

BB 422/622

ANABOLISM II: Lipids

Biosynthesis of Fatty Acids and Lipids

Fatty Acids
 contrasts
 location & transport
 Synthesis
 acetyl-CoA carboxylase
 fatty acid synthase
 ACP priming
 4 steps
 Control of fatty acid metabolism
 ACC
 Reciprocal control of b-ox
 Diversification of fatty acids
 Elongation
 Desaturation
 Eicosanoids
 Prostaglandins, Thromboxanes,
 and Leukotrienes
 Triacylglycerides
 Membrane lipids
 Glycerophospholipids

 Isoprene lipids:
 Ketone Bodies
 Cholesterol
 isoprene synth.
 Joining
 Fates
 Cholesterol esters
 Bile acids
 Steroid Hormones
 Metabolism & transport
 Control

ANABOLISM III: Nitrogen Compounds

Biosynthesis of Amino Acids and Nucleotides

Nitrogen cycle
 Nitrogen Fixation
 Nitrogenase
 Nitrogen Assimilation
 Glutamine synthetase
 Glutamate synthase (GOGAT)
 Amino-acid biosynthesis
 Non-essential
 Essential
 Nucleotide Biosynthesis
 Purines
 Salvage
 De novo
 Pyrimidines
 Deoxyribonucleotides
 Biosynthesis of secondary products of AA

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ANABOLISM III: Biosynthesis Amino Acids & Nucleotides

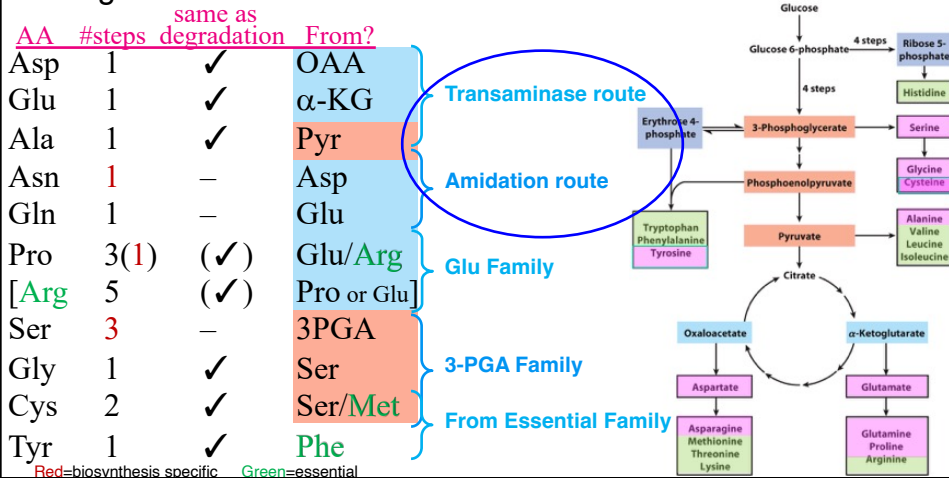
43

Biosynthesis Amino Acids & Nucleotides

Non-essential Amino acids:

Arg-Val-His-Ile-Leu-Lys-Met-Phe Thr-Trp
Professor A.V.HILL M.P. was a Tea Totaller

These are very few steps and often the same enzyme(s) used for degradation.

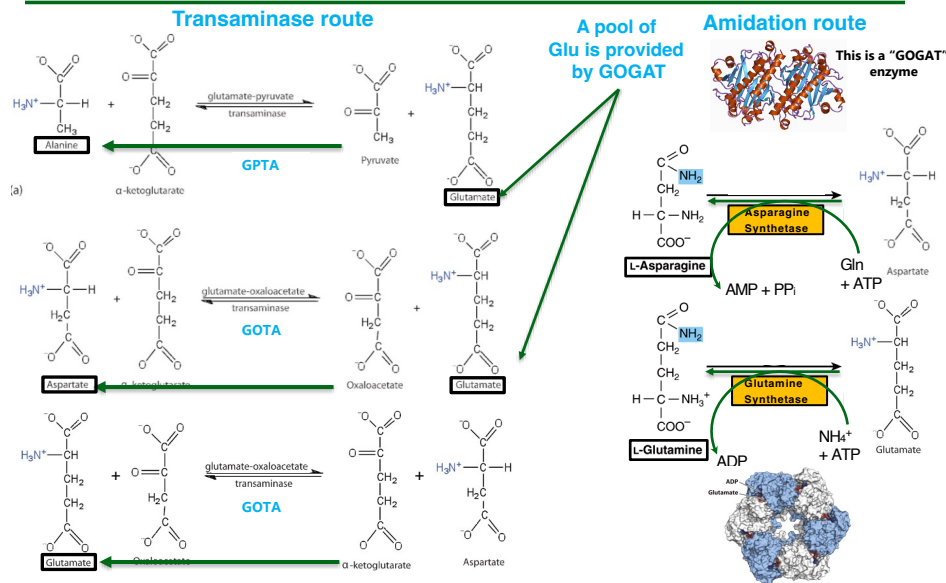


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Biosynthesis Amino Acids & Nucleotides

