Structure and Function of Bone

Introduction

Kinesiology – study of human movement

- Anatomy
- Process of movement

Biomechanics – study of mechanical principles' function

These concepts will help you understand why, how, and what happens when we move.

Skeletal System Basics

Skeletal system structure:

- Bones
- Joints
  - Articulation – where bones connect at joint
- Connective tissues
  - Bones don't have enough room to attach all the muscles, so membranes and ligaments expand the system, allowing muscles to attach.

Musculoskeletal system formed by muscles and bones

An endoskeleton is an internal support structure – our bodies grow around it. An exoskeleton is an external support structure. An exoskeleton cannot grow at the same rate as the body and periodically needs to be shed, whereas growth is accommodated easily with an endoskeleton.

It is important for us to learn the skeletal system because muscles attach to bones; learning the names, functions, and various landmarks of the bones first helps in locating the muscles.

Main Functions of the Skeletal System

Supports soft tissues and serves as framework for entire body

Provides attachment points for muscles, ligaments

Protects delicate internal organs

Serves as levers to provide movement

Bones act as simple machines (levers) in that the force applied to one end of the bone rotates the bone in the opposite direction.

Stores calcium, phosphorus, other minerals for release to body

Stores lipids in marrow for energy

Produces blood cells in the red marrow

Erythrocytes, platelets, and leukocytes are manufactured in human red marrow.

As the skeleton matures, fat-storing yellow marrow displaces red marrow in the long bones.

Bones

All bones have the same fundamental cells and matrix.

Composed of osseous tissue

Two-thirds inorganic, one-third organic

Piezoelectric quality

- Collagen in bones deforms and vibrates when electric currents pass through it.

The adult body contains 206 bones, although individuals might have more or fewer sesamoid bones, and some people have an extra rib.

When stretched, twisted, or compressed, bone produces minute electric currents; the strength and direction of these currents change with the direction of the stress load. It is helpful for the massage therapist to work this to the advantage of the client during bodywork.

Bone Structure

Common attributes of all bones:

- Rigid matrix
- Articulation with other bones
- Connective tissue structure (periosteum)
- Growth of new bone matrix and remodeling responsible for shaping bones

The structure and function of bones are connected intrinsically.

Bones remodel themselves constantly, and the skeletal system is one of the more dynamic systems in the body.

Bone Tissue

Compact (dense) bone

- Compact arrangement of hard inorganic matrix
- Makes up the main shaft of the long bones and the outer layer of all bones

Spongy (cancellous) bone

- Larger spaces within bony matrix = lighter weight than compact bone
- Made of an irregular meshing of small, bony plates called trabeculae

Compact bone protects spongy bone and provides the firm framework of the bone and the body.

Spongy bone is found at the ends of the long bones or at the center of all bones except the shafts of long bones.

Bone Marrow

Red – manufactures blood cells

Yellow – mostly fat found mainly in the central cavities of the long bones

Red marrow is found at the end of long bones and at the center of other bones of the thorax and pelvis.

Periosteum and Endosteum

Periosteum

- Membrane covering bones (except ends that form joints)
- Contains osteoblasts, blood and lymph vessels, and nerve fibers

Endosteum

- Thin, connective tissue lining marrow cavity
- Contains cells that aid in growth and repair of bone tissue

