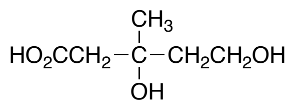
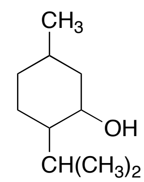
Chapter 19 Lipids

Solutions to In-Chapter Problems

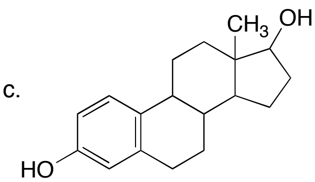
19.1 Recall from Example 19.1 that lipids contain many nonpolar C–C and C–H bonds and few polar bonds.

a. 

two polar OH groups
and a COOH
six carbons
not a lipid

b. 

one polar OH group
10 carbons
lipid

c. 

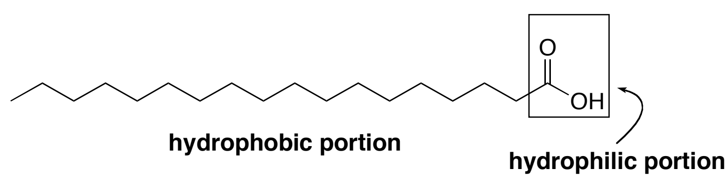
two polar OH groups
18 carbons
lipid

19.2 Since lipids contain many nonpolar C–C bonds, they are soluble in nonpolar and weakly polar organic solvents. Therefore, lipids are likely to be soluble in (a) CH_2Cl_2 and (c) $CH_3CH_2CH_2CH_2CH_3$. The 5% aqueous NaCl solution (b) is not a solution in which lipids are soluble since it is a polar solvent.

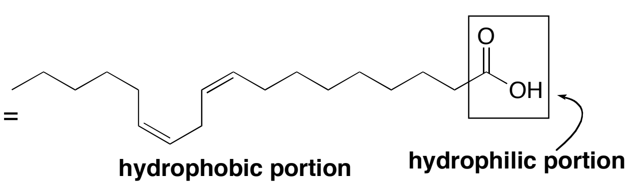
19.3 Answer the questions as in Example 19.2.

- Skeletal structures have a carbon at the intersection of two lines and at the end of every line. The double bond must have the cis arrangement in an unsaturated fatty acid.
- The nonpolar C–C and C–H bonds comprise the hydrophobic portion of a molecule and the polar bonds comprise the hydrophilic portion.
- For the same number of carbons, increasing the number of double bonds decreases the melting point of a fatty acid.

a. and b.

$CH_3(CH_2)_{16}COOH$ = 

A

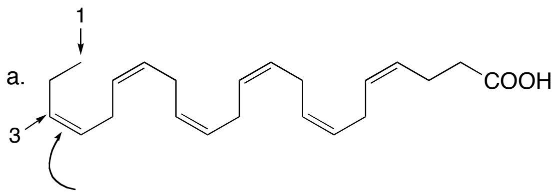
$CH_3(CH_2)_4CH{=}CHCH_2CH{=}CH(CH_2)_7COOH$ = 

B

c. **A** will have the higher melting point because the molecules can pack together better.

19.4 In omega-*n* acids, *n* is the carbon at which the first double bond occurs in the carbon chain, beginning at the end of the chain that contains the CH_3 group.

a.



b. first C=C at C3 → an **omega-3 acid**

19.5 In omega-*n* acids, *n* is the carbon at which the first double bond occurs in the carbon chain, beginning at the end of the chain that contains the CH_3 group.

first C=C at C9 → an **omega-9 acid**

a. $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH{=}CHCH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$

↑ 1 ↑ 2 ↑ 3 ↑ 4 ↑ 5 ↑ 6 ↑ 7 ↑ 8 ↑ 9

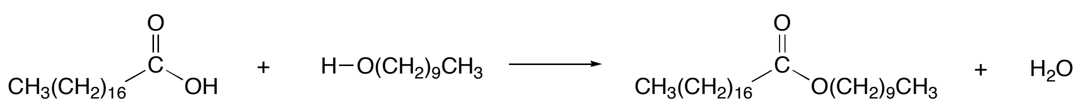
first C=C at C6 → an **omega-6 acid**

b. $CH_3CH_2CH_2CH_2CH_2CH{=}CHCH_2CH{=}CHCH_2CH{=}CHCH_2CH{=}CHCH_2CH_2CH_2COOH$

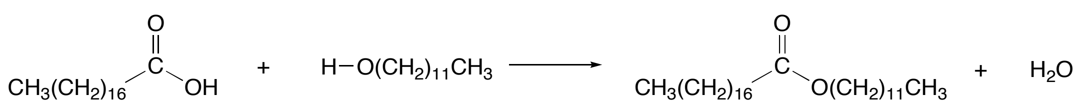
↑ 1 ↑ 2 ↑ 3 ↑ 4 ↑ 5 ↑ 6

19.6 Use the steps in Example 19.3 to draw each wax.

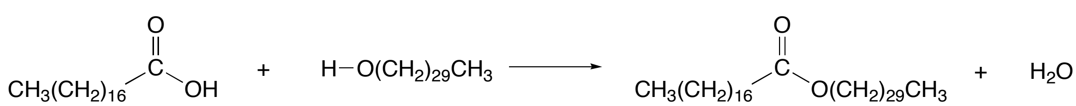
a.



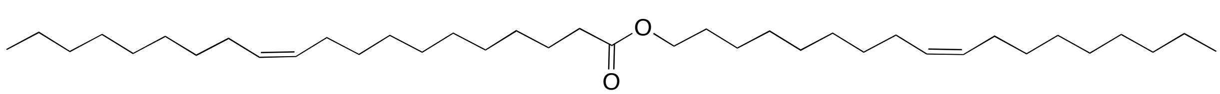
b.



c.

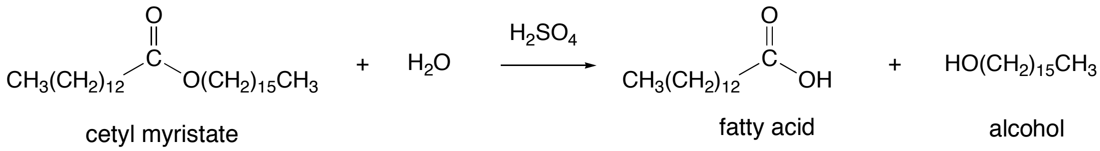


19.7 Draw the structure of the wax formed from eicosenoic acid.



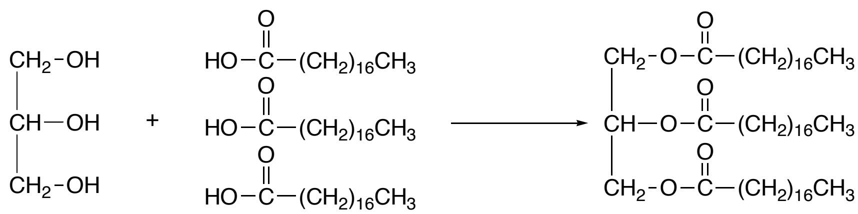
19.8 Beeswax is hydrophobic since it contains very long hydrocarbon chains. It will therefore be insoluble in a very polar solvent like water, only slightly soluble in the less polar solvent ethanol, and very soluble in the weakly polar solvent chloroform.

19.9 Draw the products of the hydrolysis of cetyl myristate.

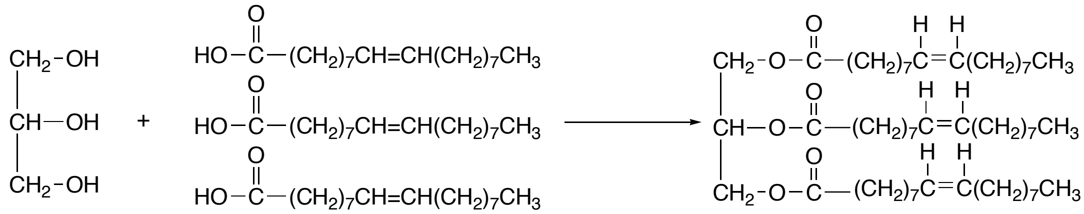


19.10 Draw the structure of each triacylglycerol as in Example 19.4.

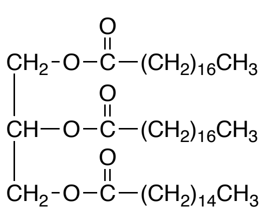
a.

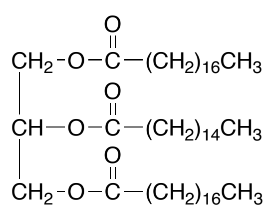


b.



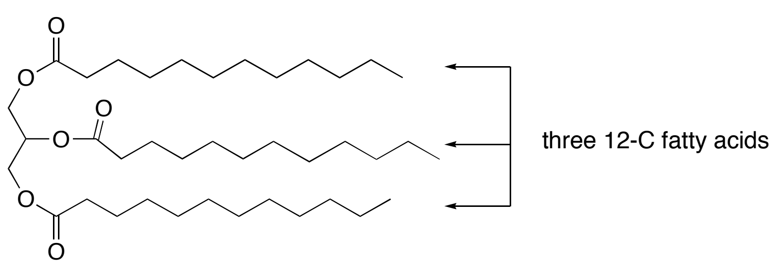
19.11 Draw two different triacylglycerols.



