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Forecast of United States Precipitation through 1967

A family of regular harmonic periods of identical lengths in the sun's radiation and in weather has been discovered. The periods are exact submultiples of 273 months. In weather they have hitherto been unrecognized. Though the periods remain unaltered, their phases alter with seasons of the year, with sunspot frequency, and also secularly. Having eliminated these phase changes, I have determined average forms and amplitudes of 27 periods from monthly records since 1870. By adding the thus-cleared monthly-expressed 27 harmonic periods, monthly departures from the normal precipitation for the years 1950 through 1967 are predicted for 32 cities. Correlation coefficients of 50 to 70 percent are found for the 9-year interval 1950–58. Similar correlation is to be expected 1959–67.

This work is sponsored by the Association for Applied Solar Energy and by the Smithsonian Institution.

C. G. ABBOT
Smithsonian Institution

Relation of Photosynthetic Transients to Respiration

It was suggested last year that the time course of "chromatic transients" in photosynthesis could be ascribed to characteristic changes in respiration during the first few minutes of exposure to light of different wavelength. This hypothesis, based on *Ulva*, has now been verified in a more favorable green alga, *Enteromorpha*, a tubular form in which the tissue is but one cell thick, and in which the plastids are sometimes aligned along the outer, very thin cell wall. When this tissue is held tightly against a polarized platinum electrode, the latter shows especially rapid responses to oxygen released in photosynthesis, or respired in the dark. It is possible to follow the respiration at very short intervals after varying durations of illumination, and at critical points along the photosynthetic transient.

During exposure to light of 650 mμ (absorbed by chlorophyll *b*) or 490 mμ (absorbed by carotenoids) there is little change of respiration during the initial cusp; a striking increase during the depression; and a gradual decrease toward normal in the recovery phase. After long exposure to light there is sometimes a delayed increase of respiration, appearing a minute or two after darkening. Conversely, during illumination with long wavelengths (702 mμ, absorbed only by chlorophyll *a*), the respiration is at first enhanced, but falls off during the next minute or two. This accounts for the slow rise of O_2 evolution in the far red, and the absence of an initial cusp.

These respiratory changes seem adequate to explain the chromatic transients found on going directly from far red to shorter wavelengths and vice versa. In one specimen of *Enteromorpha* (kept for some time in dim light) the chromatic transients and respiratory changes remained large even through the "Emerson effect" (enhancement) was essentially absent.

L. R. BLINKS
Hopkins Marine Station, Stanford University

Submicroscopic Changes in "Paling" of Irradiated Parts of Chromosomes

A small part of a chromosome, after appropriate exposure to ultraviolet light, shows a decrease in refractive index ("paling"), a decreased absorption of light at 260 mμ, and greatly diminished or negative reactions with basophil dyes and the Feulgen and pyronin-methyl green stains. These findings strongly suggest that in the irradiated area most, if not all, of the deoxyribonucleic acid (DNA) is either lost or greatly changed. In electron micrographs of unstained cells fixed in 10 percent neutral formalin in Tyrode's solution, the chromosomes are seen to have sharp outlines and a homogeneous appearance except in the irradiated areas where they are markedly vacuolated and have less circumscribed margins. In similarly fixed cells stained with 0.5 percent phosphotungstic acid in absolute alcohol, the chromosomes consist of two major components: (i) a homogeneous or finely granular, pale grey substance which fills the interstices between and (ii) delicate rod or tubelike structures 75 to 300 A in diameter. These branch occasionally and extend several thousand angstroms in the thin sections. Some continue into interchromosomal areas. The homogeneous substance diminishes progressively from nonirradiated portions of chromosomes through a transitional zone into the heavily irradiated region where it is apparently absent, leaving only a network of tubules. It thus seems that the grey substance, which disappears after irradiation, contains DNA alone or associated with protein. (Osmic acid solutions, the usual fixatives for electron microscopy, do not show differences in structure between the irradiated and nonirradiated portions of the chromosomes, presumably because they do not demonstrate DNA.)

WILLIAM BLOOM
University of Chicago

Energy Relations in Chromosome Paling by Ultraviolet Microbeams

The characteristics of chromosome paling have been described by Bloom (foregoing abstract). This phenomenon offers opportunity for study of chemical and ultrastructural disassembly of a chromosome within a living cell. One approach to understanding of its nature is to obtain quantitative data concerning the ultraviolet energy relations, absolute and spectral. The following information was obtained in experiments on newt chromosomes in tissue culture with ultraviolet microbeams 8 μ in diameter. Based on number of incident quanta required to produce a standard degree of paling, the relative actions of wavelengths 2250, 2400, 2500, 2600, 2700, 2800, and 3000 A are proportional to 220, 30, 10, 16, 19, 16 and 2.2. This action spectrum deviates widely from the absorption spectra of deoxyribonucleic acid (DNA) and of its constituent nucleotides but agrees reasonably well with those of proteins containing tyrosine or tryptophan, or both. With a 2600-A microbeam, paling is produced in 50 percent of the cells by an exposure of 1.2×10^9 quanta/μ^2. From this number and additional data in the literature, a minimal value of 2 is calculated for the number of quanta absorbed per DNA nucleotide initially present. However, from detailed consideration not only of the foregoing data but of certain qualitative aspects of paling, it is concluded that the photons involved in paling are not those absorbed by the DNA but more probably start their action by absorption in a protein.

