



Blood Results Interpretation

Dr Sanjeev Kalia



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III Introduction

- Trainer for today – Dr Kalia
- Housekeeping
- Not here to become experts –have a sensible roadmap

Teaching session timetable

- FBC
- Renal Function
- LFTs
- Cholesterol
- TFTs
- HbA1c/Glucose

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Teaching session timetable

- PSA
- Vitamin D
- Vitamin B12
- Ferritin
- Folate

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GP Vs Secondary Care

- Reduced time constraints
- Certain bloods inappropriate for either setting eg Troponin
- Delays in results suitable in GP but not acute setting

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Scattergun Approach



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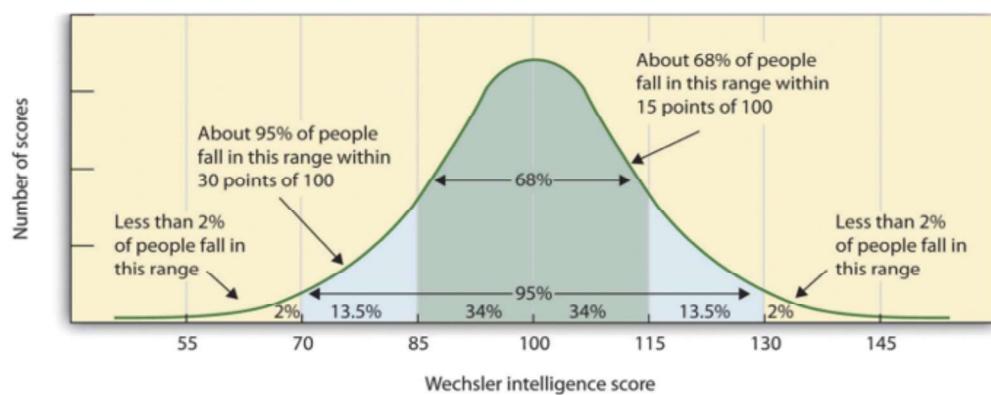
GP Vs Secondary Care

- KEY POINT: 90% OF DIAGNOSIS IS IN THE HISTORY
- Wherever you are
 - Reduce scattergun approach
 - Remember if you requested it you are responsible for chasing
 - Make requests concise to the questions you are asking

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Reference ranges - 'pathology or normal?'

Following is the distribution of Intelligence among people in general.



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Remember – You are not alone



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▼ Services

Pathology Requests Radiology

Common Tests

Chemistry Blood Therapeutic Drug Chemistry Other Haematology Microbiology Immunology Specific IgEs Histology Profiles/Screen COVID testing Search Set as Default Panel

Clinical Chemistry	Haematology	Microbiology
<input type="checkbox"/> U/E and Creatinine/eGFR (Renal)	<input type="checkbox"/> Full Blood Count	<input type="checkbox"/> Urine (Routine Investigations)
<input type="checkbox"/> Liver Function Test	<input type="checkbox"/> Peripheral Blood Film	<input type="checkbox"/> Respiratory Investigations
<input type="checkbox"/> Glucose	<input type="checkbox"/> Malarial Parasite	<input type="checkbox"/> Swab (Routine Investigations)
<input type="checkbox"/> Calcium	<input type="checkbox"/> Monospot	<input type="checkbox"/> STI screen
<input type="checkbox"/> Gamma GT	<input type="checkbox"/> Sickle Screen	<input type="checkbox"/> Mycology Investigations
<input type="checkbox"/> Lipids	<input type="checkbox"/> PT / INR	<input type="checkbox"/> Helicobacter pylori Stool Antigen
<input type="checkbox"/> HDL-Cholesterol	<input type="checkbox"/> Haemoglobinopathy Screen	Serology
<input type="checkbox"/> Thyroid Function Test	<input type="checkbox"/> ESR	<input type="checkbox"/> Serology Investigations
<input type="checkbox"/> HbA1c	<input type="checkbox"/> Vitamin B12	Immunology
<input type="checkbox"/> Alb/Creat ratio (ACR)(Urine)	<input type="checkbox"/> Folate	<input type="checkbox"/> Liver autoantibodies (SMA, AMA, LKM)
<input type="checkbox"/> Pregnancy Test (Urine)	<input type="checkbox"/> Ferritin	<input type="checkbox"/> Anti-Nuclear Abs
<input type="checkbox"/> Total CK	<input type="checkbox"/> Activated PTT	<input type="checkbox"/> Complement C3 & C4
<input type="checkbox"/> CRP	<input type="checkbox"/> Reticulocytes	<input type="checkbox"/> DNA Ab (Screen)
<input type="checkbox"/> Faecal Occult Blood		<input type="checkbox"/> Rheumatoid Factor

Powered by ICL

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FBC

Hb	115	180	g/L
MCV	76	96	fL
Platelets	150	400	10 ⁹ /L
WCC	4.0	11.0	10 ⁹ /L
Neutrophils	2.0	7.5	10 ⁹ /L
Leucocytes	1.3	3.5	10 ⁹ /L
Monocytes	0.2	0.8	10 ⁹ /L
Eosinophils	0.04	0.44	10 ⁹ /L

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Specimen : BLOOD

Taken : 08-Jul-2020 14:24

Received : 08-Jul-2020 18:14 

UC

RANDOM SAMPLE

FULL BLOOD COUNT

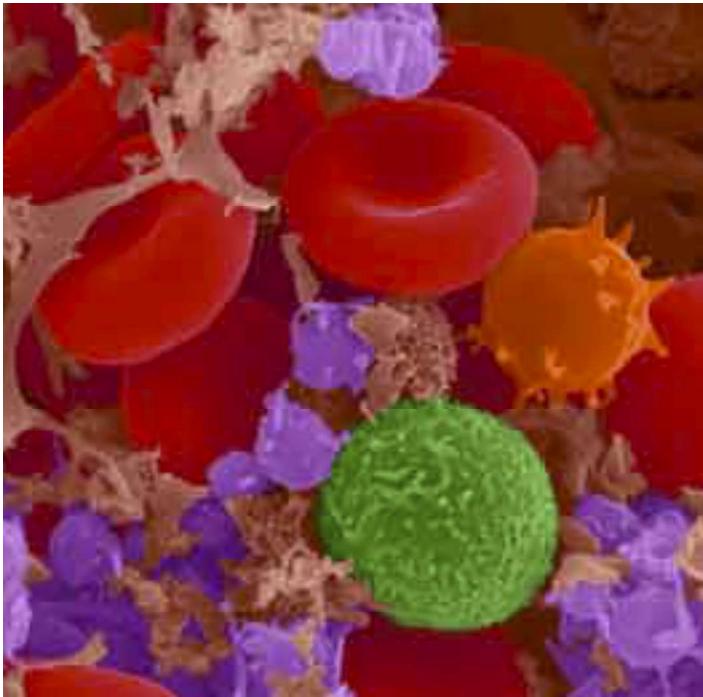
(SK) - 2 Satisfactory - no action required

Total white cell count	8.0 10 ^{*9} /L	(4.0 - 11.0)	SR
Red blood cell (RBC) count	5.15 10 ^{*12} /L	(3.50 - 6.50)	SR
Haemoglobin estimation	146 g/L	(125 - 180)	SR
Haematocrit	0.43 L/L	(0.38 - 0.54)	SR
Mean corpuscular volume (MCV)	84.1 fL	(79.0 - 99.0)	SR
Mean corpusc. haemoglobin(MCH)	28.3 pg	(27.0 - 34.5)	SR
Mean corpusc. Hb. conc. (MCHC)	337 g/L	(316 - 365)	SR
Platelet count	208 10 ^{*9} /L	(150 - 450)	SR
Neutrophil count	3.13 10 ^{*9} /L	(1.70 - 7.50)	SR
Lymphocyte count	4.28 10 ^{*9} /L	(1.00 - 4.50)	SR
Monocyte count	0.37 10 ^{*9} /L	(0.20 - 0.80)	SR
Eosinophil count	0.17 10 ^{*9} /L	(0.00 - 0.50)	SR
Basophil count	0.03 10 ^{*9} /L	(0.00 - 0.10)	SR

CONS BLOOD FILM SAND

SR UC

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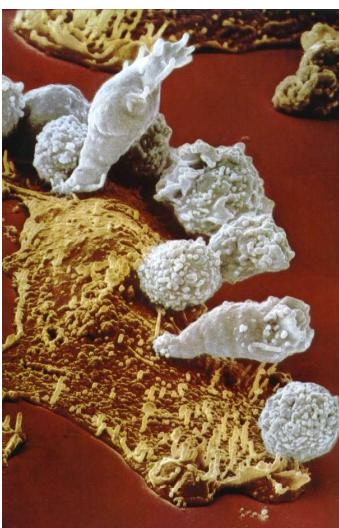


Not all blood
cells are the
same....



