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**Diploma in Pharmacy 2<sup>nd</sup> Year**  
**Hospital & Clinical Pharmacy**  
**Chapter 9 : Clinical Laboratory Tests**

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## **Clinical Laboratory Tests**

- In diagnosis, monitoring and screening, clinical laboratory test results are a very essential parameter, 70-80% of judgements in diagnosis are based on the laboratory results and analyses.
- Hence, various data are delivered, and it is important for patient care and safety that the doctors are aware with the laboratory tests and clarification of results.
- The laboratory test results also have a role in delivering suitable information to the clinicians that can help them in the precise interpretation of the data.

### **Haematological Tests**

- A hematological test is a blood test. Any test that requires blood or blood parts is a hematological test. These tests can offer information to a doctor about what is happening in the blood. The most common hematological tests include :

#### **1. Haemoglobin Test : (Hb test )**

- This Test is performed to check Haemoglobine level of the body.

#### **Normal Range**

- Male : 13.2 to 16.6 g/dl
- Female : 11.6 to 15 g /dl
- Children 6-12 years : 11.2 to 14.5 g /dl

#### **Significance and Interpretation**

- ▲ Normal level is necessary for enough oxygen supply to tissues and transport of CO<sub>2</sub> to lungs .
- ▲ Low level than normal range indicates Anaemia , Leukemia . and High level of haemoglobin indicates polycythemia .( High concentration of RBCs).

#### **2. RBCs Count**

- RBCs Contain Haemoglobin which transports O<sub>2</sub> and CO<sub>2</sub> , it hpls in Blood clotting . This Test is performed to check Count of RBCs in blood.

#### **Normal range Male**

- 4.5- 5.5 million/mm<sup>3</sup>
- Female : 3.5 - 5.5 million /mm<sup>3</sup>
- Children : 4.0-5.5 Million /mm<sup>3</sup>

## Significance and Interpretation

- ▲ Low level of RBCs than normal range in blood indicates Anaemia and leukemia.
- ▲ High range of RBCs indicates Polycythemia.

### 3. Hematocrit (Hct)

- This test Indicates percentage of RBCs in whole blood sample.
- For example 40% Hct indicates that a 100ml sample has 40ml of red blood cells.

## Normal range

- Male : 40-50%
- Female : 37 - 47 %

## Significance and Interpretation

- ▲ Two small and same quantities of blood samples are compared. One sample is centrifuged and compared to the first sample to obtain a percentage value.
- ▲ This comparison is the Hct value. If the Hct value is abnormal, the RBC count may also be abnormal.
- ▲ If the RBC count is normal, the average size of RBC will possibly be too small. Shock, dehydration, haemorrhage, or excessive IV fluid administration can decrease the value of Hct.

### 4. White Blood Cell or Total Leucocyte Count (TLC)

- This test is performed to check conditions like : Infection , allergic reaction , Inflammation , Blood cancer ( leukemia )

## Normal Range

- Male : 4500 to 11000 / ml
- Female : 4500 to 11000 / ml

## Significance and Interpretation

- ▲ High Level of WBCs indicates Infection like( Appendicitis ( inflammation of appendix ) , Leukemia , Pneumonia , , meningitis etc. ) Allergic reaction , Inflammation , Blood cancer.
- ▲ High level may be due to these reason also : Certain drugs ( antibiotics ) ,Smoking , Removal of spleen , blood cancer , Inflammation.
- ▲ Low level of WBCs is called Leucopenia it indicates typhoid , Hepatitis , influenza , measles , anxiety.
- ▲ Low level of WBCs is may be due to these reasons also Bone marrow problems , Cancer treatment , certain viral illness etc.



## 5. Erythrocyte Sedimentation Rate ( ESR )

- It indicates the rate at which erythrocytes sediment ( settle ) to the bottom , this rate of settlement is called RSR . the distance they cover in 1 hour is recorded.

### Normal range

- Male : 0-15 mm/hr
- Female : 0-20 mm/hr

### Significance and Interpretation

- ▲ This test is performed to estimate inflammation in body , or infection . if it is more than normal range indicates Inflammation in the body.

