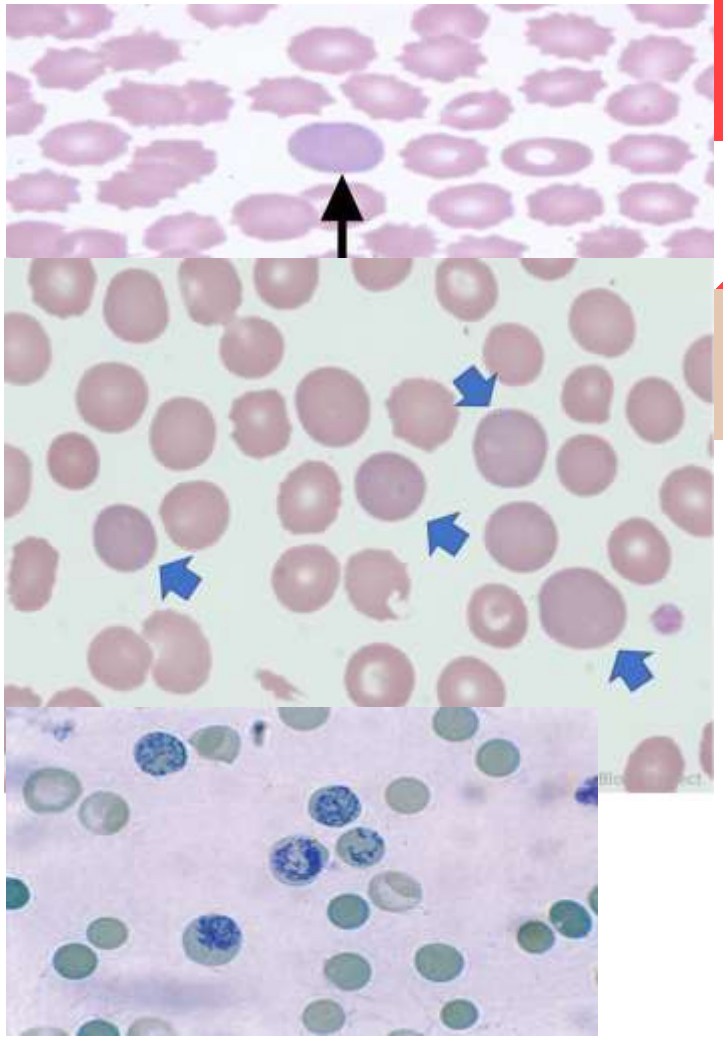
Red Cell Disorders
Anemia

Ghadeer AlMuhaisen, M.D.
Consultant hematopathologist
Mutah University

Reticulocytes

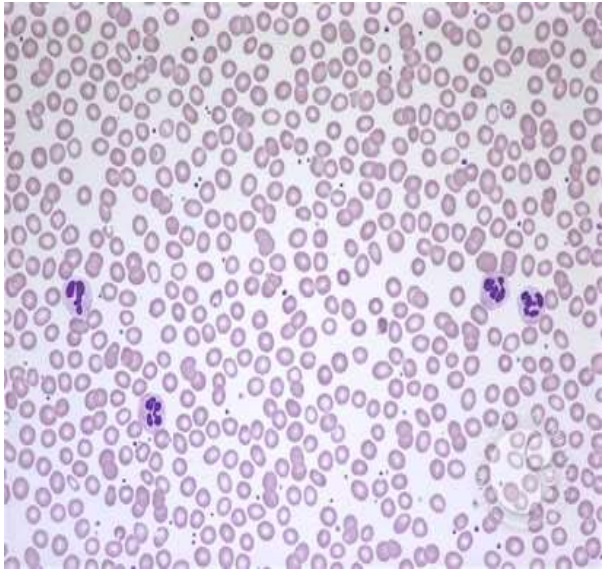
- The rise in marrow output due to erythropoietin → the appearance of increased numbers of newly formed red cells (reticulocytes) in the peripheral blood.
- In contrast, anemia caused by decreased red cell production is associated with subnormal reticulocyte counts



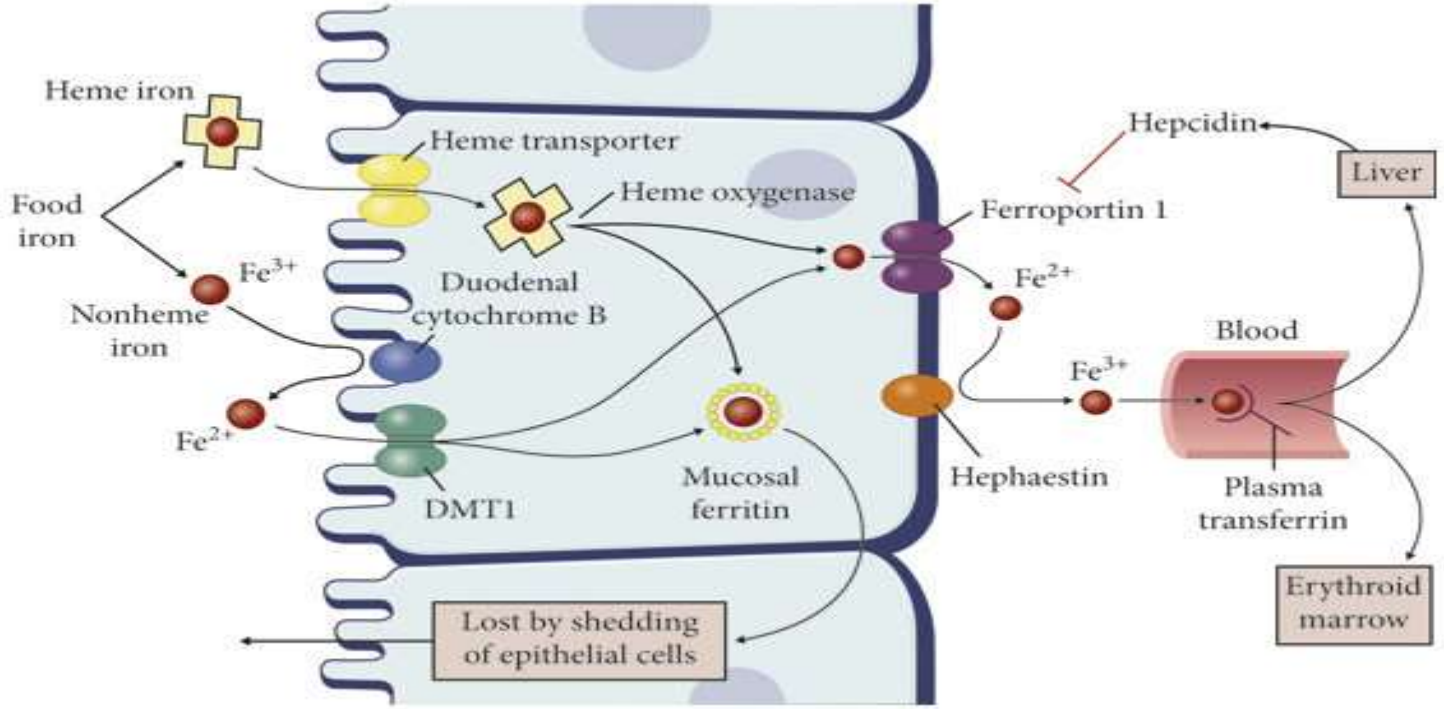
Blood component	Abbreviation used	Reference range	SI Reference range
White blood cells	WBC	4500-11,000/mm^3	4.5-11.0 x 10^9/L
Red blood cells*	RBC	Male: 4.3-5.9 million/mm^3 Female: 3.5-5.5 million/mm^3	Male: 4.3-5.9 x 10^{12}/L Female: 3.5-5.5 x 10^{12}/L
Hemoglobin*	HGB	Male: 13.5-17.5 g/dL Female: 12.0-16.0 g/dL	Male: 2.09-2.71 mmol/L Female: 1.86-2.48 mmol/L
Hematocrit*	HT	Male: 41%-53% Female: 36%-46%	Male: 0.41-0.53 Female: 0.36-0.46
Mean corpuscular volume	MCV	80-100 μm^3	80-100 fl
Mean corpuscular hemoglobin	MCH	25.4-34.6 pg/cell	0.39-0.54 fmol/cell
Mean corpuscular hemoglobin concentration	MCHC	31%-36% Hb/cell	4.81-5.58 mmol Hb/L
Platelets	Platelets	150,000-400,000/mm^3	150-400 x 10^9/L

Anemia also can be classified based on red cell morphology. Features that provide etiologic clues include the size, color, and shape of the red cells. Judged subjectively by visual inspection of peripheral smears and expressed quantitatively using the following indices:

Mean cell volume (MCV):	the average volume per red cell, expressed in femtoliters (cubic micrometer)
Mean cell hemoglobin (MCH)	the average mass of hemoglobin per red cell, expressed in picograms
Mean cell hemoglobin concentration (MCHC)	the average concentration of hemoglobin in a given volume of packed red cells, expressed in grams per deciliter
Red cell distribution width (RDW)	the coefficient of variation of red cell volume



Hepcidin, a small peptide that is synthesized and secreted from the liver in an iron-dependent fashion.



