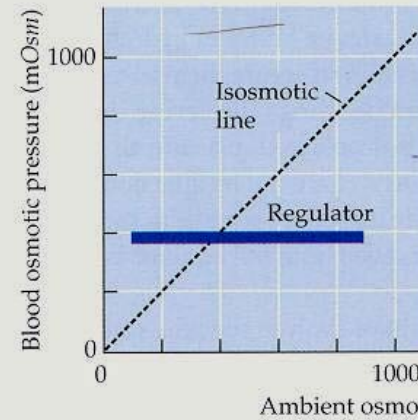


Vylučování a vodní hospodářství

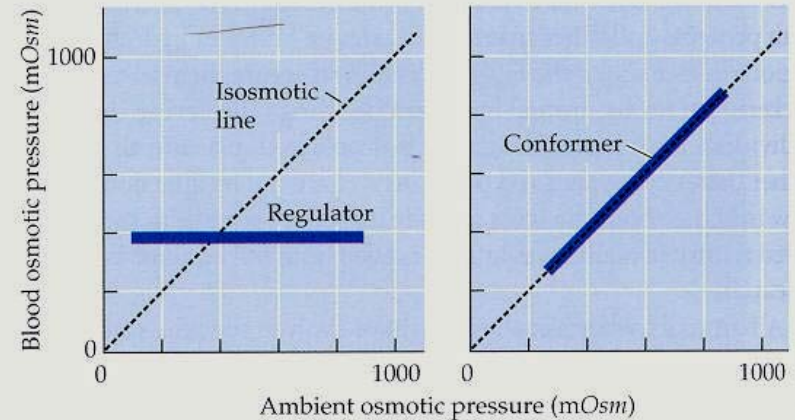
Udržování vnitřního prostředí:

- Koncentrace odpadních a toxických látek
- Koncentrace rozpuštěných látek – osmolalita
- Navzdory nerovnováze s okolím

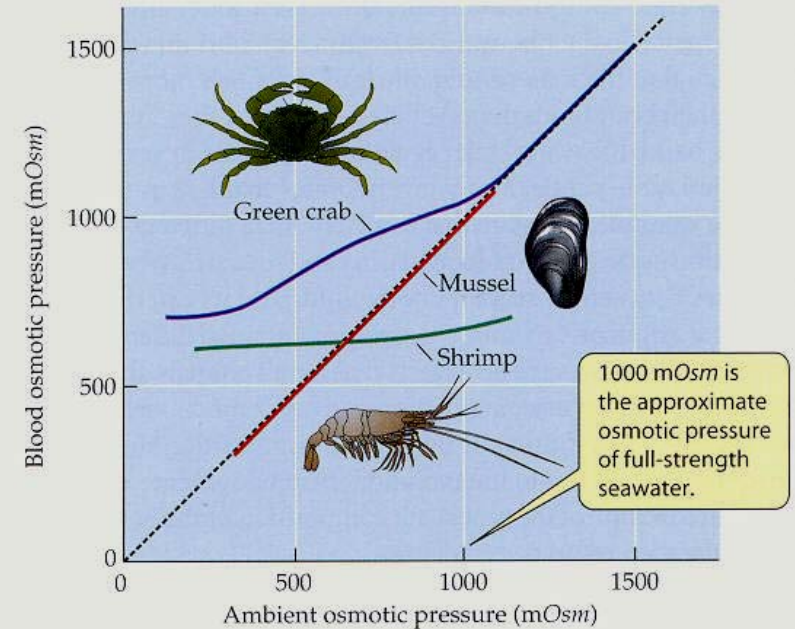
(a) Osmotic regulation (idealized)



(b) Osmotic conformity (idealized)



(c) Actual relations of three marine invertebrates



Bílkoviny a nukleové kyseliny – toxické metabolity dusíku.
Amoniak jen při dostatku vody.

Molekuly tří nejběžnějších dusíkatých exkretčních produktů - amoniaku, močoviny a kyseliny močové. Nízký poměr H:N pro kyselinu močovou znamená, že na její syntézu bylo spotřebováno méně vody než u močoviny nebo amoniaku (vodíkový atom pochází z vody).

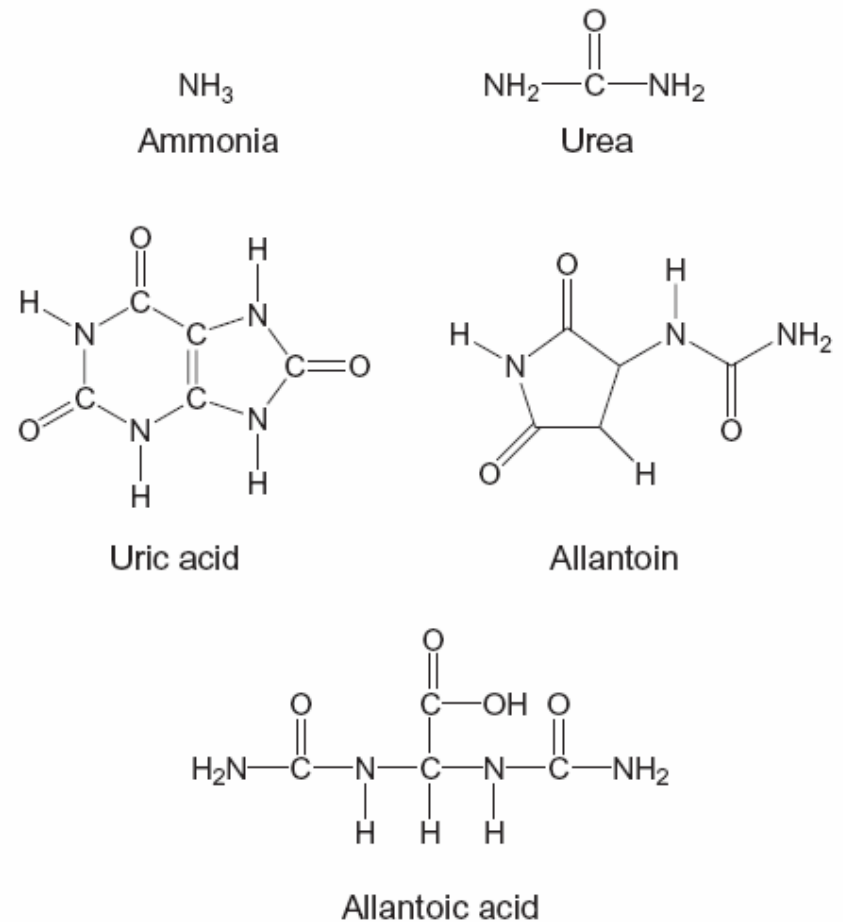
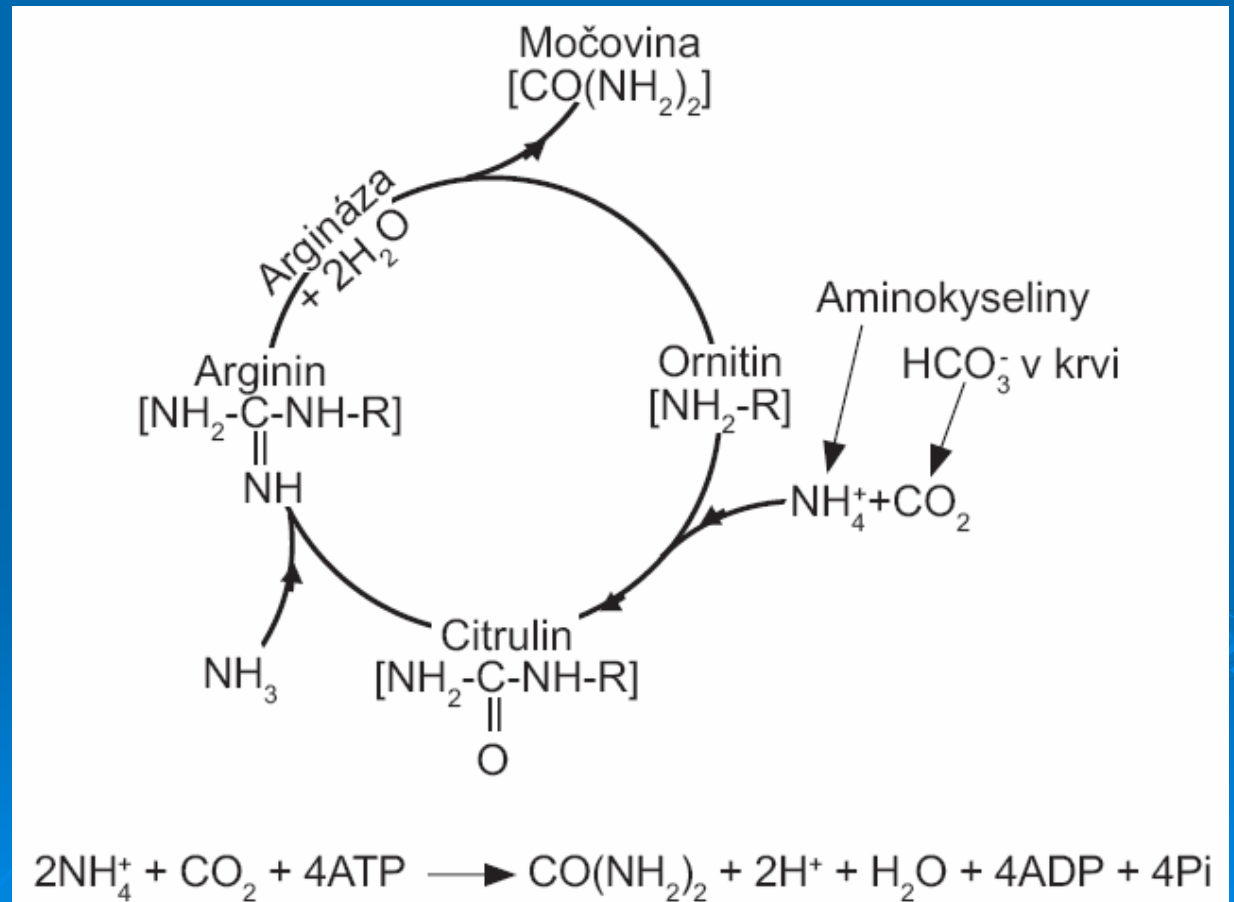


FIGURE 8.2. Excretory molecules that incorporate nitrogen.

