Table 14-1 Composition of extracellular fluids of representative animals*

	Habitat†	Osmolarity (mosM)	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	HPO_4^{2-}	Urea
Seawater†		1000	460	10	10	53	540	27		
Coelenterata										
Aurelia (jellyfish)	SW		454	10.2	9.7	51.0	554	14.6		
Echinodermata										
Asterias (starfish)	SW		428	9.5	11.7	49.2	487	26.7		
Annelida										
Arenicola (lugworm)	SW		459	10.1	10.0	52.4	537	24.4		
Lumbricus (earthworm)	Ter		76	4.0	2.9		43			
Mollusca										
Aplysia (sea slug)	SW		492	9.7	13.3	49	543	28.2		
Loligo (squid)	SW		419	20.6	11.3	51.6	522	6.9		
Anodonta (clam)	FW		15.6	0.49	8.4	0.19	11.7	0.73		
Crustacea										
Cambarus (crayfish)	FW		146	3.9	8.1	4.3	139			
Homarus (lobster)	SW		472	10.0	15.6	6.7	470			
Insecta										
Locusta	Ter		60	12	17	25				
Periplaneta (cockroach)	Ter		161	7.9	4.0	5.6	144			
Cyclostomata										
Eptatretus (hagfish)	SW	1002	554	6.8	5.9	23.4	532	1.7	2.1	3
Lampetra (lamprey)	FW	248	120	3.2	1.9	2.1	96	2.7		0.4

* The osmolarity and composition of seawater vary, and the values given here are not intended to be absolute. The composition of body fluids of osmoconformers will also vary, depending on the composition of the seawater in which they are tested.
† SW = seawater; FW = freshwater; Ter = terrestrial.
Sources: Schmidt-Nielsen and Mackay, 1972; Prosser, 1973.

Table 14-1 Composition of extracellular fluids of representative animals*

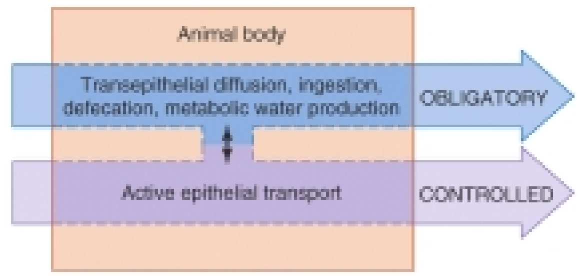
	Habitat†	Osmolarity (mosM)	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	HPO_4^{2-}	Urea
Seawater†		1000	460	10	10	53	540	27		
Chondrichthyes										
Dogfish shark	SW	1075	269	4.3	3.2	1.1	258	1	1.1	376
Carcharhinus	FW		200	8	3	2	180	0.5	4.0	132
Coelacanths										
Latimeria	SW		181	51.3	6.9	28.7	199			355
Teleostei										
Paralichthys (flounder)	SW	337	180	4	3	1	160	0.2		
Carassius (goldfish)	FW	293	142	2	6	3	107			
Amphibia										
Rana esculenta (frog)	FW	210	92	3	2.3	1.6	70			2
Rana cancrivora	FW	290	125	9			98			40
	80% SW	830	252	14			227			350
Reptilia										
Alligator	FW	278	140	3.6	5.1	3.0	111			
Aves										
Anas (duck)	FW	294	138	3.1	2.4		103		1.6	
Mammalia										
Homo sapiens	Ter		142	4.0	5.0	2.0	104	1	2	
Lab rat	Ter		145	6.2	3.1	1.6	116			

* The osmolarity and composition of seawater vary, and the values given here are not intended to be absolute. The composition of body fluids of osmoconformers will also vary, depending on the composition of the seawater in which they are tested.
† SW = seawater; FW = freshwater; Ter = terrestrial.
Sources: Schmidt-Nielsen and Mackay, 1972; Prosser, 1973.

Table 14-2 Electrolyte composition of the human body fluids

Electrolytes	Serum ($meq \cdot kg^{-1} H_2O$)	Interstitial fluid ($meq \cdot kg^{-1} H_2O$)	Intracellular fluid (muscle) ($meq \cdot kg^{-1} H_2O$)
Cations			
Na^+	142	145	10
K^+	4	4	159
Ca^{2+}	5		3
Mg^{2+}	2		26
Totals	153	149	198
Anions			
Cl^-	104	114	2
HCO_3^-	27	31	8
HPO_4^{2-}	2		95
SO_4^{2-}	1		20
Organic acids	6		
Proteins	13		55
Totals	153	145	180

Note: Some of the ions contained within cells are not completely dissolved within the cytosol, but may be partially sequestered within cytoplasmic organelles. Thus, the true free Ca^{2+} concentration in the cytosol is typically below the overall value given in the table for intracellular Ca^{2+}. Failure of anion and cation totals to agree reflects incomplete tabulation.



