

GOOD AFTERNOON



# **BIOCHEMICAL INVESTIGATION**

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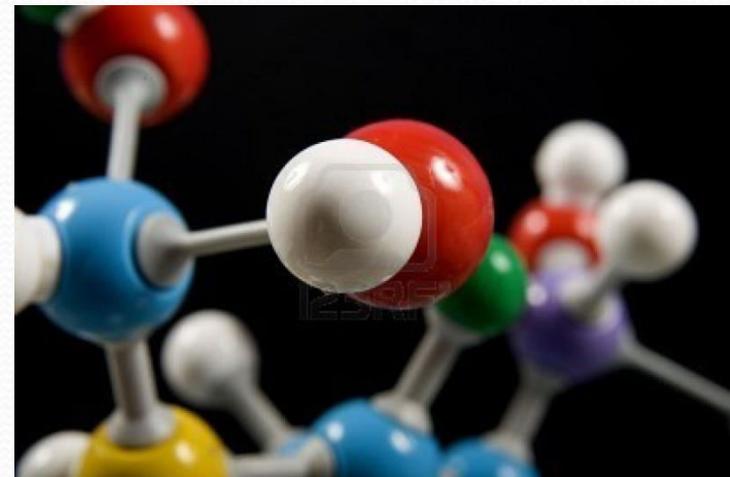
Amylase

lipase

## **CONCLUSION**

# Introduction

Blood chemistry refers to individual measurement of the large number of enzymes and other chemical substances dissolved and transported in the blood serum. Similar analyses are also carried out on urine, saliva, and other body fluids. A number of important constituents of the erythrocyte as well as substances bound to the erythrocyte are also measured in the clinical chemistry



# SERUM (PLASMA-FIBRINOGEN)

The clear, thin, watery portion of a liquid that can be separated from the more solid elements. The fluid portion of whole blood that separates after coagulation of the specimen. It is devoid of fibrinogen (a clotting protein). Serum may be separated out of whole blood by centrifugation.

# PLASMA(FIBRINOGEN+SERUM)

- Blood plasma is the yellow liquid component of blood in which the blood cells in whole blood are normally suspended. It makes up about 55% of the total blood volume.
- Blood serum is blood plasma without fibrinogen or the other clotting factors (i.e., whole blood minus both the cells *and* the clotting factors).

# BLOOD SUGAR

- Blood sugar, also known as blood glucose, is the body's fuel that feeds the brain, nervous system, and tissues.
- Maintaining a balanced blood glucose level is essential to a body's everyday performance.
- Glucose is absorbed directly into the bloodstream from the intestine and results in a rapid increase in the blood glucose level.
- The pancreas releases insulin, a natural hormone, to prevent blood glucose levels from excessively elevating, and aids in the moving of glucose into the cells.
- Glucose is then carried to each cell, providing them with the energy needed to carry out its specific function.

# DIABETES

- Diabetes mellitus is a disease of insidious onset causing serious tissue changes leading to permanent cardiovascular, renal, cerebral, and optic damage.

# Blood glucose or Fasting Blood sugar

- This test is performed to discover whether there is disorder in glucose metabolism.
- The glucose concentration in whole blood is normally between 50 and 150 mg /dl, 10% to 15% in plasma. An increase in the blood glucose level is found in uncontrolled diabetes, chronic liver disease, and over activity of a number of the endocrine glands.
- In mild diabetes there may be a normal glucose level; so if diabetes is suspected, more sensitivity test such as the glucose tolerance test must be performed.
- There may be a decrease in blood sugar in the case of tumors of the islets of langerhans, under functioning of various endocrine glands, glycogen storage disease (gierke's) and overtreatment with insulin.

# Cont..

- Carbohydrates in the diet are digested to form monosaccharides. After absorption, these are converted to glucose in the liver. Glucose is used by the cell for the production of energy.
- The hormone insulin is necessary to mediate the use of glucose in certain cells.
- The blood glucose determination measures the amount of circulating glucose and indicates the adequacy of the available insulin.
- Interpretation of the results depends on the method of determination and whether the patient was actually fasting when the test was performed. If the patient was not fasting, the results are not diagnostic.

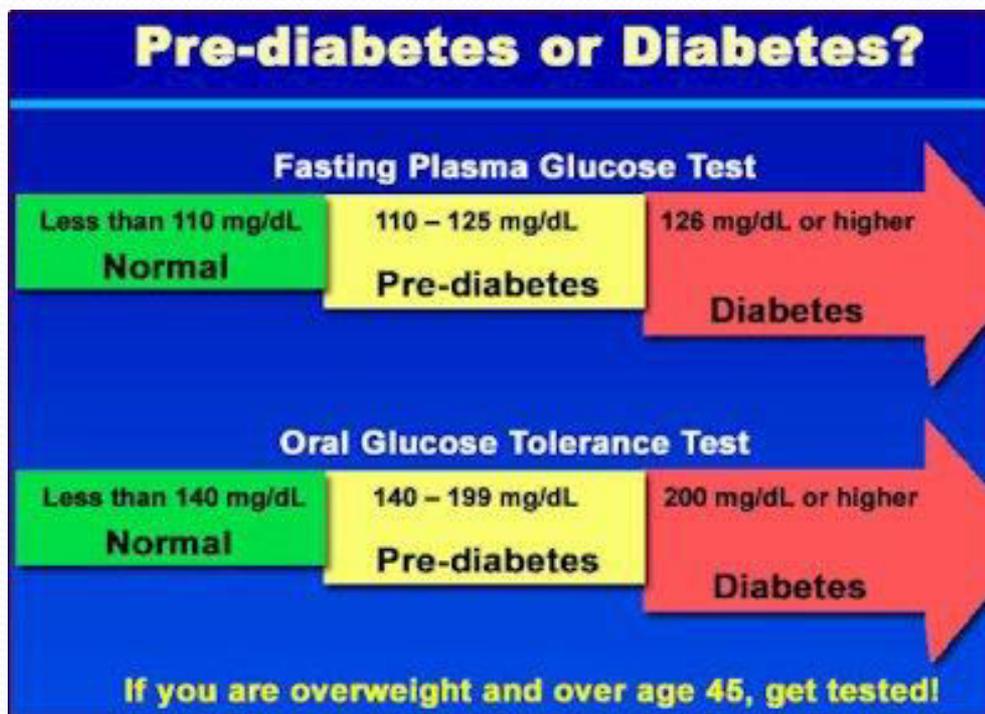
# Cont...

