the possibility of subclinical hepatitis—a condition known to depress cell-mediated responses (*5*)—and indirectly indicated that the subjects were not using drugs, at least those that cause abnormal liver enzyme levels (*6*).

The functional status of T and B lymphocytes was determined in vitro by their respective blastogenic responses to phytohemagglutinin-P (PHA) (Difco Laboratories) and pokeweed mitogen (PWM) (Grand Island Biological) in a microculture system similar to that described by Thurman and associates (*7*). A marihuana smoker and an appropriately matched control subject were studied within the same experiment. Lymphocyte suspensions were prepared from fresh, heparinized, peripheral blood by separation in a Hypaque-Ficoll gradient. Approximately 2×10^5 lymphocytes were cultured in 0.2 ml of RPMI 1640 medium (Grand Island Biological) containing 20 percent autologous plasma. Triplicate cultures were stimulated with 0.4 μg of either PHA or PWM; unstimulated cultures served as controls. The cultures were incubated at 37°C for 3 days when each was treated with 1 μc of [^{3}H]-thymidine (New England Nuclear) and harvested 4 hours later. Lymphocyte blastogenesis was measured by assay of cellular incorporation of radioactivity and was expressed as the average number of disintegrations per minute (dpm) per culture. The methods described by Croxton (*8*) were used for paired and unpaired *t*-tests of the significance of differences in blastogenic responses between the marihuana smokers and the matched control subjects.

The comparison of mitogen-induced blastogenic responses of lymphocytes from marihuana smokers and matched control subjects is shown in Table 1. Statistical analysis of the data by both the paired and unpaired *t*-tests confirmed that there were no significant differences ($P > .10$) in the responses to either mitogen between the groups. There also was no significant difference in [^{3}H]thymidine incorporation in the unstimulated control cultures; the respective mean values for marihuana smokers and control subjects were 735 and 737 dpm.

These results indicate that long-term marihuana smoking had no significant effect on the functional status of T and B lymphocytes and are consistent with recent evidence suggesting that chronic marihuana smokers have unimpaired immune response capabilities. They have been found to develop and exhibit delayed-type hypersensitivity responses to 2,4-dinitrochlorobenzene in the same manner as healthy nonsmokers (*9*) and even to develop humoral antibody reactivity against *Cannabis* extracts (*10*).

Our findings, however, differ completely from those of Nahas and his co-workers (*2*) who described depressed in vitro blastogenic responses in lymphocytes of marihuana smokers. Although the disagreement cannot be explained at present, it is possible that our study populations were not comparable, other than on the basis of marihuana use. They did not describe the health status of their subjects, and there was no indication in their report that they attempted to exclude subclinically ill subjects from their study, as we purposely did. Another variable to consider is the time elapsed between blood sampling and when the subjects last smoked marihuana. Because plasma levels of Δ^9-tetrahydrocannabinol, the putative active component of marihuana, reach a peak within 15 minutes after smoking and decrease rapidly thereafter (*11*), it is possible that impaired lymphocyte responses may be detectable only within a relatively short period after smoking. Even though our study subjects admitted to smoking at least once within 48 hours before study, it is likely that only a few had smoked within the 12 hours immediately preceding study. Nahas and his associates did not include this information in their report so that this possibility also remains to be evaluated. Obviously, similar immunologic studies of other populations of marihuana smokers appear necessary to clarify these divergent observations.

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Hot Hydrogen in Prebiological and Interstellar Chemistry

I was interested to read the recent report by Hong *et al.* (*1*) on the production of amino acids and gas-phase organic compounds from the ultraviolet irradiation of simple gases, with hot hydrogen atoms used as the principal energy conversion agent. Although the earlier work of Sagan and Khare (*2*) on the subject is mentioned, it is not apparent from (*1*) that the initiating mechanism of Hong *et al.*—the production of hot hydrogen atoms by ultraviolet photodissociation of such long-wavelength photon acceptors as H_2S—is the same as ours, that their quantum yields for amino acid production of several times 10^{-5} are the same as ours, and even that the specific amino acids produced in comparable experiments are the same as ours. The great importance of such experiments is that they employ the long-wavelength part of the solar ultraviolet spectrum, where most of the energy available for organic synthesis resides. Although CH_3SH and C_2H_5OH probably were not abundant constituents of the primitive atmosphere of the earth, H_2S and HCHO, used in our experiments, probably were in fair abundance. Our results suggest that the product of energy flux and efficiency is, of all known energy sources, highest for long-wavelength ultraviolet prebiological organic synthesis. The claim by Hong *et al.* that one-carbon-atom precursors rather than two-carbon-atom precursors are adequate is of interest and increases the overall yields, since the primitive ratio of CH_4 to C_2H_6, for example, is likely to be

several orders of magnitude, as it is on Jupiter. Applications of hot hydrogen organic chemistry to the atmospheres of Jupiter and the other Jovian planets have also been published (*3*).

