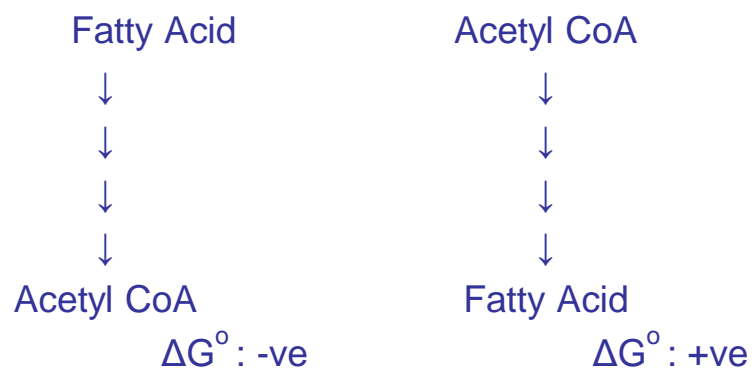


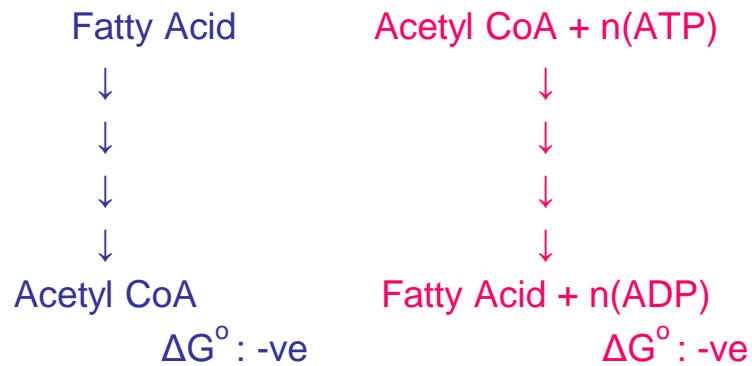
## Fatty Acid Synthesis

- Requires
  - Carbon Source: Acetyl CoA
  - Reducing Power: NADPH
  - Energy Input: ATP

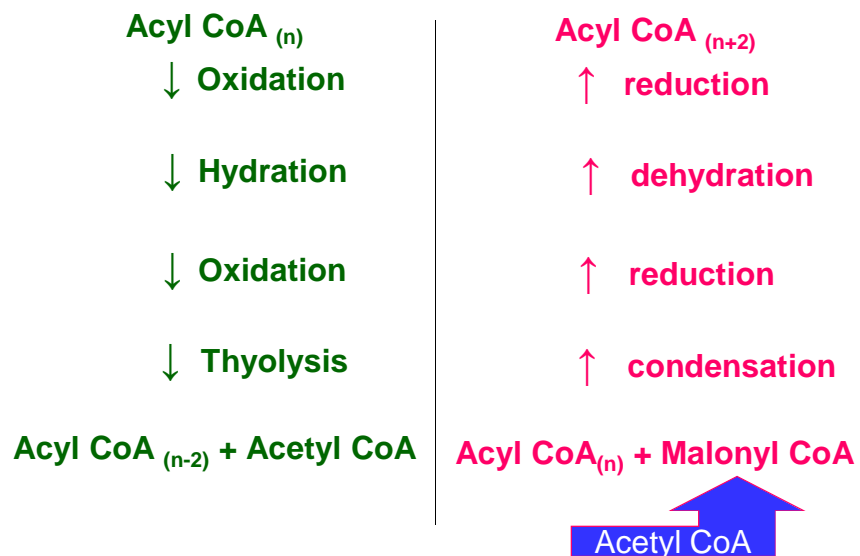
## Why Energy ?



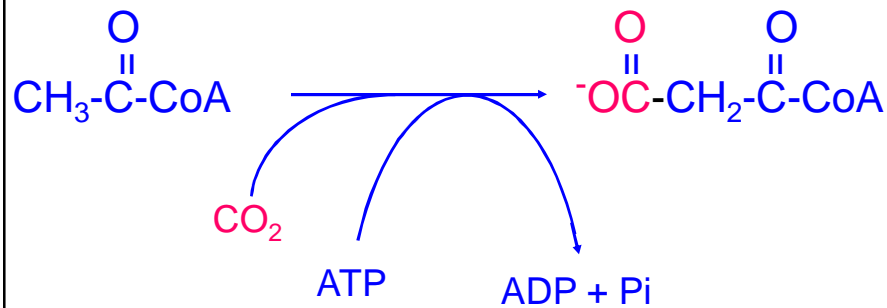
## Why Energy ?



