APPROACH TO ANEMIA

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- 06/10/25

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REFERENCES

- HARRISON
- UPTODATE
- ALGAPPAN –MANUAL OF PRACTICAL MEDICINE

DEFINITION

- **Anemia definitions** —

- Anemia is defined as a condition in which the hemoglobin concentration or number of Red cell count.
- “Anemia is defined as a reduction in the red blood cell mass, as evidenced by low hemoglobin concentration and hematocrit, resulting in decreased oxygen-carrying capacity of the blood.
- A low hemoglobin concentration and/or low hematocrit are the parameters most widely used to diagnose anemia.

Definitions of anemia from the World Health Organization

Population	Hemoglobin			
	Non-anemic	Mild anemia*	Moderate anemia	Severe anemia
Children 6 to 23 months	≥10.5 g/dL	9.5 to 10.4 g/dL	7.0 to 9.4 g/dL	<7.0 g/dL
Children 24 to 59 months	≥11.0 g/dL	10.0 to 10.9 g/dL	7.0 to 9.9 g/dL	<7.0 g/dL
Children 5 to 11 years	≥11.5 g/dL	11.0 to 11.4 g/dL	8.0 to 10.9 g/dL	<8.0 g/dL
Children 12 to 14 years	≥12.0 g/dL	11.0 to 11.9 g/dL	8.0 to 10.9 g/dL	<8.0 g/dL
Females ≥15 years (non-pregnant)	≥12.0 g/dL	11.0 to 11.9 g/dL	8.0 to 10.9 g/dL	<8.0 g/dL
Females, pregnant				
▪ First trimester	≥11.0 g/dL	10.0 to 10.9 g/dL	7.0 to 9.9 g/dL	<7.0 g/dL
▪ Second trimester	≥10.5 g/dL	9.5 to 10.4 g/dL	7.0 to 9.4 g/dL	<7.0 g/dL
▪ Third trimester	≥11.0 g/dL	10.0 to 10.9 g/dL	7.0 to 9.9 g/dL	<7.0 g/dL
Males ≥15 years	≥13.0 g/dL	11.0 to 12.9 g/dL	8.0 to 10.9 g/dL	<8.0 g/dL

Refer to UpToDate for additional caveats and definitions. To convert g/dL to g/L, multiply by 10 (eg, 7.0 g/dL = 70 g/L). Iron deficiency without anemia has consequences and can cause significant symptoms and disability before anemia develops.

* "Mild" is a misnomer: iron deficiency is already advanced by the time anemia is identified.

TABLE 66-2 Changes in Normal Hemoglobin/Hematocrit Values with Age, Sex, and Pregnancy

AGE/SEX	HEMOGLOBIN, g/dL	HEMATOCRIT, %
At birth	17	52
Childhood	12	36
Adolescence	13	40
Adult man	16 (±2)	47 (±6)
Adult woman (menstruating)	13 (±2)	40 (±6)
Adult woman (postmenopausal)	14 (±2)	42 (±6)
During pregnancy	12 (±2)	37 (±6)

Source: From RS Hillman et al: *Hematology in Clinical Practice*, 5th ed. New York, McGraw-Hill, 2010.

HOW TO APPROACH THE PATIENT

- **1. The first step is a good history;**
  previous episodes of Anemia,
  history of taking iron pills
  blood transfusions, family history of anemia
  being a blood donor or dietary history of being vegetarian

Signs of Anemia (Clinical Findings)

System / Area	Signs	Comments / Significance
General appearance	Pallor (especially conjunctiva, nail beds, palms)	Most characteristic sign
Cardiovascular	Tachycardia, bounding pulse, flow murmurs	“Hemodynamic compensation”
Respiratory	Tachypnea	To compensate for low O_2
Skin and Nails	Pallor, brittle nails, koilonychia (spoon-shaped nails)	Seen in iron deficiency
Hair	Dry, brittle hair, hair loss	Nutritional anemia
Eyes	Pale conjunctiva, scleral icterus (if hemolysis)	Icterus → hemolytic anemia
Mouth	Glossitis, angular cheilitis	Megaloblastic / iron deficiency
Lymph nodes / spleen	Lymphadenopathy, splenomegaly	Seen in hemolytic or malignant causes
Bone changes	Frontal bossing, maxillary hypertrophy	Chronic severe anemia (esp. thalassemia)
Edema	In severe anemia due to low plasma oncotic pressure	Common in chronic severe cases

Specific Signs in Different Types of Anemia

Type of Anemia	Characteristic Signs / Features
Iron Deficiency Anemia	Koilonychia, glossitis, angular cheilitis, pica
Megaloblastic Anemia	Glossitis, lemon-yellow pallor, paresthesias (B_{12} deficiency)
Hemolytic Anemia	Jaundice, splenomegaly, dark urine
Aplastic Anemia	Petechiae, purpura, infections (due to pancytopenia)
Anemia of Chronic Disease	Mild pallor, features of underlying disease
Thalassemia Major	Bone deformities (frontal bossing), hepatosplenomegaly, growth retardation

Physical Examination in Anemia

1. General Inspection

Finding	Observation / Comment	Interpretation
General appearance	Patient may appear pale, tired, weak	Suggests moderate to severe anemia
Build & nourishment	Poor nutrition may indicate nutritional anemia	Iron, folate, or B12 deficiency
Posture / activity	Lethargic, dyspneic, fatigued	Hypoxia and low oxygen delivery

- **2. Pallor**
- **Most important clinical sign of anemia**
- **Sites to check:**
  - Lower palpebral **conjunctiva**
  - **Nail beds**
  - **Palmar creases**
  - **Tongue and lips**
- **Severe pallor** → Hb usually **<7 g/dL**

3. Skin and Mucous Membranes

Feature	Possible Indication
Pallor	All anemias
Icterus (yellowish sclera/skin)	**Hemolytic anemia** or megaloblastic anemia (indirect hyperbilirubinemia)
Pigmentation	Seen in Addison’s disease or megaloblastic anemia
Petechiae / Purpura	**Aplastic anemia** (thrombocytopenia)
Koilonychia (spoon nails)	**Iron deficiency anemia**
Brittle nails / ridging	Nutritional anemia
Angular cheilitis, glossitis	Iron or vitamin B12 deficiency

4. Eyes

Finding	Interpretation
Pale conjunctiva	Most reliable sign of anemia
Scleral icterus	Hemolysis
Retinal hemorrhages / papilledema	Severe anemia or associated thrombocytopenia

5. Oral Cavity

Finding	Associated Type of Anemia
Glossitis (smooth, beefy red tongue)	Megaloblastic or iron deficiency
Angular stomatitis	Iron deficiency
Pale mucosa	All anemias
Sore or burning tongue	Vitamin B12 / folate deficiency

6. Lymph Nodes and Spleen

Finding	Interpretation
Lymphadenopathy	Lymphoma, leukemia, infections causing anemia
Splenomegaly	Hemolytic anemia, thalassemia, myeloproliferative disorders
Hepatomegaly	Extramedullary hematopoiesis, hemolytic anemia

7. Cardiovascular System

Finding	Explanation
Tachycardia	Compensation for low oxygen
Bounding pulse / collapsing pulse	Seen in severe anemia (high output state)
Flow (systolic) murmur	Due to hyperdynamic circulation
Cardiomegaly / signs of failure	Seen in chronic severe anemia

- **8. Respiratory System**
- **Tachypnea** and **dyspnea on exertion**
- **Basal crepitations** if high-output cardiac failure develops

9. Skeletal Abnormalities

- (Seen in chronic hemolytic anemias, esp. **thalassemia major**)
- **Frontal bossing**
- **Maxillary hypertrophy**
- **Malar prominence**
  → Due to marrow expansion from increased erythropoiesis.

