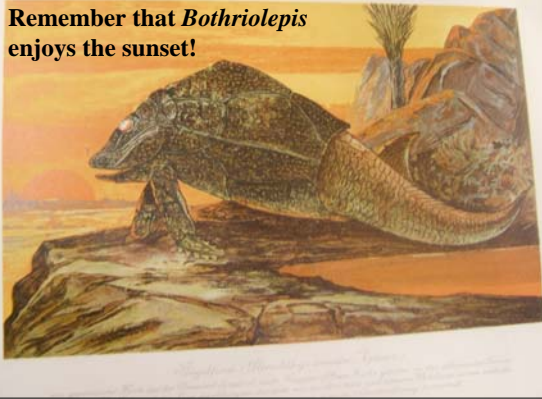


Remember that *Bothriolepis* enjoys the sunset!



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Shoulder region structure changes relate to position of forelimb and movement pattern

Allows for better support of body in correlation with different body forms

Allows greater freedom of limb movement in specific directions

Some additional new structures appear, primarily for new or reoriented locations for muscle attachments

Clavicles and pectoral muscles brace the body wall for standing or walking

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Clavicles and pectoral muscles contact at midline through interclavicle, sternum or themselves

These structures replace brace with the head

Correlates with strong pectoral muscles or muscle complex

Pectoralis muscles pull forelimb toward body and provide lift and support during walking

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## **Evolution of the hind limb and the pelvic girdle**

**Less complicated than the forelimb and pectoral girdle**

**Endochondral bone only**

**Three elements arising from the earliest records remain stable throughout tetrapod evolutionary history**

**Arose as a small cartilage or bone embedded in soft tissue to which pelvic fin attached**

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**Pelvic girdles often have contact at the midline (pubic symphysis) in fishes (not only sharks)**

**Usually the pelvic fin was smaller and less important in propulsion (front wheel drive)**

**Initially arose as a single center of ossification**

**In later tetrapods three centers, each enlarging during development**

**Each bone forms part of the acetabulum**

**Pelvis carries weight of posterior body and tail**

**Tetrapods generate propulsion from pelvic limb (rear wheel drive)**

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- Ilium expands and connects to the axial skeleton
- Initially one sacral vertebrae
- Later, more become incorporated into sacrum
- Splayed body posture requires much effort to hold animal's body off the ground (depressor = flexor muscles)
- Inefficient and not conducive to fast locomotion

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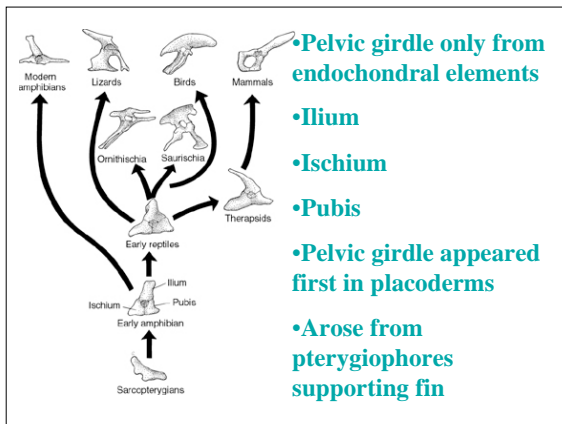
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- Ilium attaches pelvic girdle to vertebral column
- Vertebrae specialize to attach to it and become sacrum
- Sacrum varies in number of vertebrae
- Occurs first in early amphibians
- In later forms (birds and mammals) may fuse as well as become enlarged
- Forms a strong linkage to the pelvic limb
- Separates trunk of body and tail

