CHEM 181 LECTURE 5: "MINERALS"

Mineral locations
- ocean: mineral content, mixture of salts (i.e when water boiled) → 3.5% salt by weight
- **Galapagos Islands**: 3.8% salt - ↑ b/c higher temp = more water evap. + less fresh water source for dilution

[1 mol = $6x10^{23}$ molecules water]
- **Dead Sea**: 32% salt by weight = 10x normal ocean

Salts
- ionic form usually → electrons removed form outer shell of atom → Na^+
- Salts formed: balance between the cations (+) and anions (-) → both are paired together → forms neutral salts
- **Gypsum**: $CaSO_4$
- **Epson salt**: $MgSO_4$
- **Calcium bicarbonate**: $Ca(HCO_3)_2$ → decomposes calcium carbonate instantly
- **Calcium carbonate**: $CaCO_3$ limestone = most prevent in the world
- **NaCl**: sodium chloride = table salt

Sea salt
- mixture of many salts → do not all come from the sea
- Mainly NaCl composes it

Rose quartz:
- beautiful mineral = 'mystical energies' → scammed into buying the crystal/ product

Pyridine Hydrogen Quantum Sound Generator
- strange product with minerals and supposed properties

Dolomite
- mixed mineral: $CaCO_3$ + $MgCO_3$
- Named after Dolomite Mountains: Northern Italy (i.e. Composition of most statues)
- Supplements to improve minerals in body BUT tablets may contain arsenic, mercury, aluminum
  - If contaminated, over consumption = complications → contents not always well controlled

Vermillion
- co-crystallization of adjacent minerals
- Produced form H_2S → i.e. red for paintings

Periodic table of Elements
- organized rep of all known elements
- Vertical column: similar xteristics
- **halogens:** F, Cl, Br, I → same column: -1 charge in ionic form (≠ neutral as an element)
- Mass diff. b/w elements and ions = less than microgram (~ electron mass)

Elements
- defined by # of protons (nucleus) in atom: used to differentiate different atoms of elements
- Usually equal # protons and electrons to form neutral element
- **Sodium:** white, pasty, moldable (like butter)
  - In water = burns/ explodes

[$Na+2H_2O \rightarrow NaOH + H_2$]
  - H_2 element ignites and produces flame

Ionic bonding
- ions lose/gain electrons: depends on chemical beaver involved

[$Br_2+2K \rightarrow 2KBr$ + explosion]
- KBr = potassium bromide crystalline solid ionic compound
- **Potassium bromide**: K^+ Br^-
  - K: very reactive → use hydrocarbon solutions instead of water: all hydrogens bonded to C; not reactive; high melting pt.

Ionic species
- probs soluble in water (polar): can accommodate salts in solution

Polar
- electron organization in molecule: imbalance in charge distribution

Ionic solution
- salt water: conducts electricity better than non-ionic solution (distilled water i.e.)
  - I.e. 730mg NaCl: Campbell's tomato soup

Uyuni Salt Flats: Bolivia
- white patch in the west of South America
- Bolivia = big exporter of salt b/c of these flats
- Large part of local culture

Daily recommended intake
- 6g = small handful (twice daily recommended intake)
- 1.2g/day = recommended daily intake of salt CA
- 1 mg = a few grains
- 60µg = 1 salt crystal (60 millionths of a gram)

Types of salt
Morton Iodized Salt: 75¢/ 26oz
Fleur de Sel: $12/5.7oz
Kosher Salt: $1.5-2/lb.
Hawaiian Sea Salt&Pink Himalaya Salt: $$

Hypertension
- high blood pressure: related to excessive salt intake → increased water intake = harder for hear to pump
- Used to use blood letting as relief
- 120 (systolic)/ 180(diastolic) → typical for b.p.
- In 20s: 110/70 (smaller numbers are better)
- 150/100 → high; 180//110 → very very high
- Alternatives to salt → other flavorings
  - i.e. Mrs. Dash i.e. Dill pickles: no salt

Potassium
- salt substitute
- Similar chemical composition to Na
- Doesn't affect b.p like Na does
- KCl used to reduce NaCl intake: don't taste the same
  - Not proven if Na or K affect b.p.
  - KCl not clearly beneficial
- I.e. Bananas

Potassium-sodium balance
- ratio important in body: different sizes → fit into ion channels in different ways
- K much larger than Na

Macronutrients
- 400-500g/day
- I.e. Protein (100g), fat (150g), carbs (200g)

Micronutrients
- 1-2g/ day
- I.e. Ca, Phosphorus, Vanadium, Molybdenum, Tin
- Needed by proteins for proper function

Molybdenum (Mo^{+6})
- 2mg/day (2000µg/day): very little
- I.e. Nuts, canned veggies, bread, cereals etc.
- Essential enzyme component
    - **Xanthine enzymes:** removes uric acid to prevent gout disease

