

4th. Practical in clinical pathology

Abnormal morphology of Red Blood Cells (RBCs)

Includes:

1. Abnormalities in size

- Macrocytosis (Reticulocytes and (FeLV)Feline leukemia virus)
- Microcytosis (Iron deficiency)

2. Abnormalities in colour

- Polychromasia
- Hypochromasia

3. Abnormalities in shape

- Spherocytosis (Marker of immune mediated hemolytic anemia)
- Non-Specific finding Crenation ,Acanthocyte, Schistocyte/fragmentocyte ,Target Cell)

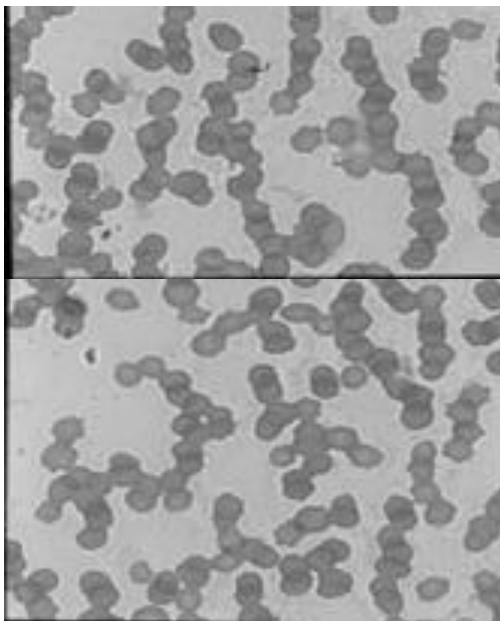
4. Abnormalities in distribution

- Rouleaux
- Agglutination

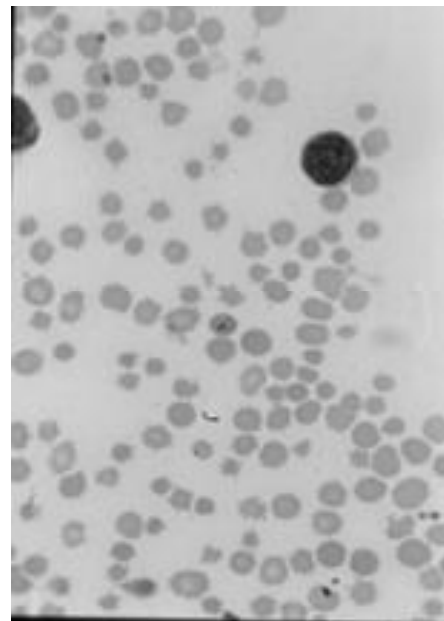
5. Inclusion Bodies and infectious agents

Variation in species

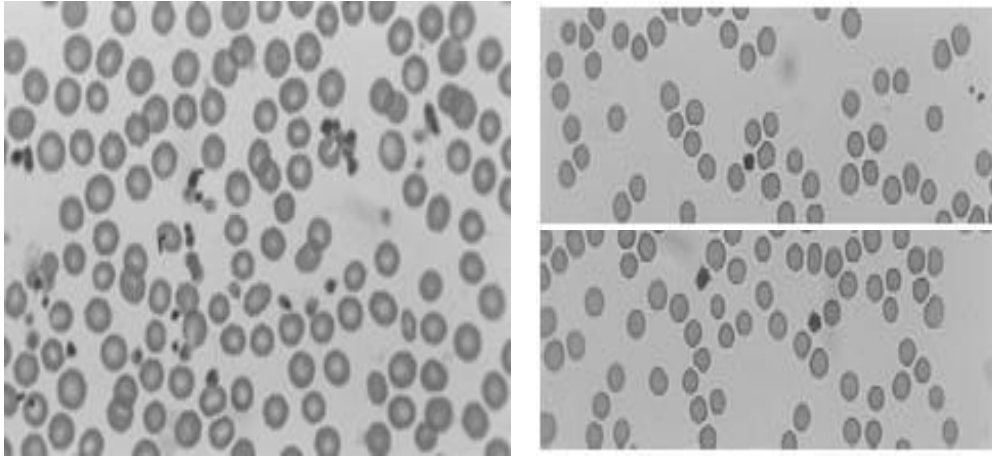
Erythrocytes (red blood cells) Most common cell present ,
No nucleus present, Uniform size and shape (round), Smooth margins,
No granules



