The results of this study suggest that polymerization of adsorbed amino acids on the edge faces of dioctahedral clay minerals could have played a significant role in the pre-biotic origin of optically active polypeptides, given a range of pH conditions not radically different from that of most contemporary natural waters. The data also suggest that clay minerals, by preferentially adsorbing and reacting with certain organic compounds, or with particular isomers of these compounds, may exert a selective influence in the geochemistry of sedimentary organic matter (cf. [5]).

A more complete manuscript on this work will be published elsewhere[1,6].

Zusammenfassung. Auf Kaolinitkristallen werden die L-optischen Isomeren der Aminosäuren vollständiger adsorbiert und schneller polymerisiert als die D-optischen Isomeren.

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The Redox Cleavage of the Sulfur-Sulfur Bond and Carbon-Sulfur Bond in Organic Disulfides by a Model Coenzyme

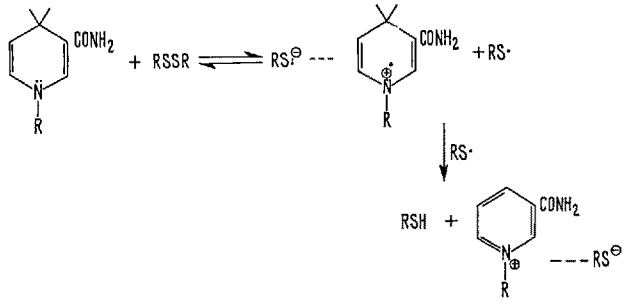
The studies on the oxidation of L-alkyl-1,4-dihydronicotinamide by malachite green[1] and thiobenzophenone[2] as model reactions for the oxidation of the coenzyme nicotinamide-adenine nucleotide, NADH, have been reported to involve the shift of hydride ion. However, these model reactions seem to deviate from the generally accepted one-electron transfer theory in biological oxidation-reductions[3].

As a continuation of our studies on the redox cleavage of sulfur-sulfur bonds in organic disulfides with amines[4],

$$RSSR + R_3N: \longrightarrow RS\cdot + RS:^{\ominus} \text{ ---- } R_3N\cdot^{\oplus}$$

We wish to report briefly the reactions between N-benzyl-1,4-dihydronicotinamide and several disulfides including diphenyl disulfide, α-lipoamide and N,N,N′,N′-tetramethylthiuram disulfide and monosulfide.

Reduction of lipoamide and diphenyl disulfide by N-benzyl-1,4-dihydronicotinamide. Lipoic acid possesses a relatively weak sulfur-sulfur bond which can be cleaved by reducing agents such as ferrocene and N,N-dimethylaniline[4]. However, lipoic acid in ethanol catalyzed the decomposition of the dihydronicotinamide[5]. With lipoamide (1×10^{-4} moles, mp 129–130°[6]) and N-benzyl-1,4-dihydronicotinamide (7.5×10^{-5} moles, mp 115–119°[7]; λ_{max} 350 nm, ε 7220) in absolute ethanol at 25 °C in the dark under nitrogen, the reaction furnished, at the end of 4 weeks, the corresponding pyridinium ion[8] in 30% yield (λ_{max} 265 nm, ε 4250). Under the same conditions diphenyl disulfide and the same dihydronicotinamide furnished the pyridinium ion in 85% yield. By direct analogy to the mechanism proposed for the redox cleavage of sulfur-sulfur bond in diphenyl disulfide with N,N-dimethylaniline[4], the present reaction may proceed by the following mechanism:



This model reaction offers a mechanism which not only concurs with the compulsory one-electron transfer concept in biological oxidation-reductions but also has the advantage that disulfides are better and more attractive oxidants in simulating physiological conditions.

Reduction of N,N,N′,N′-tetramethylthiuram disulfide (TMTD) and monosulfide (TMTM) by N-Benzyl-1,4-dihydronicotinamide[9]. Equal molar quantities of TMTD mp 153–154° lit 145–146°[10], and N-benzyl-1,4-dihydronicotinamide in ethanol at 25 °C in the dark under nitrogen produced, over a period of 4 weeks, 2 products (uv λ_{max} 410 nm and 435 nm respectively). The compound with λ_{max} 410 nm (ε 1700), mp 249–250° (dec.), was isolated in 67% yield.

Analysis calculated for

$C_{16}H_9N_3OS_2$:	C, 57.6;	H, 5.8;	N, 12.6.
Found:	C, 57.4;	H, 5.89;	N, 12.64.

It was identified as N-benzyl-3-carbamylpyridinium dimethyldithiocarbamate.

Attempt to isolate the compound with λ_{max} 435 nm failed because it decomposes on exposure to air.

