

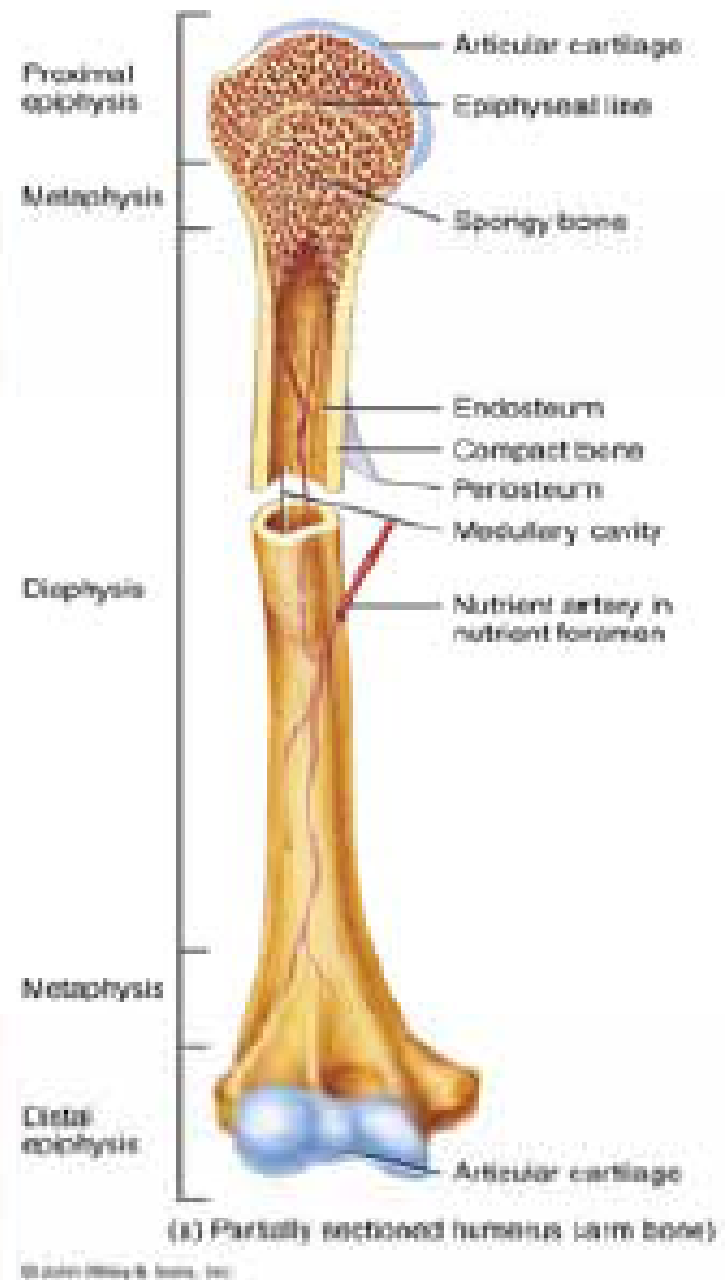
Section 17: Structure of Bone

Some Purposes of Bone

- Provides mechanical support
- Produces red blood cells
- Protects internal organs
- Provides rigid mechanical links and muscle attachment sites
- Facilitates muscle action and body movement
- Serves as active ion reservoir for calcium and phosphorus

