Hematology 101

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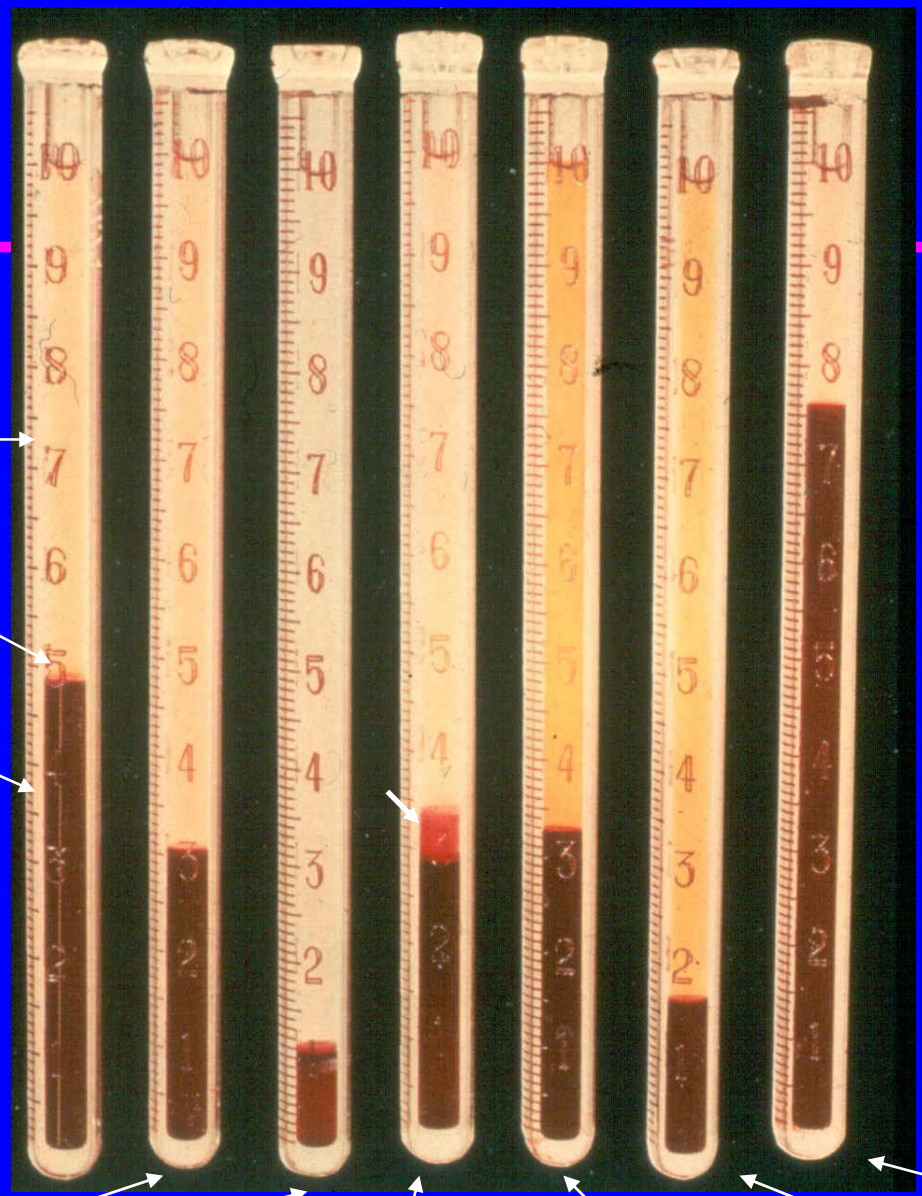
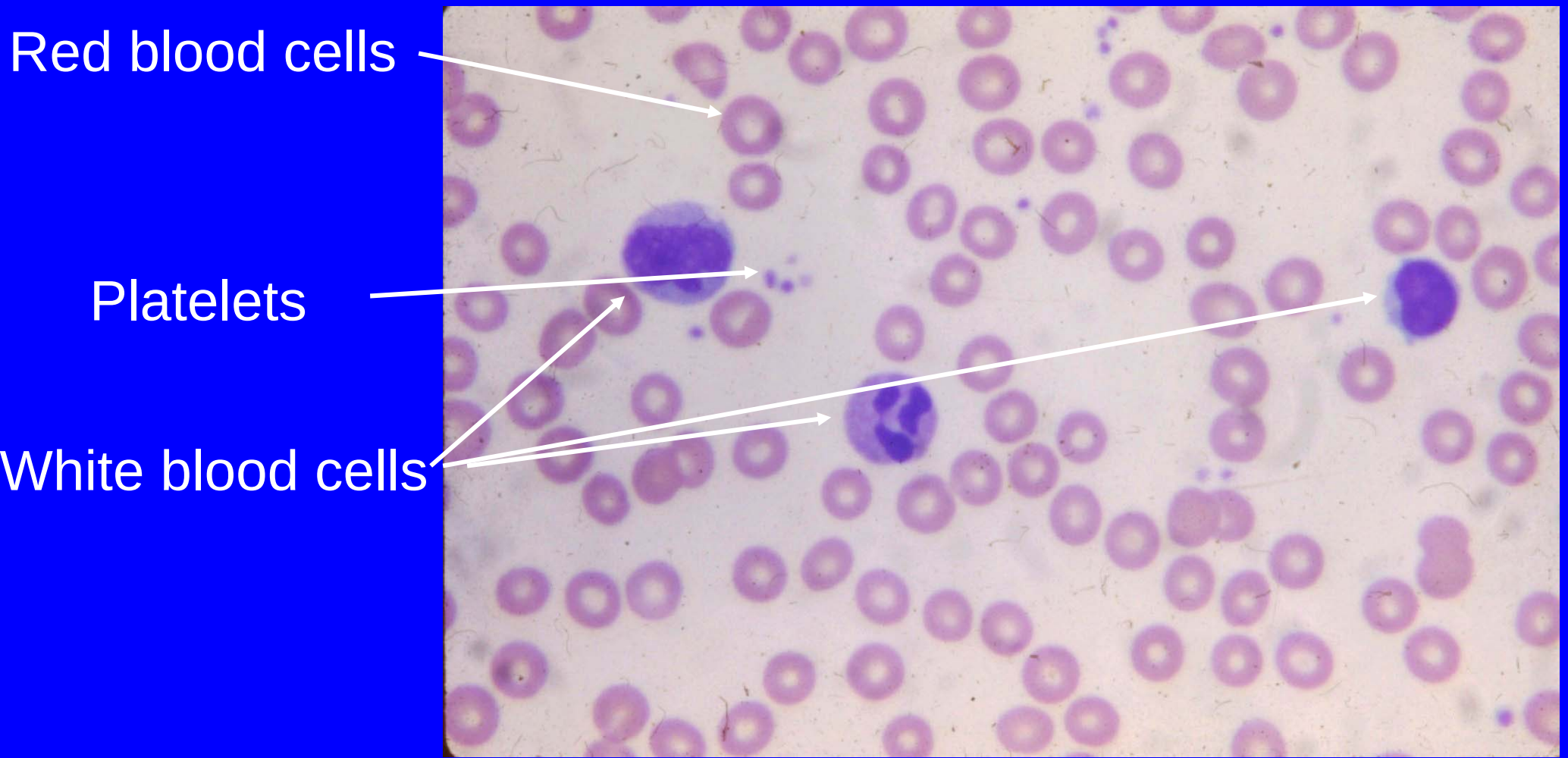
Hematocrits



