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**Erythrocyte AKA Red Corpuscle AKA red blood cell (RBC):** *Gk erythros = red + kytos = hollow vessel, changed to -cyte = cell see Red Blood Cell for all alternative names*

**Erythrocytic Sedimentation Rate (ESR):** the rate at which the RBCs move to the bottom of a testube, is indicative of the viscosity of the B - & the number of additional PP present which indicates an upgrading of the ImR / lFR & so the presence of disease

**Erythropenic:** produces erythrocytes.

**Erythroleukemia:** an abnormal condition characterized by proliferation of erythroblastic & myeloblastic cells.

**Erythropania:** a decrease in the number of RBCs in the B.

**Erythropoiesis:** the production of erythrocytes (RBCs) *see MT for more details.*

**Erythropoietin (EPO) AKA Haematopoietin AKA Haemopoietin:** a H produced primarily by the kidneys, stimulates erythropoiesis (↑RBCs) *see MT for more details*



**Etiology AS Aetiology**

**Extracellular (EC):** occurring outside the cell

**Extravascular:** occurring outside the CVS

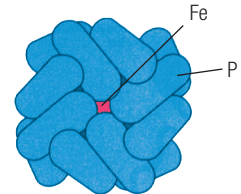
**Extrinsic pathway AKA Tissue Factor Pathway:** The main role of this pathway is to facilitate a rapid release of F2a - i.e. THROMBIN. It does this via F7a, the most concentrated CF in the B, & its reaction to F3a - TISSUE FACTOR which is present at the site of any BV damage.

F7a/F3a form a complex which activates F9 & F10, which then activates F2 - beginning a rapid cascade of activating CFs & forming a BClot at the site of injury *see MT for more details*



**Factor (F) AKA Clotting factor (CF):** a protein in the B that is needed to form a BClot *see MT for more details*

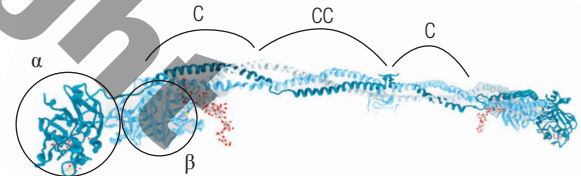
**Ferritin:** a large hollow protein which stores Fe & acts as an indicator of Fe stores in the body. It is composed of 24 identical protein subunits that form a hollow shell, enclosing the Fe to protect Ts from its toxic properties. It is released from the liver & recycled to the RBMA for erythropoiesis *see MT for more details*



**Fibril:** a microscopic filament often composed of fibrin.

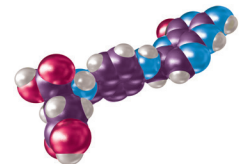
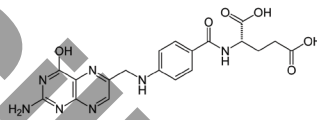
**Fibrin (F1a) see Fibrinogen**

**Fibrinogen (F1):** the inactive form of fibrin. It has α & β globular nodules connected via coiled proteins(C) which join on either side of a central connector(CC) & *see also Clot & MT for more details*



**Fibrinolysin AKA Plasmin**

**Folate AKA folic acid AKA Vita B9 AKA Vita Bc AKA Vita M:** an essential Vita closely associated with Vita B12 & necessary for the formation of RBCs. Absence or inability to process these substances (Folate & Vita B12) results in a hyperchromic, macrocytic anaemia, & may give rise to birth defects.



**Fragility Test (Osmotic):** a test devised to measure the resistance of the RBCs to break down (haemolyze) when subjected to varying concentrations of hypotonic salt solutions.

