Interpreting Blood Tests Part 1

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SIMPLY FINALS

Outline

- Part 1 (This Week)
- Introduction
- Which Tube!?!
- FBCs
- U+Es

Part 2 (Next Week):

- More Electrolytes
- LFTs
- Clotting
- Extras

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Introduction

- Bloods are a core area of data interpretation in exams and real life.
- It's important to monitor trends, although you do often have to work with isolated values.
- You should be given normal values in the exam;
  - but it helps to have a feel for what is right and wrong
  - ranges/units will vary between labs.
  - The significance of results will vary depending on the context
- **As always, be systematic – don't try to process all the data at once!**

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Which Tube?

Complex Version:

Reversible anticoagulant →

Clot activator (Serum Separating Tube) →

Anti-coagulant →

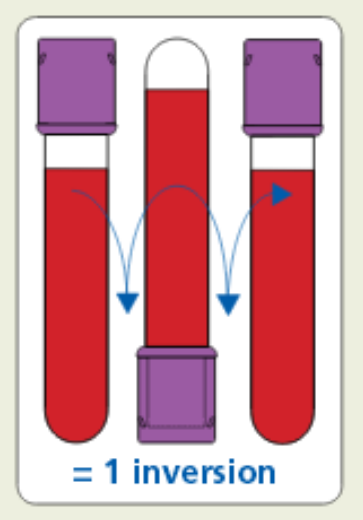
Enzyme inhibitor *so glucose isn't metabolised* →

Colour Code	Tube Type	Determinations
	Blood Culture	Aerobic followed by anaerobic - if insufficient blood for both culture bottles, use aerobic bottle only
 Light Blue	Sodium Citrate	Coagulation Tests, Heparin & Warfarin Control, Anti-Xa, Thrombophilia Screen, Lupus Screens, Confirmation Platelet Clumps
 Gold	SST™ II	Routine Chemistry, Endocrinology, Serology (viral, bacterial, parasite & fungal), Drug Levels (Vancomycin, Gentamicin, Amikacin & Tobramycin) Immunology, B12, Ferritin, Serum Folate, EPO, Androstenedione, Insulin, C-Peptide, DHEAS
 Red	Serum	Serum Porphyrins, HIT, Screens, CDT, Fluoride, Thyroglobulin, Calcitonin
 Green	Heparin & PST™ II	Genetics, Homocysteine, Ammonia, Renin, Aldosterone, Gut Hormones / Chromogranins
 Lavender	EDTA	FBC, Adult ESR, Sickle, Malaria, Retics, HBA1C, G6PD, DCT, Cyclosporin, GF, Bloodfilm, Red-Cell Folate, Lymphocyte Subsets, HLA, B27, PNH Screen, Red Cell Protoporphyrins, Red Cell PBG-Deaminase, PTHI, ACTH, AAT; AAT CF and HFE Genotyping, Viral DNR / RNA (qualitative, quantative & sequencing), Red Cell Analysis, Gilbert's Testing
 Pink	Cross Match	Blood Group, Cross Match **(K2E sample tube type ONLY)**, DCT
 Grey	Fluoride Oxalate	Blood Glucose, Lactate (Blood & CSF)
 Royal Blue	Trace Element	Trace Element, Toxicology

Which Tube? Simple Version:

Order of Draw (to stop contamination)

- Blood Cultures
- **Blue** – Clotting
- **Orange** – U+Es and most biochemistry
- **Purple** – FBC
- **Pink** – Cross Match/Group and Save
- **Grey** – Glucose



NB: exact colours may vary depending on the hospital's supplier

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Case 1

- A 24 year old patient comes to your GP practice reporting that they have been feeling very tired recently.

Hb	125
RBC	4.3
Hct	0.38
MCV	88
MCH	29
MCHC	328
RDW	12
Plt	267

SIMPLY FINALS

Case 1

- A 24 year old patient comes to your GP practice reporting that they have been feeling very tired recently.

