National Academy of Sciences

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Examination of Human Erythrocyte Populations for Somatic Mutation at the ABO Locus

In view of the size of the human erythropoietic system, its stem-line mode of propagation, and the normal range of mutation rates, it seems inevitable that a heterogeneity resulting from somatic mutation should be detectable in the peripheral blood. This has in fact been found in the form of a small proportion of exceptional erythrocytes lacking A antigen in normal AB and in heterozygous A individuals. The proportion of such cells was determined by an isotope dilution method involving successive agglutinations of Cr^{51}-labeled cells with excess carrier (unlabeled) cells. At age about 35, the proportion is about 0.001, indicating a mutation rate of about 3×10^{-9} per hour. The cells were isolated from AB bloods in quantities sufficient for phenotypic characterization. They show a great increase in H substance, are fully agglutinated by anti-B, and sometimes show partial agglutination with anti-A reagents other than the one used in the isolation procedure. A mutational origin is not proved, but the results are highly suggestive.

K. C. Atwood, S. Scheinberg
Oak Ridge National Laboratory

Changes in the Sun's Polar Magnetic Field

The existence of a primary dipolar magnetic field of the sun was shown by the magnetograph in 1952. This field, with effective intensity of about 1 gauss, was limited to high latitudes, above ± 55°. As reported by Babcock and Babcock in 1955, the polarity was positive in the North, and negative in the South, opposite to that of the earth's magnetic field. The sun's poloidal field is, in the mean, symmetric about the axis of rotation but shows random fine structure and marginal irregularity.

Observations of solar magnetic fields have been continued in Pasadena and, since May 1957, also on Mount Wilson. Through 1955 and 1956, the preceding description of the polar fields is confirmed. By June 1957, the intensity had irregularly decreased, and the field at the South Pole had reversed its polarity. Since then the field near the South Pole has been dominantly positive and stronger than the field near the north heliographic pole, which shows the same magnetic polarity. Results from both magnetographs are accordant, and the combined mean intensities for latitudes greater than ± 50° are: North Pole, + 0.2 gauss; South Pole, + 0.6 gauss.

This significant change of intensity at both poles, and reversal of polarity at the South Pole, is delayed in phase some 3 years with respect to the minimum in the frequency of sunspots. The variations of the sun's poloidal field probably reflect large-scale patterns of circulation related to the 22-year solar magnetic cycle; they are presumably closely related to various solar-terrestrial phenomena.

Harold D. Babcock
William C. Livingston
Mount Wilson and Palomar Observatories

Ionic Fission of the O-O Bond in t-Butyl Persulfonates

t-Butyl benzenepersulfonate, a new class of perester, and four para-substitution products have been prepared. These decompose quantitatively in methanol to give acetone and arylsulfonic acid by ionic cleavage of the peroxide bond. Kinetic studies of the decomposition of *t*-butyl pertosylate in methanol and aqueous methanol have been carried out. The reaction is subject to unusual salt effects, which show pronounced maxima with salt concentration and which disappear almost completely with the addition of water to the methanol. In contrast to 9-decalyl perbenzoate, *t*-butyl pertosylate shows strong negative deviation from the Grunwald-Winstein equation [E. Grunwald and S. Winstein, *J. Am. Chem. Soc.* **70**, 846 (1948)] near the methanol end of a series of methanol-water mixtures, but obeys this equation over the rest of the range. A mechanistic interpretation of this behavior is offered.

Paul D. Bartlett, Bayard T. Storey
Harvard University

Bioelectric Phenomena in Hydrodictyon africanum

Hydrodictyon patenaeforme was the subject of sap analysis some years ago; potassium accumulation was 4000-fold the external concentration. Bioelectric measurements were made during the past year with *H. africanum*; this species has spherical cells up to 3 or 4 mm in diameter. They can be impaled upon microcapillary salt bridges and live for about a day, yielding large bioelectric potentials and supplying appreciable current. A potential difference (P.D.) of 50 to 60 mv (outside positive) was found when the cells were bathed in tap water or culture solution. This value was increased to 100 mv when the cells were exposed to flowing distilled water. Salts lower this value, KCl being about 3 times as effective as NaCl in this regard. The relative mobility of K^+ in the protoplasmic surface is about 5, if Cl^- is taken as unity.

The resistance of intact cells to direct current was about 100,000 ohms, when the cells were washed with distilled water; allowing for leakage along the cellulose wall, protoplasmic values of 10,000 ohms/cm^2 of cell surface were calculated. Very high current densities lowered this value, but no stimulation phenomena could be evoked, either anodally or cathodally.

Both potential and resistance were sensitive to light, the effect being greatest in distilled water. Illumination (100 ft-ca) raised the P.D. by 10 or 15 mv and lowered the resistance; darkening lowered the P.D. in a characteristic time course, accompanied by a twofold increase of resistance for several minutes. These light effects were greatly decreased by salts (especially by KCl)—along with the P.D. itself.

