L24 Wächtershäuser's hypothesis < non-genetic metabolism >

> That anything answering to our impressions exists outside of ourselves is not a *fact*, but [is] an *inference*. —John Tyndall.

In aerobic cell metabolism, the reaction that releases packets of energy (the Krebs citric acid cycle),[2] expels from each acetic acid molecule two carbon atoms as carbon dioxide. In anaerobic metabolism, this cycle runs backwards. At hydrothermal vents in the oxygen-deficient Hadean world, heat-loving bacteria could have so operated (***Figure L24.1***).

Metabolism (extraction of energy from food) is the hallmark of the living over the inanimate. In this, the forming of acetic acid (the simple, carbon, hydrogen, and oxygen, inorganic volatile compound, familiar for giving vinegar its odor) is a primary ingredient. In retrospect: Life's genetic code, logically, would have been invented only after a primitive metabolism had evolved. The proteins, which allow this, form when ammonia reacts with pyruvic acid. Three-carbon pyruvic acid forms when cell ions catalyze the addition of a carbon molecule to acetic acid. To fashion acetic acid from the material about them in an anaerobic aqueous environment, life's precursors were likely enabled by catalytic metallic ions.

Life's beginning, Günter Wächtershäuser (pronounced *goon-ter vac-ter-shoe-ser*) hypothesizes, was a natural metabolic cycle that escaped a surface catalyst to perpetuated itself.[3] ❑

Figure L24.1 [4] Life, which has evolved, could have been inorganically jump started by sulfide minerals (not shown in the figure) on which a succession of biomolecules assembled. Each step incorporates raw materials readily available at hydrothermal vents.

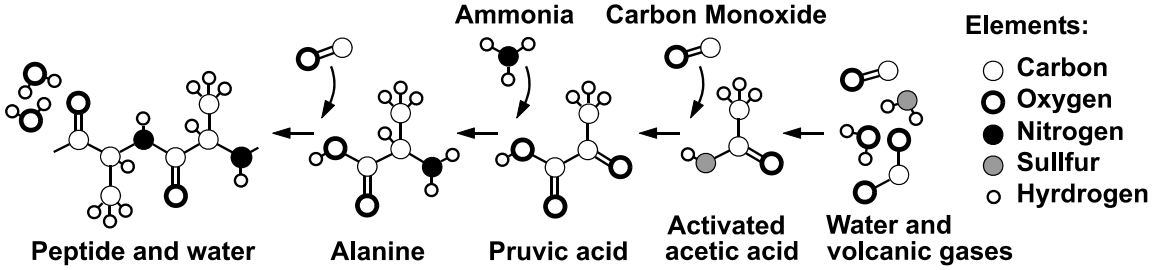
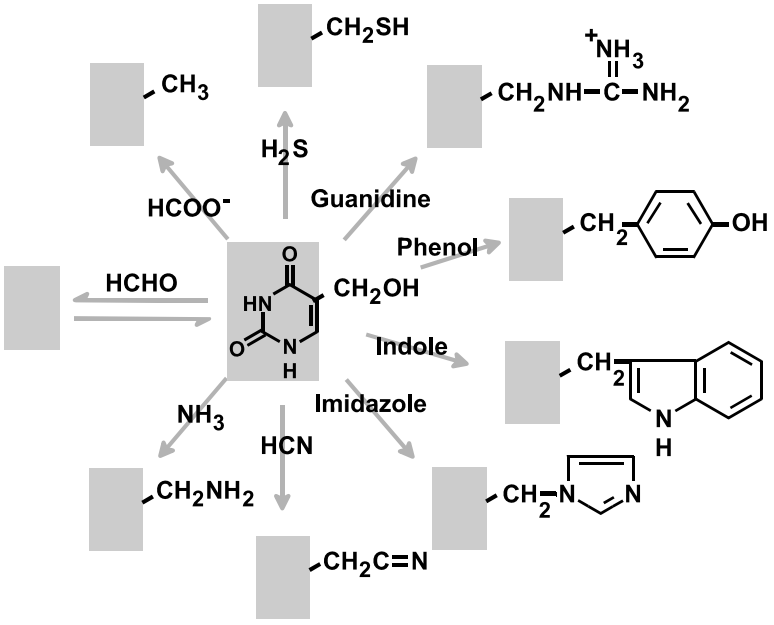


Figure L22.1 [15] (*see* page 695) A 'reaction wheel' shows amino acid analogs (outer circle) formed when HMU (center) reacts with various prebiotic molecules. (The content of the gray areas is as in the middle one.)



