Chapter 12 Review Problems

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12.1) In chapter 4, you learned that organic compounds are categorized into various families based on the presence of certain *functional groups*. For example, an organic molecule with a hydroxyl group (OH) bonded to a hydrocarbon part is in the alcohol family. **Lipids**, in contrast, are **not** defined by the presence of specific functional groups.

i). Lipids are defined as biological compounds that are <u>in</u>soluble in ____________________.

a) organic solvents
b) water
c) oil
d) all solvents

ii) Biological compounds are organic compounds that occur in living organisms. There are three solubility classes for biological compounds: hydrophilic, hydrophobic, and amphipathic. Of these three classes, ____________________ are water insoluble.

a) hydrophilic and hydrophobic
b) hydrophilic and amphipathic
c) amphipathic and hydrophobic

iii) Amphipathic molecules form ______________________ when placed in water.

a) solids
b) suspensions
c) waxes
d) monolayers and micelles

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i). Lipids are defined as biological compounds that are insoluble in ____________________.

HINT: a) organic solvents
b) water
c) oil
~~d) all solvents~~

ii) Biological compounds are organic compounds that occur in living organisms. There are three solubility classes for biological compounds: hydrophilic, hydrophobic, and amphipathic. Of these three classes, ____________________ are water insoluble.

HINT: a) hydrophilic and hydrophobic
~~b) hydrophilic and amphipathic~~
c) amphipathic and hydrophobic

iii) Amphipathic molecules form ____________________ when placed in water.

HINT: a) solids
b) suspensions
~~c) waxes~~
d) monolayers and micelles

For more help: See chapter 12 part 1 video or chapter 12 section 3 in the textbook.

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12.1) In chapter 4, you learned that organic compounds are categorized into various families based on the presence of certain *functional groups*. For example, an organic molecule with a hydroxyl group (OH) bonded to a hydrocarbon part is in the alcohol family. **Lipids**, in contrast, are **not** defined by the presence of specific functional groups.

i). Lipids are defined as biological compounds that are insoluble in ____________________.

a) organic solvents
b) water
c) oil
d) all solvents

You were introduced to seven classes of lipids in this chapter: fatty acids, waxes triglycerides, steroids, phospholipids, glycolipids, and eicosanoids.

ii) Biological compounds are organic compounds that occur in living organisms. There are three solubility classes for biological compounds: hydrophilic, hydrophobic, and amphipathic. Of these three classes, ____________________ are water insoluble.

a) hydrophilic and hydrophobic
b) hydrophilic and amphipathic
c) amphipathic and hydrophobic

Hydrophilic compounds are water soluble.

iii) Amphipathic molecules form ____________________ when placed in water.

a) solids
b) suspensions
c) waxes
d) monolayers and micelles

You first learned about this in chapter 7 and then had a brief review in chapter 12.

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For more details: See chapter 12 part 1 video or chapter 12 section 3 in the textbook.

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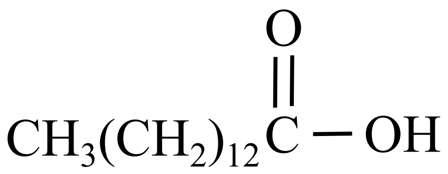
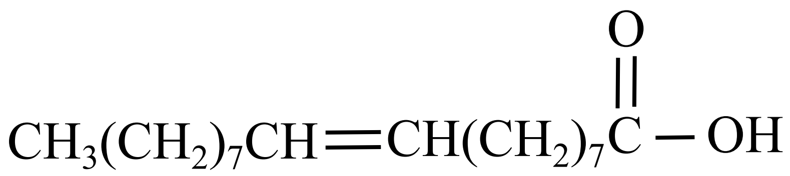
12.2) The *abbreviated* condensed structures for two fatty acid molecules are shown below. Draw a *standard* (unabbreviated) condensed structure for each of these molecules.





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12.2) The *abbreviated* condensed structures for two fatty acid molecules are shown below. Draw a *standard* (unabbreviated) condensed structure for each of these molecules.

$$\mathrm{CH_3(CH_2)_{12}\overset{\overset{\displaystyle O}{||}}{C}-OH}$$

$$\mathrm{CH_3(CH_2)_7CH{=}CH(CH_2)_7\overset{\overset{\displaystyle O}{||}}{C}-OH}$$

HINT:

In abbreviated condensed structures, repeating structural units are shown in parenthesis with a subscripted number where the subscript is equal to the number of times that the structural unit within the parenthesis is repeated. Carbons that are *single bonded* to each other in a linear sequence, along with the hydrogens that are bonded to them, are abbreviated as $(CH_2)_{\mathbf{n}}$, where **n** is equal to the number of number of times that the CH_2 is repeated.

For more help: See chapter 12 part 1 video or chapter 12 section 3 in the textbook.

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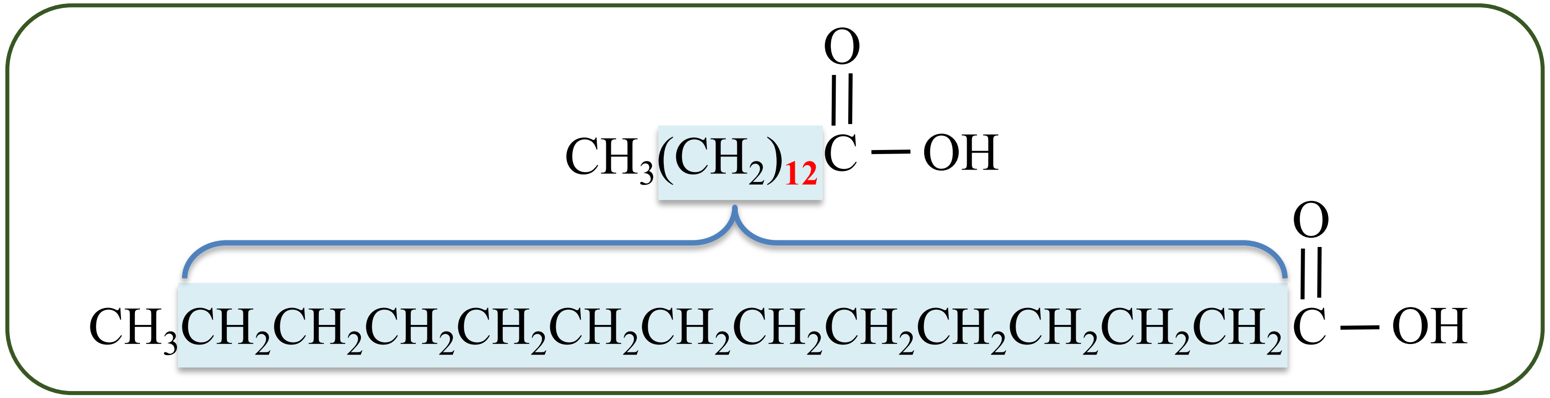
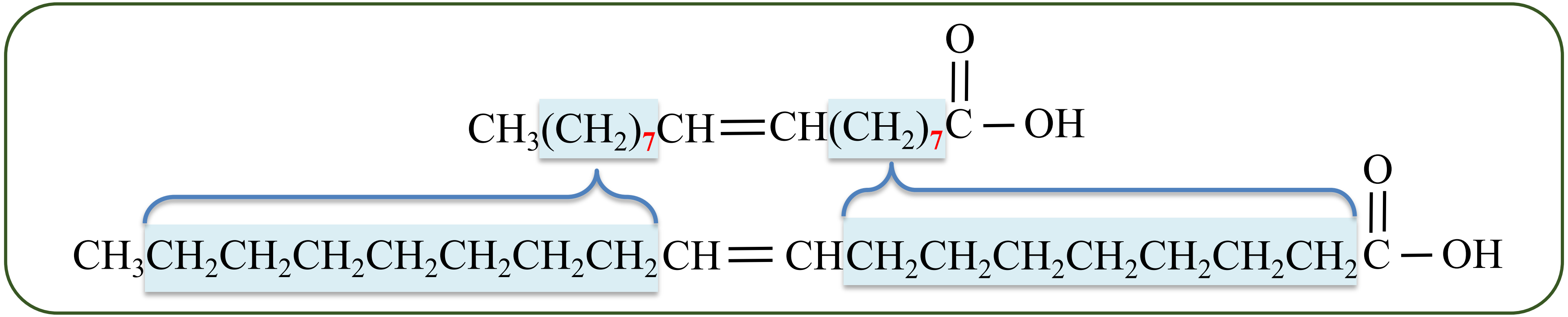
12.2) The *abbreviated* condensed structures for two fatty acid molecules are shown below. Draw a *standard* (unabbreviated) condensed structure for each of these molecules.





EXPLANATION: In order to save time when drawing structural formulas for large molecules such as fatty acids, an abbreviated condensed structure is used. Repeating structural units are shown in parenthesis with a subscripted number where the subscript is equal to the number of times that the structural unit within the parenthesis is repeated. For example, carbons that are single bonded to each other in a linear sequence, along with the hydrogens that are bonded to them, are abbreviated as $(CH_2)_n$, where **n** is equal to the number of number of times that the CH_2 is repeated.

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For more details: See chapter 12 part 1 video or chapter 12 section 3 in the textbook.

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12.3) Classify each of the fatty acids shown below as either **saturated**, **monounsaturated**, or **polyunsaturated**.

a) $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$

b) $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH{=}CHCH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$

c) $CH_3(CH_2)_4(CH{=}CHCH_2)_2(CH_2)_6COOH$

d) $CH_3(CH_2)_{10}COOH$

e) $CH_3(CH_2)_5CH{=}CH(CH_2)_7COOH$

f) $CH_3CH_2(CH{=}CHCH_2)_3(CH_2)_6COOH$

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12.3) Classify each of the fatty acids shown below as either **saturated**, **monounsaturated**, or **polyunsaturated**.

a) $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2\,COOH$

b) $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH{=}CHCH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$

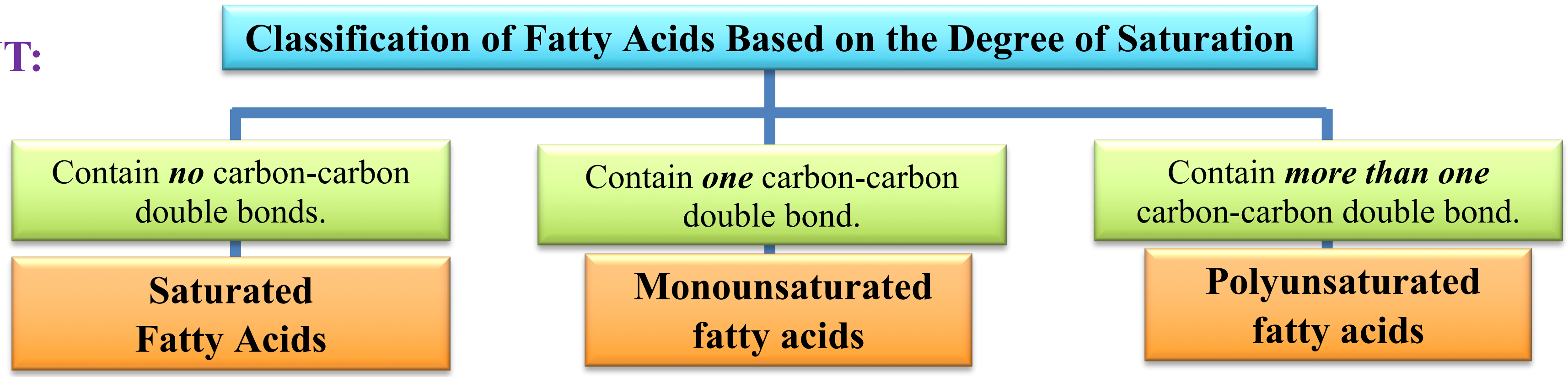
c) $CH_3(CH_2)_4(CH{=}CHCH_2)_2(CH_2)_6COOH$

d) $CH_3(CH_2)_{10}COOH$

e) $CH_3(CH_2)_5CH{=}CH(CH_2)_7COOH$

f) $CH_3CH_2(CH{=}CHCH_2)_3(CH_2)_6COOH$

HINT:



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a) $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$ **saturated**

b) $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH{=}CHCH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$ **monounsaturated**

c) $CH_3(CH_2)_4(CH{=}CHCH_2)_2(CH_2)_6COOH$ **polyunsaturated** – Contains two carbon-carbon double bonds. Note that the structural unit with the carbon-carbon double bond occurs *twice*.

d) $CH_3(CH_2)_{10}COOH$ **saturated**

e) $CH_3(CH_2)_5CH{=}CH(CH_2)_7COOH$ **monounsaturated**

f) $CH_3CH_2(CH{=}CHCH_2)_3(CH_2)_6COOH$ **polyunsaturated** – Contains three carbon-carbon double bonds. Note that the structural unit with the carbon-carbon double bond is repeated *three* times.

Classification of Fatty Acids Based on the Degree of Saturation

Contain ***no*** carbon-carbon double bonds.	Contain ***one*** carbon-carbon double bond.	Contain ***more than one*** carbon-carbon double bond.
Saturated Fatty Acids	**Monounsaturated fatty acids**	**Polyunsaturated fatty acids**

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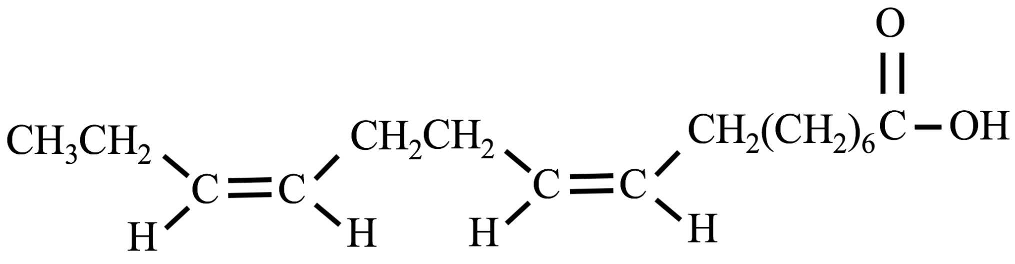
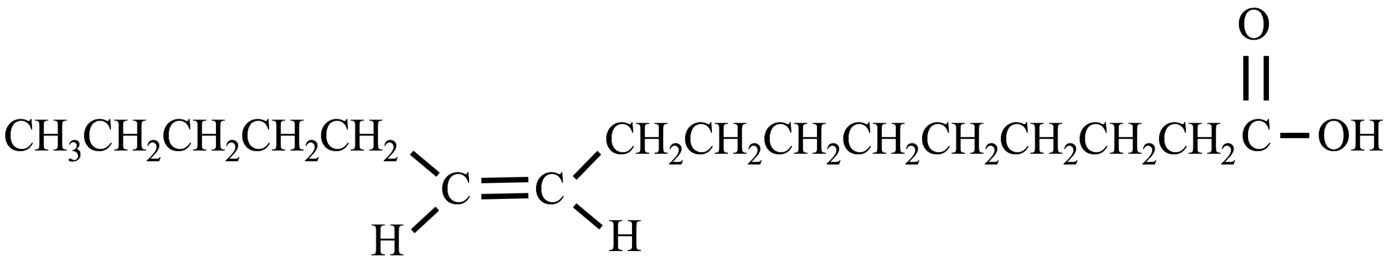
12.4) Although not used in IUPAC naming, ***omega notation*** is frequently seen in popular nutrition literature. In omega notation, the carbon at the ***end*** of a fatty acid's hydrocarbon chain is designated as the "***omega*** carbon" or "**ω**-carbon." Omega (**ω**) is the last letter of the Greek alphabet, making the omega designation appropriate for the "last" carbon in a fatty acid's hydrocarbon chain. *Unsaturated* fatty acids are put into omega notation classes by the position of the *first* double bond that occurs, counting from the omega carbon.

Classify each of the fatty acids shown below by its ***omega*** notation (**ω**-**?**)





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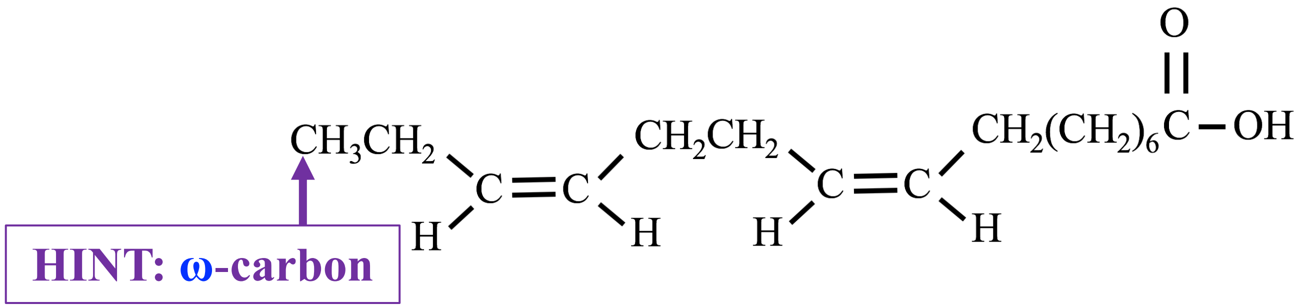
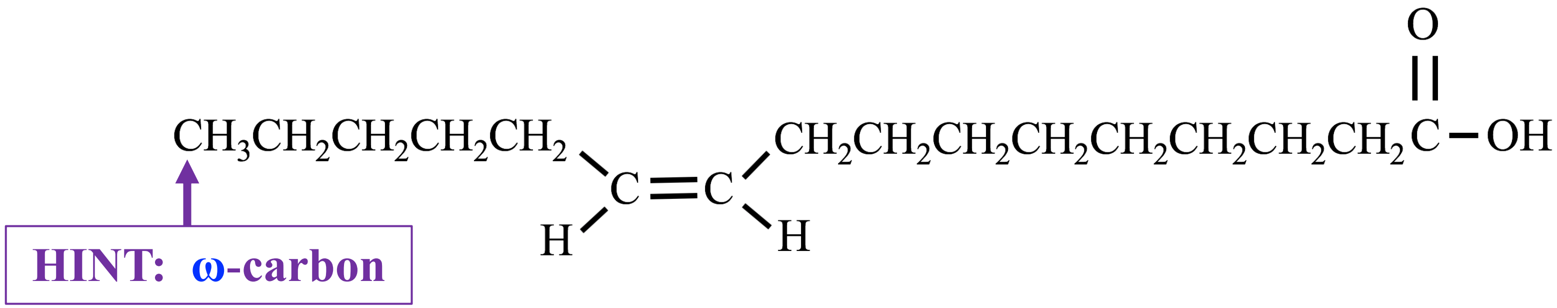
Classify each of the fatty acids shown below by its omega notation (**ω**-**?**)





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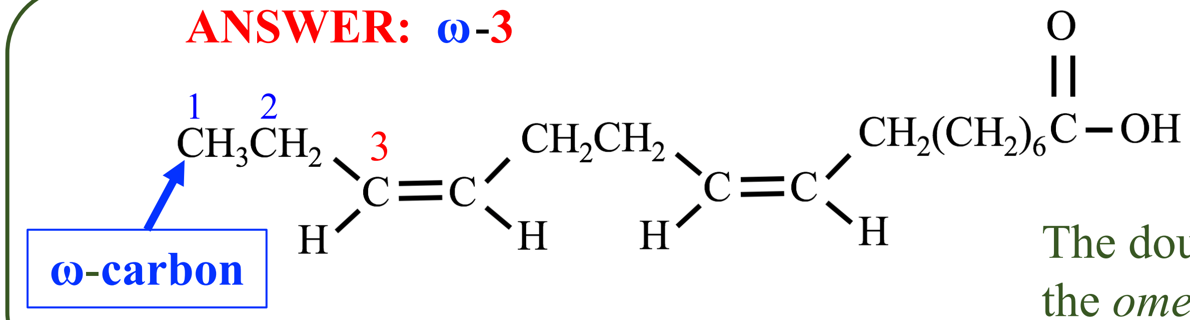
12.4) Although not used in IUPAC naming, ***omega notation*** is frequently seen in popular nutrition literature. In omega notation, the carbon at the ***end*** of a fatty acid's hydrocarbon chain is designated as the "***omega*** carbon" or "**ω**-carbon." Omega (**ω**) is the last letter of the Greek alphabet, making the omega designation appropriate for the "last" carbon in a fatty acid's hydrocarbon chain. *Unsaturated* fatty acids are put into omega notation classes by the position of the *first* double bond that occurs, counting from the omega carbon.

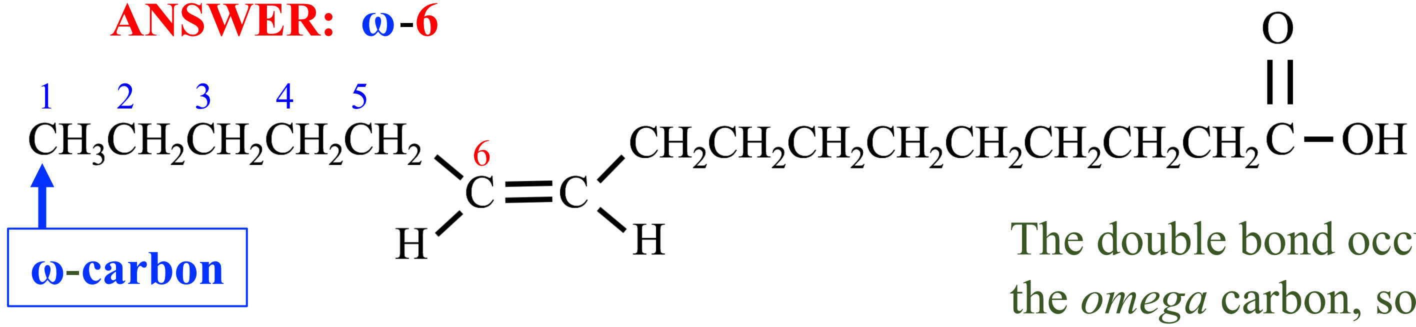
Classify each of the fatty acids shown below by its omega notation (**ω**-**?**)

ANSWER: ω-3



The double bond occurs at the ***third*** carbon, counting from the *omega* carbon, so this fatty acid is classified as **ω-3**.

ANSWER: ω-6



The double bond occurs at the ***sixth*** carbon, counting from the *omega* carbon, so this fatty acid is classified as **ω-6**.

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12.5) Predict the order of increasing ***boiling points*** for the fatty acids shown below.

$CH_3(CH_2)_{10}COOH$

lauric acid

$CH_3(CH_2)_{14}COOH$

palmitic acid

$CH_3(CH_2)_{12}COOH$

myristic acid

highest boiling point

1.__________________

2.__________________

3.__________________

lowest boiling point

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12.5) Predict the order of increasing ***boiling points*** for the fatty acids shown below.

$CH_3(CH_2)_{10}COOH$

lauric acid

$CH_3(CH_2)_{14}COOH$

palmitic acid

$CH_3(CH_2)_{12}COOH$

myristic acid

highest boiling point

1.________________

2.________________

3.________________

lowest boiling point

HINT:

Stronger/more noncovalent interactions = higher boiling and melting points

For more help: See chapter 12 part 1 video or chapter 12 section 3 in the textbook.

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12.5) Predict the order of increasing ***boiling points*** for the fatty acids shown below.

$CH_3(CH_2)_{10}COOH$	$CH_3(CH_2)_{14}COOH$	$CH_3(CH_2)_{12}COOH$
lauric acid	**palmitic acid**	**myristic acid**

highest boiling point

1. **palmitic acid**
2. **myristic acid**
3. **lauric acid**

lowest boiling point

EXPLANATION:

Stronger/more noncovalent interactions = higher boiling and melting points

- The larger the nonpolar hydrocarbon part, the stronger the London forces and the higher the melting point.

For more details: See chapter 12 part 1 video or chapter 12 section 3 in the textbook.

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12.6) Predict the order of increasing ***boiling points*** for the fatty acids shown below.

highest boiling point

1.__________________

2.__________________

3.__________________

lowest boiling point

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

stearic acid $CH_3(CH_2)_{16}COOH$

linolenic acid $CH_3CH_2CH{=}CHCH_2CH{=}CHCH_2CH{=}CH(CH_2)_7COOH$

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12.6) Predict the order of increasing ***boiling points*** for the fatty acids shown below.

highest boiling point

1.________________

2.________________

3.________________

lowest boiling point

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

stearic acid $CH_3(CH_2)_{16}COOH$

linolenic acid $CH_3CH_2CH{=}CHCH_2CH{=}CHCH_2CH{=}CH(CH_2)_7COOH$

HINT: Stronger/more noncovalent interactions = higher boiling and melting points

The strength of the noncovalent interactions, and therefore, boiling and melting points, of fatty acids depends on two parameters:

(1) The **number or carbon atoms** - the more carbon atoms a fatty acid contains, the ***higher*** the boiling and melting point.

(2) The **degree of saturation** - the more double bonds a fatty acid contains, the ***lower*** the boiling and melting point.

- The inability of rotation around double bonds prevents less saturated molecules from getting as close to each other as is possible for more highly saturated molecules. The strength of London forces - and all other noncovalent interactions - are distant dependent; the closer the particles are to each other, the stronger the attractive force.

For more help: See chapter 12 part 1 video or chapter 12 section 3 in the textbook.

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12.6) Predict the order of increasing ***boiling points*** for the fatty acids shown below.

highest boiling point

1. **stearic acid**
2. **linoleic acid**
3. **linolenic acid**

lowest boiling point

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

stearic acid $CH_3(CH_2)_{16}COOH$

linolenic acid $CH_3CH_2CH{=}CHCH_2CH{=}CHCH_2CH{=}CH(CH_2)_7COOH$

EXPLANATION: Stronger/more noncovalent interactions = higher boiling and melting points

The strength of the noncovalent interactions, and therefore, boiling and melting points, of fatty acids depends on two parameters:

(1) The **number or carbon atoms** - the more carbon atoms a fatty acid contains, the ***higher*** the boiling and melting point.

(2) The **degree of saturation** - the more double bonds a fatty acid contains, the ***lower*** the boiling and melting point.

- The inability of rotation around double bonds prevents less saturated molecules from getting as close to each other as is possible for more highly saturated molecules. The strength of London forces - and all other noncovalent interactions - are distant dependent; the closer the particles are to each other, the stronger the attractive force.

All of the molecules in this problem have the *same number of carbon atoms*, so the boiling point order is predicted based on the **degree of saturation** (number of double bonds).

For more details: See chapter 12 part 1 video or chapter 12 section 3 in the textbook.

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12.7)

i) Predict the products of the reaction that occurs when myristic acid (below) reacts with water.

$$CH_3(CH_2)_{12}\overset{\overset{\displaystyle O}{\|}}{C}-OH \quad + \quad H_2O \quad \rightleftharpoons$$

myristic acid

ii) Name the *base form* of myristic acid.

iii) In previous chapters, you learned that the relative amounts of a conjugate pair's acid form and base form that are present in an aqueous solution depends on the pH of the solution and the pK_a of the particular acid (as described by the Henderson-Hasselbalch Equation). The pK_a of carboxylic acids (*including fatty acids*) is about 5.

For the myristic acid/myristate ion pair, predict the species that is predominant at physiological pH (~7.4).

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Click here for a **hint**

Click here to **check your answer**

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i) Predict the products of the reaction that occurs when myristic acid (below) reacts with water.

$$CH_3(CH_2)_{12}\overset{\overset{\Large O}{||}}{C}-OH \quad + \quad H_2O \quad \rightleftharpoons$$

myristic acid
(acid form)

HINT:
Fatty acids will react with water in the same manner as *all carboxylic acids*.

ii) Name the *base form* of myristic acid.

myristic acid ⟶ **?**

HINT: The base forms of fatty acids are named by replacing the "**-ic acid**" suffix of the ***fatty acid*** name with "**-ate ion**."

iii) In previous chapters, you learned that the relative amounts of a conjugate pair's acid form and base form that are present in an aqueous solution depends on the pH of the solution and the pK_a of the particular acid (as described by the Henderson-Hasselbalch Equation). The pK_a of carboxylic acids (*including fatty acids*) is about 5.

For the myristic acid/myristate ion pair, predict the species that is predominant at physiological pH (~7.4).

HINT:

Solution Condition	Relative Amounts of Acid and Base Forms
$pH < pK_a$	$[HA] > [A^-]$
$pH > pK_a$	$[A^-] > [HA]$
$pH = pK_a$	$[HA] = [A^-]$

For more help: See chapter 12 part 1 video or chapter 12 section 3 in the textbook.