Low oxygen tension in the medium lowered the P.D. by about 50 percent with prompt recovery in the light. There were no special effects of NH_3 (as in *Halicystis*), either alone or in combination with light. The temperature coefficient of the P.D. is very low.

L. R. Blinks
Hopkins Marine Station

Behavior of Calcium Carbonate

Anomalies in the chemical, mineralogical, and biological behavior of calcium carbonate diminish when they are viewed concurrently. Best values for the apparent solubility product constant K'_{CaCO_3} in sea water are consistent mineralogically. At salinity 36‰ and *T* 30°C, *K'* aragonite is 0.99×10^{-6} and *K'* calcite 0.53×10^{-6}. Free energy difference indicated is − 370 cal/mole, compared with recent experimental values of − 270 to − 334.

Slope relations of salinity ratios for the empirical product $Ca^{++} \times CO_3^{--}$ and for provisional activity products confirm the thermodynamic significance of the empirical parameter K'_{CaCO_3}. Very high supersaturation in $CaCO_3$ implied for warm ocean waters by *K'* values suggests complexing of some analytical calcium, inhibiting combination with CO_3^{--}.

Experimental precipitation of $CaCO_3$ from solutions and sea water indicates that mineral structure depends on degree of saturation, not on impurity content or on temperature alone. Aragonite precipitates from solutions supersaturated for

both calcite and aragonite; calcite precipitates between saturation levels for the two species. Hypersaline sea water west of Andros Island, Bahamas, yields aragonite with O^{18}/O^{16} and C^{13}/C^{12} ratios indicating precipitation mainly during the warmer months. Calcite is the usual precipitate from fresh waters, except where high supersaturation results from slow diffusion, high evaporation, or biologic intervention. Variations in scleroprotein suites of calcite and aragonite layers in shells imply distinct chemical regimens.

Metastable aragonite persists in contact with supersaturated solutions. Inversion to thermodynamically stable calcite follows transfer to solutions undersaturated for aragonite or to the atmosphere. Retarded inversion of dry aragonite may reflect primary concentration in the crystal structure of isomorphous cations. These implications are consistent with geologic evidence.

PRESTON E. CLOUD, JR.
U.S. Geological Survey

Dose-Effect Relationships for X-ray Induction of Mutations in Three Genes of Escherichia coli

By means of a technique developed during the past few years, it is possible to measure reverse mutability in individual genes that control the biosynthesis of essential compounds (reversions from auxotrophy to prototrophy), even though the rate is extremely low. The limit of sensitivity for detection of the reverse mutants is about 10^{-11}. We are studying dose-effect relations in several auxotrophs of *Escherichia coli* by using low doses of x-rays. Results obtained with three mutants, arginine-3 (*ar-3*), methionine-2 (*me-2*), and threonine-1 (*thre-1*), are presented here. It has been determined that the spontaneous mutation rates per 10^{10} bacteria are 10.8 in *ar-3*, 15.6 in *me-2*, and 2.3 in *thre-1*, and that the doubling doses are 68 r for *ar-3*, 186 r for *me-2*, and 85 r for *thre-1*. The lowest dose used in experiments was 8.5 r with *ar-3* and 17 r with the other two; and the highest dose was 4320 r. The data show a linear dose-effect relationship for these three genes. Thus, within the limits of the experiments, no threshold was detected. The results also indicate that natural radiation could account for only a small fraction of the spontaneously occurring mutations.

M. DEMEREC
Carnegie Institution of Washington, Cold Spring Harbor

JOAN SAMS
Biological Laboratory, Cold Spring Harbor

Interaction Properties of Sonically Fragmented Collagen Macromolecules

From viscosity and optical rotation measurements Doty and Nishihara suggested that sonic irradiation of acid solutions of soluble collagen (tropocollagen or TC) fragments the macromolecules without appreciable denaturation—that is, uncoiling of the triple helix structure. We have verified this supposition by application of well-established methods for testing the specificity of macromolecular interaction. This involves electron microscopic examination of the aggregation patterns produced under various conditions. Sonic irradiation rapidly destroys the ability of TC to reconstitute the native type fibrils (having a band pattern with 700 A axial repeat). However, such irradiated macromolecules can still form the "segment long-spacing" (SLS) type aggregates having lengths and band patterns indistinguishable from those obtained from untreated preparations. Dimeric and polymeric SLS structures, only rarely encountered in untreated material, are commonly found. With longer irradiation the transverse fragmentation of the TC macromolecules becomes more extensive, judging from the lengths of the SLS structures observed. With longer irradiation transverse fragmentation of the TC macromolecules occurs. Analysis of the band patterns of aggregates of SLS formed from these fragments indicates that rupture occurs at well-defined regions of the macromolecules.

These results not only demonstrate directly the nonrandom nature of the fragmentation but draw attention to the importance of the end regions of the macromolecules in the formation of the various possible aggregation types, normal and abnormal.

