1. What is the systematic IUPAC name of the compound below?

![Chemical structure]

1) 6-bromo-4-ethylbenzenecarboxylic acid  
2) 2-bromo-4-ethylbenzenecarboxylic acid  
3) ortho-bromo-para-ethylbenzoic acid  
4) 1-bromo-3-ethylbenzoic acid

2. Which of the following has the largest acid equilibrium constant, $K_a$?

1) benzoic acid  
2) ortho-nitrobenzoic acid  
3) para-methylbenzoic acid (para-toluic acid)  
4) para-methoxybenzoic acid

3. What is the product of the reaction below?

$$\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H} + \text{Br}_2 \xrightarrow{\text{PCL}_3}$$

1) 2,3-dibromobutanoic acid  
2) 3-chlorobutanoic acid  
3) 2-bromobutanoic acid  
4) 2-chlorobutanoic acid

4. What is the product of the reaction sequence below?

![Reaction sequence]

1) 1  
2) 2  
3) 3  
4) 4
5. Which structure below is the hydroxy acid which corresponds to the following lactone.

![Lactone structure]

1) 1  2) 2  3) 3  4) 4

6. What is the product of the reaction shown below?

![Reaction diagram]

1) 1  2) 2  3) 3  4) 4
7. A mixture of 1-hexanol and hexanoic acid in diethyl ether is shaken with an aqueous sodium bicarbonate solution. Which line below correctly describes the major organic species in the two resulting immiscible solutions?

ether         sodium bicarbonate solution
1) hexanoic acid 1-hexanol
2) 1-hexanol    hexanoic acid
3) sodium hexanoate 1-hexanol
4) 1-hexanol sodium hexanoate

8. Which one of the following has the best soap cleansing properties?

1) CH₃(CH₂)₁₆CO₂H  2) CH₃CH₂CO₂H
3) CH₃(CH₂)₁₆CO₂Na  4) CH₃CH₂CO₂Na

9. Reaction of acetic acid, CH₃CO₂H, with isotopically labeled CH₃¹⁸OH and catalytic sulfuric acid gives:

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\begin{align*}
1) & \quad CH₃COCH₃ + H₂O & \quad 3) & \quad CH₃COCH₃ + H₂¹⁸O \\
2) & \quad CH₃C¹⁸OCH₃ + H₂O & \quad 4) & \quad \text{equal amounts of 1 and 2}
\end{align*}
\]

1) 1  2) 2  3) 3  4) 4

10. What is the product of the thermal decarboxylation of dimethylpropanedioic acid?

1) propanoic acid  2) 2-methylpropanoic acid
3) 2,2-dimethylpropanoic acid  4) acetic acid

11. Which of the following is the enol intermediate in the thermal decarboxylation of methylpropanedioic acid, CH₃CH(CO₂H)₂?

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\begin{align*}
1) & \quad \text{HO} \quad \text{CH₃} & \quad 2) & \quad \text{HO} \quad \text{CH₃} & \quad 3) & \quad \text{HO} \quad \text{CH₃} & \quad 4) & \quad \text{HO} \quad \text{CH₃} \\
& \quad \text{HO} \quad \text{H} & \quad \text{HO} \quad \text{H} & \quad \text{HO} \quad \text{H} & \quad \text{HO} \quad \text{H}
\end{align*}
\]

1) 1  2) 2  3) 3  4) 4
12. Acetic acid is mixed with isotopically labeled water, H$_2^{18}$O, and a small amount of hydrochloric acid. Which of the following results of $^{18}$O incorporation would be expected?

1) CH$_3$COH (only)  
2) CH$_3$C$^{18}$OH (only)  
3) a mixture of 1 and 2  
4) no $^{18}$O incorporated in acetic acid

1) 1  
2) 2  
3) 3  
4) 4

13. Which of the following has the largest acid equilibrium constant, $K_a$?

1) CH$_3$CO$_2$H  
2) CH$_2$ClCO$_2$H  
3) CHCl$_2$CO$_2$H  
4) CCl$_3$CO$_2$H