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## *Lipids*

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Benjamin Caballero, MD, PhD  
Johns Hopkins University



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## *Section A*

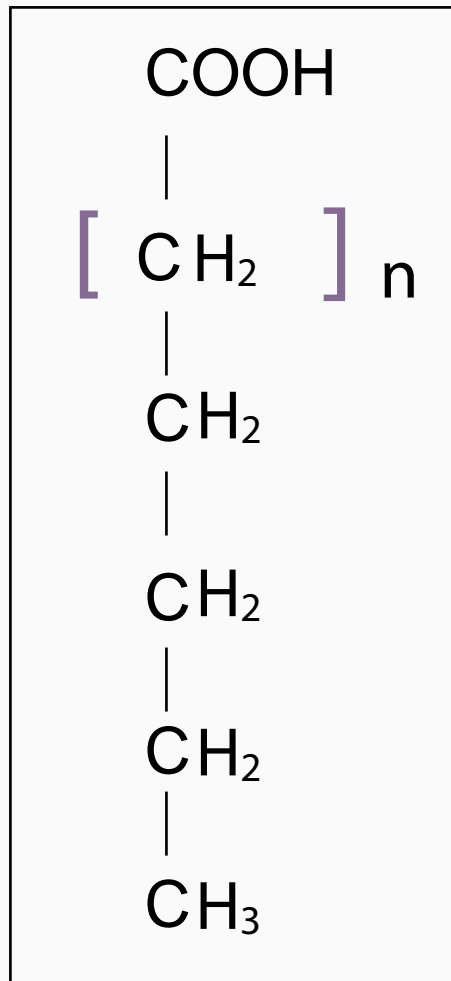
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Definitions

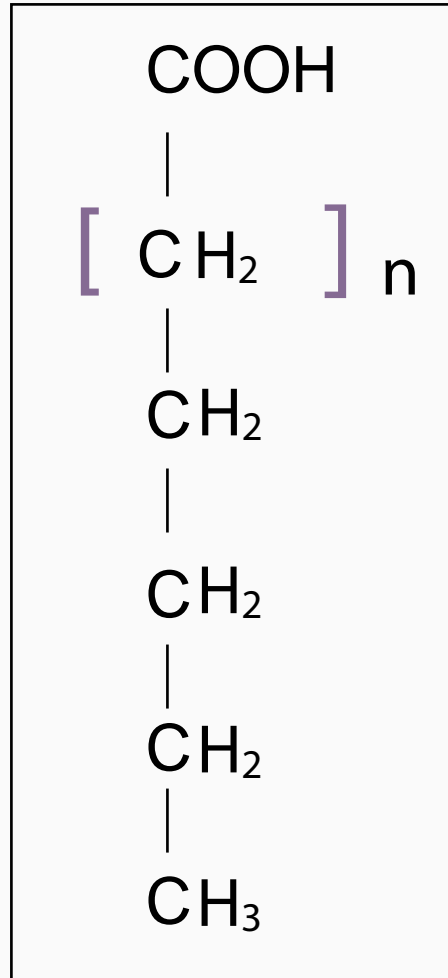
## Some Definitions

- *Lipids* —Generic name, may include lipoproteins, phospholipids, etc.
- *Fats* —Also a generic name, but applied mostly to fats that are solid at room temperature
- *Oils*—Liquid at room temperature
- *Fatty Acids*—Basic building blocks for fats
- *Triglycerides*—Esters of fatty acids with glycerol (may also be mono- or di-glyceride)