ALAN J. HODGE, FRANCIS O. SCHMITT
Massachusetts Institute of Technology

Role of Extracellular Enzymes in the Pathogenesis of Dutch Elm Disease

Cellulase and polygalacturonase are produced extracellularly by the Dutch elm disease pathogen, which lives in water-conducting tubes of the xylem and induces symptoms of water deficiency. The cellulase does not attack cellulose from elm wood, cotton, or filter paper but rapidly hydrolyzes carboxymethylcellulose to glucose. The pectic enzyme hydrolyzes sodium polypectate to galacturonic acid, the dimer and trimer of galacturonic acid being the principal products. Neither the cellulase nor the polygalacturonase produces signs of water shortage when introduced into elm cuttings. Impeded water flow in diseased trees has been ascribed to increased viscosity of water or mechanical obstructions. Enzymes are said to raise the viscosity of water in the stem by partially hydrolyzing cell-wall materials. This cannot be so in Dutch elm disease because of the inability of the cellulase to attack the native cellulose of the cell wall, the inability of the simple hydrolytic products resulting from the action of these enzymes to raise the viscosity of water, and the observation that viscosity of tracheal fluid in diseased stems is that of water itself. Ballooning of the pectic middle lamellae into water-transporting vessels to form tyloses occurs in diseased trees too infrequently to impede water flow significantly. However, polygalacturonase might dislodge tyloses by weakening the point of attachment. Thus, several could move in the transpiration stream to form a dam at a narrow orifice. The main function of the enzymes is probably to digest cell-wall materials, thus aiding the fungus in obtaining its food supply.

A. E. DIMOND, AKHTAR HUSAIN
Connecticut Agricultural Experiment Station

Wall Thickening in Sieve Elements and Concepts of Translocation

The present study continues the survey of the structural features of sieve elements, specialized cells generally assumed to be the main conduits through which materials move vertically in the phloem tissue of plants. The mature and, presumably, conducting sieve elements show a wide range of variation in thickness of walls.

Some species have rather thin homogeneous walls, others have a distinct inner thickening which varies from a barely perceptible layer to one that almost occludes the lumen of the cell. Since thick-walled sieve elements occur in many species—one third of approximately 150 species examined in this study had the special wall thickening—this character is not unusual and must be taken into account in formulating concepts of translocation. The presence of thick walls weakens support for the pressure-flow hypothesis; it puts less strain on certain diffusion hypotheses. Whether extensive or not, the thickening never develops over the various sieve areas. This feature strengthens the usual assumption that sieve areas play an important role in translocation through the sieve elements.

KATHERINE ESAU
VERNON I. CHEADLE
University of California, Davis

Yield of Photosynthesis from Simultaneous Illumination with Pairs of Wavelengths

In general, the yield of photosynthesis from suspensions of algal cells illuminated with two wavelengths of light given simultaneously is not greater than the sum of the yields for the same two wavelengths given individually. We found this to be true for a number of pairs of wavelengths (for example, 546 and 468 mμ, 436 and 644 mμ, and 578 and 480 mμ). Warburg [*Angew. Chem.* 69, 627 (1957)] reported that the yield for light of 546 mμ was substantially increased by simultaneous illumination with light of about 460 mμ. Although we made measurements with light of 546 and 468 mμ under a considerable range of conditions (including those specified by Warburg), we found no evidence of increased yield from the combination of these two wavelengths. We tested various combinations of intensities and exposures for periods ranging from minutes to hours. We tried both

Table 1. Increase in yield of photosynthesis from a band of long-wave red light.

Wavelength of supplementary light	Increase in yield (%)	
(mμ)	*Chlorella*	*Porphyridium*
644	28	0
578	19	15
546	12	100
508	5	85
480	60	0
468	40	
436	10	0
405	5	
365	7	0

dense and thin suspensions of cells, in alkaline carbonate buffer and in acid culture medium, with carbon dioxide concentrations ranging from 0.5 to 9 percent, at temperatures of 5° and 20°C.

On the other hand, as we reported a year ago [*Science* 125, 746 (1957)], the yield of photosynthesis from a band of wavelengths longer than about 685 mμ can be substantially increased by simultaneous illumination with light of shorter wavelengths. We have improved our methods of comparing the effects of different wavelengths of supplementary light, and we have tested additional wavelengths. Table 1 shows the percentage increase in yield of photosynthesis from a band of red light (690 mμ and longer), brought about by supplementing the long-wave red with light of shorter wavelengths. At each wavelength the increase was measured for two intensities of the supplementary light, and interpolation was used to estimate the increase for an intensity of supplementary light which, by itself, would sustain a standard rate of photosynthesis.

For *Porphyridium,* the increases in yield from long-wave red brought about by different wavelengths of supplementary light correspond approximately with the absorption spectrum of phycoerythrin. For *Chlorella,* the dependence of action on wavelength shows a rough correspondence with the absorption spectrum of chlorophyll *b*. For both algae, the results suggest that excitation of chlorophyll *a* alone may be insufficient to sustain maximum efficiency of photosynthesis and that pigments having absorption bands at wavelengths shorter than the red maximum of chlorophyll *a* may play some essential part in photosynthesis.

