Protein structure and function

https://youtu.be/9ssCKw-7OvQ?si=SIru6VZ8o9hL2cyp intro

Amino acids

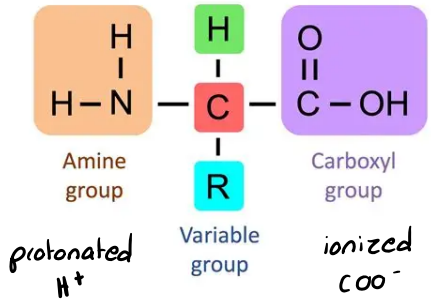
★ نصائح مهمة
- فرغت حكي الدكتورة ✓
- فيديوهات + شرح + توضيح ✓
- اسئلة + اللسنوات ✓
(كيف يجي السؤال)

Wish you best luck ★
By raneem Al-syouf

فيديو رائع لتصنيفات Amino acid ✳ https://youtu.be/_gZlf3JcyDY?si=VVm29JXRcElf-R7w start 2:00 min

لطلاب حافظوهم حرفيا

Structure of amino acids



- Proteins are diverse in function but share common structural feature of being linear polymers of α-amino acids (20 aa in nature)

Alpha

- Amino acids are very small biomolecules with an average molecular weight of about 135 daltons.

g/mol

- Each a.a. has a carboxyl group, an amino group (except proline) and distinctive side chain

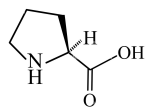
$C_5H_9NO_2$ → imino group

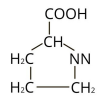
مميز / خاص

A **zwitterion** is a molecule that carries **both a positive charge and a negative charge at the same time**, but the **overall (net) charge is zero**.

The word comes from German: *"zwitter"* meaning **hybrid or double**.

حلقة خماسية





- They exist naturally in a zwitterion state where the carboxylic acid moiety is ionized and the basic amino group is protonated

جزء

- In amino acids, COOH has a pKa (about 2) lower than that of normal carboxylic group (4-5) due to the presence of nitrogen which acts as electron withdrawing group

مهم حفظ

N

Structure of amino acids

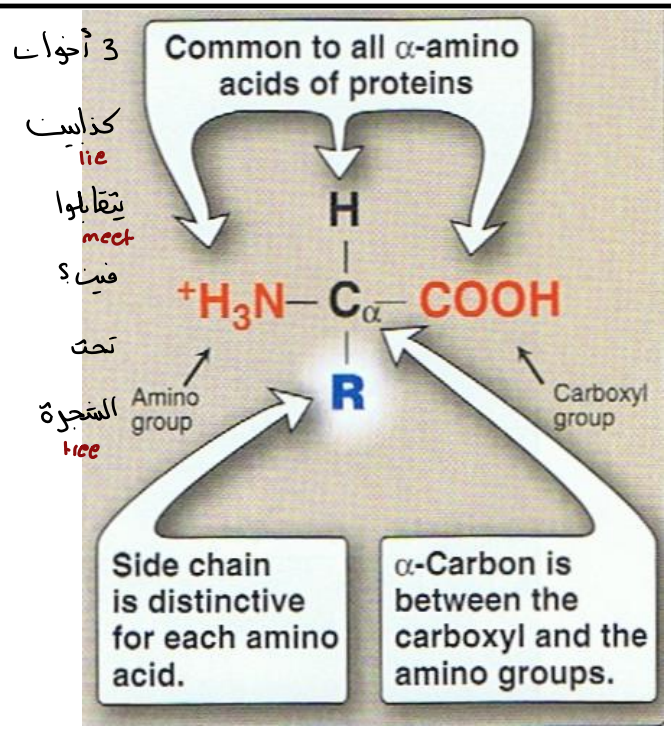
- They are classified as α, β, γ, *etc*. amino acids according the carbon that bears the nitrogen.

diet → 9 | body produce it → 11

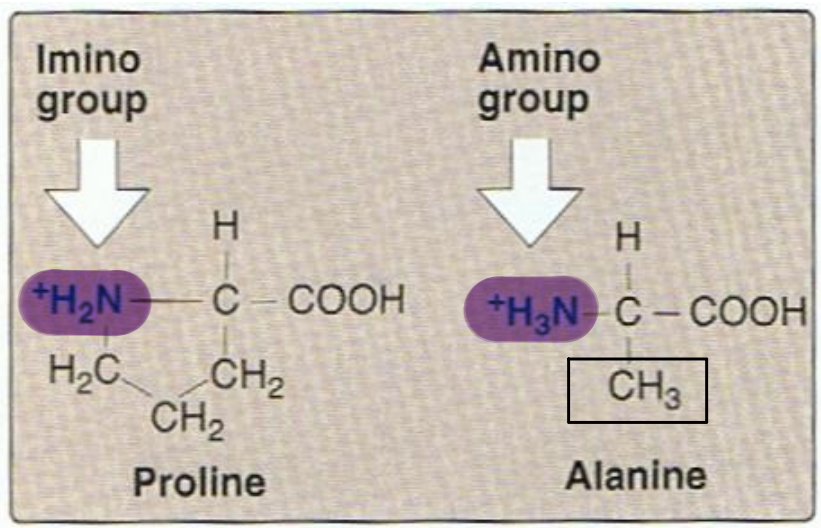
- Amino acids are devided into: essential and non-essential

The essential are Ile, Leu, Lys, Met, Phe, Thr, Trp, His and Val. while the rest can be synthesized in our bodies

Essential
valine
leucine
isoleucine
lysine
methionine
phenyalanine
Threonine
Tryptophan
+
Histadine
(Basic)



Histadine
essential



2. Which of the following essential amino acids is not synthesized by the body?

a. Arginine
b. Glutamine
c. Histidine
d. Proline

Answer: (c)

نفس السؤال

-20 Amino acids- ∝ amino acids

essential (diet)
- Threonine
- Tryptophan
- phenylalanine
- valine
- leucine
- Isoleucine
- lysine
- methionine
- histidine

non essential (body)
- All
- others

(9) non polar
- Valine
- Isoleucine
- proline
- Methionine
- Alanine
- leucine
- Tryptophan
- phenylalanine
- Glycine

polar
- Asparagine
- Glutamine
- Serine
- threonine
- tyrosine
- Cysteine
- Histadine
- Arginine
- Lysine
- Aspartic acid
- Glutamic acid

in slides

- = NH_2 + Aspartic Acid
- = NH_2 + Glutamic Acid

Acidic
- Aspartic Acid
- Glutamic Acid

basic
- Histidine
- Arginine
- Lysine

polar

بيسك هلا

basic HLA

(OH) Hydroxyl containing
- serine
- threonine
- Tyrosine

(S) sulfur containing
- methionine
- cysteine

Aromatic ⬡
- phenylalanine
- Tyrosine
- Tryptophan

branched chain
- Valine
- Leucine
- Isoleucine

All of the following are sulfur-containing a.a. EXCEPT ....

a. Cysteine
b. Methionine
c. Homocysteine
d. Valine

d

Which amino acids not classified as branched chain a.a?

1) lysine
2) valin
3) isoleucine
4) leucine

Which of the following amino acid you don't need to take it from the diet

1 serine
2 phenylalanine
3 leucine
4 histidine

Which amino acid is aromatic 'R' group:

عدة خيارات بس الجواب histidine+

phenylalanine+ tyrosine+ tryptophan

كانوا ع خيارين ٣+٤

hydrophobic

1. Nonpolar amino acids

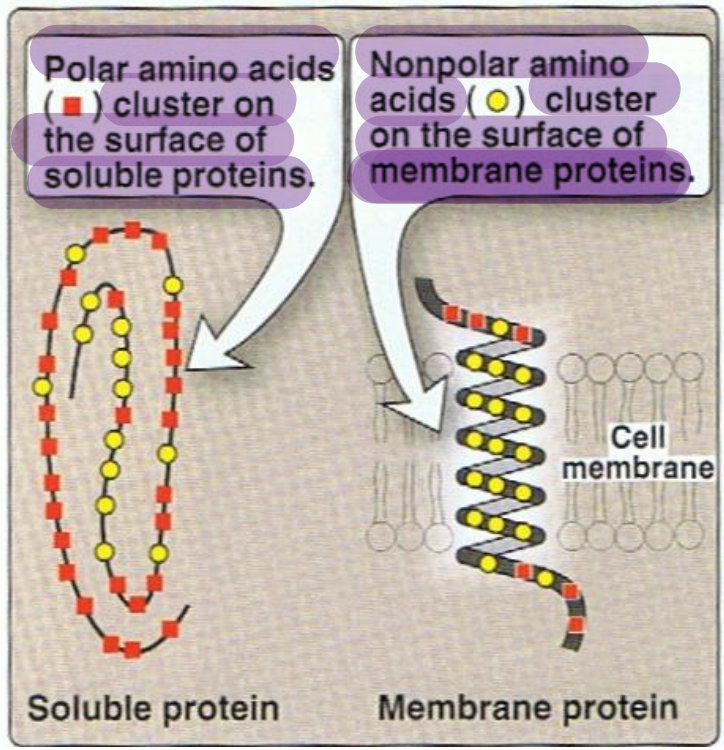
non polar / polar

https://youtu.be/cL2_e83v3js?si=H7p3a8E1LJx9WRdM

- Include: 1 Alanine, 2 Glycine, 3 Isoleucine, 4 Leucine, 5 Methionine, 6 Phenylalanine, 7 Proline, 8 Tryptophan, 9 Valine

- Nonpolar amino acids share only in hydrophobic interaction (No hydrogen or ionic bonds) which stabilize the protein structure

- Determine the three dimensional shape and their location in the cell. (non polar)



- ☆ Proline contains imino so it interrupts the α-helices in globular proteins and contributes to the formation of fibrous proteins

معلومة لشابتر fibrous proteins

بدل α helices فيبروا α-chains

mismatch
• prolin = form kink with alpha chain

مش متأكدة من الصيغة بس هاد كان الاجابة

proline يكسر α-helices

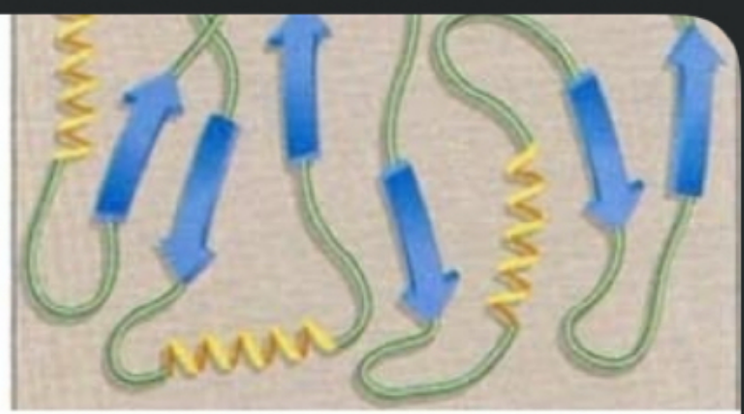
α-chain فينتج عندي

[redacted]

[redacted]

3. β-turns: usually at the surface of the protein, contains usually proline which causes a kink the structure in addition to glycine.

only Achiral



[redacted]

[redacted]

