

UNDERSTANDING THE COMPLETE BLOOD COUNT

Series 107

THE RED CELLS (107.1)

This Instructor's Guide contains:

Brief Description, Objectives, Discussion Questions, Pretest, Post-test, Answer Keys, Glossary, and Tables for this program, Understanding the Complete Blood Count: The Red Cells. The questions included in this Guide follow the NCLEX model. Institutions that have purchased this program from Concept Media have permission to duplicate any of the contents of this Instructor's Guide for teaching purposes.

Understanding the Complete Blood Count: The Red Cells

Program Description:

The Red Cells is the first part in the series examining the Complete Blood Count (CBC). It describes the formation and function of the erythrocytes, as well as relevant laboratory values including the RBC count, and hemoglobin / hematocrit levels. Different types of anemia and polycythemia are described, as are the etiology and symptoms of each disorder. Using laboratory slides, electron photomicrographs, and actual clinical settings, this program gives a detailed overview that is rich in visuals and easy to comprehend.

Objectives:

Upon completion of this program, the learner will be able to:

1. Describe the lifecycle of the erythrocyte.
2. State the normal ranges for the red blood cell count, hemoglobin level, and hematocrit.
3. Name five causes of anemia.
4. Describe the complications of polycythemia.
5. Discuss appropriate ways to obtain and handle blood samples.

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Previewing Questions:

True or False

1. The fluid portion of blood without fibrinogen is called serum.
2. Red blood cells become smaller as they mature.
3. Vitamin A is needed for the formation of RBCs.
4. RBCs usually survive about 150 days.
5. Normal adult RBC count ranges from 4 to 5.4 million/mm³.
6. Individuals with kidney dysfunction are likely to be anemic.
7. In spherocytosis, the membranes of the RBCs have defects which make them fragile.
8. A person living in Death Valley is more likely to have polycythemia than one who lives in Denver.
9. Cigarette smokers have a lower RBC count than non-smokers.
10. Adult hemoglobin ranges from 12 to 17 gm/dL.
11. Adults have a predominance of hemoglobin F.
12. In the United States, the most common inherited hemoglobinopathy is sickle cell disease.
13. Hematocrit is usually one-third of the hemoglobin value.
14. Normal adult hematocrits range from 36 to 51 percent of whole blood.
15. Hematocrit is decreased during pregnancy.
16. A CBC analysis should not be run on capillary blood.
17. A reticulocyte is an RBC that is nearing the end of its life.

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Previewing Questions: Answer Key

Correct Answer Blacked Out

1. False
2. False
3. True
4. True
5. False
6. False
7. False
8. True
9. True
10. False
11. True
12. False
13. True
14. False
15. False
16. True
17. True

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Discussion Questions:

1. What organs are involved in the formation, distribution, and destruction of red blood cells?
2. What are the clinical manifestations of anemia and how may it be treated?
3. What conditions will cause:
 - an increased hematocrit?
 - a decreased hematocrit?
4. What are the risks and benefits of blood transfusion?
5. How can phlebotomy technique affect the results of a blood sample?

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Post-Test Questions:

1. Blood:
 - a. bathes cells.
 - b. nourishes cells.
 - c. removes waste from cells.
 - d. All of the above

2. The fluid portion of blood that does not contain fibrinogen is called:
 - a. plasma.
 - b. serum.
 - c. lymph.
 - d. coruna.

3. RBCs:
 - a. become larger as they mature.
 - b. are fully functional when their nucleus is intact.
 - c. are biconcave in shape.
 - d. normally survive 30 days.

4. RBC production is mainly regulated by:
 - a. the level of tissue oxygenation.
 - b. stimulation of the hormone erythropoietin.
 - c. intake of vitamins A and C
 - d. a and b
 - e. All of the above

5. Normal adult RBC values range from:
 - a. 4.0 to 5.4 hundred RBCs per microliter of blood.
 - b. 4.0 to 5.4 thousand RBCs per microliter of blood.
 - c. 4.0 to 5.4 million RBCs per microliter of blood.
 - d. 4.0 to 5.4 billion RBCs per microliter blood.