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12.7)

i) Predict the products of the reaction that occurs when myristic acid (below) reacts with water.

$$CH_3(CH_2)_{12}C(=O)-OH + H_2O \rightleftharpoons CH_3(CH_2)_{12}C(=O)-O^- + H_3O^+$$

myristic acid (acid form) → **myristate ion** (base form)

Fatty acids, *like all carboxylic acids*, can react with *water* to produce their corresponding ***carboxylate ion*** forms (**base forms**).

ii) Name the *base form* of myristic acid.

myristic acid ⟶ **myristate ion**

The base forms of fatty acids (carboxylate ions) are named by replacing the "**-ic acid**" suffix of the ***fatty acid*** name with "**-ate ion**."

iii) In previous chapters, you learned that the relative amounts of a conjugate pair's acid form and base form that are present in an aqueous solution depends on the pH of the solution and the pK_a of the particular acid (as described by the Henderson-Hasselbalch Equation). The pK_a of carboxylic acids (*including fatty acids*) is about 5.

For the myristic acid/myristate ion pair, predict the species that is predominant at physiological pH (~7.4).

ANSWER: At physiological pH, the pH (7.4) > pK_a(5), so the base form (myristate ion) is predominant

Since the physiological pH in cells, blood, and intercellular solutions is greater than 5, the carboxylate (base) form of a fatty acid is predominant in these solutions (pH > pKa).

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For more details: See chapter 12 part 1 video or chapter 12 section 3 in the textbook.

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12.8)

i) Waxes are members of the ____________ family of organic compounds.

a) carboxylic acid
b) alcohol
c) ether
d) ester

ii) Waxes contain a ______________ group that is bonded between two long hydrocarbon parts.

a) carboxylate
b) hydroxyl
c) carboxyl
d) amino

iii) Waxes are ________________ because of their large and nonpolar hydrocarbon parts.

a) hydrophilic
b) amphipathic
c) hydrophobic

iv) Waxes are formed by the esterification reaction of fatty acids with _________________.

a) large carboxylic acids
b) large alcohols
c) large hydrocarbons

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i) Waxes are members of the ____________ family of organic compounds.

HINT: a) carboxylic acid
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b) hydroxyl
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iii) Waxes are ________________ because of their large and nonpolar hydrocarbon parts.

HINT: ~~a) hydrophilic~~
b) amphipathic
c) hydrophobic

iv) Waxes are formed by the esterification reaction of fatty acids with _________________.

HINT: a) large carboxylic acids
b) large alcohols
~~c) large hydrocarbons~~

For more help: See chapter 12 part 2 video or chapter 12 section 4 in the textbook.

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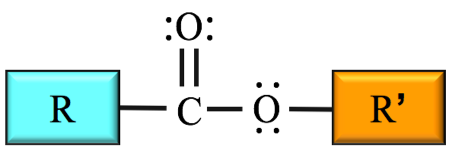
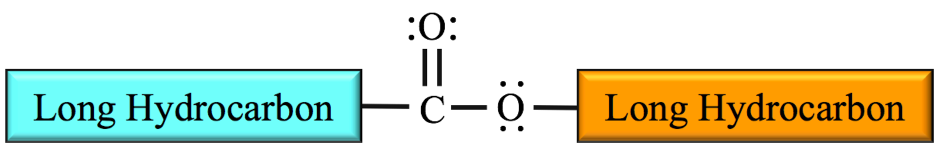
12.8)

i) Waxes are members of the _____________ family of organic compounds.

a) carboxylic acid
b) alcohol
c) ether
d) ester



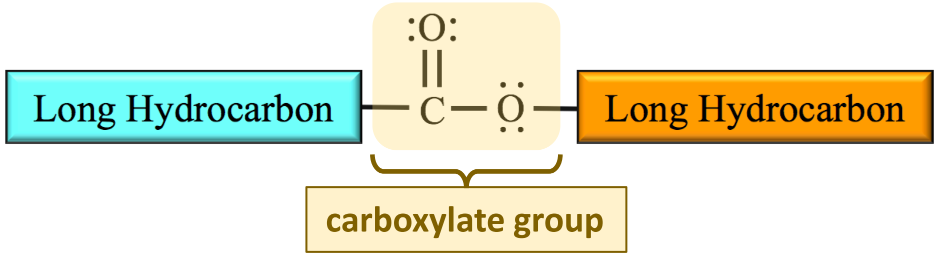
general form of an *ester*



general form of a *wax*

ii) Waxes contain a _______________ group that is bonded between two long hydrocarbon parts.

a) carboxylate
b) hydroxyl
c) carboxyl
d) amino



iii) Waxes are _________________ because of their large and nonpolar hydrocarbon parts.

a) hydrophilic
b) amphipathic
c) hydrophobic

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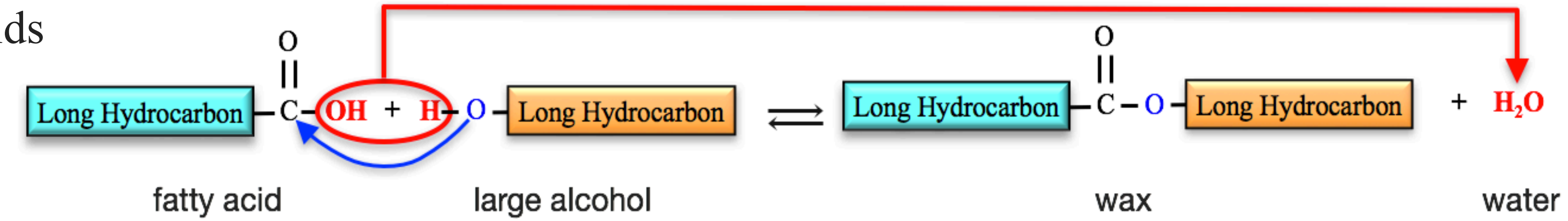

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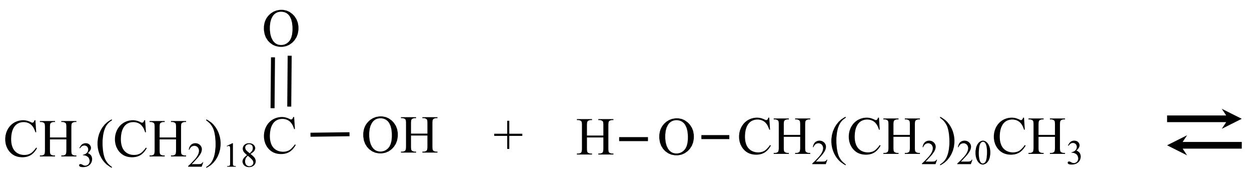
12.9) Draw the condensed structure of the wax that is produced in the reaction shown here.



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Click here to **check your answer**

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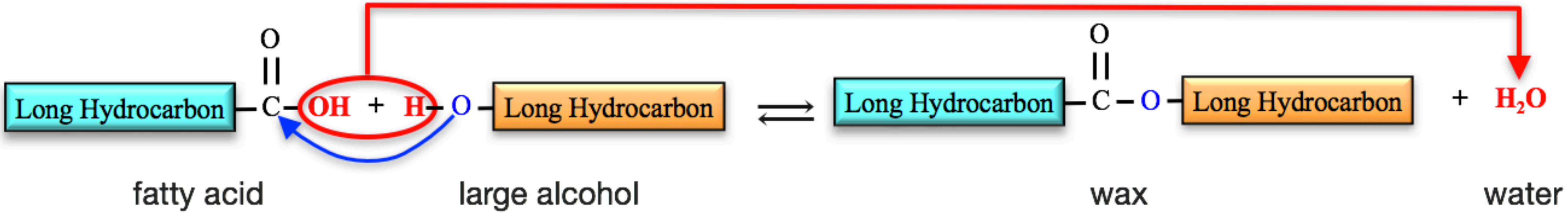
12.9) Draw the condensed structure of the wax that is produced in the reaction shown here.

$$CH_3(CH_2)_{18}\overset{\overset{\displaystyle O}{\|}}{C}-OH \;+\; H-O-CH_2(CH_2)_{20}CH_3 \;\rightleftharpoons$$

HINT: ***Waxes*** are formed by the *esterification* reaction of *fatty acids* with *large alcohols*.

- The **general form** of the *esterification* reaction of a fatty acid with a large alcohol is shown below.



- In this reaction, the **OH** from the *fatty acid* and an **H** from the *alcohol* are removed, and then combined to form **H_2O**. The oxygen (**O**) and hydrocarbon that was originally part of the alcohol, forms a new bond to the fatty acid's carbonyl carbon.

For more help: See chapter 12 part 2 video or chapter 12 section 4 in the textbook.

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Click here to check **your answer**

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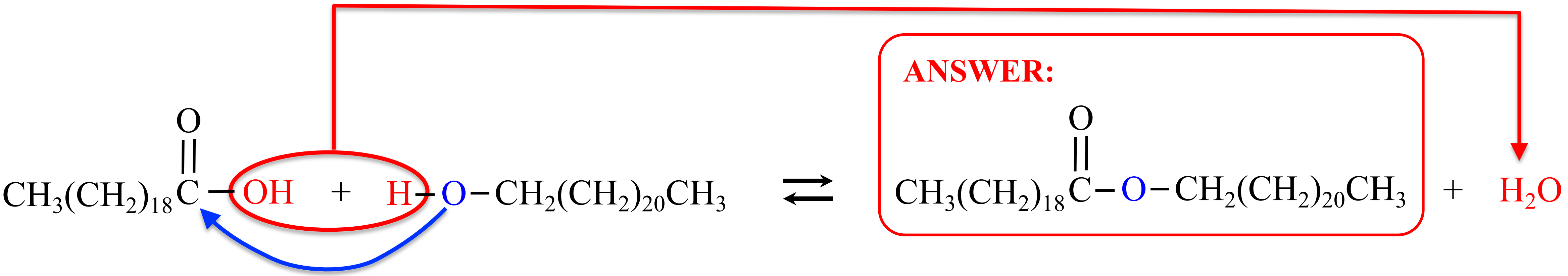
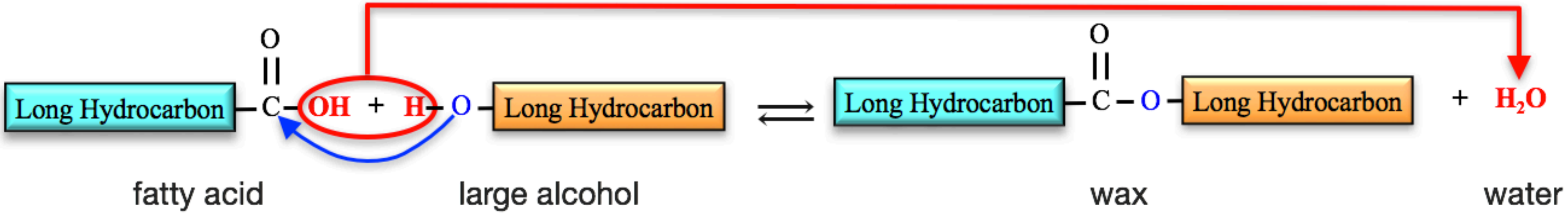
12.9) Draw the condensed structure of the wax that is produced in the reaction shown here.



EXPLANATION: ***Waxes*** are formed by the *esterification* reaction of *fatty acids* with *large alcohols*.

- The **general form** of the *esterification* reaction of a fatty acid with a large alcohol is shown below.



- In this reaction, the **OH** from the *fatty acid* and an **H** from the *alcohol* are removed, and then combined to form **H_2O**. The oxygen (**O**) and hydrocarbon that was originally part of the alcohol, forms a new bond to the fatty acid's carbonyl carbon.

For more details: See chapter 12 part 2 video or chapter 12 section 4 in the textbook.

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12.10)

i) Triglycerides - also referred to as triacylglycerides - contain three ________ - type bonds.

a) ether
b) ester
c) amide
d) amine

ii) Triglycerides are composed of contain three ________ residues and one __________ residue.

a) alcohol, ester
b) fatty acid, ester
c) fatty acid, glycerol
d) alcohol, glycerol

iii) Draw the general form of a triglyceride molecule.

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

12.10)

i) Triglycerides - also referred to as triacylglycerides - contain three ________ - type bonds.

HINT: a) ether
b) ester
c) amide
~~d) amine~~

ii) Triglycerides are composed of contain three ________ residues and one __________ residue.

HINT: ~~a) alcohol, ester~~
b) fatty acid, ester
c) fatty acid, glycerol
d) alcohol, glycerol

iii) Draw the general form of a triglyceride molecule.

HINT: You will find the general form in your lecture notes and the textbook.

For more help: See chapter 12 part 3 video or chapter 12 section 5 in the textbook.

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Click here to **check your answer**

Go to next question

12.10)

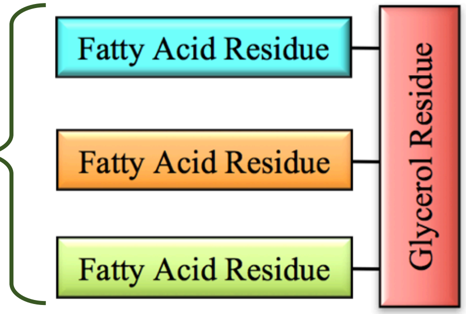
i) Triglycerides - also referred to as triacylglycerides - contain three ________ - type bonds.

a) ether
b) ester
c) amide
d) amine

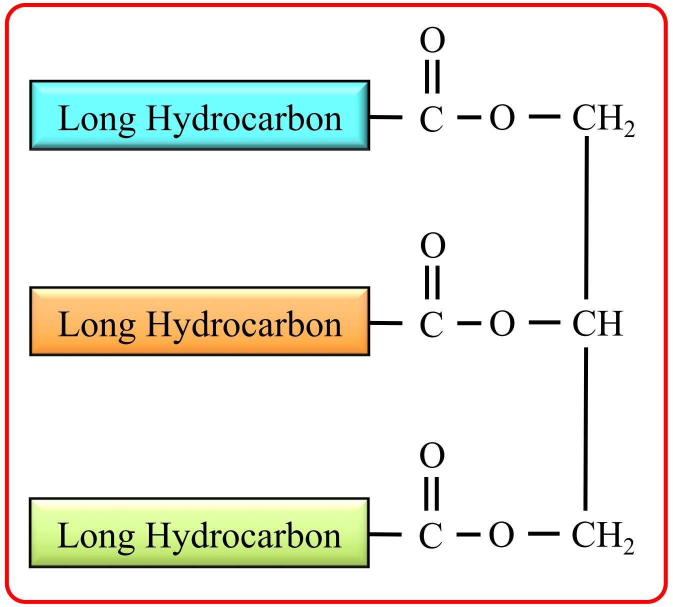
The ester bonding pattern is highlighted yellow in the general form of a triglyceride (on the bottom of this page).

ii) Triglycerides are composed of contain three ________ residues and one __________ residue.

a) alcohol, ester
b) fatty acid, ester
c) fatty acid, glycerol
d) alcohol, glycerol



iii) Draw the general form of a triglyceride molecule.



For more details: See chapter 12 part 3 video or chapter 12 section 5 in the textbook.

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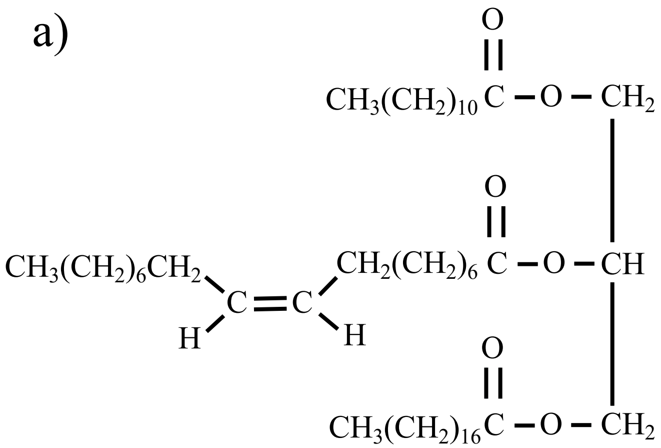
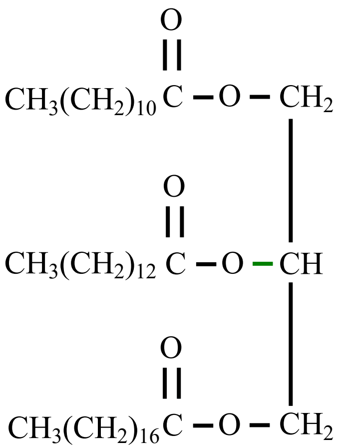
12.11) Classify each of the triglycerides below as either **saturated** or **unsaturated**.

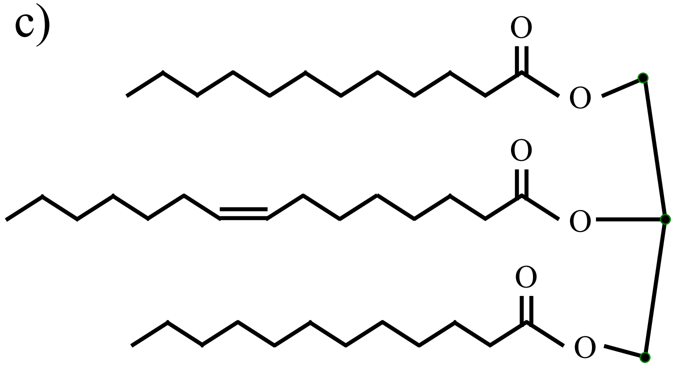
a)



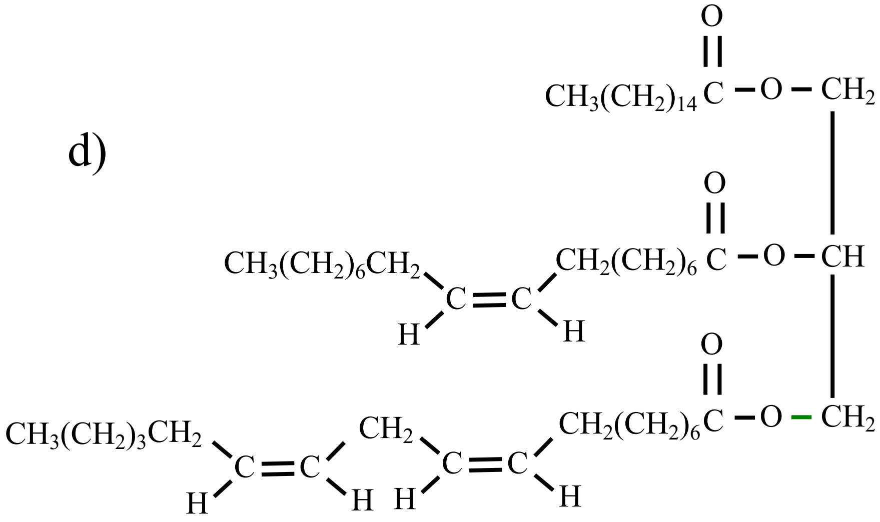
b)



c)



d)



Go back

Click here for a **hint**

Click here to **check your answer**

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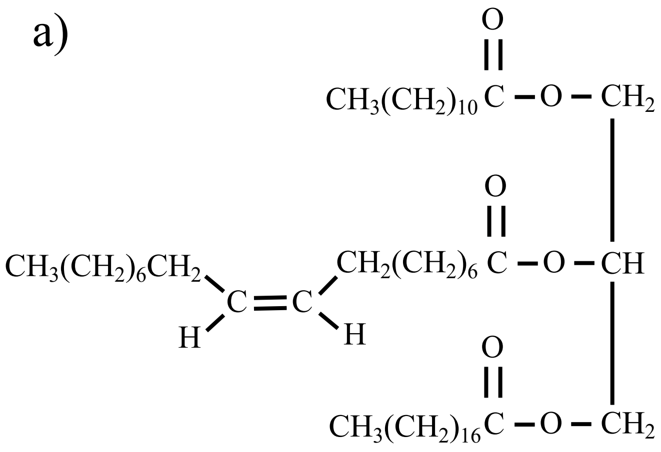
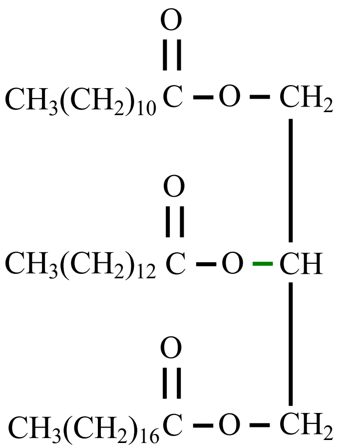
12.11) Classify each of the triglycerides below as either **saturated** or **unsaturated**.

a)



b)

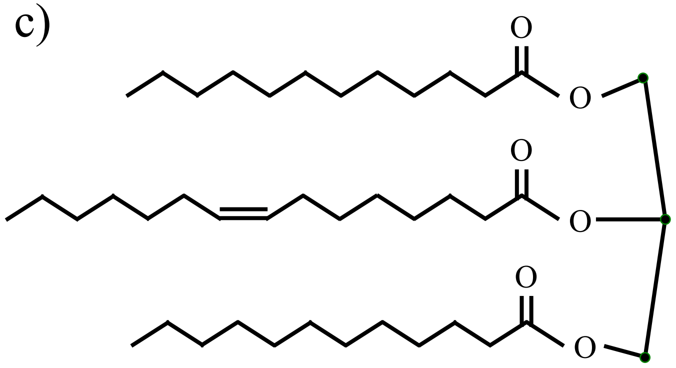


HINT:

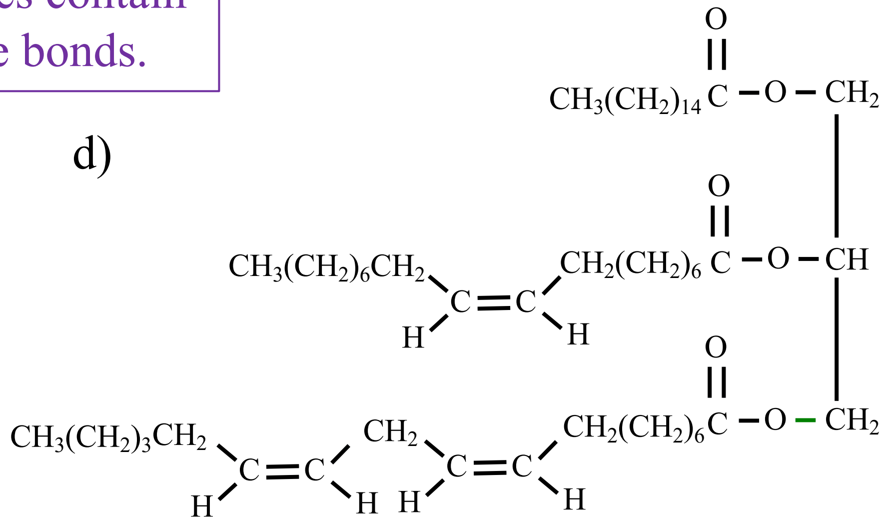
We classify *triglyceride* molecules as either **saturated** or **unsaturated** using the same criteria as we used for *fatty acids*.

- **Saturated** triglyceride molecules ***do not*** contain *carbon-carbon* double bonds.
- **Unsaturated** triglyceride molecules contain ***one or more*** carbon-carbon double bonds.

c)



d)



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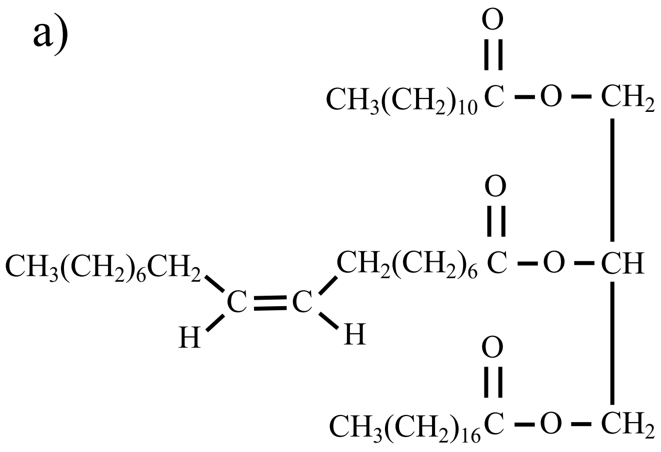
For more help: See chapter 12 part 3 video or chapter 12 section 5 in the textbook.

Click here to check your answer

Go to next question

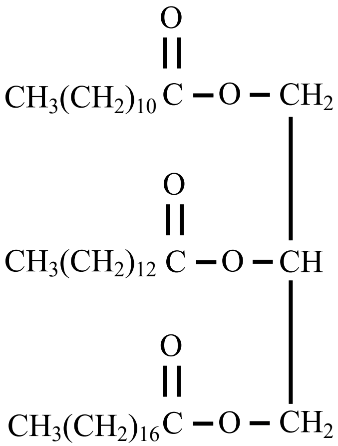
12.11) Classify each of the triglycerides below as either **saturated** or **unsaturated**.

a)



unsaturated

b)



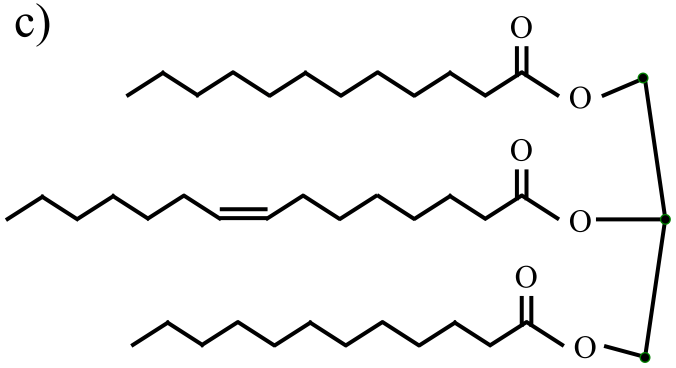
saturated

EXPLANATION:

We classify *triglyceride* molecules as either **saturated** or **unsaturated** using the same criteria as we used for *fatty acids*.

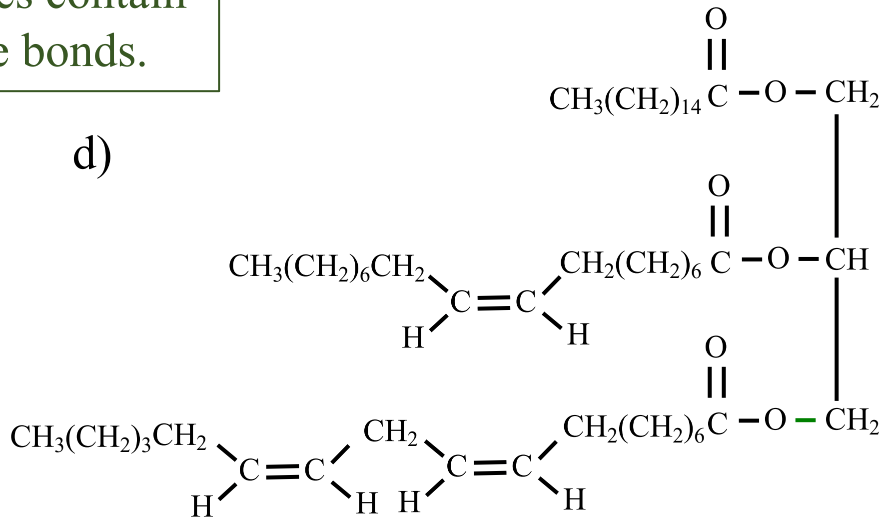
- **Saturated** triglyceride molecules ***do not*** contain *carbon-carbon* double bonds.
- **Unsaturated** triglyceride molecules contain ***one or more*** carbon-carbon double bonds.

c)



unsaturated

d)



unsaturated

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For more details: See chapter 12 part 3 video or chapter 12 section 5 in the textbook.

