

Anaemia - what's it all about?

Tim Watts

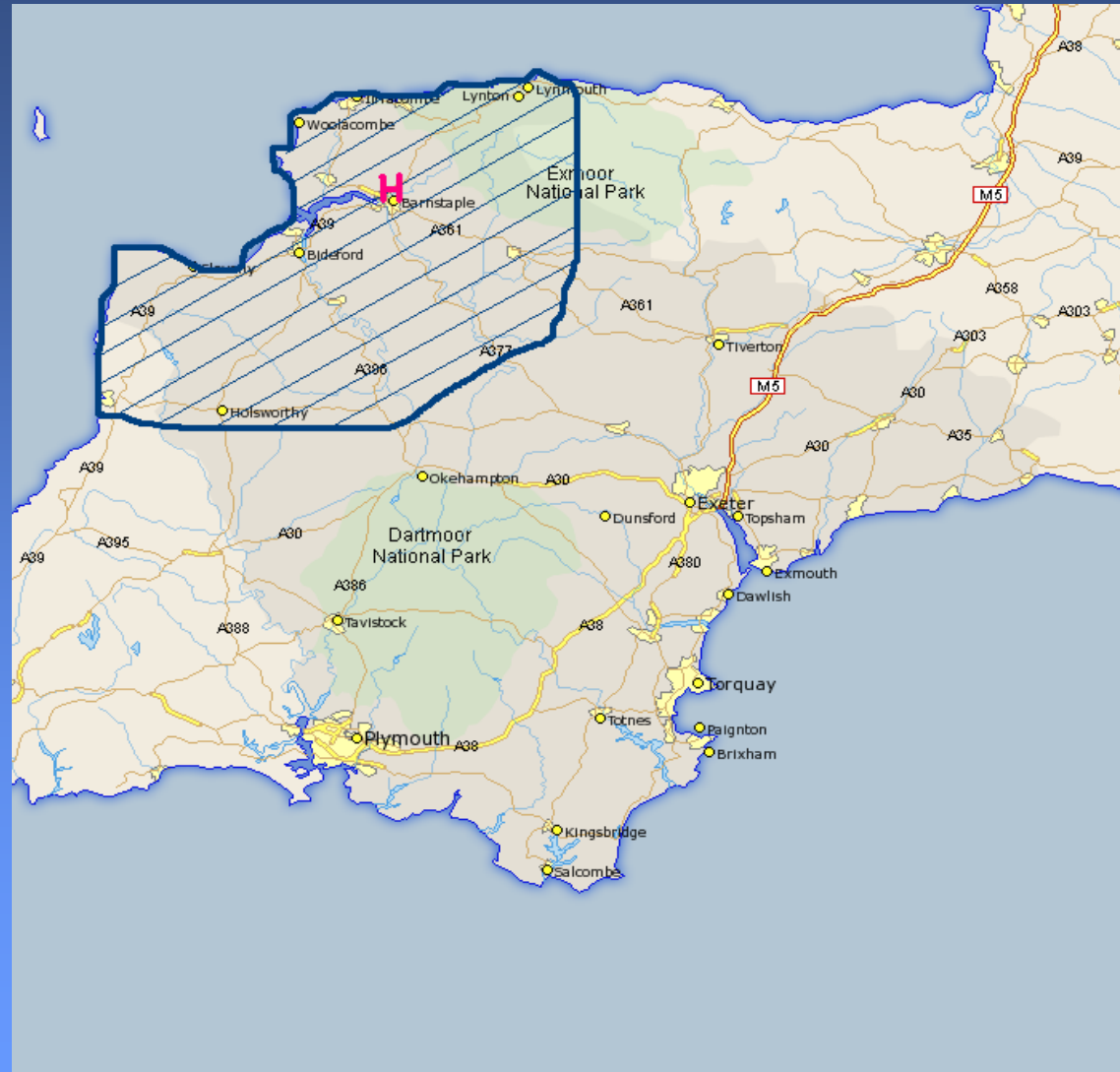
Laboratory manager

Blood Sciences

NDDH

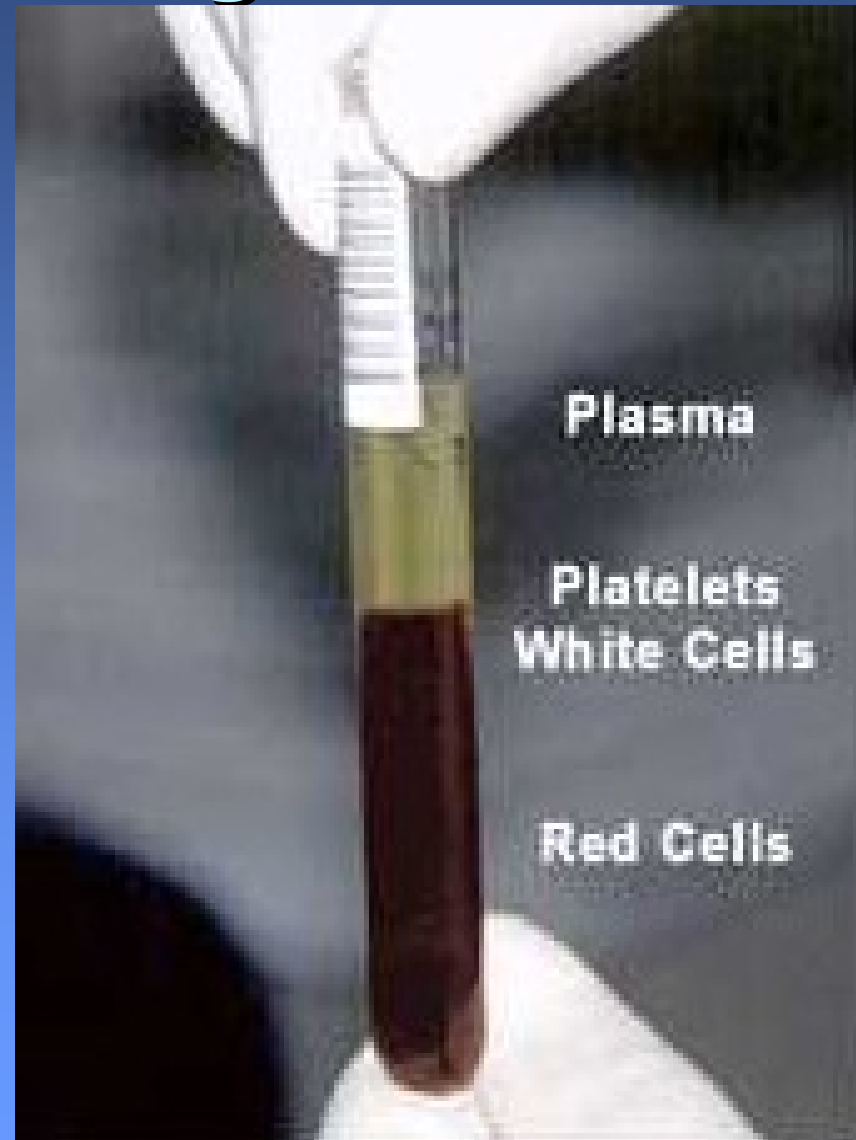
NDDH laboratory coverage

