

A Ferroelectric Transition in Proton Ordered Ice Crystallised in Liquid Nitrogen released Laser Light, Explaining the Origin of Life with many Consequences

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Abstract

A serendipitous observation during a student class practical with liquid nitrogen led me to propose that a variant of cubic ice crystallizing on the silica helium thermometer bulb had distorted it. Pauling argued the H-bonds in hexagonal ice retain entropy at 0K. Recent evidence for a ferroelectric transition in 'ice XIc' at ~72 K validates that suggestion. This paper introduces a lifetime's research based on three axioms:

1. Proton ordered ice crystallized in liquid nitrogen undergoes a ferroelectric transition at ~72 K releasing latent energy as ~4 μ laser light, 'ice light', matching phosphodiester bond energy.
2. Ice crystallizing in liquid nitrogen on Earth's poles during a primordial ice age released ice light. Polarised by multiple reflection in ice clouds and surface ice, it photo-phosphorylated nucleotides in tropical waters, creating a 'noodle soup' of chiral DNA. Some formed 'transport DNA's, tDNAs, tRNA analogues.
3. tDNAs used an ice light powered mechanism to actively transported substrates into Oparin's 'coacervate' proto-cells.

The resulting model for the origin of life makes predictions consistent with scientific research. Applying evolutionary and thermodynamic principles reveals life's atomic alphabet, molecular vocabulary and metabolic grammar, predating protein synthesis evolving. It offers new perspectives on metabolism, bioenergetics, genetics, endocrinology and tissue differentiation:

- Dietary prevention of health disorders including: heart attacks, cancers, diabetes and Alzheimer's disease.
- Energy coupling for N-fixation and power generation.
- Medical diagnosis pre-empting pharmaceutical interventions.

'Minions', DNA-protein complexes evolved to pack chromosomes and facilitate their replication, are bound by proton ordered H-bonds using a 63-character alphabet to store information as 18-letter words. Similar words resonate and nerve fibres act as wave guides, explaining brain function. Trace element supplements and AI modelled on 'minions' could improve health and create user-friendly IT. These proposals are consistent with science, philosophy and tradition.

Ice as Ordering Force

Water molecules' irregular shape explains the sixteen known phases of ice [1]. Ice Ic shares diamond's cubic structure, (Figure 1A), at liquid nitrogen temperature. Water molecules are usually randomly oriented, accounting for Linus Pauling's residual entropy. They tend to align below the observed ferroelectric transition temperature, ~72 K [2]. Re-crystallisation in liquid nitrogen yields an orderly variant of cubic ice. Its ferroelectric phase transition is accompanied by shape change, (Figure 1B), releasing 'ice light', explaining this anomaly. The estimated wavelength of ice light, λ , is ~4 μ . Reflection in ordinary ice, (Figure 2A) polarises it. Planetary temperatures observed by astronomers [3] are consistent with polar liquid nitrogen and Charles Darwin's warm equatorial waters coexisting during a primordial ice age. Over millions of years, dynamic equilibrium maintained small nucleotide concentrations. Diurnal, annual and random temperature fluctuations caused ice light release, creating DNA, it's more stable than RNA. 'Transport DNA's, analogues of transfer RNA involved in modern protein synthesis, lined pores through Oparin's 'coacervate' membranes [4] with H-bonds, (Figure 2B). Electric storms polarized the H-bonds, creating a membrane potential. When ice light depolarized them, the residual electric field ingested charged complexes, (Figure 2C). This explains how order arising in ice created life from chaos.

The Bioenergetics of Proton Ordered H-bonds

In isolation, H-bonds are weak and disorderly, *en masse* they're

strong. All biological systems use photochemistry, $\frac{1}{2}$ -wave resonant cavities for ice light couple chemical to mechanical energy, they're more efficient than processes subject to thermodynamic constraints:

