(14) **Today**

Sections 2.7 – 2.11
Acids and Bases

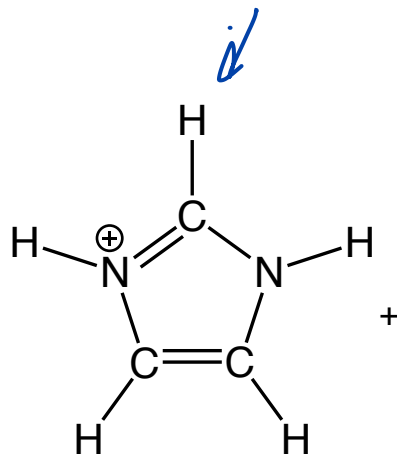**Next Class** (15)

Sections 2.7 – 2.11
Acids and Bases

Section 2.12
Noncovalent Interactions Between Molecules

Chapter 3

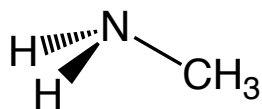(16) **Second Class from Today**

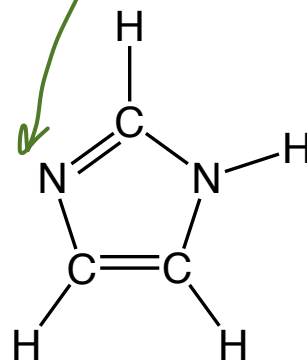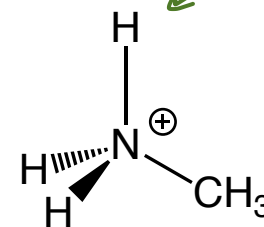**Third Class from Today** (17)

BL acid proton donor

the H is gone

here it is

BL base accepts the proton

imidazole

Methyl amine

Will it go?

yes, the protonated imidazole ring will donate it's proton to the methyl amine

a acid dissociation equilibrium constant

$$HA(aq) \rightleftharpoons H^+(aq) + A^-(aq)$$

pH?

