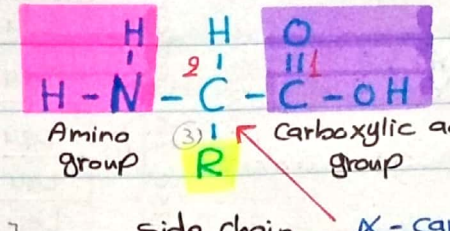
By: Rofida Awwad

[Amino Acids 1]

~ Biologically important organic molecules that contain both two functional groups

- carboxylic acid (-COOH)
- amino ($-NH_2$).

* We can differentiate between 20 standard amino acids from the side chain [R-group].



* Carboxylic group is [reference point]

- Side chain [R group] is specific to each amino acid.
- Amino group is attached to α- carbon (C_2).

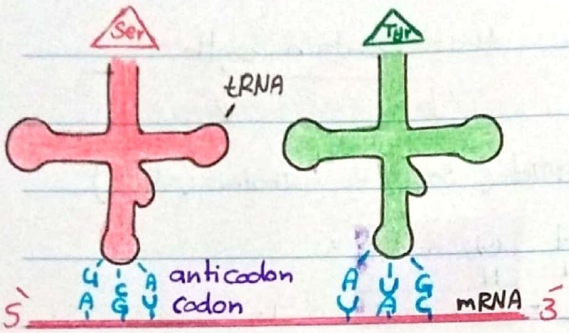
note Standard amino acids are called [α- amino acid] because the Amino group is attached to α- carbon (C_2).

- Biological significance of amino acids -

1- Amino acids are N- containing molecules.
2- The basic structural building units -monomers- of proteins.
3- Precursors of many biomolecules like neurotransmitters [non-Protein role].
4- They are also utilized as an energy source.

20 standard [canonical] amino acids which are encoded directly by triplet codons in the universal genetic code during in vivo protein synthesis process [mRNA translation].

~ Genetic code table ~



- standard يعني موجود في الجدول
- الجدول متفق عليه -

* The [20 standard] amino acids are known as [proteinogenic] or [netural] amino acids.

* proteinogenic [time of addition] added to the polypeptide chain ← أثناء [mRNA translation]

* netural [automatically] بشكل طبيعي ← يعني طالعين أنا حسب متى يترجم ببروتينات :)

2nd base in codon

1st base in codon	U	C	A	G	3rd base in codon
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	Stop	Stop	A
	Leu	Ser	Stop	TrP	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

كل هاد بجدول مش للحفظ

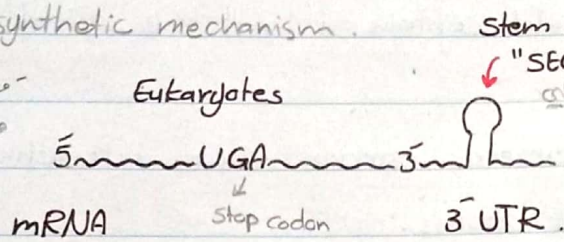
• Standard Amino Acids List •

- Histidine
- Isoleucine
- Leucine
- Methionine
- Phenylalanine
- Threonine
- Tryptophane
- Valine
- Lysine
- Arginine
- Asparagine
- Glutamine
- Glycine
- Proline
- Serine
- Tyrosine
- Alanine
- Aspartate
- cysteine
- Glutamate

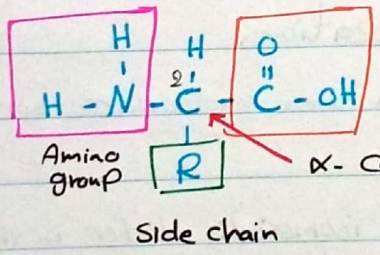
Standard Amino Acids

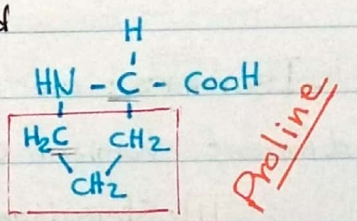
1- Proteinogenic and natural amino acids (the other proteinogenic amino acids N-formyl methionine, Pyrrolysine and selenocysteine are called non-standard or non canonical amino acids).

▷ they are added to the polypeptide chain during mRNA translation Process by unique synthetic mechanism.



