

# CLINICAL PATHOLOGY (PATH-404) PART IV

**An Illustrated Summarized Study on**

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**Red Blood Cells Abnormalities**

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**An Easy Key to Remember !!!**

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## RED BLOOD CELLS ABNORMALITIES

Specie	Diameter	Crenation	Central paler	Rouleaux	Other
Cattle	5.8 μm	Common	Slight	No	Anisocytosis
Buffalo	5.8 μm	Moderate			
Horse	5.5 μm		No	Marked	↑ ESR, uniform size
Dog	7 μm				Few blue colored cells can be seen- reticulocytes (0-1.5%)
Goat	3.2 μm (smallest)		No		Piokilocytosis marked
Sheep	4.5 μm				
Cat	5.8 μm	With few blunt processes	Slight	Slight	Reticulocytes may be present (0.2-1.6%)
Camel	7.5 x 4.4 μm				Oval cells in healthy camels Elliptocytes
Poultry	10.7 x 6.1 μm to 15.8 x 10.2 μm				Nucleated, oval, cytoplasm clear
In camel: thin RBC of decreased volume in relation to diameter (often characterized by abnormality of shape seen in hereditary iron deficiency)					

### Artifacts

Artifacts	Characteristics
Over night storage at 4-8 °C	Aged blood: echinocyte formation & swollen neutrophil nuclei
Blood with EDTA for 48 hours at room temperature	Extreme crenation in erythrocytes, Leukocyte nucleus has undergone pyknosis and karyorrhexis, Making certain identification impossible
Stain precipitates (Using aged stain)	Inadequate rinsing of slides following application of stain. Finer precipitate can effectively mimic epicellular parasites or bacteria
Water artifact	Mouth-eaten appearance, Refractile artifact that results from the presence of water in the fixative, Usually occurs when using poorly-maintained quick stains, Often mistaken for some form of red blood cell inclusion, such as a parasite
Platelets in blood film	Occasionally platelets can come to rest on top of erythrocytes in a blood film.

### Age Related Changes

RBC	WBC
Crenation (echinocyte formation) Lysis	Swelling and smoothing of the nuclear chromatin (mimicking band neutrophil)

Hemoglobin crystallization	formation) Pyknosis Karyorrhhexis of nuclei
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## Abnormalities of RBC

Abnormality	Appearance	Cause	Other
Anisocytosis	Variation in the size, microcytes, macrocytes		
Macrocytes	Immature cells	active bone marrow	
Microcytes	Smaller than normal	Iron deficiency	
Polychromasia	Erythrocytes with faint, bluish tint	Admixture of the characteristic color of Hb and basophilic erythrocytic cytoplasm	
Hyperchromasia	Saturation of hemoglobin in RBC is not possible , not found		
Hypochromasia	Conc. of Hb reduced		
Poikilocytosis	Abnormal shaped RBCs	Trauma to the erythrocyte membrane associated with turbulent blood flow or intravascular fibrin deposition	Normal in calves & goats, abnormal in others. Removed from circulation leading to hemolytic anemia
Echinocytes	Speculated with evenly spaced uniform projections. Spicules (few) on the periphery or Burr cells with spicules on the entire surface		Seen in uremia, electrolyte depletion, lymphoma and glomerulonephritis
Crenation	Shrinkage of cells with the formation of irregular margins and a number of prickly points on the surface (uneven)	Changes in, temperature, pH, drying, excessive EDTA used, dirty glass slides	
Keratocytes (Helmet cells)	First vesicle like appearance then vesicle may rupture – helmet cell	Oxidative damage	Leads to Heinz body formation
Schistocytes	Irregular RBC fragments	Shearing by intravascular fibrin or by turbulent blood flow	Seen/associated with disseminated intravascular coagulation (DIC), hemangiosarcoma, glomerulonephritis, congestive heart failure, myelofibrosis and vasculitis (all these lead to DIC)

Acanthocytes	Spiculated with 2 or more irregular, often blunted projections Some times these cells are helmet shaped	Altered lipid : cholesterol ratio in RBC membrane	Seen: Damage to the membrane of the erythrocytes, autoimmune disease, pyruvate kinase deficiency, hemangiosarcoma (especially involving the liver), glomerulonephritis, lymphoma, and liver diseases.
Dacryocytes	Tear-drop shaped erythrocytes	Inability of the RBC to return to pre-existing shape after deforming in the blood vessels. Change may be related to alterations in cytoskeleton proteins. If the "tails" of the dacryocytes are all in the same direction, this may be artifact of blood smear preparation	Observed in blood smears of Llamas with iron deficiency anemia
Fusocytes	Elongated erythrocytes		Seen in healthy Angora goats
Leptocytes	Thin cells with an increased membrane : volume ratio. May appear folded due to the excess membrane		Polychromatophilic erythrocytes (reticulocytes) may appear as leptocytes due to ↑ cell memb.
Stomatocytes	Leptocyte that are bowl-shaped with oval areas of central pallor on blood smears	Expansion of the inner layer of the cell membrane	Also can be artifacts in the thick area of the smear
Target cells (codocytes)	Leptocytes that is bell-shaped, but resemble a target cell due to the distribution of Hb centrally and peripherally in the cell	Increasing the amount of membrane via lipid and cholesterol insertion Decreasing cytoplasmic volume as in hypochromia.	May be associated with liver disease and iron deficiency anemia
Spherocytes	Small dark microcytes with reduced amount of membrane per unit volume		Common in dogs Frequently in immune-mediated hemolytic anemia Also seen in Heinz body anemia
Nucleated erythrocytes	Immature erythrocytes		Presence of nucleated RBC and

