Recovery of Osmolarity in the Extracellular Fluid and the Brain During an Acute Hypo-Osmotic Challenge

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I. Introduction

A. Homeostasis:

- pH
- Body Temperature
- Concentration of Nutrients
- Waste Products
- WATER!!

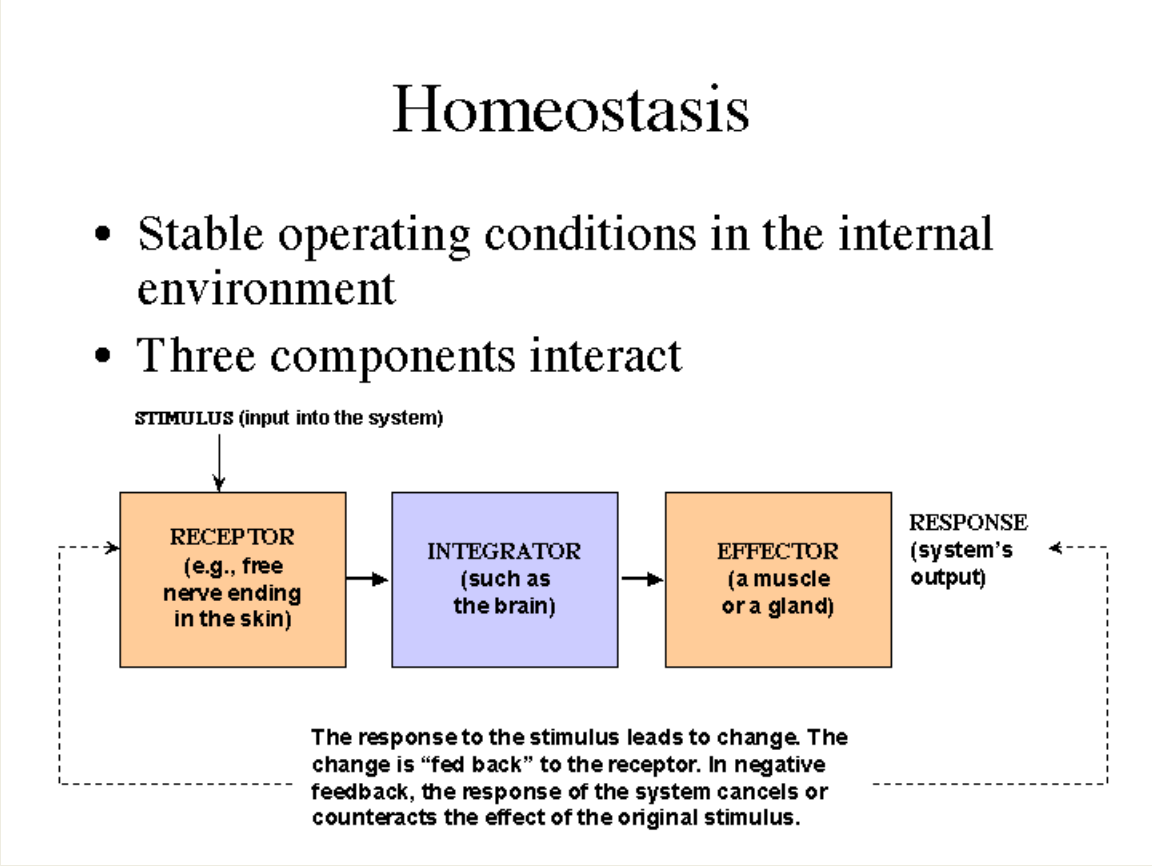


Image source: http://trc.ucdavis.edu/biosci10v/bis10v/week10/homeostasis.gif

How Do We Control the Amount of Water in Our Body?

- B. Osmoregulation:

Osmoregulation is a physiological processes that organisms use to maintain water balance

1. Compensate for water loss
2. Avoid excess water gain
3. Maintain the proper osmotic concentration (osmolarity) of the body fluids.

There were two main systems I wanted to concentrate *on*...

Extracellular Fluid

- All of the body fluid outside of the cell
- It is found in blood, lymph, body cavities lined with serous membrane, in the cavities and channels of the brain and spinal cord, and in muscular and other body tissues.

