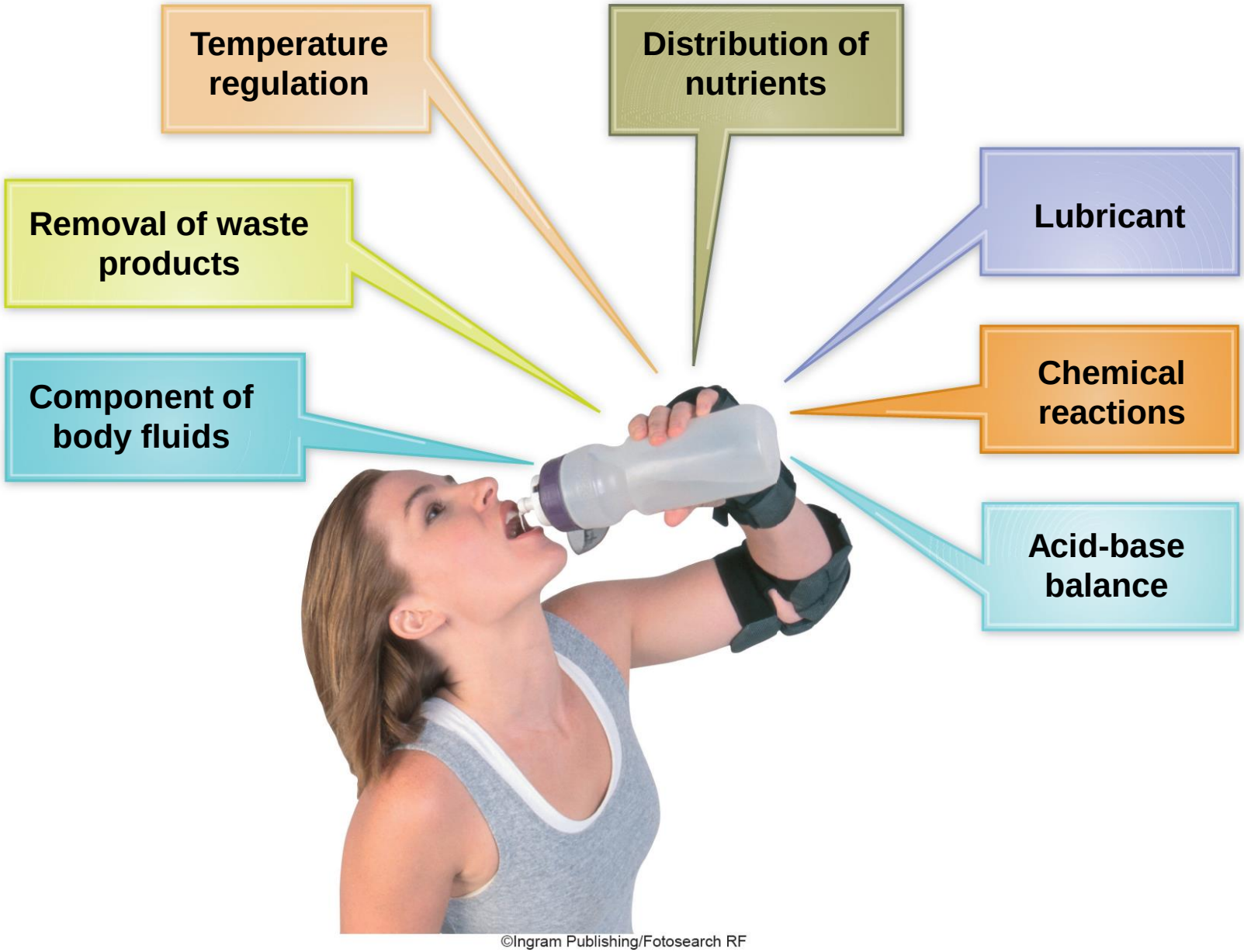
Chapter 9

Micronutrients Involved in Fluid and Electrolyte Balance

Livefit4life.net

Functions of Water



Water Percentages

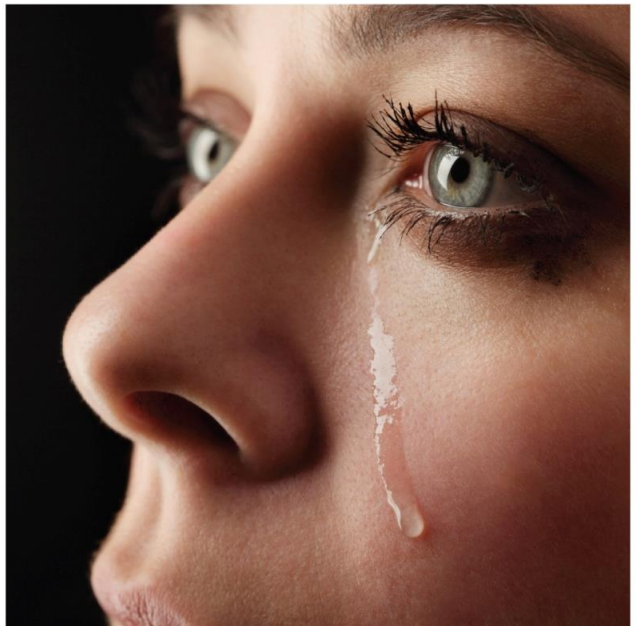
- Human body contains 50-70% water
- Muscle is 73% water
- Adipose tissue is 10-20% water
- As body fat content increases, % of lean tissue decreases and total body water decreases
- Extremely lean athletes = 70% body water
- Bone is approximately 20% water

Water Is the Universal Solvent

- **Universal solvent**
  - Dissolves substances in the body
- Water transports nutrients and wastes
- Most nutrients are water soluble
