MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) What is the acetal formed when propanone reacts with two molecules of methanol?

A) \[
\begin{align*}
\text{CH}_3 & \quad \text{CH}_3 \\
\text{CH}_3 & \quad \text{C} - \text{O} - \text{C} \quad \text{CH}_3 \\
\text{H} & \quad \text{H}
\end{align*}
\]

B) \[
\begin{align*}
\text{OH} & \\
\text{CH}_3 & \quad \text{C} \quad \text{CH}_3 \\
\text{C} & \quad \text{H}_3
\end{align*}
\]

C) \[
\begin{align*}
\text{OCH}_3 & \\
\text{CH}_3 & \quad \text{C} \quad \text{CH}_3 \\
\text{O} & \quad \text{CH}_3
\end{align*}
\]

D) \[
\begin{align*}
\text{OCH}_3 & \\
\text{CH}_3 & \quad \text{C} \quad \text{OCH}_3 \\
\text{O} & \quad \text{CH}_3
\end{align*}
\]

E) \[
\begin{align*}
\text{OH} & \\
\text{CH}_3 & \quad \text{C} \quad \text{CH}_3 \\
\text{O} & \quad \text{CH}_3
\end{align*}
\]
2) Which of the following compounds contains a ketone functional group?

A) \[ \text{CH}_3 \text{C} - \text{O} - \text{CH} \]

B) \[ \text{CH}_3 \]

C) \[ \text{CH}_3 - \text{O} - \text{CH} \]

D) \[ \text{CH}_3\text{CH}_2\text{C} - \text{CH}_3 \]

E) \[ \text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3 \]

3) Which of the following pairs of compounds are constitutional isomers?

A) \[ \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} \text{ and } \text{CH}_3\text{CH}_2\text{CHCH}_2\text{CH}_3 \]

B) \[ \text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3 \text{ and } \text{CH}_3\text{C} - \text{CH}_3 \]

C) \[ \text{CH}_3\text{CH}_2\text{C} - \text{CH}_3 \text{ and } \text{CH}_3\text{C} - \text{CH}_2\text{CH}_3 \]

D) \[ \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} \text{ and } \text{CH}_3\text{OCH}_3 \]

E) \[ \text{CH}_3\text{CH}_2\text{OH} \text{ and } \text{CH}_3\text{C} - \text{CH}_3 \]
4) The oxygen atom in a carbonyl group is ____ the carbon atom.
   A) more electropositive than
   B) more electronegative than
   C) less electronegative than
   D) identical in electronegativity to
   E) more soluble than

5) In the IUPAC naming system, a ketone is named by replacing the –e in the corresponding alkane name with

6) The increased boiling point of ketones compared to alkanes and ethers of similar mass is due to
   A) dipole–dipole interactions.
   B) hydrogen bonding.
   C) resonance.
   D) a bent chain structure.
   E) ionic interactions.

7) The Tollens test may be used to distinguish
   A) esters from acids.
   B) aldehydes from ketones.
   C) acids from amines.
   D) alcohols from alkenes.
   E) ketones from alcohols.

8) Aldehydes and ketones may be reduced to

9) An acetal is formed from two molecules of an alcohol and a(n)
   A) alkyl ether.
   B) aldehyde.
   C) ester.
   D) ether.
   E) carboxylic acid.

10) How do sugars form cyclic hemiacetals?
    A) A molecule of sugar reacts with an added alcohol.
    B) A sugar molecule decomposes.
    C) A molecule of sugar reacts with an added aldehyde.
    D) A molecule of sugar reacts with itself.
    E) Two molecules of a sugar react with one another.
11) The reduction of 3-pentanone with hydrogen in the presence of a nickel catalyst will yield
A) 2-pentene.
B) diethyl alcohol.
C) pentane.
D) 3-pentanol.
E) pentanaldehyde.