RAYMOND E. ZIRKLE, ROBERT B. URETZ
University of Chicago

Vector Meson Coupling in Nucleon-Nucleon Interactions

Evidence for considering the repulsive core and the spin-orbit interaction which appear indicated by nucleon-nucleon scattering as originating in the coupling of nucleons through a heavy vector meson field is presented. The approximate mass of the meson is estimated as about 10 or 12 pion masses. It is shown that the treatment of antinucleon scattering by Ball and Chew falls in with the hyopthesis requiring a change believed to be unimportant. Heavy vector mesons have apparently not been directly observed in antinucleon-nucleon collisions or other circumstances. This situation is reviewed. It is shown that for the most likely process the energy used in experiments was too low. Difficulties which the hypothesis might encounter with the binding

energy of H^3 are discussed with the conclusion that there are many possibilities for reconciliation. Partial support for the hypothesis is found in the comparison of data on the photodisintegration of the deuteron with calculations employing fixed potentials and neglecting exchange currents. Similar qualitative support is found in the simplicity of electromagnetic form factors derived from e-p and e-d scattering experiments, the direct effect of the vector meson coupling being to smear the proton and neutron charge and current distributions equally. This corresponds to the naive interpretation of empirical evidence. The view proposed leads to more nearly energy independent depth and range parameters of nucleon-nucleon potentials than would be expected on the pion theory without the vector field.

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G. BREIT
Yale University

Effects of Structural Changes in the Long Arm of Chromosome 10 in Maize on Paramutation of the R^r Factor

Three reciprocal translocations involving, in each case, a break in the long arm of chromosome 10, two proximal and one distal to the *R* locus and removed from the latter by at least 5 to 10 crossover units, if in coupling but not repulsion with R^r, (i) increase the aleurone pigment-producing action of R^r from dark mottling to near self-color, in single dose, and (ii) render R^r comparatively insensitive to paramutation in stippled (R^{st} heterozygotes (TR^r/R^{st} or R^rT/R^{st}). Insertion of R^{st} in a translocation (T) chromosome has little or no influence on the strong paramutagenic action of this allele in heterozygotes with R^r on a normal chromosome (TR^{st}/R^r). The effects, under (i) and (ii), seemingly appear only after a lag of at least one generation following introduction of R^r into a T chromosome. Such germinally transmissible changes in R^r action, once induced in a TR^r/r^r plant, invariably persist for at least one generation following return of R^r from a T to a structurally normal chromosome by crossing over. This fact excludes conventional position effect as an explanation of the phenomenon. For reasons not at present apparent, R^r in coupling with a translocation (TR^r) is somewhat lower in pigment-producing action, and is more sensitive to paramutation in R^{st} heterozygotes, when derived from TR^r/R^r (homozygous colored) than from TR^r/r^r (heterozygous colorless) plants. The evidence from these experiments suggests the occurrence of functional components of the chromosome much larger than individual loci.

R. ALEXANDER BRINK
University of Wisconsin
MARGARET BLACKWOOD
Melbourne University
N. K. NOTANI
Indian Cancer Research Center, Bombay

Induction and Acceleration of Gametogenesis in Flagellates by the Insect Hormone Ecdysone

Ecdysone, which is produced by the prothoracic glands of insects, was crystallized in 1954 by Butenandt and Karlson. It is a growth and differentiation hormone and is also referred to as the molting hormone.

The wood-feeding roach *Cryptocercus* is the host of a large assortment of protozoan flagellates: 9 families, 14 genera, and over 30 species. Each time this host molts its flagellates are induced to undergo sexual cycles, which they never undergo at any other time. An adult roach has no prothoracic glands, no ecdysone, no sexuality in its flagellates, and it does not molt. When it is injected with ecdysone, gametogenesis is induced in its flagellates, and the time required for induction depends, within certain limits, on the amount of ecdysone injected. 2000 units induces gametogenesis in four genera within 3 hours.

Under natural conditions the sexual cycles of some genera of these flagellates require 6, some 9, some 26, and some 40 to 50 days for completion. When fairly large amounts of ecdysone are administered to hosts lacking this hormone, the sexual cycles are greatly accelerated; those requiring 40 to 50 days for completion under natural conditions are all completed in experimental hosts in 7 days. If the experimental host is an intermolt nymph or an adult, it does not molt, yet its flagellates are induced to undergo sexual cycles.

Ecdysone does not induce zygotic meiosis, nor is its presence essential for fertilization. It is responsible for only the gametogenesis phase of sexual cycles.

L. R. CLEVELAND
University of Georgia

Strand Separation and Specific Recombination in Deoxyribonucleic Acids

When solutions of bacterial deoxyribonucleic acids (DNA) are denatured by heating to 100°C and then cooled, two different molecular states can be obtained in essentially pure form, depending on the choice of conditions. When the cooling is fast and the concentration of DNA below 40 μg/ml, the DNA is single stranded, unaggregated and has a molecular weight of about half that of the original DNA. This is essentially inactive in bacteriological transformation and is called denatured DNA. With slow cooling at 0.3 m*M* sodium ions and at concentrations of DNA near 20 μg/ml the DNA consists of recombined strands united by complementary base pairing over most of their length. This form has as much as 50 percent of its original transforming activity and is called renatured. These two forms can be clearly identified by differences in (i) absorbance-temperature curves, (ii) density, (iii) appearance in electron micrographs and (iv) hydrodynamic properties. The recombination has the concentration dependence of a bimolecular association. Wild-type DNA can replace homologous DNA carrying genetic markers but nonhomologous DNA has no effect on the extent of recombination. Thus the recombination is specific.

Density gradient experiments on N^{14} and N^{15} *Escherichia coli* DNA have shown the existence of hybrids in the DNA renatured from the mixture. Similarly, hybrids have been shown to form between the strands of bacteria that are closely related genetically. Thus the possibility of forming, by renaturation, heterozygous DNA molecules with different genetic markers or different chemical modifications in the two strands seems assured.

