Excretion of Nitrogeneous waste

-When amino acids catabolized, amino group ($-NH_2$) is released (deamination)

-If not reused, need to excrete because toxic

-Three main ways to dispose:

1-ammonia (most toxic, requires lots water)
'ammonotelic' (NH_3)

2-urea (need 10% of water of NH_3, but costs ATP)
'ureotelic' (2N)

3-uric acid (white pasty substance, low solubility, need 1% water as NH_3) 'uricotelic' (4N), also costs ATP

-Disposal depends on water availability →

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Excretion of Nitrogeneous waste

Foodstuff		End product
Carbohydrate	→	$CO_2 + H_2O$
Fat	→	$CO_2 + H_2O$
Protein	→	NH_3 → Urea / Uric acid
Nucleic acids	→	Purines +Pyrimidines
		↓ ↓
		Uric acid β-Amino acids
		↓ ↓
		Allantoin NH_3
		↓
		Allantoic acid
		↓
		Urea
		↓
		NH_3

Table 9.3 Metabolic end products of the major groups of foodstuffs. Ammonia from protein metabolism may be excreted as such or may be synthesized into other N-containing excretory products; purines from nucleic acids may be excreted as such or as any of a number of degradation products, including ammonia.

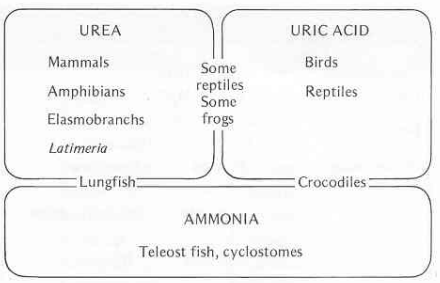
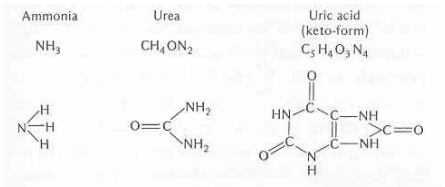


Figure 9.13 Different groups of vertebrates use different compounds as their major nitrogenous excretory product. There are many exceptions to the general pattern indicated in this diagram, most of them related to environmental factors rather than to phylogenetic relationships. See text for further details.



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Knut Schmidt_Nielsen 1997

Animal	Major end product of protein metabolism	Adult habitat	Embryonic environment
Aquatic invertebrates	Ammonia	Aquatic	Aquatic
Teleost fish	Ammonia, some urea	Aquatic	Aquatic
Elasmobranchs	Urea	Aquatic	Aquatic
Crocodiles	Ammonia, some uric acid	Semiaquatic	Cleidoic egg[a]
Amphibians, larval	Ammonia	Aquatic	Aquatic
Amphibians, adult	Urea	Semiaquatic	Aquatic
Mammals	Urea	Terrestrial	Aquatic
Turtles	Urea and uric acid	Terrestrial	Cleidoic egg
Insects	Uric acid	Terrestrial	Cleidoic egg
Land gastropods	Uric acid	Terrestrial	Cleidoic egg
Lizards	Uric acid	Terrestrial	Cleidoic egg
Snakes	Uric acid	Terrestrial	Cleidoic egg
Birds	Uric acid	Terrestrial	Cleidoic egg

[a] The role of cleidoic eggs is discussed later in this chapter.

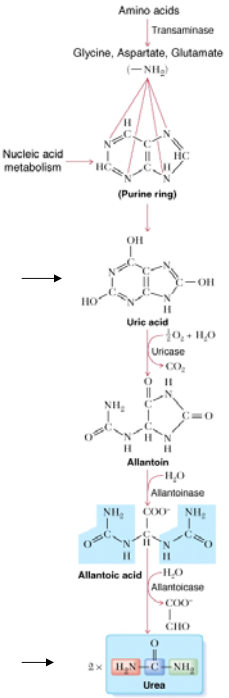
Table 9.4 Major nitrogen excretory products in various animal groups.

Knut Schmidt_Nielsen 1997

Excretion of Nitrogeneous waste

-ammonia converted to non-toxic glutamine in the body for transport

-ammonia toxic because
-increases pH,
-competes with K^+ for ion transport,
-alters synaptic transmission

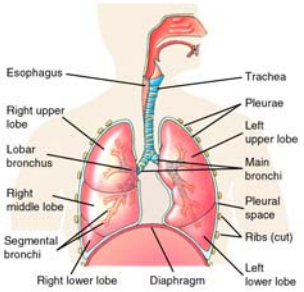


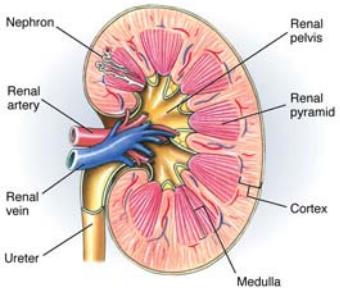
(14-31)

pH regulation

Acid Secretion

(Eckert 14-17)





CO_2 via lungs, H^+ via kidneys
(skin and gills can also play role)

Proximal tubule and loop of henle:
Na^+/H^+ antiporter (driven by Na/K-ATPase)

Distal tubule and collecting duct:
A-type cells with proton pump and anion exchanger

