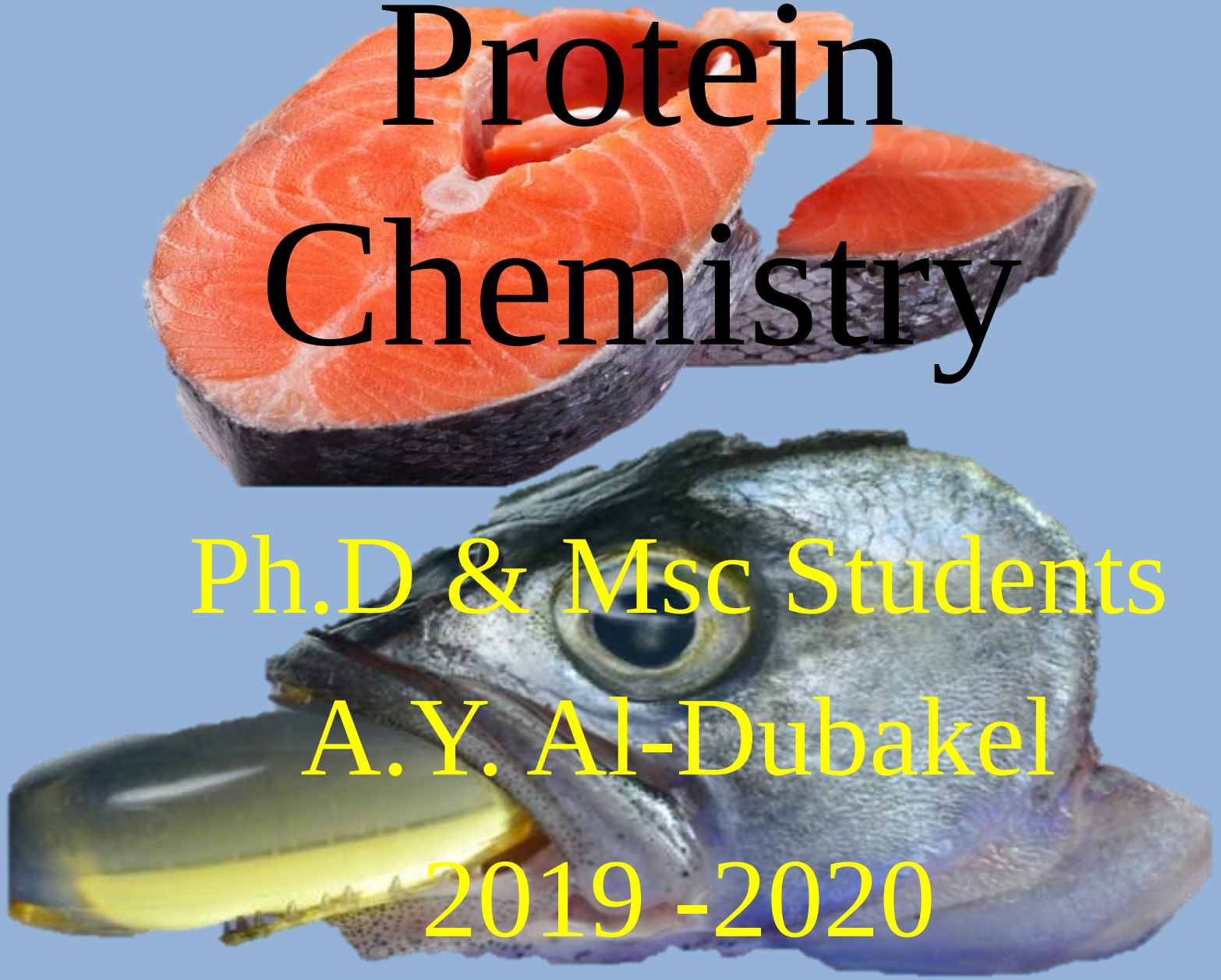
Protein Chemistry



Ph.D & Msc Students

A. Y. Al-Dubakel

2019 -2020

Essential	Conditionally essential	Non-essential
Histidine (H)	Arginine (R)	Alanine (A)
Isoleucine (I)	Cysteine (C)	Aspartic acid (D)
Leucine (L)	Glutamine (Q)	Asparagine (N)
Lysine (K)	Glycine (G)	Glutamic acid (E)
Methionine (M)	Proline (P)	Serine (S)
Phenylalanine (F)	Tyrosine (Y)	Selenocysteine (U)
Threonine (T)		Pyrrolysine* (O)
Tryptophan (W)		
Valine (V)		

