

# HEMATOLOGY

## *Hematocrit and Smear*

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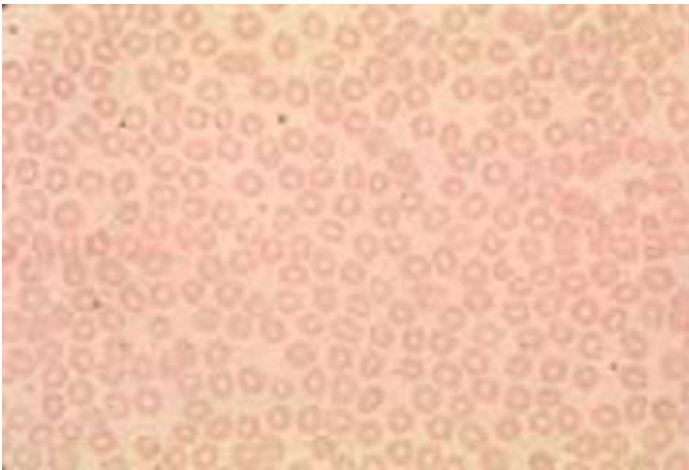


Figure 1: Normal blood smear

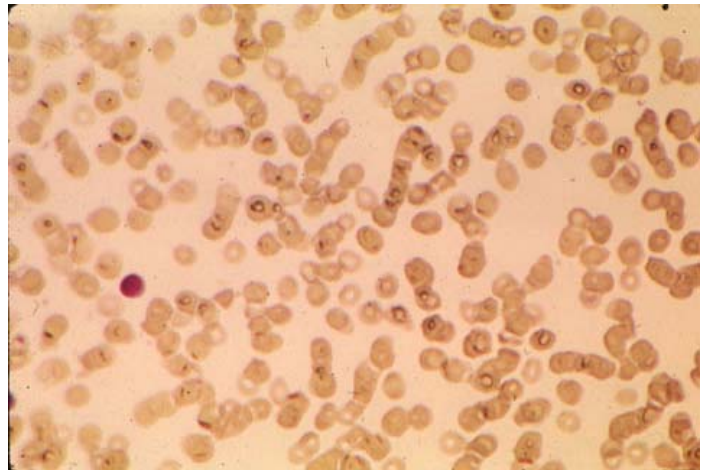


Figure 4: Thick area, plus drying artifacts

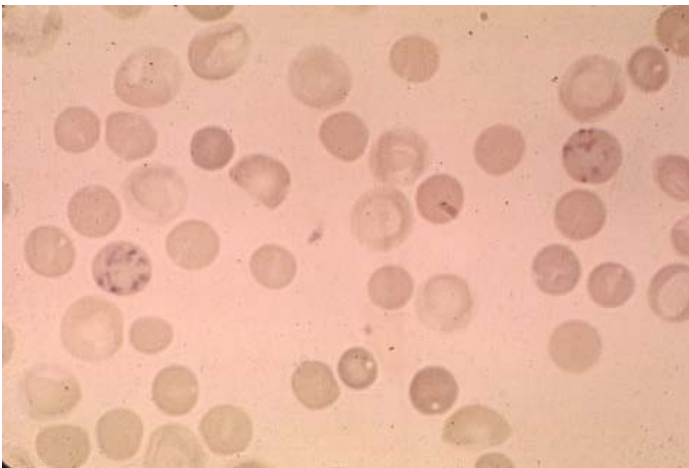


Figure 2: **RETICULOCYTE** stain

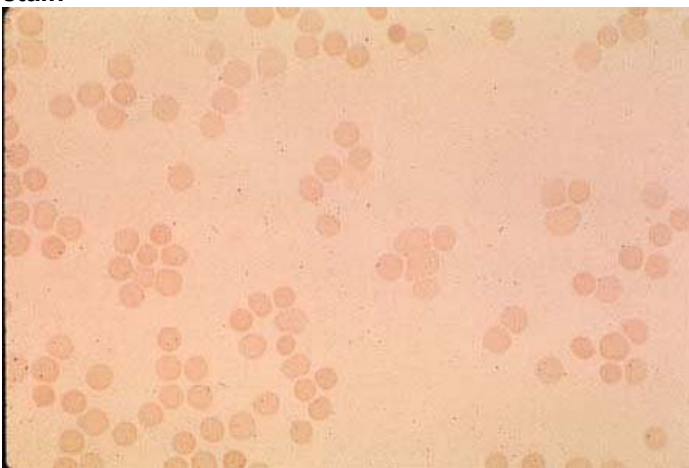


Figure 3: Thin area of smear

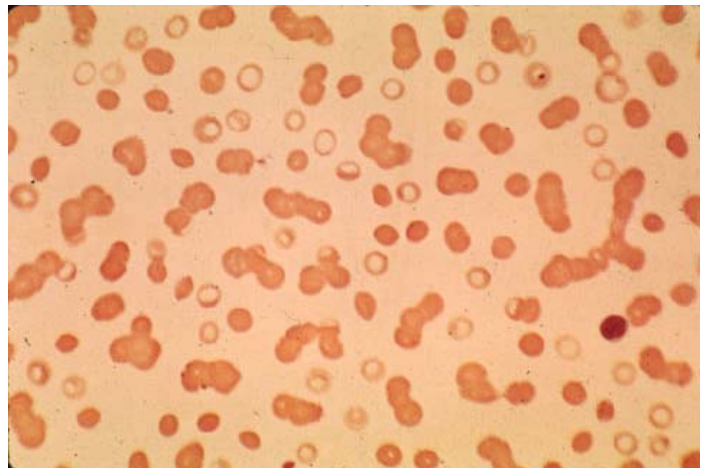


Figure 5: (for comparison) **TRUE ROULEAUX**- when protein concentration in the blood is high (e.g. **multiple myeloma**) red cells are coated and their normal electrostatic repulsion is lost. This leads to the "**stacked coin**" appearance seen in the slide.

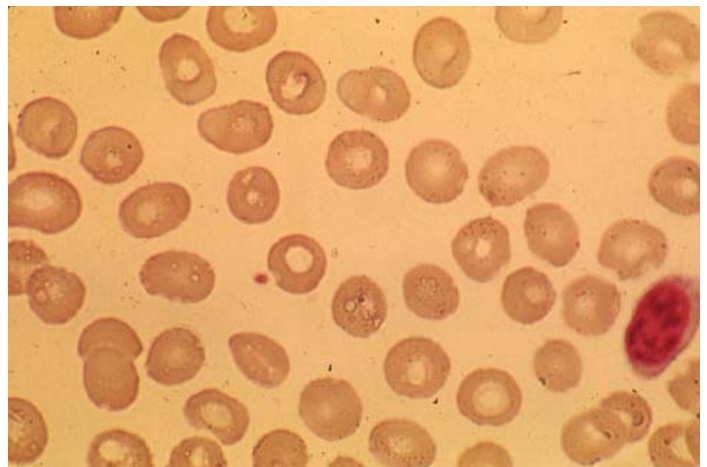


Figure 6: Drying Artifacts

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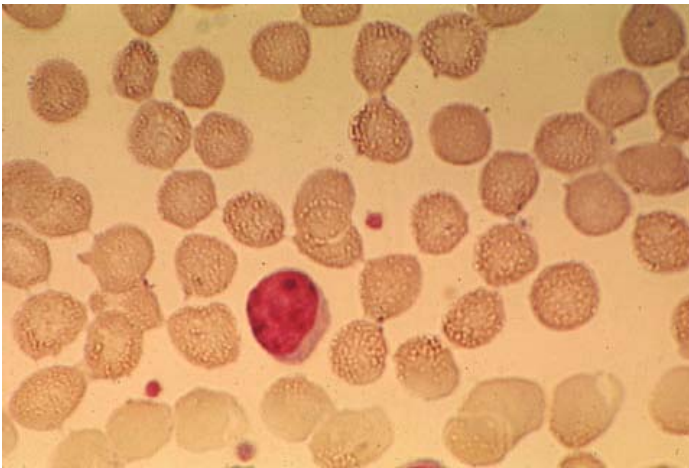


Figure 7: Drying Artifacts



Figure 10: MONOCYTE

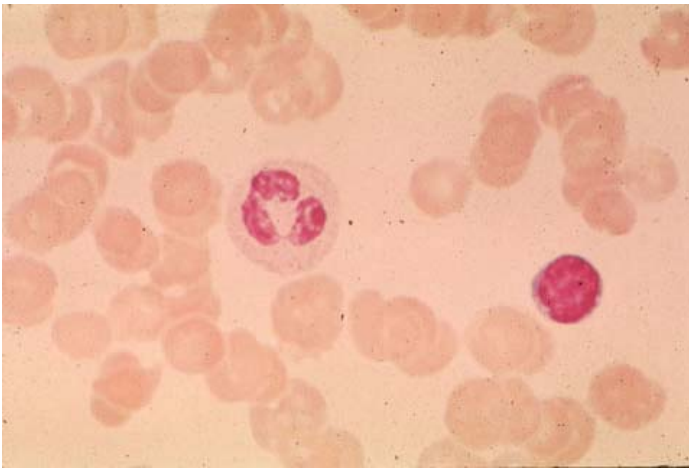


Figure 8: Normal NEUTROPHIL and LYMPHOCYTE

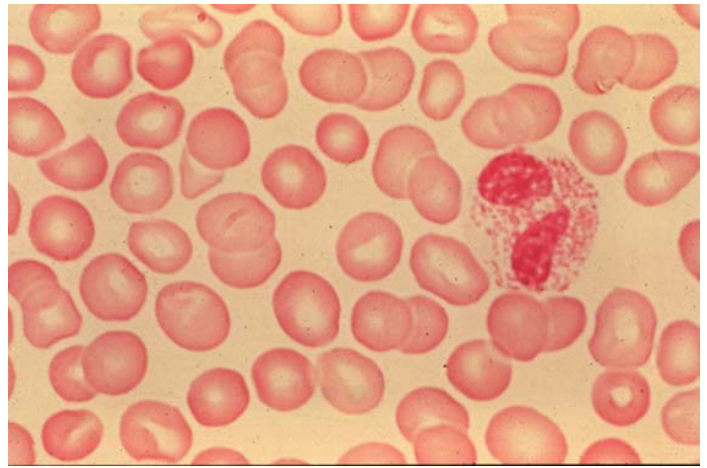


Figure 11: EOSINOPHIL

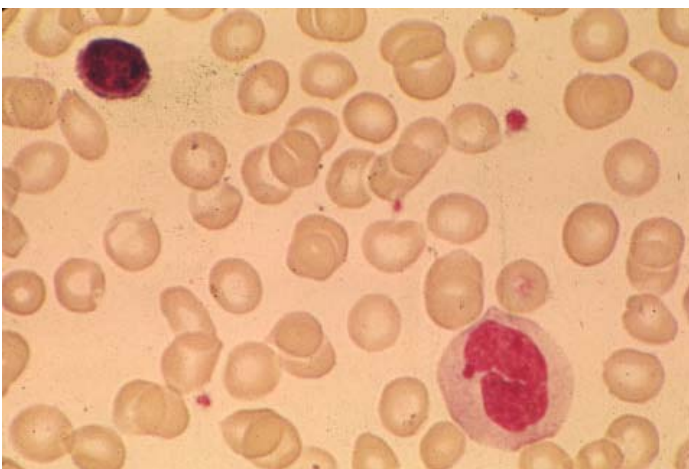


Figure 9: Normal MONOCYTES and LYMPHOCYTE

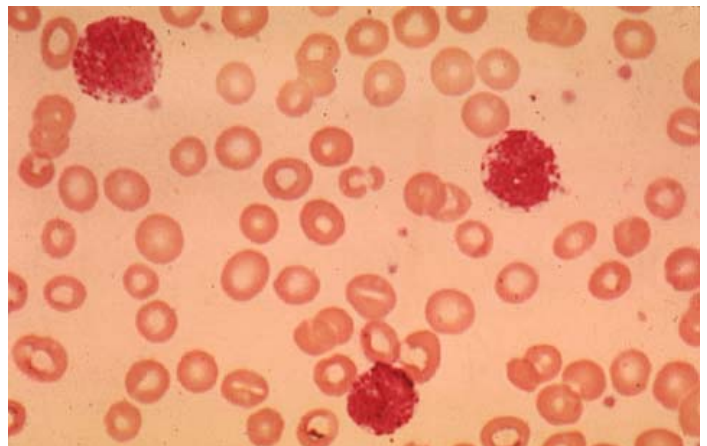


Figure 12: BASOPHILS

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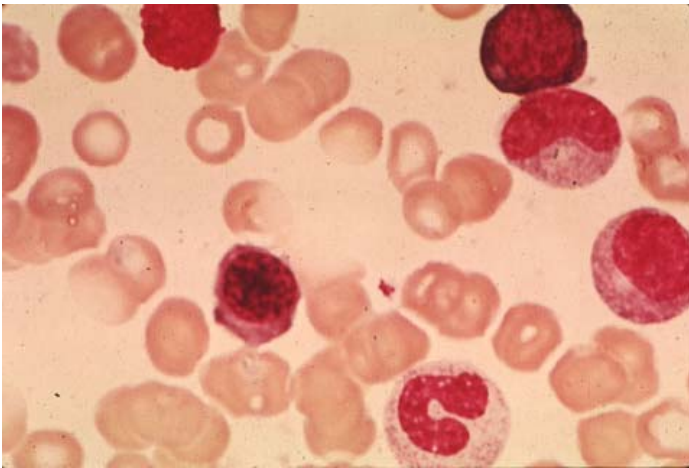


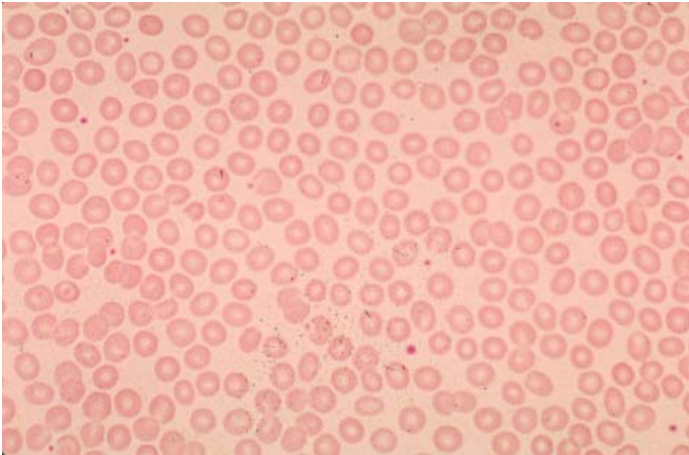
Figure 13: Peripheral blood- **MYELOCYTES** and **METAMYELOCYTE** are not normal findings in peripheral blood but may be seen in conditions such as **myelophthisis** (invasion of the bone marrow), **hemolytic anemias**, and other stressful states.



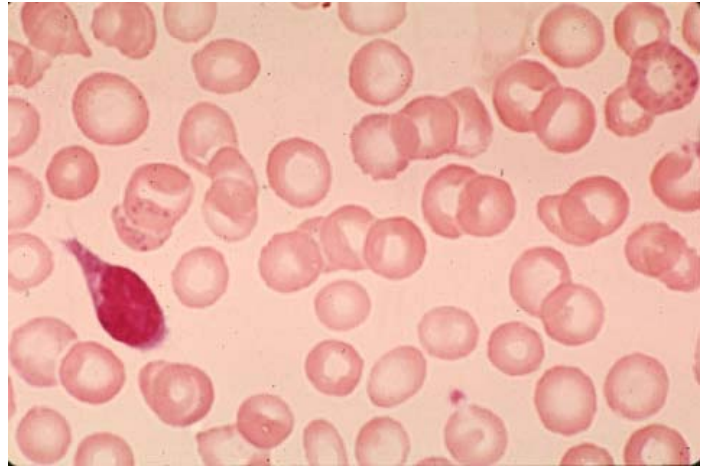
Figure 14: Nucleated RBC (**orthochromic normoblast**)- similarly not seen normally but seen with **myelophthisis**, **hemolysis**, and other stresses.

