

INORGANIC CHEMISTRY

I. MAJOR ELECTROLYTES

- All excreted by the kidneys
- Used with caution for patients with kidney problems

Intracellular Fluid	Extracellular Fluid
<u>Major cations</u>	<u>Major cations</u>
K⁺	Na⁺
Mg⁺²	Ca⁺²
<u>Major anion</u>	<u>Major anions</u>
HPO₄⁻²	HCO₃⁻

*in bold – principal ion

Na⁺

- Essential ion
- Involved in the processes of:
 - ✓ Fluid and electrolyte balance
 - ✓ Action potentials
- Aldosterone – mediates mechanism of sodium level control in the body in times of need (K⁺- *does not have this kind of mechanism*)

Cl⁻

- Mobile; there is presence of leakage channels in the plasma membrane
- Involved in chloride shift → exchange of Cl⁻ with HCO₃⁻
- Principally found in gastric juice (HCl)
- Antidiuretic hormone (ADH) → controls levels of Cl⁻
- Processes that affect renal reabsorption of Na⁺ → Cl⁻ follows Na⁺

HCO₃⁻

- CO₂ released via cell metabolism
- Chloride shift

K⁺

- Establishes resting membrane potential and repolarization phase of action potential
 - Neuron
 - Muscle fibers
- Normal ICF Volume
- Exchanged for H⁺ when K⁺ moves in and out of cells
 - pH regulation in the body

Ca⁺²

- Most abundant mineral in the body
 - Ionized Ca⁺
 - Blood clotting
 - Neurotransmitter release
 - Muscle tone
 - Excitability of nervous and muscle tissue
 - Unionized Ca⁺
 - Bones and teeth
- Regulatory mechanisms of Ca⁺² levels
 - Parathyroid hormone
 - ↑ bone resorption
 - Promotes production of calcitriol
 - Calcitriol
 - 1,25-dihydroxyvitamin D₃ → active form of Vitamin D
 - Vitamin D → promotes Ca⁺² absorption from GIT
 - Calcitonin
 - Promotes deposition of blood Ca⁺² to bone
- Calcium deficiency
 - Osteomalacia (Rickets in children)
 - Bones fail to calcify
 - Soft and rubbery
 - Easily deformed
 - Osteoporosis
 - Porous bones
 - More Ca⁺² lost than absorbed

Absorption of Minerals

- Ca: Vitamin D
- Fe: Vitamin C
 - Red meat, liver → best source of Fe
- Se: Vitamin E
- Zn: Pyridoxine

HPO₄⁻²

- Important H⁺ buffer
- HPO₄⁻²
 - Bones and teeth (85%)
 - Ionized (15%)
- Regulatory mechanisms of HPO₄⁻²
 - Parathyroid hormone effect
 - Bone resorption
 - ↓ blood phosphate level
 - Phosphate excretion in urine
 - Ca⁺² reabsorption
 - Calcitriol effect
 - Promotes Ca⁺² and PO₄³⁻ abs. from GIT

Mg⁺²

- 54% bone matrix
- 46% ionized
 - 45% ICF
 - 1% ECF
- Cofactor for enzymes
- Metabolism: carbohydrates and proteins
- Na⁺/K⁺/ATPase
- Neuromuscular activity
- Nerve impulse transmission
- Myocardial functioning
- Needed for PTH secretion

II. MICROMINERALS

Microminerals/Trace elements/ Micronutrients

- <15mg per day
- Cr³⁺, Co⁺², Cu⁺², F⁻, I⁻, Fe⁺², Mn⁺², MoO₄⁻², Ni⁺², SeO₃⁻², SiO₄⁻⁴, Sn⁺², VO₃⁻, Zn⁺²

Fe⁺²

- Most important transition metal
- Hemoglobin & myoglobin production
 - Hematinic
- Cofactor for enzymes
- Deficiency:
 - Iron-deficiency anemia
 - Hypochromic, microcytic anemia
- Immune deficiency
- Absorption:
 - Duodenum and proximal jejunum
 - +2: oxidation state of Iron absorbed
- Heme vs Non-heme iron
 - Heme: from red meat, liver
 - Non-heme: from plant sources
- Salts:
 - Sulfate
 - Fumarate (highest iron content)
 - Gluconate (lowest)
 - Iron Dextran (IV)
 - Iron Sorbitex (IV)
- Forms of Iron in the body
 - Hemoglobin
 - Oxygen transport
 - Transferrin
 - Transport form
 - Ferritin
 - Storage form
- Chronic toxicity
 - Hemochromatosis (iron overload)
 - Regular therapeutic phlebotomy
 - Deferoxamine → iron-chelating agent
- Seafood, meat, liver, eggs, milk, whole grain cereals
- Salts:
 - Sulfate
 - Gluconate

Zn⁺²

- 2nd most important trace element in the body
- DNA and RNA synthesis
- Cofactor for enzymes
- Normal growth and reproduction
- Wound healing
- Tissue repair
- Release of insulin

- Deficiency:
 - impaired wound healing
 - growth retardation
 - hair loss
 - dermatitis (parakeratosis → scaly, thickened, and inflamed skin)
 - diarrhea
 - anorexia
 - glucose intolerance
- Salts:
 - Sulfate
 - Gluconate

Cu⁺²

- Biologically significant form of Cu
- Necessary in:
 - Hemoglobin synthesis
 - Fe utilization
 - Electron transport
 - Wound healing
- Salts:
 - Sulfate
 - Chloride
 - Gluconate
 - Less irritating to the GIT
 - More readily absorbed
- Metabolism disorders:
 - Wilson's disease (too much)
 - Penicillamine (Cuprimine® - innovator), Trientine
 - Promote excretion of excess Cu through urine
 - Zinc acetate, Zinc sulfate
 - Promote excretion of excess Cu through feces
 - Menke's syndrome (deficiency)

Mn⁺²

- Involved in:
 - Hemoglobin synthesis
 - Glucose use
 - Bone structure
 - Reproduction
 - CNS function
- Salts:
 - Chloride
 - Gluconate
 - Sulfate

Se (as SeO₃⁻²)

- Antioxidant reactions
- Salt:
 - Selenious acid

Mo (as MoO₄⁻²)

- Antioxidant reactions
- Salt:
 - Ammonium molybdate

I (as I⁻)

- Necessary for the production thyroid hormones (T₃ and T₄)
 - Growth and development
 - Body temperature
 - Energy levels
- Deficiency: goiter
- Salts:
 - NaI
 - KI
 - More common because more stable

Cr⁺³

- Modulates carbohydrate metabolism (glucose tolerance factor [GTF])
- Insulin sensitivity
- Promotes lean body mass
- Increases basal metabolic rate
- Salt:
 - Chloride

Trace Elements Injection, USP

- Pharmaceutical preparation:
 - Zinc chloride, Zinc sulfate
 - Cupric chloride, Cupric sulfate
 - Chromic chloride
 - Manganese chloride, Manganese sulfate
 - Selenious acid
 - NaI
 - Ammonium molybdate

III. GROUP IA ELEMENTS

Group IA Elements

- *Alkali metals*
- React with H_2O forming highly basic solutions
- Typically stored under kerosene because they react violently with air or water
- Hydrogen → has both metallic and nonmetallic properties
- Pharmaceutically important:
 - H_2O , acids
 - Li_2CO_3
 - Na compounds
 - K compounds

Water

H_2O

- Universal solvent
- Essential to life
- Maximum density at $4^{\circ}C$
- Highly polar solvent
- Natural/Mineral Waters
 - Basis for classification: presence of dissolved ions
 - Alkaline water
 - Major components: Na_2SO_4 , $MgSO_4$, $NaHCO_3$
 - HCO_3^- → gives alkaline water its alkalinity
 - Carbonated water
 - Contains CO_2 under pressure
 - Effervesces
 - $CaCO_3$ and $MgCO_3$ present as dissolved HCO_3^-
 - Chalybeate water
 - Chalybeate → iron-containing
 - Natural water unsuitable for drinking
 - Fe in solution or in suspension
 - Ferruginous taste
 - $Fe(OH)_3$ or Fe_2O_3 formation upon air exposure
 - Brown colloidal precipitate
 - Lithia water
 - Contains low quantities of lithium as (CO_3^{2-} or Cl^-)
 - No source in the Philippines
 - Saline water (Purgative water)
 - $MgSO_4$, Na_2SO_4 , $NaCl$
 - $MgSO_4$, Na_2SO_4 have laxative properties
 - Sulfur water
 - H_2S → rotten egg odor
 - *Mud baths*
 - Volcanic water

- Deposition of S upon air exposure
- Siliceous water
 - Soluble alkali silicates
- Mineral spa water – acrid (*mapakla*) taste
- Seawater
 - Na^+
 - K^+
 - Mg^{+2}
 - Sr^{+2}
 - Se
 - Br

- Water hardness
 - Consequence of using hard water
 - Lime scale/boiler scale → deposits in percolator/boilers
 - More time to boil
 - Can be treated through water softening process
 - **Hard water**
 - With dissolved ions
 - Temporary hard → contains Ca & Mg ions as HCO_3^-
 - HCO_3^- → easily removed by boiling
 - Permanent hard
 - Harder to remove
 - Can be removed through ion exchanged resin, reverse osmosis
 - **Soft water**
 - “distilled water”
 - No dissolved ions

Purified Water

- Aqueous dosage forms
- NOT for parenterals

Pharmaceutical Waters

- Purified Water, USP
- Water for Injection, USP
 - Not required to be sterile
 - Pyrogen-free
 - Injectable products to be sterilized after preparation
- Sterile Water for Injection, USP
 - Single dose containers (max. 1L)
 - Pyrogen-free
 - Solvent, vehicle, or diluent for already sterilized and packaged injectables
- Bacteriostatic Water for Injection, USP
 - Sterile water for injection with antimicrobial agent/s
 - Prefilled syringes or in vials (max. 30mL)

→ Sterile vehicle for reconstitution of small volumes of injectables

- Sterile Water for Inhalation, USP
- Sterile Water for Irrigation, USP

Acids

Strong Acids

- Fuming acids
 - HCl: 36.5 – 38% w/w
 - HNO₃: 60 – 71% w/w
 - H₃PO₄: 85 – 88% w/w
 - H₂SO₄: 95 – 98% w/w – strongest
- Concentrated acids expressed as w/w; diluted acids expressed as w/v
- High corrosive
- Binary acids: acids with 2 kinds of atoms
- Oxyacids: acids which contain oxygen

HCl

- Technical grade: Muriatic acid
- Used as cleaner
- Major component of gastric juice

H₂SO₄

- “Oil of Vitriol” (vitriol → sulfate-containing)
- Diprotic acid (can ionize in water)
- Highly exothermic process when diluted with water
 - Most pronounced in H₂SO₄
 - Always add acids to water
- Hot, concentrated: strong oxidizing acid

HNO₃

- *Aqua fortis*
- *Eau forte*
- Oxidizing acid (even at room temp/diluted)

H₃PO₄

- Phosphoric acid/Orthophosphoric acid
- Etching solution
- Component in cola beverages → imparts tartness
- Buffer
- Oxidizing acid (event at room temp/diluted)

HPH₂O₂

- Hypophosphorous acid/Phosphinic acid
- P atom: +1 (with reducing property/RA)
P atom = Group 5A
→ +1 can still undergo oxidation to +5 (max. +5 = RA)
- Used as antioxidant

HF

- Hydrogen fluoride/Hydrofluoric acid
- Reacts with glass (and alkali hydroxides: NaOH, KOH)
- Highly corrosive

Phosphate salts

- Nomenclature

Chemical formula	IUPAC (Chemistry)	IUPAC (Pharmacy)	Classical
PO ₄ ⁻³	Phosphate	Tribasic phosphate	Tertiary phosphate
HPO ₄ ⁻²	Hydrogen phosphate	Dibasic phosphate	Secondary phosphate
H ₂ PO ₄ ⁻	Dihydrogen phosphate	Monobasic phosphate	Primary phosphate

- Mostly with medical purpose
- Tribasic – not used internally; only as laboratory reagent
- In prescription: Sodium phosphate [refers to dibasic salt]

CH₃COOH

- Glacial acetic acid/GAA
- Solid, glassy appearance when congealed = Glacial
- Caustic and vesicant
- Acidifying agent
- Forms:
 - 100% w/w sol'n → GAA
 - ~36.5% w/w sol'n → acetic acid, NF
 - 6% w/v sol'n → diluted acetic acid

Dil. CH₃COOH

- Vinegar
 - Cervical cancer screening in low resource settings
 - Neutralize marine invertebrate stings (i.e., Jellyfish, sea urchin stings)
 - current recommendation = plain sea water/vinegar
 - Vinegar (4-6% AA) – w/ local anti-infective action
- *Almost all common inorganic diluted acids = 10% w/v solution

Alkali Hydroxides

- Highly corrosive
- Very deliquescent
 - Hygroscopic – tendency of substance to absorb moisture in the atmosphere but prolonged exposure to environment can lead to deliquescence; also Deliquescent
- Incompatible w/ glass

A substance is said to be:

- Efflorescent
→ Loss of water of crystallization form a crystalline substance
- Hygroscopic
→ Ability to remove water from air
- Deliquescent
→ Ability to take on sufficient water from the environment to form a liquid
- Synonyms:
 - NaOH – caustic soda
 - KOH – caustic potash; potash lye
- Alkalizing agent – strong bases
- Saponifying agent
→ Hard soaps – soaps made from NaOH
→ Soft soaps – soaps made from KOH
(*Soaps – alkali salts of high MW fatty acid; strong base + fat)
- Chemical reagent
- Drain cleaner – technical grade
- Cuticle remover – dil. KOH (0.4%)
- Hair rebonding
- Escharotic – to destroy unwanted tissues (i.e., warts)
- KOH smear
→ Mounting fluid for filamentous fungi (candida)
- How do soaps cleanse?
→ Micelle formation – soaps have polar and nonpolar portion amphiphilic mol. → emulsifies grease/dirt
- Action of hard water on soap
→ Soaps are usually formulated with chelating agents to react with the ions enhance stability
→ Hard water contains Ca^{2+} & Mg^{2+} ions
e.g., NaOH + coconut oil (w/ palmitic acid) [saponification] → sodium palmitate (soluble soap; hard soap) + glycerol (side product)
→ If soluble soaps are used with hard water, a portion of it will react with Ca^{2+} ions → calcium palmitate (insoluble soap/soap scum that will ppt out; devoid any cleansing activity)

