PART I: MULTIPLE CHOICE

DIRECTIONS: Each of the numbered items or incomplete statements in this section is followed by answers or by completions of the statement. Select the ONE lettered answer or completion that is BEST in each case.

1. Autopsy of a fetus that had reached the 17th week of gestation (2nd trimester) should reveal that hematopoiesis was:
   A. Occurring mainly in the bone marrow
   B. Occurring mainly in the liver
   C. Occurring mainly in the spleen
   D. Occurring only in the yolk sac
   E. Ending in the liver and just about to begin in the spleen

2. What type of blood vessel is most likely to match the following description? “An internal elastic lamina may be present, the tunica adventitia may contain longitudinally arranged smooth muscle, hydrostatic pressure is low.”
   A. Elastic artery
   B. Large vein
   C. Muscular artery
   D. Muscular venule
   E. Sinusoidal capillary

3. You have to explain a pathology report to your patient stating that he has a mesothelioma of the heart. Which of the following would best describe this tumor:
   A. It is located in the muscle layer of the wall of the heart
   B. It is a tumor of the epithelium that lines the inner surface of the endocardium
   C. It is a tumor of the epithelium that lines the outer surface of the epicardium
   D. It is a lipid-rich tumor within the tunica intima of one of the coronary arteries

4. Yellow bone marrow:
   A. Begins to appear at approximately age 20
   B. Contains few hematopoietically active cells, but can convert back to an active state of hematopoiesis
   C. Consists only of a vascular compartment
D. Is found only in the sternum and iliac crests of an adult
E. Is yellow because it consists primarily of leukocytes

5. A skin biopsy was taken at the site of a bee sting where a localized allergic reaction (Type I hypersensitivity reaction) had occurred. The connective tissue of the biopsy contained an unusually high number of cells with a lobed nucleus and numerous large cytoplasmic granules. The granules stained bright pink with H&E, and were of relatively uniform size. These cells were __________, and the role they played in the allergic response was to __________.

A. Basophils ………. contribute to the development of the allergic reaction, in part by secreting histamine
B. Basophils ………. limit the extent of the allergic reaction, in part by secreting histaminase and aryl sulfatase
C. Eosinophils ………. contribute to the development of the allergic reaction, in part by secreting histamine
D. Eosinophils ………. limit the extent of the allergic reaction, in part by secreting histaminase and aryl sulfatase
E. Macrophages ………. phagocytize debris from tissue that was damaged in the allergic response

6. Leukocytes normally leave the hematopoietic compartment of red bone marrow and enter the peripheral circulation by crossing the walls of:
   A. Lymphatic capillaries
   B. Metarterioles
   C. Nutrient arteries
   D. Postcapillary venules
   E. Sinusoids

7. The sinoatrial node:
   A. Is composed of autonomic neurons
   B. Is composed of ordinary cardiac myocytes
   C. Is composed of Purkinje fibers
   D. Is located in the interventricular septum
   E. Receives input from sympathetic and parasympathetic neurons that modulates the intrinsic rate of cardiac contraction

8. Electron microscopy of the hematopoietic compartment of normal red bone marrow shows a large multinucleated cell with highly acidophilic cytoplasm. This cell is a/an:
   A. Epitheloid cell derived from a macrophage
   B. Macrophage in an erythroblastic islet
C. Megakaryocyte  
D. Myeloblast  
E. Osteoclast

9. Your 2-year-old female patient has von Willebrand disease. Which of the following is true:
   A. She has one of the rarest of all heritable bleeding disorders  
   B. Von Willebrand disease is most often an autoimmune condition caused by anti-platelet antibodies  
   C. Von Willebrand factor is normally found in the alpha granules of platelets  
   D. Her platelets would adhere normally to the wall of a damaged blood vessel, but would be incapable of aggregating to form a multi-layered platelet plug  
   E. Her platelets would adhere and aggregate normally at a site of endothelial damage, but it would not be possible to activate them

10. The respiratory burst:
   A. Generates microbicidal reactive forms of oxygen such as hydroxyl radicals  
   B. Is defined as a measurable increase in the rate of oxygen production by leukocytes  
   C. Is initiated by the conversion of myeloperoxidase to an active, membrane-associated form  
   D. Occurs entirely within mitochondria  
   E. Occurs only in neutrophils

11. Activated platelets cause vasoconstriction at a site of vascular injury. This shunts blood away from the damaged vessel and thus limits the extent of hemorrhaging. Activated platelets cause vasoconstriction by:
   A. Releasing prostacyclin (PGI₂) from their specific granules  
   B. Releasing serotonin from certain types of their granules  
   C. Synthesizing and releasing thromboxane A₂  
   D. All the above  
   E. Choices A and B only  
   F. Choices B and C only