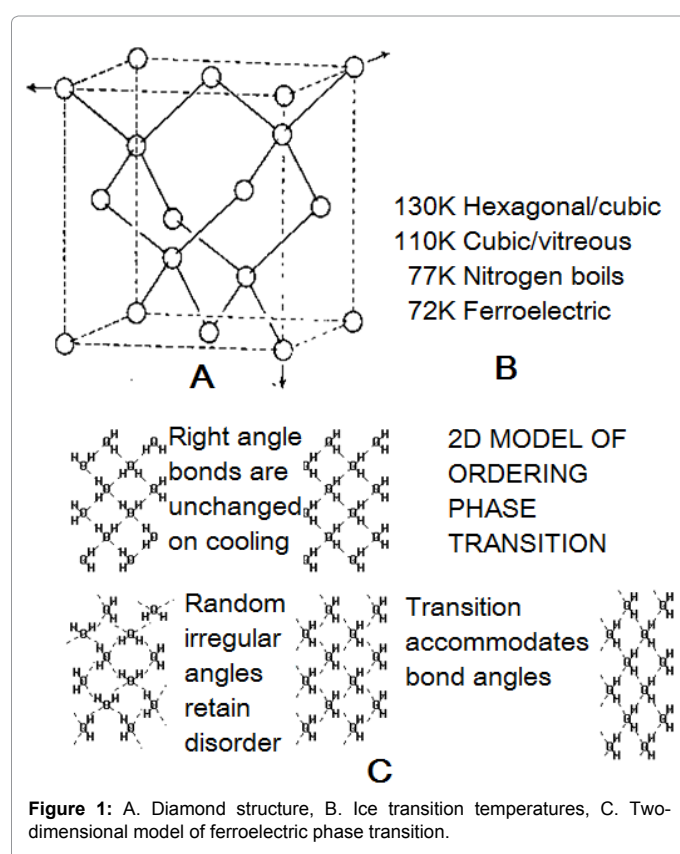
- Adrian Huxley's model for striated muscle contraction [6], involving the random attachment of actin to myosin is as inefficient as a steam engine. Hydrolysis of ATP releases ice light and sarcomeres change shape, forming $\frac{1}{2} \lambda$ cavities resonating with it, sharing the efficiency of electric motors.
- Peter Mitchell presumed unit membranes were semi-permeable when he proposed chemiosmosis [7]. Na^+/K^+ exchange maintains membrane potential, see *Sensitivity*. It creates an electric field preventing charged ions or polarisable molecules

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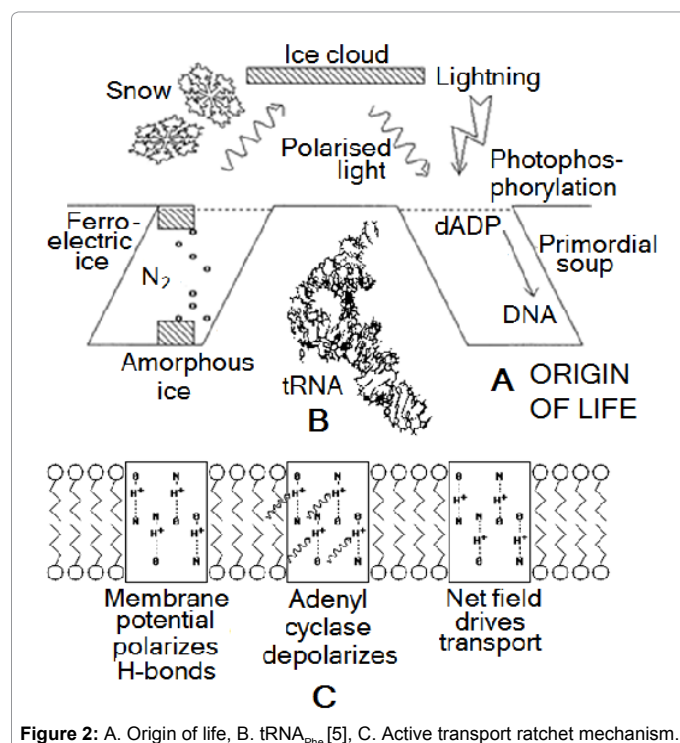
- Nicotinamide on NAD and NADP exchanging protons fixes nitrogen more efficiently than the Haber process. Parallel reactions account for proton transport and release of atmospheric oxygen, see *Respiration*.
- The consensus model for active transport, involving barrels of α -helices opening and closing, is less efficient than DNA's ratchet mechanism, (Figure 2C).
- Centrioles are $\sim \frac{1}{2} \lambda$ long, resonating with ATP's phosphodiester energy which accumulates in their nine peripheral rods. They simultaneously feed energy along spindle proteins. These comprise three α -helical proteins forming helices, each incorporates three paths of alternate conjugated double bonds transmitting ice light to centromeres.
- Chromosomes at cell division have circumference $\sim \frac{1}{2} \lambda$, oscillating H-bonds between their amino acid ω -amines and phosphate groups accelerate protons along spiral 'minion' tunnels. They create alternating magnetic fields with frequencies dependent on chromosome length. The chromosomes repel one another, causing them to separate, if the centrioles converged they'd disobey Isaac Newton's third law of motion.
- The cavities in photosynthetic grana are smaller, accommodating visible wavelengths. Exchange of light quanta between cytochrome pairs releases ice light, replacing the consensus view of cytochromes forming electron chains. Electric currents would short-circuit in the wet biological environment.
- Retinal rods and cones encode colour and other features on minions, sending signals to the brain for recognition. Minion logic bypasses the pixel image processing computers use.
- Ear cells lining the cochlea encode sounds' pitch, frequency and timbre, similarly putting recognition before analysis.

