

## Water

- **60% of adult's weight**
  - Infants 70%
  - Elderly 45%
- **Most essential nutrient**
  - Months to years without vitamins and minerals
  - Weeks without macronutrients
  - Few days to weeks without water

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## Water in the body

- **Body temperature regulation**
  - Evaporation
  - Temp. > 106° F may cause death
- **Solvent**
- **Protection/cushion**
  - Joints
  - Spinal cord
  - Eye
  - Amniotic fluid

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## Dehydration

- **16 ounces water is 1 pound**

Body fluid loss	Symptom/condition
1 to 2%	Fatigue and thirst
4%	Loss of muscular strength and endurance
7 to 10%	Severe weakness
20%	Death

## Chronic mild dehydration

- **Increases risk of:**
  - Gallstones
  - Kidney stones
  - Urinary tract infections
  - Bladder cancer

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## Water intoxication

- More than two gallons in a few hours
- Infants < 4 months

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## Body Water Compartments

**Intracellular water** : inside cells

**Extracellular water** : surrounding cells or in blood vessels (*plasma*)

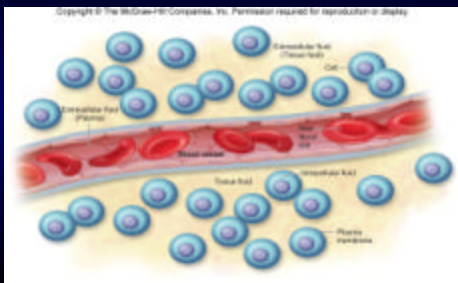
*Plasma membrane of cell* is selectively permeable

*Osmosis* — diffusion (movement) of water through a selectively permeable membrane

**Concentration** of substances dissolved in water influences osmosis

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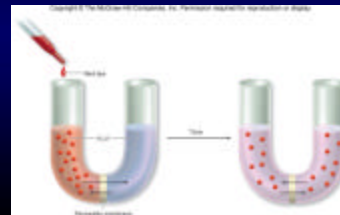
## Fluid Compartments in the Body



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## Body Water Distribution

**Simple diffusion** — molecular movement from a region of higher to lower concentration

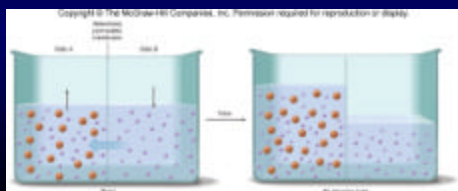


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## Body Water Distribution

**Osmosis** — movement of water through a selectively permeable membrane



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## Two Major Water Compartments

### Intracellular Water

~ 2/3 of body water is inside cells

### Extracellular Water

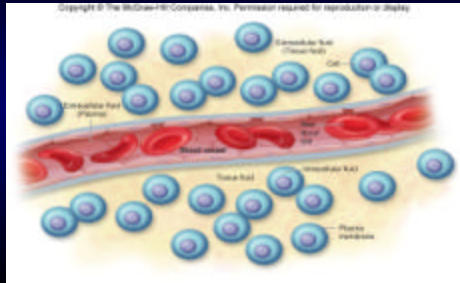
Water surrounding the cells or in the fluid portion of blood (*plasma*)

Balance between intra- and extracellular fluid is maintained by concentration of ions.

Main ions = sodium, potassium, chloride, and phosphate

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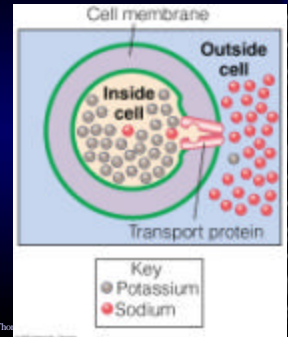
## Fluid Compartments in the Body



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## Water

- Transport proteins move ions across cell membranes to regulate water balance



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## Hydration

- Water in (sources):
  - Water, liquids
  - Food (fruit and veg 80% to 90% water)
  - Energy metabolism

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## Hydration

- Water out:
  - Urine
  - Sweat (up to ½ gallon per hour – if working hard or exercising)
  - Insensible perspiration
  - Lungs
  - Feces

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## Daily Water Balance



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## Kidneys and Hydration



### Kidneys:

- major regulator of water content and ion concentration
- Maintain hydration by filtering excess ions from blood.
  - Remove excess sodium ions; water follows sodium.
- Remove drugs and metabolic wastes.
  - **Urea** and **uric acid** — waste products of protein metabolism.