## FA Degradation and Synthesis



## Carboxylation of Acetyl CoA Produces Malonyl CoA

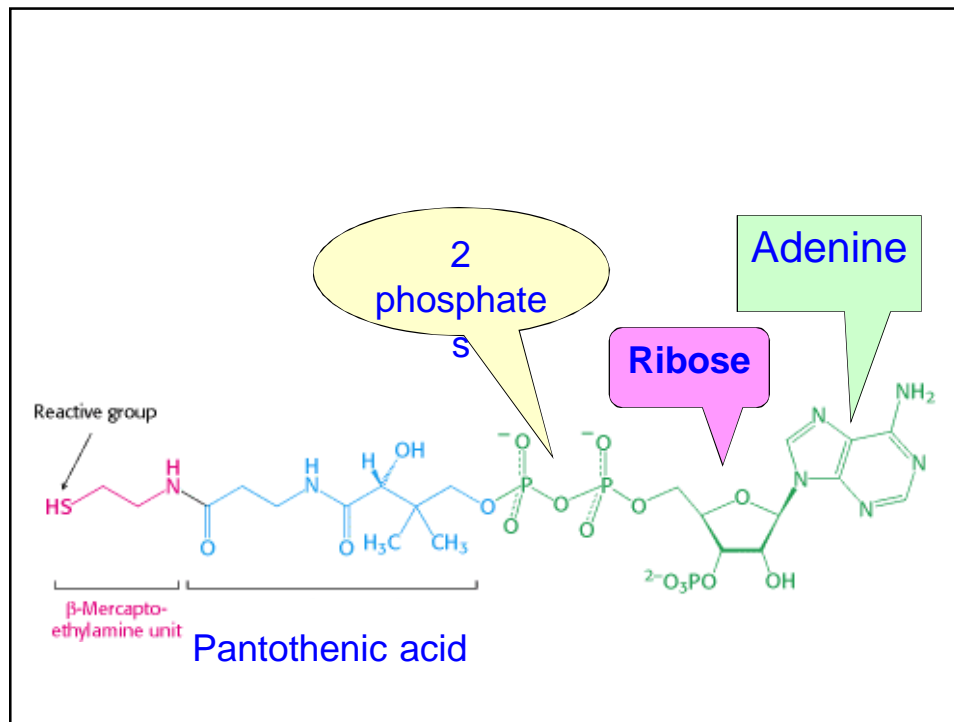


**Acetyl CoA Carboxylase**

Biotin-Containing Enzyme

## Fatty Acid Synthase Catalyzes the remaining steps

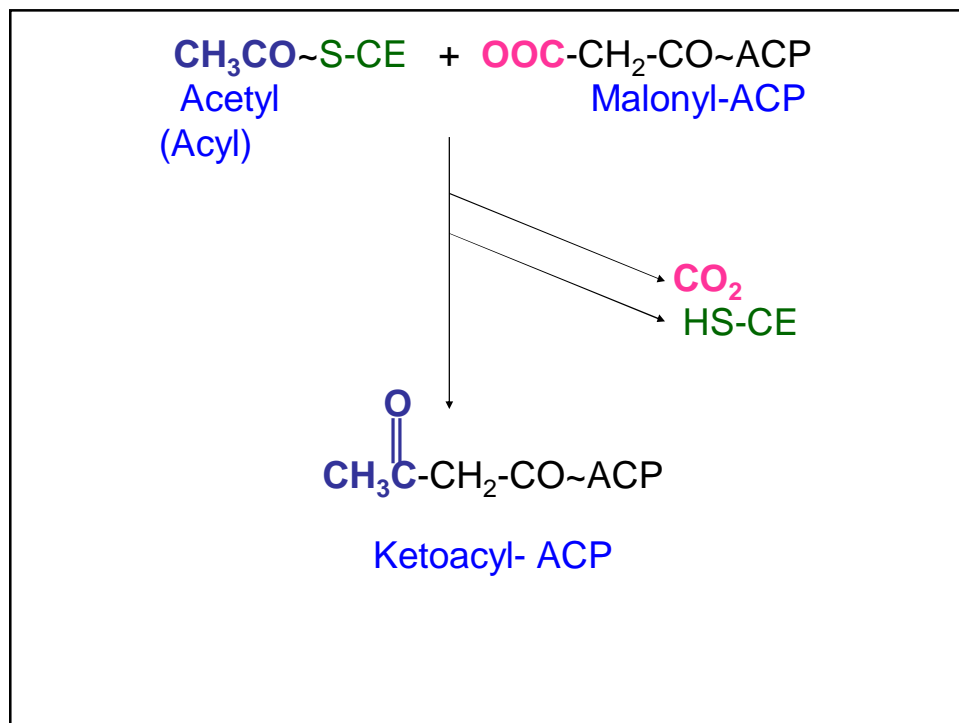
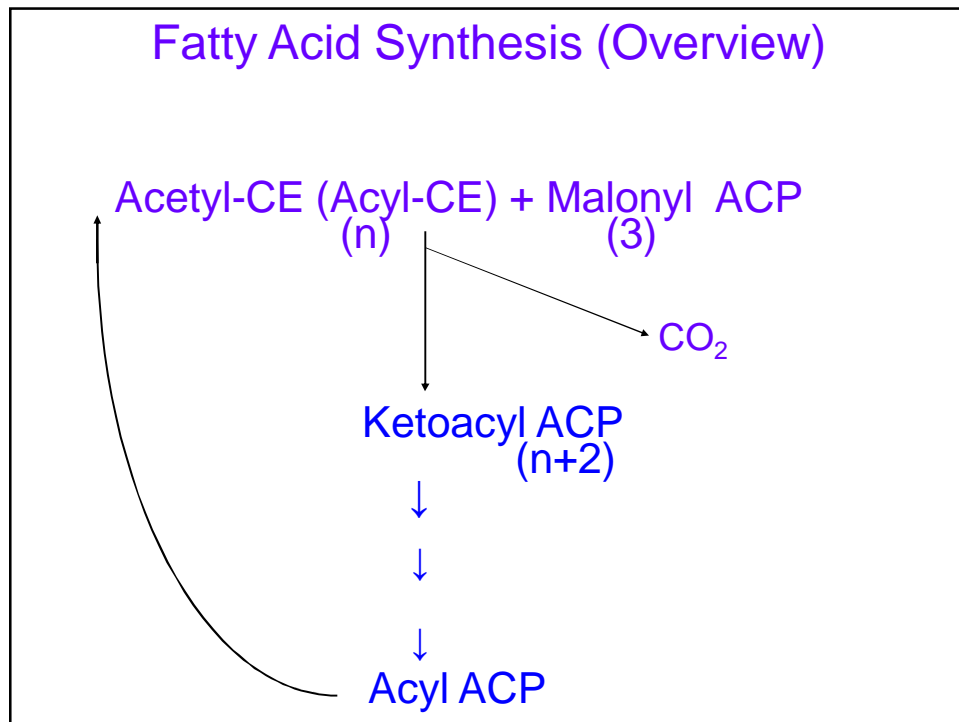
- Multifunctional Enzyme Complex
- Dimer of two Identical Chains
- Each has Seven Catalytic Activities
  - One activity is Condensing Enzyme with  $-\text{SH}$
- One Domain is Linked to Phosphopantetheine
  - With Reactive  $-\text{SH}$

