

24 Animal, Vegetable, Mineral



Did you read chapter 24 before coming to class?
A. Yes
B. No

IT'S ALL CHEMISTRY



Atomic-Level Structure of Complex Materials Determines Properties

Animals & Vegetables

Fats (obtained from animals)
&
Oils (obtained from vegetables)

Covalent Molecules
Whose Melting Points
Are Related To Behavior
in Our Bodies

Minerals

Silicate Mineral Family

Primarily Ionic Material

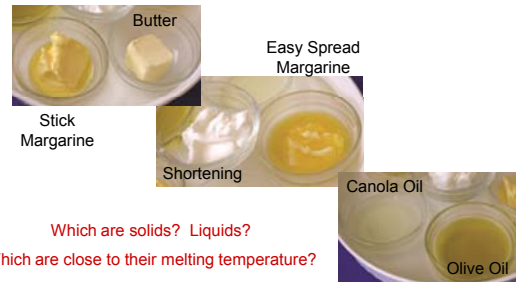
Different Arrangements of
 SiO_4^{4-} units leads to
stringy, sheet-like
and chunky minerals

How to read a nutrition label: Margarine and Olive oil

Nutrition Facts	
Serving Size 1 TBSP (14g) Servings Per Container 32	
Amount Per Serving	
Calories	100
% Daily Value*	
Total Fat	11g 17%
Saturated Fat	2g 10%
Polyunsaturated Fat	4g
Monounsaturated Fat	3g
Cholesterol	0mg 0%
Sodium	160mg 7%
Total Carbohydrate	0g 0%
Protein	0g
Vitamin A 10%	
<small>Not a significant source of cholesterol, dietary fiber, sugars, vitamin C, calcium, and iron.</small>	
<small>*Percent Daily Values are based on a diet of 2,000 calories per day.</small>	

Nutrition Facts	
Serving Size 1 Tbsp (15 ml) Servings per Container 33	
Amount Per Serving	
Calories	120
% Daily Value*	
Total Fat	14g 22%
Saturated Fat	2g 10%
Polyunsaturated Fat	2g
Monounsaturated Fat	10g
Cholesterol	0mg 0%
Sodium	0mg 0%
Total Carbohydrate	0g 0%
Protein	0g
<small>Not a significant source of cholesterol, dietary fiber, sugars, vitamin A, vitamin C, calcium, and iron.</small>	
<small>*Percent Daily Values are based on a diet of 2,000 calories per day.</small>	

Fats and oils at room temperature – What observations can we make?

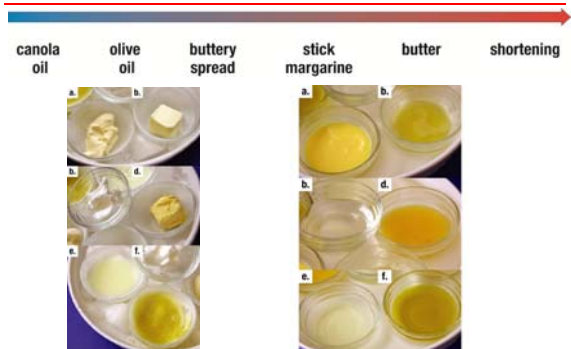


Which are solids? Liquids?
Which are close to their melting temperature?

Fats and Oils differ in Their Physical State at Room Temperature

Chicken Fat & Marbling in Meat	Solid	Fat
Shortening (Crisco)	Solid	Fat
Butter	Solid	Fat
Margarine	Liquid-Solid mix	
"Promise" or "Benacol"	Liquid-Solid mix	
Olive Oil	Liquid	Oil
Canola Oil	Liquid	Oil
Fish Oil	Liquid	Oil

Sequence of melting temperatures



Sequence of Melting Temperatures

canola oil olive oil buttery spread stick margarine butter shortening

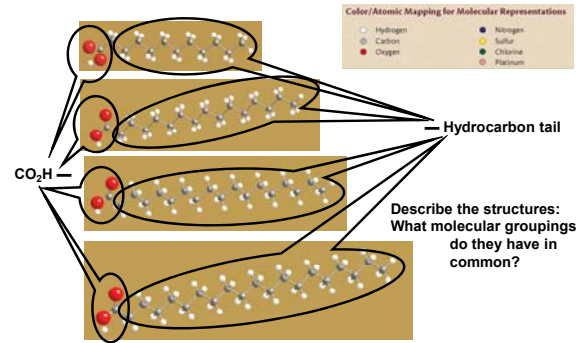
WHY THIS SEQUENCE? UNDERLYING MOLECULAR STRUCTURES

Heart Healthy Sequence (approximately)