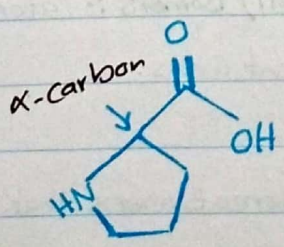
2- known as 2- , alpha- , or α-amino acids as the primary amino group ($-NH_2$) is attached to α-carbon [the carbon next to -COOH group]. Proline is an exception which has a secondary amino group ($-NH-$).





* في كل الـ standard amino acids الـ primary amino group هي اللي بترتبط بالـ α-carbon.

* الـ secondary amino group هي في Proline بس.

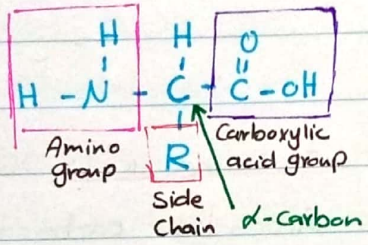


3. They are all chiral molecules [except glycine which has a chiral C] with L- stereochemical configuration (left-handed isomers).

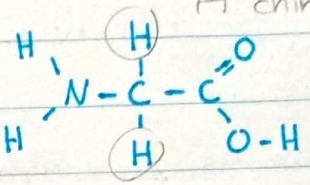
- Chiral objects : cannot be superimpased.
- A chiral objects : can be superimposed

. Chiral molecules should contain at least one chiral center (usually acarbon atom).

. Chiral carbon :- asymmetric carbon atom attached to 4 different groups of atoms.



A chiral



Glycine

Isomerization

- Isomers : are molecules with same molecular formula but different chemical structures.

[1] Stereoisomers (spatial isomers): differ in the configuration of atoms rather than the order of atomic connectivity.

[2] Constitutional (structural) isomers :- atoms and functional groups bind together in different ways.

* Enantiomers :- are two stereoisomers that are mirror images to each other but not superimposable.

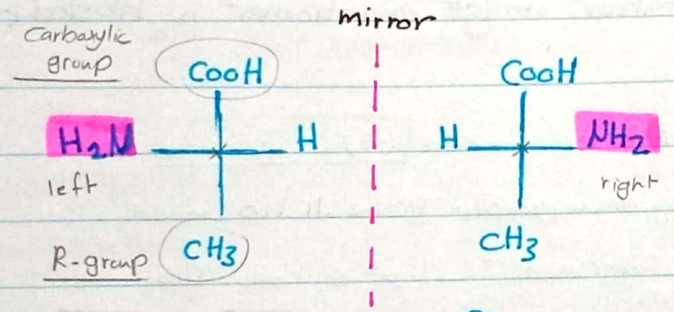
at least one chiral center

• D- (dexter) L-(laevus) Nomenclature system

Commonly used to assign the configurations (التكوين) in sugars [carbohydrates] and amino acids.

• As a rule of thumb: if the amino group is on the (right-hand side) of α-Carbon at fisher projection, the configuration is (D). If it is on the (left-hand side), the configuration is assigned as (L).

~ Fischer Projections of Amino Acids ~



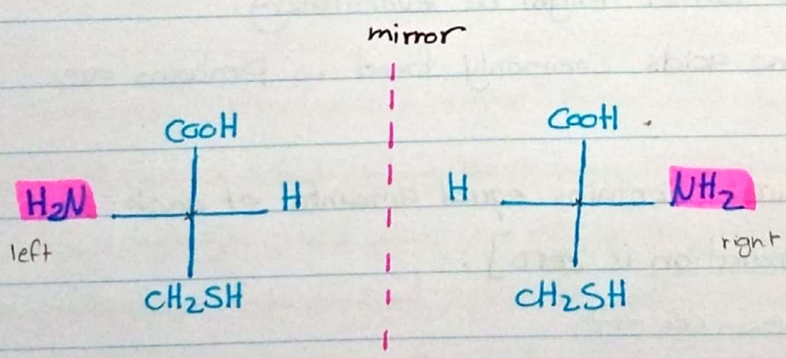
L- alanine D- alanine

~FISCHER PROJECTION~

• is one way commonly used to represent the structure of chiral molecules like Carbohydrates and amino acids.

