



# Top Ten RBC Morphologic Changes Helpful in Classifying Anemia

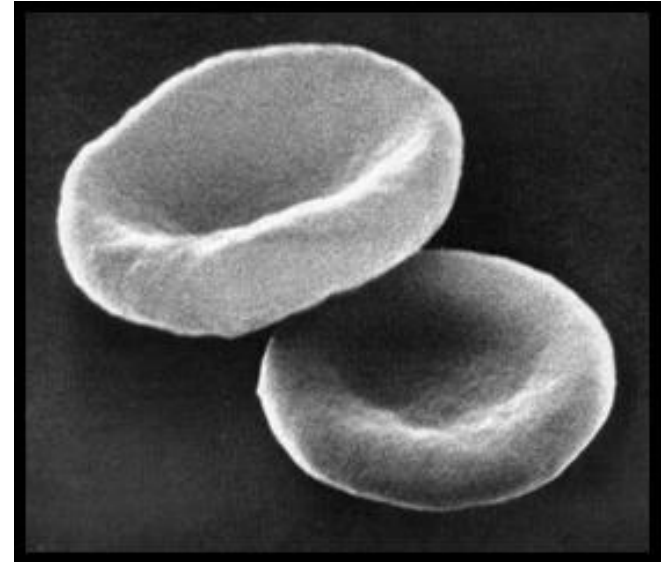
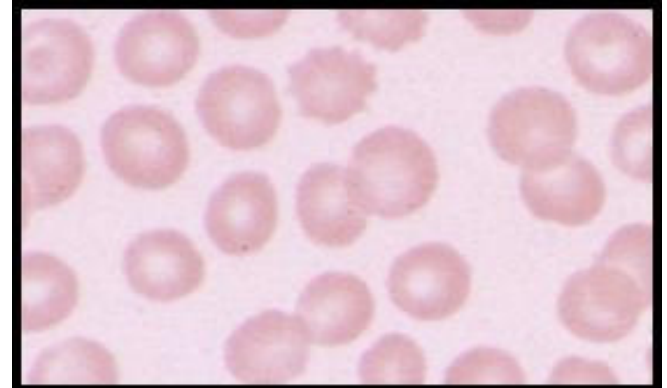
Dennis B. DeNicola, DVM, PhD, Diplomate ACVP  
Chief Veterinary Educator  
IDEXX Laboratories

# Erythron – “Top Ten List”

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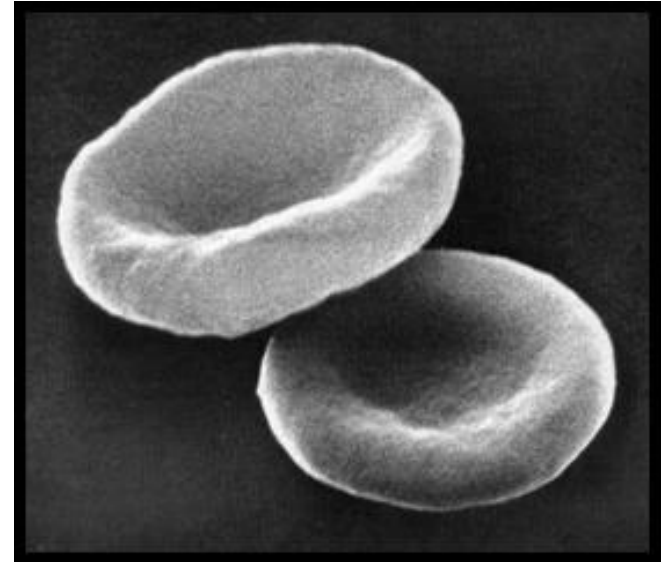
# Normal Erythrocyte Morphology

- Features similar in dogs, cats, horses and ruminants
- All lack nuclei
- Stain reddish to reddish-orange
- Generally biconcave discoid-shaped cells
- Major differences are in size and central pallor



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- Major differences are in size and central pallor

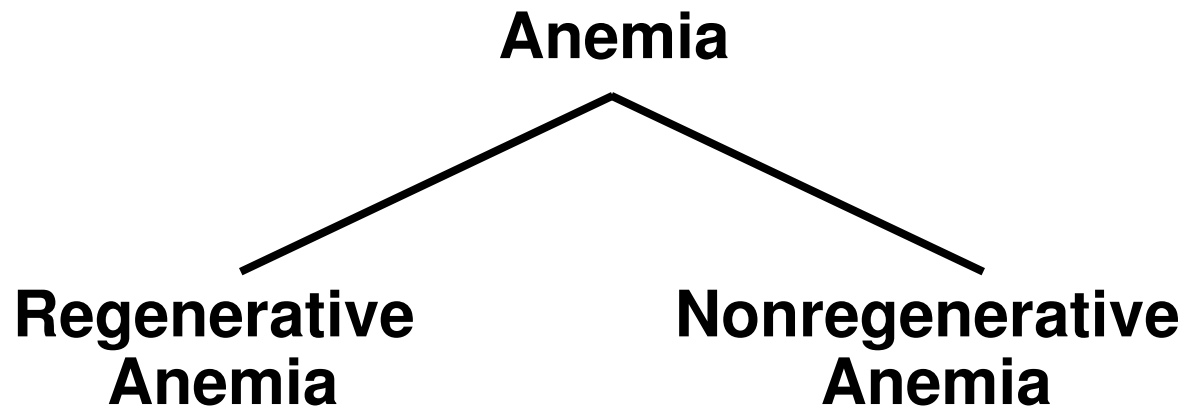


# Erythron – “Top Ten List”

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## 1. Polychromasia

# Classification of Anemia

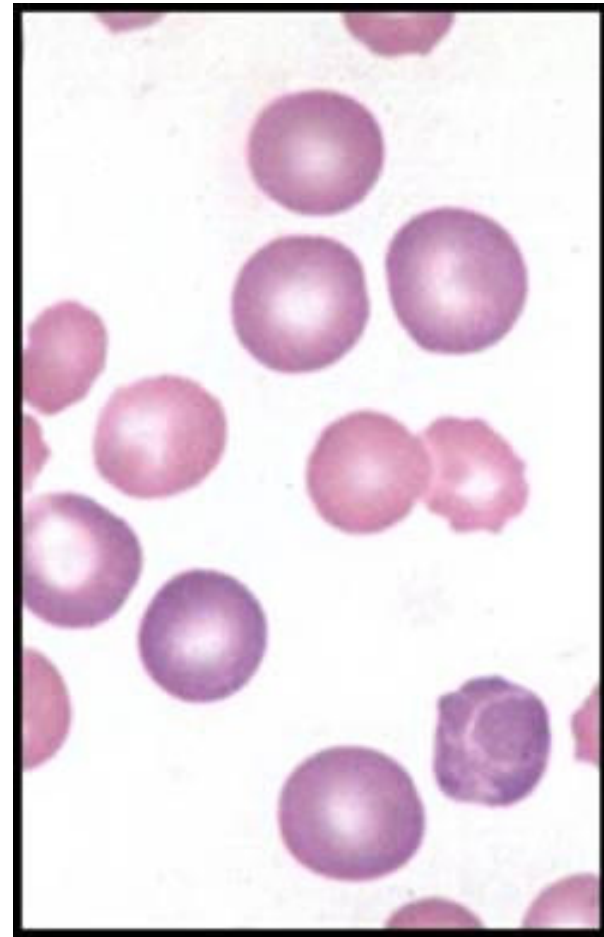


Absolute Reticulocyte count most objective method of differentiating regenerative from non-regenerative anemia

Polychromasia correlates with Reticulocyte count

# Polychromasia

- Variation in color among cells
- Bluish color in erythrocytes (RNA)
- Cells generally larger than mature RBCs
- Represent reticulocytes
- Few are normal in dogs and cats
- Good morphologic evidence of a bone marrow response to a peripheral demand



# Morphologic Features of Regeneration

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- Polychromasia
- Potential findings only if associated with polychromasia
  - Anisocytosis
  - Target cell formation
  - Howell-Jolly bodies
  - Basophilic stippling
  - Nucleated red blood cells



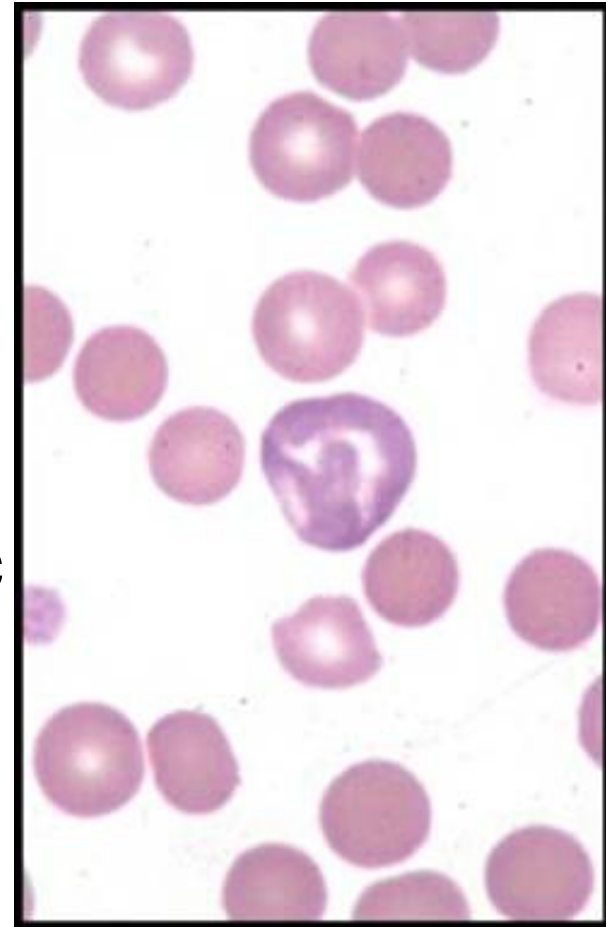
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1. Polychromasia
2. Spherocytosis

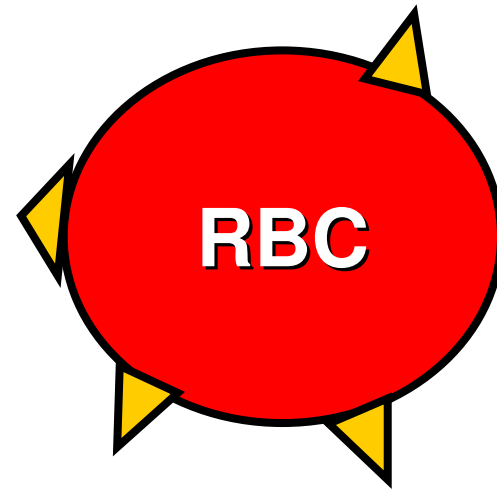
# Spherocytosis

- Appear smaller than normal mature erythrocyte
- More dense staining than normal mature erythrocyte
- No central zone of palor
- As name suggests, they have lost their normal biconcave disc shape and are “spherical”
- Supportive of extravascular immune mediated destruction
  - Partial phagocytosis



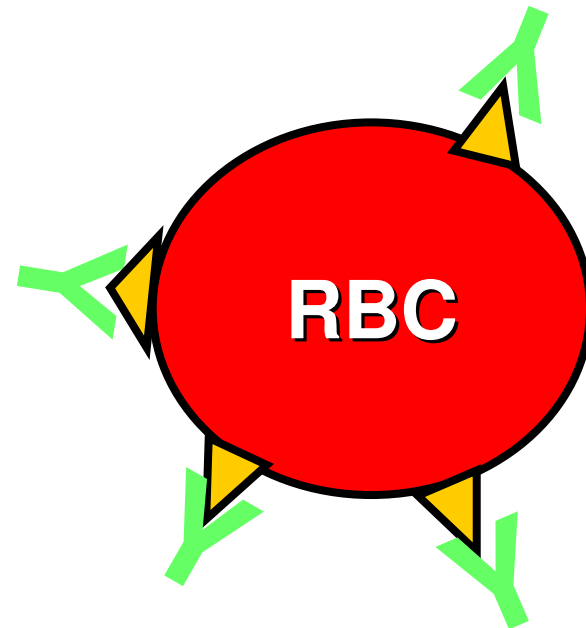
# Immune Mediated Hemolytic Anemia

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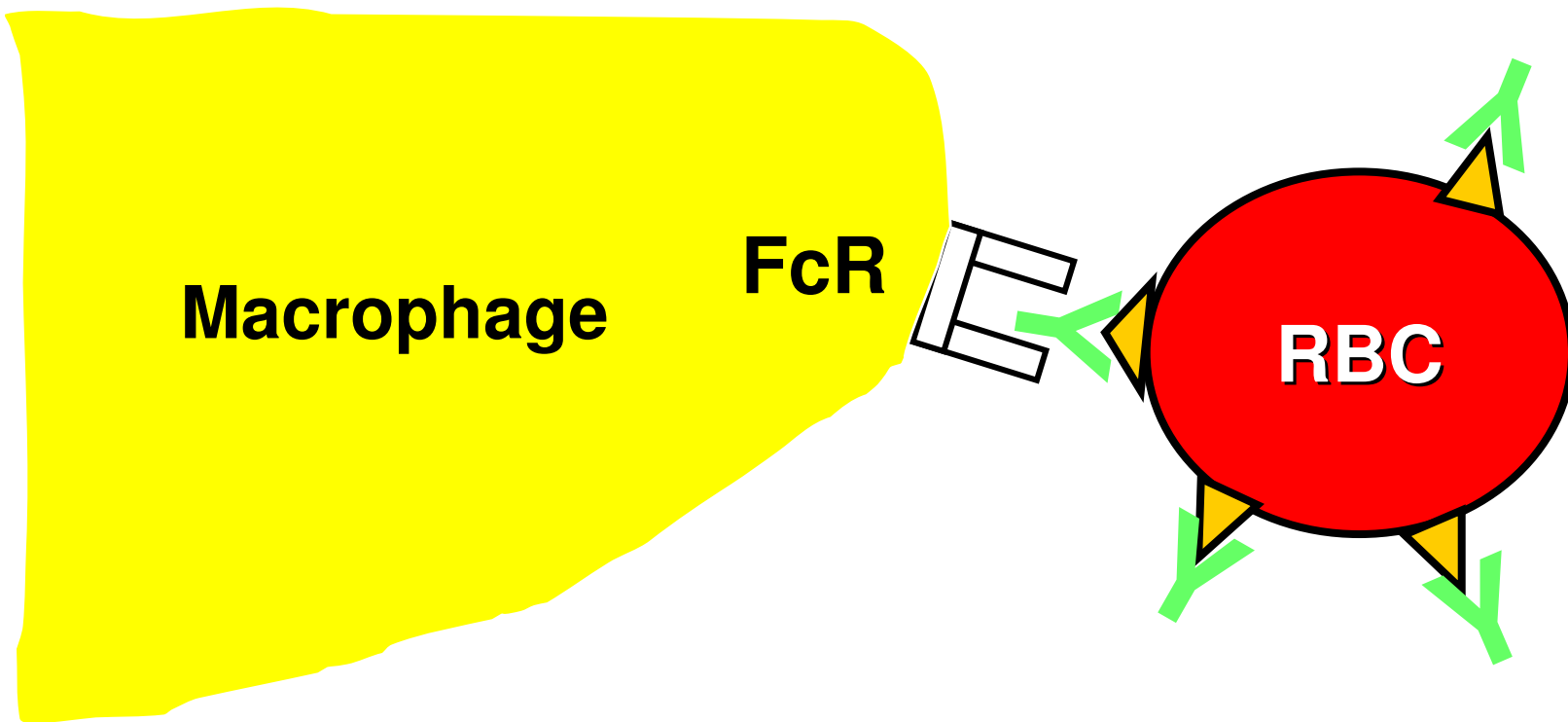