Strong Ammonia Solution

- Concentrated ammonia
- Spirit of Hartshorn
→ Originally obtained by destructive distillation of horns of small deer
- ~28% w/w NH_3

- Detergent, stain remover

Effect of alkali on hair:

- Permanent oxidation hair color – contains ammonia to increase pH such that the hair cuticle will swell to enable formation of chemicals/pigments in hair
- TGA- based waving lotions
 - TGA – thioglycolic acid (pangkulot)

Lithium (Li)

- Lightest metal
- First formal member of alkali metals
- Stored under kerosene; floats on kerosene
- Batteries
- Li_2CO_3 & Lithium citrate – used as mood stabilizers; treatment of bipolar disorder

Li_2CO_3

- Mood stabilizers
- Treatment of bipolar disorder
 - Narrow TI
 - Promotes Na^+ excretion → ensure adequate Na intake; hyponatremia (NaCl tablets)
 - 450mg MR tab (e.g., Quilonium-R®)
- Interferes w/ transmembrane Na^+ exchange
→ Li competes w/ Na ion in Na channels → depressant effect
- Alters release of aminergic neurotransmitters (dopamine)
- Blocks inositol metabolism

Na Compounds

- Na ion is a carrier ion (Inorganic ions = carrier ions)
- Inorganic ions: Electrolyte replenisher
- Therapeutic activity is due to the anion present
- Cation of choice to optimize pharmaceutically utility of organic medicaments
- Caution: heart & kidney conditions
- Inorganic ions as carrier ions → water-soluble forms of drugs (e.g., Sodium → water-soluble & stable form)

➢ Dextromethorphan HBr	➢ Atorvastatin Calcium
➢ Hyoscine N-Butylbromide	➢ Sodium Picosulfate
➢ Thiamine Mononitrate	➢ Amoxicillin + Potassium Clavulanate (Augmentin®)
➢ Streptomycin Sulfate	➢ Heparin Sodium
➢ Pen VK	➢ Insulin preparation
➢ Lysine HCl	➢ Tocopheryl Acetate
	➢ Rosuvastatin Calcium

NaHCO₃

- Reaction w/ heat → readily decomposed by heat
- Systemic & urinary alkalizer
- Systemic antacid
 - Direct source of bicarbonate
 - Very water soluble (easily absorbed) → more prone to SE → systemic alkalosis, electrolyte imbalance, etc.

[preferred: local antacids]

Antipruritic – as a paste [e.g., baking soda + water → insect bite]

- Effervescent preparations – CO₂ liberated masks the unpleasant taste source of carbonates; with a weak acid: citric or tartaric acid
- Antidote: H₂O-soluble Zn²⁺ salts → to prevent formation of ZnCl₂ in the stomach because ZnCl₂ is highly corrosive
- Mild abrasive
- Parenteral form: 8.4% solution
- Non-pharmacological uses:
 - Baked products (crispy)
 - Bath bombs
 - Household cleaning products

Systemic Alkalizers

Direct HCO ₃ ⁻ sources	Indirect HCO ₃ ⁻
<ul style="list-style-type: none">• NaHCO₃• KHCO₃	<ul style="list-style-type: none">• NaCH₃COO•3H₂O, KCH₃COO• Sodium citrate, Potassium citrate• Sodium lactate <p><i>*requires metabolism to be converted to HCO₃⁻</i></p>

Antacids

- Chemical nature: chemically weak bases
- Neutralize acids (xs HCl in stomach)
e.g., NaHCO₃ + xs HCl → H₂O + NaCl + CO₂ (belching or flatus)
- Decrease pepsin activity
- Primary role: for IMMEDIATE pain relief → Heartburn, dyspepsia
- Heal ulcers + strengthen gastric mucosal barrier
- PUD – LT mgt – use PPI; ST mgt – (for acute attacks ONLY) – H₂ blockers & antacids
- Antacids + H₂-blockers equally effective – PUD

1. Systemic

- NaHCO₃; KHCO₃
- Rapid onset; immediate relief
- Water soluble; absorbed in systemic circulation → systemic alkalosis, electrolyte imbalance, milk alkali syndrome

2. Non-systemic

- All other alkali except NaHCO₃ & KHCO₃ [MgOH, Ca(OH)₂, Al(OH)₃]
- Water insoluble but will dissolve in the presence of HCl
- Unlike in systemic, unreacted HCO₃ will not go to systemic circulation → adv: less SE

Side Effects of Antacids

NaHCO ₃	CaCO ₃
<ul style="list-style-type: none">• Acid rebound<ul style="list-style-type: none">➔ More HCl is produced therefore antacids are for acute attacks• Electrolyte disturbances• Systemic alkalosis• Milk-alkali syndrome/ Burnett's syndrome<ul style="list-style-type: none">➔ [Cl/never co-administer] Milk + Antacids = reversible renal failure	<ul style="list-style-type: none">• Acid rebound• Stimulate gastric secretion• Constipation• Hypercalcemia• Milk-alkali syndrome/ Burnett's syndrome<ul style="list-style-type: none">➔ [Cl/never co-administer] Milk + Antacids = reversible renal failure

Al-containing antacids	Mg-containing antacids
<ul style="list-style-type: none">• Phosphate depletion → esp. w/ kidney failure – mitigate hyperphosphatemia → Al(OH)₃ – used as phosphate binder for px w/ kidney disease• Constipation “Al-ang tae” (walang tae)• Osteoporosis and osteomalacia• Neurotoxicity	<ul style="list-style-type: none">• Diarrhea (Mg-tatae)• Hypermagnesemia <p>Mg(OH)₂ + HCl → water + MgCl₂ → MgCl₂ – Mg salts are saline laxatives → SE: Diarrhea</p>

General Considerations

- Non-systemic > Systemic [less likelihood of SE]
- Suspensions (shake well first) > Tablets (chewable tablets; warm water – faster effect) [Suspension → better ANC – acid neutralizing capacity]
- Mixtures > Single agent [e.g., Maalox; counteract side-effects of one another → less SE]

Combination Preparations

- NaHCO_3 , CaCO_3 & Sodium alginate (raft-forming antacid) (Gaviscon®)
- $\text{Al}(\text{OH})_3$ & $\text{Mg}(\text{OH})_2 \rightarrow$ most common (Maalox®)
- Alumina, Magnesia & Simethicone (for reflux if w/ silicone polymer or antifoaming agent) (Kremil-S®)
- CaCO_3 , $\text{Mg}(\text{OH})_2$ and Famotidine (Kremil-S plus®)

Antacids ↑ gastric pH

Must be administered 2hrs before or after because of DI w/:

- Tetracyclines
- Quinolones
- Fe supplements
- Digoxin

Alginic Acid

- Raft-forming antacid
- Protective barrier that floats on the surface of gastric contents
- Raft preventing reflux

NaCl

- Tonicity-adjusting agent
 \rightarrow NaCl equivalents
- Electrolyte replenisher
 \rightarrow closely resemble composition of ECF (extracellular fluid) as a single salt
- Isotonic = 0.9% NaCl

Sodium Compounds

- Bacteriostatic Sodium Chloride for Injection
 - For reconstitutions of small volumes of parenterals ONLY

➤ Vehicle – IV admixtures	➤ Substitution for plasma in volume expansion
➤ Fluid and electrolyte replacement	➤ Enema
➤ Reconstitution of drugs (small volumes)	➤ Irrigation \rightarrow 0.9% or 0.45% (half normal saline)
	➤ Corneal edema \rightarrow 2% or 5%

Parenteral NaCl Preparations

- 0.9% NaCl (NSS)
- 5% Dextrose in 0.3% NaCl
- 5% Dextrose in 0.45% NaCl (half normal saline)
- 5% Dextrose in 0.9% NaCl (normal saline)

Parenteral Rehydration Solutions

Combination parenteral products

- Ringer's Solution (Isotonic sol'n of 3 chlorides: NaCl, KCl & CaCl_3)
- Lactated Ringer's Solution (Ringer's Lactate Solution/Hartmann's solution)
 \rightarrow 5% Dextrose in LRI
 \rightarrow NaCl, KCl, CaCl_3 & sodium lactate \rightarrow systemic alkalizer; indirect source of bicarbonate ion
- Acetated Ring's Solution
- Darrow's Solution
- Balanced Multiple Maintenance Solution (w/ 5% Dextrose)
- Balanced Multiple Replacement Solution
 \rightarrow Na^+ , K^+ , Mg^{+2} , Cl^- , Acetate, 5% dextrose
- Balanced Multiple Replacement Solution w/ pH 7.4
 \rightarrow Na^+ , K^+ , Mg^{+2} , Cl^- , Acetate (*systemic alkalizer; indirect source of bicarbonate ion*)

Ophthalmic Preparations

- Ointment
- 5% solution
- Balanced salt solution
 \rightarrow Intraocular Irrigating Solution (BSS) – used during eye surgery
 \rightarrow NaCl, KCl, CaCl_2 , MgCl_2 , H_2O , NaOAc, Na citrate, WFI

NaCl

- Other Uses
 \rightarrow Preservative ($> -6\%$)
 - *Clostridium botulinum*

Oral Rehydration Solution

- ORS-75 Replacement
 \rightarrow Reduced osmolarity
- Oresol
 \rightarrow Components:
 - NaCl
 - Trisodium citrate dihydrate
 - KCl
 - Glucose, anhydrous \rightarrow Reconstitute with clean potable water
 \rightarrow Discard unused solution after 24 hours

Oral Preparations containing NaCl

- Oral Colonic Lavage Solution (PEG-3350 Electrolyte Solution)
 \rightarrow Components:
 - PEG-3350 – nonabsorbable; osmotic laxative

- NaHCO_3
- NaCl
- Na_2SO_4
- KCl
- Sports drinks
- NaCl tablets
- NaCl tablets for solution
- Sodium chloride and Dextrose tablets
- Hemodialysis solutions
 - Solution concentrate
 - $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$
 - $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$
 - $\text{NaOAc} \cdot 3\text{H}_2\text{O}$
 - NaCl
 - Potassium-free Dialysate
 - Acetate
 - Bicarbonate
 - Low Calcium Dialysate
- Nebulizing solution
- Nasal drops and spray
- NaCl for irrigation

Sodium Citrate

- Uses:
 - In vitro:
 - Anticoagulant for blood samples
 - Citrates form complexes with Ca^{+2}
 - Sequestering agent
 - In vivo:
 - Systemic and urinary alkalizer
 - Blood coagulant
 - Expectorant
 - Laxative – if consumed at large amounts

Disodium EDTA

- Uses:
 - Anticoagulant for blood samples
 - Chelating agent for Ca^{+2}
 - Antioxidant synergist

MSG

- Uses:
 - Increases palatability of bitter drugs (with sugar)
 - Formerly used for the management of hepatic coma
 - Currently used: *Lactulose*
 - Flavor enhancer

Potassium Replenishers

- KCl
- Potassium citrate

NH_4^+

- Pseudoalkali metal ion
- Acidic aqueous solutions due to hydrolysis
- Ammonia solutions:
 - Strong Ammonia solution – not used as a respiratory stimulant
 - Diluted Ammonia solution
 - Ammonia water
 - 10% Ammonia solution
 - Respiratory stimulant – because of its very pungent odor
 - Ammonium Carbonate
 - Ammonium Chloride
 - *Salmiak*/Salmiac or Sal ammoniac
 - Systemic acidifier
 - Respiratory stimulant – because of its very pungent odor
 - Aromatic Ammonia Spirit
 - Respiratory stimulant – because of its very pungent odor

IV. COINAGE METALS

Cu

- “*tanso*”
- Reddish-colored metal
- 3rd best conductor of electricity (1st – Ag, 2nd – Au)
- Uses:
 - Typically used in wiring and motors
 - Copper-impregnated IUDs
- Important alloys: (Bronze – Sn; Brass – Zn)
 - Bronze (*tansong dilaw*)
 - Cu & Sn
 - Brass
 - Cu & Zn
- Common oxidation states
 - Cu⁺¹
 - Unstable
 - Has tendency towards disproportionation (atom in a certain compound undergoes simultaneous oxidation and reduction)
 - ✚ Example: $\text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + \text{O}_2$
 - Water-insoluble
 - White solids except:
 - $\text{Cu}_2\text{S} \rightarrow$ black
 - $\text{Cu}_2\text{O} \rightarrow$ reddish brown
 - ✚ Fehling’s test
 - ✚ Benedicts’ test
 - ✚ Barfoed’s test
 - Cu⁺²
 - Biologically and medically relevant
 - Blue color
 - Due to $\text{Cu}(\text{H}_2\text{SO}_4)_4^{+2}$ [tetra aqua copper (II) ion]
 - ✚ Cu^{+2} dissolved in water
 - Protein precipitant
 - Compounds:
 - Cupric sulfate
 - ✚ “blue vitriol”
 - ✚ Agricultural poison
 - ✚ Algaecide
 - ✚ Antidote for white phosphorous poisoning
 - = $\text{P}_4 \rightarrow \text{PO}_4^{-3}$
 - = $\text{Cu}^{+2} \rightarrow$ Cu metal
 - ✚ Emetic chemical reagent
 - ✚ Trace element