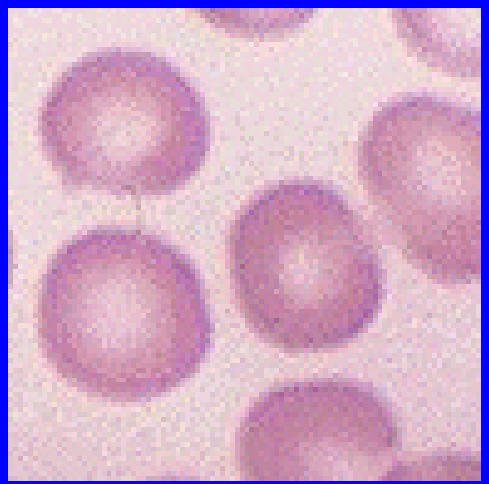
Normal Peripheral Blood



Aplastic Anemia Peripheral Blood

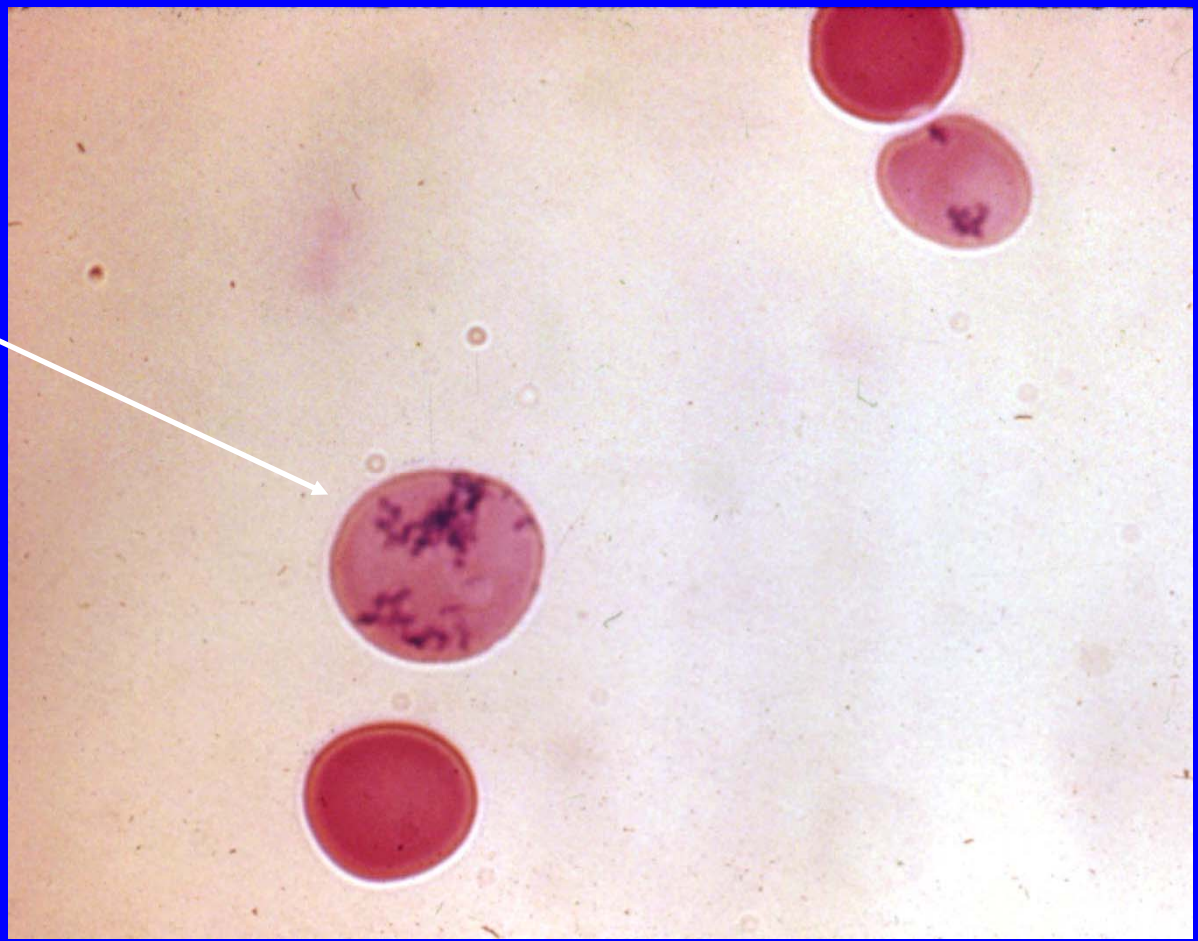
Red Cells

- Contain a red pigment, hemoglobin
- Carry oxygen from the lung to other tissues that need it
  - Muscles, liver, kidney, heart, brain
- Normally live 4 months



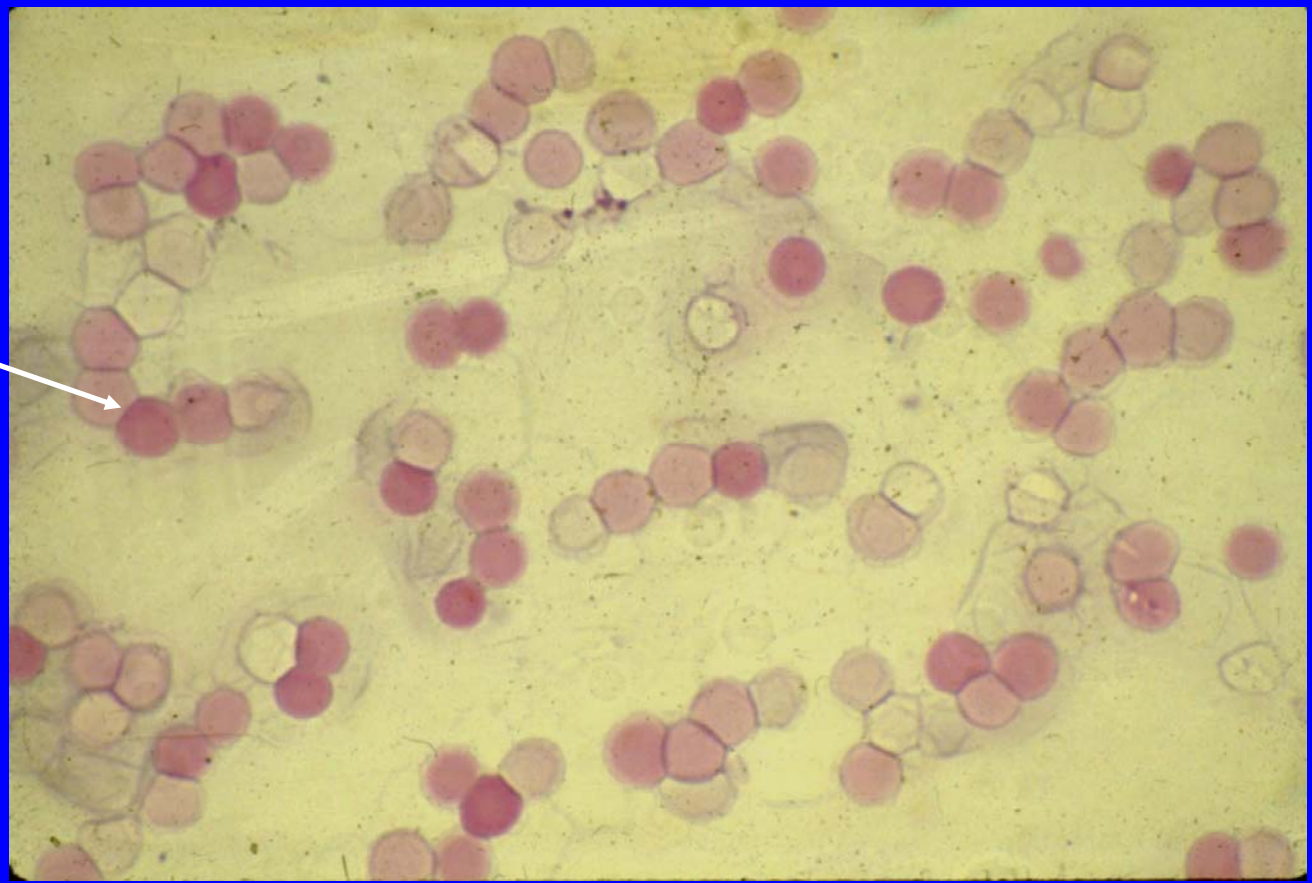
Reticulocytes

Red cells newly released from bone marrow



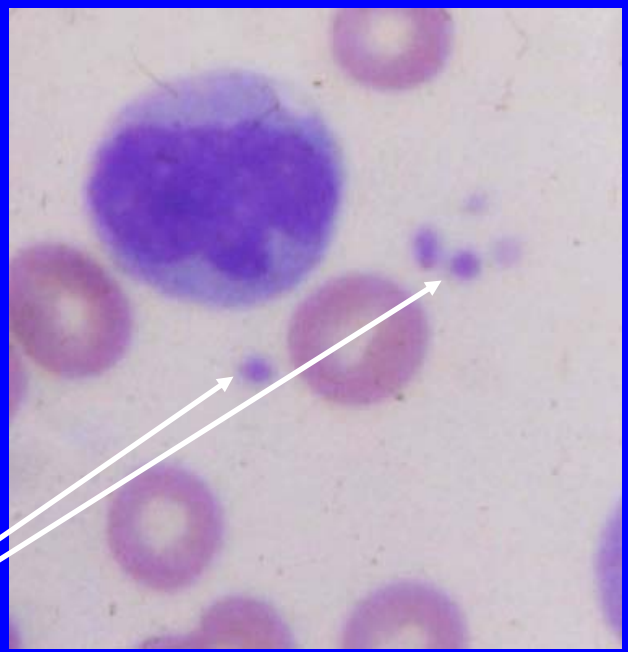
Fetal Hemoglobin

Kleihauer-Betke stain



Platelets

- Help blood clot
- Live 7-10 days
- Low numbers can lead to:
  - Bruising
  - Petechiae (tiny red dots)
  - Nosebleeds
  - Internal bleeding



Platelets

Types of White Cells (Leukocytes)

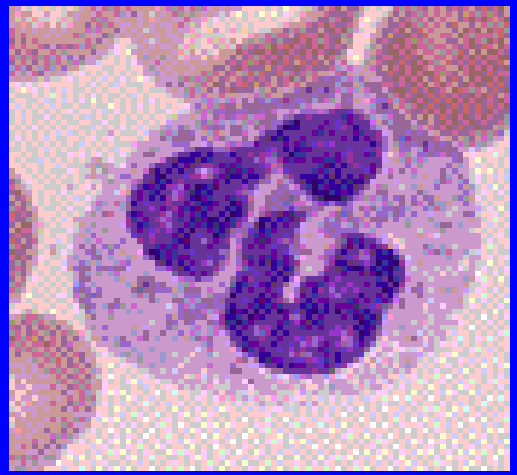
Type	Life Span
Phagocytes (eaters):	
Neutrophil	hours
Monocyte	days
Eosinophil	hours
Basophil	hours
Lymphocyte	months-years

White Blood Cell Functions

- Neutrophils - eat bacteria and fungus
- Lymphocytes - direct the other cells and make antibodies
- Monocytes - eat particles coated with antibody
- Eosinophils - allergies and fight parasites
- Basophils - allergies

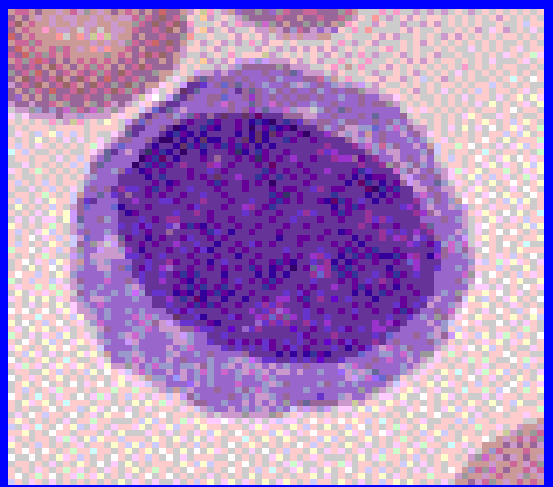
Neutrophils (Phagocytes)