# HEMATOLOGY

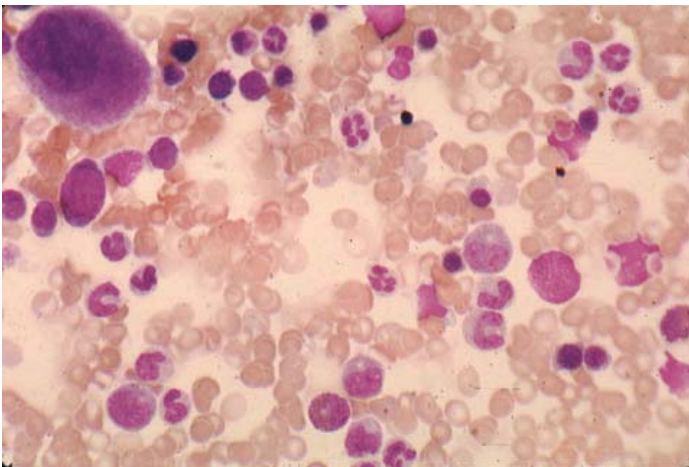
## Morphological Abnormalities of Red Blood Cells



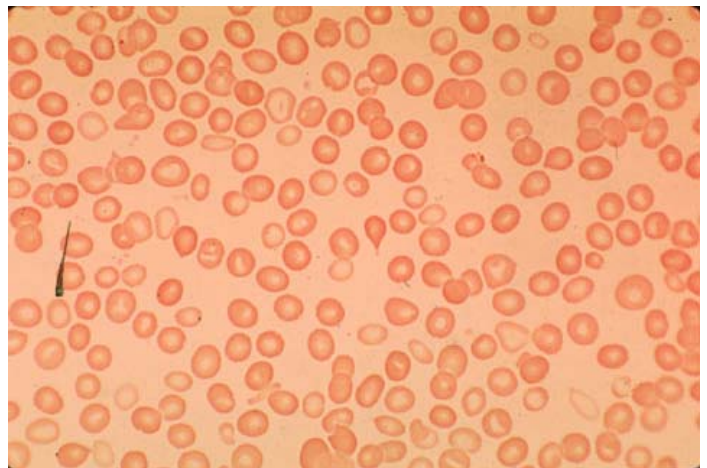
Lab 1- Kodachrome: 1 Peripheral blood: normal; 525x



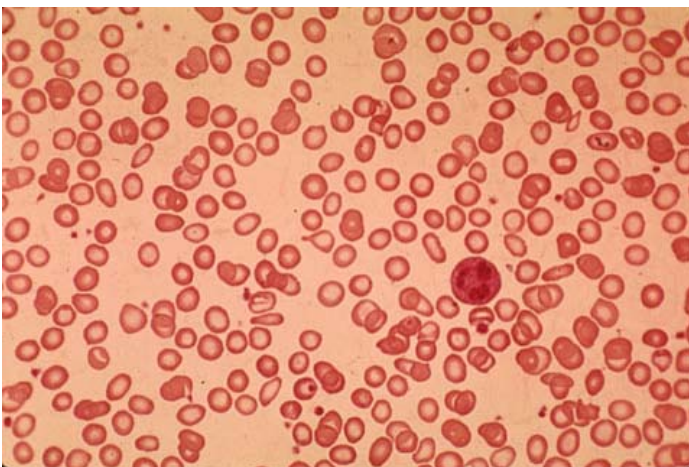
Lab 1- Kodachrome: 4 Peripheral blood: **Lead poisoning**- basophilic stippling 1250x



Lab 1- Kodachrome: 2 Bone marrow: normal; 525x



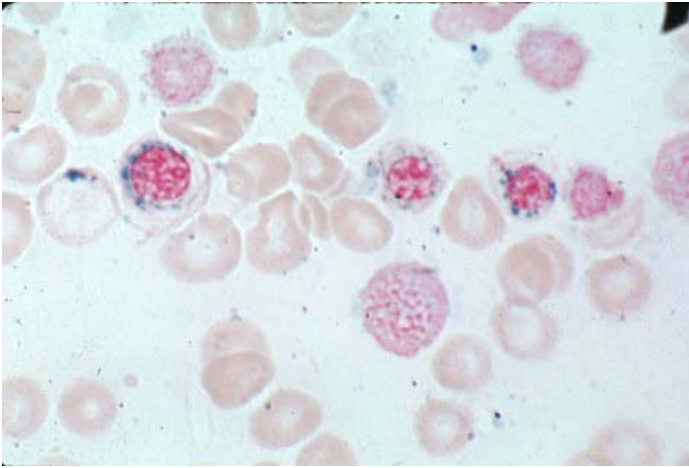
Lab 1- Kodachrome: 5 Peripheral blood: **Sideroblastic anemia**- one classically sees dimorphic red cells: a hypochromic/microcytic population and larger cells that are not hypochromic. This type of picture could also be seen after blood transfusion and with partially treated **iron-deficiency anemia**. 525x



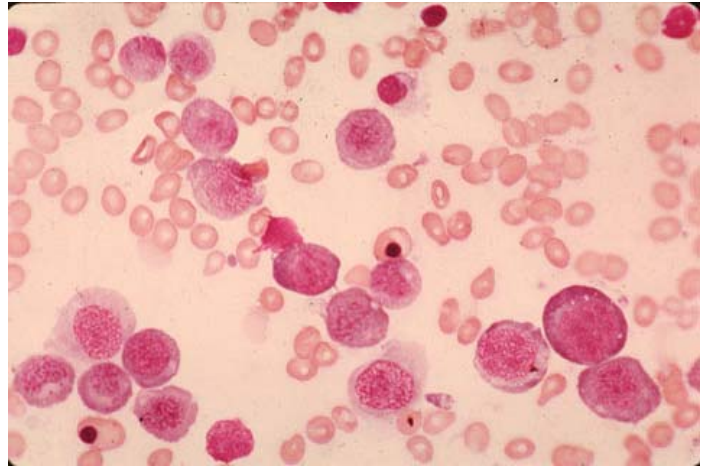
Lab 1- Kodachrome: 3 Peripheral blood: **iron deficiency anemia** 525x

# HEMATOLOGY

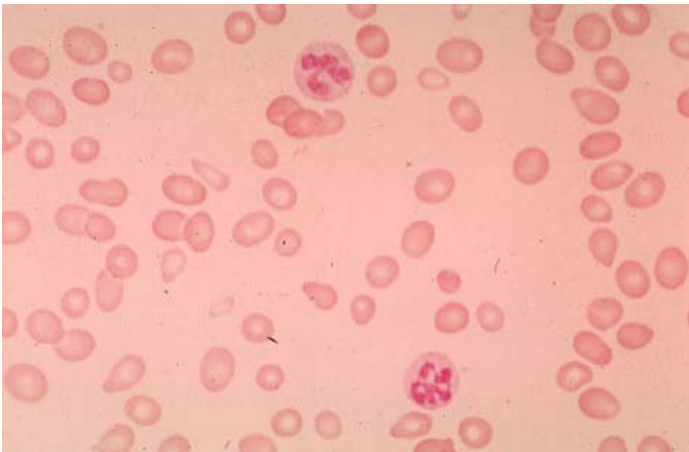
## Morphological Abnormalities of Red Blood Cells



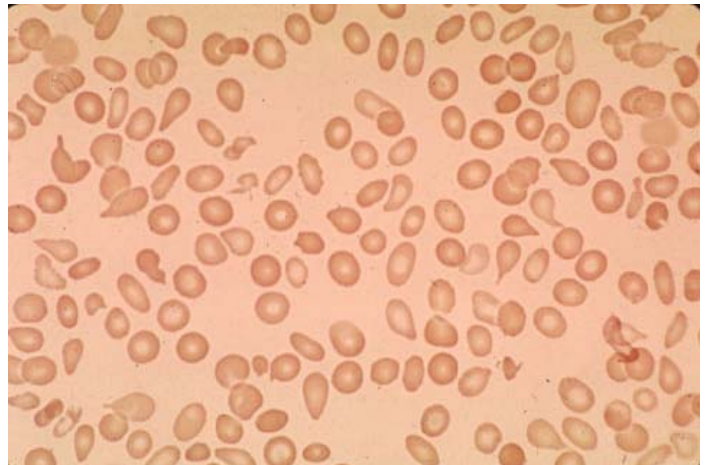
Lab 1- Kodachrome: 6 Bone marrow: **Sideroblastic anemia**; Prussian blue stain; in pathognomonic ringed **SIDEROBLASTS**, the iron appears to surround the nucleus because it is trapped in mitochondria. Ringed **SIDEROBLASTS** can be idiopathic (e.g. **myelodysplastic syndrome**), hereditary, and can occur with drugs and toxins (especially alcohol). 1250x



Lab 1- Kodachrome: 8 Bone marrow: **megaloblastic anemia**- the hallmark of megaloblastic change is nuclear/cytoplasmic asynchrony or dissociation. Most of the cells in this field are red cell precursors with cytoplasmic maturation but large nuclei with non-condensed chromatin. 525x



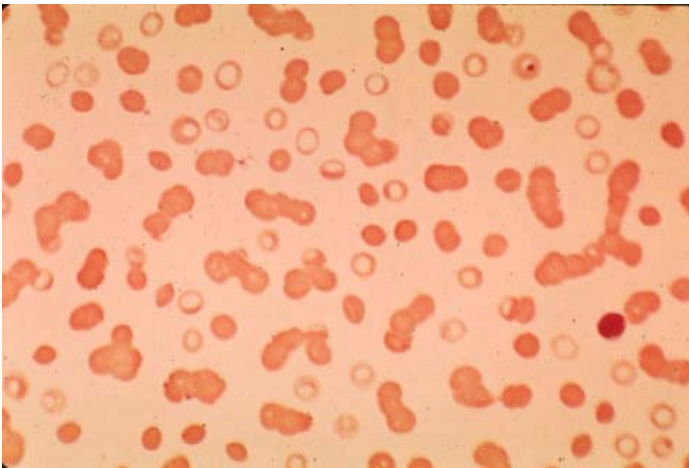
Lab 1- Kodachrome: 7 Peripheral blood: **megaloblastic anemia**- The earliest morphologic abnormality in **B12/Folate deficiency** is hypersegmentation of the **NEUTROPHILS** (greater than 5 lobes). There is pancytopenia, oval **MACROCYTES**, and extreme anisocytosis; 640x



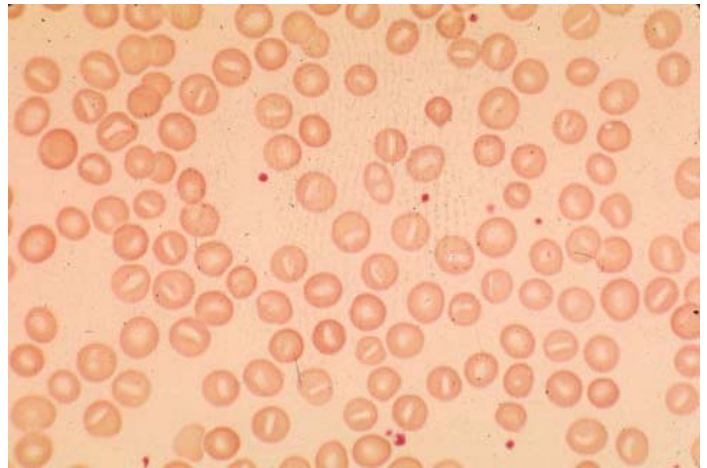
Lab 1- Kodachrome: 9 Peripheral blood: **myelofibrosis**- **TEARDROPS** and **ELLIPTOCYTES** are characteristic of myelophthitic processes and are most extreme in **myelofibrosis**. **Leukoerythroblastosis** (immature myeloid cells and nucleated red blood cells in the blood) are also most characteristic of myelophthitic processes and is always seen in **myelofibrosis**. 640x

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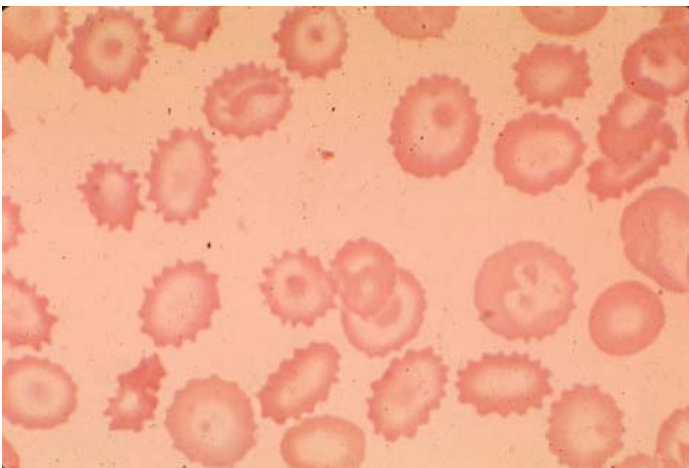
## Morphological Abnormalities of Red Blood Cells



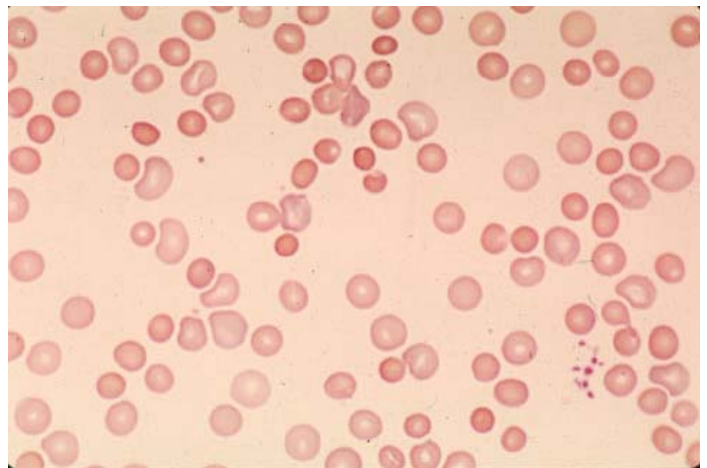
Lab 1- Kodachrome: 10 Peripheral blood: **macroglobulinemia**, **ROULEAUX** 525x



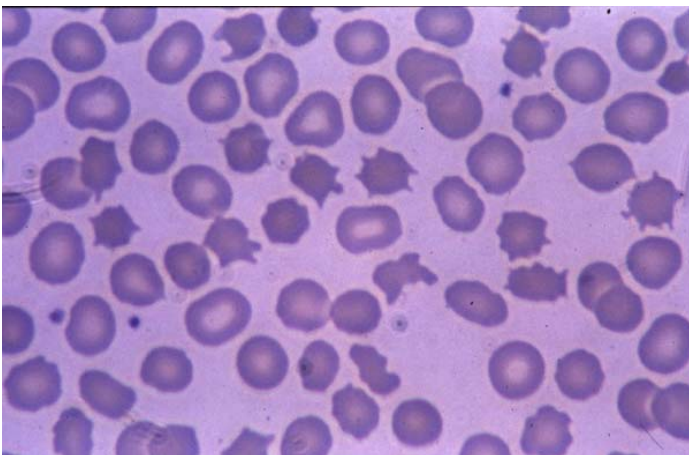
Lab 1- Kodachrome: 13 Peripheral blood: **STOMATOCYTES**- most often artifacts, but true stomatocytes can be seen after alcohol binges and with rare hereditary conditions; 640x



Lab 1- Kodachrome: 11 Peripheral blood: **ECHINOCYTES** and **TARGET CELLS**; 1250x



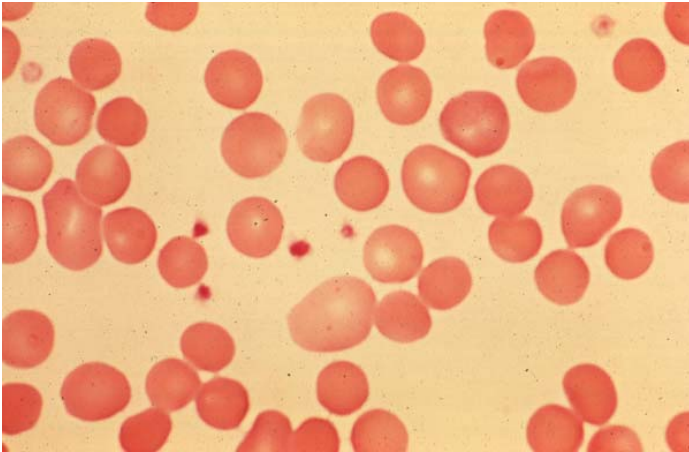
Lab 1- Kodachrome: 14 Peripheral blood: **autoimmune hemolytic anemia**; **SPHEROCYTES**, small cells lacking central pallor, are formed when red blood cells lose some of their membrane and must maximize surface: volume ratio. **SPHEROCYTES** is the predominant abnormality in the blood smear in **autoimmune hemolytic anemia** and **hereditary spherocytosis**. Note also in this slide the large bluish cells, which represent **RETICULOCYTES**. 640x



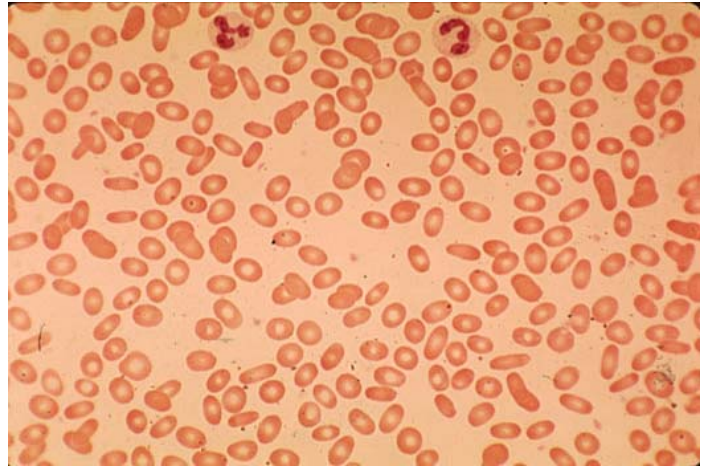
Lab 1- Kodachrome: 12 Peripheral blood: **spur cell anemia** (**ACANTHOCYTES** with liver disease) 1250x

# HEMATOLOGY

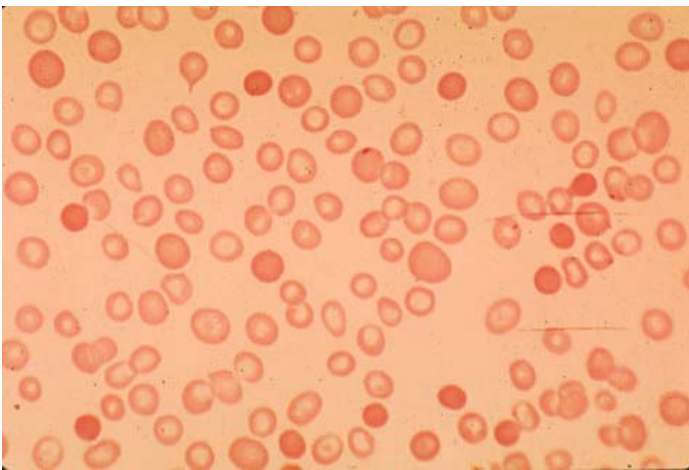
## Morphological Abnormalities of Red Blood Cells