Horse Rouleaux (sedimentation tendency)



Ruminant Anisocytosis and crenation



Dog: Large erythrocytes , Size uniformity and Central pallor

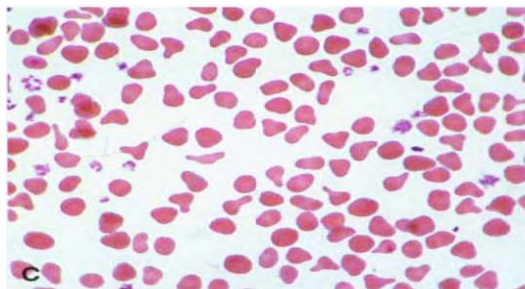
Cat : Smaller erythrocytes, Anisocytosis and Scarce central pallor

Stained peripheral blood film examination

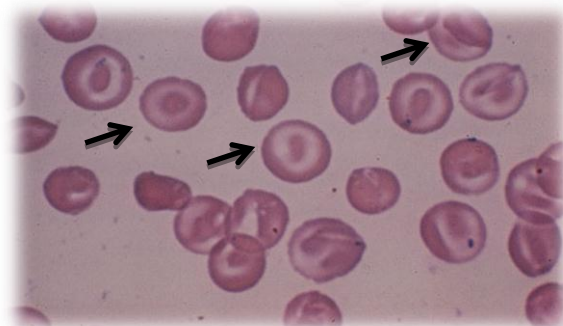
A. Abnormal RBCs morphology:

1. Abnormalities of shape (Poikilocytosis):

It means major deviations from normal shape of erythrocytes for the particular animal sp. (minor deviations are normal).



1.a. Leptocyte :Thin, flat, hypochromic rbc's with increased surface area and normal cell volume. They are of two types, target (Codocytes) are bell-shaped cells that exhibit a central density or "bull's-eye" in stained blood films and folded cells, mostly observed in chronic diseases, iron deficiency anaemia, haemolytic anaemia, liver diseases, thalassemia. Small number is normal in the blood of dogs.



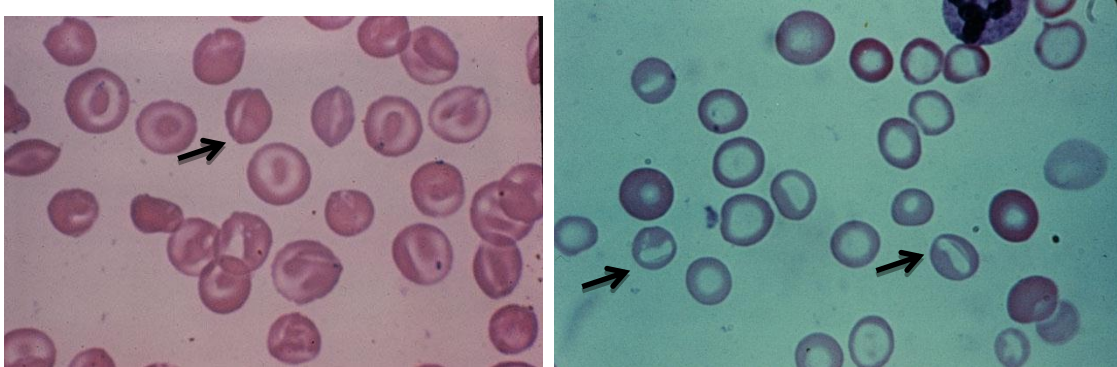
1.B. Crenated RBC (Echinocytes) :

Spiculated, their spicules are relatively evenly spaced and of similar sizes, it is considered as an artifact resulting from excess EDTA ,prolonged sample storage or delay in the dryness of blood films.



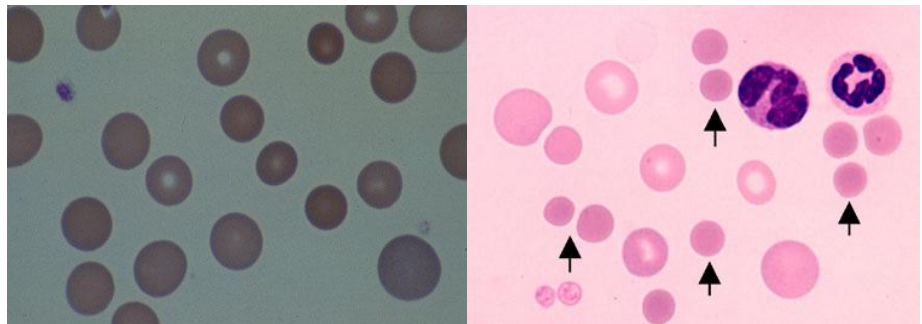
1.c. Stomatocytes:

Cup -shaped rbc's that have elongated or slit- like central pallor. It is mostly seen thick stained blood films as an artifact or in hereditary stomatosytosis, liver diseases or chronic anaemias.