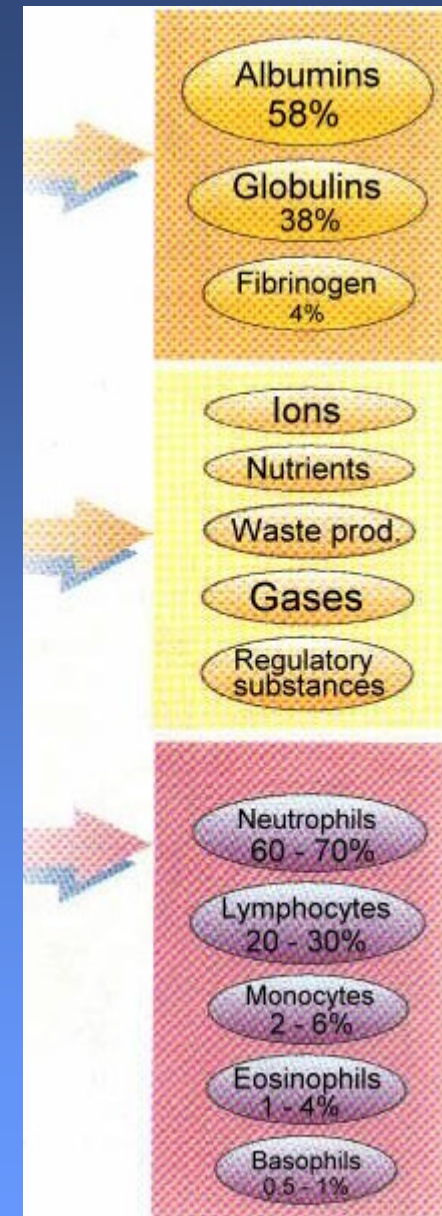
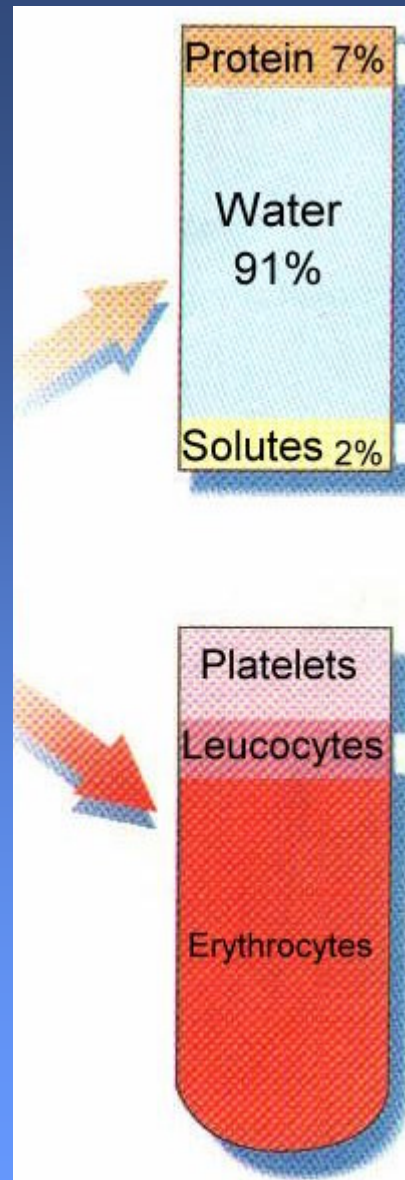
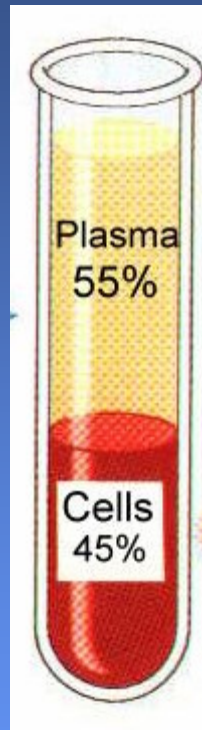
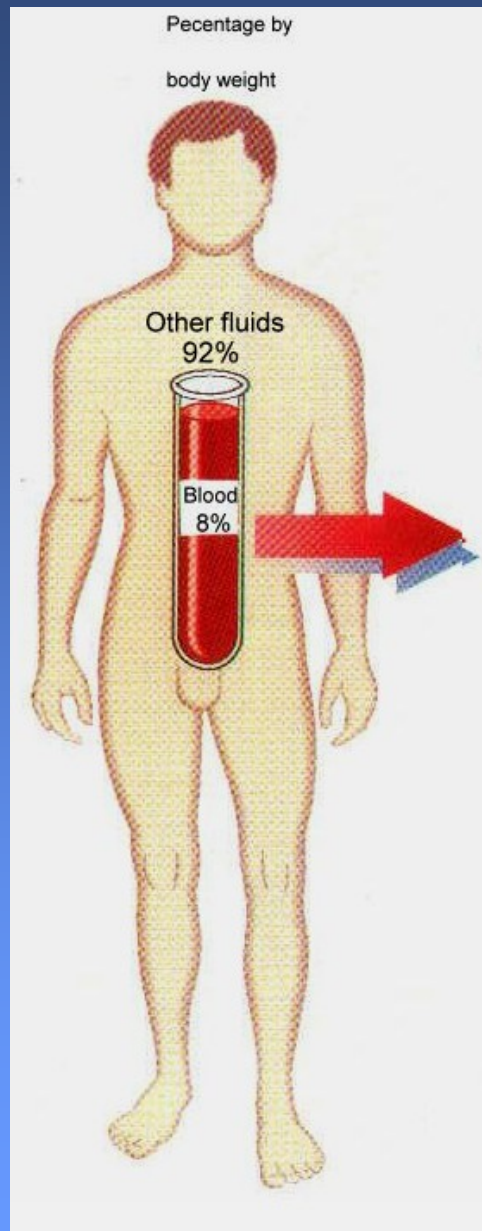
- Population of area covered: 170000.