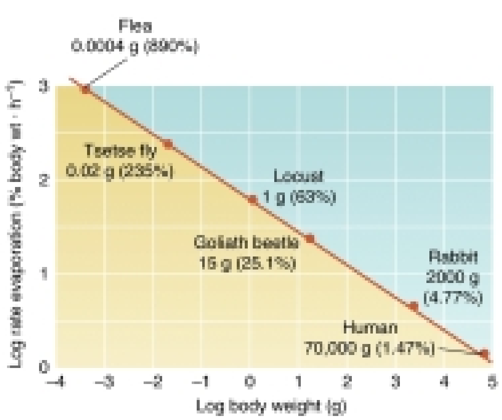


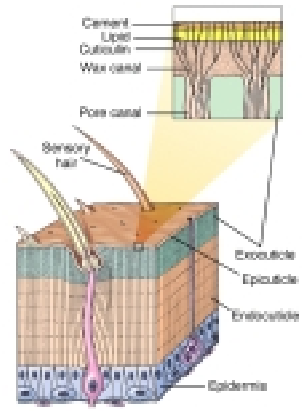
Table 14-3 Evaporative water loss of representative animals under desert conditions

Species	Water loss ($mg \cdot cm^{-2} \cdot h^{-1}$)	Remarks*
Arthropods		
Eleodes armata (beetle)	0.20	38°C; 0% r.h.
Hadrurus arizonensis (scorpion)	0.02	30°C; 0% r.h.
Locusta migratoria (locust)	0.70	30°C; 0% r.h.
Amphibians		
Cyclorana alboguttatus (frog)	4.90	25°C; 100% r.h.
Reptiles		
Coleonyx variegatus (gecko)	0.22	30°C; dry air
Uta stansburiana (lizard)	0.10	0°C

* r.h. stands for relative humidity. Where not indicated, relative humidity is not available.
† The cactus mouse and African rats are desert animals and employ various water-conservation measures. Thus their evaporative water loss is much less than that of humans.
Source: Hadley, 1972.

Table 14-3 Evaporative water loss of representative animals under desert conditions		
Species	Water loss ($mg \cdot cm^{-2} \cdot h^{-1}$)	Remarks*
Birds		
Amphispiza belli (sparrow)	1.48	30°C
Phalaenoptilus nuttallii (poorwill)	0.56	30°C
Mammals†		
Peromyscus eremicus (cactus mouse)	0.86	30°C
Oryx beisa (African oryx)	3.24	22°C
Homo sapiens	22–35	70 kg; nude, sitting in sun, 35°C

* r.h. stands for relative humidity. Where not indicated, relative humidity is not available.
† The cactus mouse and African oryx are desert animals and employ various water-conservation measures. Thus their evaporative water loss is much less than that of humans.
Source: [illegible], 1972.



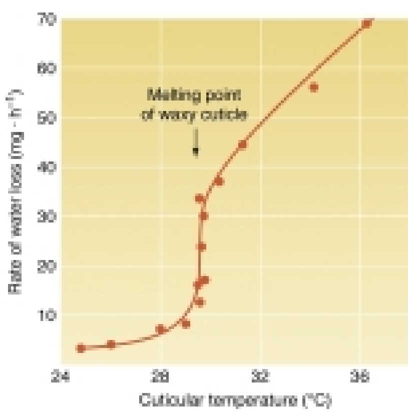
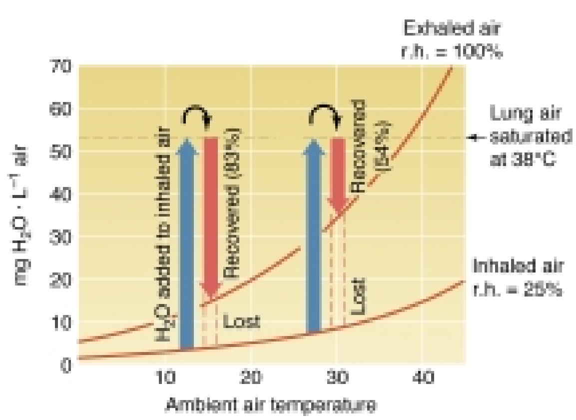
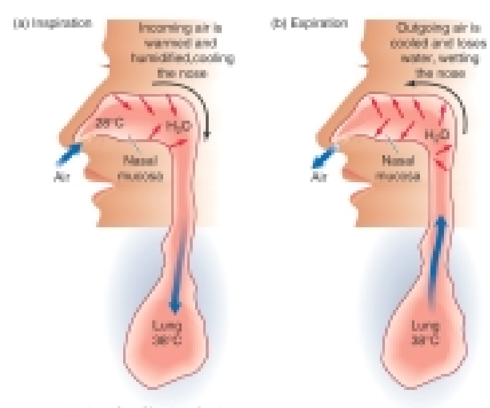
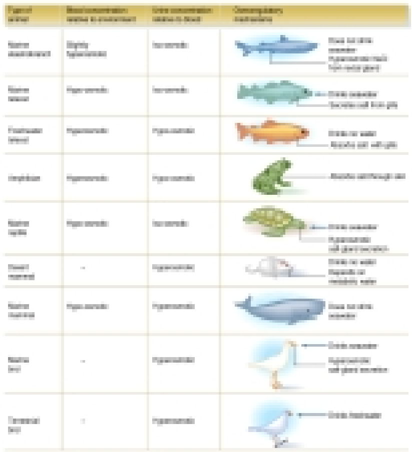