# Immune Mediated Hemolytic Anemia

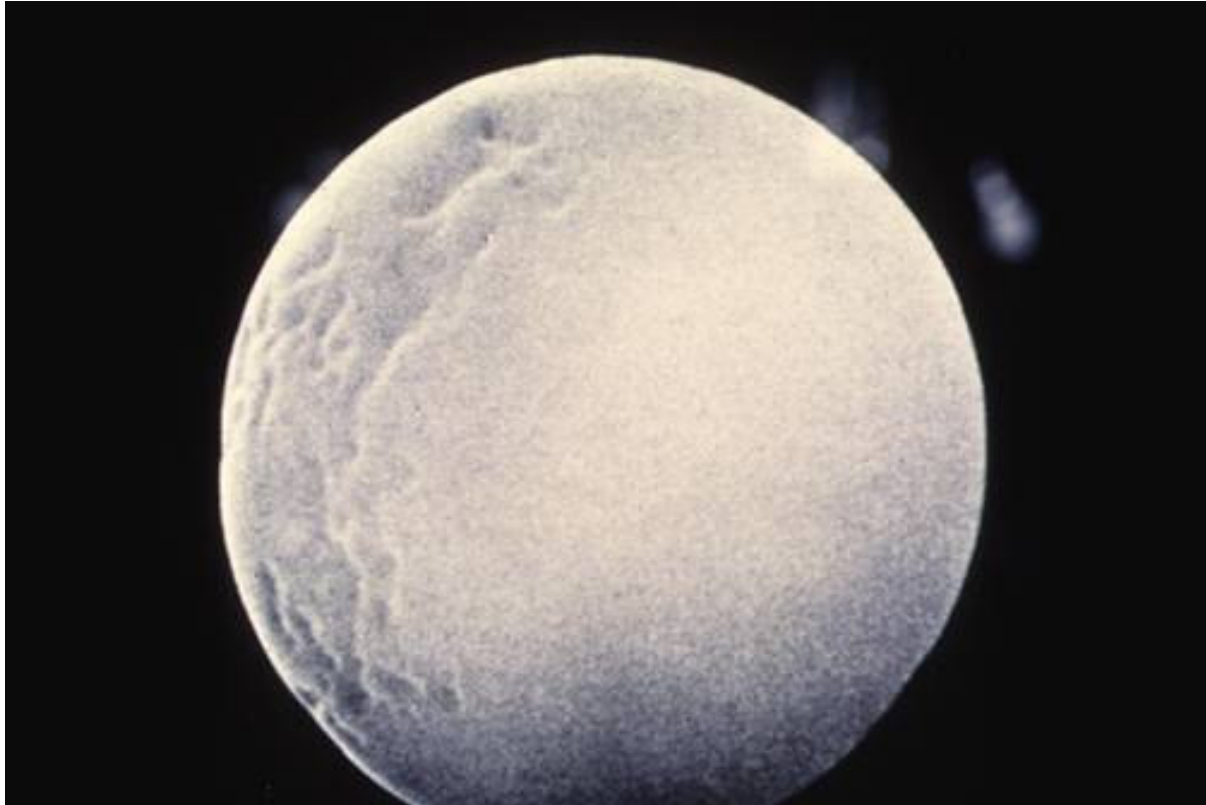
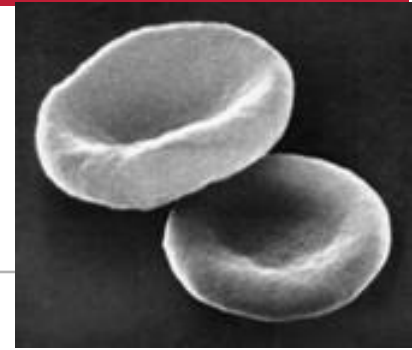
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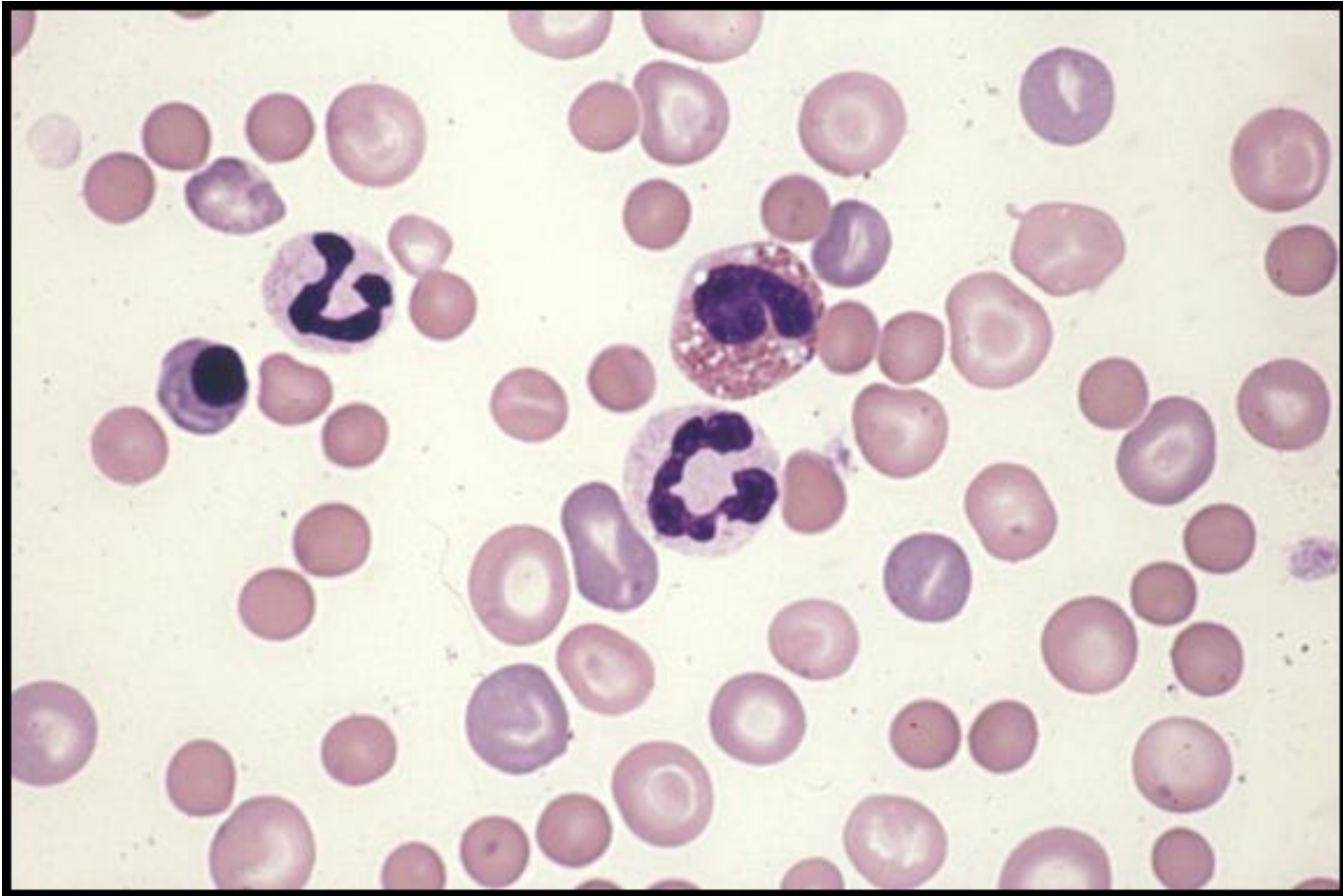
# Immune Mediated Hemolytic Anemia



# Spherocytosis



# Spherocytosis



# Erythron – “Top Ten List”

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1. Polychromasia
2. Spherocytosis
3. Agglutination

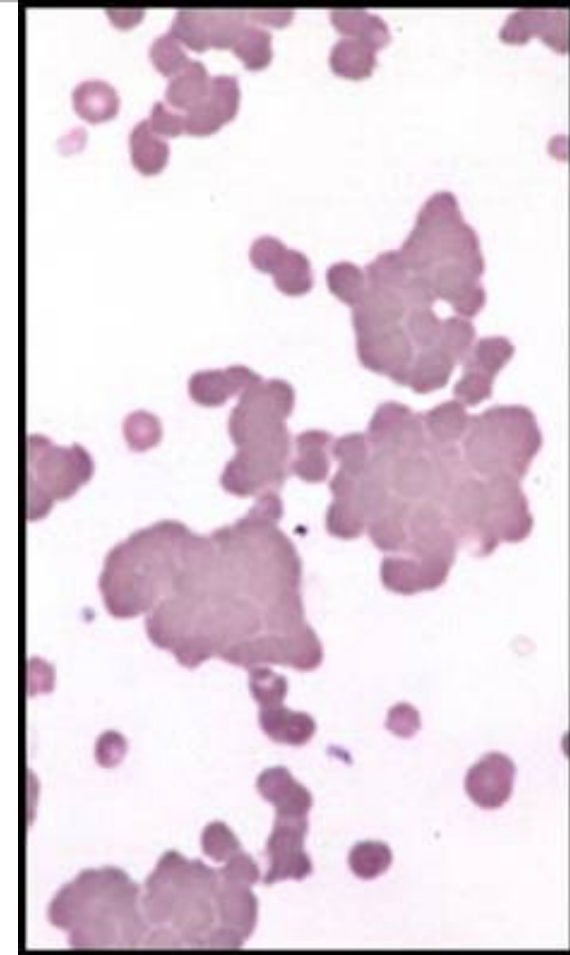


# Autoagglutination

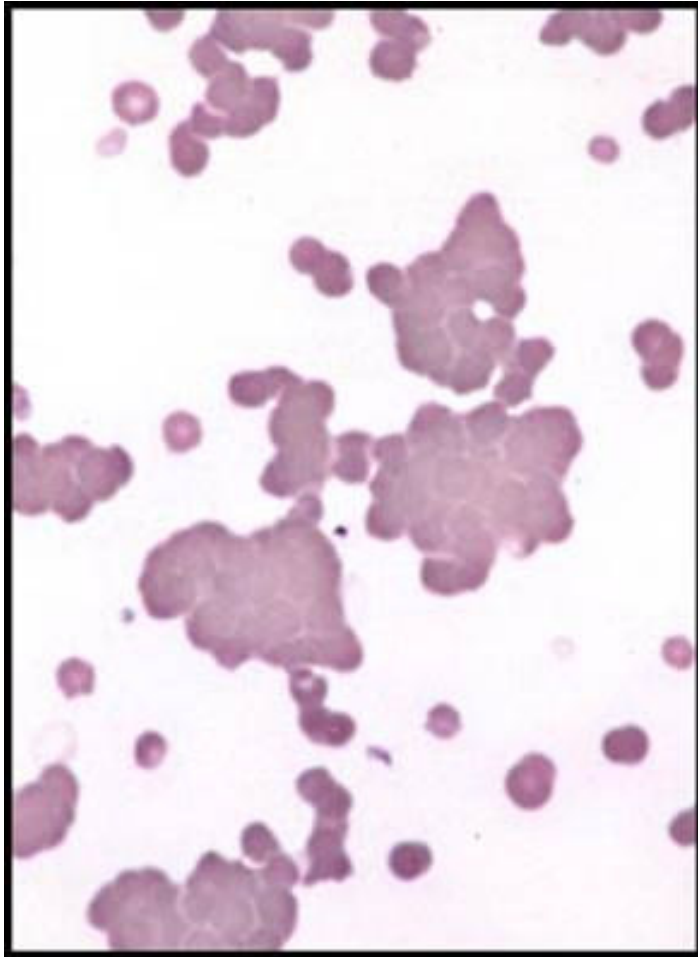


# Agglutination

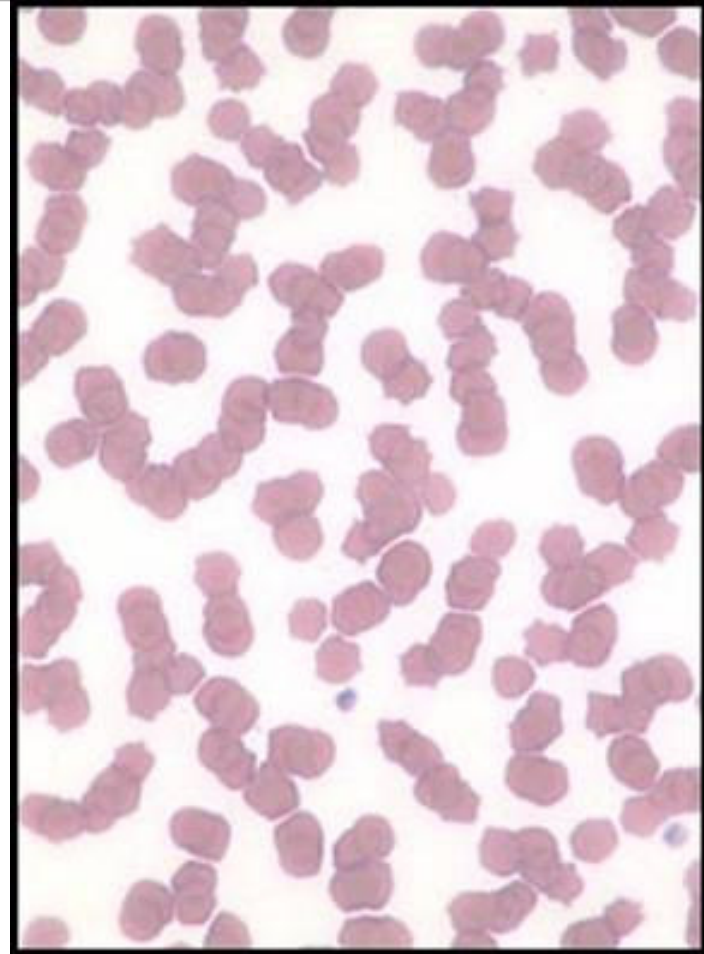
- Three dimensional clumps of erythrocytes
  - Unorganized in contrast to “stack of coins” as with Rouleaux
- Relatively strong binding between cells because of cross-linking of antibodies on surface
- Supportive of an immune-mediated mechanism



