# 32.3

## OSMOREGULATION

- the processes by which animals control SOLUTE CONCENTRATIONS in the INTERSTITIAL FLUID & balance WATER LOSS and WATER GAIN
  - i.e. SODIUM, CALCIUM

**PROBLEM** → the break down of proteins and nucleic acids [NITROGENOUS COMPOUNDS] released AMMONIA = TOXIC !!

↓

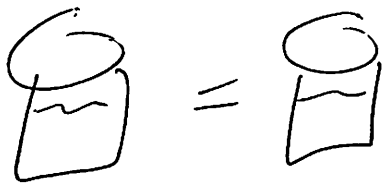
## EXCRETION

→ the process that RIDS the body of nitrogenous waste products.

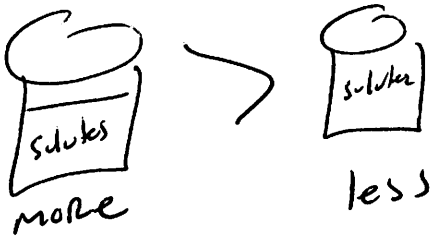
EXCRETION & OSMOREGULATION are linked

## OSMOLARITY

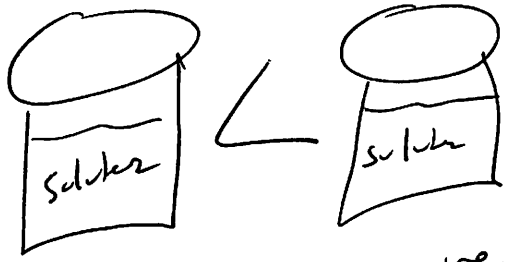
- osmotic pressure
- TOTAL SOLUTE CONCENTRATION expressed as MOLARITY
  - ↳ milli Osmoles per liter [mOsm/L]



Iso-osmotic




the one with more solutes is Hyper-osmotic




the one with less solute [more DILUTE] is Hypo-osmotic

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Osmoconformer — marine animals
— iso-osmotic with surrounding)

Osmoregulator — control internal osmolarity independent of the environment.

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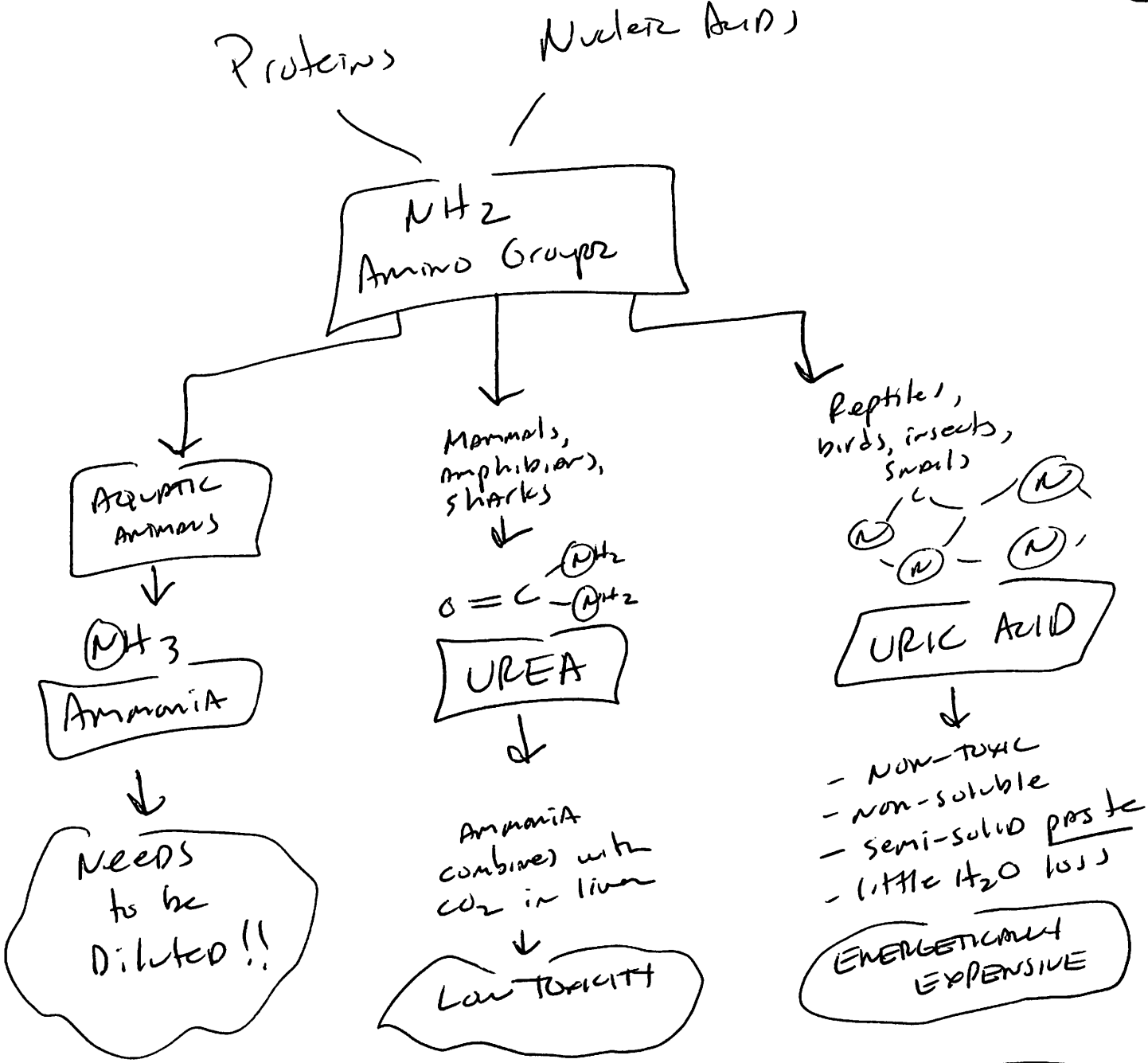
$NH_3$ (Ammonia) when ionized is
$NH_4^+$ (ammonium) which Disrupts
OXIDATIVE Phosphorylation