Ag

- Best conductor of heat and electricity
- Tarnishes slowly in air
- Alloy:
 - Sterling silver (92.5% Ag, 7.5% Cu)
- Uses:
 - Dental alloys
 - Photochromic lenses (transition lenses)
 - Mirrors
 - Silver is the best reflector of visible light
 - Used in Tollen’s test
- Argyria – bluish-black discoloration of skin; deposition of metallic silver on the skin
- Antidote for Ag ingestion: NaCl through precipitation
- Ag Stains:
 - Indelible ink $\rightarrow \text{AgNO}_3$
 - Can be removed by:
 - I_2 tincture then $\text{Na}_2\text{S}_2\text{O}_3$
 - KCN
- Compounds
 - AgNO_3
 - Latin name: *Argenti nitras*
 - White crystal
 - Light-sensitive; should be stored in opaque or amber-colored bottles
 - Most common water-soluble salt of Ag
 - Strongly bactericidal
 - Heavy metal salts exhibit protein precipitant action
 - Oligodynamic property
- **Uses:**
 - Used before as prophylaxis for gonorrhea ophthalmia neonatorum (1% eyedrops)
 - Caustic
 - Chemical reagent
 - Silver nitrate stick
 - Indelible ink
 - Photography (because of silver halides)
- AgBr
 - Used in photography
- AgI
 - Used for cloud seeding (artificial rain)
- Silver Sulfadiazine
 - Topical antibacterial
 - Flammazine®
 - 1%
 - For burns (2nd and 3rd degree burns)
- Silver technology
 - Anti-odor textiles

- Antiperspirant products
 - Nivea (silver acetate)
- Home appliances
- Silver proteinates
 - Obsolete (1999: US FDA not recognized as safe and effective)
 - Mild Silver Protein
 - 19-23% Ag (\downarrow free Ag^+ ion)
 - Strong Silver Protein
 - 7.5-8.5% Ag (\downarrow free Ag^+ ion)
 - Part of PA-TSC-SP (periodic acid-thiosemicarbazide silver proteinate) stain for carbohydrates and proteoglycans
 - Colloidal Silver Protein
 - 18-22% Ag

- Gold Sodium Thiomalate
- Auranofin
 - + Only orally administered gold compound

Au

- "King of all metal"
- Yellowish-color
- Gold salts and solutions are light-sensitive
- 2nd best conductor of heat and electricity
- Most malleable metal
 - Leaf
 - Food wires (computer chips)

Uses:

- Jewelry
 - Measured in karats
 - 24 karats = 100% gold
 - \downarrow karat = \downarrow gold content, \uparrow alloying
- Electroplating
- Gold nanoparticles
 - Catalyst
- Solvents for Gold:
 - Aqua Regia
 - 3:1 (HCl: conc HNO_3)
 - Best solvent for gold
 - Selenic acid
 - Single acid that can dissolve gold
- Common oxidation states:
 - Au^+ ion
 - Unstable; has tendency to undergo disproportionation reaction
 - Au^{+3} ion
 - Alkaloidal reagent
- Chrysotherapy – use of gold compounds to treat diseases
 - Non-biological DMARDs
 - 2nd line agent for the management of Rheumatoid arthritis
 - NDLE
 - Aurothioglucose

V. GROUP IIA ELEMENTS

- Alkaline Earth metals
- Pharmaceutically important:
 - Ca^{+2}
 - Mg^{+2}

Be

- Aka *Glucinum* – due to sweet taste of Be salts
- Most toxic metal
 - Replaces Ca^{+2} and Mg^{+2} in the body
 - Itai itai disease → Cd ingestion, also replaces Ca^{+2} in the body, characterized by severe bone pain

Mg

- Magnesia (Greece)
- Lightest of all structurally important metals
- Central metal ion in chlorophyll
- Component of Grignard Reagent (RMgX)
- Compounds:
 - **Water-soluble compounds**
 - Mg replenishment
 - Saline laxative
 - $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$
 - **Water-insoluble compounds**
 - Non-systemic antacids (weak bases)
 - Magaldrate
 - MgCO_3
 - Mg(OH)_2
 - ✚ Milk of Magnesia
 - ✚ 7-8.5% suspension
 - ✚ Typically packaged in blue bottles
 - MgO
 - ✚ Calcinated Magnesia, Magnesia Usta (*usta* – burnt)
 - ✚ Calcination → strong heating of inorganic matter
 - ✚ $\text{MgCO}_3 \rightarrow \text{MgO} + \text{CO}_2$
 - Mg trisilicate
 - ✚ Slow-acting antacid but exerts protective effect
 - ✚ Forms silicic acid → coats ulcers in the stomach → promotes healing
 - Magnesium silicates
 - ✚ Talc, asbestos
 - $\text{Mg(SO}_4)_2$
 - Epsom salt, bitter salt
 - $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$

Uses:

 - Saline laxative

- Anticonvulsant (IV; in cases of eclampsia and pre-eclampsia)
- Antiarrhythmic agent
- Tocolytic
 - 250mg/mL, 500mg/mL
- Anti-inflammatory (topical)

Ca

- Only pharmaceutically relevant form: Precipitated CaCO_3
- Prepared CaCO_3
 - Native CaCO_3 purified by elutriation
 - “elutriation” → purified by washing
- **Precipitated CaCO_3**
 - Steps: Calcination → Slaking → Carbonation
 - Calcination
 - CaCO_3 (ignition) → $\text{CaO} + \text{CO}_2$
 - ✚ CaCO_3 ” limestone (native)
 - ✚ CaO : quicklime/lime
 - Slaking
 - Controlled addition of water to a substance
 - $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2$
 - ✚ Ca(OH)_2 : slaked lime
 - Carbonation
 - $\text{Ca(OH)}_2 + \text{CO}_2 \rightarrow \text{CaCO}_3 \downarrow + \text{H}_2\text{O}$
 - ✚ CaCO_3 : precipitated/purified CaCO_3
- **Calcium supplements (oral)**
 - Carbonate
 - Antacid
 - Lactate
 - For geriatric population
 - Dibasic Phosphate (dihydrate)
 - Dental abrasive
 - Acetate
 - Citrate
 - Glubionate
 - Gluconate
 - Phosphate
- **Calcium Replenishers (Parenterals)**
 - Chloride
 - Systemic acidifier
 - Gluconate
 - Antidote for F exposure
 - Gluceptate
 - Levulinate
- Compounds
 - CaCl_2
 - Anhydrous form is used as drying agent
 - Antagonizes cardiac effects of Mg^{+2} and K^+

→ Ca(OH)₂

- Topical solution
- Lime water
- *Baryta water*
 - Saturated of Ba(OH)₂ in water
 - Used to detect carbonated and bicarbonates in solution
- ↑ solubility as ↓ T
 - Should be dispensed at 25C
- Local astringent
- Laboratory reagent
- Pharmaceutic necessity for the preparation of calamine lotion

→ **Calcium Sulfate**

- 2 pharmaceutically relevant forms:
 - Calcium Sulfate, NF
 - ✚ CaSO₄·2H₂O
 - ✚ Gypsum
 - ✚ Tablet diluent
 - Plaster of Paris
 - ✚ (CaSO₄)₂·H₂O
 - ✚ CaSO₄·1/2H₂O (hemihydrate)
 - ✚ Exsiccated calcium sulfate
 - ✚ Surgical cast
 - ✚ Dental impression

Sr

- Red color of fireworks
- Modern glow in the dark paints and plastics
 - Strontium aluminate
- Sr-90
 - Bone marrow
 - Best high energy beta emitter (but Sr-89 is used in radiopharmaceuticals)

Ba

- Water-soluble compounds are poisonous
- Nitrate: green color of fireworks
- Antidote: Na₂SO₄ or MgSO₄ (Ba must be precipitated)
- BaSO₄
 - Only pharmaceutically relevant compound of Ba
 - Should be free from other water-soluble compounds of Ba
 - Radiographic Contrast Media
 - Radiopaque
 - X-ray imaging of GIT (due to high atomic weight of Ba)
 - Absorbs X-rays
 - “barium meal”
 - Name must be written in full in Rx

Ra

- Not used medicinally at present
- 1st radionuclide used in medicine
- Ra-223: used for the treatment of bone cancer
 - Alpha-emitter
 - Alpha emitters are not used anymore at present
 - Beta: used to destroy unwanted tissues
 - Gamma: used for imaging studies
- Luminous paints
 - “radium girls” → gave rise to the concept of occupational safety
- Discovered by Marie Curie (also Po)

VI. GROUP IIB ELEMENTS

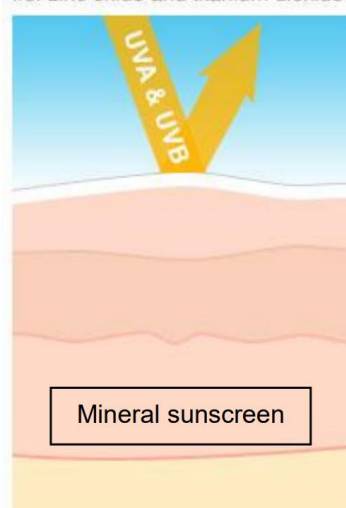
Zn

- Galvanizing
 - Zn coated on steel or Fe to prevent rusting
- Element present in insulin
- Compounds
 - Zinc sulfate
 - White vitriol
 - Weak antiseptic
 - Protein precipitant activity
 - 0.25% ZnSO_4 solution: only US FDA OTC ophthalmic astringent
 - Used for the management of acute diarrhea (WHO)
 - In conjunction with ↓ concentration ORS
 - Also zinc acetate or zinc citrate (but not zinc chloride → highly corrosive)
 - Dietary supplement
 - Zinc capsules, tablets
 - Emetic
 - Zinc gluconate
 - Complementary therapy for common cold
 - Immune-boosting property
 - Dietary supplement
 - Zinc chloride
 - ZnCl_2
 - Highly substance
 - Butter of zinc
 - "butter of" → chloride salt
 - Burnett's Disinfecting Fluid
 - Protein precipitant action
 - Astringent and antiseptic
 - + Component of the original Astring-O-sol mouthwash
 - + No alcohol-based mouthwash anymore → oral cancer
 - Caustic
 - Dentin desensitizer
 - Zinc oxide
 - ZnO
 - Flowers of zinc
 - Philosopher's wool
 - Lana philosophica
 - Water-insoluble white powder
 - Thermochromic property
 - + Yellow color develops at 400C - 500C that disappears on cooling

- Pigmentary grade
 - + >200nm
 - = Colorant
 - = Skin protectant
- Attenuation grade (formerly used as an inorganic sunscreen/UV filter)
 - + Micronized
 - = 100-200 nm
 - = usually used in cosmetics
 - + Nanoparticle/microfine
 - = <100 nm (UV filter – UVA)

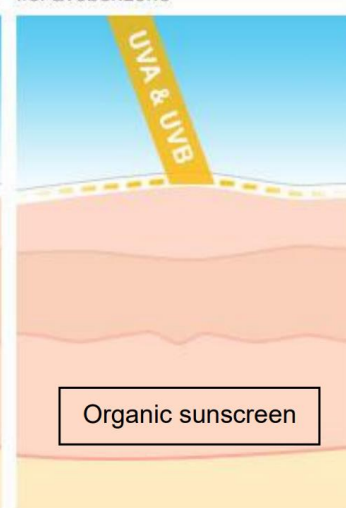
Physical Sunscreen

i.e. zinc oxide and titanium dioxide



Chemical Sunscreen

i.e. avobenzone



UV Filters	
INORGANIC	ORGANIC
Advantages	Advantages
Chemically inert	
Full UV protection (UVA & UVB)	
Low skin irritancy potential	
Disadvantages	Disadvantages
Cosmetic issue	Stinging sensation on skin
Safety issues <ul style="list-style-type: none"> - Photoreactivity - May generate reactive species (coated) 	No UVB protection

Flowers of Benjamin – Benzoic acid
 Flowers of Sulfur – Sublime Sulfur
 Flowers of Zinc – Zinc Oxide

Hg

- Compounds are poisonous
 - Mercuric (Hg^{2+}) compounds MORE toxic than mercurous (Hg_2^{2+}) compounds
 - Hg_2^{2+} ions are also unstable because of their tendency for disproportionation
- Quicksilver, asoge
- Only metal that exists as a liquid at room temperature
- Thermometers
- Amalgams: alloys of metal with mercury
 - Used for recovery of gold and in dental fillings
- Spills: $\text{Hg} + \text{S} \rightarrow \text{HgS}$ (black ppt)
 - Spray powdered sulfur and leave for a few days until black ppt seen
- Former therapeutic uses:
 - Diuretic
 - Antiseptic
 - Antisymphilitic
 - Laxative: e.g., calomel (Hg_2Cl_2) an irritant laxative
 - Antiparasitic
 - Fungicide
- Hg_2Cl_2
 - Kalos (Gk. Beautiful)
 - Melas (Gk. Black)
 - Black powder forms with addition of caustic alkali
 - Pink disease: Infant teething powders
 - Other synonyms: calomel, mild mercury chloride
- HgCl_2
 - Mercuric chloride, corrosive sublimate
 - Disinfection of surgical instruments
- Hg-containing ointments appeared in major pharmacopoeias until 1960s
 - Eczema, psoriasis, syphilitic warts
- Hg one of the oldest drug prototypes
 - Mersalyl
 - Drug prototype for: Ethacrynic acid, a diuretic (1962)
- Antiseptic/Disinfectant (still can be seen now)
 - Merbromin (Mercurochrome®)
 - Thimerosal (Merthiolate®)
 - Preservative for vaccines, antitoxins, and immune sera