P. DOTY, J. MARMUR,
J. EIGNER, C. SCHILDKRAUT
Harvard University

Stress and Duodenal Ulcer

The concept that duodenal ulcers are usually caused by an abnormal hypersecretion of gastric juice of nervous origin is supported by the following evidence. (i) Duodenal ulcer patients usually secrete from 3 to 10 times more acid in the fasting, empty stomach at night than do normal people. (ii) If a hypersecretion of this degree is produced in experimental animals they regularly develop duodenal ulcers. (iii) If the vagus nerves to the stomach in duodenal ulcer patients are divided, the hypersecretion is abolished, and the ulcers usually heal.

Recently an alternative concept has been advanced to account for the role of physical and mental stress in duodenal ulcer. It is postulated that such stress stimulates the hypothalamus which in turn stimulates the anterior hypophysis to increased liberation of adrenocorticotropic hormone (ACTH). This in turn causes increased production of cortisone. Cortisone, it is claimed, stimulates gastric secretion and causes duodenal ulcer. In this report evidence will be presented that ACTH, cortisone, and epinephrine do not stimulate gastric secretion and, furthermore, that physical and mental stress do not stimulate gastric secretion if the vagus nerves have been cut.

It is suggested that the stresses of modern life play an important role in duodenal ulcer by causing in some way an increased activity of the vagus nerves. This in turn causes an increase in stomach motility and an abnormal hypersecretion of acid gastric juice.

LESTER R. DRAGSTEDT
University of Florida

Dissociation Energies of Gaseous Alkali Halides

The newly available data on gas imperfections of alkali halide vapors, together with entropies calculated from low temperature heat capacities, microwave determinations of internuclear distances, and infrared observations of vibrational frequencies were used to carry out a critical evaluation of all the vapor pressure data for the alkali halides. The resulting heats of sublimation were com-

bined with heats of formation to obtain dissociation energies of the gaseous alkali halides.

These experimental dissociation energies were compared with those calculated on the basis of a classical electrostatic model. Although reasonable agreement is obtained for alkali halides with large ions, when the polarizability of the ions is taken into account, alkali halides containing small ions and particularly the halides of lithium show substantial discrepancies.

LEO BREWER
University of California, Berkeley
ELIZABETH BRACKETT
Rice Institute

Morphological Model for Human Intelligence

The results from a factor-analytical approach to the investigation of abilities, particularly in the past 10 years, has revealed some 55 distinct dimensions of intellect. Consideration of their logical relationships has resulted in the organization of those abilities into a system known as the "structure of intellect."

The abilities are cross-classified according to three parameters—operations (five kinds), content (four kinds), and products (six kinds). These interacting classes can be represented geometrically by a rectilinear model. Vacant cells within the model forecast many abilities yet to be discovered, possibly bringing the number of intellectual factors to 120 or more.

The implications of this conception of intellect are numerous for general psychological theory, for aptitude testing, and for education. The kind of psychology implied emphasizes the individual as an agent for dealing with information. Two of the parameters of the model pertain to varieties of information, its sources, and the kinds of products that the individual makes of it. Aptitude testing can become far more analytical. The knowledge of new factors extends considerably the possibilities of assessment into areas of intellect previously neglected, for example, creative thinking and evaluation or judgment. Education may again put "training the mind" among its highest objectives. Furthermore, education will have a more enlightened basis for its operations of developing intellectual skills.

J. P. GUILFORD
University of Southern California

Pleiotropism as Studied in Galactokinaseless Mutants of Escherichia coli K-12

As has been reported previously [H. M. Kalckar, K. Kurahashi, and E. Jordan, *Proc. Natl. Acad. Sci. U.S.* **45**, 1776 (1959)], the synthesis of galactose-1-phosphate uridyl transferase (which is low in the galactose positive strains without addition of galactose) is independent of galactose in two strains with hereditary blocks in galactokinase. The following code is used with respect to inducibility and constitutivity of kinase (K) and transferase (T). If the rate of enzyme activity in the absence of galactose is below 10 percent, "i" is used, below 1 percent, "ii," whereas rates above 20 percent of full constitutivity are denoted "c,i." Full constitutivity is represented by "c." Omission of these letters means that inducibility has not been tested. The galactose-positive wild type is accordingly $K^{+}{}_{ii}T^{+}{}_{i}$; the galactokinaseless, $K^{-}T^{+}{}_{c}$. The latter strains can revert to galactose positive in which galactokinase activity is restored (K^{+}) and at the same time T loses constitutivity, that is $K^{+}T^{+}{}_{i}$ or $K^{+}T^{+}{}_{ii}$. From $K^{-}T^{+}{}_{c}$ has been isolated $K^{-}T^{+}{}_{i}$, which readily reverts to $K^{+}T^{+}{}_{i}$ (M. B. Yarmolinsky, H. Wiesmeyer, and E. Jordan, unpublished). It is also of interest that transduction of $K^{-}T^{+}{}_{c}$ to a transferaseless host ($K^{+}T^{-}$) yields a galactose-positive heterogenote $[K^{-}T^{+}{}_{c}]_{\lambda gal}/K^{+}T^{-}$ which phenotypically is $K^{+}T^{+}{}_{c,i}$ [H. Wiesmeyer and M. B. Yarmolinsky, *Bacteriol. Proc.* (1960)]. As emphasized previously (H. M. Kalckar *et al.*), the galactokinase activity seems an irrelevant factor in determining $T^{+}{}_{c}$; rather, true pleiotropism is involved or an alternative galactokinase is synthesized which results in the formation of an enzyme capable of destroying a naturally occurring cellular repressor for T. This possibility might be approached by obtaining a time curve for T right after the formation of the above-mentioned heterogenote, in case a $T^{+}{}_{i}$ activity can be detected prior to a $T^{+}{}_{c,i}$.