Non EAA

EAA

New AA

Name	Three letter code	One letter code	Molecular Weight	Molecular Formula
Alanine	Ala	A	89.1	$C_3H_7NO_2$
Arginine	Arg	R	174.2	$C_6H_{14}N_4O_2$
Asparagine	Asn	N	132.12	$C_4H_8N_2O_3$
Aspartic acid	Asp	D	133.11	$C_4H_7NO_4$
Cysteine	Cys	C	121.16	$C_3H_7NO_2S$
Glutamic acid	Glu	E	147.13	$C_5H_9NO_4$
Glutamine	Gln	Q	146.15	$C_5H_{10}N_2O_3$
Glycine	Gly	G	75.07	$C_2H_5NO_2$
Histidine	His	H	155.16	$C_6H_9N_3O_2$
Hydroxyproline	Hyp	O	131.13	$C_5H_9NO_3$
Isoleucine	Ile	I	131.18	$C_6H_{13}NO_2$
Leucine	Leu	L	131.18	$C_6H_{13}NO_2$
Lysine	Lys	K	146.19	$C_6H_{14}N_2O_2$
Methionine	Met	M	149.21	$C_5H_{11}NO_2S$
Phenylalanine	Phe	F	165.19	$C_9H_{11}NO_2$
Proline	Pro	P	115.13	$C_5H_9NO_2$
Pyroglutamatic	Glp	U	139.11	$C_5H_7NO_3$
Serine	Ser	S	105.09	$C_3H_7NO_3$
Threonine	Thr	T	119.12	$C_4H_9NO_3$
Tryptophan	Trp	W	204.23	$C_{11}H_{12}N_2O_2$
Tyrosine	Tyr	Y	181.19	$C_9H_{11}NO_3$
Valine	Val	V	117.15	$C_5H_{11}NO_2$

4)Classification based on metabolic fate

The carbon skeleton of amino acids can be used either for glucose production or for the production of ketone bodies, Based on that

1) Both glucogenic and ketogenic amino acids:
   Isoleucine, Tyrosine, Phenylalanine and Tryptophan

2) Purely Ketogenic amino acids:
   Leucine and Lysine

3) Purely Glucogenic amino acids:

III.

The remaining 14 amino acids are glucogenic.
Alanine, valine ,serine, threonine, glycine, methionine, asparagine, glutamine, cysteine, cystine, aspartic acid, glutamic acid, histidine and arginine.

4)Classification based on metabolic fate (Con.)

