# COURSE TITLE: Biomolecules and Microbial Metabolism

## Course Code: 24MICCC2

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# INTRODUCTION TO LIPIDS

- Lipids may be regarded as Organic substances relatively insoluble in water, soluble in organic solvents (alcohol, ether etc) actually or potentially related to fatty acids and utilized by the living cells.
- Unlike the polysaccharides, proteins and nucleic acids, lipids are not polymers. Further, lipids are mostly small molecules

## INTRODUCTION

- Lipogenesis is a critical metabolic process involving in synthesis of fatty acid from acetyl CoA, which are subsequently converted to triglycerides from storage.
- This process is fundamental for maintaining energy homeostasis in body. allowing organisms to store excess energy derived from food intake and utilize it during periods of fasting or increased energy demand.

## MECHANISM OF LIPOGENESIS

- The process of lipogenesis occur predominantly in liver and adipose tissue. It begins with the conversion of carbohydrates into acetyl CoA, a two carbon molecule that serves as a building block for fatty acid synthesis. The pathway involves a series of enzymatic reactions, with two key enzymes playing crucial roles: acetyl-CoA carboxylase (ACC) and fatty acid synthase (FAS).
- Fatty acids can be once synthesis it is elongated and desaturated to form a variety of other fatty acids. These fatty acids are then esterified with glycerol to form triglycerides.

# BIOSYNTHESIS OF FATTY ACID

- The dietary Carbohydrates and amino acids, when consumed in excess, can be converted to fatty acids and stored as triacylglycerols.
- De novo synthesis of fatty acid predominantly in liver, kidney, adipose tissue and lactating mammary glands.
- The enzyme machinery for fatty acid production is located in the cytosomal fraction of the cell.
- The fatty acid synthesis may learnt in three stages.

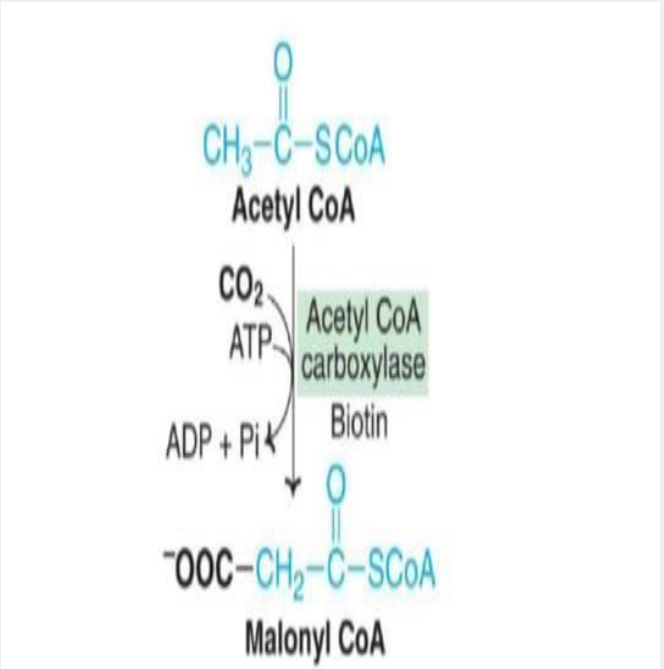
(i) Production of acetyl CoA and NADPH

(ii) Conversion of acetyl CoA to malonyl COA

(iii) Reactions of fatty acid synthase Complex.

## Production of acetyl CoA and NADPH

- Acetyl CoA is produced in the mitochondria by the oxidation of pyruvate and fatty acids.
- Mitochondria, however, are not permeable to acetyl CoA.
- An alternate or a bypass arrangement is made for the transfer of acetyl CoA to cytosol.