Ala, Asp, Glu

Gln, Asn



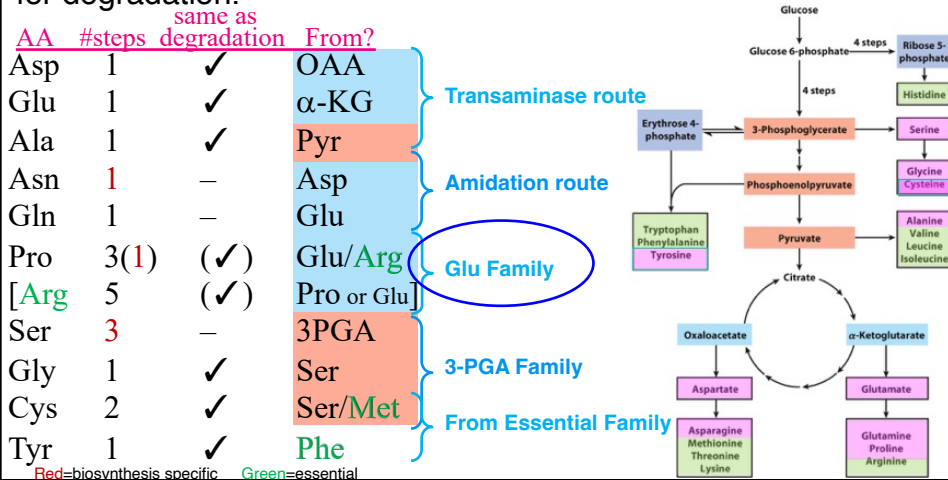
49

Biosynthesis Amino Acids & Nucleotides

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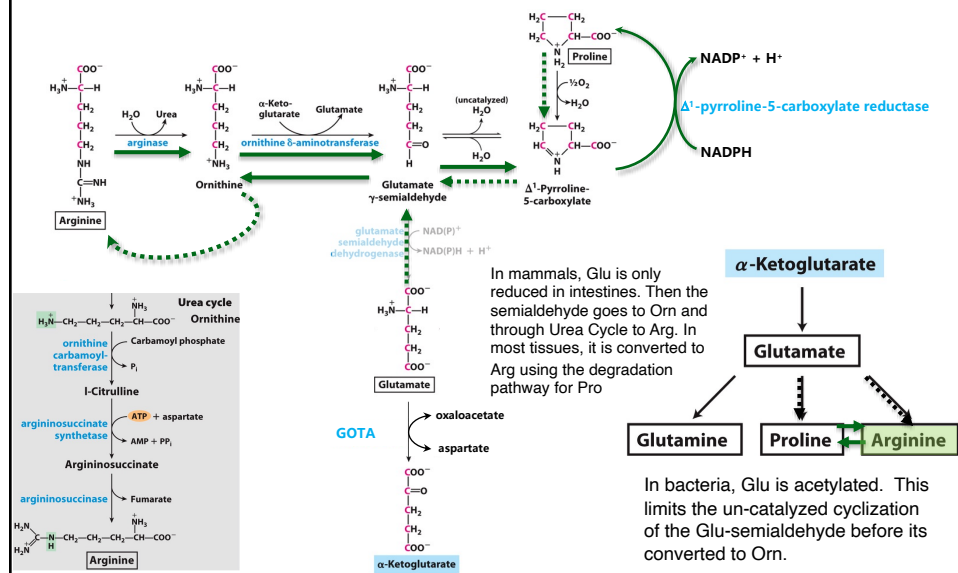
These are very few steps and often the same enzyme(s) used for degradation.



52

Biosynthesis Amino Acids & Nucleotides

Glu Family: Pro (Arg)