12) Which of these compounds is the hemiacetal that forms when ethanol reacts with propanal?
A) \[
\begin{array}{c}
OCH_2CH_3 \\
| \\
CH_3 C OCH_3 \\
| \\
H
\end{array}
\]
B) \[
\begin{array}{c}
OH \\
| \\
CH_3CH_2 C OCH_2CH_3 \\
| \\
H
\end{array}
\]
C) \[
\begin{array}{c}
OH \\
| \\
CH_3 C OCH_2CH_3 \\
| \\
H
\end{array}
\]
D) \[
\begin{array}{c}
OCH_2CH_3 \\
| \\
CH_3CH_2 C OCH_2CH_3 \\
| \\
H
\end{array}
\]
E) \[
\begin{array}{c}
OCH_2CH_2CH_3 \\
| \\
CH_3 C OCH_2CH_2CH_3 \\
| \\
CH_2CH_2CH_3
\end{array}
\]

13) A carbohydrate that gives two molecules when it is completely hydrolyzed is known as a
A) trisaccharide.
B) disaccharide.
C) polysaccharide.
D) starch.
E) monosaccharide.
14) A monosaccharide that consists of 5 carbon atoms, one of which is in a ketone group, is classified as a(n)

15) Stereoisomers that are mirror images of each other are known as
   A) superimposable isomers.
   B) Fischer projections.
   C) achiral isomers.
   D) enantiomers.
   E) anomers.

16) An organic compound is chiral if it has
   A) one or more carbon atoms attached to four different atoms or groups.
   B) a superimposable mirror image.
   C) at least four carbon atoms.
   D) one or more carbon atoms attached to four hydrogen atoms.
   E) one or more carbon atoms attached to four carbon atoms.

17) In the L- isomer of a Fischer projection of a monosaccharide, the defining –OH group is written
   A) on the left of the top chiral carbon.
   B) on the left of the bottom chiral carbon.
   C) on the left of the middle chiral carbon.
   D) on the right of the bottom chiral carbon.
   E) on the right of the top chiral carbon.

18) In the cyclic structures of D-glucose, the α and β-isomers are known as

19) Which of the following contains a β–1,4-glycosidic bond?
   A) maltose    B) sucrose    C) lactose    D) galactose    E) amylose
Refer to the disaccharide below to answer the next four questions.

20) In the figure above, the monosaccharide unit on the right is a(n)

21) In the figure above, the monosaccharide unit on the right displays what type of anomer?
   A) beta  B) alpha  C) neither of the above

22) In the figure above, the monosaccharide unit on the right is
   A) galactose  B) glucose  C) amyllose  D) none of the above

23) In the figure above, the monosaccharide unit on the left is a (n)
   A) ketohexose  B) ketopentose  C) aldohexose  D) aldopentose  E) none of the above

24) Cellulose is not digestible by humans because it contains glucose units linked by
    _____-glycosidic bonds.
    A) α-1,2  B) α-1,6  C) β-1,4  D) α-1,4  E) β-1,2
25) Which of these carbohydrates is NOT a reducing sugar?

A)

B)

C)

D)

E)

26) Which functional group is a carboxylic acid?

A) - OH

B) O

C) O

D) OH

E) - CH₂OH
27) The neutralization of formic acid by NaOH produces
   A) sodium formate and H₂O.
   B) sodium formate as the only product.
   C) sodium formaldehyde.
   D) formate ion and hydronium ion.
   E) methyl alcohol.

28) Which of the following compounds is most soluble in water?
   A) CH₃CH₂CH₃
   B)  
      O
     / \CH₃CH₂CH₂CH₂ C OH
   C) CH₃CH₂CH₂CH₂OH
   D) CH₃CH₂CH₂OCH₃
   E)  
      O
     / \CH₃ C OH

29) Many of the fragrances of flowers and the flavors of fruits are due to
   A) ethers.
   B) carboxylic acids.
   C) esters.
   D) amides.
   E) amines.

30) What is the name of this compound?
    
