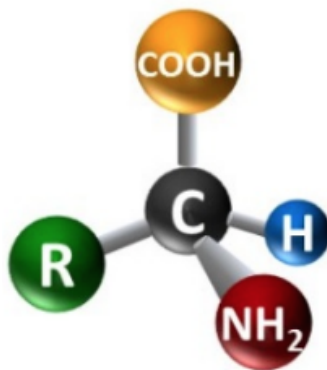




Amino Acids 1



Dr. Nesrin Mwafi

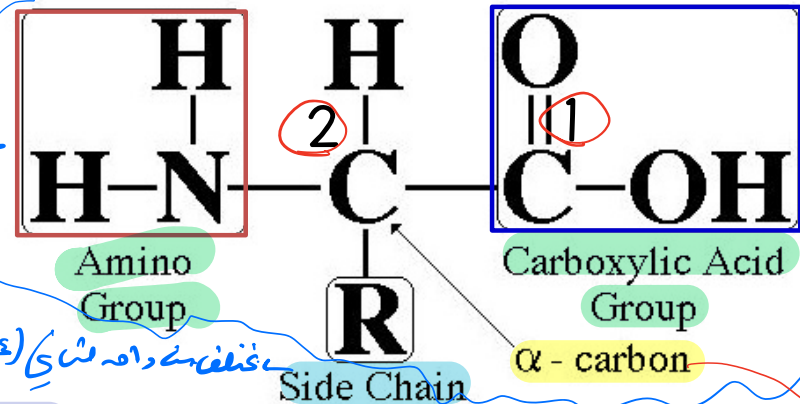
*Biochemistry & Molecular Biology Department
Faculty of Medicine, Mutah University*



Amino Acid Structure

- Amino acids are biologically important organic molecules that contain both carboxylic acid (-COOH) as well as amine (-NH₂) groups
- The side-chain also called "R" group is specific to each amino acid

standard



Standard amino acid
 القواعد الستة التي يتكون منها
 البروتين
 يطلق عليهم بروتينات
 القياسية
 Standard amino acid
 هي الستة التي تتكون منها
 البروتين
 not standard

تختلف دعامتها (R) تختلف (amino acid)

- Amino group is attached to α-carbon (C2)
- C, N, O and H are the key elements of amino acids

وهي التي
 تتكون منها
 البروتين
 Standard amino acid
 هي الستة التي تتكون منها
 البروتين

amino acid
 structure
 carboxylic acid amino group

إذا بدأنا من الكربون الذي يمتد
 من الكربون الحامض
 إذا بدأنا من الكربون الذي يمتد
 من الكربون الحامض

The first carbon in the next of functional group (carboxylic acid) called α then we go to R and called β and so on



biological significance of Amino Acids

أحد أهم مصادرها الطبيعية للحياة والوظائف الأساسية

1. Amino acids are N-containing molecules
2. The basic structural building units (monomers)

poly peptide chain → long chain of repeated amino acid
 of proteins
 بروتين مكون من سلاسل طويلة من الأحماض الأمينية المتكررة
 المتكررة في سلسلة البروتين

3. Precursors of many biomolecules like neurotransmitters (non-protein role)

مثل gaba

بعض الأحماض الأمينية لها دور في تصنيع الناقلات العصبية

وظيفة

gaba → non standard amino acid

4. They are also utilized as an energy source

- There are 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)

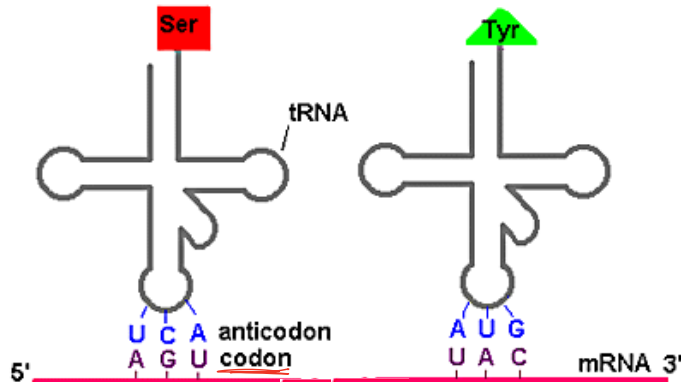
القياسية
noncanonical & nonstandard amino acids

تسريحي

standard → amino acid is incorporated to the polypeptide chain via mRNA translation process
تتمثل في عملية الترجمة



Genetic Code Table



انذا تم اتمام الترجمة (تسري الـ mRNA) في الـ ribosome
 Synthesis process

- The 20 standard amino acids are known as proteinogenic or natural amino acids.

لانه يتم اتمامه في الـ ribosome
 يعني انه طبيعي وفعال

لانه لو تم انه غير طبيعي
 يعني انه غير فعال

2nd base in codon *الخطوة*

	U	C	A	G	
U	Phe Phe Leu Leu	Ser Ser Ser Ser	Tyr Tyr STOP STOP	Cys Cys STOP Trp	U C A G
C	Leu Leu Leu Leu	Pro Pro Pro Pro	His His Gln Gln	Arg Arg Arg Arg	U C A G
A	Ile Ile Ile Met	Thr Thr Thr Thr	Asn Asn Lys Lys	Ser Ser Arg Arg	U C A G
G	Val Val Val Val	Ala Ala Ala Ala	Asp Asp Glu Glu	Gly Gly Gly Gly	U C A G