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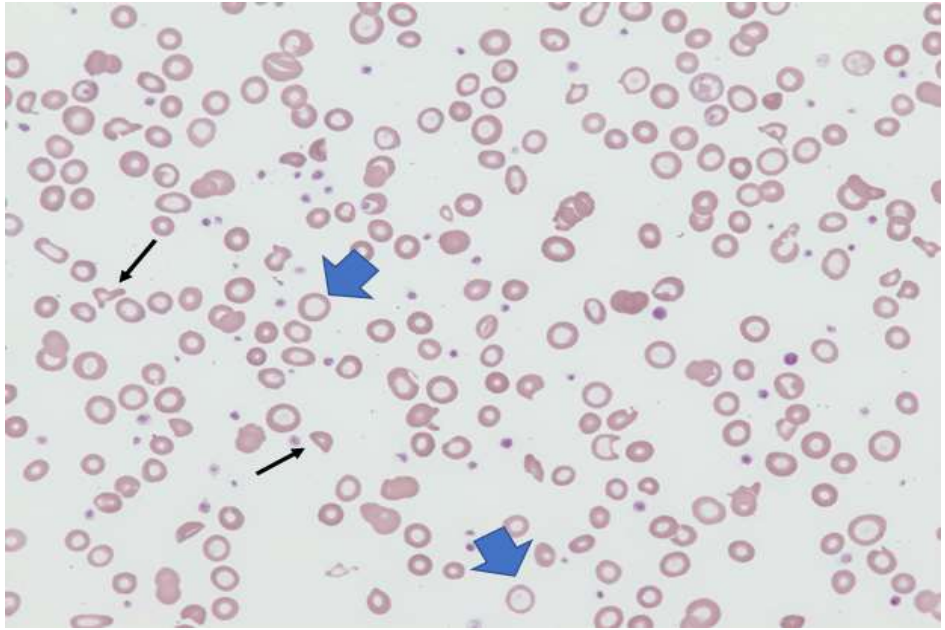
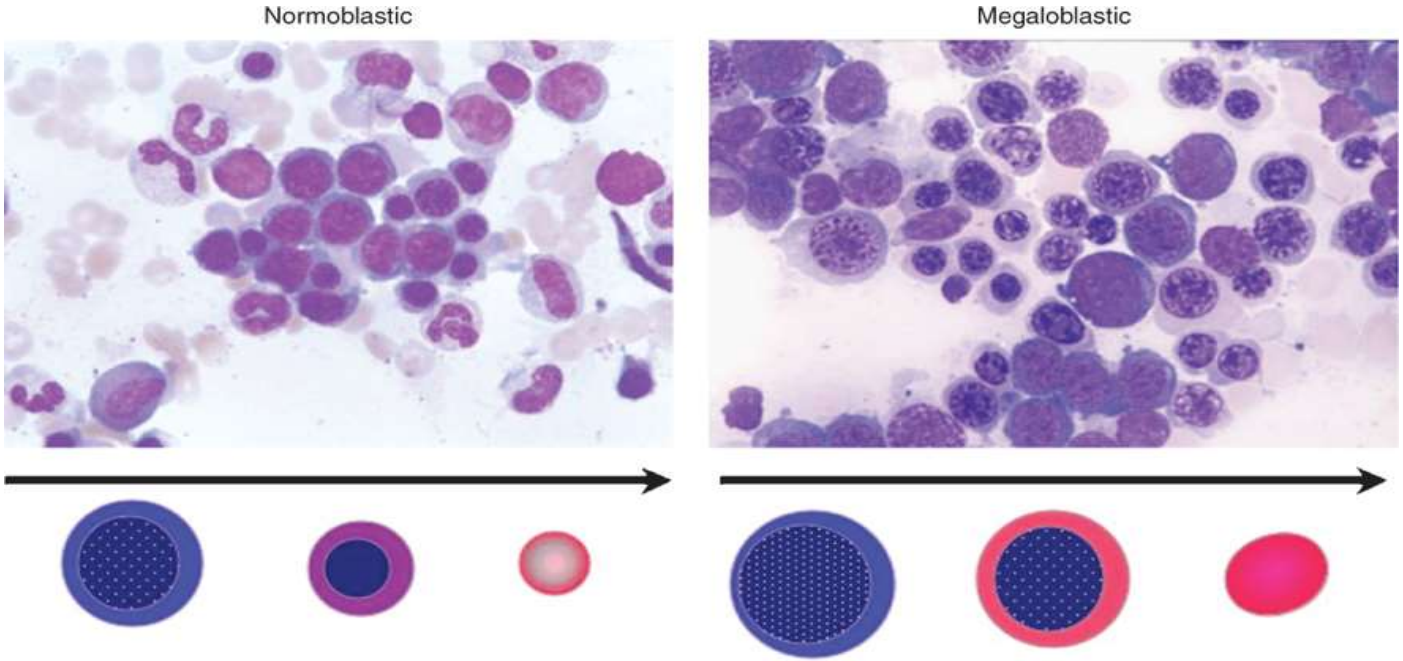
Laboratory manifestation

- ↓↓ Iron storage (Serum ferritin) → ↓↓ serum iron → ↑↑ transferrin (TIBC) → microcytic anemia (↓MCV, ↓MCHC, ↑RDW)
- Peripheral blood smear: red cells are microcytic and hypochromic



Morphology of megaloblastic anemia - BM



Source: Jon C. Aster, H. Franklin Bunn:
Pathophysiology of Blood Disorders, Second Edition
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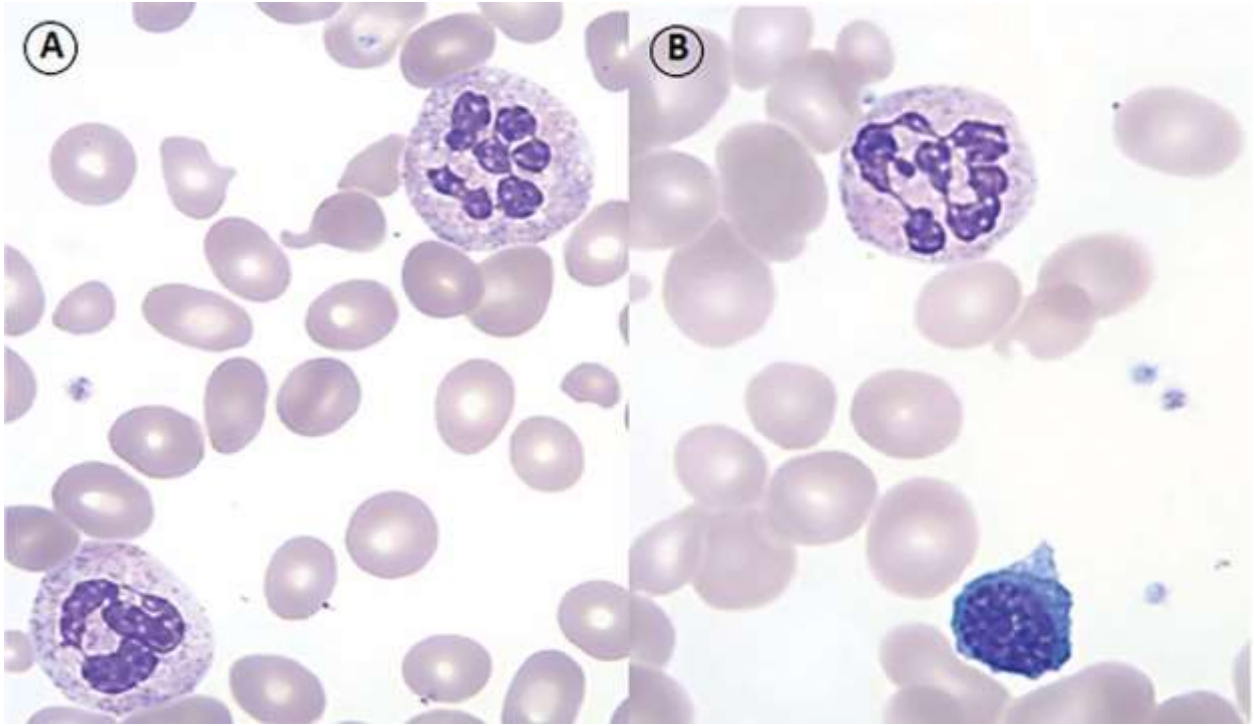
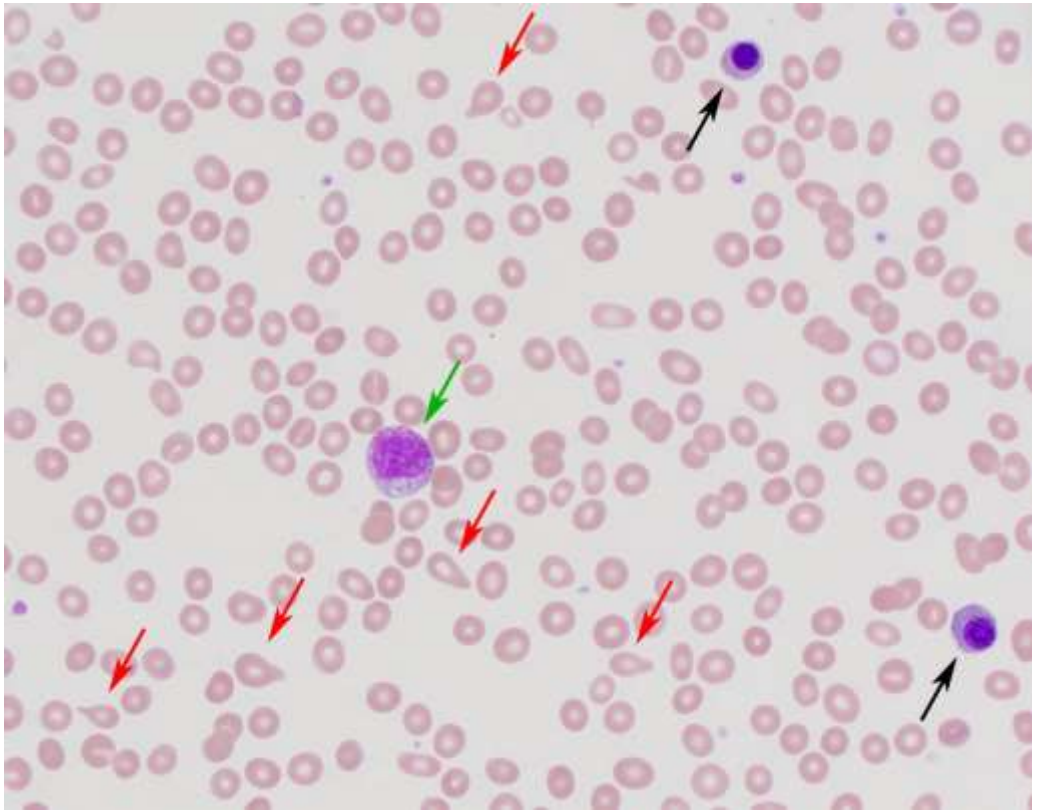
Morphology of megaloblastic anemia - PB