THE AUTHOR

My interest in geology was early sparked by Linley King, (my neighbor and beautiful) daughter of Lester C. King, the world-famous geomorphologist and continental driftist who headed the Department of Geology at the University of Natal, South Africa (and who often dropped the hint that he would like to be addressed familiarly as "doc" but, being too imposing, never was). Later, as a student at Natal U, Durban, my first interest was for mathematics and physics but geology would pay my way. I found work at the mines in the Transvaal (as an electrician at Randfontein Mines, Summer of 1957, as a mine sampler and finder of fault-block remnants in the "madala" (old) deep levels of the West Rand. Cons. gold and uranium mines, Summer of 1958, and as a prospector for coal in the Lubombo Flats, Swaziland, using geophysics to select drill sites, logging core, and preparing geological maps, for Rand Mines, Summer of 1959. In 1960, with a B. Sc. (Hons.) in geology, I was employed by Anglo-American Corp. of S. Africa to work for Williamson's Diamond Mines, Tanganyika. In the vicintiy of the mine I worked with Dr. Edward Murray to prove a "barrage sampling" prospecting technique that I subsequently introduced to the prospectors in the Southern Province. At my Southern Province camp, Adolf Pius Shimyambala, a teacher on leave during a school break began to work with me and then elected to stay on as my chief *korani* (clerk) to help me organize a large camp: in the Songea district where we prospected the mountainous eastern border of Lake Tanganyika; in the Mahengi area where (between my bouts of malaria) we conduct weeks-long safaris deep into the Selous Game Preserve; and later, in the Central Province where I investigated the enigmatic Kilamatinde cement. Regrettably, I was required, being a South African, to leave Tanganyika at the end of 1961 when *uhuru na kazi* (freedom to work) Tanzanian laws were enacted. I returned to South Africa and wrote the thesis for my M. Sc degree based on samples of Kilamatinde cement put aboard my return ship (against ancient monument laws) out of Dar-es-Salaam by my by dear Indian friend Jafayladic (whose full name I should not mention). My wanderlust was then to leave for overseas and after traveling on the cheap in Europe until I ran out of funds, I emigrated to Canada. There I began to interview for jobs advertized in the *Northern Miner* and, having nothing much else to do, wrote an article that summarized the long running debate in that newspaper over whether mining companies should be able to prospect for minerals and establish mines in what would be otherwise wilderness preserves. I thought they should; respecting their presence as an honored role that would give access. The editor published this to close the debate. Job offers started to arrive at the YMCA where my shaky finances allowed me to board. I chose Falconbridge as the company that offered me the opportunity to do outcrop mapping rather than prospecting based on geophysics and drill-core logging. At Falconbridge Sudbury Mines I worked with Jill Hill-Walker, an Oxford University geology graduate, who was barred from going underground (which the miners thought would bring on bad luck) and later was denied the right to work in the field (after which she returned to England and got married). I worked summer field seasons 1962-66 under the directorship of Dr. J. J. (Joe) Brummer prospecting for nickel in the Wabowden area, Manitoba (where I was greatly assisted in northern survival in my first season by Cree Indian Henry McLeod). I was enrolled in the geology doctoral program at the University of Western Ontario in 1963. My thesis advisor was Dr. W. (Bill) R. Church. In 1966 I received the first Ph. D. in geology awarded by UWO. My interest in applied mathematics had returned and a letter by Dr. C. Gordon Winder, Head of the Department of Geology at UWO, to Dr. (now Lord) E. R. (Ron) Oxburgh at the Department of Geology, University of Oxford, England, gained me a post-doctorate position there. With Oxburgh's help, I matriculated into St. Edmund Hall, Oxford University, to pursue rowing (I received a half-blue for rowing bow in Teddy Hall's first eight) and the Masters degree in Mathematics. Before completing that, I was offered a job by Dr. D. (Dave) H. Krinsley, who was visiting, to teach structural geology at Queens College of the City University of New York. During the CUNY summer vacations I worked as a geological consultant for Falconbridge Mines - Northwest Territory, Canada, Summer 1971, Canadian Occidental Petroleum - Ontario, Summer 1973, Dickenson Mines Ltd., Canada - Ontario, Fall 1974. At CUNY I have lectured on plate tectonics at Brooklyn College and have taught undergraduate historical geology at Queensborough Community College and at York College. This book is a selection of topics that I have given as lectures at various times. Used with a light touch it can be used for an introductory historical geology course but its main focus is for a capstone course for graduate students. The rationale for my book was discussed (or was written-in) with approval by Drs. Michael Brookfield, Stephen K. Boss, Tom Anderson, John Huntsman, Francis H. Brown, Michael A. Gibson, Rick Diecchio, and Fredrick D. Siewers at a technical session in at the GSA Annual Meeting, Reno, 2000. I am currently using it as the textbook for a graduate course in historical geology for Earth Science Teachers. Nothing like historical geology brings together so well the many branches of geology. A chronologic ordering of revelations and methods in geology leads one forward in time historically and back in time geologically. To live up to its title, that is the way I have sequenced topics in my book: *The Present is the Key to the Past*.