Origin of Life

Precipitation in polar pools of nitrogen during a primordial ice age created ice XIc. Its ferroelectric phase transition converted random temperature fluctuations to ice light. Multiple reflection by surface ice and ice in clouds polarized it. On reaching Charles Darwin's warm tropical waters it photophosphorylated nucleotides. The primordial soup became a 'noodle soup' of chiral DNA. Some formed tDNAs which actively transported substrates, including nucleotides, to Oparin's 'coacervate' proto-cells. A tDNA replica and the cell bursting in two created daughter cells, life had started. Mutant tDNAs selected various nutrients. Eventually, a family of 64 types evolved, each with a matching substrate-carrier complex consisting mostly of trace element ions (Figure 4A) shows some of the nine substrate-carrier complexes underlying the metabolic pathways summarised under *Trace element nutrition*. tDNA replication constituted the start of life. All life forms share a common atomic alphabet and molecular vocabulary. Micronutrient deficient diets arising as human civilizations evolve are problematic. Cataloguing medical, veterinary and pharmaceutical data, tradition, philosophy and belief systems reveals nine mutually independent biochemical pathways. Each is associated with a different nutrient requirement, chemistry and pathology. Together, they offer a comprehensive guide for diagnosing, preventing and treating most common maladies. Biotechnologists breaching life's early established principles may imperil its survival.

Minion Structure and Function

'Minion' connotes mind and subservience. Every human cell nucleus



such as water from diffusing, see *Osmoregulation*. 'Proton gradients' and osmotic pressure are meaningless at molecular scales. Mitochondria are commensurate with λ , accommodating ice light and coupling oxidative phosphorylation to kinase enzymes, feedback-inhibiting ATPase.

contains ~1.8 Mminions. They incorporate 1,701 DNA base pairs held flat by anti-parallel β -pleated protein sheets, (Figure 3A). The uncoiled DNA retains the base-pair spacing and overlap found in the B-helix. The proteins have alternate neutral Ala | Leu | Ile | Val and basic Arg | Lys amino acids, Pro makes an asymmetric U-bend. Gramicidin S, (Figure 3B), has an analogous structureTwenty-one nine-base-pair units form a coil and nine coils bound by similar proteins complete a minion. Super-coiled minions pack chromosomes neatly for efficient, error-free replication mediated by proton currents around their $\sim\frac{1}{2}\lambda$ circumference. ‘Nucleosome core particles’ are preparative artefacts. Ala, Leu, Ile and Val bind specifically to bases Cytosine, Guanine, Adenine and Thymine, mnemonic ALIVE CiGArE Tte, preserving DNA sequence integrity, (Figure 3C).

