Use your knowledge of organic functional groups to answer the following nine questions. For Questions 1 – 5, predict the products and provide the appropriate curved-arrow formalism where requested.

1. [Image of progesterone, a steroid]

   - 1. NaBH₄
   - 2. H₂O

   *Progesterone, a steroid*

2. [Image of cholesterol, another steroid]

   - K₂Cr₂O₇
   - H₂SO₄

   *Cholesterol, another steroid*

3. [Image of a compound under H₂SO₄ at 140 °C]

   - MAJOR and MINOR

   **Mechanism:**

   **Major:**

   - OH⁻ → OH₂⁻ → OH⁺ → OH₂ → OH

   **Minor:**

   - OH⁻ → OH₂⁻ → OH⁺ → OH₂ → OH

   *MAJOR and MINOR*
4. 

\[
\text{hemiacetal}
\]

represented below generically in order to save space:

\[
\text{product}
\]

5. 

\[
\text{Testosterone (male sex hormone)}
\]

6. An unknown has been determined to be one of the following three compounds:

The unknown is fairly soluble in water and produces a silver mirror when treated with Tollens’ reagent. Which of the compounds is the correct structure for the unknown? Circle your structure above and briefly explain your identification.

Tollens’ reagent contains AgNO\(_3\) and NH\(_3\) in water which combine to form the complex ion \([\text{Ag(NH}_3\text{)}_2]^+\) and solid silver (i.e. silver mirror) in the presence of an aldehyde, but NOT a ketone.
7. Virgin olive oil contains vanillic acid, 3,4-dihydroxycinnamic acid, and syringic acid, compounds that can be prepared by oxidizing the appropriate starting materials. Complete each reaction below by drawing the structures of the reactants. *To simplify this question, ignore the possible oxidation of –OH groups.*

8. An unknown compound A is known to have the molecular formula $C_4H_{10}O$. When dehydrated, compound A results in compound B, which is known to have the molecular formula $C_4H_8$. Compound A cannot be oxidized. Determine the identities of compounds A and B.

9. Compound C has the formula $C_3H_8O$. When C is heated with acid, compound D forms, which has the molecular formula $C_3H_6$. When C is oxidized, compound E ($C_3H_6O$) forms that oxidizes further to a carboxylic acid. Another compound F has the molecular formula $C_3H_8O$. When F is heated with acid, compound D ($C_3H_6$) forms. When F is oxidized, compound G ($C_3H_6O$) forms that cannot be oxidized further. What are the structures of compounds C, D, E, F, and G?
10. **Mechanism!** Give the appropriate curved arrow notation for formation of the final product shown.

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\[
\text{HO-CH}_{2}\text{-CH}_{2}\text{CHOH+} \xrightleftharpoons{\text{H}^+} \text{HO-CH}_{2}\text{-CH}_{2}\text{C(OH)CH}_{2}\text{O}
\]
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**mechanism:**

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\[
\text{HO-CH}_{2}\text{-CH}_{2}\text{CHO-} \xrightarrow{\text{H}^+} \text{HO-CH}_{2}\text{-CH}_{2}\text{CHOH} \xrightarrow{\text{H}^+} \text{HO-CH}_{2}\text{-CH}_{2}\text{C(OH)CH}_{2}\text{O}
\]
```

```
\[
\text{HO-CH}_{2}\text{-CH}_{2}\text{O} \xrightarrow{\text{H}^+} \text{HO-CH}_{2}\text{-CH}_{2}\text{OH} \xrightarrow{\text{H}^+} \text{HO-CH}_{2}\text{-CH}_{2}\text{C(OH)CH}_{2}\text{O}
\]
```

```
\[
\text{HO-CH}_{2}\text{-CH}_{2}\text{O} \xrightarrow{\text{H}^+} \text{HO-CH}_{2}\text{-CH}_{2}\text{OH} \xrightarrow{\text{H}^+} \text{HO-CH}_{2}\text{-CH}_{2}\text{C(OH)CH}_{2}\text{O}
\]
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