Guidelines

Journal Club

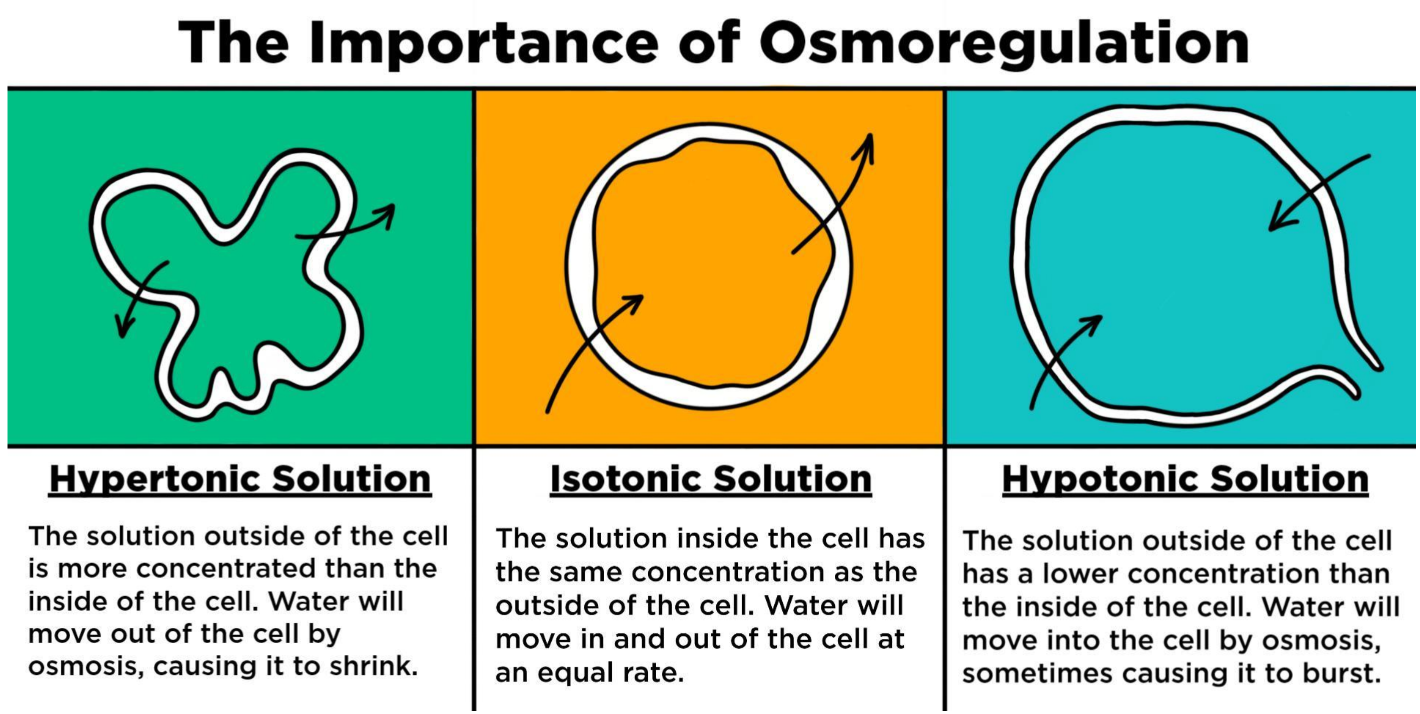
- ✓ Pick an article with good data and innovative research
- ✓ Provide a background for the research proposed
- ✓ Explain any non-standard techniques
- ✓ Present the main findings
- ✓ Discuss authors' conclusions and whether the data supports it
- ✓ Put conclusions in context

Osmoregulation

Physiological systems of animals operate in a fluid environment

Relative concentrations of water and solutes must be maintained within fairly narrow limits

Osmoregulation regulates solute concentrations and balances the gain and loss of water



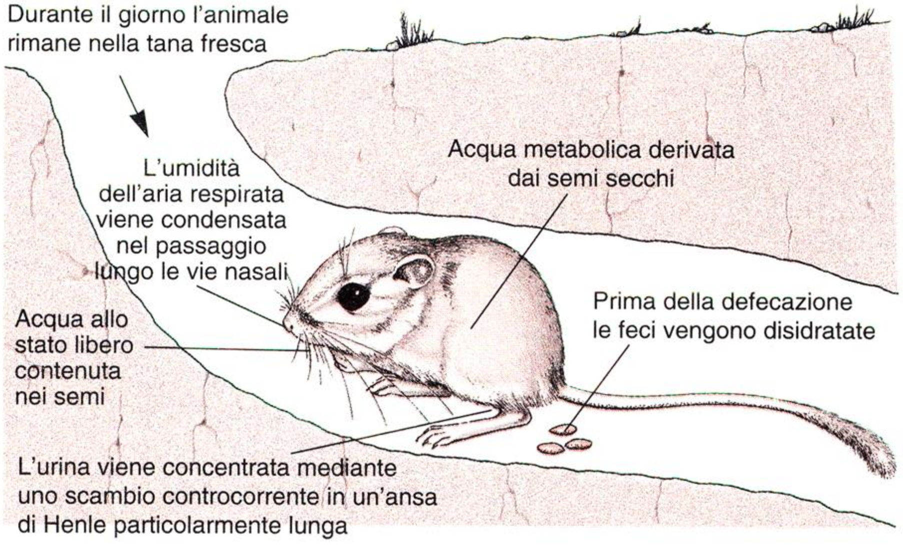
I piccoli mammiferi che vivono nel deserto

Il **ratto canguro** può vivere nel deserto senza bere, poiché riduce al minimo le perdite di acqua e produce il 90% dell'acqua necessaria tramite il metabolismo.

Tabella 14.7 Bilancio dell'acqua nel ratto canguro

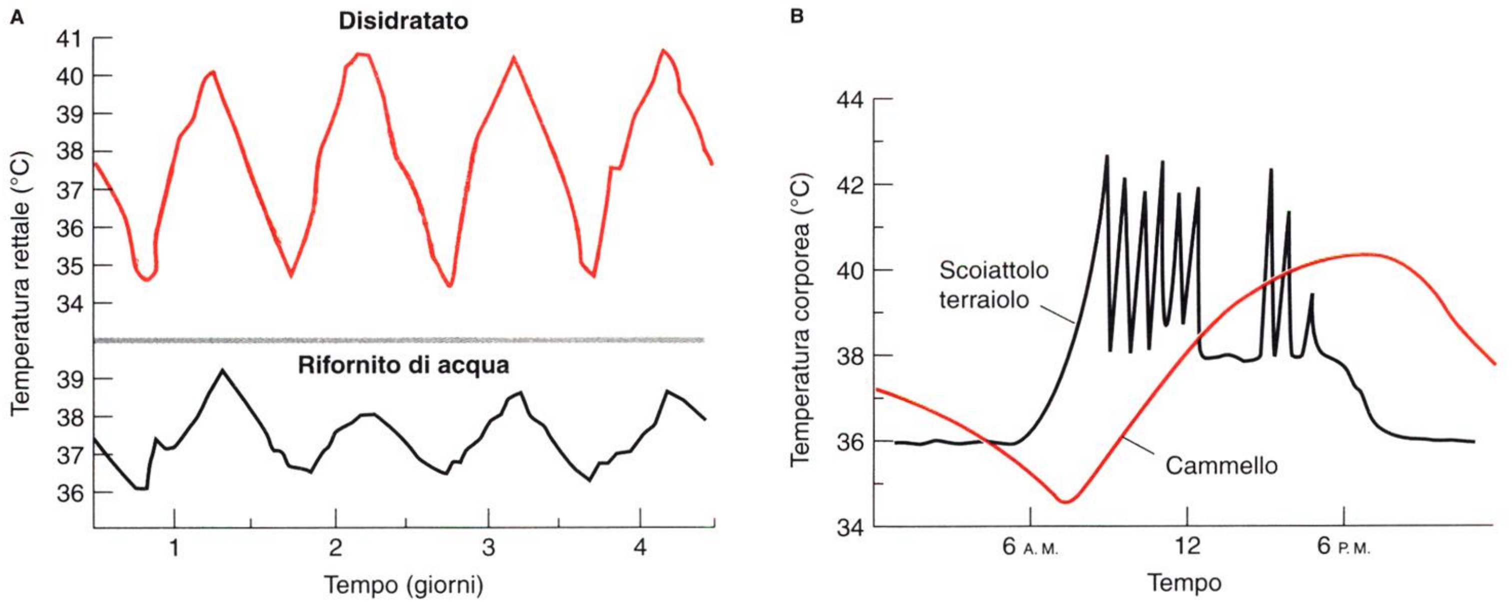
Entrate		*Uscite*	
Acqua metabolica	90 %	Evaporazione + traspirazione	70 %
Acqua libera presente nei cibi "secchi"	10 %	Urina	25 %
Bevande	0 %	Feci	5 %
	100 %		100 %

Fonte: Schmidt-Nielsen, 1972.



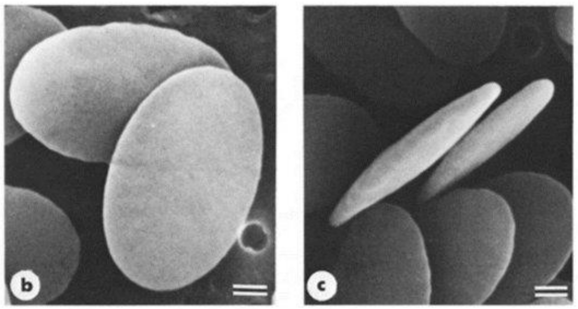
Le strategie del ratto canguro per la conservazione dell'acqua sono caratteristiche di molti piccoli mammiferi del deserto.

I grandi animali del deserto: il cammello

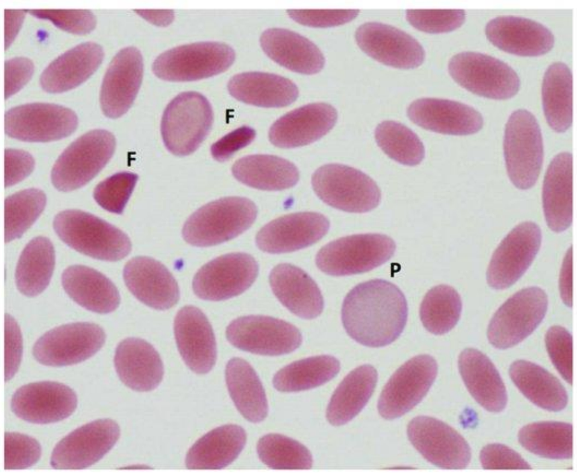


Quando l'acqua scarseggia, i grossi animali del deserto come il cammello subiscono un grande, ma lento incremento della temperatura durante il giorno, mentre gli animali più piccoli si riscaldano più velocemente quando vengono esposti al sole. (**A**) Fluttuazione giornaliera della temperatura corporea di un cammello ben approvvigionato di acqua e di un cammello disidratato. Quando il cammello viene privato dell'acqua, la fluttuazione giornaliera può aumentare anche di 7 °C. Ciò ha una grande influenza sull'utilizzo dell'acqua per la regolazione della temperatura. (**B**) Diagramma delle variazioni giornaliere della temperatura corporea in un grosso e in un piccolo mammifero soggetti a stress calorico nel deserto. I piccoli animali devono rientrare periodicamente nelle tane per evitare un eccessivo surriscaldamento. [Parte A da Schmidt-Nielsen, 1963; parte B da Bartholomew, 1964.]

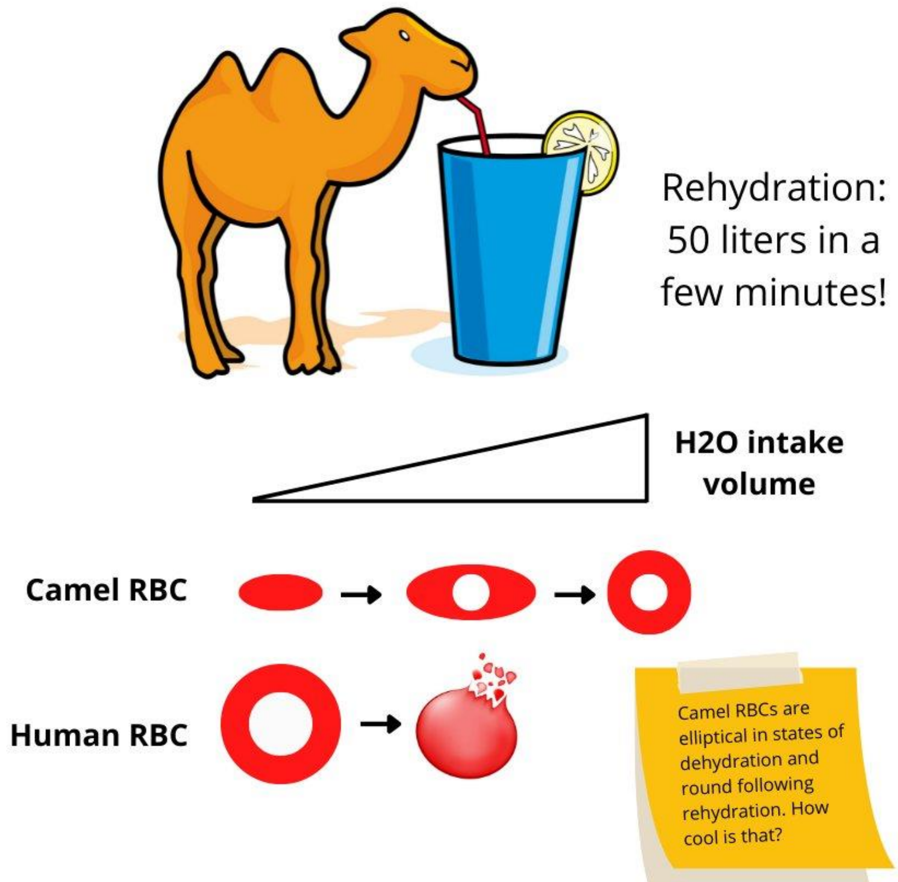
I grandi animali del deserto: il cammello



Scanning EM of camel RBCs



Peripheral blood smear from camel



Do frogs drink water?

Frogs do not drink water. Instead, they have a unique ability to soak up water through their rubbery skin via a process called osmosis. If a frog’s skin dries out, it can be fatal, so a supply of fresh water must be available to your frog at all times.

Assunzione di vapore acqueo

Artropodi non volatori assumono acqua dall’aria anche se non satura.

Ciascuna specie possiede una umidita’ critica all’equilibrio: rappresenta il più basso valore di umidità dell’aria al quale l’animale può captare il vapore acqueo.

Tabella 5.5. Valori dell'umidità critica all'equilibrio (CEH) in vari artropodi non volatori, capaci di assumere vapore acqueo dall'aria insatura. Quando per una specie è dato un intervallo di valori, gli estremi rappresentano la variazione con la temperatura.

Taxon	CEH (% dell’umidità relativa)
ARACNIDI	
Acari e zecche	
Ornithodorus	94
Ixodes	92
Echinolaelaps	90
Acarus	70
Dermatophagoides	52÷69
Amblyomma	87÷89
INSETTI	
Tisanuri-apterigoti	
Ctenolepisma	48
Thermobia	44÷47
Mallofagi/Sifonatteri-pulci	
Ceratophyllus	82
Goniodes	60
Xenopsylla	50
Liposcelis	54
Ftiratteri-pidocchi	43÷52
Psocotteri-pidocchi dei libri	
Liposcellis knulleri	70
L. bostrychophilus	60
L. rufus	58
Ortotteri-blatte + cavallette	
Arenivaga	80÷83
Ninfe di *Chortophaga*	92
Lepidotteri	
Larva di *Tinea*	95
Coleotteri-blatte	
Larva di *Tenebrio*	88
Larva di *Lasioderma*	43
Larva di *Onymacris*	84
CROSTACEI	
Isopodi-oniscoidei	
Porcellio	87÷91

Meccanismi di assunzione di vapore acqueo

Negli acari e nelle blatte del deserto vi è assunzione a livello della bocca in associazione con le ghiandole salivari. Attraverso la secrezione di elevate quantità di soluti ipertonici sui quali si condensa l’acqua e/o l’uso di superfici complesse allo scopo di trattenere questo fluido e di assumerlo per capillarità.

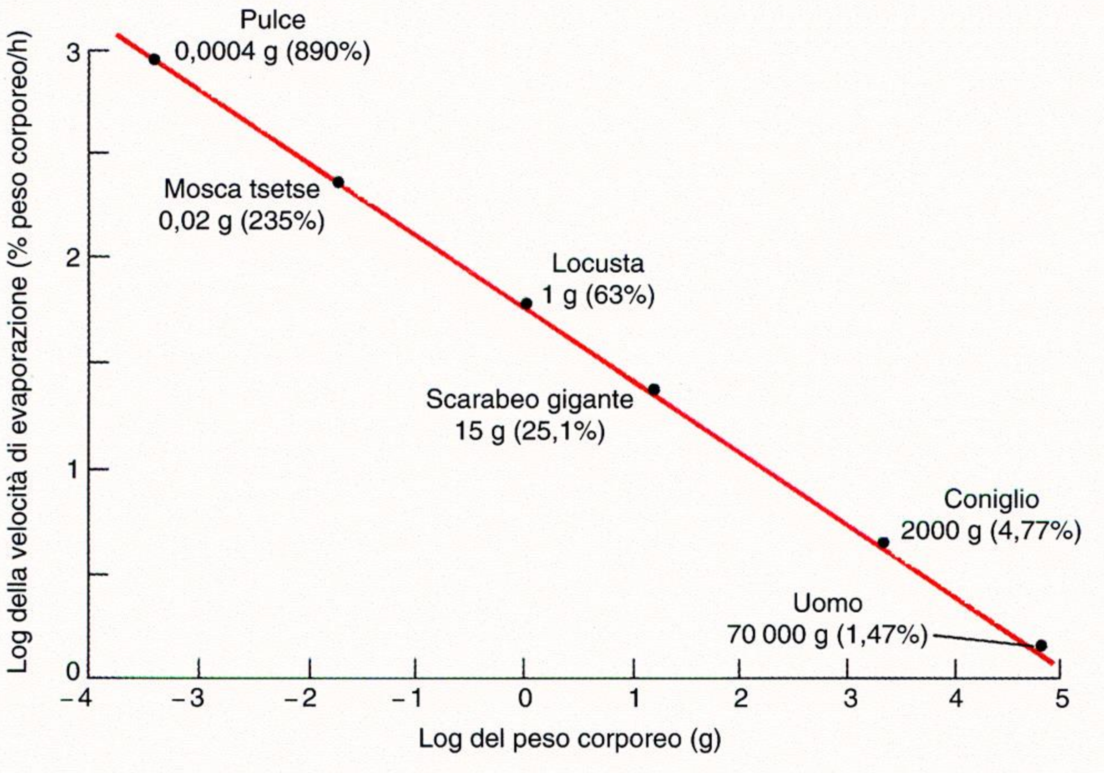
In altri casi, l’assunzione avviene attraverso superfici rettali o anali, specializzate per l’assorbimento dell’acqua.