The Chip in the Brain

To address Turing’s question *Can machines think*, computers need do better than answer ‘Yes’ or ‘No’. I deduced the structure of ‘minions’, the chips in our brains, by iteration. Minions ‘think’ both laterally and vertically. One of the H-bonds connecting basic Arg | Lys amino acid ω -amines to DNA phosphates on the inner and outer surface of each coil is reversed. They form 18*63 proton-ordered H-bond arrays storing information as eighteen-letter words using a sixty-three character alphabet. Those in any cell nucleus could remember the Bible and Shakespeare. Memory recall involves resonance between minions storing similar words, nerve fibres serve asoptic fibres, theirsynaptic junctions as filters. Minions have evolved, taking natural intelligence beyond computer technology. They use exponents and logarithms to make comparisons, consistent with using ratios and percentages (mixing metaphors in politics an journalism can be confusing). Their 18 frequency bands embrace theelectromagneticspectrum, equivalent to a piano spanning 103 octaves. Each has an associated quality, personality type, sense, etc, Table 1. Theneural network brain model fails to account for this.Each word playsacoloured, personality dependent chord, partial resonance achieves compromise. Lateral thinking is equivalent to transposing between musical key, questions on one coil may be answered if an analogous conundrum has been solved on another. The Table 1 compares nine independent, mathematically orthogonal, traditional, psychiatric and philosophic classifications. The astrological correlation between birth time and personality is consistent with the oxygen tension change at birth establishing a common base-line on every minion; their ~2000 year ‘Great Ages’ and zodiac signs correspond to minion coil characteristics. Occult traditions support the minion concept.Minion memory storage is consistent with perfectpitchrecognition and Chinese tonal pronunciation. The musical stave’s five lines and four spaces reflect the nine minion coils. Shakespeare’s Portia in *The merchant of Venice* offering silver, lead and gold caskets and synaesthetes transposing sensesillustrate the meanings of colour. Gamblers are misled by confusing cardinal and ordinal numbers.The H-bonds between amino acid ω -amines and DNA phosphates oscillate like rows of dominoes collapsing, (Figure 4A), constituting the eighteen hands of biological clocks with time unit:

$$\tau = 3 * 189 * 7.37 * 10^{-10} / 3 * 10^8 \approx 1.39 * 10^{-15} \text{ seconds}$$

where the initial ‘3’ reflects Dekatron™ logic [8], ‘189’ is the number of base pairs per coil, 7.37 Å the β -sheet spacing and $3 * 10^8$ m/s the velocity of light. The times associated with its eighteen tracks, $63^N \tau$, N = 11, 13 and 18, predict day length, Sun-spot cycle period and the ‘age of the universe’ respectively. Time intervals outside the range τ to $63^{18} \tau$ such as the mathematical zero and infinity, 0 and ∞ are meaningless. Substituting τ for Planck’s constant explainsHeisenberg’suncertainty principle. The 63 units forming each coil correlate with 60 seconds/minute and minutes/hour, its prime factors, 7, 3 and 9 correlate with using base-10 arithmetic and assigning 7 days/week.

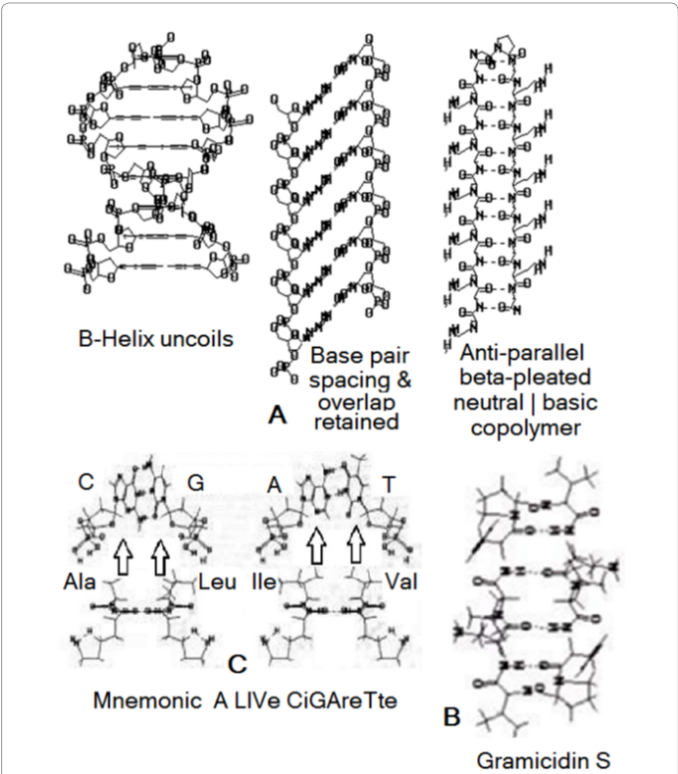


Figure 3: A. B-helix uncoils and binds to anti-parallel β -pleated sheet protein hairpin. B. Gramicidin S. C. Amino acids match base pairs.

