PATHOLOGY OF HEMOPOITIC AND IMMUNE SYSTEM

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**DEVELOPMENTAL ANOMALIES**

**Hereditary anemia**
Hereditary anemia has been reported in mice due to defects in erythropoiesis or reduced vitality of erythrocytes. Erythropenia along with leucopenia occurs in mouse foetus on 20th day of gestation due to defective autosomal chromosome 4. Sex linked anemia in mouse is hypochromic with deficient bone marrow and occurs in hemizygus males or homozygus females. This anemia occurs due to deficiency of iron as a result of poor absorption from gastrointestinal tract.

**Autoimmune hemolytic anemia in foals**
It occurs due to incompatible blood group antigens of male and female parents. The mare does not have that blood group antigen but foetus acquires it from father. The foetal blood exposed to dam through placental exchanges that leads to induction of antibody production in mares against foetal blood group antigen. These antibodies accumulate in colustrum and when foal suck the milk from mares, they are readily absorbed through G.I. tract of foals in blood and causes destruction of erythrocytes leading to anemia.

**Congenital defects in lymphocytes**
Congenital defects in lymphocytes are classified under stem cell aplasia/agenesis leading to combined immunodeficiency with absence of both T- and B-lymphocytes in Arabian foals. It occurs either due to inherited gene defect or there is differentiation/maturation defects in lymphocytes. It is characterized by agammaglobulinemia, lymphopenia, hypoplasia of thymus, lymphnodes and spleen.

**Chediak Higa Syndrome**
This syndrome is related with defects in phagocytic cells such as defective neutrophils and monocytes. The defects are in chemotaxis, engulfment and killing of bacteria and associated with defective assembly of cytoplasmic microtubules responsible for degranulation and release of lysosomal enzymes, there is depression of superoxide anions leading to persistent bacterial infections.

**ANEMIA**
Anemia is the decrease in number of erythrocytes or hemoglobin concentration in erythrocytes per unit of blood and is characterized by pale mucus membrane, dyspnoea, cardiac hypertrophy and weakness. Anemia is classified according to morphological characteristics of erythrocytes and on the basis of causative factors. Morphologically, anemia is classified as macrocytic, normocytic and microcytic depending on the size of red blood cells and normochromic and hypochromic based on the presence of quantity of hemoglobin in RBC. 

**Macrocytic anemia** is characterized by increased size of RBC and occurs due to acute blood loss or hemolysis resulting in excessive production and availability of immature erythrocytes in blood. Such cells also have reduced amount of hemoglobin and termed as hypochromic.

**Macrocytic normochromic** anemia is increase size of RBC with normal hemoglobin and has been observed in deficiency of folic acid, niacin and vitamin B12. **Normocytic anemia** are most common in animals occurs due to neoplasia, irradiation and are also known as aplastic anemia as a result of aplasia or agenesis of RBC. Normocytic normochromic, normal size of RBC with normal hemoglobin anemia occurs as a result of depression of erythropoiesis. **Microcytic anemia** is reduction in size of erythrocytes with decreased hemoglobin (Microcytic hypochromic) and occurs in deficiency of iron and pyridoxine or chronic blood loss.

In anemia, the size of RBC varies markedly with some large and some small size and is known as anisocytosis. The presence of abnormal shape (elongated, angular, ovoid, distorted) of RBC is termed as poikilocytes. In some blood smears, there are nucleated RBC’s which are immature due to increased production to meet the demand. Sometimes, the erythrocytes are having minute dark spots known as basophilic stippling which occurs in acute blood loss. Some erythrocytes stain unevenly with some dark and light colour spots and are known as polychromatophilia which is an indication of active erythropoiesis. The denaturation and precipitation of hemoglobin leads to appearance of purplish granules in RBC near the
Fig. 17.1. Diagram showing autoimmune hemolytic anemia in foal

Fig. 17.2. Photograph showing toxic aplastic anemia A. Normal B. Yellow bone marrow

Fig. 17.3. Diagram showing autoimmune hemolytic anemia

Fig. 17.4. Photograph showing atrophy in spleen (A. Normal, B, C and D atrophy spleen)

Fig. 17.5. Photograph showing depletion of lymphoid tissue
cytoplasmic membrane which are known as “Heinz bodies”. According to etiological factors, the anemia is classified as hemolytic, haemorrhagic or deficiency anemia.

HEMOLYTIC ANEMIA
Hemolytic anemia occurs due to excessive lysis of erythrocytes and characterized by icterus, hemoglobinuria, and presence of nucleated erythrocytes in blood and hemosiderosis in spleen.