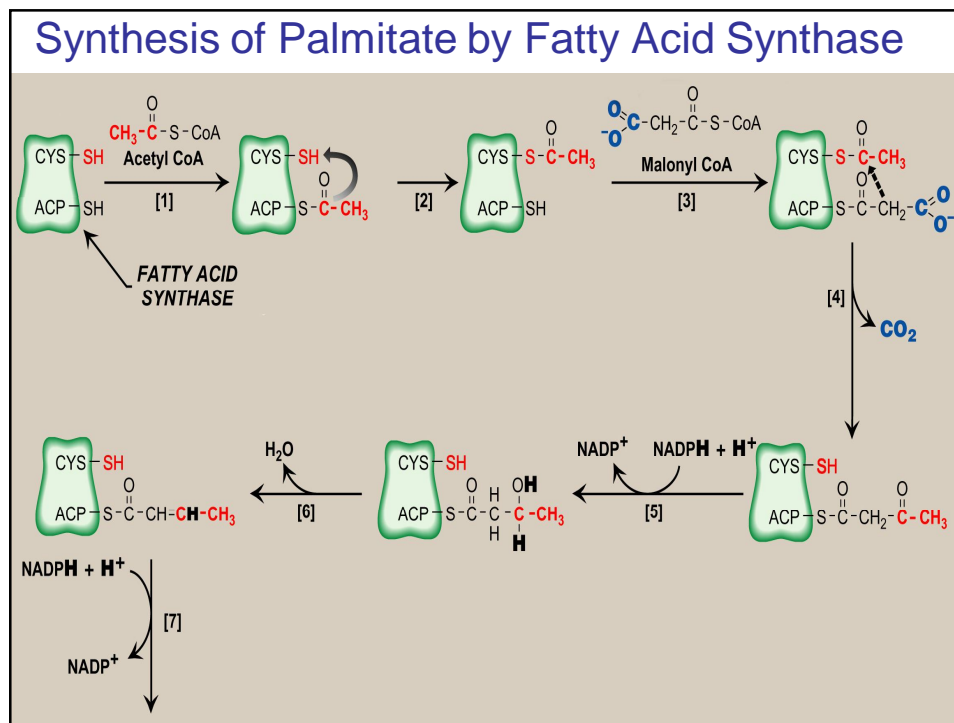
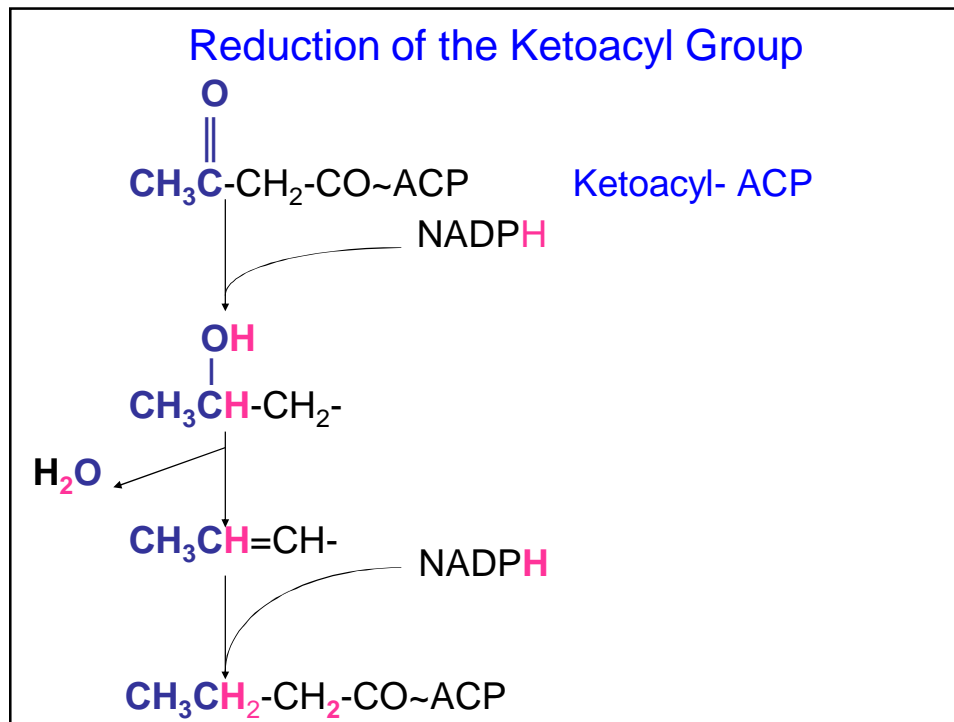