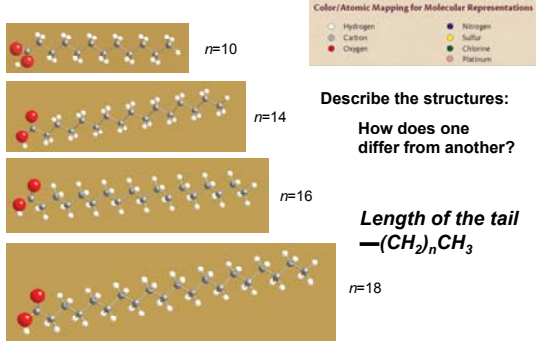
canola oil olive oil buttery spread stick margarine butter shortening

maybe the best for you

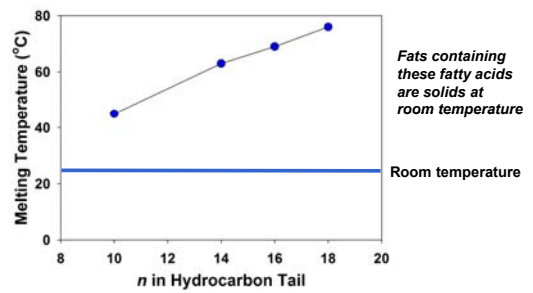
Fatty Acids – major component of fats and oils



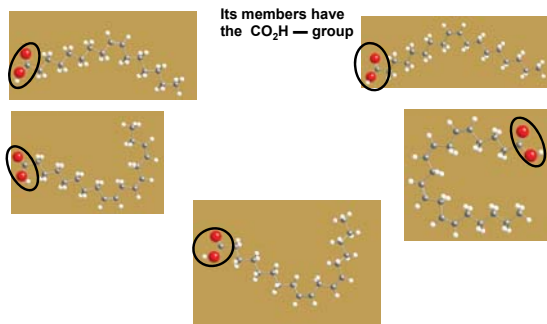
Fatty Acids – major component of fats and oils



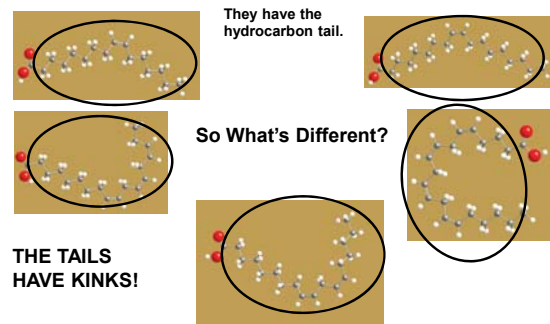
What difference does a tail make?



How do we get oils? (lower melting temperatures) A new family of fatty acids



How do we get oils? (lower melting temperatures) A new family of fatty acids



What causes the kinks?

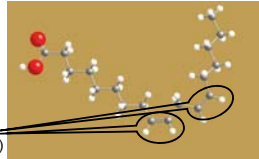
Differences in the Tails

- Saturated fatty acids**
 No kinks
- Unsaturated fatty acids**
 One kink (mono)
 More than 1 kink (poly)



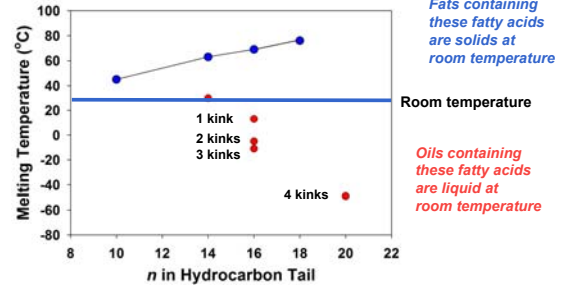
each C has 2 H atoms
 $C-C-C-C$
 (carbon-carbon single bonds)

Some C have only 1 H atom
 $C=C-C-C$
 (carbon-carbon double bonds)



Kinks occur at double bonds.
 (True of Unsaturated Fatty Acids that are found in Nature.)