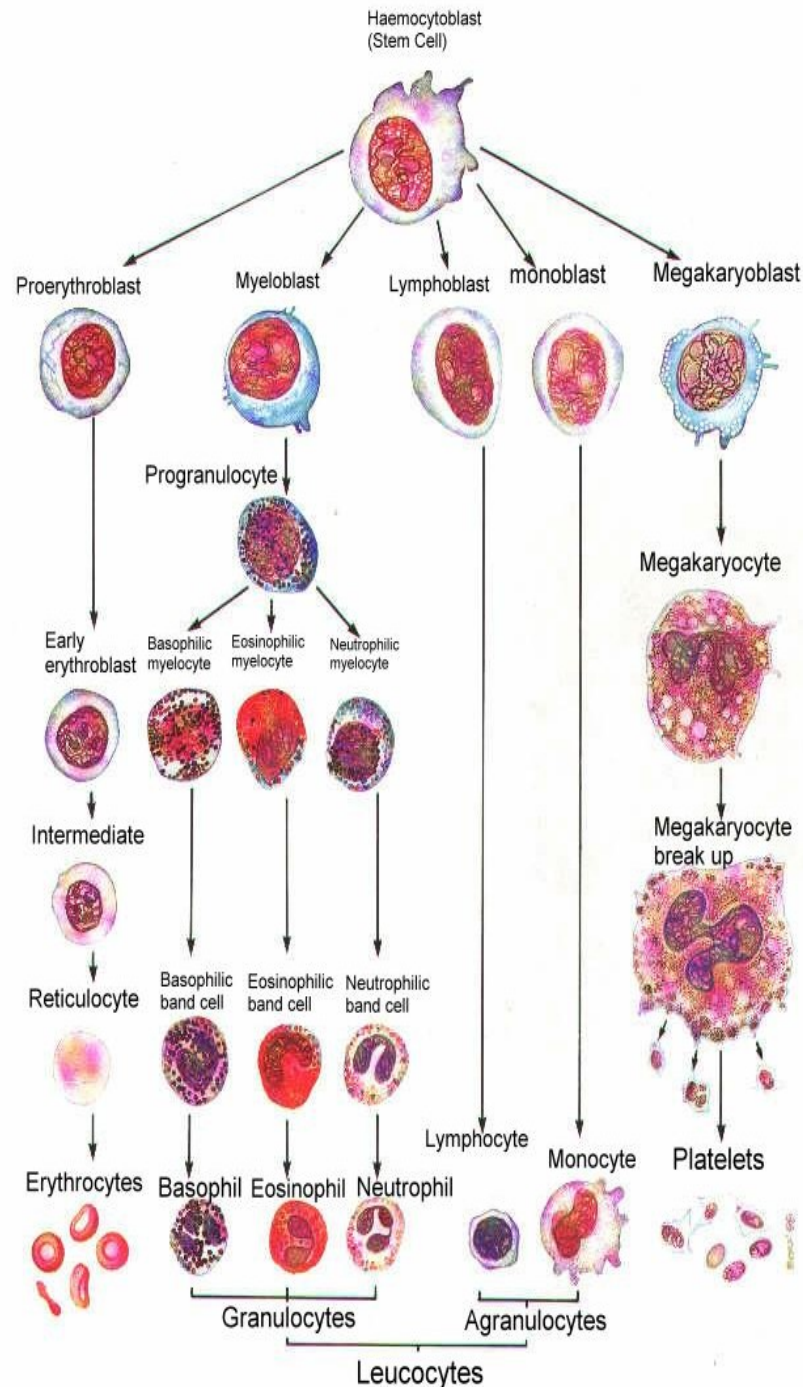


Interesting facts

- A person of average height and weight will have approximately 4.6 litres of blood
- Blood accounts for about 8% of body weight.
- Approx 2 million red blood cells are made and destroyed each second







Haematopoiesis

All blood cells are produced from a common precursor cell, in the bone marrow.

(haematopoietic stem cell)

Acute leukaemia is an abnormal proliferation of **blast** cells

What is anaemia?

- An - lack of
- Aemia - in the blood
- We define anaemia as:
- **A suboptimal Oxygen carrying capacity**

Haemoglobin

- Carries oxygen to all tissues
 - Contained within red cells
 - Fairly important!
 - Accurate measurement vital
 - pre-anaesthesia
 - general health
 - blood loss/ trauma/ surgery
- Lack (anaemia) is commonest blood disorder

- **Some causes of Anaemia:**
 - iron deficiency
 - vitamin B12/ folate deficiency
 - malabsorption
 - bleeding/ trauma/ surgery
 - pregnancy
 - renal failure
 - mechanical or autoimmune cell damage (haemolysis)
 - secondary to other illnesses, e.g. leukaemia, cancer, rheumatoid
 - and their treatments (myelosuppression)

XE2100 analyser



XE-2100 screenshot

XE-2100 - [Data Browser]

File Edit View Record Action Report Setting Window Help

open save H-Copy property menu QC work list explorer browser Auto Manual delete Upper Lower last20 validate pending

Negative Sample No. 10000001 Birth Ward Date 22/01/2003
 Pat. ID Sex Dr. Time 22:09
 Name Comment

Main Graph **WBC** RBC Cumulative Q-Flags Service HPC Research(W) Research(R)

Items

Item	Data	Unit
WBC	6.72	10 ⁹ /L
RBC	4.38	10 ¹² /L
HGB	145	g/L
HCT	0.413	Ratio
MCV	94.3	fL
MCH	33.1	pg
MCHC	351	g/L
PLT	259	10 ⁹ /L
RDW-SD	45.2	fL
RDW-CV	13.0	%
PDW	13.2	fL
MPV	11.3	fL
P-LCR	34.8	%
PCT	0.29	%
RET%		%
RET#		10 ⁹ /L
IRF		%
LFR		%
MFR		%
HFR		%
NRBC#		10 ⁹ /L
NRBC%		/100WBC

WBC Differential

Item	Data	Unit
NEUT#	4.11	10 ⁹ /L
LYMPH#	1.85	10 ⁹ /L
MONO#	0.60	10 ⁹ /L
EO#	0.11	10 ⁹ /L
BASO#	0.05	10 ⁹ /L

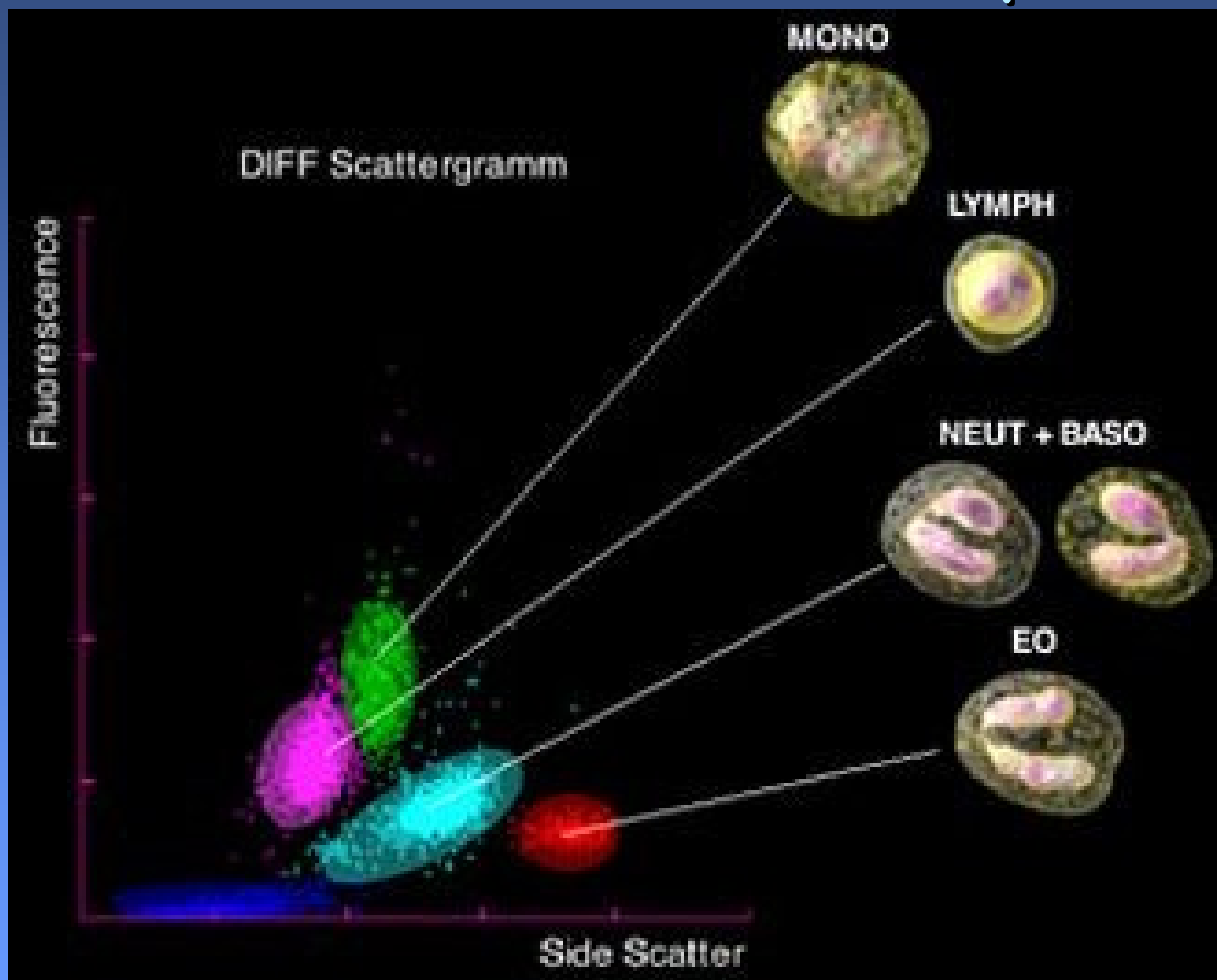
Item	Data	Unit
NEUT%	61.3	%
LYMPH%	27.5	%
MONO%	8.9	%
EO%	1.6	%
BASO%	0.7	%

