HOW TO APPROACH THE BLOOD

The key to understanding this chapter is to focus on the formed elements of blood (erythrocytes, thrombocytes, and leukocytes), blood clotting, and dissolving blood clots. You need to be able to recognize all abbreviations such as RBC, WBC, etc. You can quickly test yourself by taking a scratch piece of paper and listing all the formed elements listed above and write down a BRIEF description of function, where they are formed, and what regulates them. You also need to remember what each of the leukocytes responds to. Example: neutrophils – bacteria; eosinophils – parasites, etc. Flash cards are particularly helpful with this. Put the formed element on one side with questions on what you need to remember and the answers on the other side.

The ABO system is simple yet tends to give students difficulty, so make sure you are comfortable with the questions regarding blood transfusions. If you can answer these questions, you are doing well and understand the major concepts. See the study tip in this section. Be sure to use a scratch piece of paper when answering these questions.

For coagulation and fibrinolysis, you should be able to quickly write out on paper the sequence of events for each. Example: fibrinolysis = plasminogen – tPA – plasmin – clot breakdown.

BLOOD COMPOSITION AND RED BLOOD CELLS

Fill in the blanks with the correct answers.

1. _______________ accounts for 55% of blood, while _______________ account for 45%.

2. The packed cell volume at the bottom of the test tube is called the _______________.

3. _______________ extrudes its nucleus and also loses its ribosomes, mitochondria, and other organelles before the cell reaches maturity in the bone marrow.
4. When four oxygen molecules chemically bond to hemoglobin it is called ______________ and when carbon dioxide bonds to the hemoglobin it is called ______________.

FC 5. If oxygen levels decrease, the ______________ release erythropoietin, which in turn stimulates the ______________ to increase production of red blood cells (RBCs).

Matching – match each description or word with the correct term.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. _____ Hematopoietic stem cells</td>
<td>a. Measure of cellular portion of blood</td>
</tr>
<tr>
<td>FC 7. _____ Erythropoiesis</td>
<td>b. Hormone</td>
</tr>
<tr>
<td>FC 8. _____ Erythropoietin</td>
<td>c. Nucleated cells that form erythrocytes</td>
</tr>
<tr>
<td>9. _____ Globin</td>
<td>d. Protein chain</td>
</tr>
<tr>
<td>10. _____ Hemoglobin</td>
<td>e. Liquid portion of blood</td>
</tr>
<tr>
<td>11. _____ Erythrocytes</td>
<td>f. RBCs</td>
</tr>
<tr>
<td>12. _____ Hematocrit</td>
<td>g. Making RBCs</td>
</tr>
<tr>
<td>13. _____ Formed elements</td>
<td>h. Protein</td>
</tr>
<tr>
<td>14. _____ Plasma</td>
<td>i. Cellular portion of blood</td>
</tr>
</tbody>
</table>

Multiple choice – select the best answer.

15. Conditions that result in decreased RBC numbers are called:
   a. hematocrit.
   b. polycythemia.
   c. anemia.
   d. leukopenia.

FC 16. Mature red blood cells are called:
   a. thrombocytes.
   b. erythrocytes.
   c. leukocytes.
   d. hematopoietic cells.

FC 17. Low oxygen levels in the blood increase secretion of what glycoprotein hormone?
   a. Diapedesis
   b. Heparin
   c. Thrombopoietin
   d. Erythropoietin

18. What replaces the nucleus and organelles in mature erythrocytes?
   a. Hemoglobin
   b. Mitochondria
   c. Granules
   d. Histamine

19. Each hemoglobin molecule is composed of _____ protein chains with _____ iron atoms.
    a. 2, 2
    b. 4, 2
    c. 4, 4
    d. 2, 4

20. Which of the following describes erythropoiesis?
    a. Destruction of RBCs
    b. Creation of hematopoietic stem cells
    c. Production of erythropoietin
    d. Process of RBC formation

21. Maturing erythrocytes that have lost their nuclei are called:
    a. EPO.
    b. reticulocytes.
    c. myeloid cells.
    d. megakaryoblasts.