1st base in codon

3rd base in codon



Standard Amino Acids List

صفا

Histidine	Arginine	Alanine
Isoleucine	Asparagine	Asparatate
Leucine	Glutamine	Cysteine
Methionine	Glycine	Glutamate
Phenylalanine	Proline	
Threonine	Serine	
Tryptophan	Tyrosine	
Valine		
Lysine		

Standard Amino Acids

يعني يتم اصطناعها بواسطة الخلية (تسمى RNA)



- They are **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**)

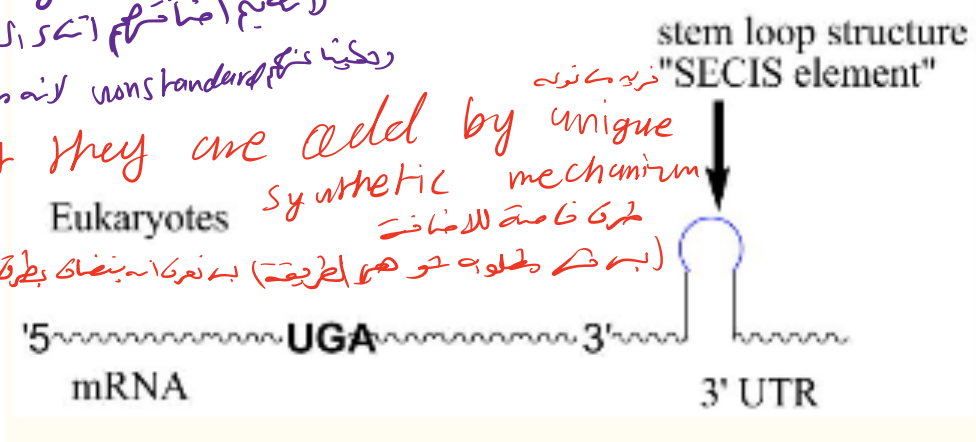
موجود بتركيبته
الاسترنيك

proteinogenic
لا يتم اصطناعها
من خلال الـ tRNA
non standard
لانه ما يتم كودده

but they are added by unique
synthetic mechanism

فريدة من نوعها

طرق خاصة للاضافة
(بما في ذلك طوله هو هو الطريقة) به تعرف انه يضاف بطريقة خاصة



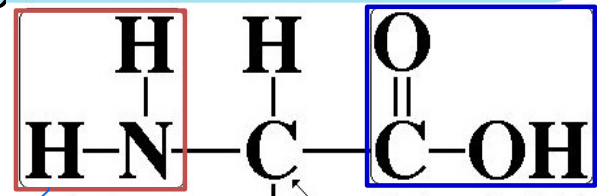
Incorporation of selenocysteine in protein structure by unique mechanism



Standard Amino Acids

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 ($-NH-$)



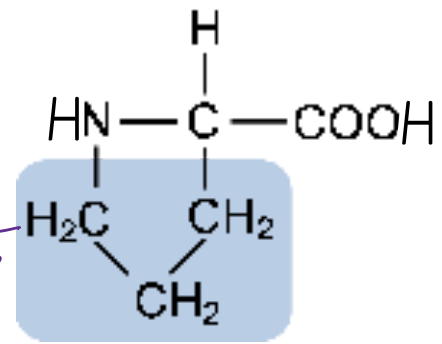
Primary
2H + R

2R + H secondary
3R tertiary

Side Chain
 α -carbon
Standard amino acids

Carboxylic Acid Group

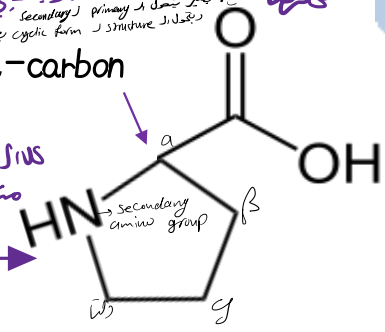
هنا R يحدد تفرع
ويحفظ بالـ N
الربطية
Secondary amino group
التي هي تتصلب
الربطية في شكل
Cyclic form



proline

Standard amino group
التي هي تتصلب الربطية
primary amino group
التي هي تتصلب الربطية

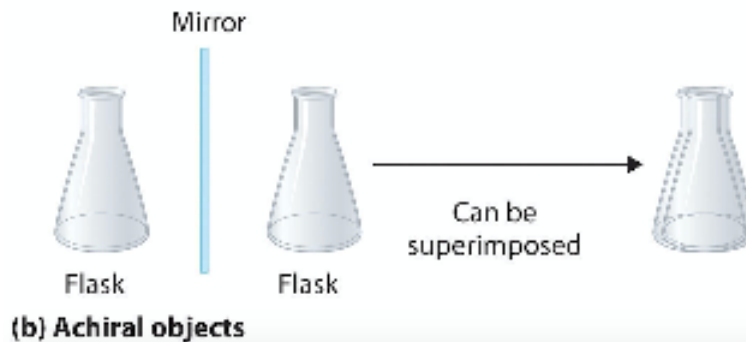
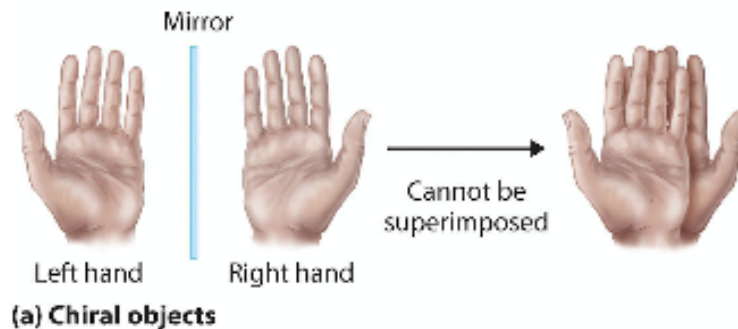
Proline amino group
التي هي تتصلب الربطية
secondary amino group
التي هي تتصلب الربطية