HERMAN M. KALCKAR
ELKE JORDAN
Johns Hopkins University

Evaporation Resistances of Mixed Monolayers

In our previous paper [*Proc. Natl. Acad. Sci. U.S.* **45**, 1274 (1959)] we emphasized that the resistance which a monolayer spread on a water surface exhibits to evaporation is very sensitive to the presence of contaminants of lower resistance. We have accordingly investigated mixed monolayers of saturated long-chain hydrocarbon compounds where the head groups are COOH, or OH, or mixtures of COOH and OH. The logarithm of the resistance to evaporation is a linear function of the mol fraction of the components, if the polar head groups are the same. When the head groups are a mixture of COOH and OH, specific interactions are found.

When the C_{18} alcohol is contaminated with the C_{12} alcohol, the latter molecules are squeezed out of the monolayer on compression, so that above a surface pressure of about 14 dyne/cm the mixture behaves as though it were almost pure C_{18} alcohol. On the other hand, when C_{14} alcohol is added to C_{18} alcohol, the C_{14} alcohol is not squeezed out entirely on compression, and the evaporation resistance is lowered. These findings have a bearing on the selection of commercial samples of mixed alcohols for field studies on the reduction of evaporation of water from reservoirs.

VICTOR K. LA MER
GEOFFREY T. BARNES
Columbia University

Relation of Beet-Yellows Virus to Phloem Tissue

Beet-yellows virus induces the formation of inclusions in infected plants. These inclusions appear first in phloem tissue but later develop also in ground tissues outside the phloem and in the epidermis. Within the phloem, the inclusions develop in nucleate cells (phloem-parenchyma and companion cells) located next to mature enucleate sieve elements. No inclusions were seen in mature sieve elements themselves. The initial localization of inclusions and their subsequent spread suggest that the virus is translocated in mature enucleate sieve elements but multiplies outside these elements in nucleate cells, first in those of the phloem, later also outside the phloem. In its host-tissue relation the beet-yellows virus appears to be intermediate between the typical phloem-limited yellows viruses and the mosaic viruses, which are able to multiply in any tissue.

KATHERINE ESAU
University of California, Davis

Plasmatypes of Maize as Evidence of Cytoplasmic Diversity and Continuity within a Species

In *Zea mays* three different types of cytoplasm have been found. These types are separated by their interaction with known genes to produce either normal or aborted pollen. These cytoplasmic differences have persisted without alteration during 15 generations of backcrossing and presumably have existed for very long periods of time. This raises two questions which have not yet been answered: Have these different plasma-types been derived from the different species that have presumably contributed to cultivated maize as we now know it? Or have the plasma-genes mutated since the species was established? This has an important bearing on the origin of cytoplasmic differences and the differentiation and separation of species.

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Connecticut Agricultural Experiment Station

Enzymic Mechanism of Increased Utilization of Glucose during Virus Multiplication in the Chorioallantoic Membrane of the Chick Embryo

The chorioallantoic membrane of the chick embryo responds with a marked increase of lactic acid accumulation in vitro, when virus multiplication takes place in this tissue. This increased glycolysis was previously found to be caused by an augmentation of glycolytic enzymes [E. Kun and M. H. D. Smith, *Proc. Soc. Exptl. Biol. Med.* **73**, 628 (1950); M. H. D. Smith and E. Kun, *Brit. J. Exptl. Pathol.* **34**, 1 (1954)]. Recent investigations have revealed that the increase of glycolysis occurs simultaneously with a net increase

of glucose utilization and an increased turnover of the "pentose cycle," as measured by CO_2 production from glucose-1-C^{14}. Since the concentration of enzymes catalyzing the oxidation of hexose monophosphates does not increase [E. Kun, *Proc. Soc. Exptl. Biol. Med.* **83**, 532, (1953)] in contrast to glycolytic enzymes, the enzymic mechanism of the increase in the hexose monophosphate pathway was further analyzed. It was found that the rate-limiting reaction in the rate of the pentose cycle was the reoxidation of reduced triphosphopyridine nucleotide (TPNH). The main oxidizing agent is pyruvate, and the enzyme catalyzing this oxidation is a lactate dehydrogenase of the chorioallantoic membrane. The synthesis of this enzyme in virus-infected membranes occurs simultaneously with an increase in the pentose cycle. A study of the properties of this enzyme revealed that one of the reactions catalyzed by it,

$$\text{TPNH} + \text{H}^+ + \text{pyruvate} \rightarrow \text{TPN}^+ + \text{lactate},$$

is inhibited by iodoacetate, in contrast to other lactate dehydrogenases. It is concluded that virus infection results in an activation of biosynthesis of glycolytic (and other) enzymes. The increase in the pentose cycle is explained by an increase of lactate dehydrogenase (TPNH-oxidizing enzyme) and by some change in the intracellular availability of DPN^+, which otherwise inhibits the TPNH→pyruvate reaction. A possible implication of these findings in the mechanism of glycolysis in tumors is suggested.

ERNEST KUN, J. E. AYLING, BENJAMIN V. SIEGEL
University of California School of Medicine, San Francisco

Amplification by Fluid Stream Interaction

Recent experiments with interacting fluid streams show that it is possible to achieve an amplifying action by a stream-deflection method. Since this amplification does not require the use of moving parts, it is termed "pure fluid amplification." A "pure fluid amplifier" consists of a "power nozzle" which provides a high-velocity stream; two or more apertures to receive the kinetic energy of this stream; and one or more control nozzles to issue a control stream which impinges on the side of the high-velocity stream and thus varies the proportioning of the energy between the apertures.