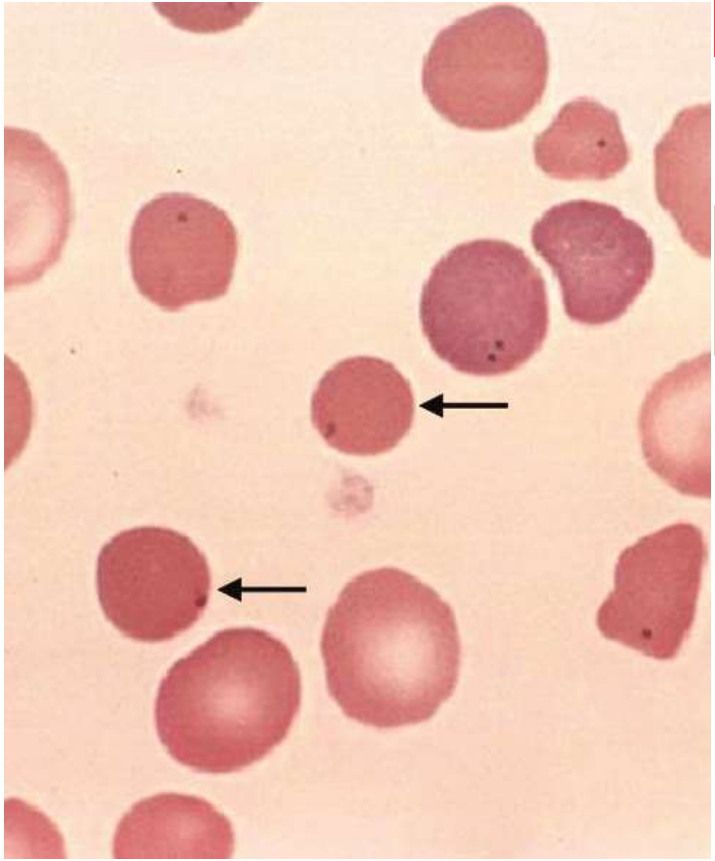
https://doi.org/10.3949/ccjm.87a.19072

Leukoerythroblastosis



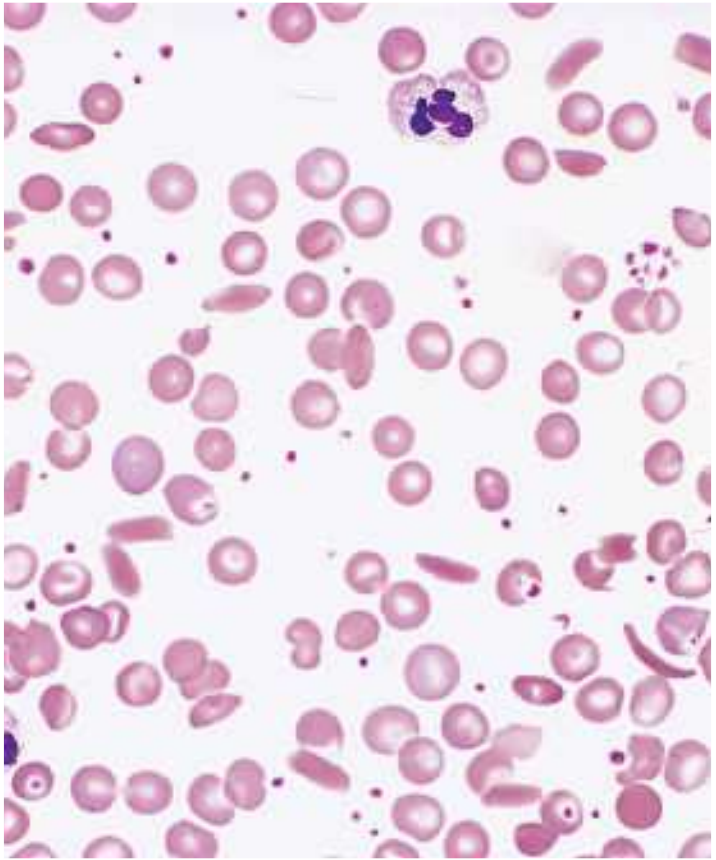
Clinical & morphology

- On smears, **spherocytes** are dark red & lack central pallor.
- Manifestations are anemia, splenomegaly, & jaundice
- Splenomegaly is more common and prominent in hereditary spherocytosis than in any other form of hemolytic anemia.
- Splenectomy improves the anemia → removing the major site of RBC destruction
- The course is stable, may be complicated by aplastic crises, the most severe of which are triggered by parvovirus B19 infection.



SICKLE CELL ANEMIA - Morphology

- PB: elongated, spindled, or boat-shaped **irreversibly sickled red cells.**



SICKLE CELL ANEMIA - Morphology

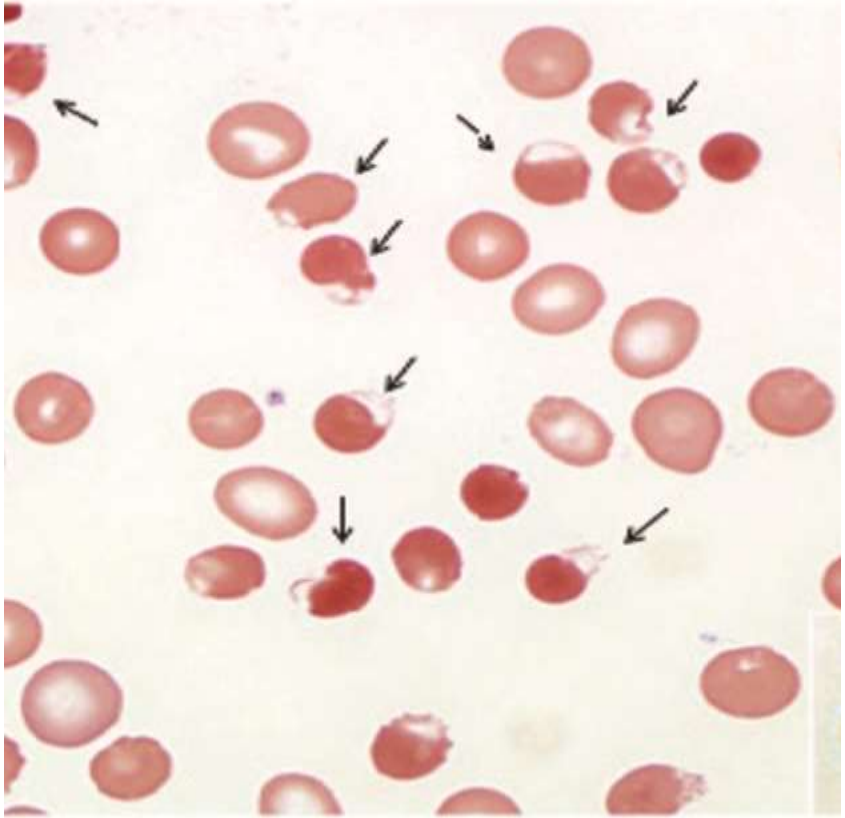
- A compensatory **hyperplasia of erythroid progenitors** in the marrow.

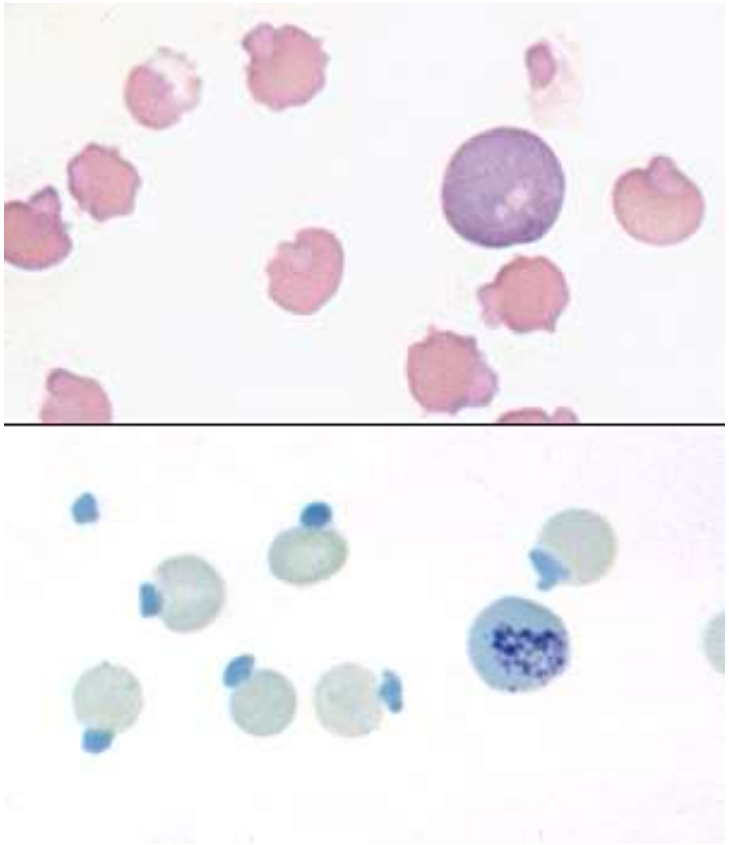
- Cellular proliferation in the marrow often causes bone resorption and secondary new bone formation, resulting in prominent cheekbones and changes in the skull resembling a “crewcut” in x-rays.

- Extramedullary hematopoiesis may appear in the liver and spleen.