# Agglutination

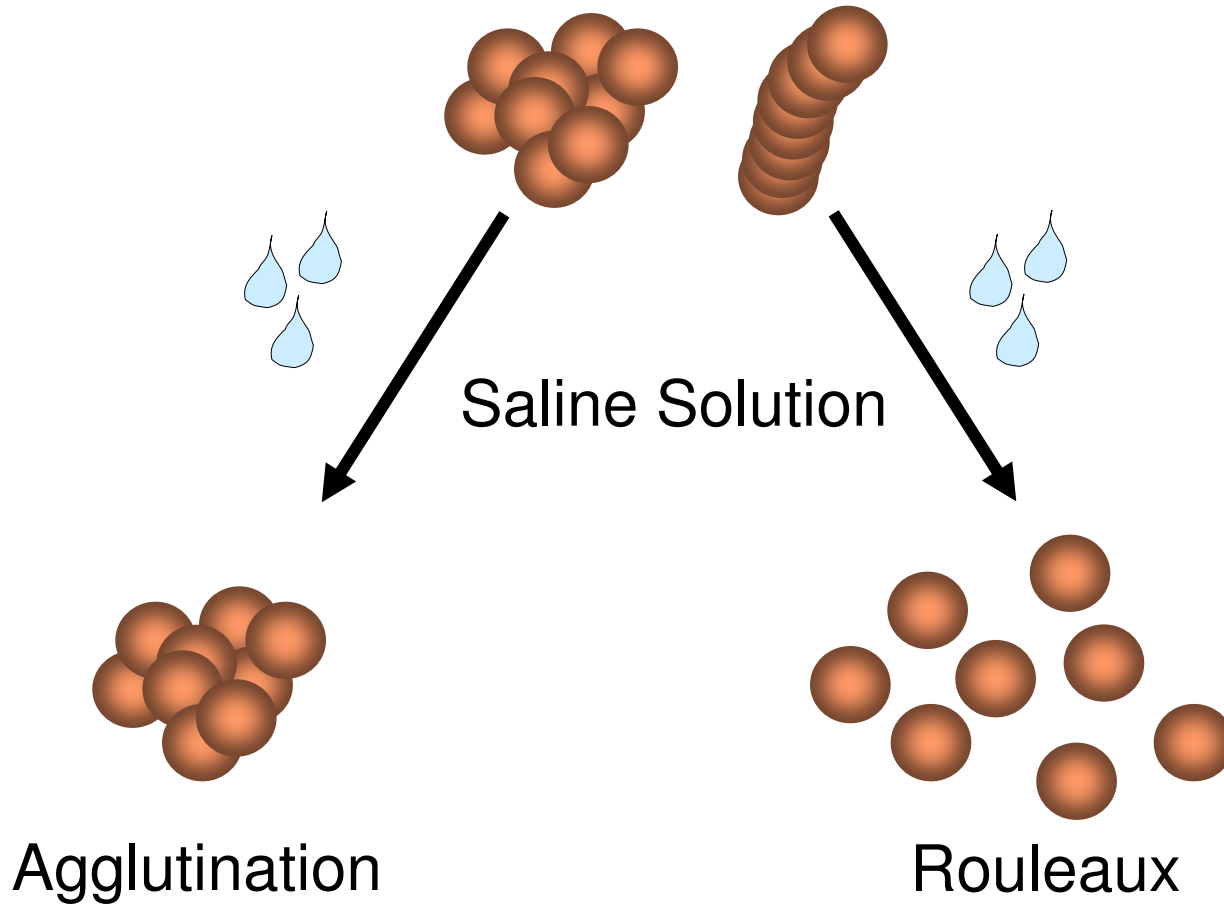


Agglutination

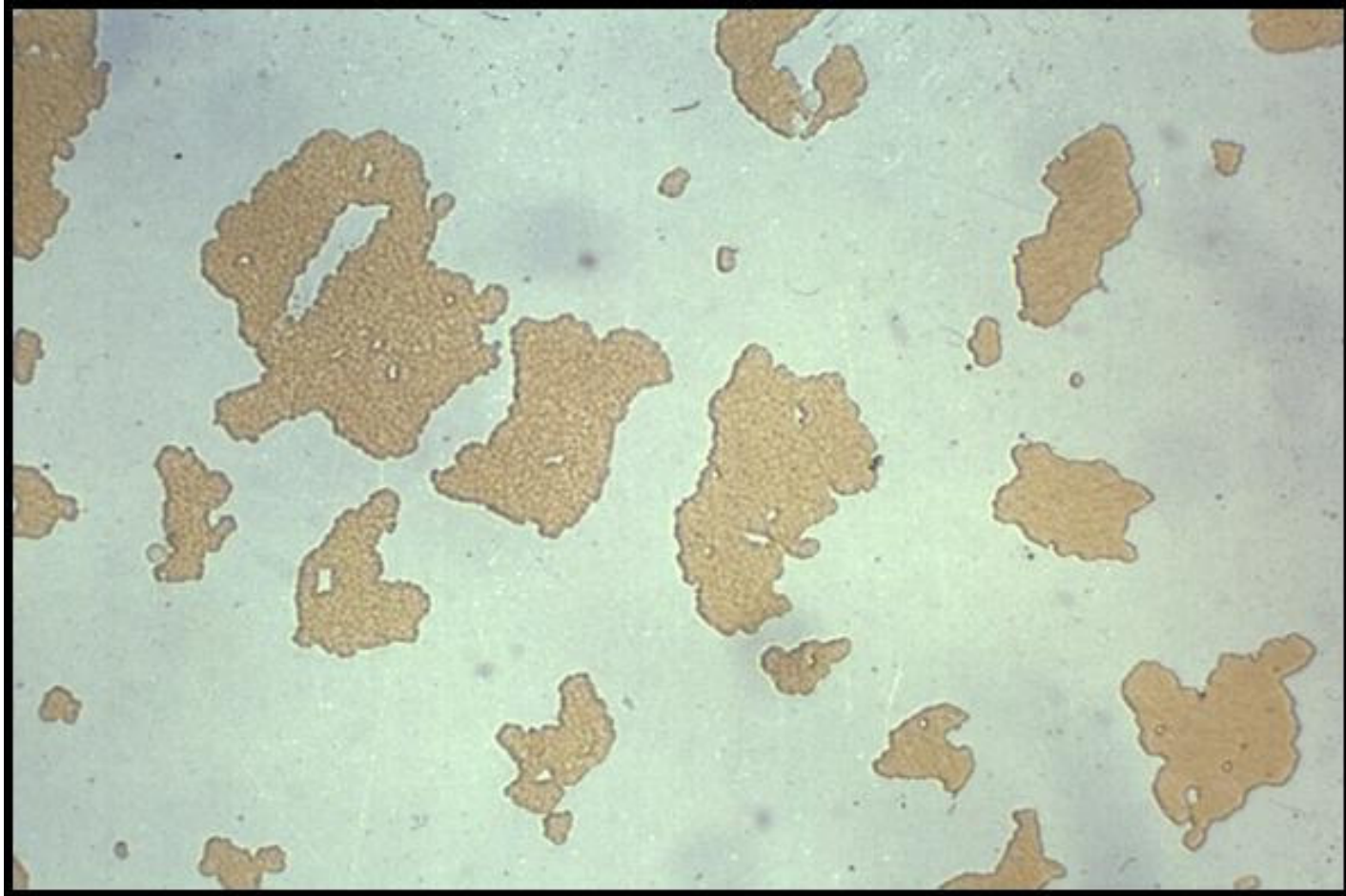


Rouleaux

# Saline Agglutination Test



# Autoagglutination



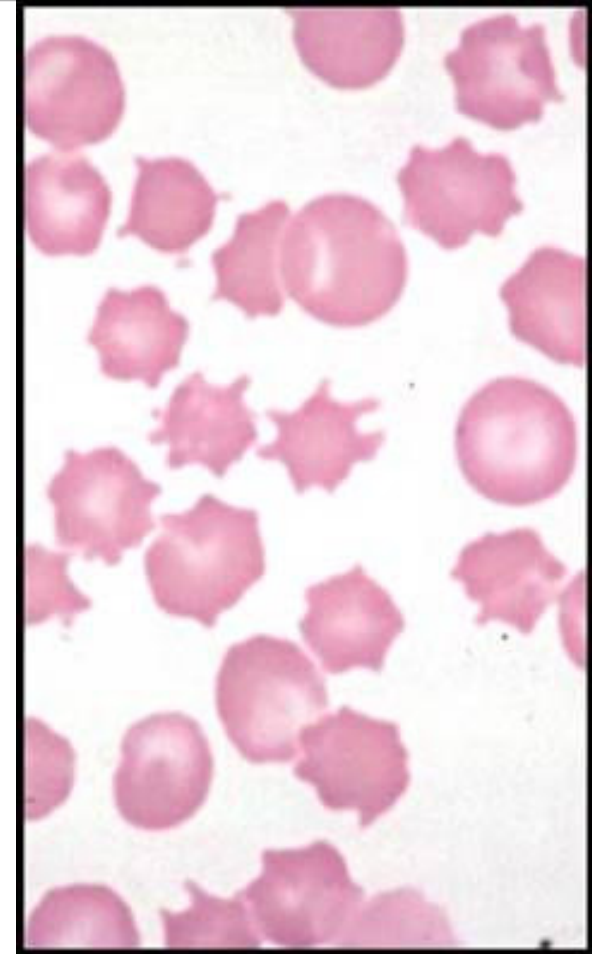
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2. Spherocytosis
3. Agglutination
4. Acanthocytosis

# Acanthocytosis

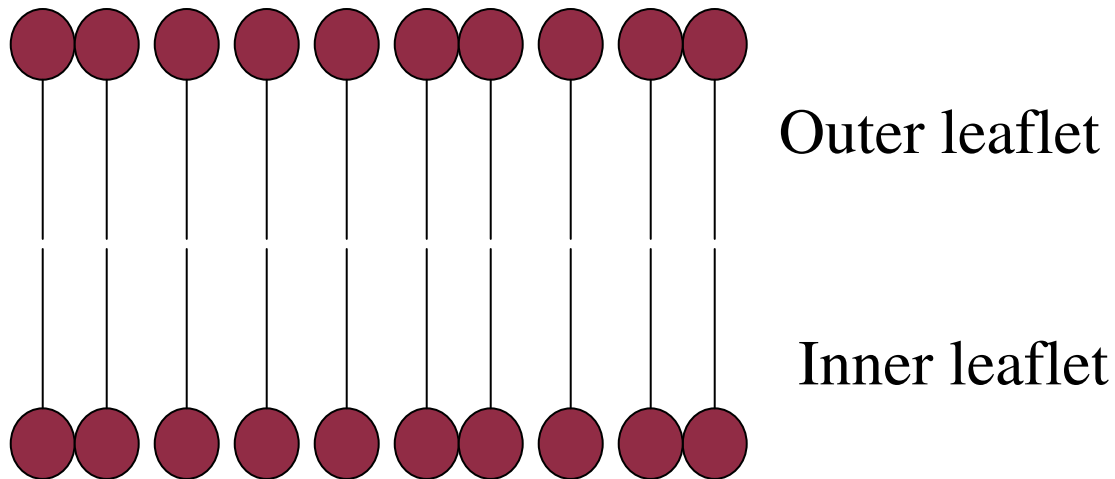
- Specific type of poikilocyte
- Spherical shape with 2-10 surface projections
- Projections are:
  - Blunt
  - Variably sized
  - “Finger-like”
- Cholesterol:phospholipid ratio in RBC membrane is increased
- Supportive of potential liver, splenic or metabolic disorder



