BIOMECHANICS AND SKELETAL SYSTEM

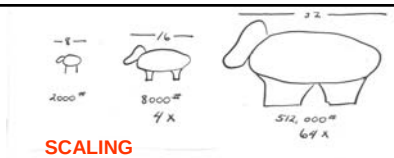
Physics and Biological Design

Statics--gravity

Dynamics--motion

General Capabilities of Supportive Systems

1) Accommodate Size Increases

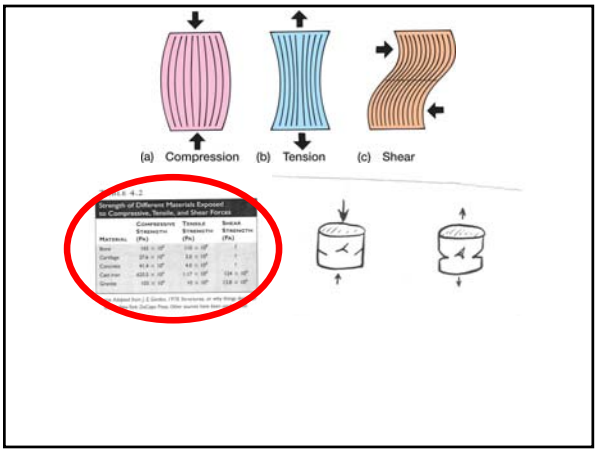


SCALING

General Capabilities of Supportive Systems
(continued)

1) Accommodate Size Increases

2) Accommodate Direction Force Application



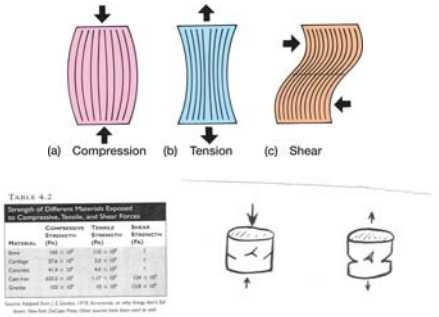
Compressive > Tensile > Shear

TABLE 4.2

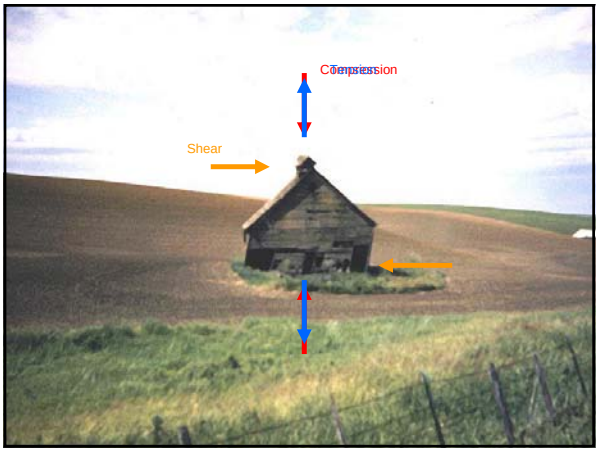
Strength of Different Materials Exposed to Compressive, Tensile, and Shear Forces

Material	Compressive Strength (Pa)	Tensile Strength (Pa)	Shear Strength (Pa)
Bone	165×10^6	110×10^6	?
Cartilage	27.6×10^6	3.0×10^6	?
Concrete	41.4×10^6	4.0×10^6	?
Cast iron	620.5×10^6	1.17×10^6	124×10^6
Granite	103×10^6	10×10^6	13.8×10^6

Source: *Adapted from J. E. Gordon, 1978. Structures, or why things don't fall down, New York: DaCapo Press. Other sources have been used as well.*

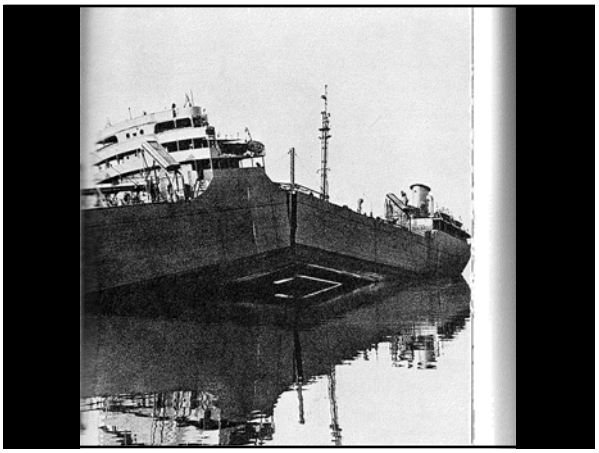


St. Paul



If bone is so strong, then how does it break?

