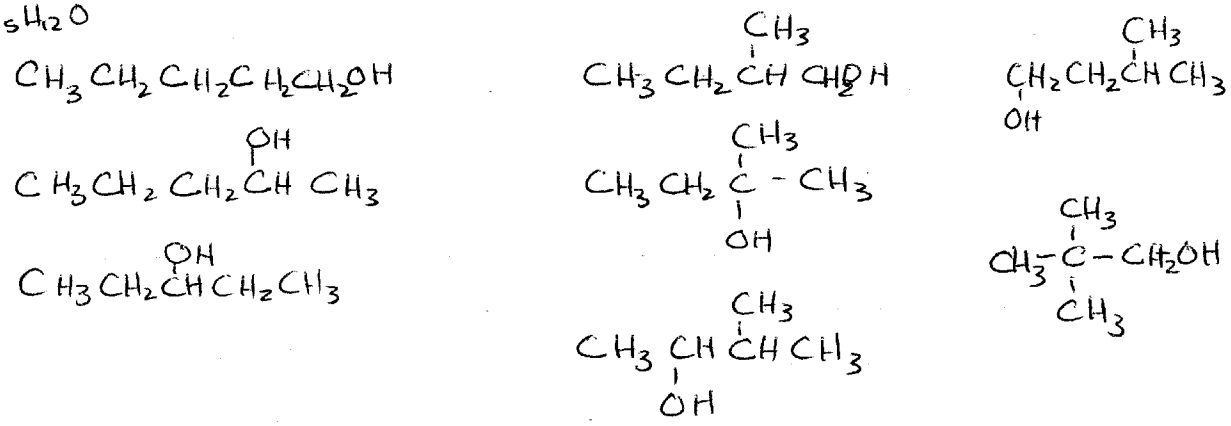
Chem 30B - Answers to Review Q for Final part 1

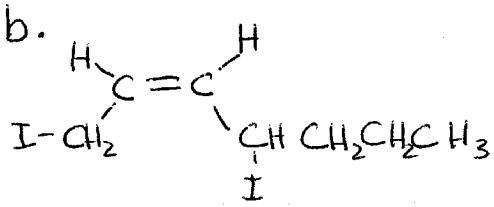
1 a. 3-chloro-4-methylpentanal
b. ortho-nitrotoluene
c. 1,1-dimethylcyclohexane
d. N,N-dimethyl-2-fluoropropanamide
e. 4,5-dibromo-2-hexyne
f. ethyl propyl ether or 1-ethoxypropane
g. 4-ethyl-3,5-dimethylheptane
h. trans-5-fluoro-3-heptene
i. 4-bromo-5-chloro-3-hexanone
j. triethylamine OR N,N-diethylethanamine
k. 3-chlorobutanoic acid

2. $C_5H_{12}O$

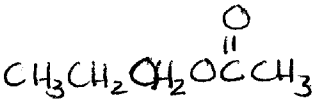


3. a.

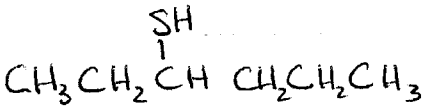
b.



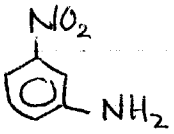
c.



d.

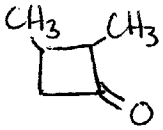


e.

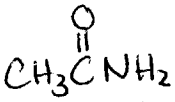


f. $HC\equiv CH$

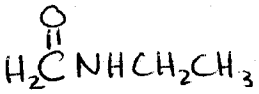
g.



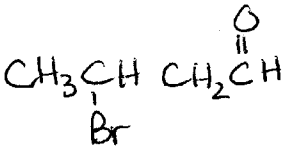
h.



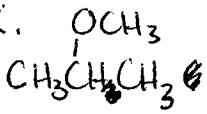
i.



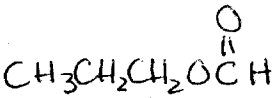
j.



k.



l.



