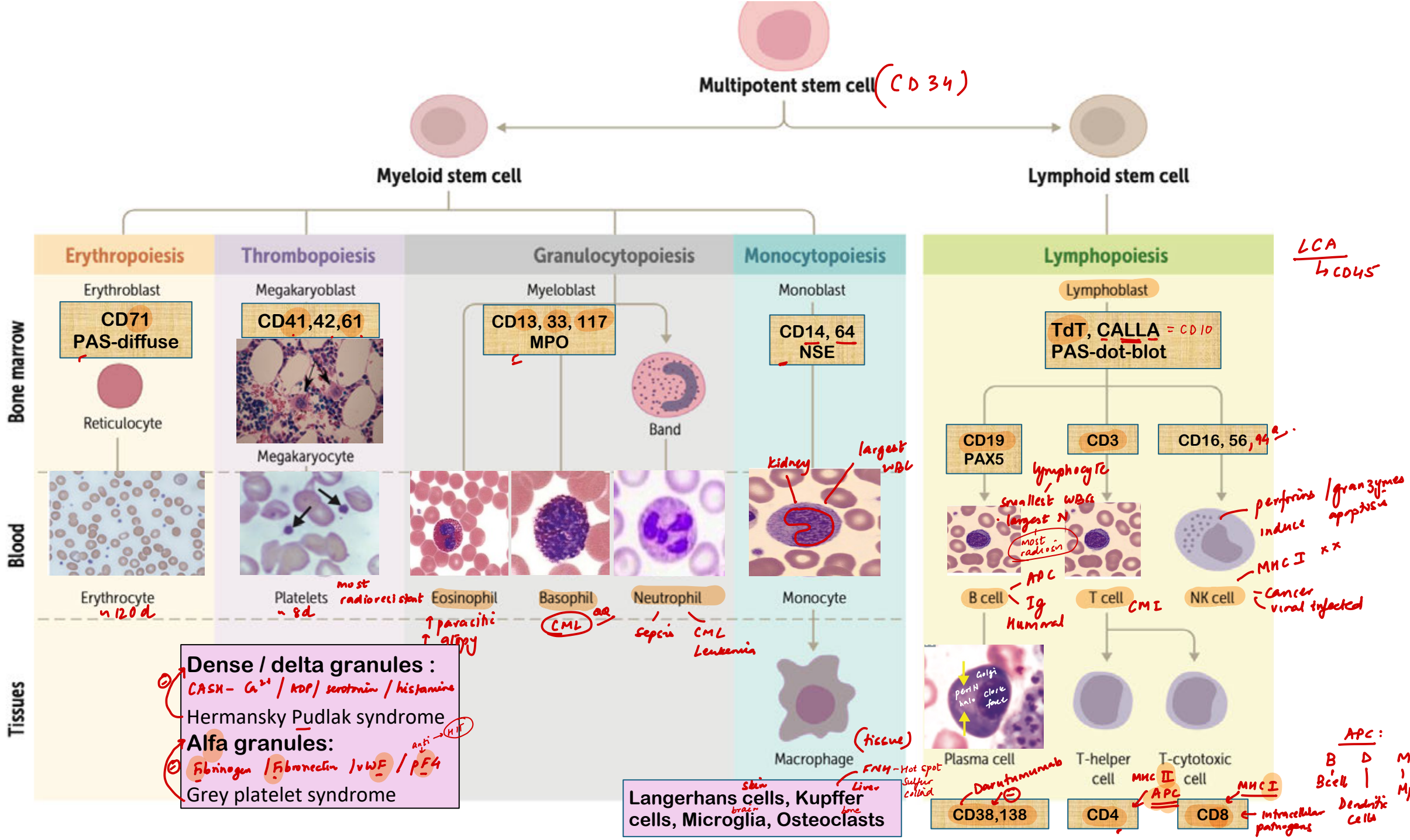
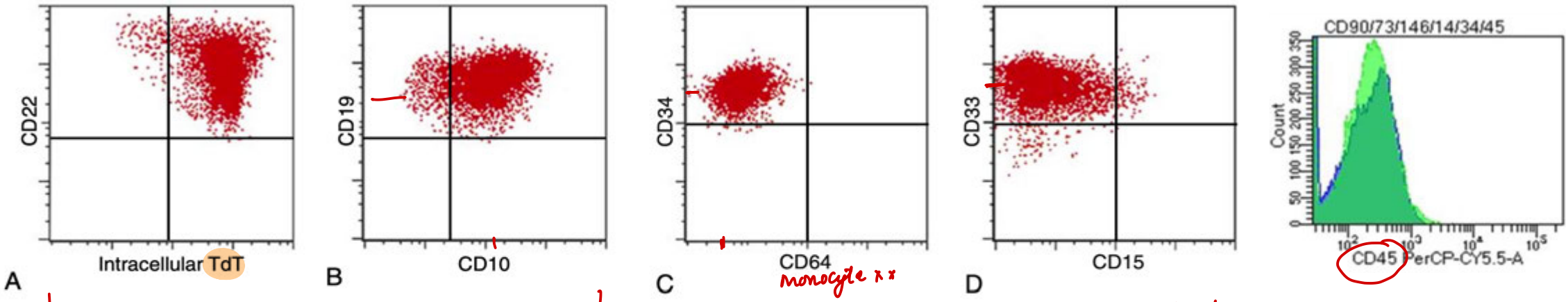
INTEGRATED SYSTEMS: HEMATOLOGY


Multipotent stem cell (CD34)
Myeloid stem cell
Lymphoid stem cell
Erythropoiesis
Thrombopoiesis
Granulocytopoiesis
Monocytopoiesis
Lymphopoiesis
LCA
↳ CD45
Bone marrow
Blood
Tissues
Erythroblast
CD71
PAS-diffuse
Reticulocyte
Megakaryoblast
CD41,42,61
Megakaryocyte
Myeloblast
CD13, 33, 117
MPO
Band
Monoblast
CD14, 64
NSE
Lymphoblast
TdT, CALLA = CD10
PAS-dot-blot
CD19
PAX5
CD3
CD16, 56, 94
Erythrocyte
~120 d
Platelets
~8d
most radioresistant
Eosinophil
↑ paracitic
↑ allergy
Basophil
CML
aa
Neutrophil
sepsis
CML
Leukemia
kidney
largest WBC
Monocyte
Macrophage
(tissue)
FNA - Hot spot
Sulfur colloid
Liver
brain
bone
skin
Langerhans cells, Kupffer cells, Microglia, Osteoclasts
lymphocyte
smallest WBC
largest N
most radiosin
B cell
APC
Ig
Humoral
T cell
CMI
NK cell
perforins / granzymes
induce apoptosis
MHC I
xx
cancer
viral infected
Golgi
perin
halo
clear
Plasma cell
T-helper cell
T-cytotoxic cell
Daratumumab
CD38,138
MHC II
APC
CD4
MHC I
CD8
intracellular pathogens
APC:
B
B cell
D
Dendritic cells
M
Mphg
Dense / delta granules :
CASH - Ca2+ / ADP / serotonin / histamine
Hermansky Pudlak syndrome
Alfa granules:
Fibrinogen / Fibronectin / vWF / PF4
anti → HIT
Grey platelet syndrome



AML - M2

B cell - ALL

monocyte ++

Scatter plot

FLOW CYTOMETRY

Histogram

. Immunophenotyping

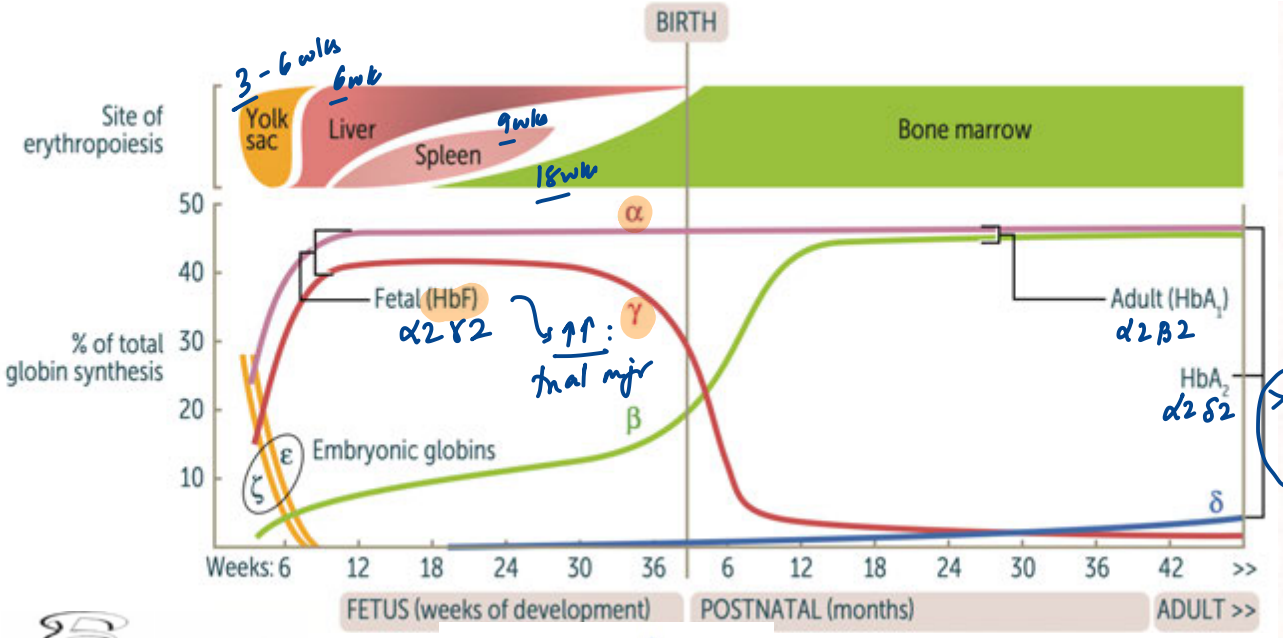
. Staining

. translocations → FISH

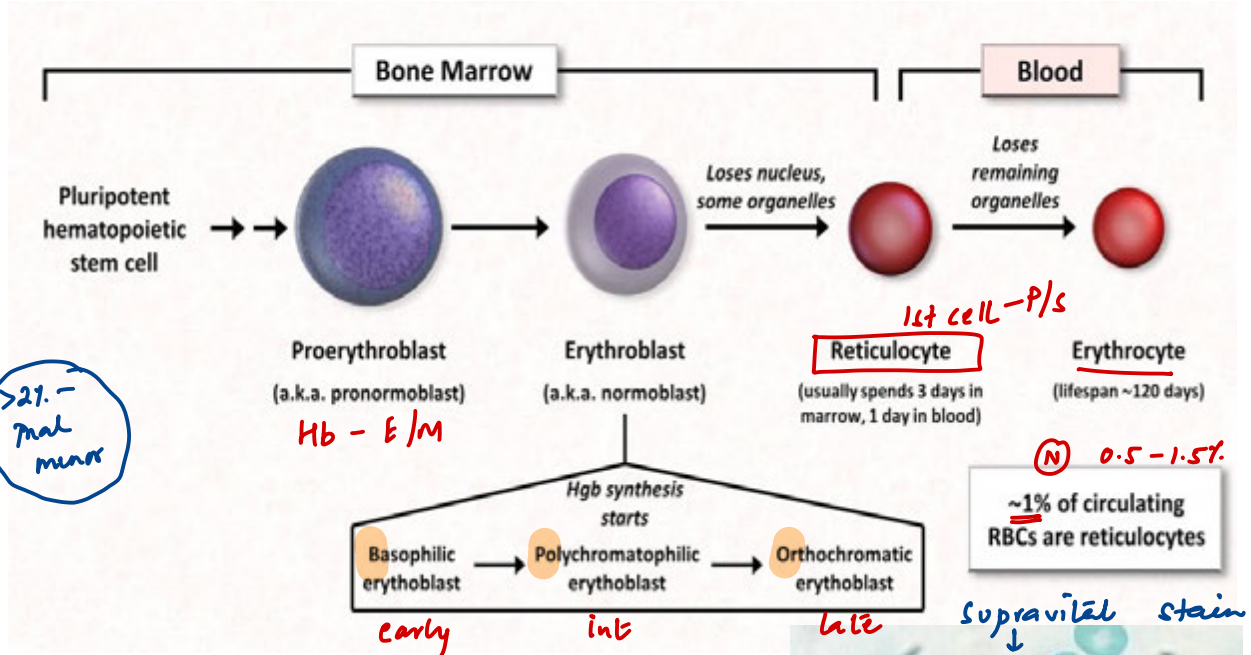
↳ cytogenetics

RBC

α - always
γ - Goes β - Birth



>2% - normal minor



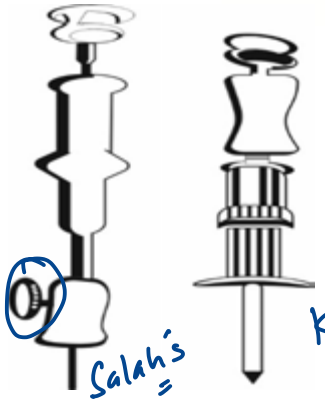
1st cell - P/S

Hb - E/M

int → Hb - L/M

N 0.5 - 1.5%

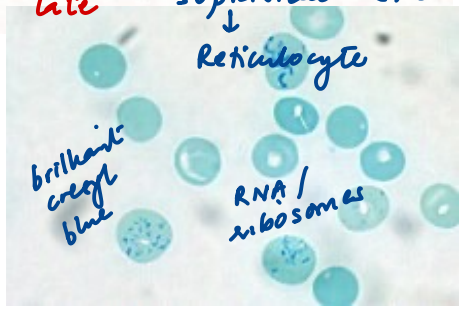
~1% of circulating RBCs are reticulocytes