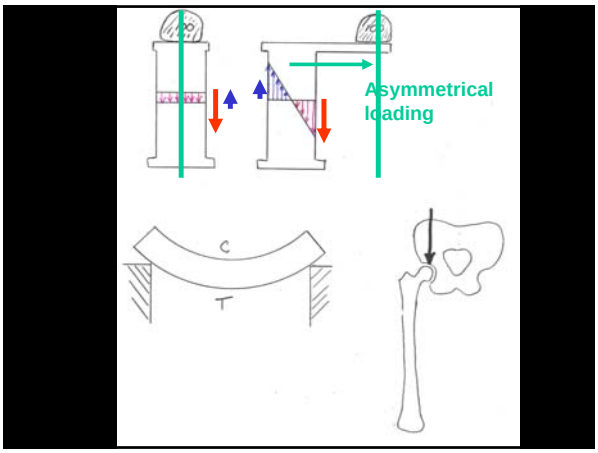
1) Stress concentration

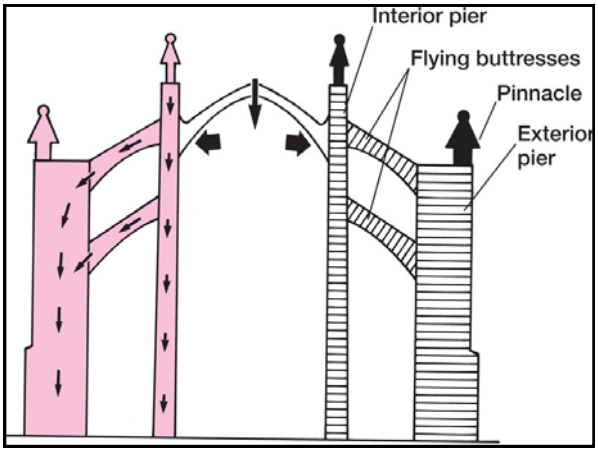


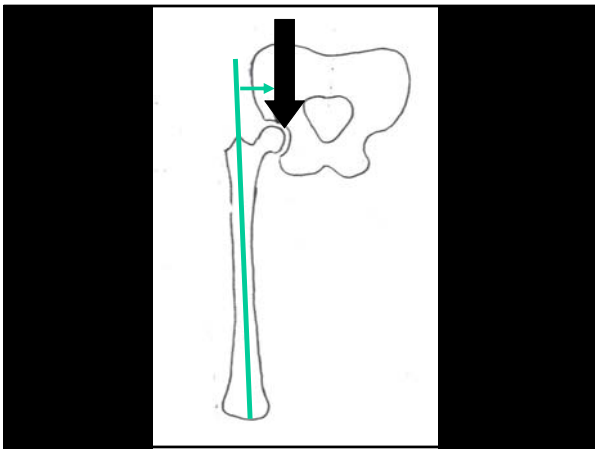
If bone is so strong, then how does it break?