		Normal Range (F)
Hb	125	115-165 g/L
RBC	4.3	3.8-5.8 x 10^9/L
Hct	0.38	0.37-0.47
MCV	88	76-96
MCH	29	27-32 pg
MCHC	328	301-350 g/L
RDW	12	10-14
Plt	267	150 – 400 x 10^9/L

They are a final year medical student studying for finals *(and it's 18:42 on a Wednesday!)*

SIMPLY FINALS

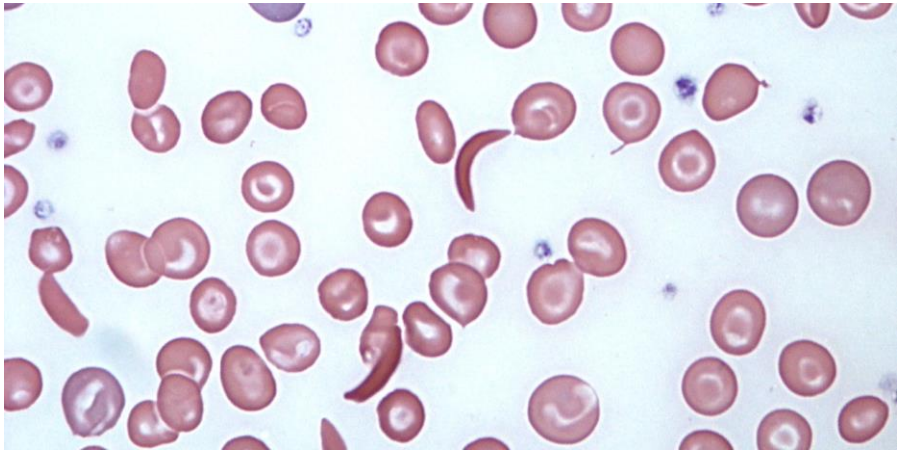
Case 2

- An 18 year old man attends AnE feeling generally unwell with some pain in the upper abdomen.
- O/E splenomegaly

Hb	110
RBC	4.2
Hct	0.3
MCV	71
MCH	26
MCHC	366
RDW	18
Plt	128

Case 2

- An 18 year old man attends AnE feeling generally unwell with some pain in the upper abdomen.
- O/E splenomegaly



		Normal Range (M)
Hb	110	130-180 g/L
RBC	4.2	4.5-6.5 x 10^9/L
Hct	0.3	0.40.54
MCV	71	76-96
MCH	26	27-36 pg
MCHC	366	301-350 g/L
RDW	18	10-14
Plt	128	150 – 400 x 10^9/L

High MCHC – classically:

- Sickle Cell
- Hereditary spherocytosis
- Severe dehydration

SIMPLY FINALS

Case 2b

- An 18 year old man attends AnE feeling generally unwell with some pain in the upper abdomen.
- O/E splenomegaly

		Normal Range (M)
Hb	82	130-180 g/L
RBC	4.38	4.5-6.5 x 10^9/L
Hct	0.24	0.40.54
MCV	55	76-96
MCH	19	27-36 pg
MCHC	302	301-350 g/L
RDW	12	10-14
Plt	128	150 – 400 x 10^9/L

Hypersplenism

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The Full Blood Count Summary – 1 of 2

Hb	**Haemoglobin**	• Low levels indicate an anaemia • High levels generally indicate dehydration or true polycythaemia *Always look at in the context of the below parameters*	
RBC	**Red Blood Cell Count**	*The number of RBCs in the blood*	• High in polycythaemias and dehydration • Low in anaemia or blood dilution
Hct/ PCV	**Haematocrit/ Packed Cell Volume**	*The fraction / % of blood that is RBCs*	
MCV	**Mean Cell/Corpuscular Volume**	*The average volume of red cells (= Hct/RBC)* • High in macrocytic anaemias (e.g. B12/folate def., alcoholism) • Low in microcytic anaemias (e.g. Fe def., thalassaemia, SS)	
MCH	**Mean Cell Haemoglobin**	*The average mass of Hb in RBC (=Hb/RBC)* *A marker of the chromacity (colour) of the cell.* • High in macrocytosis • Low in microcytosis	
MCHC	**Mean Cell Haemoglobin Concentration**	*The amount of Hb in a certain volume of red cells (= Hb/Hct)* *A (more accurate) marker of the chromacity (colour) of the cell.* • High in spherocytosis and sickle cell anaemia • Normal in macrocytic anaemias • Low in other microcytic anaemias	
RDW	**Red Cell Distribution Width**	*A measure of the range of size of red cells.* • High when there are mixed populations of cell size e.g. Mixed anaemias. • A normal RDW with anaemia suggests thalassaemia	

Case 3

- A 57 year old man presents...

