

Blood

Avian Physiology

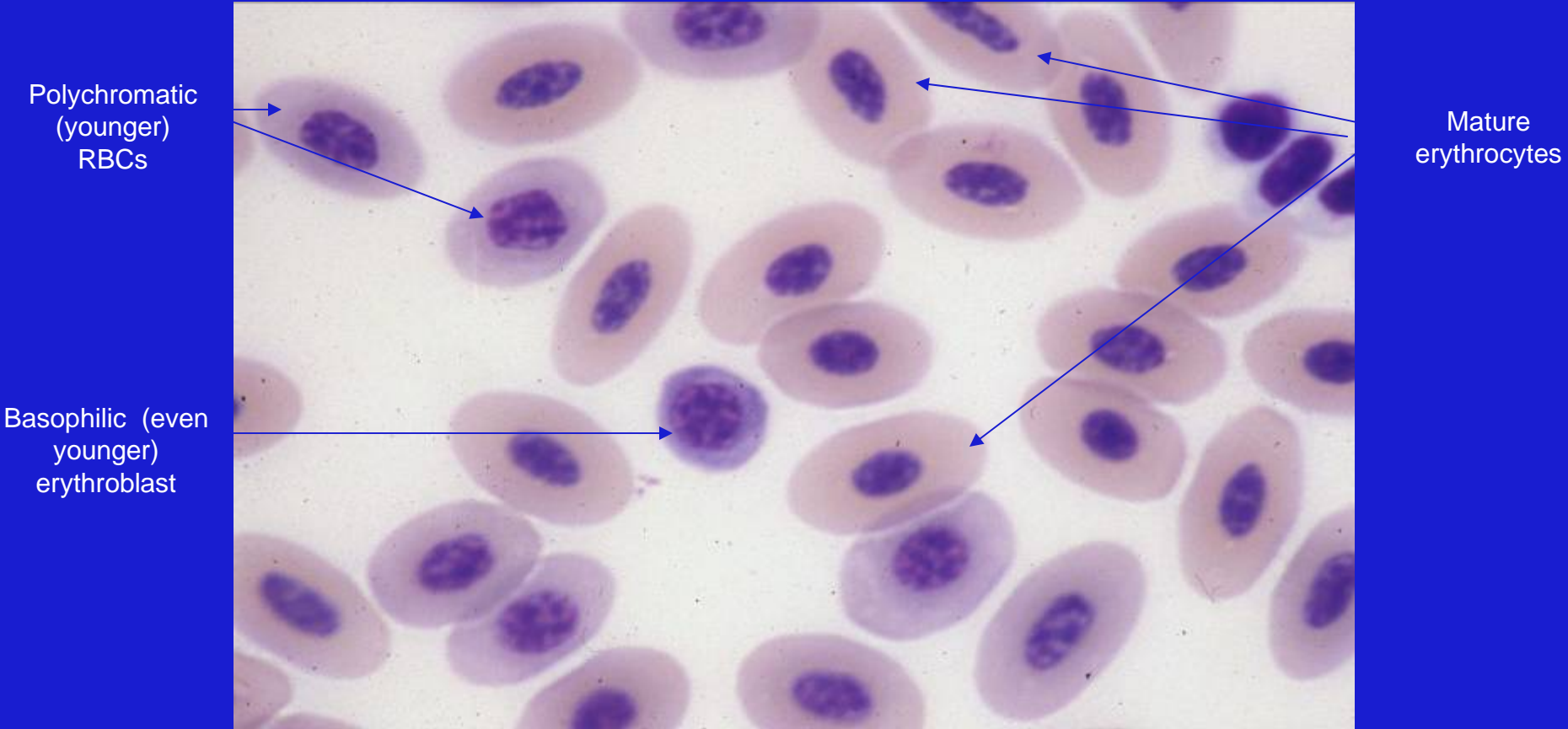
Corpuscles

- **Erythrocytes** = Red blood cells (RBC)
- **Leukocytes** = white blood cells (WBC)
- **Thrombocytes** = similar to platelets in mammals
- All are nucleated in birds, but in mammals RBC and platelets are not nucleated
- RBC and platelets are biconcave disc in mammals but football shaped in birds.

