DISEASES OF THE BLOOD

CHAPTER 8

Learning Objectives

After studying this chapter, you should be able to

- Distinguish between formed elements and fluid portions of the blood
- Delineate the function of red blood cells, white blood cells, and platelets
- Identify the causes, signs, and symptoms of anemia, bleeding disorders, platelet disorders, and white blood cell disorders
- Describe various treatment modalities for anemia, bleeding disorders, platelet disorders, and white blood cell disorders
- Explain the role of various diagnostic tests in identifying systemic diseases and blood disorders

Fact or Fiction?

Sickling of red blood cells results from inadequate oxygen saturation of red blood cells.

Fact: In 1948, using the new technique of protein electrophoresis, Linus Pauling and Harvey Itano showed that abnormal hemoglobin was responsible for sickle cell disease. Sickle cell disease was the first disorder linked to the presence of a specific abnormal protein.
Four Body Humors

Prior to the time of Hippocrates (460–377 BCE), all illnesses were attributed to one disease with variable symptoms. Careful clinical observations by Hippocrates led to the recognition of specific disease states with identifying symptoms. It was during this time that the concept of body humors developed. The four fluid substances (humors) of the body were blood, phlegm, yellow bile, and black bile. Health depended on the proper balance of these humors. Bloodletting was a method used for adjusting one of the humors to proper balance. It was thought that blood carried the vital force of the body and was the seat of the soul; body weakness and insanity were ascribed to a defect in this vital fluid. Blood spurting from fallen gladiators was drunk with the hope that it would transfer strength to the recipient. Caspar Bartholin, MD, (1655–1738) described an epileptic girl in Breslau who drank the blood of a cat. The girl, so the report goes, became endowed with the characteristics of a cat. She climbed on the roofs of houses and imitated the manner of a cat by jumping, scratching, and howling. Not content with that, she would sit for hours gazing into a hole in the floor.
Introduction

The blood serves as the body’s major transport system. It is the medium for transporting oxygen from the lungs to the cells, and carbon dioxide waste from the cells to the lungs. Components of the blood protect the body from disease by recognizing and engulfing microorganisms and foreign molecules in the blood. Other components of the blood transport metabolic waste from the cells to the kidneys, nutrients from the digestive system to the cells, and hormones throughout the body.

The cellular components or formed elements of blood are red blood cells or erythrocytes, white blood cells or leukocytes, and clotting cells or platelets. Blood cells are suspended in the plasma or the fluid portion of circulating blood. Formed elements comprise about 45% of the blood, and plasma comprises the remaining 55%. The ratio of red blood cell–volume to whole blood is called hematocrit.

The plasma is the fluid portion of the blood. It contains water, proteins, potassium, sodium, chloride, potassium, and bicarbonate. It also contains metabolic waste products, hormones, nutrients, proteins, and gases. When platelets are removed from the plasma, the remainder is known as serum.

Red Blood Cells

The red blood cells make up about half of the blood’s volume. Unlike other cells in the body, red blood cells are biconcave sacs filled with hemoglobin that enables them to carry oxygen from the lungs to all the body tissues. Erythrocytes normally number about 5 million/mm³ of blood in males and 4.5 million/mm³ in females.

Red blood cells are produced in the red marrow of bones such as the vertebrae, ribs, and body of the sternum. The process of red blood cell formation, called erythropoiesis, is regulated by the hormone erythropoietin. Red blood cell synthesis begins with large, nucleated stem cells that progress through many stages before emerging as mature red blood cells. In the process, hemoglobin accumulates within the cytoplasm and the nucleus disappears. Mature red blood cells emerge from the bone marrow as reticulocytes.

Iron, vitamin B₁₂, and folic acid are critical nutrients for red blood cell synthesis and red blood cell integrity. Nutrient deficiencies, the presence of immature red blood cells, as well as the characteristic color and volume of red blood cells, are laboratory variables used to distinguish different types of anemia.

Anemia

Anemia is the condition of reduced numbers of red blood cells. Hemorrhages, excessive destruction, or impaired synthesis of red blood cells, and chronic diseases reduce the number of red blood cells and oxygen delivery to cells and tissues. Thus symptoms of anemia are due to tissue hypoxia or lack of oxygen. General symptoms of anemia include pallor or deficiency of color, fatigue, dizziness, headaches, decreased exercise tolerance, rapid heartbeat, and shortness of breath. Untreated anemia may progress to death from heart failure or cardiovascular collapse or shock.