1.d.Spherocyte:

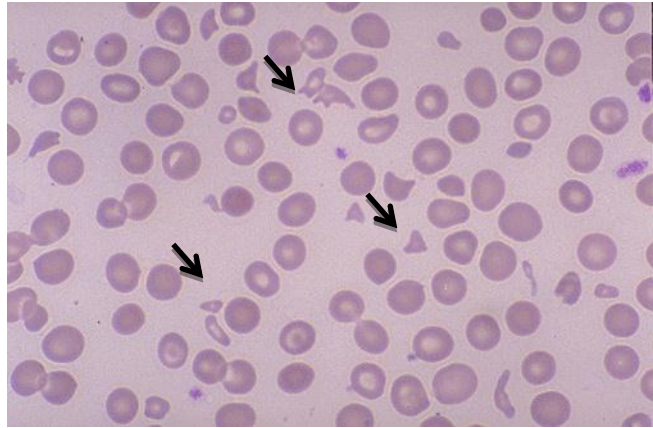
RBCS lack central pallor with smaller diameter than normal and biconvex surface with spherical shape , it results from cell swelling and/ or loss of part of cell membrane; as in immune mediated haemolytic anaemia e.g. blood parasite infection, snake bite, zink toxicity, it causes anisocytosis, decrease in MCV.



1.e Schistocyte:

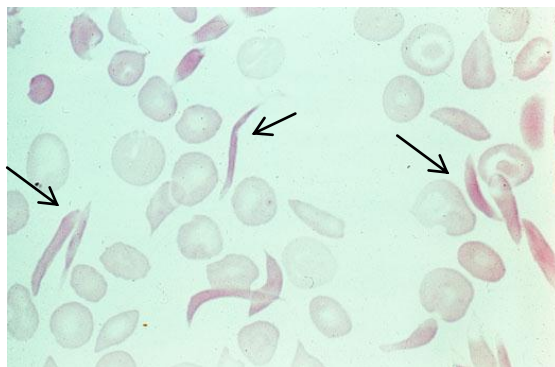
Fragment of an RBCs with two or three pointed extremities, they are smaller than normal rbc's. Its observation in a stained blood may indicates

severe iron deficiency anaemia , DIC in dogs fibrin strands may split its rbc's.



1.f. Sickle cell: (Drepanocytes)

Spindle – shaped rbc's ,it is considered normal in deer and young goat(in vitro phenomena due to high o₂ tension + pH between (7.6-7.8). Sickle cell anaemia in man is due to abnormality in amino acid sequences of the β globin chain of haemoglobin (HB-S).

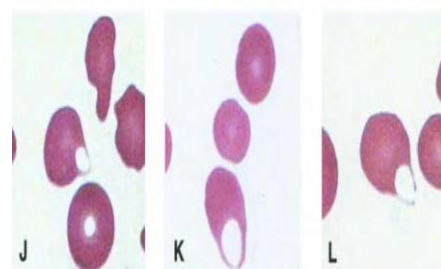


1-g Keratocytes

Erythrocytes containing what appear to be one or more intact or ruptured vesicles" are called keratocytes . These non staining areas appear to be circular areas of apposed and sealed membrane rather than true vesicles. The removal or rupture of this area results in the formation of one or two projections.

Keratocytes have been recognized in various disorders including iron-deficiency anemia," liver disorders," doxorubicin toxicity in cats;" and myelodysplastic syndrome" and in various disorders in dogs having concomitant echinocytosis or acanthocytosis.