10. Abdomen

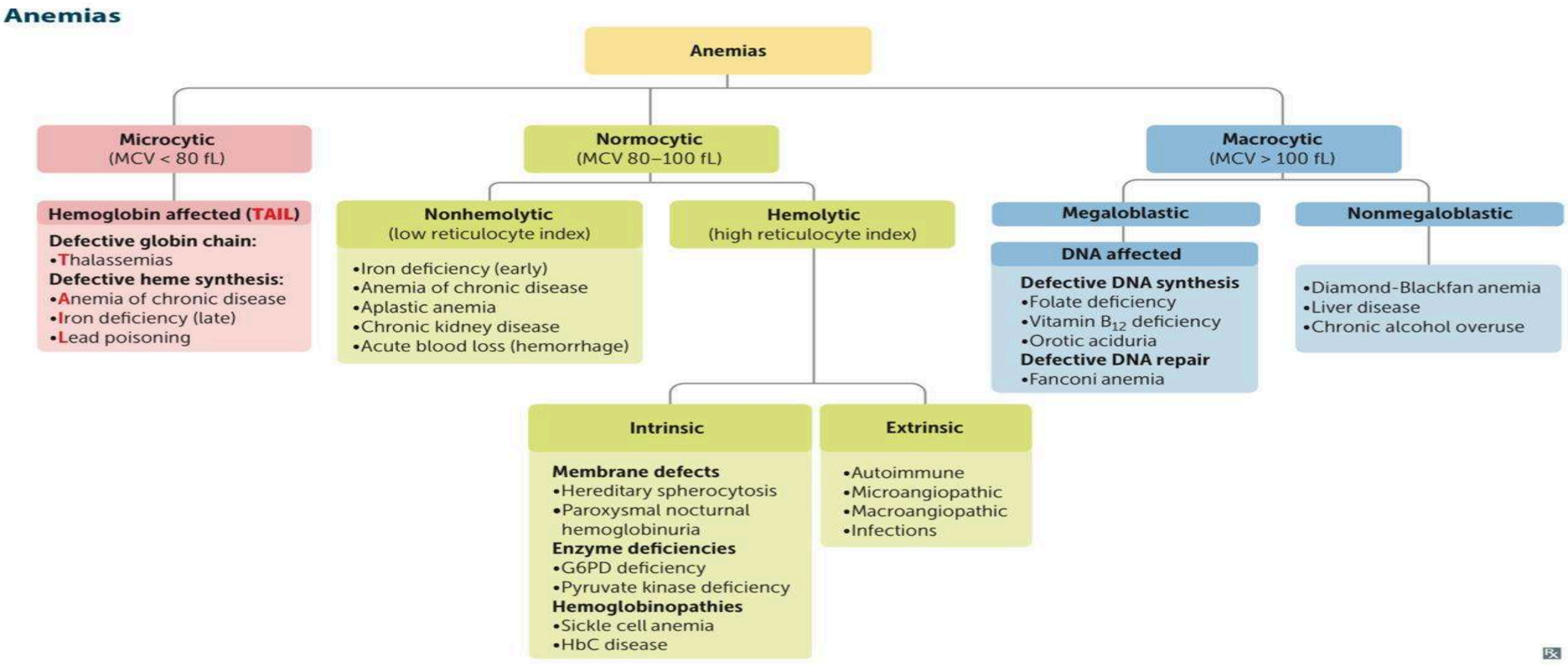
Finding	Associated Condition
Splenomegaly	Hemolytic anemia, thalassemia, leukemia
Hepatomegaly	Hemolysis, leukemia, extramedullary hematopoiesis
Ascites	Severe chronic anemia or associated liver disease

🧾 Summary Table

System	Key Findings
General	Pallor, fatigue, weakness
Skin/Nails	Pallor, koilonychia, petechiae
Eyes	Pale conjunctiva, scleral icterus
Mouth	Glossitis, cheilitis
CVS	Tachycardia, flow murmur
Abdomen	Splenomegaly, hepatomegaly
Nervous system	Neuropathy (B12 deficiency)
Bones	Frontal bossing (thalassemia)

- I**. Complete blood count (CBC**)
  - **A. Red blood cell count**
    - 1. Hemoglobin
    - 2. Hematocrit
    - 3. Reticulocyte count
  - **B. Red blood cell indices**
    - 1. Mean cell volume (MCV)
    - 2. Mean cell hemoglobin (MCH)
    - 3. Mean cell hemoglobin concentration (MCHC)
    - 4. Red cell distribution width (RDW)

CLASSIFICATION OF ANEMIA



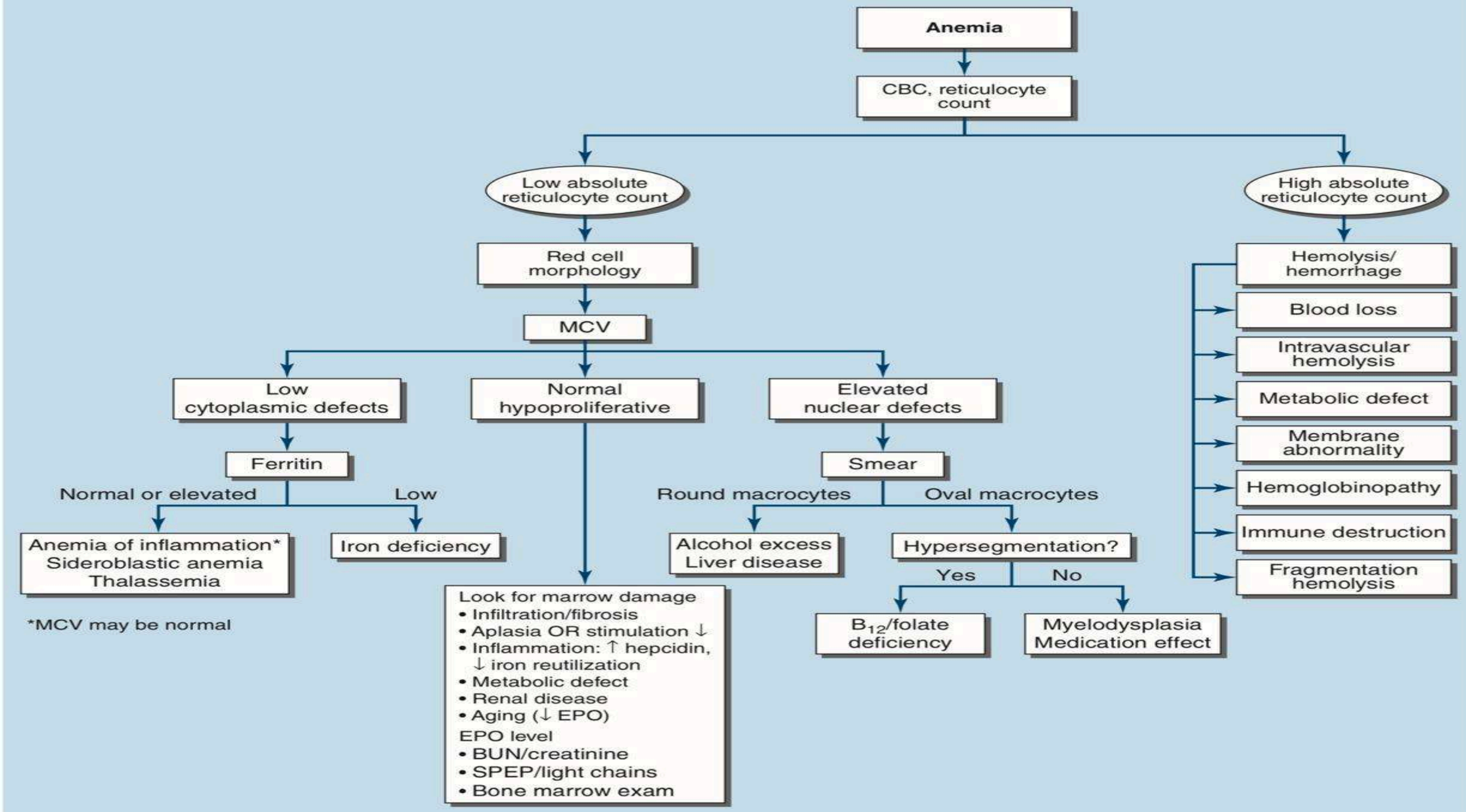


FIGURE 66-17 The physiologic classification of anemia. BUN, blood urea nitrogen; CBC, complete blood count; EPO, erythropoietin level; MCV, mean corpuscular volume; SPEP, serum protein electrophoresis.

