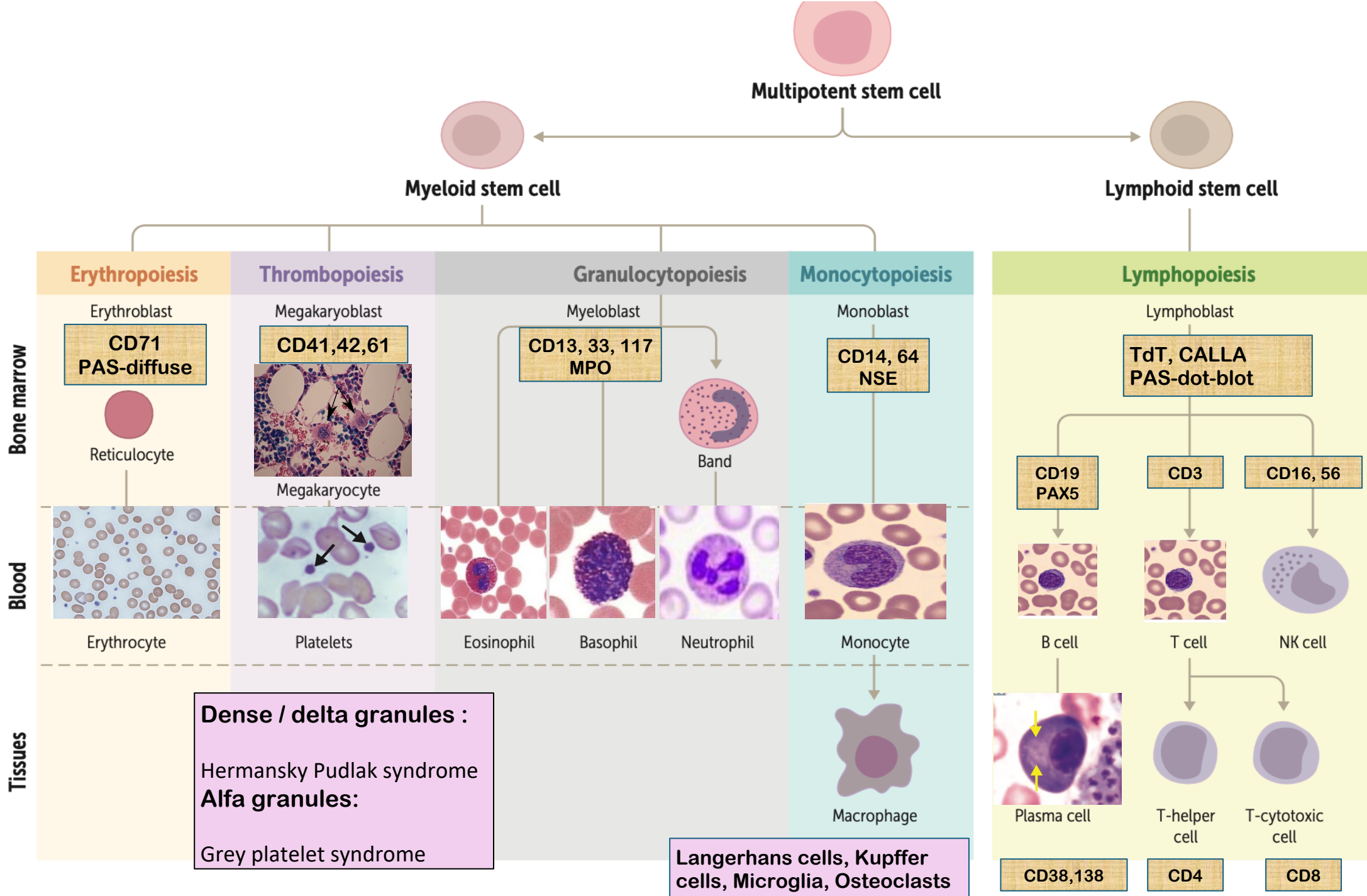
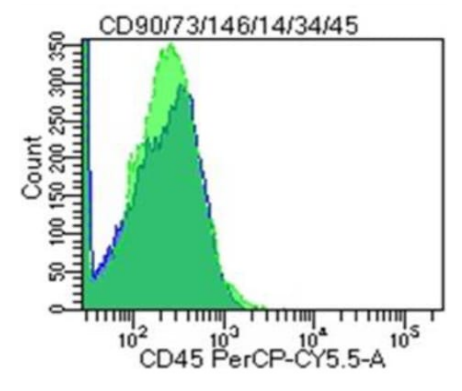
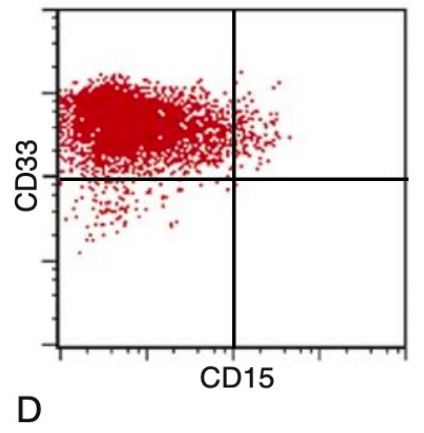
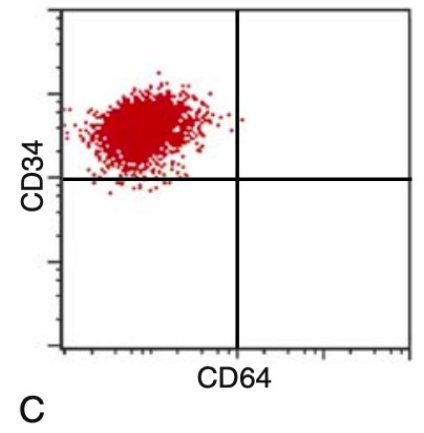
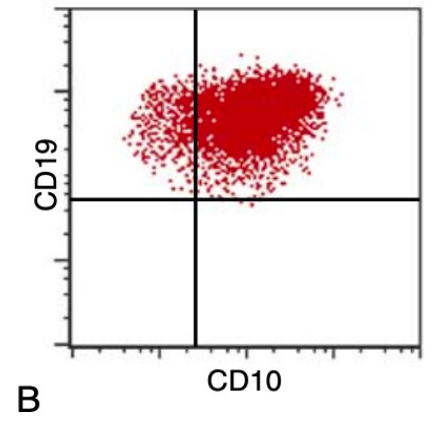
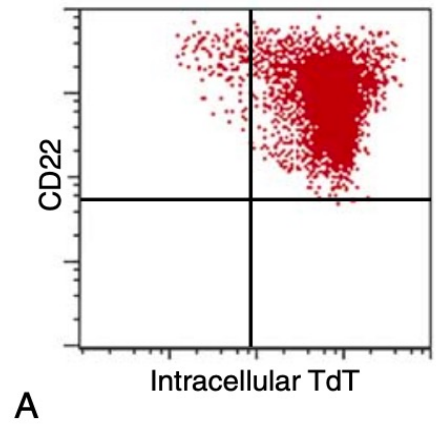
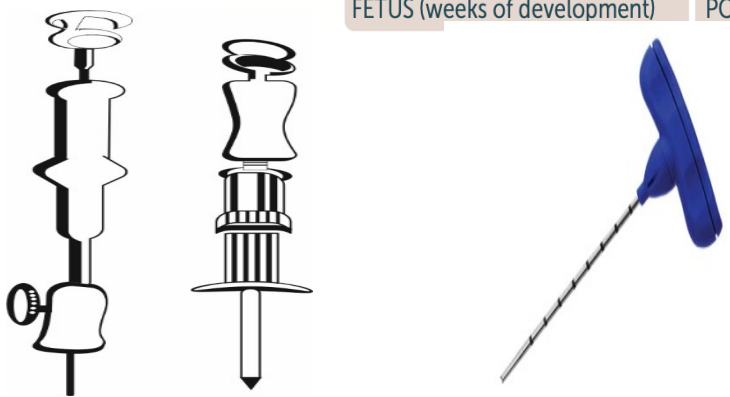
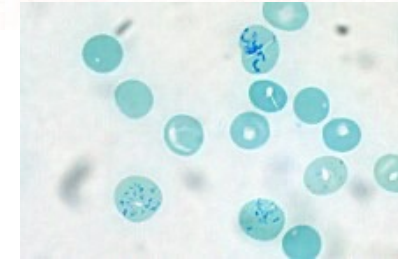
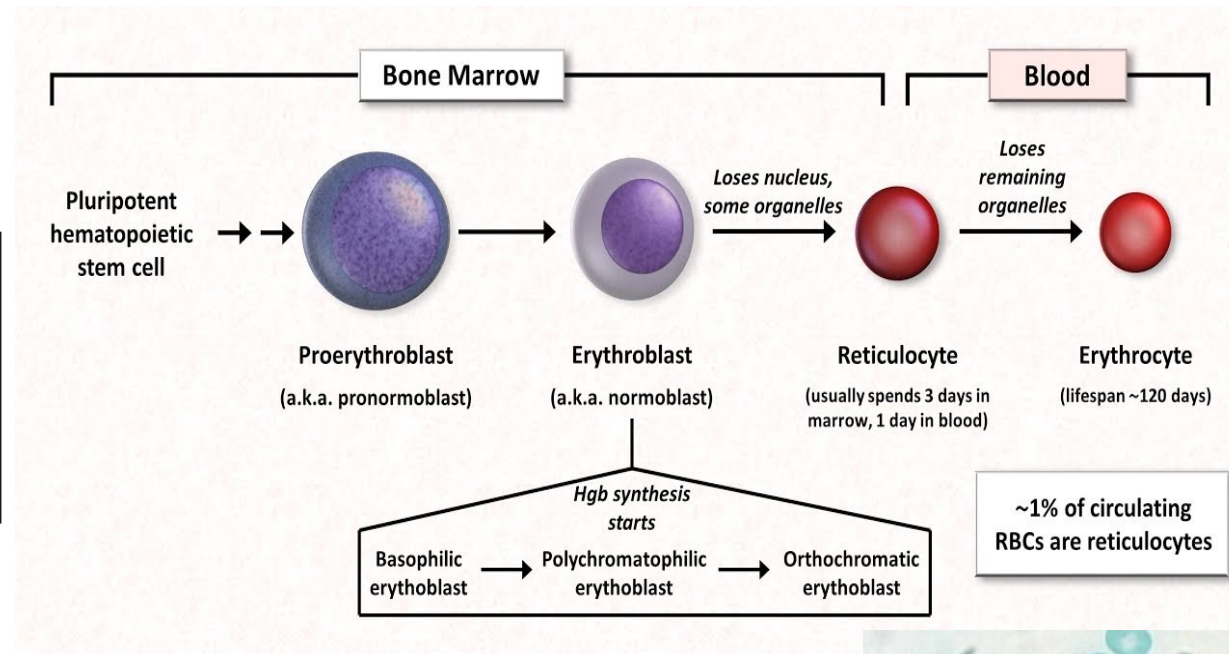
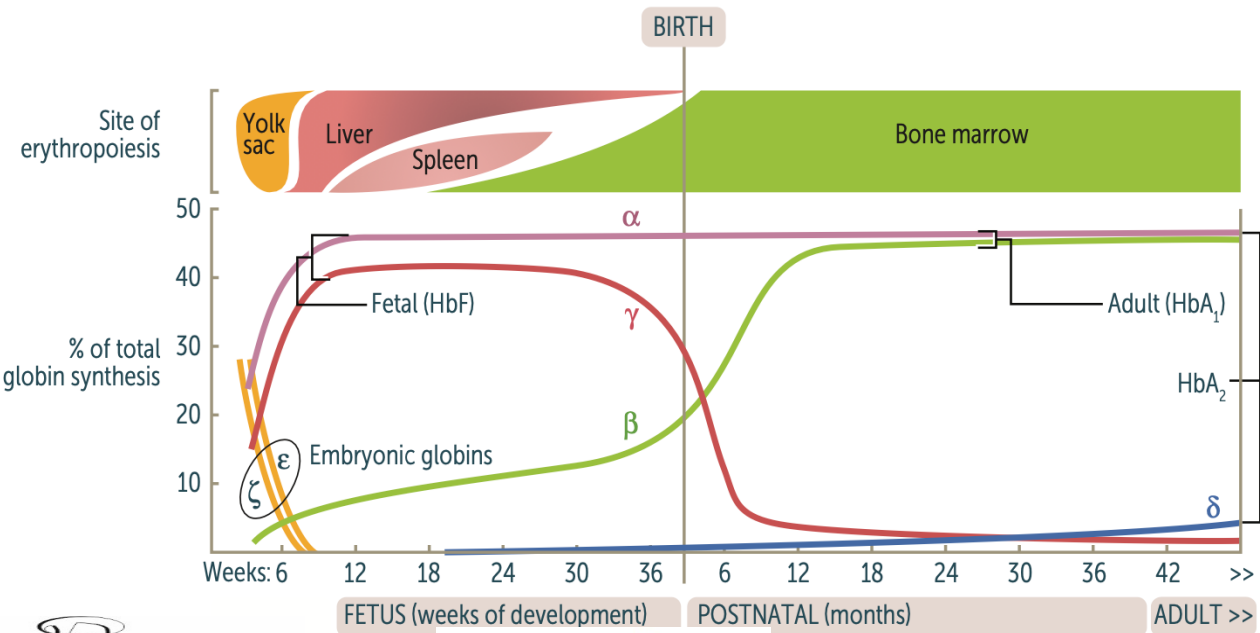