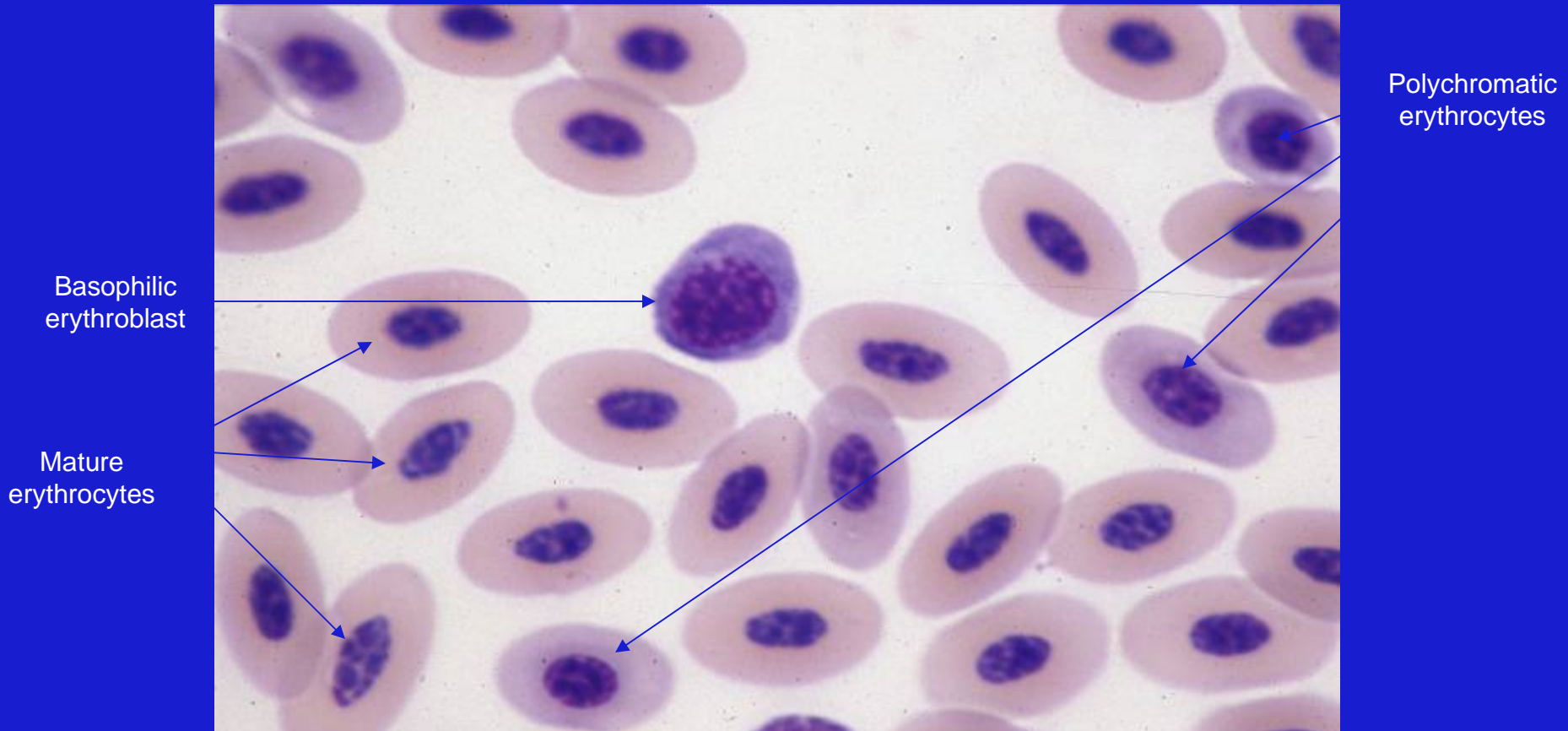
Erythrocytes or red blood cells

- ~3 million (10^6) per mm^3
- Nucleated
- Male > female
 - Because androgens \uparrow RBC formation and estrogens \downarrow RBC formation
- Formed in bone marrow as well as liver, spleen, and thymus at times in birds life.
- Lifespan 28-35 days (cf. 120 days in human)

Avian RBC maturation-The younger cells are smaller, rounder and have a more basophilic cytoplasm. Mature erythrocytes are oval with eosinophilic cytoplasm. The nuclear size decreases and the amount of cytoplasm increases as the cell matures.



This is a very young red blood cell or basophilic erythroblast. Also present are some polychromatocytic and mature erythrocytes.



Red Blood Cells Formation

- **Erythropoiesis** = process of RBC formation
- **Erythropoietin (EPO)** = kidney hormone that controls erythropoiesis
 - Increased at high altitudes
 - Glycoprotein hormone
 - Stimulates red blood cell formation
 - Humans - Anemia Treatment
 - EPO = endurance.

Erythrocytes or red blood cells

Storage and Removal

- Spleen stores RBC in mammals
- Bone marrow stores RBC in birds, little spleen storage
- **Phagocytes** remove dead and dying RBC.
- **Kupffer cells**= stationary macrophages (phagocytes were monocytes) in liver that remove RBC.

Erythrocytes or red blood cells

Functions

- Transport hemoglobin
- **Hemoglobin** transports
 - Oxygen
 - CO₂
- Convert carbon dioxide and water into carbonic acid and vice versa
 - **Carbonic anhydrase enzyme**
 - $\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{HCO}_3^- + \text{H}^+$ (bicarbonate)+H⁺
 - Maintains acid base balance = osmotic regulation

Erythrocytes or red blood cells

Hemoglobin (Hb)

- Made by RBC and not bone marrow
- 8-12 g/dl in chicken blood
- **Mean corpuscular hemoglobin (MCHb) =**
 - Amount of Hb in RBC = 50 pg/cell
- **Mean corpuscular hemoglobin concentration (MCHC)=**
 - Relative volume of RBC that is Hb = 25%

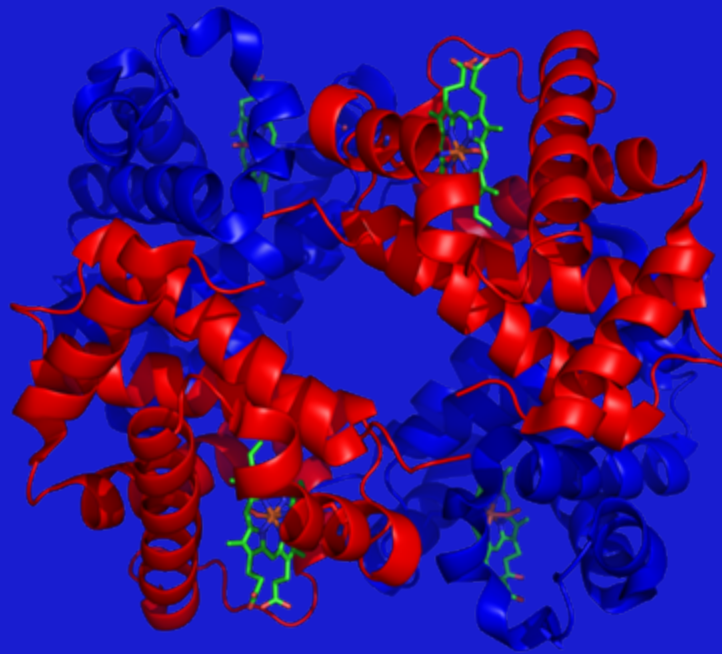
Erythrocytes or red blood cells

Hemoglobin (Hb) Structure

- 4 heme molecules + 4 polypeptide chains (globulins)
- Each heme molecule contains one Fe molecule
- Each Fe molecule can carry one O₂ molecule
- **Therefore each hemoglobin molecule carries 4 O₂ molecules**

Erythrocytes or red blood cells

Hemoglobin (Hb) Structure



- The protein subunits are in red and blue, and the iron-containing heme groups in green.

Red Blood Cells

Anemia

- Physiopathological term meaning:
 - Reduction in circulating RBC numbers or
 - A deficiency of hemoglobin in blood
- 4 types of anemia