1) Stress concentration

2) Loading

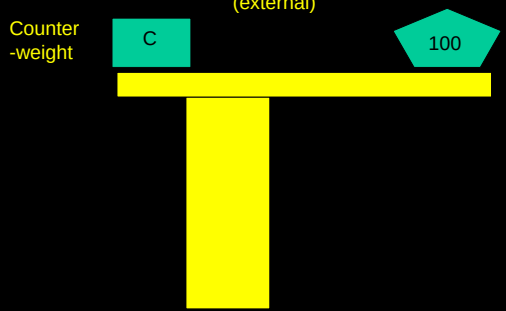


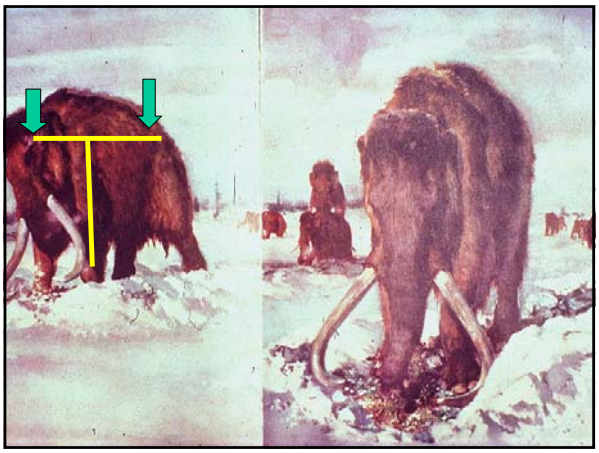




Ways to Prevent Breaks

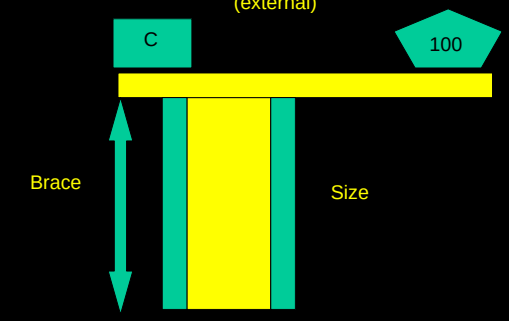
(external)

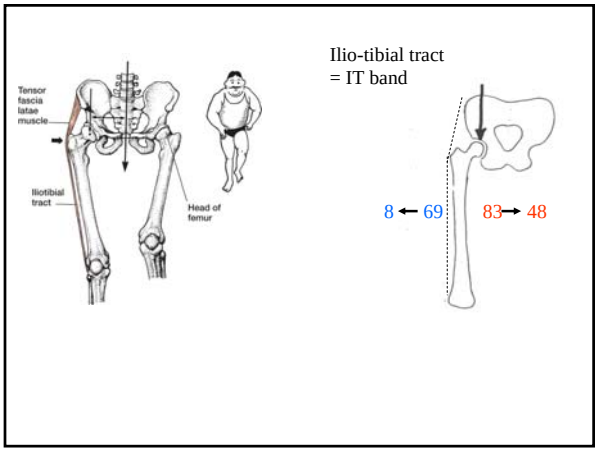




Ways to Prevent Breaks

(external)





General Capabilities of Supportive Systems

(continued)

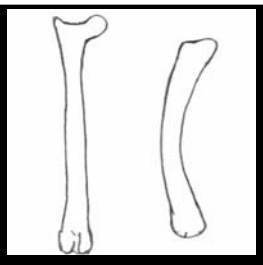
1) Accommodate Size Increases

2) Accommodate Direction Force Application

3) Duration of Force Application

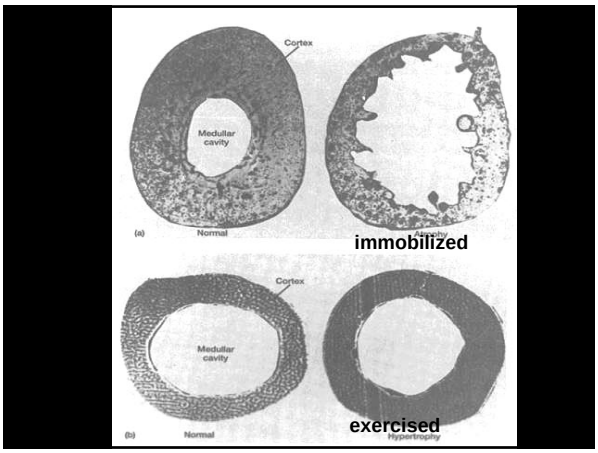
Duration of Force Application

- Continuous → Atrophy
  - aneurism, tumor, dislocation
- Unstressed → Atrophy
  - weightlessness
- Intermittent → Hypertrophy



