

## 7. Organ function tests

VII	3 (T)	Explain different function tests and interpret the findings	<p>Organ function tests (biochemical parameters &amp; normal values only)</p> <ul style="list-style-type: none"> <li>• Renal</li> <li>• Liver</li> <li>• Thyroid</li> </ul>	<ul style="list-style-type: none"> <li>• Lecture cum Discussion</li> <li>• Visit to Lab</li> <li>• Explain using charts and slides</li> </ul>	<ul style="list-style-type: none"> <li>• Short answer</li> <li>• Very short answer</li> </ul>
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# SYLLABUS

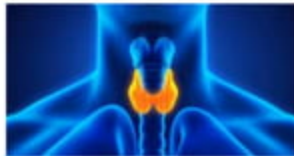
## INTRODUCTION

- ❑ **Organ function tests are the test of the major organs, which help in maintaining the normal functioning of the body.**
- ❑ **Various biochemical tests are carried out to assess whether particular organ is functioning normally or not.**
- ❑ **These include liver function tests (LFTs), renal function tests (RFTs) and thyroid function tests.**

## **Thyroid function tests (TFTs)**

- ❑ Thyroid hormones play a key role in metabolism and general functioning of the body.**
- ❑ Thyroid stimulating hormone (TSH) regulates the thyroid hormones production.**
- ❑ Hyperthyroidism and hypo can be diagnosed by TFTs in which TSH is important**

## Thyroid .....



- Thyroid hormone secreted by thyroid are T3 and T4, thyroxine**
- Necessary for proper functioning of all cells and for all biological processes.**
- Thyroid hormones are derived from tyrosine by iodination.**
- Thyroid hormone secretion is stimulated by pituitary thyrotropic hormone.**
- TSH binds to receptors on thyroid cells and stimulates all steps in production and secretion of hormone.**

Iodine is required for the synthesis of thyroid hormones (Fig. 2).

Sources of iodine are:

- **Seafood:** Tuna, cod, prawns.
- **Vegetables:** Green beans, navy beans, dried seaweed.
- **Fruits:** Strawberries, cranberries, bananas.
- **Plasma bound iodine (PBI):** Decreases in hypothyroidism and increases in hyperthyroidism.

### **Absorption, Storage and Excretion**

- **Absorption:** Small intestine.
- **Storage:** Iodothyroglobulin—a glycoprotein in nature can be stored for several months in the thyroid gland.

Sources of iodine are depicted in Figure 2.



Fig. 2: Sources of iodine

- **Excretion:** Kidney and also through saliva, bile skin, and milk (in case of lactating women).

# ABNORMALITIES OF THE THYROID

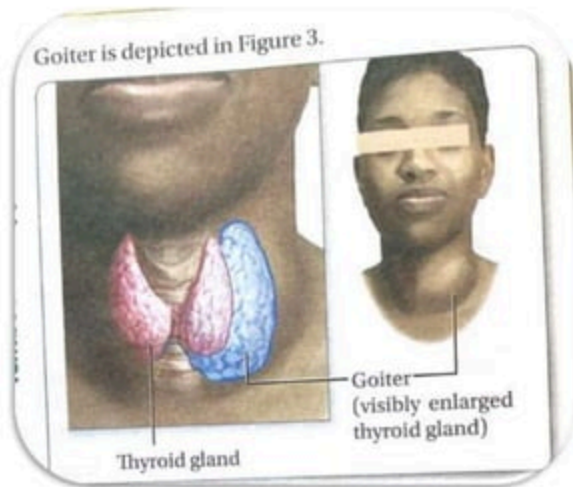
## Disorders of the Thyroid Gland

- **Goiter** is enlargement of thyroid gland
  - Simple goiter
  - Adenomatous or nodular goiter
- **Hypothyroidism**
  - Infantile hypothyroidism (cretinism)
- **Myxedema**
- **Hyperthyroidism**
  - Graves disease
  - Thyroid storm
- **Thyroiditis**
  - Hashimoto disease

❖ Hypothyroidism (Hashimoto's disease, Goiter) and

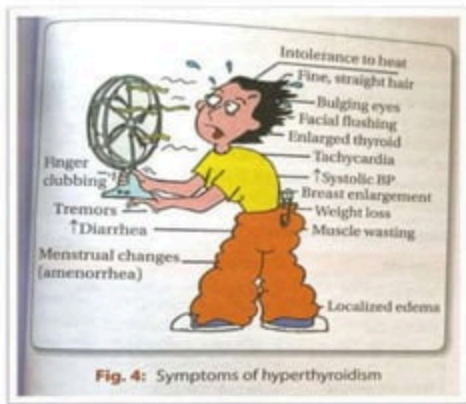
❖ Hyperthyroidism (Graves' disease)