Anemia - 4 types

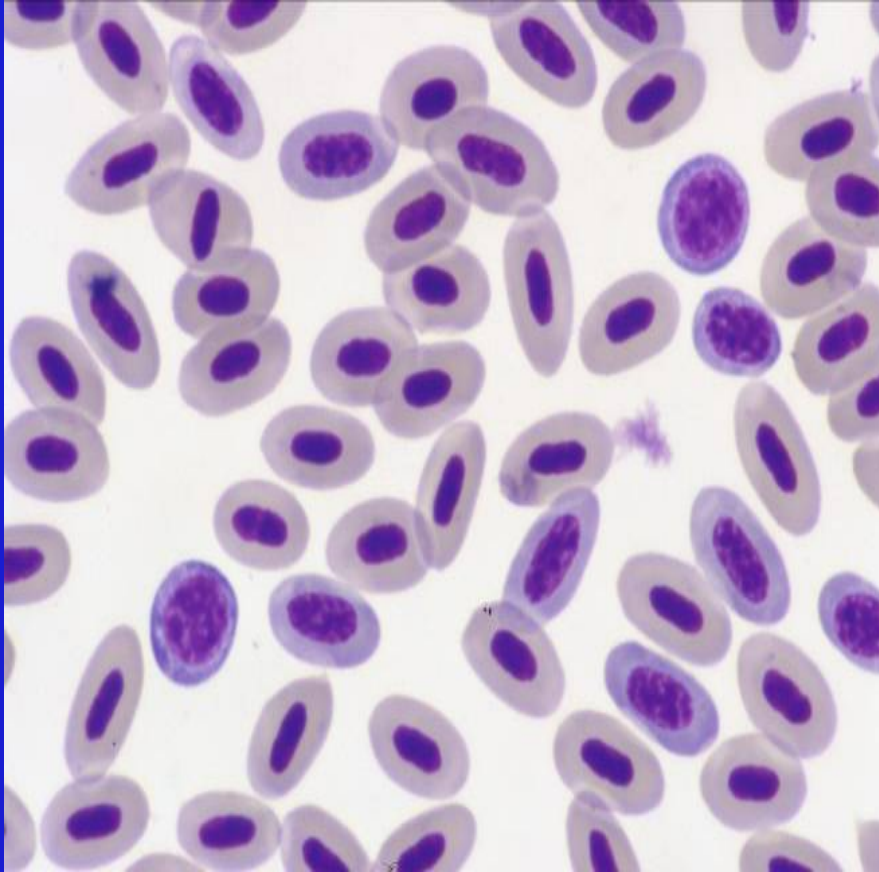
- **Hemorrhagic** = excessive blood (RBC) loss
- **Aplastic** = due to drugs, irradiation
 - Too much coccidiostat
 - Common in older animals
- **Pernicious** = bone marrow doesn't make RBC
 - Lack of Vit. B₁₂ in diet or absorption of B₁₂
 - **B₁₂ intrinsic factor** – mucoprotein secreted by intestines to help in B₁₂ uptake
- **Hemolytic** – intravascular explosion of RBC
 - Genetic, recessive trait
 - Made worse by high temp, poor diet, toxins

Red Blood Cells Excess

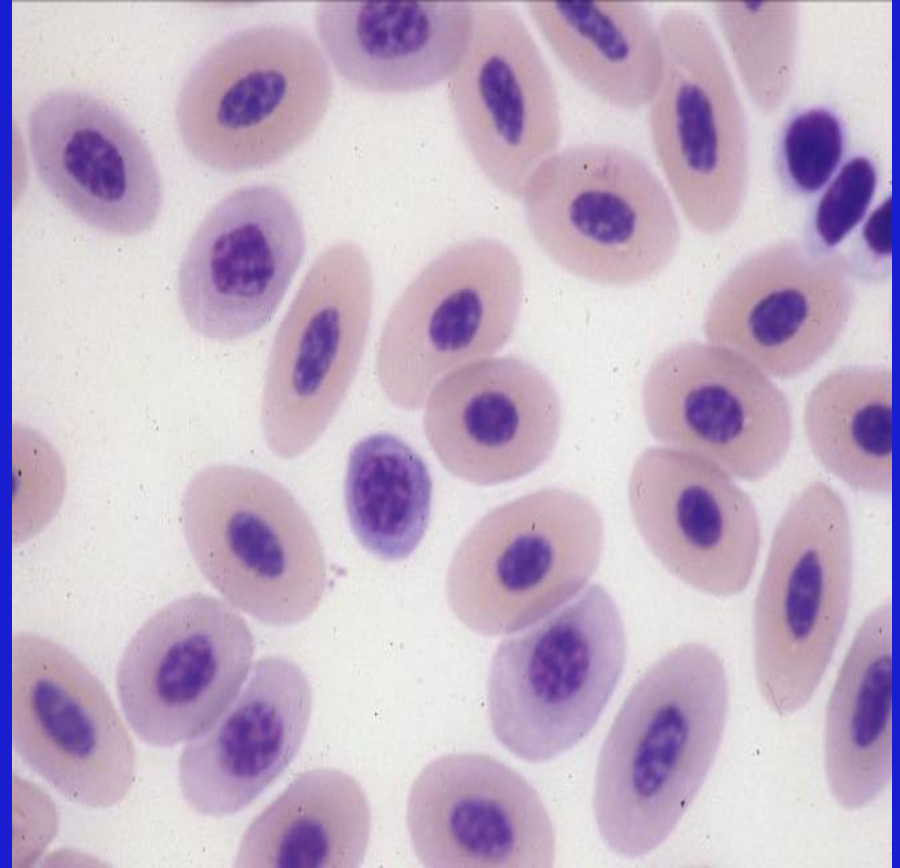
- **Polycythemia:**

- Excess RBC
- Not pathological
- Occurs as a result of need for oxygen
- Adaptation that occurs when animals are reared at high elevations

Polycythemia:



Normal:



White blood cells or Leukocytes

- Cells of the immune system
- Defend the body against infectious diseases and foreign materials
- Derived from a multipotent cell known as a hematopoietic stem cell
- Found in the blood and lymphatic system