G6PD deficiency

- Oxidized hemoglobin denatures→ precipitates intracellular inclusions called **Heinz bodies.**
- → damage the RBC membrane → intravascular hemolysis
- Lesser damaged cells lose their deformability and splenic phagocytes attempt to “pluck out” the Heinz bodies, creating **bite cells.**
- → trapped on recirculation to the spleen & destroyed by phagocytes (extravascular hemolysis)





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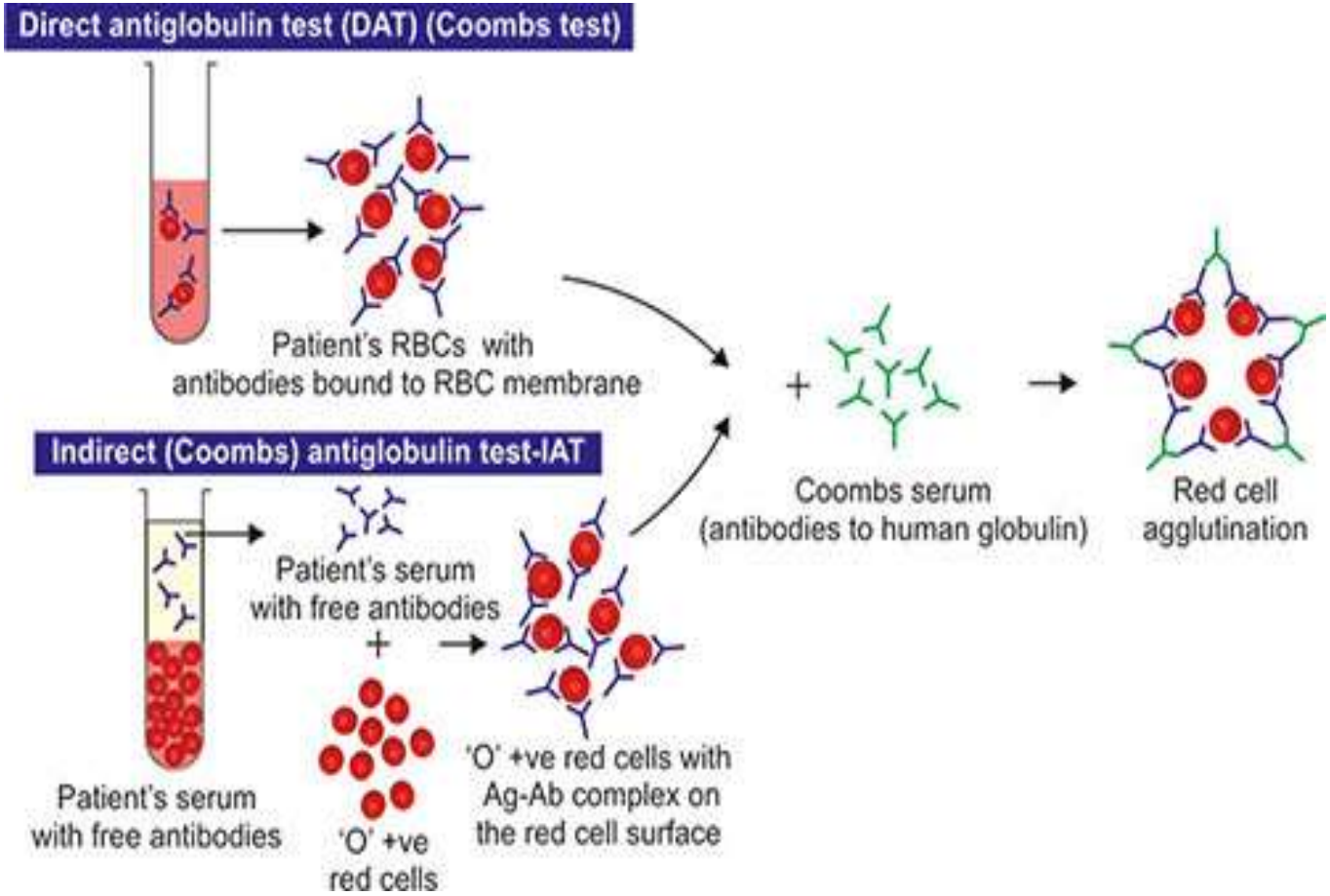
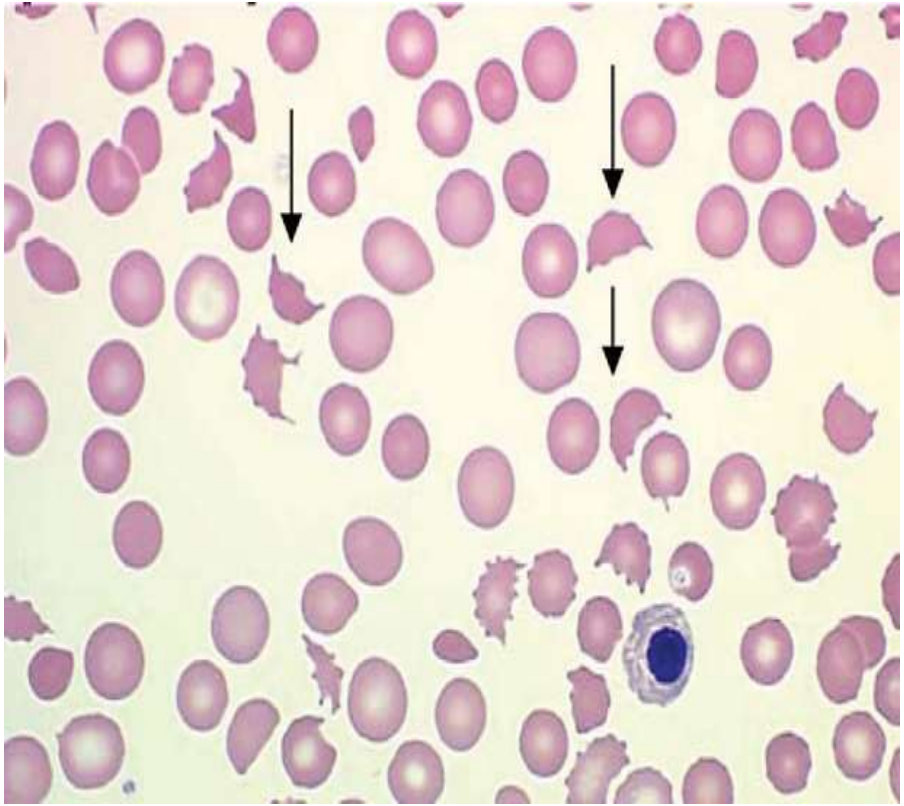
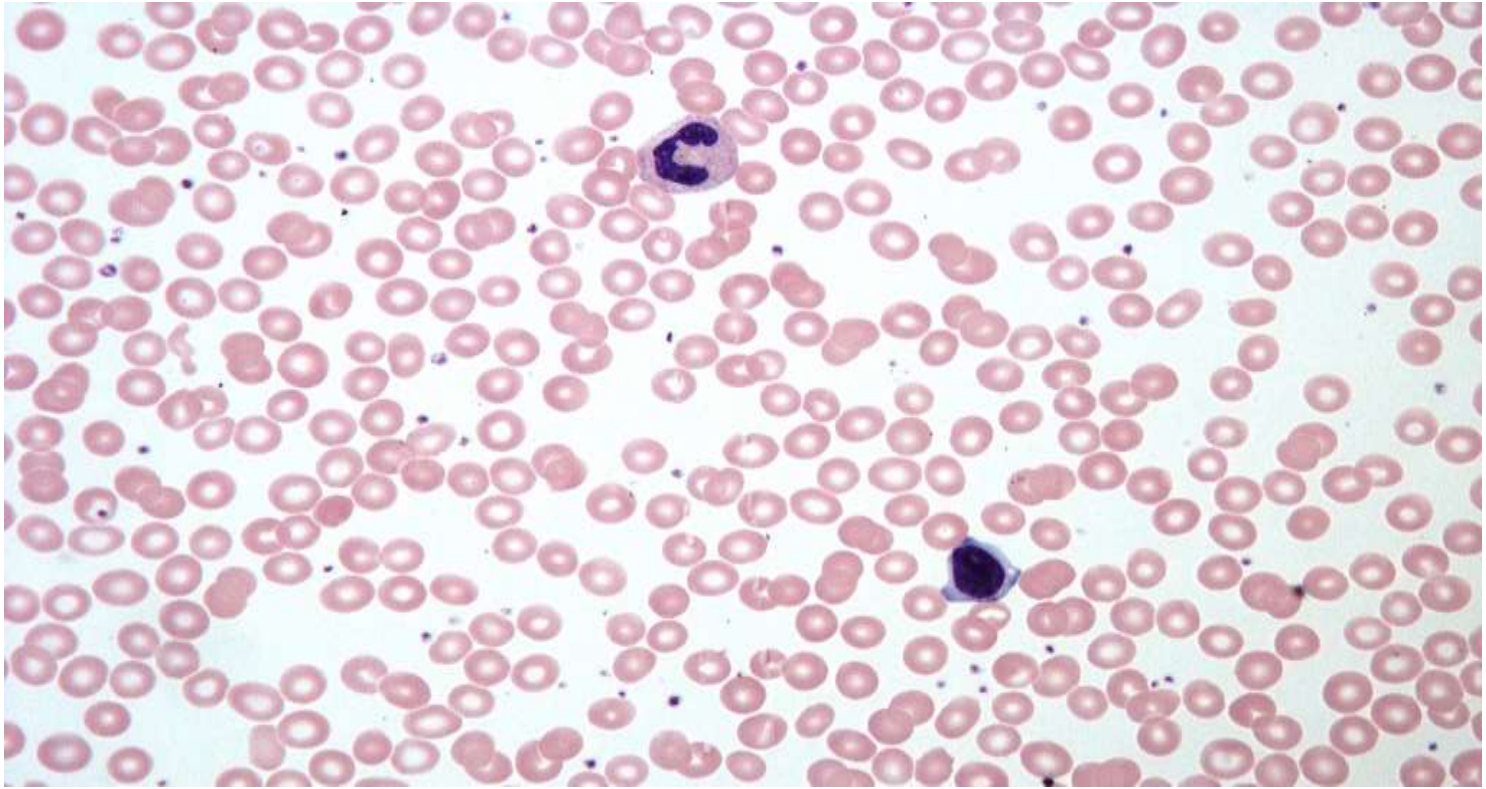

Direct antiglobulin test (DAT) (Coombs test)
Patient's RBCs with antibodies bound to RBC membrane
Indirect (Coombs) antiglobulin test-IAT
Patient's serum with free antibodies
Patient's serum with free antibodies
+
'O' +ve red cells
'O' +ve red cells with Ag-Ab complex on the red cell surface
+
Coombs serum (antibodies to human globulin)
Red cell agglutination