Iron Deficiency Anemia

Iron deficiency is one of the most common causes of anemia. Increased iron requirements, impaired iron absorption, or hemorrhage may cause iron deficiency anemia. Without enough iron, the body fails to synthesize hemoglobin, and the ability to transport oxygen is reduced.

Iron requirements are greatest during the first two years of life. Adolescent girls may become iron deficient due to inadequate dietary iron, increased growth requirements, and the onset of menstruation. Likewise, a sudden growth spurt in adolescent boys may significantly increase physiological demands for iron, resulting in iron deficiency anemia. Supplemental iron is needed during pregnancy as iron is provided to the developing fetus.

Decreases in iron absorption occur with malabsorption syndromes and chronic disease. Iron absorption requires an intact gastrointestinal...
tract with healthy intestinal mucosal cells. Chronic disease, removal of the stomach, and bowel disorders limit availability of iron required for the synthesis of hemoglobin.

Symptoms specific to iron deficiency include a craving for ice, swelling of the tongue, and dry lips. The diagnosis of iron deficient anemia is confirmed by microscopic examination of the blood. Red blood cells are reduced in number and appear hypochromic, or lighter than normal, due to a lack of hemoglobin.

The first step in treating iron deficiency anemia is to identify and correct any causes of bleeding. Oral supplements are effective in those with an intact gastrointestinal tract. The addition of vitamin C enhances iron absorption. Injectable iron supplements are available for individuals with malabsorption or those who cannot tolerate oral supplementation.

Anemia of Chronic Disease

Anemia of chronic disease is the second leading cause of anemia worldwide. Chronic disease such as heart disease, cancer, arthritis, and infectious disease induce inflammatory changes that suppress red blood cell synthesis in the bone marrow and shorten survival of red blood cells already within the systemic circulation. The chronic nature of the disease usually parallels the severity of the anemia.

Vitamin B_{12} Deficiency Anemia

Vitamin B_{12} deficiency anemia, or pernicious anemia, is caused by inadequate absorption or intake of Vitamin B_{12} or a deficiency in a protein called intrinsic factor. Intrinsic factor is produced in the stomach and is essential for the absorption of vitamin B_{12} from the small intestine. Without vitamin B_{12} and intrinsic factor, the membranes of immature red blood cells rupture easily within the chemical environment of the blood stream. The result is fewer than normal red blood cells and consequently a reduced oxygen-carrying capacity.

Causes of pernicious anemia include inadequate diet, inadequate absorption, inadequate utilization, increased requirements, and increased excretion of vitamin B_{12}. Principal dietary sources of vitamin B_{12} come from animal products. Strict vegetarians who restrict all animal products develop pernicious anemia unless they consume vitamin B_{12} supplements. Abnormal bacterial growth in the small intestine and bowel disorders induce pathological changes that either impair absorption or enhance elimination of vitamin B_{12}. Removal of the stomach or the bowel impairs availability of intrinsic factor and limits absorption of vitamin B_{12}.

Symptoms of pernicious anemia include abdominal distress such as nausea and vomiting, and burning of the tongue. Neurological disturbances include numbness, weakness, and peculiar yellow and blue color blindness.

Vitamin B_{12} supplementation effectively reverses the effects of pernicious anemia. Because vitamin B_{12} cannot be absorbed into the bloodstream, it must be replaced by injection. Vitamin B_{12} supplementation is required for life for strict vegetarians and for those with chronic bowel disorders or individuals who have had their stomach or bowel partially or fully removed.

Folic Acid Deficiency Anemia

Folic acid deficiency anemia is common in the Western world where consumption of raw fruits and vegetables is low. Inflammation of the bowel as in Crohn’s disease and adverse effects certain medications impair absorption of folic acid. Body stores of folic acid are small and as such folic acid deficiency anemia occurs within a few months. Pregnant and lactating females, alcoholics, and individuals with kidney disease are especially susceptible to folic acid deficiency anemia owing to increased metabolic demands.

Measurement of serum folic acid levels is conclusive for folic acid deficiency anemia. Oral folic acid supplementation is effective in replacing folic acid and meeting increased requirements for those with increased metabolic demands.

