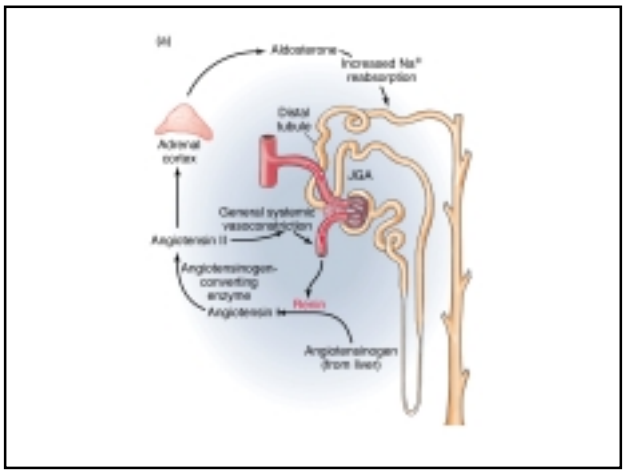


(b)

Angiotensinogen (Renin substrate)

Asp-Arg-Val-Tyr-Ile-His-Pro-Phe-His-Leu-Leu-Val-Tyr-Ser-Protein

↓ Renin

Angiotensin I

Asp-Arg-Val-Tyr-Ile-His-Pro-Phe-His-Leu

↓ Angiotensinogen-converting enzyme

Angiotensin II

Asp-Arg-Val-Tyr-Ile-His-Pro-Phe

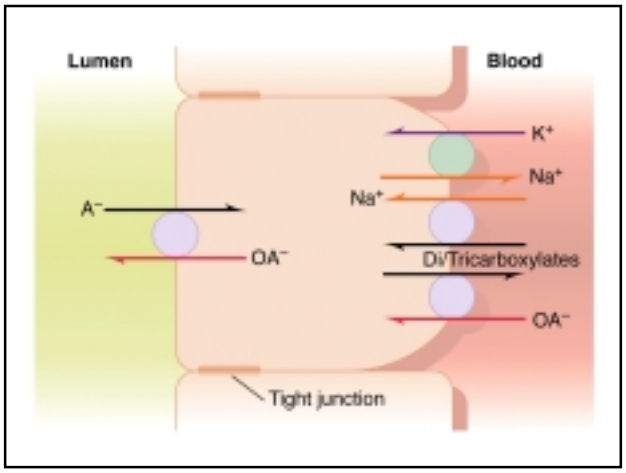
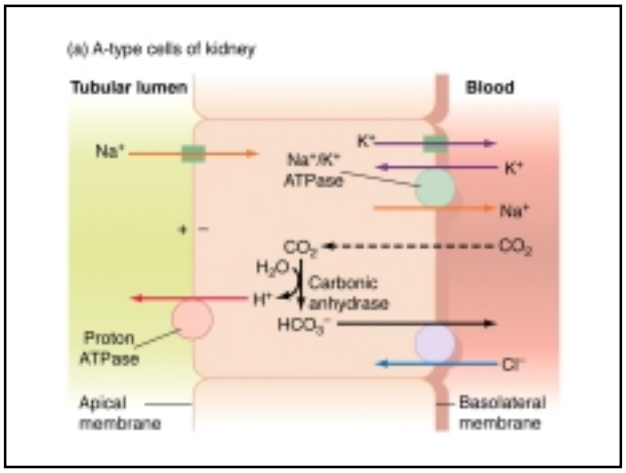
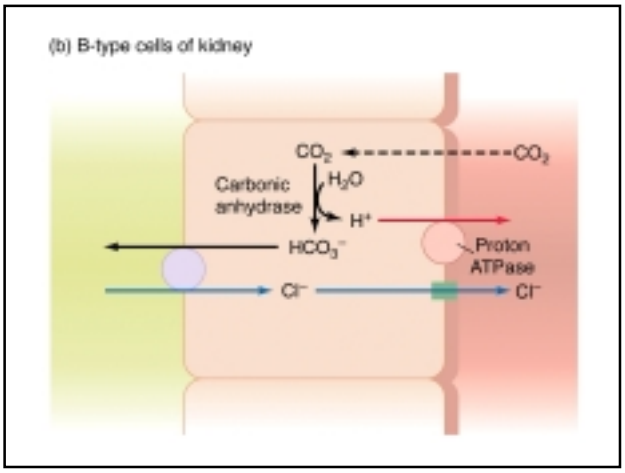
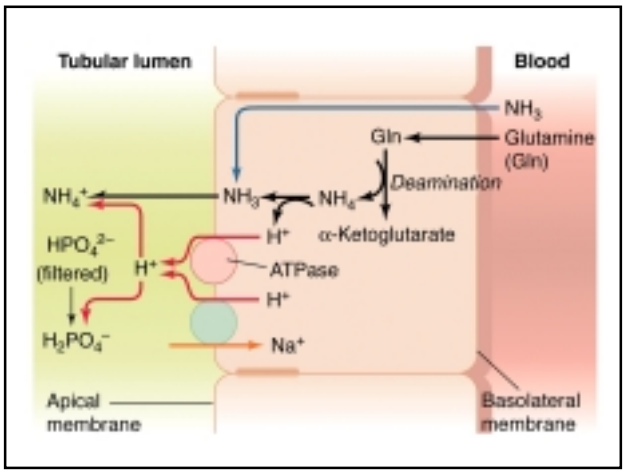