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## Water Conservation

- Hormones that participate in sodium and water conservation:
  - Antidiuretic hormone (ADH)
  - Aldosterone

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## What Is a Diuretic?



Diuretics —increase urine output

**Caffeine** – coffee, tea, “energy” drinks, soft drinks

**Alcohol** – beer, wine, and spirits

Inhibits ADH resulting in urinary water losses > amount of fluid consumed

*Hangover may be an effect of dehydration on the brain.*

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## How Much Water Is Needed

Adequate Intake (AI) for *total water* (including water in foods) is:

**Young Women** = 11 cups (2.7 L)/day

**Young Men** = 15.5 cups (3.7 L)/day

Urine output is best indicator

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## Bottled water?

- 250 to 10,000 times the cost of tap
- In a study of 103 brands
  - 1/3 contaminated with bacteria
  - ¼ were tap water
- Less rigorous safety standards than tap water
- 60 million bottles a day in US

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## Minerals

- **Inorganic elements**
  - Amount in food depends on soil, location, agricultural practices
- **Major minerals**
  - Need > 100 mg/day
- **Trace minerals**
  - Need < 100 mg/day
- **Ultratrace**
  - VERY small amounts

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### Major Minerals

- Calcium
- Chloride
- Magnesium
- Phosphorus
- Potassium
- Sodium
- Sulfur

### Trace Minerals

- Iodine
- Iron
- Zinc
- Selenium
- Fluoride
- Chromium
- Copper
- Manganese
- Molybdenum

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## Minerals

- Bioavailability – how much we absorb of a mineral depends on:
  - Need (increased in childhood, pregnancy)
  - Fiber
  - Competition with other minerals (iron, calcium, etc)
  - Phytate (in whole grains and nuts - binds minerals including zinc, calcium)
  - Oxalate (in spinach and rhubarb – binds calcium)

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## Calcium

- Most abundant in body
- 99% in bones and teeth



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## Calcium

- Bone formation/maintenance
- Nerve transmission
- Blood clotting
- Muscle contraction
- Blood pressure regulation

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## Sources of calcium

- Milk, cheese, yogurt
- Some tofu, legumes, molasses, sesame seeds, almonds
- Leafy greens



## Vegetable sources of calcium

- Rutabaga
- Broccoli
- Beet and collard greens
- Turnip greens
- Bok choy
- Kale
- Green cabbage
- Kohlrabi
- Watercress
- Parsley
- Some seaweeds
- Including **nori**



## Calcium

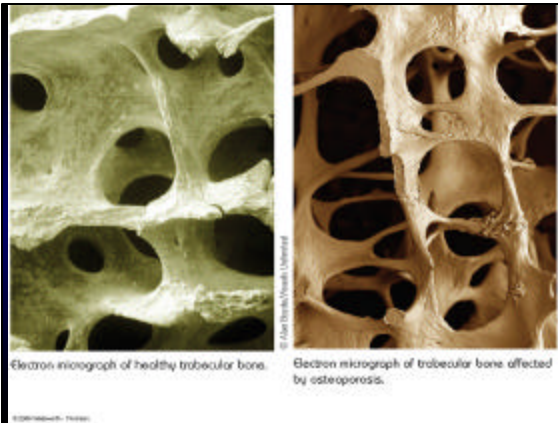
- "3 a Day"
- Milk - 300 mg per cup (8 oz)
  - 1 cup yogurt
  - 1 ½ ounces cheese
  - 1 cup calcium fortified soy milk, oj, etc

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## Osteoporosis

- Chronic disease characterized by *low bone mass* and *reduced bone structure* leading to increased risk of fractures
- Increases fractures: hip, wrist, arm, pelvis
- 80% women
- Menopause – decreased estrogen

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## Osteoporosis

- Genetics
  - Asian, Caucasian
  - Small frame
- Weight bearing exercise protective
- Eating disorders