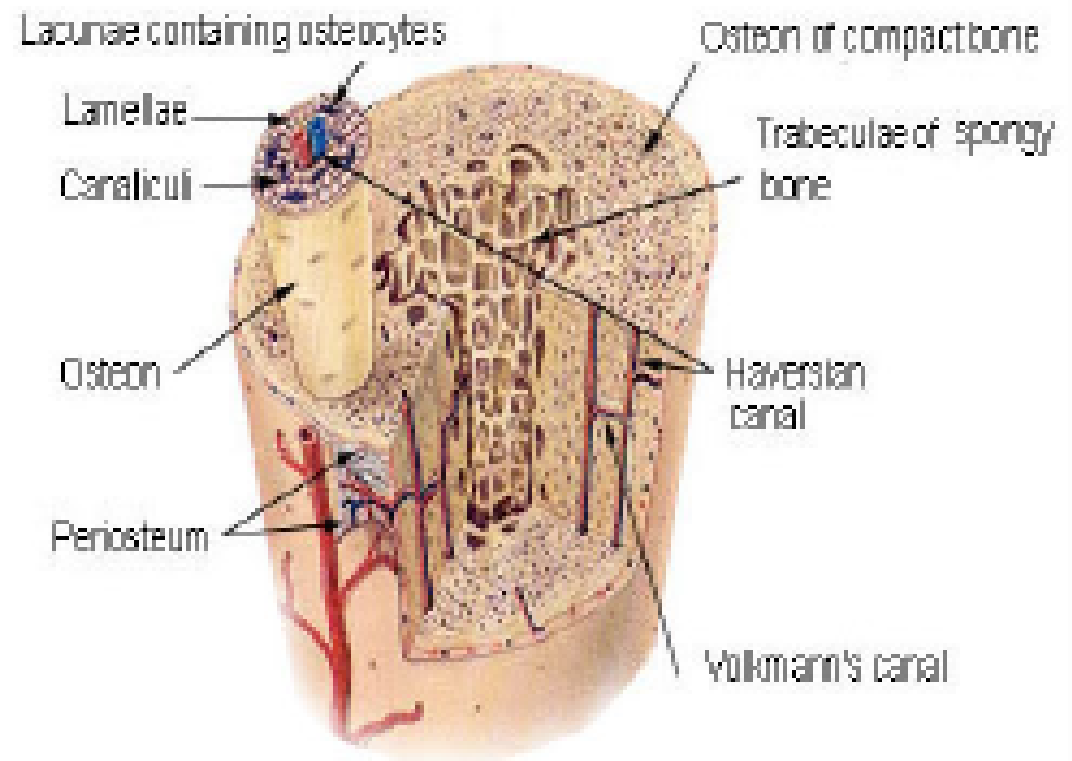
Skeletal structure

- Skeletal system contains 4 types of tissue:
 - cartilage
 - osseous tissue
 - bone marrow
 - periosteum/endosteum



Bone Structure

- Bones are organs. Thus, they're composed of multiple tissue types. Bones are composed of:
 - Bone tissue (a.k.a. osseous tissue).
 - **Fibrous connective tissue.**
 - **Cartilage.**
 - **Vascular tissue.**
 - Lymphatic tissue.
 - **Adipose tissue.**
 - **Nervous tissue.**