**GOITER-** Abnormal enlargement of butterfly shaped gland below adam's apple (thyroid)





# Hyperthyroidism- when thyroid gland produces more hormone thyroxine



**Table 1:** Laboratory findings in hyperthyroidism

Condition	Plasma total T3, T4	Plasma TSH	Response to TRH
Graves' disease	Increased	Decreased	Nil
Toxic goiter	Increase	Decrease	Nil
T3-toxicosis	T3 increase, T4 normal	Decrease	Sluggish
Excess intake of thyroxine	Increase	Decrease	Sluggish

**Diagnosed by scanning and estimation of T3 and T4 and TSH in plasma**

## Hypothyroidism- does not make T3 and T4

**Table 2:** Laboratory findings in hypothyroidism

Condition	T3, T4 in blood	TSH in blood	Response to TRH
Primary hypothyroidism	Decreased	Increased	Exaggerated response
Secondary hypothyroidism	Decreased	Decreased	No response

**Table 3:** Types of thyroid function test

Domain	Description
Tests based on primary function of the thyroid	<ul style="list-style-type: none"><li>• Radioiodine uptake study</li><li>• PBI<sup>131</sup> estimation</li><li>• T3 suppression test</li><li>• TSH stimulation test</li><li>• TRH stimulation test</li></ul>
Tests measuring blood level of thyroid hormones	<ul style="list-style-type: none"><li>• Serum PBI test</li><li>• T3 and T4 level</li><li>• TSH level</li><li>• Plasma Tyrosine level</li><li>• <i>In vitro</i> resin uptake of T3</li></ul>
Tests based on metabolic effect of thyroid hormones	<ul style="list-style-type: none"><li>• BMR</li><li>• Serum cholesterol level</li><li>• Serum creatinine level</li><li>• Uric acid level</li><li>• Creatine kinase (CK) enzyme</li></ul>

Immunological test to detect autoimmune disease of thyroid gland

- Agar gel diffusion test
- Complement fixation test
- Tanned red cell hemagglutination (TRCH)

Scanning of thyroid gland

- Radioimmunoassay (RIA)
- Enzyme linked immunosorbent assay (ELISA)
- Semi-automatic
- Antigen antibody reaction
- Chemiluminescence

**Table 4:** Normal ranges of TFT

Hormone	Range
T3	0.52–1.85 ng/mL
T4	<b>Male:</b> 4.4–10.8 $\mu\text{g/dL}$ <b>Female:</b> 4.4–11.6 $\mu\text{g/dL}$
TSH	0.39–6.16 $\mu\text{IU/mL}$
FT3 (Free T3)	1.4–4.2 pg/mL
FT4 (Free T4)	0.8–2.0 ng/dL

# LIVER FUNCTION TESTS

(also known as a liver panel) are blood tests that measure different enzymes, proteins, and other substances made by the liver. These tests check the overall health of your liver

## WHEN IT IS DONE .....

- A liver function test is often given in the following situations: to screen for liver infections, such as hepatitis C**
- To monitor the side effects of certain medications known to affect the liver**
- If you already have a liver disease, to monitor the disease and how well a particular treatment is working**
- To measure the degree of scarring (cirrhosis) on the liver**
- If you're experiencing the symptoms of a liver disorder**

# Liver Function Tests (LFTs)

## AST (aspartate aminotransferase) (11 – 47 IU/L)

- AST is an enzyme found throughout the body, but predominantly in heart and liver cells.
- Most useful in detecting liver damage due to hepatitis, drugs toxic to the liver, cirrhosis, and alcoholism.
- Often ordered in conjunction with ALT.

## ALT (alanine aminotransferase) (7 – 56 IU/L)

- An enzyme found mostly in the cells of the liver and kidney. When the liver is damaged, ALT is released into the blood stream. ALT is a useful test for detecting liver damage.
- Most useful in detecting damage due to hepatitis and drugs or other substances toxic to the liver.
- Often ordered in conjunction with AST.

## AST/ALT Ratio

- The AST/ALT ratio is usually increased in alcoholic hepatitis, cirrhosis, and in the first day or two of acute hepatitis or injury from bile duct obstruction.

## ALP (alkaline phosphatase) (30 – 120 IU/L)

- Found in bone and in the cells of bile ducts. ALP can indicate blockage of one or more bile ducts, liver cancer, hepatitis, cirrhosis, or when hepatotoxic drugs are taken.