Flag(s)

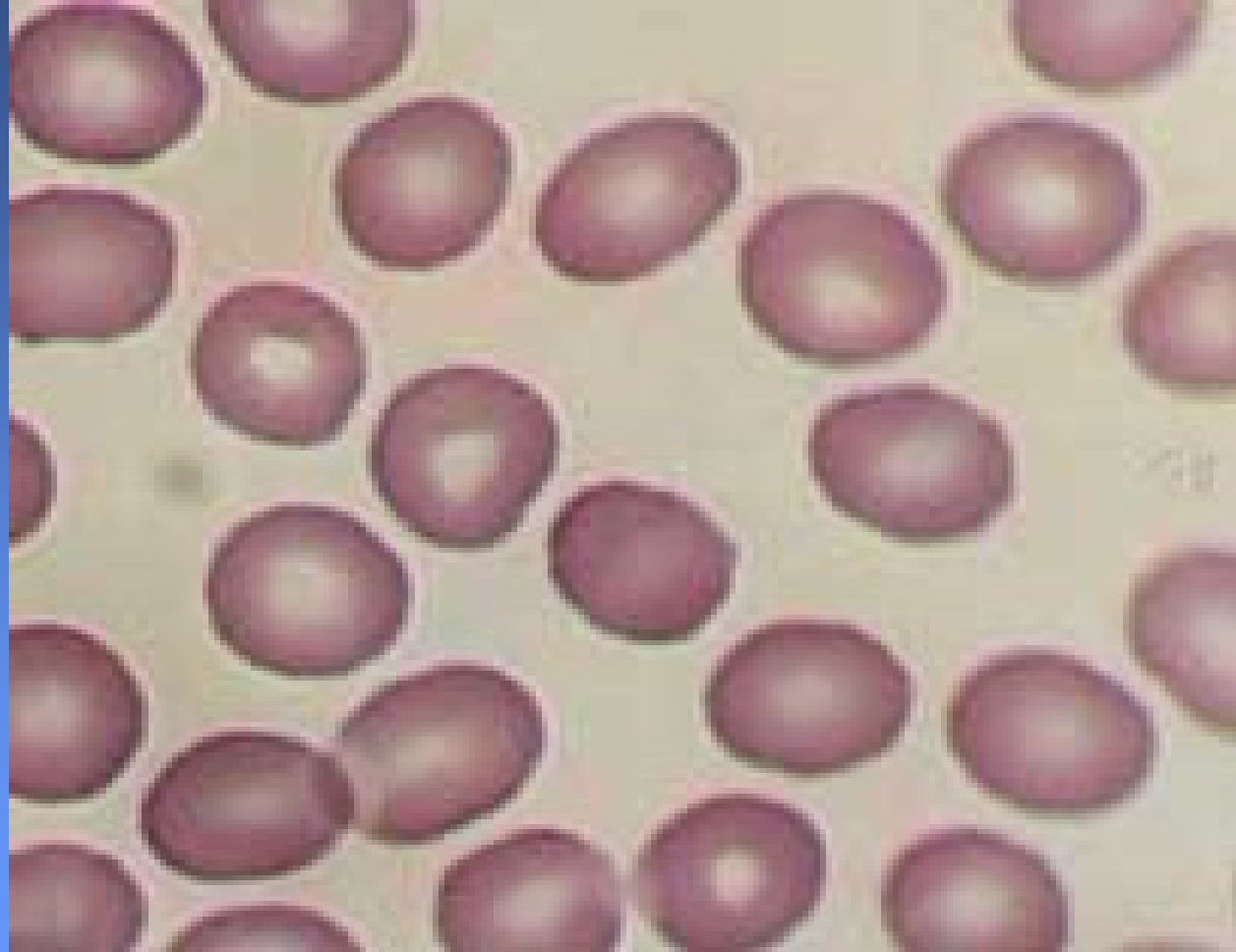
WBC RBC/RET
 PLT

Message HOST(HC)

XE2100 - diff scatterplot



- Normal red cells



The Full Blood Count

- Red blood cell parameters:
- **MCV** - mean (red) cell volume - f L
- **MCH** - mean (red) cell haemoglobin - g/ dL
- **RDW** - red (cell) distribution width - %
- **HCT** - haematocrit
- **RBC** - red cell count - $10^{12}/L$

Iron deficiency

- The most common type of anaemia worldwide
- Haemoglobin is not produced
- RBCs are plentiful but small and contain reduced amount of haemoglobin
- So - RBC normal/low, MCV/ MCH low
- RDW usually normal/high

Iron deficiency

- A fine balance - gain and loss

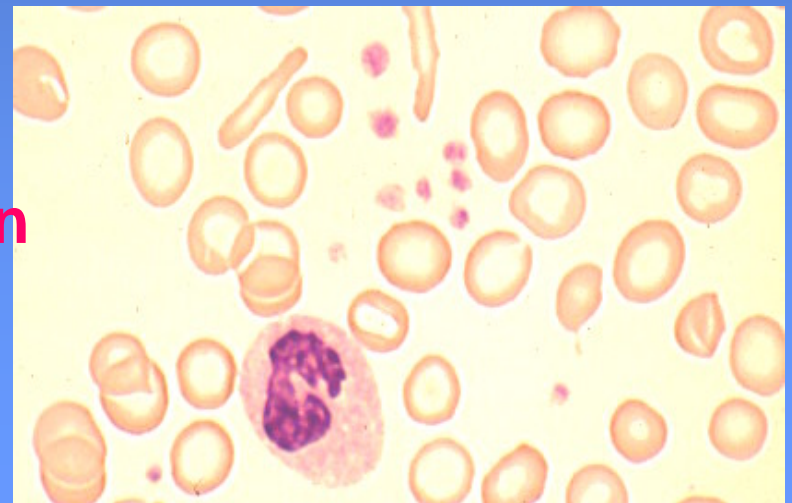
Iron deficiency

- **Caused by:**
- Dietary deficiency/ malabsorption
- Excess chronic blood loss, e.g. menstruation
- Functional deficiency - the iron is there but cannot be used. Anaemia of chronic disorders.
- Common in children due to muscle growth