Ornithinový cyklus – syntéza močoviny

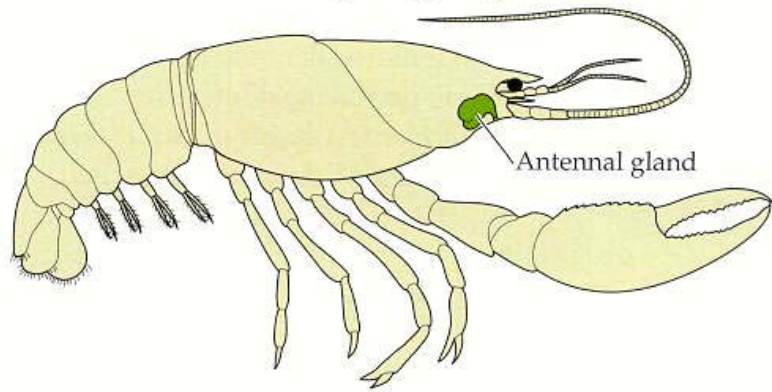
Ještě „dražší“ kyselina močová.



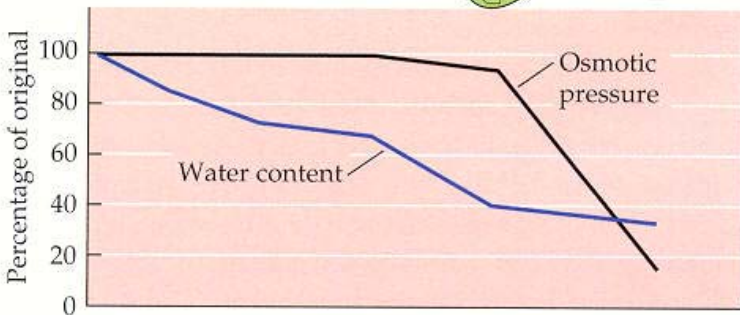
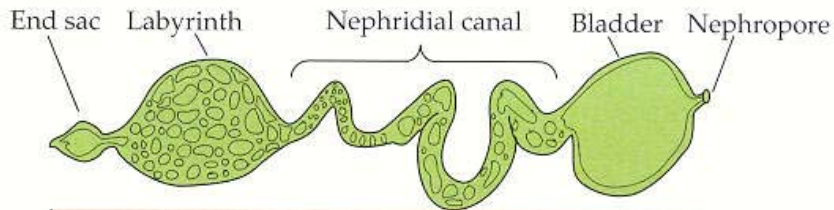
Stavba exkretčních orgánů:

- Epiteliální povrchy těla
- Tubulární orgány

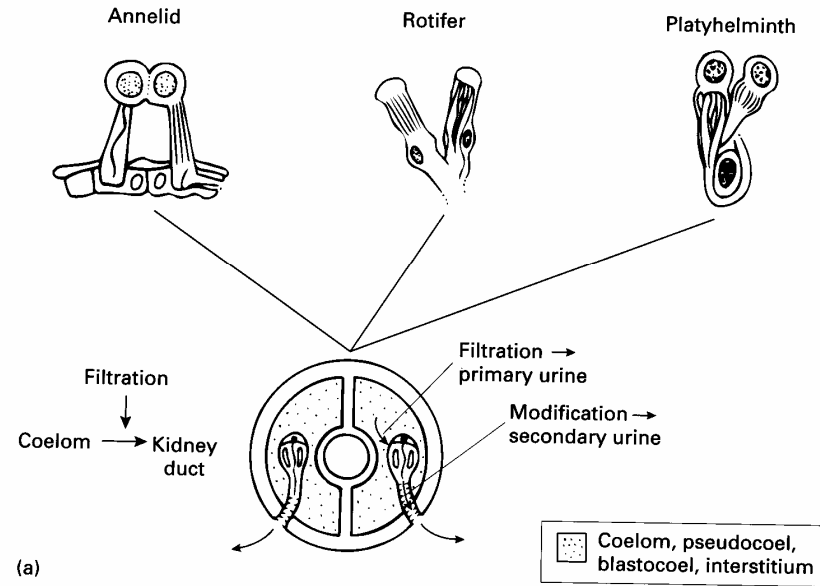
(a) Position of the antennal gland (green gland)



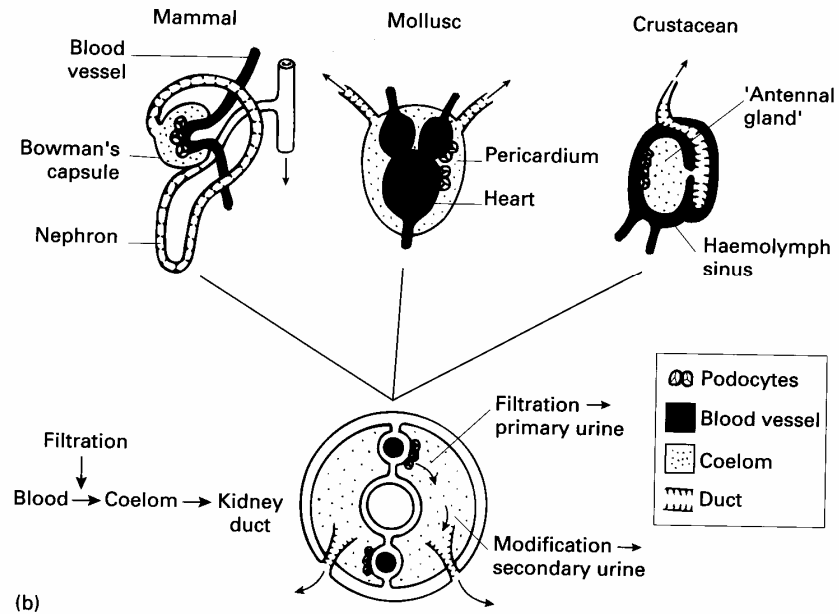
(b) Antennal gland unfolded with urine properties plotted below corresponding anatomical locations



'Protonephridia' or 'flame cell'



'Metanephridia' or 'coelomduct'



