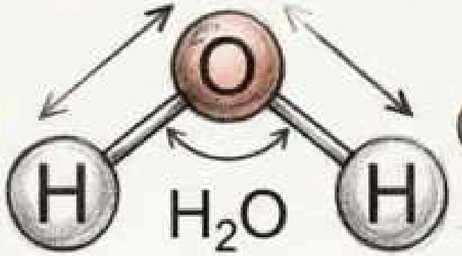
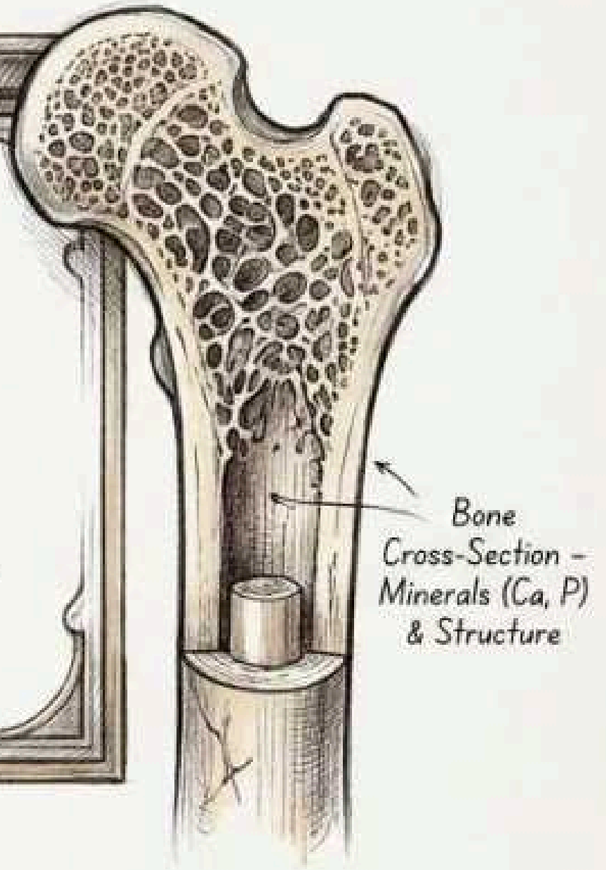
¶ 4.1



Lecture 4: Vitamins, Minerals, and Water

From historical scurvy to modern hydration, fortifications, and the antioxidant paradox.



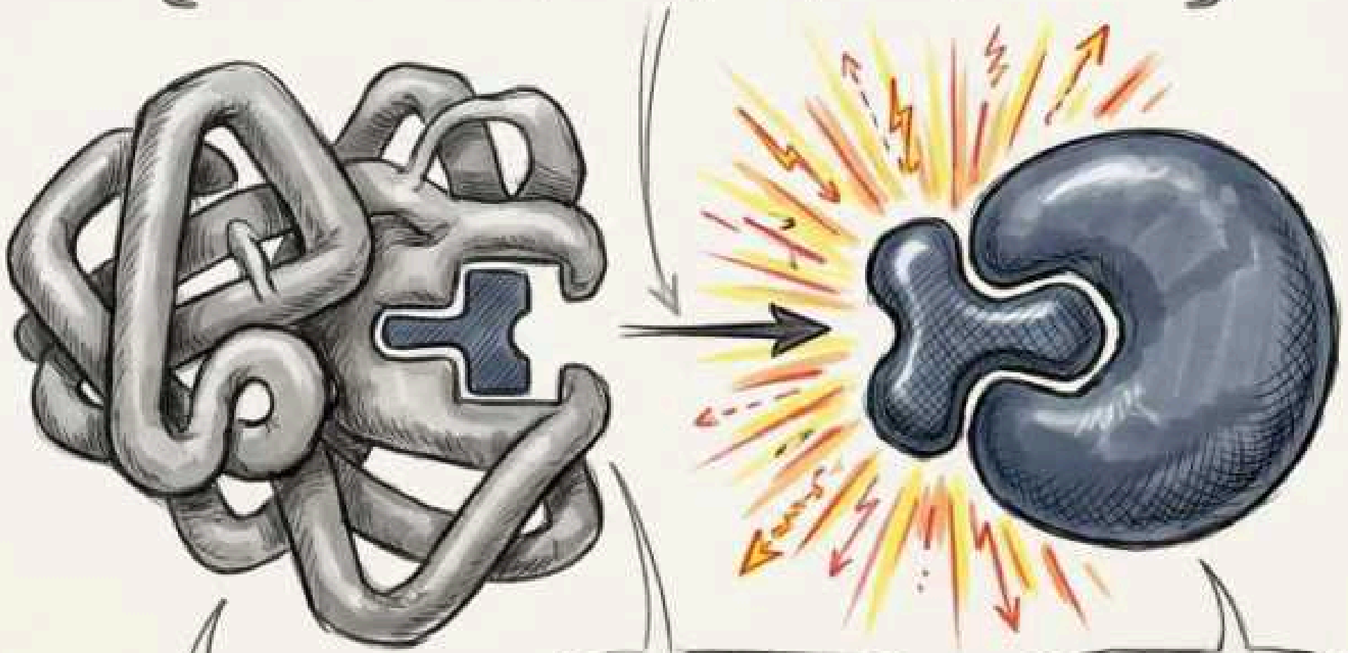


Gemini Notebook

Nutrients = 0 kcal, but Life ∝ Nutrients

Act as essential biochemical catalysts (helpers).