4. ① try burning it – an organic compound will combust (burn), an inorganic compound won't. ② try dissolving it in water – most organic compounds won't dissolve in water ③ see if it has an odor – if so, probably organic.
5. Try adding bromine. If positive, the orange color of the bromine added will disappear.
6. Add I_2. If positive – will turn blue/black
7. Add Benedict's reagent (Cu^{2+} in basic solution). If positive, will get a red/orange precipitate.
8. a. neither – different # H's C_6H_{12} vs C_6H_6
   b. identical – same name 2,3-dimethylbutane
   c. isomers – both are C_4H_8O but different structure
9. a. 2° amine b. 3° alcohol c. 1° amine
10. burning something in O_2. ex: $2CH_3CH_3 + 7O_2 \rightarrow 4CO_2 + 6H_2O$
    all organic compounds undergo combustion.
11. alkanes – unreactive, nonpolar, less dense than H_2O, flammable
    alkenes – more reactive than alkanes because of the double bond. Undergo addition rxns.
    alkynes – similar properties compared to alkenes
    aromatic – aren't as reactive as alkenes
    alcohols – polar, can H-bond. High bps. Small ones soluble in H_2O.
    ethers – good solvents, extremely flammable. Slightly polar.
    thiols – smell bad
    phenols – weak acids, antiseptics
    aldehydes – some smell good polar
    ketones – good solvents polar
    carboxylic acids – weak acids – ionize slightly in water. high bps. can form dimers. Polar + can H-bond.
    esters – smell good – (many smell like fruits)
    amines – smell bad, weak bases polar, some can H-bond
    amides – not acidic or basic polar

12. most soluble: (c) small alcohol - can form H-bonds to water and no long hydrocarbon chain to get in the way.
(f) longer alcohol - can H-bond to water (but larger nonpolar section)
(e) Ketones are more polar than ethers (b) ethers are more polar than alkanes/alkenes (a, d) both insoluble in H_2O.

13. Highest bp: (f) has the highest molar mass (so strongest London forces) and can H-bond. The molecules a, b, c, and e have very similar molar masses, so similar London forces. (c) has next highest bp - it can H-bond. (e) ketone, so more polar than ethers, can't H-bond. (b) ether is more polar than alkene. (a) nonpolar, higher MM than (d). (also nonpolar)

14. $CH_3CH_2\overset{O}{\overset{\|}{C}}OH + CH_3CH_2OH \underset{heat}{\overset{H^+}{\rightleftharpoons}} CH_3CH_2\overset{O}{\overset{\|}{C}}OCH_2CH_3 + H_2O$

ethyl propanoate (propionate)

15. $CH_3CH_2\overset{O}{\overset{\|}{C}}OH + CH_3CH_2NH_2 \longrightarrow CH_3CH_2\overset{O}{\overset{\|}{C}}NHCH_2CH_3 + H_2O$

N-ethyl propanamide

16. $CH_3O\overset{O}{\overset{\|}{C}}CH_3 + H_2O \underset{heat}{\overset{H^+}{\rightleftharpoons}} CH_3OH + CH_3\overset{O}{\overset{\|}{C}}OH$

methanol + acetic acid

$CH_3O\overset{O}{\overset{\|}{C}}CH_3 + NaOH \longrightarrow CH_3OH + Na^+\ ^-O\overset{O}{\overset{\|}{C}}CH_3$

methanol + sodium acetate

17. $CH_3CH_2CH_2\overset{O}{\overset{\|}{C}}N(CH_3)_2 + H_2O + HCl \rightarrow CH_3CH_2CH_2\overset{O}{\overset{\|}{C}}OH + H_2\overset{+}{N}(CH_3)_2\ Cl^-$

butanoic acid + dimethylammonium chloride

$CH_3CH_2CH_2\overset{O}{\overset{\|}{C}}N(CH_3)_2 + NaOH \rightarrow CH_3CH_2CH_2\overset{O}{\overset{\|}{C}}O^-Na^+ + HN(CH_3)_2$