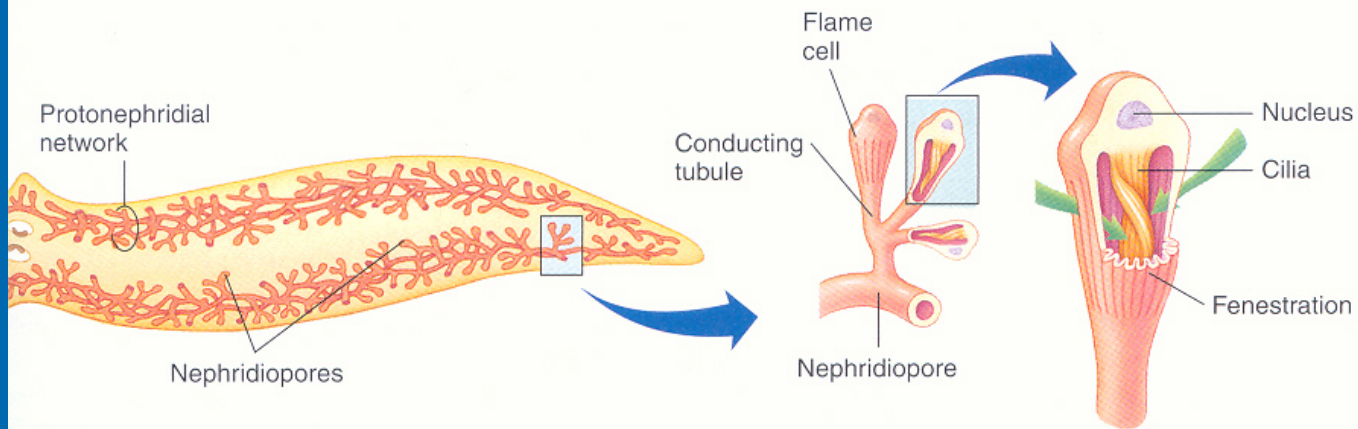
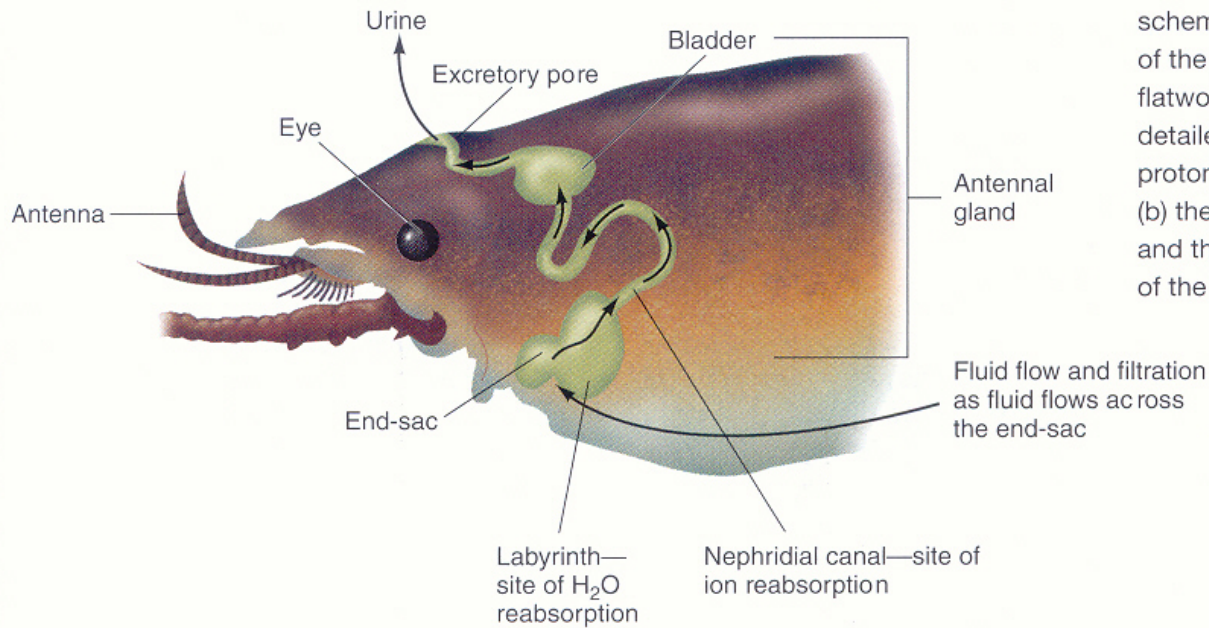
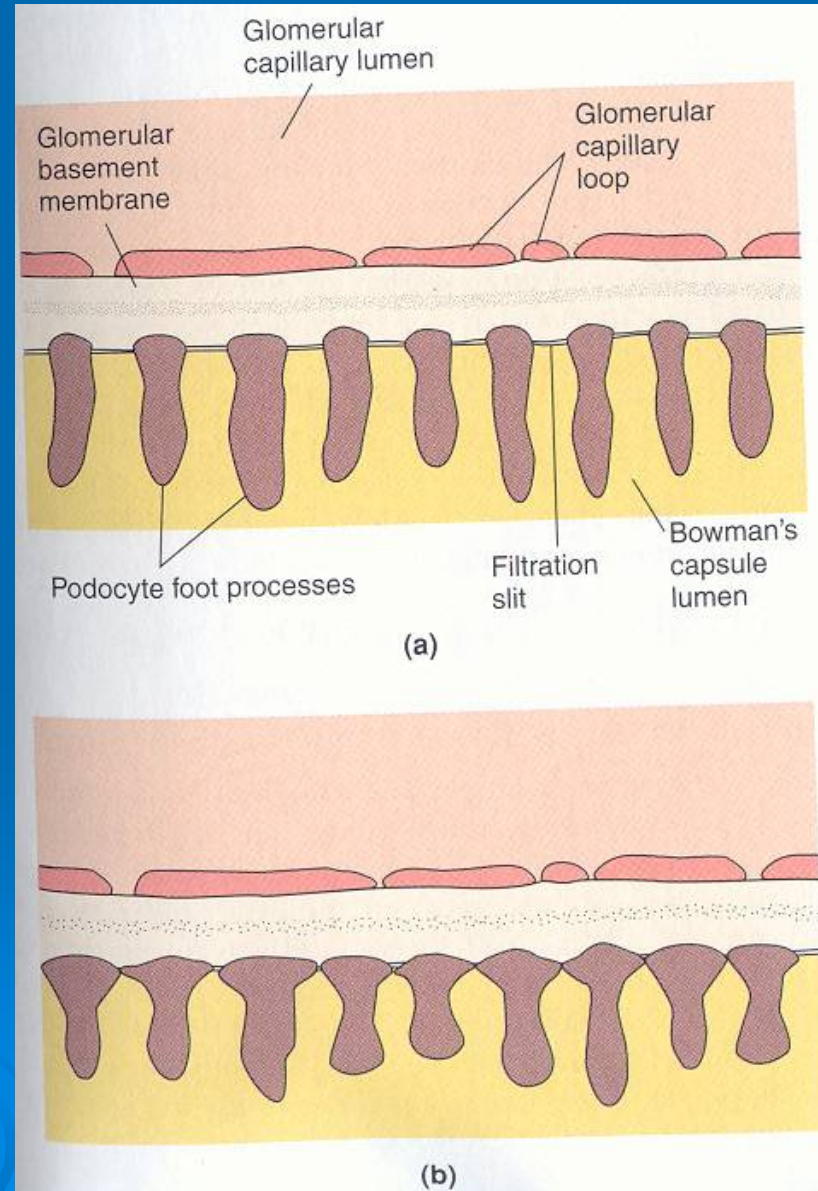


Figure 12-5 • (a) General schematic for the organization of the protonephridia in a triclad flatworm *Dendrocoelum* and the detailed structure of a single protonephridium and its flame cell. (b) the head region of a crustacean and the location and arrangement of the antennal gland (green gland).



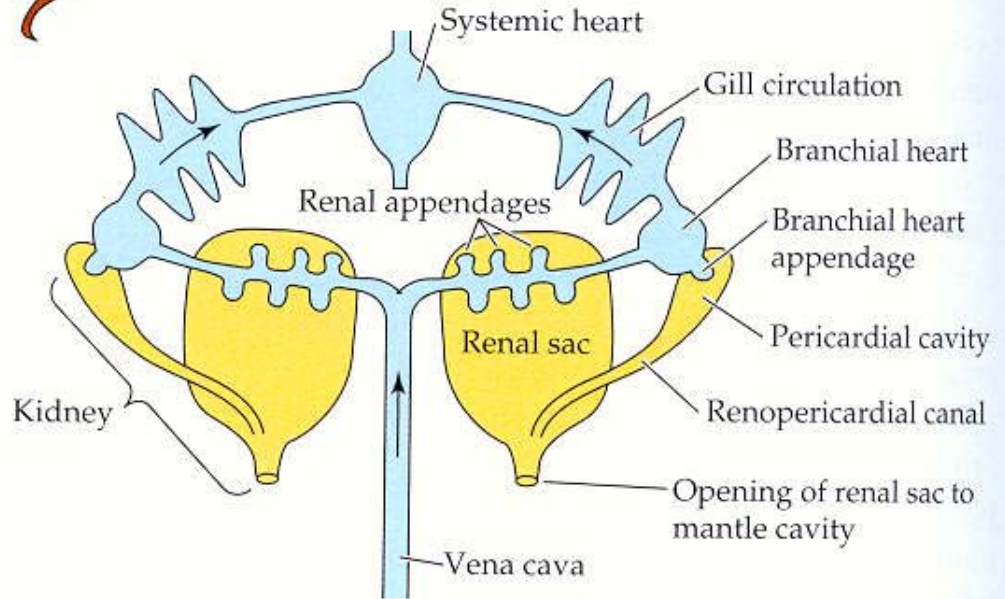
(Sources: (a) From P. C. Withers, 1992, *Comparative Animal Physiology*, Fort Worth, TX: as modified from R. D. Barnes, 1987, *Invertebrate Zoology*, Philadelphia: Saunders, and G. Kummel, 1962, Zwei neue formen von cyrtocyten vergleich der bisher bekannten cyrtocyten und erörterung des begriffes "zelltyp," *Zeitschrift Zellforschung* 57:172–201. (b) From I. Kay, 1998, *Introduction to Animal Physiology*, New York: Springer, Figure 10.4, p. 166). Reprinted by permission.)

Podocyty

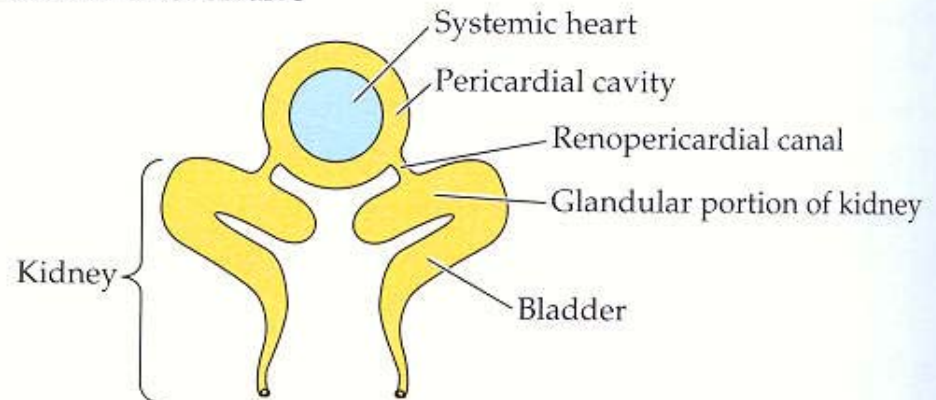


Perikardiální dutina měkkýšů.

