

Anemia & Dyscrasias

OCCC Nursing Program
NUR 143
Linda Mollino

General Overview

- Hematology ~ the study of blood
- Blood cells ~ general types include
 - Red, white, platelets, & plasma
- Influences in the formation of blood
 - Bone marrow, spleen, liver, pH

Peripheral Vascular System: Two Main Components

- Arterial network
 - Major artery branches from aorta
 - Successively small arteries
 - Arterioles
 - Capillary bed
- Venous system
 - Capillary bed
 - Venules
 - Veins
 - Inferior and superior vena cavae
 - Right atrium

Definitions

■ Blood Flow

- The volume of blood transported in a vessel, in an organ, or throughout the circulation over a given period of time
- Commonly expressed as liters or milliliters per minute or cubic centimeters per second

■ Peripheral Vascular Resistance

- The opposing forces or impedance to blood flow as arterial channels become more distant from the heart
- Determined by blood viscosity, length of vessel, and diameter of vessel

Functions of the Blood

- Transporting oxygen, nutrients, hormones, and metabolic wastes
- Protecting against invasion of pathogens
- Maintaining blood coagulation
- Regulating fluids, electrolytes, acids, bases, and body temperature

Complete Blood Count (CBC)

- Red blood cells (RBCs) 4-6 million
 - Erythrocyte indices
 - MCV mean cell volume
 - MCHG mean cell Hgb concentration in %
 - MCH mean cell Hgb
 - Erythrocyte sedimentation rate (ESR) - the rate RBC's settle from unclotted blood in 1 hour
 - Reticulocyte count
 - Indicator of bone marrow function producing RBC's (0.5-2%) of total erythrocytes is normal

RBC Terminology

- Describes RBCs by size & amount of Hgb
- Cytic – size
 - Normocytic – cells of normal size
 - Microcytic – cells too small (↓ MCV)
 - Macrocytic – cells too large (↑ MCV)
- Chromic – concentration of Hgb in cell
 - Normochromic – normal Hgb
 - Hypochromic - ↓ Hgb (↓ MCHC)
 - Hyperchromic – Dense Hgb (↑ MCHC)

Hemoglobin

- a measure of the oxygen carrying capacity of the blood
- Normal:
 - Male: 13-17gm
 - Female: 11 – 16gm

Hematocrit

- The volume in % of RBC's in the blood
- Normal
 - Male: 38-49%
 - Female: 34-44%

Hematocrit

THE HEMATOCRIT LOTTERY

One for Every Age



White Blood Cells (WBC) & Other Lab Values

- WBC Normal Range: 3.2- 10,000
- Differential:
 - Granulocytes: neutrophils, eosinophils, basophils
 - Non-Granulocytes: lymphocytes, monocytes
- Platelets: normal range 150,000-400,000/mm³
- Blood Assay: analysis of constituents & proportions of blood (coagulation factors)
- Bone Marrow Biopsy
- Iron: male 75-175ug/dl, female 65-165, child 50-120

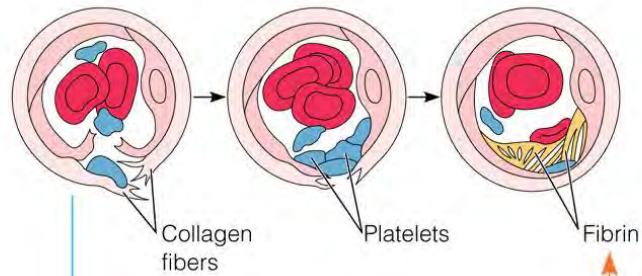
Erythropoiesis ~ red cell development

- Bone marrow
 - produces stem cells
- Erythropoietin
 - Stimulates stem cells
- Stem cell + Iron (Fe) = Hemoglobin

Injury to vessel lining exposes collagen fibers; platelets adhere

Platelet plug forms

Fibrin clot with trapped red blood cells



Chemical release increases platelet adhesion

Mediating factors from platelets and thromboplastin from damaged cells + Calcium and other clotting factors in blood plasma

Coagulation

1

Prothrombin activator

2

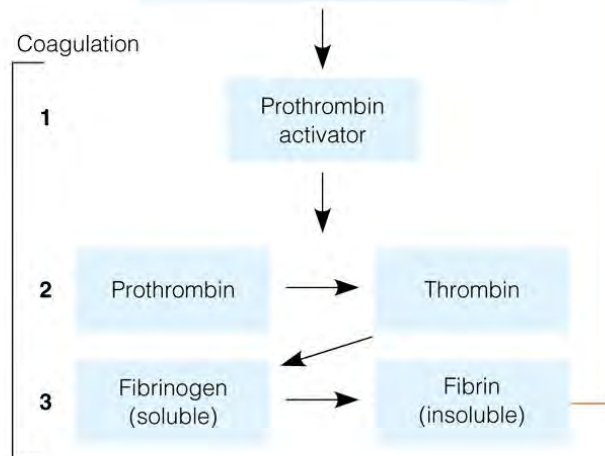
Prothrombin

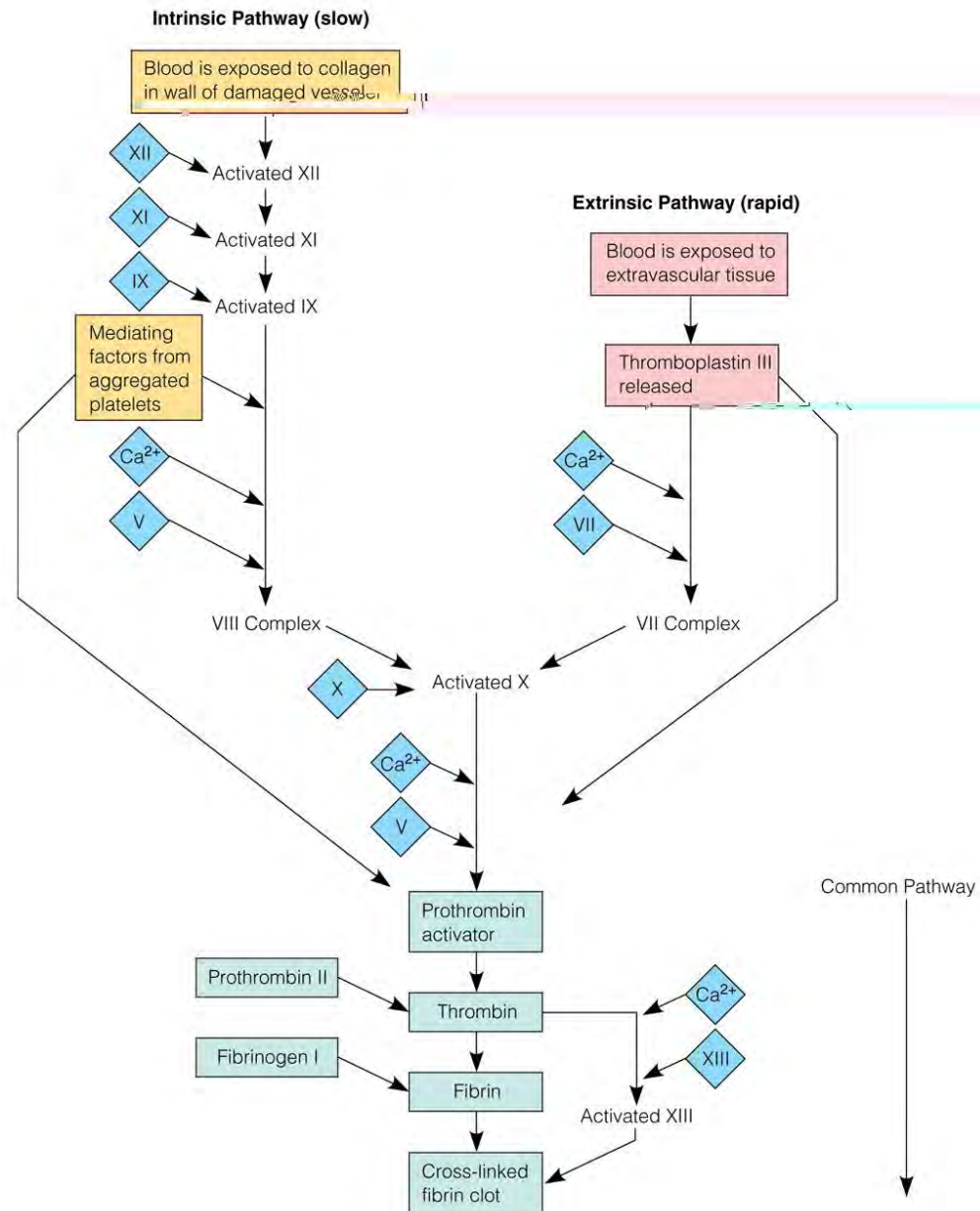
Thrombin

3

Fibrinogen (soluble)