## 6. Platelets Count

- They are necessary for blood clotting.

### Normal range

- 1.5 lac to 4.5 lac

### Significance and Interpretation

- ▲ This test is performed to check number of platelets . and before surgery procedure this test is performed
- ▲ Low range than normal indicates bone marrow problems , leukemia , or infection such as Hepatitis C , Dengue fever , Chikungunya , HIV . etc a minor reduction occurs in pregnancy.
- ▲ High count of Platelets indicates Bleeding , Cancer, iron Deficiency ,bone marrow problems

## 7. Coagulation or Blood Clotting Time

- This test indicates the time blood takes to clot.

### Normal Range

- Slide method : 2-6 minutes
- Capillary method : 2-6 minutes

### Significance and Interpretation

- ▲ Increased clotting time indicates Haemophilia , Vitamin K Deficiency , increased heparin level and pneumonia.

# Liver Function Tests (LFT Test)

→ Liver function test is performed to estimate the dysfunctions of liver

→ Several testes are performed under liver function test.

→ Like

- Serum Bilirubin ,
- serum (Plasma) proteins ,
- Alkaline Phosphatase ( ALP) ,
- Serum Glutamic Oxaloacetic transaminase (SGOT) or Aspartate transaminase (AST),
- Serum Glutamate Pyruvate Transaminase ( ALT) etc.

## 1. Serum Bilirubin

➤ It is the breakdown product of haemoglobin and is the major pigment in bile.

### Normal Range

- Total serum bilirubin is 0.3-1.3 mg/dL.
- and that of direct bilirubin 0.1-0.4 mg/dL..

### Significance and Interpretation

- ▲ Increased level of bilirubin indicates jaundice
- ▲ Increased level of total bilirubin indicates haemolysis.

## 2. Serum (plasma ) Protein

➤ Albumins and globulins proteins are major protein of plasma and produced by Liver.

### Normal Range

- Albumins : 3.5-5.1 gm/dl
- Globulins : 1.8-3.1 gm /dl

### Significance and Interpretation

- ▲ Increased level indicates dehydration Liver problems .
- ▲ Deceased level Indicate Oedema, haemorrhage , Increased protein break down .

## 3. Alkaline Phosphatase ( ALP)

➤ This enzyme produced in liver , bones , small intestine and kidneys , It catalyses splitting of phosphate group from monophosphoric ester.

### Normal range

- 29-92 IU/L

### Significance and Interpretation

- ▲ High level indicates Rickets , Osteomalacia , abnormal absorption of vitamin D .
- ▲ Low level indicates Hypophosphatacia .

#### 4. **Serum Glutamic Oxaloacetic transaminase (SGOT) or Aspartate transaminase (AST)**

- This enzyme is produced by liver and it helps in energy production.

##### **Normal range**

- 0.40 U/L

##### **Significance and Interpretation**

- ▲ Increased level of SGOT indicates liver disease ( hepatitis , cirrhosis )

#### 5. **Serum Glutamate Pyruvate Transaminase ( ALT)**

- This enzyme produced by liver and helps in formation of alanine.

##### **Normal Range**

- 5-36 U/L

##### **Significance and Interpretation**

- ▲ Its increased level indicates Liver cell damage.

#### 6. **Serum Cholesterol test( Lipid Profile )**

- This test is performed to check triglyceride and Cholesterol level in blood.

##### **Normal Range**

- Total cholesterol level is < 200 mg /dl
- LDL cholesterol level < 100 mg/dl
- HDL Cholesterol level is equal or more than 60 mg/dl
- Triglycerides level is < 150 mg/dl

##### **Significance and Interpretation**

- ▲ Increased level of LDL and triglyceride indicates the risk of heart diseases , blockage of arteries.

# Renal Function Tests (KFT Test)

→ Kidney or renal function tests are performed using urine ( and some test a re performed using blood like urea clearance test) , and the presence of different substances in abnormal amount in urine or in blood indicates the kidney problems .