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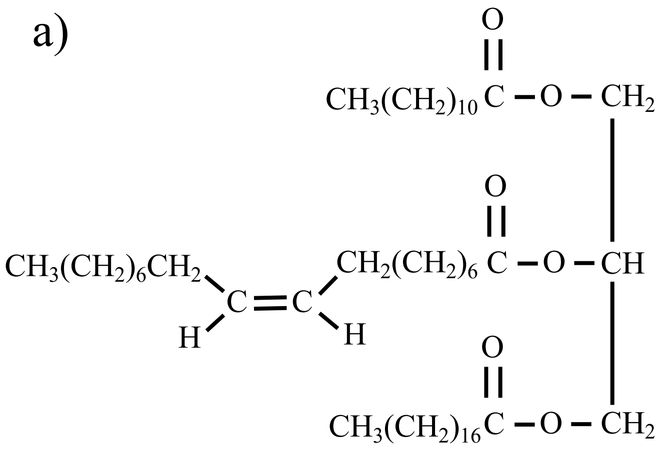
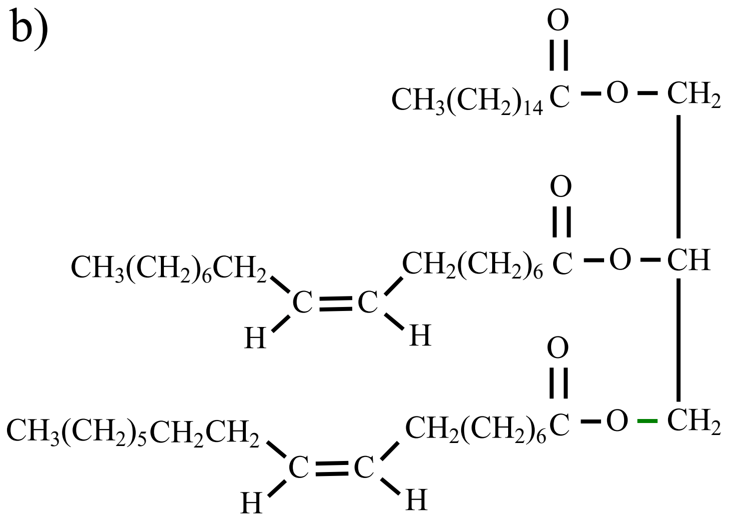
12.12) Classify each of the triglycerides below as either **monounsaturated** or **polyunsaturated**.

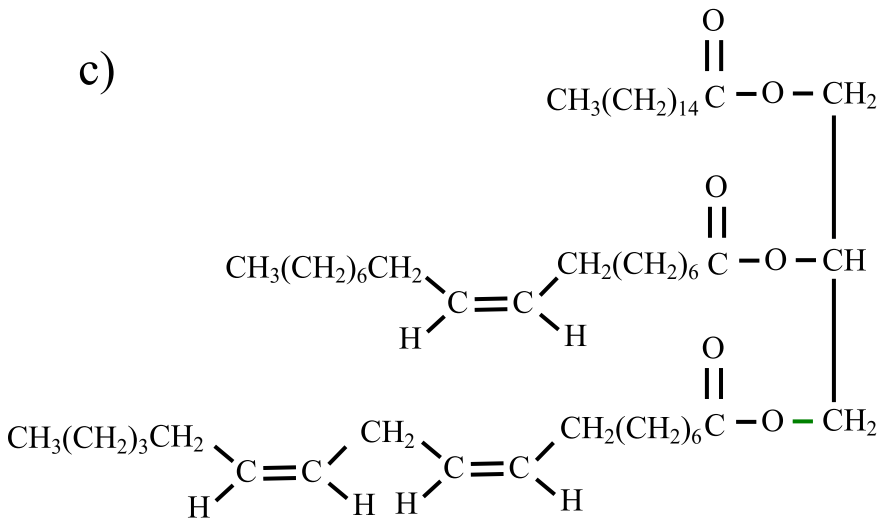
a)



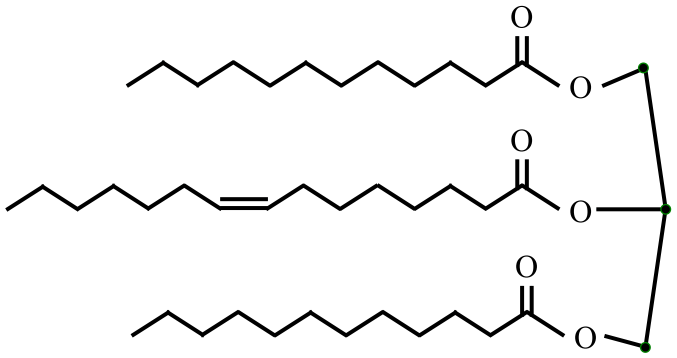
b)



c)



d)



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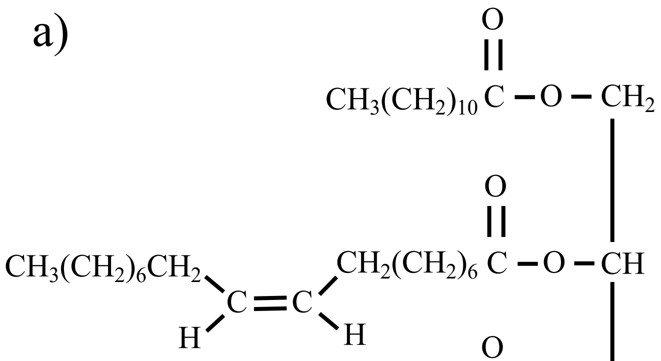
Click here for a **hint**

Click here to **check your answer**

Go to next question

12.12) Classify each of the triglycerides below as either **monounsaturated** or **polyunsaturated**.

a)

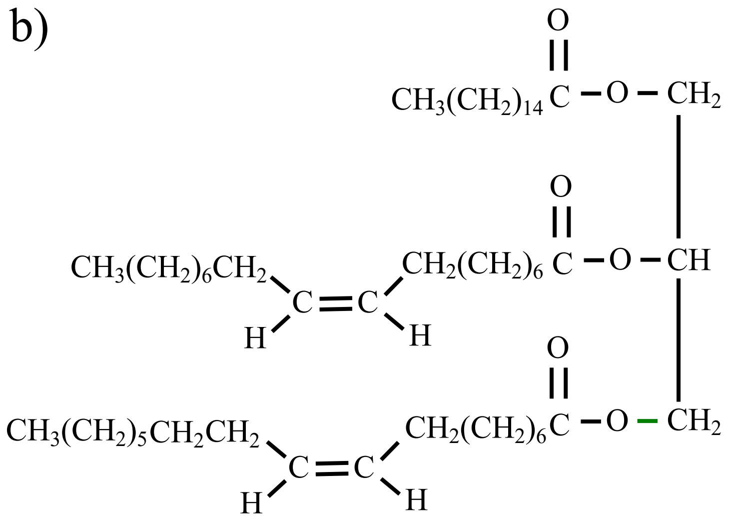


HINT:

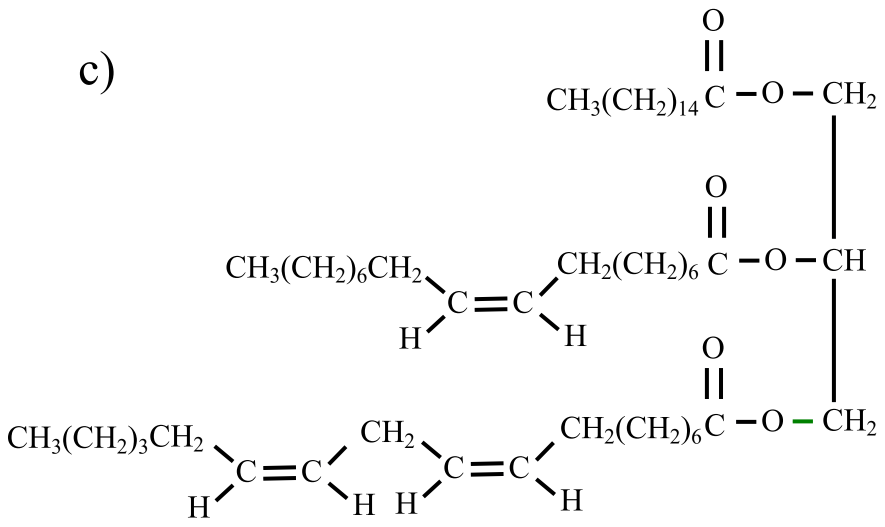
Unsaturated triglycerides are often further subcategorized as either **monounsaturated** or **polyunsaturated**.

- **Monounsaturated** triglycerides contain only ***one*** carbon-carbon double bond.
- **Polyunsaturated** triglycerides contain ***two or more*** carbon-carbon double bonds.

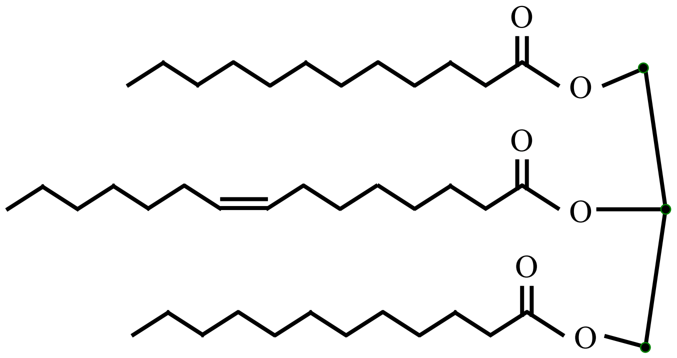
b)



c)



d)



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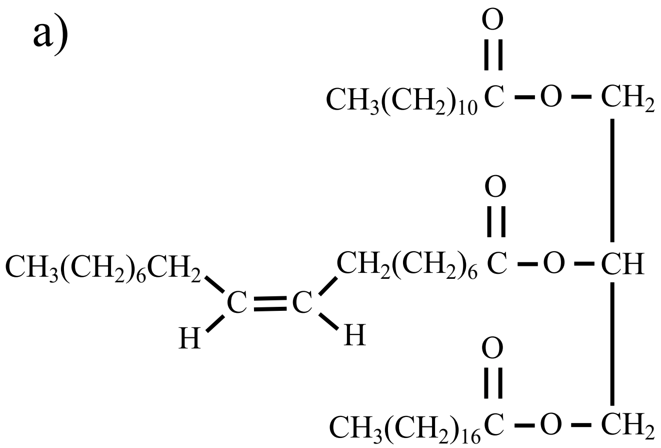
For more help: See chapter 12 part 3 video or chapter 12 section 5 in the textbook.

Click here to **check your answer**

Go to next question

12.12) Classify each of the triglycerides below as either **monounsaturated** or **polyunsaturated**.

a)



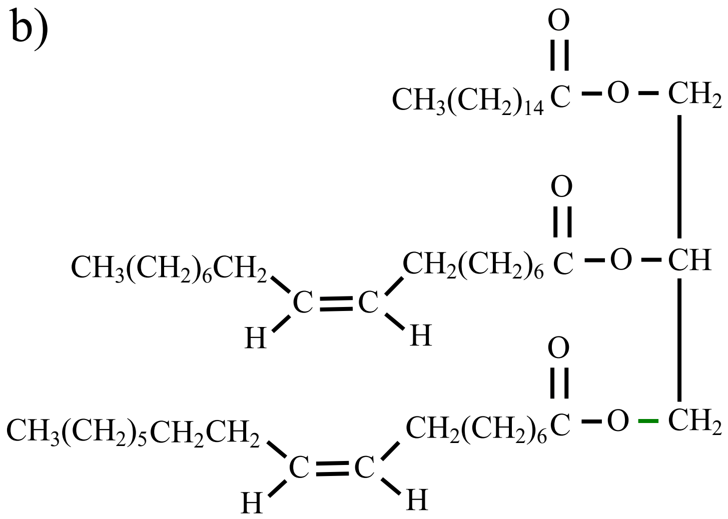
monounsaturated

EXPLANATION:

Unsaturated triglycerides are often further subcategorized as either **monounsaturated** or **polyunsaturated**.

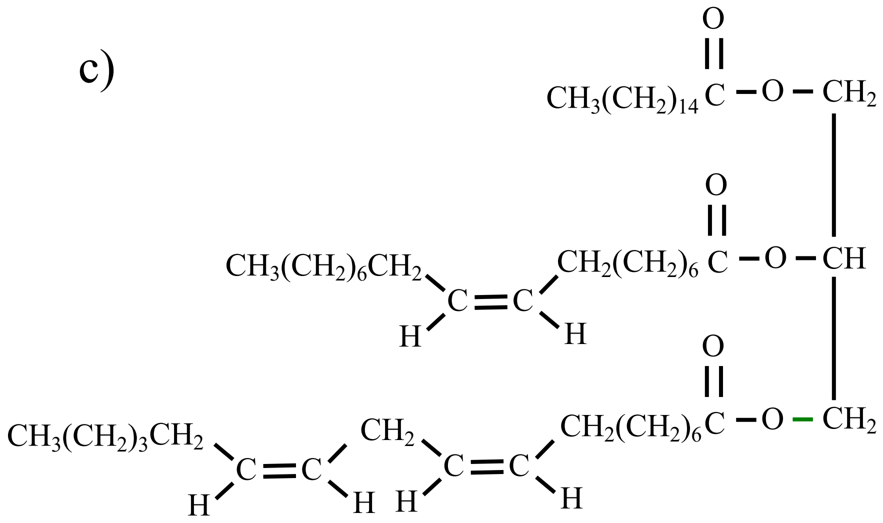
- **Monounsaturated** triglycerides contain only ***one*** carbon-carbon double bond.
- **Polyunsaturated** triglycerides contain ***two or more*** carbon-carbon double bonds.

b)



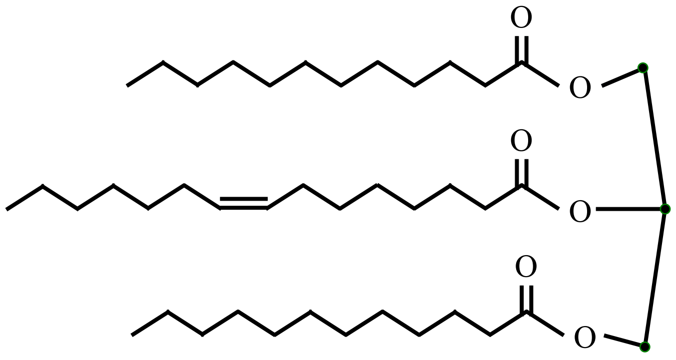
polyunsaturated

c)



polyunsaturated

d)



monounsaturated

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For more details: See chapter 12 part 3 video or chapter 12 section 5 in the textbook.

Go to next question

12.13)

i) What is the term that is generally used for a triglyceride that is liquid at room temperature?

ii) What is the term that is generally used for a triglyceride that is solid at room temperature?

iii) What is the name of the tissue that is composed of cells that store triglycerides?

iv) What are *four* primary biological roles of triglycerides in animals?

v) What is the term that is generally used for liquid triglycerides that are produce from plants?

vi) What is the term that is generally used for solid triglycerides that are produce from animals?

vii) In which nutritional labeling category are all triglycerides, whether from plants or animals, solid or liquid?

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Go to next question

12.13)

i) What is the term that is generally used for a triglyceride that is liquid at room temperature?

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v) What is the term that is generally used for liquid triglycerides that are produce from plants?

vi) What is the term that is generally used for solid triglycerides that are produce from animals?

vii) In which nutritional labeling category are all triglycerides, whether from plants or animals, solid or liquid?

HINT: You will find the answers to all of these questions in the "triglycerides" section of your lecture notes and the textbook.

For more help: See chapter 12 part 3 video or chapter 12 section 5 in the textbook.

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Click here to **check your answer**

Go to next question

12.13)

i) What is the term that is generally used for a triglyceride that is liquid at room temperature? **oil**

ii) What is the term that is generally used for a triglyceride that is solid at room temperature? **fat**

iii) What is the name of the tissue that is composed of cells that store triglycerides? **adipose tissue**

iv) What are *four* primary biological roles of triglycerides in animals? **energy storage, the production of energy when metabolized, provision of fatty acids for the production of other lipids, and insulation**

v) What is the term that is generally used for liquid triglycerides that are produce from plants? **vegetable oil**

vi) What is the term that is generally used for solid triglycerides that are produce from animals? **animal fat**

vii) In which nutritional labeling category are all triglycerides, whether from plants or animals, solid or liquid? **"total fat"**

The answers to all of these question are found in the "triglycerides" section of your lecture notes and the textbook.

For more details: See chapter 12 part 3 video or chapter 12 section 5 in the textbook.

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Go to next question

12.14) Draw the ***condensed*** structure of the triglyceride that is formed from the esterification reaction of ***three*** stearic acid molecules and a glycerol molecule.

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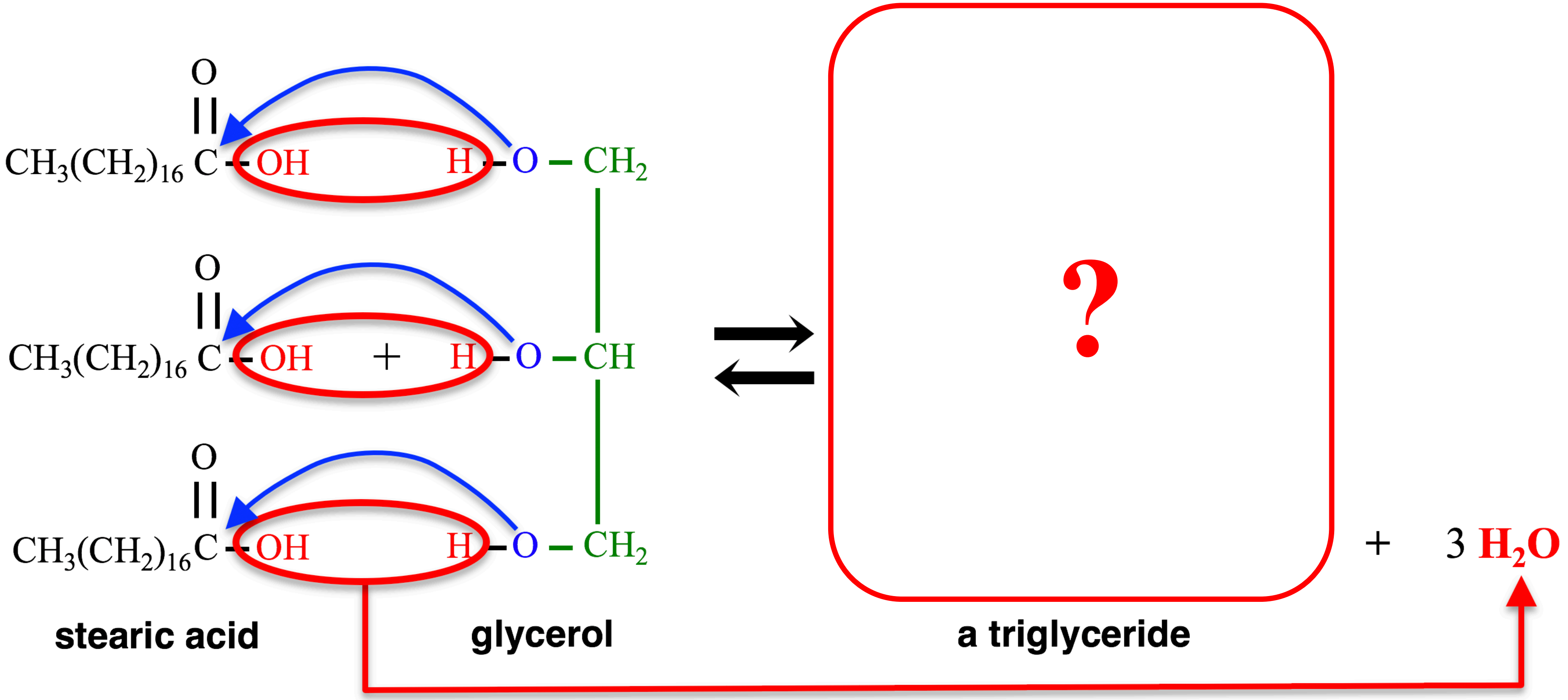
Click here to **check your answer**

Go to next question

12.14) Draw the ***condensed*** structure of the triglyceride that is formed from the esterification reaction of ***three*** stearic acid molecules and a glycerol molecule.



HINT: In this esterification reaction, the **OH**'s from the fatty acids and *three* **H**'s from glycerol's hydroxyl groups are removed, and then combined to form *three* **H_2O** molecules. The three oxygens, (**O**) that were originally in glycerol, each form anew bond to a fatty acid's carbonyl carbon.

For more help: See chapter 12 part 3 video or chapter 12 section 5 in the textbook.

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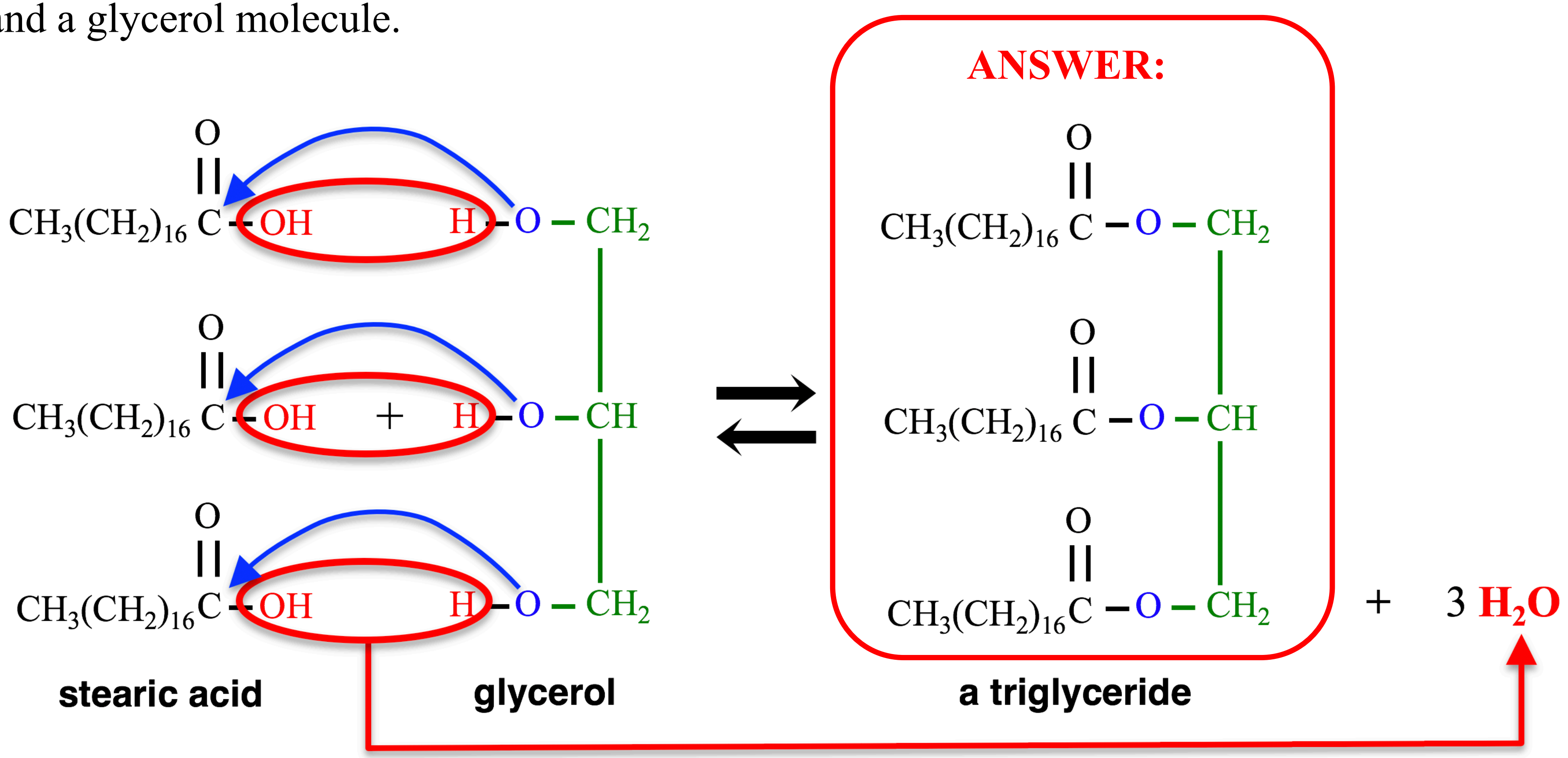
Click here to **check your answer**

Go to next question

12.14) Draw the ***condensed*** structure of the triglyceride that is formed from the esterification reaction of ***three*** stearic acid molecules and a glycerol molecule.



EXPLANATION: In this esterification reaction, the **OH**'s from the fatty acids and *three* **H**'s from glycerol's hydroxyl groups are removed, and then combined to form *three* **H_2O** molecules. The three oxygens, (**O**) that were originally in glycerol, each form anew bond to a fatty acid's carbonyl carbon.

For more details: See chapter 12 part 3 video or chapter 12 section 5 in the textbook.

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Go to next question

12.15) Using the table of fatty acids, draw the *condensed* structure of an **unsaturated** triglyceride.

Some Fatty Acids that are Frequently Encountered in Biological Systems

Number of Carbons	Number of Carbon-Carbon Double Bonds	Common Name	Condensed Structure	Major Source
12	0	lauric acid	$CH_3(CH_2)_{10}COOH$	coconut
14	0	myristic acid	$CH_3(CH_2)_{12}COOH$	nutmeg
16	0	palmitic acid	$CH_3(CH_2)_{14}COOH$	palm
16	1	palmitoleic acid	$CH_3(CH_2)_5CH{=}CH(CH_2)_7COOH$	macadamia, animals
18	0	stearic acid	$CH_3(CH_2)_{16}COOH$	animal fat
18	1	oleic acid	$CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$	olives
18	2	linoleic acid	$CH_3(CH_2)_4(CH{=}CHCH_2)_2(CH_2)_6COOH$	safflower, soy
18	3	linolenic acid	$CH_3CH_2(CH{=}CHCH_2)_3(CH_2)_6COOH$	flax, corn

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Click here for a **hint**

Click here to **check your answer**

Go to next question

12.15) Using the table of fatty acids, draw the *condensed* structure an **unsaturated** triglyceride.

Some Fatty Acids that are Frequently Encountered in Biological Systems

Number of Carbons	Number of Carbon-Carbon Double Bonds	Common Name	Condensed Structure	Major Source
12	0	lauric acid	$CH_3(CH_2)_{10}COOH$	coconut
14	0	myristic acid	$CH_3(CH_2)_{12}COOH$	nutmeg
16	0	palmitic acid	$CH_3(CH_2)_{14}COOH$	palm
16	1	palmitoleic acid	$CH_3(CH_2)_5CH{=}CH(CH_2)_7COOH$	macadamia, animals
18	0	stearic acid	$CH_3(CH_2)_{16}COOH$	animal fat
18	1	oleic acid	$CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$	olives
18	2	linoleic acid	$CH_3(CH_2)_4(CH{=}CHCH_2)_2(CH_2)_6COOH$	safflower, soy
18	3	linolenic acid	$CH_3CH_2(CH{=}CHCH_2)_3(CH_2)_6COOH$	flax, corn

HINT:

- **Saturated** triglyceride molecules ***do not*** contain *carbon-carbon* double bonds.
- **Unsaturated** triglyceride molecules contain ***one or more*** carbon-carbon double bonds.

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For more help: See chapter 12 part 3 video or chapter 12 section 5 in the textbook.

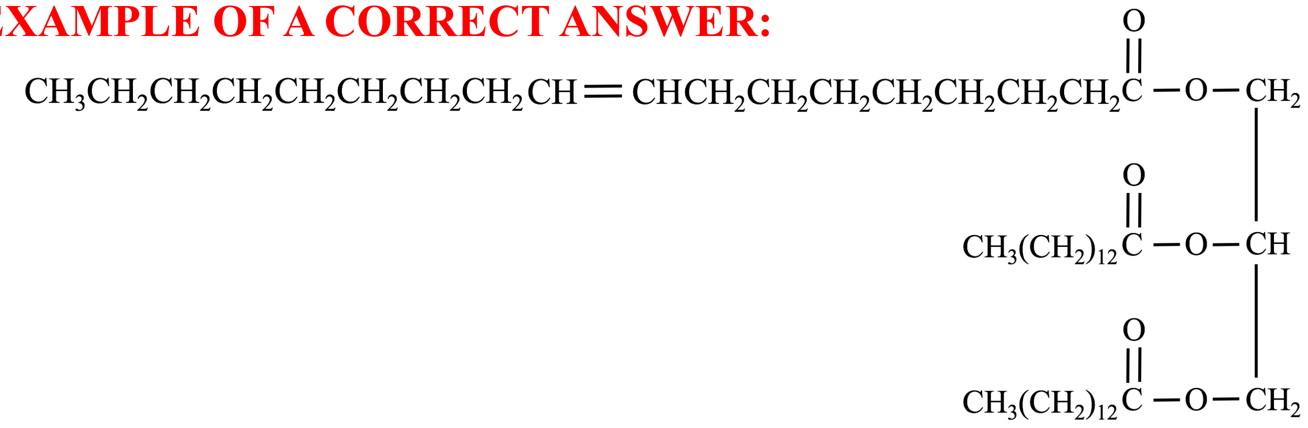
Click here to check your answer

Go to next question

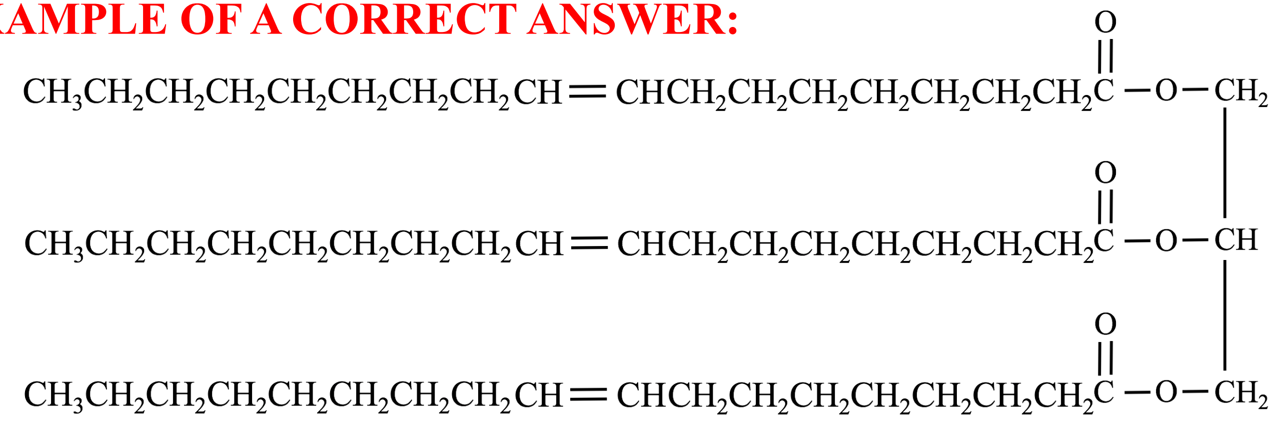
12.15) Using the table of fatty acids, draw the *condensed* structure of an **unsaturated** triglyceride.