Tolleranza alla perdita di acqua

Anellidi	
Allolobophora	75
Molluschi	
Patella	35÷60
Chitoni	75
Helix	45÷50
Limax	80
Sphincterochila	50÷55
Granchi	
Gecarcinus	15÷18
Uca	18
Insetti	
Coleotteri delle zone temperate	25÷45
Blatte delle zone temperate	25÷35
Cicale del deserto	25
Formiche, cavallette deserticole	40÷70
Coleotteri tenebrionidi deserticoli	60÷75
Rane	
Rana	28÷35
Hyla	35÷40
Bufo	42÷45
Scaphiopus	45÷48
Uccelli e mammiferi	
Piccoli uccelli	4÷8
Ratto	12÷15
Uomo	10÷12
Cammello	30

Tabella 5.2. Tolleranza alla perdita di acqua (espressa come percentuale massima tollerata di perdita di peso) di vari animali viventi in habitat terrestri o semiterrestri.

Velocità di perdita d'acqua



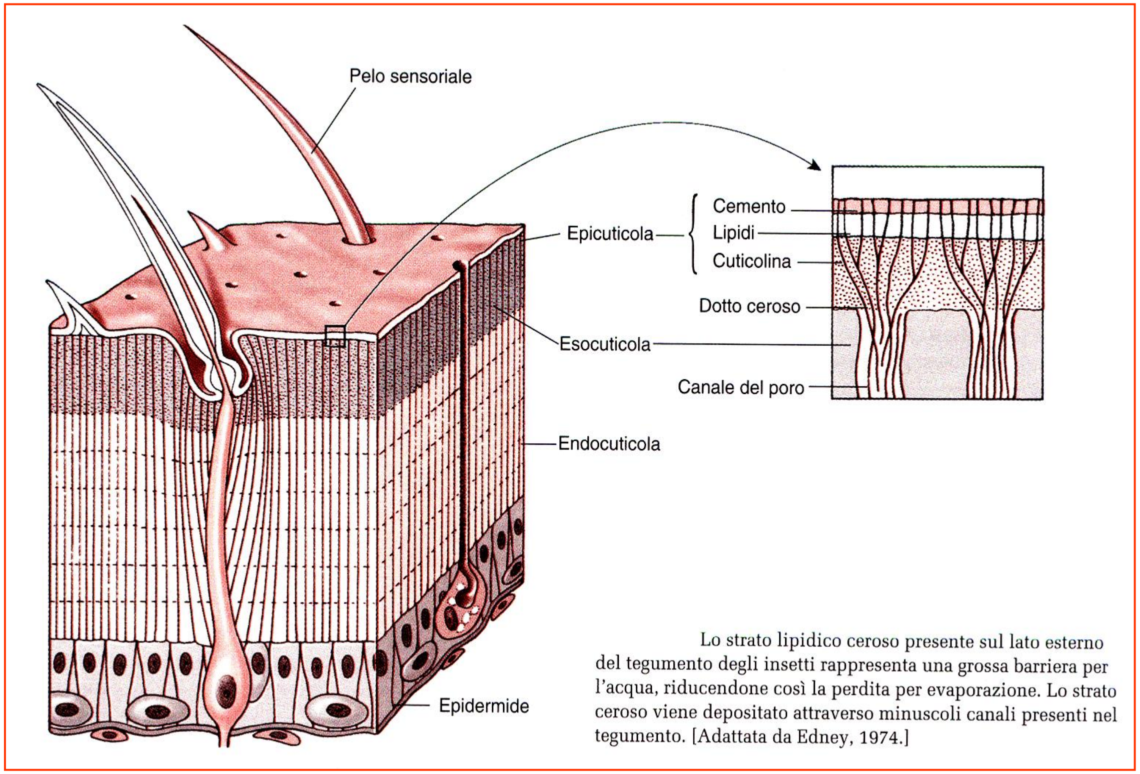
I piccoli animali si disidratano più velocemente di quelli di grande taglia a causa del loro alto rapporto superficie/massa (e perciò del loro rapporto superficie/volume). Questo grafico mostra la quantità di acqua, in percentuale rispetto al peso corporeo, perduta ogni ora nelle calde condizioni climatiche del deserto. [Edney e Nagy, 1976.]

La permeabilità del tegumento

La permeabilità del tegumento varia in modo considerevole e si va da epiteli caratterizzati da permeabilità estreme a cuticole molto impermeabili.

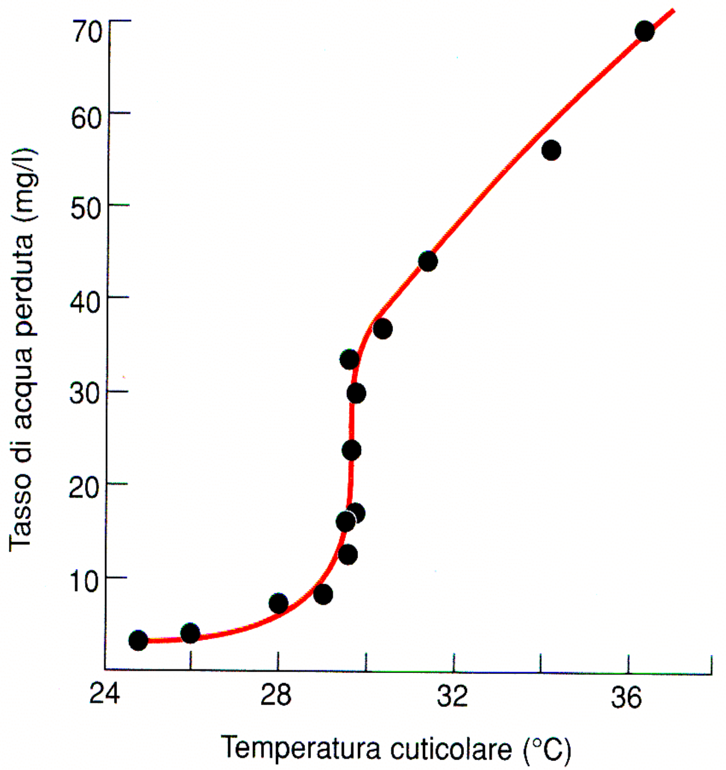
La pelle degli anfibi e le branchie dei pesci sono altamente permeabili. Rettili, uccelli e mammiferi o anfibi del deserto possiedono una pelle altamente impermeabile.

Contribuiscono ad una bassa permeabilità del tegumento all'acqua il materiale cuticolare (chitina, cheratina, sali di calcio) ed uno strato lipidico.

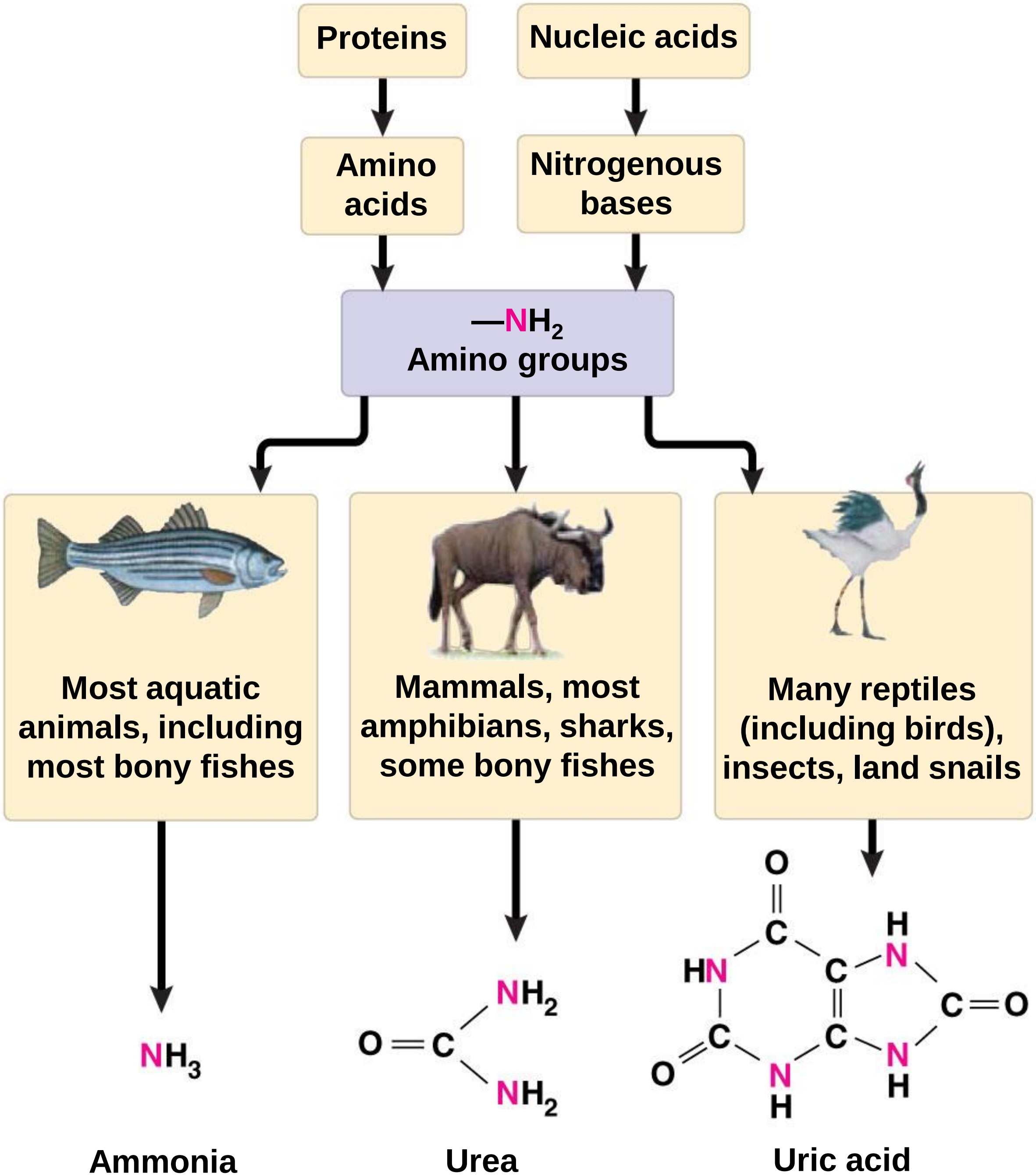


Lo strato lipidico ceroso presente sul lato esterno del tegumento degli insetti rappresenta una grossa barriera per l'acqua, riducendone così la perdita per evaporazione. Lo strato ceroso viene depositato attraverso minuscoli canali presenti nel tegumento. [Adattata da Edney, 1974.]

Effetto della temperatura sulla perdita d'acqua in un insetto

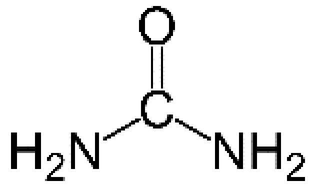


La quantità d'acqua perduta dagli insetti risulta molto più elevata a temperature che superano il punto di fusione dello strato ceroso che ricopre la cuticola. In questo diagramma, la ripida variazione della perdita d'acqua rispetto alla temperatura cuticolare di una blatta corrisponde al punto di fusione della cuticola cerosa. [Da: Beament, 1958.]


Proteins
Nucleic acids
Amino acids
Nitrogenous bases
—NH2
Amino groups
Most aquatic animals, including most bony fishes
Mammals, most amphibians, sharks, some bony fishes
Many reptiles (including birds), insects, land snails
NH3
Ammonia
NH2
O=C
NH2
Urea
O
C
HN
C
H
N
C=O
C
N
H
O
N
H
Uric acid

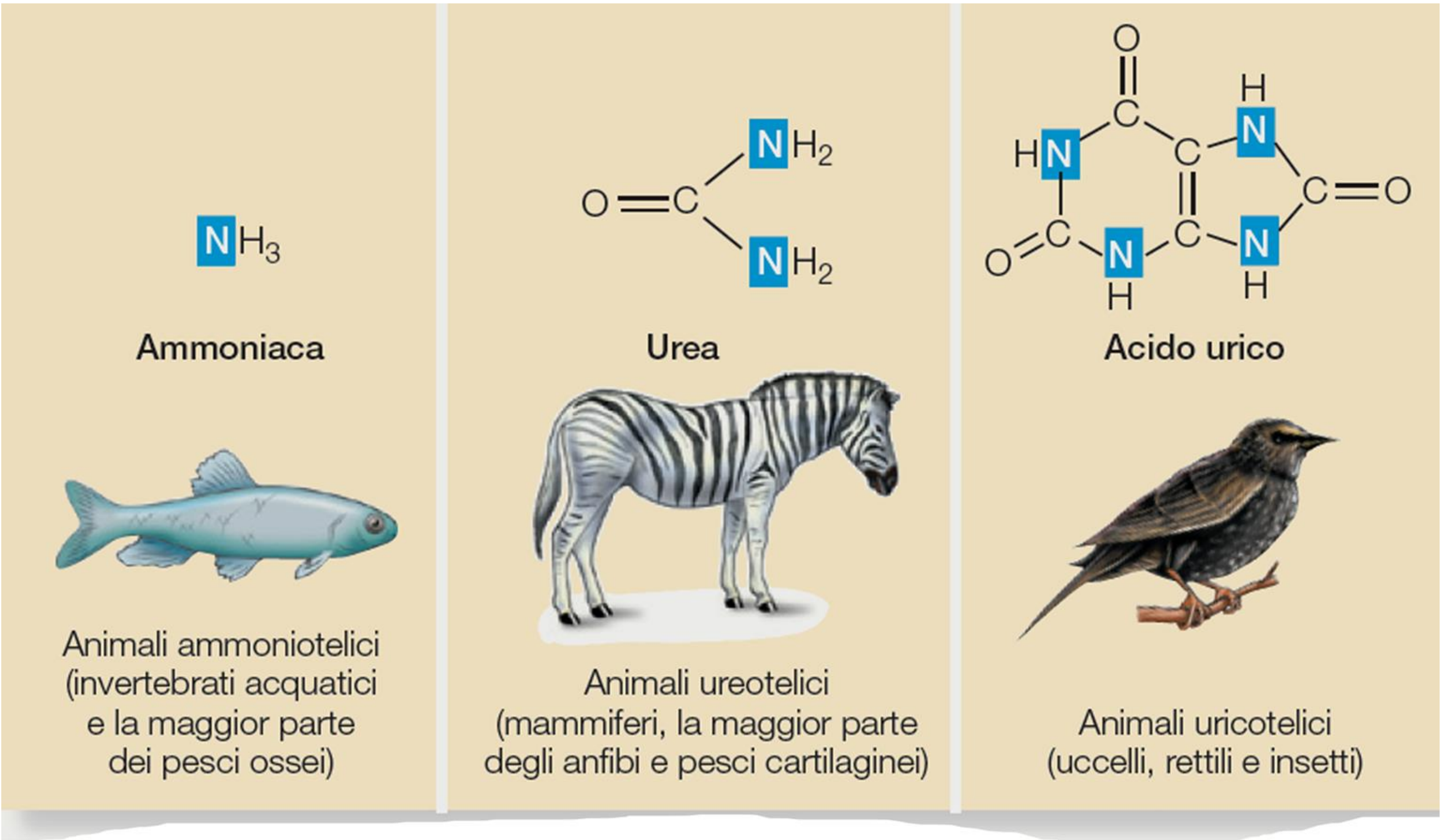
NITROGENOUS WASTE PRODUCTS

- **Catabolism of amino acids** and nucleic acids results in **ammonia**
  - High solubility permits it to be excreted directly by many aquatic animals
  - Terrestrial animals must convert ammonia to urea or uric acid
    - **Urea** causes loss of much water per unit of nitrogen
      - Mammals and amphibians
      - Must drink lots of water



    - **Uric acid** requires much less water per unit of nitrogen excreted
      - Reptiles, birds, and arthropods
      - Allows invasion of drier habitats far from standing water

Escrezione dell’azoto



Ammonotelic animals

Ammonotelic animals are those that excrete ammonia in their waste.

The nitrogenous waste of an ammonotelic organism is excreted as soluble ammonia.

The ammonia produced as a byproduct or waste is extremely toxic.

Because it is highly soluble, it necessitates a large amount of water for excretion.

(a) Many invertebrates and aquatic species excrete ammonia.

Uricotelic Animals

The liver of mammals and most adult amphibians converts ammonia to the less toxic **urea.**

The circulatory system carries urea to the kidneys, where it is excreted.

Conversion of ammonia to urea is energetically expensive; excretion of urea requires less water than ammonia.

(b) Mammals, many adult amphibians, and some marine species excrete urea.

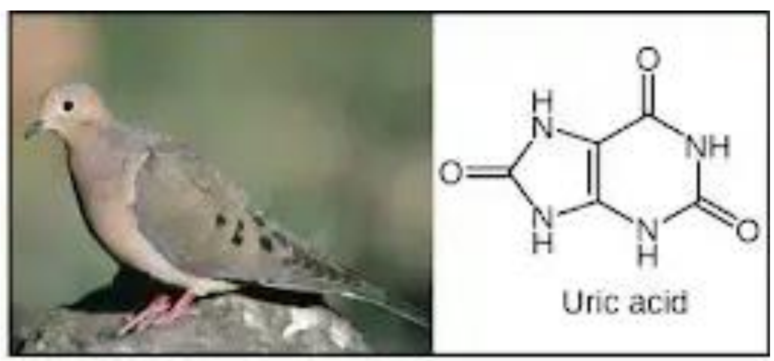
Uricotelic animals

Birds, reptiles, and most terrestrial arthropods, such as insects, are called uricotelic organisms mainly excrete uric acid

Uric acid is relatively nontoxic and does not dissolve readily in water

It contains four nitrogen atoms; only a small amount of water is needed for its excretion; It can be secreted as a paste with little water loss

Uric acid is more energetically expensive to produce than urea



(c) Insects, land snails, birds, and many reptiles excrete uric acid.

The Influence of Evolution and Environment on Nitrogenous Wastes

The kinds of nitrogenous wastes excreted depend on an animal's evolutionary history and habitat, especially water availability

- Aquatic, urea
- Shelled eggs, uric acid

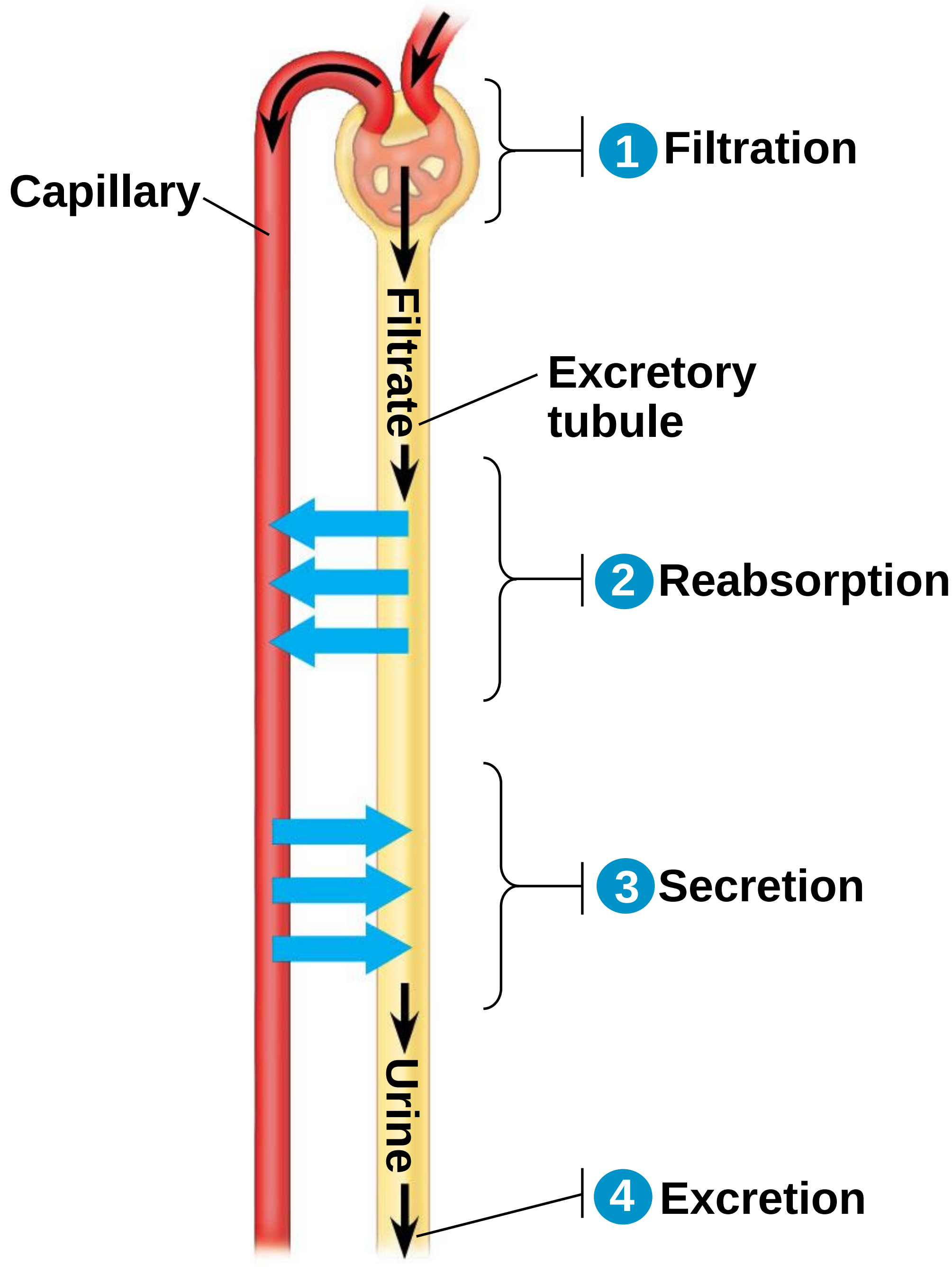
The amount of nitrogenous waste produced is coupled to the animal's energy budget and amount of dietary protein.

