Homeostasis
Maintaining relative stable environment for animal cells

The problem!!!
How do animals maintain an ionic and osmotic balance in a wide variety of environments?
Functions of Excretory systems:

1. To adjust the quantity of water and various plasma constituents to be conserved by the body or eliminated in the urine.

2. Responsible for eliminating potentially toxic metabolic waste and foreign compounds from an animal's body.

Definitions

**Osmoregulators:**

Animals that maintain an internal osmolarity different from the medium surrounding them.

**Osmoconformers:**

Animals that maintain an internal osmolarity similar to the osmolarity of the surrounding medium.
The rate of transfer for water and salts from an environment depends on:

- Surface area of animal
- Size of gradient
- Permeability of the surface

Every animal has its own unique water problem!!

- Frog skin is very permeable to water
- Reptiles, birds and many mammals have impermeable skin
- Other mammals perspire and lose water through their skin
- Insects have a waxy cuticle that is impermeable to water.
Every animal has its own unique feeding problem!!

- Most terrestrial vertebrates (especially birds and mammals) produce hyperosmotic urine to eliminate unwanted solutes.
- Reptiles and amphibians have kidneys but can’t produce hyperosmotic urine.
- Fish contain kidneys but also control osmoregulation at gills.
- Insects and spiders have a “kidney-like” system that produces concentrated urine.

Fish problems!

Freshwater fish are hyperosmotic to their environment

- Subject to swelling as water moves into their body
- Subject to continual loss of body salts to the surrounding water

Saltwater fish are hypo-osmotic to their environment

- Subject to tissue shrinking as water moves out of their body

Migratory fish are hyperosmotic to their environment during some periods and hypoosmotic at other times.
Osmoregulation problems for marine reptiles!

Marine reptiles need to drink salt water to get their water requirements.
Osmoregulation problems for marine mammals!

Whales, dolphins and seals don’t drink salt water.

Osmoregulation problems for desert mammals!

Desert rats don’t drink water.
Urine Formation

Glomerular filtration

Tubular reabsorption

Tubular secretion
Layers of the glomerular membrane

Basic renal processes
**Hydrogen ion secretion**

Important in the regulation of acid-base balance in the body

Hydrogen ions can be added to the filtered fluid in the proximal, distal and collecting tubules

The extent of hydrogen secretion depends on the acidity of the body fluids
**Potassium secretion**

Potassium is actively reabsorbed in the proximal tubule.

Potassium is actively secreted in the distal and collecting tubules.
**Renin-angiotension-aldosterone system**

Acts to increase sodium reabsorption in the distal tubule

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**The juxtaglomerular apparatus**
Atrial natriuretic peptide (ANP) opposes the renin-angiotension-aldosterone system

- Inhibits sodium reabsorption
- Inhibits renin secretion by the kidneys
- Increases GFR through dilation of the afferent arterioles
Two factors are responsible for being able to excrete urine at varying concentrations:

The medullary countercurrent system

Vasopressin (ADH; anti-diuretic hormone)
The final vertical osmotic gradient is established and maintained by the ongoing countercurrent multiplication of the long loops of Henle.
Function of vertical osmotic gradient in loop of Henle

Enables the kidneys to produce urine of various concentrations from 100 to 1200 mosm/liter

Medullary countercurrent system

Loops of Henle
Vasa recta
Collecting tubules
Descending limb features:
- Is highly permeable to water
- Does not actively extrude sodium

Ascending limb features:
- Actively transport sodium out of the tubular lumen
- Is impermeable to water

**What’s the purpose of creating a vertical osmotic gradient??????**

The vertical osmotic gradient is used by the collecting ducts to concentrate tubular fluid so that concentrated urine can be excreted.

Because the fluid is hypotonic as it enters the distal tubule, it enables the kidneys to excrete urine more dilute than normal blood fluids.
**Vasopressin**

Acts to increase tubules permeability to water

Produced in the hypothalamus and stored in the posterior pituitary gland

Hypothalamus controls the release of vasopressin from the posterior pituitary into the blood

Vasopressin is released in a negative-feedback fashion
How does vasopressin increase tubule permeability to water????

Binding of vasopressin activates the cAMP second messenger system and increases the number of water channel in the membrane.

Mechanism of action of vasopressin
The final vertical osmotic gradient is established and maintained by the ongoing countercurrent multiplication of the long loops of Henle.