Salah's

Klima's

Core BM bx = Jamshedi's



Corrected retic count = Retic % × Hct / 45

Preferred site for BMA/ BMB:
Adult- PSIS
Child- tibia
Low Platelet CI?: <20K → Plt transfusion — No

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

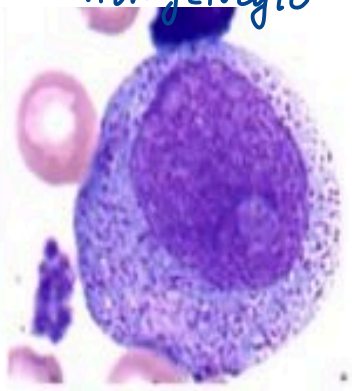
<2 → Inadequate BM response

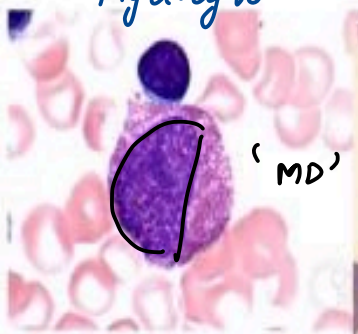
Hematocrit (Hct)	Maturation Factor
≥ 40%	1.0
30 – 39.9%	1.5
20 – 29.9%	2.0
< 20%	2.5

WBCs

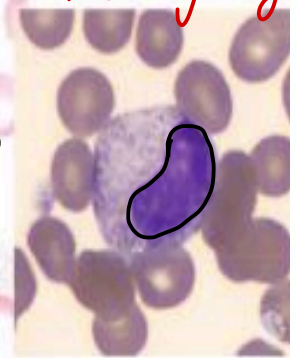
"Lt shift"

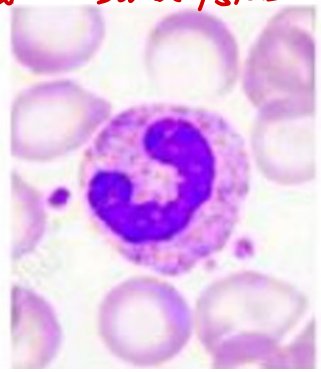

Myeloblast

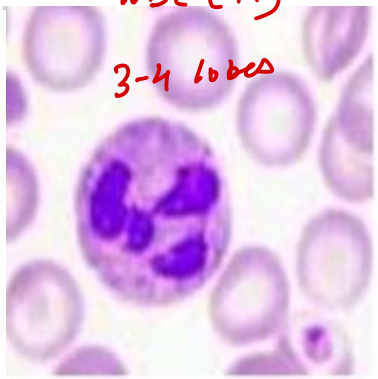

Promyelocyte



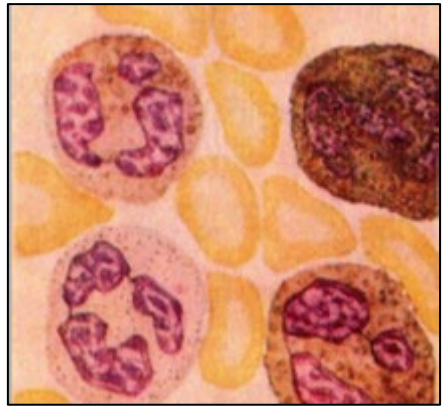
Myelocyte


Metamyelocyte


Band / stab



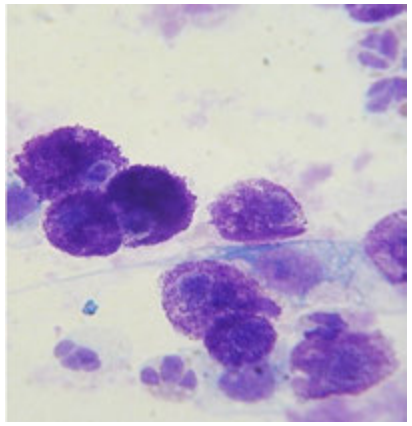
WBC (N)



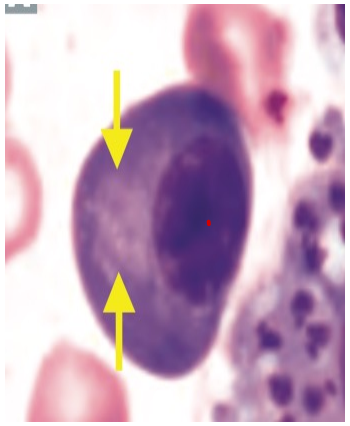
LAP score

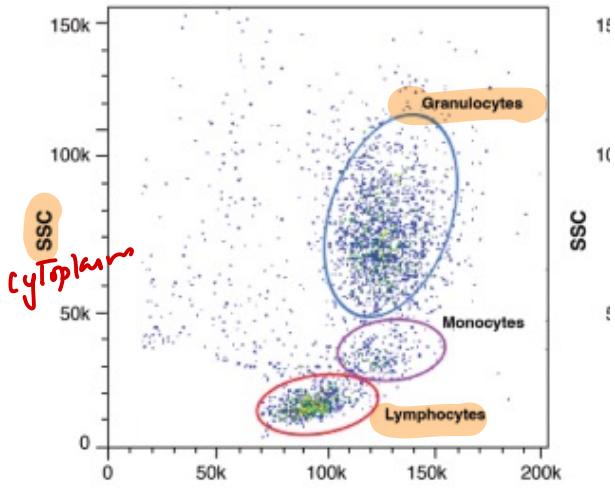
LOW → . CML . PNH

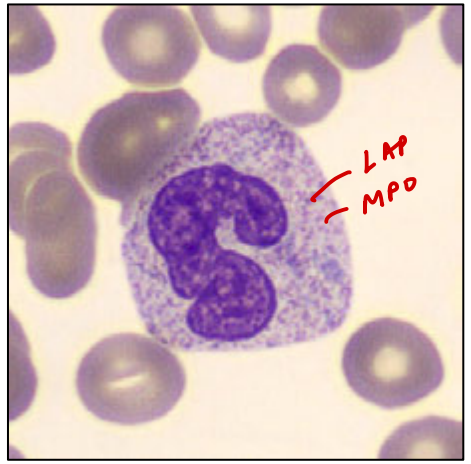
HIGH → "Sepsis" leukemoid rxn


Mast cells → Histamine

Tol. blue


Plasma cells





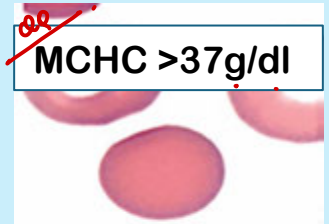
Toxic granules
Dohle bodies - dilated ER

- IgE mediated degranulation - anaphylactic – atopy
- IgE-independent: Vancomycin, opioids, radiocontrast dye anaphylactoid

RBC Shapes and Disorders

Elliptocytes – mc → Spectrin

HE AD



~~all~~ MCHC >37g/dl

Spherocytes → mc: ankyrin

most severe: spectrin

HS AD child since birth

EVH - splenomegaly jaundice pigment gallstones

· EMA - binding test

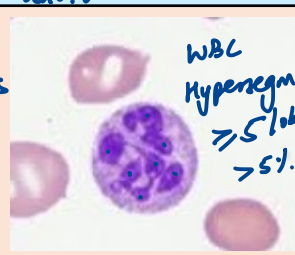
· OF ↑

AIHA (mc) - adult

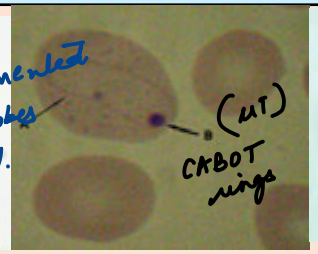
G6PD

Rx: splenectomy

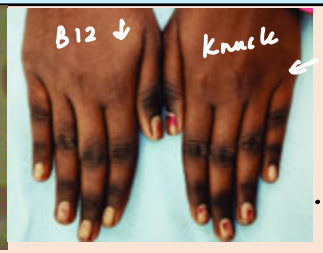
MCV >100fl macrocytes



WBC Hypersegmented ≥5 lobes >5%



(MT) CABOT rings



B12 ↓ Knuckle

Megaloblastic anemia

↓ pancytopenia

Fanconi anemia

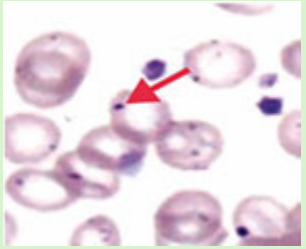
Folate def B12 def UMP synthase (XR) OROTIC ACIDURIA

U → T

target cell = Codocyte

H A L T – Malassemia

HbC Asplenia Liver ↓

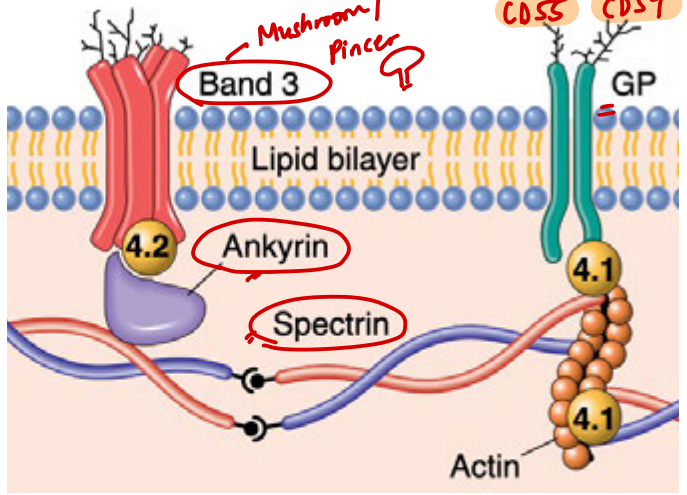


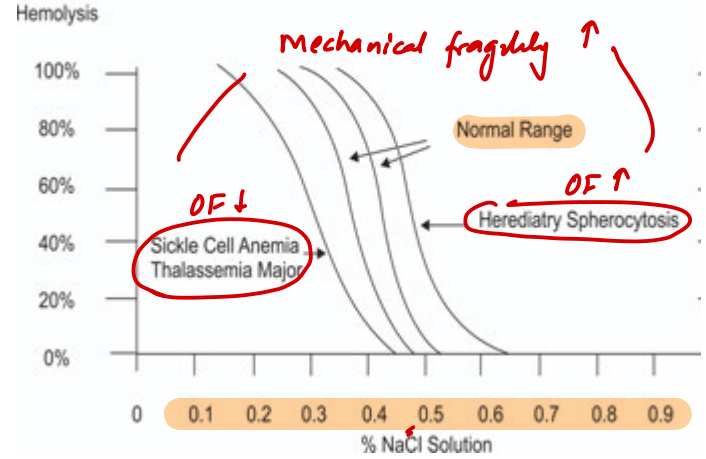
Sickle = Drepanocytes – auto-splenectomy

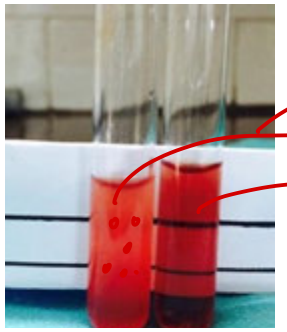
Howell-Jolly bodies → asplenia

↓

nuclear remnants





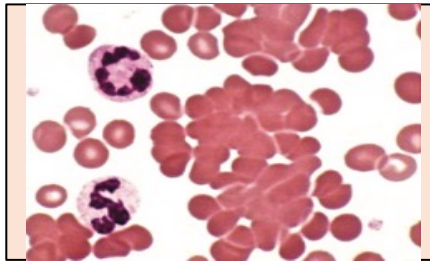


Thallasemia NESTROFT

Thallasemia

OF ↓

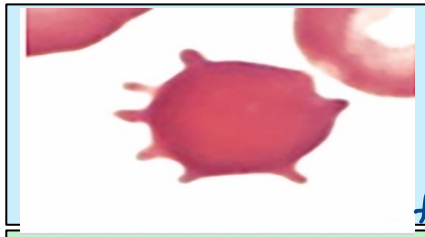
N



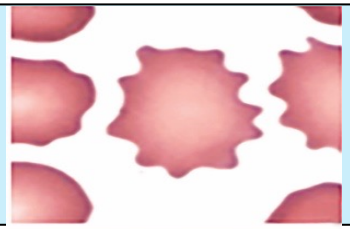
Auto-agglutn
- warm (IgG) – SLE, CLL, β-lactams, methyldopa — Rx – steroids → Rituximab
- cold (IgM) – Mycoplasma, EBV — Rx – cold avoid → "
- Donath-Landsteiner Ab = PCH – cold hemolysin IgG – P-Ag

AIHA

Direct Coombs test (+) – RBCs coated ε Ab.