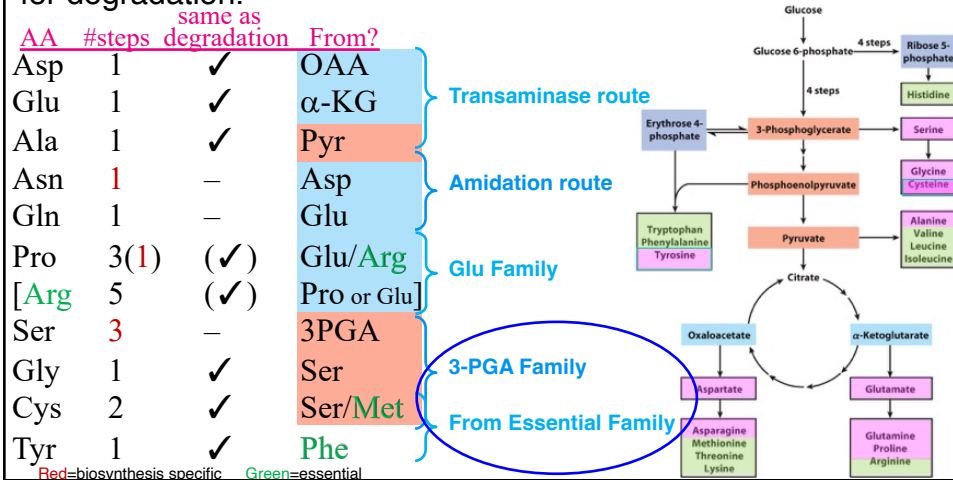
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Biosynthesis Amino Acids & Nucleotides

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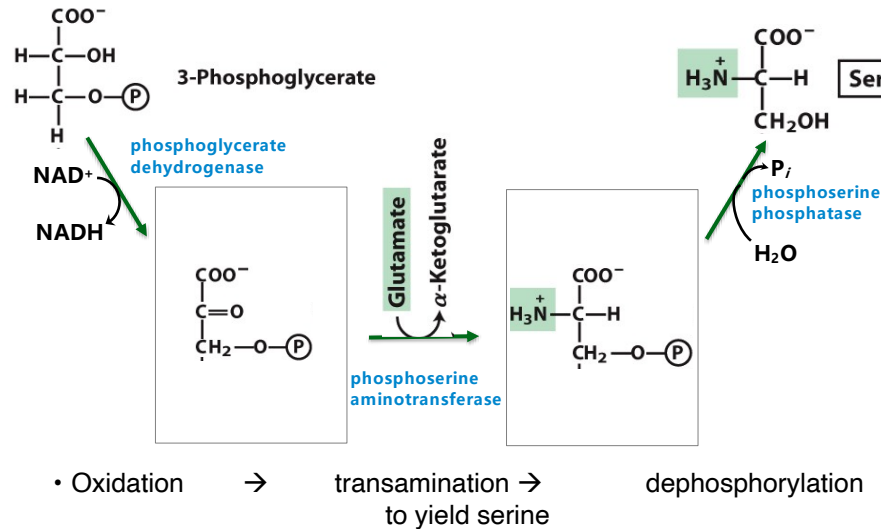


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Biosynthesis Amino Acids & Nucleotides

3-PGA Family: Ser

Serine Derives from 3-Phosphoglycerate of Glycolysis

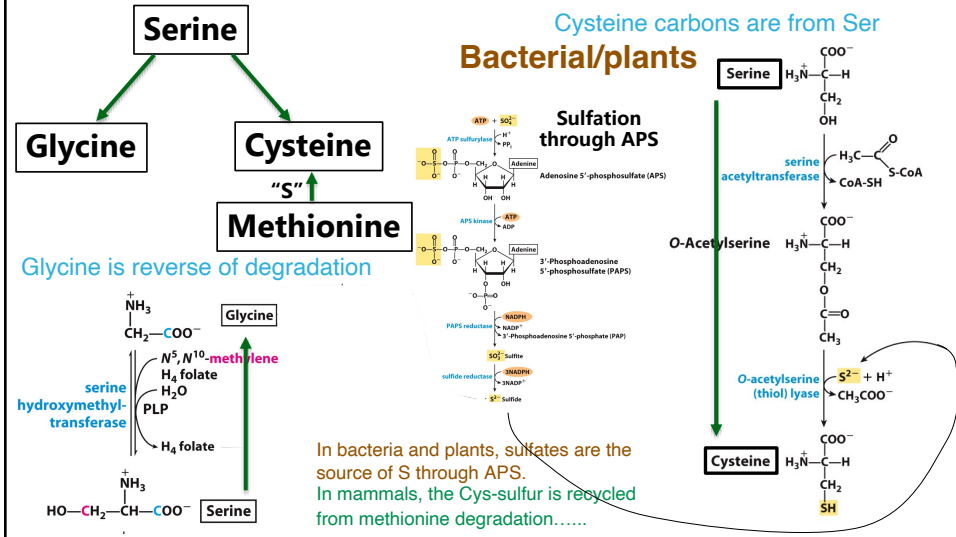


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Biosynthesis Amino Acids & Nucleotides