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White Blood Cells



- WBC's are fighter cells
- Some make antibodies
- Some fight directly
- Divided into types by how they look and what they do

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Different Types of WBC's

- Neutrophils (40-75% of WBC) fight bacterial infections but also autoimmune disease; low count=neutropenia (HIV, some meds can cause neutropenia)
- Lymphocytes (20-45% of WBC) found in spleen, liver, bone marrow 'lymphoid tissue'. 2 types:
 - T cells attack + Kill germs/regulate immune system need to know lymphocyte count to calculate T cells
 - B cells make antibodies (recognize, attack, destroy pathogens)
 - Some viruses eg HIV attack lymphocytes

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More Types of WBC's

- Monocytes or Macrophages (2-10% of WBC): fight infections by eating germs; high count usually signifies infection
- Eosinophils (1-6% of WBC): involved with allergies and reaction to parasites
- Basophils(<1% of WBC): Seem to be involved in long term allergic response; not well understood

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Neutropenic Sepsis

- **Neutropenic sepsis** is defined by NICE as a neutrophil count of 0.5×10^9 per litre or lower, plus one of the following:¹
- Temperature $\geq 38^\circ\text{C}$ or
- Other signs or symptoms consistent with significant sepsis
- **Medical emergency** -rapidly progress to haemodynamic instability.
- Therefore, **rapid assessment** and administration of empirical **antibiotic therapy** can be lifesaving

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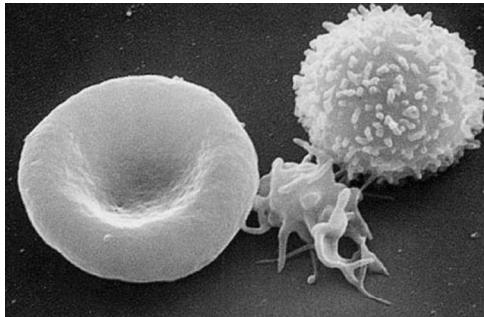
Other causes

- **Recent chemotherapy** (most commonly within 7 – 10 days) causes neutropenia through bone marrow suppression and is the major cause of neutropenic sepsis in cancer patients. The risk of neutropenia varies in both severity and timescale between different chemotherapy treatment regimes.⁴
- **Other causes of neutropenia include:**⁴
 - Malignant bone marrow infiltration
 - Extensive radiotherapy
 - Bone marrow failure secondary to non-malignant disease (e.g. aplastic anaemia)
 - Hypersplenism
 - Megaloblastic anaemia
 - Drug-induced (e.g. clozapine)

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Red Blood Cell Tests

- Erythrocytes
 - “cytes” = cells
- Shaped like a bagel with hole covered
- Red Blood Cell count: total number of red blood cells
- Hemoglobin (HGB): protein in RBC's that actually carries O₂



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Red Blood Cell Tests

- Hematocrit (HCT): measures the % of blood volume taken up by RBC's
- Mean Corpuscular Volume (MCV): average volume (size) of RBC's
- Mean Corpuscular Hemoglobin (MCH): amt/concentration of hgb in average cell
- Platelets: help stop bleeding by forming clots. Low plt count (thrombocytopenia)

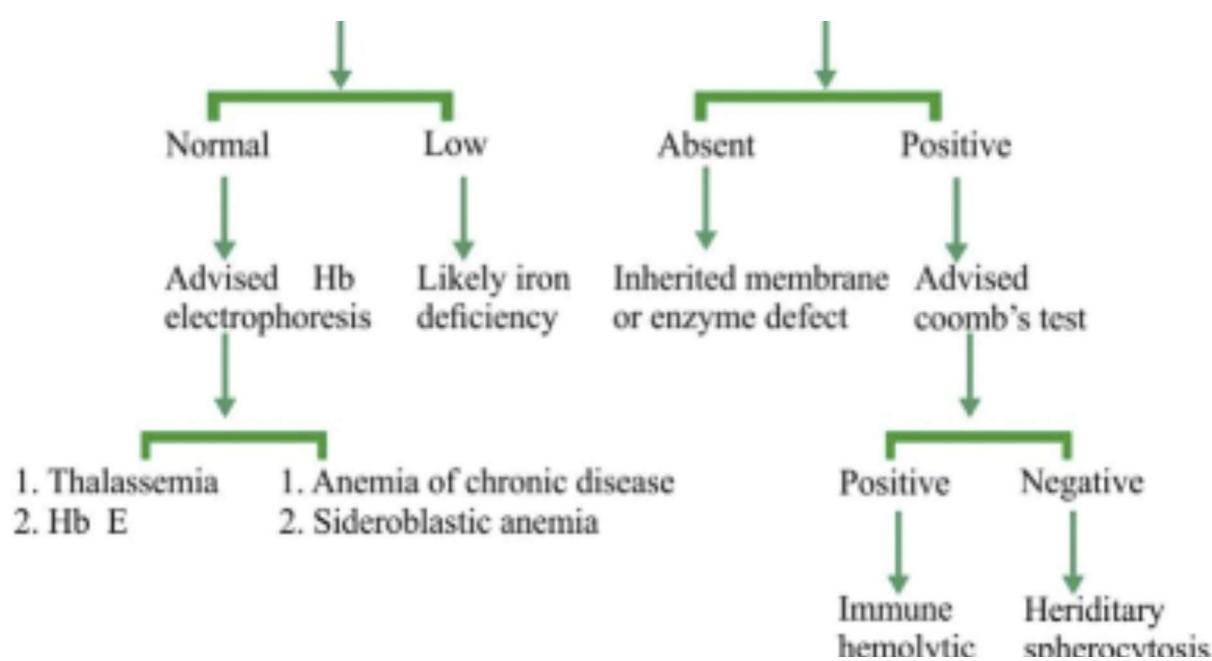
III Anaemia

- Result of long-term negative iron balance. The iron deficiency spectrum ranges from iron depletion to iron deficiency anaemia.
- Anaemia is defined as a haemoglobin (Hb) level two standard deviations below the normal for age and sex:
 - In men aged over 15 years — Hb below 130 g/L.
 - In non-pregnant women aged over 15 years — Hb below 120 g/L.
 - In children aged 12–14 years — Hb below 120 g/L.
- Multifactorial: dietary deficiency, malabsorption, increased loss, or increased requirements.