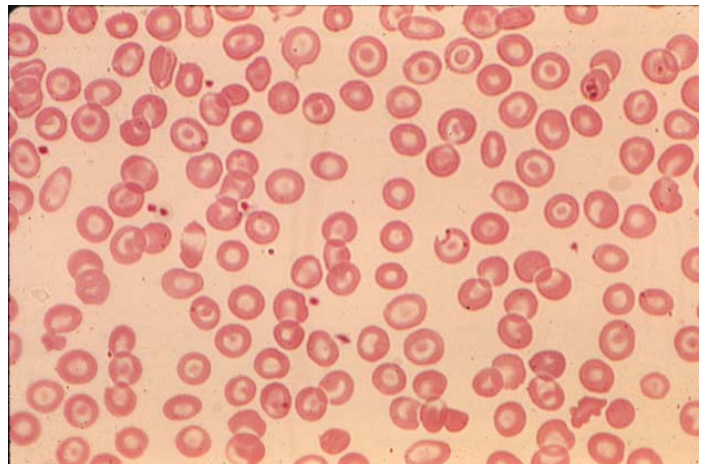
Lab 1- Kodachrome: 15 Peripheral blood: **hereditary spherocytosis** cannot be distinguished from **autoimmune hemolytic anemia** on the blood film. The disorders can be distinguished by history, physical exam (**splenomegaly**), and **DIRECT Coombs' test**. 1250x



Lab 1- Kodachrome: 17 Peripheral blood: **hereditary elliptocytosis**- usually a mild hereditary hemolytic anemia. 525x



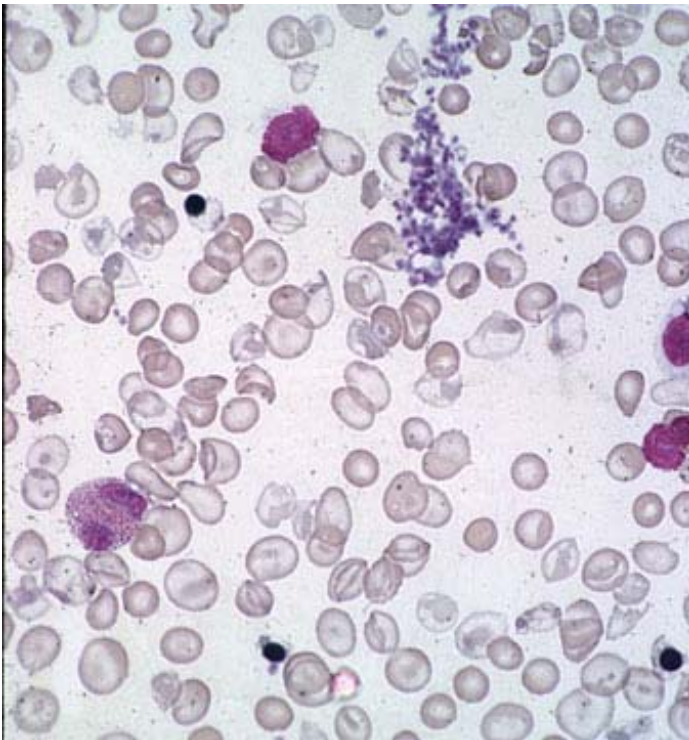
Lab 1- Kodachrome: 16 Peripheral blood: **iron deficiency anemia** complicated by hemolytic transfusion- There is underlying hypochromic/microcytic red cells. **SPHEROCYTES** are a result of the immune hemolytic reaction to mismatched blood. 640x



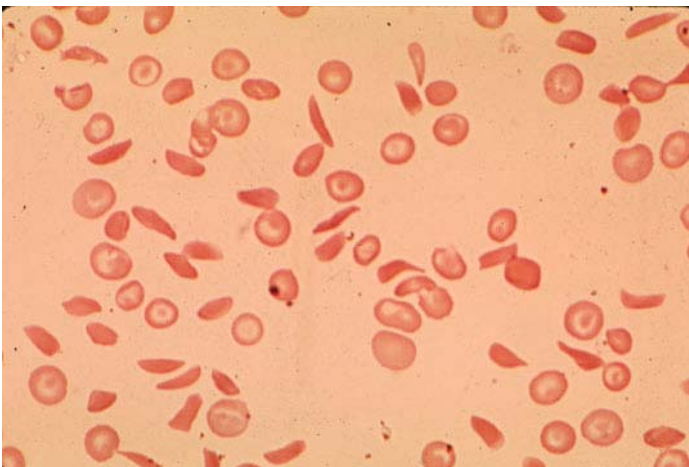
Lab 1- Kodachrome: 18 Peripheral blood: **thalassemia minor**- there is always substantial **MICROCYTOSIS**. **TARGET CELLS**, basophilic stippling, and hypochromia may or may not be prominent. 640x

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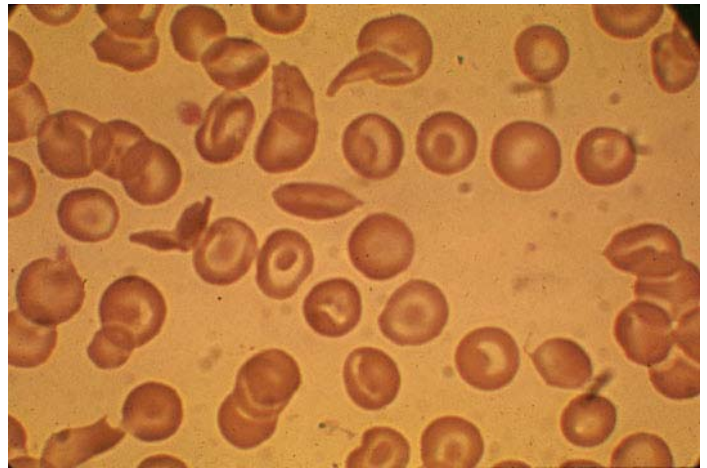
## Morphological Abnormalities of Red Blood Cells



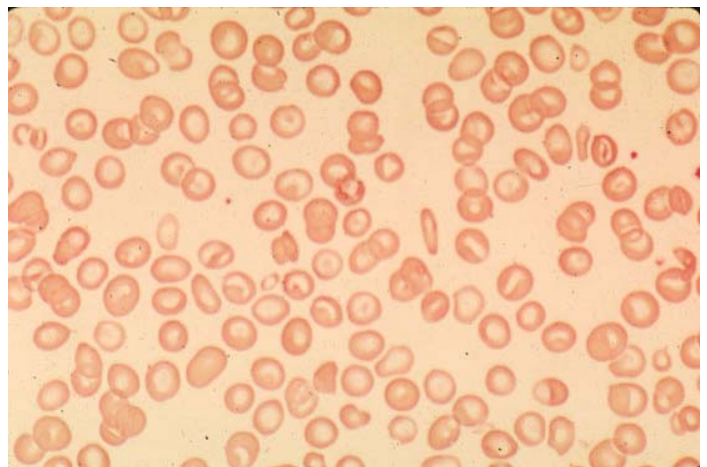
Lab 1- Kodachrome: 19 Peripheral blood: **thalassemia major** 640x



Lab 1- Kodachrome: 20 Peripheral blood: **sickle cell anemia**- **TARGET CELLS** are seen in **hemoglobinopathies**, **thalassemias**, in **liver disease**, and **asplenia**. 640x



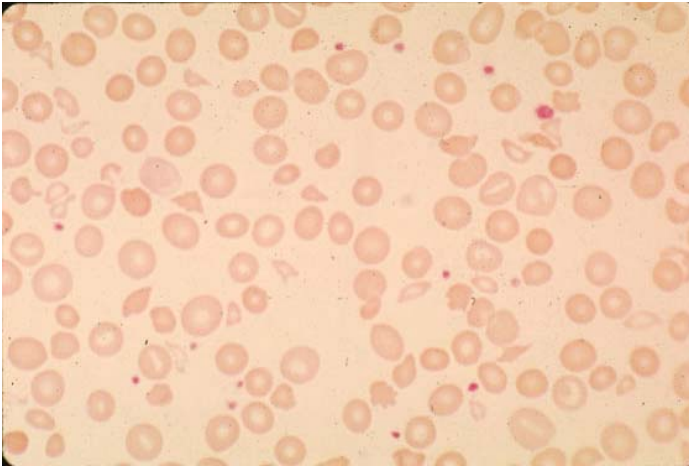
Lab 1- Kodachrome: 21 Peripheral blood: **hemoglobin SC disease**- SC patients frequently have compensated hemolysis (they are not anemic). **SICKLE CELLS** tend to be few, **TARGET CELLS** prominent, and there are a number of unusual forms (**BOAT CELLS**). 800x



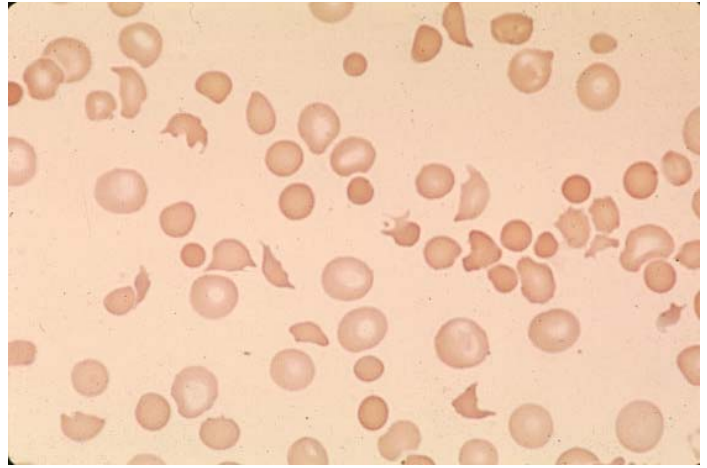
Lab 1- Kodachrome: 22 Peripheral blood:  
**S-thalassemia**- In Sickle-thalassemia, the anemia tends to be milder than in SS disease, there are few **SICKLE CELLS**, and there is **MICROCYTOSIS**. 640x

# HEMATOLOGY

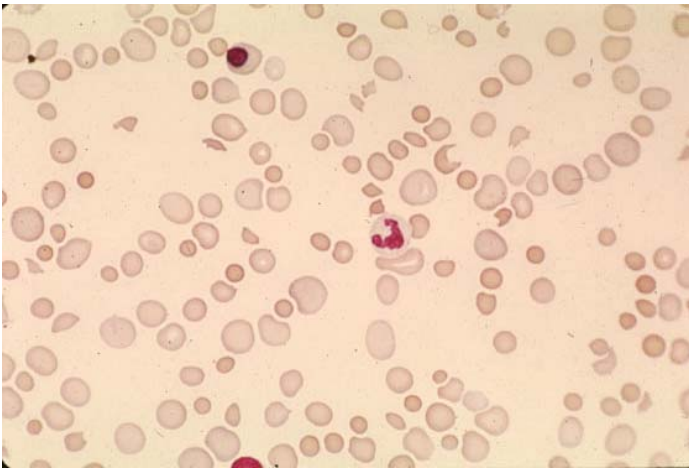
## Morphological Abnormalities of Red Blood Cells



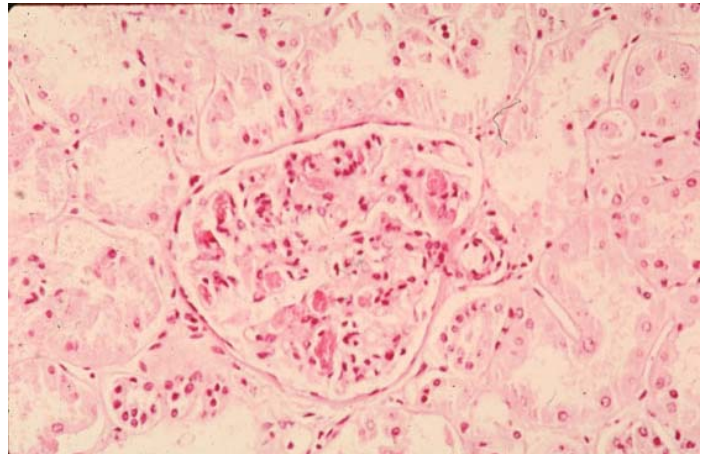
Lab 1- Kodachrome: 23 Peripheral blood: red cell fragmentation due to artificial valve- In contrast to microangiopathic hemolysis, the platelet count is not low. 640x



Lab 1- Kodachrome: 25 Peripheral blood: **microangiopathic hemolytic anemia**- In microangiopathic hemolytic anemias, there are **SCHISTOCYTES**, **SPHEROCYTES**, **polychromasia**, and **thrombocytopenia**. 800x



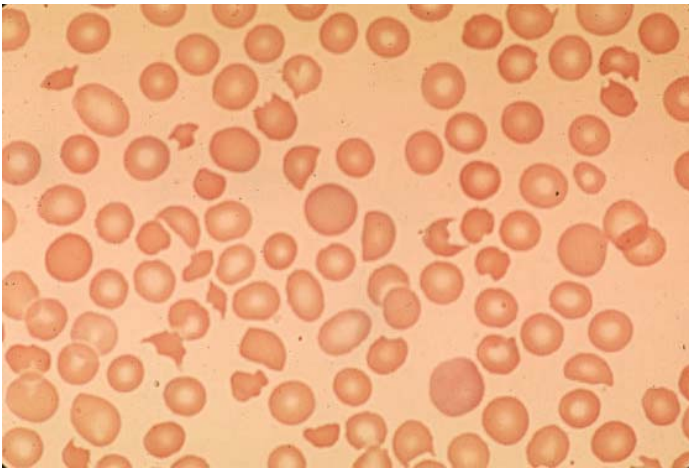
Lab 1- Kodachrome: 24 Peripheral blood: **thrombotic thrombocytopenic purpura**- Causes of microangiopathic hemolytic anemia include: **TTP**, **hemolytic-uremic syndrome**, **disseminated intravascular coagulation**, **disseminated carcinomatosis**, **malignant hypertension**, and **renal vasculitis**. Conditions other than TTP would rarely, if ever, produce a blood smear picture this severe. In the proper clinical context (neurologic symptoms), this smear would be diagnostic of TTP. 525x



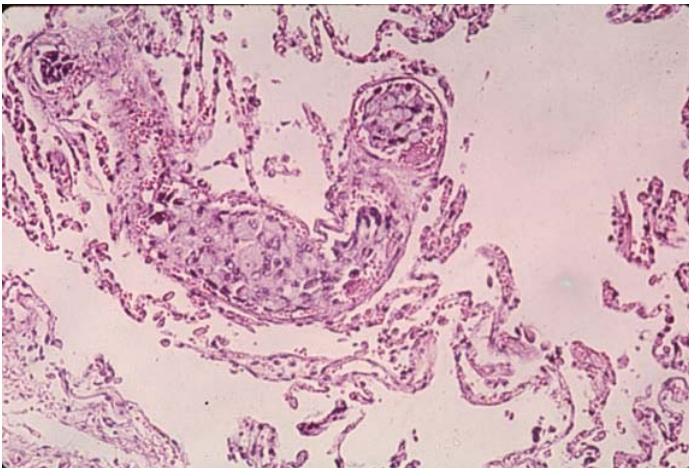
Lab 1- Kodachrome: 26 Kidney: **microangiopathic hemolytic anemia** 200x

# HEMATOLOGY

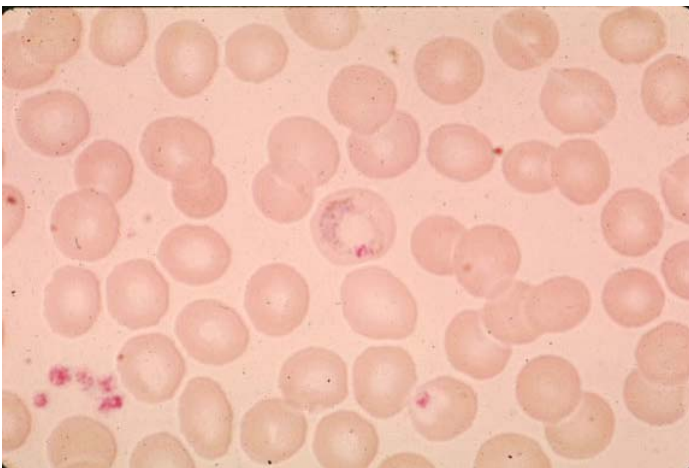
## Morphological Abnormalities of Red Blood Cells