Fibrin (insoluble)





Aging & Hematologic Changes

- Modest changes in RBC's
 - Men Hgb drops 1g/dl between 70 & 88 yrs
 - Women Hgb drops 0.2g/dl
- Insufficient dietary intake, malabsorption
- Leukocytes & platelets are unaffected
- Antibodies and their responses decreased
- Bone marrow ~ less cells
- Co-morbid diseases may cause anemia
- Manifestations may be mistaken for normal aging

Red Blood Cells ~ Other Problems

- Polycythemia Vera ~ production and presence of increased number of RBC's
- Thrombocytopenia ~ reduction of platelets below 150,000
- Disseminated Intravascular Coagulation (DIC) ~ serious bleeding and thrombotic disorder.
 - It results from abnormally initiated and accelerated clotting
- Thalassemia ~ microcytic; an autosomal recessive genetic disorder involving inadequate production of normal hemoglobin.

Polycythemia

- Pathophysiology
 - Increased production of red blood cells.
- Symptoms
 - headaches, dizziness, tinnitus, blurred vision, fatigue, weakness, pruritus, exertional dyspnea, angina, and increased blood pressure and pulse.
- Treatment
 - phlebotomy, medications, and dietary changes.

Thrombocytopenia

- Decrease in the number of platelets in the blood.
- Symptoms
 - Petechiae, ecchymosis, and bleeding from mucous membranes.
- Treatment
 - transfusions of platelets, splenectomy, medications, and diet changes.

Thrombocytopenia

- Immune Thrombocytopenic Purpura (ITP)
 - Manifestations—petechiae, purpura, bruising, epistaxis, hematuria, excess menstrual bleeding, bleeding gums
- Thrombotic Thrombocytopenic Purpura (TTP)
 - Manifestations—purpura, petechiae, headache, seizures, altered consciousness
- Heparin Induced Thrombocytopenia (HIT)
 - Manifestations—bleeding, arterial thrombosis, venous thrombosis

Anemia

- A deficiency in the number of erythrocytes (red blood cells), the quantity of hemoglobin, and/or the volume of packed red blood cells (hematocrit).
- Anemia can result from primary hematologic problems or can develop as a secondary consequence of defects in other body systems.
Lewis et al 2007

Pathophysiology

- Anemia
 - Decreased RBC production
 - Increased RBC loss
 - Increase RBC destruction
- Nutritional Anemias
 - Nutrient deficits affect RBC formation or hemoglobin synthesis
 - Inadequate diet
 - Malabsorption of the nutrient
 - Increased need for the nutrient

Classifications of Anemia

- Etiologic ~ related to the clinical condition causing the anemia
- Morphologic ~
 - Normocytic, normochromic: (normal size and color)
 - Acute blood loss, hemolysis, chronic kidney disease, chronic disease, cancer, aplastic anemia, sickle cell, pregnancy
 - Microcytic, hypochromic: (small size, pale color)
 - Iron deficiency anemia, Thalassemia, lead poisoning
 - Macrocytic, normochromic: (large size, normal color)
 - Vitamin B₁₂ deficiency, folic acid deficiency, liver disease, post splenectomy

Anemia ~ Causes

- Impaired or decreased RBC production
 - Iron deficiency, Pernicious Anemia, Aplastic Anemia
- Acute or chronic blood loss
 - Hemorrhage, chronic disease (ulcers)
- Increased erythrocyte destruction
(intrinsic/extrinsic) Hemolytic anemia, Sickle Cell,

Assessment

- Demographic data ~
 - Age, gender, general appearance, recent blood loss/trauma, surgery, other medical history
- Family history~
 - Endocrine, renal disease, hx of anemia
- Diet history ~
 - General dietary patterns, consumption of alcohol, pica

Assessment ~ Physical

- CNS- fatigue, LOC changes & Paresthesias
- Skin – pallor, jaundice, puritis
- Head, Neck & Eyes – vertigo, headache, irritability blurred vision, icteric eyes
- Cardiopulmonary - palpitations, tachycardia, bounding pulses, angina, edema, dyspnea
- Gastrointestinal – anorexia, hepatomegaly, dysphagia, splenomegaly, N&V, sore mouth, diarrhea bleeding
- Genitourinary – hematuria, menstrual irregularity
- Musculoskeletal – cramps bone pain, stiff joints
- General – weight loss, sensitivity to cold, lethargy

General Signs & Symptoms

- Pallor
- Listlessness
- Shortness of breath
- Tachycardia
- HGB decreased
- HCT decreased
- Fe decreased

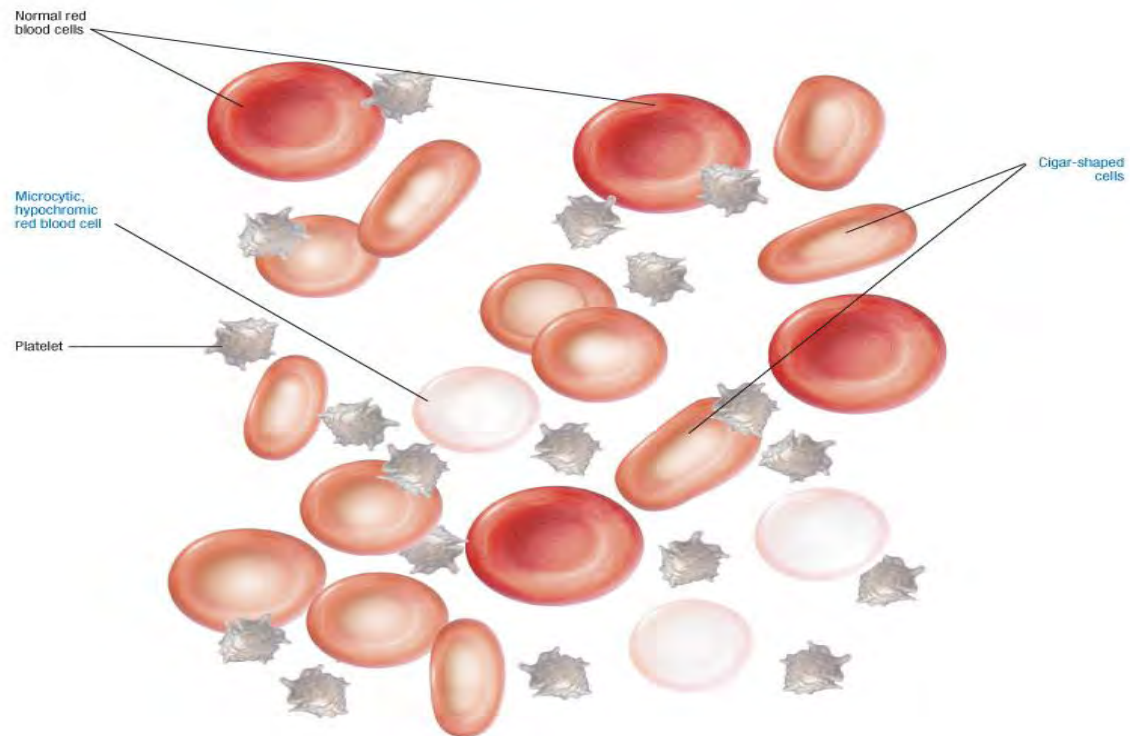
Iron (Fe) Deficiency Anemia

- Microcytic in origin
- Etiology:
 - Inadequate dietary intake, malabsorption, blood loss, or hemolysis
- Diagnostics:
 - Lab: RBC, Hgb, HCT, Fe results are lower than norm
 - WBC, platelets are normal, guaiac stool, scope
- Signs & Symptoms:
 - Pallor, Paresthesia, headache
- Treatment :
 - Treat underlying cause, increase iron in diet,
 - RX ferrous sulfate *PO/IM. Goal 150 – 200mg elemental iron. 1 hour before meals