## Fatty Acid Synthase Catalyzes the remaining steps

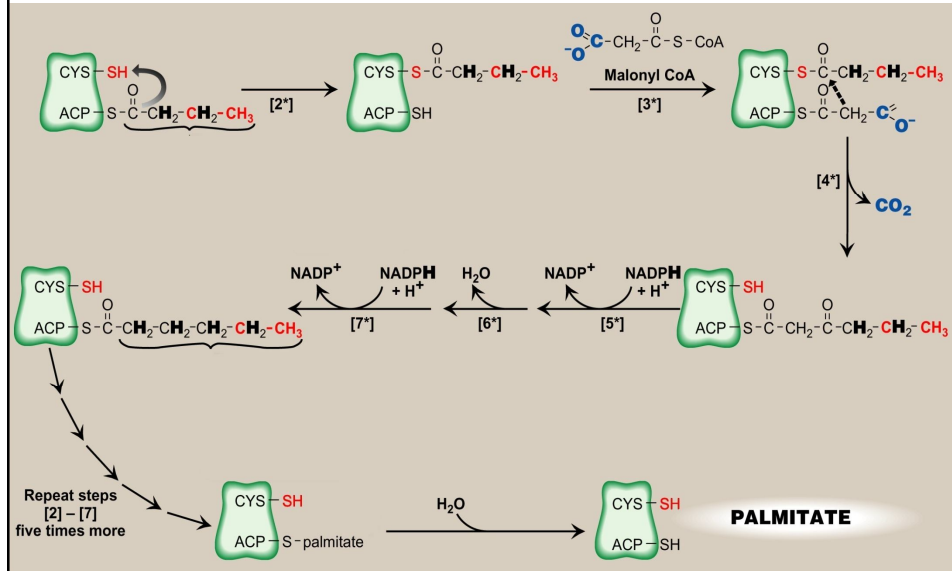
- **Multifunctional Enzyme Complex**
- **Dimer of two Identical Chains**
- **Each has Seven Catalytic Activities**
  - One activity is Condensing Enzyme with  $\text{-SH}$
- **One Domain is Linked to Phosphopantetheine**
  - With Reactive  $\text{-SH}$
  - Carries Intermediates during Catalysis
  - (Acyl, Acetyl and Malonyl Groups)
  - Known as **Acyl Carrier Protein (ACP)**

## Fatty Acid Synthesis (Overview)





## Synthesis of Palmitate by Fatty Acid Synthase (Cont.)



## Synthesis of Palmitate (net reaction)

How many cycles of synthesis (Condensation)?

\* 7

How many Malonyl CoA?

\* 7

How many Acetyl CoA?

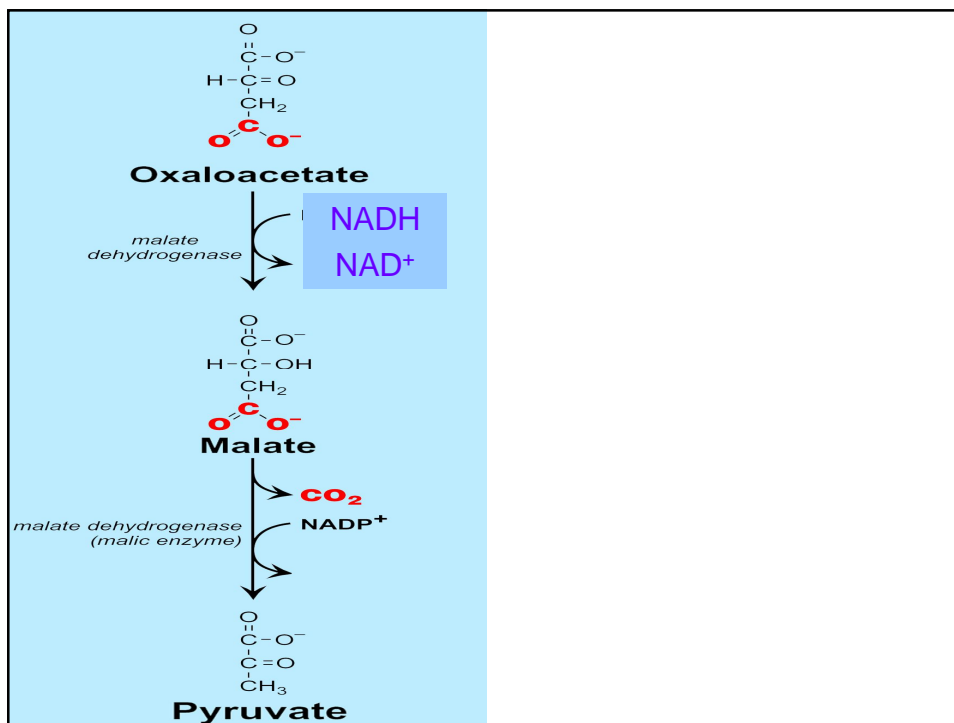
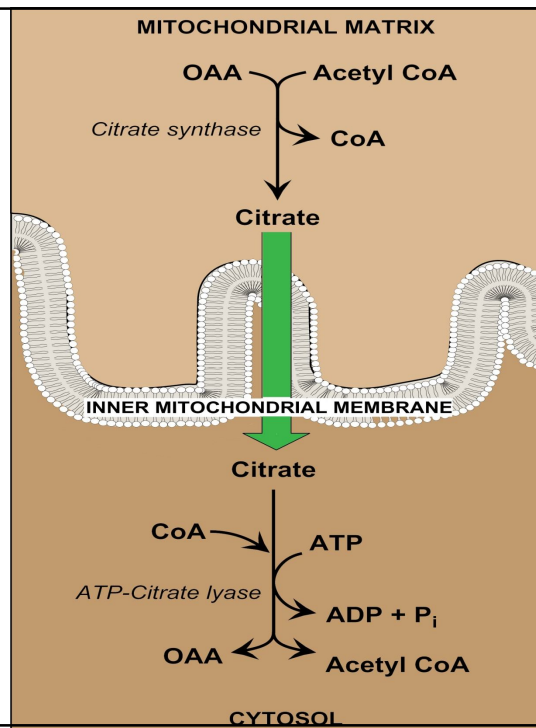
\* 1

How Many NADPH?

