

Organic Molecules Functional Groups

Lipids:
terpenes, fats, oils, waxes, steroids

Dr. Ron Rusay



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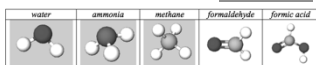
Lipids: Fats & Oils

Lipids are natural plant & animal products more soluble in non-polar solvents like gasoline than in water.

Combustion (burning) of one gram: of carbohydrate produces 4 to 5 Calories, protein produces 4 to 5 Calories, **fat produces 9 to 10 Calories — more than twice that of either sugars or proteins.**

Lipids Common Functional Groups

Name	General Formula
Alcohols	R-OH (R is very large, note: glycerol is not a lipid)
Ethers	R-O-R'
Amines	R-NH ₂
Carboxylic Acids	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{OH} \end{array}$ (R is very large)



Lipids Common Functional Groups

Name	General Formula
Aldehydes	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{H} \end{array}$
Ketones	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{R}' \end{array}$
Carboxylic Acids	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{OH} \end{array}$ (R is very large)
Esters	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{OR}' \end{array}$ (R is very large)
Amides	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{N} \begin{array}{l} \text{R}'' \\ \text{R}' \end{array} \end{array}$

Lipid Wordsearch

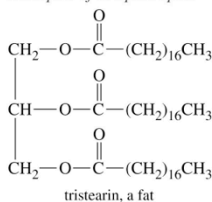
This puzzle contains 37 names, terms, prefixes and acronyms that describe lipids. They may be in any linear direction. Find and highlight these terms in the matrix below. "TRICACYLGLYCEROL" is already done for you. Then, correctly transfer them to the blanks in the description below the matrix. Use the letters remaining in the matrix to complete the sentence describing these molecules. Your answers will be revealed. The answers to the Lipid Wordsearch are found below. Good hunting!

N F A T T Y L A I T N E S S E S L
 I P O R E S E A C I D P T D A
 D A C Y L F A T X T I H A S A I N
 N O L Y T E C A I P I N S N E P O
 A S T P H E W E T N E S F A L L
 L F R I A C Y L G L Y C E R O L I
 G R S U E L O O X I D A T I O N
 A R T O L I M N S T E A R A T E
 T O E L P Y I I F M O S A I C I P
 S L R S S E P L T Y F F I N O P A S
 O P O L Y U M S A T U R A T E D
 R H I E D I L O R E T S E L O H C
 P N D S D T E R P E N E R P O S I

TRICACYLGLYCEROL are R ___ s of G ___
 G ___ and O ___ with glycerol. R ___ then
 to make G ___ R ___ O ___ cleaves their ___
 C ___ A ___ I ___ A ___ The R ___ A ___ I ___ F ___
 A ___ s include ___ and ___ which
 are R ___ with 2 or 3 C ___ double bonds.
 They are precursors for V ___ hormones and
 maintain F ___ M ___ membranes as part of
 F ___ and G ___ Hydrogenating
 such V ___ makes C ___ which are called F ___
 double bonds. L ___ is a R ___ Polymer of ___
 from the V ___ and other simple L ___ like the
 and G ___ hormones.
 Use the remaining 16 letters to fill in the following sentences:

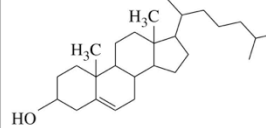
Molecular Formula: C₅₇H₁₁₀O₆
Molecular weight: 891.4797

Examples of complex lipids



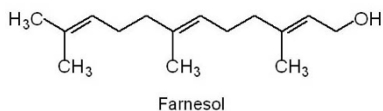
$\Delta_c H^\circ_{\text{solid}}$	-35806.7 ± 1.8	kJ/mol
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Examples of simple lipids



Question

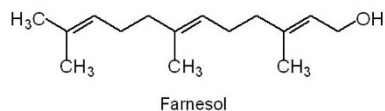
- Farnesol is a lipid that is classified as a



- A) C₁₀, monoterpene, aldehyde.
- B) C₁₅, sesquiterpene, aldehyde.
- C) C₁₀, monoterpene, alcohol.
- D) C₁₅, sesquiterpene, alcohol.