# Fatty Acids



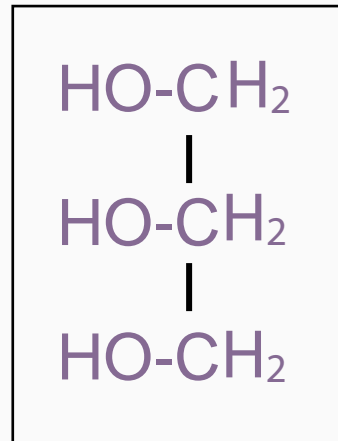
# Fatty Acids



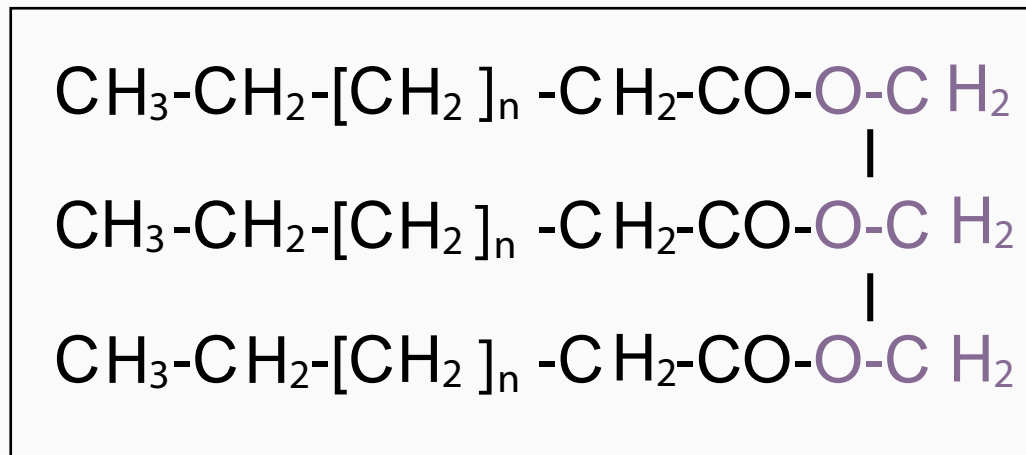
*Carboxyl end*  
 *$\Delta$  numbering system*

*Methyl end*  
 *$n$  ( $\omega$ ) numbering system*

# Glycerides



*Glycerol*

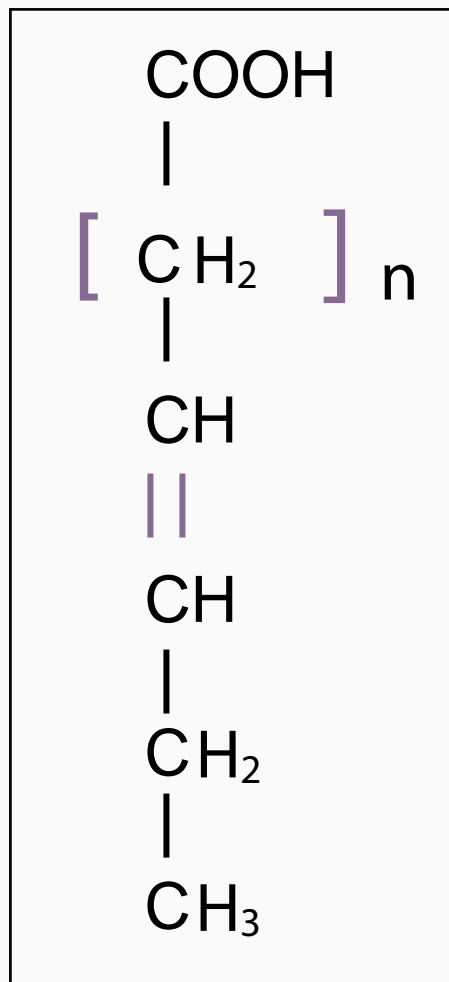


*Triglyceride*

- **Phospholipids**
  - Phosphatidylcholine
  - Phosphatidylethanolamine
- **Sphingolipids, glycolipids**
- **Sterols**
  - Sex hormones
  - Cholesterol
  - Bile acids

