
Ordering Blood Work: Back to the Basics

Tamara Petrosyan, O.D.

Associate Clinical Professor

SUNY College of Optometry

NYC Health + Hospitals/Gotham Health

Financial Disclosure

- Tamara Petrosyan is financially affiliated with Armenian Eye Care Project, Anteo Health, Emergent, and Bernell Corp. but has not received commercial support and has no financial or proprietary interest in any companies, products or services mentioned in this presentation.
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Goal

Basic overview of common laboratory tests, what they test for, and what the results may indicate

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Clinical Laboratory Tests Approved for Optometry

The list of laboratory tests accessed by the [link](#) below may be ordered by Doctors of Optometry licensed in New York State to be performed by clinical laboratories certified by the [New York State Department of Health](#). Such tests must be relevant to and inform the diagnosis and treatment of conditions and diseases of the eye that are within the scope of practice of optometry. In cases where such test results indicate a systemic disease or condition that is beyond the scope of practice of optometry, the optometrist shall make a referral to an appropriate physician and facilitate transfer of the test results to the extent feasible.

Tests

- [Blood Tests](#)
- [Microbiology Tests](#)
- [Other](#)

Microbiology Tests

- Bacterial, Viral, and Fungal Cultures
- Nucleic Acid Amplification test (NAAT)

Last Updated: September 30, 2022

Optometrist in NYS are allowed to order the following blood testing:

- Acetylcholine receptor (AChR) Blocking, Binding and Modulating
- Adenovirus detector
- Angiotensin Converting Enzyme (ACE)
- Antibody titers (Lyme, Toxoplasmosis, Toxocara, HSV 1/2, VZV, Hepatitis, CMV)
- Anticardiolipin
- Anti-dsDNA
- Antinuclear Antibody (ANA)
- Anti-RNP
- Anti-SM
- C-Antineutrophil Cytoplasmic Antibodies
- C-reactive protein
- CD4:CD8 ratio
- Complement C3, Complement C4 (C3,C4)
- Complete Blood Count with Differential (CBCD)
- Cyclic citrullinated peptide (anti- CCP)
- Erythrocyte sedimentation rate
- Factor V Leiden
- Fasting Plasma Glucose
- Fluorescent Treponemal Antibody -absorption (FTA-ABS)
- Folate
- Genetic testing
- Glucose – full blood count (FBC)
- Hemoglobin A1C(HbA1C)
- Hemoglobin Electrophoresis
- HIV Antigen/Antibody, Cluster of Differentiation 4 (CD4)
- HLA-B27, HLA-B51, HLA DR4, HLA B8, HLW B54
- Immunoglobulin G (IgG)/ Immunoglobulin M (IgM)
- Lipid Profile/Panel: Cholesterol, LDL,HDL,Triglycerides
- Liver function tests - Hep C
- Oral Glucose Tolerance Test (OGTT)
- P-Antineutrophil Cytoplasmic Antibodies
- Protein C, Protein S
- Prothrombin time (PT), Partial thromboplastin time (PTT), International normalized ratio (INR)
- QuantiFERON-TB gold Assay (TB testing)
- Rapid Plasma Reagin (RPR)
- Rheumatoid Factor (RF)
- Sedimentation Rate and Non-ultraC-reactive Protein (CRP)
- Serum Lysozyme
- Sjogren's Antibody A +B (SS-A/SS-B), SSC
- Thiamine
- Thyroid Stimulating Hormone (TSH), Triiodothyronine (T3), Thyroxine (T4), Thyroid stimulating immunoglobulin (TSI)
- Total Complement Immunoassay
- Toxocariasis Titer
- VDRL
- Venereal Disease Reference Lab VDRL
- Vitamin B12 levels

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Introduction

- Optometrists are primary eye care providers
 - Play key role in preventing, diagnosing, and comanaging systemic diseases
- Laboratory tests are important tools for diagnosis and management of systemic and ocular disease
- Must be able to
 - Recognize indications for ordering blood work
 - Analyze and communicate results
 - Treat / Comanage the patient

Introduction

- Why order blood work?
 - Rule out, Confirm, Screen for a disease / ddx
 - Before initiating a systemic medication
 - Follow treatment of a disease



Introduction

- Laboratory results have 'normal' reference ranges
 - Vary with laboratory
 - Norms will be provided with results
 - Lab will highlight abnormal findings
 - Interpretation may be provided
- Important to review both pertinent *positive* and pertinent *negative* results

TEST NAME	RESULT	UNITS	REFERENCE RANGE
CHEM-SCREEN PANEL			
GLUCOSE	87	mg/dL	65 - 125
SODIUM	140	mmol/L	136 - 144
POTASSIUM	4.6	mmol/L	3.6 - 5.1
CHLORIDE	106	mmol/L	99 - 109
CARBON DIOXIDE (BICARBONATE)	28	mmol/L	21 - 31
BUN (BLOOD UREA NITROGEN)	9	mg/dL	8 - 24
CREATININE	0.9	mg/dL	0.7 - 1.3
BUN/CREATININE RATIO	10.0		
URIC ACID	6.0	mg/dL	3.0 - 8.1
PHOSPHATE	3.5	mg/dL	2.3 - 4.5
CALCIUM	9.6	mg/dL	8.8 - 10.3
MAGNESIUM	2.09	g/dL	1.50 - 2.50
CHOLESTEROL	258	mg/dL	120 - 199
HDL CHOLESTEROL	41	mg/dL	35 - 59
CHOL/HDL RATIO	6.3		3.6 - 6.4
LDL CHOL., CALCULATED	179	mg/dL	75 - 129
TRIGLYCERIDES	231	mg/dL	40 - 200
PROTEIN, TOTAL	8.3	g/dL	6.5 - 8.3
ALBUMIN	4.5	g/dL	4.0 - 5.0
GLOBULIN, CALCULATED	3.8	g/dL	2.1 - 3.6
A/G RATIO	1.2		1.1 - 2.0
BILIRUBIN, TOTAL	0.51	mg/dL	0.20 - 1.50
BILIRUBIN, DIRECT	0.10	mg/dL	0.00 - 0.20
ALKALINE PHOSPHATASE	85	IU/L	30 - 110
GGT	24	IU/L	5 - 80
AST (SGOT)	46	IU/L	5 - 43
ALT (SGPT)	45	IU/L	5 - 60
AMYLASE, SERUM	33	IU/L	0 - 100
LD	235	IU/L	100 - 215
IRON	106	mg/dL	50 - 170

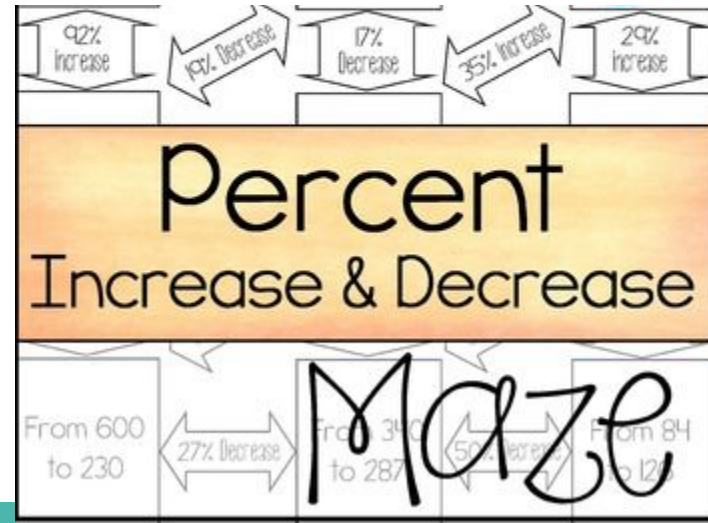
Introduction

- Order any test you think may be beneficial on initial order
 - Decreasing need for multiple blood draws
- Tests should be driven by *possible differentials*
 - More tests ordered = higher chance of an 'abnormal' finding (false positive)

	Test says you don't have it	Test says you do have it
You really don't have it	TRUE NEGATIVE	FALSE POSITIVE
You really do have it	FALSE NEGATIVE	TRUE POSITIVE

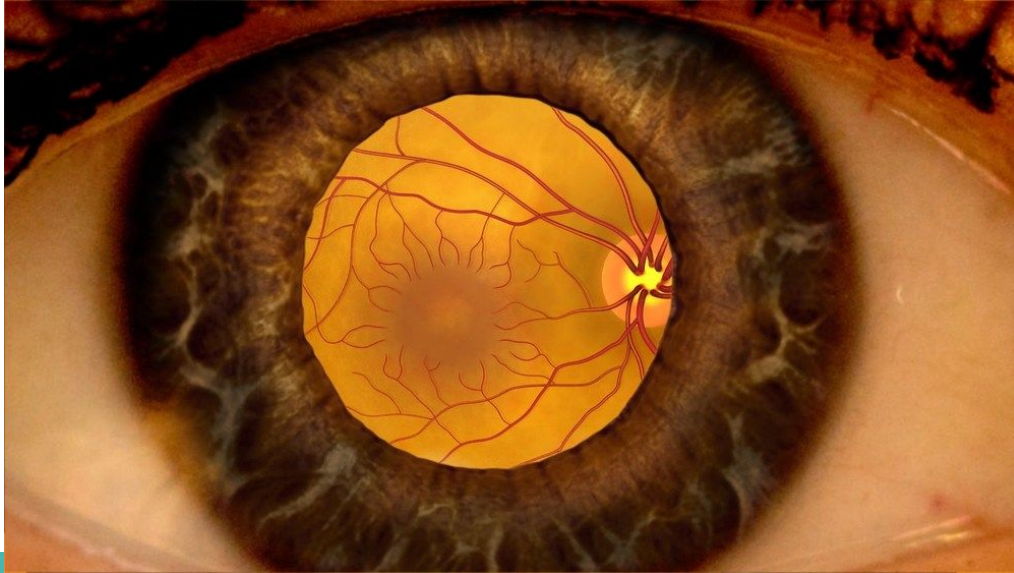
Introduction

- Results are rarely pathognomonic
 - Must be used in conjunction with patient *history* and clinical *findings*
 - Increases or decreases the *possibility* of a disease



Before you order blood work

- Narrow down the differentials
 - Good case history
 - Good ocular / physical examination



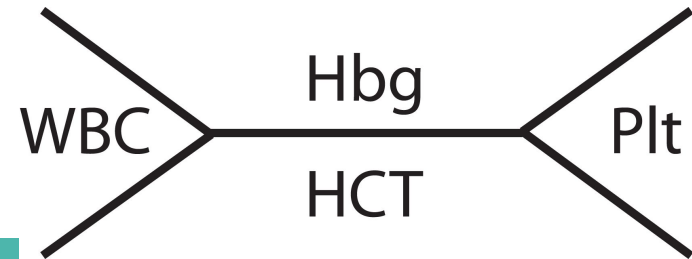
Review of Common Laboratory Tests

BLOOD CHEMISTRY Anemia, Atherosclerosis	HEMATOLOGY Coagulation	IMMUNOLOGY Non Granulomatous	INFECTIOUS Granulomatous
CBC c Diff	PT / INR	ESR	RPR
BMP	PTT	CRP	VDRL
Hgb A1C	Protein C / S	ANA	Lyme ELISA
Lipid Panel	Factor V Leiden	ENA Panel	Herpes
Thyroid Panel		RF	
		CCP	
		HLA Typing	
		AChR Antibody	
		ACE	
		Serum Lysozyme	

Blood Chemistry	Hematology	Immunology	Infectious
CBC c Diff	PT / INR	ESR	PPD
BMP	PTT	CRP	AFB Smear
Hgb A1C	Protein C / S	ANA	QFT
Lipid Panel	Factor V Leiden	ENA Panel	FT-ABS
Thyroid Panel		ANCA	RPR
		RF	VDRL
		CCP	Lyme
		HLA Typing	Herpes
		AChR Antibody	
		ACE	
		Serum Lysozyme	

Complete Blood Count with Differential

- AKA: CBC c Diff
- Evaluates: blood *makeup*
 - Determine general health status
 - Screen for, diagnose, or monitor conditions that affect *blood cells*
 - Monitor treatment known to affect blood cells



Complete Blood Count with Differential

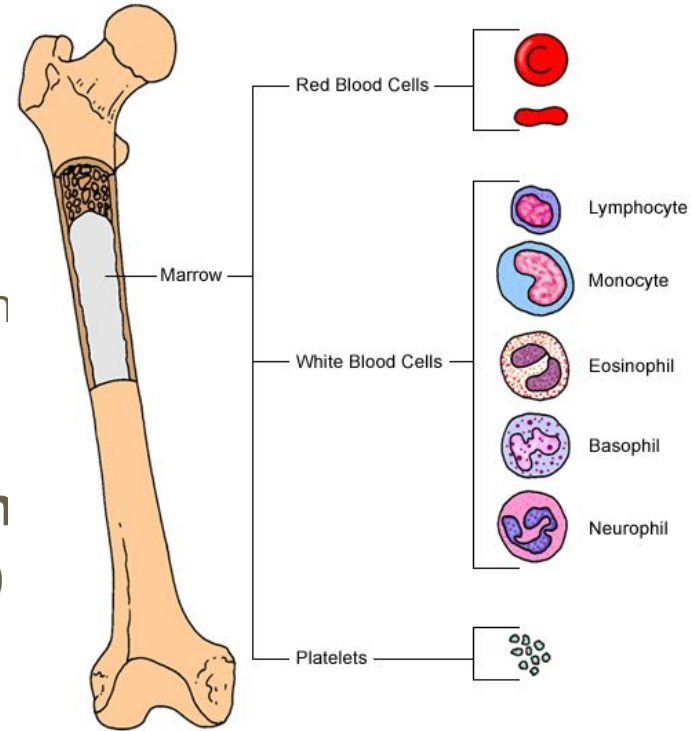
- **Red blood cell - anemia**

- Total red blood cell count (RBC)
- Hemoglobin (Hgb)
- Hematocrit (Hct)
- Mean Corpuscular Hemoglobin (MCH)
- Mean Corpuscular Hemoglobin Concentration
- Red blood cell distribution width (RDW)
- Mean corpuscular volume (MCV)

- **White blood cell - infection / inflammation**

- Total white blood cell / leukocyte count (WBC)
- WBC count with differential may be ordered

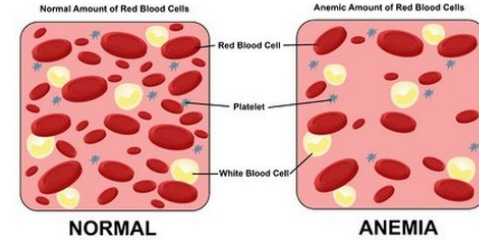
- **Platelet Count (PLT) - clotting**



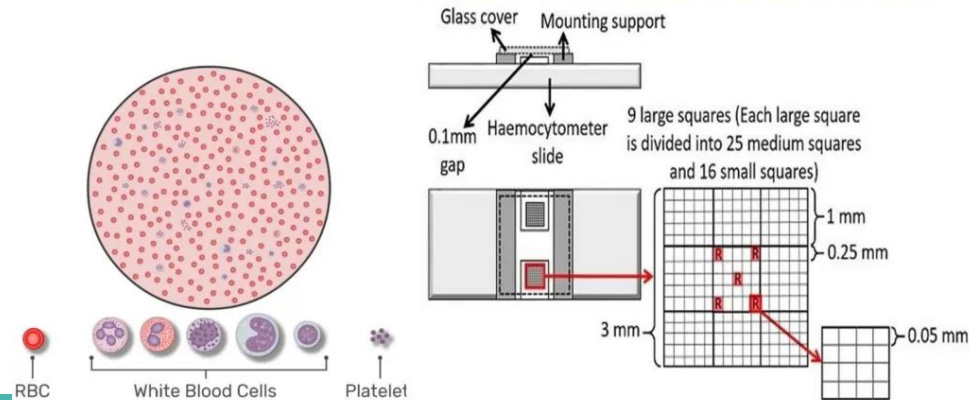
Complete Blood Count with Differential

- Red blood cell
 - Total red blood cell count (RBC)
 - *Number of circulating RBC in 1mm^3 of VB* (~20 drops of blood)
 - Does not inform on how well the RBCs are, just how many there are
 - Low = Deficiency in iron vitamin / minerals

ANEMIA

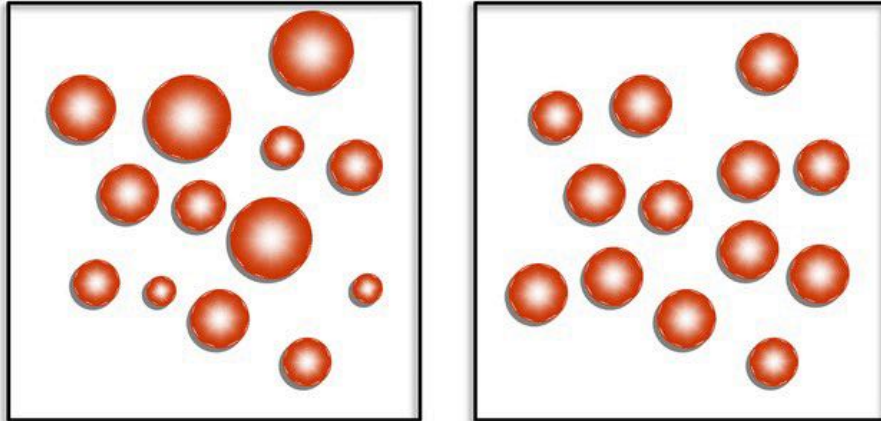


Total RBC Count Method



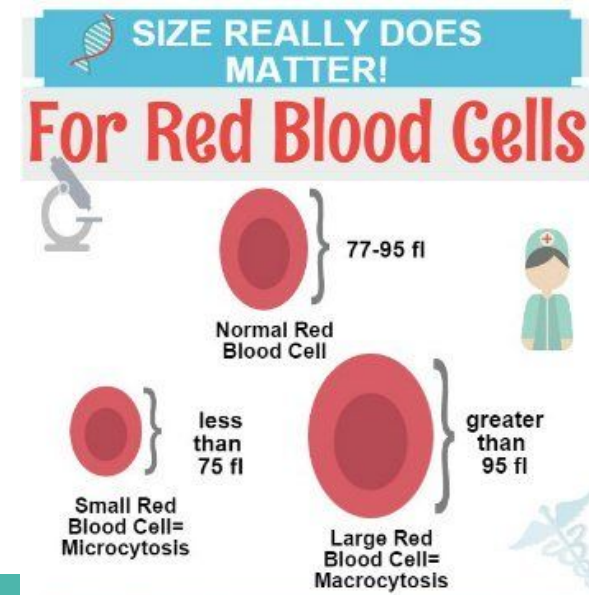
Complete Blood Count with Differential

- Red blood cell
 - Red blood cell distribution width (RDW)
 - Amount of *variation in size* of RBC
 - Elevated RDW ~ more variation in size of RBC
 - Young RBCs larger
 - High in sickle cell disease



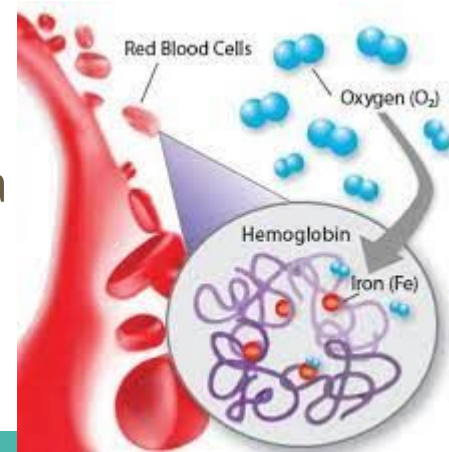
Complete Blood Count with Differential

- Red blood cell - Mean corpuscular volume (MCV)
 - *Average size of RBCs*
 - Important in *classifying anemias*
(normocytic, microcytic, macrocytic anemia)
 - Low in iron deficiency anemia
 - High in vitamin deficiency anemia



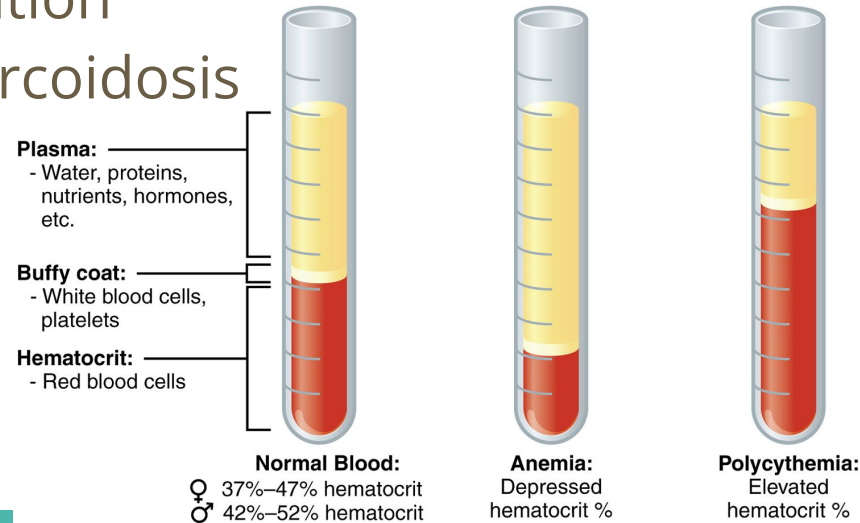
Complete Blood Count with Differential

- Red blood cell
 - Hemoglobin (Hgb)
 - Protein in RBCs that *carries oxygen to tissue*
 - Amount of Hgb is indicative of amount of RBC in venous blood
 - Hgb makes up about 90% of RBC
 - Decreased Hgb concentration = anemia
 - Increased Hgb concentration = polycythemia



