Amino acids

You are required to know and identify the 20 amino acids : their names, 3 letter abbreviations and their structures.

If you wanna make any classification in the world, you have to find what's different

Amino acids are similar in α- carbon, H, carboxylic acid group and amino group

What's different in amino acids is the R-group and amino acids are either polar or non polar

Polar ones can be charged or uncharged

Charged amino acid can be either negatively charged (acidic) or positively charged (basic)

Negatively charged (acidic) : they are either one of two : aspartic acid or glutamic acid

A before G Alphabetically so aspartic acid is smaller in size (It has 2 carbon units at the R group)

Glutamic acid has 3 carbon units at R group

-Basic ones : they do have a positive charge in their side chain (R group)

Positive charged (basic)

3 basics either it has a cycle (five members ring) or it doesn't have a cycle

If it has a cycle (five members ring) then it's histidine

If the side chain has not a cycle then it's either lysine or arginine

Lysine has one nitrogen

arginine has 3 nitrogens, one of them is titratable

***polar but uncharged**

(similar to acidic ones) if we remove the acidic group (O-) and replace it by nitrogen >> amide bond

Aspartic acid > replacing O by N and form amide bond > Asparagine

glutamic acid > replacing O by N and form amide bond > glutamine

3 amino acids that have hydroxyl group in their side chain:

Tyrosine has phenyl group (benzene ring) attached to OH

Serine has one carbon unit

Threonine has 3 carbon units

S before T alphabetically so serine is smaller than Threonine

A before G Alphabetically >> aspartic acid < glutamic acid

S before T alphabetically >> serine < Threonine

Sulfur is reactive (polar) when it's free , peripheral in the molecule which means it attaches to one carbon unit and the other is H

SH (thiol group)

When it attaches to 2 carbon units from both sides then it's not reactive (not polar)

S-C (high energy bond)

Co-enzyme A : large structure has cystine (SH group) free reactive sulfur group, when it's broken it will give you high energy compared to the energy of the ATP, so it's energy molecule inside the body

Cystine is the only amino acid that has thiol group, it's important to disulfide bridges

Non-polar :

Phenylalanine = tyrosine – hydroxyl group

When you add hydroxyl group to phenylalanine, it will become tyrosine (this is how we get tyrosine in the body)

Naming of enzymes: substrate + type of reaction + ase

The enzyme that catalysis this reaction (convert Phenylalanine to tyrosine) addition of hydroxyl group to Phenylalanine : Phenylalanine hydroxylase

This enzyme can be diffident (phenylketonuria)

Phenylalanine increase inside patients' bodies, when it gets high it will cause problem in the maturation of the brain … those patient must not take foods which contain Phenylalanine especially diet sodas .. Phenylalanine sweeten diet foods

2 amino acids contain sulfur :

reactive Thiol group: cystine

sulfur attached from both ends with carbon (not reactive, non polar) : methionine

smallest amino acid : glysine (R-group is H)

Largest amino acid: tryptophan (It has 2 cyclic rings : six member ring, five member ring)

-Amino acids which have hydrocarbon content:

-Alanine : one carbon unit (methyl group)

-Valine : 3 carbon units

-Leucine and isoleucine (isomers) : both of them have 4 carbon units

-Proline : side chain forms ring (cycle) with the nitrogen of the back bone

Amino acid (primary amine) : nitrogen of the amino group attaches to one carbon

imino acid (secondary amine): nitrogen of the amino group attaches to 2 carbons

proline is not an amino acid, actually chemistry wise it's imino acid

naturally occurring amino acids of the L type (left handed ones)

Please check the slides !

***posttranslational modification:**

what do we mean by posttranslational modification ??

any modification that can occur to the amino acid after the process of translation

what posttranslational modification that can occur to amino acids ??

1. **Two amino acids (proline and lysine) , both of those amino acids can be hydroxylated (addition of hydroxyl group)**

   In collagen, cross links formed between hydroxyl proline with another hydroxyl proline, and between hydroxylysine and another hydroxyl lysine (without hydroxyl group they can't form those cross links)

   Lysyl hydroxylase and prolyl hydroxylase are enzymes which add hydroxyl group to those amino acids and they can't work without the presence of vitamin C

   Scurvy (deficiency of vit C)

   Collagen exist mainly in the capillaries, and deficiency of vit C make it's fibers not connected to each other (weak collagen) , this can lead to rapture of the capillaries, spontaneous bleeding of gums and underneath

2. Thyroxine : hormone of thyroid gland, it's a modification of tyrosine

******Titration of amino acids:**

Titration: It's the gradually increase of PH so as titratable groups can loss their protons in the solution

At which PH titratable groups will lose or gain H

All amino acids are zwitterions in their nature

Zwitterions: molecules that have a negative charge and a positive charge at the same time and the total charge on them is zero

Amino acids => positive amino group + negative carboxylic group

Any amino acid has at least 2 titratable groups (amino and carboxylic)

Some of the amino acids have titratable side chains (5 amino acids) negatively and positively charged

Isoelecrtric point (pl) :

The PH point at which the total charge of any molecule is zero

How to calculate Isoelecrtric point ??

You will start titrating any amino acid, acidic group COOH (with H) , at a certain PH it will lose it's proton COO-

PKa1: it's the PH at which this group will lose it's proton

Also amino group has one extra proton NH3+ , we increase the PH at which this group will lose It's proton PKa2

Isoelecrtric point (pl)= (PKa1 + PKa2)/2

General speaking:

all acidic groups (carboxylic acid group) will lose their proton at a PH below 6

amino group will lose it's proton at a PH above 8

amino group inside a ring (commonly case in histidine) => it's titration will be around PH = 6

if the molecule has 2 carboxylic groups in the side chain and in the back bone. Which one will lose It's proton first ??

PKa of the carboxylic group close to amino group (back bone) has lower PKa than free carboxylic group in the side chain

PKa of an amino group close to carboxylic group < PKa of free amino group in the side chain

Priority of loss proton:

Carboxylic acid (back bone) followed by carboxylic acid (side chain) amino group (inside a cycle) followed by amino group (back bone) followed by amino group (side chain)

Calculation of the Isoelecrtric point in these cases :

When the total charge of the molecule is zero (PKa1: PKa before it, PKa2: PKa after it)

Isoelecrtric point (pl)= (PKa1 + PKa2)/2

This also applied to peptides, if they have sequence of amino acids, when the total charge of the molecule is zero, we apply the same equation

The peptide bond:

Connection of 2 amino acids between carbon and nitrogen (amide bond)

We can get an amide bond throw condensation reaction (polymerization process are condensation reaction)

It occurs by loss of water molecule so It's dehydration reaction

If you have 2 different amino acids. How many di-peptide type you can make ??

At least 2 di-peptides

Sequnse is very important in different amino acids, and it's not important if the functional groups are the same

Amino acids in life:

1. **Tryptophan can be modified inside the body to a compound called 5-hydroxytryptophan, it can be again modified to a 5- hydroxytryptamine (serotonin)**

Milk contains high amount of tryptophan

2. **Tyrosine by metabolism convert into l-dopa >> dopamine >> epinephrine**
   Derivatives of tyrosine called mono amines
   Mono amino oxidase enzyme breaks mono amines
   Depression patient given mono amino oxidase inhibitors (MAO inhibitors)