IRON DEFICIENCY

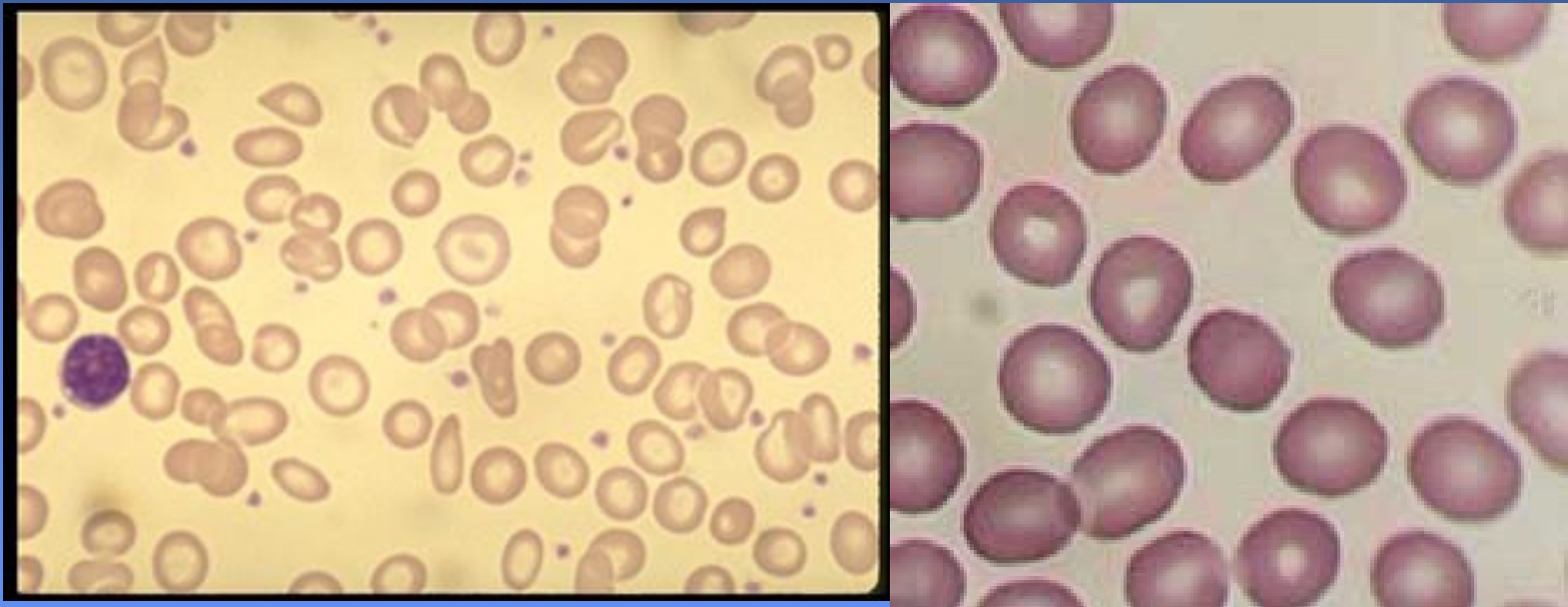


Treatment IRON - not transfusion



Iron deficiency

- Iron deficient red cells vs. normal

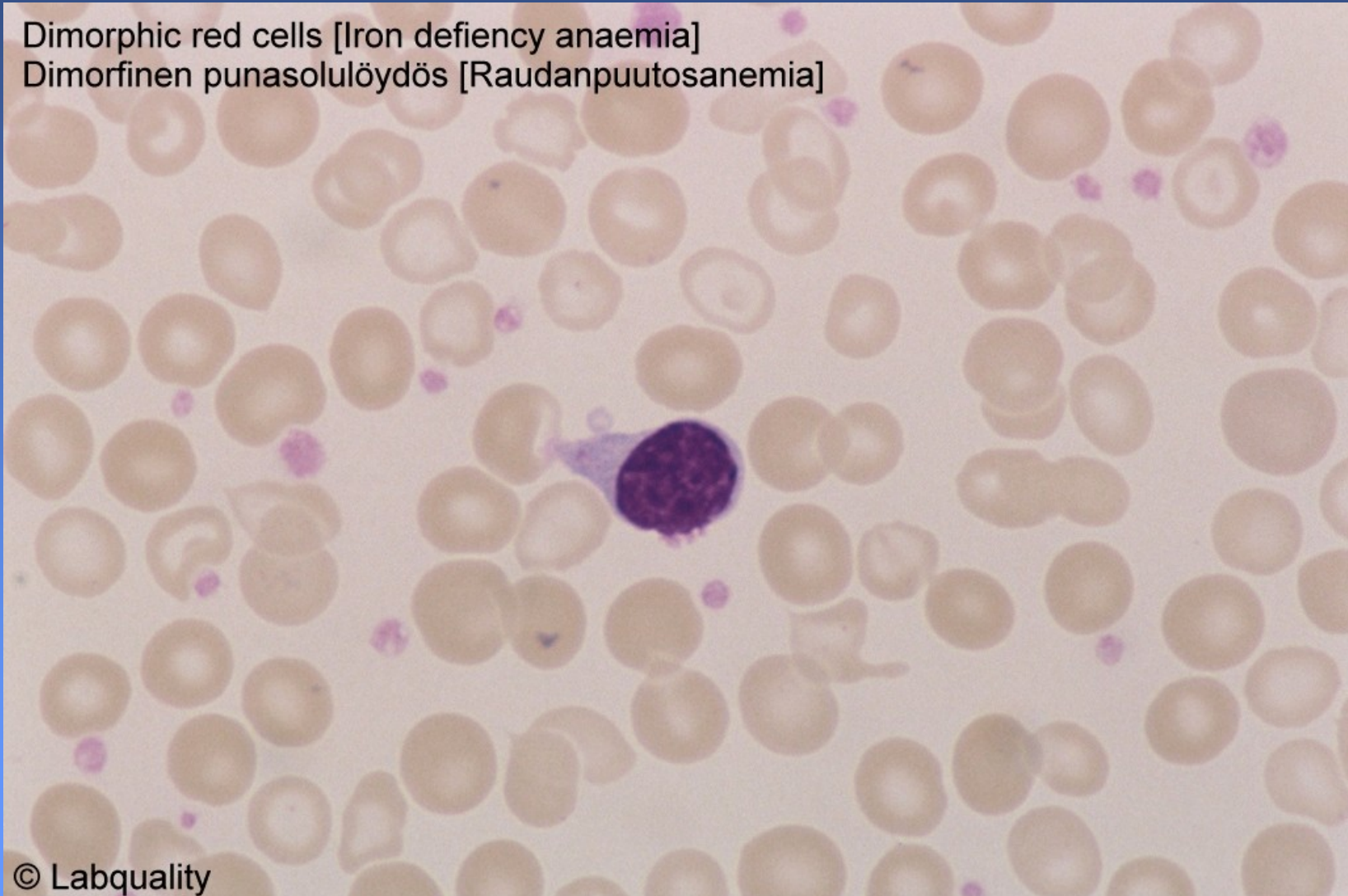


Iron deficiency

- Treatment will give a rapid response
- Hb, MCV and MCH will rise
- RDW will increase dramatically
- Treat over 3 months to build stores