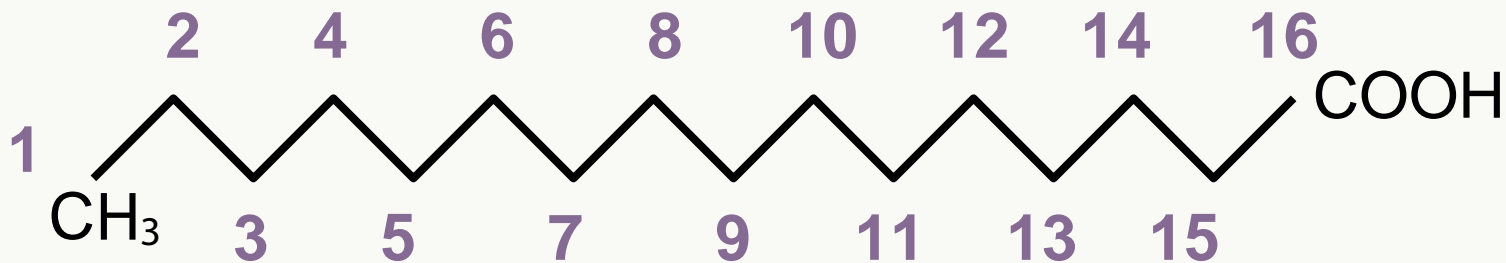


# Unsaturated Fatty Acids

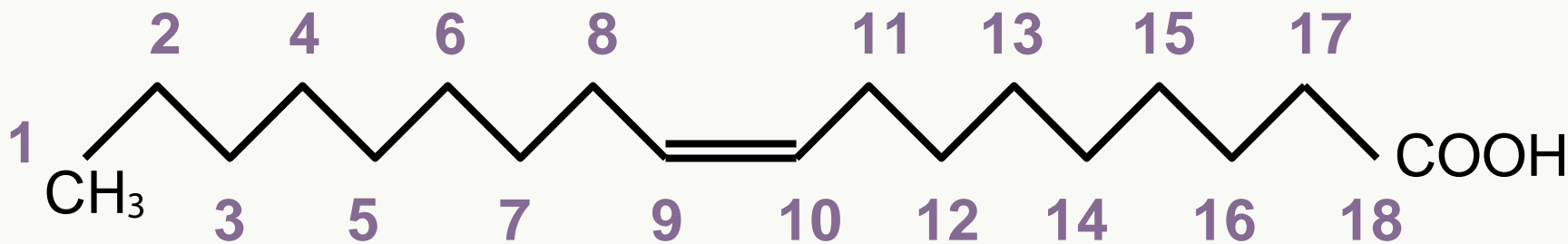


*Methyl end  
n ( ω ) numbering system*

# Structural Notation



*Palmitic acid, 16:0*



*Oleic acid, 18:1, n-9*

# *Functions*

- Energy storage, mobilization, and utilization
- Prostaglandin, cytokine synthesis
- Cell differentiation and growth
- Cell membrane structure, myelination
- Signal transmission
- Hormone synthesis
- Bile acid synthesis