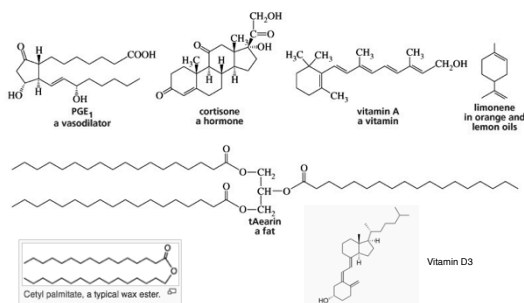
Answer

- Farnesol is a lipid that is classified as a



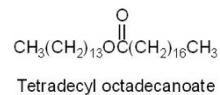
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Lipid Examples



Question

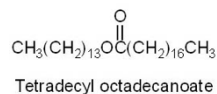
Tetradecyl octanoate is classified as a(n)



- A) ester (wax). B) fatty acid.
- C) ketone (terpene). D) steroid.

Answer

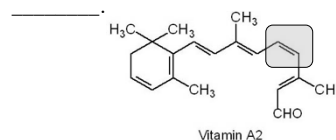
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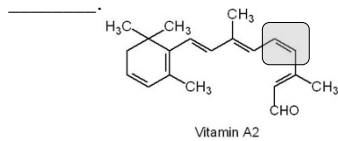
Vitamin A2 binds to opsin. It is a(n) _____ and has an important C=C double bond, which is _____.



- A) alcohol, trans
- B) alcohol, cis
- C) aldehyde, trans
- D) aldehyde, cis

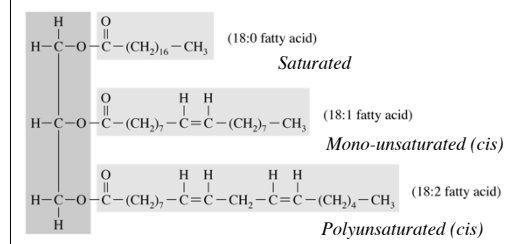
Answer

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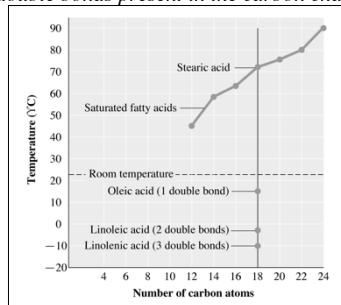


- A) alcohol, trans
- B) alcohol, cis
- C) aldehyde, trans
- D) aldehyde, cis

Structure of a mixed triacylglycerol in which three different fatty acid residues are present.



The melting point of a fatty acid depends on the length of the carbon chain and on the number of double bonds present in the carbon chain.



Question

Which of the following statements regarding fatty acids is false?

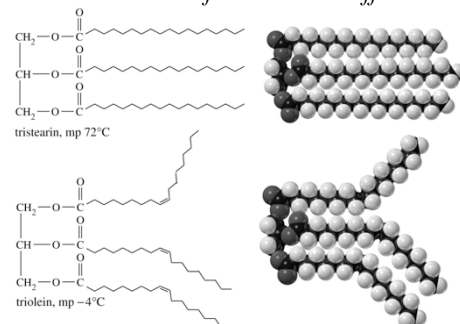
- A) Fatty acid can have one or more carbon-carbon double bonds.
- B) Naturally occurring fatty acids have an odd number of carbons.
- C) The configuration of the double bond(s) is (are) generally *cis* in naturally occurring fatty acids.
- D) Unsaturated fatty acids have a lower melting point than saturated ones.