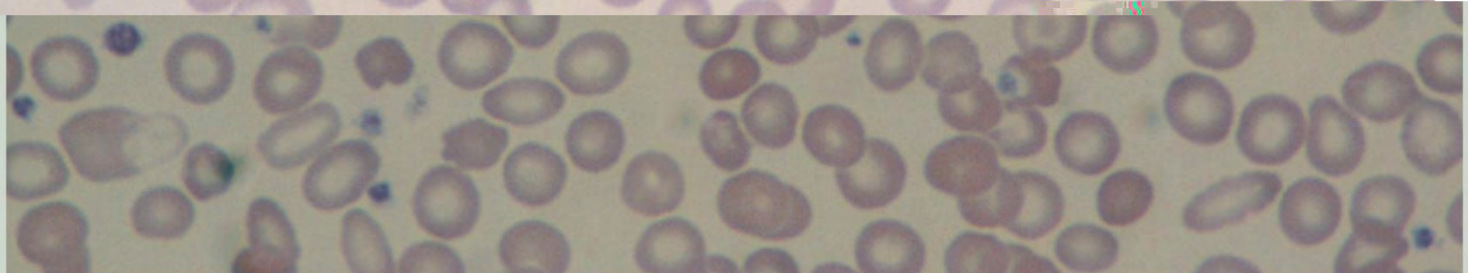
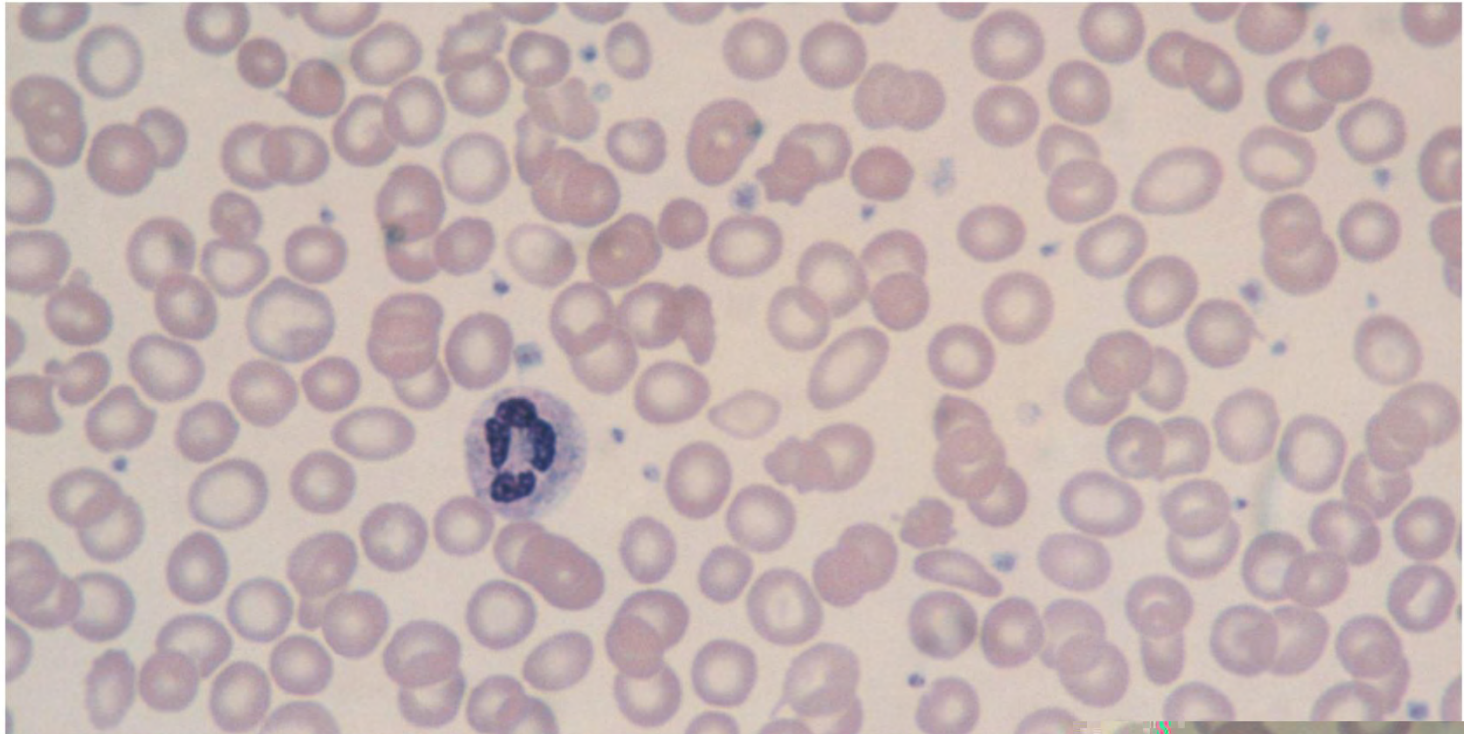
Anemia



PERIPHERAL BLOOD SMEARS IN IRON DEFICIENCY ANEMIA



Iron Deficiency Anemia



Causes

- Cancer of bone marrow
- Autoimmune destruction of bone marrow
- Vitamin deficiency
- Ingestion of many drugs or chemicals
- High-dose radiation & chemotherapy
- Various viral infections
- Frequently cause unknown