Supply zero energy.



Delicate balance between deficiency and excess.

Gemini Notebook

The Genesis of Vitamins: James Lind, 1747

N=10
(Standard naval ration)



Mortality / Scurvy:
bleeding, lost teeth

N=2
(Added Oranges & Lemons)



Citrus limon



Rapid Recovery

One of the earliest controlled clinical trials.
The actual cause remained a mystery for another 200 years.

Gemini Notebook

Vitamin C → Collagen Deficit → Scurvy

Thiamin → Nerve/Energy Deficit (ATP) → Beriberi

Niacin → Cellular Deficit → Pellagra (Dermatitis, Diarrhea, Dementia, Death)

Vitamin D → Bone Deficit → Rickets

Coined in the early 20th century as "Vital Amines" → Vitamins.

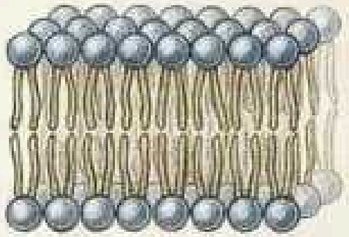
Gemini Notebook



Water-Soluble
(Vitamin C + 8 B Vitamins)

- Dissolve in water
- Short storage duration
- Excess is mostly excreted

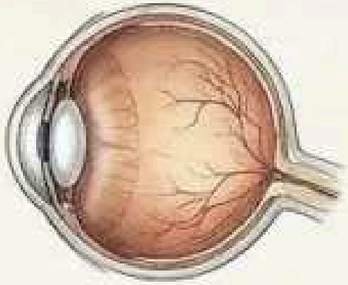
Fat-Soluble
(Vitamins A, D, E, K)



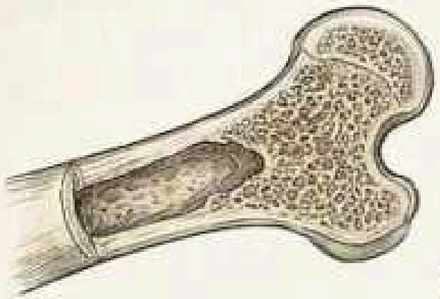
- Stored in body fat and the liver
- Long storage duration
- Excess builds up (risk of toxicity)

Gemini Notebook

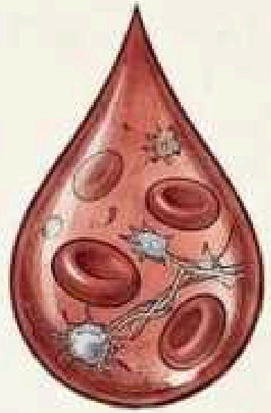
¶ 4.6



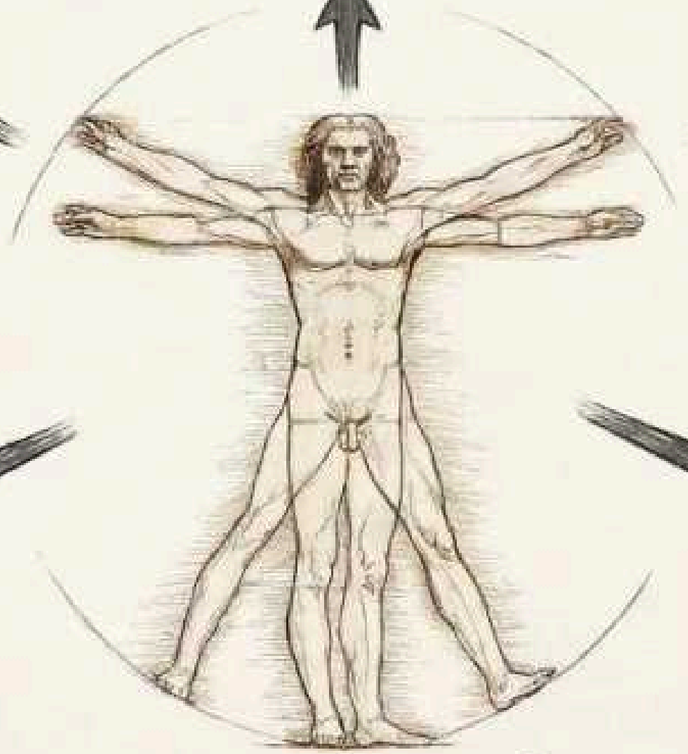
Vitamin A
(Vision and immune function)

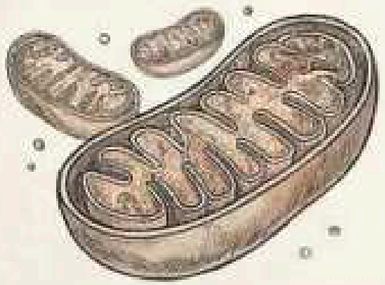


Vitamin D
(Calcium absorption, bone strength)