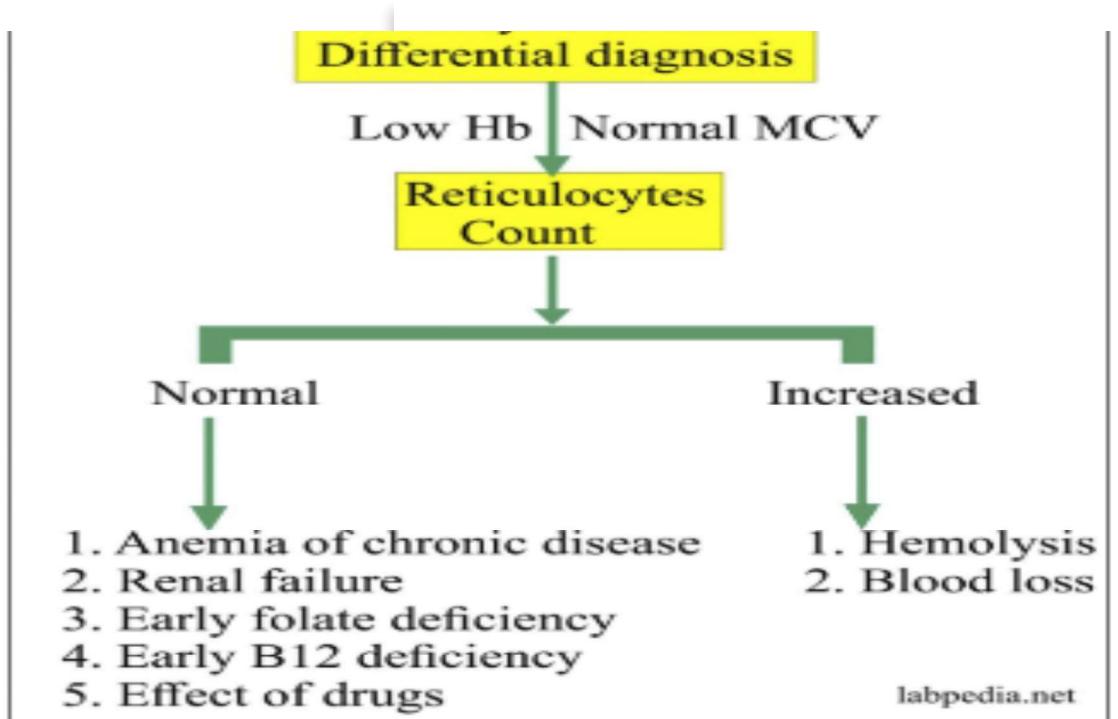
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findings	hypochromic	normochromic	
MCV	<80 fl (decreased)	80 to 95 fl (normal)	>95 fl (increased)
MCH	<27 pg (decreased)	≥27 pg (normal)	Increased
MCHC	Decreased	Normal	Normal
Etiological factors	<ol style="list-style-type: none">1. Iron deficiency2. Thalassemia3. Sideroblastic anemia4. Chronic diseases5. Lead	<ol style="list-style-type: none">1. Hemolytic anemias2. After acute blood loss3. Bone marrow failure by chemotherapy or cancer	<ol style="list-style-type: none">1. Vitamin B12 deficiency2. Folic acid deficiency3. Aplastic anemia4. Non-megaloblastic anemia due to:<ol style="list-style-type: none">1. Alcohol use2. Liver diseases

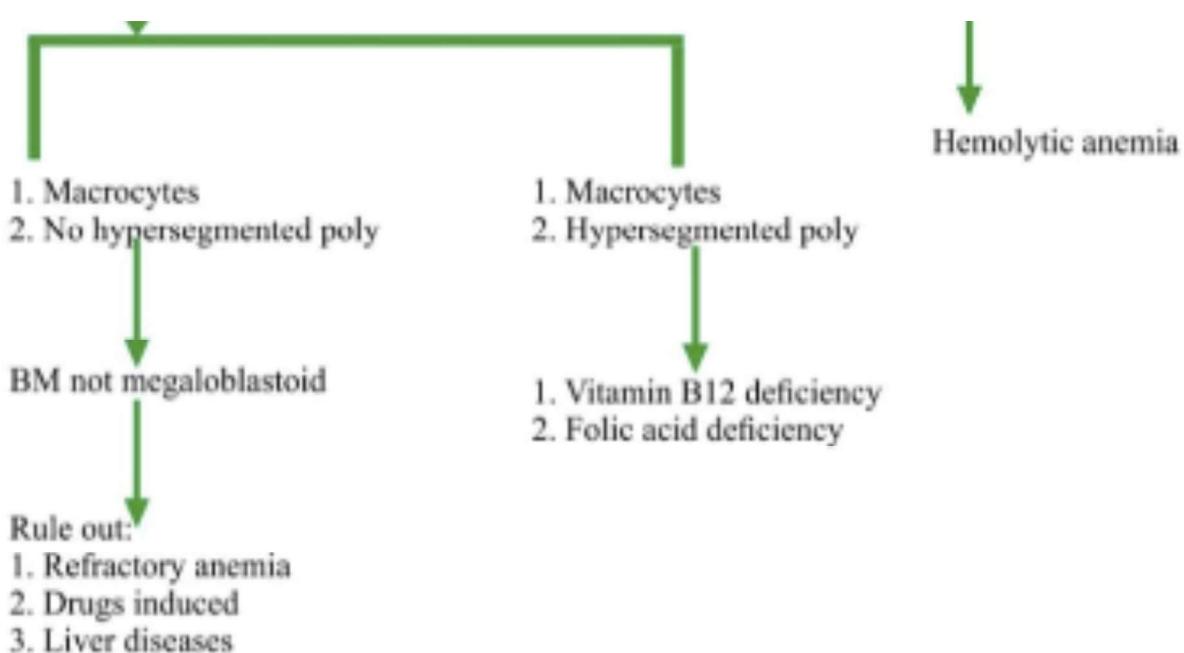
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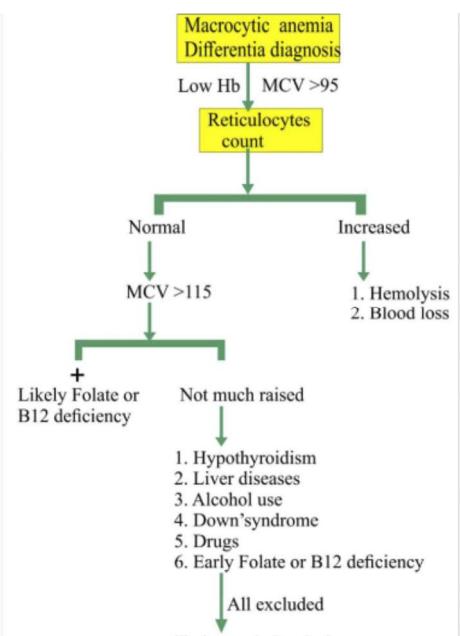
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Interpretation

↑Result

↑Production

↓Consumption

↓Result

↓Production

↑Consumption

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Anaemia

- Low Haemoglobin (Hb)

- ↓Production
 - Low iron/B12/Folate
 - Thalassemia
 - Chronic disease
 - Myelodysplasia

↓Result ↓Production ↑Consumption

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Anaemia

- Low Haemoglobin (Hb)
 - ↑Consumption
 - Bleeding
 - Haemolysis
- ↓Result ↓Production ↑Consumption

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Lymphocytosis/Neutrophilia

- High White Cell Count (WCC, differential)
 - ↑Production
 - Infection
 - Steroids (neutrophils)
 - Leukaemia's (Lymphocytes)
- ↑Result ↑Production ↓Consumption

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Leucopenia/Neutropenia

- Low White Cell Count (WCC, differential)

↓Result ↓Production ↑Consumption

- ↓Production
 - Chemotherapy
 - Bone marrow failure

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Leucopenia/Neutropenia

- Low white cells

↓Result ↓Production ↑Consumption

- ↑Consumption
 - Chronic infection

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Thrombocytopenia

- Low platelets

↓Result ↓Production ↑Consumption

- ↓Production
 - Chemotherapy
 - Bone marrow failure

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Thrombocytopenia

- Low platelets

↓Result ↓Production ↑Consumption

- ↑Consumption
 - Autoimmune
 - Enlarged spleen (sequestration)

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Pancytopenia

- Low everything

↓Result ↓Production ↑Consumption

- ↓Production
 - Chemotherapy
 - Bone marrow failure

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Case 1

- 28 Female
 - Tired
 - Heavy periods

Hb	95 g/L	(115-180)
MCV	70 fL	(76-96)
Plat	330 10 ⁹ /L	(150-400)

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III Case 1

- Diagnosis?
 - Menorrhagia
 - GI bleeding
- Further tests?
 - Iron studies

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Case 2

- 53 Male
 - Regular alcohol intake

Hb	135 g/L	(115-180)
MCV	103 fL	(76-96)
Plat	203 10 ⁹ /L	(150-400)

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III Case 2

- Diagnosis?
- Further tests?
 - B12 & Folate
 - LFTs

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Case 3

-
- 35 Female
 - Lupus
 - Long-term prednisolone

Hb	122 g/L	(115-180)
MCV	95 fL	(76-96)
Plat	340 10 ⁹ /L	(150-400)
WCC	15.0 10 ⁹ /L	(4.0-11.0)
Neutrophils	11.5 10 ⁹ /L	(2.0-7.5)
Lymphocytes	1.2 10 ⁹ /L	(1.3-3.5)

