Functional Groups:

Functional groups participate in chemical changes and give each molecule unique properties. Circle the functional groups that we have discussed in the molecules below. Label each of the following where they appear in the molecules below: hydroxyl group, carboxyl group, carbonyl group, amino group, sulphydryl group, methyl group and phosphate group. The properties of the molecules are described at the right.

1. Formaldehyde is the starting point for making many chemicals.
   ![Formaldehyde](image)
   Carboxyl - Aldehyde

2. Formic acid gives ant venom its sting.
   ![Formic Acid](image)
   Carboxyl

3. Lactic acid builds up as a waste product in exercising muscles and makes them feel tired.
   ![Lactic Acid](image)
   Carboxyl - Hydroxyl

4. Ethylene glycol is an automobile antifreeze. Based on the structure of the molecule can you generate a hypothesis as to how it prevents water from freezing?
   ![Ethylene Glycol](image)
   Hydroxyl
   Repeated H-bonding with water disrupts the chemical structure needed for freezing to occur

5. Acrolein is produced when meat is heated; it is the barbecue smell.
   ![Acrolein](image)
   Carbonyl (End)

6. Serine is part of many protein molecules.
   ![Serine](image)
   Amino, Carbonyl, Hydroxyl

7. Urea is a waste product in urine.
   ![Urea](image)
   Carbonyl
   Amino
8. Putrescine’s name is descriptive; it is produced in rotting flesh.

9. Methanethiol is a colorless gas that has a putrid odor found in the blood and brain of humans. A main component of “bad breath”.

- sulf hydrol
- methyl

10. Adenosine triphosphate is used as the energy currency molecule of the cell. Why is ATP so likely to react with water?

11. Functional groups can modify the properties of organic molecules. In the following table, indicate whether each functional group is polar or nonpolar and hydrophobic or hydrophilic. Which of these functional groups are found in proteins and lipids?

<table>
<thead>
<tr>
<th>Functional group</th>
<th>Polar or Nonpolar</th>
<th>Hydrophobic or Hydrophilic</th>
<th>Found in…</th>
</tr>
</thead>
<tbody>
<tr>
<td>-OH</td>
<td>Polar</td>
<td>Hydrophilic</td>
<td>No</td>
</tr>
<tr>
<td>-CO₂H</td>
<td>Polar</td>
<td>Hydrophilic</td>
<td>Yes</td>
</tr>
<tr>
<td>-NH₂</td>
<td>Polar</td>
<td>Hydrophilic</td>
<td>Yes</td>
</tr>
<tr>
<td>-SH</td>
<td>Polar</td>
<td>Hydrophilic</td>
<td>No</td>
</tr>
<tr>
<td>-PO₄</td>
<td>Polar</td>
<td>Hydrophilic</td>
<td>No</td>
</tr>
</tbody>
</table>
**Matching:**
Match the formulas (a-f) to the terms at the right. Choices may be used more than once; more than one right choice may be available.

1. structural isomers
2. geometric isomers
3. can have enantiomers
4. can make cross link in protein
5. carboxylic acid
6. hydrophilic
7. hydrocarbon
8. amino acid
9. organic phosphate
10. aldehyde
11. amine
12. ketone
13. alkene
14. trans-2-butene
15. L-cysteine
16. glyceraldehyde
17. D-hydroxyacetone
18. D-galactose enantiomers

**Structures:**
- **a.** trans-2-butene
- **b.** D-galactose
- **c.** D-hydroxyacetone
- **d.** L-cysteine
- **e.** Alkene, cis-2-butene
- **f.** Glyceraldehyde

**Additional Notes:**
- D- and L-galactose enantiomers are important in biology, with D-galactose being the more common form.
- Hydroxyacetone is an intermediate in the glycolysis pathway.