sodium butanoate + dimethylamine

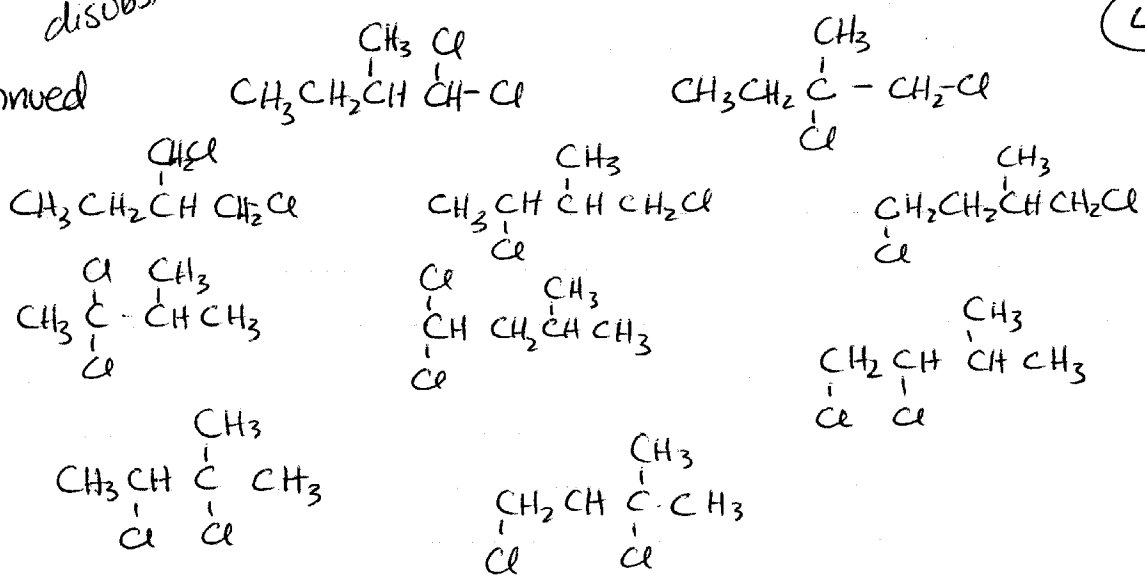
18. $CH_3CH_2CH(CH_3)CH_3 + Cl_2 \xrightarrow{light} CH_3CH_2CH(CH_3)CH_2{-}Cl + HCl$

4 monosubstituted

$CH_2(Cl)CH_2CH(CH_3)CH_3$ $\quad$ $CH_3CH_2C(Cl)(CH_3)CH_3$ $\quad$ $CH_3CH(Cl)CH(CH_3)CH_3$