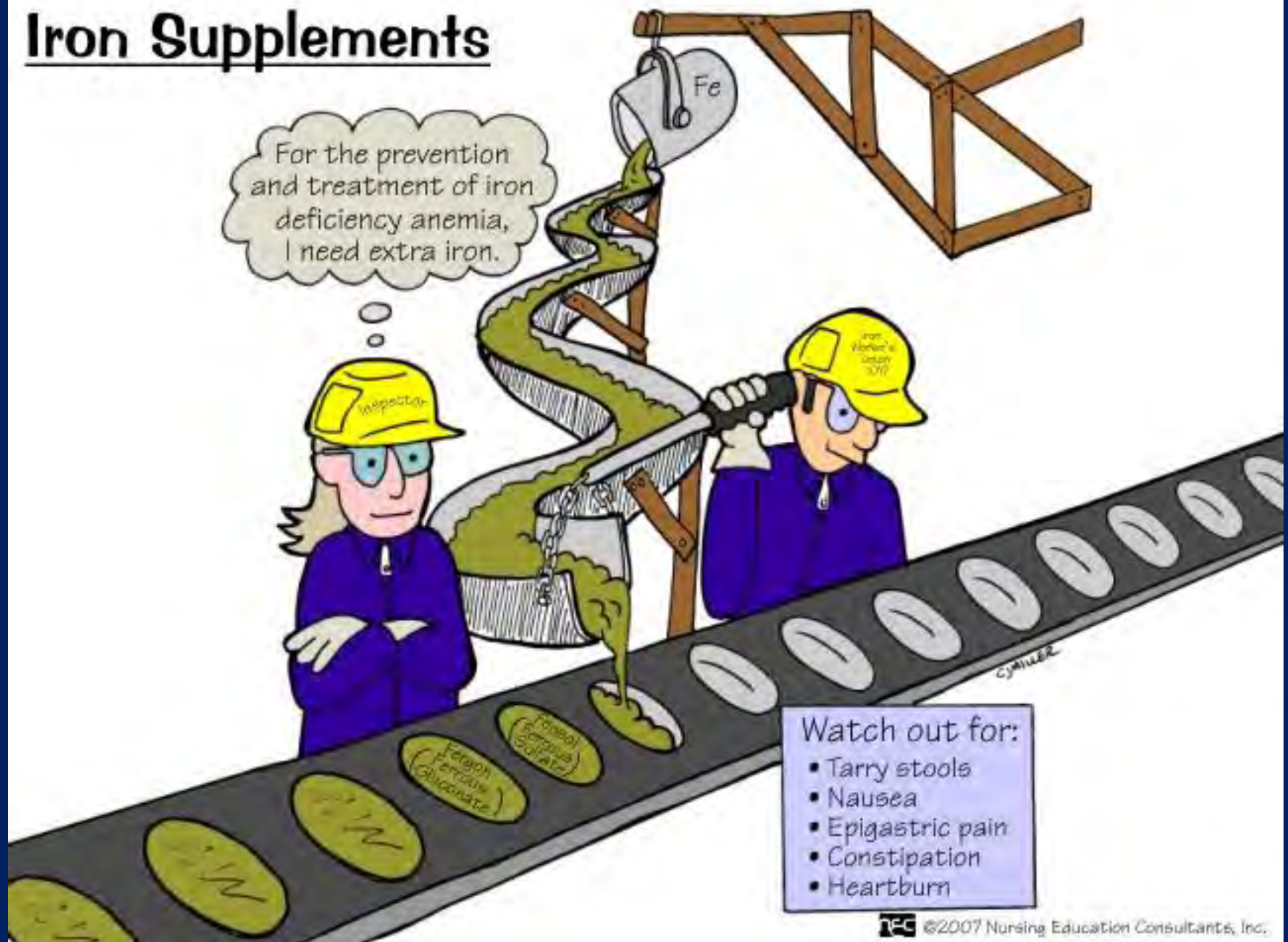
Clinical Manifestations

- Pancytopenia a deficiency of Erythrocytes, Leukocytes, and Thrombocytes
 - Classic systemic signs of anemia
 - If platelets & WBCs involved:
 - Bleeding from gums & teeth
 - Petechiae & purpura
 - Easy bruising
 - Recurrent infection
 - Poor healing skin & mucosal sores
 - Systemic signs of anemia once Hgb < 12
 - Seek treatment once Hgb ↓ 8
 - Pale palms, conjunctiva & earlobes

Treatment

- Iron-rich diet
 - Red meats
 - Dark green vegetables (spinach)
- Oral iron supplementation
- Treat cause of abnormal bleeding

Iron Supplements



Pernicious Anemia

- Macrocytic in origin
- Etiology
 - Vitamin B₁₂ deficiency, auto immune
 - Diagnostics
 - Large RBC's with abnormal shape, decreased vit B₁₂, gastric biopsy, Shilling test
 - Deficiency in Vit B₁₂
 - Essential for DNA synthesis in RBCs
 - Deficiency in intrinsic factor
 - Occur congenitally
 - Atrophy or destruction of gastric mucosa
 - Surgical removal of all or part of stomach

Clinical Manifestations

- Anorexia
- Nausea/vomiting
- Abd pain
- Confusion – dementia
- Weakness
- Ataxia
- Sensory loss
- Paresthesia

Treatment

- Must be diagnosed and treated quickly
- Vitamin B₁₂ deficiency that progresses more than 3 months may result in degenerative lesions of the spinal cord
 - Lifetime replacement of vitamin B₁₂
 - (cyanocobalamin)

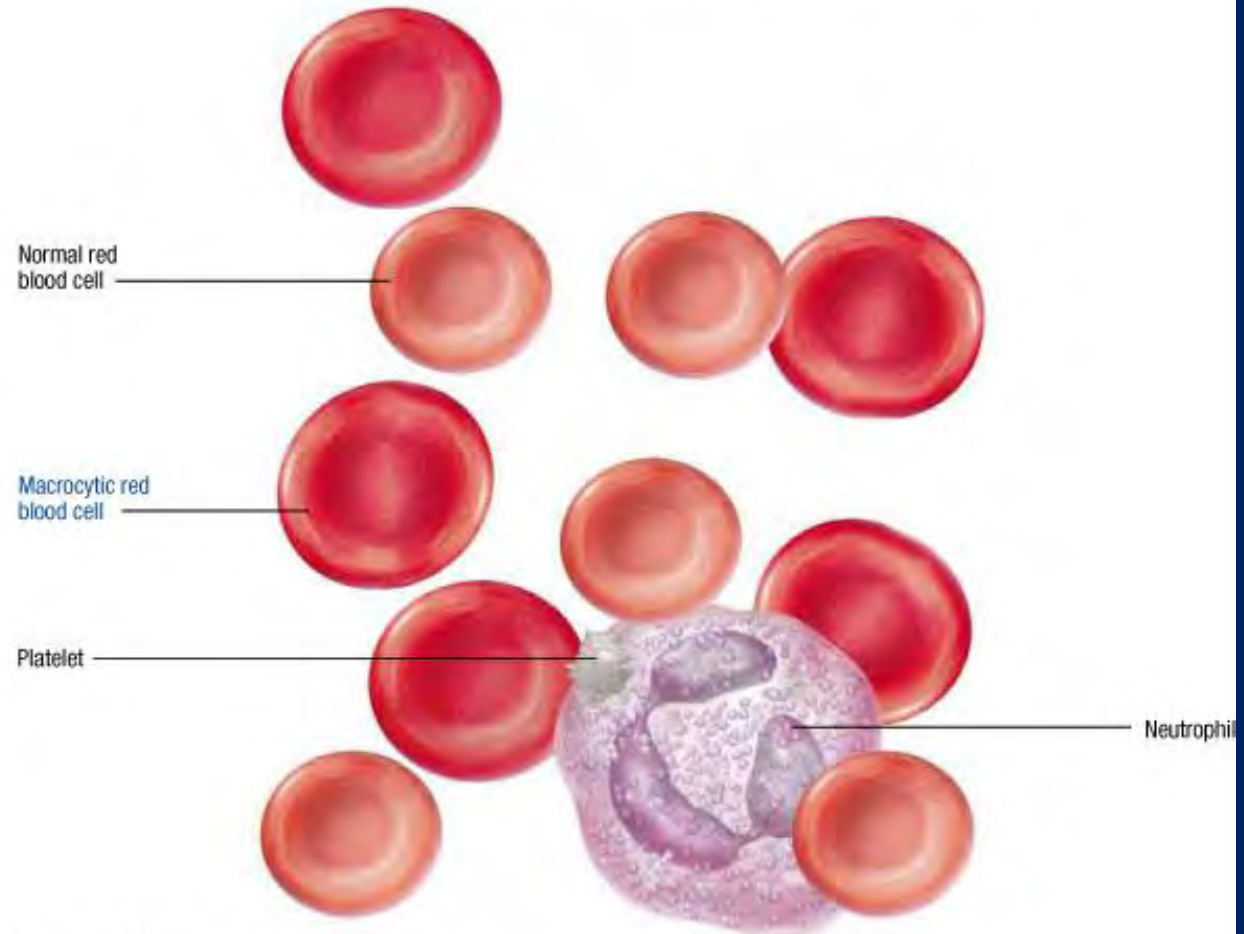
Aplastic Anemia

- Pathophysiology
 - Dysfunction of bone marrow
 - Dying blood cells are not replaced
 - Deficiency in RBCs, WBCs & platelets
 - Rarely affects only RBCs
- Etiology
 - infection, drugs, chemical exposure, virus, 50% unknown, Cancer of bone marrow
 - Autoimmune destruction of bone marrow
 - Ingestion of many drugs or chemicals
 - High-dose radiation & chemotherapy
 - Various viral infections

Aplastic Anemia

- **Diagnostics:**
 - Lab values (as above), bone marrow biopsy, serum iron
- **Signs & Symptoms:**
 - Fatigue, dyspnea, palpitations, pallor
- **Treatment:**
 - Bone marrow transplant, immunosuppressive agents, prednisone, blood transfusions