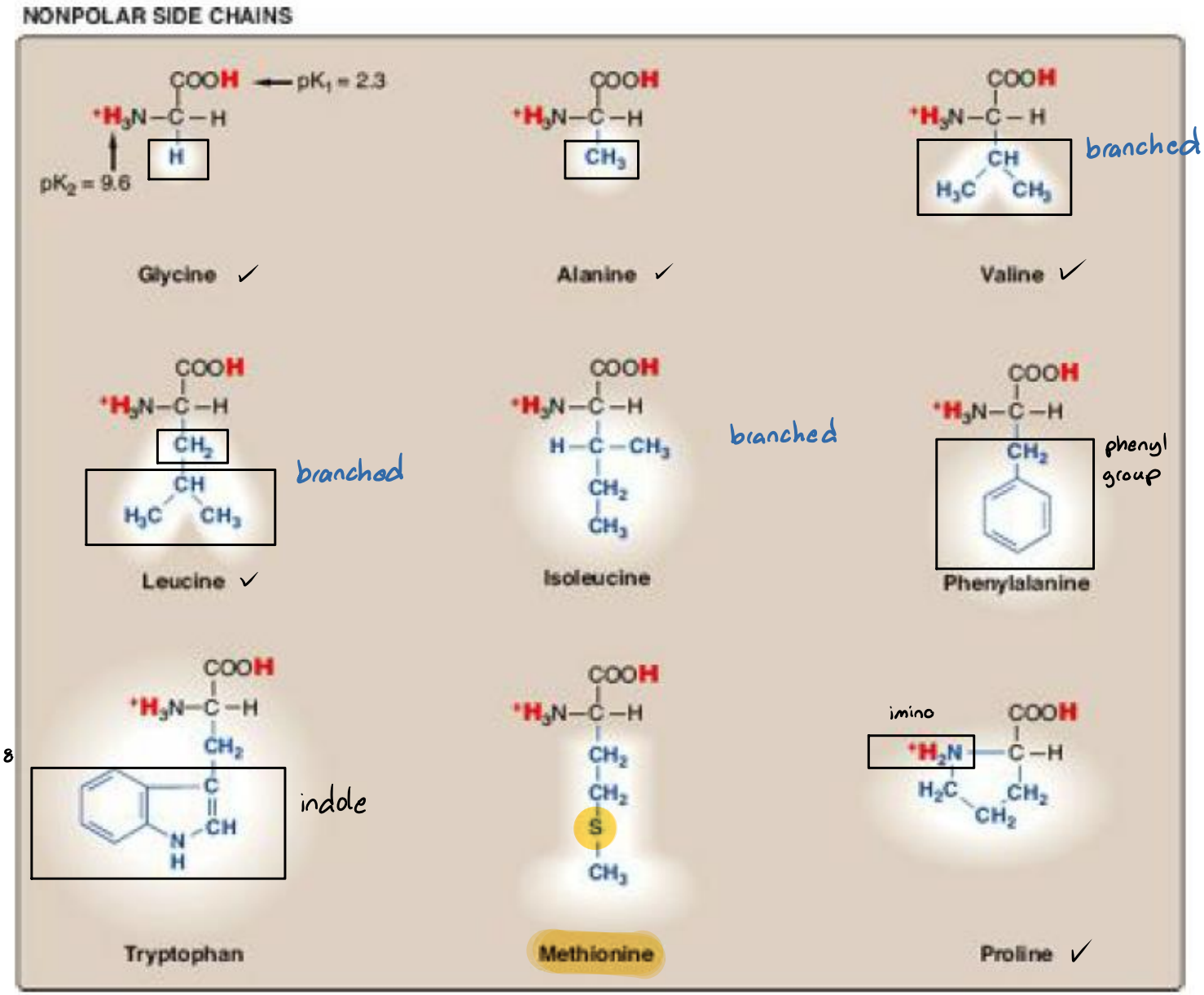
هاد السؤال حسيت كان فيه اجابتين [redacted]

ال allanine كان مكتوب انه achiral وهو chiral

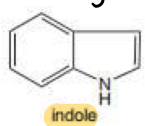
1. Nonpolar amino acids

معهم تجيب اسم Amino acid وتطلبك ترسمه بالكويز / أو رسمته واسمه بالأمتحان

structure كل معهم + حفظ تمييز هم



connect with organic 2 8



hydrophilic

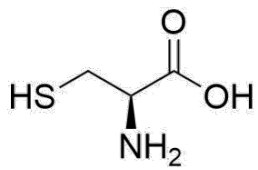
2. Uncharged polar amino acids

- Include: 1 Asparagine, 2 Glutamine, 3 Serine, 4 Threonine, 5 Tyrosine and 6 Cysteine

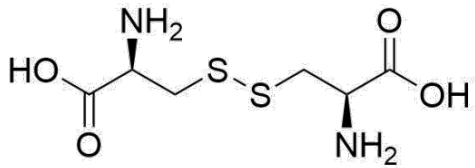
- form hydrogen bond with other polar aa

- Present outside of the proteins that function in aqueous environment and in interior of membrane associated proteins.

- Cysteine has sulfhydryl group which can be oxidized to form a dimer, Cystine (C-S-S-C)

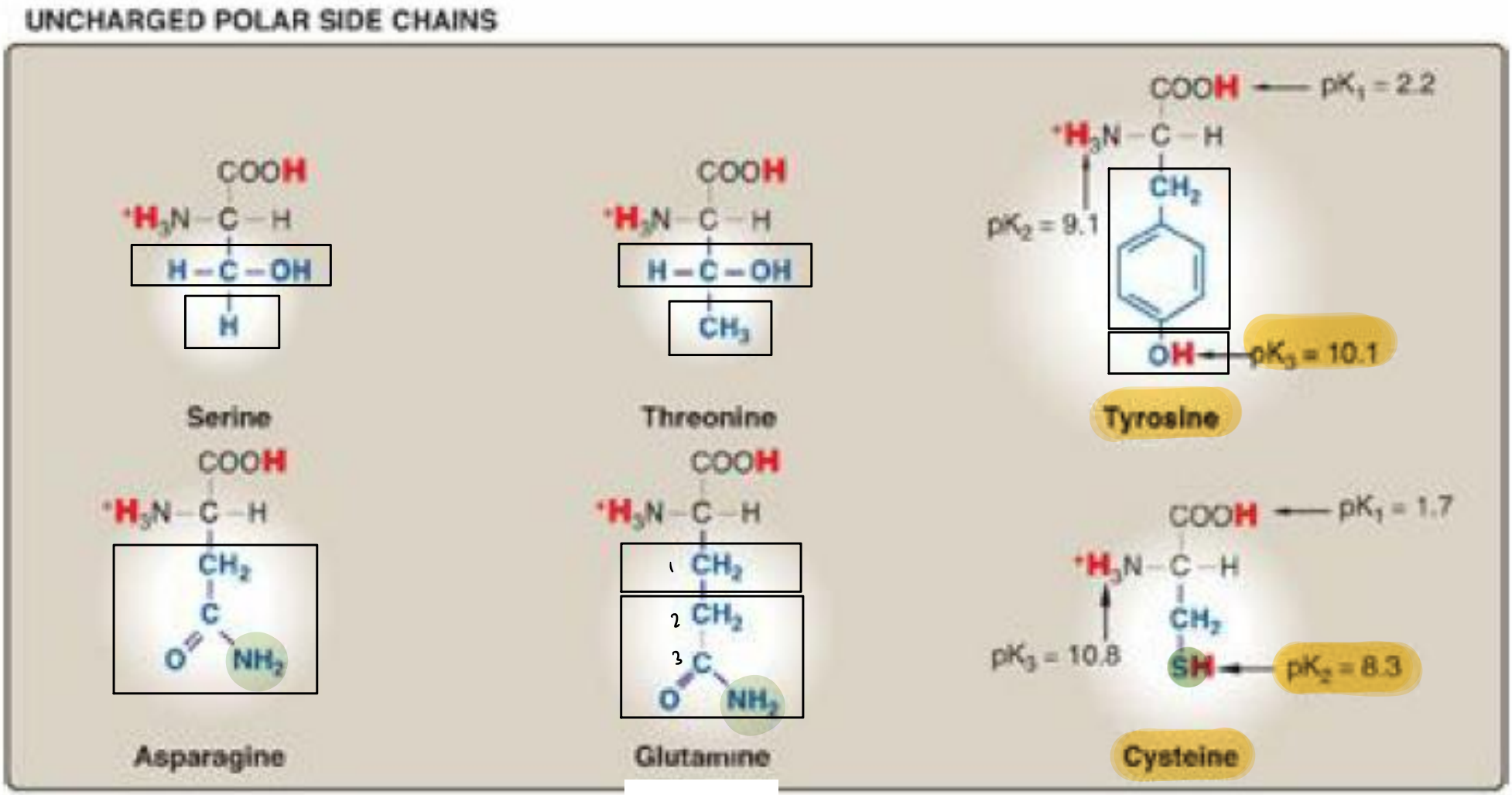


Cysteine



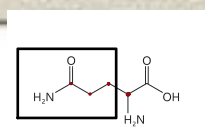
Cystine (dimer)

2. Uncharged polar amino acids



OH pKa = 10.1

SH pKa = 8.3



GLUTAMINE

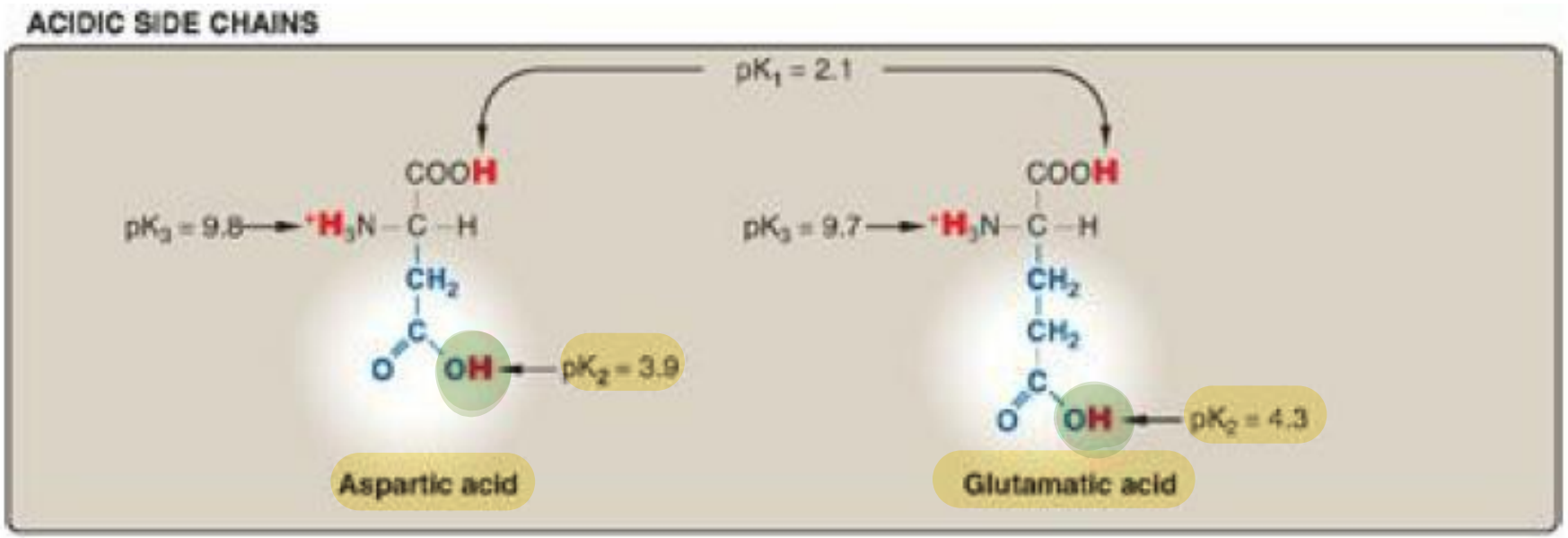
3. Acidic amino acids

E

(Asp D)