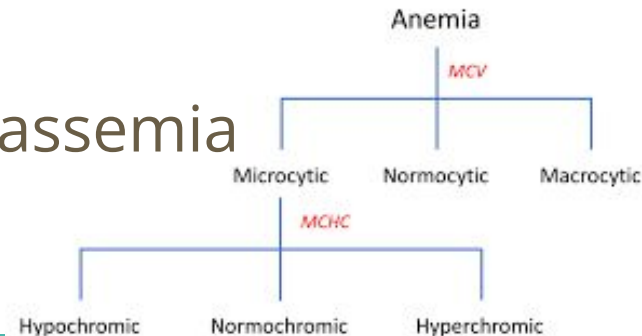
Complete Blood Count with Differential

- Red blood cell
 - Hematocrit (Hct)
 - What % of blood is made up of RBC (vs WBC / Plasma)
 - Closely related to RBC and hemoglobin levels
 - High - CHF, COPD, dehydration
 - Low - Anemia, bleeding, sarcoidosis



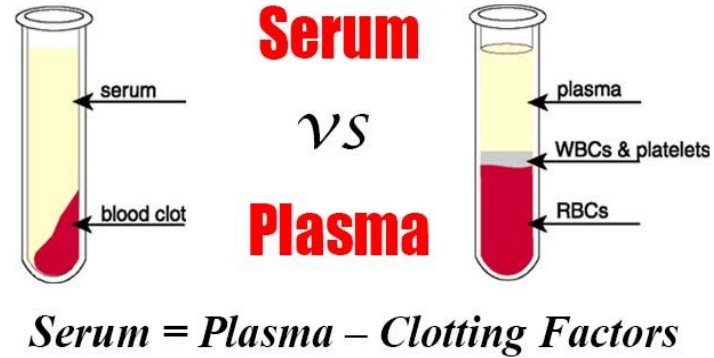
Complete Blood Count with Differential

- Red blood cell
 - Mean Corpuscular Hemoglobin (MCH)
 - Concentration of hemoglobin *per RBC*
 - Mean Corpuscular Hemoglobin Concentration (MCHC)
 - Average concentration of hemoglobin *per total RBC volume*
- Low ~ Iron deficiency anemia and thalassemia
- High ~ Hemolytic anemia



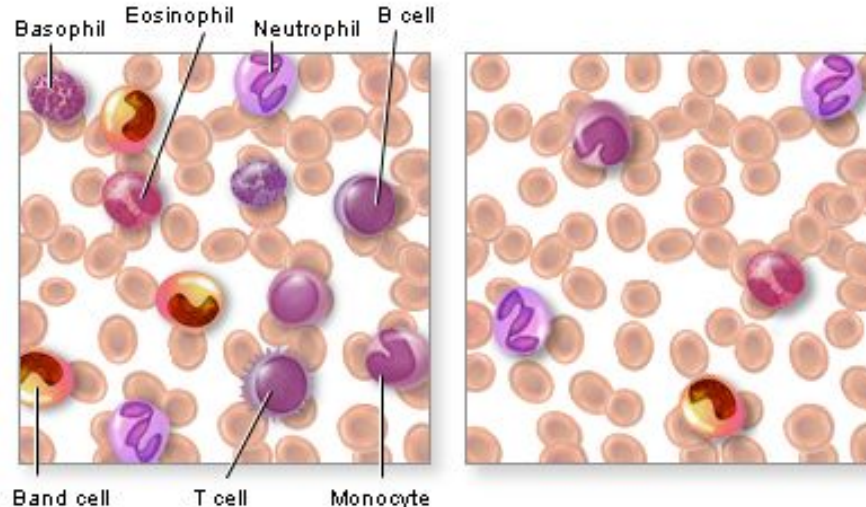
Complete Blood Count with Differential

- Red blood cell
 - Plasma - Liquid component of blood with the blood cells removed (via centrifuge) - containing platelets, proteins, sugar, and salt which carry blood cells, hormones, nutrients, and chemicals to the body
 - Maintains blood pH ~7.4
 - Serum - Same as plasma, except all clotting factors removed



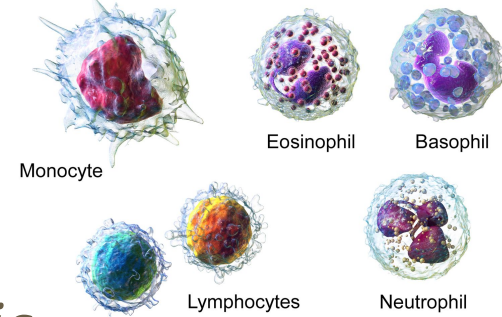
Complete Blood Count with Differential

- White blood cell
 - Total WBCs or leukocytes in 1mm^3 of VB (~20 drops of blood)
 - Low ~ Bone marrow disorder, autoimmune / granulomatous dx
 - High ~ Infection, Inflammation, Leukemia



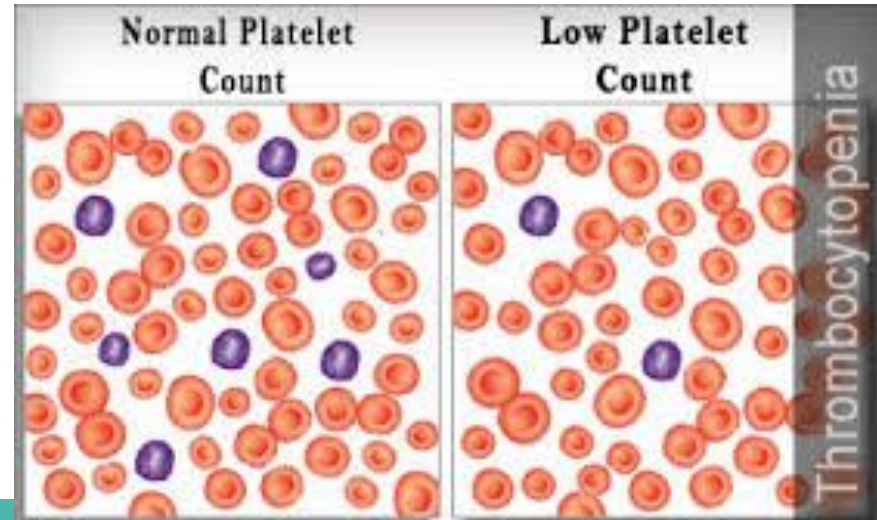
Complete Blood Count with Differential

- Leukocyte Differential
 - Neutrophils - inc. in *bacterial* infection
 - Most abundant / intrinsic immune system
 - 45-75% of WBCs
 - Lymphocytes - inc. in *viral* infection
 - Monocytes - inc. in *bacterial* infection
 - Eosinophils - inc. in *allergies* and *parasitic* infection
 - Basophils - inc. during *immediate immune response* to external antigen



Complete Blood Count with Differential

- Platelet Count (PLT)
 - Amount of platelets / thrombocytes per 1mm^3 of VB
 - Platelets are needed for clotting and scab formation
 - Low ~ Autoimmune dx, chemotherapy, medication
 - High ~ Cancer, RA, IBD, SLE



Complete Blood Count

- When Is It Ordered?
 - Routine health exam
 - Signs and symptoms of disorders that affect blood cells
 - Fatigue or weakness
 - Infection or inflammation
 - Bruising or Bleeding
 - Prior to initiating certain oral medications
 - To monitor a disease or patients on medications
- Consider ordering B9/B12/Thiamine to check for nutritional deficiency



Dark circles under eyes



Pale Conjunctiva



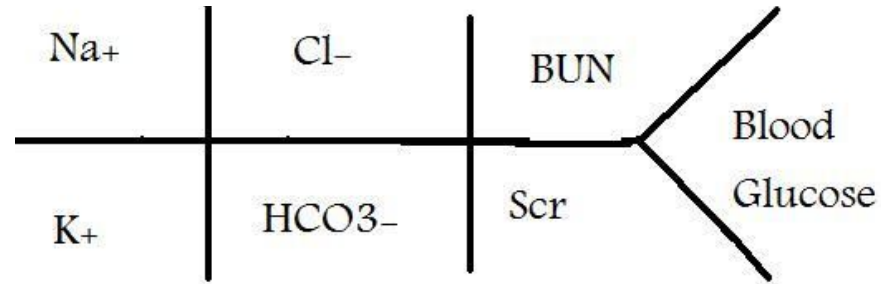
Hypoxia

Blood Chemistry	Hematology	Immunology	Infectious
CBC c Diff	PT / INR	ESR	PPD
BMP	PTT	CRP	AFB Smear
Hgb A1C	Protein C / S	ANA	QFT
Lipid Panel	Factor V Leiden	ENA Panel	FT-ABS
Thyroid Panel		ANCA	RPR
		RF	VDRL
		CCP	Lyme
		HLA Typing	Herpes
		AChR Antibody	
		ACE	
		Serum Lysozyme	

Basic Metabolic Panel

- AKA: BMP or Chem-8
- Evaluates:
 - Information about body's *metabolism*

- Kidney function
- Blood glucose level
- Electrolyte balance
- Acid/Base balance



- May need to fast 10-12 hrs prior (as ordered)

Basic Metabolic Panel

- Performed together to make ordering the tests easier

- Serum glucose (Glu)

- Total Calcium (Ca)

- Electrolytes

- Sodium (Na)

- Potassium (K)

- Chloride (Cl)

- Carbon Dioxide Content (CO₂)

- Kidney function

- Blood Urea Nitrogen (BUN)

- Serum Creatinine (Cr)

Na⁺ 135-147 meq/L	Cl 95-106 meq/L	BUN 6-20 mg/dL	Glucose 70-110 mg/dL
K⁺ 3.5-5.2 meq/L	CO₂ 22-30 meq/L	SCr 0.6-1.3 mg/	

Basic Metabolic Panel

- Blood Glucose
 - Fasting Blood Glucose (FBG)
 - Amount of glucose in blood *at time* of collection with fasting
 - Random Glucose (RBG)
 - Amount of glucose in the blood at time of collection *without fasting* (postprandial)
 - Two-Hour Postprandial Glucose
 - Measure of serum glucose *two hours after a meal* (should normalize after 2 hours)
 - Used to Dx gestational diabetes

Fasting Blood Glucose

GLUCOSE LEVEL	INDICATION
From 70 to 99 mg/dL (3.9 to 5.5 mmol/L)	Normal fasting glucose
From 100 to 125 mg/dL (5.6 to 6.9 mmol/L)	Prediabetes (impaired fasting glucose)
126 mg/dL (7.0 mmol/L) and above on more than one testing occasion	Diabetes

2-Hour Oral Glucose Tolerance Test (OGTT)

Levels applicable except during pregnancy. Sample drawn 2 hours after a 75-gram glucose drink.

GLUCOSE LEVEL	INDICATION
Less than 140 mg/dL (7.8 mmol/L)	Normal glucose tolerance
From 140 to 199 mg/dL (7.8 to 11.1 mmol/L)	Prediabetes (impaired glucose tolerance)
Equal to or greater than 200 mg/dL (11.1 mmol/L) on more than one testing occasion	Diabetes

Basic Metabolic Panel

- Calcium
 - Used in muscle, nerve, and heart function, blood clotting, and bone formation
- Sodium
 - Determinant of extracellular osmolarity. Used in nerve and muscle function
- Potassium
 - Determinant of intracellular osmolarity. Used in cell metabolism and muscle function
- Chloride
 - Major extracellular anion. Regulates amount of fluid in body
- Carbon Dioxide
 - Helps maintain body's pH

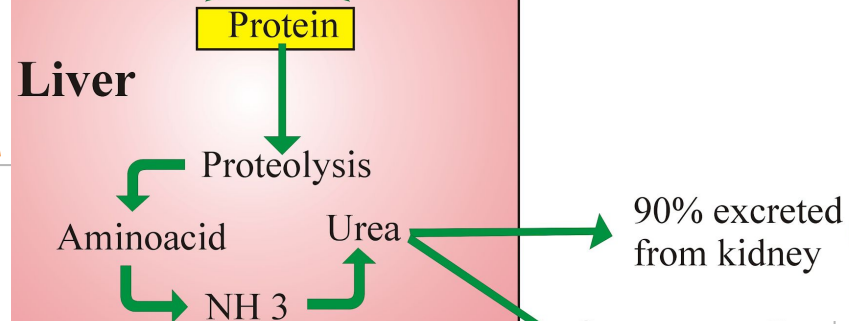
Basic Metabolic Panel

- Kidney Function

- Blood Urea Nitrogen (BUN)

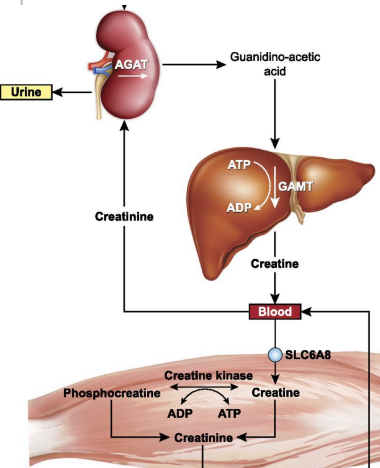
- Amount of urea nitrogen in the blood

- Urea formed in liver (2* protein metabolism) and transported to kidneys for excretion
 - Renal disease → decreased urea excretion → increased BUN
 - Increased BUN
 - Impaired kidney, Dehydration, Congestive heart failure, Medication
 - Decreased BUN
 - Impaired liver



Basic Metabolic Panel

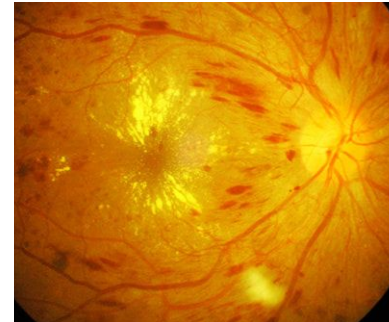
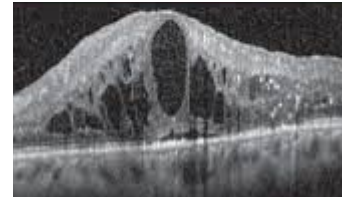
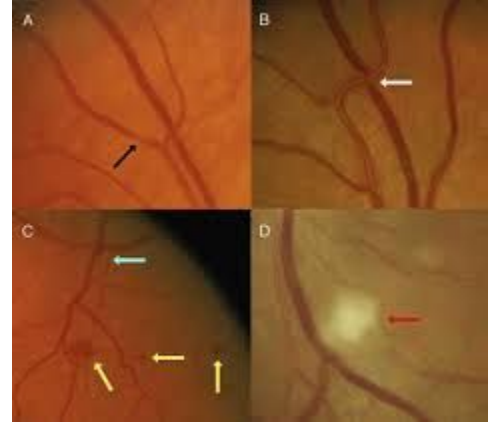
- Kidney Function
 - Creatinine
 - Amount of creatinine in blood
 - Chemical waste from muscle metabolism → excreted in kidney → levels are proportional to renal excretory function



- Increased Creatinine
 - Kidney disease, Prostate disease, Urinary tract obstruction, Congestive heart failure, Atherosclerosis, Diabetes
- Decreased Creatinine
 - Decreased muscle mass

Basic Metabolic Panel

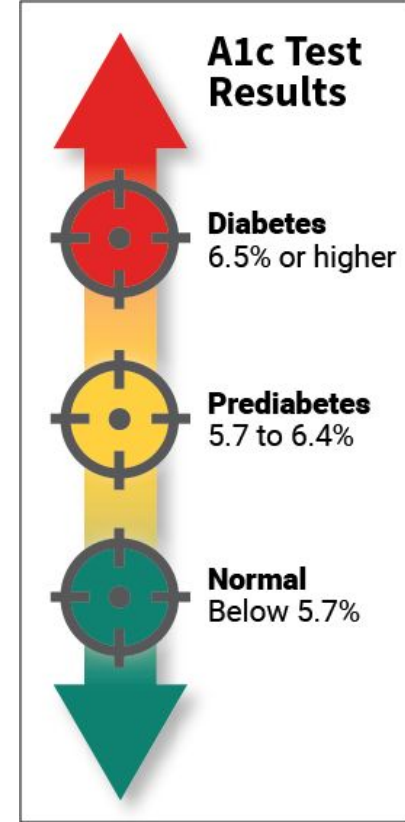
- Commonly used for:
 - As part of a routine health exam
 - Determine underlying systemic problems
 - Evaluate patient's metabolism
 - Hypertensive or Diabetic patients
 - Hx of cardiovascular disease
 - When hospitalized or in ER
- Complete Metabolic Panel (CMP) includes liver function



Blood Chemistry	Hematology	Immunology	Infectious
CBC c Diff	PT / INR	ESR	PPD
BMP	PTT	CRP	AFB Smear
Hgb A1C	Protein C / S	ANA	QFT
Lipid Panel	Factor V Leiden	ENA Panel	FT-ABS
Thyroid Panel		ANCA	RPR
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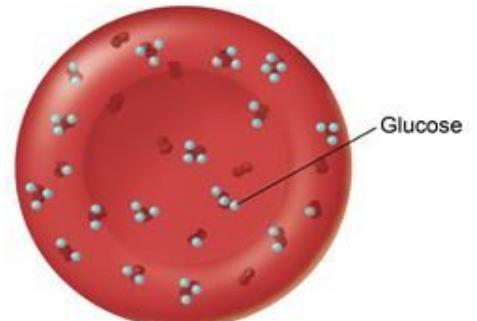
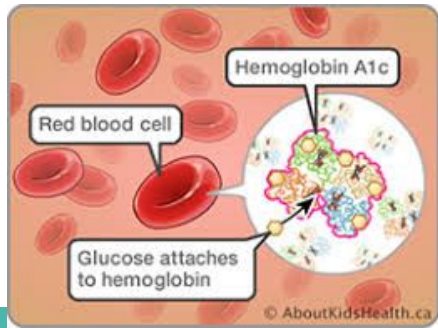
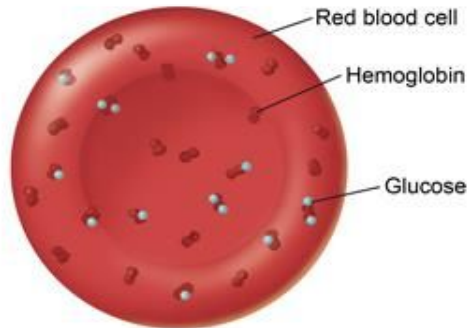
Glycated Hemoglobin Test

- AKA: HbA1C, A1C
- Evaluates:
 - Average glucose level in last 3 *mos*
 - Screen for increased risk of developing DM
 - Diagnose DM
 - Monitor DM patients and their treatment
- No fasting required



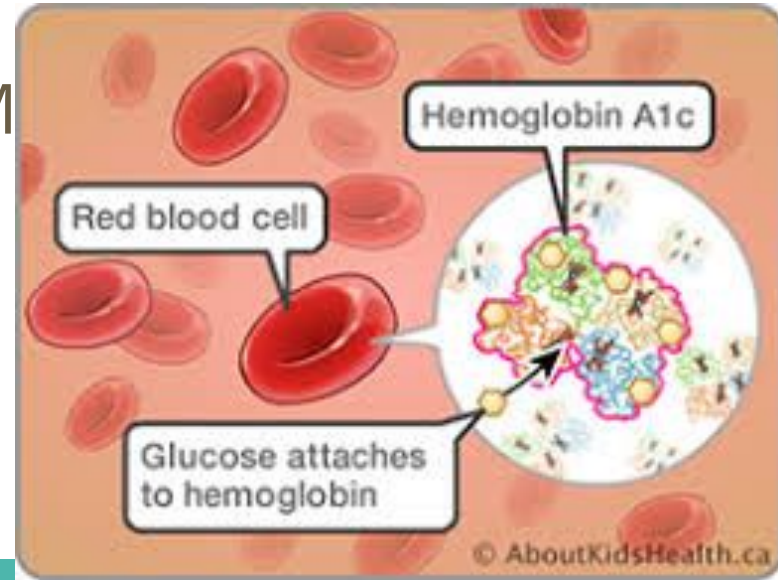
Glycated Hemoglobin Test

- Hemoglobin is an oxygen-transporting protein in RBC
 - Hemoglobin A is the predominant form
- As glucose circulates in the blood, it *binds to hemoglobin A* and stays for the RBCs lifespan (120 days)
- Prominent form of *glycated hemoglobin* is called A1c



Glycated Hemoglobin Test

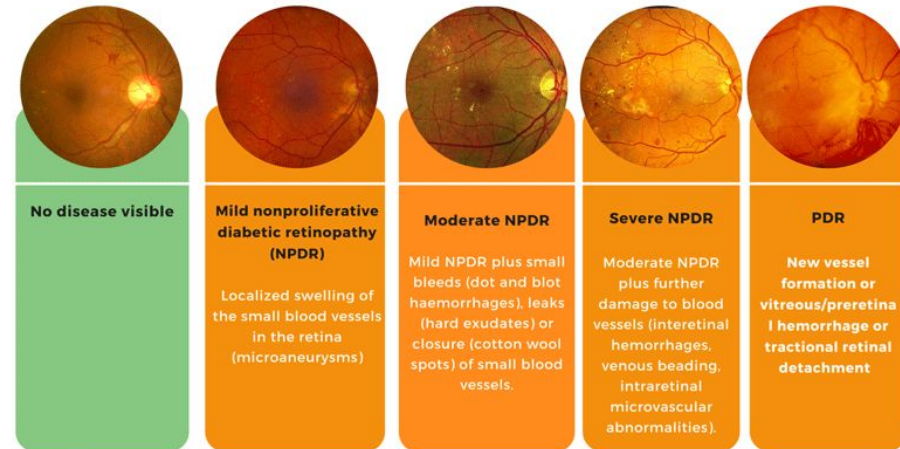
- % of free glucose bound to hemoglobin A in RBCs (% of RBCs that are glycated)
 - Estimates blood glucose average over past 2-3 months
 - $\geq 6.5\%$ - diagnostic of DM
 - “prediabetes” or borderline if 5.7-6.4%
 - ‘Normal’ $<5.7\%$