VII. GROUP IIIA ELEMENTS

Boron

- Toxic, very limited use at present and usually for external use
- Elements and compounds:
 - Boric acid
 - Borates
 - Perborates
- Pyrotechnic Flares
- Borosilicate Glass (Boric Oxide) e.g., Pyrex

H_3BO_3

- White powder, Unctuous (slippery in the skin)
- 2.2% aq. Solution
 - Isotonic with lacrimal fluid
- Eye preparations
 - Tonicity-adjusting agent
 - Bacteriostatic eyewash
- Borate buffer systems

Sodium Borate (Borax)

- In water, undergoes extensive hydrolysis forming an alkali solution
- Alkalizing agent
- Antimicrobial preservative
- Local anti-infective
- Buffer component (eyewash)
- Water softener
- Food preservative (banned for now)
 - For external use. (*all internal use functions are obsolete)

Aluminum

- Strong, lightweight, corrosion-resistant metal
- 2nd most important metal (after Fe)
- Amphoteric
- Low density
- Non-toxic
- High thermal conductivity and excellent corrosion resistance
- Malleable (2nd)
- Ductile
- Non-magnetic, non-sparking
- Packaging material
 - Food and beverages
 - Aerosols
 - Pharmaceuticals

Aluminum Compounds

- **Water-Soluble compounds**
 - Aluminum chloride
 - Aluminum sulfate
 - Alums
 - Aluminum chlorohydrate
 - Pharmacologic action: Astringent action (protein precipitant activity)
 - Water soluble: typically used as Antiperspirants
- **GI-drugs**
 - Aluminum hydroxide: non-systemic antacid
 - Sucralfate: cytoprotector
 - Magaldrate: non-systemic antacid
 - Aluminum silicates:

Pharmacological Action:

Astringents

- Locally applied protein precipitates with decreased cell penetrability
- Irritant or caustic at high concentration
- Astringents: Al^{3+} , Fe^{3+} , MnO_4^- , Zn^{2+} , Bi^{3+} , Lime water
- Astringents
 - Hemostat: aka styptic (stops bleeding wounds)
 - Hemostats now are usually iron salts
 - Iron: Fe^{2+} - hematinic substance that tends to increase the amount of hemoglobin in the blood; Fe^{3+} -hemostat
 - Antidiarrheal
 - Decrease mucous membrane inflammation
 - Promote healing
 - Toughen skin
 - Antiperspirant

Sweat glands in the Human Axilla

- Apocrine glands: When gram (+) act on these glands → responsible for smell
- Eccrine Glands
- Sebaceous glands
- Gram (+) bacteria

Types of Body Odor

- Sour
 - *Micrococcus*
 - Isovaleric acid
- Acrid or pungent
 - Lipophilic diphtheroid bacteria
 - Androsterol, androsterone

Antiperspirant vs. Deodorant

- Antiperspirant: Controls sweating by forming a protein plug; It forms a precipitate in the pore of sweat gland
- Deodorant: Neutralizes the smell but does not block sweat production

Antiperspirants

- Aluminum chloride
 - Aqueous solutions are acidic
 - Clothing damage, skin irritation
- Partially hydrolyzed Al^{3+} salts
- Al-Zr salts (Disadv: Hypersensitivity, Granuloma, brown skin in armpits)
- Alums (tawas)
- Aluminum sulfate

Partially Hydrolyzed Al salts

- Aluminum chlorohydrate (ACH)
 - 10-25%
- Aluminum sesquichlorohydrate
- Aluminum zirconium chlorohydrate
- Aluminum zirconium tetrachlorohydrate gly
- Hypersensitivity granuloma due to use of aluminum zirconium complex

Alums

- Double salts: $\text{M}^+_2\text{M}^{3+}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$
- True alum vs. False alum
 - True Alum: Monovalent and divalent
 - Ferric ammonium sulfate (Fe charge is 3+, and ammonium charge is 1+)
 - Potassium Alum
 - Ammonium Alum
 - False Alum: Multivalent and trivalent
 - E.g., Ferrous ammonium sulfate (Fe charge is 2+, ammonium charge is 1+)
- Astringent
- Hemostat
- Cosmetic active

GI Drugs

- $\text{Al}(\text{OH})_3$ Gel
 - Antacid
 - Lowest acid neutralizing capacity
 - Phosphate binder
 - Skin protectant (0.275% gel)
- Sucralfate
 - Sucrose sulfate-aluminum hydroxide complex
 - Cytoprotector

Gallium (Ga)

- Eka-aluminum
- The only metal that melts at near human body temperature (29.75°C)
- Gallium (III) nitrate
 - Cancer-related hypercalcemia
 - Bind with transferrin

Thallium (Tl)

- Element and compounds are toxic
 - Thallium 201 (only use today)
- Ant poison, rodenticide, depilatory
- Prussian Blue (Ferric ferrocyanide) is antidote for Ce and Tl toxicity
 - Prevents absorption of ^{137}Ce and ^{201}Tl

VIII. GROUP IIIB ELEMENTS

Cerium (Ce)

- Most abundant of the rare earth metals
- $\text{Ce}(\text{SO}_4)_2$: Chemical reagent

IX. GROUP IVA ELEMENTS

- First member is nonmetallic (metalloid → metallic) [evident in grp. IVA, VA, VIA]

Carbon (C)

Allotropes of C

- Exhibits nonmetallic catenation (another element that can do this is Si)
→ Catenation: ability to form bonds with itself
- Two natural allotropes: Crystalline & Amorphous
→ Crystalline: diamond (hardest mineral) and graphite (manufacture of lead and pencil)
→ Amorphous: bituminous coal (soft coal) and anthracite (hard coal)
- Man-made allotropes: Fullerenes (C₆₀, buckyball) and Graphene

Activated Charcoal

- General antidote
→ Usually for HIGH MW Poisons
- Intestinal adsorbent
→ Original formulation of Diatabs makes use of attapulgite and charcoal
- Gas absorption in instrumentation
- Cosmetic active

Substances not effectively adsorbed by charcoal

- Strong acids and alkalis
- Cyanide
- Alcohols
→ EtOH, MeOH
- Organic solvents: ethylene glycol
- Heavy metal salts
→ Pb, Mg
- Inorganic salts
→ Fe, Li, K
→ Fluoride
- Common denominator among all these substances: LOW MW

Carbon Dioxide Therapeutic Gas

- Respiratory stimulant: 5-7% O₂
- Carbogen Therapy 5%: 95%, 10%: 90%
- Headspace Gas/Air displacement
→ To displace oxygen (e.g., in chips, oxygen is displaced para di kumunat)

Supercritical CO₂

- "Green Solvent"
→ Decaf coffee
→ Spice extracts: vanilla, pepper, cloves
→ Volatile oil extraction: flowers
→ Dry cleaning

CO₂

- Natural greenhouse effect
- Popping candy
- Carbonation of beverages
- Generation of smoke
- Baked goods
- Refrigerant
→ For solid CO₂ or dry ice
→ 2 refrigerants: Solid CO₂ and Liquid nitrogen

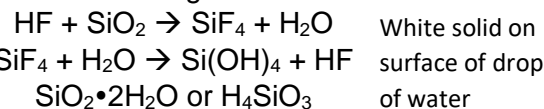
Silicon (Si)

- 2nd most abundant elements in earth's crust (27.7%), next to oxygen
- Nonmetal closely related to carbon
- Hard, metallic-looking solid with crystal structure of diamond
- Exists in nature as silicates and as silicon dioxide, does not occur in free state

SiO₂

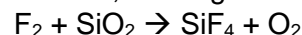
- Silica
- Sources: sand, quartz
- Inert, except in the following chemicals:
→ Silica readily reacts with HF, forming silicon tetrafluoride

Further reaction would give silicic acid

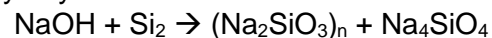


*Note: This is actually used for qualitative determination for the presence of fluoride salts, or silicates. The visible result is written above

- Silica reacts with fluorine gas in an analogous manner, forming tetrafluoride



- The last equation (below), explains why basic substances should not be stored in glass containers. Stored bases in polyethylene bottles



- **Pharmacopeial Articles:**

→ Naturally Occurring:

- Purified siliceous earth, NF
 - Kieselguhr, Diatomaceous Earth
 - Purified Infusorial Earth

→ Synthetic

- Dental type silica, NF
- Silicon Dioxide, NF
 - Silica gel
 - Precipitated silica
- Colloidal silicon dioxide, NF

- Precipitates silica
- Silica gel
 - $\text{SiO}_2 \cdot \text{O}$
 - Amorphous
 - Very porous
 - Obtained by dehydrating silicic acid, - 4% H_2O
 - Drying agents
 - Chromatography



Figure 1. CoCl_2 . Left side is dry (CoCl_2). Right side is hydrated ($\text{Co}(\text{H}_2\text{O})_6^{2+}$)

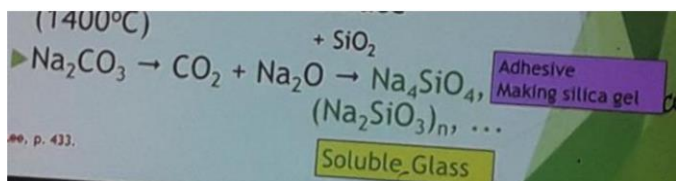
- In Figure 1, cobaltous chloride is not a drying agent. SiO_2 is the drying agent. CoCl_2 was placed simply as an indicator.

Colloidal SiO_2

- Fumed silica
- Flame pyrolysis of SiCl_4 at 3000°C
 - Tablet glidant
 - Thickener
 - Anti-caking agent in powders
 - Drying agent
 - Light abrasive
- Aerosol®, Cab-O-Sil®

Silicates

- Soluble silicates
- Produced by fusing alkali metal carbonate with sand in an electric furnace (1400°C)
- Na_4SiO_4 (sodium silicate): used as adhesive and in making silica gel
 - Sodium silicate aka soluble glass



- Silicates are classified based on their crystalline structure

Sheet Silicates (tend to cleave into thin sheets)

- Thin and therefore typically soft and have low values in Mohs hardness scale (Diamond is 10)
- Four classifications: clay minerals, white asbestos, micas, montmorillonites

Clay Minerals

- Elec. Neutral layers
- Kaolinite
 - Double sheet
- Talc (soap stone)
 - Triple sheet
 - Softest mineral known

$\text{Mg}(\text{OH})_2$ layer
Silicate layer
$\text{Mg}(\text{OH})_2$ layer

White Asbestos

- Fireproofing materials
 - May cause asbestosis
- Chrysotile, biotite

Micas

- Substitution of atoms in triple layer structure
 - Si partly replaced by Al
 - Sheet (-) charged
 - Balanced by (+) charged metal ions between layers
- Natural: Muscovite, Margarite
 - Natural have heavy metal content
- The more useful mic pharmaceutically speaking is the synthetic fluorgophite

Montmorillonites

- (-) charged layers
- Hydromicas
- Fuller's Earth
 - Calcium montmorillonite
 - Ion-exchanged for Ca^{2+} , absorbant
- Bentonite
 - Sodium montmorillonite
 - Thixotropic
 - Therefore, may be used as suspending agent
- Vermiculite

Three Dimensional Silicates

Zeolites

- More open structure
- Honeycomb-like structure
- Ion-exchange materials
- Molecular sieves

Ultramarines

- $\text{Na}_8[\text{Al}(\text{SiO}_4)_6]\text{S}_2$

- Color due to: polysulfide ion, used as pigments
- E.g., Naturally-occurring ultramarine: Lapis lazuli
- Synthesis - Ignite: kaolinite, sodium carbonate, sulfur in absence of air
 - Gives rise to synthetic ultramarines

Pharmaceutically Important Silicates

- 95% Earth's crust: silicate minerals, aluminosilicate clays, silica
- **Magnesium Silicate**
 - Asbestos: Fireproofing
 - Attapulgit: Adsorbent, antidiarrheal (insufficient efficacy)
 - Talc: Baby powder
 - Magnesium trisilicate: non-systemic antacids with protective effect
- **Aluminum Silicate**
 - Bentonite: Suspending agent due to its thixotropic property
 - Pumice: An igneous rock, very porous and light rock
 - Kaolin: Antidiarrheal in the form of Kaopectate® (Pectin + Kaolin)
 - Mica

Talc

- Native hydrous magnesium silicate
- Dusting powder
 - USP grade
 - Action on skin: Cutaneous desiccant
- Do not use in broken skin
- Pharmaceutical uses:
 - Clarifying agent
 - Filter aid
 - Adsorbent
 - Tablet lubricant
- Cosmetic uses:
 - Baby powder
 - Face powder
 - Eye shadow
 - Blusher

Kaolin

- Native hydrated aluminum silicate
- $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$
- Antidiarrheal (adsorbent)
- Dusting powder
- Tablet diluent
- Used in face powders
 - Does not exhibit high degree of slip

- Absorbent
- Dense
- Matte surface effect

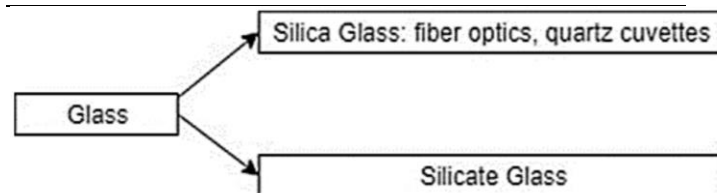
Pumice

- Substance of volcanic origin
- Filtering and distributing medium
- Skin exfoliation

Mica

- Potassium aluminum silicates
- Interference pigment
 - Synthetic coated mica

Glass



- Solid solution
- Temperature required for melting can be reduced by adding various oxides to the melt
- Na_2CO_3 : soda glass
- K_2CO_3 : potash glass
 - Water soluble glass
- MgO , CaO , BaO
- B_2O_3 , Al_2O_3 , PbO , ZnO
- Vitreous silica
 - Pure SiO_2 , fused with sodium carbonate or CaCO_3
 - Low coefficient of expansion
 - Shock-resistant
 - Very transparent to visible and UV light
 - Lab glassware
 - Optical components: lenses, prisms
 - Cell holders: UV-Vis spectrophotometers
 - Packaging materials