3-PGA Family +
From Essential Family: Gly, Cys

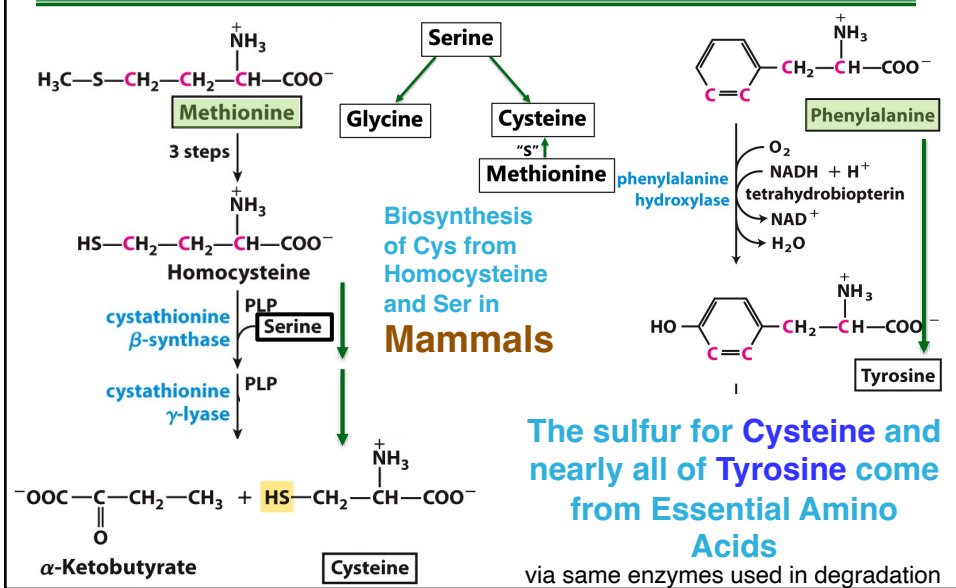
Serine contributes to Glycine and Cysteine



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Biosynthesis Amino Acids & Nucleotides

3-PGA Family +
From Essential Family: Cys, Tyr



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Biosynthesis Amino Acids & Nucleotides

Asp	1	✓	OAA
Glu	1	✓	α-KG
Ala	1	✓	Pyr
Asn	1	–	Asp
Gln	1	–	Glu
Pro	3(1)	(✓)	Glu/Arg
[Arg]	5	(✓)	Pro or Glu
Ser	3	–	3PGA
Gly	1	✓	Ser
Cys	2	✓	Ser/Met
Tyr	1	✓	Phe

Red-biosynthesis specific Green-essential

Asp/Pyruvate Family

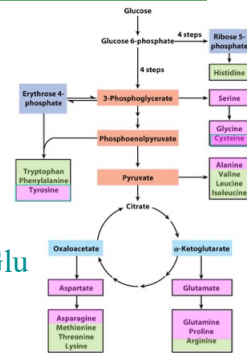
Aromatic Family

Histidine

Essential Amino acids:

These require many steps and unique to those used for degradation.

Met	7	–Asp/Cys/THF/Glu
Thr	5	–Asp/Glu
Lys	9	–Asp/Pyr/Glu
Ile	10	–Asp(Thr)/Pyr/Glu
Val	4	–Pyr/Glu
Leu	7	–Pyr/AcCoA/Glu
Phe	10	–E4P/PEP/Glu
Trp	12	–E4P/PEP/Gln/R5P/Ser
His	10	–R5P/ATP/Gln/Glu



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Biosynthesis Amino Acids & Nucleotides

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Glu	1	✓	α-KG
Ala	1	✓	Pyr
Asn	1	–	Asp
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Pro	3(1)	(✓)	Glu/Arg
[Arg]	5	(✓)	Pro or Glu
Ser	3	–	3PGA
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Cys	2	✓	Ser/Met
Tyr	1	✓	Phe

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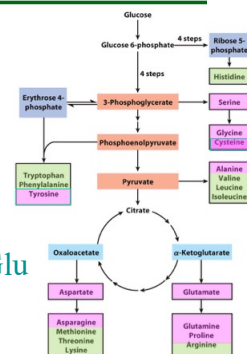
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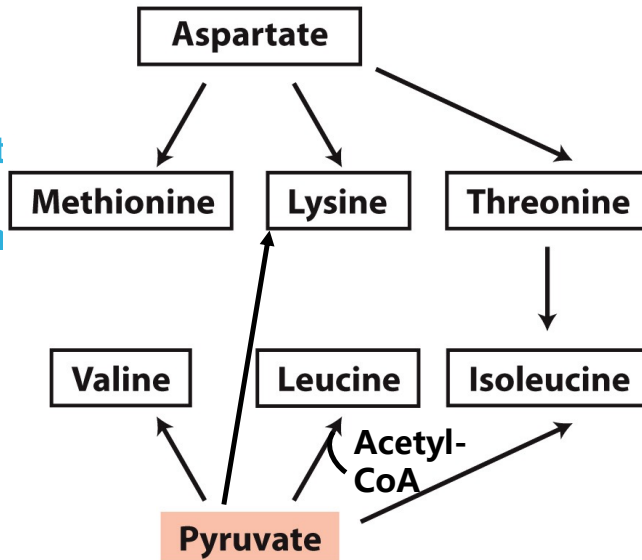


