Bones

Osteocytes :

- Are responsible for maintenance of bones
- Present in lacunae, and send processes.
- Unable to divide.

The division of bones anatomically is : long, short, irregular, flat and sesamoid.

The long bones have proximal epiphysis, distal epiphysis, proximal metaphysis, distal metaphysis and a shaft which is the diaphysis.

Types of bones:

1. Compact bones, hard or haversian bone.
2. Spongy, non-lamellated or cancellous bones.

The bone is always is surrounded by periosteum, composed of two layers:

A. An outer layer which is fibrous.
B. An inner region which is cellular and contains undifferentiated cells

(the book calls these undifferentiated cells osteogenic or osteoprogenitor).

If they differentiate into bone cells then they were originally osteoprogenitor cells, but they will be probable able to differentiate into other types of cells, ex: chondroblasts, fibroblasts and others.

Bone cells:

1. Osteoblast:
    - present on the surface of bones, responsible for laying down of bones.
2. Osteocytes:
    - is responsible for maintenance of bones
    - Present in lacunae.
    - When they are in the lacunae they send processes which pass through cannaliculae.
    - They are interconnected with each other, at the site of contact between them is gap junctions (allowing the passage of certain elements of nutrients from one cell to another).

- In the hard bones, the osteocytes are arranged around a haversian canal and the whole structure is called haversian system.
- They are unable to divide, but when needed as in case of fracture, the revert into osteoblasts and osteoblasts will divide and start laying down new bones, then it will differentiate or become more mature, then it is called osteocytes.

3. Osteoclast:
    - Is originally a monocyte, more than one monocytes which fuse together forming one large cell.
    - It's function is resorb the bone, it's a bone eater.
    - Is present on the surface of the bone and this is what keeps the shape of bone in general.

Ossification: we have two types of ossification

1. Endochondral ossification: where there is a cartilaginous model and on top of this cartilaginous model, the process of ossification starts.

    The inducer of this type are blood vessels; which elevates the level of oxygen inside it, and in this case (ex: when the level of oxygen is elevated, the undifferentiated cells will differentiate into osteoblasts).

    We have different zones: ossification, calcification, hypertrophy, proliferation and the resting zone.
    Then we have a secondary ossification center, what is left is cartilage inside bone is epiphyseal growth plate, which is just above the metaphysis in the region of the metaphysis of the bone above and below, we have epiphysis.
    As long as we have epiphyseal growth plate, the bone is liable to grow more and more, but if the epiphyseal growth plate is closed (ex: closed by bones) then the growth of bones now stops and the bone cann't grow any more.

2. Intramembranous ossification: a group of mesodermal cells that come together and form a more compact structure which is penetrated by blood vessels that starts the changes there, the cells differentiate into osteoblasts and start the process of laying down cells.

The osteoid is uncalcified matrix and this matrix hasn't undergone any calcification.

Histologically, the bones are calcified into two types:

1. Woven bones (non-lamellar): immature bones, primary.
2. Lamellar: mature bone, secondary.

This gives an indication that there is an organization of lamellae seen secondary bone, while it is not seen in primary bone.

For example the building up of bones will starts by primary and ends up with the more mature secondary lamellar bones.

So, the primary will be replaced by the secondary and the time needed for this to happen is variable for each bone.

- NOTE: the reason behind not having a lamella inside the primary is due to the irregular arrangement of collagen fibers, if so (ex: the collagen fibers were regularly arranged making up a lamellae); we will have lamellar bones, in other words, lamella is regularly arranged collagen fibers in a proper way.

The cells that make or lay down bones are osteoblasts; initially, the initial bone form has no calcium, as a result the mineral content of the tissue is less, while the number of cells is more, consequently because the mineral content is less, penetration of X-ray is easy and this area appears in between black and white.

In X-rays, the whitish area gives an indication that there is a high content of calcium in that bone, whereas the soft tissue appears black. The primary bone appears somewhere between the white "bony area" and the black "soft tissue", which tells that the mineral content is less.