Microangiopathic hemolytic anemia

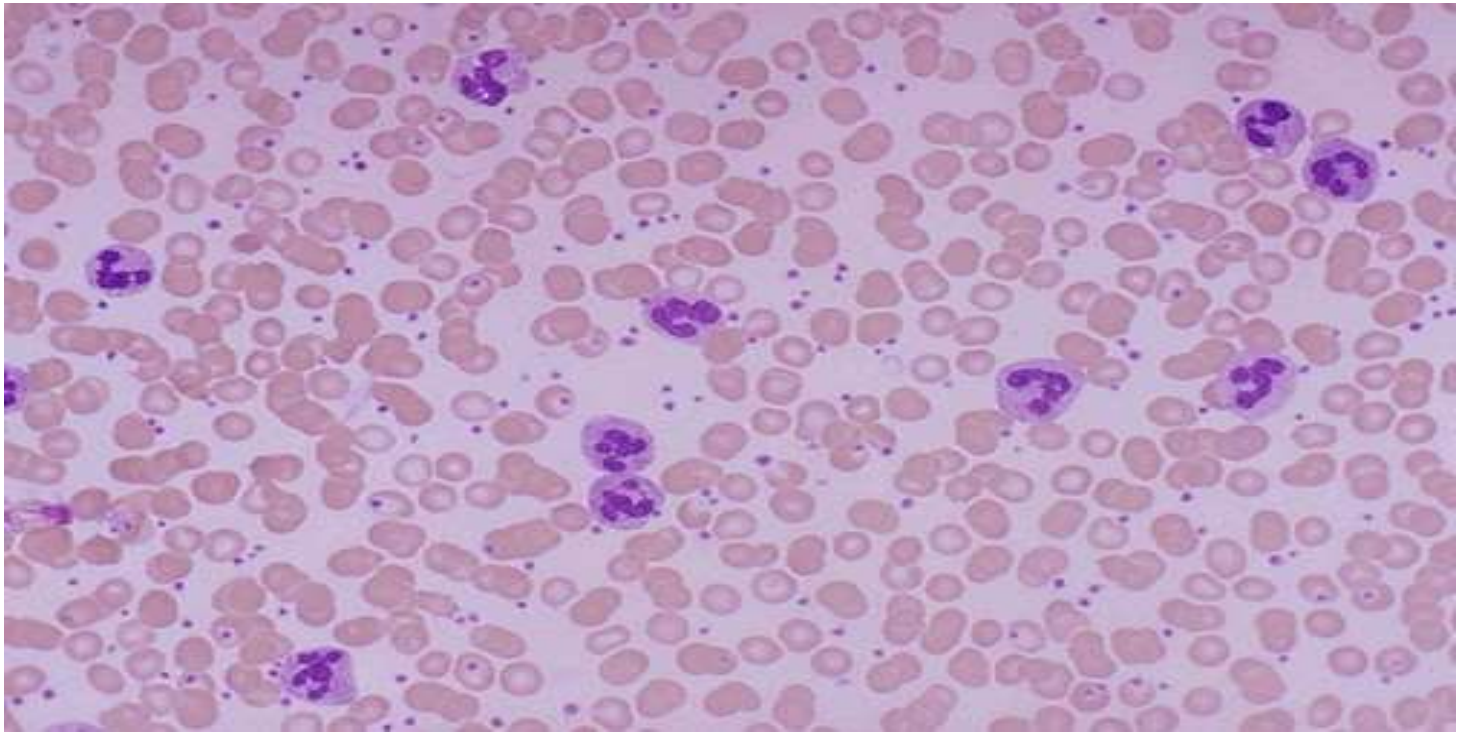
Schistocytosis: leads to the appearance of characteristic “burr cells,” “helmet cells,” and “triangle cells” in peripheral blood smears.



Normal Blood film

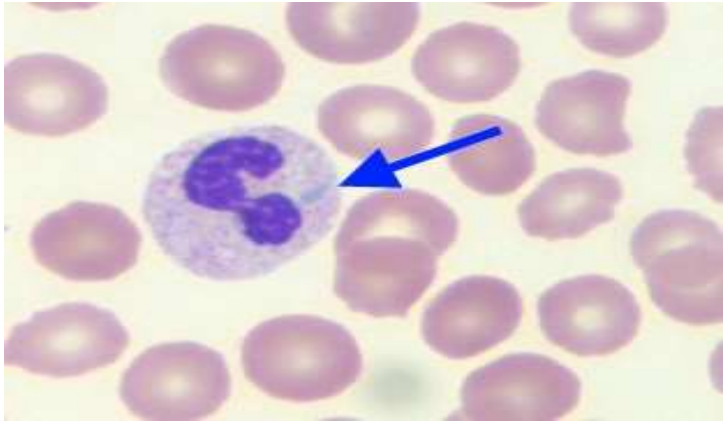


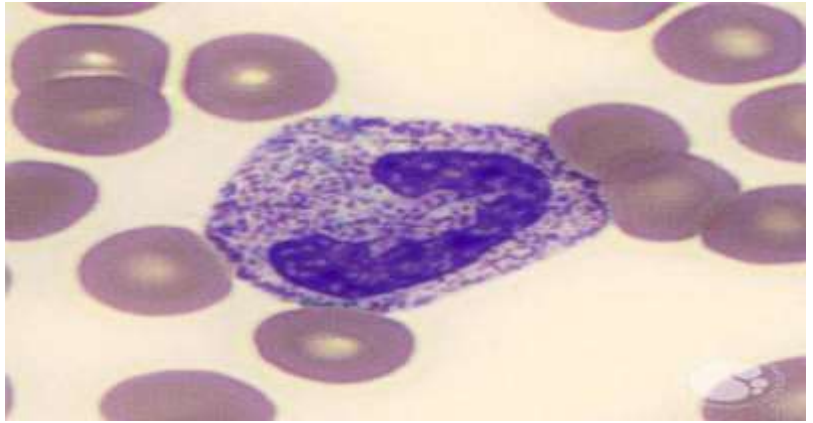
Leukocytosis - neutrophilia



Leukocytosis - neutrophilia

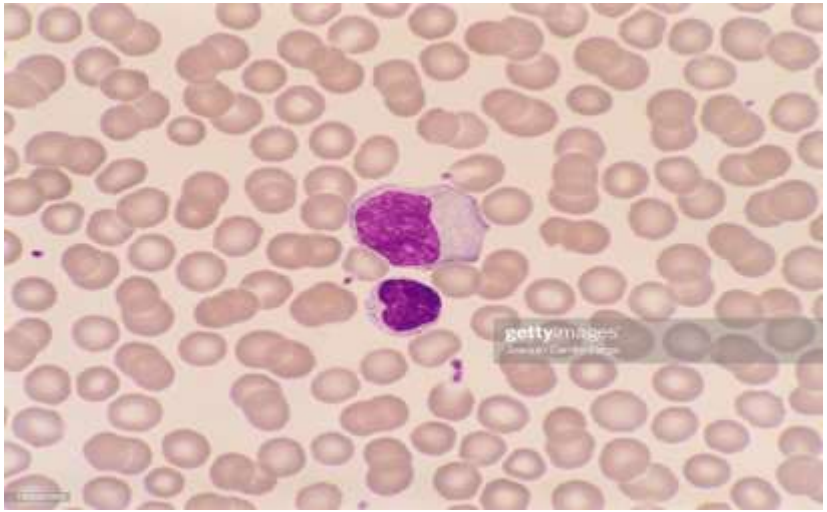
In sepsis or severe inflammation neutrophilia is accompanied by morphologic changes: + cytoplasmic vacuoles
+Toxic granules, coarser & darker than normal granules
+ Döhle bodies: patches of dilated ER (appear →sky-blue cytoplasmic "puddles."