Glycated Hemoglobin Test

- Commonly used for:
 - Diabetes Mellitus risk factors or symptoms.
 - Increased thirst, Increased urination, Increased appetite, Fatigue, Blurred vision, Slow-healing infections
 - Physical inactivity, First-degree relative with diabetes, High-risk race/ethnicity, Hypertension, Abnormal lipid profile, History of cardiovascular diseases
 - To monitor treatment of DM

Diabetic Retinopathy Classification



Blood Chemistry	Hematology	Immunology	Infectious
CBC c Diff	PT / INR	ESR	PPD
BMP	PTT	CRP	AFB Smear
Hgb A1C	Protein C / S	ANA	QFT
Lipid Panel	Factor V Leiden	ENA Panel	FT-ABS
Thyroid Panel		ANCA	RPR
		RF	VDRL
		CCP	Lyme
		HLA Typing	Herpes
		AChR Antibody	
		ACE	
		Serum Lysozyme	

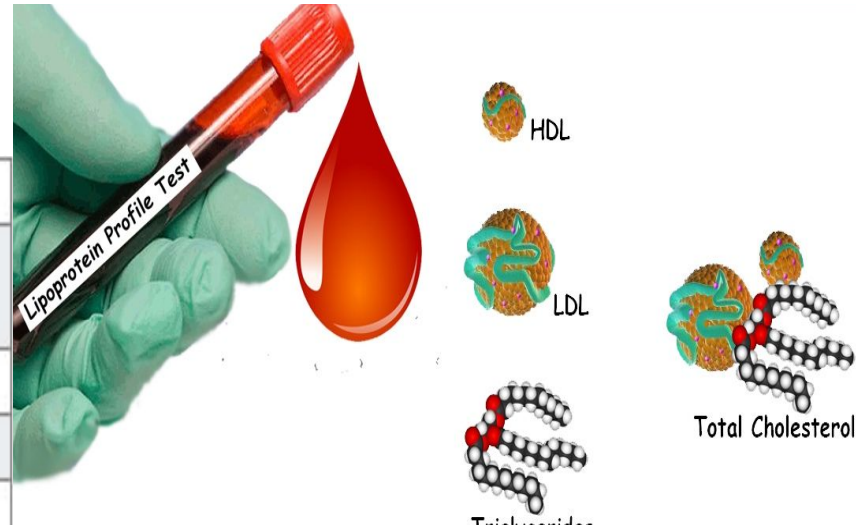
Lipid Panel

- AKA: Cholesterol panel, Coronary Risk Panel
- Evaluates:
 - Assess risk of developing cardiovascular disease
 - Initial overall screening for cholesterol, HDL, LDL, triglyceride levels
- May need fasting 9-12 hours before - lab dependent

Lipid Panel

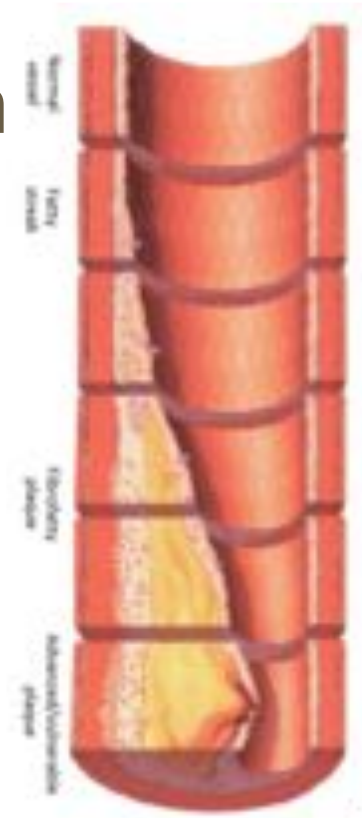
- Each lipid particle consists of a protein, cholesterol, triglyceride, and phospholipid
 - Lipid panel classifies the lipids by *density*

Test (mg/dL)	Preferred	Boderline	Poor	Very Poor
Total Cholesterol	Below 200	200-239	Above 240	
HDL	Above 60	50-59	Below 40	
LDL	100-129	130-159	160-189	Above 190
Triglycerides	Below 150	150-199	200-499	Above 500



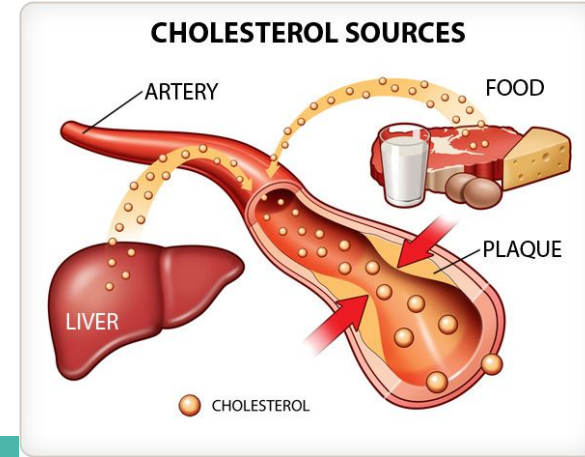
Lipid Panel

- Excess cholesterol in the bloodstream → deposits as plaques on walls of blood vessels → narrowing / blocking vessel wall → atherosclerosis → increased risk of heart disease and stroke
- Excess triglycerides are associated with cardiovascular disease



Lipid Panel

- Total Cholesterol
 - Pregnancy, Steroids, Beta blockers, Oral contraceptives, Protease inhibitors, Vitamin D can increase total cholesterol levels
- Low-Density Lipoprotein (LDL)
 - Deposits cholesterol in the arteries → binds to arteries → increases risk for cardiovascular disease
- Very Low-Density Lipoprotein (VLDL)
 - Triglyceride lined cholesterol
 - Contribute to development of atherosclerosis and coronary heart disease
- Triglycerides
 - Increase risk of heart disease



Lipid Panel

- High-Density Lipoprotein (HDL)
 - *Removes* cholesterol from arteries and transport it to the liver ~“cardio-protective”
- Every 5mg/dc decrease in HDL
= 25% increase in coronary heart disease



Lipid Panel

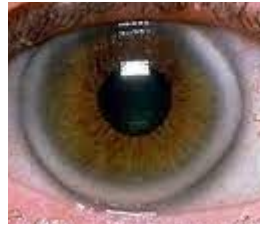
- Commonly used for:
 - Part of a cardiac risk assessment for atherosclerosis, heart disease, and stroke
 - Cigarette smoking, Obesity, Unhealthy diet, Physically inactive, Age, Hypertension, Diabetes, Family history of premature heart disease
 - Pre-existing heart disease or already having had a heart attack

You can Control

1. Obesity/Being Fat/Weight Gain.
2. Diet & Foods.
3. Medications.

You Cannot Control.

1. Age and Gender.
2. Heredity Factors.
3. Other Diseases.



Blood Chemistry	Hematology	Immunology	Infectious
CBC c Diff	Hgb S Solubility	ESR	PPD
BMP	Hgb Electrophoresis	CRP	AFB Smear
Hgb A1C	PT / INR	ANA	QFT
Homocysteine	PTT	ENA Panel	FT-ABS
Lipid Panel	Protein C / S	ANCA	RPR
Thyroid Panel	Factor V Leiden	RF	VDRL
		CCP	Lyme
		HLA Typing	Herpes
		AChR Antibody	HIV / Viral Load
		ACE	CD 4
		Serum Lysozyme	

Homocysteine Level

- AKA: Homocysteine
- Evaluates:
 - Risk of cardiovascular disease/stroke by measuring level of homocysteine in the blood
- Must fast 12 hour prior to test

Homocysteine Level

- Homocysteine is an amino acid present in cells
 - Vit B6, B12, and Folate are necessary to metabolize homocysteine - If these are decreased, homocysteine will be elevated
- Elevated homocysteine associated with increased risk of cardiovascular disease, stroke, plaque formation, osteoporosis, thromboembolism, and ectopia lentis
 - Marfanoid appearance, mental retardation
- Identifies twice as many people at risk than routine cholesterol screening

Homocysteine Level

- Commonly used for:
 - Coronary heart disease, Stroke, Vascular disease, Atherosclerosis without cardiovascular risk factors
 - Newborn screening for homocystinuria
 - Ectopia lentis, Marfanoid appearance, Osteoporosis, Mental retardation, carotid disease, stroke
 - Suspicion of Vit B6, B12 or B9 (folate) deficiency

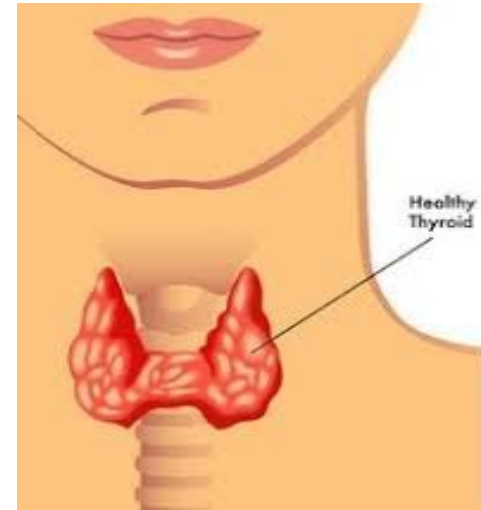
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CBC c Diff	PT / INR	ESR	PPD
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		AChR Antibody	
		ACE	
		Serum Lysozyme	

Thyroid Panel

- AKA: Thyroxine (T4), Thyroid Stimulating Hormone (TSH)
- Evaluates:
 - Evaluate thyroid gland function
 - Help diagnose thyroid disorders
 - Measures amount of free T3, T4, and TSH in blood
- May need to fast (lab dependent)
 - Affected by sleep, stress, certain medication (Interferon, Amiodarone, Estrogen)

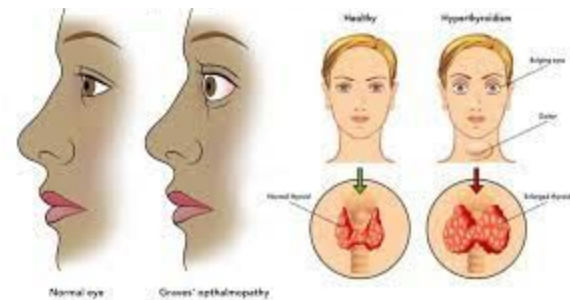
Thyroid Panel

- Measure amount of thyroid hormones in the blood
 - Chemical substances that control body's metabolism
 - How body functions and uses energy
- Thyroid-stimulating hormone (TSH) is released by pituitary gland in a feedback system
 - TSH promotes release of T3 (triiodothyronine) and T4 (thyroxine) from thyroid
 - T3 and T4 signal pituitary to decrease release of TSH

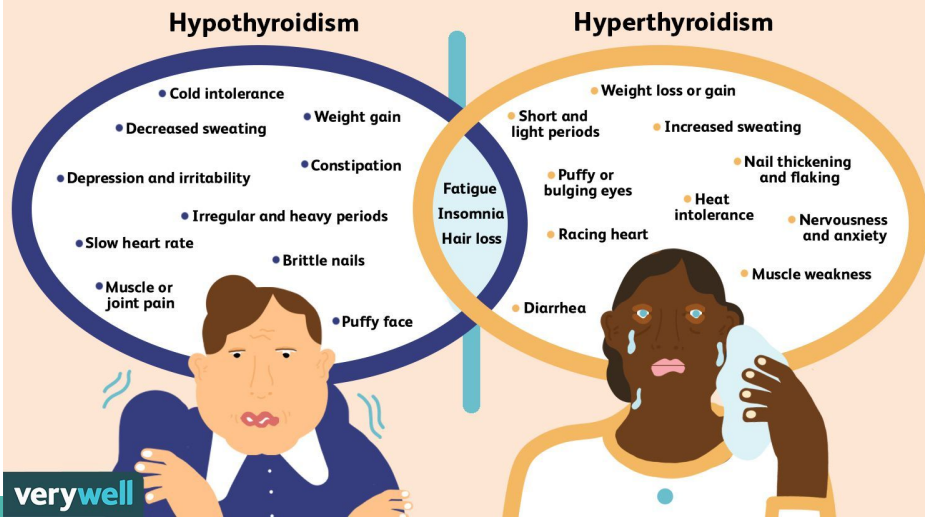


Thyroid Panel

- Hyperthyroidism / Graves' Disease
 - Overactive thyroid secretes excessive T3 and T4 so less TSH is produced
- Hypothyroidism
 - Low amounts of T3 and T4 stimulate pituitary to release TSH
 - Hashimoto thyroiditis



Hypothyroidism vs. Hyperthyroidism Symptoms



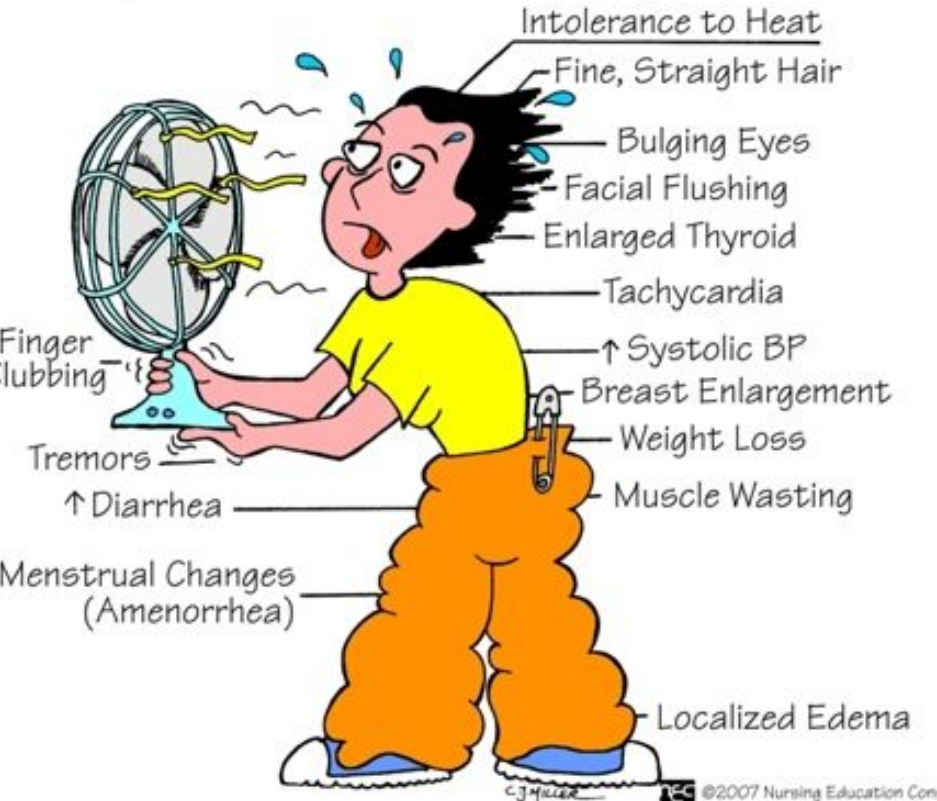
Thyroid Panel

Commonly used for:

HYPOTHYROIDISM

@nurse_elsie

HYPERTHYROIDISM



Blood Chemistry	Hematology	Immunology	Infectious
CBC c Diff	PT / INR	ESR	PPD
BMP	PTT	CRP	AFB Smear
Hgb A1C	Protein C / S	ANA	QFT
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		HLA Typing	Herpes
		AChR Antibody	
		ACE	
		Serum Lysozyme	

Hemoglobin Electrophoresis

- AKA: Hgb ELP
- Evaluates:
 - Investigate presence of any hemoglobinopathy

Hemoglobin Electrophoresis

- Hemoglobinopathy → abnormal shape of hemoglobin (sickle cell) or decreased production of hemoglobin (thalassemia)
- Evaluates the kind of hemoglobin present
 - Normally, adults have 95-98% Hemoglobin A present in the blood



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Sickle Cell

Normal Cell

β -thalassemia

Hemoglobin S solubility

- AKA: Hgb S
- Evaluates:
 - Determine if sickle cell trait or disease is present by measuring hemoglobin S

Hemoglobin S solubility

- Hemoglobin → iron containing protein in RBCs → binds to oxygen → carries it to tissues
- Sickle cell anemia → inherited disorder → produces abnormal hemoglobin (hemoglobin S / Hb S / Hgb S)
 - Shape of RBCs sickles when exposed to low oxygen levels
 - Decreases RBC lifespan (10-20 days vs. 120)
 - Impairs ability to transport oxygen
 - Impair ability of RBCs to smoothly flow through vessels

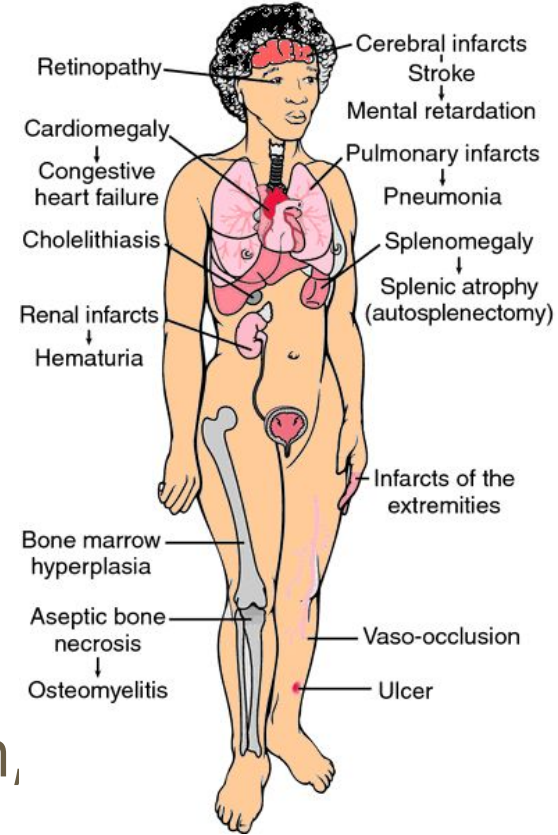
Hemoglobin S solubility

- Causes hemolytic anemia (RBC die before 120 days)
 - Decreased number of RBCs
 - Reduced ability to RBCs to transport oxygen
- If inherit one normal and one Hb S gene, pt has sickle cell trait (carrier)
 - 40% Gb S and 60% normal Hb A
- If inherits two Hb S genes, pt has SC anemia
- Test can not distinguish SCD from SC trait

Results Seen	Condition	Genes
Slightly decreased Hb A Moderate amount Hb S (about 40%)	Sickle cell trait	One gene copy for Hb S (heterozygous)
Majority Hb S Increased Hb F (up to 10%) No Hb A	Sickle cell disease	Two gene copies for Hb S (homozygous)
Majority Hb C No Hb A	Hemoglobin C disease	Two gene copies for Hb C (homozygous)
Majority Hb A Some Hb H	Hemoglobin H disease (alpha thalassemia)	Three out of four alpha genes are mutated (deleted)
Majority Hb F Little or no Hb A	Beta thalassemia major	Both beta genes are mutated
Majority Hb A Slightly Increased Hb A2 (4-8%) Hb F may be slightly increased	Beta thalassemia minor	One beta gene is mutated

Hgb S / Hgb ELP

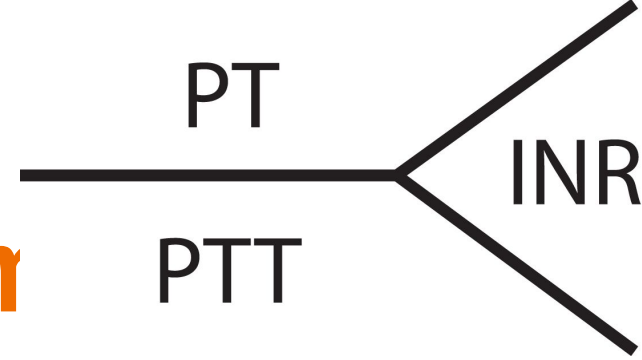
- Commonly used for:
 - Newborn screening
 - Abnormal CBC
 - Signs / Symptoms of SCD
 - Pain throughout body, Anemia, Pneumonia, Coughing, Chest Pain, Fever, Growth problems, Retinal neovascularization, Stroke at young age



Blood Chemistry	Hematology	Immunology	Infectious
CBC c Diff	Hgb S Solubility	ESR	PPD
BMP	Hgb Electrophoresis	CRP	AFB Smear
Hgb A1C	PT / INR	ANA	QFT
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		HLA Typing	Herpes
		AChR Antibody	
		ACE	
		Serum Lysozyme	

Prothrombin Time

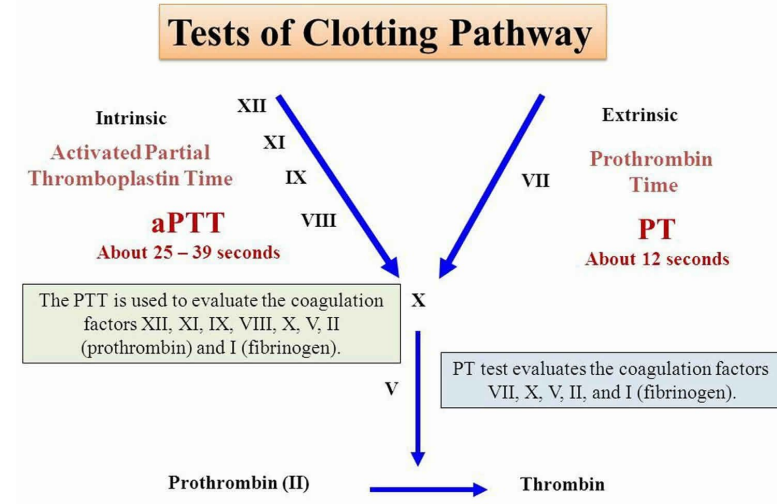
Partial Thromboplastin Time



- AKA: PT / PTT
- Evaluates:
 - Detect *bleeding* and *clotting* disorders by evaluating time it takes for sample of *blood to clot*
 - Evaluate how well a blood thinner is working
 - Screening before surgery