Standard Amino Acids

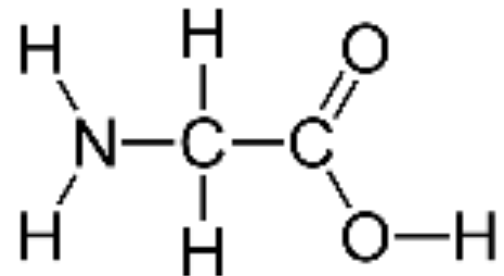
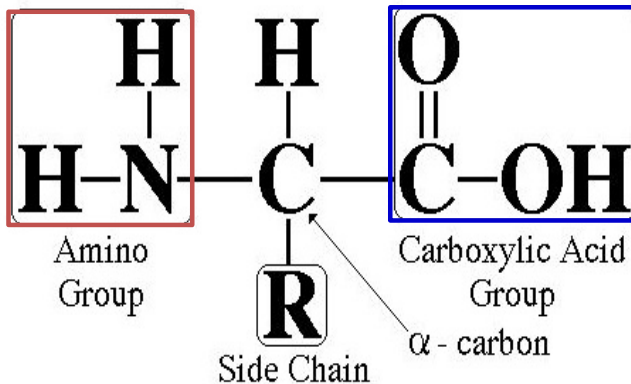
3. *Chiral (عنه) له 2 (9) (ل, ل)* *2M (منه) له 2 (9) (ل, ل)* *R-group (ج, ج)*
They are all chiral molecules (except glycine which has achiral C) with L- stereochemical configuration (left-handed isomers)



Standard Amino Acids



- Chiral molecules should contain at least one chiral center (usually a carbon atom)
- **Chiral carbon:** asymmetric carbon atom attached to 4 different groups of atoms



Glycine

Isomerization



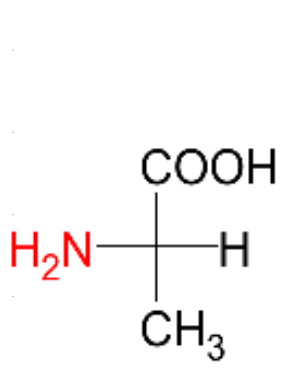
- Isomers: are molecules with same molecular formula but different chemical structures
 1. Constitutional (structural) isomers: atoms and functional groups bind together in different ways
 2. Stereoisomers (spatial isomers): differ in the configuration of atoms rather than the order of atomic connectivity

D/L Amino Acids



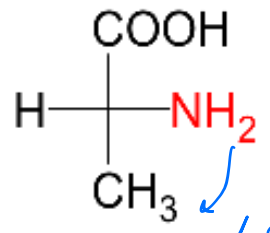
- Enantiomers: are two stereoisomers that are mirror images to each other but not superimposable
- D- (dexter)/L- (laevus) Nomenclature system: commonly used to assign the configurations in sugars (carbohydrates) and amino acids
- As a rule of thumb: if the amino group is on the right-hand side of α -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



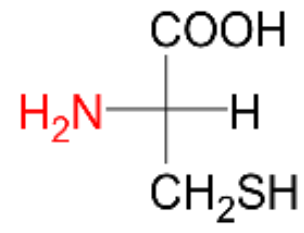
L-alanine

mirror



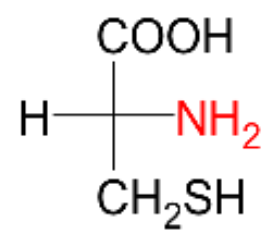
D-alanine

right-hand sided



~~D-alanine~~ = cysteine

mirror



D-cysteine

a way to draw structure of chiral molecules

Fischer Projection: is one way commonly used to represent the structure of chiral molecules like carbohydrates and amino acids



D/L Amino Acids

- Most naturally occurring sugars are D-isomers while most naturally occurring amino acids are L-isomers (amino acids of protein)
- D-amino acids polypeptides (right-handed isomers) are components of bacterial cell walls to resist digestion by other organisms