(a) Octopus



(b) Clam or other bivalve



Tvorba a úprava primárního filtrátu.

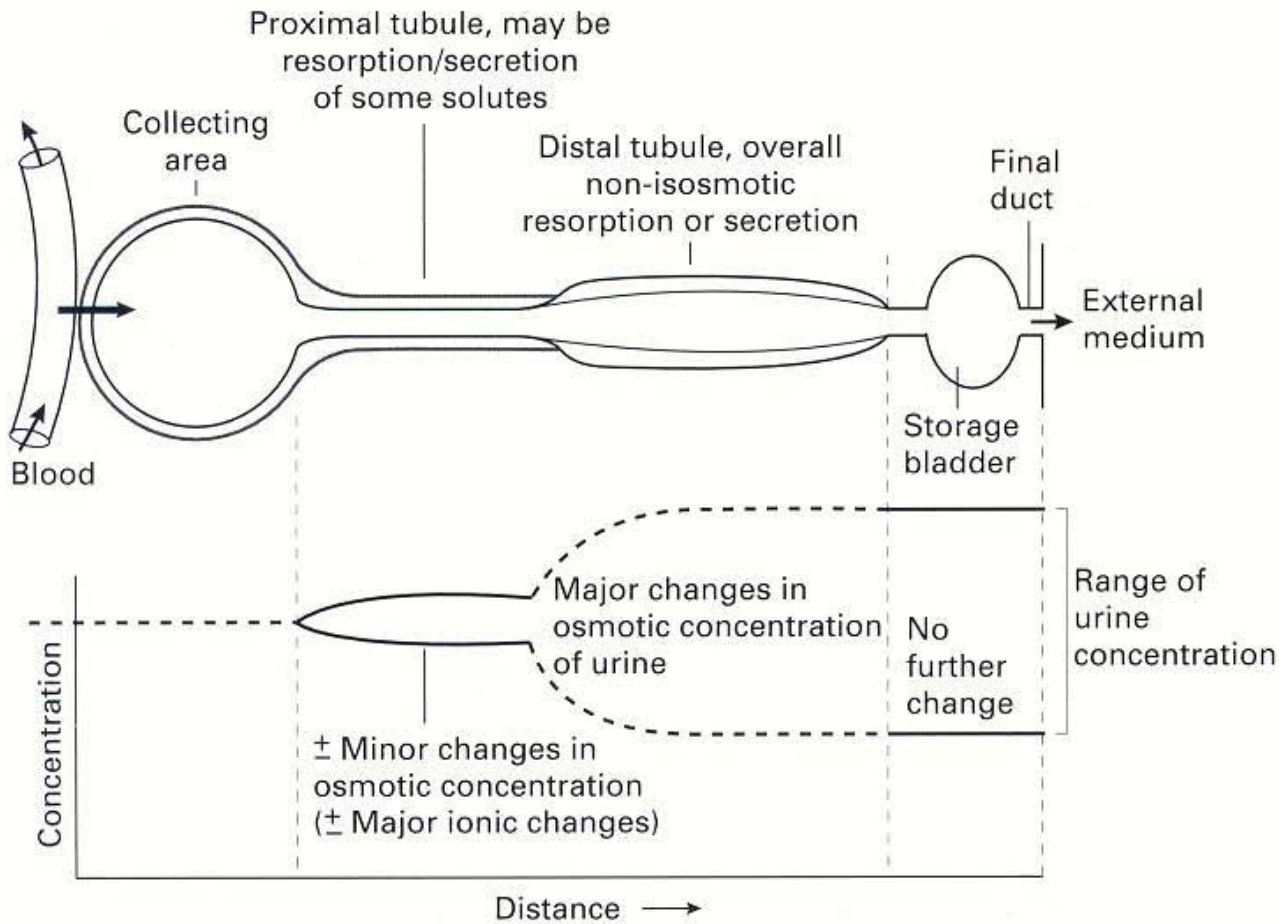


Fig. 5.8 A schematic basic design of osmoregulatory/excretory systems, and the patterns of change of concentration commonly found in each region.

Malpighické trubice – jiná varianta tubulárního vylučování.
Spolu s rektum mimořádně výkonný systém šetřící vodu.

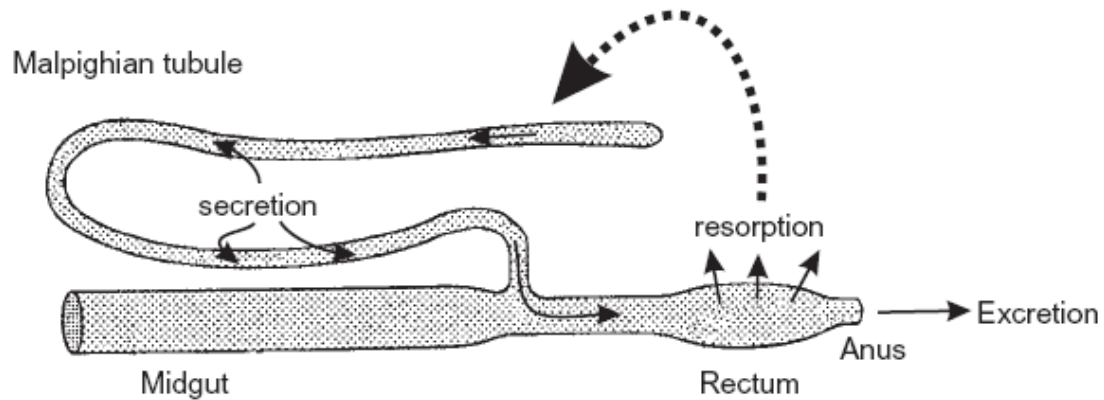
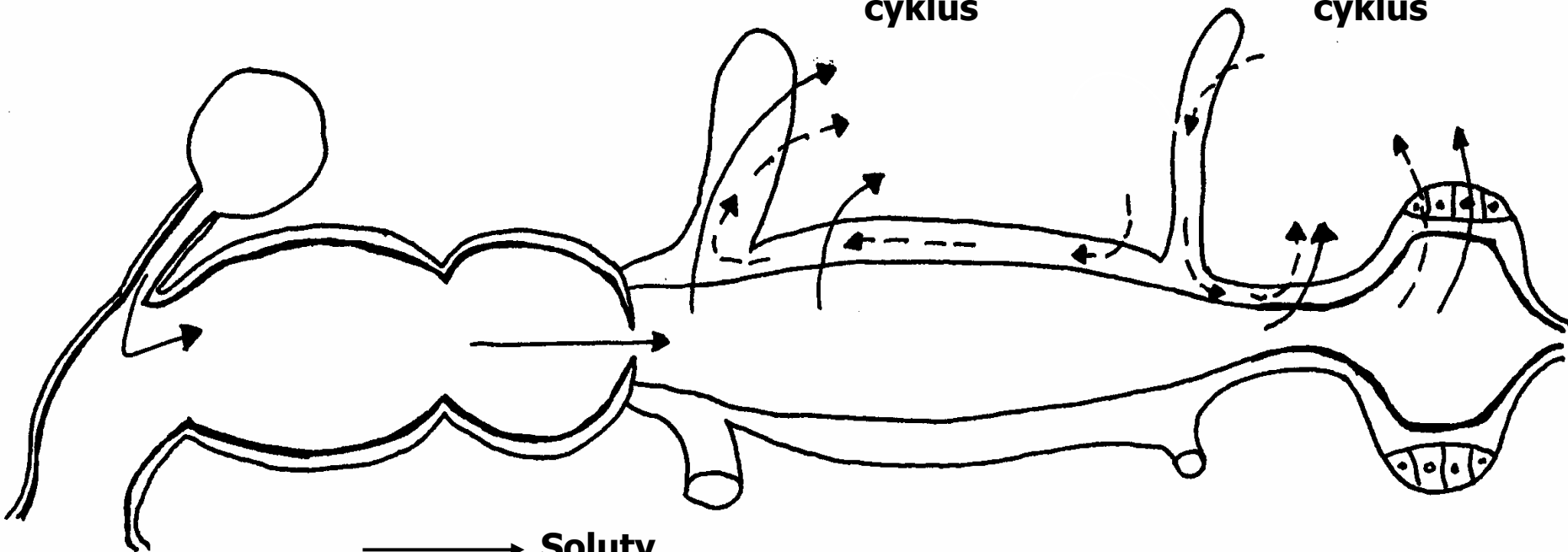


FIGURE 8.7. The overall mechanism of insect excretion. Fluid is taken up by the Malpighian tubules and moves to the hindgut, where the rectum resorbs some of the water, salts, and amino acids while the remainder is excreted.

Koloběh vody a látek – spolupráce trávicích a vylučovacích pochodů.