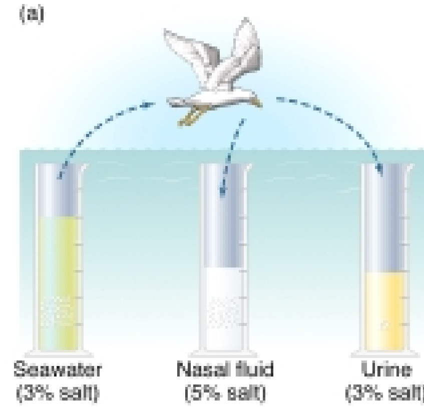
Table 14-4 Production of metabolic water during oxidation of foods	Food		
	Carbohydrates	Fats	Proteins
Grams of metabolic water per gram of food	0.56	1.07	0.40
Kilojoules expended per gram of food	17.58	39.94	17.54
Grams of metabolic water per kilojoule expended	0.032	0.027	0.023

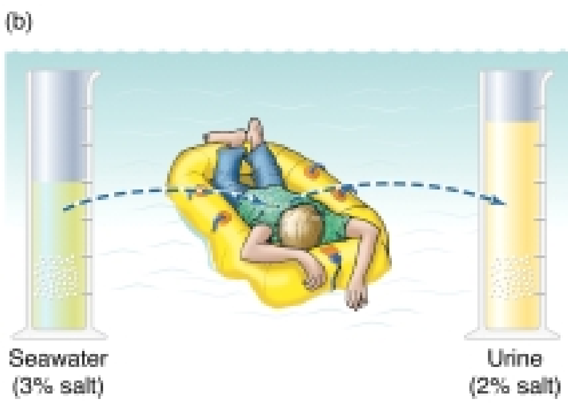
Source: Edney and Nagy, 1976.











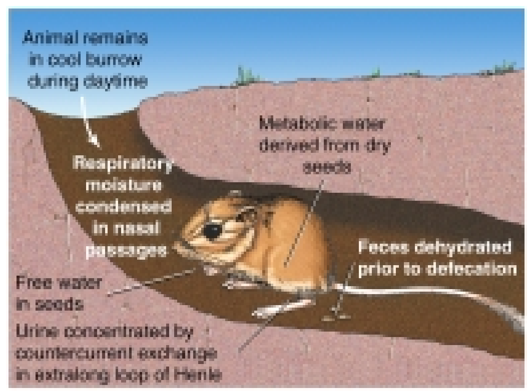
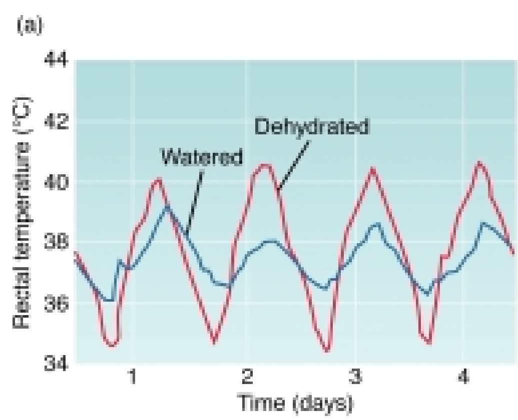
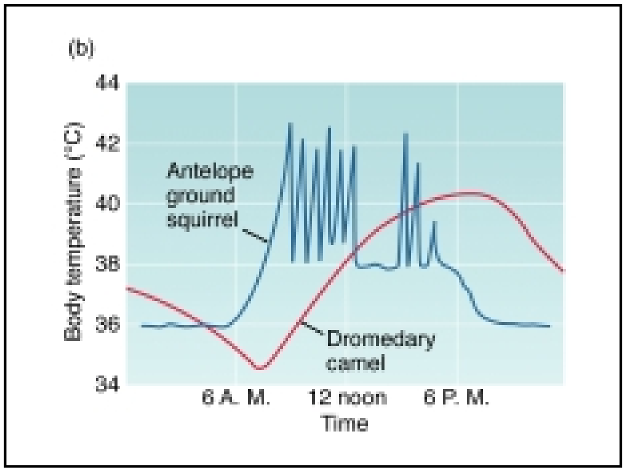