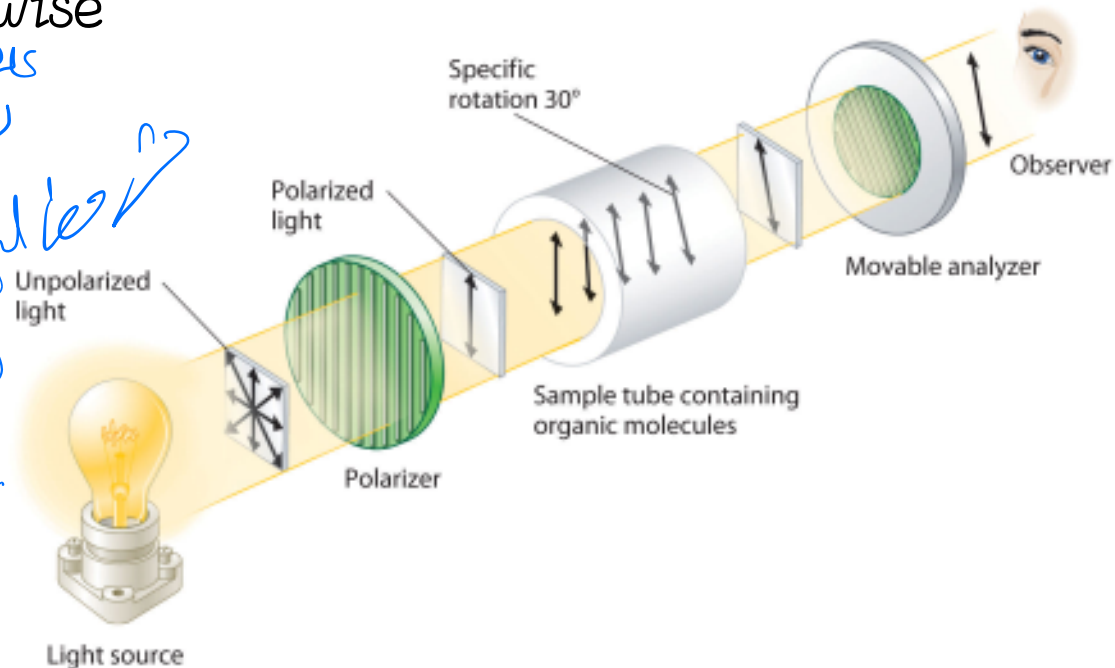
موجود في الكائنات الحية
(as way of protection)
D amino acids Cell-walls
من اليمين
توجد في جدران الخلايا البكتيرية



Optical Activity

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

Glycine
الكلمة باقية انك ان
لا بد
Actual
في الواقع
بالتجربة
لا بد
من التجربة
في الواقع



Polarimeter is used to measure optical rotation

Optical Activity



- (+)/(-) nomenclature system: if one enantiomer rotates the light clockwise, it is labeled (+) or (d) (dextrorotatory). The second mirror image enantiomer is labeled (-) or (l) laevorotatory
- 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
لا تدور ← glycine لا تدور ← Achiral
بلعوا بالتحال
- Racemic mixture contains equal amounts of each enantiomer (net rotation is zero)



Classification of Amino Acids

>300 amino acids classified in many ways:

protein role
ما له علاقة بالبروتين
(له دور في البروتين)
الاما غير البروتينية

20 standard → 3 non standard

300 - 28 →

1) **Proteinogenic and non-proteinogenic amino acids**

(either have non-protein role like GABA and carnitine or formed by post-translational modification of protein like hydroxyproline)

البروتينية
غير البروتينية
MRA
منها يتم تصنيع
الاما عن طريق البروتين
Standard
او بطريقة غير
non standard

مادة ما له
protein role
باعتبارها جزء من البروتين
مادة غير
gaba
في مادة البروتين
→ في مادة البروتين
after the mRNA
translation proses
باعتبارها مادة البروتين
في مادة البروتين
→ في مادة البروتين

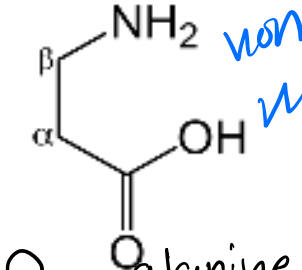
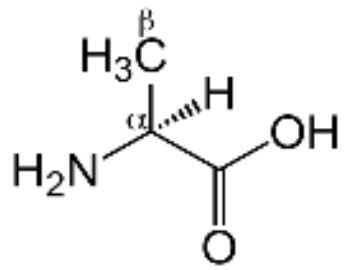
non proteinogenic + non standard amino acid
with protein role