- Polymorphonuclear (PMN), segmented, granulocytes
- Bands, juveniles = early forms
- First line of defense against bacterial infection is intact skin and lining of the mouth, throat and intestines
- Second line of defense is neutrophils, which eat bacteria and kill them
- Low neutrophil number increases susceptibility to bacterial and fungal infections



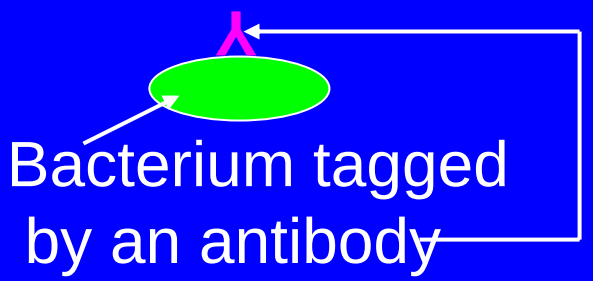
Lymphocytes

- Regulate other white cells
- Make antibodies
  - Proteins that act as flags to stick to bacteria and viruses
  - Tell other cells to eat things



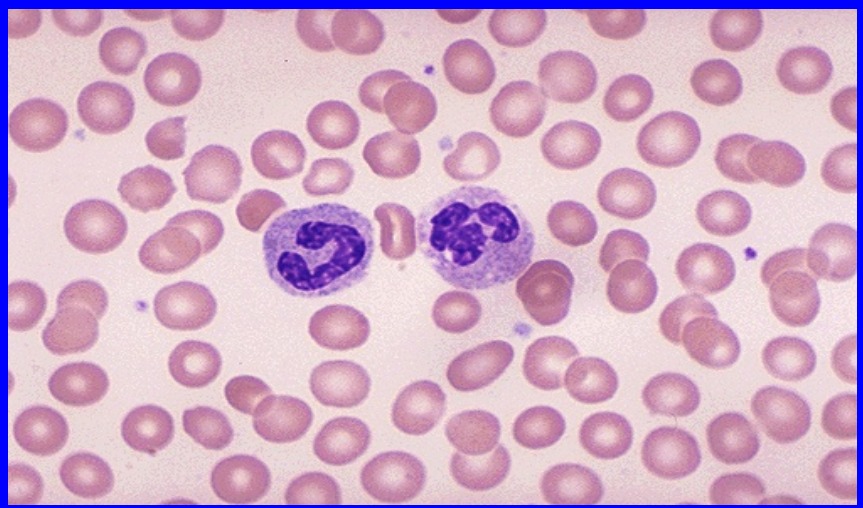
Monocytes

- Phagocytes
- Become tissue macrophages
  - Cells in the tissues that eat particles tagged with antibodies



Count Blood Cells

- Draw a sample of blood
- Run it through a machine
- Smear it on a glass slide, soak it in stain, and look under the microscope



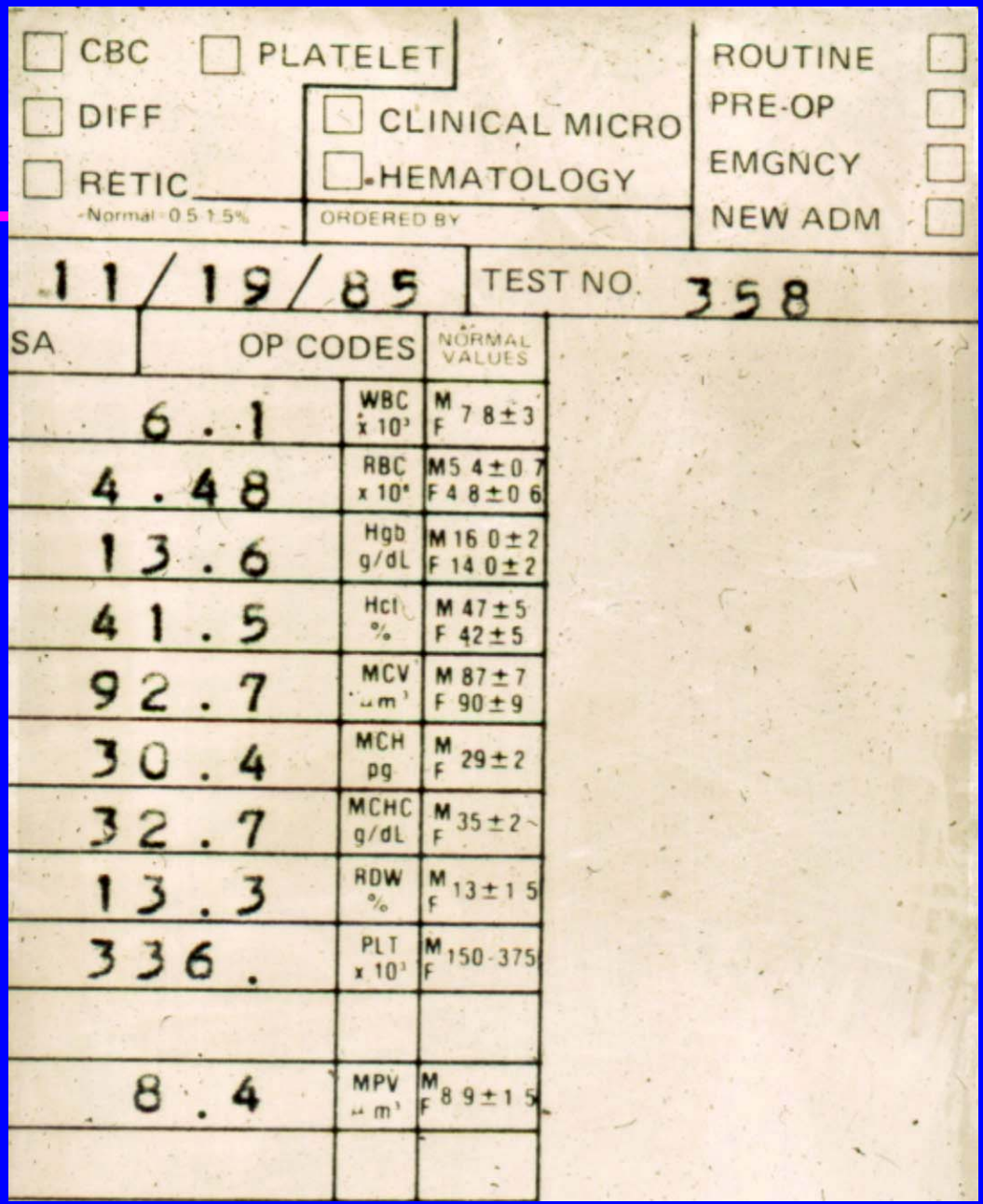
CBC Machine

- Draw blood from the tube into an electronic counter
- Result is called the complete blood count (CBC)

Blood Counts

WBC
RBC
Hb
Hct
MCV
MCH
MCHC
RDW
Plat

MPV



CBC ☐ PLATELET ☐ | ROUTINE ☐
DIFF ☐ | CLINICAL MICRO ☐ | PRE-OP ☐
RETIC ☐ | HEMATOLOGY ☐ | EMGNCY ☐
Normal 0.5-1.5% | ORDERED BY | NEW ADM ☐

11/19/85 TEST NO. 358

SA	OP CODES		NORMAL VALUES
6.1		WBC x 10³	M F 7.8±3
4.48		RBC x 10⁶	M 5.4±0.7 F 4.8±0.6
13.6		Hgb g/dL	M 16.0±2 F 14.0±2
41.5		Hct %	M 47±5 F 42±5
92.7		MCV µm³	M 87±7 F 90±9
30.4		MCH pg	M F 29±2
32.7		MCHC g/dL	M F 35±2
13.3		RDW %	M F 13±1.5
336.		PLT x 10³	M F 150-375
8.4		MPV µm³	M F 8.9±1.5

Red Cells

- Hemoglobin (Hb, Hgb)
  - 12-15 grams/100 ml (g/dl) [lower for children]
- Hematocrit (Hct)
  - 35 to 45%

Anemia = Low Hb/Hct (H/H)

Platelets

- Platelet count (Plt)
  - 150,000 to 400,000/μl

Thrombocytopenia = low platelets

White Blood Cells (Leukocytes)

- WBC = white blood cell count
  - 5000–10,000/μl, 5 – 10 thousand/μl
- WBC differential
  - % Neutrophils, bands, lymphocytes, monocytes, eosinophils, basophils

Leukopenia = low WBC

Absolute Neutrophil Count (ANC)

- **ANC** = WBC x % Neutrophils
  - e.g. WBC = 5000/ μl, 30% neutrophils
  - ANC = 5000 x 0.30 = 1500/μl
- Normal: above 1500/μl
- OK: above 500
- Low: 200-500
- Very low: below 200

Neutropenia = low neutrophils

CBC Summary

- Quick and easy assessment of numbers of blood cells
- Relatively inexpensive
- No single test tells us more about a blood disorder
- Measures all three cell types (RBC, WBC, platelets)
- Provides other valuable details