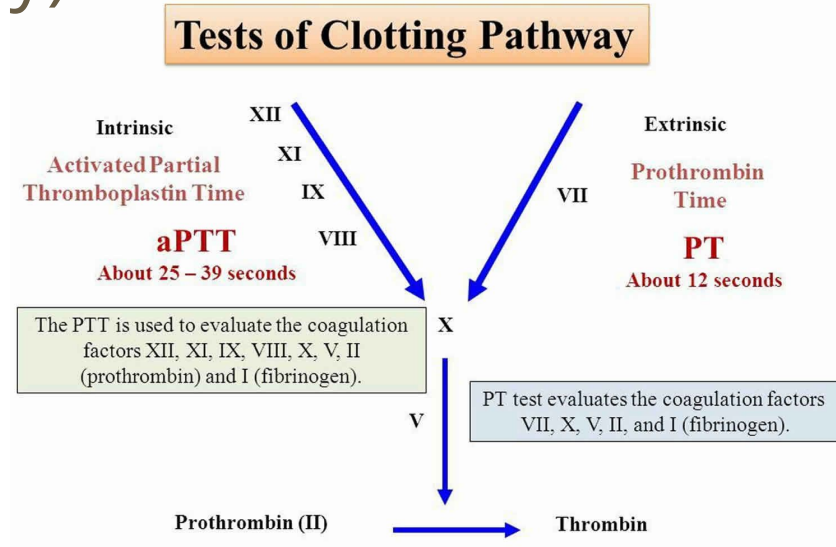
Prothrombin Time

- Body is injured → coagulation cascade begins → activating clotting factors → stop bleeding
 - Too little → excessive bleeding
 - Too much → excessive clotting / thrombus
- Prothrombin (PT) is a vitamin K dependent glycoprotein, produced by liver → PT is needed for fibrin clot formation
- Partial Thromboplastin Time (PTT) includes other clotting factors and also determines speed of clotting
 - Mainly used to evaluate if Warfarin is working



Prothrombin Time

- Two pathways that initiate clotting (together called the common pathway)
 - Extrinsic pathway → PT (initiates the process)
 - Intrinsic pathway → PTT (amplifies the process)



Prothrombin Time

- International Normalized Ratio (INR)
 - PT results widely vary between labs so INR is used
 - Standardizes PT results for patients on anticoagulation treatment
 - Allow results from different labs to be compared

$$INR = \left(\frac{PT_{\text{test}}}{PT_{\text{normal}}} \right)^{ISI}$$

INR - International Normalised Ratio

PT - Prothrombin time

ISI - International Sensitivity Index

PT / PTT

- Commonly used for:
 - Excessive bleeding
 - Excessing clotting
 - Prior to surgery
 - Unexplained miscarriages
 - Monitor patients on certain oral medications



Blood Chemistry	Hematology	Immunology	Infectious
CBC c Diff	PT / INR	ESR	PPD
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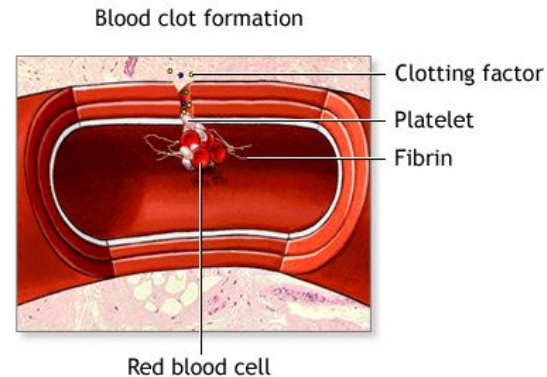
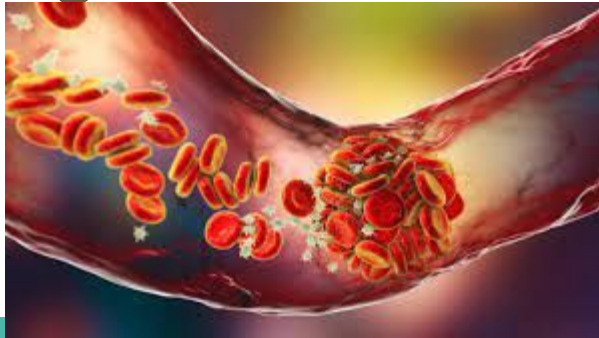
Protein C and Protein S Activity

- AKA: Protein C / S Level
- Evaluates:
 - Identify a protein C or S deficiency to help evaluate cause of excessive clotting disorders



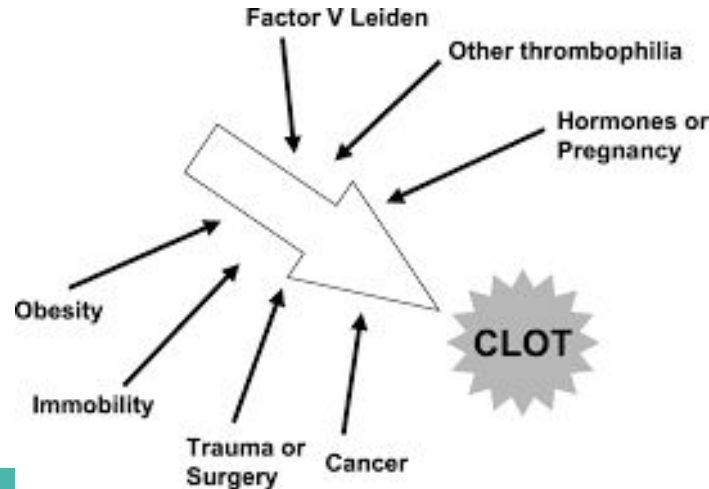
Protein C and Protein S Activity

- Protein C and S help regulate blood clot formation by *slowing down* the clotting process
 - Protein C and S *inactivate* coagulation factors → slow down clot formation
 - If not present / functioning → *excessive clotting* (hypercoagulable disorder)



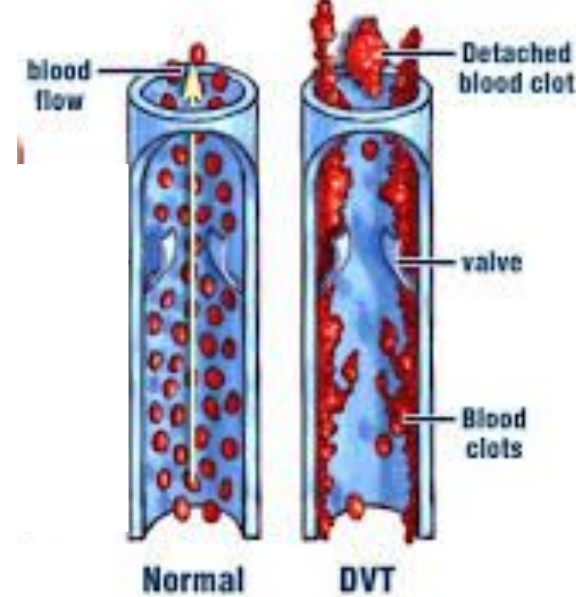
Factor 5 Leiden Mutation

- AKA: Factor V mutation, FVL
- Evaluates:
 - If factor V Leiden mutations are present in patients with a thromboembolic event



Factor 5 Leiden Mutation

- During hemostasis (clotting), Factor V works to *promote clotting*



- Factor V Leiden is a genetic mutation → *unable to deactivate* → clotting remains more active than usual → 2-4x more likely to develop deep vein thrombosis or venous thromboembolism

Protein C / Protein S / Factor 5 Leiden

- Commonly used for:
 - Investigate cause for thromboembolism or deep vein thrombosis
 - Stroke in a young person <50yo
 - Family history of hypercoagulable disorders
 - Liver/Kidney disease suspicion
 - Multiple miscarriages
 - Monitor levels during anticoagulant therapy



BLOOD CHEMISTRY	HEMATOLOGY	IMMUNOLOGY (Non Granulomatous)	INFECTIOUS
CBC c Diff	PT / INR	ESR	PPD
BMP	PTT	CRP	AFB Smear
Hgb A1C	Protein C / S	ANA	QFT
Lipid Panel	Factor V Leiden	ENA Panel	FT-ABS
Thyroid Panel		RF	RPR
		CCP	VDRL
		HLA Typing	Lyme
		AChR Antibody	Herpes
		ACE	
		Serum Lysozyme	

Erythrocyte Sedimentation Rate

- AKA: ESR, Sed Rate
- Evaluates:
 - Rate at which RBCs settle in 1 hour
 - Detect presence of *inflammation* caused by
 - Infection
 - Tumors
 - Autoimmune disease

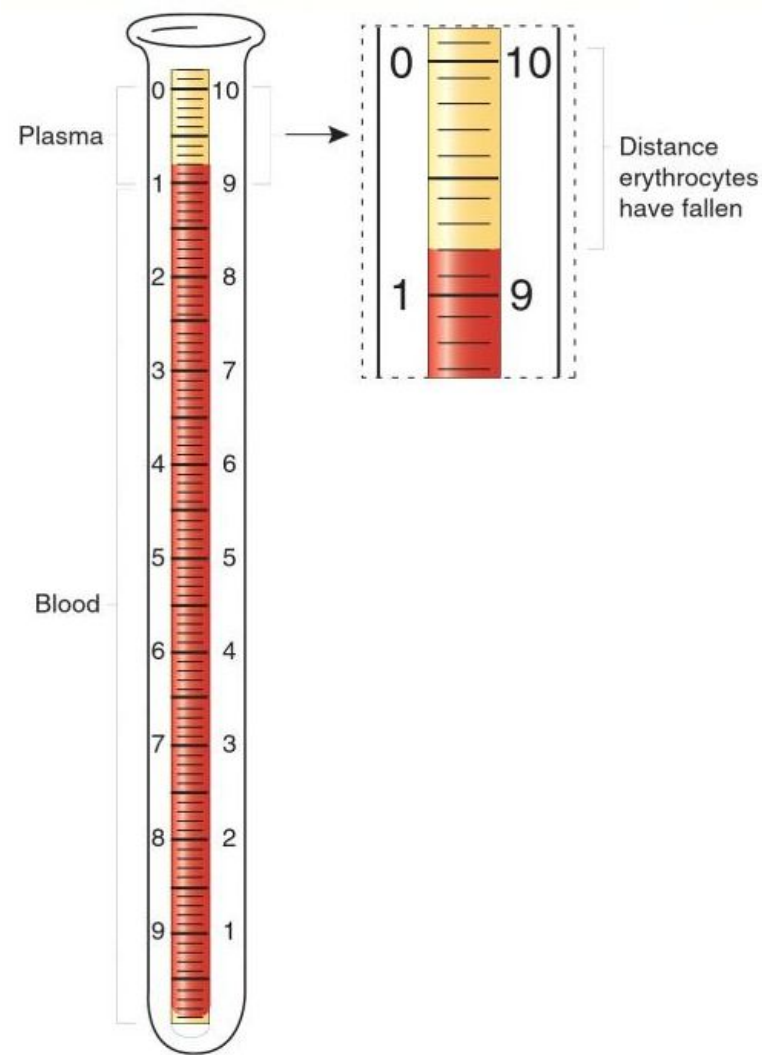
Erythrocyte Sedimentation Rate

- Inflammatory disease (acute and chronic) increases plasma protein → RBCs become positively charged and *clump* together
 - RBCs *heavier* due to proteins from inflammation, so settle /sediment down quicker
- Sensitive to, but not specific for, *inflammation*
 - Affected by temperature, medication, infection, pregnancy, smoking
 - Anemia can falsely elevate ESR

$$\text{ESR (mm/h)} \leq \frac{\text{Age (in years)} + 10 \text{ (if female)}}{2}$$

Erythrocyte Sedimentat

- Very high ESR usually due to Temporal arteritis (GCA), severe infection, Polymyalgia rheumatica
- Low ESR can be due to Polycythemia (high RBC count), Leukocytosis (high WBC count), Protein abnormalities, Sickle cell anemia

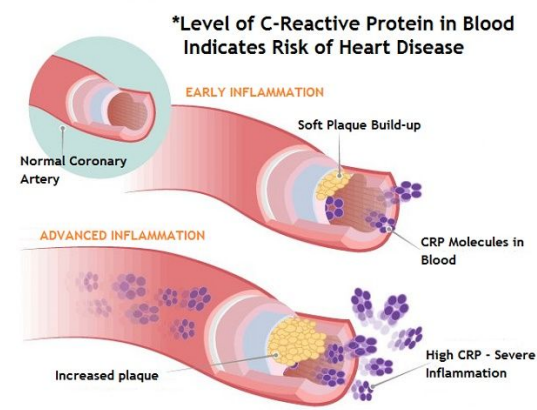


Erythrocyte Sedimentation Rate

- Commonly used for:
 - Headaches, neck or shoulder pain, pelvic pain, joint stiffness, anemia, poor appetite, unexplained weight loss, recurrent non-granulomatous uveitis
 - Help diagnose or monitor inflammatory disease
 - Temporal arteritis, Systemic vasculitis, Polymyalgia rheumatica, Rheumatoid arthritis, Sarcoidosis, IBD, Autoimmune disease

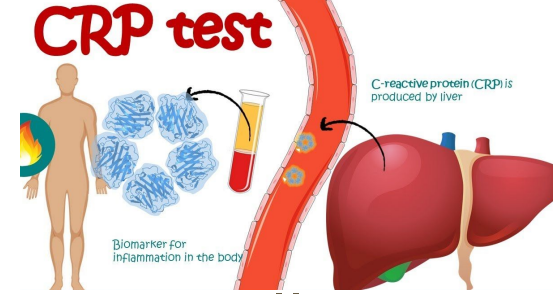
C-Reactive Protein

- AKA: CRP
- Evaluates:
 - Identify presence of *inflammation* by measuring amount of C-reactive protein produced by the liver
 - Monitor response to treatment of inflammation



C-Reactive Protein

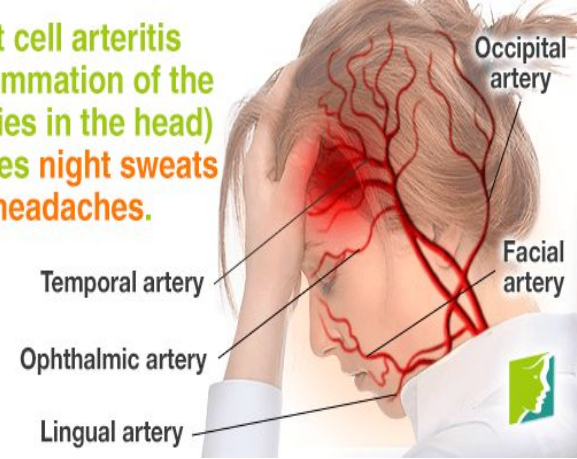
- CRP is a nonspecific, acute phase protein produced by liver in *early response* to all inflammation, injury, and infection
 - Released into blood within hours of tissue damage, infection or inflammation (before ESR)
 - Decreases rapidly once inflammation subsides (before ESR)
- Not affected by blood cell size or shape, plasma composition, or plasma fluid status



C-Reactive Protein

- Commonly used for:
 - Diagnosing and monitoring Sepsis, Fungal infection, Inflammatory disease, Arthritis, Malignancies, Autoimmune disease
 - High ESR + CRP ~97% specificity for *TA/GCA*

Giant cell arteritis (inflammation of the arteries in the head) causes night sweats and headaches.



BLOOD CHEMISTRY	HEMATOLOGY	IMMUNOLOGY (Non Granulomatous)	INFECTIOUS
CBC c Diff	PT / INR	ESR	PPD
BMP	PTT	CRP	AFB Smear
Hgb A1C	Protein C / S	ANA	QFT
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		Serum Lysozyme	

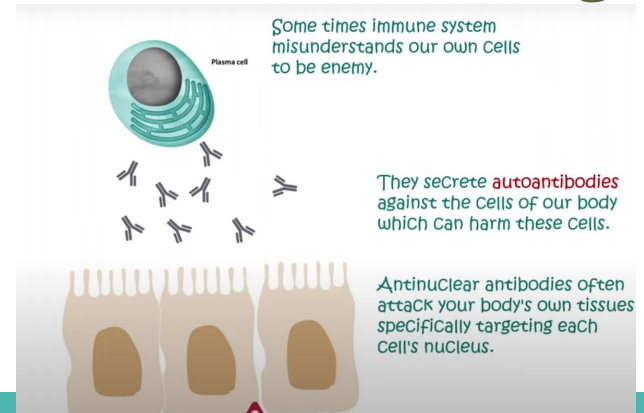
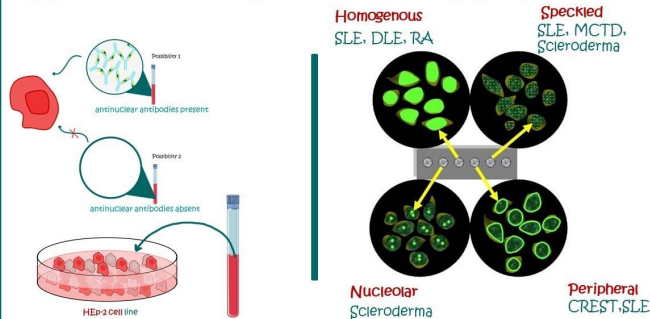
Antinuclear Antibody

- AKA: ANA
- Evaluates:
 - Autoimmune markers to screen for *autoimmune* disease
 - SLE
 - RA
 - Connective Tissue Disease
 - Scleroderma

Antinuclear Antibody

- ANA are a group of autoantibodies produced by the immune system when it fails to distinguish between 'self' and 'nonself' antigens
 - Attack body's own healthy cells, specifically the nucleus - 'antinuclear' - and cause tissue damage

What does positive ANA means?



Antinuclear Antibody

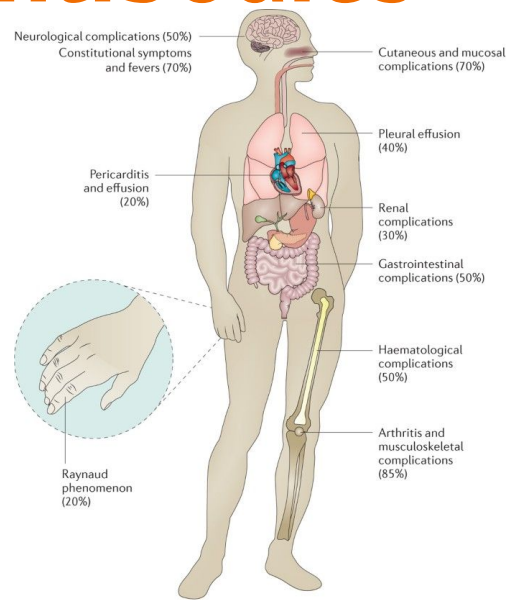
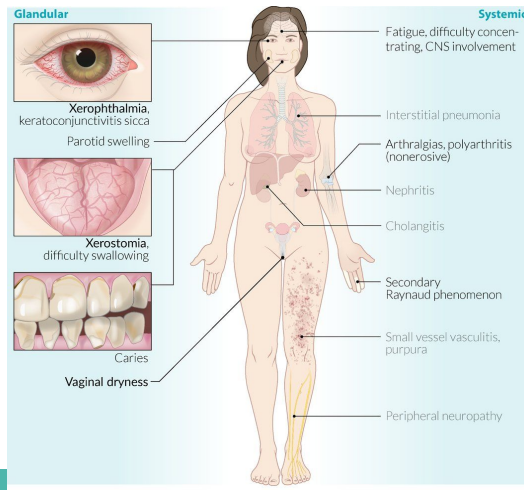
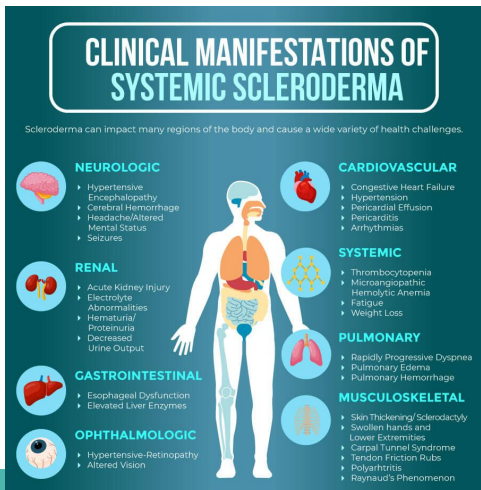
- Patients who have elevated ANA
 - 15% positive in healthy patients (false positive - ANA naturally increases with age, especially women)
 - 95% positive in SLE
 - Negative ANA makes SLE unlikely
 - 40-70% positive in Sjogren's syndrome
 - 60-90% positive in Scleroderma

Antinuclear Antibody

- Commonly used for:
 - Diagnosing autoimmune disorders (SLE, Sjogrens, Scleroderma, RA, Connective tissue disease, Raynaud's syndrome)
 - Low-grade fever, Persistent fatigue, Recurrent non-granulomatous uveitis, Arthritis-like pain, Malar rash, Sensitivity to light, Hair loss, Muscle pain, Numbness or tingling in the hands or feet, Inflammation and damage to organs and tissues

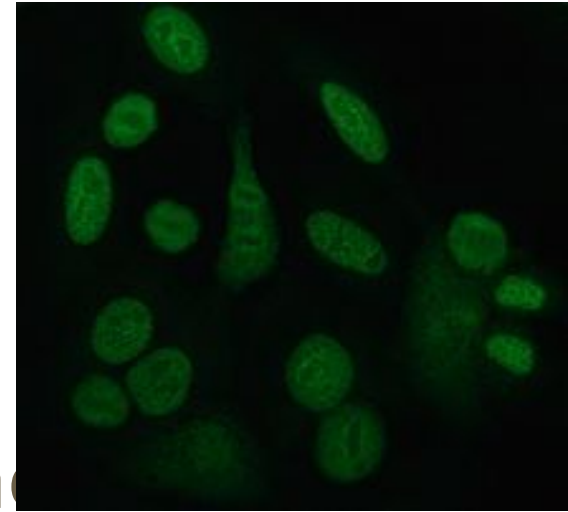
Extractable Nuclear Antigen Antibodies

- AKA: ENA Panel, Sjogren Antibody, SS-A, SS-B
- Evaluates:
 - Help diagnose, distinguish, and monitor certain autoimmune
 - SLE, Sjogren's Syndrome, Scleroderma