HCT

- **Hematocrit (Hct)** is a critical parameter in a **Complete Blood Count (CBC)** test. It represents the **percentage of red blood cells (RBCs) in the total blood volume**. It provides essential information about a patient's **oxygen-carrying capacity**, **hydration status**, and **overall health**
- **Why Hematocrit Matters Clinically**
- **Oxygen Transport:** Directly relates to the number of RBCs available to carry oxygen.
- **Guides Fluid Therapy:** Useful in assessing dehydration or fluid overload.
- **Assesses Response to Treatment:** In anemia or polycythemia management.
- **Indicator in Shock or Blood Loss:** Helps detect acute or chronic bleeding.

Condition	Hematocrit Change	Clinical Insight
Anemia	↓ Low	Fewer RBCs; often due to blood loss, nutritional deficiencies, chronic diseases
Dehydration	↑ High	Plasma volume decreases, falsely raising Hct
Polycythemia	↑ High	Increased RBC production (e.g., polycythemia vera, chronic hypoxia)
Overhydration	↓ Low	Dilutional effect from excess plasma
Bleeding	↓ Low (delayed)	RBCs and plasma lost equally at first, then Hct drops
Heart or Lung Disease	↑ High	Chronic hypoxia can stimulate RBC production

MCV

- **MCV (Mean Corpuscular Volume)** is a key red blood cell (RBC) index included in the **CBC (Complete Blood Count)**. It measures the **average size (volume) of red blood cells** in femtoliters (fL)
- **Normal MCV range: 80–100 fL**
- **<80 fL**: Microcytic (small cells)
- **80–100 fL**: Normocytic (normal size)
- **>100 fL**: Macrocytic (large cells)

MCV Category	Type of Anemia	Common Causes
🔴 **Low MCV (<80 fL)**	Microcytic Anemia	Iron deficiency, Thalassemia, Anemia of chronic disease, Lead poisoning
⚪ **Normal MCV (80–100 fL)**	Normocytic Anemia	Acute blood loss, Hemolysis, Chronic disease, Kidney disease
🔵 **High MCV (>100 fL)**	Macrocytic Anemia	Vitamin B12 or folate deficiency, Liver disease, Alcoholism, Hypothyroidism, Certain medications

- **Why MCV Matters Clinically**
- **Guides Anemia Classification**: First step in differentiating types of anemia.
- **Suggests Nutritional Deficiencies**: High MCV may point to B12 or folate deficiency.
- **Monitors Chronic Conditions**: Changes in MCV can reflect disease progression or response to therapy.
- **Flags Early Abnormalities**: Before symptoms appear, MCV changes may suggest subclinical issues.

MCH

- In a **Complete Blood Count (CBC)** test, **MCH (Mean Corpuscular Hemoglobin)** is one of the red blood cell (RBC) indices. It reflects the **average amount of hemoglobin present in a single red blood cell**.
- **What MCH Indicates**
- **Normal MCH (27–33 pg/cell in adults):**
  Suggests adequate hemoglobin content per RBC, supporting normal oxygen-carrying capacity.
- **Low MCH (hypochromic cells):**
  - Often seen in **iron deficiency anemia** or **thalassemia**.
  - RBCs appear paler under the microscope (hypochromia).
- **High MCH (hyperchromic cells):**
  - May indicate **macrocytic anemias** (e.g., vitamin B12 or folate deficiency).
  - RBCs are larger, carrying more hemoglobin per cell.

MCHC

- It measures the **average concentration of hemoglobin inside a red blood cell**, expressed in grams per deciliter (g/dL).

. Clinical Significance

- More reliable than MCH, because it accounts for cell size (MCV).
- Useful to distinguish between:
  - **Hypochromic anemias** (iron-related)
  - **Normochromic anemias** (blood loss, chronic disease)
  - **Hyperchromic conditions** (rare, usually membrane disorders)

Relevance of MCHC

1. Indicator of Hemoglobin Concentration

- Normal range: **32 – 36 g/dL** (varies slightly by lab).
- Reflects how "full" each RBC is with hemoglobin.

2. Helps Classify Anemia

- **Low MCHC (Hypochromia):**
  - RBCs have less hemoglobin, appear pale.
  - Seen in **iron deficiency anemia**, **thalassemia**.
- **Normal MCHC (Normochromia):**
  - Seen in **acute blood loss** or **anemia of chronic disease**.
- **High MCHC (Hyperchromia):**
  - Rare; RBCs appear densely colored.
  - Seen in **hereditary spherocytosis**, **autoimmune hemolytic anemia**, sometimes with **severe burns**.

RDW

- **In a Complete Blood Count (CBC), RDW (Red Cell Distribution Width) is an important parameter that reflects the variation in size of red blood cells (anisocytosis).**
- **Relevance of RDW**
- **1. What RDW Measures**
- **Normal range: 11.5 – 14.5% (may vary slightly by lab).**
- **A higher RDW means there is more variation in RBC size.**
- **A normal/low RDW means RBCs are relatively uniform in size**

Clinical Importance

- Helps in Anemia Classification (along with MCV):
- High RDW + Low MCV → Iron deficiency anemia (wide variation: some small, some normal RBCs).
- Normal RDW + Low MCV → Thalassemia trait (all cells small but uniform).
- High RDW + High MCV → Vitamin B12 or Folate deficiency (macrocytic with size variation).
- Normal RDW + Normal MCV → Anemia of chronic disease or acute blood loss.

- **Early Indicator:**
- RDW can be the **first abnormal parameter** before hemoglobin drops, especially in nutritional anemias.
- **Predictive Value Beyond Anemia:**
- Studies show high RDW may be linked with **cardiovascular risk, chronic kidney disease, liver disease, and inflammatory states**, though its main clinical use remains anemia evaluation.

THE RETICULOCYTE COUNT

- **Red cells still contain mRNA for about 24 h after being released by the marrow. This mRNA can be detected by staining, and these cells are called “reticulocytes.”**
- **The percentage of red cells that take up the stain Methylene Blue determine the reticulocyte count.**
- **This needs to be adjusted for the hematocrit as the reticulocyte percentage will appear to increase with decreasing blood counts when the absolute count has not actually increased. For example, a reticulocyte count of 1% will increase to 2% with a hematocrit of 23%.**
- **Corrected reticulocyte count = Measured reticulocyte count × (Patient hematocrit/45%)**

- **The number of reticulocytes present is a measure of red cell production and is helpful in separating increased destruction from anemias due to impaired red cell production.**

MCV (Cell Size)	**MCHC** (Hb Concentration)	**RDW** (Size Variation)	**Likely Cause of Anemia**
Low (Microcytic)	**Low (Hypochromic)**	**High**	**Iron deficiency anemia**
Low (Microcytic)	**Low/Normal**	**Normal**	**Thalassemia trait**
Low (Microcytic)	**Low**	**High**	**Sideroblastic anemia** (less common)
Normal (Normocytic)	**Normal**	**Normal**	**Anemia of chronic disease**, **acute blood loss**
Normal (Normocytic)	**Normal/High**	**High**	**Hemolytic anemia**, **sickle cell disease**, mixed deficiencies
High (Macrocytic)	**Normal/High**	**High**	**Vitamin B12 or Folate deficiency**, **liver disease**, chemotherapy effects
High (Macrocytic)	**Normal**	**Normal**	**Aplastic anemia**, **chronic liver disease**