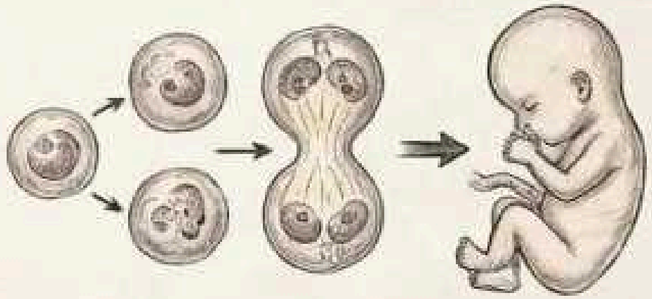


Vitamin K
(Blood clotting)





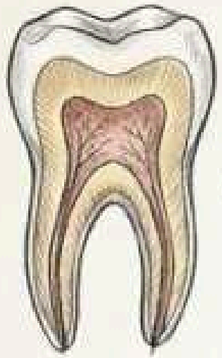
B Vitamins
(Releasing energy from food)



Folate
(Forming new cells, crucial early pregnancy)

Gemini Notebook

¶ 4.7



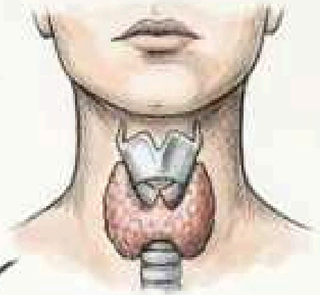
Bones & teeth

Ca

P

Fe

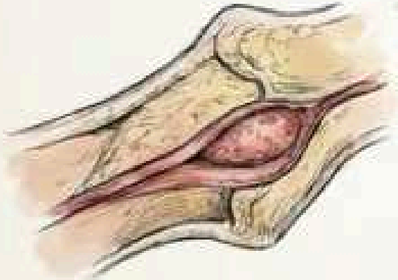
I



Thyroid hormones



Immune/healing



Plazned oxygen

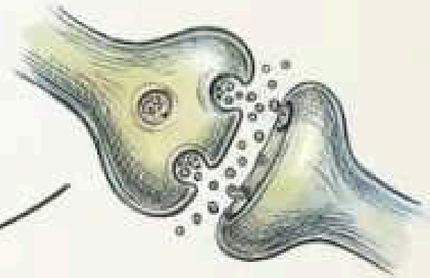


Carries oxygen

Zn

K

Na



Nerves, muscles, fluid balance

Optimal Health = The Goldilocks Zone
(Too little AND too much are harmful)

Gemini Notebook

¶ 4.8



Iron Deficiency

#1 global shortage, leading cause of anemia



Iodine Deficiency

Causes goiter; harms fetal brain development



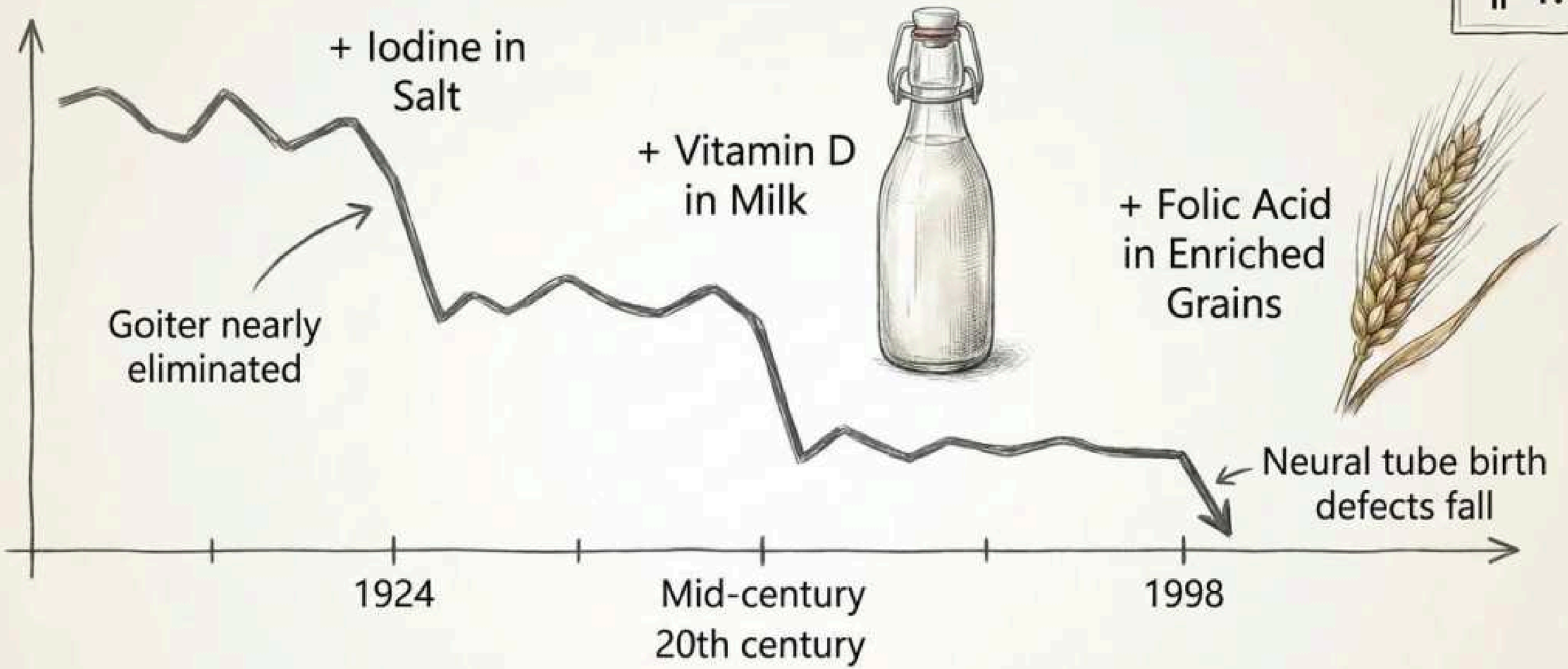
Vitamin A Deficiency

Major cause of preventable childhood blindness

Solutions require better diets and systemic fortification.