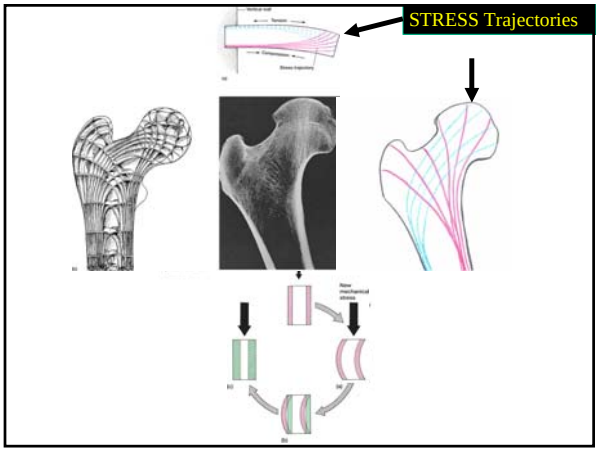
Intermittent Experimental

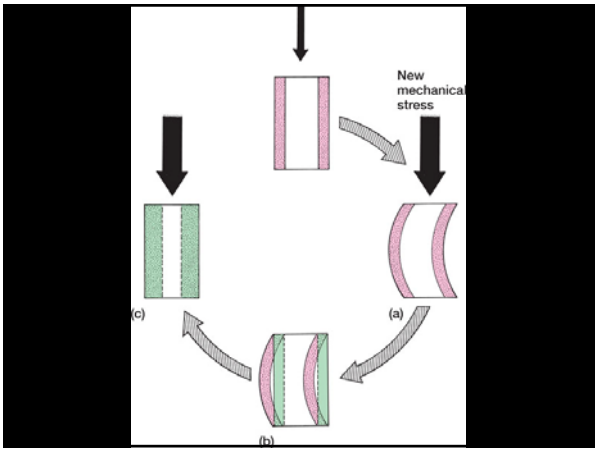
Intermittent Experimental

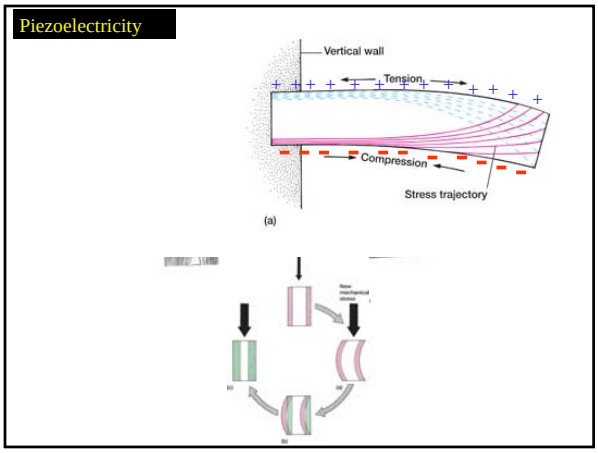


Internal

Response of Bone to Mechanical Factors

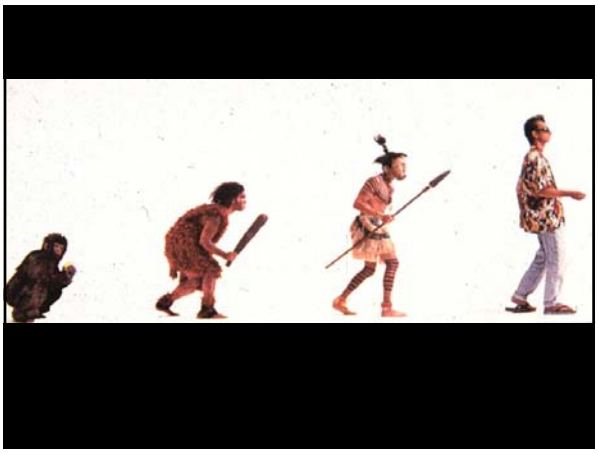




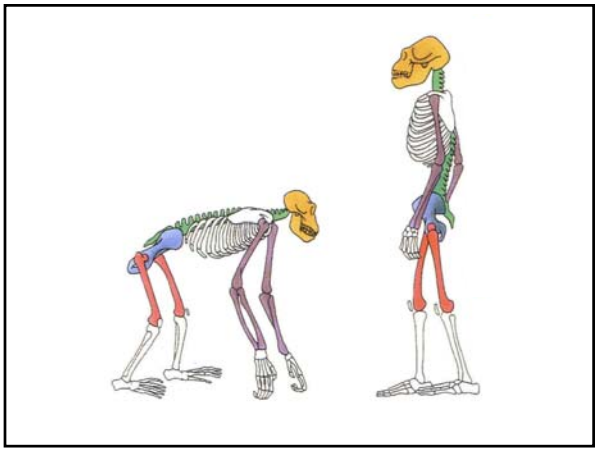


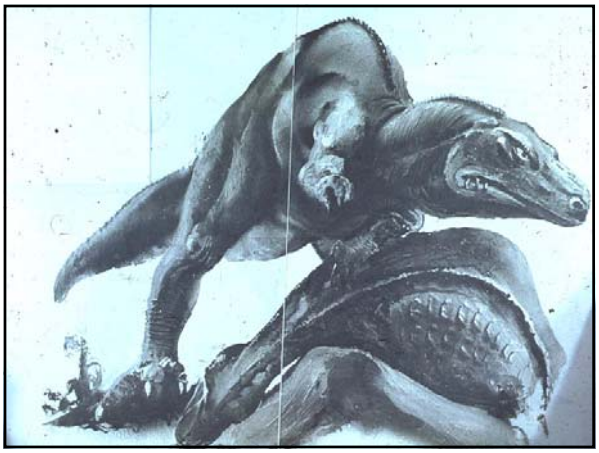
Quick Summary

- Environment of forces affect design
- Physiological response of bone to forces
- Next,
  - Evolutionary response of skeletal system