INTEGRATED SYSTEMS: HEMATOLOGY





RBC

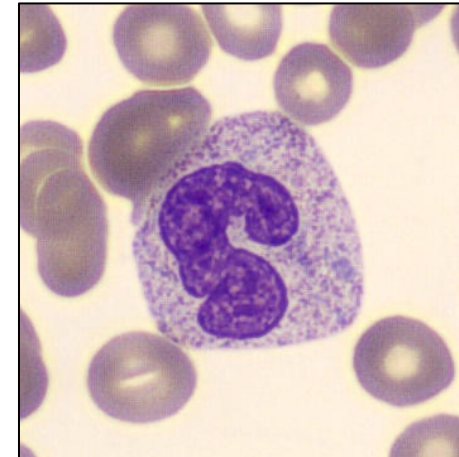
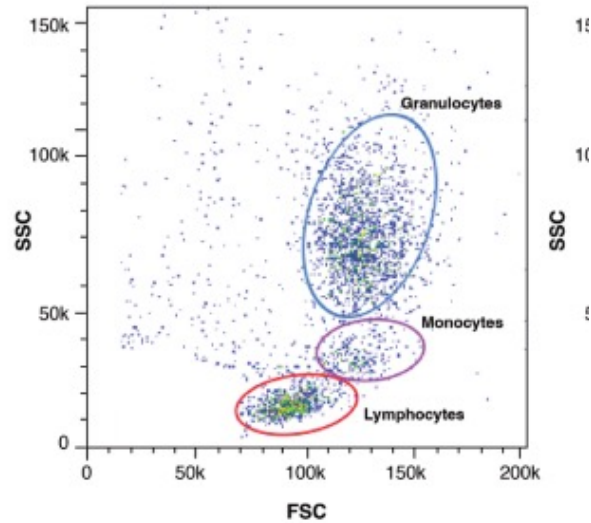
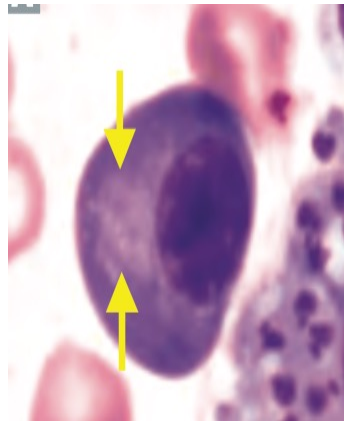
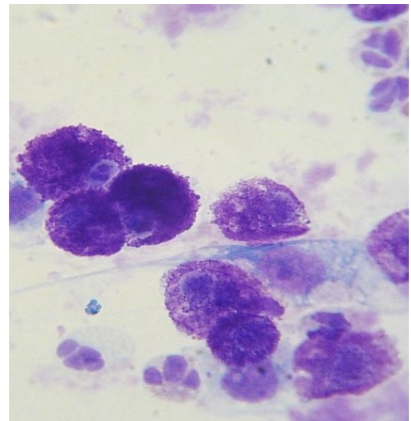
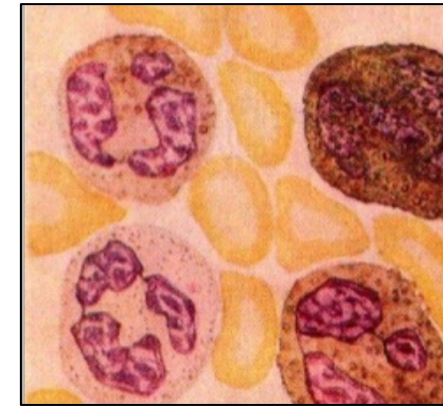
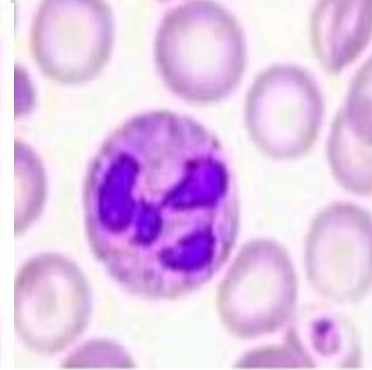
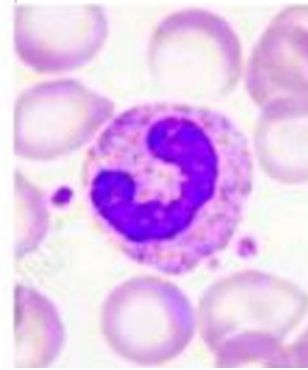
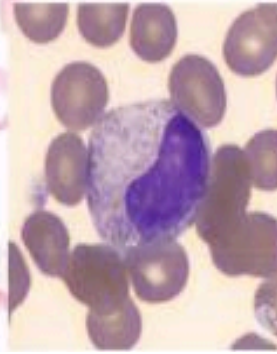
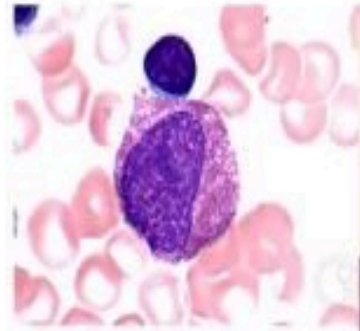
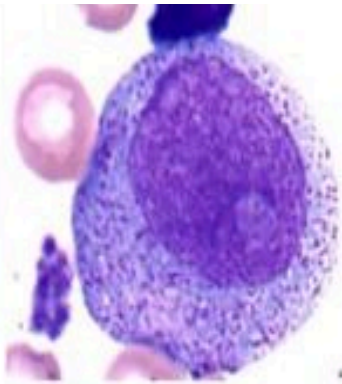


Preferred site for BMA/ BMB:
Adult-
Child-
Low Platelet CI?:

$$\text{Reticulocyte Production Index (RPI)} = \frac{(\text{Retic } \%) \times \left(\frac{\text{Hct}}{45}\right)}{\text{Maturation Factor}}$$

Hematocrit	Maturation Factor
≥ 40%	1.0
30 – 39.9%	1.5
20 – 29.9%	2.0
< 20%	2.5

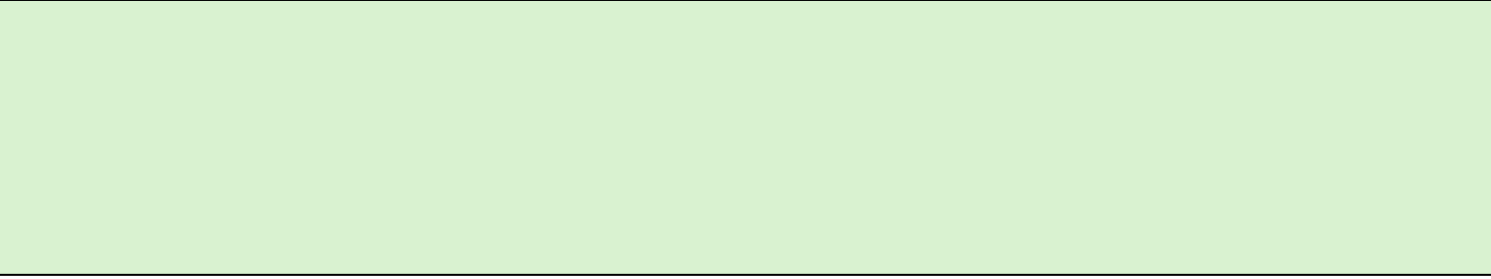
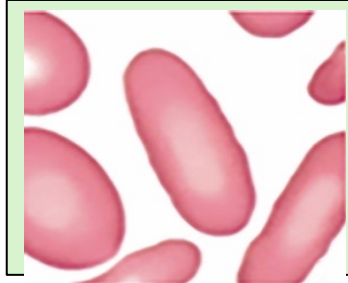
WBCs



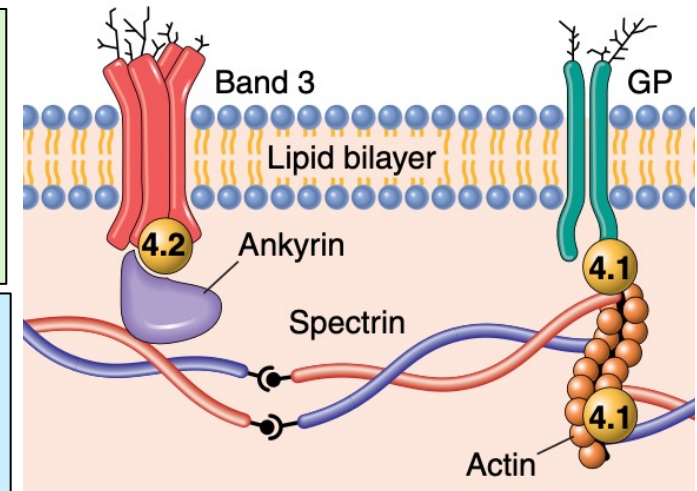
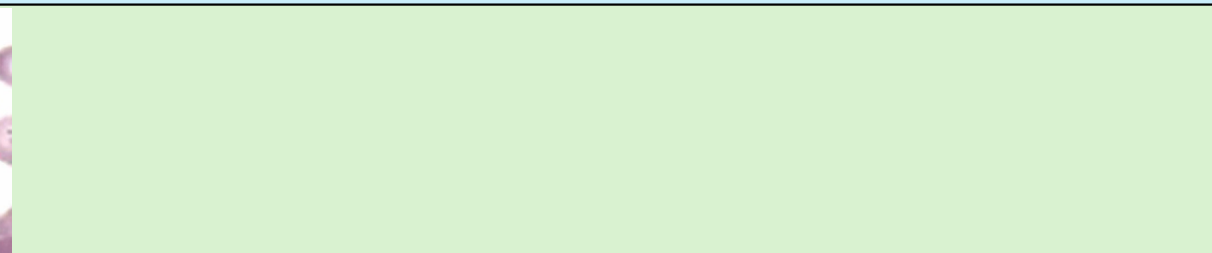
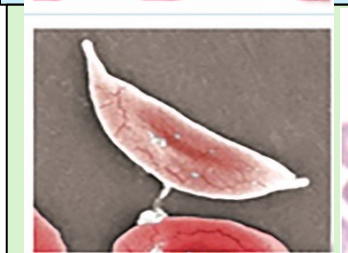
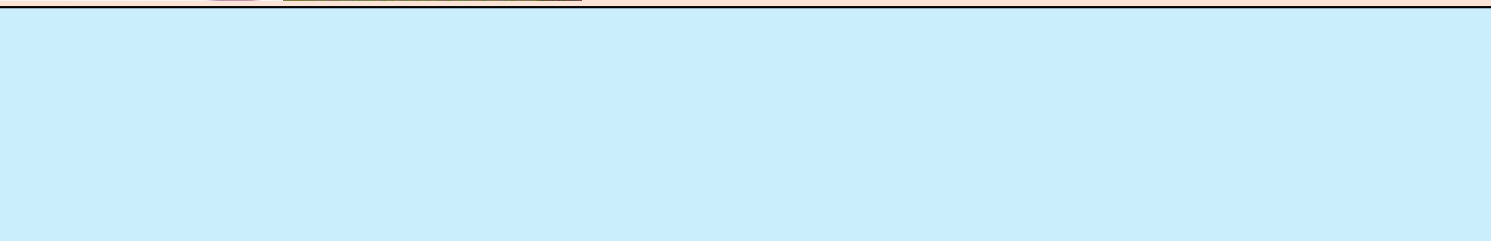
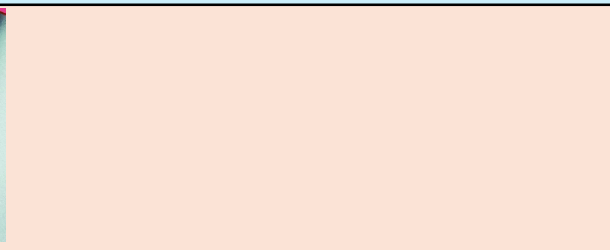
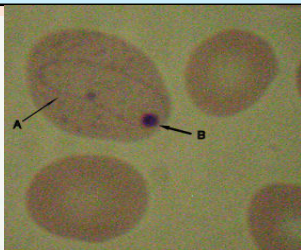
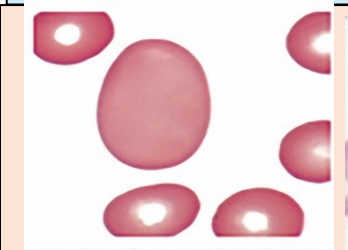
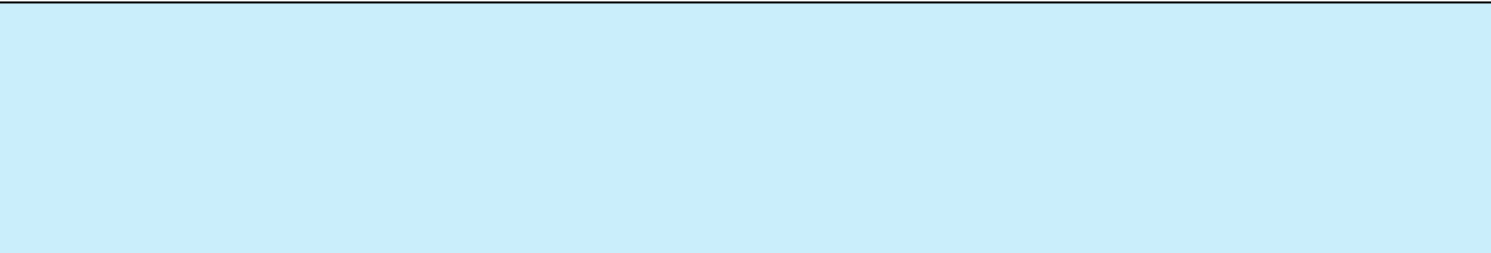
Toxic granules
Dohle bodies