- Include: aspartic acid, Glutamic acid

- The side chain dissociate to COO^- at physiological pH = 7.40



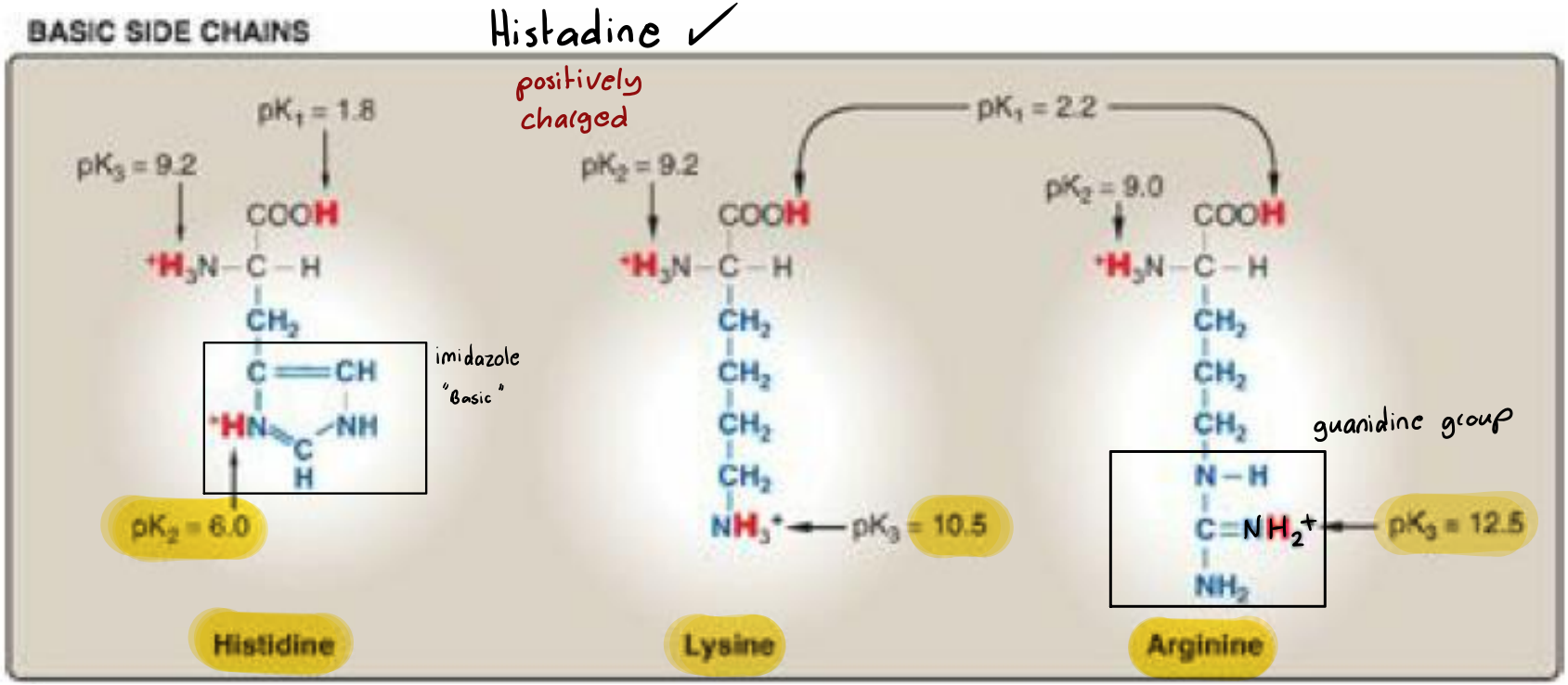
4. Basic amino acids

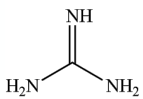
H K R

- Include Histidine, Lysine and Argenine

- Side chain is protonated and generally has a positive charge at physiological pH.

COO⁻ so glutamate has an ionic bond with Histadine ✓ positively charged





Guanidine group

حفظ PKa

زي هيك ↓

معلم نكون عارفين نميز بهذا ال structure

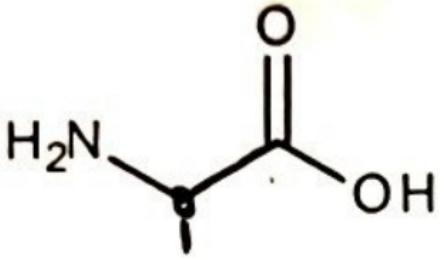
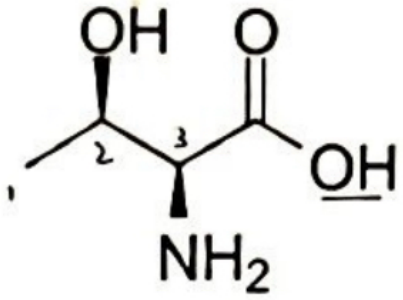
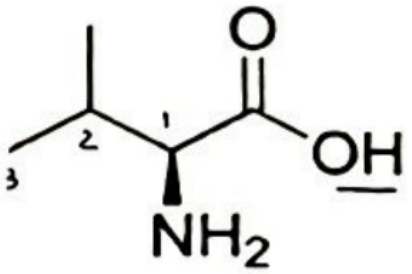
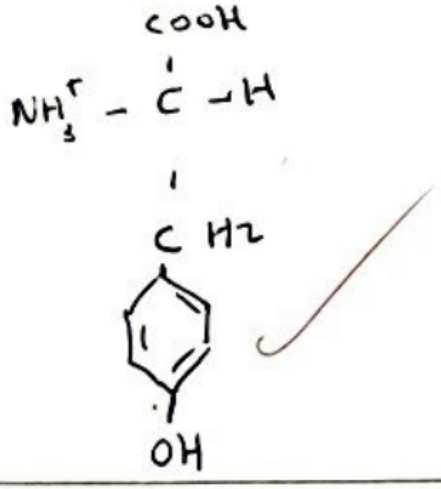
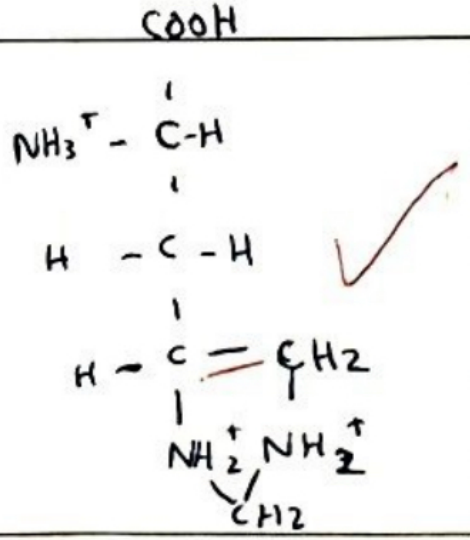
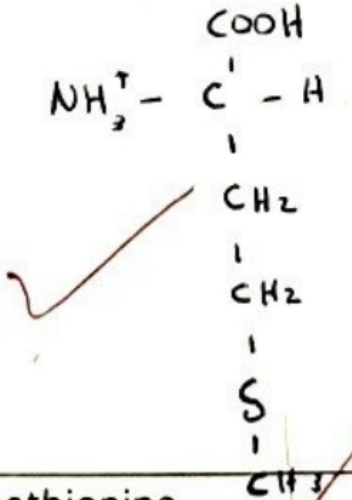
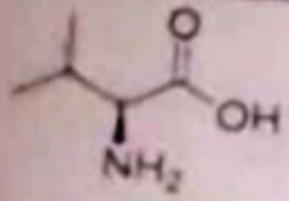
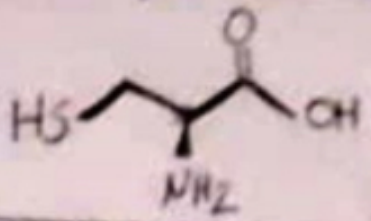
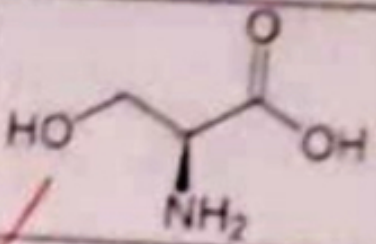
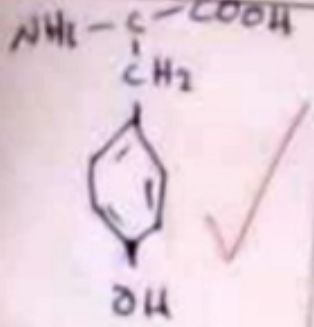
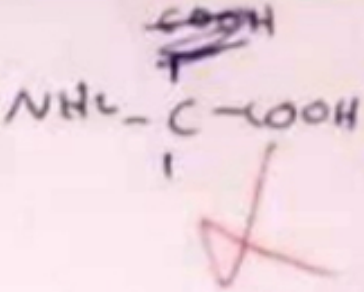
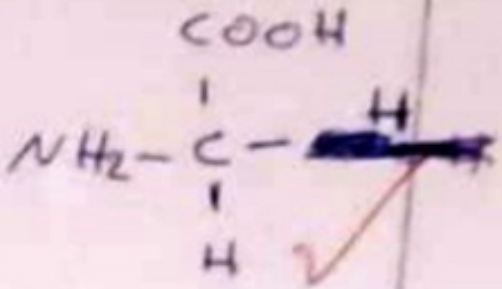
Chemical structure			
The amino acid	~~Serine~~ Glycine	Theronine	valine
One letter abbreviation	~~S~~ G	T	V

Table B:

Chemical structure			
The amino acid	Tyrosine	Histidine	methionine
One letter abbreviation	Y	H	M

(6 pts)

Chemical structure			
The amino acid	Valine ✓	~~Aspartic~~ cystein ✓	Serin ✓
One letter abbreviation	V ✓	[redacted] C ✓	S ✓
Chemical structure	 ✓	 ✗	 ✓
The amino acid	Tyrosine ✓	Histidine ✓	Glycine ✓
One letter abbreviation	Y ✓	H ✓	G ✓

Intiraction between side chain arginine and glutamaic acid شو نوع الروابط يلي يكونوهم

الخيارات

ionic

covalent

dipole- dipole

van der wal

All of the above

Mismatched sentences about values of di

Glutamate has an ionic bond with His

Coulombs law relation ($F = \frac{kq_1q_2}{r^2}$)

ionized form of glutamic acid COO^- some goes to Aspartate

Abbreviations and symbols of amino acids

1 Unique first letter:

Cysteine	= Cys =	C
Histidine	= His =	H
Isoleucine	= Ile =	I
Methionine	= Met =	M
Serine	= Ser =	S
Valine	= Val =	V

2 Most commonly occurring amino acids have priority:

Alanine	= Ala =	A
Glycine	= Gly =	G
Leucine	= Leu =	L
Proline	= Pro =	P
Threonine	= Thr =	T

3 Similar sounding names:

Arginine	= Arg =	R	("aRginine")
Asparagine	= Asn =	N	(contains N)
Aspartate (acid)	= Asp =	D	("asparDic")
Glutamate (acid)	= Glu =	E	("glutEmate")
Glutamine	= Gln =	Q	("Q-tamine")
Phenylalanine	= Phe =	F	("Fenylalanine")
Tyrosine	= Tyr =	Y	("tYrosine")
Tryptophan	= Trp =	W	(double ring in the molecule)

amidic

4 Letter close to initial letter:

Aspartate or asparagine	= Asx =	B	(near A)
Glutamate or glutamine	= Glx =	Z	
Lysine	= Lys =	K	(near L)
Undetermined amino acid	=	X	

acids

Name	Abbreviation	Symbol	Name	Abbreviation	Symbol
Alanina	Ala	A	Methionine	Met	M
Cysteine	Cys	C	Asparagine	Asn	N
Aspartic Acid	Asp	D	Proline	Pro	P
GlutamicAcid	Glu	E	Glutamine	Gln	Q
Phenylalanine	Ph	F	Arginine	Arg	R
Glycine	Gl	G	Serine	Ser	S
Histidine	His	H	Threonine	Thr	T
Isoleucine	Ile	I	Valine	Val	V
Lysine	Lys	K	Tryptophan	Trp	W
Leucine	Leu	L	Tyrosine	Tyr	Y

https://youtu.be/JQYHLRkLF_k?si=luGTLDEXenuLk1VY to memorize Amino acids structures

Amino acid	3-letter	1-letter
Aspartic acid / Aspartate	Asp	D
Glutamic acid / Glutamate	Glu	E
Asparagine	Asn	N
Glutamine	Gln	Q

Sometimes we **cannot distinguish** between:

🔹 **Aspartate (D) and Asparagine (N)**

So we use:

- B = Asp OR Asn

👉 Why B? Just a convention (think "both similar")

🔹 **Glutamate (E) and Glutamine (Q)**

So we use:

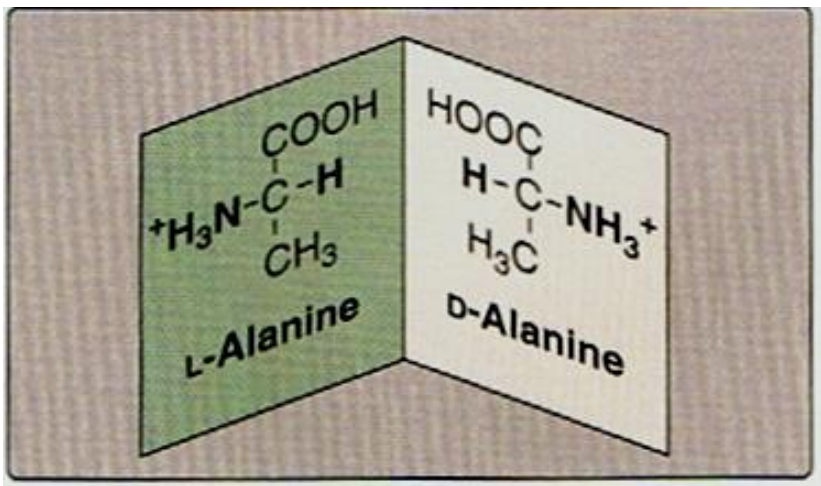
- Z = Glu OR Gln

glycine is the only amino acid that is not chiral (No L/D configuration)

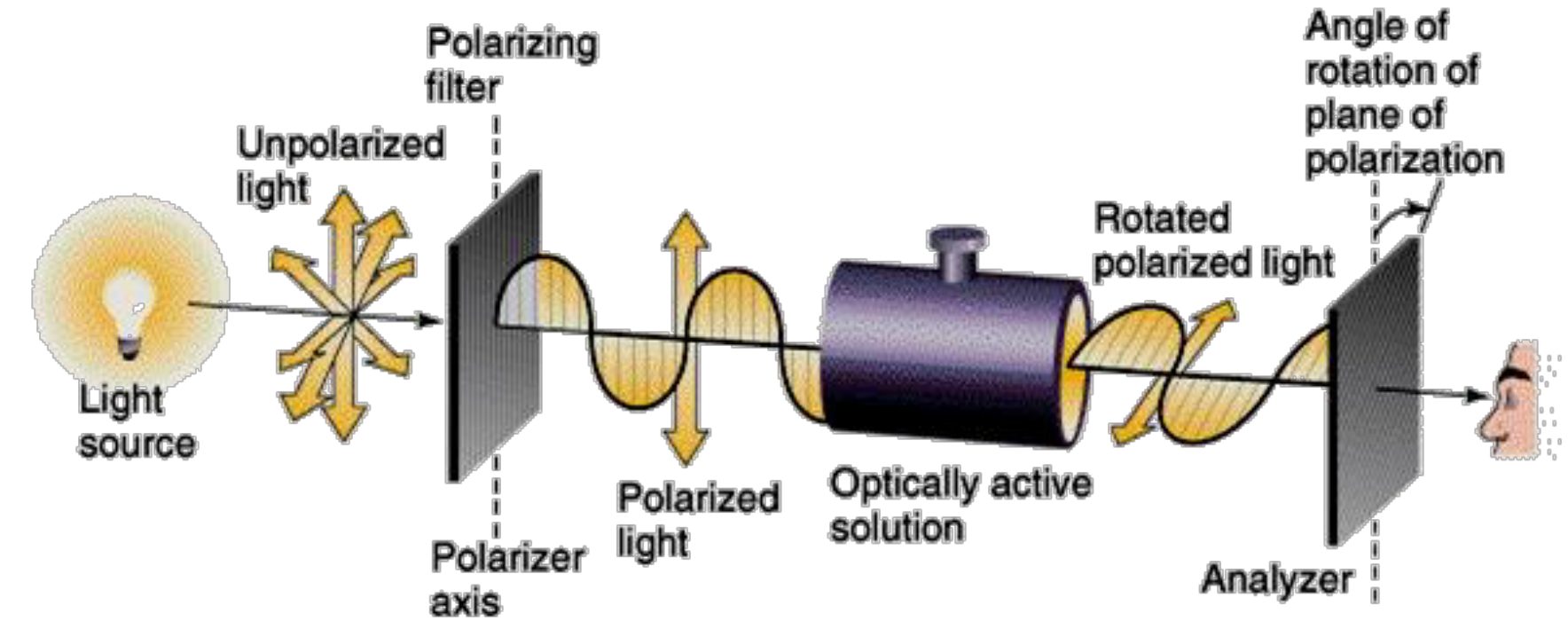
Optical properties of amino acids

https://youtu.be/LHNNQIMt5x0?si=6Fh9NxMfxXMWAU8r

- With the exception of glycine, the α-carbon of all aa's is optically active (chiral)
- a.a. Exist in two forms, L and D, which are mirror images
- All amino acids found in proteins are of the L-configuration
- D- amino acids are found in some antibiotics and in bacterial cell walls

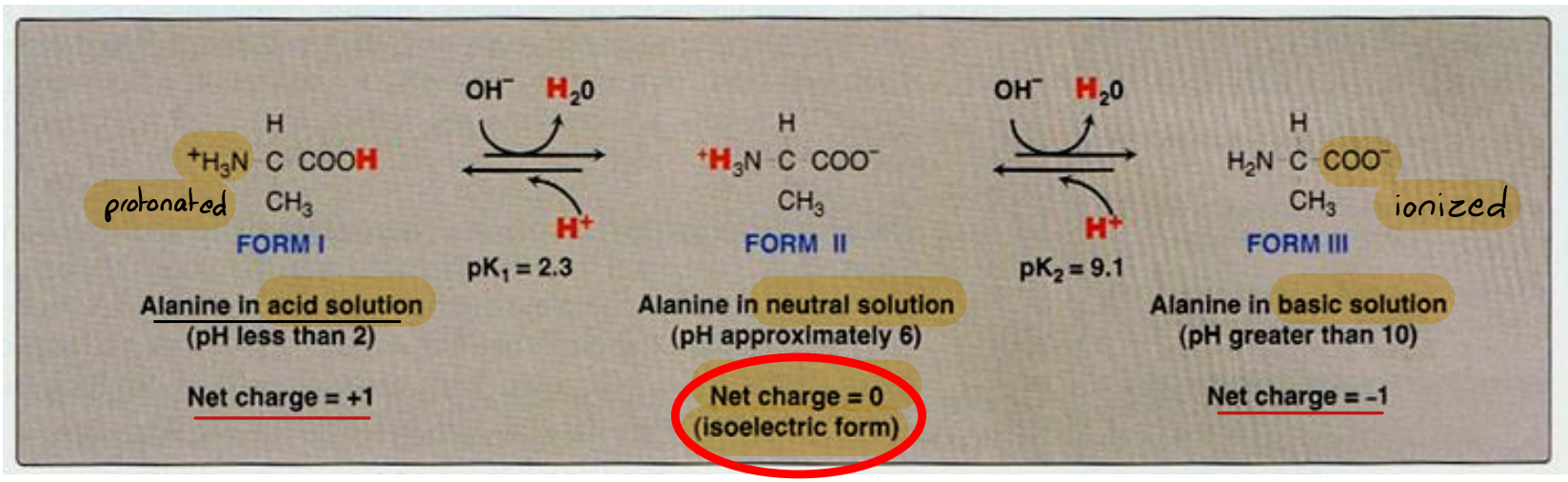


Optical properties of amino acids



Acidic and basic properties of amino acids

- Amino acids can act as buffers



- The quantitative relationship is described by Henderson-Hasselbalch equation:

$$pH = pK_1 + \log \frac{[II]}{[I]}$$

pKa لنطلع

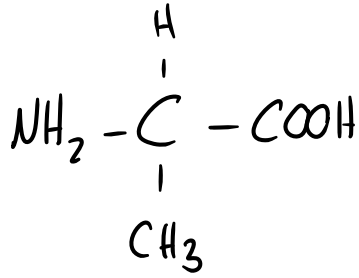
① خلي Amino acid acidic
H^+ addition

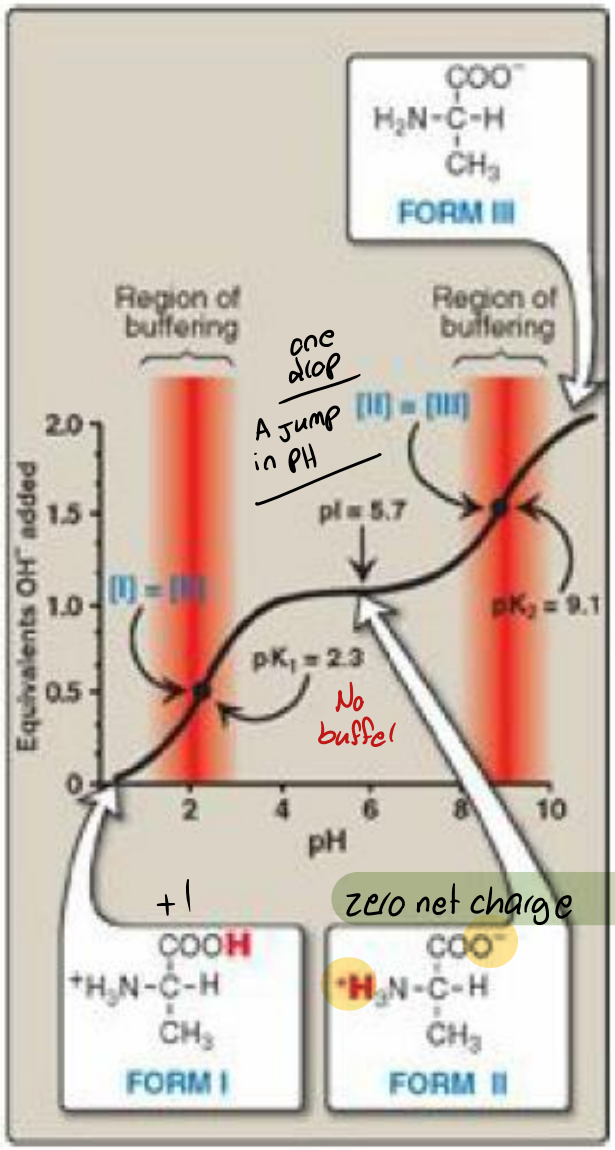
② نعمل titration by adding NaOH

③ COOH يتفاعل مع OH ويكون H_2O water

$\rightarrow$ COO^- ionized

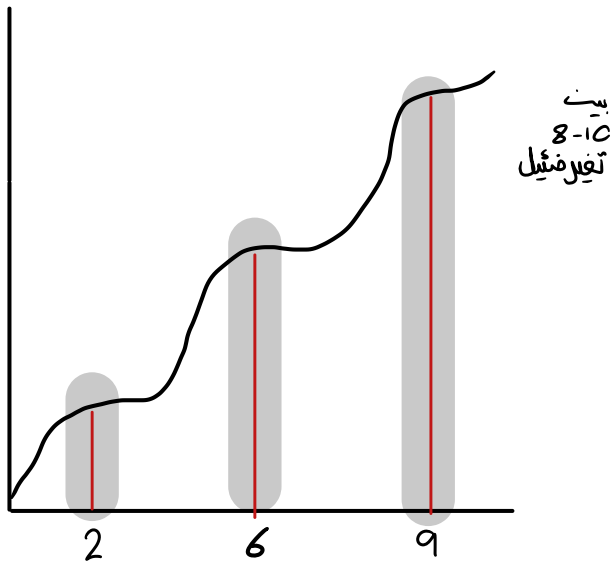
Titration curve for alanine





pH

zero net charge (isoelectric point)



بين 8-10 تغير فيزيائي

between 7.5

Histadine لو عندي

PKa = 6

Isoelectric point (pI)