- Primary component of blood and lymph
- Primary medium for chemical reactions:
  - Due to so many compounds being dissolved in water; CHO/pro/fat metabolism = results in **metabolic water** – 1 cup/day

Water Moistens, Lubricates, and Cushions

- **Saliva**
  - helps food pass from esophagus → stomach
- **Mucus**
  - protective coating through GI tract & lungs
- **Lubricating fluids**
  - in **knees** and other **joints**
  - tears in eyes
- **Cerebrospinal fluid**
  - spinal cord and brain
- **Amniotic fluid**
  - shock absorber, mother's womb



Water Intake

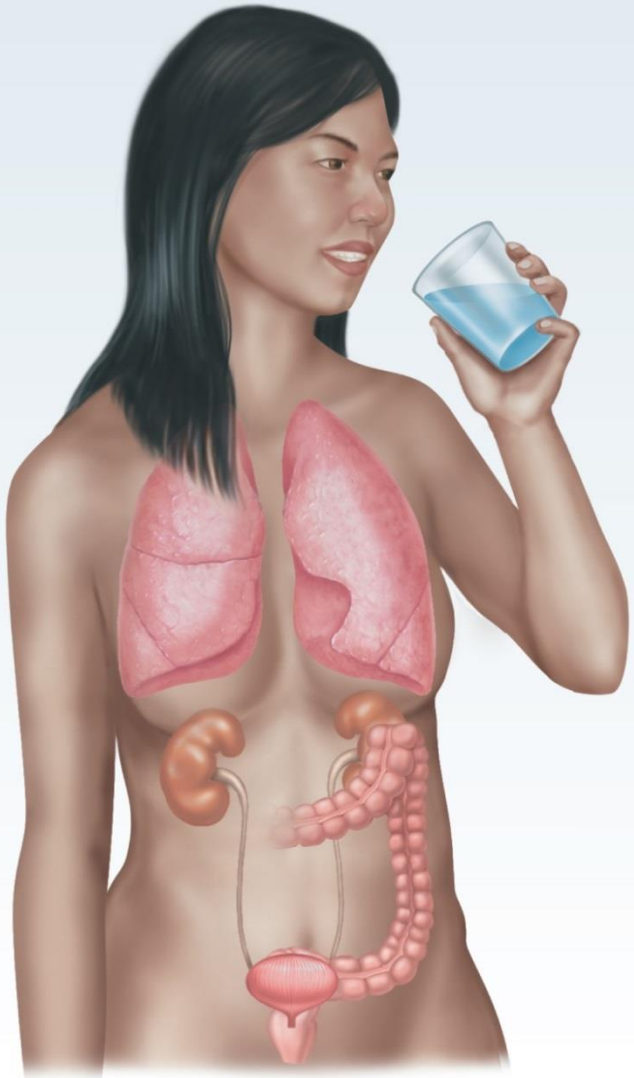
Fluids:
2150 milliliters (~9 cups)