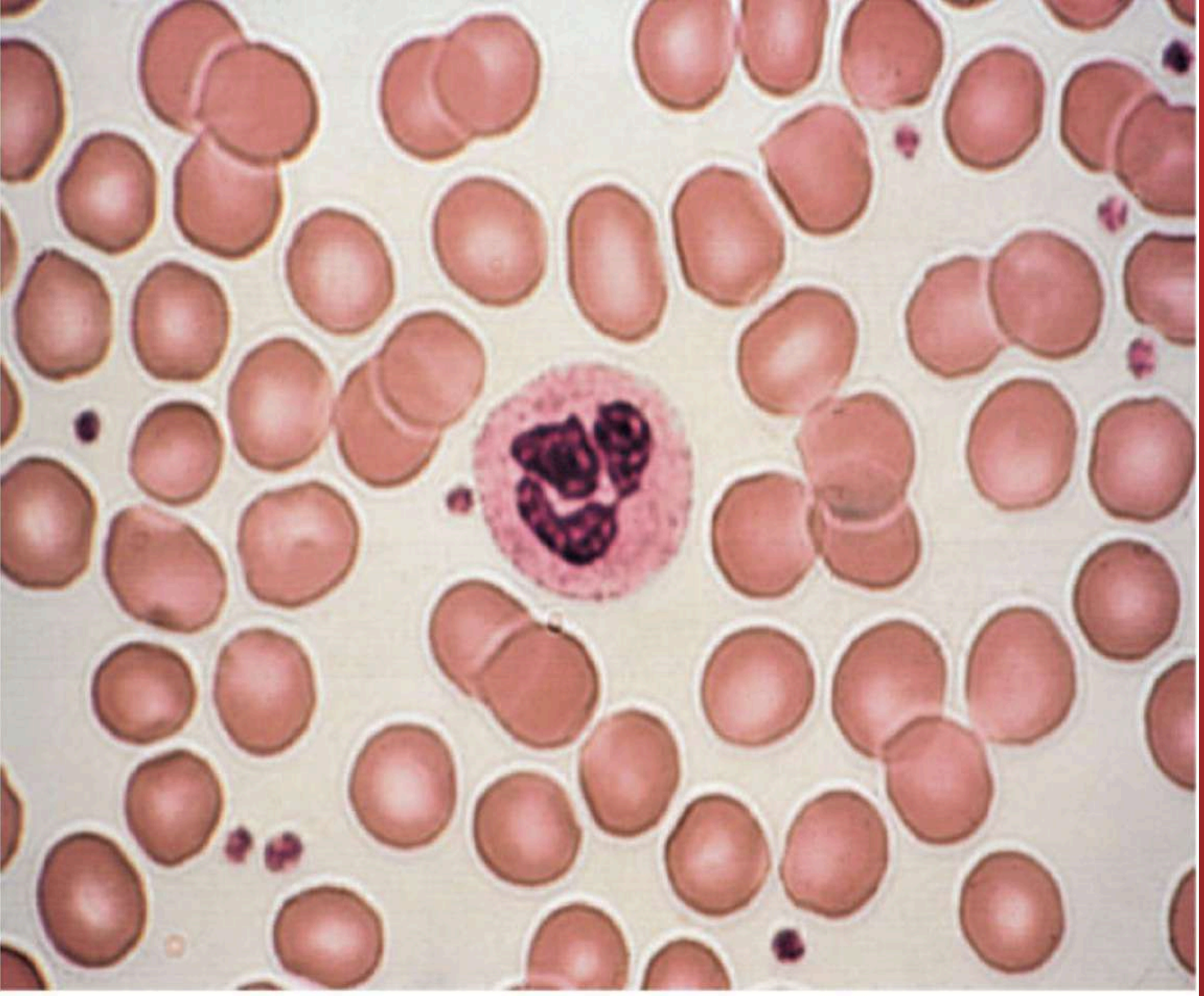
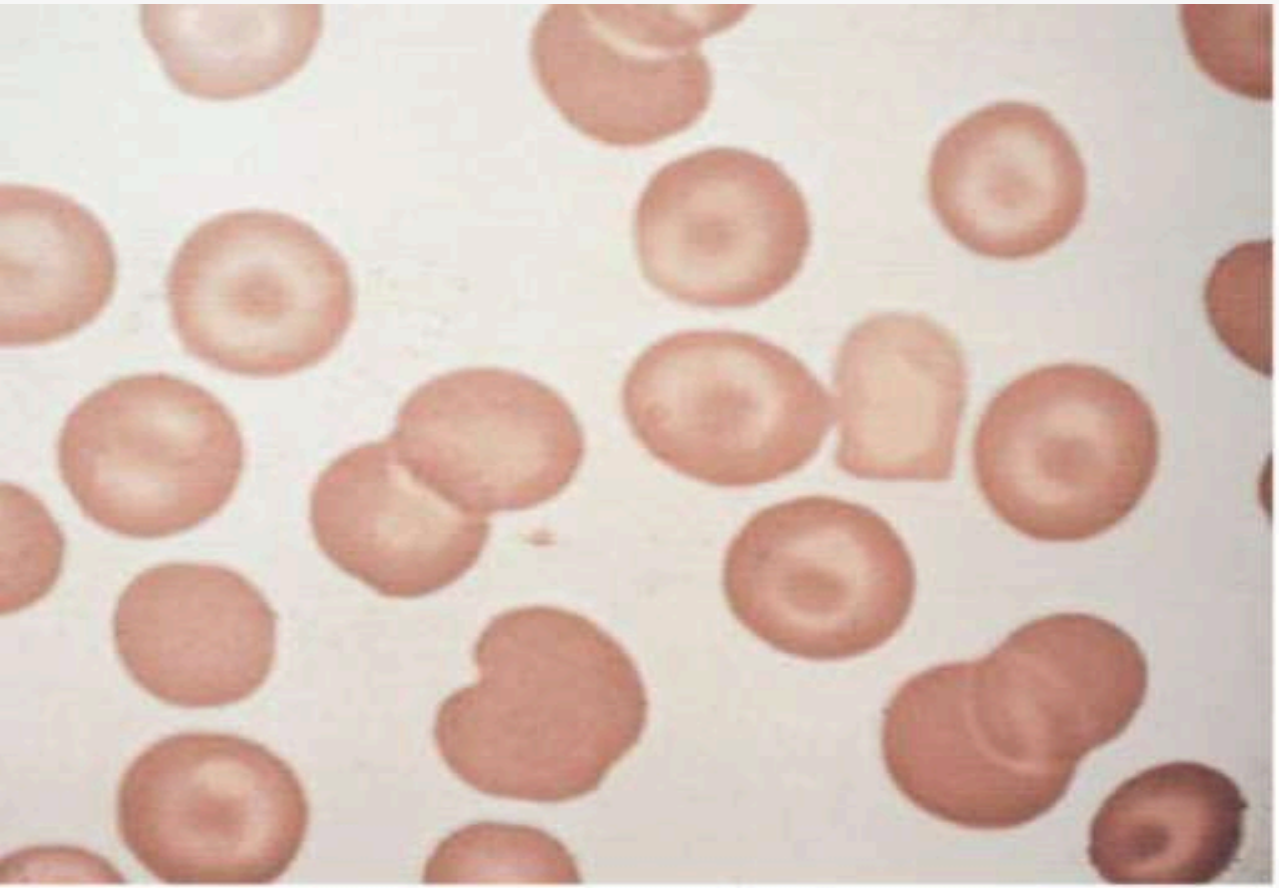


FIGURE 66-3 Normal blood smear (Wright stain). High-power field showing normal red cells, a neutrophil, and a few platelets. *(From RS Hillman et al: Hematology in Clinical Practice, 5th ed. New York, McGraw-Hill, 2010.)*

PERIPHERAL SMEAR

NORMAL



arget cells. Target cells have a bull's-eye appearance and are seen in
d in liver disease. *(From M Lichtman et al (eds): Williams Hematology,*
ork, McGraw-Hill, 2005; RS Hillman, KA Ault: Hematology in General
d. New York, McGraw-Hill, 2005.)