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Case 3

- Diagnosis?
- Further tests?
 - Blood film
 - Kidney function

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Case 4

- 57 Female
 - Neck swelling

Hb	101 g/L	(115-180)
MCV	82 fL	(76-96)
Plat	94 10 ⁹ /L	(150-400)
WCC	45.6 10 ⁹ /L	(4.0-11.0)
Neutrophils	2.2 10 ⁹ /L	(2.0-7.5)
Lymphocytes	38 10 ⁹ /L	(1.3-3.5)

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III Case 4

- Diagnosis?
 - CLL (Chronic Lymphocytic Leukaemia)
- Further tests?
 - Blood film
 - Urgent two week referral to Haematology services

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Case 5

- 19 Male
 - Nosebleeds
 - Bruising

Hb	120 g/L	(115-180)
MCV	90 fL	(76-96)
Plat	48 10 ⁹ /L	(150-400)

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III Case 5

- Diagnosis?
 - Autoimmune ITP
- Further tests?
 - Blood film
 - TFTs and immunology screen

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III Vitamin B12 (187-883ng/l)

- Vitamin B12 is essential for life (needed to make new cells eg many new red blood cells which are made every day).
- Found in meat, fish, eggs and milk - but not in fruit or vegetables.
- Common symptoms: tiredness, lethargy, feeling faint, breathlessness.
- Causes: Pernicious anaemia, malabsorptive states, medicines (dmards/metformin)
- Treatment: Injections Vs Tabs

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Ferritin (10-300 µg/L))

- Ferritin plays a significant role in the absorption, storage, and release of iron.
- Found in serum in low concentrations and is directly proportional to the body's iron stores.
- TO BE CHECKED IF CONCERNED ABOUT POSS 2WW!!!!

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Ferritin

- Elevated in the presence of the following conditions and do not reflect actual body iron stores:
 - inflammation
 - significant tissue destruction
 - liver disease
 - malignancies such as acute leukaemia and Hodgkin's disease
 - therapy with iron supplements

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Folate

(3.1-20.0 µg/L)

- Folate (folic acid) is one of the B group of vitamins found in small amounts in many foods.
- Absorbed through the upper part of the small intestine.
- The body's reserves of folate, unlike vitamin B12, are low and only sufficient for around four months.
- Almost half of the body folate is found in the liver.
- Sources :broccoli, Brussels sprouts, asparagus, peas, chickpeas and brown rice.

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Folate

Dietary deficiency?

- Malabsorption (eg, [coeliac disease](#), [tropical sprue](#), congenital specific malabsorption, jejunal resection, inflammatory bowel disease).
- Poor intake.
- Old age.
- Poor social conditions.
- [Malnutrition](#).
- Alcohol excess (also causes impaired utilisation).
- Poor intake due to [anorexia](#).
- Food fads.

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Folate

Excessive requirements?

- Physiological (e.g, pregnancy, lactation, prematurity and infancy).
- Malignancy (e.g, leukaemia, carcinoma, lymphoma).
- Blood disorders (eg, haemolytic anaemias, sickle cell anaemia, thalassaemia major, chronic myelosclerosis).
- Inflammation (eg, tuberculosis, Crohn's disease, malaria).
- Metabolic (eg, homocystinuria).
- Haemodialysis or peritoneal dialysis.

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Folate

Excessive urinary excretion?

This includes, for example, congestive heart failure, acute liver damage and chronic dialysis.

Antifolate drugs?

- With uncertain mechanism of action (eg, anticonvulsants and possibly alcohol and nitrofurantoin).
- Causing malabsorption of folate (eg, colestyramine, sulfasalazine, methotrexate).
- Trimethoprim may exacerbate pre-existing folate deficiency but does not cause megaloblastic anaemia.
- **Genetic disorders**
Mutations in the SLC46A1 gene, leading to proton-coupled folate transporter deficiency.

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Questions?



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Bilirubin	3	17	µmol/L
ALT	5	35	U/L
Alk Phos.	30	100	U/L

LFTs



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Managing LFTs

- Always be systematic:
 - History and examination
 - Investigations
 - When to refer

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Liver function

- Components?
 - Bilirubin
 - Alanine aminotransferase (ALT)
 - Alkaline Phosphatase (Alk Phos.)
- Common disorders
 - Jaundice
 - Liver damage/failure

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Bilirubin

- Breakdown of haemoglobin
- Processed by the liver
- ↑Bilirubin = Jaundice

↑Result

↑Production

↓Processing

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||| Bilirubin

- ↑Production
 - Haemolysis
 - Hepatolysis
- ↓Processing
 - Obstruction
 - Cirrhosis

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||| Isolated bilirubin investigations

- Split bilirubin- conjugated/ unconjugated
- Reticulocyte count
- Gilbert's syndrome

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||| Bilirubin

- Gilbert's syndrome
 - Jaundice
 - ↓Processing
 - Normal liver enzymes
 - Benign condition

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ALT

- Liver enzyme in hepatocytes (liver cells)
- Hepatic jaundice
 - Hepatitis
 - EBV/CMV
 - Paracetamol overdose
 - Autoimmune

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Isolated raised ALT

- Most likely fatty liver/ alcohol
- Needs complete liver aetiology screen
- Check AST/Gamma GT
- USS
- Biopsy if ALT >twice normal

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Alk Phos.

- Liver enzyme found in bile duct cells
- Obstructive jaundice
 - Gall stones
 - Biliary obstruction
 - Pancreatic cancer

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Isolated raised ALP

- Ensure origin
 - ALP isoenzymes
 - Gamma GT
- USS
- If of bony origin
 - Ca/Vitamin D/PTH

Alk Phos

- ▶ Source may be the liver/bone/gut/kidney or placenta
- ▶ Causes: cholestasis or hepatic disease; bone mets or Pagets; puberty; pregnancy
- ▶ Investigate with liver screen, ultrasound scan and auto antibody screen
- ▶ If asymptomatic, normal liver screen/USS and raised by <50% could consider observation, otherwise refer

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Medication

- NSAIDs
- Flucloxacillin
- Statin
- Anti-epileptic
- TB drugs
- Co-Amoxiclav

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Hepatic Jaundice

- **Bili increased.**
- **ALT increased ++**
- **ALP normal or mildly elevated**

- Short history
- No signs of CLD
- Causes- Hep A/B
- EBV
- CMV
- Paracetamol overdose
- Autoimmune
- Pregnancy

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Case study

- After assessing GO's cardiovascular risk you decide you'd like to initiate a statin for him, but notice his last LFTs 2 years ago were slightly abnormal:
 - ▶ AST 68 (8-40)
 - ▶ GGT 102 (11-50)
 - ▶ ALP 114 (20-130)
 - ▶ Bili 14 (<21)
- ▶ What actions (if any) would you take? Would you start the statin?

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- Can raise transiently due to viral infection, drugs or alcohol
- Consider Hx alcohol/recreational drug use (also penicillins/antifungals/statins/ anti- epileptics/NSAIDs/herbal medicines)
- Hepatitis screen: Hep (A)/B/C; ferritin; +/- EBV/ autoantibodies/ (alpha-1 antitrypsin/ caeruloplasmin)
- USS (?)

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- Baseline reading recommended, if stronger than pravastatin/simvastatin 40mg daily repeat 3 and 12 months
 - If abnormal look for cause cirrhosis
 - Trial without statin if >3 times upper limit of normal AST/GGT
 - Consider initiation even in patients with cirrhosis as proven benefits and no confirmed risks
 - What is the most common cause of deranged LFTs in the UK?
 - Non-alcoholic fatty liver disease (though alcohol commonly implicated also!)

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Case Study

- TD is a 40 year old woman with a history of non-specific abdominal pain. She has been treated for IBS for the last year. When she sees you she tells you that she has felt 'fluey' and had no energy for the last 2 weeks. You notice she has not had any blood tests before and you arrange a 'tired all the time' blood screen. This is all normal except for the following LFTs:
 - ▶ AST 24 (8-40)
 - ▶ GGT 46 (11-50)
 - ▶ ALP 160 (20-130)
 - ▶ Bili 36 (<21)
- ▶ What would you do?