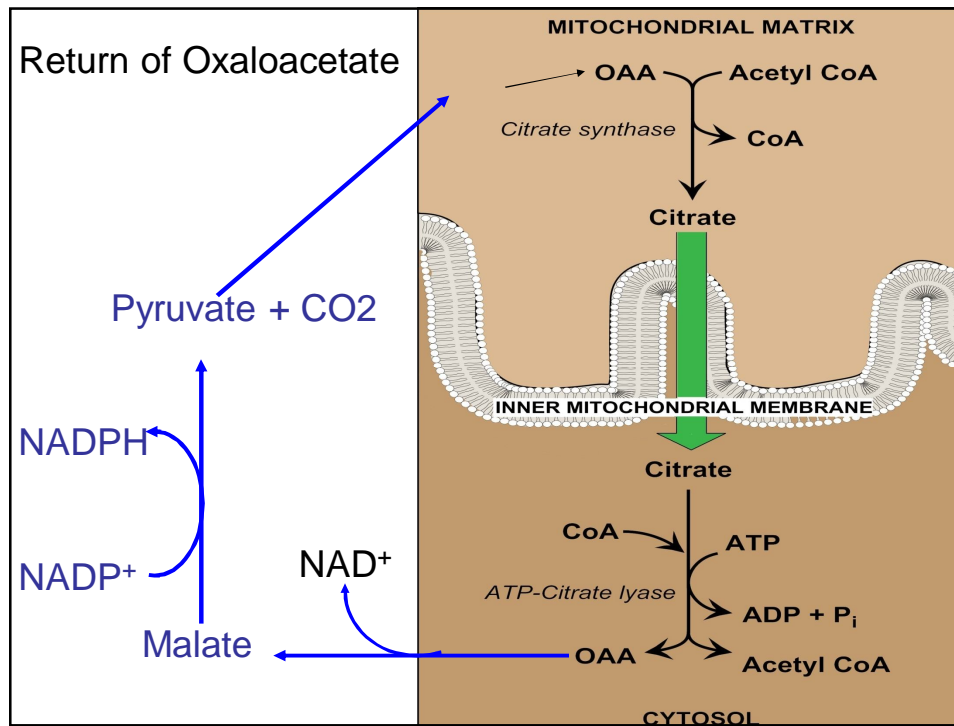
\* 14

## Production of Cytosolic Acetyl CoA for FA Synthesis

Inner mitochondrial membrane is impermeable to Acetyl CoA







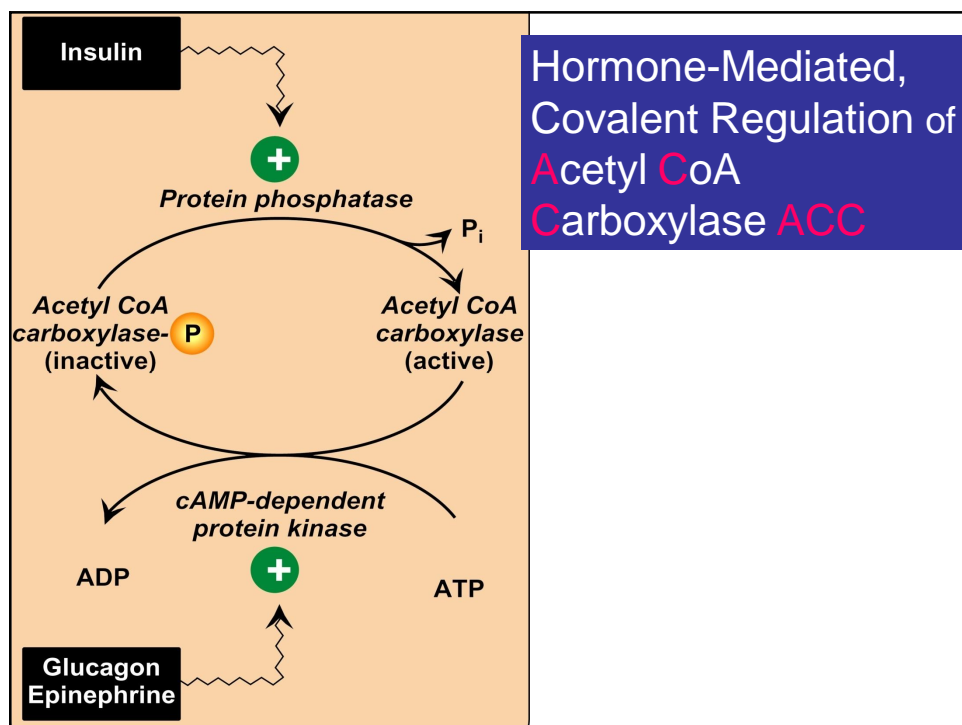
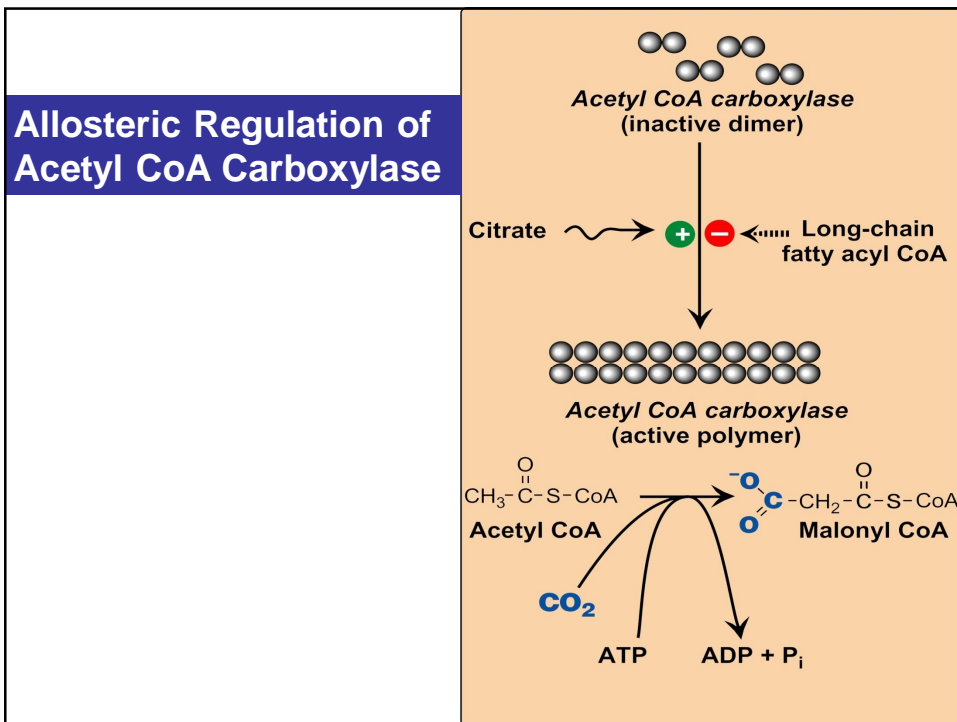
## Regulation of FA Oxidation & Synthesis