- At Its Isoelectric pH (pI), an Amino Acid Bears No Net Charge (zero)
- The isoelectric pH is calculated as the pH midway between p*K*a values on either side of the isoelectric species.
- Example: alanine has only two dissociating groups, p*K*a (R-COOH) is 2.35 and p*K*a (R-NH_3^+) is 9.69. The isoelectric pH (pI) of alanine is

  pI = (pKa1 + pKa2)/2 = 6.02

- For polyfunctional acids, pI is also the pH midway between the p*K*a values on either side of the isoionic species. For example, the pI for aspartic acid is

  pI = (pKa1 + pKa2)/2

  (2.09 + 3.96)/ 2 = 3.02

Q.2 calculate the isoelectric points for the following (show your calculation):

a. Proline pKa1=1.99, pKa2=10.6 (2 pts)

$$\frac{pK_1 + pH_2}{2} = 6,295$$ ✓

b Glutamic acid pKa1=2.17 pKa2=5.65 pKa3=9.13

pH=1 2,17 pH=3 5,65 pH=7 9,13 pH=10

net charge 0,00

$$\frac{2,17 + 5,65}{2} = 3,91$$

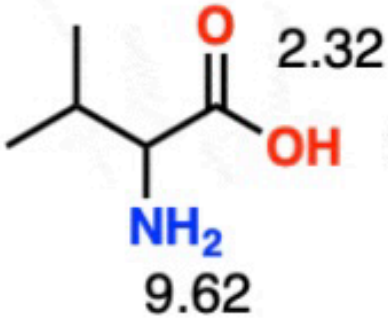
وسؤال عن isoelectric point of histidine
وأعطتنا ٣ قيم من pka وبنجمع أعلى قيمتين وهم
بنفس الوقت أقرب قيمتين ع بعض وبنقسم ع ٢

جابت سؤال شو pka of amino group if
(pka1=2.2 , Pka2= 6 , Pka3 = 9.2)

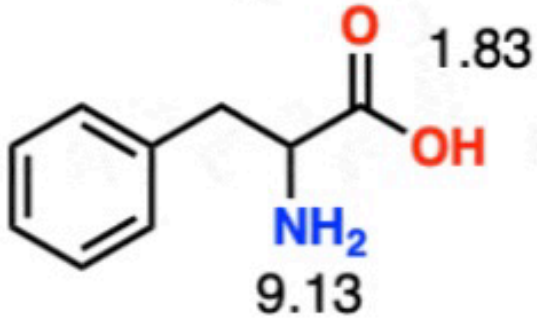
كونه سألت عن الamino group فال pka = 9.2

و برضو سؤال عن pl بنوخد اعلى قيمتين و بنقسم ع ٢ بعتقد الجواب 10,86

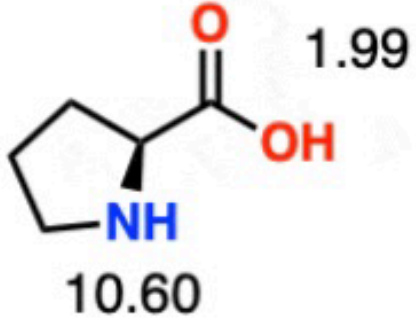
Calculate the isoelectric points for the following amino acids, given their pK_a values



Valine pI = 5.97



Phenylalanine pI = 5.48



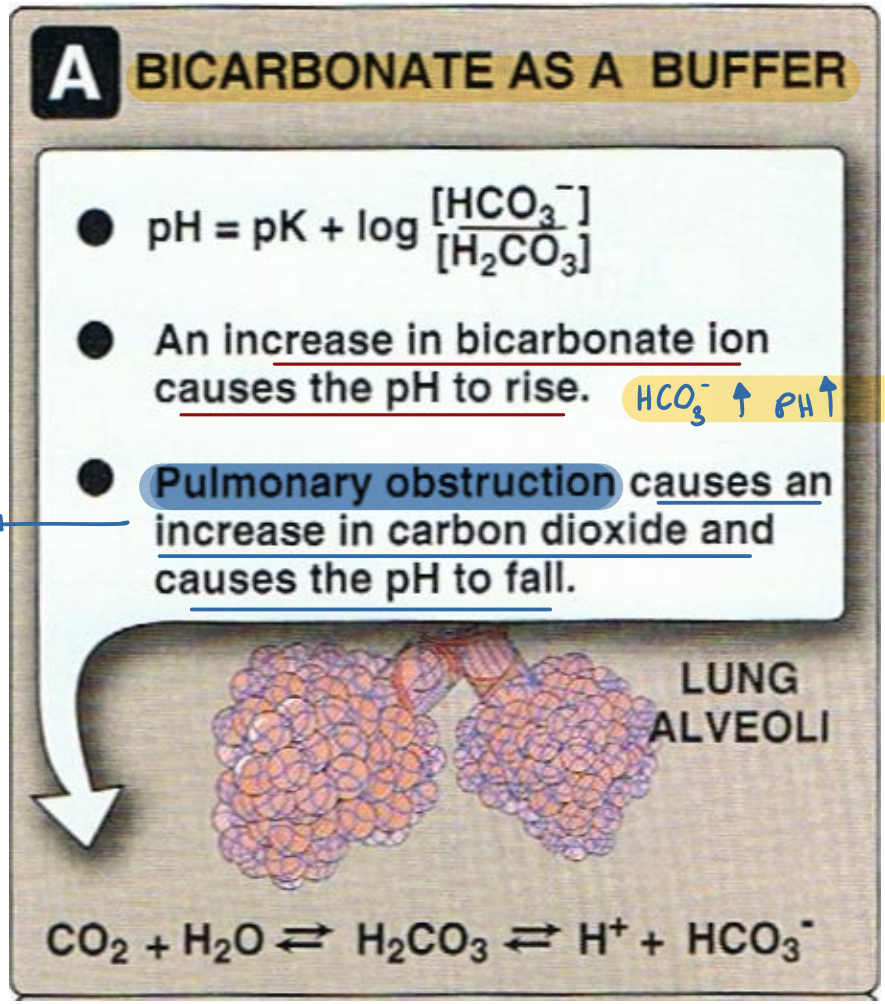
Proline pI = 6.3

note 8

(uncharged) unionized بسبب يقلل absorption

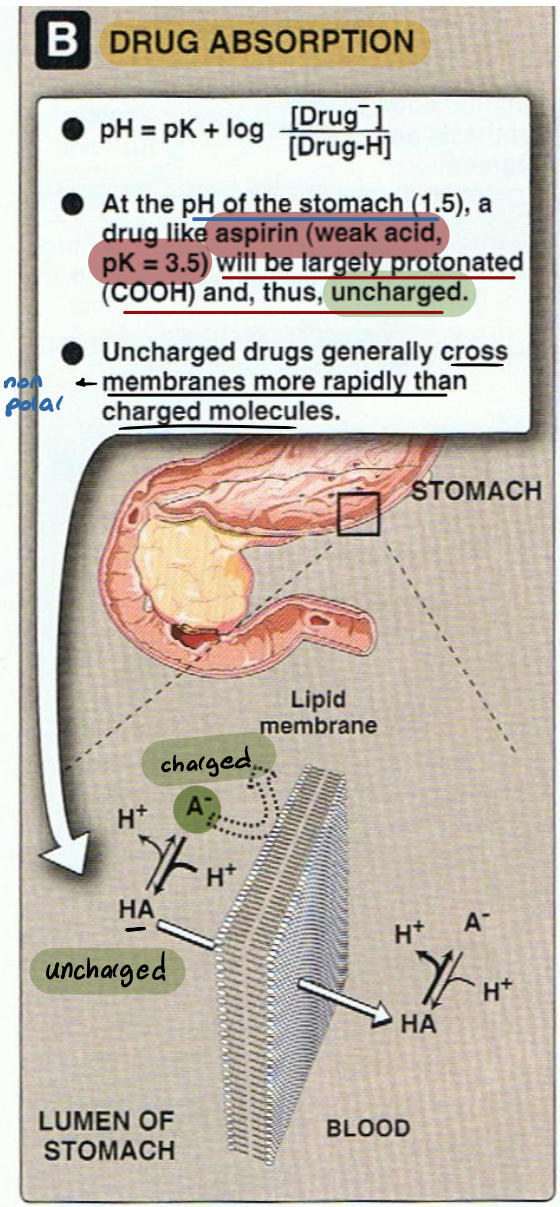
membrane is nonpolar

Application on buffer effect



HCO_3^- ↑ pH ↑ H^+ ↓ CO_2 ↓

CO_2 ↑ تخفض pH ↓



non polar

Aspirin absorption ↑

No Base absorption in stomach

In intestine 80%

/ we prefer acidic drugs

Biological importance of proteins

1. Proteins are essential component of membranes.

- transporter
- receptor

2. Plasma membrane proteins regulate the transfer of various substances across the cell membrane or act as *receptors*.

3. All enzymes are protein in nature.

4. All antibodies (immunoglobulins) are protein in nature, play an important role in the bodies' defensive mechanisms.

5. Some hormones are proteins in nature e.g. insulin, glucagon, and growth hormone.

(1) (2) (3)

6. *Hemoglobin* carries oxygen in the blood and *myoglobin* stores O_2 in muscles. Both are proteins in nature.

= muscle

unlike hemoglobin, myoglobin :

act as reservoir for oxygen إنه الجواب كان

كان سؤال عن اياهم مش بروتين

All receptors

All enzymes

All antibody

Hemoglobin

All hormones ✗ اشي هيك

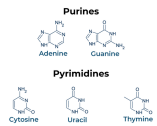
Biological importance of proteins

7. Some proteins are protective e.g. *keratins* make the skin resistant to chemicals. Others have supportive functions e.g. *collagen and elastin*.

support = collagen / elastin

protect = Keratins

8. Amino acids are converted to other substances of great physiologic importance e.g. creatine, heme, histamine, serotonin, purines and pyrimidines.



nucleotide

9. *Actin* and *myosin* are contractile proteins found in muscle cells and are responsible for muscular contraction.

(1)

10. Plasma proteins can carry: lipids forming lipoprotein complexes; (2) hormones (e.g. thyroid and steroid hormones) and minerals (3) (e.g. calcium and copper).

Ca^{+2} Cu

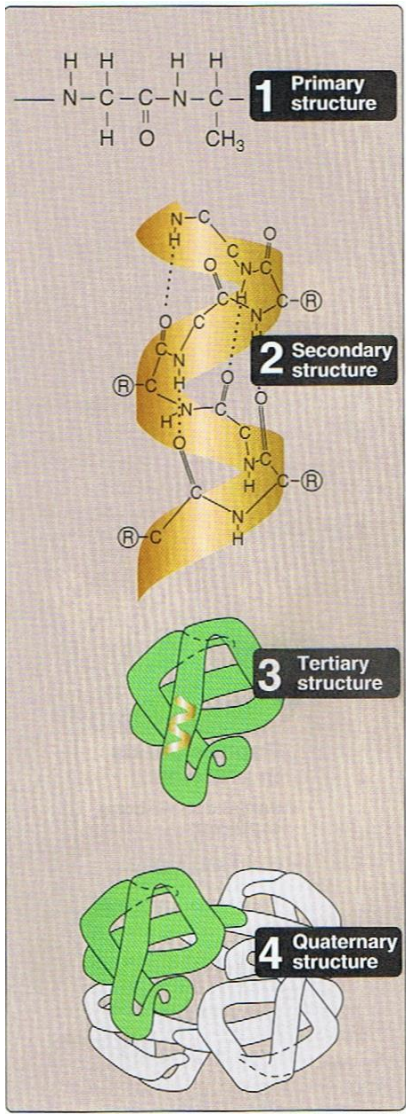
Structure of proteins

primary
secondary
tertiary
quaternary

- The are four levels of protein structures:

1. Primary structure: the amino acid sequence of proteins.
2. Secondary structure: α-helices and β-sheets.
3. Tertiary structure: the three dimensional structure of protein
4. Quaternary structure: arrangement of polypeptide subunits

- The folding of the protein ranges from simple combinations of α -helices and β-sheets forming small motifs to the complex folding of polypeptide domains of multifunctional proteins.



proteins → polypeptide → oligopeptides → Amino acids

Big (15-50) 15< small

50>

Classification of proteins

- Oligopeptides: Peptides with fewer than 15 residues e.g., gonadotropin-releasing hormone [GnRH] contains 10 residues

- Polypeptides: Peptides consisting of 15 to 50 residues e.g., adrenocorticotropin hormone consists of 39 residues.