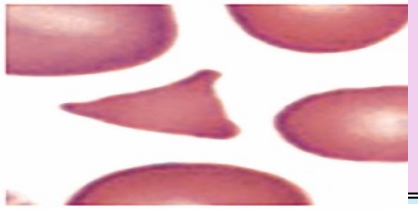


SPUR cells = Acanthocytes
- Abetalipoproteinemia
- vit E ↓
- fat malabsorp"



BURR cells = Echinocytes
- Burns
- Renal failure
- Pyruvate kinase def

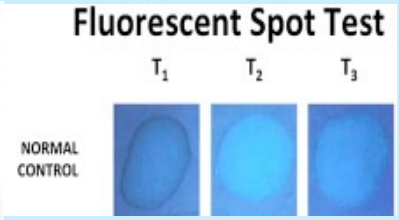
Tear drop = Dacryocyte
- Myelofibrosis / Myelophthisis
  - HSM ++
  - leukoerythroblastic picture



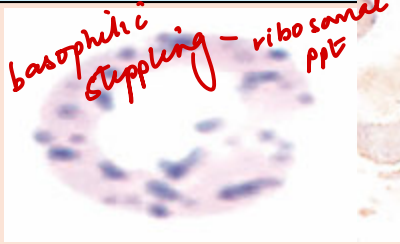
Helmet cells = Schistocytes → MAHA
- angiopathic – HUS / TTP / HELLP / DIC
- macro-angiopathic – prosthetic valves / marathon

Bite cells = Degmacytes

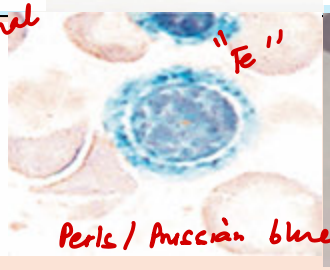
Heinz bodies
- supravital stain
- denatured Hb



G6PD deficiency (X2R)
- NADPH ↓↓
- oxidative stress – Fava beans / sulfa drugs
- auto-fluorescence

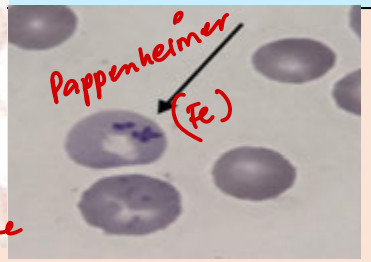


basophilic stippling – ribosomal ppt



"Fe"

Perls / Prussian blue



Pappenheimer (Fe)

Sideroblastic anemia
- ALA Synthase
  - XLR
  - B6 ↑
  - INH
- Pb poisoning
  - ALA dehydratase
  - Ferrochelatase
  - (–) pyrimidine nucleotidase

Anemias

Male: <13 Female: <12 Pregnant/CKD: <11g/dl

MICROCYTIC
<80fl

S I T A
Sideroblastic anemia / IDA
Thallasemia / ADCD

NORMOCYTIC
80 - 100 fl

Reticulocyte >2%

NON-HEMOLYTIC
- EPO deficiency CKD
- Aplastic anemia
- ADCD/IDA

HEMOLYTIC
INTRINSIC
- **MEMBRANE:** · HS (AD) / HE (AD) · PNH (acquired)
- **ENZYME:** · G6PD (XLR) · Pyr kinase (AR)
- **HB:** Hbs / HbC / thallasemias (AR)

EXTRINSIC
- AIHA
- MAHA

IVH: · Haptoglobin ↓↓ · LDH ↑↑ · Hburia → PNH → MAHA

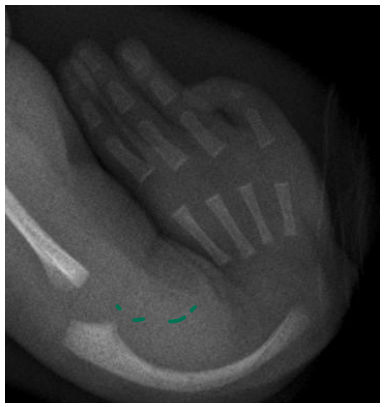
EVH: LDH ↑ / Haptoglob ↓ → splenomegaly / ind bil ↑ / gallstones

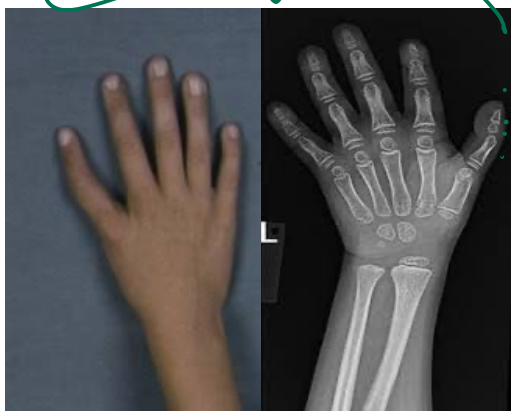
AIHA HS/HE/ thallas — born · G6PD · Sickle cell

MACROCYTIC
>100 fl

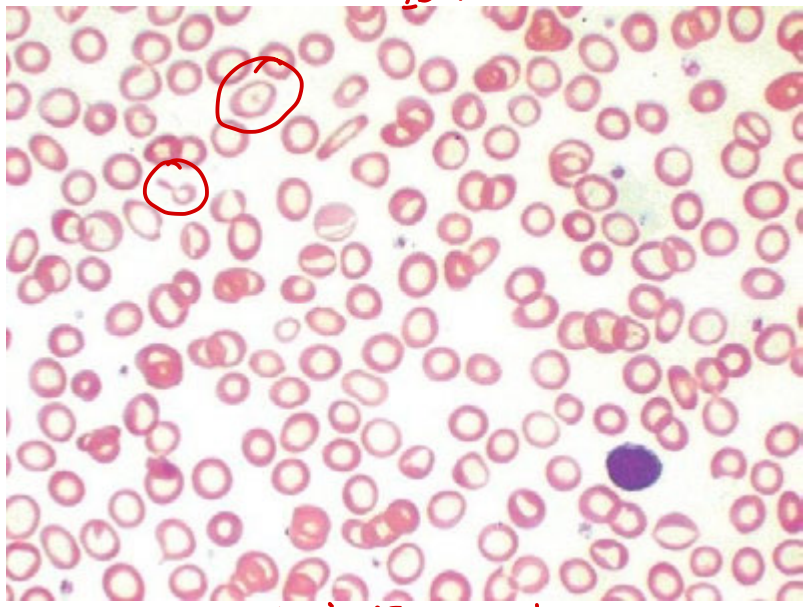
MEGALOBLASTIC
- vit B12
- vit B9
- orotic aciduria
- Fanconi anemia
  - short stature
  - CALM
  - radial ray anomaly

NON-MEGALOBLASTIC
- ALCOHOL
- Hypothyroidism
- Diamond-Blackfann

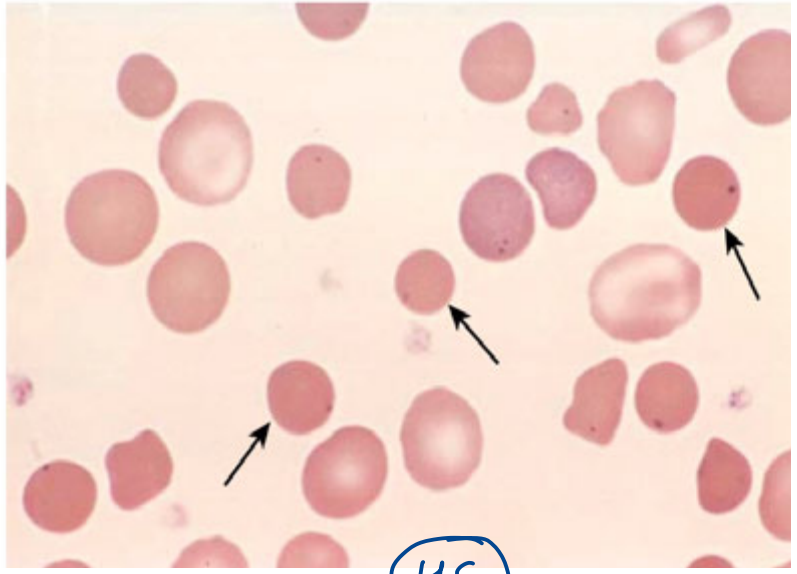




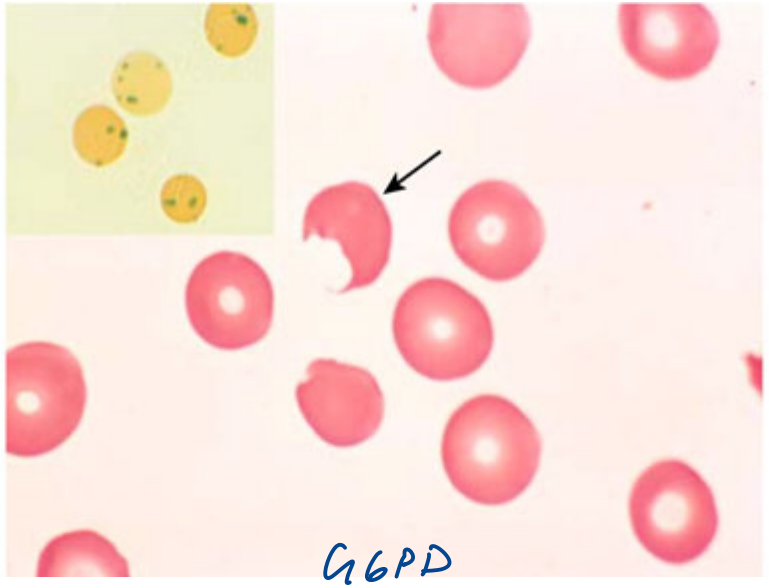
IDA



poikilocytosis → shape
anisocytosis → size

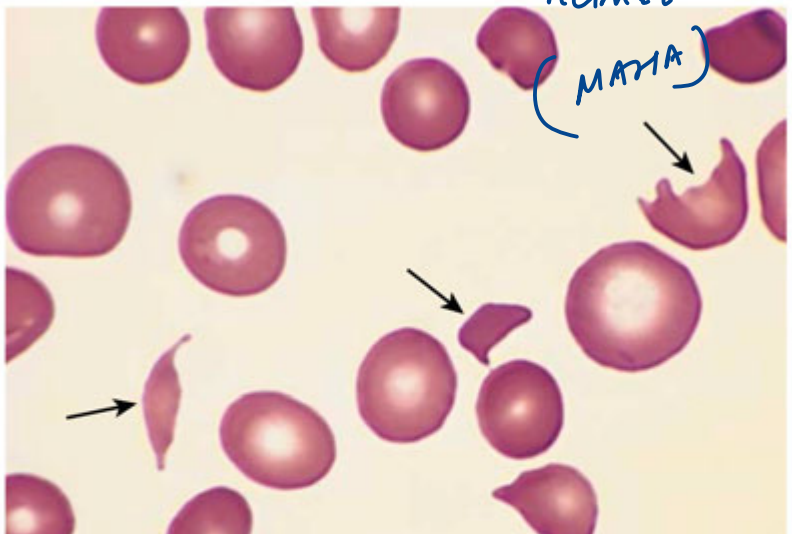


HS

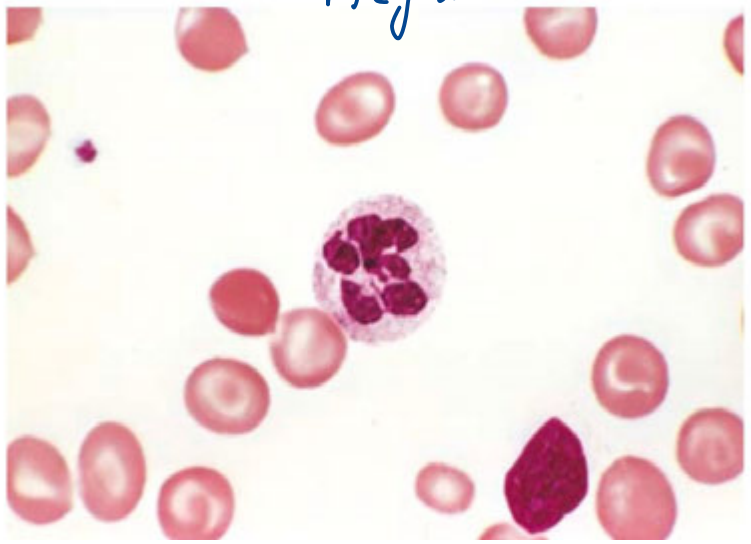


G6PD

Helmet (MAHA)