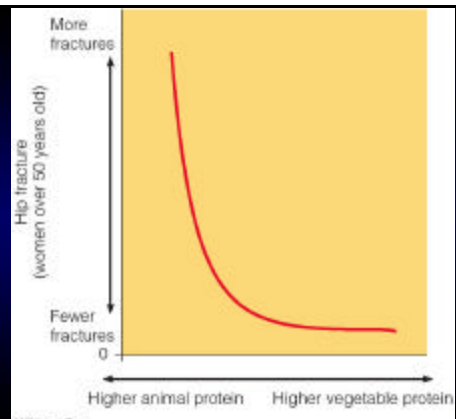
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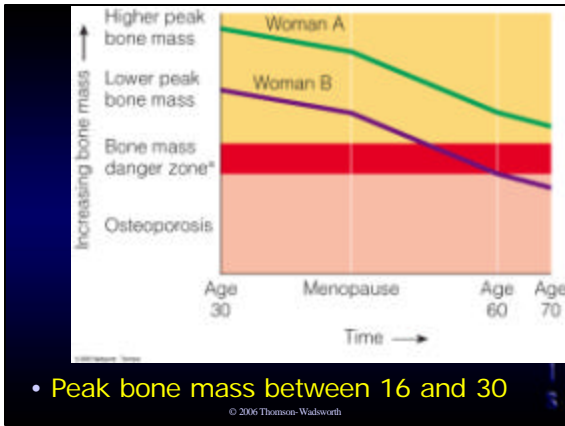
## Osteoporosis

- Smoking
- Alcohol
- Excess protein, animal protein
- Caffeine
- Soft drinks



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## Sodium

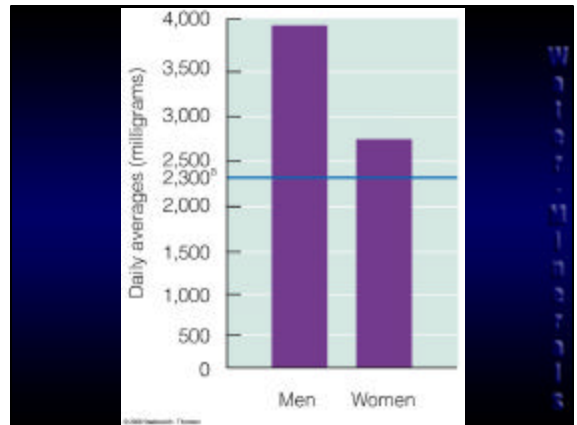
- Positive ion in NaCl
  - 40% of weight of table salt
- Why is *Sodium* Necessary?
  - Major positive ion in extracellular fluid
  - Conducts nerve impulses
  - Involved in transporting glucose and amino acids into cells

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## Sodium

- Deficiency – not known
- DRI 1500 mg, TUL 2300 mg
  - Most US adults exceed TUL
  - Teaspoon salt has 2325 mg

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## Blood Pressure

- Epidemiological studies: blood pressure rises with sodium intake
- Hypertension: persistently elevated blood pressure
- Hypertension increases risk of:
  - Heart disease
  - Stroke
  - Kidney failure

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## Blood Pressure

- Force of circulating blood on the walls of blood vessels (arteries)
- Systolic (contraction)
- Diastolic (relaxation)
- Normal: 120/80 mmHg

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## DASH Diet

- Dietary Approaches to Stop Hypertension
- Achieves lower blood pressure than sodium restriction alone

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## DASH Diet

- Unprocessed food
- Potassium-rich foods
  - Fruit and vegetables
  - Nuts, legumes
- Fish
- Whole grains lower blood pressure

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## DASH Diet

- Small portions of red meat, butter and other high-fat foods
- Small amounts of sweets
- Salt, sodium reduced

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## Sodium

- Added salt as little as 15% of salt consumed
- Biggest sources?
  - Processed food contributes 75% or more

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## Potassium

- Positive ion inside cells
- Most in US don't get enough
- Roles:
  - Nerve transmission, muscle contraction, kidney function
  - May reduce blood pressure
- Sources:
  - Fruit and vegetables



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## Potassium

- Deficiency
  - Sudden death during fasting or severe diarrhea, dehydration
  - Kwashiorkor, eating disorders (bulimia)
  - Heart failure

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## Magnesium

- Over half in bone
- Involved in hundreds of enzyme reactions
- Muscle relaxation
  - cardiac and other muscle function

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## Magnesium sources

- Water in some places
- Plant foods: leafy greens
  - Component of green pigment chlorophyll
- Whole grains (not refined)
- Legumes, nuts, seeds



