

Specific Examination Objectives

Question Topic	Total	Average Difficulty
Anemia	23	1.35
Anticoagulants	4	1.25
Blood Smear Examination	1	1.00
Blood Smear Preparation	1	1.00
Bone Marrow	9	1.22
Cell Counts	4	1.75
Coagulation	5	1.60
Hematocrit	1	2.00
Hemoglobin	14	1.64
Hemoglobinopathies	4	2.00
Hemolytic Anemia	8	1.50
Indices	2	2.50
Introduction	5	1.00
Lab Safety	2	1.50
Leukemia	12	1.92
Leukocyte Metabolism	1	1.00
Macrocytic Anemia	1	3.00
Maturation	7	1.43
Megaloblastic Anemia	2	2.50
Myeloproliferative Disease	1	2.00
Normal Values	1	1.00
Polycythemia	4	1.25
Quality Assurance	4	3.00
RBC Membrane	2	2.00
RBC Morphology	5	1.40
RBC Production	3	1.00
RBCs	5	1.80
Reticulocytes	4	2.00
Special Stains	5	1.40
WBC Disorders	1	1.00
WBC Morphology	5	1.40
WBCs	4	1.25

Exam ID	Total Questions	Average Difficulty
CLS 432 Final Comprehensive Examination	150	1.57

On this examination, the student will be expected to:

1. [Level 1/Hematology/Coagulation/1]
Discuss the importance of vasoconstriction in coagulation.
2. [Level 2/Hematology/Coagulation/2]
Evaluate the expected PT and APTT results in a patient with Factor VIII deficiency.
3. [Level 2/Hematology/Coagulation/3]
Describe which of the coagulation factors are mainly responsible for the effectiveness of the coumarin anticoagulants.

4. [Level 1/Hematology/Coagulation/4]
Describe the importance of Factor XIII.
5. [Level 2/Hematology/Coagulation/5]
Explain why Vitamin K is necessary for normal coagulation.
6. [Level 2/Hematology/Anemia/6]
Identify the three components comprising the 'diagnostic triad' of pernicious anemia.
7. [Level 1/Hematology/Anemia/7]
Describe the peripheral blood morphologic findings associated with megaloblastic anemia.
8. [Level 2/Hematology/Anemia/8]
Discuss the significance of Cabot Rings and Howell Jolly bodies within erythrocytes.
9. [Level 2/Hematology/Anemia/9]
Differentiate between iron deficiency anemia and beta thalassemia minor, utilizing expected laboratory findings.
10. [Level 2/Hematology/Anemia/10]
Explain how the effectiveness of iron therapy in the treatment of an anemia might be evaluated by the laboratory.
11. [Level 1/Hematology/Anemia/11]
Correlate WBC and Platelet findings with other morphologic findings often seen in megaloblastic anemia.
12. [Level 1/Hematology/Anemia/12]
Describe the red cell morphology most often seen in aplastic anemia.
13. [Level 1/Hematology/Anemia/13]
Explain the difference between a relative, and an absolute, anemia.
14. [Level 1/Hematology/Anemia/14]
Contrast the MORPHOLOGIC and ETIOLOGIC classifications of anemia.
15. [Level 1/Hematology/Anemia/15]
State the definition of a preleukemic state, and list several examples.
16. [Level 1/Hematology/Anemia/16]
Correlate expected changes in Red Cell Indices with different morphologic types of anemia.
17. [Level 2/Hematology/Anemia/17]
Discuss the possibility of a finding of leukocytosis on a blood smear of a patient with severe megaloblastic anemia.
18. [Level 1/Hematology/Anemia/18]
Define Heinz Bodies.
19. [Level 1/Hematology/Anemia/19]
Define and Describe the clinical symptoms of Paroxysmal Nocturnal Hemoglobinuria.
20. [Level 1/Hematology/Anemia/20]
Describe the characteristic morphology expected in a patient with Hereditary Elliptocytosis.
21. [Level 1/Hematology/Anemia/21]
State the expected morphologic findings in a patient with lead (Pb) poisoning.
22. [Level 1/Hematology/Anemia/22]
Evaluate the clinical usefulness of the Prussian Blue stain with respect to the diagnosis of anemia.
23. [Level 2/Hematology/Anemia/23]
Define and state the expected laboratory findings in a patient with aplastic anemia.