+

Water content in food:
500 milliliters (~2 cups)

+

Water produced
from metabolism:
300 milliliters (~1.25 cups)



Water Output

Urine:
1950 milliliters
(~8.25 cups)

+

Skin perspiration:
600 milliliters
(~2.5 cups)

+

Lung respiration:
300 milliliters (~1.25 cups)

+

Feces:
100 milliliters (~0.4 cup)

Total Water Intake
2950 milliliters
(approximately ~12.25 cups)

Total Water Output
2950 milliliters
(approximately ~12.25 cups)

Urine Production

- Typical urine production: 1 liter
- Less than 500 ml (2 cups) = concentrated urine and increase work by kidneys
- A way to determine adequacy of fluid intake is to observe urine color:
  - Clear or light yellow is good hydration
  - Dark yellow and pungent is poor hydration

Can you drink too much water?

Jury Rules Against Radio Station After Water-Drinking Contest Kills Calif. Mom

•BY SUZAN CLARKE
•RICH MCHUGH

Nov. 2, 2009

ABC News Photo Illustration

The husband of a California woman who died after participating in a radio station's water drinking contest said he hopes a jury's $16.5 million compensation award following a wrongful death lawsuit will send a message to other corporations dealing with the public. "It was a preventable thing," Billy Strange told "Good Morning America" today of his wife's 2007 death from water toxicity. The radio station, he said, "had the information months in advance that this could cause harm."

Fatal water intoxication

Water intoxication can occur in a variety of different clinical settings but is generally not well recognised in the medical literature. The condition may go unrecognised in the early stages when the patient may have symptoms of confusion, disorientation, nausea, and vomiting, but also changes in mental state and psychotic symptoms. Early detection is crucial to prevent severe hyponatraemia, which can lead to seizures, coma, and death.

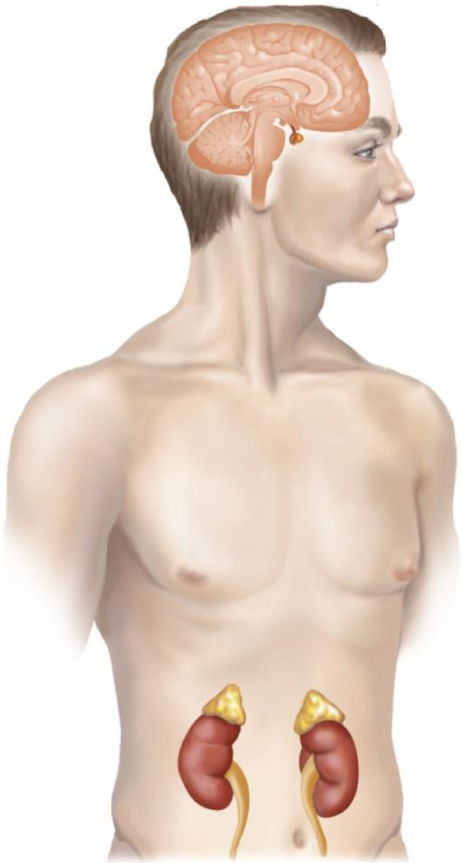
The patient reported here was a 64 year old woman with a known history of mitral valve disease but no other relevant past history. On the evening before her death, she began compulsively drinking water in vast quantities, estimated at between 30 and 40 glasses, and this was interspersed with episodes of vomiting. She became hysterical and also distressed, shouting that she had not drunk enough water. She declined medical attention but continued to drink water after she had

Body fluids are depleted.

Osmoreceptors in the hypothalamus sense that blood is becoming more concentrated. The hypothalamus signals the pituitary gland.

The posterior pituitary gland releases antidiuretic hormone (ADH).

ADH signals the kidneys to retain more water.



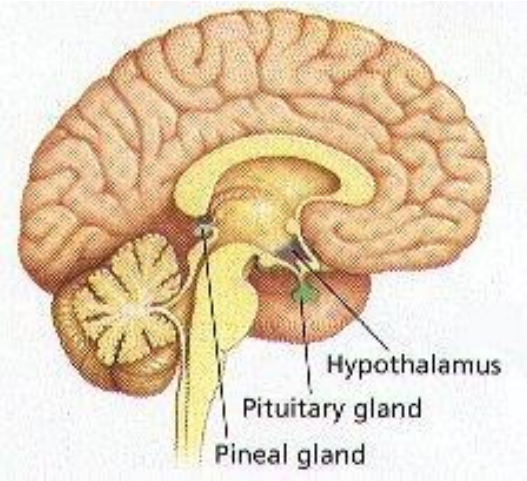
Kidneys sense decreased blood flow.