18 continued

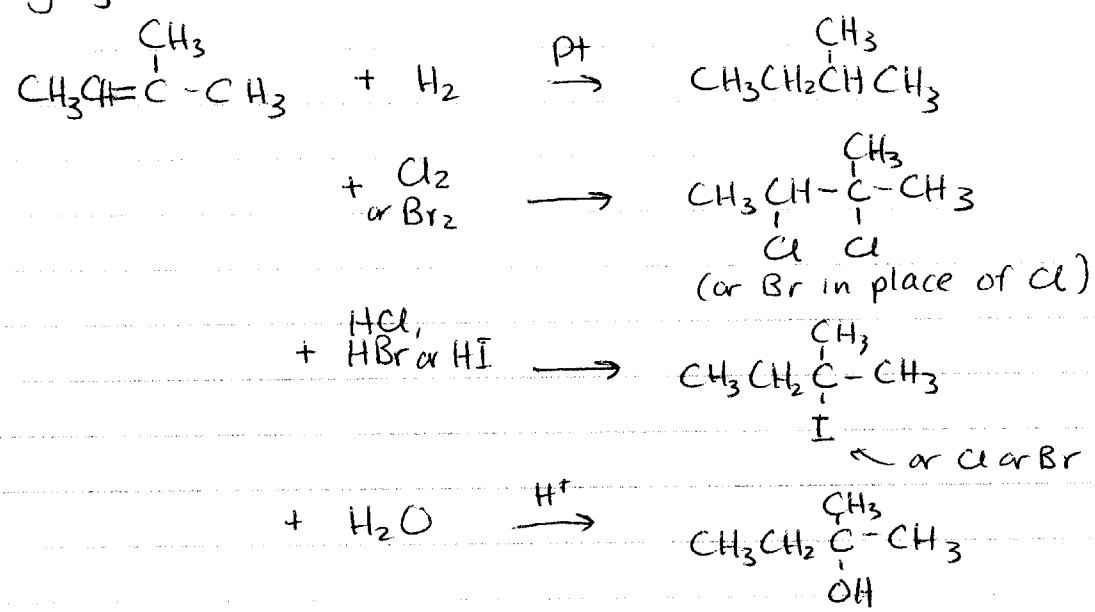
10 disubstituted



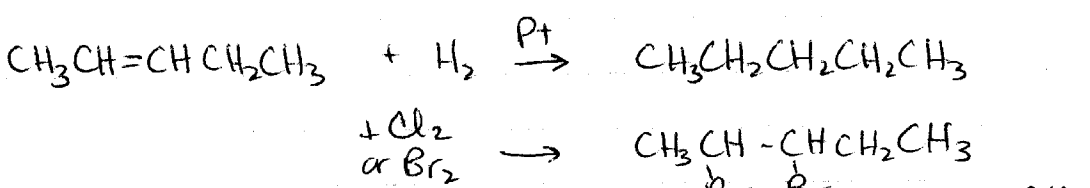
conditions needed: light or heat.

19. Applies to addition rxns to a double bond where the 2 C's of the double bond have different degrees of substitution, and at the same time the substance being added is asymmetric: H_2O or HCl or HBr or HI. The H adds to the C that already has more H's on it. the other substituent goes on the more highly substituted carbon.

20.



21.



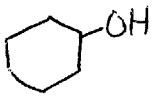
21. cont $CH_3CH{=}CHCH_2CH_3$ + HCl, HBr, or HI $\rightarrow$ $CH_3\underset{I}{C}HCH_2CH_2CH_3$

and $CH_3CH_2\underset{I}{C}HCH_2CH_3$

(2 products)
(or Br, Cl in place of I)

$+ H_2O \xrightarrow{H^+}$ $CH_3\underset{OH}{C}HCH_2CH_2CH_3$

and $CH_3CH_2\underset{OH}{C}HCH_2CH_3$

22.  + H_2O $\xrightarrow{H^+}$ 

one product
(symmetric reactant)

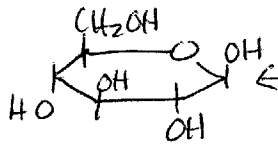
23. CH_3CH_2OH + $CH_3CH_2\overset{O}{\overset{\|}{C}}CH_3$ $\rightleftharpoons$ $CH_3CH_2\overset{OH}{\underset{CH_3}{C}}{-}OCH_2CH_3$

hemiacetal

above product + CH_3CH_2OH $\overset{H^+}{\rightleftharpoons}$ $CH_3CH_2\overset{OCH_2CH_3}{\underset{CH_3}{C}}{-}OCH_2CH_3$ + H_2O

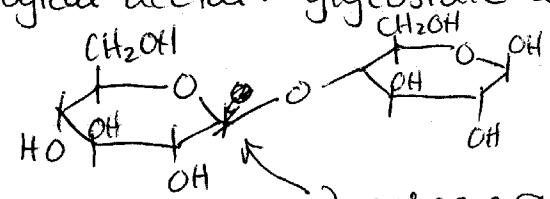
acetal

biological hemiacetal: ring form of a monosaccharide

ex: 

alcohol + ether group on same carbon.

biological acetal: glycosidic bond between sugars



2 ether groups on same carbon.