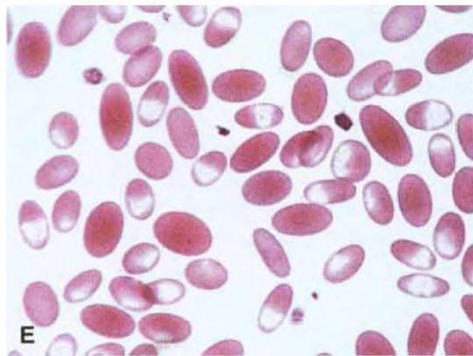
Keratocyte formation is potentiated by the storage of cat blood collected with EDTA.



1-h : Elliptocytes (Ovalocytes)

Erythrocytes from non mammals and animals in the Camelidae family normally are elliptical or oval in shape. They are generally flat rather than biconcave.

Abnormal elliptocytes have been recognized in cats with bone marrow abnormalities (myeloproliferative disorders and acute lymphoblastic leukemia).“ hepatic lipidosis," portosystemic shunts," and doxorubicin toxicity and in dogs with myelofibrosis myelodysplastic syndrome, and glomerulonephritis, in which the elliptocytes may be spiculated. Hereditary elliptocytosis has been reported in a dog with a membrane protein deficiency.



1-L:Dacryocytes :

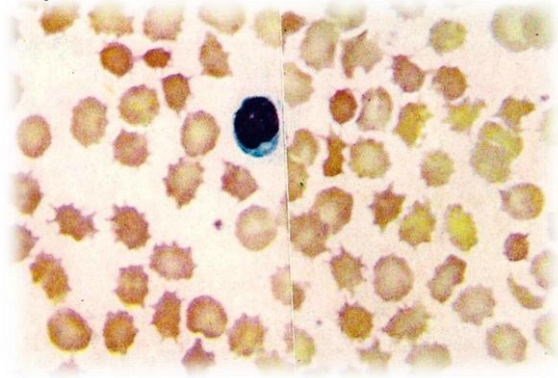
These erythrocytes are teardrop-shaped with single elongated or pointed extremities. Dacryocytosis is a common feature of myelofibrosis in people, but dacryocytes are not as commonly recognized in dogs with myelofibrosis.

Dacryocytes are common erythrocyte shape abnormalities in iron-deficient ruminants, including llamas.

<p>J- Hypochromic dacryocytes in blood from a goat with severe iron-deficiency anemia.</p>		<p>Hypochromic dacryocytes in blood from a llama with severe iron-deficiency anemia.</p>
--	--	--

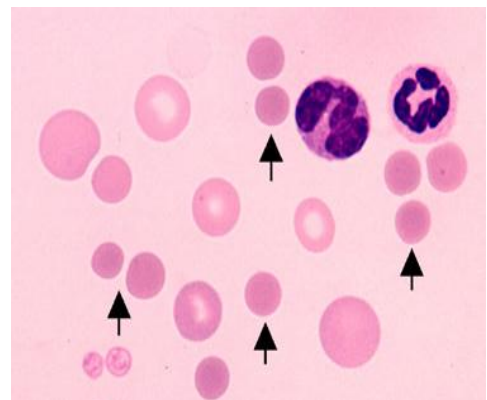
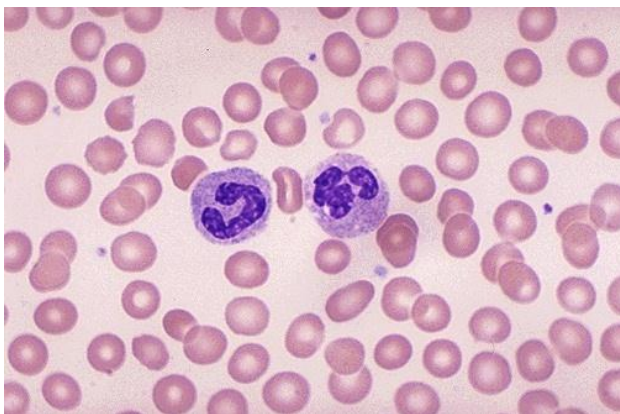
1.M : Acanthocyte:

Spiculated rbc's with irregularly spaced and variably-sized spicules, it is formed when cholesterol is present in excess to phospholipid in rbc cell membrane. It is mostly due to increase in blood cholesterol, presence of abnormal plasma lipoprotein and liver diseases.