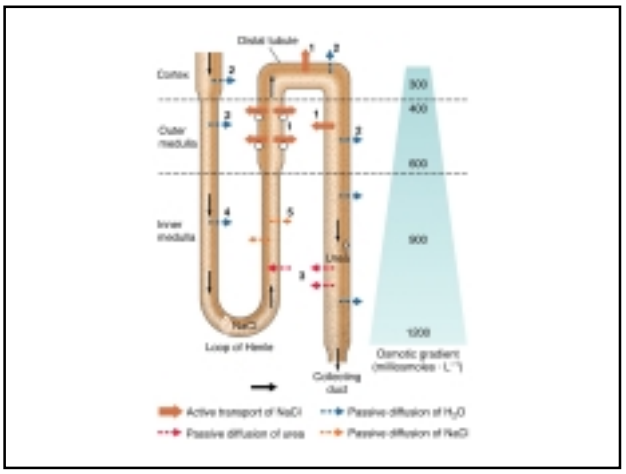
Table 14-9 Some organic ions secreted by the proximal tubule

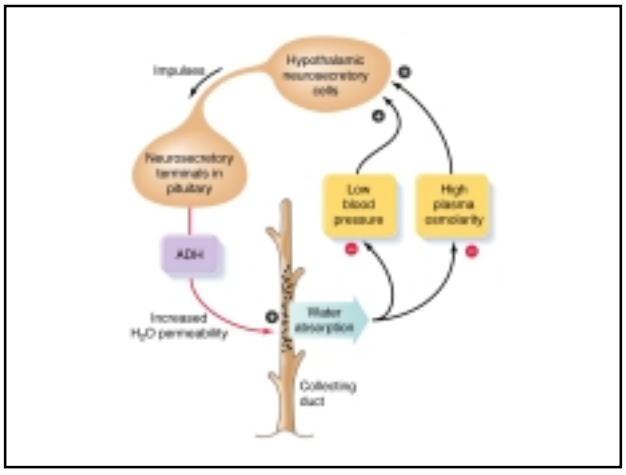
Anions	Cations
Endogenous	*Endogenous*
Urates	Dopamine
Hippurates	Epinephrine
Oxalate	Norepinephrine
Prostaglandins	Creatinine
cAMP	
Exogenous	*Exogenous*
Furosemide	Morphine
Bumetanide	Amiloride
Penicillin	Quinine
Aspirin	Atropine
Chlorothiazides	Isoproterenol