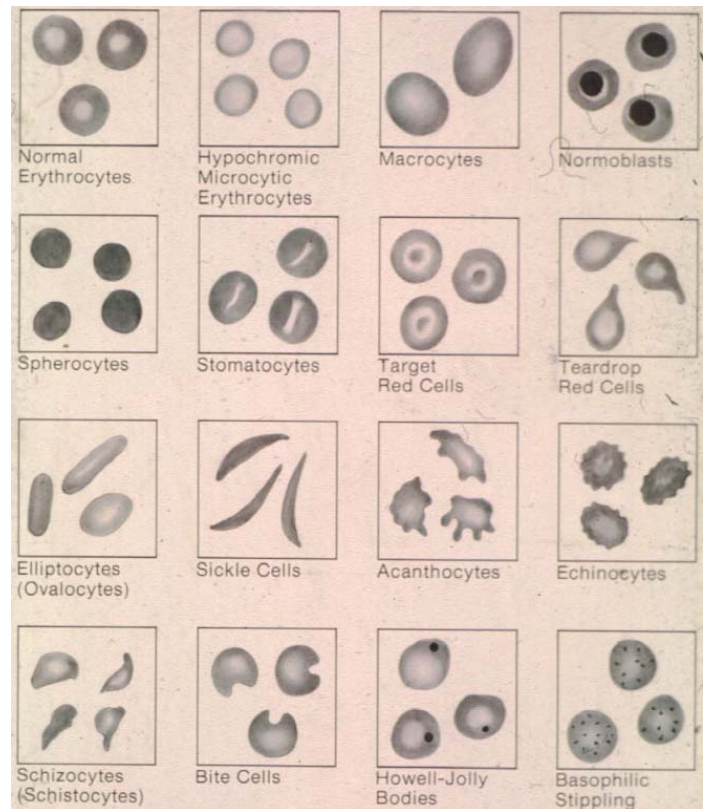
Lab 1- Kodachrome: 27 Peripheral blood: **microangiopathic hemolytic anemia associated** with disseminated cancer 800x



Lab 1- Kodachrome: 28 Lung: intravascular tumor 125x



Lab 1- Kodachrome: 29 Peripheral blood: **malaria** parasite- this slide illustrates a ringed form **MEROZOITE**. 1250x



Lab 1- Kodachrome: 30 Review abnormal red cell shapes:

# HEMATOLOGY

## Anemia

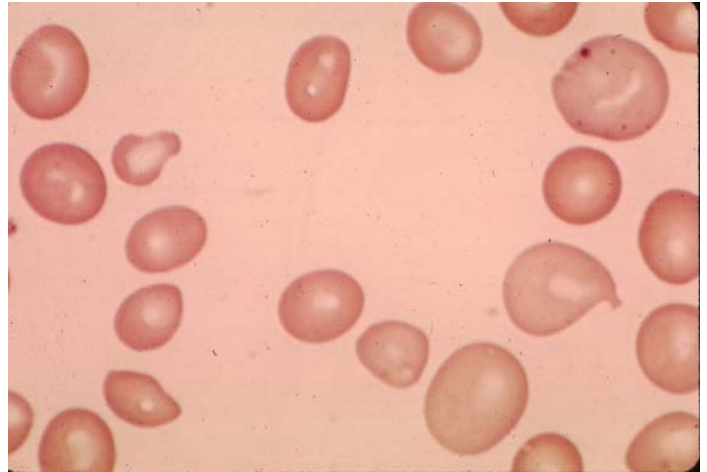
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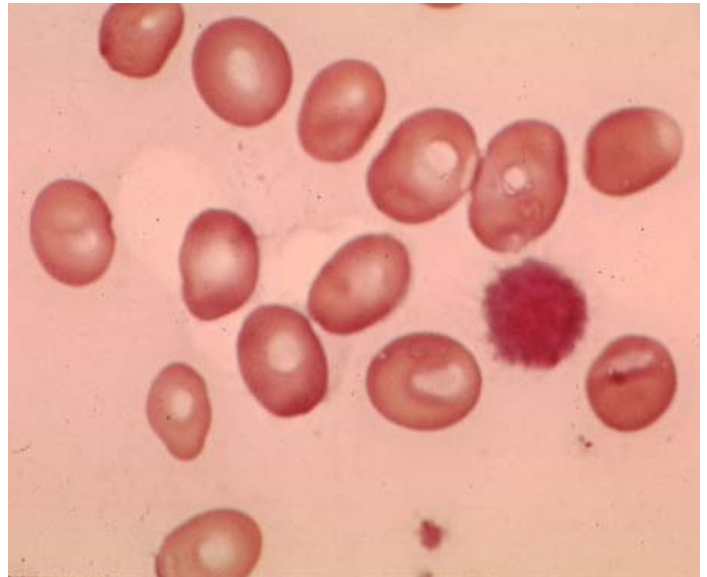
Lab 3- Kodachrome: 1 Case A: **Iron deficiency anemia**, 640x



Lab 3- Kodachrome: 2 Case B: **Pernicious anemia**, 640x



Lab 3- Kodachrome: 3 Case B: **Pernicious anemia**, 1225x

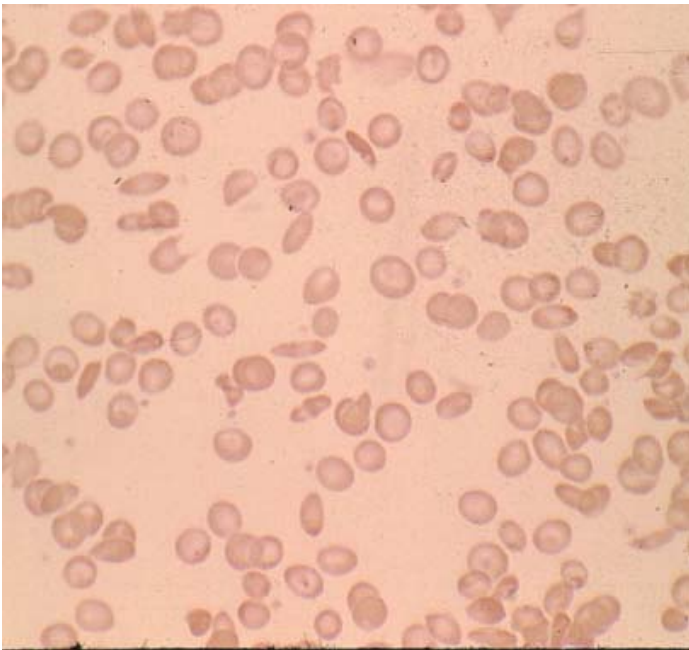


Lab 3- Kodachrome: 4 Case B: **Pernicious anemia**, 640x

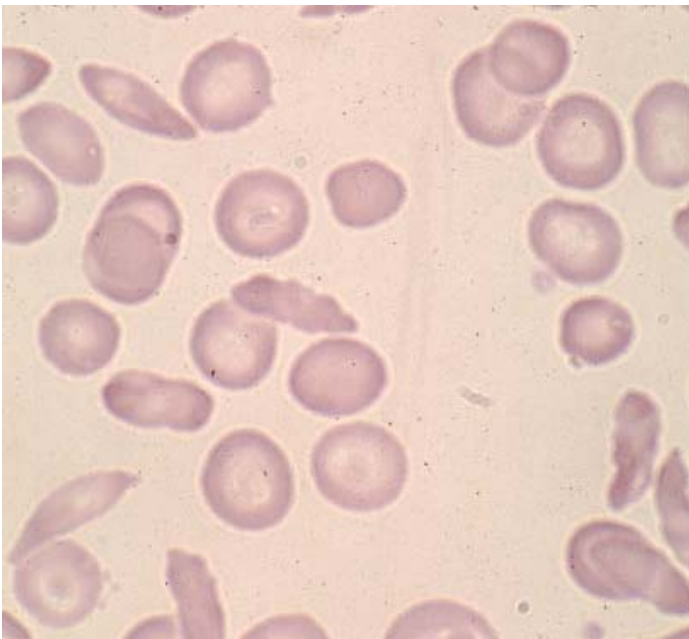
# HEMATOLOGY

## Anemia

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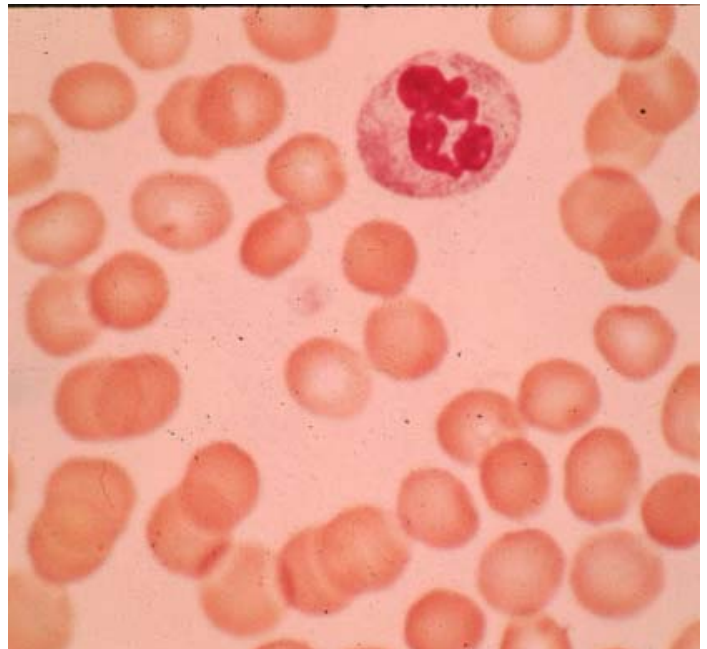
Lab 3- Kodachrome: 5 Case C: **Sickle Cell Anemia**, 525x



Lab 3- Kodachrome: 6 Case C: **Sickle Cell Anemia**, 1225x



Lab 3- Kodachrome: 7 Case D: **Hereditary Spherocytosis**, 640x

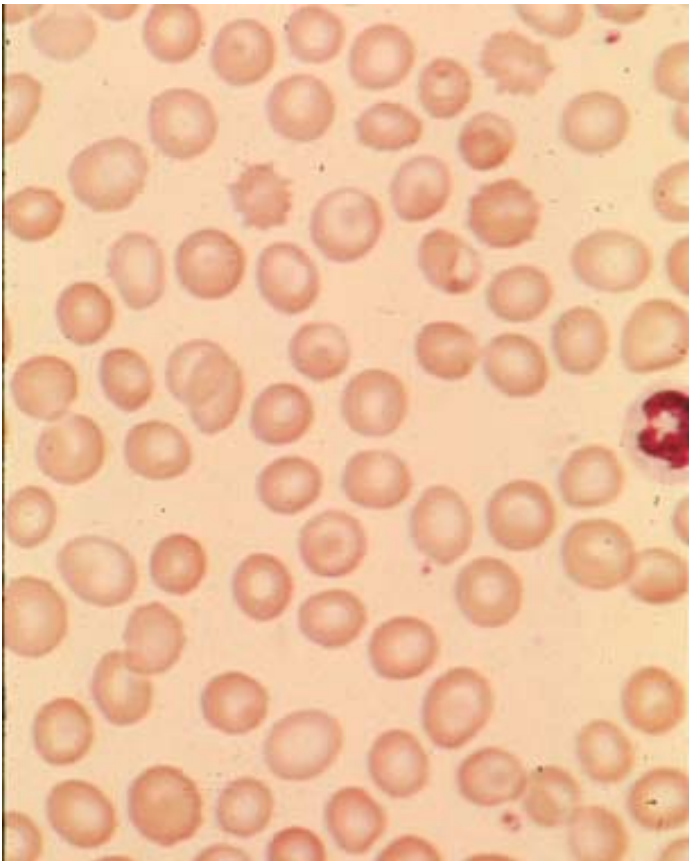


Lab 3- Kodachrome: 8 Case D: **Hereditary Spherocytosis**, 1225x

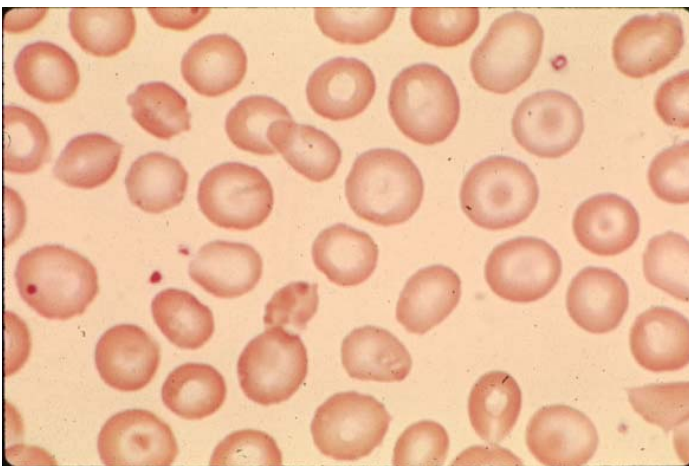
# HEMATOLOGY

## *Anemia*

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Lab 3- Kodachrome: 9 Case E: **Postsplenectomy state**, 800x

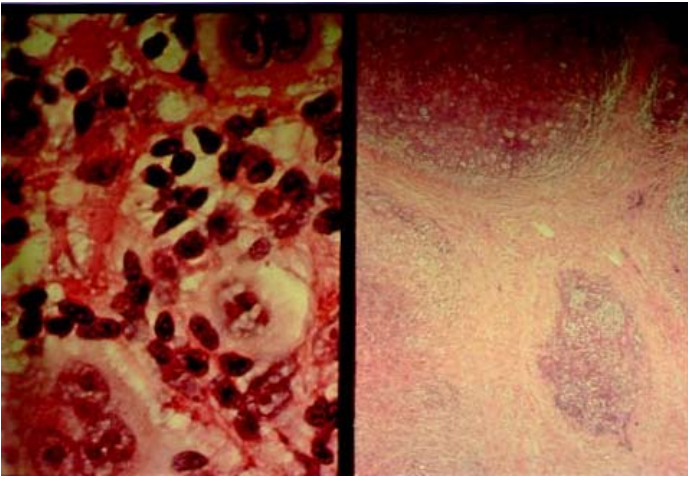


Lab 3- Kodachrome: 10 Case E: **Postsplenectomy state**, 1225x

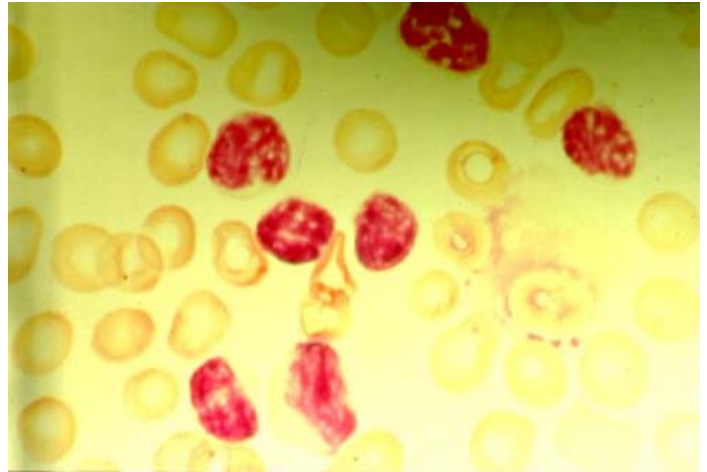
# HEMATOLOGY

## Lymphoma

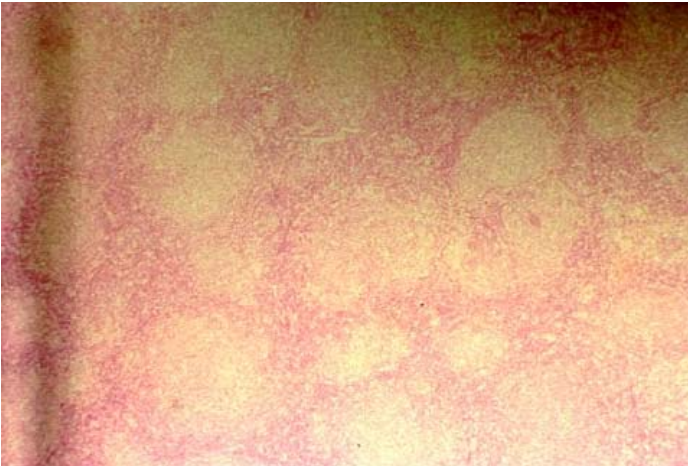
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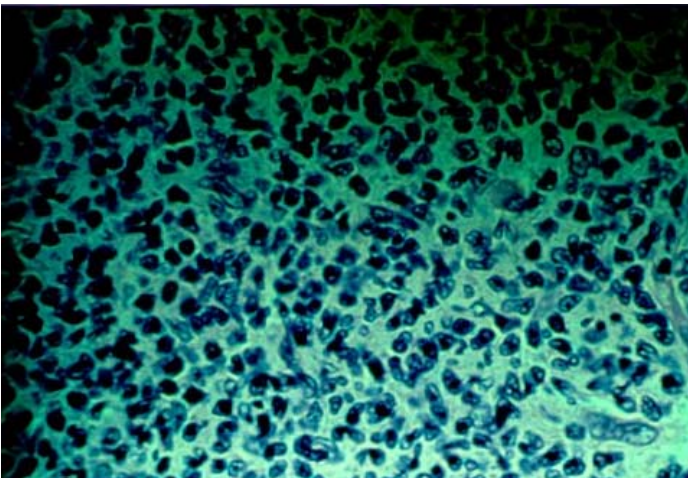
Lab 7- Kodachrome: 1 **Hodgkin's disease**, nodular sclerosing



Lab 7- Kodachrome: 4 **Follicular lymphoma** ("BUT-TOCK" CELL)