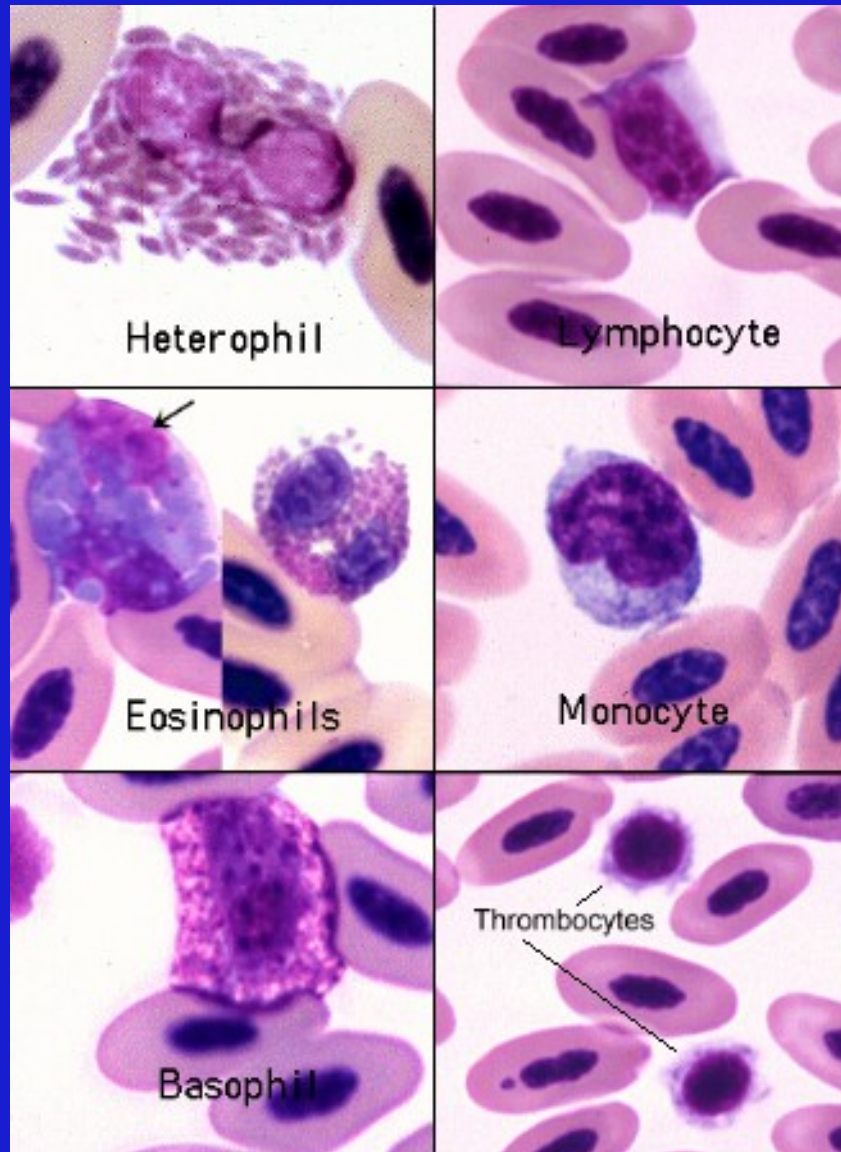
White blood cells or Leukocytes

- ~ 20,000 per mm^3 – if healthy
- Produced by:
 - Bone marrow
 - Liver
 - Lymphoid tissue
 - **Bursa of Fabricius**
 - Spleen
 - Thymus
 - **Gut Associated Lymphoid Tissue (GALT)**
 - **Peyer's Patches**

White blood cell or **Leukocyte Types**

- Agranulocytes or nonpolymorphonuclear leukocytes
 - Monocytes
 - Lymphocytes
- Granulocytes or polymorphonuclear leukocytes
 - Heterophils
 - Eosinophils
 - Basophils

