

Chapter 5: Fat

Fat's Function & Types

Study Questions:

- What are the basic functions of fat?
- What is the chemical form of fat in food and the body?
- What are the two categories of fatty acids?
- How do saturated fatty acids differ from unsaturated fatty acids?

Fat as a Nutrient

- Fat provides about 30-35% of total calories in diet
- Excess fat is linked to chronic disease
 - Heart disease
 - Cancer
 - Obesity
- **Functions:**
 - Energy source
 - Fat consumption per year = 270,000 cal
 - Or 30,000 g of fat (6,000 teaspoons of fat!)
 - Regulation
 - Hormones - sex hormones
 - Structure
 - Insulation
 - Membrane Structure
- **Triglyceride (TG):** chemical form in food fat & body fat
 - 3 carbon: Glycerol + 3 fatty acids
- **Fatty Acids:** impart distinct properties and characteristics to foods
 - **Saturated Fatty Acid**
 - Ex: butter, coconut oil (highest in sat fat), beef lard - dairy
 - If predominate in a fat: solid @ room temp
 - Even # carbons: 6Cs, 12Cs, up to 26Cs
 - Most common:
 - palmitic acid = 16C = majority!
 - Stearic acid = 18C
 - SOLID AT ROOM TEMP
 - **Unsaturated Fatty Acid**
 - Most common: olive oil (oleic acid - 18C or 18:1 (18Carbon long, 1 double bond))
 - MISSING hydrogens → Carbon-Carbon double bond!
 - LIQUID AT ROOM TEMP

- If 1 C-C double bond: monounsaturated
- If 2 C-C double bond: polyunsaturated (less than 6!)
- All fatty acids are chains of carbons in even #s

Unsaturated Fats & Their Essentiality

Study Questions:

- What are the characteristics of unsaturated fats?
- What are food sources of unsaturated fats?
- What are the essential unsaturated fatty acids?
- What are food sources of essential fats?
- What role do essential fatty acids play in the body and how does this impact health?
- What are the consequences of a diet deficient in essential fats?

Unsaturated Fats

- Liquid at room temp
- Most Common:
 - Oleic acid - 18:1 - olive, canola, avo oil, peanut oil, eggs - monounsaturated → Omega-9 non-essential → NOT DIETARY ESSENTIAL
 - Linoleic Acid - 18:2 - Sunflower, corn oil, soybean, safflower, and nut oils - veg oil → Omega-6 Essential → POLYUNSATURATED
 - Linolenic Acid: 18:3 - Flaxseed oil/flaxseed meal, fish & other seafood → “Omega 3s” essential → POLYUNSATURATED
 - ^^^ 18:2 & 18:3 = dietary essential fatty acids!

Triglyceride

- Fats are a mix of saturated, monounsaturated & polyunsaturated fatty acids
 - “Saturated fat”: if majority of the fatty acids are saturated
 - “Unsaturated fat”: majority of the fatty acids are unsaturated

Food Sources of Essential Fatty Acids

- 18:2/Linoleic: 12-17g daily: Sunflower, corn oil, soybean, safflower, and nut oils - veg oil - nuts!
- 18:3/Linolenic: 1.1-1.6g daily: fish, seafood, flaxseed oil/meal, walnuts (a bit)

Unsaturated Essential Fatty Acids Needed For:

- Membrane structure
- Brain development and integrity
 - May lead to alzheimers
- Produce prostaglandins: hormone-like substances needed for:
 - Inflammatory response

- Blood clot formation

Essential Fatty Acid Deficiency

- Tube Feeding = most common for deficiency
 - (RARE) Skin disorder w/ EFA treatment

Fat in Food

Study Questions:

- What are food sources of saturated and unsaturated fats?
- How do the triglycerides of various food fats differ?
- How do animal fats differ from vegetable fats?
- What are food exceptions to the animal versus vegetable fats differences?