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- You decide to repeat the test a month later. When she comes in for the result you notice that she looks a little more yellow...
 - ▶ AST 40 (8-40)
 - ▶ GGT 80 (11-50)
 - ▶ ALP 260 (20-130)
 - ▶ Bili 60 (<21)
- ▶ What would you do next?

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Raised bilirubin

- Gilbert's: Raised unconjugated bilirubin; mild or no symptoms; if <3 times ULN interval retest and if no signs haemolysis or other disease no further testing required
- ► Most patients without Gilbert's Disease or self limiting virus will not require referral
- ► Consider haemolysis as cause of raised bilirubin, make sure you have checked FBC/reticulocytes
- ► Obstructive causes: gallstones; cancer; primary biliary cirrhosis; primary sclerosing cholangitis

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Case Study

- 40 Female
 - Episodes of abdominal pain after meals
 - Associated with loose stools

Bilirubin	27 µmol/L	(3-17)
ALT	28 U/L	(5-35)
Alk Phos.	220 U/L	(30-150)

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Case Study

- Diagnosis?
 - Obstructive Jaundice
 - Gallstones
- Further tests?
 - Ultrasound
 - Amylase

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Case Study

- 51 Male
 - On isoniazid for tuberculosis for two weeks

Bilirubin	12 µmol/L	(3-17)
ALT	155 U/L	(5-35)
Alk Phos.	166 U/L	(30-150)

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Case Study

- Diagnosis?
 - Hepatitis
- Further tests?
 - Iron studies
 - Immune screen
 - Ultrasound
 - Medication review

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Case Study

- 21 Male
 - Cold symptoms for three days
 - Yellow tinge to eyes

Bilirubin	39 µmol/L	(3-17)
ALT	21 U/L	(5-35)
Alk Phos.	88 U/L	(30-150)

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III Case Study

- Diagnosis?
 - Gilbert's syndrome
 - Unconjugated hyperbilirubinaemia
- Further tests?
 - Repeat
 - No further tests, benign condition

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III Vitamin D

- Where do we get it from?
 - Sunlight, oily fish (pilchards, mackerel, eggs, red meat, liver)
- Who should we test for it?
 - Those with increased need, reduced intake, lack in diet.
 - Housebound
 - Those who cover up
 - Elderly
 - Tanned skin
 - Chronic malabsorptive states

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Vitamin D insufficiency

- 30-50 nmol/L
- Do not need supplements but OTC
- Advise annual blt

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Vitamin D deficiency

- <30 nmol/L
- Need oral supplements-dosage depends on local guidance
- Ideally need repeat calcium/albumin 1 month after initiation
- Risks: Digoxin, BZD, kidney stones

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Questions?



Cholesterol

- Serum cholesterol (2.5-5.0)
- HDL (>1.2)
- Triglycerides (<2.3)
- Eg patient
 - Serum cholesterol 5.6
 - HDL 1.0
 - Triglycerides 3.1

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Qrisk2

- The QRISK®2 algorithm has been developed by doctors and academics
- Based on routinely collected data from many thousands of GPs across the country who have freely contributed data for medical research.
- Updated annually each April, refitted to the latest data to remain as accurate as possible.

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About you

Age (25-84):

Sex: Male Female

Ethnicity:

UK postcode: leave blank if unknown

Clinical information

Smoking status:

Diabetes status:

Angina or heart attack in a 1st degree relative < 60?

Chronic kidney disease (stage 4 or 5)?

Atrial fibrillation?

On blood pressure treatment?

Rheumatoid arthritis?

Leave blank if unknown

Cholesterol/HDL ratio:

Systolic blood pressure (mmHg):

Body mass index

Height (cm):

Weight (kg):

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To treat or not to treat....

- Qrisk >10% start on statins
- Qrisk < 10% diet/lifestyle advice
- Needs annual review
- Document....

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Sodium	135	145	mmol/L
Potassium	3.5	5.0	mmol/L
Urea	2.5	6.7	mmol/L
Creatinine	70	150	µmol/L
eGFR	>90		ml/min

Kidney
Function

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Kidney function

- Role
 - Electrolyte balance
 - Measure of kidney function
- Components?
 - Sodium (Na)
 - Potassium (K)
 - Urea
 - Creatinine/GFR

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Sodium

- Physiology
 - Blood volume
 - Cell membrane reactions
- Pathology
 - Depends on how much water is circulating in plasma
 - Neurological and cardiac effects

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Hypernatremia

- High Sodium (Na)

↑Result ↑Circulating ↓Excretion

- ↑Circulating
 - Fluid loss

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↑Result ↑Circulating ↓Excretion

Hypernatremia

- High Sodium (Na)
- ↓Excretion
 - Diabetes insipidus

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Hyponatremia

- Low Sodium (Na)



- ↓Circulating
 - Reduce intake – elderly
 - Water overload
 - Heart failure
 - Kidney failure

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Hyponatremia

- Low Sodium (Na)

↓Result ↓Circulating ↑Excretion

- ↑Excretion
 - Diuretics
 - Kidney failure
 - Diarrhoea & vomiting
 - Addison's disease

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Potassium



Physiology

Muscle function

- Especially heart

Pathology

Arrhythmias

Muscle weakness

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Hyperkalaemia

- High Potassium (K)

- ↑Circulating
 - Artefactual – traumatic venepuncture/transit time?
 - Rhabdomyolysis

↑Result

↑Circulating

↓Excretion

- K>6.5 - 999

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Hyperkalaemia

- High Potassium (K)

- ↓Excretion
 - Kidney failure
 - Diuretics – ACE-i, spironolactone
 - Addison's disease

↑Result ↑Circulating ↓Excretion

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Hypokalaemia

- Low Potassium (K)

- ↓Circulating
 - Intestinal absorption disorders (rare)

↓Result ↓Circulating ↑Excretion

- K<2.5 - 999

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Hypokalaemia

- Low Potassium (K)

- ↑Excretion
 - Diuretics
 - Diarrhoea & vomiting
 - Cushing's disease

↓Result ↓Circulating ↑Excretion

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Hypokalaemia

Management:

- Admit if K+ <2.5
- Cushings syndrome/ steroids Renal tubular failure
- Consider oral potassium supplement if <3 (but poorly tolerated due to nausea)
- If >3 and on thiazidediuretic rarely needs treatment (Oxford GP Handbook)

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Urea

Physiology

- Waste product
- Broken down proteins

Pathology

- ↑ Production
- ↓ Excretion

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Uraemia

- High Urea

↑ Result

↑ Production

↓ Excretion

- ↑ Production

- Dehydration (concentration)
- Gastro-intestinal bleeding
- Haemolysis

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Uraemia

↑Result	↑Production	↓Excretion
---------	-------------	------------

- High Urea
- ↓Excretion
 - Kidney failure

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Creatinine/GFR

Physiology

- Measure of kidney function
- Inverse relationship

Pathology

- Acute or chronic kidney failure

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Creatinine/GFR

- Creatinine
 - Waste product removed by kidney
 - Direct measurement
- GFR
 - Flow rate of blood through kidneys
 - Indirect measurement (calculated)

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Kidney injury/failure

- Creatinine
 - ↑Rise
 - > 150 µmol/L
- GFR
 - ↓Fall
 - < 90 ml/min

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III Case Study

- DR is a 72 year old man with a past history of: hypertension; an MI 3 years ago; COPD . He is a smoker and you notice he has a long list of medications. He came in as the receptionist said that his salt level was low. His U&Es were:
 - Na 128 (135-145)
 - K 4.8 (3.5-5.2)
 - Creat 105 (60-120)
- ▶ How would you manage this result?
- ▶ You repeat the test a month later and his sodium is now 124. What further investigations would you like to arrange?

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III Case Study

- You are the duty doctor at the surgery and a fax comes in from the biochemistry lab.
- JF is a 60 year old diabetic who had routine blood test at the surgery:
 - ▶ Na 137 (135-145)
 - ▶ K 6.2 (3.5-5.2)
 - ▶ Creat 122 (60-120)
- ▶ What would you do?

Case Study

- A few minutes later you receive another fax from the lab, results for BK, a 67 year old lady with heart failure who was seen last week with diarrhea and vomiting:
 - ▶ Na 132 (135-145)
 - ▶ K 2.4 (3.5-5.2)
 - ▶ Creat 70 (60-120)

What action would you take?