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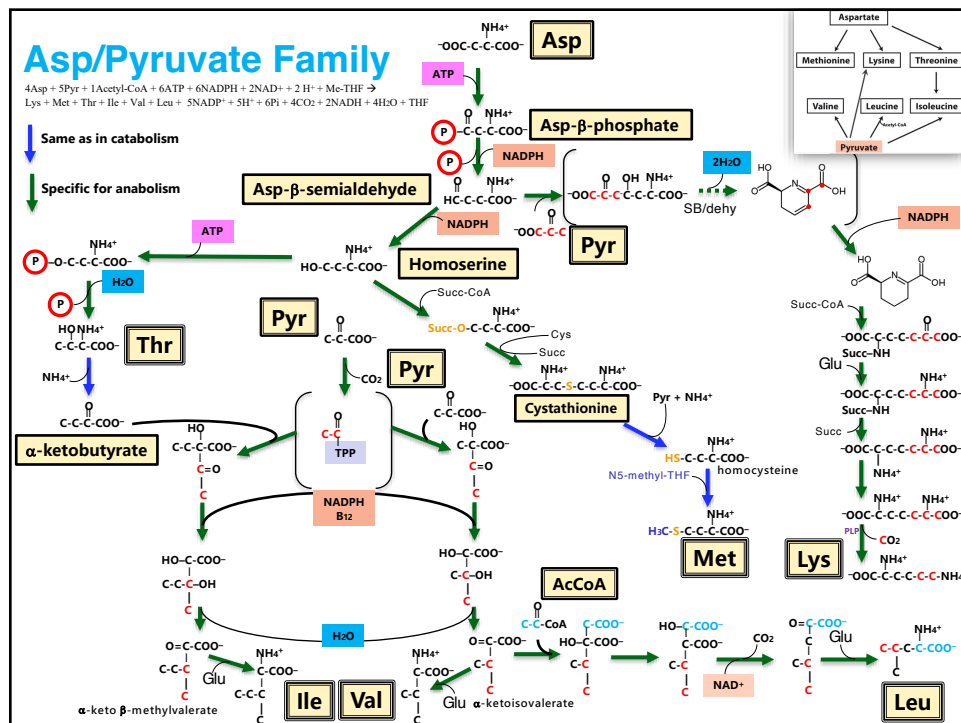
Biosynthesis Amino Acids & Nucleotides

Asp/Pyruvate Family:
Lys, Met, Thr, Ile, Val, Leu

Oxaloacetate
Yields Asp,
which Yields Met
Lys, and Thr,
which along with
Pyruvate and
Acetyl-CoA
Yields Val, Leu,
and Isoleucine



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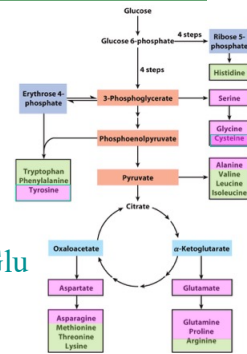
Biosynthesis Amino Acids & Nucleotides

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Ala	1	✓	Pyr
Asn	1	—	Asp
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Pro	3(1)	(✓)	Glu/Arg
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Ser	3	—	3PGA
Gly	1	✓	Ser
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Tyr	1	✓	Phe

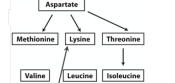
Red - biosynthesis specific Green - essential

Essential Amino acids:

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Asp/Pyruvate Family



Aromatic Family

Histidine

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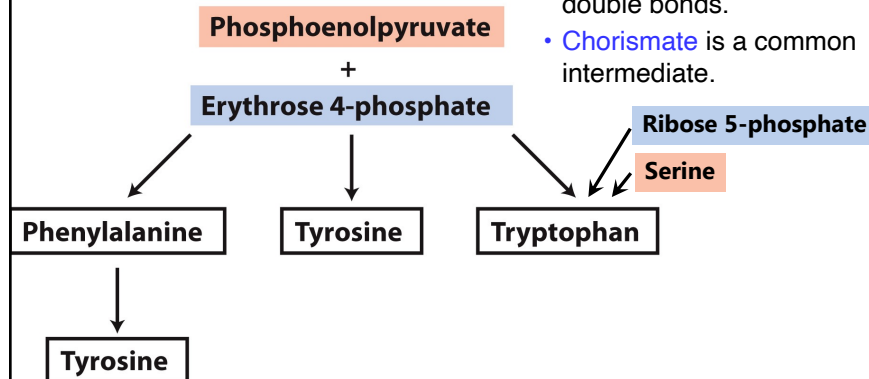
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Biosynthesis Amino Acids & Nucleotides