# Metabolic Disorders

- RBCs have phospholipid bilayer

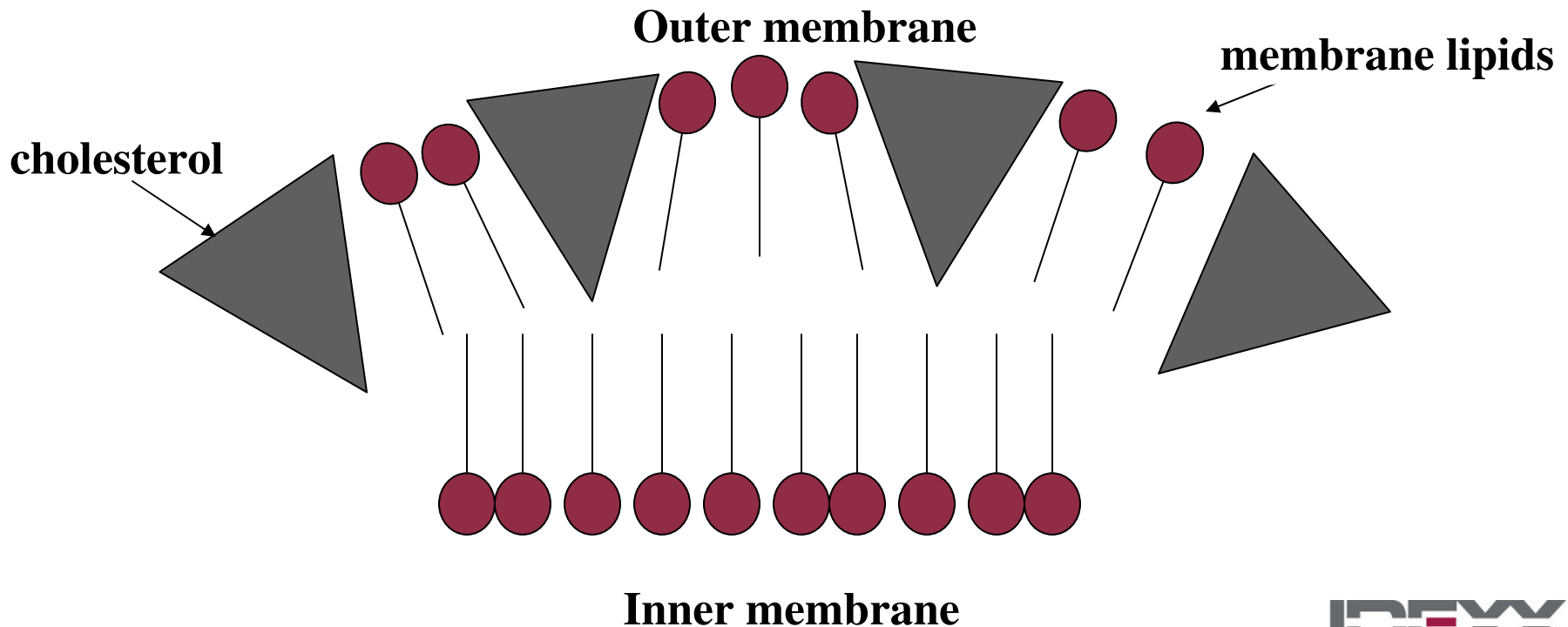
Normal Red Blood Cell Membrane





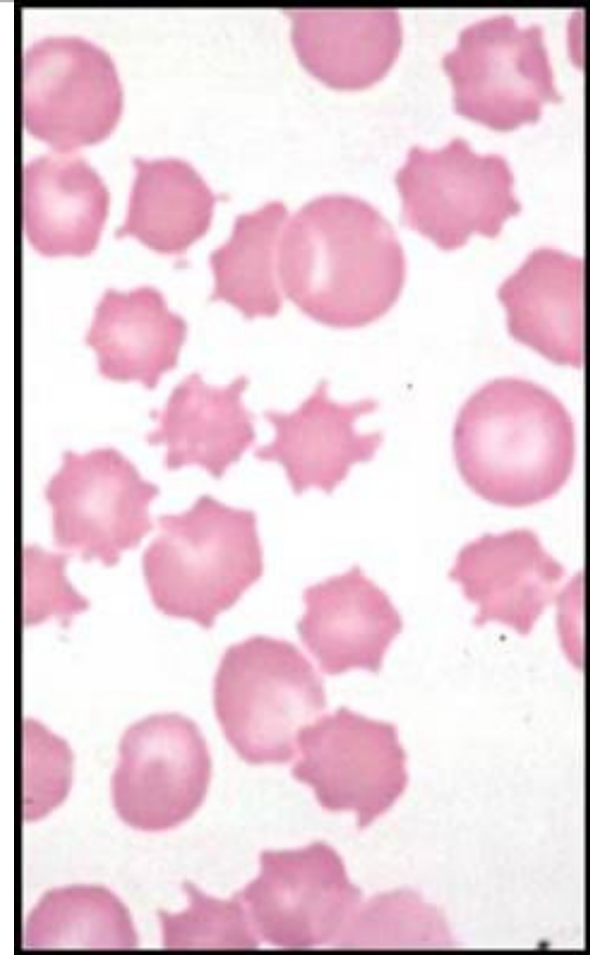
# Metabolic Disorders

- RBCs have phospholipid bilayer
- Insertion in either the outer or inner leaflets can cause shape changes in RBC

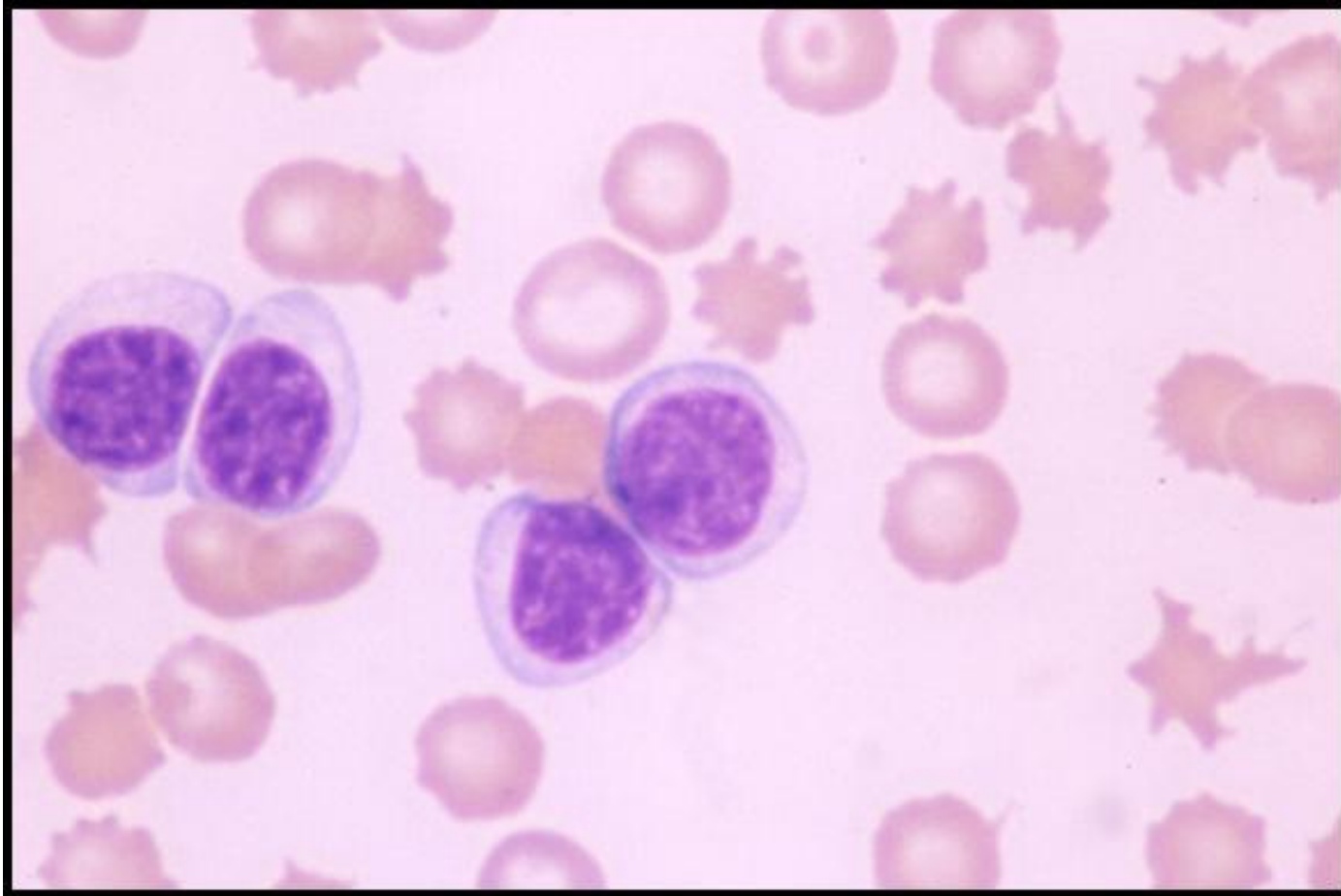


# Acanthocytosis

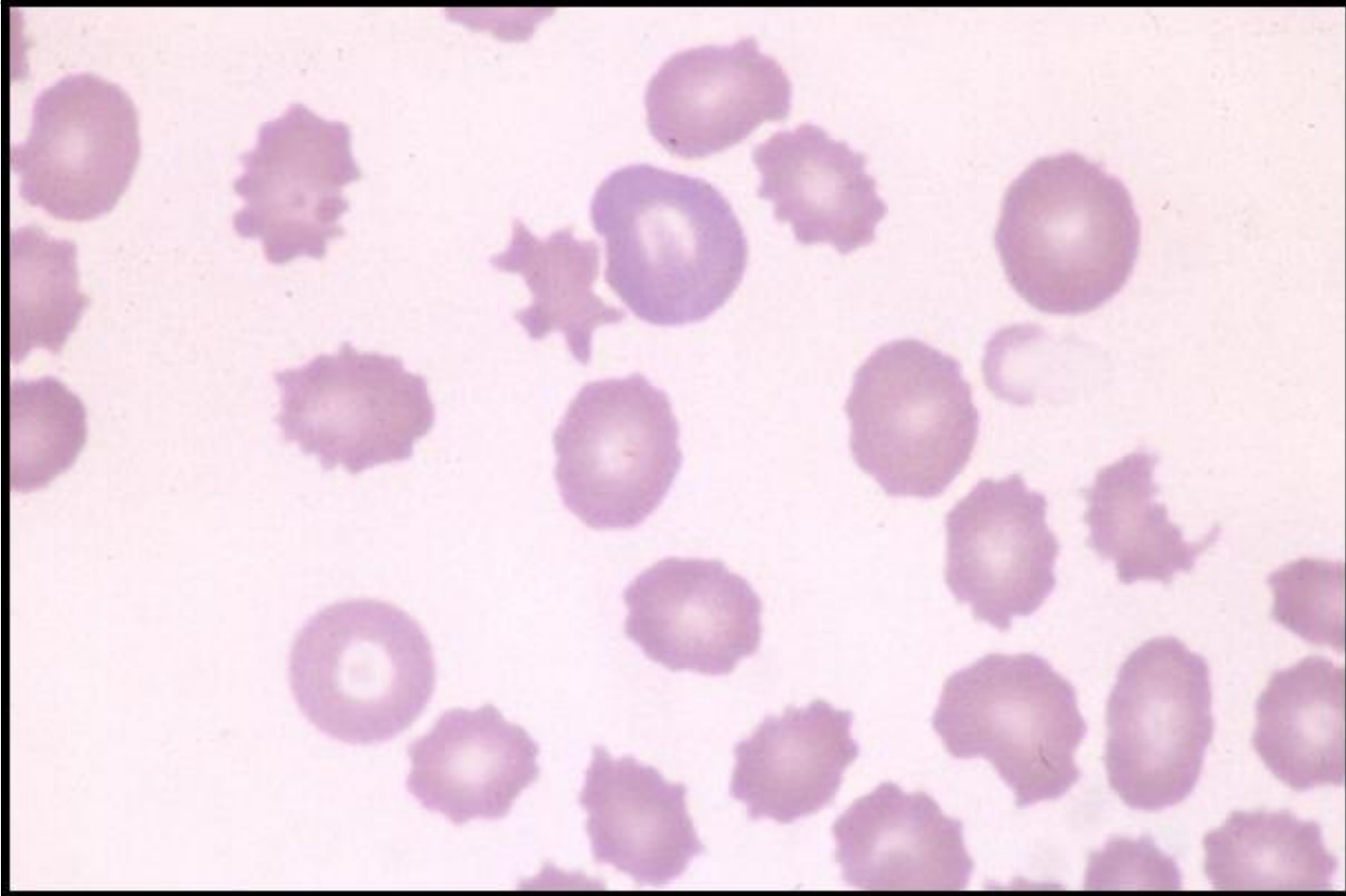
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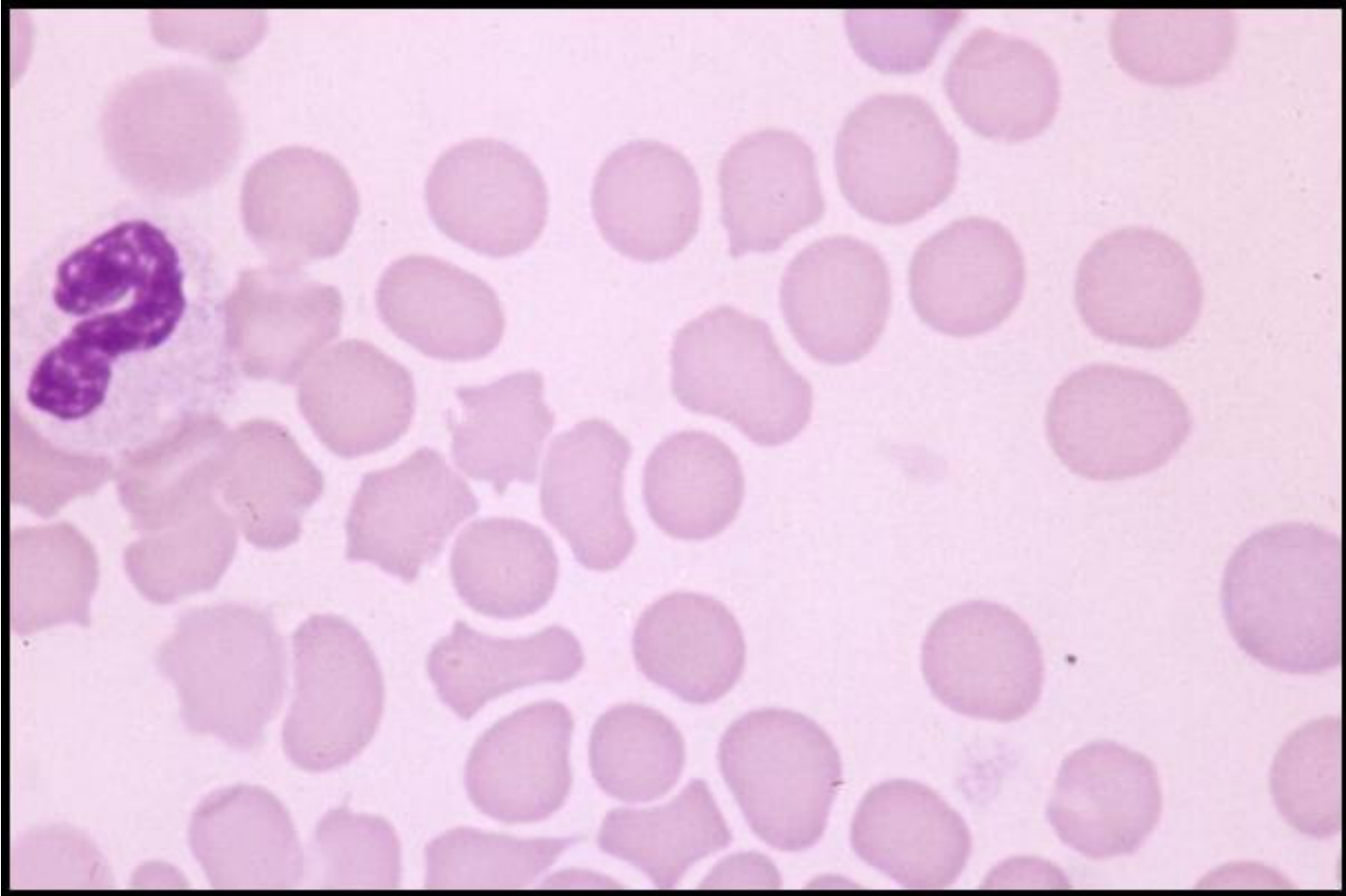
# Acanthocytes