2. Abnormalities and major deviations in size of rbc's (anisocytosis):

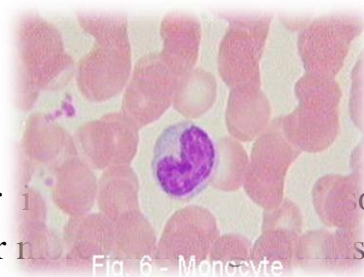
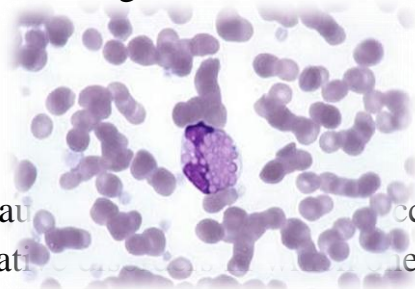
Slight anisocytosis is normal in certain animal sp. as cow, less frequently in cat sheep and goat. Mostly it is due to the presence of different populations of cells e.g. macrocytes (reticulocytes) in responsive anaemia; or the production of small- sized (microcytes) rbc's as in iron deficiency anaemia. Spherocytes may also leads to anisocytosis.



b-Abnormality in arrangement of RBCs:

1- Rouleaux:

It means adhesion of rbc's together like a stalk of coins .This is mostly due to changes in plasma protein con., as increase in fibrinogen and γ – globulin in inflammatory conditions .Extensive rouleaux is normal in equine , moderate to slight rouleaux is normal in cat & dog.



Note :- Rouleaux occur in some lymphoproliferative or neoplastic conditions.

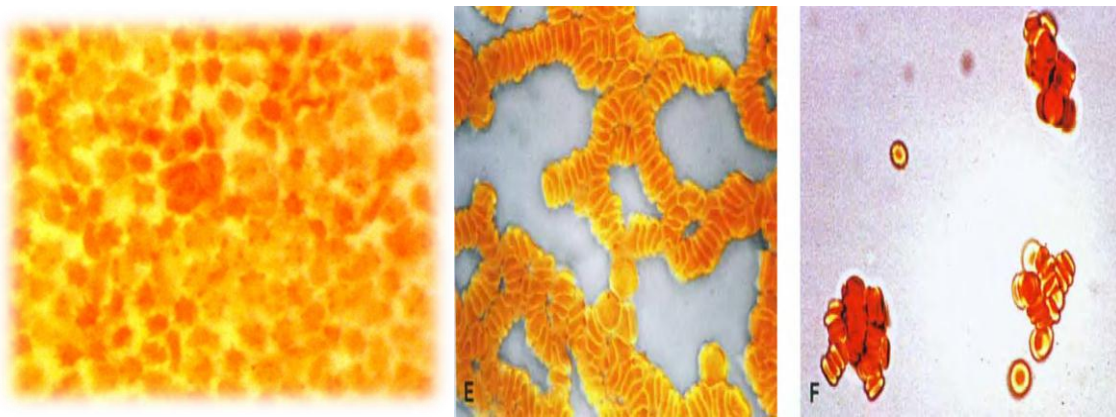
Fig. 6 - Monocyte

secreted in high amounts. Prominent rouleau formation in species other than horses, cats, or pigs should be noted as an abnormal finding.

2- Agglutination:

The aggregation or clumping of rbc's in together in clusters not in chains. It is caused by immunoglobulins bound to rbc's surfaces, as in immune-mediated anaemia. Because of their pentavalent nature, IgM immunoglobulins have the greatest propensity to produce agglutination.

Note :- Agglutination can be differentiated from rouleaux by washing erythrocytes in physiologic saline or by adding equal drops of physiologic saline and blood together to see if the aggregation of erythrocytes is dispersed (rouleaux) or remains (agglutination).

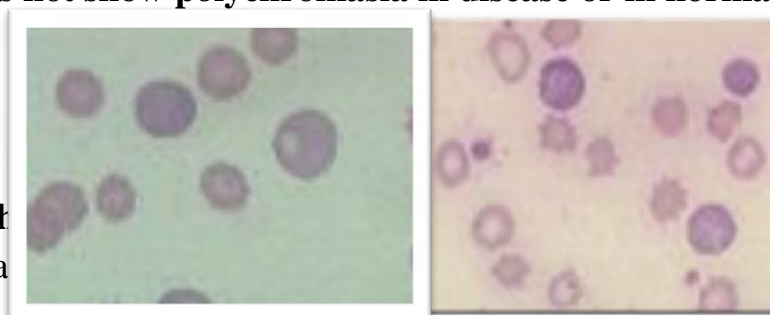


E. Microscopic rouleaux in an unstained wet mount preparation of normal cat blood.
 F- Microscopic agglutination in an unstained wet mount preparation of saline-washed erythrocytes from a foal with neonatal isoerythrolysis