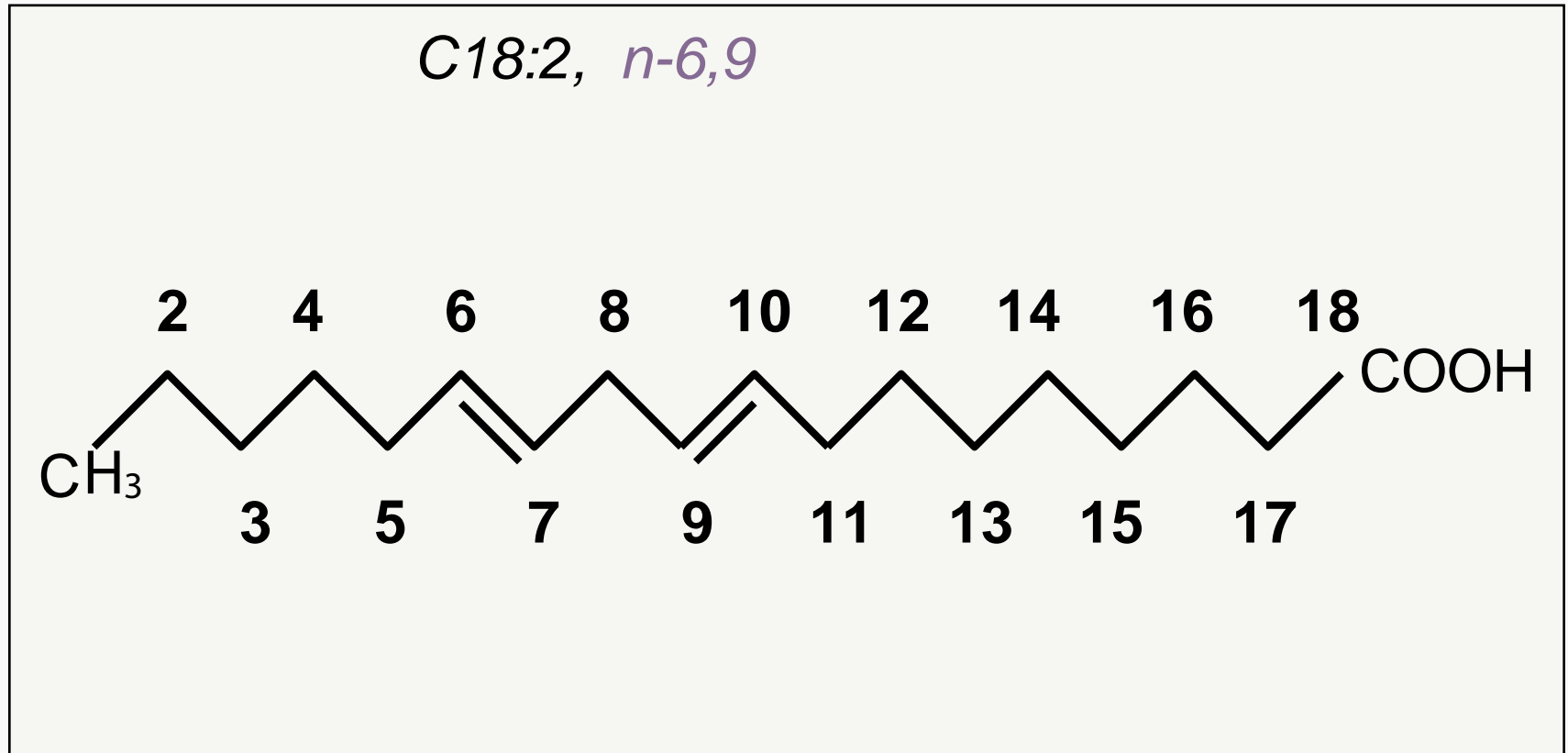
# *Essential Fatty Acids*

- Humans cannot synthesize double bonds within the last nine carbons of the methyl end (n) of any fatty acid chain
- Fatty acids with double bonds in those locations must therefore come from the diet—and are considered essential
- Thus, EFA are (poly)unsaturated
  - There are no essential saturated fats