    O
   / \CH₃ C - O - CH₂CH₃

   A) ethyl methanoate
   B) ethyl acetate
   C) ethyl methyl ester
   D) 2-ether-2-butane
   E) diethyl ester
31) The reactants that will form an ester in the presence of an acid catalyst are
A) a carboxylic acid and an alcohol.
B) two carboxylic acids.
C) two aldehydes.
D) two alcohols.
E) an aldehyde and an alcohol.

32) Which of these compounds is the ester formed from the reaction of acetic acid and 1-propanol?
A)
\[
\begin{array}{c}
\text{CH}_3\text{CH}_2\text{C} \equiv \text{OCH}_2\text{CH}_3
\end{array}
\]
B)
\[
\begin{array}{c}
\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_2\text{C} \equiv \text{OH}
\end{array}
\]
C)
\[
\begin{array}{c}
\text{CH}_3\text{OH} \\
\text{CH}_2\text{C} \equiv \text{OH} \\
\text{OCH}_2\text{CH}_3
\end{array}
\]
D)
\[
\begin{array}{c}
\text{CH}_3 \equiv \text{C} \equiv \text{OH} \\
\text{OCH}_2\text{CH}_2\text{CH}_3
\end{array}
\]
E)
\[
\begin{array}{c}
\text{CH}_3 \equiv \text{C} \equiv \text{OCH}_2\text{CH}_2\text{CH}_3
\end{array}
\]
33) Which of the following is the reaction for the saponification of methyl acetate?

A)

\[
\text{CH}_3\text{C OCH}_3 + \text{NaOH} \rightarrow \text{CH}_3\text{C O}^-\text{Na}^+ + \text{CH}_3\text{OH}
\]

B)

\[
\text{HC OCH}_3 + \text{H}_2\text{O} \rightarrow \text{HC O}^- + \text{CH}_3\text{OH H}_2^+
\]

C)

\[
\text{CH}_3\text{C OCH}_3 + \text{NaOH} \rightarrow \text{CH}_3\text{C OH} + \text{CH}_3\text{O}^-\text{Na}^+
\]

D)

\[
\text{CH}_3\text{C OCH}_3 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{C O}^- + \text{CH}_3\text{OH H}_2^+
\]

E)

\[
\text{HC OCH}_3 + \text{NaOH} \rightarrow \text{HC O}^-\text{Na}^+ + \text{CH}_3\text{OH}
\]

34) A carboxylic acid is named in the IUPAC system by replacing the –e in the name of the parent alkane with

A) –oate.

B) –oic.

C) –carboxylic acid.

D) –oic acid.

E) acid.

35) What type of chemical structure characterizes triacylglycerols?

A) ether  B) amide  C) alcohol  D) ketone  E) ester

36) What kind of intermolecular bonding occurs between carboxylic acids?

A) nonpolar bonding

B) covalent bonding

C) hydrogen bonding

D) charge-transfer bonding

E) ionic bonding

37) What happens to water solubility as chain length increases in carboxylic acids?

A) It increases.  B) It stays the same.  C) It decreases.

38) Which of the following lipids will give a single molecule of fatty acid when hydrolyzed?

A) fat  B) wax  C) phospholipid  D) petroleum  E) glycolipid
39) Compared to saturated fatty acids, unsaturated fatty acids have
   A) longer carbon chains.
   B) shorter carbon chains.
   C) lower melting points.
   D) greater intermolecular attraction.
   E) higher melting points.

40) Waxes are lipids derived from
   A) terpenes and steroids.
   B) a long-chain alcohol and a long-chain fatty acid.
   C) glycerol, fatty acids, phosphate, and an amino alcohol.
   D) glycerol and three fatty acids.
   E) sphingosine, fatty acids, phosphate, and an amino alcohol.