Iron deficiency

Dimorphic red cells [Iron deficiency anaemia]
Dimorfinen punasolulöydös [Raudanpuutosanemia]



Vitamin B12/folic acid deficiency

- More common in the elderly
- Severe form (Pernicious anaemia) results from lack of gastric intrinsic factor - either autoimmune (65%) or other stomach problem
- Also caused by diet (vegans) or malabsorption (Crohn's, coeliac)

Vitamin B12/folic acid deficiency

- Very few, very large red cells due to delayed nuclear maturation in marrow
- Hb drops very low, (<3.0 g/dl) until no longer compatible with life (hence the term Pernicious)
- MCV high, RBC low
- RDW high

Vitamin B12/folic acid deficiency

- Very few, very large red cells

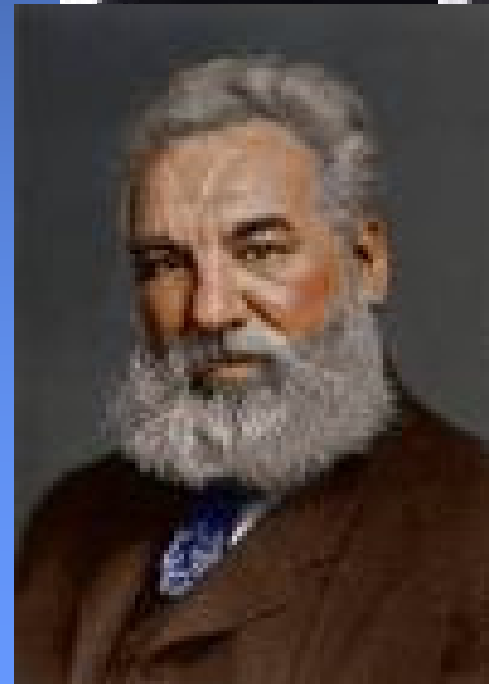


- Note the neutrophil!

Vitamin B12/folic acid deficiency - P.A.

- Pernicious anaemia was treated by eating raw liver as this is very rich in vitamin B12 and passive absorption sufficient
- The more wealthy soaked it in Port first!
- Now B12 is given intramuscularly
- No need for I.F.

FAMOUS
PERNICIOUS
ANAEMIA
SUFFERERS



PERNICIOUS ANAEMIA - VITAMIN B12 DEFICIENCY



LOW HAEMOGLOBIN

RAISED MCV

LOW VITAMIN B12 - FAILURE TO ABSORB

OTHER AUTO-IMMUNE DISORDERS

Treatment Vitamin B12 - not transfusion

Use of RBC indices

- **MCV** - low in iron deficiency, some thalassaemias
- High in B12/ folate deficiency, liver disease, some thyroid disorders
- **RDW** - normal if all RBCs the same size
- Increased if there is a significant variation within a patient

Anaemia of Renal failure

- The bone marrow is stimulated to produce red cells by a hormone called ERYTHROPOEITIN (EPO)
- This is made by the kidney and is lacking in renal failure so the marrow produces minimal cells
- Treated by giving recombinant EPO
- Some athletes cheat by giving themselves EPO

Anaemia of Pregnancy

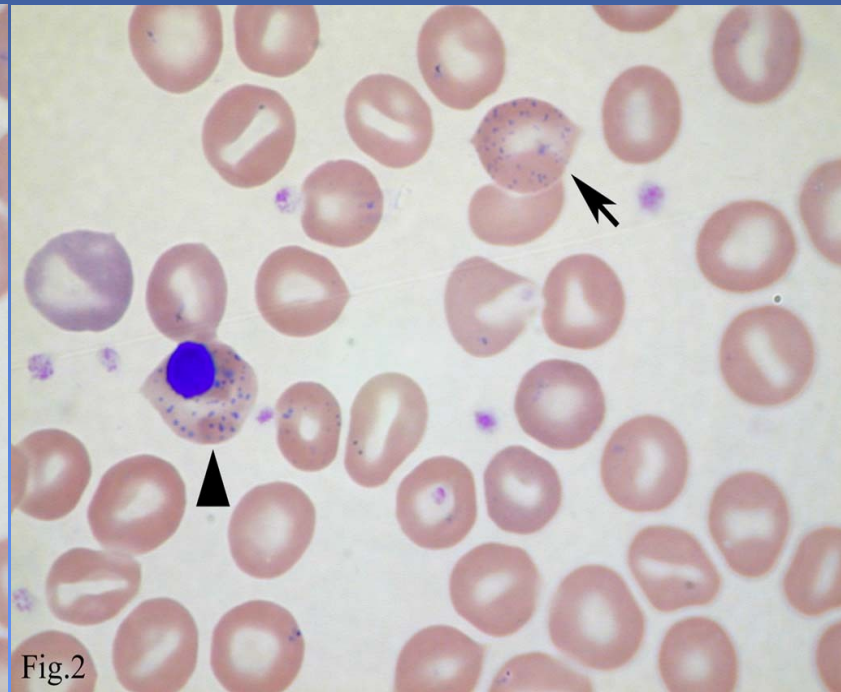
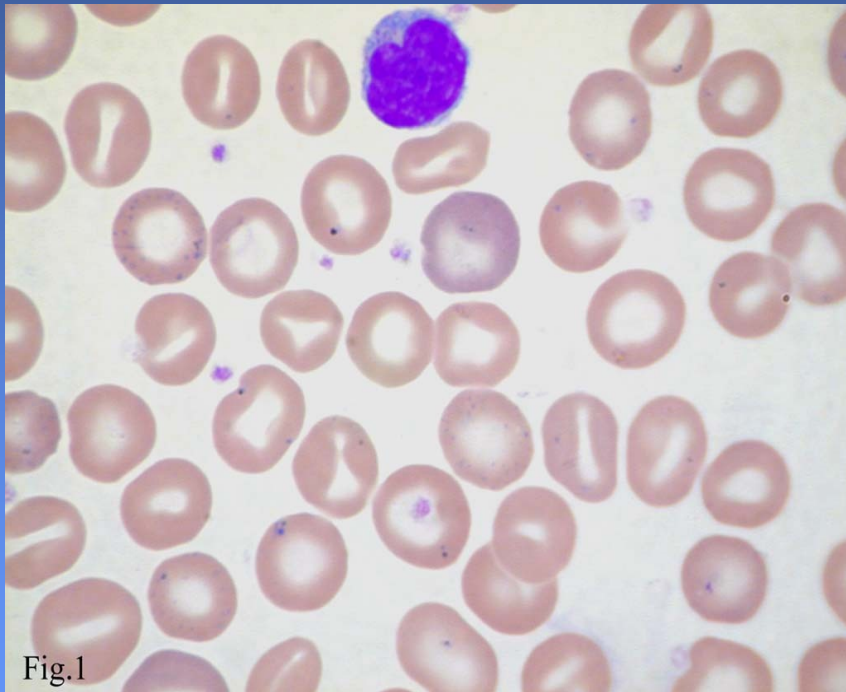
- Usually caused by haemodilution during 3rd trimester - increasing plasma volume
- Expectant mums also prone to iron and folate deficiency due to demands of growing foetus