Kidneys activate an enzyme cascade involving angiotensin and aldosterone. These hormones increase reabsorption of Na^+ and Cl^- by the kidneys, which results in increased water retention by the kidneys.

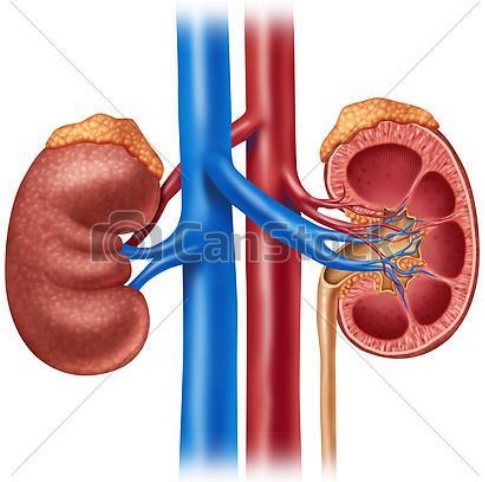
Fluid balance is restored.

Fluid Conservation Hormones

- **Antidiuretic hormone (ADH)**
  - Secreted by pituitary gland when blood volume is ↓
  - Tells kidneys to ↓ water excretion which in turn ↑ blood volume



- **Aldosterone & Angiotensin**
  - Produced by adrenal glands
  - Tells kidneys to conserve sodium and water



A Thirsty Swimmer: Medical Mystery Solved

- BY ABC NEWS

Aug. 3, 2006

- Email

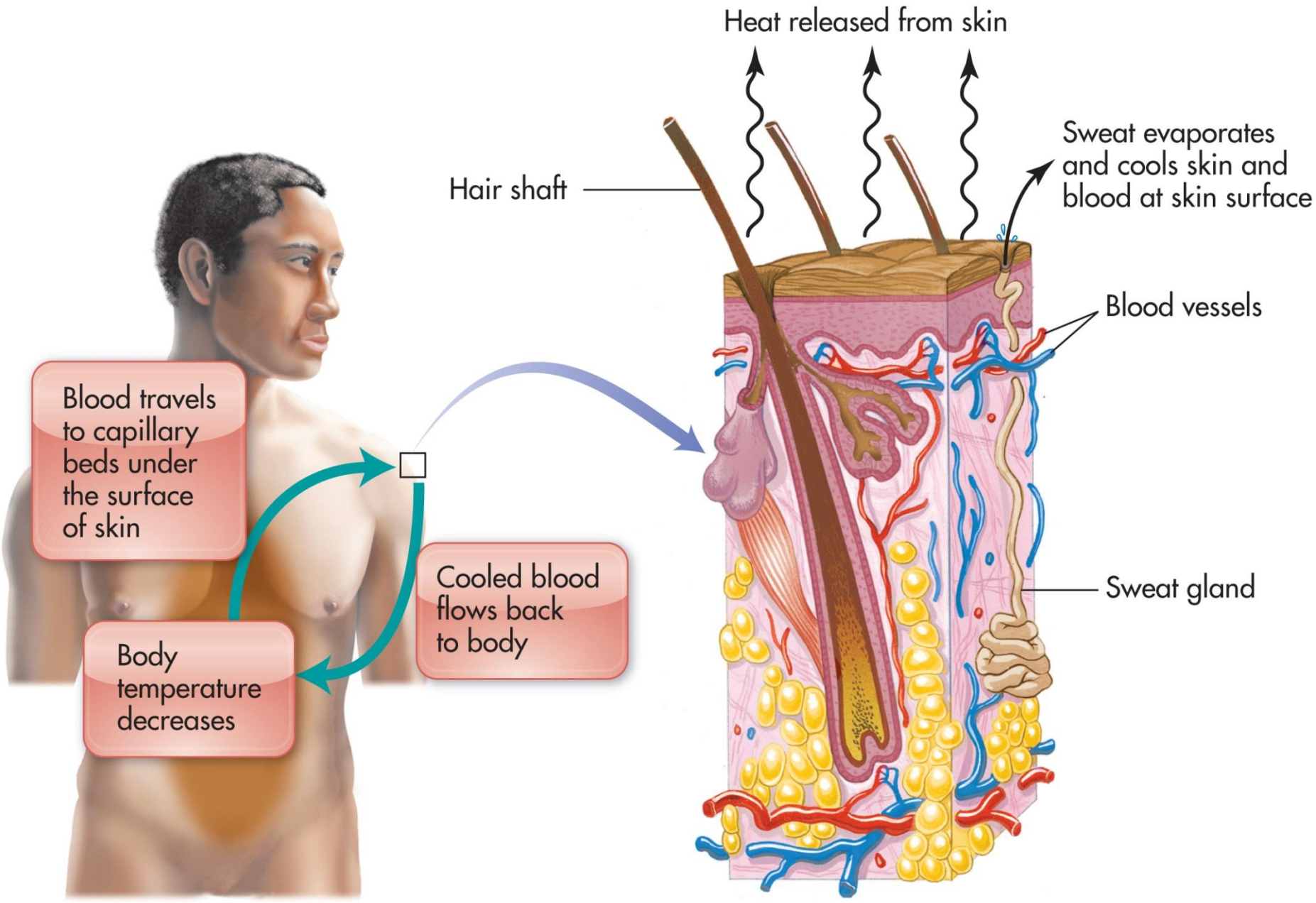
Sharon Callahan was the subject of this week's Primetime: Medical Mystery. In 1985, she was a competitive college diver and pre-med student at a college in Virginia. She complained to her mother, Ginger Callahan, that she was exhausted and had been having hallucinations. Ginger contacted Dr. Fred Miller, a professor of medicine at Drexel University College of Medicine and Executive Vice Chair of the Department of Medicine, and asked him to see Sharon and try to diagnose her condition.

