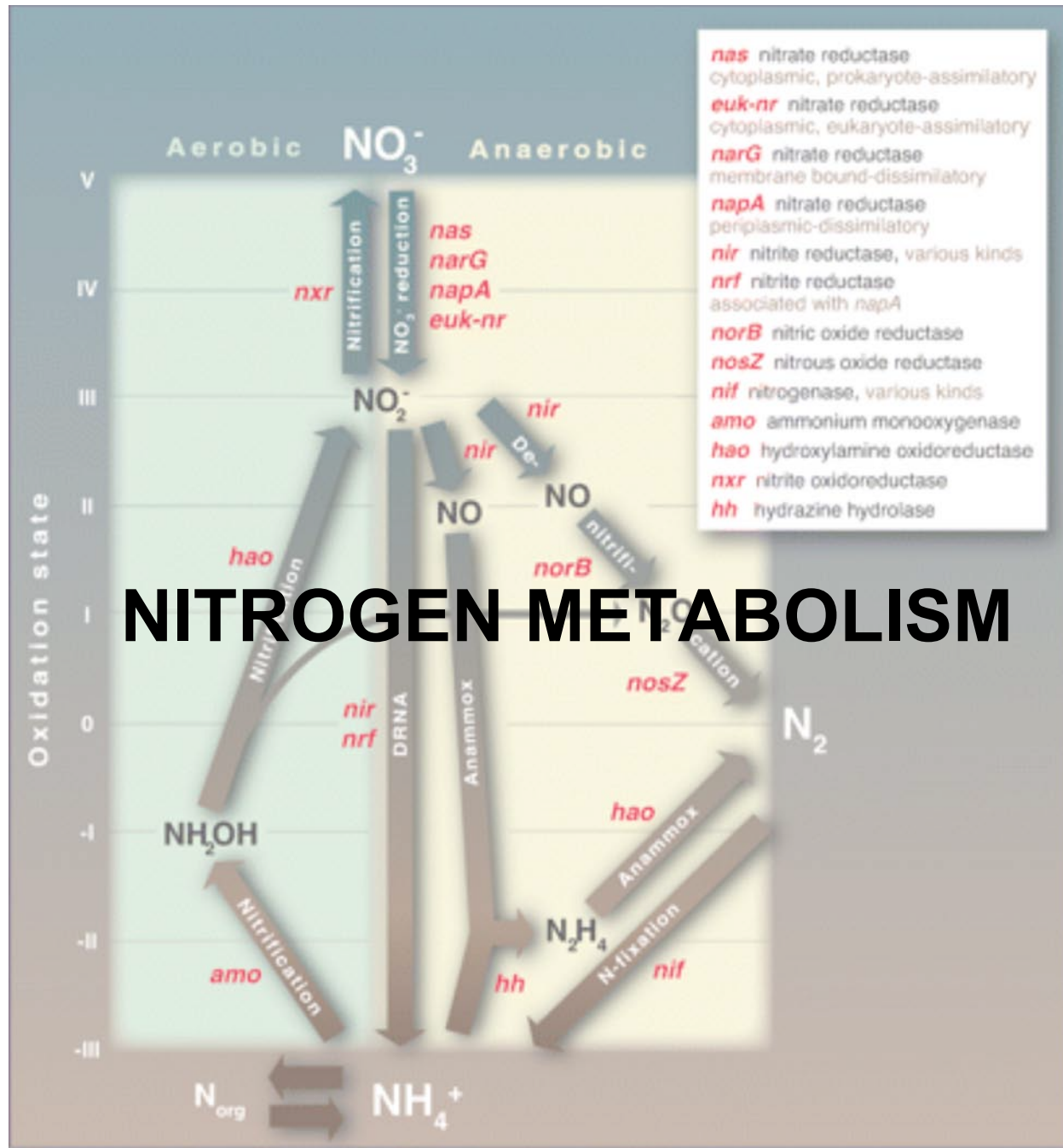
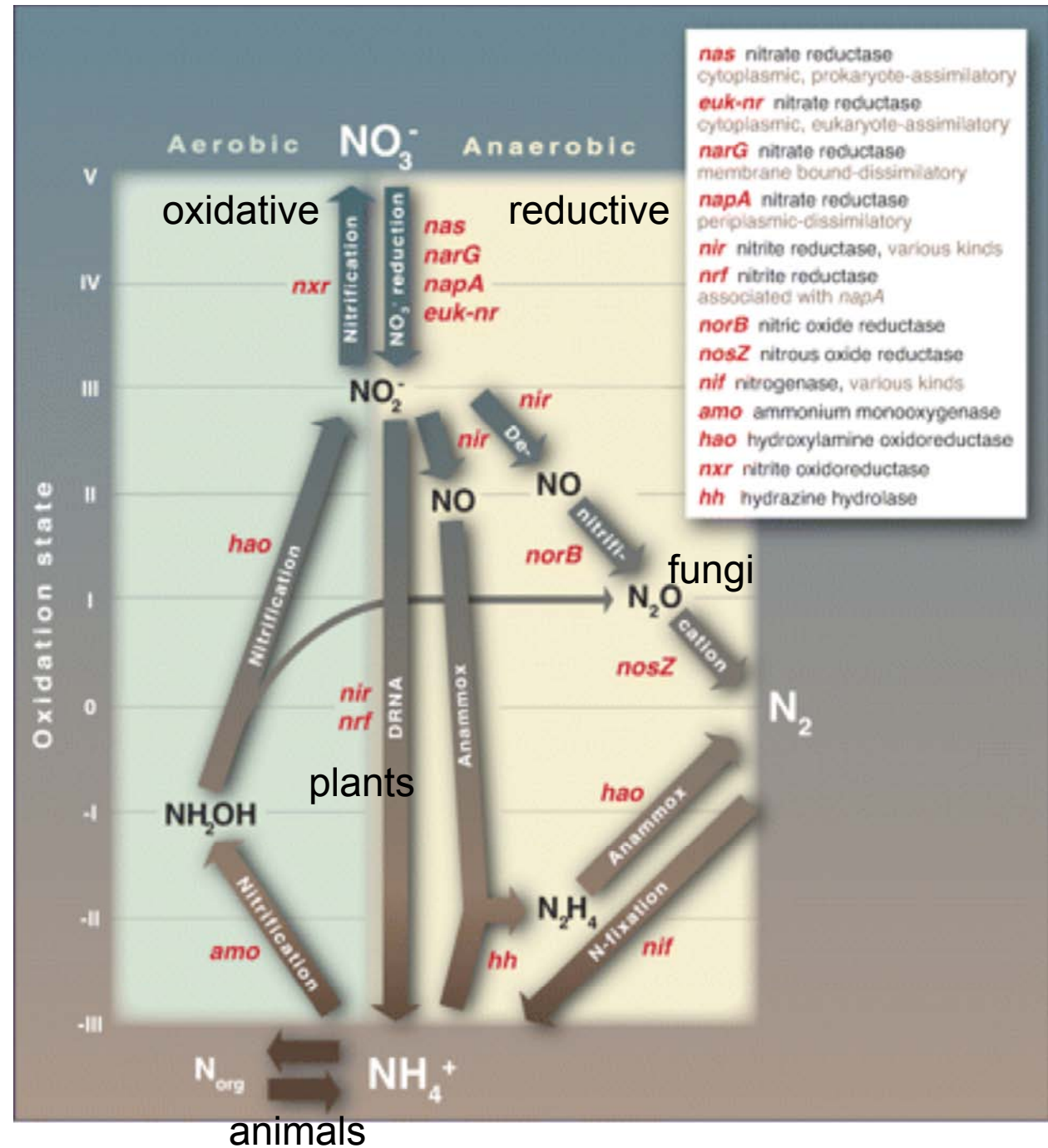