**Absorbční
cyklus**

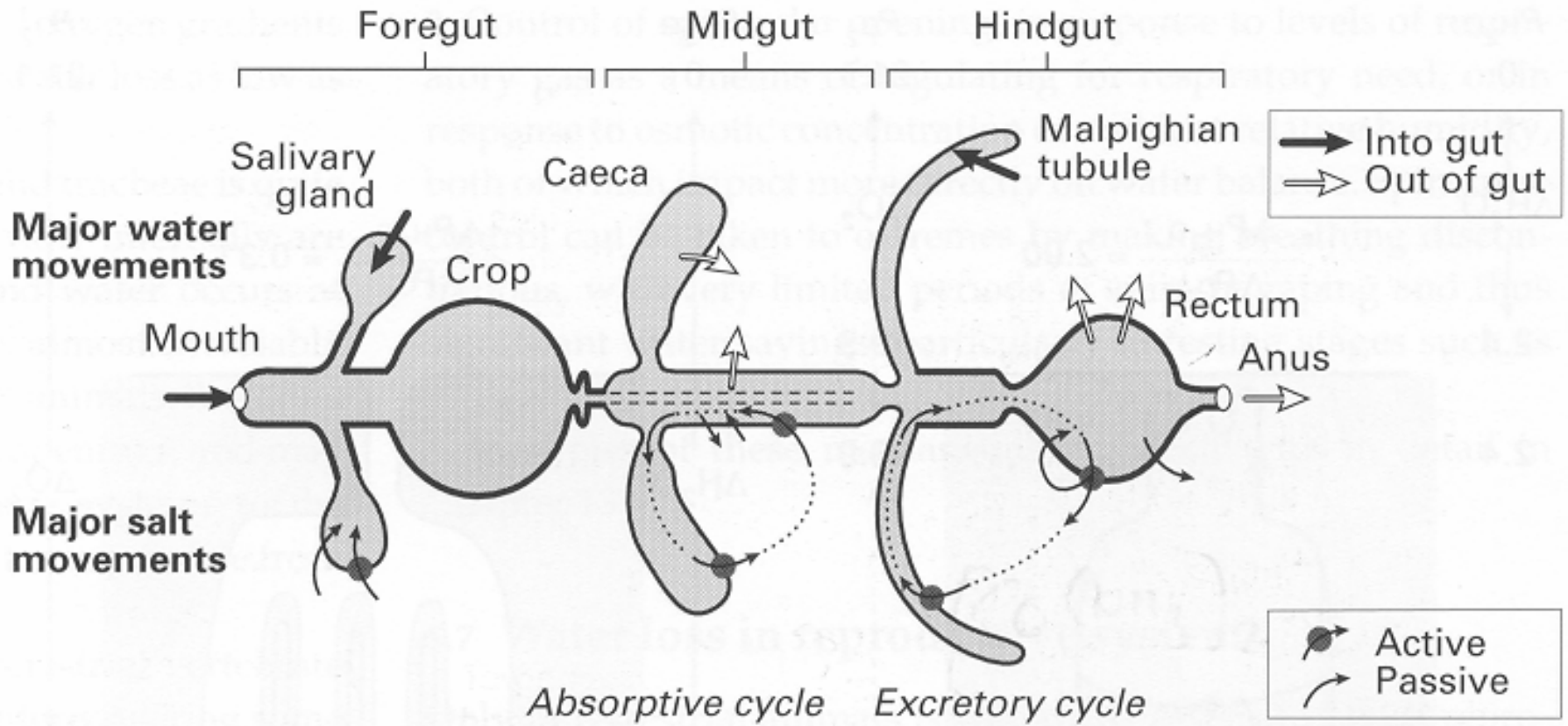
**Exkreční
cyklus**



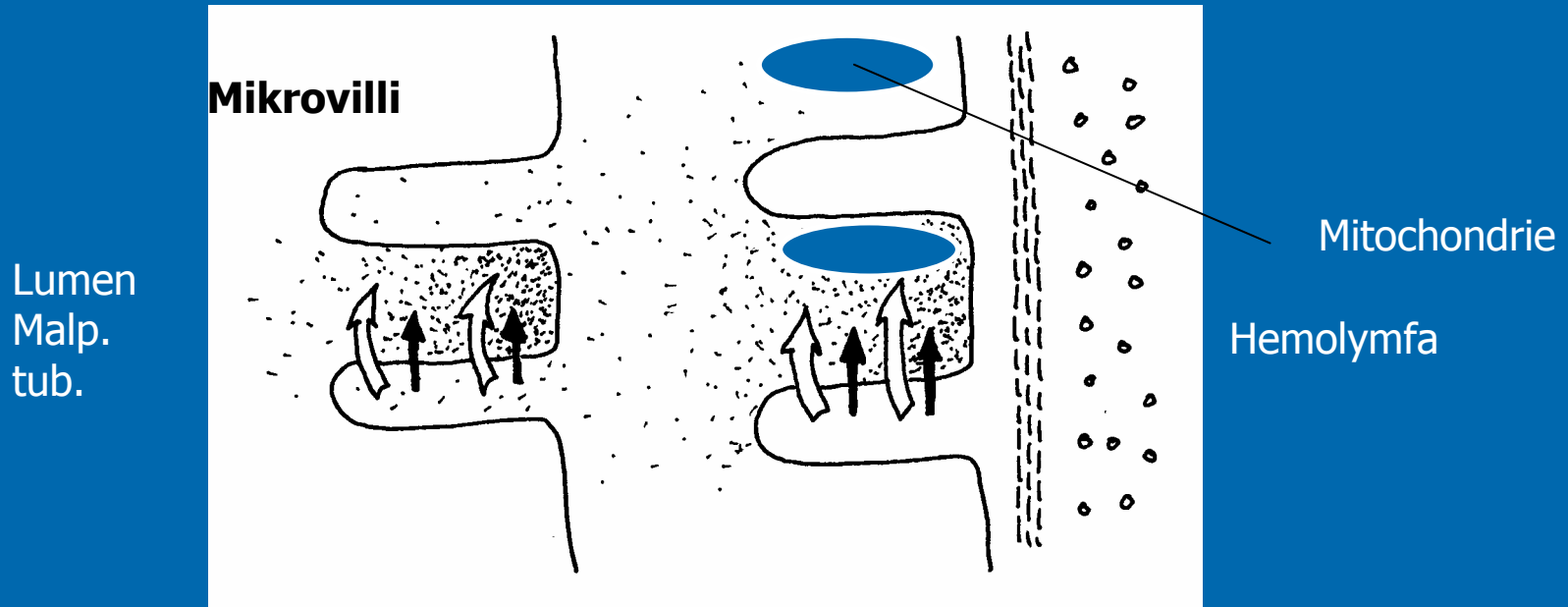
—————→ Soluty

- - - - -→ H₂O

Koloběh vody a látek – spolupráce trávicích a vylučovacích pochodů.