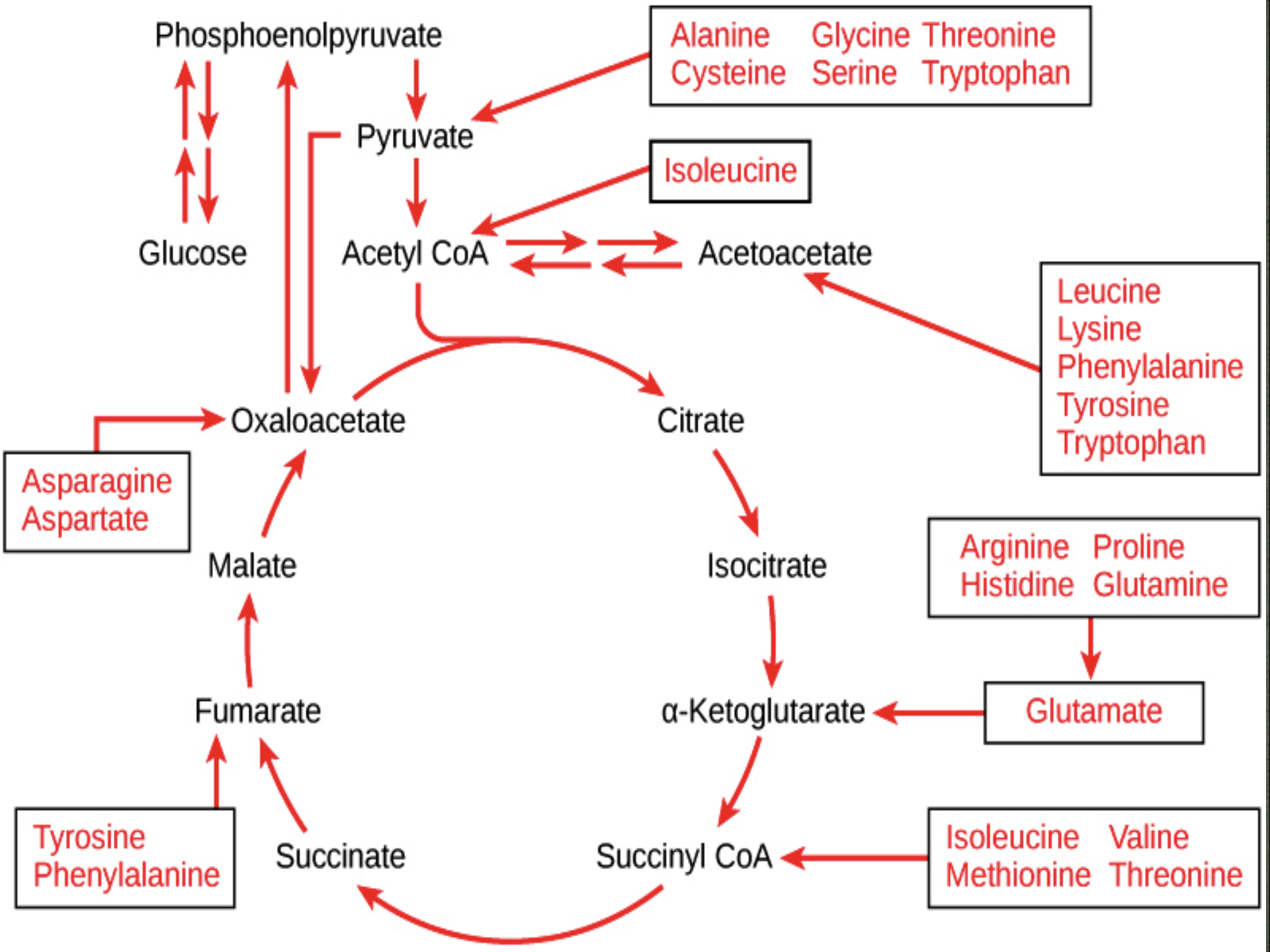
Glucogenic amino acids	Glucogenic and ketogenic	Ketogenic amino acids
Alanine, Arginine, Asparagine, Aspartate Asparagine, Cysteine, Methionine Glutamate, Glutamine, Glycine, Histidine Proline, Serine, Threonine,Valine	Tyrosine Isoleucine Phenylalanine Tryptophan	Leucine Lysine

These amino acids serve as precursors gluconeogenesis for glucose formation.

These amino acids breakdown to form precursors for both ketone bodies and glucose.

These amino acids breakdown to form ketone bodies.

Metabolic breakdown of individual amino acids
Catabolism of amino acids gives rise to the intermediate compounds of citric acid cycle. Alanine, serine, cysteine and asparagine are converted to oxaloacetate. Glutamine, proline, arginine and histidine are converted to α-ketoglutarate through glutamate. Succinyl CoA is a point of entry for non polar amino acids like methionine, valine and isoleucine. Leucine is degraded to acetyl CoA and acetoacetate. Tryptophan, lysine, leucine, phenylalanine, tyrosine and isoleucine donate their carbons to acetyl CoA.


Phosphoenolpyruvate
Alanine Glycine Threonine
Cysteine Serine Tryptophan
Pyruvate
Isoleucine
Glucose
Acetyl CoA
Acetoacetate
Leucine
Lysine
Phenylalanine
Tyrosine
Tryptophan
Oxaloacetate
Citrate
Asparagine
Aspartate
Malate
Isocitrate
Arginine Proline
Histidine Glutamine
Fumarate
α-Ketoglutarate
Glutamate
Tyrosine
Phenylalanine
Succinate
Succinyl CoA
Isoleucine Valine
Methionine Threonine