A simplified treatment of a highly idealized, two-dimensional pure fluid amplifier shows that the power gain is of the order of $(2\ L/W)^{3/2}$, where L is the distance from the region where the streams collide to the apertures and W is the width of the high-velocity stream at the apertures. Achieving a high power gain requires that the high-velocity stream maintain its integrity over a distance much greater than its width. In 1897 L. Mach published schlieren photographs showing that high-velocity jets of air maintain their integrity over considerable distances. It has been found that such streams of air can retain their integrity even while deflected, thus making pure pneumatic amplifiers possible. Control of the streams is accomplished through the use of momentum interaction and boundary layer effects.

BILLY M. HORTON, R. E. BOWLES
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Surface Changes during Division

The problem of what occurs when the fertilized egg of *Amblystoma puntatum* forms two cells is considered in the light of its relative time when compared with the formation of the embryo. The question of deformation of the egg is postulated as a measure of its relationship to the pile-up of potential energy which must be much larger than that indicated by the measurements of its surface energy.

Observation by incident-light, dark-field illumination shows definitely that in this form the primary furrow is intrinsically localized in the egg cortex and that this dominates the position taken by the dividing nucleus. The nuclear mechanism shows its influence in the way in which it causes the intrinsic determinative furrow forming mechanism to become indeterminate or modifiable. Usually the determinative dominates.

The breakdown of the nuclear membrane has been photographed and described. This process involves a change in structure of the nuclear periphery from a structural continuum to a lattice in which the interstices appear as beads. In optical section a halo is changed to a rosary.

The observations herewith presented support Selman and Waddington's view of reaction in the amphibian egg cortex. This is not growth in the accepted meaning of the word, but it is a new formation of cortical material from the subcortical layers and the formation from the cortical layer of an interface membrane.

Thirty years ago the time sequence of the important things occurring in development was considered as being slow and deliberate. It is now revealed that our feeling of the deliberateness of reactions was obscuring the interpretation of continuous development. Events proceed in a much closer chronology than we have hitherto conceived.

J. S. NICHOLAS
Yale University

Evidence for Oxides of Nitrogen in the Atmosphere of Mars

Observations of the spectrum of Mars, in July 1956, with the high dispersion of a concave-grating spectrograph, at the Slope Observatory on Mauna Loa, show a steady decline in intensity in the green, blue, and violet regions, relative to sunlight reflected from the moon. This effect is similar to that observed for Jupiter and Venus, and is attributed to absorption by nitrogen peroxide in the planet's atmosphere. As evidence for this inference we offer a microphotometric comparison of the spectra of Mars and the Moon. The curve showing the general decline in intensity of the Martian spectrum with wavelength closely resembles the absorption curve of nitrogen dioxide as published by several investigators. Further features of the curve are dips and depressions at wavelengths in close agreement with similar features observed in laboratory experiments on NO_2 with lower dispersion. As a check on this we have made observations at high dispersion on the absorption spectrum of NO_2 and find good agreement between our Martian and laboratory results. We conclude that oxides of nitrogen are present in the atmosphere of Mars and explain observed features of the Martian spectrum. The toxicity of these gases is evidence for the nonexistence of life on Mars.

C. C. KIESS
C. H. CORLISS
HARRIET K. KIESS
National Geographic Society and *National Bureau of Standards*

Reappearance of Certain Structural Features of Native Collagen after Transformation

When soluble collagen is gently heated, configurational changes occur at a reproducible temperature which result in a sharp drop in optical rotation and intrinsic viscosity. Upon heating, tanned collagen fibers shrink and lose characteristic low angle x-ray reflections. On cooling, the physical properties partially return to their original values. Most significantly, the temperature of melting corresponds to the original temperature. These changes have been interpreted as evidence of a phase transition involving melting of the native helical structure to form random coils. Although the close agreement of temperatures for the initial and final products of the heating cycle indicates equivalence of the crystalline regions, reversion to *short* crystalline segments of the helix could give the results observed.

We have obtained electron micrographs of the particles present in calf-skin collagen solutions before heating, immediately after heating, and after subjecting the solution to 5°C for several hours. The characteristic rod-shaped collagen particles disappear completely on heating, being replaced by globular particles as seen in the electron micrographs. Upon cooling, significant numbers of rod-shaped particles (tropocollagen) reappear. We have also established the presence of highly ordered aggregates (segment long spacing or SLS type) after adding adenosine triphosphoric acid to heated and cooled collagen. The latter experiments show that the macromolecules can regain not only the original size and shape but also the rather precise side chain charge distribution necessary for SLS formation. Sedimentation, viscosity, and optical rotation studies confirm these results. Electron microscope studies of collagen *fibrils* crosslinked with formalin reveal that the characteristic striations (considered to be indicative of crystallinity) not only disappear with ele-

vation of temperature, but are regained upon cooling.

The results of this study demonstrate that the reversal of the collagen helix $\rightleftharpoons$ random coil transition is accompanied by restoration of the structure characteristic of the native state when proper heating and cooling schedules are followed.

ROBERT V. RICE
Mellon Institute

Mutation Frequency at Low Radiation Intensity

In the experiments that resulted in our finding that fewer mutations are produced by a given dose of chronic irradiation than by the same dose of acute irradiation, the radiation intensities adequately compared were approximately 90 r/wk and 90 r/min. The possible effect of a further reduction in dose rate is now being tested by measuring mutation frequency at specific loci in spermatogonia of mice irradiated at an intensity of 10 r/wk for total doses of 86 and 300 r (Cs^{137} source). The data already accumulated show that the mutation frequency at this dose rate is significantly higher than that in the controls ($P = 0.002$). Thus, there is no indication of a threshold dose rate (a dose rate below which no mutation occurs) even when the dose rate is reduced to this low level of 10 r/wk. This is, as far as we know, the lowest dose rate ever tried in laboratory mutation rate experiments with animals.

The mutation frequency at 10 r/wk is not significantly different from that obtained at 90 r/wk. Thus, there is, so far, not only no evidence for a threshold dose rate, but also no indication that further lowering of radiation intensity will result in any further reduction in mutation frequency.