Etiology
- Infections e.g. Anaplasma spp., Babesia spp., Equine infectious anemia virus
- Toxins/poisons e.g. snake venom, chronic lead poisoning.
- Immune mechanisms e.g. autoimmunity against erythrocytes (Fig. 17.17).

Macroscopic features
- Pale mucus membranes
- Icterus
- Blood is thin, watery.
- Hemoglobinurea

Microscopic features
- Decreased number of erythrocytes
- Presence of nucleated/immature RBC in blood
- Hemosiderin laden cells in spleen

HAEMORRHAGIC ANEMIA
Haemorrhagic anemia occurs due to severe haemorrhage, extravasation of blood and characterized by pale mucus membrane and haemorrhage in body.

Etiology
- Infections e.g. Acute septicemic diseases
- Toxins/poisons e.g. Bracken fern poisoning
- Parasites e.g. Hemonchus contortus
- Deficiency e.g. vitamin C deficiency

Macroscopic features
- Petechiae or Echymotic haemorrhage
- Pale mucus membrane
- Hematuria
- Haemorrhage in various tissues/organs
- Macrocytic or normocytic characters of RBC
- Poikilocytosis
- Hyperplasia of bone marrow

DEFICIENCY ANEMIA
Deficiency anemia occurs as a result of deficiency of iron, copper, cobalt and vitamins and characterized by pale mucus membrane, weak and debilitated body and decreased number of erythrocytes with hypochromasia in blood.

Etiology
- Deficiency of iron
- Deficiency of copper
- Deficiency of cobalt
- Deficiency of vitamin B_{12}, Pyridoxine, riboflavin and folic acid.
- Parasitic infestation may lead to deficiency.

Macroscopic features
- Pale mucus membrane
- Thin watery blood with light red colour
- Weak and debilitated carcass
- Heavy parasitic load in gastrointestinal tract.

Microscopic features
- Microcytic hypochromic erythrocytes.
- Poikilocytosis

TOXIC APLASTIC ANEMIA
Toxic aplastic anemia is agenesis or aplasia of hemopoietic tissues in bone marrow and there is lack of erythrocyte production. It is characterized by the absence of developmental stages of erythrocytes viz., normoblasts, megaloblasts etc.

Etiology
- Radiation e.g. X-rays, γ rays, or UV rays
- Sulfonamides
- Bracken fern toxicity
- Uremia
- Feline panleukopenia
Fig. 17.6. Photograph of spleen showing tubercles/granulomatous lesions (ARS/USDA)

Fig. 17.7. Photograph showing lymphadenitis in horse due to glanders

Fig. 17.8. Photograph showing caseous lymphadenitis (ARS/USDA)

Fig. 17.9. Photomicrograph of lymphnode showing acute lymphadenitis

Fig. 17.10. Photomicrograph of lymphnode showing chronic lymphadenitis

Fig. 17.11. Photograph showing atrophy of thymus A. Normal B, C and D. progressive atrophy

Fig. 17.12. Photomicrograph of thymus showing depletion of lymphoid tissue.

Fig. 17.13. Photograph showing oedema in bursa of Fabricius due to Gumboro disease.
**Macroscopic features**
- Pale mucus membrane
- Weak and debilitated animal
- Dyspnoea
- Bone marrow becomes yellow/fatty (Fig. 17.2).

**Microscopic features**
- Absence of developmental stages or RBC such as normoblasts, megaloblasts etc.
- Agranulocytosis i.e. Reduction of WBC in circulating blood.
- Bone marrow becomes fatty.

**AUTOIMMUNE HEMOLYTIC ANEMIA**
Autoimmune hemolytic anemia occurs as a result of destruction of erythrocytes by immune mechanisms developed against erythrocytes.

**Etiology**
- Autoimmune hemolytic anemia in foals.
- Antibodies produced against own RBC of an animal (Fig. 17.3).
- Equine infectious anemia
- Anaplasmosis
- Systemic lupus erythematosus

**Macroscopic features**
- Pale mucus membrane
- Enlargement of liver, spleen and lymphnodes
- Hemoglobinuria
- Lameness due to rheumatoid arthritis

**Microscopic features**
- Erythrophagocytosis
- Demonstration of antibodies against own RBC in sera of animals.
- Active erythropoiesis
- Glomerulonephritis

**POLYCYTHEMIA**
Polycythemia is increase in number of erythrocytes in circulating blood. It may be relative increase as a result of dehydration or decrease in plasma volume or absolute due to anoxia.