FC 22. Which of the following is the average life span of an RBC?
    a. 30 days
    b. 60 days
    c. 120 days
    d. 160 days
23. Macrophages in what organ(s) primarily recycle RBCs?
   a. Liver
   b. Spleen
   c. Bone marrow, liver, and spleen
   d. Liver and spleen

24. What results from the breakdown of hemoglobin and is/are excreted as part of bile?
   a. Bilirubin
   b. Cholesterol
   c. Iron
   d. Iron and globin

### WHITE BLOOD CELLS

**STUDY TIP**

How to remember the leukocytes and their abundance in the blood:

<table>
<thead>
<tr>
<th>Nurse</th>
<th>Neutrophils</th>
<th>Most common</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary</td>
<td>Monocytes</td>
<td></td>
</tr>
<tr>
<td>Loves</td>
<td>Lymphocytes</td>
<td></td>
</tr>
<tr>
<td>Elevating</td>
<td>Eosinophils</td>
<td></td>
</tr>
<tr>
<td>Beds</td>
<td>Basophils</td>
<td>Least common</td>
</tr>
</tbody>
</table>

Also remember that the granulocytes are the “phil”s and the agranulocytes are the “cytes,” or you could also remember AC-GP.

**Fill in the blanks with the correct answers.**

25. ____________________ are called leukocytes.

26. The two basic types of lymphocytes are ____________________ and ____________________.

27. ____________________ is an overall decrease in the number of white blood cells (WBCs), where ____________________ is an increase.

28. ____________________ tissue and ____________________ tissue together constitute the hematopoietic, or blood-forming, tissues of the body.

29. ____________________ are really tiny pieces of cells.
Matching – match each leukocyte with the correct description or word (leukocyte may be used more than once).

<table>
<thead>
<tr>
<th>Description</th>
<th>Leukocyte</th>
</tr>
</thead>
<tbody>
<tr>
<td>30. ______ Increase with parasitic worms and allergic reactions</td>
<td>a. Neutrophils</td>
</tr>
<tr>
<td>31. ______ Immunity</td>
<td>b. Eosinophils</td>
</tr>
<tr>
<td>32. ______ Fight primarily against bacteria and viral-infected cells</td>
<td>c. Basophils</td>
</tr>
<tr>
<td>33. ______ Nuclei may have two, three, or more lobes</td>
<td>d. Lymphocytes</td>
</tr>
<tr>
<td>34. ______ Produce histamine and heparin</td>
<td>e. Monocytes</td>
</tr>
<tr>
<td>35. ______ Most numerous</td>
<td></td>
</tr>
<tr>
<td>36. ______ Largest</td>
<td></td>
</tr>
<tr>
<td>37. ______ Cause inflammation and allergies</td>
<td></td>
</tr>
<tr>
<td>38. ______ Fight primarily against invading bacteria</td>
<td></td>
</tr>
<tr>
<td>39. ______ Produce antibodies</td>
<td></td>
</tr>
</tbody>
</table>

Multiple choice – select the best answer.

40. What is it called when leukocytes migrate out of blood vessels and enter tissues?
   a. Diapedesis
   b. Granulocytosis
   c. Leukocyte migration
   d. Leukocytosis

41. Eosinophils are most abundant where?
   a. Liver
   b. Liver and spleen
   c. Lining the respiratory and digestive tracts
   d. Lymph nodes, liver, and spleen

42. Which of the following produce and release histamine and heparin?
   a. Neutrophils
   b. Basophils
   c. Monocytes
   d. Lymphocytes

43. If a person was infected with parasitic worms, which leukocyte would you expect to see increase?
   a. Monocytes
   b. Lymphocytes
   c. Eosinophils
   d. Neutrophils

44. Antibodies come from which leukocyte?
   a. Basophils
   b. Monocytes
   c. Neutrophils
   d. Lymphocytes

45. Which of the following is descriptive of a neutrophil?
   a. Platelet
   b. Phagocyte
   c. Agranulocyte
   d. Erythrocyte
46. Which of the following is the largest leukocyte?
   a. Monocyte
   b. Lymphocyte
   c. Basophil
   d. Neutrophil

47. Aggregation, adhesiveness, and agglutination are properties of:
   a. leukocytes.
   b. granulocytes.
   c. erythrocytes.
   d. thrombocytes.