Endotherms eat more food, produce more nitrogenous waste

Excretory Processes

- Most excretory systems produce urine by refining a **filtrate** derived from body fluids.
- Key functions of most excretory systems:

1. **Filtration**: Filtering of body fluids
2. **Reabsorption**: Reclaiming valuable solutes
3. **Secretion**: Adding nonessential solutes and wastes from the body fluids to the filtrate
4. **Excretion**: Processed filtrate containing nitrogenous wastes, released from the body



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Diverse excretory systems are variations on a tubular theme

Excretory systems regulate solute movement between internal fluids and the external environment.

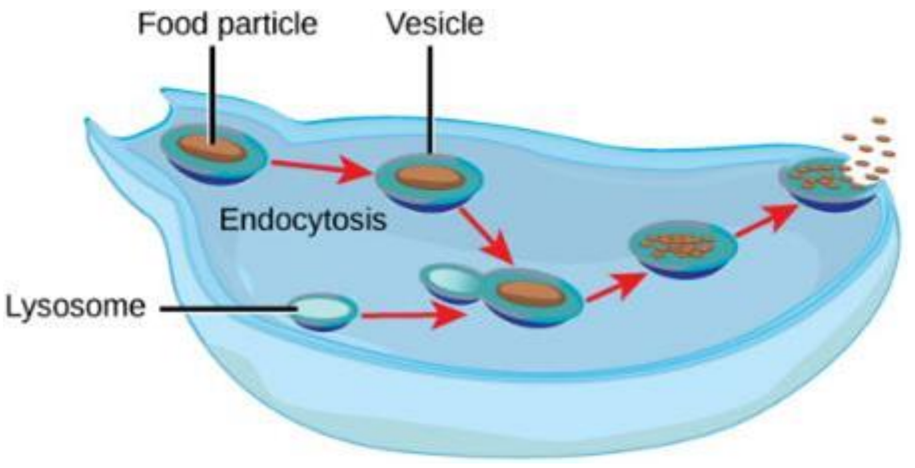
Microorganisms and invertebrate animals use more primitive and simple mechanisms to get rid of their metabolic wastes than the mammalian system of kidney and urinary function.

Three excretory systems evolved in organisms before complex kidneys:

I. Vacuoles
II. flame cells
III. Malpighian tubules

Contractile Vacuoles in Microorganisms

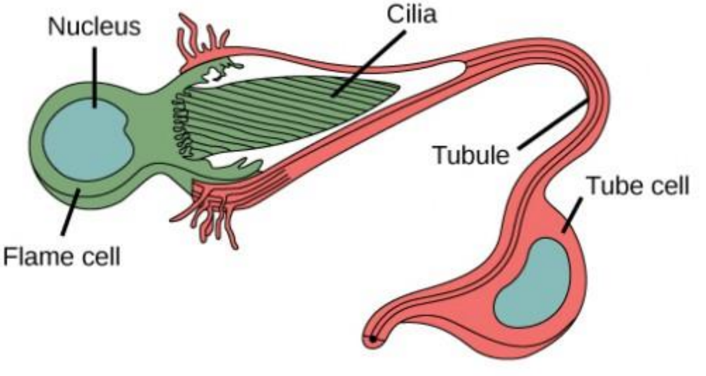
The cells of microorganisms like bacteria, protozoa, and fungi are bound by cell membranes and use them to interact with the environment.



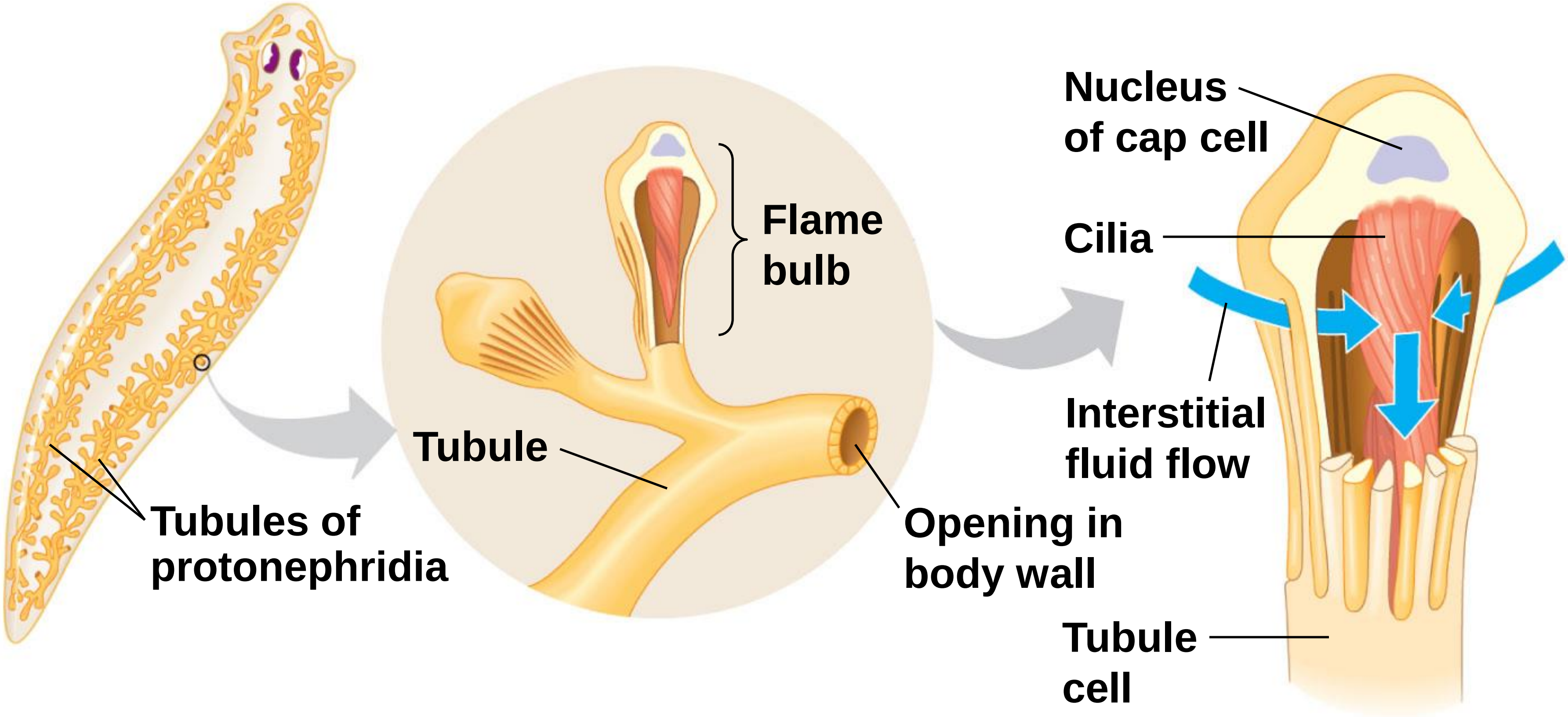
Some unicellular organisms, such as the amoeba, ingest food by endocytosis. The food vesicle fuses with a lysosome, which digests the food. Waste is excreted by exocytosis.

Flame Cells of Planaria

As multi-cellular systems evolved to have organ systems that divided the metabolic needs of the body, individual organs evolved to perform the excretory function. Planaria are flatworms that live in fresh water. Their excretory system consists of two tubules connected to a highly branched duct system.



(a) Flame cell of a planarian



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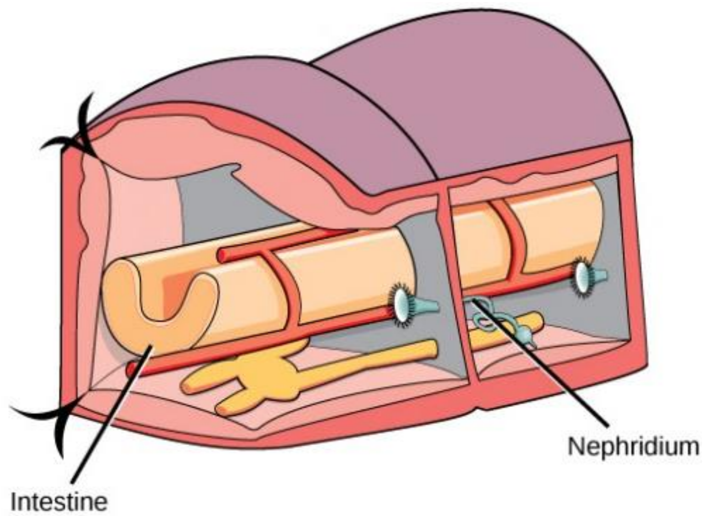
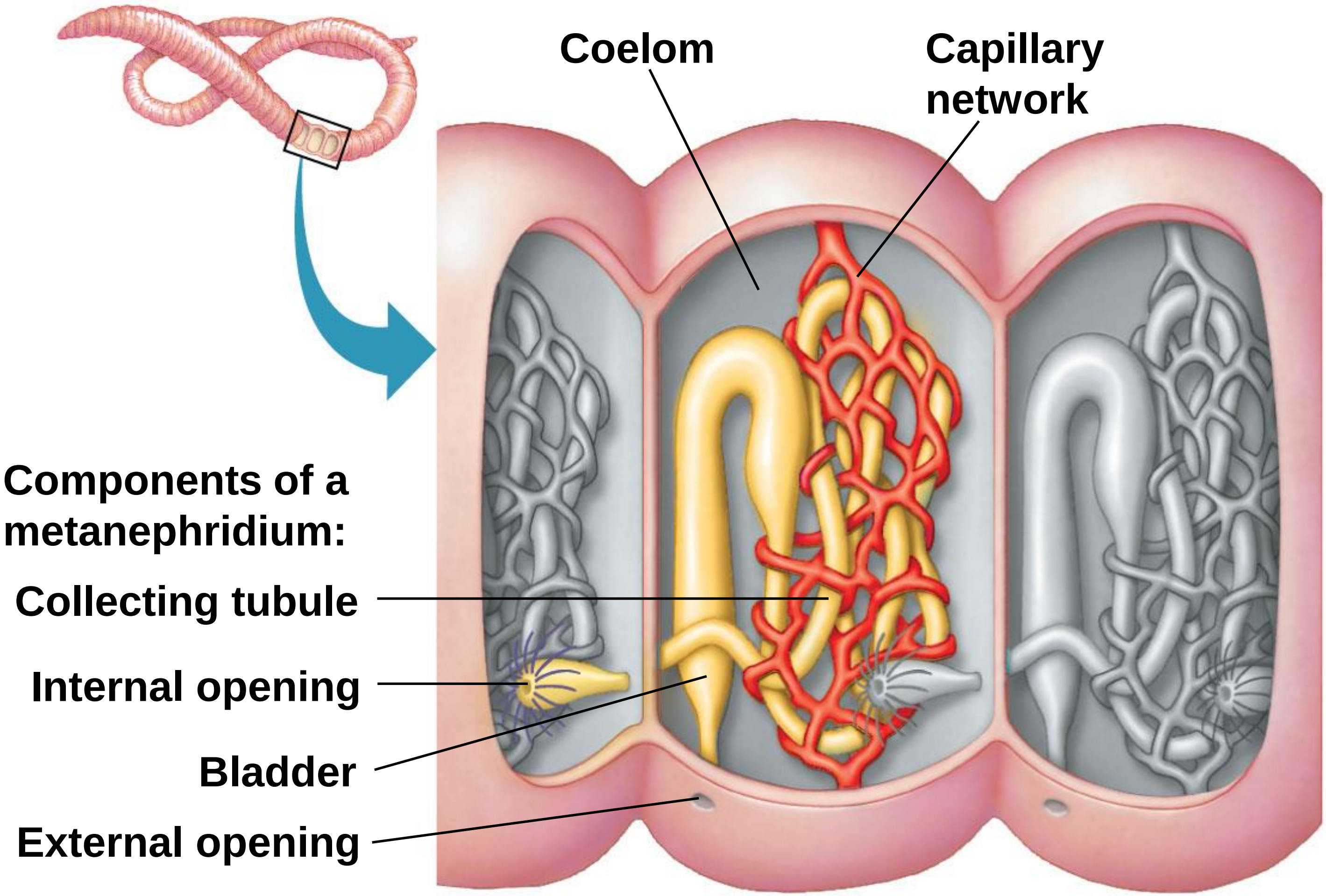
Nephridia of Worms

In annelids such as earthworms, nephridia filter fluid from the coelom, or body cavity and produce dilute urine for excretion.



(b) Nephridium of an earthworm



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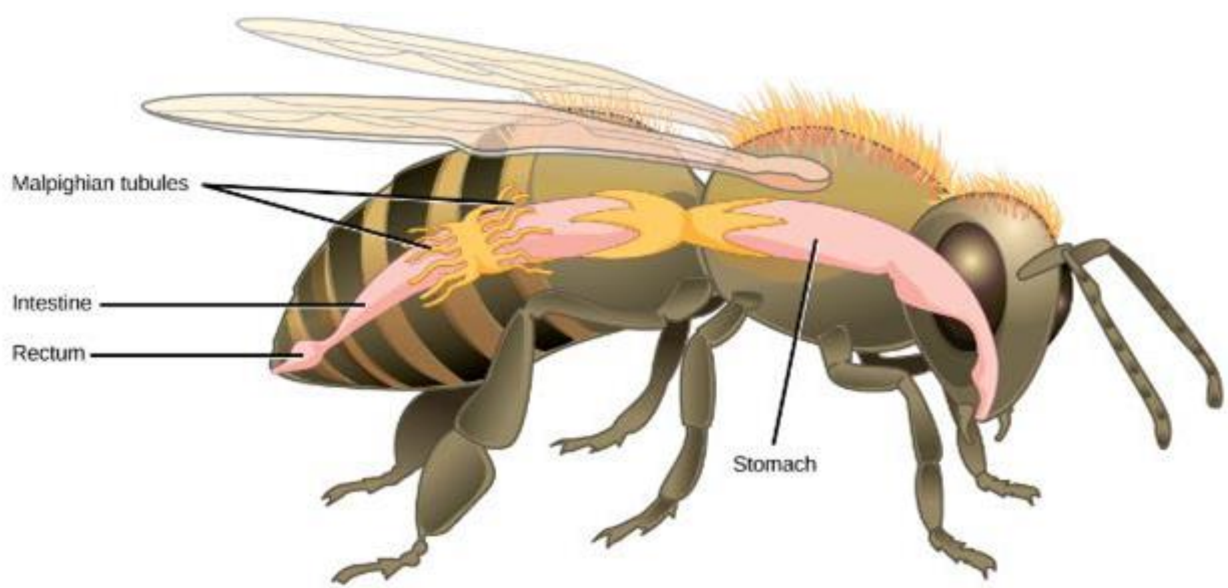
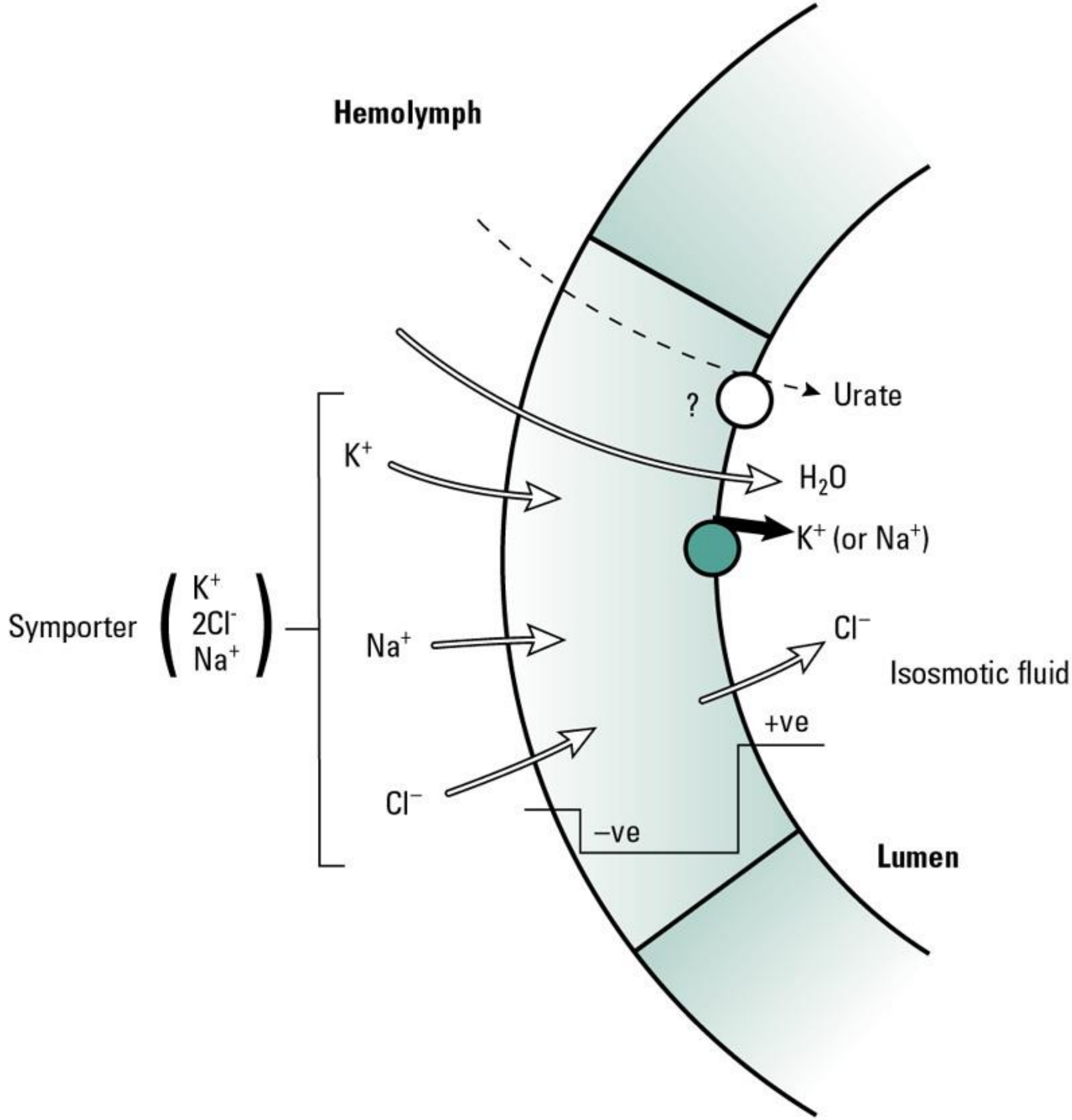
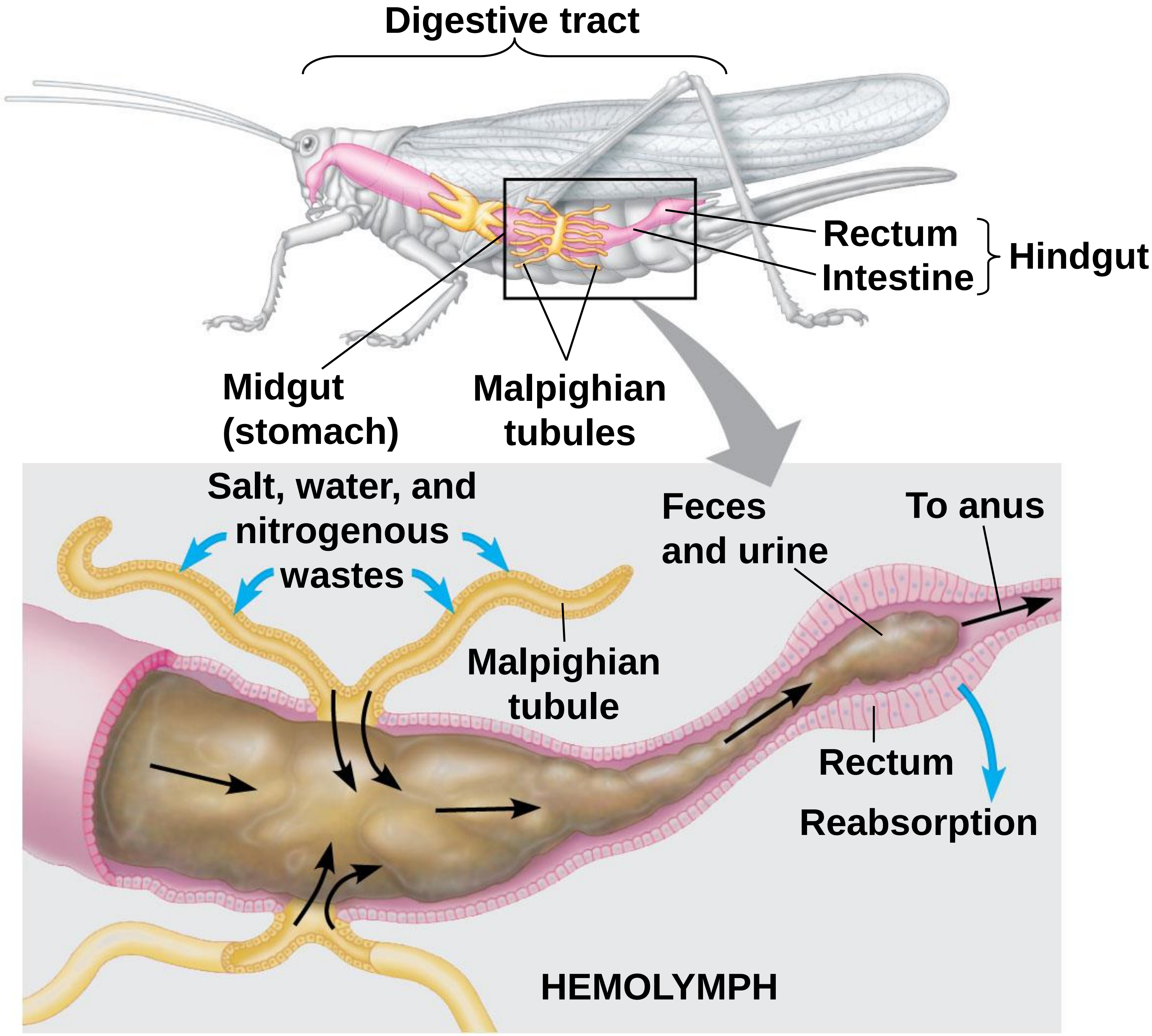
Malpighian Tubules of Insects