24. $CH_3\overset{OH}{C}HCH_2CH_2CH_3$ $\xrightarrow[\text{heat}]{H_2SO_4}$ $CH_3CH{=}CHCH_2CH_3$ + H_2O major product (more highly substituted double bond)

$CH_2{=}CHCH_2CH_2CH_3$ minor product

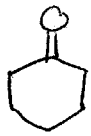
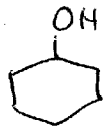
<u>dehydration</u> rxn

25. a) $CH_3CH(OH)CH_2CH_2CH_3 \xrightarrow{[O]} CH_3C(=O)CH_2CH_2CH_3$ 2-pentanone

b) $CH_3CH_2CH_2CH_2CH_2OH \xrightarrow{[O]} CH_3CH_2CH_2CH_2C(=O)H \xrightarrow{[O]} CH_3CH_2CH_2CH_2C(=O)OH$

pentanal pentanoic acid

c) $CH_3C(CH_3)(OH)-CH_2CH_2CH_3 \xrightarrow{[O]}$ NR (3° alcohols can't be oxidized – can't have 5 bonds to C.)

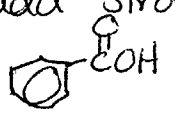
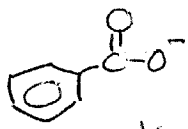
d)  $\xrightarrow[2.\ H_3O^+]{1.\ NaBH_4}$  cyclopentanol

e) $CH_3CH_2CH_2CH_2CH_2C(=O)H \xrightarrow[2.\ H_3O^+]{1.\ NaBH_4} CH_3CH_2CH_2CH_2CH_2CH_2OH$

1-hexanol

f) $\xrightarrow{[O]} CH_3CH_2CH_2CH_2CH_2C(=O)OH$ hexanoic acid

26. add strong base to it to deprotonate it

 + NaOH $\longrightarrow$  + H_2O

ionic – much more soluble in water!

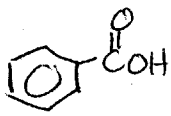
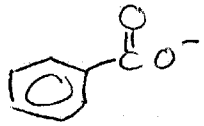
sodium benzoate

27. $CH_3CH_2NH_2 + H_2O \rightleftharpoons CH_3CH_2NH_3^+ + OH^-$

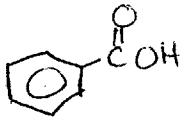
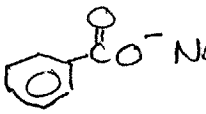
ethylammonium ion hydroxide ion

$CH_3CH_2NH_2 + HCl \longrightarrow CH_3CH_2NH_3^+\ Cl^-$

methylammonium chloride

28.  + $H_2O \rightleftharpoons$  + H_3O^+

benzoate ion hydronium ion

 + NaOH $\longrightarrow$  + H_2O

sodium benzoate

29. Hydrolysis: water is added, bond breaks, splits into two (or more) molecules. Examples: amide and ester bonds can be hydrolyzed.
Hydration: water is added to a double bond. An alkene group is converted to an alcohol group.

30 a. $CH_2=CH_2 \rightarrow\rightarrow CH_3\overset{O}{\overset{\|}{C}}H$

$CH_2=CH_2 + H_2O \xrightarrow{H^+} CH_3CH_2OH \xrightarrow{[O]} CH_3\overset{O}{\overset{\|}{C}}H$

1. hydration 2. oxidation (hard to stop here though..)

b. $CH_3\overset{CH_3}{\underset{OH}{C}}CH_3 \rightarrow\rightarrow CH_3\overset{CH_3}{C}HCH_3$

$CH_3-\overset{CH_3}{\underset{OH}{C}}-CH_3 \xrightarrow[\text{heat}]{H_2SO_4} CH_2=\overset{CH_3}{C}-CH_3 + H_2O$

1. dehydration

$CH_2=\overset{CH_3}{C}-CH_3 \xrightarrow[Pt]{+H_2} CH_3\overset{CH_3}{C}HCH_3$

2. hydrogenation

c. $CH_3CH_2CH=CH_2 \rightarrow\rightarrow CH_3CH_2\overset{O}{\overset{\|}{C}}CH_3$