12. A blood smear from your patient shows that there is approximately 1 leukocyte for every 50 red cells. The most abundant type of leukocyte in the smear has a lobulated nucleus with an average of 4 lobes, and a pale-staining cytoplasm containing numerous granules that are poorly staining and barely visible. You conclude from this information that:
A. The patient is normal
B. The smear demonstrates leukocytosis
C. The smear demonstrates poikilocytosis
D. The leukocytes described above are hypersegmented
E. The patient is likely to be suffering from a parasitic infection

13. A patient with defective integrins in the plasma membrane of his blood cells is most likely to suffer from which of the following:
   A. Chronic granulomatous disease (CGD) due to defective fusion of the specific granules of neutrophils with the plasma membrane
   B. Chediak-Higashi syndrome due to a defective respiratory burst
   C. Leukocyte adhesion deficiency (LAD) resulting in defective diapedesis
   D. Polycythemia vera due to an abnormally high rate of erythrocyte destruction

14. During an acute inflammation, which of the following would be most effective in reducing the extent of edema by taking up excess fluid from the extravascular space:
   A. Continuous blood capillaries
   B. Lymphatic capillaries
   C. Muscular venules
   D. Medium and large veins
   E. Vasa vasorum

15. Which of the following is characteristic of all anemias:
   A. A decreased hematocrit
   B. A decreased oxygen carrying capacity of the blood
   C. Abnormality in either the erythrocyte cytoskeleton or the structure of the hemoglobin molecule
   D. Hypochromic erythrocytes
   E. All the above

16. The most abundant agranulocyte in normal peripheral blood usually has:
   A. A “lacey” chromatin pattern
   B. A peripheral region called the hyalomere
   C. A heterochromatic nucleus with 3-5 lobes
   D. A nucleus that is U-shaped, folded, or irregular in outline
   E. The smallest diameter of any mature leukocyte
17. In which of the following items are the stages of granulocyte development listed in the correct order from least differentiated to most differentiated:
   A. Myeloblast, CFU-GM, myelocyte, promyelocyte, metamyelocyte
   B. Myeloblast, CFU-GM, metamyelocyte, promyelocyte, myelocyte
   C. CFU-GM, myeloblast, promyelocyte, myelocyte, metamyelocyte
   D. CFU-GM, metamyelocyte, promyelocyte, myelocyte, myeloblast

18. In humans, the cardiac skeleton is composed of __________, and includes structures such as __________.
   A. Dense connective tissue .......... annuli fibrosi
   B. Dense connective tissue .......... chordae tendineae
   C. Dense connective tissue .......... trabeculae carnea
   D. Fibrocartilage .......... annuli fibrosi
   E. Fibrocartilage .......... chordae tendineae
   F. Fibrocartilage .......... trabeculae carnea

19. Which of the following is a stage in normal hematopoiesis in which a cell type that is capable of mitosis gives rise to a cell type that can no longer divide:
   A. Development of basophilic erythroblasts into polychromatophilic erythroblasts
   B. Development of orthochromatic erythroblasts into reticulocytes
   C. Development of polychromatophilic erythroblasts into orthochromatic erythroblasts
   D. Development of reticulocytes into mature erythrocytes

20. A leukemia patient receives radiation treatment to wipe out the hematopoietic stem cells in her marrow prior to receiving a bone marrow transplant. In order to maximize the number of pluripotential hematopoietic stem cells that are later transplanted into the patient, the donor marrow should be enriched for cells that express __________ on their plasma membranes.
   A. CD34
   B. CD8
   C. Fc receptors for IgE
   D. Major histocompatibility proteins (MHC proteins)
   E. NADH oxidase enzyme activity
   F. Toll-like receptors
21. Which of the following clinical or histological signs commonly appear(s) following a myocardial infarction:
   A. Release of cardiac forms of troponin I and troponin T into the blood by dying cardiac myocytes
   B. Loss of cross-striations and nuclei in dying cardiac myocytes observed by light microscopy
   C. Neutrophil infiltration into damaged areas of the myocardium
   D. Replacement of dead myocytes by a connective tissue scar
   E. All the above

22. In the tunica media of the aorta, elastic fibers are produced mainly by which of the following cell types:
   A. Endothelial cells of the tunica intima
   B. Fibroblasts in the tunica media
   C. Macrophages in the tunica adventitia
   D. Smooth muscle cells in the tunica media