Bone Cells

Osteocyte: a bone cell

Osteoblasts: specialized cells that form new bone tissue

Osteoclasts: specialized cells that resorb existing bone tissue

Under normal circumstances the activity of these cells is balanced

Bone Tissue

Calcium compounds

- **60-70% of bone weight**
- **Provide stiffness and strength**

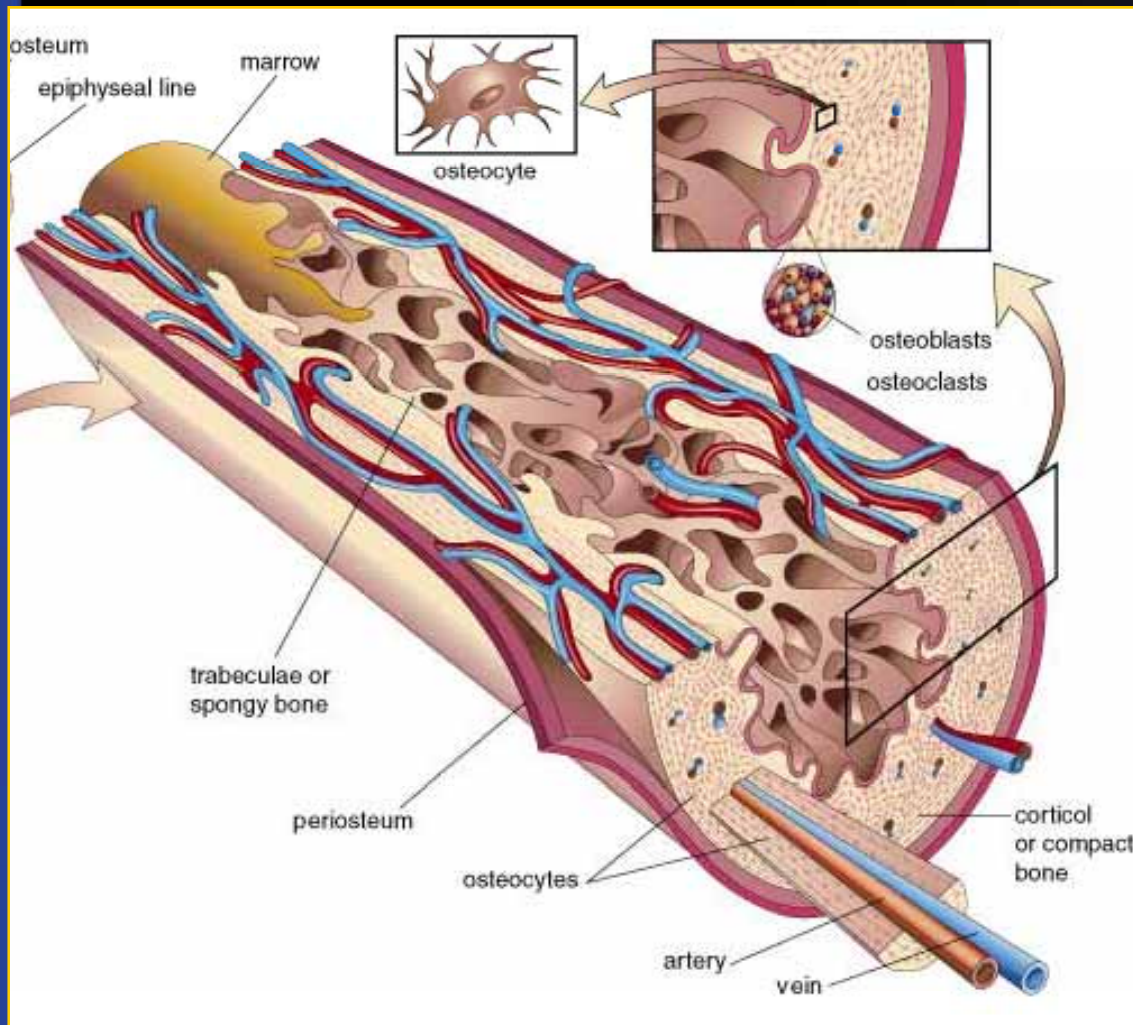
Collagen

- **Flexibility**
- **Tensile strength**

Water

- **25-35% of bone weight**
- **Important to bone strength, especially in withstanding compressive forces and maintaining bone health**