Haemolytic anaemia

- Caused by red cell destruction either by mechanical damage or by autoimmune process (antibody coating, incompatible blood Tx)
- Spleen removes broken/ coated cells
- Causes marrow to increase cell production by as much as 8x

Haemolytic anaemia

- Blood film appearance

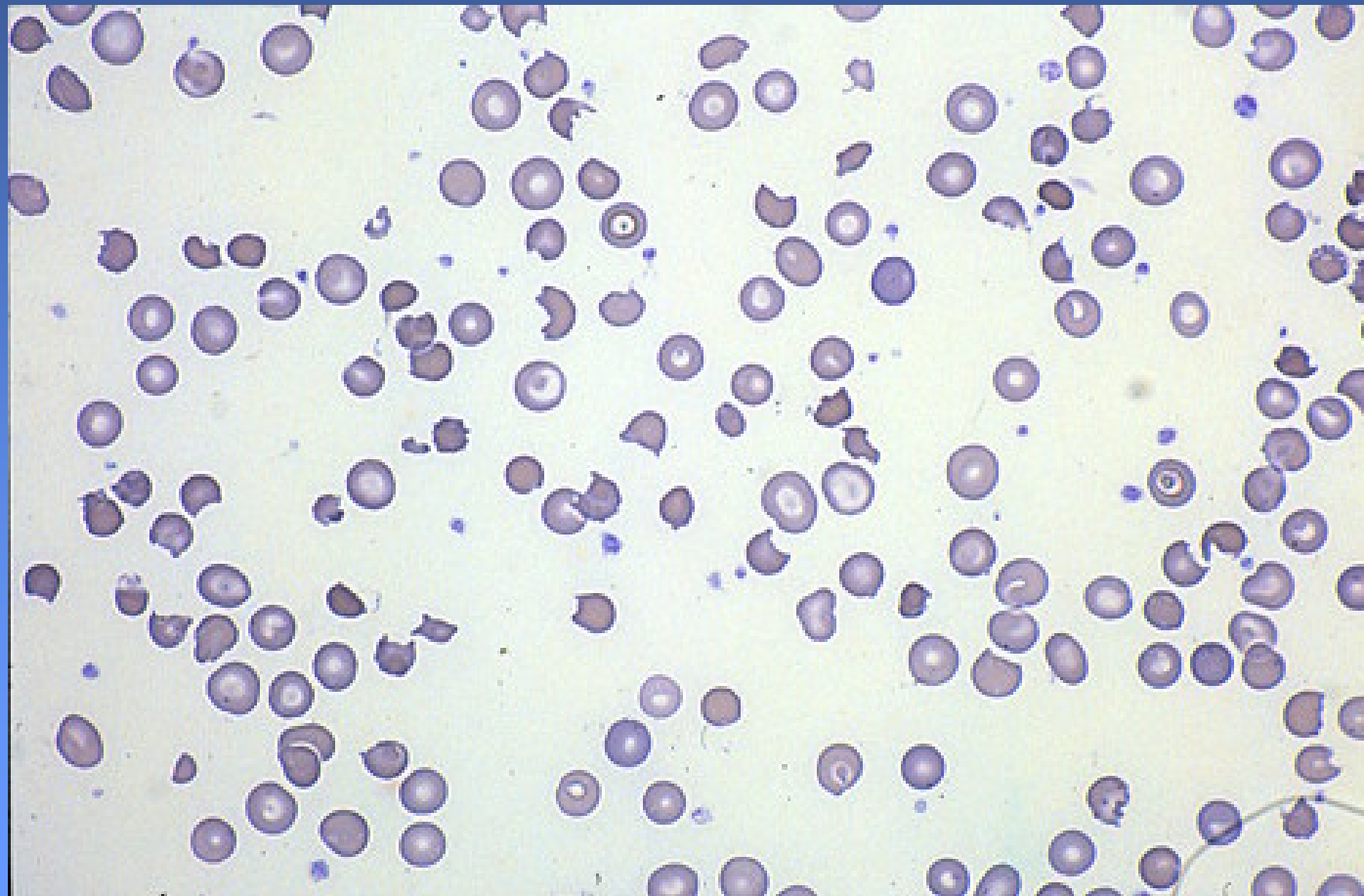


Haemolytic anaemia

- Causes of mechanical RBC destruction
 - old-type artificial heart valves
 - burns
 - microangiopathic disease
 - malaria
 - sickle cell disease
 - other Hbopathy