# Acanthocytes



# Acanthocytes – Feathered Edge



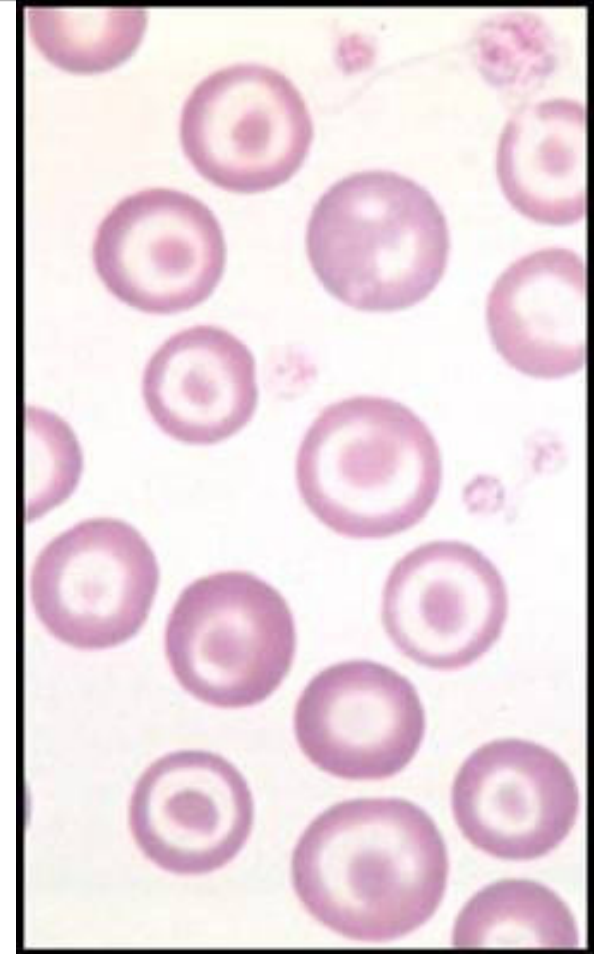
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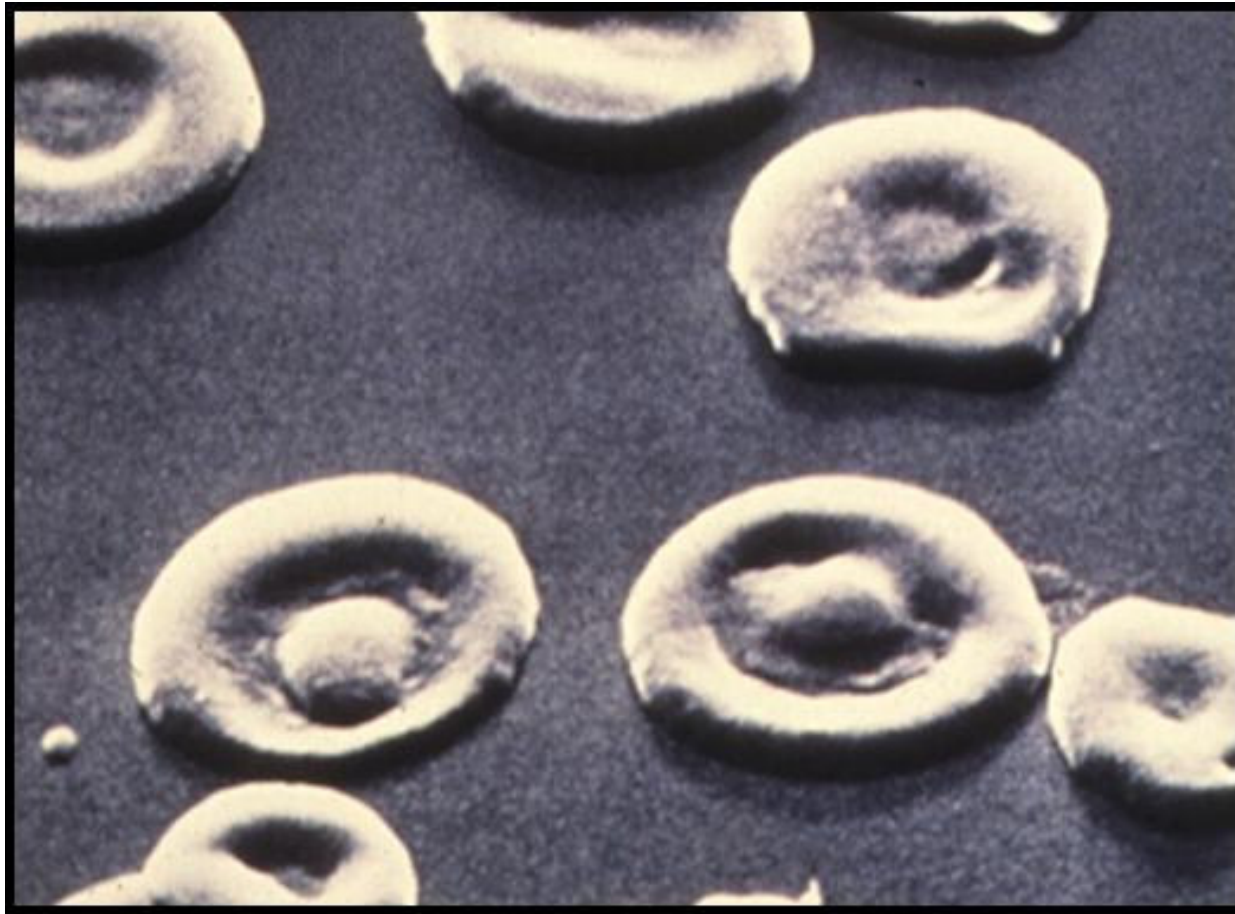
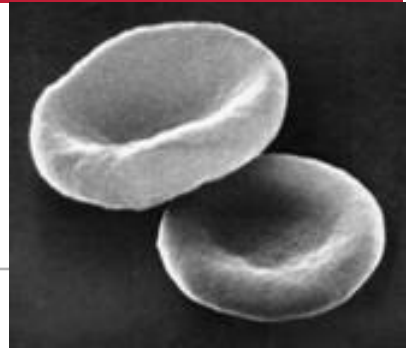
1. Polychromasia
2. Spherocytosis
3. Agglutination
4. Acanthocytosis
5. Target Cell Formation / Leptocytosis

## Target Cells - Leptocytosis

- “Floppy” cells with excess cell membrane compared to normal erythrocyte
- When associated with “regenerative” blood picture
  - Typical for immature erythrocytes
- When not associated with “regenerative” blood picture
  - Indicative of “lipid loading” potentiall associated with liver, splenic or metabolic disorder



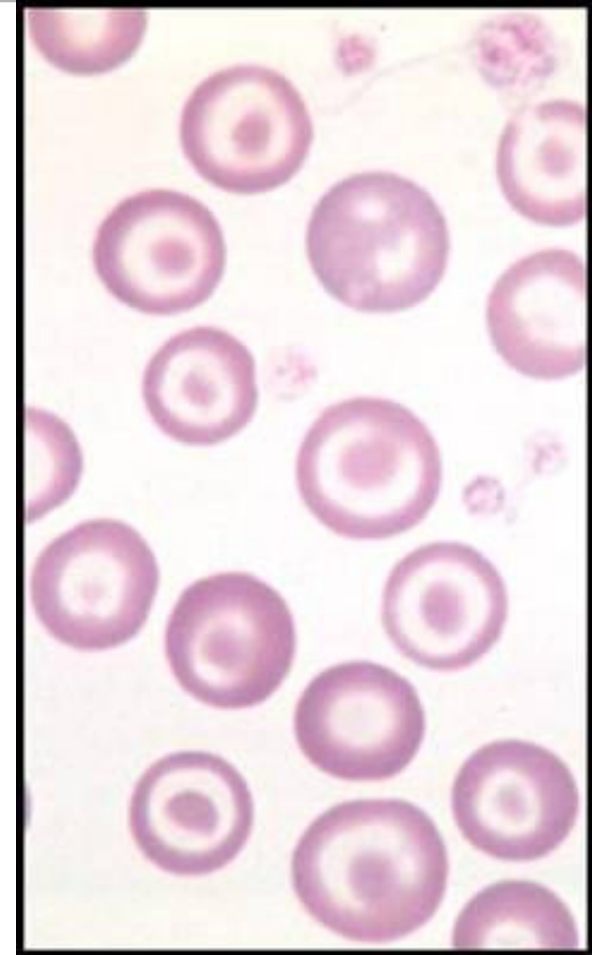
# Target Cells





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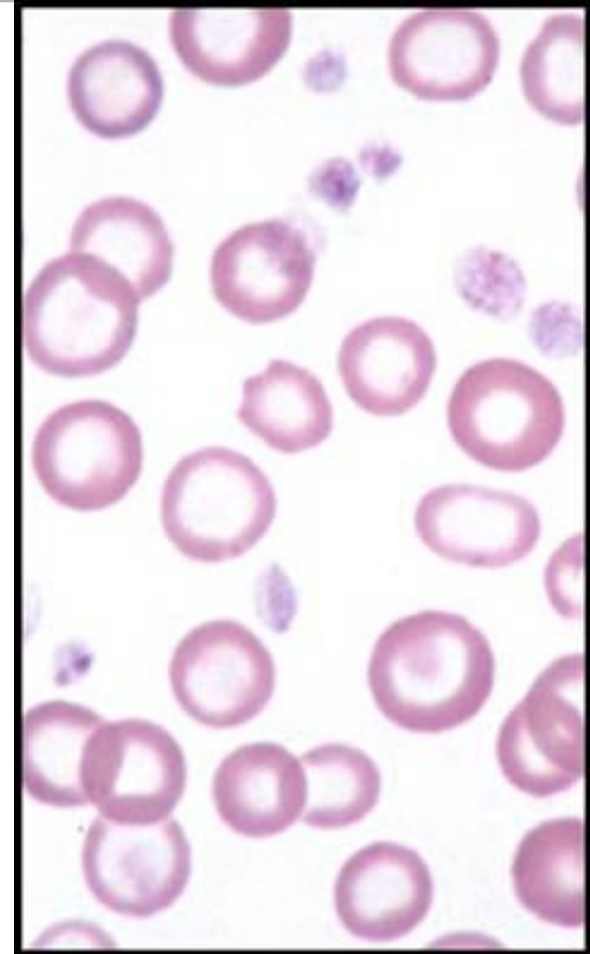
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2. Spherocytosis
3. Agglutination
4. Acanthocytosis
5. Target Cell Formation / Leptocytosis
6. Hypochromasia

# Hypochromasia

- Pale staining cells compared to normal
- Increased zone of central palor
- Supportive of decreased mean cellular hemoglobin content
- In veterinary medicine primarily suggests chronic blood loss