- ***Normal values: 70 to 110 mg/dl (serum)***
- ***60 to 110 mg/dl (whole blood)***
- High values are seen in diabetes mellitus. Cushing's disease, pheochromocytoma, and in patients taking corticosteroids.
- Low values are seen in insulin secreting tumors. Extensive liver diseases, pituitary hypofunction. Addison's disease and in malabsorption of monosaccharides.

# FASTING BLOOD GLUCOSE

- Fasting, as the name suggests, means refraining from eating or drinking any liquids other than water for eight hours. It is used as a test for diabetes.
- After fasting, a carbohydrate metabolism test is conducted which measures blood glucose levels.
- When fasting, the hormone glucagon is stimulated and this increases plasma glucose levels in the body.
- If a patient doesn't have diabetes, their body will produce insulin to re-balance the increased glucose levels.
- The fasting blood sugar test is also used to test the effectiveness of different medication or dietary changes on people already diagnosed as diabetic.

# FASTING BLOOD GLUCOSE



# Fasting tests

- The fasting test should be conducted on two separate occasions to ensure consistent results and in order to avoid a false diagnosis.
- This is the case as increased glucose levels may be as a result of Cushing's syndrome, liver or kidney disease, and pancreatitis.
- However many of these conditions are often picked up in lab diagnostic tests.

# Fasting test results

- The results of a fasting test with respect to glucose levels in the body are as follows:
- **Normal: 70 to 100 mg/dl (5.6 mmol/l)**
- **Prediabetes or Impaired Glucose Tolerance: 101 to 126 mg/dl (5.6 – 7 mmol/l)**
- **Diagnosis of diabetes: more than 126 mg/dl (7 mmol/l)**

# Two hour postprandial serum glucose

- After an overnight fast (8-12 hours), draw a specimen for fasting serum glucose
- The patient is then given a breakfast containing 100 grams of carbohydrate.
- Two hours later, a single sample of blood is drawn into a red top or grey top (NaF) tube for glucose determination. **Normal – 70 to 145 mg/dl**

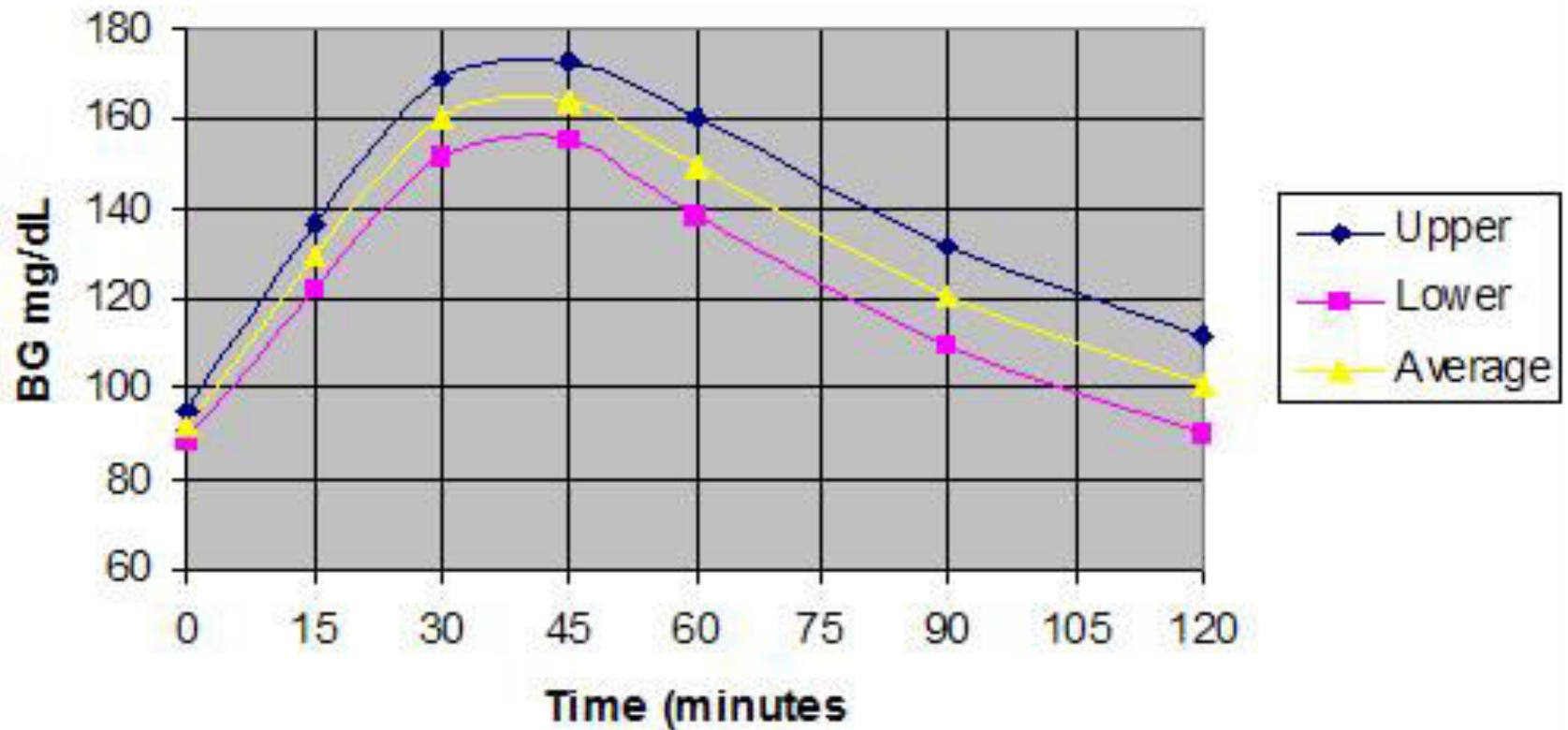
# Venous Blood Sugar Measurement

- The specimen should be collected according to the directions of the laboratory being used and should be transported there as soon as possible and should not be frozen.
- Test results are quoted in terms of plasma glucose or venous whole blood glucose. While a variety of enzymatic and chemical procedures (e.g., glucose oxidase, hexokinase, O-toluidine, Somogyi-Nelson, Auto-Analyzer ferricyanide, and neocuproine techniques) are used by different laboratories, compares for both plasma and whole blood glucose.