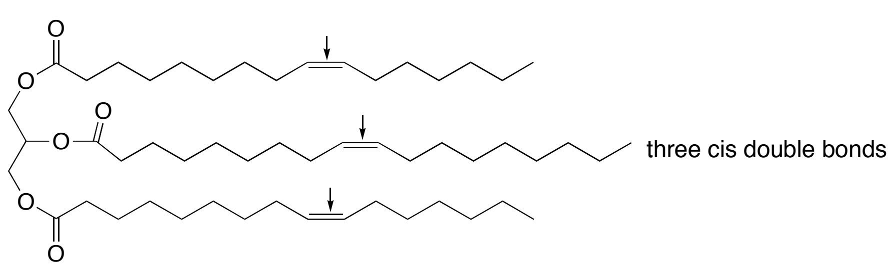


19.12 Draw a triacylglycerol to fit each description.

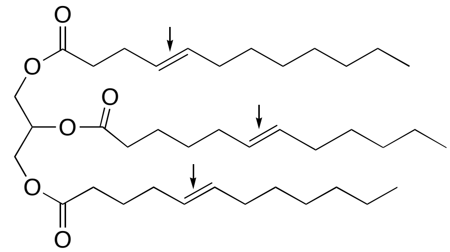
a.



b.



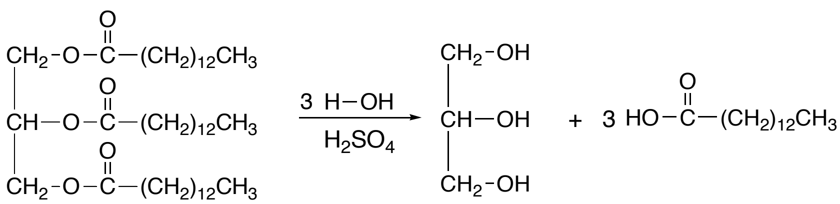
c.



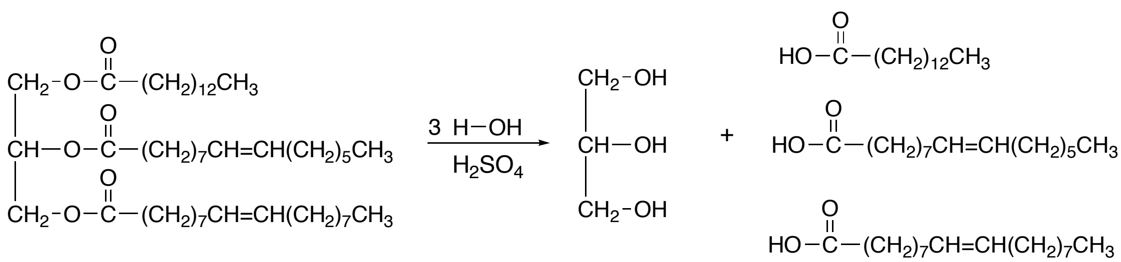
trans double bonds

19.13 Draw the products of the hydrolysis of each triacylglycerol as in Example 19.5.

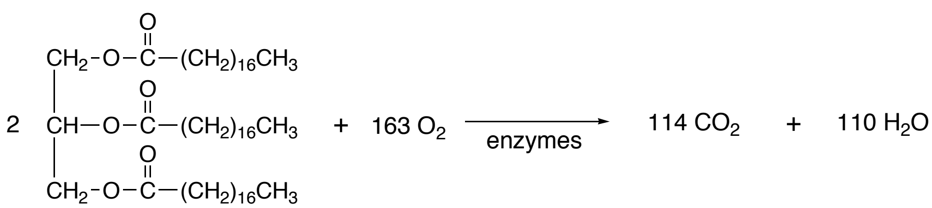
a.



b.



19.14 Balance the equation for the combustion of tristearin.

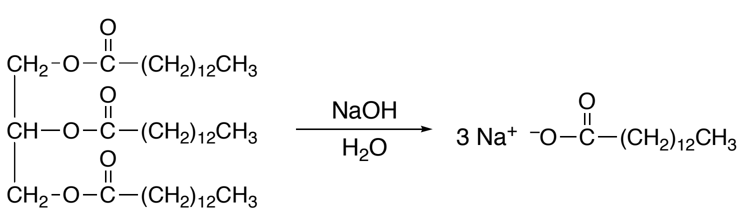


tristearin
$C_{57}H_{110}O_6$

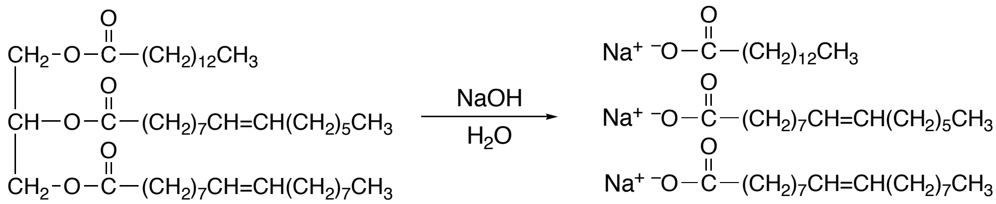
total of 338 O atoms on each side
220 H atoms
114 C atoms

19.15 Draw the soap prepared by saponification of each triacylglycerol.

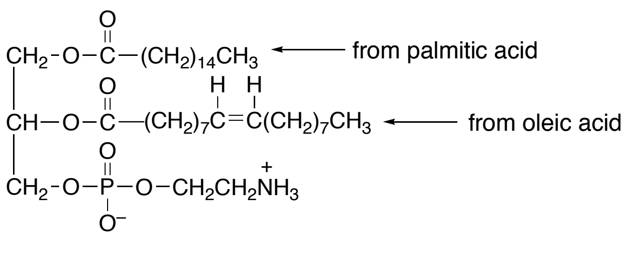
a.

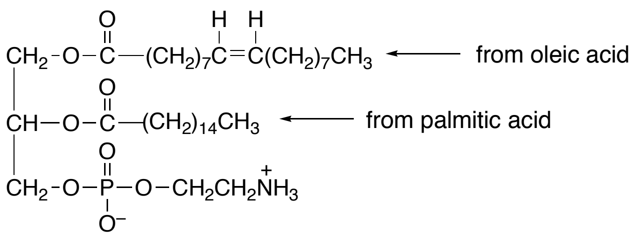


b.



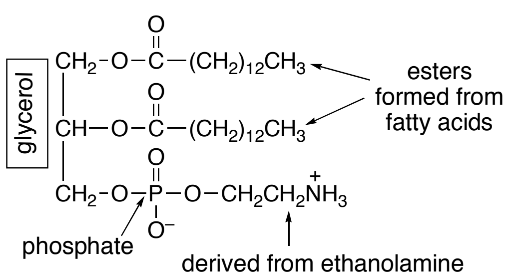
19.16 Draw the structure of the two cephalins as in Example 19.6.



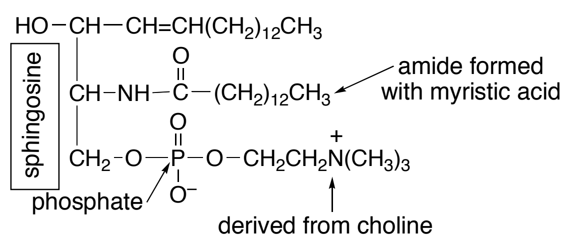


19.17 A **triacylglycerol** has glycerol as the backbone, and three nonpolar side chains formed from esters with fatty acids.
A **phosphoacylglycerol** has glycerol as the backbone, a phosphodiester on a terminal carbon, and two nonpolar side chains formed from esters with fatty acids.
A **sphingomyelin** has sphingosine as the backbone, one amide, and a phosphodiester on a terminal carbon.

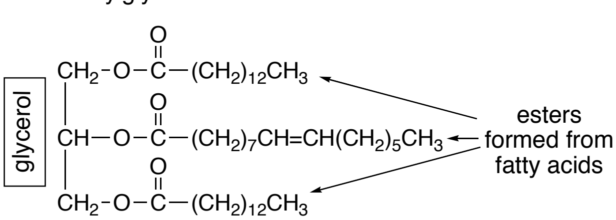
a. phosphoacylglycerol, cephalin



c. sphingomyelin



b. triacylglycerol



19.18 Phospholipids are present in cell membranes because they have an ionic polar head and two nonpolar tails, and can form a lipid bilayer needed for cell membrane function. Triacylglycerols are basically nonpolar compounds, so they have no polar head to attract water on the outside of a membrane.

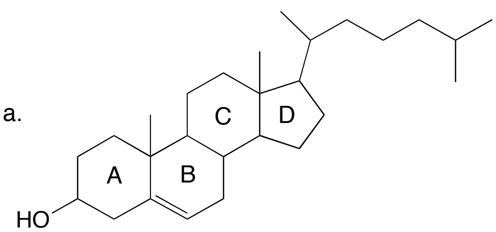
19.19 Membrane **A** is formed from the phospholipids linoleic and oleic acids, and will be more fluid or pliable because it contains unsaturated fatty acids. Membrane **B** is formed from the saturated fatty acids stearic and palmitic acids, which have no double bonds and therefore pack very tightly, making it more rigid.

19.20 Ions don't diffuse readily through the interior of the cell membrane because it is hydrophobic and ions are insoluble in a nonpolar medium.

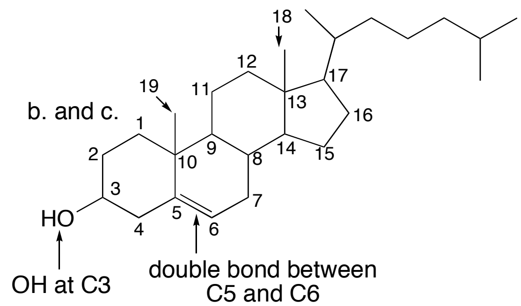
19.21 Cholesterol is a lipid since it contains many C–C and C–H bonds and it is insoluble in water.

19.22 Answer each question about cholesterol.

a.



b. and c.