Transport vody a látek přes membránu Malpighické trubice



← Soluty
← H₂O

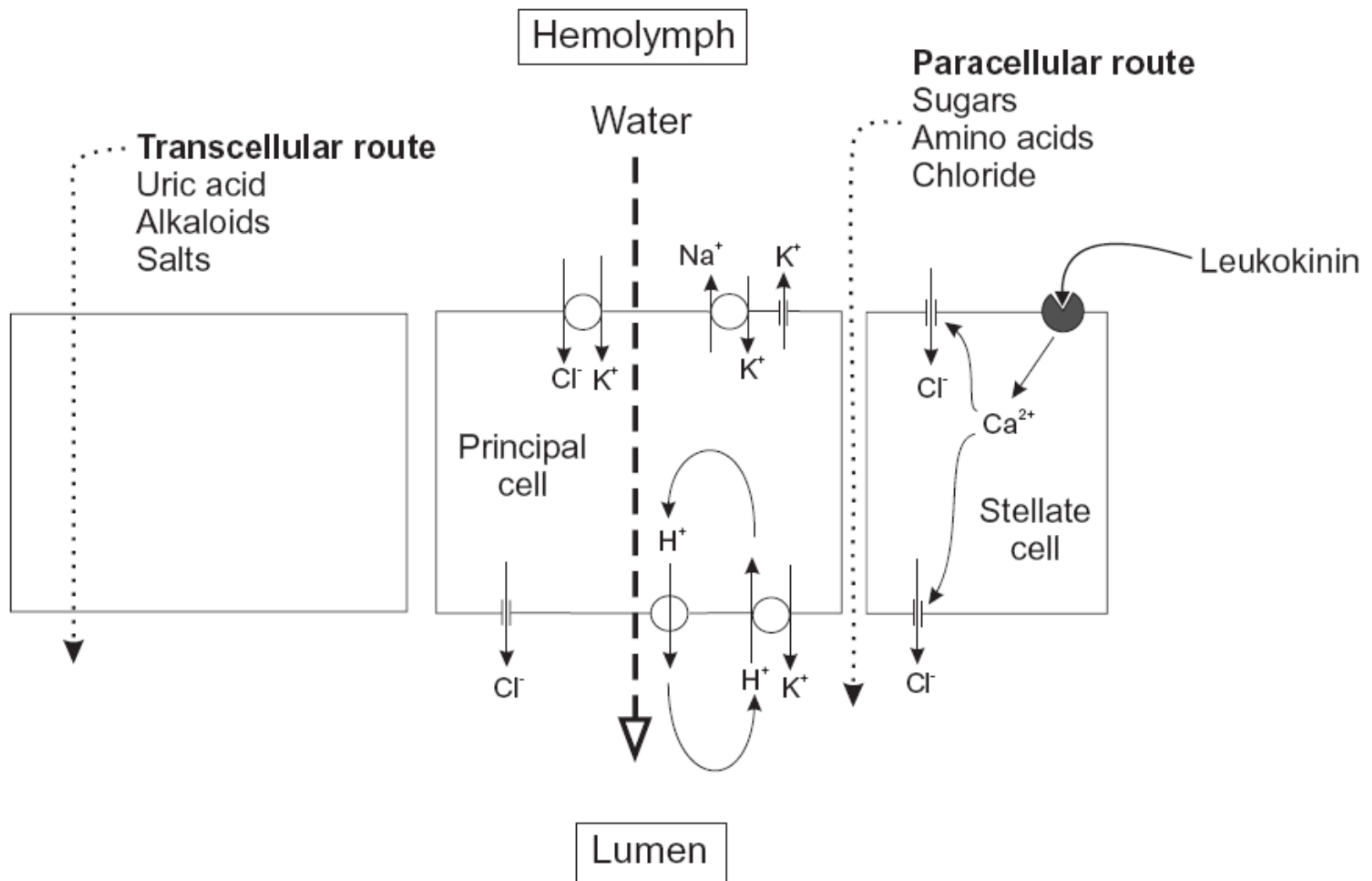


FIGURE 8.12. The transport of substances through the Malpighian tubule cells. The major ion movements result from the action of the V-ATPase that moves protons and energizes the cell membrane. Na/K ATPases actively transport ions from the hemolymph into the lumen, with ion channels allowing some passive transport. Some components move into the lumen by a transcellular route through the cells, while others move by a paracellular route between cells. Chloride ions move through stellate cells when the cells are stimulated by leucokinin. Adapted from Wang et al. (2004). Reprinted with permission.

Suchozemský hmyz

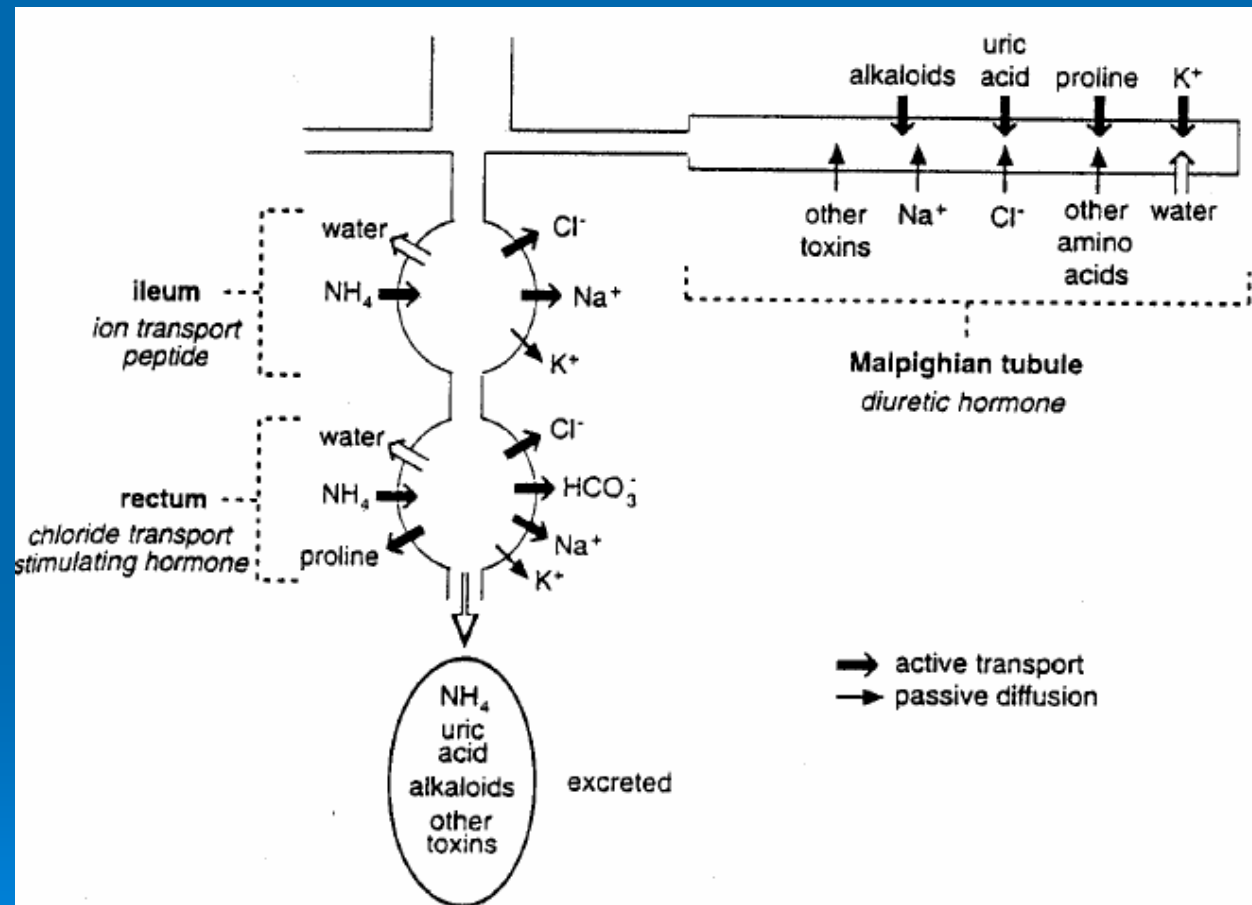


Fig. 18.7. Urine production and modification in a terrestrial insect (*Schistocerca*). Active transport of potassium into the Malpighian tubule leads to the osmotic movement of water and most other solutes follow passively. Many of the solutes are recovered as the urine moves through the hindgut, but ammonia is actively secreted into it. The hormones regulating the processes are shown in italics (partly based on Phillips & Audsley, 1995).