# Oral Glucose Tolerance Test

- The glucose tolerance test is one of the procedures used for the definitive diagnosis of diabetes mellitus
- It is performed on a series of blood samples by a laboratory and is used to confirm a diagnosis of diabetes in patients who do not exhibit consistently elevated fasting blood glucose levels.
- For many years, the glucose tolerance test has been the accepted procedure for making a definitive diagnosis of diabetes mellitus and for distinguishing diabetes from other causes of hyperglycemia such as hyperthyroidism.

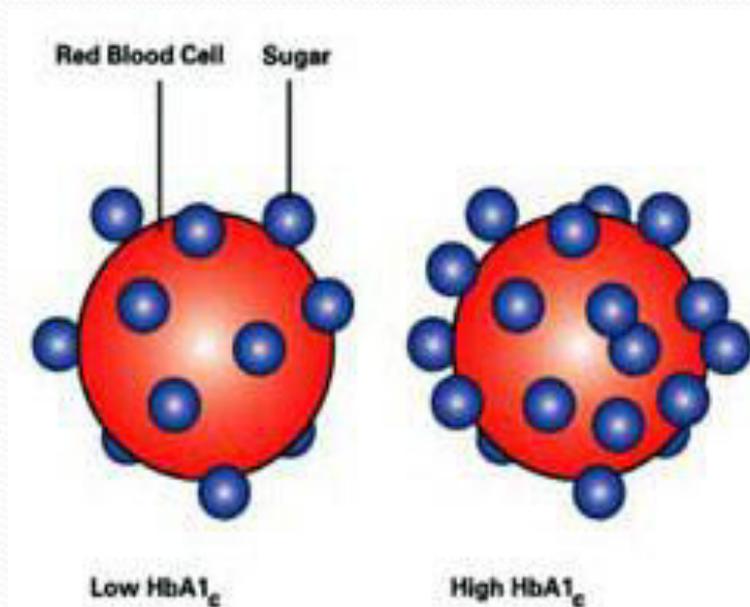
## Response to OGTT



Category of a person	Fasting value		Post prandial
	Minimum	Maximum	Value 2 hours after consuming glucose
Normal	70	100	Less than 140
Early diabetics	101	126	140-200
Established diabetics	More than 126	-	More than 200

# Glycosylated Hemoglobin

- Glycosylated hemoglobin is normally formed in the circulating blood by the nonenzymatic addition of hexose molecules to the N-terminal valine of the beta chains of hemoglobin A.



# Calcium

- The majority of the calcium in the body is deposited in the skeleton and teeth.
- Only a small quantity is in extracellular fluid. About 50% of the extracellular calcium is protein bound and the other half is ionized.
- The concentration of the ionized calcium is controlled by parathyroid hormone which increase serum levels, and thyrocalcitonin which decreases serum levels.
- Vitamin D is essential for the intestinal absorption of calcium. Ionized calcium is necessary for nerve conduction blood coagulation, muscle contraction and membrane permeability.

# Cont...

- Serum calcium concentration x serum phosphorus concentration .
  - 30 to 40 in normal adults
  - 50 to 60 in growing children, &
- serum calcium levels below 7 mg/dl, signs on tetany appear. General anesthetic and surgical procedures may lead to cardiac arrhythmia and heart block under these circumstances

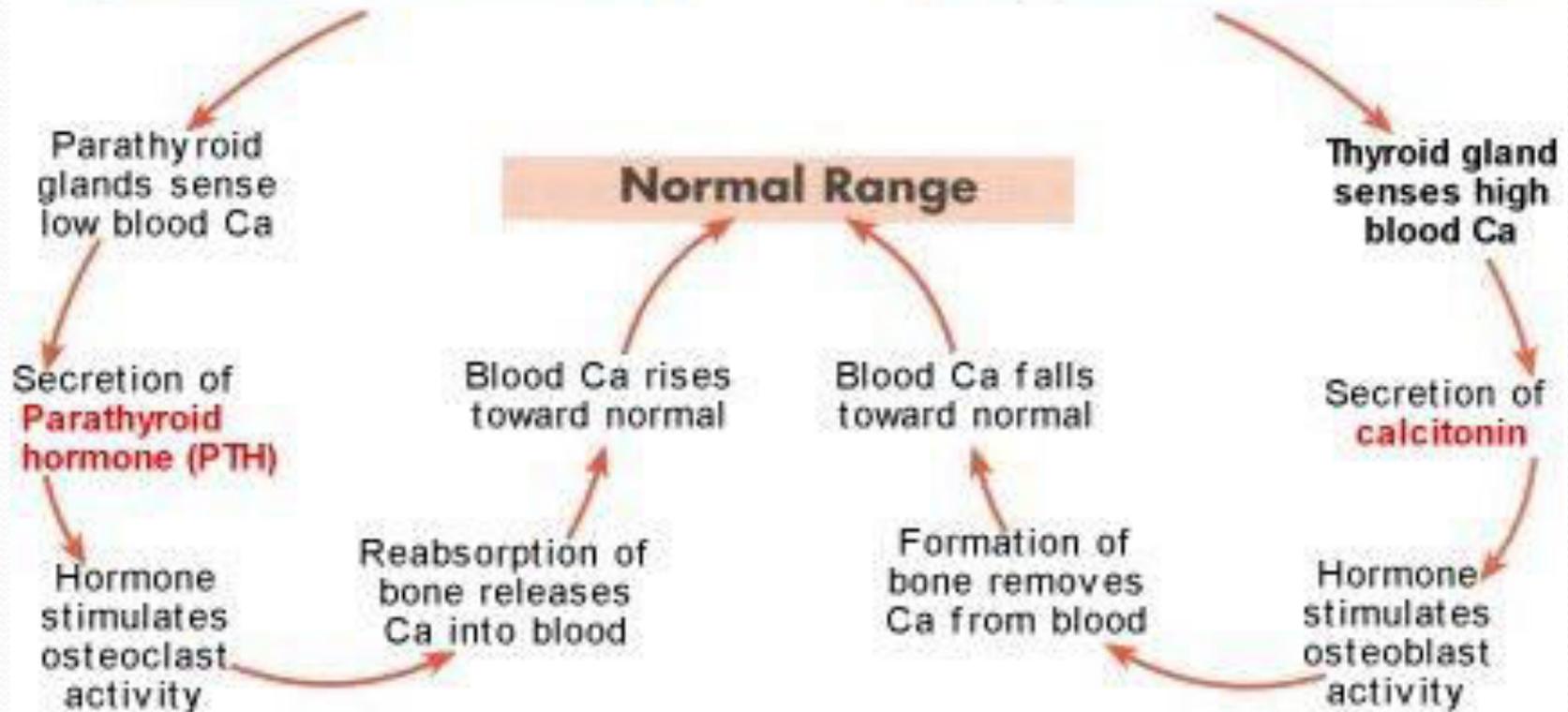
# Cont..

