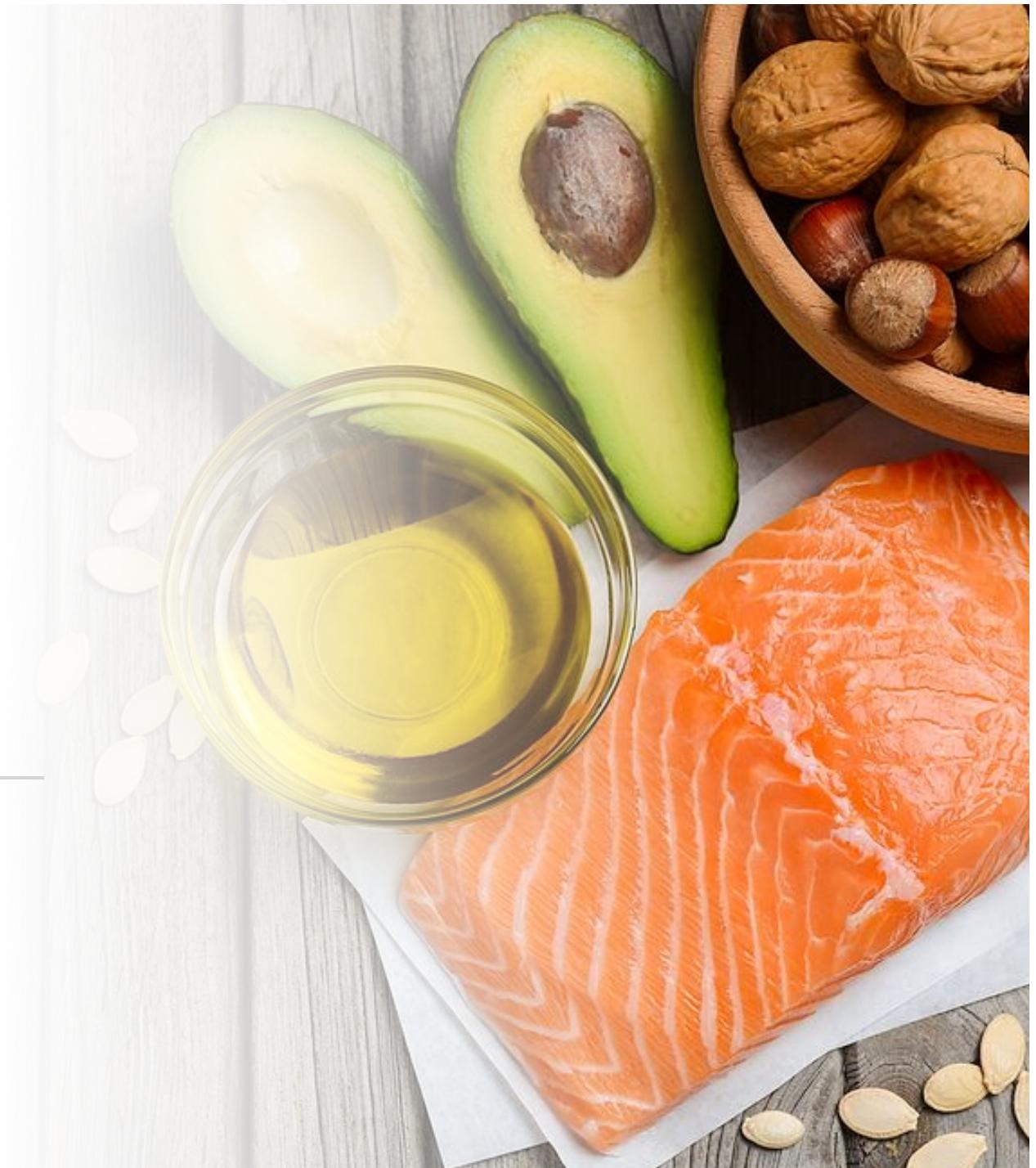


Fats & Lipids

Module 5



Learning Objectives

- Recognize the basic chemical structure of fatty acids and describe how they are named.
- Explain the functions of lipids in the body.
- Identify food sources of different lipids.
- Discuss the recommended intake of lipids.
- Identify strategies for modifying total fat, saturated fat, and *trans*-fat intake.
- Summarize the digestion, absorption, and transport of lipids in the body.
- Explain the relationship of lipid intake to chronic disease
- Describe dietary measures to reduce the risk of developing cardiovascular disease.



Lipids: The Basics

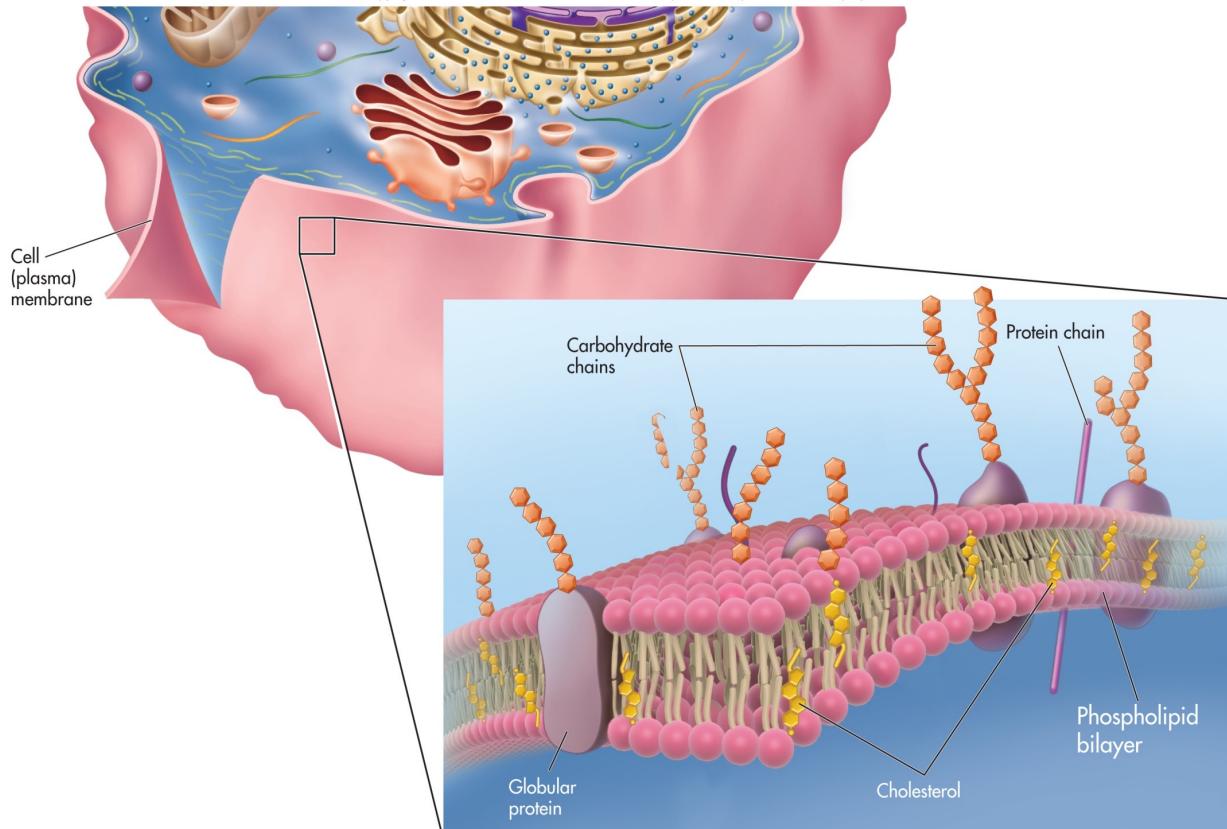
- Diverse group of chemical compounds
 - One common property, lipids do not readily dissolve in water
- Types
 - Triglycerides
 - Phospholipids
 - Sterols (Cholesterol)
- Fats (solid) and oils (liquid)
 - 9 kcal /gm

Functions of Fats in the Body

- Provide energy
- Efficient storage of energy
- Insulating and protecting body
- Transport fat-soluble vitamins A, D, E, and K
- Phospholipids, become part of cell membrane
- Cholesterol, becomes part of hormones, estrogen, testosterone, and precursor of active vitamin D hormone
 - Structural component in cells and lipoproteins