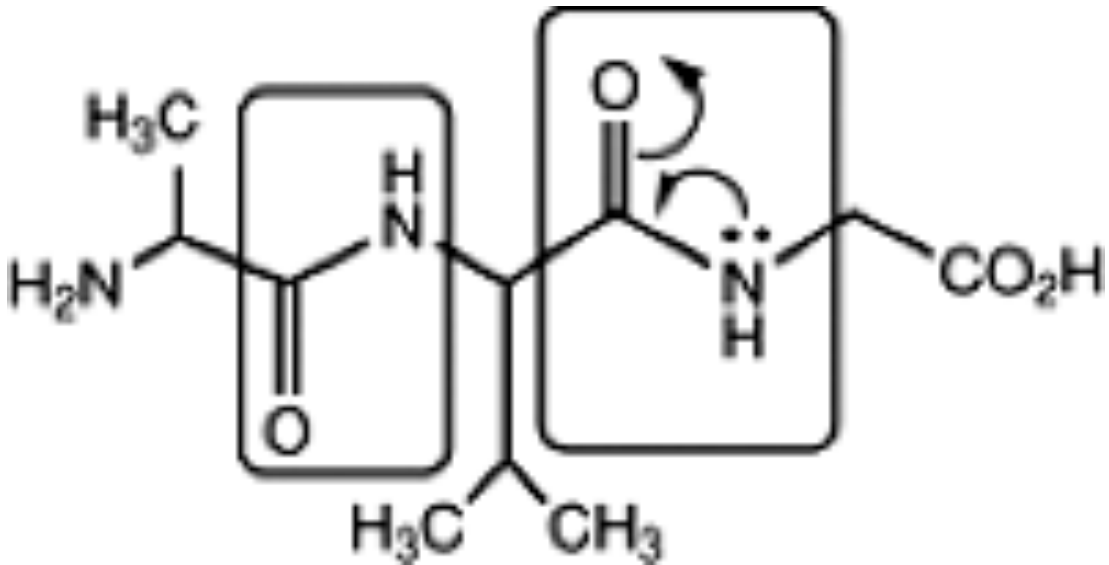
  ACTH

- Protein: polypeptide that contains more than 50 amino acid residues e.g., parathyroid hormone contains 84 residues

GnRH → 10 a.a

ACTH → 39 a.a

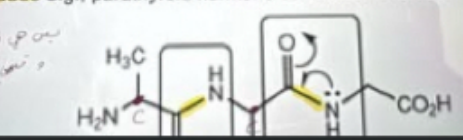
parathyroid H → 84 a.a



هدول جابتهم و خربطت بالأمثلة

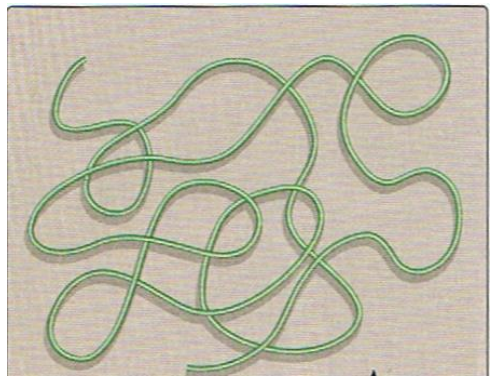
Classification of proteins

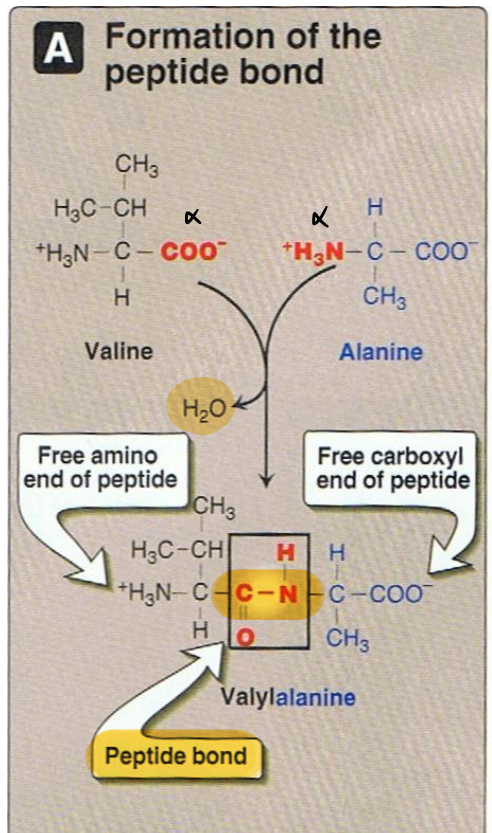
- **Oligopeptides**: Peptides with fewer than 15 residues e.g., gonadotropin-releasing hormone [GnRH] contains 10 residues
- **Polypeptides**: Peptides consisting of 15 to 50 residues e.g., adrenocorticotropin hormone consists of 39 residues.
- **Protein**: polypeptide that contains more than 50 amino acid residues e.g., parathyroid hormone contains 84 residues



1. Primary strucure covalent bonds

- The amino acid sequence of proteins
- Genetic diseases occurs due to defect in the amino acid sequence leading to improper folding and impairment of function.
- In proteins, amino acids are joined covalently by peptide bonds, which are amide linkages between the α-carboxyl group of one amino acid, and the α-amino group of another.
- The peptide bond of the protein can be hydrolyzed by prolonged exposure to acid or base at high temperature or enzymatically.





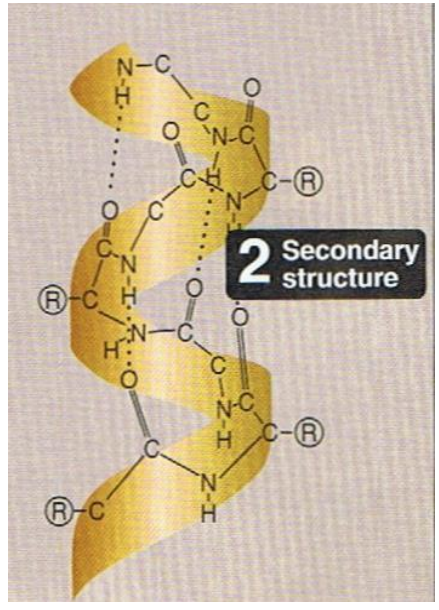
2. Secondary structure hydrogen bonds

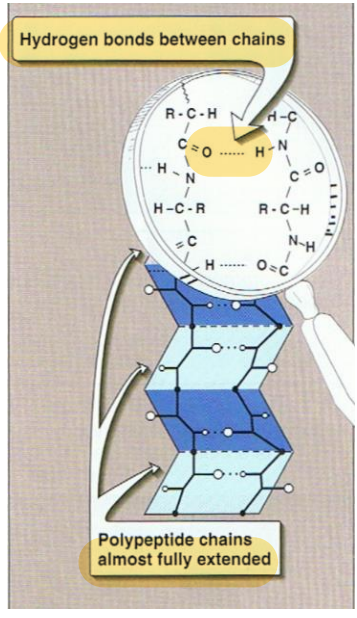
- The secondary structure of protein is stabilized by hydrogen bonding only
- Folding of the protein to:

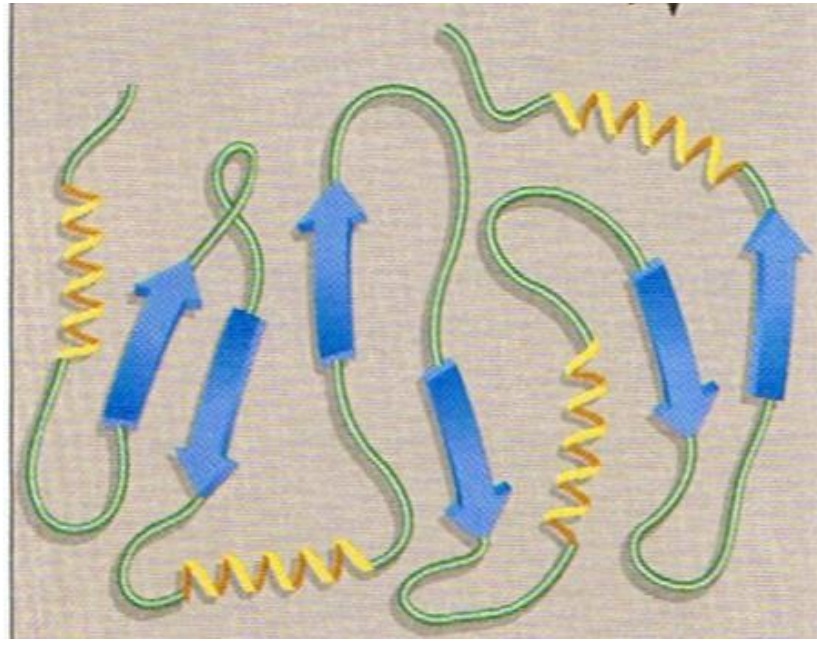
1. α-helix:

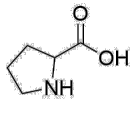
2. β-pleated sheats: can be parallel or antiparallel

3. β-turns: usually at the surface of the protein, contains usually proline which causes a kink the structure in addition to glycine.





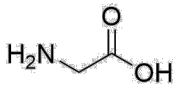




Proline

α-helices بكسر

Achiral وحيد



Glycine

Q.3. Mention two types of protein folding that occurs at the secondary level of protein creation?

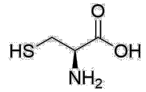
a- helix alpha

b- Sheet Beta

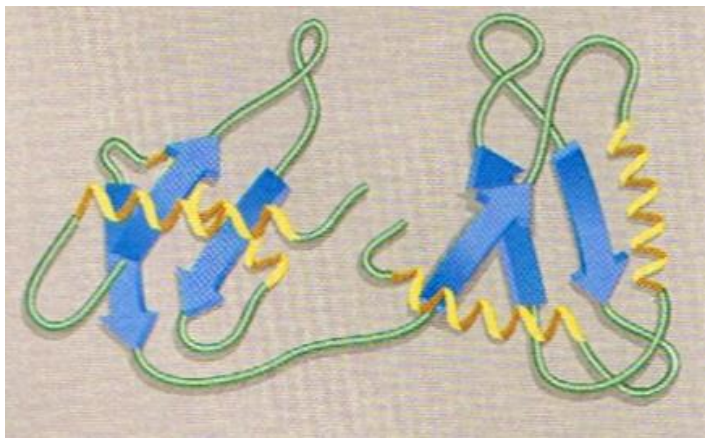
3. Tertiary structure like myoglobin

- The tertiary structure is the three dimensional structure of proteins (folding of the domains)
- The protein tends to fold correctly with a low energy state.
- Interactions stabilizing the tertiary structure:

1. Disulfide bond: in presence of Cysteine which forms a covalent bond (-S-S-)
2. Hydrophobic interactions
3. Hydrogen bonding
4. Ionic interactions



Cysteine



👉 Quaternary structure = interaction between TWO OR MORE subunits

4. Quaternary structure

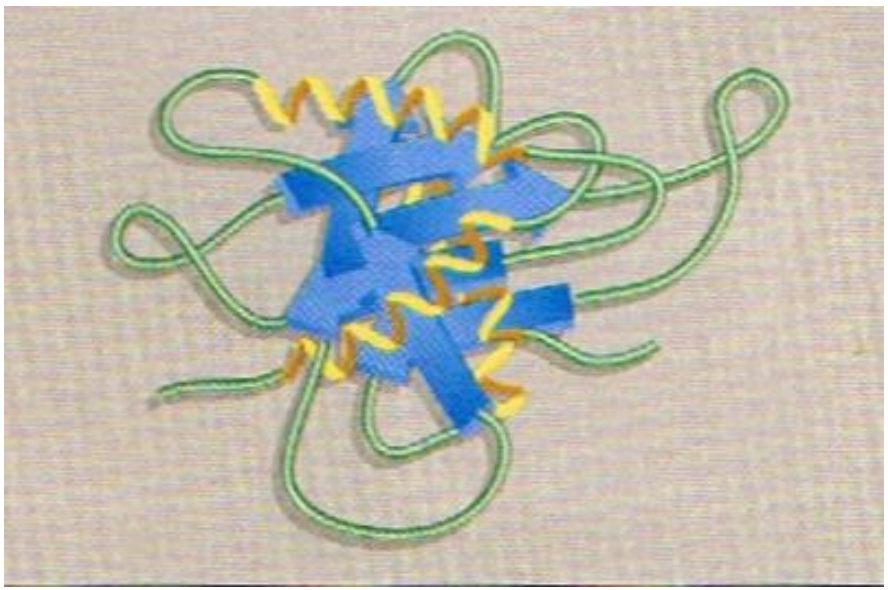
like hemoglobin

non covalent interactions

- The polypeptide can be one domain (monomer), dimer, trimer depends on the number of subunits.