- A Decreased serum calcium levels are also seen when there is hypoproteinemia
- High levels of calcium are seen in hyperparathyroidism, malignant metastasis to bone and Paget's disease of bone.
- Low values occur in hypoparathyroidism, vitamin D deficiency (rickets, osteomalacia), and renal insufficiency.
- Normal level-8.5mg/dl to 10.5 mg/dl

## Low Blood Calcium

## High Blood Calcium

## Normal Range



# Phosphorus

- When calcium levels increase, inorganic phosphate levels decrease.
- Phosphorus levels are regulated by parathyroid hormone, which acts on kidney tubules to inhibit reabsorption. Vitamin D controls intestinal absorption of phosphorus.
- Phosphorus acts in carbohydrate metabolism, in the production of adenosine triphosphate, in the mineralization of bone and teeth, and in the synthesis of nucleic acids.

# *Normal values*

- ***ADULTS: 2.5 to 4.5 mg/100 ml***
- ***CHILDREN: 4 TO 7 mg /100 ml***
- High values of phosphorus are seen in chronic renal disease, healing bone fractures, hypoparathyroidism, hypervitaminosis D and elevated levels of growth hormone.
- Low readings occur in diabetic acidosis, rickets, and severe alkalosis

# Alkaline phosphatase

- Alkaline phosphatase occurs in many tissues of the body but notably in osteoblasts.
- Alkaline phosphatase has been shown to exist as several isozymes originating respectively in bone, liver (biliary duct epithelium), placenta and intestine.
- More than 30% heat stable alkaline phosphatase suggests a liver origin for the increased enzyme, less than 30% suggests a bone origin.

## Cont...

- Alkaline phosphatase is an enzyme that is produced in small amounts by the liver and in larger amounts by osteoblasts.
- It is active in bone formation and therefore is found at higher levels there.
- It also increases in generalized bone disease.

# Normal value

	Adult	Child
<i>King-Armstrong units</i>	4 to 13	15 to 30
<i>Bodansky units</i>	1.5 to 4.5	5 to 14
<i>Bessey-Lowry units</i>	0.8 to 2.3	3.4 to 9.0

***International units (IU) 30 to 110 IU/L***

- High alkaline phosphatase values are seen in obstructive liver disease. metastatic carcinoma involving bones. hyperparathyroidism, paget's disease of bone. Osteomalacia, Rickets, and acute or chronic liver disease.
- Low values are occasionally seen in hypothyroidism and scurvy.

	<b>Serum Calcium</b>	<b>Serum Phosphorus</b>	<b>Serum Alkaline Phosphatase</b>
Normal ranges	9-11mg/dl	2.5-4.5mg/dl	50-75mg/dl
Hyperparathyroidism	Increased	Decreased	Normal
Paget's disease	Normal	Normal	Elevated
Metastatic bone tumors	Elevated	Normal	Elevated
Rickets	Normal	Decreased	Increased
Osteomalacia	Decreased	Decreased	Increased
Hypoparathyroidism	Decreased	Increased	Normal

# Acid Phosphatase

- Acid phosphatase occurs in large quantities in the prostate and erythrocytes.
- Elevated serum levels are found in about three-fourths of patients with metastatic prostatic carcinoma and in about one-fourth of these before metastasis occurs.
- The serum level also rises as a result of prostatic massage or biopsy and may also be increased in metastatic breast carcinoma as a result of production of this enzyme by the neoplastic tissue.
- **Normal – 0 to 5.5 IU/L**

# ALBUMIN

- Serum albumin, often referred to simply as albumin, is the most abundant plasma protein in humans and other mammals. Albumin is essential for maintaining the osmotic pressure needed for proper distribution of body fluids between intravascular compartments and body tissues.

# Globulin

Globulins are produced in the liver.

- The total protein value includes albumin and globulin.
- These proteins are important in coagulation, transport a variety of hormones, act on antibodies and enzymes, act as buffers, and supply protein when tissue depletion is present. Additionally, they help to maintain osmotic pressure.
- Proteins are digested in the small intestine and end up in the blood in the form of amino acids.
- They may be deaminated in the liver to form other nitrogen-containing compounds.