**Fulminating:** sudden & severe.



**Ghost cells AKA Lysed cells AKA Selenocytes:** CM of lysed RBCs in part or complete, where the contents have been removed or leaked away



**Gilbert's syndrome (GS):** a genetic liver disorder in 3-12% of the population. Elevated levels of BR-U are produced in the BS (hyperbilirubinaemia) due to ↓ of **glucuronyltransferase**, which conjugates BR (BR-C), (making it water soluble). SS mild jaundice, particularly when stressed. *see MT for more details*

**Giemsa stain (GEEM-suh):** is a stain used in cytogenetics & to stain: BSms, BMA smears & to demonstrate the histopathological Dx of malaria & other parasites. Similar but more stable than Wright's stain, it demonstrates different IC structures also human & bacterial cells *see MT for more details*

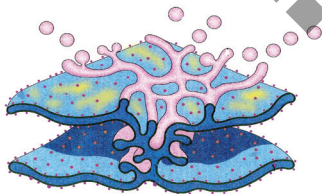
**Globular protein:** a protein which can disperse in H<sub>2</sub>O to form a colloid e.g. Hb *see also Haemoglobin*

**Glycohaemoglobin (A1cHb):** a form of Hb used to measure the average B[glucose] levels for the past 3 months – the average life of RBCs *see also A1c test*.

**Granulation:** the accumulation of proteins, lipids, carbohydrates, pigments, & secretory granules w/n the cytoplasm

**Granulocyte:** a type of WBC that contains specific cytoplasmic granules which are peroxidase positive. Granulocytes include neutrophils, eosinophils, & basophils

**Golgi Apparatus (GA):** a meshwork of membrane plates w/n the cytoplasm; used to facilitate protein transport.



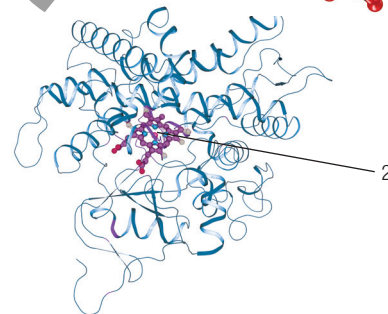
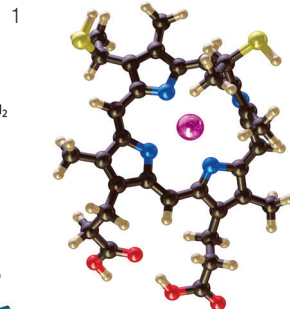
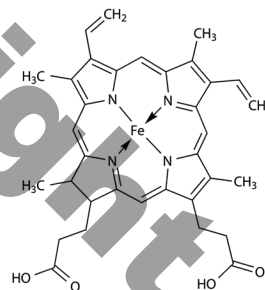
**Granulocytopenia AKA Granulopenia:** a ↓ in the number of granulocytes in the B.

**Granulocytosis:** the presence of ↑ numbers of granulocytes in the B.

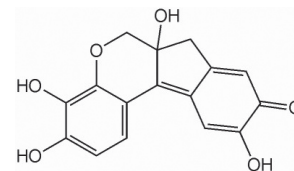
**Granulopoiesis:** the production of granulocytes.



**Haem AS Haeme AKA Heme (HEEM):** *Gk haima = blood* is a cofactor for many enzymes, made up of porphyrin ring with a central Fe<sup>2+</sup>, held in place by the 4 pyrrolic groups, joined by methine rings. Its main use is, as the O<sub>2</sub> carrier of the RBC but it is also used in a number of other reactions in the body, relying upon the ability of Fe<sup>2+</sup> to further oxidise to Fe<sup>3+</sup>. Haem(1) is at the centre of most metalloproteins, i.e. haemoproteins, the most common being Haemoglobin (Hb) of RBCs. It is also present in the following enzymes: catalase, cytochrome P450(2), endothelial NO synthetase, haem peroxidases, & myoglobin



**Haematein:** a dark purple water-insoluble crystalline substance used as an indicator & biological stain.



## Platelets AKA Thrombocyte (Plt)

### Structure

The platelet is a small discoid piece (1-4 $\mu$  diameter) of a megakaryocyte. It is not a true cell. When activated it is called a thrombocyte but these terms are used interchangeably. It lives for 7-10 days. A megakaryocyte forms 2-5000/cell.