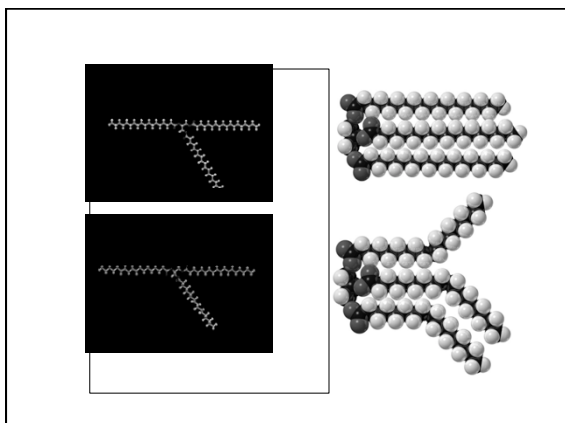
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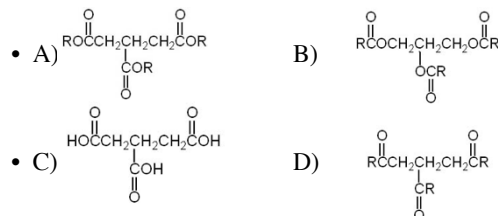
How do fat molecules differ?





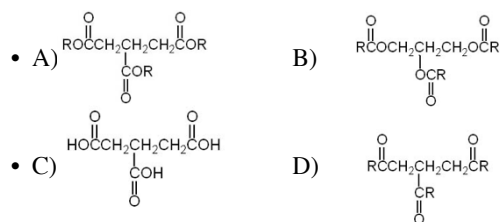
Question

- Which one of the following is a fat, triacylglycerol (triglyceride)?



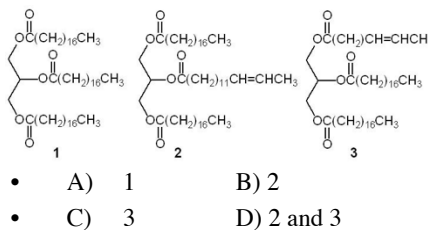
Answer

- Which one of the following is a fat, triacylglycerol (triglyceride)?



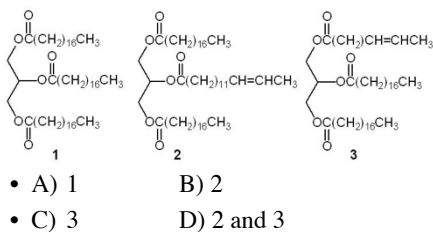
Question

- Which of the triglycerides below is (are) chiral?



Answer

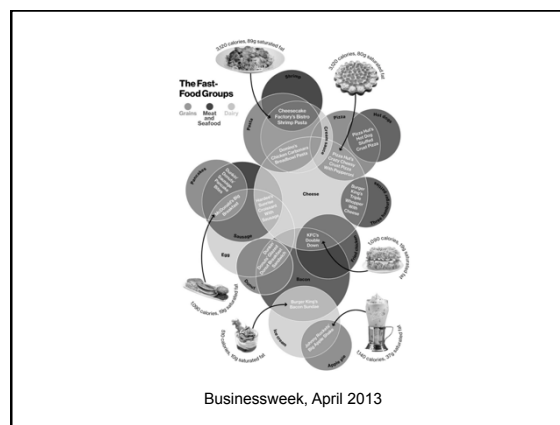
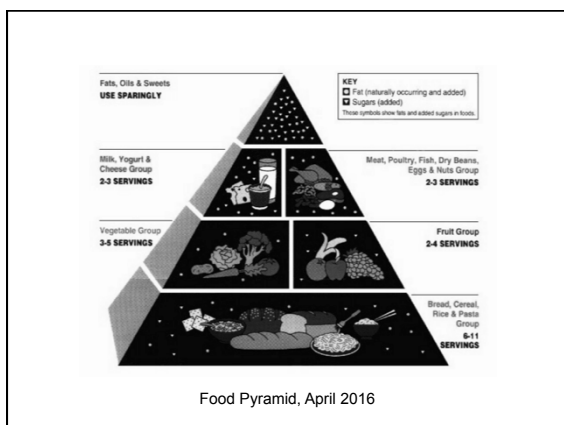
- Which of the triglycerides below is (are) chiral?