# Normal values

- **Total protein**      **6.0 to 8.0 g/100 ml**
- **Albumin**              **3.2 to 5.6 g/100 ml**
- **Globulin**              **2.3 to 3.5 g/100 ml**
- **A/ G ratio**            **1.5 to 2.5:1 g/100 ml**

- High total protein values are seen in lupus erythematosus, rheumatoid arthritis and other collagen diseases, acute liver destructive disease, and multiple myeloma.
- Low total protein values are seen in liver disease due to decreased protein synthesis and in inadequate protein intake, malabsorption, anemia, diarrhea, burns, and nephrosis.
- High albumin values are rare but may be seen in dehydration and shock.

# Cont...

- Low albumin values are caused by the same processes as the low protein values.
- High globulin values are caused by multiple myeloma, nephrosis, chronic infections, collagen diseases, and liver disease.
- Low globulin values may be seen in burns and severe malnutrition .
- Abnormal A/G ratio is seen in malabsorption, severe liver disease, multiple myeloma, and Hodgkin's disease.

# TOTAL SERUM PROTEIN

- Elevations of total serum protein most commonly occur as a result of diseases affecting 'the production of globulins by the plasma cells, such, as multiple myeloma and the collagen diseases.
- Raised serum protein also occurs with the nephritic syndrome.
- In the majority of these conditions, abnormal serum proteins are produced along with the elevation in total protein, and these abnormal proteins are detected by the technique of serum protein electrophoresis

# Serum protein electrophoresis

- small volume of serum is subjected to a low-voltage electric current, causing the proteins of the serum to migrate at different rates.
- Also demonstrates the presence of abnormal serum proteins such as the macroglobulins that occurs in multiple myeloma, collagen disease and nephritic syndrome.
- By this technique albumin and fibrinogen separated from the globulins, and the globulins are separated into four main groups: Alpha 1,2, beta, and gamma globulins
- This procedure is therefore a useful screening test in patients with suspected oral lesions of multiple myeloma or systemic lupus erythematosus.

# High-density lipoprotein (HDL)

- HDL is known for being the good cholesterol. High density lipoprotein is produced by the liver to carry cholesterol and other fats from tissues and organs back to the liver for recycling. High levels in the blood of HDL are a good sign of a healthy heart
- In healthy individuals, about thirty percent of blood cholesterol is carried by HDL.

# Cont..

- HDL is the smallest of the lipoprotein particles. They are the densest because they contain the highest proportion of protein
- HDL transports cholesterol mostly to the liver or to organs such as adrenals, ovary, and testes by direct and indirect pathways
- In humans, probably the most relevant pathway is the indirect one, which is mediated by cholesteryl ester transfer protein (CETP) pathways.
- **Normal value:40 to 50 mg/dl**

# Low-density lipoprotein

- LDL particles transport cholesterol into the artery wall, retained there by arterial proteoglycans and attract macrophages which engulf the LDL particles and start the formation of plaques, increased levels are associated with atherosclerosis.
- Over time vulnerable plaques rupture, activate blood clotting and produce arterial stenosis, which if severe enough results in heart attack, stroke, and peripheral vascular disease symptoms.
- **Normal value;100 to 129 mg/dl**

# VERY-LOW-DENSITY LIPOPROTEIN

Made by the liver.

VLDL is one of the five major groups of lipoproteins (chylomicrons, VLDL, intermediate-density lipoprotein, low-density lipoprotein, high-density lipoprotein) that enable fats and cholesterol to move within the water-based solution of the bloodstream.

- VLDL is assembled in the liver from triglycerides and cholesterol. VLDL is converted in the bloodstream to low-density lipoprotein (LDL).
- VLDL particles have a diameter of 30-80 nm.
- VLDL transports endogenous products, whereas chylomicrons transport exogenous (dietary) products.

# Function

- VLDL transports endogenous triglycerides, phospholipids, cholesterol.
- It functions as the body's internal transport mechanism for lipids.

# Cholesterol

- Cholesterol, can be produced in many tissues of the body, is absorbed by the intestine and combines with fatty acids.
- The combined form is transported to the liver and is used in making bile salts.
- The amount of circulating cholesterol is influenced by thyroid and estrogenic hormones. Cholesterol deposits are seen in many disease processes of which the most important is atherosclerosis.
- *Normal value: 160 to 250 mg/100ml*

- Total serum cholesterol is also elevated in Hypothyroidism, in obese and elderly diabetics, and in patients with the nephrotic syndrome .patients with serum triglycerides above 175' mg/dl are also usually given dietary counseling.
- High values are seen in cardiovascular disease, biliary obstruction, nephrosis, chronic hepatitis, and uncontrolled diabetes mellitus.
- Low cholesterol concentrations are seen in acute infections, acute hepatitis, anemia, hemolytic jaundice, malnutrition, and occasionally hyperthyroidism.

# Triglycerides

- A blood test that measures your cholesterol also measures your triglycerides.
- Triglycerides are a type of fat found in your blood. Your body uses them for energy.
- You need some triglycerides for good health. But high triglycerides can raise your risk of heart disease and may be a sign of metabolic syndrome.

## Cont...

- Metabolic syndrome is the combination of high blood pressure, high blood sugar, too much fat around the waist, low HDL ("good") cholesterol, and high triglycerides.
- Metabolic syndrome increases your risk for heart disease, diabetes, and stroke.
- **NORMAL VALUE <150mg/dl**

# Bilirubin

- Bilirubin is a bile pigment derived from the breakdown of hemoglobin when this happens, free bilirubin enters the circulation and becomes bound to albumin.
- Bilirubin is conjugated in the liver and enters the intestinal tract.
- Jaundice can be recognized by examination of the color of skin, oral mucous membrane and sclera of eyes

## Cont...

- It may indicate the presence of hepatitis which can constitute an infectious hazard for a dentist and his patients
- Jaundice is usually not evident until the total serum bilirubin (derived from red blood cells, broken, down at the end of their normal 120-day life) span) rises from a normal range of 0.1 mg/dl to 1.2mg/dl to above 2 mg/dl to 3 mg/dl.