Gemini Notebook

¶ 4.9

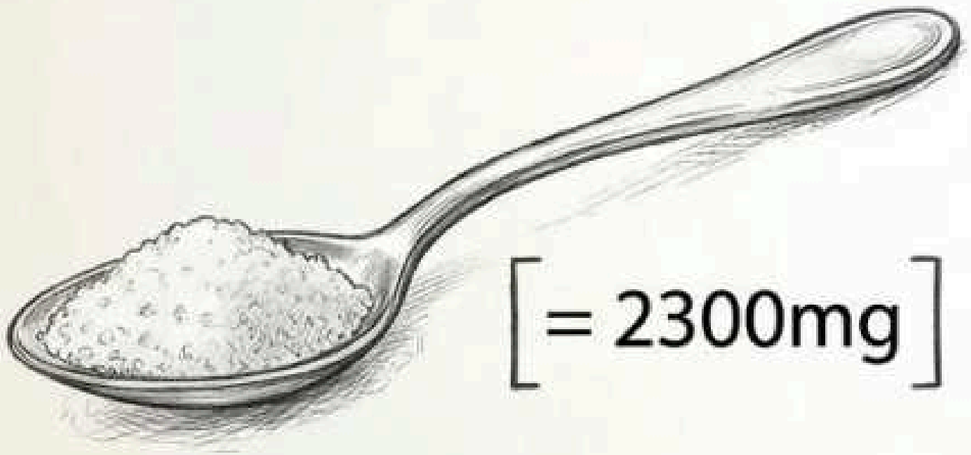


Fortification: Adding nutrients to common foods is one of the cheapest, most effective public health measures in history.