Malpighian tubules are found lining the gut of some species of arthropods, such as the bee. Malpighian tubules are convoluted, which increases their surface area, and they are lined with microvilli for reabsorption and maintenance of osmotic balance.





Hemolymph
Urate
?
H2O
K+ (or Na+)
Symporter
K+
2Cl-
Na+
K+
Na+
Cl–
Cl–
Isosmotic fluid
+ve
–ve
Lumen



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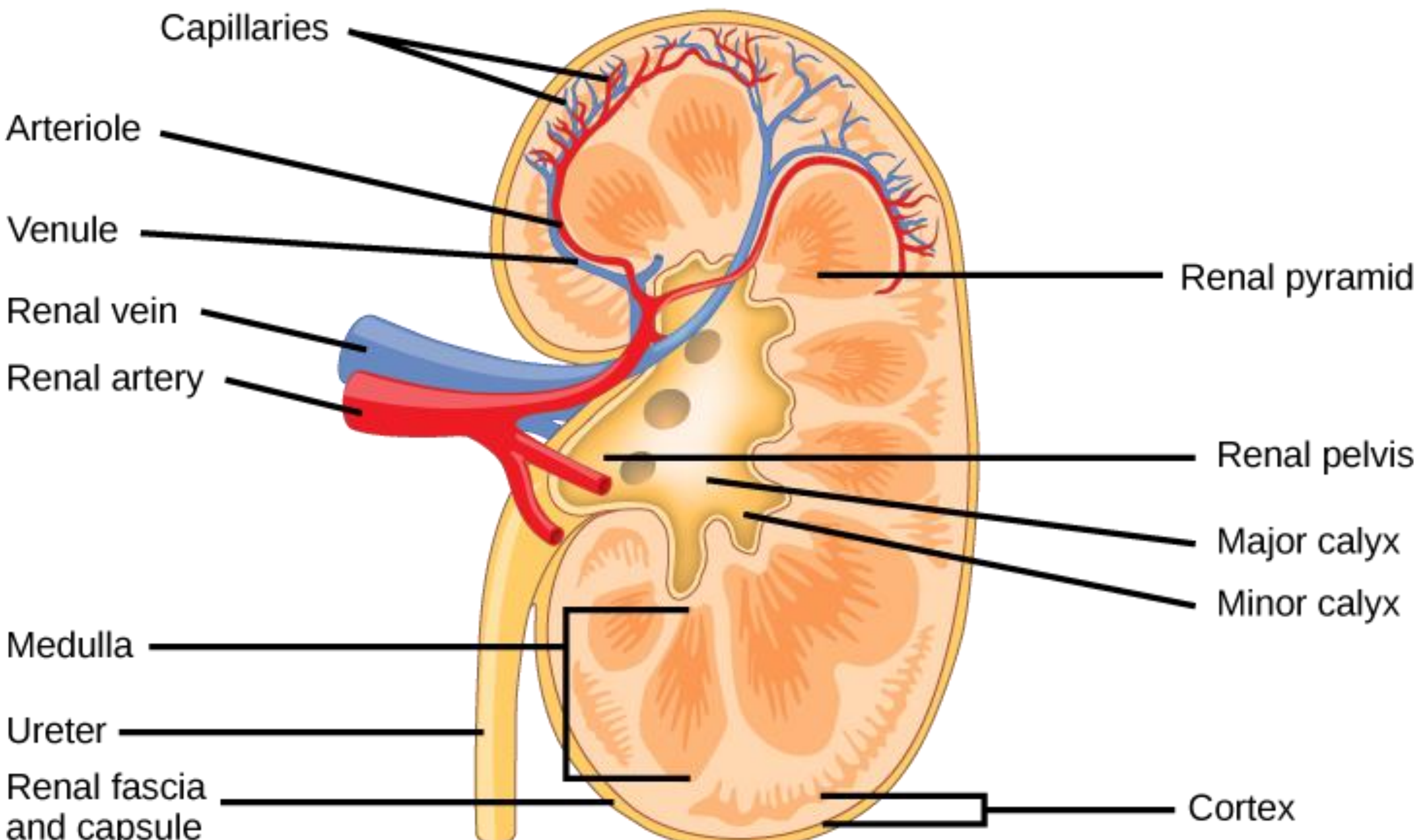
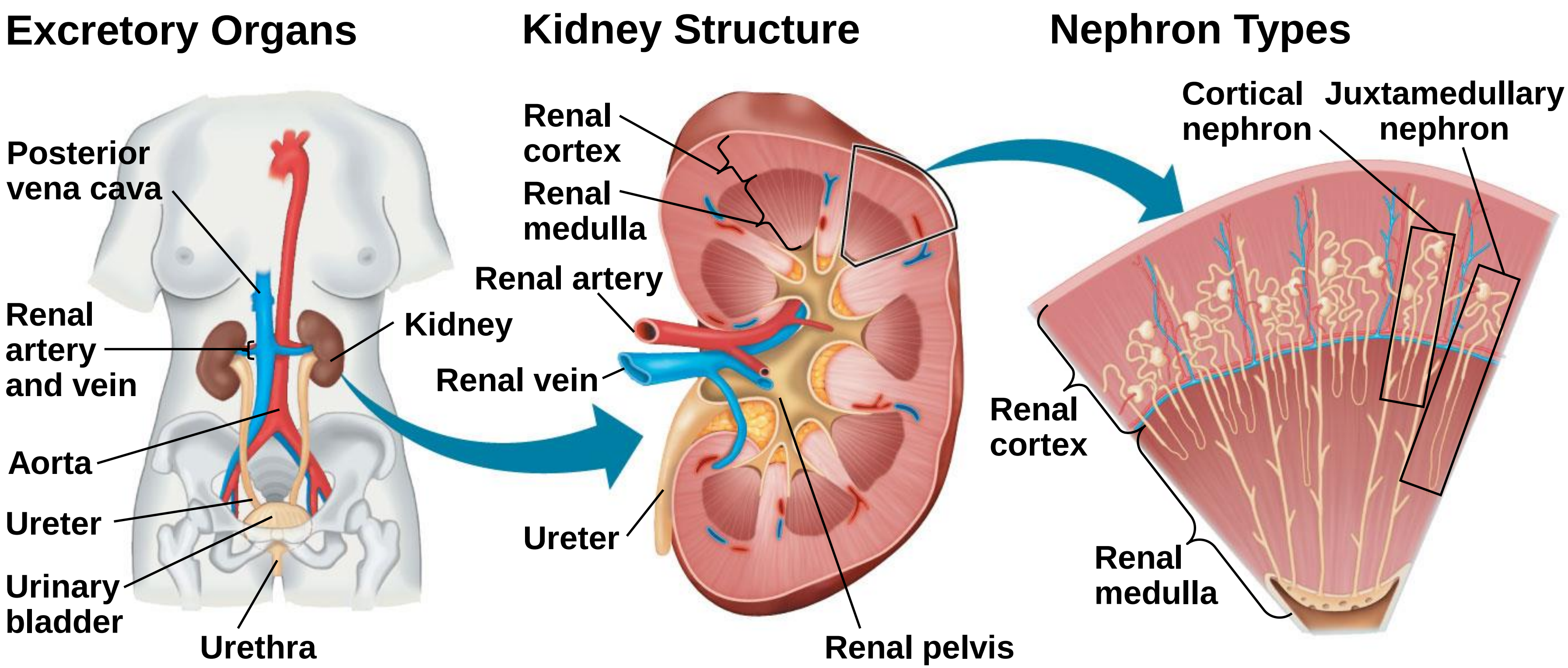
Vertebrates





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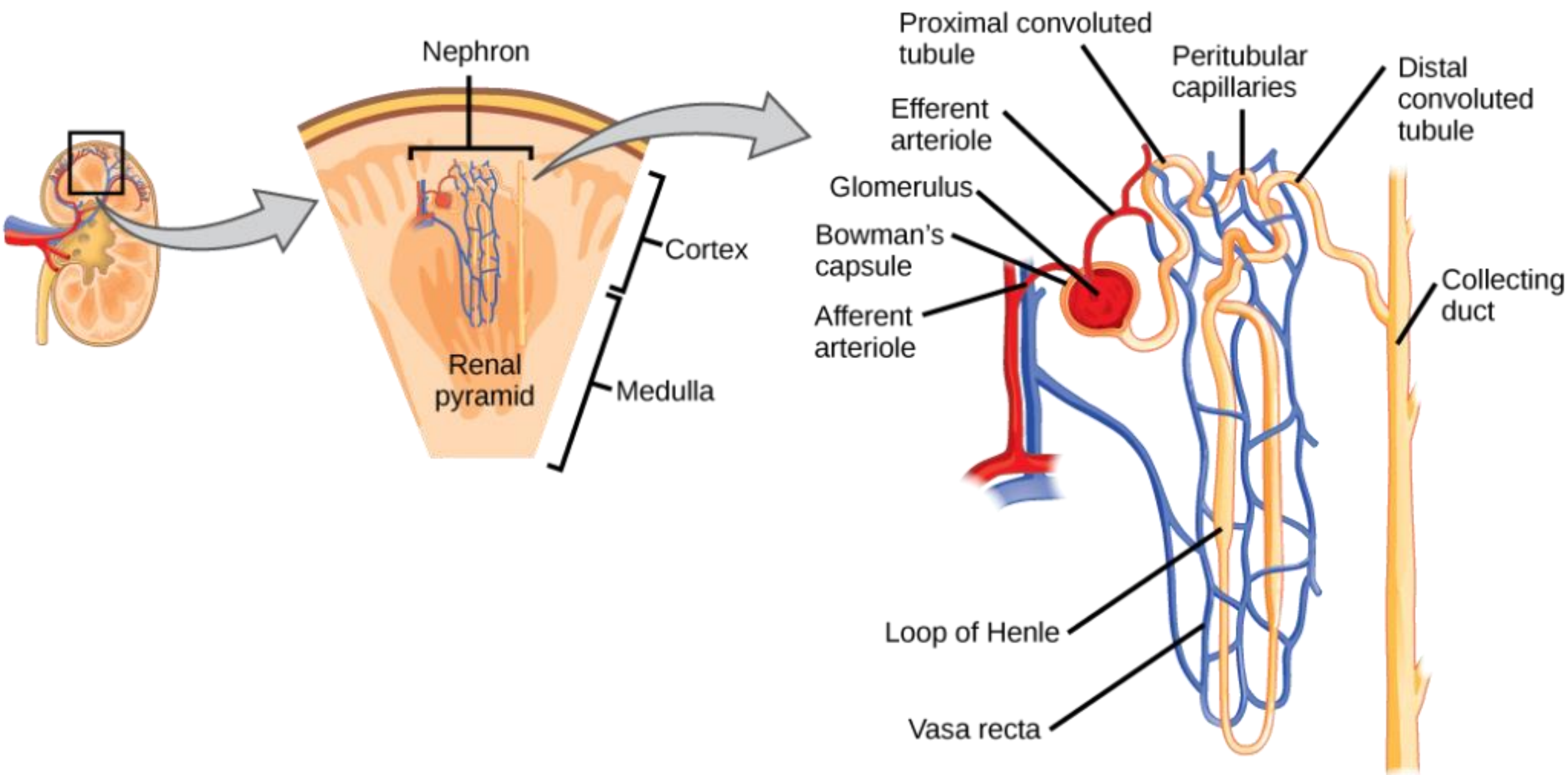
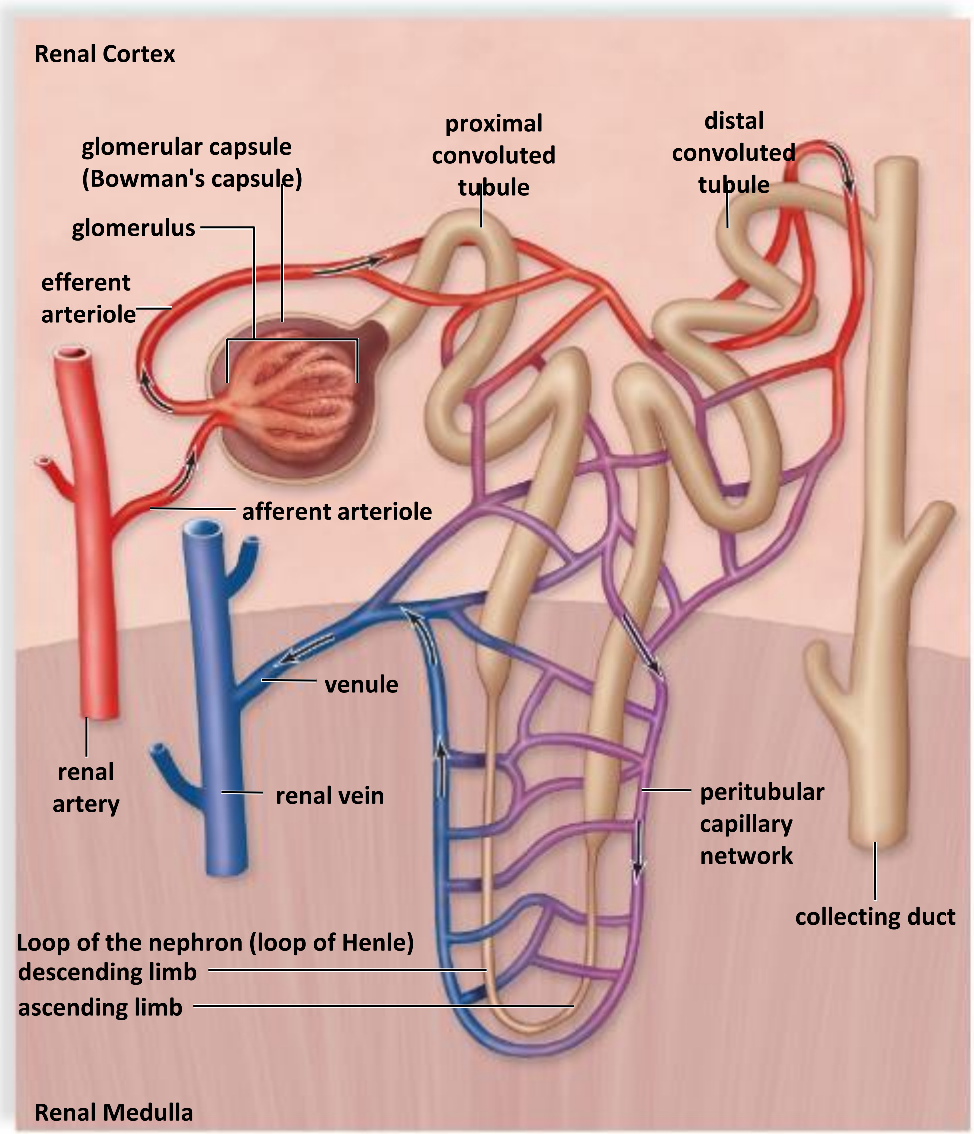
Nephron