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- PB sees you again after some repeat tests.
- The second eGFR was 37, his creatinine was 142, and you also notice from his blood results that he was slightly anaemic (normocytic) with a haemoglobin of 12.3.
- His albumin/creatinine ratio on the urine sample was 32 mg/mmol.

What would you do in the consultation and what follow up would you arrange?

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Chronic Kidney Disease

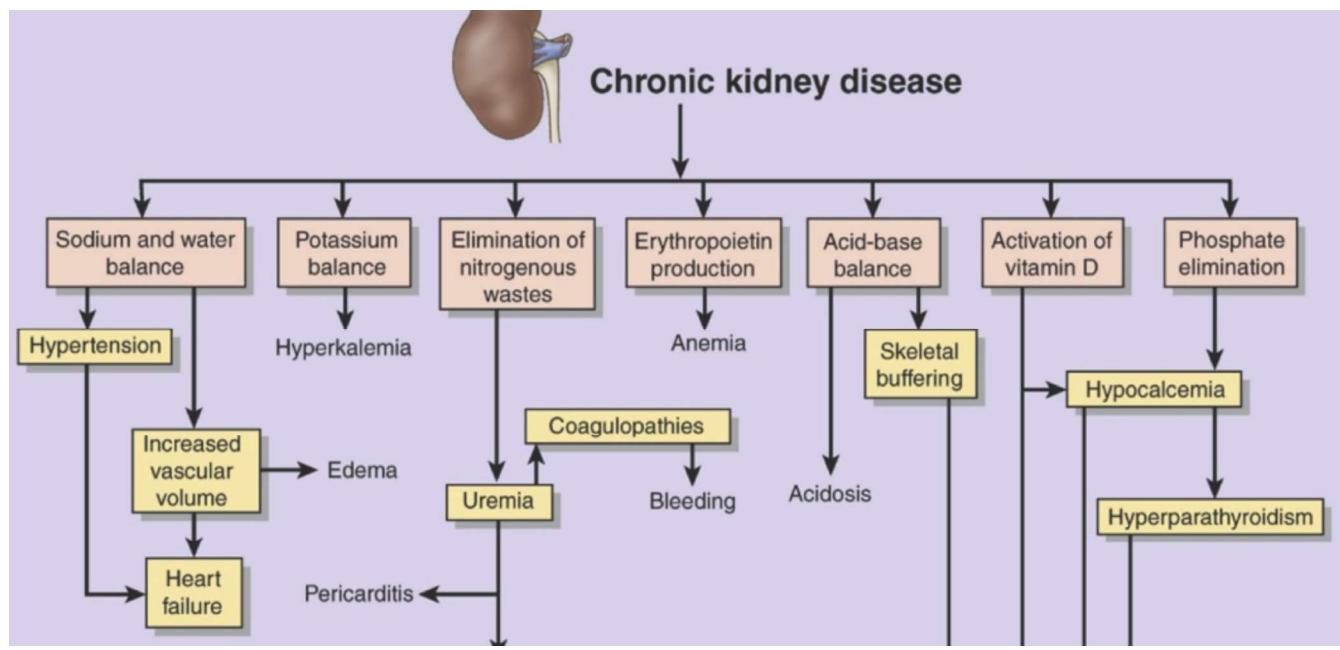
- DIAGNOSIS:
- At diagnosis: First eGFR <60 you should re-test within 2 weeks, and obtain an ACR, confirmed on an early morning ACR after first abnormal result (if not early morning sample)
- ACR >30 indicates proteinuria. In diabetics microalbuminuria considered significant (ACR>2.5 in men, >3.5 in women)
- Test for haematuria using reagent strips. Investigate appropriately if persistent

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Stages of CKD

Stage	Description	eGFR (mL/min)	Potential complications of reduced GFR (in alphabetical order)
1	Kidney damage with normal or ↑ GFR	≥90	<ul style="list-style-type: none">• Anemia, including functional iron deficiency• Blood pressure increases• Calcium absorption decreases• Dyslipidemia /heart failure/volume overload• Hyperkalemia• Hyperparathyroidism• Hyperphosphatemia• Left ventricular hypertrophy• Metabolic acidosis
2	Kidney damage with mild ↓ GFR	60–89	
3	Moderate ↓ GFR	30–59	
4	Severe ↓ GFR	15–29	
5	Kidney failure	<15 or dialysis	

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Chronic Kidney Disease

- Education and lifestyle advice
- Monitor progression (6 monthly in CKD stage)
- Offer renal ultrasound in stage 3 CKD if:
 - Haematuria present
 - Progressive CKD (>5/year or >10/5 yrs)
 - FHx polycystic kidneys
 - Outflow obstruction
- **Aim to keep BP <140/90 (<130/80 if diabetic and ACR >70)**
- **Check Hb in stage 3B (eGFR<45)**

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Chronic Kidney Disease

- **Diabetics:**
 - Offer ACEi/ARB to all diabetics with microalbuminuria
- **Non-diabetics:**
 - Offer ACEi/ARB to patients with hypertension and
- ACR>30
 - Offer ACEi/ARB to all patients with ACR>70
- **Otherwise treat according to normal hypertension guidance**

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Chronic Kidney Disease

- Refer to a specialist for:
- Stage 4 and 5 CKD
- Higher levels of proteinuria (ACR \geq 70 mg/mmol) unless known to be due to diabetes and already appropriately treated

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Case Study

- 52 female
 - Weakness, fall
 - PMH: Hypertension

Sodium	126 mmol/L	(135-145)
Potassium	3.2 mmol/L	(3.5-5.5)
Urea	7.5 mmol/L	(2.5-6.7)
Creatinine	98 µmol/L	(70-150)

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Case Study



Diagnosis?

Hyponatraemia
Diuretics



Further tests?

Magnesium
Postural BP

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Case Study

- 66 Male
 - PMH: Type 2 diabetes, hypertension

Sodium	139 mmol/L	(135-145)
Potassium	5.4 mmol/L	(3.5-5.5)
Urea	7.4 mmol/L	(2.5-6.7)
Creatinine	183 µmol/L	(70-150)
eGFR	48 ml/min	(>90)

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Case Study

- Diagnosis?
 - Renal impairment
 - Diabetes
- Further tests?
 - HbA1C
 - Ultrasound
 - Bone profile

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Questions?



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III Diabetes

- Diabetes is diagnosed on the basis of history (ie polyuria, polydipsia and unexplained weight loss) PLUS
 - a random venous plasma glucose concentration $\geq 11.1 \text{ mmol/l}$
 - OR a fasting plasma glucose concentration $\geq 7.0 \text{ mmol/l}$
 - OR 2 hour plasma glucose concentration $\geq 11.1 \text{ mmol/l}$ 2 hours after 75g anhydrous glucose in an oral glucose tolerance test (OGTT)
- In the absence of symptoms 2 results from different days are required

Impaired fasting glycaemia

- ▶ Fasting plasma glucose ≥ 6.1 but < 7.0 mmol/L
- ▶ British Dietetic Association recommends all should have glucose tolerance test
- ▶ 2.2% relative annual risk progression to diabetes (?higher), remember gestational.
- ▶ Manage risk factors and arrange annual follow up

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HbA1c

- Refined marker of sugar control over 3 months
- High risk of DM 42-48
- Diabetic 48+ on more than 1 reading
- Diabetic control should be 48-58
- Beware of variants

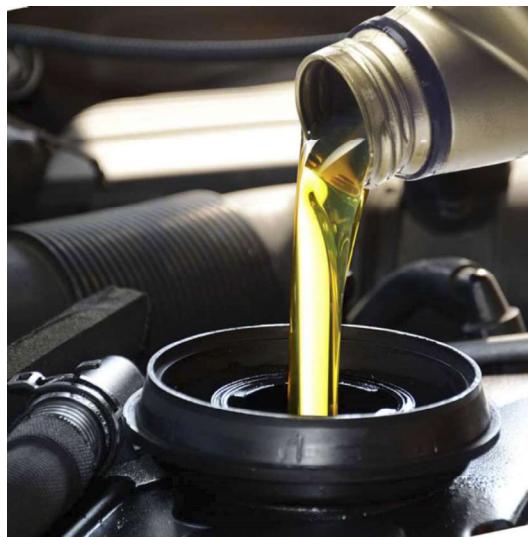
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TFTs

- TSH ($0.4 - 4 \text{ mU/L}$)
 - Free T4 ($9 - 25 \text{ pmol/L}$)
 - Free T3 ($3.5 - 7.8 \text{ nmol/L}$)
-
- Whilst free T3 (fT3) is measured, it is less relevant than free T4 (fT4), because the thyroid releases T4 and T3 at a ratio of about 20:1 respectively, with T3 mainly being produced by peripheral conversion of T4. As a result, T4 is a much better marker of thyroid function.
 - Free T4 (fT4) is roughly 1% of the total T4, with the rest being bound to thyroid binding globulin.
 - T4 has a half-life of about one week, therefore to monitor the impact of an intervention (e.g. increasing a patient's levothyroxine dose) you need to wait several weeks before repeating TFTs.