Food Fat

- **Saturated:** majority of fatty acids are saturated
- **Unsaturated:** majority of fatty acids are unsaturated
- **Animal Sources of Fat:**
 - Saturated Fat
 - Low: 18:2 & 18:3
 - Solid at Room Temp
 - Exceptions:
 - Fish, Chicken (50/50), Egg
- **Vegetable Fats:**
 - Unsaturated Fat
 - High 18:2
 - Liquid
 - Exceptions:
 - Coconut Oil, Palm Oil (Sat Fat!)
- Unsaturated Fat Sources: Tofu, Peanut Butter

Fats and Food Processing

Study Questions:

- How do saturated fatty acids and unsaturated fatty acids differ in terms of their stability?
- What does hydrogenation of a vegetable oil do to the unsaturated fat in terms of stability, properties in foods, and essential fat composition?
- What is a trans fatty acid and what are the properties of trans fatty acids in foods?
- How do trans fatty acids affect health?
- What are food sources of trans fats?

Margarine / Trans Fat

- Hydrogenated Fat: adding hydrogen to a liquid fat
- Double bonds = can go bad/rancid
- Active free radicals destroy essential fats & taste
 - Fat goes “bad” in salad dressings and cooking oils
 - Hydrogenation converts an unsaturated fat to a saturated fat (NO linoleic acid!) = liquid → solid = increased shelf life/stability = loss of essential fatty acid content = formation of “trans” fatty acids
 - Veg shortening made from corn oil does NOT have linoleic acid
- Sat fat: solid
- Unsat fat → cis form: bend in chain = liquid
- Unsat fat during hydrogenation = trans form = straight chain = solid
- Trans fat intake = associated w heart disease!
 - Source: Margarine, anything made with hydrogenated oil, veg shortening
- No Daily Value for trans fat on food label → recommended to avoid

Fat Digestion, Absorption & Transportation in the Body

Study Questions:

- How does the body handle the insolubility of fat in the digestive tract?
- What is the end product of fat digestion?
- How can fat digestion be blocked?
- What is a chylomicron? What are its components and purpose?
- How does fat move through the circulation, and where does fat end up in the body?

Fat Digestion & Absorption

- Fat and Water do not mix = insoluble
 - Fat must be emulsified (made soluble) for absorption into the body
 - Fat's insolubility in water affects digestion, absorption, and transport through the circulation
- Use Bile to emulsify the TG of fat & help digest
 - Made from cholesterol in liver! , stored in Gallbladder
- Lipase enzyme from Pancreas help break down TG and bile
 - All digestive enzymes come from pancreas
- End product of fat digestion: micelle = fat droplets = broken TG

- Absorbed by intestinal walls! Protein coat the TG/fat-like compound and they go into bloodstream
- Fat droplet with protein coat: **Chylomicron** (type of lipoprotein = fat + protein) - enters circulation
 - Delivered to muscle cells or fat cells
 - Goes to back to the liver (lipoprotein headquarters!) - packages up TG → new lipoprotein (**VLDL**) = delivers TG to muscle cells or fat cells

Can Fat Absorption Be Blocked?

- Fat blocker → do not work! Ppl lost weight but super unhealthy
- OTC Drug: inhibits lipase enzyme: reduces fat absorption = alli pills
 - Obesity
 - Anal leakage! → lower fat content

Fat Energy Metabolism and Integration with Protein and Carbohydrate Energy Metabolism

Study Questions:

- What are the end products of fat energy metabolism?
- How does the body process carbohydrate, fat, and protein following a meal?
- What happens to energy metabolism several hours after eating, such as in the morning after a night's sleep?
- How does the body fuel itself during a prolonged fast of more than 24 to 36 hours?
- What is the critical fuel source the body must manufacture during a fast and how is this done?

