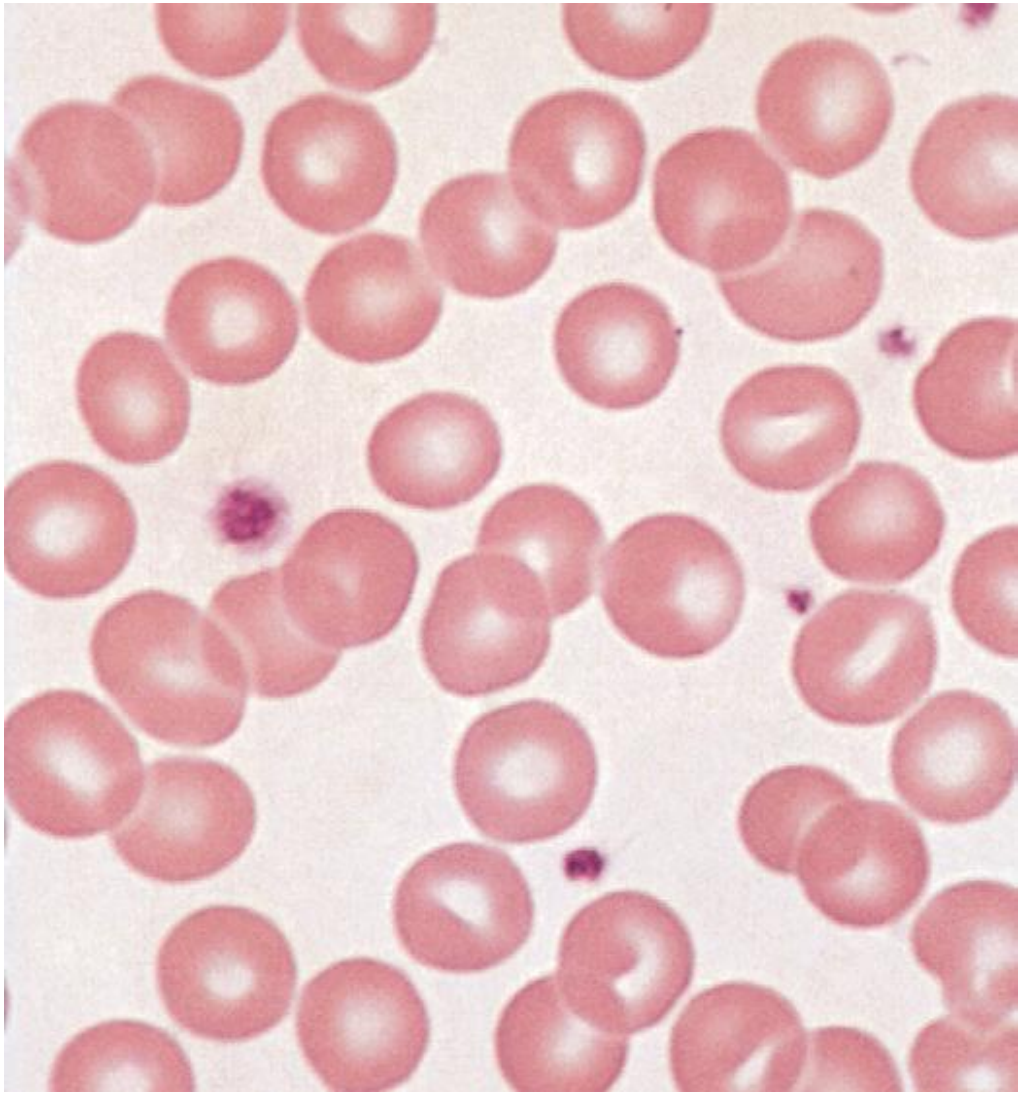
Spot Diagnosis

Peripheral Blood Smear

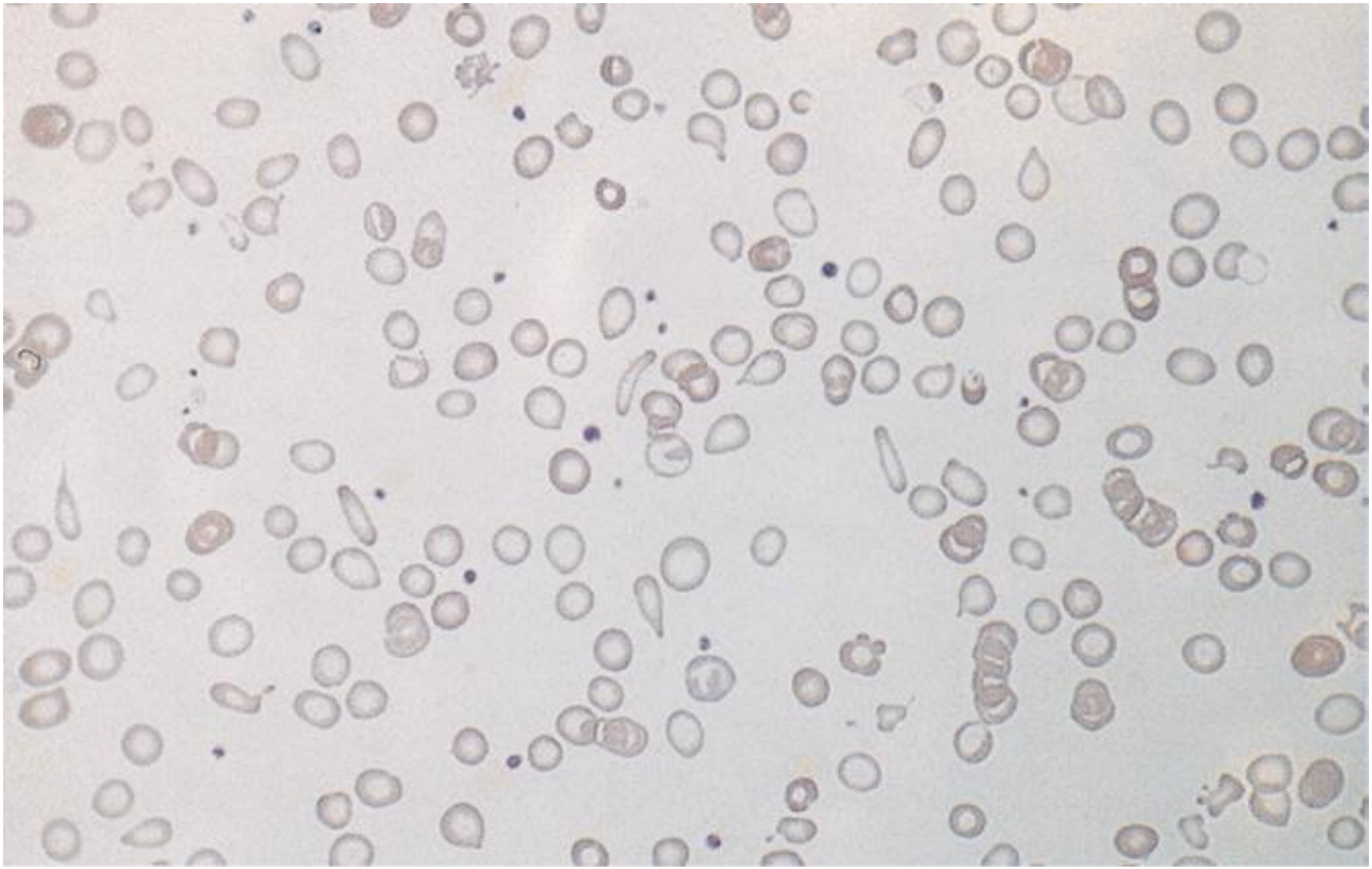
Kirati Sawayanukit

