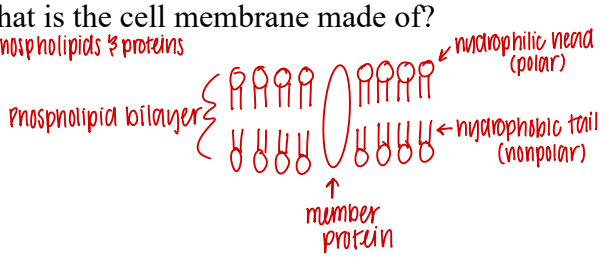
Exam 1 Test Prep
09/24

- Define Biochemistry
  - the chemistry of life
  - the study of chemical properties/composition/structure & function of living organisms

- What is the cell membrane made of?
  - phospholipids & proteins



- What type of organism(s) have a cell wall? What are their respective cell walls made of?
  - prokaryotes: peptidoglycan
  - plants: cellulose
  - fungi: chitin

- Define permeable and semi-permeable
  - permeable: molecules pass through in an un-regulated fashion
  - semi-permeable: molecules pass through in a regulated fashion

- What are the five classifications of molecules? (Think hierarchy)

held together typically by covalent bonds

- low molecular weight. molecules 20-100 daltons
  - H_2O, O_2, N_2, PO^{-3}
- metabolic intermediate. 50-250 d
  - pyruvate, α-keto acid, acetate
- monomeric building blocks. 100-600 d
  - amino acids, fatty acids, monosaccharides, nucleotides
- biopolymers or macromolecules. 10^3-10^6 d
  - proteins, lipids, polysaccharides, nucleic acids

} all cells have these

- macromolecular complexes 10^6-10^{12} d
  - nucleoproteins, lipoproteins, glycoproteins
    - ex: chromosome (DNA) ribosomes (RNA)
    - ex: membranes
    - ex: cell wall of prokaryotic cells

→ continues to organelles → cells → tissues

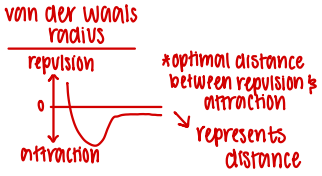
- Name a few essential ions.

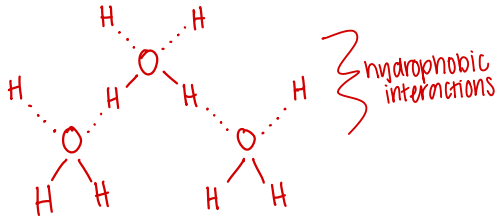
calcium (Ca^{2+})
potassium (K^+)
sodium (Na^+)
chloride (Cl^-)
magnesium (Mg^{2+})
iron ($Fe^{2+/3+}$)
protons (H^+) → hydrogen without an electron

- What are the 6 essential atoms?
  - oxygen
  - sulfur
  - phosphorous
  - nitrogen
  - hydrogen
  - carbon

- What are the five molecular interactions? Define them.

- van der waals: weakest, fluctuation of charges... a brief, transient dipole moment experienced by all atoms
- hydrophobic interaction: weak, avoids / doesn't interact with water, VDW
- hydrogen bonds: weak, form bonds with electronegative atoms such as Fluorine, oxygen & nitrogen
- ionic bonds: weak, full charge ions, the electrostatic interaction between ions of opposite charges
  - ex: $Na^{\oplus}$ $Cl^{\ominus}$
- covalent bonds: strong, the sharing of electrons between atoms





- Define Redox Reaction
  - the transfer of electrons between atoms

- Define Bronsted Acid and Bronsted Base.
  - BA: proton donor
  - BB: proton acceptor

- How do we know if an acid is weak? How do we determine if an acid is a strong weak acid of a weak weak acid?
  - pKa!!
  - low pKa = stronger
  - high pKa = weaker

- Derive the Henderson Hasselbach equation.

acid, base, conj base, conj acid

$AH + B \longrightarrow A^{\ominus} + B^{\oplus}H$

1) $K_{eq} = \frac{[products]}{[reactants]}$ *water would not be included because its negligent