Hemolytic Anemia

Hemolytic anemia is a reduction in circulating red blood cells that is caused by pathological conditions that accelerate destruction of red
blood cells. Inherited abnormalities such as hemoglobin defects, enzyme defects, and membrane defects impair intrinsic physical properties that are needed for optimal red blood cell survival. Infectious agents, certain medications, and immune disorders may also reduce red blood cell survival.

Significant red blood cell destruction produces symptoms similar to those of other anemias. Unlike other anemias, hemolytic anemia produces increased serum levels of bilirubin that result from the degradation of heme in destroyed red blood cells. Accumulation of bilirubin causes a jaundiced or yellow-orange appearance in the tissues, urine, and feces.

### Anemia Caused by Defective Hemoglobin Synthesis

**Hemoglobin**

Hemoglobin is composed of four protein chains: two alpha chains and two beta chains. Each chain is attached to a heme group that contains iron. Oxygen molecules bind to the heme portion of the hemoglobin to form oxyhemoglobin. Since single hemoglobin has four heme groups, it can transport four oxygen molecules. Hemoglobin also transports a small amount of carbon dioxide.

**Sickle Cell Anemia**

Sickle cell anemia is a genetically transmitted disorder marked by severe hemolytic anemia, episodes of painful crisis, and increased susceptibility to infections. Approximately 10% of African Americans have the sickle cell trait or are heterozygous for the disorder. Those with the disease are homozygous or have inherited two genes (one from each parent).

In sickle cell disease, red blood cells contain an abnormal form of hemoglobin, or hemoglobin S. As the red blood cell deoxygenates, hemoglobin S forms cross-links with other hemoglobin S molecules, and long crystals develop. Crystals continue to form as oxygen is released, and the red cells assume a sickled shape.

Sickled red blood cells are inflexible and rigid, and cause mechanical obstruction of small arterioles and capillaries, leading to pain and ischemia. Sickled cells are also more fragile than normal, leading to hemolysis. Tissue death secondary to ischemia causes painful crises that progress to organ failure with repeated occlusive episodes.

Sickle cell anemia cannot be cured. Treatment is aimed at preventing sickle cell crisis, controlling the anemia, and relieving painful symptoms. Painful crises are adequately managed with narcotic analgesics. Blood transfusions and fluid replacement expand blood volume and oxygen exchange needed for reperfusion of occluded vessels.

**Thalassemia**

Thalassemia is a group of inherited blood disorders in which there is deficient synthesis of one or more alpha or beta chains required for proper formation and optimal performance of the hemoglobin molecule. Several different categories of thalassemia produce mild to severe symptoms (Table 8–1).

The most severe forms of thalassemia produce severe, life-threatening anemia, bone marrow hyperactivity, and enlargement of the spleen, growth retardation, and bone deformities. Blood transfusions are required to sustain life, and life expectancy is reduced.

### Bleeding Disorders

**Platelets and Clotting Factors**

Bleeding disorders result from platelet dysfunction or deficiency, vitamin K deficiency, and clotting factor deficiencies. Platelets are blood elements produced in the bone marrow that are essential for blood clotting in response to immediate injury, and for the mobilization of clotting factors. Clotting factors are formed in the liver and released in response to tissue injury and platelet fragments to form insoluble fibrin clots. Vitamin K is required for the synthesis of the prothrombin and fibrinogen, clotting factors. Platelets, clotting factors, vitamin K, and cal-
### Alpha Thalassemia

<table>
<thead>
<tr>
<th>Thalassemia</th>
<th>Affected Protein Chain</th>
<th>Severity</th>
<th>Cultural Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silent carrier state</td>
<td>Alpha chain</td>
<td>Mild anemia</td>
<td>Africa, Middle East, India, Southeast Asia, Southern Asia, occasionally in the Mediterranean region</td>
</tr>
<tr>
<td>Hemoglobin Constant spring</td>
<td>Mutation of the alpha chain</td>
<td>Mild anemia</td>
<td></td>
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<tr>
<td>Mild alpha Thalassemia</td>
<td>Slight deficiency of alpha protein</td>
<td>Mild anemia</td>
<td></td>
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<tr>
<td>Hemoglobin H disease</td>
<td>Severe deficiency of alpha protein forms H hemoglobin</td>
<td>Severe disease, hemoglobin destroys red blood cells</td>
<td>Mediterranean region</td>
</tr>
<tr>
<td>Hemoglobin H constant spring disease</td>
<td>Deficiency in alpha protein is greater than in hemoglobin H disease</td>
<td>Severe anemia, greater destruction of red blood cells than in hemoglobin H disease</td>
<td></td>
</tr>
<tr>
<td>Homozygous constant spring</td>
<td>Similar to hemoglobin H disease</td>
<td>Generally less severe than hemoglobin H disease</td>
<td></td>
</tr>
<tr>
<td>Alpha thalassemia major, or hydrops fetalis</td>
<td>Complete lack of alpha chains</td>
<td>Death at birth or lifelong transfusions with constant medical care</td>
<td></td>
</tr>
</tbody>
</table>