NITROGEN METABOLISM



Nitrogen is essential for all organisms (in amino acids and nucleic acids).

Most of the conversions between organic and inorganic nitrogen are catalyzed by bacterial and archaeal enzymes.

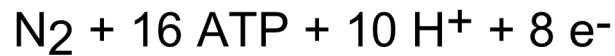


Nitrogen fixation

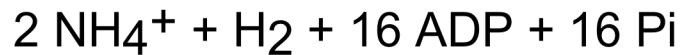
Reduced nitrogen (amines, amides) is required for proteins, nucleic acids, et al.

Environmental supplies of nitrogen are oxidized (N₂, NO₃⁻)

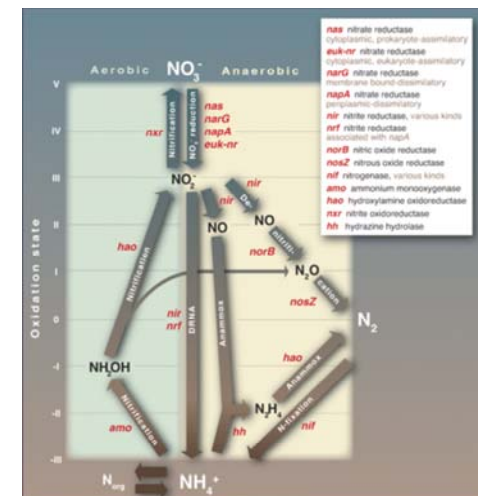
Issues include N fixation (prokaryotes only)



↓ Nitrogenase reductase, nitrogenase

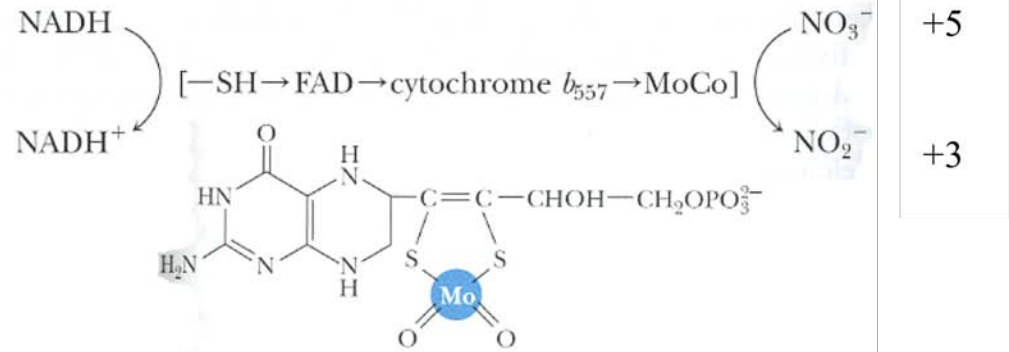


and nitrate reduction (bacteria, plants, fungi)