W. L. RUSSELL, ELIZABETH M. KELLY
Oak Ridge National Laboratory

Phonetic Typewriter

The factors involved in the development of a phonetic typewriter are as follows: the particular form in which the words are typed; identification of the analyzed sounds; encoding, coding, and decoding of speech sounds for the operation of the actuating mechanism; and the design of the mechanism for actuating the typewriter. The system for analyzing and separating the sounds of speech constitutes one of the basic elements for the conversion of speech into the typed page. Since a sound wave may be completely described in terms of the amplitude and frequency of the components and time, the system for identifying the sounds of speech is based upon frequency, amplitude and time. The speech identifier includes (frequency, amplitude, and time) analyzers, compensators, correlators, and normalizers.

HARRY F. OLSON
RCA Laboratories

Beach Rock Investigations

Investigations in the Lesser Antilles and Puerto Rico lead to the conclusion that beach rock consists of beach materials cemented by calcite. Cementation is initiated in the vicinity of the water table under the beach. Exposure results from removal of overlying sediments, and quite commonly occurs intermittently, producing successive bands of beach rock. Each band indicates the position of a former beach. Divergent trends of these bands in some places provide a record of stages in the development of coastal outlines during the 4500-year interval of the existing still-stand of ocean levels. Outer bands of beach rock are commonly in process of transformation into reefs. After the poleward limits of beach rock along the coasts of the major oceans have been ascertained, it may be possible to state a climatic value indicating the length of season of warmth necessary to permit beach rock formation. If, upon investigation, it is found that considerable numbers of fringing reefs are anchored on beach rock, it may be possible to apply the climatic formula to one or more of the halting stages associated with the last general rise of sea level.

RICHARD J. RUSSELL
Louisiana State University

Phase Transition of a Superconductor

The Bardeen-Cooper-Schrieffer model of a superconductor is one of the few systems whose partition function can be evaluated in a closed form such that the phase transition is exhibited in a mathematically rigorous manner. This derivation (Bogoliubov, Zubarev, Tserkovnikov) implies certain tacit assumptions which call for a critical discussion. Another question is: How sensitive is the theoretical result—that is, the character of the phase transition—to the way one chooses to "reduce" the Hamiltonian, namely to split it into a main part that is treated rigorously, and perturbations which are either shown to have no effect or, otherwise, are deliberately neglected on the basis of plausibility arguments? As an example it will be pointed out that inclusion of the lowest order self-energy (or exchange Coulomb energy, or both) in the reduced Hamiltonian changes the character of the transition from second-order to first-order. Numerically, one may expect the heat of condensation to be very small, yet it might be detectible in very precise measurements.

G. WENTZEL
University of Chicago

Scale Size of Mechanisms for Solar Modulation of Cosmic Ray Intensity

The galactic cosmic radiation undergoes large changes in intensity and spectrum at the earth as a consequence of electromagnetic phenomena of solar origin. Over the 11-year solar activity cycle, there is an intensity decrease of a factor 2 to 4 at solar activity maximum. On a shorter time scale, there are intensity decreases of 10 to 50 percent which take place in the order of hours—the Forbush decreases. To investigate the magnitude of the latter phenomenon in space, experiments have been performed with cosmic ray detectors on the earth and in the satellite Explorer VI. A Forbush decrease has been observed simultaneously at the earth and at a distance of more than 7 earth radii. Thus the scale size for the electromagnetic fields producing this effect is much greater than this distance, and it is unlikely that geocentric models for these fields account for the observations.

Pioneer V, recently launched in an orbit about the sun, also provides information on the magnitude of the region in interplanetary space over which the 11-year depression of cosmic ray intensity persists.

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Molecular Reorientation as Unifying Principle Underlying Cellular Selectivity

One of the most fundamental properties of cells is their discriminatory capacity for admitting or excluding selectively specific physical stimuli, chemical agents, and exchanges with fellow cells in their environment (for example, in food ingestion, drug reactions, hormone responses, parasitic infections, permeability, immune reactions, fertilization, virus reproduction, nerve excitation, cell-to-cell interactions in development and tissue repair). Some of these phenomena have been interpreted in terms of interlocking molecules of matching configuration. But the relation between the specificity and the dynamics of such interactions (transfer of substance and energy, current flow, cementing, and so forth) has remained undefined.

As a step toward a unitary concept, a "dualistic" hypothesis is herewith presented, based on the following assumptions. (i) A major fraction of the cell surface is occupied by a network of filiform macromolecules in essentially planar (surface parallel) array, barring substance passage ("barrier position"). (ii) Certain of these molecules have end groups of specific configuration as selective acceptors for complementary groups. (iii) Carriers of complementary end groups approaching the cell from the environment attract and combine with the matching surface groups and thereby right the respective molecules from tangential into radial ("open-gate") positions. (iv) For molecules with an axial (length : diameter) ratio of 100, this reorientation implies the uncovering of 99 percent of a formerly covered surface site; in other words, the opening of local "leaks" or "pores" as channels for secondary outflow or inflow across the surface. (v) Local electrostatic disturbances produce surface "leaks" in similar, but unspecific, fashion.

According to this concept, specific molecular interactions at the surface serve merely to unlock less specific and dynamically more potent transport and transmission mechanisms.

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Effects of Ribonucleic Acid on Mouse Ascites Cells

Intramuscular injection of Nelson's mouse ascites cells resulted in the formation of solid tumors with frequency of 96 percent in 146 Swiss mice. When these cells were incubated with RNA from calf liver, tumors developed in less than 10 percent of 154 mice. Electron microscopy and vital staining revealed no apparent difference between cells of the RNA-treated and untreated series. Both series were capable of incorporating *dl*-leucine-1-C^{14} into protein, although the liver-RNA treated cells were less active than the control. However, the fraction of TCA protein that cross-reacted with antiserum against bovine serum albumin was 3 to 7 times more radioactive in the experimental series than in the control. It appears that TCA protein synthesis of the liver-RNA incubated cells diminishes while their ability for synthesizing specific protein increases.

