

Ossification

Phylogenetically dual bone development:

- primary (covering bone)
- secondary (replacement bones)

Primary bones

- an ossification from ligament = desmogenous ossification

secondary bones

- at first-cartilaginous
- chondrogenic ossification

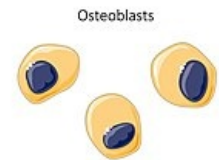
Chondrogenic (deeper) and desmogenous (superficial, covering) were often combined to form larger combined units.

Both methods of bone formation were preserved in human embryonic development:

1. ossification desmogenous = endesmal (in ligament)
2. chondrogenic ossification - division into two groups according to the place of origin in the cartilage:
 - perichondrial – surface ossification from the perichondrium
 - enchondral – ossification inside the cartilage

Ossification process

1. **osteoblasts** – cells from the mesenchyme, produce non-calcified precursors of the ground substance → turn into **osteoid** by polymerization
 - osteoblasts become stuck in this mass
 - **bone beams** – structures that are created by osteoblasts, further increase by apposition
2. **osteocytes** – typical bone cells, it arises from immobile osteoblasts (which are stuck in osteoid)
3. **osteoclasts** - break down bone
 - broken bone is replaced by new bone → bone remodeling
 - Bone breakdown occurs in two ways. On the basis of the genetic program, the bone is given the desired shape and on the basis of its loading, the internal architecture is formed in the spongiosa.



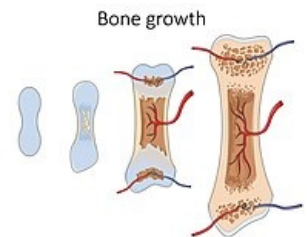
Desmogenous ossification

- new formation of bone beams directly in the ligament → **endesmally**
- first **fibrous** bone, which is then rebuilt into cancellous bone
- bones of the cranial vault, facial part of the skull

Osteoblasts

Chondrogenic ossification

- it replaces the original cartilaginous bone model, which is destroyed by this bone formation



Ossification of long bones

1. **perichondral ossification** (in the middle of the length of the bone)
 - in the perichondrium, osteoblasts differentiate, which produce the bone mantle (surrounds the body of the future bone)
 2. **enchondral ossification** – inside the cartilage (changes will take place in the cartilage before that)
 - mesenchyme buds with blood vessels penetrate into the cartilage from the periosteum → differentiation of primitive bone marrow cells and osteoblasts (enchondrally form bone tissue and the remains of cartilage are broken down)
 - this is how an **ossification nucleus** is formed inside the cartilage (in the middle of the length of the bone) → middle part of a long bone = **diaphysis, diaphysis**
 - from the diaphysis, ossification spreads to both ends of the bone
- the ends of long bones ossify from separate ossifying nuclei – they are formed enchondrally only
 - in cartilage, the same changes as during ossification of the diaphysis, formation of an ossification core → epiphysis, epiphysis – at one or two ends of a long bone
 - **growth (epiphyseal) plates** – between the epiphyses and the diaphysis, they are maintained throughout the bone growth (disappears around the age of 18)
 - only in them the bone grows in length - the cartilage creates new material
 - one of them (proximal or distal) is more involved in bone growth than the other (e.g. proximal is more

Bone growth

- active in the humerus and lower leg bones, distal is more active in the forearm and femur)
- at the same time, the bone beams break down in the diaphysis → **cavitas medullaris**, a medullary cavity is created.
- growth in thickness – by apposition from the periosteum and partly also from the endosteum
- apposition must be supplemented by bone resorption (remodeling)

Ossification of short bones

- enchondrally** - in the middle of the cartilaginous base
- spread of ossification to the bone surface (occurs throughout the growth period)
- formation of perichondral mantle lamella (at the end of the growth period) → formation of superficial compact bone

Ossa pneumatica

- the mucous membrane of the nasal **cavity is inserted** into some skull bones after birth
- the mucous membrane of the middle ear cavity is inserted into part of the temporal bone
- the spongiosa of the bone recedes in front of the mucous membrane, the cavity enlarges
- with the original cavity (nasal, middle ear) from which the mucous membrane has been removed, the cavity in the pneumatic bone remains connected only by a narrow passage

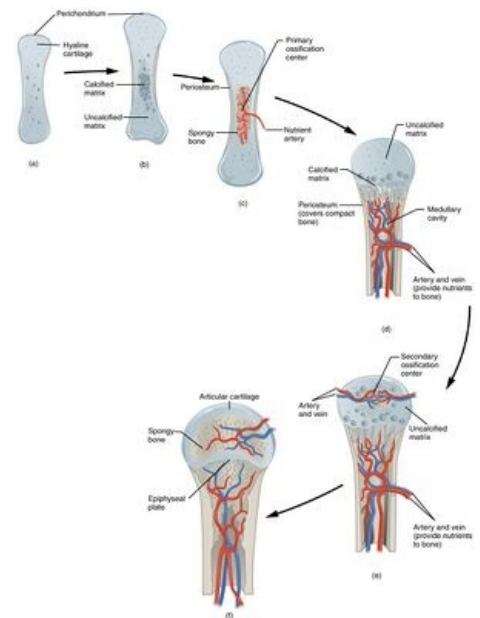
Links

Related Articles

- Bones
- Cartilage
- Epithelium
- Ligament
- Osteogenesis imperfecta

Reference

- ČIHÁK, Radomír. *Anatomie*. 2.. edition. Grada, 2001. ISBN 80-7169-970-5.



Endochondral ossification