Lab 7- Kodachrome: 2 **Follicular lymphoma**, low power

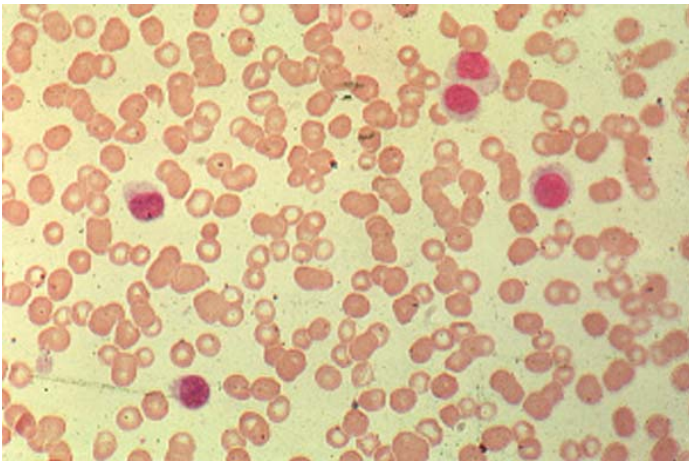


Lab 7- Kodachrome: 3 **Follicular lymphoma**, small cleaved (high power)

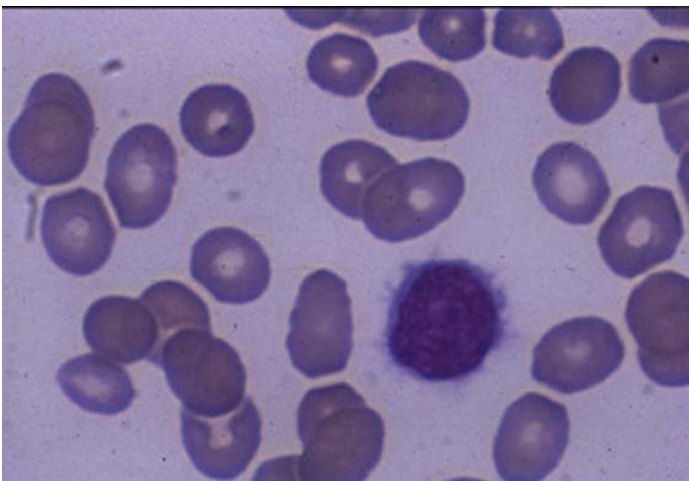
# HEMATOLOGY

## *Pancytopenia and Thrombocytopenia*

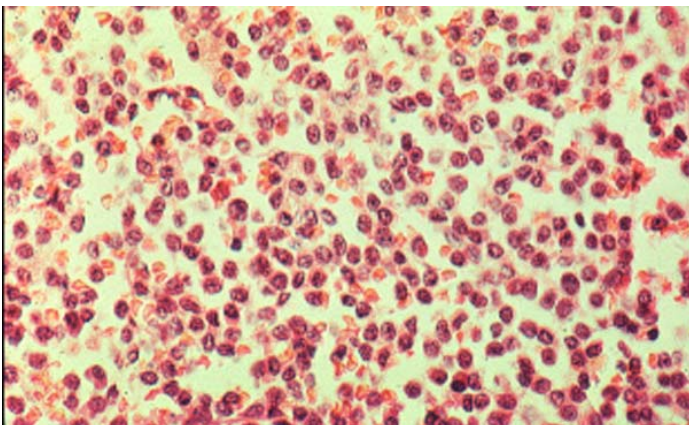
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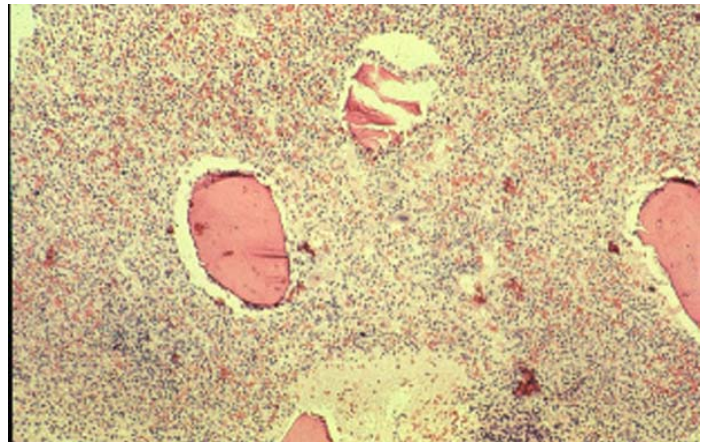
Lab 8- Kodachrome: 1 Peripheral blood



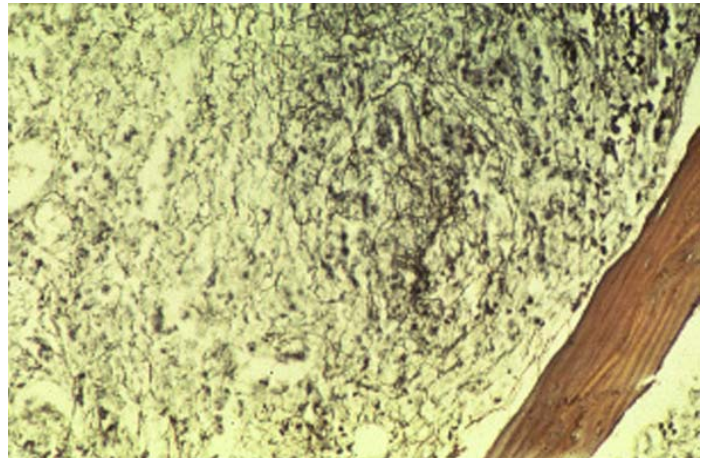
Lab 8- Kodachrome: 2 Peripheral blood



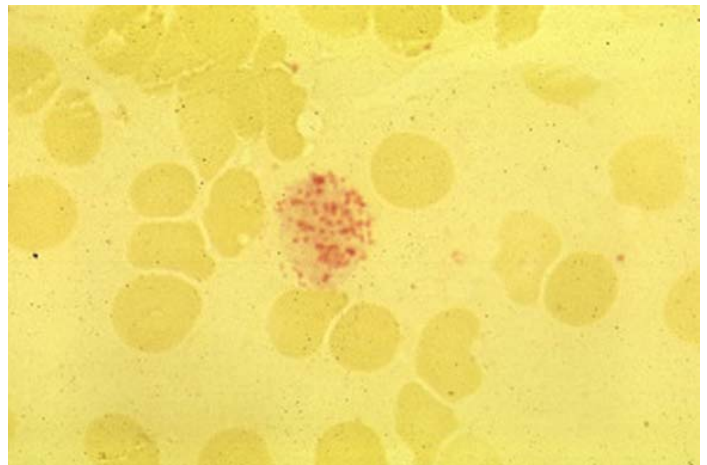
Lab 8- Kodachrome: 3 Bone marrow aspirate



Lab 8- Kodachrome: 4 Bone marrow biopsy



Lab 8- Kodachrome: 5 Reticulin Stain

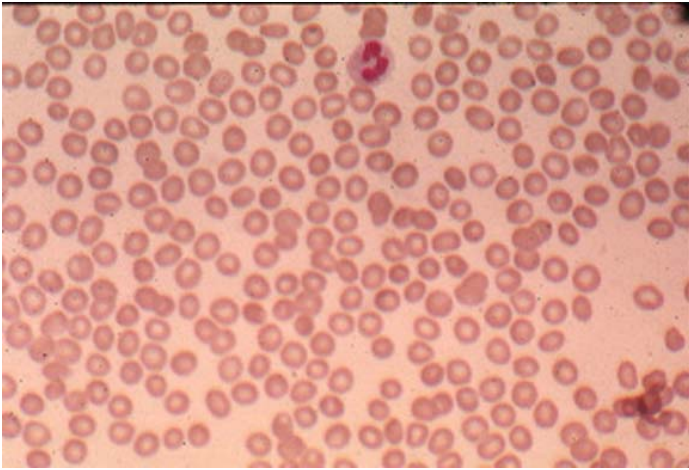


Lab 8- Kodachrome: 6 Tartrate-resistant acid phosphatase

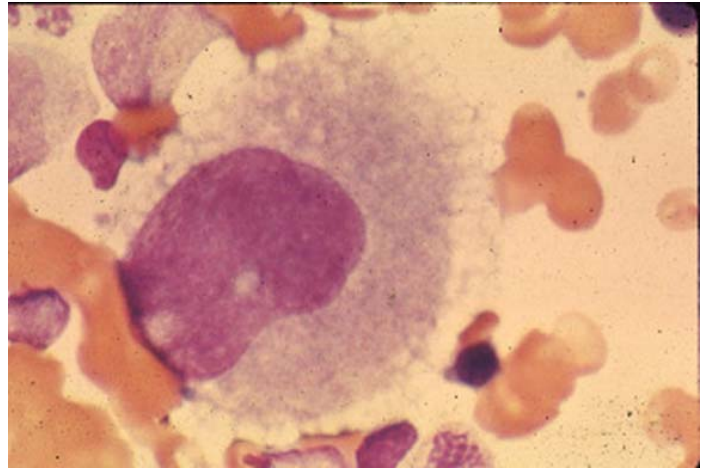
# HEMATOLOGY

## *Pancytopenia and Thrombocytopenia*

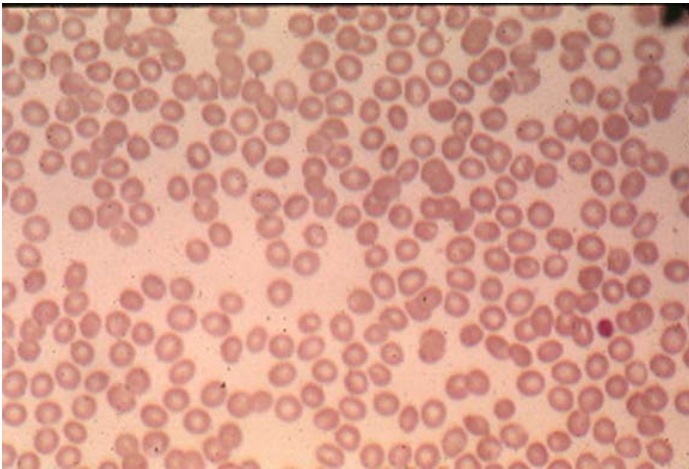
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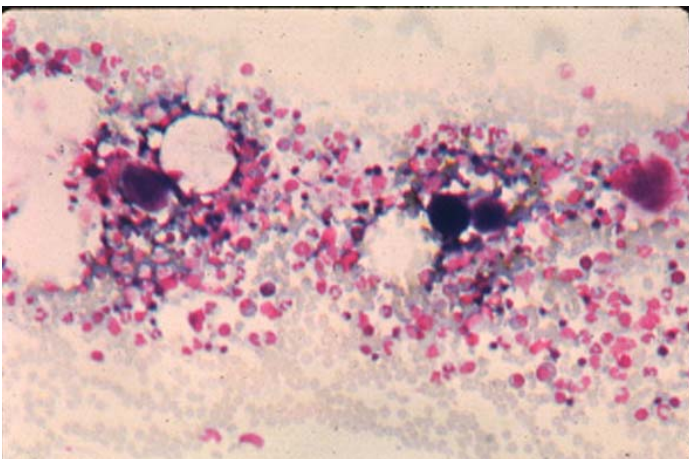
Lab 8- Kodachrome: 7 Peripheral Blood- **thrombocytopenia**



Lab 8- Kodachrome: 10 Bone marrow/vacuolated **MEGAKARYOCYTE**



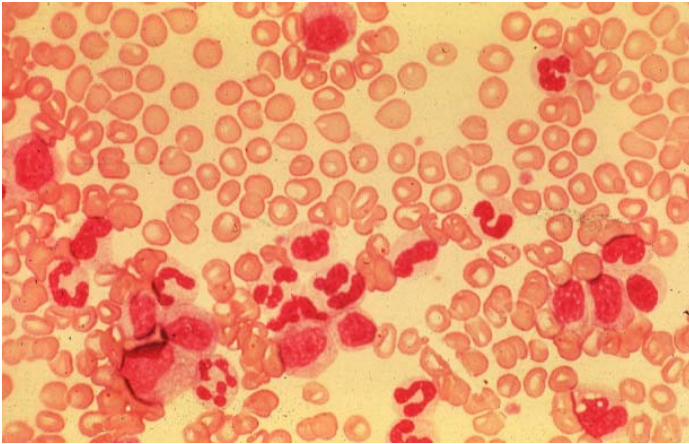
Lab 8- Kodachrome: 8 Peripheral Blood- **MEGATHROMBOCYTE**



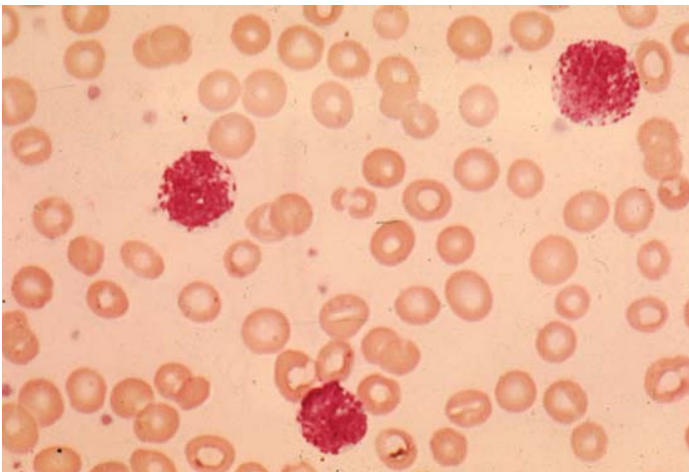
Lab 8- Kodachrome: 9 Bone marrow/increased **MEGAKARYOCYTES**

# HEMATOLOGY

## Morphological Abnormalities of Leukocytes and Platelets



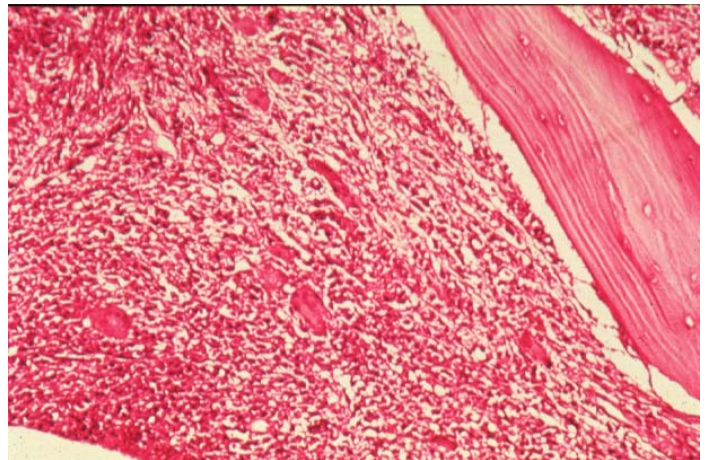
Lab 9- Kodachrome: 1 Peripheral blood: **chronic myeloid leukemia**; The full spectrum of myeloid maturation visible from immature **MYELOCYTES** to **NEUTROPHILS**. There are usually peaks in the differential at the myeloid and neutrophil stages. A LAP (**Leukocyte Alkaline Phosphatase**) score is useful to differentiate **CML** (low) from a leukemoid reaction (high). 525x



Lab 9- Kodachrome: 2 Peripheral blood: **BASOPHILS** in a patient with **chronic myeloid leukemia**; Basophilia is found in all myeloproliferative disorders and is sign of acceleration in **CML**. 800x



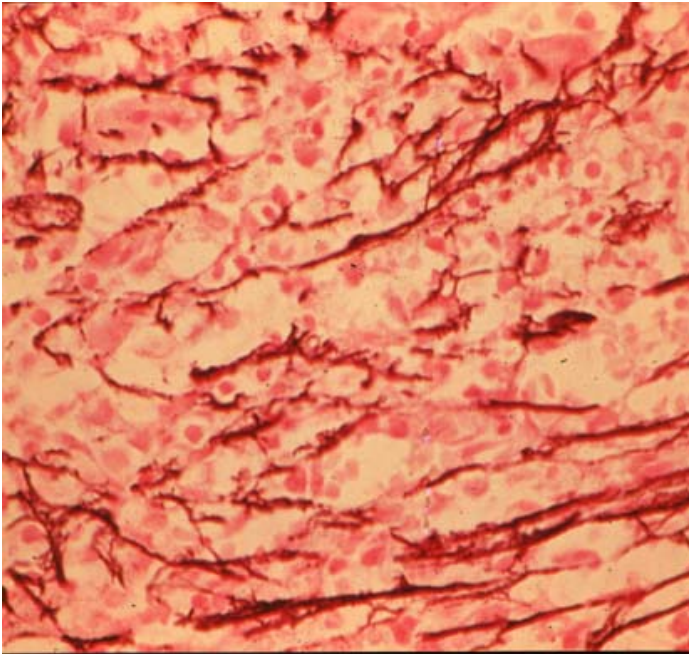
Lab 9- Kodachrome: 3 Peripheral blood: **Myelophthisis**. There are numerous **TEARDROPS** and **ELIPTOCYTES**. **Leukoerythroblastosis** (immature myeloid cells and nucleated **RBCs** in the blood) is also consistent with **myelophthisis** but especially **myelofibrosis**. 525x



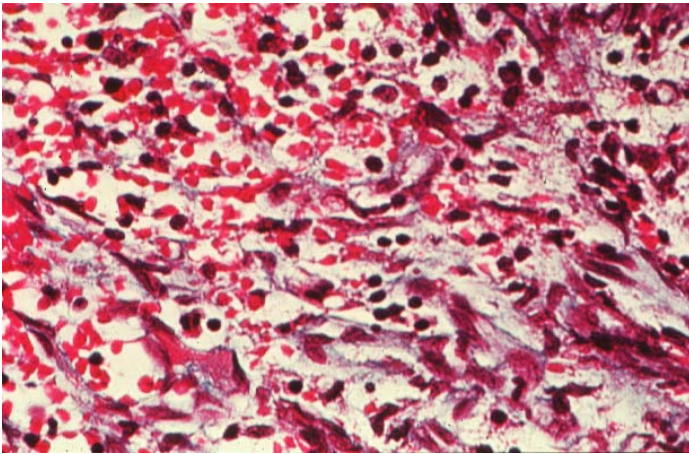
Lab 9- Kodachrome: 4 Bone marrow biopsy: **Myelofibrosis**; Wright's stain. The bone marrow aspirate is usually dry, and one sees a swirling pattern H/E. 160x