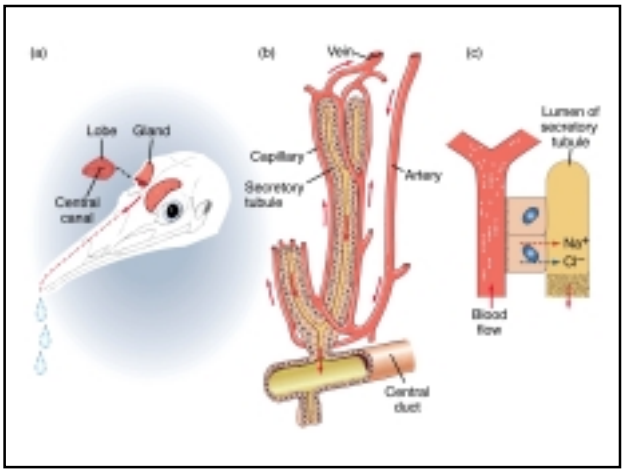


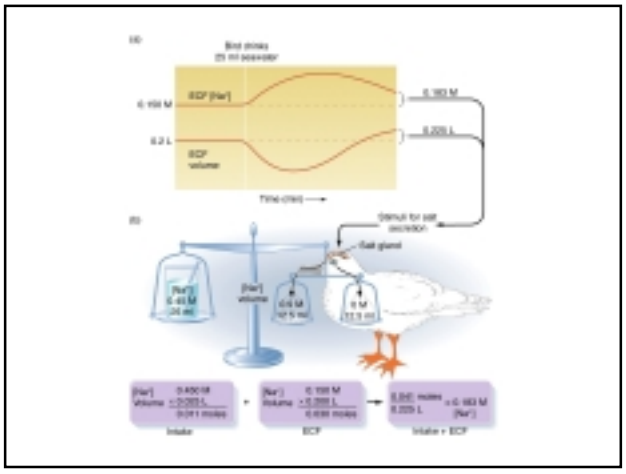


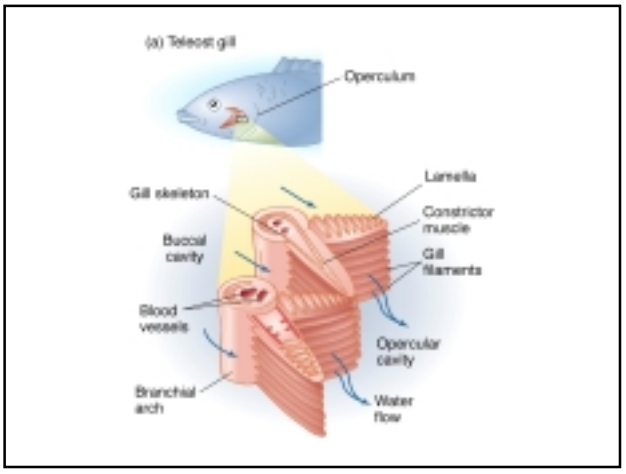

Tubular lumen
Blood
NH_3
Gln
Glutamine (Gln)
Deamination
NH_4^+
NH_3
NH_4
H^+
α-Ketoglutarate
HPO_4^{2-} (filtered)
H^+
ATPase
H^+
$H_2PO_4^-$
Na^+
Apical membrane
Basolateral membrane