#	Quality	Period	Colour	Mass	Discipline
-9	unity	8.7 fsec	red	$m_e / 7$	quantum mechanics
-8	justice	5.5 psec	silver	$m_p / 7$	physics
-7	stability	350 psec	blue	2 bp	chemistry
-6	progress	22 nsec	violet	8.3 ag	computer processing
-5	Love	1.4 μ sec	bronze	33 fg	biochemistry
-4	Peace	87 μ sec	yellow	130 pg	genetics
-3	beauty	5.5 msec	pied	0.51 μ g	biology
-2	truth	350 msec	gold	2 mg	engineering
-1	goodness	22 sec	green	8.1 g	psychology
+1	goodness	23 min	green	32 kg	psychiatry
+2	truth	1 day	gold	130 t	head hunting
+3	beauty	9 weeks	pied	0.5 Mt	sociology
+4	peace	11 yr	yellow	2000 Mt	politics
+5	love	685 yr	bronze	8 Gt	history
+6	progress	43,000 yr	violet	31 Pt	archaeology
+7	stability	2.7 Myr	blue	1.8 Moons	palaeontology
+8	Justice	170 Myr	silver	84 Earths	astronomy
+9	Unity	11Byr	red	1 Sun	cosmology

Where periods = $63^N \tau$, $\tau \sim 1.4 * 10^{-15}$ sec is the minion time unit. Colours feature in metaphors, adverts, national flags and political party logos. The ratio between masses = 63^2 , m_e = electron mass, m_p = proton mass, bp = base pair, a = 10^{-18} , f = 10^{-15} , p = 10^{-12} , n = 10^{-9} , μ = 10^{-6} , m = 10^{-3} , k = 10^3 , M = 10^6 , G = 10^9 , T = 10^{12} and P = 10^{15} . Replacing μ = \sqrt{M} for mass M in Albert Einstein’s $E = Mc^2$ yields the more symmetric $E = \mu^2 c^2$.

Table 1: Associations with minion coils.

Trace Element Nutrition

Most carriers invoke trace element ions. Micronutrient deficient diets arise as civilizations evolve. The minion’s nine coils control nine mutually independent biochemical systems. Each has associated

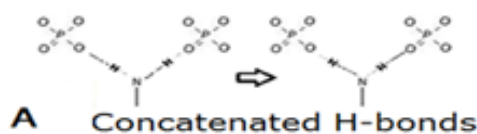


Figure 4A: H-bonds between amino acid ω -amines and DNA phosphates oscillate.

tDNAs, substrates, carriers, glands, hormones, vitamins, nutrient requirements, chemistry and pathology. They facilitate diagnosis, prevention and treatment of most common maladies.

Motility

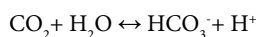
Vitamin A is either retinol or retinal, depending on pH. Retinal's conjugated $(-C=C-)_n$ bonds conduct energy through membranes as solutions [9], converting the sulphur in glutathione to sulphite, SO_3^- . Likewise vitamin E, α -tocopherol delivers energy converting the selenium, Se in oxytocin and vasopressin to selenite, SeO_3^- . SO_3^- and SeO_3^- exchange Mg^{++} and Mn^{++} for Ca^{++} respectively, (Figure 5A). Mg catalyzes hydrolysis of ATP, releasing ice light energy. Sarcomeres contract to form $\frac{1}{2}\lambda$ resonant cavities. For sustained muscle contraction, exchanging creatine for creatinine phosphate replenishes ATP.

Sensitivity

Nerves serve as wave guides, enabling minions throughout the body to resonate, transmitting pleasure and pain. Catecholamines adrenalin, noradrenalin and dopamine exchange sodium ions, Na^+ for potassium, K^+ at synapses. Na^+ has the same shape and size as H_2O , forming large hydrates such as $Na^+ \cdot 28H_2O$, making the cell sap viscous and slowing metabolism. K^+ binds less water, enabling faster reactions. Four- and six-member catecholamine rings exchange 3 Na^+ for 2 K^+ , explaining the 'fight or flight' reaction, (Figure 5B). Substituting codeine or morphine creates larger complexes, preventing pain by blocking the pump. Sensitivity increases when more pumps are enrolled to compensate, explaining drug addiction.