## Formation of Malonyl CoA

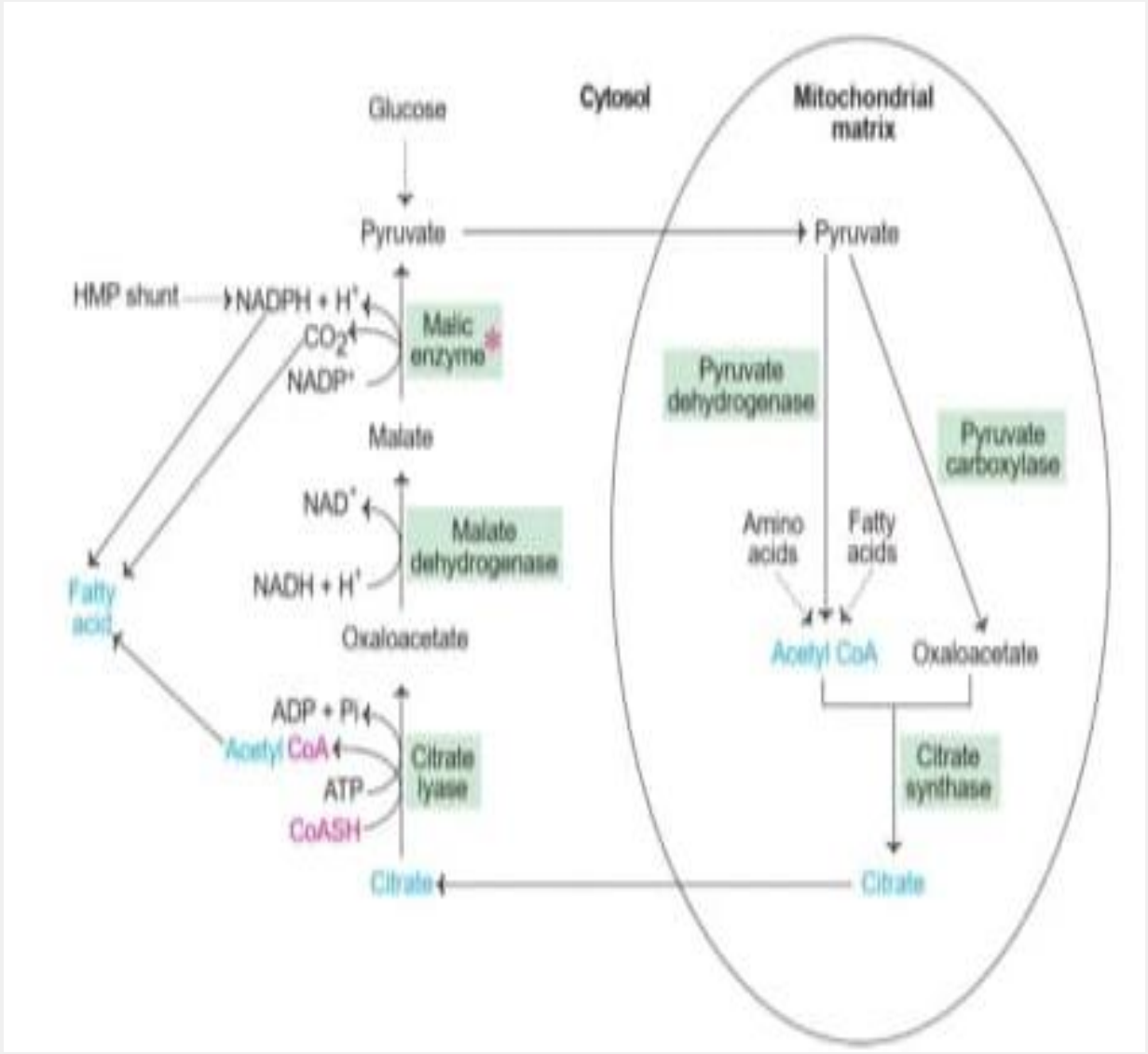
- Malonyl CoA formed from Acetyl CoA and bicarbonate in the presence of enzyme Acetyl CoA carboxylase.

