Blood management in surgery – understanding haemoglobin

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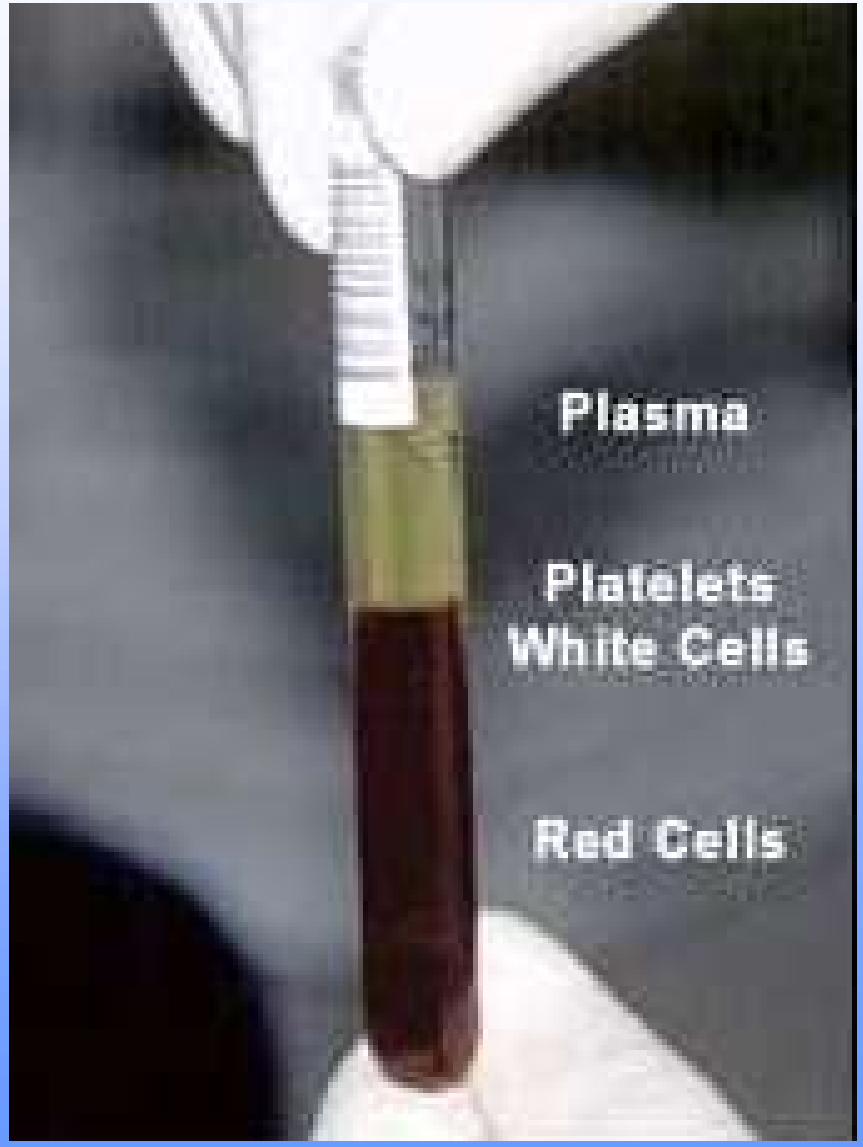
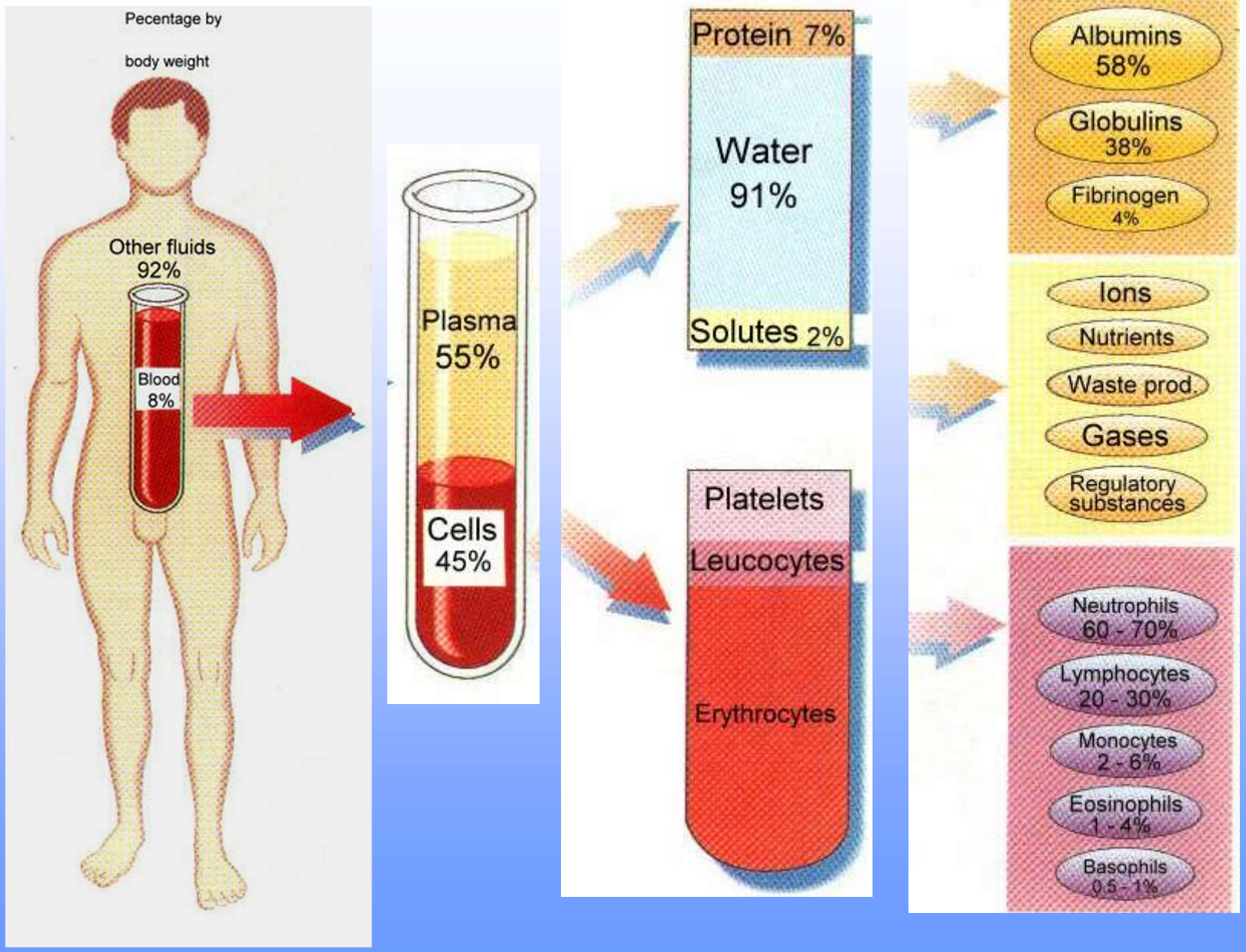
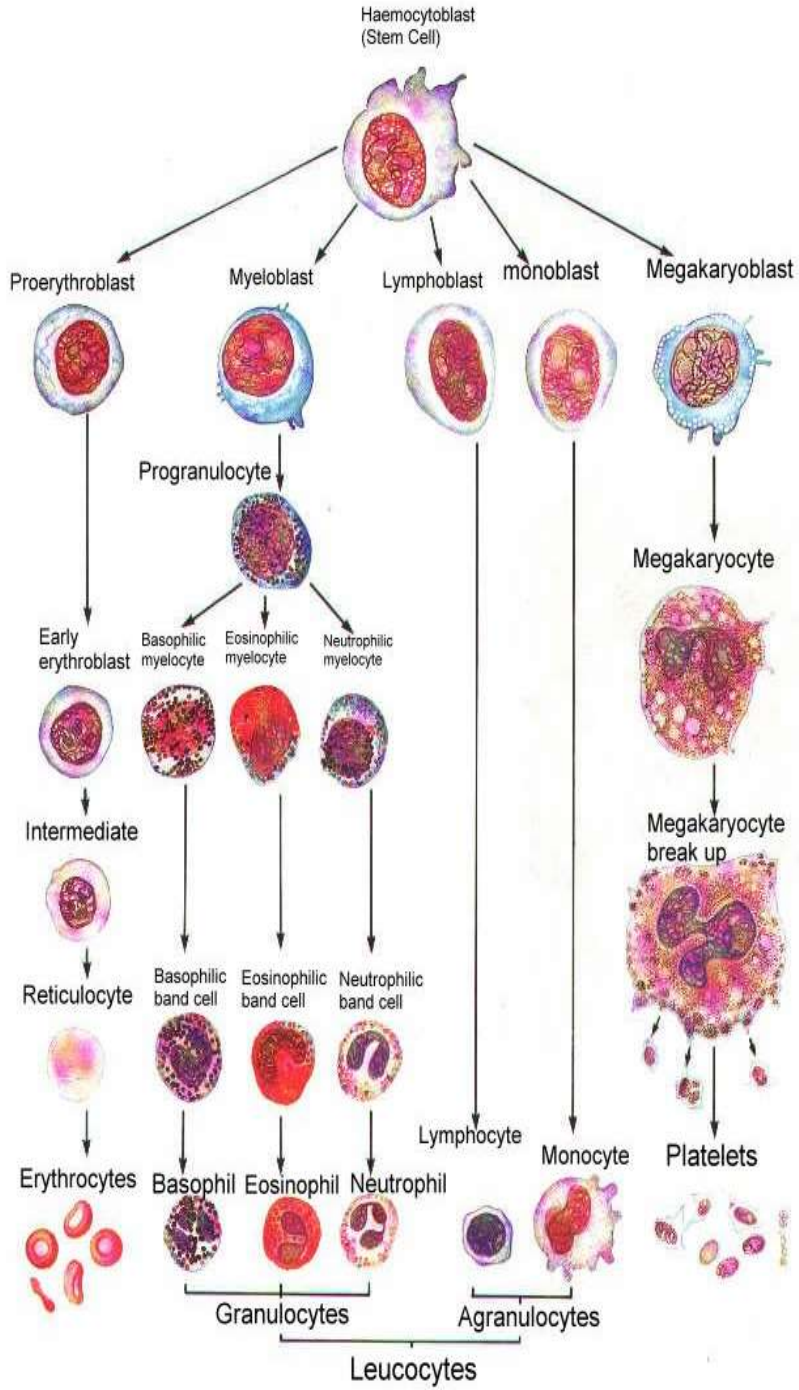
Interesting facts