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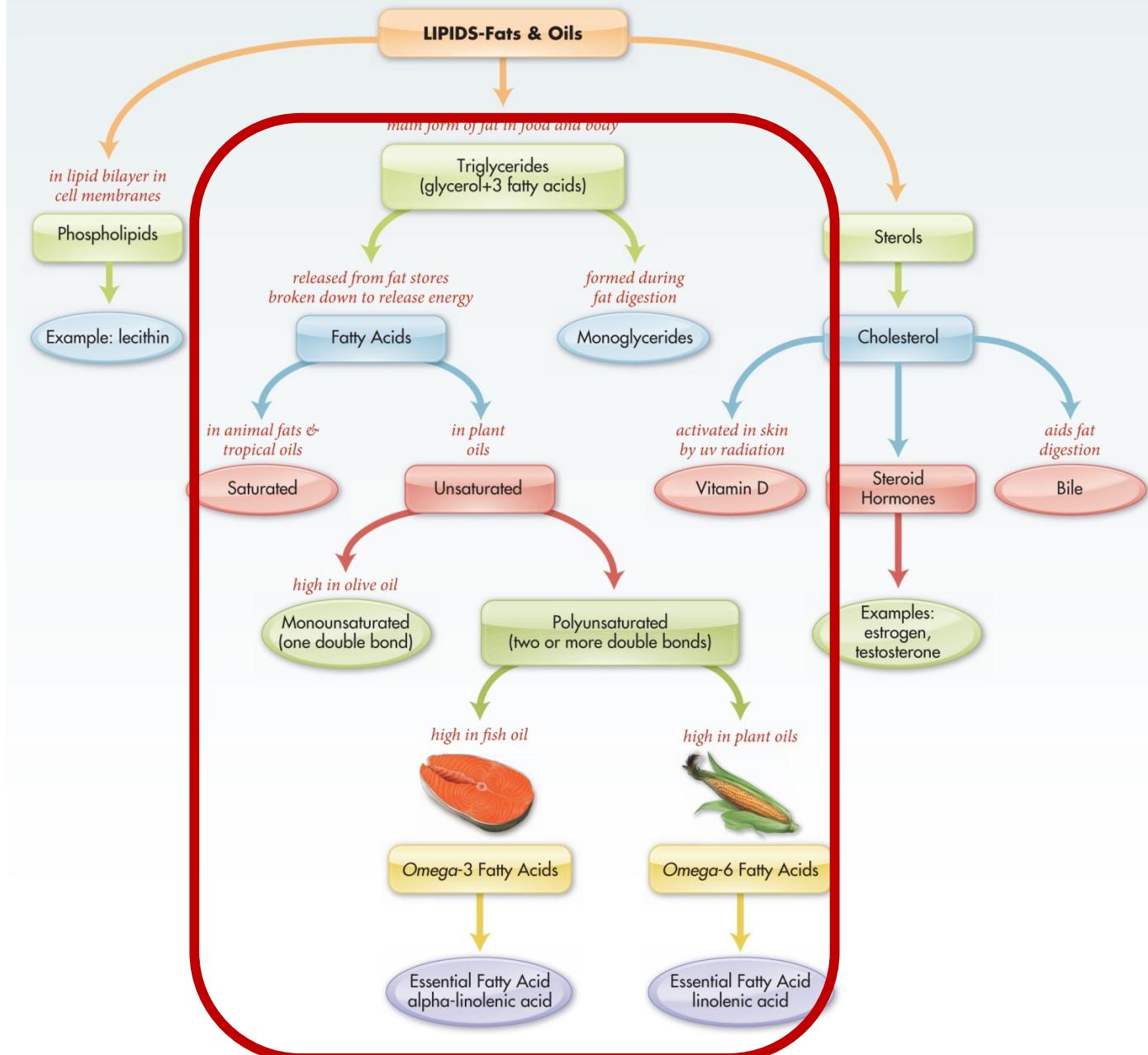
Phospholipid and Cell Membranes



Functions of Fat in Food

- Provides:
 - Satiety
 - Flavor
 - Texture

LIPIDS CONCEPT MAP

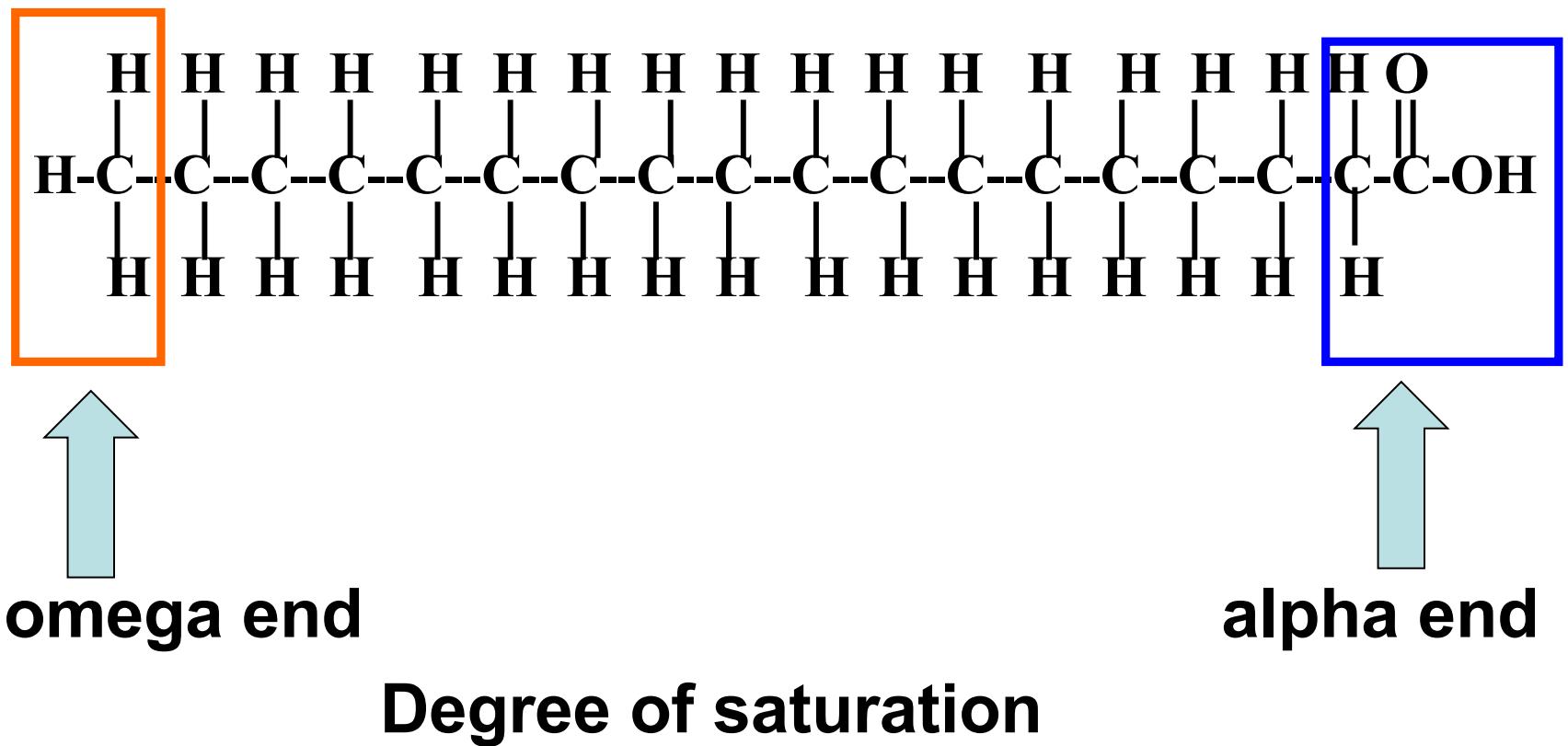


Triglycerides & Fatty Acids

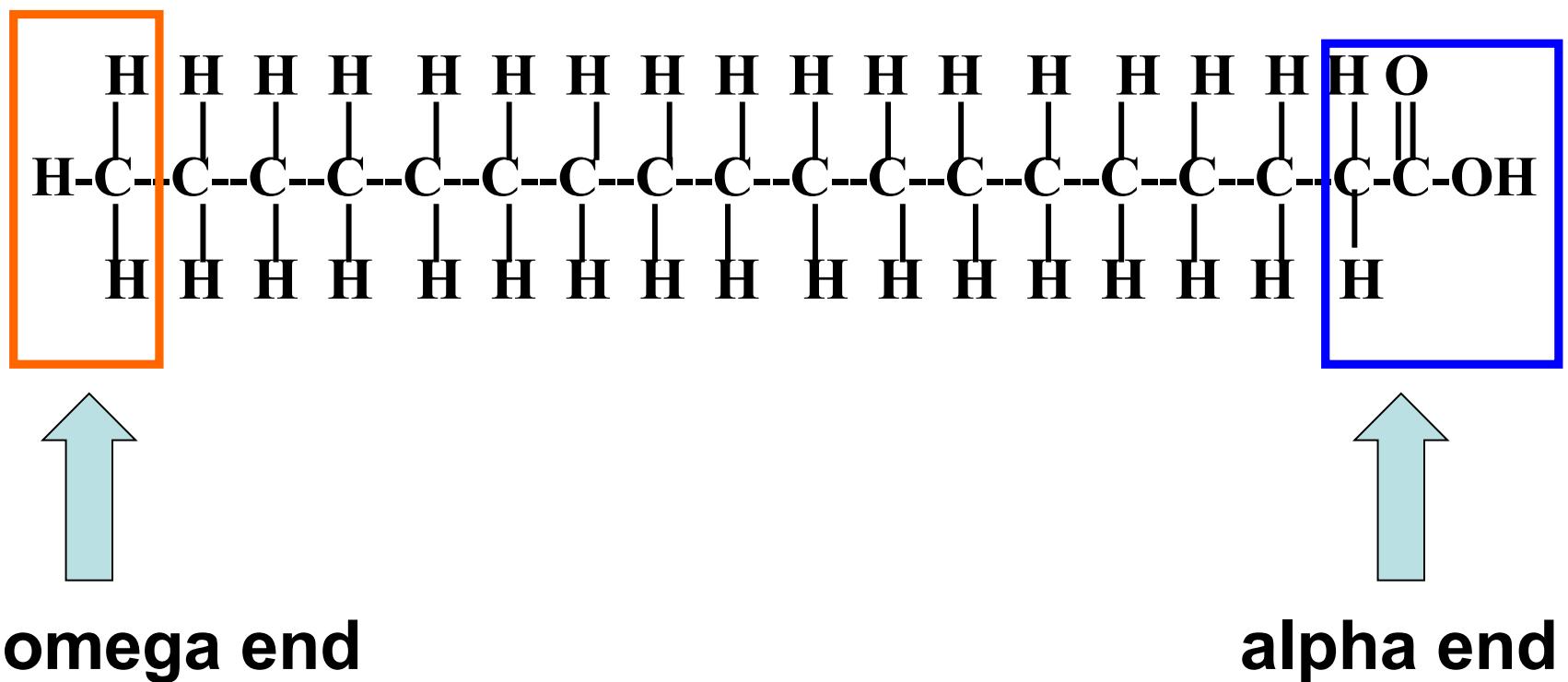
- Found in our body and foods
 - In triglycerides, composed of three fatty acids bonded to glycerol, an alcohol
- Saturated fatty acids, higher in animal foods
 - Solid form
- Unsaturated fatty acids, higher in plant foods
 - Liquid form
 - *Cis* and *Trans*
- Fats are composed of both saturated and unsaturated