Lumen

Blood

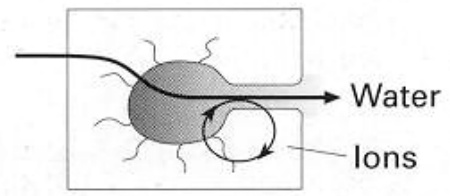
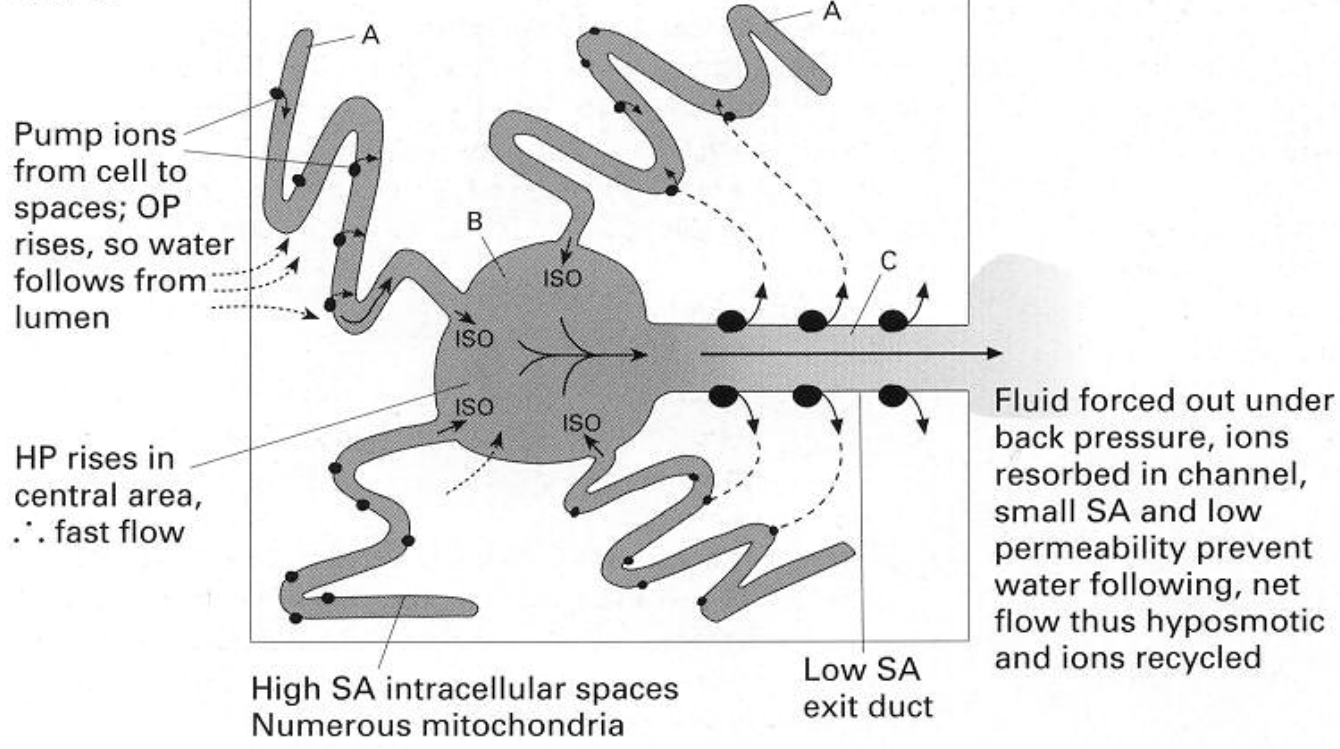
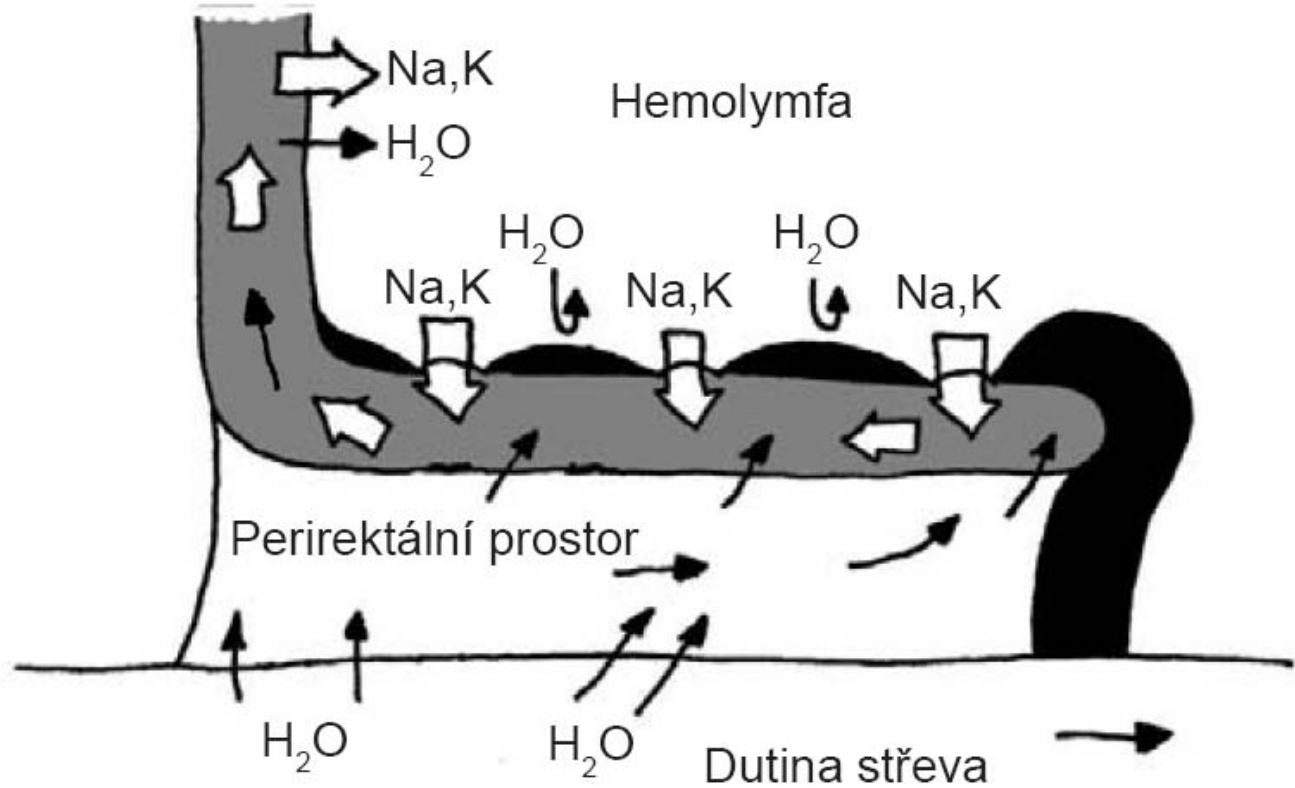
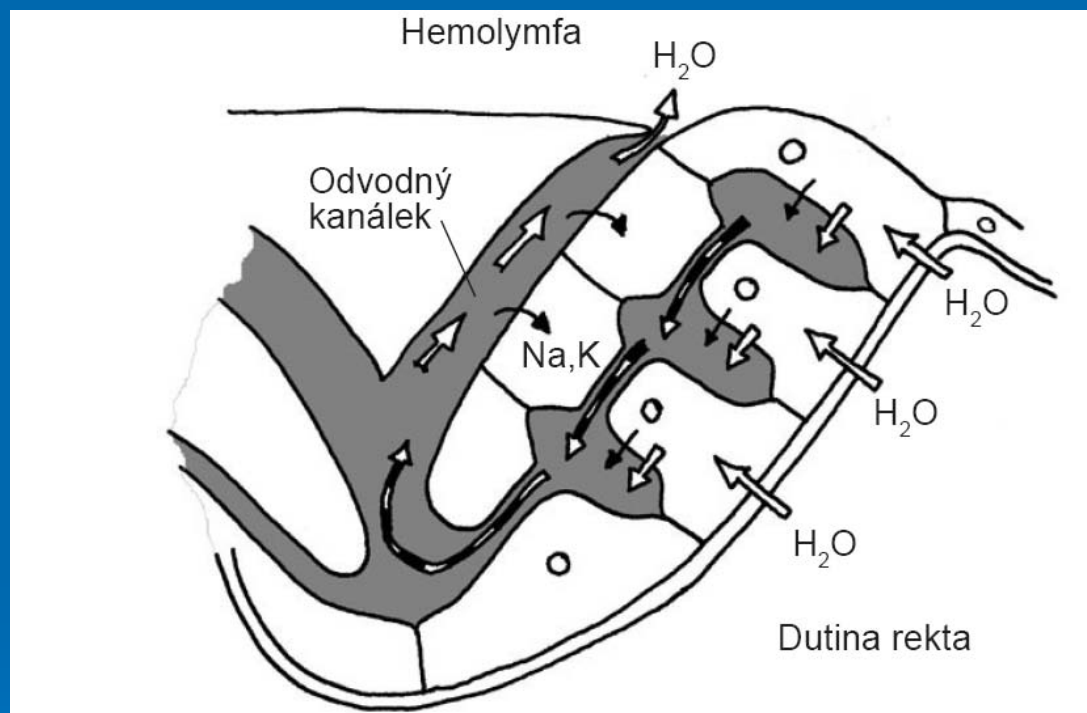


Fig. 5.14 A model for 'water transport' across a cell within a resorptive epithelium where solute recycling within the cell occurs and a fluid hypotonic to the lumen is discharged into the blood, representing net water resorption. HP, hydrostatic pressure; ISO, isosmotic fluid; OP, osmotic pressure (or osmotic concentration); SA, surface area



Obr. 14.11. Kryptonefridiální komplex je tvořen konci malpighických tubulů přiloženými ke střevu. Opačné proudy ve střevě a v tubulu si vyměňují vodu. Ta je z rekta nasávána do perirektálního prostoru hyperosmotickým prostředím, odtud pokračuje tubulem do hemolymfy. Soli jsou čerpány zpět do tubulu – jejich cirkulace je uzavřená. Voda je však následovat nemůže – epitel komplexu je pro ni nepropustný.

Rektální papily



Obr. 14.10. Rektální papila much. Systémem dutin v papile cirkulují ionty v uzavřeném cyklu – tenké šipky. Vysoká osmolalita prostředí vysává vodu z rekta – bílé šipky. Voda však neprojde, na rozdíl od solí, zpět epitelem odvodného kanálku a proudí do hemolymfy. Zpětnému toku vody brání systém záklopek (není zakreslen).