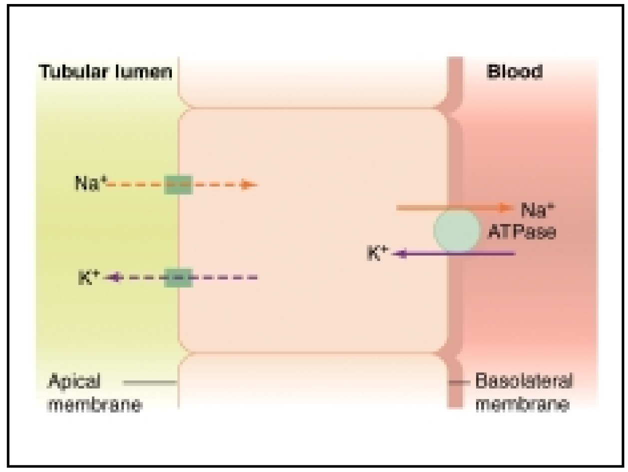
Table 14-5 Sources of water gain and loss by the kangaroo rat

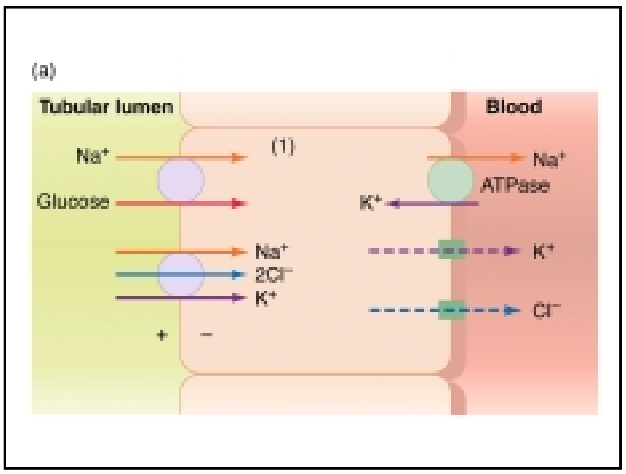
Gains		Losses	
Metabolic water	90%	Evaporation and perspiration	70%
Free water in "dry" food	10%	Urine	25%
Drinking	0%	Feces	5%
	100%		100%

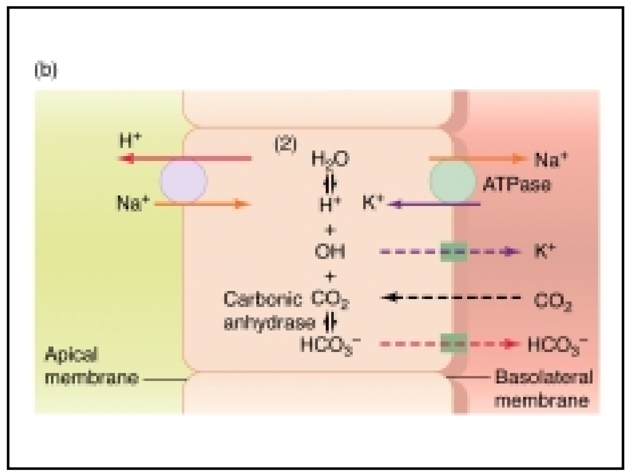
Source: Schmidt-Nielsen, 1972.

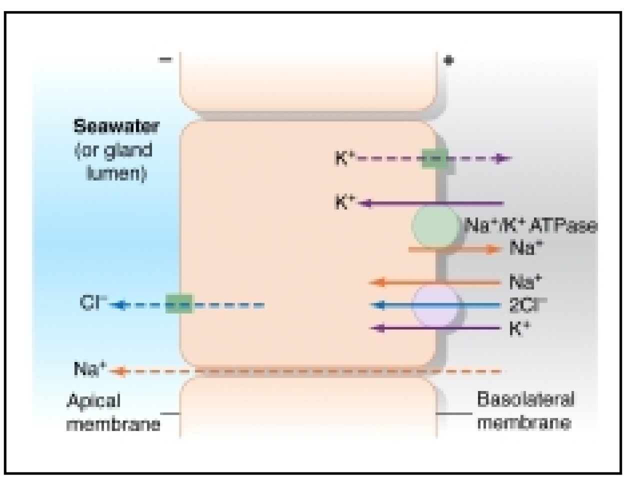


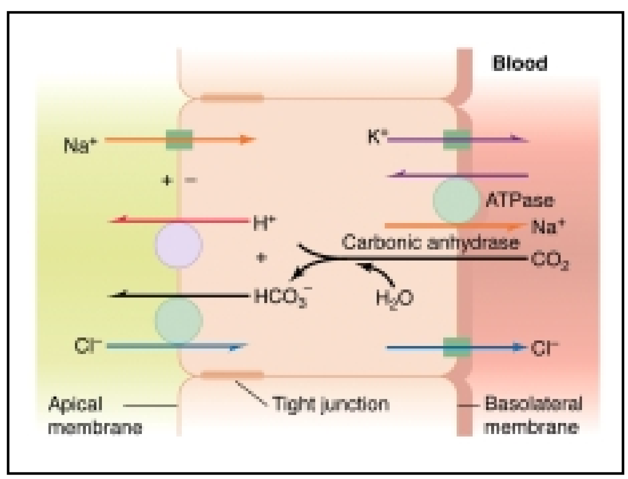

(b)
44
42
40
38
36
34
Body temperature (°C)
Antelope ground squirrel
Dromedary camel
6 A. M.
12 noon
6 P. M.
Time