PERIPHERAL BLOOD SMEAR IN APLASTIC ANEMIA



Clinical Manifestations and Treatment

- Classic systemic signs of anemia

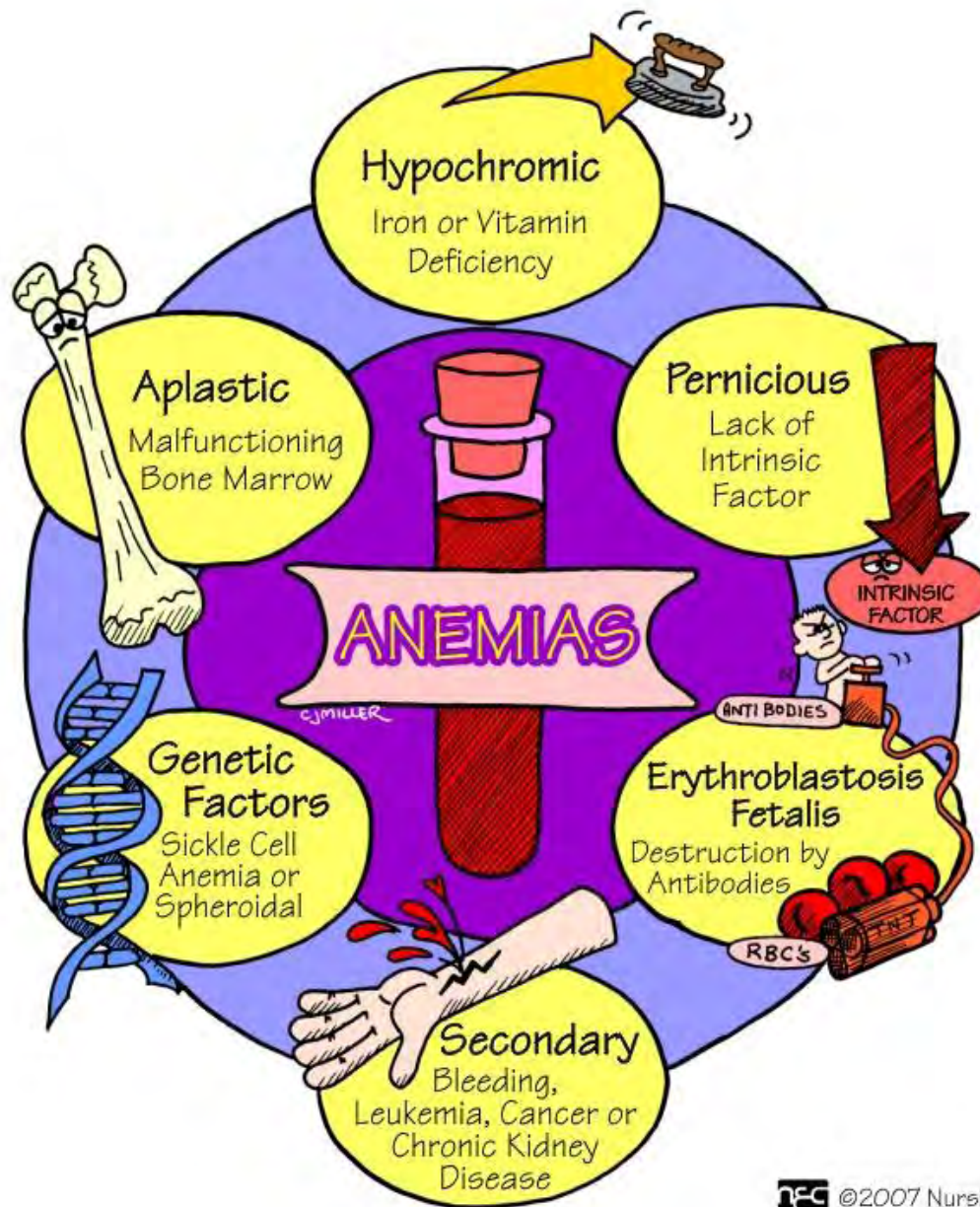
- Bleeding from gums & teeth
- Petechiae & purpura
- Easy bruising
- Recurrent infection
- Poor healing skin & mucosal sores

- Treatment

- Treat underlying disorder if known
- Remove causative agent
- Transfusions

Nursing Intervention

- Blood transfusions: note that transfusions are discontinued as soon as the bone marrow begins to produce RBCs.
- Immunosuppressive therapy to prevent the destruction of normal RBCs.
- Prepare the child for splenectomy, for the client with an enlarged spleen that is destroying normal RBCs or suppressing their development.



Problems of Hemostasis

- Hemostasis ~ a process to minimize blood loss from a damaged vessel involving vascular endothelium, platelets, and coagulation factors. Disruption in any of these components may result in bleeding or thrombic disorders.
- Major Disorders of homeostasis:
 - Thrombocytopenia (low platelets)
 - Hemophilia & von Willbrand disease
 - Disseminated intravascular coagulation (DIC)

Acute & Chronic Blood Loss

- Acute ~ sudden hemorrhage
- Etiology : trauma, surgery complications, conditions/diseases that disrupt vascular integrity.
- Diagnostics: serum lab values (H/H), symptoms
- S/S: **more important than lab values*. Dependent on volume lost.
 - 10% none, 20% none at rest, tachycardia with exercise
 - 30% postural hypotension, tachycardia with exercise
 - 40% BP, CVP & CO low, rapid thready pulse, cold/clammy
 - 50% shock & potential death
- Treatment: replace blood volume, treat cause of hemorrhage

Acute & Chronic Blood Loss

- Chronic ~ usually related to depletion of iron stores, usually considered an iron deficiency anemia
- Etiology: bleeding ulcers, hemorrhoids, menstrual bleeding
- Diagnostics: lab values
- S/S: same as iron deficiency
- Treatment: treat underlying cause, supplemental iron as needed

Clotting Mechanisms ~ Associated with Hemostasis

- Vascular Response
 - Blood vessel injury leads to immediate local vasoconstriction. Allows time for platelet response
- Platelet plug formation
 - Activated and clump together to form plug
- Plasma clotting factors
 - Plasma proteins are stimulated to initiate clotting via intrinsic (damaged blood vessel) or extrinsic pathways (injured tissues)

Hemophilia

- An X-linked recessive trait.
- Hemophilia A (classic hemophilia) results from a deficiency of factor VIII.
- Hemophilia B (Christmas disease) is a deficiency of factor IX.
- Males inherit hemophilia from their mothers, and females inherit the carrier status from their fathers.
- Some females who are carriers have an increased tendency to bleed, and, although it is rare, females can have hemophilia if their fathers have the disorder and their mothers are carriers of the genetic disorder.

Hemophilia

- Hemophilia A: 20.6 per 100,000 males
 - Severe: 50-60%
- Hemophilia B: 5.3 per 100,000 males
 - Severe: 44%

Types of Bleeds

- Diagnostics ~ serum laboratory values
 - PT, Thrombin time: normal
 - Partial thromboplastin time prolonged
 - Bleeding time prolonged in VW, normal Hemophilia A/B
 - Factor assays: hemophilia A VII is low, Hemophilia B IX is low, von Willebrand's vWF is low
- Signs & Symptoms ~
 - Slow persistent prolonged bleeding from minor trauma & cuts
 - Delayed bleeding after minor injuries – several hours/days
 - Bleeding gums, epistaxis, GI or GU bleeding
 - Hemarthrosis – bleeding into joints

Life-Threatening Bleeding

- Joint bleeding - hemarthrosis
- Muscle hemorrhage
- Soft tissue
- Life threatening-bleeding
- Symptoms of Joint or Muscle
 - Tingling or bubbling sensation
 - Stiffness
 - Warmth
 - Pain
 - Unusual limb position

Complications of Bleeding

- Head / Intracranial
 - Nausea, vomiting, headache, drowsiness, confusion, visual changes, loss of consciousness
- Neck and Throat
 - Pain, swelling, difficulty breathing/swallowing
- Abdominal / GI
 - Pain, tenderness, swelling, blood in the stools
- Muscle
 - Back pain, abdominal pain, thigh tingling/numbness, decreased hip range of motion

Complications Related to Concentrate

- Flexion contractures
- Joint arthritis
- Chronic pain
- Muscle atrophy
- Compartment syndrome
- Neurologic impairment

Treatment

Hepatitis

- Hepatitis A- small risk of transmission
 - Vaccination recommended
- Hepatitis B - no transmissions since 1985
 - Vaccination recommended
- Hepatitis C - no transmissions since 1990
 - ~90% of patients receiving factor concentrates prior to 1985 are HCV antibody positive

Human Immunodeficiency Virus

- No transmissions of HIV through factor concentrates since 1985 due to viral inactivation procedures
- HIV seropositive rate - 69.6% of patients with severe hemophilia A receiving factor concentrates prior to 1985