Bone

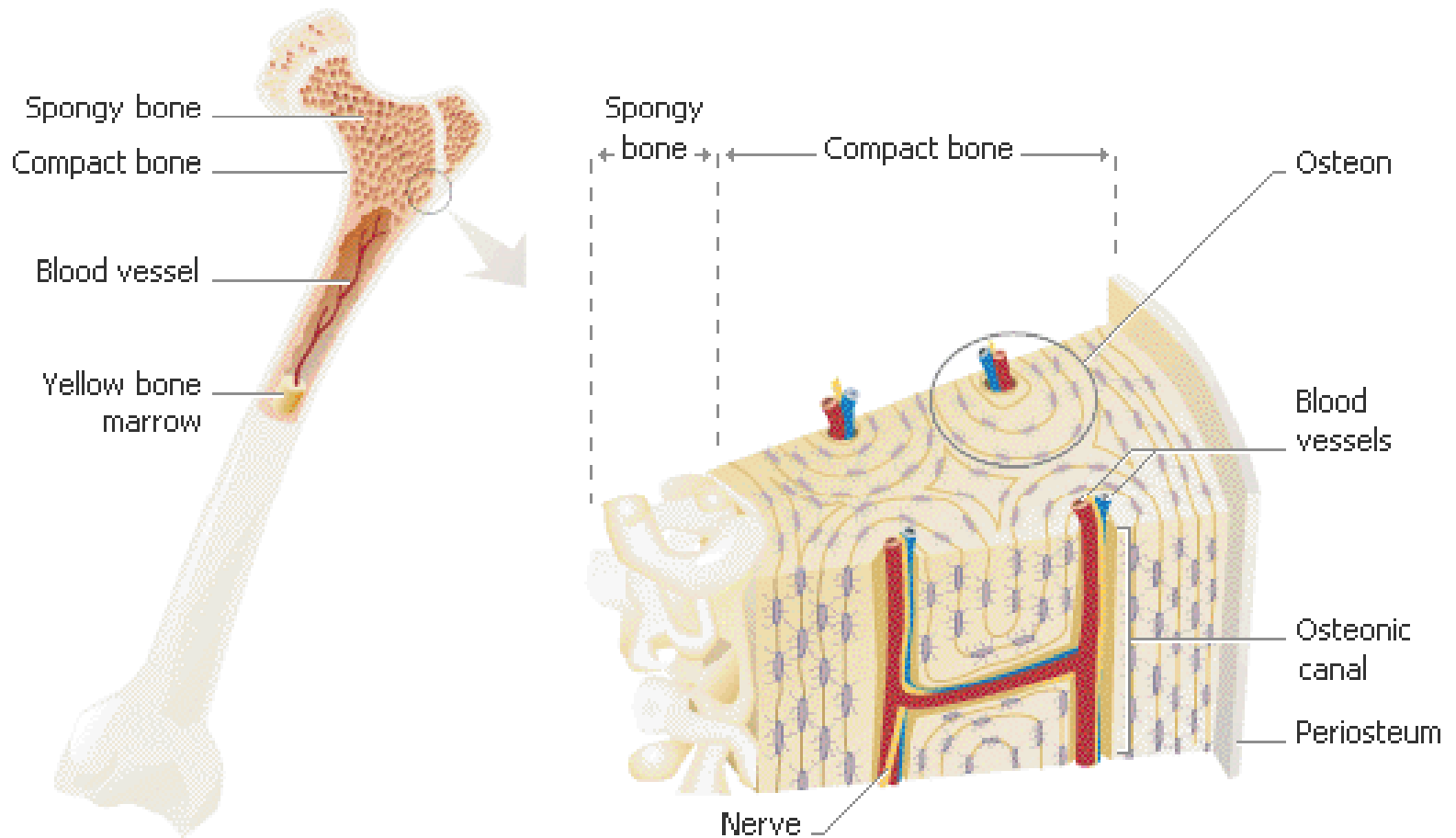


Human bone is primarily comprised of **compact** bone and **spongy** bone.

Some bones have at their center a **medullary cavity** containing bone marrow.

Basic Structural Components of Bone:

- Compact (Cortical)
- Spongy (Cancellous, or Trabecular)

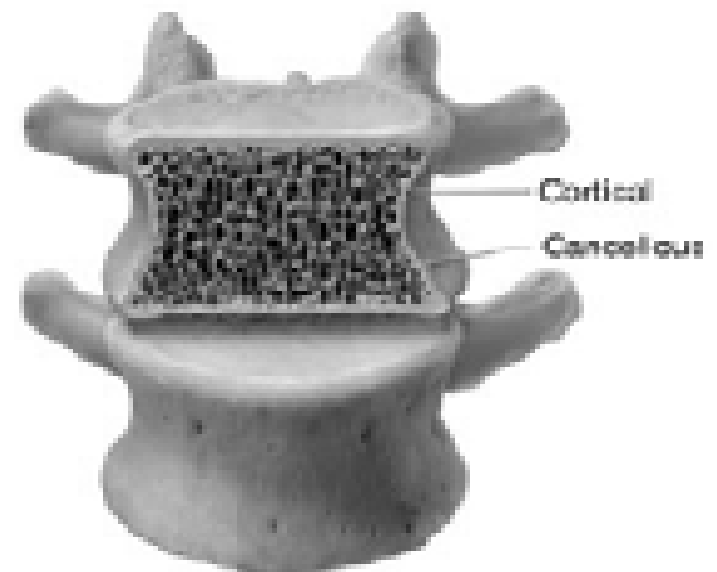


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Bone Architecture

Two architectures (classified by porosity) are also related to function:

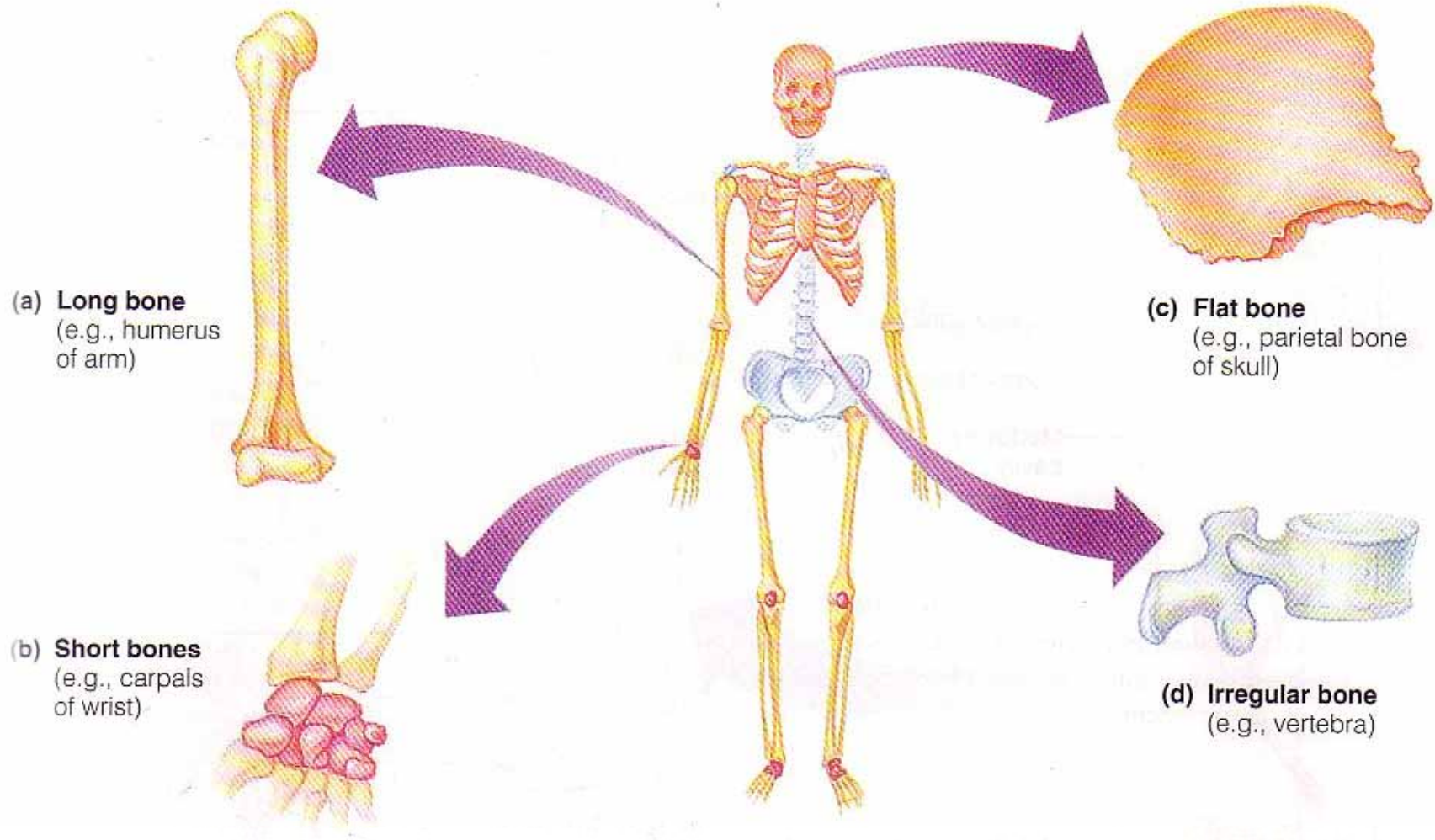
1. **Cortical, or compact, bone is 5-30% porous**
2. **Cancellous, trabecular, or spongy, bone is 90% porous**



Cortical vs. Cancellous Bone

- Cortical bone stiffer, withstand greater stress but less strain before failure
- Cancellous bone fractures when strain exceeds 75%
- Cortical bone fractures when strain exceeds 2%
- Cancellous bone has larger capacity to store energy

