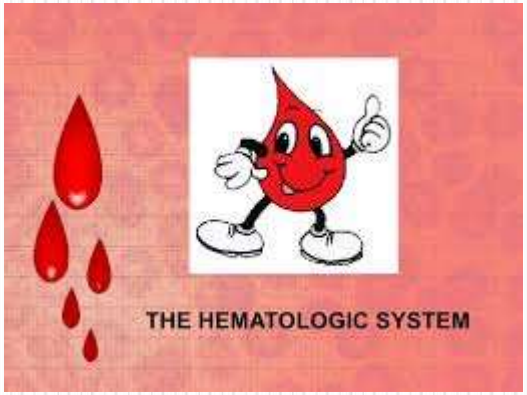
Pathophysiology of Hematologic system



Blood Components

- Plasma
- Liquid part of blood
  - Pale yellow made up of 91% water,9% other.
- Colloid: liquid containing suspended substances that don't settle out.
  - Albumin: Important in regulation of water movement between tissue.
  - Globulin: Immune system or transport molecules.
  - Fibrinogen: Responsible for formation of blood cell.
- Blood Cells
- Erythrocytes: RBC
- Leukocytes: WBC
  - Neutrophil
  - Monocyte
  - Eosinophil
  - Basophil
  - Lymphocytes: T lymphocytes, B lymphocytes.
- Thrombocyte: Platelet

Pathophysiology related to RBCs functions

ANEMIA

Definition: decreased red blood cell count or decreased hemoglobin percent

General manifestation of anemia:

In anemia, there is decreased O2 transport to tissues →

1-Pale or yellowish skin

2-Fatigue

3-Cold hands and feet

4-Headache

5-Ischemia

6-Blurring of vision

7- Irregular heartbeat

8-Shortness of breath

Types of anemia

Based on red cell morphology, anemia is classified into:

I) Normocytic normochromic anemia: normal size and normal Hg content of each RBC

II) Microcytic hypochromic anemia: small size and smaller Hg content of each RBC

III) Macrocytic anemia: increased size of each RBC

Normocytic normochromic anemia

Results from:

A) Decreased production of RBCs: caused by depression of bone marrow → decreased all blood elements including RBCs (aplastic anemia)

Bone marrow is a red, spongy material inside your bones that produces stem cells, which give rise to other cells. Stem cells in the bone marrow produce blood cells — red cells, white cells and platelets.

Causes of aplastic anemia

1-Radiation 2-Chemicals

3-Chemotherapy 4-Certain antibiotics

5- infection 6- Toxins

B) Very rapid loss of RBCs: due to

1- Massive hemorrhage → *hemorrhagic anemia*

2-Hemolysis of RBCs → *hemolytic anemia*

Hemolytic anemia

This group of anemia develops when red blood cells are destroyed faster than bone marrow can replace them either in the blood vessels or elsewhere in the human body.

Hemolysis of RBCs may be:

Acquired: caused by :

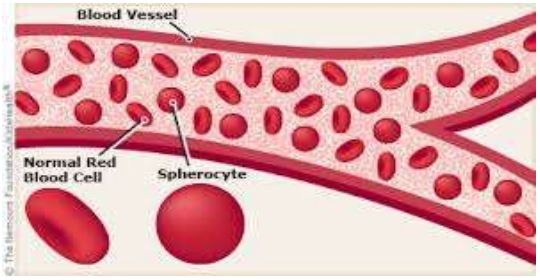
- chemical toxins, bacterial toxins,
- drugs (quinidines, snake venom),
- Autoimmune : incompatible blood transfusion
- Cancers.
- Certain viral infection and Parasitic infection (malaria)

Heriditary:e.g,

Hereditary spherocytosis, sickle cell anemia and thalassemia

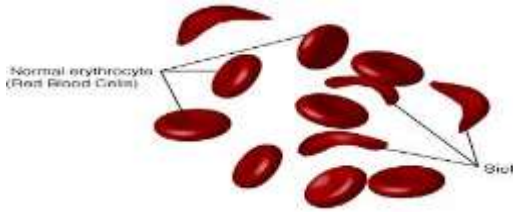
Hereditary sperocytosis:

RBCs are abnormally sphere shaped → abnormally fragile → hemolysis



Sickle cell anemia

is an inherited form of anemia, it's caused by a defective form of hemoglobin, the red blood cells become rigid and sticky and are shaped like sickles or crescent. These irregularly shaped cells can get stuck in small blood vessels, which can slow or block blood flow and oxygen to parts of the body.



Thalassemia

Inherited blood disorders in which the body is not able to make enough hemoglobin,. This causes the body to make fewer healthy red blood cells than normal. → increased RBCs fragility → hemolysis of RBCs

Manifestations of hemolytic anemia:

1- Common manifestations of anemia

2- Hemolysis of RBCs → Jaundice, i.e, yellowish coloration of skin and mucous membranes due to increased blood bilirubin

3-Sickling of RBCs in sickle cell anemia → increased blood viscosity →

- Decreased blood flow to tissues → ischemia, hypoxia &pain

4-Splenomegally

II) Microcytic hypochromic anemia

- RBCs are smaller in size and contain smaller amount of Hg than normal RBCs
- Caused by iron deficiency

- *Causes of iron deficiency:*

1-Decreased iron intake: especially occurs in vegetarians , infants and females in reproductive periods

2-Decreased iron absorption from intestine

3-Chronic blood loss e.g, bleeding piles, bleeding peptic ulcers and neoplasia (an abnormal growth of tissue)

III) Macrocytic anemia

- RBCs are larger in size than normal RBCs always associated with **insufficient numbers of cells** and often also insufficient hemoglobin content per cell

- Caused by vitamin B12 or folic acid deficiency

Pathophysiological Effects of Anemia:

Decreased blood viscosity in anemia ---> increased rate of blood flow --> increased venous return --> increased cardiac output this will compensates for the decreased 0_2 content in the anemic blood.