Composition of common fats and oils

Dietary fat/oil	% Saturated fat	% Monounsaturated fat	% Polyunsaturated fat
Canola oil	6	58	36
Safflower oil	9	13	78
Sunflower oil	11	20	69
Corn oil	13	25	62
Olive oil	14	77	9
Soybean oil	15	24	61
Peanut oil	18	48	34
Cottonseed oil	27	19	54
Lard	41	47	12
Palm oil	51	39	10
Beef tallow	52	44	4
Butterfat	66	30	4
Coconut oil	92	6	2

The collapse of movie theater popcorn sales!



The human body is 60-70 percent water, blood is ~90 percent, the brain and muscles are ~75 percent , and bones are ~20 percent by mass. * A human can survive for a month or more without eating food, but only 1-2 weeks without drinking water.

How much energy is required to raise the water in your body from 25°C (average room temperature) to 37°C (average body temperature [that is, chemical -biological temperature])? Assume that there is the equivalent of 5 liters of water, $d = 1.0 \text{ g/mL}$ in your body. The heat capacity of water is $4.184 \text{ J/g}^\circ\text{C}$ ($1.00 \text{ cal/g}^\circ\text{C}$); ($0.001 \text{ Cal/g}^\circ\text{C}$); ($0.001 \text{ kcal/g}^\circ\text{C}$)

How many grams of fat would need to be burned? (9 Cal/g)

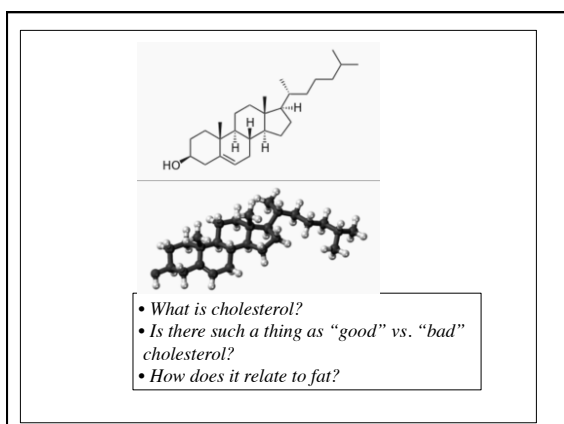
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 $(37^\circ - 25^\circ\text{C}) * 5,000 \text{ mL} * 1.0 \text{ g/mL} * 4.184 \text{ J/g}^\circ\text{C} = 250 \text{ kJ} = 60 \text{ Cal}$

How many grams of fat would need to be burned? (9 Cal/g)

$$60 \text{ Cal} / 9 \text{ Cal/g} = 6.7 \text{ g}$$

... but how long does it last before you need more?



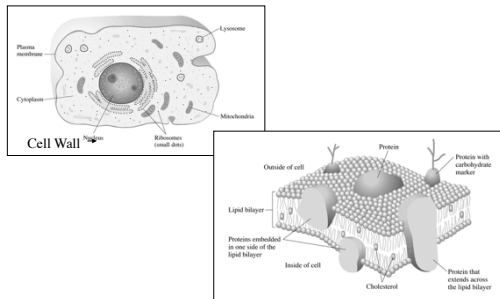
Total Cholesterol Level	Category
Less than 200mg/dL	Desirable
200-239 mg/dL	Borderline high
240mg/dL and above	High

LDL (Bad) Cholesterol Level	LDL Cholesterol Category
Less than 100mg/dL	Optimal
100-129mg/dL	Near optimal/above optimal
130-159 mg/dL	Borderline high
160-189 mg/dL	High
190 mg/dL and above	Very High