- 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




Pecentage by
body weight
Other fluids
92%
Blood
8%
Plasma
55%
Cells
45%
Protein 7%
Water
91%
Solutes 2%
Platelets
Leucocytes
Erythrocytes
Albumins
58%
Globulins
38%
Fibrinogen
4%
Ions
Nutrients
Waste prod.
Gases
Regulatory
substances
Neutrophils
60 - 70%
Lymphocytes
20 - 30%
Monocytes
2 - 6%
Eosinophils
1 - 4%
Basophils
0.5 - 1%



Haematopoiesis

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

(haematopeitic stem cell)

Acute leukaemia is an abnormal proliferation of *blast* cells

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

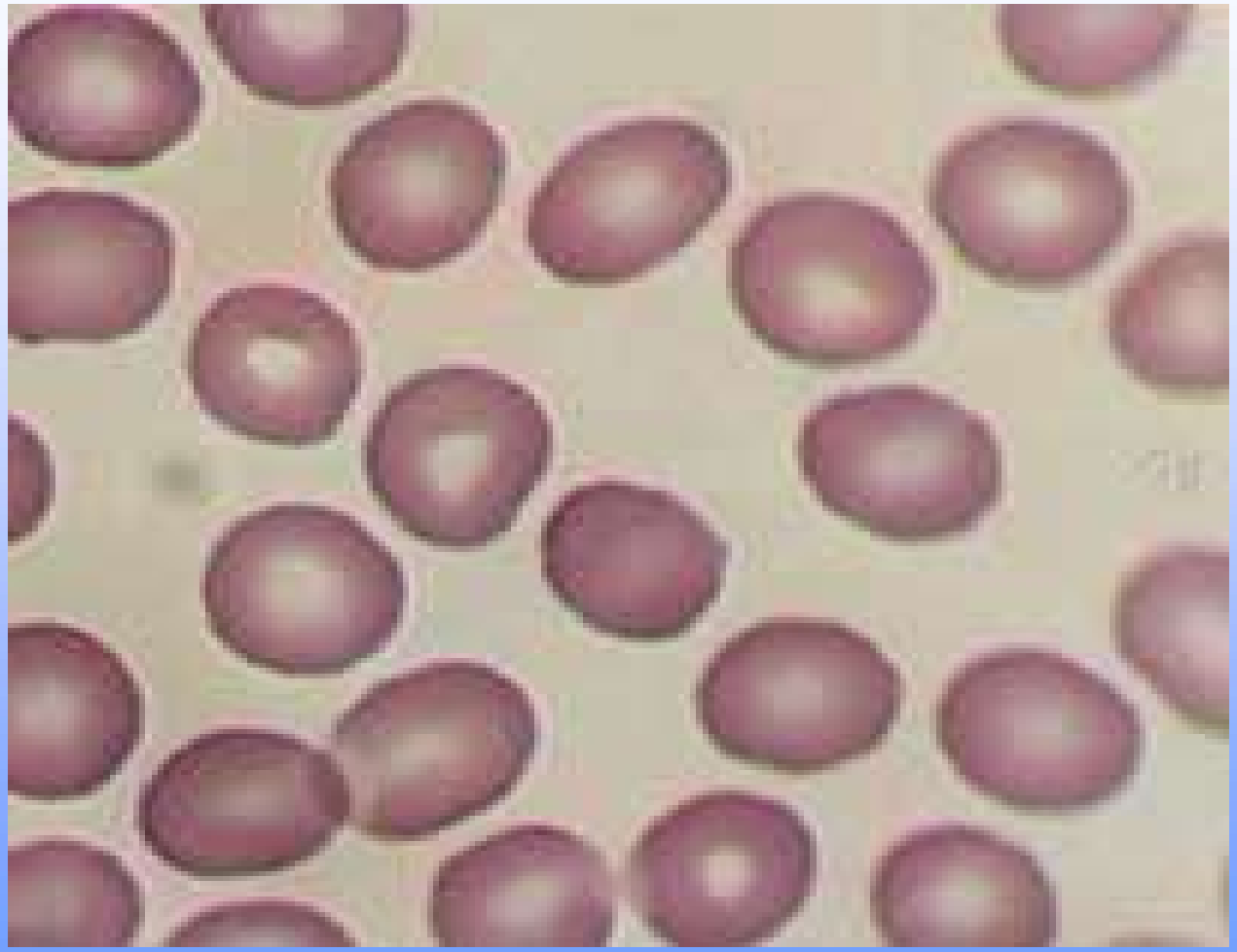
What is anaemia?

