

## Review Article

### Trace Element Nutrition

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#### Abstract

Recent reports of ice XIc corroborated my discovery of its phase transition at 72 K. Crystallizing in liquid nitrogen on Earth's poles during a primordial ice-age, temperature fluctuations released  $\sim 4\mu$  laser light. Polarized by multiple reflections in cloud and surface ice, it selectively activated nucleotides in tropical waters, creating chiral DNA. Some formed transport DNAs, tDNA sharing transfer RNA's H-bond-lined holes. Embedding in primitive cell membranes, laser light drove the active transport of charged carrier-substrate complexes through them. Concentration promoted their metabolism, a replicate tDNA signaled life's origin. Complementing barrels of  $\alpha$ -helical protein, sufficient Ca, K, Mn, I, Cu, F, Zn, Ag and Se and controlling acid air pollution would counter maladies associated with Western diets. Hairpin proteins predating the evolution of ribosome neutralized DNA's acidity, binding uncoiled DNA to form minions. They pack DNA on chromosomes and facilitate their replication. Proton-ordered arrays of H-bonds on minion surfaces serve as biological clocks, 'Chips in the brain' and govern nine independent metabolic pathways. This paper addresses some consequences.

#### Introduction

(Figure 1) shows the phase transition at 72 K in proton-ordered ice XIc releasing  $\sim 4\mu$  infrared laser light, ice-light. Ice XIc crystallized in liquid nitrogen on Earth's poles during a primordial ice-age and temperature fluctuations drove its transition. Polarized by multiple reflections, ice-light reached Darwin's warm tropical waters. There, lightning synthesized deoxy-nucleotides and it photo-phosphorylated them, polymerizing to form chiral DNA. Some formed transfer RNA analogues, transport DNAs, tDNAs, sharing their H-bond-lined hole. tDNAs lined pores through coacervate proto-cell membranes. Ice-light powered a ratchet mechanism importing charged carrier-substrate complexes to them. Now some 2,000 tDNAs complementing barrels of  $\alpha$ -helical protein control nine parallel pathways. Diets need satisfy their requirements to maintain health. Alternate neutral and basic [A, L, I | V and K | R] residues form anti-parallel  $\beta$ -pleated-sheet protein hairpins holding uncoiled B-helical DNA flat. P creates a  $17^\circ$  bend between adjacent units to form a twenty-one-unit coil, degrading to a nucleosome core particle, NCP on extraction. The Fs in gramicidin are analogous to bases. Further protein hairpins binding nine coils complete a minion. Stacked minions pack better than NCPs, predicting their

dimensions and replicating 1,701 base-pairs without uncoiling or recoiling. H-bonds between bases, across pleated sheets and connecting  $\omega$ -amines to phosphates hold minions together. The latter are concatenated and oscillate, accelerating protons along adjacent tunnels, T. Their default settings are retained, storing intellectual data; their progress measures the passage of time. Protons fuse with obstructing nuclei, driving the carbon-nitrogen cycle and emitting  $\gamma$ -rays with periods and frequencies matching those of pulsars.