2) $K_a = \frac{[A^{\ominus}][^{\oplus}H]}{[HA]}$

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

4) $pH = -\log[H^{\oplus}]$

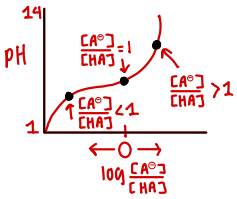
5) $-\log K_a = -\log\left(\frac{[A^{\ominus}]}{[HA]}\right) - \log[H^{\oplus}]$

6) $-\log K_a = pK_a$

7) $pK_a = -\log\left(\frac{[A^{\ominus}]}{[HA]}\right) + pH$

8) $pH = pK_a + \log\left(\frac{[A^{\ominus}]}{[HA]}\right)$

- What is the significance of the pKa dissociation curve?



as the concentration of base increases, so does the pH!!

as the concentration of acid increases, the pH decreases.

* make sure you know how to solve for the ratio of $\frac{[base]}{[acid]}$!!
— these are located in your book!!

•if $pK_a = pH$, then ratio of acid & base are equal.... also 1 ☺
•you can change the concentration of acid or base before significantly changing the pH

- Label the conjugate pairs.

$H_2CO_3 + OH^{\ominus} \rightleftharpoons HCO_3^{\ominus} + H_2O$

H_2CO_3: acid; $OH^{\ominus}$: base; $HCO_3^{\ominus}$: CA; H_2O: CB

$HCO_3^{\ominus} + S^{2-} \rightleftharpoons HS^{\ominus} + CO_3^{2-}$

$HCO_3^{\ominus}$: acid; S^{2-}: base; $HS^{\ominus}$: CA; CO_3^{2-}: CB

- Define what it means to be a strong acid and a weak acid
  - strong acid: total dissociation.... gives up $H^{\oplus}$ ions easily
    ex: $HCl \rightarrow H^{\oplus} Cl^{\ominus}$
  - weak acid: partial dissociation, can reassociate
    ex: acetic acid
    $HCH_3COO \rightleftharpoons H^{\oplus} + CH_3COO^{\ominus}$

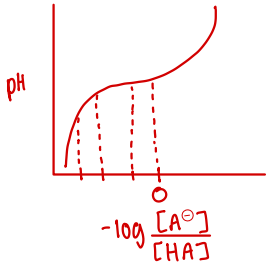
- Define pKa
  - weak acid dissociation constant
  - equals concentration $[HA] = [A^{\ominus}]$ } conjugate pair

- Define pH and list the formula used to calculate it
  - pH: negative log of $H_3O^{\oplus}$ in solution

$pH = -\log[H_3O^{\oplus}]$

$H_3O^{\oplus} = H^{\oplus}$

- What is a buffer?
  - buffer: resists change in pH
    - must be near pKa to have buffer capacity
    - } you must have a conjugate pair to make a buffer



Buffer range = ± 1 pH unit around pKa
plateau = buffer

- Calculate the pH of a buffer solution containing 0.1 M of sodium acetate and 0.2 of acetic acid. pKa of acetic acid = 4.76

  - $pH = pKa + \log \frac{[base]}{[acid]}$

$pH = pKa + \log \frac{[0.1]}{[0.2]}$

$pH = 4.46$

- Calculate the pH of a solution containing 150 mL of 0.3 M Sodium Benzoate and 220 mL of 0.4 M Benzoic acid, AFTER the addition of 42 mL of 0.1 M KOH (KOH is a strong base). pKa of benzoic acid is 4.2

$M = \frac{mol}{L_x}$

$0.3 = \frac{x}{.15}$

mol = .045 sodium benzoate

$M = \frac{mol}{L_x}$

$0.4 = \frac{x}{.22}$

mol = .088 benzoic acid

$M = \frac{mol}{L_x}$

$0.1 = \frac{x}{.042}$

mol = .0042 KOH

$pH = pKa + \log \frac{base}{acid}$

$pH = 4.2 + \log \frac{.045 + .0042}{.088}$

pH = 3.915

- From the question above, what is the pH difference between the solutions before the addition of KOH and after the addition of KOH? Did we exceed the buffering capacity of the solution?