6. Adult males generally have _____ adult females.
 - a. the same number of RBCs as
 - b. more RBCs than
 - c. fewer RBCs than

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Post-Test Questions: *continued*

7. RBC count may be decreased due to:
 - a. certain kinds of diarrhea.
 - b. lack of intrinsic factor.
 - c. intake of phenytoin.
 - d. presence of Addison's disease.
 - e. All of the above

8. Destruction of RBCs may occur with:
 - a. spherocytosis.
 - b. sepsis.
 - c. systemic lupus erythematosus.
 - d. b and c
 - e. All of the above

9. Polycythemia can be caused by:
 - a. hemorrhage.
 - b. low altitudes.
 - c. decreased production of erythropoietin.
 - d. increased oxygen levels in the blood

10. Polycythemia vera shows an increase in:
 - a. RBCs.
 - b. WBCs.
 - c. platelets.
 - d. All of the above

11. Hemoglobin:
 - a. binds with carbon dioxide to remove it from the body.
 - b. is composed of three proteins.
 - c. is found in RBCs and platelets.
 - d. is dependent on intake of vitamin B12 for synthesis.

12. The most common form of hemoglobinopathy in the US is:
 - a. thalassemia.
 - b. sickle cell anemia.
 - c. leukemia.
 - d. polycythemia vera.

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Post-Test Questions: *continued*

13. Defective synthesis of the heme molecule may be due to:
- iron deficiency.
 - sideroblastic anemia.
 - pregnancy.
 - a and b
 - All of the above
14. The most common cause of increased hemoglobin is:
- anemia.
 - sickle cell disease.
 - dehydration.
 - thalassemia.
15. Hematocrit is the percentage of:
- RBCs per volume of whole blood.
 - platelets per volume of whole blood.
 - hemoglobin cells per volume of RBCs.
 - RBCs as compared to WBCs.
16. Normal adult hematocrits range from:
- 36 to 51 percent of RBCs.
 - 36 to 51 percent of whole blood.
 - 36 to 51 percent of WBCs.
 - 36 to 51 percent of plasma.
17. Hematocrit:
- is decreased when the number or size of RBC is decreased.
 - can be increased during pregnancy.
 - is usually high in high altitudes.
 - a and c
 - All of the above

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Post-Test Questions: *continued*

18. Hematocrit should increase:
- with severe dehydration.
 - after a transfusion of packed RBCs.
 - after administration of exogenous erythropoietin.
 - a and b
 - All of the above
19. When obtaining blood for a CBC:
- the phlebotomist should massage the sampling site for 5 minutes prior to the needle stick.
 - the tourniquet should be in place for at least 1 to 2 minutes before the skin is punctured.
 - a sample from a capillary should be put on ice.
 - blood should not be taken from a vein that is being used for IV therapy.
 - c and d
20. If the RBC count is low, which of the following additional tests should be performed?
- Stool for occult blood
 - Reticulocyte count
 - Bone marrow biopsy
 - a and b
 - All of the above

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Post-Test Questions Answer Key:

1. a b c e
2. a c d e
3. a b d e
4. a b c e
5. a b d e
6. a c d e
7. a b c d
8. a b c d
9. b c d e
10. a b c e
11. b c d e
12. a c d e
13. a b c e
14. a b d e
15. b c d e
16. a c d e
17. a b c e
18. a b c d
19. a b c e
20. a b c d

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Glossary

Absolute neutrophil count (ANC): number of neutrophils in the blood, measured by cells per cubic millimeter. It is determined by adding the percentage of neutrophils and bands, multiplying that number by the white blood count and dividing the product by 100. This represents the number of neutrophils, at the time of the blood test. Normal range is between 1800 and 7000.

Addison's disease: chronic adrenocortical deficiency, characterized by hypotension, weight-loss, anorexia, weakness, and a bronze-like hyperpigmentation of the skin.

Agranulocyte: a type of mononuclear leukocyte with nongranular cytoplasm and large spherical nuclei. They are produced either in the lymphatic system or in the bone marrow.

Anemia: condition in which the blood is deficient in red blood cells, hemoglobin, or total volume.

B-cell: a form of lymphocyte that provides humoral-mediated immunity by producing antibodies in response to antigens. Normal values range from 10 to 20 percent of total lymphocytes.

Bands: immature neutrophils that have unsegmented nuclei. Values range from 150 to 400 /mm³ or 3 to 5 percent of the total white blood cell count.

Basophil: a type of granulocytic WBC involved in inflammatory and allergic responses. Normal ranges are between 0 to 0.75 percent of the total white blood cell count.

Biconcave: having two concave surfaces, as the opposite sides of a structure.