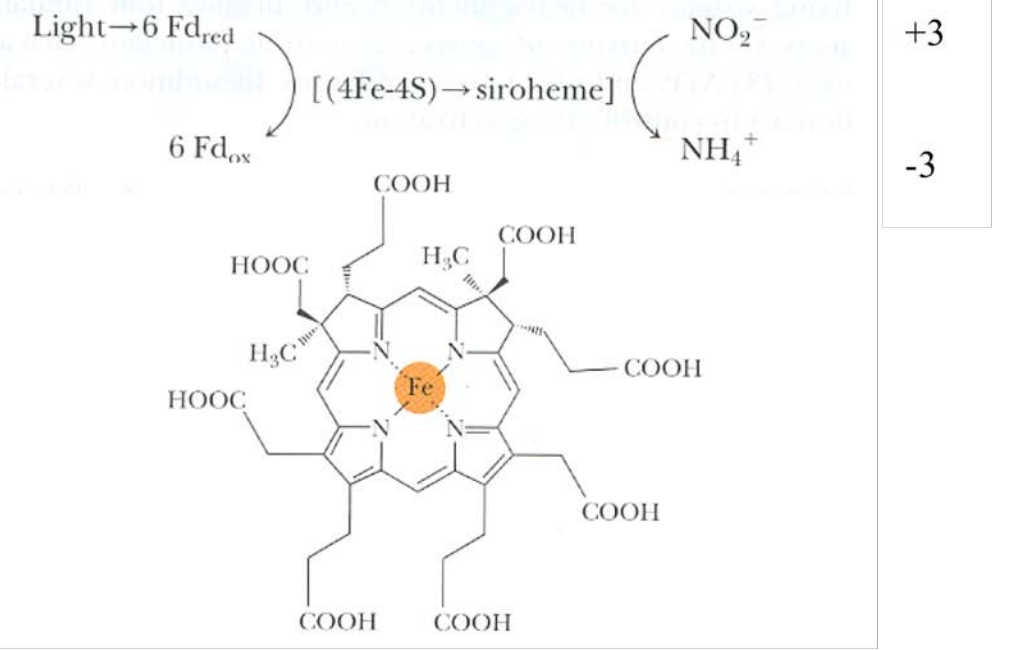


Nitrate reductase, nitrite reductase

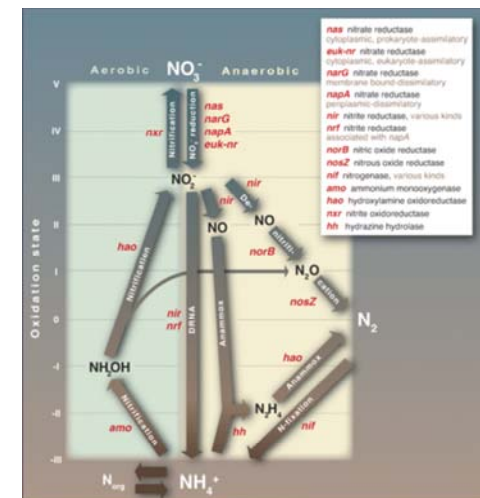
Nitrate reductase



Nitrite reductase

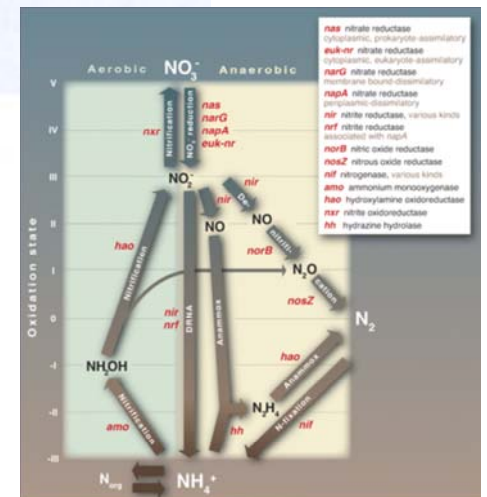
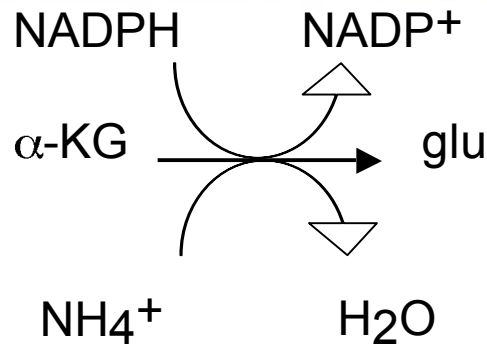
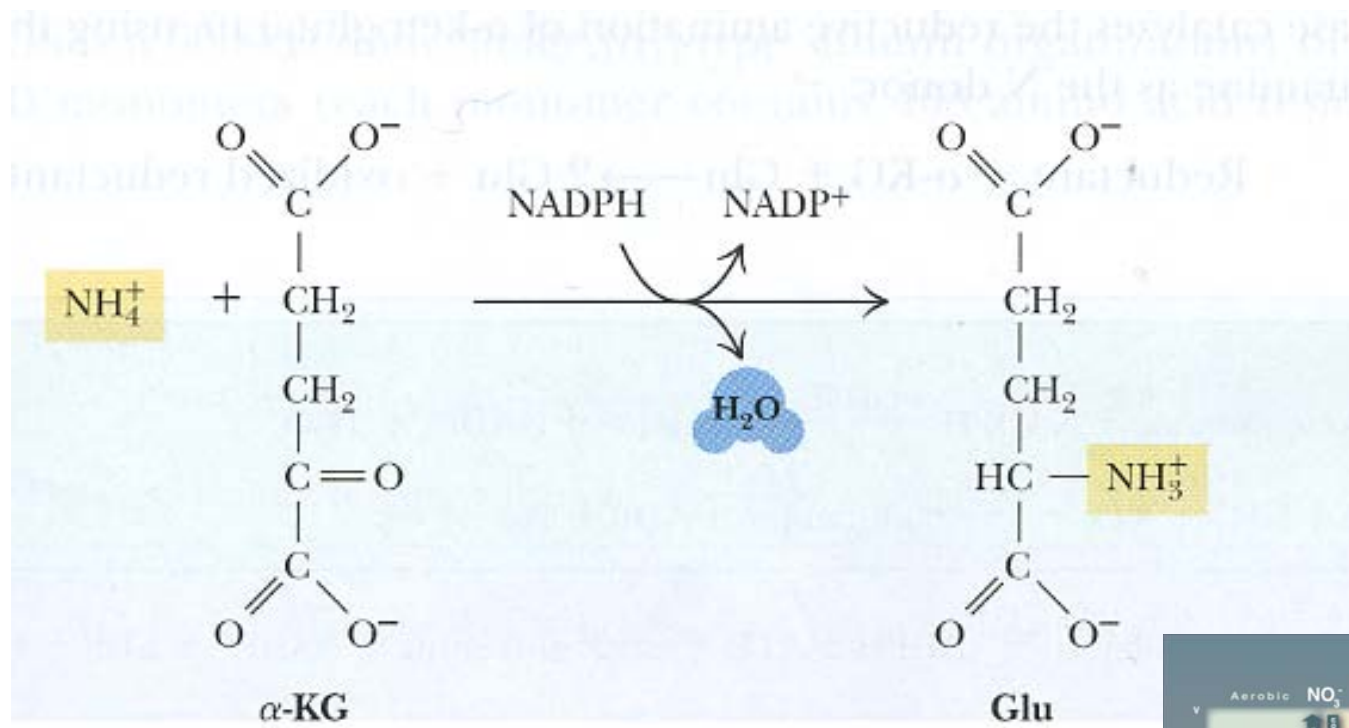