#### Bioenergetics

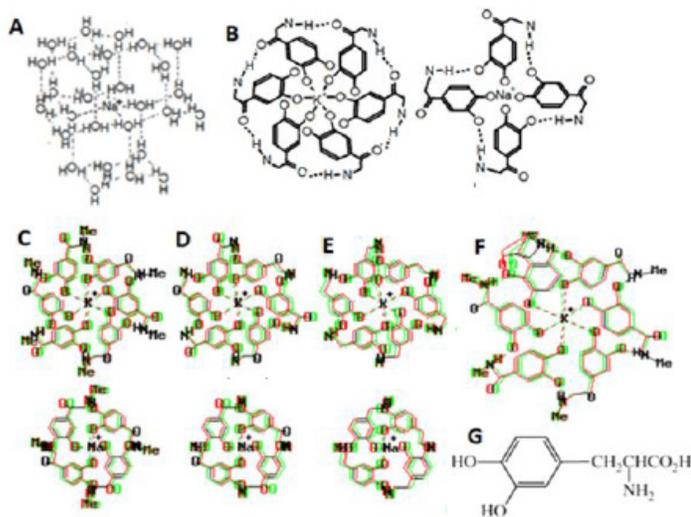
(Figure 2) illustrates aspects of biological energy. The water molecules in ice XIc adopt the same positions as carbon atoms in diamond. Each water molecule is a dipole, they all point the same way, during the ice XIc phase transition, the ice crystal expands along its x-/y-axes and contracts along the z-axis to accommodate their irregular tetrahedral shape. The latent energy it releases drove life's origin. The three-stage cytochrome chain splits the energy released by the Krebs cycle oxidizing carbohydrates. Cholinesterase release choline from acetylcholine, its uptake changes membrane potential.



[3], energizing such processes as silicon hexafluoride synthesis-dimerizing phosphate to pyrophosphate and oxidizing selenium to selenite,  $\text{SeO}_3^-$ .

### Sensitivity

(Figure 4) shows sodium ions have the same shape and size as water molecules, such large hydrates as  $\text{Na}^+ \cdot 28\text{H}_2\text{O}$  make the cell sap viscous. Since potassium ions bind less water, substituting  $\text{K}^+$  for  $\text{Na}^+$  speeds reactions, explaining the fight or flight reaction [4]. Catecholamines adrenaline, noradrenaline and dopamine form 4-/6-member rings around  $\text{Na}^+/\text{K}^+$ , exchanging 3  $\text{Na}^+$  for 2  $\text{K}^+$  at synaptic junctions [5]. This enables inter-minion information exchange and pain transmission. Substituting codeine or morphine creates larger complexes, preventing pain transmission by blocking tDNAs. The enrolments of more tDNAs to compensate increases pain sensitivity. Further drug consumption alleviates it, explaining addiction [6]. The differentiated brain areas (basis for the neural network model) employ different neurotransmitters.  $\text{L}_1$ Dopa corrects dopamine deficiency, countering Parkinson's disease [7].



**Figure 4:** Sensitivity. (A)  $\text{Na}^+ \cdot 28\text{H}_2\text{O}$  (B) Adrenaline forms four-/six-member rings around  $\text{K}^+$  and  $\text{Na}^+$  (C) adrenaline (D) noradrenaline (E) dopamine (F) Morphine substitution (G)  $\text{L}_1$ Dopa.

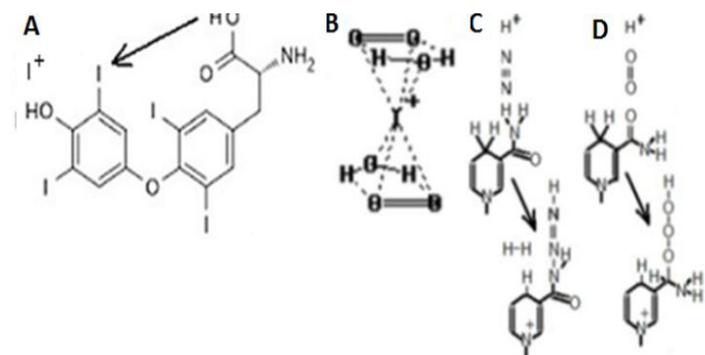
### Excretion

Manganese chlorides:  $\text{MnCl}_3^-$ ,  $\text{MnCl}_4^-$  and  $\text{MnCl}_6^{4-}$  excrete salt in urine, sweat and tears. Catalyzing exchange of  $\text{HCO}_3^-$  for  $\text{Cl}^-$ , the chloride shift [8] controlling ionic strength. Erythrocytes carry oxygen bound to hemoglobin, the exchange of  $\text{O}_2$  for  $\text{CO}_2$  [9]. Zn cofactors carbonic anhydrase:  $\text{CO}_2 + \text{H}_2\text{O} \leftrightarrow \text{HCO}_3^- + \text{H}^+$ . Together with  $\text{CO}_2$  excretion, it controls pH.

