

ANABOLISM III:

Biosynthesis

Amino Acids &

Nucleotides

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- 1) Nitrogen fixation: $N_2 \rightarrow NH_4$ *reduced form*
- 2) Nitrogen assimilation: incorporation of ammonia into biomolecules *Amino acids*
- 3) Biosynthesis of amino acids
 - a) non-essential ✓
 - b) essential ✓
- 4) Biosynthesis of nucleotides → *RNA + DNA*
- 5) Control of nitrogen metabolism
- 6) Biosynthesis and degradation of heme; other 2° products of amino acids

Biosynthesis Amino Acids & Nucleotides

- Nitrogen (after H, O, and C) is a major element of living organisms
- Most nitrogen is inert in the atmosphere
- Making nitrogen useful is not easy

Atmosphere is 80% N₂, but is chemically inert

need $\text{N}_2 + 3 \text{H}_2 \rightarrow 2 \text{NH}_3$

Even though $\Delta G^\circ = -33.5 \text{ kJ/mol}$... **breaking a triple bond has high activation energy (i.e., SLOW, kinetically stable).**

can be accomplished using non-biological processes:

N₂ and O₂ → NO via lightning

N₂ and H₂ → NH₃ via the industrial *Haber-Bosch process*
requires T>400 °C, P>300 atm

Haber Process

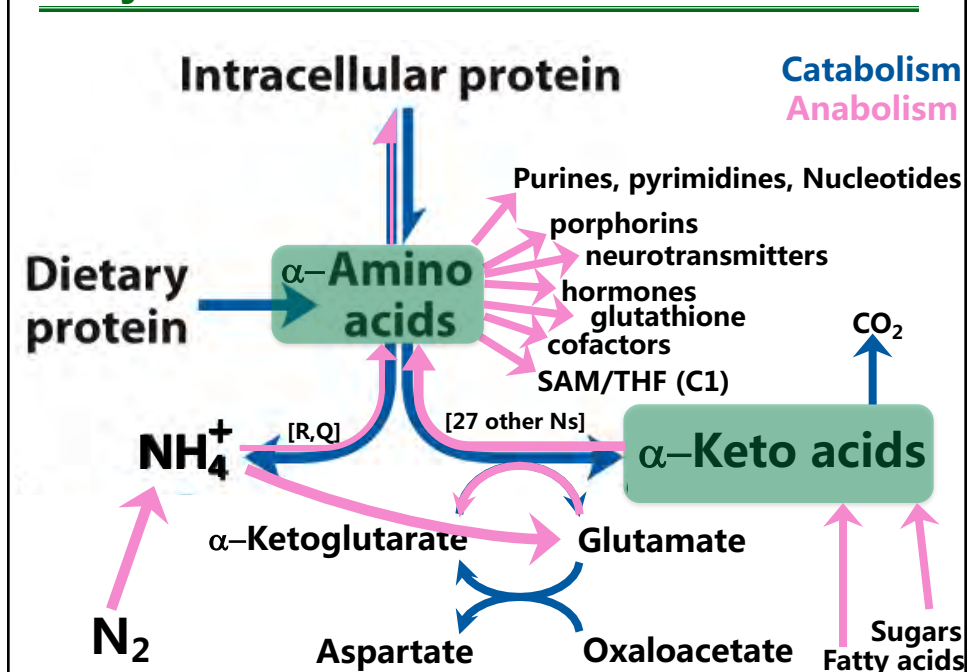
Dr. Kornberg:

Lecture 04.07.17

(4:10-6:25) 2 min

Industrial synthesis of NH₃ via the Haber process is one of mankind's most significant chemical processes.

Biosynthesis Amino Acids & Nucleotides



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Chemistry of Molecular Nitrogen

Review: Oxidation States of Nitrogen Compounds

Nitrate	Nitrogen(IV) dioxide	Nitrite	Nitrogen(II) oxide	Nitrogen(I) oxide	Nitrogen	Ammonia
<ul style="list-style-type: none"> • NO_3^- • $\text{N}^{+5} \text{O}_3^-$ • Nitrate • Also Nitric acid (HNO_3) and Dinitrogen pentoxide (N_2O_5) • "ate" is the higher oxidation state. 	<ul style="list-style-type: none"> • NO_2 • $\text{N}^{+4} \text{O}_2^-$ • Nitrogen dioxide • gas 	<ul style="list-style-type: none"> • NO_2^- • $\text{N}^{+3} \text{O}_2^-$ • Na-Nitrite • Also Nitrous acid (HONO) • "ite" is light on oxygen and oxidation state. 	<ul style="list-style-type: none"> • NO • N^{+2} • Non-salt • Gas • Physiologically important 2° messenger and paracrine signal 	<ul style="list-style-type: none"> • N_2O • N^{+1} • Non-salt • gas 	<ul style="list-style-type: none"> • N_2 • N^0 • Covalent triple bond • gas 	<ul style="list-style-type: none"> • NH_3 • $\text{N}^{-3} \text{H}_3^+$ • NH_3: N has oxidation state of -3. • gas