Commercial yeast RNA was also used as control for the incorporation studies. The pattern of the incorporation was almost the same as that in the untreated ascites cells.

Ascites tumor cells treated with RNA from solid tumors developed tumors with frequency of 71 percent in 24 mice. This finding helps rule out the possibility that the inhibitory activity of liver RNA is associated with contaminating substances introduced during the isolation procedure. When trypsinized kidney cells treated with tumor RNA were injected intramuscularly into the thigh, solid tumors developed at the site of injection in three of five mice. This was repeated three times, and four tumors appeared in 15 mice injected.

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Sensory and Motivating Properties of Taste Stimuli

The sense of taste may be studied from two points of view. One emphasizes the processes involved in receptor stimulation and the resulting activity in the sensory nerves and central nervous system. The other pertains to the behaviorial consequences of such receptor-neural activity. In particular, taste stimuli motivate strong unlearned preference or aversion reactions in animals and humans. The present report brings together data from both points of view.

The physiological properties of the sense of taste were studied in a variety of animals by recording the electrical activity in the chorda tympani nerve from the tongue and in the medullary and thalamic sensory relays for taste. Both at the peripheral and subcortical levels, physiological activity is a rising function of stimulus intensity. Such measures were then correlated with results of studies utilizing preference and other behavior methods. When adequate account is taken of the role of post-ingestion factors, the behavioral response to certain positive stimuli, like sucrose, is directly related to the strength of the sensory discharge. A similar relation holds in the case of aversive stimuli. But in still other instances, behavior may be a duplex function of the intensity of the sensory input —that is, the stimulus is attractive at low, but aversive at higher, intensities.

These phenomona will be discussed in relation to the general problem of the motivating effects of sensory stimulation in the control of behavior.

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Two Fundamental Errors Widely Held in Fusion Research

Two commonly made assumptions lead to the belief that a sufficiently strong magnetic field may be impressed upon a container made of ordinary materials which cannot withstand more than a few thousand degrees centigrade and that the field will allow the container to hold a plasma gas at a temperature high enough for a thermonuclear reaction, more than 10^8 degrees, to take place and yield its energy for a useful purpose.

One error [L. Spitzer, Jr., *Physics of Fully Ionized Gases* (Interscience, New York, 1956), p. 20, approximation 1.] comes from neglecting the convective change of momentum, $s\bar{v}\cdot\nabla\bar{v}$ in the total change of momentum of the gas,

$$s\frac{d\bar{v}}{dt} = s\frac{\delta\bar{v}}{\delta t} + s\bar{v}\cdot\nabla\bar{v}$$

The other error [L. Spitzer, Jr., *op. cit.*, p. 83 (5-34 and 5-35); p. 21 (2-12). The velocity $\bar{v}$ in question is not that of a Lorentz gas.] comes from underestimating the force exerted by the electrons upon the ions as they move through the latter. This force leaves the moment of momentum of the ions practically unchanged during their motion. At the same time its negative forces the electrons to move radially with the ions. Thus the magnetic field has little effect on the rate of the loss of ionization to the walls.

The way to utilize nuclear energy is by means of the ionic centrifuge [J. Slepian, *Science* **129**, 1289 (1959)] with the cylinder at the same voltage as the central arc and the end plates at a very high positive potential.

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Fixation of Nitrogen by Cell-Free Extracts from Microorganisms

Various methods have been applied to several types of organisms in past attempts to obtain cell-free extracts capable of fixing nitrogen. The experiments yielded some positive results, but fixation has been limited and inconsistent. Carnahan *et al.* [*Biochim. et Biophys. Acta* **38**, 188 (1960)] reported that cells of *Clostridium pasteurianum* dried at 40° to 50°C yield a soluble preparation capable of consistent and readily measurable nitrogen fixation in the presence of pyruvate. We have confirmed their results and have successfully extended the same method to *Rhodospirillum rubrum*. Fresh cells of several species of blue-green algae have also given active cell-free preparations after disruption by sonic oscillation. In a representative experiment with a preparation from *C. pasteurianum* exposed to N_2^{15} for 0.5 to 4 hours, the total nitrogen carried 0.72 to 1.58 atom percent N^{15} excess. Preparations from *R. rubrum* incubated with N_2^{15} for 2 hours had 0.54 to 3.08 atom percent N^{15} excess in their total nitrogen. Cell-free extracts from fresh cells of the blue-green algae *Mastigocladus laminosus* accumulated from 0.017 to 0.247 atom percent N^{15} excess in 90 minutes. A preparation from *C. pasteurianum* yielded ammonia with 52 atom percent N^{15} excess after 3 hours; this high level of N^{15} in the ammonia recovered supports the ammonia hypothesis of nitrogen fixation. Although a few positive results have been observed with preparations from two other nonphotosynthetic anaerobic nitrogen-fixers, *Aerobacter aerogenes* and *Bacillus polymyxa*, these preparations to date have been less satisfactory than those obtained with the *Clostridium* and the photosynthetic organisms.

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Factors Causing a High Frequency of Mice Having the XO Sex-Chromosome Constitution

Earlier work at this laboratory demonstrated that XO mice are fertile females. Incidence of primary XO ranges from 0.4 to 0.8 percent in various stocks. XO animals were postulated to arise either from nondisjunction of the sex-chromosomes in gametogenesis or from events occurring after fertilization. Because there seemed some evidence in support of the second hypothesis (for example, nonrandom distribution of primary XO's among litters and sibships), an experiment was undertaken to test whether the frequency of XO could be increased by irradiation shortly after fertilization. Sex-linked markers were used so that each XO animal could be recognized and the X identified as matroclinous or patroclinous.