## Transport Epithelia

-specialized epithelial cells – in layers – to move solutes [under control + in specific directions] in order to solve OSMOREGULATION and METABOLIC WASTE DISPOSAL

URINE – produced by A series of steps:

(1) Filtration
(2) Re absorption
(3) Secretion
(4) Excretion

- Basic process with lots of variations
- selectively permeable membrane of the transport epithelium
- powered by blood pressure

Invertebrate Systems

Planarians – "flame bulbs"
– protonephridia

Insects – Malpighian tubules is the transport epithelium
– solid waste, conserve water
– adaptations to life on land.

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Excretory Organs (humans)

(1) Pair of KIDNEYS (10 cm in length)
(2) Ureter – duct – 2 of them
(3) URINARY BLADDER – storage
(4) URETHRA – tube to the outside controlled by sphincter muscles.

# KIDNEY STRUCTURE

OUTSIDE - RENAL CORTEX
INNER - RENAL MEDULLA

renal artery - supplies blood
renal vein - drains blood

↓

contain tightly-packed excretory tubules and associated blood vessels

→ the inner renal pelvis collects urine and passes it to bladder via ureter

## ✡ Nephrons

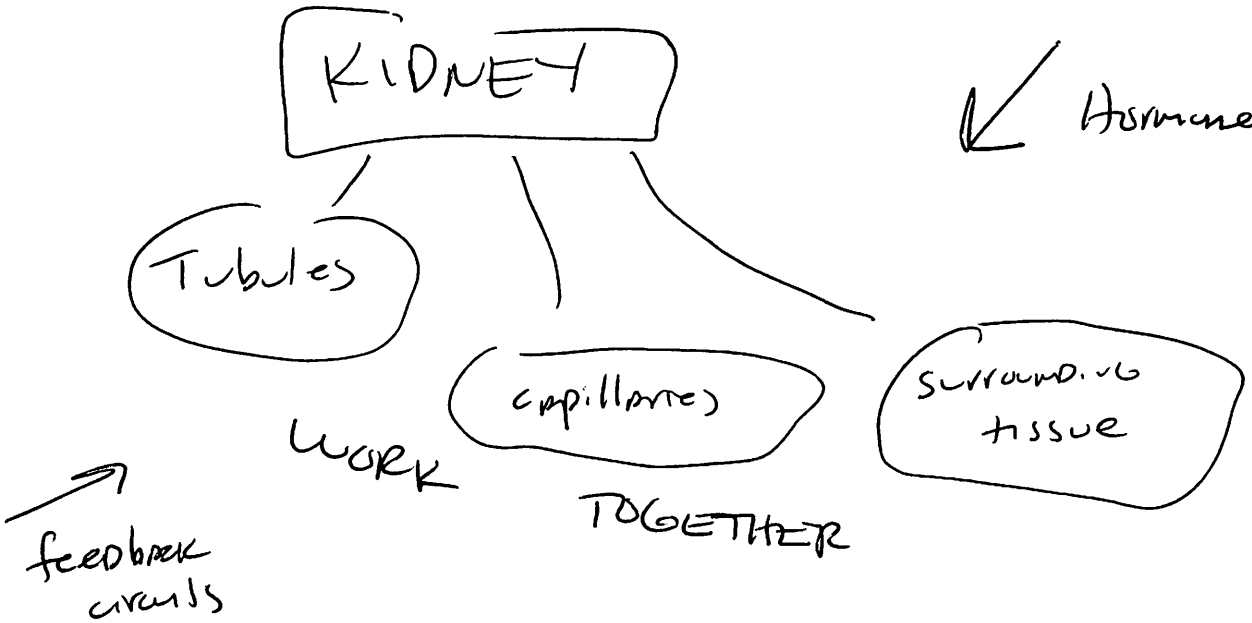
- the functional unit of the vertebrate KIDNEY