The claim (*1*) that these results are relevant to the interstellar medium is, however, extremely dubious, if it is gas-phase interactions that are being invoked. Even though hydrogen atoms produced in such experiments will be substantially superthermal in the interstellar medium, the three-body reaction rate coefficients are so low that no reactions of any importance can proceed until the gas densities are already so high that we are considering a collapsing interstellar cloud, on its way to forming stellar or planetary systems (*4*). This objection applies equally well to some other experiments purportedly of relevance for interstellar chemistry (*5*). However, in the near-ultraviolet irradiation of frozen ices—including frozen HCHO, an observed interstellar constituent—hot hydrogen atoms are produced and there is sufficient mobility at low temperatures to initiate further organic synthesis (*6*). Thus the production of hot hydrogen atoms on interstellar grains or cometary surfaces may be of relevance to interstellar organic chemistry.

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There are several considerable differences with respect to the reports of Hong *et al.* (*1*) and Sagan and Khare (*2*). Among these are the following. The production of protein amino acids as well as other amino acids was authenticated by gas chromatography–mass spectrometry by Hong *et al.* (*1*). Furthermore, some additional protein amino acids not reported by Sagan and Khare (*2*) were found (*1, 3*). Still other organic compounds were produced and verified by gas chromatography–mass spectrometry by Hong *et al.* (*1*), and some of these in turn were used as intermediates for the production of amino acids. The one-carbon-atom substrate CH_4 was found to successfully give amino acids (and other organic molecules), and hydrolysis of a polymer was not believed to be a major source for the production of amino acids (*1*). Quantum yields were experimentally determined by Hong *et al.* (*1*).

The results reported by Sagan and Khare (*2*) indicate the strong possibility of mercury-sensitized reactions occurring with traps at temperatures as high as −23°C and even at −64°C unless true equilibration with the walls has been attained, especially with the use of a mercury line resonance source (*3*). Experiments 4 and 5 of (*2*) are not clear since, if Pyrex excludes ultraviolet light in experiment 4, it should also exclude it in experiment 5. In addition, all reactions in which amino acids were obtained (except experiment 5) were conducted at very elevated temperatures where reactions of thermal hydrogen atoms can become important.

There is no way to resolve such questions as whether HCHO and CH_3SH were abundant in the atmosphere of the primitive earth. Furthermore, these compounds in themselves are not important; their significance arises from the fact that they *are representative* of hot hydrogen atom sources. It is worth pointing out that in many instances the production of some of these compounds is the key issue; for example, C_2H_5OH has recently been found in interstellar space.

In (*4*) Khare and Sagan do not discuss reaction products from frozen ices as arising from the reactions of hot hydrogen atoms. Indeed, until it can be shown that the products do arise in this way by independent known hot hydrogen atom reactions, not by thermal hydrogen atom reactions, and, importantly, not through formyl radical reactions, such a proposition would be purely speculation.

Three-body collisions are not required for the formation of reactive radicals via hot hydrogen atoms. At least in abstraction reactions, such radicals are commonly formed "cold." Even if these radicals and others were not formed "cold," they could become "cold" by radiative processes or collisions such that, upon reaction, any translation energy and enthalpy of reaction could be taken up by nondissociative internal modes in the molecule. If the lifetime of the metastable molecule is long enough, radiative deactivation would stabilize the system. Also, a second two-body collision of the metastable molecule with a molecule, notably H_2, would stabilize the system (*5*). It was never our intention to exclude from consideration three-body collisions with dust as a third body, and indeed this type of collision is a strong possibility (*5*).

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Erroneous Date for Chilean Glacial Advance

In their report Mercer and Laugenie (*1*) discussed the implications of an age of about 36,000 years (sample I-6348) for a tree pushed over by advancing ice in south-central Chile. The Quaternary Isotope Laboratory at the University of Washington has recently dated a sample of this wood and obtained an age of 56,000 + 2,000, − 1,700 years (sample QL-61).

The counter size and the background counting rate determine the maximum age range that can be measured in a specific counter. The maximum age range of the counter for which the 36,000-year date was obtained appears to be about 39,000 years. Evidently the 36,000-year date was either the result of statistically unexpectedly large variations in counting rate that resulted in the reported finite age, or it was caused by a less likely contamination of the sample with about 1 percent of recent material.