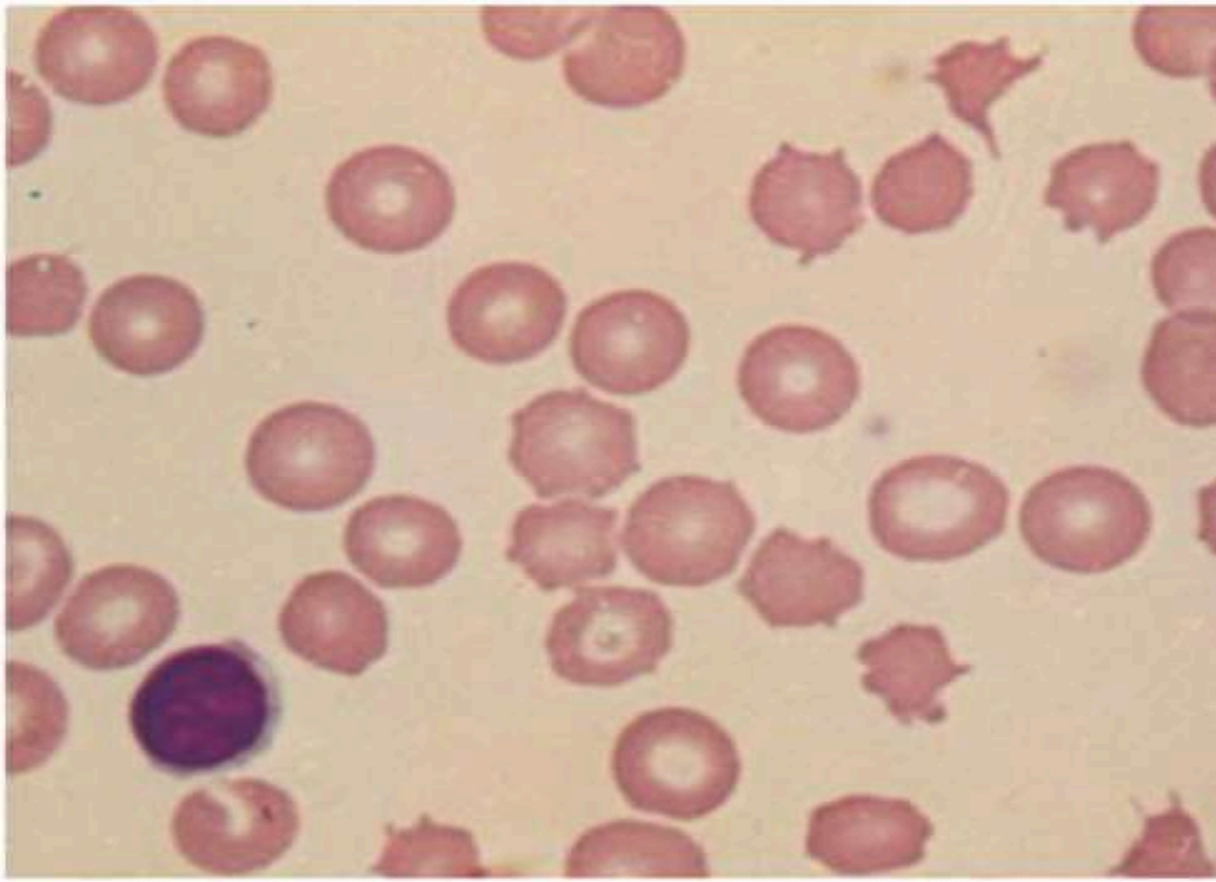


FIGURE 66-11 Spur cells. Spur cells are recognized as distorted re
several irregularly distributed thorn-like projections. Cells with
abnormality are also called acanthocytes. *(From RS Hillman et*
Clinical Practice, 5th ed. New York, McGraw-Hill, 2010.)

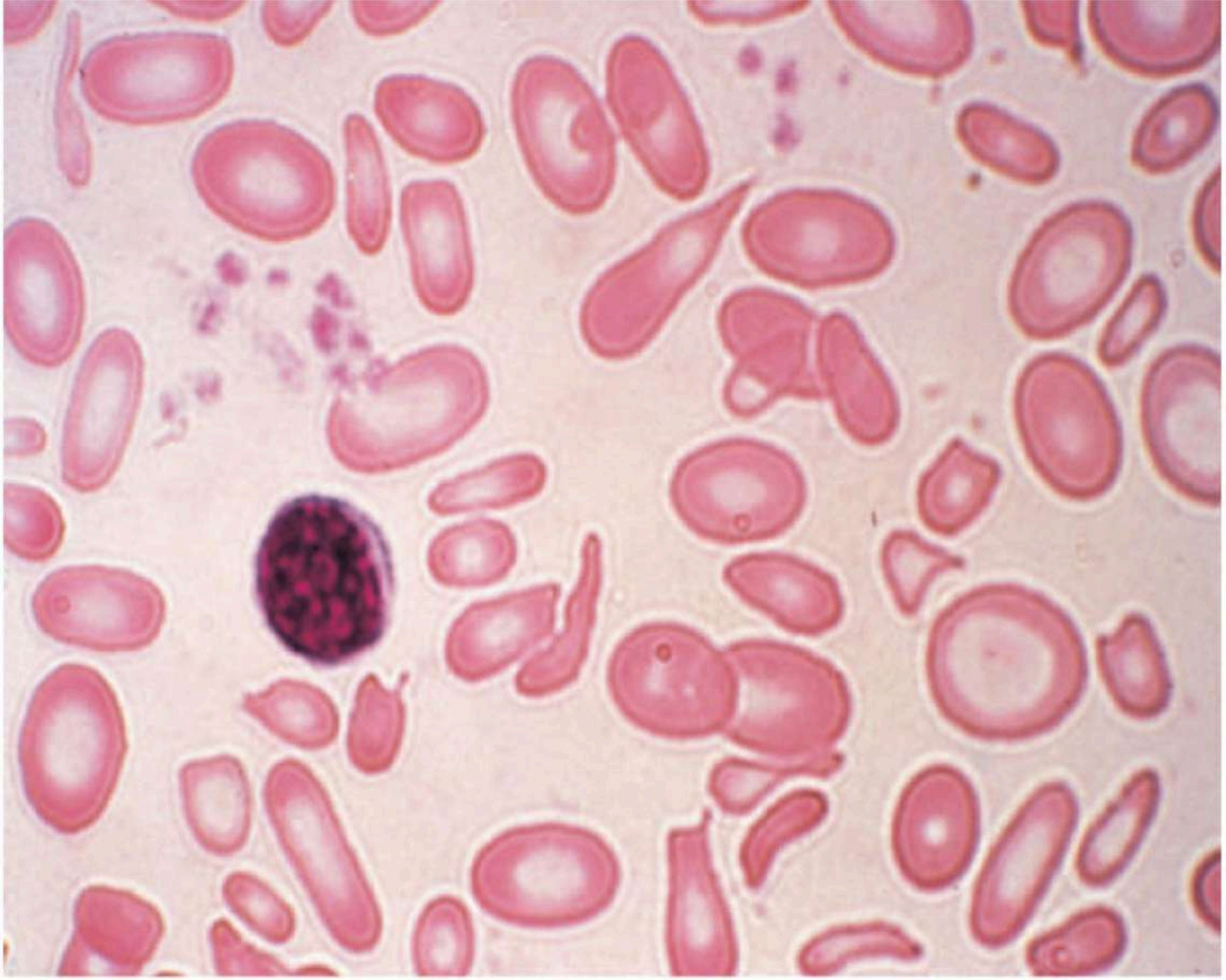


FIGURE 66-4 Severe iron-deficiency anemia. Microcytic and hypochromic red cells smaller than the nucleus of a lymphocyte associated with marked variation in size (anisocytosis) and shape (poikilocytosis). *(From RS Hillman et al: Hematology in Clinical Practice, 5th ed. New York, McGraw-Hill, 2010.)*