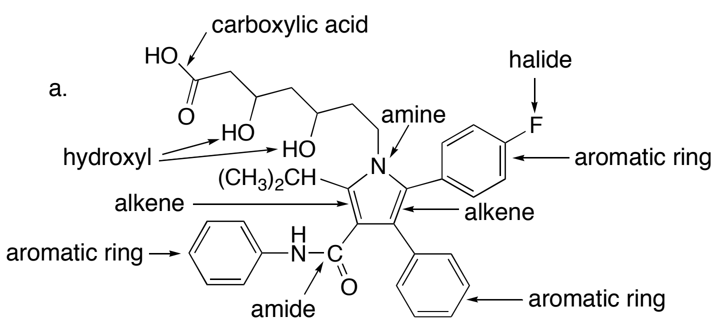


d. Cholesterol contains one polar C–O bond and one polar O–H bond from the polar OH group. The large hydrocarbon skeleton with nonpolar C–C and C–H bonds makes it water insoluble.

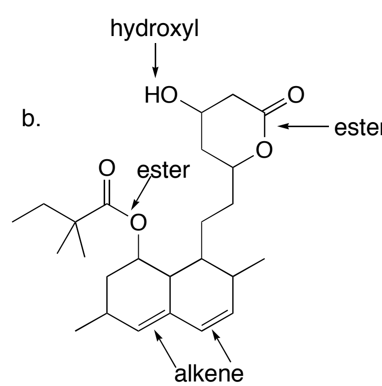
19.23 Triacylglycerols would be found in the interior of a lipoprotein particle, since this is the hydrophobic region of lipoproteins.

19.24 Label the functional groups.

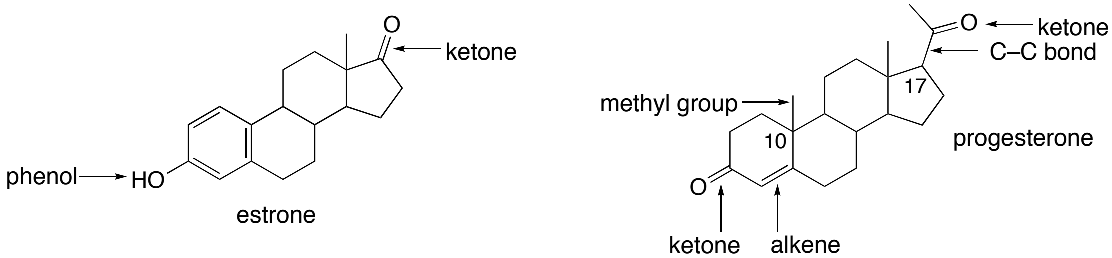
a.



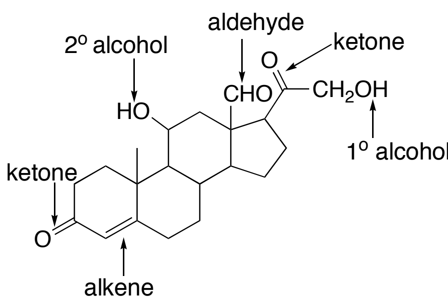
b.



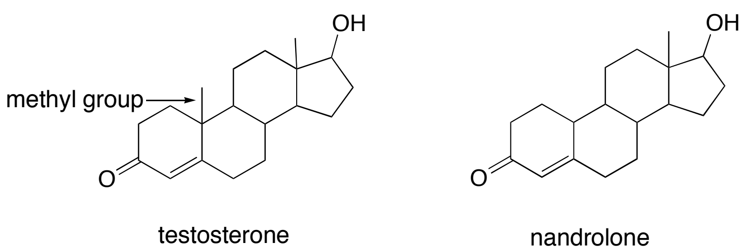
19.25 a. Estrone has a phenol (a benzene ring with a hydroxyl group) and progesterone has a ketone and C=C in ring A. Progesterone also has a methyl group bonded to C10.
b. Estrone has a ketone at C17 and progesterone has a C–C bond, which is attached to a ketone.



19.26 Label the functional groups in aldosterone.

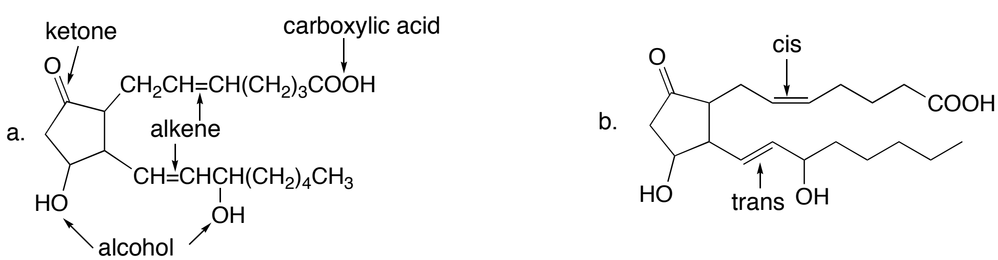


19.27 Testosterone has a methyl group at C10 that nandrolone lacks.



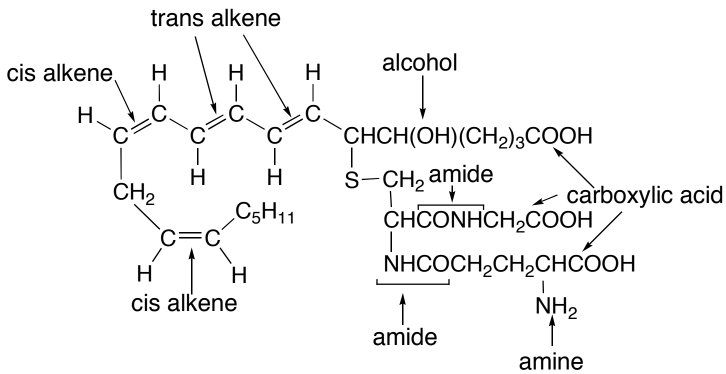
19.28 Water-soluble vitamins are excreted in the urine whereas fat-soluble vitamins are stored in the body. When a person ingests a large quantity of a water-soluble vitamin, much of it is excreted in the urine. When a person ingests a large quantity of a fat-soluble vitamin, it can be retained in the fat in the body, potentially building up to toxic levels.

19.29 Label the functional groups and draw the skeletal structure for PGE_2.



19.30 Label the functional groups and the double bonds as cis or trans in LTC_4.

a. and b.



Solutions to End-of-Chapter Problems

19.31 **Hydrolyzable lipids** include waxes, triacylglycerols, and phospholipids.
Nonhydrolyzable lipids include steroids, fat-soluble vitamins, and eicosanoids.

a. prostaglandin—nonhydrolyzable
b. triacylglycerol—hydrolyzable
c. leukotriene—nonhydrolyzable
d. vitamin A—nonhydrolyzable
e. phosphoacylglycerol—hydrolyzable
f. lecithin—hydrolyzable
g. cholesterol—nonhydrolyzable

19.32 **Hydrolyzable lipids** include waxes, triacylglycerols, and phospholipids.
Nonhydrolyzable lipids include steroids, fat-soluble vitamins, and eicosanoids.

a. eicosanoids—nonhydrolyzable
b. oleic acid—hydrolyzable
c. phospholipid—hydrolyzable
d. cephalin—hydrolyzable
e. wax—hydrolyzable
f. estrogen—nonhydrolyzable
g. PGE_1—nonhydrolyzable

19.33 A wax is hydrophobic. As a result, it is soluble in (b) CH_2Cl_2 and (c) $CH_3CH_2OCH_2CH_3$, both organic solvents, but insoluble in (a) water, which is polar.

19.34 A steroid would be soluble in (b) CCl_4 but insoluble in (a) blood plasma and (c) 5% NaCl solution.

19.35 For the same number of carbons, increasing the number of double bonds decreases the melting point of a fatty acid.

a. $CH_3(CH_2)_3CH{=}CH(CH_2)_7COOH$, $CH_3(CH_2)_{12}COOH$, $CH_3(CH_2)_{14}COOH$
b. $CH_3(CH_2)_5CH{=}CH(CH_2)_7COOH$, $CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$, $CH_3(CH_2)_{16}COOH$

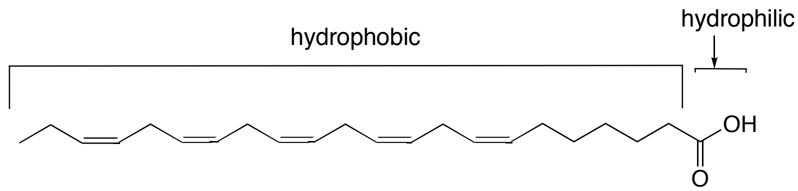
19.36 a. The hydrocarbon chain of a saturated fatty acid is comprised of carbon–carbon single bonds. The hydrocarbon chain of a monounsaturated fatty acid contains one carbon–carbon double bond. The hydrocarbon chain of a polyunsaturated fatty acid contains multiple carbon–carbon double bonds.

b. Stearic acid is a saturated fatty acid, oleic acid is a monounsaturated fatty acid and linoleic acid is a polyunsaturated fatty acid.
c. Of the fatty acids in part b, linoleic acid has the lowest melting point and stearic acid has the highest melting point.

19.37 a. Increasing the number of carbon atoms increases the melting point of fatty acids.
b. Increasing the number of double bonds decreases the melting point of fatty acids.