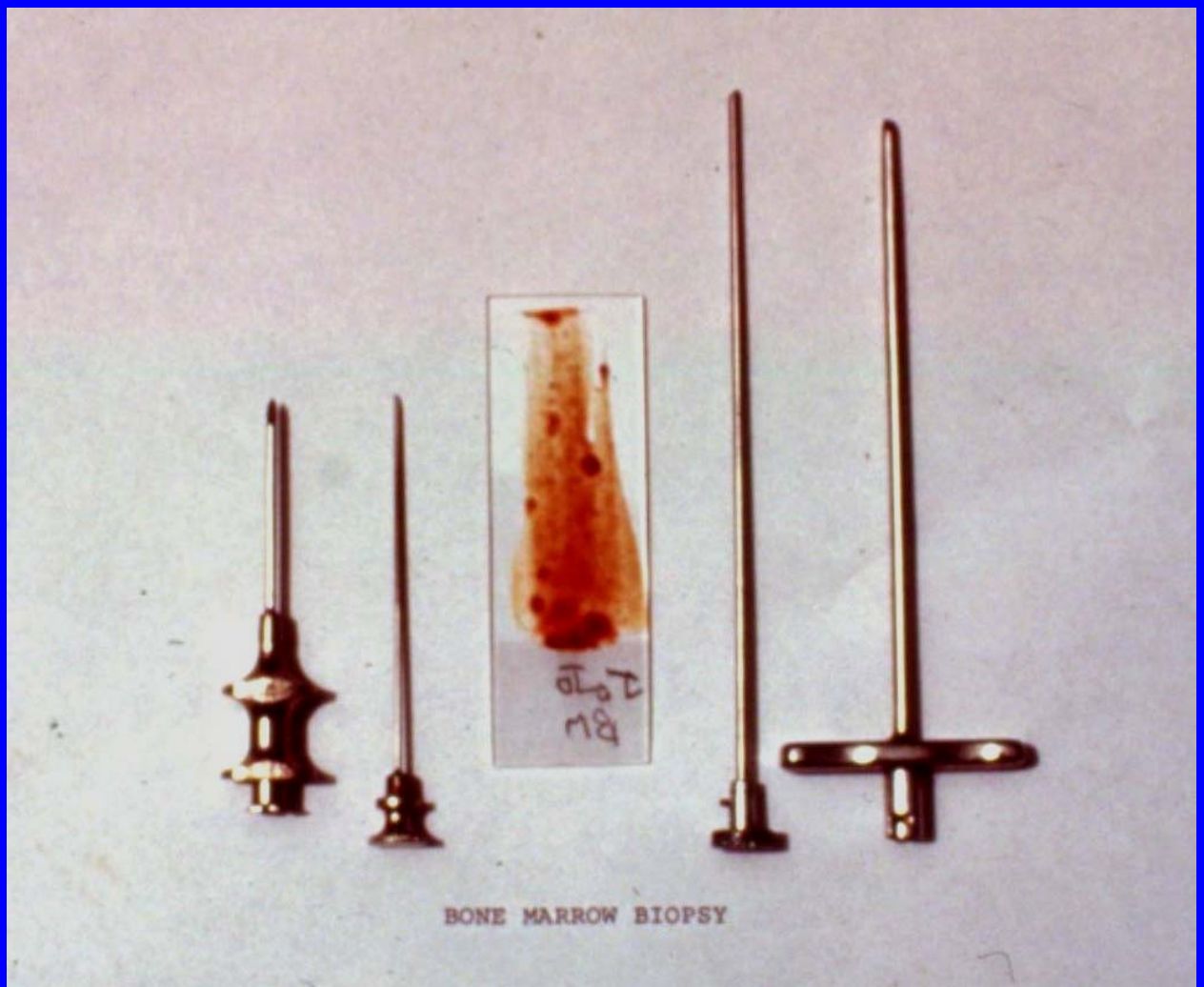
Causes of Anemia

- Decreased production
  - Decreased reticulocytes
- Increased destruction
  - Increased reticulocytes
- Blood loss
  - Increased reticulocytes

Definitions

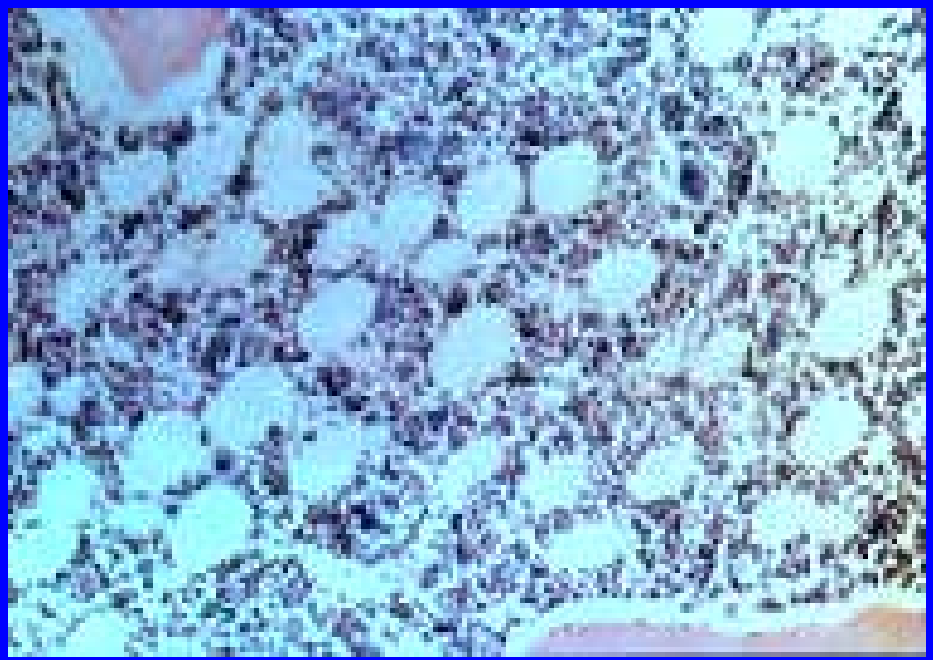
- Aplastic Anemia (AA):
  - Pancytopenia due to decreased production
  - Hypocellular bone marrow
- Leukemia:
  - Malignant proliferation of immature cells
- Myelodysplastic syndrome (MDS):
  - Cytopenia with hypercellular bone marrow