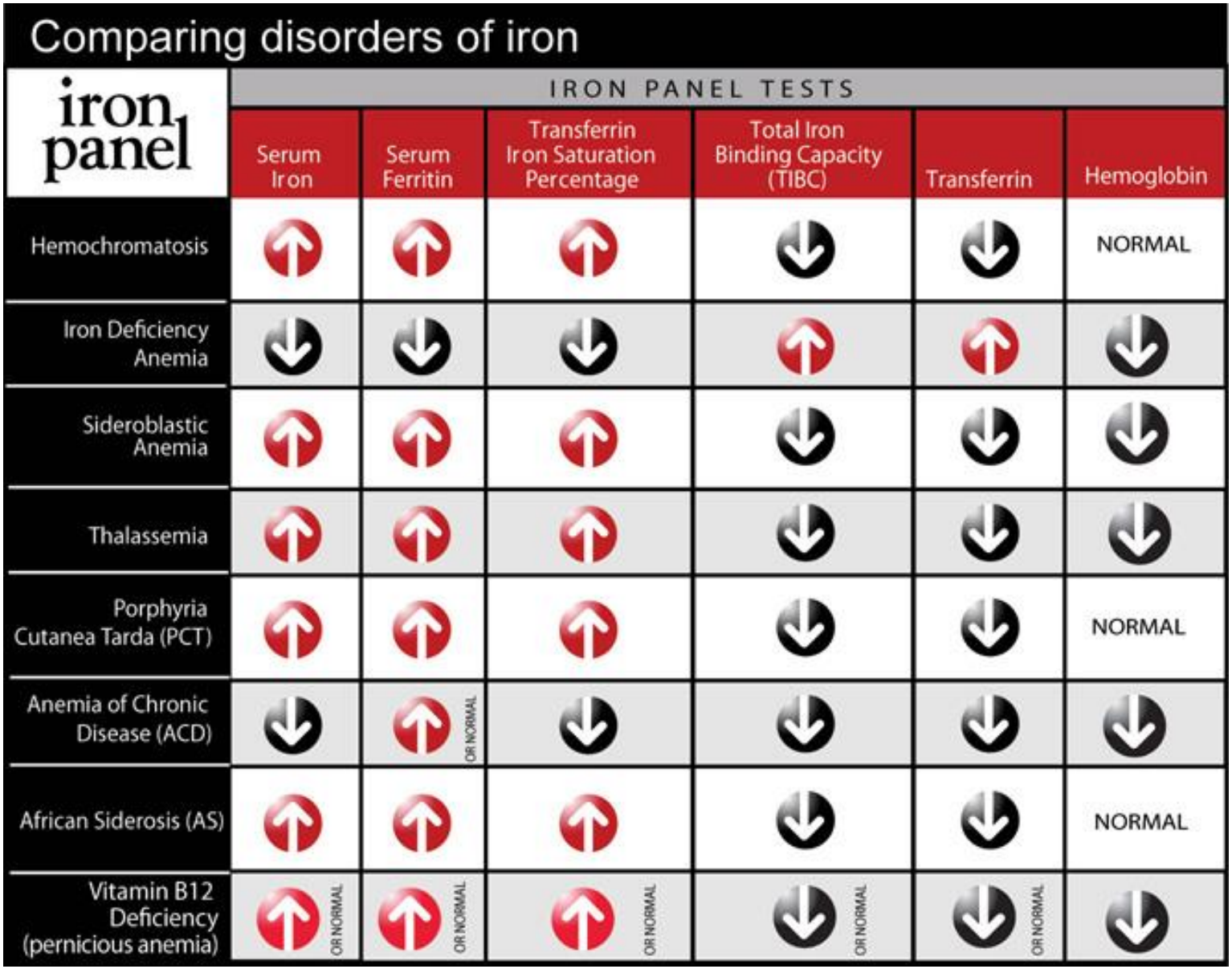
		Normal Range (M)
Hb	98	130-180 g/L
RBC	4.4	4.5-6.5 x 10^9/L
Hct	0.33	0.40.54
MCV	75	76-96
MCH	22	27-36 pg
MCHC	297	301-350 g/L
RDW	16	10-14
Plt	456	150 – 400 x 10^9/L

What questions do you want to ask?

What further tests do you want?

