

# Lipid Degradation

1

## Lipid Catabolism

### **OUTLINE:**

Fat Catabolism

diet

storage

Fatty acid Catabolism

mobilization

Activation

Transport

Oxidation

Saturated FA

$\beta$ -oxidation

energetics

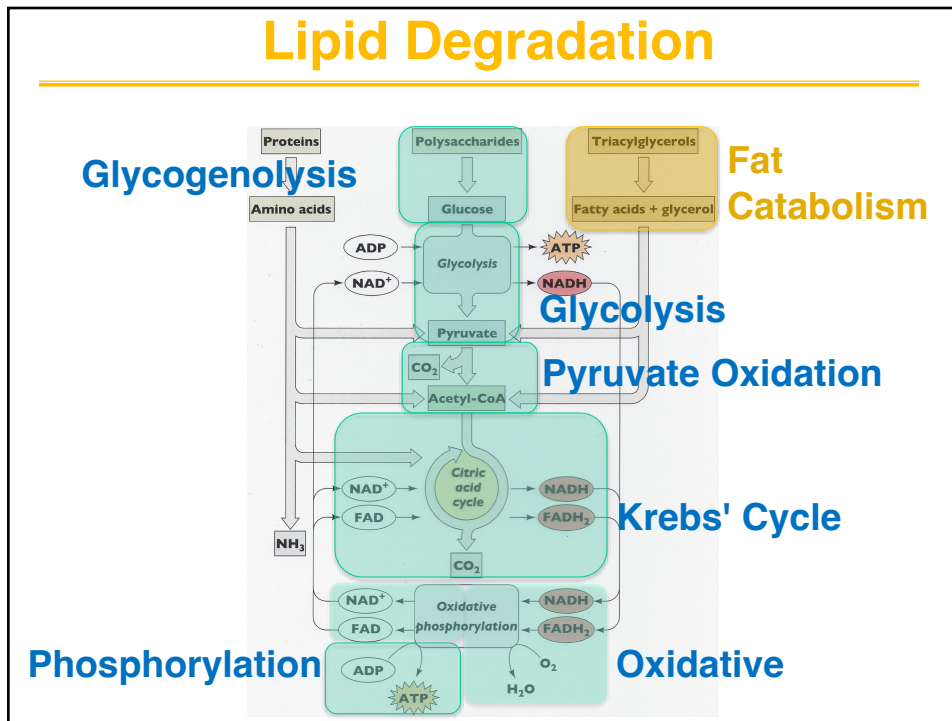
Unsaturated FA

Odd-chain FA

Ketone Bodies

2

## Lipid Degradation



3

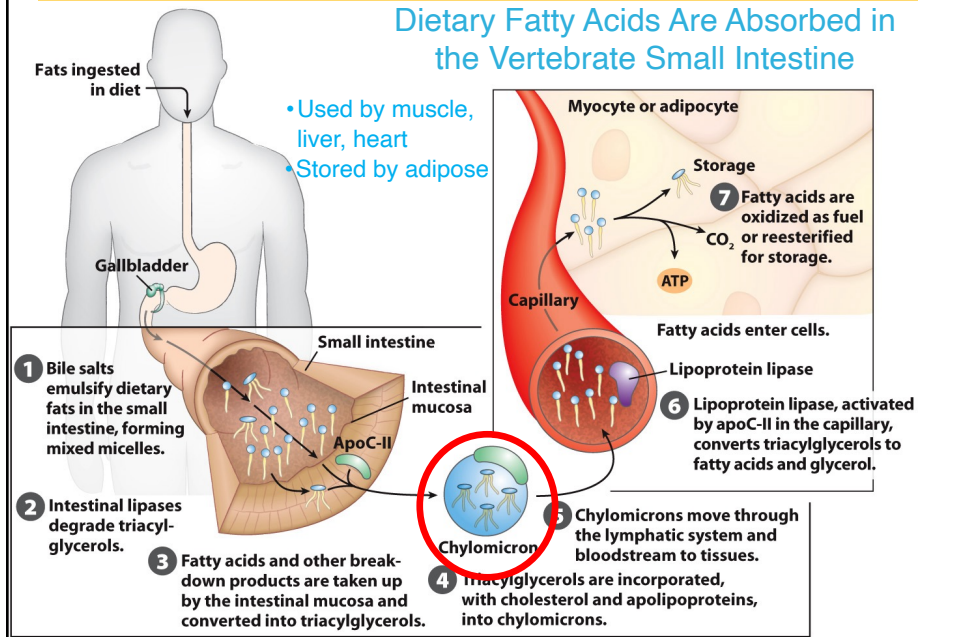
## Fat Catabolism

- Fat as a fuel; ingestion of the “chunks”
- How fats are mobilized and transported in animal tissues
- COMPARTMENTATION
  - How fats are oxidized in mitochondria
    - Glycerol
    - Saturated Fatty Acids
    - Un-saturated Fatty Acids
    - Odd-chain Fatty Acids
  - Blocks to oxidation in mitochondria: How “ketone bodies” are utilized
  - Fatty-acid metabolism in other organelles