Additives to Glass		
MnO_2	Colorless glass	Hide blue-green color of iron usually present in silica
B_2O_3	Borosilicate glass (Pyrex)	Decrease coefficient of expansion
K_2O	Actinic glass	"Amber bottles"
PbO	Lead glass aka Crystal glass	Increase refractive index, for glass decors

Rare Earth		Selectively absorb light of certain wavelengths
Colloidal Cu particles		Ruby-red color
CoO	Cobalt blue glass	Deep blue color Also used in flame test: "under cobalt glass"
UO ₂ ⁺	Vaseline glass/Uranium glass	Green color
Fe ₂ O ₃	Bottle glass	Green color

Type	General Description
I	Highly resistant, borosilicate glass
II	Treated soda lime glass
III	Soda lime glass
NP	General purpose soda-lime glass

- Types I, II and III – parenteral products
- NP – non-parenteral products
- Gorilla Glass: touchscreen of mobile phones

Silicones (Alkylsiloxanes)

- Silicones: Organic polymers of silicones
- Si-O backbone
 - Flexible
 - Thermal and oxidative stability
- Pendant organic groups, usually -CH₃
 - Intrinsic surface activity
- Simethicone
- Dimethicone (PDMS)
 - Most widely used silicon polymer in personal care products
 - Film former
 - Lubricant

Simethicone (or Simeticone)

- Anti-flatulent
- Antifoam agent

Dimethicone

- Antifoam agent
- Skin protectant
- Emollient
 - Skin feel agents
 - Hair cosmetics

Properties of Dimethicone

- Good skin adherence

- Water-repellant
- Substantive
- Feel, lubricity, softness
- Decrease tackiness
- Decrease whitening during rubbing

Main Families of Silicones (Bases on Structure)

1. Cyclomethicones/Cyclosiloxanes
2. Dimethicones
3. Silicone Blends
4. Dimethicone and Vinyl dimethicone blends
5. Functional silicones

Functional Silicones

1. Dimethicone copolyols
2. Phenyl trimethicones
3. Amodimethicones (trimethylsilyldimethicones)
4. Alkyl dimethicones
5. NylIn-611/Dimethicone copolymer
6. Cyclomethicone and dimethicone copolyol

Conditioning Ability

- Silicones (From top to bottom → descending order of "conditioning" ability)
 - Amodimethicone
 - Dimethicone
 - Dimethicone copolyols
- Properties
 - Lubricity
 - Low IMFA
 - Water-insoluble
 - Low surface tension

Tin (Sn)

- Packaging material for pharmaceuticals and beverages
- Common oxidation states: Sn²⁺, Sn⁴⁺
- Sn²⁺
 - Pharmaceutically relevant
 - Stannous salts are susceptible to air oxidation
- Sn⁴⁺

Lead (Pb)

- Corrosion-resistant metal (Romans)
 - Pipes, pewter, paints
 - Pottery glaze
- Car batteries, pigments, ammunition, weights, lead crystal glass, radiation protection
- Plumbism/Saturnism
 - Deposited in the bone
 - Toxic, teratogenic, carcinogenic
 - No pharmaceutical use nowadays

X. GROUP IVB ELEMENTS

Titanium

- Strong, light transition metal
- Excellent corrosion resistance
- Ti alloy: Joint replacement materials
- TiO₂
 - Colorant
 - UV filter (rutile)
 - UVB
 - White pigment

Zirconium

- Also pharmaceutically-relevant

XI. GROUP VA ELEMENTS

Nitrogen

N₂

- Air displacement/headspace gas
- Aerosol propellant
- Liquid N₂: Refrigerant

Therapeutic Gases

- N₂
 - Diluent for oxygen for deep sea divers in the past
 - Diver's bends/Decompression sickness
 - Decompression Sickness:
underwater = high pressure = gases are more soluble; up motion → sudden decrease in pressure → gases dissolved will start to bubble out → decompression sickness → hospital
 - Nitrogen narcosis: drunk feeling
 - Changed to Helium
- N₂O
 - Nitrous oxide, laughing gas
 - Anesthetic gas (w/ 20-25% O₂)
 - Dentistry

Common Oxides of Nitrogen

- NO
 - Nitric oxide
 - Vasodilator, platelet inhibitor, immune regulator, neurotransmitter
 - Medicines like nitroglycerin, isosorbide relive angina because they get metabolized into NO
- N₂O
 - Anesthetic
- NO₂
 - Nitrogen dioxide
 - Pulmonary irritant

NaNO₂

- Antidote for CN toxicity
- Preservative (curing)
 - Color development
 - Flavor production (w/ NaCl)
 - Preservation against bacteria
 - Drawback: May cause cancer by N-nitrosoamine formation

Organic Nitrites and Nitrates

- Nitric and nitrous acid esters of polyalcohols
 - Amyl nitrite

- Nitroglycerin (1mg/mL inj.)
- Isosorbide dinitrate
- Release NO in vascular smooth muscle target tissues

Sodium Nitroprusside

- $\text{Na}_2[\text{Fe}(\text{CN})_5\text{NO}] \cdot 2\text{H}_2\text{O}$
- Direct acting vasodilator
- Also metabolized to nitric oxide, but also to cyanide ion
 - › reason why nitroprusside solutions are infused at a slow rate
 - Otherwise, CN toxicity
- Reddish-brown powder

NaNO_3

- Chile saltpeter
- Meat preservative
- Saltpeter = Potassium nitrate
- Note: The tagalog “salitre” does not distinguish b/w Na and Potassium Nitrate

Phosphorus (P)

Main Allotropes of Phosphorus

- White/Yellow Phosphorus (Supportive Therapy – NAC)
 - Poisonous
 - Stored in water, reacts violently in air
- Red Phosphorus (Safety matches)
 - Yung kiskisan sa gilid ng kahon, NOT THE ULO of the posporo
- Violet Phosphorus
- Black Phosphorus

Phosphate Salts

- Monobasic Phosphate salts: NaH_2PO_4 , KH_2PO_4
 - Systemic and urinary acidifier
- Dibasic Phosphate salts: Na_2HPO_4 , K_2HPO_4
 - Saline laxative
- When combined: Monobasic and dibasic sodium phosphate
 - Fleet enema
 - Saline laxative
 - Rectal
 - Acute phosphate nephropathy

Arsenic (As)

- Arsenikon (Gr. Potent)
 - Orpiment
- Lewisite metal (component of Lewisite Gas), chemical warfare

- Kaya nagkaroon ng antidote na British Anti-Lewisite aka Dimercaprol, which chelates As among many others.

- Arspenamine (Salvarsan®)
 - Paul Ehrlich and Sahachiro Hata
- Toxic so not used anymore

Common Oxidation States

- As^{3+} Ion
 - High affinity for -SH groups in enzymes
 - More toxic than As^{5+}
- As^{5+} ion

As_2O_3

- Arsenic trioxide
- White arsenic
- Arsenicum album
- Lab reagent
- It made a comeback recently as an anticancer drug for Leukemia (Trisenox)

Fowler's Solution

- 1% KAsO_2 solution
- Former use: Antileukemic
- FDA (2001): Promyelocytic leukemia

Antimony (Sb)

Former Uses

- Astringent
- Emetic
- Expectorant
- Anthelmintic
 - Antimony Potassium Tartrate
 - Schistosomiasis

Pentavalent Antimonials

- These organic antimonials are still used today
- Sodium stibogluconate
 - DOC cutaneous and visceral leishmaniasis
- Meglumine antimonate

Bismuth

Compounds of Bismuth

- Bismuth subcitrate
- Milk of Bismuth
- Potassium Bismuth Citrate
- Bismuth Subsalicylate
 - Traveler's diarrhea
- Antidiarrheal with antiseptic action
 - Kills *H. pylori*
- Gastric protectant

- Side Effect: Black stools due to Bi_2S_3 (bismuth sulfide)

Tripe Therapy

- Ranitidine Bismuth citrate 400mg
- Clarithromycin 500mg
- Amoxicillin 1000mg
→ PUD: BID 7 days
- For eradication of *H. pylori*

XII. GROUP VB ELEMENTS

Tantalum (Ta)

Tantalum (Group VB) & Thallium (Group IIIA)

- Tantalum
 - Surgical repair of bone (sheet)
- Thallium
 - Radioactive
 - Absorbs x rays
 - Compounds retained by the body almost indefinitely
 - Note: Group IIIA ito

XIII. GROUP VIA ELEMENTS-CHALCOGENS

Oxygen

Allotropes of Oxygen

- O₂
 - Oxidant for catabolism of food molecules
- O₃
 - Ozone
 - Absorbs UV light in the atmosphere
 - Disinfectant
 - Bleaching agent

Medical O₂

- Hypoxia
 - Diluted with N₂
- CO poisoning

Therapeutic Gases

- Medical Air
 - 21% oxygen gas: 79% nitrogen gas
 - Carrier for anesthetic gases
 - Ventilator, incubator, resuscitator
- Artificial Air (Heliox)
 - 80% He: 20% O₂
 - Deep sea diving

Peroxides

- H₂O₂
- Carbamide peroxide (Urea peroxide)
 - Oral and ear infections
 - Cerumen remover (6.5% in anhydrous glycerin)
 - Teeth whitening pens
- Benzoyl peroxide (2.5 – 10%)
- Zinc peroxide
- Sodium perborate

H₂O₂ – Chemical Properties

- Disinfectant/Sterilant
 - Materials with low organic content
 - Decomposition products not toxic (water and oxygen gas)
- Broad spectrum
 - Bacteria
 - Spores (10-25%)
 - Viruses
 - Fungi
- Act as an oxidizing agent (most of the time)
 - When it encounters a stronger oxidizing agent (eg. KMnO₄), it acts as a reducing agent. In the assay of hydrogen peroxide, titrant - potassium permanganate.

H₂O₂

- Volume strength
 - 3% solution or 10 volumes is the aqua oxinada, red label, used as antiseptic
 - 6% solution is 20 volumes (color blue)
 - Interpretation of volume strength: Example sa 3%: 1mL of 3% hydrogen peroxide will liberate 10mL of oxygen gas when decomposed at standard temperature and pressure
- Topical antiseptic
 - Chemical Reaction in Wounds: Disproportionation Reaction
 - Advantages: Good for aerobic bacteria
 - Disadvantages: Not very good for deep puncture wounds,
 - anaerobic bacteria
- Olden days: Vincent's stomatitis (trenchmouth)
- Earwax softener
 - 1.5% H₂O₂ in glycerin or warm water

Bleach Accelerators ("Boosters")

- Persulfate salts of NH₄⁺, Na⁺, or K⁺

Sulfur

- Brimstone, Tagalog: asupre
- Shulbari
 - Sanskrit: "Enemy of copper"
 - Cu is relatively inert but reacts with some compounds. An example is sulfur
- Vulcanization of rubber
- Fungicide
- Production of H₂SO₄

Common Allotropes (Non-exhaustive list)

- α-sulfur
 - rhombic sulfur
 - stable at room temperature
- β-sulfur
 - monoclinic sulfur
 - stable at 96°C

Pharmaceutical Forms of Sulfur

- Precipitated Sulfur
 - The "fine" form of sulfur, hence the one used in ointments and cosmetics
 - Milk of Sulfur, Lac sulfur
 - Ointment and lotions
 - More rapidly soluble in CS₂
- Sublimed Sulfur
 - Flowers of Sulfur
 - In the past: Irritant Laxative
- Washed Sulfur

Pharmaceutical Uses of S:

- Scabicide and pediculicide
- Keratolytic
 - w/ salicylic acid
- Antiacne
 - Sulfur 3-8% + 2% resorcinol
- Metallic hair dyes (It will deposit PbS in the buhok so namamask yung puting buhok ng mga oldies)
- Volatile Sulfur Compounds (VSCs)
 - H_2S , CH_3SH , $(\text{CH}_3)_2\text{S}$
 - Component of halitosis (bad breath)

SO₂ and Sulfites

- In 4^+ oxidation state
 - In this oxidation state, they are typically used as antioxidants, kasi pronounced yung reducing activity niya
- SO_2 (sulfur dioxide)
- $\text{Na}_2 \cdot 2\text{SO}_2$ ($\text{Na}_2\text{S}_2\text{O}_5$) (sodium metabisulfite)
- Na_2SO_3 (sodium sulfite)
- NaHSO_3 (sulfurous acid)
 - Chiefly $\text{Na}_2\text{S}_2\text{O}_5$

SO₃ and Sulfates

- In 6^+ oxidation state, gives rise to sulfuric acid and the sulfates
- H_2SO_4
 - Oxidizing agent
- $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ (sodium sulfate decahydrate, Glauber's salt)
 - Saline laxative
- BaSO_4

SeS₂

- Selenium sulfide
- Seborrheic dermatitis
- Anti-infective and anti-fungal
- Active ingredient: 1%

Sulfurated Potash

- Synonym: Liver of sulfur
- K_2S_x and $\text{K}_2\text{S}_2\text{O}_3$
- Not used by itself, it is used to prepare: White Lotion
 - New monograph title: Zinc Sulfide Topical Suspension
 - Sulfide ion: sakit sa balat (scabicide, keratolytic effect)
 - Zinc Ion: Astringent effect
- AI of White Lotion: Zinc Sulfide
- ZnS is the only WHITE sulfide precipitate.