# Direct and Indirect Reacting Bilirubin

- Hemoglobin is released from the red blood cells and converted to bilirubin in the reticuloendothelial system of the body from where it is transported in the blood and combined with serum proteins.
- Such bilirubin (referred to as unconjugated bilirubin) cannot be filtered by the renal glomerulus and is taken up from the blood by the hepatic parenchyma, which conjugates the bilirubin with glucuronic acid.

## Cont....

- Conjugated bilirubin is water soluble whereas unconjugated form is soluble only in alcoholic solvents
- when there is uncertainty, one of the paper strip tests discussed earlier in this chapter can be used to indicate the presence or absence of bilirubin.
- High values may be seen in hemolytic anemia, biliary obstruction, hepatitis, malignant hepatic disease, and Gilbert's disease.
- ***Normal value: 0.1 to 1.2 mg/100 ml***

# Lactic Dehydrogenase (LDH)

- Lactate dehydrogenase (LDH) is distributed in the same tissues as SGOT, as well as in the erythrocytes.
- Lactic dehydrogenase is an enzyme responsible for the oxidation of lactic acid to pyruvic acid.
- This enzyme has several separate isoenzymes present in several tissues of the body.
- Particularly the erythrocytes, heart, liver, skeletal muscle, kidney, and brain.
- The enzyme is released in the circulation following cellular damage.

# Cont...

- *Normal value: 85 to 300 IU/L calorimeter*
- High values of lactic dehydrogenase are seen in acute myocardial infarction, acute leukemia, hemolytic anemia, pernicious anemia, pulmonary tissue destruction, malignant neoplasia, generalized viral infections and renal infarcts.

# Serum Glutamic Oxaloacetic Transaminase (SGOT)

- An enzyme that is normally present in liver and heart cells. SGOT is released into blood when the liver or heart is damaged.
- The blood SGOT levels are thus elevated with liver damage (for example, from viral hepatitis) or with an insult to the heart (for example, from a heart attack).
- Two transaminases' (glutamic-oxaloacetic, SGOT; and glutamic-pyruvic, SGPT) are present in large amounts in liver, heart, kidney, and skeletal muscle.

# Cont...

- SGOT concentration is also a sensitive indicator of myocardial necrosis.
- This enzyme is found primarily in the heart and liver and is involved in the conversion of amino acids to keto acids. Usually, the enzyme is within cell and is released after injury.
- In hepatitis and other forms of liver disease with associated liver necrosis, serum levels of SGOT and SGPT both rise, even before clinical symptoms appear
- ***Normal values: 10 to 40 U ml***
- High values are seen in acute hepatitis, acute myocardial infarction, cirrhosis, skeletal muscle disease, generalized infections, and congestive heart failure.

# SGPT

- Serum glutamic pyruvic transaminase, an enzyme that is normally present in liver and heart cells.
- SGPT is released into blood when the liver or heart are damaged.
- The blood SGPT levels are thus elevated with liver damage (for example, from viral hepatitis) or with an insult to the heart (for example, from a heart attack).
- Also called alanine aminotransferase (ALT).
- **NORMAL VALUE: 5 to 40 IU/L**

# Amylase and Lipase

- Serum amylase is derived both from the parotid gland and the pancreas
- Enzymes derived from each source have been shown to be different but are not distinguished in the usual test.
- Small increases may occur with parotid hyperplasia seen in cirrhosis, but raised levels are usually due to pancreatitis.

## Cont....

- In patients with acute pancreatitis, serum amylase levels generally rise to values greater than 550 Somogyi units/dl and even as high as 2000 to 4000 units.
- Morphine and cholinergic drugs cause a temporary rise in serum lipase and amylase as a result of contraction of the sphincter of Oddi)
- ***NORMAL VALUE***
- ***Amylase – 80 to 189 U/dl***
- ***Lipase – 10 to 150 U/L***

# Alkaline Phosphatase and 5V Nucleotidase

- The causes of raised serum alkaline phosphatase and the dual origin of this enzyme from liver and bone cells are described in the previous section dealing with abnormalities of serum calcium and phosphorus.
- In the presence of increased \_serum alkaline phosphates, determination of serum 5'-nucleotidase, which is elevated in obstructive biliary disease but not in bone disease, can be helpful in identifying the site of origin of the alkaline phosphates
- **NORMAL VALUE: 12 to 17 ug/L**

# Blood Urea Nitrogen (BUN)

- Urea is formed from the deamination of amino acids in the liver.
- Protein metabolism produces ammonia, a toxic substance that is converted into urea. Urea, which is high in nitrogen, is excreted in the urine through concentration by the renal tubules.
- ***Normal value: 10 to 25mg 100 ml (3.6 TO 7.1mmol/l)***
- As a result of deamination of amino acids primarily in the liver, the soluble nitrogenous end product of protein catabolism (urea) is produced, transported in the blood, and excreted by the kidneys

# Cont...

- High BUN readings are seen in acute or chronic renal failure, congestive heart failure and urinary tract obstructions.
- Two methods for detecting increased blood urea are available commercially as office-screening procedures (Urograph and Azostix) Both involve a strip impregnated with urease, which splits urea  $[(\text{NH}_2)_2\text{CO}]$ , with formation of carbon dioxide and ammonia detected by change in an indicator).
- This technique does not quantitate blood urea and does not detect early renal disease.

# Serum Creatinine

- Creatinine is a metabolic product of creatine phosphate dephosphorylation in muscle. It is produced at a fairly constant rate, is maintained at a stable level, and is excreted in the urine by a combination of glomerular filtration and tubular resorption.
- Measurement of serum creatinine is preferable to that of urea because dietary protein and protein catabolism in the body do not influence serum creatinine concentration as they do the urea concentration

# Cont...

- Creatinine phosphate is a high-energy source for skeletal muscle.
- The degradation of creatinine phosphate yields creatinine.
- This degradation is an end product of protein metabolism. Creatinine is filtered by the renal glomeruli.
- ***Normal value: 0.7 to 1.4 mg 100 ml***
- High values are seen in kidney disease and acromegaly and in patients with large muscle mass.