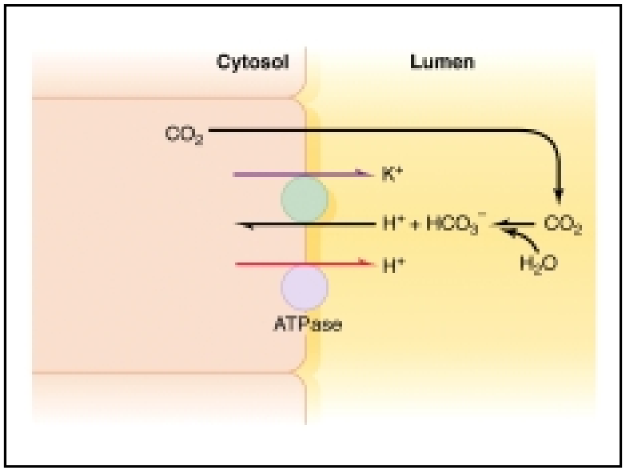

Tubular lumen
Blood
Na+
Na+
ATPase
K+
K+
Apical membrane
Basolateral membrane


(a)
Tubular lumen
Blood
(1)
Na+
Glucose
Na+
ATPase
K+
Na+
2Cl−
K+
K+
Cl−
+
−

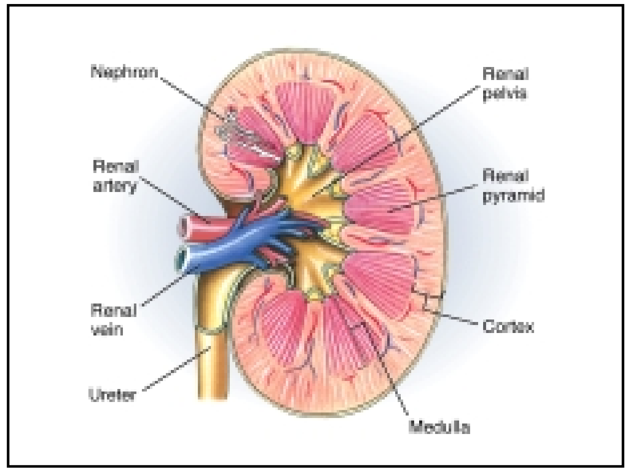

(b)
H+
(2)
H_2O
Na+
ATPase
Na+
H+
K+
+
OH
K+
+
Carbonic anhydrase
CO_2
CO_2
HCO_3^-
HCO_3^-
Apical membrane
Basolateral membrane


−
+
Seawater (or gland lumen)
K+
K+
Na+/K+ ATPase
Na+
Na+
2Cl−
K+
Cl−
Na+
Apical membrane
Basolateral membrane

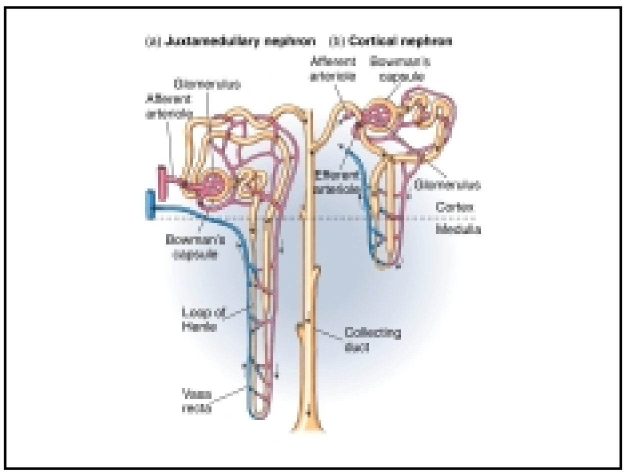

Blood
Na+
K+
+ −
ATPase
Na+
H+
+
Carbonic anhydrase
CO_2
HCO_3^-
H_2O
Cl−
Cl−
Apical membrane
Tight junction
Basolateral membrane