Types of Bones



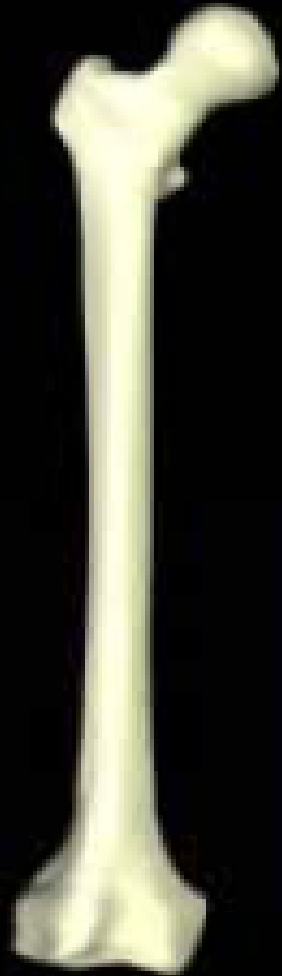
(a) **Long bone**
(e.g., humerus
of arm)

(c) **Flat bone**
(e.g., parietal bone
of skull)

(b) **Short bones**
(e.g., carpals
of wrist)

(d) **Irregular bone**
(e.g., vertebra)

Classification of Bones: By Shape



- Long bones – longer than they are wide (e.g., humerus)