- An – lack of
- Aemia – in the blood
- We define anaemia as:

- A suboptimal Oxygen carrying capacity

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

- Normal red cells



The Full Blood Count

- Red blood cell parameters:
- MCV - mean (red) cell volume -fL
- 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

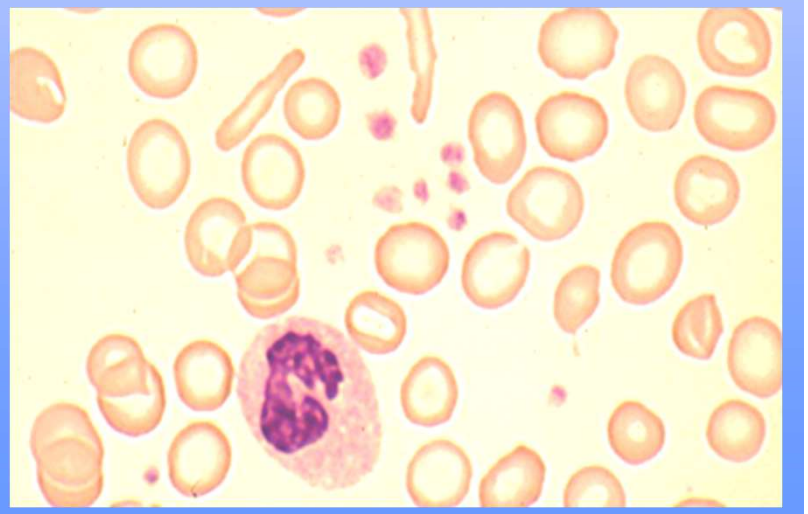
- A fine balance – gain and loss

Iron deficiency

- Caused by:
- Excess chronic blood loss, e.g. menstruation
- Dietary deficiency/malabsorption
- Functional deficiency - the iron is there but cannot be used due to interaction of immune system (cytokines, hepcidin). (ACD).
- Common in children due to muscle growth