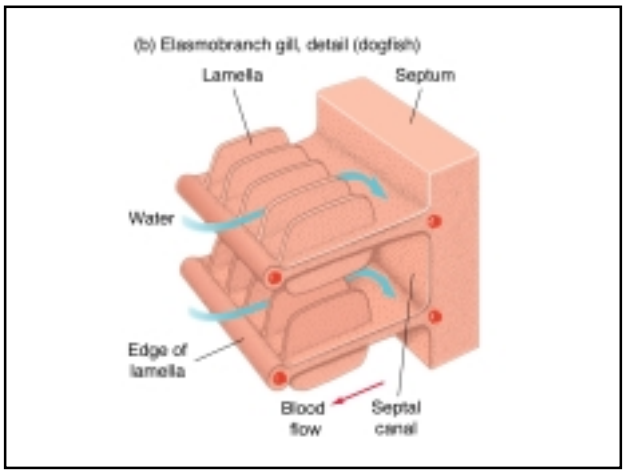

Distal tubule
Cortex
Outer medulla
Inner medulla
Loop of Henle
Collecting duct
300
400
600
900
1200
Osmotic gradient (milliosmoles · L^{-1})
Active transport of NaCl
Passive diffusion of H_2O
Passive diffusion of urea
Passive diffusion of NaCl

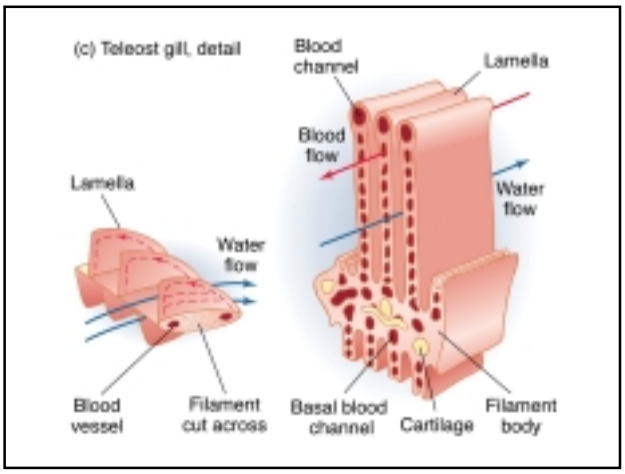

Impulses
Hypothalamic neurosecretory cells
Neurosecretory terminals in pituitary
ADH
Low blood pressure
High plasma osmolarity
Increased H_2O permeability
Water absorption
Collecting duct

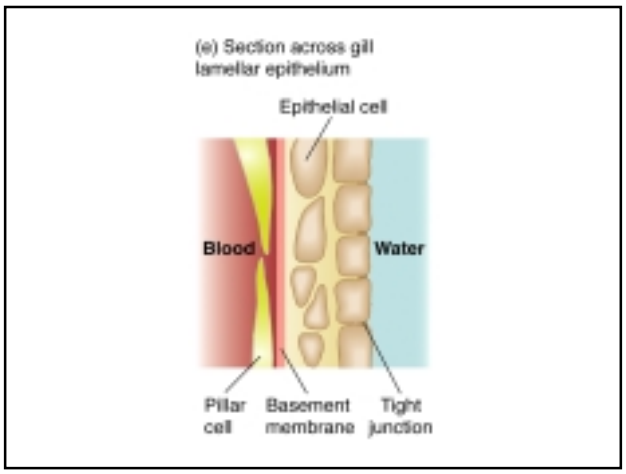

(a)
(b)
(c)
Vein
Lobe
Gland
Central canal
Capillary
Secretory tubule
Artery
Lumen of secretory tubule
Na^+
Cl^-
Blood flow
Central duct