24. [Level 2/Hematology/Anemia/24]
Contrast Sickle Cell Trait (Hgb AS) with Sickle Cell Disease (Hgb SS).
25. [Level 1/Hematology/Anemia/25]
Correlate the Indices with expected red blood cell morphology.
26. [Level 1/Hematology/Anemia/26]
Define 'ringed sideroblast' and state the disorders in which it is most frequently seen.
27. [Level 2/Hematology/Anemia/27]
Given laboratory data, calculate the MCV for a patient.
28. [Level 1/Hematology/Anemia/28]
Define thalassemia.
29. [Level 1/Hematology/Anticoagulants/29]
State which of the anticoagulants does not act by binding calcium, and the mechanism of its action.
30. [Level 1/Hematology/Anticoagulants/30]
Identify the color of the stopper for a Vacutainer tube containing the anticoagulant EDTA.
31. [Level 1/Hematology/Anticoagulants/31]
Identify the stopper color of a Vacutainer tube containing the anticoagulant heparin.
32. [Level 2/Hematology/Anticoagulants/32]
Explain the mechanism by which all of the anticoagulants, except heparin, exert their effects.
33. [Level 1/Immunology/Blood Smear Examination/33]
Define anisocytosis.
34. [Level 1/Hematology/Blood Smear Preparation/34]
State the physical characteristics of a properly prepared peripheral blood smear.
35. [Level 2/Hematology/Bone Marrow/35]
Describe the morphologic appearance of 'stress' reticulocytes.
36. [Level 2/Hematology/Bone Marrow/36]
Identify the location in healthy adults in which all erythropoiesis occurs.
37. [Level 1/Hematology/Bone Marrow/37]
Describe the location of hematopoietic marrow in adults.
38. [Level 1/Hematology/Bone Marrow/38]
Define 'hyperplasia'.
39. [Level 1/Hematology/Bone Marrow/39]
State which of the major types of normal white blood cells is NOT produced in the bone marrow.
40. [Level 1/Hematology/Bone Marrow/40]
Identify which of the formed elements of blood is first produced by the developing embryo.
41. [Level 1/Hematology/Bone Marrow/41]
Identify the two major sites for obtaining bone marrow from an adult.
42. [Level 1/Hematology/Bone Marrow/42]
Define 'marrow cellularity'.
43. [Level 1/Hematology/Bone Marrow/43]
Discuss the mechanism of bone marrow hypoplasia in myeloproliferative disease.
44. [Level 2/Hematology/Cell Counts/44]
State the conditions which might produce an elevated absolute eosinophil count.

45. [Level 3/Hematology/Cell Counts/45]
Given appropriate laboratory data, correct the WBC count for the presence of nucleated red blood cells.
46. [Level 1/Hematology/Cell Counts/46]
Define 'absolute granulocytic leukocytosis'.
47. [Level 1/Hematology/Cell Counts/47]
Define 'leukocytosis'.
48. [Level 2/Hematology/Hematocrit/48]
Given appropriate laboratory data, calculate results by applying the 'Times-3' rule.
49. [Level 2/Hematology/Hemoglobin/49]
Define 'haptoglobin'.
50. [Level 2/Hematology/Hemoglobin/50]
Diagram the sequence in the synthesis of the heme molecule.
51. [Level 2/Hematology/Hemoglobin/51]
Explain the effects on the oxygen affinity of hemoglobin of a change in intracellular 2,3 DPG levels.
52. [Level 2/Hematology/Hemoglobin/52]
Explain the significance of delta-aminolevulinic acid.
53. [Level 1/Hematology/Hemoglobin/53]
State the normal hemoglobin value of an adult male.
54. [Level 2/Hematology/Hemoglobin/54]
Explain how lipemia might affect the results of a hemoglobin assay performed by the Cyanmethemoglobin Method.
55. [Level 2/Hematology/Hemoglobin/55]
State the major production site of urobilinogen.
56. [Level 2/Hematology/Hemoglobin/56]
Explain the effects of a change in pH on the oxygen affinity of hemoglobin.
57. [Level 1/Hematology/Hemoglobin/57]
Identify the plasma protein responsible for the transport of iron.
58. [Level 1/Hematology/Hemoglobin/58]
Define methemoglobin.
59. [Level 1/Hematology/Hemoglobin/59]
Identify the hemoglobins which would not be able to be produced in an individual who is lacking the ability to make beta globin chains.
60. [Level 2/Hematology/Hemoglobin/60]
Explain the significance of a 'shift to the left' of the oxygen dissociation curve of hemoglobin.
61. [Level 1/Hematology/Hemoglobin/61]
State which of the globin chains are normally present ONLY during embryonic development.
62. [Level 2/Hematology/Hemoglobin/62]
Define 'bilirubin glucuronide'.
63. [Level 2/Hematology/Hemoglobinopathies/63]
Evaluate the process by which iron deficiency anemia may be differentiated from thalassemia.
64. [Level 3/Hematology/Hemoglobinopathies/64]
Given appropriate laboratory data, evaluate the procedures that need to be done for a final diagnosis in a patient with hypochromia and microcytosis.