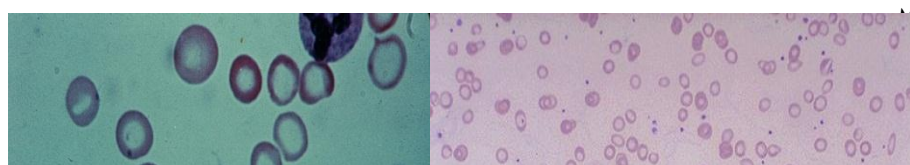
c- Abnormalities in colour of RBCs:

- 1. Polychromasia:** The presence of bluish-red rbc's in stained blood film, due to the presence of a combination of Hb (red) and ribosomes (blue). They are immature rbc's (reticulocytes) present in low number in normal dog (1%-1.5%), increased polychromasia indicate reticulocytosis and responsive anaemia. **Equine blood does not show polychromasia in disease or in normal conditions**

2- Hypochromic central pale



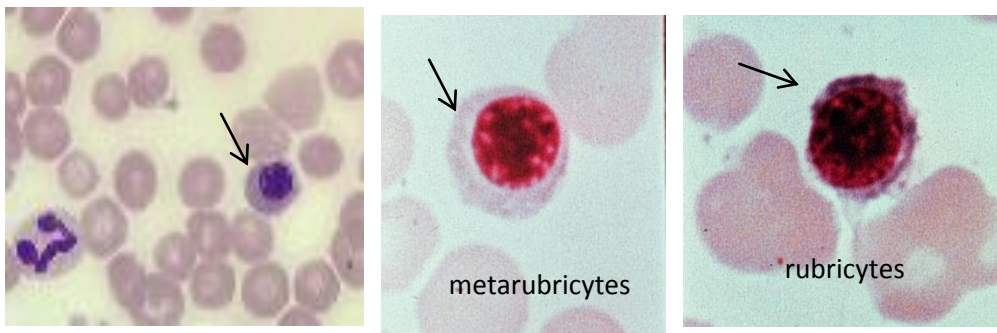
increase in
 . Increased



hypochromasia is associated with iron deficiency anaemia and chronic blood loss.

3- RBC inclusions: It means the presence of abnormal bodies inside rbc.

a-Nucleated rbc: Presence of immature rbc in peripheral circulation e.g. rubricytes, metarubricytes is seldom in the blood of normal adult mammals, It is seen in regenerative anaemia ,haematopoietic neoplasia and various inflammatory conditions.



b- Howell-Jolly body:

They are small dark blue nuclear remnant (DNA in nature) formed in the bone marrow and it should be removed by pitting activity of the spleen. May be present in low number in rbc of normal cats and horses, also it is associated with regenerative anaemia and blood films of splenectomized animals.

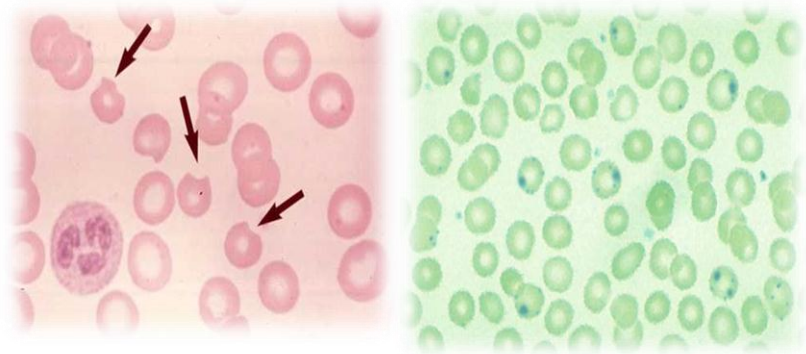


c-Heinz body:

Large aggregates of oxidized precipitated Hb attached mostly to the internal surfaces of rbc cell membranes ,they stain pale pink with Romanowsky's stains, dark blue with supra-vital stains.

Normal cat blood film may show few Heinz bodies (5-10%).In pathological conditions it is associated with dietary causes as consumption of large quantities of onion by small and large animals ,kale and other Brassica sp. in ruminants, copper toxicity in sheep .