Factor VIII Concentrate

- Hemophilia A:
 - Cryoprecipitate, plasma, anti-hemophiliac factor, Koate, Humate, Hemofil
- Hemophilia B
 - Factor IX concentrate, plasma, Konyne, Proplex
- von Willebrand's Disease
 - Cryoprecipitate with factor VIII & VWF
 - Whole blood, plasma, plasma fractions, DDAVP
 - vW factor

Nursing Care

- Intravenous infusion
 - IV push
 - Continuous infusion
- Dose varies depending on type of bleeding
 - Ranges from 20-50+ units/kg. body weight
- Half-life 8-12 hours
- Each unit infused raises serum factor VIII level by 2 %

■ Goals ~

- control bleeding, prevent deformity, maintain function

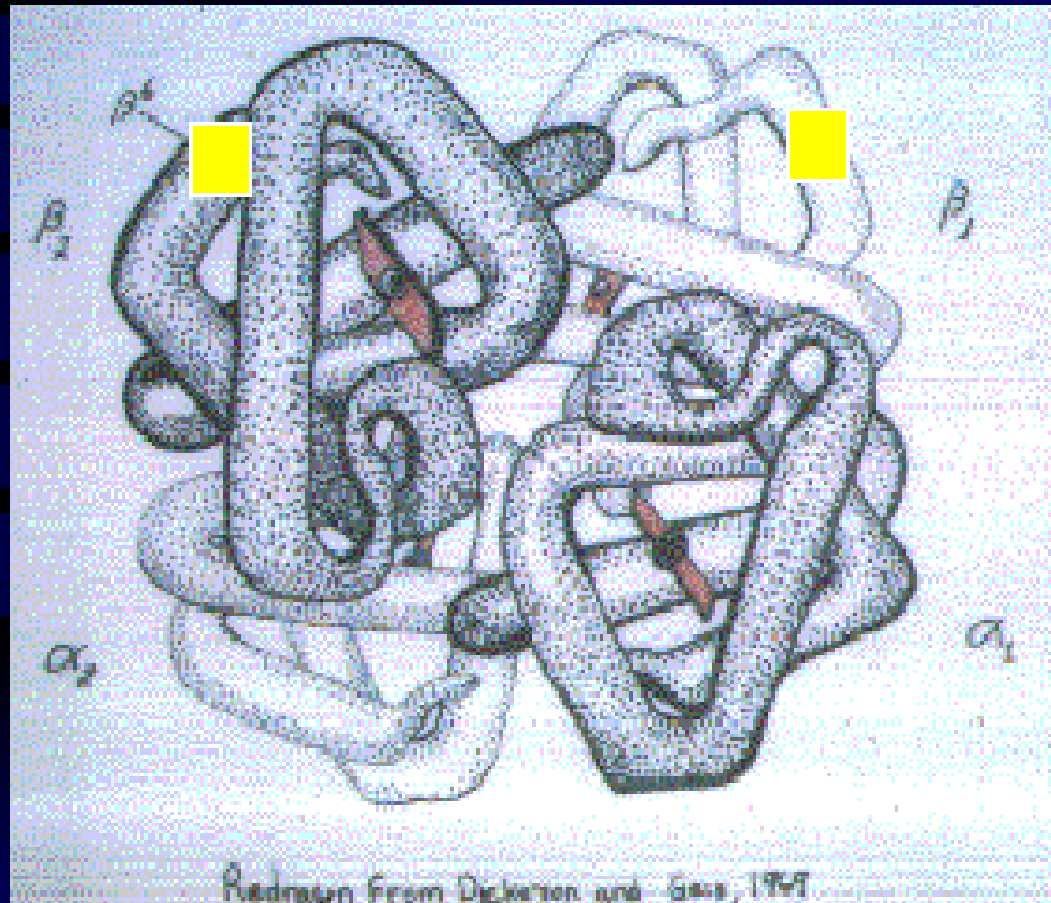
■ Nursing Care ~

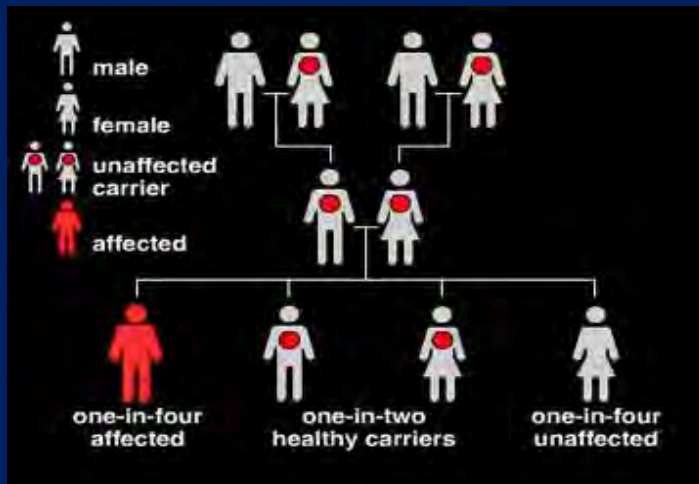
- Provide safe environment
- Assess for purpura, ecchymosis, CMS with bleeding
- Test stool, nasogastric output, emesis
- Assess abdominal girth, dressings, oral care
- Assess Hgb, Hct
- Not limitation of movement, analgesics
- Avoid injections, no aspirin
- Comfort measures – ice, elevate, immobilize
- Patient & family education

What is Sickle Cell Disease?

A person with sickle cell disease has one different substance in the way it makes hemoglobin. This substance is the amino acid valine in one spot where there should be glutamic acid.

This one change causes the chemical to form long strings when it lets loose of its' oxygen. This causes the red cell to become deformed into a "sickle" shape.





- Sickle Cell Disease (SCD) is a group of inherited, autosomal recessive disorders characterized by the presence of an abnormal form of hemoglobin (HbS) in the erythrocyte which causes the erythrocyte to stiffen and elongate taking on a sickle shape in response to low oxygen levels.



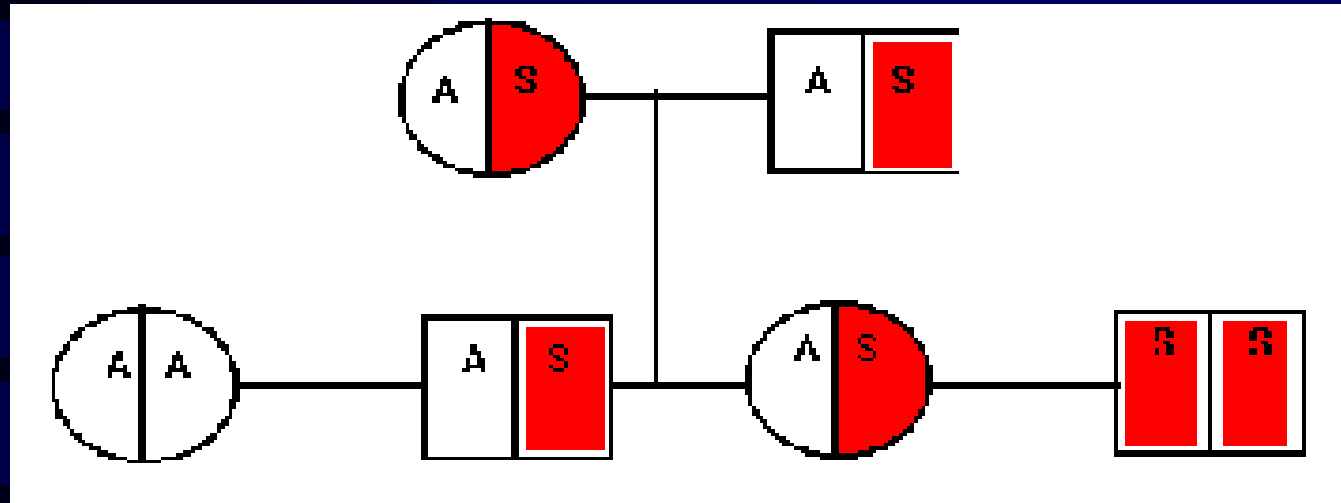
Diagnosis Sickledex

The presence of sickle hemoglobin can be rapidly determined by a five minute solubility test (Sickledex). This test is only helpful by identifying sickle cell disease without severe anemia or a very high fetal hemoglobin level with difficulty to separate sickle cell disease from sickle cell trait. It is not possible to separate sickle cell trait from individuals with disease.