Collaboration of Ruth Chalmers in the experimental work and support from the National Science Foundation (grant G-1398) are gratefully acknowledged.

ROBERT EMERSON
University of Illinois

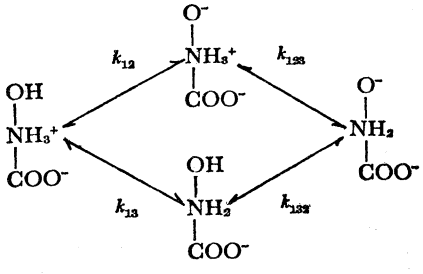
Tetrapod Extinctions at the End of the Triassic Period

The extinctions of various tetrapods (particularly the dinosaurs) at the end of the Cretaceous period are justly famous in geological and biological literature. At the end of the Triassic period several evolutionary lines of tetrapods died out, and although these extinctions were not as extensive as those of the Cretaceous, they were nevertheless significant. The Triassic extinctions, which involved on the whole about half as many known taxonomic units as did the Cretaceous extinctions, evidently indicate a profound change in the history of tetrapod life, probably influenced by changes in environmental conditions. Moreover, the Triassic extinctions caused the disappearance of several lines of tetrapod evolution which had been successful during late Paleozoic and early Mesozoic times. These evolutionary lines were replaced ecologically during middle and late Mesozoic times for the most part by other lines of reptilian evolution, whereas by contrast the tetrapods that became extinct at the end of the Cretaceous period were ecologically replaced for the most part by mammals and birds. Perhaps the changes that distinguish the later Mesozoic vertebrate faunas from those of the Triassic period may be correlated with changes from rather high continental masses and varied environments to low lands and the beginning of a long span of environmental uniformity that was to characterize earth history for many millions of years.

EDWIN H. COLBERT
American Museum of Natural History

Ionization of Individual Groups in Dibasic Acids, with Application to the Amino and Hydroxyl Groups of Tyrosine

In acids containing two groups ionizing in the same *p*H range, it is often possible to follow the state of ionization of a single group by spectroscopic measurements. Thus tyrosine in alkaline solutions, with the carboxyl group ionized, contains four different microscopic forms, interrelated as follows:



The fraction (α_{OH}) of all phenolic groups which are ionized can be obtained from ultraviolet absorption at 2950 to 3050 A. It is readily expressed in terms of the dissociation constants indicated above and the hydrogen ion activity (H^+). More useful, however, is the function:

$$M \equiv \frac{(H^+)\alpha_{OH}}{1-\alpha_{OH}} = \frac{k_{12}(H^+) + k_{13}k_{132}}{(H^+) + k_{13}} \qquad (1)$$

It is seen that, as $\alpha_{OH} \rightarrow 0$, and (H^+) becomes very large, M approaches k_{12} as a limit; as $\alpha_{OH} \rightarrow 1$, and $(H^+) \rightarrow 0$, M approches k_{132}. A plot of log M as a function of α_{OH} thus yields these two constants by extrapolation and also gives k_{13} from the form of the curve in the middle region; k_{123} is automatically determined from the other constants. The experimental curves for tyrosine fit Eq. 1 very satisfactorily; values at 25°C and $\Gamma/2 = 0.16$ are $pk_{12} = 9.63$, $pk_{13} = 9.27$, $pk_{123} = 9.69$, $pk_{132} = 10.05$. These can be checked independently by comparison with overall *p*H titrations of tyrosine and O-methyl tyrosine. Equation 1 also gives a good fit to the data of Benesch and Benesch for α_{SH} in cysteine. The extension of the method to more complicated cases will be discussed.

JOHN T. EDSALL
R. BRUCE MARTIN
BARBARA R. HOLLINGWORTH
Harvard University

Steroid Hormones as Coenzymes of Hydrogen Transfer

Previous experiments [*Proc. Natl. Acad. Sci. U.S.* 44, 15 (1958)] demonstrated that certain steroid hormones in minute amounts may mediate an enzymatic transfer of hydrogen between di- and triphosphopyridine nucleotides (DPN and TPN).

The following evidence speaks for the identity of the estradiol-17β-dependent soluble transhydrogenase of human placenta with the estradiol-17β hydroxysteroid dehydrogenase of the same source which reacts with both DPN and TPN: (i) The two enzymatic activities are not separated by fractionation procedures which result in purification of more than 100-fold. (ii) No differential inhibition of the two activities could be obtained. (iii) Only those steroids which can undergo enzymatic oxidation will act as coenzymes for transhydrogenation. (iv) The specificity and affinity for natural pyridine nucleotides and synthetic analogs thereof is the same for both reactions.