## Physical examination of urine

- Colour
- Odour
- pH ( 4.5-8 )
- Turbidity

## Chemical examination of Urine

1. **Proteins** : Globulin less than 5 mg/dl and albumin less than 30 mg/dl .
2. **Abnormal Glucose level** : Normal is 0-0.8 mmol /L .
3. **Ketone Bodies** : Under normal condition , < 1 mg of Ketone Bodies is excreted in 24 hours .
4. **Blood** : blood in urine indicates Sore of kidneys , UTI and nephritis .
5. **Urine Osmolality Test** : Urine osmolality is the number of dissolved particles in urine( creatinine , urea, potassium , sodium etc.) . Normal Range : 500-850 mOsm/kg . Significance : Increased level indicates Kidney problems and congestive heart failure . and cause dehydration.
6. **Urine Concentration Test** : kidneys maintain the osmolarity of body fluid ( 290-300 mOsmol/L) , and excrete urine with average 500-850 mOsm/l normally

Some blood sample test are performed to Evaluate kidney function.

### 1) Blood Urea nitrogen test ( BUN )

- Urea is obtained as a by-Product of protein metabolism . It is formed in liver and excreted out in urine through filtration of blood by kidneys.

#### Normal range

- 10-12mg /dl

#### Significance and Interpretation

- ▲ Increased level of Blood urea nitrogen indicates kidney problems.

### 2) Creatinine Test

- Creatinine is a waste product of body metabolism which present in blood excreted out by Kidneys.

#### Normal Range

- Creatinine in blood 1-2mg/dl or 0.6-1.2 mg/dl

#### Significance and Interpretation

- ▲ Increased level in blood and low level in urine indicates kidneys dysfunction.

### 3) Creatinine Clearance Test

- This test shows the ability of kidneys to clear( Excrete out) creatinine from blood through urine. In this test 24 hours collected urine sample is taken. along this test blood creatinine level also examined.

#### Normal Range

- of Creatinine clearance /min in urine in
- adult men : 90-139 ml/min In adult
- women : 80- 125 ml / min

#### Significance and Interpretation

- ▲ Lower than normal creatinine excretion indicates the kidney problems.

### 4) Urea Clearance test

- This test is also performed to check the kidneys functions . In this test using blood , the amount of urea in blood Checked , and along with two urine sample are collected with a gap of one hour to determine the amount of urea filtered by the kidneys into urine.

#### Normal Range

- of urea clearance
- 12-20 gm/24 hours

#### Significance and Interpretation

- ▲ Low level of urea than normal range indicates kidney problems , Protein deficiency in diet.
- ▲ High level than normal range indicates excessive protein metabolism , or too much protein intake in diet.

# Thyroid Function Tests ( TFT test )

- There are many different blood tests which are performed to check thyroid gland functioning .
- some of them are following

## 1) TSH ( thyroid stimulating Hormone ) test

- This test is performed using blood to check Level of TSH pituitary gland makes this hormone which stimulates the thyroid gland to produce thyroid hormones

### Normal range

- of TSH in blood 0.5 - 5.0 mU/L

### Significance and Interpretation

- ▲ High level than normal indicates low production of thyroid hormone (primary Hypothyroidism),
- ▲ low level of TSH indicates too much thyroid hormone production (Hyperthyroidism).

## 2) T<sub>3</sub> or Triiodothyronine test

- This test is used to check production level of thyroid hormone T<sub>3</sub> in blood.

### Normal range

- 100- 200 ng /dl

### Significance and Interpretation

- ▲ High level indicates Hyperthyroidism , when low level indicates Hypothyroidism.