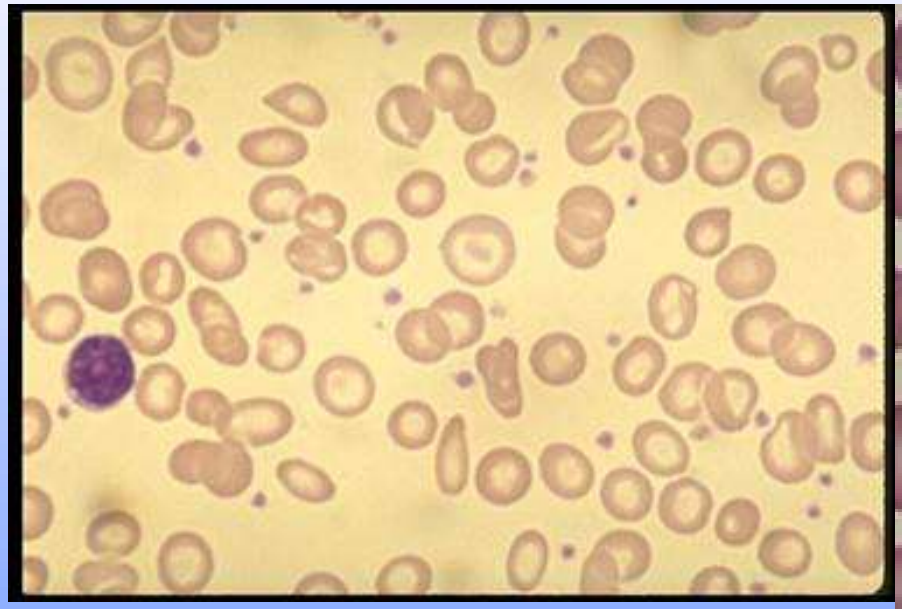
IRON DEFICIENCY

Treatment IRON oral or IV - not transfusion



Iron deficiency

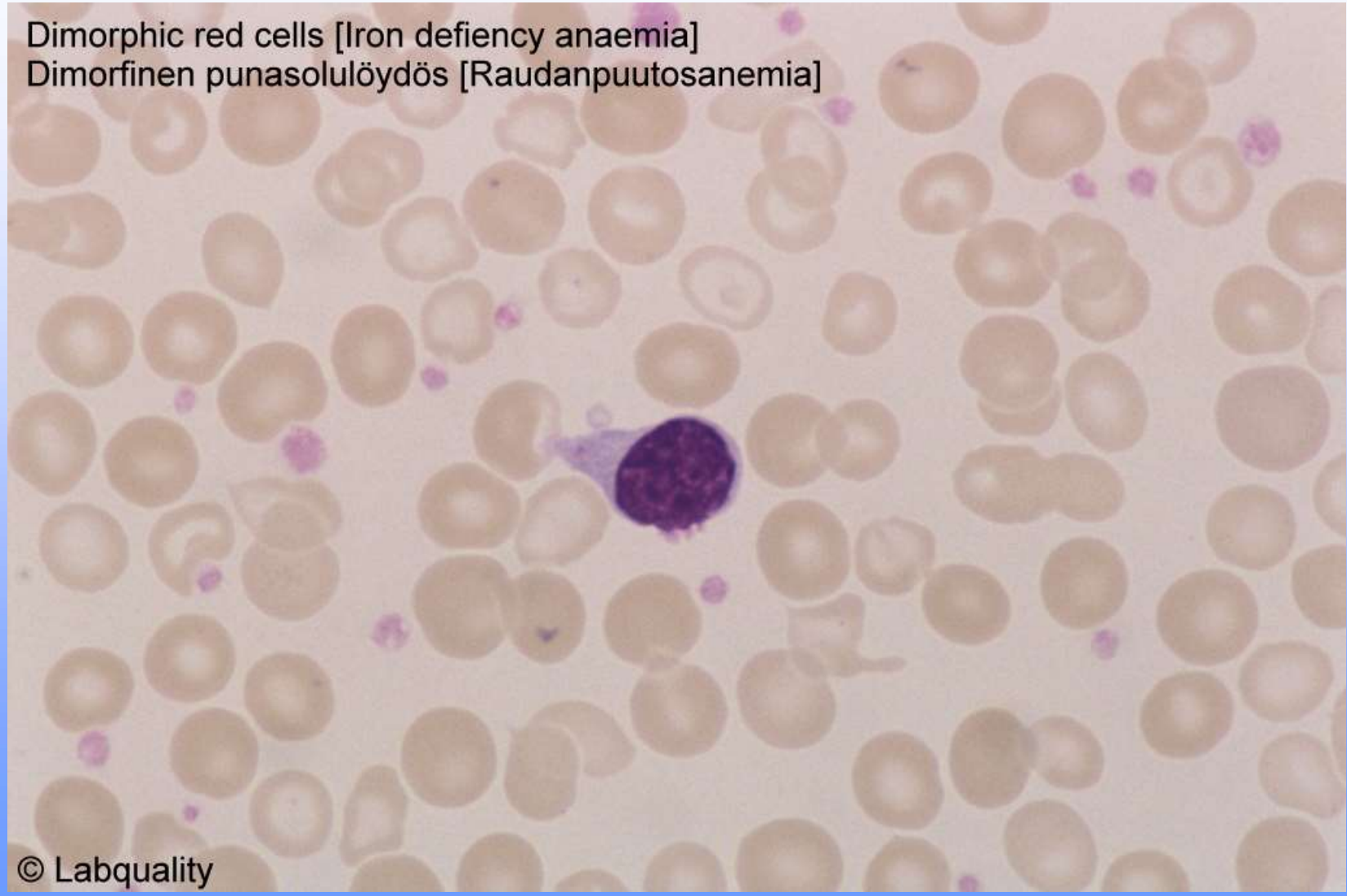
- Iron deficient red cells vs. normal



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



Vitamin B12/folic acid deficiency

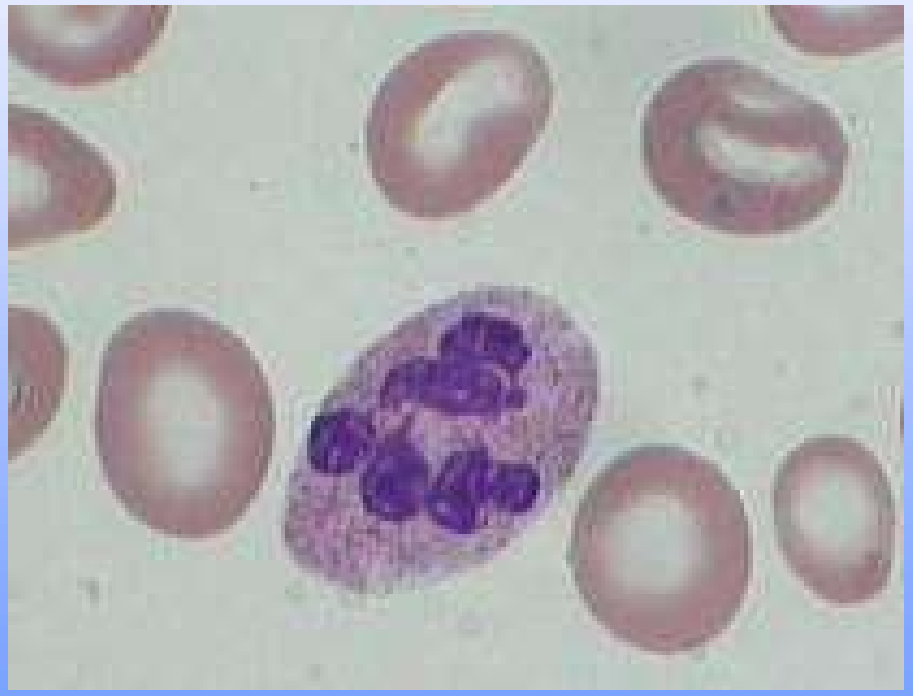
- More common in the elderly
- Severe form (Pernicious anaemia) results from lack of gastric intrinsic factor - either autoimmune (65%) or other stomach problem
- Also caused by diet (vegans) or malabsorption (Crohn's, coeliac)

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.