4

# Fat Catabolism

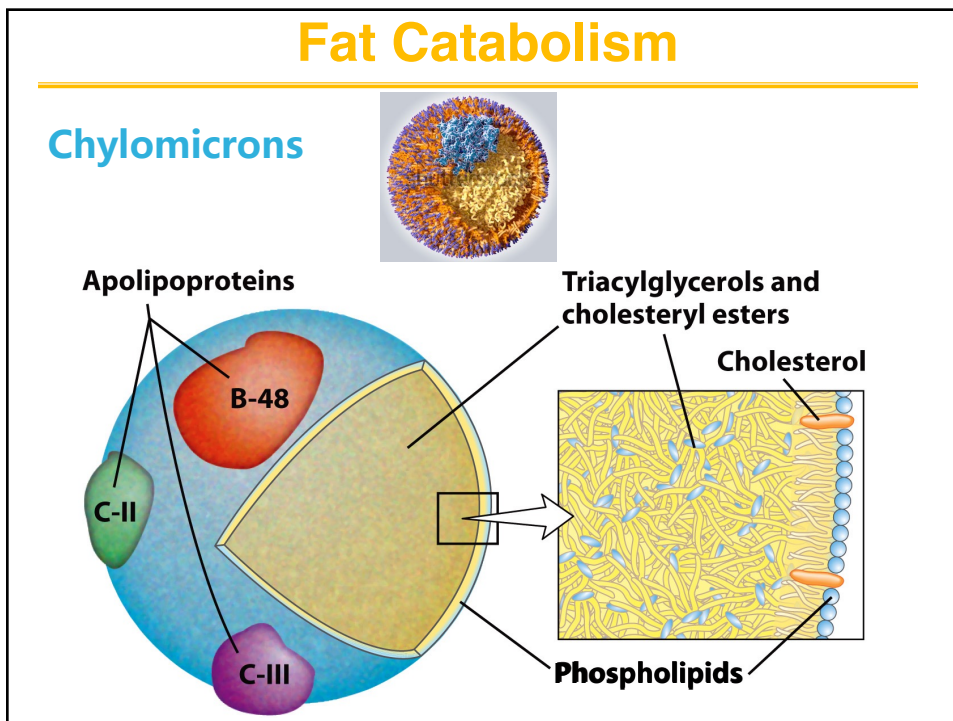
## Dietary Fatty Acids Are Absorbed in the Vertebrate Small Intestine



5

# Fat Catabolism

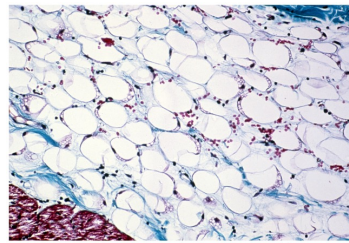
## Chylomicrons



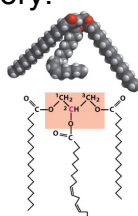
6

## Fat Catabolism

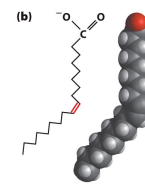
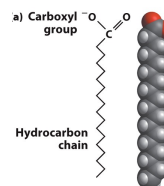
- Fuel Storage of Fat is efficient
- The advantage of fats over polysaccharides:
  - Fatty acids carry more energy per carbon because they are more reduced.
  - Fatty acids complex or carry less water because they are nonpolar.
- Glucose and glycogen are for short-term energy needs and quick delivery.
- Fats are for long-term (months) energy needs, storage, and have slow delivery.



125 μm



1-Stearoyl, 2-linoleoyl, 3-palmitoyl glycerol, a mixed triacylglycerol



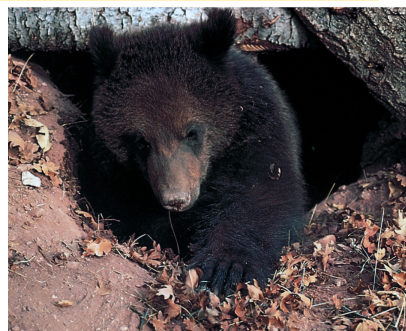
Fatty acids come in all types: ± double bonds, long & short, odd & even, etc.

- How are fat stores accessed?

7

## Lipid Degradation: Fatty Acids

- Fatty Acid Oxidation is a Major Energy Source
- About one-third of human energy needs comes from dietary triacylglycerols (fat).
- There are differences in tissue utilization. About 80% of energy needs of mammalian heart and liver are met by oxidation of fatty acids.
- Many hibernating animals, such as grizzly bears, rely almost exclusively on fats as their source of energy.