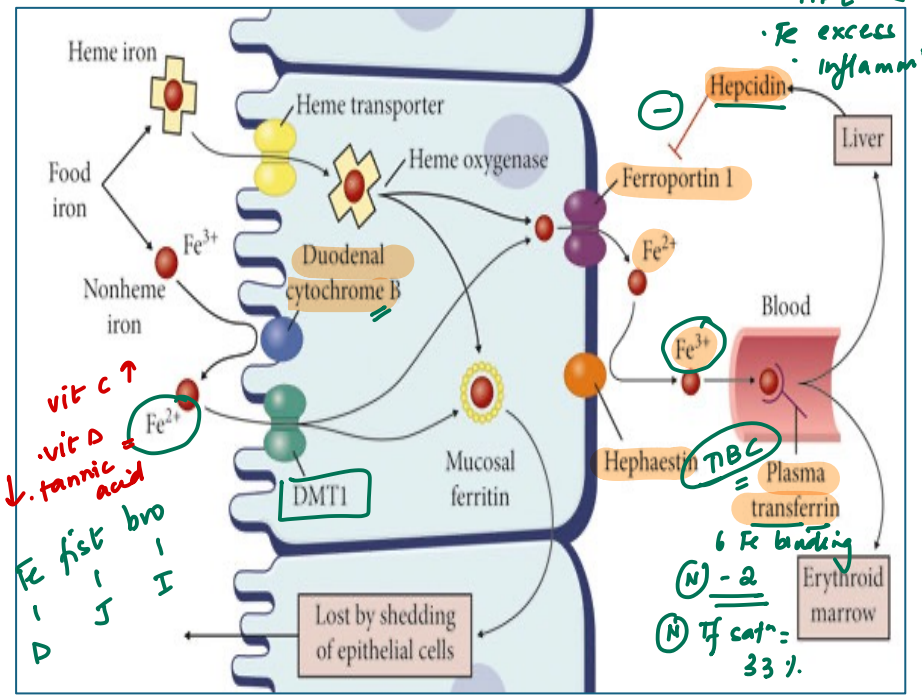


Megaloblastic



Myelofibrosis

Specific Anemias



- HFE ⟷ Hemochromatosis (AR) ↓ Hepcidin ↑↑ Fe absorb
- Fe excess
- inflamm

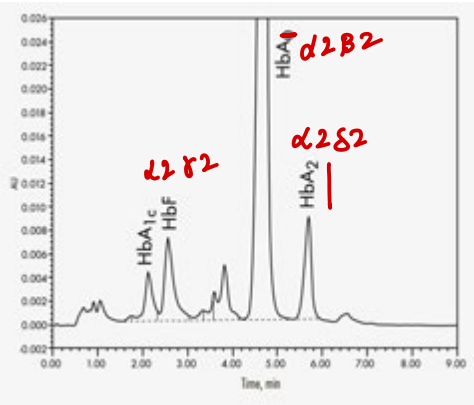
	IDA	AOCD	Sideroblastic anemia	OCP/pregnancy
Serum iron	↓	↓	↑	–
Transferrin or TIBC	↑	↓	↓	–
Ferritin (Fe stores, acute phase reactant)	↓	↑	↑	–
% transferrin saturation	↓↓	↓	↑↑	–

↑↑ / – / ↓

IDA vs Thalassemia minor

- Mentzer index: MCV/RBC (>13 / <13)
- RDW: ↑ – IDA
- Confirmatory test for thalassemia minor: HPLC (DNA sequencing BEST) — HbA2 ↑ >2%

. Mal mjr – Hb F ↑↑



Crew cut / hair on end

mediastinum EMH

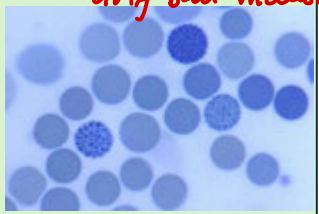
Chipmunk facies

Chr 16 deletion: α Thallasemia – – – –

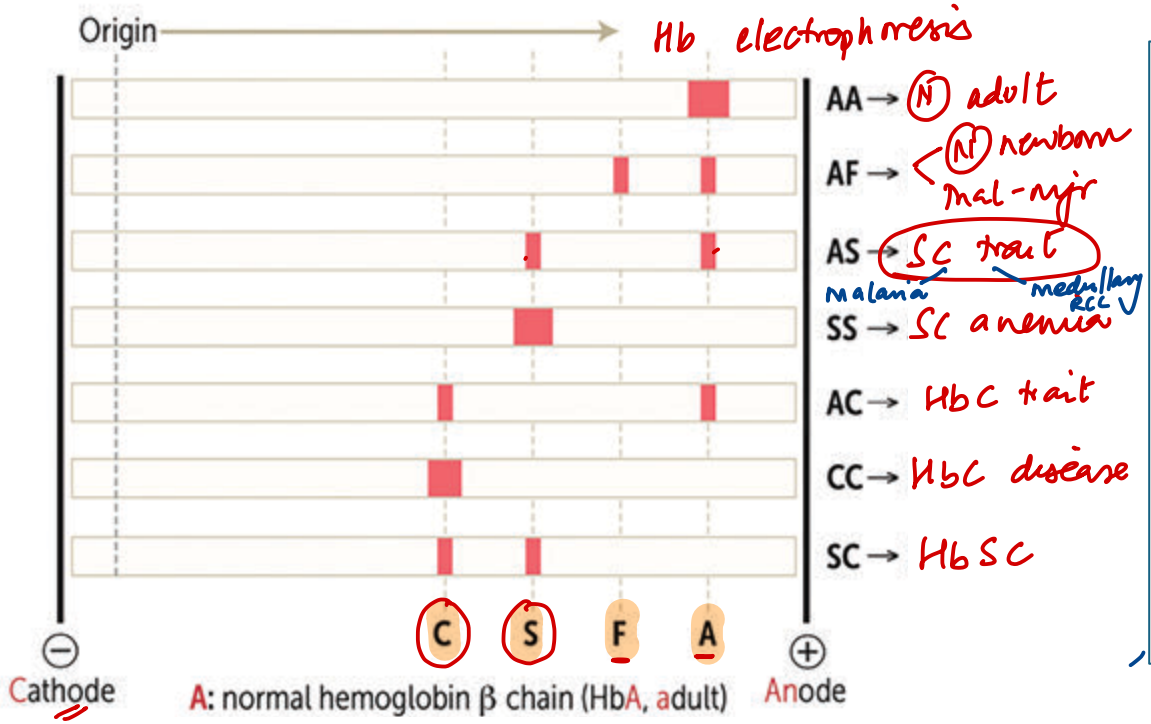
1- ++/+– : minima – (N)
2- +–/+– : minor – IDA-like
3- ––/–+ : Bart – HbH disease
4- ––/–– : Bart → Hydrops fetalis

Chr 11 Splicing mutation: β Thallass –/–

1- –/+ – Thall minor – IDA-like
2- –/– – Thal mjr – transfusion (Hb F ↑↑)



Golf ball inclusions



Glu → Valine B6: HbS

Glu → Lysine : HbC

PPT: Hypoxia / acidosis - microvasc occlusions

Metabisulfite test (↓ O_2)

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

Mx-

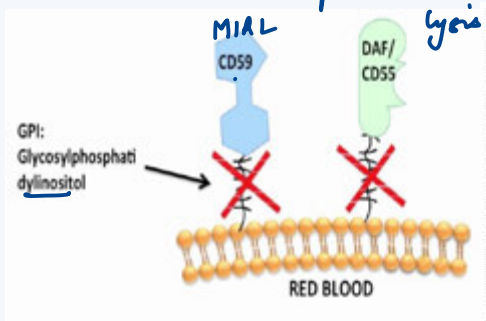
Glutamic acid

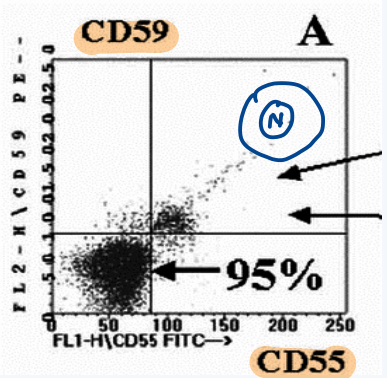
Hydroxyurea, Voxelotor ↓ sickling

Crizanlizumab p-selectin (-)

PNH

- Intravascular hemolysis -Sporadic nocturnal IVH resp acidosis
- Pancytopenia
- Thrombosis: Budd Chiari syndrome
- LAP score: low
- Aplastic anemia, Leukemia - least common





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

GEL CARD TEST

Rx-Eculizumab, Ravulizumab (C5⊖)

aHUS Mg.

IOC → Flow cytometry / FLAER

Approach to Pancytopenia

RBC ↓ – anemia – fatigue
WBC ↓ – Infns (WBC count TP)
Plt ↓ – petechiae

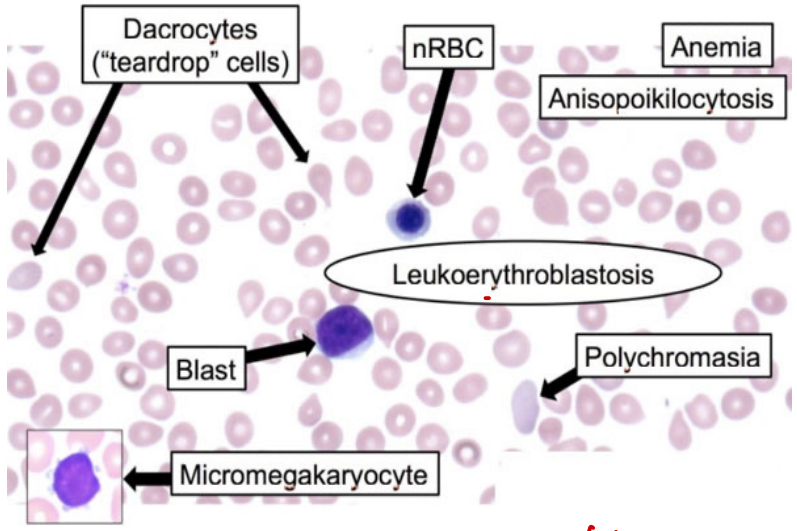
HSM +

HYPERCELLULAR MARROW

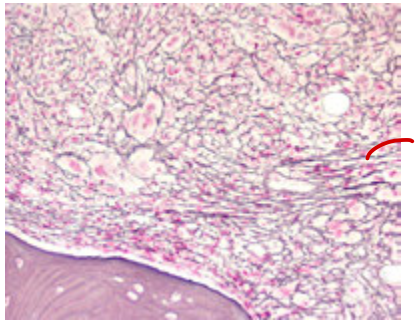
≥ 20% blasts WHO /
≥ 30% blasts FAB

Leukemia

DRY TAP +



Myelofibrosis

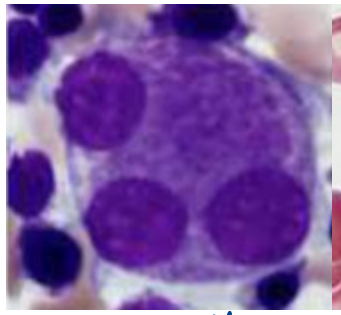


Reticulin fibres ++

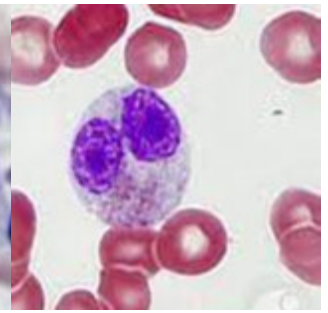
TGF-β ↑↑

HSM –

HYPERCELLULAR MARROW



Pawn-ball megakaryocyte



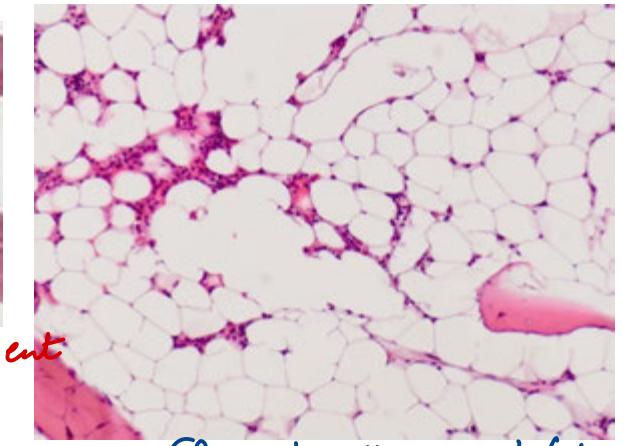
Pseudo-Pelger-Huet

Myelodysplasia

MDS → AML

Marrow blasts < 20% ⊕
Mutation:
5q del^n / SF_3B_1 / p53
(mc elderly)
mc children: monosomy 7

DRY TAP +
BMB:



Ⓝ 50% cells 50% fat

Aplastic anemia

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

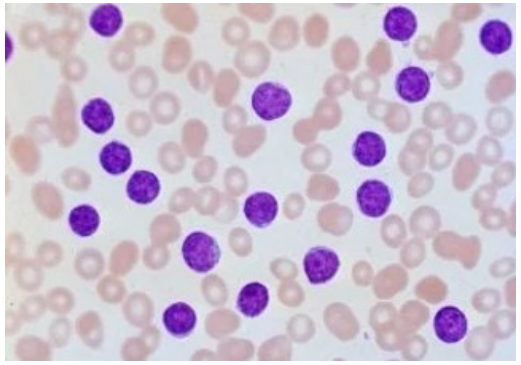
Approach to 'Leukemias'