غ كلاهما مرآة مينية

- [D] → التوأم الكامل
- [L] → التوأم الشنيع



L- cysteine D- cysteine

✓ Most naturally occurring sugars are D- isomers while most naturally occurring amino acids are L- isomers [amino acids of protein].

* أصلاً D مش موجود غ جسمي.

✓ D- amino acids polypeptides [right- handed isomers] are components of bacterial cell walls to resist digestion by other organisms.

(تقاوم)

- Optical Activity -

- Enantiomers are optically active and can rotate the Polarized light plane either clockwise or counterclockwise.

(مع عقارب الساعة ..... عكس عقارب الساعة)

- (+)/(–) nomenclature system :- * راجع الصورة في السلايد

If one enantiomer rotates the light clockwise, it is labeled (+) or (d) (dextrorotatory). The second mirror image enantiomer is labeled (–) or (l) (leavorotatory).

* Question :- What it does mean (+) L- Tyrosine ?!

- يعني هنا ال Tyrosine ال Amino group فيه جاي on the left-hand side

ولما احطوا في جهاز Polarimeter يلف عاليمين.

- D/L system should not be confused with +/- or d/l system.
  - for example : D- isomer might be levorotatory.
- 9 of 19 L- amino acids commonly found in proteins are dextrorotatory.
- Racemic mixture :- Contains equal amounts of each enantiomer [net rotation is zero].

  ← فيه rotation وهو zero

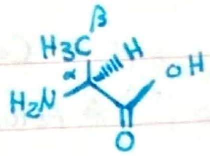
~ Amino Acids [>300] ~

- **Proteinogenic Amino Acids [23]**
  - [20] • Standard
  - [3] • Non-standard

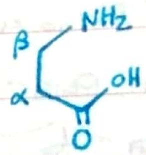
  - Protein role يتم اضافتهم
  إلى سلسلة البروتين يتم اثناء
  mRNA translation Process.

- **Non-Proteinogenic Amino Acids**
  - • non-Protein role السبقة الكبيرة
    - functional هم بحد ذاتهم -
    - مثل [GABA] ، [Carnitine].
    - non-standard =
  - • Protein role [hydroxy Proline].
    - • هي بسيطة non-proteinogenic
    - يدخل في تكوين سلسلة البروتين
    - لكن متى؟! بعدما
    - يتصنع البروتين ويروح إلى ال
    - Cytoplasm ويروح على منطقة
    - فيه وحدة ذي بيصنع اسمو
    - [Post-translational system]
    - هاد بروح حسب اوامر الخلية بضيف
    - functional group معينة على الاحماض الأمينية الأساسية
    - وبالتالي بغير اسمها ، مثلاً : Proline [standard-aminoacid] بنضاف اثناء Proteinogenic
    - عملية mRNA translation ، إذا هذا البروتين اللي فيه بروتين رايح على connective tissue مثلاً تيجي
    - الخلية وتوديه على المصنع هاد و تحطلوا هي بروتين منضافلي عليه (OH) فبيصير
    - Hydroxy Proline فهاد اصبح تصنيفو مختلف صار non-proteinogenic/non-standard
    - with protein role تم إضافة بعدما تصنع

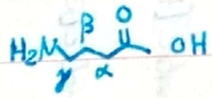
- • α, β, γ and δ amino acids.



α-alanine



β-alanine



γ-amino butyric acid [GABA].

* **β-aminoacids** are non-proteinogenic with **β-alanine** is the only common naturally occurring β-amino acid. **β-alanine** is used in plants and microorganisms in the synthesis of pantothenic acid (vitamin B_5).

* unlike α-peptides, The β-peptides are artificial peptides used in some antibiotics to counter resistance as they are more stable against proteolytic degradation.

Categories of standard Amino Acids

according to Polarities of their "R" groups.

1- Amino acids with non-Polar [R groups]
- (6) aliphatic [R groups]
- (2) aromatic [R groups]
- (1) cyclic [R groups]

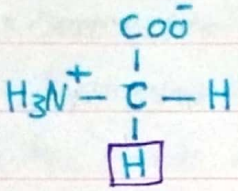
2- Amino acids with charged Polar [R groups]
- (3) amino acids are Positively charged (basic).
- (2) amino acids are negatively charged (acidic).