### Beta Thalassemia

<table>
<thead>
<tr>
<th>Thalassemia</th>
<th>Affected Protein Chain</th>
<th>Severity</th>
<th>Cultural Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thalassemia minor or thalassemia trait</td>
<td>Lack beta protein</td>
<td>Mild symptoms</td>
<td>Mediterranean descent: Greeks, Italians; Arabian Peninsula, Iran, Africa, southeast Asia, Southern China</td>
</tr>
<tr>
<td>Thalassemia intermedia</td>
<td>Lack beta protein</td>
<td>Moderately severe anemia</td>
<td></td>
</tr>
<tr>
<td>Thalassemia major or Cooley’s anemia</td>
<td>Complete lack of beta protein</td>
<td>Severe life threatening anemia</td>
<td></td>
</tr>
</tbody>
</table>

Calcium are essential for hemostasis, or the arrest of bleeding.

**Vascular Bleeding Disorders**

**Purpura Simplex.** Purpura simplex, or easy bruising, usually affects women and appears to have a hereditary predisposition. Bruises develop without an apparent cause, and the vascular appears fragile. The number of platelets as well as the platelet activity is normal, and the condition is generally not serious. Bedrest and avoidance of products containing aspirin, which can suppress platelet function, is recommended.

**Hereditary Hemorrhagic Telangiectasia.** Hereditary hemorrhagic telangiectasia is a disorder characterized by malformations of the vasculature. This hereditary disorder affects both men and women. Red to violet telangiectatic lesions appear on the
face, lips, oral and nasal mucosa, as well as on
the tips of the fingers and toes. Telengiectatic le-
sions are due to abnormal dilation of existing or
small vessels. These vessels rupture easily and
form artificial shunts, or fistulas, to critical or-
gans of the body. Mild disease is characterized
by recurrent nosebleeds. With severe disease, ex-
tensive fistulas develop to the lungs, resulting in
shortness of breath and fatigue due to deficient
oxygenation. Infected emboli also develop in te-
leniectatic vessels, resulting in strokes or is-
chemia to brain.

Telengiectases in the nose and gastrointesti-
nal tract may be treated with laser ablation.
Large fistulas usually require surgical resection.
Multiple blood transfusions and continuous
iron therapy may be needed if blood loss is ex-
cessive.

### Platelet Disorders

**Thrombocytopenia** An abnormally small number
of platelets, or thrombocytopenia, result from con-
ditions that either impair production, increase
destruction, or cause sequestration of platelets.
Regardless of cause, prolonged bleeding results
from minor and major trauma. Spontaneous he-
morrhages are often-visible on the skin as small,
flat, red spots called petechiae, or as larger pur-
plish patches called ecchymosis. Spontaneous he-
morrhages may also occur in the mucous
membranes of the mouth and internal organs.

Suppression of the bone marrow by certain
medications or cancer may diminish platelet
production. Autoimmune disorders may in-
crease platelet destruction or impair platelet
function. Massive blood transfusions dilute cir-
culating platelets and decrease platelet viability.

Thrombocytopenia can usually be corrected
by treating the underlying cause. Preventative
measures such as bedrest to avoid accidental
trauma are highly recommended until platelet
counts increase to acceptable levels. Platelet
transfusions are reserved for severe thrombo-
cytopenia or in cases of severe bleeding.

**Primary Thrombocytopenia** Primary thrombo-
cytopenia is a marked increase in circulating
platelets due to unknown causes. Primary
thrombocytopenia occurs most frequently in
adult men and women during the sixth or sev-
enth decade of life. Symptoms are related to ab-
normal platelet function and thrombosis.
Thrombosis causes ischemia to the central ner-
vous system, the peripheral extremities, and vital
organs of the body. Symptoms include dizziness,
visual problems, headaches, difficulty breathing,
and extreme pain in the extremities. Bleeding
may result in some cases due to abnormal
platelet function.