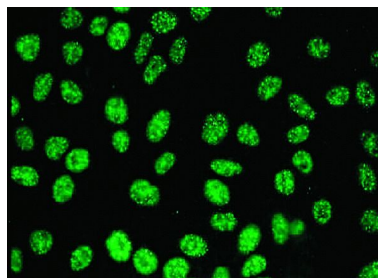


Extractable Nuclear Antigen Antibodies

- Detects presence of *specific* autoantibodies that react with proteins in the cell nucleus
 - Tests for specific antinuclear antibodies
 - Previously only ordered when ANA is positive, now commonly ordered with ANA



Autoantibody Test	Results That Support an Autoimmune Disorder Diagnosis
Anti-RNP	Positive result seen in 95-100% of mixed connective tissue disease (MCTD) cases; may also be positive with SLE and scleroderma
Anti-Sm	Positive result seen in 30% of those with SLE; very specific antibody marker for this disease
Anti-SS-A (Ro)	Positive result seen in 75% of those with Sjögren's syndrome; may also be positive with SLE and scleroderma
Anti-SS-B (La)	Positive result seen in 60% of those with Sjögren's syndrome; may also be positive with SLE and scleroderma; rarely present without anti-SS-A
Scl-70	Positive result seen in 60% of those with scleroderma; highly specific antibody marker for this disease
Anti-Jo-1	Positive result seen in 30% of those with polymyositis; may be positive with pulmonary fibrosis



SLE EVAL APPROACH

Screen with ANA plus ENA

Negative

Likelihood of lupus-like condition low
Further testing probably not indicated *

One or Both Positive

Interpret results in clinical context
Clarify with dsDNA

* If persisting suspicion of lupus-related disorder despite "negative" ANA + ENA, consider requesting further specific ENAs, especially ribosomal-P

Extractable Nuclear Antigen Antibodies

- Commonly Used For
 - Ordered if ANA positive or if SLE suspected
 - Symptoms of autoimmune disorder
 - Sicca syndrome, Fever and persistent fatigue, Muscle pain, Joint swelling and pain, Skin rash, Recurrent nongranulomatous uveitis, Sensitivity to ultraviolet light, Raynaud phenomenon, Proteinuria, Neurologic symptoms such as seizures, depression, psychoses, Hemolytic anemia, Leukopenia

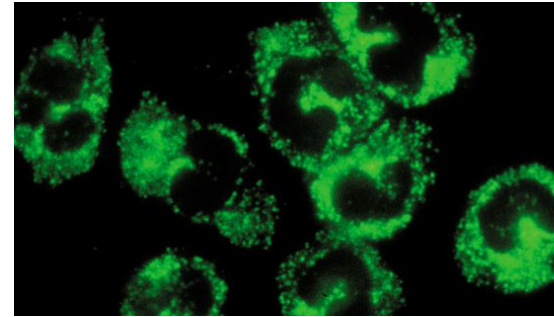
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Thyroid Panel	Protein C / S	ANCA	RPR
	Factor V Leiden	RF	VDRL
		CCP	Lyme
		HLA Typing	Herpes
		AChR Antibody	HIV / Viral Load
		ACE	CD 4
		Serum Lysozyme	

Antineutrophil Cytoplasmic Antibodies

- AKA: ANCA
- Evaluates:
 - Helps diagnose and monitor vascular autoimmune disorders/Systemic Vasculitis (Wegener granulomatosis, Polyarteritis nodosa)
 - Help distinguish between Crohn disease and Ulcerative colitis when patient has inflammatory bowel disease

Antineutrophil Cytoplasmic Antibodies

- ANCA are autoantibodies which mistakenly attack proteins within neutrophils.



- Perform an IFA
 - (+) ANCA in 80% of ulcerative colitis patients
 - (+) ANCA in 80% of Wegener granulomatosis
 - (+) ANCA in 20% of Crohn disease

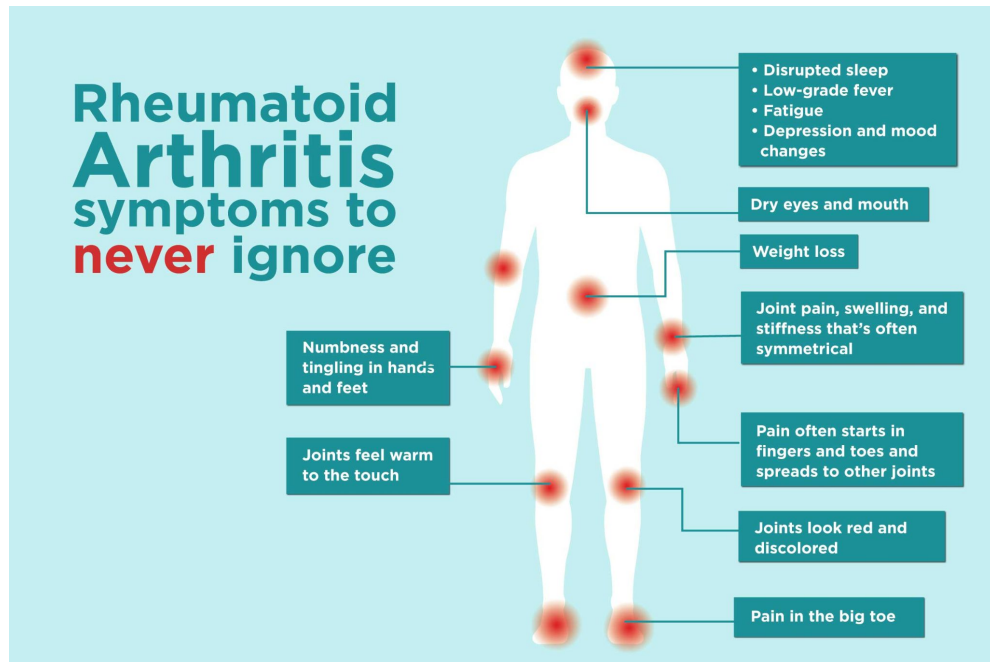
Antineutrophil Cytoplasmic Antibodies

- Commonly used for:
 - Diagnosing Vasculitis - blood vessel inflammation
 - Eyes —conjunctivitis, blurry vision, loss of vision
 - Ears — hearing loss
 - Nose — chronic runny nose or upper respiratory symptoms
 - Skin — rashes and/or granulomas
 - Lungs — cough and/or difficulty breathing
 - Kidneys —protein in the urine (proteinuria)
 - Diagnosing IBD
 - Abdominal pain and cramps, Diarrhea, Rectal bleeding, Fever, Fatigue, Joint/Skin/Bone/Organ-related symptoms
 - Children may have delayed development / growth retardation

BLOOD CHEMISTRY	HEMATOLOGY	IMMUNOLOGY (Non Granulomatous)	INFECTIOUS
CBC c Diff	PT / INR	ESR	PPD
BMP	PTT	CRP	AFB Smear
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Lipid Panel	Factor V Leiden	ENA Panel	FT-ABS
Homocysteine		RF	RPR
Thyroid Panel		CCP	VDRL
		HLA Typing	Lyme
		AChR Antibody	Herpes
		ACE	
		Serum Lysozyme	

Rheumatoid Factor

- AKA: RF
- Evaluates:
 - A marker for presence of RF autoantibody in the blood



Rheumatoid Factor

- RF is an autoantibody protein which is directed against the body's immune system
- Present in healthy patients, increases with age
 - 25% over 65yo are (+)

POSITIVE REACTION:

ELITex Bicolor RF:

Red agglutinates on a blue background.



NEGATIVE REACTION:

ELITex Bicolor RF:

Homogeneous purple suspension.

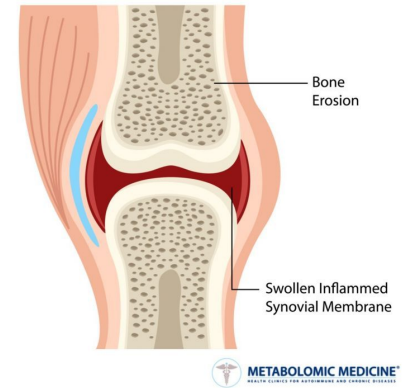
Rheumatoid Factor

- 80% of patients with RA will have (+) RF
- 20% of patients with RA will have (-) RF
- 5% of patients without RA will have (+) RF
- Other factors that may have a (+) RF
 - Sjogren, Scleroderma, SLE, Sarcoidosis, Endocarditis, Tuberculosis, Syphilis, HIV, AIDS, Hepatitis, Infectious mononucleosis, Leukemia, Multiple myeloma, Parasitic infection, Lung disease, Liver disease, Kidney disease

Rheumatoid Factor

- Commonly used for:
 - Rheumatoid arthritis (RA)
 - pain, warmth, swelling, and morning stiffness in the joints, nodules under the skin, swollen joint capsules, loss of cartilage and bone
 - SLE
 - Sjogren's
 - Sarcoidosis
 - Tuberculosis

RHEUMATOID ARTHRITIS



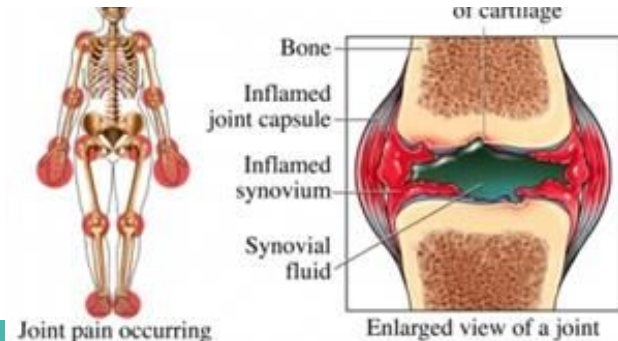
Cyclic Citrullinated Peptide Antibody

- AKA: CCP
- Evaluates:
 - Presence of CCP antibodies
 - Diagnose Rheumatoid arthritis
 - Differential RA from other type of arthritis
 - Evaluate prognosis of patient with RA



Cyclic Citrullinated Peptide Antibody

- CCPs naturally produced as part of amino acid metabolism
- In joints with RA, this metabolism occurs at a higher rate → changes the protein structure of CCPs
- The altered structure triggers immune response → produce CCP autoantibodies against joint proteins
- CCP antibodies detected in about 50-70% of people with early RA (within 3-6 months)
 - 97% specificity for RA
 - 2% without RA are CCP (+)
 - Seropositive RA has a worse prognosis



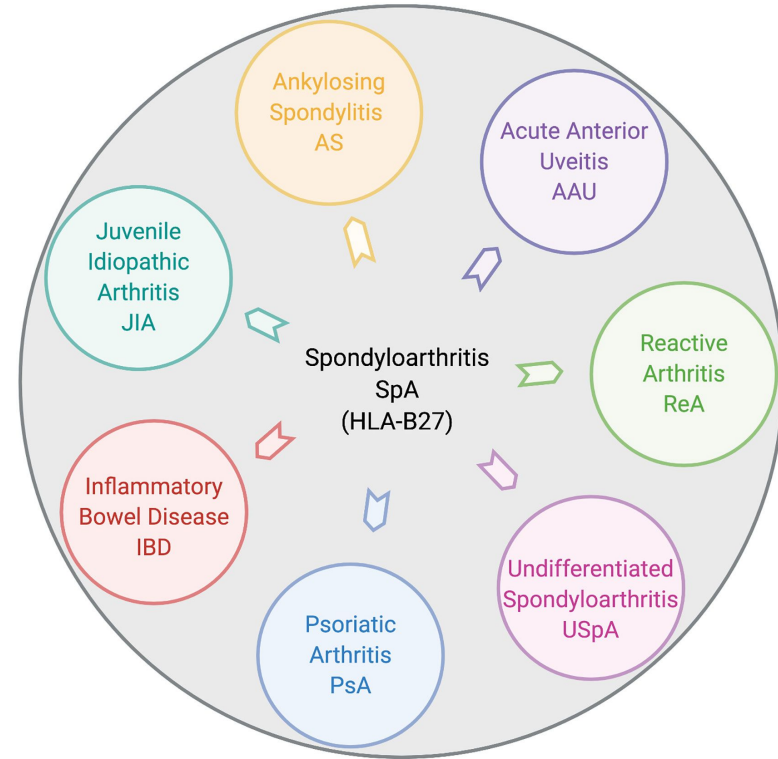
Cyclic Citrullinated Peptide Antibody

- Commonly used for:
 - Early Dx of Rheumatoid arthritis (RA)
 - Recurrent non-granulomatous uveitis
 - Painful, warm, swollen joints of the hands and wrists
 - Pain of elbows, neck, shoulders, hips, knees, and/or feet
 - Stiffness in the morning that improves during the day
 - Fatigue, Fever, Malaise
 - Development of nodules under the skin, especially at the elbows

BLOOD CHEMISTRY	HEMATOLOGY	IMMUNOLOGY (Non Granulomatous)	INFECTIOUS
CBC c Diff	PT / INR	ESR	PPD
BMP	PTT	CRP	AFB Smear
Hgb A1C	Protein C / S	ANA	QFT
Lipid Panel	Factor V Leiden	ENA Panel	FT-ABS
Thyroid Panel		RF	RPR
		CCP	VDRL
		HLA Typing	Lyme
		AChR Antibody	Herpes
		ACE	
		Serum Lysozyme	

Human Leukocyte Antigen

- AKA: HLA typing
- Evaluates:
 - Detect presence of specific HLA genes and antigens



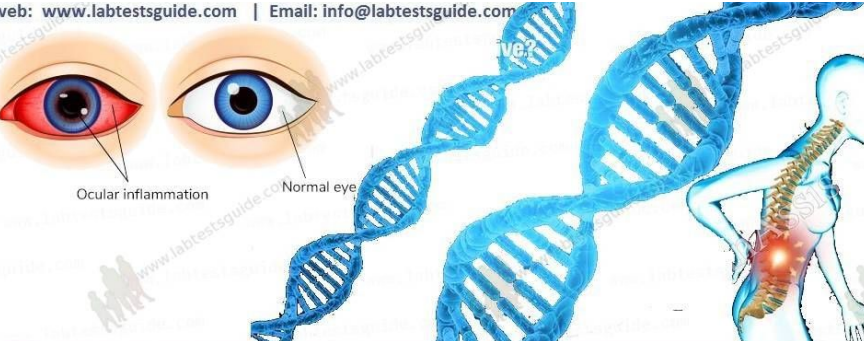
Human Leukocyte Antigen

- Genes for Human Leukocyte Antigens (HLA) are located on chromosome 6
 - If present, the antigen will be present on the surface of WBCs, platelets, and tissue cells
 - Help the immune system identify 'self' vs. 'nonself' cells
 - Everyone has a distinctive, inherited combination of HLA genes

Human Leukocyte Antigen


- HLA-B27 is found in 6% of the US population
 - Increased likelihood for developing Ankylosing spondylitis, Juvenile rheumatoid arthritis, Reactive arthritis, Reiter syndrome, Inflammatory bowel disease

web: www.labtestsguide.com | Email: info@labtestsguide.com



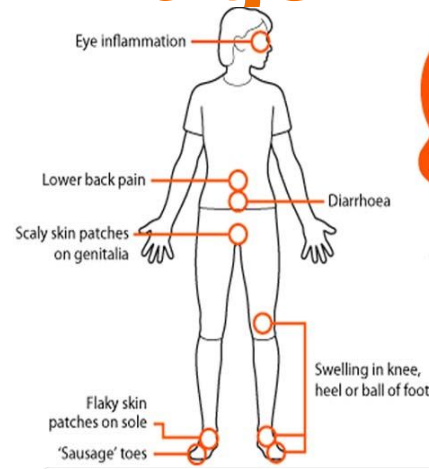
Fasting	No Need
Sample	4 ml in EDTA Tube
UNIT	N/A
N.Value	Negative
Report	2-3 days
Method	Flow Cytometry

95% - Ankylosing Spondylitis
80% - Reiter's Syndrome (Reactive Arthritis)
70% - Psoriatic Arthritis (Spondylitis with Psoriasis)
50% - Enteropathic Arthritis (Spondylitis with Inflammatory Bowel Disease)
6-8% - Incidence in general population without disease

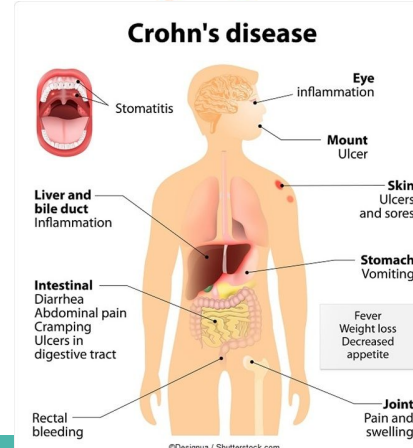
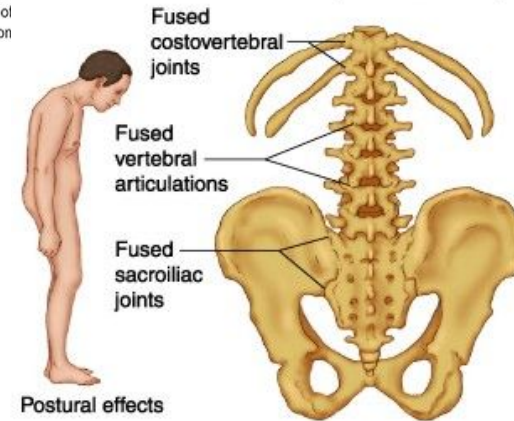
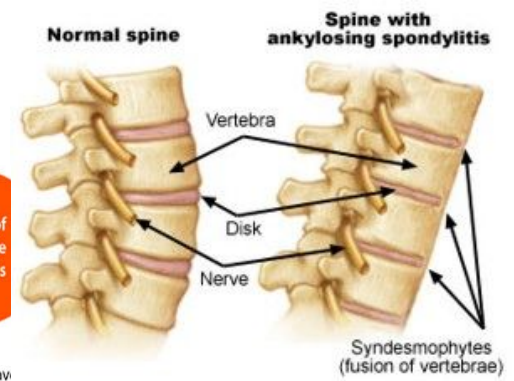


Human Leukocyte Antigen

- 90% of AS patients are HLA-B27 (+)
 - 7% of non-AS patients are HLA-B27 (+)
- 75% Reiter's syndrome (Reactive Arthritis)
- 50% Crohn's disease / IBD are HLA-B27 (+)



You may have only some of these symptoms



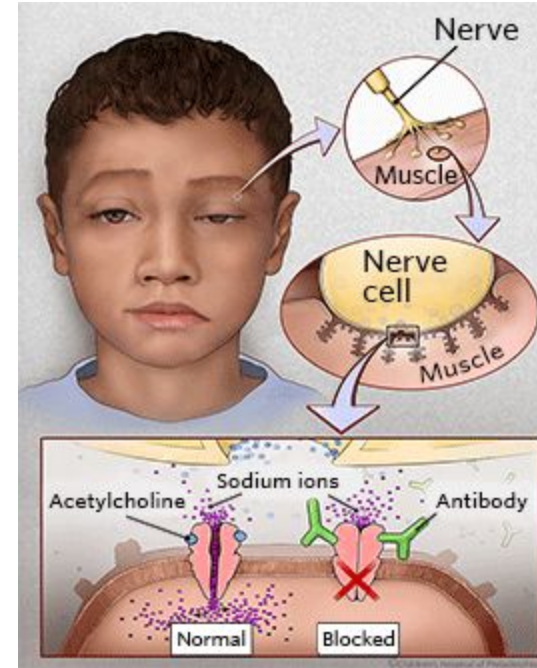
Human Leukocyte Antigen

- Commonly used for:
 - Autoimmune disorder
 - Acute or chronic pain and inflammation in the spine, neck, chest, eyes, and/or joints
 - Painful inflammation of the joints
 - Between the vertebrae in the spine
 - Between the spine and pelvis
 - Before vertebrae fusion evident on X-ray

BLOOD CHEMISTRY	HEMATOLOGY	IMMUNOLOGY (Non Granulomatous)	INFECTIOUS
CBC c Diff	PT / INR	ESR	PPD
BMP	PTT	CRP	AFB Smear
Hgb A1C	Protein C / S	ANA	QFT
Lipid Panel	Factor V Leiden	ENA Panel	FT-ABS
Thyroid Panel		RF	RPR
		CCP	VDRL
		HLA Typing	Lyme
		AChR Antibody	Herpes
		ACE	
		Serum Lysozyme	

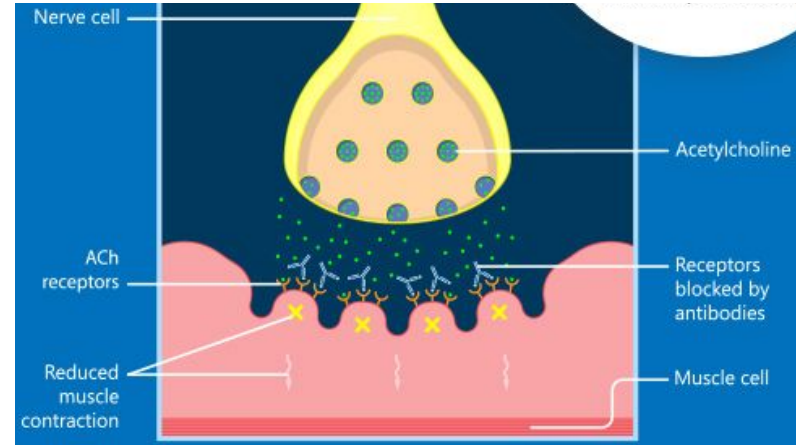
Acetylcholine Receptor Antibodies

- AKA: AChR Antibody
- Evaluates:
 - Presence of acetylcholine receptor antibodies to help diagnose and monitor Myasthenia Gravis (MG)