Blasts: immature white blood cells that are activated before completing their differentiation and maturation. Normal levels are from 0 to 2 percent of the total white blood cell count.

Buffy coat: thin layer of white blood cells lying between red blood cells (on the bottom) and plasma (on the top) as a result of centrifuge.

Cubic millimeter (mm³): a measure of volume, also called a microliter (uL). Exponentially represented as 10⁻⁹ liter.

Differential: a laboratory report of the number or percentages of each type of leukocyte. The differential is determined by examining cell morphology.

Disseminated intravascular coagulation (DIC): a pathological process where the blood starts to coagulate throughout the entire body, depleting it of platelets and coagulation factors, and paradoxically increasing risk of hemorrhage.

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Glossary *continued*

Dyscrasia: a pathologic condition usually referring to disorders of the cellular elements of the blood.

Ecchymosis: a small hemorrhagic spot on the skin caused by extravasation of blood, differing from petechiae only by its larger size.

Eosinophils: second most common type of granulocytic WBC, they are involved in inflammatory, allergic or antiparasitic responses. Normal ranges are between 50 and 250/ mm³ or 1 to 3 percent of the total white blood cell count.

Eosinophilia: elevated eosinophil count.

Erythrocytes: red blood cells (RBCs). Normal adult levels are between 4 and 5.7 million/mm³.

Erythropoietin: hormone formed in the kidney that stimulates the development of red blood cells in the bone marrow.

Fanconi's anemia: a rare recessive disorder with a poor prognosis, characterized by pancytopenia, bone marrow hypoplasia, and patchy brown skin discoloration due to deposition of melanin.

Fibrinogen: a soluble plasma protein that is essential for the clotting of blood.

Granulocytes (polymorphonuclear, PMNs or "polys"): leukocytes produced in the bone marrow that have many well-pigmented granules. These cells, which comprise about 70 percent of all WBCs, digest microorganisms or produce inflammatory reactions.

Hematocrit: percentage of red blood cells in the blood. Normal adult ranges are between 36 to 51 percent.

Hematology: the branch of medical science dealing with the blood and blood-forming tissues.

Hemoglobin: a red-pigmented, iron-containing protein found in red blood cells. Its main function is to transport oxygen from the lungs to the tissues. It also binds with carbon dioxide to remove it from the body. Normal adult levels range from 12 to 17 mg/dL.

Hemolysis: disruption of the integrity of a red blood cell membrane causing the release of hemoglobin.

Heparin induced thrombocytopenia: a severe immune-mediated drug reaction that causes excessive thrombin formation, thrombi, and consumption of the platelets, leading to excessive bleeding.

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Glossary continued

Idiopathic thrombocytopenic purpura (ITP): an autoimmune disorder characterized by an abnormal decrease in the number of blood platelets, resulting in internal bleeding.

Immunodeficiency: either a lack or dysfunction of the leukocytes that provide immunity against disease and foreign proteins.

Leukocytes: white blood cells (WBCs). Normal ranges are between 4,000 to 10,000/mm³.

Leukocytosis: increase in the number of circulating white blood cells.

Leukopenia: decrease in the number of circulating white blood cells.

Lymphocytes: most common type of agranulocyte, they are involved in the production of antibodies and other substances that fight infection and diseases. Normal values are between 25 to 33 percent of the total white blood cell count.

Lymphocytosis: increase in the number of lymphocytes.

Lymphoid tissues: can be divided into primary tissues (the thymus and bone marrow) where lymphocytes differentiate from stem cells, and secondary tissues (the lymph nodes, spleen, tonsils, and Peyer's patches) where lymphocytes take part in immune responses.

Macrophages: monocytes which enter the blood, circulate for about 40 hours, and subsequently enter tissues, where they increase in size, phagocytic activity, and lysosomal enzyme content.

Megakaryocyte: a giant cell with a greatly lobulated nucleus, found in the bone marrow; mature blood platelets are released from its cytoplasm.

Monocytes: agranular mononuclear white cells which circulate in the blood stream. When they enter tissues, they develop into macrophages which ingest bacteria, dead cells, and other debris. Normal values are 3 to 7 percent of the total white cell count.

Mononucleosis: excessive numbers of circulating monocytes.

Morphology: the science of the forms and structure of organisms and cells.

Myeloproliferation: abnormal proliferation of cells from the bone marrow.