### Disorders of Platelet Adhesion

**von Willebrand’s Disease** A mutation in the von
Willebrand factor gene causes a severe disorder
characterized by a tendency to bleed from mu-
cous membranes despite adequate levels of cir-
culating platelets. A deficiency in the von
Willebrand clotting factor as well as defective
platelet aggregation and adherence lead to ex-
cessive and prolonged bleeding and anemia.

Chronic medical treatment is generally not
required for most individuals with platelet-func-
tion disorders. The avoidance of aspirin that in-
hibits platelet function is recommended, as are
preventive measures prior to invasive medical,
surgical, or dental procedures. The most defini-
tive treatment for severe bleeding is platelet
transfusion.

### Blood Coagulation Disorders

**Hemophilia** Hemophilia is a sex-linked, inherited
coaulation disorder caused by a deficiency of
clotting factors. Because hemophilia is an X-
linked disorder, almost all symptomatic individ-
uals are males. Daughters of affected males have
a 50:50 chance of being carriers, whereas sons of
carriers have a 50:50 chance of having hemo-
ophilia.

The severity of hemophilia depends on how
the gene affects the activity of the clotting fac-
tors, the number of bleeds and whether the
bleeds occur spontaneously or with trauma.
Severely affected individuals may have two or
three bleeding episodes per month, may sponta-
neously bleed without noticeable trauma, or
may bleed profusely without immediate treat-
ment. Moderately affected individuals bleed ap-
proximately five or six times per year but may
have prolonged periods free of bleeding, and usually bleed only with trauma. Mildly affected individuals bleed rarely, unless provoked by significant trauma or surgery.

Severely affected individuals require regular transfusion to replace deficient clotting factors. Mildly affected individuals may occasionally need transfusions. In all cases, situations that might provoke bleeding should be avoided, and preventative medications can be administered prior to dental procedures and surgery.

White Blood Cells

Leukocytes, or white blood cells, include neutrophils, eosinophils, basophils, monocytes, and lymphocytes. White blood cells are synthesized in the bone marrow from their respective stem cells. The primary function of leukocytes is to defend tissues against infections and foreign substances. Quantitative abnormalities, inherited acquired defects, and neoplastic alterations result in disease and disability.

Disorders of White Blood Cells

Neutropenia A reduction of circulating neutrophils increases the risk for bacterial and fungal infections. Because neutrophils are responsible for most clinical findings during an acute infection, the classic signs of infection may be diminished or absent in a severely neutropenic individual.

Neutropenia is a frequent complication of medication used for cancer chemotherapy or medications used for immune suppression. These medications suppress cellular proliferation within in the bone marrow. Infectious complications depend on the severity of neutropenia and are usually profound and severe in cancer patients.

Immune destruction of neutrophils occurs with rheumatoid arthritis or as a primary condition with unknown causes. Neutropenia may be either mild or severe, and infectious complications are variable. Chronic and severe cases require medical treatment with medications that increase neutrophil proliferation or medications that suppress immune function.

Neoplastic Abnormalities of Leukocytes

Leukemia Leukemia, or cancer of the white blood cells, results in production of a large number of abnormal leukocytes. Overproduction of malignant white cells suppresses the production of red blood cells and platelets. Organs where blood is stored, such as the liver and the spleen, become greatly enlarged with infiltration of malignant white blood cells.

The cause of leukemia is unknown, but it may be due to a virus or exposure to radiation. A high incidence of leukemia has been reported in areas around the world exposed to fallout from nuclear energy. Heredity may also play a part in its etiology. Table 8–2 compares the types of leukemias.

Signs and symptoms of leukemia include fever, swollen lymph nodes or lymphadenopathy, joint pain, abnormal bleeding, and weight loss. Anemia with its manifestations of weakness, shortness of breath, and heart palpitations accompanies leukemia. Blood clotting is reduced with a reduction of platelets, causing a tendency to bruise and hemorrhage. White blood cells are produced faster than they mature and are ineffective in fighting infections.

The two main types of leukemia are named for the site of the malignancy. If the cancer originates in the bone marrow, it is called myelogenous leukemia because the primitive white cells in this tissue are called myelocytes. In myelogenous leukemia, neutrophil production is greatly increased, and both red blood cells and platelets production is suppressed.