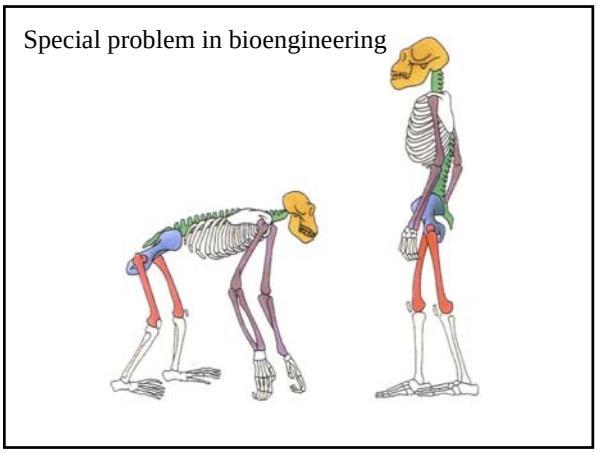


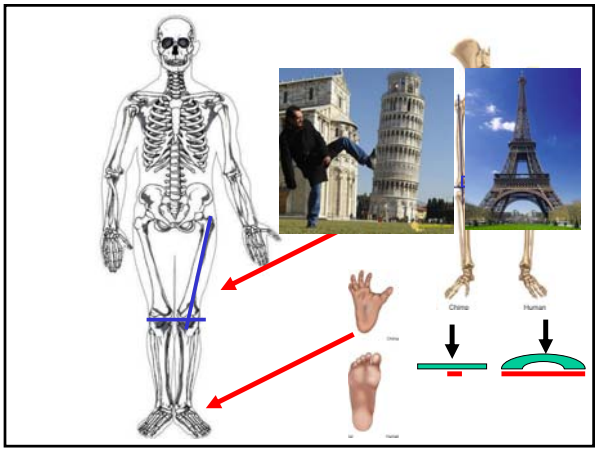
Bipedal Locomotion

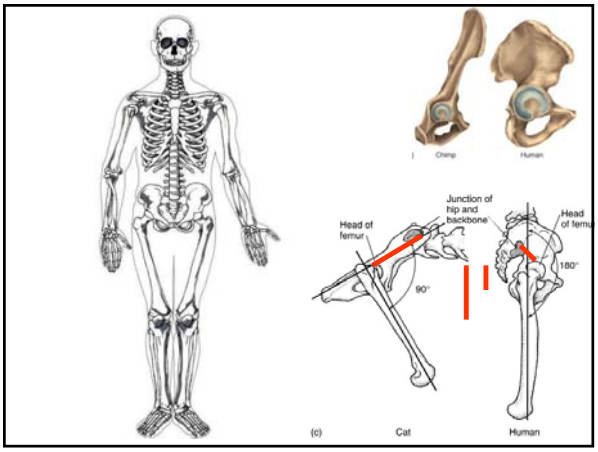


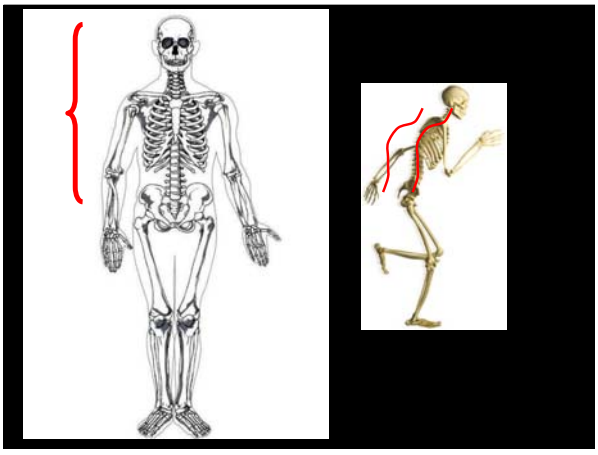


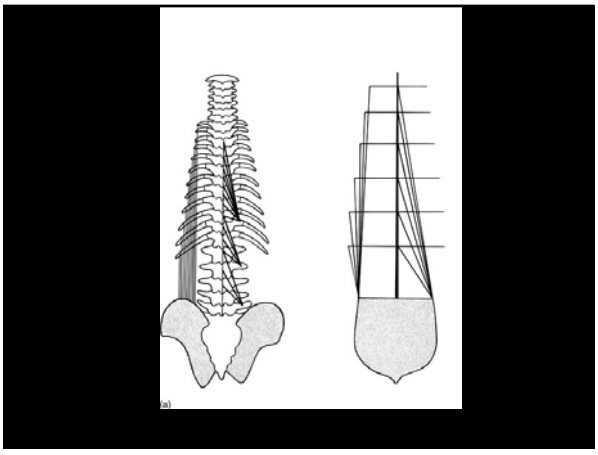