# Reactions of fatty acid synthase complex(FAS).

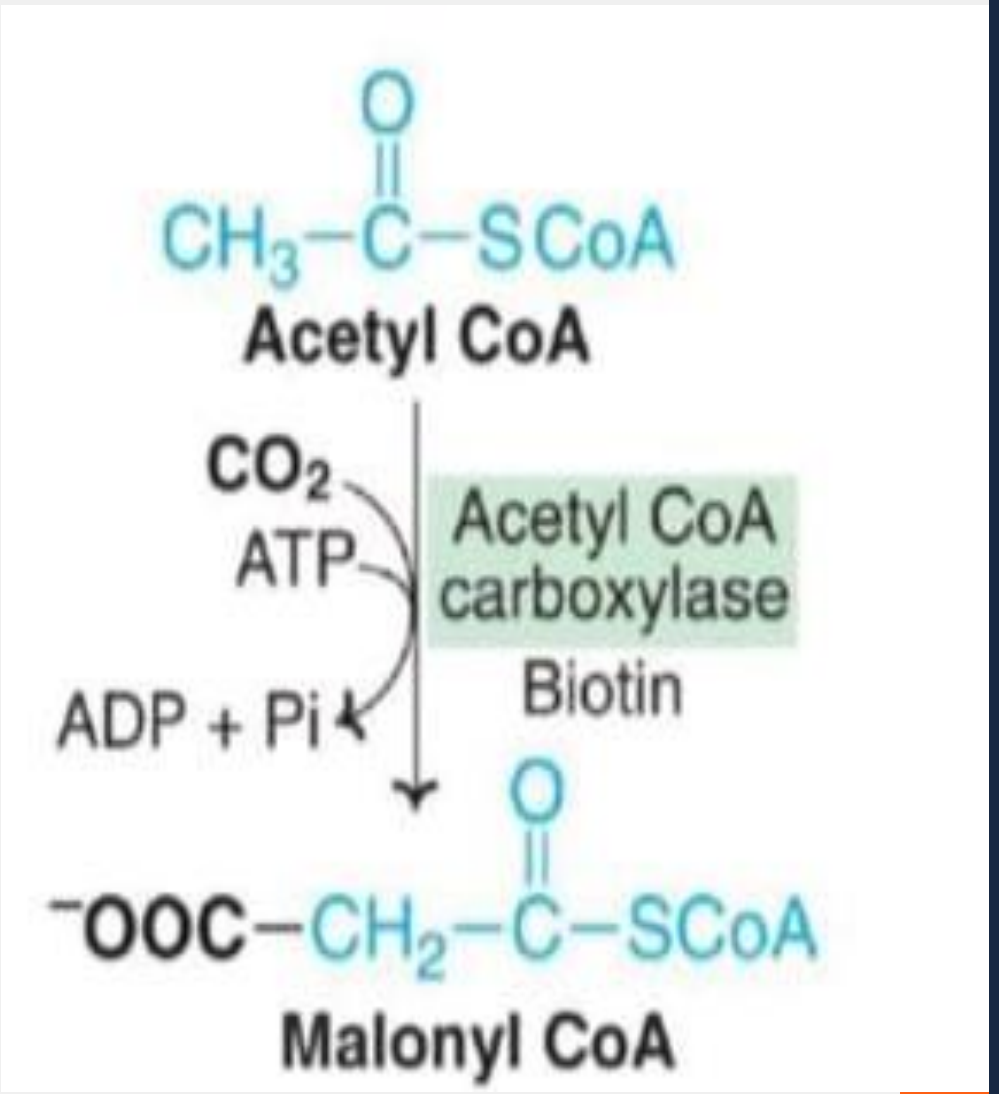
- The remaining reactions of fatty acid synthesis are catalysed by a multifunctional enzyme known as fatty acid synthase (FAS) Complex.
- Enzyme Consist of seven polypeptide

i. Aceyl Carrier Protein (ACP)
ii. Acetyl CoA ACP transacetylase (AT)
iii. Malonyl CoA ACP Transferase (MT)
iv. B- Keto aceyl ACP synthase(KS)
v. B- Keto aceyl ACP reductase (KR)
vi. B- Hydroxyl acyl ACP dehydratase (HD)
vii. Enoyl ACP reductase (ER)