41) Commercially, liquid vegetable oils are converted to solid fats such as margarine by
   A) hydration.
   B) hydrogenation.
   C) oxidation.
   D) saponification.
   E) hydrolysis.
42) Palmitic acid is a 16 carbon acid. In a balanced equation, the products of the saponification of tripalmitin (glyceryl tripalmitate) are

A) \[
\begin{align*}
\text{CH}_2 - \text{OH} & + 2 \text{H}_3\text{C} - (\text{CH}_2)_{14} - \text{C} - \text{O}^- \text{Na}^+ \\
\text{CHOH} & \\
\text{CH}_2 - \text{OH} & + \text{H}_3\text{C} - (\text{CH}_2)_{16} - \text{C} - \text{O}^- \text{Na}^+
\end{align*}
\]

B) \[
\begin{align*}
\text{CH}_2 - \text{OH} & + \text{H}_3\text{C} - (\text{CH}_2)_{14} - \text{C} - \text{O}^- \text{Na}^+ \\
3 \text{CHOH} & \\
\text{CH}_2 - \text{OH}
\end{align*}
\]

C) \[
\begin{align*}
\text{CH}_2 - \text{O}^- \text{Na}^+ & + 3 \text{H}_3\text{C} - (\text{CH}_2)_{14} - \text{C} - \text{OH} \\
\text{CH} - \text{O}^- \text{Na}^+ & \\
\text{CH}_2 - \text{O}^- \text{Na}^+
\end{align*}
\]

D) \[
\begin{align*}
\text{CH}_2 - \text{OH} & + 3 \text{H}_3\text{C} - (\text{CH}_2)_{14} - \text{C} - \text{O}^- \text{Na}^+ \\
\text{CHOH} & \\
\text{CH}_2 - \text{OH}
\end{align*}
\]

E) \[
\begin{align*}
\text{CH}_2 - \text{OH} & + 3 \text{H}_3\text{C} - (\text{CH}_2)_{14} - \text{C} - \text{OH} \\
\text{CH} - \text{OH} & \\
\text{C} \text{H}_2 - \text{OH}
\end{align*}
\]

43) A fatty acid salt can act as a soap to remove grease because

A) the grease molecules form a thin layer around each salt molecule, making them soluble in water.

B) the nonpolar tails of the salt dissolve in the grease and the polar salt ends dissolve in water.

C) the nonpolar tails of the salt cause the salt to float on the surface of the water.

D) the polar salt ends dissolve in the grease and the nonpolar tails cause the resulting micelles to float on water.

E) the salt molecules combine with grease and either Ca\(^{2+}\) or Mg\(^{2+}\) to form a precipitate.
44) Glycerolphospholipids can interact both with other lipids and water because they contain both _____ and _____.
   A) bile salts, cholesterol
   B) polar regions, nonpolar regions
   C) single bonds, double bonds
   D) saturated fatty acids, unsaturated fatty acids
   E) glycerol, sphingosine

45) Glycoglycosphingolipids are lipids composed of
   A) glycerol and fatty acids.
   B) glycerol, fatty acids, and a sugar.
   C) glycerol, fatty acids, phosphate, and an amino alcohol.
   D) sphingosine, fatty acids, phosphate, and an amino alcohol.
   E) a long-chain alcohol and a fatty acid.

   Answer the next five questions about the diagram shown below.

46) In this diagram of a cell membrane, the small branched object labeled (A) is part of a
   A) steroid.
   B) hydrophobic region.
   C) glycolipid.
   D) membrane protein.
   E) glycerolphospholipid.

47) In this diagram of a cell membrane, the large object labeled (E) is
   A) an integral membrane protein.
   B) a steroid.
   C) a glycolipid.
   D) a phospholipid.
   E) a hydrophobic region.
48) In this diagram of a cell membrane, the object labeled (C) is a
A) steroid.
B) glycolipid.
C) polar phosphate head group.
D) mitochondrion.
E) hydrophobic region.

49) In this diagram of a cell membrane, the object labeled (B) is a
A) steroid.
B) glycolipid.
C) hydrophobic region.
D) membrane protein.
E) glycerolphospholipid bilayer.

50) In this diagram of a cell membrane, the object labeled A would be found on which side of the cell membrane?
A) Exterior
B) Interior
C) Could exist on the exterior or the interior