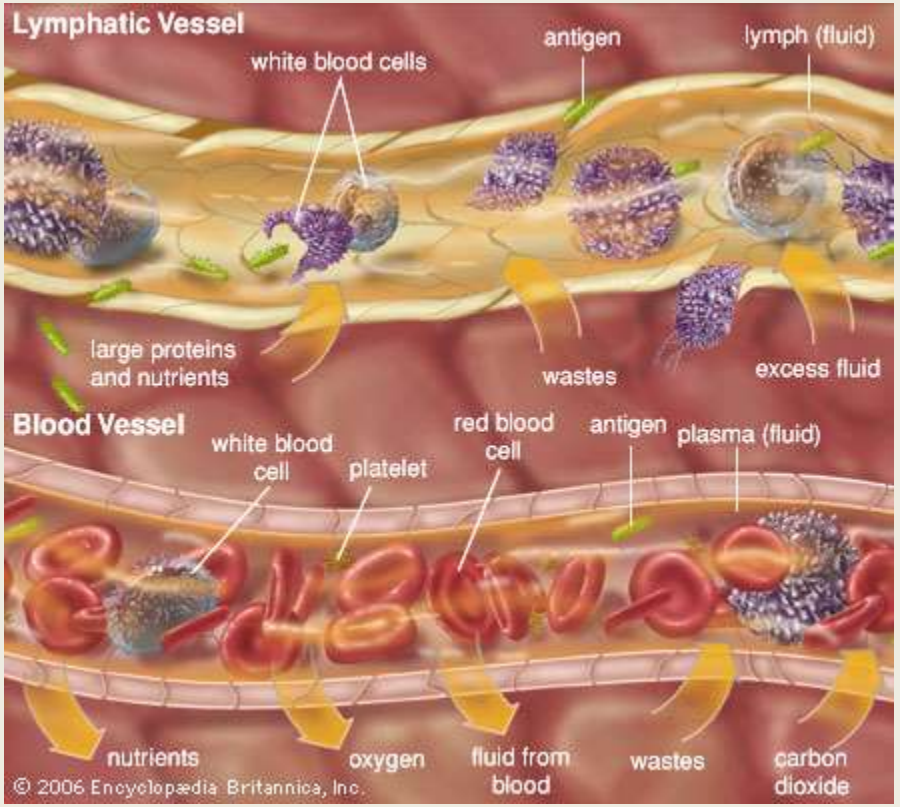


Image Source: "extracellular fluid." Encyclopædia Britannica. Encyclopædia Britannica Online. Encyclopædia Britannica.

The Blood Brain Barrier

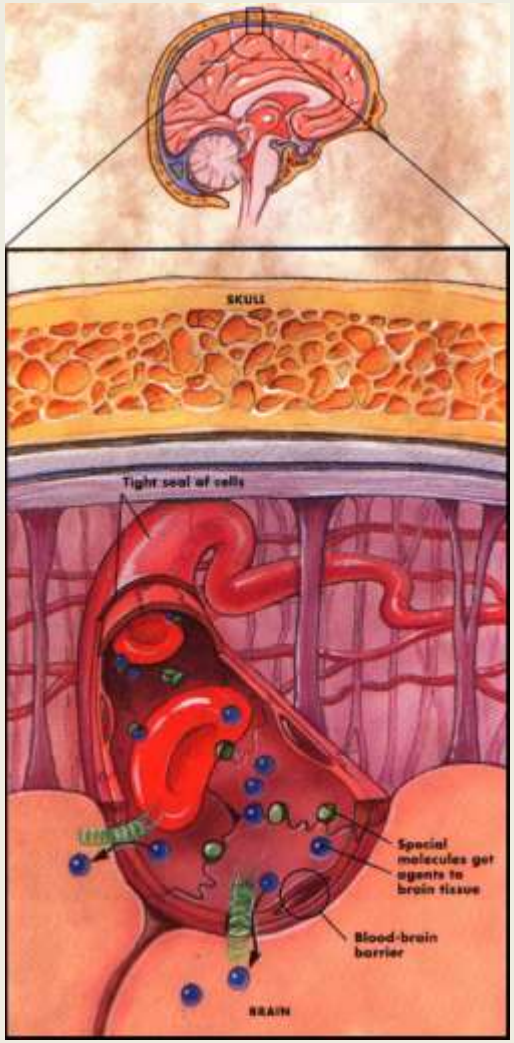


Image Source: addiandcassie.com

- The blood–brain barrier (BBB) is a separation of circulating blood and the brain extracellular fluid in the central nervous system.
- Occurs along all capillaries and consists of tight junctions around the capillaries that do not exist in normal circulation.
- Endothelial cells restrict the diffusion of microscopic objects and large or hydrophilic molecules into the cerebrospinal fluid
- Allows the diffusion of small hydrophobic molecules (O_2, hormones, CO_2).

