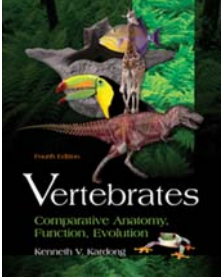


The McGraw-Hill Companies



Chapter 9

Image PowerPoint

Skeletal system: The Appendicular Skeleton

Swimming forms use axial locomotion while others use appendicular propulsion

Gravity must be exceeded to provide lift and overcome resistance of the body passing through the medium (=body drag)

Fish swim bladder gives additional buoyancy

Friction drag often greatest – fluid medium passing over skin

Muscle types differ for specialized function

Two main muscle fiber types:

- White muscle fibers – fast twitch**
- Deeper and more abundant**
- High gear – activated during bursts of speed – short levers = speed advantage**
- Muscle attachment angles vary to equalize mechanical advantage**
- This is why fishes have cone-shaped muscle segments**

Slow twitch red muscle fibers-

Superficial and lateral along body

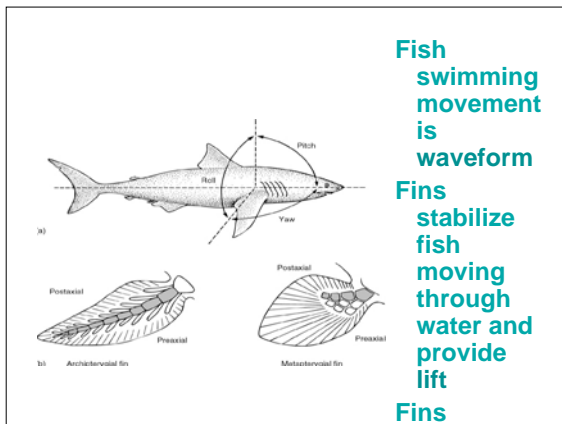
Low gear – used most of the time

Long levers – greater mechanical advantage

Pink muscle fibers – intermediate in speed, oxygen use and resistance to fatigue

Located medial to red band

As fishes grow muscle fiber length increases as does absolute swimming speed



Fish swimming movement is waveform

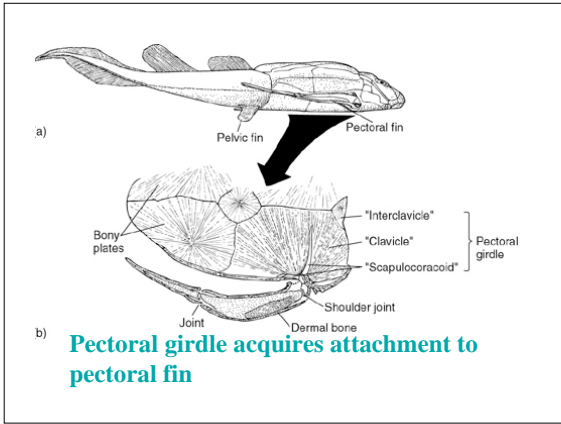
Fins stabilize fish moving through water and provide lift

Fins

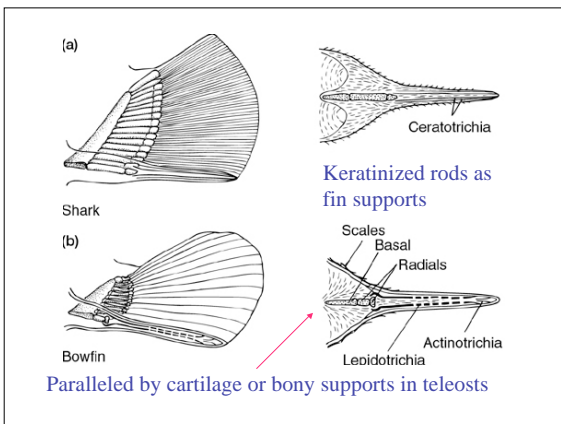
- Pectoral fins supported by pectoral girdles
- Pectoral girdle immediately posterior to head
- Dermal and endochondral bones
- Stabilized by connection to cranial dermal bones
- Animals that swim quickly have similar structure and body forms

More rigid bodies

More rigid and lunete tail shape



Large muscle masses
Tail with narrow peduncles where only tendons (no muscle bellies) cross
This fusiform body form present in many groups and through time
Sharks
Teleosts
Ichthyosaurs
Whales



Fin composition – pterygiophores, basals, radials and dermal fin rays

Morphological term	Forelimb	Hindlimb
Stylopodium	Upper arm	Thigh
Zyugpodium	Forearm	Shank (crust)
Autopodium	Manus (wrist-palm-fingers)	Pes (ankle-sole-toes)

Generalized terminology for designating limb regions in all tetrapods

Three directions in which a fish can move away from intended line of travel and how they are stabilized

Symmetrical longitudinal axis of fin

Asymmetrical fin axis

Gill arch theory of fin evolution (1850's)

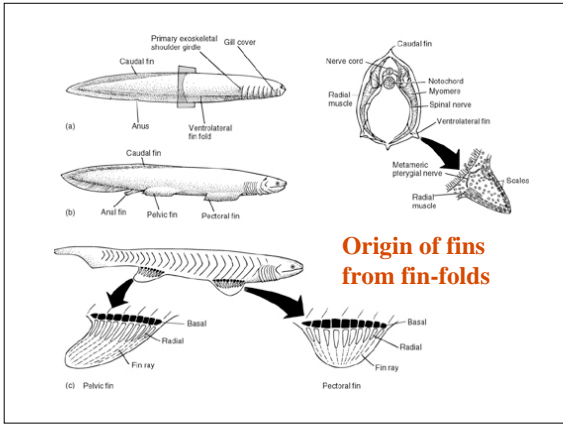
Gegenbauer – fins arose from gill arches

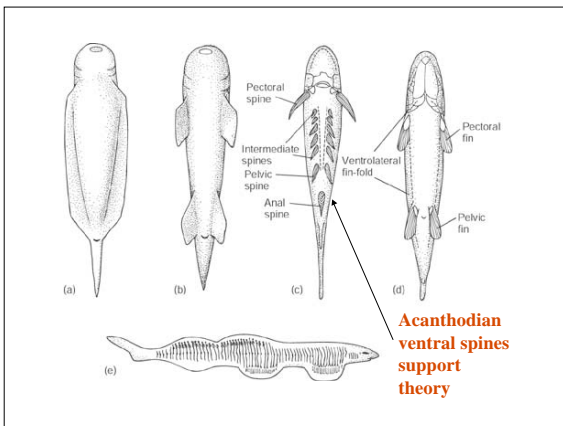
Derived from sharks and lungfish *Neoceratodus*

Fin fold theory same time

More support

Balfour and Thacher





Tetrapods need support out of water
Must replace buoyancy
Long period of evolutionary change and many limb forms
Amphibians were first terrestrial vertebrates
These and crossopterygians were transitional forms (intermediate forms for creationists)
Locomotion changes great
Wavelike body length muscular contractions and tail flips change to using waves to move shoulders and