Bone Marrow Equipment

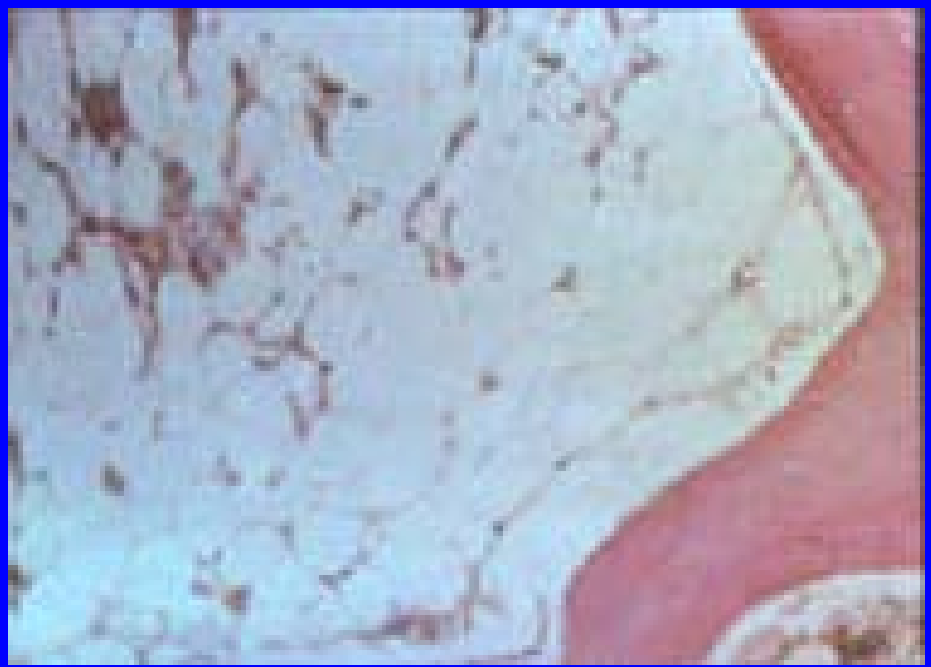


Bone Marrow Biopsy

Normal

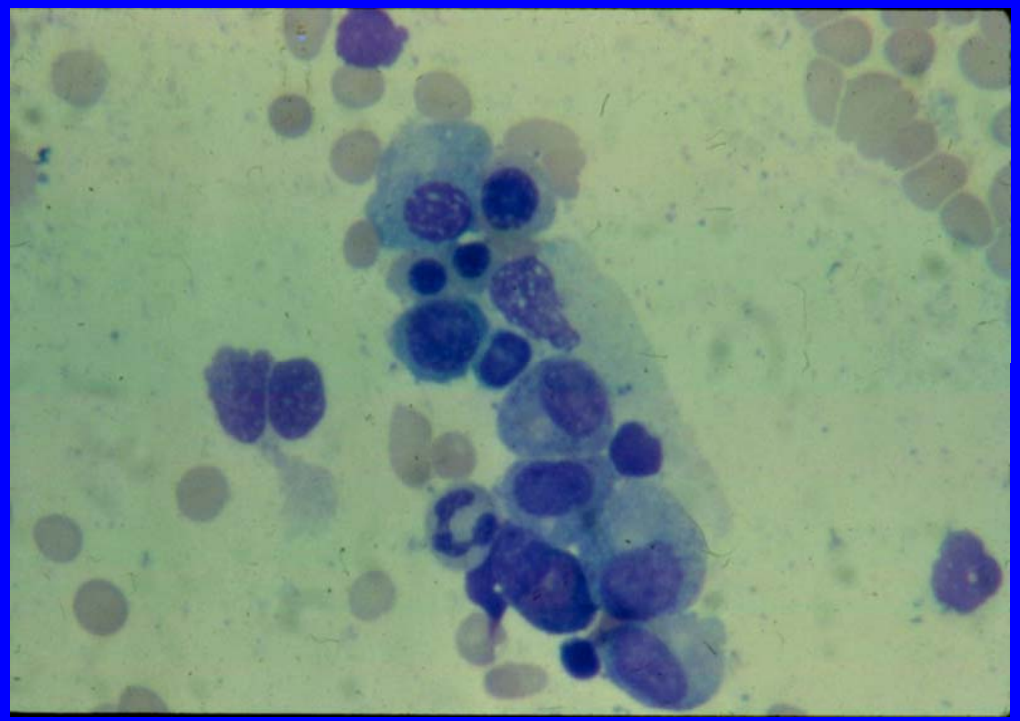


Aplastic

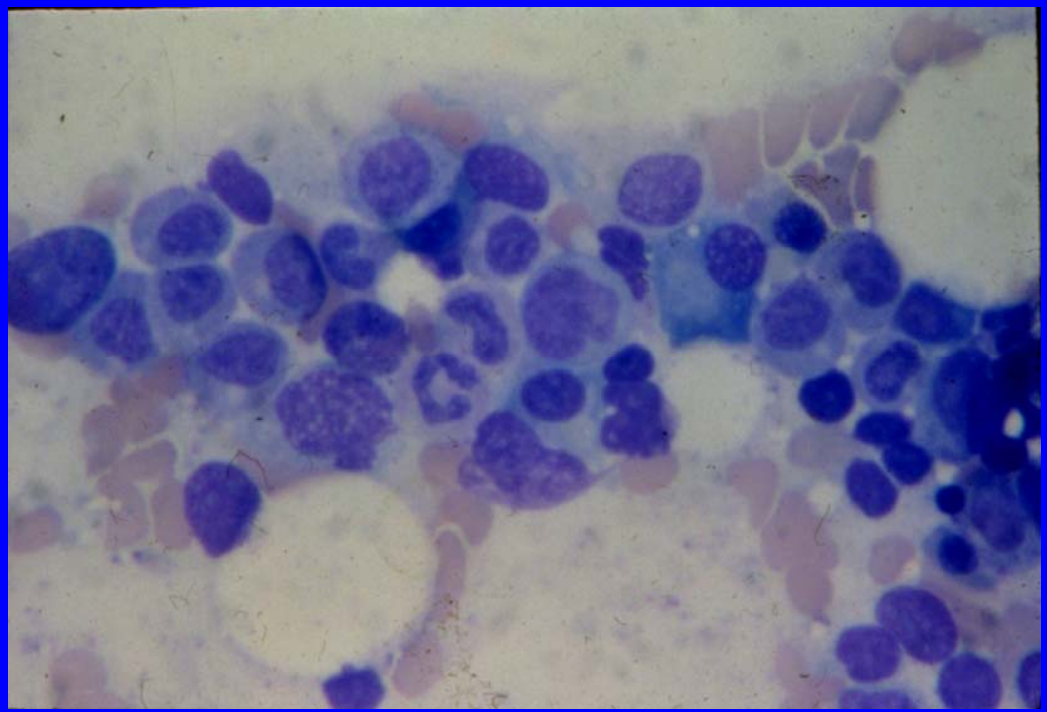


Normal Bone Marrow Aspirate

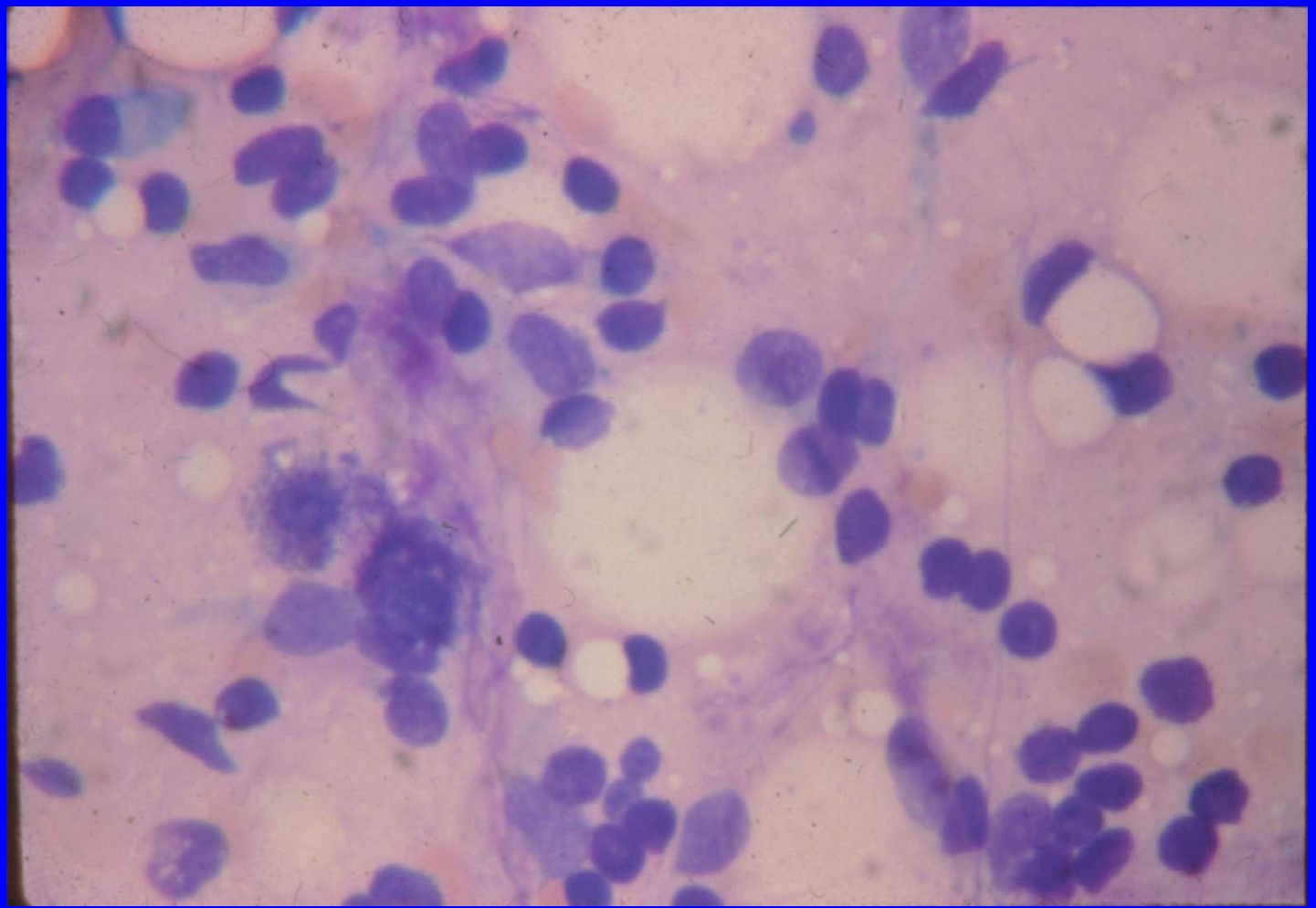
Erythroid (red cells)



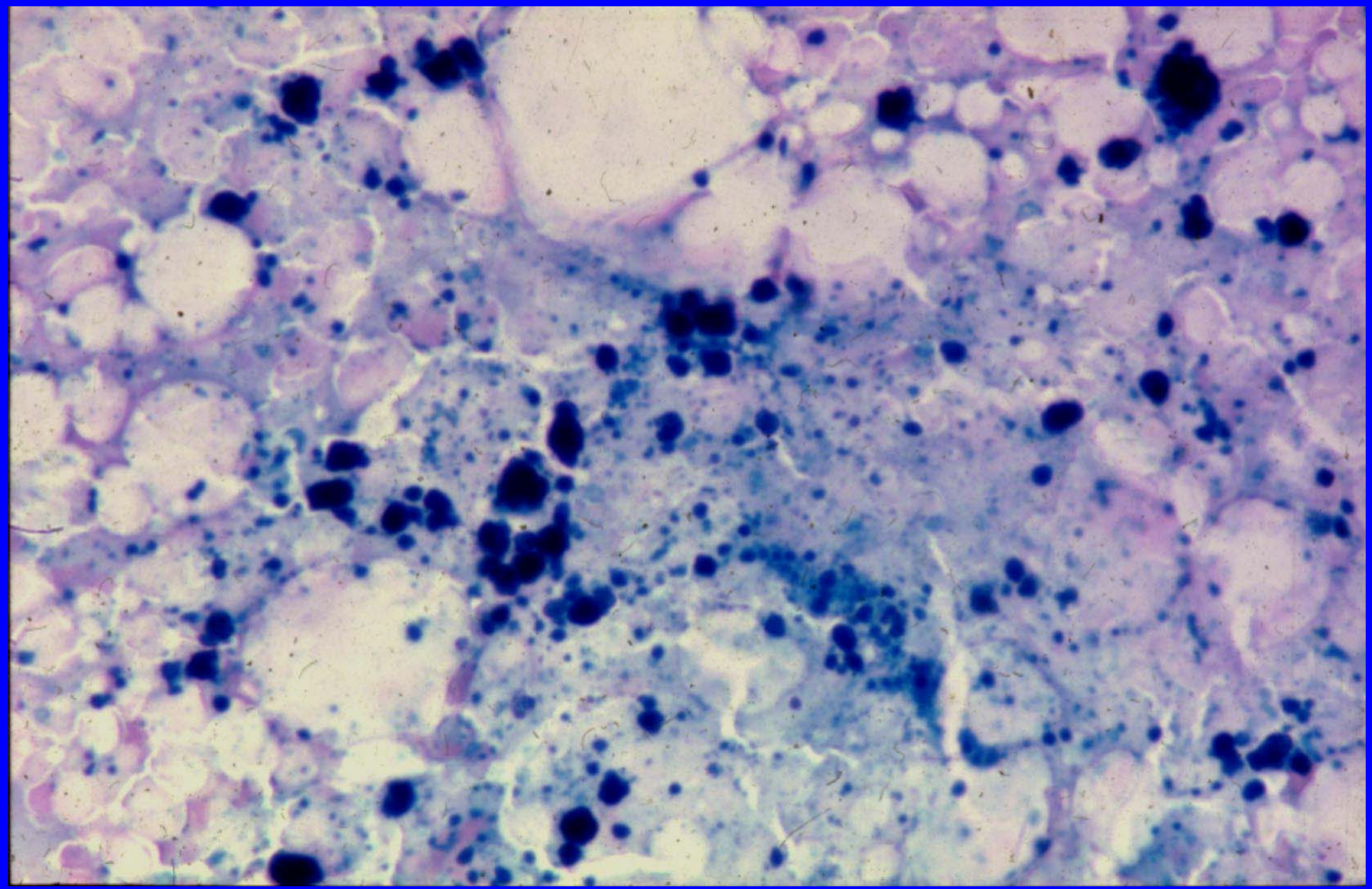
Myeloid (white cells)