2) **Standard and non-standard amino acids**

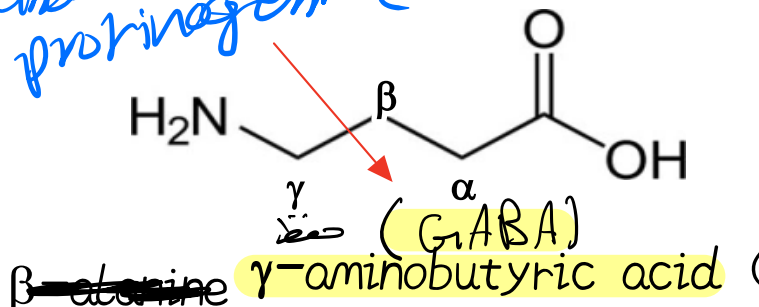
20 standard
غير البروتينية

3) **α, β, γ and δ amino acids**

Standard
α
كبريتا
غير كبريتا



non standard
non proteinogenic

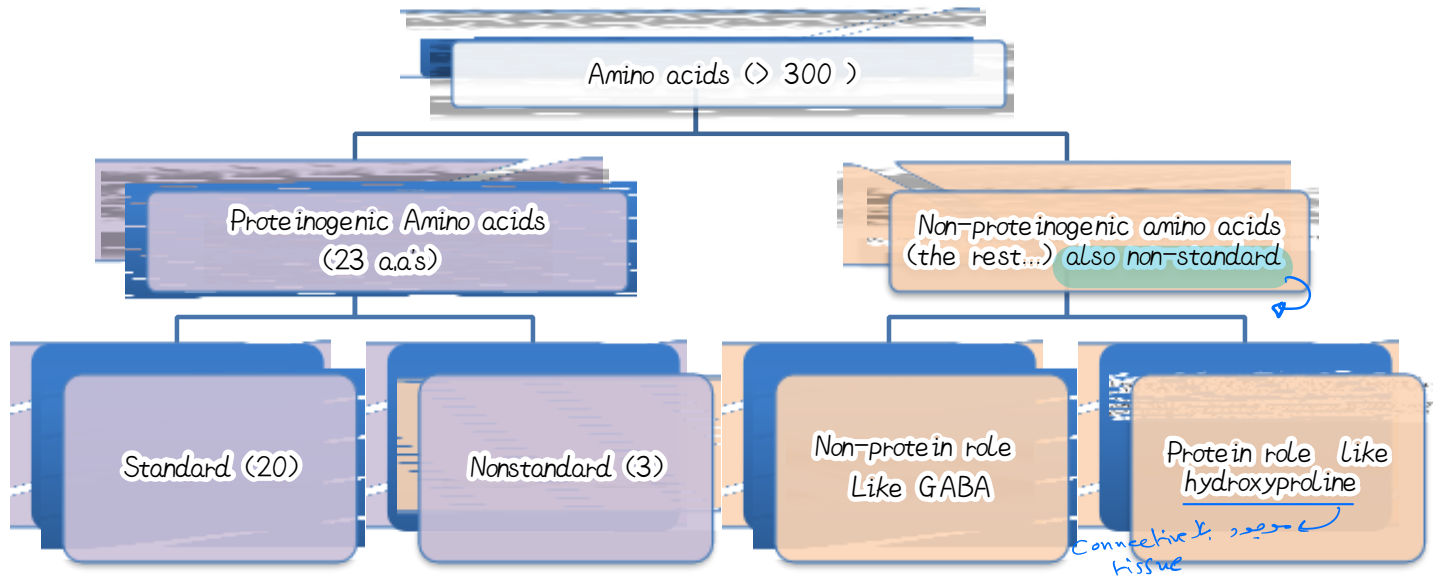


Classification of Amino Acids



- β -amino acids are ^{non-standard & not natural except} non-proteinogenic with ^{طبيعية} β -alanine ^{طبيعية} is the only common naturally occurring β -amino acid. β -alanine is used in plants and microorganisms in the synthesis of pantothenic acid (vitamin B₅)
- Unlike α -peptides, The β -peptides are artificial peptides used in some antibiotics to counter resistance as they are more stable against proteolytic degradation

Classification of Amino Acids



Categories of Standard Amino Acids



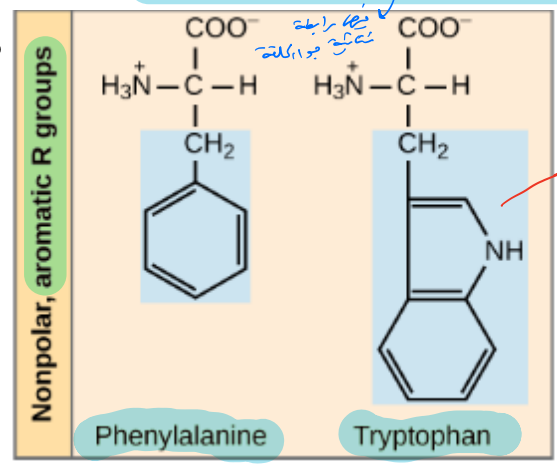
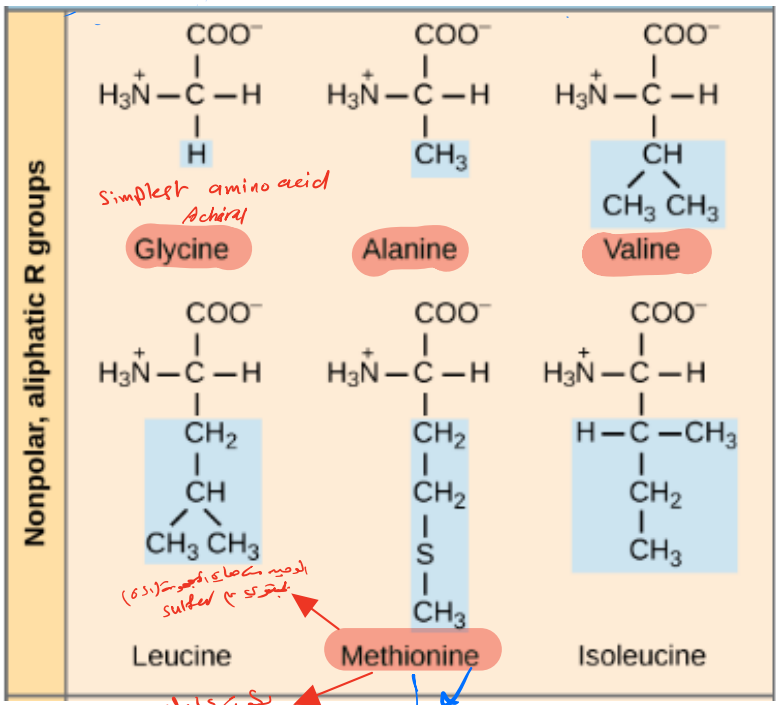
- The 20 standard amino acids are classified into 3 major categories according to the polarities of their "R" groups:
 - 1) Amino acids with non-polar R groups
 - 2) Amino acids with charged polar R groups
 - 3) Amino acids with uncharged polar R groups