- IgE mediated degranulation
- IgE-independent: Vancomycin, opioids, radiocontrast dye

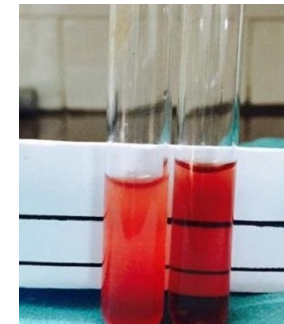
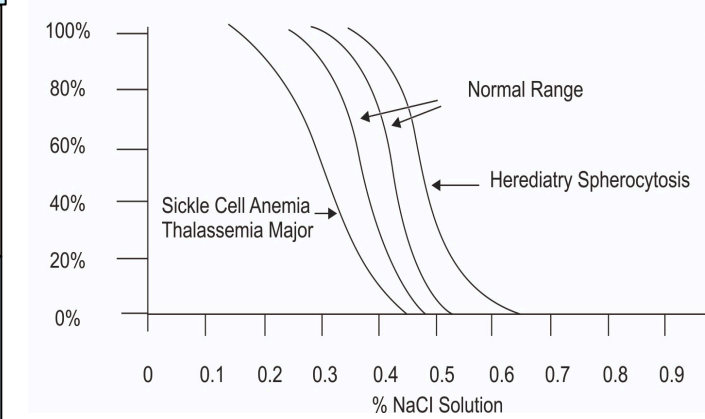
RBC Shapes and Disorders

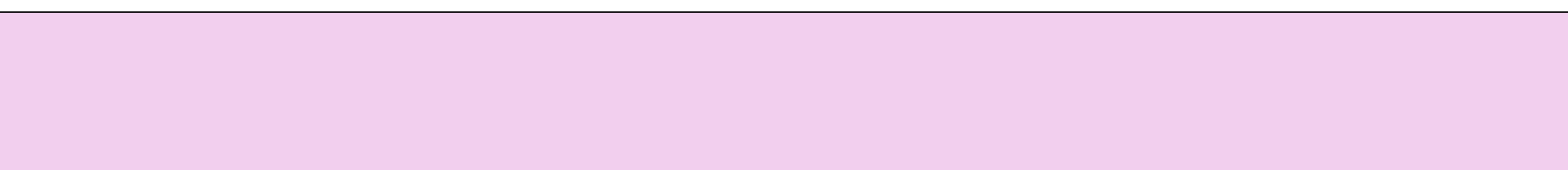
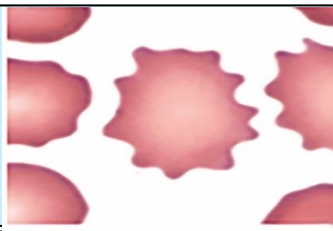
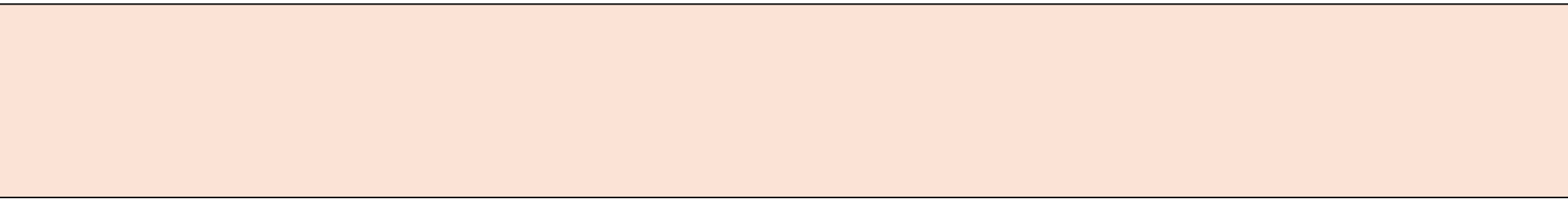
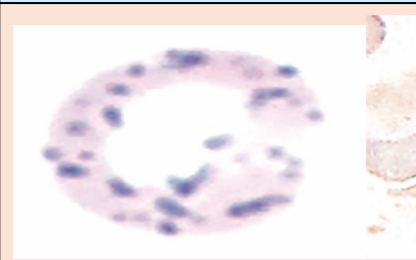
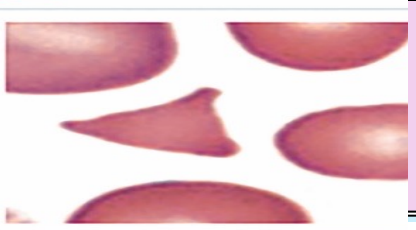
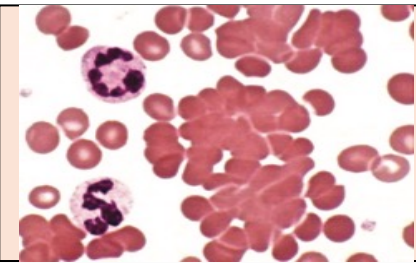


MCHC >37g/dl



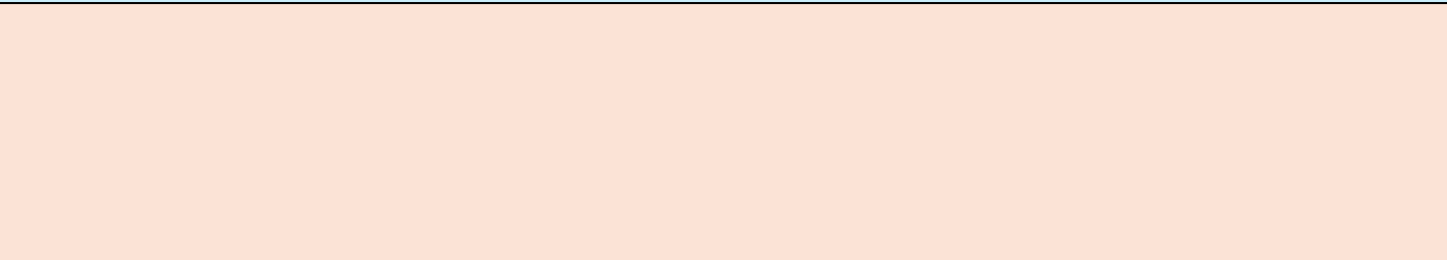
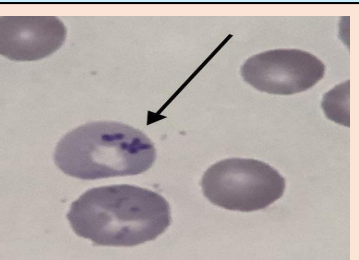
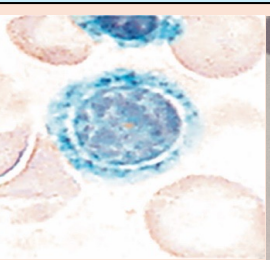
Hemolysis





Fluorescent Spot Test

	T ₁	T ₂	T ₃
NORMAL CONTROL			



Anemias

Male:

Female:

Pregnant/CKD:

MICROCYTIC

NORMOCYTIC

MACROCYTIC

NON-HEMOLYTIC

HEMOLYTIC

MEGALOBLASTIC

NON-
MEGALOBLASTIC

INTRINSIC

EXTRINSIC

MEMBRANE:

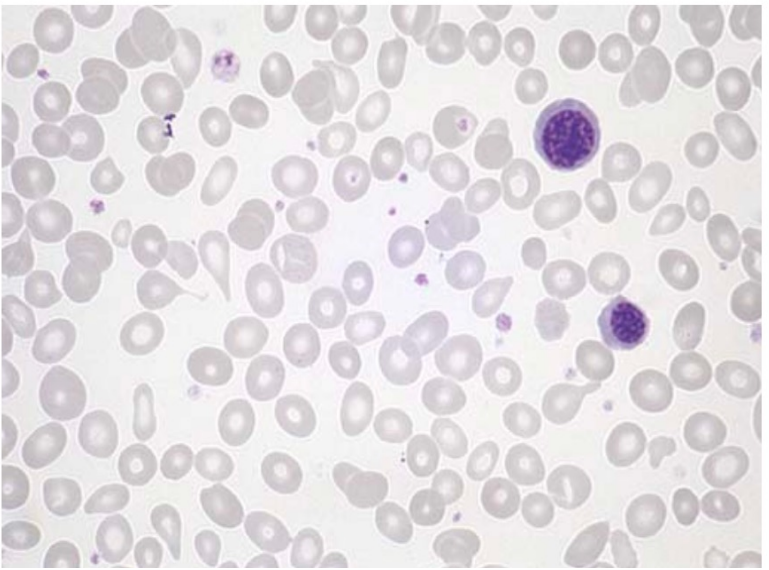
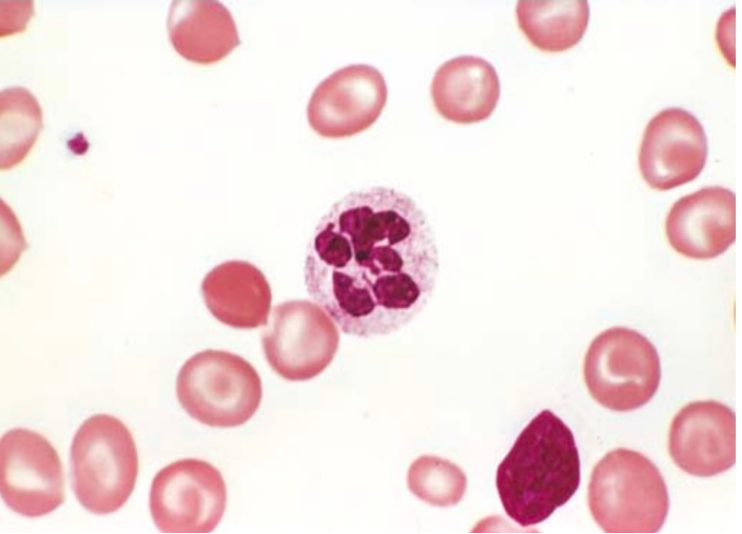
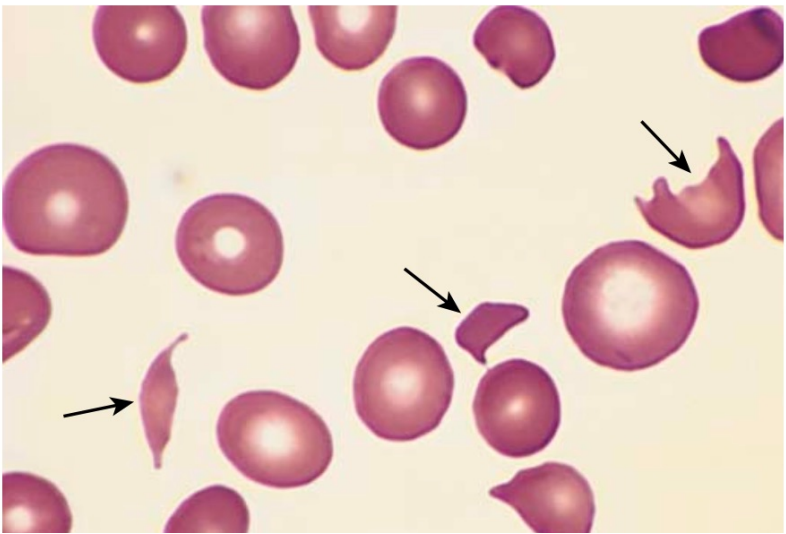
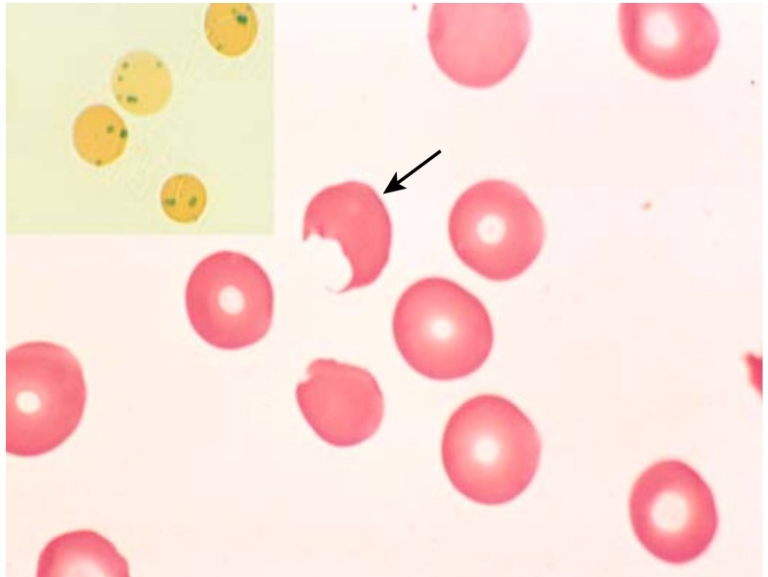
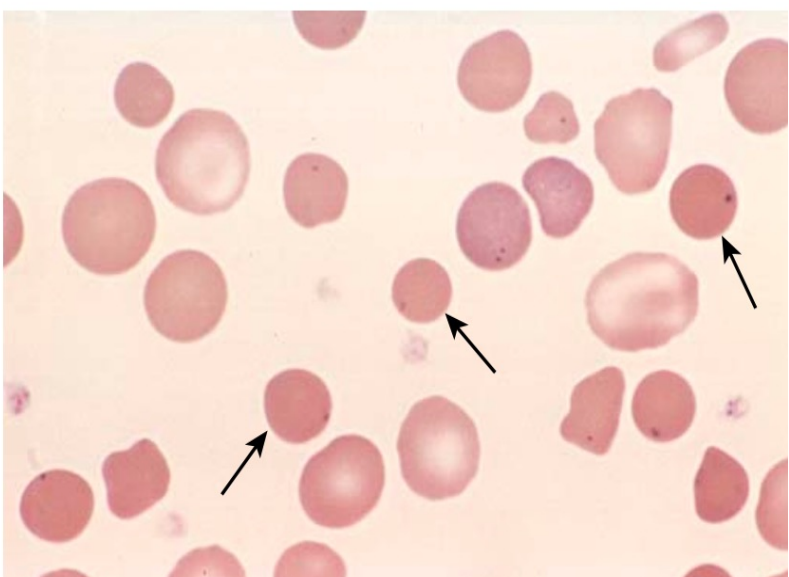
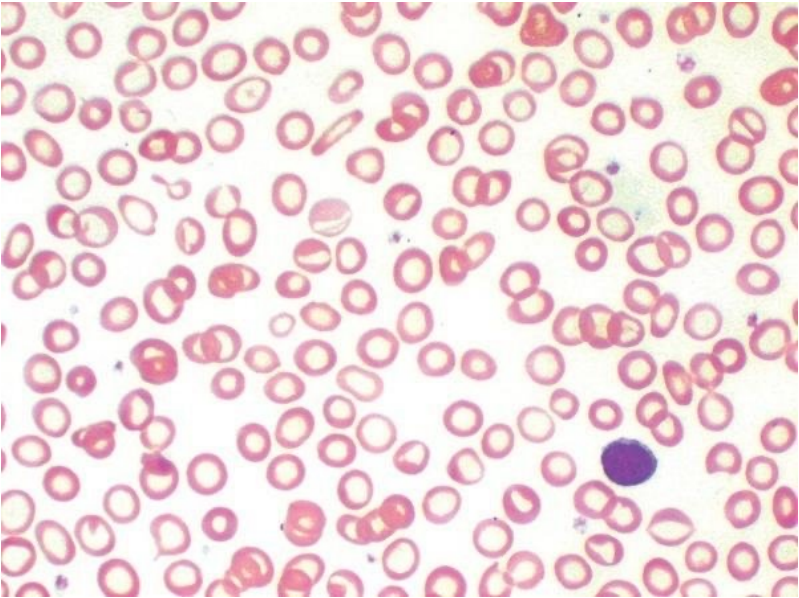
ENZYME:

HB:

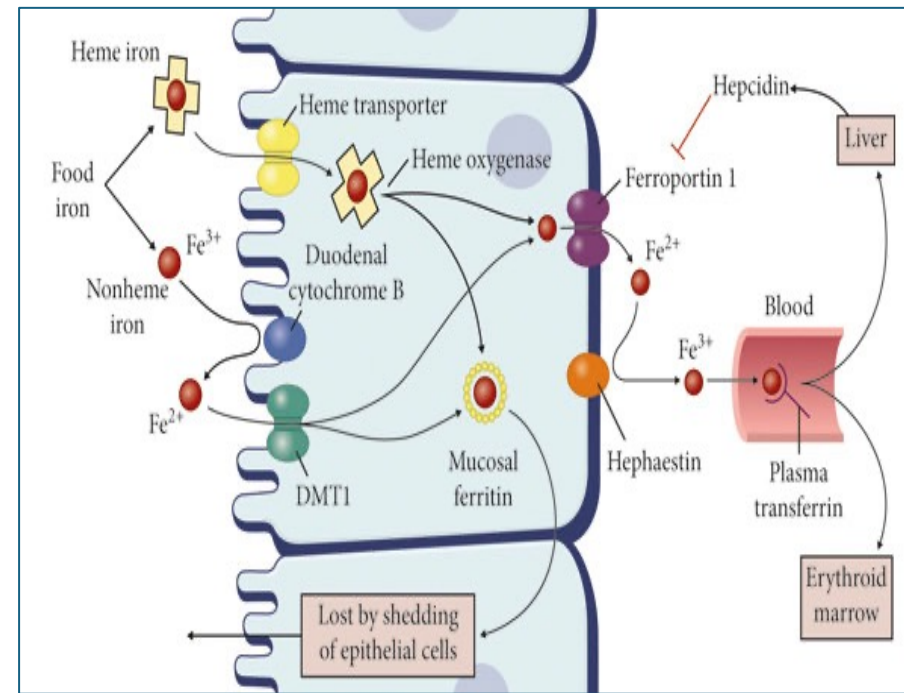
IVH:

EVH:



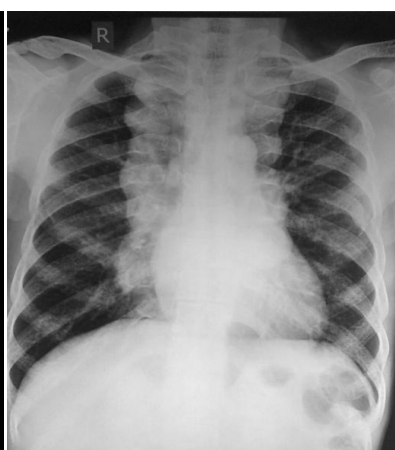
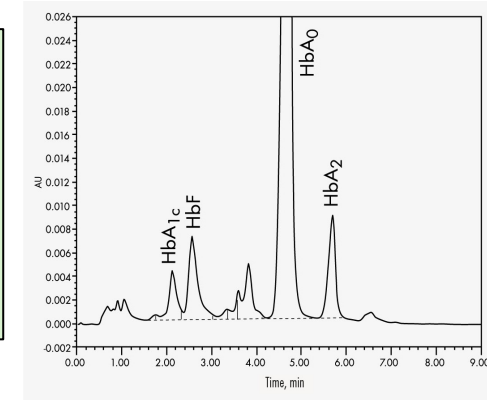


Specific Anemias

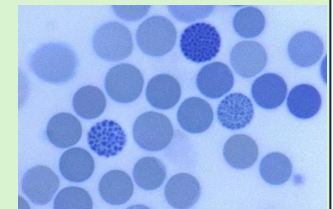


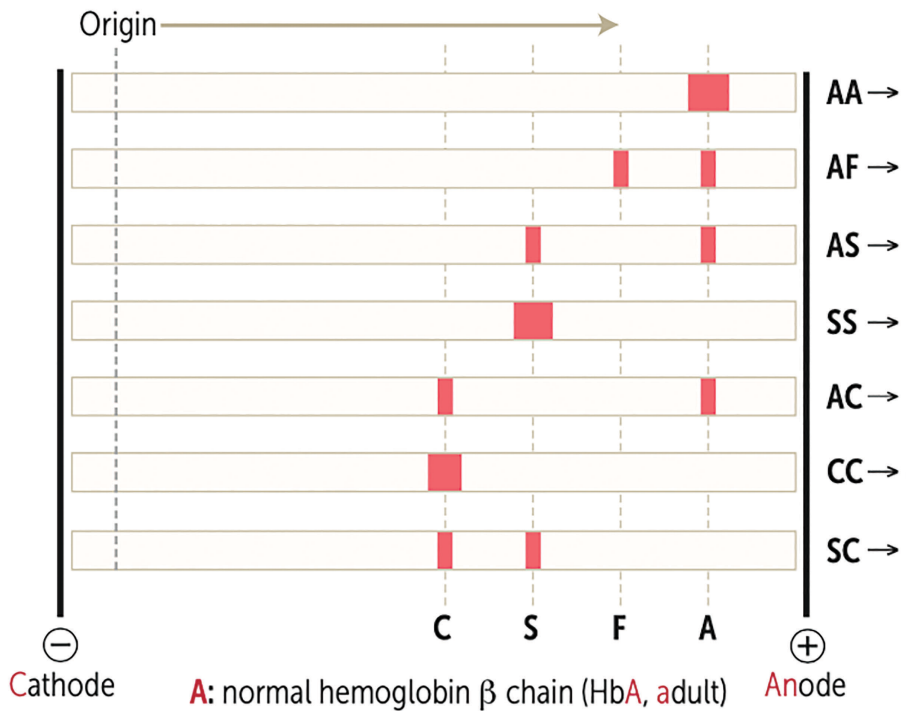
Serum iron	↓	↓	↑
Transferrin or TIBC	↑	↓	↓
Ferritin	↓	↑	↑
% transferrin saturation	↓↓	↓	↑↑

IDA vs Thalassemia minor
Mentzer index
RDW:
Confirmatory test for thalassemia minor:



Chr 16 deletion:
 1-
 2-
 3-
 4-
Chr 11 Splicing mutation:
 1-
 2-





Glu —Valine B6:

Glu — Lysine

PPT:

Metabisulfite test

Vaso-occlusive crises-Dactylitis, priapism, acute chest syndrome, avascular necrosis, stroke, papillary necrosis