The reaction velocities observed in the dehydrogenase assay with substrate amounts of estradiol-17β are in each case commensurate with the corresponding rates of transhydrogenation promoted by catalytic quantities of the hormone. In both reactions the 3-acetylpyridine and the 3-pyridinealdehyde analogs of DPN may replace one of the natural nucleotides, whereas desamino DPN is inactive. The affinity of the enzyme for TPN(H) is much higher than for DPN(H), and there is competition between the nucleotides which indicates a single binding site. The relationship of the extent of binding of different pyridine nucleotides to the direction of hydrogen flow in the transhydrogenase reaction will be considered.

The ability of steroid hormones to act as coenzymes for hydrogen transfer between pyridine nucleotides in the presence of mammalian hydroxysteroid dehydrogenases with dual nucleotide specificity will be discussed in relationship to the physiological actions of these hormones, and to the specificity of their interaction with these activating proteins.

P. TALALAY, B. HURLOCK,
H. G. WILLIAMS-ASHMAN
University of Chicago

Surface of Given Space-Curve Boundary

Let s be a curve in Euclidean three-space, infinity being regarded as a single point. For convenience, the space will be homeomorphic by a mapping I to one with ∞ invariant and s a circle. We define a surface of boundary s as a set S which is compact and connected and (i) outside a toroidal neighborhood of s is a regular surface (that is, adequate for applications of Green's theorem) composed of a finite number of regular elements, such that no two have in common more than an edge or vertex, (ii) every one-cycle of odd linkage with s cuts S, (iii) no open portion of S may be omitted without vitiating (ii).

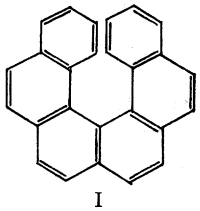
Thus S may have nodal lines and vertices and need not be orientable. The main facts are the following. If E is a compact set satisfying I, (i), (ii), (iii), it contains s, occludes no points from ∞, is connected and is a surface of boundary s (Proof of connectedness involves Alexander's duality theorem). If E is compact, with I, (i), (ii), it contains a subset which is an S. If S_1 and S_2 are nonidentical surfaces of boundary s there exists a bounded domain with boundary in $S_1 + S_2$. If S_1 and S_2 are surfaces of simply linked boundaries s_1, s_2 respectively, S_1 and S_2 intersect.

Surfaces S_1, as above described, may be used as cut surfaces with branch curves s_1, for multiply valued functions.

G. C. Evans
University of California, Berkeley

Optical Activity Due to Intramolecular Overcrowding

The synthesis of hexahelicene (I)



I

completes one phase of the study of molecules which owe their asymmetry to intramolecular overcrowding. The problems involved in the synthesis and theoretical aspects of the study of compounds which owe their optical asymmetry to intramolecular overcrowding will be reviewed, and future problems will be briefly outlined.

Melvin S. Newman
Ohio State University

The Dependence of Longevity of Human Beings on Body Weight

A discussion of the treatment of statistical information about longevity that seems to have some novel features will be presented. For a factor such as radiation exposure or cigarette smoking, which may decrease longevity even for small values of the parameter, an expansion in a power series including the linear term may be proper. However, the dependence on body weight needs to be discussed in a different way. Both obesity and emaciation decrease life expectancy. There is accordingly an optimal value of body weight that maximizes the longevity, and a power-series expansion in a parameter equal to the difference between body weight and this optimal value will have no linear term. It is found in fact that the statistical information about decrease in longevity in relation to obesity can be satisfactorily expressed by a single term, involving the square of the amount of obesity. Some consequences of this discussion will be presented.

Linus Pauling
California Institute of Technology

Broken Bottlenecks and the Future of Molecular Quantum Mechanics

In the early gold-rush days of quantum mechanics, the effort of theoretical physicists was largely concentrated in applying the new theory to the problem of the basic structure of atoms, molecules, solids, and liquids. Great advances were made, but quantitative progress toward understanding the electronic structure of extranuclear matter was frustrated for all but the simplest cases by the immensely complicated and laborious computations needed.

The development of computationally practicable expressions for certain very difficult integrals (by Kotani in Japan, Coulson and Barnett at Oxford, Boys in Cambridge, Ruedenberg and Roothaan here, and others) has gone far recently toward breaking this computational bottleneck. A still more important new factor has been the programming for large electronic digital computers of the otherwise still excessively time-consuming numerical computation of these integrals. In our laboratory, machine programs have been completed for this purpose and for additional steps needed to obtain fairly good molecular wave functions for simple molecules. (Others elsewhere have also made substantial progress.)

With these wave functions available, various molecular properties can be computed, and fundamental understanding of molecular and solid structures and of intermolecular forces can be advanced immensely. Computations on radicals, ions, and excited and activated states of molecules, which often are experimentally little accessible, will be especially valuable. We in this laboratory are now working in these directions. We believe the investigators in this field have crossed the threshold of a new era in the application of quantum mechanics to molecular physics and quantum chemistry.