It plays a major role in the formation of a clot in both pathways but mainly the extrinsic pathway. There are 3 zones in the platelet -

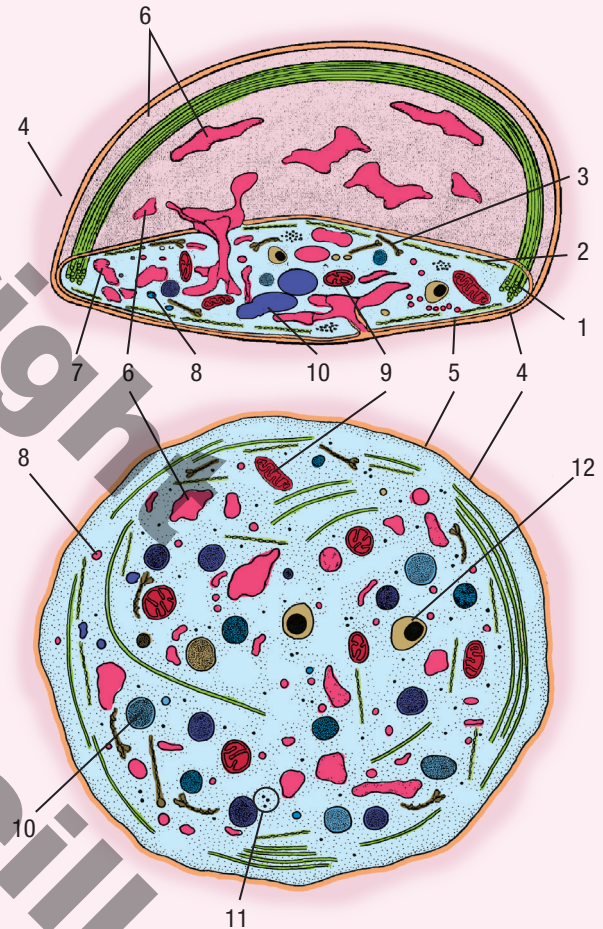
**the structural zone** = containing 3 types of fibrils (1,2 & 3)

**the peripheral zone** or hyalomere = relatively clear of organelles (6-7) with light blue cytoplasm and the centrally located

**the organelle zone** or chromomere = a granular central region with specific granules related to activating the Plt.

The CM has a glycocalyx coating, increasing its stickiness, & the extensive canaliculi & tubules - allow for rapid transport of lc substances to the surface - a well developed fibrillar system allows for extensive morphological changes, upon activation.

- 1 microtubules
- 2 actin
- 3 myosin (II)
- 4 glycocalyx - coating outside the CM
- 5 CM
- 6 open canalicular system - indenting of the CM to invaginate shallowly into the cytoplasm - few other organelles
- 7 dense tubular system - deeper CM invagination - to the chromomere zone
- 8  $\delta$  granules
- 9 mitochondria
- 10  $\alpha$  granules
- 11 glycogen granules
- 12  $\lambda$  granules (lysosomes)



## Blood Specimens, Blood Smears (BSms)

### Preparation

BSms obtained from any free-flowing B are similar, but capillary specimens from cyanotic, calloused or areas of local stasis, will have higher WBC counts. Hence venous samples are preferred.

A small drop of B no larger than 3-4mm in diameter is placed near one end of a clean glass slide.

Using a second slide at about 30° move it up to the B drop & spread the drop to the edges of both slides before slowly smoothly & lightly pushing the spreader slide towards the opposite end, leaving a thin B film - the Blood Smear (BSm), with a feathered end. The BSm should be labelled (with a pencil to stop the label being lost during the staining process) & **completely air-dried** before fixing & staining.

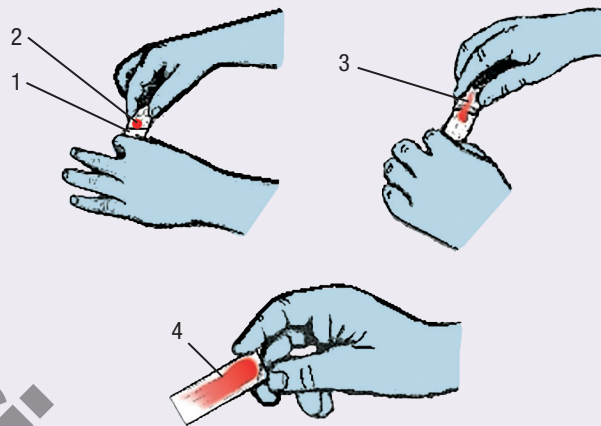
Note fixing should occur w/n 1 hour of collection as the WBCs will start to deteriorate after this time. B from a patient on anticoagulant Tx may have varied WBCs morphology, although B samples anticoagulated with EDTA do not show any differences.