Special problem in bioengineering

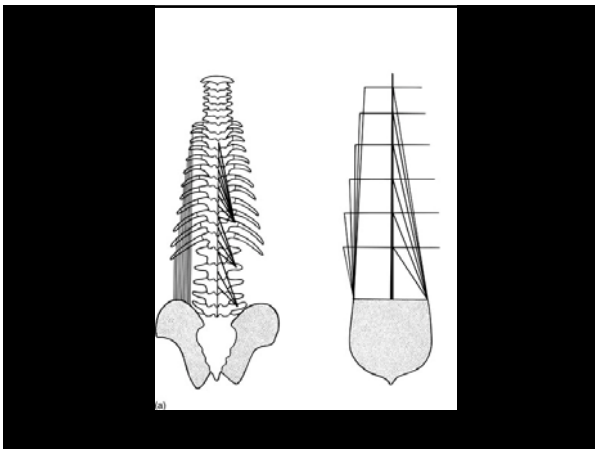


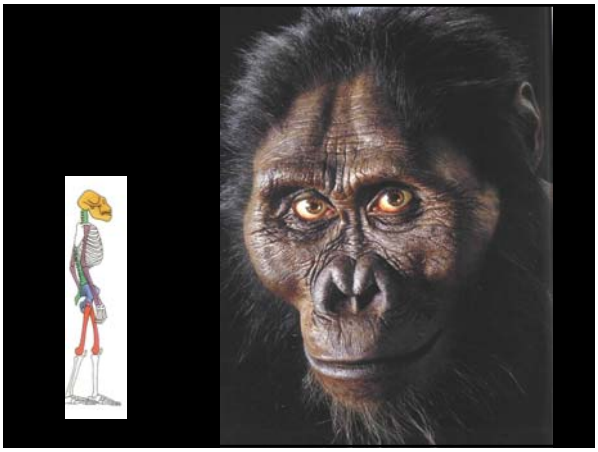




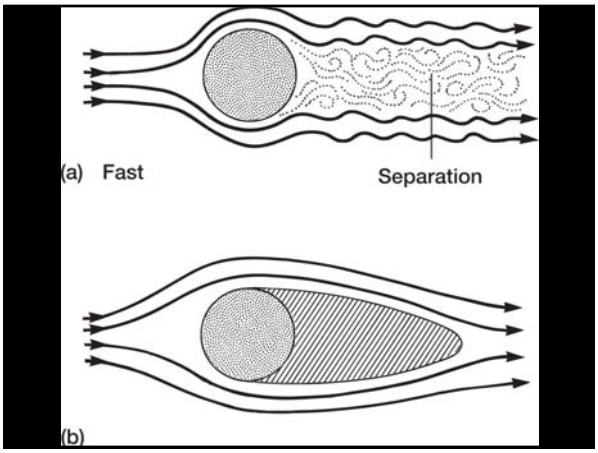


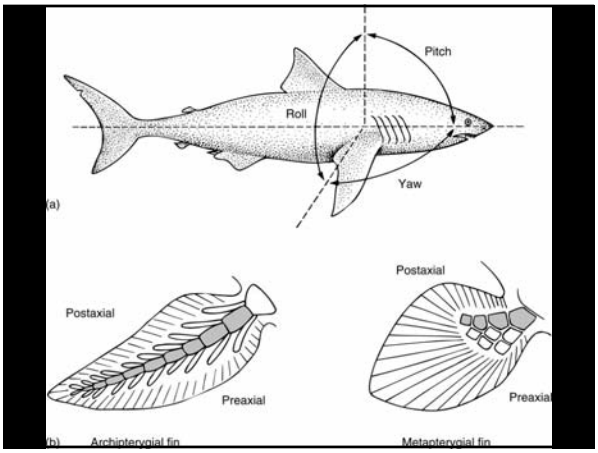






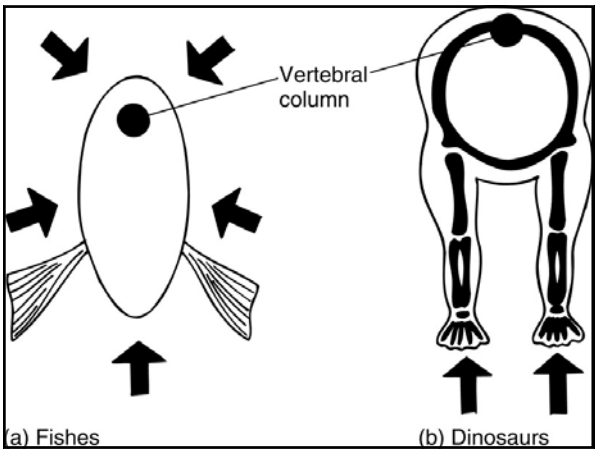