This work was assisted in part by contracts with the Office of Naval Research and the U.S. Air Force Office of Scientific Research and by a grant from the National Science Foundation.

R. S. Mulliken
C. C. J. Roothaan
University of Chicago

Perception Time and Evoked Potentials

The customary temporal measure of perception has been the duration of a stimulus necessary for perception. Another measure, designated *perception time*, is here proposed. A time-limiting method of restricting perception is employed. A 10-msec informational flash readily perceived on each presentation, when followed by a second, noninformational flash of brief duration (10 μsec), is blanked out if the second flash occurs within 25 to 30 msec. From 30 to 45 msec, perceptual blanking is only partial and by 50 msec the blanking flash no longer interferes with perception of the first flash. Four normal adult subjects all gave similar results; three intensities of the blanking flash representing relative values of 1, 2, and 8 all gave similar S-shaped curves of complete, partial, or no blanking, depending upon the duration between the onset of the first stimulus and the onset of the second. Absolute perception time would be the duration when blanking is complete; relative perception time that period when blanking is partial.

Perceptual blanking is believed to occur at the cortical level, when the arrival of impulse discharges from the second stimulus interfere with the consolidation processes of those from the first stimulus. The recording of evoked potentials from over the visual area of the brain provides data on latency, form, and duration of evoked potentials which tend to support the argument that perception time is a cortical phenomenon. Evoked potentials were reconstructed by an algebraic summation method from multiple oscillograms.

This work was supported by the Research and Development Division, Office of the Surgeon General, Department of the Army (DA-49-007-MD-722).

Donald B. Lindsley
William H. Emmons
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Geologic Significance of Accumulator Plants in Rock Weathering

Accumulator plants differ widely in the elements accumulated but have been studied chiefly for their capacity to pick up minor elements deleterious to agriculture. However, the ability of some plants to accumulate certain major elements, such as silicon, aluminum, manganese, and iron, has geologic implications. Many kinds of vegetation, especially in the tropics, contain several percent silica or alumina dry weight. Some 10 to 20 tons dry weight of new growth per acre is added each year above ground in tropical jungles, and the roots add several tons more. A forest of silica-accumulator plants averaging 2.5 percent silica and 16 tons dry weight new growth per year would extract about 2000 tons of silica per acre in 5000 years—equivalent to the silica in 1 acre-foot of basalt. Comparison of lateritic soils with parent rock suggests that a silica-accumulator jungle could convert basalt

into lateritic soil rapidly, geologically speaking. The silica in ground water increases with depth and time in contact with the rock, but vadose water seems inadequate to yield the silica required by such a jungle of silica-accumulator plants; biochemical factors must therefore cause much more rapid solution of silica. Although some organically derived silica may be recycled or added to ground water, nevertheless, in tropical regions with high rainfall, large amounts of siliceous organic debris must be swept off the forest floor into the drainage system. Plants that accumulate other elements may have geologic importance in developing other special soil types and in expediting the selective removal of certain elements.

T. S. LOVERING
U.S. Geological Survey, Denver

Isotope Separation in the Magneto-Ionic Expander

The one-fluid hydromagnetic equation of completely ionized gases [G. F. Chew, M. L. Goldberger, F. E. Low, *Proc. Roy. Soc. (London)* **A236**, 112 (1956)],

$$\rho\left(\frac{d\mathbf{u}}{dt}\right) = n_0 M\left(\frac{d\mathbf{u}}{dt}\right) = (-\operatorname{div}\overleftrightarrow{P_0} + [\mathbf{j}\times\mathbf{B}]), \quad (1)$$

may be modified for the case of two isotopic ions into two equations

$$n_1 M_1\left(\frac{d\mathbf{u}_1}{dt}\right) = (n_1/n_0)(-\operatorname{div}\overleftrightarrow{P_0} + [\mathbf{j}\times\mathbf{B}]) \quad (2)$$

$$n_2 M_2\left(\frac{d\mathbf{u}_2}{dt}\right) = (n_2/n_0)(-\operatorname{div}\overleftrightarrow{P_0} + [\mathbf{j}\times\mathbf{B}]) \quad (3)$$

where M_1, M_2 are the ionic masses and n_1, n_2 are the particle densities of the two isotopes. If $M_1 < M < M_2$ the values of the last parentheses in the right hand sides of Eqs. 1, 2, and 3 will differ at most in the ratio $\left(1 \pm \frac{\delta M}{M}\right)$, $\delta M = M_2 - M_1$ which we will regard as negligible.