### Stains - Giemsa, Wright's stains

**Giemsa & Wright's stains** are differential polychromic stains; simple histologic dye mixtures which facilitate the differentiation of BC types. Classically they are mixtures of eosin (red) - an acidic dye which stains the background & cytoplasm various red shades & methylene blue (blue) - basic dyes, which stain the nucleic & other acids blue.

They are used to stain BSms & BMA aspirates. WBCs are mostly identified by their preference for these dyes, & named after this preference e.g. granules in WBCs with an equal preference for acid & basic dyes are called neutrophils; eosinophils are WBCs with intensely red (basic) granules in their cells, & basophils are the opposite.

**Wrights stain**, appears similar to the T stains H&E. It is less stable & deteriorates in an alkaline solution. **Giemsa**, has an added dye **Azure B** to compensate for this defect, which also accentuates the azurophilic staining (blue) properties, present in lymphocytes. It is also used to identify B parasites, particularly malarial parasites.



- 1 base slide
- 2 Blood drop
- 3 spreader slide
- 4 BSm

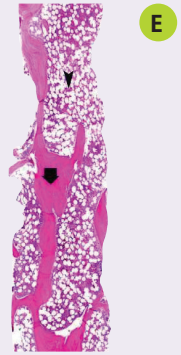
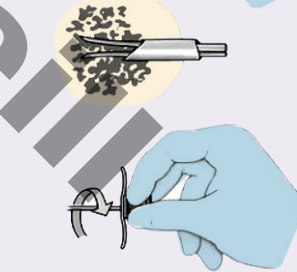
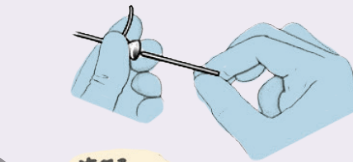
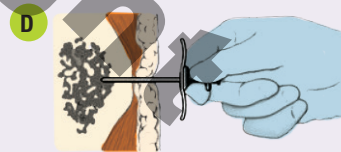
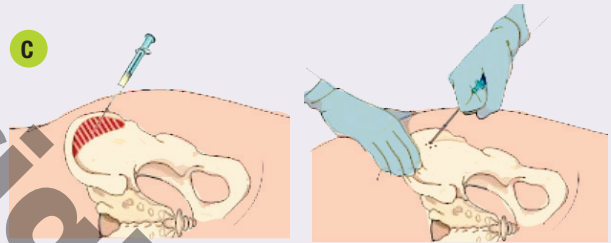
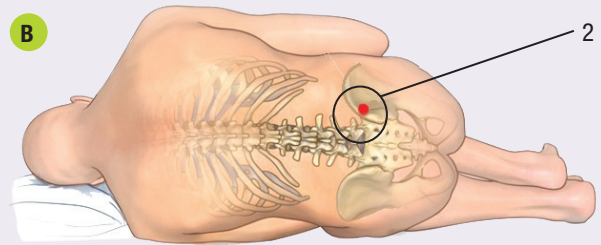
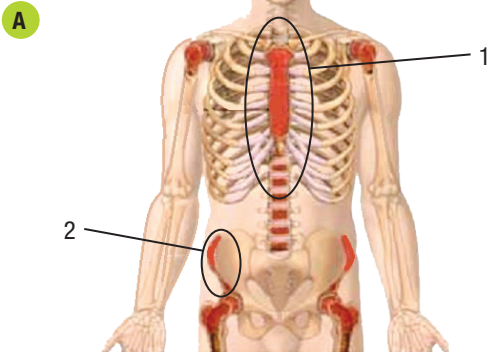
Type of BC or component	Balanced / Good stain	too Acidic	too Acidic
RBCs	pink - orange	bright red	blue - green
nuclei	purple - blue	pale blue	deep dark blue
eosinophilic granules	granules red	brilliant red	deep grey - blue
neutrophilic granules	violet - pink	pale pink	dark blue
lymphocyte cytoplasm	blue	pale blue	dark blue