- A specialized group of proteins (called chaperones) are required for the proper folding of the protein.

regulation



Question:
Which of the following is an **incorrect match** between protein structure level and its stabilizing bond?

A) Primary protein → covalent bond
B) Secondary protein → ionic bond
C) Tertiary protein → disulfide bond
D) Quaternary protein → covalent bond
E) None of the above
F) Two of the above

Answer: F) Two of the above (B, D)

جابت ايش الي ما بعمل denaturation
الجواب chaperones

Denaturation of the proteins

- Unfolding of protein: occurs due to different factors:
  - Urea CH_4N_2O
  - Extreme pH and temperature
  - Organic solvents

- Leads to loss of secondary and tertiary structure and hence, loss of function.

- Most of proteins can't refold upon removal of the denaturant (irreversible denaturation)

معلميا

1- Alzheimer

2- mad-cow

Diseases related to denaturation of proteins

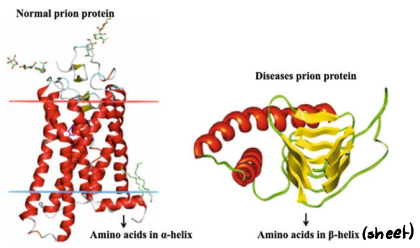
- **Alzheimer disease**:

  Normal proteins, after abnormal chemical processing, take on a unique conformational state that leads to the formation of neurotoxic amyloid protein assemblies consisting of β-pleated sheets.

  amyloid protein يكون soluble → تعرضا لـ oxidatives منفوطات → α helix → β-sheet → يترسب في neurons تتلف

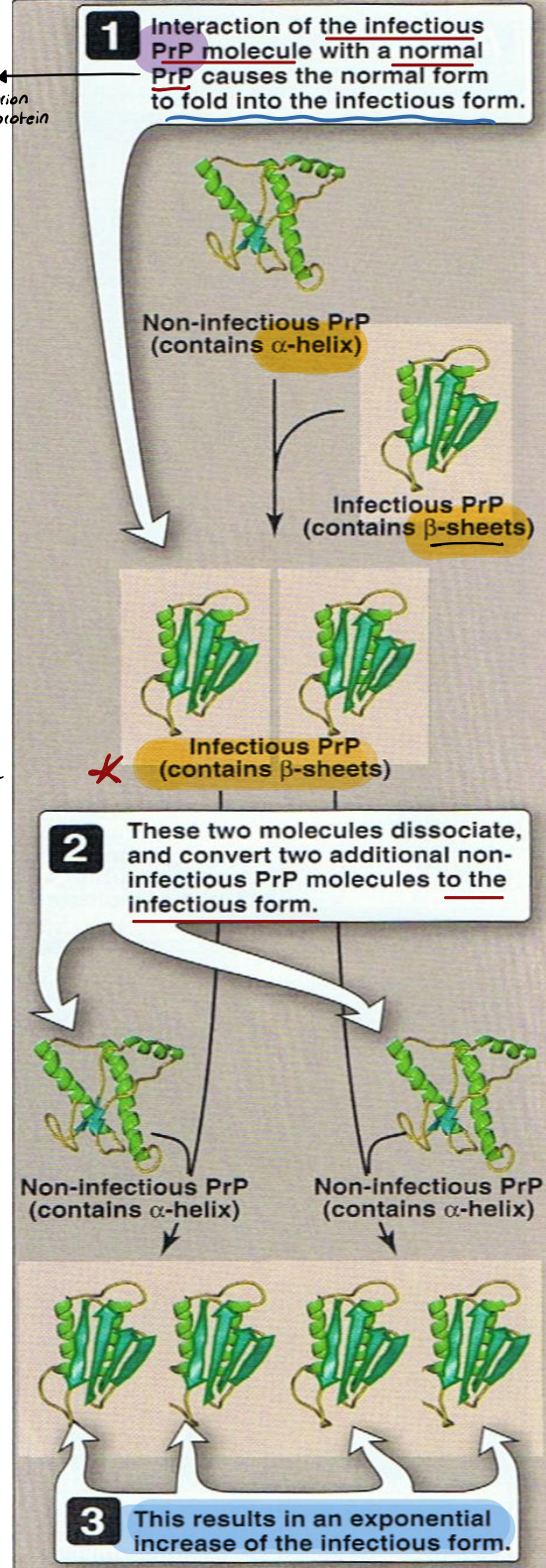
- In Transmissable Spongiform Encephalopathy 5 (Mad cow disease): (TSEs)

  معدي The infective agent is an altered version of a normal prion protein that acts as a "template" for converting normal protein to the pathogenic conformation.



معدي فيه β-sheets

غير معدي فيه α-helix



Q3 Mention two examples of diseases related to denaturation of protein? (2 pts)

1) Alzahaimar

2) Mad cow

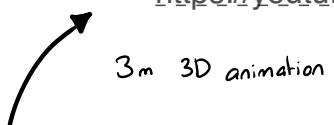
Biosynthesis of protein

- The information that tells a cell how to build the proteins it needs to survive is coded in the structure of the DNA in the nucleus of that cell.

- Because there are only four nucleotides and there are 20 amino acids that must be coded. the nucleotides are grouped in threes, however, there are 64 possible triplets, or **codons**

- DNA only stores the genetic information, while RNA is responsible of its translation to protein

https://youtu.be/gG7uCskUOrA?si=JJGoPhp3n-YWl_Ib



Biosynthesis of protein

1- transcription
2- translation
3- post transational modification

nucleus

1. Transcription

DNA → mRNA

نسخ

- Before the information in DNA can be decoded, a small portion of the DNA double helix must be uncoiled
- A strand of RNA is then synthesized that is a complementary copy of one strand of the DNA using RNA polymerase.
- RNA uses U where T would be found in DNA and base pairing occurs between two chains that run in *opposite directions*. The RNA complement of this DNA should therefore be written as follows.
- 3´ T-A-C-A-A-G-C-A-G-T-T-G-G-T-C-G-T-G... 5´ *DNA*
- 5´ A-U-G-U-U-C-G-U-C-A-A-C-C-A-G-C-A-C... 3´ *mRNA*

mRNA start from 5' end

5´ → 3´

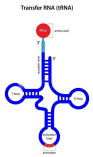
- Since this RNA strand contains the message that was coded in the DNA, it is called **messenger RNA**, or **mRNA**.

Biosynthesis of protein

mRNA → protein ← **2. Translation** ترجمة

- The messenger RNA now binds to a ribosome, where the message is translated into a sequence of amino acids.

- The amino acids that are incorporated into the protein being synthesized are carried by relatively small RNA molecules known as **transfer RNA**, or **tRNA**.



- There are at least 60 tRNAs, which differ slightly in their structures, in each cell. At one end of each tRNA is a specific sequence of three nucleotides that can bind to the messenger RNA. At the other end is a specific amino acid.

- each three-nucleotide segment of the messenger RNA molecule codes for the incorporation of a particular amino acid.

Biosynthesis of protein

2. Translation

- The signal to start making a polypeptide chain in simple, prokaryotic cells is the triplet AUG, which codes for the amino acid methionine (Met). The synthesis of every protein in these cells therefore starts with a Met residue at the *N*-terminal end of the polypeptide chain. After the tRNA that carries Met binds to the start signal on the messenger RNA, a tRNA carrying the second amino acid binds to the next codon. A dipeptide is synthesized when the Met residue is transferred from the first tRNA to the amino acid on the second tRNA.

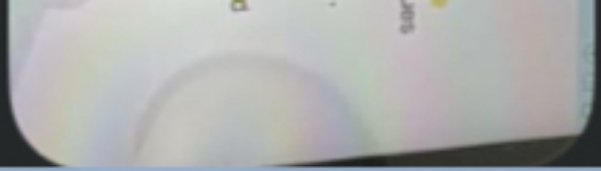
- The mRNA now moves through the ribosome, and a tRNA carrying the third amino acid (Val) binds to the next codon. The dipeptide is then transferred to the amino acid on this third tRNA to form a tripeptide.

- This sequence of steps continues until one of three codons is encountered: UAA, UGA, or UAG. These codons give the signal for terminating the synthesis of the polypeptide chain, and the chain is cleaved from the last tRNA residue

stop codons

UAG يا أنا جعان
UGA يا جعان أنا
UAA يا أنا أظرف

لتسهيل الحفظ



UAG / UGA / UAA

جابت عن stop codons وخربطت بترتيب الأحرف في الكودونات

Biosynthesis of protein
2. Translation

- The sequence of DNA described in this section would produce the following sequence of amino acids.

Met-Phe-Val-Asn-Gln-His-...

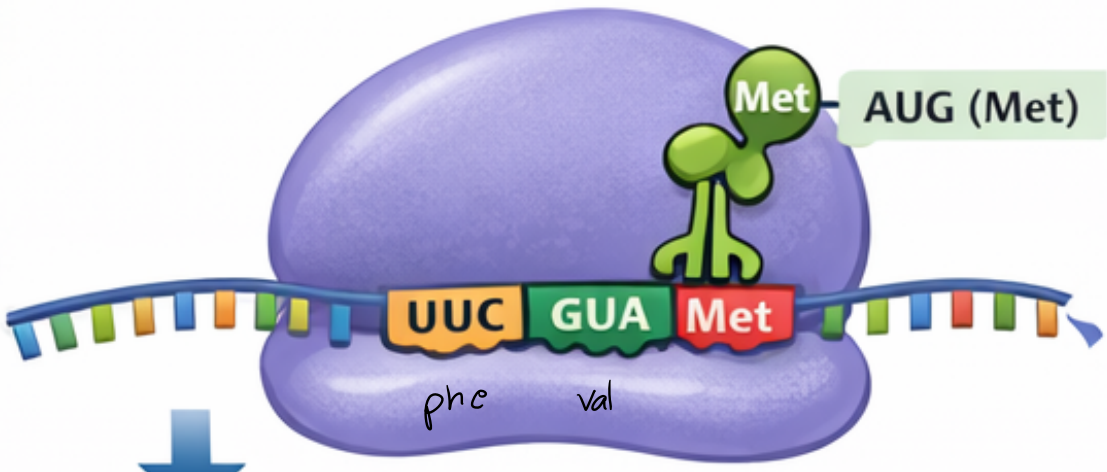
- This polypeptide is not necessarily an active protein. All proteins in prokaryotic cells start with Met when synthesized, but not all proteins have Met first in their active form.