23. Identify the type of vessel described by the following statements: It has a discontinuous layer of pericytes exterior to the endothelium. It is the primary site of action of vasoactive agents such as histamine and serotonin.
   A. Fenestrated capillary
   B. Lymphatic capillary
   C. Muscular venule
   D. Postcapillary venule
   E. Sinusoidal capillary

24. Your 52-year old female patient has partial bone marrow failure, with very little hematopoiesis still occurring in the marrow. However, some hematopoiesis is taking place outside the bone marrow (a phenomenon known as extramedullary hematopoiesis). In which of the following organs does extramedullary hematopoiesis most commonly occur in adults:
   A. Heart
   B. Kidney
   C. Liver
   D. Lung

25. Which of the following is most likely to cause spontaneous bleeding from the nose and gums (i.e., bleeding that is not due to trauma):
   A. Anaphylactic shock
   B. Hemolytic anemia
C. Hereditary elliptocytosis
D. Primary thrombocytopenic purpura

26. Erythropoiesis:
   A. Involves major changes in the shape of the nucleus
   B. Involves production of azurophilic and specific granules
   C. Occurs in cell clusters that are centered around a macrophage
   D. Occurs mainly in the spleen in midterm fetuses
   E. Begins several months later than granulopoiesis in a fetus

27. Activation of platelets and some leukocytes results in cleavage of arachidonic acid from cell membranes by phospholipase A$_2$. Among the many products that can be enzymatically derived from arachidonic acid are:
   A. Histamine
   B. Myeloperoxidase
   C. Serotonin
   D. Thromboxane A$_2$
   E. Von Willebrand factor

28. The blood-brain barrier is effective partly because the capillaries of the brain are:
   A. Continuous, with few pinocytic vesicles
   B. Continuous, with many pinocytic vesicles
   C. Fenestrated, with diaphragms
   D. Fenestrated, without diaphragms
   E. Sinusoidal, with diaphragms
   F. Sinusoidal, without diaphragms

29. The ordinary atrial myocardium is completely separated from ordinary ventricular myocardium by components of the cardiac skeleton. The only structure(s) that pierce(s) the skeleton to convey impulses from the atria to the ventricles is/are:
   A. Pectinate muscles
   B. Purkinje fibers
   C. The atrioventricular (AV) node
   D. The atrioventricular bundle (of His)
   E. The sinoatrial (SA) node
   F. Trabeculae carneae
30. The site of an inflammatory reaction is generally characterized by swelling (tumor) and pain (dolor) that are due to edema, and by redness (rubor) and heat (calor) that are due to local vasodilation. The leukocyte that is most directly responsible for causing edema and vasodilation in inflammatory responses is the:
   A. Basophil
   B. Eosinophil
   C. Lymphocyte
   D. Monocyte
   E. Neutrophil

31. Which of the following often plays an important role in stimulating the phagocytic activity of neutrophils by acting as an opsonin:
   A. Eotaxin
   B. Histamine
   C. IgG
   D. Major basic protein
   E. Myeloperoxidase

32. The epicardium is:
   A. A component of the interventricular septum
   B. Also known as the parietal pericardium
   C. Continuous with the endothelium of blood vessels
   D. The layer that contains the large vessels of the coronary circulation
   E. The layer that contains the Purkinje fibers

33. Consider a muscular artery and the vein that accompanies it. The vein will generally have:
   A. A smaller lumen than the artery
   B. A more regularly shaped, circular lumen than the artery
   C. A thinner wall relative to the diameter of the lumen
   D. Layers that are more distinct and better defined than in the artery
   E. The tunica media as its thickest and most prominent layer, while in the artery the tunica adventitia dominates

34. Which of the following is most characteristic of patients with sickle cell anemia:
   A. Fewer reticulocytes in the blood than normal
   B. Hypochromic microcytic erythrocytes
C. Poikilocytes that are more fragile than normal erythrocytes
D. Spherocytes

35. The external elastic membrane lies between the:
   A. Epicardium and myocardium in the heart
   B. Pericytes and endothelial cells in postcapillary venules
   C. Tunica intima and tunic media in elastic arteries
   D. Tunica media and tunica adventitia in muscular arteries

36. The type of vessel whose main function is regulating blood pressure is the:
   A. Arteriole
   B. Elastic artery
   C. Large lymphatic
   D. Muscular artery
   E. Muscular venule

37. Which of the following is the most characteristic feature of large veins inferior to the level of the heart, such as the inferior vena cava:
   A. A thinner tunica media than in veins superior to the level of the heart
   B. Longitudinally oriented bundles of reticular fibers in the intima that give the lumen a scalloped appearance in cross section
   C. Longitudinally oriented bundles of smooth muscle in the adventitia
   D. Numerous fenestrated elastic laminae in the media
   E. The absence of vasa vasorum