$$pH = -\log[H^+]$$

.1 —··· .00000 .0000000001

$$K_a = \frac{[products]}{[reactants]}$$

$$K_a = \frac{[H^+][A^-]}{[HA]} = small?$$

pH = 7

$$[H^+] = 1 \times 10^{-7}$$
$$= 0.0000001$$

$$= \frac{small}{big} \quad \frac{1}{4}$$

a strong acid has a large or small K$_a$? Big

Large K$_a$ means lots of products $\frac{10000}{1}$

few reactions

the larger the K$_a$ the stronger the acid

$$pK_a = -\log K_a$$

3

$$pK_a = -\log K_a$$

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

$$-\log K_a = -\log \left(\frac{[H^+][A^-]}{[HA]} \right)$$

rearrange

$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

minimize changes in pH when acids or bases are added to the solution

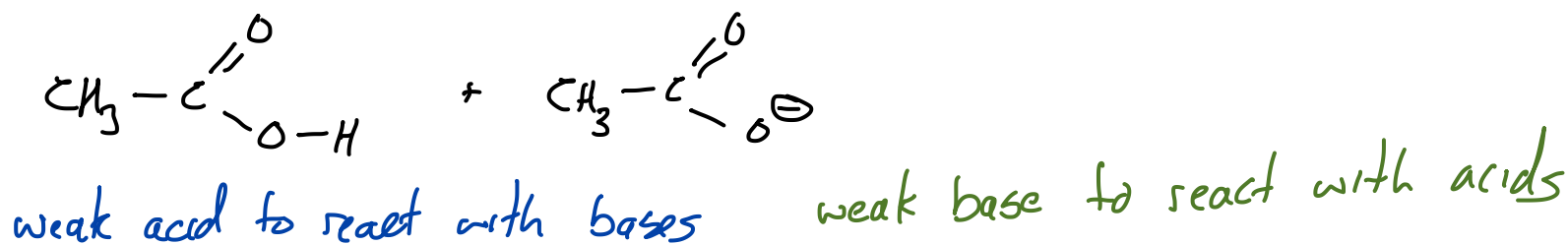pKa of acetic acid is 4.74

$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

Buffer has to be a base to grab onto H^+'s that are added

Buffer has to be an acid to grab the base that was added

Buffer must be a mix of an acid + base

$HCl + NaOH \longrightarrow H_2O + NaCl$ Strong acids + bases... nope

Mixtures of weak acids + weak bases make buffers

$CH_3 - C \overset{O}{\underset{O-H}{<}}$ + $CH_3 - C \overset{O}{\underset{O^\ominus}{<}}$

weak acid to react with bases   weak base to react with acids

Minimize changes in pH
when acids or bases are added
to the solution

pK$_a$ of acetic acid is 4.74

$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

Acetate buffer with a pH of 5 ?

$$5.00 = 4.74 + \log \frac{[A^-]}{[HA]}$$

$$0.26 = \log \frac{[A^-]}{[HA]}$$

$$10^{0.26} = \frac{[A^-]}{[HA]}$$

so now I know how much
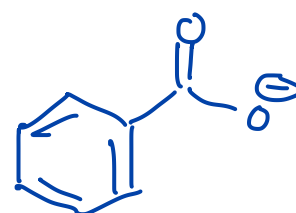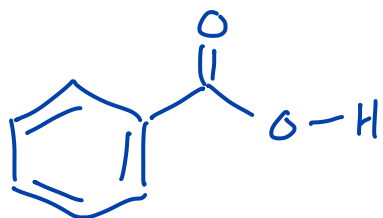A$^-$ I need for the
amount of HA I
chose