- It is often necessary to clip off this Met after the polypeptide has been synthesized to give a protein with a different *N*-terminal amino acid

Translation (Protein Synthesis)

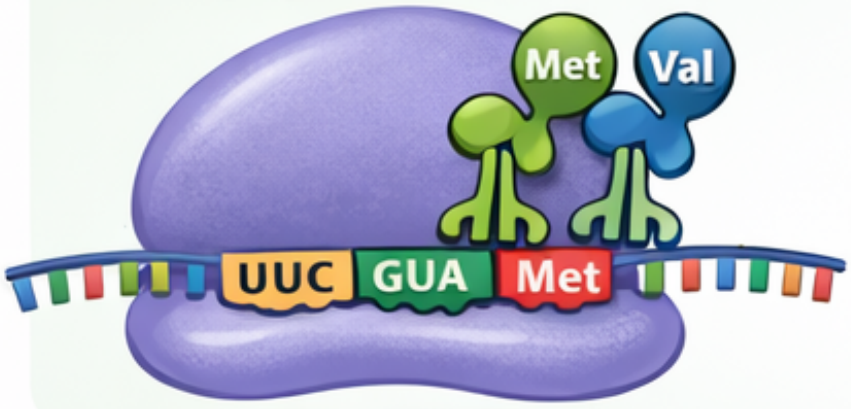
1. Initiation

- Start Codon: **AUG (Met)**
- tRNA with Methionine (Met)



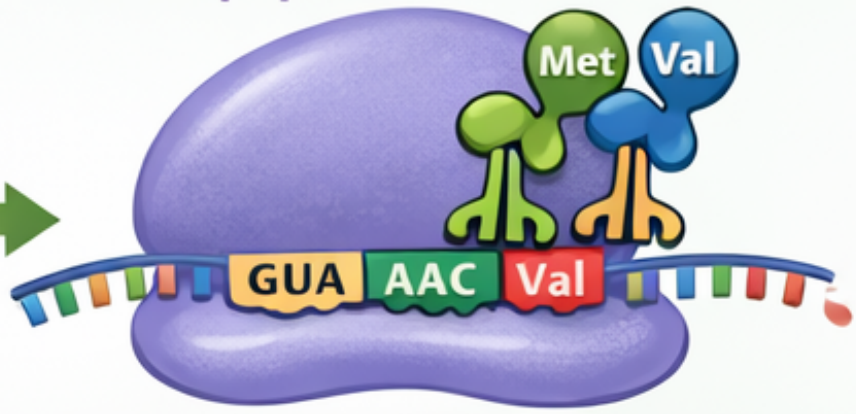
2. Elongation

A. Dipeptide



Met–Phe

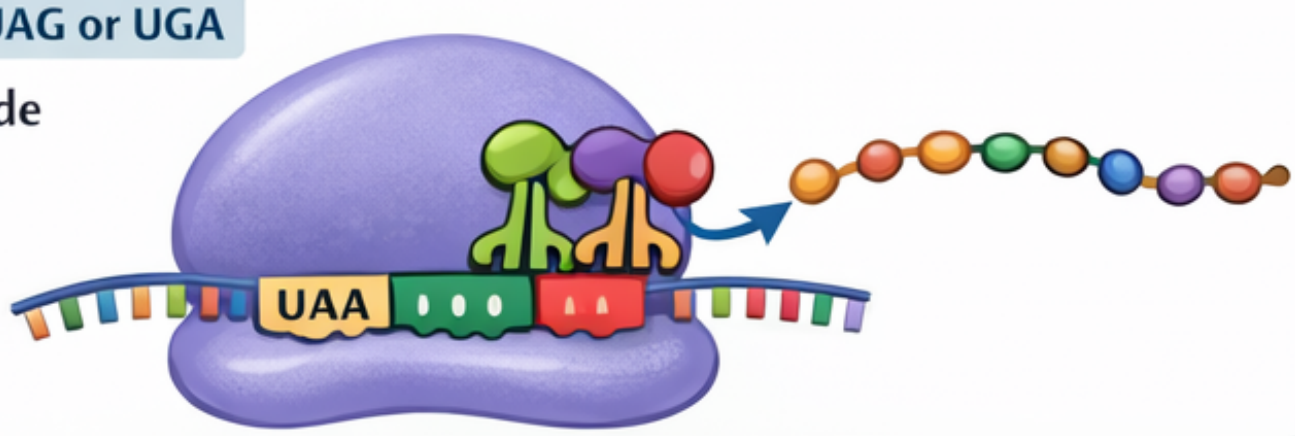
B. Tripeptide



Met–Phe–Val

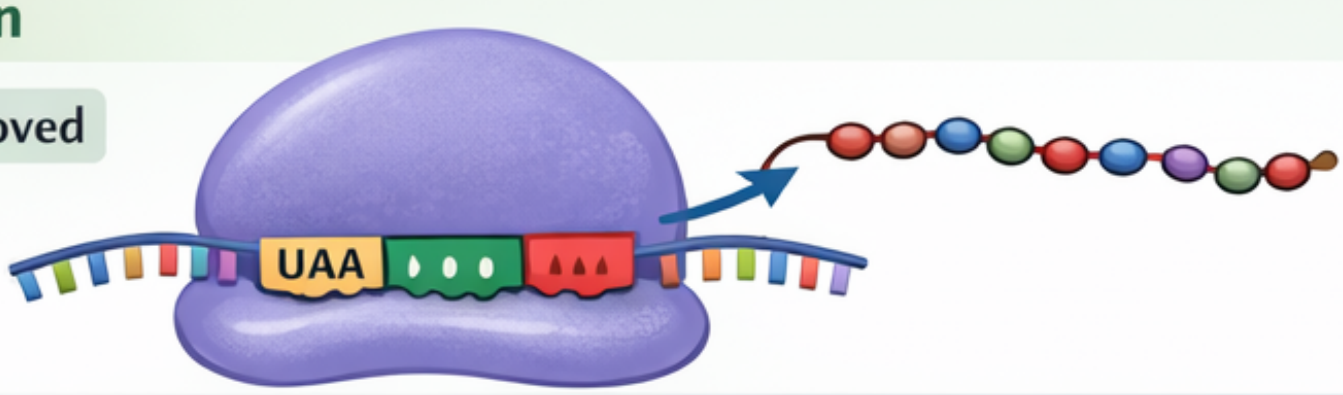
3. Termination

- Stop Codon: **UAA, UAG or UGA**
- Release of Polypeptide



4. Final Protein

Methionine Removed



Phe – Val – Val – Asn – Gln – His ...

Phe – Val – Asn – Gln – His

Biosynthesis of protein

3. Post-translational modification

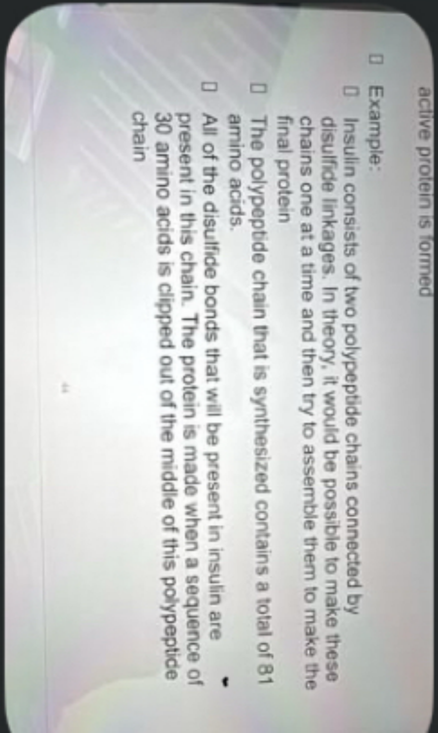
- Modifications to the polypeptide often have to be made before an active protein is formed

- Example: protein hormone
  - Insulin consists of two polypeptide chains connected by disulfide linkages. In theory, it would be possible to make these chains one at a time and then try to assemble them to make the final protein
  - The polypeptide chain that is synthesized contains a total of 81 amino acids.
  - All of the disulfide bonds that will be present in insulin are present in this chain. The protein is made when a sequence of 30 amino acids is clipped out of the middle of this polypeptide chain but the active insulin 51 amino acids

شو ممكن أستفيد من المعلومة؟ إذا مريض سكري يأخذ insulin

marker [كميتها كويسة c peptide
معناها البنكرياس يصنع insulin

هون جابت سؤال انه الأنسولين ينعطى على شكل سلسلة او سلسلتين لمرضى السكري


active protein is formed

- Example:
  - Insulin consists of two polypeptide chains connected by disulfide linkages. In theory, it would be possible to make these chains one at a time and then try to assemble them to make the final protein
- The polypeptide chain that is synthesized contains a total of 81 amino acids.
- All of the disulfide bonds that will be present in insulin are present in this chain. The protein is made when a sequence of 30 amino acids is clipped out of the middle of this polypeptide chain

2 polypeptide chains
linked by disulfide bonds.

A 16-year-old patient presents with symptoms of hyperglycemia. Laboratory results show:

- Blood glucose: High
- Plasma insulin level: High
- C-peptide level: Very low

Which of the following is the **most likely explanation**?

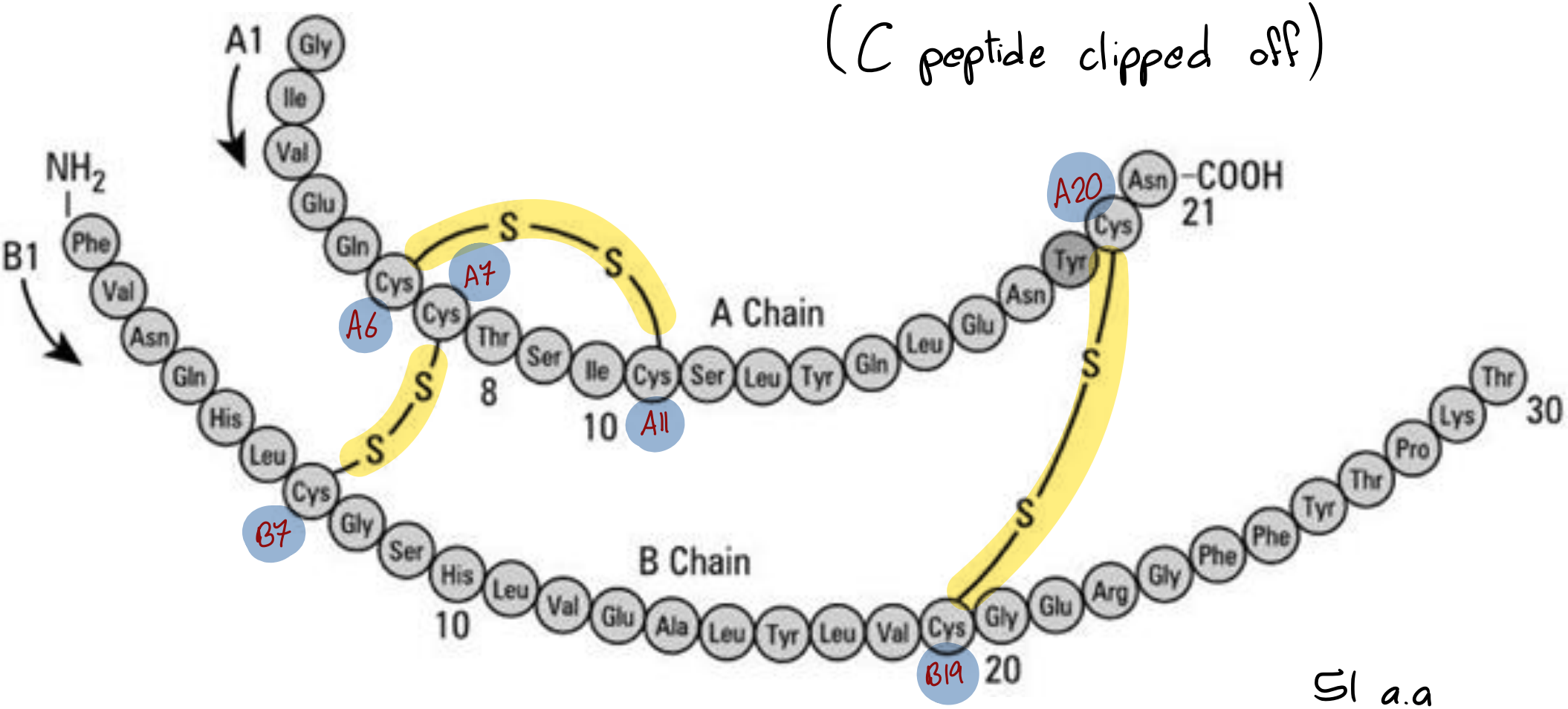
A) Increased endogenous insulin production by the pancreas
B) Insulin resistance with normal pancreatic function
C) Exogenous insulin administration

A chain + B chain = ?

Primary structure of human insulin

Chains A and B, including the interchain disulfide bonds A7-B7 and A20-B19 and intrachain disulfide bond A6-A11

(C peptide clipped off)



51 a.a

Tertiary and quaternary structure of insulin