In bacteria, the electron donor is NADPH



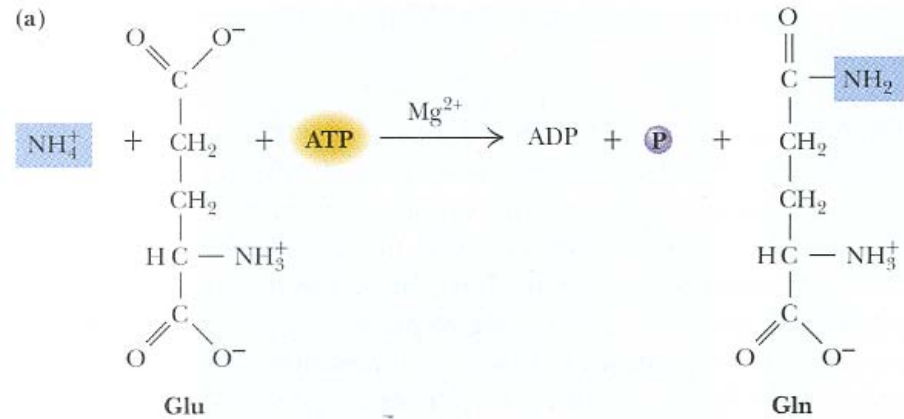
Ammonium assimilation

glutamate dehydrogenase



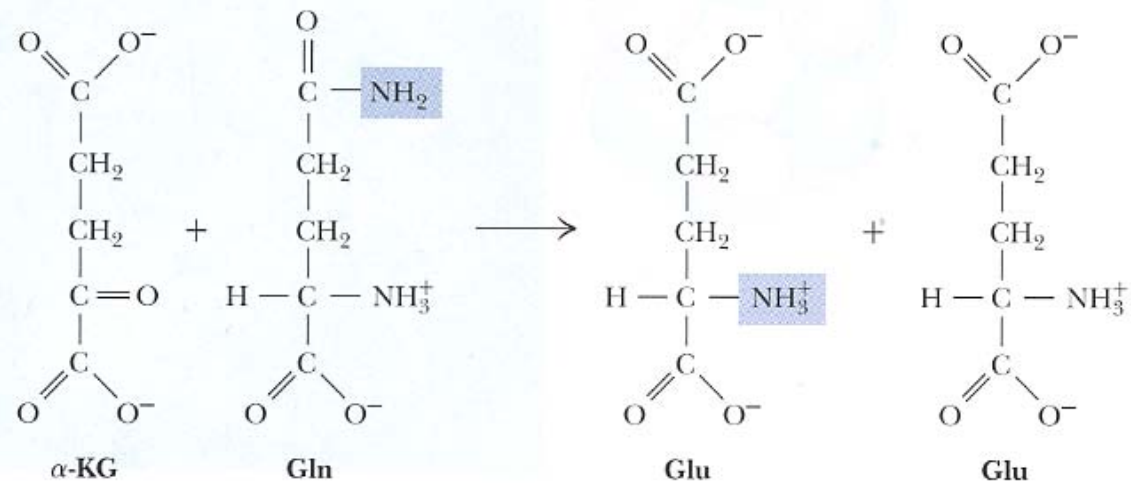
Ammonium assimilation

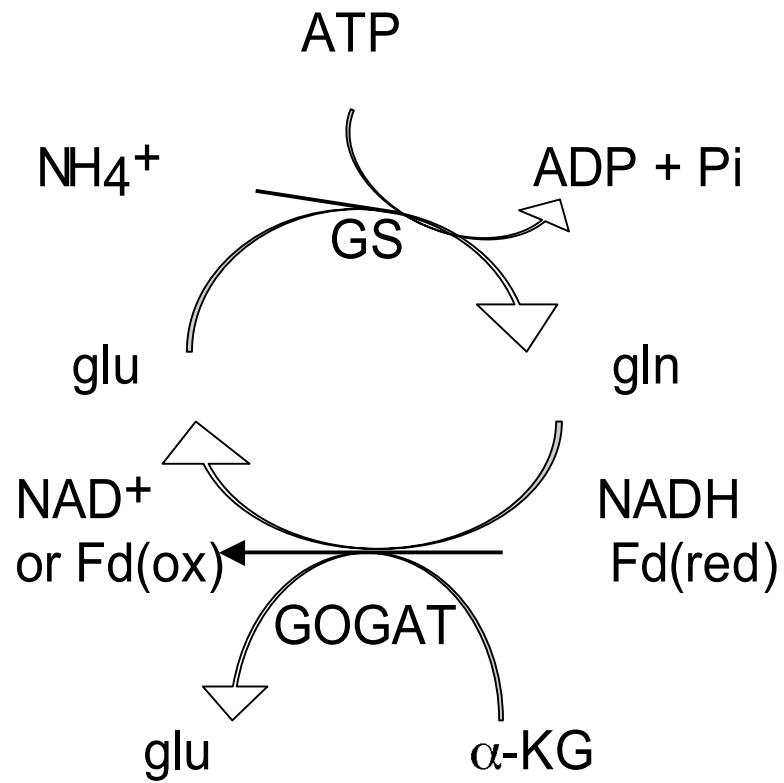
Glutamine synthetase



GOGAT

(glutamine oxo-glutarate amino transferase)