65. [Level 2/Hematology/Hemoglobinopathies/65]
State which of the abnormal hemoglobins found in certain adults seems to give some protection against certain Plasmodium species.
66. [Level 1/Hematology/Hemoglobinopathies/66]
Explain how the diagnosis of Hgb E hemoglobinopathy is determined.
67. [Level 2/Hematology/Hemolytic Anemia/67]
Discuss the participation of haptoglobin in the process of hemolysis.
68. [Level 1/Hematology/Hemolytic Anemia/68]
Define Hereditary Pyropoikilocytosis.
69. [Level 1/Hematology/Hemolytic Anemia/69]
State the chain composition of Hgb F.
70. [Level 2/Hematology/Hemolytic Anemia/70]
Explain the effect the presence of large numbers of spherocytes would have on a calculated MCHC.
71. [Level 2/Hematology/Hemolytic Anemia/71]
Evaluate why large numbers of target cells (>60%) might be seen in a patient having a known sickle cell trait.
72. [Level 1/Hematology/Hemolytic Anemia/72]
Define methemoglobin.
73. [Level 1/Hematology/Hemolytic Anemia/73]
Define Bart's hemoglobin.
74. [Level 2/Hematology/Hemolytic Anemia/74]
Evaluate the efficacy of a transfusion of normal packed red cells into a patient having an extrinsic hemolytic episode.
75. [Level 3/Hematology/Indices/75]
Given appropriate laboratory data, calculate the MCH of a patient.
76. [Level 2/Hematology/Indices/76]
Correlate changes in the RBC Indices (MCV, MCH, MCHC) with the morphologic appearance of red blood cells on a Wright Stained blood smear.
77. [Level 1/Hematology/Introduction/77]
Define 'diapedesis'.
78. [Level 1/Hematology/Introduction/78]
Identify and state the function of the major type of intracellular organelles.
79. [Level 1/Hematology/Introduction/79]
State the function of cellular mitochondria.
80. [Level 1/Hematology/Introduction/80]
State the normal ranges of relative percentages for each of the major types of white blood cells found in peripheral blood.
81. [Level 1/Hematology/Introduction/81]
State the reference ranges for the ABSOLUTE counts of each of the major types of leukocytes found in normal peripheral blood.
82. [Level 2/Hematology/Lab Safety/82]
State the major safety requirements of Universal Precautions.
83. [Level 1/Hematology/Lab Safety/83]
Define 'universal precautions'.

84. [Level 2/Hematology/Leukemia/84]
Evaluate the possible significance of many smudge cells and an absolute lymphocytosis in an elderly patient.
85. [Level 3/Hematology/Leukemia/85]
State the clinical and laboratory findings expected in a patient with FAB M3 acute leukemia.
86. [Level 3/Hematology/Leukemia/86]
Describe and Evaluate the special cytochemical staining results seen in a person with FAB M4 acute leukemia.
87. [Level 1/Hematology/Leukemia/87]
Identify the major acute leukemia found in children.
88. [Level 1/Hematology/Leukemia/88]
State the significance of ringed sideroblasts seen on a bone marrow examination.
89. [Level 1/Hematology/Leukemia/89]
Evaluate how the Leukocyte Alkaline Phosphatase stain may be used in the differentiation of leukemia from a 'leukemoid reaction'.
90. [Level 2/Hematology/Leukemia/91]
Identify the cell type in which Auer Rods are seen.
91. [Level 2/Hematology/Leukemia/92]
Identify the FAB (French-American-British) classification of acute lymphoblastic leukemia which represents a heterogeneous population and is morphologically similar to AML (acute myeloblastic leukemia), type M1
92. [Level 1/Hematology/Leukemia/93]
State the importance of the Ph1 (Philadelphia) chromosome.
93. [Level 3/Hematology/Leukemia/94]
Evaluate the clinical usefulness of the TRAP (tartrate-resistant acid phosphatase) stain.
94. [Level 1/Hematology/Leukemia/95]
Define aleukemic leukemia.
95. [Level 3/Hematology/Leukemia/96]
State the laboratory findings and expected cytochemical staining results in a patient with FAB M2 leukemia.
96. [Level 1/Hematology/Leukocyte Metabolism/97]
State the primary source of blood glycogen.
97. [Level 3/Hematology/Macrocytic Anemia/98]
Correlate clinical and laboratory data in Folic Acid and/or Vitamin B12 deficiency .
98. [Level 2/Hematology/Maturation/99]
Describe the morphologic characteristics of a Rubricyte.
99. [Level 2/Hematology/Maturation/100]
Explain how the myelocyte might be differentiated from the metamyelocyte.
100. [Level 1/Hematology/Maturation/101]
Explain how the myeloblast might be differentiated from the promyelocyte.
101. [Level 2/Hematology/Maturation/102]
Explain which morphologic criteria would provide the most reliable criteria for identification when examining and differentiating the various maturation stages of granulocytes.