Unsaturated triglyceride molecules contain ***one or more*** carbon-carbon double bonds. **Your answer is CORRECT if** the triglyceride that you drew has the correct esterification bonding patterns between the fatty acid residues and the glycerol residue AND has ***one or more*** carbon-carbon double bonds. Two *examples* of correct answers are shown below.

EXAMPLE OF A CORRECT ANSWER:



EXAMPLE OF A CORRECT ANSWER:



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For more details: See chapter 12 part 3 video or chapter 12 section 5 in the textbook.

Go to next question

12.16) Using the table of fatty acids, draw the **SKELETAL** structure of an **unsaturated** triglyceride.

Some Fatty Acids that are Frequently Encountered in Biological Systems

Number of Carbons	Number of Carbon-Carbon Double Bonds	Common Name	Condensed Structure	Major Source
12	0	lauric acid	$CH_3(CH_2)_{10}COOH$	coconut
14	0	myristic acid	$CH_3(CH_2)_{12}COOH$	nutmeg
16	0	palmitic acid	$CH_3(CH_2)_{14}COOH$	palm
16	1	palmitoleic acid	$CH_3(CH_2)_5CH{=}CH(CH_2)_7COOH$	macadamia, animals
18	0	stearic acid	$CH_3(CH_2)_{16}COOH$	animal fat
18	1	oleic acid	$CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$	olives
18	2	linoleic acid	$CH_3(CH_2)_4(CH{=}CHCH_2)_2(CH_2)_6COOH$	safflower, soy
18	3	linolenic acid	$CH_3CH_2(CH{=}CHCH_2)_3(CH_2)_6COOH$	flax, corn

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

12.16) Using the table of fatty acids, draw the **SKELETAL** structure of an **unsaturated** triglyceride.

Some Fatty Acids that are Frequently Encountered in Biological Systems

Number of Carbons	Number of Carbon-Carbon Double Bonds	Common Name	Condensed Structure	Major Source
12	0	lauric acid	$CH_3(CH_2)_{10}COOH$	coconut
14	0	myristic acid	$CH_3(CH_2)_{12}COOH$	nutmeg
16	0	palmitic acid	$CH_3(CH_2)_{14}COOH$	palm
16	1	palmitoleic acid	$CH_3(CH_2)_5CH{=}CH(CH_2)_7COOH$	macadamia, animals
18	0	stearic acid	$CH_3(CH_2)_{16}COOH$	animal fat
18	1	oleic acid	$CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$	olives
18	2	linoleic acid	$CH_3(CH_2)_4(CH{=}CHCH_2)_2(CH_2)_6COOH$	safflower, soy
18	3	linolenic acid	$CH_3CH_2(CH{=}CHCH_2)_3(CH_2)_6COOH$	flax, corn

HINT:

- **Saturated** triglyceride molecules ***do not*** contain *carbon-carbon* double bonds.
- **Unsaturated** triglyceride molecules contain ***one or more*** carbon-carbon double bonds.

Go back

For more help: See chapter 12 part 3 video or chapter 12 section 5 in the textbook.

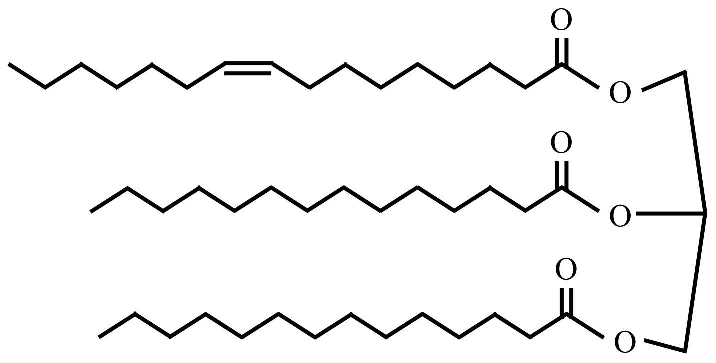
Click here to check your answer

Go to next question

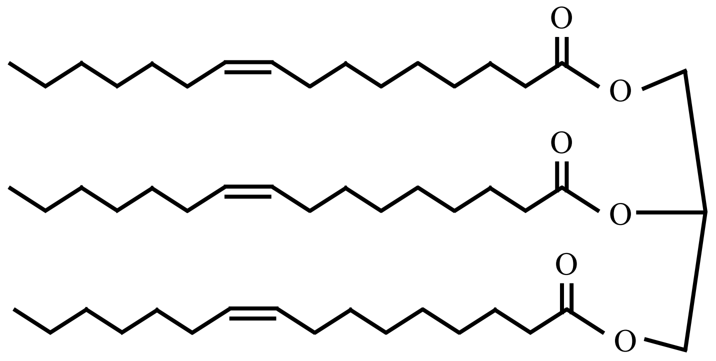
12.16) Using the table of fatty acids, draw the **SKELETAL** structure of an **unsaturated** triglyceride.

Unsaturated triglyceride molecules contain ***one or more*** carbon-carbon double bonds. **Your answer is CORRECT if** the triglyceride that you drew has the correct esterification bonding patters between the fatty acid residues and the glycerol residue AND has ***one or more*** carbon-carbon double bonds. Two *examples* of correct answers are shown below.

EXAMPLE OF A CORRECT ANSWER:



EXAMPLE OF A CORRECT ANSWER:

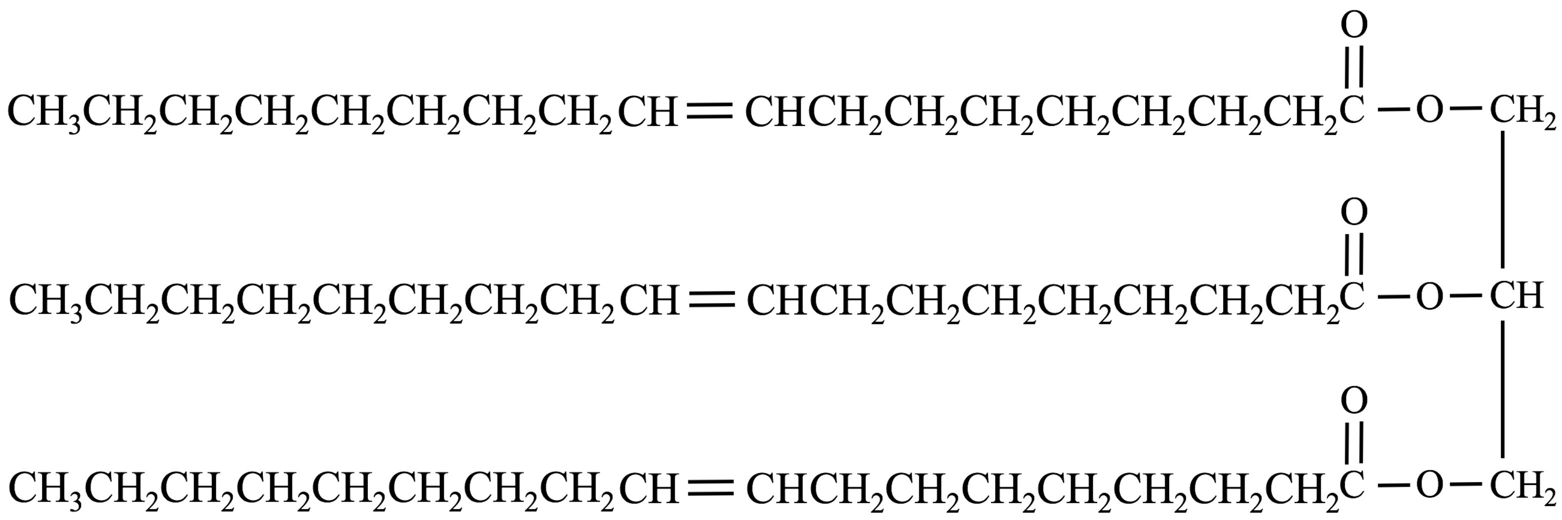


Go back

For more details: See chapter 12 part 3 video or chapter 12 section 5 in the textbook.

Go to next question

12.17) Draw the condensed structure of the product in the *complete hydrogenation* of the triglyceride shown below.



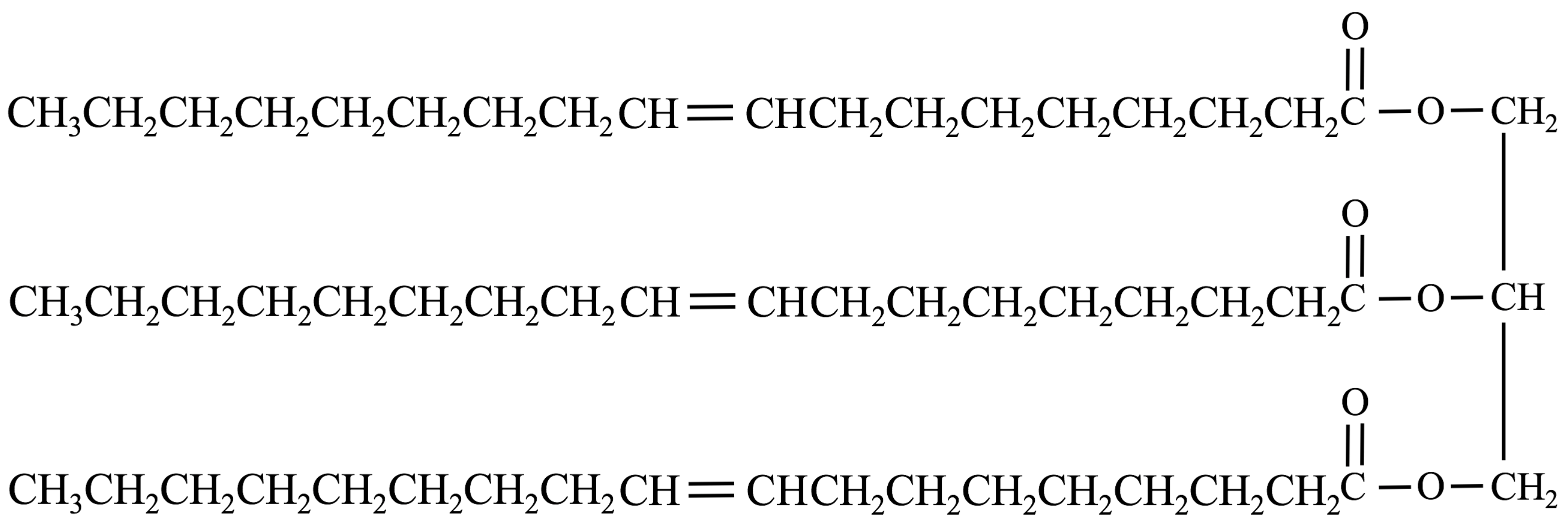
Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

12.17) Draw the condensed structure of the product in the *complete hydrogenation* of the triglyceride shown below.



HINT:

The *carbon-carbon* double bonds of triglycerides will react with hydrogen gas (**H_2**) in the presence of a catalyst (at high temperatures). If enough **H_2** is supplied, **ALL** of the carbon-carbon double bonds in *unsaturated triglycerides* become completely saturated; a *saturated triglyceride* is formed; we call this ***complete hydrogenation***. A hydrogen atom is added to each of the double-bonded carbons, thereby converting them into single bonds.

For more help: See chapter 12 part 4 video or chapter 12 section 5 in the textbook.

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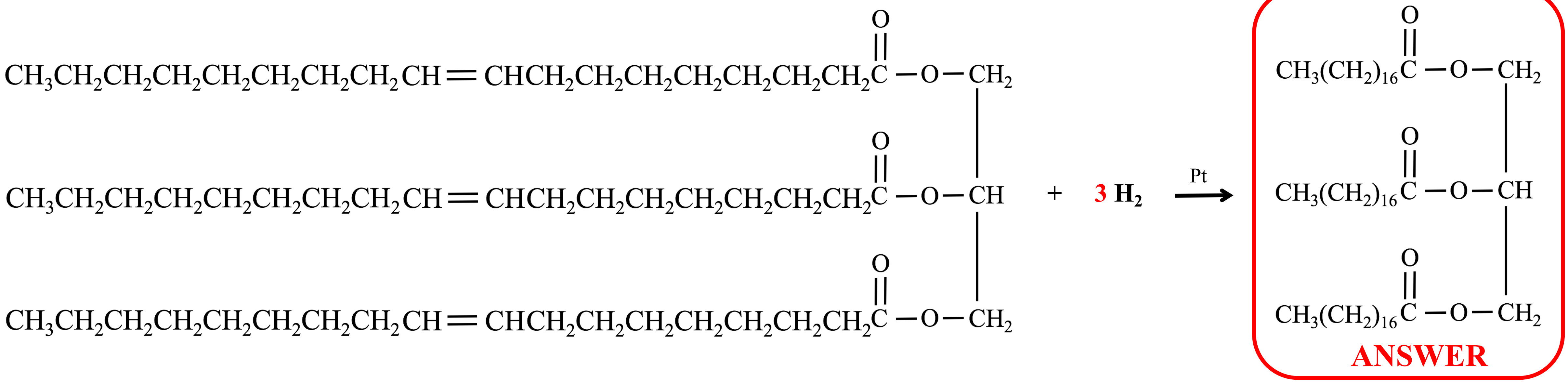
Click here to **check your answer**

Go to next question

12.17) Draw the condensed structure of the product in the *complete hydrogenation* of the triglyceride shown below.



EXPLANATION:

The *carbon-carbon* double bonds of triglycerides will react with hydrogen gas (**H_2**) in the presence of a catalyst (at high temperatures). If enough **H_2** is supplied, **ALL** of the carbon-carbon double bonds in *unsaturated triglycerides* become completely saturated; a *saturated triglyceride* is formed; we call this ***complete hydrogenation***. A hydrogen atom is added to each of the double-bonded carbons, thereby converting them into single bonds. The reaction must be done at a high temperature and on the surface of a *metal catalyst*. The catalysts used are typically platinum, palladium, rhodium, or ruthenium.

- Note that this unsaturated triglyceride molecule reactant contains **three** double bonds, therefore **three H_2** molecules are needed to achieve ***complete saturation***.

For more details: See chapter 12 part 4 video or chapter 12 section 5 in the textbook.

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Go to next question

12.18) Using complete sentence(s), write the definition of the following:

a) partial hydrogenation

b) trans fat

c) rancidification

d) saponification

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

12.18) Using complete sentence(s), write the definition of the following:

a) partial hydrogenation

b) trans fat

c) rancidification

HINT:

You can find the definitions for all of these terms/phrases in the "reactions of triglycerides" section of your lecture notes or the textbook.

For more help: See chapter 12 part 4 video or chapter 12 section 5 in the textbook.

d) saponification

Go back

Click here to **check your answer**

Go to next question

12.18) Using complete sentence(s), write the definition of the following:

a) partial hydrogenation

Partial hydrogenation is a chemical reaction that occurs if the amount of H_2 is limited or the chemical reaction time is reduced in the oxidation of a triglyceride so that the triglyceride product will contain unreacted carbon-carbon double bonds.

b) trans fat

Trans fats are triglycerides containing one or more carbon-carbon double bonds that have the ***trans*** configuration. An undesirable consequence of partial hydrogenation is the formation of trans fats.

- In the partial hydrogenation process, many of the unreacted cis carbon-carbon double bonds are converted to the trans configuration.

c) rancidification

Rancidification is a term used for the chemical reaction in which triglyceride food substances are oxidized to produce aldehydes and carboxylic acids that have foul odors.

- In order to prevent or slow the rancidification of foods, the oxygen supply can be limited by air-tight containers and packaging, and the food can be stored at low temperatures.

d) saponification

Saponification is a chemical reaction in which a ***triglyceride*** reacts with ***hydroxide ions*** to produce ***three long-chain carboxylate ions*** and ***glycerol***.

- The saponification reaction is used to make **soap**. The long-chain carboxylate ions that are produced are ***amphipathic***, and act as emulsifying agents to remove nonpolar molecules (i.e. grease or oil) from surfaces, including - very importantly – skin and clothing.

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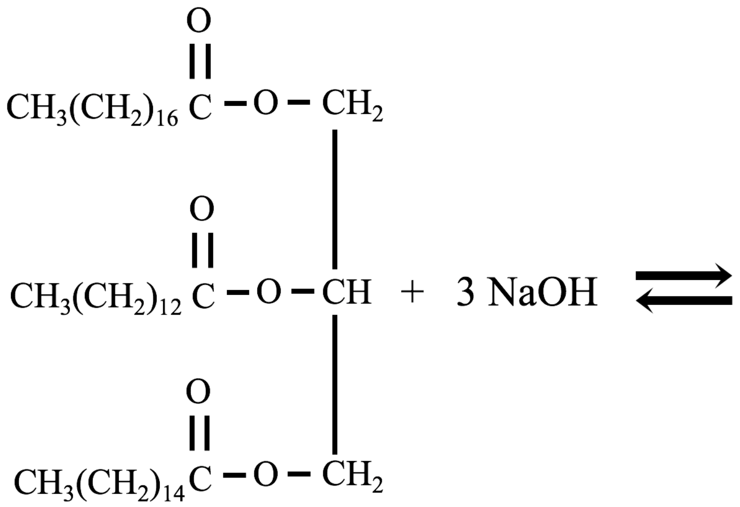
For more details: See chapter 12 part 4 video or chapter 12 section 5 in the textbook.

Go to next question

12.19) Draw the *condensed structure* of the products for the saponification reaction shown below. Include the cations when drawing the fatty acid salts.



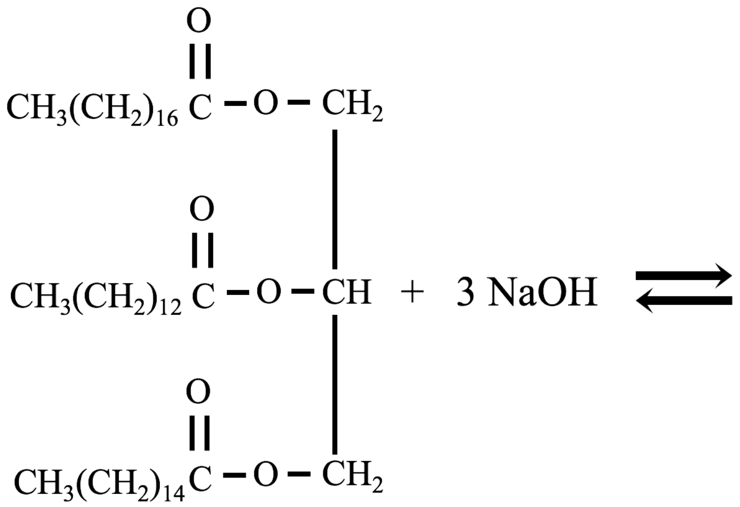
Go back

Click here for a **hint**

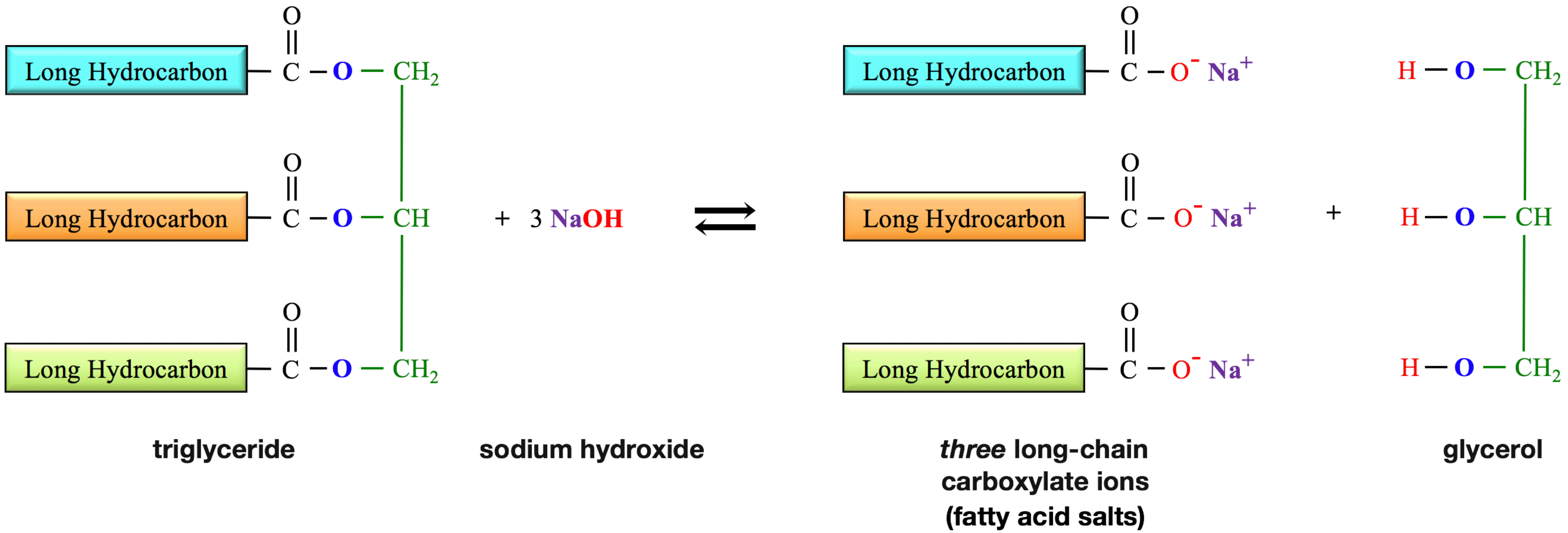
Click here to **check your answer**

Go to next question

12.19) Draw the *condensed structure* of the products for the saponification reaction shown below. Include the cations when drawing the fatty acid salts.



HINT:
The general form for the saponification reaction is shown below.



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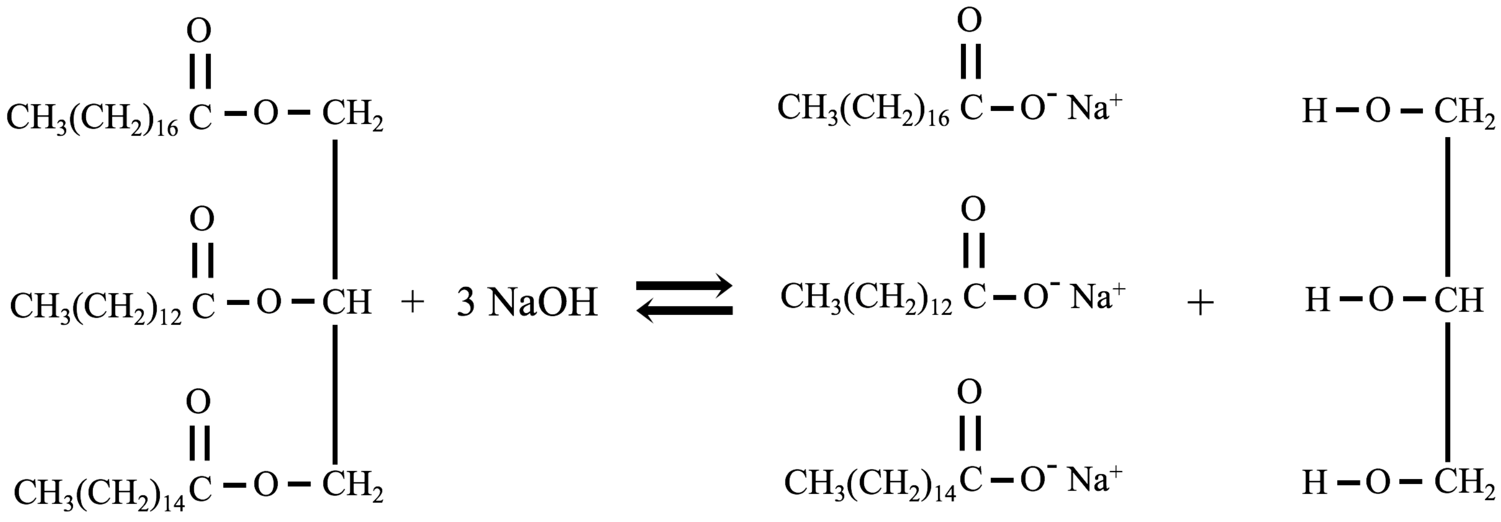
For more help: See chapter 12 part 4 video or chapter 12 section 5 in the textbook.

Click here to check your answer

Go to next question

12.19) Draw the *condensed structure* of the products for the saponification reaction shown below. Include the cations when drawing the fatty acid salts.



triglyceride **sodium hydroxide** **fatty acid salts** **glycerol**

EXPLANATION:

In the ***saponification*** reaction, a ***triglyceride*** reacts with ***hydroxide ions*** to produce ***three long-chain carboxylate ions*** and ***glycerol***.

- The hydroxide ions in the saponification reaction come from hydroxide-containing ionic compounds, usually sodium hydroxide (NaOH) or potassium hydroxide (KOH). When the cation of the hydroxide-containing compound is specified, it is often written after the long-chain carboxylate ion products as shown in the solution to this problem.
- The compounds formed from the long-chain carboxylate anions and the **Na^+** (or **K^+**) cations are ***ionic*** and are called ***fatty acid salts***.

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For more details: See chapter 12 part 4 video or chapter 12 section 5 in the textbook.

Go to next question

12.20) Identify the following items as being properties of either **glycerophospholipids**, **sphingophospholipids**, **or both glycerophospholipids** AND **sphingophospholipids**.

a) contain a phosphate residue

b) contain a glycerol residue

c) present in biological membranes

d) amphipathic

e) contain a sphingosine residue

f) contain an alcohol residue

g) can contain two fatty acid residues

12.20) Identify the following items as being properties of either **glycerophospholipids**, **sphingophospholipids**, **or both glycerophospholipids** AND **sphingophospholipids**.

a) contain a phosphate residue

b) contain a glycerol residue

c) present in biological membranes

d) amphipathic

e) contain a sphingosine residue

f) contain an alcohol residue

g) can contain two fatty acid residues

HINT:

For the items that involve *residues*, consider the general form of **glycerophospholipids** and **sphingophospholipids**.

You can find the correct responses for the items that *do not involve residues* in the phospholipids section of your lecture notes or the textbook.

For more help: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

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Click here to **check your answer**

Go to next question

12.20) Identify the following items as being properties of either **glycerophospholipids**, **sphingophospholipids**, **or both glycerophospholipids** AND **sphingophospholipids**.

a) contain a phosphate residue **both glycerophospholipids** AND **sphingophospholipids**.

b) contain a glycerol residue **glycerophospholipids**

c) present in biological membranes **both glycerophospholipids** AND **sphingophospholipids**.

d) amphipathic **both glycerophospholipids** AND **sphingophospholipids**.

e) contain a sphingosine residue **sphingophospholipids**.

f) contain an alcohol residue **both glycerophospholipids** AND **sphingophospholipids**.

g) can contain two fatty acid residues **glycerophospholipids**

For more details: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

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Go to next question

12.21) The difference between sphingophospholipids and glycerophospholipids is that sphingophospholipids

a) have three alcohol residues that replace the fatty acid residues.
b) have one phosphate, but the phosphate is attached to the fatty acid residue, not the glycerol.
c) have three phosphates, not one, and they are attached to all of the fatty acids.
d) none of the above.