3- Amino acids with uncharged Polar [R groups]
- (6) amino acids with hydroxyl, amide, or thiol groups.

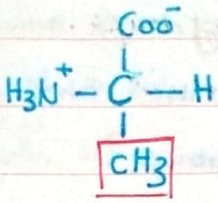
1- Amino acids with non-polar R groups.

- Glycine has the simplest side chain: H atom. [achiral].
- Alanine, Valine, leucine and isoleucine have aliphatic hydrocarbon side chains.
- Methionine has a thioether side chain [sulfur atom].
- Proline has a cyclic pyrrolidine side chain.
- Phenylalanine has a phenyl moiety.
- Tryptophan has an indole group.

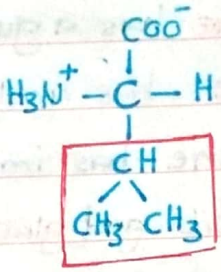
~ NonPolar, aliphatic [R groups] ~



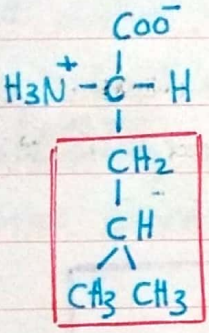
Glycine



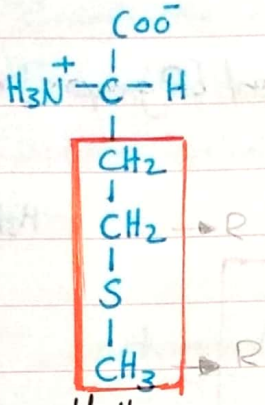
Alanine



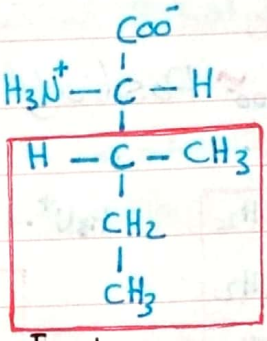
Valine



Leucine

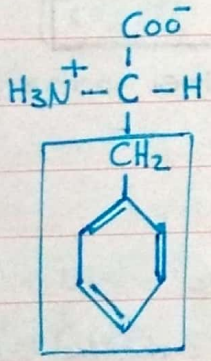


Methionine

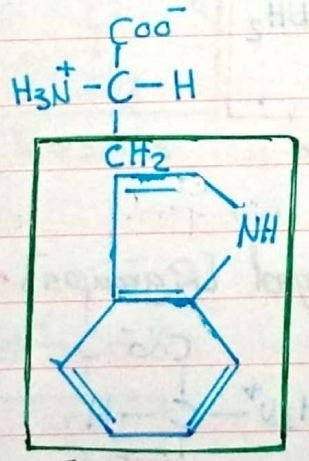


Isoleucine

~ Nonpolar, aromatic [R groups] ~

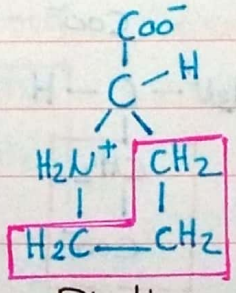


Phenylalanine



Tryptophan

~ Nonpolar, cyclic [R group] ~

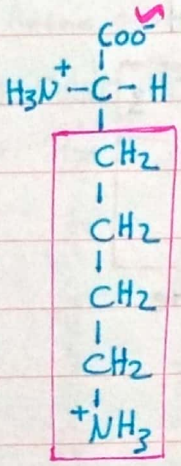


Proline

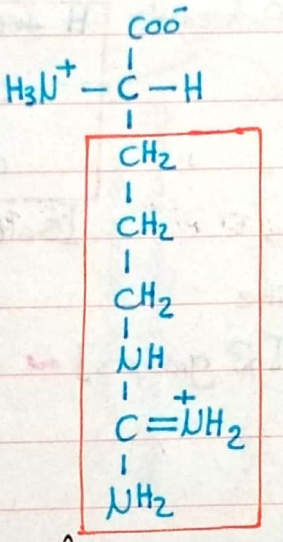
2- Amino acids with charged polar [R groups].

- Arginine has a guanidine group.
- Lysine has abutyl ammonium side chain.
- Histidine has imidazole group.
- Aspartic and glutamic acids in their ionized state are called aspartate and glutamate, respectively.