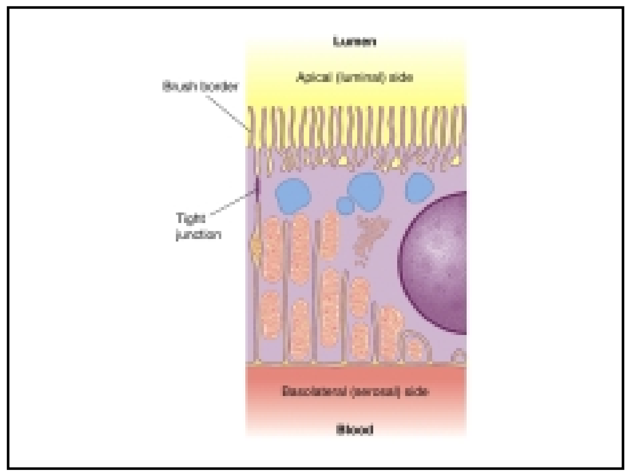
Cytosol
Lumen
CO_2
K^+
$H^+ + HCO_3^-$
CO_2
H_2O
H^+
ATPase



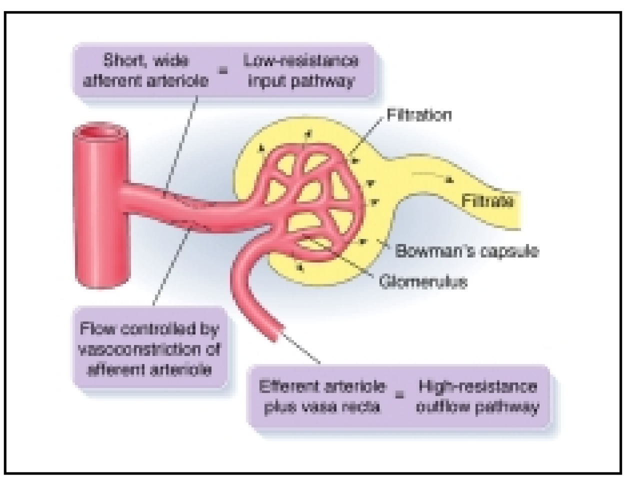
Nephron
Renal pelvis
Renal artery
Renal pyramid
Renal vein
Cortex
Ureter
Medulla



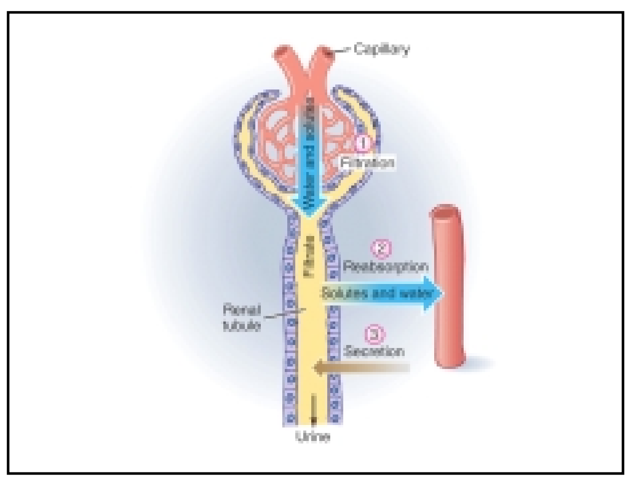
(a) Juxtamedullary nephron
(b) Cortical nephron
Afferent arteriole
Bowman's capsule
Glomerulus
Afferent arteriole
Efferent arteriole
Glomerulus
Cortex
Medulla
Bowman's capsule
Loop of Henle
Collecting duct
Vasa recta



Lumen
Apical (luminal) side
Brush border
Tight junction
Basolateral (serosal) side
Blood



Short, wide afferent arteriole = Low-resistance input pathway
Filtration
Filtrate
Bowman's capsule
Glomerulus
Flow controlled by vasoconstriction of afferent arteriole
Efferent arteriole plus vasa recta = High-resistance outflow pathway



Capillary
Water and solutes
1
Filtration
Filtrate
2
Reabsorption
Solutes and water
Renal tubule
3
Secretion
Urine

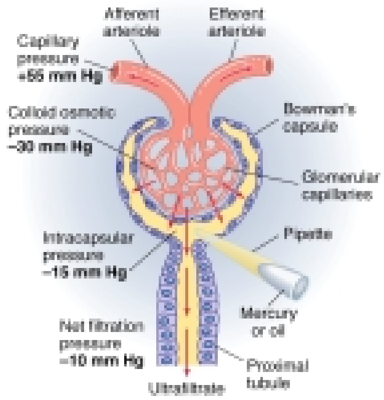


Table 14-7 **Balance sheet of pressures (in mm Hg) involved in glomerular ultrafiltration**

	Salamander	Human
Glomerular capillary pressure	17.7	55
Intracapsular pressure	− 1.5	− 15
Net hydrostatic pressure	16.2	40
Colloid osmotic pressure	− 10.4	− 30
Net filtration pressure	5.8	10

Source: Pitts, 1968; Brenner et al., 1971.