102. [Level 1/Hematology/Maturation/103]
Define karyorrhexis.
103. [Level 1/Hematology/Maturation/104]
Describe how impaired synthesis of DNA would lead to megaloblastic, asynchronous development within the red cell.
104. [Level 1/Hematology/Maturation/105]
State the differentiating characteristics of a promyelocyte.
105. [Level 3/Hematology/Megaloblastic Anemia/106]
Correlate clinical and laboratory findings in a patient with macrocytic anemia.
106. [Level 2/Hematology/Megaloblastic Anemia/107]
Correlate clinical and laboratory hematologic findings of a patient with alcoholism.
107. [Level 2/Hematology/Myeloproliferative Disease/108]
Evaluate and contrast urinary erythropoietin levels in patients with polycythemia vera and with secondary polycythemia.
108. [Level 1/Hematology/Normal Values/109]
State the normal ranges of relative percentages for each of the major types of white blood cells found in peripheral blood.
109. [Level 1/Hematology/Polycythemia/110]
State the effects that a patient's erythropoietin-concentrating primary tumor might have on the patients Hemoglobin, Hematocrit, and RBC counts.
110. [Level 2/Hematology/Polycythemia/111]
Differentiate between Absolute and Relative Polycythemia.
111. [Level 1/Hematology/Polycythemia/112]
Evaluate the expected erythropoietin activity in a patient with primary polycythemia.
112. [Level 1/Hematology/Polycythemia/113]
Define a M:E ratio.
113. [Level 3/Hematology/Quality Assurance/114]
Given appropriate laboratory data, calculate the z-score for a set of values.
114. [Level 3/Hematology/Quality Assurance/115]
Given appropriate laboratory data, be able to properly interpret a shift, trend, or dispersion with regard to quality control (Levy-Jennings) plotting.
115. [Level 3/Hematology/Quality Assurance/116]
Evaluate the significance of a Gaussian distribution curve that has a narrow base.
116. [Level 3/Hematology/Quality Assurance/117]
Calculate the standard deviation for a set of results, given the variance.
117. [Level 2/Hematology/RBC Membrane/118]
Describe the function of the Na⁺K⁺ pump.
118. [Level 2/Hematology/RBC Membrane/119]
Identify the predominant red blood cell cation.
119. [Level 1/Hematology/RBC Morphology/120]
Define and state the significance of rouleaux.
120. [Level 2/Hematology/RBC Morphology/121]
Contrast the expectation of visualizing 'sickle cells' in a person having Hgb SS disease, versus a person with sickle cell trait.