IRON DEFICIENCY ANEMIA

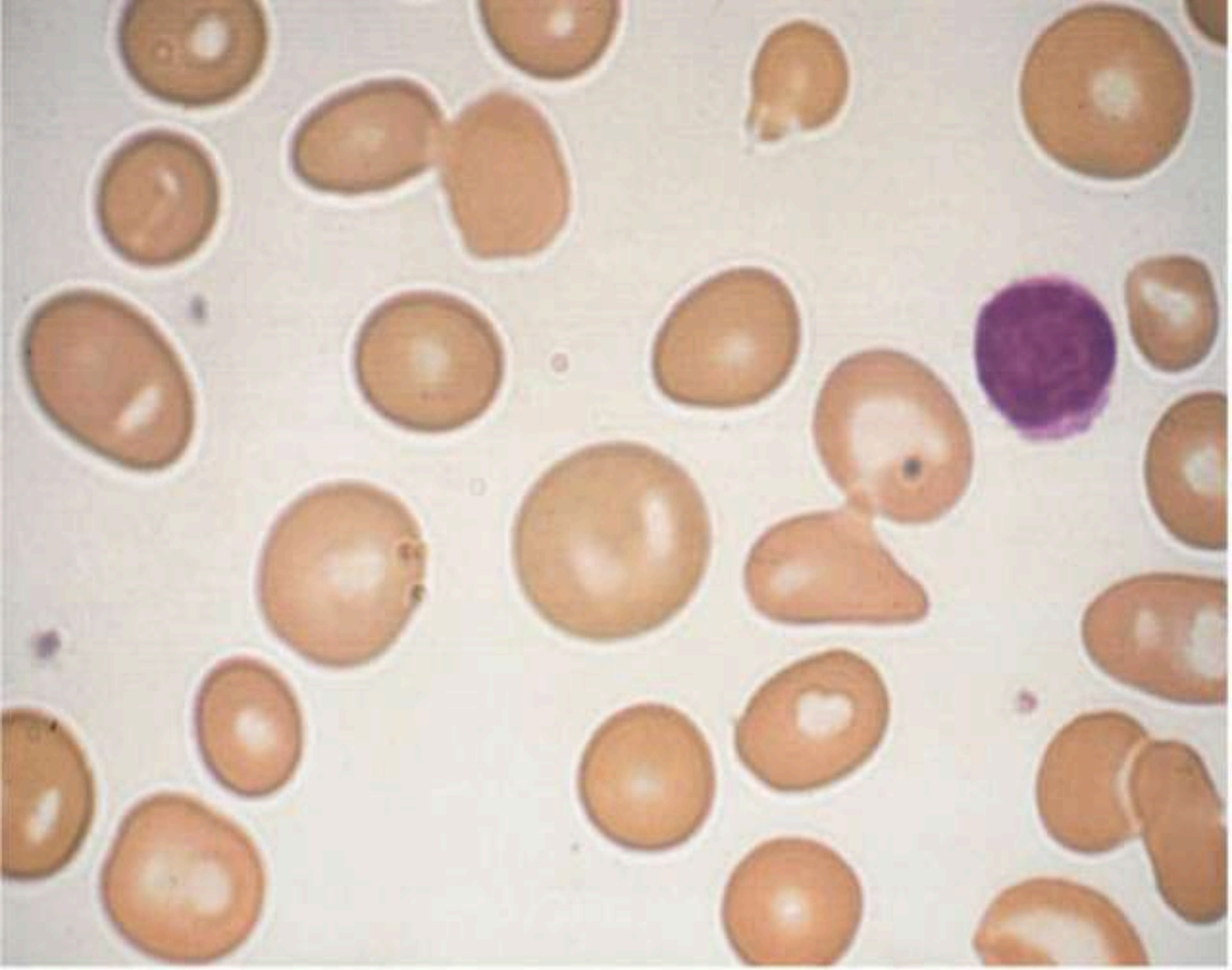


FIGURE 66-5 Macrocytosis. Red cells are larger than a small lymphocyte and well hemoglobinized. Often macrocytes are oval shaped (macro-ovalocytes). *(From RS Hillman et al: Hematology in Clinical Practice, 5th ed. New York, McGraw-Hill, 2010.)*

MACROCYTOSIS

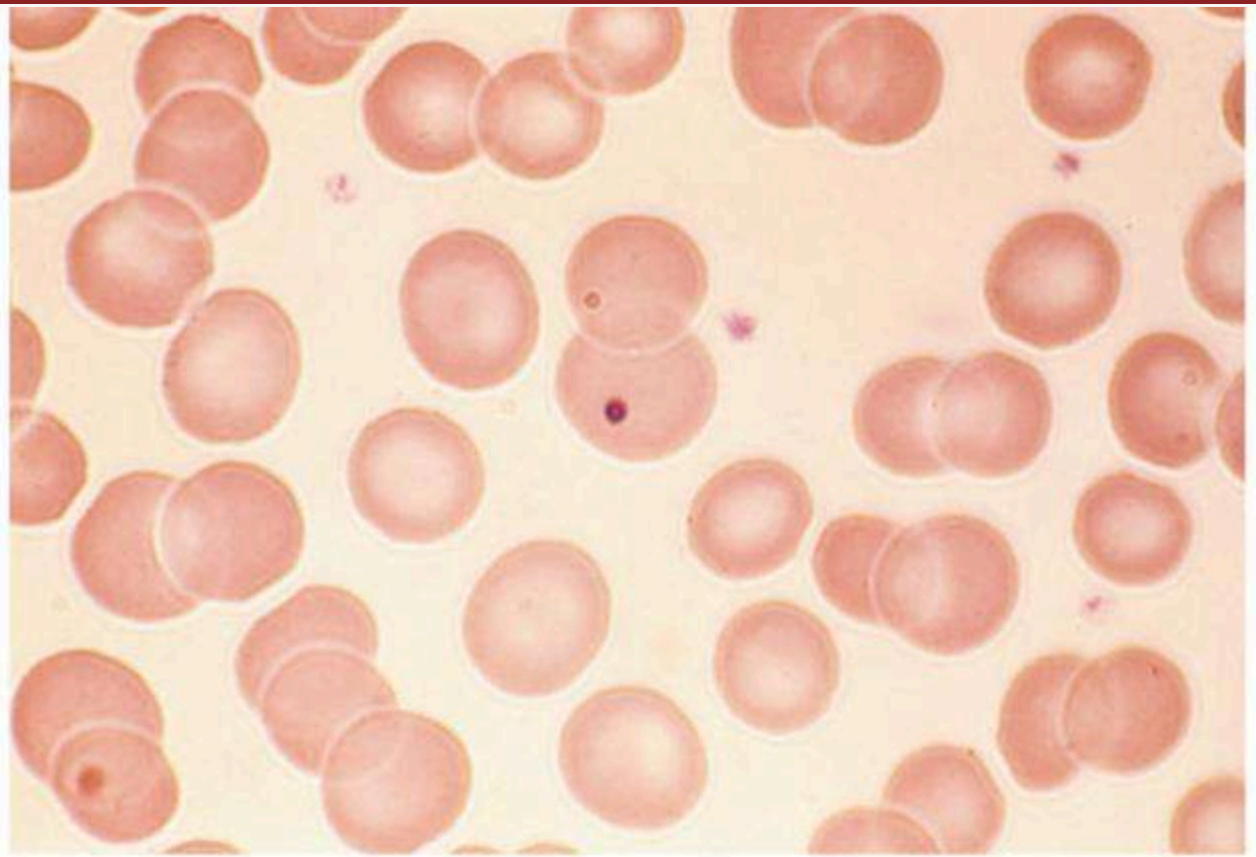


FIGURE 66-6 Howell-Jolly bodies. In the absence of a functional spleen, nuclear remnants are not culled from the red cells and remain as small homogeneously staining blue inclusions on Wright stain. *(From M Lichtman et al (eds): Williams Hematology, 7th ed. New York, McGraw-Hill, 2005; RS Hillman, KA Ault: Hematology in General Practice, 4th ed. New York, McGraw-Hill, 2005.)*