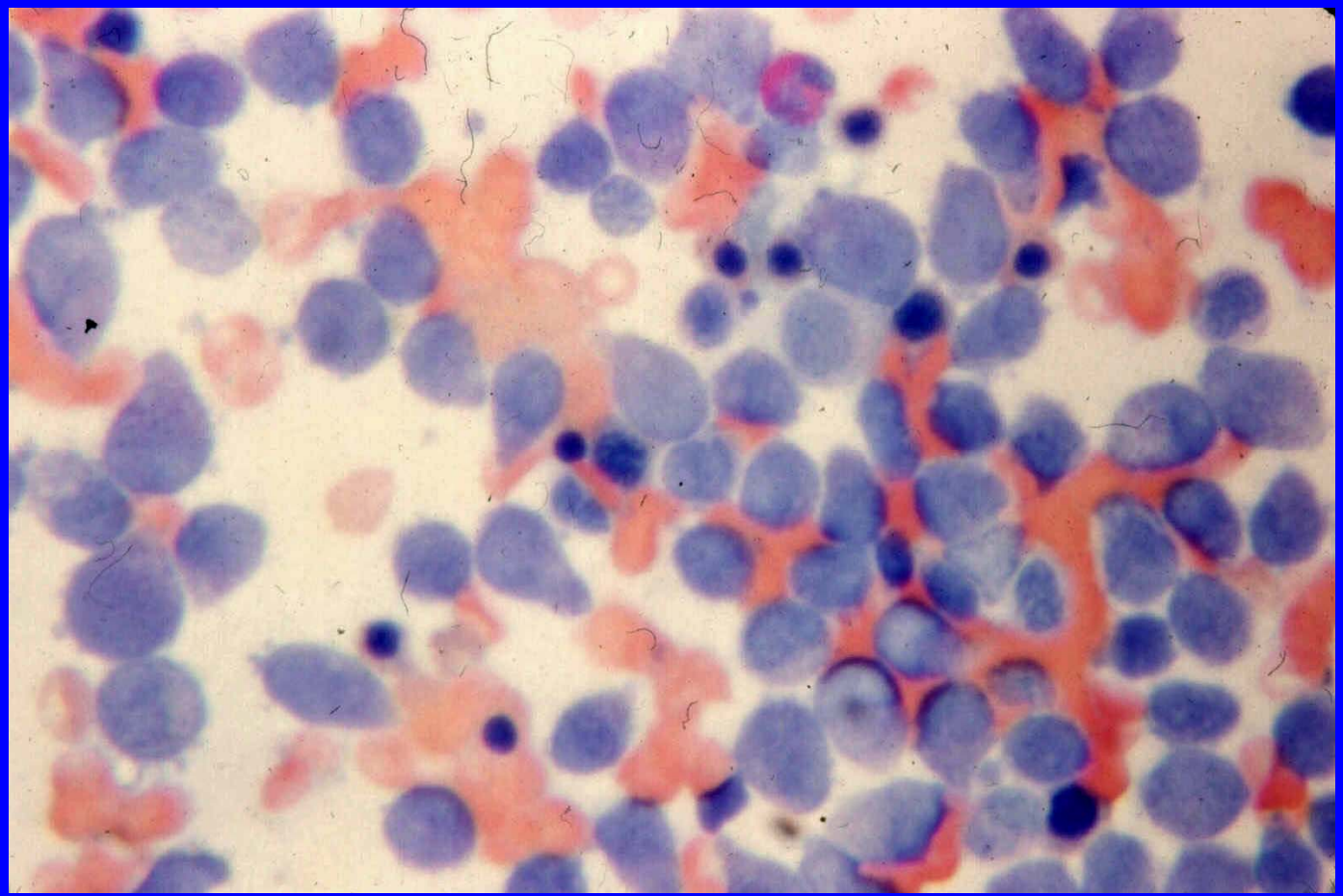
Aplastic Anemia Bone Marrow Aspirate



Bone Marrow Iron



Leukemia Bone Marrow

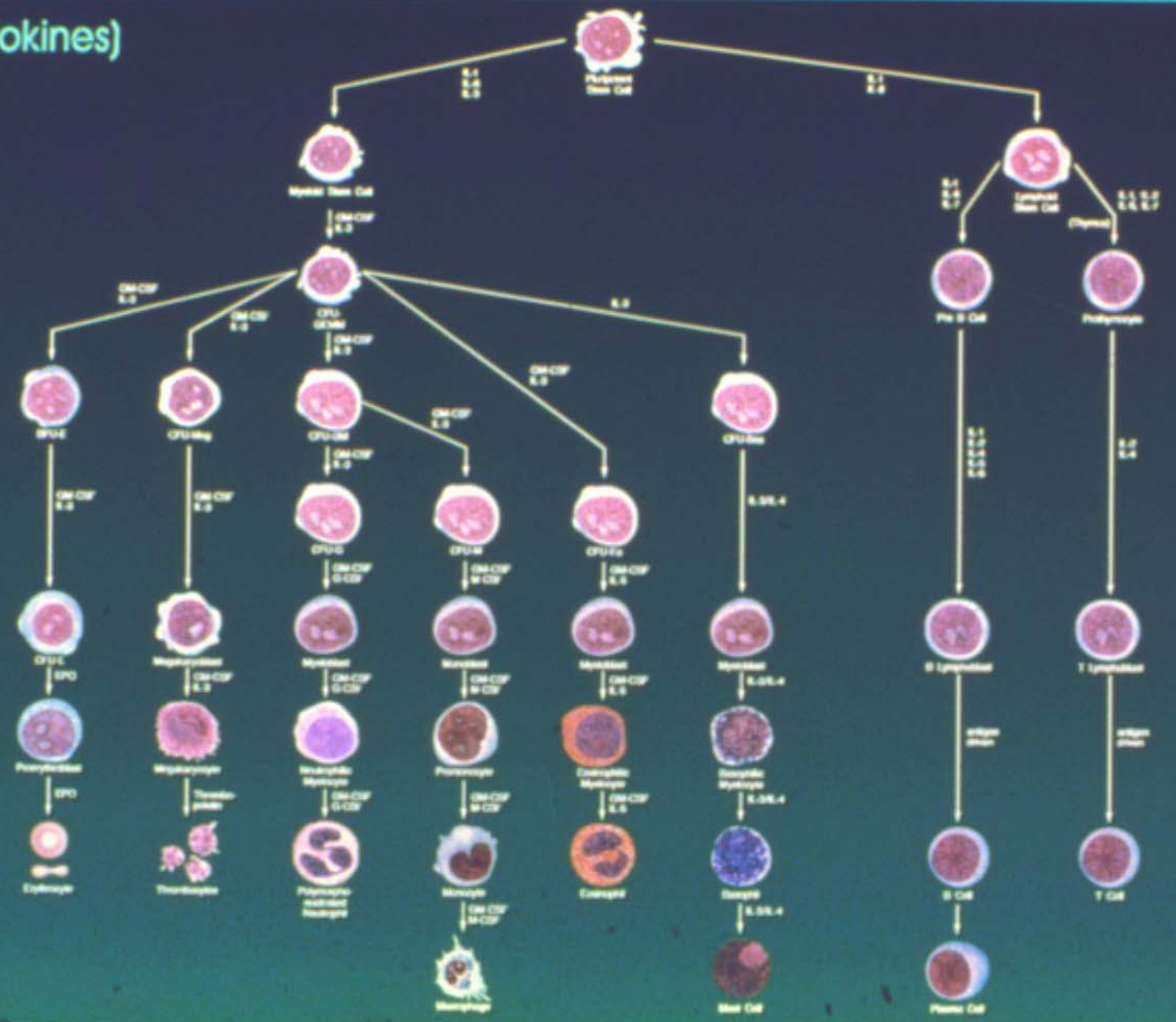


Hematopoiesis

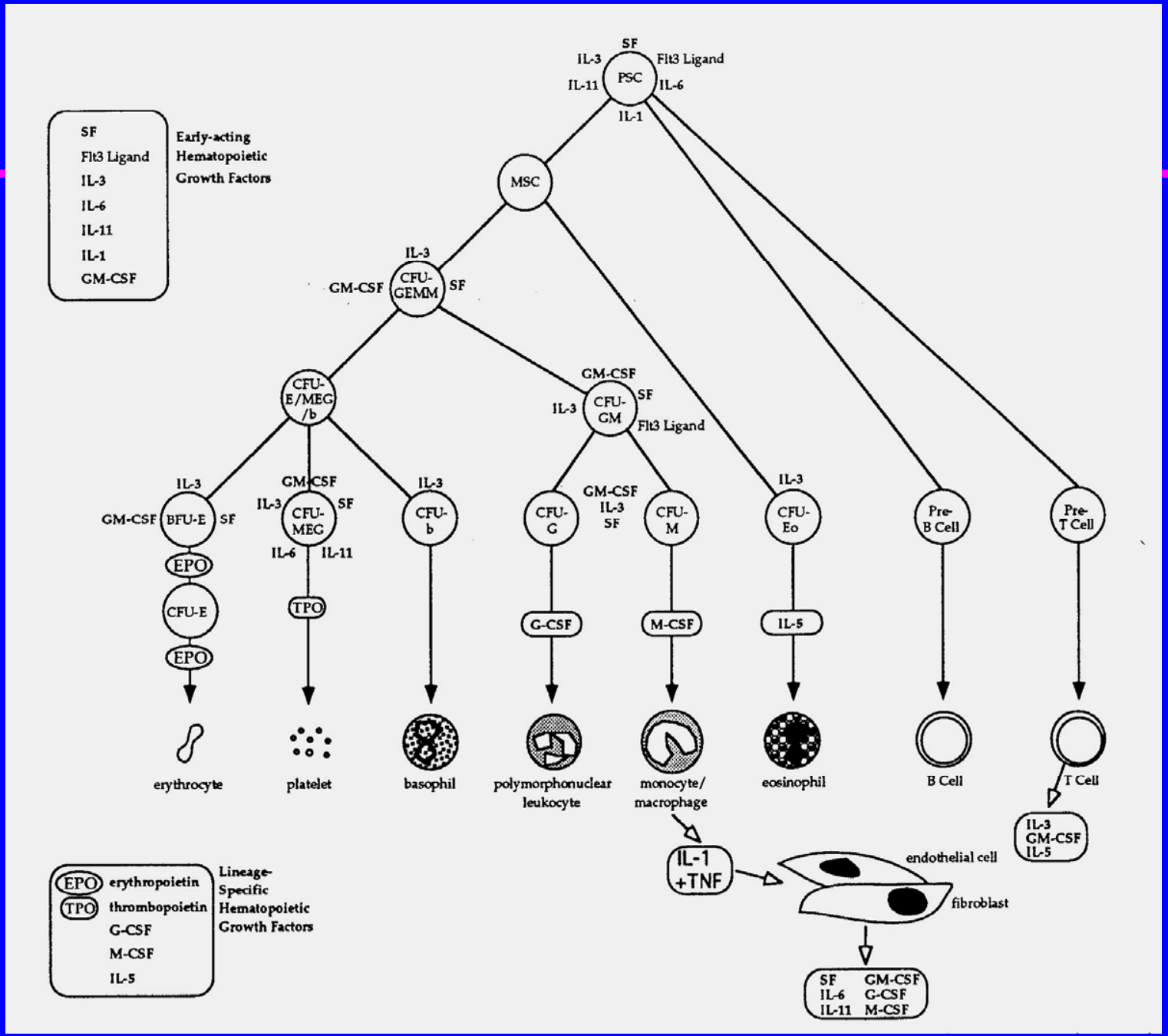
- Formation and development of blood cells
- Takes place in the bone marrow
- Involves “stem cells”

HEMATOPOIETIC TREE

(With Cytokines)



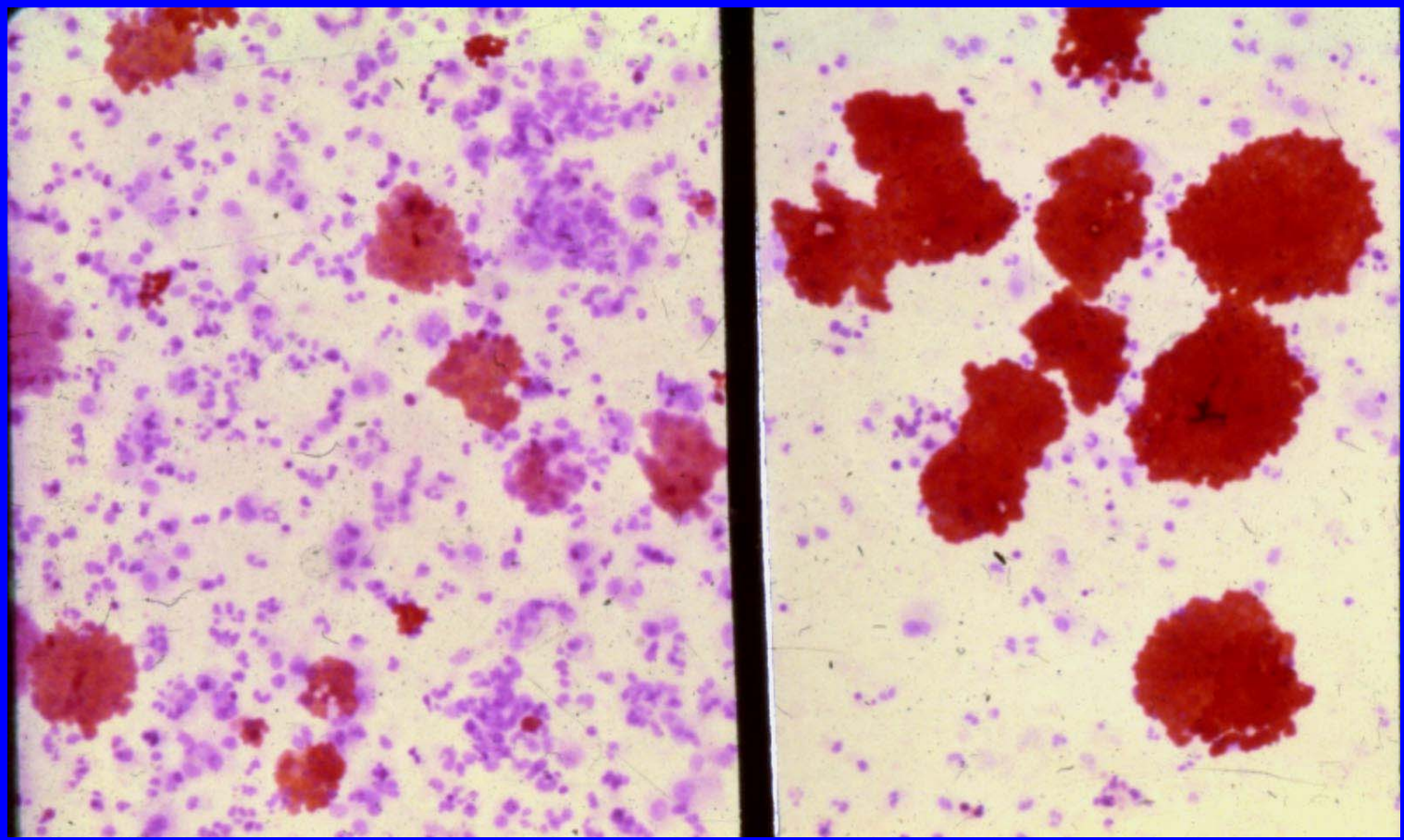
Hematopoiesis



BM Cultures

- CFU-E: colony-forming unit, erythroid
- BFU-E: burst-forming unit, erythroid