CHRONIC

asymptomatic
HSM +

Lymphocytic

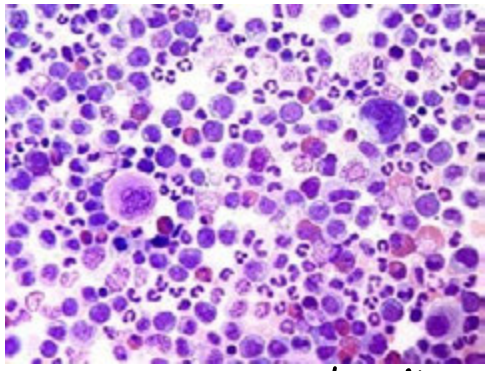
CLL/SLL



convent school girl

Myeloid origin

CML

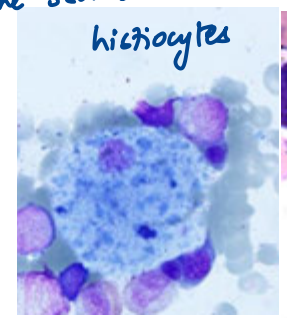


garden party / college

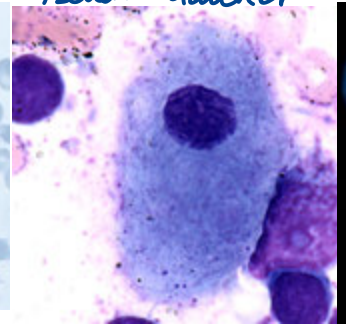
Ph chromosome
t (9;22)
ABL BCR

Binet / Rai staging

IOC: Flow cytometry
Rx: Fludarabine

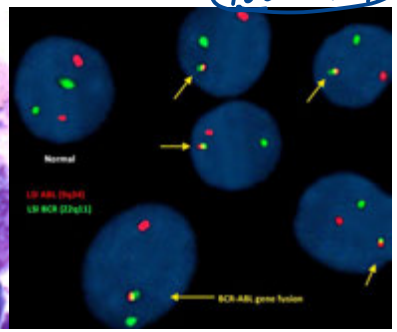


Sea blue histiocytes



Pseudo-Gaucher

IOC: FISH

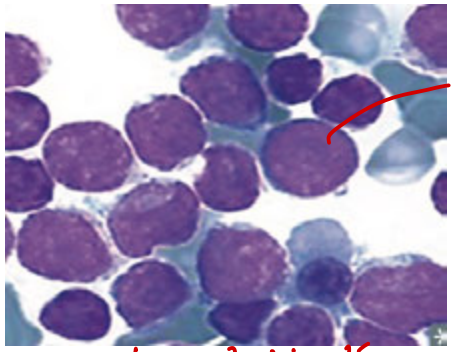


Chronic - <10%
Accelerated - 10-20% blasts
Blastic - >20%

Rx → TKI → Imatinib D/I

ACUTE

CHILD - ALL



↑N:C

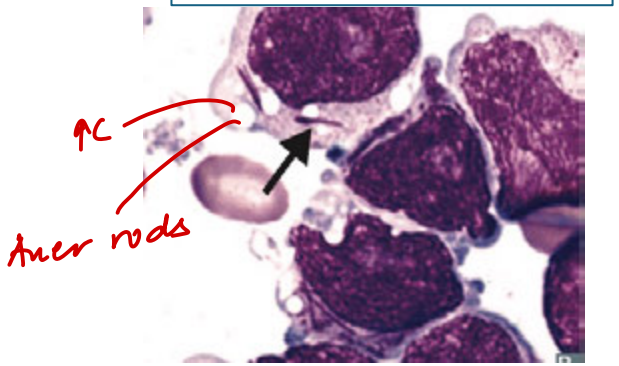
Lymphoblast
- TdT / CALLA = CD10
- PAS-dot Bblot

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

190 ALL
210 CML
230 CNL

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

ADULT - AML



↑C
Auer rods

Myeloblast
- CD13, 33, 117
- MPO +
- Sudan black B +

Accelerated phase CML

- **Blast percentage**: 15-29% (or blasts+promyelocytes >30% with blasts <30%)
- **Hematologic parameters**: Thrombocytopenia <100 x 10^9/L unrelated to therapy; Basophils >20%
- **Cytogenetics**: Clonal evolution while on therapy
- **Miscellaneous**: Splenomegaly unresponsive to therapy (MDACC)

Blast phase CML

- **Blast percentage**: ≥ 30% (MDACC and ELN); ≥20% (WHO)
- Extramedullary disease

MC in children: ALL
MC in down syndrome: ALL
MC in downs (<3yr): AML-M7
MC in adults: AML
MC with radiation: AML ← Benzene
MC in elderly: CLL
MC in west: CLL
Not associated with radiation: CLL
Associated with deletion-13q: CLL

WHO-FAB – AML

M0: Undifferentiated acute myeloblastic leukemia	
M1: Myeloblasts with < 10% granulocytic differentiation.	
M2: Myeloblasts with granulocytic differentiation > 10%, NSE < 20%.	MPO+ → mc – chloromas (mc-orbit) t(8;21)
M3: Promyelocytes that are hypergranular with many Auer rods on CAE or Wright-stain	Faggot cells → DIC, PML;RARA t(15;17) → Rx - ATRA → As_2O_3; ↳ resp distress: differentiate Sx / Rx - dexamethasone; APML
M4: 20%- 80% NSE-butyrate positivity in Monocytic cells	inv 16 → monoblastic – leukemia cutis
M5: >80% NSE positivity in Monocytic cells	
M6: >30% myeloblasts with more than 50% erythroblasts eliminating the erythroid cells.	CD71 / PAS+
M7: Acute megakaryoblastic leukemia	CD41, 42, 61 → Dry tap – Down's Sx.

HAIRY CELL LEUKEMIA

SPLENOMEGALY + PANCYTOPENIA

DRY TAP +

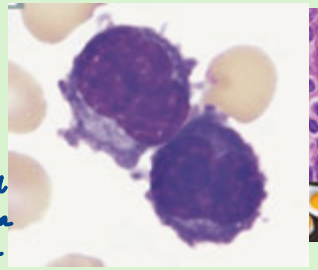
TRAP+

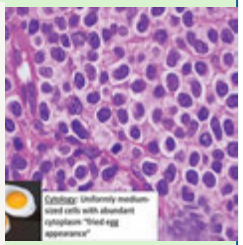
BRAF mutation

Markers:
- Annexin A1
- CD 11c
- 25
- 103

- LCH / HCL
- Pilo / Papill
- GIST / adca
- melanoma

DOC- Cladribine





fried egg cytoplasm
- Reticulum
- ODG.

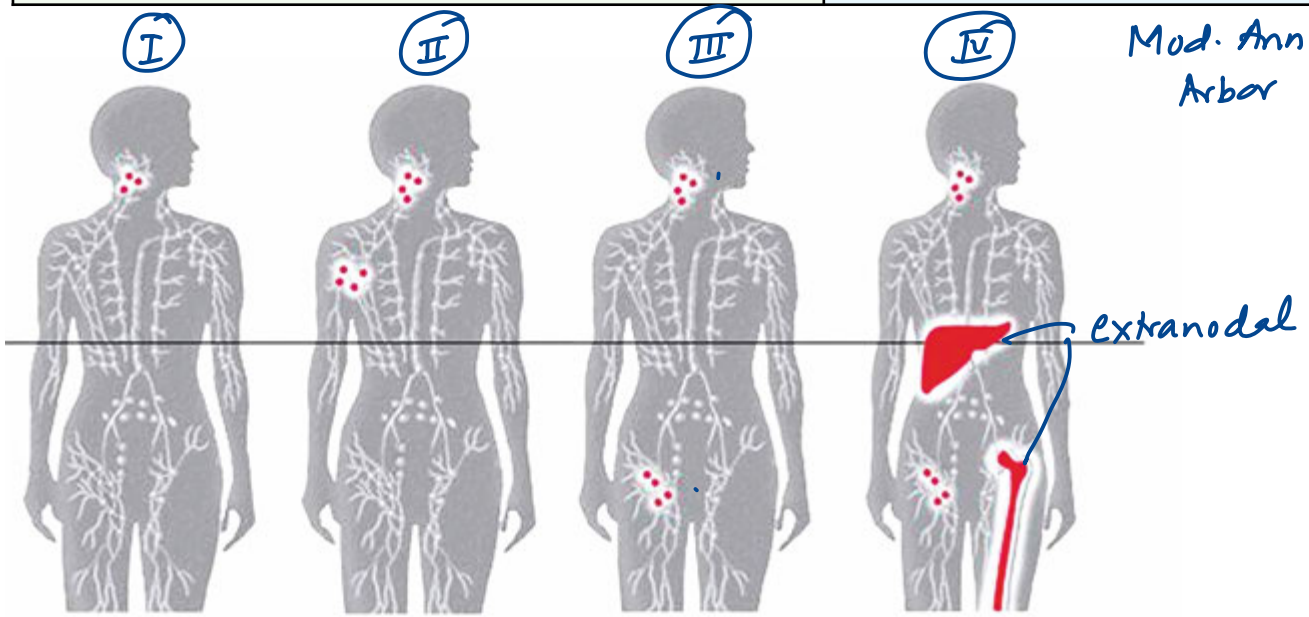
– myeloplasms
↳ M. fergusoni

Lymphomas - Hodgkin's vs Non-Hodgkin's

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

NHL Translocations

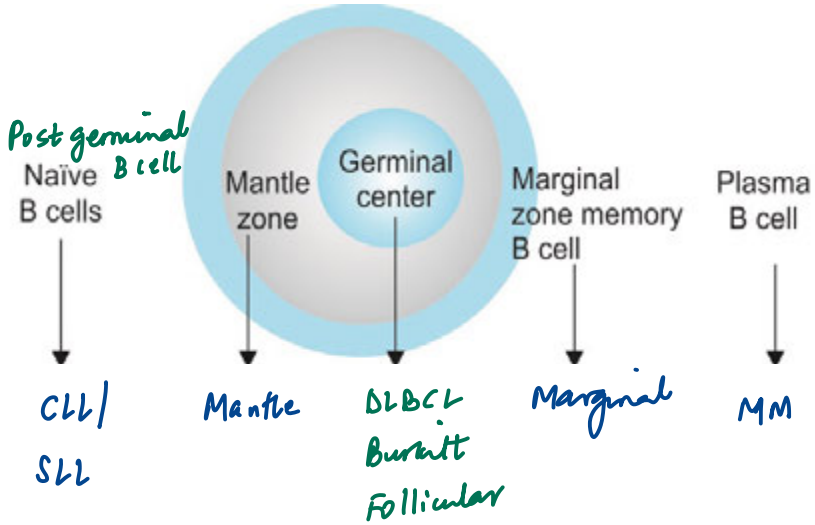
8 - Burkitt (c-myc)	11 (cyclin D1) 14 (IgH) 18 (BCL-2)
t(8;14)	t(11;18) - Marginal zone
t(8;22)	t(11;14) - Mantle
t(2;8)	t(14;18) - Follicular



Mod. Ann Arbor / Costwold's staging

→ B : constitutional symp (+)
(Pel-Ebstein fever

→ X : bulky D >10cm



Approach to 'B-cell NHL'

CD 19/20 +

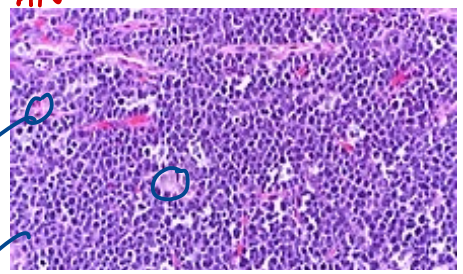
CD 10 +
BCL6 +

DLBCL

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

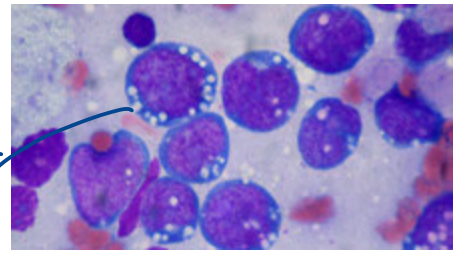
C-myc
Ki 67 100%
Endemic
Sporadic

Burkitt 'L3'
EBV
Africans - jaw
- abdomen
HIV



tingible bodies / mphges

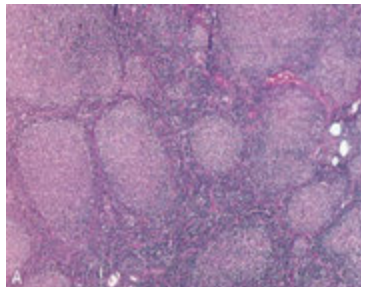
starry sky



'fat' / oil red O

L3

CD 10 +
BCL-2 +



Best prognosis
Waxing and waning LN
Centrocytes, blasts

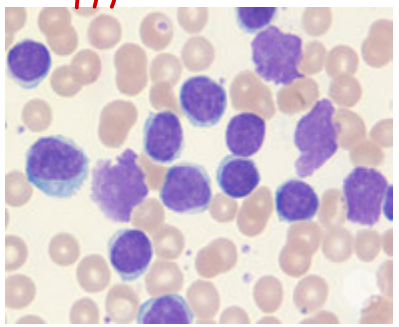
Follicular lymphoma
t(14;18)

CD 5 +

CD 23+
Cd 200+
DELETION 13q
AIHA - Evan's Sx

CLL/SLL

ITP



Smudge cells.