It is known as Heinz body haemolytic anaemia.



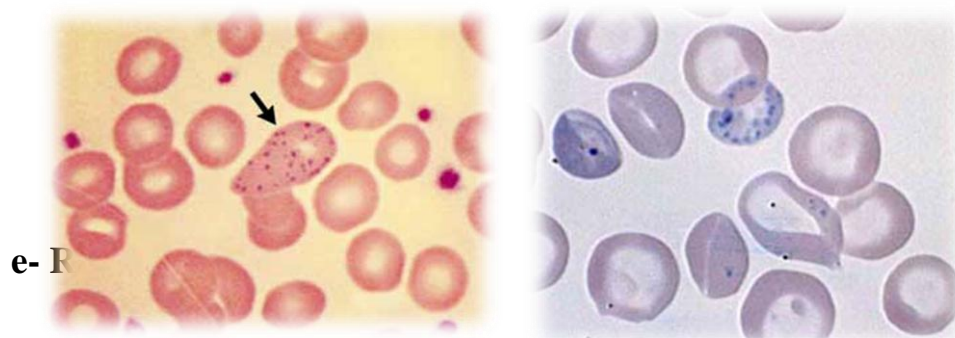
Note :

How are Howell-Jolly and Heinz bodies distinguished morphologically?

Although both structures are round, **Howell-Jolly bodies are basophilic and located deeper within the cytoplasm** than **Heinz bodies, which protrude from the red blood cell (RBC) surface**. Also, Heinz bodies on Wright's stain are the same color as the erythrocyte's cytoplasm because they are derived from hemoglobin.

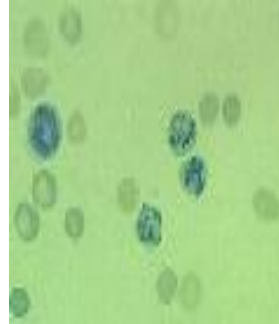
d- Basophilic stippling:

Blue staining punctuate inclusions stained with Romanowsky's stains ,it represents RNA of polyribosomes, occur in regenerative anaemia in ruminants and lead toxicity in canine, punctuate may be fine or coarse.



They are immature non nucleated red blood cells containing network of ribosomes ,remained to complete haemoglobin synthesis.

In man and dog, reticulocytes may be found normally(0.5 -1.5%). In ruminants it is not found in health, it is detected in responsive anaemia. In equine it is not released from bone marrow neither in health nor in disease. It is stained with a special stain known as supra vital stain(New methylin blue or Brilliant crysel blue).

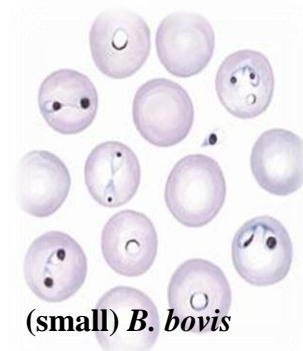
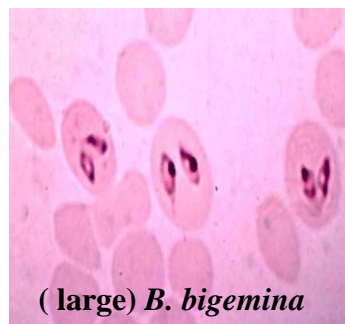
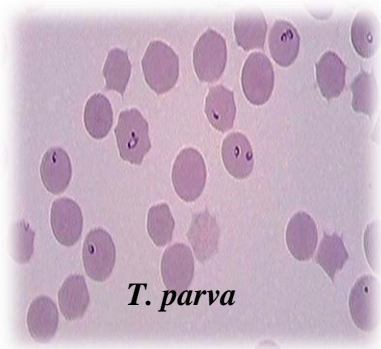


Note:

Polychromasia is used as an index of regeneration in anemia because all polychromatophilic erythrocytes are reticulocytes; however, not all reticulocytes have enough reticulin to be polychromatophilic.

f- Infectious agents:

As protozoa e. g . *Babesia*, *Theileria*, *Malaria*. *Bacteria* as the *Rickettsial* microorganism, *Anaplasma*. Viral inclusions e.g. *Canine distemper* viral inclusions appear as red or orange mostly rounded bodies (it should be differentiated from Howell-Jolly bodies).



Canine distemper inclusion