- NOTE: primary bone is temporary, while secondary is permanent.

Secondary bones are those that aren't going to be replaced.

- The collagen fibers are regularly arranged.

- Contains four types of lamellae.
- Number of cells is less than those formed in primary bones.
- Penetration of X-ray is hard, because of the precipitation of calcium.

Lamella is arranged in four patterns:

1. Concentric lamella: which surrounds the Haversian canal, osteocytes are arranged regularly (in) lamella around a blood vessel.
2. Interstitial lamella: found in the spaces between Haversian systems.
3. External (outer) circumferential lamella: found beneath the periosteum.
4. Inner circumferential lamella: found beneath the endosteum.

The outer and inner circumferential lamellae are not found in Haversin systems, as a result; they get their blood supply from blood vessels found in periosteum and endosteum, respectively.

Bones from outside to inside:

External circumferential—Haversian (concentric) system—interstitial—inner circumferential.

JOINTS

Types of joints:

1. Diarthrosis**:** synovial joint which has a wide range of mobility.
   - As long as we have wide range of mobility, the stability is less.
   - Synovial joints have a capsule surrounding them, attached to margins of articular surfaces.
   - Synovial joints have synovial membrane, which is a specialized connective tissue that secretes a fluid similar to the plasma to lubricate the joint and to nourish the cartilage present there.

   Factors affecting the stability of joints:

   - Bony factors (ex: the shapes of the articular surfaces).
   - Muscles around the joints, which stabilize it.
   - Ligaments around the joint, In knee joint, ligament factor is very important.

a) Pivot joints: one in cervical vertebrae, the other is found in the superior radio-ulnar joint.
b) Hinge joint, like a door: ex; elbow, knee joints. Of limited uni-axial movement.
c) Glide: slide over each other. ex; carpal bones.
d) Condyloid: in which heads have different dimensions. ex; head of mandible.Sometimes the carpal bones are described as condyloid.

NOTE : (the type of joint is depend on movement)

e) Saddle joint: such as the one between the first metacarpat and trapezium bone.

2. Synarthrosis**:** this type of joints has a nucleus, ex: bones of skull, during intra-embryonic life they are separated from each others to allow for the growth of the brain and CNS, soon, when they approach each other, the joints between them become synostoses, which is the sutures that connect all parts of skull together. By the age of 70 or 75 we will notice that the bones become one mass, an indication that it was a fibrous tissue and then it was replaced by bones (sutures are gone)

3. chondrosis**:** no mobility (mobility is zero).

We have epiphysis, epiphysial growth plate, and metaphysis.

The area of the cartilage is just as if it is uniting with the epiphysis above and metaphysis or shaft below; so this type of joint is described as chondrosis.

No mobility in this type, the mobility is zero, but in certain circumstances, if a child who is still growing came to you and he has an epiphyseal growth plate in a place and you hit the epiphyseal growth plate, in this case, you are accelerating or descelerating the fusion of the epiphyseal growth plate with the bone, sometimes we create a false joint, so that the head and the shaft move on the epiphyseal growth plate, in this case the growth of the bone will definitely be affected.

Pseudoarthrosis: a false joint present due to the presence of cartilage that shouldn't be there (mainly due to the bad healing in certain places), ex: in the case of bad healing in certain places, this bad healing process will lead to the growth of cartilage instead of bone, and when a trauma is found in certain places the patient will suffer from a false joint.

4. Syndesmoses**:** the most famous example is the symphysis pubis.

Right hip bone and left hip bone come to contact with each other, there is a plate of cartilage between them. The presence of cartilage there is to give a source of flexibility during ex: labor or delivery.

Mandible: it's one bone (one piece) which undergoes endochondral ossification because cartilage is present there, however this doesn't mean that we have right mandible and left mandible, it is one bone.