

Instructional Objectives / Learning Outcomes
DMP 775, Veterinary Clinical Pathology
Department of Diagnostic Medicine/Pathobiology
College of Veterinary Medicine, Kansas State University

Chapter 4: Erythrocytes

57. Given erythrograms and reference intervals of domestic mammals with the major anemia disorders:
- a. List and classify abnormalities using appropriate terms.
 - b. Classify anemias as regenerative or nonregenerative if reticulocyte percentages are available.
 - c. Propose appropriate diseases, syndromes, pathologic states, or conditions that could cause the defined abnormalities.
 - d. Based on your conclusions or ideas, explain the pathogenesis of each defined abnormality if the abnormality could be caused by the disorder.
58. Explain the clinical significance of the following if found in an animal's blood; be able to identify those followed by (*ID*).
- a. Rouleau, rouleaux (*ID*)
 - b. Agglutination (*ID*)
 - c. Rubricytosis (*ID*) (also, see later objective)
 - d. Increased central pallor
 - e. Decreased central pallor
 - f. Ghost cell (*ID*)
 - g. Hypochromic erythrocyte (*ID*)
 - h. Hypochromasia (*ID*)
 - i. Polychromatophilic erythrocyte (polychromatophil) (*ID*)
 - j. Increases polychromasia (*ID*)
 - k. Reticulocyte (*ID*)
 - l. Reticulocytosis
 - m. Organisms: *Anaplasma*, *Babesia*, *Cytauxzoon*, *Eperythrozoon*, *Mycoplasma (Haemobartonella)* (*ID*)
 - n. Basophilic stippling (*ID*)
 - o. Heinz body (*ID*)
 - p. Howell-Jolly body (*ID*)
 - q. Siderotic granules (Pappenheimer bodies)
 - r. Anisocytosis (*ID*)
 - s. Macrocytes (macrocytosis) (*ID*)
 - t. Microcytes (microcytosis) (*ID*)
 - u. Acanthocyte (spur cell) (acanthocytosis) (*ID*)
 - v. Codocyte (target cell, Mexican hat cell) (codocytosis) (*ID*)
 - w. Eccentrocyte (bite cell, cross-banded cell, hemighost cell) (eccentrocytosis) (*ID*)
 - x. Echinocyte (echinocytosis) (*ID*)
 - y. Keratocyte (helmet cell) (keratocytosis) (*ID*)
 - z. Leptocyte (leptocytosis) (*ID*)
 - aa. Poikilocyte (poikilocytosis) (*ID*)
 - bb. Pyknocyte (pyknocytosis) (*ID*)
 - cc. Schizocyte (schistocyte or RBC fragment) (schizocytosis) (*ID*)
 - dd. Spherocyte (spherocytosis) (*ID*)

- ee. Stomatocyte (stomatocytosis) (*ID*)
59. Contrast and compare appropriate and inappropriate rubricytosis including rule-outs and pathogenesises. (p. 95)
 60. List the information that is needed to use each of the three anemia classification systems.
 61. If a reticulocyte percentage or concentration is not available, list or explain other information that would suggest there is an effective marrow response to the anemia. When considered individually, state why such information would not be as reliable as establishing the presence or absence of reticulocytosis.
 62. List the basic pathologic states or processes that are probably present if an animal has a regenerative (responsive) anemia.
 63. Explain why:
 - a. Most nonregenerative anemias are normocytic normochromic anemias.
 - b. Nearly all hemorrhagic and hemolytic anemias are normocytic normochromic anemias during the first few days after the hemolytic or hemorrhagic episodes.
 - c. Most regenerative anemias are either macrocytic normochromic or macrocytic hypochromic anemias.
 64. State major rule-outs (diseases, pathologic states, etc) for each of the following; for each, explain the process by which the MCV or MCHC changes. In which of the states do you expect the MCH to change (either increase or decrease)?
 - a. Normocytic normochromic anemia
 - b. Macrocytic normochromic anemia
 - c. Macrocytic hypochromic anemia
 - d. Microcytic normochromic anemia
 - e. Microcytic hypochromic anemia
 65. Wintrobe's erythrocyte indices typically reflect erythrocyte changes that can also be seen during the microscopic examination of erythrocytes, but not always. List reasons why the following may be found.
 - a. MCV is WRI but macrocytes are seen in a blood film.
 - b. MCV is increased but macrocytes are not seen in a blood film.
 - c. MCV is decreased but microcytes are not seen in a blood film.
 66. List and explain the reasons for increased MCHC values, both factitious and pathologic.
 - a. Factitious
 - b. Pathologic
 67. List the three major pathophysiologic processes that produce anemias and are the basis of the pathophysiologic classification of anemias. For each process, explain how it produces an anemia.
 68. Recognize and list the four major types of disorders or conditions that cause nonregenerative anemia. For each, recognize and explain the pathologic processes that cause anemias in these disorders. Compare and contrast these processes.
 69. Explain the pathogenesis of the anemia of:
 - a. Inflammatory disease (3 major components)
 - b. Renal disease (3-4 major components)
 - c. Marrow hypoplasia or aplasia
 - d. Erythroid hypoplasia or ineffective erythropoiesis
 70. List types of diseases or disorders that cause marrow hypoplasia or aplasia (4 major types).
 71. List types of diseases or disorders that cause erythroid hypoplasia or ineffective erythropoiesis (5 types).