- Etiology
 - SCD disorders include sickle cell anemia, sickle cell Thalassemia, sickle cell Hb C disease & sickle cell trait. Sickle cell anemia is the most severe. This occurs when the person inherits HbS from both parents.
- Pathophysiology
 - sickling of RBC's. triggered by low oxygen tension in the blood. The RBC's become "sickle" in shape. 20 – 50% of cells are sickled.
 - These cells can: clog up the blood vessels causing vascular occlusion

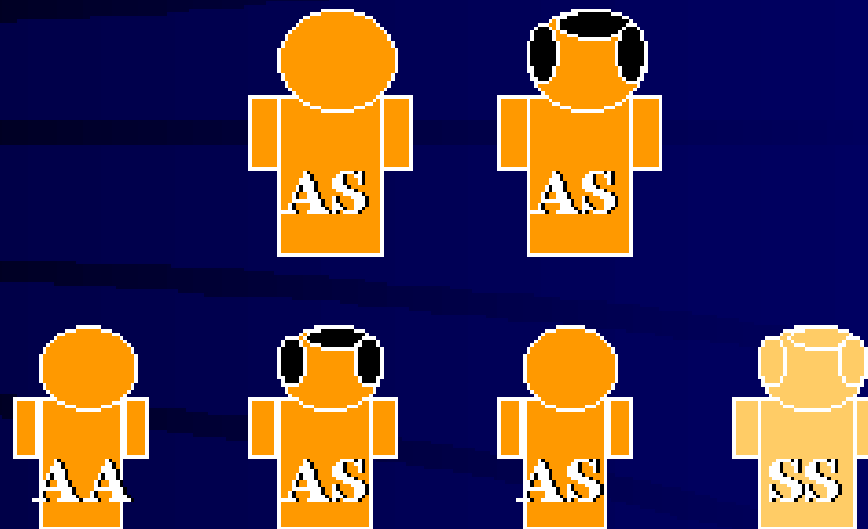
Pedigree



A pedigree is a map of the types of hemoglobin in the family tree. This helps to identify those with the trait and those with disease. In this pedigree, both parents have sickle trait, 1 in 4 children will have Sickle cell disease, one half will have trait and 1 in 4 will have normal hemoglobin



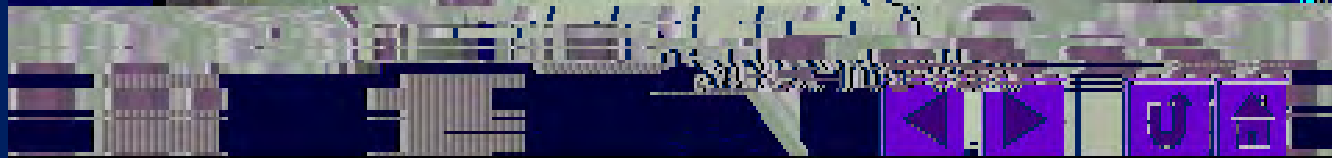
Pedigree



If an individual inherits an abnormal gene from each parent, 80-100 percent of the abnormal hemoglobin will be manufactured and the disease will result. There is a 1 in 4 chance of this happening