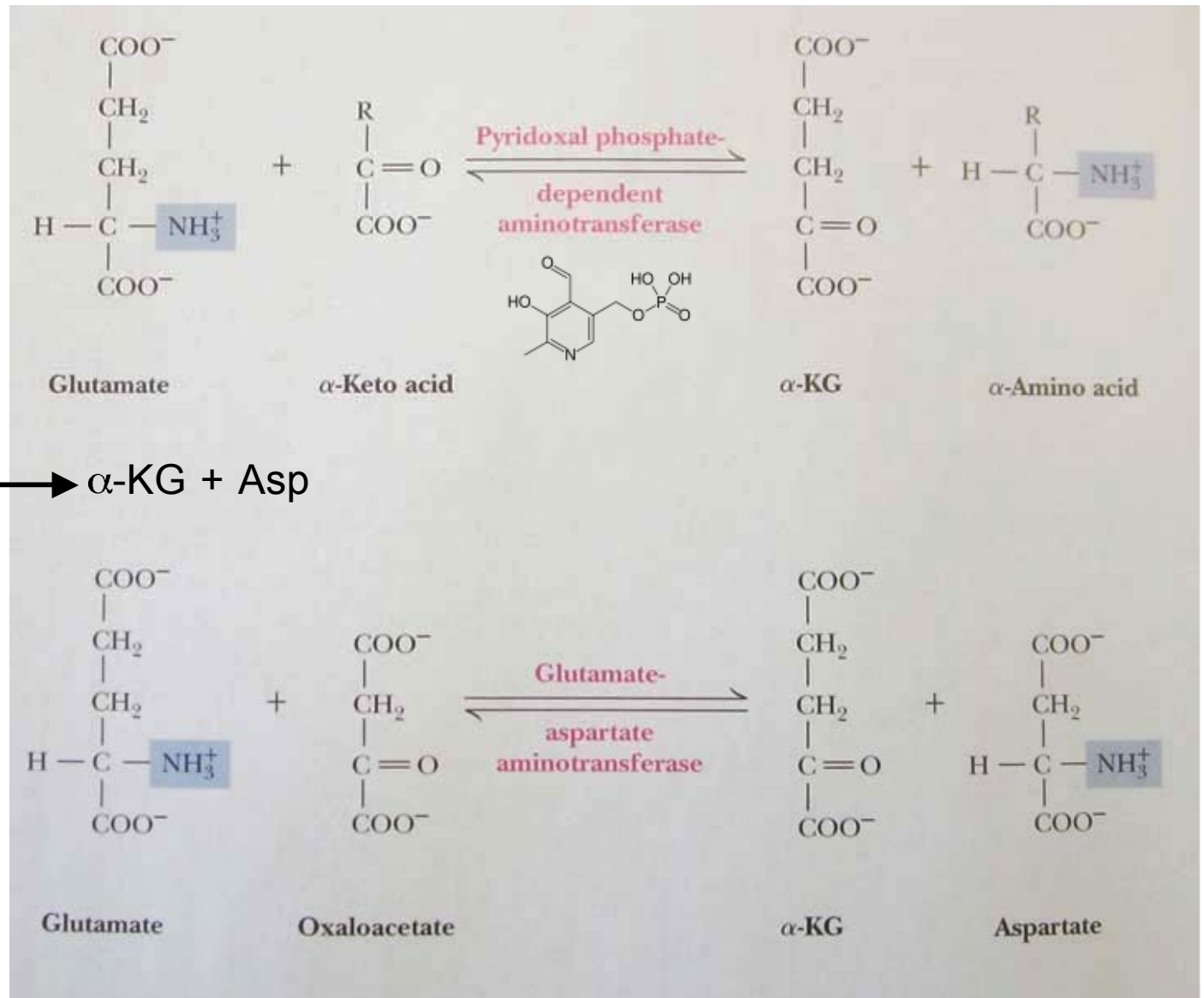




Glutamate and glutamine are major $-\text{NH}_2$ donors through transaminases

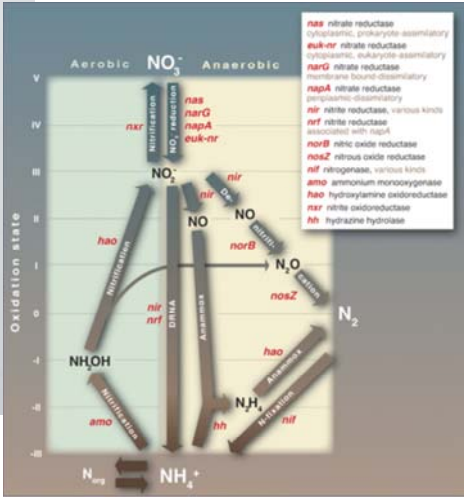
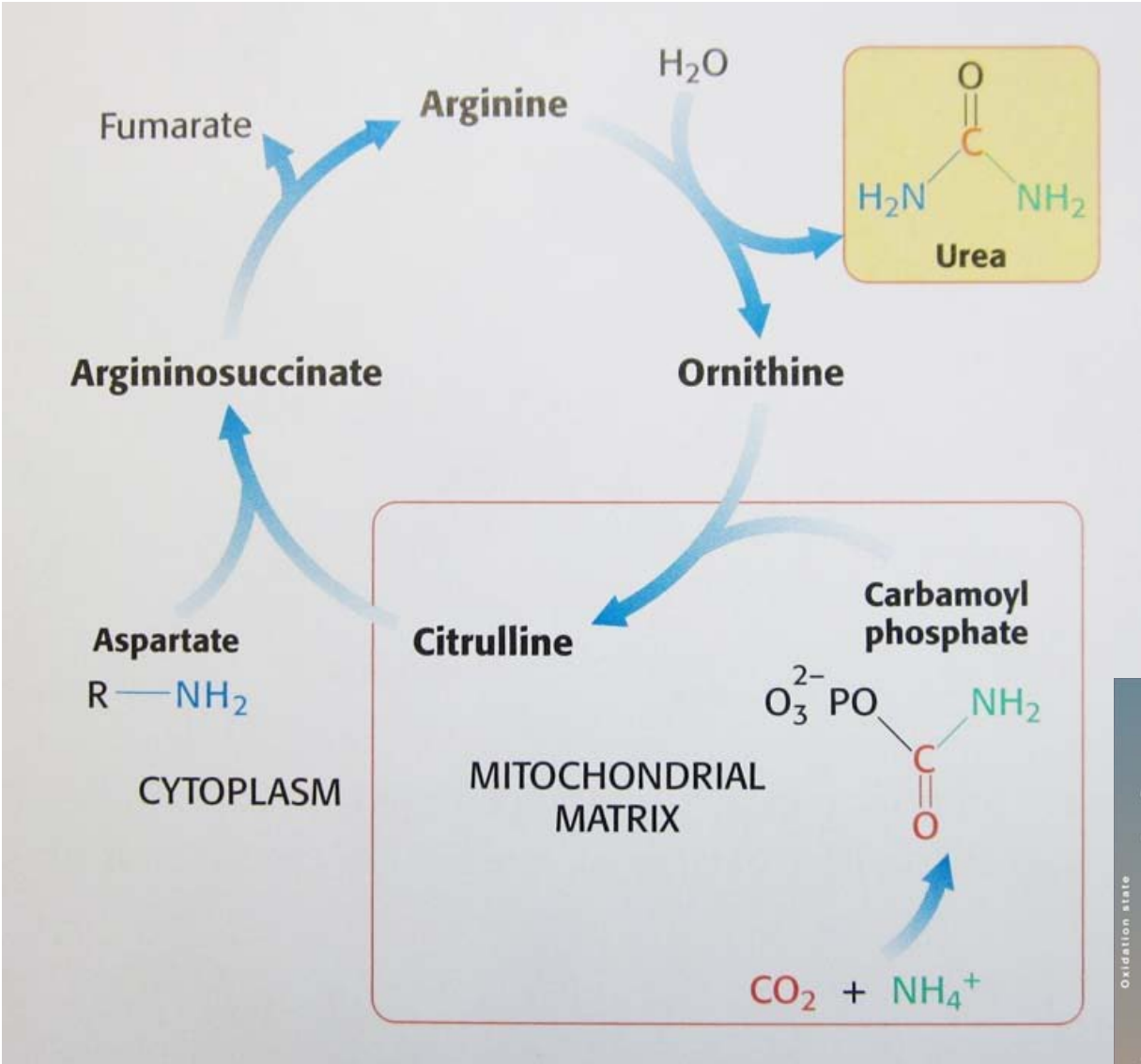