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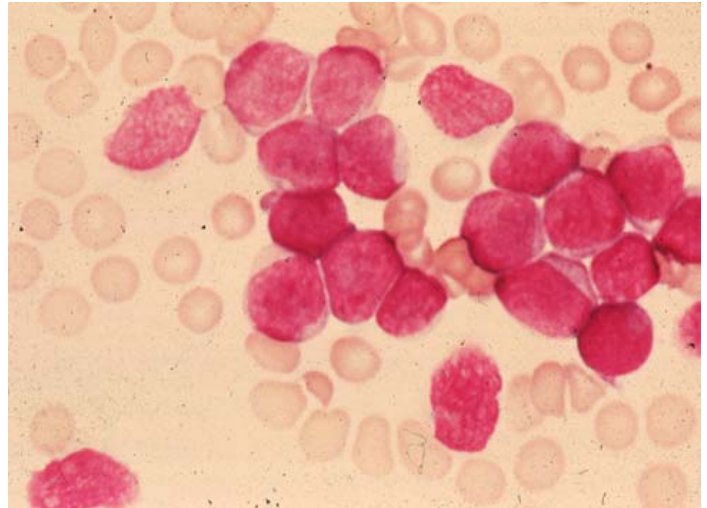
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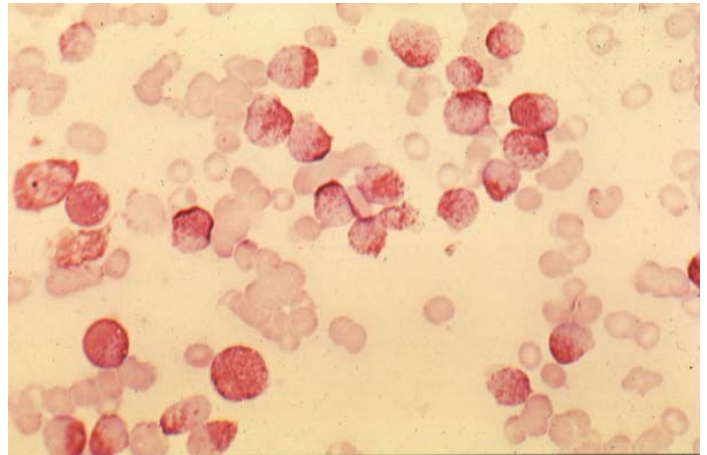
Lab 9- Kodachrome: 5 Bone marrow biopsy: **myelofibrosis**; Reticulin stain 160x



Lab 9- Kodachrome: 6 Bone marrow biopsy: **myelofibrosis**; Masson stain 525x



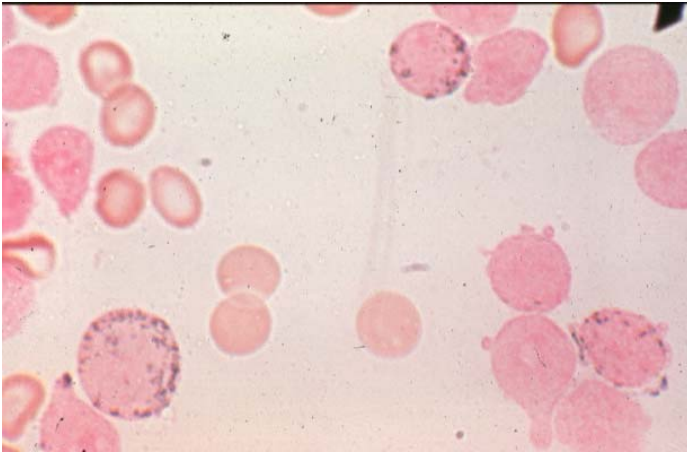
Lab 9- Kodachrome: 7 Peripheral blood: **acute myeloblastic leukemia**. There are numerous **BLASTS** with pale, blue cytoplasm, an increased N/C ratio, fine uncondensed chromatin, and +/- nucleoli.



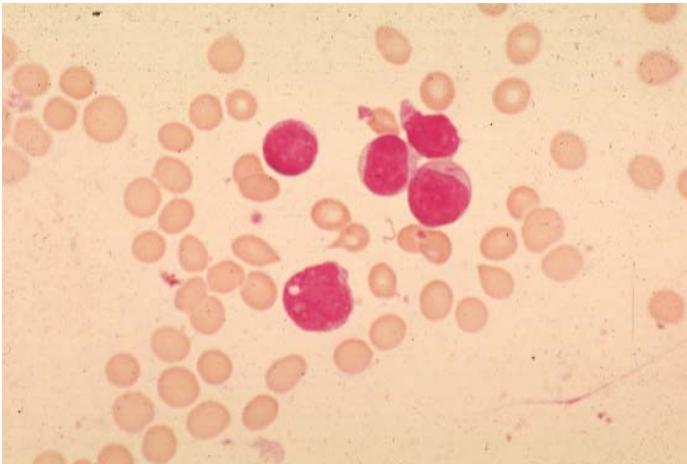
Lab 9- Kodachrome: 8 Peripheral blood: **acute myeloblastic leukemia**- note the abundance of immature **GRANULOCYTES**; Sudan black stain 640x

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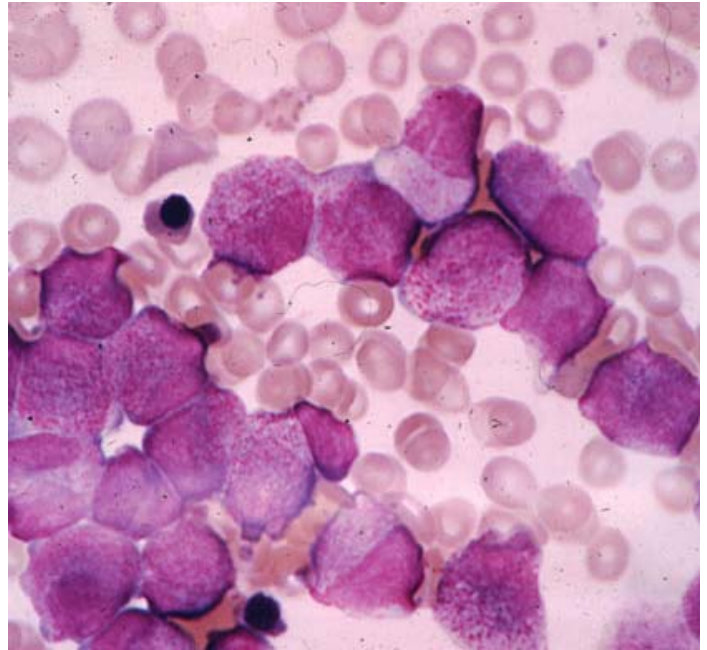
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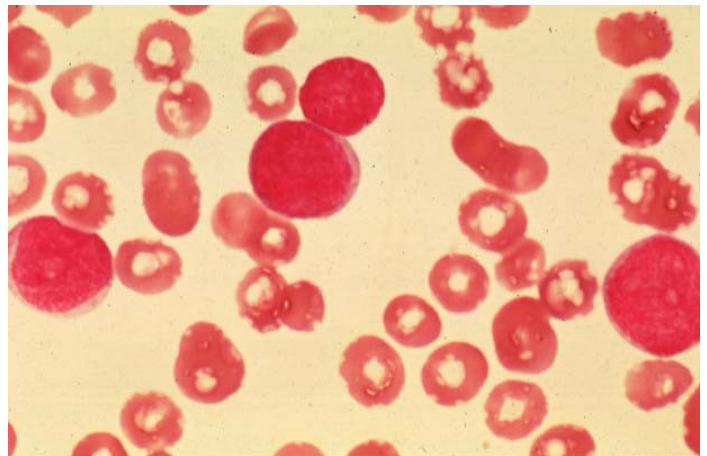
Lab 9- Kodachrome: 9 Peripheral blood: **acute myeloblastic leukemia**; Peroxidase stain 1225x



Lab 9- Kodachrome: 10 Peripheral blood: **acute myeloblastic leukemia**; Approximately 20 % of myeloid/monocytic leukemic cells have **Auer Rod** - linear condensations of abnormal primary granules.; Wright's stain; 640x



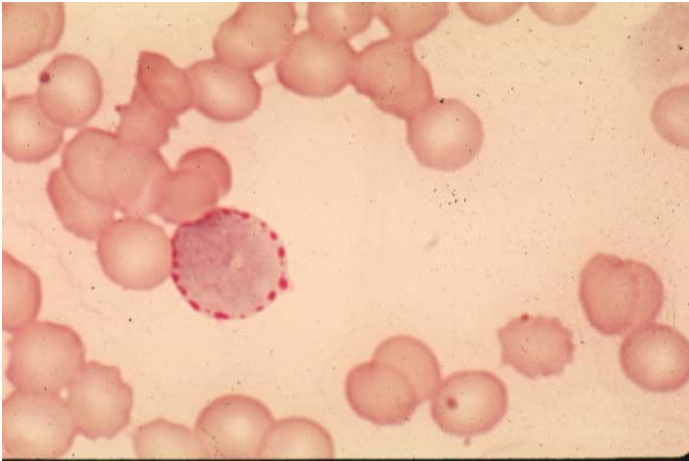
Lab 9- Kodachrome: 11 Bone Marrow: **acute promyelocytic leukemia**; The cells are not only morphologically distinguishable due to the hypergranularity, but this variant of **AML** also has a number of distinguishing characteristics including: association with **DIC**, a specific chromosomal abnormality (t15;17), and a high response rate to congeners of retinoic acid.



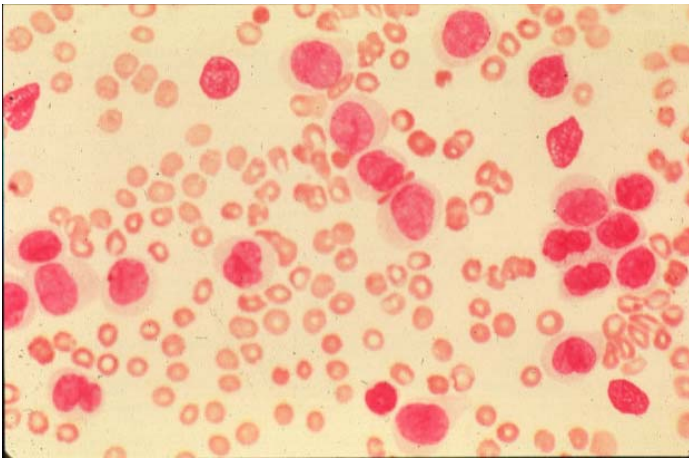
Lab 9- Kodachrome: 12 Peripheral blood: **acute lymphoblastic leukemia**; Wright's stain, 1225x

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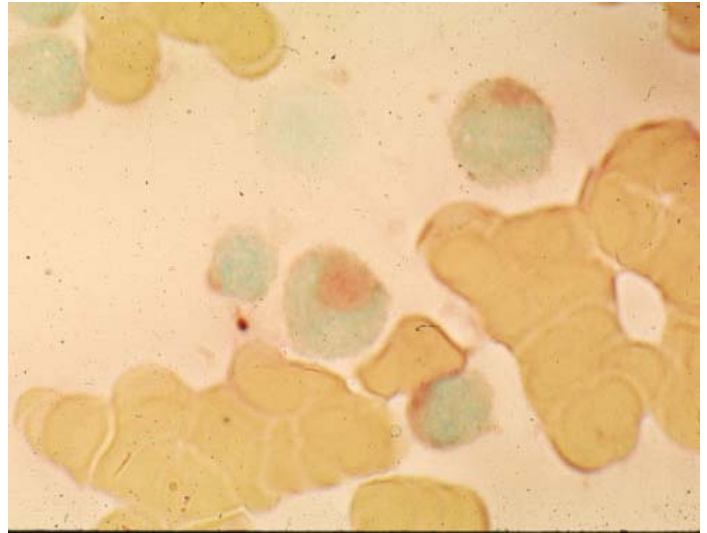
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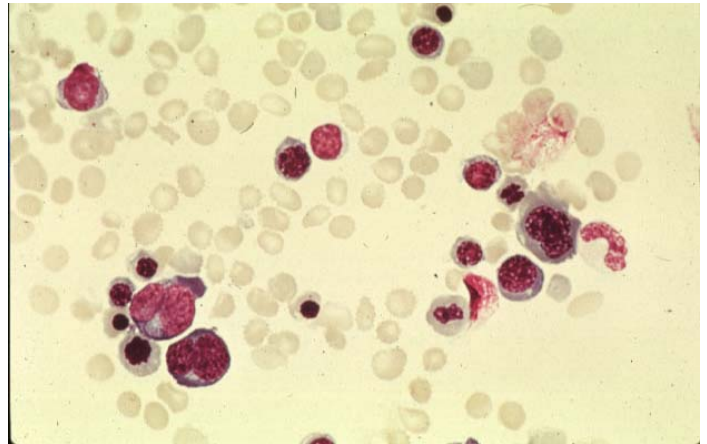
Lab 9- Kodachrome: 13 Peripheral blood: **acute lymphoblastic leukemia**; PAS stain. Both **LYMPHOBLASTS** and **RED CELL BLASTS** in erythroleukemia stain PAS +. 1225x



Lab 9- Kodachrome: 14 Peripheral blood: **acute monocytic leukemia**; The malignant cells have the same characteristics as **MONOCYTES** with blue-gray cytoplasm and folded nuclei. There is also a propensity to involve extramedullary sites, including the gums. 1225x



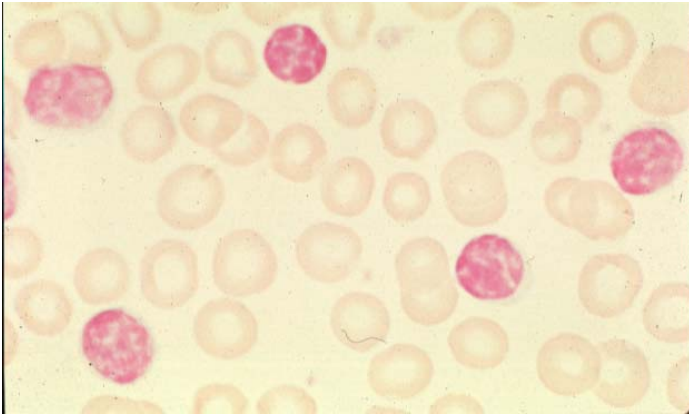
Lab 9- Kodachrome: 15 Bone marrow: **acute monocytic leukemia**; non specific esterase; NSE stains cells of the monocytic lineage. 1225x



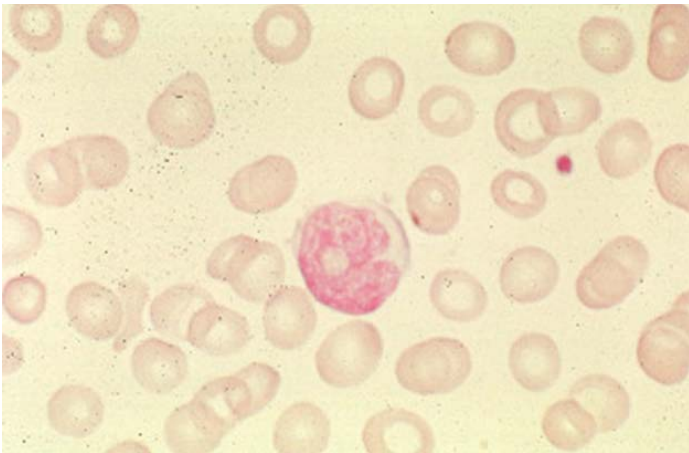
Lab 9- Kodachrome: 16 Peripheral blood: **Erythroleukemia**- the bizarre red cell precursors indicate erythroleukemia; 525x