- MnS only pink sulfide
- Sulfides are generally black in color (e.g., PbS)

XIV. GROUP VIB ELEMENTS

Chromium (Cr)

Chromium Compounds

- Chromic chloride: dark green amorphous solid, exact name is chromic chloride hexahydrate
- Chromium picolinate: typically used by bodybuilders
- Chromium in +6 oxidation state:
 - Dichromate ion, good oxidizing agent
 - Red crystals
 - Chromate ion, good precipitating agent
 - Yellow crystals
 - Also +6 oxidation state of Cr
- Chromic Acid: H_2CrO_4
 - Potassium dichromate + concentrated sulfuric acid
 - "Cleaning Solution": Not used now kasi ang problema ay yung handling of wastes

Uranium

Common Oxidation States of Uranium

- U^{4+} ion
 - Green
- UO_2^{2+} ion
 - Uranyl ion
 - Yellow with green fluorescence
 - Vaseline glass (uranium glass)

XV. GROUP VIIA ELEMENTS

Cl, Br, and I form of Oxyacids

- HClO_2 only known halous acid
- All halogens except F form halic and perhalic acid
- For a given halogen, acid strength decreases from perhalic to hypohalous acid
- Periodic acid exists as H_5IO_6

The Oxyacids

Acid Form		Salt Form	
HXO Oxidation state of X = 1+	Hypohalous acid e.g., Hypochlorous acid if X=Cl	XO^- Oxidation state of X = 1+	Hypohalite ion
HXO_2 Oxidation state of X = 3+	Halous acid e.g., Chlorous acid if X=Cl	HXO_2 Oxidation state of X = 3+	Halite ion
HXO_3 Oxidation state of X = 5+	Halic acid e.g., Chloric acid if X=Cl	HXO_3^- Oxidation state of X = 5+	Halate ion
HXO_4 Oxidation state of X = 7+	Perhalic acid e.g., Perchloric acid if X=Cl	HXO_4^- Oxidation state of X = 7+	Perhalate ion

X = Cl, Br or I

Fluorine (F)

Appearance and Characteristics

- Appears as a yellowish-green gas
- Most electronegative element
- Strongest oxidizing agent
- Exists as a diatomic molecule
- HF

Fluoride Salts

- Promote tooth remineralization
→ Why? Because of oral flora in the mouth, carbohydrates we eat nourishes them → they will undergo fermentation and produce organic acids which readily attacks hydroxyapatite
→ We therefore need to promote conversion of hydroxyapatite → hydroxyfluoroapatite (more resistant against acid attack)
- Beverages

- NaF
→ 0.22% or 0.24%; 0.32%
- Na Monofluorophosphate
→ 0.76% or 0.80%
- Stannous Fluoride (SnF_2)
→ 0.4%
→ Ingredient in Crest® toothpaste

Other Uses of Fluorine

- Fluoridated dentrifices
- Beverages
- Uranium hexafluoride
- Teflon®
- Gore-Tex®
- CFCs

Dental Fluorosis

- Mottled enamel of teeth due to excessive fluoride intake

Chlorine (Cl)

Appearance and Chemical Property

- Note: As you go down Halogen group: From gas (F and Cl) to liquid (Br) to solid (I)
→ But the Br and I easily vaporized to gas
- Appearance and Chemical Properties:
→ Highly irritating to eyes, skin, and mucous membrane
→ Exists as diatomic molecule (Cl_2)
- HCl
- Chlorides
→ NaCl , KCl , CaCl_2 , NH_4Cl
- Hypochlorites
→ NaOCl , Ca(OCl)_2 , Chlorinated Lime
- ClO_2

NaOCl

- Universal disinfectant
→ Commercial Household Bleach: 5.25% NaOCl solution
→ Dilutions made in pH 7.5 to 8 tap water active for months
→ Tightly closed, opaque containers
- Surfaces must be cleaned first before applying NaOCl sol'n
→ NaOCl is rapidly decomposed by organic matter
- Active biocide: Hypochlorous acid
- Should not be mixed with acids or urine
→ Evolution of chlorine gas: Toxic
- Solutions corrosive to Al, Ag, and stainless steel

NaOCl as a Disinfectant

- Sodium Hypochlorite Solution, USP
 - By definition: 4.6% w/w solution
 - Commercial Bleach: 5.25% w/w solution
 - Biocide
 - Bleaching agent
- Labarraque's solution
 - NaOCl solution diluted with equal volume of water
 - Disinfectant

NaOCl as Antiseptic

	Modified Dakin's solution	Dakin's solution	NaOCl Topical Solution, USP
Synonym	Diluted NaOCl solution		
NaOCl conc.	0.5%	0.5%	0.025%
Buffer	NaHCO ₃	Na ₂ CO ₃ , H ₃ BO ₃	Phosphate buffer

- Dakin's solution: Masyadong irritating sa skin (sodium carbonate and boric acid pa ang buffer)
 - Modified Dakin's solution: sodium bicarbonate buffer system, can be applied to wounds
- Advantage of NaOCl Topical Solution, USP: Allows tissue regeneration

Chlorinated Lime (Bleaching Powder)

- Not a pure compound
- Ca(OCl)₂, CaCl₂, Ca(OH)₂, and H₂O
 - Disinfectant property due to calcium hypochlorite
- Unstable Cl₂ carrier in solid form
- If nakakita kayo sa market na may label na "Bleach", tapos solid powder siya, most probably it is chlorinated lime

Chlorine Releasers

- ClO₂ (chlorine dioxide)
 - OraCare Mouthwash contains chlorine dioxide
- Chloramine-T
 - Wound disinfection
- Halazone
- Sodium dichloroisocyanurate
 - Drinking water

Bromine

- The only liquid nonmetal
- Reddish brown fumes
- Main source: Seawater
- Caustic and germicide
 - Too corrosive for this purpose so Br will forever remain as a lab reagent
- Always keep ammonia water ready when handling Br₂
 - Prevent bromism
- Chemical reagent

Bromides

- Sedative, central depressant (no longer used now. This function was dati pa, before the discovery of diazepam, phenobarbital, etc.)
 - NaBr
 - KBr
 - NH₄Br
- Bromism

Iodine (I)

- Violet solid that easily sublimates
- Heaviest, nonmetallic element
- Most metallic halogen

Iodine

- Topical antiseptic and disinfectant
 - At present: Povidone-iodine is the preferred disinfectant for small cuts and wounds
 - Bacteria, virus, yeast, mold, fungi, protozoa, spores
 - Inorganic Iodine Preparations
 - Iodophors

	Solubilizer	I ₂ Content
Iodine Tincture	NaI	2%
Iodine Topical Soln	NaI	2%
Strong Iodine Soln (Lugol's Soln)	KI	5%
Strong Iodine Tincture	KI	7.5%

- Lugol's solution: Also used for hyperthyroidism
- Note that iodine (I₂) is poorly soluble. You need organic solvents to dissolve this. Pero bawal naman organic solvents sa wounds. So we use iodines (I⁻)
- Chemical Equation: $I_2 + I^- \leftrightarrow I_3^-$
 - Advantage: triiodide ion renders iodine less volatile and more water soluble
 - Disadvantages: Leaves a brown stain

Iodophors

- Complexes of iodine with surface-active agent
 - Less irritation
 - Less skin hypersensitivity
 - Non-staining (unlike inorganic iodine preparations mentioned earlier)
- Povidone-Iodine
- Iodine- β -Cyclodextrin
- Kahit lumagpas sa expiry, ok lang basta dark brown pa color.
NOTE: If naging clear or straw-colored na, you cannot use it anymore

Form	%I ₂
Cream	10%
Ointment	10%
Dry Powder Spray	2.5%
Feminine Wash	7.5%
Gargle	1%
Paint	10%
Throat Spray	0.45%
Vaginal Douche	10%
Vaginal Gel	10%

Figure 2. Forms of Betadine

Iodides: NaI and KI

- Advantages of KI over NaI
 - In general, the sodium salt of a compound is more advantageous than the potassium salt, except in certain cases (like in the case of iodide)
 - In this case, potassium iodide is more stable than sodium iodide in air
 - Cheaper ang KI over NaI
- Iodides exert multiple effects on thyroid
- Antithyroid
 - Iodine (Lugol's solution)
 - Sodium Iodide I-131
- Major Action (>6mg/day)
 - Inhibit thyroid hormone release
 - Decrease vascularity, size, and fragility of hyperplastic gland
 - Preoperative preparation for surgery (hyperthyroidism) in the form of KISS
 - KISS: Potassium iodide saturated solution

Other Functions of Iodine

- Fortication of table salt
- Radiation emergency: Increase intake of iodine to prevent thyroid gland (by saturating it with

inorganic iodine) to prevent uptake of radioactive iodide (I-131)

- Anticataract: NaI and KI combination (3mg/3mg per mL)
 - Lens nutrient
- Expectorant (in the past)

Iodism

- Acneiform rash, or *ioderma* (sim. Bromism)
- Swollen salivary glands
- Mucous membrane ulcerations
- Conjunctivitis
- Rhinorrhea
- Drug fever
- Metallic taste
- Bleeding disorders
- Anaphylactoid reactions

Antithyroid Anions: ClO₄⁻, TcO₄⁻, and SCN⁻

- Blocks I⁻ uptake by thyroid (similar ng charge)
 - Competitive inhibition of iodide transport mechanism

Iodinated Contrast Media

- Iodate
- Iopanoic Acid
- Diatrizoate sodium
- Diazatrizoate
- Iothalamate
- Iohexol
- Iopamidol
- Iopromide
- Ioversol

Radioactive Iodine (Radioiodine)

- ¹³¹I Sodium
 - Tx: Thyrotoxicosis
 - MOA: I-131 is a beta emitter. It can destroy thyroid tissue

Astatine (At)

- Only metallic and radioactive halogen

Pseudohalogens

- Pseudohalogens: In terms of behavior, they act like halides
 - CN⁻
 - CNO⁻ (fulminate)
 - CNS⁻
 - N₃⁻ (Azide ion)
 - [Fe(CN)₆]³⁻ (ferricyanide or hexacyanoferrate(III))

XVI. GROUP VIIB ELEMENTS

Manganese

- Trace element
 - Manganese (II) chloride
 - Manganese (II) gluconate
 - Manganese (II) sulfate
- In 2+ oxidation II, compounds appear light pink
 - The only pink sulfide is MnS!!!

KMnO₄ (Manganese is present as +7 O.S)

- "Mineral chameleon"
- Oxidizing property
- Antiseptic, Astringent
- Deodorant and cleanser → 0.01-1%

Technetium

- 1st element produced artificially
- ^{99m}Tc: Most commonly used radionuclide in diagnostic imaging

Sodium Pertechnetate Tc 99m

- ^{99m}TcO₄⁻ handled by the body similar to ¹³¹I
- Imaging studies

XVII. GROUP VIIIA ELEMENTS

Helium (He)

- 2nd lightest gas
- Donald Duck sound
- Diluent
 - Medical Gases
 - O₂ for deep sea diving
 - Preferred – He is not that soluble in the blood as compared to nitrogen gas

*All elements of the inert gas group occurs naturally in the atmosphere EXCEPT RADON (Rn)

Artificial Air (Heliox)

- Originally: 80 parts He: 20 parts O₂
- But other references also state: 79:21, 70:30, 60:40
- Lower density vs. N₂
- Respiration difficulties
- Deep sea diving

Neon (Ne)

- Advertising purposes: Brilliant orange-red light

Argon (Ar)

- Most abundant noble gas
 - Least abundant: Krypton
- Substitute for N₂ as inert atmosphere for pharmaceuticals

Xenon (Xe)

- Xe lamps
 - Blue glow
 - Flash bulbs
 - Sunbed lamps
 - Bactericidal lamps
- General anesthetic action
 - Issue: Expensive so not used for this purpose
- Xenon Xe 127 and Xe 133 Gas
- Xenon Xe 133 Injection
 - Cerebral and pulmonary imaging

Radon (Rn)

- Heaviest inert gas
- Radioactive decay of ²²⁶Ra in rocks
 - Carcinogenic (lung, leukemia)
- ²²²Rn: Cancer treatment
 - Alpha-emitter

XVIII. GROUP VIIIB ELEMENTS

- Ferrous Metals: Fe, Co, Ni
- Platinum Metals/Noble Metals: Rh, Ru, Pd, Os, Ir, Pt

First Triad or Iron Triad: Fe, Co, Ni

- Ferrous Metals: Fe, Co, Ni

Iron (Fe)

- Anglo-Saxon "iren"
- Problem: Metal that rusts in damp air
 - Alloyed with C to prevent this problem: Steel
 - Stainless Steel: at least 10.5% Cr
 - Architecture, surgical instruments, cutlery, jewelry
- Most important metal
- Most abundant element in Earth

Common Oxidation States of Iron:

- Fe^{2+} : Green vitriol is ferrous sulfate heptahydrate
- Fe^{3+}

Enteral Forms of Iron

- Nutritional supplements
 - Infants and children
 - Adult men and woman
 - Geriatric
- Fortified milk
- Fortified food

Iron Supplements (Oral)

- Hematinics

<u>Salt</u>	<u>Tablet</u>	<u>Elemental Iron</u>
Ferrous sulfate, hydrated	325mg	65mg
Ferrous sulfate, desiccated	200mg	65mg
Ferrous gluconate	325mg	36mg
Ferrous fumarate	200mg	66mg
	325mg	106mg

Precautions

- Constipation (typically taken with meals to prevent this)
- Iron toxicity (children)
- Doctor's supervision
 - Men with increased ferritin levels more prone to heart attacks
 - Hematinics used when ferritin 1

Iron Supplements (Parenteral)

- Iron dextran (Problem: immunogenic. Minsan may hypersensitivity rxns)
- Sodium ferric gluconate complex in sucrose
 - Preferred over iron dextran

- Iron sucrose
 - Better safety profile than iron dextran
- Iron sorbitex
- Ferumxylol