Equations 2 and 3 yield the single equation

$$\left(\frac{d\mathbf{u}_2}{dt}\right) - \left(\frac{d\mathbf{u}_1}{dt}\right) = \frac{\delta M}{M}\frac{1}{\rho}(-\operatorname{div}\overleftrightarrow{P_0} + [\mathbf{j}\times\mathbf{B}]) = \frac{\delta M}{M}\left(\frac{d\mathbf{u}}{dt}\right) \quad (4)$$

Consider the magneto-ionic expander [J. Slepian, *J. Franklin Inst.* **263**, 129 (1957); *Nuclear Sci. and Eng.* **2**, 108 (1958)]. In the throat of the expander tube, n_1/n_2 is a constant. At an expander side wall one of the isotopes has a perpendicular component of acceleration equal to $\left(\frac{\partial l}{\partial y}\right)\mathbf{u}_y^2$ where l is the normal distance between the two expander plates taken at distance y on the expander plate from the arc. The other isotope will have a perpendicular component of acceleration equal to

$$\left(1 \pm \frac{\delta M}{M}\right)\left(\frac{\partial l}{\partial y}\right)\mathbf{u}_y^2$$

The displacement of the precipitating isotopic ions upon the slats will therefore vary as the square of the length of the expander wall.

Calculation thus yields for a 100-amp uranium arc a cost of \$8 per gram of U^{235}, and for a 1000-amp arc a cost of \$2. The cost per gram of U^{235} by the present diffusion method is more than \$15.

JOSEPH SLEPIAN
Pittsburgh, Pennsylvania

Protein Biosynthesis by a Cell-Free Bacterial System

A particulate fraction from sonically disrupted cells of *Alcaligenes faecalis* incorporates C^{14}-labeled L-amino acids into protein. The incorporation of one is stimulated by addition of the unlabeled 18 remaining amino acids and is inhibited by chloramphenicol. Small net increases in protein nitrogen (up to 20 percent) have been observed. The system appears to depend on oxidative phosphorylation for generation of the adenosine triphosphate (ATP) required for amino acid activation.

After the particles have been washed with 1.0*M* NaCl, amino acid incorporation is markedly depressed. Reactivation can be effected by addition of ribonucleic acid or by addition of an enzyme present in the original supernatant fluid. After several hundredfold purification, this enzyme can restore the activity of the washed particles at concentrations of 2 to 3 μg of protein per milliliter of reaction mixture and is active in stimulating the incorporation of all the labeled amino acids so far investigated—that is, glycine, alanine, threonine, valine, leucine, lysine, proline, phenylalanine, tyrosine, and tryptophan.

Neither the purified soluble enzyme nor the washed particles (whether intact or disintegrated by further sonic treatment) contain activating enzymes catalyzing the exchange of P^{32}-labeled pyrophosphate with ATP in the presence of amino acids. Such enzymes are present in the initial extract and at some stages of purification but are absent from the purest fractions of the amino acid incorporation enzyme. The new enzyme is not involved in the oxidative phosphorylation carried out by the particles and appears to be concerned with some phase of protein biosynthesis.

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Infant Mortality Rates and Poliomyelitis: An Epidemiological Study

An increasing body of information indicates that where sanitary conditions are substandard, poliomyelitis is generally reported as an *endemic* disease of infants with low case incidence rates. In some contrast is the pattern in countries with the highest sanitary standards, where the incidence is greater, the disease generally appears in the form of periodic epidemics, and the patients are of school age or older. A recognized index of such sanitary standards is the local *infant mortality* rate (that is, the number of infant deaths per 1000 live births). This may vary from country to country with a range of from 150 or more to less than 30. Several analyses have been made of the inverse ratio of infant mortality rates to poliomyelitis case incidence, and such analyses, although they involve many variables, exhibit fairly consistent trends, one feature being that, as infant mortality declines from 100 to about 75, local epidemics of poliomyelitis begin to appear.

The present report is concerned with data obtained through the Pan American Sanitary Bureau from North, South, and Central American countries during the period 1940–1955. In some of these countries the epidemiologic picture has changed during this period from old fashioned endemic "infantile paralysis" to the periodic scourge of modern "polio." Attempts are made in this study to determine the degree to which the afore-mentioned ratios hold in Pan America, and whether one can predict when and where modern "polio" will appear in Central and South America.

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Comparison between Mutation Rates Induced by Chronic Gamma and Acute X-irradiation in Mice

Extensive data are being collected on the induction of specific locus mutations in mice exposed to chronic gamma radiation from Cs^{137}. Results already obtained from an accumulated dose of 600 r given to spermatogonia at approximately 100 r/wk continuous irradiation show a much lower mutation rate than that obtained earlier with a 600-r acute dose of x-rays. In view of the nature of the material, which consists of cells undergoing rapid cycles of mitosis, it cannot be assumed that mutation rate will prove to be linearly related to dose or even that the shape of the dose curve will be the same as that obtained with x-rays, which itself shows a departure from linearity. Therefore, it would be incautious to assume that the same difference between x-rays and gamma rays will be found at lower doses or lower dose rates. The information obtained from a gamma radiation dose of 100 r given at approximately 10 r/wk is not yet adequate to settle this point. It does, however, already provide a reassuring answer to the more extreme possibility arising from the nonlinearity of the x-ray data that the mutation rate at low doses or low dose rates might actually be higher than that calculated by interpolation between the control rate and the rate from high acute x-ray doses. Even the upper 95 percent confidence limit for the induced mutation rate in this 10-r/wk, 100-r experiment does not exceed the interpolated rate by more than a factor of two.