Figure 8.2a

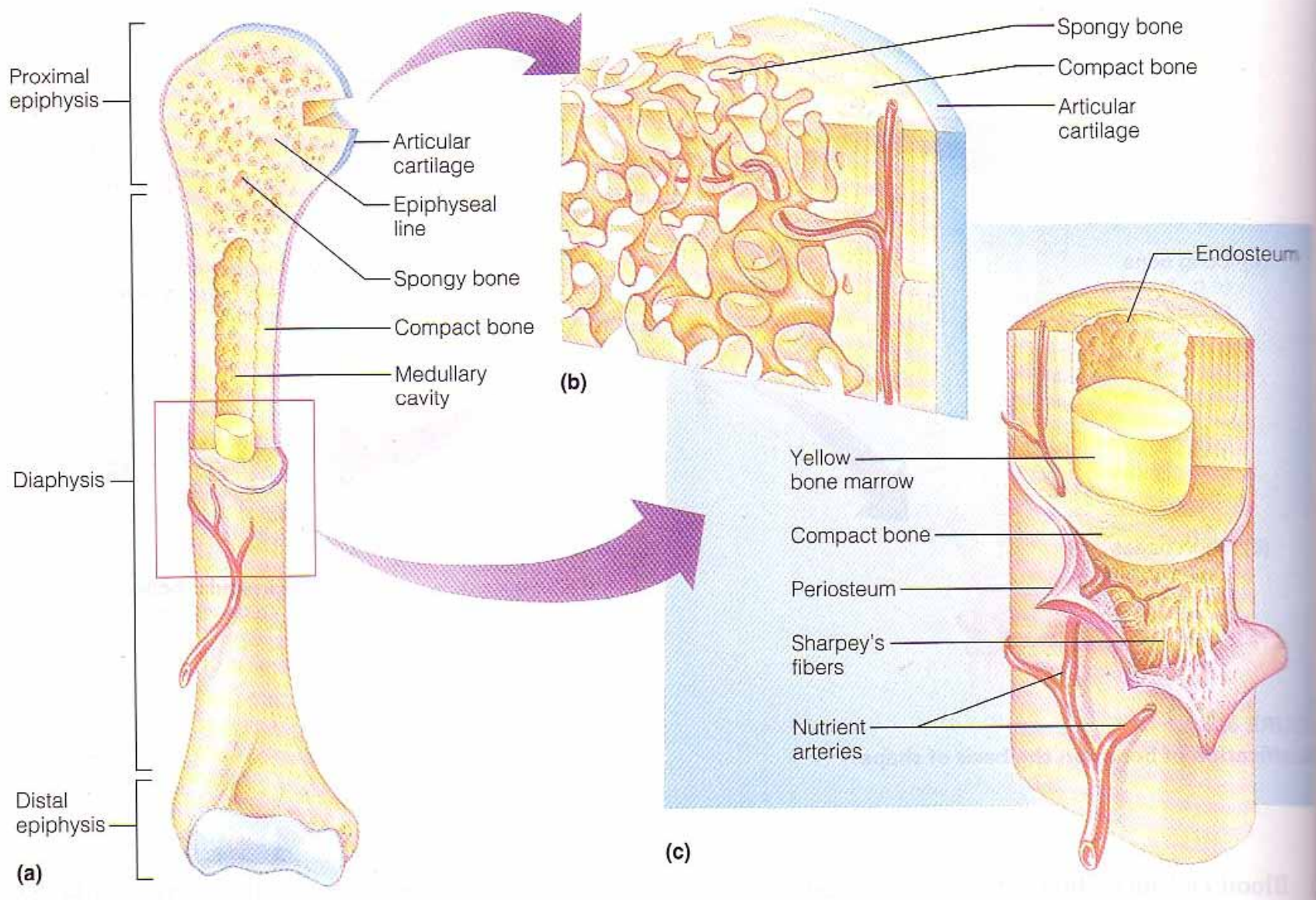
Example of the long bone

■ 2 types of materials :

- ◆ Cortical bone
- ◆ Cancellous bone (trabecular bone)
- ◆ Orientation of the bone cells according to the stresses



Figure 1.3. Coupes transversales de l'humérus (os du bras). Le corps ou diaphyse d'un os long est un cylindre d'os compact ; la cavité médullaire contient de la moelle osseuse rouge ou jaune ou une combinaison des deux.