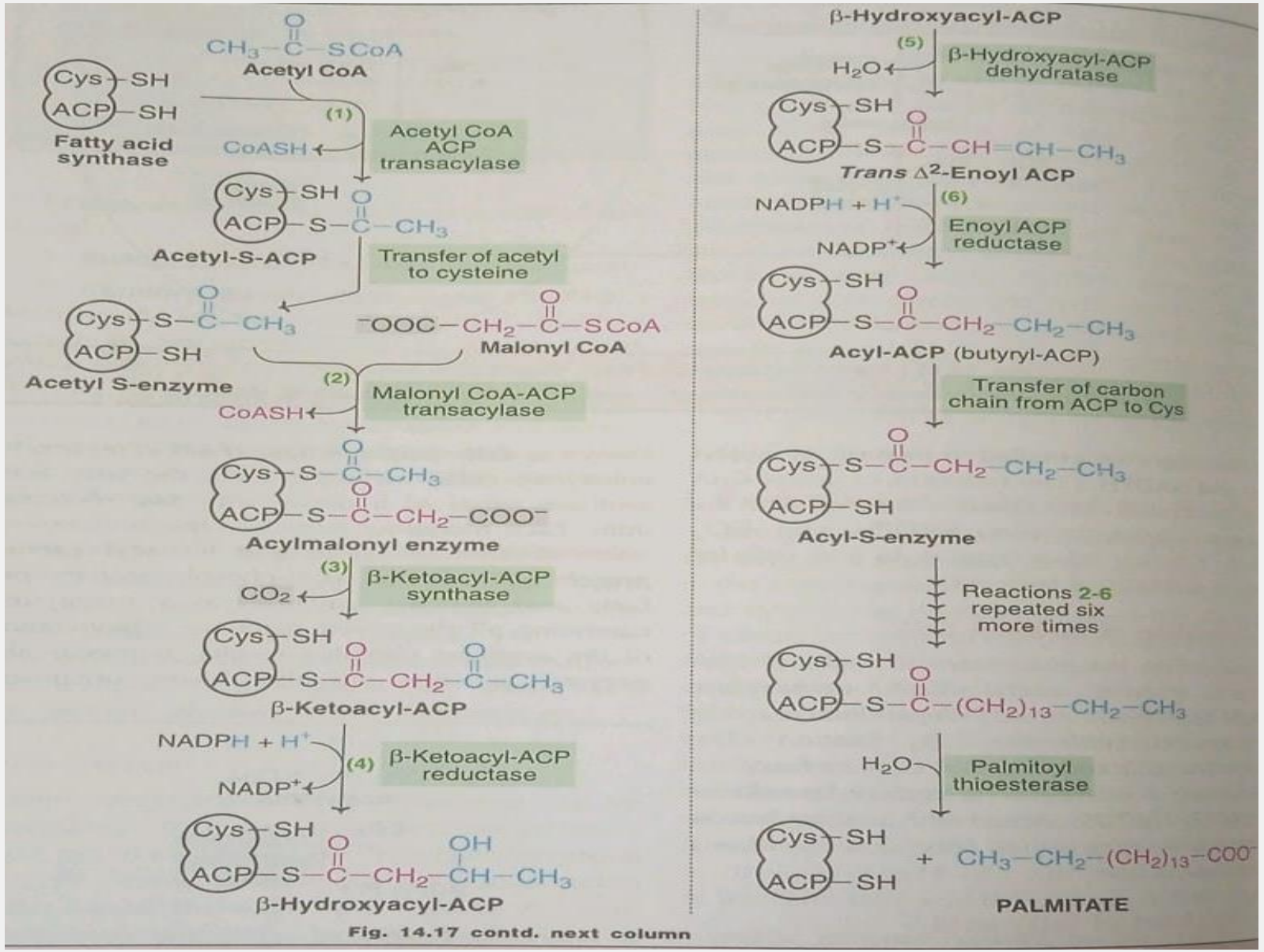
## Production of acetyl CoA and NADPH




## Formation of Malonyl CoA



# Reactions of fatty acid synthase complex(FAS)



# BIOSYNTHESIS OF TRIGLYCERIDES

- Triglycerides also known to be Triacylglycerol (TG), synthesis mostly occurs in liver and adipose tissue, and to a lesser extent in other tissues.
- Fatty acid and glycerol must be activated prior to the synthesis of triacylglycerols, Conversion of fatty acid to acetyl CoA by thiokinase.
- Stages for synthesis of triglycerides are as follows,
  (i) Synthesis of glycerol 3 phosphate
  (ii) Addition of acyl groups to form TG.

## 1. Synthesis of glycerol 3 phosphate

- Two mechanisms are involved for the synthesis of glycerol 3 phosphate.