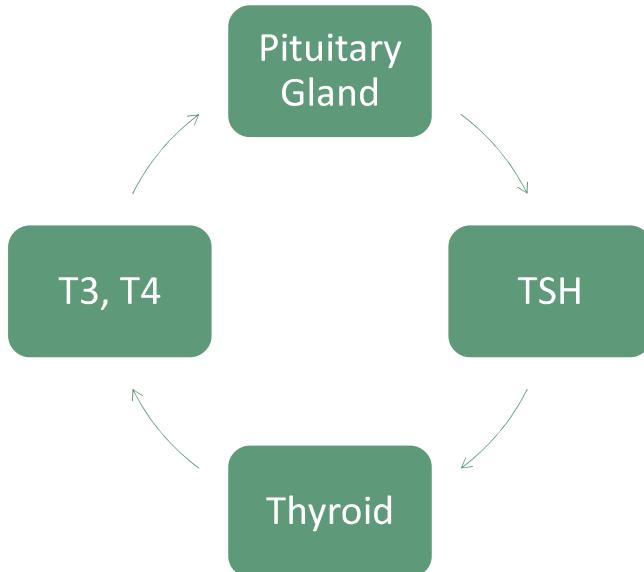
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The engine oil of life



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Thyroid axis



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Thyroid hormonal axis overview

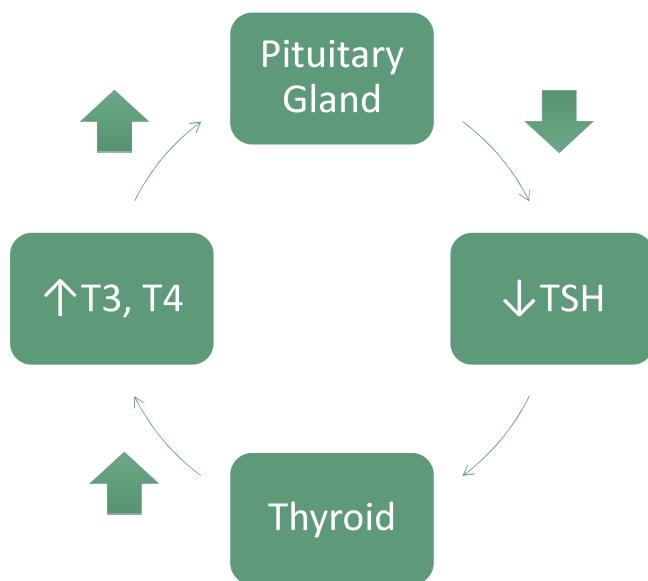
1. The paraventricular nuclei in the hypothalamus release thyroid releasing hormone (TRH).
2. This causes thyrotrope cells in the anterior pituitary to release thyroid stimulating hormone (TSH).
3. The thyroid responds to the TSH by releasing T4 and T3.
4. T4 inhibits the pituitary and hypothalamus in a negative feedback loop. This is the 'brake system' which aims to maintain a state of homeostasis.

III Hyperthyroidism

- Excess secretion of T3 & T4
- Negative feedback on pituitary gland
- Decreased production of TSH

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Hyperthyroidism



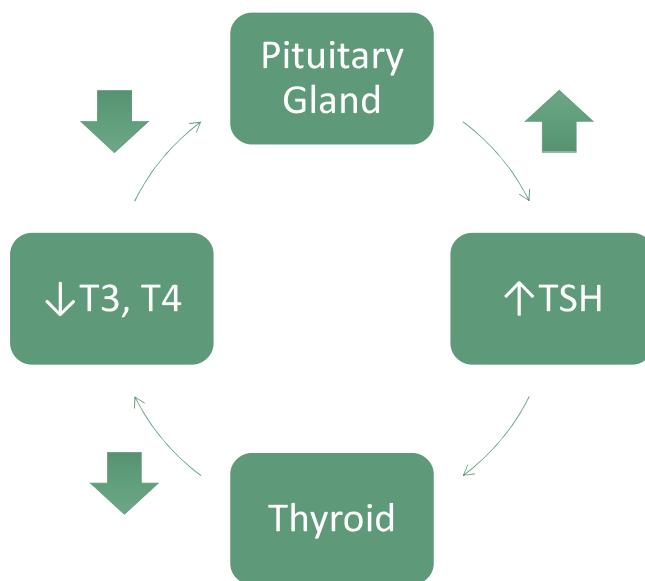
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Hypothyroidism

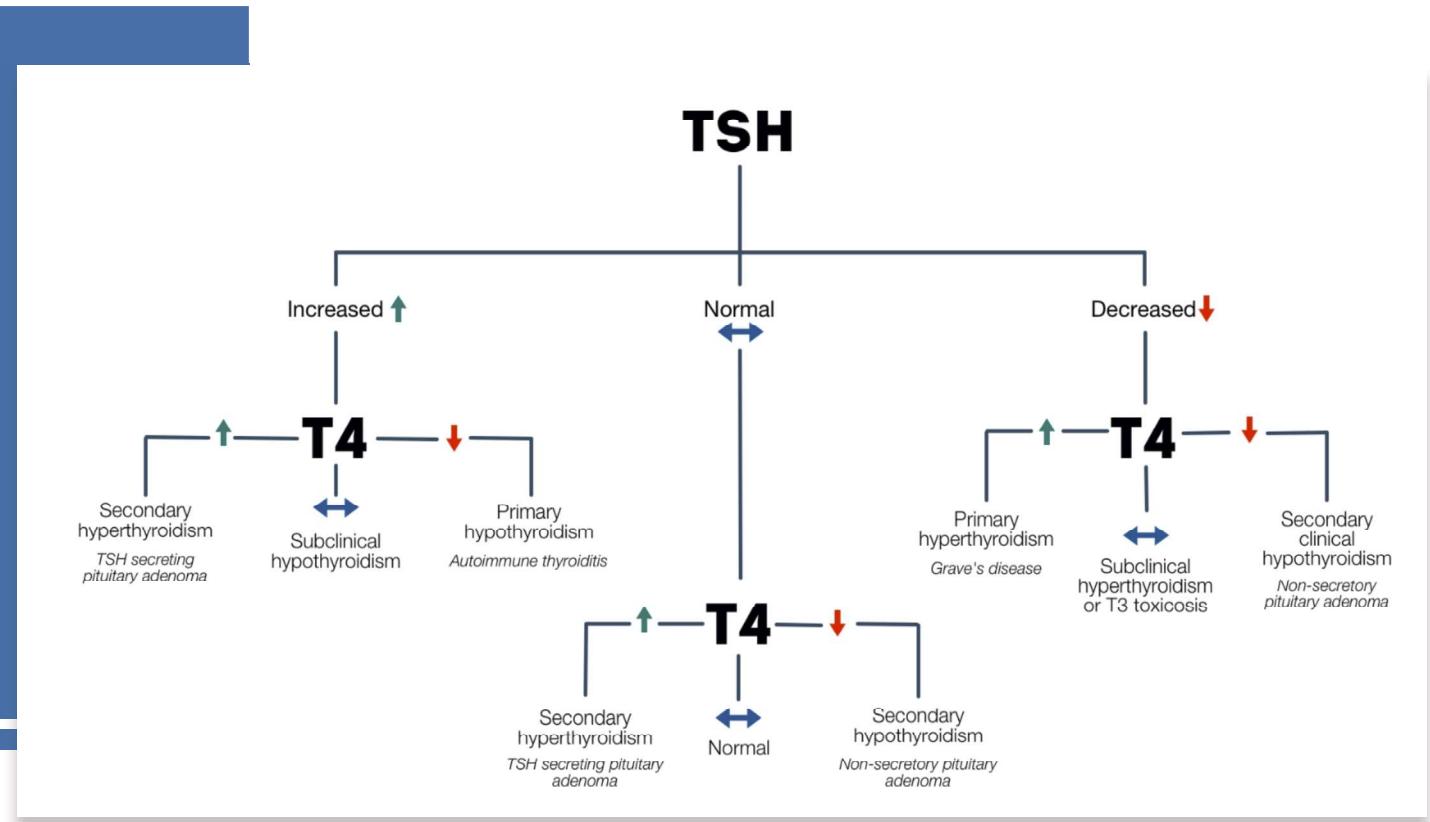
- Reduced secretion of T3 & T4
- Reduced response to TSH
- Positive feedback on pituitary gland
- Increased production of TSH