### OXIDATION

- Supply of Fatty Acids
  - Hormonal Control
- Entry into Mitochondria
- Availability of NAD<sup>+</sup>

### SYNTHESIS

- Regulation of AcCoA Carboxylase
  - Allosteric Mechanism
  - Phosphorylation
- Amounts of Enzymes



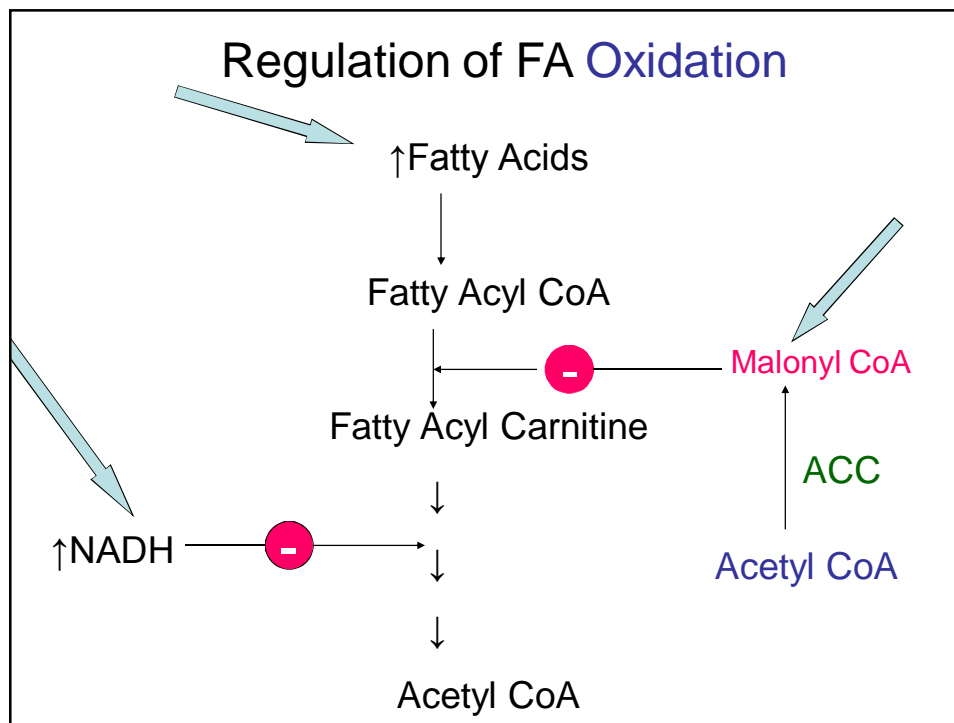
## Regulation of FA Oxidation & Synthesis

### OXIDATION

- Supply of Fatty Acids  
-Hormonal Control
- Entry into Mitochondria
- Availability of  $\text{NAD}^+$

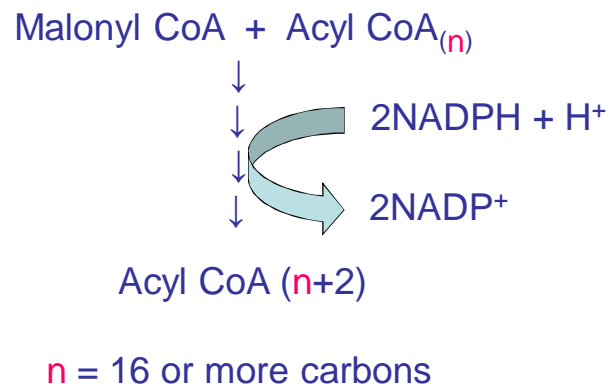
### SYNTHESIS

- Regulation of AcCoA Carboxylase  
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- Amounts of Enzymes