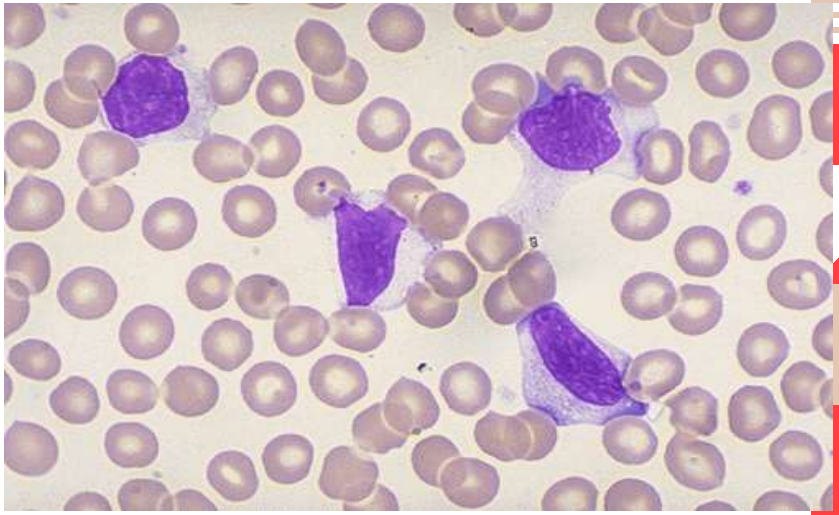




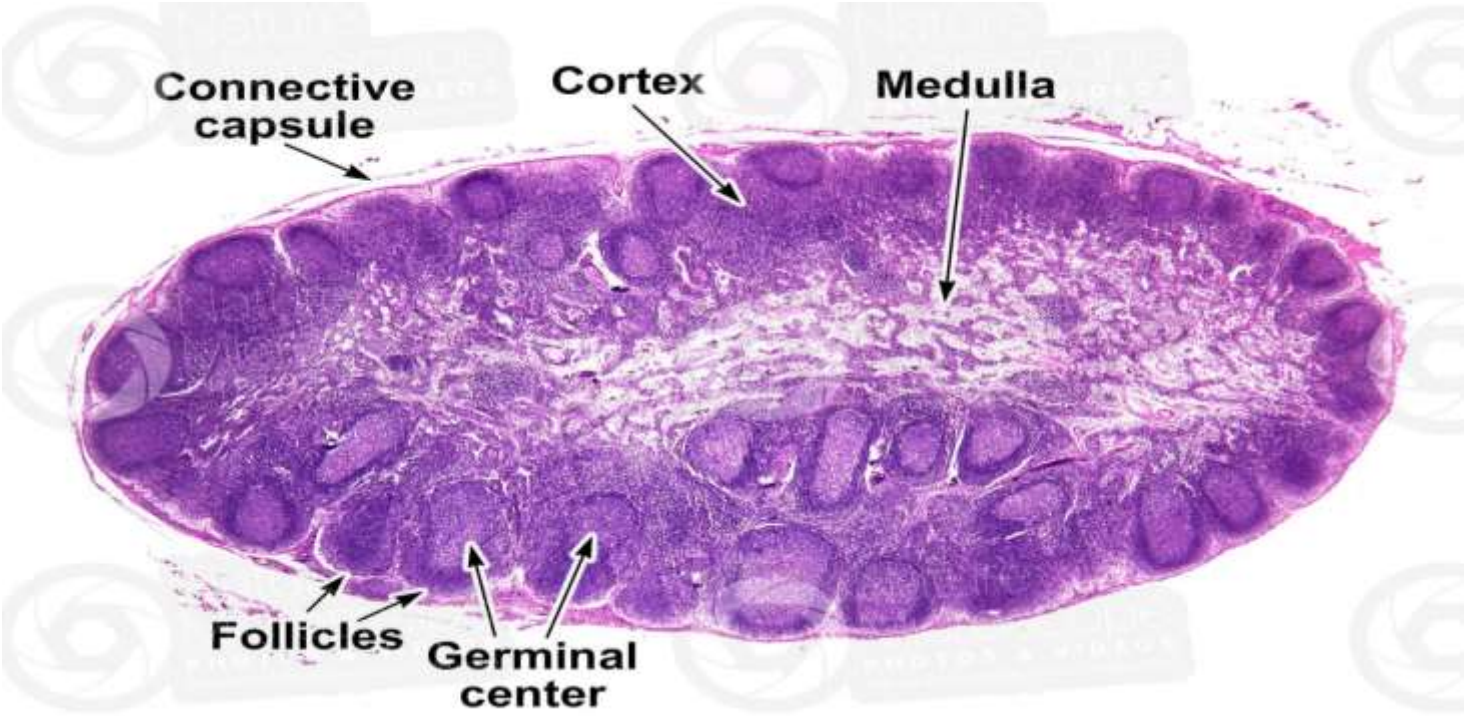
Infectious mononucleosis

- More than half of these cells are large **atypical lymphocytes**; with an oval, indented, or folded nucleus & abundant cytoplasm with a few azurophilic granules



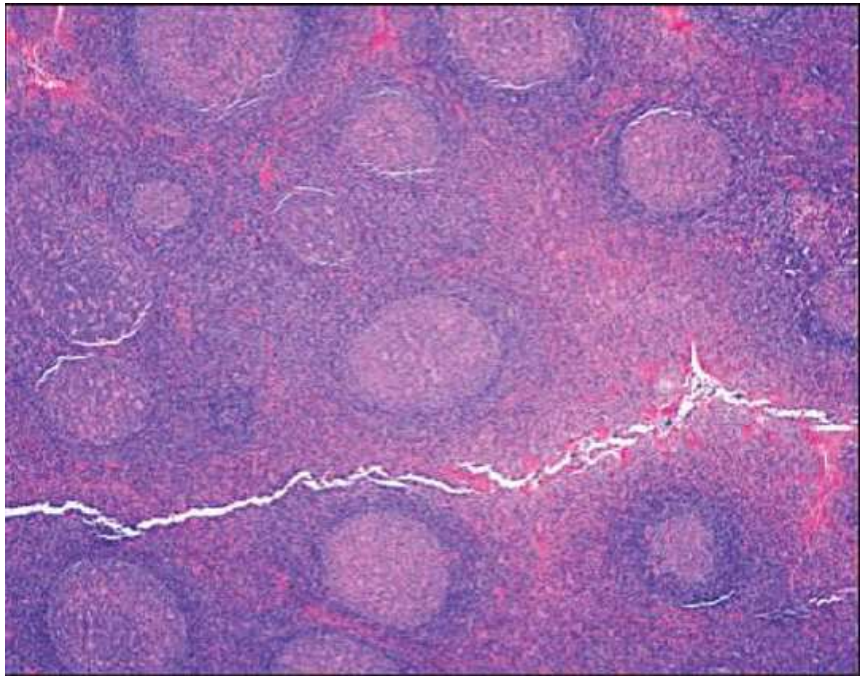


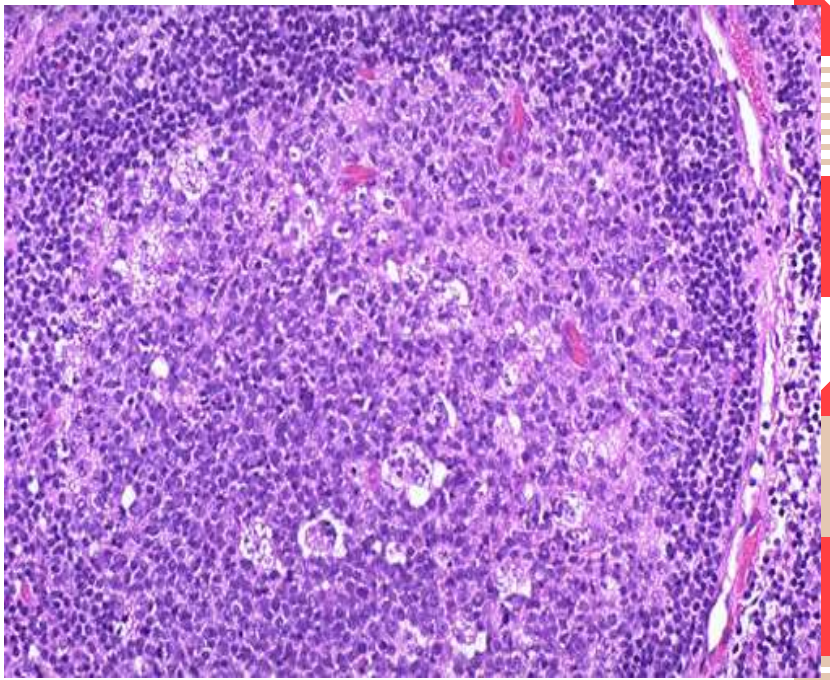
Reactive Lymphadenitis



Reactive Lymphadenitis

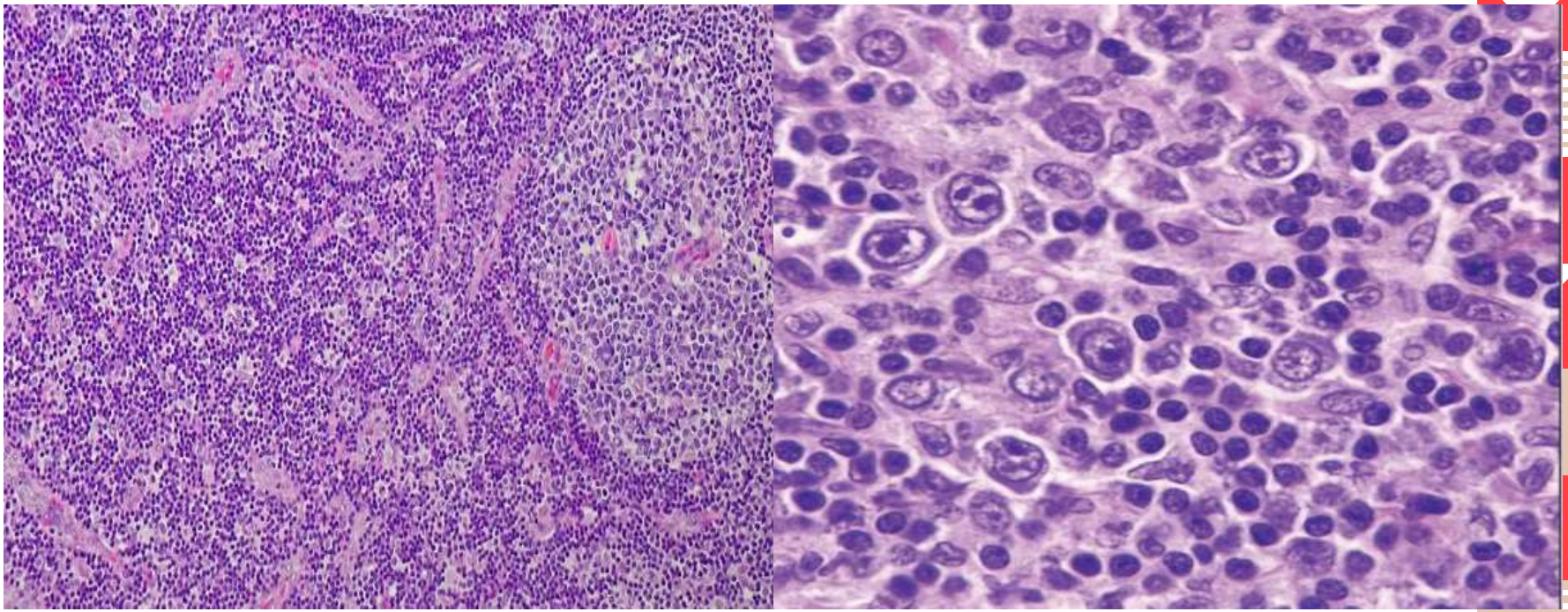
Chronic Nonspecific Lymphadenitis - Follicular hyperplasia.