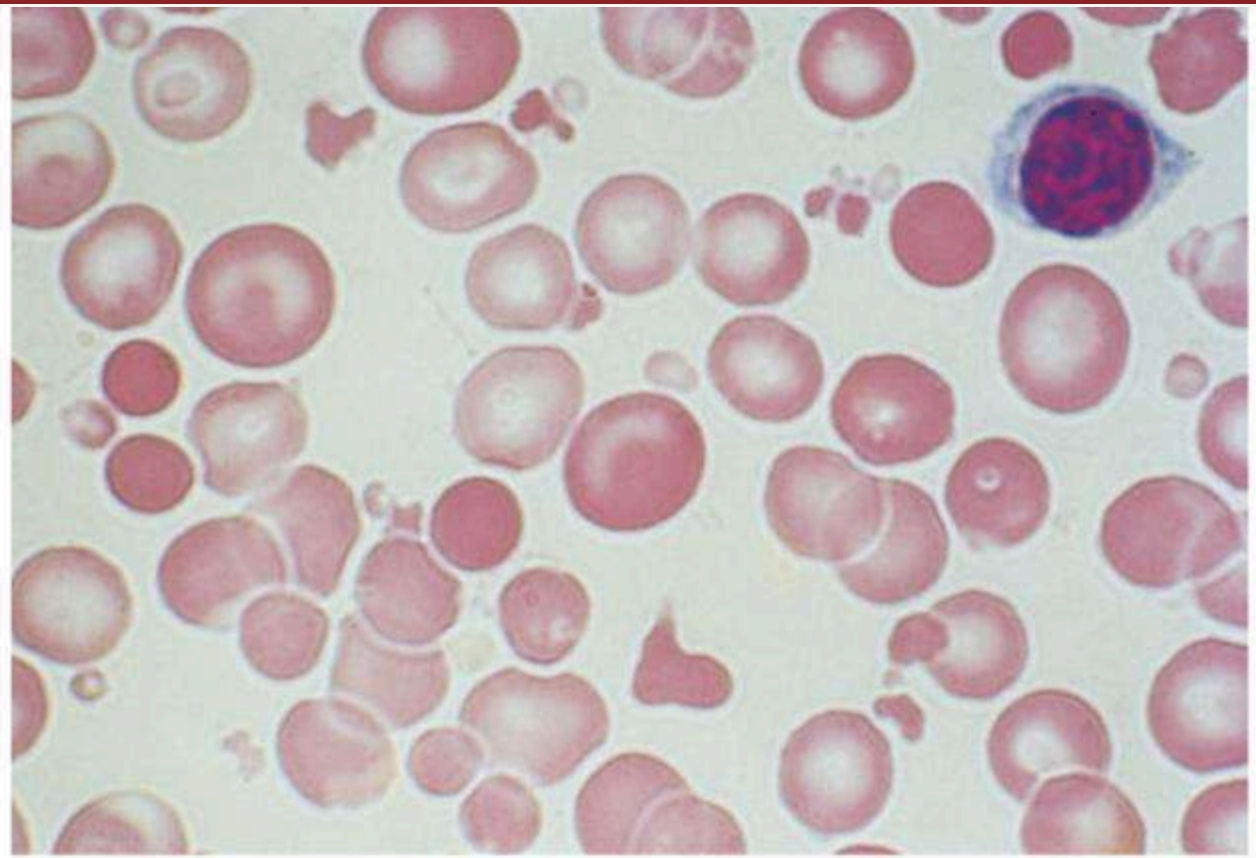
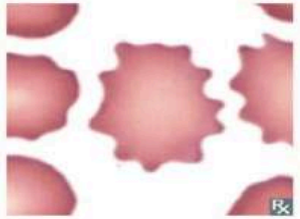
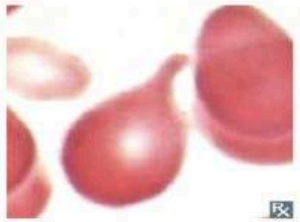
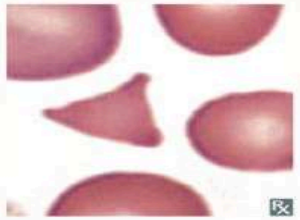
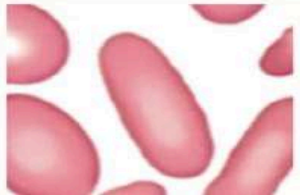
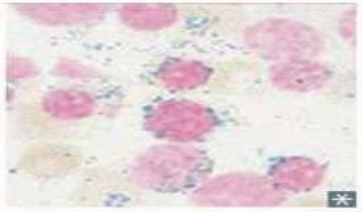
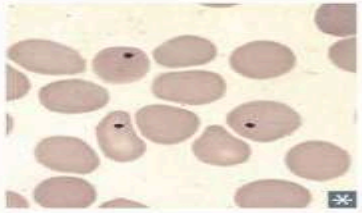
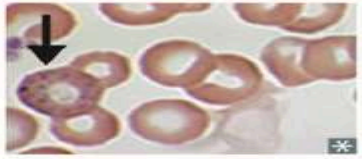
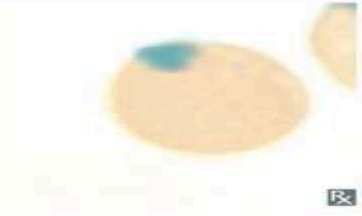


FIGURE 66-9 Red cell fragmentation. Red cells may become fragmented in the presence of foreign bodies in the circulation, such as mechanical heart valves, or in the setting of thermal injury. *(From RS Hillman et al: Hematology in Clinical Practice, 5th ed. New York, McGraw-Hill, 2010.)*

TYPE	EXAMPLE	ASSOCIATED PATHOLOGY
Acanthocytes ("spur cells")		Liver disease, abetalipoproteinemia, vitamin E deficiency
Echinocytes ("burr cells")		Liver disease, ESRD, pyruvate kinase deficiency
Dacrocytes ("teardrop cells")		Bone marrow infiltration (eg, myelofibrosis)
Schistocytes ("helmet" cells)		MAHAs (eg, DIC, TTP/HUS, HELLP syndrome), mechanical hemolysis (eg, heart valve prosthesis)
Degmacytes ("bite cells")		G6PD deficiency
Elliptocytes		Hereditary elliptocytosis

PERIPHERAL SMEAR

RBC inclusions

TYPE	EXAMPLE	ASSOCIATED PATHOLOGY	NOTES
Bone marrow			
Iron granules		Sideroblastic anemias (eg, lead poisoning, myelodysplastic syndromes, chronic alcohol overuse)	Perinuclear mitochondria with excess iron (forming ring in ringed sideroblasts) Require Prussian blue stain to be visualized
Peripheral smear			
Howell-Jolly bodies		Functional hyposplenia (eg, sickle cell disease), asplenia	Basophilic nuclear remnants (do not contain iron) Usually removed by splenic macrophages
Basophilic stippling		Sideroblastic anemia, thalassemias	Basophilic ribosomal precipitates (do not contain iron)
Pappenheimer bodies		Sideroblastic anemia	Basophilic granules (contain iron) "Pappen-hammer" bodies
Heinz bodies		G6PD deficiency	Denatured and precipitated hemoglobin (contain iron) Phagocytic removal of Heinz bodies → bite cells Requires supravital stain (eg, crystal violet) to be visualized

BONE MARROW

- 🔹 **Purpose**
- Bone marrow examination helps in evaluating the **cause of anemia** when peripheral blood findings and routine tests are inconclusive. It assesses:
- The **marrow cellularity**
- The **erythroid series maturation**
- Presence of **abnormal cells or infiltrates**
- **Iron stores**

- **Indications**

- Bone marrow study is indicated in:
- **Unexplained anemia**
- **Pancytopenia or bicytopenia**
- **Suspected bone marrow infiltration** (e.g., leukemia, lymphoma, metastasis)
- **Megaloblastic anemia** (for confirmation)
- **Aplastic anemia** (for cellularity assessment)
- **Sideroblastic anemia** (to detect ring sideroblasts)
- **Iron deficiency anemia** (to assess marrow iron)
- **Hemolytic anemia** (to check erythroid hyperplasia)
- **Myelodysplastic syndromes**

Findings in Common Types of Anemia

Type of Anemia	Bone Marrow Finding
Iron Deficiency Anemia	Hypocellular erythroid series, microcytic normoblastic marrow, **absent iron stores** on Prussian blue stain
Megaloblastic Anemia	**Hypercellular marrow**, megaloblastic erythroid precursors, nuclear-cytoplasmic asynchrony
Aplastic Anemia	**Hypocellular marrow** replaced by fat spaces
Hemolytic Anemia	**Erythroid hyperplasia**, M:E ratio ↓
Sideroblastic Anemia	**Ring sideroblasts** on Prussian blue stain
Myelodysplastic Syndrome (MDS)	Dysplastic changes in all cell lines, variable cellularity
Leukemia / Marrow infiltration	Replacement by abnormal/blast cells

What is Erythropoietin?

- **Erythropoietin (EPO)** is a **glycoprotein hormone** that regulates **red blood cell (RBC) production**.
- **Produced mainly** by **peritubular interstitial cells of the kidney** (90%) and partly by the **liver** (10%).
- **Gene location:** Chromosome 7q21.
- **Normal Physiology**
- **Stimulus:** ↓ Tissue oxygen (hypoxia) → detected by renal peritubular cells.
- **Response:** ↑ EPO synthesis and release.
- **Action:**
  - Acts on **erythroid progenitor cells** in bone marrow.
  - Stimulates proliferation and differentiation of **CFU-E → proerythroblast → mature RBC**.
  - Prevents apoptosis of erythroid precursors.

