Answers

1. (a) glycerol: Glycerol has three hydroxyl groups per molecule. ethylene glycol has two. Glycerol can form more hydrogen bonds and has a higher boiling point.
   (b) water: Water has hydroxyl groups which can hydrogen bond: methoxymethane has no hydroxyl groups. Water has a higher boiling point.
   (c) propanol: Both alcohols have hydroxyl groups but propanol has a longer carbon chain and thus has greater van der Waals intermolecular forces.
   (d) propanol: Propanol has hydroxyl groups capable of hydrogen bonding while methoxyethane does not. Propanol has a higher boiling point.

2. $CH_3CH_2CH_2CH_2CH_2-OH$
   LF, DD, HB
   ↑mp bcz ↑ IMF

   $CH_3CH_2OCH_2CH_2CH_3$
   LF, DD
   ↓mp bcz ↓ IMF
   ↑sol in nonpolar

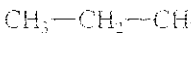
3. carboxyl group
   The hydroxyl group in this functional group is polar and can hydrogen bond, making the molecule soluble in water. The carbonyl group is also polar and, with the hydroxyl group, increases intermolecular attractions and thus raises the melting and boiling points of carboxylic acids.

4. An ester contains an —OR group in place of the —OH in the carboxylic acid. The OH group is responsible for the acidic properties of carboxylic acids, and also for hydrogen bonding; thus, esters have lower melting and boiling points, are less soluble in water, and are less acidic.

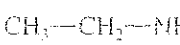
5. Amines contain —NH groups which are less polar than —OH groups in alcohols, and are less capable of hydrogen bonding than are —OH groups.

6. (a) alcohol, amine; the OH group in alcohols is more polar than the NH group in amines, making them less soluble in nonpolar solvents than are amines.
   (b) primary amine, tertiary amine; tertiary amines do not contain the polar NH groups that are present in primary amines. The more polar primary amine is less soluble in nonpolar solvents than is the tertiary amine. However, if the nonpolar group on the primary amine is large, the increased attraction between nonpolar groups may make it more soluble in the nonpolar solvents.
   (c) tertiary amine, hydrocarbon; bonds between N and C are more polar than bonds between H and C, and therefore, tertiary amines are slightly more polar than hydrocarbons, making them less soluble in nonpolar solvents. However, if the nonpolar groups on the tertiary amine are large, the increased attraction between nonpolar groups may make it more soluble in the nonpolar solvents.
   (d) low molecular mass, high molecular mass; both are primary amines with the same number of NH bonds. The higher molecular mass amine has a larger nonpolar hydrocarbon component and is therefore more soluble in nonpolar solvents.

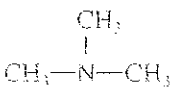
7.



primary amine: *n*-propylamine



secondary amine: ethylmethylamine



tertiary amine: trimethylamine

8.

presence of length of nonpolar hydrocarbon component: $CH_3CH_2CH_2CH_2CH_3$
double or triple bonds: $CH_2{=}CH_2$, $CH{\equiv}CCH_3$
OH bonds: CH_3CH_2OH
NH bonds: H_2NCH_3
C=O bonds: CH_3CHO, CH_3COOH

10.

Each small unit must contain an amino group and a carboxyl group so that an amide bond can form between small units.
With both amino groups and carboxyl groups, amino acids are likely fairly soluble in water; they are capable of forming strong amide bonds.