II. Purpose

Study the differences in osmoregulation between the BBB and ECF during an acute hypo-osmotic challenge in:

1. Mice exposed to 20% of their body weight in water vs. mice exposed to 10% of their body weight in water.
2. Young mice vs. adult mice

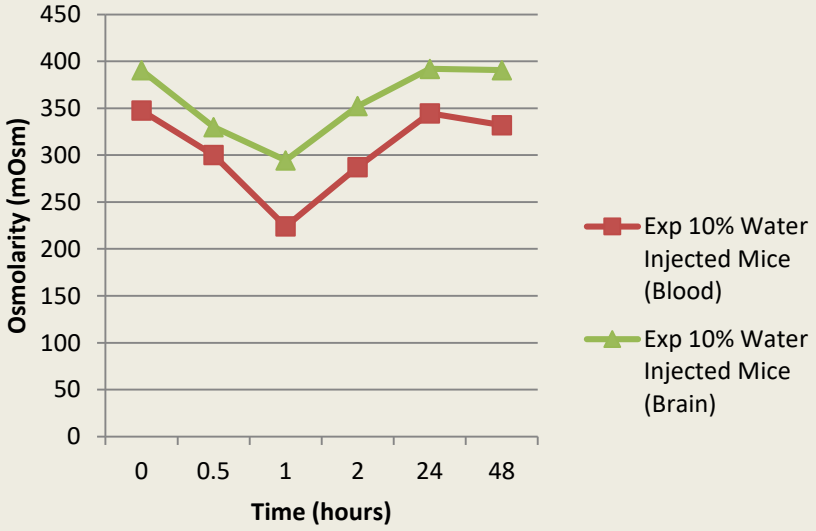
III. Methods

- Started with a baseline (control) samples using mice of various ages and weight.
- Inject mice with water based on their body weight and experiment being performed.
- At various time points, sacrifice mice and gather a blood sample and a brain sample.
- Place those samples in the Osmometer for osmolarity readings and collect data.
- Plot data based on experiment.