$$CH_3CO_2H \rightleftharpoons H^+ + CH_3CO_2^{\ominus}$$

$$K_a = 10^{-4.74}$$

5

benzoic acid

pK$_a$ of ~~acetic acid~~ is 4.20

the HH equation tells us which species dominates
at a given pH

$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

+ NaOH $\longrightarrow$
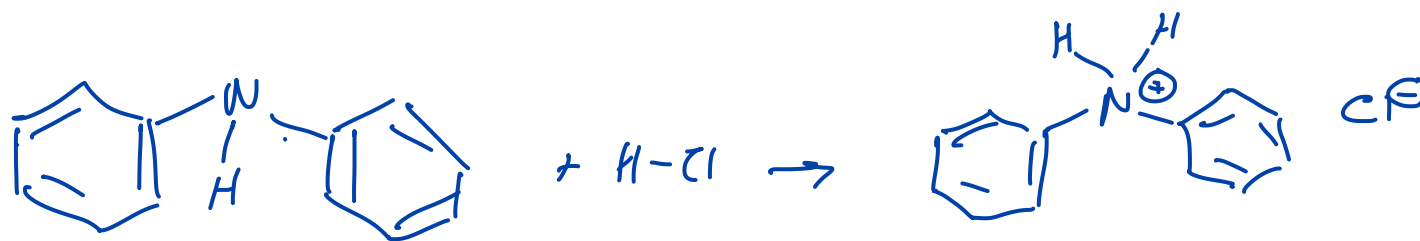
 Na$^{\oplus}$

H$_2$O

not particularly
water soluble

much more
water soluble

much more soluble
in organic solvents

$pH = 4.2 + \log \frac{[A^-]}{[HA]} \quad \frac{100}{1}$

$pH = 4.2 + 2$

$pH = 6.2$

Less Soluble in Water
More Soluble in Organic Solvents

Less Soluble in Organic Solvents
Increased Solubility in Water

acid? no

$CH_4 \rightarrow CH_3^{\ominus} + H^{\oplus}$ **? no**

$pk_a = 50$ ... $k_a = 10^{-50}$

NH_3

smaller/more negative pk_a is the stronger acid

H_2O

$pk_a = 3.18$ $k_a = 10^{-3.18}$ stronger

$HF \rightleftharpoons H^+ + F^-$

$-log\, k_a = pk_a$

pKa's   CH₄, ~50   NH₃, ~36   H₂O, 15.6   HF, 3.18
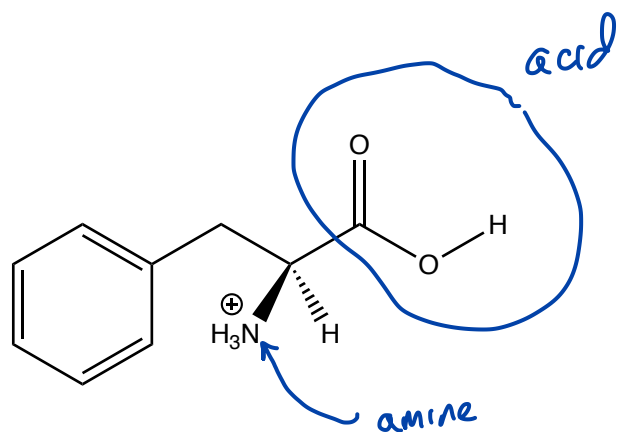
acid

phenylalanine

pK$_a$ = 1.83

stronger acid

K$_a$ $10^{-1.83}$
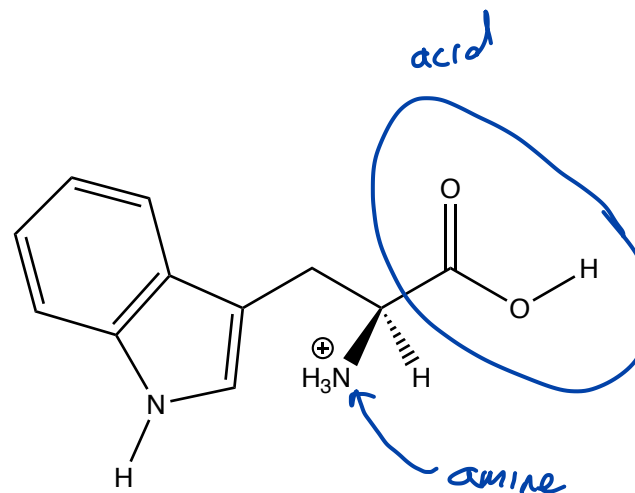
acid

tryptophan

pK$_a$ = 2.83   ammonium ion

amine

K$_a$ $10^{-2.83}$

$NH_4^+ \rightleftharpoons NH_3 + H^+$

pK$_a$ values from Organic Chemistry, 10th ed. McMurry, (2023) openstax.
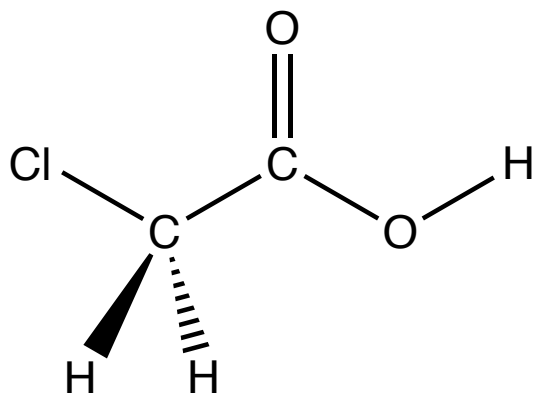
pK$_a$ = 2.87