Mx-

Glutamic acid

Hydroxyurea, Voxelotor

Crizanlizumab

- **Intravascular hemolysis**

- **Pancytopenia**

- **Thrombosis: Budd Chiari syndrome**

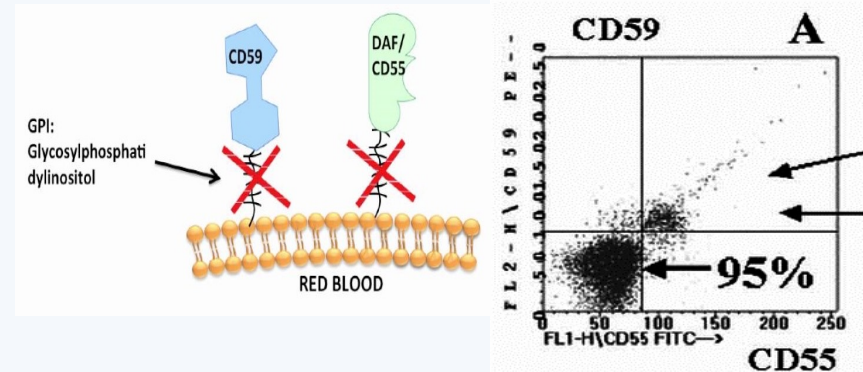
- **LAP score: low**

- **Aplastic anemia, Leukemia**

TESTS:Ham's acidified serum test, sucrose lysis test

GEL CARD TEST

Rx-Eculizumab, Ravulizumab

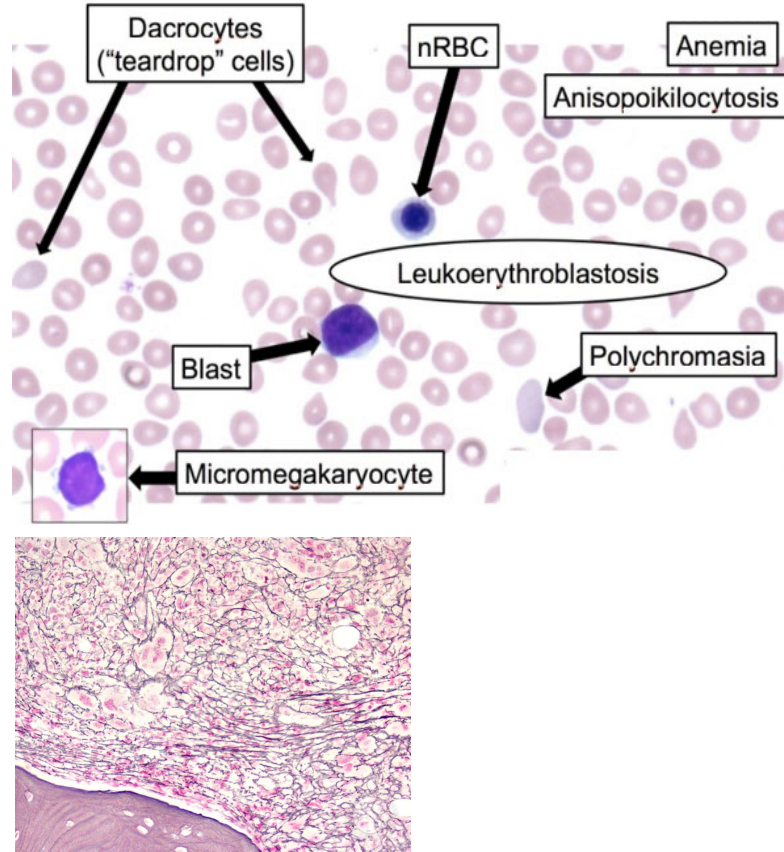


Approach to Pancytopenia

HSM +

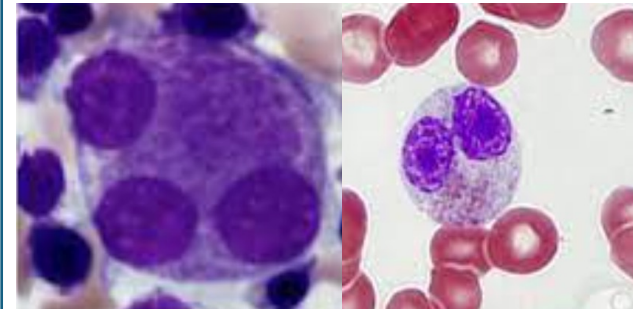
**HYPERCELLULAR
MARROW**

DRY TAP +

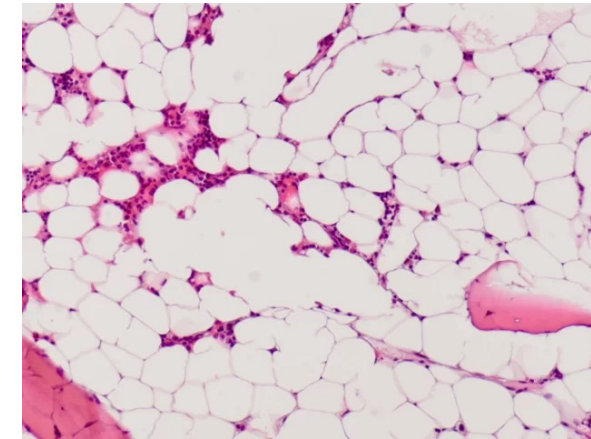


HSM -

**HYPERCELLULAR
MARROW**



**DRY TAP +
BMB:**



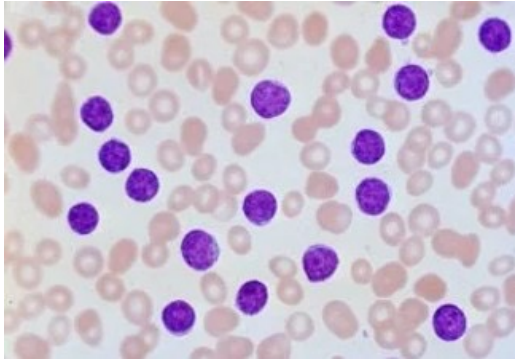
**Marrow blasts < 20%
Mutation:**

**Idiopathic, Viral (EBV,
HIV, hepatitis), Radiation,
Fanconi anemia**

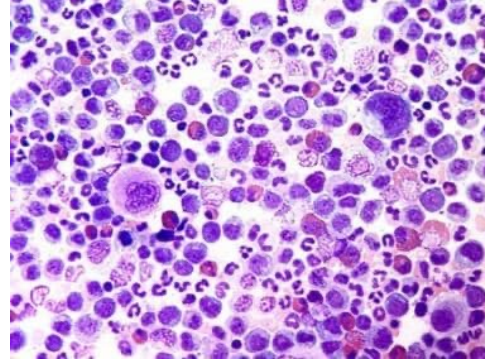
Approach to 'Leukemias'

CHRONIC

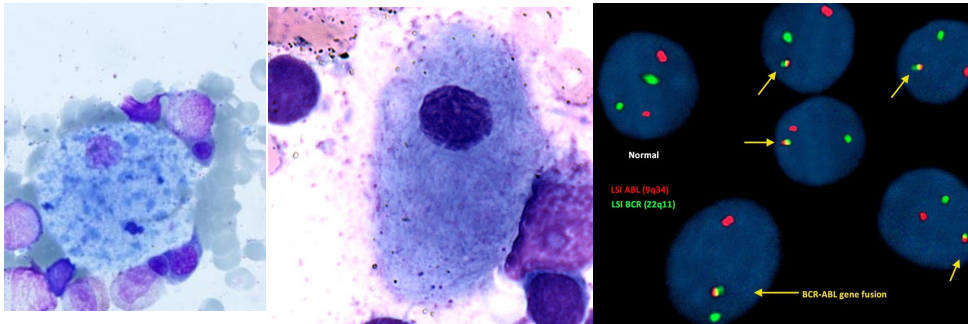
Lymphocytic



Myeloid origin

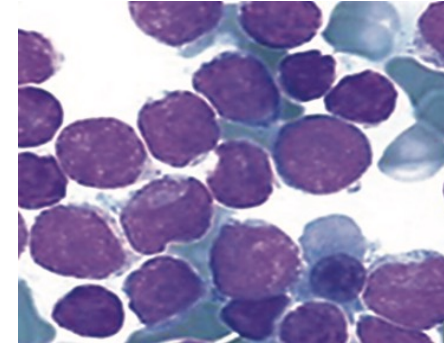


Binet / Rai staging

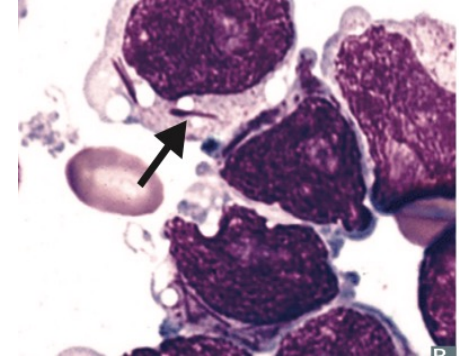


ACUTE

CHILD

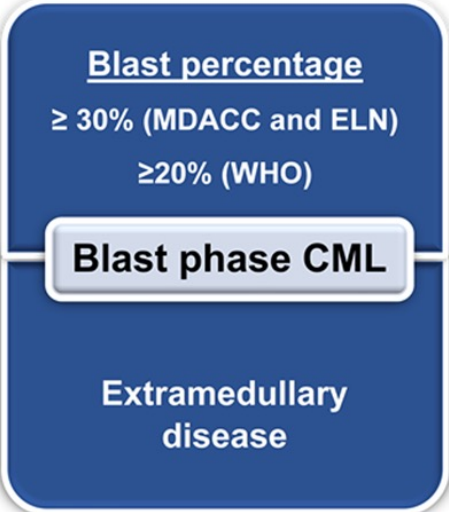
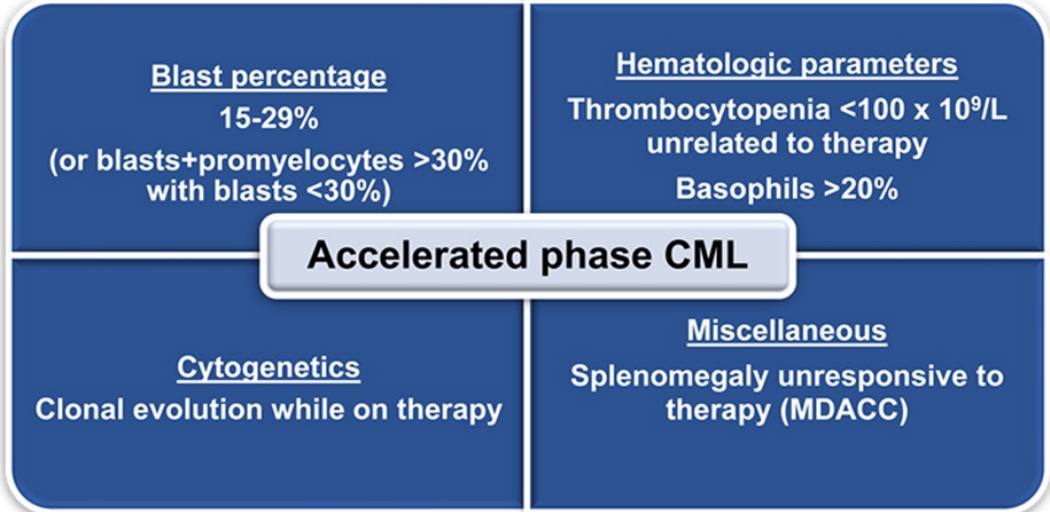


ADULT



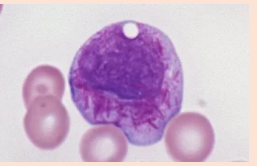
<1yr, >10yr
T cell –Acid phosphatase +
GOF NOTCH-T ALL
Mediastinum, Brain, Testes
L2,L3
Hypodiploidy
t (9;22) 190KD
t (4;11)

Pre B cell
LOF PAX5, RUNX1 E2A
L1
Hyperdiploidy
t 12;21
TRISOMY 4,7,10



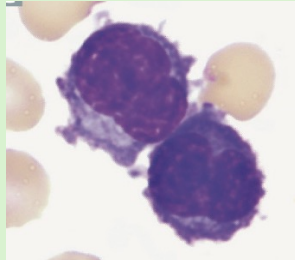

MC in children:
 MC in down syndrome:
 MC in downs (<3yr):
 MC in adults:
 MC with radiation:
 MC in elderly:
 MC in west:
 Not associated with radiation:
 Associated with deletion-13q:

- M0:** Undifferentiated acute myeloblastic leukemia
- M1:** Myeloblasts with < 10% granulocytic differentiation.
- M2:** Myeloblasts with granulocytic differentiation > 10%, NSE < 20%.
- M3:** Promyelocytes that are hypergranular with many Auer rods on CAE or Wright-stain
- M4:** 20%- 80% NSE-butyrate positivity in Monocytic cells
- M5:** >80% NSE positivity in Monocytic cells
- M6:** >30% myeloblasts with more than 50% erythroblasts eliminating the erythroid cells.
- M7:** Acute megakaryoblastic leukemia



SPLENOMEGALY + PANCYTOPENIA

DRY TAP +
TRAP+
BRAF mutation
Markers:

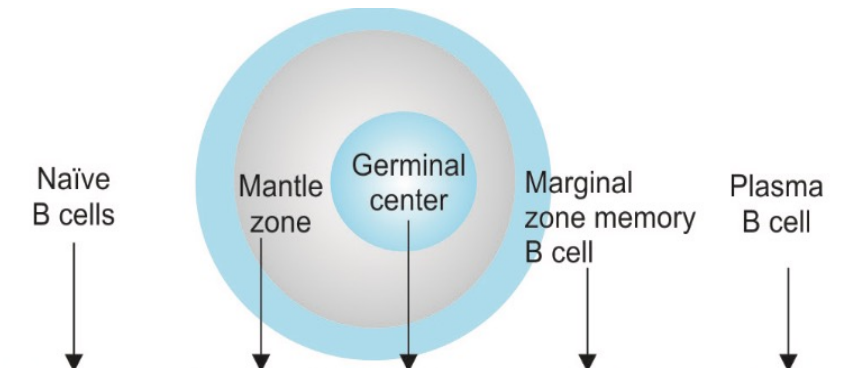
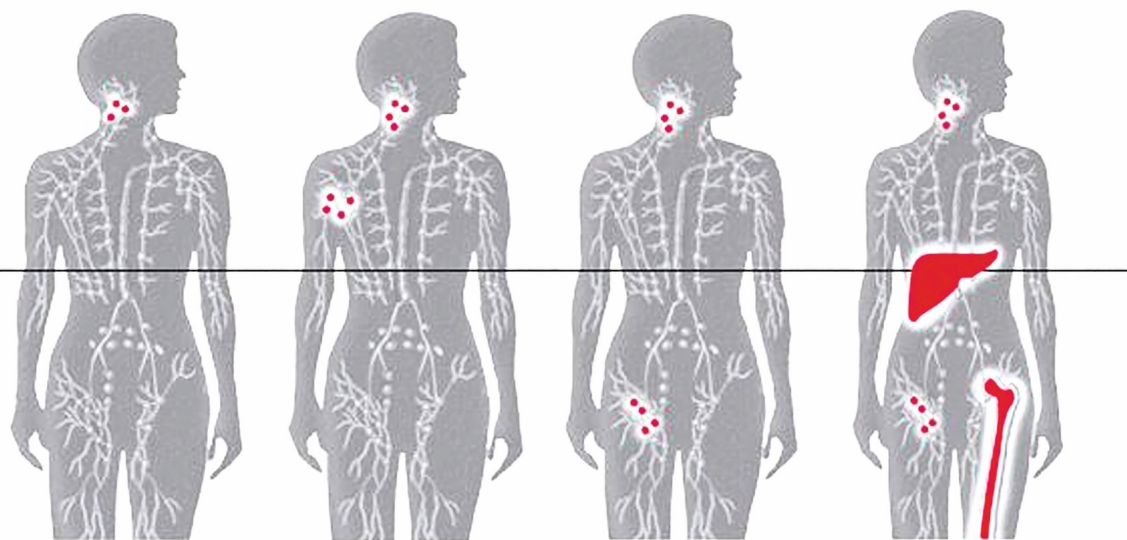
DOC-