### Respiration

Figure 5 shows how littoral seaweeds' purple and yellow colors reflect those of iodine,  $\text{I}^-$  and  $\text{I}^+$ . The  $\text{I}^- \cdot [\text{O}_2 \cdot \text{H}_2\text{O}]_2$  complex

protects them from tidal fluctuations in oxygen concentration. Iodine deficiency causes goiter [10] and the complex carries water into the aqueous humor causing exophthalmos. Nerve cell oxygen uptake is disrupted by mutant tDNAs, explaining bipolar disorder [11]. Mania and depression correlate with excess and deficient oxygenation. Lithium, diagonally related to iodine in the periodic table, stabilizes oxygen transport, and excess can cause kidney failure. tDNA drives proton transport binding nitrogen to nicotinamide, it fixes nitrogen more efficiently than the Haber process [12]. Parallel reaction photolyzed water, introducing the oxygen in Earth's atmosphere [13]. This tDNA releases nitric oxide, controlling vasodilation and cyanide poisons it.



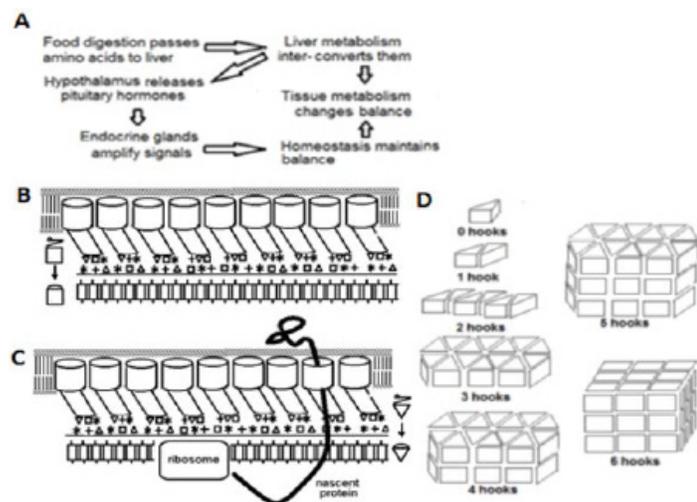
**Figure 5:** Respiration. (A) Proton releases iodine from thyroxine (B)  $\text{I}^+$  complexes with oxygen hydrate (C) Nitrogen fixation (D) Oxygen release.

### Growth

The liver inter-converts amino acids [14] ensuring a balanced mixture for the brain. The anterior pituitary packs somatotropin with copper for distribution throughout the body, promoting enzyme catalysis. Any metabolic disruption can signal somatotropin release, stimulating the hypothalamus to issue somatomedins supplying copper to endocrine glands, their hormones alert all body cells [15], an exquisitely tuned feedback reaction. Differentiation DNAs select tDNAs determining cell diet which controls metabolism, analogous to mRNAs selecting transfer RNAs for protein synthesis. tDNAs facing blastula and gastrula at cell division are starved of nutrients. Adenylcyclase driven substrate transport is replaced by guanylyl cyclase synthesizing hook proteins. They pair, binding sister cells together, determining tissue morphology. Stem cells lack hooks, gametes and leucocytes have 1, spirogyra filaments 2, sponge sheets 3 and bi-layered worms 4. 5 hooks suffice to form all body tissues and limit their growth. A 6th hook arising enables neoplastic growth unless 1-hook leucocytes digest them.

Biotechnologists creating variant tDNAs could yield monsters. Publication of a proof of my five-hook theorem, 3D equivalent of the Four-color mapping theorem [16] would encourage research on cancer treatment. Copper supplements control growth disorders and might ameliorate arthritis. Mutant tDNAs account for

acromegaly[17], dwarfs andgiants. Copper accumulating in the eyes causes Wilson’s disease, (Figure 6).