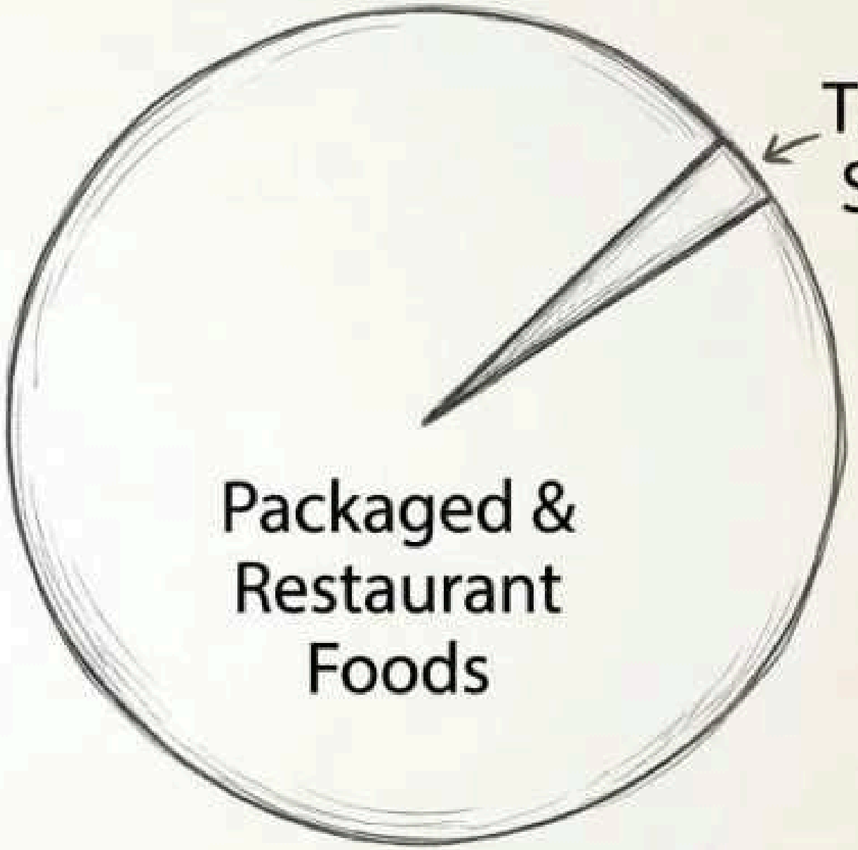
Gemini Notebook

¶ 4.10

$Na^+ \leq 2300$ mg/day



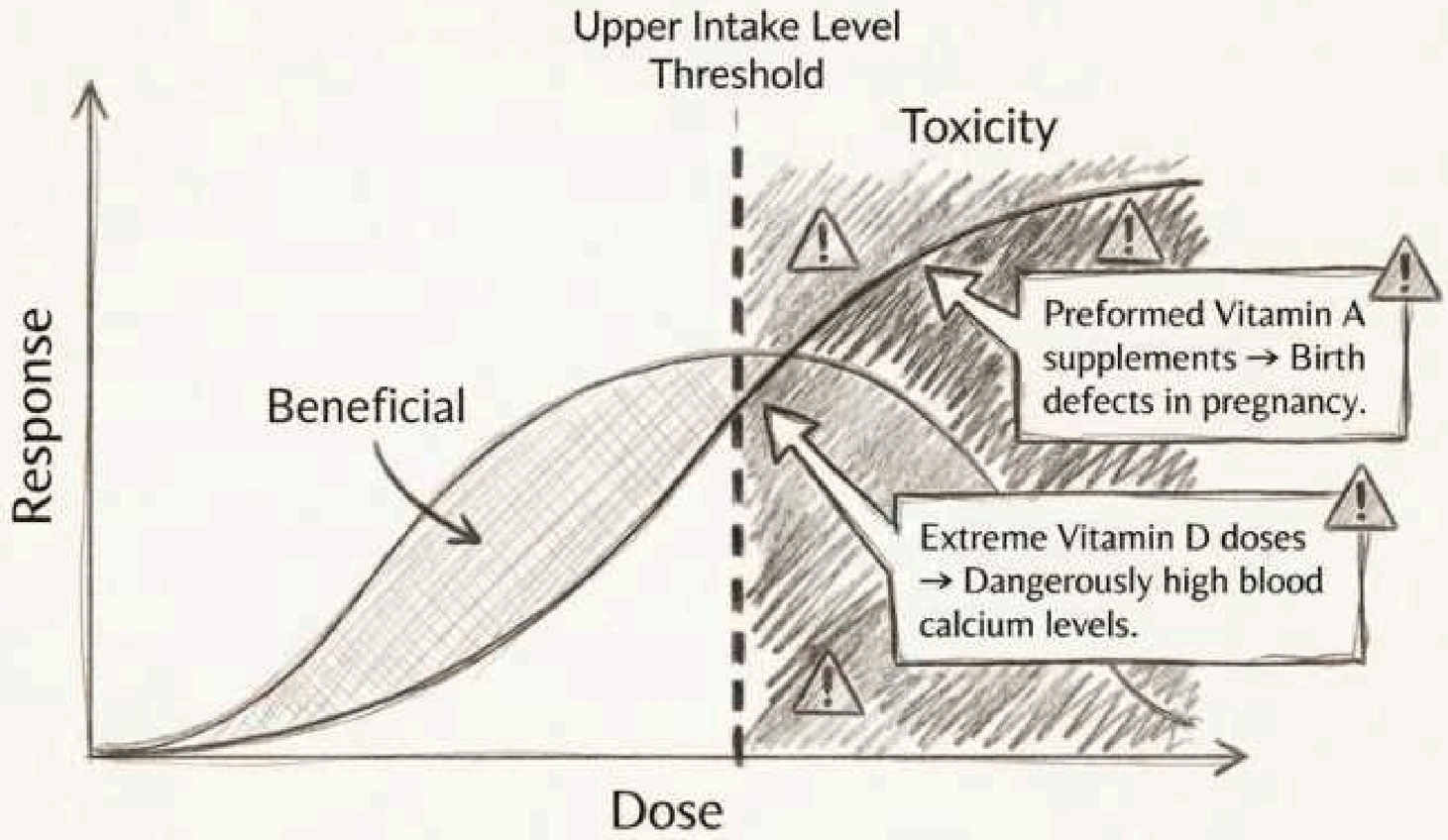
[= 2300mg]



High sodium intake raises blood pressure. The danger is hidden in processing, not added at the table.