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## Magnesium

- Deficiency rare – alcoholics
- Toxicity – with supplements
  - Diarrhea, dehydration
- Magnesium-containing laxatives:
  - Milk of magnesia
  - Magnesium sulfate

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## Iron

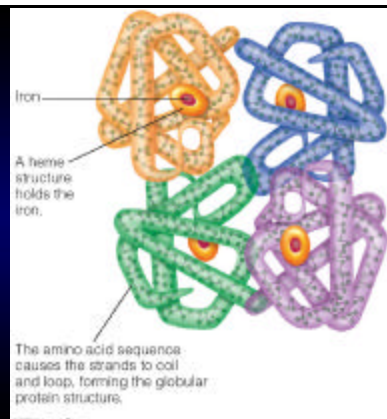
- Oxygen transport in body
  - Hemoglobin – in red blood cells
  - Myoglobin – in muscle
- Brain development in children
- Immunity

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## Iron

- Most common deficiency worldwide
- In US – deficiency common in:
  - Toddlers
  - Teenage and young women
  - Pregnant women

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## Heme vs. Non-heme iron

- Heme: animal foods – about 25% absorbed



- Non-heme – plant foods – about 10% absorbed



- Cast iron pans add non-heme iron to food

## Increases iron absorption

- MFP factor (meat, fish, poultry factor)
- Vitamin C – can triple non-heme absorption
- Need for iron (childhood, pregnancy)

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## Too much iron is toxic

- Children - supplements
- Liver damage
- Hemochromatosis
  - Genetic

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## Zinc

- Component of hundreds of enzymes and other proteins
- Needed for:
  - Wound healing
  - Normal taste and smell
  - DNA synthesis
  - Immune function

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## Sources of Zinc

- Protein foods
  - Meat, poultry, milk
  - Shellfish
  - Some legumes
  - Whole grains (not refined)



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## Zinc deficiency

- Iran and Egypt in 1960s – young boys
  - Growth retardation
  - Geophagia
  - Poor immunity/increased infections
- Diet adequate in zinc
  - High in whole grains & beans (fiber & phytate)
  - Unleavened bread

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## Zinc toxicity

- Interferes with copper and iron absorption

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## Iodide

- Normal thyroid function and production of thyroid hormone
  - Thyroxine regulates basal metabolism

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## Iodine

- Deficiency
  - Enlarged thyroid (**goiter**)
  - Cretinism
    - Irreversible mental retardation and growth failure in child



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## Iodine

- Deficiency common in US before.....
  - Iodized salt
- Sources:
  - Seafood
  - Milk (iodine used as disinfectant in dairies)
  - Iodized salt
  - Plants grown in high iodine soil (near sea)

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## Selenium

- **Antioxidant**
  - lower risk of prostate cancer, other cancers?
- **Deficiency: heart disease, weakness**
  - China in areas with selenium-deficient soil
- **Unprocessed foods: meats, shellfish, vegetables and grains (if Se in soil)**

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## Chromium



## Chromium

- **Enhances action of insulin**
- **Deficiency**
  - Diabetes-like symptoms
  - Taking chromium will not cure diabetes?
- **Sources: Nuts and unrefined grains**
  - Cooking in stainless steel cookware

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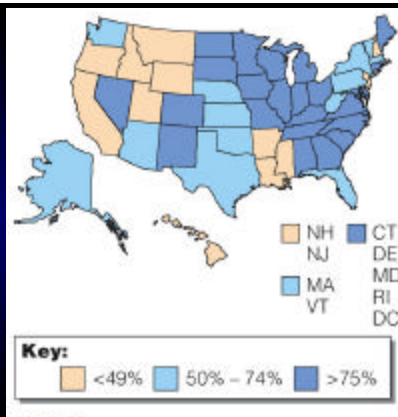
## Fluoride

- **Prevents dental caries**
- **Water fluoridation in US began in 1940s**



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Percent of population in each state with access to fluoridated water



## Fluoride

- **Toxicity = fluorosis**
  - Discolored teeth
  - Only when teeth are developing
  - Irreversible

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## Sources of fluoride

- Water – not bottled
- Toothpaste – keep away from young children
- Tea
- Food cooked in fluoridated water

## Ultra trace minerals

- Arsenic
- Boron
- Lithium
- Nickel
- Silicon
- Vanadium