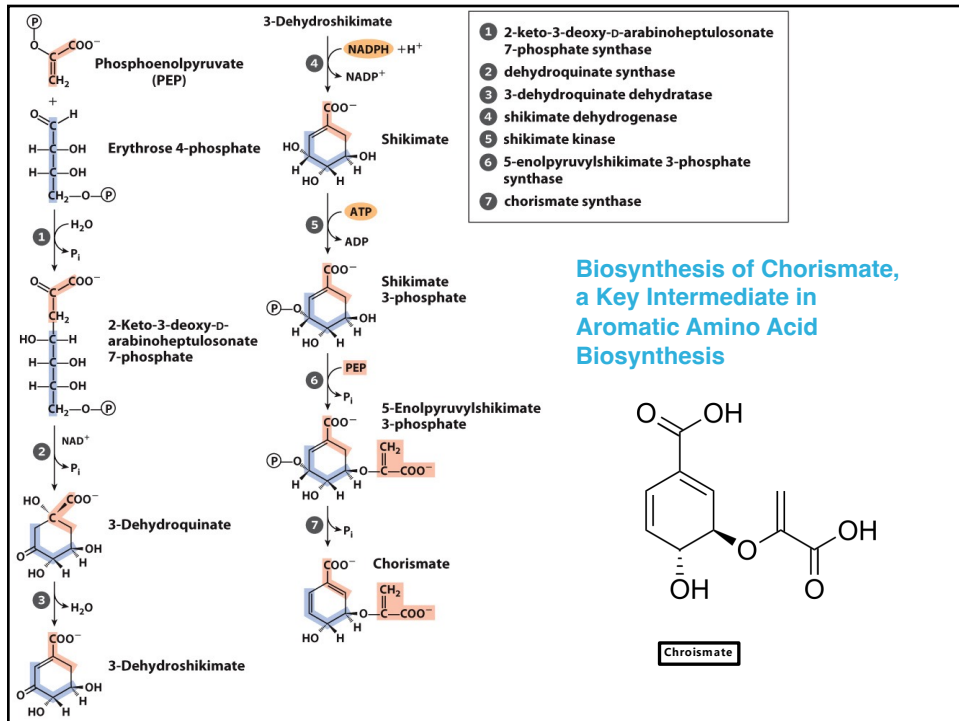
Aromatic Family: Phe, Trp

Aromatic Amino Acids Derive from PEP and Erythrose 4-Phosphate (and Rib5P and Ser)

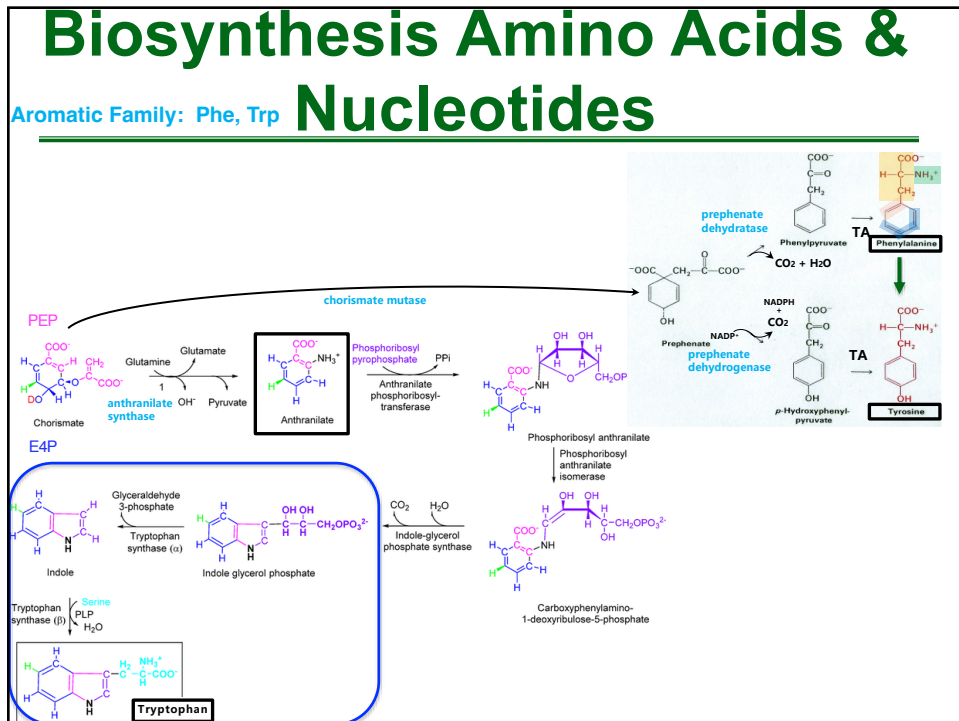
- Very complicated and amazing chemistry!
- Rings must be synthesized and closed and then oxidized to create double bonds.
- Chorismate is a common intermediate.