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

12.21) The difference between sphingophospholipids and glycerophospholipids is that sphingophospholipids

a) have three alcohol residues that replace the fatty acid residues.

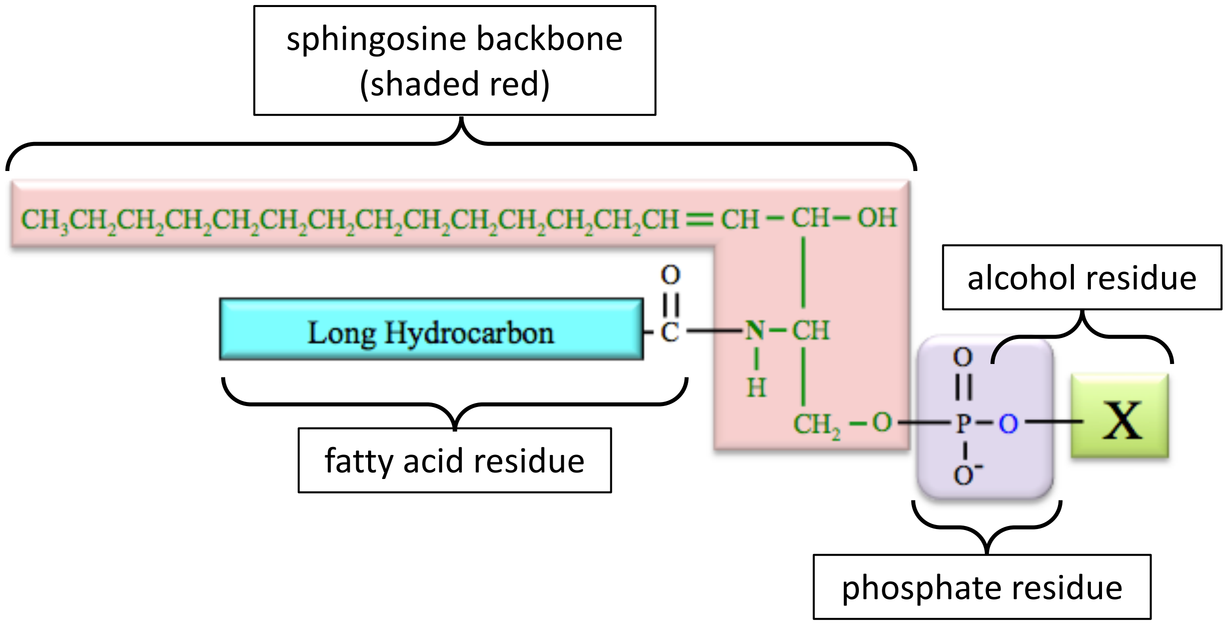
b) have one phosphate, but the phosphate is attached to the fatty acid residue, not the glycerol.

c) have three phosphates, not one, and they are attached to all of the fatty acids.

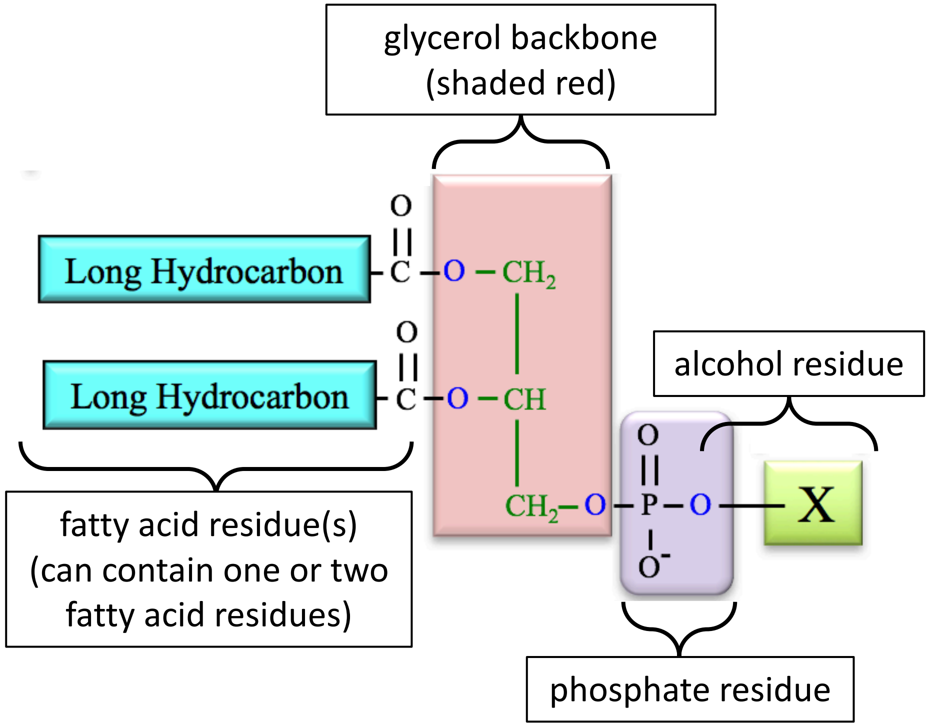
d) none of the above.

HINT:

general form of a sphingophospholipid



general form of a glycerophospholipid



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For more help: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

Click here to check your answer

Go to next question

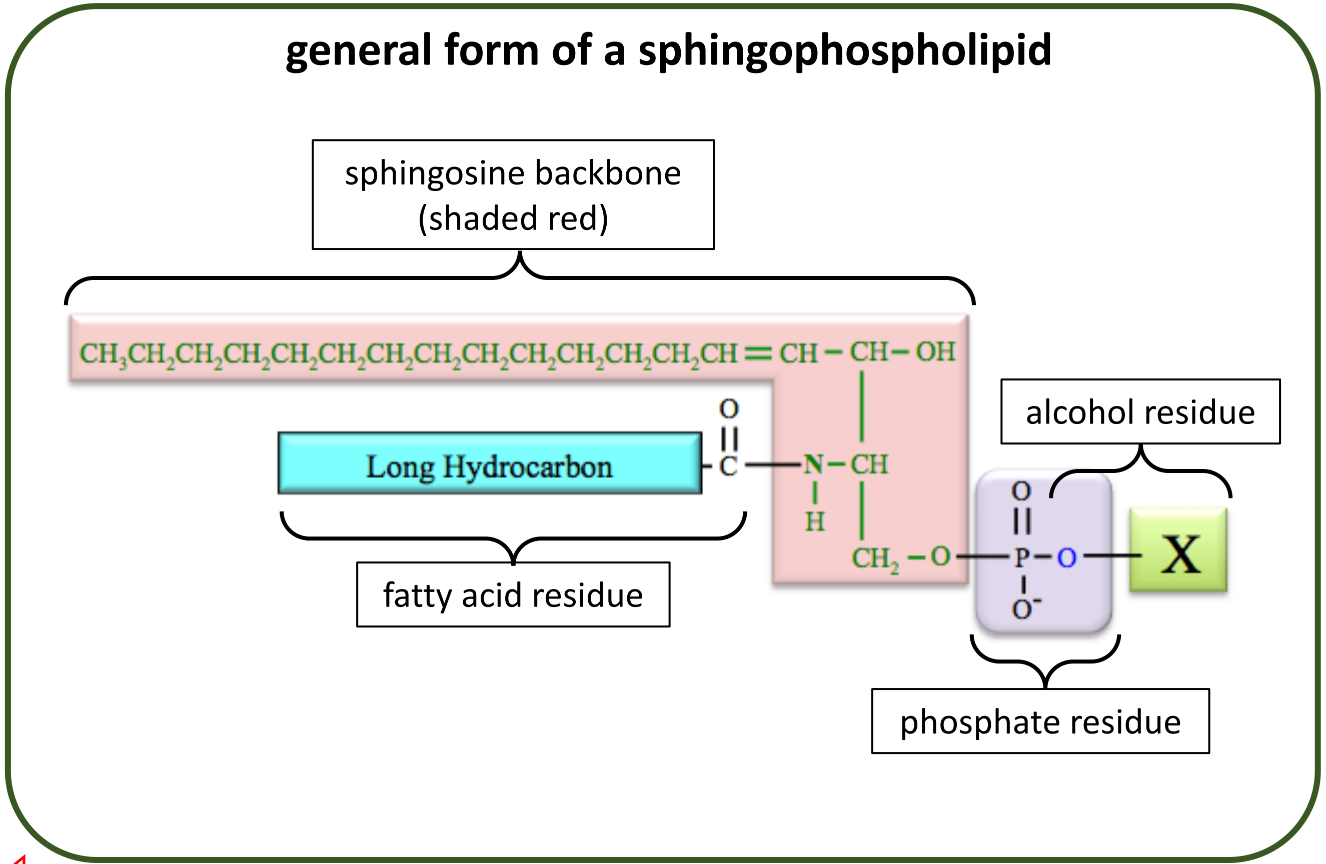
12.21) The difference between sphingophospholipids and glycerophospholipids is that sphingophospholipids

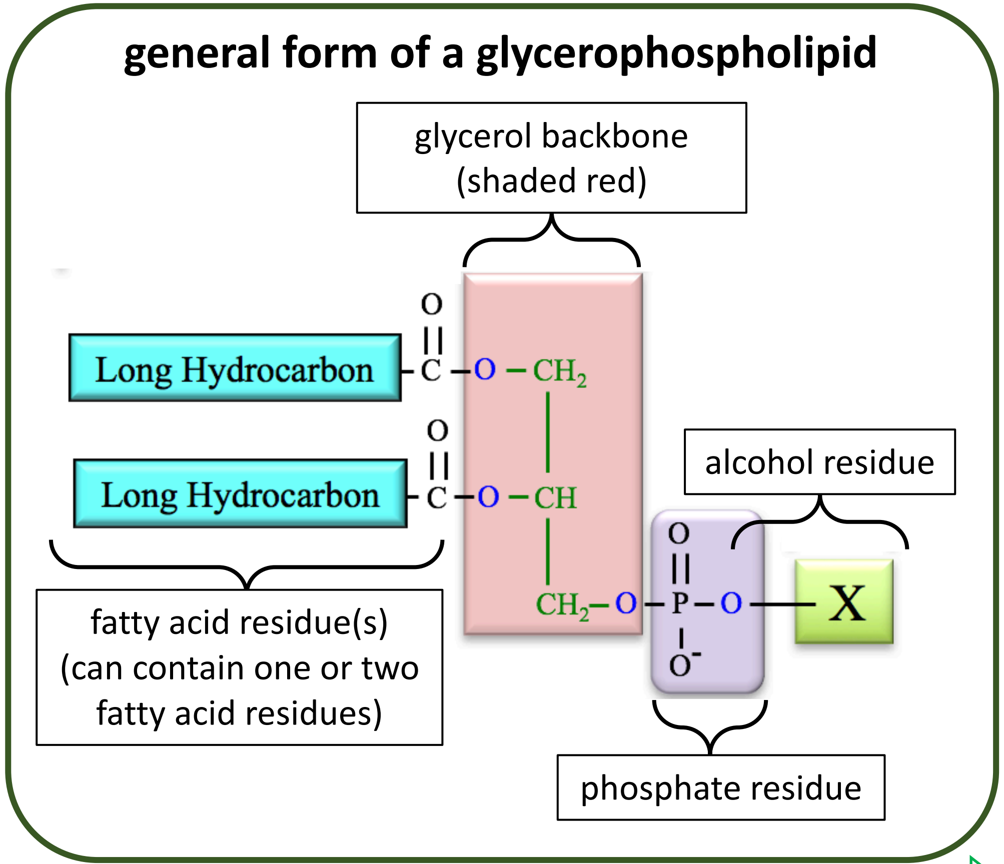
a) have three alcohol residues that replace the fatty acid residues.

b) have one phosphate, but the phosphate is attached to the fatty acid residue, not the glycerol.

c) have three phosphates, not one, and they are attached to all of the fatty acids.

d) none of the above.





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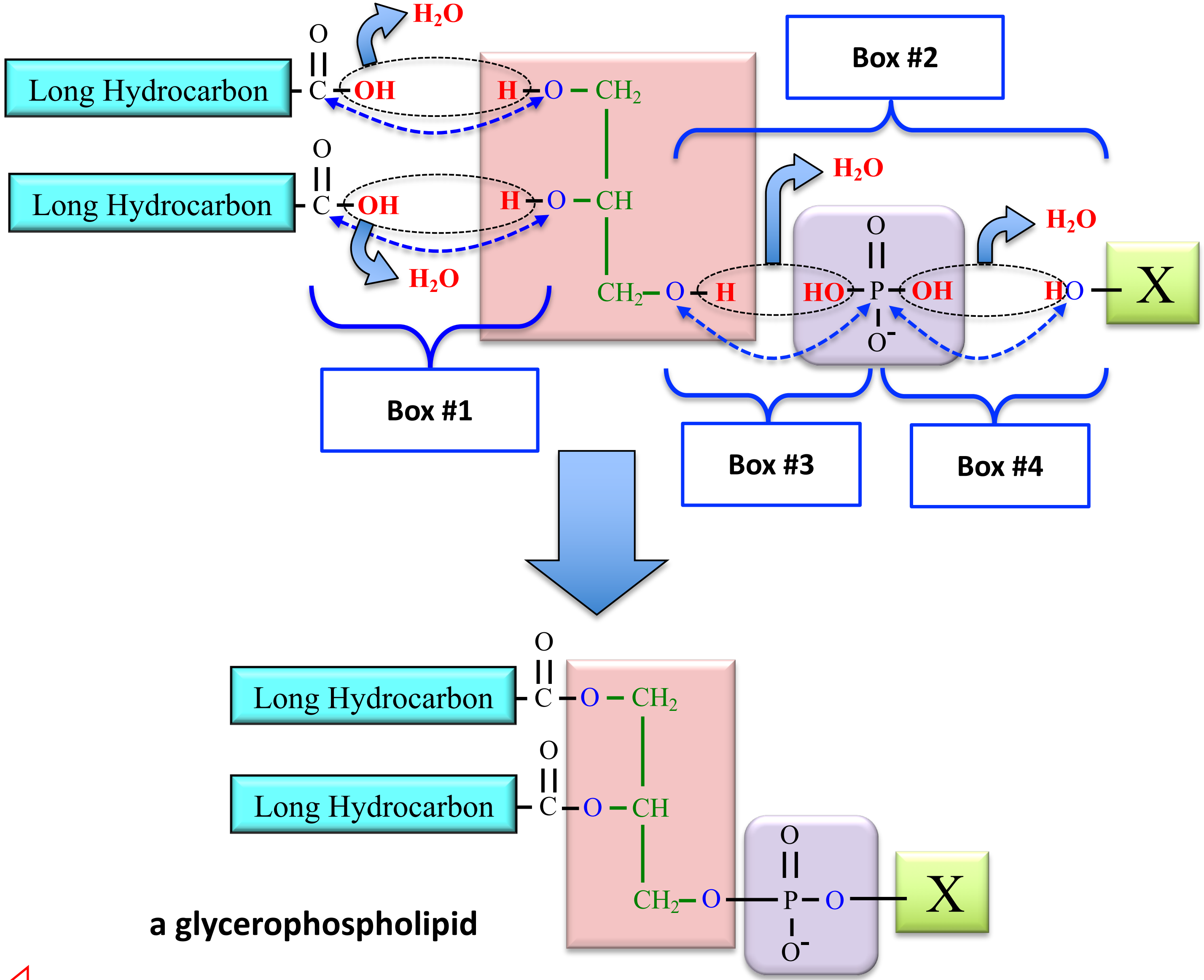
For more details: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

Go to next question

12.22) The illustration below shows how the fatty acid, glycerol, phosphate, and alcohol residues combine to form a ***glycerophospholipid***. Match the box number with the ***type of bonding pattern*** that is formed.



a glycerophospholipid

Type of bonding pattern choices:

a) ester
b) amide
c) phosphoester
d) phosphodiester
e) peptide
f) glyosidic

i) **Box #1**: ________________

ii) **Box #2**: ________________

iii) **Box #3**: ________________

iv) **Box #4**: ________________

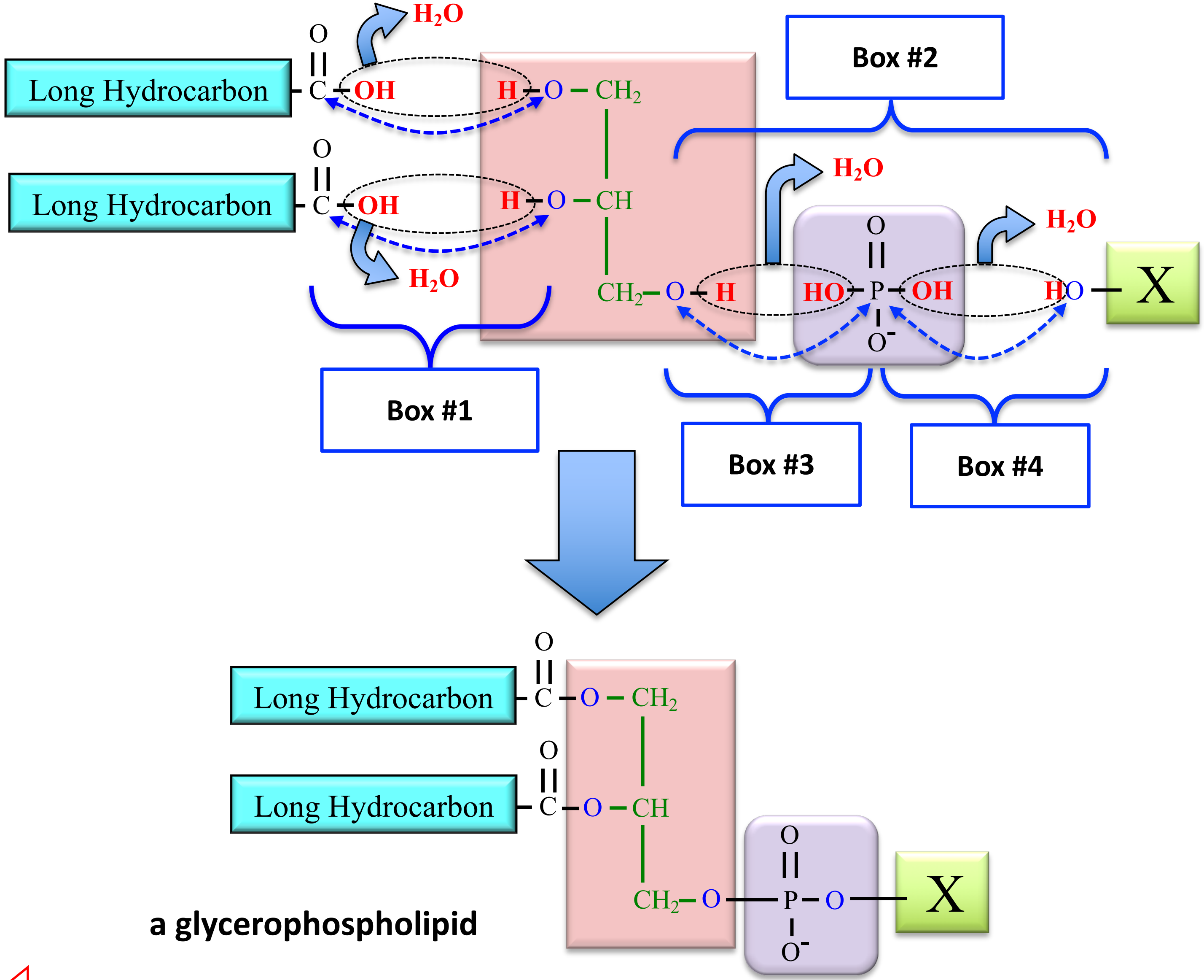
Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

12.22) The illustration below shows how the fatty acid, glycerol, phosphate, and alcohol residues combine to form a ***glycerophospholipid***. Match the box number with the ***type of bonding pattern*** that is formed.



Type of bonding pattern choices:

a) ester
b) amide
c) phosphoester
d) phosphodiester
~~e) peptide~~
~~f) glyosidic~~

HINT:

i) **Box #1**: ____________

ii) **Box #2**: ____________

iii) **Box #3**: ____________

iv) **Box #4**: ____________

For more help: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

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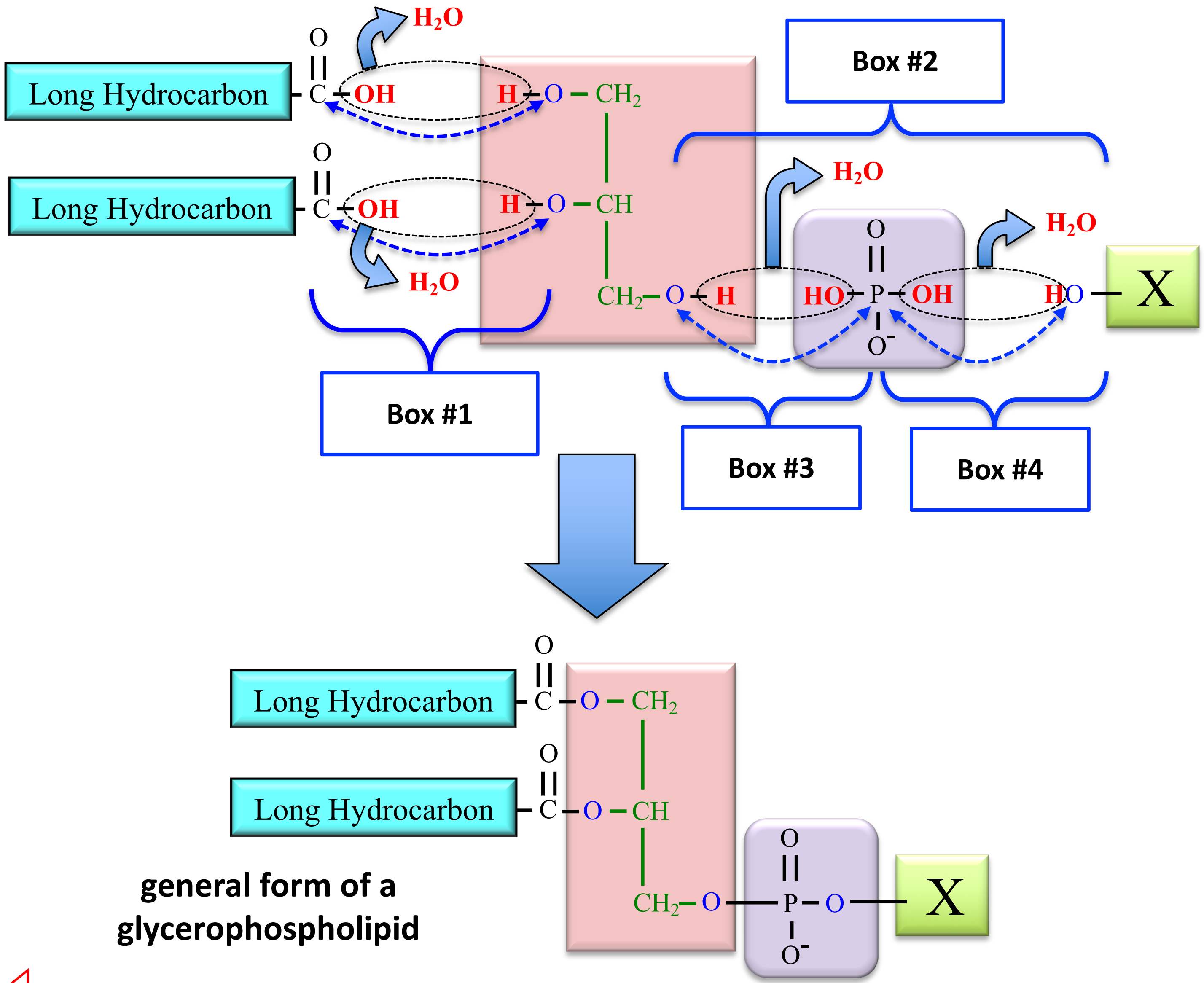
Click here to check your answer

Go to next question

12.22) The illustration below shows how the fatty acid, glycerol, phosphate, and alcohol residues combine to form a ***glycerophospholipid***. Match the box number with the ***type of bonding pattern*** that is formed.



Type of bonding pattern choices:

a) ester
b) amide
c) phosphoester
d) phosphodiester
e) peptide
f) glyosidic

i) **Box #1**: ester

ii) **Box #2**: phosphodiester

iii) **Box #3**: phosphoester

iv) **Box #4**: phosphoester

For more details: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

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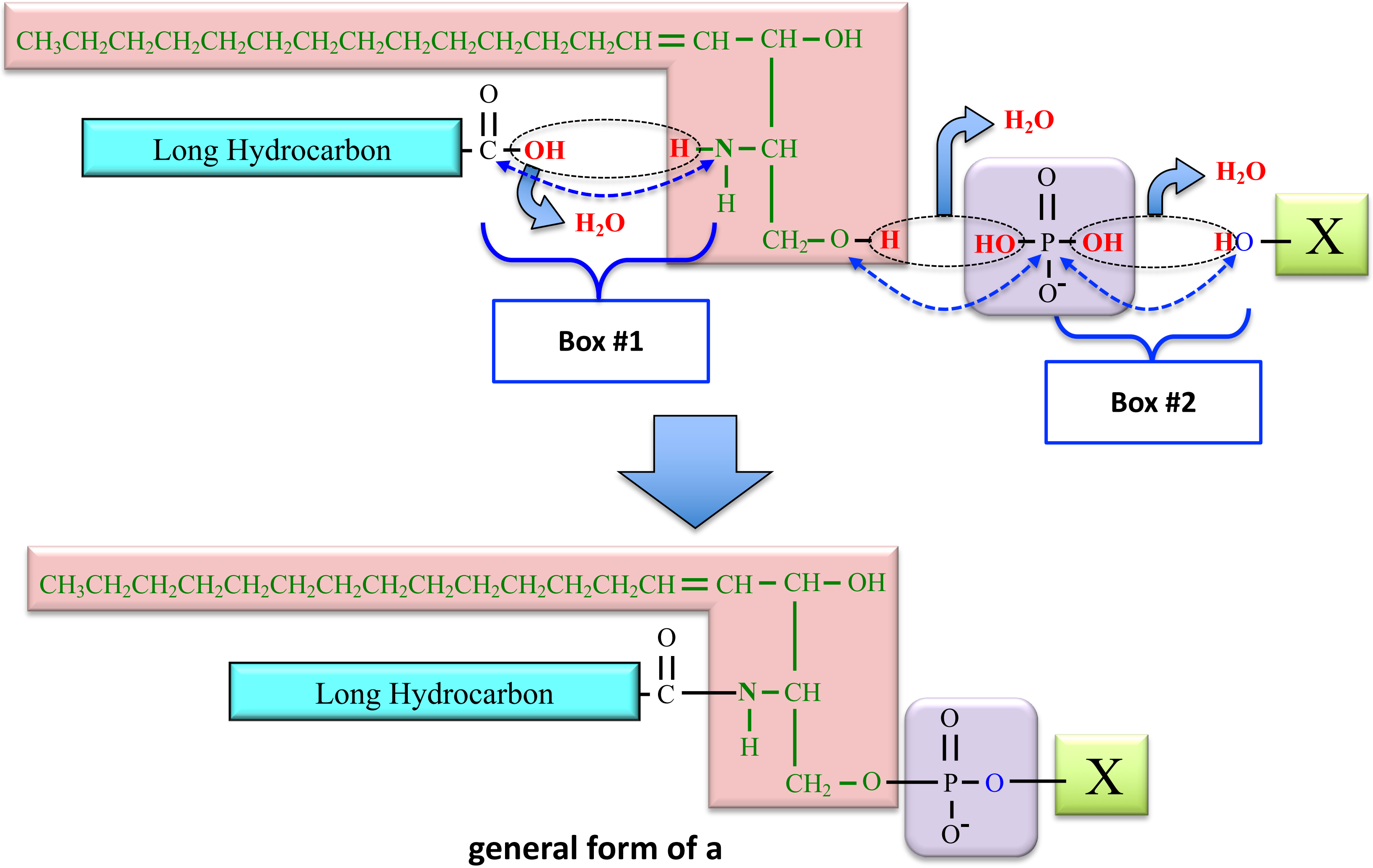
Go to next question

12.23) The illustration below shows how the fatty acid, sphingosine, phosphate, and alcohol residues combine to form a ***sphingophospholipid***. Match the box number with the ***type of bonding pattern*** that is formed.