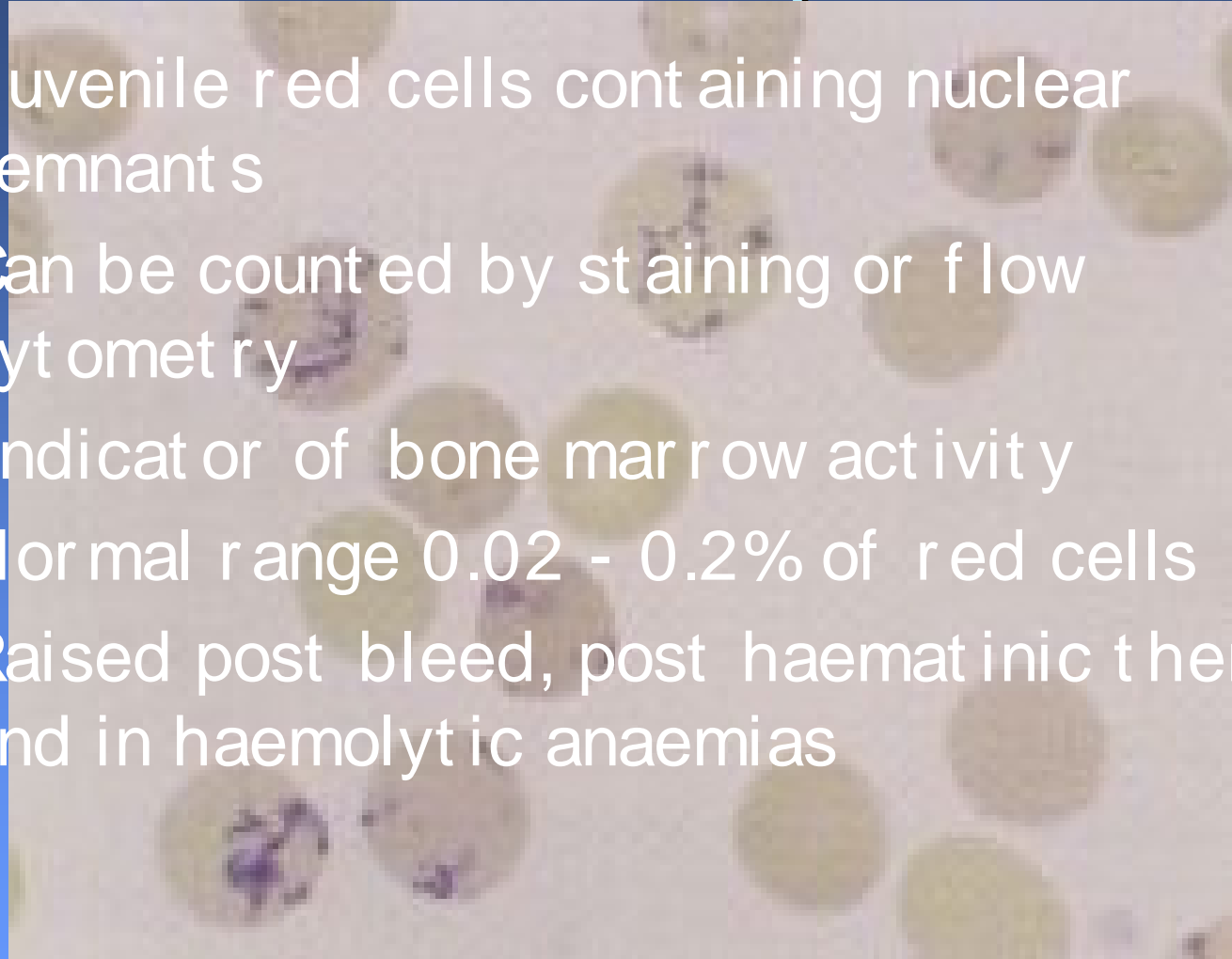
Haemolytic anaemia

- Blood film appearance - RBC damage



Reticulocytes

- Juvenile red cells containing nuclear remnants
- Can be counted by staining or flow cytometry
- Indicator of bone marrow activity
- Normal range 0.02 - 0.2% of red cells
- Raised post bleed, post haematinic therapy and in haemolytic anaemias



Sickle cell anaemia

- Caused by a single amino acid substitution - Hb S
- Irreversibly crystallises in reduced O₂ levels
- Deforms red cell, hence 'Sickle'
- Cells cannot pass oxygen or move through capillaries - pain, hypoxia, death
- Confers protection against malaria
- Treated with transfusion and O₂

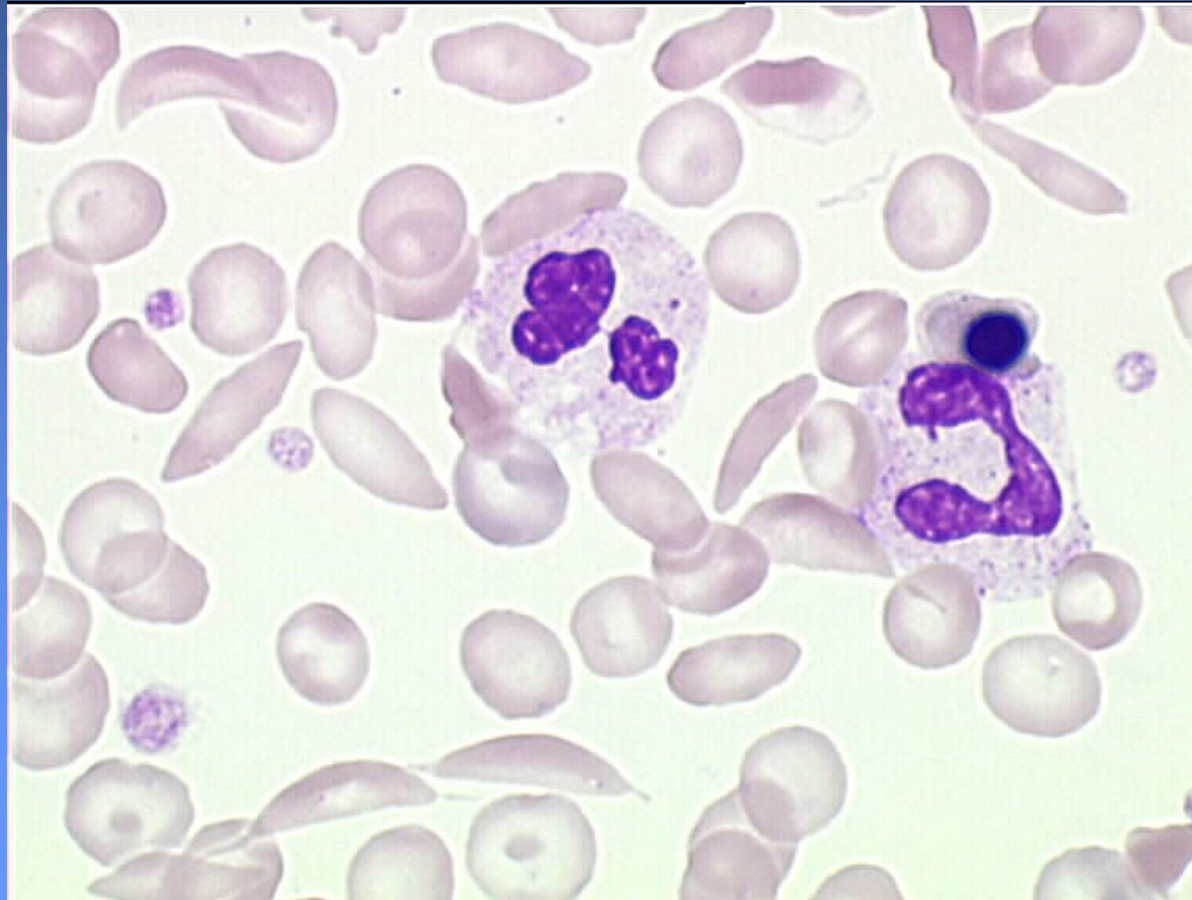
Sickle cell anaemia

- Sickled red cells - electron microscope



Sickle cell anaemia

- Sickled red cells - light microscope



Thalassaemia

From thalassa - sea

- Alpha - mainly Chinese, far eastern
- Beta - mainly Greek, Cypriot
- Homozygotes - alpha do not survive
 - Beta transfusion dependant
- Heterozygotes (trait)
 - Normal/lowish Hb
 - Low MCV
 - Raised RBC
 - Raised A2/F or Hb H in Alpha

Haematinics

- Vitamin B₁₂ and folate
- Essential for healthy blood cell production
- Decreased in deficiency/ malabsorption
- B12 increased in MDS, liver disease and when on therapy
- Folate also increased when being taken orally

Haematinics

- **Ferritin**
- Serum protein that mirrors level of iron in storage
- Useful indicator of early or latent iron deficiency
- Differentially diagnoses functional deficiencies
- Raised in liver disease, hereditary haemochromatosis, transfusion dependency, thalassaemias

Any Questions?