In hemolytic anemia, there is excessive production of bile pigments causing jaundice.

In pernicious anemia (is a condition in which the body can't make enough healthy red blood cells because it doesn't have enough vitamin B12), there are sensory disturbances due to degeneration of dorsal column of spinal cord.

Polycythemia

- Means the RBC count is greatly increased

- **Types:**

I)Relative polycythemia: decreased plasma volume → increased concentration of RBCs

11) Primary polycythemia (polycythemia vera):

Caused by bone marrow makes too many RBCs

may also result in production of too many of the other types of blood cells — white blood cells and platelets. These excess cells thicken your blood and cause complications, such as such as a risk of blood clots or bleeding.

III) Secondary polycythemia: caused by chronic hypoxia, e.g, living at high altitudes.

Manifestations of polycythemia:

1- Increased blood volume

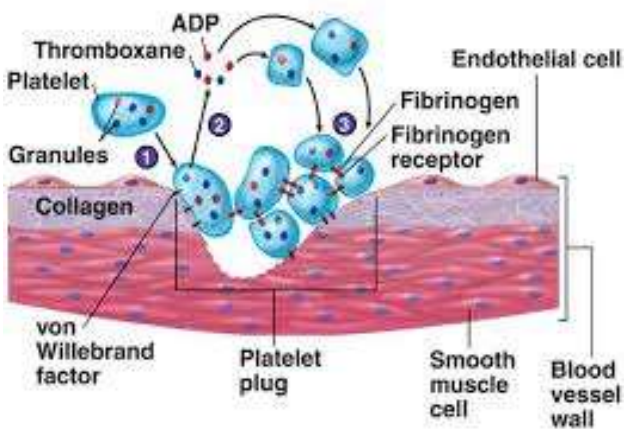
2- Increased blood viscosity →

- Risk of thrombosis
- Occlusion of small blood vessels
- Impaired blood flow to tissues (ischemia)

3-Hepatosplenomegally due to pooling of blood

Pathophysiology of hemostasis

Definition of hemostasis: stoppage of bleeding when a blood vessel is injured



Steps of hemostasis:

1-Vasoconstriction of blood vessel

2-Formation of platelet plug .

3-Formation of blood clot .

4-Growth of fibrous tissue

Abnormalities of hemostasis

I) Increased bleeding tendencies:

Causes:

Abnormalities in coagulation process

Abnormalities in blood platelets

2) Increased blood coagulability

Abnormalities in coagulation process→ increased bleeding tendencies

Causes:

-Genetic : e.g, hemophilia

-Acquired: Vit K deficiency

Liver diseases

Drug-induced

Characteristics:

1-Increased coagulation time

1-Hemophilia

- Is a rare bleeding disorder in which the blood doesn't clot normally, caused by deficiency of some clotting factors.

Manifestations:

- Mild, moderate to severe bleeding disorders
- Excessive bleeding with trauma or surgery
- Bleeding into soft tissues (muscles and joints)

Treatment of hemophilia:

- Avoidance of injury and prevention of bleeding
- Replacement of the deficient clotting factors

2-Vitamin K deficiency:

- Vit K is required for synthesis of clotting factors II,VII,IX & X

- Sources of Vit K:

  Exogenous: from diet

  Endogenous: from bacteria flora of intestine

- Causes of deficiency:

1-Intestinal malabsorption,.

2-Destruction of bacteria flora by antibiotics

- Treatment:

1- Vitamin K administration

2-Supplementation of deficient clotting factors

3-Liver diseases:

- Clotting factors are synthesized in the liver.
- Liver diseases → decreased production of clotting factors → defect in blood coagulation → increased bleeding tendencies
- Examples of liver diseases: hepatitis, cirrhosis, liver cancer, liver failure

4-Drug induced :

Use of anticoagulants, e.g, Warfarin and heparin

Abnormalties in blood platelets→ increased bleeding tendencies (Purpura)

- Include:

1-Decreased platelet count (thrombocytopenic purpura)

2-Impaired platelet functions (thrombocytoasthenic purpura)

- Charactrized by:

1-Prolonged bleeding time

Increased blood coagulability

- Causes:

1-Inherited disorders of coagulation
2- Polycythemia
3-Obesity
4- Prolonged bed rest
5-Cancer
6- Venous stasis
7-Sepsis
8- Trauma or surgery

- Danger:

Increased risk of venous thrombosis and emboli.

Embolus: which may be a blood clot, fat globule, gas bubble or foreign material in the bloodstream. This can cause a blockage in a blood vessel.

What are common white blood cell disorders?

Two major types of white blood cell disorders are **proliferative disorders** and **leukopenia's**.

•In the proliferative disorders, there is an increase in the number of white blood cells. This increase is commonly a reaction due to infection, but may, less commonly, be related to some types of cancer or leukemia (myelocytic leukemia and lymphocytic leukemia).

•In leukopenia's, there is a decrease in the number of white blood cells, which can be caused by cells being destroyed by an illness or by other conditions.