48. Most of the agranulocytes originate where?
   a. Spleen
   b. Bone marrow
   c. Lymphatic tissue
   d. Liver

49. The blood-forming tissues of the body are called:
   a. myeloid tissue.
   b. lymphatic tissue.
   c. red marrow.
   d. hematopoietic.

50. *Hemostasis* refers to what?
   a. Destroying of blood cells
   b. Creating blood cells
   c. Stoppage of blood flow
   d. Dissolving blood clots

51. What is the first step in hemostasis?
   a. Coagulation
   b. Platelet plug
   c. Agglutination
   d. Thrombopoiesis

52. When platelets encounter _______ in damaged vessel walls, they become sticky and adhere.
   a. collagen
   b. erythrocytes
   c. fibrin
   d. protein

53. What is the formation of platelets called?
   a. Thrombocytosis
   b. Thrombopenia
   c. Thrombopoiesis
   d. Thrombogenesis

54. Thrombocytes originate from:
   a. megakaryoblasts.
   b. myeloblasts.
   c. proerythroblasts.
   d. monoblasts.
Labeling – label the following blood components

55. Composition of whole blood

a. _____________________________

b. _____________________________

c. _____________________________

d. _____________________________

e. _____________________________

f. _____________________________

g. _____________________________

h. _____________________________

i. _____________________________

j. _____________________________

k. _____________________________

l. _____________________________
56. The formed elements of blood

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
<th>h</th>
<th>i</th>
<th>j</th>
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</tbody>
</table>

**Short answer**

57. What are the three formed elements of blood?

58. What are the two general types of leukocytes?

59. List the five basic types of leukocytes.

60. List the three granulocytes.

61. List the two agranulocytes.
BLOOD TYPES, BLOOD PLASMA, AND BLOOD CLOTTING

When studying the ABO blood types, there are some things you need to remember.

1. Antigens are agglutinogens.
2. Antibodies are agglutinins.
3. There are only A, B, and Rh agglutinogens and agglutinins.
4. Type A blood has A agglutinogens and B agglutinins, type B has B agglutinogens and A agglutinins, and O has zero or 0 (this is how you remember O) agglutinogens and both A and B agglutinins.
5. Rh-positive blood has the Rh agglutinogens and Rh-negative blood does not.
6. When you receive blood, you almost always only receive the cells that do NOT contain the agglutinins. This is called packed red cells (PRC) or a “unit” of blood.
7. You CANNOT have the same agglutinogen and agglutinin in your blood or you have a transfusion reaction.
8. Simply draw a picture of the blood cell (a circle) and label it according to its blood type. Then label it with the agglutinogens and agglutinins. Whatever is NOT on the surface of the cell is the agglutinins and in the plasma. Do this on any questions regarding blood types. See the example below.

Fill in the blanks with the correct answers.

62. Blood types are determined by the __________________ present on the plasma membrane.

63. Plasma consists of ________% water and ________% solutes and the solutes are classified as __________________ or __________________.

64. ________________ is plasma without its clotting elements.