Cytology: Uniformly medium-sized cells with abundant cytoplasm "fried egg appearance"

Lymphomas - Hodgkin's vs Non-Hodgkin's

Non-Hodgkin Lymphoma	Hodgkin Lymphoma
Multiple lymph node groups	Single axial group of nodes MC:
Non-contiguous spread	Orderly spread by contiguity
Mesenteric nodes/ Waldeyer ring ++	--
Extranodal involvement ++	--
Worse prognosis	Better prognosis
Rituximab, Cyclophosphamide, Doxorubicin, Vincristine, Prednisone	Adriamycin, Bleomycin, Vinblastine, Dacarbazine

<u>NHL Transloactions</u>			
8	11	14	18



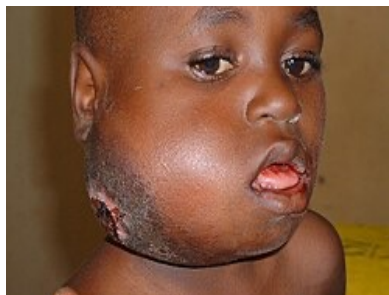
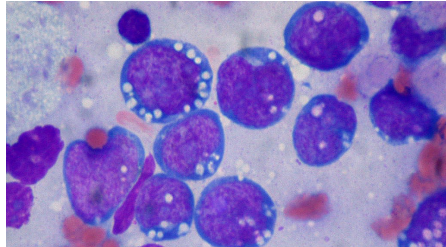
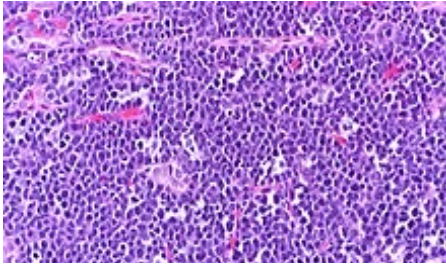
Approach to 'B-cell NHL'

CD 19/20 +

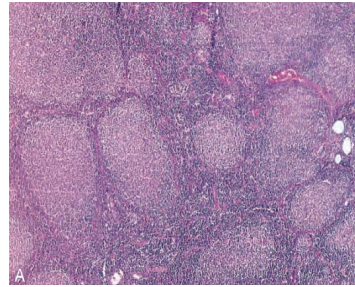
CD 10 +
BCL6 +

MC NHL
MC aggressive
MC extranodal
EBV
Richter
transformation
(SLL)

C-myc
Ki 67 100%
Endemic
Sporadic



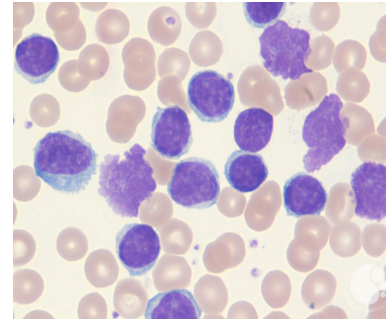
CD 10 +
BCL-2 +



Best prognosis
Waxing and
waning LN
Centrocytes,
blasts

CD 5 +

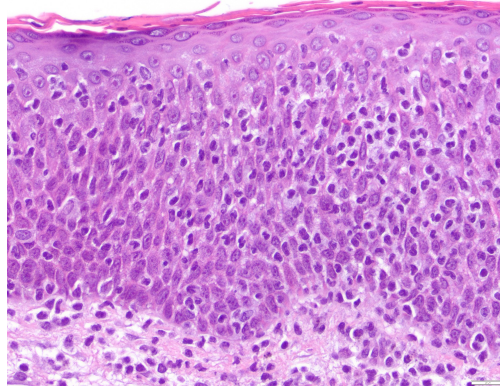
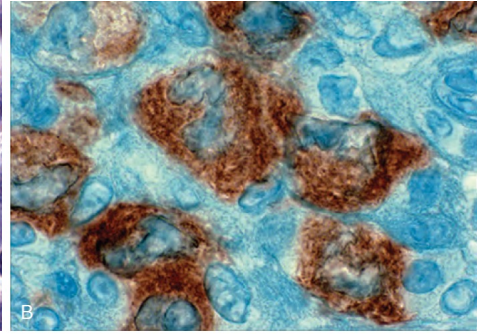
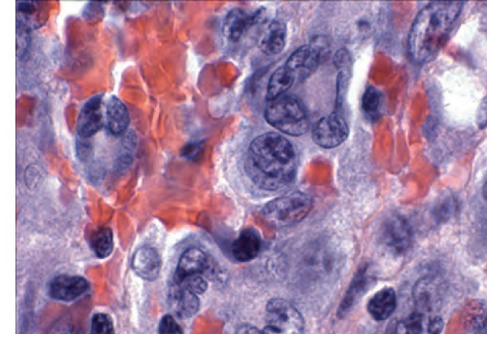
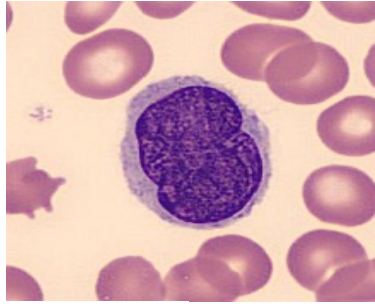
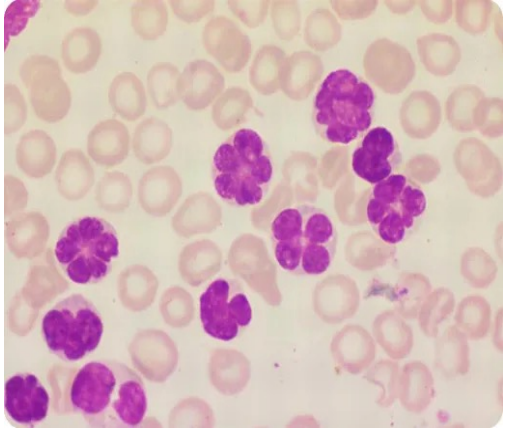
CD 23+
Cd 200+
DELETION 13q
AIHA



CD 23-
CYCLIN D1+
SOX 11+
Lymphomatoid
polyposis

CD5-
CD 23-
CD 10-
Sjögren, chronic
gastritis

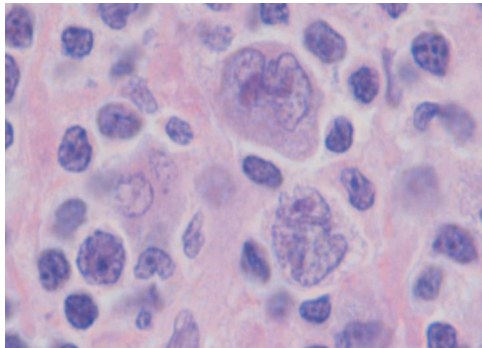
Approach to 'T-cell NHL'



Approach to Hodgkin's Lymphoma

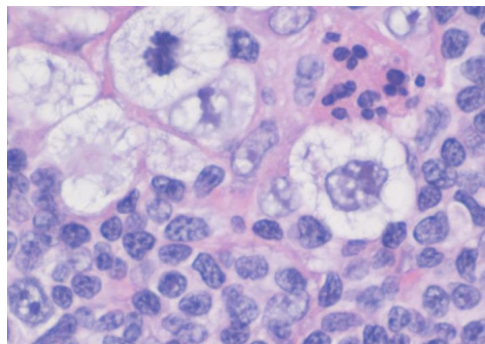
CD20 +
CD45+
EMA +
BCL-6 +
EBV LMP -

POPCORN CELL

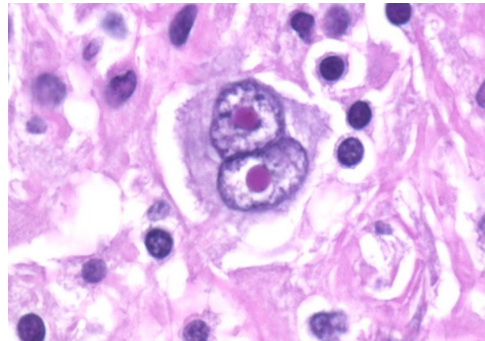


CD 15 +
CD30 + most sensitive
PAX5 most specific
EBV LMP +

COLLAGEN
NODULES,
LACUNAR CELL
Most common

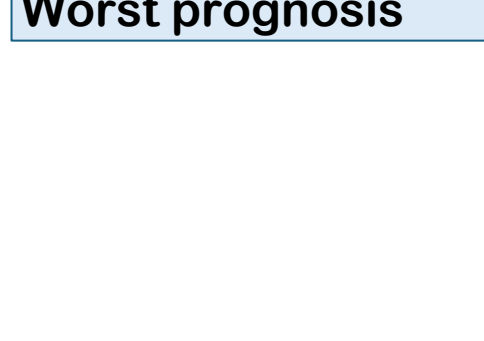


BACKGROUND
MIXED,
HIV +
CLASSICAL RS



BACKGROUND
LYMPHOCYTE,
MONONUCLEAR RS

LOW
LYMPHOCYTE,
PLEOMORPHIC /
MUMMIFIED RS
Worst prognosis



Plasma Cell Dyscrasias

MM:

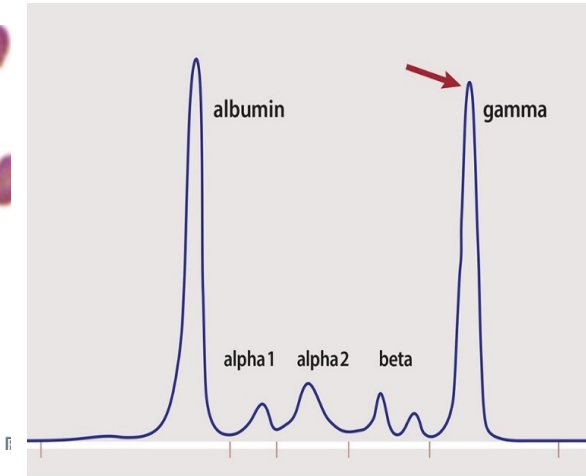
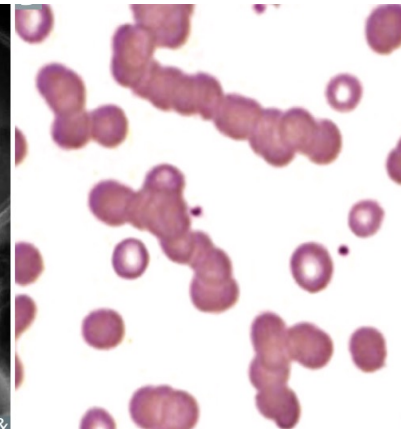
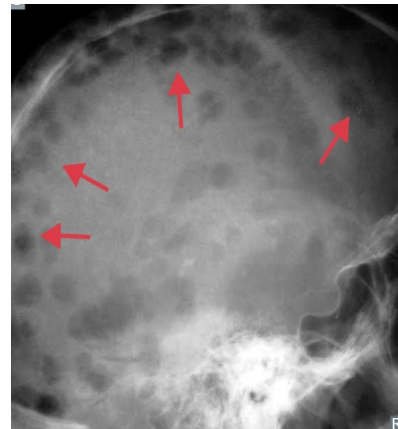
Smouldering MM:

MGUS:

Plasma cell leukemia:

Waldenström's macroglobulinemia (MYD88):