There are FOUR stages in the catabolism of fatty acids:

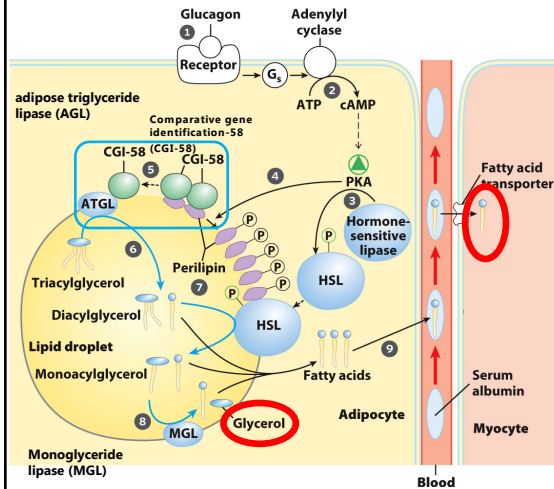
- 1) Mobilization from tissues (mostly adipose)
- 2) Activation of fatty acids
- 3) Transport
- 4) Oxidation

8

# Fatty Acid Degradation Mobilization

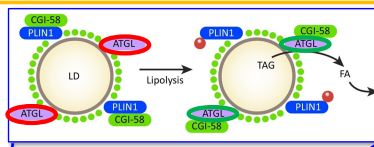


- Stored **Triacylglycerides** are released in response to Hormone signals
- Hormones trigger a mobilization “cascade” that activates **lipases**
- Lipases are activated by hormones glucagon and epinephrine. ①
- In the case of glucagon, Protein Kinase A (**PKA**) is activated, ②③④ which leads to the progressive activation of 3 lipases, one for each position on glycerol (ATGL, HSL, & MGL). ③⑥⑧
- **Fats are degraded** into fatty acids and glycerol in the **cytoplasm** of adipocytes. ③
- Fatty acids are transported to ⑨ other tissues through the blood.

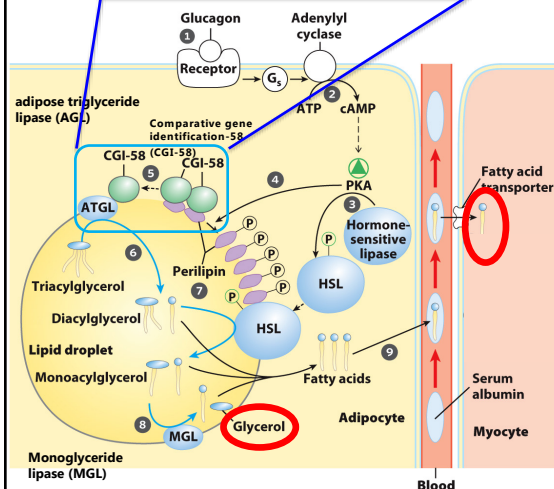


10

# Fatty Acid Degradation Mobilization



- Stored **Triacylglycerides** are released in response to Hormone signals
- Hormones trigger a mobilization “cascade” that activates **lipases**
- Lipases are activated by hormones glucagon and epinephrine. ①
- In the case of glucagon, Protein Kinase A (**PKA**) is activated, ②③④ which leads to the progressive activation of 3 lipases, one for each position on glycerol (ATGL, HSL, & MGL). ③⑥⑧
- **Fats are degraded** into fatty acids and glycerol in the **cytoplasm** of adipocytes. ③
- Fatty acids are transported to ⑨ other tissues through the blood.



11

## Fatty Acid Degradation

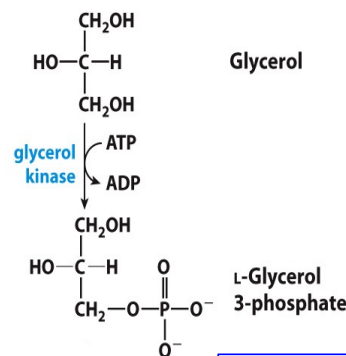
There are FOUR stages in the catabolism of fatty acids:

- 1) Mobilization from tissues (mostly adipose)
- 2) Activation of fatty acids
- 3) Transport
- 4) Oxidation

12

## Fatty Acid Degradation

- Glycerol is a sugar alcohol and is converted to a glycolytic intermediate
- **Glycerol kinase** activates glycerol at the expense of ATP.
- Subsequent reactions recover more than enough ATP to cover this cost.
- Allows limited **anaerobic catabolism** of fats
- A redox reaction is required to convert the alcohol to a ketone. Done by **glycerol-3-phosphate dehydrogenase**
- We'll see this reaction again in lipid synthesis



Same cytosolic enzyme as used by the Glycerol-3-Phosphate Shuttle

13