65. The process of clotting is divided into the ________________ clotting pathway and ________________ clotting pathway.

66. ________________ is synthesized in the intestine by bacteria and is essential to clotting.
## Matching – match each term with the correct description.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>67. ______</td>
<td>Agglutinin</td>
</tr>
<tr>
<td>68. ______</td>
<td>Agglutinogens</td>
</tr>
<tr>
<td>69. ______</td>
<td>Agglutination</td>
</tr>
<tr>
<td>70. ______</td>
<td>Hemolysis</td>
</tr>
<tr>
<td>71. ______</td>
<td>Fibrinolysis</td>
</tr>
<tr>
<td>72. ______</td>
<td>Thrombosis</td>
</tr>
<tr>
<td>73. ______</td>
<td>Plasminogen</td>
</tr>
<tr>
<td>74. ______</td>
<td>tPA</td>
</tr>
<tr>
<td>75. ______</td>
<td>Plasmin</td>
</tr>
<tr>
<td>76. ______</td>
<td>Serum</td>
</tr>
<tr>
<td>a. Dissolves fibrin</td>
<td></td>
</tr>
<tr>
<td>b. Clot formation</td>
<td></td>
</tr>
<tr>
<td>c. RBCs breaking apart</td>
<td></td>
</tr>
<tr>
<td>d. Clumping of RBCs</td>
<td></td>
</tr>
<tr>
<td>e. Antibodies</td>
<td></td>
</tr>
<tr>
<td>f. Clot dissolution</td>
<td></td>
</tr>
<tr>
<td>g. Converts plasminogen to plasmin</td>
<td></td>
</tr>
<tr>
<td>h. Found on the plasma membrane</td>
<td></td>
</tr>
<tr>
<td>i. Inactive plasma protein</td>
<td></td>
</tr>
<tr>
<td>j. Plasma without the clotting factors</td>
<td></td>
</tr>
</tbody>
</table>

## Multiple choice – select the best answer.

77. Which of the following is NOT an antigen in the ABO system?
   a. A
   b. B
   c. O
   d. Rh

78. The term agglutinin is often used to describe what?
   a. Antigens
   b. Antibodies
   c. Receptor sites
   d. Transfusion reaction

79. Specific blood antigens are called:
   a. agglutinogens.
   b. agglutinins.
   c. antibodies.
   d. agglutinates.

80. When agglutinins combine and react to agglutinogens it is called:
   a. agglutination.
   b. blood clot.
   c. thrombosis.
   d. hemolysis.

81. What is the “universal donor”?
   a. AB+
   b. AB–
   c. O+
   d. O–

82. What is the “universal recipient”?
   a. AB+
   b. AB–
   c. O+
   d. O–

83. A+ blood has which agglutinogens?
   a. B and Rh
   b. B
   c. A
   d. A and Rh

84. O– blood has which agglutinogens?
   a. A, B, and Rh
   b. A and B
   c. Rh
   d. None

85. Which of the following blood types has no agglutinins?
   a. AB+
   b. AB–
   c. O+
   d. O–

86. A– blood could be given to all the following blood types EXCEPT:
   a. A+.
   b. AB–.
   c. A–.
   d. AB+.
87. Which of the following can receive O– blood?
   a. Only O–
   b. Only O+
   c. All types
   d. O+ and O–

88. Synthesis of most of the plasma proteins occurs where?
   a. Bone marrow
   b. Spleen
   c. Liver
   d. Blood

89. Which of the following is the correct sequence of events in the formation of a clot?
   a. Fibrinogen, fibrin, thrombin, prothrombin activator, prothrombin
   b. Fibrin, fibrinogen, prothrombin, prothrombin activator, thrombin
   c. Prothrombin, prothrombin activator, thrombin, fibrinogen, fibrin
   d. Prothrombin activator, prothrombin, thrombin, fibrin, fibrinogen

90. For the liver to synthesize prothrombin, blood must contain an adequate amount of what?
   a. Vitamin K
   b. Calcium
   c. Thrombin
   d. Prothrombin activator

91. **Fibrinolysis** refers to what?
   a. Formation of fibrin
   b. Dissolving clots
   c. Conversion of fibrinogen to fibrin
   d. Formation of a fibrin clot

92. Formation of a blood clot is called:
   a. thrombosis.
   b. thromboembolus.
   c. fibrinolysis.
   d. thrombocytosis.

93. What hydrolyzes fibrin strands and dissolves blood clots?
   a. Plasmin
   b. tPA
   c. Plasminogen
   d. Fibrinogen

94. What compound impairs the liver’s use of vitamin K?
   a. Heparin
   b. tPA
   c. Coumarin
   d. Streptokinase

**Short answer**

95. List the three main kinds of proteins found in the blood.

96. List the three things that ALL plasma proteins contribute to maintenance of blood.

97. List the four essential components critical to coagulation.

98. List the three substances critical to fibrinolysis.

99. List two anticoagulants.