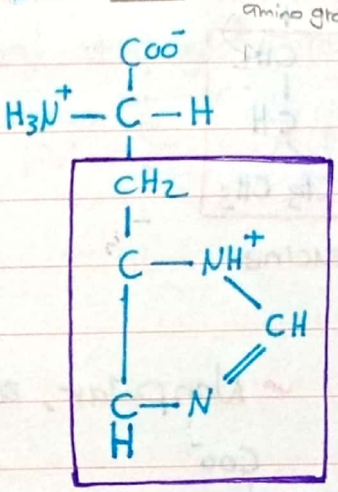
~ Positively charged [R groups] ~ basic → [extra amine group].



Lysine



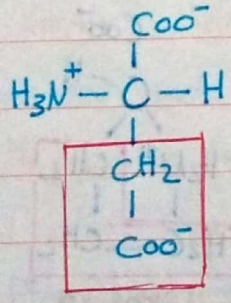
Arginine



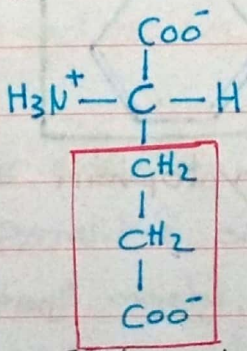
Histidine

~ Negatively charged [R groups] ~ acidic

* Extra carboxylic acid group.



Aspartate



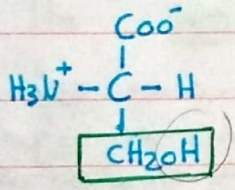
Glutamate

3- Amino acids with uncharged polar [R groups].

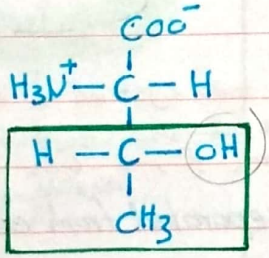
- Serine and threonine bear hydroxyl (-OH) R group.
- Asparagine and glutamine have amide bearing side chains. They are the amide derivatives of aspartic and glutamic acids.
- Tyrosine is aromatic and has aphenolic group.
- Cysteine has a thiol group that can form a disulfide bond (-S-S) with another cysteine through the oxidation of 2 thiol groups ([Cystine] is the oxidized dimeric form).

The disulfide bridge in proteins contributes to the stability and overall shape of a protein.

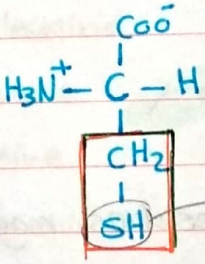
~ Polar, uncharged polar [R groups] ~



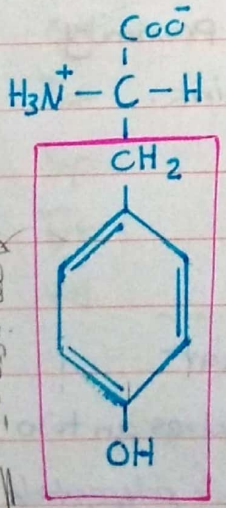
Serine



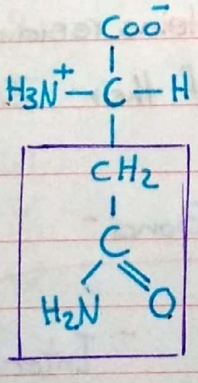
Threonine



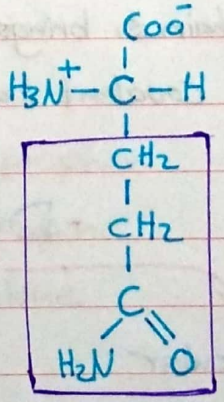
Cysteine : the most important amino acid.