Erythropoietin Levels in Different Types of Anemia

Type of Anemia	Erythropoietin Level	Mechanism / Comment
Iron Deficiency Anemia	↑↑	Hypoxia stimulates EPO; marrow response blunted due to iron lack
Megaloblastic Anemia	↑↑	EPO elevated due to hypoxia; ineffective erythropoiesis
Hemolytic Anemia	↑↑	EPO markedly increased due to rapid RBC destruction
Acute Blood Loss Anemia	↑↑	Rapid rise to stimulate erythropoiesis
Aplastic Anemia	↑↑	EPO high, but marrow unable to respond due to stem cell failure
Anemia of Chronic Disease (ACD)	↔ or ↓	**Inadequate EPO production** and poor marrow response due to inflammatory cytokines (IL-6, TNF-α)
Chronic Kidney Disease (CKD)	↓↓↓	**Decreased renal production** of EPO → normocytic normochromic anemia
Polycythemia vera	↓	Negative feedback due to excess RBC mass
Secondary Polycythemia	↑	Due to hypoxia or EPO-secreting tumors

anemia of Chronic Disease (ACD)

This is mild and nonprogressive anemia, occurring over a period of 3-4 weeks and remains static thereafter.
ACD is most often associated with chronic infections, inflammatory diseases, trauma, and neoplastic diseases.

Causes of ACD

anemia of chronic inflammation:
Infection
Connective tissue disorders
Malignancy.

There is disturbed iron metabolism and hypoferremia despite normal body iron stores.

PATHOPHYSIOLOGY

Interleukin-1, TNF-a and IFN-gamma are inflammatory mediators, which stimulate release of lactoferrin from granulocytes. There is diversion of iron from the dynamic pool to the intracellular storage pool and an insufficient supply iron for erythropoiesis in the bone marrow.
Interleukin-1: It suppresses erythropoietin production.
TNF-a: It suppresses response to erythropoietin in erythroid cells.
Hepacidin: It is released from liver in the setting of inflammation, which causes decreased iron absorption and utilisation.

Hypoferremia and disturbance in iron kinetics is the hallmark of ACD,

Clinical Features

The signs and symptoms are referrable to the underlying disease. Anemia is usually mild and nonprogressive, rarely less than 9 g/dL.

Anemia of chronic inflammation: Anemia is never severe. If it is severe, search for other causes like bleeding or drug-induced myelosuppression.

Anemia due to renal disease: This is of normochromic and normocytic type. This is due to lack of secretion of erythropoietin and suppression of its production by toxins. Some patients have evidence of hemolytic jaundice due to defect in hexose monophosphate shunt pathway.

In some forms of acute renal failure the correlation between anemia and renal function is weak Patients with hemolytic uremic syndrome have increased erythropoiesis in response to hemolysis despite renal failure requiring dialysis.

Anemia due to hypometabolic states (Anemia secondary to endocrine failure): This may be due to hypothyroidism (associated pernicious anemia, menorrhagia), Addison's disease, hypogonadism, and panhypopituitarism.

Anemia of liver disease: This can be normocytic or slightly macrocytic. Stomatocytes (increased membrane due to deposition of cholesterol and phospholipid) and target cells may be seen in the peripheral smear.

In alcoholics, there is direct suppression of erythropoiesis. Ringed sideroblasts may be seen (due to malnourishment). Hemorrhage, gastritis, varices, and duodenal ulcer may worsen anemia.

MANAGEMENT

- Anemia resolves when underlying cause is treated.
- Anemia of chronic inflammation is not responsive to hematinics like iron, folate, vitamin B 12
- Anemia is never severe and transfusion is rarely indicated.
- anemia of uremia corrects dramatically after renal transplantation. anemia is proportional to azotemia (except in polycystic kidney disease). Recombinant human erythropoietin can be given to maintain hematocrit between 0.32 and 0.37.
- Treatment of anemia secondary to endocrine failure is by giving appropriate hormone replacement.
- Anemia of liver disease may improve with improvement in liver function.

Parameter	**Iron Deficiency Anemia (IDA)**	**Thalassemia Trait (Minor)**	**Vitamin B12 Deficiency Anemia**
Hemoglobin (Hb)	↓ (often moderate–severe)	↓ (mild)	↓ (often severe)
RBC Count	↓ or normal	**Normal / ↑ (key clue)**	↓
MCV	↓ (microcytic)	↓ (more markedly microcytic)	↑ (macrocytic)
MCH	↓	↓	↑ / normal
MCHC	↓ (hypochromic)	Normal or ↓	Normal / ↓
RDW	↑ **(variable sizes)**	**Normal** (uniform small cells)	↑ **(anisocytosis)**
WBC Count	Normal	Normal	↓ (may show leukopenia)
Platelets	Normal or ↑ (reactive)	Normal	↓ (may be low)
Peripheral Smear	Microcytosis, hypochromia, pencil cells, elliptocytes	Microcytosis, target cells, uniform RBCs	Macro-ovalocytes, hypersegmented neutrophils
Other Notes	Responds to iron therapy	High RBC count with low MCV is hallmark	Often associated with neurologic symptoms (paresthesia, memory issues)

CBC -1

Parameter	Result	Normal Range	Interpretation
Hemoglobin (Hb)	**7.8 g/dL**	12 – 16 g/dL (F), 13 – 17 g/dL (M)	↓ Severe anemia
Hematocrit (Hct/PCV)	**25%**	36 – 46% (F), 40 – 52% (M)	↓
RBC Count	**3.2 million/µL**	4.0 – 5.5 million/µL	↓
MCV	**68 fL**	80 – 96 fL	↓ Microcytic
MCH	**20 pg**	27 – 33 pg	↓ Low Hb per cell
MCHC	**28 g/dL**	32 – 36 g/dL	↓ Hypochromic
RDW	**18.5%**	11.5 – 14.5%	↑ Marked anisocytosis
WBC Count	**7,600 /µL**	4,000 – 11,000 /µL	Normal
Platelet Count	**480,000 /µL**	150,000 – 400,000 /µL	↑ Reactive thrombocytosis

- IRON DEFICIENCY ANEMIA

CBC-2

Parameter	Result	Normal Range	Interpretation
Hemoglobin (Hb)	**10.5 g/dL**	12 – 16 g/dL (F), 13 – 17 g/dL (M)	↓ Mild anemia
Hematocrit (Hct/PCV)	**34%**	36 – 46% (F), 40 – 52% (M)	↓ Slightly low
RBC Count	**5.9 million/µL**	4.0 – 5.5 million/µL	↑ Relatively high (key clue)
MCV	**64 fL**	80 – 96 fL	↓ Markedly low (microcytosis)
MCH	**20 pg**	27 – 33 pg	↓ Low Hb per cell
MCHC	**30 g/dL**	32 – 36 g/dL	↓ Slightly low
RDW	**13%**	11.5 – 14.5%	Normal (cells uniform)
WBC Count	**7,200 /µL**	4,000 – 11,000 /µL	Normal
Platelet Count	**280,000 /µL**	150,000 – 400,000 /µL	Normal

- THALASSEMIA

CBC-3

Parameter	Result	Normal Range	Interpretation
Hemoglobin (Hb)	**6.5 g/dL**	12 – 16 g/dL (F), 13 – 17 g/dL (M)	↓ Severe anemia
Hematocrit (Hct/PCV)	**22%**	36 – 46% (F), 40 – 52% (M)	↓
RBC Count	**2.1 million/µL**	4.0 – 5.5 million/µL	↓ Low
MCV	**112 fL**	80 – 96 fL	↑ Markedly high (macrocytosis)
MCH	**34 pg**	27 – 33 pg	↑ Slightly high (more Hb per cell)
MCHC	**31 g/dL**	32 – 36 g/dL	Normal/Low
RDW	**19%**	11.5 – 14.5%	↑ High (anisocytosis)
WBC Count	**3,200 /µL**	4,000 – 11,000 /µL	↓ Leukopenia (possible)
Platelet Count	**90,000 /µL**	150,000 – 400,000 /µL	↓ Thrombocytopenia (possible)

- B12 DEFICIENCY ANEMIA

- ***THANK-YOU***