White Blood Cells

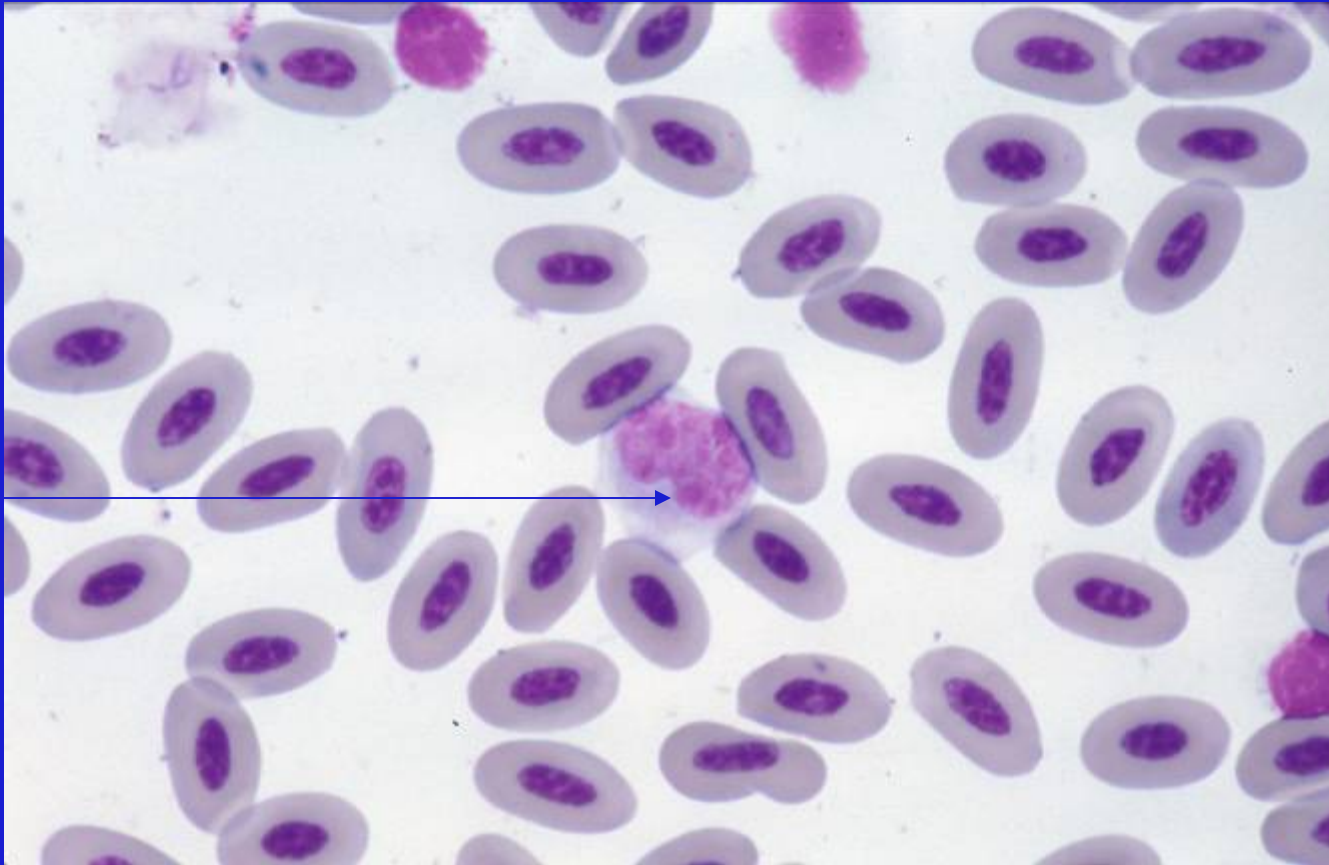


Agranulocytes

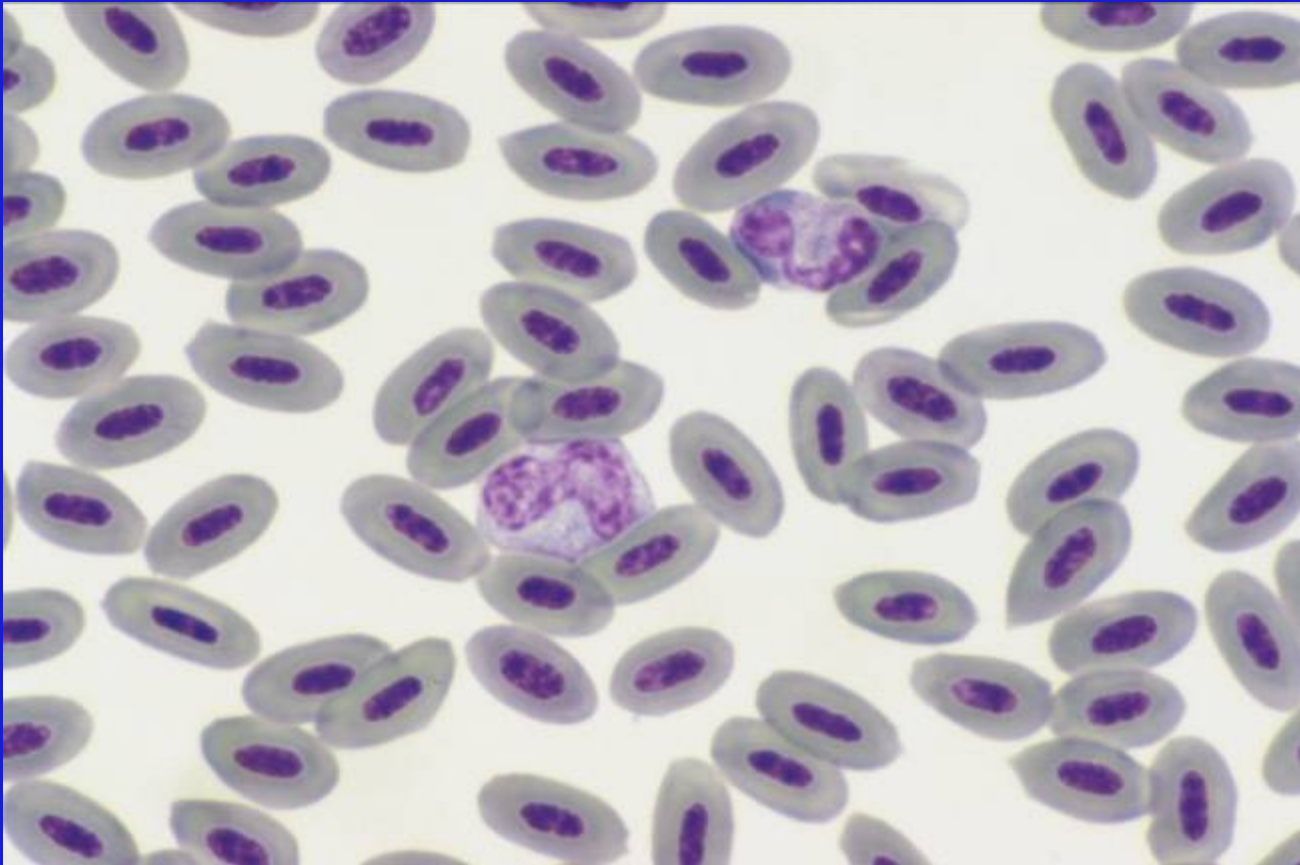
- **Monocytes**
 - 5-15% of total WBC count

This is a monocyte. Note the indented nucleus, and the abundant amount of light blue cytoplasm. This helps to distinguish it from a lymphocyte, which has a smaller proportion of cytoplasm.

Monocyte



Here you see a monocyte with an indented nucleus and some vacuoles.
Above it is a heterophil.