**Commonly used tests to check liver function are the alanine transaminase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), albumin, and bilirubin tests**

**Table 5:** Classification of liver function tests

Group	Test
<b>Group I:</b> Tests of hepatic excretory function	<ul style="list-style-type: none"><li>• <b>Serum:</b> Bilirubin; total, conjugated, and unconjugated</li><li>• <b>Urine:</b> Bile pigments, bile salts and urobilinogen</li></ul>
<b>Group II:</b> Liver enzyme panel	<ul style="list-style-type: none"><li>• Alanine aminotransferase (ALT) (marker of liver injury)</li><li>• Aspartate aminotransferase (AST) (marker of liver injury)</li><li>• Alkaline phosphatase (ALP) (marker of cholestasis)</li><li>• Gamma-glutamyl transferase (GGT) (marker of alcoholism)</li></ul>
<b>Group III:</b> Plasma proteins (tests for synthetic function of liver) (marker, chronic liver diseases)	<ul style="list-style-type: none"><li>• Total proteins</li><li>• Serum albumin, globulins, A/G ratio</li><li>• Prothrombin time</li><li>• Blood ammonia</li></ul>
<b>Group IV:</b> Special tests (tests for metabolic liver disease)	<ul style="list-style-type: none"><li>• Ceruloplasmin</li><li>• Ferritin and iron</li><li>• Alpha fetoprotein (AFP)</li></ul>



# INDICATION FOR LFT- JAUNDICE

**Table 7:** Laboratory findings in serum in jaundice cases

Category	Hemolytic jaundice	Obstructive jaundice	Hepatocellular jaundice
Total bilirubin	Elevated	Elevated	Elevated
Conjugated bilirubin	Normal	Elevated	Elevated
Unconjugated	Elevated	Normal	Elevated
Van den Bergh reaction	Indirect +ve	Direct +ve	Biphasic

## Laboratory Findings in Urine in Jaundice

Laboratory findings in urine in jaundice cases is depicted in Table 8.

**Table 8:** Laboratory findings in urine in jaundice cases

	Hemolytic jaundice	Obstructive Jaundice	Hepatocellular jaundice
Bile pigments	Absent	+++	++
Bile salts	Absent	++	+
Urobilinogen	Elevated	Absent	Normal or decreased
Positive test	Ehrlich's +ve	Fouchet's +ve	Hey's +ve

## MEASUREMENT OF BILIRUBIN

**is a yellowish pigment that is made during the breakdown of red blood cells.**

**Bilirubin passes through the liver and is eventually excreted out of the body.**

## What causes high bilirubin levels (hyperbilirubinemia)?

**Bilirubin might build up in your blood if:**

- Your body breaks down too many red blood cells too fast. You might be overproducing bilirubin if you have a blood disorder, such as hemolytic anemia, that destroys red blood cells.**
- Your liver is struggling to process its normal load of bilirubin. Your liver might struggle with occasional toxic overload, or it might have a chronic liver disease that affects its functioning.**
- Your biliary system isn't clearing bile efficiently. There might be a blockage in your bile ducts or your gallbladder that's causing bile to back up and leak into your bloodstream.**

What are symptoms of high bilirubin?

High bilirubin leads to jaundice, a yellow cast to your skin

## What causes low bilirubin levels (hypobilirubinemia)?

Certain medications can lower your bilirubin levels, including antibiotics, birth control pills, sleeping pills and seizure medications. Low levels aren't generally a cause for concern.

VALUE-

### High Tip

- Normal serum bilirubin level varies from 0.2 to 0.8 mg/dL.

## ***Normal Reference Range of LFT (Table 11)***

**Table 11:** Normal reference range of LFT

<b>Liver function test</b>	<b>Normal range</b>
S. bilirubin (total)	0.1–1.2 mg/dL
S. bilirubin (conjugated)	Up to 0.25 mg/dL
S. protein (total)	6.3–8.3 g/dL
S. albumin	3.5–5.0 g/dL
S. globulin	2.4–3.5 g/dL
A:G ratio	1.5–2.5
SGOT (AST)	5–35 IU/L
SGPT (ALT)	5–40 IU/L
S. alkaline	151–471 U/L (children)
Phosphatase	60–170 U/L (adult)

# RENAL OR KIDNEY FUNCTION TEST

Kidney function tests measure how efficiently your kidneys are working.

Most of these tests check how well your kidneys clear waste from your system.