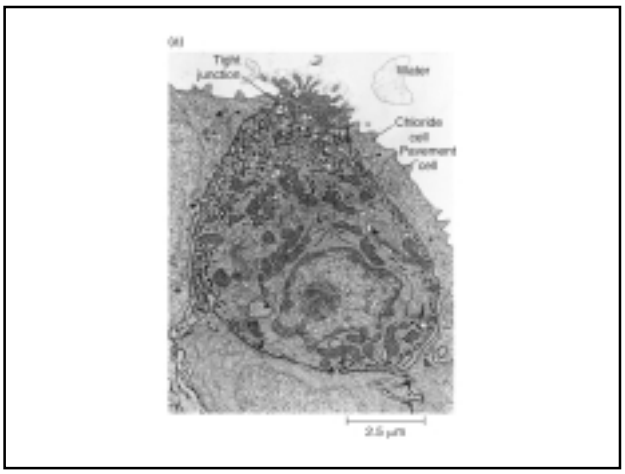

ECF [Na+]
ECF volume
Time (days)
Gill gland
Intake
ECF
Intake + ECF

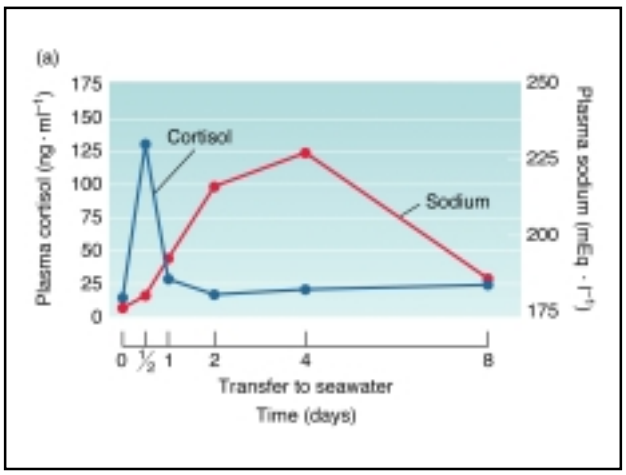

(a) Teleost gill
Operculum
Gill skeleton
Lamella
Constrictor muscle
Buccal cavity
Gill filaments
Blood vessels
Opercular cavity
Branchial arch
Water flow


(b) Elasmobranch gill, detail (dogfish)
Lamella
Septum
Water
Edge of lamella
Blood flow
Septal canal


(c) Teleost gill, detail
Blood channel
Lamella
Blood flow
Water flow
Lamella
Water flow
Blood vessel
Filament cut across
Basal blood channel
Cartilage
Filament body


(e) Section across gill lamellar epithelium
Epithelial cell
Blood
Water
Pillar cell
Basement membrane
Tight junction


(a)
Tight junction
Water
Chloride cell
Pavement cell


(a)
Plasma cortisol (ng · ml⁻¹)
Cortisol
Sodium
Plasma sodium (mEq · l⁻¹)
0 ½ 1 2 4 8
Transfer to seawater
Time (days)

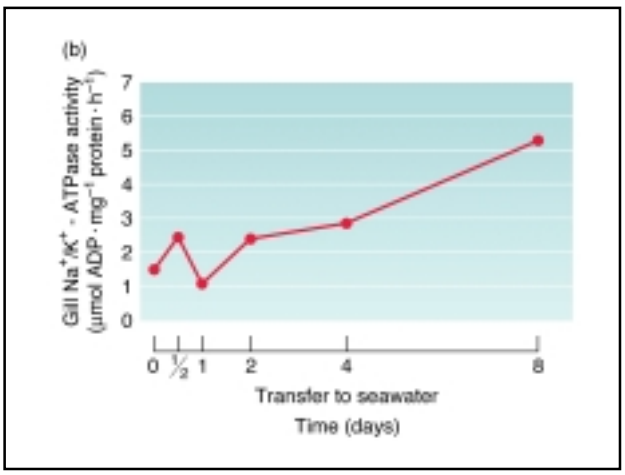

(b)
Gill Na⁺/K⁺ - ATPase activity (μmol ADP · mg⁻¹ protein · h⁻¹)
0 ½ 1 2 4 8
Transfer to seawater
Time (days)

Table 14-10 Physiological acclimatizations that accompany the movement of fish to water of differing salinity