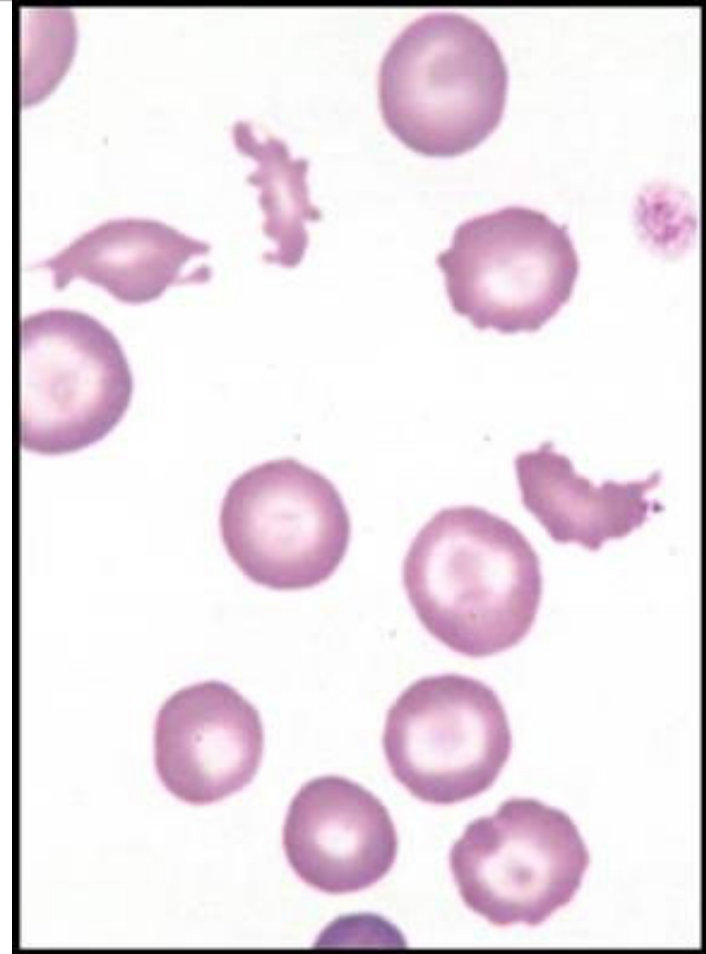
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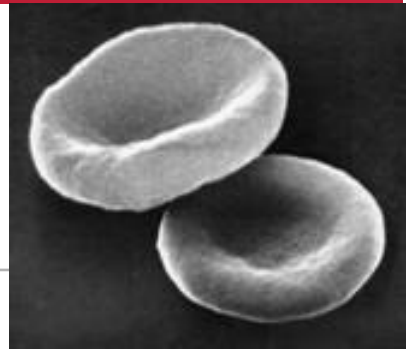
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5. Target Cell Formation / Leptocytosis
6. Hypochromasia
7. Schistocytosis

# Schistocytosis

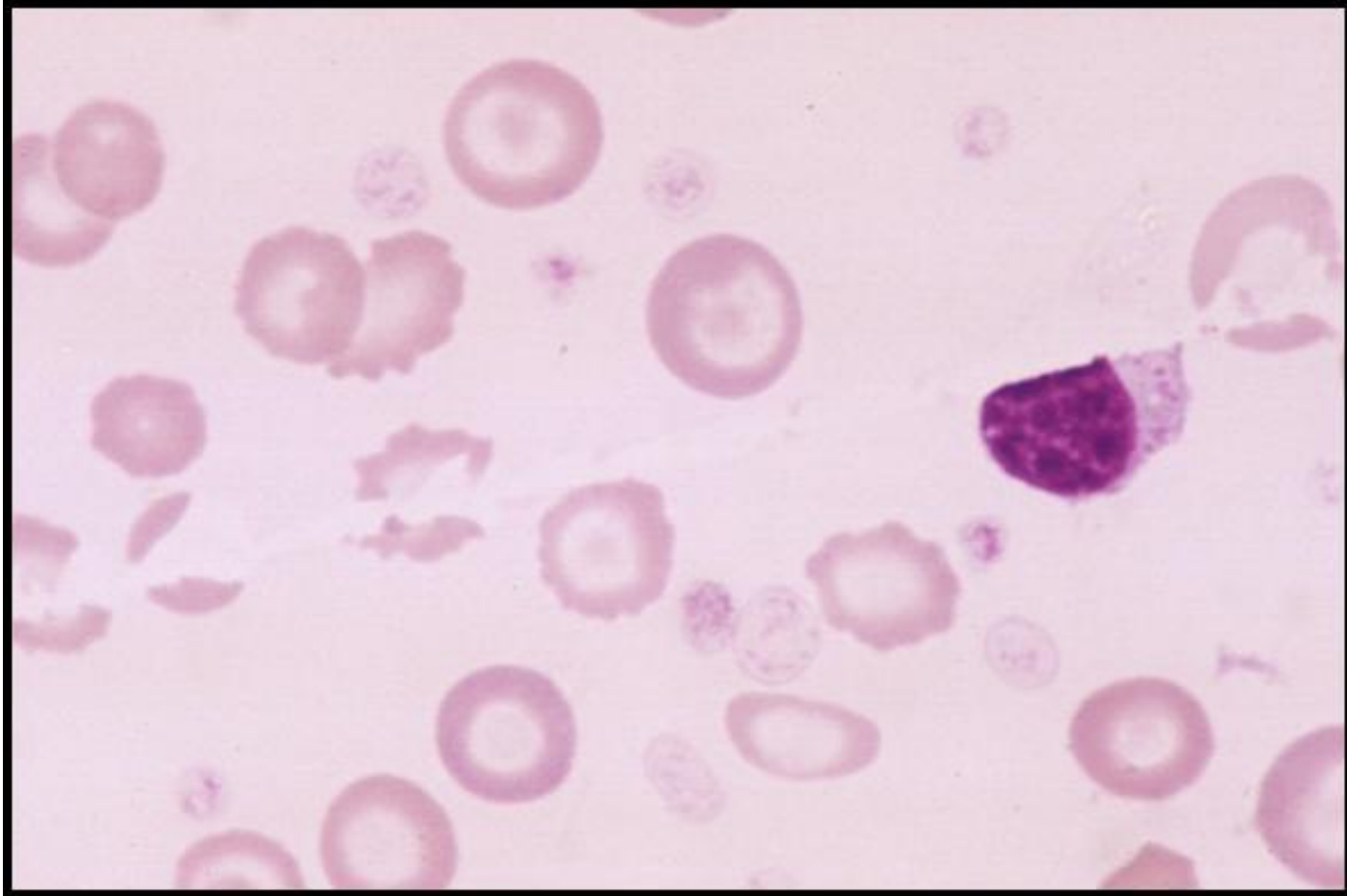
- Irregularly shaped erythrocyte fragments
- Indicate mechanical injury to erythrocytes
- Damage often in small blood vascular system
  - “microangiopathy”
- Could prove helpful in recognizing underlying Disseminated Intravascular Coagulopathy (DIC)



# Schistocytes

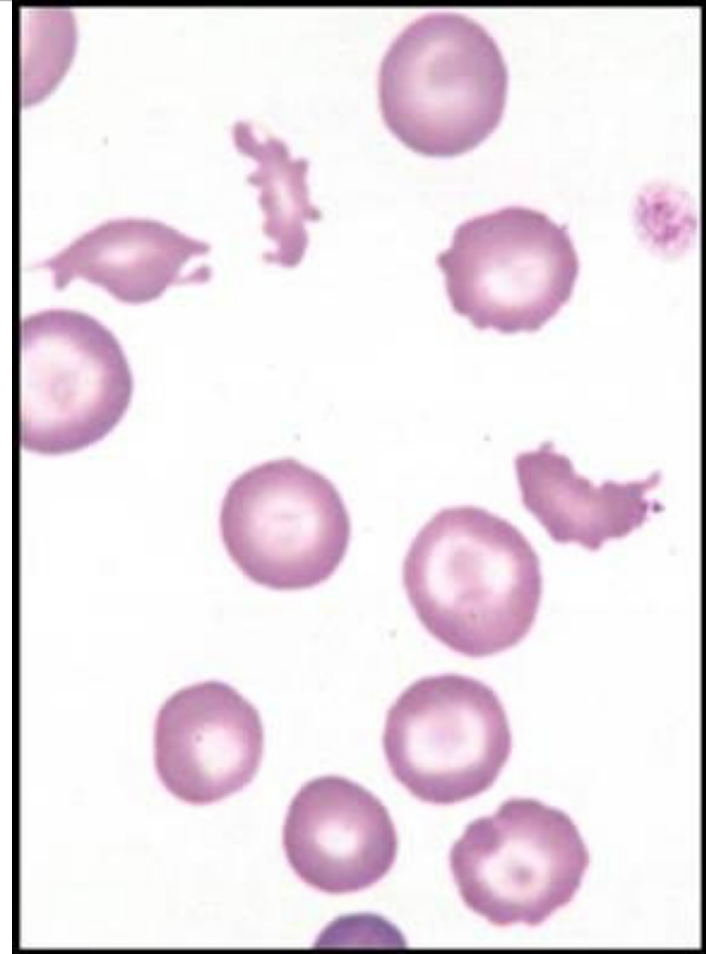


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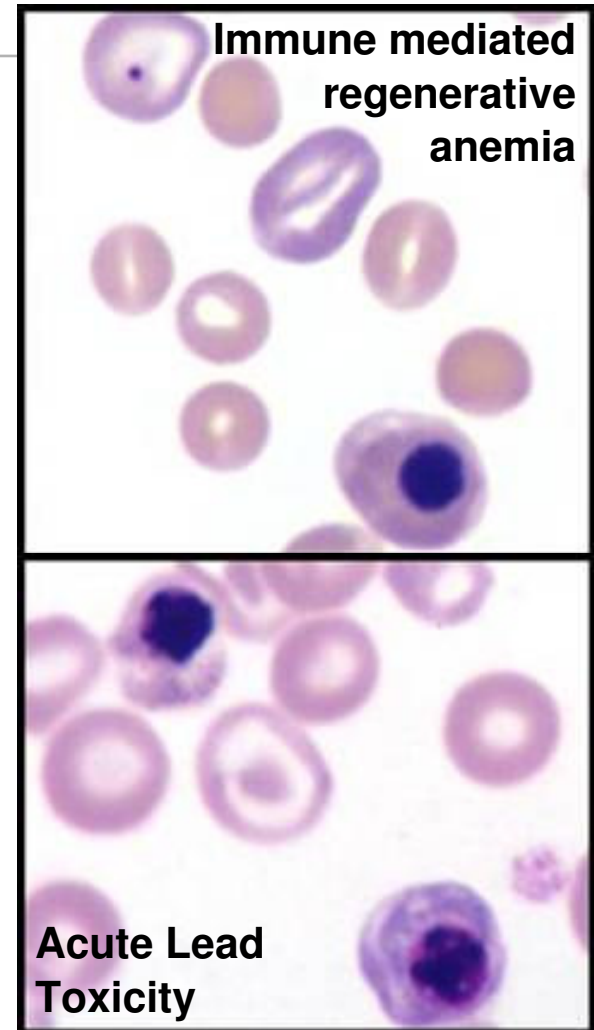
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6. Hypochromasia
7. Schistocytosis
8. Metarubricytosis

# Metarubricytosis

- Metarubricytes are late stage nucleated red blood cells
- Typically restricted from movement into the blood
- Potentially present during:
  - Marked erythroid hyperplasia in “regenerative” marrow response
  - Marrow stromal damage without marked erythroid hyperplasia
    - Acute lead toxicity
    - Marrow infiltrative disease
    - Septicemia



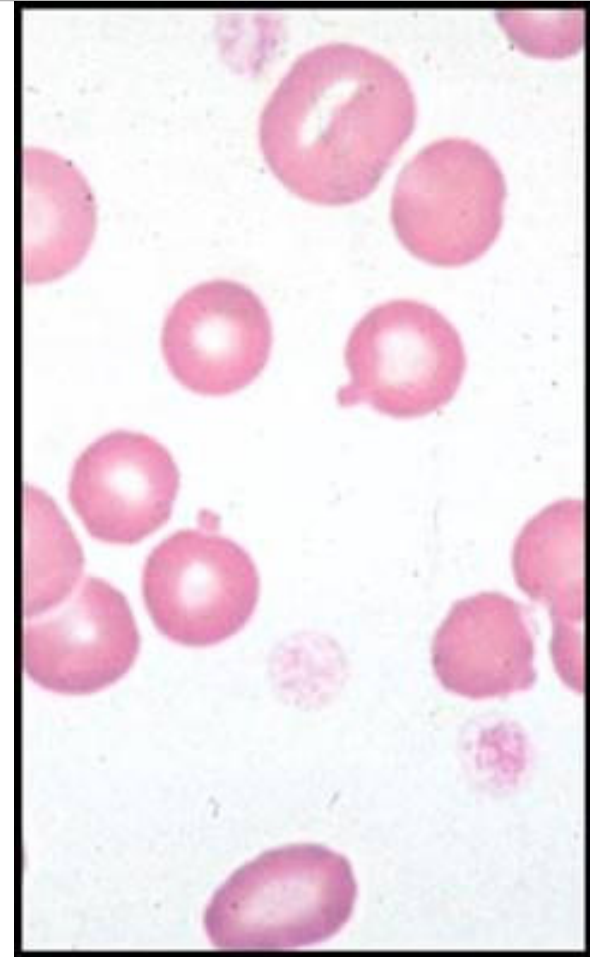
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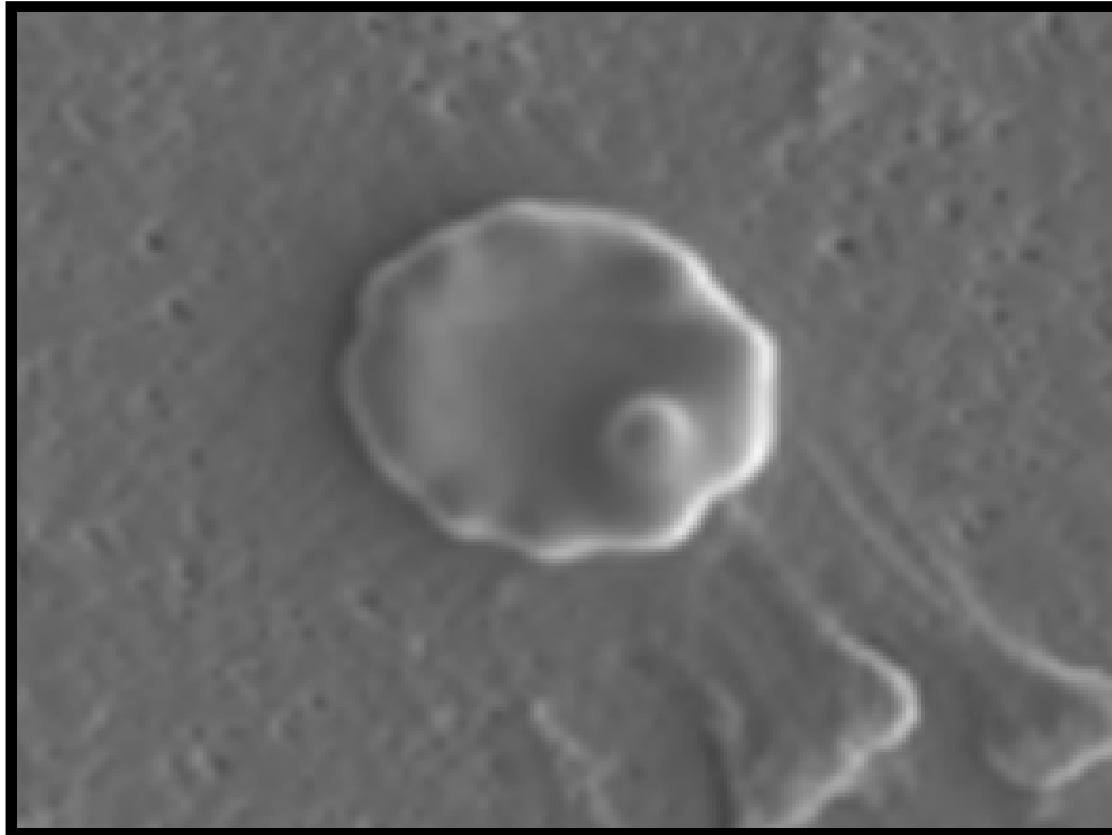
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9. Heinz Body Formation