**Figure 6:** Growth. (A) Liver equilibrates amino acids (B) Adenylcyclase substrate transport (C) Guanylcyclase synthesizes hook proteins (D) Hook proteins govern tissue morphology.

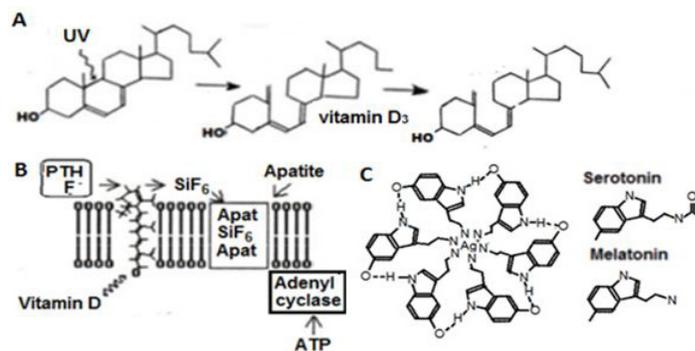
### Bone and tooth maintenance

Fluorine maintains bones and teeth, preventing bone fracture, osteoporosis and dental caries. The stability of fluorapatite illustrates the affinity of Ca for F [18]. Silicon hexafluoride, SiF<sub>6</sub><sup>=</sup> transports apatite and fluorapatite across osteoblast and osteoclast membranes. The ~265 nm UV light stored in vitamin D has energy matching that of Si ~ F bonds [19]. Continuous secretion of parathyroid hormone, PTH prevents toxic F-accumulation[20]. Retinal transfers energy as solitons, driving the pH sensitive reaction: SiO<sub>2</sub>+ 6F<sup>-</sup>+ 4H<sup>+</sup>+ UV → SiF<sub>6</sub><sup>=</sup>+ 2H<sub>2</sub>O

Acid conditions in kidney failure and at menopause cause osteoporosis [21].Phosphate is scarce for plant life, they use silica to build their hard parts, apatite transports SiO<sub>2</sub>, diatomaceous earthpreserves their fossilized remains [22]. SO<sub>x</sub> or NO<sub>x</sub> air pollutionentering the stomata of forest trees causes leaf-fall [23]. Liming the soil has no effect, reducing interest in its regulation. SO<sub>x</sub> or NO<sub>x</sub> air pollutionpromotes inappropriate SiF<sub>6</sub><sup>=</sup> synthesis in the nasal fossa and olfactorynerves deliver it to the brain. There its breakdown releases F<sup>-</sup> and deposits aluminosilicate plaques. F-Disrupts the citric acid cycle, progressively killing cells. It also disrupts protein folding [24] as nascent proteins pass through tDNAs, creating β-amyloid and □-protein tangles. Mutant tRNAs misinterpreting mRNA sequences create similar tangles in prion diseases [25], embedded tRNAs render them infectious. Fluorinated anesthetics, typically administered for hip replacement, relieve Alzheimer Disease symptoms four days later [26].

Kidneys excretion of AlF<sub>6</sub><sup>=</sup> is accompanied by brain clear-

ance of F<sup>-</sup>. Acid air pollution control or a pharmaceutical delivering F to the brain might manage the condition.Other pathologies include vitamin D deficiency causing rickets, F- supplements might prove more effective than UV lamps, sunlight and cod liver oil [27]. Fluoridation of water suppliessubstitutesF<sup>-</sup> for OH<sup>-</sup>, hardening tooth enamel and preventing dental caries [28]. Excess F-can cause fluorosis, tea supplies adequate F[29], (Figure 7).



**Figure 7:** Bone and tooth maintenance. (A) Vitamin D stores UV light energy (B) SiF<sub>6</sub> synthesis (C) Pineal hormones transport Ag<sup>+</sup>.