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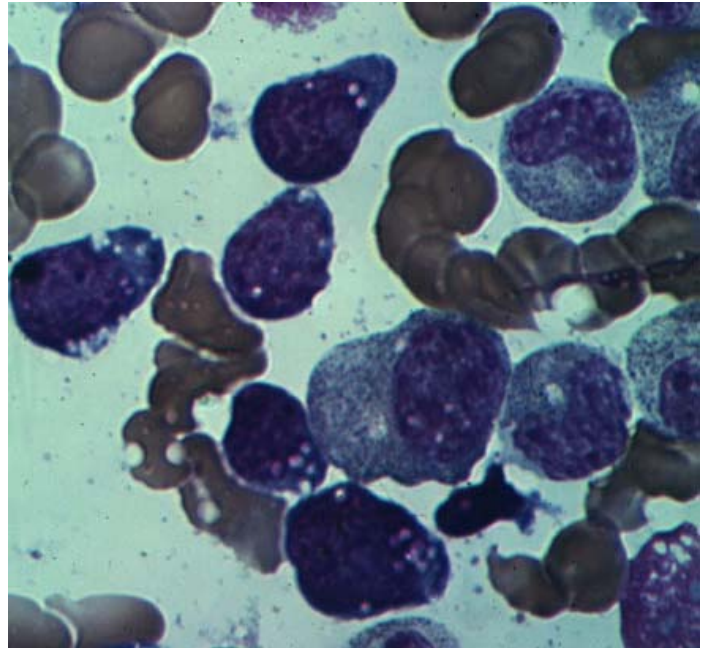
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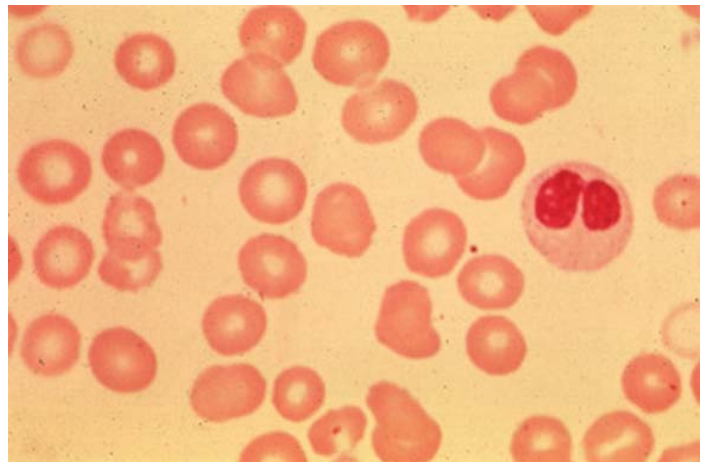
Lab 9- Kodachrome: 17 Peripheral blood: **Chronic lymphocytic leukemia**; There are a number of small, mature lymphocytes c/w CLL. The diagnosis is usually confirmed with a bone marrow biopsy or flow cytometry which shows **MONOCLONAL B CELL** proliferation (classically CD5+)1225x



Lab 9- Kodachrome: 18 Peripheral blood: **Follicular B Cell Lymphoma**- The clefted lymphoid cell with a nucleolus ("**BUTTOCK**" **CELL**) is characteristic of this type of lymphoma; 1225x



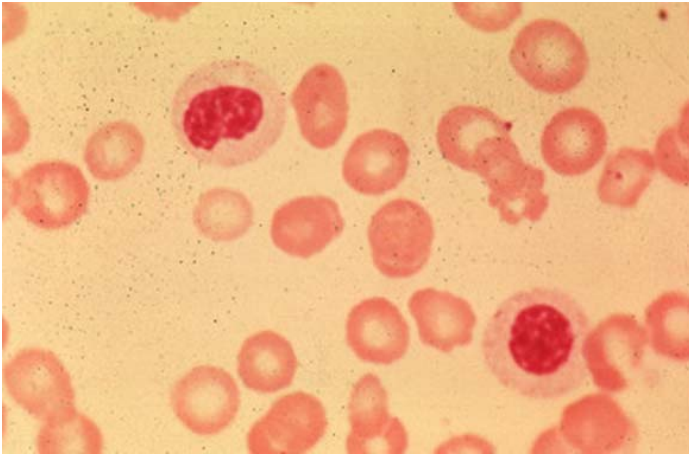
Lab 9- Kodachrome: 19 Bone marrow: **Burkitt's lymphoma**- The Burkitt's lymphoma/leukemia cells are immature, deeply basophilic, and highly vacuolated. This lymphoma is associated with the t8;21, the **Epstein-Barr Virus** in the African variant, and has shown an increased incidence in patients with AIDS and immunosuppression. In addition, it is the fastest growing cancer known to man with a doubling time of 24 hours. Wright stain.



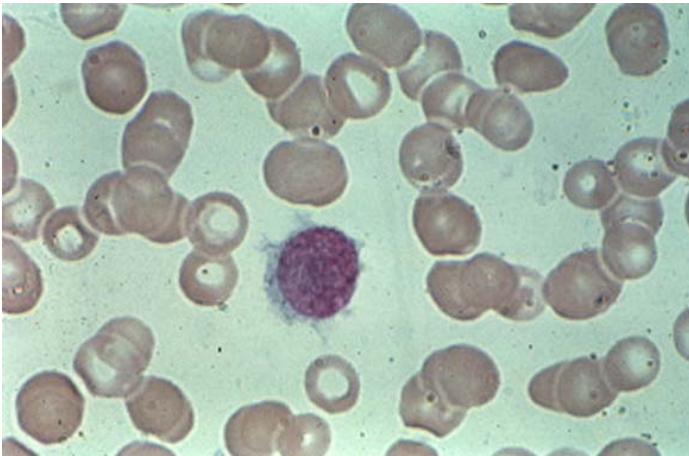
Lab 9- Kodachrome: 20 Peripheral blood: **Pelger-huet anomaly**; **PELGER-HUET CELLS** are mature **NEUTROPHILS** with 2 symmetric round/oval nuclear lobes with a thin strand of chromatin in between. These cells are associated with a benign hereditary condition and an acquired pseudo-Pelger-Huet abnormality in myeloproliferative disorders, myelodysplastic syndromes, in addition to reactive processes. 1225x

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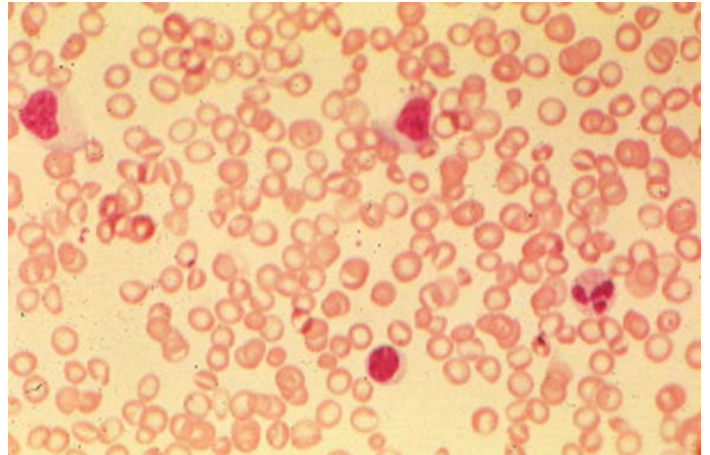
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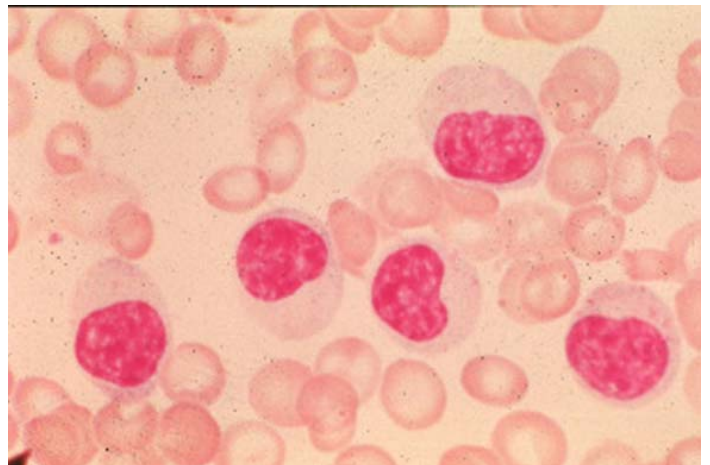
Lab 9- Kodachrome: 21 Peripheral blood: **Pelger-huet anomaly**; Stodtmeister cell. This is a uninuclear variant of the Pelger-Huet anomaly.; 1225x



Lab 9- Kodachrome: 22 Peripheral blood: **Hairy cell leukemia** classically presents with **splenomegaly**, **pancytopenia** with **lymphadenopathy**. There is an excellent prognosis with certain treatments including 2-CDA or IFN.; 1225x



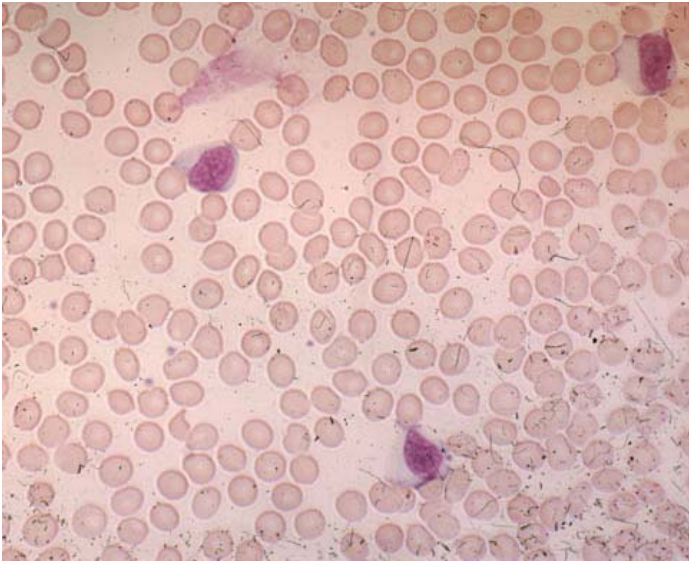
Lab 9- Kodachrome: 23 Peripheral blood: Atypical lymphocytes: excessive cytoplasm, eccentric nuclei, +/- nucleoli, and the chromatin may not be completely clumped. The DDx includes: **Infectious mononucleosis**, **CMV**, **Toxoplasmosis**, and reactive processes. N.B. In mononucleosis, the **B cells** are infected, but it is the **T cells** which appear atypical; 1225x



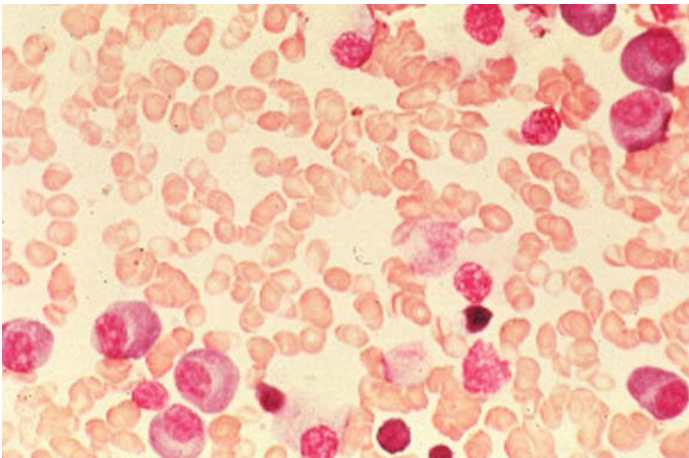
Lab 9- Kodachrome: 24 Peripheral blood: There are several reactive **LYMPHOCYTES** suggestive of **infectious mononucleosis**; 1225x

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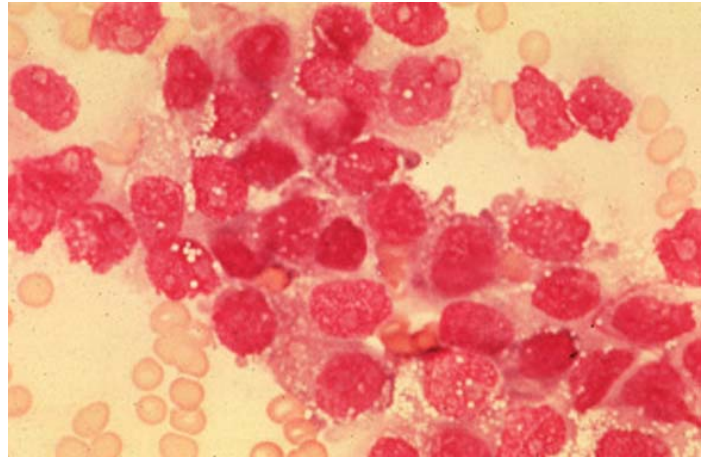
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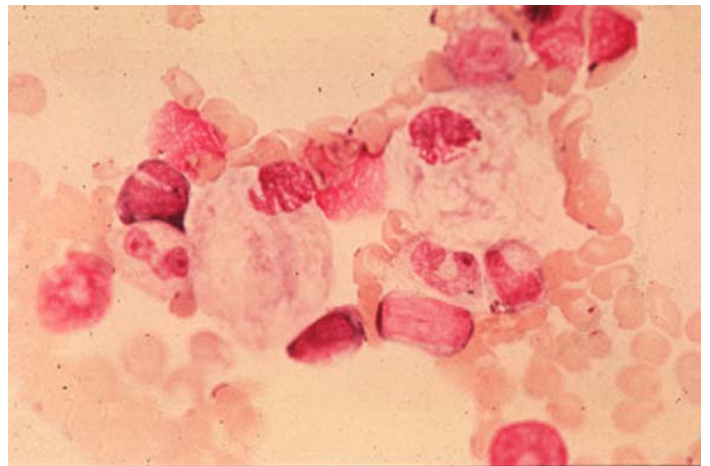
Lab 9- Kodachrome: 25 Peripheral blood: **Reactive Lymphocytosis** (influenza)



Lab 9- Kodachrome: 26 Bone Marrow: **PLASMA CELLS** characterized by deeply basophilic cytoplasm, eccentric nuclei, perinuclear clear zone. These cells are diagnostic of a variant of **multiple myeloma** (1% of all cases) called **plasma cell leukemia**.; 525x



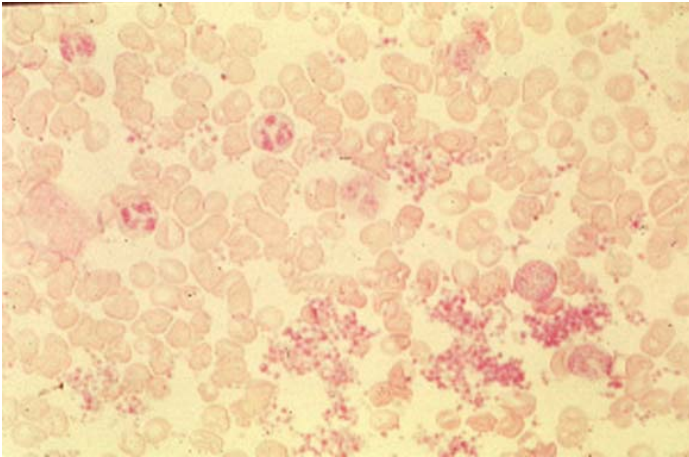
Lab 9- Kodachrome: 27 Bone Marrow: Tumor clumps of **metastatic adenocarcinoma of the prostate** in the bone marrow.; 640x



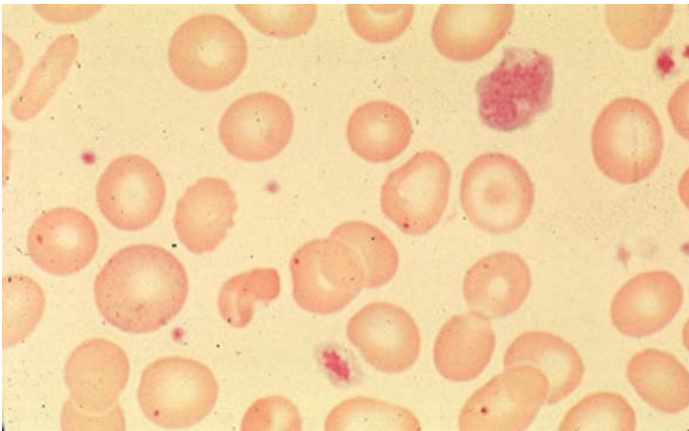
Lab 9- Kodachrome: 28 Bone Marrow: Lipid laden **MACROPHAGES** consistent with **Gaucher's disease**, in which the glucocerebrosidase enzyme is deficient. 800x

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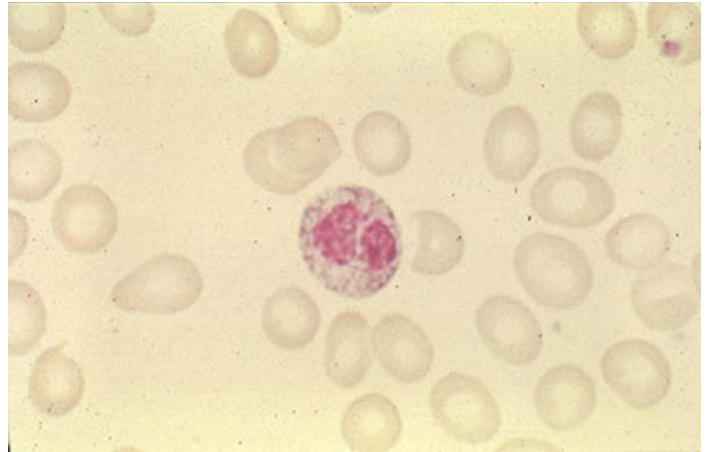
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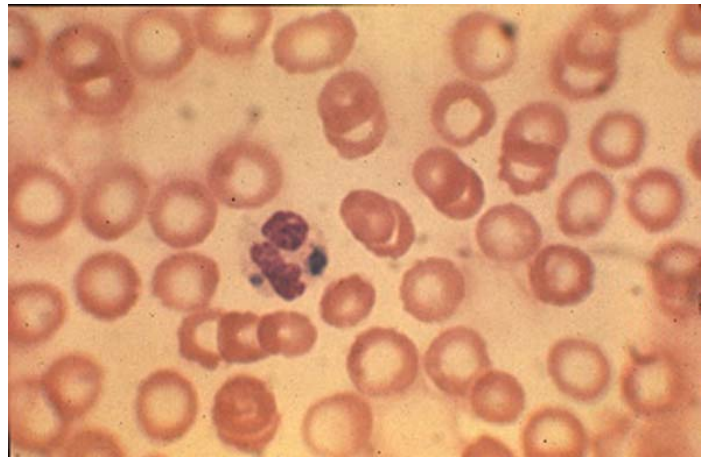
Lab 9- Kodachrome: 29 Peripheral blood: Extreme **thrombocytosis**. Platelet counts this high (1.5 to 2,000,000) are only seen in myeloproliferative disorders, including essential **thrombocythemia**, which is characterized by both hemorrhagic and thrombotic tendencies.; 800x



Lab 9- Kodachrome: 30 Peripheral blood: **MEGATHROMBOCYTE** (giant platelet)- these are seen in a reactive processes but also myeloproliferative disorders. These platelets are often functionally abnormal.; 1225x



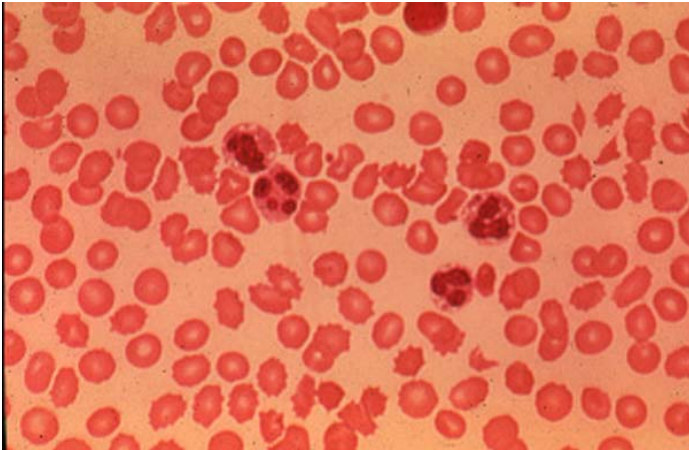
Lab 9- Kodachrome: 31 Toxic Granulation of **NEUTROPHIL**- a non-specific sign of infection.