Excretion

Excretion of salt, NaCl and exhaling carbon dioxide, CO_2 regulate ionic strength and acidity, pH. Manganese chlorides: $MnCl_3^-$, $MnCl_4^-$ and $MnCl_6^{4-}$ carry NaCl, subject to aldosterone, angiotensin, rennin, histamine and aspirin. The 'chloride shift', catalyzed by Zn-dependent carbonic anhydrase:



and red cells, erythrocytes exchanging Cl^- for HCO_3^- control pH.

Respiration

Erythrocyte haemoglobin transports O_2 , breathing exchanges it for CO_2 . The thyroids distribute iodine in thyroxine, T_4 . Protons at target tissues displace metallic iodine, I^+ , carrier for $O_2 \cdot H_2O$, (Figure 5C). Littoral seaweeds use iodine to protect them from tidal changes in oxygen concentration, their purple and ochre colours match those of I^+ and I^- . tDNAs accelerate protons causing nitrogen, N_2 , oxygen, O_2 and nitric oxide, NO to bond with the amide group of nicotinamide in NAD or NADP. This accounts for nitrogen fixation releasing hydrogen, photolysis of water oxygenating the atmosphere and how NO controls vasodilation. Hydrogen cyanide, HCN and carbon monoxide, CO toxicity block this tDNA. Iodine deficiency causes goitre. I^- accumulating in the eyes causes exophthalmos. Mutant tDNAs disrupting nerve cell oxygenation explain bipolar disorder, mania and

depression correspond to excess or deficient O_2 supply to brain cells. Lithium, Li^+ diagonally related to I^+ in the periodic table, stabilizes the condition by substituting for I^+ .

Growth

The anterior pituitary gland packs copper, Cu into growth hormones, Cu^{++} carries amino acids, *c.f.* Biuret test. tRNAs transfer amino acids through the endoplasmic reticulum membrane to ribosomes for protein synthesis. Failure causes growth defects: gigantism, dwarfism and acromegaly. Cu accumulating in the eyes causes Wilson's disease. Cu supplements and bracelets may relieve arthritis. Differentiation DNAs, dDNAs coordinate tDNAs, analogous to mRNAs selecting tRNAs. Stem cells have a full complement of tDNAs. At stages in tissue differentiation such as gastrulation and blastulation, tDNAs are starved of nutrients and overheat, causing reversal of dDNA binding. Reversed tDNA sequences encode 'hook' proteins, determining tissue morphology:

1. Eggs, sperm and immune system leukocytes have 1 hook
2. Spirogyra filaments have 2 hooks
3. Sponge sheets have 3 hooks
4. Bi-layered worms have 4 hooks
5. Liver and other organs use 5 hooks
6. 6 hooks allow tumour and cancer growth controlled by leukocytes.