38. Which of the following is an example of a poikilocyte:
   A. A drepanocyte
   B. A hypersegmented neutrophil
   C. A neutrophilic band cell
   D. An erythrocyte whose diameter is < 6 micrometers
   E. An erythrocyte whose diameter is > 9 micrometers
   F. Choices D & E

39. After being activated, which of the following undergoes an actin-myosin mediated contraction that is important to its function:
   A. Eosinophils
   B. Epithelioid cells
   C. Macrophages
40. Eosinophils:
   A. Have a polyploid nucleus resulting from the process of endomitosis
   B. Have azurophilic granules but no specific granules
   C. Have specific granules whose major contents include histamine
   D. Have the ability to either enhance or inhibit the effects of basophils and mast cells

41. During the later stages of an acute inflammation, which of the following cell types is characteristically most abundant at the site of the reaction:
   A. Basophils
   B. Eosinophils
   C. Lymphocytes
   D. Monocytes and macrophages
   E. Neutrophils

42. Neutrophils are most characteristically involved in:
   A. Causing hives
   B. Causing petechial rashes
   C. Combating bacterial infections
   D. Destruction of airway epithelial cells in asthma
   E. Phagocytosis of apoptotic macrophages during inflammation

43. Which of the following characteristically accumulates lipid to become “foam cells” in the tunica intima of atherosclerotic arterial walls:
   A. Basophils
   B. Endothelial cells
   C. Eosinophils
   D. Macrophages
   E. Platelets

44. The amount of red marrow normally:
   A. Decreases in acute myelogenous leukemia
   B. Decreases in patients undergoing chemotherapy
   C. Increases with age in healthy individuals
   D. Stays the same in healthy individuals at all ages
45. Which cell type is still capable of mitosis:
   A. B lymphocytes
   B. Mature eosinophils
   C. Neutrophilic band cells
   D. Orthochromatric erythroblasts
   E. Reticulocytes

46. In an orthochromatric erythroblast, the color of the cytoplasm is due mainly to:
   A. Actin
   B. Free polysomes
   C. Hemoglobin
   D. Mitochondria
   E. Specific granules

47. What is the earliest stage of development at which the different granulocyte lines can be distinguished from one another by ordinary brightfield microscopy:
   A. Metamyelocyte
   B. Myeloblast
   C. Myelocyte
   D. Promyelocyte
   E. Reticulocyte

48. The major function of precapillary sphincters is:
   A. Controlling the blood flow into capillary beds
   B. Converting pulsatile blood flow to a more constant flow rate
   C. Establishing collateral circulation in the heart
   D. Nourishing the wall of medium and large veins
   E. Regulating systemic blood pressure

49. Under normal circumstances, 70% or more of the total blood volume is contained in:
   A. Arteries
   B. Arterioles
   C. Capillaries
   D. The heart
50. Which of the following is the direct precursor of a band cell:
   A. Metamyelocyte
   B. Myeloblast
   C. Myelocyte
   D. Normoblast
   E. None of the above

DIRECTIONS: Each of the numbered items or incomplete statements in this section is negatively phrased, as indicated by a capitalized word such as NOT, LEAST, or EXCEPT. Select the ONE lettered answer or completion that is BEST in each case.

51. Identify the FALSE statement. Cytotoxic T cells:
   A. Are CD8+
   B. Are the main cell type that is infected and killed by the human immunodeficiency (HIV) virus
   C. Play a major role in cell-mediated immunity
   D. Have receptors that recognize specific antigen on the plasma membrane of target cells
   E. Secrete cytotoxic mediators when activated, including perforin and granzymes

52. Identify the FALSE statement. The sinoatrial node (SA node):
   A. Contains modified cardiac muscle cells that are smaller in diameter and paler staining than ordinary cardiac myocytes
   B. Includes the cell bodies of postganglionic autonomic neurons
   C. Is located in the wall of the right atrium near the opening of the superior vena cava
   D. Normally serves as the pacemaker of the heart
   E. Receives input from sympathetic and parasympathetic nerves

53. Identify the FALSE statement concerning valves in the cardiovascular system:
   A. Atrioventricular valves are associated with chordae tendineae and papillary muscles, but semilunar valves are not
   B. Lymphatic capillaries and blood capillaries both contain valves
C. Semilunar valves separate the ventricles from the aorta or pulmonary trunk
D. The free surface of all valves is covered by endothelium

54. In a microliter of normal adult blood you should expect to find all the following **EXCEPT**:
A. More lymphocytes than monocytes
B. More platelets than neutrophils
C. Several hundred thousand leukocytes
D. Several million erythrocytes
E. Albumin, made by the liver, as the most abundant plasma protein