			represents a premature release of these cells into the circulation- metarubricytosis
Reticulocytes	Any non-nucleated cell of erythrocytic series; seen in hemolytic anemia.		
Howell-Jolly bodies	Nuclear remnants in young erythrocytes		Characteristic finding in splenectomy or non-functioning of spleen as seen in sickle cell anemia. It also indicates accelerated erythropoiesis.
Micronucleus	Cytoplasmic chromatin-containing bodies that appears in the cell like a small satellite	DNA damage caused by chemicals/ insecticides	
Heinz bodies	Round structure that protrudes from the membrane of the erythrocyte or appears as a small refractile spot in the cytoplasm.	Oxidative damage to erythrocytes, deficiency of glucose-6-phosphate dehydrogenase and results in hemolytic anemia.	Often attach to the inner cell membrane because these are derived from hemoglobin. Up to 10% of feline erythrocytes may contain these.. In birds, these are smaller and more numerous within erythrocytes
Eccentrocytes (Herni-ghost erythrocytes)	RBC with the hemoglobin condensed in one portion of the cell, leaving a clear or blister-like area in the remaining portion of the cell	oxidative injury with lipid peroxidation and cross-linking of the cell membrane	

## Blood parasites

Intracellular: within erythrocytes

Extracellular: within plasma

Epicellular: within depression on membrane surface

## Intracellular Parasites

Parasite	Specie	Other
Hemoproteus spp (protozoan)	Birds	Leads to hemolytic anemia
Leukocytozoon spp		Gametocytes seen in peripheral blood develop in erythrocytes rather than leukocytes. The extreme distortion of the host cell by the parasite, however, makes this difficult to appreciate. Both elongated and round gametocytes usually are seen.
Plasmodium spp. (protozoan)	Birds	Avian malaria. Transmitted by mosquitoes, infection with <i>Plasmodium</i> can be a cause of hemolytic anemia in some species
Cytauxzoon felis (protozoan)	Cats	The disease has been reported in Missouri and Oklahoma; cytauxzoonosis is an extremely unlikely diagnosis in cats that have not lived in endemic areas. The cat is a dead-end host, with the bobcat being the primary host and transmission being mediated by <i>Dermacentor</i> ticks. Bobcats infected with <i>Cytauxzoon</i> are typically asymptomatic.
Babesia felis	Cats	
Babesia cati,	Cats	
Anaplasma marginale	Cattle	
Anaplasma centrale	Cattle	
Babesia bovis	Cattle	
Babesia bigemina	Cattle	
Theileria mutans	Cattle	
Theileria annulata	Cattle	
Theileria cervi	Deer, elk	
Babesia canis	Dogs	
Babesia gibsoni	Dogs	
Babesia equi	Horses	
Babesia caballi	Horses	
Babesia avis	Sheep	
Babesia motasi	Sheep	

## Extracellular Parasites

Parasite	Specie	Other
Dipetalonema reconditum	Dogs	
Dirofilaria immitis	Dogs, rarely cats	
Trypanosoma cruzi	Dogs	Trypanosoma cruzi
Trypanosoma theileri	Cattle	
Trypanosoma congolense	Cattle	
Trypanosoma vivax	Cattle	
Setaria sp.	Horse	
Trypanosoma brucei,	Horses	
Trypanosoma evansi	Horses	

## Other Abnormalities

Abnormality	Appearance
Oxidative injury	
Lead Toxicosis	Basophilic stippling is seen in side erythrocytes
Inclusion bodies	Bright red to bluish round inclusion bodies of canine distemper are seen in side erythrocytes

## Classification of Anemia

Anemia	MCV (cytic)	MCHC (chromic)
Normocytic Normochromic	Normal	Normal
Normocytic, Hypochromic	Normal	↓
Macrocytic, Normochromic	↑	Normal
Macrocytic, Hypochromic	↑	↓
Microcytic, Normochromic	↓	Normal
Microcytic, Hypochromic	↓	↓

### Disseminated Intravascular Coagulation (DIC)

- ◆ DIC - a pathological activation of coagulation (blood clotting) mechanisms that happens in response to a variety of diseases (Cancer of lungs, stomach, pancreas, histoplasmosis, aspergillosis, etc)
- ◆ Formation of small blood clots inside the blood vessels throughout the body
- ◆ Small clots consume all the available coagulation proteins and platelets, normal coagulation is disrupted and abnormal bleeding occurs from the skin.

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