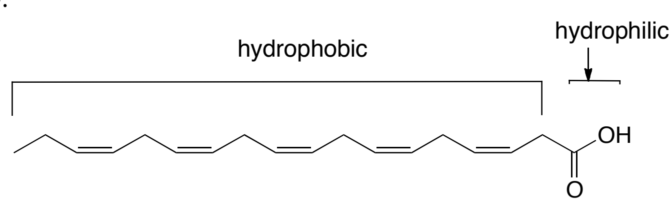
19.38 Cis double bonds induce kinks in the long hydrocarbon chain, making it difficult for the molecules to pack closely together in a solid. The larger the number of cis double bonds, the lower the melting point. The first fatty acid has one trans double bond, whereas the second fatty acid as one cis double bond. The first fatty acid will have a higher melting point than the second fatty acid.

19.39 Answer each question about 7,10,13,16,19-docosapentaenoic acid.
a. and b.



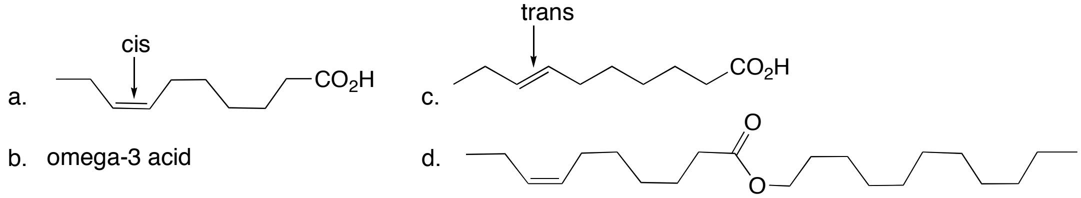
c. The melting point of the cis isomer would be lower than the melting point of the trans isomer.
d. This fatty acid will be a liquid at room temperature.
e. 7,10,13,16,19-Docosapentaenoic acid is an omega-3 fatty acid because there is a double bond at the third C from the left (numbered from the CH_3 group).

19.40 Answer each question about 3,6,9,12,15-octadecapentaenoic acid.
a. and b.

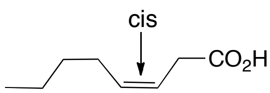


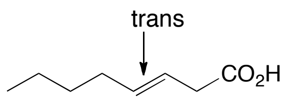
c. The melting point of this fatty acid will be lower than the melting point of oleic acid because this fatty acid has multiple double bonds.
d. This fatty acid will be a liquid at room temperature.
e. 3,6,9,12,15-Octadecapentaenoic acid is an omega-3 fatty acid because there is a double bond at the third C from the left (numbered from the CH_3 group).

19.41

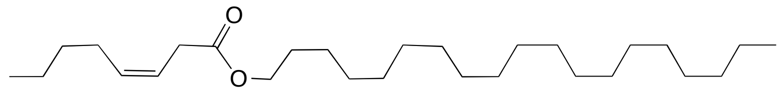


19.42

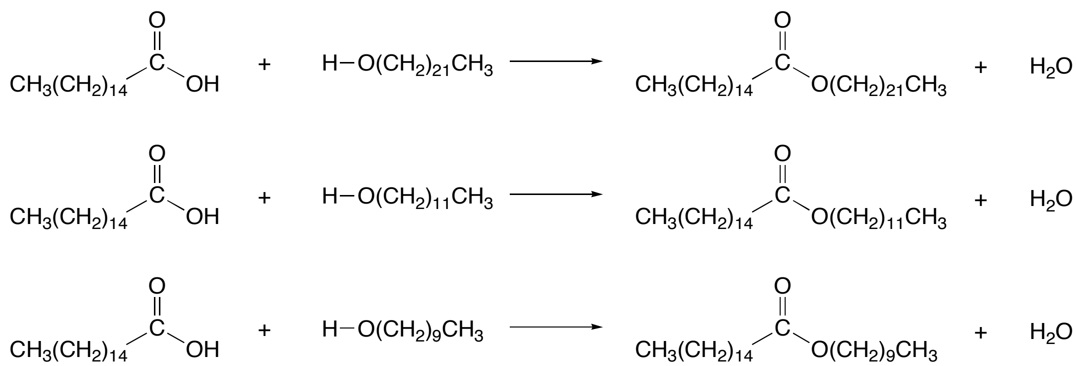
a. 

c. 

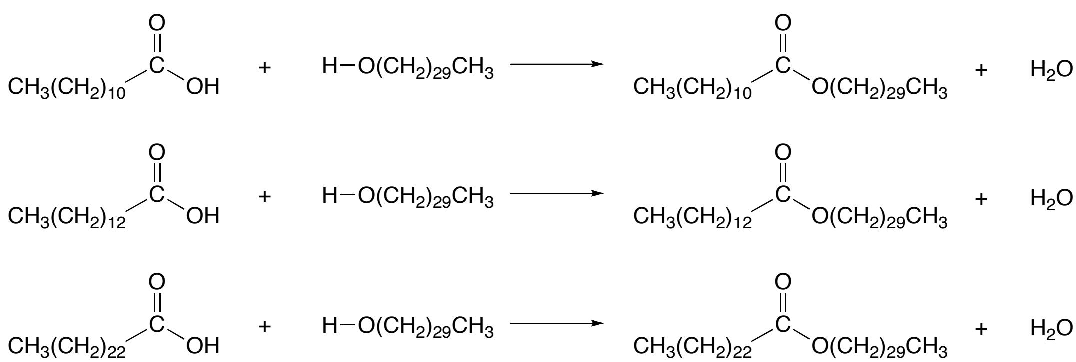
b. omega-5 acid

d. 

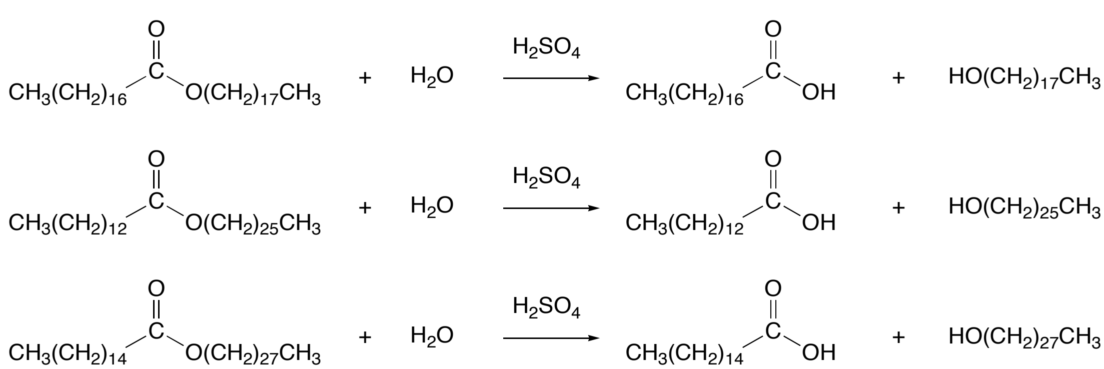
19.43 Draw the structure of each wax.

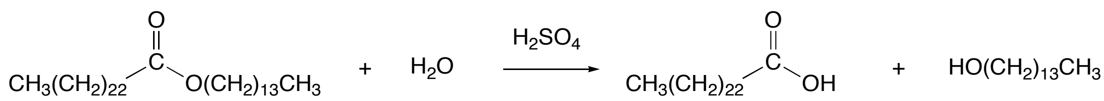


19.44 Draw the structure of each wax.

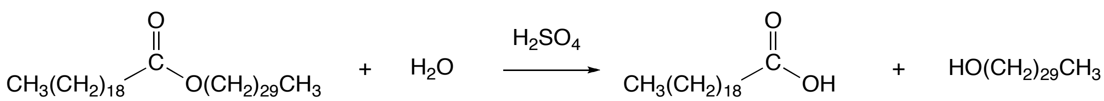


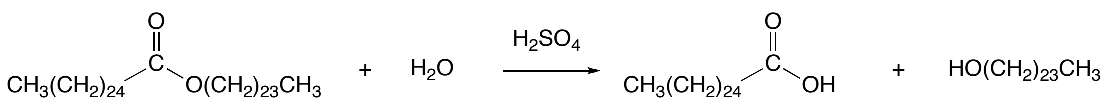
19.45 Draw the products of the hydrolysis of each wax.

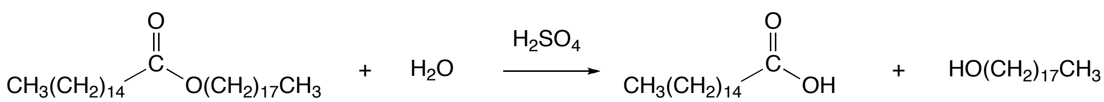


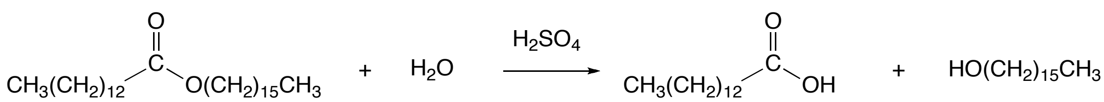
d. 

19.46 Draw the products of the hydrolysis of each wax.

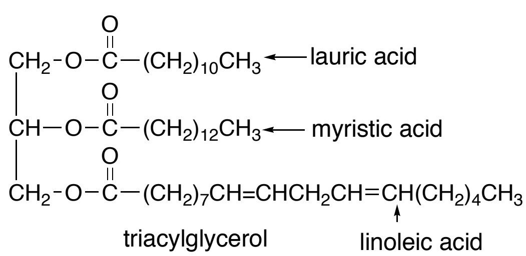
a. 

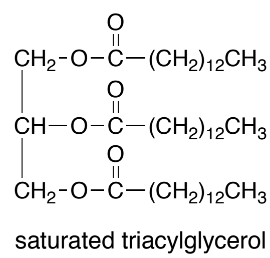
b. 