Vodní hmyz

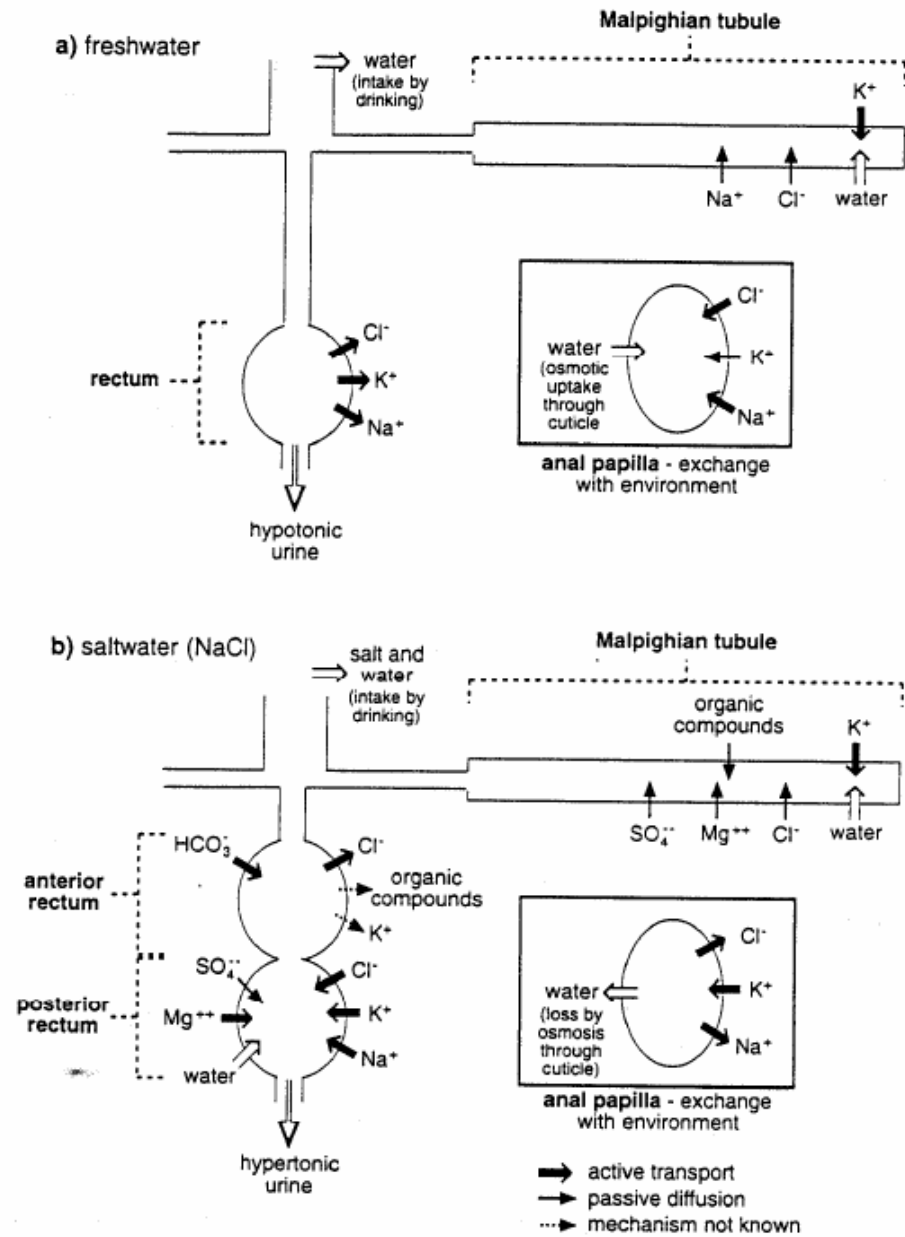


Fig. 18.8. Urine production and modification in aquatic insects (mosquito larvae). Nitrogenous excretory products not shown. (a) A freshwater insect, such as *Aedes aegypti*. The larva gains water by drinking and through the permeable cuticle of the anal papillae; excess water is removed as urine. (b) A saltwater insect, such as *Aedes campestris*. The gain of water due to drinking is greater than osmotic loss through the cuticle. Further water is lost in the urine. Note that although water is moved into the posterior rectum, the fluid produced there is hypertonic to the hemolymph and the medium (partly based on Bradley & Phillips, 1977b).

Cloridové buňky a chloridový epitel

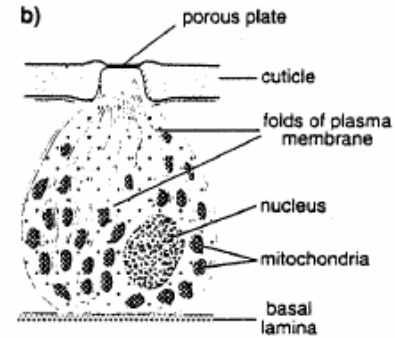
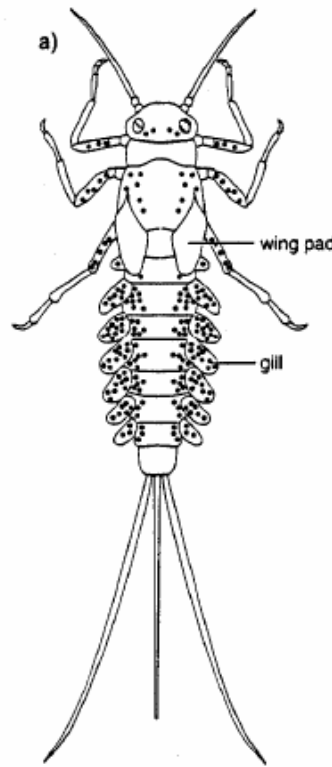


Fig. 18.2. Chloride cells in a mayfly larva (after Komnick, 1977). (a) Dorsal view of larva. Dots show positions of the chloride cells. Their size is greatly exaggerated. (b) Diagrammatic section through a chloride cell. In some chloride cells, the basal plasma membrane, rather than the apical membrane, is infolded.

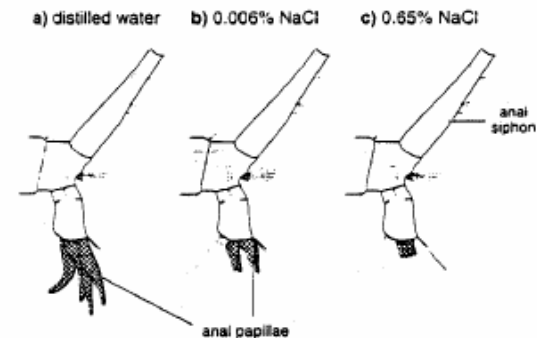


Fig. 18.3. Chloride epithelium. Posterior end of a mosquito larva showing the anal papillae (shaded), which contain the chloride epithelium. Their size is reduced in larvae reared in water containing higher salt concentrations (after Wigglesworth, 1965).

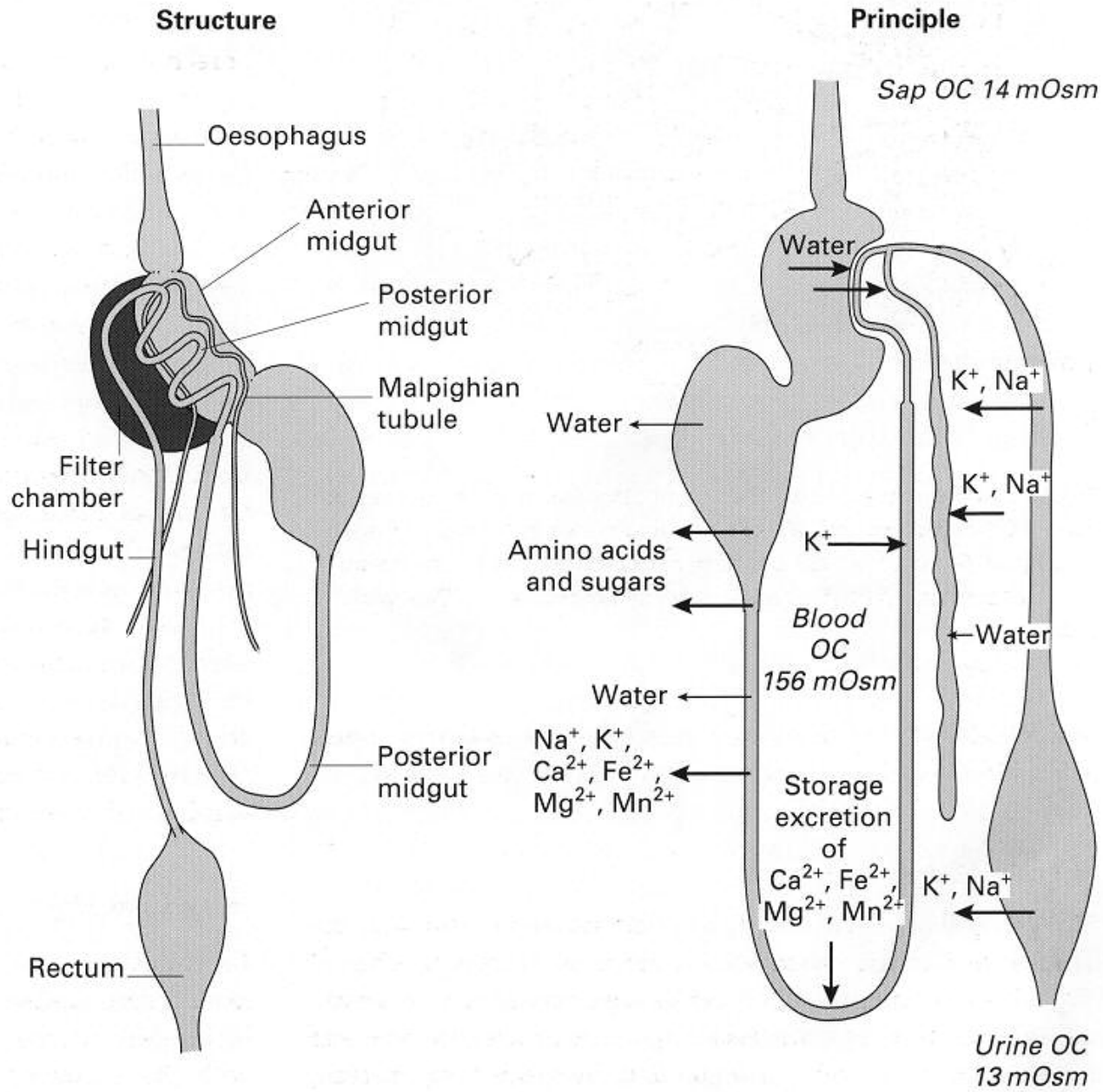


Fig. 5.24 The structure of a 'gut bypass' system in a sap-feeding insect, whereby much of the fluid taken in is filtered directly to the hindgut, bypassing the midgut resorptive areas. OC, osmotic concentration. (Adapted from Cheung & Marshall 1973.)