Gemini Notebook

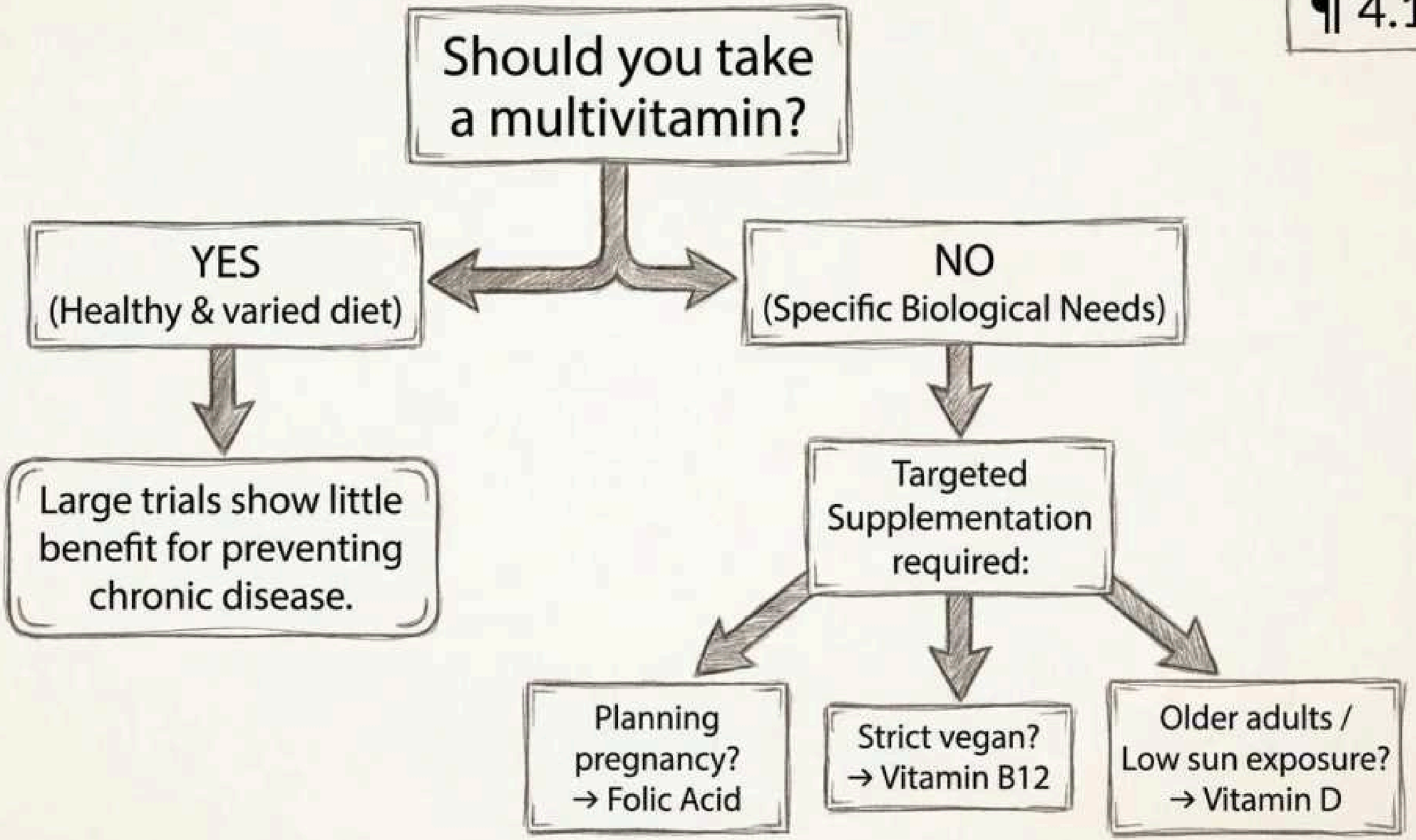
Upper Intake Level



The fallacy of "**More is Better.**" Fat-soluble vitamins accumulate to toxic levels. Upper intake levels exist for a reason.

Gemini Notebook

¶ 4.12



Gemini Notebook



1994 — 1994 US Law: Manufacturers can sell supplements without proving effectiveness before marketing.

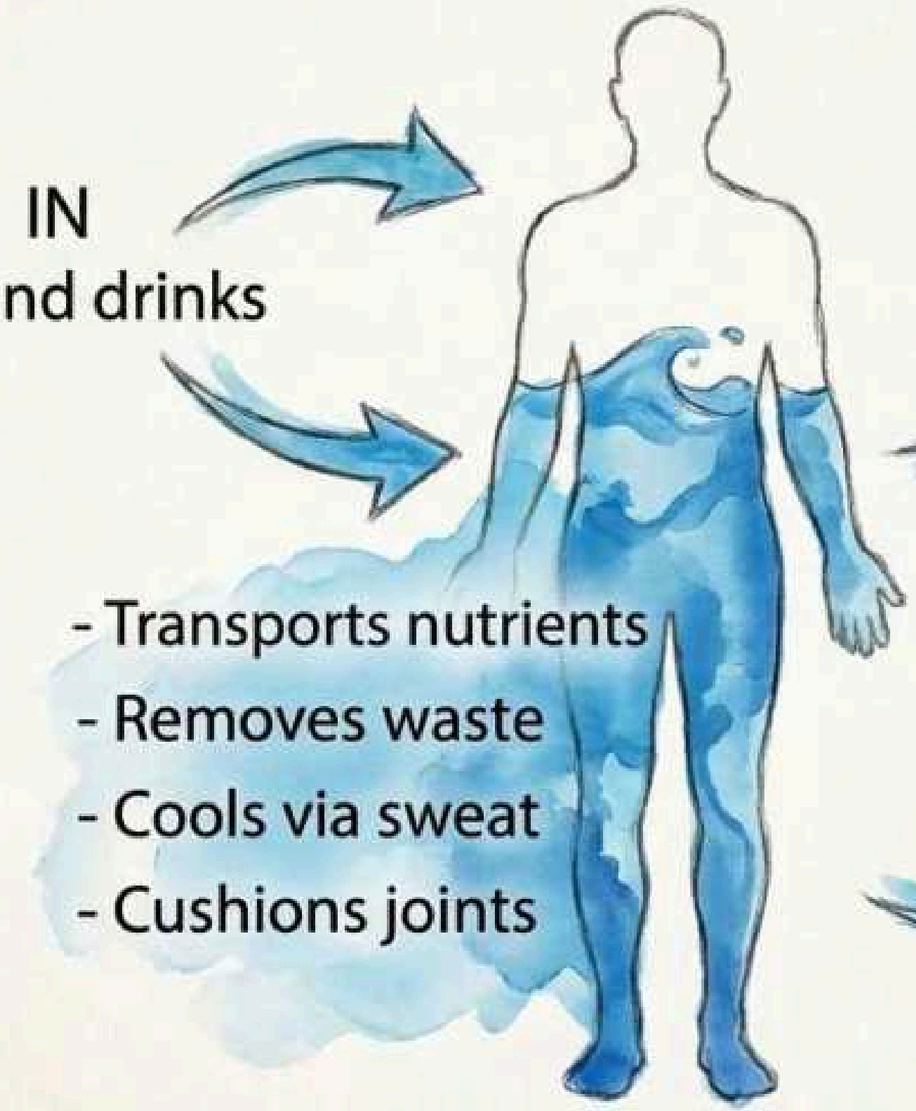
- Supplements ≠ Medicines
- Content can vary wildly
- Potential for dangerous interactions with prescription drugs
- Always consult a pharmacist or doctor.