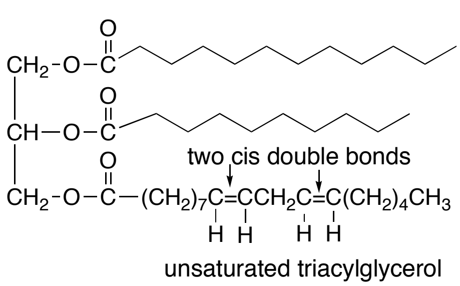
c. 

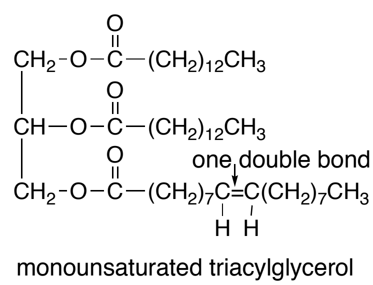
d. 

19.47 Draw a triacylglycerol that fits each description.

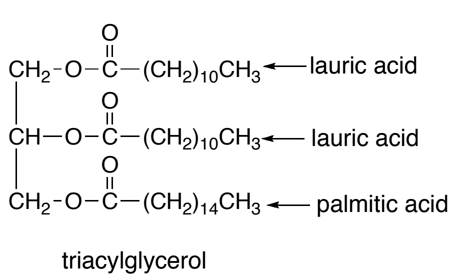
a. 

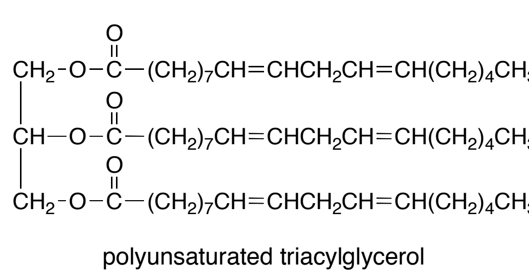
c. 

b. 

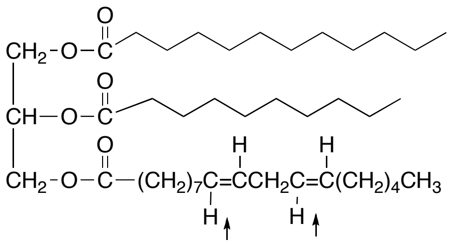
d. 

19.48 Draw a triacylglycerol that fits each description.

a. 

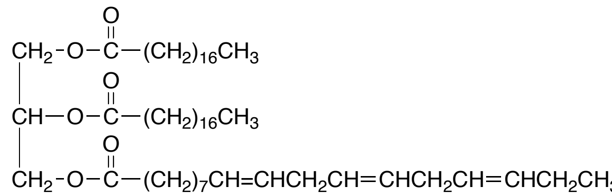
b. 

c.



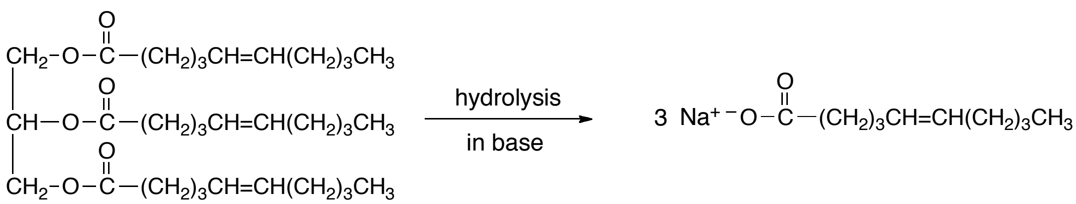
two trans double bonds
trans triacylglycerol

d.

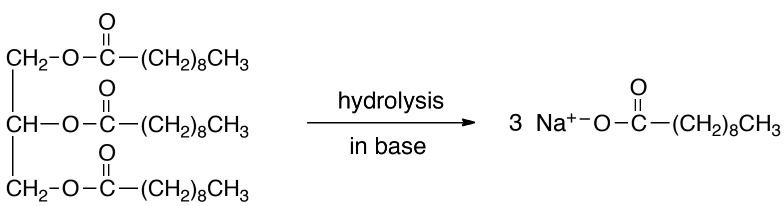


unsaturated triacylglycerol

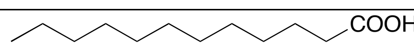
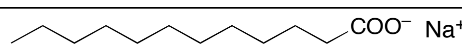
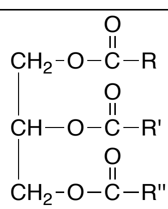
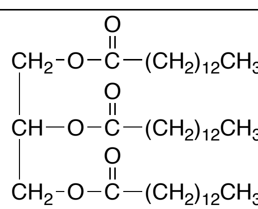
19.49 Draw the triacylglycerol that fits the description.



19.50 Draw the triacylglycerol that fits the description.



19.51 Answer each question.

Compound	a. General structure	b. Example	c. Water soluble (Y/N)	d. Hexane soluble (Y/N)
[1] Fatty acid	RCOOH		N	Y
[2] Soap	$RCOO^{-}Na^{+}$		Y	N
[3] Wax	RCOOR'		N	Y
[4] Triacylglycerol			N	Y

19.52 Answer each question about fats and oils.

a. Fats and oils are both derived from fatty acids and are triacylglycerols (i.e., they contain three ester groups).

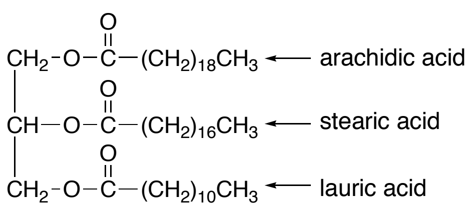
b. Fats contain few carbon–carbon double bonds, whereas oils contain a larger number of carbon–carbon double bonds.

c. Fats have higher melting points and are solids at room temperature. Oils have lower melting points and are liquids at room temperature. The melting point decreases as the number of carbon–carbon double bonds increases.

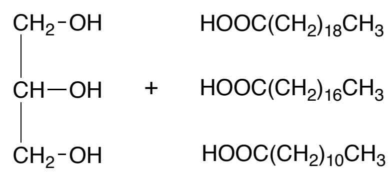
d. Natural sources of fats include lard, butter, and whale blubber. Natural sources of oils include canola oil, peanut oil, coconut oil, and fish oils.

19.53 Answer each question about the triacylglycerol.

a.



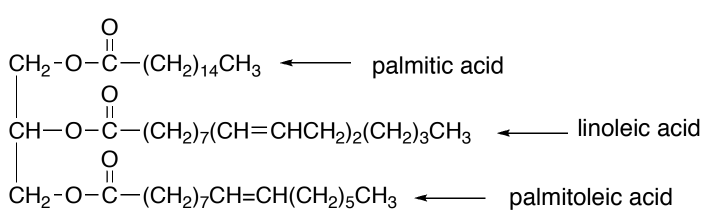
e.



b. It would be a solid at room temperature since it is formed from saturated fatty acids.
c. The long hydrocarbon chains are hydrophobic.
d. The ester linkages are hydrophilic.

19.54 Answer each question about the triacylglycerol**.**

a.

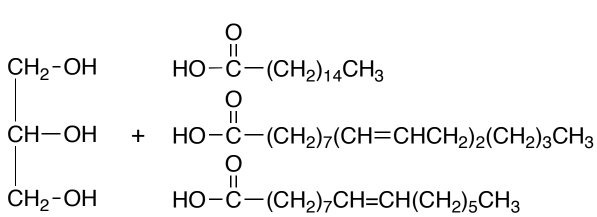


b. It would be a liquid at room temperature because it is formed from two unsaturated fatty acids and one saturated fatty acid.

c. The long hydrocarbon chains are hydrophobic.

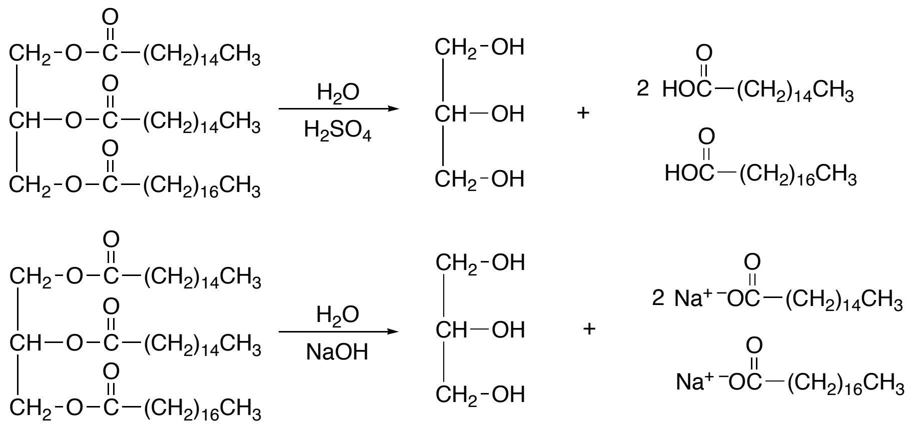
d. The ester linkages are hydrophilic.

e.