## Bone Marrow (Bma) Specimen Site & Procedure

- A sites of RBMa in adult
- B position to take iliac sample
- C procedure to obtain aspirate sample
- D procedure & equipment for Bone Bx
- E Bone Bx sample

BMa is commonly taken from either the Sternum(1) or Ilium(2) of the hip. In adults the main RBMa is in the axial skeleton. The patient is placed on their side, & the needle for an aspiration approaches inferiorly to the iliac ridge. The needle pierces the outer cortical bone & then sucks up a BMa sample, containing the cells of the BMa but not necessarily the stromal support & endosteal niches. With a Bx the needle(4) is wider & cutting blades(6) are inserted to form a core which is then retrieved after removal of the cutting blades. This sample maintains the structure of the BMa.


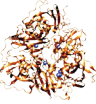
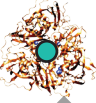



- 1 Sternum - site of RBMa - samples taken from here tended to scar
- 2 Iliac crest - preferred site for RBMa sampling
- 3 Sylet
- 4 Bx needle
- 5 Obturator
- 6 Cutting blade

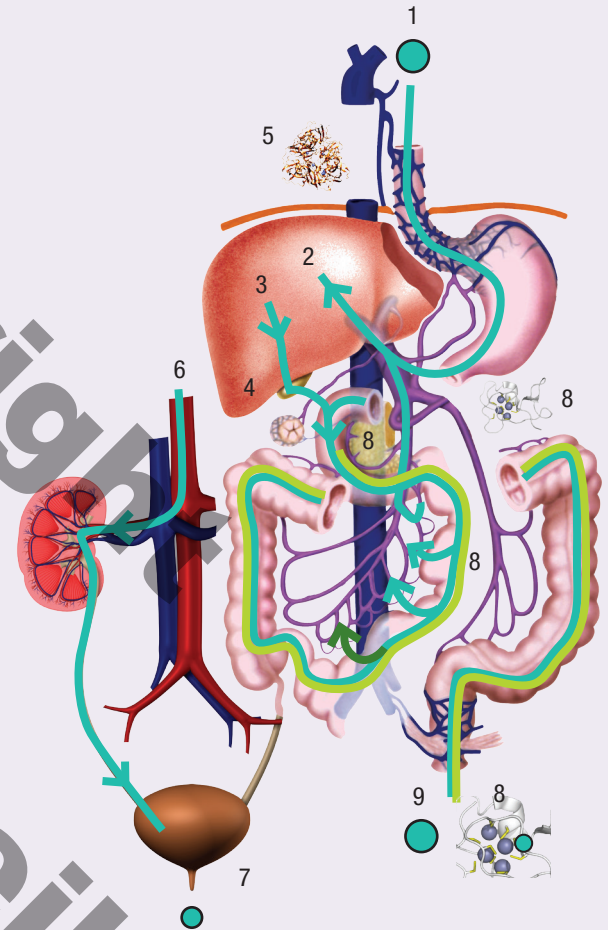


## Copper - Cu

### Metabolism

Cu & Fe metabolism are interdependent, but unlike Fe there is an adequate way of eliminating excess Cu from the body. Like Fe it is toxic to the body & only small amounts are tolerated in the BS as a free ion. Most of ingested Cu passes through the body, 95% of the rest is combined with Ceruloplasmin with small amounts found in macroglobulins. Cu deficiency leads to Fe deficient anaemia.

- 1 average intake of Cu is approx 2mg / day 
- 2 25% is transported to the liver
- 3 in the liver it is combined with Ceruloplasmin 
- 4 excess Cu is excreted with bile from the GB
- 5 95% of Cu in the B is bound to ceruloplasmin 
- 6 < 5% of Cu circulates as free Cu in the serum
- 7 < 5% of Cu is excreted via the urine 
- 8 50% combines with metallothioneins in the duodenum, which is excreted in the faeces 
- 9 25% is excreted in the faeces directly 