The other type of leukemia is a lymphocytic leukemia and results from malignancy of the lymphatic cells, found both in the bone marrow and lymph nodes. The lymphocytes in this case are the only blood cells that are increased; however, they become disproportionately high in number and are immature and ineffective.

Both types of leukemia can be chronic or acute. Acute lymphocytic leukemia is the more common form in children. It has an abrupt onset and progresses rapidly. Immature lymphocytes with diminished activity accumulate
in the systemic circulation, and symptoms appear rapidly.

Acute myelogenous leukemia is more common in adults. Chronic forms of leukemia produce cells that undergo some maturation and are at least partially functional. Because the cells do function, the disease is slow to develop and is often discovered by accident, during routine blood tests.

Progress is being made in controlling and finding a cure for leukemia. Treatment goals include eliminating leukemic cells by inhibiting their growth, maintaining remission, and preventing complications from the disease and its treat-
ments. Chemotherapy medications inhibit the growth of malignant cells and healthy cells. The side effects of chemotherapy are due in part to growth suppression of healthy cells. The ability of the patient to tolerate adverse medication effects determines the intensity of the chemotherapy. Remission is possible in 50% to 90% of patients.

Abnormalities of Monocytes

Myelomonocytic Leukemia Myelomonocytic leukemia is a variation of acute myelogenous leukemia most commonly seen in adults. Common symptoms are fever, weight loss, lymphadenopathy, enlarged spleen, anemia, and thrombocytopenia. This disorder is rapidly fatal if left untreated. With treatment, current survival is approximately 40%.

Abnormalities of Eosinophils and Basophils

Idiopathic Hypereosinophilic Syndrome The onset of idiopathic hypereosinophilic syndrome occurs between the ages of 20 and 50 years, and there is a strong male predominance. Persistent increases in blood eosinophils and associated involvement of the heart and nervous system are responsible for the most important clinical symptoms. Cardiac involvement produces congestive heart failure, valvular dysfunction, conduction defects, and myocarditis. Congestive heart failure is a frequent cause of death. Neurologic findings may include altered behavior and cognitive function, spasticity, and ataxia.

Prognosis in the idiopathic hypereosinophilic syndrome historically has been poor, with median survival of approximately 1 year. However, chemotherapy has recently been reported to produce 70% survival at 10 years.

Eosinophilia-Myalgia Syndrome A recently described disorder, eosinophilia-myalgia syndrome is a chronic, multisystem disease with a spectrum of clinical symptoms ranging from self-limited myalgias, or muscle pain, and fatigue to a progressive and potentially fatal illness characterized by skin changes, nervous system abnormalities, and pulmonary hypertension. Elevation of circulating levels of eosinophils is a universal feature of this disorder, and the illness has been related to ingestion of the dietary supplement L-tryptophan.

Diagnostic Tests

Blood tests are diagnostic for systemic diseases as well as specific blood disorders. Blood analysis measures total blood counts (red blood cells, white blood cells, and platelets), hemoglobin, hematocrit, serum chemistry, and enzyme and hormone levels within the body. Differential blood analysis provides qualitative information such as size, shape, and ratio of one cell type to another.

A bone marrow smear is used to diagnose malignant blood disorders and increases or decreases in blood counts without any apparent cause. Bone marrow samples are obtained by needle aspiration of the bone marrow from the bone marrow cavity. Bone marrow analysis provides information on the function of the bone marrow and the qualitative characteristics of stem cells that give rise to all blood cells.

CHAPTER SUMMARY

The blood is the connective tissue that transports red blood cells, platelets, white blood cells, proteins, and nutrients. Normal amounts of all blood cells are essential for life. Elevations or deficiencies in blood cells are due to conditions that suppress or enhance growth and differentiation, including malignancies, certain medications, environmental exposures, nutrient deficiencies, and inherited genes.