LN + HSM, Hyperviscosity, Neuropathy



C = **Ca** >11.5 mg/dL

R = **Renal** insufficiency (creatinine >2 mg/dL or creatinine clearance <40 mL/min)

A = **Anemia** (Hb <10 g/dL or 2 g/dL below normal)

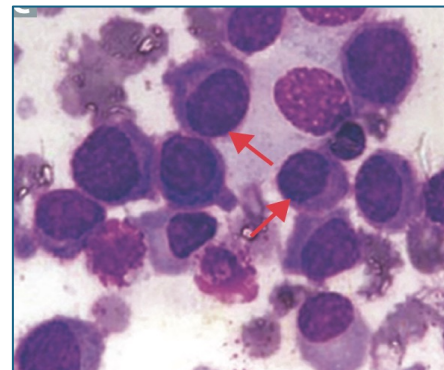
B = presence of **bone** lesions (One or more osteolytic lesions on Xray/ MRI/ FDG PET/CT)

MM DEFINING BIOMARKERS

S = **>sixty** percent plasma cells in the bone marrow

Li = involved/uninvolved free **light** chain ratio of 100 or more

M = **MRI** with more than one focal marrow lesion



Protein gap (total-albumin) >4g/dl

URINE:

B2 microglobulin

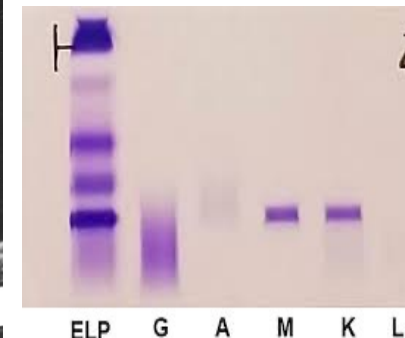
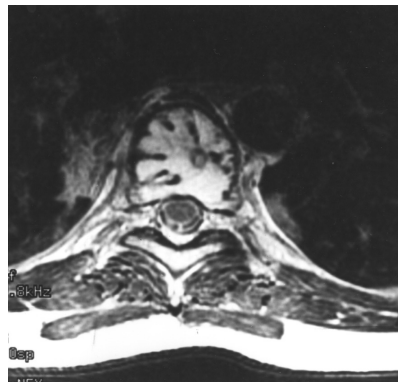
Mulberry/Mott cells

Flame cells

Russel body-

Dutcher body-

MCC of death-

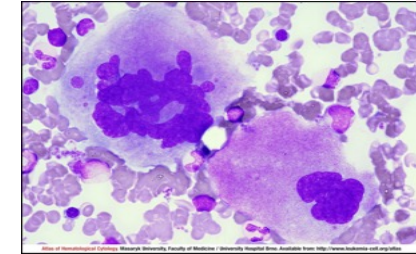


- Lenalidomide
- Dexamethasone
- Bortezomib
- Daratumumab

Myeloproliferative Disorders

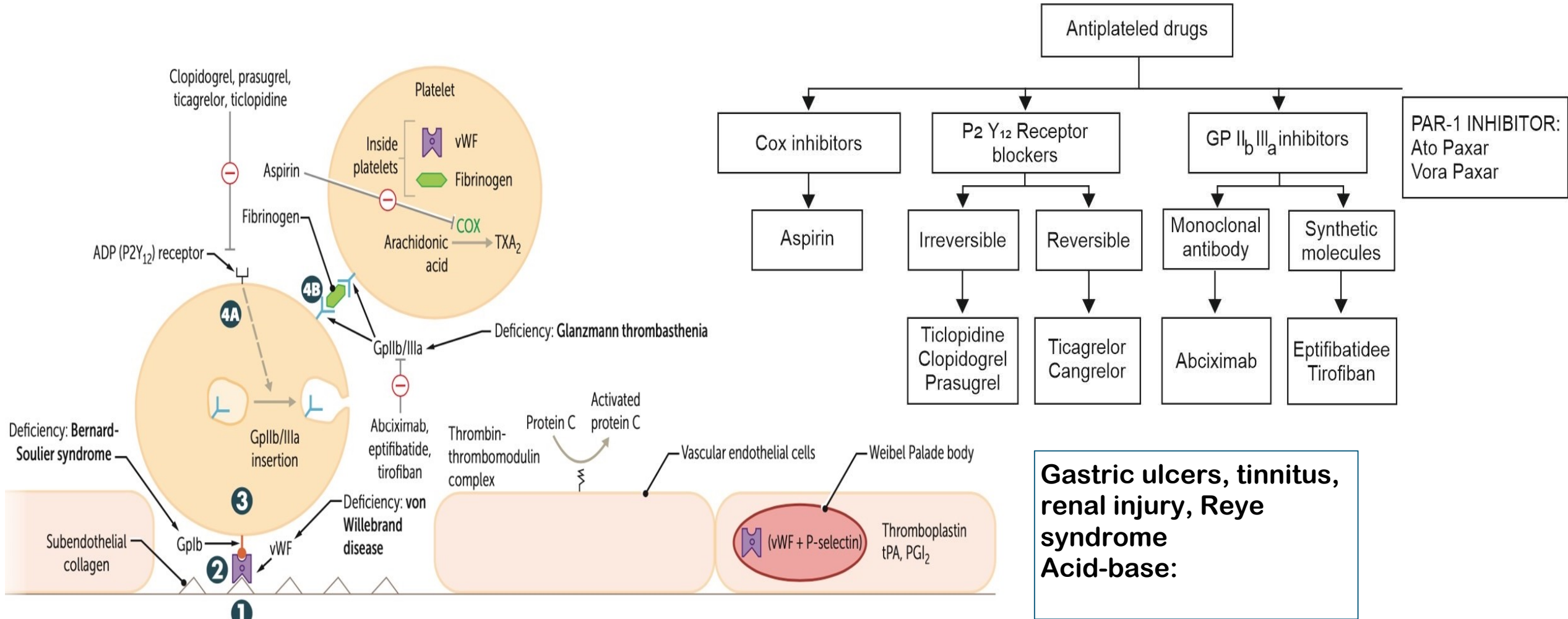
	RBC	WBC	PLATELET	JAK2 MUTATIONS
Polycythemia vera Hb>16				Ruxolitinib
Essential Thrombocytosis Platelet >4.5L/mm3				
CML				
MYELOFIBROSIS				

Hyperviscosity
Thrombosis
Aquagenic pruritus

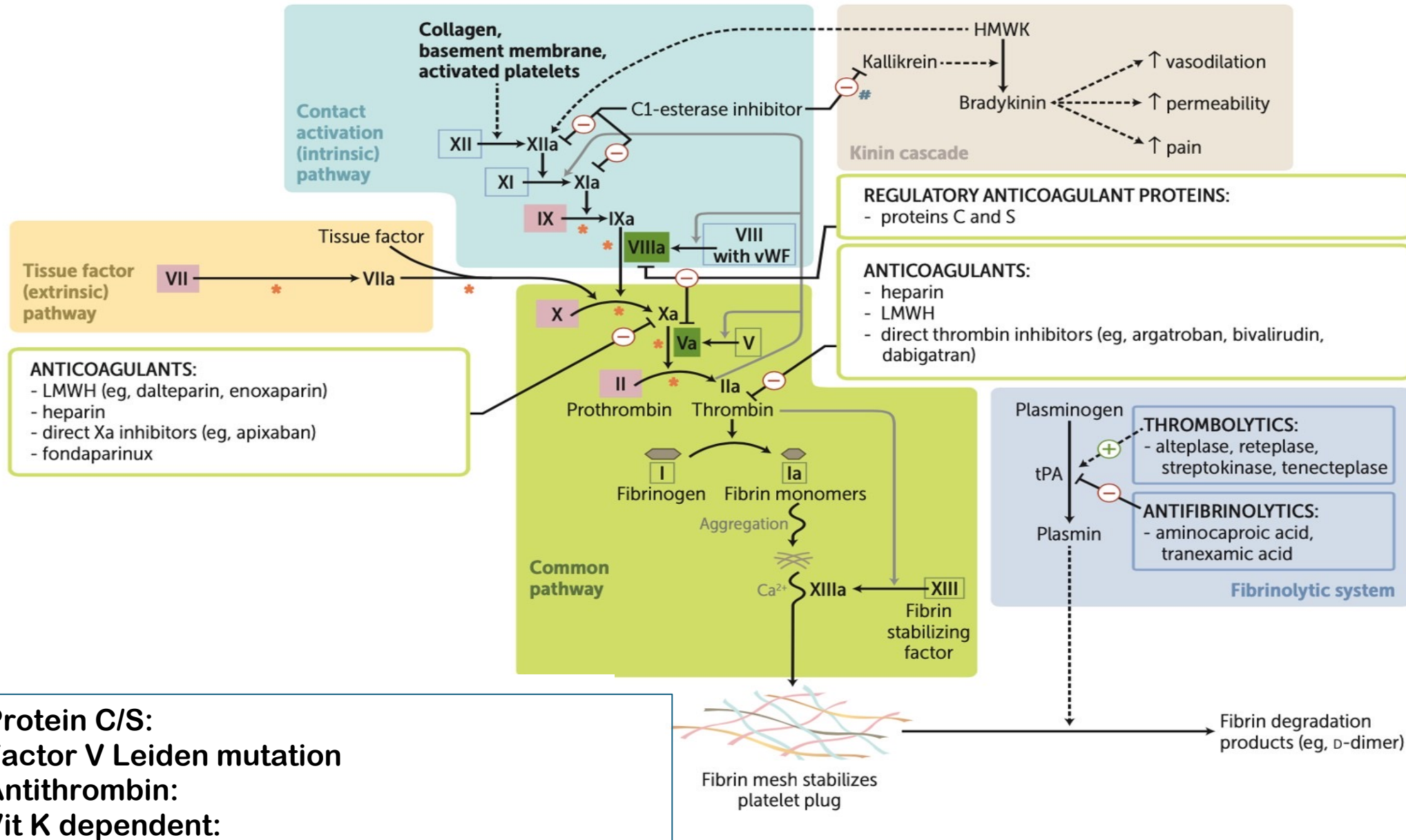


POLYCYTHEMIA
EPO-90% kidney; 10% liver
RELATIVE
PRIMARY
SECONDARY

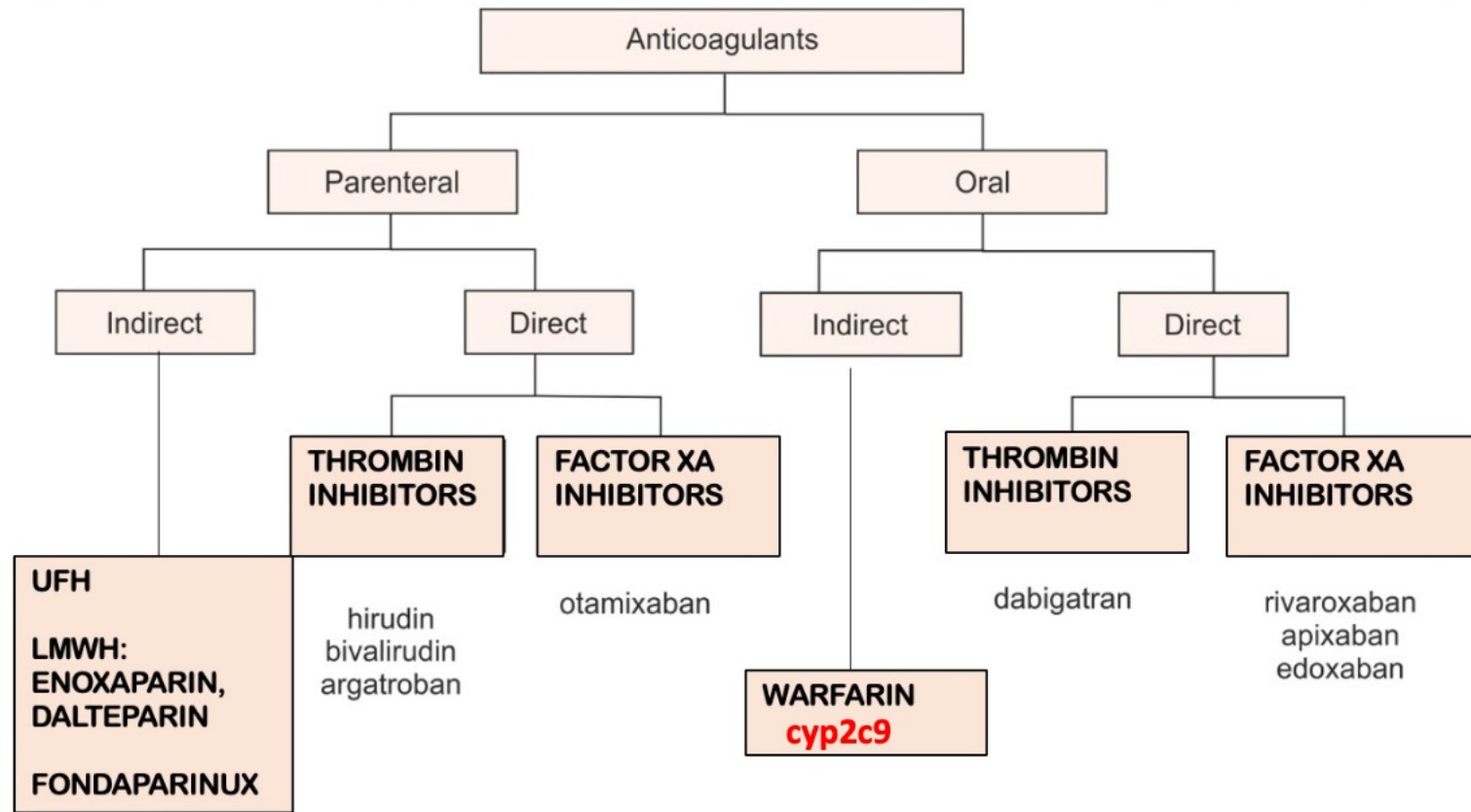
Platelets



Coagulation Cascade



Pharmacology of Anticoagulants



DOC for DVT/PE/ ACS

Antidote:

HIT: Type 2-

DOC:

Type 4 RTA, Osteopenia

Safe in pregnancy

Ciraparantag:

Approach to Bleeding Disorders

Petechiae
Purpura
BT (N-2-9min)

PLATELET COUNT
(N-1.5-4lakh/mm³)

BT + aPTT prolonged
Epistaxis / menorrhagia/ high bleeding after procedures
Chr 12 AD
Ristocetin aggregation test IOC
Type 1:
Type 2: 2N (f8 release x-AR): RIPA N
Type 3: AR
TOC:

Ecchymosis
Hemarthrosis
CT

PT (N-11-15s)
aPTT (N-30-35s)

NORMAL

REDUCED

PT RAISED

aPTT raised

Both normal

Both raised

Abn ADP/collagen
Aggregation

Abn Ristocetin aggregation
Giant platelets

- Immature Platelet >6%
- Giant platelet
- SLE, HIV, Hep C, CLL

Steroids, IVIG
Rituximab
Oprelevkin
Romiplostim , Eltrombopag
Fostamatinib

Emicizumab

Oozing from
puncture sites

Transfusion Medicine

Blood Group	Antigens	Antibodies
A		
B		
AB		
O		
Bombay Blood Group		

Resistance to *P.vivax* and *P.knowlesi* :

McLeod syndrome :

Antigens adsorbed from plasma:

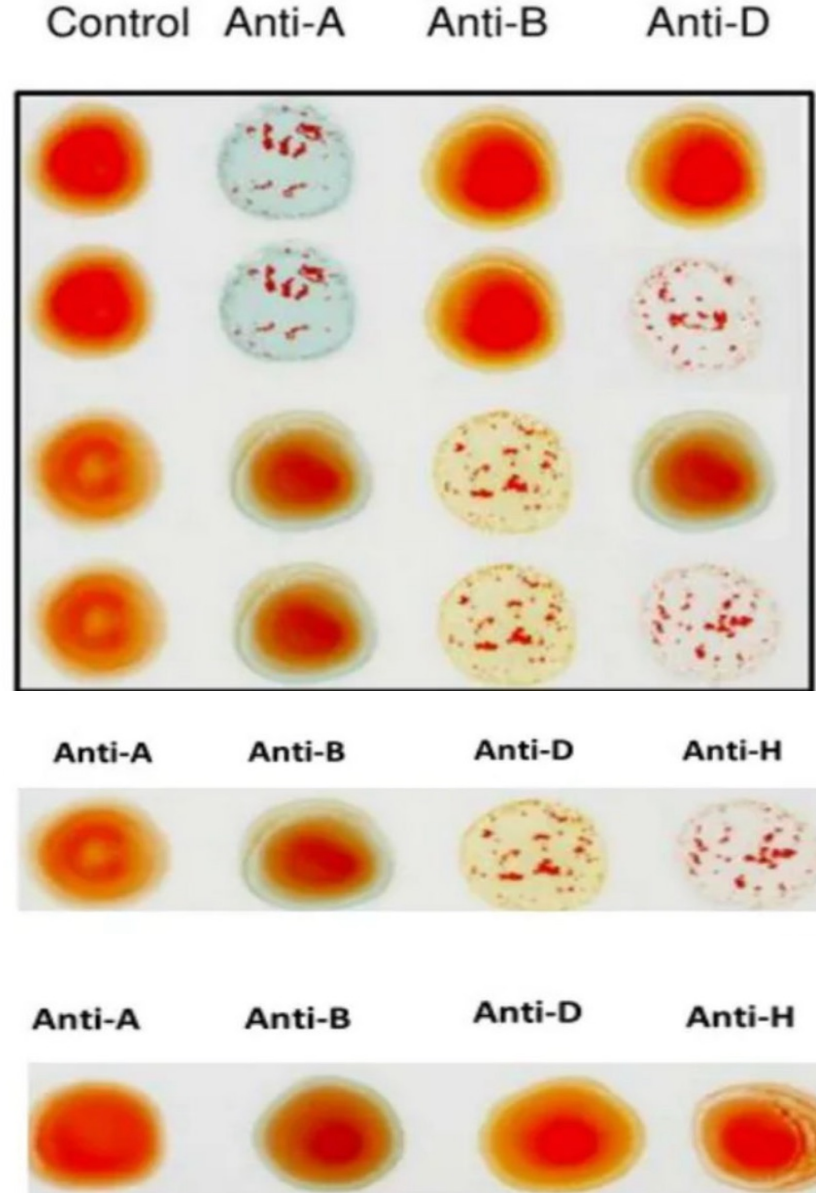
Massive transfusion:

Ca:

K:

Acid-base:

MCC of death:



BLOOD PRODUCTS

	Storage temp	Shelf life	Increase by
Whole/ PRBC		CPD CPDA SAGM	
Platelet: Pooled/ SDAP			
FFP Cryoppt			

Screen for: HIV/ HBV/ HCV/ SYPHILIS /MALARIA
All components:

<u>Complication</u>	<u>Signs/ Symptoms</u>	<u>Treatment</u>
	Fever, Chills, Malaise	Supportive- acetaminophen
>24hrs:	Fever, chills, pain at the site of reaction, nausea/vomiting, shock, dark urine	STOP the transfusion IV fluids +/- diuretics
	Urticaria, pruritis, hives IgA deficiency	Symptomatic- antihistamines.
	Dyspnea, hypoxemia, bilateral chest infiltrates	STOP the transfusion airway control, supportive care
	Dyspnea, edema, JVP Raised	Slow infusion + Diuretics
	Hypotension ACE inhibitors	

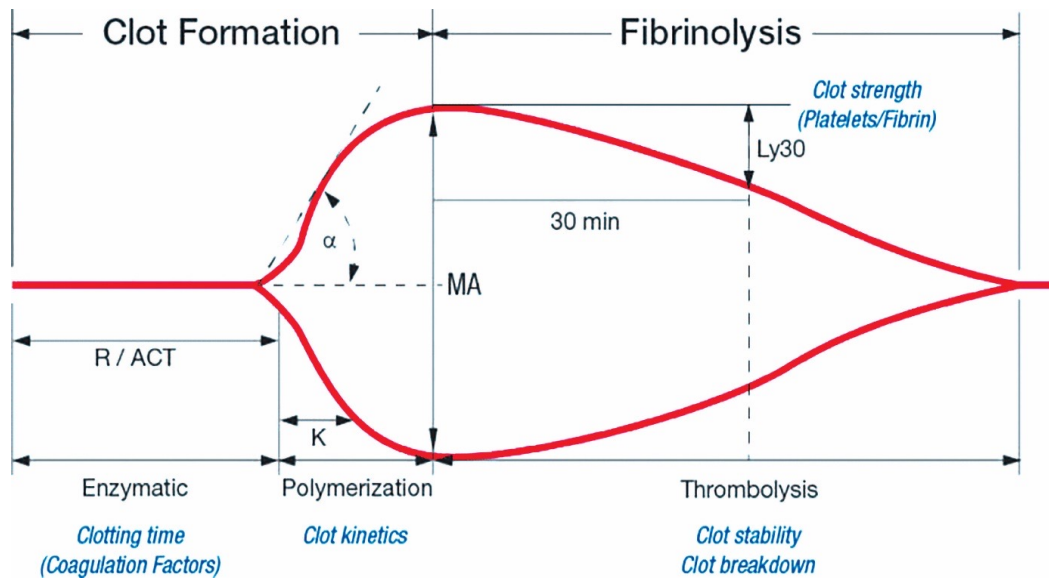


Miscellaneous

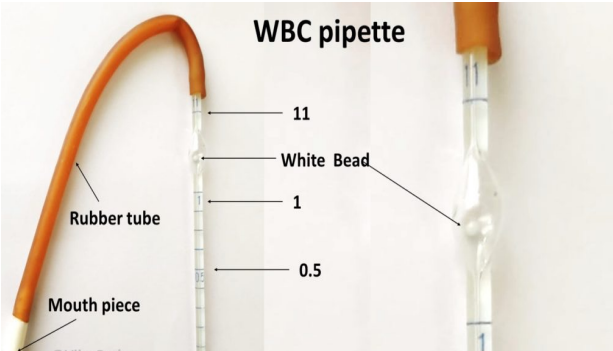
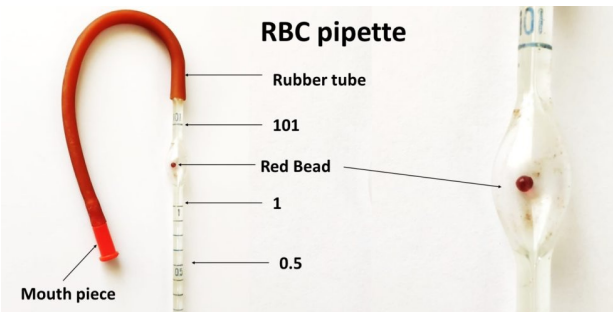
TTP	HUS
Thrombocytopenia, microangiopathic hemolytic anemia (↓ Hb, schistocytes, ↑ LDH), acute kidney injury Normal PT/aPTT	
Triad + fever + neurologic symptoms	Triad + bloody diarrhea
Plasma exchange, glucocorticoids, rituximab	Supportive care

TUMOR LYSIS SYNDROME

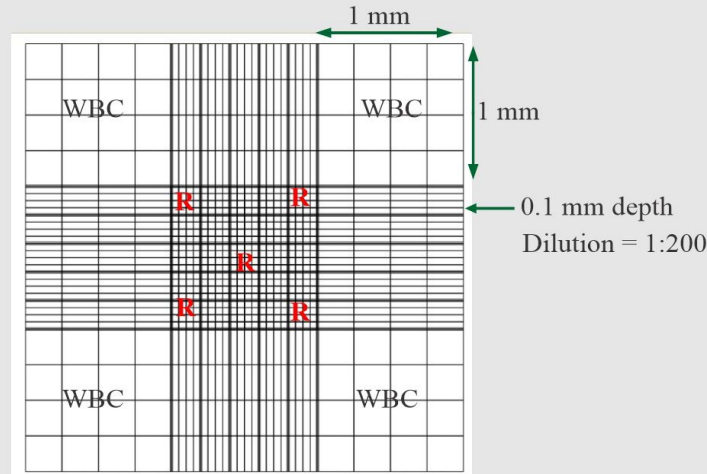
SVC syndrome:
Acute back pain due to bone mets:



<u>TEG</u>	<u>Normal</u>	<u>Abnormality / Cause</u>	<u>Treatment</u>
Reaction Time (R value)	5–10 min	↑ R value: ↓ factors	
K value	1–5 min	↑ K : ↓ fibrinogen	
α-angle	45–75°	↓ α-angle: ↓ fibrinogen	
Maximum Amplitude (MA)	50–75 mm	↓ MA / MCF: ↓ platelet count and/or function	
LY-30	0–10%	↑ LY-30 / CL: clot breakdown	



Improved Neubauer chamber



$$\text{RBC/cmm} = \text{no. of cell counted} \times \text{dilution factor} \times \text{Depth} \times \text{Area counted}$$

$$\text{RBC/cmm} = 500 \times 200 \times 10 \times 5 = 5,000,000$$

labpedia.net

Wintrobe

- Tube is closed at lower end & open at upper end
- 11cm-Less volume
- Less sensitive
- EDTA











Westergren

- Tube is opened at both ends
- 30cm-large volume
- More sensitive
- Sodium citrate

Diluting fluids :

- WBC : Turk's fluid
- RBC : Dacie, Hayem's fluid, NS
- Platelets : Rees & Ecker diluting fluid



<u>Vacutainer Color</u>	<u>Additive</u>	<u>Use</u>
 Blue		
		
 Gold		
 Red		
 Light Green		
 Green		
 Lavender		
 Pink		
 Royal Blue		
 Gray		