

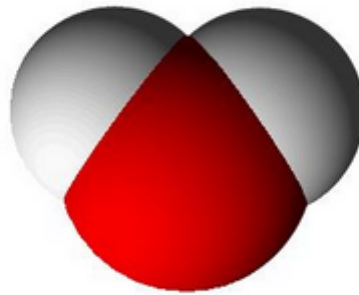


University of
Zurich^{UZH}

Institute of Animal Nutrition



Water – the source of life



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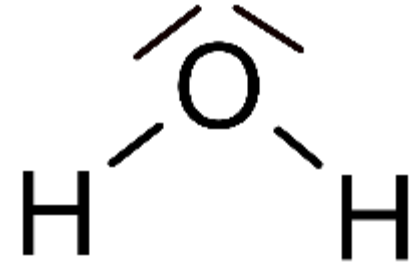




Introduction

Water...

- H_2O
- Major constituent of the body
 - most animals cannot produce enough water by metabolism
 - OR obtain enough water by food ingestion
 - separate drinking water essential (on pasture, temperature, infections)
- Main constituent of cells → vital for life → tightly regulated

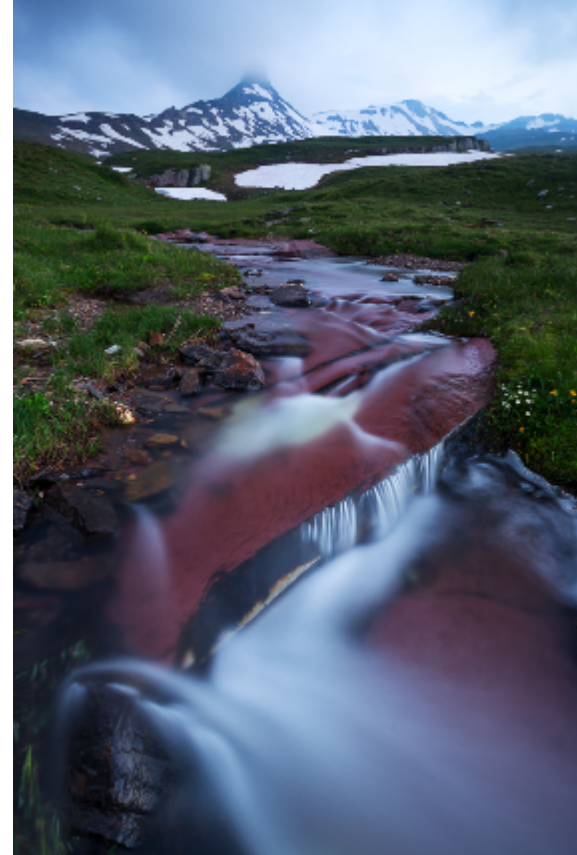




Sources of water

- Drinking water
- Water content in feed
- Metabolic water from oxidation of macronutrients

Per 1 gram of glucose 0.6 ml,
Per 1 gram of albumin 0.37 ml,
Per 1 gram of palmitic acid 1.12 ml