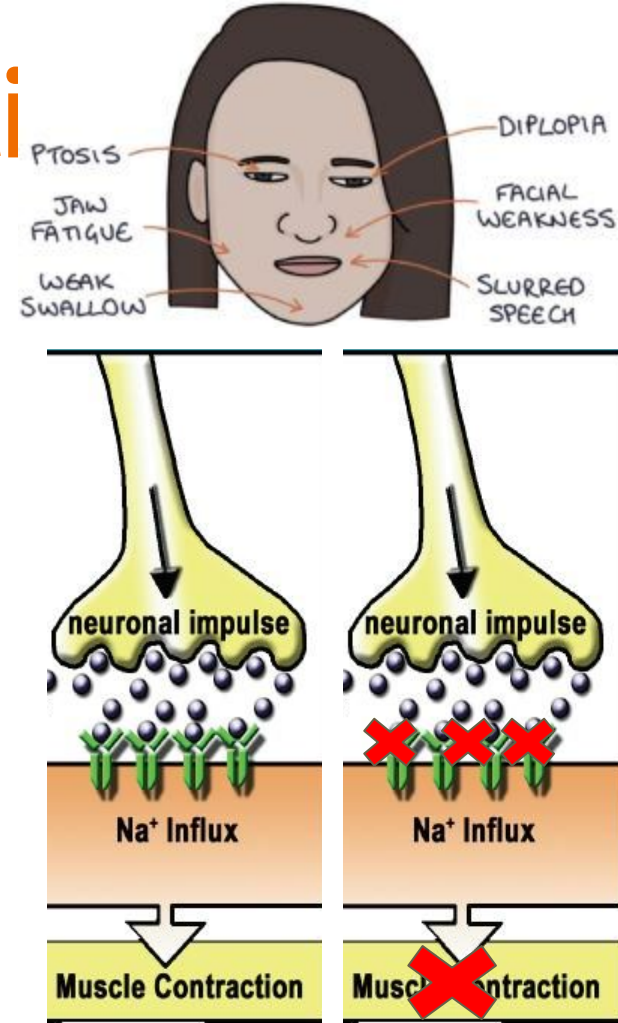
Acetylcholine Receptor Antibodies

- Acetylcholine is a neurotransmitter
→ binds to acetylcholine receptors
→ initiate muscle contraction
- AChR antibodies are autoantibodies
→ mistakenly target 'self'
acetylcholine receptor proteins
- AChR antibodies block, alter, or
destroy the receptors → don't allow
acetylcholine to bind to the
receptor or kill the receptor all
together



Acetylcholine Receptor Anti

- 85-90% of MG have autoantibodies to AChR
 - 10-15% with confirmed myasthenia gravis have no measurable binding, blocking, or modulating antibodies
- Positive in 50% with ocular MG



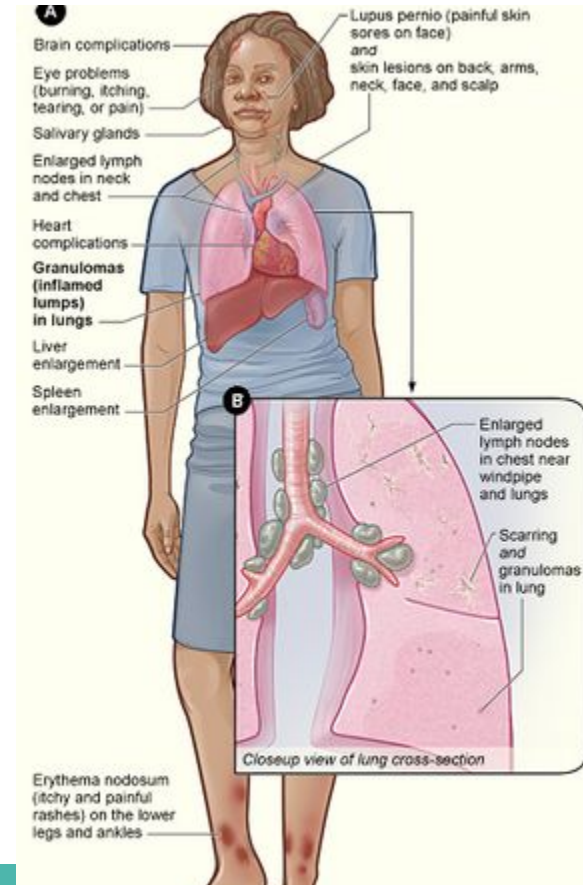
Acetylcholine Receptor Antibodies

- Commonly used for:
 - Diagnosing and monitoring MG
 - Variable ptosis and diplopia, Gaze palsy, Difficulty chewing or swallowing, Weakness, Difficulty breathing, Enlarged Thymus gland

BLOOD CHEMISTRY	HEMATOLOGY	IMMUNOLOGY (Non Granulomatous)	INFECTIOUS
CBC c Diff	PT / INR	ESR	PPD
BMP	PTT	CRP	AFB Smear
Hgb A1C	Protein C / S	ANA	QFT
Lipid Panel	Factor V Leiden	ENA Panel	FT-ABS
Thyroid Panel		RF	RPR
		CCP	VDRL
		HLA Typing	Lyme
		AChR Antibody	Herpes
		ACE	
		Serum Lysozyme	

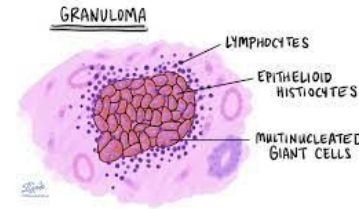
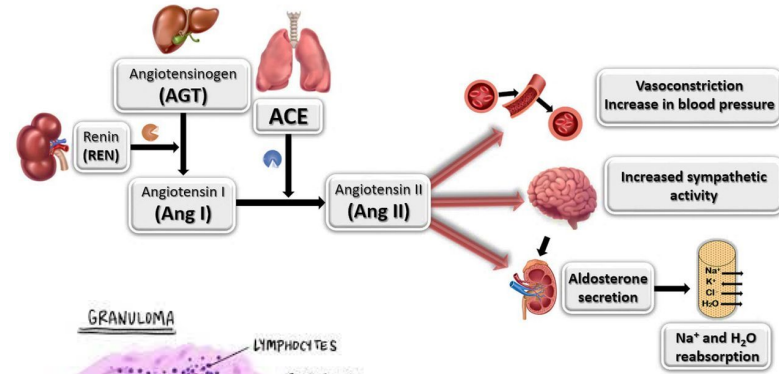
Serum Angiotensin-Converting Enzyme

- AKA: ACE, SACE
- Evaluates:
 - Diagnosis and monitoring of Sarcoidosis
 - Help with the DDX of other **granulomatous** conditions



Angiotensin-Converting Enzyme

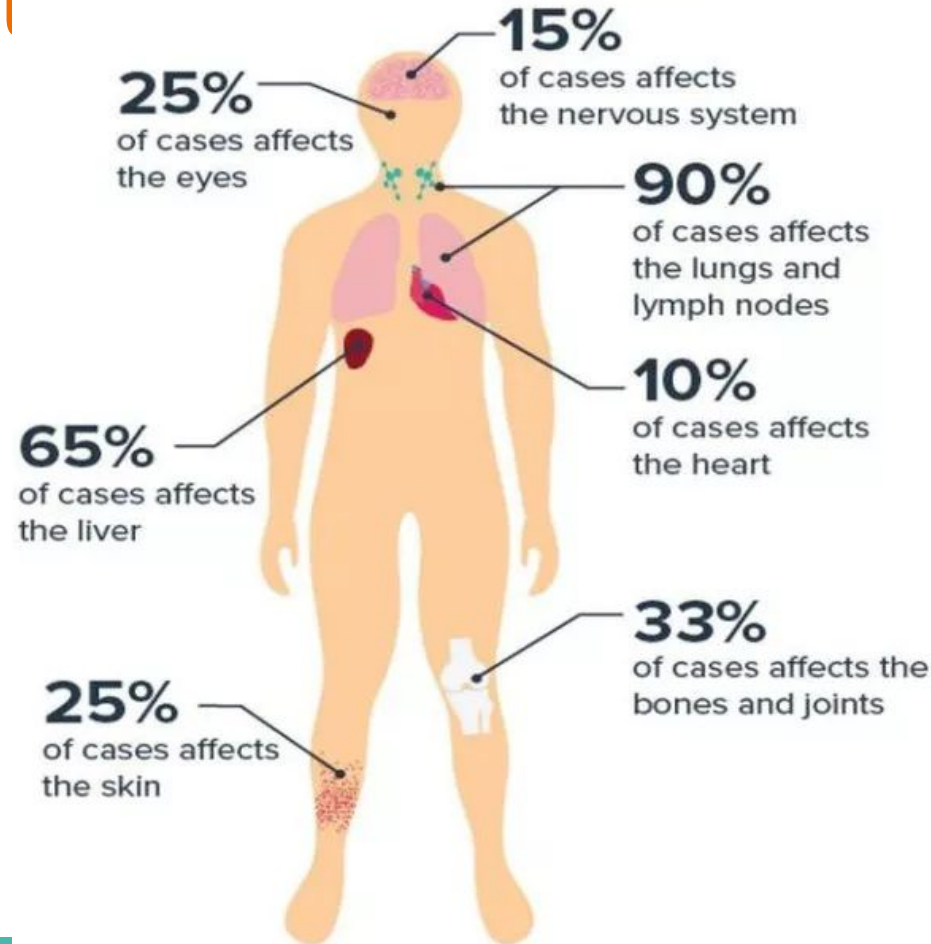
- ACE is found primarily in lung epithelium
 - Enzyme which helps regulate BP
- Granulomas → small nodules under skin and in organs made up of immune and inflammatory cells and fibrous tissue
 - Largely comprised of macrophages
 - Granulomas also produce ACE → level of ACE in blood increases proportionately



Angiotensin-Convert

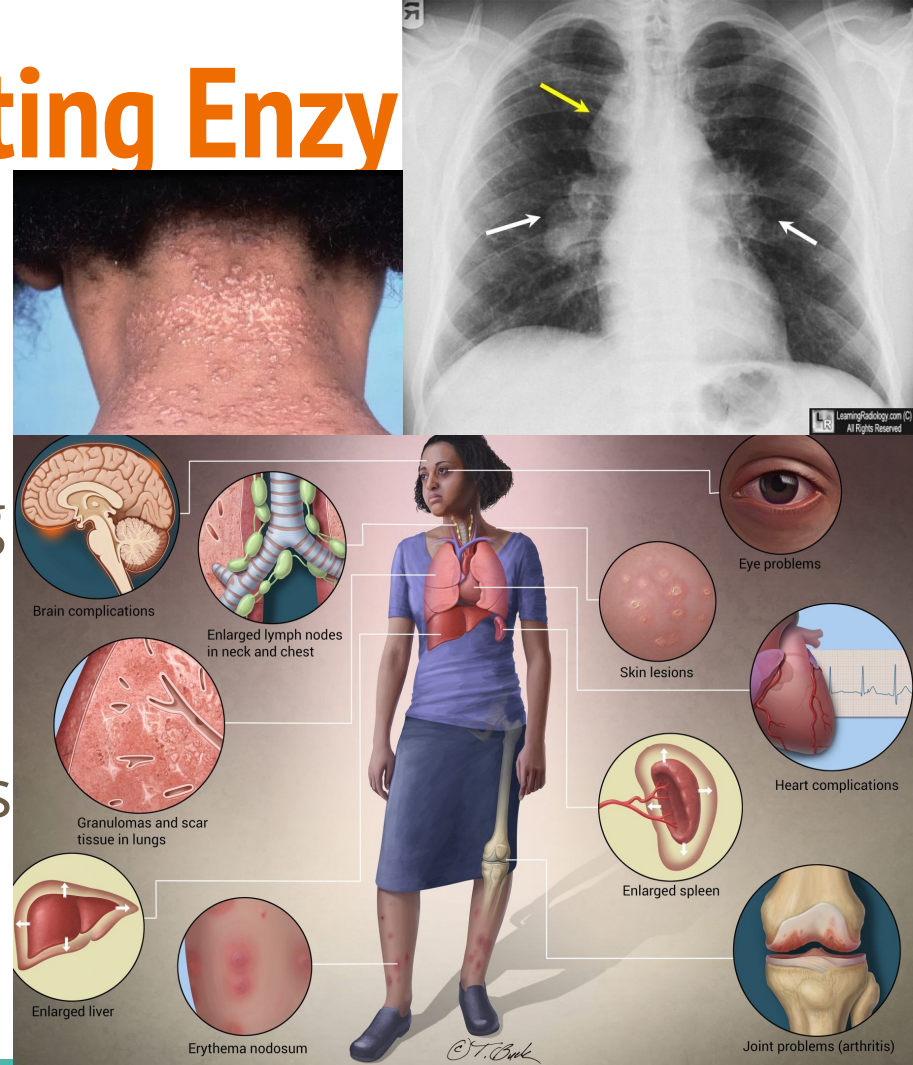
- Elevated in 50-80% of active sarcoidosis
 - Sarcoidosis can be present without an elevated ACE
 - Inactive state, early disease, chronic sarcoidosis
 - Falsely low in Lung disease, steroid therapy, Hypothyroidism
- Confirm with chest X-ray

Effects of Sarcoidosis



Angiotensin-Converting Enzy

- Commonly used for
 - Diagnosing and Monitoring Sarcoidosis
 - Granulomas, lingering cough, shortness of breath, joint pain, granulomatous uveitis
- Confirm with exam, biopsy and X-ray

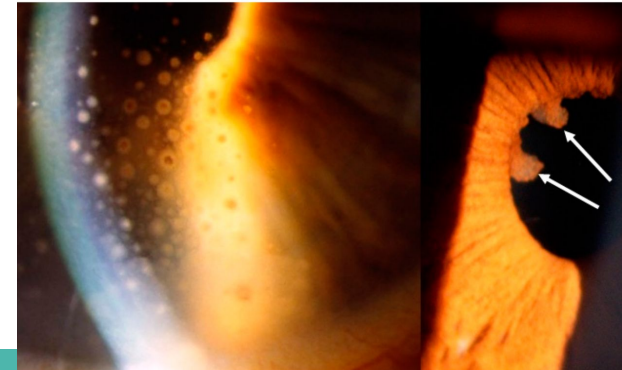
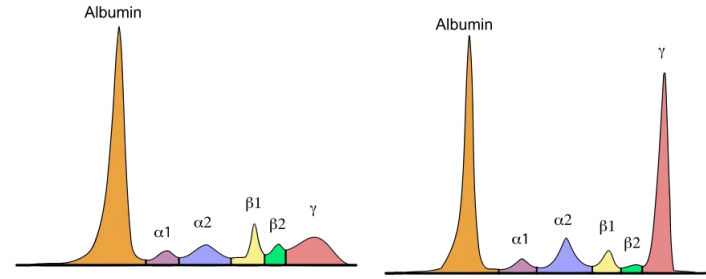


Serum Lysozyme

- AKA: Serum Lysozyme
- Evaluates:
 - To diagnose and monitor Sarcoidosis
 - Also elevated in
 - Leukemia
 - Tuberculosis
 - IBD

Serum Lysozyme

- Lysozyme is an enzyme which damages bacterial cell walls
 - Present in macrophages of *fresh granulomas*
 - Level increases with number of organs involved
- Highly sensitive, but low specificity for sarcoid
- If both ACE and Serum Lysozyme are elevated, 83% predictive for Sarcoidosis



Blood Chemistry	Hematology	Immunology	Infectious
CBC c Diff	Hgb S Solubility	ESR	PPD
BMP	Hgb Electrophoresis	CRP	AFB Smear
Hgb A1C	PT / INR	ANA	QFT
Lipid Panel	PTT	ENA Panel	FT-ABS
Thyroid Panel	Protein C / S	ANCA	RPR
	Factor V Leiden	RF	VDRL
		CCP	Lyme ELISA
		HLA Typing	Herpes
		AChR Antibody	
		ACE	
		Serum Lysozyme	

Purified Protein Derivative

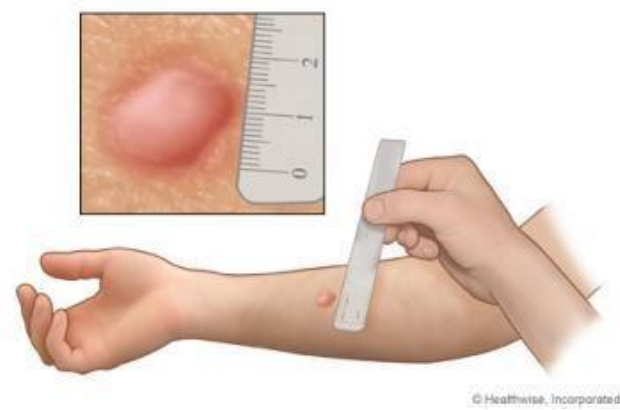
- AKA: PPD
- Evaluates:
 - Exposure to or active Tuberculosis

Purified Protein Derivative

- Tuberculosis is an infectious disease caused by *Mycobacterium tuberculosis*
- PPD tests body's immune response to TB antigens
 - If Hx of exposure/active infection, body will have antibodies against the mycobacterium
 - Does not distinguish between active and inactive disease

Purified Protein Derivative

- Inactivated Tuberculin antigens injected intradermally
- Will provoke hypersensitivity reaction in those with TB exposure / vaccination
 - Takes 6 weeks s/p infection to get (+) result
 - Results read 48-72hrs later
 - 10mm diameter elevation
 - Hx of TB, Hx of BCG vaccine, Has active TB



Acid-Fast Bacillus Smear

- AKA: AFB Smear
- Evaluates:
 - Help detect and monitor infections caused by *Mycobacterium*, specifically *Mycobacterium tuberculosis* (TB)
- Preparation: *sputum* samples are acquired on different days

Acid-Fast Bacillus Smear

- Negative result may be due to not enough bacteria being present yet (false negative)
- Positive result means a probable mycobacterial infection (high specificity)



Quantiferon-TB Gold Assay

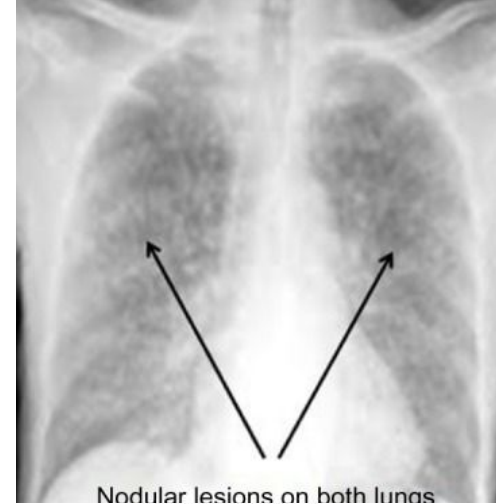
- AKA: Quantiferon Gold, QFT
- Evaluates:
 - ELISA to detect and monitor infections caused by *Mycobacterium tuberculosis* (TB)

Quantiferon-TB Gold Assay

- Patients with TB exposure have lymphocytes in their blood that recognize TB antigens
 - Test detects and quantifies TB specific cytokines
- Unaffected by previous Bacille Calmette-Guerin (BCG) vaccination
- Can not distinguish between active and latent infection
- Highly sensitive and specific for TB

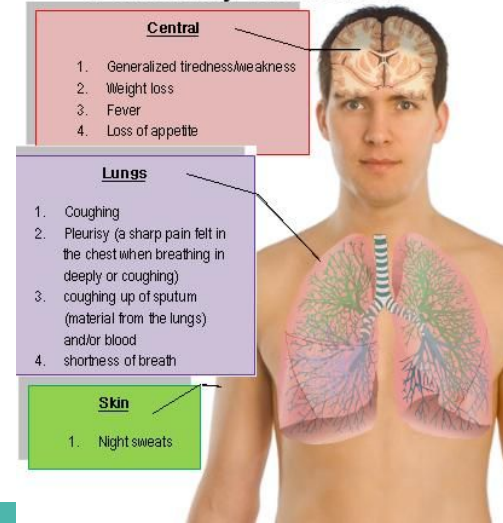
PPD/Quantiferon Gold

- Commonly used for:
 - Screening, Diagnosing, Monitoring TB
 - Immune compromised, Healthcare workers, Confined living conditions, Drug use
 - Signs / Symptoms for TB (chronic cough, bloody cough, fever, chills, night sweats, weight loss, Granulomatous uveitis)
 - Travel to foreign country
- Confirm with chest X-ray