SUSPENSION SYSTEM

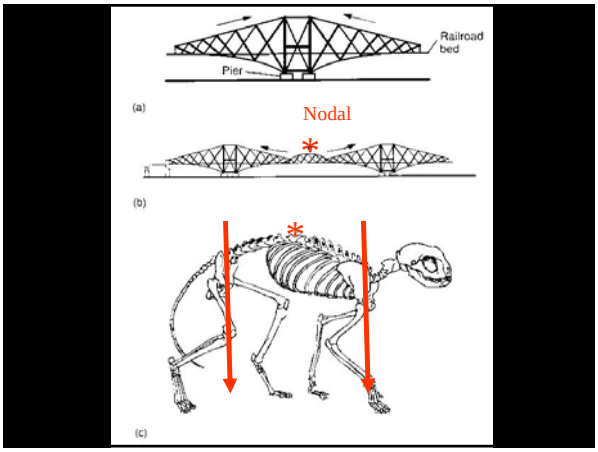


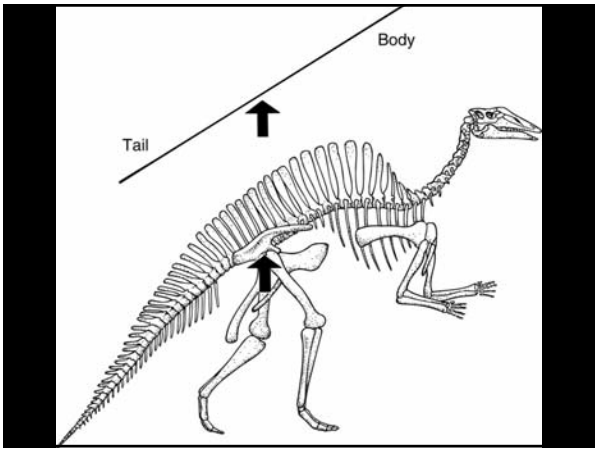


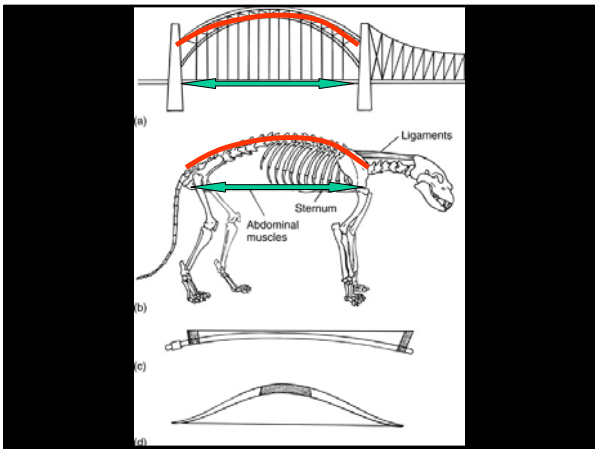
SUSPENSION SYSTEM

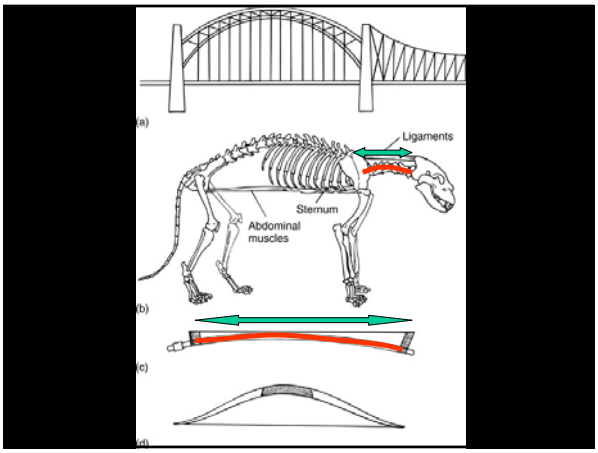
Static Support