Fatty Acid Structure

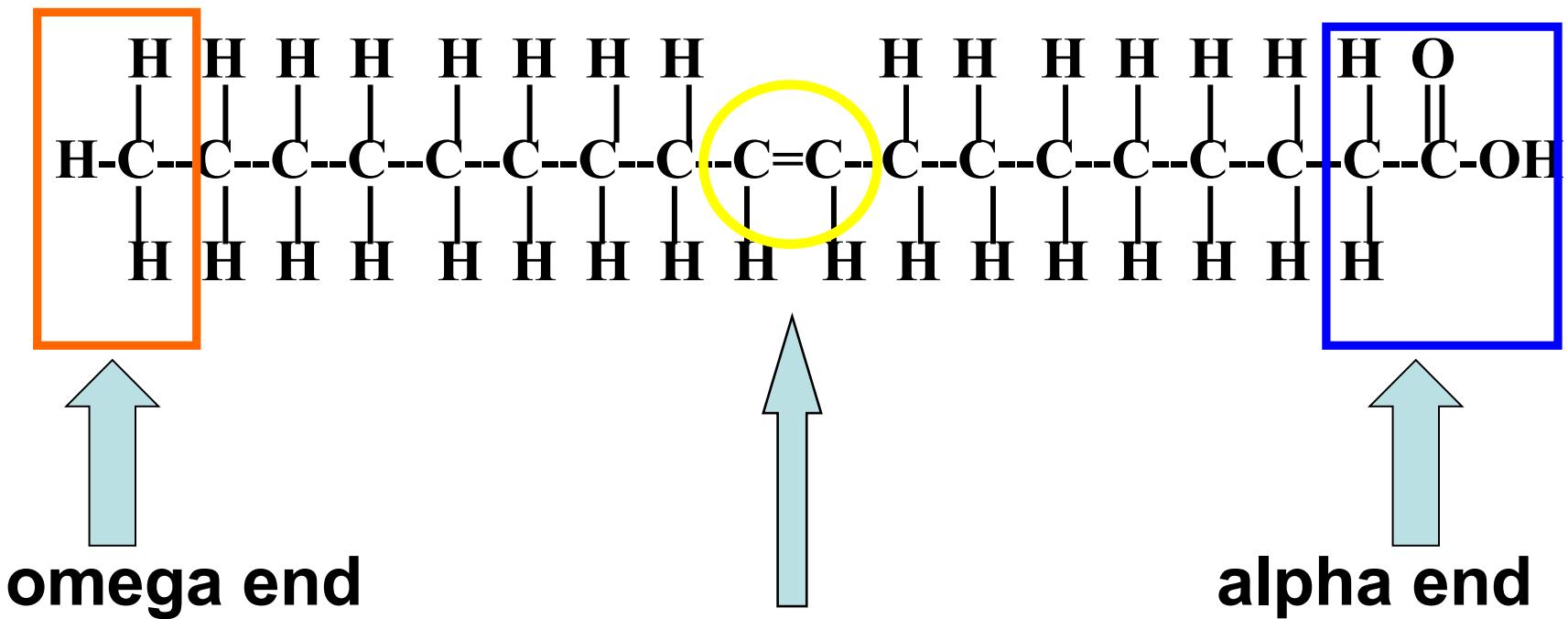


Saturated Fatty Acid Structure



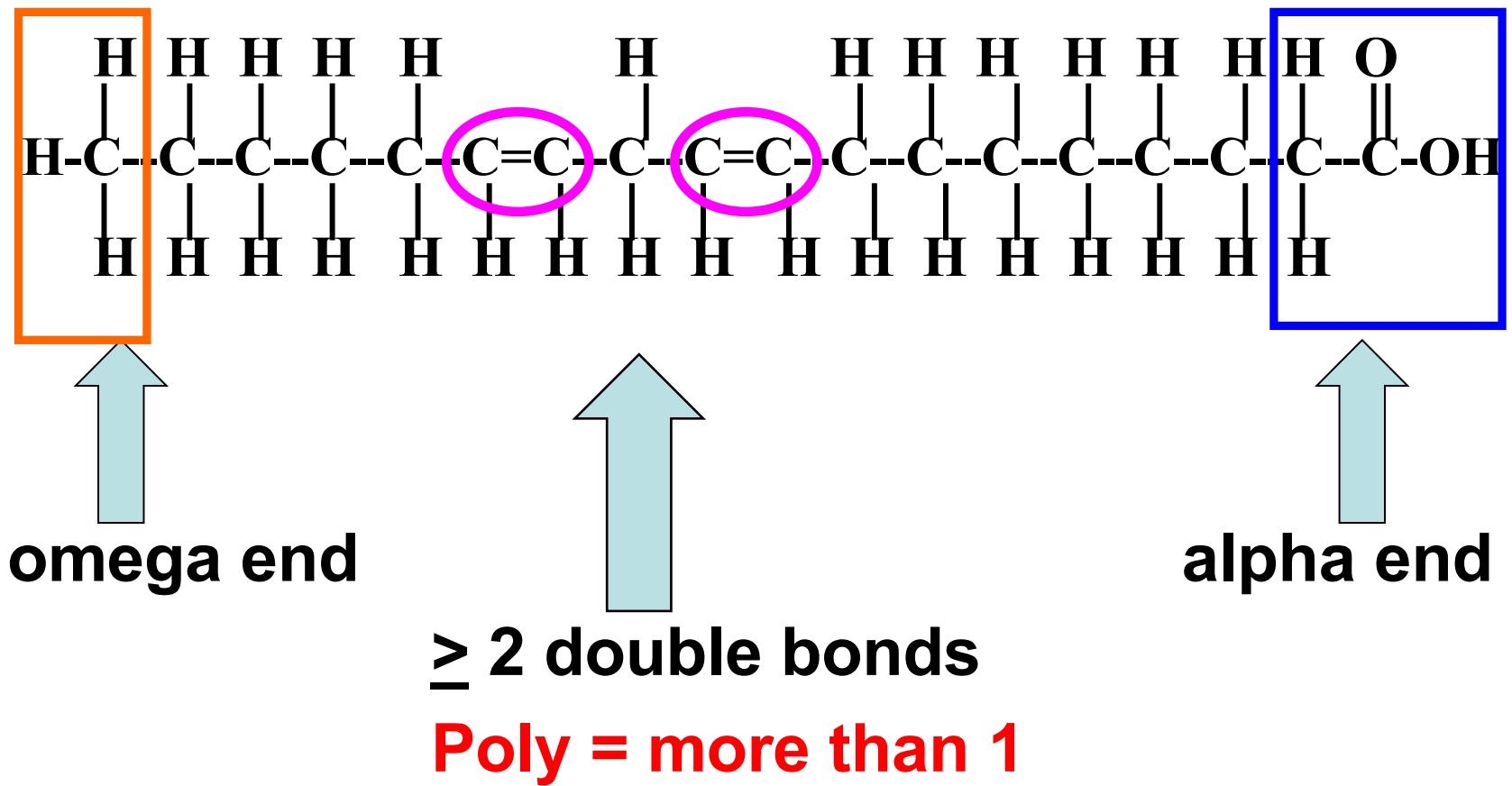
Degree of saturation: single carbon bond