Hemostats

- Hemostats: Iron in its 3+ oxidation state
 - Kapag 2+ oxidation state, opposite function (Hematinic)
- Ferric sulfate
 - Dentistry
- Ferric subsulfate solution
 - Monsel's solution
 - Superficial skin biopsies
- Ferric chloride
 - Astringent
 - Chemical reagent: Detection for presence of benzoate, acetate, tannins

Miscellaneous

- $\text{K}_4[\text{Fe}(\text{CN})_6]$ – potassium ferrocyanide (yellow prussiate of potash)
- $\text{K}_3[\text{Fe}(\text{CN})_6]$ – potassium ferricyanide (red prussiate of potash)
 - Prussite = cyanide containing
- $\text{Fe}_3[\text{Fe}(\text{CN})_6]_2$ – Turnbull's blue, ferrous ferricyanide
- $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$ – Prussian blue, ferric ferrocyanide

Inorganic Pigments

- Yellow Ferric Oxide
 - $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$
 - FeOOH
- Red Ferric Oxide
 - Fe_2O_3
- Black Ferric Oxide
 - Fe_3O_4
 - Ferrous and ferric oxide

Cobalt (Co)

- Ger. "kobold" = goblin
 - Leads miners astray in search of tin
- Central metal ion in Vitamin B12 (cyanocobalamin)
 - Development of erythrocytes
 - Deficiency: pernicious anemia
- Blue pigment (cobalt blue)
- Co-60
 - Cancer chemotherapy
 - Food irradiation
 - γ - emitter

CoCl₂•6H₂O

- Lover's ink
- Sympathetic ink

Nickel (Ni)

- Salts exists as +2 oxidation state, usual color is aqua
- Ger. "kupfernickel"
 - Devil's copper or St. Nicholas' copper
- Fancy jewelries
 - Resistance to corrosion
 - Drawback: Sensitivity (Nickel dermatitis or nickel itch)
- Rechargeable batteries (Ni-Cd batteries)

Second Triad: Ruthenium & Rhodium

Ruthenium (Ru)

- L. "Ruthenia" = Russia
- One of the rarest metals
- Hardener for Pt and Pd

Rhodium (Rh)

- Corrosion-resistant
 - Plated on Ag
 - Harden Pt

Third Triad: Os, Ir, Pt

Osmium (Os)

- Gk. "osme" = smell
- Heaviest and most dense metal
- Corrosion resistant
- Hard alloys
 - Pen nibs

Iridium (Ir)

- Gk. Goddess of Rainbow Iris
- Unreactive (~Au)
- Most corrosion-resistant material known
 - Pt-Ir bar (SI standard for meter dati)
 - Pen tips

Platinum (Pt)

- Sp. "platina" = little silver
- Corrosion-resistant (~Au)
- Anti-Neoplastic
 - Cisplatin: Cell Cycle-Nonspecific Agent
 - Carboplatin
 - Oxaliplatin

XIX. RADIOPHARMACEUTICALS

- Drug component + Radioactive component
 - Diagnostic
 - Therapeutic

Types of Radiation Emitted from a Radioactive Nuclei

- a-emitters
 - Quite similar to Helium atom
 - less commonly used therapeutic agents
 - Very destructive
 - High charge breaks DNA
- B-emitters
 - Commonly used therapeutic agents
 - Deposits radiation to target organ
 - High kinetic energy
 - I-131
- γ-emitters
 - diagnostic agents
 - Short wavelength and high energy
 - Most penetrating
 - ^{99m}Tc

Radiopharmaceuticals

- Beta Emitter: ⁸⁹Sr, ⁹⁰Y, ¹⁵³Sm, ¹⁸⁸Re
- Gamma Emitter: ^{99m}Tc, ²⁰¹Tl, ⁶⁷Ga, ¹¹¹In, ¹²³I
- Both beta and gamma emitter: ¹³¹I

^{99m}Tc

	Imaging
^{99m} Tc-Mebrofenin	Hepatobiliary
^{99m} Tc-Sestamibi ^{99m} Tc-Tetrofosmin	Myocardial perfusion
^{99m} Tc Sulfur colloid	RES (liver, spleen, bone marrow)
^{99m} Tc-DPTA (Pentetate)	Cerebrospinal
^{99m} Tc Macroaggregated Albumin (MAA)	Lung perfusion
^{99m} Tc-RBCs	Left ventricular function

Thallous Chloride Tl-201

- K⁺ analog
- Rapid active transport in the heart
- Gold standard (in old books): Myocardial perfusion imaging
 - Largely replaced by:
 - ^{99m}Tc-Sestamibi
 - ^{99m}Tc-Tetrofosmin

Gallium Citrate Ga-67

- Behaves similarly to Fe³⁺ ion
- Diagnosis and monitoring of Pneumocystis carinii pneumonia

Indium Chloride In-111

- w/ Capromab pendetide
→ Prostate cancer imaging
- w/ Ibritumomab tiuxetan
→ In-111 biodistributive study
→ Y-90 imaging study: Tx certain forms of non-Hodgkin's lymphoma

Nal I-131

- Thyroid
→ Imaging (But I-123 is preferred if imaging pag-uusapan)
→ Destroy tissue (Tx for thyrotoxicosis)
- Radioiodine therapy

Nal I-123

- Thyroid imaging (preferred)
→ Superior image vs. ^{99m}Tc

Sodium Phosphate P32

- Tx: Polycythemia vera

Chromic Phosphate P32

- Peritoneal effusions

⁹⁰Y

- Solid large tumors and lymphomas
- Pain relief involving soft tissue
→ TheraSphere: liver cancer

⁸⁹Sr, ¹⁵³Sm, ¹⁸⁸Re

- SrCl₂ Sr-89
- ¹⁵³Sm-EDTMP
- ¹⁸⁸Re-HEDP
→ Bone pain palliation

Radionuclide Tracers for PET Scan

<u>Radiopharmaceutical</u>	<u>Application</u>
[¹⁵ O]-O ₂	Brain physiology
[¹⁵ O]-CO	Blood volume: brain, heart
[¹⁵ O]-H ₂ O	Blood flow: brain, heart
[¹³ N]-NH ₃	Blood flow: heart
[¹¹ C]-Palmitic acid	Heart metabolism
[¹⁸ F]-fluorodeoxyglucose (FDG)	Glucose metabolism: brain, heart tumors
[⁸² Rb]]-Rb ⁺	Blood flow: heart

XX. OTHER TOPICS

Gastric Antacids

- Systemic Antacids
→ NaHCO₃, KHCO₃
- Non-Systemic Antacids
→ CaCO₃
→ Al(OH)₃
→ Aluminum phosphate
→ Milk of bismuth
→ Magaldrate
→ MgCO₃
→ Milk of Magnesia
→ MgO
→ Magnesium Trisilicate

Systemic acidifiers

- NaH₂PO₄
- KH₂PO₄
- NH₄Cl
→ Also used as: Osmotic diuretic
- CaCl₂

Inorganic Antiseptics & Disinfectants

- Oxidizing Agents
→ H₂O₂
→ Perborates
→ KMnO₄
- Protein Precipitants
→ Heavy metal salts
▪ Also have oligodynamic action
- Halogenating Agents
→ Cl₂
→ OCl-
→ I₂

Antiseptics

- KMnO₄
→ 1:1000-1:20,000
▪ Wounds and ulcers
→ 1:4,000
▪ Mouthwash and gargle
→ Freshly prepared
- Povidone-Iodine
- H₂O₂
→ 3% soln
- NaOCl
→ 0.5% Available chlorine solution
→ For further dilution for skin wounds
- Aluminum Acetate
→ 13% solution
▪ Lotion (0.65%)
▪ Freshly prepared

- AgNO₃
→ 0.5% solution
→ 95% Stick
- Benzoyl peroxide

Precipitating Germicides

- Silver nitrate
- Toughened silver nitrate (94.5% silver nitrate, remainder is silver chloride)
→ Purpose if silver chloride: To lessen the friability of sticks
- Boric acid
- Sodium borate
- Antimony potassium tartrate
- Zinc acetate
- Zinc chloride
- Zinc sulfate
- Zinc undecylenate
→ Undecylenate → antifungal properties (undecylinic acid)

Anti-Infectives

Antibacterial

- Silver sulfadiazine
→ 1% cream
→ Scabicide and pediculicide
- Sulfur
→ 5% cream, ointment

Antifungal

- Na₂S₂O₃
→ 2.5%, 5% solution
- SeS₂
→ 2.5% lotion
→ 1% shampoo

Protectives

Skin Protectives

- Remember that skin protectives are water-insoluble
- ZnO
- Calamine lotion (8%)
- Talc
- White lotion

Inorganic UV Filters

- ZnO
- TiO₂
→ Hybrid formulations: Combo or organic and inorganic UV filters

Protectives

- Also water insoluble
- Magnesium trisilicate
- Basic aluminum carbonate
- Chalk
- Bismuth sub-salts
- Kaolin
- Bentonite



















Chemical Cautery – Remove unwanted tissue

AgNO₃

- Crystals
→ 5%, 10%, 30% solution
- Stick (95%)

Therapeutic Gases (Artificial Atmospheres)

- O₂
- Artificial Air (Heliox)
- Medical Air
- N₂
- N₂O
- CO₂

	USA	ISO
Carbon Dioxide	 Grey	 Grey
He-O ₂	 Brown and Green	 Brown and White
Medical Air	 Yellow	 Black and White
Nitrogen	 Black	 Black
Nitrous Oxide	 Blue	 Blue
O ₂ -He	 Green and Brown	 White and Brown
Oxygen	 Green	 White
Vacuum (Suction)	 White	 Yellow
WAGD (EVAC)	 Purple	 Purple

CO₂ Absorbers

- Soda Lime
→ Ca(OH)₂ and NaOH or KOH or both
- Barium Hydroxide Lime
→ Ba(OH)₂•8H₂O and Ca(OH)₂
→ May also contain KOH
- Why combine two hydroxides?
- Para di ma-“spent” kaagad yung calcium hydroxide

Respiratory Stimulants

- Carbon Dioxide
- Diluted Ammonia Solution
 - Syn. Ammonia water
- Ammonium Carbonate
 - "Smelling salts"
 - Not a pure compound: combo of ammonium carbonate and bicarbonate
- Aromatic Ammonia Spirit

Expectorants and Laxatives

Expectorants

- Best expectorant: Water vapor
- NH_4^+ salts
 - NH_4Cl , ammonium carbonate
- I⁻ salts
 - NH_4I , KI
- Citrate salts
 - Sodium citrate, potassium citrate

Laxatives

- Saline Laxatives
 - Magnesium Citrate
 - Milk of Magnesia
 - Magnesium Sulfate
 - Dibasic Sodium Phosphate
 - Sodium Phosphates
 - Sodium Sulfate
 - Sodium Potassium Tartrate
 - Potassium Bitartrate
- Combination of Saline and Osmotic Laxative: PEG-3350 and Electrolytes for Oral Solution

Phosphate Binders

- For px with kidney failures suffering from hyperphosphatemia
- IV Calcium
- $\text{Ca}(\text{CH}_3\text{COO})_2$
- CaCO_3
- $\text{Al}(\text{OH})_3$

Antidiarrheals

Safe and Effective

- Kaolin
- Bismuth subsalicylate
- Loperamide

Insufficient Efficacy

- Attapulgate

Contrast Media

Radiographic Contrast Media

- BaSO_4
- Iodinated organic compounds

MRI Contrast Agents

- Gadopentetic acid (Gd-DTPA) w/ Meglumine (Dimeglumine Gadopentetate)
- Ferumoxides
- Ferumoxsil

Gas Forming Agent

- Used for visualization of stomach
- NaHCO_3
- Glutamic acid
- Tartaric acid
- Silicone resin

Structural Repairs

- Common Denominator: Typically, inert
- Ta
- Ag
- Hg amalgams of Au and Ag
- Zinc-Eugenol Cement
- Plaster of Paris

Toothpaste Ingredients

Anticariogenic Agents

- NaF
- Na Monofluorophosphate
- Aluminum Fluoride
- SnF_2

Surfactant

- SLS
- Cocamidopropyl betaine

Abrasives

- Hydrated SiO_2
- Dicalcium phosphate dihydrate (DCPD)
- Calcined Al_2O_3
- NaHCO_3
- Sodium metaphosphate
- Calcium pyrophosphate
- CaCO_3
- MgCO_3

Desensitizing Agents

- KNO_3 (5%)
 - Only US FDA approved tooth desensitizer
- Arginine (8%)
- Potassium citrate

- $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ (10%)
→ Original Sensodyne formulation
- Strontium acetate (8%)
- Calcium sodium phosphosilicate (Novamin®)

Antiplaque

- Sn^{2+}
- Zn^{2+} salts

Antibacterials

- Triclosan (0.3%)
- Chlorhexidine

Anticalculus (Tartar Control)

- Only proven: Sodium pyrophosphate (33%)
- Insufficient data: Zinc salts
→ ZnCl_2
→ Zinc citrate

Gum Bleeding

- Aluminum lactate

Whitening

- Hydrated SiO_2
- Carbamide peroxide (10%)
- H_2O_2
- Potassium pyrophosphate
- NaHCO_3

ANTIDOTES

General Antidotes

- Activated charcoal: For high MW poisons
→ USP Grade Powder (slurry)
- Sodium Sulfate: Saline laxative
→ USP grade powder

Specific Antidotes

- Deferoxamine
→ Acute Iron Toxicity
- Deferiprone
→ Chronic Iron Toxicity
- Dimercaprol/British Antilewisite (BAL)
→ Hg, Pb, As
→ Inj in oil (IM)
- N-acetylpenicillamine (NAP)
→ Cu, Hg, Pb
- Succimer (DMSA)
→ Water-soluble analogue of Dimercaprol
→ Pb, Hg, As, ...
- Dimercapto-propane sulfonate (DMPS)
→ As, methemoglobin
→ IM

- Calcium disodium Edetate
→ Pb
→ IM
- Penicillamine (Cu toxicity, Wilson's disease)
- Prussian Blue (Radiogardase®) (Cs, TI poisoning)
- Sodium formaldehyde sulfoxylate
- Edetate disodium
→ Zn-DTPA (Plutonium, Am, Cm)
- Cyanide poisoning: Sodium nitrite injection followed by sodium thiosulfate injection
→ Nitrite ion induces formation of methemoglobin, which is a poor carrier of cyanide (so lumalabas yung cyanide from hemoglobin)
→ Sodium thiosulfate to convert cyanide to thiocyanate by enzyme rhodanase (or rhodanese) → excretable
→ Note: Methemoglobin, although poor carrier of cyanide, is also a poor carrier of oxygen. So before you induce methemoglobinemia, siguraduhin mo munang cyanide talaga yung poisoning mo.