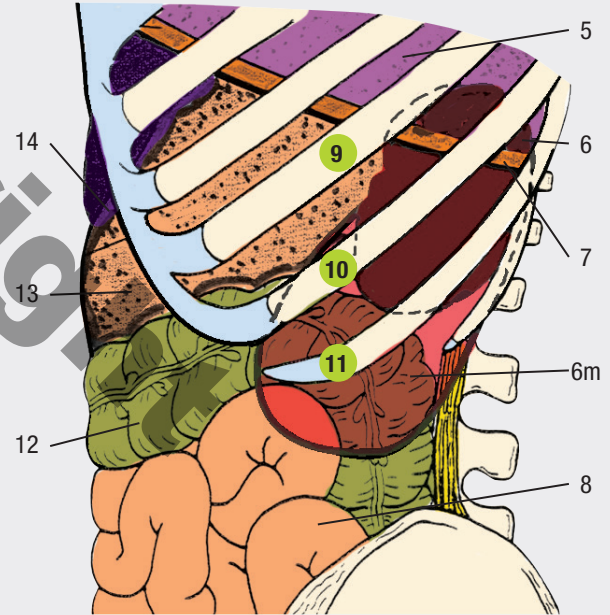
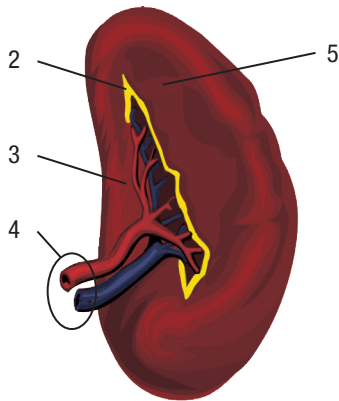


# Spleen

## Surface Anatomy & Splenomegaly

The spleen is like a large bag of B, in a thin capsule normally protected by the rib cage. In parasitic ins (e.g. malaria) it may swell up to 5X and then becomes vulnerable when there is an abdominal trauma to ly which may result in death, from internal Hg.

- 1 spleen - gastric surface
- 2 spleen - renal surface
- 3 gastrosplenic lig
- 4 splenic a&v
- 5 L lung
- 6 spleen / m = splenomegaly - ie enlarged outlines
- 7 diaphragm
- 8 small intestine
- 9 rib 9
- 10 rib 10
- 11 rib 11
- 12 large intestine
- 13 stomach
- 14 liver





## Vitamin K (Vita K)

### Role in protein synthesis

#### A Table T½ of CFs dependant on Vita K

#### B Reaction pathway of Vita K

Vita K is a CoF of **γ-carboxylase**. Glutamate carboxylation is necessary for the synthesis of serine proteases. Serine proteases are efficient chelators of Ca<sup>2+</sup> & also bind to membrane bound PLs, forming enzyme complexes & so activating Plts, & vascular endothelium.

There are 4 CFs which are serine proteases, all released into the BS as zymogens, from the liver -. F2,7,9 & 10. The coagulants; Protein C, S & Z, are also Vita K dependant, but Vita K deficiencies result in inadequate clot formation, causing bleeding, particularly in the NB, haemorrhagic bleeding of the NB AKA Vita K deficiency bleeding (VKDB).

Vita K also antagonises the effects of Warfarin - an anticoagulant. Warfarin prevents Vita K renewal, affecting the CF production.

Serine proteases are found in the bone, cartilage, Ky & lungs. Working with Vita D it is thought Vita K also plays a role in the mineralization of bone.

- 1 w/n the hepatocyte
- 2 a signal protein
- 3 stimulates the mRNA
- 4 & RER
- 5 to synthesize the serine protease proprotein
- 6 which moves in the ER to **γ-carboxylase**.
- 7 Vita K-H2 acting as a CoF + CO<sub>2</sub> carboxylates the glutamine residues which forms ..
- 8 Gla-serine protease proprotein + epoxide Vita K
- 9 Golgi apparatus (GA)-
- 10 in the GA further glycosylation & folding occurs +
- 11 removal of the propeptide
- 12 completed serine protease zymogen is released into the BV

#### A Elimination T½ of Vita K dependent CFs

<b>F2</b>	<b>60 hours</b>
<b>F7</b>	<b>4-6 hours</b>
<b>F9</b>	<b>24 hours</b>
<b>F10</b>	<b>48-72 hours</b>
<b>Protein C</b>	<b>8 hours</b>
<b>Protein S</b>	<b>30 hours</b>
<b>Protein Z</b>	<b>2-3 hours</b>