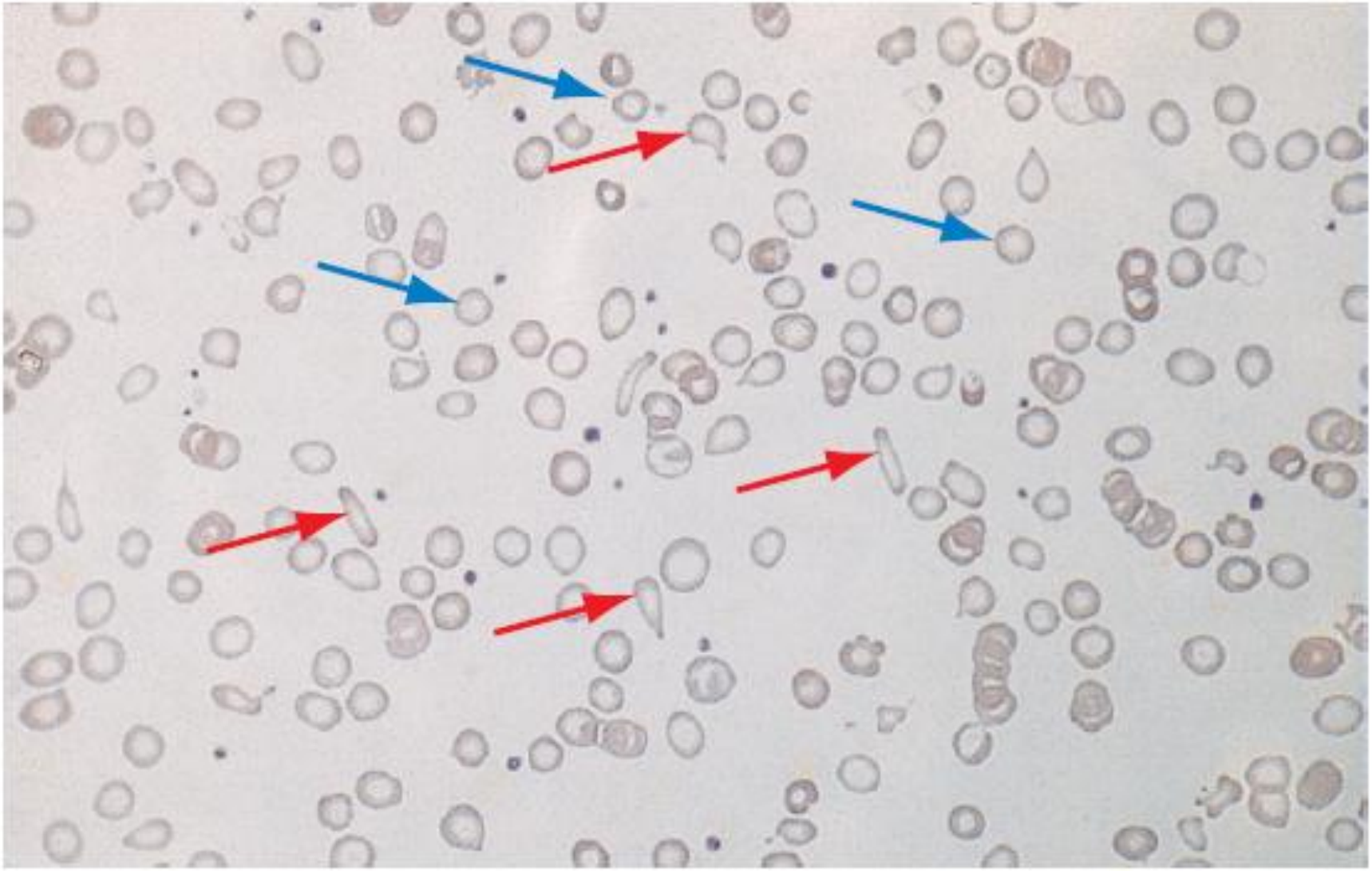
Normal PBS



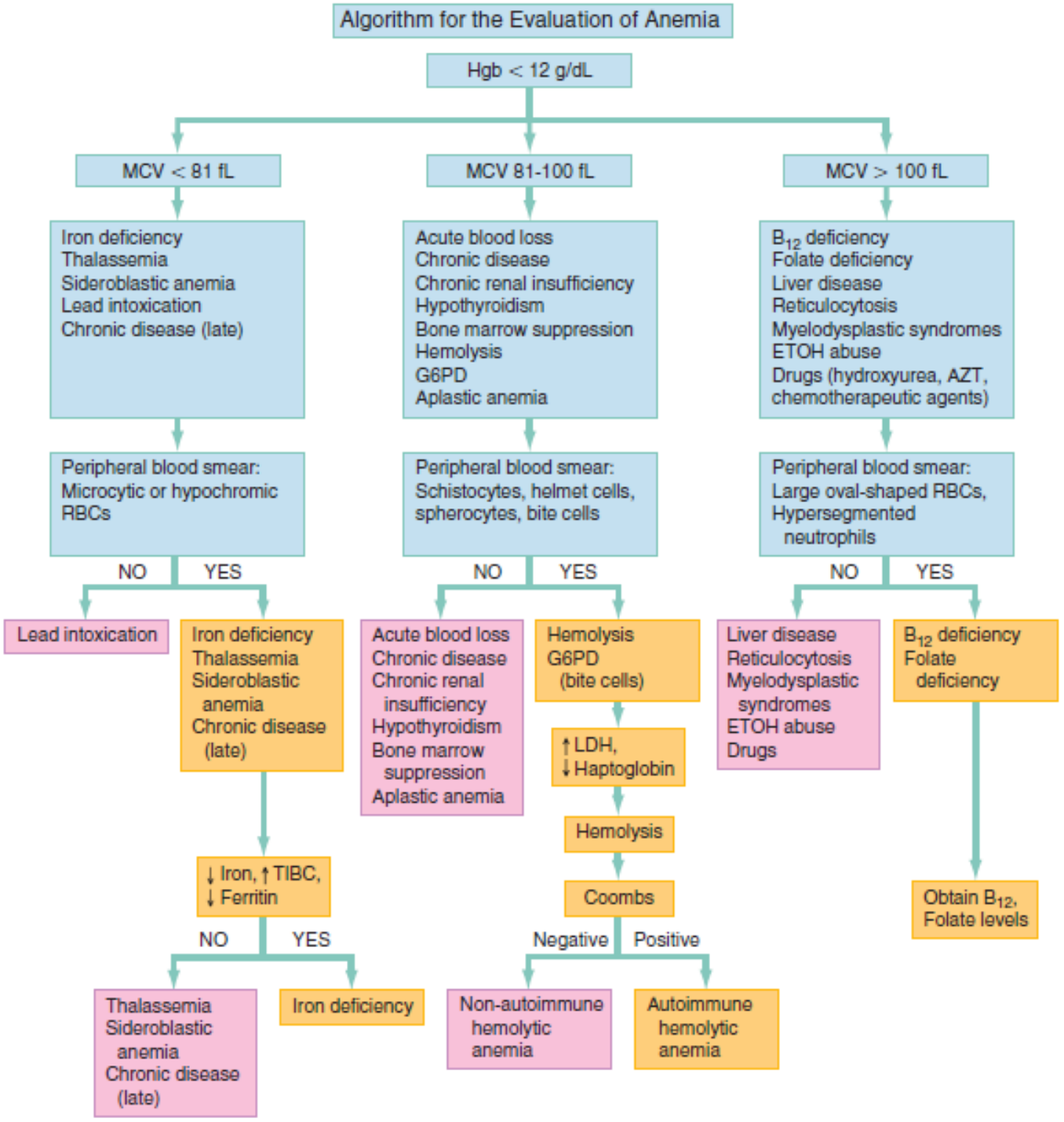
- RBC : normochromic normocytic
- WBC : not seen
- Platelet : adequate