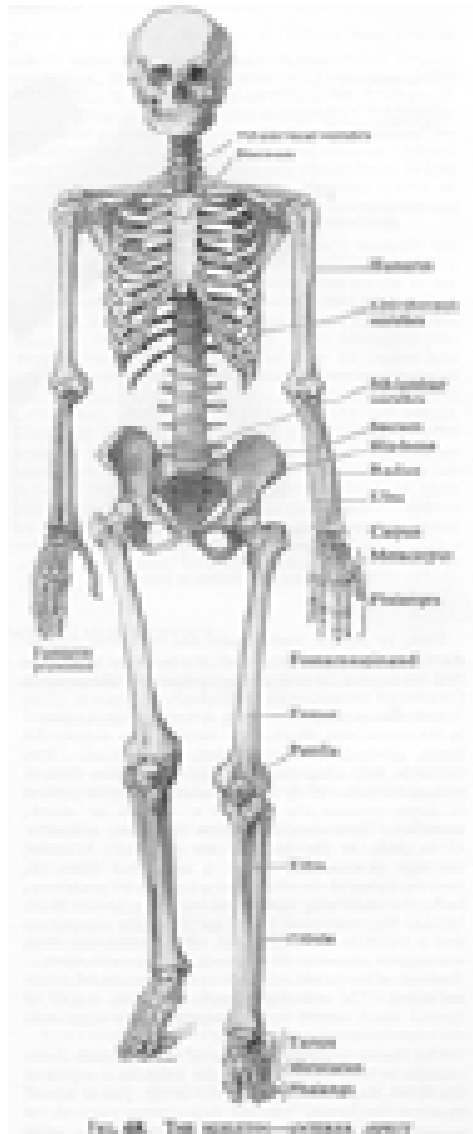
17-14

From: Garner

Marieb, 1997

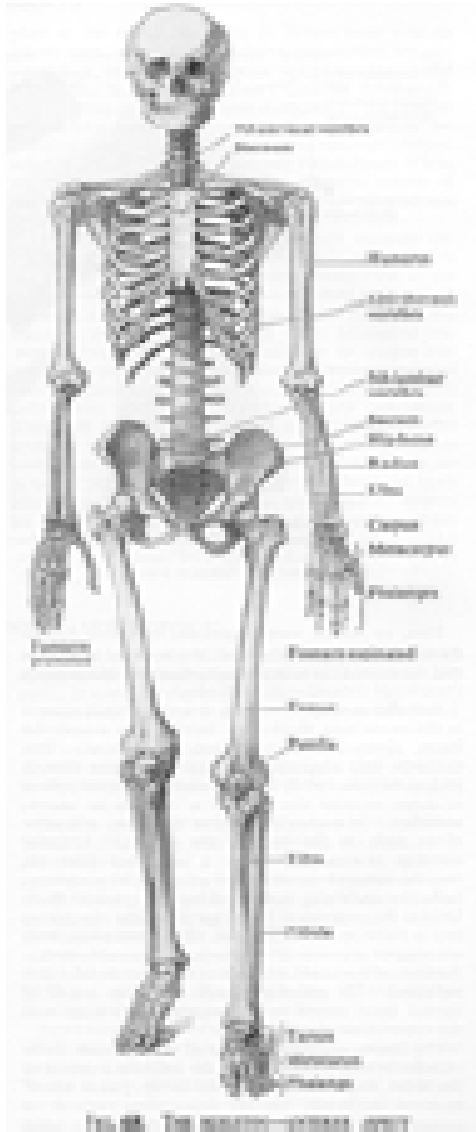
Table 2.3.3 Selected physical properties of bone based on data from Yamada (1970); Burstein et al. (1976); Noyes et al. (1984); and Ascenzi and Bonucci (from Martin and Burr, 1989, with permission of Williams & Wilkins, Baltimore, Maryland).

VARIABLE	COMMENT	MAGNITUDE	UNIT
DENSITY	cortical bone	1700-2000	kg/m ³
	lumbar vertebra	600-1000	kg/m ³
	water	1000	kg/m ³
MINERAL CONTENT	bone	60-70	%
WATER CONTENT	bone	150-200	kg/m ³
ELASTIC MODULUS (TENSION)	femur (cortical)	5-28	GPa
TENSILE STRENGTH	femur (cortical)	80-150	MPa
	tibia (cortical)	95-140	MPa
	fibula (cortical)	93	MPa
COMPR. STRENGTH	femur (cortical)	131-224	MPa
	tibia (cortical)	106-200	MPa
	wood (oak)	40-80	MPa
	limestone	80-180	MPa
	granite	160-300	MPa
	steel	370	MPa



Skeletal System: Mechanical Functions

- Leverage/Attachment sites for muscle
- Support
- Protection

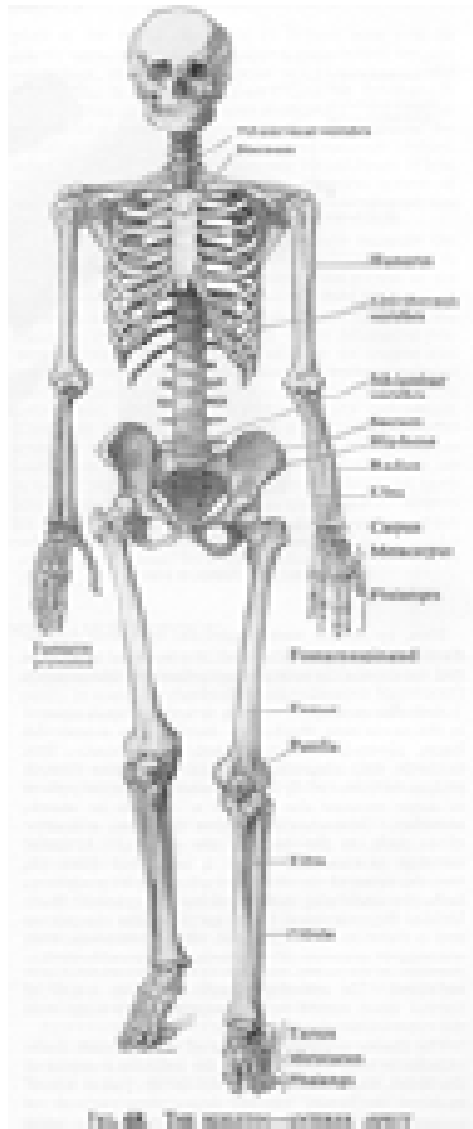


Skeletal System: Mechanical Functions

Leverage: provides levers (simple machines that magnify force or speed of movement) and axes of rotation about which the muscles generates movement

- **The levers are the long bones**
- **The axes are the joints**

Recall how these concepts relate to mechanical advantage



Skeletal System: Mechanical Functions

Support: provides a support structure which aids in maintaining upright posture, and to which the muscular system attaches

Protection: provides protection for internal organs