Monounsaturated Fatty Acid Structure



Mono = 1

Polyunsaturated Fatty Acid Structure



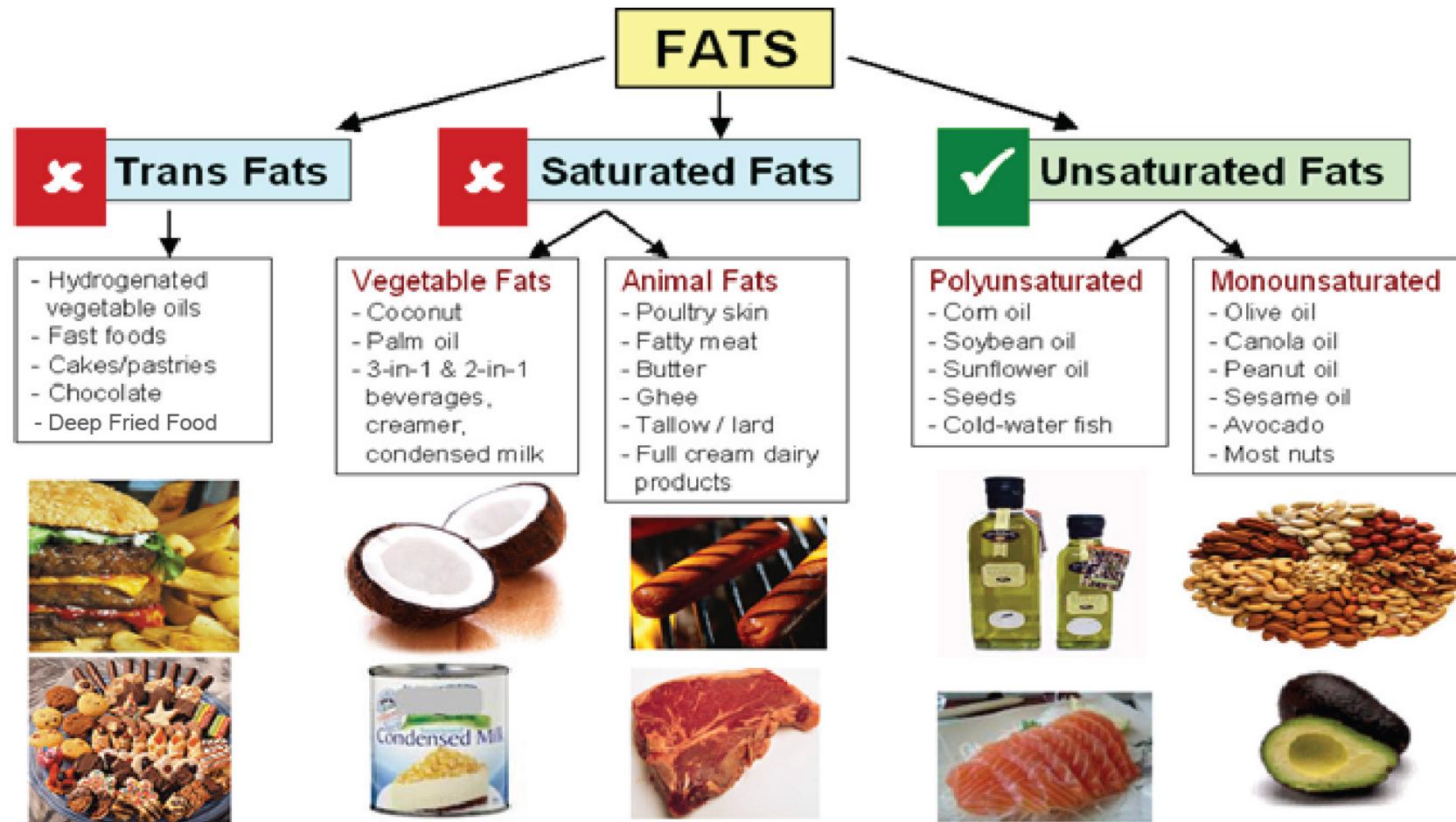
Composition of Common Fats / Oils

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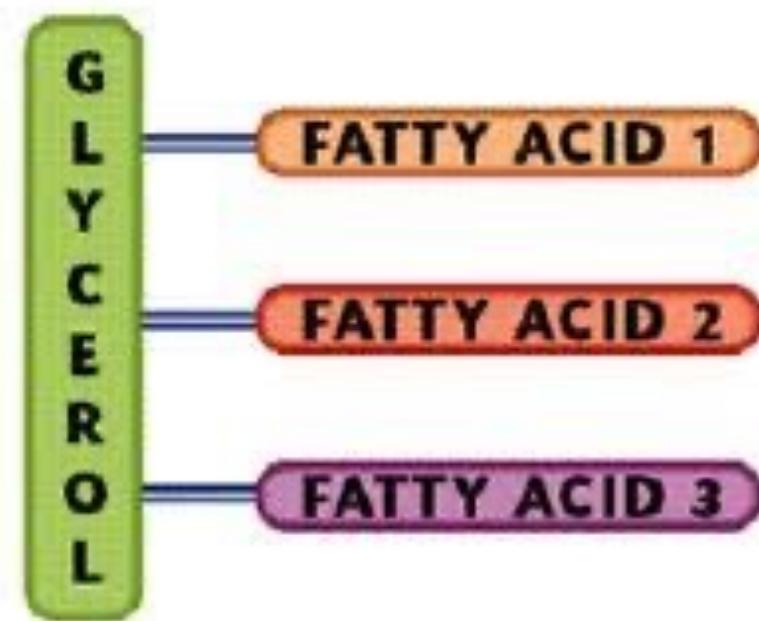
*Rich source of the omega-3 fatty acid alpha-linolenic acid (7% and 12% of total fatty acid content for soybean oil and canola oil, respectively).

**The natural *trans* fatty acids in butter are not harmful and may even have health-promoting properties, such as preventing certain forms of cancer.



Triglycerides & Phospholipids

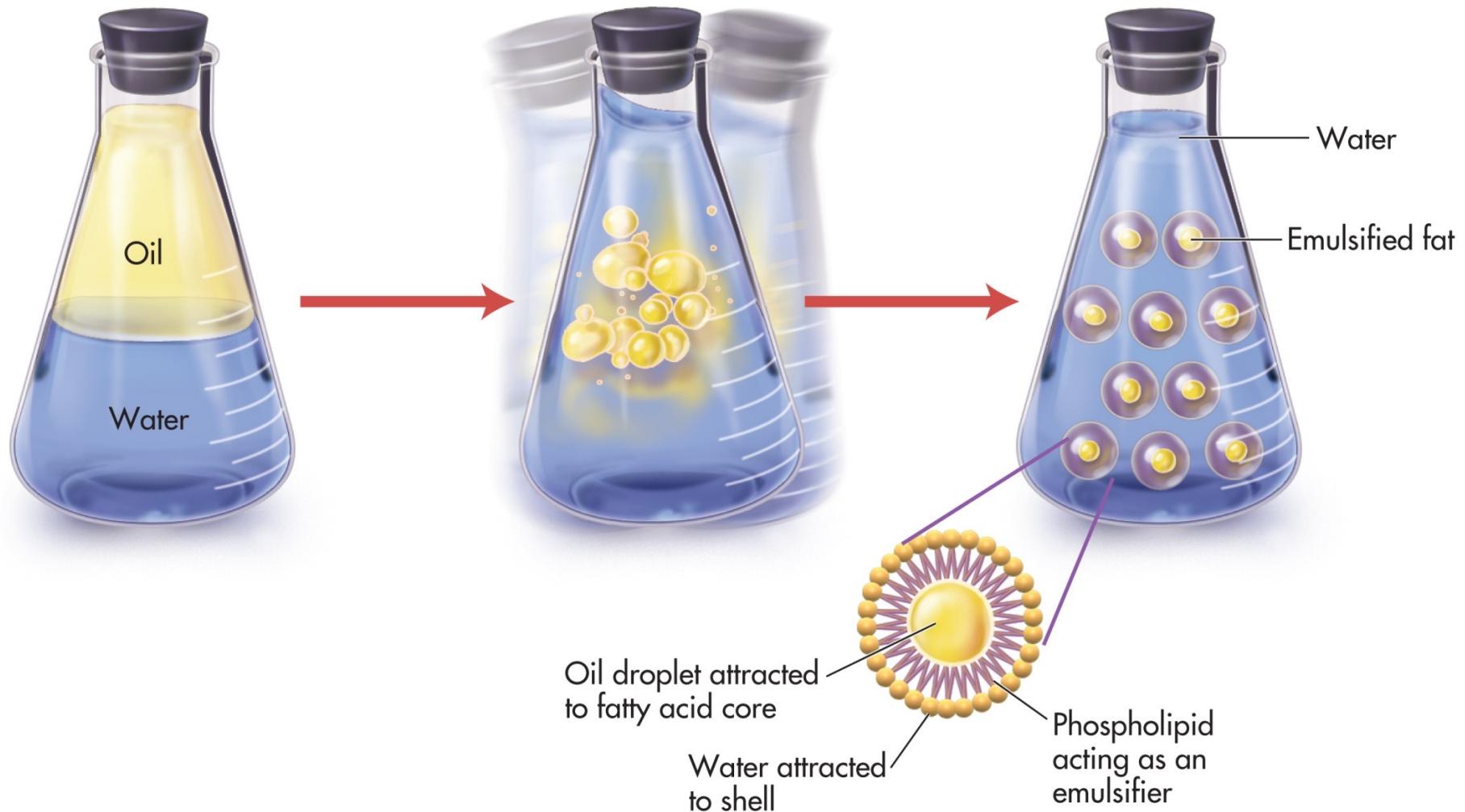
- Triglycerides (tri = 3)
 - Most common form of fats and oils
 - 3 fatty acids attached to a glycerol
- Phospholipids
 - Found in body
 - Synthesized as needed
 - Component of cell membranes
 - Functions as emulsifier
 - Bile acids
 - Lecithins
 - Improves texture and consistency of food products
 - Food sources: wheat germ, peanuts, yolks, soy beans, organ meat



Emulsifiers

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Emulsifiers and Agitation in Salad Dressing



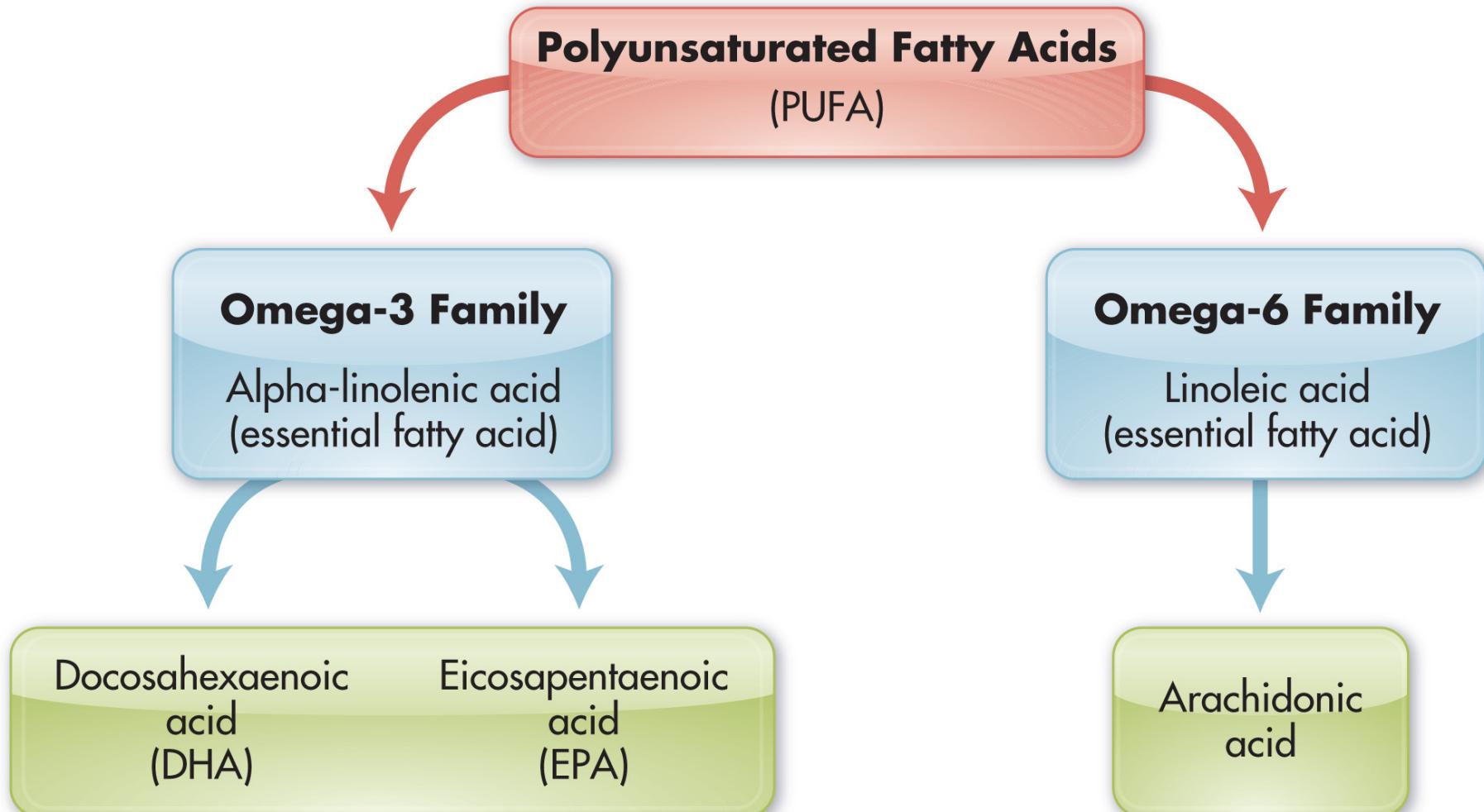


Essential Fatty Acids

- **Must be supplied by the diet to maintain health**
 - Omega-3 fatty acid (alpha-linolenic acid)
 - Omega-6 fatty acid (linoleic acid)
- **Functions**
 - immune system function and vision
 - help form cell membranes
 - produce **eicosanoids**, which are involved in practically all important functions in the body
- **Deficiency signs/symptoms**
 - Flaky, itchy skin
 - Diarrhea
 - Increased risk of infection
 - Stunted growth and reduced wound healing