Iron deficiency anemia





- Iron deficiency anemia with hypochromic, microcytic cells and poikilocytes (abnormally shaped cells).


Algorithm for the Evaluation of Anemia
Hgb < 12 g/dL
MCV < 81 fL
MCV 81-100 fL
MCV > 100 fL
Iron deficiency
Thalassemia
Sideroblastic anemia
Lead intoxication
Chronic disease (late)
Acute blood loss
Chronic disease
Chronic renal insufficiency
Hypothyroidism
Bone marrow suppression
Hemolysis
G6PD
Aplastic anemia
B12 deficiency
Folate deficiency
Liver disease
Reticulocytosis
Myelodysplastic syndromes
ETOH abuse
Drugs (hydroxyurea, AZT, chemotherapeutic agents)
Peripheral blood smear: Microcytic or hypochromic RBCs
Peripheral blood smear: Schistocytes, helmet cells, spherocytes, bite cells
Peripheral blood smear: Large oval-shaped RBCs, Hypersegmented neutrophils
NO
YES
NO
YES
NO
YES
Lead intoxication
Iron deficiency
Thalassemia
Sideroblastic anemia
Chronic disease (late)
Acute blood loss
Chronic disease
Chronic renal insufficiency
Hypothyroidism
Bone marrow suppression
Aplastic anemia
Hemolysis
G6PD
(bite cells)
Liver disease
Reticulocytosis
Myelodysplastic syndromes
ETOH abuse
Drugs
B12 deficiency
Folate deficiency
↑ LDH,
↓ Haptoglobin
Hemolysis
Coombs
Obtain B12, Folate levels
↓ Iron, ↑ TIBC, ↓ Ferritin
Negative
Positive
NO
YES
Thalassemia
Sideroblastic anemia
Chronic disease (late)
Iron deficiency
Non-autoimmune hemolytic anemia
Autoimmune hemolytic anemia

Iron deficiency anemia

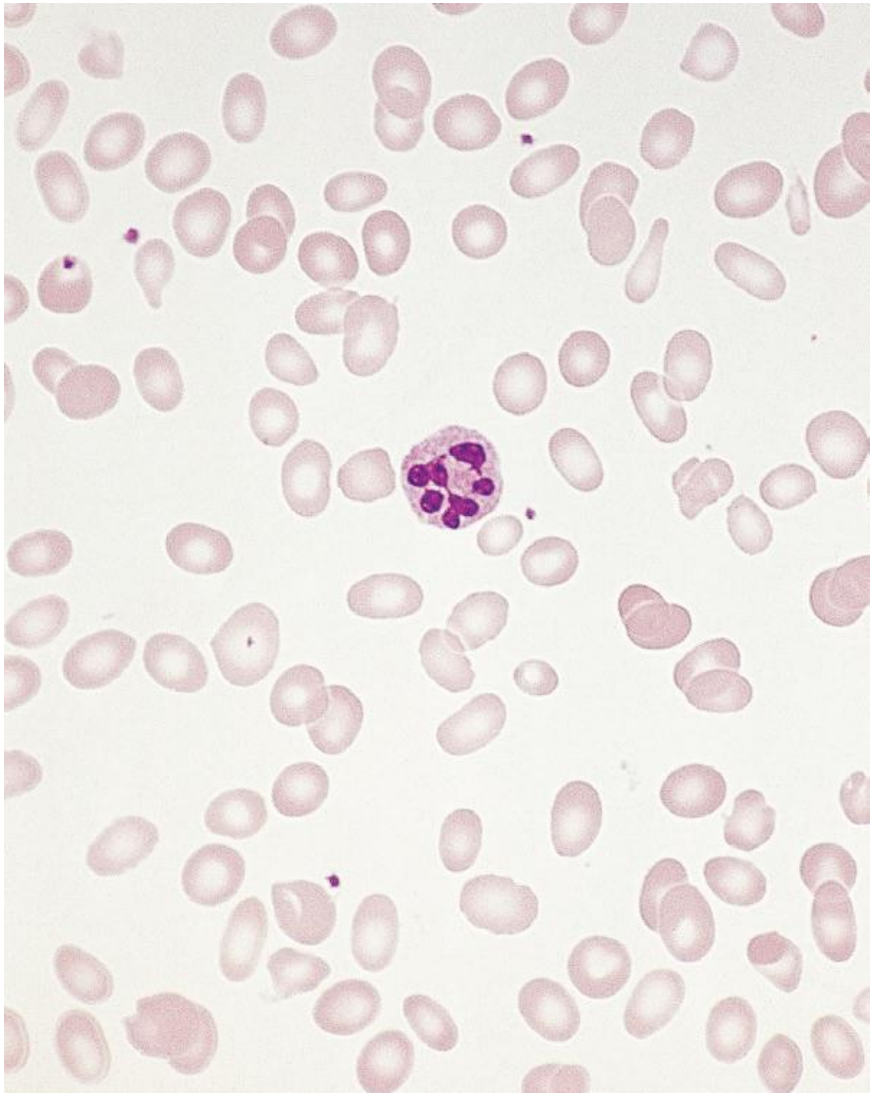
Table 121-3 Diagnostic Tests for Iron Deficiency Anemia

TEST	NORMAL RESULT	IRON DEFICIENCY LEVEL	INTERPRETATION
Fasting serum iron	60-180 µg/dL	<60 µg/dL	Diurnal variation (draw in morning); increased by hepatitis, hemochromatosis, hemolytic anemia, and aplastic anemia; decreased in infection
Total iron-binding capacity	250-400 µg/dL	>400 µg/dL	Increased in late pregnancy or hepatitis; decreased in infection
Percentage of saturation (serum iron) of total iron-binding capacity	15-45%	<15%	
Serum ferritin	10-10,000 mg/mL	<10 mg/mL	Reflects iron stores; may increase as an acute-phase reactant in infection
Bone marrow stainable iron	Hemosiderin granules in reticuloendothelial cells	Absent	Standard for assessment of iron stores