$pH = 4.2 + \log \frac{0.045}{0.088}$ ← before

pH = 3.91

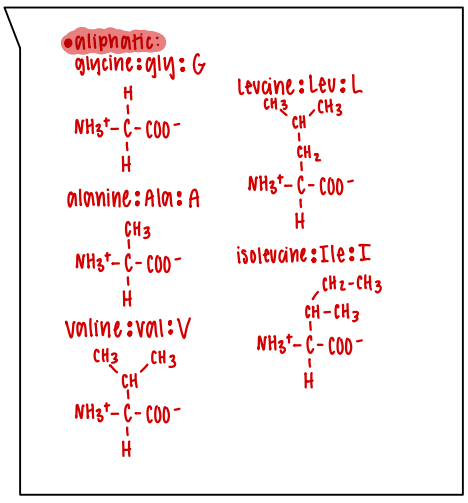
$pH_A - pH_B = 0.04$

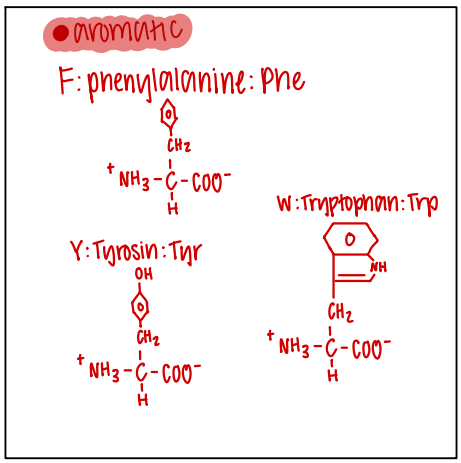
NO! pH difference = 0.04 which is within the buffering range

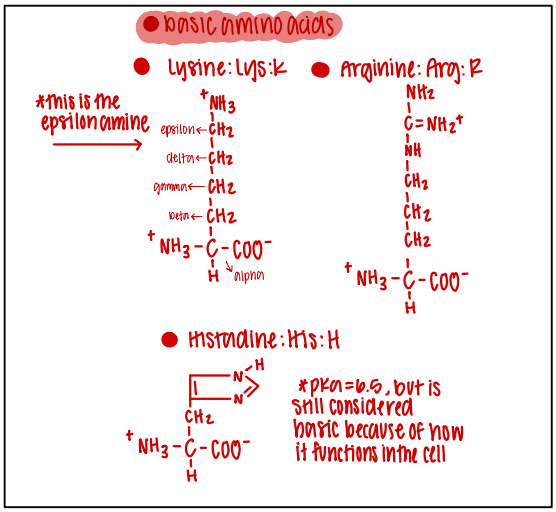
- In the general structure of an amino acid, what must be present?

1. amine group
2. carboxyl / carbonyl
3. alpha carbon
4. hydrogen atom
5. R group ⟶ this is what gives variability

- Draw all 20 amino acids, include their 3 letter & 1 letter codes.

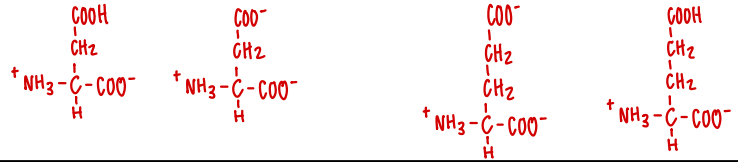






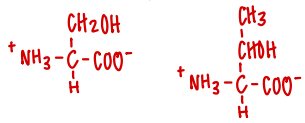
● acidic amino acids

● aspartic acid/aspartate : Asp : D ● glutamic acid / glutamate : glu : E



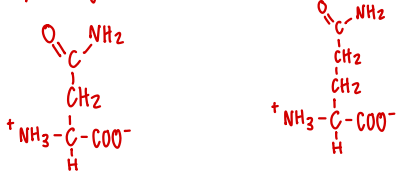
● hydroxyl AAs

● serine : Ser : S ● Threonine : Thr : T



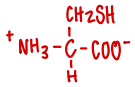
● amide amino acids

● asparagine : asn : N ● glutamine : Gln : Q

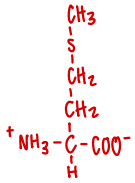


● sulfur AAs

● cysteine : cys : C

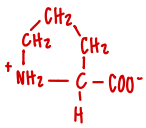


● methionine : met : M

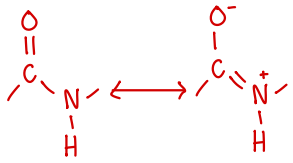


*proline does NOT belong to a specific group. aka "imino acid"