Essential Fatty Acids

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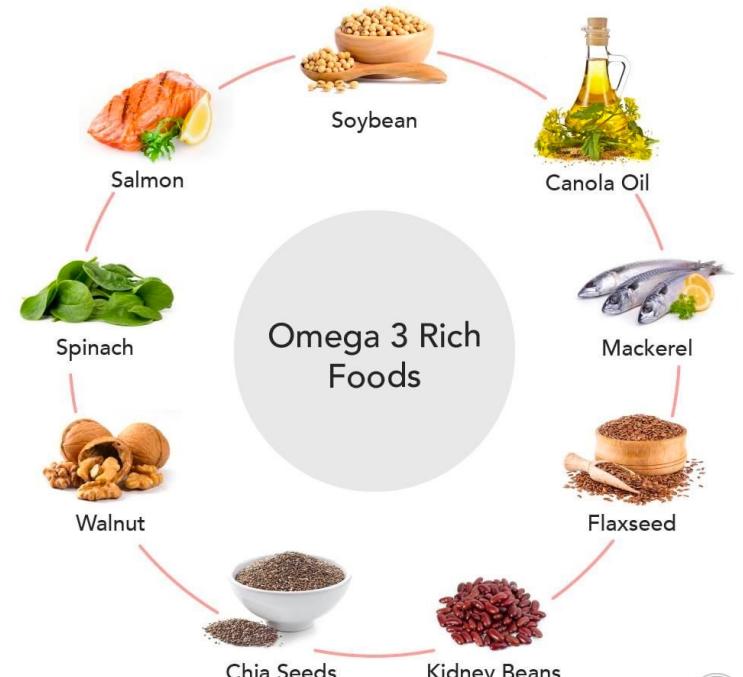
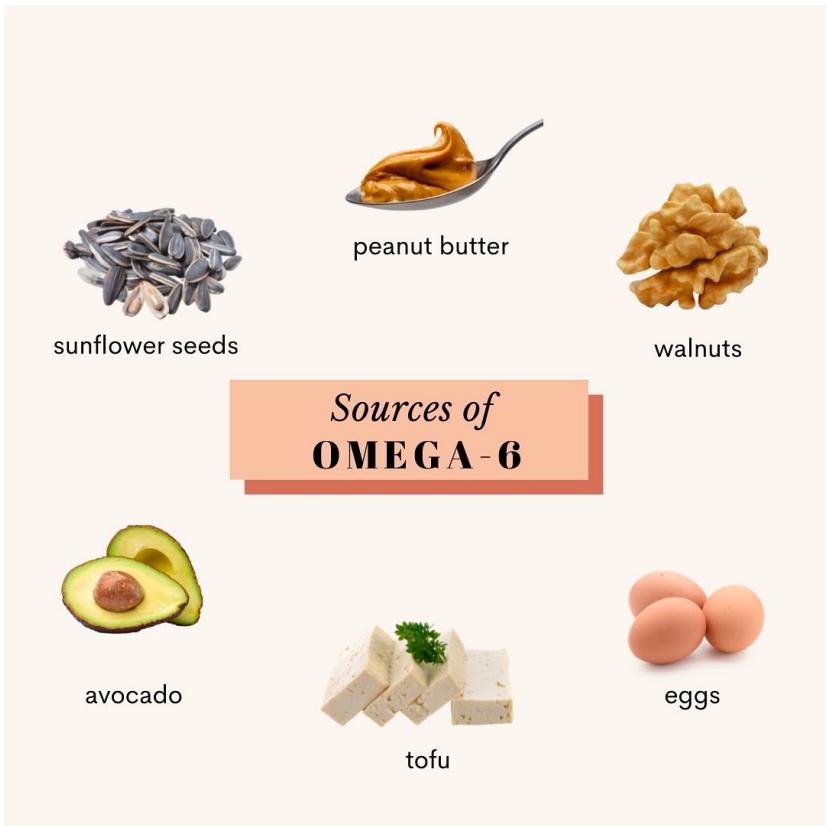
Comparing EFA's

Omega 3

- Primarily from nuts, seeds, fish oil, flax seed oil
- Decrease blood clotting
- Reduce heart attack
- **Decrease inflammation**
- Other possible uses: lower triglycerides, rheumatoid arthritis, behavioral disorders
- Recommended intake of ~2 servings of fish per week

Omega 6

- Found in vegetable oils
- Need is about 2-4 tablespoons a day
- Increases blood clotting
- **Increases inflammatory responses**
- Regulates blood pressure

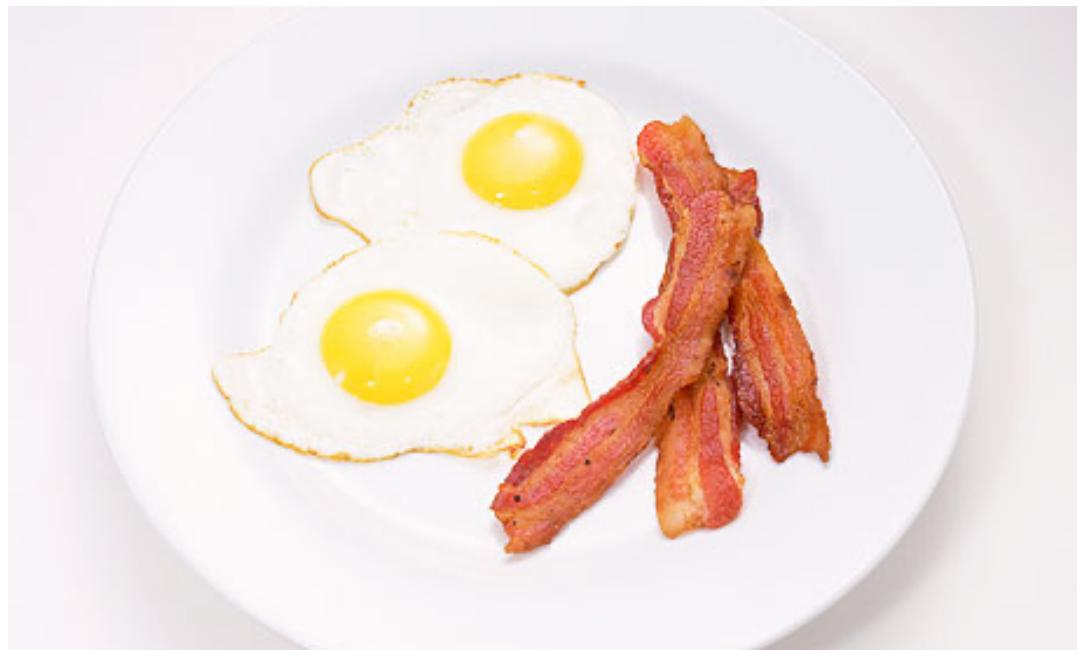


LIPIDS CONCEPT MAP



Sterols

- Multi-ringed structure
- Do not have a glycerol backbone
- Waxy substance
- Do not readily dissolve in water
- Found in animal foods
 - Ex. Cholesterol is a sterol



Functions of Cholesterol

- Essential component of cell membrane
- Produced by the liver
- Found only in animal products
- Forms important hormones
 - Estrogen
 - Testosterone
 - Cortisol
 - Vitamin D
- Precursor to bile acids

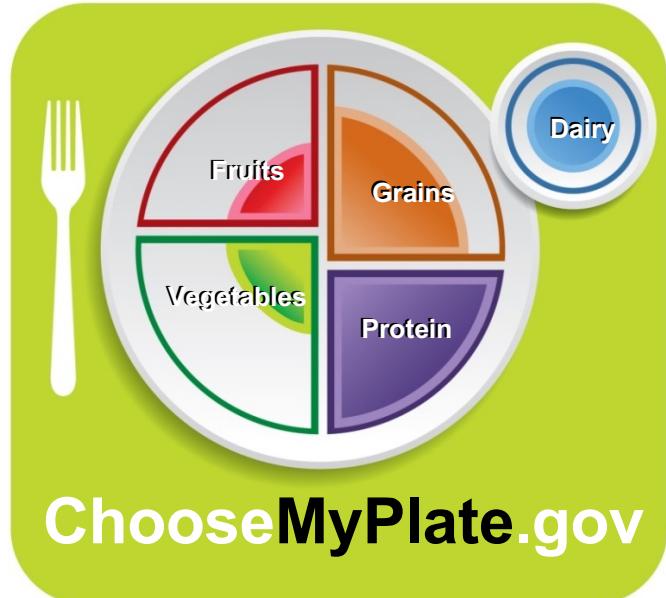




What foods have fat?