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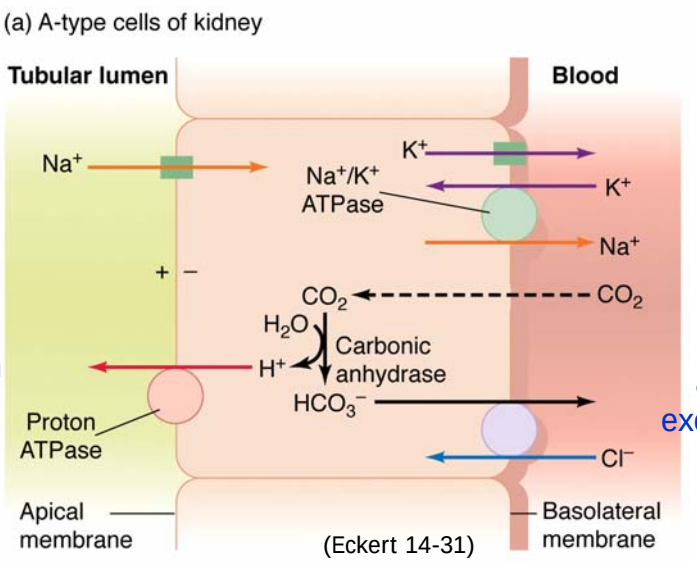

proton pump

anion exchanger

(Eckert 14-31)

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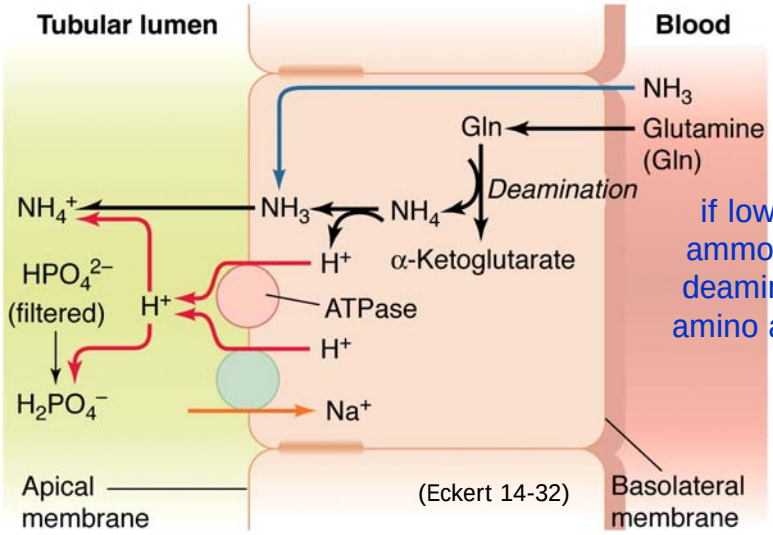
Ultrafiltrate buffered by bicarbonate, phosphates, and ammonia allowing for more acid secretion

e.g., $NH_3 + H^+ \rightarrow NH_4^+$



if low on ammonia, deaminate amino acids

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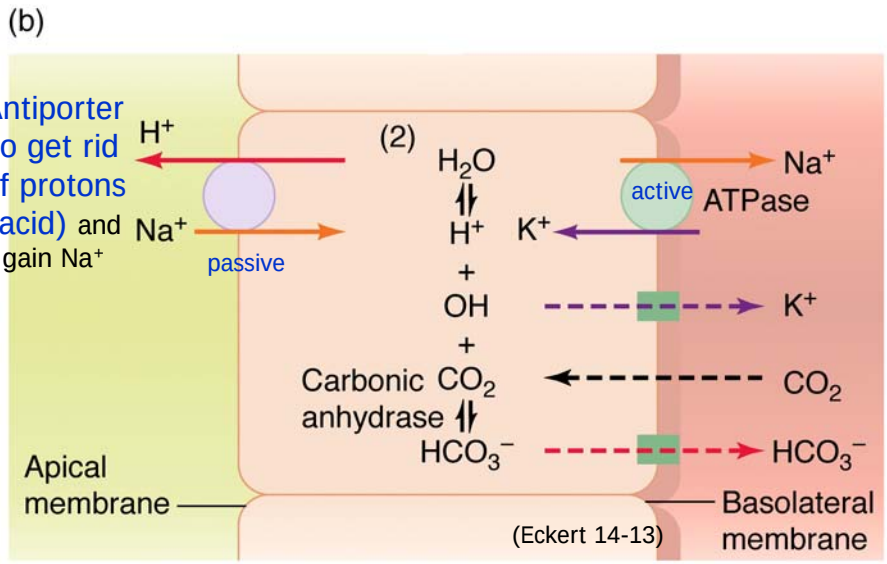
Gradients established and used:



Mammalian Kidney

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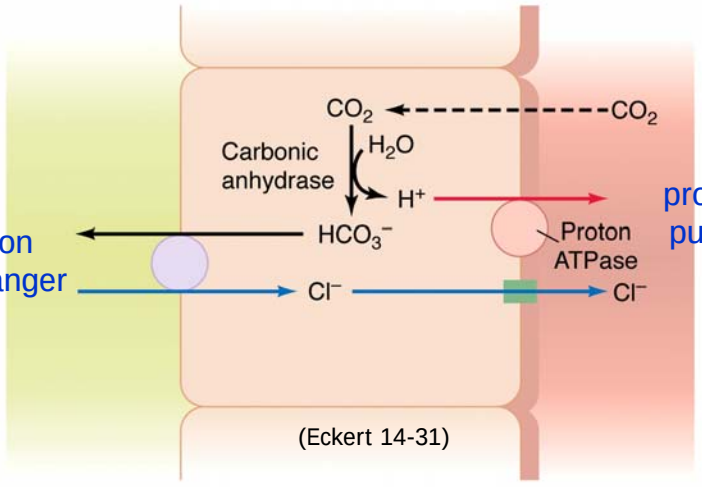
pH regulation

<u>Base Secretion</u> (opposite A-type cells)

(b) B-type cells of kidney



anion exchanger

proton pump

(Eckert 14-31)