SIMPLY FINALS

Haematinics



http://www.irondisorders.org/tests-to-determine-iron-levels/

Case 4

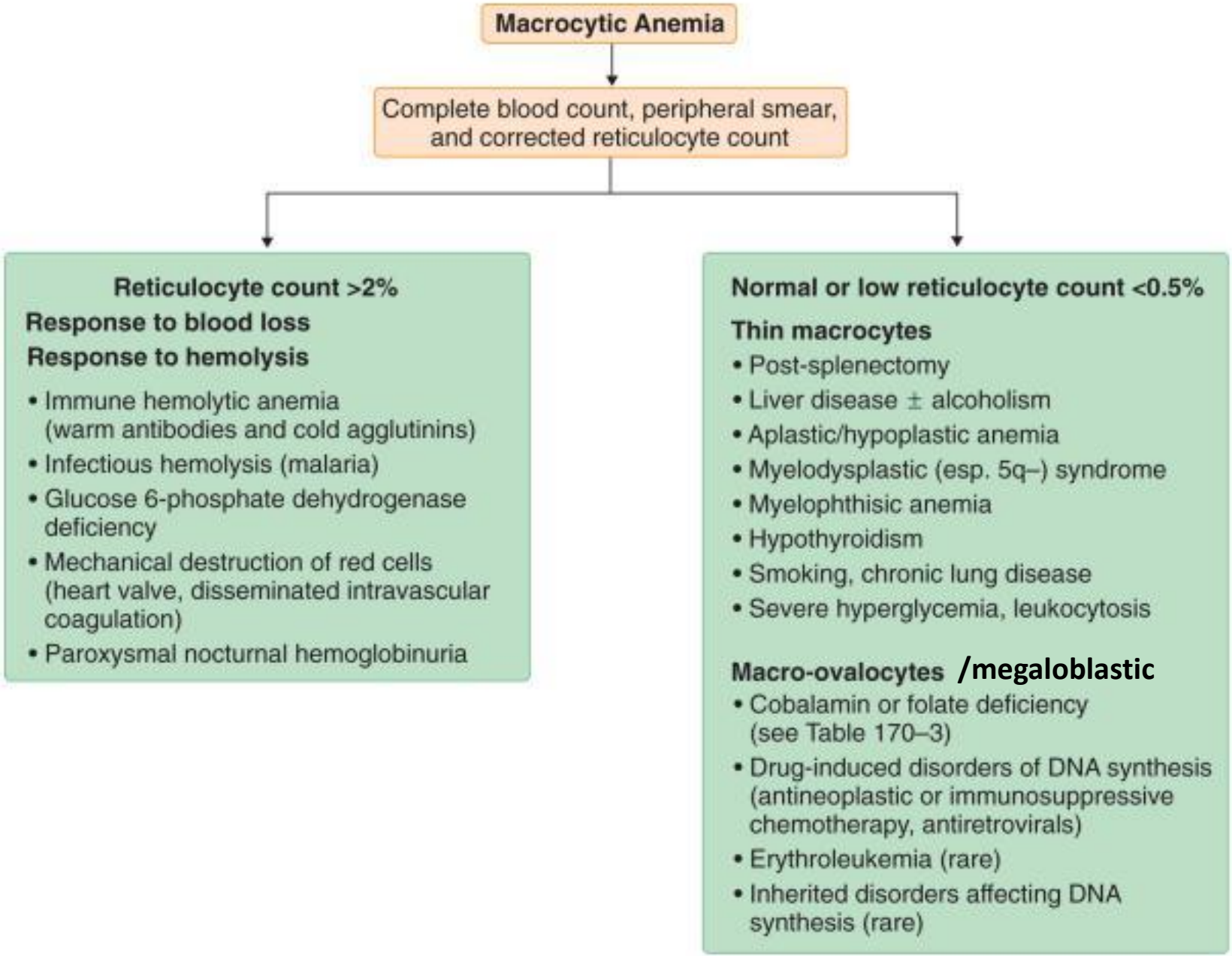
- 67 year old female presents...

		Normal Range (F)
Hb	110	115-165 g/L
RBC	2.9	3.8-5.8 x 10^9/L
Hct	0.36	0.37-0.47
MCV	124	76-96
MCH	38	27-32 pg
MCHC	306	301-350 g/L
RDW	18	10-14
Plt	248	150 – 400 x 10^9/L

What questions do you want to ask?

What further tests do you want?