Gemini Notebook

H_2O = 60% of adult body weight

¶ 4.14

IN
Food and drinks



- Transports nutrients
- Removes waste
- Cools via sweat
- Cushions joints

OUT
Urine, breath, and sweat
(continual loss requires continual replacement)

OUT

Gemini Notebook

Myth



Myth: 8 glasses a day
(No firm scientific basis)

Science

Women: $\sum$ (Drinks + Food Water) ≈ 2.7L

Men: $\sum$ (Drinks + Food Water) ≈ 3.7L

Needs scale upwards with heat, exercise, and illness.
For healthy individuals, thirst is a reasonably good guide.

Gemini Notebook

¶ 4.16

Optimal







Caution/Negative



Water
(The fine default)

Coffee & Tea
(Moderate caffeine is NOT dehydrating for regular drinkers)

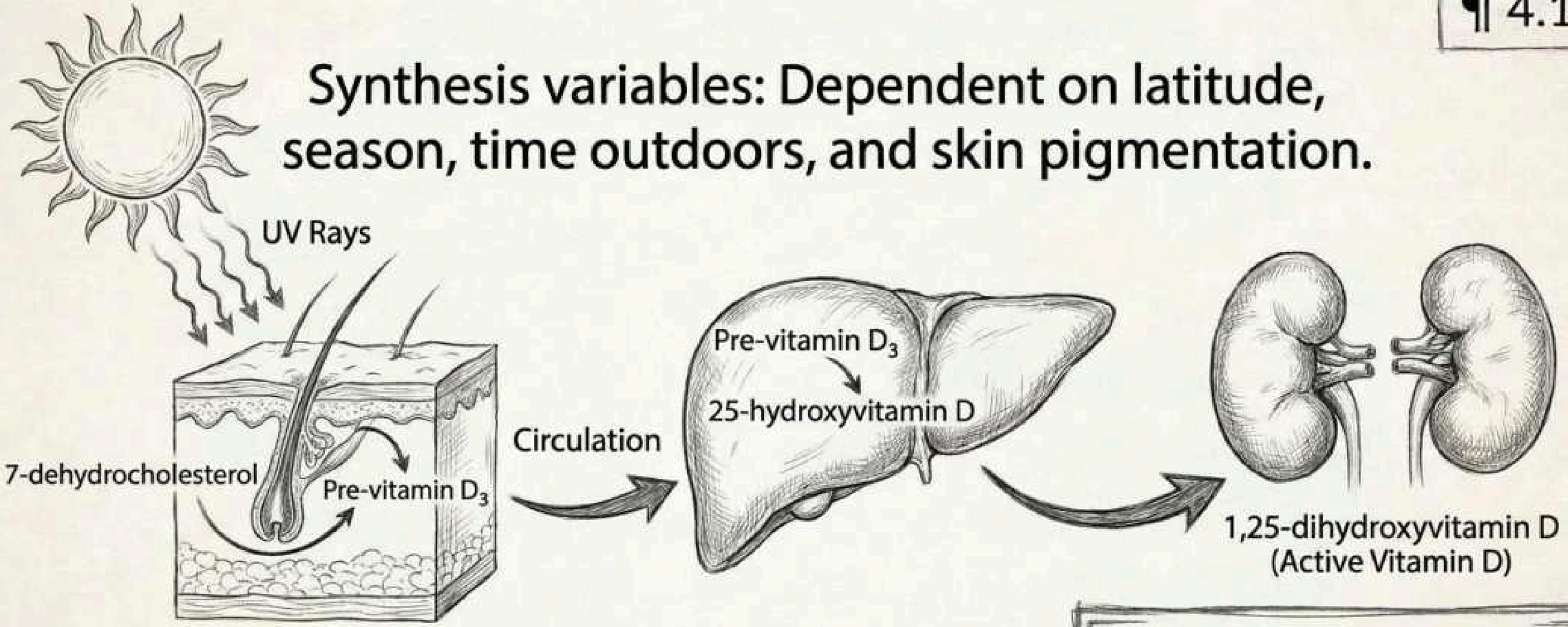
Sugary Drinks
(Keep occasional)

Alcohol
(Brings calories and risks without nutrients)

Overhydration is possible but uncommon, occurring mostly in extreme endurance events.

Gemini Notebook

Synthesis variables: Dependent on latitude, season, time outdoors, and skin pigmentation.