$CH_3CH_2CH=CH_2 + H_2O \xrightarrow{H^+} CH_3CH_2\overset{OH}{C}HCH_3 \xrightarrow{[O]} CH_3CH_2\overset{O}{\overset{\|}{C}}CH_3$

1. hydration (one product - Markovnikov) 2. oxidation

d. $CH_3CH_2CH_2OH \rightarrow\rightarrow CH_3CH_2\overset{O}{\overset{\|}{C}}NH_2$

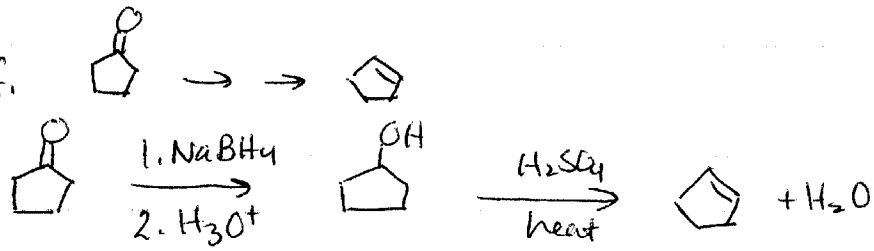
$CH_3CH_2CH_2OH \xrightarrow{[O]} CH_3CH_2\overset{O}{\overset{\|}{C}}H \xrightarrow{[O]} CH_3CH_2\overset{O}{\overset{\|}{C}}OH + NH_3 \rightarrow CH_3CH_2\overset{O}{\overset{\|}{C}}NH_2$

1. oxidation (continued oxidation) 2. amidation

e. $CH_3CH_2CH_2CH_2\overset{O}{\overset{\|}{C}}H \rightarrow\rightarrow CH_3CH_2CH_2CH=CH_2$

$CH_3CH_2CH_2CH_2\overset{O}{\overset{\|}{C}}H \xrightarrow[2.\ H_3O^+]{1.\ NaBH_4} CH_3CH_2CH_2CH_2\overset{OH}{C}H_2 \xrightarrow[\text{heat}]{H_2SO_4} CH_3CH_2CH_2CH=CH_2 + H_2O$

1. reduction 2. dehydration

30 f. 

① reduction ② dehydration

g. $CH_3CH_2CH_2\overset{O}{\overset{\|}{C}}H \rightarrow\rightarrow CH_3CH_2\underset{Br}{C}H\underset{Br}{C}H_2$

$CH_3CH_2CH_2\overset{O}{\overset{\|}{C}}H \xrightarrow[2.\ H_3O^+]{1.\ NaBH_4} CH_3CH_2CH_2CH_2OH \xrightarrow[heat]{H_2SO_4} CH_3CH_2CH{=}CH_2 + H_2O$

① reduction ② dehydration

$CH_3CH_2CH{=}CH_2 + Br_2 \longrightarrow CH_3CH_2\underset{Br}{C}H\underset{Br}{C}H_2$

③ bromination

31. 16-C saturated CC|CC|CC|CC|CC|CC|CC|CC

7 breaks - 7 cycles of β oxidation
8 molecules acetyl CoA formed

β oxidation −2 ATP activation
7 cycles 7 NADH × 3 ATP = 21
7 $FADH_2$ × 2 ATP = 14

8 acetyl CoA
Steps 3,9,8 3 NADH × 8 × 3 ATP = 72 ATP
6 1 $FADH_2$ × 8 × 2 ATP = 16
5 1 ATP × 8 = 8 ATP
129 ATP total

32. Diunsaturated: 2 double bonds in chain.
doesn't need to do step 1 in β-oxidation twice, so 2 $FADH_2$ <u>less</u> than otherwise.