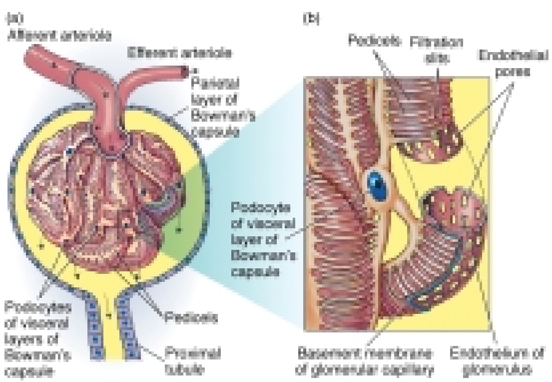
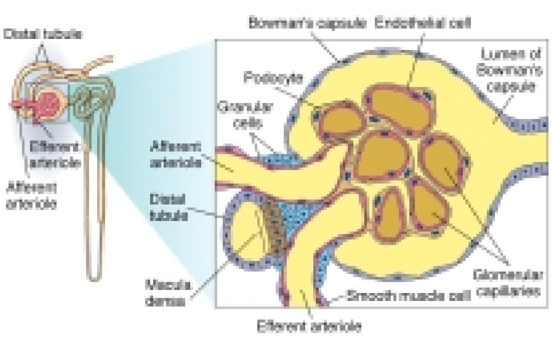
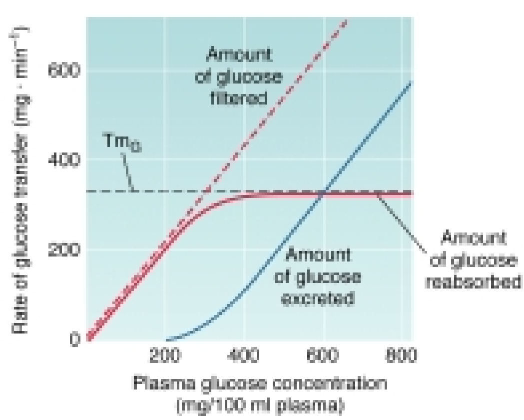


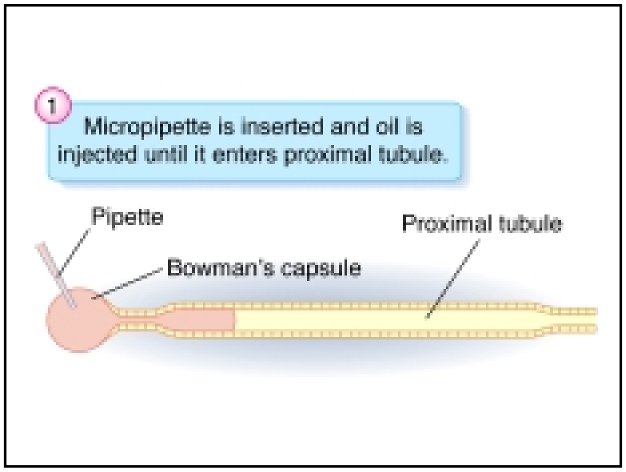
Table 14-8 **Relation between the molecular size of a substance and the ratio of its concentration in the filtrate appearing in Bowman's capsule to its concentration in the plasma [filtrate]/[filtrand]**

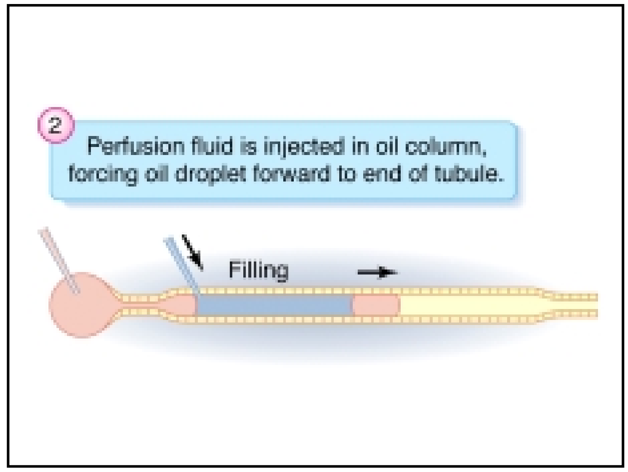
Substance	Mol. wt.	Radius from diffusion coefficient (nm)	Dimensions from X-ray diffraction (nm)	[filtrate] / [filtrand]
Water	18	0.11		1.0
Urea	60	0.16		1.0
Glucose	180	0.36		1.0
Sucrose	342	0.44		1.0
Insulin	5500	1.48	6	0.98
Myoglobin	17,000	1.95	20	0.75
Egg albumin	43,500	2.85	20	0.22
Hemoglobin	68,000	3.25	54	0.03
Serum albumin	69,000	3.55	150, 36	< 0.01

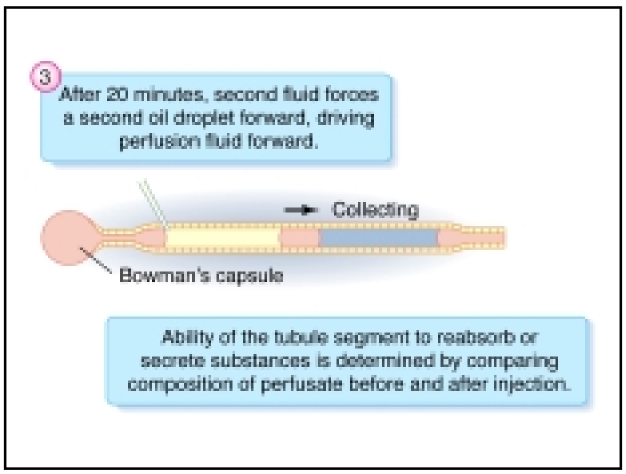
Source: Pitts, 1968.