SIMPLY FINALS



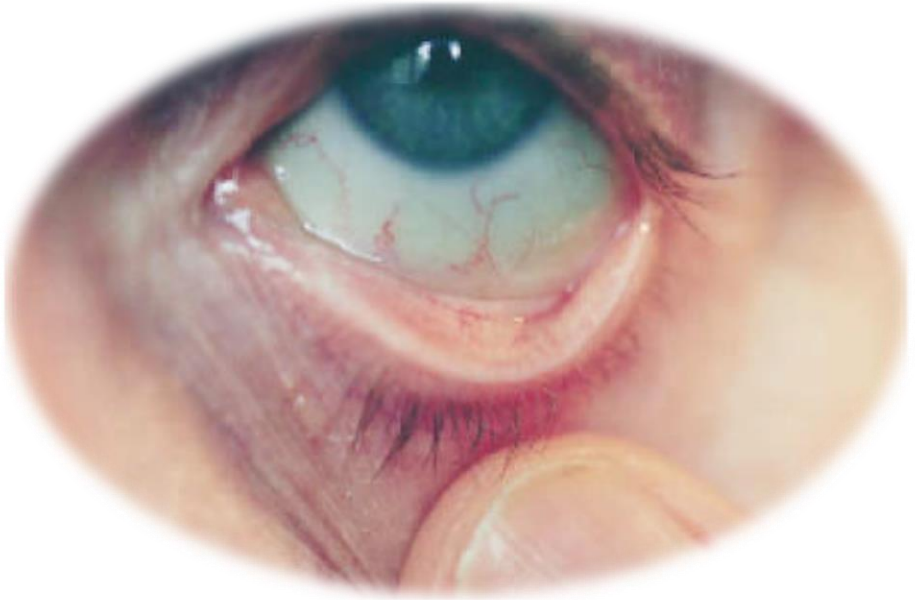
http://blog.naver.com/PostView.nhn?blogId=masterhand05&logNo=20104426549

Anaemia Summary

- Remember: Anaemia is not a complete diagnosis.
- Find the cause!

Consider:

- Blood film
- Haematinics
- Coombs Test
- Electrophoresis
- Coeliac serology
- Vitamins/minerals
- Ultrasound/Other Imaging
- Endoscopy
- Bone marrow aspirate



White Cell Differentials

Case 1		
WCC	16.6	4.0-11.0 x 10^9/L
Neut	12.4	2.0-7.5 x 10^9/L
Lymph	3.8	1.0-4.0 x 10^9/L
Mono	0.3	0.2-1 x 10^9/L
Eosin	0.1	0.0-0.4 x 10^9/L
Baso	0.0	0.0-0.1 x 10^9/L