CD 23-
CYCLIN D1+
SOX 11+
Lymphomatoid polyposis

aa

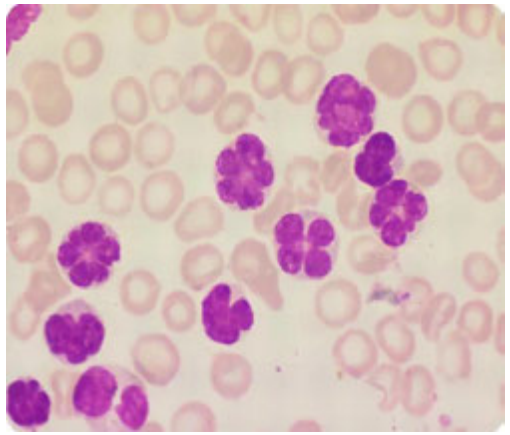
Mantle cell
t(11;14)

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

Marginal / MALToma
t(11;18)

Approach to 'T-cell NHL'

CD 3 +

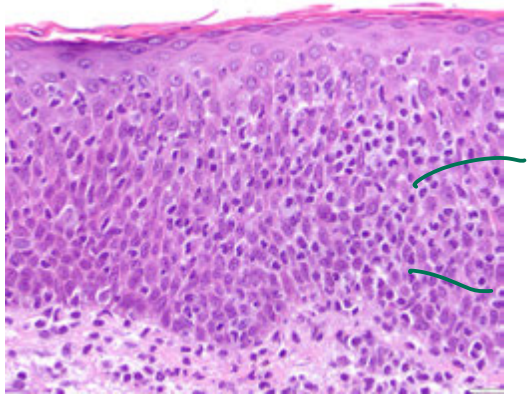


Clover leaf

HTLV

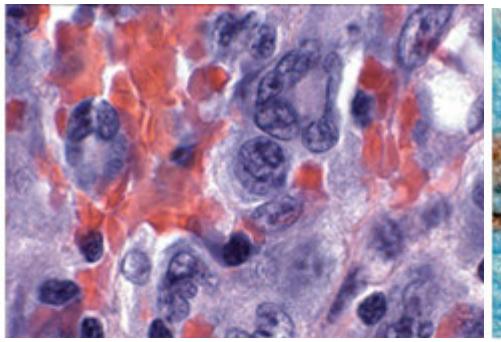
Human T cell leukemia

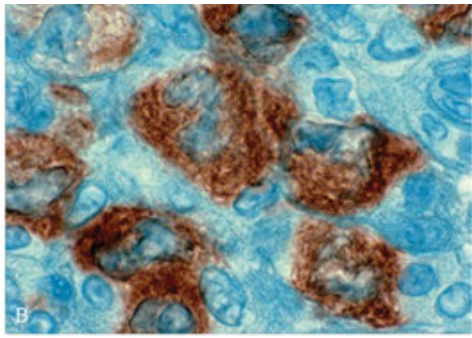
Sezary s/x



Cut T cell lymphoma =

Mycoises fungoides





Hallmark / Donut cells

ALK + CD 30 +

- Anaplastic large cell lymphoma
- NB
- adenoca lung
- Inflammatory pseudotumor

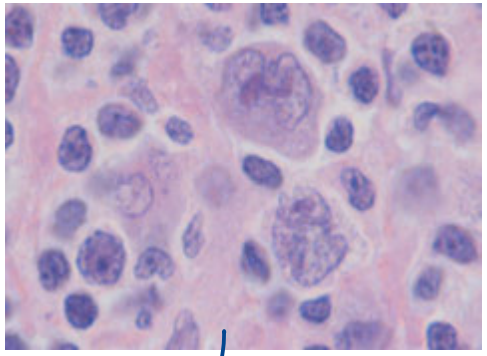
Approach to Hodgkin's Lymphoma

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

QQ

Lymphocyte predominant

POPCORN CELL

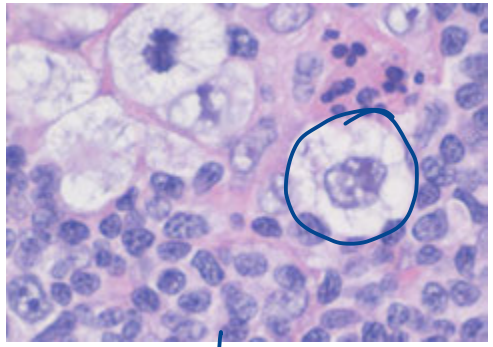


Best prognosis

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

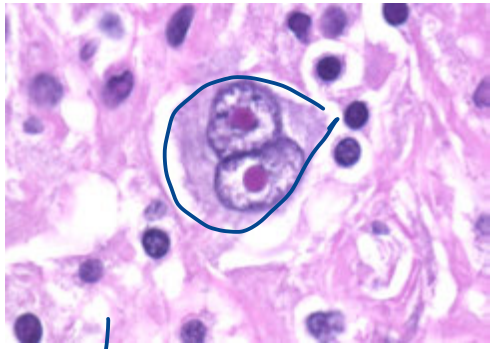
CLASSICAL R-S cell

COLLAGEN NODULES, LACUNAR CELL
Most common



Nodular sclerosis
(mc world)

BACKGROUND MIXED,
HIV +
CLASSICAL RS



owl-eye

Mixed cellularity
(mc India)

BACKGROUND LYMPHOCYTE, MONONUCLEAR RS

Lymphocyte rich

LOW LYMPHOCYTE, PLEOMORPHIC / MUMMIFIED RS
Worst prognosis

Lymphocyte - depleted

Plasma Cell Dyscrasias - monoclonal ↑↑ Ig.

> > +
> > −
< < −

GAMDE
IgG

MM: Plasma cells >10% (BM) + Mprtn >3g/dl + CRAB (+)

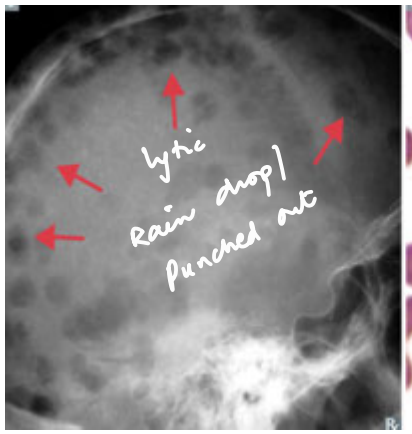
Smouldering MM: Plasma >10% (BM) + Mprtn >3g/dl + CRAB (−)

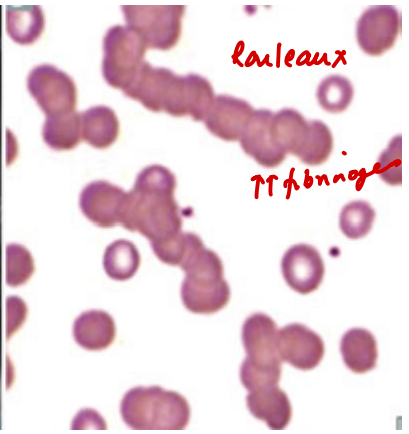
MGUS: BM <10% (Plasma) + Mprtn <3g/dl + CRAB (−)

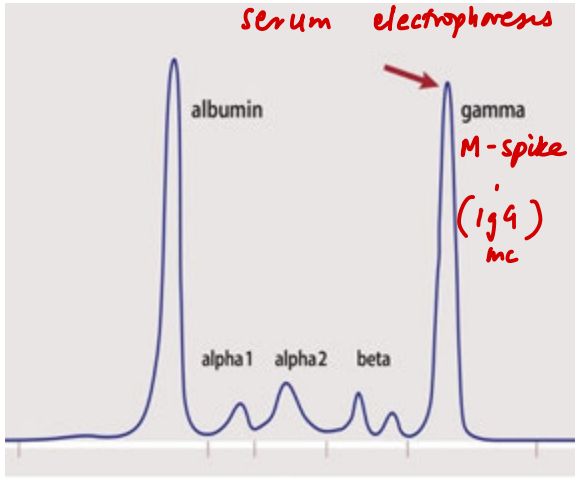
Plasma cell leukemia: Blood plasma cell >20%

Walderstrom's macroglobulinemia (MYD88): headache / blurring; IgM ↑↑

LN + HSM, Hyperviscosity, Neuropathy

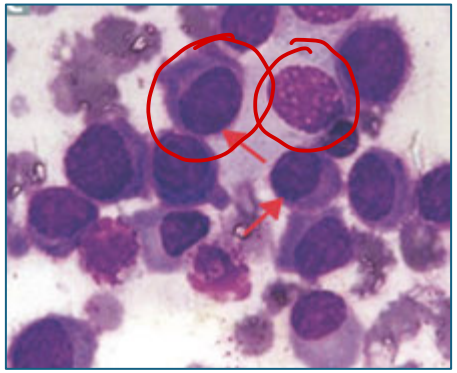




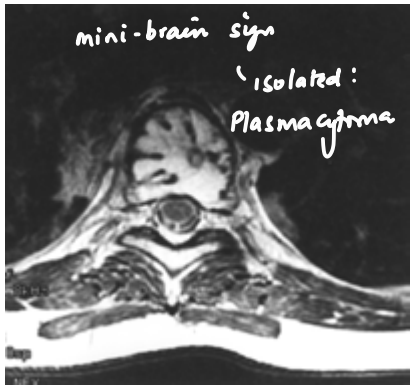


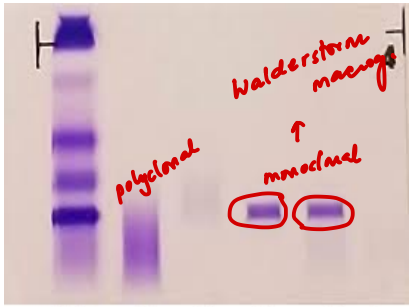
C = Ca >11.5 mg/dL
R = Renal insufficiency (creatinine >2 mg/dL or creatinine clearance <40 mL/min)
A = Anemia (Hb <10 g/dL or 2 g/dL below normal)
B = presence of bone lesions (One or more osteolytic lesions on Xray/ MRI/ FDG PET/CT)
↳ Bone scan – cold spot
ALP – (N)

MM DEFINING BIOMARKERS (↑risk)
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



DD
Protein gap (total-albumin) >4g/dl
URINE: Bence-Jones proteinuria → light chains
B2 microglobulin prognostic
Mulberry/Mott cells Flame cells
Russel body- intra-cytoplasmic
Dutcher body- intra-nuclear
MCC of death- infns.





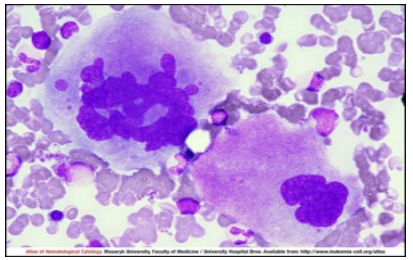
- Lenalidomide
- Dexamethasone
- Bortezomib as proteasome (−) (Sle: reactivation of NSV; ubiquitin tagged)
- Daratumumab → CD38 (−)

Myeloproliferative Disorders

	RBC	WBC	PLATELET	JAK2 MUTATIONS
Polycythemia vera Hb>16	↑↑	↑	↑	+ + Ruxolitinib JAK⊖
Essential Thrombocytosis Platelet >4.5L/mm3	-	-	↑↑	30-50%
CML	↓	↑↑	↑	⊖
MYELOFIBROSIS	↓	↑	↑	30-50%