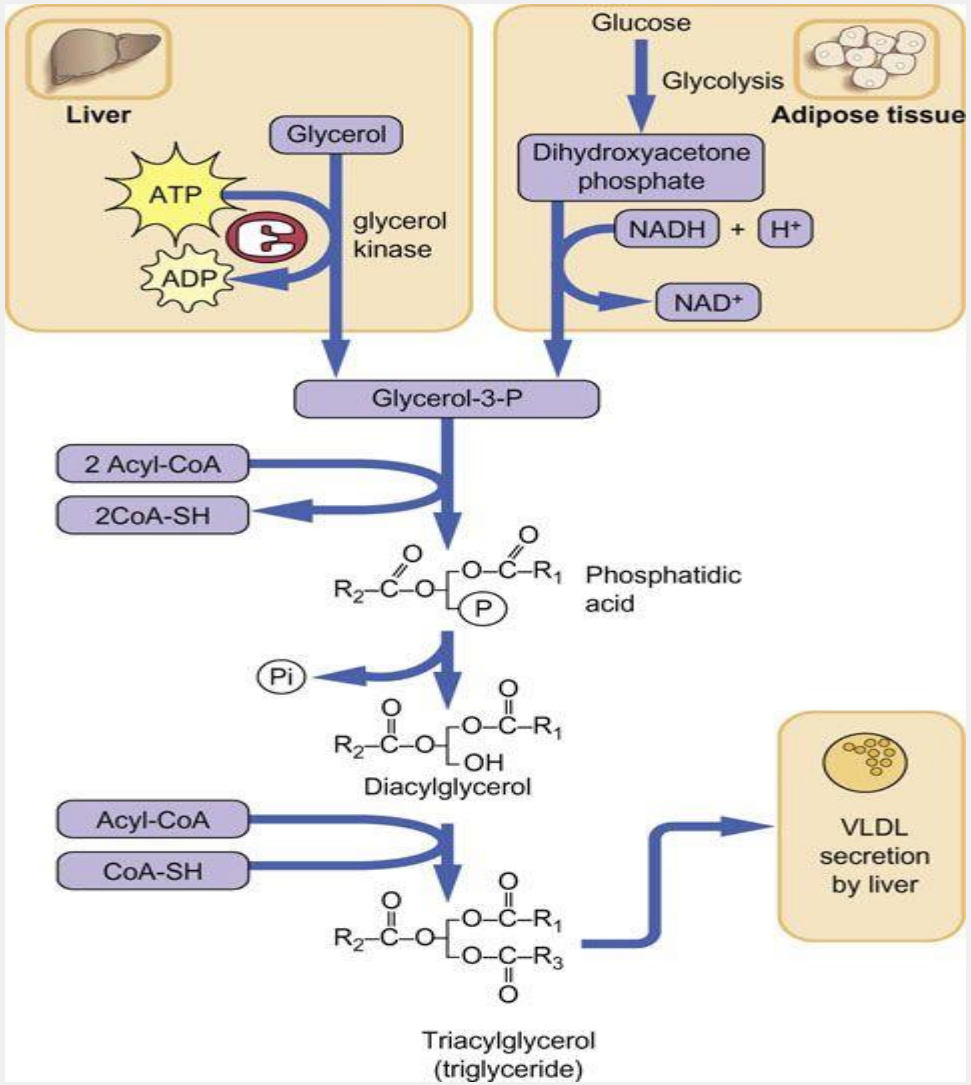
In the liver, glycerol is activated by glycerol kinase. This enzyme is absent in adipose tissues.

