ANATOMY, HISTOLOGY AND DISEASE ASSOCIATED WITH BONE MARROW

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Anatomy of Bone Marrow

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Bone Marrow

- Bone marrow is a nutrient-rich spongy tissue located mainly in the hollow portions of long flat bones like the sternum and the bones of the hips.
- Pluripotent stem cells
Bone Marrow

- Red Bone marrow
- Yellow Bone marrow
Red Bone Marrow

• Hematopoietic tissue found mainly in the flat bones, such as the hip bone, sternum (breast) bone, skull, ribs, vertebrae, and shoulder blades, as well as in the metaphyseal and epiphyseal ends of the long bones, such as the femur, tibia, and humerus, where the bone is cancellous or spongy. (Proximal end)

• The majority of RBCs, platelets, and most of the WBCs are formed
Yellow Bone Marrow

• Fatty tissue found in the hollow interior of the diaphyseal portion or the shaft of long bones.
• By the time a person reaches old age, nearly all of the red marrow is replaced by yellow marrow.
• However, the yellow marrow can revert to red if there is increased demand for red blood cells, such as in instances of blood loss.
• HISTOLOGY OF THE BONE MARROW
BONE MARROW

- H & E: Hematoxylin and eosin stain
- Wright’s stain: histologic stain that facilitates the differentiation of blood cell types
Bone Marrow (H&E)

- Tendon
- Tendon Sheath
- Bone Marrow cavity containing yellow bone marrow
- Patella
- Bone
- Fibrocartilage
Bone marrow smear (Wright’s Stain)

- Nucleus of immature hematopoietic cells
- Nucleus of maturing granulocytes
- Nucleus of maturing erythroblasts
- Reticulocytes
What Is the General Structure of Bone Marrow?

• Bone marrow consists of connective tissue that forms a delicate meshwork within the marrow cavity of bones, and it is permeated by numerous thin-walled blood vessels.

• The active bone marrow, or red marrow, is responsible for the production of red blood cells, white blood cells and platelets (found in the end of long bones).

• Yellow marrow is made up mostly of fatty tissue and is located in the shafts of long bones.
What Are the Functions of Bone Marrow?

• production of blood cells (red blood cells carry oxygen and carbon dioxide, white blood cells fight infection, and platelets assist in clot formation).

• for replacing that lost cell (thousands of red blood cells, white blood cells and platelets are removed from circulation and replaced by the bone marrow).
• responds to various needs of the body by producing new blood cells.

• produces all blood cells from one common cell called a stem cell.
DISEASE ASSOCIATED WITH BONE MARROW
Aplastic anemia

- has been reported in dogs, cats, ruminants, horses, and pigs with pancytopenia and a hypoplastic marrow, replaced by fat.
- Due to infections (feline leukemia virus, *Ehrlichia*), drug therapy, toxin ingestion, and total body irradiation
- Treatment consists of eliminating the underlying cause and providing supportive measures such as broad-spectrum antibiotics, and transfusions.
- Recombinant human erythropoietin and granulocyte colony-stimulating can be used until the marrow recovers.
In pure red cell aplasia (PRCA), only the erythroid line is affected
classified by a nonregenerative anemia with severe depletion of red cell precursors in the bone marrow
Primary leukemias

- have been reported in dogs, cats, cattle, goats, sheep, pigs, and horses.
- can develop in myeloid or lymphoid cell lines and are further classified as acute or chronic.
- Most affected animals have nonregenerative anemia, neutropenia, and thrombocytopenia, with circulating blasts usually present.
- Acute leukemias, characterized by infiltration of the marrow with blasts, generally respond poorly to chemotherapy. Cell lineage is often difficult to identify morphologically, so cytochemical stains or immunologic evaluation of cell surface markers may be necessary for definitive diagnosis.
- Chronic leukemias, characterized by an overproduction of one hematopoietic cell line, are less likely to cause anemia and more responsive to treatment.
Acute leukaemia
Chronic leukemia
Myelodysplasia

• Disorders of the stem cell in the bone marrow.
• Also known as preleukemia.
• Involve ineffective production (or dysplasia) of the myeloid class of blood cells.
• Can cause severe anemia, cytopenias, and acute mylogenous leukemia.
• Treatment: Blood transfusion, chemotherapy.
Example (trilineage myelodysplasia)
Myelofibrosis

• Disorder of the bone marrow, in which the marrow is replaced by scar (fibrous) tissue.
• When bone marrow cannot produce enough RBCs, liver and spleen try to produce RBCs, resulting in swelling of the organs (extramedullary hematopoiesis).
• Can cause acute myelogenous leukemia and liver failure.
• Treatment: Blood transfusions, chemotherapy, surgical removal of the organs, and bone marrow transplant.
Peripheral blood smear showing leuko-erythroblastic reaction: teardrop RBCs (black arrows), and myelocyte (red arrow) and promyelocyte (blue arrow)
HEMOPOIESIS

• The formation of blood cells before and after birth is called hemopoiesis and occurs at different locations prenatally and within the bone marrow in birds and mammals postnatally.
• During fetal development, blood cells originate from the mesenchyme of the yolk sac as small islands of erythroblastic cells.

• Subsequently, stem cells for blood cell formation migrate to the liver and eventually to the spleen, thymus, lymph nodes, and bone marrow.
• Shortly after birth, hemopoiesis within the liver and spleen is principally replaced by hemopoiesis within the bone marrow, especially regarding erythropoiesis and granulocytopoiesis.
CENTER OF HEMOPOIESIS

• The marrow of the long bones, ribs, vertebrae and pelvis, skull and sternum becomes the primary center of blood formation within the young, developing individual.

• With age, hemopoiesis becomes reduced in activity and the marrow of the bones changes from red marrow to yellow marrow as adipose tissue is added increasingly in these areas, particularly within the diaphyses of long bones.
Avian bone marrow

• Avian still have bone marrow eventhough their bones are hollow.
• Just that the marrow cavity is smaller.
• The production of red blood cells are lower but it is still enough.
• Primary functions: erythropoiesis, thrombopoiesis.
• Granulopoiesis occur in spleen, kidney, lungs, thymus, gonad, pancreas, and other tissues including bone marrow.