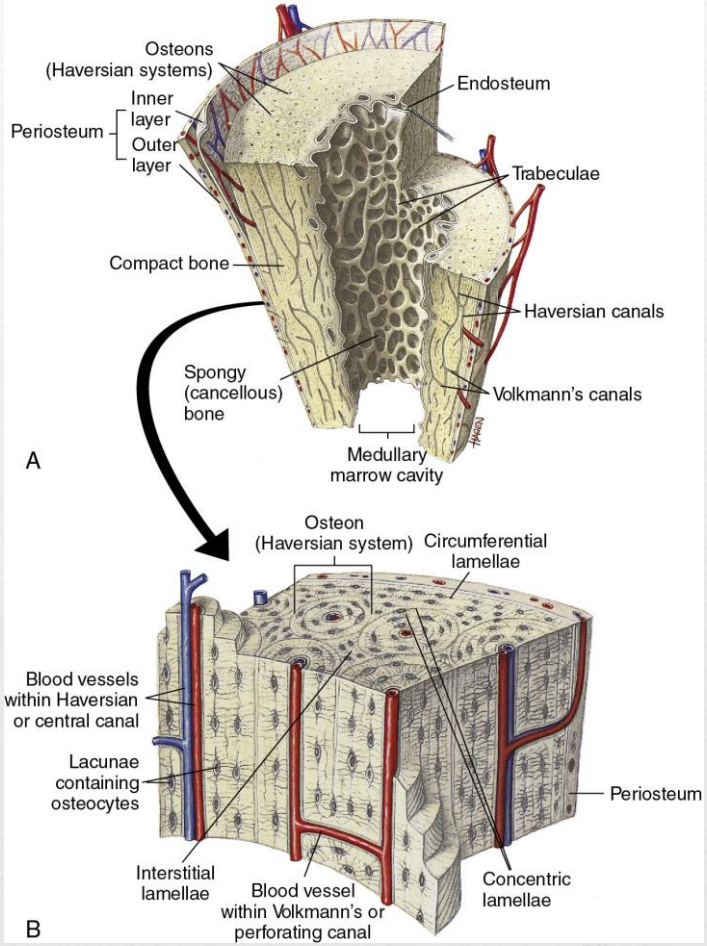
Osteoblasts are essential to bone formation during periods of growth and in the repair of bones.

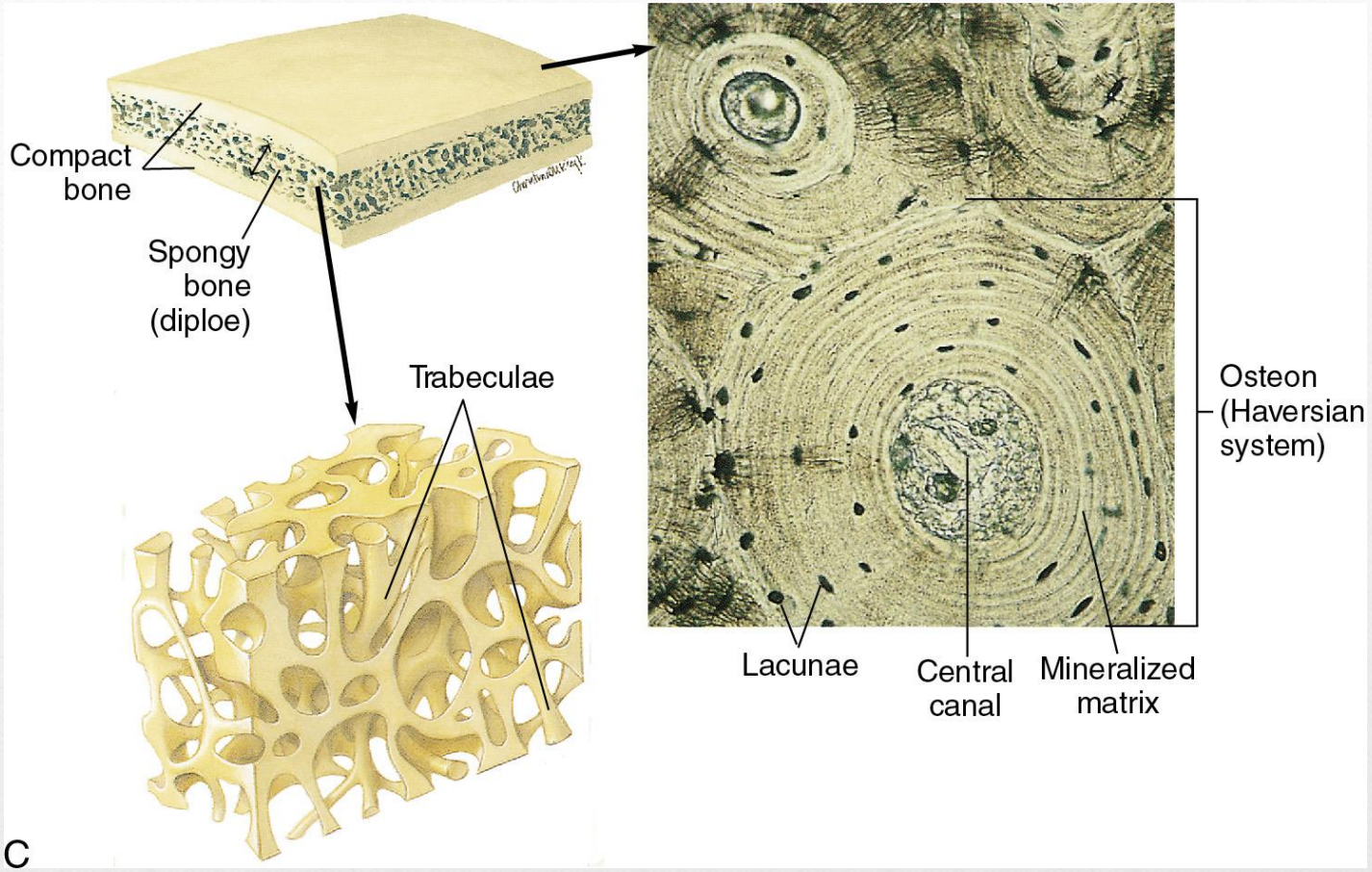
In addition to blood and lymph vessels, the periosteum has nerve fibers that alert the person to trauma, such as a blow to the shin or a fractured arm.