## What do your kidneys do?

- Your kidneys are part of your urinary system.
- They help your body filter waste materials and expel them as urine.
- Your kidneys are also vital for producing:
  - Hormones that maintain blood pressure.
  - Red blood cells, which carry oxygen throughout your body.
  - Vitamin D, which maintains bone and muscle health.



## Why might I need a kidney function test?

- Some conditions, such as diabetes or high blood pressure (hypertension), affect how well the kidneys work. If you have one of these conditions, your healthcare provider may use kidney function tests to help monitor these conditions.
- You may also need a kidney function test if you have symptoms that indicate possible kidney problems. These symptoms might include:
  - Blood in your urine (hematuria).
  - Painful urination (dysuria).
  - Frequent urge to urinate.
  - Problems with starting to pee.

# EXAMINATION OF URINE



# PHYSICAL CHARACTERISTICS

- Volume:** The average output of urine is about 1.5 liters per day.
- Appearance: Clear:** Normal urine is straw colored.
- Cloudy-ppt of phosphate**
- High color:** Concentrated urine Oxidation of urobilinogen to urobilin.
- Yellow:** Bilirubinuria in jaundice . B-complex intake.
- Smoky: Red** Presence of blood.
- Brownish red:** Hemoglobinuria.
- Orange:** High levels of bilirubin; Rifampicin.
- Brownish red:** Hemoglobinuria
- Red:** Porphyria; Ingestion of red beet.
- Black:** Urine Alkaptonuria; Formic acid poisoning.
- Milky:** Urine chyluria.

# PHYSICAL CHARACTERISTICS

- Odor:** Normal urine has a faintly aromatic smell due to presence of volatile organic acids.
- Urine in diabetic Keto acidosis** may have fruity odor due to acetone.
- Color:** Normal urine is straw-colored (amber yellow) due to the pigment, urochrome.
- Presence of bilirubin** makes urine yellow in jaundiced patients.
- Specific gravity:** Normal specific gravity of urine is 1.015-1.025.

# CHEMICAL CHARACTERISTICS

**PROTEIN**

**BLOOD**

**REDUCING SUGARS**

**KETONE BODIES**

**BILE PIGMENT**

## Assessment of Kidney Function

- Extent of renal damage
- Monitoring the progression of renal damage
- Monitoring and adjusting the dose of potentially toxic drugs.

## Renal (Kidney) Function Tests Profile

- Serum urea
- Serum creatinine
- Uric acid
- Urea clearance
- Creatinine clearance
- Preliminary investigations to renal function tests

## Clearance Tests

**Table 13:** Classification of renal function test

Domain	Classification
Tests based on glomerular filtration	<b>Clearances</b> <ul style="list-style-type: none"><li>• Urea clearance test</li><li>• Endogenous creatinine clearance test</li><li>• Inulin clearance test</li></ul>
Tests to measure renal plasma flow	<ul style="list-style-type: none"><li>• Para-aminohippurate (PAH) test</li><li>• Filtration fraction</li></ul>
Tests based on tubular function	<ul style="list-style-type: none"><li>• Concentration and dilution tests</li><li>• 15 minutes phenolphthalein test</li></ul>

**CLEARANCE-** VOLUME OF BLOOD WHICH CONTAIN AMT OF SUBSTANCE WHICH IS EXCRETED BY KIDNEY IN 1 MIN

$$C = U \times \frac{V}{P}$$

U = concentration of the substance in urine.

V = volume of urine in ml excreted in minute.

P = concentration of the substance in plasma.

The clearance of a substance is determined by its mode of excretion.



## Important Takeaway

### Maximum Clearance

If the urine volume exceeds 2 mL/min, the rate of urea clearance is at a maximum and is directly proportional to the concentration of urea in the blood.

Average normal value is 75 mL/min (Normal range 75  $\pm$  10).

## High Tip

### Normal Value of Creatinine

- 95–140 mL/min (males)
- 85–125 mL/min (females)

$$C = UV/P$$

## High Tip

### Normal Value of Inulin

125 mL of plasma cleared of inulin/minute.  
= 100 – 150 mL/minute.

# END.....

VII	3 (T)	Explain different function tests and interpret the findings	Organ function tests (biochemical parameters & normal values only) <ul style="list-style-type: none"><li>• Renal</li><li>• Liver</li><li>• Thyroid</li></ul>	<ul style="list-style-type: none"><li>• Lecture cum Discussion</li><li>• Visit to Lab</li><li>• Explain using charts and slides</li></ul>	<ul style="list-style-type: none"><li>• Short answer</li><li>• Very short answer</li></ul>
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