HDL (Good) Cholesterol Level	HDL Cholesterol Category
Less than 40 mg/dL	A major risk factor for heart disease
40-59 mg/dL	The higher, the better
60 mg/dL and higher	Considered protective against heart disease

<https://www.nlm.nih.gov/medlineplus/magazine/issues/summer12/articles/summer12pg6-7.html>

Eukaryotic Cell and Cell Wall



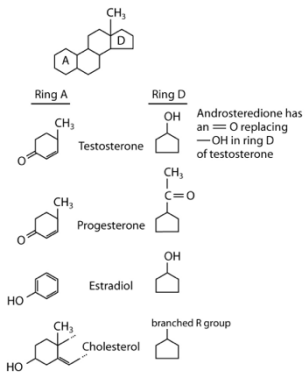
Question

- A major component of a lipid bilayer is
- A) carbohydrate
- B) wax
- C) cholesterol
- D) fat

Answer

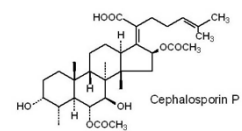
- A major component of a lipid bilayer is
- A) carbohydrate
- B) wax
- C) cholesterol
- D) fat

Steroids



Question

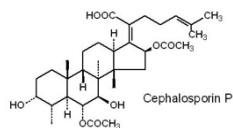
- The backbone structure of cephalosporin P is classified as a



- A) fatty acid.
- B) steroid.
- C) cholesterol.
- D) wax.

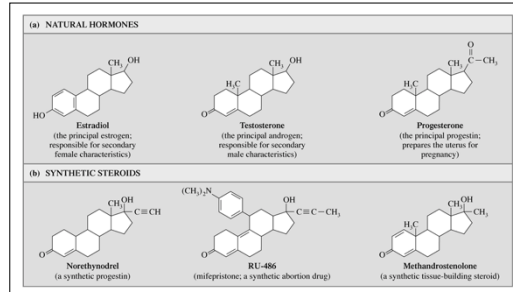
Answer

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- A) fatty acid.
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- C) cholesterol.
- D) wax.

Structures of selected steroids. (Sex hormones and synthetic compounds that have similar actions.)



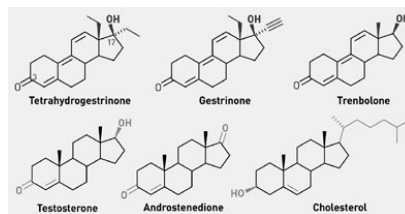
<http://www.cbsnews.com/videos/russias-dark-secret/>

Anabolic Steroids



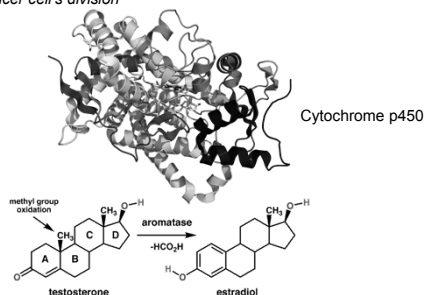
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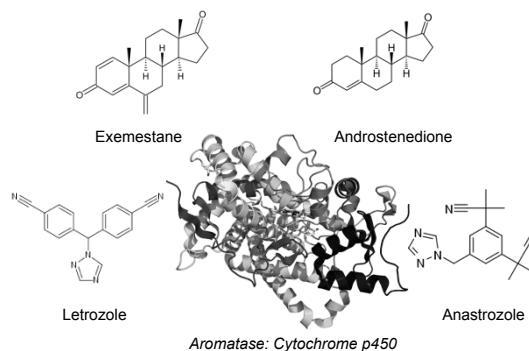


Enzyme Inhibition: Estrogen & Breast Cancer

Inhibiting a cancer cell's division



Enzyme Inhibition



Question

- Which of the following is not classified as a steroid?
- A) testosterone
- B) estradiol
- C) cortisone
- D) β -carotene

Answer

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- A) testosterone
- B) estradiol
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