TABLE 231-4 Treatment for Specific Anemias

Anemia Type	Treatment (Adult Doses)
Iron deficiency anemia	Elemental iron, 200–300 milligrams PO daily (e.g., ferrous sulfate, 325 milligrams PO, 3–4 tablets taken on an empty stomach over the course of day); reticulocyte count should increase within 4–7 d and peak at 10 d; sustained treatment after correction of anemia is usually necessary to replenish iron stores.
Cyanocobalamin (vitamin B_{12}) deficiency anemia	Cyanocobalamin, 1000 micrograms IM per week for 8 wk and every month thereafter; reticulocyte count should increase within 4 d and peak at 7 d. Oral replacement with 2000 micrograms daily is also effective (see "Treatment" section).
Folate deficiency anemia	Folate, 1 milligram PO daily (doses up to 5 milligrams may be needed for patients with malabsorption); reticulocyte count should increase within 4 d with normalization of hemoglobin level in 1–2 mo.
Sideroblastic anemia	Evaluate for reversible causes, including alcohol or other drug toxicity, or toxin exposure. Discontinue any offending agents. Treatment is mainly supportive, consisting primarily of blood transfusions to maintain the hemoglobin level. A trial of pyridoxine at pharmacologic doses (500 milligrams PO daily) may be helpful, with response most commonly seen in cases resulting from ethanol abuse or the use of pyridoxine antagonists. Some patients with hereditary, X-linked sideroblastic anemia also respond to pyridoxine. Improvement with pyridoxine is rare for sideroblastic anemia of other causes.
Aplastic anemia	Supportive care, including transfusion if appropriate. Referral for further workup.
Anemia of chronic disease	Supportive care, including transfusion if appropriate. Referral for further workup and evaluation for underlying disease.

Megaloblastic anemia



- Megaloblastic anemia with macrocytic red cells and hypersegmented polymorphonuclear neutrophils

Megaloblastic anemia

- Cause of megaloblastic anemia
  - Vitamin B12 deficiency
  - Folic acid deficiency

Megaloblastic anemia

Table 121-5 Serum Tests for Diagnosis and Differentiation of Megaloblastic Anemia

TEST	TECHNIQUE	VALUE	INTERPRETATION
Vitamin B_{12}	Microbiologic or radioisotope	Normal: 300-900 µg/L Deficient: <200 µg/L	Although they may overlap clinically, vitamin B_{12} level is usually normal in folate deficiency.
Folate	Microbiologic or radioisotope	Deficient: <3 µg/L	Vitamin B_{12} deficiency may elevate folate levels by blocking transfer of serum folate to RBCs; hemolysis may elevate folate levels.
Red cell folate	Calculated	Normal: 200-700 µg/L Folate deficiency: <140 µg/L	Index of tissue folate is less influenced by diet and is increased in vitamin B_{12} deficiency because of block.
Lactate dehydrogenase	Spectrophotometric	Normal: 95-200 IU Megaloblastic anemia: 4-50 times normal	Normal in other macrocytic anemias; elevated two to four times normal in hemolytic anemias; isoenzymes may be helpful.

TABLE 231-4 Treatment for Specific Anemias

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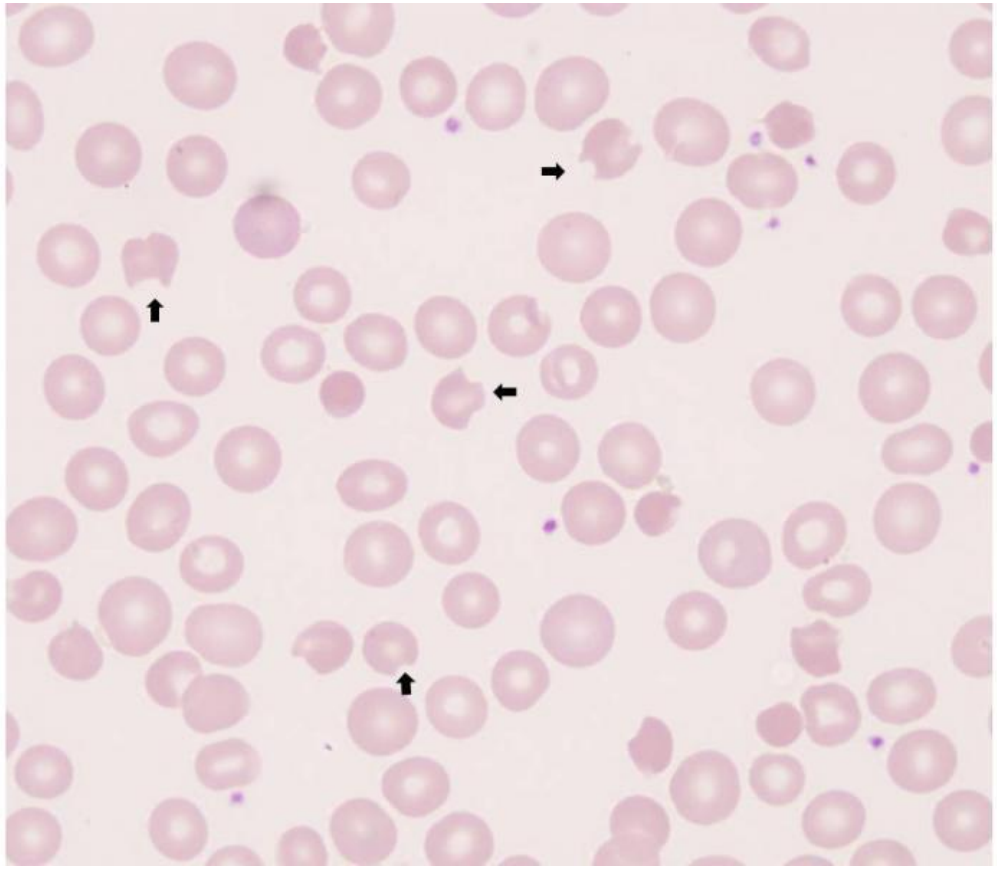
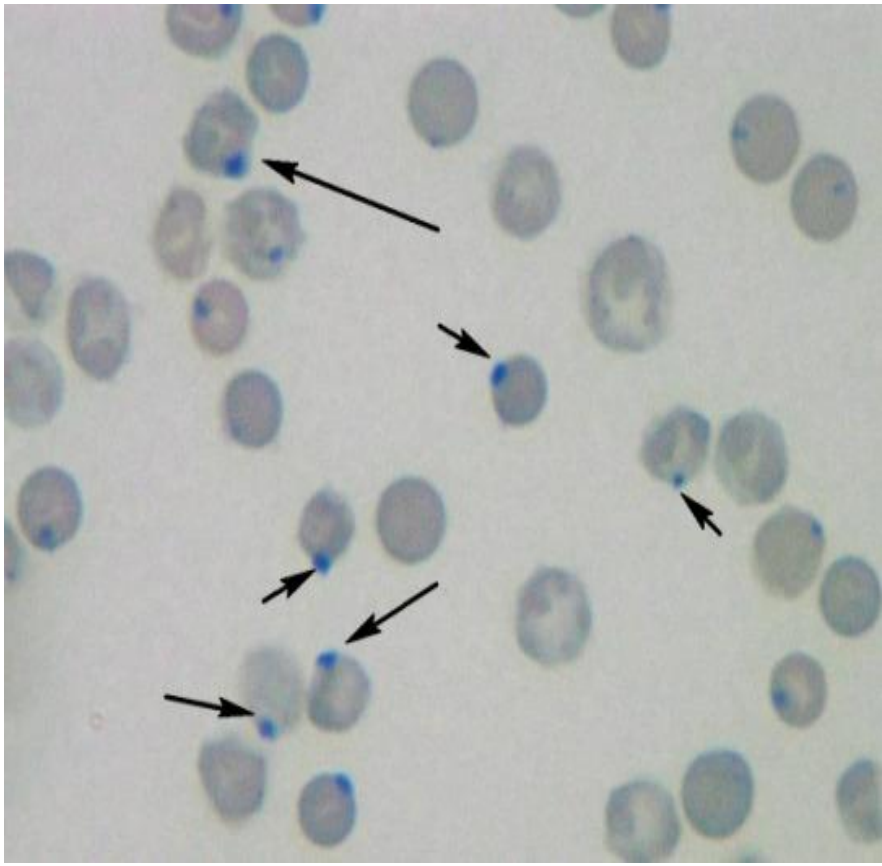
Anemia of chronic disease	Supportive care, including transfusion if appropriate. Referral for further workup and evaluation for underlying disease.