Lipids in Foods

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MyPlate: Sources of Fats

Grains

- Crackers
- Pasta dishes with added fat

Vegetables

- French fried potatoes

Fruits

- Fruit pies
- Avocados

Dairy

- Whole milk
- Low-fat milk (1%, 2%)
- Some yogurts
- Many cheeses
- Premium ice cream

Protein

- Marbled meat
- Bacon
- Poultry (skin)
- Deep-fat-fried meat
- Nuts

0-18 grams per serving

0-27 grams per serving

0-11 gram per serving

0-10 grams per serving

7-17 grams per serving

Type and Health Effects	Main Sources	State at Room Temperature
Saturated Fatty Acids Increase blood levels of cholesterol		
Long chain	Lard; fat in beef, pork, and lamb	Solid
Medium and short chain	Milk fat (butter), coconut oil, palm oil, palm kernel oil	Soft or liquid
Monounsaturated Fatty Acids Decrease blood levels of cholesterol	Olive oil, canola oil, peanut oil	Liquid
Polyunsaturated Fatty Acids Decrease blood levels of cholesterol	Sunflower oil, corn oil, safflower oil, fish oil	Liquid
Essential Fatty Acids Omega 3: alpha-linolenic acid Reduces inflammation responses, blood clotting, and plasma triglycerides	Cold-water fish (salmon, tuna, sardines, mackerel), walnuts, flaxseed, hemp oil, canola oil, soybean oil, chia seeds, and perilla oil	Liquid
Omega 6: linoleic acid Regulates blood pressure and increases blood clotting	Beef, poultry, safflower oil, sunflower oil, corn oil	Solid to liquid

Fat Rancidity

- Caused by products of decomposed oils
- Unpleasant odor and flavor
- Limited shelf life of food products
- Prevention:
 - Hydrogenation

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Hydrogenation of Fatty Acids

- Process used to solidify an oil
- Addition of H to C=C double bonds
- Increases shelf life of food product
- Formation of *trans* fatty acid
 - Similar to shape of saturated fatty acid
- Presents health risk like saturated fats
 - Increases risk of cardiovascular disease



Minimize Intake of *Trans Fat*

Nutrition Facts

Serving Size 1 tbsp

Amount Per Serving

Calories	35	Calories From Fat	15
Total Fat	1.5g	% Daily Value*	2%
Saturated Fat	0g		0%
Trans Fat	0g		
Polyunsaturated Fat	0g		
Monounsaturated Fat	0g		
Cholesterol	0mg		0%
Sodium	5mg		0%
Total Carbohydrate	5g		2%
Sugars	5g		
Protein	0g		

** Percent Daily Values are based on a 2,000 calorie diet.

Not a significant source of dietary fiber, sugar, vitamin A, vitamin C, calcium, and iron.

Learn More about Mindful Portion Awareness at
<http://www.nestleusa.com/nutrition/beverage/calories-in-my-cup>

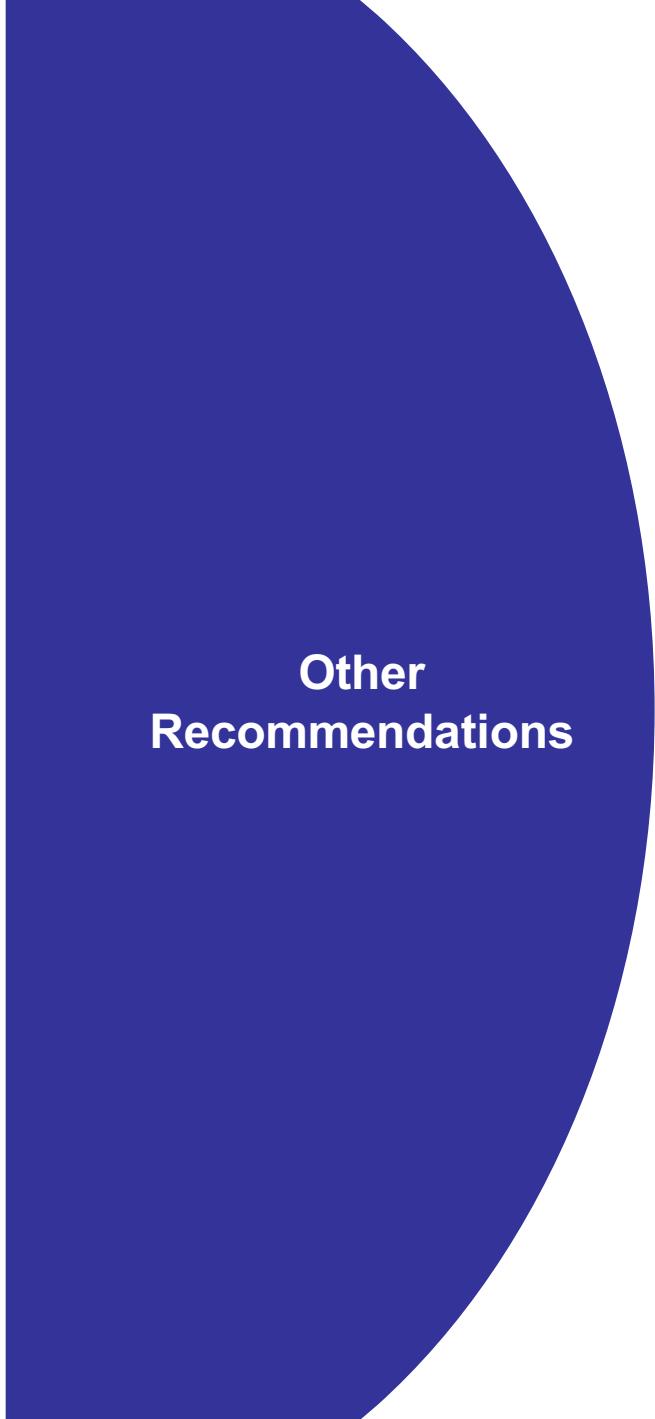
INGREDIENTS: WATER, SUGAR, VEGETABLE OIL (HIGH OLEIC SOYBEAN AND/OR PARTIALLY HYDROGENATED SOYBEAN AND/OR PARTIALLY HYDROGENATED COTTONSEED), AND LESS THAN 2% OF NATURAL & ARTIFICIAL FLAVOR, SODIUM CASEINATE (A MILK DERIVATIVE)**, MONO- AND DIGLYCERIDES, DIPOTASSIUM PHOSPHATE, CELLULOSE GEL, CELLULOSE GUM, CARRAGEENAN. CONTAINS: A MILK DERIVATIVE.
**Not a source of lactose
Current as of August 2015. Please see shelf packaging for any changes.

- Limit use of
 - hydrogenated fats
 - deep-fried foods
 - high-fat baked goods
 - non-dairy creamers

Recommendations for Fat Intake

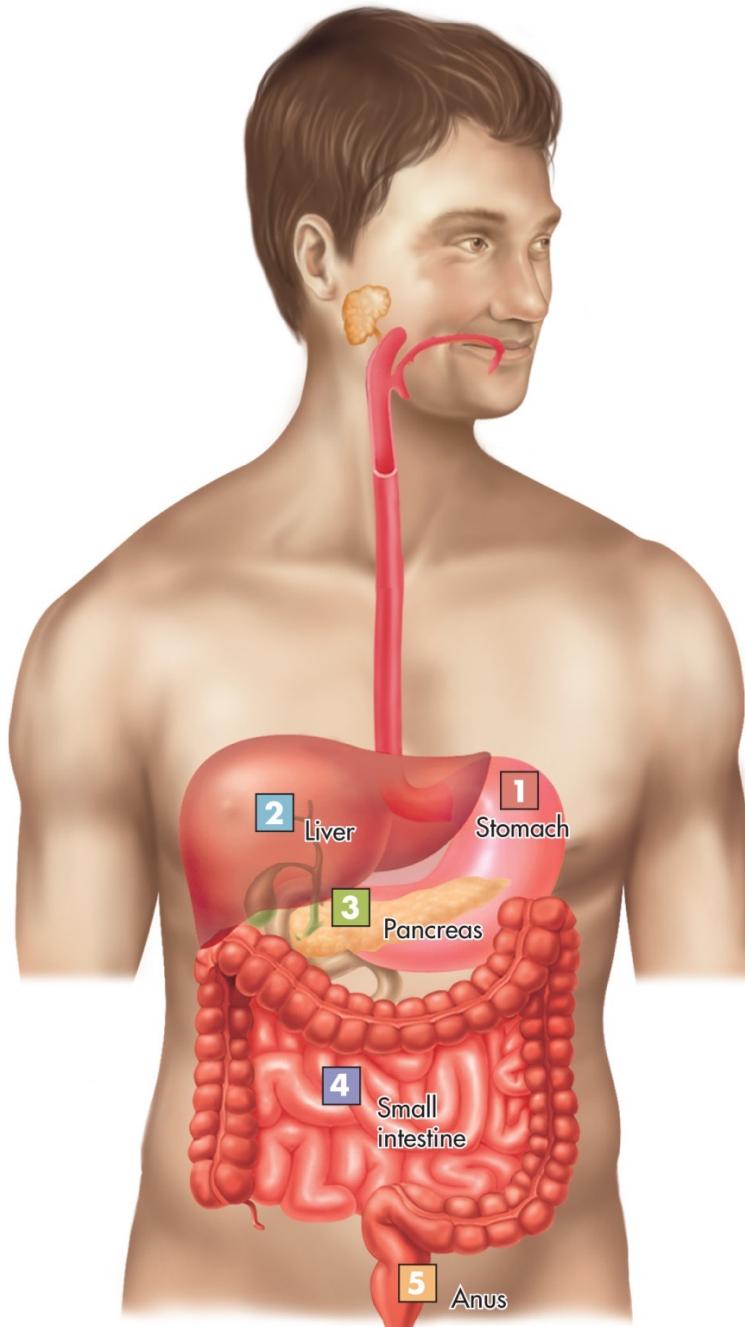
- Focus on quality of fat
- <10% from saturated fats
- Avoid trans fat
- Replace saturated fat with healthier monounsaturated and polyunsaturated fats.
- Omega 3>omega 6





Other Recommendations

- Fat intake can be higher as long as saturated and *trans* fatty acid are minimal
 - Eat plenty of fruits and vegetables
 - Cut down on red meats
 - Cut down on simple sugars and refined carbohydrate
 - Be active
- 



Fat Digestion and Absorption



1

Stomach: Only minor digestion of fat takes place in the stomach through the action of lipase enzymes.