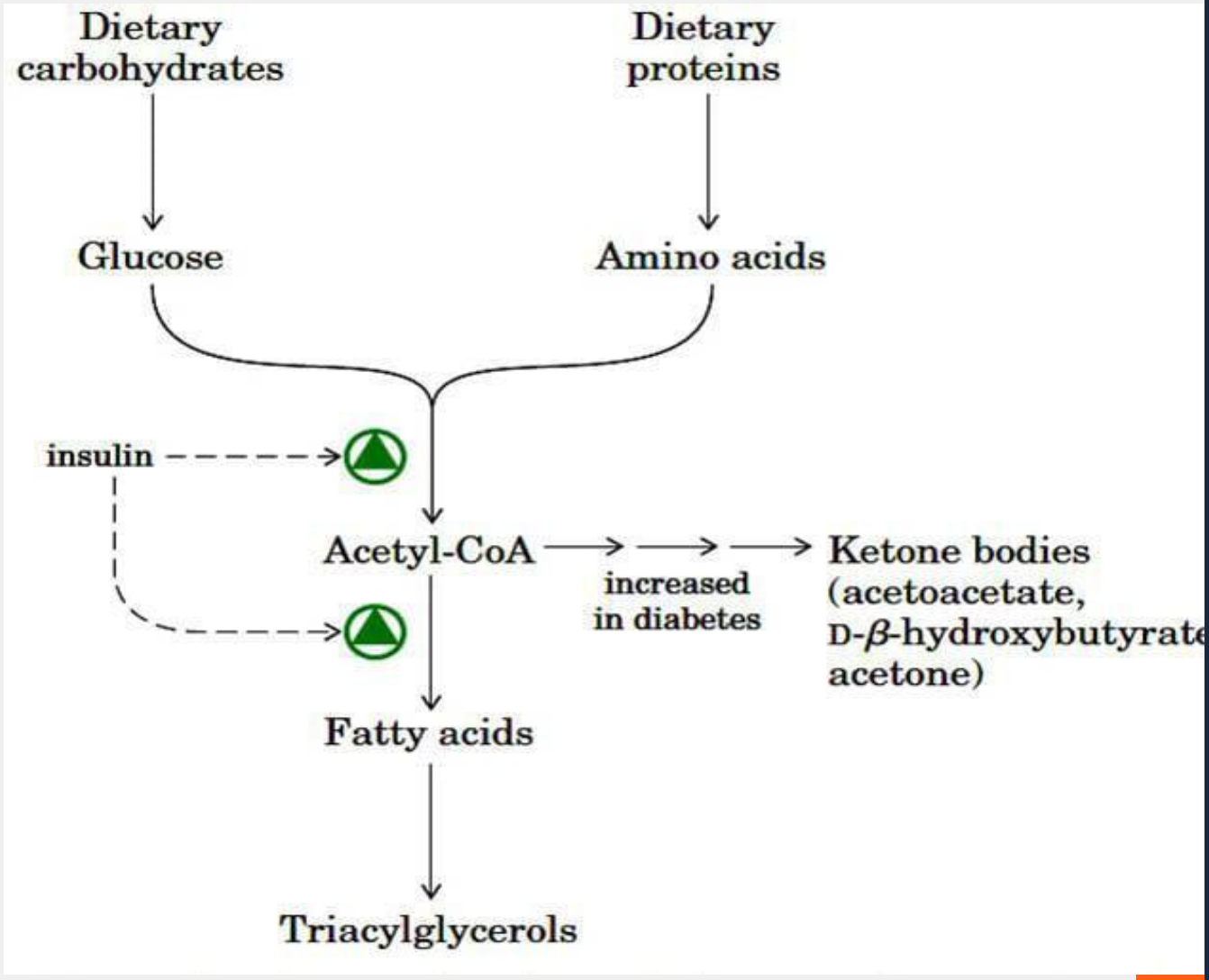
In both liver and adipose tissue, glucose serves as a precursor for glycerol 3-phosphate. Dihydroxyacetone phosphate (DHAP) produced in glycolysis is reduced by glycerol 3 phosphate dehydrogenase to glycerol 3- phosphate.

# 2. Addition of acyl groups to form TG

- Glycerol 3-phosphate acyltransferase calalyses the transfer of an acyl group to produce lysophosphatidic acid.
- DHAP can also accept acyl group, ultimately resulting in the formation of lysophosphatidic acid. Another acyl group is added to lysophosphatidic acid to form phosphatidic acid.
- The enzyme phosphatase cleaves off phosphate of phosphatidic acid to produce diacylglycerol Incorporation of another acyl group finally results in the synthesis of triacylglycerol.
- The three fatty acids found in triacylglycerol are not of the same type. A Saturated fatty acid, is usually present on carbon 1, an unsaturated fatty acid is found on Carbon 2, and Carbon 3 may have either.