- CFU-C: colony-forming unit in culture
- CFU-GM: colony-forming unit, granulocyte-macrophage

CFU-E and BFU-E



MDS Diagnostic Criteria

Major	Intermediate	Minor
Overt dysplasia	Suggestive dysplasia	MPO deficiency
Clonal cytogenetics		Dual esterase + PAS+ erythroblasts Ring sideroblasts

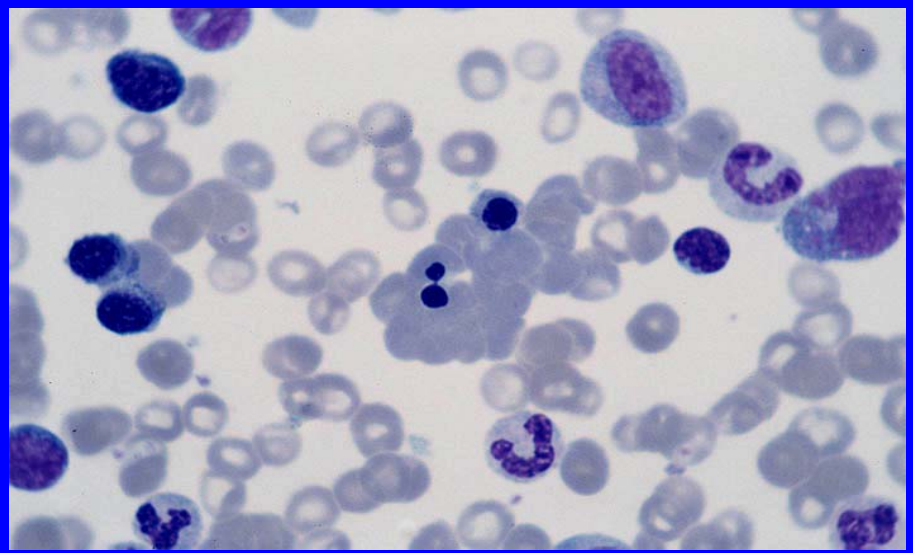
MDS = 1 major, or 1 intermediate + 1 minor.

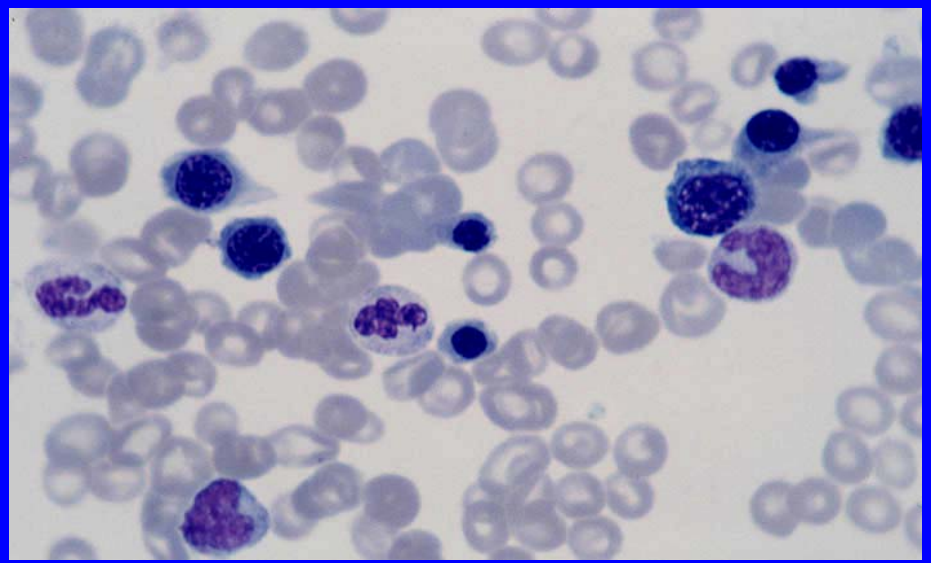
Overt dysplasia = 2 cell lines. Suggestive = 1 cell line.