G6PD deficiency

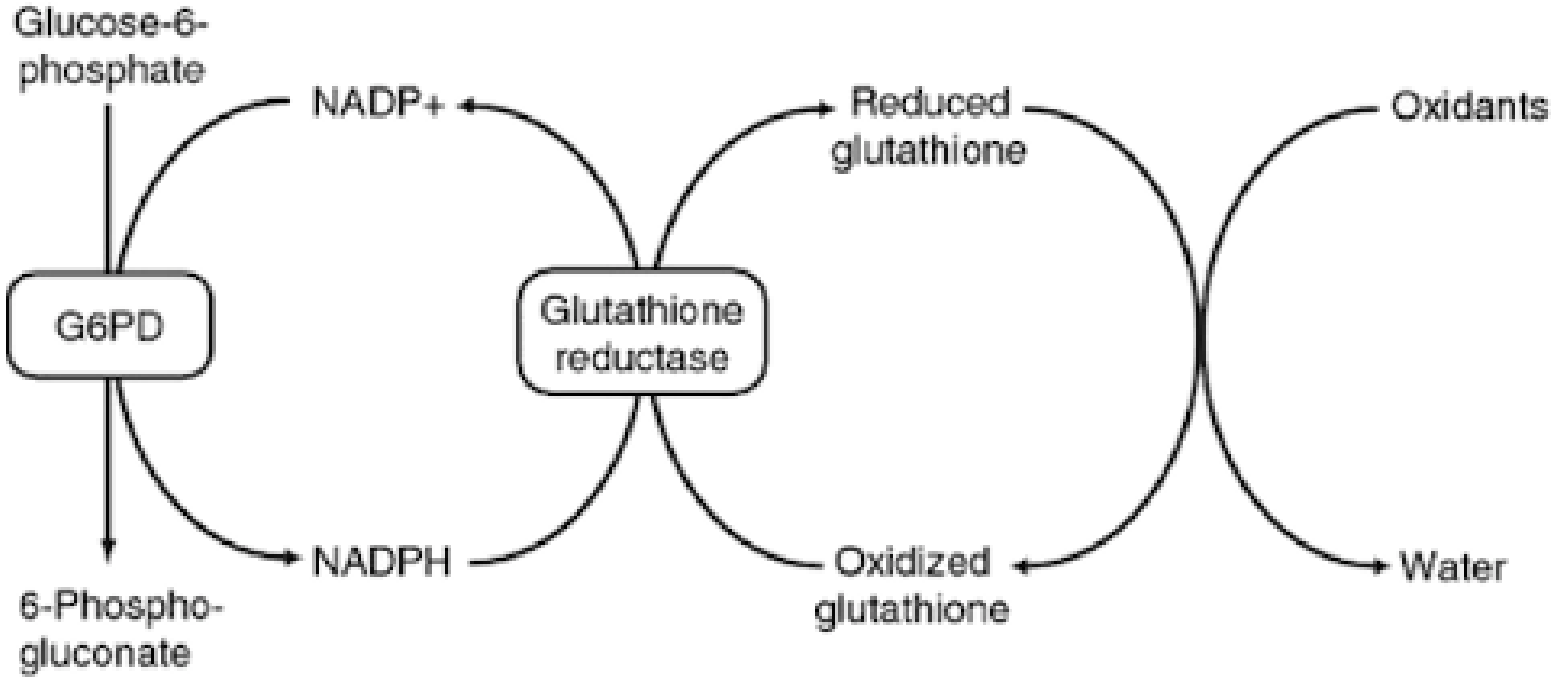




- Bite cells
- Heinz bodies

G6PD deficiency

- G6PD deficiency is an X-linked inherited disorder that primarily affects males.



G6PD deficiency

TABLE 236-6 World Health Organization Classification of Glucose-6-Phosphate Dehydrogenase (G6PD) Variants

Class I variants: severe enzyme deficiency (<1% of normal activity) and have chronic hemolytic anemia.

Class II variants, such as G6PD Mediterranean: severe enzyme deficiency (1%–10% normal activity), associated with acute intermittent hemolytic episodes.

Class III variants, such as G6PD A–: moderate enzyme deficiency (10%–60% of normal activity) with intermittent hemolysis usually associated with stressors such as infection or drugs.

Class III variants are the most prevalent G6PD mutations

Class IV variants: no enzyme deficiency (60%–150% normal activity), no hemolysis or other clinical significance.