# BIOSYNTHESIS OF TRIGLYCERIDES - PATHWAY



# BIOSYNTHESIS OF PHOSPHOLIPIDS

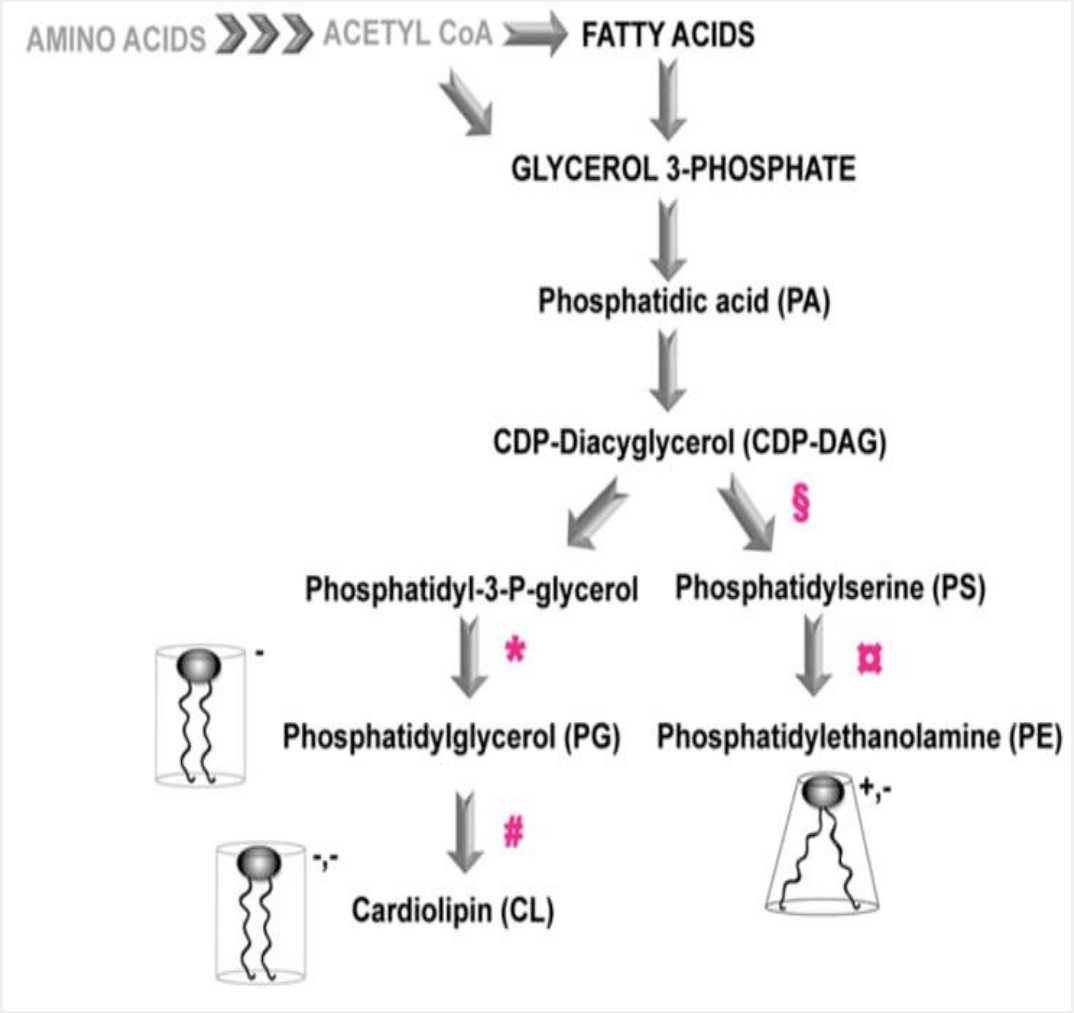
Phospholipids are specialized group of lipids performing a variety of functions. These include a membrane structure and functions involvement in blood clotting and supply of arachidonic acid for the synthesis of prostaglandins. Almost all the cells except RBC can synthesis phospholipids.