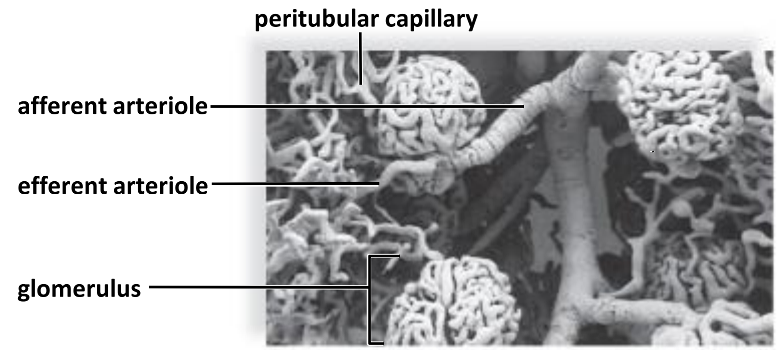
1. renal corpuscle
2. renal tubule
3. the associated capillary network



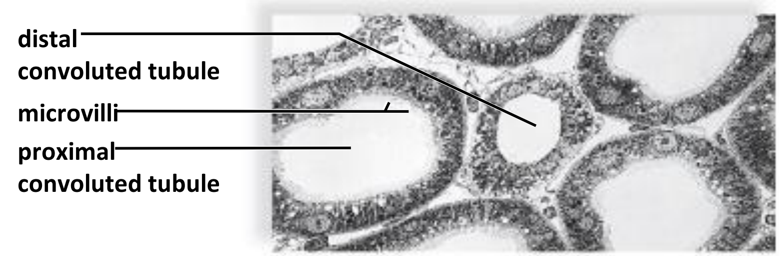
NEPHRON ANATOMY



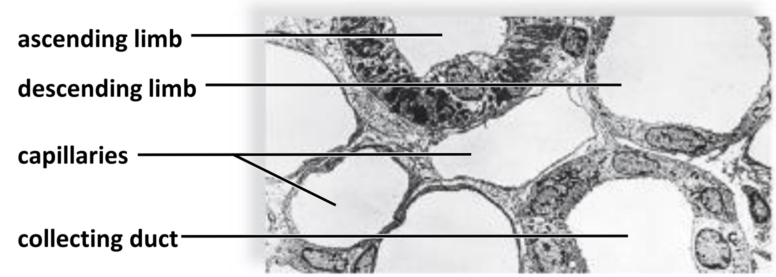
a. Anephron and its blood supply



b. Surface view of glomerulus and its blood supply

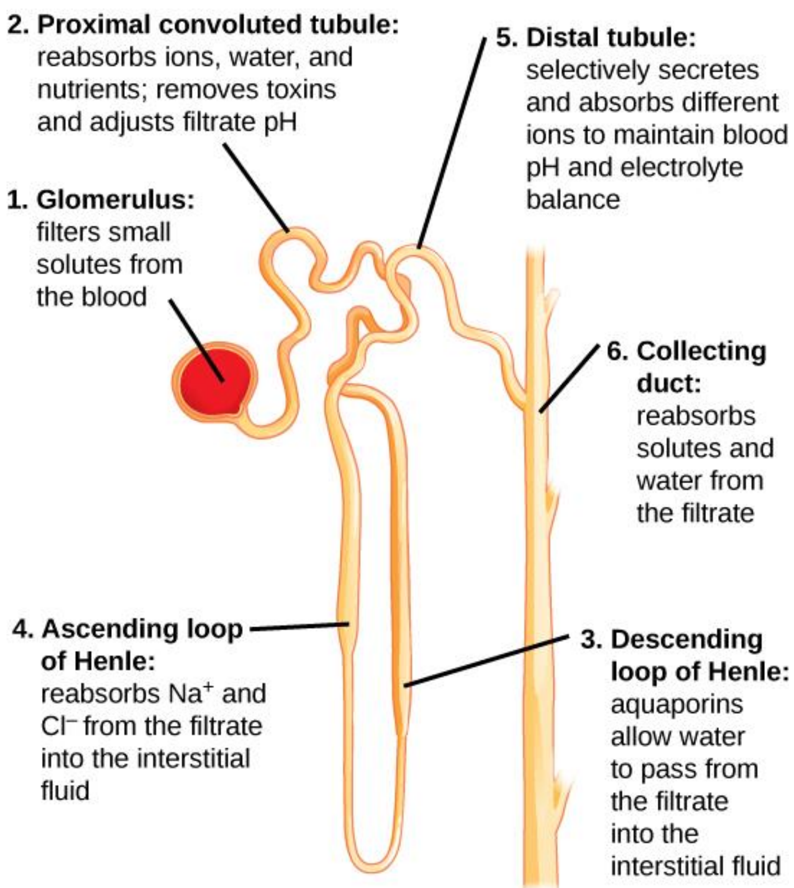


c. Cross sections of proximal and distal convoluted tubules



d. Cross sections of a loop of nephron limbs and collecting duct. (The other cross sections are those of capillaries.)

Urine formation



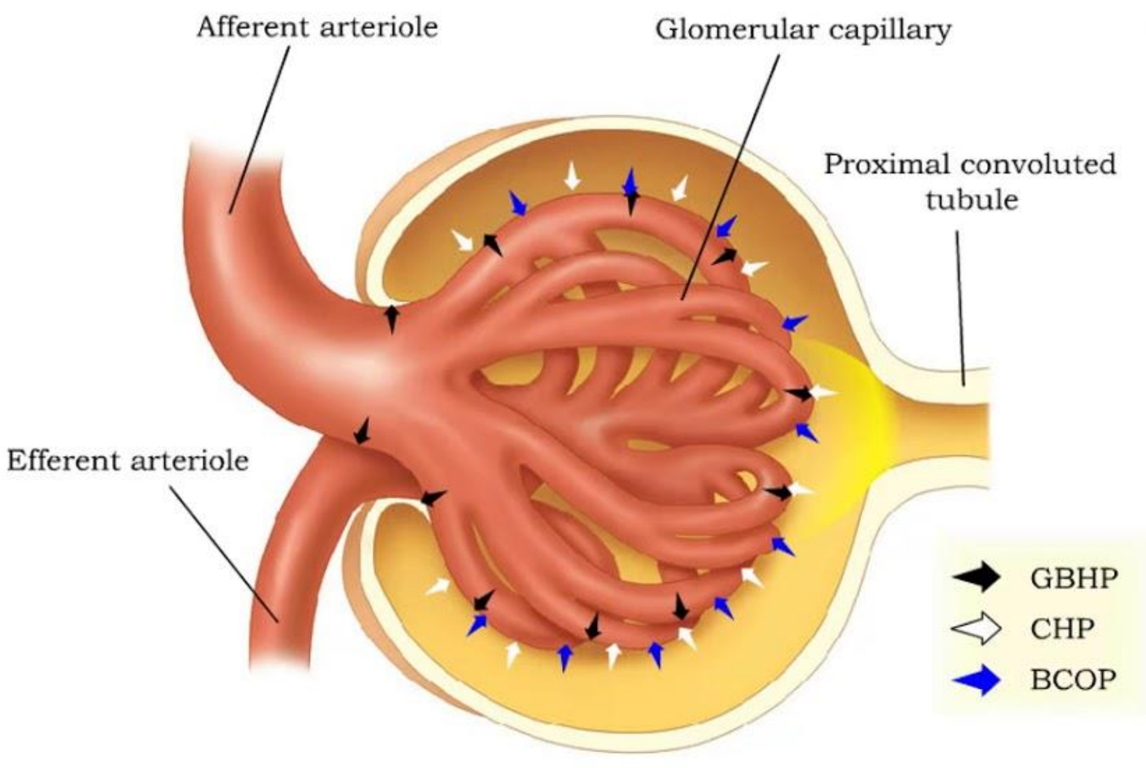
Urine production requires three distinct processes:

- **Glomerular filtration** in glomerular capsule
- **Tubular reabsorption** at the proximal convoluted tubule
- **Tubular secretion** at the distal convoluted tubule

Glomerular Filtration

The glomerulus forces small solutes out of the blood by pressure.

The filtrate produced in Bowman's capsule contains salts, glucose, amino acids, vitamins, nitrogenous wastes, and other small molecules



Glomerular (Bowman's) capsule

Glomerular filtrate rate - pressures that affect GFR

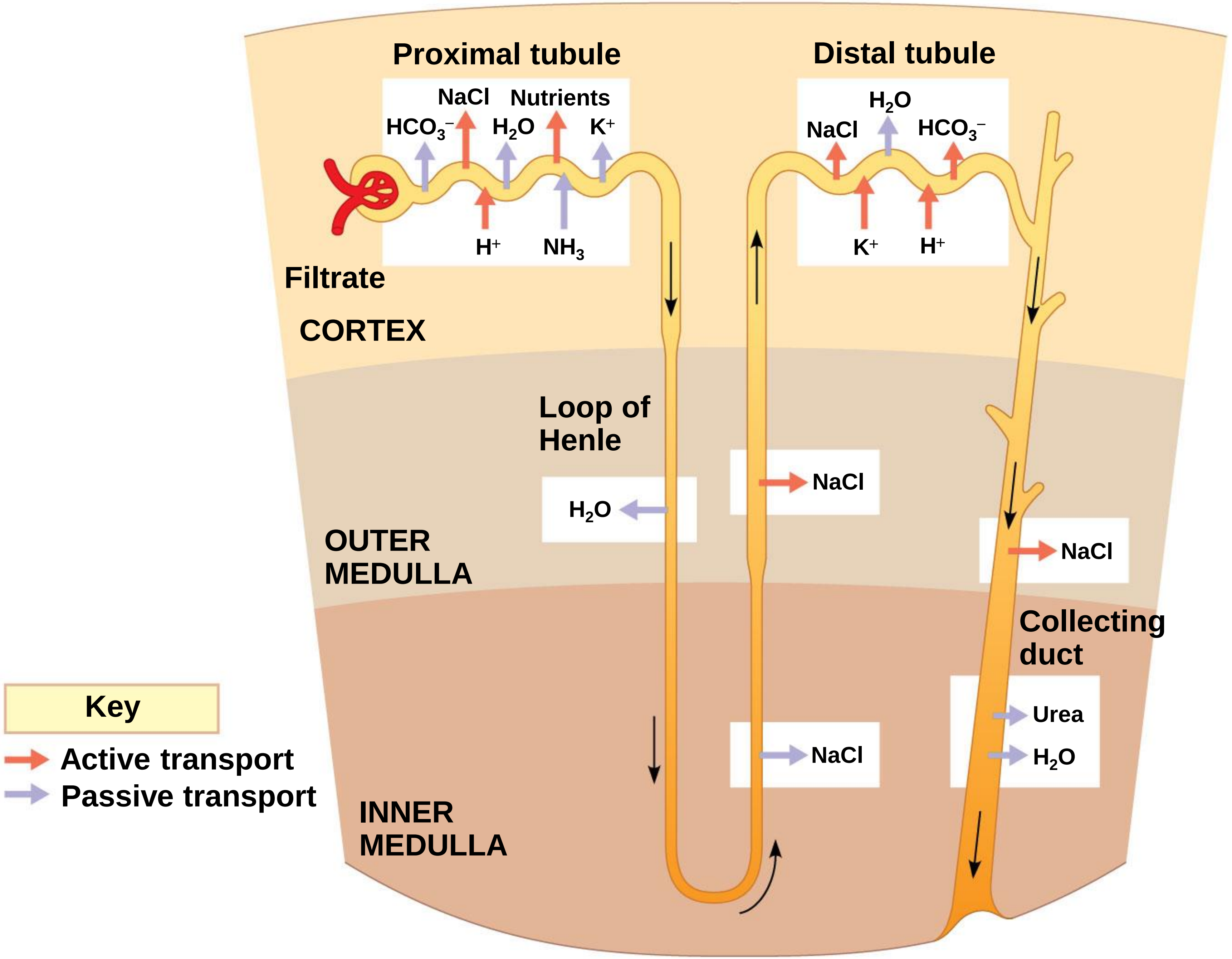
- The production and movement of filtrate depends on three pressures:
  1. Glomerular blood hydrostatic pressure (GBHP) is pressure within the capillaries. GBHP is dependent on blood pressure.
  2. Capsular hydrostatic pressure (CHP) is back pressure from the fluid already in the glomerular (Bowman's) capsule.
  3. Blood colloidal osmotic pressure (BCOP) is the tendency of blood proteins to draw water back into blood.

Proximal Tubule

The proximal convoluted tubule reabsorbs ions, water, and nutrients from the filtrate into the interstitial fluid, and actively transports toxins and drugs from the interstitial fluid into the filtrate.

The proximal convoluted tubule also adjusts blood pH by selectively secreting ammonia (NH_3) into the filtrate, where it reacts with H^+ to form NH_4^+.

The more acidic the filtrate, the more ammonia is secreted.



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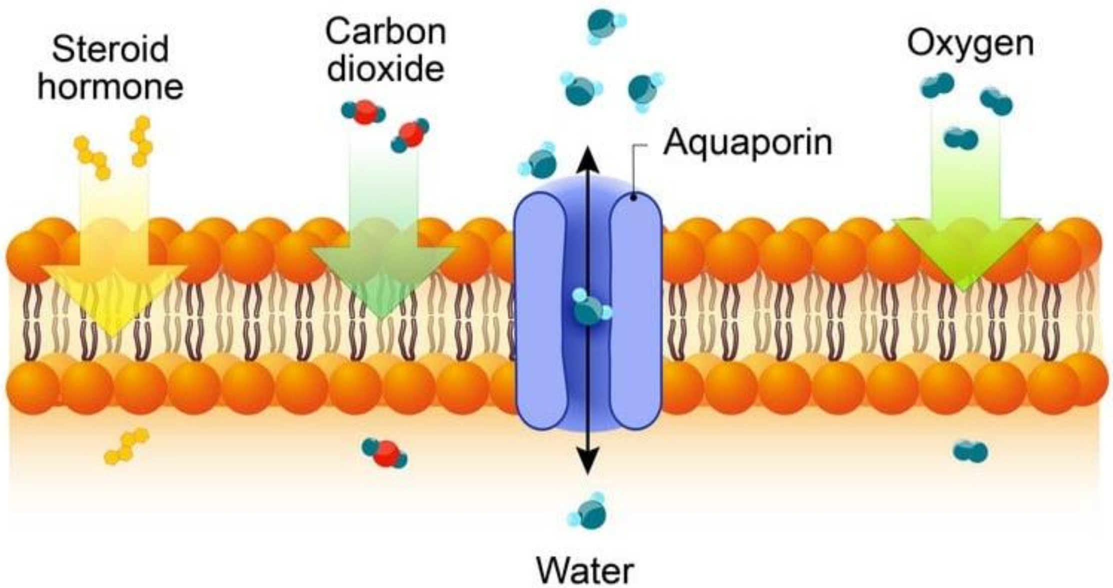
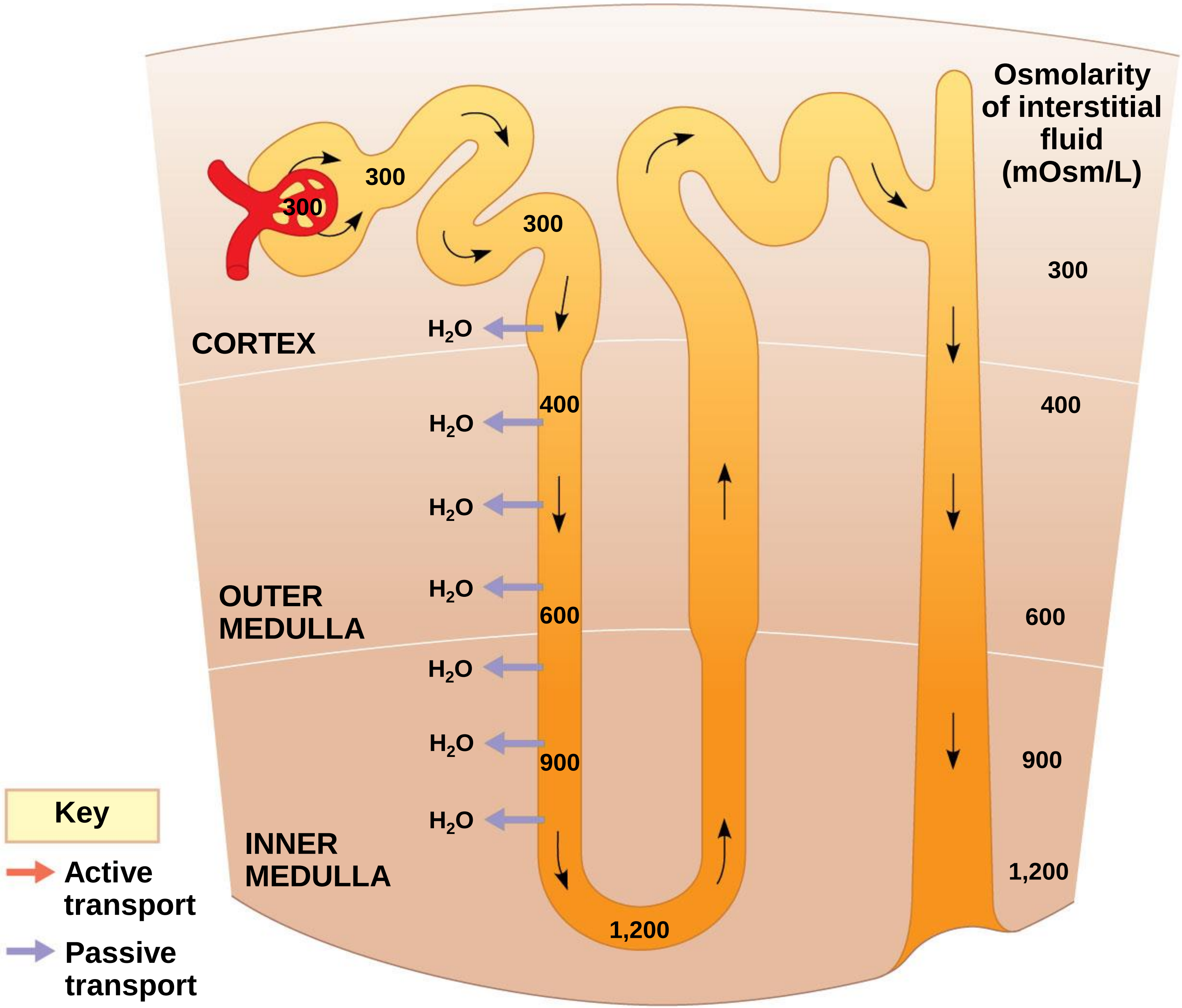
Tubular reabsorption - Descending Limb of the Loop of Henle

Reabsorption of water continues through channels formed by **aquaporin** proteins



Movement is driven by the high osmolarity of the interstitial fluid, which is hyperosmotic to the filtrate