Structure of Compact and Cancellous Bone

A, Longitudinal section of a long bone showing cancellous and compact bone

B, Magnified view of compact bone





This illustrates a section of flat bone. Note how outer layers of compact bone surround cancellous bone.

Bone Development

Begins in the second month of prenatal growth

Calcification takes place just after birth.

Ossification process

- Chondroblasts (cartilage-forming cells) create the cartilage model of bones.
- Osteoblasts (bone-building cells) develop the bone tissue from the cartilage model.

Ossification is the process that creates our skeleton. First, chondroblasts create the cartilage model for bone; then osteoblasts build the bone according to the model.

Articular Cartilage

Tough, flexible connective tissue with a high water content

Softer than bone

Smooth, slippery, porous, and malleable

Integral component of synovial joint

Recall that cartilage forms the skeletal framework in the fetus. In the adult the only remaining cartilage in bone is called articular (or hyaline) cartilage.

Articular cartilage is "massaged" by synovial fluid during joint movement. The degenerative process of arthritis involves the breakdown of articular cartilage.

Ligaments

Bundles of parallel connective tissue fibers, primarily collagen

Connect bones and stabilize the joints

Can also serve as muscle attachment sites

Poor vascularization leads to longer healing time.

Ligaments are not typically elastic, nor do they have much stretch.

Some joint positions place ligaments under tension, whereas other positions slacken them.

Bone Growth and Repair

Bones grow faster during puberty due to the influence of estrogen and testosterone, then stop in late teens or twenties.

Bones widen and lengthen over time.

Stages of fracture healing:

- Hematoma formation
- Cellular proliferation
- Callus formation
- Ossification
- Remodeling

Children are more flexible than adults because children have more cartilage and soft bone cells, whereas in adults, bone cells outnumber cartilage.

Skeletal Changes Caused by Aging

Bones may become brittle.

Loss of calcium starts earlier in women.

Bone fractures heal more slowly as we age.

Average person loses half an inch of height every 20 years.

- Vertebral bodies lose height.

Shapes of Bone

Flat: ribs and skull bones

Irregular: vertebrae and scapula

Long: femur and ulna

Short: metacarpals

Cube-shaped: carpals, tarsals

Sesamoid bones: patella

Irregular bones are those with complex shapes that occur as two or more forms within the same bone structure. The vertebrae may be the best-known examples.

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