● proline : pro : P



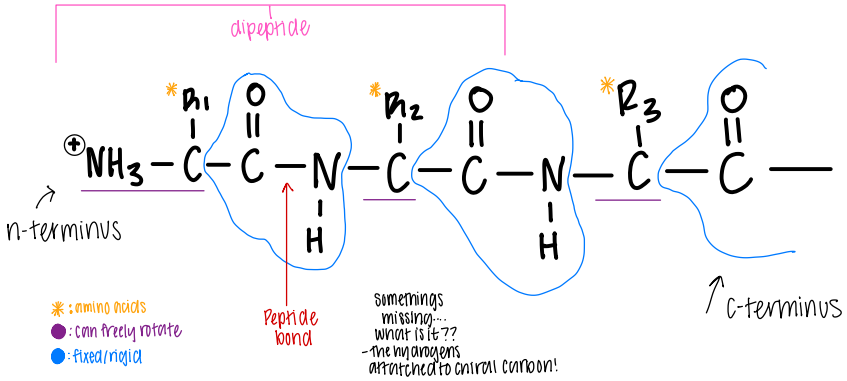
- What is a peptide bond?
  - holds amino residues together
  - covalent bond
  - special type of amide bond



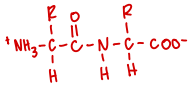
What stabilizes a peptide bond?
- resonance
- carbonyl & amide portions are trans to each other

- What is a dipeptide?
  - two amino acids linked together

- Using the image below, explain what you see, and identify the need-to-know structures.



- Define primary structure. Include an example.
  - a simple amino acid sequence



- Define secondary structure.

amine group, carbonyl group

– hydrogen bonds between >N-H and >C=O of peptide backbone on same polypeptide

ex: beta-pleated sheets & alpha helix

- Define tertiary structure.

tertiary: interactions between R groups on the same polypeptide

- covalent, ionic, van der walls, hydrogen, + ALL other types of interactions/bonds are present!

- Define quaternary structure.

quaternary: when two or more polypeptides (subunits) interact. *one subunit = one polypeptide

- all 5 bonds are able to be present. covalent is rare.

- What amino acid forms disulfide bridges?

- cysteine

$-CH_2-S-H + H-S-CH_2- \xrightarrow{2e^-} -CH_2-S-S-CH_2$

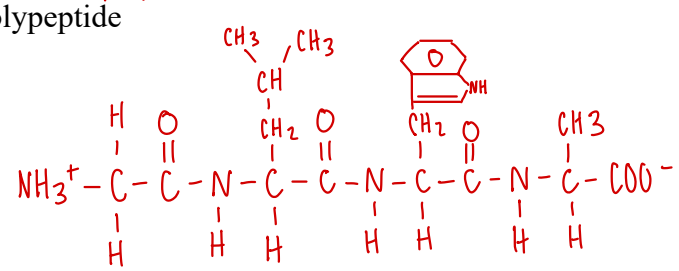
- How are subunits distinguished?

- greek letters

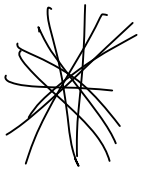
- What is the function of a protein? (most generalized answer you can think of)

all proteins bind some sort of molecules

- If given GLWA:
    a. Give the 3 letter code
        Gly-Leu-Trp-Ala
    b. Give the full amino acid name
        Glycyl-Leucyl-Tryptophyl-alanine
    c. Draw the polypeptide



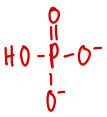
- What are proteins analogous to?
    - jello shots!



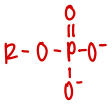
something I left out (on accident)

- not included in your kahoot for functional groups, are your phosphate groups! make sure you know how to draw these AND provide their shorthand!!!

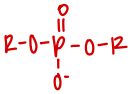
- inorganic phosphate: Pi



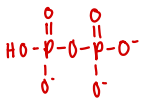
monophosphate: R-Ⓟ



phosphodiester: R-Ⓟ-R



- pyrophosphate: PPi



diphosphate: R-Ⓟ-Ⓟ