The filtrate becomes increasingly concentrated



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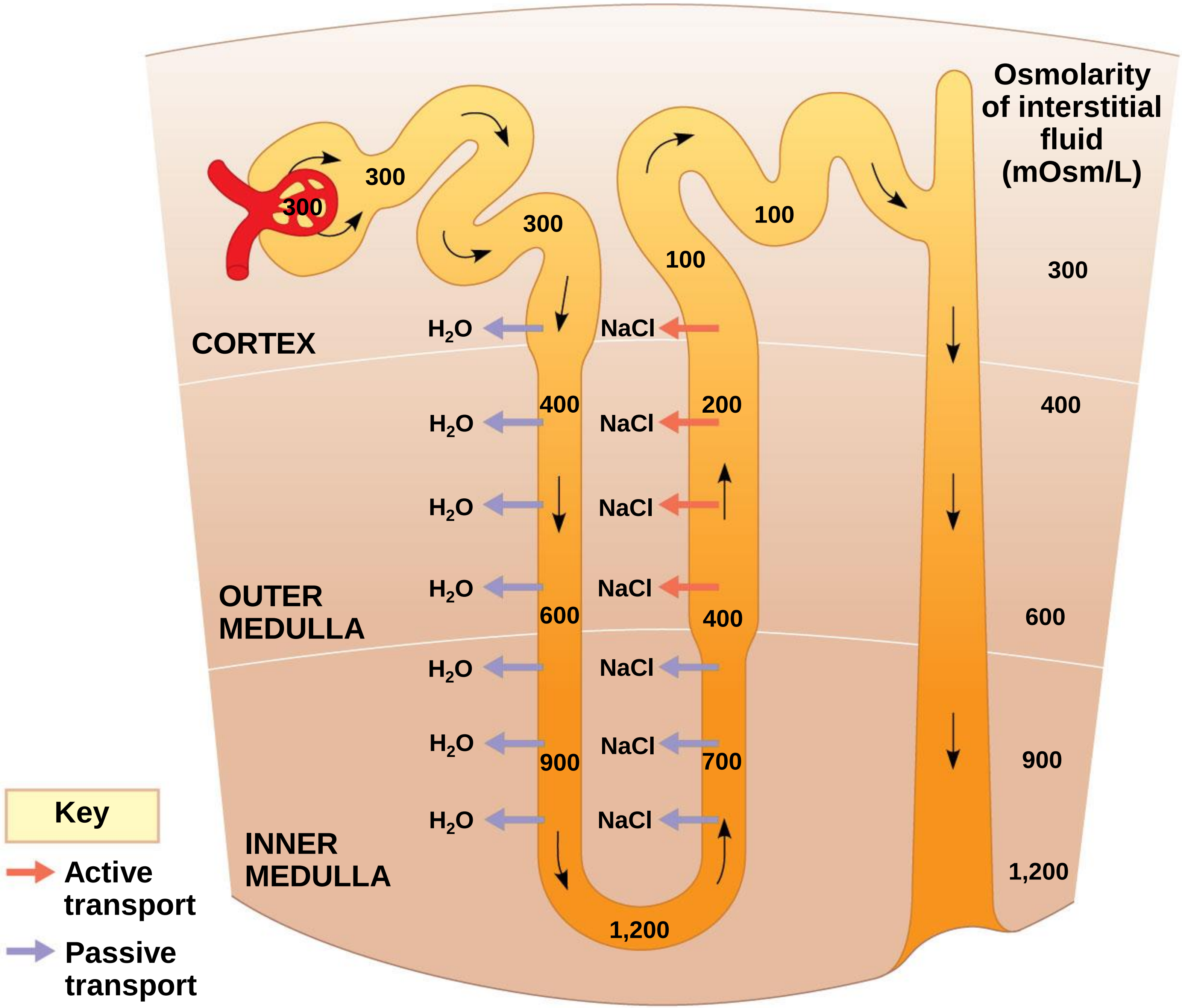
Tubular secretion - Ascending Limb of the Loop of Henle

In the ascending limb of the loop of Henle, salt but not water is able to diffuse from the tubule into the interstitial fluid

In the thin part of the ascending loop of Henle, Na^+ and Cl^- ions diffuse into the interstitial fluid.

In the thick part, these same ions are actively transported into the interstitial fluid.

Because salt but not water is lost, the filtrate becomes more dilute as it travels up the limb.



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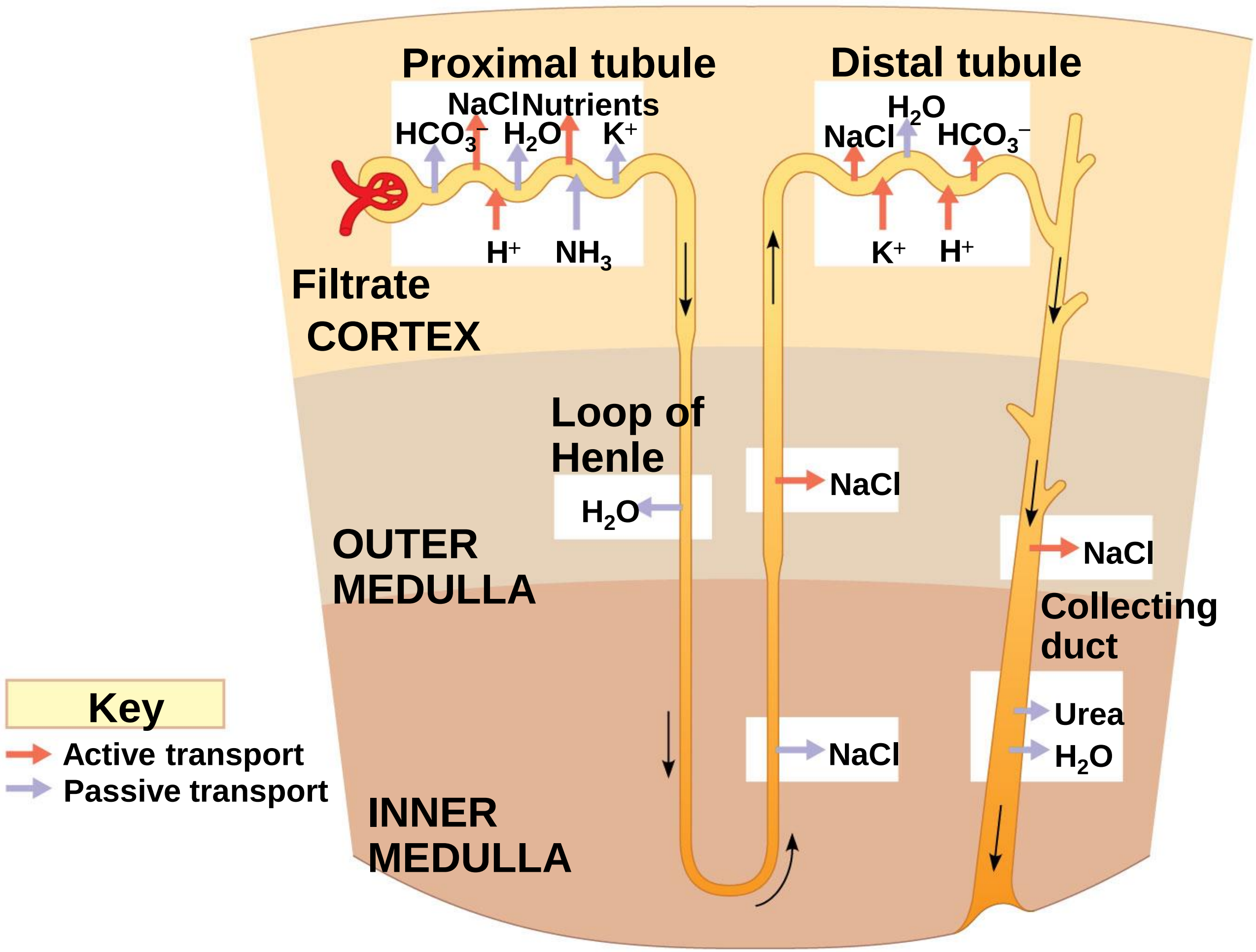
Distal Tubule

In the distal convoluted tubule, K+ and H+ ions are selectively secreted into the filtrate, while Na+, Cl-, and HCO3- ions are reabsorbed to maintain pH and electrolyte balance in the blood.



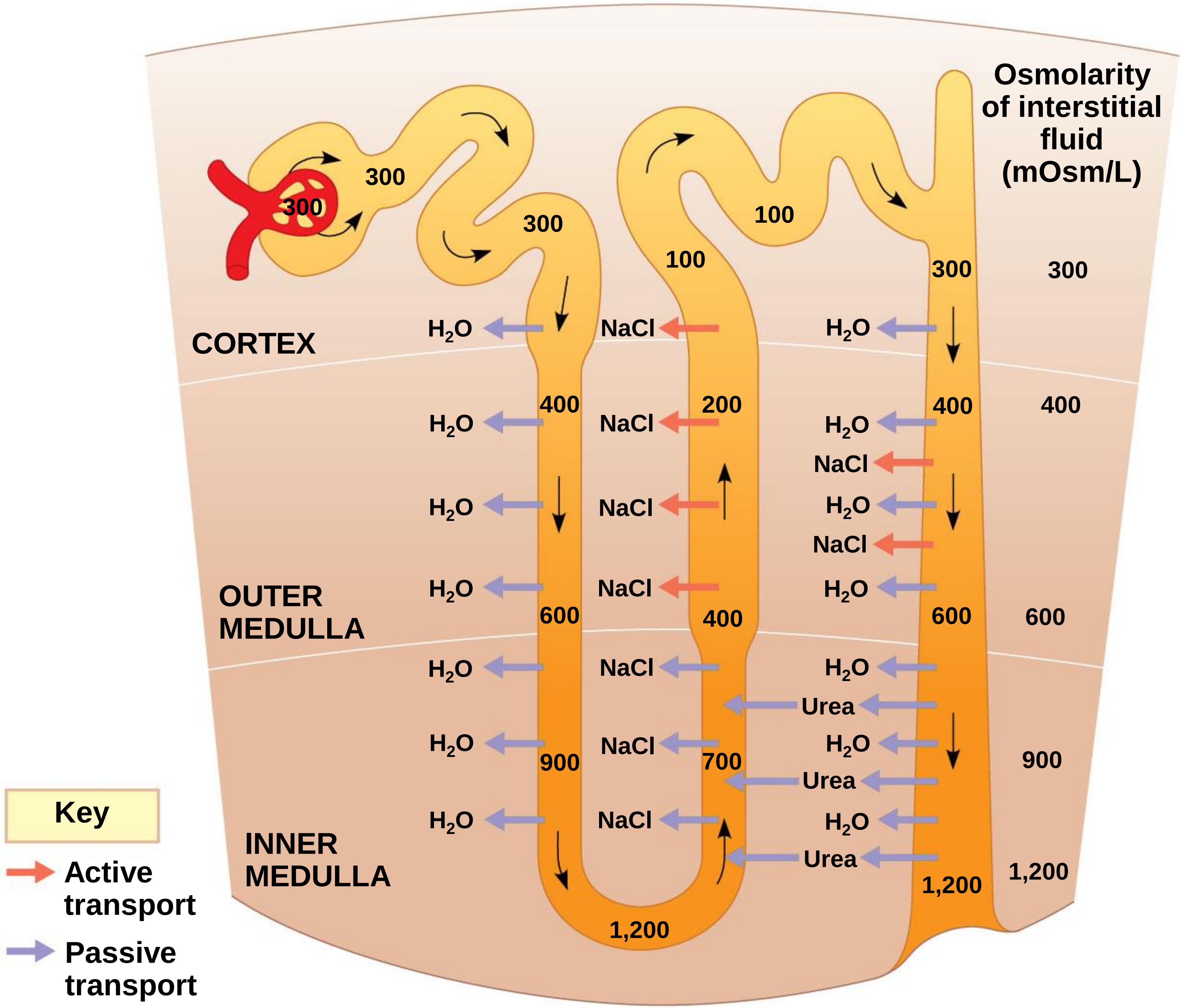
Collecting Duct

The collecting duct reabsorbs solutes and water from the filtrate, forming dilute urine.

The collecting duct carries filtrate through the medulla to the renal pelvis

One of the most important tasks is reabsorption of solutes and water

Urine is hyperosmotic to body fluids



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Adaptations of the Vertebrate Kidney to Diverse Environments

The form and function of nephrons in various vertebrate classes are related to requirements for osmoregulation in the animal’s habitat.

Mammals

The juxtamedullary nephron is key to water conservation in terrestrial animals

Mammals that inhabit dry environments have long loops of Henle, while those in fresh water have relatively short loops

Capacità di produrre urina iperosmotica

Tabella 10.2. Capacità massima di concentrazione del rene di diversi mammiferi in rapporto al normale habitat dell'animale. Gli animali del deserto hanno le concentrazioni di urina più elevate, mentre quelle più basse si riscontrano negli animali d'acqua dolce

Animale	Concentrazione max dell'urina (osm/litro)	Concentrazione urina/plasma
Castoro[a]	0,52	2
Maiale[a]	1,1	3
Uomo[b]	1,4	4
Ratto albino[b]	2,9	9
Gatto[b]	3,1	10
Dipodimide[b]	5,5	14
Ratto della sabbia[b]	6,3	17
Topo saltellante[c]	9,4	25

(a) B. Schmidt-Nielsen e O'Dell (1961), *(b)* K. Schmidt-Nielsen (1964), *(c)* MacMillen e Lee (1967).

Birds and other Reptiles

Birds have shorter loops of Henle but conserve water by excreting uric acid instead of urea

Other reptiles have only cortical nephrons, but also excrete nitrogenous waste as uric acid

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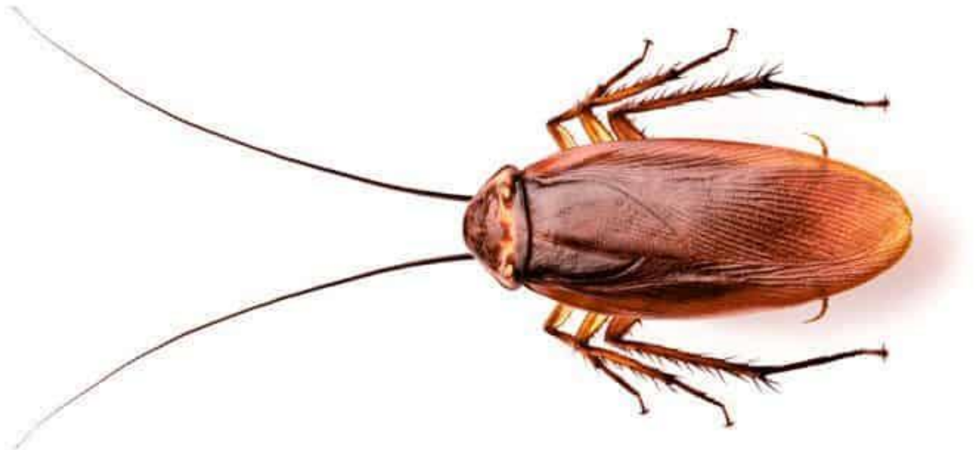
Animali uricotelici

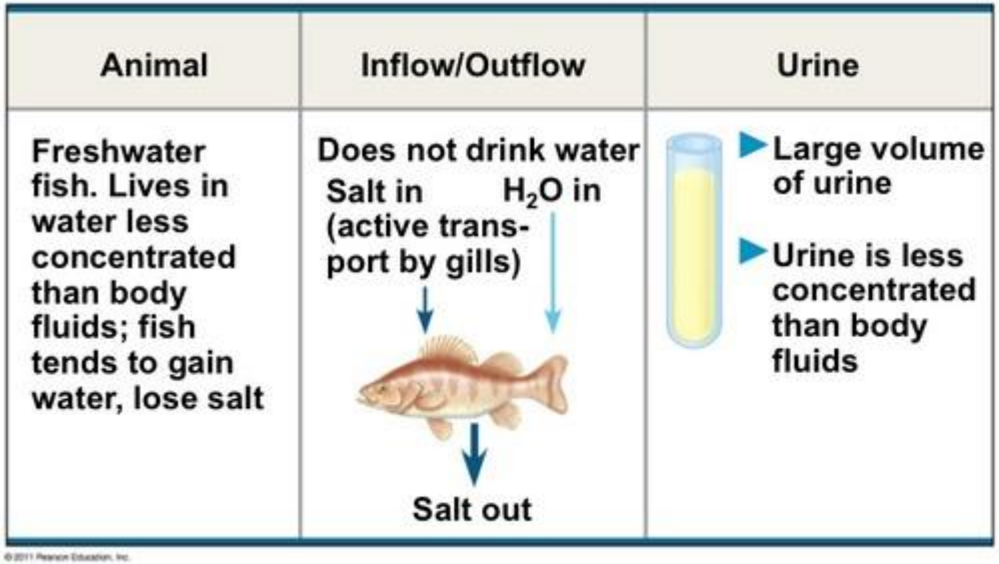
Blatta periplaneta e insetti negli stadi giovanili eliminano l'eccesso di urato nella successiva muta insieme alla cuticola.

Alcuni insetti con vita adulta breve, che hanno problemi di carenza di acqua, interrompono del tutto l'eliminazione di acido urico e lo depositano in forma cristallina in varie parti del corpo (escrezione per stoccaggio) talvolta utilizzandolo come pigmento cuticolare.