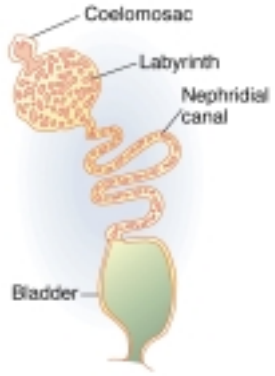
(A) From freshwater to seawater

1. The proton pump that powers active uptake of NaCl is down-regulated.
2. The rise in the flux of Na^+ into the body raises plasma Na^+, stimulating an increase in plasma cortisol and growth hormone levels.
3. Hormones induce the proliferation of chloride cells and an increase in the infolding of their basolateral membranes.
4. The changes above cause an increase in the activity of the Na^+/K^+ pump and the secretion of NaCl.
5. Plasma Na^+ levels return to normal.

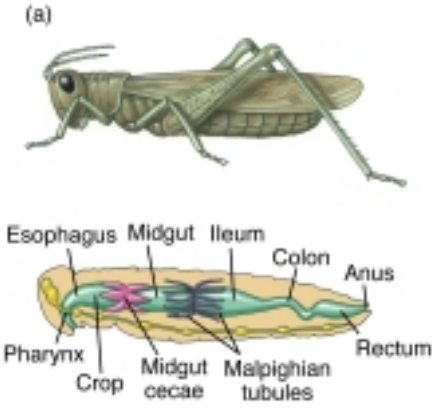
Table 14-10 Physiological acclimatizations that accompany the movement of fish to water of differing salinity

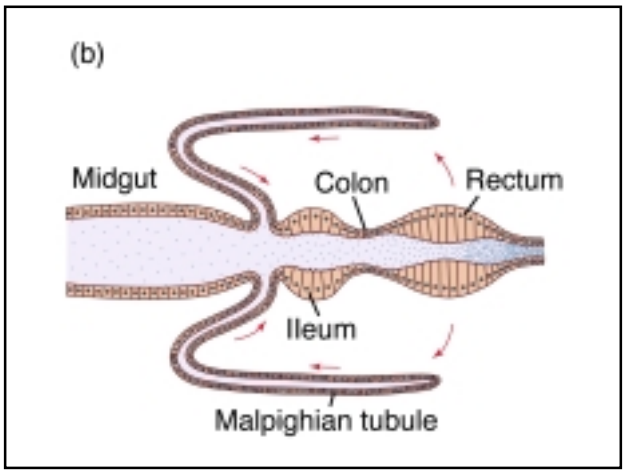
(B) From seawater to freshwater

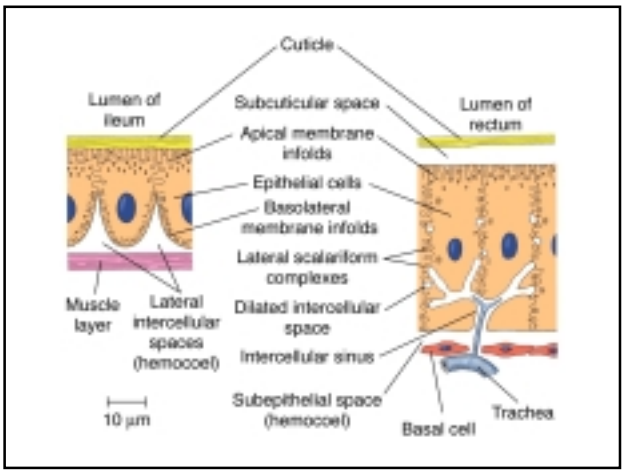
1. The paracellular gaps between chloride and accessory cells close in response to low external Na^+ levels, causing NaCl efflux to fall rapidly.
2. Plasma prolactin levels increase.
3. Prolactin causes the number of chloride cells to decrease and the apical pits to disappear.
4. As a result, the activity of the Na^+/K^+ pump falls.
5. Up-regulation of the proton pump returns the fish to the freshwater condition.