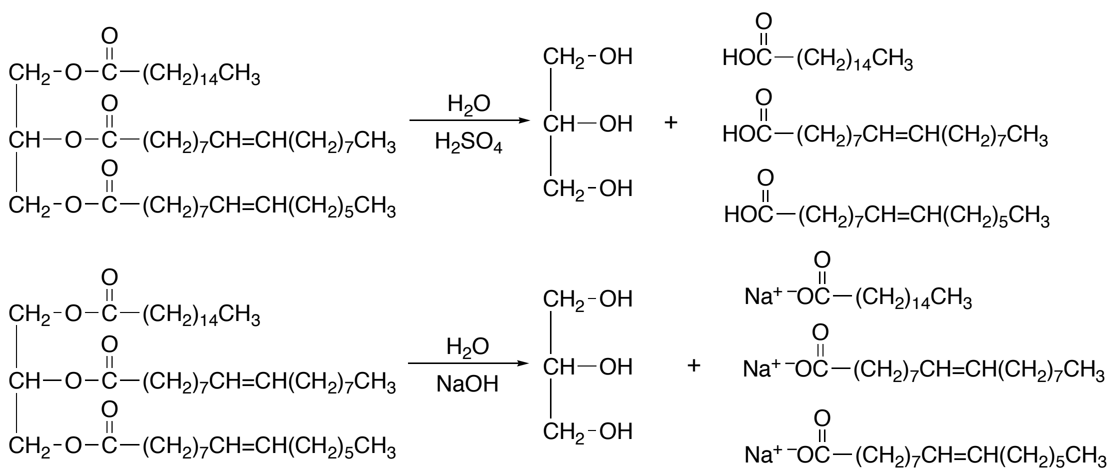


19.55 Draw the products of triacylglycerol hydrolysis.

a.

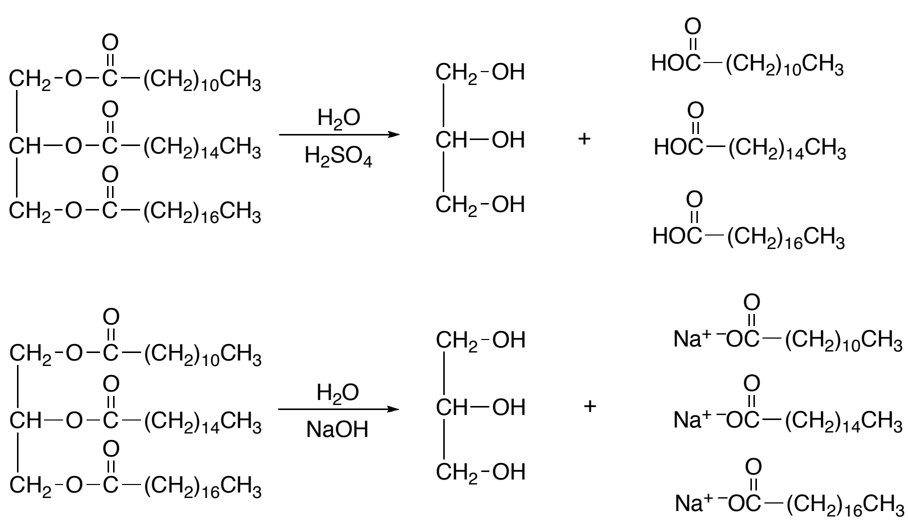


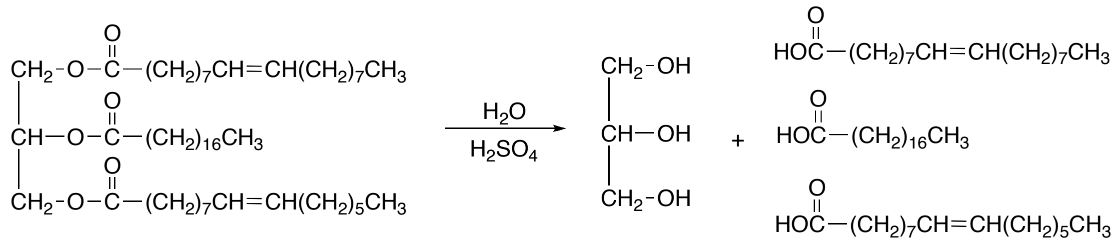
b.

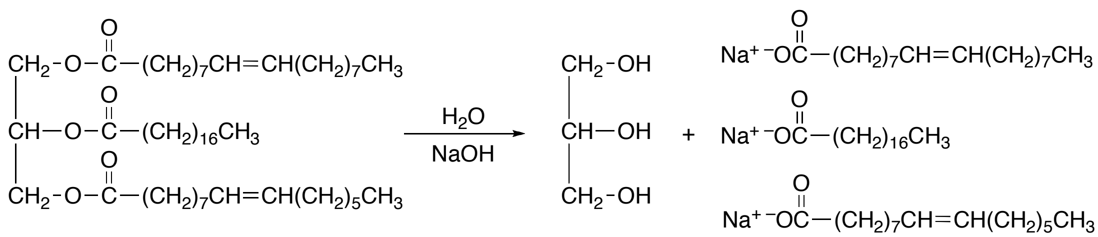


19.56 Draw the products of triacylglycerol hydrolysis.

a.



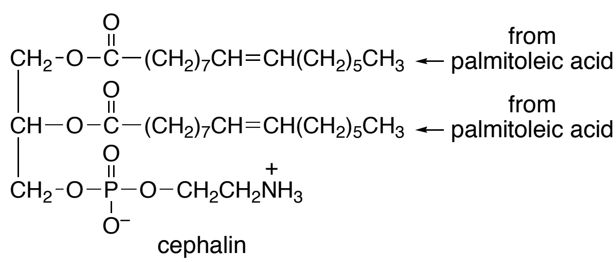
b. 

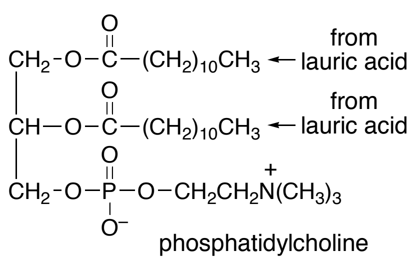


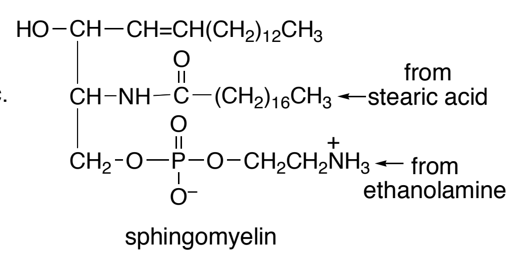
19.57 Phospholipids are lipids that contain a phosphorus atom. Sphingomyelins (c) contain phosphorus. Triacylglycerols (a), leukotrienes (b), and fatty acids (d) do not.

19.58 Cephalins (b) and lecithins (c) are phospholipids. Prostaglandins (a) and steroids (d) are not.

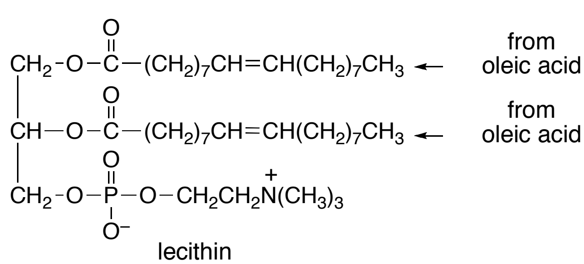
19.59 Draw a phosphoacylglycerol that fits each description.

a. 

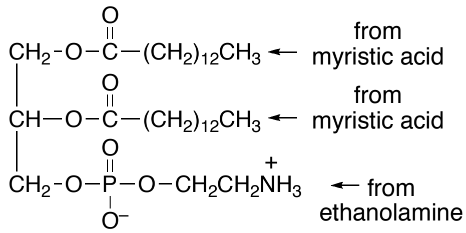
b. 

c. 

19.60 Draw a phosphoacylglycerol that fits each description.

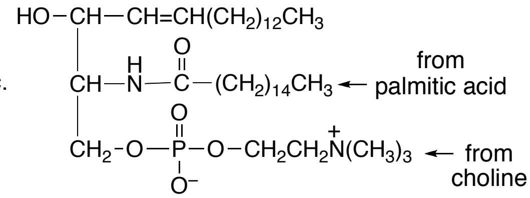
a. 

b.



phosphatidylethanolamine

c.



sphingomyelin

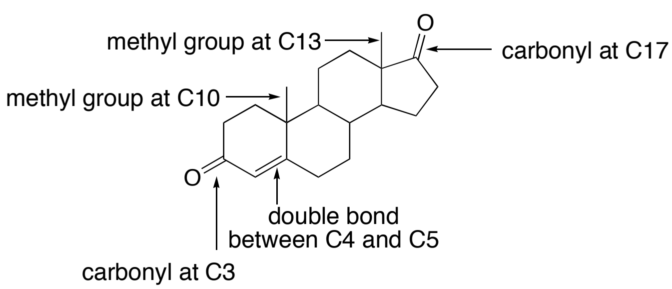
19.61 Triacylglycerols do not have a strongly hydrophilic region contained in a polar head, so they cannot form a lipid bilayer.

19.62 A cell membrane having phospholipids that contain a high percentage of oleic acid would be more fluid than a cell membrane having phospholipids that contain a high percentage of stearic acid.

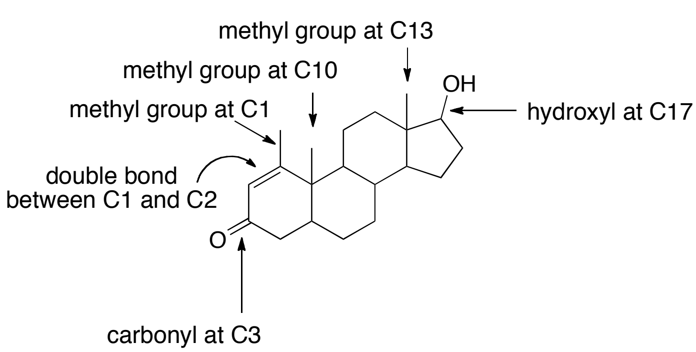
19.63 Diffusion is the movement of small molecules through a membrane along a concentration gradient. Facilitated transport is the transport of molecules through channels in the cell membrane. O_2 and CO_2 move by diffusion, whereas glucose and Cl^- move by facilitated transport.