stronger

3.18

pK$_a$ = ~~2.87~~

weak but very
dangerous

H$^+$ (F$^-$)Ca^{2+}

CaF$_2$
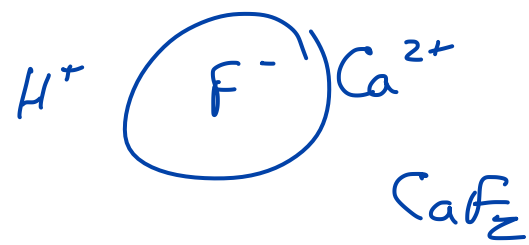
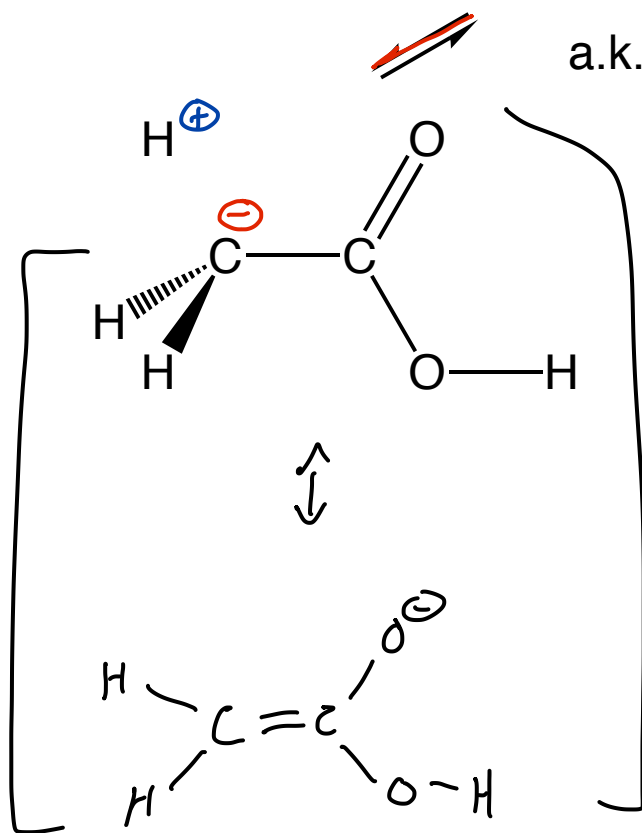Which is the acidic H⁺ in acetic acid (HC₂H₃O₂)?
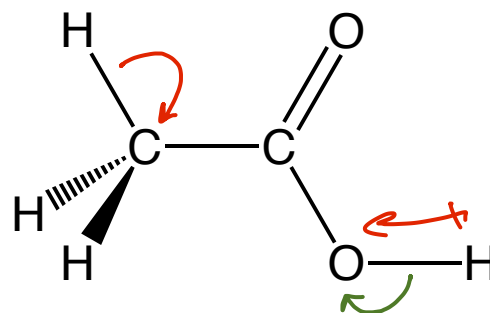
a.k.a. CH_3CO_2H

O atom has 8 !p⁺ in its nucleus and is betterable to support the ⊖ charge
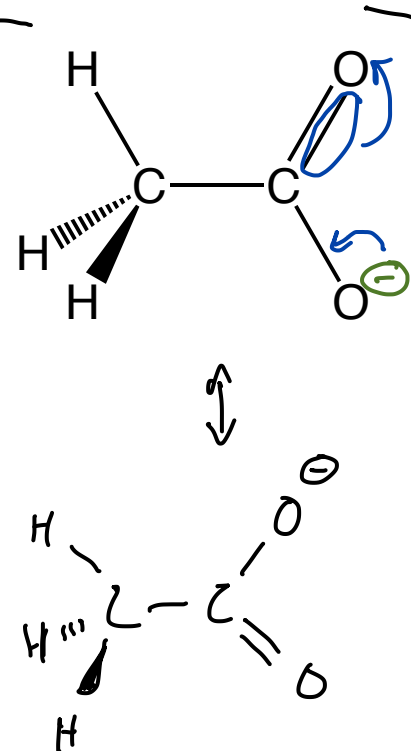
The atom that supports the ⊖ charge better is the one where the bond to the H⁺ will break

?

The one that leaves the more/most stable base behind