The kidney function tests

Liver Function Tests (LFTs) – Introduction

- Liver Function Tests (LFTs) are a group of blood tests that assess various aspects of **liver health and functionality**.
- These tests help detect **liver damage, inflammation, infection**, and monitor the progression of **liver diseases** such as hepatitis, cirrhosis, fatty liver, and liver cancers.

Common Parameters in LFTs

1. **Serum Bilirubin** – Total, Direct (Conjugated), and Indirect (Unconjugated)
2. **Aminotransferases** – ALT (Alanine Aminotransferase) and AST (Aspartate Aminotransferase)
3. **Alkaline Phosphatase (ALP)**
4. **Gamma-glutamyl transferase (GGT)**
5. **Serum Albumin**
6. **Prothrombin Time (PT) / INR**
7. **Serum Total Protein**
8. **Lactate Dehydrogenase (LDH)** – Less specific, sometimes included

- Each of these tests correlates with specific liver functions or damage to particular liver cells or structures.

Interpretation of Common LFTs

Test	Indicates
Alanine transaminase (ALT)	Hepatocellular injury (very liver-specific)
Aspartate transaminase (AST)	Liver injury (also found in heart, muscle)
Alkaline phosphatase (ALP)	Biliary obstruction or bone disease
Gamma-glutamyl transferase (GGT)	Biliary tract damage, alcohol use
Bilirubin (Total, Direct, Indirect)	Hepatic excretion capacity, hemolysis
Albumin	Synthetic function of liver
Prothrombin Time (PT)	Clotting factor synthesis
Lactate Dehydrogenase (LDH)	Non-specific marker, may rise in liver damage

Physiological Roles of the Liver

- The liver is a vital organ located in the upper right quadrant of the abdomen. It performs over 500 biochemical functions.

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These can be classified under the following broad physiological roles:

A. Metabolic Functions of the Liver

The liver plays a central role in **metabolism of carbohydrates, proteins, and lipids**.

1. Carbohydrate Metabolism

- **Glycogenesis**: Conversion of excess glucose into glycogen for storage.
- **Glycogenolysis**: Breakdown of stored glycogen into glucose when blood sugar levels fall.
- **Gluconeogenesis**: Synthesis of glucose from non-carbohydrate precursors like amino acids and glycerol during fasting.
- **Regulation of blood glucose**: The liver ensures glucose levels are stable by balancing storage and release.

2. Lipid Metabolism

- **Beta-oxidation**: Fatty acids are broken down to produce energy.
- **Lipoprotein synthesis**: The liver produces VLDL, LDL, and HDL for lipid transport.
- **Triglyceride synthesis**: Formation of triglycerides for storage and transport.
- **Cholesterol synthesis and excretion**: Liver synthesizes cholesterol and also converts cholesterol into bile acids for excretion.

3. Protein Metabolism

- **Deamination**: Removal of amino groups from amino acids to form ammonia, which is then converted into urea for excretion (urea cycle).
- **Transamination**: Interconversion of amino acids for biosynthesis.
- **Synthesis of plasma proteins**: Such as albumin, clotting factors, transferrin, and acute phase reactants.
- **Detoxification of ammonia**: Through urea synthesis.

B. Storage Functions

- The liver stores several essential nutrients and compounds for future use:
  - **Glycogen**: Stored form of glucose.
  - **Fat-soluble vitamins**: A, D, E, K
  - **Vitamin B12**: Stored in large quantities, enough to last for years.
  - **Iron**: Stored as ferritin and hemosiderin.
  - **Copper**: Bound to ceruloplasmin.
- These stored substances are mobilized when needed by the body, maintaining metabolic homeostasis.

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C. Excretory Functions

1. Bile Production and Secretion

- Hepatocytes produce **bile**, a greenish fluid essential for fat digestion and absorption.
- Bile contains:
  - **Bile salts** (derived from cholesterol)
  - **Bilirubin** (a waste product from hemoglobin breakdown)
  - Cholesterol, electrolytes, phospholipids

2. Bilirubin Metabolism

- **Unconjugated (indirect) bilirubin** is produced from hemoglobin degradation.
- It is transported to the liver bound to albumin.
- In the liver, it is **conjugated** with glucuronic acid (by UDP-glucuronyl transferase) to form **conjugated (direct) bilirubin**, making it water-soluble.
- Conjugated bilirubin is excreted into bile, enters the intestine, and is eventually excreted as:
  - **Stercobilin** (in feces – gives brown color)
  - **Urobilinogen** (some reabsorbed and excreted in urine as urobilin)

Disruptions in this process cause **jaundice**.

D. Protective and Detoxification Functions

The liver serves as a **detoxification center**, protecting the body from harmful substances.

1. Detoxification Mechanisms

- **Phase I reactions** (oxidation, reduction, hydrolysis) – primarily carried out by cytochrome P450 enzymes.
- **Phase II reactions** (conjugation) – binding of drugs/toxins to glucuronic acid, sulfate, or glutathione to increase solubility.

2. Endogenous detoxification

- Ammonia from amino acid metabolism is converted to **urea**.
- Metabolism of hormones (estrogens, corticosteroids).
- Clearance of bilirubin, a breakdown product of hemoglobin.