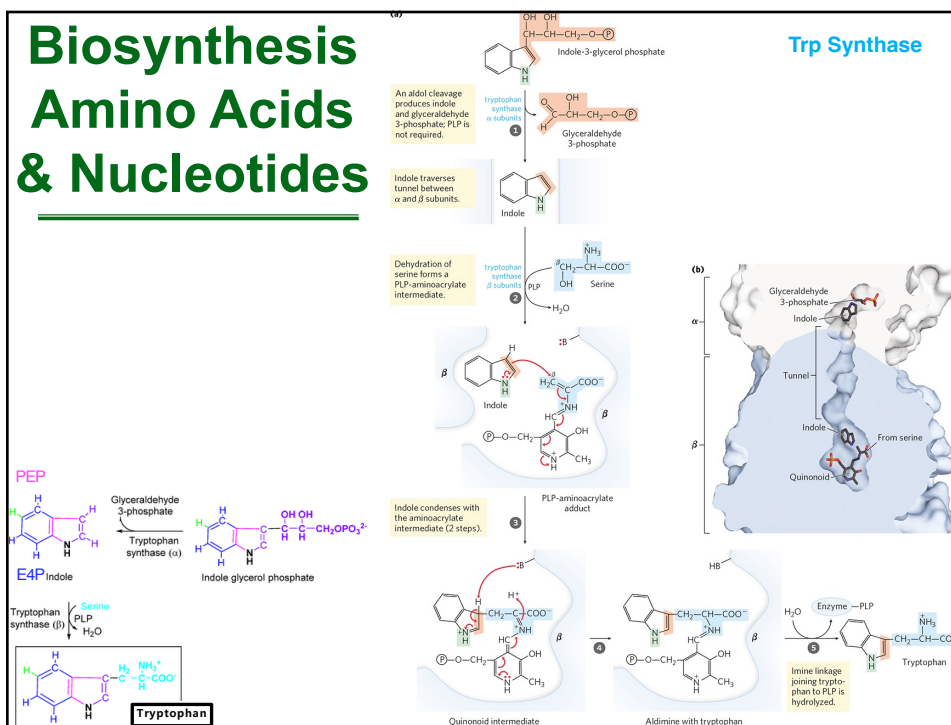
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66



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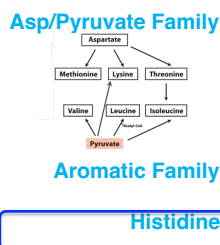
Biosynthesis Amino Acids & Nucleotides

Essential Amino acids:

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Glu	1	✓	α-KG
Ala	1	✓	Pyr
Asn	1	–	Asp
Gln	1	–	Glu
Pro	3(1)	(✓)	Glu/Arg
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Cys	2	✓	Ser/Met
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Red = blood/tyrosine specific Green = essential

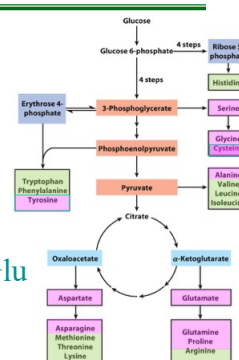


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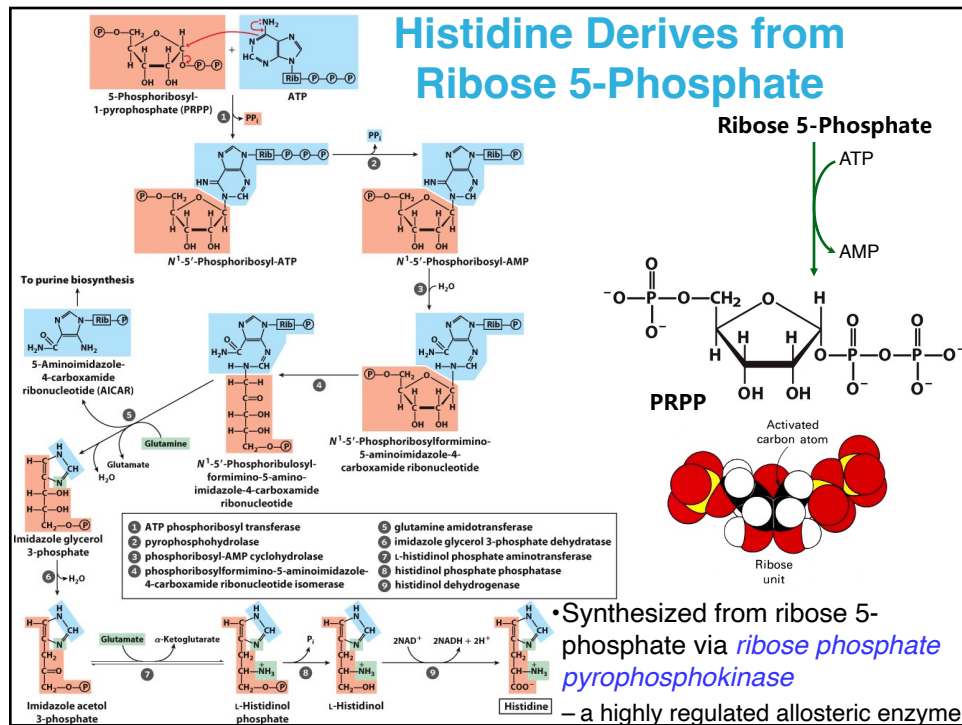