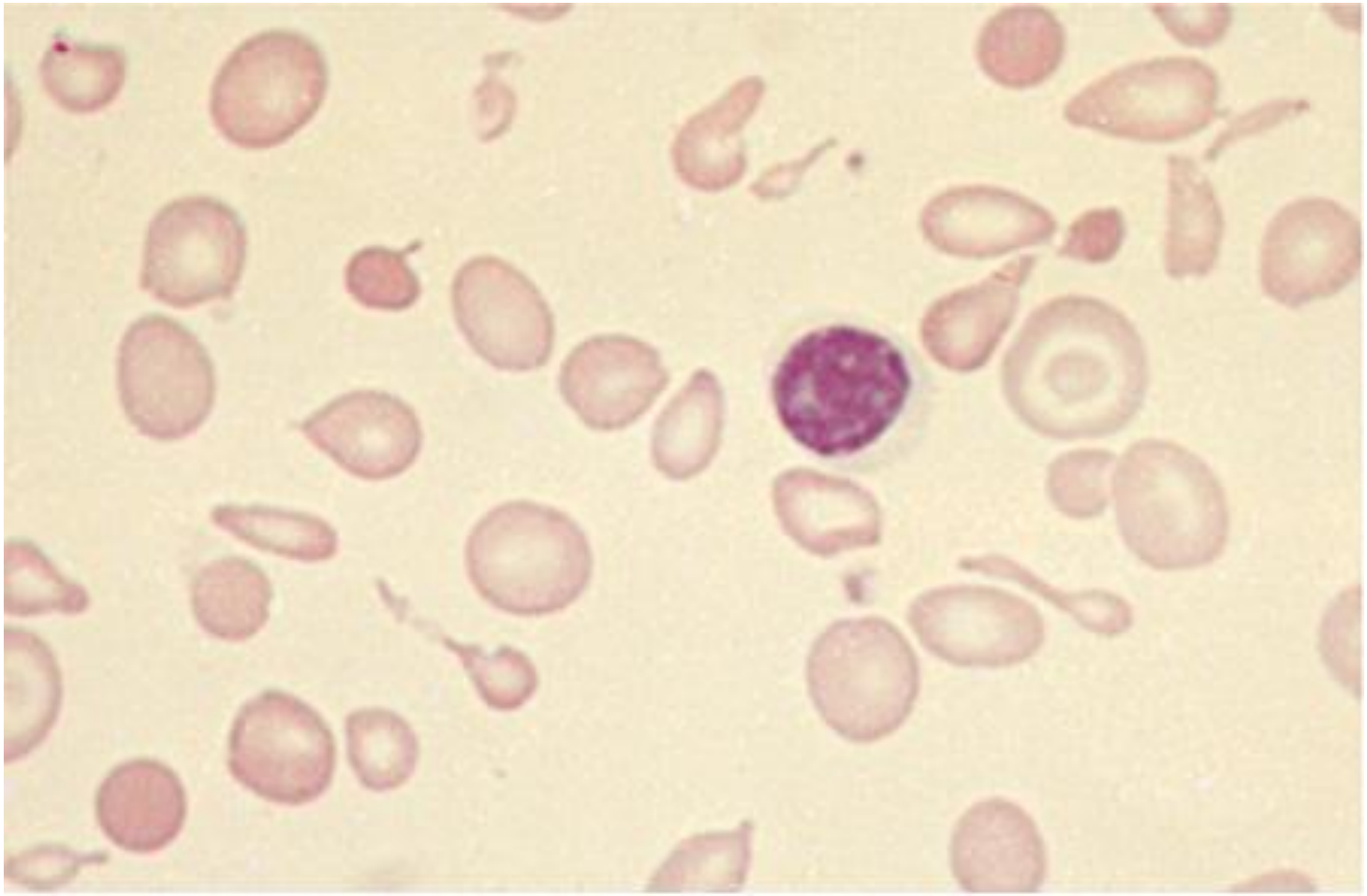
Class V variants: increased enzyme activity (>150% normal activity), no clinical significance.

G6PD deficiency

- Treatment of the patient with G6PD deficiency is determined by the patient's overall clinical condition.

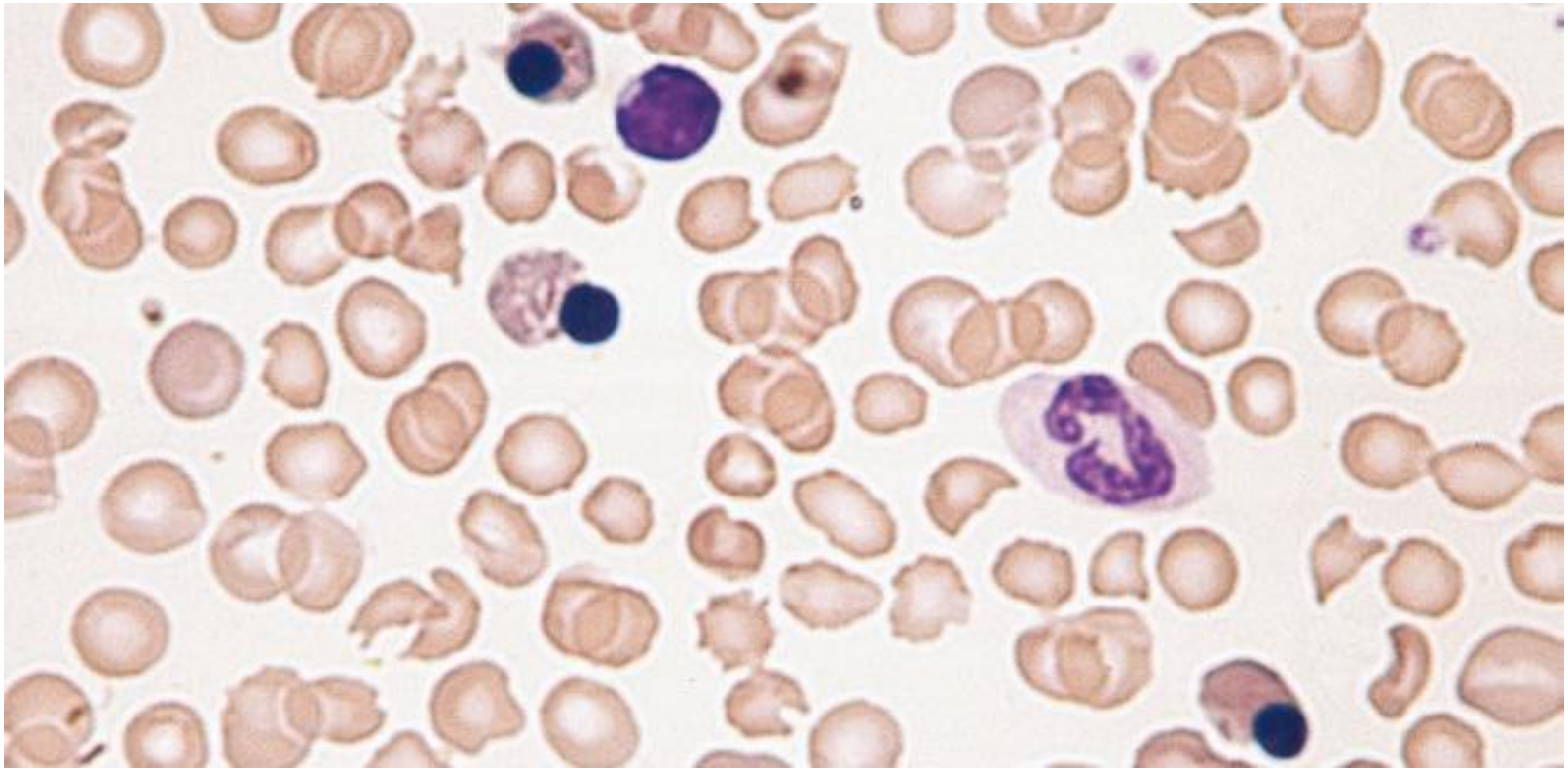
- Medications as causing acute hemolysis :
  1. Dapsone
  2. Phenazopyridine
  3. Nitrofurantoin
  4. Primaquine
  5. Rasburicase
  6. Methylthioninium chloride (methylene blue)
  7. Tolonium chloride (toluidine blue)

Thalassemia



- Microcytic and hypochromic red blood cells. Many elliptical and teardrop–shaped red blood cells

Microangiopathic Hemolytic Anemia



- Schizocytes (fragmented cell and nucleated red cells).