3. Exogenous detoxification

- Alcohol
- Drugs and medications
- Environmental toxins

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- Heavy metals

4. Kupffer Cells (Macrophages of the Liver)

- These are phagocytic cells that remove pathogens, cellular debris, old red blood cells, and endotoxins from the portal blood.

E. Circulatory and Vascular Functions

- The liver has a unique dual blood supply:
  - **Portal vein (75%)**: Brings nutrient-rich blood from the gastrointestinal tract and spleen.
  - **Hepatic artery (25%)**: Supplies oxygenated blood.

1. Filtration of Blood

- As portal blood passes through the liver sinusoids, it's filtered by hepatocytes and Kupffer cells.
- Toxins, bacteria, and debris are removed before blood re-enters systemic circulation.

2. Blood Reservoir

- The liver can hold up to **500 mL of blood** and can contract to release it during hypovolemia (e.g., hemorrhage).

3. Regulation of Blood Volume

- Through its compliance and reservoir function, the liver helps maintain central venous pressure and blood volume homeostasis.

F. Function in Blood Coagulation

The liver plays a critical role in **hemostasis (the process of stopping bleeding)** by synthesizing most of the **clotting factors**:

1. Clotting Factors Synthesized by Liver

- **Fibrinogen (Factor I)**
- **Prothrombin (Factor II)**
- **Factors V, VII, IX, X, XI**
- **Factor XII** (also synthesized, but less essential)
- **Protein C and Protein S**: Natural anticoagulants
- **Antithrombin III**: Inhibits thrombin and Factor Xa

2. Vitamin K–Dependent Factors

- Factors II, VII, IX, X require **vitamin K** for gamma-carboxylation.
- The liver facilitates this process, enabling calcium binding and activation of these factors.

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3. Prothrombin Time (PT)

- PT is commonly used to evaluate liver function, especially synthetic function.
- A prolonged PT indicates:
  - Decreased synthesis of clotting factors (especially VII, which has a short half-life)
  - Vitamin K deficiency
  - Severe liver damage

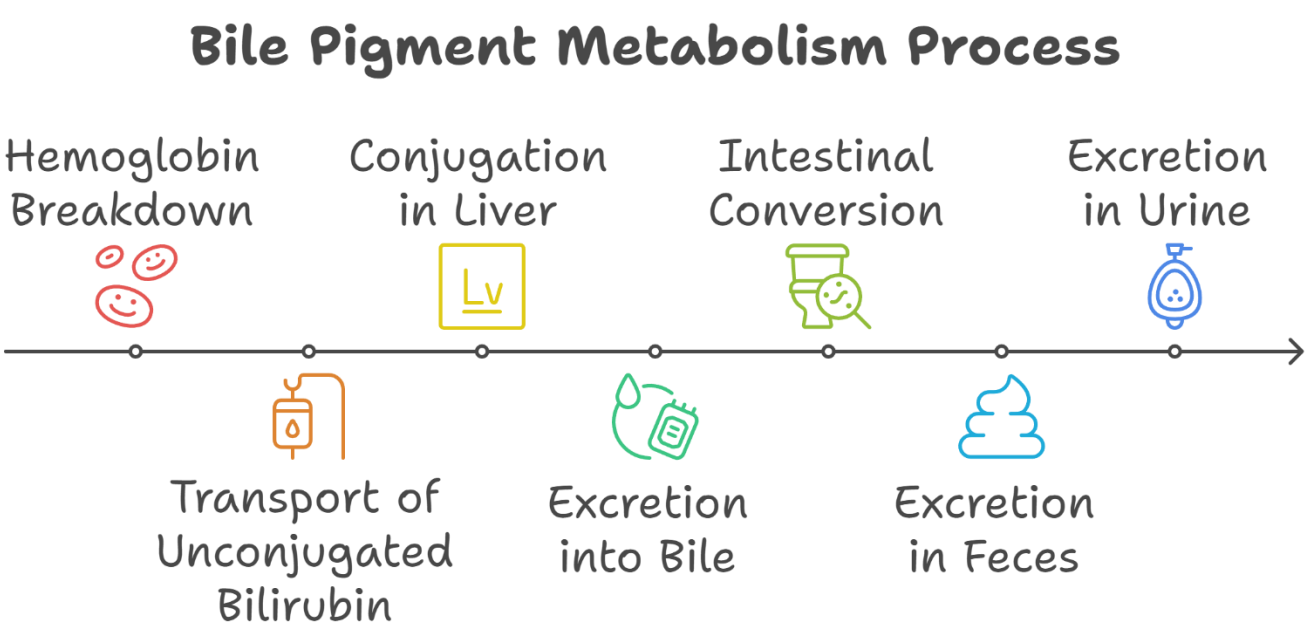
4. Bleeding Tendencies

- In advanced liver disease, decreased clotting factor production leads to **increased bleeding risk**, seen in conditions like cirrhosis.

Test for Hepatic Dysfunction – Bile Pigment Metabolism

Bile pigments are derived from the breakdown of hemoglobin in the reticuloendothelial system (mainly in spleen and liver).

Steps of Bile Pigment Metabolism:



1. Hemoglobin Breakdown:

- Red blood cells are broken down in the spleen after their 120-day lifespan.
- Hemoglobin splits into:
  - **Globin** → broken into amino acids.
  - **Heme** → converted to biliverdin and then to **unconjugated bilirubin**.

2. Transport of Unconjugated Bilirubin:

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