Daily Need = 15 µg (600 IU)

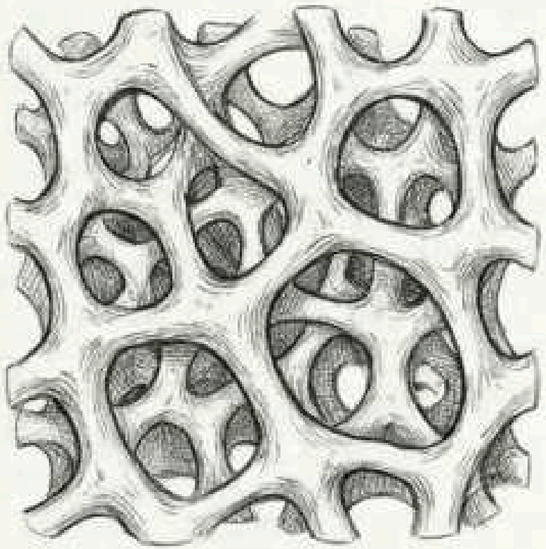
Few foods contain it naturally (oily fish, fortified milk). Some groups are at chronic risk of low levels.

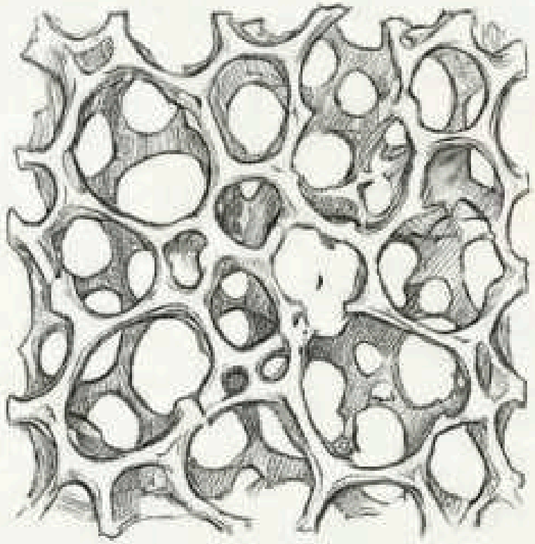
Gemini Notebook

¶ 4.18

99% sits in bones and teeth.
Most abundant mineral in the body.

Dense, healthy bone matrix





Porous, fragile bone matrix (Osteoporosis)

Goal = 1000 mg/day

(Sources: Dairy, fortified plant milks, canned fish with bones, leafy greens)

Bone Strength = Calcium + Vitamin D + Weight-Bearing Exercise

(Build bone early to prevent osteoporosis)

Gemini Notebook

¶ 4.19

Free radicals damage cells → Antioxidants stop free radicals → Antioxidant pills will prevent disease

Given to smokers, the supplement unexpectedly INCREASED lung cancer rates.

A nutrient isolated in a pill is fundamentally not the same as that nutrient integrated within whole fruit and vegetables.

Gemini Notebook

¶ 4.20

The Personal Assessment Equation

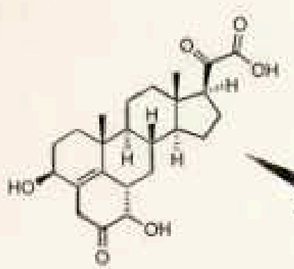
Which nutrient is is hardest to get enough of on your usual diet? → [ ]

Which are you most likely to overconsume? → [ ]

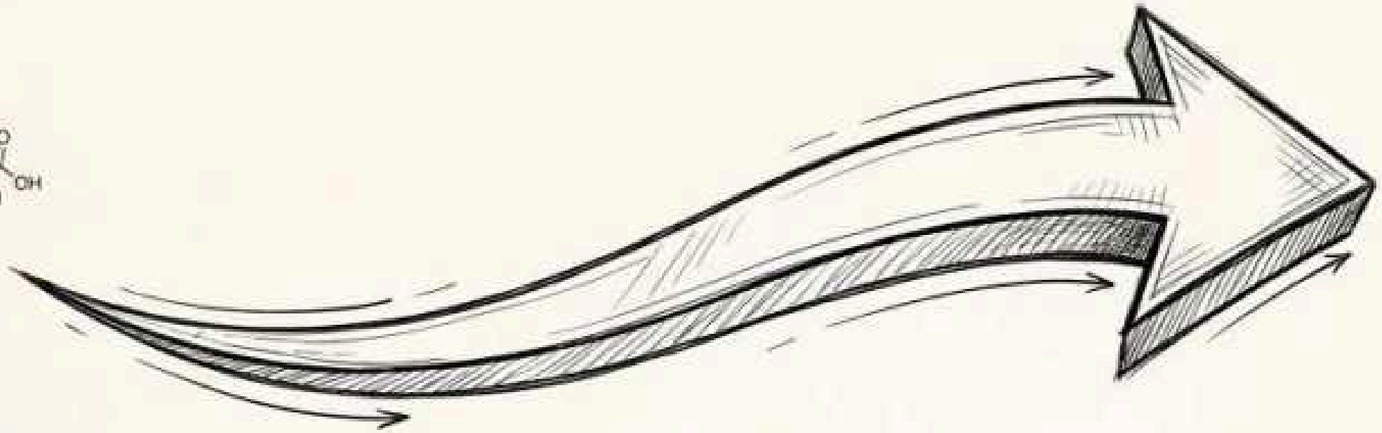
Look up the recommended amounts in official sources and compare them with your actual intake.

Gemini Notebook

¶ 4.21



Micro





Macro

Looking Ahead to Lecture 5: Whole Eating Patterns.
We will step back from single, isolated nutrients to ask what the broad evidence says about building healthy, holistic diets.

Gemini Notebook