## 3) T<sub>4</sub> or thyroxine Test

- It is also a Thyroid hormone , it is found in two forms free and bounded with proteins,

### Normal range

- of T<sub>4</sub> (free and bounded with protein) for
- adult 5.0-11.0 ng/dl

### Significance and Interpretation

- ▲ High TSH and low T<sub>4</sub> indicates the Hypothyroidism ( due to problems in thyroid gland) ,
- ▲ Normal TSH and High T<sub>4</sub> indicates Hyperthyroidism ( due to problems in thyroid gland )

## Tests associated with Cardiac Disorders

→ Many different tests are used to diagnose heart disease. Besides blood tests and a chest X-ray, tests to diagnose heart disease can include :

- **Electrocardiogram (ECG or EKG)** : This test measures the electrical activity of the heart and can detect abnormal heart rhythms, damage to the heart muscle, and other problems.
- **Echocardiogram** : This is an ultrasound test that uses sound waves to create images of the heart. It can be used to evaluate the size and shape of the heart, the thickness of the heart muscle, and the function of the heart valves.
- **Stress test** : This test involves exercising the heart to see how it responds. It can be done on a treadmill or with medication. It can be used to detect problems with blood flow to the heart or abnormal heart rhythms.
- **Cardiac catheterization** : This test involves inserting a thin, flexible tube (catheter) into a blood vessel in the arm or leg and guiding it to the heart. It can be used to diagnose blockages in the coronary arteries or to measure pressures within the heart.
- **Holter monitor** : This is a portable device that records the heart's electrical activity over a period of 24-48 hours. It can be used to detect abnormal heart rhythms that may not show up on a regular ECG.
- **Cardiac MRI** : This test uses a powerful magnetic field and radio waves to create detailed images of the heart. It can be used to evaluate the size and function of the heart and to detect problems such as blockages or damage to the heart muscle.
- **CT scan** : This test uses X-rays to create detailed images of the heart and blood vessels. It can be used to detect blockages in the coronary arteries or to evaluate the size and function of the heart



# Fluid and Electrolyte Balance

- About 56% of adult human body is fluid. Although most of this fluid is inside the cells and is called intracellular fluid; about one-third is in the space outside the cells and is called extracellular fluid.
- The extracellular fluid has ions and nutrients needed by the cells for maintenance of life. Therefore, all the cells essentially live in the same environment. i.e.. extracellular fluid. This is the reason that extracellular fluid is called internal environment of the body.
- Around 60-70% of the volume of body is water. Fluids in the body are solutions of organic and inorganic solutes which undergo distribution in the following
- Major fluid compartments :
  - Interstitial fluid,
  - Vascular fluid or plasma fluid, and
  - Intracellular fluid.

## 1. Osmolarity of Body Fluids

- This test is performed to check level of Water in Body fluid or fluid balance.

### Normal Range

- 275 - 300 mmole /Kg

### Significance and Interpretation

- ▲ High Osmolarity than normal range of body fluid Indicates dehydration which causes many of body function problems .
- ▲ Low Osmolarity than normal range of body fluid indicates water intoxication ( Nausea , fatigue , Headache , seizure )

## 2. Serum Electrolyte test

- This test is performed to check the amount of electrolytes of blood . They are important to balance water in body fluids.

### Normal range

- Sodium : 136 - 145 m moles /L
- Potassium : 3.5 to 5 m moles/L
- Chloride : 98 to 106 m moles/L

### Significance and Interpretation

- ▲ High level than normal range indicates
- ▲ Sodium : Hyponatremia
- ▲ Potassium : Hypokalemia
- ▲ Chloride : Hypochloremia
- ▲



# Pulmonary Function Tests

- Pulmonary Function Tests (PFTs) are a group of diagnostic tests used to evaluate the function of the lungs. These tests can help diagnose a range of respiratory conditions and can help monitor the progression of lung disease.
- The most common types of PFTs include :
  - ◆ **Spirometry** : This test measures the amount of air a person can inhale and exhale, and how quickly they can do it. It can help diagnose conditions such as asthma and chronic obstructive pulmonary disease (COPD).
  - ◆ **Lung volume measurements** : These tests measure the amount of air in the lungs, both when they are full and when they are empty. They can help diagnose conditions such as interstitial lung disease and sarcoidosis.
  - ◆ **Diffusion capacity** : This test measures how easily oxygen passes from the lungs into the bloodstream. It can help diagnose conditions such as pulmonary fibrosis and emphysema.
  - ◆ **Exercise testing** : This test measures how well the lungs function during physical activity. It can help diagnose conditions such as exercise-induced asthma and evaluate the effectiveness of treatments

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