numbers of animals required to establish a reliable mutation frequency with a dose as low as 50 r. In this new experiment a dose of 400 r of 90 r/min x-irradiation was given to female mice in eight fractions of 50 r spaced 75 minutes apart. Mutations were scored by our standard specific-locus method. The data reported are restricted to conceptions occurring within the first three weeks after irradiation. This makes possible a rigorous comparison with the data from single 400 r exposures which were similarly restricted. The observed number of mutations, 13 in 23,387 offspring, is significantly ($p = 0.005$) below the approximately 34 that would have been expected on the basis of the frequency obtained from single 400 r exposures (21 mutations in 14,591 offspring). Thus the fractionation experiment confirms the finding from the 50 r single-dose experiment. The results indicate that some repair of premutational damage can occur at low doses as well as at low dose rates. In estimating human genetic hazards it would now appear that the risk from small doses of acute irradiation may be lower than had been calculated on the basis of large doses.

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## An ESR Study of Radicals Resulting from Ionizing Irradiation of Some Urea Compounds

There is an interesting variation in the effects of ionizing irradiation on urea compounds. For a given amount of x-irradiation, ESR measurements show that the number of stabilized radicals at room temperature in hydroxyurea is approximately 100 times the number stabilized in urea or thiourea. The electron-spin-resonance spectra show that the electrons of urea and thiourea unpaired by irradiation are localized on the oxygen and sulfur atoms, respectively. In hydroxyurea, 41 percent of the unpaired electron spin density is localized on a nitrogen atom. An appreciable unpaired spin density on a nitrogen atom in hydroxyurea is quite different from the results obtained for methyl- and ethylurea, where the unpaired spin density was stabilized on the substitutional group, with no detectable localization on a nitrogen [T. S. Jaseja and R. S. Anderson, *J. Chem. Phys.* **35,** 2192 (1961)]. The radicals trapped in x-irradiated hydroxyurea are identified as $-\dot{N}-H$. This radical is of particular interest because of its structural similarity to the

$$>\dot{C}-H$$

radical which is frequently found in irradiated organic solids. Principal values for the hyperfine interactions in the –N–H radical are in gauss −21.2, −13.5, and −1.5 for hydrogen; and +22.5, +1.5, and +1.2 for nitrogen. If the unpaired electron were in a pure $p$ orbital, the induced isotropic hyperfine interactions would be in gauss −31.0 for hydrogen and +20.2 for nitrogen. The principal $g$ values for the ESR spectra are 2.0027, 2.0062, and 2.0108. Analysis of the ESR data indicates that –N–H is a planar radical.

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## Possible Transfer of Metallurgical and Astronomical Approaches to Problem of Environment versus Ethnic Heredity

The analogy proposed here makes impure "chemically pure" elemental metals correspond to impure "genetically pure" populations and makes a radioactive tracer atom correspond to a tracer gene $G_i$—for example, blood type or taste discrimination—that occurs in different fractions $a_i$ and $b_i$ of individuals in "elemental populations" $P_A$ and $P_B$. A large group of $G$'s can be used to measure, for each individual studied (rather than for populations,[1]), the "ethnic composition fractions" $f_A$ and $f_B$ of the individual's genes that come from $P_A$ and $P_B$ ancestors. Measurements of $f$ become potentially highly reliable as advances in biochemistry and genetics identify additional $G$'s. A proposed ethnic composition index is

$$H = \Sigma\,(a_i - b_i)\,(2\delta_i - a_i - b_i)\,/\,\Sigma\,(a_i - b_i)^2$$

where $\delta_i = 1$ or 0 if the individual has or has not $G_i$ and the sum extends over all identifiable traits. For random $G$ selections, expected values of $H$ vary from +1 for pure $P_A$ to −1 for pure $P_B$ or generally equal $2f_A - 1$. ($H$ should be modified for correlated $G$'s.) That the expectation value of an individual's performance is independent of ethnic composition (that is, ethnic heredity is trivial compared with environment) should be possible to establish or to reject to a high level of statistical significance by observations on siblings of mixed $P_A - P_B$ ancestry. Data about such individuals, whose prior development is uninfluenced by the study, are analogous to data of pre-sputnik astronomy. Like selected sequences of stars, siblings provide one controlled variable (same family home environment) and one observable varying feature (values of $H$ should differ significantly for siblings, especially for offspring of first generation $P_A$-$P_B$ hybrids). For example, correlation of physical, mental, and social measurements with one another and with values of $H$ might give scientific support for Washburn's proposal (that is, for equal environments American Negroes might surpass whites,[2]) by showing a positive correlation of performance with fraction of Negro genes. Data on correlations of $G$'s would be genetically significant and relevant to I.Q. and other polygenic traits.

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### References

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## Defect Energies and Electrically Charged Surfaces and Dislocations in Silver Chloride

Because the surface of an ionic crystal is in equilibrium with both positively and negatively charged lattice imperfections—defects which generally require differing energies for their formation—surface charges and surface electric fields appear. Such effects in silver halides are significant not only for their intrinsic interest, but also because of their relation to the photographic process. This paper describes two experiments on AgCl to determine the energy of formation of the silver ion vacancy, a critical parameter in the surface charge phenomenon. Instead of the crystal surface, it is experimentally more convenient to work with crystal lattice dislocations, which may be considered to be equivalent to one-dimensional internal surfaces. Dislocations (with their electrical charges) can readily be moved by a mechanical stress, thereby producing an electric current in an external circuit. In one experiment, W. McGowan studied the voltages produced by pulsed deformation as a function of temperature and concentration of divalent impurity. For each specimen there is an "isoelectric temperature," such that the dislocation