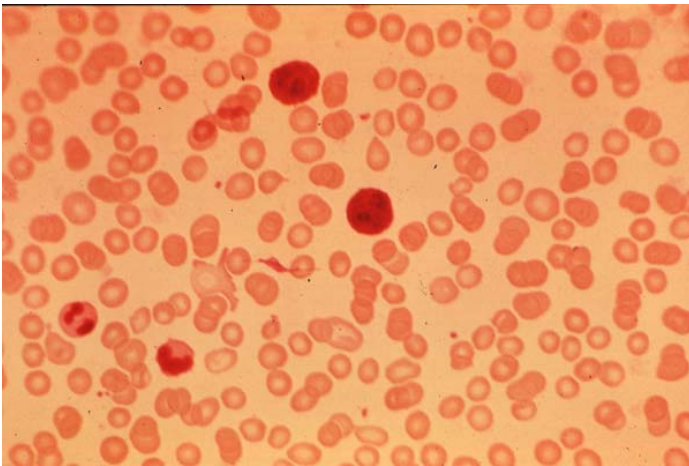
Lab 9- Kodachrome: 32 **Dohle Body**. These areas in the cytoplasm of **NEUTROPHILS** stain blue with Wright's stain due to the increase in RNA present in the RER of the cells. Dohle bodies are seen in a number of conditions, including: **sepsis**, **burns**, myelodysplastic conditions, and hereditary conditions.

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Lab 9- Kodachrome: 33 Vacuolization of **NEUTROPHILS**

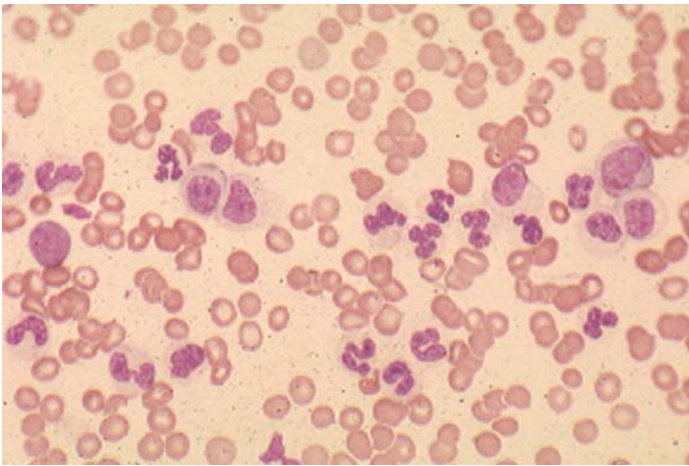


Lab 9- Kodachrome: 34 LAP stain of **NEUTROPHILS**; In this case, the LAP is high, consistent with **reactive neutrophilia**. A low LAP score would be consistent with **CML**.

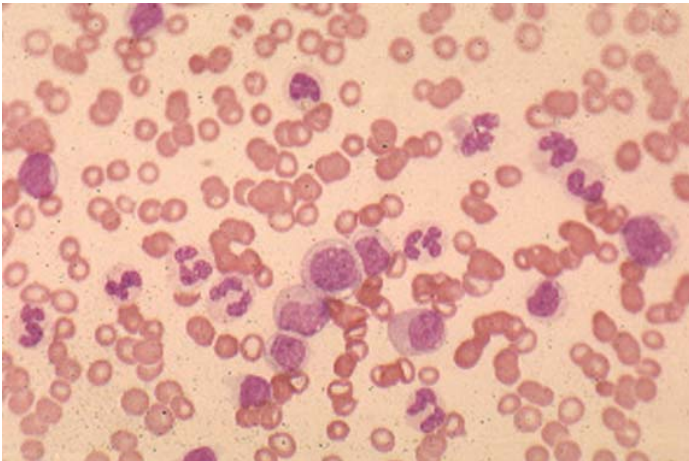
# HEMATOLOGY

## *Leukocyte and Platelet Disorders*

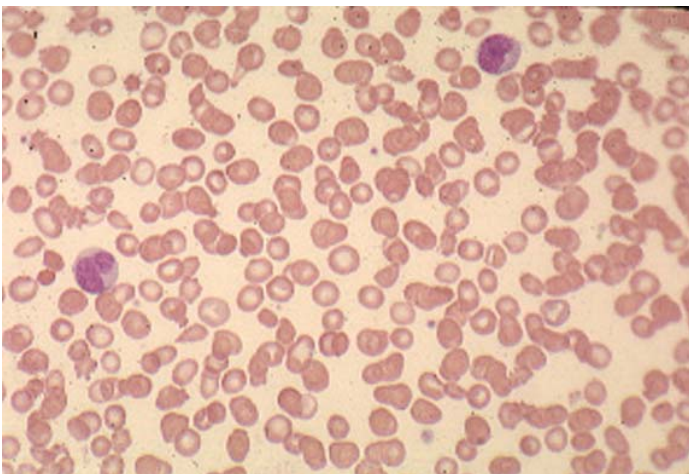
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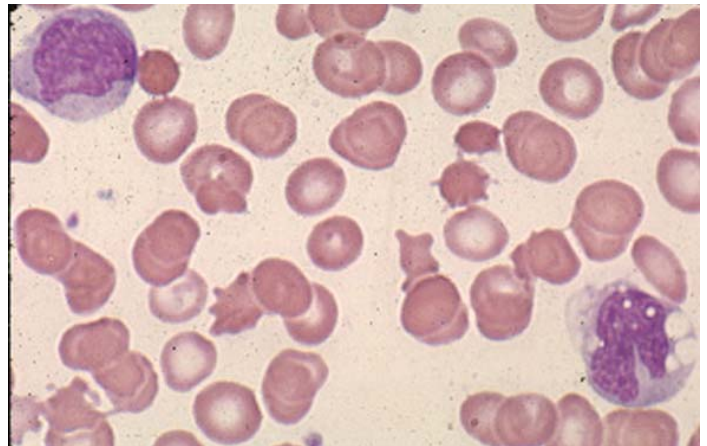
Lab 10- Kodachrome: 1 Case H: **Chronic myelogenous leukemia**- many mature white cells; low LAP score (high in **reactive leukocytosis**)



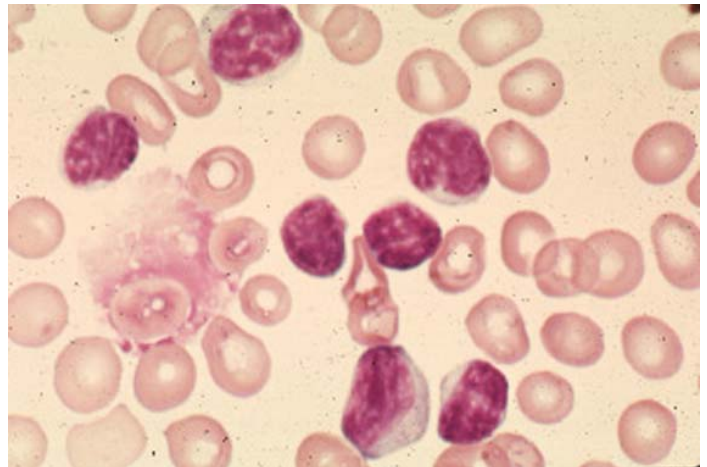
Lab 10- Kodachrome: 2 Case H: **Chronic myelogenous leukemia**



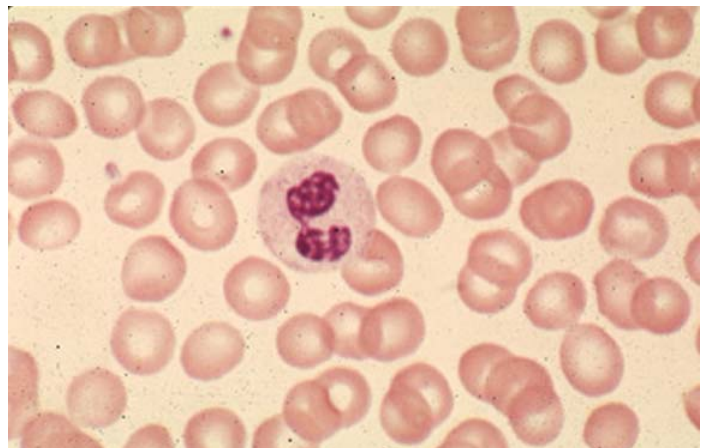
Lab 10- Kodachrome: 3 Case I: **Hodgkin's disease**



Lab 10- Kodachrome: 4 Case I: **Hodgkin's disease**



Lab 10- Kodachrome: 5 Case J:

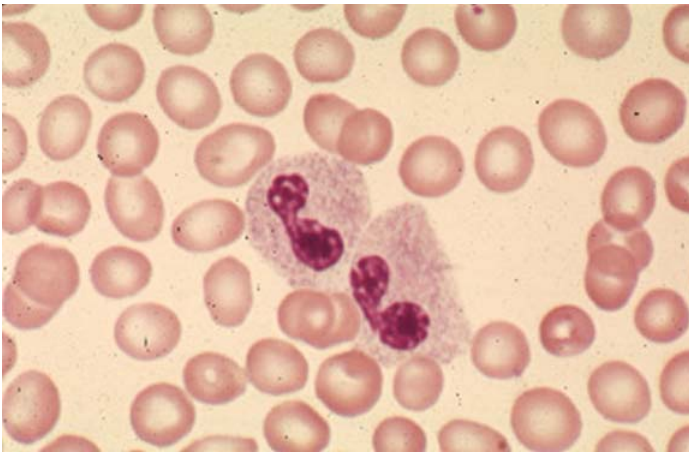


Lab 10- Kodachrome: 6 Case K: **Hereditary Pelger-Huet anomaly**

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## *Leukocyte and Platelet Disorders*

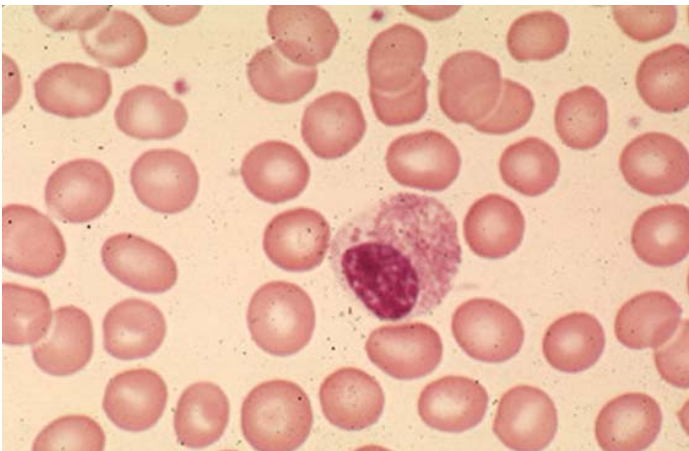
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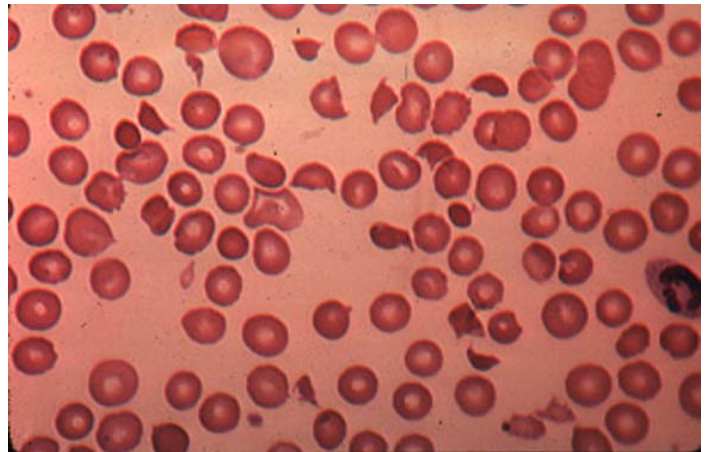
Lab 10- Kodachrome: 7 Case K: **Hereditary Pelger-Huet anomaly**



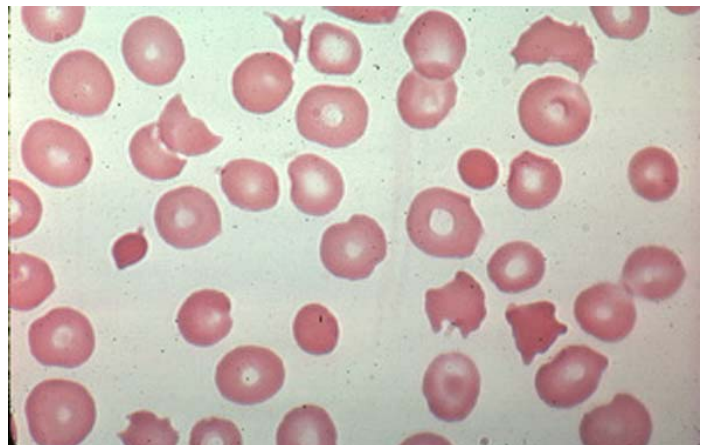
Lab 10- Kodachrome: 8 Case K: **Hereditary Pelger-Huet anomaly**



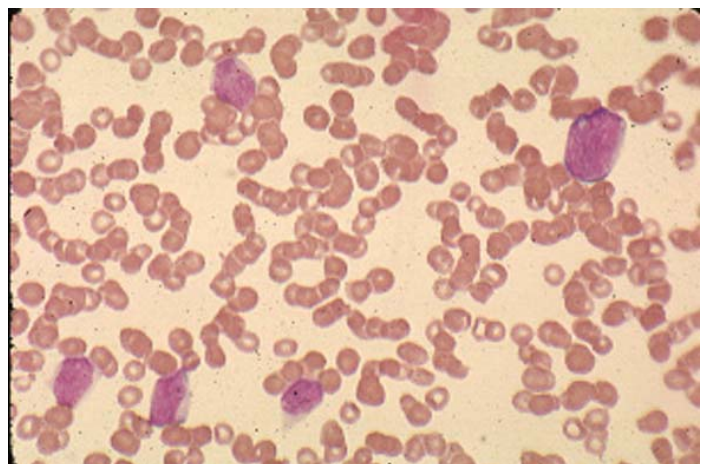
Lab 10- Kodachrome: 9 Case K: **Hereditary Pelger-Huet anomaly**



Lab 10- Kodachrome: 10 Case L: **Thrombotic thrombocytopenic purpura**- marked **SCHISTOCYTES**, occasional **SPHEROCYTES**, moderate **polychromasia**, **thrombocytopenia**



Lab 10- Kodachrome: 11 Case L: **Thrombotic thrombocytopenic purpura**- **SCHISTOCYTES**, **thrombocytopenia**

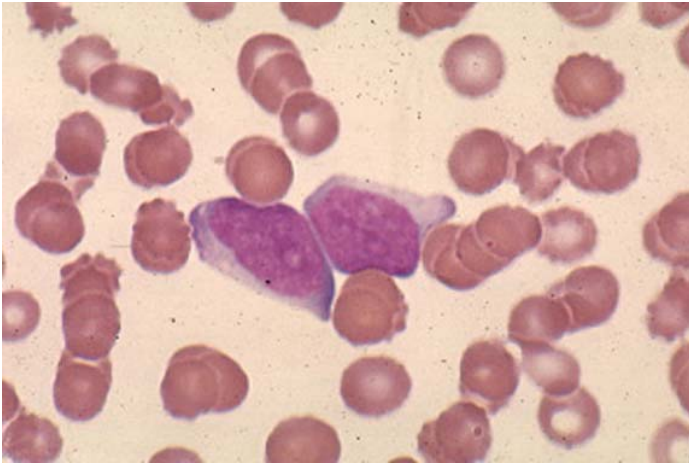


Lab 10- Kodachrome: 12 Case M: **Acute leukemia**, probably lymphoblastic

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## *Leukocyte and Platelet Disorders*

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Lab 10- Kodachrome: 13 Case M: **Acute leukemia**,  
probably lymphoblastic