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The Earth's Crust

It has been firmly established that the earth's crust is approximately 35 km thick under the continental shield areas and 5 km thick under ocean basins. Anomalous parts of the crust, such as mountain regions, are now receiving special attention. Three methods of investigation are being used: (i) gravity variations, (ii) explosion seismology, and (iii) variations in the phase velocity of earthquake-generated surface waves. Methods i and iii give concordant results which may best be interpreted in terms of compensation of high topography by regional crustal thickening. Method ii seems to support this interpretation in some regions, such as the Soviet Union, and gives contradictory results in other regions such as the western United States. An attempt is made to reconcile these divergent results. It is concluded that a higher degree of precision in explosion seismology is required, particularly in identifying later arriving seismic waves by correlation methods, in order to delineate velocity variations within the crust.

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Neutrino Theory of Gravitation

This paper is a preliminary report on an attempt to account for gravitation by means of a quantized neutral, massless field, which is coupled to the energy density of matter, the electromagnetic field, and all strong and electromagnetic interactions. The quanta of the gravitational field may consist of spin zero particles, or of neutrino-antineutrino pairs. The theory has no relation to the general theory of relativity, which is successful in accounting for the five known experimental phenomena but is difficult to quantize. The present theory accounts for three of these phenomena: the Newtonian inverse-square law of attraction between distant masses, the precise proportionality between gravitational and inertial mass demonstrated by Eötvös, and the red shift of light originating in a strong gravitational field. The other two phenomena, the deflection of light passing through a strong gravitational field, and the advance of the perihelion of the orbit of the planet Mercury, are predicted to have half their observed values. In its present form the theory is not Lorentz-invariant; it is being modified in the hope of making it Lorentz-invariant and improving agreement with observation.

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Lytic and Reproduction-Inhibiting Antibodies against Trypanosoma lewisi

Both ablastin that inhibits the reproduction of *Trypanosoma lewisi* early in the infection in the rat and the lysin that terminates the infection localize in the gamma-1 or T fraction during electrophoresis. Ablastin is a small molecule ($S_{20}=6S$), whereas the lysin is large ($S_{20}=16S$). Ablastin, first described by Taliaferro [*J. Exptl. Med.* **39**, 171 (1924)], specifically inhibits mitosis and cell division of the trypanosomes with no apparent effect on general vitality, motility, or infectivity. Moulder [*J. Infectious Diseases* **83**, 42 (1948)] found that the inhibition by ablastin shifted the carbohydrate metabolism from a state of active assimilation to one of maintenance. We have found that dividing trypanosomes incorporate 3 to 4 times as much S^{35}-labeled amino acids into their TCA-insoluble fraction as do inhibited parasites. Dividing trypanosomes incorporate relatively large quantities of adenine-8-C^{14} sulfate into their TCA-insoluble fraction, whereas inhibited parasites incorporate practically none. The results indicate that the parasites inhibited by ablastin are forming no nucleic acid and very little protein.

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Some Observations on the Abundance of the Elements

An estimate of the abundances of the elements made by Suess and Urey has been used by Fowler *et al.* and Cameron as a basis for theories for the origin of the elements in the interior of stars. However, they used abundances in the neighborhood of iron and in the lead-uranium regions taken from astronomical data. A study has been made to see whether any likely chemical separation would result in errors in the meteoritic abundances of sufficient magnitude to account for the difference in data of these two sources. It is concluded that the meteoritic data very probably represent one cosmic composition. No systematic chemical separations have been discovered which would lead to errors in these particular elements and not in others. A considerable variation in the abundance of primitive lead in various chondrites suggests that some loss of lead may have occurred. Because of this, as well as analytical difficulties, it may be presumed that the abundance of lead in meteorites is not well known, but no such uncertainty exists in the cases of uranium and thorium. If the solar abundances are correct, then it is concluded that the source of elements in the meteorites and the sun have not been the same or that differences in abundances have been produced during the history of the solar system. Theories for the origin of the elements should be able to account for the meteoritic abundances.

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Infrared Spectra of Symmetrical Molecules under High Resolution

A grating spectrometer has been designed which achieves high resolution in the region from 2 to 5 μ. This region is measured with two gratings of 15,000 lines/in. and 10,000 lines/in. A resolution of about 0.03 cm^{-1} is obtained throughout the region, and lines separated by 0.024 cm^{-1} have been resolved at 3.6 μ. Infrared bands of methane, ethylene, and ethane have been measured, and each line of the *P* and *R* branches is resolved into several components. From the observed spectra more precise values of the molecular constants can be obtained. Illustrations of the observed spectra will be shown.

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