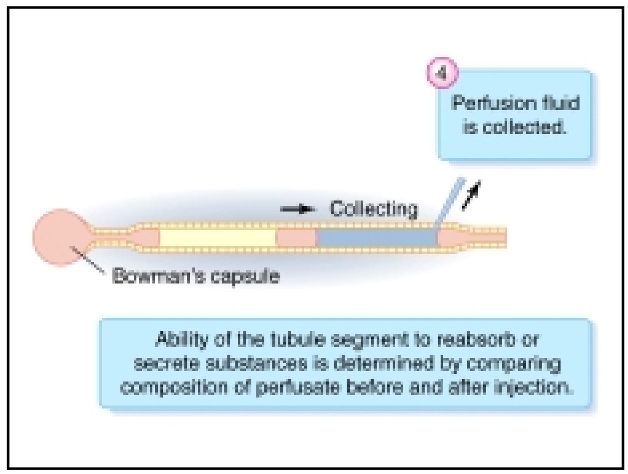


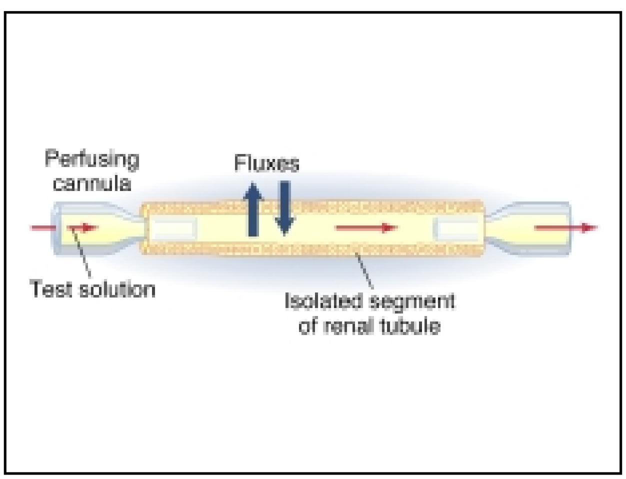


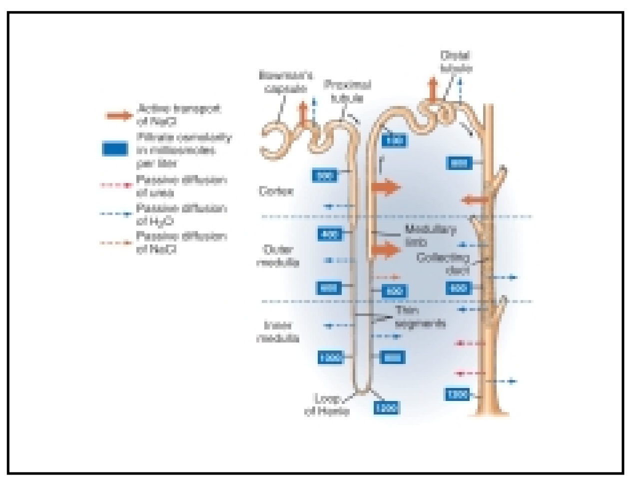

1
Micropipette is inserted and oil is injected until it enters proximal tubule.
Pipette
Proximal tubule
Bowman's capsule


2
Perfusion fluid is injected in oil column, forcing oil droplet forward to end of tubule.
Filling


3
After 20 minutes, second fluid forces a second oil droplet forward, driving perfusion fluid forward.
Collecting
Bowman's capsule
Ability of the tubule segment to reabsorb or secrete substances is determined by comparing composition of perfusate before and after injection.


4
Perfusion fluid is collected.
Collecting
Bowman's capsule
Ability of the tubule segment to reabsorb or secrete substances is determined by comparing composition of perfusate before and after injection.


Perfusing cannula
Fluxes
Test solution
Isolated segment of renal tubule


Distal tubule
Bowman's capsule
Proximal tubule
Active transport of NaCl
Filtrate osmolality in milliosmoles per liter
Passive diffusion of urea
Passive diffusion of H2O
Passive diffusion of NaCl
Cortex
Medullary limb
Outer medulla
Collecting duct
Thin segments
Inner medulla
Loop of Henle