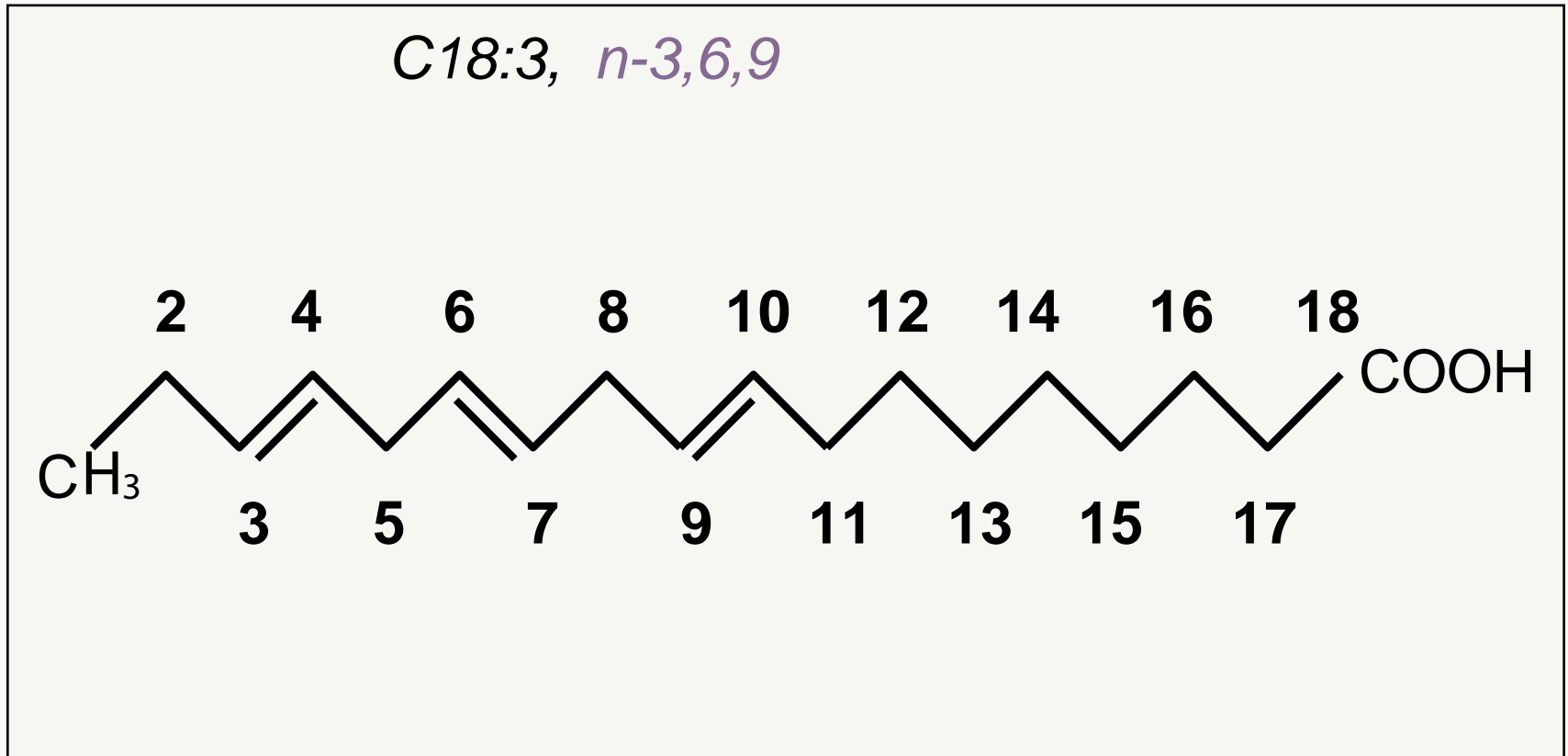
# *Essential Fatty Acids*

- Only two fatty acids are essential:
  - Linoleic and alpha-linolenic acids (ALA)
- Both are (poly)unsaturated
- Therefore, absolute requirements for fat in the diet applies only to unsaturated fat

# Linoleic Acid: Cottonseed, Sunflower, Soybean, Corn



# Alpha-Linolenic Acid: Soybean, Mustard, Linseed, Walnut



# Each EFA Heads a Powerful Family

- **18:3, n-3 (ALA)**



- 20:5, n-3

- Eicosapentaenoic (EPA)



- 22:5, n-3

- Docosapentaenoic (DPA)



- 22:6, n-3

- Docosahexaenoic (DHA)



# Each EFA Heads a Powerful Family

- **18:3, n-3 (ALA)**



- 20:5, n-3

- Eicosapentaenoic (EPA)



- 22:5, n-3

- Docosapentaenoic (DPA)



- 22:6, n-3

- Docosahexaenoic (DHA)

- **18:2, n-6 (Linoleic)**



- 20:4, n-6

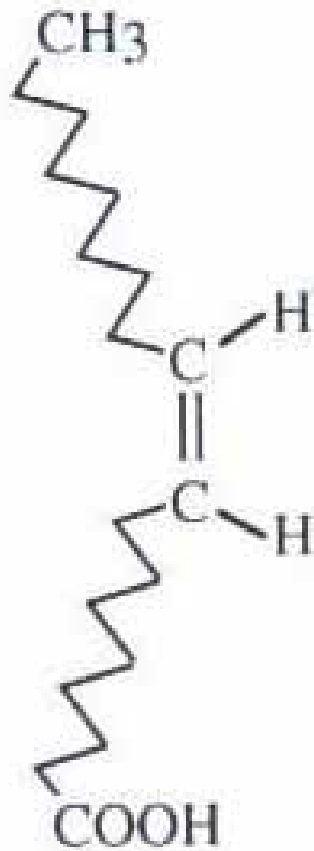
- Arachidonic acid (AA)