72. Explain how blood loss results in:
 - a. Regenerative anemia
 - b. Iron deficiency anemia
73. Define hemolysis; contrast and compare intravascular hemolysis and extravascular hemolysis including clinical manifestations and sites of erythrocyte destruction.
74. Explain how hemolysis produces:
 - a. Anemia
 - b. Hemoglobinemia and hemoglobinuria
 - c. Icterus, hyperbilirubinemia, and bilirubinuria
75. Explain why a thorough examination of erythrocytes in a blood film is indicated if laboratory test results suggest or indicate the presence of a hemolytic anemia.
76. List the major mechanisms or processes that cause hemolytic anemias in the hemolytic disorders. For each type, list the major diseases and other conditions for domestic animals.
77. Describe pathologic events or physiologic responses that lead to the development of:
 - a. Immune hemolytic anemias
 - b. Heinz body hemolytic anemias
 - c. Eccentric hemolytic anemias
 - d. Parasitic hemolytic anemias
 - e. Fragmentation hemolysis
 - f. Hemolytic disorders of bacterial infections
78. Red urine can indicate the presence of three pathologic states; list them and explain how the one caused by hemolysis is differentiated from the other two.
79. Describe situations when bone marrow examinations may be indicated for an animal with a persistent normocytic normochromic nonregenerative anemia.
80. Describe how the following findings might help determine the cause of an animal's anemia.
 - a. Hyperproteinemia
 - b. Hypoproteinemia
 - c. Hyperbilirubinemia and bilirubinuria
 - d. Hemoglobinemia and hemoglobinuria
 - e. Positive Coombs' test
 - f. Hypoferremia
81. Define, compare, and contrast erythrocytosis, hemoconcentration, polycythemia, "relative polycythemia," and "spurious polycythemia."
82. List the 5 major types of erythrocytotic (erythrocytosis) disorders.
83. Describe the pathologic events or physiologic responses which cause erythrocytosis in the following:
 - a. Hemoconcentration
 - b. Splenic contraction
 - c. Secondary appropriate erythrocytotic disorders
 - d. Secondary inappropriate erythrocytotic disorders
 - e. Primary erythrocytotic disorders
84. Recognize or explain the pathologic or physiologic processes that produce the following. For each, briefly explain how the process created the abnormality (if known).
 - a. Hyperferremia
 - b. Hypoferremia

- c. ↑ TIBC
 - d. ↓ TIBC
 - e. ↑ iron storage
 - f. ↓ iron storage
 - g. Hyperferritinemia
 - h. Hypoferritinemia
85. If provided with clinical information and results of an iron profile, differentiate the following disorders.
- a. Fe deficiency from inflammation
 - b. Inflammation from iron overload
 - c. Inflammation from hemolysis
 - d. Hepatic insufficiency from Fe deficiency
86. Extra credit material: explain the pathogenesis (fact or theory) of the erythrocyte abnormalities associated with or due to:
- a. Erythrocyte enzyme deficiencies: PK, PFK, G6PD, cytochrome b₅ reductase
 - b. Erythrocyte FAD deficiency
 - c. Hereditary stomatocytosis
 - d. Hereditary elliptocytosis
 - e. Megaloblastic anemia
 - f. Nutritional deficiencies: copper, folate, cobalamin
 - g. Hypophosphatemia
 - h. Porphyria
 - i. Heparin
 - j. Infusion of hypotonic fluid
 - k. Envenomation