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Glossary continued

Neutrophils: most common type of granulocytic WBC, they remove or destroy bacteria, cell debris, and solid particles in the blood. Normal levels are between 49.1 to 70 percent of the total white cell count.

Ovalocyte (elliptocyte): Erythrocytes that are oval or elliptic in shape.

Oxyhemoglobin dissociation curve: graph that shows the percent saturation of hemoglobin at various partial pressures of oxygen.

Pancytopenia: shortage of all types of blood cells, including red and white blood cells as well as platelets – usually due to bone marrow failure.

Pernicious anemia: autoimmune disorder characterized by the body's failure to absorb vitamin B₁₂, an essential element for the production of normal red blood cells.

Petechiae: pinpoint-sized hemorrhages of small capillaries in the skin or mucous membranes.

Phagocyte: any cell capable of ingesting particulate matter, such as a microphage, macrophage, or monocyte. Such cells ingest microorganisms and other particulate antigens.

Plasma: the fluid portion of the blood in which the particulate components are suspended.

Platelet aggregation: a clumping together of platelets, leading to the formation of a thrombus or clot.

Polycythemia: abnormal increase in the number of circulating red blood cells.

Polycythemia vera: disorder characterized by abnormal proliferation of all hematopoietic bone marrow elements and an increase in both red blood cell mass and total blood volume.

Purpura: small amounts of bleeding into the skin and mucous membranes resulting in the appearance of purplish spots or patches.

Reticulocytes: immature red blood cells. Normal levels are between 0.5 and 2.5 percent.

Schistocyte: a fragment of an erythrocyte, commonly observed in the blood in hemolytic anemias.

Segs: mature neutrophils that have segmented nuclei. Values range from 54 to 62 percent of the total white blood cell count.

Sequester: to detach or separate abnormally a small portion from the whole

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Glossary continued

Serotonin: neurotransmitter which stimulates blood vessel contraction at the site of injury.

Serum: the fluid portion of the blood remaining after the blood cells and clotting materials, such as fibrinogen, have been removed.

Shift to the left: an increase in the number of circulating immature neutrophils, indicating the presence of acute infection.

Sickle cell anemia (Hemoglobin S): an autosomal-recessive disease caused by an abnormal type of hemoglobin called hemoglobin S in which the red blood cells become crescent shaped. This leads to disruption of blood flow as well as diminished oxygen delivery to the body's tissues.

Sideroblastic anemia: a group of rare blood disorders in which erythrocytes do not mature normally, causing many of them to be destroyed in the bone marrow before reaching the circulation.

Spherocytosis: a genetic disorder causing a defect in the membrane of red blood cells, causing them to have a spherical rather than biconcave shape. These cells, which are more fragile and less flexible than normal RBCs, are prone to hemolysis.

Stem cell: a blood cell progenitor; it has the capacity for both replication and differentiation, and has pluripotentiality, giving rise to precursors of various different blood cell lines, such as the proerythrocyte and myeloblast, which cannot self-replicate and must differentiate into more mature daughter cells.

Systemic lupus erythematosus: an autoimmune disorder that causes chronic inflammation of and damage to the joints, tendons, other connective tissues, and organs, including the heart, lungs, blood vessels, brain, kidneys, and skin.

T cell: form of lymphocyte responsible for cell-mediated immunity which does not rely upon antibodies. They are most effective in removing virus-infected cells. Normal values range from 68 to 75 percent of lymphocytes.

Thalassemia: group of genetic disorders that which involve underproduction of hemoglobin.

Thrombocytopenia: decrease in platelets.

Thrombocytes: platelets.

Thrombocythemia: an increase in platelets

Primary pathological thrombocythemia: thrombocythemia of unknown cause.

Secondary pathological thrombocythemia: thrombocythemia of known cause.

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Glossary continued

Thromboplastin: a complex enzyme that is found in blood platelets that functions in the conversion of prothrombin to thrombin in the clotting of blood.

Thrombopoietin: a hypothetical substance believed to serve as the humoral regulator of the production of platelets.

Thrombosis: formation of a blood clot within the hollow spaces of the blood vessels or heart.

Uremia: toxic condition resulting from an accumulation of substances in the blood which are normally eliminated in urine.

Von Willebrand's disease: most common inherited (usually autosomal dominant) bleeding disorder characterized by deficiency of von Willebrand's factor which helps platelets adhere to blood vessel walls and each other. Because normal clotting is impaired, bleeding time is prolonged.