general form of a sphingophospholipid

***Type of bonding pattern choices*:**

a) ester
b) amide
c) phosphoester
d) phosphodiester
e) peptide
f) glyosidic

i) **Box #1**: ________________

ii) **Box #2**: ________________

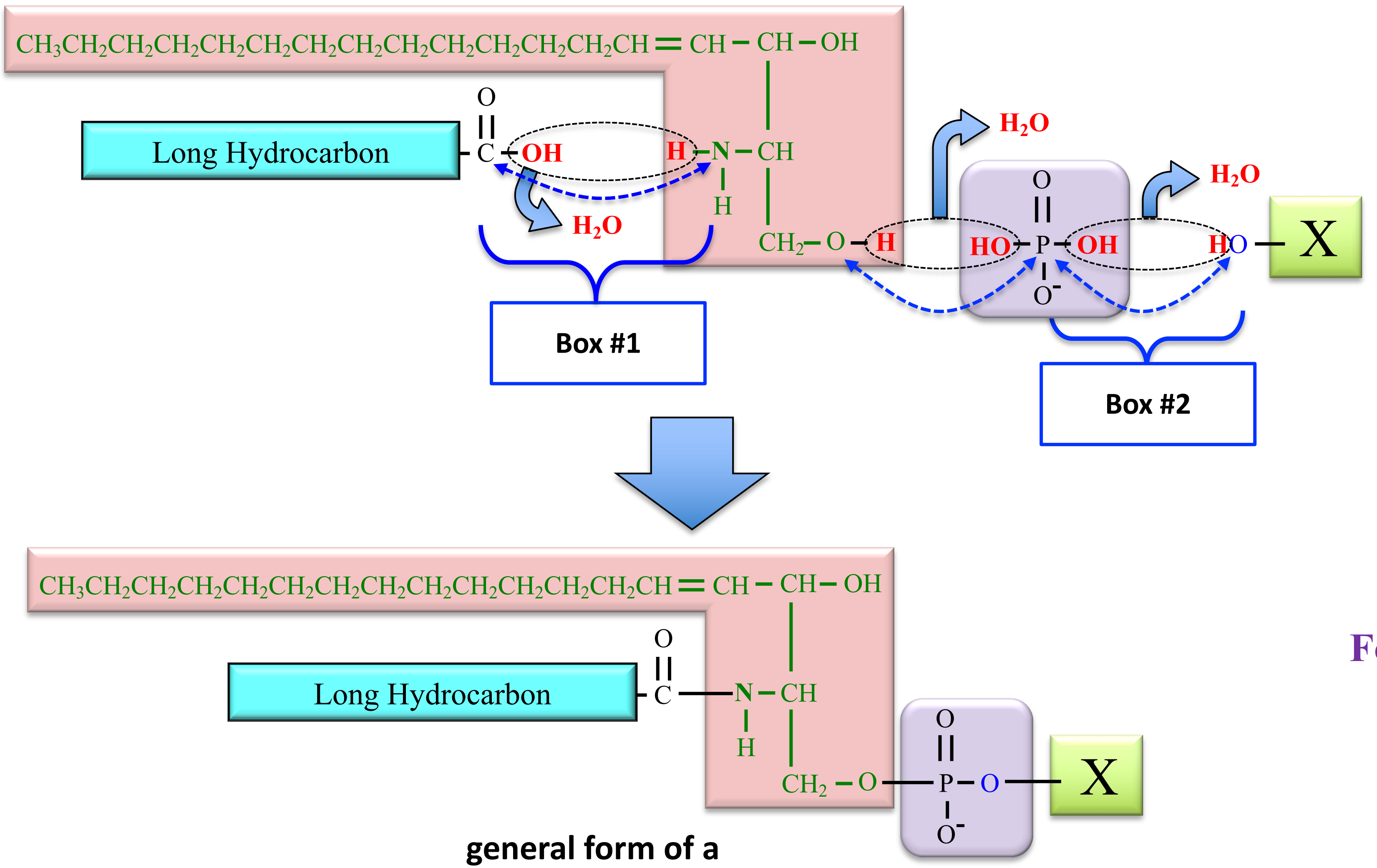
Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

12.23) The illustration below shows how the fatty acid, sphingosine, phosphate, and alcohol residues combine to form a ***sphingophospholipid***. Match the box number with the ***type of bonding pattern*** that is formed.



general form of a sphingophospholipid

***Type of bonding pattern choices*:**

a) ester
b) amide
c) phosphoester
d) ~~phosphodiester~~
e) ~~peptide~~
f) glyosidic

HINT:

i) **Box #1**: ______________

ii) **Box #2**: ______________

For more help: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

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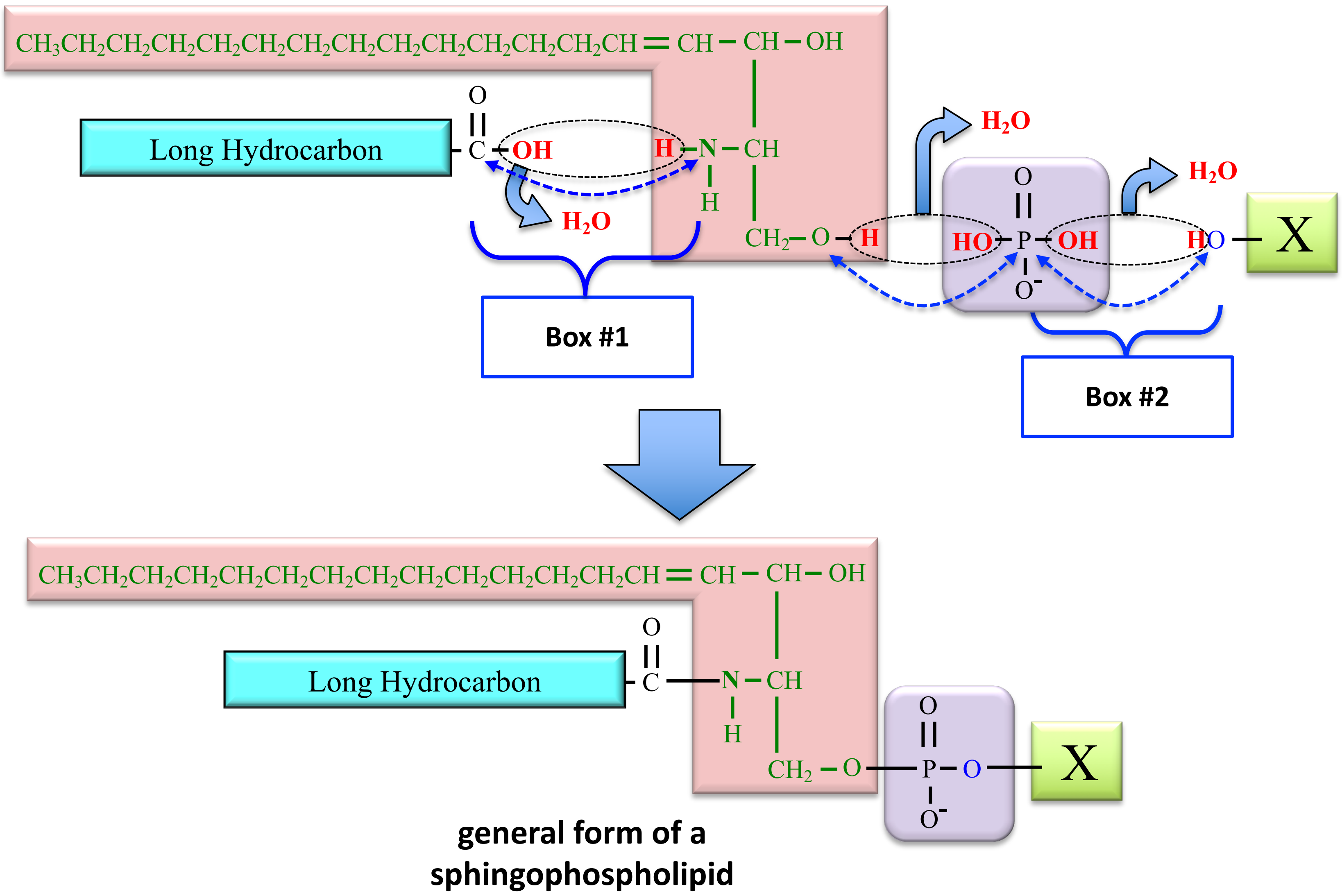
Click here to check your answer

Go to next question

12.23) The illustration below shows how the fatty acid, sphingosine, phosphate, and alcohol residues combine to form a ***sphingophospholipid***. Match the box number with the ***type of bonding pattern*** that is formed.



***Type of bonding pattern choices*:**

a) ester
b) amide
c) phosphoester
d) phosphodiester
e) peptide
f) glyosidic

i) **Box #1**: **amide**

ii) **Box #2**: **phosphoester**

For more details: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

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12.24) The subclasses of glycerophospholipids are determined by the identity of their X-group. Phosphatidylethanolamines are a subclass of glycerophospholipids. In humans, phosphatidylethanolamines are found in nervous tissue such as the white matter of brain, nerves, neural tissue, and in spinal cord.

Draw the condensed structure of the *phosphatidylethanolamine* that contains two stearic acid residues.

Organic "X group"	Glycerophospholipid Class
$-CH_2CH_2NH_3^+$	Phosphatidylethanolamine (present in *Cephalin*)
CH_3 $-CH_2CH_2\overset{+}{N}-CH_3$ CH_3	Phosphatidylcholine (present in *Lecithin*)
O ‖ $-CH_2CHC-O^-$ $\vert^{+}$ NH_3	Phosphatidylserine (present in *Cephalin*)

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

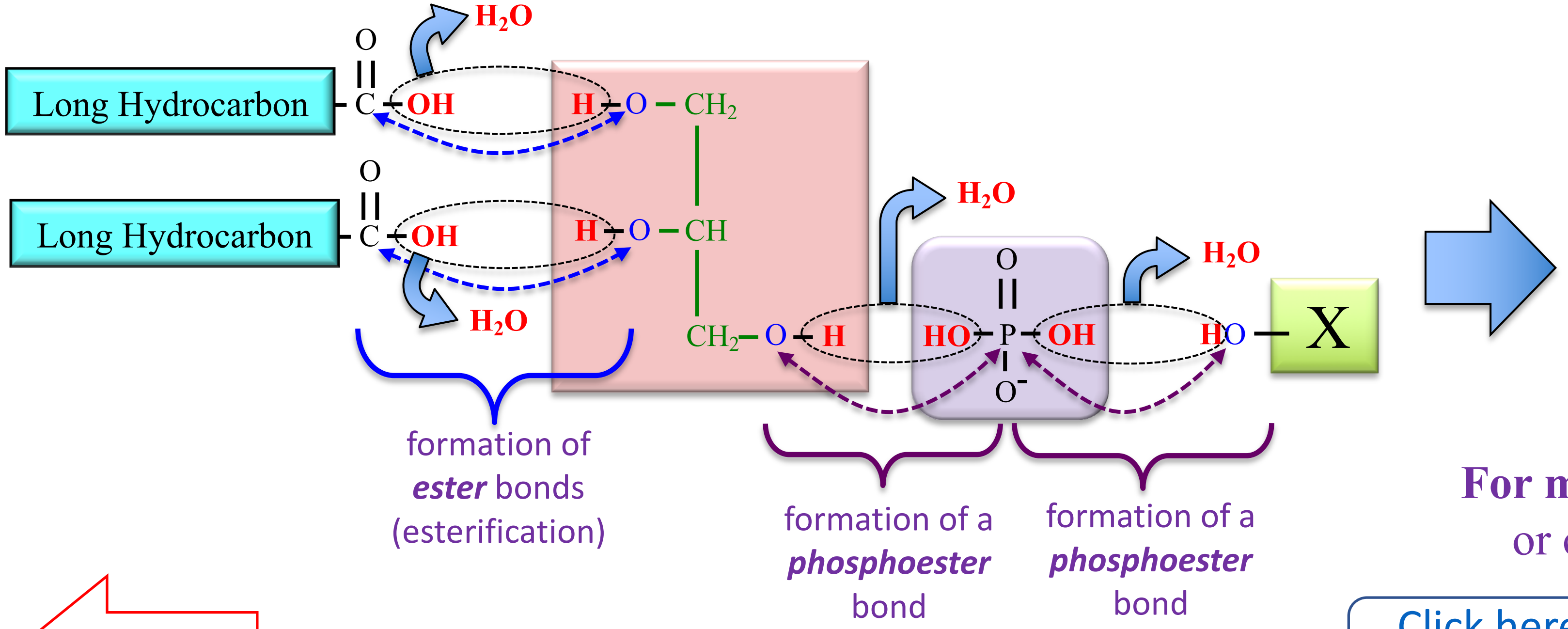
12.24) The subclasses of glycerophospholipids are determined by the identity of their X-group. Phosphatidylethanolamines are a subclass of glycerophospholipids. In humans, phosphatidylethanolamines are found in nervous tissue such as the white matter of brain, nerves, neural tissue, and in spinal cord.

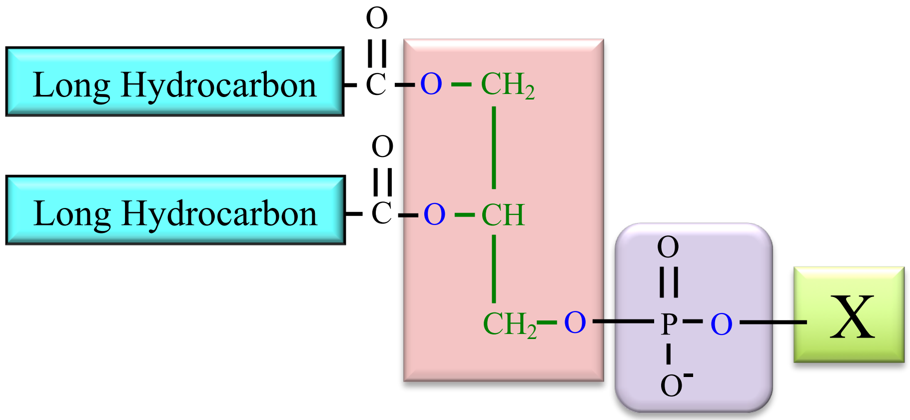
Draw the condensed structure of the *phosphatidylethanolamine* that contains two stearic acid residues.

Organic "X group"	Glycerophospholipid Class
$-CH_2CH_2NH_3^+$	Phosphatidylethanolamine (present in *Cephalin*)
$-CH_2CH_2\overset{+}{N}(CH_3)_3$	Phosphatidylcholine (present in *Lecithin*)
$-CH_2CH(\overset{+}{N}H_3)C(=O)O^-$	Phosphatidylserine (present in *Cephalin*)

HINT:

Fatty acid, glycerol, phosphate, and alcohol residues combine to form a ***glycerophospholipid*** as illustrated below.





For more help: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

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Click here to check your answer

Go to next question

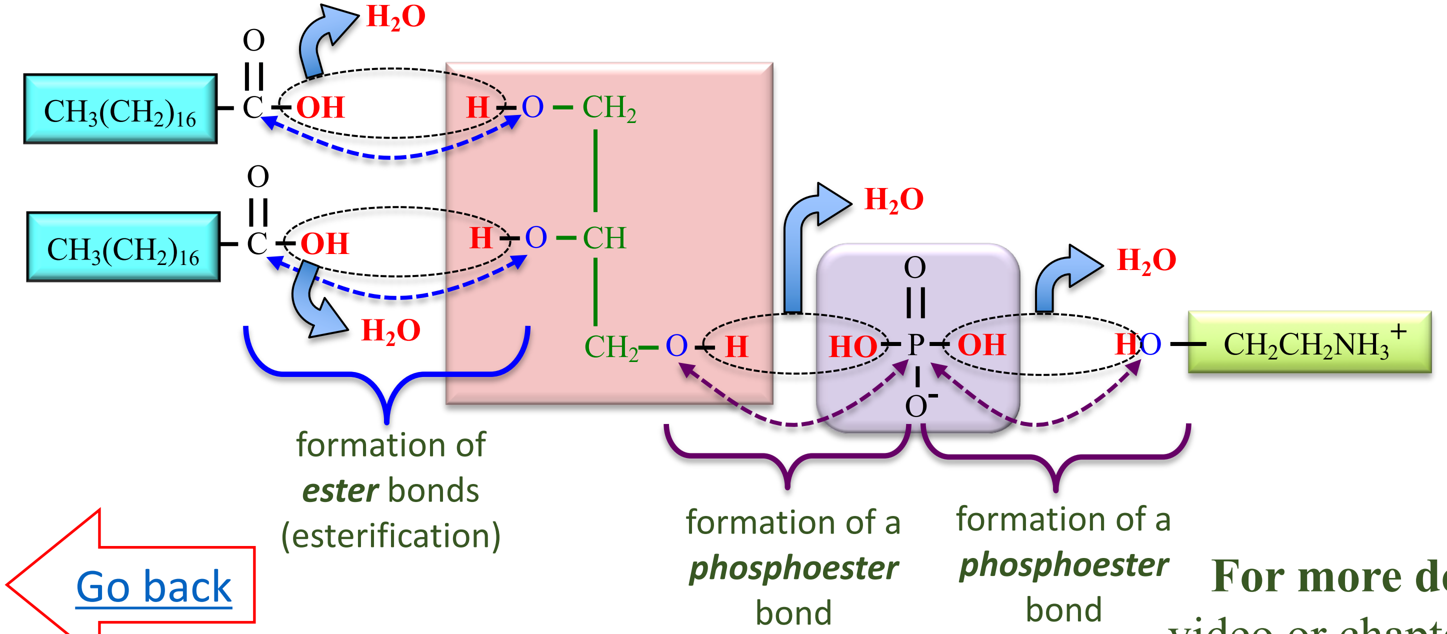
12.24) The subclasses of glycerophospholipids are determined by the identity of their X-group. Phosphatidylethanolamines are a subclass of glycerophospholipids. In humans, phosphatidylethanolamines are found in nervous tissue such as the white matter of brain, nerves, neural tissue, and in spinal cord.

Draw the condensed structure of the *phosphatidylethanolamine* that contains two stearic acid residues.

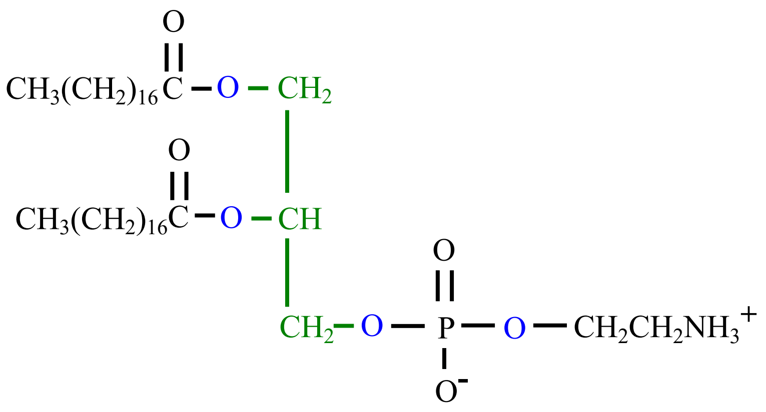
Organic "X group"	Glycerophospholipid Class
$-CH_2CH_2NH_3^+$	Phosphatidylethanolamine (present in *Cephalin*)
$-CH_2CH_2\overset{+}{N}(CH_3)_3$	Phosphatidylcholine (present in *Lecithin*)
$-CH_2CH(\overset{+}{N}H_3)C(=O)-O^-$	Phosphatidylserine (present in *Cephalin*)

EXPLANATION:

Fatty acid, glycerol, phosphate, and alcohol residues combine to form a ***glycerophospholipid*** as illustrated below.



ANSWER



a phosphatidylethanolamine

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For more details: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

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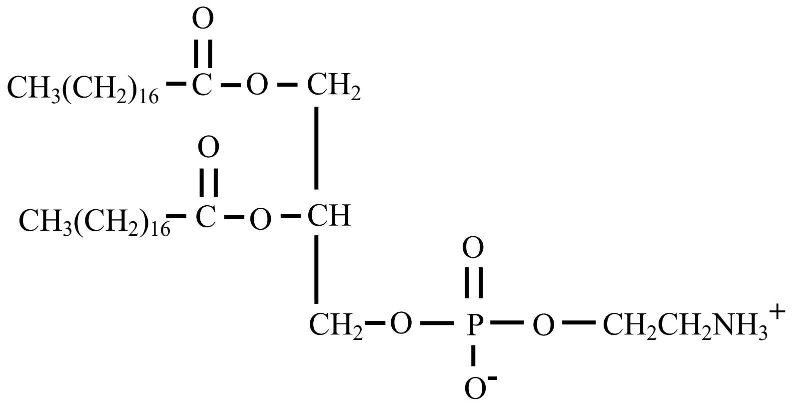
12.25) Using the *phosphatidylethanolamine* that you drew **in the previous problem** (and shown below), label the polar head and nonpolar tail regions of the molecule.



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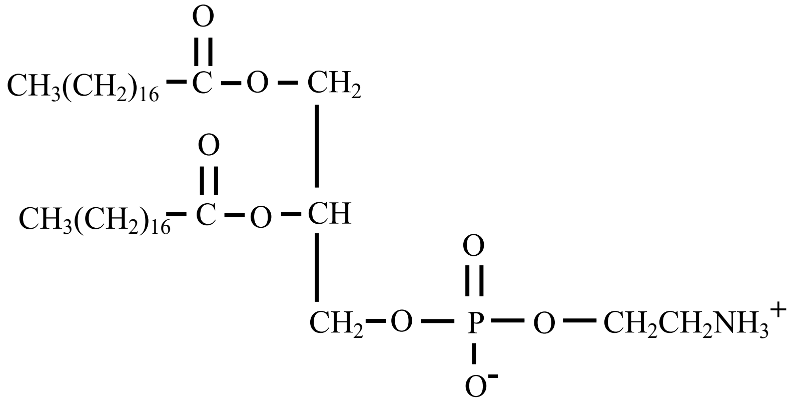
Click here for a **hint**

Click here to **check your answer**

Go to next question

12.25) Using the *phosphatidylethanolamine* that you drew **in the previous problem** (and shown below), label the polar head and nonpolar tail regions of the molecule.



HINT:

The *polar head* region is quite ***hydrophilic***. This region is attracted to water through ***dipole-dipole*** interactions because it contains several "highly polar" bonds. It can ***hydrogen bond*** with water. The polar head is also attracted to water through ***ion-dipole interactions*** because of the *formal charge* on both an oxygen *and* a nitrogen.

For more help: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

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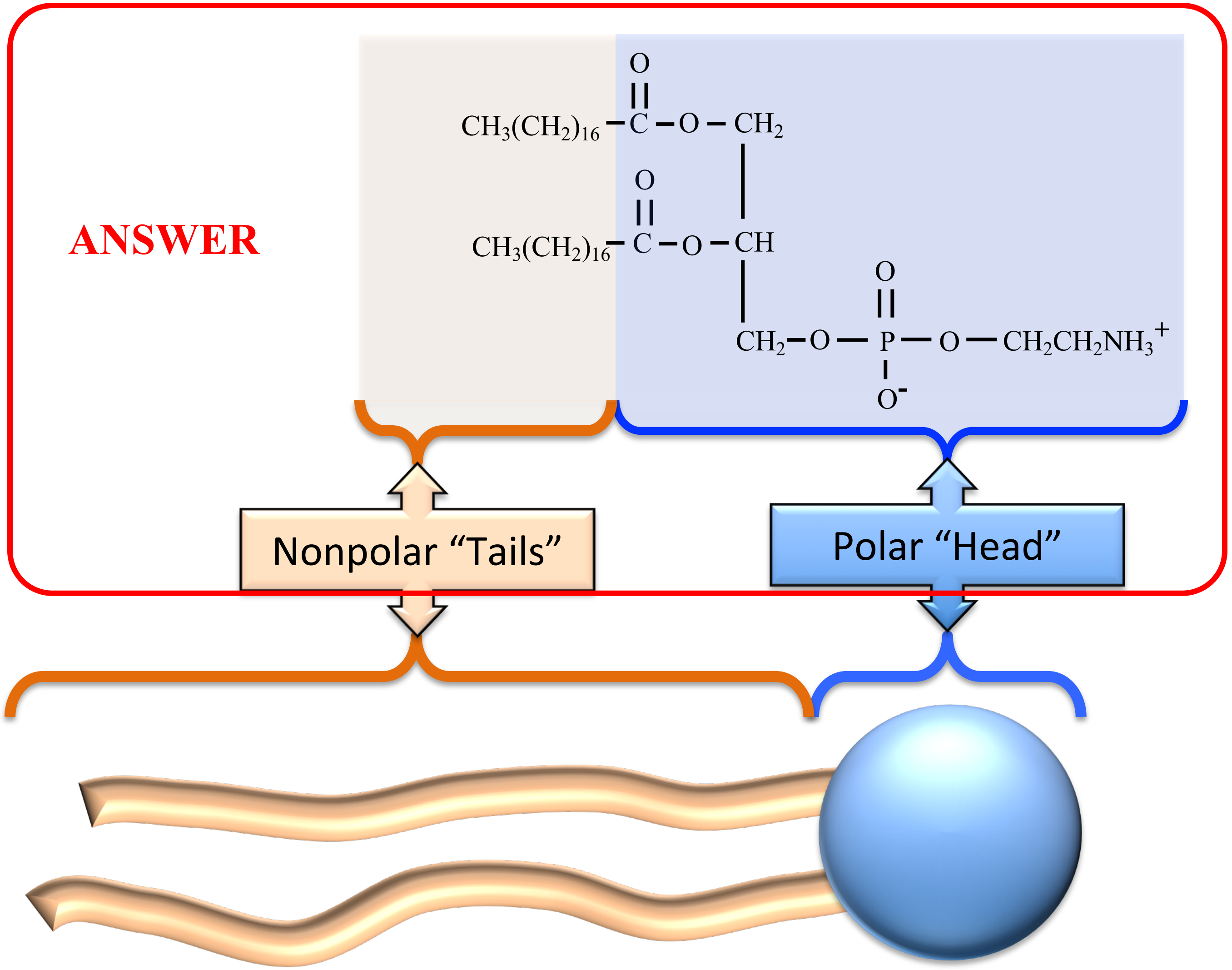
Click here to **check your answer**

Go to next question

12.25) Using the *phosphatidylethanolamine* that you drew **in the previous problem** (and shown below), label the polar head and nonpolar tail regions of the molecule.



EXPLANATION:

- The *polar head* region is quite ***hydrophilic***. This region is attracted to water through ***dipole-dipole*** interactions because it contains several "highly polar" bonds. It can ***hydrogen bond*** with water. The polar head is also attracted to water through ***ion-dipole interactions*** because of the *formal charge* on both an oxygen *and* a nitrogen.

- The hydrocarbon chains of the fatty acid residues make up the *nonpolar tails*.

For more details: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

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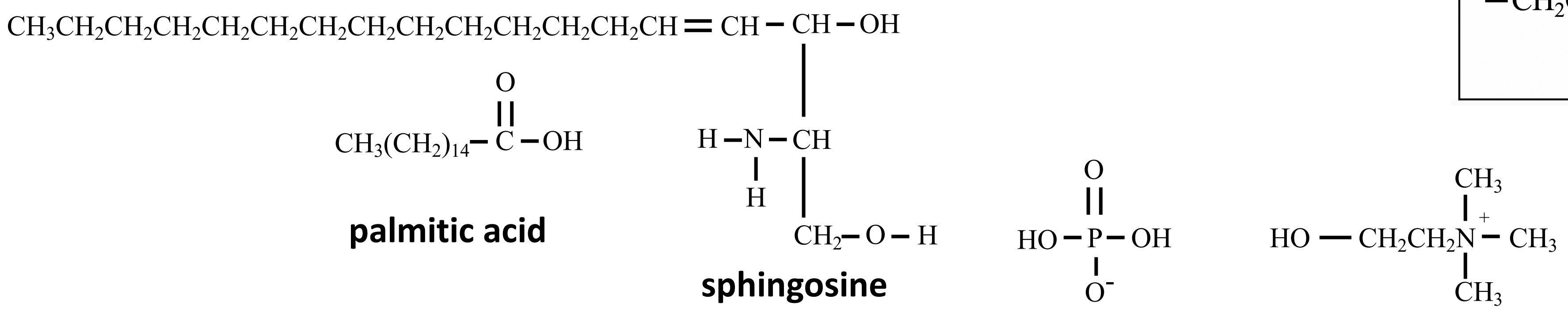
Go to next question

12.26) The subclasses of sphingophospholipids are determined by the identity of their X-group. *Sphingomyelins* are a subclass of sphingophospholipids. They are found in the myelin sheaths of nerve cells.

Draw the condensed structure of the *sphingomyelin* that is composed from the residues shown below.