**Etiology**
- Dehydration due to diarrhoea, vomiting and loss of fluid in oedema/inflammation.
- Anoxia in high altitudes.
- Heart diseases e.g. Patent ductus arteriosus
- Severe pulmonary emphysema
- Erythroid leukemia

**Macroscopic features**
- Dehydration, mucus membrane dry, sticky
- Pulmonary emphysema, fibrosis in lungs
- Increase hemoglobin concentration

**Microscopic features**
- Increased number of erythrocytes
- Severe damage in lungs, congestion, emphysema, fibrosis

**LEUCOCYTOSIS**
Leucocytosis is increase in number of leucocytes in circulating blood caused by various infections. There is also increase in white blood cells in blood due to neoplastic condition and is known as Leukemia. As the leucocytes consist of neutrophils, lymphocytes eosinophils, monocytes and basophils; the increase in number of neutrophils is termed as neutrophilia, eosinophils as eosinophilia, lymphocytes as lymphocytosis, basophils as basophilia and of monocytes as monocytosis.

**Etiology**
- Infections
- Bacterial infection- neutrophilia
- Viral infections and chronic bacterial infections- lymphocytosis
- Parasites- eosinophilia
- Allergies- basophilia, lymphocytosis

**Macroscopic features**
- No characteristic lesion.
- Reactive lymph node hyperplasia.
- Enlargement of lymphoid organs such as spleen, thymus and bursa.
Microscopic features
- Increase in number of total leucocytes in blood
- Increase in absolute lymphocyte, absolute neutrophil, absolute eosinophil counts.
- Hyperplastic lesions in lymphoid organs.

LEUCOPENIA
Leucopenia is decrease in number of white blood cells. The leucocytes are neutrophils, lymphocytes monocytes, eosinophils and basophils. If there is decrease in number of all 5 cells of leucocytes, it is known as panleucopenia. The decrease in number of neutrophils is termed as neutropenia and lymphocytes as lymphopenia.

Etiology
- Congenital e.g. Chediak Higashi syndrome
- Infections e.g. Feline panleucopenia virus, infectious bursal disease virus
- Chemicals e.g. Pesticides, heavy metals
- Radiation e.g. X-rays

Macroscopic features
- Atrophy of lymphoid organs
- Recurrent infections, vaccination failures, pyogenic disorders.
- Oedema, haemorrhage in bursa, atrophy of bursa due to fibrosis in IBD infection.

Microscopic features
- Decrease in total leucocyte count and absolute neutrophil and absolute lymphocyte counts
- Degeneration and necrosis of lymphoid cells in follicles of lymphoid organ
- Oedema, necrosis, proliferation of fibrous tissue in bursa in IBD infection.

PATHOLOGY OF SPLEEN
SPLEENITIS
Spleenitis is the inflammation of spleen characterized by enlargement, infiltration of inflammatory cells, proliferation of lymphoid follicles, congestion and oedema followed by proliferation of fibrous tissue (Fig. 17.4 to 17.6).
**Etiology**
- Infections *e.g.* bacteria, virus
- Deficiency of vitamins and minerals
- Amyloidosis
- Immunodeficiency *e.g.* environmental pollution

**Macroscopic features**
- Enlargement of spleen.
- Necrotic patches on spleen.
- In chronic cases or in immunological disorders.
- There is atrophy of spleen due to fibrosis.
- Necrotic patches and congestion leading to mottling.

**Microscopic features**
- Congestion in spleen.
- Proliferation of lymphoid follicles/cells.
- Oedema.
- In atrophied spleen, proliferation of fibrous tissue, depletion of lymphoid cells/follicles.

**PATHOLOGY OF LYMPHNODES**

**LYMPHADENITIS**
Lymphadenitis is the inflammation of lymphnodes characterized by enlargement/atrophy, congestion proliferation of lymphoid cells/depletion of lymphoid cells, oedema AND fibrosis of lymphnodes (Fig. 17. to 17.10).

**Etiology**
- Infections *e.g.* Rinderpest
- Immunological disorders *e.g.* immunodeficiency
- Deficiency *e.g.* Deficiency of protein
- Environmental pollution *e.g.* pesticides, heavy metals
- Tumors/neoplasm *e.g.* lymphosarcoma

**Microscopic features**
- Congestion, oedema, proliferation of lymphoid cells.
- In chronic cases, proliferation of fibrous tissue, depletion of lymphoid cells

**PATHOLOGY OF THYMUS**

**THYMOMA / THYMIC HYPERPLASIA**
It is characterized by congestion and hyperplasia of lymphoid cells in thymus. The inflammation of thymus in chronic cases is characterized by atrophy and proliferation of fibrous tissue (Fig. 17.11 & 17.12).