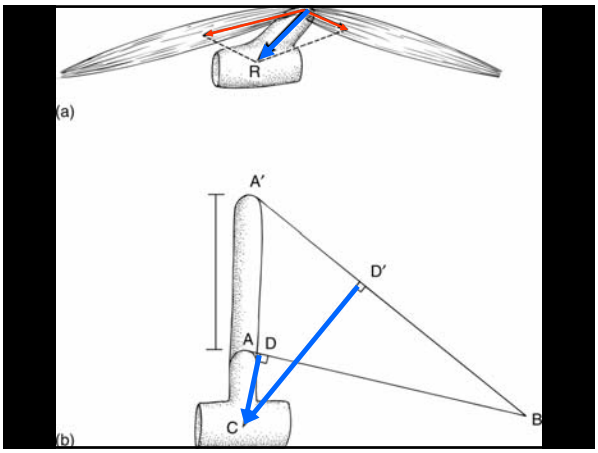


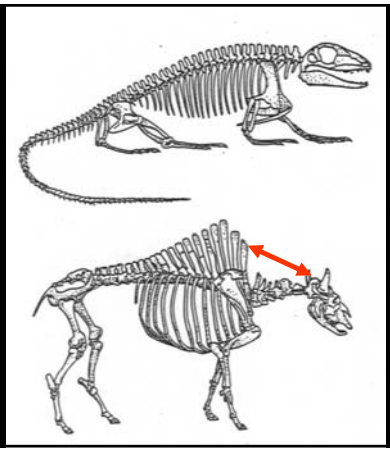




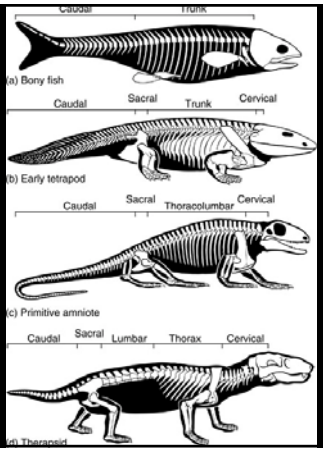
SUSPENSION SYSTEM

Form and Function of the Vertebral Column





Differentiation



Vertebral Column