Hyperviscosity
Thrombosis
Aquagenic pruritus — Histamine release ↑↑

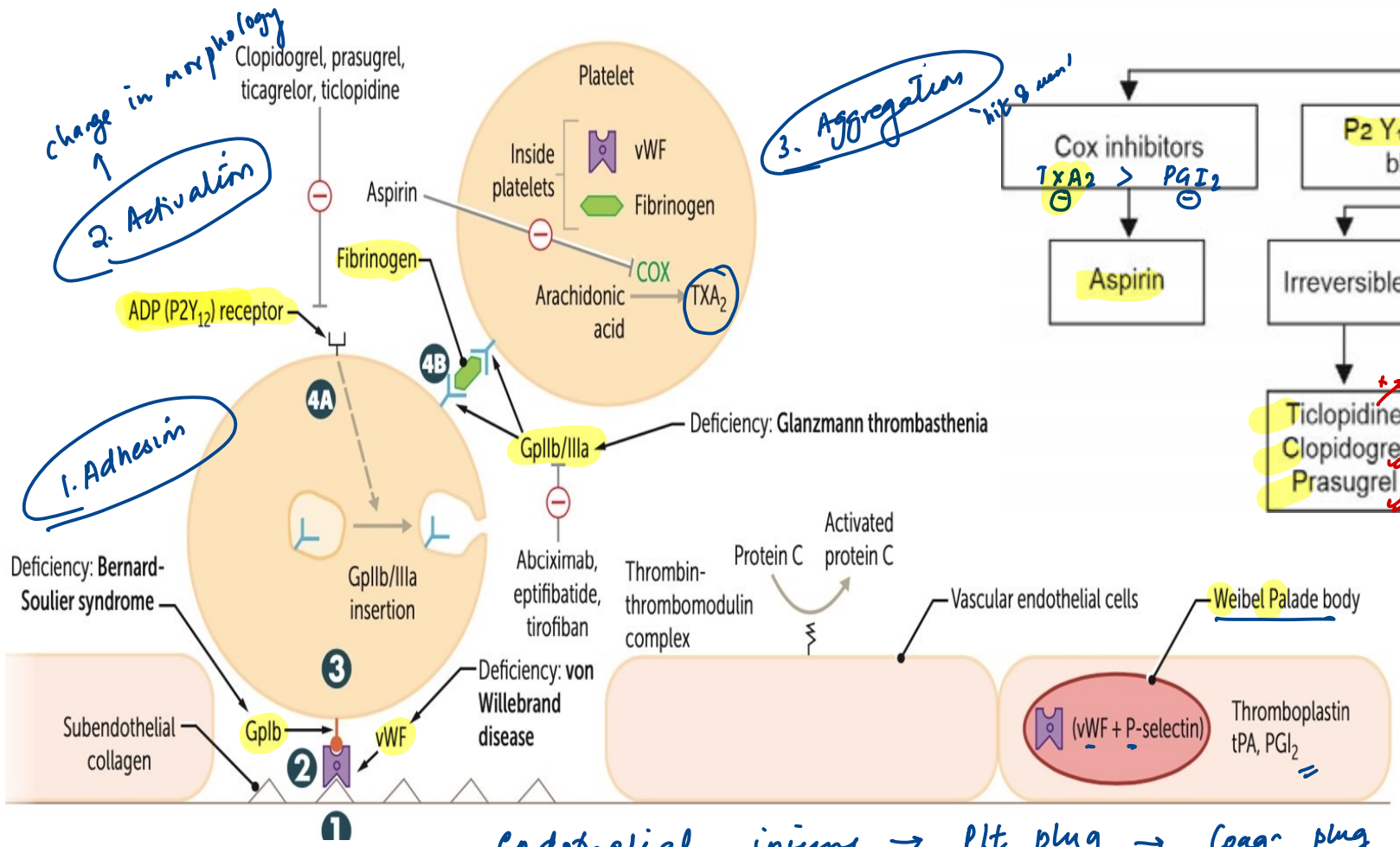
erythromelagia



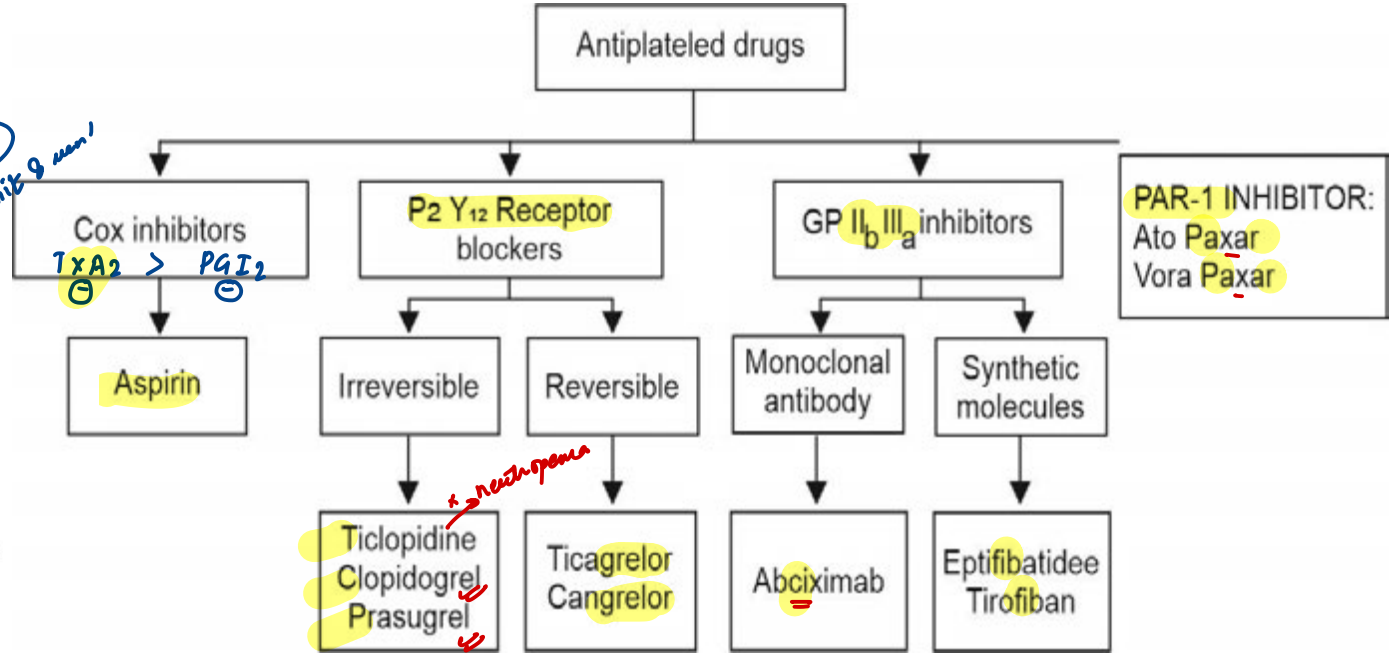
Staghorn megakaryocyte
ET

POLYCYTHEMIA
EPO-90% kidney; 10% liver
RELATIVE - Plasma vol ↓ ; EPO (N)
PRIMARY - PCV - EPO ↓
SECONDARY - EPO ↑ - Hypoxia ← smokers, ↑altitude, "endurance doping"

Platelets



3. Aggregation



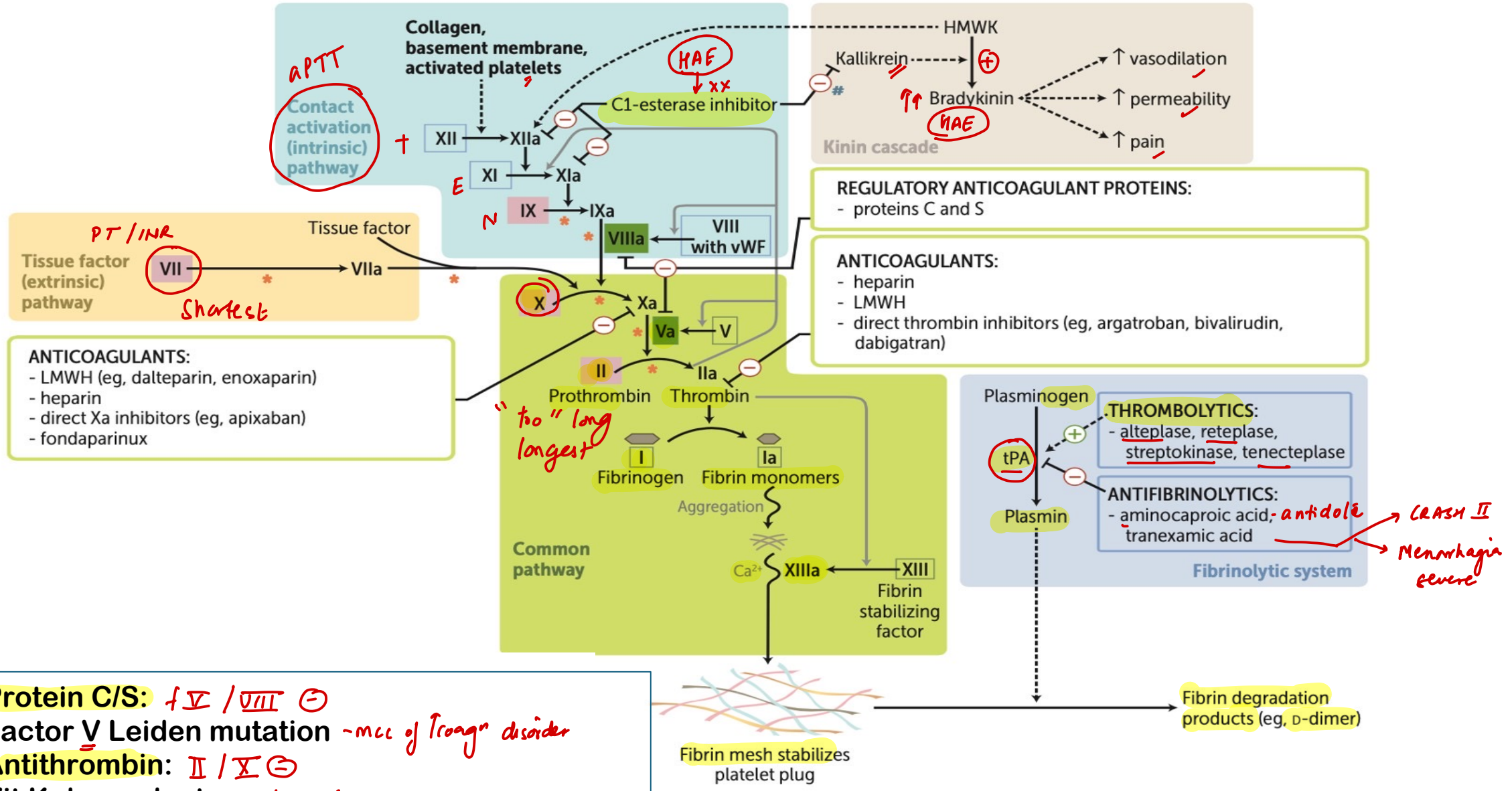
s/e Aspirin: anti-inflam^n dose

Gastric ulcers, tinnitus, renal injury, Reye syndrome V2V / influenza → microvesicular steatosis

Acid-base: Hyperventn → resp alkalosis → HAGMA

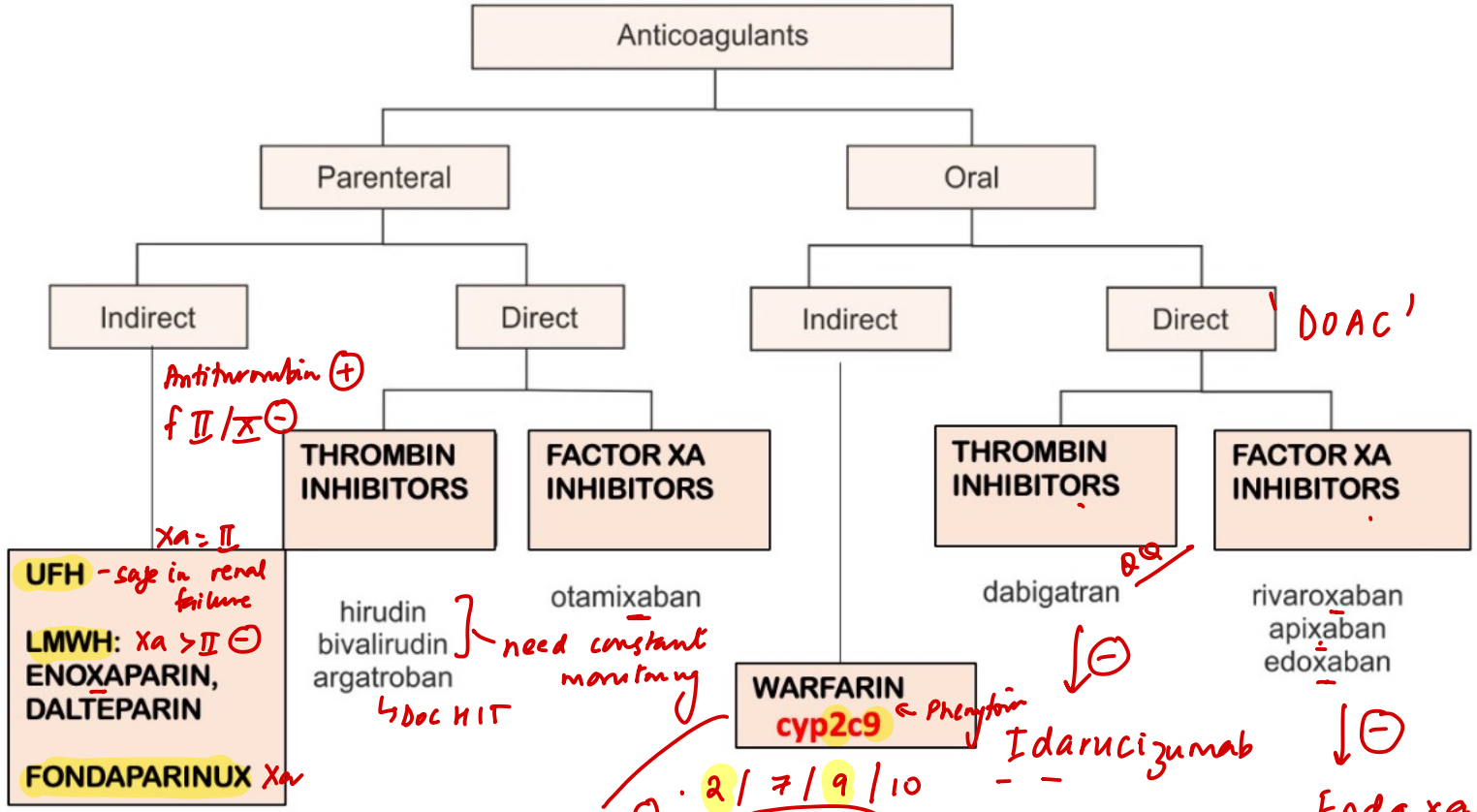
Endothelial injury → Plt plug → Coag^n plug → Fibrin mesh

Coagulation Cascade



Protein C/S: ↓ V / VIII ⊖
Factor V Leiden mutation - most common hypercoagulable disorder
Antithrombin: II / X ⊖
Vit K dependent: II / VII / IX / X

Pharmacology of Anticoagulants



purple toe syl / dermal skin necrosis

DOC for DVT/PE/ ACS
Antidote: Protamine Sog
HIT: Type 2- ≥5d / ≥50% ↓ in plt / thrombosis ⊕
DOC: DTI - Argatroban
Type 4 RTA, Osteopenia ↑K⁺
Safe in pregnancy

Ciraparantag: DOAC - antidote

Approach to Bleeding Disorders

Plt

Petechiae
Purpura
BT (N-2-9min)

PLATELET COUNT
(N-1.5-4lakh/mm3)

NORMAL

REDUCED

BT + aPTT prolonged — VWD → mc bleeding D
Epistaxis / menorrhagia/ high bleeding after procedures
Chr 12 AD QQ
Ristocetin aggregation test IOC
Type 1: quantity ↓
Type 2: quality ↓
Type 3: AR (absent vWF)
2N (f8 release x-AR): RIPA N
TOC: Desmopressin (V2 → ↑vWF/f8)

Ecchymosis
Hemarthrosis
CT

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

Abn ADP/collagen Aggregation
GpIIb xx
Glanzmann

GpIb xx Bernard Soulier
Abn Ristocetin aggregation RIPA
Giant platelets

ITP → anti-GpIIb-IIIa

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

Rx - DOC
Steroids, IVIG, anti-D → splenectomy
Rituximab
Oprelevkin - IL-11 ↑
Romiplostim, Eltrombopag TPO+
Fostamatinib TKI

PT RAISED
extrinsic
f7 ↓
early vit k ↓/ warfarin toxicity
2/7/9/10

aPTT raised
CHILD → Hemophilia
ADULT → Plasma mixing (corrects) → Hemophilia
A ↓ f8 — XLR — Desmopressin
B ↓ f9 — Christmas D
C ↓ f11 — AR
APLA — Lupus anticoagulant
f inhibitors — Acq H

Emicizumab
f8 ↑

Both normal
Q/ f 13 = Laki Lorand factor
↓
urea clot solubility test
(+) bleeding from umb stump

Both raised
· f V/X/II
· Fibrinogen ↓
· DIC
  - sepsis/Abruptio/snake bite
  - Plt ↓
  - D-Dimer ↑

Oozing from puncture sites

f12 = Hageman factor
Low role clotting

Transfusion Medicine

Rh → anti-D → IgG

- Rh – chr 1
- ABO – chr 9
- h – chr 19

Blood Group	Antigens	Antibodies
A	H, a	anti-b
B	H, b	anti-a
AB	H, a, b	–
O	H	anti-a, anti-b
Bombay Blood Group	–	anti-H, anti-a, anti-b

IgM

IgM ↑↑ IgG → jaundice at birth

Resistance to P.vivax and P.knowlesi : Duffy Ag absence

McLeod syndrome : Kell Ag

Antigens adsorbed from plasma: Lewis Ag.