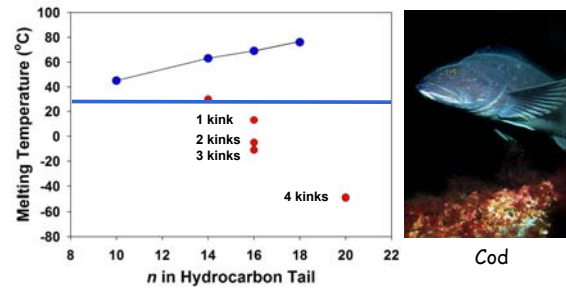
What difference does a kink make?



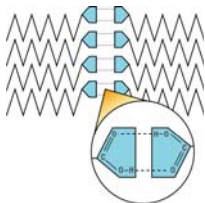
Fish that swim in the cold north Atlantic would have what type of fatty acid in their blood?

- Saturated fatty acids with short tails
- Saturated acids with long tails
- Unsaturated acids with lots of double bonds

If you were a fish, swimming in the cold North Atlantic, what would you want flowing through your veins?

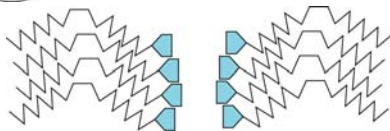


Why do kinks make a difference?



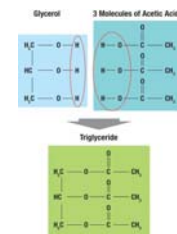
Molecules without kinks can pack closer together.

RESULT:
 more & stronger van der Waals forces between tails
 stronger hydrogen bonding between CO_2H groups on different molecules
 Strong forces mean high melting temperatures

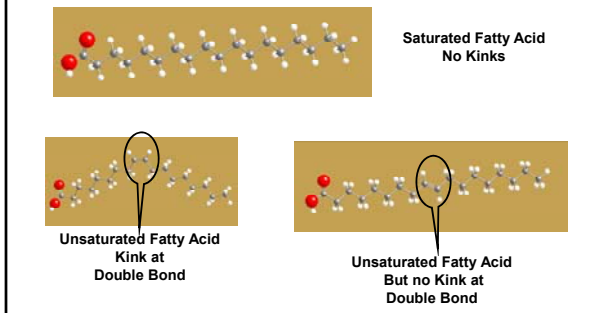


What happens in your body? Triglycerides

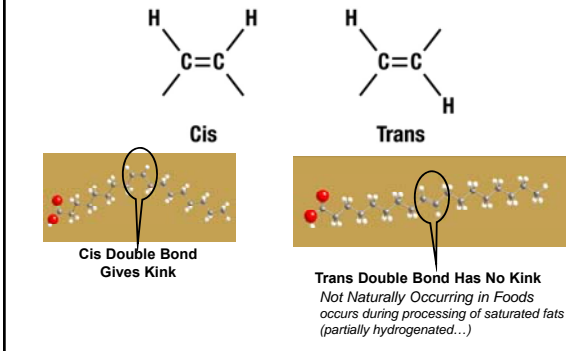
- Three fatty acids combine with glycerol to form a triglyceride
 - If the fatty acids are saturated, this is saturated fat
- Saturated fats are believed to cause heart and artery disease, increased cholesterol, and other health troubles



Trans-Fatty Acids – doing away with the kinks



Cis vs Trans Double Bonds – Where are the H atoms?

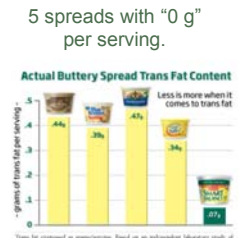


Trans Fats

- Trans fat behaves like saturated fat by raising the level of "bad cholesterol" which increases the risk of coronary heart disease. It has the additional effect of decreasing levels of HDL, the "good" lipoprotein which helps remove cholesterol from arteries.
- The majority of clinical research reports have suggested that trans fats may be worse for the body than saturated fats; in fact, the 2002 summary statement by the Institute of Medicine on trans fatty acids concluded that there was no safe level of trans fatty acids in the human diet.
- The major sources in the American diet are commercially baked goods, like cakes, cookies, doughnuts, crackers and pies.

When rounding can mislead...

- FDA guidelines allow food producers to round to the nearest gram per serving.
- By fiddling with the serving size, you can claim 0 grams per serving!