Main symptoms of

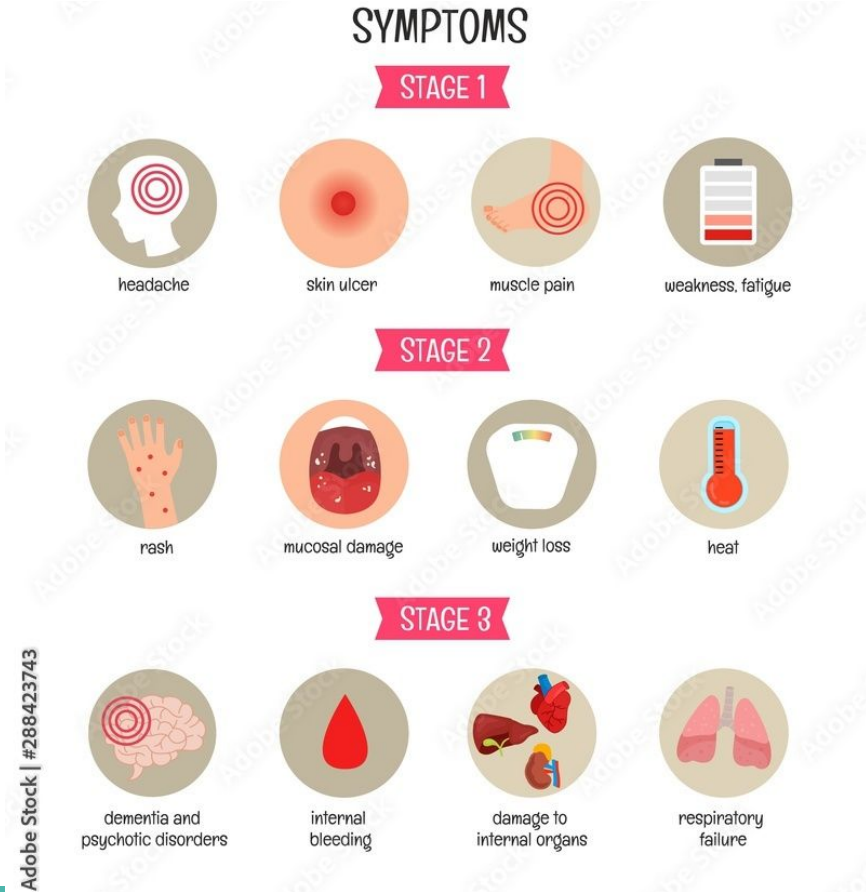
Pulmonary tuberculosis



Blood Chemistry	Hematology	Immunology	Infectious Granulomatous
CBC c Diff	PT / INR	ESR	FT-ABS
BMP	PTT	CRP	RPR
Hgb A1C	Protein C / S	ANA	VDRL
Lipid Panel	Factor V Leiden	ENA Panel	Lyme ELISA
Thyroid Panel		ANCA	Herpes
		RF	
		CCP	
		HLA Typing	
		AChR Antibody	
		ACE	

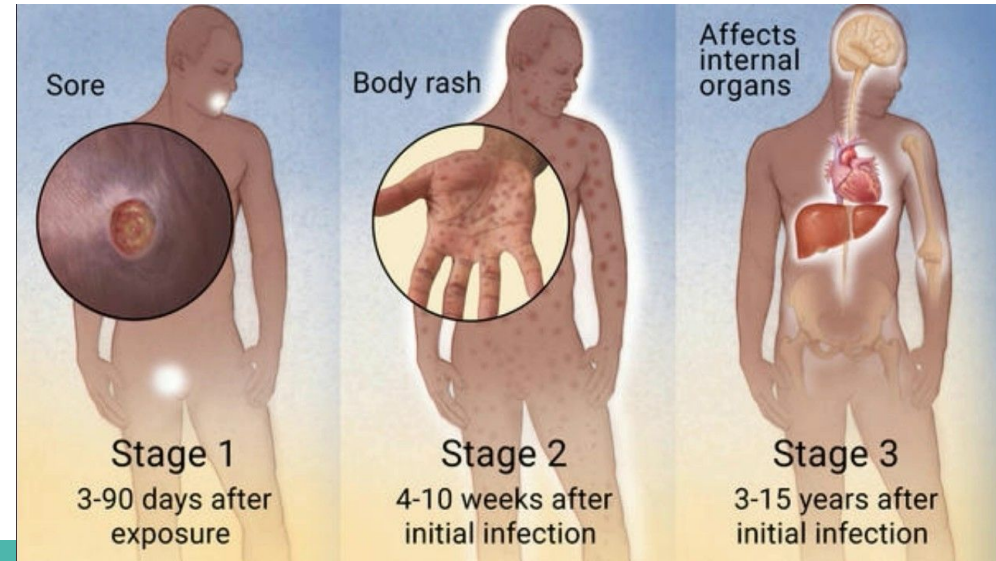
Fluorescent Treponemal Antibody Absorption

- AKA: FTA-ABS
- Evaluates:
 - Screen specifically for *Treponema pallidum*
 - Evaluate if patient has *ever had* syphilis



Fluorescent Treponemal Antibody Absorption

- Detects antibodies specifically targeting *T. pallidum* - STD bacteria that causes syphilis
- Positive after *1 month* of exposure
 - Once infected, the antibodies are present for *life*
 - Very specific



Rapid Plasma Reagin

- AKA: RPR
- Evaluates:
 - Presence of an *active* syphilis infection

Venereal Disease Research Laboratory

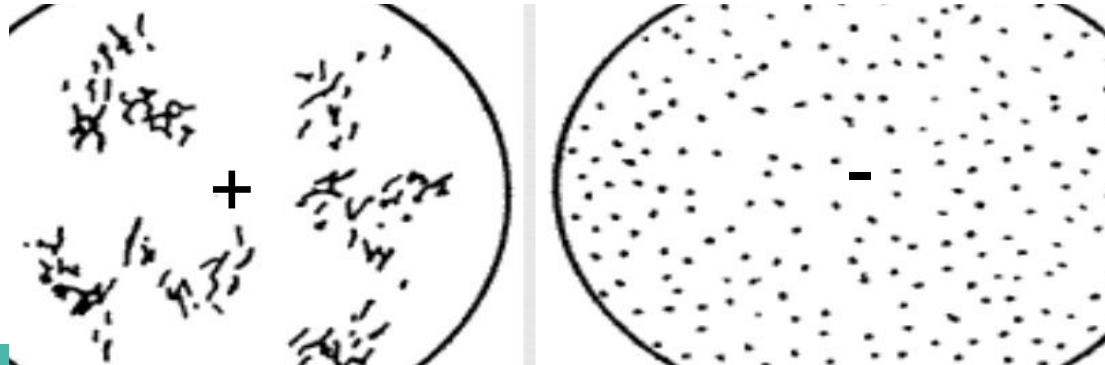
- AKA: VDRL
- Evaluates:
 - Presence of an *active* syphilis infection
 - Presence of *neurosyphilis*

RPR/VDRL

- 'Non-treponemal' - detect antibodies not specifically directed against *T. pallidum*
 - Sensitive but *non-specific* so false-positives may result
 - Pregnancy, Lyme, Pneumonia, TB, SLE
- Disappear 3 years after adequate treatment
 - RPR uses a coated card to detect antigen
 - VDRL uses a microscope to detect antigen

RPR/VDRL

- Antigen mixed with pt's serum / CSF - viewed under microscope
 - Antibodies present → combine with antigen → agglutination → clumps seen on microscope
 - Antibodies not present → mixture remains liquid



RPR/VDRL

- Commonly used for:
 - Active syphilis infection
 - Monitoring response to treatment
 - RPR vs. VDRL
 - VDRL can be run on CSF (during neurosyphilis evaluation)
 - RPR can not be run of CSF

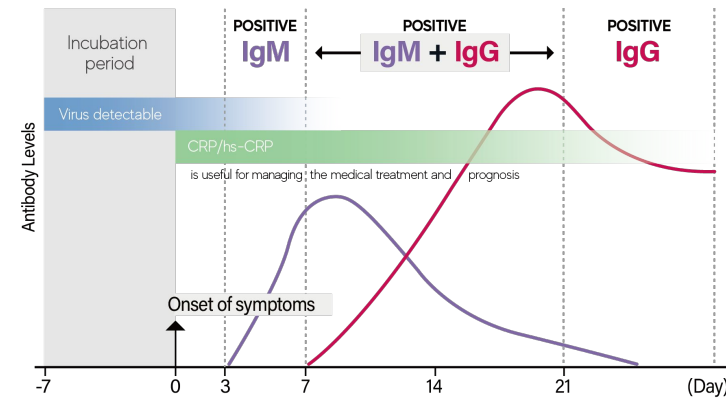
Fluorescent Treponemal Antibody Absorption

- Commonly used for:
 - History of a syphilis infection, High risk activity, History of other STD, Pregnant
 - Signs of syphilis (Chancre sores, Flu like symptoms, Neurosyphilis, Granulomatous uveitis, Vitritis, CWS without anemia or cardiovascular disease)

Blood Chemistry	Hematology	Immunology	Infectious Granulomato
CBC c Diff	PT / INR	ESR	FT-ABS
BMP	PTT	CRP	RPR
Hgb A1C	Protein C / S	ANA	VDRL
Lipid Panel	Factor V Leiden	ENA Panel	Lyme
Thyroid Panel		RF	Herpes
		CCP	
		HLA Typing	
		AChR Antibody	
		ACE	
		Serum Lysozyme	

Immunoglobulin G vs. Immunoglobulin M

- IgM - The first antibody the body makes when exposed to an antigen. Most useful for determining recent infection and usually becomes undetectable weeks to months following infection
- IgG - The most common antibody. Takes time to form after exposure but is detectable for longer periods (G = Going On)



Lyme Enzyme-Linked Immunoassay

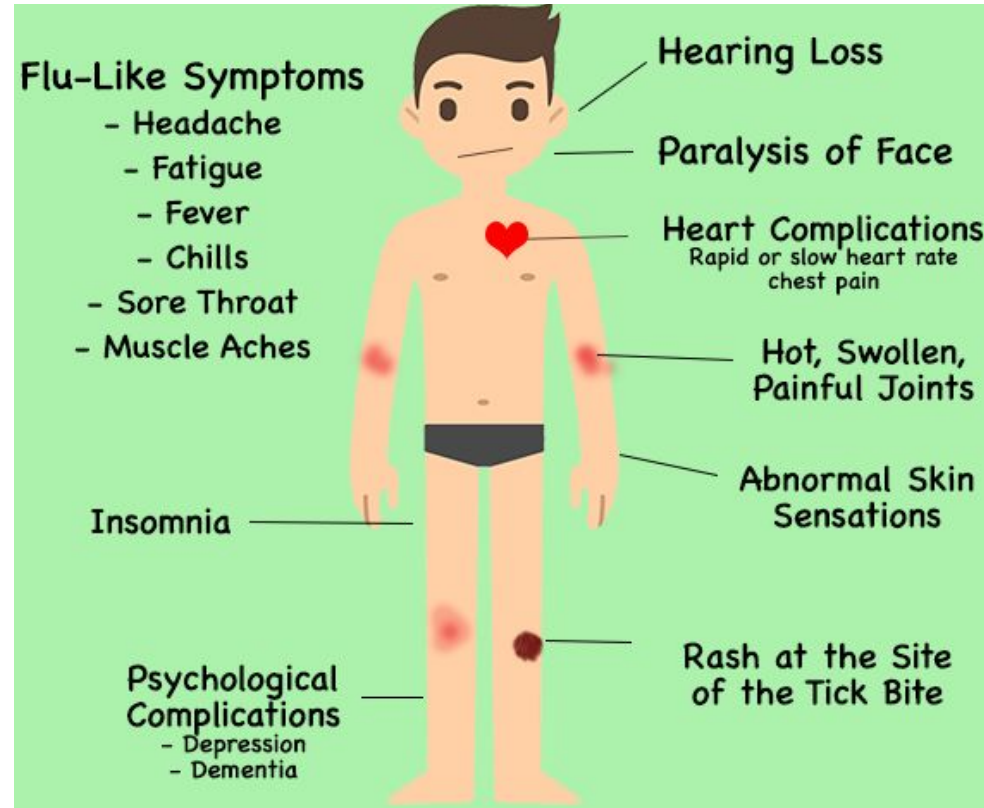
- AKA: EIA, ELISA, ELFA
- Evaluates:
 - Presence of antibodies for *Borrelia burgdorferi* and *Borrelia mayonii*

Lyme Enzyme-Linked Immunoassay

- Immune system produces specific antibodies in response to *B. burgdorferi* or *B. mayonii* bacteria
 - Infected deer tick (black-legged tick) transmit the bacteria through a bite
 - Most common in spring and summer where these ticks live (northeast, mid-Atlantic, and midwest)
- Very sensitive but not specific to *Borrelia*
- May get false positive with SLE or *Treponema pallidum*

Lyme Western Blot

- AKA:
- Evaluates:
 - Used to confirm presence of antibodies for *Borrelia burgdorferi* and *Borrelia mayonii*

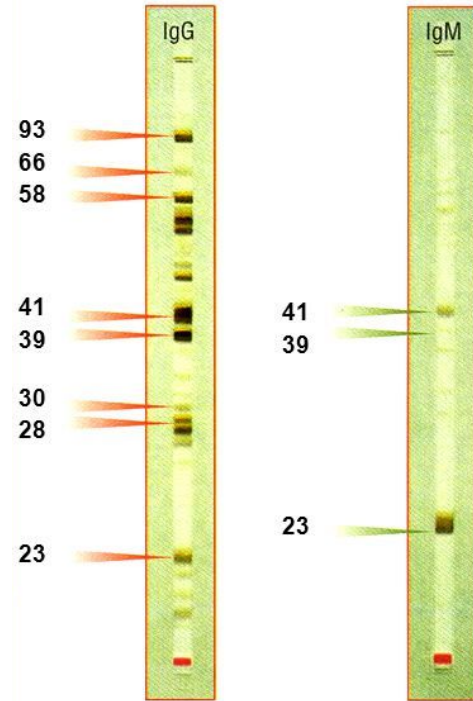


Lyme Western Blot

- Detects if *Borrelia* antibodies are present in a sample of blood or CSF
 - 2-3 weeks s/p, IgM antibodies detectable, increases at 6 weeks then declines
 - More likely to give false positive results
 - 4-5 weeks s/p, IgG antibodies detectable, increases at 4-6 months, remain high for several years

Lyme Western Blot

- 4-5 weeks s/p exposure, IgG antibodies become detectable, increases at 4-6 months, remain high for several years
- Produces bands, each representing antibodies to a different component of the bacteria
 - A combination of *at least 5* IgG bands specific for the bacteria *must* be present to be considered positive



18 kDa.	-
** 23-25 kDa.	-
28 kDa.	-
30 kDa.	-
** 31 kDa.	-
** 34 kDa.	-
** 39 kDa.	IND
** 41 kDa.	+
45 kDa.	-
58 kDa.	+
66 kDa.	-
** 83-93 kDa.	-

Lyme ELISA / Western Blot

- Commonly used for:
 - Screen, Diagnose, Manage Lyme disease
 - Erythema migrans, Fever, Chills, Headache, Fatigue, Joint pain, Bell's palsy, Weakness, Meningitis, Granulomatous uveitis, Cotton-wool spots w/o cardiovascular Dx
 - Live in high risk area

OCULAR SYMPTOMS AND SIGNS:

Conjunctivitis	Iridocyclitis
Photophobia	Pars planitis
Bell's palsy	Vitritis
Cranial neuropathy/ diplopia	Choroiditis
Disc edema and blurred vision	Panuveitis
Headache	Retinal vasculitis
Episcleritis	Exudative RD
Symblepharon	BRVO
Keratitis	Birdshot chorioretinopathy

OCULAR STAGING:

STAGE 1 (ACUTE)

Most common is follicular conjunctivitis followed by episcleritis

STAGE 2 (RAMP UP)

Anterior to posterior uveitis, panuveitis; vitritis can be served with exudative RD, papillitis

Multiple cranial nerve manifestations bundles

STAGE 3 (SMOLDERING)

Keratitis: Bilateral, focal + subepi to stromal, usually SEI present

Can take place years after initial presentation

Blood Chemistry	Hematology	Immunology	Infectious Granulomatous
CBC c Diff	PT / INR	ESR	FT-ABS
BMP	PTT	CRP	RPR
Hgb A1C	Protein C / S	ANA	VDRL
Lipid Panel	Factor V Leiden	ENA Panel	Lyme
Thyroid Panel		RF	Herpes
		CCP	
		HLA Typing	
		AChR Antibody	
		ACE	
		Serum Lysozyme	

Herpes Virus

- AKA: HSV-1, HSV-2, VZV
- Evaluates:
 - Detects presence of active or latent
 - Herpes Simplex Virus (HSV) 1 and 2
 - Varicella Zoster Virus (VZV)

Herpes symptoms

Pain or itching



Herpes rash



Herpes blisters



Vaginal discharge



Scabs



Tender lumps



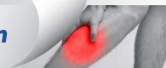
Headache



Swollen lymph nodes in the groin



Muscle pain



Fever



Herpes lesions

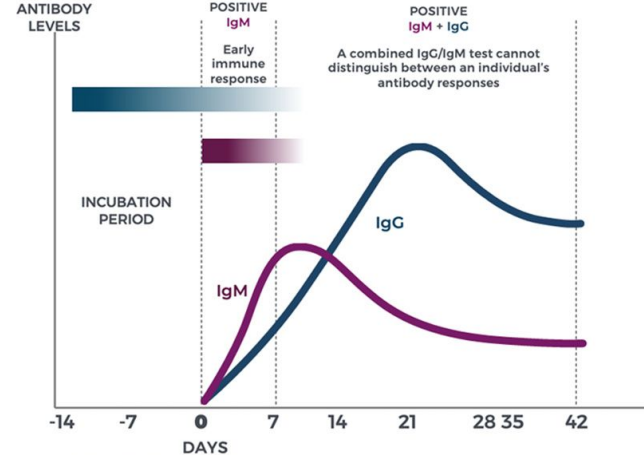


Herpes Virus

- Herpes Simplex Virus (HSV)
 - HSV-1 generally around the oral area
 - 50% of U.S. adults
 - HSV-2 generally around the genital area
 - 17% of U.S. adults
- Varicella Zoster Virus (VZV)
 - 50% of those living to 85yo will have at least one shingles attack

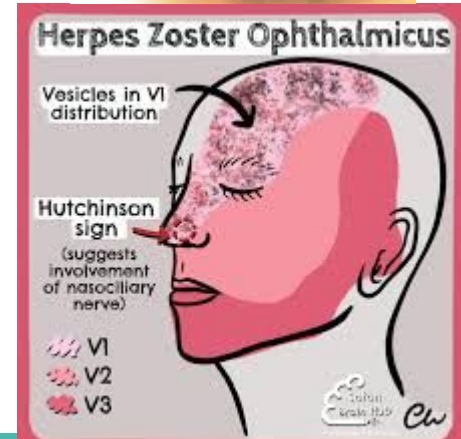
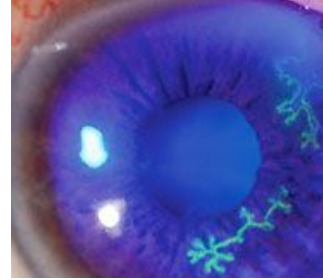
Herpes Virus

- IgM produced several days after primary infection
 - Stay in blood for several weeks
 - Indicates an active / recent infection
- IgG produced several weeks after primary infection, slowly rise, then stabilize in the blood
 - Once infected with HSV, IgG will continue to be produced in small quantities
 - Increasing IgG levels indicate an active infection



Herpes Virus

- Commonly used for:
 - Screening, Diagnosing, and Managing HSV and VZV
 - Painful rash with blisters that scab, itching, tingling, Granulomatous uveitis, Dendritic, Scleritis, Hutchinson's sign
 - High risk population or behavior, Other STDs, Pregnant, Immunocompromised



Blood Chemistry	Hematology	Immunology	Infectious
CBC c Diff	Hgb S Solubility	ESR	PPD
BMP	Hgb Electrophoresis	CRP	AFB Smear
Hgb A1C	PT / INR	ANA	QFT
Lipid Panel	PTT	ENA Panel	FT-ABS
Thyroid Panel	Protein C / S	ANCA	RPR
	Factor V Leiden	RF	VDRL
		CCP	Lyme
		HLA Typing	Herpes
		AChR Antibody	HIV / Viral Load
		ACE	CD 4
		Serum Lysozyme	

HIV Antibody and Antigen Evaluation

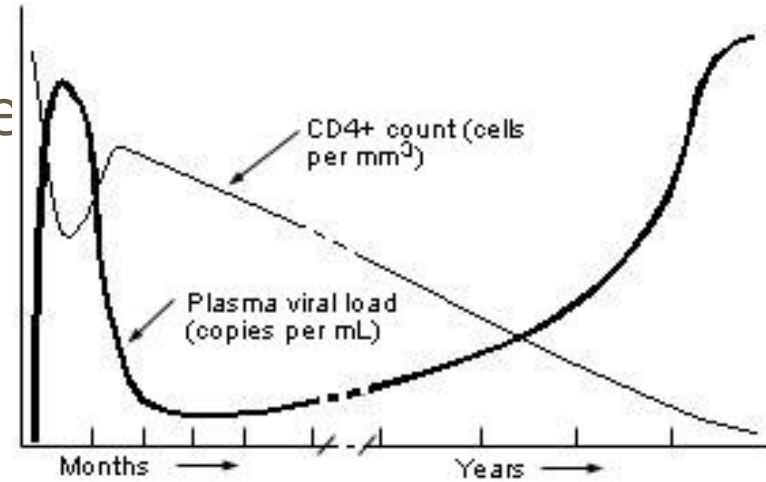
- AKA: HIV Serology, HIV Ag/Ab
- Evaluates:
 - Presence of the HIV (p24) antigen and antibodies

HIV Antibody and Antigen Evaluation

- Human Immunodeficiency Virus (HIV) causes Acquired Immunodeficiency Syndrome (AIDS)
- Initially HIV infection causes no or flu like symptoms that resolve after 1-2 weeks and cause few symptoms for 10-20 years
- Eventually AIDS emerges as HIV destroys the immune system and leaves patient vulnerable to debilitating infections and cancers

HIV Antibody and Antigen Evaluation

- During first few weeks of infection, the viral load (amount of virus) and p24 antigen increase
- 2-12 weeks after exposure, the immune system produces antibodies against the virus
- As initial infection resolves, HIV antibody increases and viral load and p24 antigen levels decrease