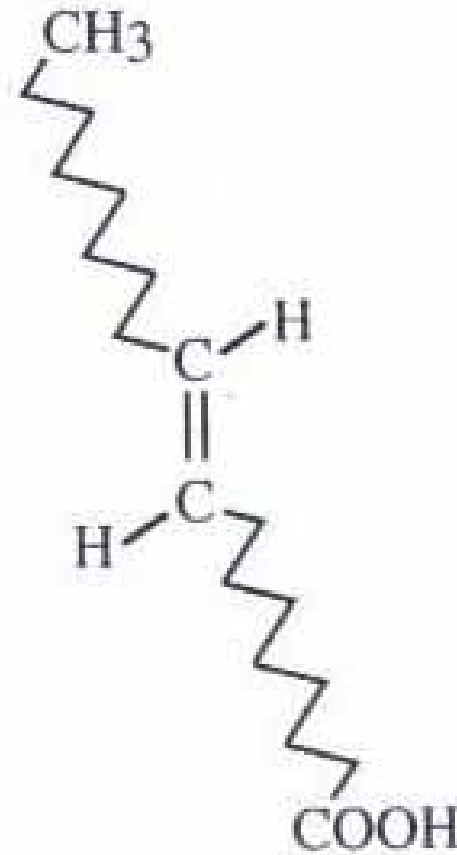
- Prostaglandins

- Leukotrienes

# *Trans- Fatty Acids*



Oleic acid  
(C18:1n-9 cis)



Elaidic acid  
(C18:1n-9 trans)

# *Trans- Fatty Acids*

- Naturally present in small amounts (<1% of total calories) in animal food sources, including human milk
- Mainly introduced in the food chain by the industrial process of hydrogenation
- This process is used to make oils solid at room temperature

## Composition of Some Edible Oils

%	16:0	18:0	18:1	18:2n6	18:3n3
Olive	12	2	72	11	1
Palm	42	4	43	8	0
Canola	5	1	56	24	10
Sunflower	6	6	33	53	0
Butter	28	16	26	1	2
Beef	28	13	43	2	1
Chicken	27	7	41	14	1
Salmon*	19	4	23	1	1

\*EPA=8%, DHA=11%



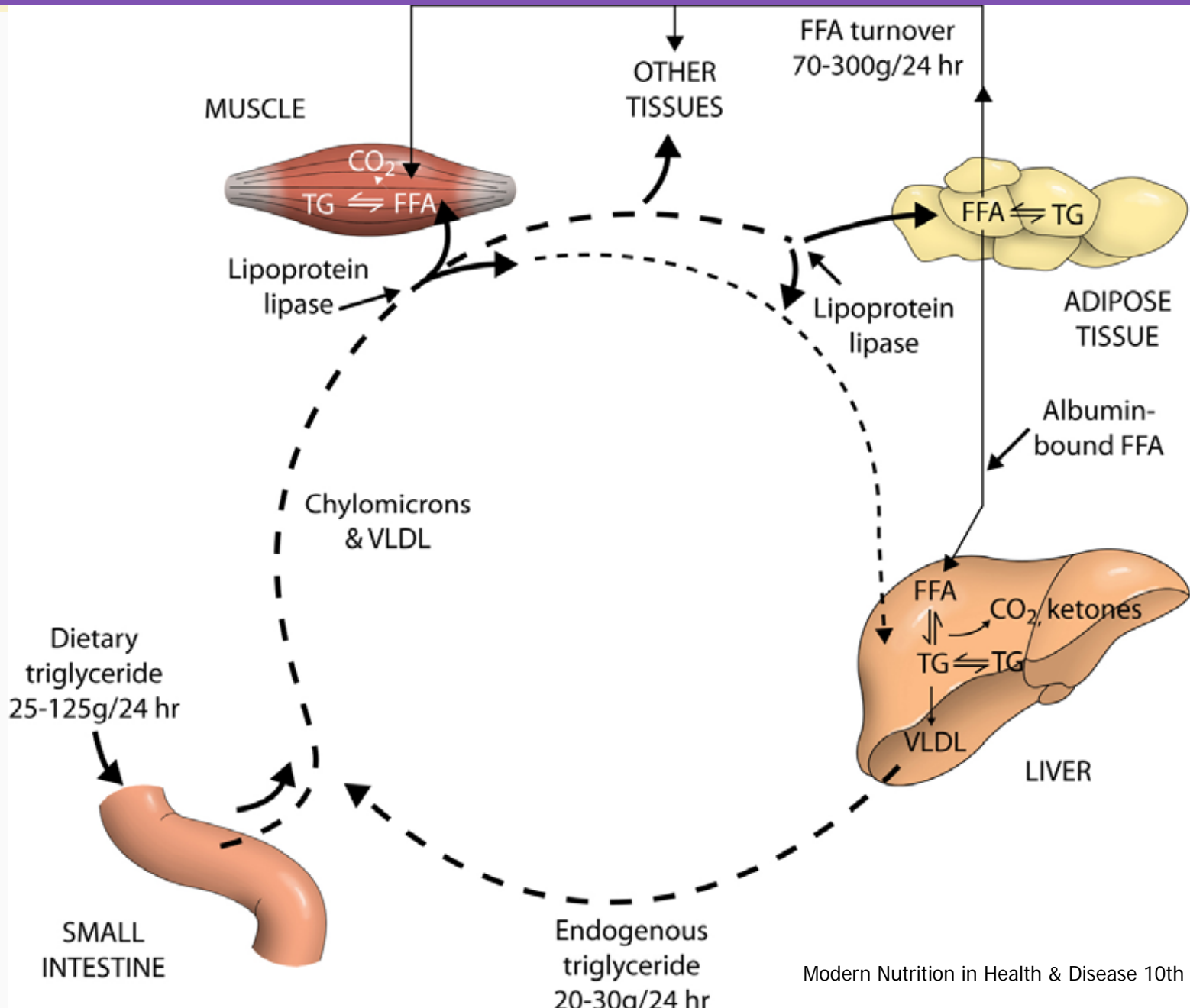
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## *Section B*