Diagnosis - Blood Smear

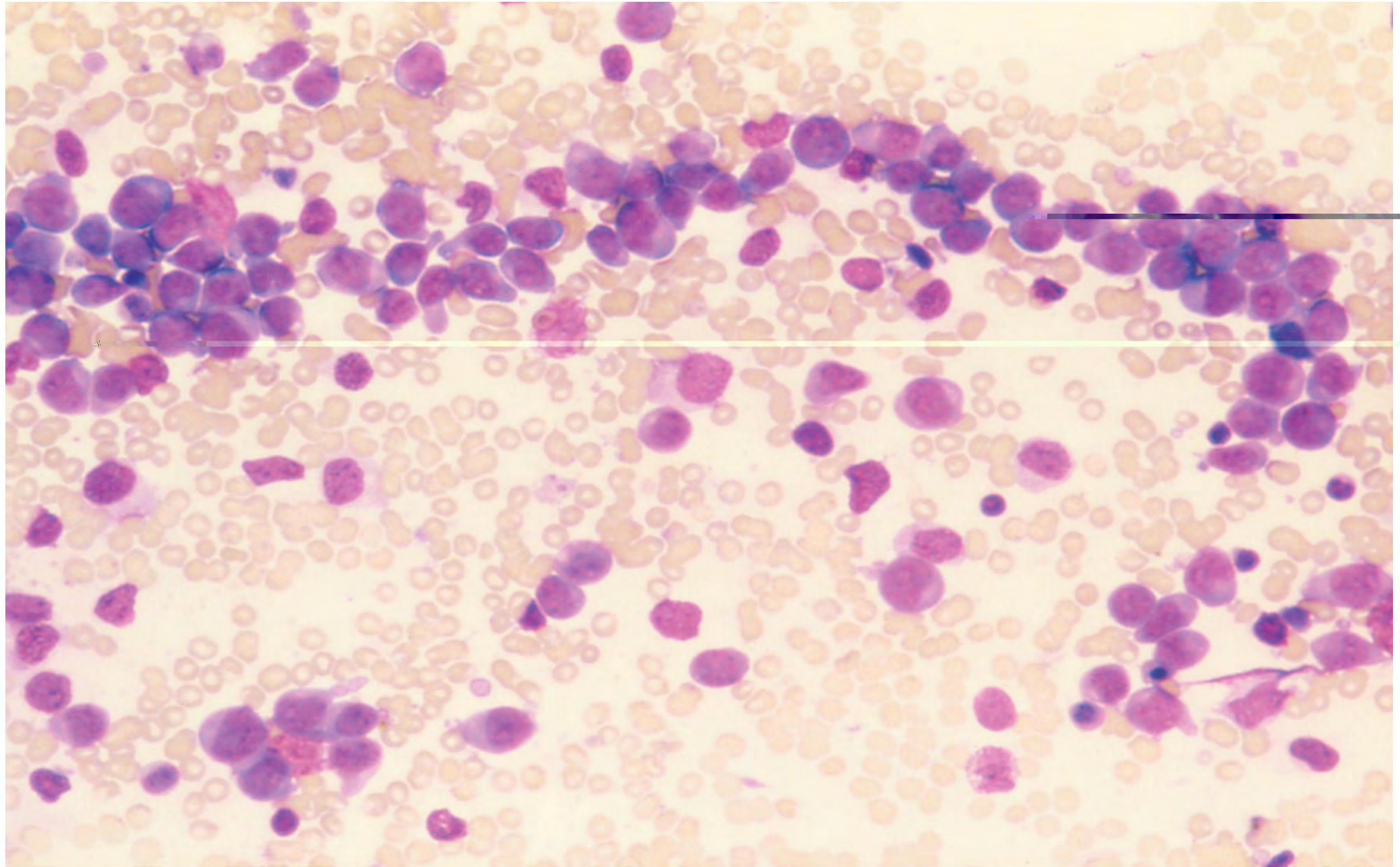


Normal red
blood cell

Sickle-shaped
red blood cell

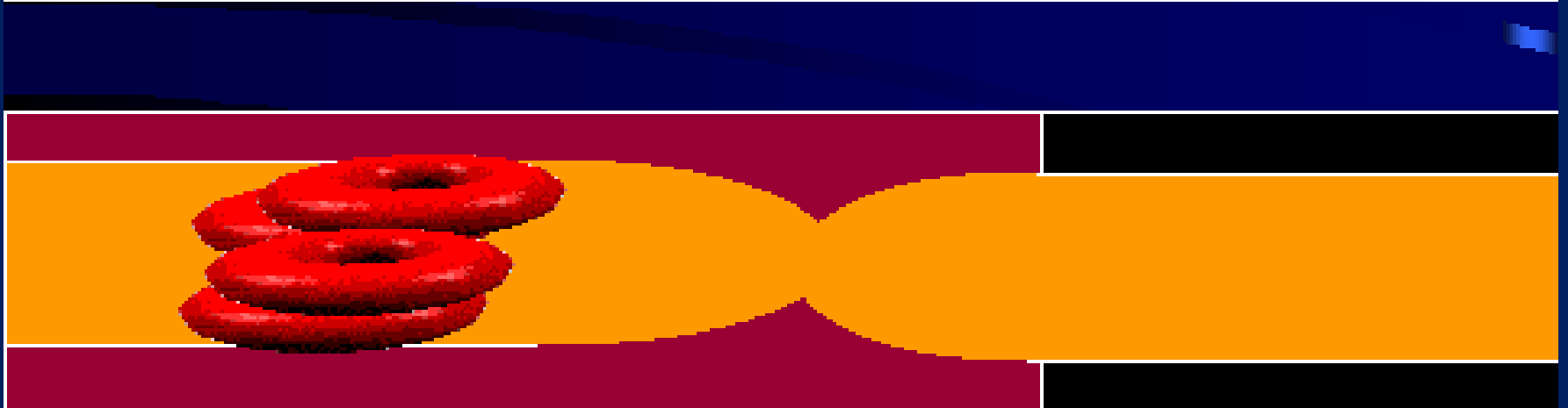
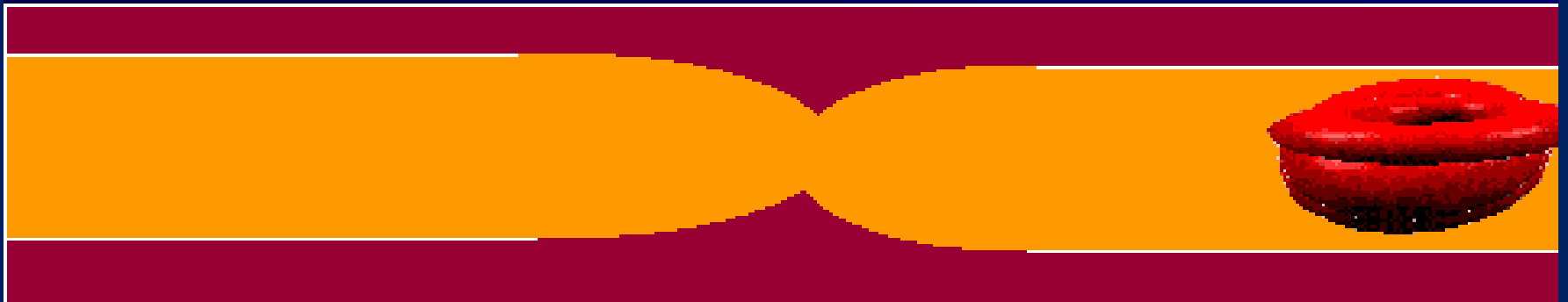


Figure 33-7 Blood cells magnified through a scanning electron microscope show normal and sickle-shaped red blood cells. (Courtesy of Philips Electronic Instruments Company.)



White and Duncan, Medical Surgical Nursing

Sickle red cells are stickier



**Sticky red cells block blood flow, then
pain and damage occurs**



- Characteristics

- Acute chest syndrome caused by occlusion of the pulmonary vessels results in chest pain, pneumonia, leukocytosis, and hypoxia leading to congestive heart failure and myocardial infarction.
- Peripheral blood smear showing classic distorted sickled erythrocytes.
- Positive HbS screening test
- Anemia
- Renal ischemia causing decreased urine concentration.

- Precipitating Factors

- Infections, high altitude, blood loss, stress, diaphoresis, anesthesia, temperature extremes, smoking, alcohol, caffeine, vasoconstrictive medications

Signs & Symptoms

- Situations that precipitate sickling include hypoxia, low environmental or body temperature, acidosis, strenuous exercise, dehydration, infections, or anesthesia.
- The process is reversible, but after repeated sickling the cell becomes permanently sickled.
- Treatment focuses on the prevention and treatment of crisis.

Crisis

- colicky behavior
- failure to thrive in a child
- swelling of hands and feet
- fatigue
- pallor
- weakness
- increased infection rate
- Hematuria
- pain
- Jaundice
- hepatosplenomegaly
- cardiomegaly
- shortness of breath

Sickle Cell Anemia

- Sickle cell
 - Severe painful exacerbation of RBC sickling leading to vasoocclusive crisis. Variable & unpredictable
 - Vasospasm, capillary hypoxia, hemoconcentration, thrombi
 - Tissue ischemia, infarction, necrosis,
 - Possible shock
- Complications
 - Anemia, stroke, pulmonary embolism, gallstones, renal tubular dysfunction, leg ulcers, aseptic necrosis, heart failure, eye damage, skeletal abnormalities, failure to thrive, “auto splenectomy”, infection

Nursing Intervention

- **Diagnosis:** serum lab tests reveal sickle shaped cells
- **Treatment:**
 - Oxygen, rest, fluids, analgesia, sedation, blood, folic acid, plasma pheresis, treat infections, stem cell transplant
- **Nursing Diagnosis & Care**
 - Symptom management, IV fluids, Blood, emotional support
 - DX: impaired mobility or gas exchange, knowledge deficit altered tissue perfusion or sensory perception

Treatment

- Prophylactic antibiotics until age 5
- Parenteral antibiotics for fever or signs of infection
- Ibuprofen or acetaminophen for pain
- ↑ hydration (1.5 to 2 X)
- Avoid O₂ demanding activities
- Therapeutic drugs
- RBC transfusion
- Bone marrow transplant

Nursing Implications

- Sickle Cell Crisis
 - Administer oxygen as prescribed.
 - Administer pain medication
 - Maintain adequate hydration and maintenance of blood flow with oral fluids and IV normal saline
 - Monitor peripheral pulses, color, sensation, motion, and capillary refill of extremities
- Instruct the child and parents about the importance of avoiding activities that lead to hypoxia
- Instruct the client to recognize the early signs and symptoms of crisis

■ Anemia

■ Medications

- Iron replacement therapy for iron deficiency anemia
- Parenteral vitamin B₁₂ for vitamin B₁₂ deficiency anemia
- Folic acid supplementation
- Hydroxyurea for sickle cell anemia
- Erythropoietin
- Immunosuppressive therapy to treat aplastic anemia

■ Treatments

- Blood transfusion

■ Nursing diagnoses

- Activity intolerance
- Impaired oral mucous membranes
- Risk for decreased cardiac output
- Self-care deficit

Question

- Your patient asks you, "What exactly is iron deficiency anemia?" You would explain that this condition is the result of:
 - a. the loss of iron from its storage place, the liver.
 - b. a lack of intrinsic factor in the liver that prevents the use of vitamin B₁₂.
 - c. a loss of iron that is greater than the available iron stored in the body.
 - d. loss of iron from red blood cells, but the iron stored remain the same

- When assessing the patient with thrombocytopenia, the nurse observes for:
- a. distended neck veins and skin discoloration.
- b. discoloration of the nails and sclera.
- c. petechiae on the skin and bleeding gums.
- d. enlarged thyroid gland and excitability.

- At the end of a shift, a nurse documents the effectiveness of parent teaching concerning the transmission of hemophilia. Which of the following statements by the mother would best indicate an accurate parental perception?
 - a. "Hemophilia is a genetic disorder and I am a carrier even though I do not have the disease."
 - b. "My son developed hemophilia because I had measles while I was pregnant."
 - c. Since my husband isn't affected by the disease, our daughter will not be a carrier."
 - d. "I know it is not necessary to have my two daughters tested for the disease."

- A patient comes into the clinic you work at and tells you they have pernicious anemia. You remember from your lecture way back in nursing school that this is a deficiency in vitamin B₁₂ and is caused by:
 - a. sickle cell disorder.
 - b. folic acid deficiency.
 - c. deoxygenated erythrocytes.
 - d. a lack of intrinsic factor.

- In case of an overdose of coumadin, the nurse would be sure that _____ is readily available.

- a suction machine
- b. protamine sulfate
- c. vitamin K
- d. a cardiac monitor

- In case of an overdose of heparin, the nurse would be sure that _____ is readily available.

- a. a suction machine
- b. protamine sulfate
- c. vitamin K
- d. a cardiac monitor

- A bone marrow biopsy is used to evaluate:
 - a. the marrow's production of white cells, red cells, and platelets.
 - b. the body's immune system and counts the red cell production.
 - c. the disease process and reaction to the prescribed pharmacology.
 - d. the cause for overstimulation of the white cell production