# Heinz Body Formation

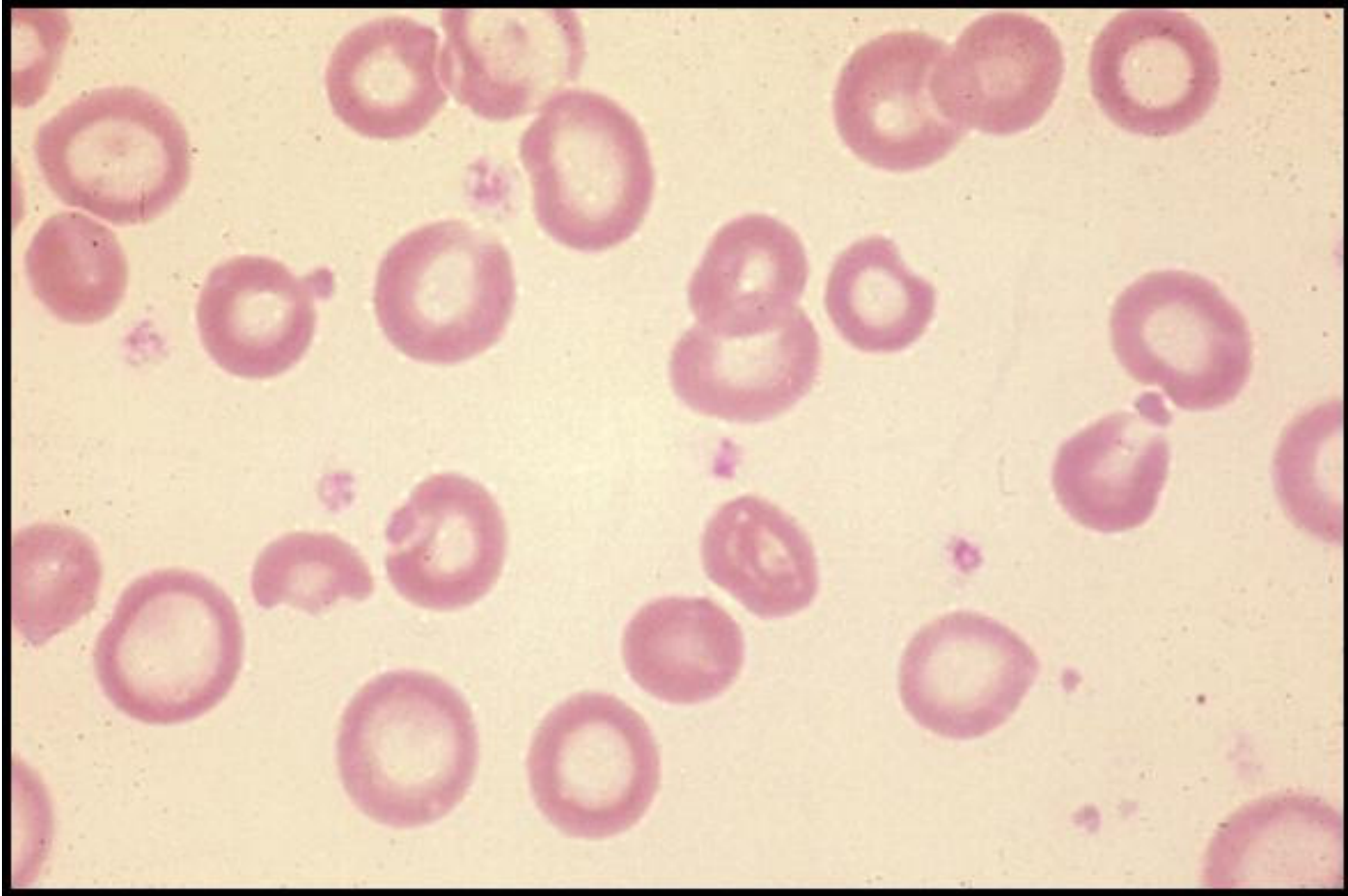
- Short blunt projections from surface of cell
- Represent oxydized denatured hemoglobin
  - Onion toxicity - dog
  - Acetaminophen toxicity - cat
  - Phenothiazide – horse
- Identification enhanced with New Methylene Blue staining



# Heinz Bodies

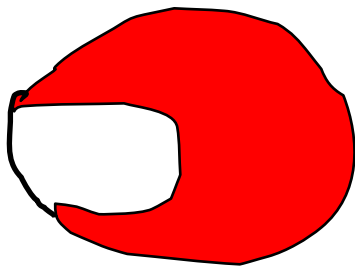


# Heinz Bodies

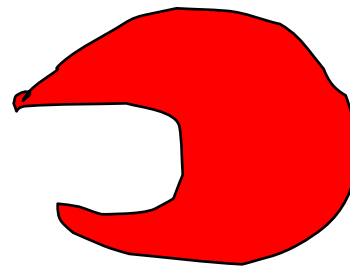


# Heinz Bodies and “Keratocytes”

- Previous “blister cell”
- One or two projections that form from a ruptured vesicle
- Usually seen with Heinz body anemias

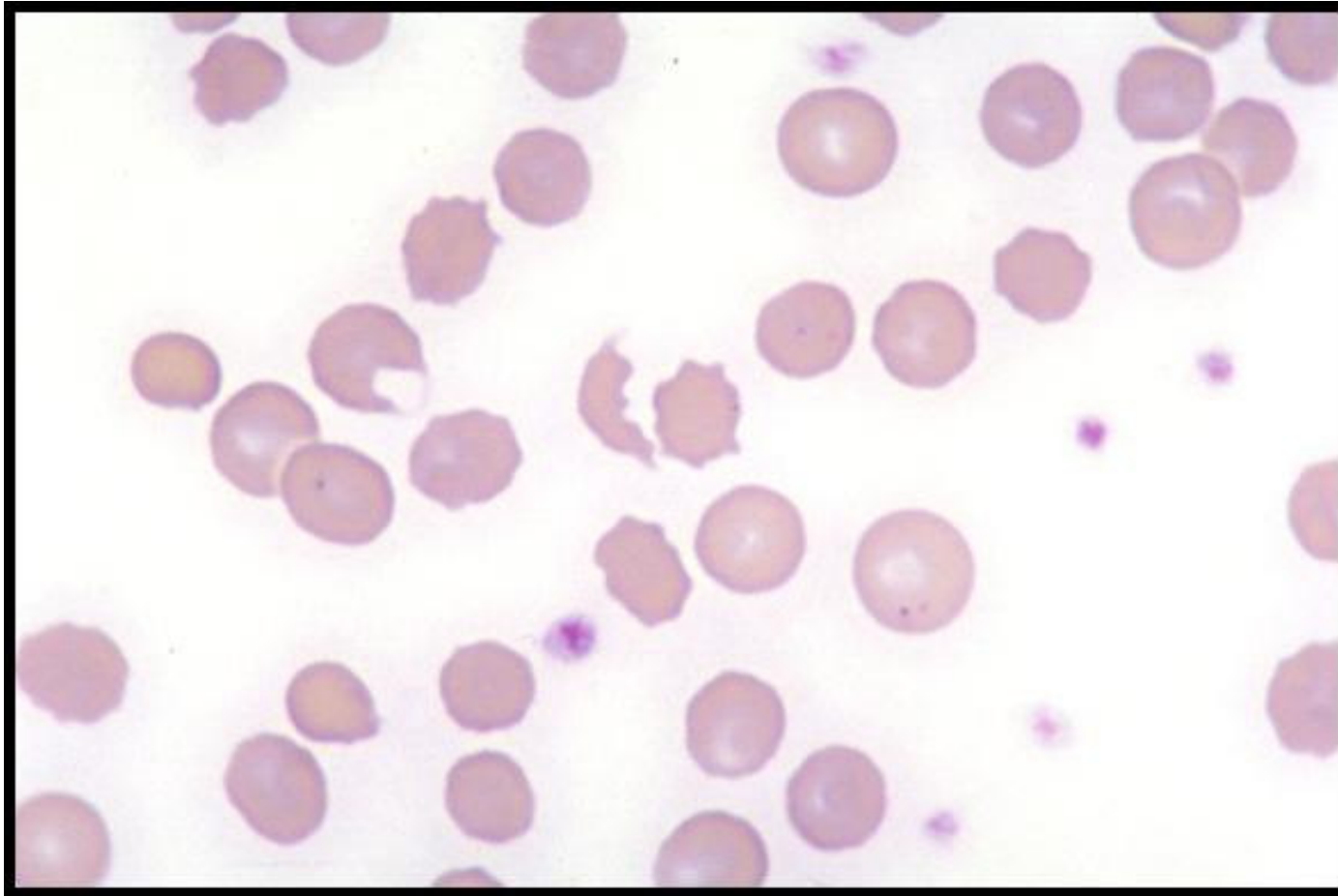


**Blister Cell**



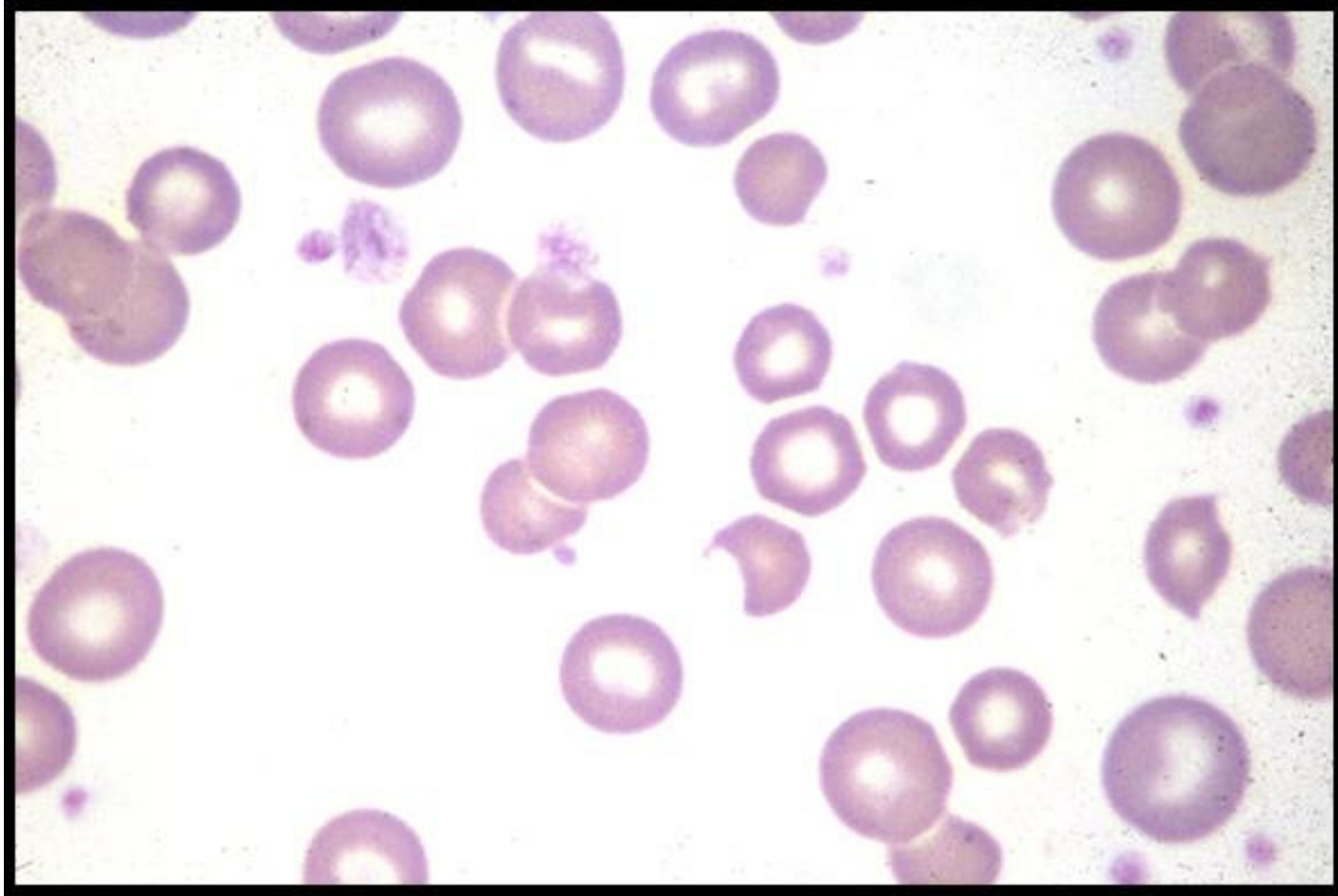
**Keratocyte**

# Blister Cell





# Keratinocyte



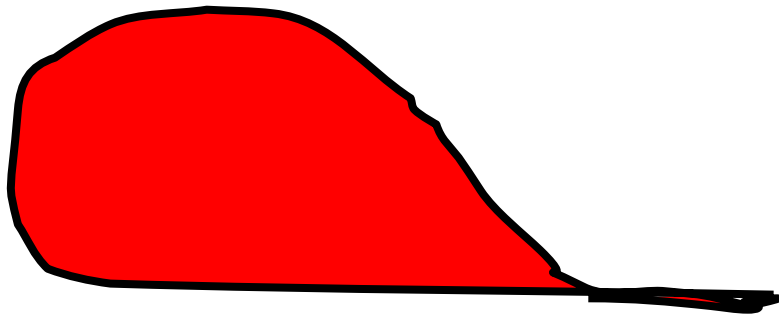
# Eccentrocyte Formation

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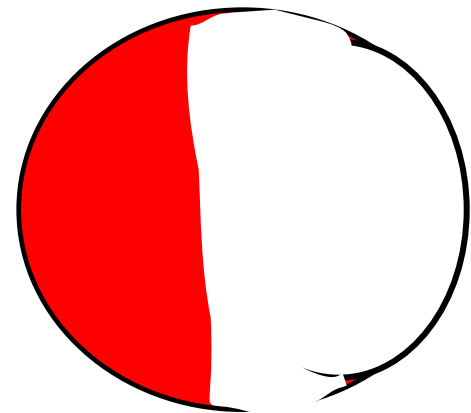
- Fusion of opposed oxidized RBC membrane
  - Potential accumulation of small portions of oxidized hemoglobin between membranes (velcro)
- Leaves a pale area on one side of RBC