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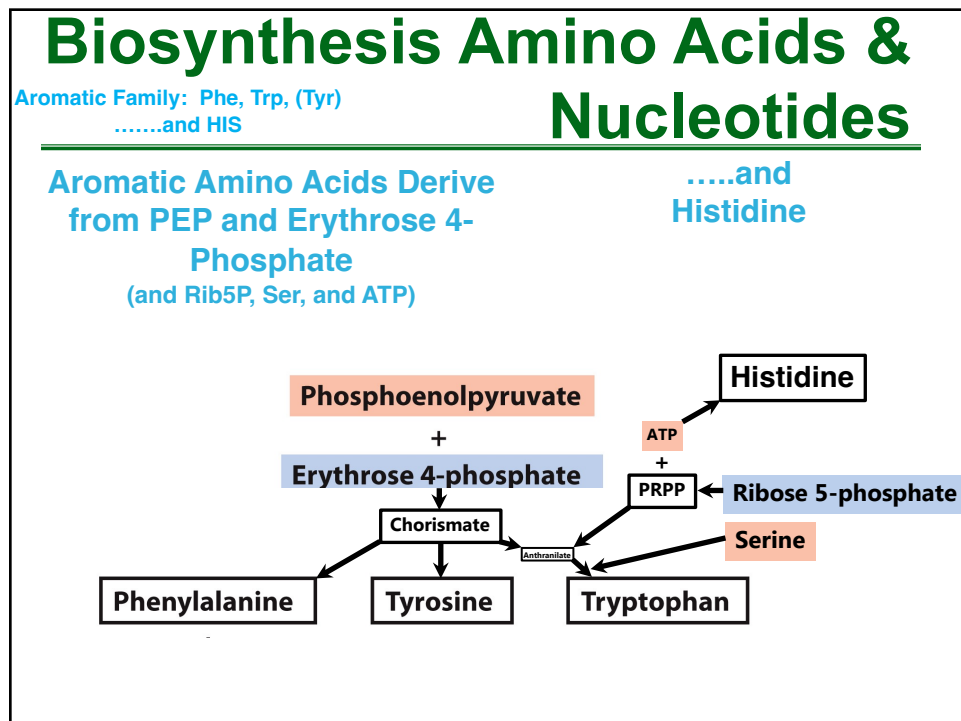
graph TD
    Oxidase --> Aspartate
    Aspartate --> Asparagine
    Asparagine --> Methionine
    Asparagine --> Threonine
    Asparagine --> Lysine
  
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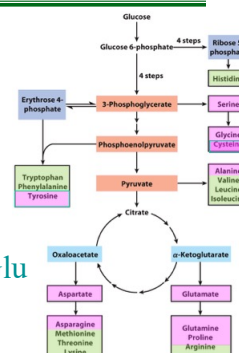
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Red=biogenesis specific Green=essential

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Histidine

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Trp	12	—E4P/PEP/Gln/R5P/Ser
His	10	—R5P/ATP/Gln/Glu

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Biosynthesis Amino Acids & Nucleotides

Essential vs. Nonessential and Conditionally Essential Amino Acids

Asp	1	*	OAA
Glu	1	*	α-KG
Ala	1	*	Pyr
Asn	1	—	Asp
Gln	1	—	Glu
Pro	3(1)	(*)	Glu/Arg
Ser	3	—	3PGA
Gly	1	*	Ser
Cys	2	*	Ser/Met
Tyr	1	*	Phe

Red=biogenesis specific *reverse of degradation

- Essential amino acids must be obtained as dietary protein.
- Nonessential amino acids are easily made from central metabolites.
- Consumption of a variety of foods supplies all the essential amino acids.

TABLE 18-1 Nonessential and Essential Amino Acids for Humans and the Albino Rat		
Nonessential	Conditionally essential ^a	Essential
Alanine	Arginine	Histidine
Asparagine	Cysteine	Isoleucine
Aspartate	Glutamine	Leucine
Glutamate	Glycine	Lysine
Serine	Proline	Methionine
	Tyrosine	Phenylalanine
		Threonine
		Tryptophan
		Valine

^aRequired to some degree in young, growing animals and/or sometimes during illness.

- Conditionally Essential amino acids are made from essential or become essential in certain physiological conditions.

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