# Uric Acid

- Uric acid is the end product of purine metabolism.
- In addition, Uric acid is derived from the breakdown of purine containing substances in the diet. Uric acid is eliminated from the kidney by glomerular filtration and tubular reabsorption and secretion.
- Uric acid is toxic to the kidney so conditions that involve hyperuricemia, such as gout can cause kidney failure.
- Elevations of serum uric acid also frequently occur in patients taking diuretic medications.

# Cont...

- Measurement of serum uric acid is important in the evaluation of intrinsic disease of the temporomandibular joint, particularly when nodules consistent with gouty tophi (subcutaneous deposits of urates) are noted about the face or ears.
- **Normal values:**
- **Male 2.5 to 8.0 mg 100ml serum**
- **Female 1.5 to 6.0mg 100ml serum**
- Abnormally high values of uric acid are seen in gout, renal failure, leukemia, lymphoma, thiazide diuretic use, starvation, lead poisoning and cancer chemotherapy.
- Low values are rare.

# Electrolytes

- Electrolytes are positively and negatively charged molecules called ions, that are found within the body cells and extracellular fluids, including blood plasma
- . A test for electrolytes includes the measurement of sodium, potassium, chloride, and bicarbonate.
- These ions are measured to assess renal (kidney), endocrine (glandular), and acid-base function, and are components of both renal function and comprehensive metabolic biochemistry profiles

# Cont...

- Other important electrolytes routinely measured in serum or plasma include calcium and phosphorus.
- These are measured together because they are both affected by bone and parathyroid diseases, and often move in opposing directions
- Magnesium is another electrolyte that is routinely measured.
- Like calcium, it will cause tetany (uncontrolled muscle contractions) when levels are too low in the extracellular fluids.

# Measurement of electrolytes

- Electrolytes are measured by a process known as potentiometry.
- This method measures the voltage that develops between the inner and outer surfaces of an ion selective electrode
- In general, imbalances in calcium concentrations affect the bones, kidney and gastrointestinal tract. Calcium also influences the permeability of cell membranes and thereby regulates neuromuscular activity.
- Sodium affects the osmolality of blood and therefore influences blood volume and pressure and the retention or loss of interstitial fluid.

# Cont...

- Potassium affects muscular activities, notably those of the heart, intestines and respiratory tract, and also affects neural stimulation of the skeletal muscles
- Magnesium is needed for secretion of parathyroid hormone, and therefore, a low serum magnesium can induce hypocalcemia
- Magnesium acts as a calcium channel blocker, and when cellular magnesium is low, high intracellular calcium results
- This leads to hypertension, tachycardia, and tetany.

# NORMAL VALUES

- Serum calcium: 8.5–10.5 mg/dl (2.0–2.5 mmol/l)
- Serum magnesium: 1.8–3.0 mg/dl
- Serum potassium: 3.5–5.1 mmol/l
- Serum or plasma sodium: 136–146 mmol/l
- Serum or plasma bicarbonate: 18–23 mmol/l
- Serum or plasma chloride: 98–106 mmol/l

# Arterial blood gas

- An arterial blood gas (ABG) is a blood test that is performed using blood from an artery.
- It involves puncturing an artery with a thin needle and syringe and drawing a small volume of blood.
- The most common puncture site is the radial artery at the wrist, but sometimes the femoral artery in the groin or other sites are used.

# Cont....

- The blood can also be drawn from an arterial catheter.
- The test is used to determine the pH of the blood, the partial pressure of carbon dioxide
- ABG testing is mainly used in pulmonology, to determine gas exchange levels in the blood related to lung function, but has a variety of applications in other areas of medicine.

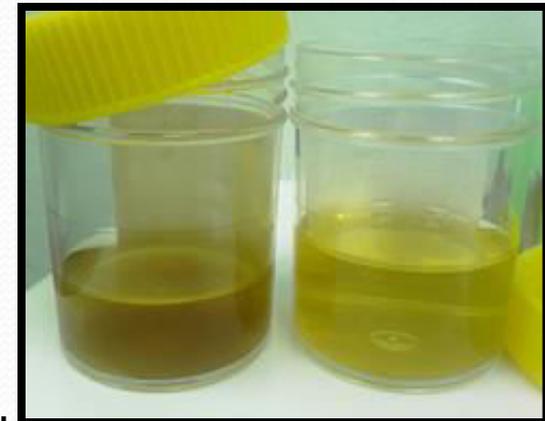
# Glucose in urine:

- When the blood level of glucose exceeds 160 to 180 mg/dl, the normal renal threshold for glucose, glucose appears in the urine, and the urine will give a positive test for glucose.
- This can occur as a result of excessively large meal, lowered renal threshold, or some pathologic state.
- It may become elevated as a result of kidney disease, Diabetes, Hyperthyroidism, general anaesthesia, intracranial lesions like stroke.
- False negatives :
  - -Parkinson's disease
  - -Alkaptonuria



# Protein in urine

- Urine from a normal person will contain only a very small amount of protein, about 50mg in a 24-hour excretion(about 1200ml to 1500ml).
- Any increase in the amount of protein-Proteinuria, is suggestive of a pathological condition, with the following exceptions.
- Functional proteinuria-occurrence of protein in the urine without the presence of any known disease complex-This may be associated with unusual muscular exertion, prolonged exposure to cold or pregnancy.
- Proteinuria due to any pathologic disease can be classified as-
  - 1.Pre renal -Proteinuria not due to primary kidney disease.
  - 2.Renal -Proteinuria due to kidney disease.
  - 3.Post renal-Proteinuria due to addition of protein to the urine at some point distal to the kidney tubules.



# Blood in urine

- Detection of occult blood in urine is called as the hematuria.
- It can be either gross(Visible) or Microscopic
- False positives-Menstruation.
- False negatives-May be encountered when the red cells in the urine have not hemolyzed.