Use of Fat for Energy

- TG → breaks off fatty acid and break off 2 Carbon units = releases energy (same 2 carbon units when breaking carbohydrate units) = aerobic metabolism!!!!
 - Release: energy (9cals/g) + CO₂ + H₂O
 - More from fat than carbs
- End Product of Fat Energy Metabolism:
 - CO₂, H₂O, Energy
 - Same as in carb energy metabolism (aerobic energy metabolism)

Energy Metabolism

- Integration of carb, protein, and fat use for energy
- Consideration of energy needs
 - Following a meal

- Several hours after eating (overnight)
- 24-36 hrs fasted

Following a Meal: Energy Storage - Energy nutrients put in storage

- Carbs → Glucose → Stored as muscle & liver glycogen
 - Excess: Body fat stores in fat cells
- Fats → Triglycerides/Fatty Acids → Stored as body fat stores
- Protein → Amino Acids → Protein replacement needs first
 - Excess: Pull Nitrogen to urine!
 - Carbon skeletons to create fat for body fat stores

Several hours after eating (overnight): Energy Use - Energy nutrients out of storage

- Carbs → Glycogen in Muscle & Liver → Glucose → used for brain energy, other tissues
- Fat Stores → fatty acid → energy for other tissues

24-36hrs Fasted: Glycogen stores depleted, NEED to make glucose

- Glycogen storage used up - lost water weight
- Body protein (energy source) → amino acids → glucose → throw away nitrogen in urine & fuel brain! Or energy for body use
 - When fasting = increased levels of nitrogen in the urine!
- Fat Stores → fatty acid → energy for body use
 - Imbalance for no fat = ketosis - make ketones (fuel sources) exhale it! Lose some in urine = smell like acetone

Atkins/Keto Diet: Low-Carb, High Protein Diets

- Lose weight but regain weight when u stop

Paleo Diet: has more carbs - eat like cavemen

- No sugar, bread, milk, rice, corn, beans, potato
- Protein, Safe Starches (Veg), Fruits
- Not sufficient if you are exercising constantly

Cholesterol - Its Role in the Body and Transport

Study Questions:

- What is cholesterol and what are its roles in the body?
- Where is cholesterol made in the body and how does this relate to food sources?
- How is cholesterol absorbed from the digestive tract and how is cholesterol transported in the circulation?
- What is the primary carrier of cholesterol in the circulation?
- How is cholesterol potentially removed from the circulation?

Cholesterol: Type of Fat

- Sterol → Cholesterol
- **Cholesterol**: fatty wax-like substance in the body that performs essential functions in:
 - Membrane structure
 - Cell membrane contains cholesterol
 - Found only in Animal products have cholesterol
 - Precursor to bile acids - made in liver - stored gallbladder
 - Precursor to sex hormones
 - Precursor to Vitamin D
- NOT AN ESSENTIAL NUTRIENT - we can make our own!
 - Made in the liver!

Sources

- Self-production: 1,000-1,500 mg daily
- Diet- food products from animals (have a liver!!!!): 200-400mg daily
- Sources:
 - Meat
 - Organ Meats (rich bc more cells!)
 - Eggs
 - Dairy
 - Seafood

Fat & Cholesterol: Transportation through the Body

- Chylomicron → VLDL → LDL: delivers cholesterol to all body cells
 - LDL: Low Density Lipoprotein! (from liver!) - “bad cholesterol” (not really!)
- HDL: (from liver!) smaller, heavier - picks up cholesterol from dead and dying cell - “the good cholesterol” → back to liver → convert to bile & leave the body
 - More HDL = Lowers risk of heart disease!
- CANNOT EAT THESE THINGS - THEY ARE WITHIN YOU! No food source!
- Lipoprotein: transport form of fat & cholesterol in the circulation

Genetic Disorder w/ Cholesterol Transport

- Hypercholesterolemia: early death - cholesterol deposits!

Dietary Supplement: lower circulating levels of cholesterol

- Fish oil capsules
- Niacin
- Psyllium: water soluble fiber that takes cholesterol from the body