IV. Data/Results

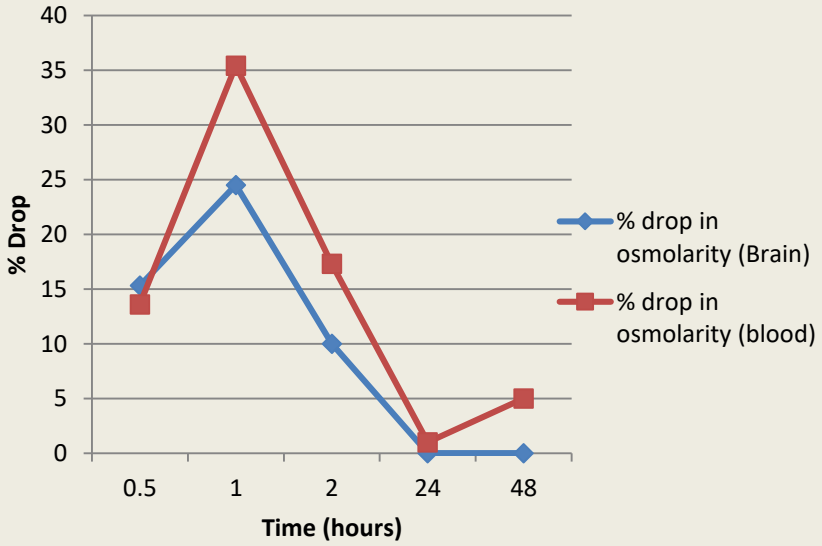
Blood Brain Barrier

Blood Osmolarity vs. Brain with 10% Water Injection



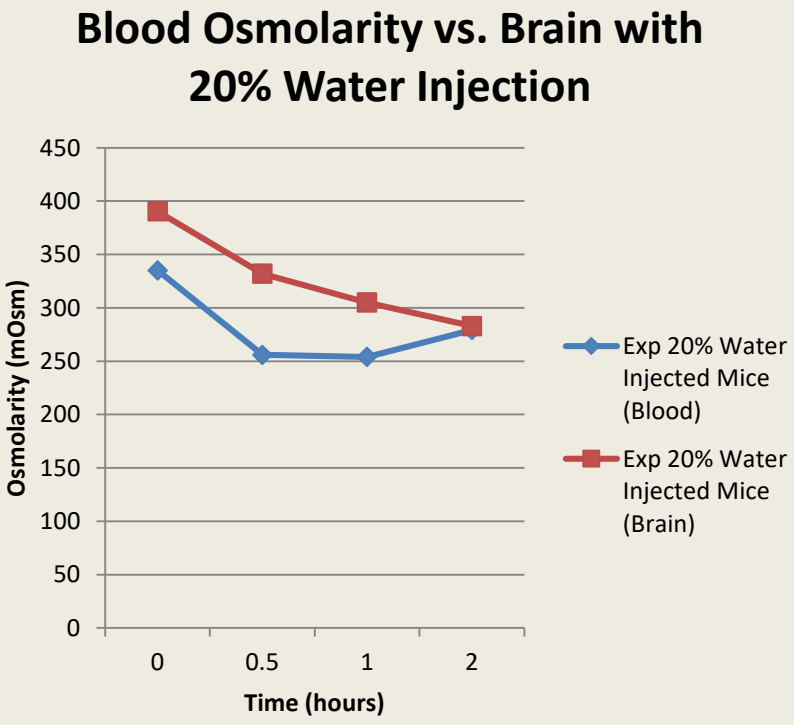
Extracellular Fluid

% Drop in Blood Osmolarity vs. Brain with 10% Water Injection

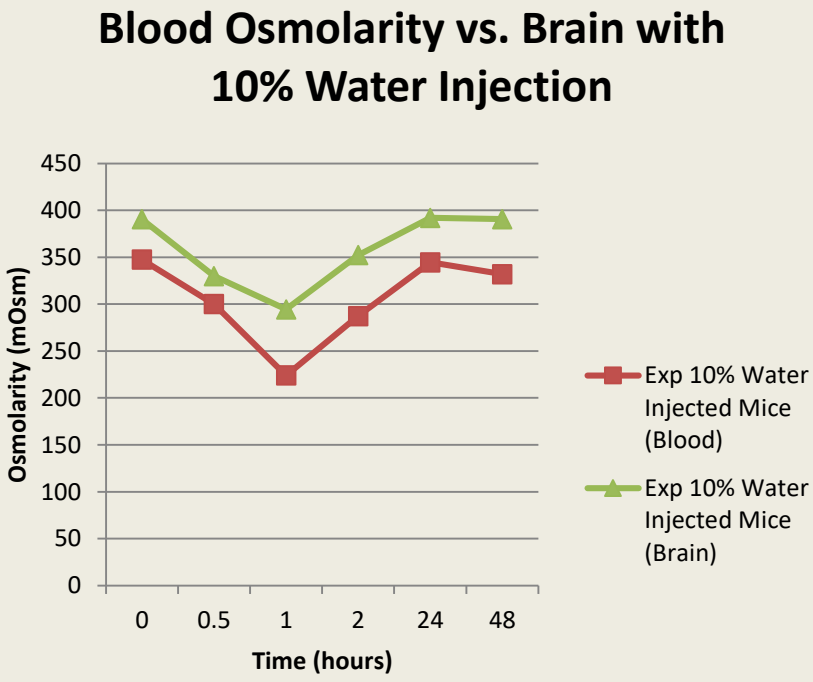


Data/Results

20% Water Injection

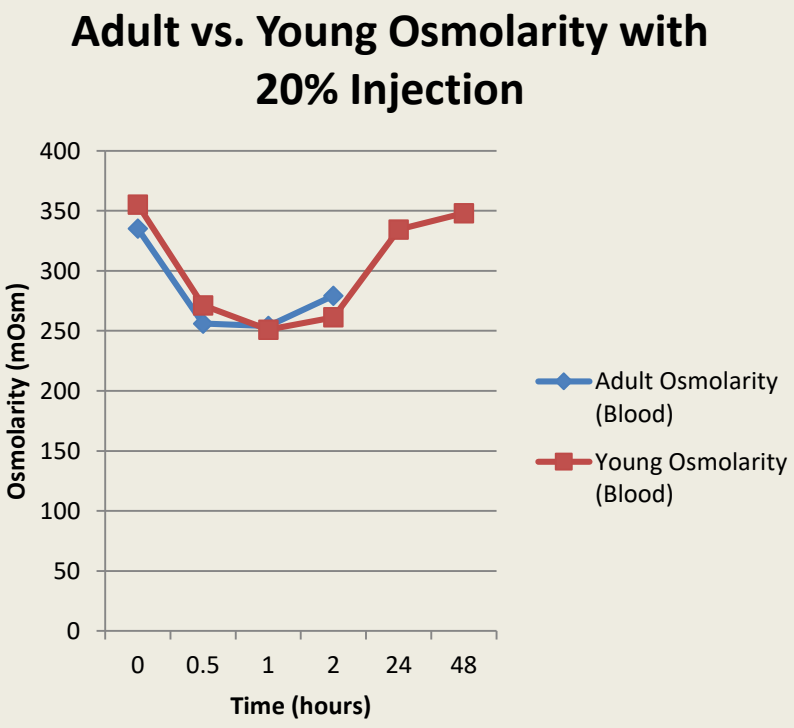


10% Water Injection

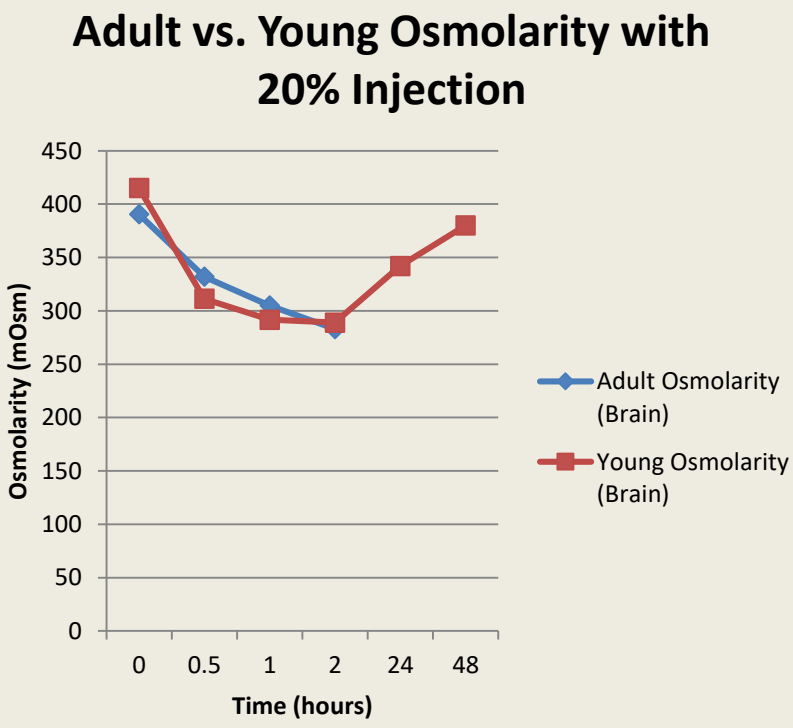


Data/ Results

Extracellular Fluid



Blood Brain Barrier



Data/Results

A. The results for the experiment followed what was expected in that the BBB showed more conserved methods for handling an acute hypo-osmotic challenge.

B. The comparison between the 10% and 20% injection also followed what was originally expected in that the mice had a more difficult time handling the 20% water injection than the 10% water injection

C. In the experiment comparing osmoregulation between adults and young mice, the results were not what was expected. The young mice had a more significant decrease in osmolarity in the brain than did the adult, but were able to recover. Most adult mice were not able to live past two hours after injection.

IV. Conclusions

- Mammalian brain cells swell dramatically upon rapid plasma dilution such as may follow in an acute hypo-osmotic challenge (Andrew, 1991).
- Changes in plasma osmolarity are closely paralleled by ECF osmolarity due to the fenestration of capillaries and the expression of a special protein called aquaporin (Sircar, 2008).
- Water is freely permeable across the BBB through Aquaporin 4 (Rubin et al., 2001) and changes in CSF osmolarity can have deadly consequences.
    - -Edema
    - -Block drainage of CSF
    - -Cut off blood flow
    - -Increase intracranial pressure

References

Andrew RD (1991) Seizure and Acute Osmotic Change - Clinical and Neurophysiological Aspects. Journal of the Neurological Sciences 101:7-18.

Bourque CW (2008) Central mechanisms of osmosensation and systemic osmoregulation. Nature Reviews Neuroscience 9:519-531.

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