55. Identify the **FALSE** statement. With regard to bone marrow:
A. Nutrient arteries pierce the bone to supply peripheral blood to the vascular compartment of bone marrow
B. Adventitial cells (reticular cells) produce the stroma of the hematopoietic compartment and secrete many of the hematopoietic growth factors (HGFs)
C. IL-5 and erythropoietin are examples of “early” HGFs that have their major effects on cells such as the pluripotential hematopoietic stem cell (PHSC)
D. The PHSC population is self-renewing, and consists of CD34+ cells that resemble small lymphocytes

56. Identify the **FALSE** statement. Megakaryocytes:
A. Are derived from the pluripotential hematopoietic stem cell (PHSC)
B. Are uninucleate
C. Are polyploid
D. Form foreign body giant cells
E. Produce platelets

57. Eosinophils contribute to the pathology of airways in chronic asthma in all the following ways **EXCEPT**:
A. Inducing fibrosis that thickens airway walls
B. Promoting smooth muscle contraction in bronchioles
C. Causing hyperplasia of goblet cells
D. Killing ciliated epithelial cells that line the airways
E. Secreting histamine to increase the permeability of alveolar capillaries
58. Maintenance of the biconcave shape of an erythrocyte involves all the following EXCEPT:
   A. Band 3 protein
   B. Microtubules
   C. Glycophorin C
   D. Spectrin tetramers

59. All the following play a significant role in the functioning of platelets EXCEPT:
   A. Arachidonic acid
   B. Fibrinogen
   C. Major basic protein
   D. von Willebrand factor
   E. Thromboxane A₂

60. All the following is/are involved in the development of platelets EXCEPT:
   A. IL-3
   B. Megakaryocytes
   C. The common lymphoid progenitor
   D. Thrombopoietin

61. During normal fetal development, which of the following is LEAST involved in the process of hematopoiesis:
   A. Bone marrow
   B. Liver
   C. Lung
   D. Spleen
   E. Yolk sac

62. All the following statements about bone marrow are true EXCEPT:
   A. Pluripotent stem cells are located mainly in the vascular compartment of bone marrow
   B. The outer boundary of the marrow cavity is formed by the endosteum
   C. Sinusoids are the most abundant type of blood vessel in the marrow cavity
   D. The hematopoietic compartment of the marrow cavity contains erythroblastic islets
E. The vasculature of the marrow cavity is directly continuous with the nutrient vessels of bone and also with the vessels in Volkmann’s canals

63. Identify the **FALSE** statement. In comparison to a large vein, a large lymphatic vessel:
   A. Contains mainly lymphocytes rather than erythrocytes within its lumen
   B. Has a more irregularly shaped lumen
   C. Has greater variation in the thickness of its wall
   D. Has layers whose boundaries are even more difficult to define than in a vein
   E. Has no valves

64. Identify the **FALSE** statement about lymphatic capillaries:
   A. The pressure inside lymphatic capillaries is higher than the blood pressure in nearby postcapillary venules
   B. They are more permeable than blood capillaries
   C. They have a basement membrane that is discontinuous or absent
   D. They have anchoring filaments that help maintain their patency
   E. They include the lacteals of the intestinal villi

65. Edema can be caused by all the following **EXCEPT**:
   A. Activation of basophils and mast cells
   B. An increase in plasma protein concentration
   C. Parasitic infestations that block lymphatic channels (e.g., elephantiasis)
   D. Surgical removal of axillary lymph nodes in the treatment of breast cancer
   E. Right-side heart failure

66. Identify the **FALSE** statement. The atrioventricular node (AV node):
   A. Can act as the pacemaker of the heart if the sinoatrial node (SA node) becomes damaged
   B. Is composed of modified cardiac muscle cells that have a larger average diameter than ordinary cardiac myocytes
   C. Is histologically more similar to the SA node than to Purkinje fibers
   D. Is located in the wall of the right atrium near the tricuspid valve
1. B
2. B
3. C
4. B
5. D
6. E
7. E
8. E
9. C
10. A
11. F
12. B
13. C
14. B
15. B
16. E
17. C
18. A
19. C
20. A
21. E
22. D
23. D
24. C
25. D
26. C
27. D
28. A
29. D
30. A
31. C
32. D
33. C
34. C
35. D
36. A
37. C
38. A
39. E
40. D
41. D
42. C
43. D
44. B
45. A
46. C
47. C
48. A
49. E
50. A
51. B
52. B
53. B
54. C
55. C
56. D
57. E
58. B
59. C
60. C
61. C
62. A
63. E
64. A
65. B
66. B