Glutamate and glutamine are major -NH_2 donors through transaminases

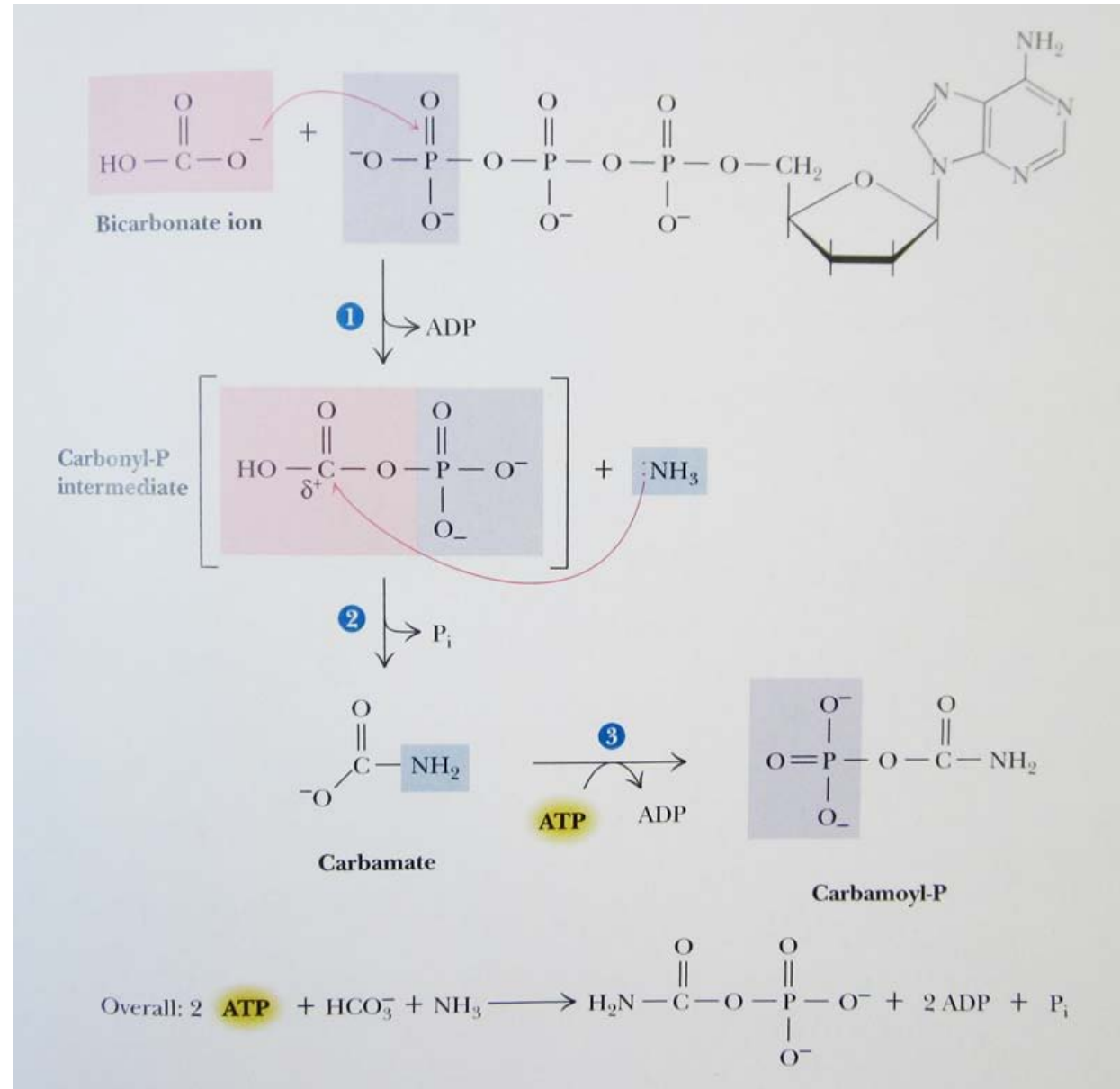


e.g., $\text{Glu} + \text{OAA} \longrightarrow \alpha\text{-KG} + \text{Asp}$