Below is a transcript of the story:

GINGER: "She was hallucinating when she would wake up in the middle of the night. [She] didn't recognize any of her roommates. It was very scary what she was telling me."

Is Thirst a Good Indicator of Hydration Status?

- Controlled by your hypothalamus
- If thirsty, you are already dehydrated
  - Can lag behind in some situations, exercise, illness
- Infants and children
  - Need close monitoring, vomiting, diarrhea
- Hypothalamus sensitivity declines with age, increase dehydration risk in elderly
- Athletes
  - consume 2-3 cups fluid/water each pound lost during exercise



CSUN Pi Kappa Phi fraternity will disband in wake of student's hazing death

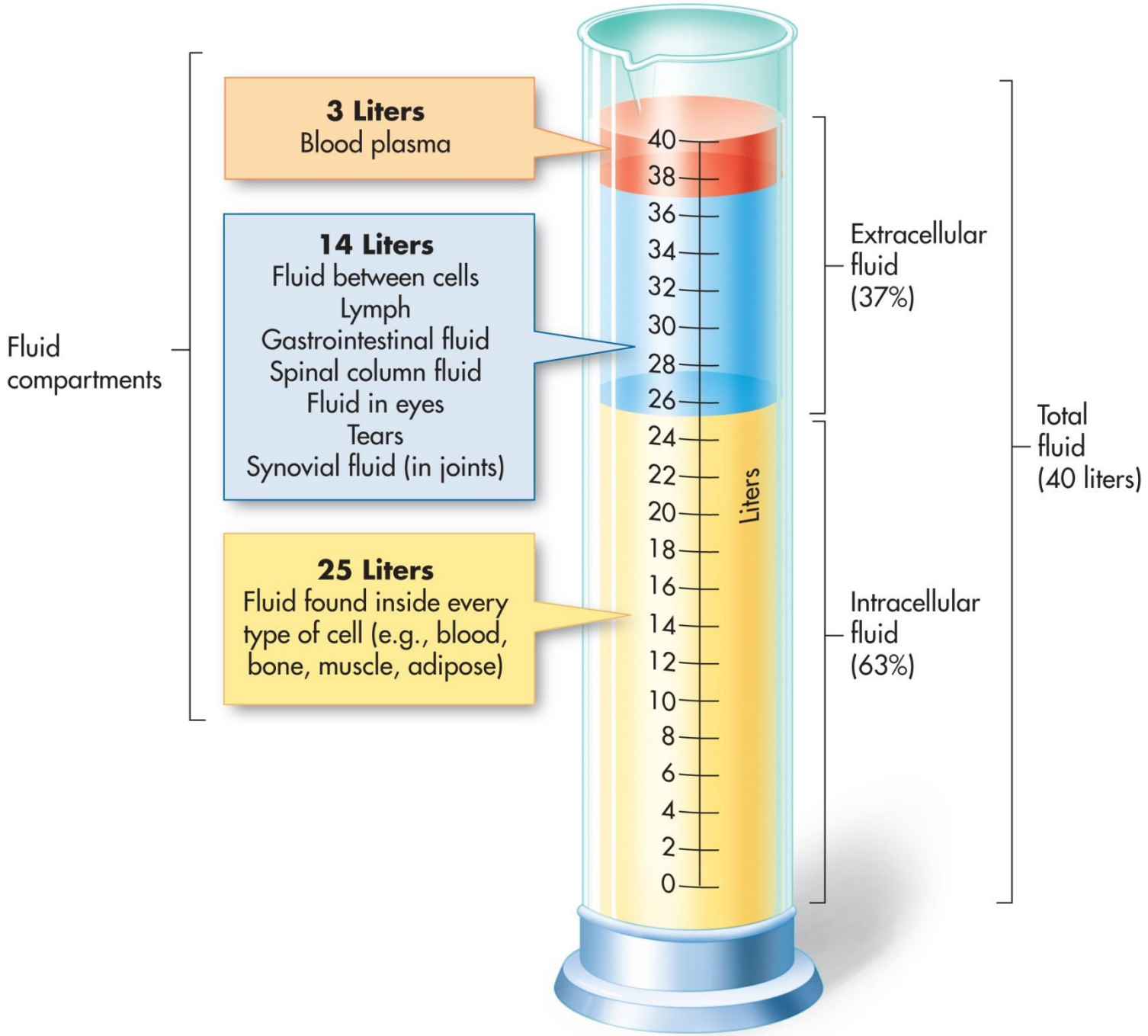
Kennedy High School graduate Armando Villa, 19, died July 1 after taking part in a barefoot hike in the Angeles National Forest for pledges to Cal State Northridge's Pi Kappa Phi fraternity. (Photo from gofundme fundraising page)

Proper Use of Water Bottles

1. Stainless steel bottles best
2. Plastic, look for recycling codes 2 and 4
3. Avoid plastic bottles with recycle codes 3 and 7 without “BPA free” embedded
4. Choose reusable bottle with a wide mouth
5. Plastic bottle scratched or cracked, throw it away
6. Do not store your containers of water in a hot garage or in the back of your hot car

Is Bottled Water Healthier Than Tap Water?

- Standards for quality, contaminant levels are identical for bottled and tap water