Microangiopathic Hemolytic Anemia

- Schistocyte–forming hemolysis

- The two classic syndromes associated with microangiopathic hemolytic anemia :

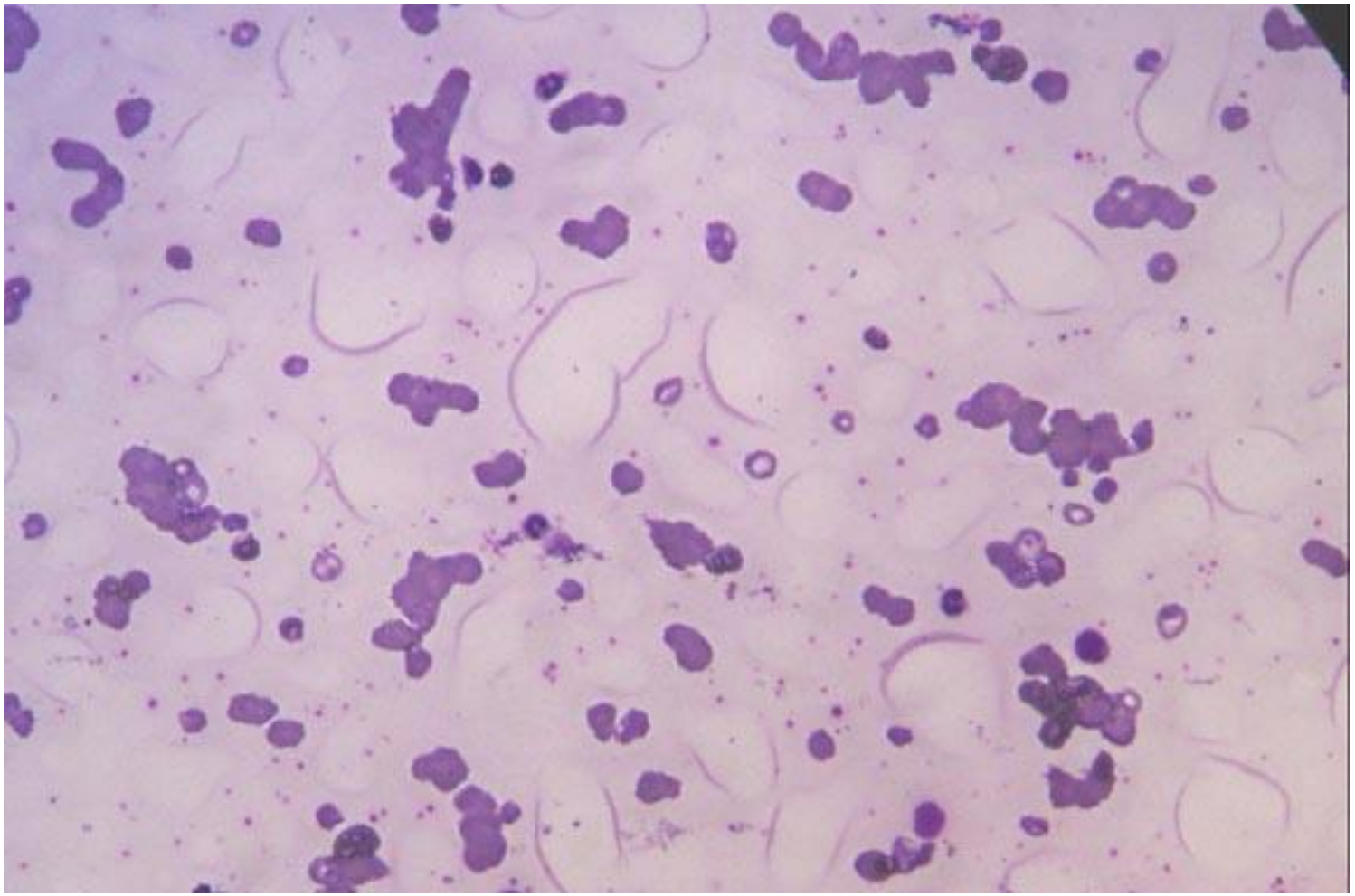
  - Thrombotic thrombocytopenic purpura (TTP)

  - Hemolytic uremic syndrome (HUS)

Microangiopathic Hemolytic Anemia

TTP	HUS
1. CNS abnormalities 2. Renal pathology 3. Fever 4. Microangiopathic hemolytic anemia 5. Thrombocytopenia	1. Microangiopathic hemolytic anemia 2. Acute nephropathy or renal failure 3. Thrombocytopenia

Autoimmune Hemolytic Anemia



Autoimmune Hemolytic Anemia

- Individuals with autoimmune hemolytic anemia make antibodies against their own RBCs.

- Diagnosis requires evidence of an antibody on the patient's RBCs, usually accompanied by an autoantibody in the plasma.

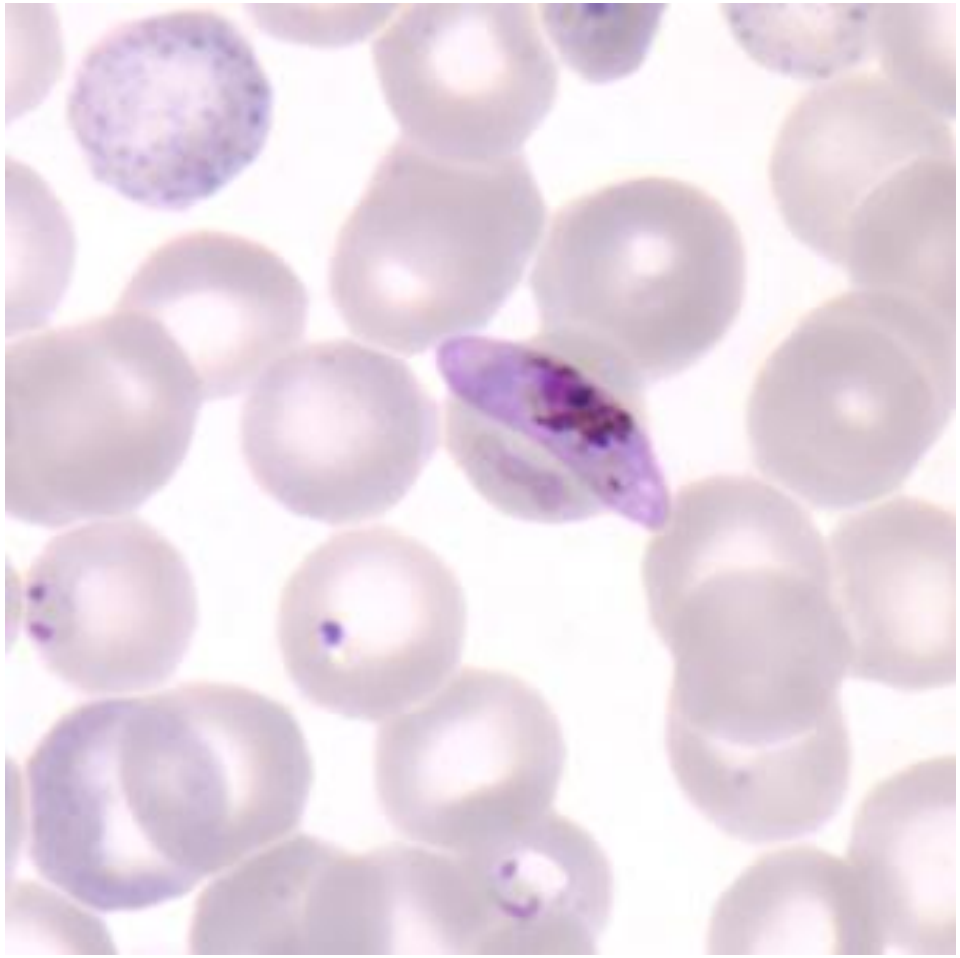
  : Indirect Coombs test

TABLE 237-3 Categories of Autoimmune Hemolytic Anemia (AIHA)