Tyrosine



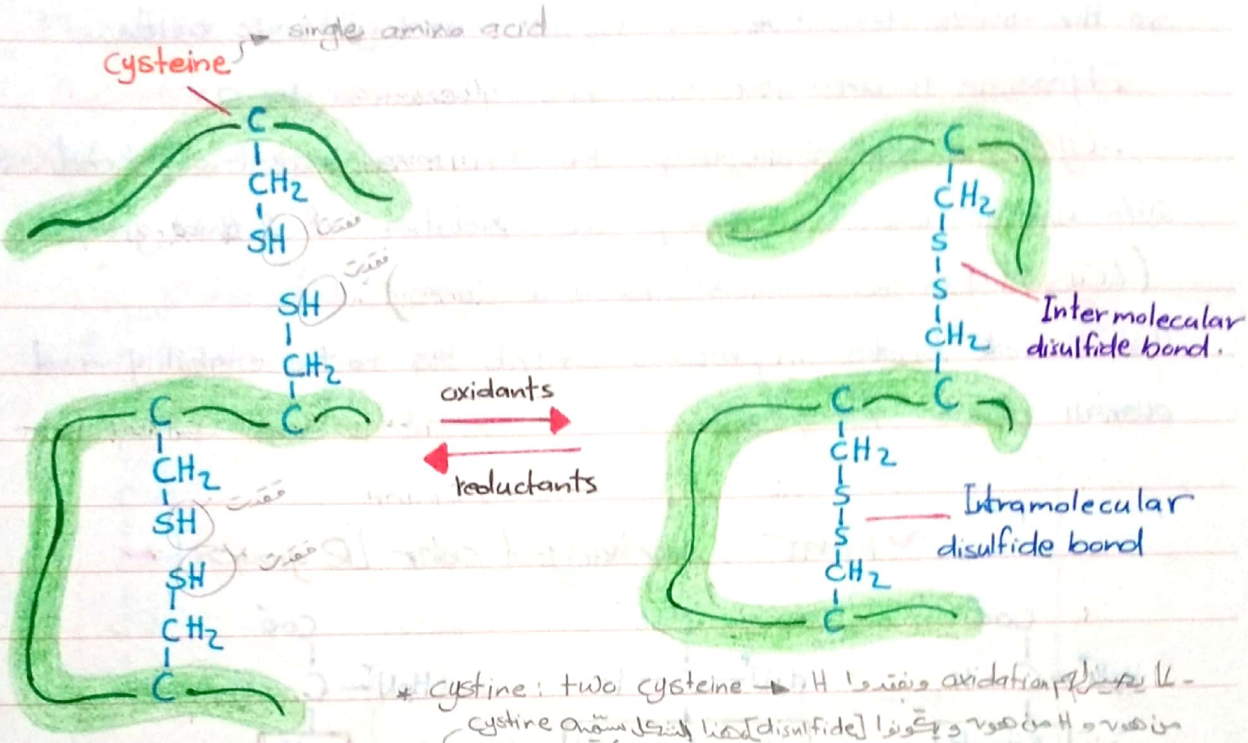
Asparagine



Glutamine

* carbonyl group بجانب nitrogen in side chain بتخلي amide bond.

* Disulfide bond is a covalent linkage formed between the sulfhydryl groups (SH) of two cysteine residues (after oxidation) to produce a cystine residue.



* cystine: two cysteine → H oxidation
cystine [disulfide] bond
dimer → two oxidize cysteine
disulfide bond

. Cysteine residues may be separated from each other by many amino acids in the primary sequence of a polypeptide or may even be located on two different polypeptides. The folding of the polypeptide chain(s) brings the cysteine residues into proximity and permits covalent bonding of their side chains.

- Disulfide Bond -

- Intramolecular
[2 cysteine residues on the same polypeptide chain].

- Intermolecular (between)
[2 cysteine residues on two separate / different polypeptide chains].

~ Amino Acids Abbreviations ~

* حفظ الـ 3 في سؤال عيني

more common

3-letters	1-letter	Amino acid
Ala	A	Alanine
Arg	R	Arginine
Asn	N	Asparagine
Asp	D	Aspartic acid [Aspartate].
Cys	C	Cysteine
Gln	Q	Glutamine
Glu	E	Glutamic acid [Glutamate].
Gly	G	Glycine
His	H	Histidine
Ile	I	Isoleucine
Leu	L	Leucine
Lys	k	Lysine
Met	M	Methionine
Phe	F	Phenylalanine
Pro	P	Proline
ser	S	Serine
Thr	T	Threonine
Trp	W	Tryptophan
Tyr	Y	Tyrosine
Val	V	Valine

* راجع سلايد 30 + 31 في الشابتر دهو Example منّي مطلوب منكم.