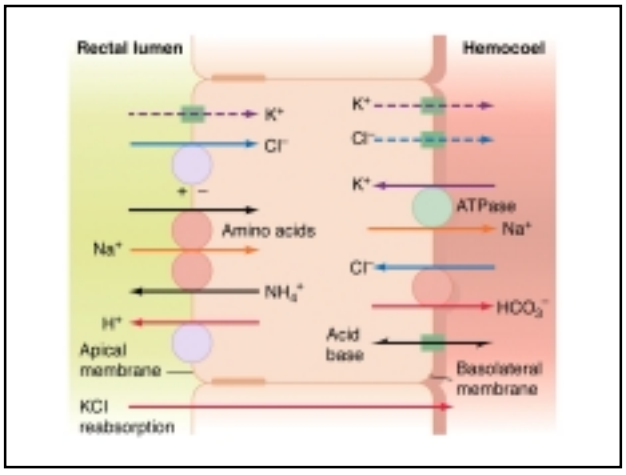


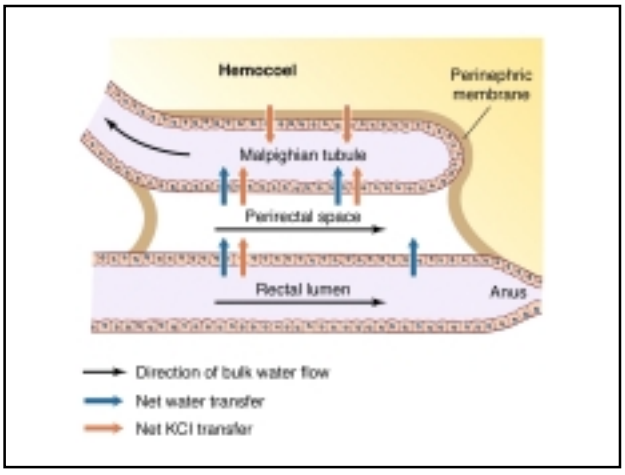
Crayfish antennal gland

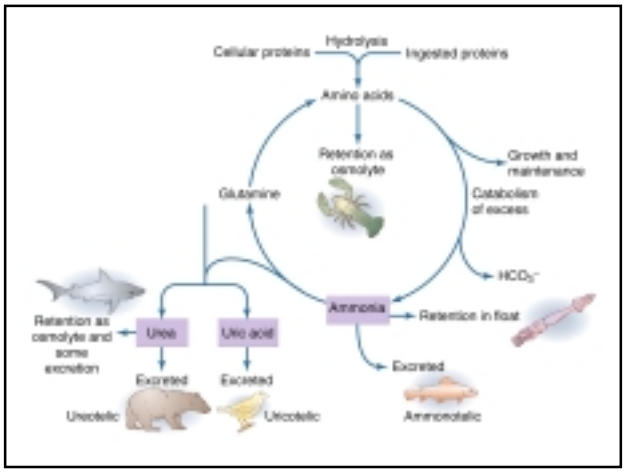


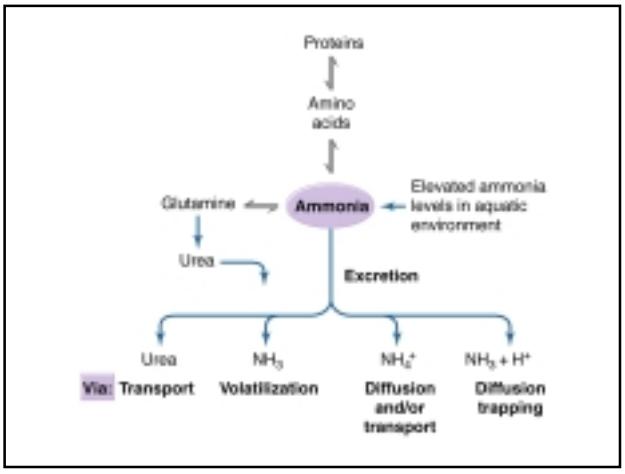

(b)
Midgut
Colon
Rectum
Ileum
Malpighian tubule

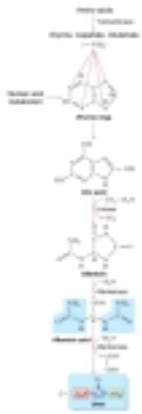

Cuticle
Lumen of ileum
Subcuticular space
Lumen of rectum
Apical membrane infolds
Epithelial cells
Basolateral membrane infolds
Lateral scalariform complexes
Muscle layer
Lateral intercellular spaces (hemocoel)
Dilated intercellular space
Intercellular sinus
Subepithelial space (hemocoel)
10 μm
Basal cell
Trachea

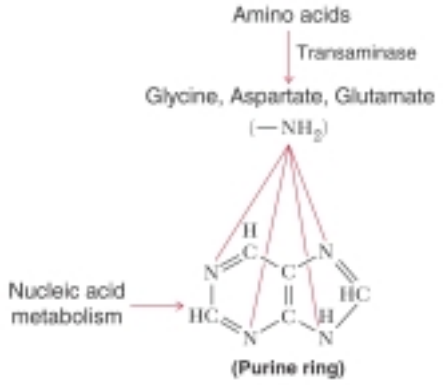

Rectal lumen
Hemocoel
K+
Cl−
Amino acids
Na+
NH4+
H+
Apical membrane
KCl reabsorption
ATPase
HCO3−
Acid base
Basolateral membrane

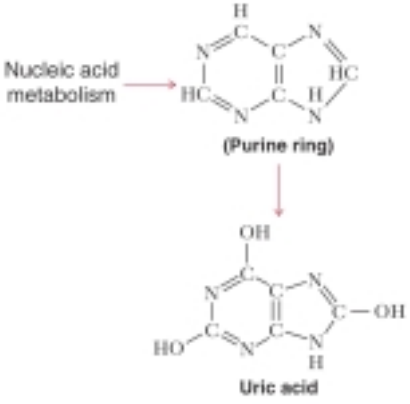

Hemocoel
Perinephric membrane
Malpighian tubule
Perirectal space
Rectal lumen