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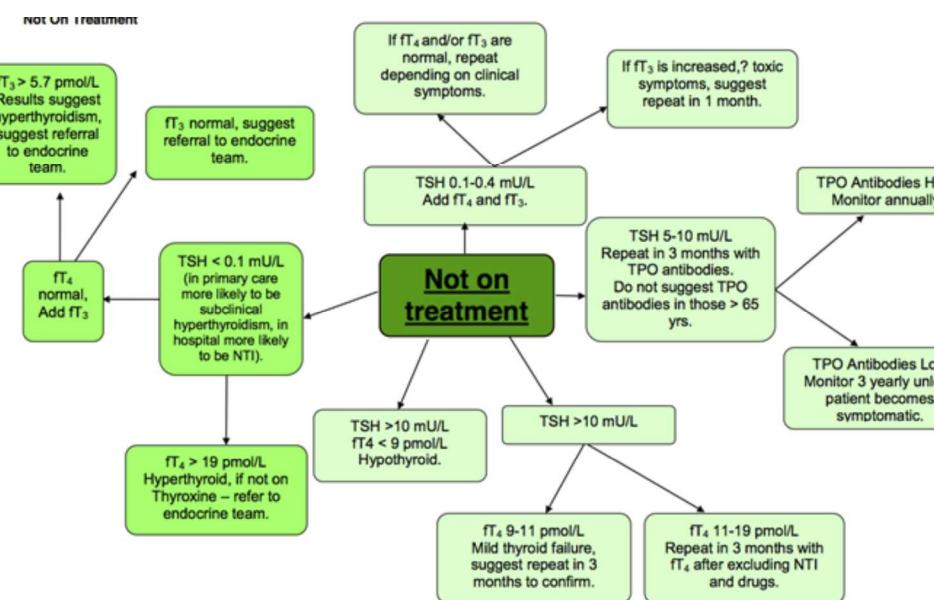
Hypothyroidism



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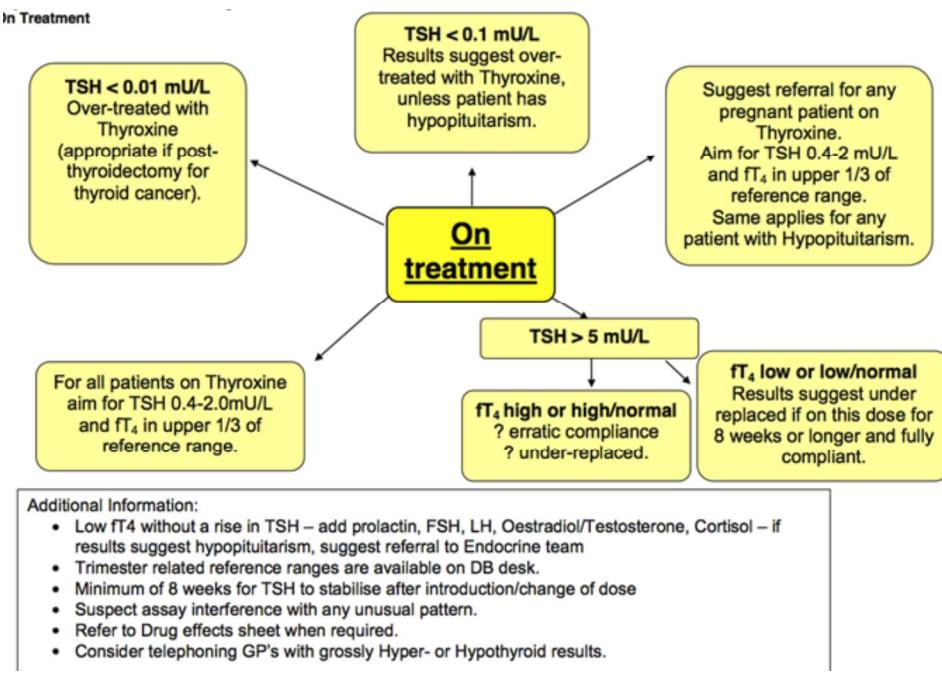
TFTs – Interpretation

CONTROLLED DOCUMENT – DO NOT PHOTOCOPY DO NOT USE AFTER REVIEW DATE

This algorithm describes the interpretation of thyroid function tests for patients not taking thyroxine.

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TFTs – Interpretation on Medication



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Case Study

- 35 Male
 - Anxious
 - Palpitations
 - Tremor

TSH	<0.01 mU/L	(0.4-4.5)
T4	55 pmol/L	(10-24)

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Case Study

- Diagnosis?
 - Primary hyperthyroidism (Grave's disease)
- Further tests?
 - ECG

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Case Study

- 66 Female
 - Tired
 - Cold
 - Confusion

TSH	10.2 mU/L	(0.4-4.5)
T4	8.9 pmol/L	(10-24)

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Case Study

- Diagnosis?
 - Primary hypothyroidism (Autoimmune thyroiditis)
- Further tests?
 - Immune screen

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Questions?



Prostate Specific Antigen

When you have a PSA test, you should not have:

- An active urine infection.
- Produced semen during sex or masturbation (ejaculated) in the previous 48 hours.
- Exercised heavily in the previous 48 hours.
- Had a prostate biopsy in the previous six weeks.
- Had an examination of the back passage with a gloved finger (a digital rectal examination) in the previous week.
- Gay, bisexual, and other men who have sex with men should avoid receptive anal intercourse for 48 hours before a PSA test.
- Each of these may produce an unusually high PSA result.

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PSA Cut-off Values

Age (years)	PSA Cut-off
40-49	2.0 nanogram/mL or higher
50-59	3.0 nanogram/mL or higher
60-69	4.0 nanogram/mL or higher
70 or older	5.0 nanogram/mL or higher

PSA

There are no age-specific reference limits for men older than 80 years of age.

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PSA

- **If your PSA level is not raised**
 - You are unlikely to have cancer. No immediate further action is needed but you may need further tests to confirm the result.
- **If your PSA level is slightly raised**
 - You probably do not have cancer. You might need further tests, including more PSA tests.
- **If your PSA level is definitely raised**
 - Your GP will refer you to see a doctor who is a specialist for you to have further tests to find out if you have prostate cancer.

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PSA

- The higher the level of PSA, the more likely it is to be a sign of cancer.
- The PSA test can also miss cancer.
- ~ 15 /100 men who have prostate cancer will have had a normal PSA level.
- A one-off test is not reliable and repeating the test may provide important information.

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PSA dilemma

- Around 2/3 of men with a raised PSA do not have prostate cancer
- One study found 1 in 6 men with a ‘normal’ PSA may have prostate cancer

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Resources

- Geekymedics.co.uk
- Labpedia
- Buku app
- cks.nice.org.uk
- Gpnotebook.co.uk

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CONTACT INFO



+00442076928709



info@belmatt.co.uk
admin@belmatt.co.uk



www.belmatt.co.uk



Suite 570, 405 Kings Road
Chelsea
SW10 0BB



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