Rigidity

Fluorspar, CaF_2 illustrates the high affinity of calcium, Ca^{++} for

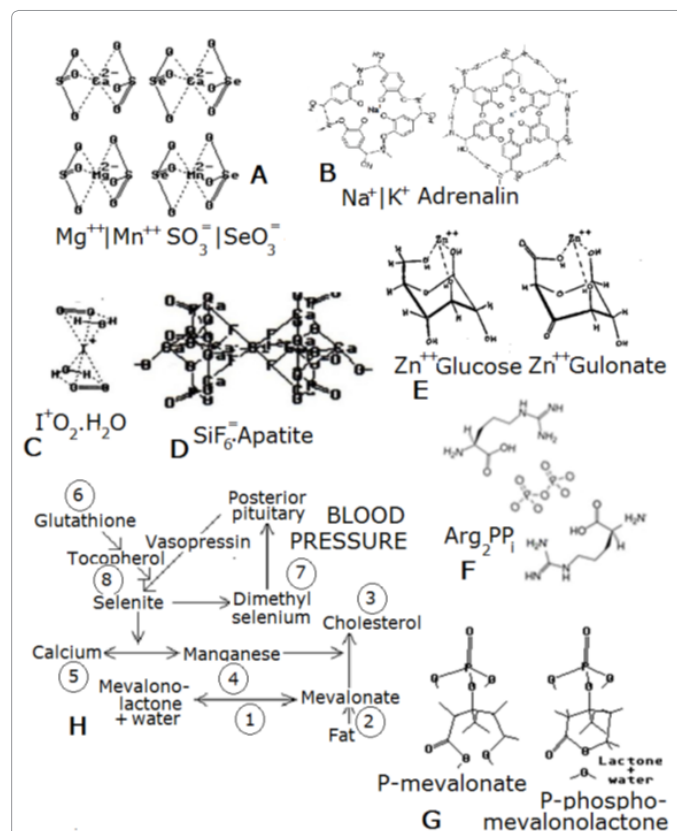


Figure 5: A. Motility, B. Sensitivity, C. Respiration, D. Rigidity, E. Assimilation, F. Reproduction, G. Osmoregulation, H. Blood pressure controls.

fluoride, F⁻. The parathyroid and coevolved thyroid glands adjacent in the neck both incorporate halides to hormones. Continuous secretion of parathyroid hormone, PTH prevents high F⁻ concentrations damaging these glands. Vitamin D stores ultraviolet sunlight with wavelength ~265 nm, creating Si-F bonds for assembling silicon hexafluoride, SiF₆⁼ at low pH:



SiF₆⁼ carries calcium phosphate, apatite, maintaining bones and teeth, (Figure 5D). The low pH associated with kidney failure and menopause reduces phosphate availability, causing osteoporosis. For plant life, phosphate, P_i is scarce. They employ the same substrate-carrier complex to form their silica, SiO₂ hard parts. Acid air pollution, SO_x and NO_x entering stomata causes leaf-fall. Liming the soil is ineffective, delaying action on controlling acid air pollution [10]. Acid air pollution and tobacco smoke lower the pH in the cavity behind the nose, promoting inappropriate SiF₆⁼ synthesis. Breakdown of SiF₆⁼ passing along the olfactory nerves to the brain causes Alzheimer's disease. Fluoride disrupts the H-bonds involved in protein folding, yielding the characteristic protein tangles. Mutant tRNAs incorporating the wrong amino acid to some proteins also cause tangled proteins in prion diseases. Mutant tRNAs embedded in these proteins render them infectious agents. Cod liver oil, UV lamps or sunlight prevent rickets due to infant vitamin D deficiency. Fluoridation of water supplies counters childhood tooth decay, hardening tooth enamel by replacing OH⁻ with F⁻. Tea supplies adequate F⁻. Fluorinated anaesthetics promote fluoride excretion as aluminium hexafluoride, AlF₆⁼ four days later. Simultaneous brain clearance temporarily relieves dementia, suggesting approaches for its prevention and treatment.

Assimilation

Pavlov's dog anticipating food caused pancreatic insulin secretion. In man, the sight, smell or timeliness of food have the same effect. Zinc, Zn⁺⁺ primes tDNA pumps to carry β_D glucose, (Figure 5E). Glucose transport, maintaining steady blood glucose concentrations, mediates carbohydrate metabolism. Plants maintain glucose levels in xylem and phloem. Converting glucose to glycogen or fat in liver or starch in leaves also mediates glucose homeostasis. Zn⁺⁺ binds to the 'triangle of sweetness'[11] found in insulin and glucagon. Insulin synthesised in the pancreatic β-cells distributes Zn and glucagon synthesised in pancreatic α-cells recycles it. Banting and Best discovered insulin and Dorothy Hodgkin determined its structure [12]. Vitamin C derivative, gulonate takes Zn where insulin can't reach. Vitamin C deficiency reduces Zn-mediated hydroxyproline incorporation for collagen synthesis causing scurvy in ancient mariners until limes supplemented their food. Zinc sulphide, ZnS in Calamine™ lotion treats skin complaints. Glucose transport defects cause diabetes and its side-effects: Zn accumulating in the vitreous humour damages the retina, causing blindness. Kidney damage and foot problems frequently arise. Assessing Zn intake or implanting a glucose concentration monitor might improve management. Zn regulates our appetites for food and sex. Zn-rich appetizers such as oysters or caviar encourage snacking, eating disorders anorexia and bulimia respond to Zn supplements. Aphrodisiacs containing Zn increase libido. Cu coil contraceptives prevent sperm getting enough Zn for glucose assimilation to reach their targets. Neonatal jaundice arises when bilirubin released from the transition between foetal and adult haemoglobin isn't conjugated with glucose for excretion. Seizures result if bilirubin enters the brain, the usual treatment is exposure to blue light, Zn in colostrum from breast feeding the natural remedy. Sucking a midwife's Zn-based pewter spoon was effective, failing when blue-blooded families substituted a silver spoon. Rhinoviruses causing colds and flu enter nasal cells via tDNAs,