Dysplastic Marrow Features in Morphologic MDS

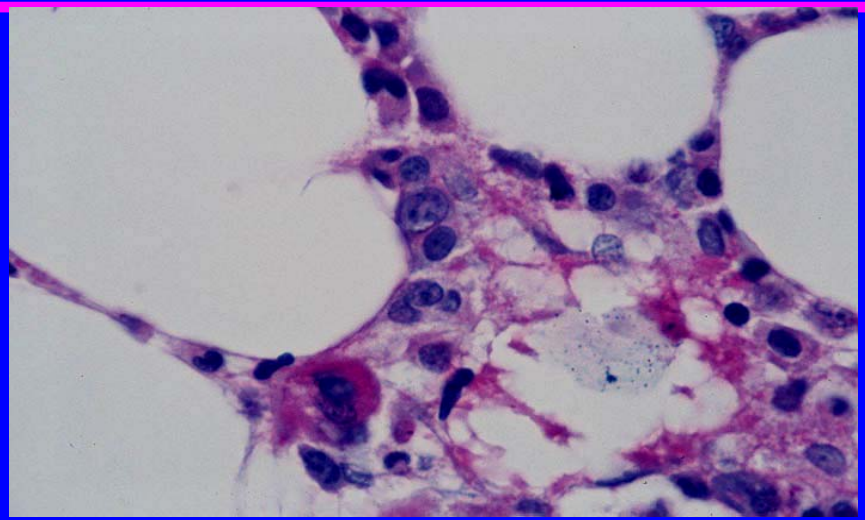
- ***Erythroid***: megaloblastic, multinucleation, nuclear fragments, increased immature forms, ring sideroblasts
- ***Myeloid***: increased immature forms, hypo/hyper-granulation
- ***Megakaryocytes***: hypo-/hyper-lobulated, small forms, increased nuclear-cytoplasmic ratio

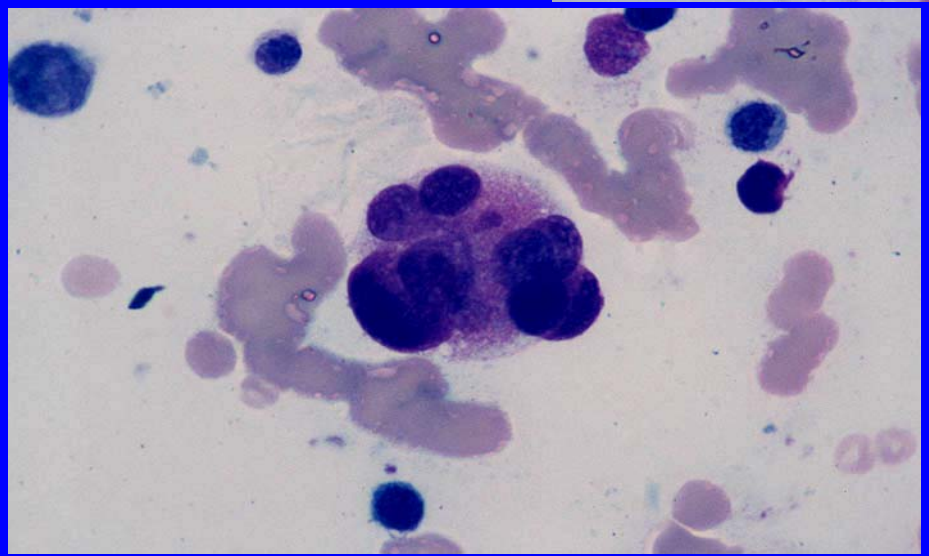
Bone Marrow in MDS - Erythroid

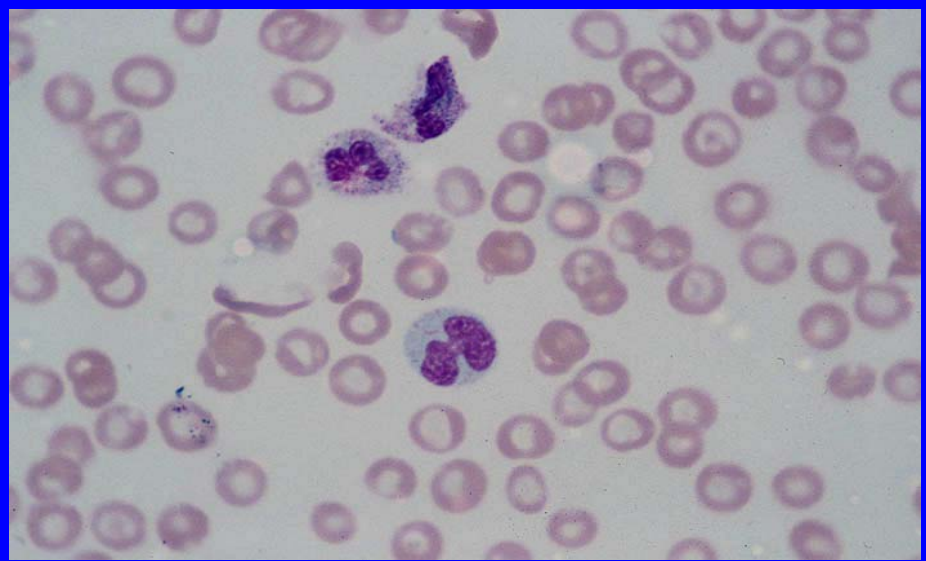




Bone Marrow in MDS - myeloid and megakaryocytic





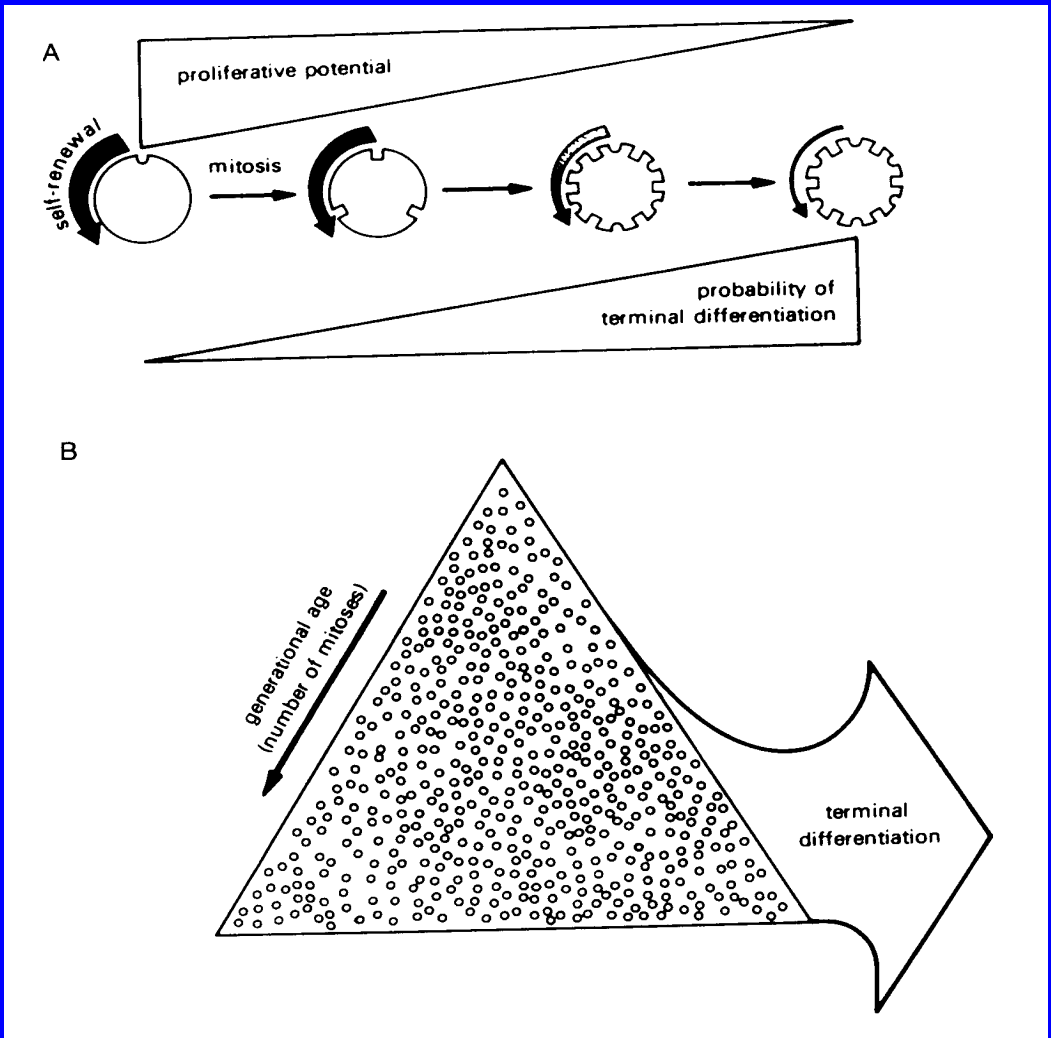


FAB CLASSIFICATION

- No MDS
- RA = refractory anemia
- RARS = ring sideroblasts
- RAEB = RA with excess blasts (5-20%)
- CMML = chronic myelomonocytic leukemia, PB monocytes >1000/μL
- RAEBIT = RA in transformation

French-American-British

Hematopoiesis



Blood and Marrow MDS Study

- Aspirate: Morphology
- Biopsy: Cellularity
- Cytochemistry: PAS, MPO, dual esterase, iron
- Flow cytometry: Lymphocytes, granulocytes
- Oncogenes: p53, p21
- Cytogenetics: Classical G banding, FISH, SKY

Contributors

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The End