- Much bottled water produced in U.S. is processed municipal tap water
- Extra packaging to provide bottled water
  - Over time, plastics break down



Electrolytes Regulate Fluid Balance

The primary extracellular ions are:

- **Sodium (Na^+)**
- **Chloride (Cl^-)**

The primary intracellular ions are:

- **Potassium (K^+)**
- Phosphate (PO_4^-)

Ion Concentration and Electrolytes

- Ions dissolve in water and are positively (+) or negatively (-) charged
  - Sodium and potassium are positive
  - Chloride and phosphate are negative
- Ion concentration controls how much water is inside vs. outside of cells
- Charged ions transfer electrical current and are called **electrolytes**

Sodium (Na^+)

- Table salt = sodium chloride = NaCl
  - 40% sodium
  - 60% chloride
- 1 tsp of salt = 2,400 mg sodium
- Very abundant in food supply
- Americans exceed requirements
  - Potential health risk

Getting Enough Sodium

- 77% added as salt during food manufacturing
- Adequate Intake:
  - 9–50 years: 1500 mg/day
  - 51–70 years: 1300 mg/day
  - >70 years: 1200 mg/day
- Average American consumption:
  - 2,300-4,700 mg/day

Dietary Guidelines

- <2,300 mg per day:
  - General population
- <1,500 mg per day:
  - African Americans
  - Middle-aged or older adults (51+ years)
  - Those with hypertension, diabetes or chronic kidney disease

Extreme hypernatremic dehydration due to potential sodium intoxication: consequences and management for an infant with diarrhea at an urban intensive care unit in Bangladesh: a case report