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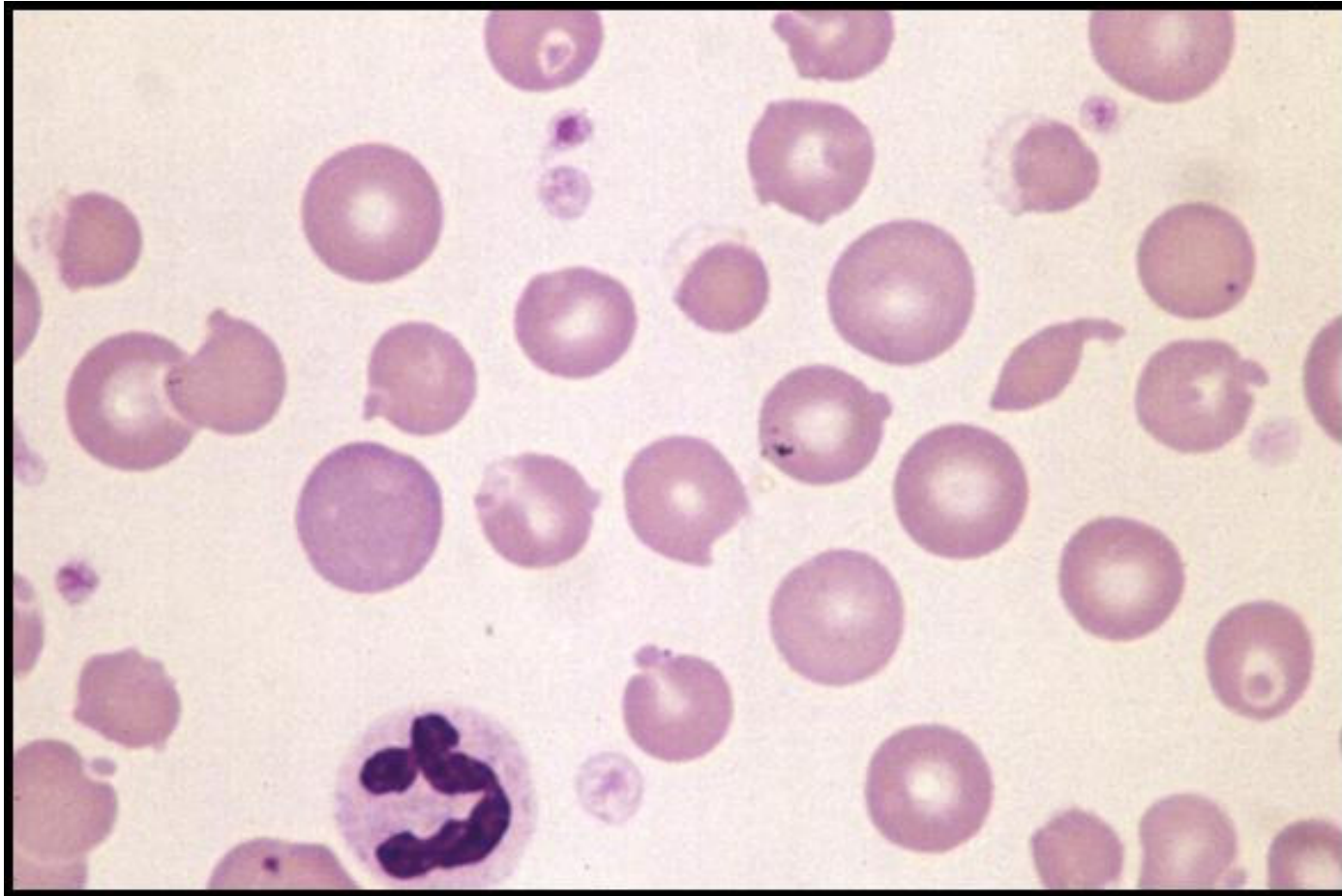


**Side view**



**Top view**

# Heinz Bodies and Eccentrocytes

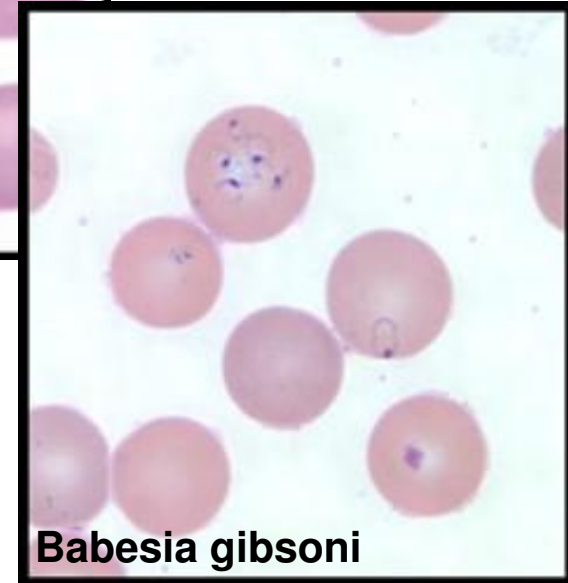
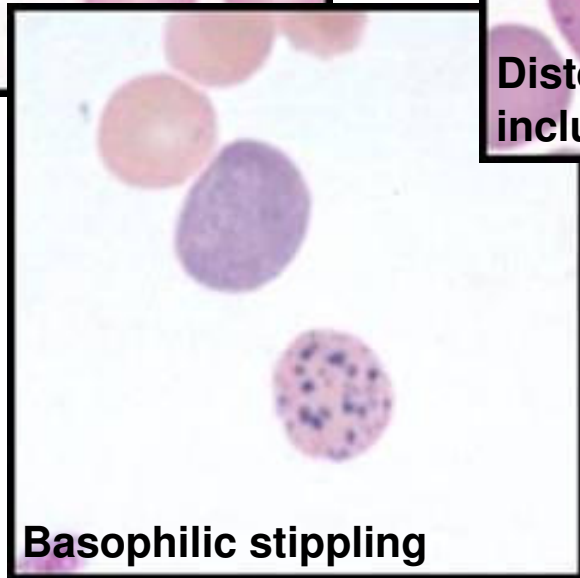
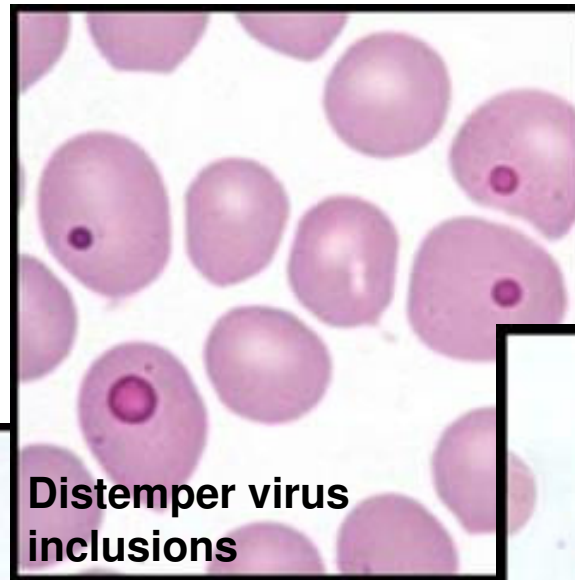
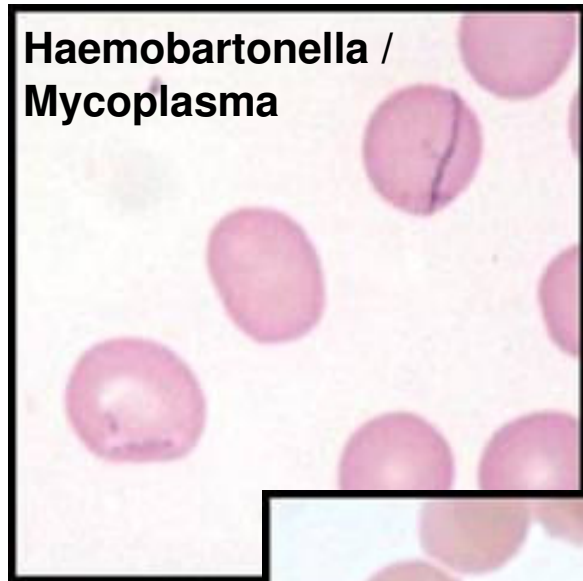


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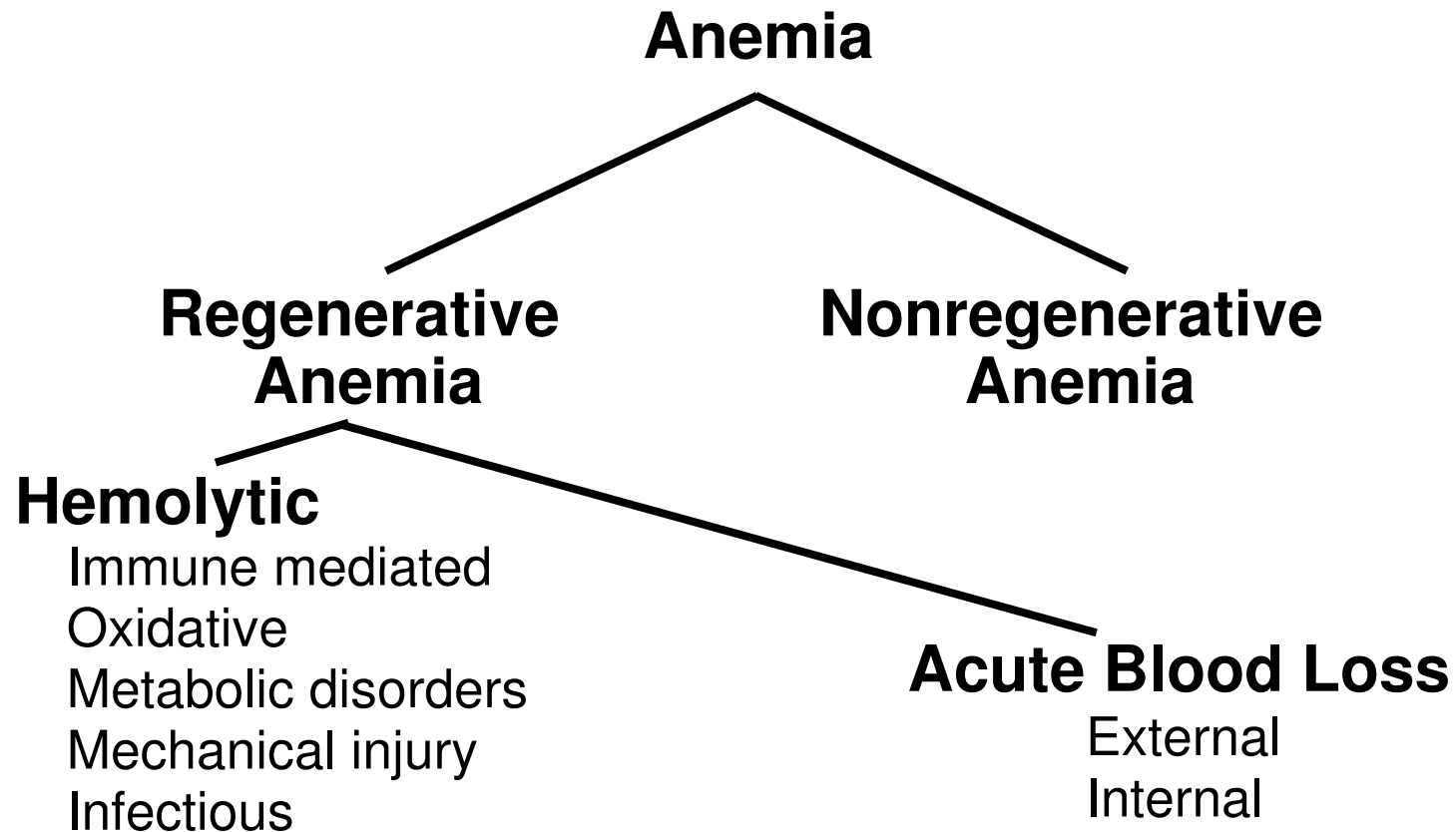
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3. Agglutination
4. Acanthocytosis
5. Target Cell Formation / Leptocytosis
6. Hypochromasia
7. Schistocytosis
8. Metarubricytosis
9. Heinz Body Formation
10. Miscellaneous Inclusion Identification

# Miscellaneous Inclusions



# Classification of Anemia



# Questions?