"X-group"	Sphingophospholipid Class
$-H$	Ceramide
$-CH_2CH_2NH_3^+$ or $-CH_2CH_2N^+(CH_3)_3$	Sphingomyelin



phosphate

an alcohol

Go back

Click here for a **hint**

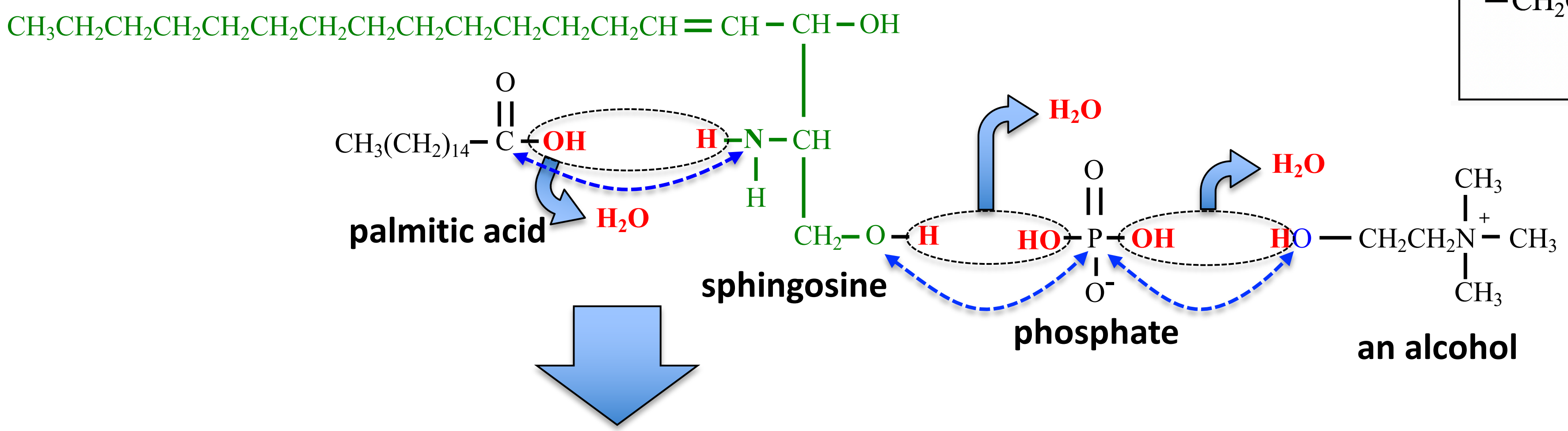
Click here to **check your answer**

Go to next question

12.26) The subclasses of sphingophospholipids are determined by the identity of their X-group. Sphingomyelins are a subclass of sphingophospholipids. They are found in the myelin sheaths of nerve cells.

Draw the condensed structure of the Sphingomyelins that is composed from the residues shown below.

"X-group"	Sphingophospholipid Class
$-H$	Ceramide
$-CH_2CH_2NH_3^+$ or $-CH_2CH_2N^+(CH_3)_3$	Sphingomyelin



?

a sphingomyelin

HINT:

A fatty acid, sphingosine, phosphate, and alcohol residues combine to form a ***sphingopmyelin*** as illustrated above.

For more help: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

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Click here to check your answer

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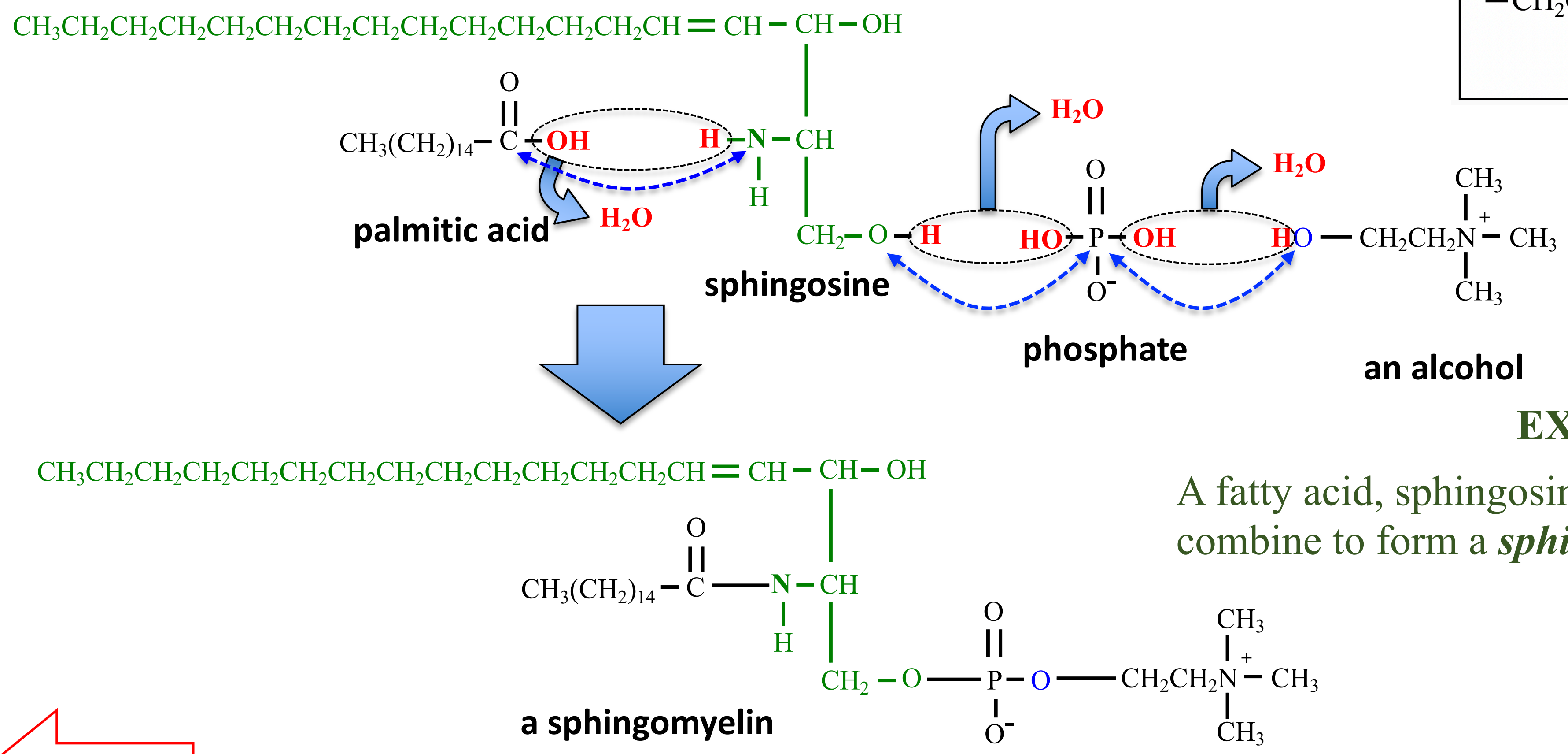
12.26) The subclasses of sphingophospholipids are determined by the identity of their X-group. Sphingomyelins are a subclass of sphingophospholipids. They are found in the myelin sheaths of nerve cells.

Draw the condensed structure of the Sphingomyelins that is composed from the residues shown below.

"X-group"	Sphingophospholipid Class
$-H$	Ceramide
$-CH_2CH_2NH_3^+$ or $-CH_2CH_2N^+(CH_3)_3$	Sphingomyelin



EXPLANATION:

A fatty acid, sphingosine, phosphate, and alcohol residues combine to form a ***sphingomyelin*** as illustrated here.

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For more details: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

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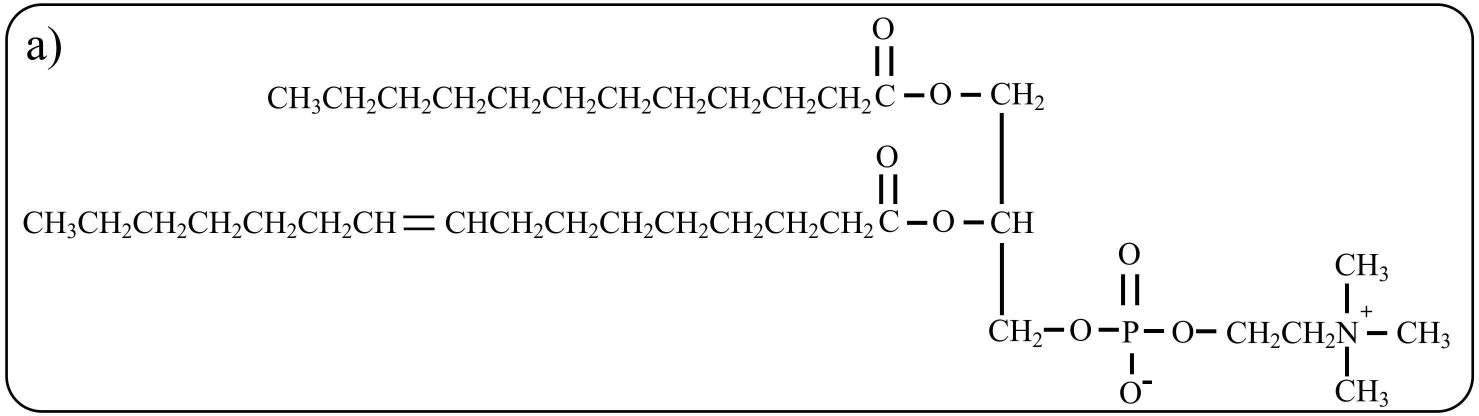
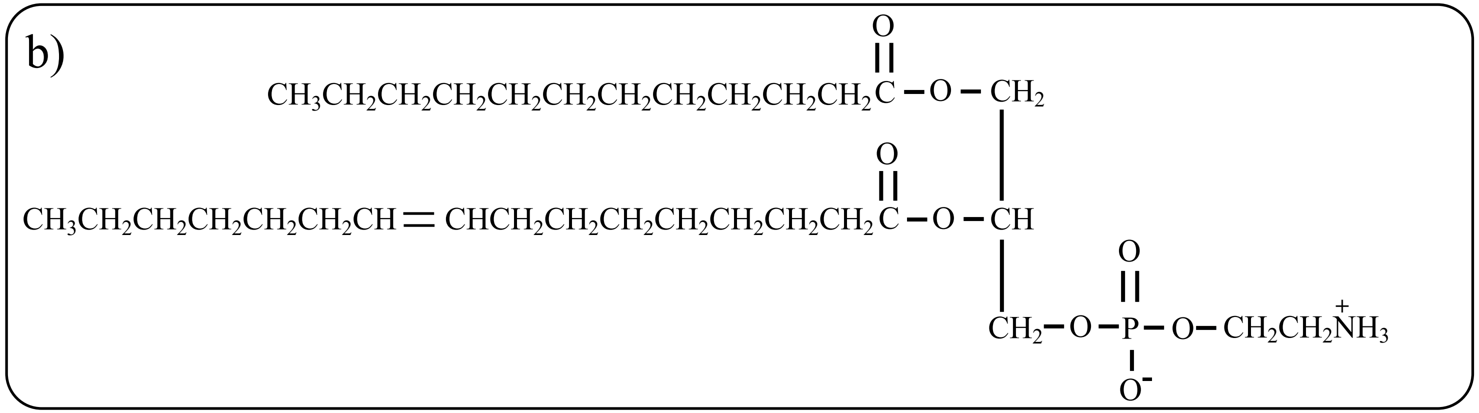
12.27)

Categorized each of these compounds as being either a **glycerophospholipid** or a **sphingophospholipid**.

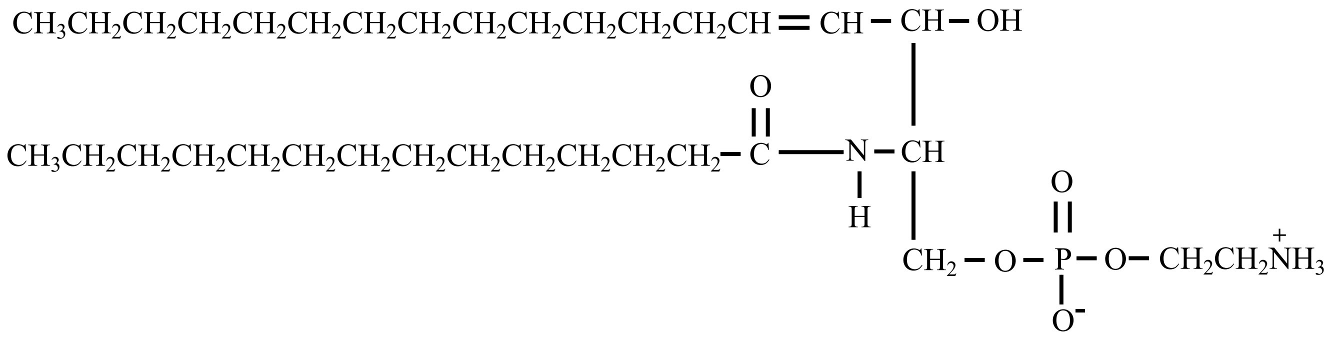
a)



b)



c)



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Click here for a **hint**

Click here to **check your answer**

Go to next question

12.27)

Categorized each of these compounds as being either a **glycerophospholipid** or a **sphingophospholipid**.

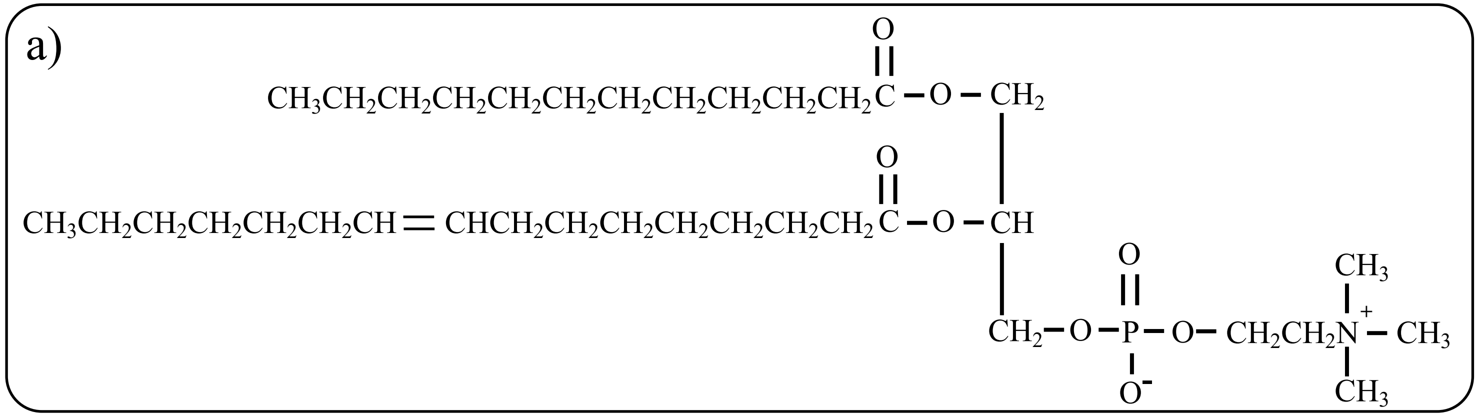
HINT:

The key to differentiating between the two classes of phospholipids is to identify either a **glycerol backbone** (for ***glycerophospholipids***) or a **sphingosine backbone** (for ***sphingophospholipids***).

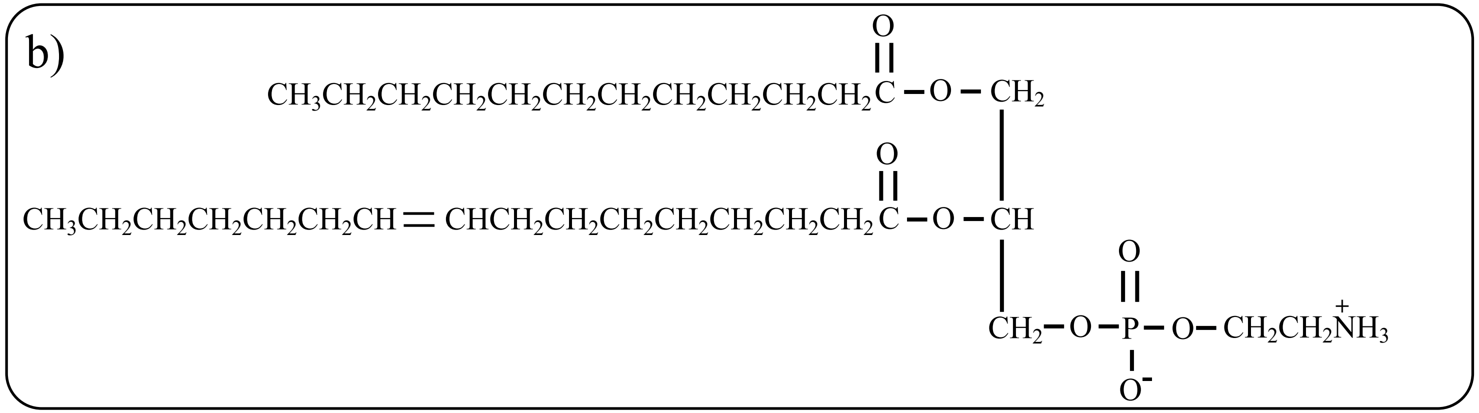
- An easy way to do so is to look for the nitrogen in the amide bond between the fatty acid residue and the sphingosine backbone. This ***amide bonding pattern is present in sphingophospholipids***, but not in glycerophospholipids.

For more help: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

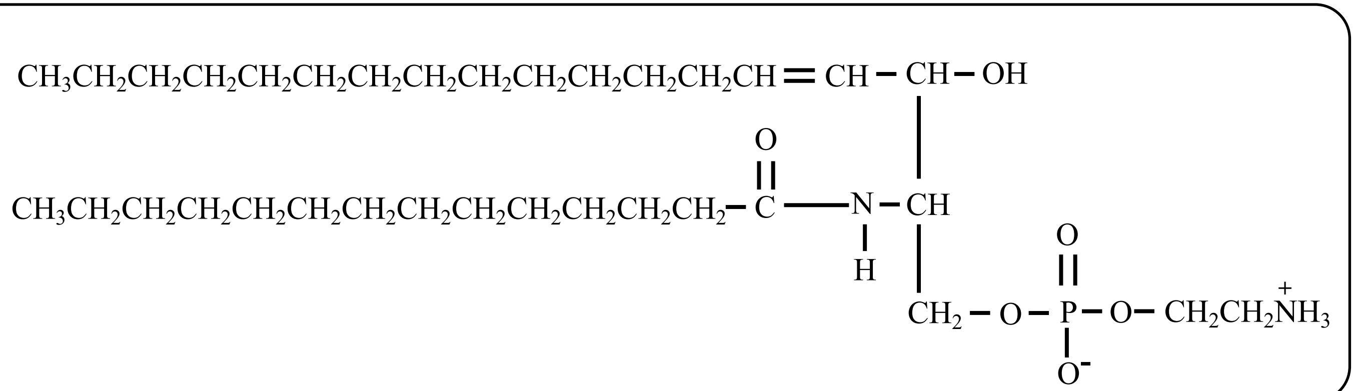
a)



b)



c)



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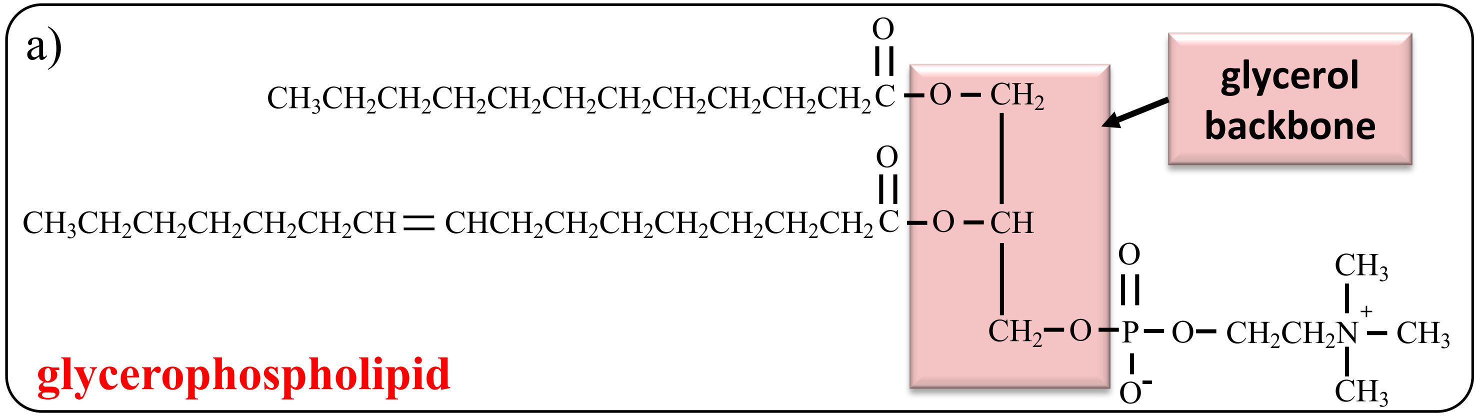
12.27)

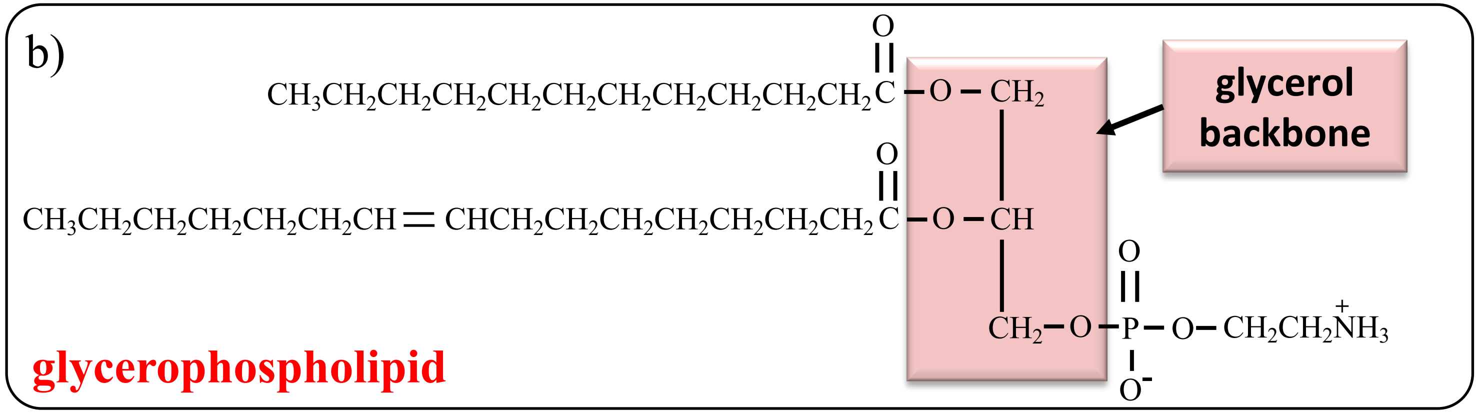
Categorized each of these compounds as being either a **glycerophospholipid** or a **sphingophospholipid**.

a)



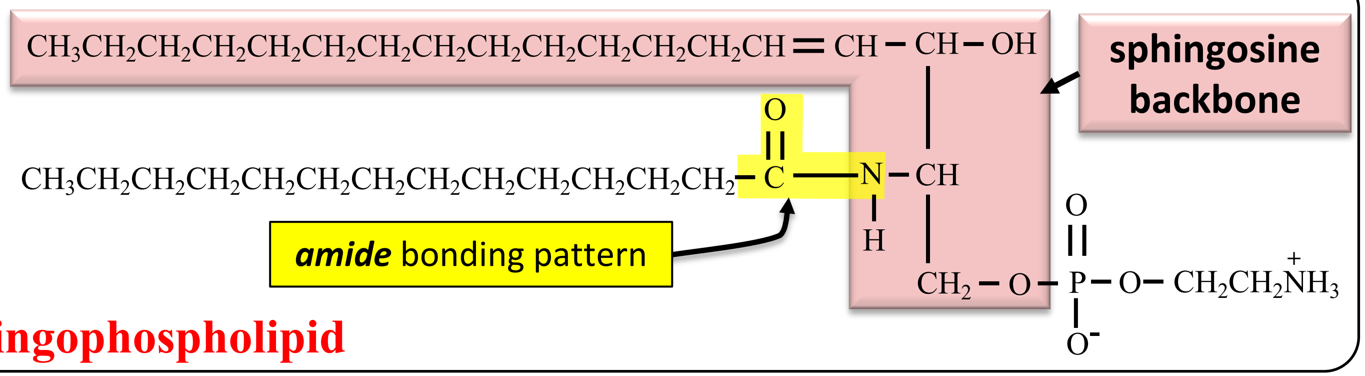
glycerophospholipid

b)



glycerophospholipid

c)



sphingophospholipid

EXPLANATION:

The key to differentiating between the two classes of phospholipids is to identify either a **glycerol backbone** (for ***glycerophospholipids***) or a **sphingosine backbone** (for ***sphingophospholipids***).

- An easy way to do so is to look for the nitrogen in the amide bond between the fatty acid residue and the sphingosine backbone. This ***amide bonding pattern is present in sphingophospholipids***, but not in glycerophospholipids.

For more details: See chapter 12 part 5 video or chapter 12 section 6 in the textbook.

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12.28)

i) Glycolipids are lipids that contain one or more ________________ residues.

a) phosphate
b) monosaccharide
c) amino acid
d) all of the above

ii) Glycolipids are easily distinguished from phospholipids by the *absence* of ________________ residues in glycolipids.

a) phosphate
b) monosaccharide
c) amino acid
d) none of the above

iii) The specific ________________ residues that protrude from red blood cells form the basis of ABO blood typing.

a) phosphate
b) monosaccharide
c) amino acid
d) all of the above

12.28)

i) Glycolipids are lipids that contain one or more ________________ residues.

HINT: a) phosphate
b) monosaccharide
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d) all of the above

Consider the *general forms* of **glycolipids** (glyceroglycolipids and sphingoglycolipids).

ii) Glycolipids are easily distinguished from phospholipids by the *absence* of ________________ residues in glycolipids.

HINT: a) phosphate
b) monosaccharide
c) amino acid
d) none of the above

Compare the *general forms* of **glycolipids** (glyceroglycolipids and sphingoglycolipids) with those of **phospholipids** (glycerophospholipids and sphingophospholipids).

iii) The specific ________________ residues that protrude from red blood cells form the basis of ABO blood typing.

HINT: a) phosphate
b) monosaccharide
c) amino acid
~~d) all of the above~~

For more help: See chapter 12 part 6 video or chapter 12 section 6 in the textbook.

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Click here to **check your answer**

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d) none of the above

EXPLANATION: Compare the *general forms* of **glycolipids** (glyceroglycolipids and sphingoglycolipids) with those of **phospholipids** (glycerophospholipids and sphingophospholipids).

iii) The specific ________________ residues that protrude from red blood cells form the basis of ABO blood typing.

a) phosphate
b) monosaccharide
c) amino acid
d) all of the above

The specific monosaccharide residues that protrude from the membrane serve in maintaining membrane stability, attaching cells to one another to form tissues, and as a "recognition site" for "cell signaling" chemicals. Cell signaling chemicals make it possible for the cells to respond to their environment in order to enable functions such as tissue homeostasis, immunity, and the development of the organism. When signaling systems are not operating correctly to process the communication between cells and their environments, diseases such as cancer, diabetes, and autoimmune disorders occur.

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For more details: See chapter 12 part 6 video or chapter 12 section 6 in the textbook.

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12.29) Glycolipids often have glycerol or sphingosine backbones. Glycolipids with a *glycerol backbone* are called **glyceroglycolipids**. Glycolipids with a *sphingosine backbone* are called **sphingoglycolipids**. Draw condensed structure for the general form of a glyceroglycolipid and a sphingoglycolipid.

general form of a glyceroglycolipid

general form of a sphingoglycolipid

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Click here for a **hint**

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Go to next question

12.29) Glycolipids often have glycerol or sphingosine backbones. Glycolipids with a *glycerol backbone* are called **glyceroglycolipids**. Glycolipids with a *sphingosine backbone* are called **sphingoglycolipids**. Draw condensed structure for the general form of a glyceroglycolipid and a sphingoglycolipid.

general form of a glyceroglycolipid

general form of a sphingoglycolipid

HINT:

The general forms of both types of glycolipids can be found in the glycolipids section of your lecture notes or the textbook.

For more help: See chapter 12 part 6 video or chapter 12 section 6 in the textbook.