19.64 Facilitated transport is the transport of molecules through channels in the cell membrane. Glucose and Cl^- move by facilitated transport. Active transport is the transport of ions across the cell membrane against the concentration gradient. K^+ ions move by active transport.

19.65 Draw the anabolic steroid 4-androstene-3,17-dione.



19.66 Draw the anabolic steroid methenolone.



19.67 Cholesterol is insoluble in the aqueous medium of the bloodstream. By being bound to a lipoprotein particle, however, it can be transported in the aqueous solution of the blood.

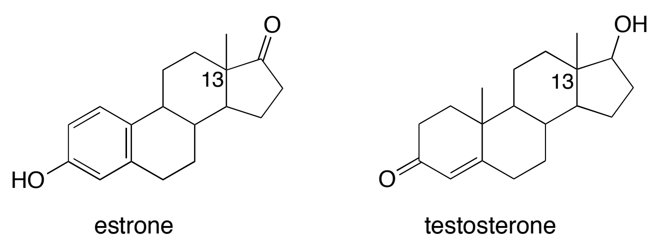
19.68 LDLs are soluble in the blood because the polar heads of the phospholipids and the polar portions of protein molecules are arranged on the surface. The nonpolar portions of the molecules are buried in the interior of the particle. This allows the LDL to be soluble in blood.

19.69 Low-density lipoproteins (LDLs) transport cholesterol from the liver to the tissues where it is incorporated in cell membranes. High-density lipoproteins (HDLs) transport cholesterol from the tissues back to the liver. When LDLs supply more cholesterol than is needed, LDLs deposit cholesterol on the walls of arteries, forming plaque. Atherosclerosis is a disease that results from the buildup of these fatty deposits, restricting the flow of blood, increasing blood pressure, and increasing the likelihood of a heart attack or stroke. As a result, LDL cholesterol is often called "bad" cholesterol. Since HDL cholesterol transports cholesterol back to the liver and removes it from the bloodstream, high levels of HDLs reduce the risk of heart disease and stroke, and it is called "good" cholesterol.

19.70 Anabolic steroids are synthetic analogues of androgens or male sex hormones. An example of an anabolic steroid is stanozolol. Long term use of anabolic steroids can cause health problems such as high blood pressure, liver damage, and cardiovascular disease.

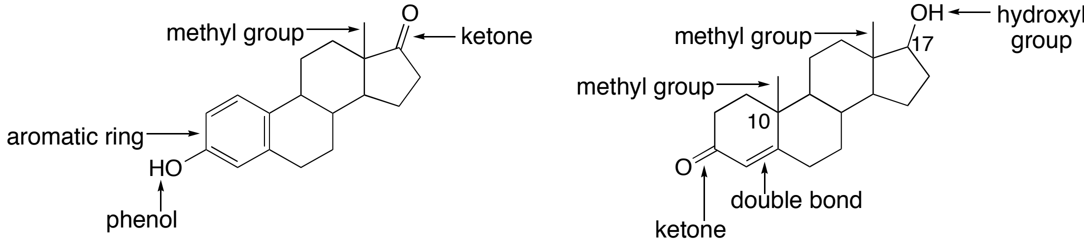
19.71 Answer each question about estrone and testosterone.

a.



b. The estrogen (left) and androgen (right) both contain the four rings of the steroid skeleton. Both contain a methyl group bonded to C13.

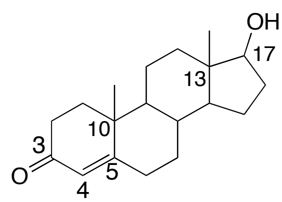
c. The estrogen has an aromatic A ring and a hydroxyl group on this ring. The androgen has a carbonyl on the A ring but does not contain an aromatic ring. The androgen also contains a C=C in the A ring and an additional CH_3 group at C10. The D rings are also different. The estrogen contains a carbonyl at C17, whereas the androgen has an OH group.



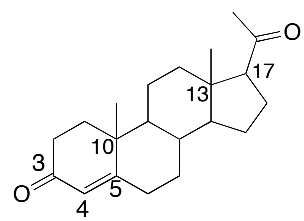
d. Estrogens, synthesized in the ovaries, control the menstrual cycle and secondary sexual characteristics of females. Androgens, synthesized in the testes, control the development of male secondary sexual characteristics.

19.72 Answer each question about testosterone and progesterone.

a.



testosterone



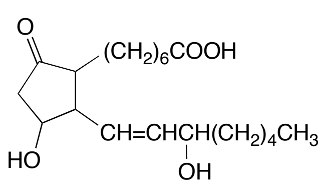
progesterone

b. The androgen (left) and progestin (right) both contain the four rings of the steroid skeleton. Both contain methyl groups at C10 and C13, a carbonyl group at C3 and a double bond between C4 and C5.

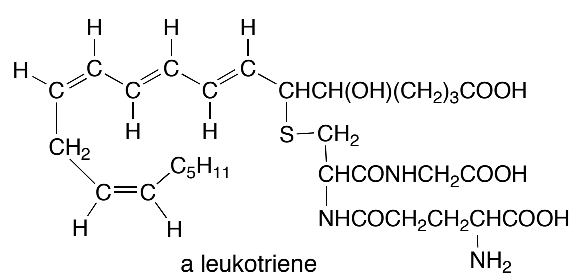
c. The androgen has a hydroxyl group at C17, whereas the progestin has a ketone group at C17.

d. Androgens, synthesized in the testes, control the development of male secondary sexual characteristics. Progestins, synthesized in the ovaries, are responsible for the preparation of the uterus for implantation of a fertilized egg.

19.73 Prostaglandins and leukotrienes are two types of eicosanoids, a group of biologically active compounds containing 20 carbon atoms derived from the fatty acid arachidonic acid. Prostaglandins are a group of carboxylic acids that contain a five-membered ring. Leukotrienes do not contain a ring. They both mediate biological activity at the site where they are formed. Prostaglandins mediate inflammation and uterine contractions. Leukotrienes stimulate smooth muscle contraction in the lungs, leading to the narrowing of airways in individuals with asthma.



a prostaglandin
PGE_1
five-membered ring



a leukotriene
LTC_4
no ring

19.74 Prostaglandins are not classified as hormones because they mediate biological activity at the site where they are formed, whereas hormones are synthesized in one part of an organism and then elicit a response at a different site.

19.75 All prostaglandins contain a five-membered ring and a carboxyl group (COOH).

19.76 Three biological functions of prostaglandins in the body are inhibition of blood platelet aggregation, relaxation of the smooth muscles in the uterus, and stimulation of uterine contractions.

19.77 Aspirin and celecoxib are both anti-inflammatory medicines. Aspirin inhibits the activity of both the COX-1 and COX-2 enzymes, whereas celecoxib inhibits the activity of COX-2 only.

19.78 Zileuton treats the cause of asthma by blocking the synthesis of leukotriene C4 from arachidonic acid by inhibiting the lipoxygenase enzyme needed in the first step.

19.79 Vitamins are organic compounds required in small quantities for normal metabolism and must be obtained in the diet since our cells cannot synthesize these compounds.

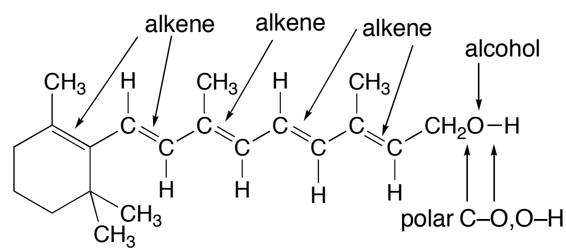
19.80 Vitamin D is technically not a vitamin because it can be synthesized in the body from cholesterol.

19.81 Answer each question about vitamins A and D.

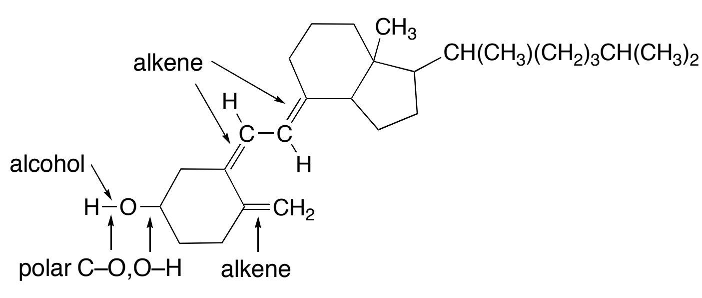
	Vitamin A	Vitamin D
a.	10 Tetrahedral carbons	21 Tetrahedral carbons
b.	10 Trigonal planar carbons	Six trigonal planar carbons
e.	Required for normal vision	Regulates calcium and phosphorus metabolism
f.	Deficiency causes night blindness.	Deficiency causes rickets and skeletal deformities.
g.	Found in liver, kidney, oily fish, and dairy	Found in milk and breakfast cereals

c. and d.