Iron (Fe^{2+})
- 10-20mg/day
- 2-4 found in body, mostly blood
- Problems:
    - Deficiency: **anemia**
    - **Hemochromatosis**: genetic disorder → absorbs too much iron → stored in heart, liver, joints, pancreas → heart and liver disease + arthritis
- **Hemoglobin**: large, complicated molec with Fe in centre: the 'iron-carrying' molec in blood → Fe atom carries O to lungs and extremities in blood
- Iron nails dissolved in wine: acidity released iron form nails → absorbed by drinker
- I.e. Meat and broccoli
- VitC: same ingestion time
    - Assists absorption from gastrointestinal tract
- Additive: in bread
- **Geritol:** iron supplement product (~3mg/ml) 50 mg in spoonful
- **Slow FE**: 'slow release' iron supplement
    - 264% of daily requirement
    - Bad to take too much of any particular mineral
- **Porphyria**: genetic → produced too much porphyn (ring-like molecule) sequesters ingested iron → hemoglobin lacks iron
    - Affecting nervous system and skin
    - Reddish skin/ excessive hair = Werewolf Syndrome

Zinc (Zn)
- Need 50mg/day
- Micronutrient: healing, smell, taste, circulation
- Zn^0: silvery Zn^{2+}: white
- Zn^{2+} = 0.003% of body weight (approx. 2g) → necessary for insulin function
- Hair samples (assay): measure of Zn level → zinc-sequestering enzymes in hair protein
    - Arsenic and mercury also tested in hair
- I.e. Meat & peanuts
- **Aspergillus niger**: black fungus causing respiratory problems needs Zn to grow
- **Anosmia:** condition can't smell/taste → zinc involved
- **Ranaud's Disease**: circulation disease → fingers/ toes turn blue → inadequate circulation
- **Schizophrenia** and **prostate gland**: involved with Zn
- Vegetarianism: high fibre diet interfere with Zn levels → fibre and protein sequester Zn
- Linked to 200 enzymes
    - **Alcohol Dehydrogenase** (alcohol processing)
    - **RNA Polymerase & tRNA Synthetase** (genetic replication)

Iodine (I^-)
- 150µg/day
- halogen group of elements: diatomic molec I_2
- Sublimes form crystal to purple vapor (no liquid transition)
- Ionic iodine deficiency: **goiters** → needed by thyroid gland for fat metabolism
    - By Theodore Kocher
    - Goiter = excessive growth of thyroid gland → growing to find more iodine
    - Reversible condition treated with **synthroid** → mimics functioning thyroid gland
- i.e. Seaweed → oceanic communities have reduced goiter cases
- 70% commercial salts have added iodine (KI)
    - 0.01% of KI added to ensure no iodine deficiencies in population
- Kazakhstan: major salt supplier
    - Add KI to prevent goiters → reduced goiters in Kazakh people: heavily promoted by gov't
- 30% (2billion) of world have iron deficiency
- Costs 5¢/person/year to make iodized salt → prevent mental retardation, dwarfism and goiter
    - 70% US Morton Salt (around for 80 years)
    - 90% China (iodized)
- india: 500 million India get too little, 54 million goiters, 2 million are cretins

Selenium
- 50mg/day
- selenite ion SeO_3^{2-} → body exposed to → provides selenium
- Similar sulphur properties
- Pill forms: 100mg
- Antioxidant working with VitE
    - Part of **Glutathione peroxidase** → protect cells against oxidative damage
- I.e. Garlic, onion, brazil nuts, tuna
    - Garlic: contains sulfur and selenium → good health but also flatulence
- China: 75% of global garlic → 12 million metric tons globally produced

Calcium
- 1000-1500g/day
    - 800mg/day (0-10)
    - 1200mg/day (10-20)
    - 800mg/day (20+)
        - Most often fulfilled by men, but not enough by women
- Ca^{2+}: most consumed micronutrient → largest portion of the 1-2g of micronutrient intake
- distribution:
    - 99% of consumed calcium → bones and teeth
    - 1% nerve transmission and blood clotting
    - Bones: 1kg of calcium and phosphate
- Middle Ages: loss calcium → osteoporosis, other bone-related diseases
- Athletes: males surpassed recc. daily reqs. (270%) ; females less calcium (118%)

- If consume 250mg/day → 85mg in urine + 265mg stool → net loss = 100mg (bad)
- If consume 820mg/day → net gain = 30mg/day (safe for adults)
    - Increased intake → more left over to use
- Low levels calcium:
    - Linked to mid-life hypertension and heart disease
    - Cause postmenopausal osteoporosis: women 50-75yrs old
    - Cause senile osteoporosis 75+ yrs old

Osteoporosis:

- affects 10% of pop. (350,000 hip fractures in USA)
- Risk factors: Short stature, underweight, early menopause, physical inactivity, alcoholism, smoking, excess caffein, protein, fibre
- Excessive curving of spine "Dowager's Hump"
- Problems dealing with resorption → 40-50yr old women 1-5%/yr. = loss of bone mass → 10-20yrs later for men
    - 5% loss/year = ½ bone mass gone after 14yrs