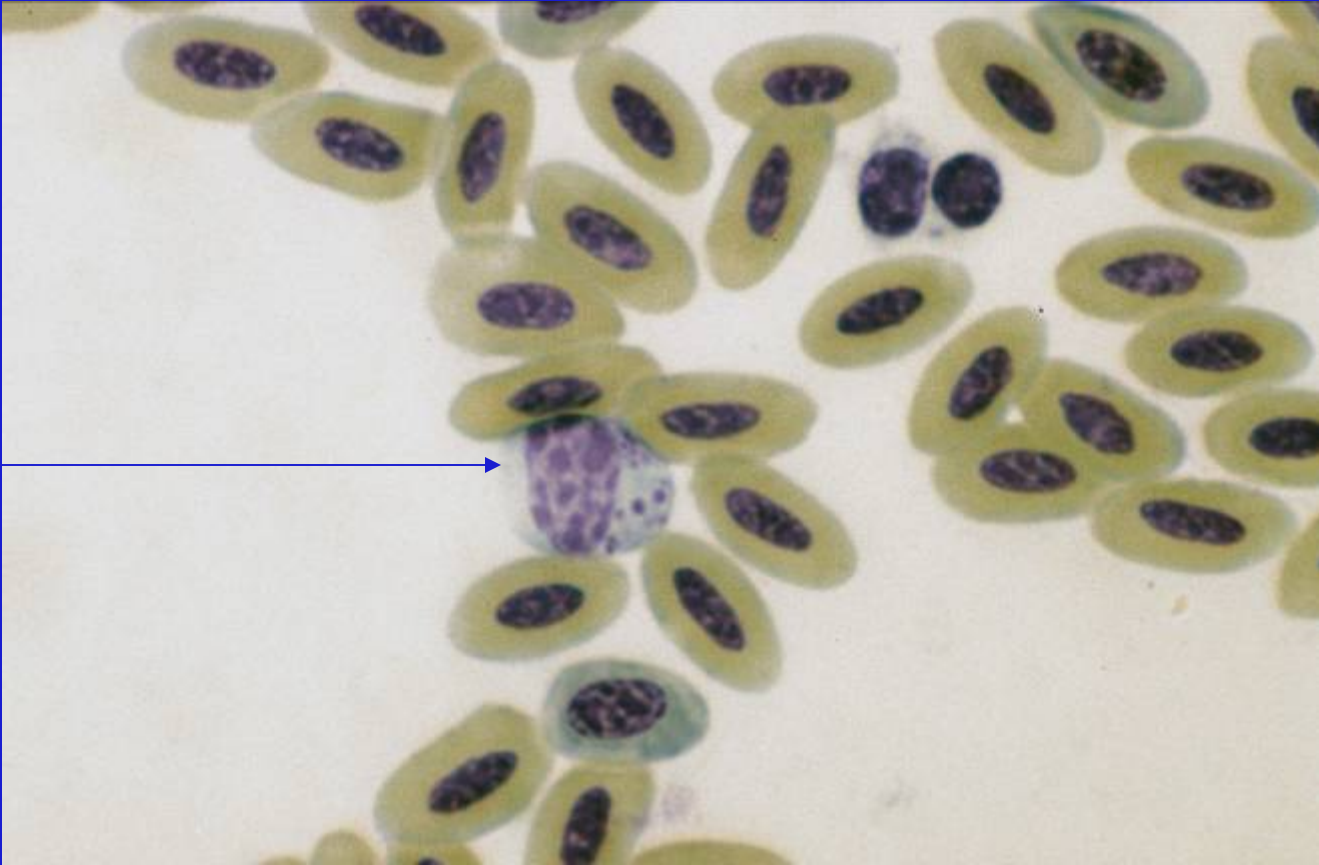
Agranulocytes

- **Lymphocytes**

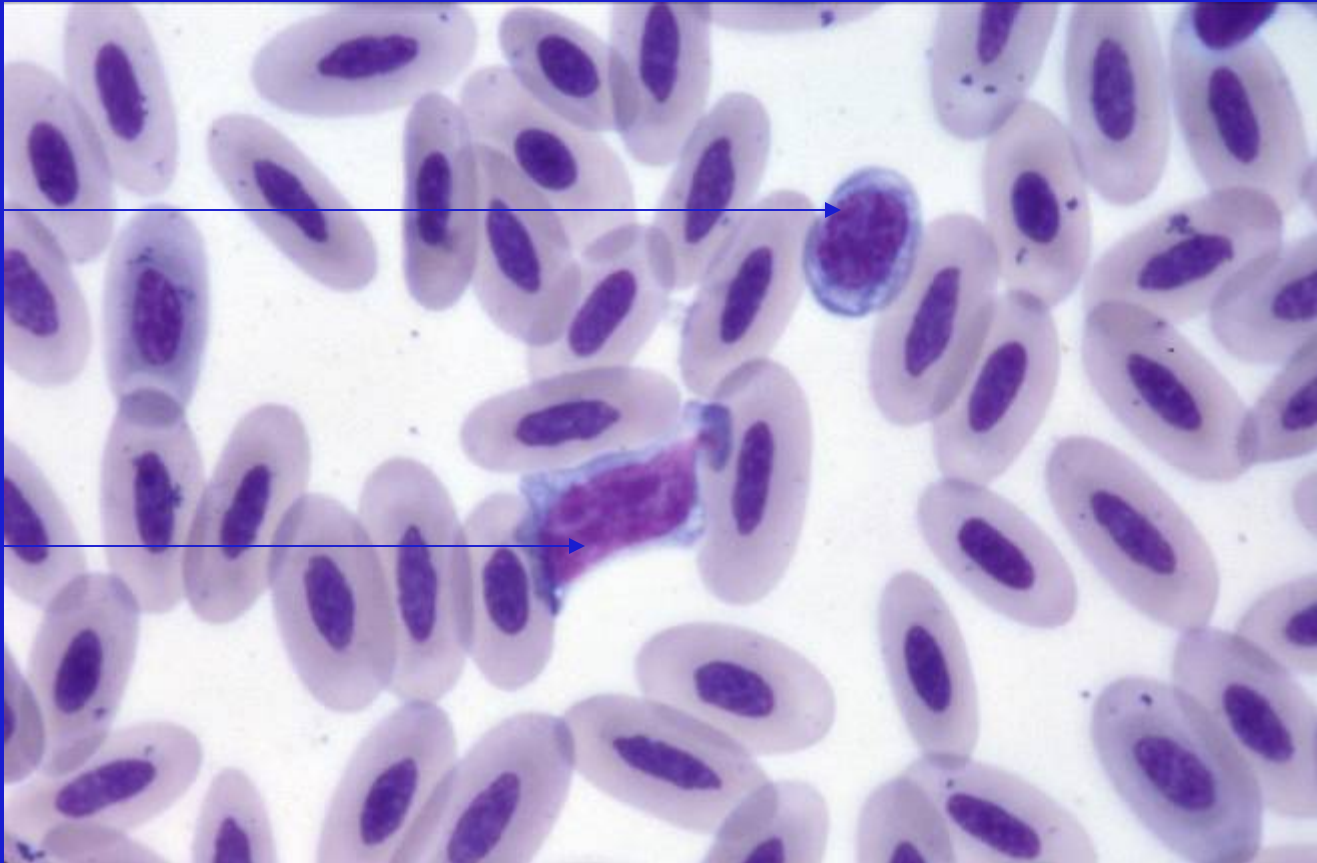
- Most numerous of all – 60-80% of WBC

This blood is from a white-winged dove. Their lymphocytes have granules in the cytoplasm.

Lymphocyte



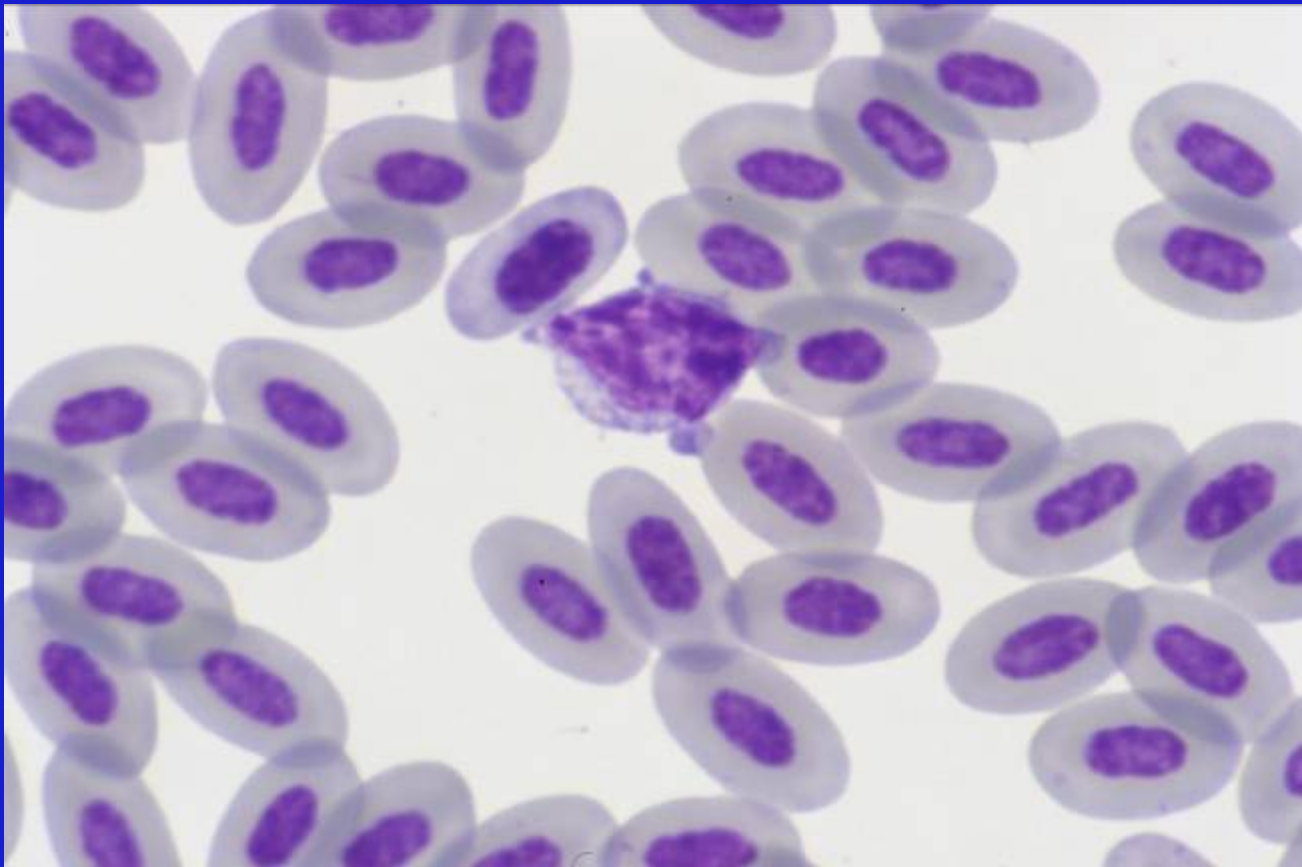
This shows mature red cells, a young (polychromatic) red blood cell and a lymphocyte. Note how the lymph is molded around the adjacent RBCs.