# Diseases

- Nephritis,
- Kidney stones,
- Kidney and urinary tract infections,
- Urethritis,
- Collagen diseases,
- Leukemia and hemorrhagic states.
- Medications that increase bleeding tendencies like Aspirin, Warfarin, can also result in hematuria.

# How is it diagnosed?

- -History
- -Evaluating urine under a microscope
- -Urine culture
- -urine cytology
- -Cryptoscopy.



# Calcium in Urine

- The urine calcium or Sulkowitch test is a simple test to determine the amount of calcium in the blood by testing for calcium in the urine. The test measures calcium being excreted from the body. Calcium absorption depends on the acidity of the stomach, as well as a number of other co-factors including the amount of phosphate present, and takes place in the upper small intestine.
- Why do we need this test?
  1. To assess serum calcium levels.
  2. As a marker for adequate digestion and absorption.
  3. To monitor calcium supplementation for adequate digestion and absorption.

# Discussion...

- -The kidneys have a calcium threshold, not unlike its glucose threshold. When calcium levels in the serum rise above a certain level, it will spill into the urine. Conversely, when the serum level of calcium drops there will be no spill-over.
- -The kidney's serum calcium threshold is 7.5 - 9.0 mg/dL or 1.875 - 2.25 mmol/L.

# Urine calcium

## Procedure:

- 1. Put a dropper full of urine into a test tube
- 2. Add one dropper of Sulkowitch Reagent- shake to mix
- 3. Wait 60 seconds and observe turbidity.

# Result

- **1.Low calcium:**
  - -Clear: Little to discernable fine white precipitate is seen
  - -Light turbidity: Black type can be seen and read through the test tube.
- **2.Normal:**
  - -Some turbidity: Black type can be seen but not read through the test tube.
- **3.High calcium :**
  - -Heavy turbidity: Black type cannot be seen through the test tube.
  - -Milky :It looks like milk which has been diluted with water.

# Urine calcium

- Clinical implications :
  - **High calcium levels :**
    - Conditions associated with an increase urine calcium
      - Parathyroid hyperfunction
      - Sarcoidosis
      - Primary cancers of the breast and bladder
      - Metastatic malignancies
      - Wilson's disease
      - Renal tubular acidosis
      - Glucocorticoid excess
      - Respiratory disease
    - **Low calcium levels :**
      - Hypoparathyroidism
      - Vitamin D insufficiency
      - Muscle spasms
      - Ingestion of alkaline supplements

# Calcium in urine

- Interfering factors:
- **Falsely increased levels**
- • Excess milk intake
- • Drugs: growth hormone, PTH, Vit. D
- • Urine taken after a high calcium meal
- • Corticosteroids
- **Falsely decreased levels**
- Increased phosphate or bicarbonate Antacid use  
Alkaline urine Thiazide diuretics

# Creatinine in Urine

- **Background...**

- It is a product of muscle metabolism
- Some Creatinine is of dietary origin
- It is freely filtered but is also actively secreted in urine.
- Its secretion is affected by several drugs  
cephalosporin, cimetidine, cisplatin, Gentamycin, trimethoprim.

- **Test:**

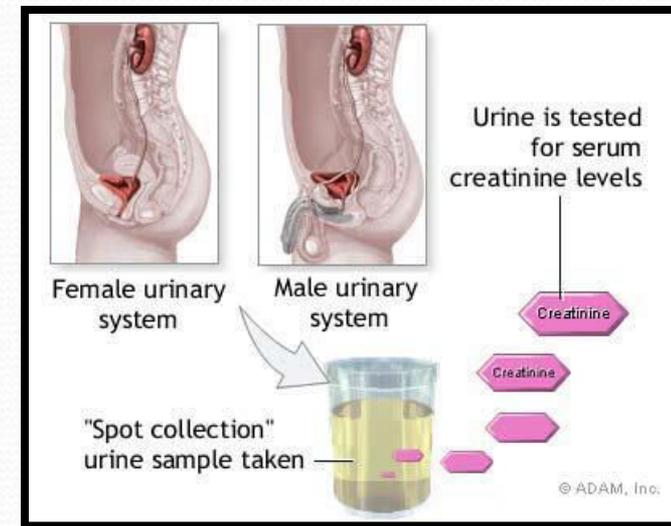
- Collection of urine is done and examined for the creatinine levels.
- -The creatinine clearance test is used to find out the rate and efficiency of kidney filtration. It is also called as the urine creatinine tests.

# Cont...

- **Normal:**
- Urine creatinine (24-hour sample) values can range from 500 to 2000 mg/day. Results depend greatly on your age and amount of lean body mass.
- Another way of expressing the normal range for these test results are:
  - 14 to 26 mg per kg of body mass per day for men
  - 11 to 20 mg per kg of body mass per day for women

# Creatinine in urine

- Abnormal results of urine creatinine are nonspecific, but may be due to any of the following conditions:
- Glomerulonephritis
- High meat diet
- Kidney infection (pyelonephritis)
- Kidney failure.
- Muscular dystrophy (late stage)
- Myasthenia gravis.
- Prerenal azotemia.
- Reduced kidney blood flow (as in shock or congestive heart failure)
- Rhabdomyolysis
- Urinary tract obstruction



# Urea in urine

- **Background...**
- Used historically as marker of GFR
- Freely filtered but both re-absorbed and excreted into the urine
- Re-absorption into blood increased with volume depletion;
- Diet, drugs, disease all significantly effect Urea production.



# Urea in urine

- **Increase:**

- -Volume depletion
- -Increased dietary protein
- -Corticosteroids
- -Tetracyclines
- Blood in gastrointestinal tract

- **Decrease:**

- -Volume expansion
- -Liver disease
- -Malnutrition.

# CONCLUSION

- Blood chemistry tests are very important to the physician for establishing a diagnosis of a disease state and following the course of treatment. Individual chemistry tests are used to screen blood for abnormalities.
- A profile test is performed when a screening test shows abnormal values. these tests assist the physician in finding a diagnosis by correlating the clinical symptoms with the lab results.

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Thank you