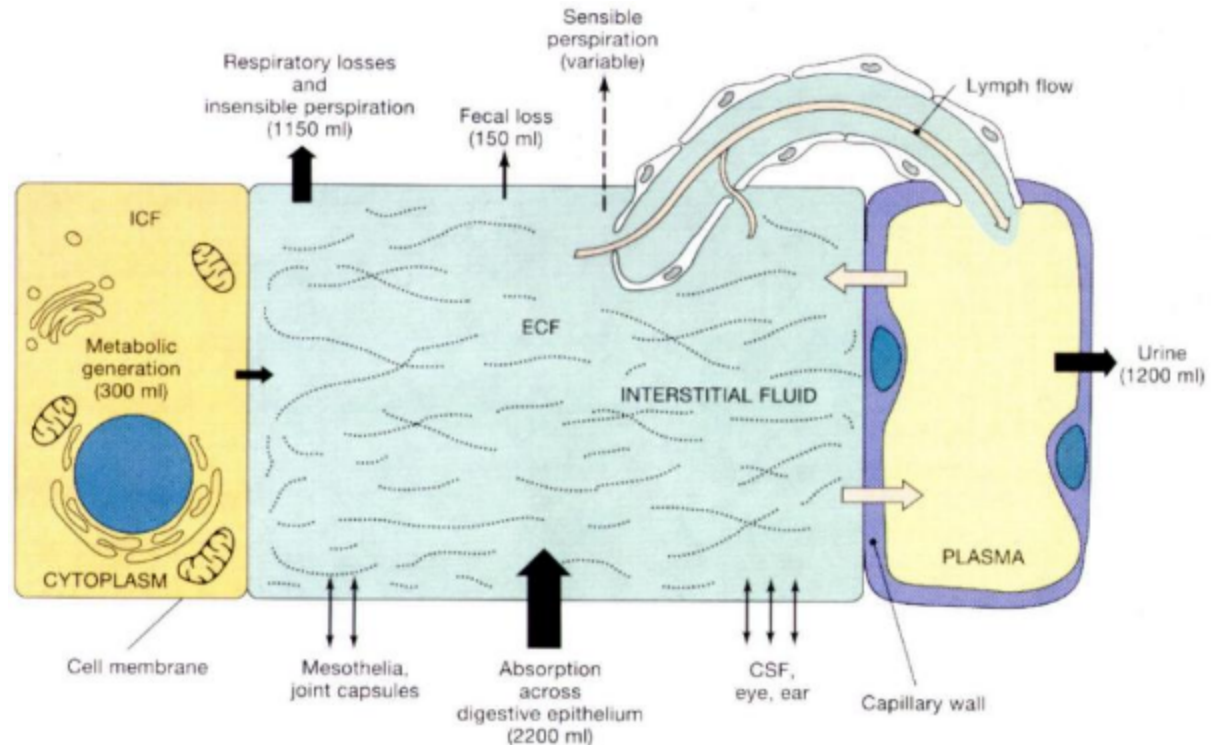


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Routes of water losses

- Kidneys
- Skin (evaporation of 1g of water loses 2.2 kJ)
- Respiratory tract
- Digestive system





Special animal adaptations to water

- Merriam's kangaroo rat (*Dipodomys merriami*):
 - kidneys produce highly concentrated urine
 - nasal heat exchanger
(↓ pulmonary water loss)
 - production of very dry feces
 - low cutaneous water loss
 - can survive on diet of air-dried seeds with no drinking water
- Marine mammals:
 - sea water drinking in otariids (eared seals) dictated by environmental temperature & fasting (thermal stress)
 - sea otters only marine mammals reported actively to drink sea water

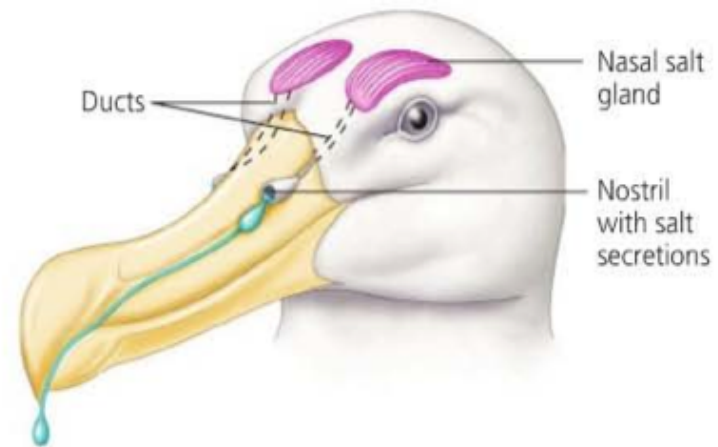




Special animal adaptations to water

Birds, reptiles:

- excrete uric acid, less water necessary for dilution
- elasmobranchs, seabirds, some reptiles have salt gland
- organ for excreting excess salts
- allow marine vertebrates to drink seawater
- active transport via sodium-potassium pump moves salt from blood into the gland, where it is excreted as a concentrated solution.





Special animal adaptations to water

Fish:

Marine Fish:

- Water leaving body through its skin and gills.
- To keep from becoming dehydrated, drinks large amounts
- produces a small amount of concentrated urine.
- Gills are adapted to secrete salt.

Freshwater Fish:

- The tissues are saltier than its surrounding environment.
- Water continually entering the body of a freshwater fish
- Freshwater fishes do not drink water, and they produce large amounts of dilute urine