Zn supplements block virus uptake. The detoxification of alcohol and barbiturates diverts Zn, cofactor for alcohol dehydrogenase, to the liver. This prevents sufficient Zn for glucose transport reaching the brain, causing inebriety. Combining barbiturates with alcohol can be lethal. Designing treatments for alcoholism need focus on Zn. Victorians called beryllium, Be⁺⁺ 'glucinium' for its sweet taste, using it as a poison. Romans died from using lead acetate as a sweetener. Exchanging indium, In, diagonally related to Zn in the periodic table, for divalent trace metals may enable their uptake by endocrine glands for incorporation to hormones. Indium has been promoted for treating obesity. Be⁺⁺, Pb⁺⁺ and In⁺⁺ mimic Zn⁺⁺.

Reproduction

The pineal gland distributes silver, Ag⁺ in six-member serotonin rings resembling those catecholamines form around K⁺. Retinal transfers energy for converting P_i to pyrophosphate, PP_i from pink Ag porphyrin as solitons, see *Motility*. The Arg₂PP_i complex provides the atomic ingredients for copying DNA at cell division [13]; anti-cancer agents mimic it, (Figure 5F). Before the advent of antibiotics, Ag was often used for tissue repair and sleep regulation. Deficiency may allow cancers to develop. Phosphate, P_i use is independently handled for energy management, DNA synthesis and skeletal maintenance.

Osmoregulation

Membrane potential prevents water diffusing through, accepting this fact is prerequisite to preventing most Western deaths. Ponder absorbing bath water through leaky skin. The residue of saturated fat breakdown, phospho-mevalonate, named after the herb *Valerian*, aka 'Allheal', reversibly forms a lactone ring, (Figure 5G). Exchanging phospho-mevalonate for its lactone transports water. The posterior pituitary gland packs selenium, Se into oxytocin and vasopressin. Vitamin E, α-tocopherol transmits energy for oxidising Se to SeO₃⁼ through the membrane as solitons, see *Motility*. SeO₃⁼ exchanges Ca⁺⁺ for Mn⁺⁺, cofactor for cholesterol synthesis from mevalonate. This by-product of osmoregulation is feedstock for steroid hormones. Se deficiency arises from water purification [14], displacement by such sulphurous fertilizers as superphosphate [15], cropping low-Se soils, using high temperatures when preparing and preserving food and poor nutrition. It causes hypertension of pregnancy, heart attacks and cancers of tissues specializing in pumping water: breast, bowel, cervix and prostate. It may contribute to Ebola [16]. Supporting evidence abounds, the consistent correlation between breast cancer distribution and surface geology [17] is compelling. Hard water from limestone in London and such igneous deposits as those in Snowdonia contain most Se, presumably recycled from early life. Se-rich diets account for the longevity of European royal families. Sea floor Mn nodules may reflect Se metabolism. Animal husbandry [18] provides the best evidence for Se dependency. Se supplementation protects cattle from hypertension during pregnancy, sheep from white muscle disease and pigs from heart failure *en route* to market. Limes for scurvy, iodine for goitre, cod liver oil for rickets and fluoridation for dental caries are precedents for intervention.

Blood pressure disorders, (Figure 5H), can be corrected by attention to:

1. The tDNA exchanging phospho-mevalonate for its lactone.
2. Saturated fat consumption.
3. Lipids transporting cholesterol.
4. Manganese, cofactor for cholesterol synthesis.
5. Exercise and using aspirin to regulate calcium levels.

6. Glutathione production by the liver.
7. Methyl mercury, HgMe^+ preventing pituitary dimethyl-Se, Me_2Se^+ uptake.
8. Selenium and vitamin E deficiency.

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