PERNICIOUS ANAEMIA -VITAMIN B12 DEFICIENCY

LOW HAEMOGLOBIN

RAISED MCV

LOW VITAMIN B12 - FAILURE TO ABSORB

OTHER AUTO- IMMUNE DISORDERS

Treatment Vitamin B12 - not transfusion

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

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

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


Fig.1

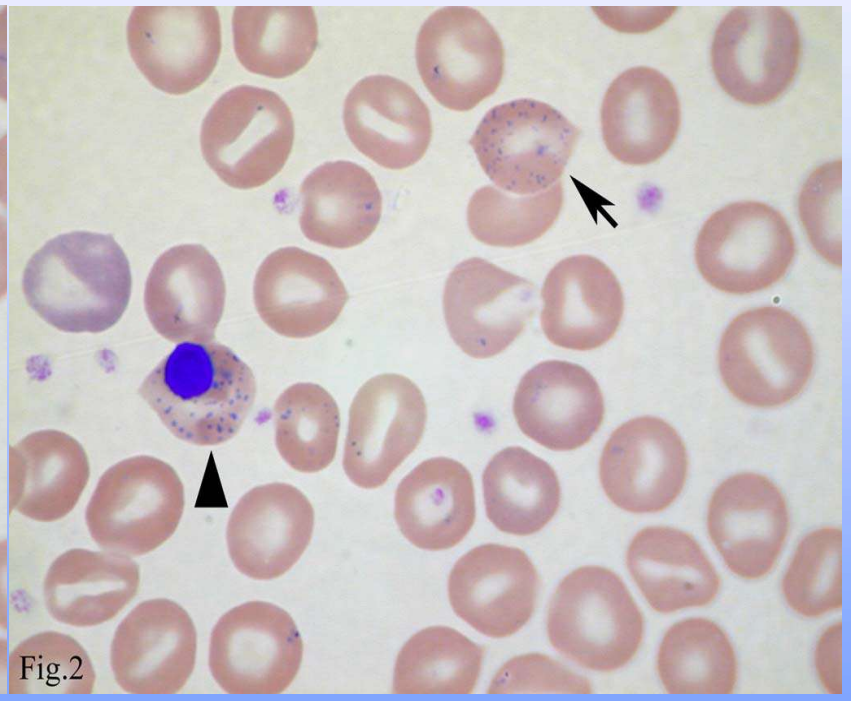


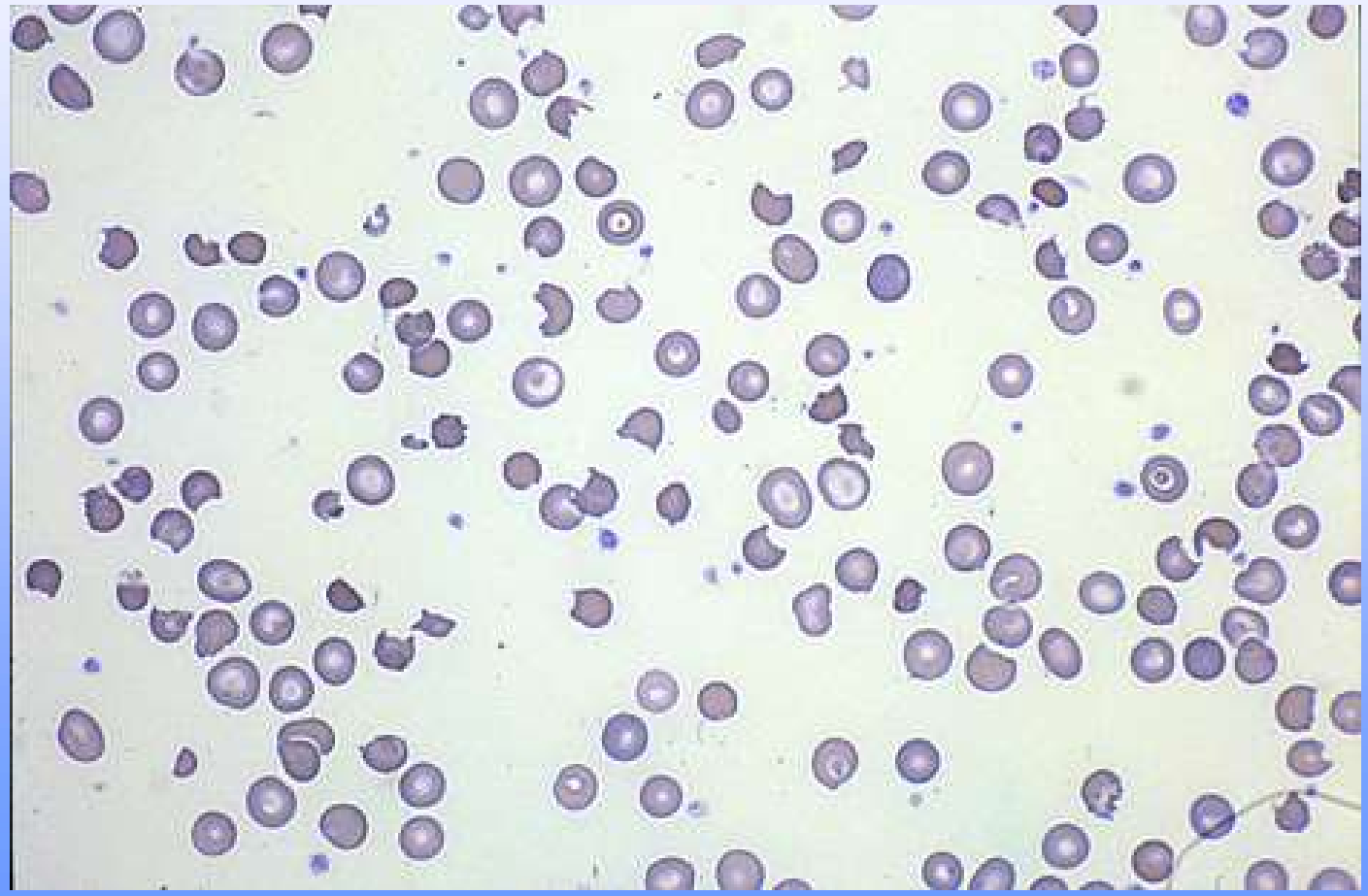
Fig.2

Haemolytic anaemia

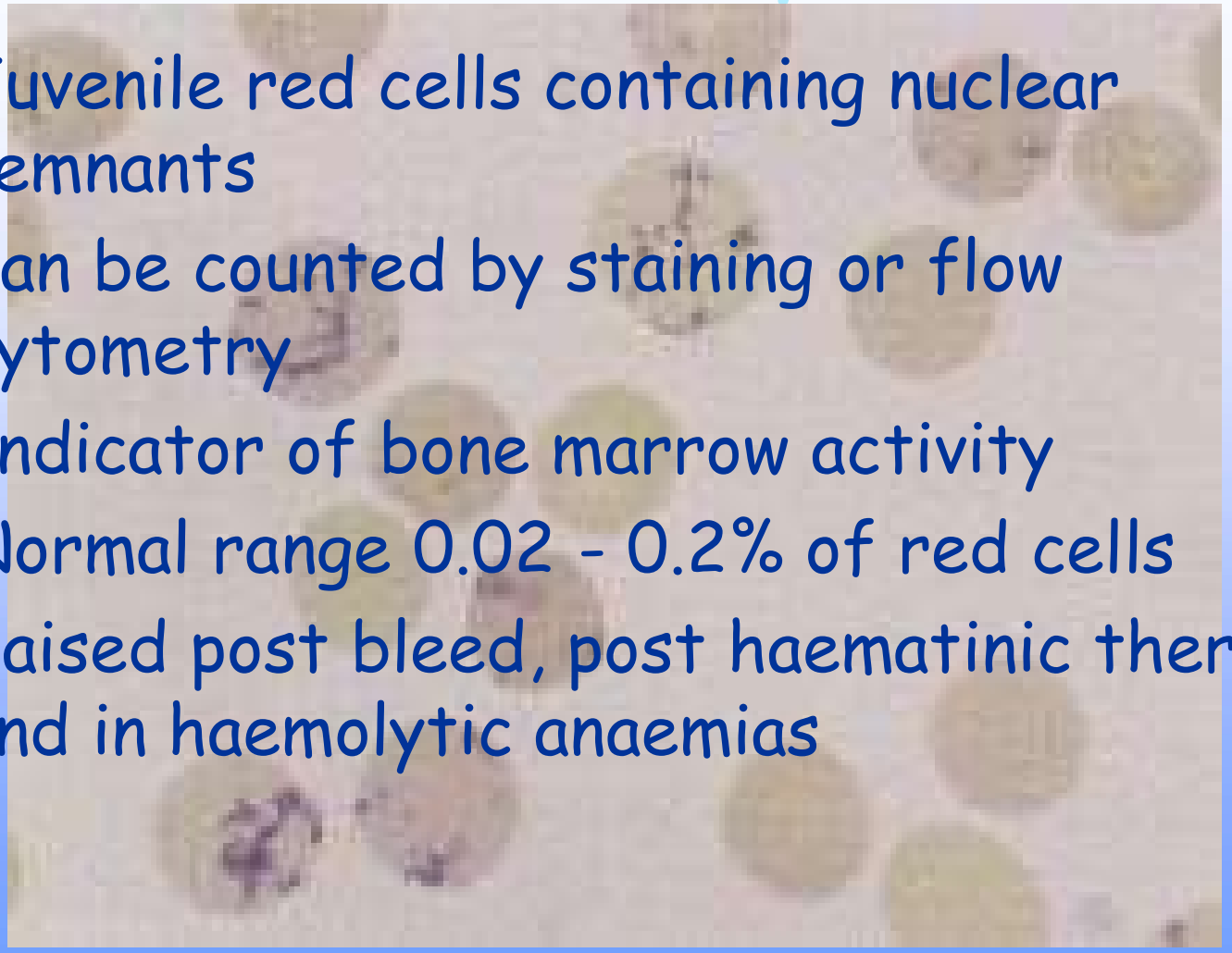
- Causes of mechanical RBC destruction
  - old-type artificial heart valves
  - burns
  - microangiopathic disease
  - malaria
  - sickle cell disease
  - other Hb opathy