RESOURCES


## DISEASES AT A GLANCE

### Diseases of the Blood

<table>
<thead>
<tr>
<th>DISEASE/DISORDER</th>
<th>ETIOLOGY</th>
<th>SIGNS AND SYMPTOMS</th>
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<tbody>
<tr>
<td>Iron deficiency anemia</td>
<td>Increased iron requirements</td>
<td>Pallor</td>
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<td></td>
<td>Impaired iron absorption</td>
<td>Fatigue</td>
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<td>Hemorrhage</td>
<td>Shortness of breath</td>
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<td>Chronic disease</td>
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<td>Vitamin B₁₂ deficiency anemia</td>
<td>Malnutrition</td>
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<td>Strict vegetarianism</td>
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<td></td>
<td>Deficiency of intrinsic factor</td>
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<td>Burning of the tongue</td>
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<td>Folic acid deficiency anemia</td>
<td>Inflammation of the bowel</td>
<td>Pallor</td>
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<td></td>
<td>Certain medications that impair absorption of folic acid</td>
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<td></td>
<td>Pregnancy and lactation</td>
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<td>Genetics: results in formation of abnormal hemoglobin</td>
<td>Pallor</td>
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<td>Fatigue</td>
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<td>Shortness of breath</td>
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<td>Fatigue</td>
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<td>Purpura simplex</td>
<td>Genetics</td>
<td>Easy bruising</td>
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<td><strong>DIAGNOSIS</strong></td>
<td><strong>TREATMENT</strong></td>
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<td>Treatment of hemorrhage</td>
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<td>Blood test</td>
<td>Vitamin B₁₂ supplementation</td>
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<td>Genetic testing</td>
<td>Prevention of sickle cell crisis</td>
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<td>Blood test</td>
<td>Supportive care during crises</td>
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<td>Blood transfusion</td>
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<td>Genetic testing</td>
<td>Supportive care</td>
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<td>Blood test</td>
<td>Blood transfusions if anemia is severe</td>
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<td>Treatment of iron overload for frequent transfusions</td>
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<td>Blood test</td>
<td>Bedrest</td>
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<tr>
<td>Rule out other disorders</td>
<td>Avoidance of aspirin or products that suppress platelet function</td>
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<td>Family history</td>
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<tr>
<td>Rule out other disorders</td>
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<td>Surgical resection</td>
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<td>Blood transfusions</td>
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</tr>
<tr>
<td></td>
<td>Iron therapy if blood loss is excessive</td>
<td></td>
</tr>
</tbody>
</table>
## DISEASES AT A GLANCE (continued)

<table>
<thead>
<tr>
<th>DISEASE/DISORDER</th>
<th>ETIOLOGY</th>
<th>SIGNS AND SYMPTOMS</th>
</tr>
</thead>
</table>
| Thrombocytopenia | Conditions that impair production or cause sequestration of platelets | Bleeding  
                                 |                                                   | Spontaneous hemorrhage |
| Thrombocythemia  | Unknown  | Clotting  
                                 |                                                   | Central nervous system damage |
| von Willibrand’s disease | Genetic hereditary disease | Bleeding tendency despite adequate levels of circulating platelets |
| Hemophilia       | Genetic hereditary disease | Bleeding tendency |
| Neutropenia      | Immune suppression, Chemotherapy, Radiation therapy | Infections  
                                 |                                                   | Fever |
| Leukemia         | Unknown  | Fever  
                                 | Virus  
                                 | Swollen lymph nodes  
                                 | Anemia |
| Myelomonocytic leukemia | Unknown  | Fever  
                                 | Virus  
                                 | Swollen lymph nodes  
                                 | Anemia |
| Idiopathic hypereosinophilic syndrome | Unknown  | Congestive heart failure  
                                 | Virus  
                                 | Valvular defects  
                                 | Myocarditis |
| Eosinophilia myalgia syndrome | Unknown  | Muscle pain  
                                 | Ingestion of L-tryptophan  
<pre><code>                             | Weakness |
</code></pre>
<table>
<thead>
<tr>
<th>DIAGNOSIS</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood test</td>
<td>Platelet transfusions</td>
</tr>
<tr>
<td>Blood test</td>
<td>Medical treatment to prevent complications</td>
</tr>
<tr>
<td>Blood test, Genetic testing</td>
<td>Platelet transfusion</td>
</tr>
<tr>
<td>Blood test, Genetic testing</td>
<td>Transfusion of deficient clotting factor(s)</td>
</tr>
<tr>
<td>Blood test</td>
<td>Medications that increase production of neutrophils</td>
</tr>
<tr>
<td>Blood test</td>
<td>Chemotherapy</td>
</tr>
<tr>
<td>Blood test</td>
<td>Radiation</td>
</tr>
<tr>
<td>Blood test</td>
<td>Chemotherapy</td>
</tr>
<tr>
<td>Blood test</td>
<td>Radiation</td>
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<td>Chemotherapy</td>
</tr>
<tr>
<td>Blood test</td>
<td>Radiation</td>
</tr>
<tr>
<td>Blood test</td>
<td>Avoidance of potentially offending agents</td>
</tr>
<tr>
<td></td>
<td>Pharmacotherapy for pain</td>
</tr>
</tbody>
</table>
Cases for Critical Thinking

1. A 17-year-old male presents to the emergency room with severe abdominal pain and shortness of breath. The whites of his eyes appear yellow. A blood count reveals a low red blood cell count and impaired hemostasis. What disorders do you suspect this patient to have? What other information do you need to obtain from the patient to make a correct diagnosis?