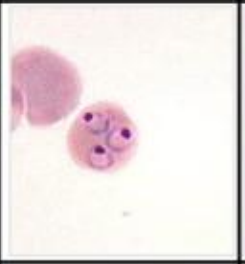
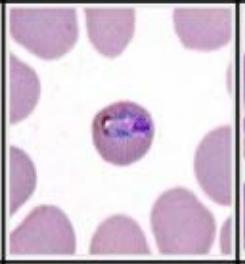
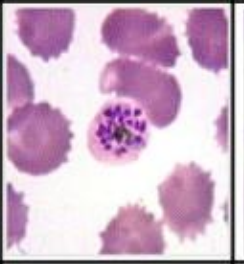
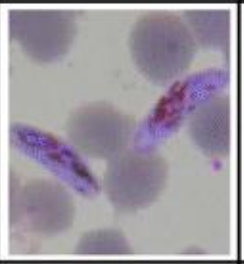
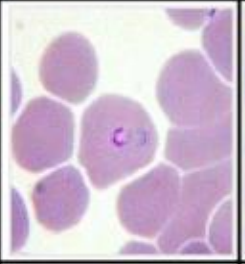
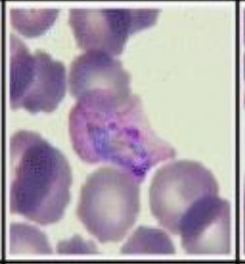
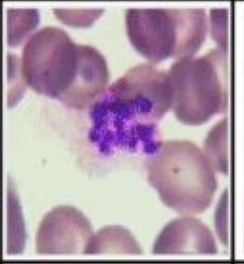
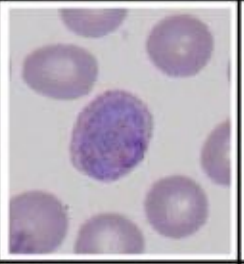
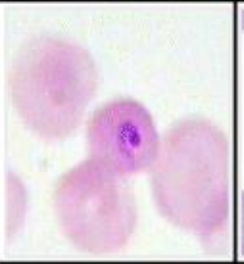
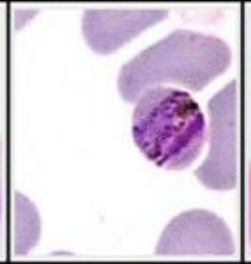
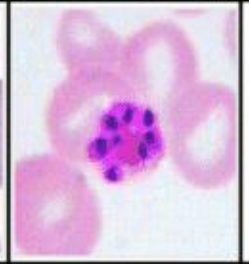
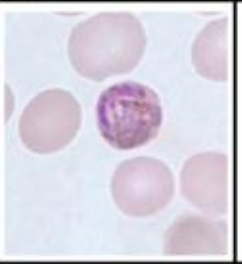
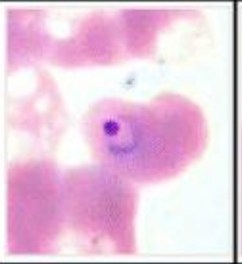
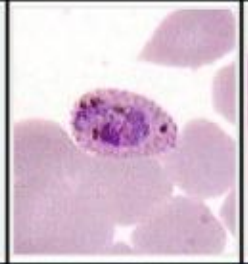
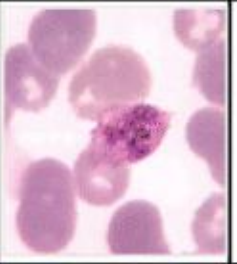
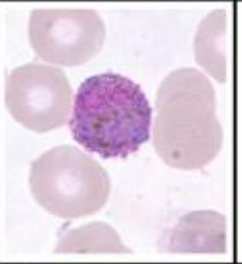
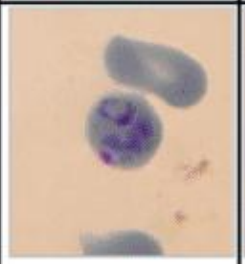
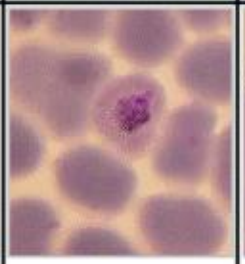
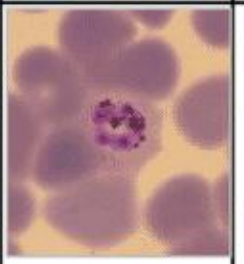
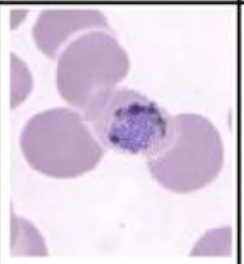
Warm antibody AIHA: Autoantibodies adhere most strongly to RBCs at 37°C (98.6°F).	70%–80% of AIHA cases 2:1 female predominance 50% primary (idiopathic) disease 50% secondary disease: lymphoproliferative, autoimmune disease, postinfection (transient) Usually immunoglobulin G (IgG) autoantibody against Rh(D) antigen Hemolysis usually extravascular Steroid responsive: 70%–80%
Cold antibody AIHA: Autoantibodies adhere most strongly to RBCs at 0–4°C (32–39.2°F).	**Cold agglutinin disease: IgM autoantibody against I antigen** Primary disease: older females Secondary disease: lymphoproliferative disorders, postinfection (transient) Raynaud's phenomenon, livedo reticularis, vascular occlusion Attacks precipitated by cold exposure Rarely intravascular hemolysis Not steroid responsive **Paroxysmal cold hemoglobinuria: IgG autoantibody against P antigen** Primary disease: rare, in adults Secondary disease: usually in children after upper respiratory infection Intravascular hemolysis during cold weather Usually not steroid responsive
Mixed-type antibody AIHA: Autoantibodies have variable temperature-dependent RBC adherence.	Primary disease: more common in older females Secondary disease: lymphoproliferative and autoimmune disorders Usually chronic course with severe exacerbations Usually steroid responsive

Abbreviation: RBC = red blood cell.

Malaria



- Plasmodium malariae

Stages / Species	Ring	Trophozoite	Schizont	Gametocyte	
P. falciparum					• *Parasitised red cells (pRBCs) not enlarged.* • *RBCs containing mature trophozoites sequestered in deep vessels.* • *Total parasite biomass = circulating parasites + sequestered parasites.*
P. vivax					• *Parasites prefer young red cells* • *pRBCs enlarged.* • *Trophozoites are amoeboid in shape.* • *All stages present in peripheral blood.*
P. malariae					• *Parasites prefer old red cells.* • *pRBCs not enlarged.* • *Trophozoites tend to have a band shape.* • *All stages present in peripheral blood*
P. ovale					• *pRBCs slightly enlarged and have an oval shape, with tufted ends.* • *All stages present in peripheral blood.*
P. knowlesi					• *pRBCs not enlarged.* • *Trophozoites, pigment spreads inside cytoplasm, like P. malariae, band form may be seen* • *Multiple invasion & high parasitaemia can be seen like P. falciparum* • *All stages present in peripheral blood.*