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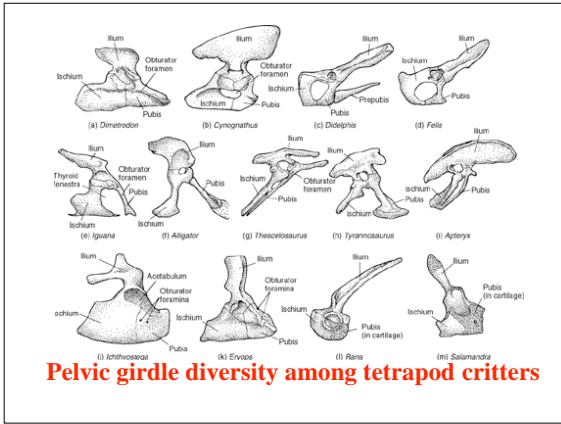
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- Muscles must be rearranged to accommodate new locomotor positions
- Dorsal fin muscles become limb elevators
- Ventral muscles (fin depressors) become limb flexors
- Rotators may derive from both and are often a combination
- Backward pull on limb causes forward motion of body
- Return of limb to original position requires contraction of opposing muscles – antagonists

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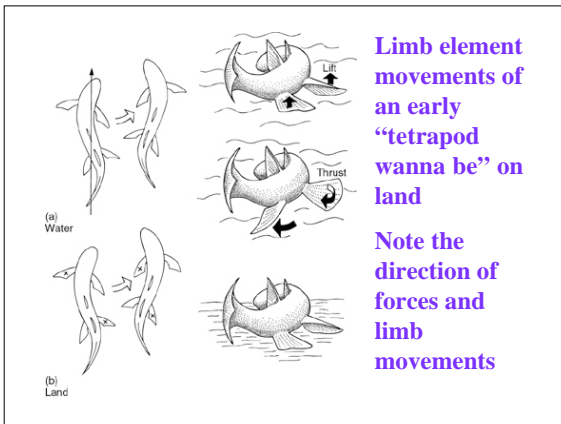
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- Antagonists contract to provide support for limb while in motion
- Femur orientation either lateral or under body or between
- Alters direction in which limb moves
- Must maintain body support if trunk is not on ground
- Knee joint bends and femur rotates on pelvis to point anteriorly
- Ankle bends to point foot forward

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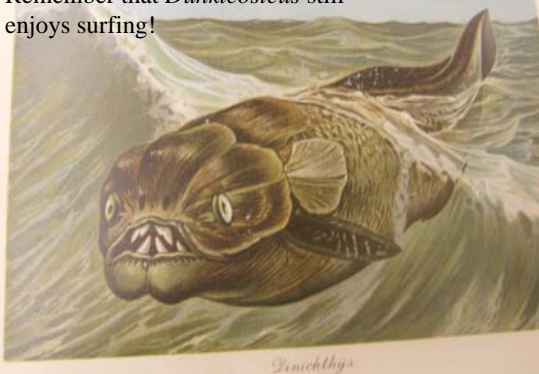
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Remember that *Dunkleosteus* still enjoys surfing!




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### Origin and function of feet

- Evolved as modifications of ends of paddle-shaped limbs
- Bony/cartilaginous supporting elements can be homologized in crossopterygians for limbs, but foot element origins are unclear
- Orientation changes needed in both hand and foot for locomotion
- Many kinds of digital arrangements