Special animal adaptations to water

Figure 44.3a

(a) Osmoregulation in a marine fish

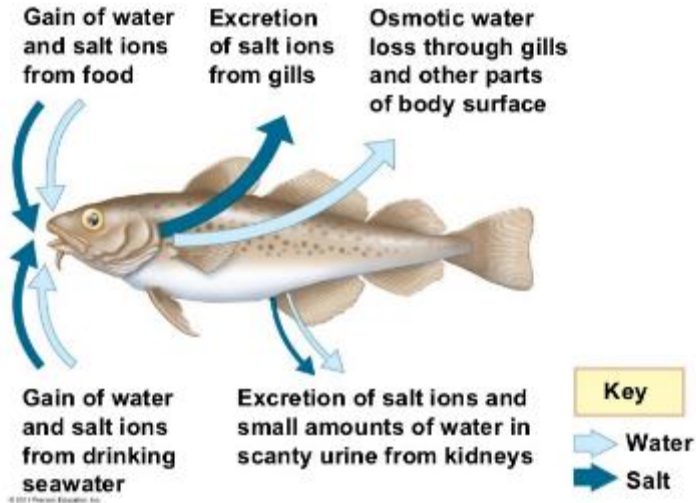
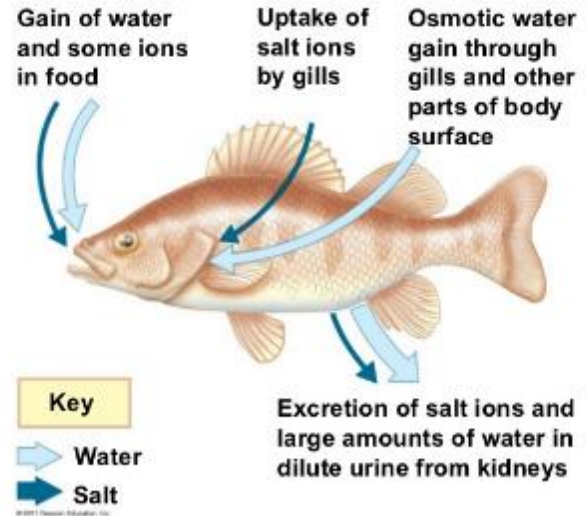


Figure 44.3b

(b) Osmoregulation in a freshwater fish





Regulations / Laws

REGULATION (EC) No 178/2002

Article 3, other definitions:

Feed' (or 'feedingstuff') means any substance or product, including additives, whether processed, partially processed or unprocessed, intended to be used for oral feeding to animals;

→ Drinking water covered by the term "feed" or "feedingstuff"



Regulations / Laws

REGULATION (EC) No 1831/2003

ANNEX II

REQUIREMENTS FOR FEED BUSINESSES OTHER THAN AT THE LEVEL OF PRIMARY PRODUCTION OF FEED

6. Water used in feed manufacture shall be of suitable quality for animals; the conduits for water shall be of an inert nature.





Regulations / Laws

REGULATION (EC) No 183/2005

ANNEX III

GOOD ANIMAL FEEDING PRACTICE: FEED AND WATER

Water for drinking shall be of appropriate quality for the animals being produced.

Feeding and watering equipment must be designed, constructed and placed in such a way that contamination of feed and water is minimised. Watering systems shall be cleaned and maintained regularly, where possible





Regulations / Laws

REGULATION (EC) No 767/2009:

Article 3: Definitions

1. For the purposes of this Regulation, the following definitions shall apply:
 - (a) the definitions of 'feed', 'feed business', and 'placing on the market' as laid down in Regulation (EC) No 178/2002;





Roles of water

- Main constituent of cells, tissues and organs
- Building material → water needs higher during growth period
- Solvent
- Involved in all hydrolytic reactions
- Reaction medium and reactant
- Carrier for nutrients and waste products
- Maintains vascular volume
- Thermoregulation (large heat capacity)
- Lubricant (joints, GIT) and shock absorber