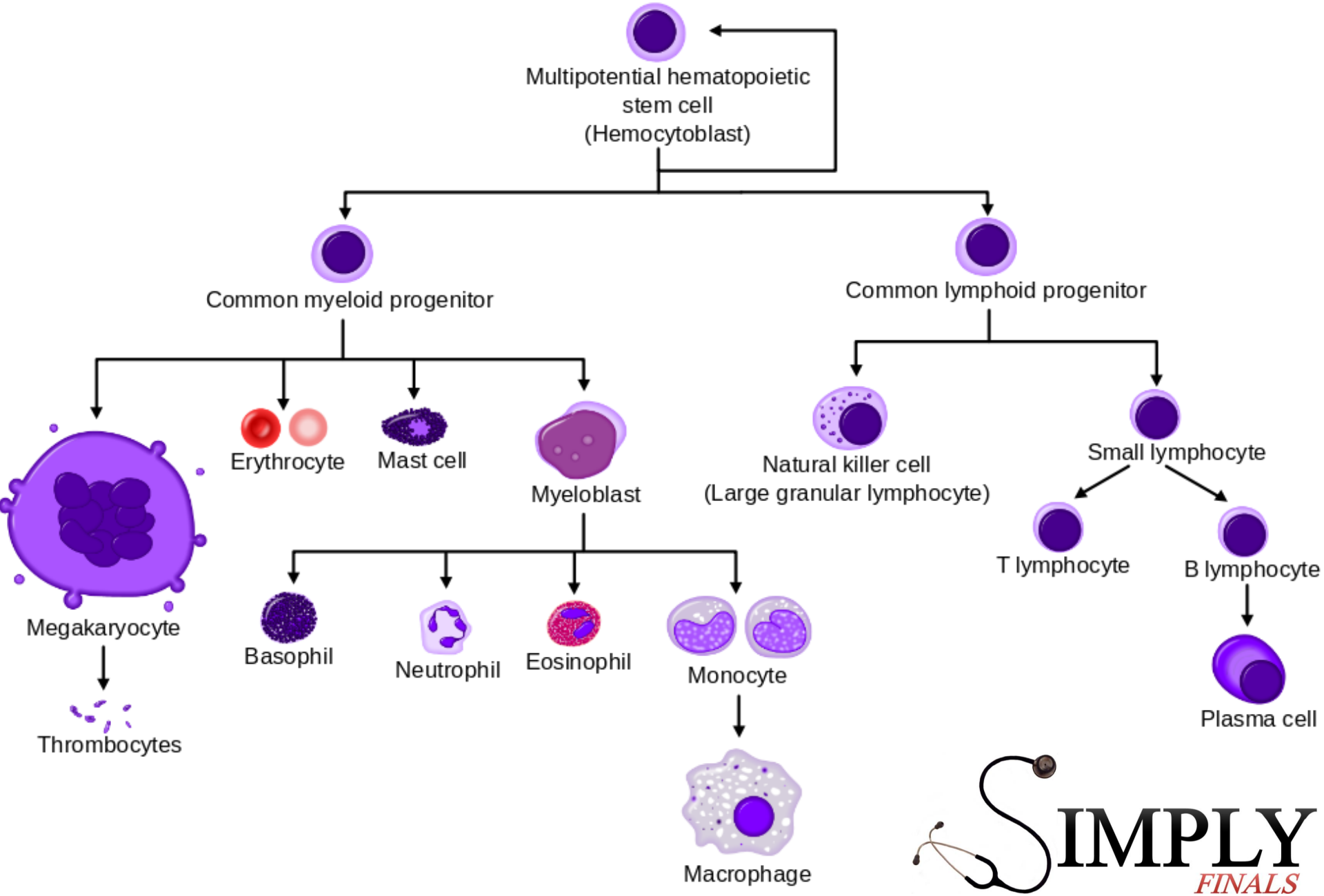
Case 2		
WCC	13.6	4.0-11.0 x 10^9/L
Neut	6.0	2.0-7.5 x 10^9/L
Lymph	7.0	1.0-4.0 x 10^9/L
Mono	0.35	0.2-1 x 10^9/L
Eosin	0.2	0.0-0.4 x 10^9/L
Baso	0.1	0.0-0.1 x 10^9/L

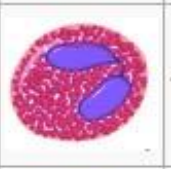
Case 3		
WCC	186	4.0-11.0 x 10^9/L
Neut	156	2.0-7.5 x 10^9/L
Lymph	2.4	1.0-4.0 x 10^9/L
Mono	2.2	0.2-1 x 10^9/L
Eosin	9.3	0.0-0.4 x 10^9/L
Baso	16.1	0.0-0.1 x 10^9/L

Case 4		
WCC	0.7	4.0-11.0 x 10^9/L
Neut	0.5	2.0-7.5 x 10^9/L
Lymph	0.2	1.0-4.0 x 10^9/L
Mono	0.0	0.2-1 x 10^9/L
Eosin	0.0	0.0-0.4 x 10^9/L
Baso	0.0	0.0-0.1 x 10^9/L

The Full Blood Count Summary – 2 of 2

Plt	**Platelets**	Thrombocytopaenia • Decreased production (e.g. Marrow suppression) • Increased destruction (e.g. autoimmune, DIC, splenomegaly) Thrombocytosis • Essential • Reactive (e.g. infection, inflammation, trauma)	
WCC	**White Cell Count**	Leukopaenia – marrow disorders, drugs (esp. Cytotoxics), infection Leukocytosis – infection, inflammation, malignancy *Useful to consider the differential (i.e. what specific cells)*	
		Raised in: (There can be crossover; malignancy can raise all)	
Neut	**Neutrophils**	Bacterial infections, trauma, inflammation	**Lower levels** seen in various states, e.g. Steroid use, cytotoxic use, severe sepsis, SLE
Lymph	**Lymphocytes**	Viral infections	
Mono	**Monocytes**	Chronic inflammation/infection (e.g. TB), autoimmunity	
Eosin	**Eosinophils**	Atopy, parasitic infections	
Baso	**Basophils**	Viral infections, urticaria	