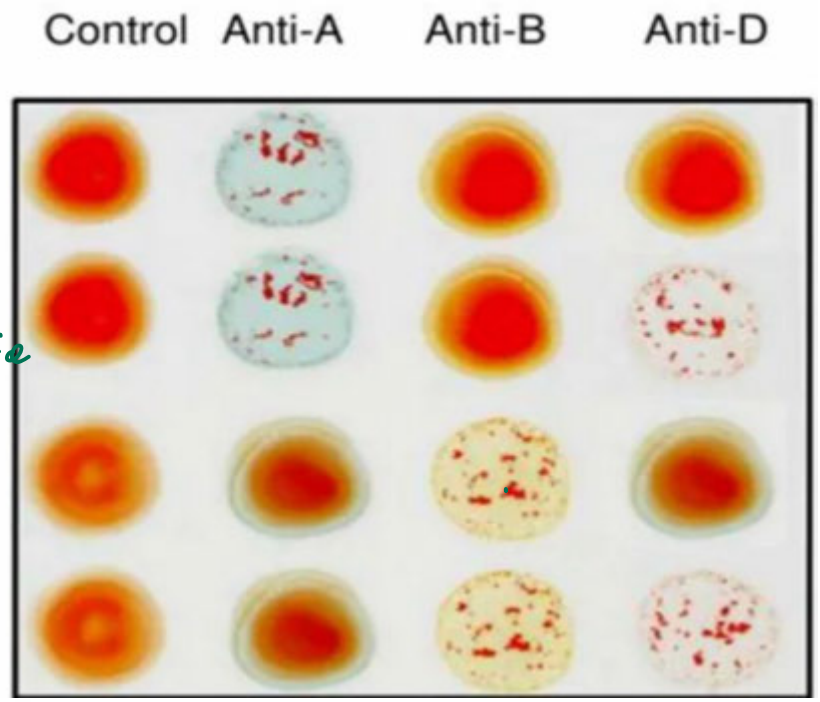
Massive transfusion: ≥ 10U/24hr ≥ 4U/hr

Ca: ↓ Mg ↓ (citrate)

K: ↑ (hemodilⁿ → lysis)

Acid-base: metab alkalosis

MCC of death: dilⁿ coagulopathy

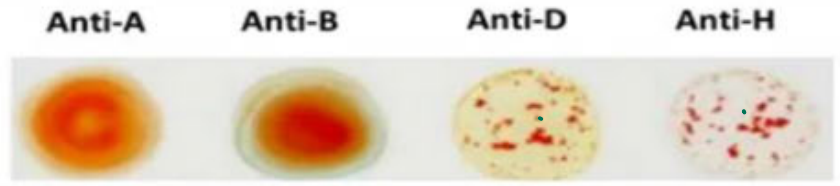


A –ve

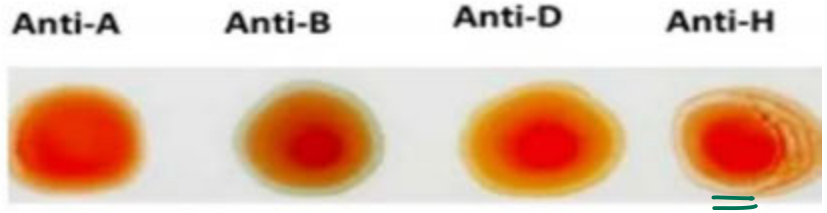
A +ve

B –ve

B +ve



O +ve



Bombay

BLOOD PRODUCTS

	Storage temp	Shelf life	Increase by
Whole/ PRBC	2-8°C	CPD - 3wk CPDA - 5wk SAGM - 6wk	↑ 1g/dl Hb
Platelet: Pooled/ SDAP	24-28°C (↑bact contam)	5d (↓ agitator)	↑ 10k-30k per unit
FFP Cryoppt (or: f8, vWF, f13, fibrinogen)	-30°C	1yr	⊖

Screen for: HIV/ HBV/ HCV/ SYPHILIS /MALARIA (⊗ Dengue)
All components: Malaria ⊗

Leukored- filter
↓ febrile
↓ CMV
↳ mc cfgn - BT

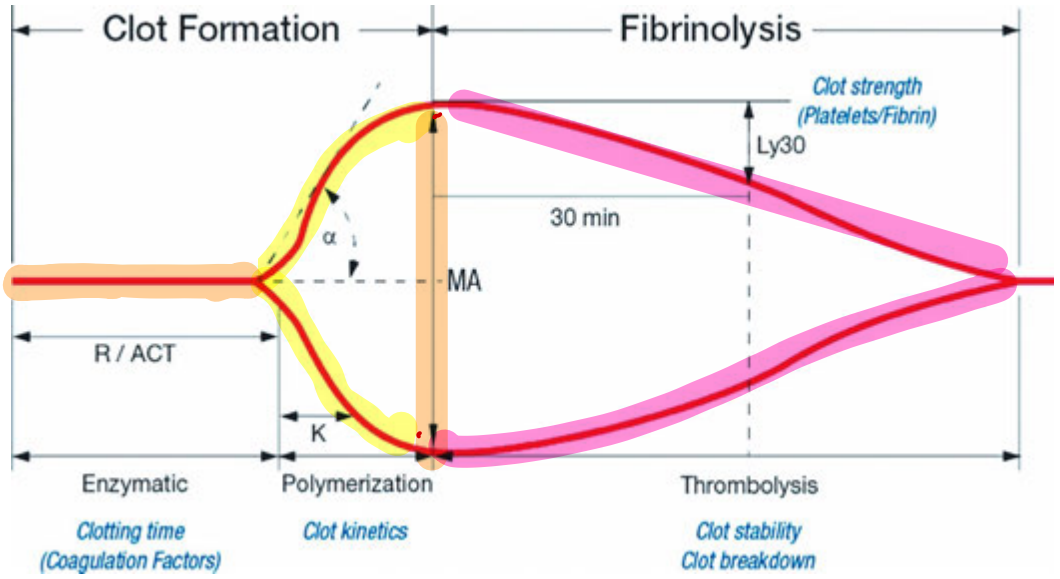
Complication	Signs/ Symptoms	Treatment
Febrile NHTR	Fever, Chills, Malaise (mc) WBC ↑	Supportive- acetaminophen
Hemolytic TR >24hrs: Delayed	Fever, chills, pain at the site of reaction, nausea/vomiting, shock, dark urine (Hburia) (ABO incomp)	STOP the transfusion IV fluids +/- diuretics
Allergic rxn	Urticaria, pruritis, hives IgA deficiency - anaphylaxis	Symptomatic- antihistamines.
TRALI (≤6hr)	Dyspnea, hypoxemia, bilateral chest infiltrates anti-HLA donor	STOP the transfusion airway control, supportive care
TACO mcc of death	Dyspnea, edema, JVP Raised	Slow infusion + Diuretics
Bradykinin ↑r	Hypotension ACE inhibitors	

Miscellaneous

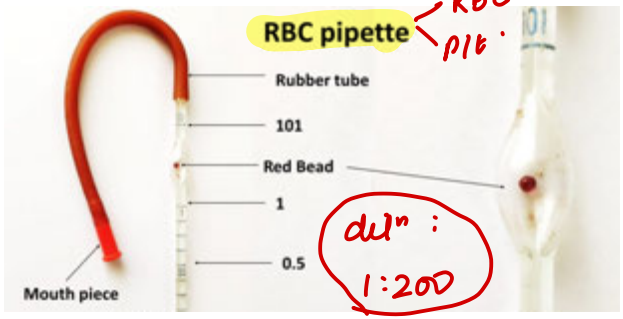
TTP	HUS
Thrombocytopenia, microangiopathic hemolytic anemia (↓ Hb, schistocytes, ↑ LDH), acute kidney injury (Normal PT/aPTT)	
Triad + fever + neurologic symptoms	Triad + bloody diarrhea
Plasma exchange, glucocorticoids, rituximab	Supportive care

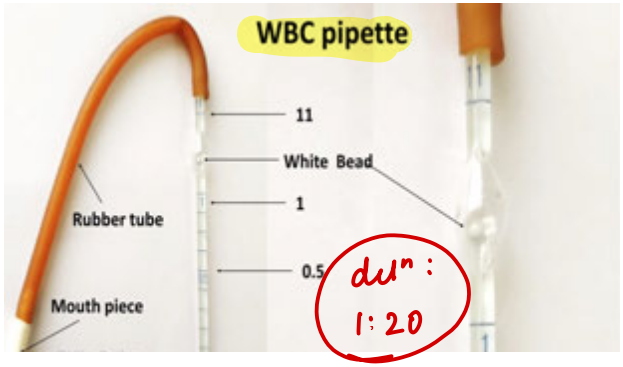
TUMOR LYSIS SYNDROME

SVC syndrome:
Acute back pain due to bone mets:

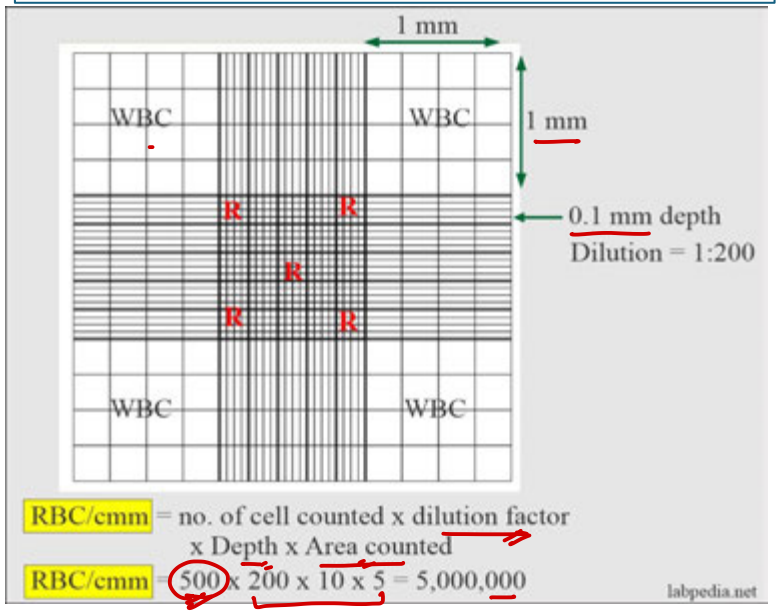


TEG	Normal	Abnormality / Cause	Treatment
Reaction Time (R value)	5–10 min	↑ R value: ↓ factors	FFP
K value	1–5 min	↑ K : ↓ fibrinogen	FFP / cryoppt
α-angle	45–75°	↓ α-angle: ↓ fibrinogen	FFP / cryppt
Maximum Amplitude (MA)	50–75 mm	↓ MA / MCF: ↓ platelet count and/or function	plt
LY-30	0–10%	↑ LY-30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





Improved Neubauer chamber



Wintrobe	Westergren
• Tube is closed at lower end & open at upper end	• Tube is opened at both ends
• 11cm-Less volume	• 30cm-large volume
• Less sensitive	• More sensitive
• EDTA	• Sodium citrate

ESR

RBC — 5 small squares — x 10^4

PLT — 1 x 1 mm^2 (all small sq) — x 2000

WBC — 4 large sq — x 50

Hb — N/10 HCl — acid hematin

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

Vacutainer Color	Additive	Use
 Blue	3.2% Na citrate	Coagn - PT & aPTT D-Diner westergren
	3.8 % Na citrate	Automated ESR
 Gold	serum sep gel	Serum - LFT / RFT / electrolytes /
 Red	+ silica	hormone
 Light Green	Li Heparin	Plasma - ABG / OFT /
 Green	Na "	electrolytes qq
 Lavender	EDTA	CBC / ESR- Wintrobe / HBA1C
 Pink	"	Cross-matching
 Royal Blue	"	Rare - Th / As Pb - TAN
 Gray qq	K oxalate + NaF enolase ⊖	Glc estimation / alcohol / Postmort