2

Liver: The liver produces bile, stored in the gallbladder and released through the bile duct into the small intestine. Bile aids in fat digestion and absorption by emulsifying lipids in the digestive juices.

3

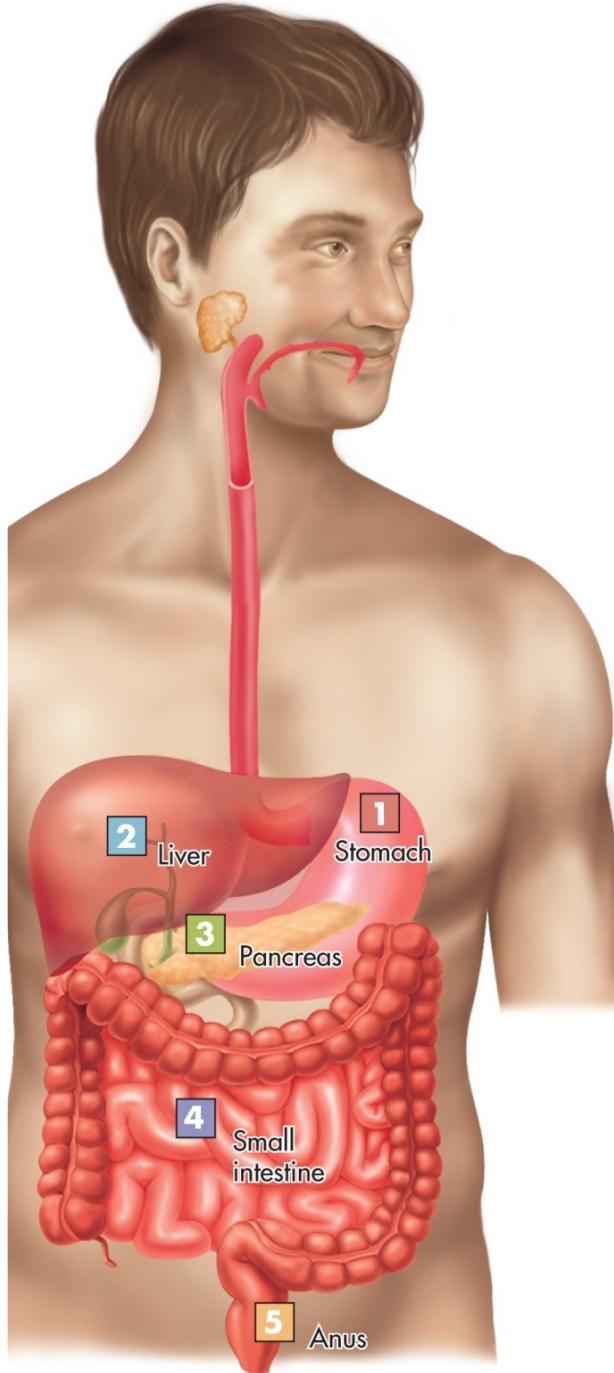
Pancreas: The pancreas secretes a mixture of enzymes, including lipase, into the small intestine.

4

Small intestine: The small intestine is the primary site for digestion and absorption of lipids. Once absorbed, long-chain fatty acids are packaged for transport through the lymph and bloodstream. (Shorter-chain fatty acids are absorbed directly into portal circulation.)

5

Large intestine: Less than 5% of ingested fat is normally excreted in the feces.



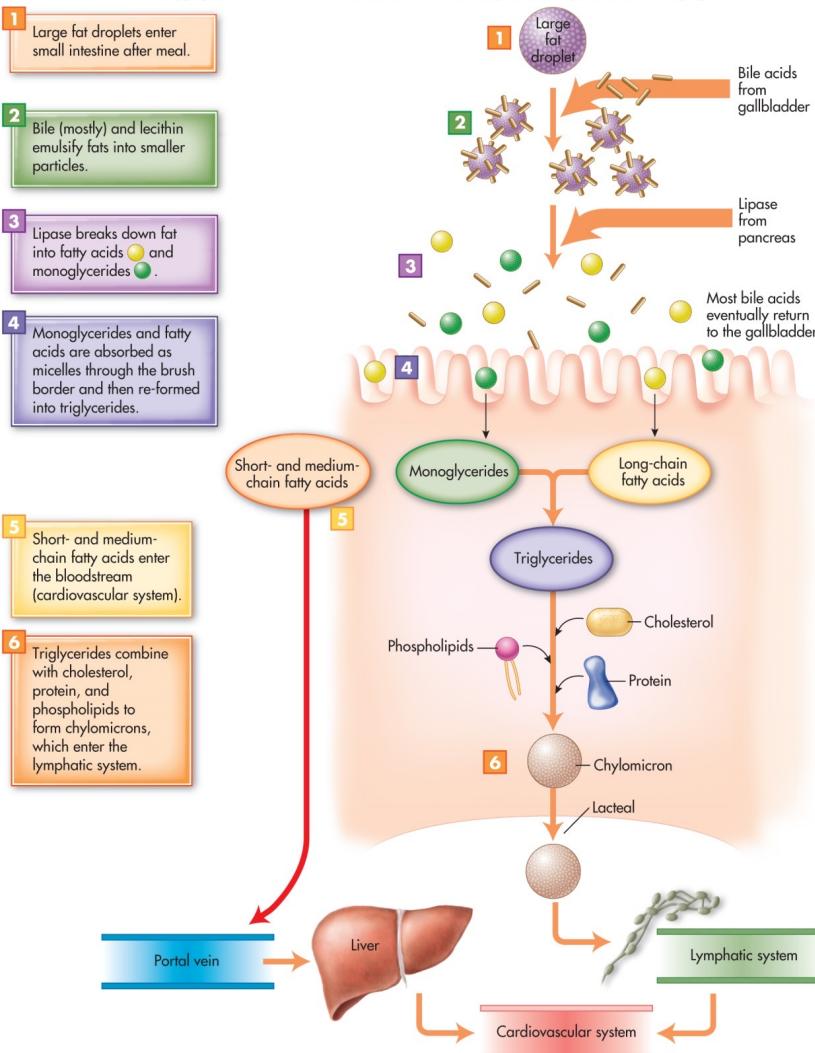
Digestion of Fats

- Enzyme **lipase**: fat-digesting enzyme produced by salivary glands, stomach, and pancreas
 - Acts on triglycerides containing short- and medium-chain fatty acids
- Small intestine is primary site of fat digestion
 - Hormone **cholecystokinin (CCK)**
 - Stimulates release of pancreatic lipase
 - Bile acid released
 - Emulsifies digested fat
 - Fat is broken down
 - To monoglycerides and fatty acids in watery digestive juices

Absorption

- **95% of dietary fat is absorbed**
- Diffused into the absorptive cells
- Short- and medium-chain fatty acids
 - Are water soluble so they enter the **portal system**
- Long-chain fatty acids re-form into triglycerides
 - Not water soluble so they enter the **lymphatic system**

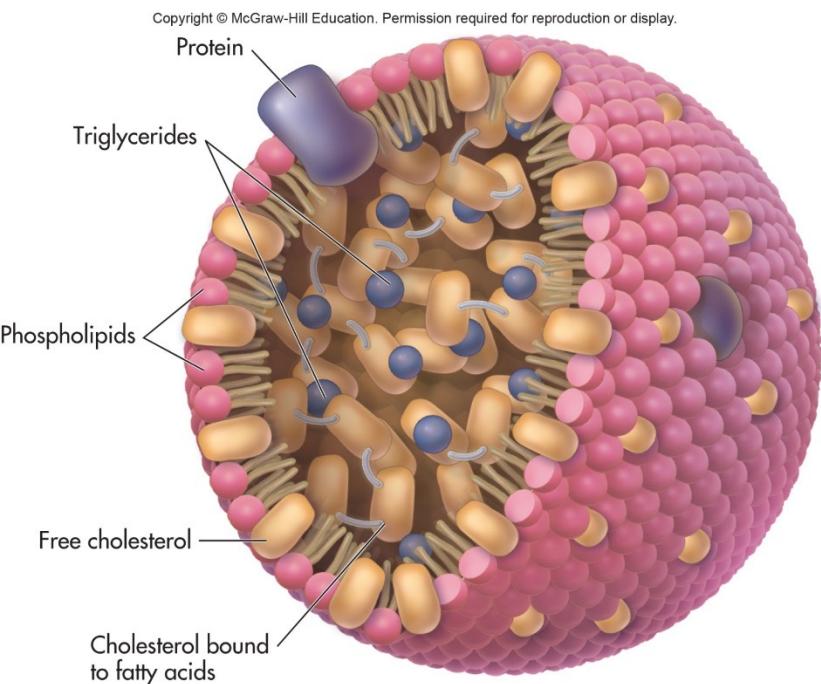
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Carrying Lipids in the Bloodstream

- Water and oil (fat) do not mix easily
- Unique system of fat transportation is needed
- **Lipoprotein** compound in bloodstream containing a core of lipids with shell composed of protein, phospholipid, and cholesterol
 - Vehicle used for lipid transport