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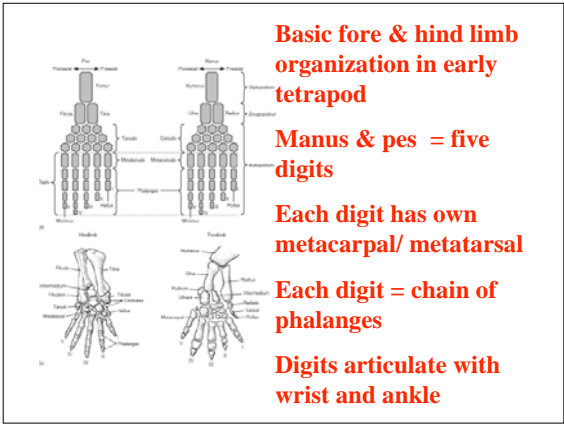
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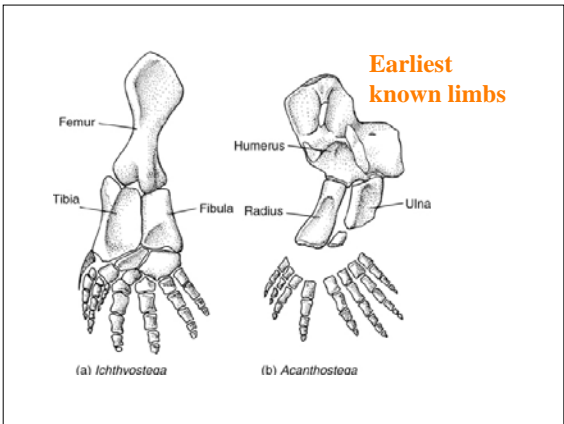
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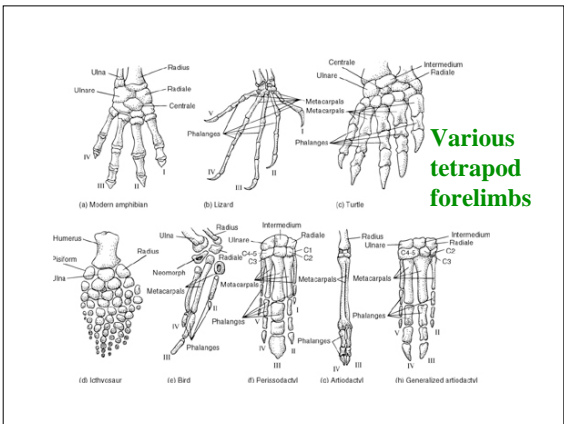
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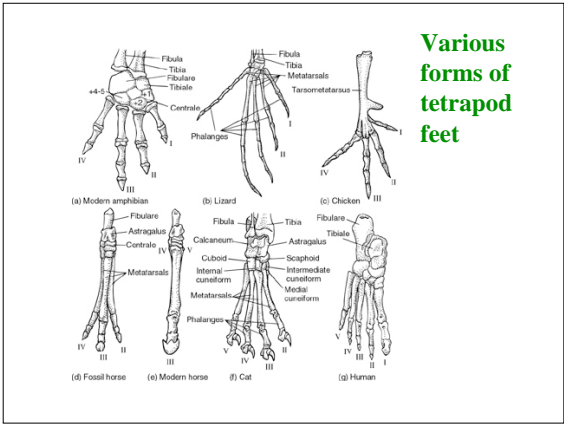
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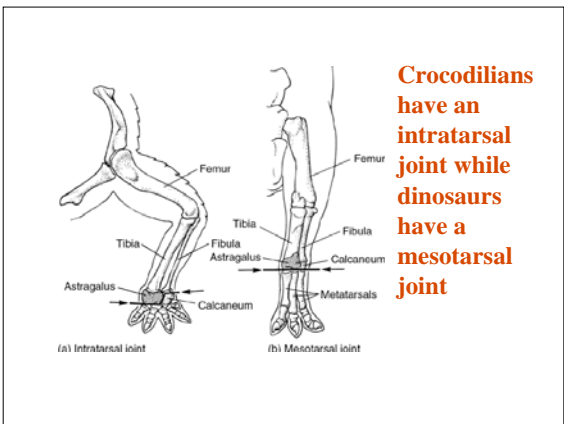
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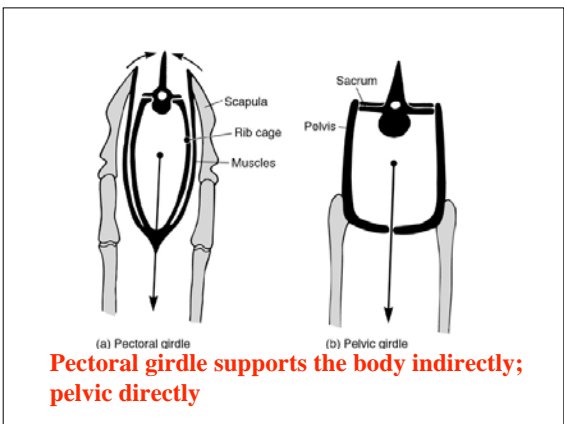
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