Sumon Kumar Das[1,2], Farzana Afroze[1,3], Tahmeed Ahmed[1], Abu Syed Golam Faruque[1*], Shafiqul Alam Sarker[1,3], Sayeeda Huq[1,3], M Munirul Islam[1,3], Lubaba Shahrin[1,3], Fariha Bushra Matin[3] and Mohammod Jobayer Chisti[1,3]

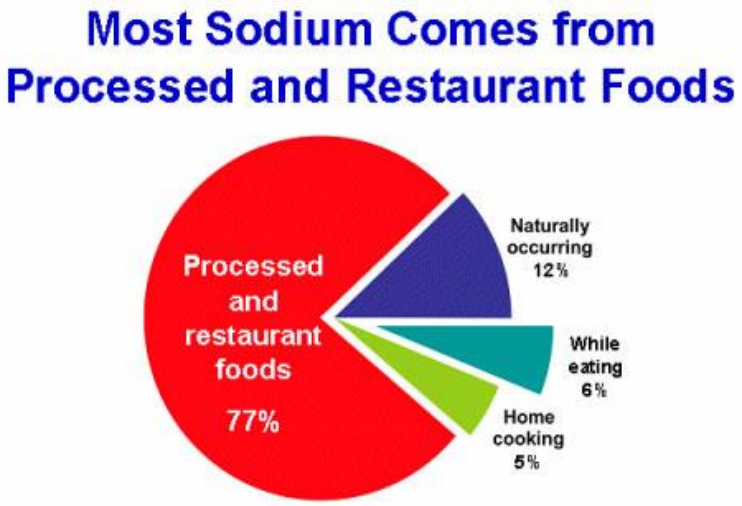
Sodium Deficiency Issues

- **Groups at risk**
  - Low sodium diet
  - Excessive sweating (ex: athletes)
  - Persistent vomiting or diarrhea
  - Ketogenic diet
- **Symptoms**
  - Muscle cramps
  - Nausea and vomiting
  - Dizziness
  - Shock
  - Coma

Food Sources of Sodium

- **High sodium foods:**
  - Packaged foods
  - Processed foods
  - Fast food
  - Canned foods
  - Frozen, ready prepared foods (ex: pizza)

- **Low sodium foods:**
  - Fruits & vegetables
  - Whole grains
  - Meats w/o sauces
  - Unprocessed foods



Seniorjournal.com

Potassium (K): Functions

- Maintaining water balance
- Nerve impulse transmission
- Principal positively charged intracellular ion
- Increasing potassium intake can help lower blood pressure – 90% absorbed
- Low blood levels from chronic diarrhea, vomiting, laxative abuse is life-threatening problem

Getting Enough Potassium

- DV used on labels:
  - 3,500 mg
- Typical North American consumption:
  - 2,000-3,000 mg/day
- Unprocessed foods
  - Fruits
  - Vegetables
  - Milk
  - Whole grains
  - Dried beans
  - Meats

- Major contributors in the diet include:
  - Milk
  - Potatoes
  - Beef
  - Coffee
  - Tomatoes
  - Orange juice
  - Bananas

Potassium: Deficiency and Excess

- Can be caused from:
  - Chronic diarrhea
  - Vomiting
  - Laxative abuse
  - Alcohol abuse
  - Eating disorders
  - Very low calorie diets
- Symptoms include:
  - Loss of appetite
  - Muscle cramps
  - Confusion
  - Constipation
  - Irregular heart beat

Too much? If kidney function is poor potassium builds up in blood, inhibits heart function and decreases heartbeat

Chloride (Cl)

- Primary negatively charged ion in extracellular fluid
- Functions:
  - Component of stomach acid (HCl)
  - Immune response, used as white blood cells attach foreign cells
  - Nerve function
- Food Sources
  - Fruits and vegetables
  - Chlorinated water
  - Salt (NaCl) – added to foods - majority

Chloride: Def vs Toxicity

- Too Little
  - Prolonged vomiting (ex: bulimia or severe flu) can lead to acid-base disturbance due to large loss of stomach acid
  - Deficiency is unlikely
    - dietary salt intake is high

- Too Much
  - Plays a role in raising blood pressure
  - UL is 3,600 mg/day
  - Because of increased salt intake, average North American intake of chloride is elevated