Major Lipoproteins in Blood

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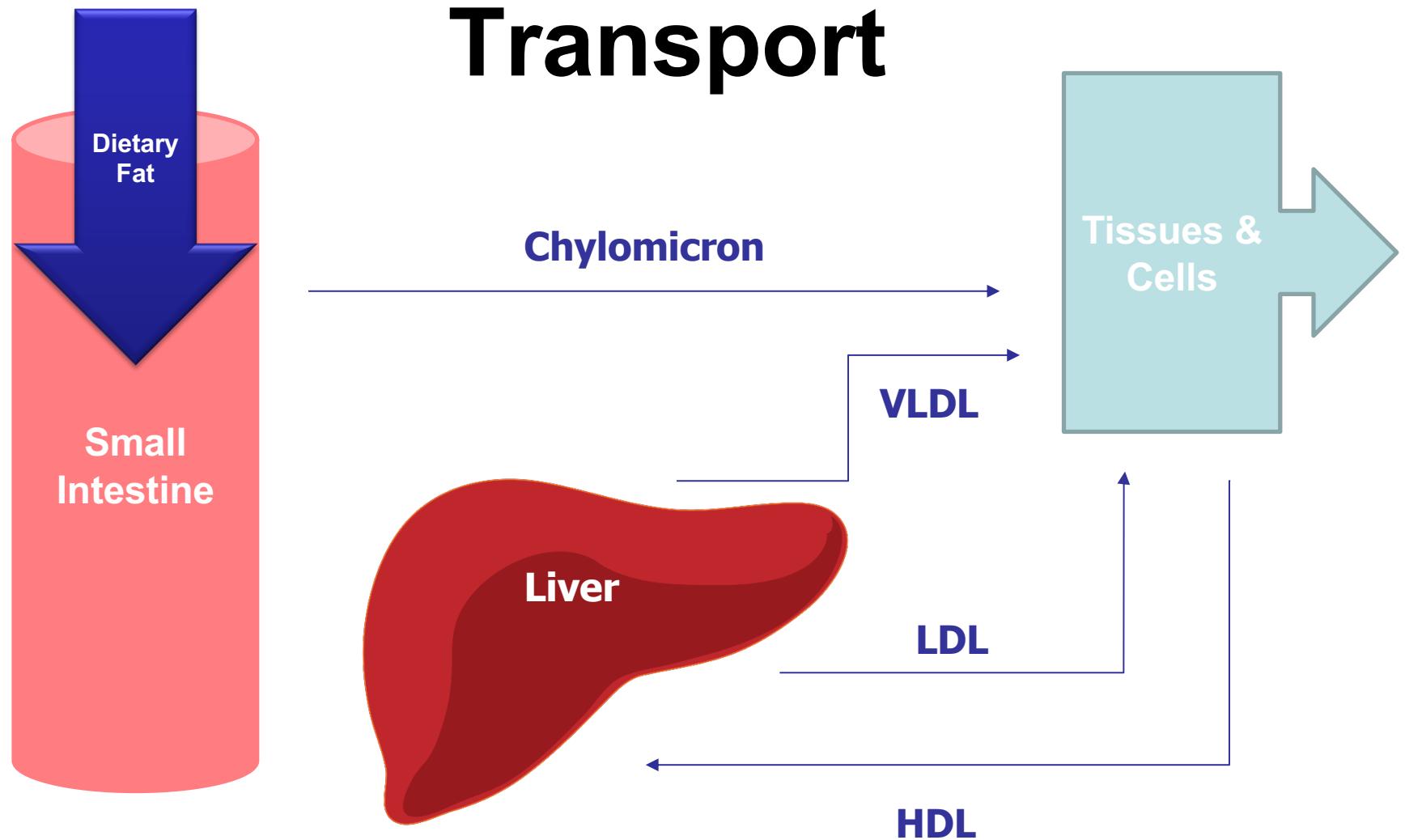
TABLE 5-2 ► Composition and Roles of the Major Lipoproteins in the Blood

Lipoprotein	Primary Component	Key Role
Chylomicron	Triglyceride	Carries dietary fat from the small intestine to cells
VLDL	Triglyceride	Carries lipids made and taken up by the liver to cells
LDL	Cholesterol	Carries cholesterol made by the liver and from other sources to cells
HDL	Protein	Contributes to cholesterol removal from cells and, in turn, excretion of it from the body

HDL = High Density Lipoprotein (HAPPY/GOOD CHOLESTEROL)

LDL = Low Density Lipoprotein (LOUSY/BAD CHOLESTEROL)

Role of Lipoprotein in Lipid Transport



Dietary Fats Are Carried by Chylomicrons

- Fatty acids re-formed into triglycerides & packaged into chylomicrons (from SI to cells)
- **Lipoprotein lipase**
 - Breaks down triglycerides within the chylomicrons
 - The fat molecules are then used by the body as energy or stored in fatty tissue for later use.
- Chylomicron remnant
 - Delivered to the liver

High-Density Lipoprotein (HDL)

- Synthesized by liver and intestine
- Picks up cholesterol from dying cells and other sources and transfers it to other lipoproteins or the liver
- Benefits of high HDL (“good cholesterol”)
 - Lowers cholesterol
 - Reduced risk of CVD
 - May block oxidation of LDL (“bad cholesterol”)

Nutrition and Your Health

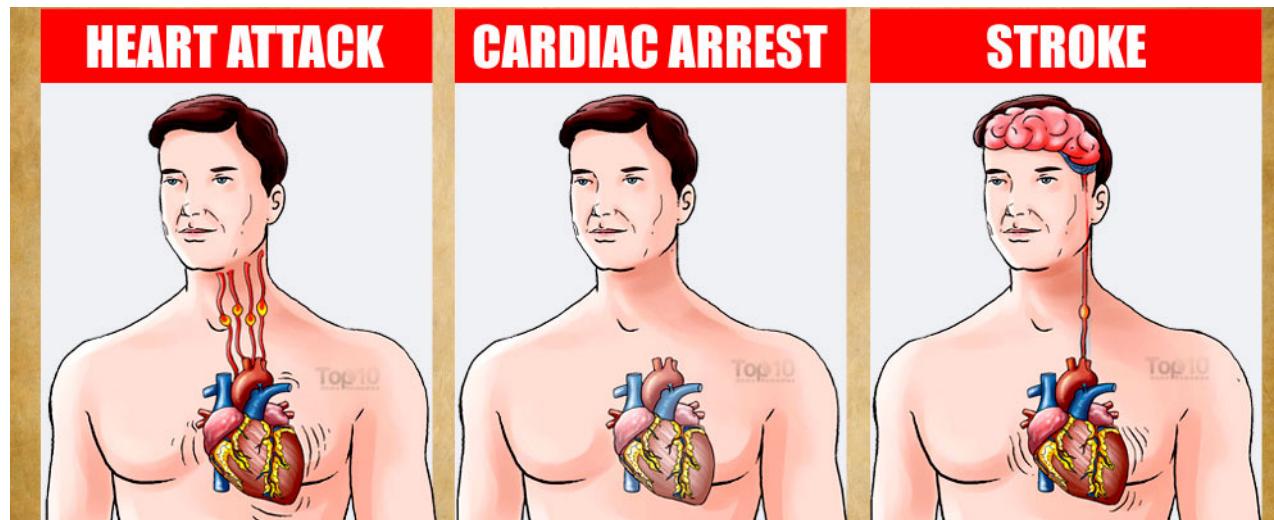
Lipids and
Cardiovascular Disease



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Cardiovascular Disease

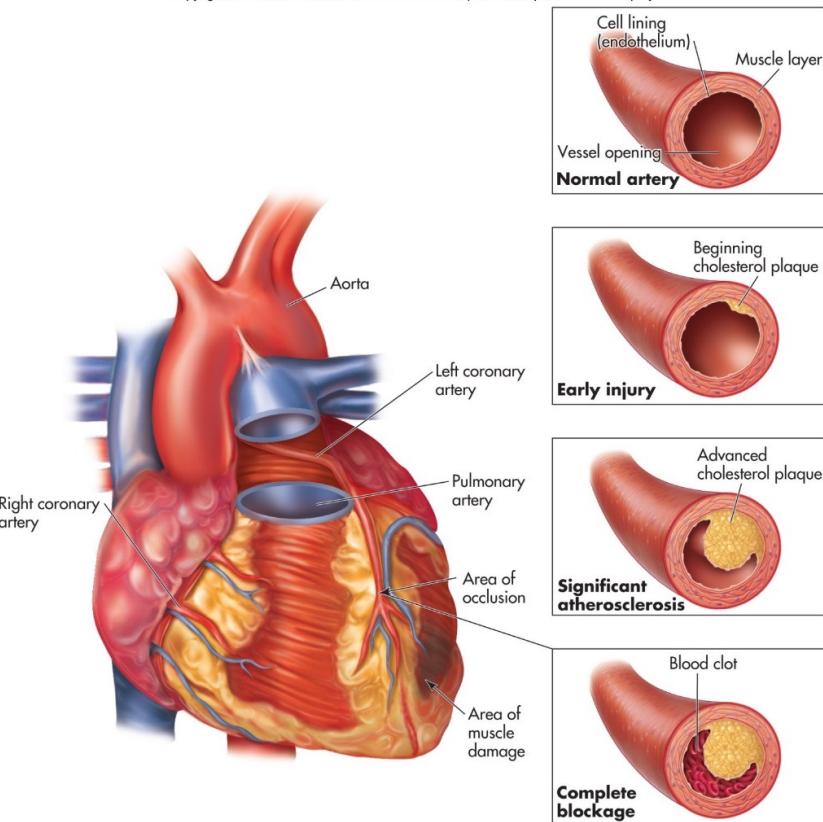
- **Leading cause of death in North America**
 - 600,000 people die each year
 - Annual cost is \$108.9 billion each year
- **Terms**
 - **Myocardial infarction (aka heart attack)**
 - **Cerebrovascular accident (aka stroke)**
 - **Plaque**
 - cholesterol-rich substance deposited in blood vessels
 - contains various white blood cells, smooth muscle cells, various proteins, cholesterol, other lipids, and eventually calcium



Risk Factors for Cardiovascular Disease

- Total blood cholesterol > 200 mg/dl
- Smoking
- High blood pressure
- Diabetes
 - Insulin increases cholesterol synthesis
 - Degrade blood vessels
 - Guarantees development of CVD
- Low HDL (< 40 mg/dl)
- Age
- Family history
- Blood triglycerides > 200 mg/dl
- Obesity
 - Fat around the waist
- Inactivity

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Raising HDL

- Physical activity
- At least 45 min/day,
4 days a week
- Don't smoke
- Eat regularly
- Eat less total fat
- Moderate intake of alcohol
increases HDL



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Lowering LDL

- See your doctor to assess for other conditions
- Reduce dietary saturated fat and cholesterol
- Increase mono and polyunsaturated fats in diet
- Increase dietary fiber (soluble)



Lowering Blood Triglycerides

- Is the most diet-responsive blood lipid
- Avoid overeating
- Limit alcohol
- Limit simple sugars
- Include fish in the diet, 2 times per week
- Walk after meal