Anus
Direction of bulk water flow
Net water transfer
Net KCl transfer

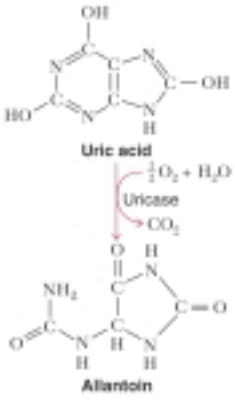

Cellular proteins
Hydrolysis
Ingested proteins
Amino acids
Retention as osmolyte
Growth and maintenance
Glutamine
Catabolism of excess
HCO3−
Ammonia
Retention in fluid
Retention as osmolyte and some excretion
Urea
Uric acid
Excreted
Excreted
Excreted
Uricotelic
Uricotelic
Ammonotelic

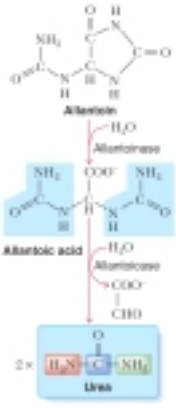

Proteins
Amino acids
Glutamine
Ammonia
Elevated ammonia levels in aquatic environment
Urea
Excretion
Urea
NH3
NH4+
NH3 + H+
Via: Transport
Volatilization
Diffusion and/or transport
Diffusion trapping




Amino acids
Transaminase
Glycine, Aspartate, Glutamate
(—NH2)
Nucleic acid metabolism
(Purine ring)


Nucleic acid metabolism
(Purine ring)
Uric acid


Uric acid
Uricase
CO2
Allantoin


Allantoin
Allantoinase
Allantoic acid
Allantoicase
Urea