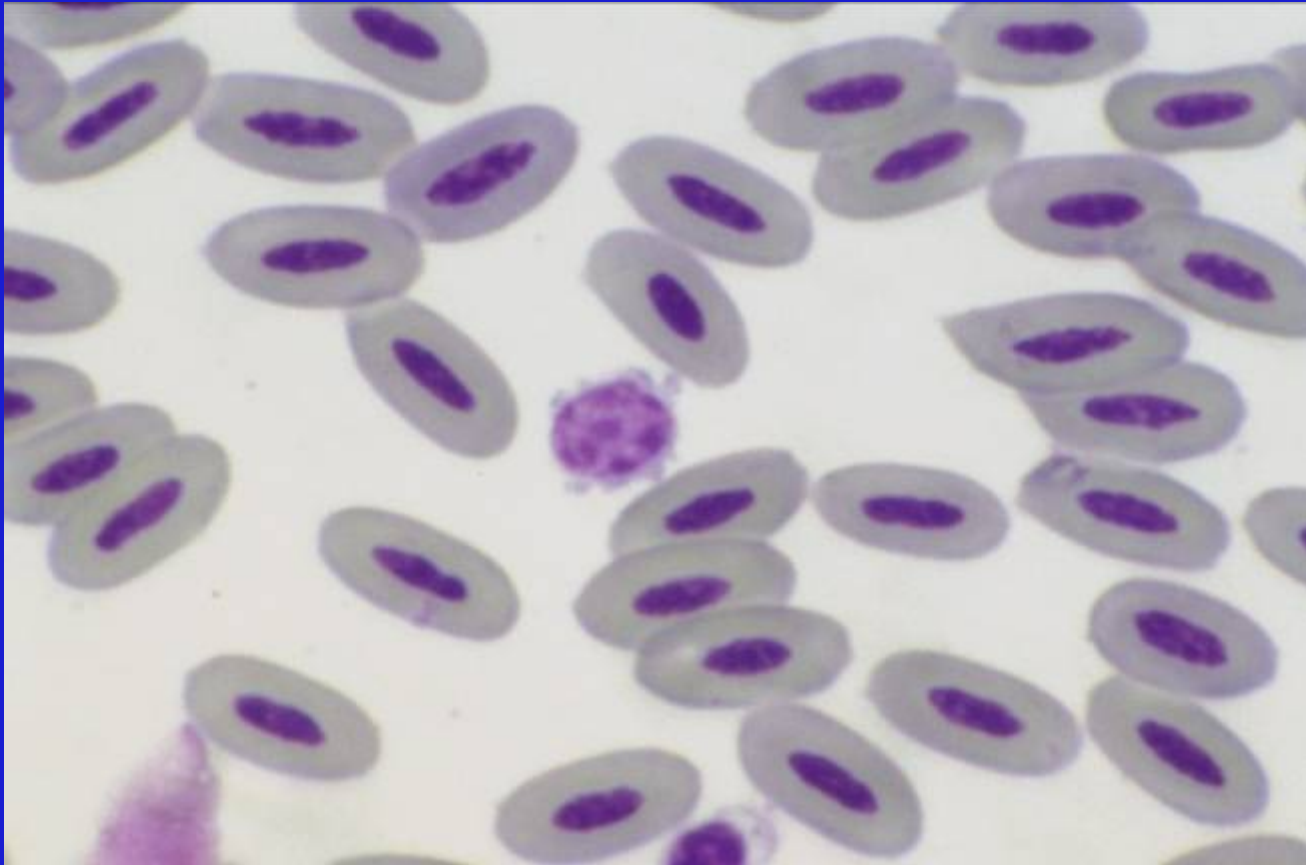
Polychromatic
RBC

Lymphocyte

This is an example of a lymphocyte that has irregular cytoplasmic projections, known as blebs.