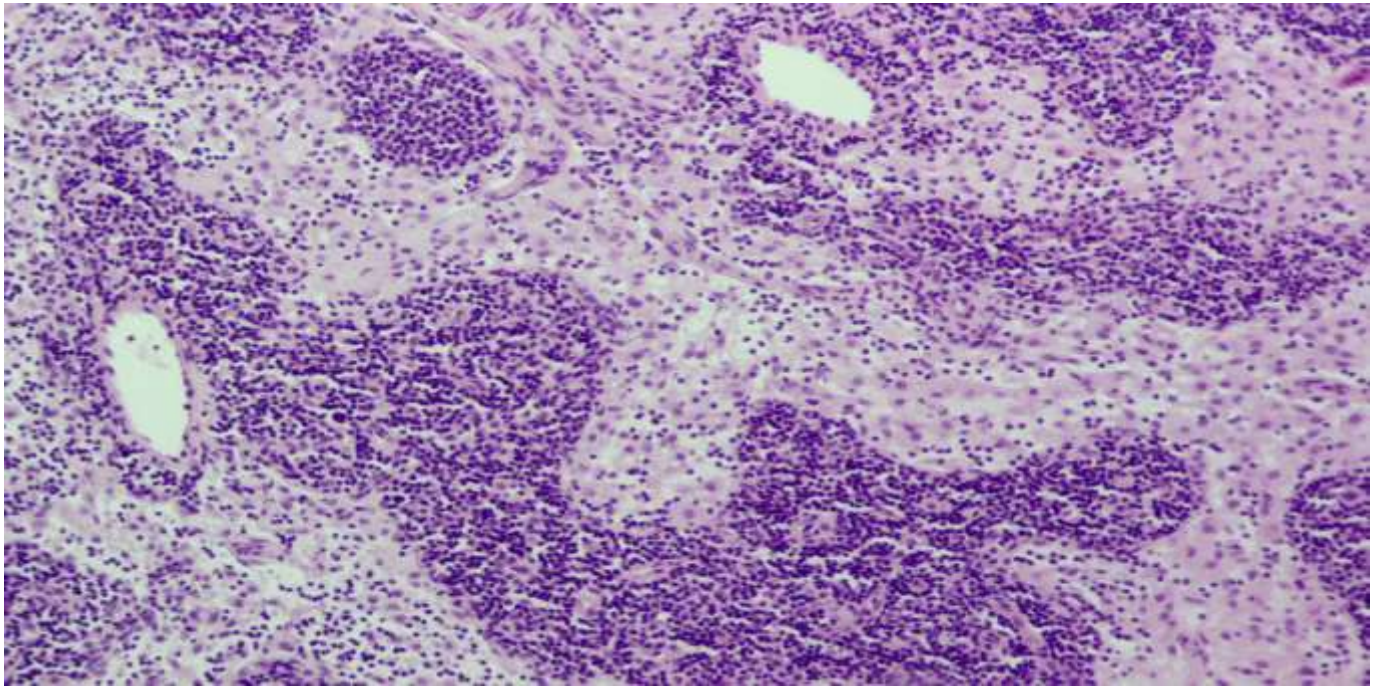
Reactive Lymphadenitis

Chronic Nonspecific Lymphadenitis - Paracortical hyperplasia

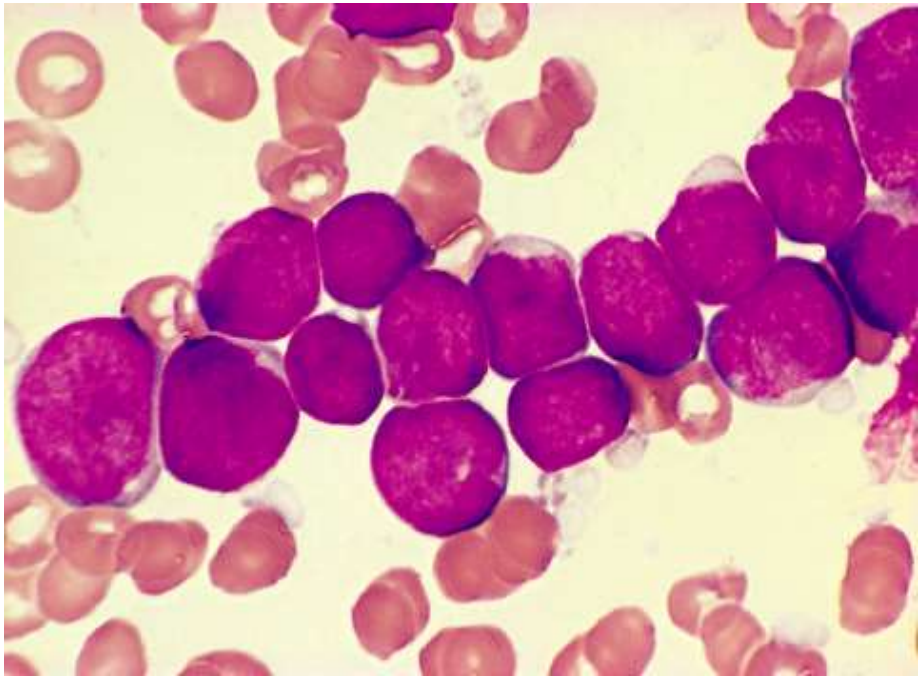


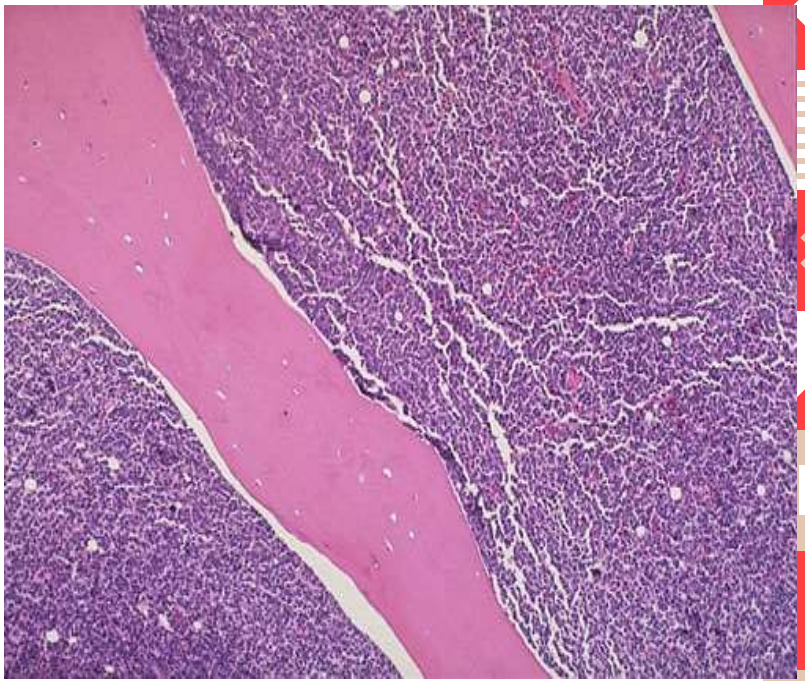
Reactive Lymphadenitis

Chronic Nonspecific Lymphadenitis - Sinus Histiocytosis

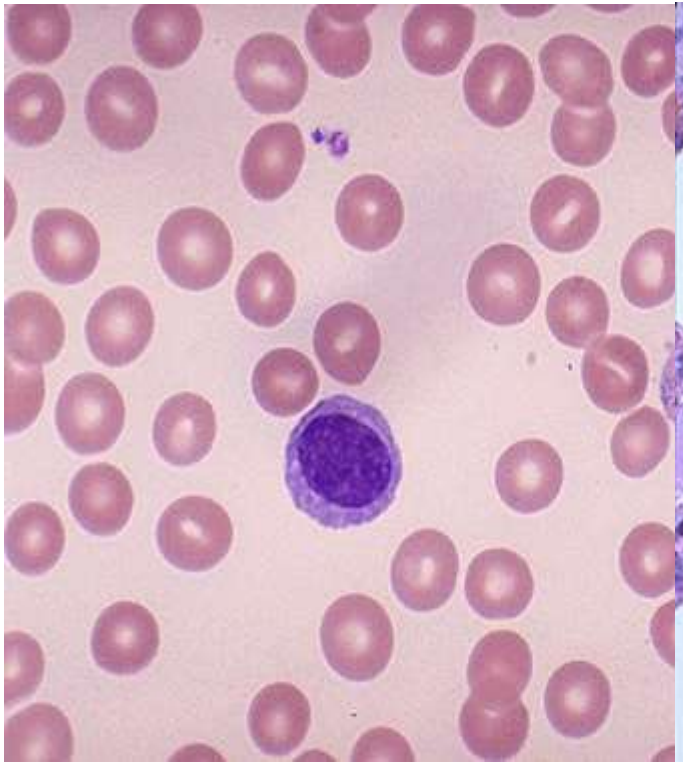


Acute Lymphoblastic Leukemia/Lymphoma (ALL) : Morphology

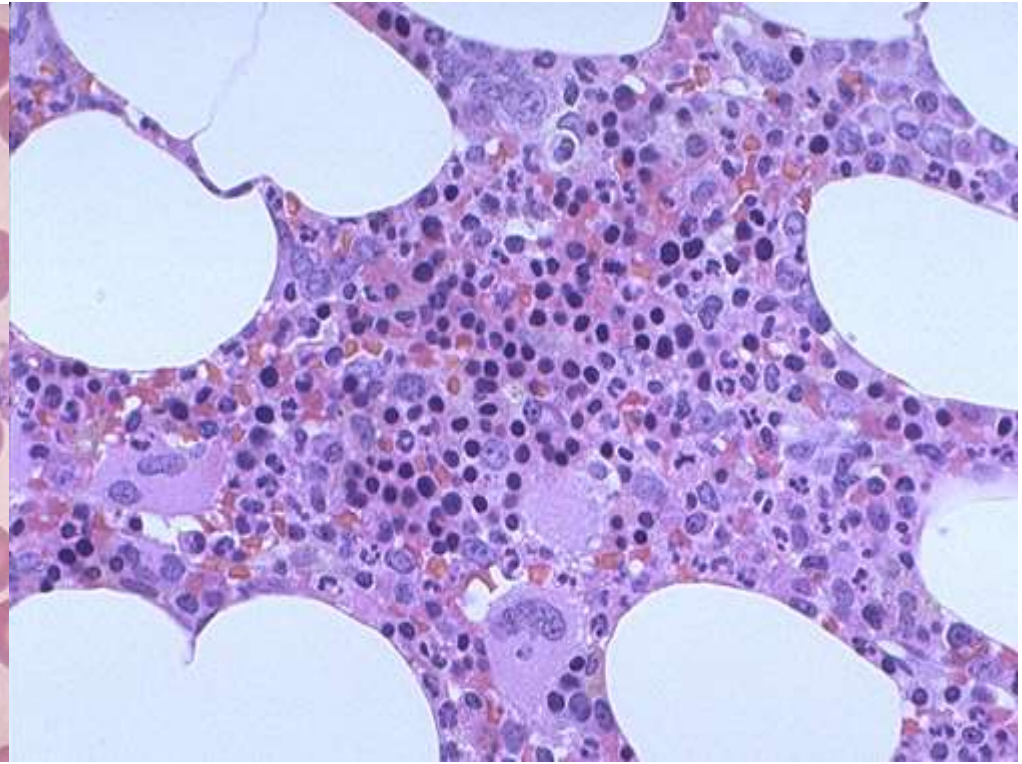




Normal mature lymphocyte

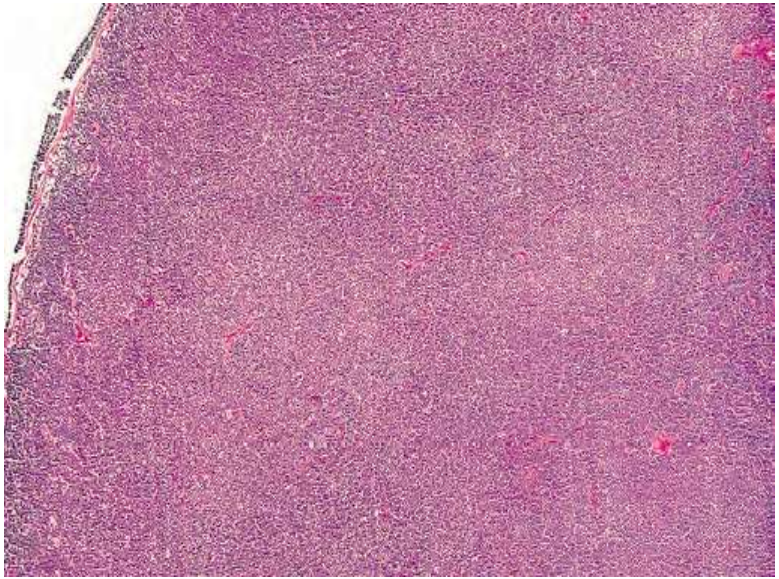