Urea cycle: removal of excess N



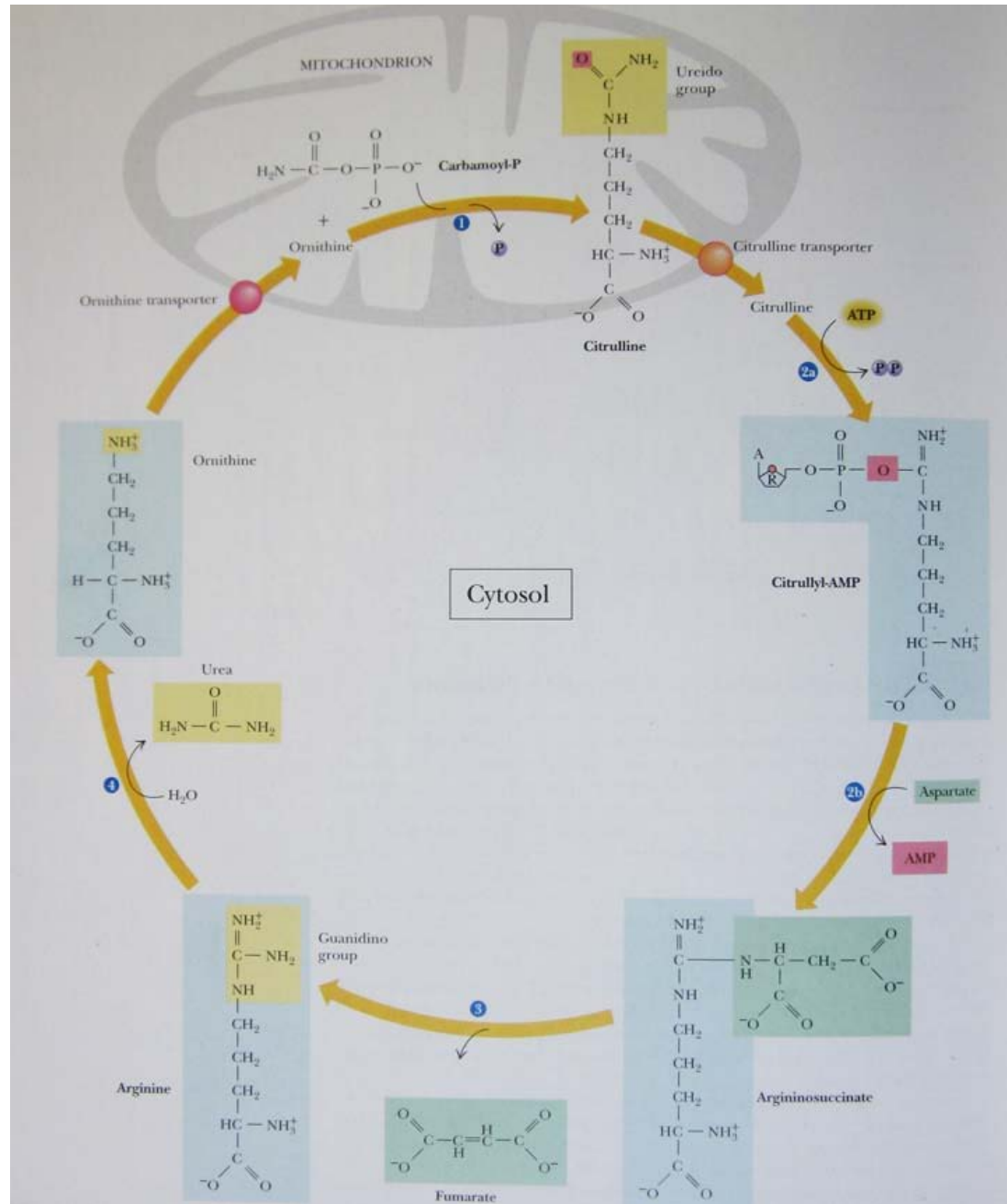
Pre-urea cycle: formation of carbamoyl phosphate



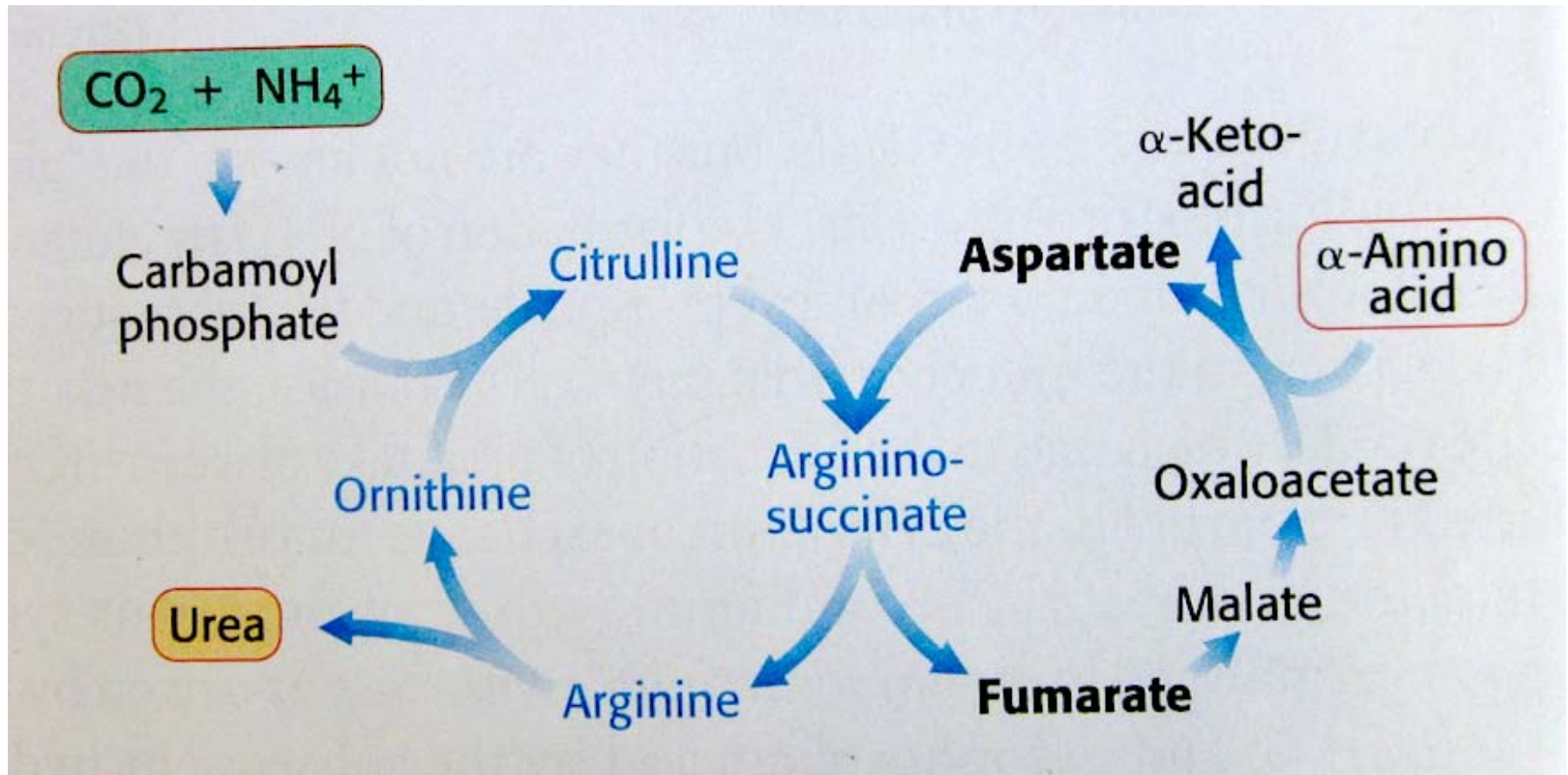
Urea cycle:

Lose two amino-N
and a HCO_3^-

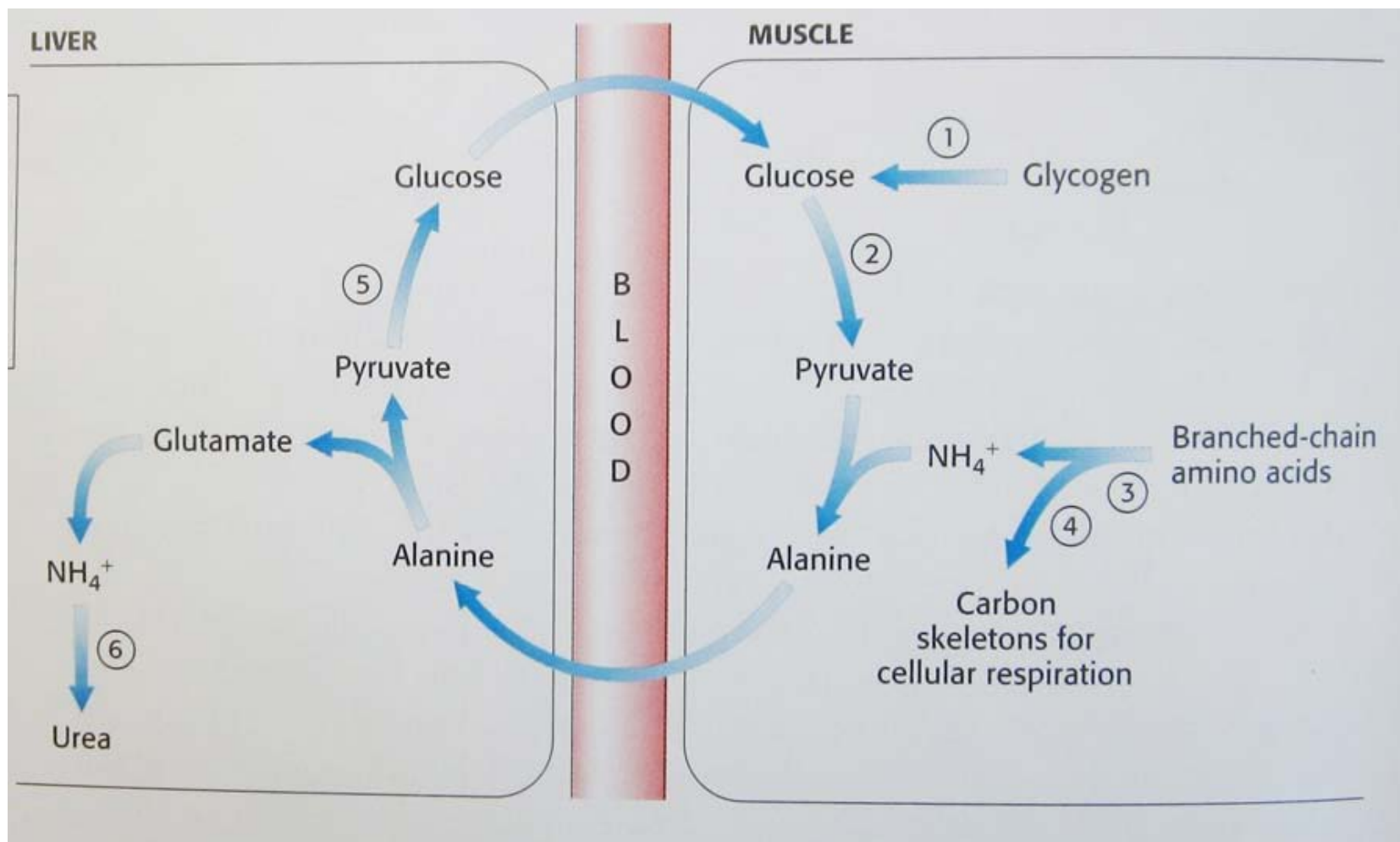
How much energy
does it take to
remove two
amino-nitrogens?



The fumarate product can be used to deaminate other amino acids.



How many of the reactions that we have studied are represented in excretion of excess nitrogen?



Summary

- Nitrogen enters the biosphere through plants, fungi, but mainly bacteria and archaea
- Plants, fungi, and bacteria reduce nitrate nitrogen to ammonium
- Ammonium is incorporated into organic molecules by glutamate dehydrogenase and glutamine synthase/GOGAT
- Other amino acids are formed by transamination
- The urea cycle removes nitrogen from ammonia and aspartate as urea