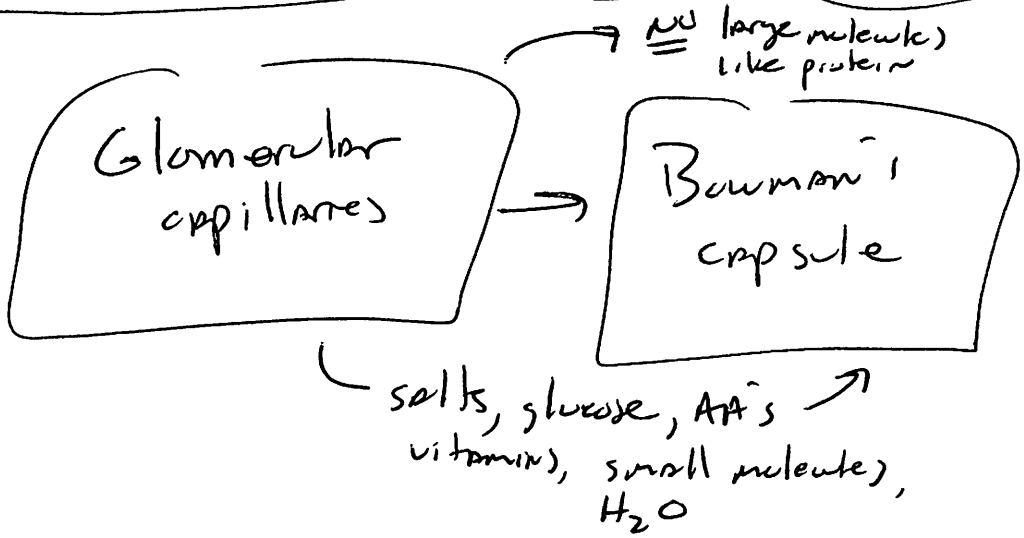
(1) CORTICAL NEPHRONS - in cortex

(2) JUXTAMEDULLARY Nephrons - extend into medulla

## Nephron Organization

(1) Glomerulus
(2) Bowman's Capsule
(3) Distal Tubule
(4) Proximal Tubule
(5) Loop of Henle — descending limb, ascending limb ) VASA RECTA
(6) Afferent arteriole
(7) Efferent arteriole




## Descending Loop of Henle

$H_2O$ moves out of the tubule by osmosis

⇒ numerous AQUAPORINS but few channels for NaCl

Ascending Loop of Henle
- "thin" and "thick" segments
↳ no AQUAPORINS, SALT moves OUT, FILTRATE becomes more DILUTE

Distal Tubule
- regulates $K^+$ and NaCl concentrations
- regulates pH through secretion of $H^+$ and reabsorption of $HCO_3^-$

→ 1600 L blood goes through KIDNEYS each DAY
↳ 180 L filtrate (99% $H_2O$)
↳ 1.5 L urine to bladder

Mammalian KIDNEY, Water Conservation Ability is A Terrestrial ADAPTATION!

# KIDNEY ADAPTATIONS

(1) - Mice, kangaroo rats, desert mammals
↳ long loops of Henle
↳ highly concentrated urine

(2) Birds – uric acid excretion
conserves water

(3) Mammals – volume & osmolarity regulated
according to circumstance

(4) Bats – large volume urine ⟷ small hyperosmotic amts

## MAMMALIAN REGULATION

**ADH** – Antidiuretic hormone (AKA VASOPRESSIN)

→ osmoreceptor cells in Hypothalamus
monitor blood & regulate release of ADH
from posterior pituitary

→ ADH increases the # of
AQUAPORINS !!
$H_2O$ in & out

# RAAS

- RENIN - ANGIOTENSIN - ALDOSTERONE system

⇒ involves the JGA (juxtaglomerular apparatus) which supplies blood to the glomerulus

Blood pressure DROPS (i.e. because of dehydration)

⇓

JGA releases RENIN

⇓

RENIN cleaves ANGIOTENSINOGEN

⇓

yields ANGIOTENSIN II

⇓ AS A hormone

triggers VASOCONSTRICTION

⇓

increases B.P.

⇓

decreases blood flow to capillaries

⇓

stimulates release of ALDOSTERONE

↓

water & $Na^+$ reabsorbed

↓

blood pressure increases

ADH & RAAS work together to maintain homeostasis