### Assimilation

Transporting the Zn<sup>++</sup>-β<sub>D</sub>glucose complex controlscarbohydrate metabolism. Pancreatic α- and β-cells release glucagon and insulin, insulin delivers Zn and glucagon clears it. Zn<sup>++</sup> binds to the triangle of sweetness [30]. Defective glucose transport causes diabetes, implanting a Zn monitor might help manage it. Zn determines appetites for food and sex [31], anticipating food promotes insulin secretion, anorexia nervosa and bulimia respond to Zn supplements.Breathing oxygen initiates adult hemoglobin replacing the fetal form, releasing bilirubin. The Zn in colostrum conjugates it, preventing neonatal jaundice [32]. Zn in the traditional midwife’s pewter spoon was as effective as current exposure to blue light. Zn deficiency prevented OH-proline incorporation to collagen, causing sailors’ scurvy, the vitamin C in limes prevented it [33]. ZnS, the active ingredient of Calamine™ lotion, works the same way.Vitamin C derivative 2-keto-Lgulonate takes Zn where insulin can’t reach. The vitamin C supplements Linus Pauling advocated prevents rhinovirus entry to nasal tDNAs[34]. The Zn in caviar increases libido and Cu in coil contraceptives competing with Zn inhibits sperm glucose uptake, preventing fertilization. Alcohol consumption and barbiturates cause Zn transfer to cofactor hepatic alcohol dehydrogenase for detoxification [35], reduced brain Zn supply starves it of glucose, causing inebriation. Better Zn nutrition might manage alcoholism.Beryllium, lead and indium, Be<sup>++</sup>, Pb<sup>++</sup> and In<sup>++</sup> mimic Zn<sup>++</sup>, Victorians used beryllium as a poison, calling it glucinium for its sweet taste [36]. Using lead acetate as a sweetener killed ancient Romans. Indium is diagonally related to zinc in the periodic table, it may mediate endocrine gland divalent ion uptake, (Figure 8).

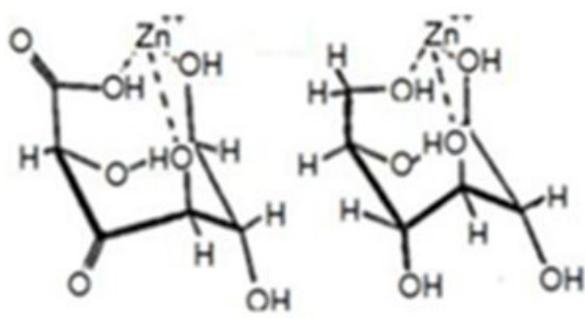


Figure 8: Assimilation 2-keto-L-gulonate and  $\beta$ -D-glucose bind zinc.

### Reproduction

Serotonin forms 6-member rings around  $Ag^+$ , c.f.  $K^+$ -adrenaline 6. Exchanging creatine for creatinine replenishes ATP. Retinal transfers solitons from pink Ag porphyrin, converting  $P_i$  to  $PP_i$ . The  $PP_i$ -Arg2 complex delivers the atomic ingredients (24H, 12C, 11O, 8N and 2P) for DNA replication at cell division, anti-cancer drugs canaverine, aminoimidazole, dacarbazine and chloroplatinate mimic it. Ag was used in medicine before antibiotics were introduced [37]. Ag colloid successfully treated animal cancer, suggesting its reinstatement [38], (Figure 9).