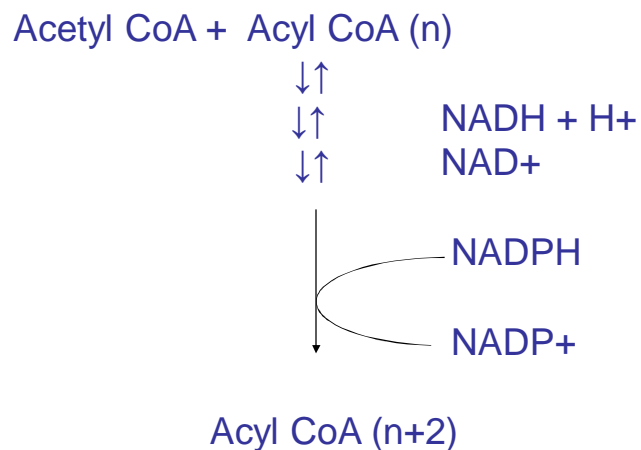


### Elongation of Fatty Acids

- in Endoplasmic Reticulum
- Similar Sequence of Reactions
- Different Enzymes



### Elongation of Fatty Acids in Mitochondria



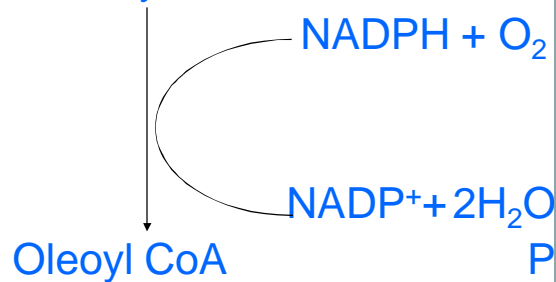
$n = \text{less than } 16 \text{ carbons}$

## Introduction of Double Bonds

- Synthesis of Monounsaturated FA
  - Oleic Acid 18: $\Delta^9$
  - Palmitoleic 16: $\Delta^9$
- In endoplasmic reticulum
- No double bond can be introduced beyond carbon 9 in human

## Introduction of Double Bonds (Cont.)

Stearoyl CoA



$\Delta^9$  Desaturase; Cytochrome  $b_5$

## Introduction of Double Bonds (Cont.)

### Formation and Modification of Polyunsaturated FA

-Elongation

- Desaturation

Additional double bonds can be introduced by:

$\Delta^4$  Desaturase

$\Delta^5$  Desaturase

$\Delta^6$  Desaturase

### Modification of Polyunsaturated FA

Linoleic 18:2 $\Delta^{9,12}$



Desaturation

18:3 $\Delta^{6,9,12}$

$\omega$  ?



Elongation

20:3 $\Delta^{8,11,14}$

$\omega$  ?



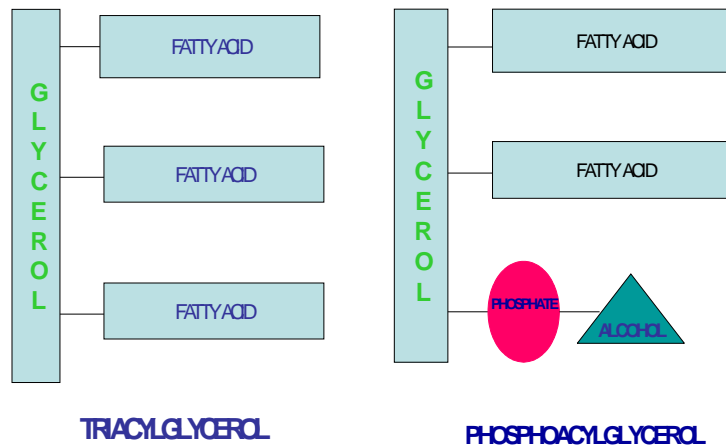
Desaturation

20:4 $\Delta^{5,8,11,14}$

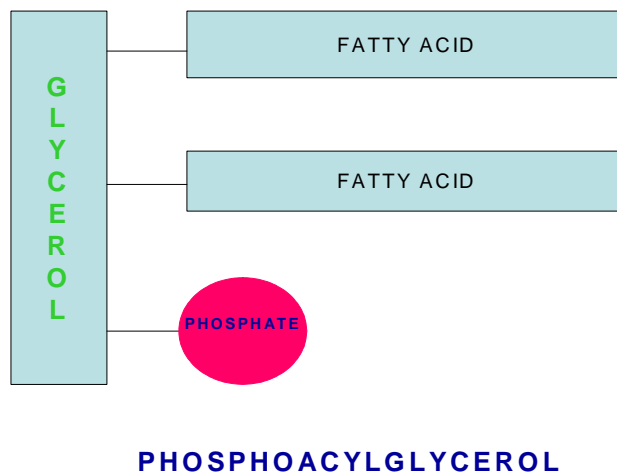
$\omega$  ?

