Table 14-1 Classification of Anemia According to Underlying Mechanism

Mechanism	Specific Examples
Blood Loss	
Acute blood loss	Trauma
Chronic blood loss	Gastrointestinal tract lesions, gynecologic disturbances*
Increased Red Cell Destruction (Hemolysis)	
Inherited genetic defects	
Red cell membrane disorders	Hereditary spherocytosis, hereditary elliptocytosis
Enzyme deficiencies	
Hexose monophosphate shunt enzyme deficiencies	G6PD deficiency, glutathione synthetase deficiency
Glycolytic enzyme deficiencies	Pyruvate kinase deficiency, hexokinase deficiency
Hemoglobin abnormalities	
Deficient globin synthesis	Thalassemia syndromes
Structurally abnormal globins (hemoglobinopathies)	Sickle cell disease, unstable hemoglobins
Acquired genetic defects	
Deficiency of phosphatidylinositol-linked glycoproteins	Paroxysmal nocturnal hemoglobinuria
Antibody-mediated destruction	Hemolytic disease of the newborn (Rh disease), transfusion reactions, drug-induced, autoimmune disorders
Mechanical trauma	
Microangiopathic hemolytic anemias	Hemolytic uremic syndrome, disseminated intravascular coagulation, thrombotic thrombocytopenia purpura
Cardiac traumatic hemolysis	Defective cardiac valves
Repetitive physical trauma	Bongo drumming, marathon running, karate chopping
Infections of red cells	Malaria, babesiosis
Toxic or chemical injury	Clostridial sepsis, snake venom, lead poisoning
Membrane lipid abnormalities	Abetalipoproteinemia, severe hepatocellular liver disease
Sequestration	Hypersplenism
Decreased Red Cell Production	
Inherited genetic defects	
Defects leading to stem cell depletion	Fanconi anemia, telomerase defects
Defects affecting erythroblast maturation	Thalassemia syndromes
Nutritional deficiencies	
Deficiencies affecting DNA synthesis	B_{12} and folate deficiencies
Deficiencies affecting hemoglobin synthesis	Iron deficiency anemia
Erythropoietin deficiency	Renal failure, anemia of chronic disease
Immune-mediated injury of progenitors	Aplastic anemia, pure red cell aplasia
Inflammation-mediated iron sequestration	Anemia of chronic disease
Primary hematopoietic neoplasms	Acute leukemia, myelodysplasia, myeloproliferative disorders (Chapter 13)
Space-occupying marrow lesions	Metastatic neoplasms, granulomatous disease
Infections of red cell progenitors	Parvovirus B19 infection
Unknown mechanisms	Endocrine disorders, hepatocellular liver disease

G6PD, Glucose-6-phosphate dehydrogenase.
*Most often cause of anemia is iron deficiency, not bleeding per se.

- *Mean cell volume*: the average volume of a red cell expressed in femtoliters (fL)
- *Mean cell hemoglobin*: the average content (mass) of hemoglobin per red cell, expressed in picograms
- *Mean cell hemoglobin concentration*: the average concentration of hemoglobin in a given volume of packed red cells, expressed in grams per deciliter
- *Red cell distribution width*: the coefficient of variation of red cell volume

Adult reference ranges for red cell indices are shown in Table 14-2.

Whatever its cause, when sufficiently severe anemia leads to certain clinical findings. Patients appear pale. Weakness, malaise, and easy fatigability are common complaints. The lowered oxygen content of the circulating blood leads to dyspnea on mild exertion. Hypoxia can cause fatty change in the liver, myocardium, and kidney. If fatty changes in the myocardium are sufficiently severe, cardiac failure can develop and compound the tissue hypoxia caused by the deficiency of O_2 in the blood. On occasion, the myocardial hypoxia manifests as angina pectoris, particularly when complicated by pre-existing coronary artery disease. With acute blood loss and shock,