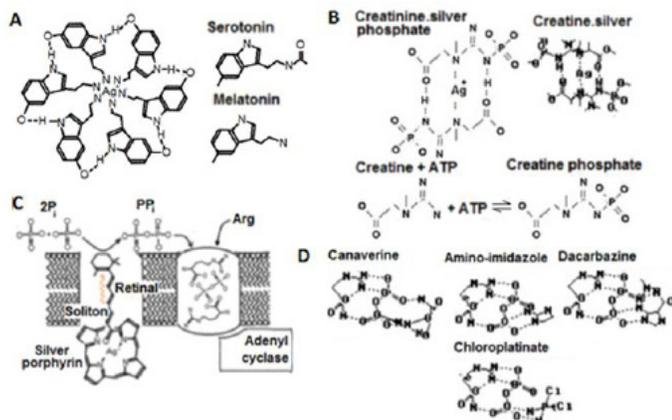


Figure 9: Reproduction. (A) Pineal hormones transport  $Ag^+$  (B) Creatine/creatinine exchange replenishes ATP (C)  $PP_i$ -Arg2 complex transports  $PP_i$  (D) Anti-cancer drugs mimic  $PP_i$ -Arg2.

### Water transport

Membrane potential precludes Mitchell's chemiosmosis [39] assuming water diffuses freely through unit membranes. The residue of saturated fat breakdown, mevalonate, is named after Valerian, aka all heal [40]. Exchanging mevalonate-5-phosphate for mevalono-lactone-5-phosphate transports water. The posterior pituitary installs S ~ Se bonds in oxytocin and vasopressin [41]. Vitamin E,  $\alpha$ -tocopherol transfers solitons, creating selenite,  $SeO_3^-$  which exchanges  $Ca^{++}$  for  $Mn^{++}$ . Manganese cofactors enzymes converting surplus mevalonate to cholesterol [42], feedstock for steroid hormones. Selenium deficiency causes most Western mor-

bidity: preeclampsia, cancers of breast, bowel, cervix and prostate and heart attacks and strokes.

The best evidence is the persistent correlation between breast cancer distribution and surface geology [43]. Hard water percolating through sedimentary and igneous rocks incorporates remnants of early selenium-dependent life, it's preferable to soft water, seafloor manganese nodules also evidence selenium-dependency. Animal husbandry affords much evidence [44]: The sulfur in superphosphate fertilizer competes with it, causing white muscle disease in sheep, selenium deficient pregnant cattle suffer hypertension and swine get heart failure en route to market, (Figure 10).

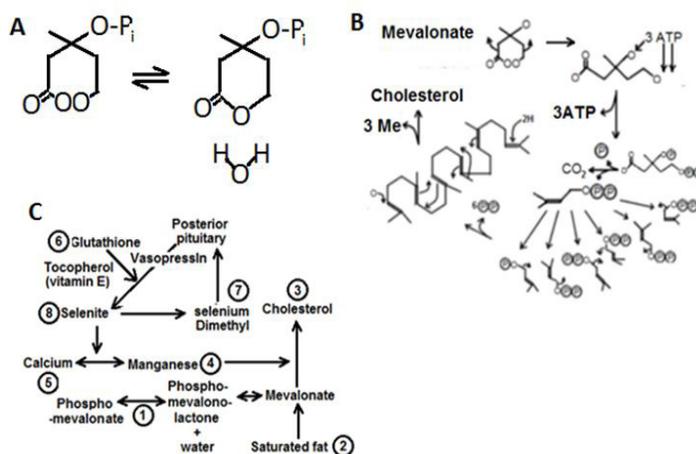


Figure 10: Water transport. (A) Mevalonate transports water (B) Cholesterol synthesis (C) Blood pressure controls: 1-tDNA<sub>water transport</sub> genetics. 2-Consuming saturated fat. 3-LDL/HDL cholesterol transport. 4-Mn and cholesterol synthesis. 5-Exercise and Ca. 6-S metabolism and glutathione. 7-HgMe prevents  $Me_2Se$  accessing pituitary. 8-Se deficiencies [45-47].

### Conclusion

Provision of limes to mariners for preventing scurvy, iodine for goiter, cod liver oil for rickets and fluoridation for dental caries are precedents for selenium supplementation to prevent heart attacks and common cancers. Research focused on enzyme-catalyzed metabolism ignores underlying biochemistry, attention to dietary nutrient content ensures health and longevity.

### Acknowledgments

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