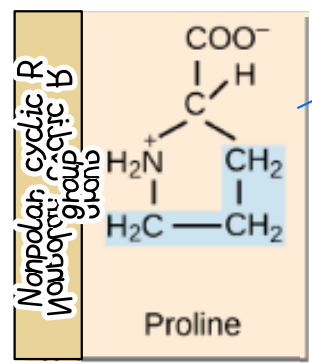
Amino acids with non-polar R groups

9 amino acid from 20

- 6 amino acids with aliphatic, 2 with aromatic and one with cyclic side chains



الدوميه
التي تسمى طبعيا
في البروتينات



Cyclic aromatic

تفظم بشكل عام مضاربها
دقيقا كئي يعني اميز (aromatic) اذا (ا)
رسمه وال Sulfur (S) صيغ
يعني من صايفه تفظم

يكون قابل
thio ether

5



Amino acids with non-polar R groups

- Glycine has the simplest side chain: H atom
- 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

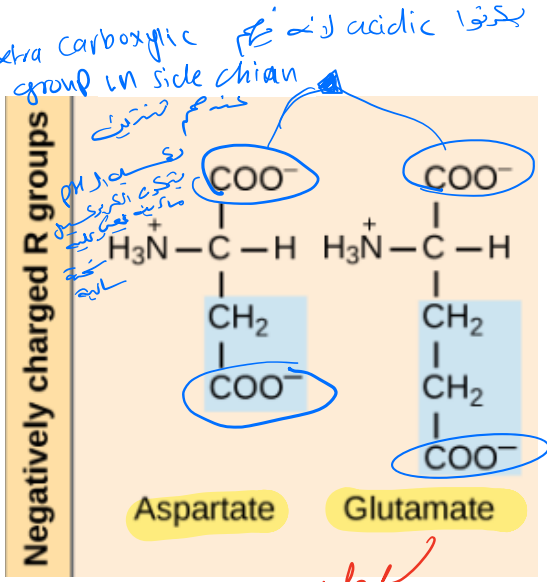
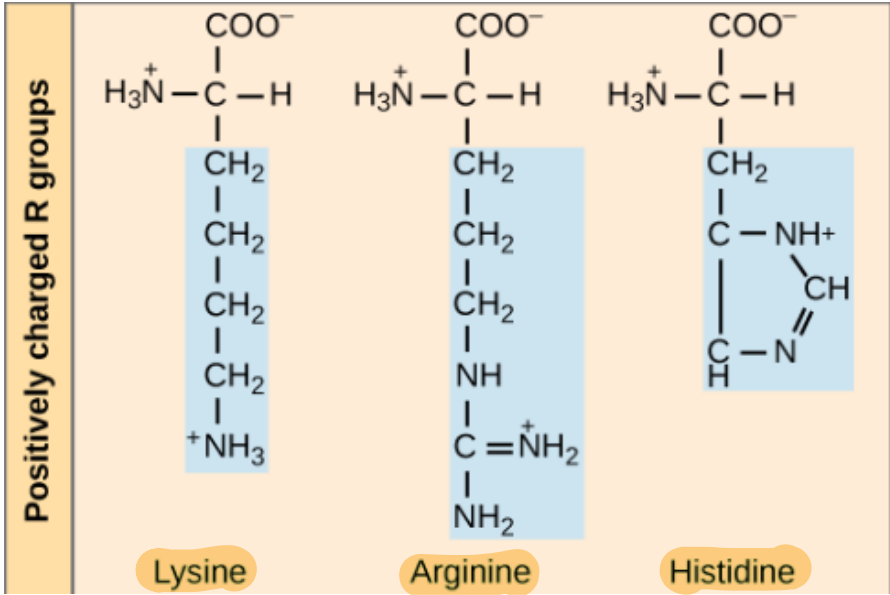
الحلقة صلبة لها

تصغير ال molecule



Amino acids with charged polar R groups

- 3 amino acids are positively charged (basic) and 2 amino acids are negatively charged (acidic)