**Etiology**
- Immunological disorders
- Environmental pollution *e.g.* Pesticide, Heavy metals
- Toxins/poisons
- Aging *e.g.* in adult poultry thymus regresses

**Macroscopic features**
- Congestion, reddening of thymus
- Oedema
- Increase in size
- Atrophy, thinning like thread.

**Microscopic features**
- Congestion, oedema
- Proliferation of lymphoid cells
- Depletion of lymphoid cells
- Proliferation of fibrous tissue

**PATHOLOGY OF BURSA**

**BURSITIS**
Bursitis is the inflammation of bursa of Fabricius in poultry characterized by oedema, congestion, haemorrhage or atrophy and depletion of lymphoid cells (Fig. 17.13 to 17.15).

**Etiology**
- Infectious Bursal disease virus (Birnavirus)
- Environmental pollution *e.g.* Pesticides, heavy metals.
Macrosopic features
- Enlargement of bursa
- Congestion and/or haemorrhage
- Oedema
- In chronic cases, atrophy and fibrosis

Microscopic features
- Oedema
- Depletion of lymphoid tissue
- Degeneration and necrosis of lymphoid cells
- Congestion and/or haemorrhage.
- Proliferation fibrous tissue.

MODEL QUESTIONS

Q. 1. **Fill in the blanks with suitable word(s).**
1. Hereditary anemia occurs in mice due to defects in .......... or .......... of erythrocytes leading to .......... and .......... .
2. Chediak Higashi syndrome is related with defects in .......... including .......... and .......... .
   The defect are in .......... and .......... of bacteria.
3. Morphologically, anemia is classified as .......... and .......... while on the basis of presence of hemoglobin in RBC, it is divided into .......... and .......... .
5. .......... (parasitic infection) may cause haemorrhagic anemia.
   .........., .........., .......... and characterized by .........., .......... and .......... .

Q. 2. **Write true or false against each statement, correct the false statement.**
1. ..........Leukemia is increase in number of all leucocytes in blood.
2. ..........Polycythemia is decrease in RBC in blood.
3. ..........Inflammation of spleen may lead to immunosuppression.
4. ..........Pesticides do not cause lymphadenitis.
5. ..........Lymphopenia is a feature of congenital defects of stem cells.
7. ..........Atrophy of bursa occurs due to heavy metal toxicity.
8. ..........Chediak Higashi syndrome is decrease in WBC in blood.
9. ..........Sex linked anemia in mouse is hypochromic in nature due to iron deficiency.
10. ..........Anisocytosis is variation in size of RBC.

Q. 3. **Define the followings.**
1. Polycythemia
2. Poikilocytosis
3. Panleucopenia
4. Leukemia
5. Anisocytosis
6. Macrocytic normochronic
7. Neutropenia
8. Microcytic
9. Polychromatophilia
10. Lymphopenia

Q. 4. **Write short notes on.**
1. Hemolytic anemia
2. Anemia due to nutritional deficiency

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3. Impact of environmental pollution on lymphoid organs
4. Leucopenia
5. Chediak Higashi syndrome.

Q. 5. Select most appropriate word(s) from the four options given against each statement.

1. Congenital defects in lymphocytes may result into .........
   (a) Lymphopenia      (b) Agammaglobulinemia      (c) Hypoplasia of spleen      (d) All of the above
2. The size of RBC varies from small to large in peripheral blood and this condition is known as...
   (a) Poikilosytosis  (b) Anisocytosis  (c) Polychromatophilia  (d) Heinz bodies
3. Hemolytic anemia is caused by ........
   (a) Anaplasma spp. (b) Coccidia  (c) Hemonchus  (d) Proteus sp.
4. Hematuria is an example of ........anemia
   (a) Hemolytic  (b) Autoimmune  (c) Haemorrhagic  (d) Deficiency
5. Eosinophilia occurs in ........infection
   (a) Bacterial  (b) Prion  (c) Viroid  (d) Parasitic
6. Decrease in number of all components of leucocytes is known as ........
   (a) Leucopoenia (b) Panleucopenia (c) Leucocytosis (d) Leukemia
7. Pesticides may cause ........
   (a) Neutropenia (b) lymphopenia (c) Hypogammaglobulinia (d) All of the above
8. Depletion of lymphoid tissue from follicles of bursa .................
   (a) Gumboro disease (b) Rinderpest (c) Coccidiosis (d) Salmonellosis
9. Macrocytic normochromic anemia is........
   (a) Large size RBC (b) Decreased Hb  (c) Small size RBC  (d) Large size RBC & normal Hb
10. Erythrocytes having minute dark spots are known as ........
    (a) Heinz bodies (b) Theleiria  (c) Basophilic Stippling  (d) None