<u>Freshwater Fishes and Amphibians</u>

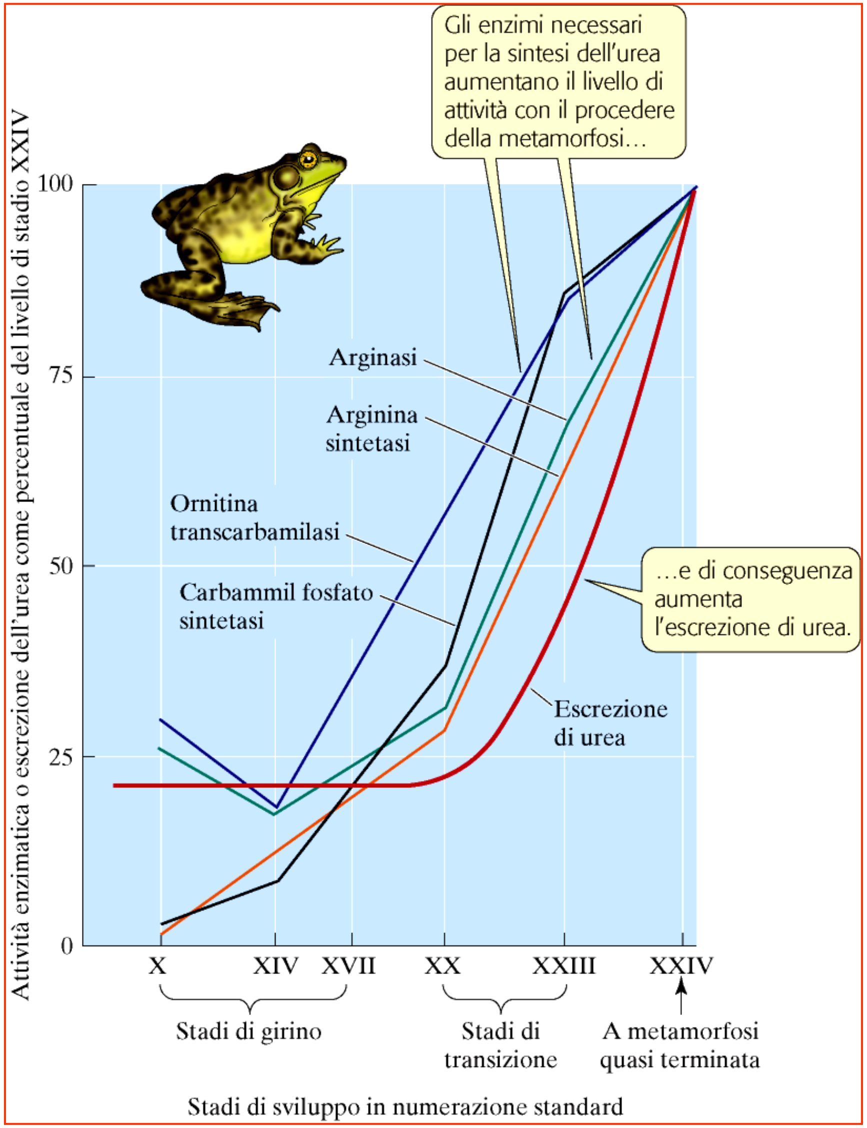
Freshwater fishes conserve salt in their distal tubules and excrete large volumes of dilute urine



Kidney function in amphibians is similar to freshwater fishes

Amphibians conserve water on land by reabsorbing water from the urinary bladder

Escrezione dell'azoto nel girino e nella rana

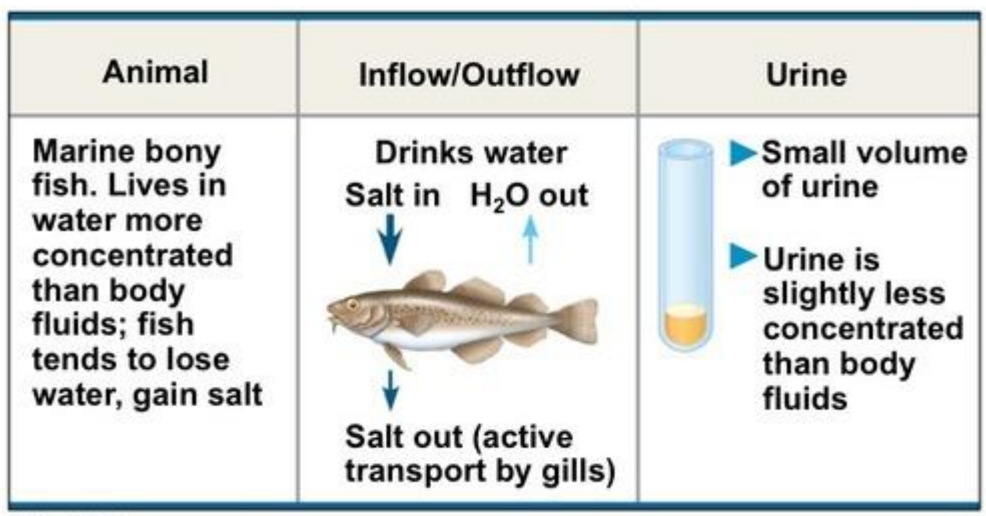


Marine Bony Fishes

Marine bony fishes are hypoosmotic compared with their environment

Their kidneys have small glomeruli and some lack glomeruli entirely

Filtration rates are low, and very little urine is excreted



Animal	Inflow/Outflow	Urine
Marine bony fish. Lives in water more concentrated than body fluids; fish tends to lose water, gain salt	Drinks water Salt in H_2O out Salt out (active transport by gills)	▶ Small volume of urine ▶ Urine is slightly less concentrated than body fluids

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Hormonal circuits link kidney function, water balance, and blood pressure

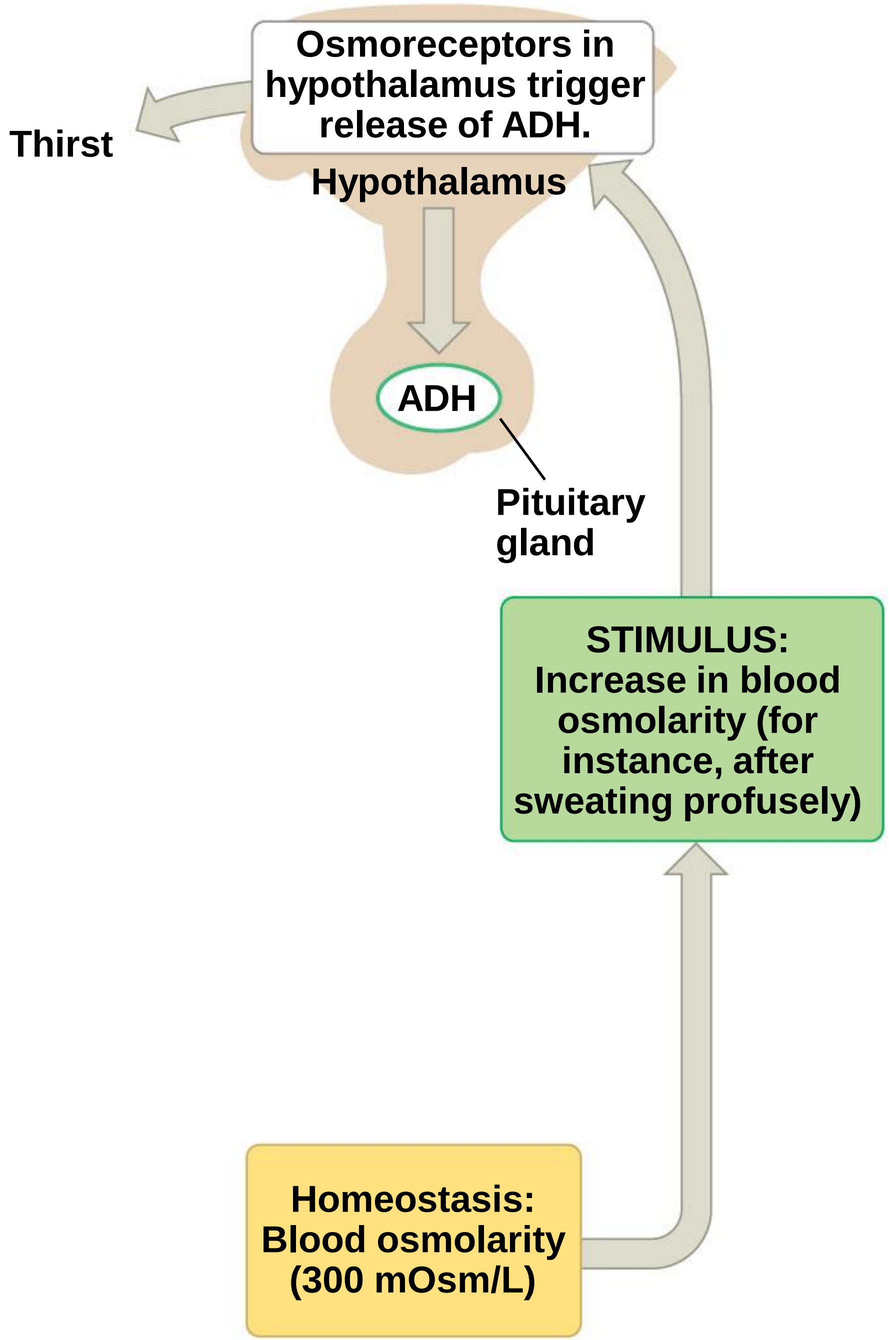
Mammals control the volume and osmolarity of urine
The osmolarity of the urine is regulated by nervous and hormonal control

<u>Antidiuretic hormone (ADH)</u>

Released by the posterior lobe of the pituitary gland, plays a role in water reabsorption.

Makes the collecting duct epithelium more permeable to water.

An increase in osmolarity triggers the release of ADH, which helps to conserve water.



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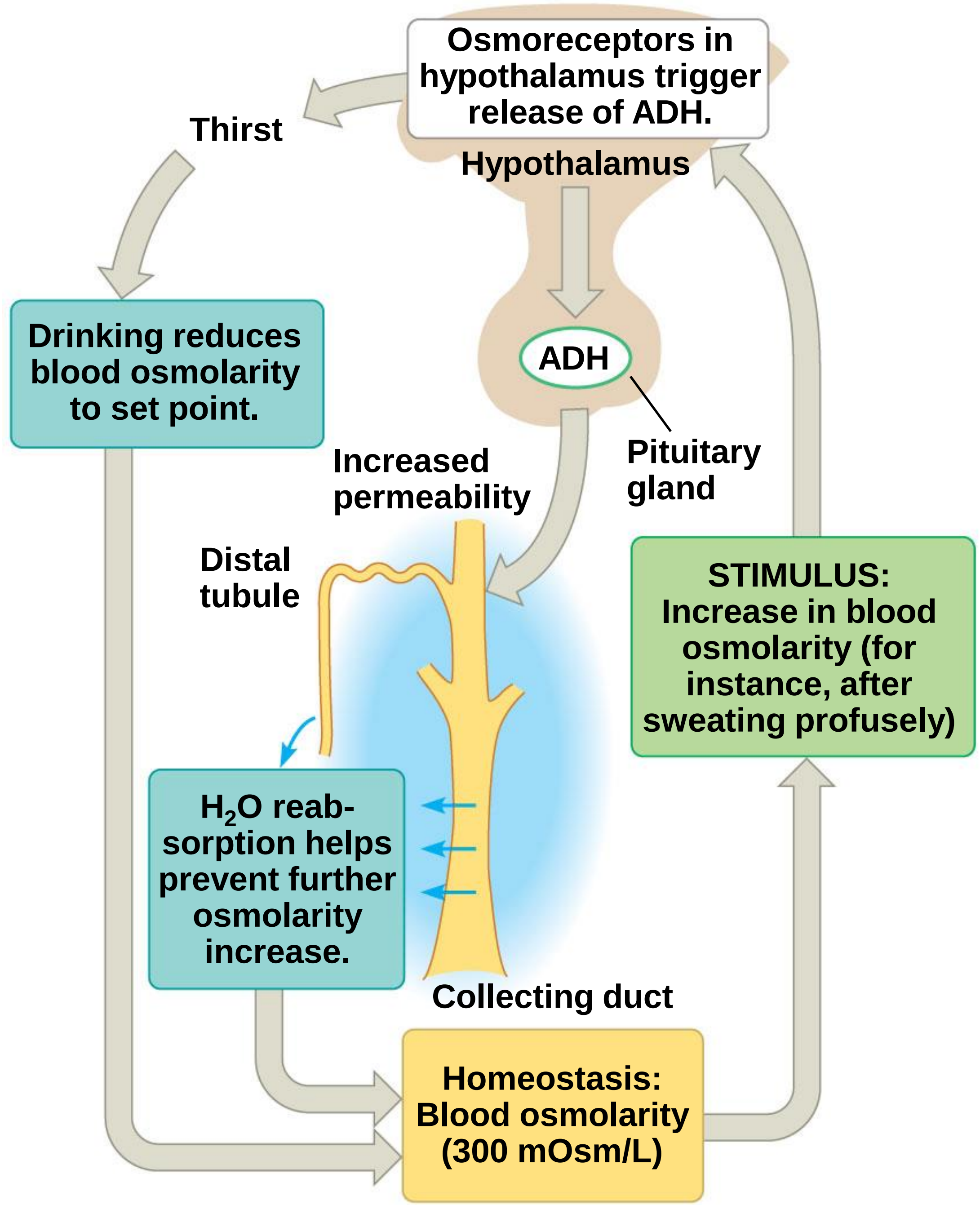

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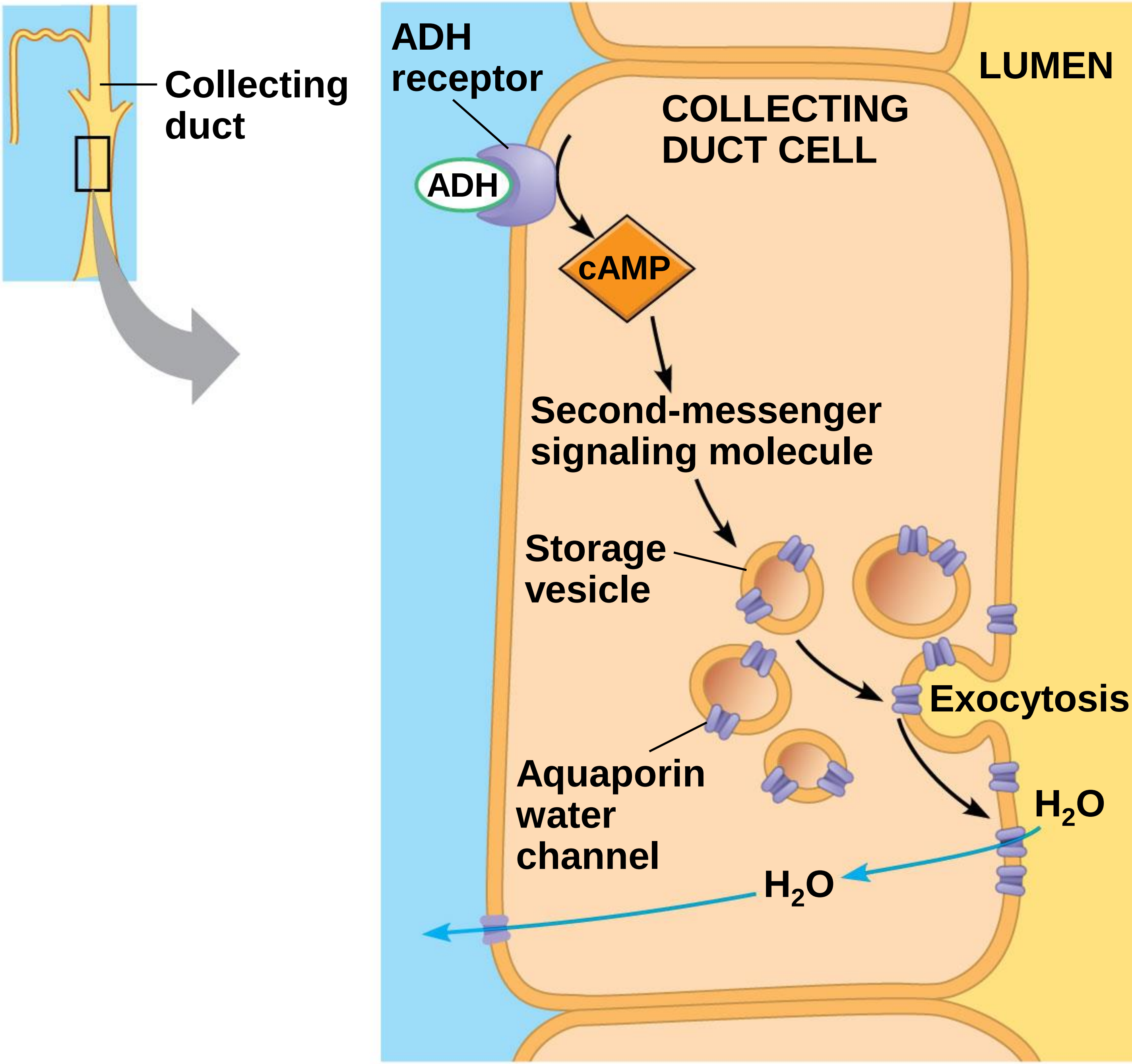

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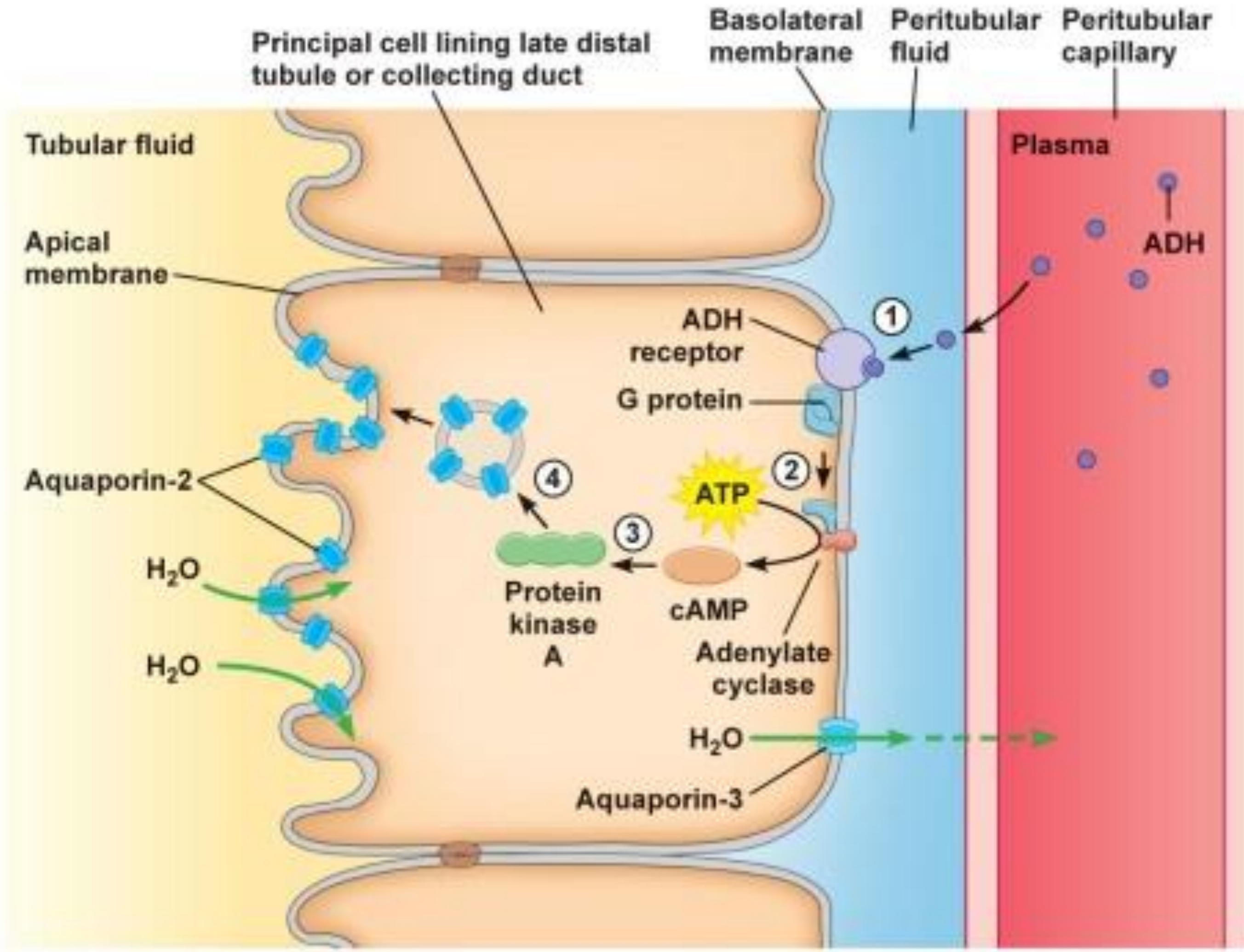
Binding of ADH to receptor molecules leads to a temporary increase in the number of aquaporin proteins in the membrane of collecting duct cells