Amino acid biosynthesis

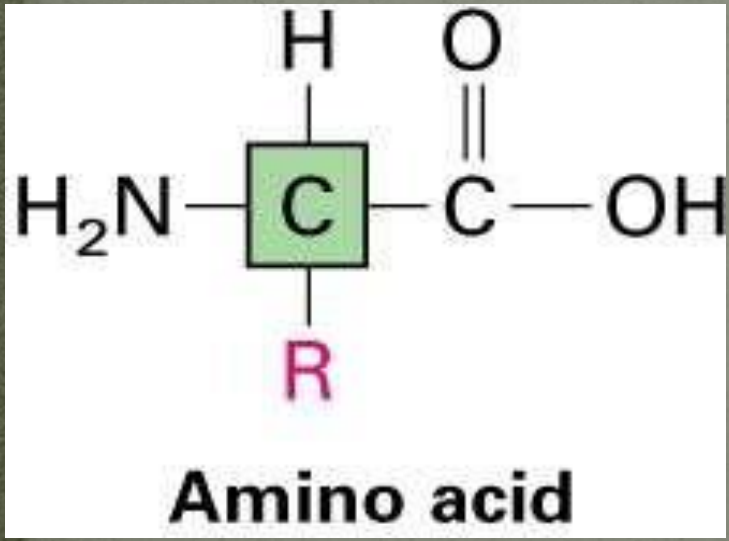
Nonessential amino acids are formed from intermediates of carbohydrate metabolism. Alanine is formed from pyruvate and aspartate from oxaloacetate. Asparagine is formed from aspartate. Glutamate is formed from α ketoglutarate and glutamine from glutamate. Glutamate is the precursor of proline and arginine. Cysteine is synthesized from 3 – phosphoglycerate. During the process, serine is the intermediate compound which gives rise to glycine.

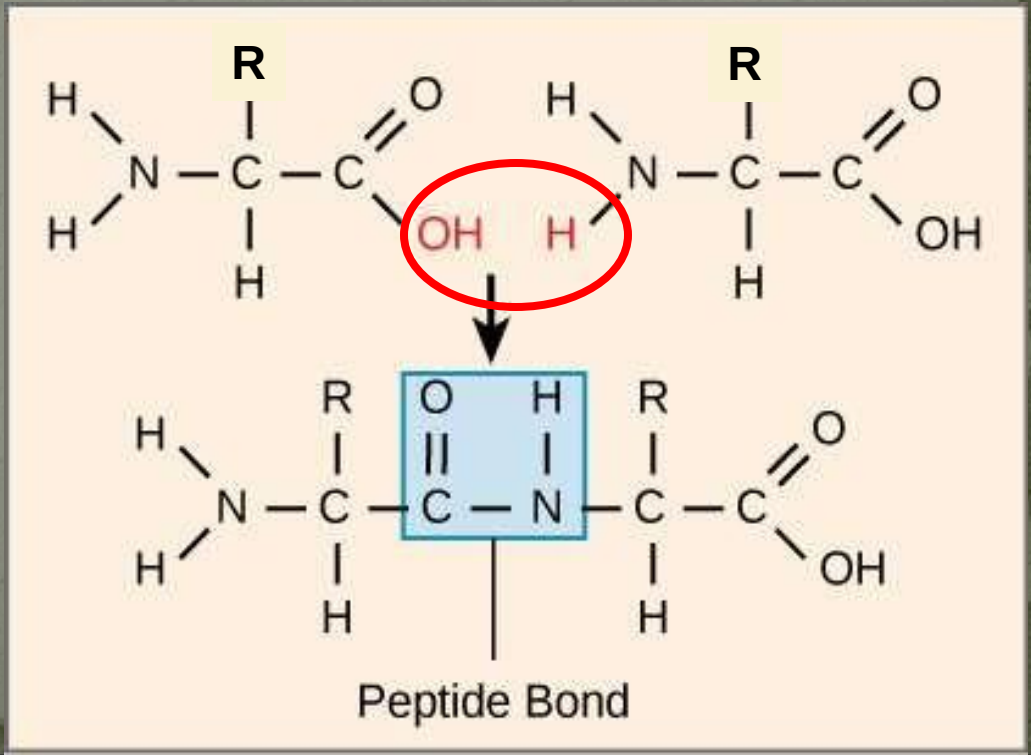
STRUCTURE OF AMINO ACIDS

- In protein molecules the amino acid residues are covalently linked to form very long chains. They are united in a head-to-tail arrangement through substituted amide linkages called **Peptide bond** that arise by elimination of the elements of water from the carboxyl group of one amino acid and α-amino group of the next.
- Three amino acids can be joined by two peptide bonds to form a tripeptide; similarly, amino acids can be linked to form tetrapeptides ,pentapeptides, and so forth.

STRUCTURE OF AMINO ACIDS

- When a few amino acids are joined in this fashion, the structure is called an oligopeptide.
- When many amino acids are joined, the product is called a polypeptide.





STRUCTURE OF AMINO ACIDS

- In a peptide, the amino acid residue at the end with a free -amino group is the amino-terminal (or N-terminal) residue; the residue *at* the other end, which has a free carboxyl group, is the carboxyl-terminal (C-terminal) residue.