Arachidonic

## Biosynthesis of Triacylglycerol & Phosphoacylglycerol



## Phosphotadic Acid is Common Intermediate

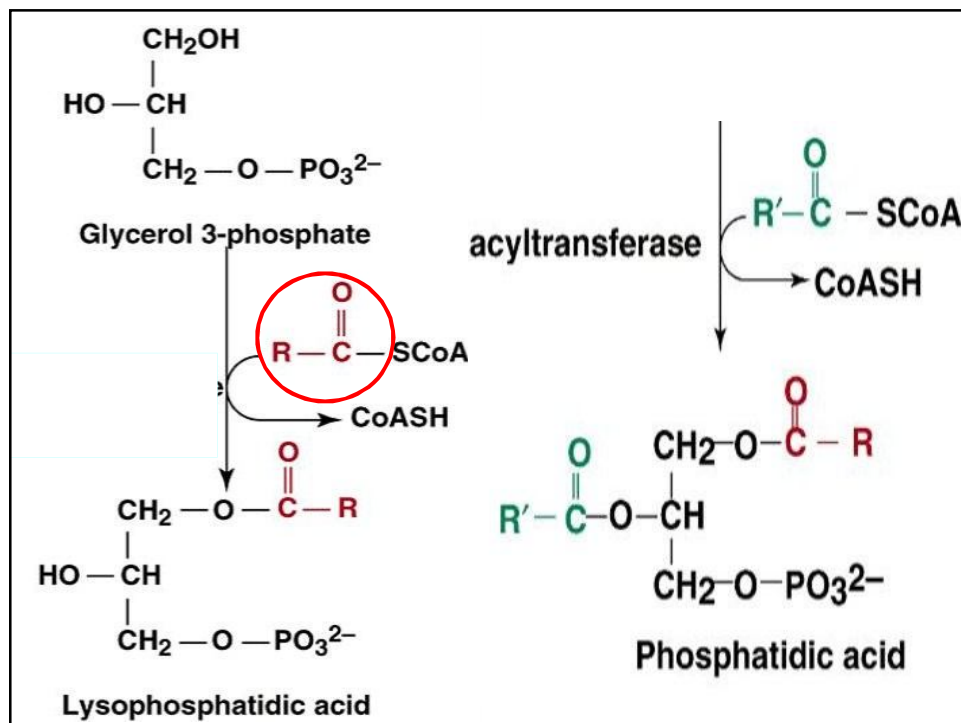
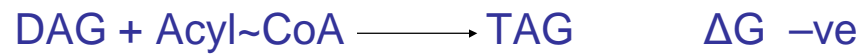
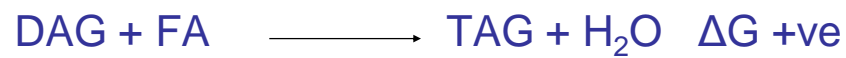
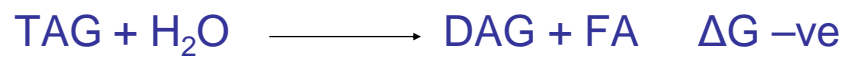


## Biosynthesis of Triacylglycerol

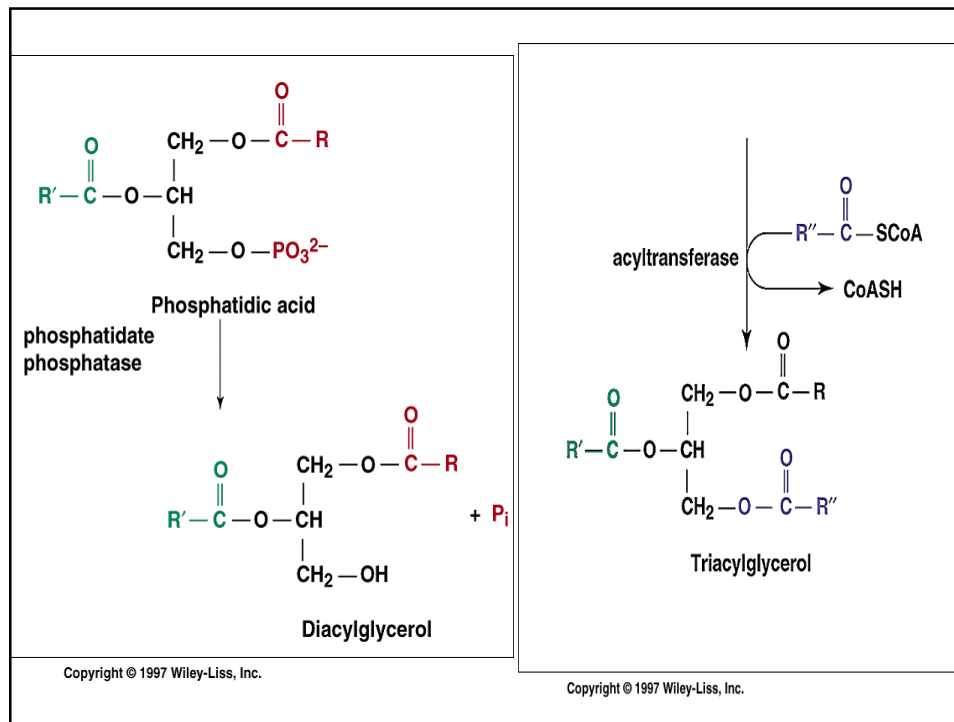
Requires

- Acyl~CoA (Active form of FA)
- Glycerol Phosphate

Why Active form?

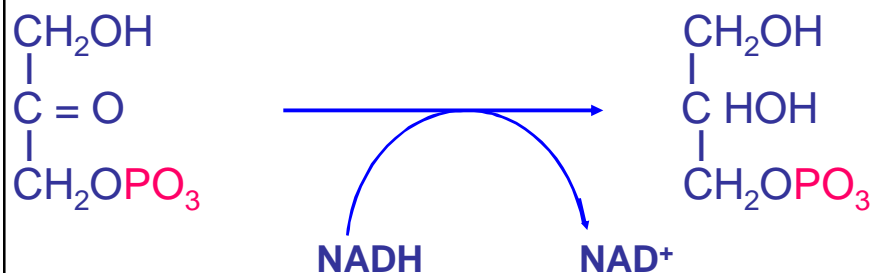






## Production of Glycerol Phosphate

- Glycerol + ATP  $\longrightarrow$  Glycerol 3 Phosphate
- Enz: Glycerol Kinase
- Not in Adipose tissue



## Production of Glycerol Phosphate