121. [Level 2/Hematology/RBC Morphology/122]
Discuss mechanisms by which schistocytes may appear on the peripheral blood smear.
122. [Level 1/Hematology/RBC Morphology/123]
Define hypochromia.
123. [Level 1/Hematology/RBC Morphology/124]
Explain the purpose of an RDW (red cell distribution width).
124. [Level 1/Hematology/RBC Production/126]
Define 'erythropoietin'.
125. [Level 1/Hematology/RBC Production/127]
State the site of production of erythropoietin.
126. [Level 1/Hematology/RBC Production/128]
State which of the normal blood cells is not normally produced in the bone marrow of an adult.
127. [Level 1/Hematology/RBCs/129]
Define microcyte.
128. [Level 1/Hematology/RBCs/130]
Identify the blood formed element which performs its functions entirely within the confines of the vasculature, i.e. it does not undergo diapedesis.
129. [Level 2/Hematology/RBCs/131]
Define hemopexin.
130. [Level 2/Hematology/RBCs/132]
Describe the physical features and characteristics of the normal, mature red blood cell.
131. [Level 3/Hematology/RBCs/133]
State the significance of a patient's urinary excretion of increased amount of delta-aminolevulinic acid.
132. [Level 2/Hematology/Reticulocytes/135]
Define polychromasia.
133. [Level 1/Hematology/Reticulocytes/136]
Define sheath fluid, with respect to flow cytometry.
134. [Level 2/Hematology/Reticulocytes/137]
State reticulocyte count collection requirements for newborns and adults.
135. [Level 3/Hematology/Reticulocytes/138]
Describe the significance of an increase in the Reticulocyte Production Index (RPI).
136. [Level 1/Hematology/Special Stains/139]
State the specific composition of the bluish filaments seen in reticulocytes.
137. [Level 1/Hematology/Special Stains/140]
Explain how a change in pH might affect the results of a Wright stained smear.
138. [Level 2/Hematology/Special Stains/141]
Identify the probable cell type when both the Sudan Black B and esterase stains are positive in a case of suspected acute leukemia.
139. [Level 1/Hematology/Special Stains/142]
Evaluate expected staining results for the PAS stain in a patient with leukemia.
140. [Level 2/Hematology/Special Stains/143]
Describe the staining characteristics of a normal Wright stain.

141. [Level 1/Hematology/WBC Disorders/144]
Define 'myeloproliferative disorder'.
142. [Level 2/Hematology/WBC Morphology/145]
Explain how B and T lymphocytes might be distinguished from one another utilizing flow cytometry.
143. [Level 1/Hematology/WBC Morphology/146]
State the significance of 'drumstick chromatin'.
144. [Level 1/Hematology/WBC Morphology/148]
Define hypersegmentation.
145. [Level 1/Hematology/WBC Morphology/149]
Evaluate laboratory differential results seen in a patient with Pelger Huet anomaly.
146. [Level 2/Hematology/WBC Morphology/150]
Explain what bone marrow finding would favor a diagnosis of Multiple Myeloma.
147. [Level 2/Hematology/WBCs/151]
Explain what is meant by a 'degenerative shift to the left'.
148. [Level 1/Hematology/WBCs/152]
State the number of plasma cells normally seen in peripheral blood.
149. [Level 1/Hematology/WBCs/153]
State the dimensions of the Improved Neubauer Ruling on the counting chamber.
150. [Level 1/Hematology/WBCs/154]
Explain what is meant by a 'left shift'.

Levels given in brackets at the beginning of the question objective indicate the level of difficulty for the actual question on this examination, NOT the level of difficulty for the stated objective. Levels of difficulty were developed using Bloom, et.al. Taxonomy of Educational Objectives. Also shown in the brackets are the Category of the question, the Topic of the question, and the number of the question in the database.

Explanation of Categories in the Cognitive Domain: (with Outcome-Illustrating Verbs)

Level 1: Recall

Knowledge of terminology; specific facts; ways and means of dealing with specifics (conventions, trends and sequences, classifications and categories, criteria, methodology); universals and abstractions in a field (principles and generalizations, theories and structures). Knowledge is (here) defined as the remembering (recalling) of appropriate, previously learned information.

* defines; describes; enumerates; identifies; labels; lists; matches; names; reads; records; reproduces; selects; states; views.

Level 2: Comprehension

Grasping (understanding) the meaning of informational materials.

* classifies; cites; converts; describes; discusses; estimates; explains; generalizes; gives examples; makes sense out of; paraphrases; restates (in own words); summarizes; traces; understands.

Level 3: Application

The use of previously learned information in new and concrete situations to solve problems that have single or best answers.

* acts; administers; articulates; assesses; charts; collects; computes; constructs; contributes; controls; determines; develops; discovers; establishes; extends; implements; includes; informs; instructs; operationalizes; participates; predicts; prepares; preserves; produces; projects; provides; relates; reports; shows; solves; teaches; transfers; uses; utilizes.

Taxonomy of educational objectives : the classification of educational goals ; / by a committee of college and university examiners ; Benjamin S. Bloom, editor [and others] IMPRINT New York : D. McKay Co., Inc., c1956-1964 (1971-72 printing) DESCRIPT. 2 v. in 1 : ill. ; 22 cm. NOTE Vol.2 by D.R. Krathwohl and others.

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