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Fat Metabolism

# Overview of Fat Metabolism



# Key Lipid Molecules 1

- Chylomicrons
  - Formed in the intestine to carry fatty acids into the circulation after a meal is consumed
  - Disappear from the blood in the fasting state, degraded in the liver
- VLD
  - TG-rich lipoprotein made in the liver
  - Releases TG to tissues and give origin to LDL

## Key Lipid Molecules 2

- LDL
  - Cholesterol-rich lipoprotein made from remnant VLDL, carries about 70% of blood cholesterol
- HDL
  - Made both in liver and intestine, carries cholesterol from the periphery to the liver
- All lipoproteins are eventually captured and degraded in the liver via a receptor system





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## *Section C*

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Recommendations and Guidelines

## *Fat in the Human Diet*

- Fat is an efficient way to pack more calories in less volume and, thus, fat is important for feeding infants and young children
- After the first year of life, there is no particular advantage in using fat to provide calories
- However, flavor and texture of foods are highly dependent on their fat content

## *Total Fat: Infants and Children*

- Infants fed breast milk consume 50% fat
- After weaning, they should progressively reach the recommended fat intake level for adults, by age 8-10

## *Total Fat: Adults*

- From 20% to 35% of total calories can be derived from fat

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- Lower limit is set by altered blood lipids (↑ TG, LDL)
- Upper limit is determined by increasing risk of excess energy intake and obesity

## *Recommended Intake: Saturated Fat*

- There is no physiological need for saturated fat; however, it is virtually impossible to create a healthy saturated fat-free diet
- Thus, the recommendation is to consume **no more than 10% of total calories from saturated fat**
- Also, some fat in the diet is needed to allow absorption of fat-soluble vitamins

## **Essential Fatty Acids**

- Linoleic acid—5-10% of total calories
- Alpha-Linolenic acid—0.2-1.2% of total calories
- Diet should contain certain amount of preformed PUFAs (DHA, EPA)
  - This can be achieved by consuming fatty fish twice a week



- Clinical
  - Dermatitis
  - Thrombocytopenia
  - Increased susceptibility to infections
  - Failure to thrive
  - History of low fat intake
- Laboratory
  - Serum Triene:Tetraene ratio  $> 0.4$