Good Fats vs Bad Fats

Good Fats
unsaturated fats with kinks
low melting points
don't clog your arteries
good for your brain

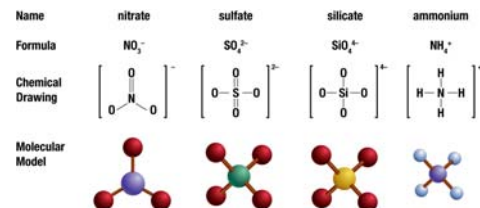
olive oil
cold water fish

Bad Fats
Fats without kinks
saturated & trans-fats
high melting points
solidify and block blood flow

lard
shortening
prime rib

Molecular Ions

- Covalent bonding within the ion
- Stronger covalent bonds if number of electrons doesn't match total nuclear charge \Rightarrow resulting molecule is charged
- These charged molecules assemble together in crystal lattice like ionic materials
- Examples: nitrate, silicate

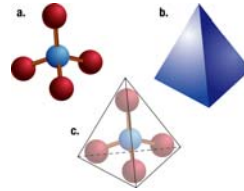


What are rocks made of?

- **MINERALS!**
 - Most rock forming mineral belong to a family of minerals called "SILICATES"
 - They all utilize the SiO_4^{4-} covalently bonded molecular ion.
 - This molecular ion may be put together in many different ways (just like the C and H molecules of organic matter)
 - Chains
 - Rings
 - Sheets
 - Isolated SiO_4 groups

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The basis of Silicate Minerals: The Silicate ion, SiO_4^{4-}



Tetrahedral arrangement of oxygen atoms around a central silicon atom

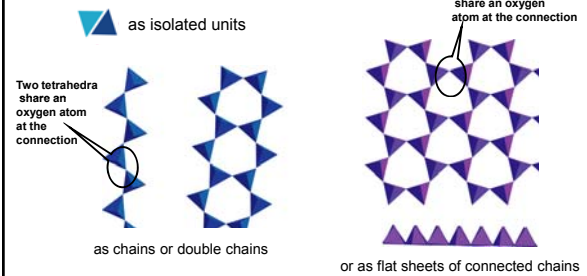
What else do we need to make silicate minerals?

- The SiO_4^{4-} group is negatively charged, so...
 - We need some positive charge to make the mineral electrically neutral
 - K^+ and Na^+
 - Fe^{2+} , Ca^{2+} , and Mg^{2+}
 - Al^{3+}
 - Ti^{4+}
 - Or we need to arrange the SiO_4^{4-} groups so that the mineral is neutral

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SiO_4^{4-} - a versatile connector

It is found in minerals



or as flat sheets of connected chains

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Quartz

Asbestos

Mica

Clay

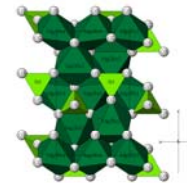
- Chains
- Sheets
- Framework

Which structures do these minerals have? How can you tell?

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Minerals with Isolated Silica Tetrahedra

- Olivine - $(\text{Mg,Fe})_2\text{SiO}_4$
 - This is the main mineral component in the Earth's mantle
 - How does this mineral achieve neutral charge?
 - How are the SiO_4^{4-} groups arranged in the mineral?
 - Why do most olivine crystals contain both Mg and Fe?

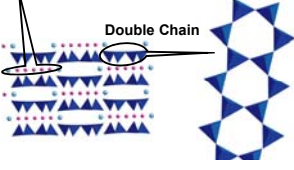


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Formation of Fibers

Positively Charged Ions (Ca^{2+} , Mg^{2+})

Double Chain



Asbestos

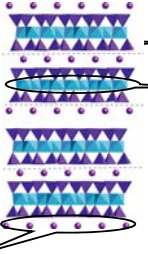


Strongly-bound unit: "Submarine sandwich"

Weaker interactions between units

You can pull apart fibers with your fingers

Formation of Sheets





silicate sheets with negative charges

Small Al^{3+} ions

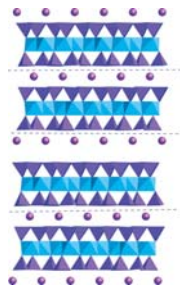

Strongly-bound unit

You can pull apart sheets with your fingers


Positively Charged Ions, K^+ and/or Na^+

Which of these minerals do you think contains a transition metal?

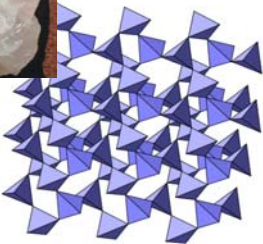



Muscovite mica



Biotite mica

Formation of Irregular Chunks



Tetrahedron-tetrahedron connections extend in 3 directions. Interactions are equally strong in all directions.

You need a hammer to break crystal into smaller chunks