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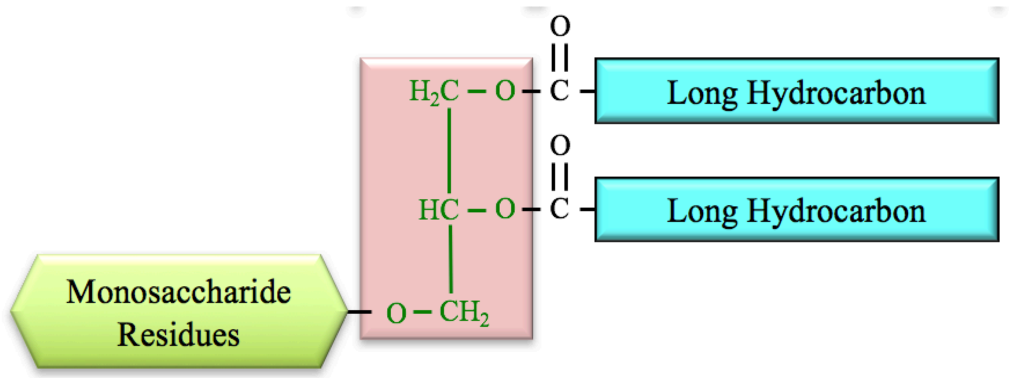
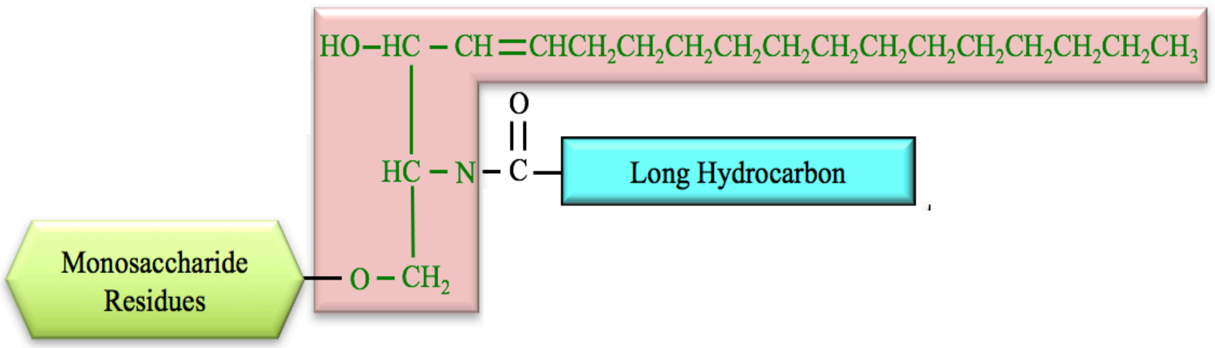
Go to next question

12.29) Glycolipids often have glycerol or sphingosine backbones. Glycolipids with a *glycerol backbone* are called **glyceroglycolipids**. Glycolipids with a *sphingosine backbone* are called **sphingoglycolipids**. Draw condensed structure for the general form of a glyceroglycolipid and a sphingoglycolipid.



general form of a glyceroglycolipid



general form of a sphingoglycolipid

For more details: See chapter 12 part 6 video or chapter 12 section 6 in the textbook.

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12.30)

a) Steroids are lipids that contain a particular fused, four-ring structure. Fused rings are rings that share atoms. Draw the fused four-ring (skeletal) structure, which is common to all steroids.

b) The ***three types of steroids*** are:

1) ______________________

2) ______________________

3) ______________________

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Go to next question

12.30)

a) Steroids are lipids that contain a particular fused, four-ring structure. Fused rings are rings that share atoms. Draw the fused four-ring (skeletal) structure, which is common to all steroids.

HINT:
The fused four-ring structure, which is common to all steroids, contains three six-member rings and one five-member ring.

b) The ***three types of steroids*** are:

1) ____________________

2) __**steroid hormones**__

3) ____________________

HINT: Outside of the health and scientific communities, the term "steroid" is often only associated with the performance enhancing drugs (**steroid hormones**) that are used by some athletes/bodybuilders. Those steroid hormones are just one type of steroid.

For more help: See chapter 12 part 7 video or chapter 12 section 7 in the textbook.

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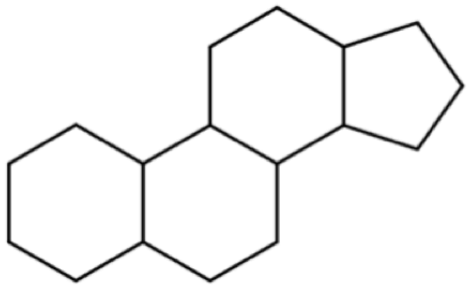
12.30)

a) Steroids are lipids that contain a particular fused, four-ring structure. Fused rings are rings that share atoms. Draw the fused four-ring (skeletal) structure, which is common to all steroids.



The fused four-ring structure, which is common to all steroids, contains three six-member rings and one five-member ring, that are fused to each other in the pattern shown here.

b) The ***three types of steroids*** are:

1) **cholesterol**

2) **steroid hormones**

3) **bile salts**

Outside of the health and scientific communities, the term "steroid" is often only associated with the performance enhancing drugs (**steroid hormones**) that are used by some athletes/bodybuilders. Those steroid hormones are just one type of steroid.

For more details: See chapter 12 part 7 video or chapter 12 section 7 in the textbook.

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12.31) Identify the following items as being characteristic of either **cholesterol**, **steroid hormones**, **or bile salts**.

a) signaling compounds

b) structural component of animal biological membranes

c) emulsify and transport_dietary triglycerides and assist in their metabolism

d) starting material for the biosynthesis of other steroids

e) produced in the liver and stored in the gallbladder

f) the name of the particular molecule

g) a subclass is adrenal corticosteroids

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Go to next question

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f) the name of the particular molecule

g) a subclass is adrenal corticosteroids

HINT:

You can find all of the information needed for this problem in the "steroids" section of your lecture notes or the textbook.

For more help: See chapter 12 part 7 video or chapter 12 section 7 in the textbook.

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Go to next question

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a) signaling compounds **steroid hormones**

b) structural component of animal biological membranes **cholesterol**

c) emulsify and transport dietary triglycerides and assist in their metabolism **bile salts**

d) starting material for the biosynthesis of other steroids **cholesterol**

e) produced in the liver and stored in the gallbladder **bile salts**

f) the name of the particular molecule **cholesterol**

g) a subclass is adrenal corticosteroids **steroid hormones**

For more details: See chapter 12 part 7 video or chapter 12 section 7 in the textbook.

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12.32) Because blood, lymph, and intercellular fluid are ***aqueous mixtures***, cholesterol and triglycerides *do not dissolve* so they must be emulsified in order to be transported throughout the body. This is done by ***lipoproteins***.

- *Lipoproteins* are composed of a core that contains emulsified triglycerides and cholesterol, which is surrounded by a micelle monolayer made from proteins, phospholipids, and cholesterol.
- There are five classes of lipoproteins: *chylomicrons, very low-density lipoproteins* (VLDL), *intermediate-density lipoproteins* (IDL), *low-density lipoproteins* (LDL), and *high-density lipoproteins* (HDL).

i) As the ratio of protein to lipid in a lipoprotein increases, the density _______________.

a) increases
b) decreases

ii) A high HDL level is correlated with a ______________ risk of heart disease.

a) greater
b) lowered

iii) A high LDL level is correlated with a ____________ risk of heart disease.

a) greater
b) lowered

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i) As the ratio of protein to lipid in a lipoprotein increases, the density _______________.

a) increases
b) decreases

HINT: Protein is more dense than lipid.

ii) A high HDL level is correlated with a ______________ risk of heart disease.

a) greater
b) lowered

iii) A high LDL level is correlated with a ____________ risk of heart disease.

a) greater
b) lowered

Review the "**Transport of Cholesterol and Triglycerides**" section of your lecture notes or the textbook.

For more help: See chapter 12 part 7 video or chapter 12 section 7 in the textbook.

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Go to next question

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i) As the ratio of protein to lipid in a lipoprotein increases, the density ________________.

a) increases
b) decreases

EXPLANATION: Since protein is more dense than lipid, the greater the percentage of protein, the higher the density of the lipoprotein.

ii) A high HDL level is correlated with a _______________ risk of heart disease.

a) greater
b) lowered

iii) A high LDL level is correlated with a _____________ risk of heart disease.

a) greater
b) lowered

For more details: See chapter 12 part 7 video or chapter 12 section 7 in the textbook.

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Go to next question

12.33) The thickening of the inner layer of the artery is caused by the accumulation of **plaque**, which is made from living white blood cells and remnants of dead cells, including **cholesterol** and **triglycerides**. Lipoproteins contain cholesterol and triglycerides in their micelle monolayers, and in their emulsified cores.

- A high LDL level is correlated with a greater risk of heart disease.
- A high HDL level is correlated with a lowered risk of heart disease.

For these reasons, it is recommended that adults have the lipid levels in their blood tested ***at least*** once every five years. The test is called a **lipoprotein panel** or a **lipid panel**. Although the concentration of cholesterol is not directly measured in these tests, the terms "***total cholesterol***," "***bad cholesterol***," and "***good cholesterol***" are often used by practitioners when describing or discussing the results of lipid panels. Write the meaning of each of these terms when they are *used in the context of lipid panels*.

a) ***total cholesterol*:**

b) ***bad cholesterol*:**

c) ***good cholesterol*:**

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Go to next question

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a) ***total cholesterol*:**

HINT:

Cholesterol is the name of a *particular molecule*, however, ***in lipid panels***, the term "***total cholesterol***" is used for something else.

You can find all of these definitions in the "**Transport of Cholesterol and Triglycerides**" section of your lecture notes or the textbook.

b) ***bad cholesterol*:**

c) ***good cholesterol*:**

For more help: See chapter 12 part 7 video or chapter 12 section 7 in the textbook.

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Go to next question

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a) ***total cholesterol***: Cholesterol is the name of a *particular molecule*, however, ***in lipid panels***, the term "***total cholesterol***" is used for the concentration of **HDL + LDL + 20% of the triglycerides**.

b) ***bad cholesterol***: The term "***bad cholesterol***" is used for the concentration of **LDL**.

c) ***good cholesterol***: The term "***good cholesterol***" is given to **HDL** since it transports cholesterol back to the liver (the liver can remove cholesterol from the body) and lowers the risk of heart disease.

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For more details: See chapter 12 part 7 video or chapter 12 section 7 in the textbook.

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12.34) Arachidonic acid, eicosapentaenoic acid, or dihomo-gamma-linolenic acid undergo *reactions* that transform them into the various classes of **eicosanoids** - such as ***prostaglandins***, ***thromboxanes***, ***leukotrienes***, and ***prostacyclin***.

- ***Prostaglandins*** have a wide range of biological effects, including causing pain, causing inflammation, causing fever, affecting blood pressure, inducing sleep, regulating blood flow to particular organs, controlling ion transport across membranes, and inducing labor.

QUESTION: Using complete sentences, explain how **Nonsteroidal Anti-inflammatory Drugs (NSAIDs)** are able to reduce pain, fever, and inflammation.

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Go to next question

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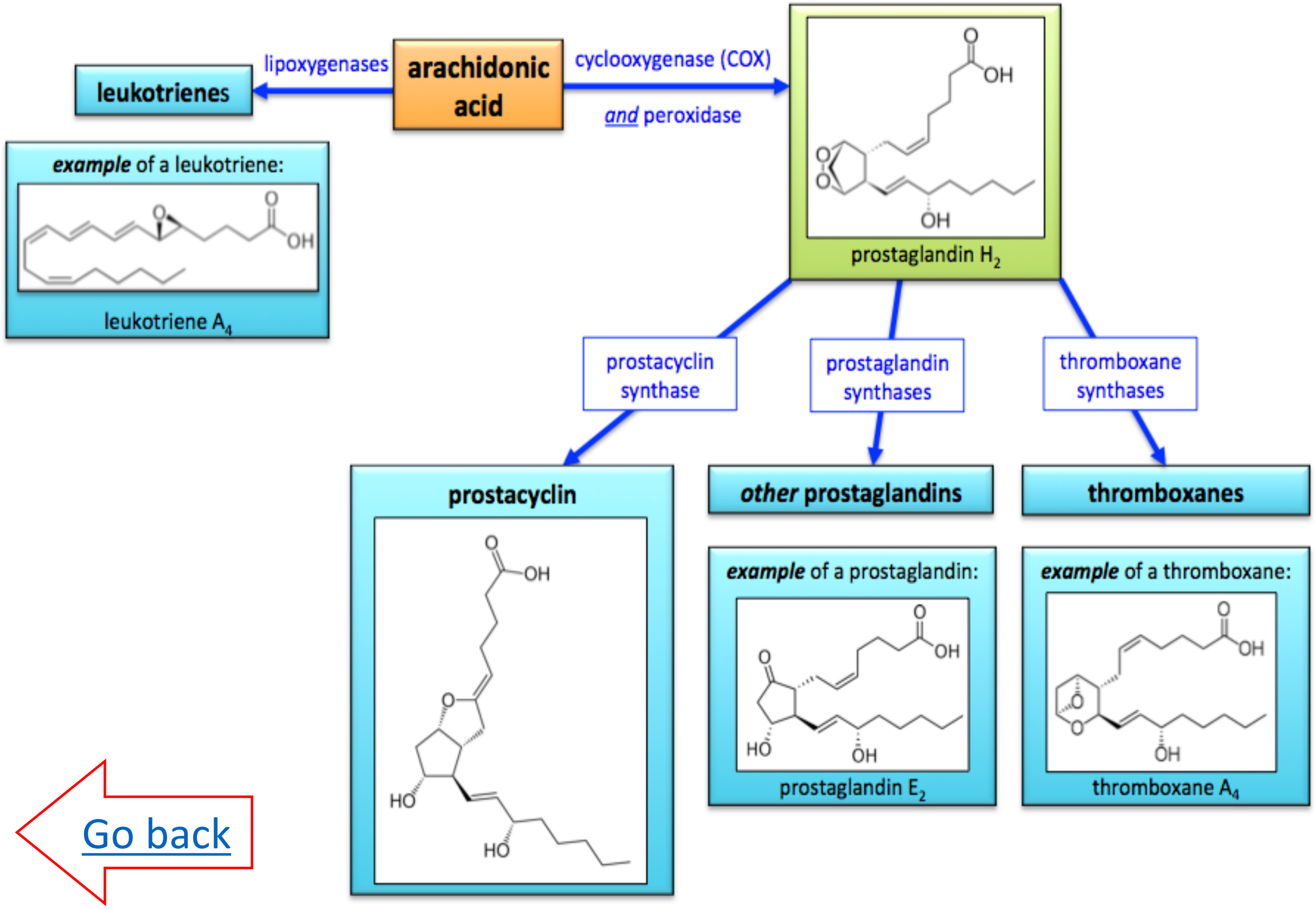

HINT:

NSAIDs such as aspirin, acetaminophen, and ibuprofen are able to reduce pain, fever, and inflammation **by blocking the action of one of the enzymes** responsible for eicosanoid formation. See the diagram on the left.

For more help: See chapter 12 part 8 video or chapter 12 section 8 in the textbook.

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Go to next question

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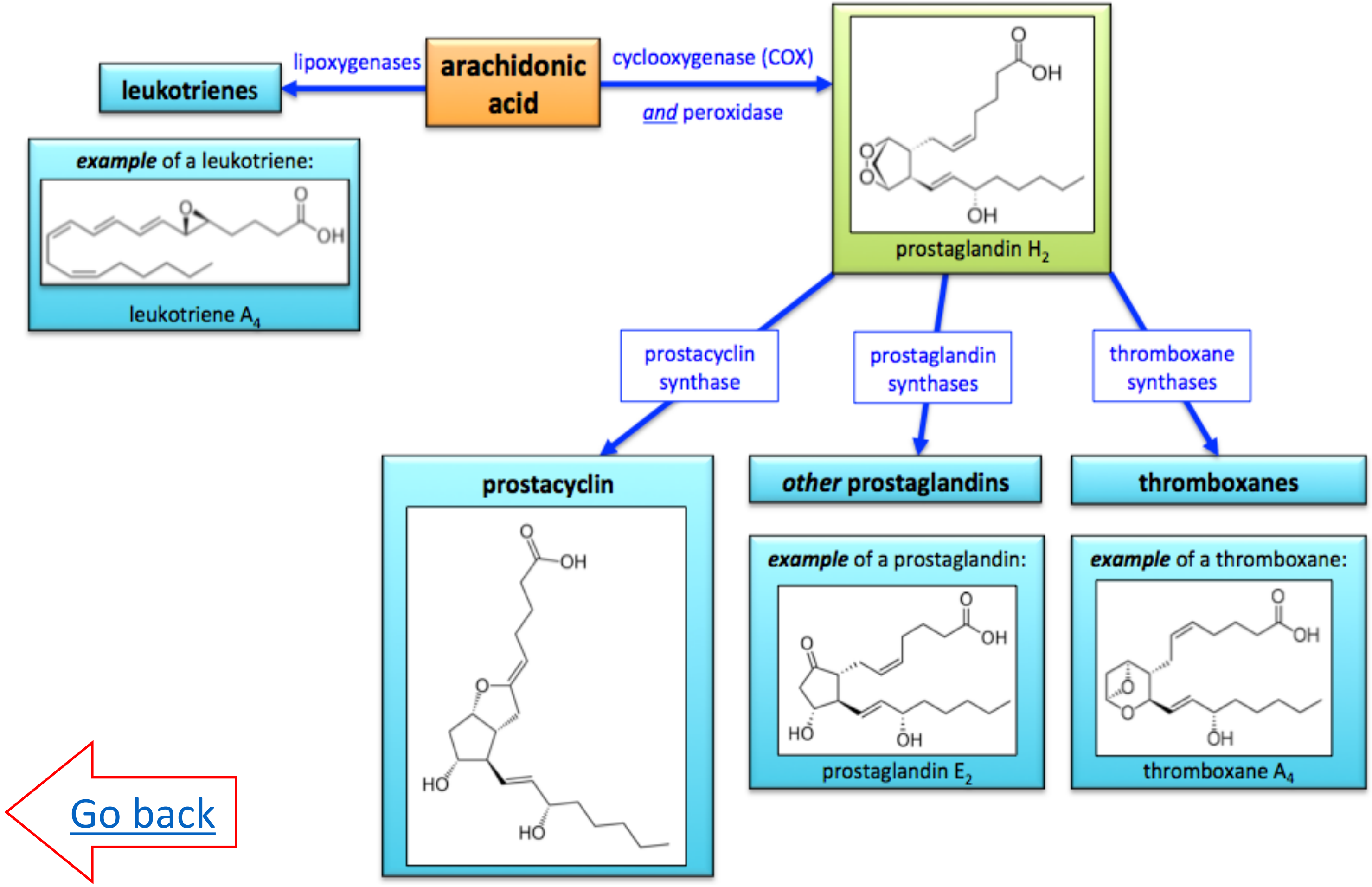
- ***Prostaglandins*** have a wide range of biological effects, including causing pain, causing inflammation, causing fever, affecting blood pressure, inducing sleep, regulating blood flow to particular organs, controlling ion transport across membranes, and inducing labor.

QUESTION: Using complete sentences, explain how **Nonsteroidal Anti-inflammatory Drugs (NSAIDs)** are able to reduce pain, fever, and inflammation.



ANSWER:

NSAIDs such as aspirin, acetaminophen, and ibuprofen are able to reduce pain, fever, and inflammation **by blocking the action of the cyclooxygenase enzyme** (COX) that catalyzes the conversion of arachidonic acid into prostaglandins (see the eicosanoids formation diagram on the left).

For more details: See chapter 12 part 8 video or chapter 12 section 8 in the textbook.

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Go to next question

12.35) Determine whether each of the following items are characteristic of either **simple diffusion**, **facilitated diffusion**, ***both* simple diffusion *and* facilitated diffusion**, **or *neither* simple diffusion *nor* facilitated diffusion**.

a) movement through a membrane

b) a net transport of a species from the side of the membrane where its concentration is ***less***, to the side where its concentration is ***greater***

c) a net transport of a species from the side of the membrane where its concentration is ***greater***, to the side where its concentration is ***less***

d) a form of passive transport

e) a form of active transport

f) require an energetic input from sources other than the concentration gradient of the transported species

g) facilitated by *protein channels* that pass through the cell membrane

Go back

Click here for a **hint**

Click here to **check your answer**

Go to next question

12.35) Determine whether each of the following items are characteristic of either **simple diffusion**, **facilitated diffusion**, ***both*** **simple diffusion *and* facilitated diffusion**, **or** ***neither*** **simple diffusion *nor* facilitated diffusion**.

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b) a net transport of a species from the side of the membrane where its concentration is ***less***, to the side where its concentration is ***greater***

c) a net transport of a species from the side of the membrane where its concentration is ***greater***, to the side where its concentration is ***less***

d) a form of passive transport

e) a form of active transport

f) require an energetic input from sources other than the concentration gradient of the transported species

g) facilitated by *protein channels* that pass through the cell membrane

HINT: Some nonpolar and amphipathic compounds (lipophilic compounds) can pass through a membrane because of their attraction to the phospholipids in the membrane. This diffusive movement of lipophilic compounds through a membrane is called ***simple diffusion***. Diffusion of small ions and polar molecules, which are *not* lipophilic, through membranes is facilitated by ***protein channels*** that pass through the cell membrane. This diffusion of species though protein channels is called ***facilitated diffusion***. Both ***simple diffusion*** and ***facilitated diffusion*** are called **passive transport** because they **do not** require an energetic input from sources other than the concentration gradient of the transported species.

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For more help: See chapter 12 part 9 video or chapter 12 section 9 in the textbook.

Click here to **check your answer**

Go to next question

12.35) Determine whether each of the following items are characteristic of either **simple diffusion**, **facilitated diffusion**, ***both*** **simple diffusion *and* facilitated diffusion**, **or *neither* simple diffusion *nor* facilitated diffusion**.

a) movement through a membrane ***both*** **simple diffusion *and* facilitated diffusion**

b) a net transport of a species from the side of the membrane where its concentration is ***less***, to the side where its concentration is ***greater*** ***neither*** **simple diffusion *nor* facilitated diffusion**

c) a net transport of a species from the side of the membrane where its concentration is ***greater***, to the side where its concentration is ***less*** ***both*** **simple diffusion *and* facilitated diffusion**

d) a form of passive transport ***both*** **simple diffusion *and* facilitated diffusion**

e) a form of active transport ***neither*** **simple diffusion *nor* facilitated diffusion**

f) require an energetic input from sources other than the concentration gradient of the transported species ***neither*** **simple diffusion *nor* facilitated diffusion**

g) facilitated by *protein channels* that pass through the cell membrane **facilitated diffusion**

EXPLANATION: Some nonpolar and amphipathic compounds (lipophilic compounds) can pass through a membrane because of their attraction to the phospholipids in the membrane. This diffusive movement of lipophilic compounds through a membrane is called ***simple diffusion***. Diffusion of small ions and polar molecules, which are *not* lipophilic, through membranes is facilitated by ***protein channels*** that pass through the cell membrane. This diffusion of species though protein channels is called ***facilitated diffusion***. Both ***simple diffusion*** and ***facilitated diffusion*** are called **passive transport** because they **do not** require an energetic input from sources other than the concentration gradient of the transported species.

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For more details: See chapter 12 part 9 video or chapter 12 section 9 in the textbook.

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12.36) Determine whether each of the following items are characteristic of either ***facilitated diffusion***, ***active transport***, or **both facilitated diffusion *and* active transport**.

a) movement through a membrane

b) a net transport of a species from the side of the membrane where its concentration is ***less***, to the side where its concentration is ***greater***

c) a net transport of a species from the side of the membrane where its concentration is ***greater***, to the side where its concentration is ***less***

d) a form of passive transport

e) require an energetic input from sources other than the concentration gradient of the transported species

f) facilitated by *proteins* that pass through the cell membrane

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Click here for a **hint**

Click here to **check your answer**

Go to next question

12.36) Determine whether each of the following items are characteristic of either ***facilitated diffusion***, ***active transport***, or **both facilitated diffusion *and* active transport**.

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b) a net transport of a species from the side of the membrane where its concentration is ***less***, to the side where its concentration is ***greater***

c) a net transport of a species from the side of the membrane where its concentration is ***greater***, to the side where its concentration is ***less***

d) a form of passive transport

e) require an energetic input from sources other than the concentration gradient of the transported species

f) facilitated by *proteins* that pass through the cell membrane

HINT:

In ***active transport***, where for molecules or ions are transported in the direction "against the concentration gradient" - from the side of the membrane where their concentration is less to the side where their concentration is greater - ***energy must be supplied***. In the ***active transport*** process, the ions or molecules cross the membrane with assistance from a ***transporter protein***.

For more help: See chapter 12 part 9 video or chapter 12 section 9 in the textbook.

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12.36) Determine whether each of the following items are characteristic of either ***facilitated diffusion***, ***active transport***, or ***both*** **facilitated diffusion *and* active transport**.

a) movement through a membrane ***both*** **facilitated diffusion *and* active transport**

b) a net transport of a species from the side of the membrane where its concentration is ***less***, to the side where its concentration is ***greater*** *active transport*

c) a net transport of a species from the side of the membrane where its concentration is ***greater***, to the side where its concentration is ***less*** *facilitated diffusion*

d) a form of passive transport ***facilitated diffusion***

e) require an energetic input from sources other than the concentration gradient of the transported species ***active transport***

f) facilitated by *proteins* that pass through the cell membrane ***both*** **facilitated diffusion *and* active transport**

EXPLANATION: Diffusion of small ions and polar molecules, which are *not* lipophilic, through membranes is facilitated by ***protein channels*** that pass through the cell membrane. This diffusion of species though protein channels is called ***facilitated diffusion***. Both ***simple diffusion*** and ***facilitated diffusion*** are called **passive transport** because they **do not** require an energetic input from sources other than the concentration gradient of the transported species.

In ***active transport***, where for molecules or ions are transported in the direction "against the concentration gradient" - from the side of the membrane where their concentration is less to the side where their concentration is greater - ***energy must be supplied***. In the ***active transport*** process, the ions or molecules cross the membrane with assistance from a ***transporter protein***.

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For more details: See chapter 12 part 9 video or chapter 12 section 9 in the textbook.

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12.37) The following statements describe different types of lipids. Match each statement with one of the ***lipid types*** shown below.

i) formed from a fatty acid residue, a phosphate residue, and a sphingosine residue

ii) lipids that contain a fused four-ring structure

iii) residues of these lipids are contained in other lipids; they have an even number of carbon atoms

iv) formed from a carbohydrate residue, one or two fatty acid residues, and a glycerol residue

v) formed from three fatty acid residues and a glycerol residue

vi) formed from a carboxylic acid residue and an alcohol residue

vii) formed from a carbohydrate residue, a fatty acid residue, and a sphingosine residue

viii) formed from one or more fatty acid residues, a phosphate residue, and a glycerol residue

***Type of lipids choices*:**

a) **triglycerides**
b) **sphingoglycolipids**
c) **glyceroglycolipids**
d) **sphingophospholipids**
e) **glycerophospholipids**
f) **fatty acids**
g) **waxes**
h) **steroids**

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Click here for a **hint**

Click here to **check your answer**

This is the last question.

12.37) The following statements describe different types of lipids. Match each statement with one of the ***lipid types*** shown below.

i) formed from a fatty acid residue, a phosphate residue, and a sphingosine residue

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***Type of lipids choices*:**

a) **triglycerides**
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c) **glyceroglycolipids**
d) **sphingophospholipids**
e) **glycerophospholipids**
f) **fatty acids**
g) **waxes**
h) **steroids**

HINT:

Review and compare the *general forms* of the **lipids** discussed in chapter 12.

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Click here to **check your answer**

This is the last question.

12.37) The following statements describe different types of lipids. Match each statement with one of the ***lipid types*** shown below.

i) formed from a fatty acid residue, a phosphate residue, and a sphingosine residue
- sphingophospholipids

ii) lipids that contain a fused four-ring structure
- steroids

iii) residues of these lipids are contained in other lipids; they have an even number of carbon atoms
- fatty acids

iv) formed from a carbohydrate residue, one or two fatty acid residues, and a glycerol residue
- glyceroglycolipids

v) formed from three fatty acid residues and a glycerol residue
- triglycerides

vi) formed from a carboxylic acid residue and an alcohol residue
- waxes

vii) formed from a carbohydrate residue, a fatty acid residue, and a sphingosine residue
- sphingoglycolipids

viii) formed from one or more fatty acid residues, a phosphate residue, and a glycerol residue
- glycerophospholipids

***Type of lipids choices*:**

a) **triglycerides**
b) **sphingoglycolipids**
c) **glyceroglycolipids**
d) **sphingophospholipids**
e) **glycerophospholipids**
f) **fatty acids**
g) **waxes**
h) **steroids**

EXPLANATION:

The solution to this problem is obtained by considering and comparing the *general forms* of the **lipids** discussed in chapter 12.

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This is the last question.