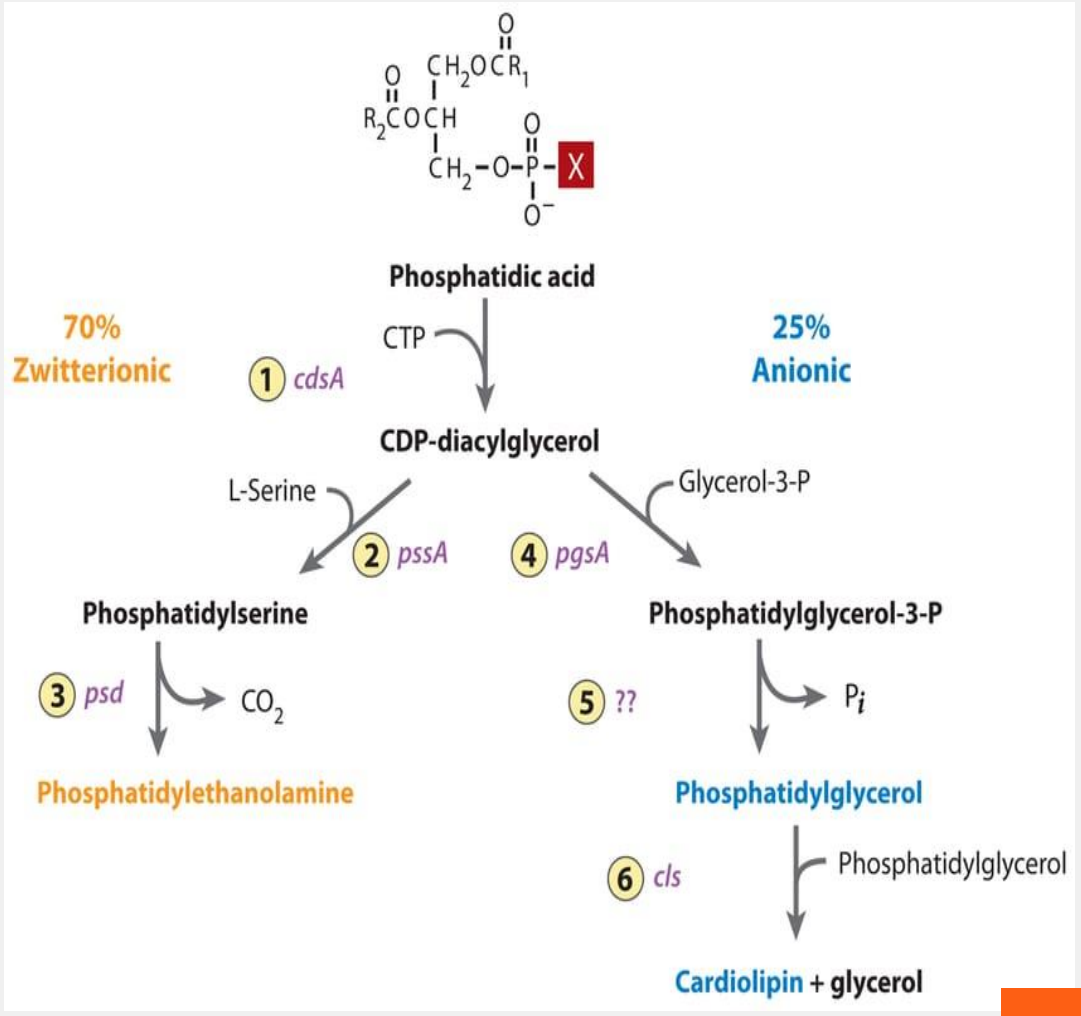
Phospholipids are synthesized from phosphatidic acid and 1,2-diacylglycerol, intermediates in the production of triacylglycerols. Phospholipid synthesis occurs in the smooth endoplasmic reticulum.

- Steps involved in the formation of phospholipids

1. Formation of lecithin and cephalin
2. Synthesis of phosphatidylserine
3. Formation of phosphatidylinositol
4. Synthesis of phosphatidyl glycerol and cardiolipin
5. Formation of plasmalogens
6. Synthesis of sphingomyelins

# BIOSYNTHESIS OF PHOSPHOLIPIDS - PATHWAY



# BIOSYNTHESIS OF CHOLESTEROL

- Cholesterol is found exclusively in animals hence it is often called as animal sterol. The total body content of cholesterol in adult man weighing 70kg is about 140g.
- About 1g of cholesterol is synthesized per day in adults. Almost all the tissues of the body participate in cholesterol biosynthesis The largest contribution is made by liver (50%) intestine (15%) skin, adrenal cortex, reproductive tissues etc.
- The enzymes involved in cholesterol synthesis are found in the cytosol and microsomal fraction of the cell. Acetate of acetyl CoA provides all the carbon atoms in cholesterol.

## STAGES FOR THE SYNTHESIS OF CHOLESTEROL

1. Synthesis of HMG CoA
2. Formation of mevalonate
3. Production of isoprenoid units
4. Synthesis of squalene
5. Conversion of squalene to cholesterol

- In fifth stage for the synthesis of cholesterol, there are four important stages are present and they are as follows,
    1. Reducing the carbon atoms from 30 to 27.
    2. Removal of two methyl groups from C4 and one methyl group from C14.
    3. Shift of double bond from C8 to C5.
    4. Reduction in the double bond present between C24 and C25.

## FUNCTIONS OF CHOLESTEROL

Cholesterol is essential to life, as it performs a number of important functions.

- It is a structural component of cell membrane
- Cholesterol is a precursor for synthesis of all other steroids in the body. These include Steroid hormones.
- Fatty acids are transported to liver as cholesteryl esters for oxidation.

# BIOSYNTHESIS OF CHOLESTEROL - PATHWAY