Ion-Exchange Resins

- Cellulose Sodium Phosphate (for calcium)
- Sodium Polystyrene Sulfonate (for potassium)
- Calcium Polystyrene Sulfonate

ANTIOXIDANTS

Types of Antioxidants

- True antioxidants
→ Terminate free radical reactions
→ Propyl gallate
→ Vit. E
→ BHA, BHT
- Reducing agents
→ Reduces oxidized drug back to original state
→ Vit C
→ Sulfites
→ PH_2O_2
- Antioxidant Synergist
→ Forms stable complexes with metal ions (metal ions catalyze oxidation reactions by free radical formation)
▪ Are chemically chelating agents
→ Citric acid
→ Tartaric acid
→ EDTA and its salts
→ Lecithin

ANTIMICROBIAL PRESERVATIVE

- Sodium nitrite
- Sodium nitrate
- Phenylmercuric salts
- Sodium benzoate
- Potassium sorbate
→ Bacteria, fungi

INORGANIC PIGMENTS

- TiO_2 (white)
- Iron oxides and iron hydroxides (yellow and red and black)
- Ultramarines (blue or violet or green)
- Prussian blue (technically same as Turnbull's blue)
- Manganese violet
- Coal black (cosmetic form of activated charcoal)
- Mica (shimmer)
- Bismuth Oxychloride (shimmer)
- Chromium oxide green (green, +3 oxidation state of Cr)
- Chromium hydroxide green (green, +3 oxidation state of Cr)
- Cu powder
- Al powder
- Aluminum stearate (if cosmetic is oleaginous)
- Calcium stearate (if cosmetic is oleaginous)
- Magnesium stearate (if cosmetic is oleaginous)

Ultramarines

- Ultramarine Blue
- Ultramarine Violet
- Ultramarine Pink
- Ultramarine Green
- Sodium/Aluminum Sulfosilicates

Manganese Violet

- Manganese Violet: $\text{NH}_4\text{MnP}_2\text{O}_7$

Iron Blue

- $\text{Fe}(\text{NH}_4)[\text{Fe}(\text{CN})_6]$
- Prussian blue

Chrome Oxides

- Chromium Oxide
→ Cr_2O_3
→ Dull yellow green pigment
- Chromium hydroxide
→ $\text{Cr}_2\text{O}(\text{OH})_4$
→ Bright bluish-green pigment
→ Aqua

Hydrated Alumina

- $\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$
- Little opacity
- Almost transparent

BaSO_4

- Translucent
- Pigment extender

Pearlescent Pigments

- Pearls
→ Guanine
→ BiOCl
→ TiO_2 -coated Mica
 - Effect: Glitter/Shimmer Effect

Pigment Pearls

- Layer of iron oxides laminated on TiO_2 -coated Mica
- Color and luster

Light-Diffusing Pigments

- Create illusions
- Hide wrinkles
→ BaSO_4
→ Silica
→ Silica spheres coated on Mica
→ $\text{TiO}_2/\text{BaSO}_4$ -coated Mica
→ $\text{Al}(\text{OH})_3/\text{Mica}$
→ Ultrafine TiO_2/Mica

LYE WATER

Lye Water vs Lye Water Substitute

- Lye Water: Aq. Solution of either sodium or potassium hydroxide
- Lye Water Substitute: Solution of alkali carbonates
- Uses:
→ Removal of skin of fruits and vegetables
→ Noodles
→ Century eggs
→ Kutsinta
→ Pichi-pichi
→ Suman sa lihiya
→ Hard pretzels
→ Alkalized cocoa

BAKING POWDER

Double-Acting Baking Powder

- E.g., of a preparation: Starch (Corn or Cassava), Baking Soda,
- Sodium Aluminum Sulfate, Calcium Acid Phosphate

→ Baking Soda: Sodium bicarbonate

- Low-T acid salt: cream of tartar
- High-T acid salts: sodium aluminum phosphate, sodium acid pyrophosphate

SOY MILK

- Water, soybeans, sugar, emulsifier (mono- and diglycerides), natural and artificial flavors, salt, stabilizers (carrageenan, sodium alginate, guar gum)
- In this formulation, sodium alginate is used as suspending agent

SOAPS

- Hard: from NaOH
- Soft: from KOH
 - In old books, soft soap aka liquid soap
 - The liquid soaps we see in market today are not soft soap.
 - Their formulation more closely resembles shampoos
- Soluble: Hard and soft soaps
- Insoluble
 - Metal
 - Mg stearate, calcium stearate, etc.
- Castile: Soaps whose oil component is olive oil
- Translucent or transparent: glycerin soaps
- Synthetic bars (syndets): Dove, Olay, or surfactant-based soaps
 - Problem: Loaded with moisturizers □ malagkit
- Combars: combination bars
- TEA soap: triethanolamine is the alkali used, not KOH nor NaOH

Bar Soap

- Sodium palmate, sodium palm kernelate, tapioca starch, palm kernel acid, water, fragrance, shea butter, sodium lactate, cocoamidopropyl betaine, triclocarban, sodium chloride, titanium dioxide, disodium etidronate, tetrasodium EDTA, CI 45410, CI
 - Hard soap
- Triclocarban Function: Antibacterial
- Na Lactate: Natural moisturizing factor component
- Titanium dioxide: Opacifying agent, para uniform ang itsura ng product
- EDTA: Antioxidant synergist

Scented Hand Gel Soap

- Aqua, SLS, Cocoamidopropyl betaine, NaCl, parfum, DMDM hydantoin, glycerin,

benzophenone-3, Na benzoate, citric acid, CI 19140, CI 42090

- SLS: Surfactant
- Na benzoate: Antimicrobial preservative

ORAL STUFF

Dentifrices

- Products that enhance stain removal and dental plaque by toothbrush
- Toothpastes
- Mouthwashes
- Cosmetic whiteners
- Desensitizing agents
- Dental gums

Gel Toothpaste

- Active ingredient: NaF 0.22% w/w (1000 ppm F)
- Sorbitol, water, hydrated silica, SLS, flavor, PEG-12, cellulose gum, cocoamidopropyl betaine, sodium saccharin, sodium fluoride, hydroxypropyl methylcellulose, menthol, colorants
- NaF: anticariogenic
- Hydrated silica: mild abrasive
- SLS: surfactant
- Sodium saccharin: artificial sweetener
 - Not use sugar kasi obviously it promotes carries (which defeats purpose of toothpaste)

Gel Toothpaste #2

- Sorbitol, hydrated silica, water, PEG-32, SLS, Flavor, cocoamidopropyl betaine, cellulose gum, Na saccharin, Na monofluorophosphate, hydroxypropyl methylcellulose, NaF, xylitol, pentasodium triphosphate, allantoin, farnesol, 2-phenoxyethanol, Mica, CI 42090
- Na Monofluorophosphate, NaF: anticariogenic
- Mica: Imparts shiny appearance in toothpaste

Toothpaste

- Water, sorbitol, hydrated silica, PVM/MA Copolymer, SLS, flavor, carrageenan, NaOH, NaF, Triclosan, Na saccharin, charcoal powder, CI 778981, Mica
- Triclosan is antibacterial
- CI 778081 is color code for titanium dioxide □ Expected color of product is white

Antiseptic Mouthwash

- Active Ingredients
 - Eucalyptol, Menthol, Methyl-salicylate, thymol

- Inactive Ingredients:
→ Water, alcohol (21.6%), sorbitol solution, flavoring, poloxamer 407, benzoic acid, Na saccharin, Na benzoate, colorant

Denture Cleanser

- Citric acid, FD&C blue # 1 Al lake, FD&C blue # 2, FD&C yellow # 5, FD&C yellow # 5 Al lake, flavor, PEG, potassium monopersulfate, Na benzoate, NaHCO₃, Na carbonate, Na lauryl sulfoacetate, Na percarbonate, Tetraacetythylenediamine, VP/VA copolymer
- Potassium monopersulfate: When dissolved in water, generates hydrogen peroxide
- Na carbonate and Na bicarbonate: Reason why this formulation is an effervescent formulation
→ Weak acid component para mag-effervesce
sya: citric acid

DEODORANT

Antiperspirant Deodorant #1

- Water, aluminum sesquichlorohydrate, steareth-2, cetareth-12, stearyl alcohol, cetareth-20, distearyl ether, shea butter, dimethicone, cetearyl dimethicone crosspolymer, dimethyl phenyl 2-butanol, ethylhexylglycerin, Hammamelis Virginiana Water, fragrance, bisabolol, methylchloroisothiazolinone, methylisothiazolinone, tetrasodium EDTA.
- Active ingredient: Al sesquichlorohydrate
- Silicon polymers: dimethicone and cetearyl dimethicone
- crosspolymer
- Stick, roll-on, or aerosol? Answer: Roll-on kasi may water. Stick and aerosols don't have water

Antiperspirant Deodorant #2

- Cyclopentasiloxane, aluminum zirconium tetrachlorohydrate gly, stearyl alcohol, C12-C15 alkyl benzoate, PPG-14 butyl ether, hydrogenated castor oil, dimethicone, polyethylene, Helianthus annuus (sunflower) seed oil, steareth-100, BHT.
- Stick product ito kasi cyclopentasiloxane kasi sticks usually have cyclopentasiloxane as their base

Antiperspirant Deodorant #3

- Butane, isobutane, propane, cyclopentasiloxane, aluminum chlorohydrate, C12-C15 alkyl benzoate, triethyl citrate, perfume, disteardimonium hectorite, dimethiconol

- Aerosol kasi ang damping gas!

POWDERS

Baby Powder Products

- Talc, Zinc oxide, Mg stearate, fragrance
→ ZnO function: cutaneous desiccant, skin protectant
- Talc, magnesium carbonate, precipitated silica, fragrance
→ Function of precipitated silica: anti-caking agent
- Talc, magnesium carbonate, parfum, linalool, coumarin, eugenol, limonene

Face Powder (Inorganic Components Only)

- Talc
- Kaolin
- CaCO₃
- MgCO₃
- Zn, Mg stearate
- Mica
- TiO₂
- ZnO

HAIR STUFFS

Hair Cuticle Coat

- Cyclopentasiloxane, dimethicone, cyclotetrasiloxane, amino propyl trimethicone, fragrance

Medicated Shampoo

- Per 100mL
→ Ketoconazole: 2g
→ Zinc pyrithione: 1g

Conditioner

- Water, cetearyl alcohol, cyclopentasiloxane, dimethiconol, stearamidopropyl dimethylamine, behentrimonium Cl, perfume, dipropylene glycol, lactic acid, NaCl, disodium EDTA, panthenol, TEA-Dodecylbenzenesulfonate, DMDM hydantoin, cyclohexasiloxane, Mg nitrate, cyclotetrasiloxane, Lysine HCl, Citric acid, aloe barbadensis leaf juice, methylchloroisothiazolinone, MgCl₂, methylchloroisothiazolinone, glycerin, Moringa pterygosperma seed extract, CI 42090.

SCAR GEL

- Polydimethylsiloxane, silicone polymer mixture – polydimethylsiloxane (85-87%) and dimethiconol (12-15%), trimethylsiloxysilicate, methyl siloxane

PHARMACEUTICALS

Table Salt

- Salt, magnesium carbonate and/or potassium ferrocyanide (as anti-caking agent), 0.01% potassium iodate

Epinephrine HCl Injection

- Special Precaution: Allergy to Sodium metabisulfite

Calcium Carbonate Tablet

- Per tablet: Equivalent to 500mg elemental calcium
 - How many mg CaCO_3 is contained in the tablet?
 - MW CaCO_3 = 100.09
 - AW Ca = 40.08

$$\frac{500\text{mg Ca}}{1 \text{ tablets}} \times \frac{1 \text{ mmol Ca}}{40.08 \text{ mg Ca}} \times \frac{1 \text{ mmol CaCO}_3}{1 \text{ mmol Ca}} \times \frac{100.09\text{mg CaCO}_3}{1 \text{ mmol CaCO}_3} = \mathbf{1,248\text{mg}}$$

Iron Supplement Capsule

- Ferrous Gluconate 250mg (Equivalent _____ mg Fe)
 - MW Ferrous Gluconate = 448.16 g/mol
 - AW Fe = 55.85
- Magnesium sulfate
- Cupric sulfate
- Folic acid
- Cyanocobalamin
- Sorbitol

EARTH'S CRUST

Abundance of Elements

1. Oxygen – Most abundant
2. Si – 2nd most abundant
 - *Oxygen and silicon = 75% mass
3. Al – Most abundant metal
4. Fe – 4th most abundant element, 2nd most abundant metal
5. Ca
6. Na – 6th most abundant element
7. Mg
8. K
9. Ti – 9th most abundant element
10. H – most abundant element in the universe; simplest and lightest element