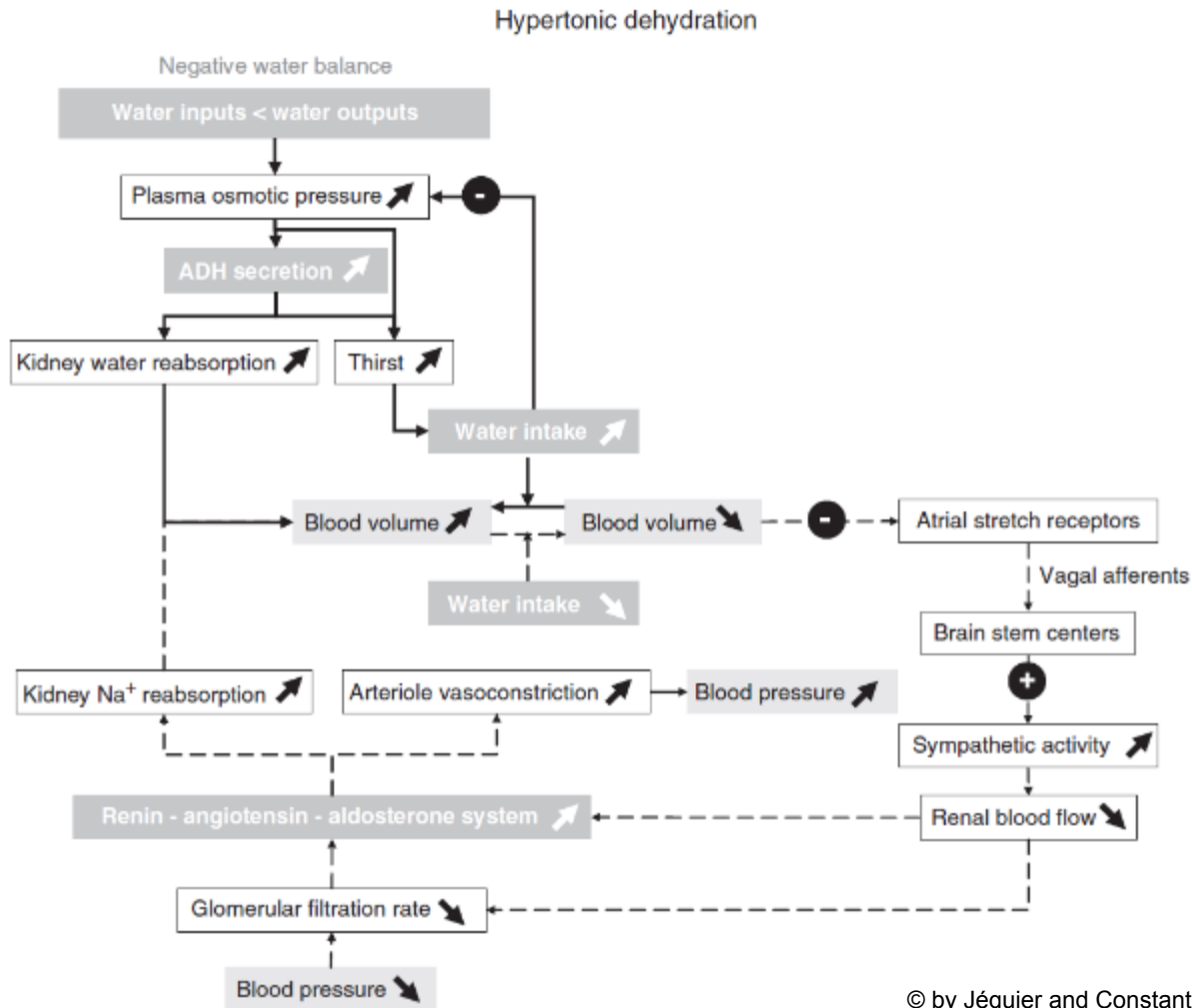
Problems with water restriction

- Reduced feed intake, loss of performance
- Concentration of urine and risk of urine concrement formation
- Retention of urinary excreted substances (Urea, Na, Mg, etc.)
- Intoxication, hemoconcentration
- Hyperthermia
- Reduced consciousness
- Weakness, hypotonia of ocular globes, tachycardia





Regulation of water



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Types of dehydration

- Isotonic dehydration, net salt loss and net water loss equal
 - salt may be lost isotonically from GI-Tract (after profuse diarrhoea) → only extracellular fluid is reduced
 - isotonic salt solutions
- Hypertonic dehydration, loss of water in excess of salt
 - inadequate water intake and excessive water loss (osmotic diuresis or diabetes insipidus)
 - vomiting → almost pure water loss → loss of hydrochloric acid replaced by NaHCO_3
- Hypotonic dehydration, loss of salt in excess of water
 - when losses of gastrointestinal fluids are replaced by water or by solution that contains less Na and K
 - Water moves intracellular → cell volume increase





Can you drink to much water?

When more water enters the body than it can process

- depletes sodium levels in extracellular fluid
- dilutes bodily fluids
- cells start filling with water and swell
- Edema in cells of nervous system
- EC swell and burst → hemolysis and hemoglobinuria



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Questions?



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References

Popkin, Barry M., Kristen E. D'Anci, and Irwin H. Rosenberg. "Water, Hydration and Health." *Nutrition reviews* 68.8 (2010): 439–458. *PMC*. Web. 22 Aug. 2017.

Jéquier, E., & Constant, F. (2010). Water as an essential nutrient: the physiological basis of hydration. *European journal of clinical nutrition*, 64(2), 115.