وكلها موجبة

مجموعة حمضية إضافية في السلسلة الجانبية
 Aspartic
 Glutamic



Amino acids with charged polar R groups

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

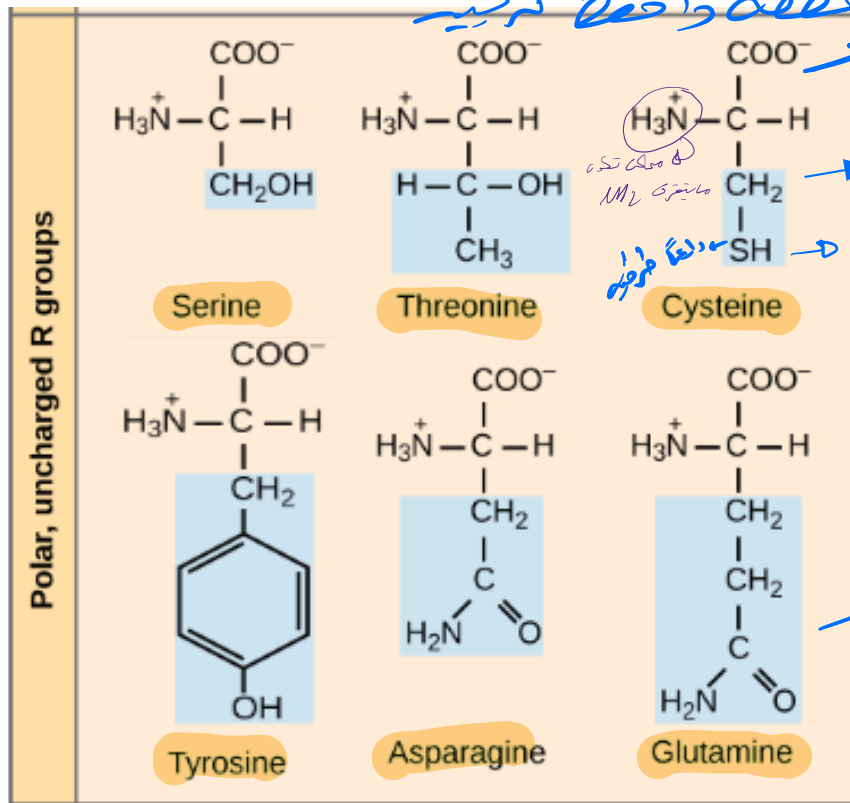


Amino acids with uncharged polar R groups

- 6 amino acids with hydroxyl, amide or thiol groups

Sulfur has R

العصافه واحفظه تركيه



مركب كبريت
مميزه
دنيا فوفيه

thiol group

Free Sulfhydryl group
يعني المعادن الثقيله تصدق ال H
وقال لايفتحة ال ايمو جيني
يصير العا تاكيد وتصفه ويزيد ويزيد
استقرار وتكسبه

نظروا الى
يد ال ه صا
amide



Amino acids with uncharged polar R groups

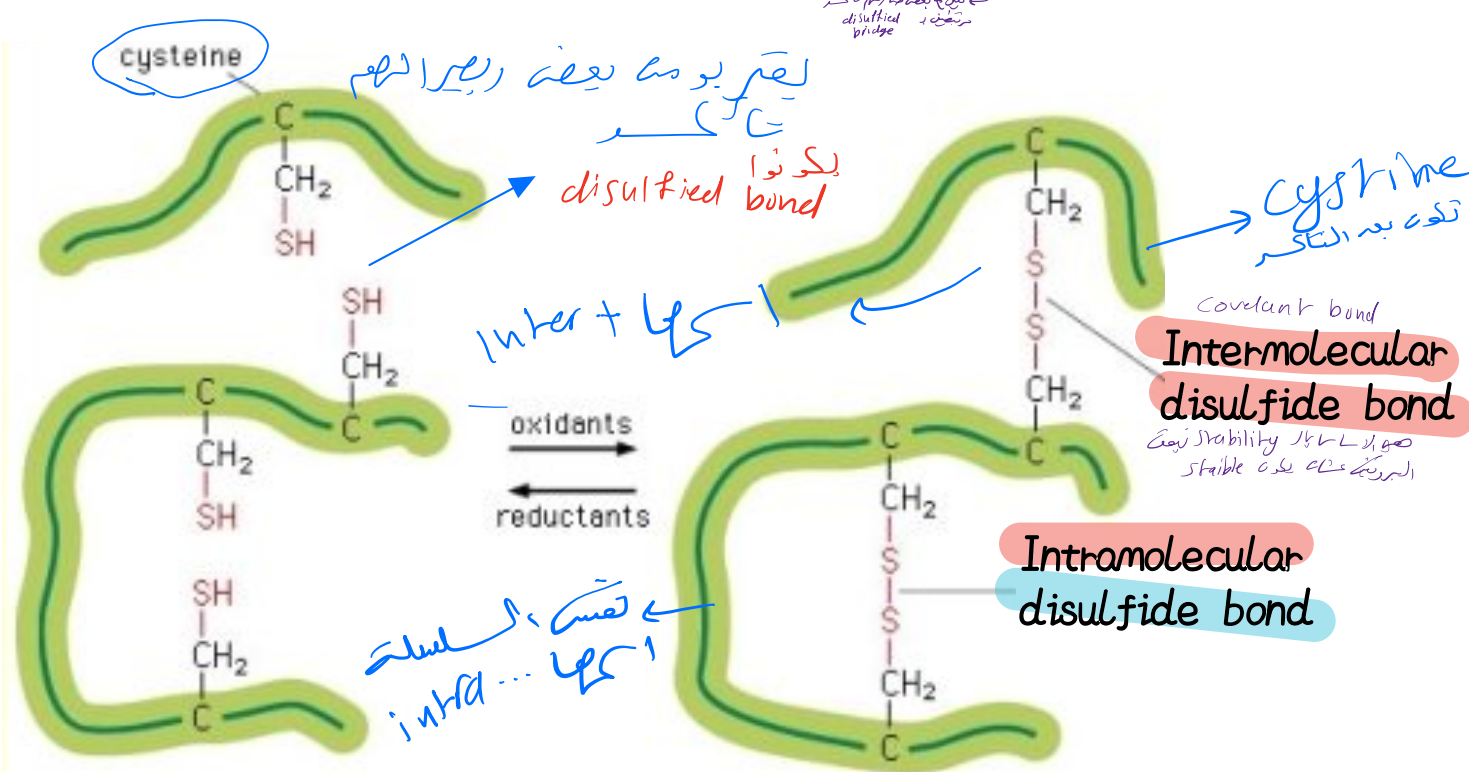
+ tyrosine

- Serine and threonine bear hydroxyl (-OH) R group بعض الناظر
رشته جاي
- Asparagine and glutamine have amide bearing side chains. They are the amide derivatives of aspartic and glutamic acids ما تفرقة بينهم
رشته
asparagine
رشته جاي
aspartate
acid
مدرسه اشتقاق اسم
استبدال في الام وسطية
extra amino group
- Tyrosine is aromatic and has a phenolic group لا حه جاي يا طاعة
phenol
- 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 البروتين



Amino acids with uncharged polar R groups

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



Amino acids with uncharged polar R groups



- 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 could be **intramolecular** (2 cysteine residues on the same polypeptide chain) or **intermolecular** (2 cysteine residues on two separate/ different polypeptide chains)