HIV Antibody and Antigen Evaluation

- P24 antigen testing allows detection of early infection
- Early screening of HIV antibody may result in a false negative (takes 2-12 weeks to develop)
 - Tests are performed together, several weeks apart
- If initial Antibody/Antigen test is (+), a second antibody immunoassay test is done to differentiate between HIV 1 (USA) and HIV 2 (Africa)

Viral Load

- AKA: HIV RNA Test, HIV Quantification
- Evaluates:
 - Status of HIV infection
 - Monitor effectiveness of anti-retroviral or HAART treatment

Viral Load

- Evaluates the viral load / amount of HIV RNA in the blood
- HIV virus attacks CD4 WBC which fight infection
 - Uses CD4 cell to replicate itself and spread
- Viral loads consistently less than 200 copies/mL → virus is adequately suppressed and risk of disease progression is low

CD 4 and CD8 Count

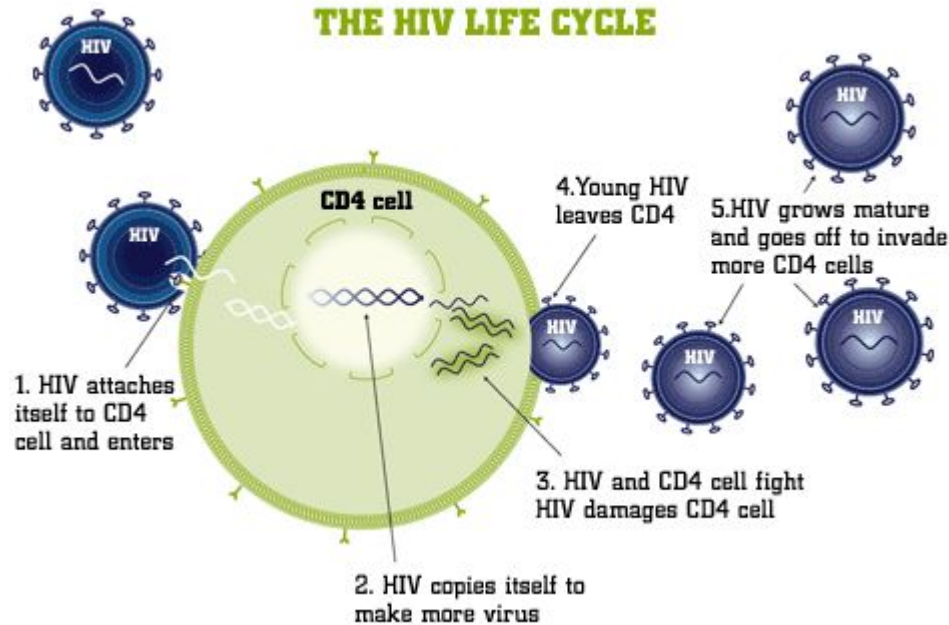
- AKA:
- Evaluates:
 - Measures strength of immune system and monitors treatment in HIV infected patients

CD 4 and CD8 Count

- CD cells are WBCs called T lymphocytes
- Made in thymus gland and circulate through blood and lymphatic system
 - Fight infection and take part in immune system function
 - Have markers on their surface called clusters of differentiation (CD)
 - The number identifies the specific type of cell

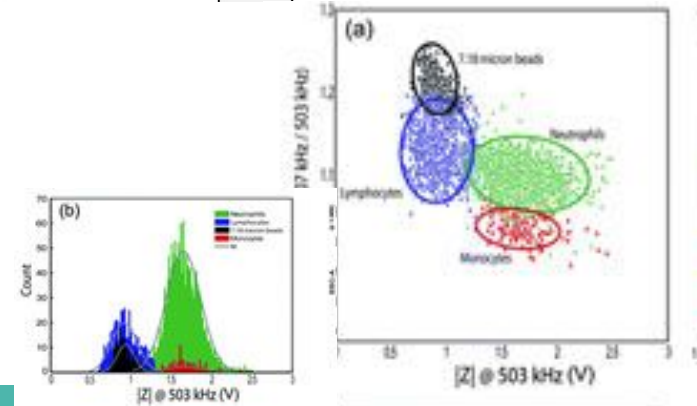
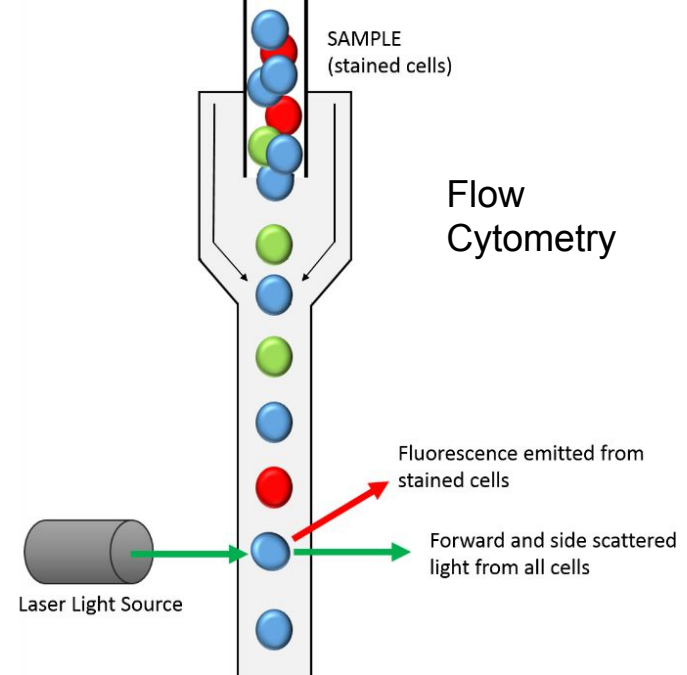
CD 4 and CD8 Count

- CD4 cells → ID, attack, and destroy bacteria, fungi, and viruses (T-helper cells)
- CD8 cells → ID, attack, destroy cells infected with viruses / cancer and block virus replication (T-suppressor cells)



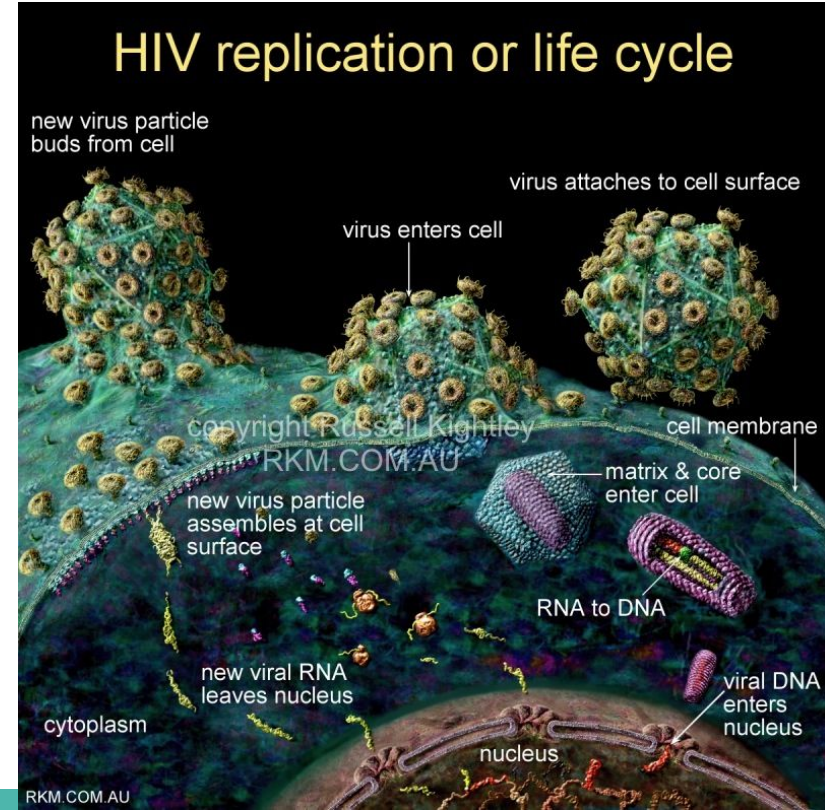
CD 4 and CD8 Count

- As HIV progresses, CD4 cell count will decrease in relation to total lymphocyte and CD8 count
- Normal CD4:CD8 ratio is 2:1
- Normal CD4 count 500–1,200 cells/mm³
- CD4 count above 300 cells/mm³ in HIV is good
- CD4 count below 200 cells/mm³ is AIDS



HIV/Viral Load / CD 4 and CD8 Count

- Commonly used for:
 - Screen and Diagnose HIV
 - High risk behaviour, Health care workers, Drug use, Other STD, Pregnancy
 - To monitor treatment effect / starting new treatment of HIV



BLOOD CHEMISTRY Anemia, Atherosclerosis	HEMATOLOGY Coagulation	IMMUNOLOGY Non Granulomatous	INFECTIOUS Granulomatous
CBC c Diff	PT / INR	ESR	RPR
BMP	PTT	CRP	VDRL
Hgb A1C	Protein C / S	ANA	Lyme ELISA
Lipid Panel	Factor V Leiden	ENA Panel	Herpes
Thyroid Panel		RF	
		CCP	
		HLA Typing	
		AChR Antibody	
		ACE	
		Serum Lysozyme	

Labs for Optic Neuropathy

- Complete Blood Count with Diff (CBC with Diff) - anemia, leukemia, hyperviscosity
- Vitamin B9 / B12 - anemia, nutritional
- Basic Metabolic Panel (BMP) - DM, Kidney function
- Glycosylated Hemoglobin (Hgb A1C) - DM
- Lipid Panel - hypercholesterolemia
- Erythrocyte Sedimentation Rate (ESR) - systemic inflammation, GCA
- C-Reactive Protein (CRP) - systemic inflammation, GCA
- Antinuclear Antibody (ANA) - autoimmune, SLE, RA, CTD
- Extractable Nuclear Antigen Antibody (ENA) - autoimmune, SLE
- Rheumatoid Factor (RF) - autoimmune, RA, SLE
- Cyclic Citrullinated Peptide Antibody (CCP) - RA
- Angiotensin Converting Enzyme (ACE) - Sarcoidosis
- Serum Lysozyme - Sarcoidosis, TB
- Purified Protein Derivative (PPD) - TB
- Fluorescent Treponemal Antibody Absorption (FTA-ABS) - Syphilis
- Rapid Plasma Reagin (RPR) / Venereal Disease Research Lab (VDRL) - Syphilis
- Lyme Immunoassay - Lyme
- Herpes Virus - HSV, VZV
- HIV Serology - HIV

Labs for Uveitis

- Complete Blood Count with Diff (CBC with Diff) - anemia, leukemia, hyperviscosity
- Erythrocyte Sedimentation Rate (ESR) - systemic inflammation, GCA, RA, Sarcoid, IBD
- C-Reactive Protein (CRP) - systemic inflammation, GCA
- Antinuclear Antibody (ANA) - autoimmune, SLE, RA, CTD
- Extractable Nuclear Antigen Antibody (ENA) - autoimmune, SLE
- Antineutrophil Cytoplasmic Antibodies (ANCA) - Wegener's granulomatosis, Vasculitis, IBD
- Rheumatoid Factor (RF) - autoimmune, RA, SLE
- Cyclic Citrullinated Peptide Antibody (CCP) - RA
- Human Leukocyte Antigen (HLA) - AS, Behcet's, SLE, RA
- Angiotensin Converting Enzyme (ACE) - Sarcoidosis
- Serum Lysozyme - Sarcoidosis, TB
- Acid-Fast Bacillus Smear (AFB) - TB
- Purified Protein Derivative (PPD) / Quantiferon-TB Gold - TB
- Fluorescent Treponemal Antibody Absorption (FTA-ABS) - Syphilis
- Rapid Plasma Reagin (RPR) / Venereal Disease Research Lab (VDRL) - Syphilis
- Lyme Immunoassay - Lyme
- Herpes Virus - HSV, VZV
- HIV Serology - HIV

UVEITIS

Non-Granulomatous ●

Acute ●

Chronic ●

- HLA-B27 Associated (AS, Reiter's, Psoriatic, IBD)
- HLA-B51 Associated (Behcet's)
- HLA-B54 Associated (Glaucomatocyclic crisis / PSS)
- Lyme
- SLE
- Drug Induced
- Traumatic
- Idiopathic

- Fuch's Heterochromic Iridocyclitis
- Juvenile Rheumatoid Arthritis / Juvenile Idiopathic Arthritis

Granulomatous ●

- Herpes Simplex / Zoster
- Syphilis
- Lyme
- Sarcoidosis
- Tuberculosis
- Wegener's Granulomatosis
- Toxoplasmosis
- Brucellosis
- Vogt-Koyanagi-Harada (VKH) Syndrome
- Autoimmune Lens Induced (Phacolytic)

Labs for Diplopia

- Complete Blood Count with Diff (CBC with Diff) - anemia, leukemia, hyperviscosity
- Complete Metabolic Panel (CMP) - DM, Kidney function, Liver function
- Glycosylated Hemoglobin (Hgb A1C) - DM
- Thyroid Panel - Hyper or Hypo thyroidism
- Acetylcholine Receptor Antibodies (AChR antibody) - MG
- Angiotensin Converting Enzyme (ACE) - Sarcoidosis
- Serum Lysozyme - Sarcoidosis, TB
- Fluorescent Treponemal Antibody Absorption (FTA-ABS) - Syphilis
- Rapid Plasma Reagin (RPR) / Venereal Disease Research Lab (VDRL) - Syphilis
- Lyme Immunoassay - Lyme

Labs for Retinal Occlusion / Hemorrhages

- Complete Blood Count with Diff (CBC with Diff) - anemia, leukemia, hyperviscosity
- Vitamin B9 / B12 - anemia, nutritional
- Complete Metabolic Panel (CMP) - DM, Kidney function, Liver function
- Glycosylated Hemoglobin (Hgb A1C) - DM
- Lipid Panel - hypercholesterolemia
- Hemoglobin S Solubility (Hgb S) - Sick cell
- Hemoglobin Electrophoresis (Hgb ELP) - SCD, SC trait, thalassemia
- Prothrombin Time with INR (PT-INR) - hyper/hypocoagulable
- Partial Thromboplastin Time (PTT) - hyper/hypocoagulable
- Factor 5 Leiden - hypercoagulable state
- Homocysteine - plaque/thromboembolism
- Antineutrophil Cytoplasmic Antibodies (ANCA) - Wegener's granulomatosis, Vasculitis
- HIV Serology - HIV

Blood Chemistry / Hematology

- ☐ CBC with Differential
- ☐ BMP
- ☐ Hemoglobin A1C
- ☐ Lipid Panel
- ☐ Thyroid Panel (TSH, T3, Free T3, T4, Free T4)
- ☐ PT / PTT / INR
- ☐ Factor V Leiden
- ☐ Protein C
- ☐ Protein S
- ☐ Homocysteine Level
- ☐ Hemoglobin Electrophoresis
- ☐ Hemoglobin S Solubility
- ☐ Vitamin B12 Level
- ☐ Folate
- ☐ Thiamine

Inflammatory / Immunology

- ☐ ESR
- ☐ CRP
- ☐ ANA
- ☐ ENA Panel
- ☐ ANCA
- ☐ RF
- ☐ CCP
- ☐ ACE
- ☐ Serum Lysozyme
- ☐ Sjogren's Antibodies: SSA, SSB, SSC
- ☐ HLA Serotyping
 - _B27 _B51 _B54 _DR4 _B8 Other: _____
- ☐ AChR
 - _Blocking _Binding _Modulating

Special Testing / Imaging

- ☐ Chest X-Ray (AP and Lateral Views)
- ☐ Carotid Duplex Scan
- ☐ Echocardiogram
- ☐ Electrocardiogram (EKG)

Other Tests

- ☐
- ☐

Infectious

- ☐ FTA - ABS
- ☐ RPR
- ☐ VDRL
- ☐ HIV Antigen / Antibodies
- ☐ HIV Viral Load
- ☐ CD4 Count
- ☐ PPD with Read
- ☐ Quantiferon-TB Gold Assay
- ☐ Antibody Titers, IgG / IgM
 - _Lyme _Toxoplasmosis _Toxocara _HSV 1 / 2
 - _VZV _CMV _Hepatitis A / B / C

Blood Chemistry / Hematology

- ☐ CBC with Differential
- ☐ BMP
- ☐ Hemoglobin A1C
- ☐ Lipid Panel
- ☐ Thyroid Panel (TSH, T3, Free T3, T4, Free T4)
- ☐ PT / PTT / INR
- ☐ Factor V Leiden
- ☐ Protein C
- ☐ Protein S
- ☐ Homocysteine Level
- ☐ Hemoglobin Electrophoresis
- ☐ Hemoglobin S Solubility
- ☐ Vitamin B12 Level
- ☐ Folate
- ☐ Thiamine

Inflammatory / Immunology

- ☐ ESR
- ☐ CRP
- ☐ ANA
- ☐ ENA Panel
- ☐ ANCA
- ☐ RF
- ☐ CCP
- ☐ ACE
- ☐ Serum Lysozyme
- ☐ Sjogren's Antibodies: SSA, SSB, SSC
- ☐ HLA Serotyping
- ☐ _B27 _B51 _B54 _DR4 _B8 Other: _____
- ☐ AChR
- ☐ _Blocking _Binding _Modulating

Special Testing / Imaging

- ☐ Chest X-Ray (AP and Lateral Views)
- ☐ Carotid Duplex Scan
- ☐ Echocardiogram
- ☐ Electrocardiogram (EKG)

Other Tests

- ☐
- ☐

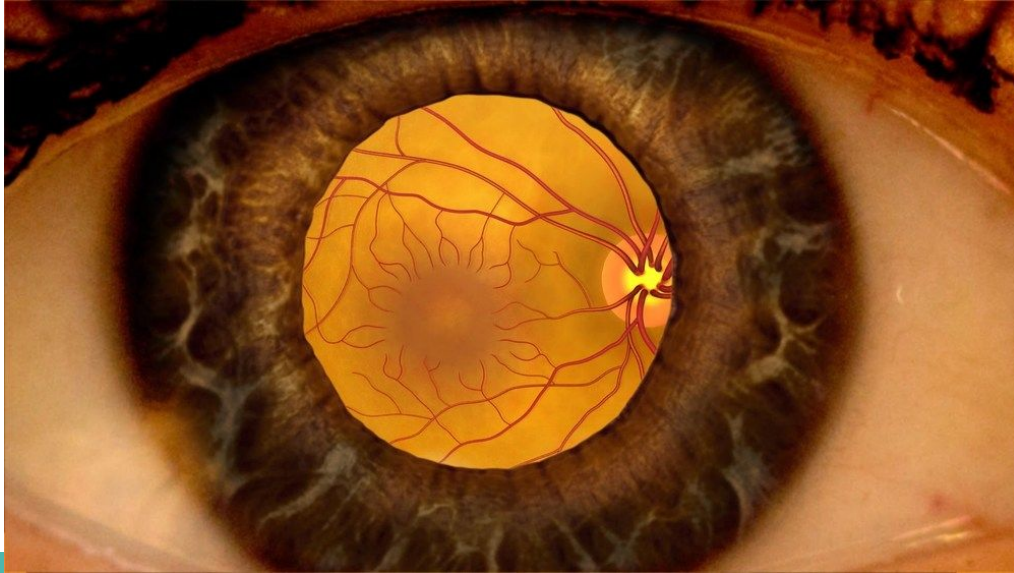
Infectious

- ☐ FTA - ABS
- ☐ RPR
- ☐ VDRL
- ☐ HIV Antigen / Antibodies
- ☐ HIV Viral Load
- ☐ CD4 Count
- ☐ PPD with Read
- ☐ Quantiferon-TB Gold Assay
- ☐ Antibody Titers, IgG / IgM
- ☐ _Lyme _Toxoplasmosis _Toxocara _HSV 1 / 2
- ☐ _VZV _CMV _Hepatitis A / B / C

Cost of Blood Work	TEST	COST
	CBC with Diff	37
	ANA	86
	ACE	125
	RA Factor	46
	HLA-B27	204
	RPR	39
	ESR	36
	CRP	68
	HIV Immunoassay	312
	Lyme Titer	125
	PPT	36
	PT	28
	Protein C and Protein S	220

Before you order blood work

- Narrow down the differentials
 - Good case history
 - Good ocular / physical examination

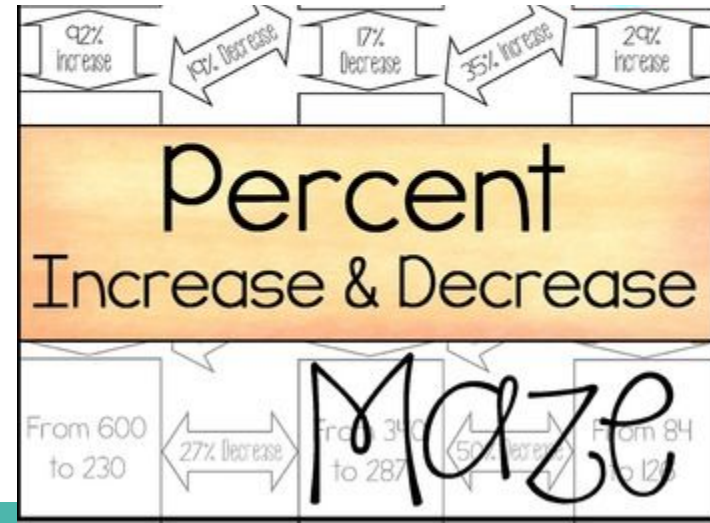


Conclusion

- Optometrists are primary eye care providers
 - Play key role in preventing, diagnosing, and comanaging systemic diseases
- Laboratory tests are important *tools* for diagnosis and management of systemic and ocular disease
- Must be able to
 - Recognize indications for ordering blood work
 - Analyze and communicate results
 - Treat / Comanage the patient

Conclusion

- Results are rarely pathognomonic
 - Must be used in conjunction with patient history and clinical findings
 - Increases or decreases the *possibility* of a disease



tvpetrosyan@gmail.com