In a parallel run, N-benzyl-1,4-dihydronicotinamide and N,N,N′,N′-tetramethylthiuram monosulfide (TMTM) (mp 106–108° lit[11] 108–110°) in ethanol under identical conditions as in the previous experiment, the reaction afforded only one product, N-benzyl-3-carbamylpyridinium N,N-dimethyldithiocarbamate, λ_{max} 410 nm, in

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65% yield. The other compound absorbing at 435 nm was absent. It is known that TMTM initiates free radical polymerization of vinyl monomers under heat or photolysis by homolytic cleavage of carbon-sulfur bond[12]. It appears reasonable that the reduction of TMTM by N-benzyl-1,4-dihydronicotinamide should occur at the same site and it also strongly suggests that the product with absorption at 435 nm in TMTD experiment may well be the corresponding pyridinium N,N-dimethylperthiocarbamate, resulting from the reductive cleavage of carbon-sulfur bond in TMTD. The rather labile nature of this compound is certainly anticipated.

The fact that these 2 pyridinium salts absorb at much longer wave length than other pyridinium salts (410 and 435 nm versus 265 nm) suggests that these pyridinium salts are not typical ones but resemble N-methylpyridinium iodide, a charge transfer complex species[13] which possesses an UV-absorption maximum at a much longer wave length than 265 nm. The longer absorption maximum for the perthiocarbamate salt than that of the dithiocarbamate may be attributed to the fact that the dithiocarbamate ion can be stabilized by resonance and has a higher ionization potential[14].

Résumé. Le N-Benzyl-1,4-dihydronicotinamide réduit, par un mécanisme redox de transfert d'un électron, la liaison disulfide de plusieurs disulfides organiques tels que le diphényl disulfide, l'α-lipoamide et le tétraméthylthiuram disulfide. Les réactions chimiques sont comparées à l'oxydation enzymique de la nicotinamide-adénine nucléotide.

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Activation of Sodium Transport Across Biological Membranes

Thermal activation of sodium transport across toad bladder and frog skin has been studied using the short circuit current (SCC) technique[1,2], and a reproducible activation energy of 14 kcal/mole determined for both tissues. Treatment of these tissues with octapeptide hormones, aldosterone or amphotericin-B leads to a stimulation of sodium transport[3-5], and the thermal activation energy measured during the period of maximum stimulation[1,2] has a value of 9 kcal/mole in all cases. We suggested that the observed lowering of the activation energy indicated an increased permeability of the mucosal surface of the epithelial transport cells to sodium. In the present work we have investigated this problem further in order to determine whether the 14 kcal/mole observed in the untreated tissue corresponds to the activation energy of the enzyme pump[6] or to a passive permeability barrier to sodium movement across the mucosal surface of the epithelial transport cells.

We have subjected frog skin to increasing conditions of anoxia by bubbling nitrogen through the bathing media during our thermal activation runs, and in this manner have obtained the results shown in Figure 1. The plot of log SCC (μA/10 mg/cm²) against reciprocal temperature is initially a straight line over the temperature range studied, having a slope corresponding to 14 kcal/mole. As the sodium transport is decreased by the steady fall in oxygen tension, this plot shows 2 slopes. At higher temperatures the activation energy corresponds to 14 kcal/mole and at lower temperatures the activation energy corresponds to 9 kcal/mole. A final plot obtained when the ion transport had been reduced to a low value gives a straight line corresponding to an activation energy of 9 kcal/mole.

Oxytocin (10 mU/ml) added to the serosal surface of frog skin, in aerated conditions, caused an increase in the SCC and as seen in Figure 2 the activation energy plot during this period of increased sodium transport gives rise to a straight line corresponding to an activation energy of 9 kcal/mole. Nitrogen gas was then bubbled through the bathing solutions and the thermal activation studied as the ion transport was reduced by the steady fall in oxygen tension. In each case, with oxytocin present, a straight line plot was obtained with an activation energy of 9 kcal/mole.

These results are interpreted as indicating that the 14 kcal/mole corresponds to the activation energy of the enzyme pump and that any treatment that predominantly affects the pump activity will produce activation energy plots parallel to but higher than those obtained for the

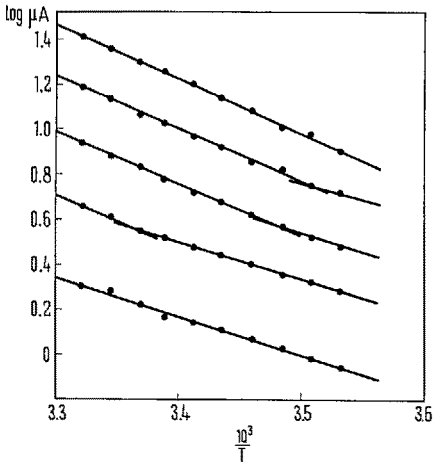

Fig. 1. A typical activation energy plot for the SCC measured across frog skin in aerated conditions (top plot) and during increasing conditions of anoxia (lower plots).