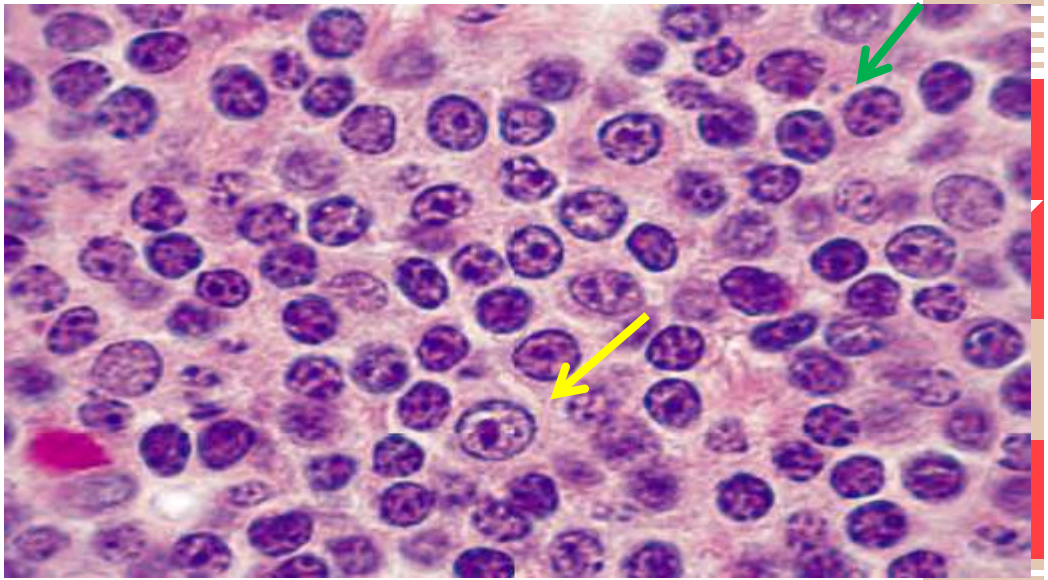
Normal bone marrow



Chronic Lymphocytic Leukemia/Small Lymphocytic Lymphoma (CLL/SLL) : Morphology

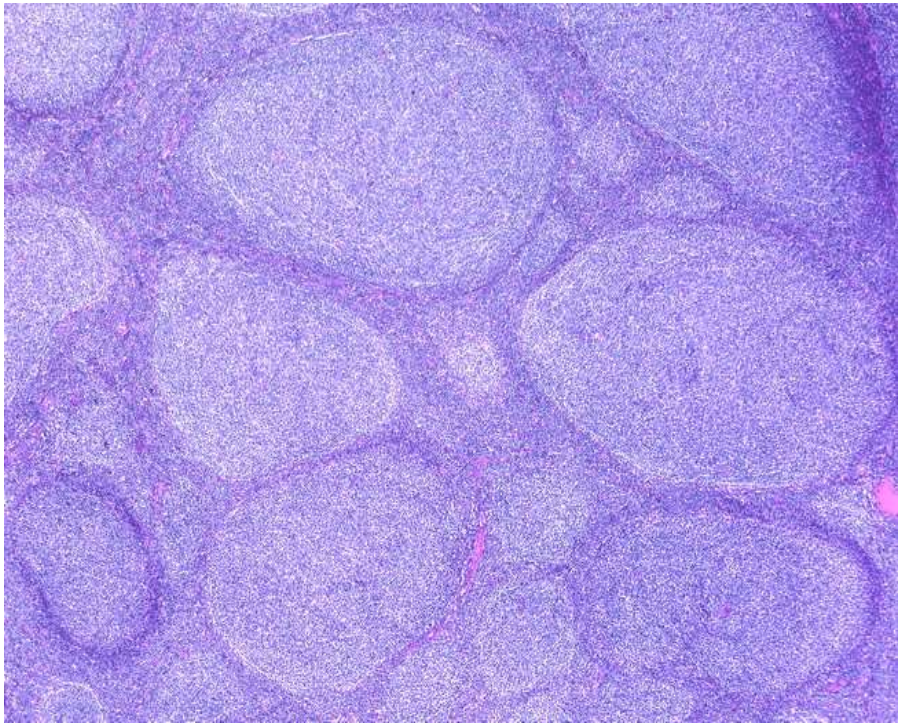
Green arrow: cells w Clumped chromatin & white areas in between conferring a “soccer ball” appearance. Yellow arrow : prolymphocytes

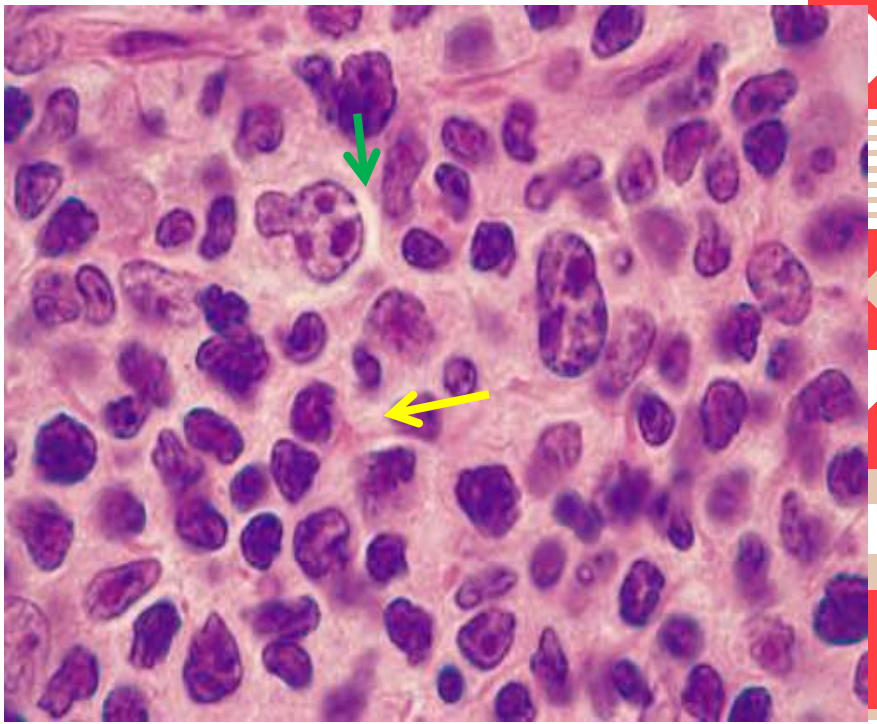




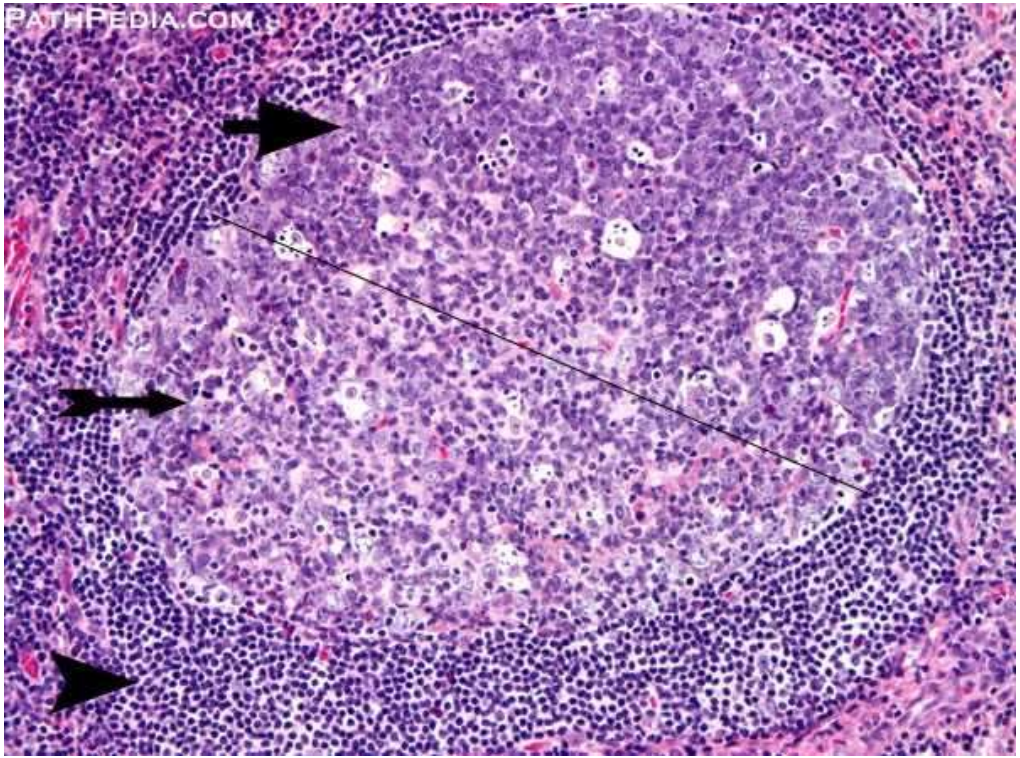
Follicular Lymphoma - Morphology

Centrocyte
centroblast





Mantle Cell Zone



Thank you