vitamin A



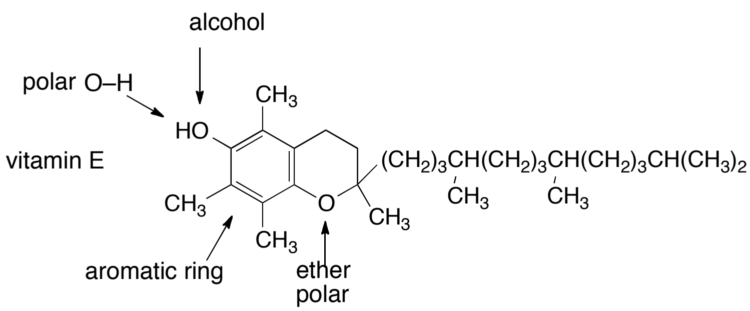
vitamin D

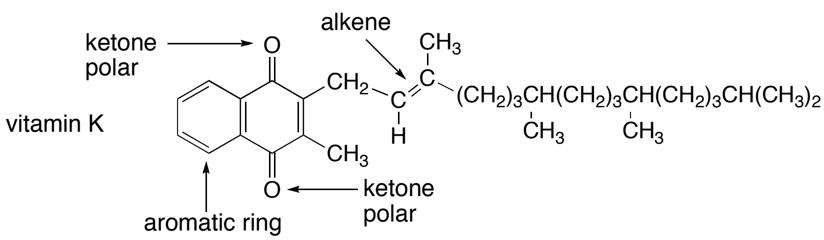


19.82 Answer each question about vitamins E and K.

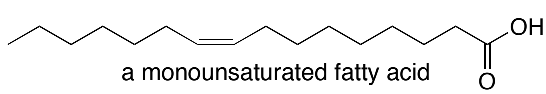
	Vitamin E	Vitamin K
a.	23 tetrahedral carbons	19 tetrahedral carbons
b.	6 trigonal planar carbons	12 trigonal planar carbons
e.	Antioxidant	Regulates blood clotting
f.	Deficiency causes neurological problems.	Deficiency causes excessive and sometimes fatal bleeding.
g.	Found in nuts and greens such as spinach	Found in green leafy vegetables such as cabbage and broccoli

c. and d.



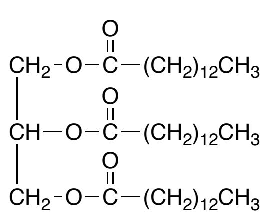


19.83 Draw an example of each type of lipid.

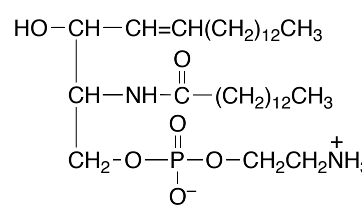
a. 

a monounsaturated fatty acid

b. $CH_3(CH_2)_{12}COO(CH_2)_{15}CH_3$
a wax that contains a total of 30 carbons

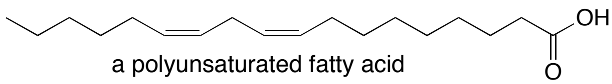
c. 

a saturated triacylglycerol

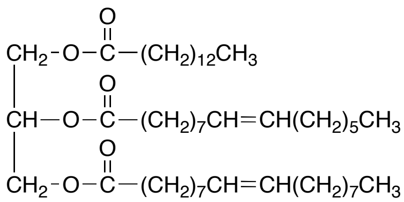
d. 

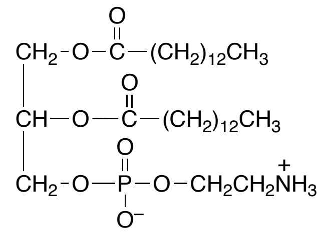
a sphingomyelin derived from ethanolamine

19.84 Draw an example of each type of lipid.

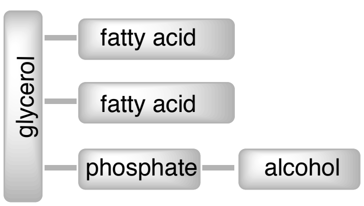
a.

a polyunsaturated fatty acid

b. $CH_3(CH_2)_{10}COO(CH_2)_{15}CH_3$
a wax derived from a 12-carbon fatty acid

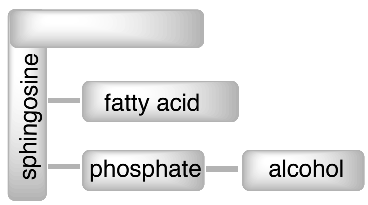
c.

a polyunsaturated triacylglycerol

d.

a cephalin

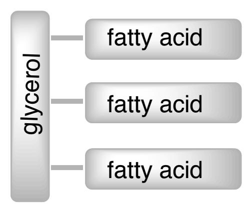
19.85 Decide which terms describe each block diagram.



A
a. phospholipid
c. hydrolyzable lipid
e. phosphoacylglycerol



B
a. phospholipid
c. hydrolyzable lipid
d. sphingomyelin



A
b. triacylglycerol
c. hydrolyzable lipid

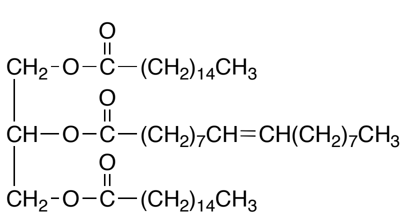
19.86 Cartoon **A** describes a soap whereas Cartoon **B** describes a phosphoacylglycerol. Soaps are metal salts of fatty acids. The ionic end is the polar head and the long hydrocarbon chain is the nonpolar tail. Phosphoacylglycerols have a polar head from the charged phosphodiester and two nonpolar tails due to the long-chain fatty acids.

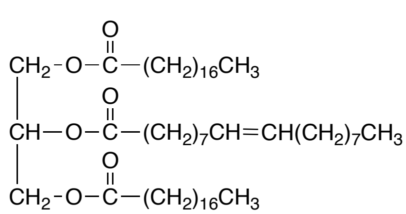
19.87 Phosphoacylglycerols contain an ionic head, making them more polar than triacylglycerols.

19.88 Soaps and phosphoacylgylcerols both have a polar head and a nonpolar end, but the phosphoacylglycerols have two nonpolar tails, whereas soaps have just one. The polar head of the phosphoacylglycerol is formed from a charged phosphodiester, whereas the polar head of the soap is the ionic end of the fatty acid.

19.89 Coconut oil is a liquid at room temperature because the hydrocarbon chains of lauric acid have only 12 carbons in them, making them short enough that the triacylglycerol remains a liquid.

19.90 Draw the structure of two possible triacylglycerols that compose cocoa butter.





19.91 Vegetable oils are composed of triacylglycerols, while motor oil, derived from petroleum, is mostly alkanes and other long chain hydrocarbons.

19.92 Laboratory blood results report the levels of cholesterol, HDLs, and LDLs because high cholesterol levels and LDLs are linked to heart disease. Current recommendations by the National Cholesterol Education Program are total serum cholesterol less than 200 mg/dL, HDL cholesterol greater than 40 mg/dL, and LDL cholesterol less than 100 mg/dL.

19.93 Humans cannot survive on a completely fat-free diet. Certain fatty acids and fat-soluble vitamins are required in the diet.

19.94 Cholesterol is synthesized in the liver but humans cannot survive on a completely cholesterol-free diet.

19.95 Saturated fats should be avoided in the diet because they are more likely to lead to atherosclerosis and heart disease.

19.96 Unsaturated fats should be substituted for saturated fats in the diet because diets high in saturated fats lead to a greater risk of heart disease.

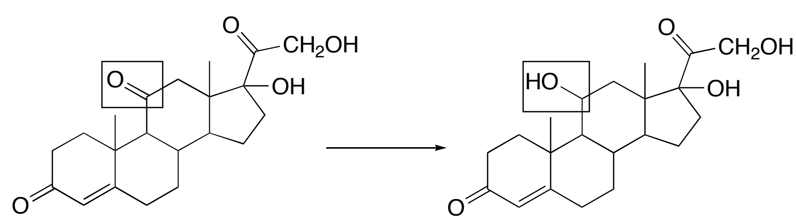
19.97 Animals that live in colder climates have triacylglycerols with more unsaturated fatty acid side chains because the unsaturated fats have lower melting points. They remain liquid at the lower temperatures of their climate, allowing the cells to remain more fluid with less rigid cell membranes than saturated triacylglycerols would allow for.

19.98 Determine the amount of cholesterol in 5.0 L of blood.

$$5.0\,\cancel{\text{L}} \times \frac{10\,\cancel{\text{dL}}}{1\,\cancel{\text{L}}} \times \frac{167\,\cancel{\text{mg}}}{1\,\cancel{\text{dL}}} \times \frac{1\text{ g}}{1000\,\cancel{\text{mg}}} = 8.4\text{ g cholesterol}$$

19.99 Recall that increasing the number of C–O bonds is an oxidation, and increasing the number of C–H bonds is a reduction.

a.

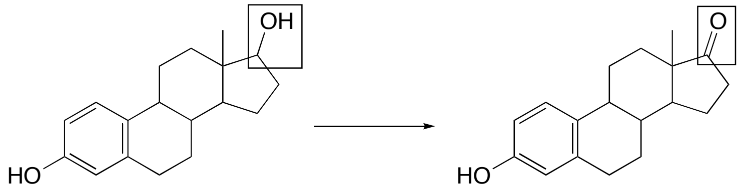


cortisone

cortisol

C=O reduced to CH–OH
reduction

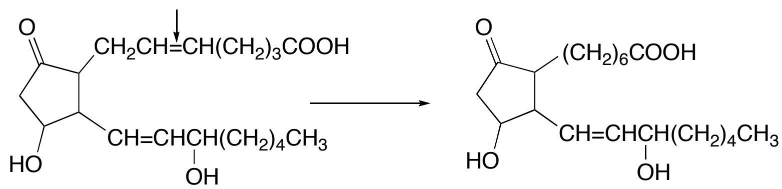
b.



estradiol estrone

CH–OH oxidized to C=O
oxidation

c.



PGE_2 PGE_1

C=C reduced to CH_2CH_2
reduction

19.100 Draw the possible structures of the triacylglycerols that can be formed from three different fatty acids.