2. A 37-year-old female seeks medical attention for increasing fatigue and several bruises that appeared on her legs for no apparent reason. Her blood differential reports the following results: elevated neutrophils with many immature cells, anemia, iron deficiency, and slightly decreased platelet counts. The nurse practitioner suspects that the patient has anemia and a bacterial infection from poor nutritional habits. Rest with iron therapy is prescribed. Do you agree or disagree with this assessment? What are some other possible causes for these symptoms? What additional information do you need to narrow down your diagnosis?

Multiple Choice

1. The ratio of red blood cell–volume to whole blood is called _____________.
   a. hematocrit  b. thrombocytes  c. monocytes  d. lymphocytes
2. Decreases in red blood cells are caused by _____________.
   a. hemorrhages  b. excess destruction  c. chronic diseases  d. all the above
3. Hemophilia is a deficiency of _____________.
   a. platelets  b. hematocrit  c. clotting factors  d. monocytes
4. The most severe forms of thalassemia are _____________.
   a. beta thalassemia major  b. hemoglobin H disease  c. alpha thalassemia major  d. all of the above
5. Compared to chronic leukemia, acute leukemia _____________.
   a. is less severe  b. is shorter in duration  c. occurs abruptly  d. progresses slowly
6. The most common cause of anemia is _____________.
   a. iron deficiency  b. folic acid deficiency  c. vitamin B₁₂ deficiency  d. intrinsic factor deficiency
7. Fever, swollen lymph nodes, and weight loss are common symptoms of _____________.
   a. leukemia  b. eosinophilia  c. thrombocytopenia  d. neutropenia
8. Unlike other anemias, hemolytic anemia results in accumulation of _____________.
   a. iron  b. bilirubin  c. heme  d. folic acid
9. Absorption of vitamin B₁₂ in the absence of intrinsic factor results in _____________.
   a. hypoxia  b. shortness of breath  c. anemia  d. all of the above
10. Sickled red blood cells result in _____________.
    a. iron deficiency and folic acid deficiency  b. ischemia and hemolysis  
    c. pain and inflammation  d. immune suppression and hemorrhage
Chapter Eight  Diseases of the Blood  145

True or False

1. von Willebrand’s disease results in decreased platelet adherence.  
2. Red blood cells in iron deficiency anemia are reduced in number and are hypochromic.  
3. Measurement of serum folic acid levels is diagnostic for pernicious anemia.  
4. Accelerated destruction of red blood cells with breakdown of heme is characteristic of platelet dysfunction.  
5. In general, the severity of thalassemia is related to the number of affected beta chains.  
6. Platelet production may be diminished by immune-suppressing agents.  
7. The primary blood cells that are affected in lymphocytic leukemia are the lymphocytes.  
8. Eosinophilia is related to ingestion of L-tryptophan.  
9. Petechiae or ecchymosis is a frequent complication of anemia.  
10. Primary thrombocythemia, or increases in circulating platelets, may be associated with bleeding.

Fill-Ins

1. White blood cells are called _____________.
2. Mature red blood cells are called _____________.
3. Oxygen combines with hemoglobin to form _____________.
4. Sickle cell disease causes formation of _____________ that forms cross-links and sickling of red blood cells.
5. Hemoglobin consists of _____________ and _____________.
6. Cancer of the white blood cells that originates in the bone marrow is called _____________.
7. Cancer chemotherapy frequently suppresses proliferation of white blood cells required to fight _____________ and _____________ infections.
8. Thrombocytopenia is a decrease in the circulating levels of _____________.
9. Myalgias, fatigue, skin changes, nervous system abnormalities, pulmonary hypertension, and elevations of eosinophils are characteristic of _____________.
10. Blood analysis measures _____________ and _____________ characteristics of blood cells.

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