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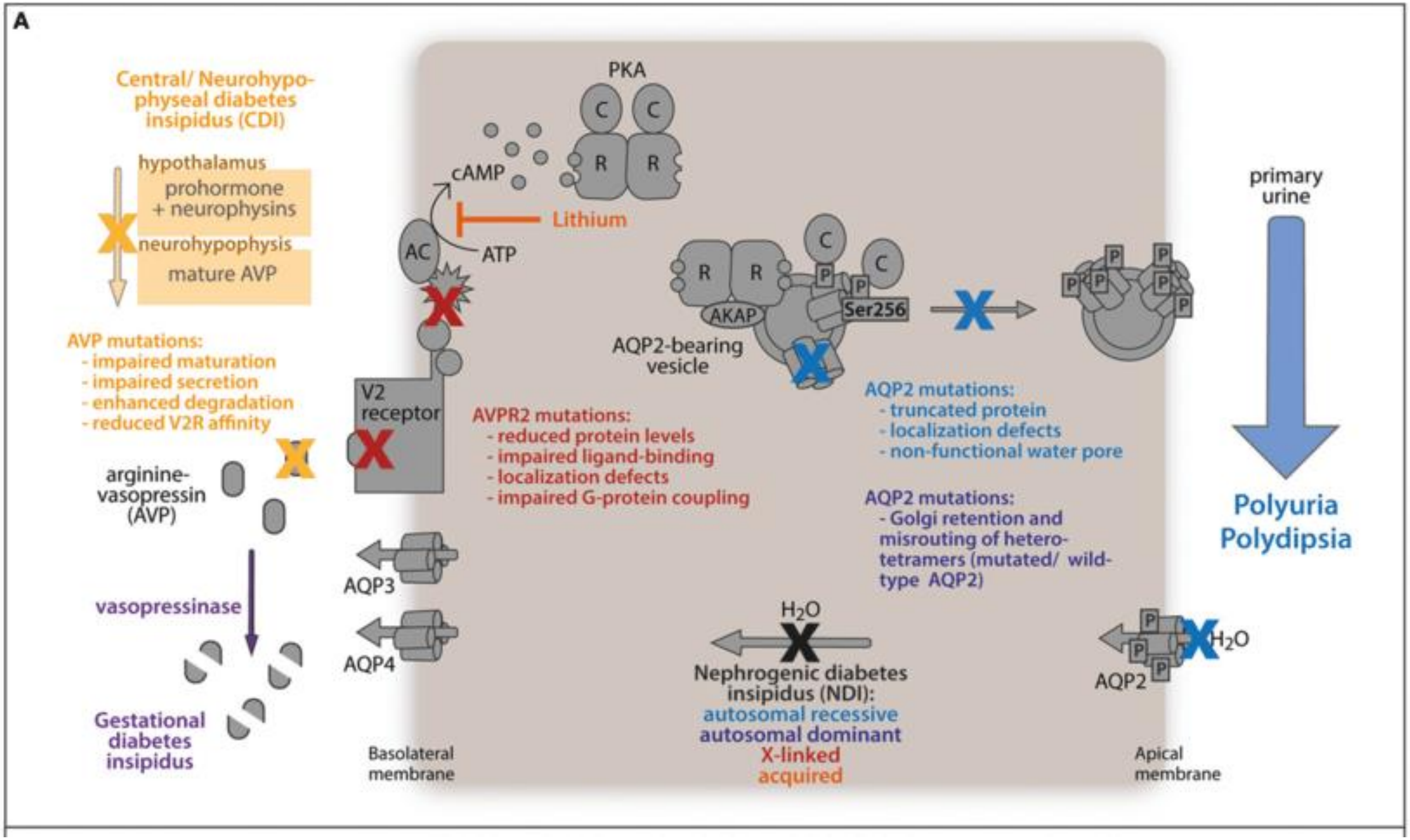
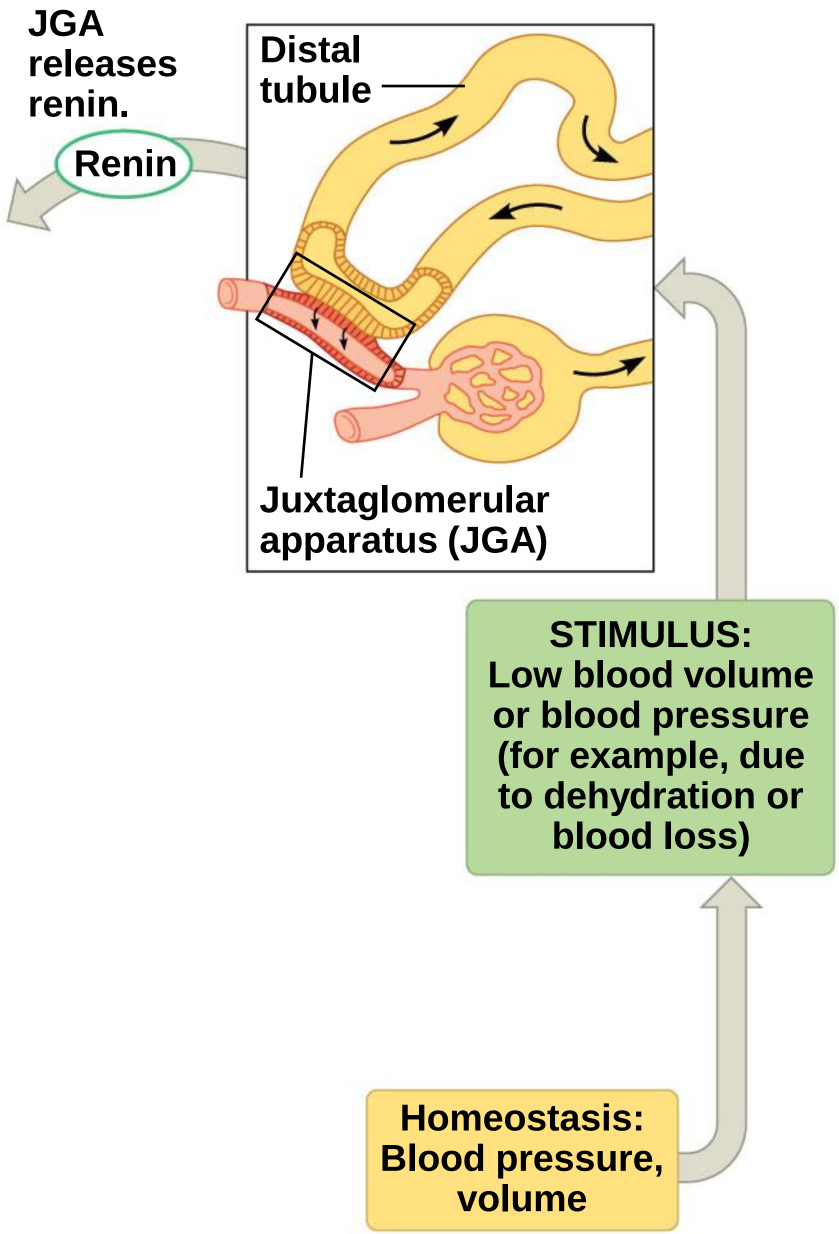
Mutation in ADH production causes severe dehydration and results in diabetes insipidus

Alcohol is a diuretic as it inhibits the release of ADH



The Renin-Angiotensin-Aldosterone System

The renin-angiotensin-aldosterone system (RAAS) is part of a complex feedback circuit that functions in homeostasis.



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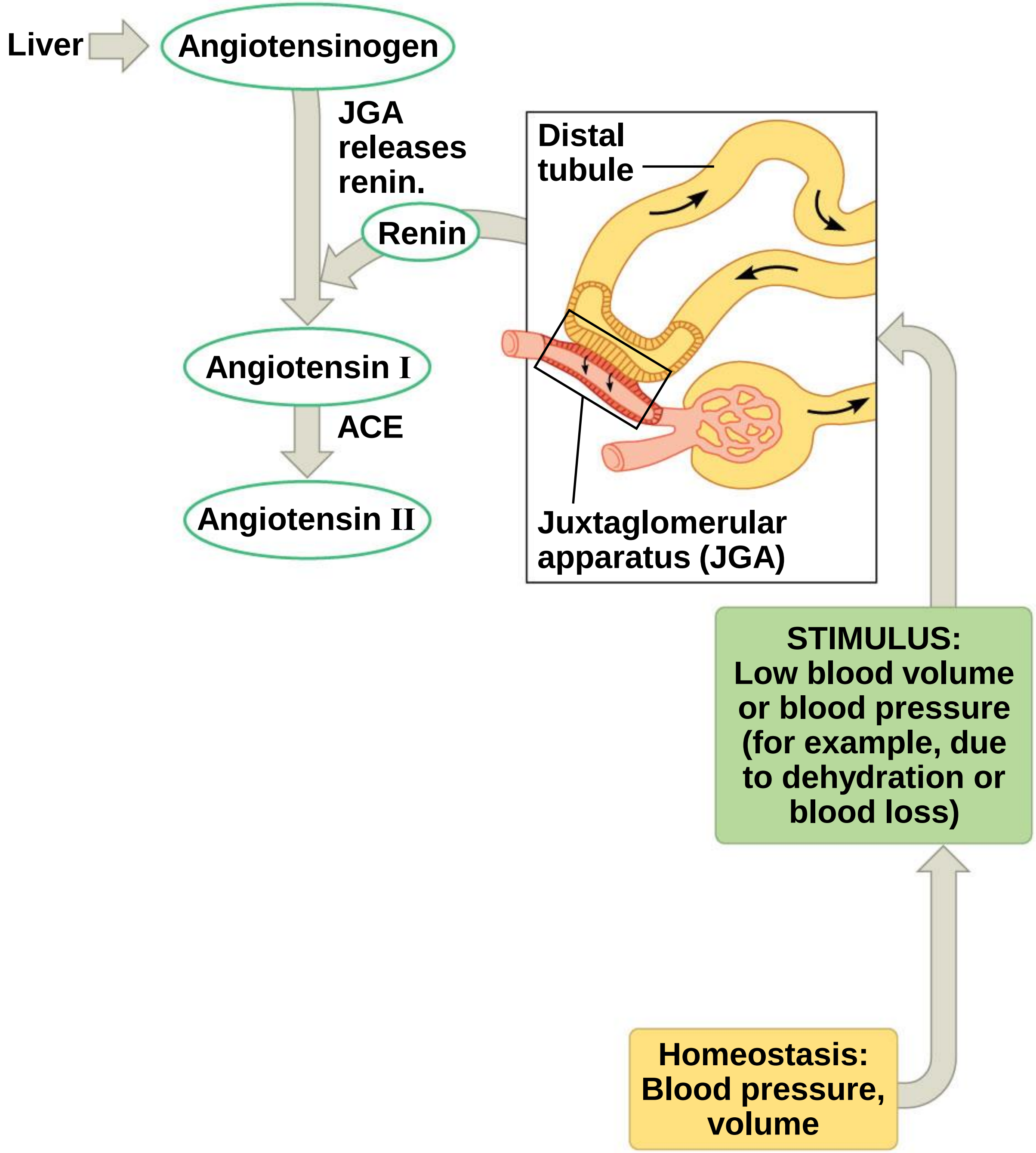

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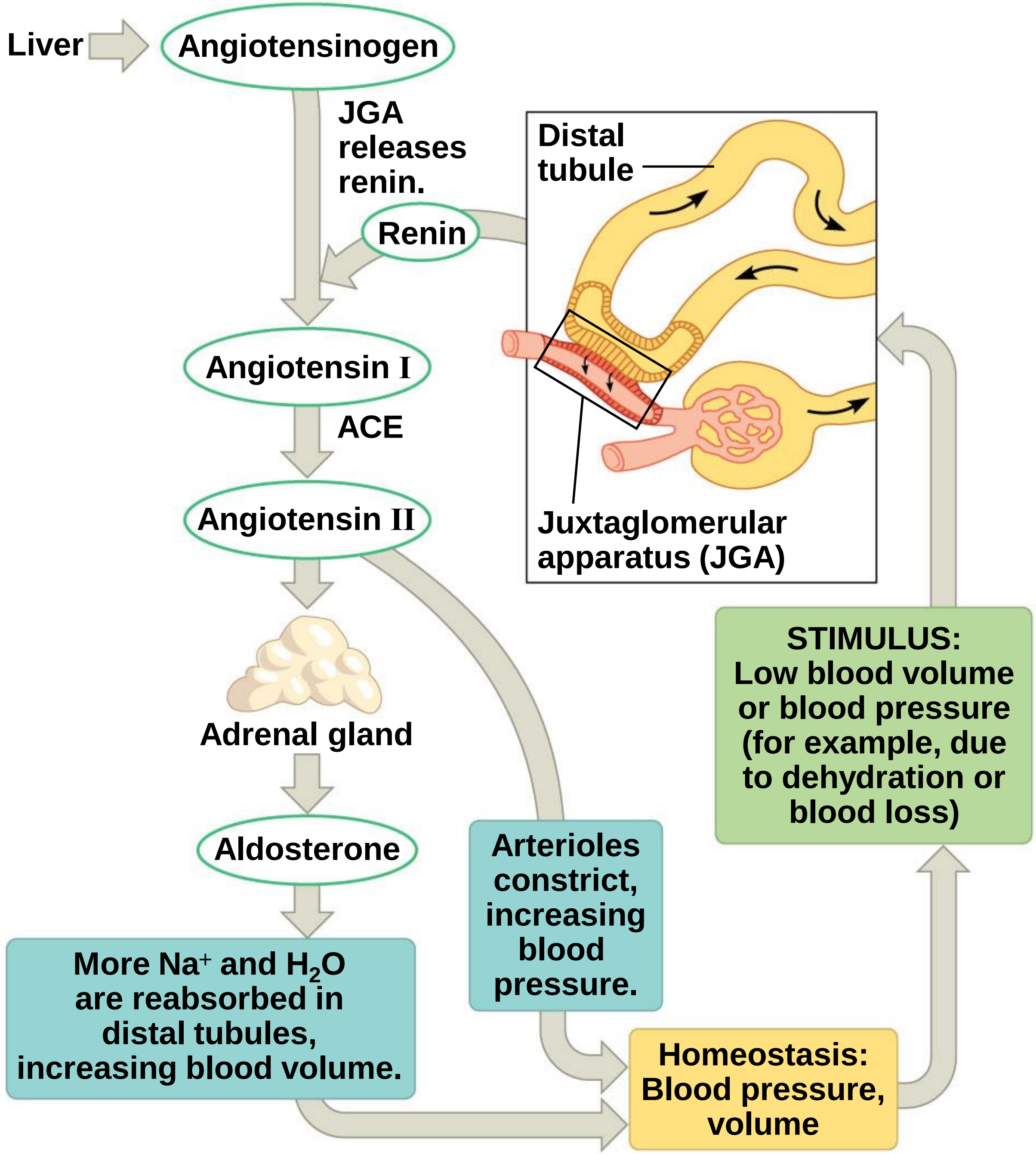

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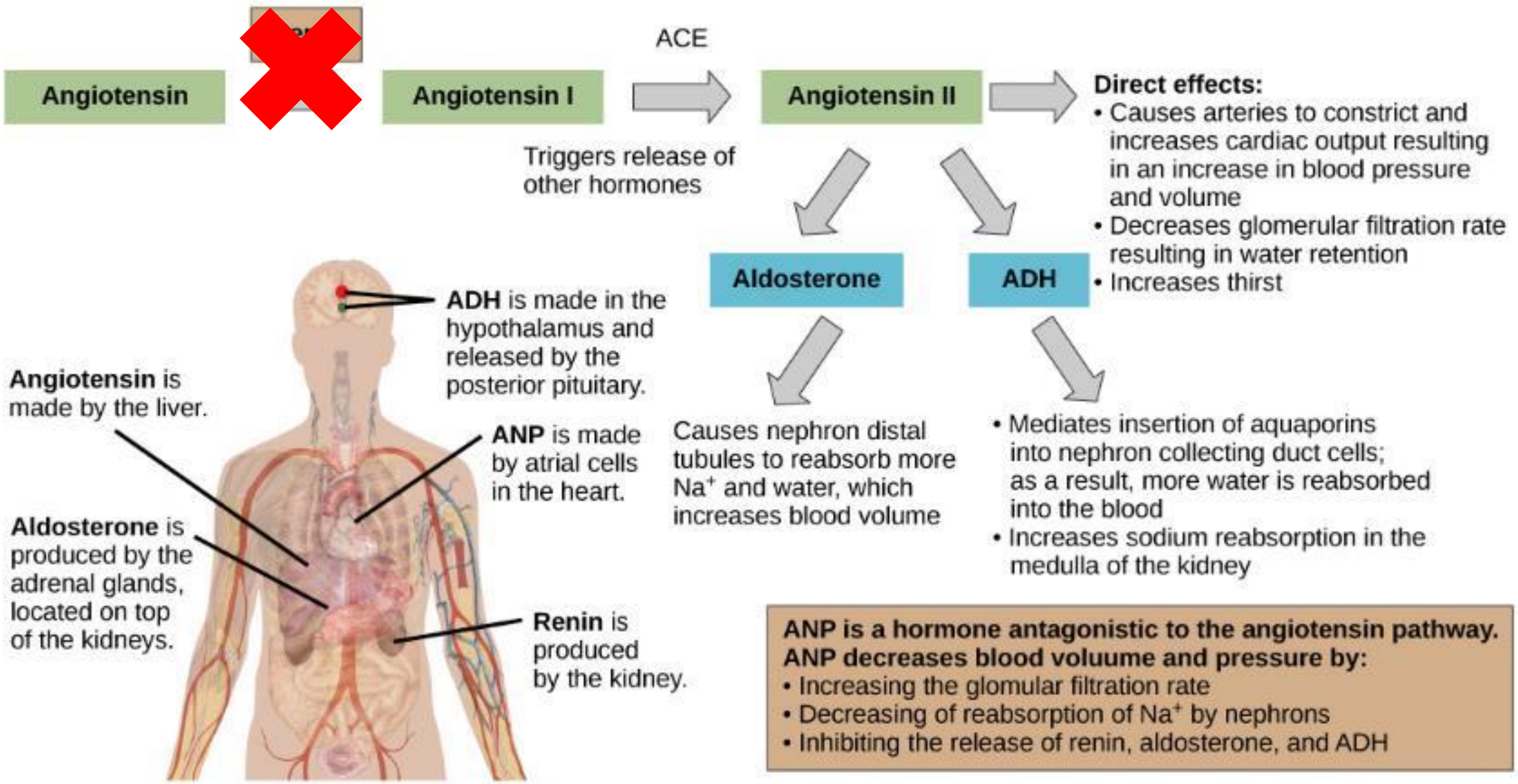
Homeostatic Regulation of the Kidney

ADH and RAAS both increase water reabsorption, but only RAAS will respond to a decrease in blood volume.

Another hormone, **atrial natriuretic peptide** (ANP), opposes the RAAS.

ANP is released in response to an increase in blood volume and pressure and inhibits the release of renin.

The renin-angiotensin-aldosterone system increases blood volume and pressure



Hormones That Affect Osmoregulation

Hormone	Where produced	Function
Epinephrine and Norepinephrine	Adrenal medulla	Can decrease kidney function temporarily by vasoconstriction
Renin	Kidney nephrons	Increases blood pressure by acting on angiotensinogen
Angiotensin	Liver	Angiotensin II affects multiple processes and increases blood pressure
Aldosterone	Adrenal cortex	Prevents loss of sodium and water
Anti-diuretic hormone (vasopressin)	Hypothalamus (stored in the posterior pituitary)	Prevents water loss
Atrial natriuretic peptide	Heart atrium	Decreases blood pressure by acting as a vasodilator and increasing glomerular filtration rate; decreases sodium reabsorption in kidneys

BIOTECHNOLOGY AND BIOSCIENCES SEMINARS

Dipartimento di Biotecnologie e Bioscienze – UNIMIB

Thursday, April 13, 2023, 4:30 p.m., BIOS building, room U3-08 / Webex

From bench to bench side

A scientific path through the author, the editor,
the publisher and the funder perspectives

Laura Galbiati

The Italian Foundation for Cancer Research (AIRC)

Abstract: Alternative careers in science are possible. I will introduce my personal career path through different professional scientific environments, in different countries and from different perspectives. I will talk about my experience in the publishing industry, as an author of research articles, as an editor and business developer with emphasis on the editorial process of review articles and an eye on the business potential of the scientific literature in the pharma industry market. I will talk more extensively about my current position back in Milan at Fondazione AIRC. From the funder perspective, I will give details on our Peer Review process and on the role of the Scientific Officer.

Host: Antonella Ronchi

Gli attestati di partecipazione al seminario sono validi anche per l'acquisizione dei CFU, per informazioni visitare la pagina del seminario

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