[70/% concerned with = number of years to reduce by half/ double for bone mass]

- bones less dense: i.e. 10% ↓ hip mass = 170% ↑ fractures
    - 165,000 fractures → 17% die 3 months → 27% die 1 yr.
- Osteoblasts → cells fixing Ca onto bones
- Osteoclasts → remove Ca from bone and body
    - **FOSAMAX (Alendronate):** inhibit osteoclast-caused bone resorption (breakdown)
        - Improve bone mass 3%/ year
        - Causes GI abnormalities, nausea, cramps, gas, obstipation, jawbone (osteonecrosis of jaw = ONJ)
    - **Zometa:** prevents osteoporosis in menopausal women: many side effects but also convenient infrequent dosing
- Absorption (from blood): $3Ca^{2+} + 2PO_4^{3-} + OH^- \rightarrow Ca_3(PO_4)_2OH$ calcium apatite (to bones)
- Resorption (dissolving) from bones to blood
    - $Ca_3(PO_4)_2OH$ = **rydoxy apatite** (bone material)
    - **Fluoridation:** treat molec with fluoride → replaces OH group (same size/charge) to strengthen apatite compound
- Therapy:
    - Ca supps and food ($20mill-$300mill 1980-1989)
        - 2005: $600mill 2009: $1.2bill
    - **Caltrate**: calcium carbonate supp → limestone
    - **Tums**: acid to melt Ca (easier to consume)
    - Calcium carbonate naturally abundant: acid-base test -- contact acid = release CO_2 bubbling

*** *$[2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2]$*

    - some supps slow dissolution rates
        - **Os-Cal:** 100% in 30mins
        - **Oyster Shell**: 2.3% per 30mins

Milk

- skim milk → no fat → same calcium as others
- Metastudy: Ca supp increase hip fractures 60%
    - Supps are calcium citrate/ calcium carbonate → interfere phosphate absorption
    - Too much Ca disturbs natural phosphate absorption → needed for building bones
- Phosphates: i.e.
    - Milk, yoghurt, cheese, meat, fish, chicken, turkey, coke
- Calcium: i.e.
    - Sardines, yogurt, milk, turnip greens, oysters, broccoli

Bone mass detection

- blood analysis
- X-ray
- CT scan
- Single&double-photon absorptiometry (send photons into wrist → least invasive)

Proton-pump inhibitor therapy

- long term use → hip fracture risk
- Taking Prilosec, Nexium, Prevacid → lowering acid levels in stomach
- interfere calcium absorption → stop Hl production in stomach
- Cause problems with calcium breakdown in stomach
- Adjusted odds ratio: 1.44x short term 2.65x long term increase risk hip fracture

Calcium build-up

- heart attacks in postmenopausal women
    - Older women (74yrs old average) taking calcium supps → 50% higher risk heart attack/stroke
- Calcium uptake better when VitD enhanced
- **Calcitonin:** 32aa peptide → calcium & phosphorus metabolism

Estrogen & calcium

- Bone cells → **estrogen receptors**
    - Estrogen: bone production

STUDY: 2 yr. D.b. 2000m Ca supps placebo/ estrogen tablet

    - Increase in bone mass: calcium and estrogen
    - Calcium needed to see effects
    - **Premarin**: (estrogen) → was most prescribed drug in US (with Progestin)
    - **Raloxifine**: estrogen micic with fewer side effects
- Thought taking estrogen with Ca prevented osteoporosis → help prevent h.d.
    - BUT estrogen increase risk uterine cancer, may increase breast cancer
- Estrogen given with **Progestin (Prempro)** → reduce cancer risk: reason for Premarin popularity
    - BUT combined treatment increases breast cancer even more and not as effective in h.d. Reduction → assess absolute risk
    - BUT decrease of cancer freeness from 96.5% to 95%

Relative vs. Absolute risk

- for women 50+
- uterine cancer: estrogen → x5-6 relative risk, 3% absolute risk
- Heart attack: absolute risk 31%

- Risk of heart attack relatively low during estrogen therapy

STUDY: 160,000 post-menopausal → estrogen + progestin → increase h.a., stroke, breast cancer and blood clot risks

- discontinued study due to ethical reasons
- Reduced risk colorectal cancer and hip fractures
- No absolute consensus

Fluoride Ion therapy

- used to treat osteoporosis
- Replaces OH group to form fluoride apatite
- Fluoride in toothpastes → stimulate osteoblast formation → build bone material
- Fluoride helps to build bones

Boron

- helps bone formation
- **BORAX**: commercial cleanser
- **Sodium Borate**: from boron salt → promote bone formation
  - From **Mojave Desert** California
- VitD maintains calcium levels and increases absorption
  - Need 500IU/day, also needs UV-B

Osteoporosis summary

- *many causes*
- *Proper Ca intake from young → reduces osteo risk → Ca supps help*
- *Estrogen supps postmenopause → reduce risk osteo → associated uterine cancer and breast cancer → calcium supp reduce estrogen dose*