Type	Microscopic Appearance	Diagram	Approx. % in adults[6] See also: Blood values	Diameter (μm)[6]	Main targets[3]	Nucleus[3]	Granules[3]	Lifetime[6]
Neutrophil			54–62%[5]	10–12	▪ bacteria ▪ fungi	multilobed	fine, faintly pink (H&E Stain)	6 hours–few days (days in spleen and other tissue)
Eosinophil			1–6%	10–12	▪ parasites ▪ in allergic reactions	bi-lobed	full of pink-orange (H&E Stain)	8–12 days (circulate for 4–5 hours)
Basophil			<1%	12–15	▪ in allergic reactions	bi-lobed or tri-lobed	large blue	?
Lymphocyte			25–33%	7–8	▪ B cells: various pathogens ▪ T cells: ▪ CD4+ (helper): extracellular bacteria broken down into peptides presented by MHC class 2 molecule. ▪ CD8+ cytotoxic T cells: virus-infected and tumor cells. ▪ γδ T cells: ▪ Natural killer cells: virus-infected and tumor cells.	deeply staining, eccentric	NK-cells and Cytotoxic (CD8+) T-cells [7]	weeks to years
Monocyte			2–8%	14–17	Monocytes migrate from the bloodstream to other tissues and differentiate into tissue resident macrophages or dendritic cells.	kidney shaped		hours to days

http://en.wikipedia.org/wiki/White_blood_cell

Case 5

- An 86 year old lady is admitted to the care of the elderly ward with confusion. Her U+Es show the following:

		Normal Values
Na	152	135-145 mmol/L
K	5.2	3.5-5 mmol/L
Urea	28	2.5-6.7 mmol/L
Creat	152	70-150 µmol/L

U: ↑↑↑↑
C: ↑
= Pre-Renal

U: ↑↑↑
C: ↑↑
= Intra/Post-Renal

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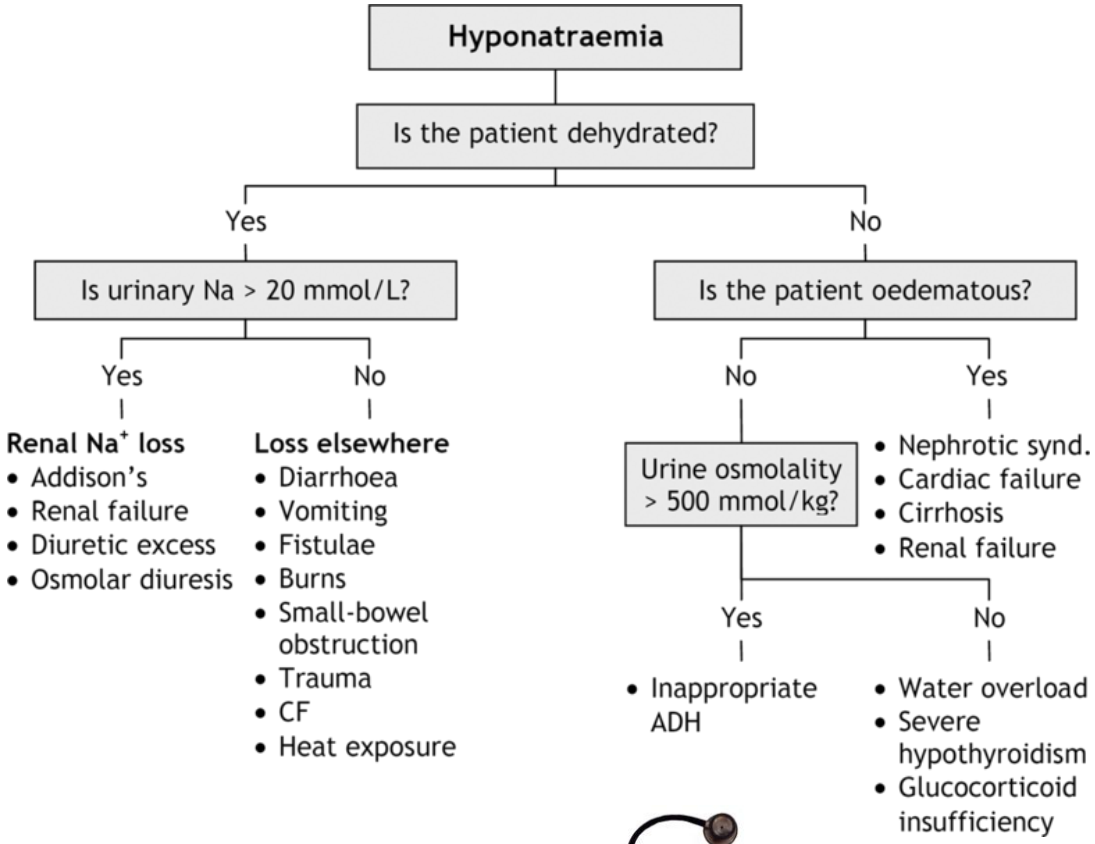
Case 6

- A 52 year old lady presents to AnE after having had D+V for 3 days.