Amino Acids Abbreviations



3 letter / more common than the 2 letter
3-letters 1-letter Amino acid

Ala	A	<u>Alanine</u>
Arg	R	<u>Arginine</u>
Asn	N	<u>Asparagine</u>
Asp	D	Aspartic acid (Aspartate)
Cys	C	<u>Cysteine</u>
Gln	Q	Glutamine
Glu	E	Glutamic acid (Glutamate)
Gly	G	<u>Glycine</u>
His	H	<u>Histidine</u>
Ile	I	<u>Isoleucine</u>
Leu	L	<u>Leucine</u>
Lys	K	Lysine
Met	M	<u>Methionine</u>
Phe	F	Phenylalanine
Pro	P	<u>Proline</u>
Ser	S	<u>Serine</u>
Thr	T	<u>Threonine</u>
Trp	W	Tryptophan
Tyr	Y	<u>Tyrosine</u>
Val	V	<u>Valine</u>

2 letter / more common than the 3 letter

Ensembl Genomic Browser



Handwritten orange text: "2. wnt8a" with arrows pointing to the transcript ID and gene name in the browser interface.

[BLAST/BLAT](#) | [VEP](#) | [Tools](#) | [BioMart](#) | [Downloads](#) | [Help & Docs](#) | [Blog](#)

Log in/Poststar

Zebrafish (GRCz11)

Location: [14,34,490,445-34,404,895](#) | Gene: [wnt8a](#) | Transcript: [wnt8a-201](#)

- Transcript-based displays
- Summary
 - Sequence
 - Exons
 - cDNA
 - Protein
 - Protein Information
 - Protein summary**
 - Domains & features
 - Variants
 - Genetic Variation
 - Variant table
 - Variant image
 - Population comparison
 - Comparison image
 - External References
 - General identifiers
 - Oligo probes
 - Supporting evidence
 - ID History
 - Transcript history
 - Protein history

Transcript: wnt8a-201 ENSDART00000192193.3

Description: [wntless-type NMTV integrin-like family member 8a](#) (Source:FlyBase;ZFIN;Gene;NCBI;Ensembl)

Gene Synonyms: [wnt8a](#), [wnt8](#), [wnt8.1](#), [wnt8.2](#), [wnt8.3](#), [wnt8.4](#), [wnt8.5](#), [wnt8.6](#), [wnt8.7](#), [wnt8.8](#), [wnt8.9](#), [wnt8.10](#), [wnt8.11](#), [wnt8.12](#), [wnt8.13](#), [wnt8.14](#), [wnt8.15](#), [wnt8.16](#), [wnt8.17](#), [wnt8.18](#), [wnt8.19](#), [wnt8.20](#), [wnt8.21](#), [wnt8.22](#), [wnt8.23](#), [wnt8.24](#), [wnt8.25](#), [wnt8.26](#), [wnt8.27](#), [wnt8.28](#), [wnt8.29](#), [wnt8.30](#), [wnt8.31](#), [wnt8.32](#), [wnt8.33](#), [wnt8.34](#), [wnt8.35](#), [wnt8.36](#), [wnt8.37](#), [wnt8.38](#), [wnt8.39](#), [wnt8.40](#), [wnt8.41](#), [wnt8.42](#), [wnt8.43](#), [wnt8.44](#), [wnt8.45](#), [wnt8.46](#), [wnt8.47](#), [wnt8.48](#), [wnt8.49](#), [wnt8.50](#), [wnt8.51](#), [wnt8.52](#), [wnt8.53](#), [wnt8.54](#), [wnt8.55](#), [wnt8.56](#), [wnt8.57](#), [wnt8.58](#), [wnt8.59](#), [wnt8.60](#), [wnt8.61](#), [wnt8.62](#), [wnt8.63](#), [wnt8.64](#), [wnt8.65](#), [wnt8.66](#), [wnt8.67](#), [wnt8.68](#), [wnt8.69](#), [wnt8.70](#), [wnt8.71](#), [wnt8.72](#), [wnt8.73](#), [wnt8.74](#), [wnt8.75](#), [wnt8.76](#), [wnt8.77](#), [wnt8.78](#), [wnt8.79](#), [wnt8.80](#), [wnt8.81](#), [wnt8.82](#), [wnt8.83](#), [wnt8.84](#), [wnt8.85](#), [wnt8.86](#), [wnt8.87](#), [wnt8.88](#), [wnt8.89](#), [wnt8.90](#), [wnt8.91](#), [wnt8.92](#), [wnt8.93](#), [wnt8.94](#), [wnt8.95](#), [wnt8.96](#), [wnt8.97](#), [wnt8.98](#), [wnt8.99](#), [wnt8.100](#)

Location: [Chromosome 14:10,490,045-10,491,088](#) forward strand

About this transcript: This transcript has [2 exons](#), is annotated with [30 domains and features](#), is associated with [263 consense](#), and maps to [226 unique probes](#).

Gene: This transcript is a product of gene [ENSDMAL0000000029810](#) [View transcript table](#)

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Name	Transcript ID	bp	Protein	Biotype	UniProt	RefSeq	Flags
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wnt8a-202	ENSDART00000144901.2	884	263aa	Protein coding	E8A6D1	NM_160346.4 M1_571821	CCDS 2 incomplete
wnt8a-203	ENSDART00000148044.3	654	163aa	Protein coding	E8A6C0	-	CCDS 2 incomplete