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

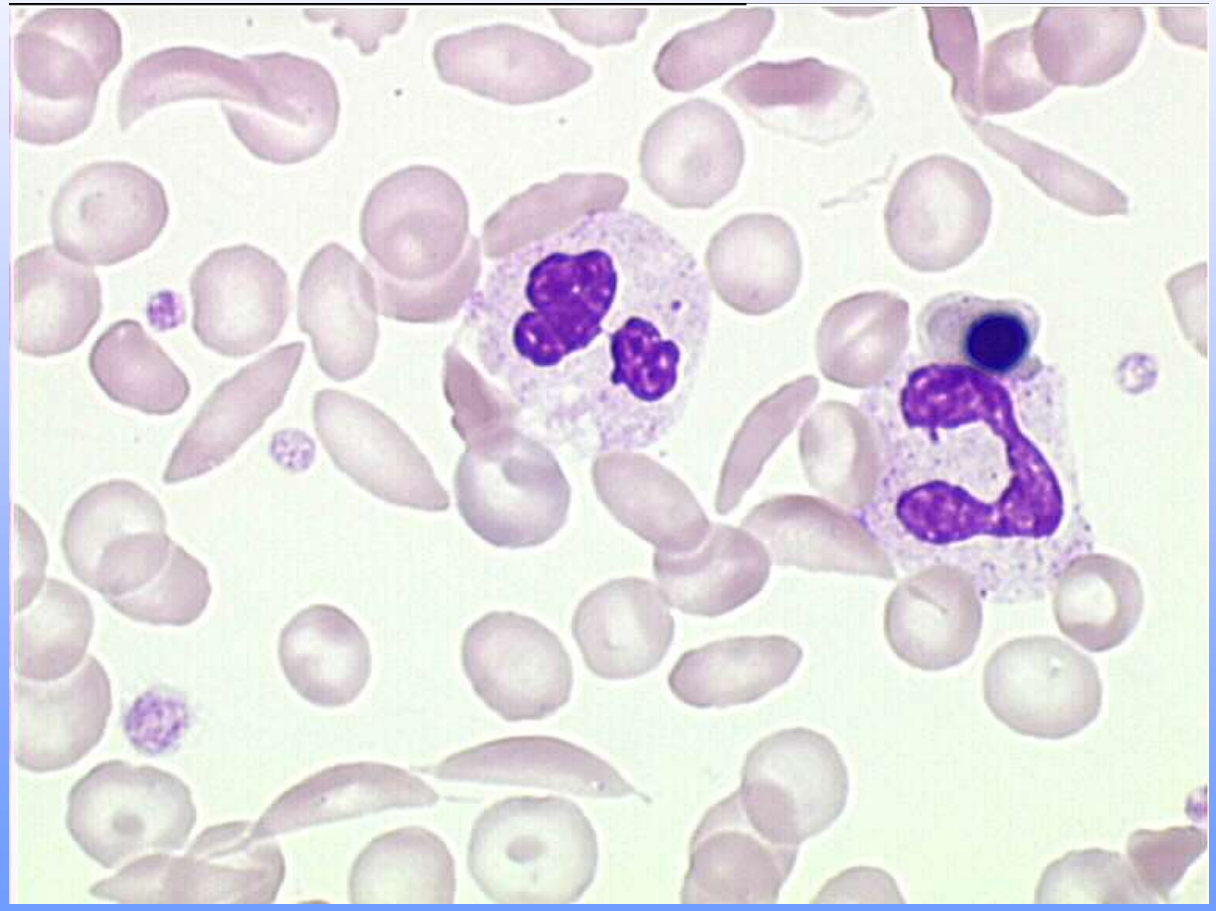
- Caused by a single amino acid substitution - Hb S
- Irreversibly crystallises in reduced O_2 levels
- Deforms red cell, hence 'Sickle'
- Cells cannot pass oxygen or move through capilliaries - pain, hypoxia, death
- Confers protection against malaria
- Treated with transfusion and O_2

Sickle cell anaemia

- Sickled red cells - electron microscope

Sickle cell anaemia

- Sickled red cells - light microscope



Thalassaemia

From thalassa – sea

Sometimes known as Mediterranean anaemia

- Alpha – mainly Chinese, far eastern
- Beta – mainly Greek, Cypriot
- According to Hb absent globin chains
- Homozygotes – alpha do not survive
  - Beta transfusion dependant
- Heterozygotes (trait)
  - Normal/lowish Hb
  - Low MCV
  - However NOT iron deficient so don't treat
  - Raised RBC
  - Elevated Hb A2 A2/F or Hb H in Alpha