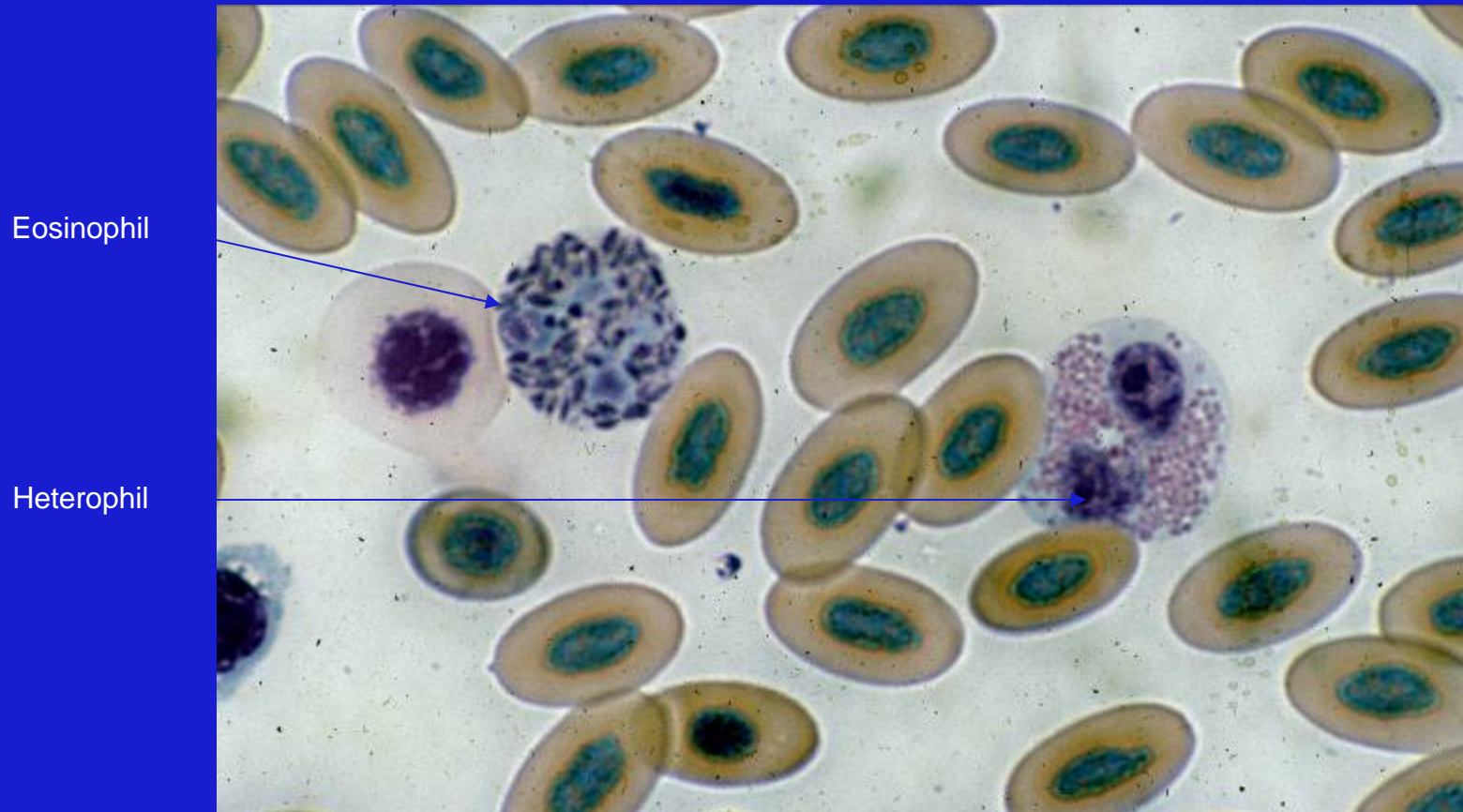
Another lymph with blebs



Granulocytes

- **Heterophils**
 - 20-30% of total WBC count

These are typical avian white blood cells. The heterophil (on the right) is round with round red granules in the clear cytoplasm. The eosinophil is also round with a blue-gray cytoplasm and stains more noticeably than the heterophil.



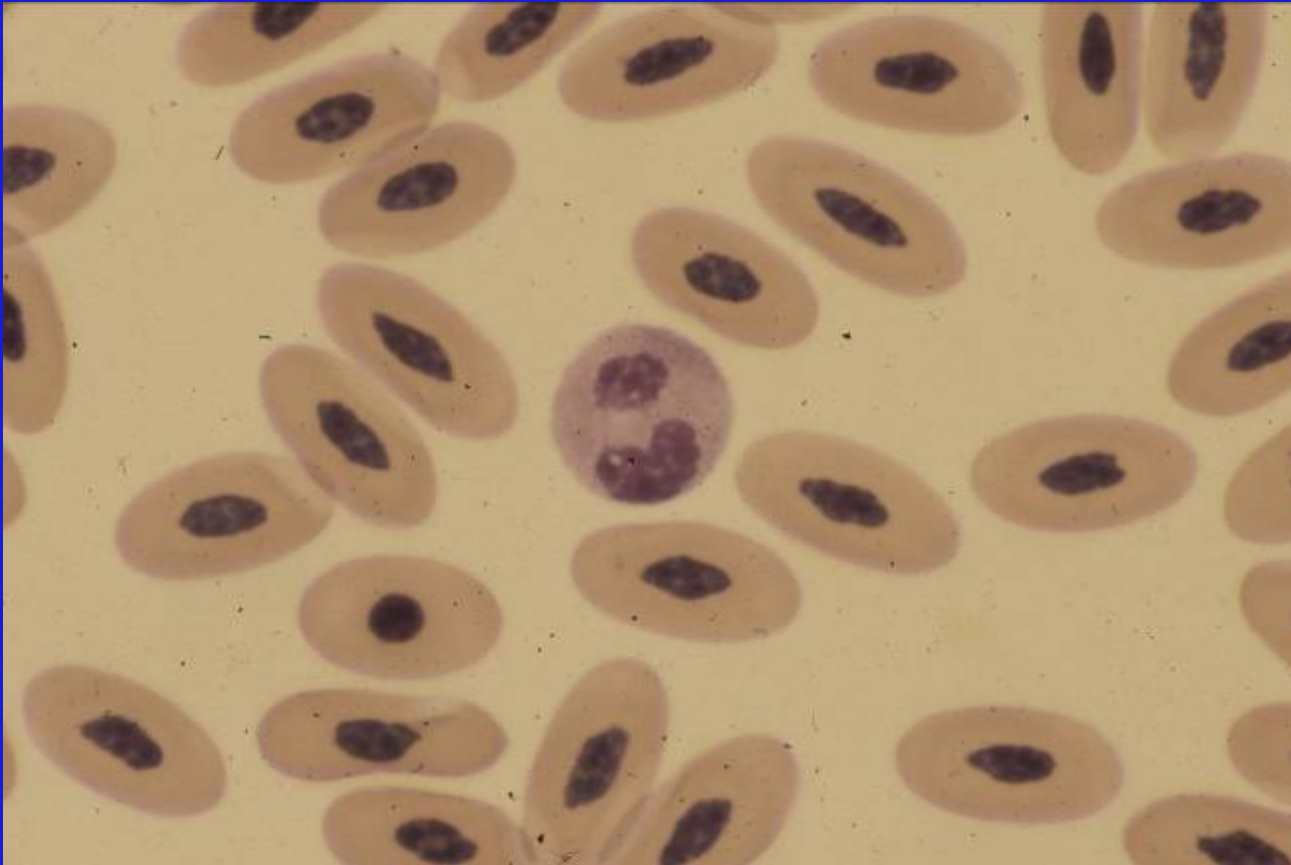
This is an example of a heterophil that is broken, revealing rod-shaped, red granules.



Granulocytes

- **Eosinophils**
 - 1-3% of WBC

This is another example of an avian eosinophil.



Granulocytes

- **Basophils**
 - 0.5-2% of WBC

This is an example of a basophil. The cell is round and contains a nucleus that is light blue in color. It has a large number of deeply basophilic-staining granules that almost cover the nucleus.



Thrombocytes

- ~ 30,000 per mm³
- No platelets
- Smaller than RBC
- Nucleated
- **Clotting and inflammation**
 - **Probably release thromboplastin**
- Phagocytize foreign particles

These are clumped thrombocytes. Note that they are small, usually more rounded than RBCs, and have clear cytoplasm.