		Normal Values
Na	130	135-145 mmol/L
K	3.2	3.5-5 mmol/L
Urea	23	2.5-6.7 mmol/L
Creat	173	70-150 µmol/L



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Serum Osmo = 2Na (+ K) + Urea + Gluc

Serum osmolality	Urine osmolality	Causes
Normal or increased	Increased	• Dehydration • Renal disease and uraemia • Congestive heart failure • Addison's disease • Hypercalcaemia • Diabetes mellitus/hyperglycaemia • Hypernatraemia • Alcohol ingestion • Mannitol therapy
Normal or increased	Decreased	• Diabetes insipidus
Decreased	Increased	• Syndrome of inappropriate ADH secretion (SIADH)
Decreased	Decreased (with no increase in fluid intake)	• Overhydration • Hyponatraemia • Adrenocortical insufficiency • Sodium loss (diuretic or a low-salt diet)

Case 7

- A confused 79 year old man of Afro-Caribbean origin is brought in by ambulance after feeling funny pains in his chest. He has known prostate disease and hasn't been able to pass urine for the last two days.

		Normal Values
Na	129	135-145 mmol/L
K	6.7	3.5-5 mmol/L
Urea	19	2.5-6.7 mmol/L
Creat	302	70-150 µmol/L

eGFR = 22

Table 1: Methods for estimating creatinine clearance (GFR) in ml/min/1.73 m^2.

Cockcroft-Gault formula:[w4]

$$\text{Creatinine clearance} = \frac{(140\text{-age})(\text{weight in kilograms})}{\text{Serum creatinine } (\mu\text{mol/L}) \times 0.81} \times (0.85 \text{ if female})$$

MDRD equation:[w5]

$$\text{GFR} = 186.3 \times (\text{serum creatinine level (mg/dl)})^{-1.154} \times \text{age}^{-0.203} \times (0.742 \text{ if female}) \times (1.21 \text{ if black})$$

(+/- urea and albumin for 6 item MDRD)

SIMPLY FINALS

Urea and Electrolytes - Summary

Na	Sodium	Hyponatraemia – see previous slides Hypernatraemia – dehydration, diabetes insipidus, hyperaldosteronism
K	Potassium	Hypokalaemia – diuretics, D+V, hyperaldosteronism, alkalosis Hyperkalaemia – renal failure, addisons, rhabdomyolysis, acidosis, K-sparing diuretics, (artefact - haemolysis)
Urea	Urea	A waste product of protein metabolism Excreted by the kidney (can be reabsorbed) so gives an arbiter of renal health/fluid status. Raised in catabolic states and upper GI bleeding.
Cr	Creatinine	Produced constantly by muscle (level varies according to muscle mass) and excreted by the kidney so is an arbiter of kidney function
GFR	Glomerular Filtration Rate	Can be calculated with 24-creatinine clearance or nuclear medicine GFR. Often estimated in adults using 4 or 6 item MDRD formula.

Stages of Chronic Kidney Disease of all Types

Stage	Qualitative Description	Renal Function (mL/min/1.73 m²)
1	Kidney damage-normal GFR	≥90
2	Kidney damage-mild ↓ GFR	60-89
3	Moderate ↓ GFR	30-59
4	Severe ↓ GFR	15-29
5	End-stage renal disease	<15 (or dialysis)

Summary

- Be systematic
- Use clinical correlation and trends (where available)
- Is there further history or tests that you need?

Red Alerts

- **Hb** <70g/L (or a sudden drop)
- **Febrile neutropaenia**
- **Plt** <20 with bleeding
- **K** <2.5 or >6.5 (or any change with ECG changes)
- **Na** <125 or >155 (or a sudden change)

SIMPLY FINALS

Thank you

Any Questions?

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