16 C C C|C C|C C|C C|C C|C C|C C|C C

again 7 breaks - 7 cycles β ox
8 molecules acetyl CoA

7. β-ox −2 ATP activation
7 NADH × 3 = 21 ATP
7 − 2 $FADH_2$ = 5 × 2 = 10 ATP

2 double bonds

8 acetyl CoA
Steps 3,4,8 3 NADH × 8 × 3 ATP = 72
6 1 $FADH_2$ × 8 × 2 ATP = 16
5 1 ATP × 8 8 ATP

125 ATP total.

33. Glycolysis
Step 10 1 ATP 1 ATP
Pyr → ac CoA 1 NADH × 3 3
CAC Step 3,4,8 3 NADH × 3 9
5 1 ATP 1
6 1 $FADH_2$ × 2 2

16 ATP

34. a. DNA - stores genetic information
b. RNA - helps to express genetic info. mRNA carries code from DNA to ribosome, where proteins are formed according to the code. tRNA molecules interpret the genetic code and deliver the appropriate amino acid to the growing protein chain.
c. proteins - many functions. Some are enzymes that catalyze biochemical rxns. Some have a structural function. ~~Some~~ one transports O_2 through blood. (many other functions) see notes
d. enzymes are catalysts for biochemical rxns.
e. vitamins can be coenzymes that are needed for

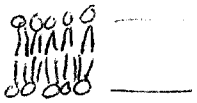
34e. certain ~~pro~~ enzymes to be functional. Other vitamins can act as antioxidants, which protect our molecules from oxidation.

f. starch – storage form of glucose. Can be hydrolyzed to provide glucose for energy. we (plants) eat starches

g. glycogen - storage form for glucose in animals. Stored in liver. Can be hydrolyzed to provide glucose for energy.

h. triacylglycerols – fats - another storage form of energy. can be hydrolyzed to glycerol + fatty acids, which can be oxidized to provide lots of energy

i. glycerophospholipids - major component of cell membranes. have a charged end and a long nonpolar tail. Cell membranes consist of a bilayer of these molecules



Charged ends face exterior + interior surfaces of cell membrane. Long nonpolar tails point inside membrane.

35. Hydrolysis - add H_2O, break molecule into smaller molecules. (amides + esters can hydrolyze)

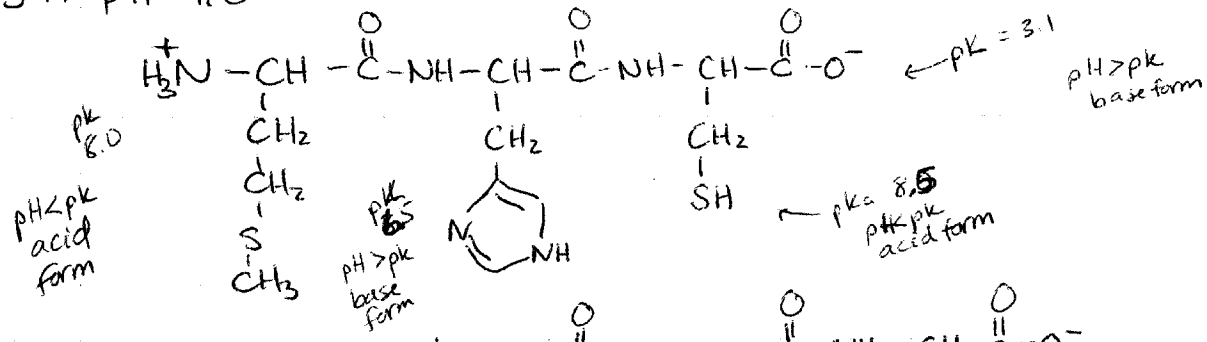
36. a. DNA + $x H_2O \rightarrow$ nucleotides (assuming complete hydrolysis)

b. starch + $x H_2O \rightarrow$ glucose

c. triacylglycerol + $x H_2O \rightarrow$ glycerol + fatty acids

d. protein + $x H_2O \rightarrow$ amino acids

37. pH 7.0



pH 4.0