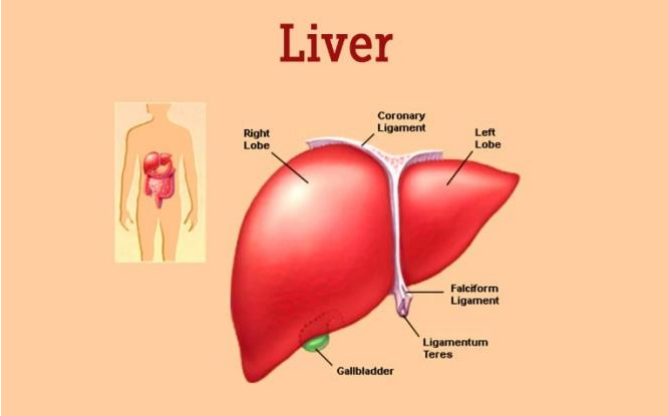
ROLE OF LIVER IN BALANCED DIET, DIGESTION AND ABSORPTION

Introduction

The liver is the largest internal organ and the central metabolic hub of the human body. It plays an indispensable role in nutrient processing, detoxification, synthesis of biomolecules, storage of vitamins and minerals, regulation of blood glucose, lipid metabolism, and protein formation. In the context of a **balanced diet**, the liver ensures that all nutrients—carbohydrates, fats, proteins, vitamins, and minerals—are converted into usable forms and distributed properly. In digestion, the liver produces **bile**, essential for fat breakdown and absorption. Thus, without the liver, the body would not be able to use nutrients efficiently, no matter how balanced the diet is.



Role of Liver in a Balanced Diet

A balanced diet provides nutrients—carbohydrates, fats, proteins, vitamins, minerals, and water—but the **liver ensures proper utilization** of these nutrients. Its roles include:

A. Carbohydrate Metabolism

1. Glycogenesis (Storage)

- After a carbohydrate-rich meal, glucose enters the liver.
- Liver converts excess glucose into **glycogen** for storage.

2. Glycogenolysis (Release of glucose)

- During fasting or exercise, the liver breaks glycogen into **glucose** to maintain blood glucose levels.

3. Gluconeogenesis

- Formation of glucose from non-carbohydrate sources (amino acids, lactate, glycerol).
- Essential during prolonged fasting.

Importance for Balanced Diet:

Maintains constant blood glucose regardless of meal pattern, preventing hypoglycemia or hyperglycemia.

B. Fat Metabolism

The liver controls the processing and distribution of dietary fats.

1. Fatty Acid Oxidation

- Breaks down fatty acids to supply energy when carbohydrates are low.

2. Lipoprotein Formation

- Synthesizes VLDL, LDL, and HDL to transport lipids in blood.

3. Cholesterol and Triglyceride Synthesis

- Converts dietary fats into essential structural and functional lipids.

4. Ketogenesis

- Produces ketone bodies during fasting.

Significance:

Prevents fat accumulation and helps regulate energy distribution.

C. Protein Metabolism

1. Deamination of amino acids

- Removes amino group, allowing amino acids to be used for energy or converted to glucose.

2. Urea cycle (Detoxification of ammonia)

- Converts toxic ammonia into urea for safe excretion by kidneys.

3. Synthesis of plasma proteins

- Albumin (maintains osmotic pressure)
- Clotting factors (I, II, V, VII, IX, X)
- Transport proteins

Importance:

Ensures nitrogen balance and supports tissue repair and immunity.

D. Storage Functions

The liver stores:

- **Glycogen**
- **Fat-soluble vitamins:** A, D, E, K
- **Water-soluble vitamin B12**
- **Minerals:** Iron (as ferritin), copper

Relevance to Balanced Diet:

Acts as a reservoir and supplies nutrients during deficiency.

Role of Liver in Digestion

The primary contribution of the liver to digestion is **bile production**.

A. Bile: Composition and Function

1. Composition of bile

- Bile salts
- Bile pigments (bilirubin)
- Cholesterol
- Phospholipids
- Electrolytes and water

2. Functions of bile

1. **Emulsification of fats:**
    - Breaks large fat globules into smaller ones.
    - Increases surface area for pancreatic lipase.
2. **Activation of lipase:**
    - Bile salts enhance the action of lipase.
3. **Neutralization of acidic chyme:**
    - Bile is alkaline; it neutralizes stomach acid entering the duodenum.
4. **Excretion of waste products:**
    - Bilirubin and excess cholesterol are removed through bile.

B. Bile Salt Cycle (Enterohepatic Circulation)

- Bile salts are reabsorbed from the ileum and returned to the liver.
- Ensures efficient reuse and continuous fat digestion.
- Disorder of this cycle leads to fat malabsorption.

Role of Liver in Absorption of Nutrients

Absorption occurs mainly in the intestines, but the **liver processes and regulates absorbed nutrients**.

A. Absorption and Processing of Carbohydrates

- Absorbed monosaccharides enter the **portal vein**.
- Liver converts fructose & galactose into **glucose**.
- Controls release of glucose into blood.

B. Absorption and Processing of Proteins

- Amino acids reach the liver through portal vein.

- Used for protein synthesis or converted to glucose or fats.
- Excess nitrogen converted to urea.

C. Absorption and Processing of Lipids

Unlike carbohydrates and proteins, dietary fats are absorbed via lymphatics.
But liver plays a key role after they enter blood:

1. Repackaging of lipids

- Chylomicron remnants taken up by liver.
- Converted into lipoproteins (VLDL, LDL, HDL).

2. Regulation of cholesterol levels

- Synthesizes, stores, and excretes cholesterol via bile.

3. Storage of fat-soluble vitamins

Supports absorption of:

- Vitamin A (vision)
- Vitamin D (bone health)
- Vitamin E (antioxidant)
- Vitamin K (clotting factors)

D. Absorption of Vitamins and Minerals

Fat-soluble vitamins (A, D, E, K):

- Require bile salts for absorption.
- Liver stores large amounts of A and B12.

Minerals:

- Liver stores iron as ferritin and releases it when required.
- Copper is also regulated by liver enzymes.

Liver in Detoxification and Metabolic Regulation

A. Detoxification of Harmful Substances

The liver neutralizes toxins from food and environment:

- Drugs
- Alcohol
- Metabolic by-products
- Food additives

This ensures nutrients are absorbed safely.

B. Hormone Metabolism

- Converts and regulates hormones like insulin, cortisol, and thyroid hormones.
- Maintains metabolic balance.

Role of Liver in Maintaining Homeostasis

1. Blood glucose homeostasis

Through glycogenesis, glycogenolysis, gluconeogenesis.

2. Lipid homeostasis

Through lipoprotein secretion and bile production.

3. Protein homeostasis

Through synthesis of albumin and clotting factors.

4. Acid-base balance

By metabolizing organic acids and producing urea.