The frequency of XO among animals given 100 r within a few hours after fertilization (pronuclear stage) was 9 percent. This is significantly higher than earlier spontaneous incidences and, moreover, includes the first cases of patroclinous XO observed in the mouse. The results indicate that XO's can originate after fertilization. At present, however, some doubt remains whether the high incidence in the experimental group is due to irradiation, since the frequency of XO in the small control group of this experiment is

also unusually high. If radiation is not the cause, the most likely alternative is genetic interaction, that is, the particular combination of stocks used (each parent strain by itself yields the usual low spontaneous incidence). Here too, however, the high incidence of XO would be due to some event connected with, or following, fertilization.

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Shortening of the Life Span by Ionizing Radiation: Possible Relation to Accelerated Aging

The life span is reduced by whole-body irradiation in rodents, the extent of life-shortening varying in relation to the amount of radiation absorbed, the linear energy transfer of the radiation, and the dose rate. The reduction in longevity is not attributable to any one cause of death but is correlated with premature onset of neoplastic and non-neoplastic diseases otherwise associated with senescence. Not all age-dependent changes are similarly affected, however, the incidence and severity of various diseases differing with the radiation dose. Hence, irradiation does not simply advance the onset of senescence, unless it is inferred that the aging of different organs is advanced to different degrees. Although certain effects of radiation resemble those of natural aging, further study will be required to disclose whether these outward resemblances imply common biologic mechanisms. Certain delayed somatic radiation effects have been noted in man, but radiation-induced shortening of the life span comparable to that observed in animals has yet to be documented in human populations.

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Crustal Structure in the United States from a Study of Gravity and Seismic Data

One result of the IGY seismic program was the verification of the fact that the composition of the earth's crust is far from uniform and that in some areas it may be almost entirely of basic rock composition and in other areas of granitic rock composition. These, however, constitute exceptions and in general the crust has a layered structure defined by variations in velocity in the range 5.4 to 7.6 km/sec corresponding on the basis of available data to density values in the range 2.65 to 3.1 gm/cm^3. A study of the relation of crustal seismic data to Bouguer and isostatic anomaly values suggests that in general positive isostatic anomalies are related to a high density, thick crust rather than a lack of isostatic equilibrium and an abnormally thin crust. In the case of negative isostatic anomalies a general case can not be established because of the large gravity contribution of surficial deficiencies in mass associated with sedimentary basins. Because compaction and cementation factors as well as the type of sediment in deep basins is usually not well known, a reliable correction for the geologic factor in such areas can seldom be made. The common association of negative anomaly values with areas of granitic rocks, however, suggests that these rock extend to considerable depth and that the mean crustal density is less than that for a crust of normal composition having the same Bouguer gravity anomaly. The departures from what might be regarded as normal crustal values are less for negative isostatic anomaly areas than would be theoretically predicted, but that for positive isostatic anomaly areas is about that to be expected theoretically. Using these empirical relations and a combination of Bouguer and regional isostatic anomaly maps, one can predict with a reliability of about 10 percent variations in crustal thickness. This has been done for the United States and a contour map for the elevation of the Mohorovičić discontinuity below sea level has been prepared.

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High Effectiveness of Fast Neutrons in Inducing Minute Deletions

A 1500-rad dose of neutrons derived from U^{235} fission, delivered in 1 hour to mature *Drosophila* sperm 1 to 2 days before their ejaculation, was found to induce recessive sex-linked lethals at approximately the same frequency (10 to 11 percent) as 4000 r of "acutely" delivered x- or Co^{60} gamma-radiation applied to spermatozoa of the same stage or to late oöcytes. This result confirms our earlier work, setting the neutron RBE (relative biological effectiveness) at approximately 2.5 for such lethals. In our present work minute deletions of several types were also detectable. Significantly more of them were found to be induced by the given neutron than by the x-ray or gamma exposure, the RBE for the deletions being of the order 3.5 to 5. Similar 4000 r x-ray or gamma exposure of oögonia resulted, as in our earlier work, in a frequency of lethals only a seventh to a fifth as high as from the irradiated spermatozoa or oöcytes, while the frequency of minute deletions appeared even more reduced. A similar result for deletions was obtained from spermatogonia irradiated with 4000 r x- or gamma-radiation in genetic set-ups that protected affected spermatogonia from the otherwise lethal hypoploidy caused by such deletions. Again, the 1500-rad neutron treatment of gonial stages resulted in frequencies of deletions distinctly higher than after 4000 r x- or gamma-irradiation. The higher effectiveness of the more crowded ionizations resulting from neutron exposure in inducing the two nearby breaks required for minute deletions demonstrates the shortness of the path from site of ionization to resultant break.

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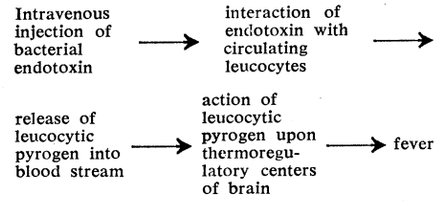
Studies on Experimental Fever with Particular Reference to the Pathogenetic Role and Chemical Properties of Leucocytic Pyrogen

When fever is produced experimentally in rabbits by the intravenous injection of bacterial endotoxin, the injected endotoxin causes a prompt leucopenia and is rapidly cleared from the blood stream. In its place there appears an endogenous pyrogen which acts directly upon the thermoregulatory centers of the brain. The biological properties of the endogenous factor are different from those of the injected endotoxin but are indistinguishable from the properties of the pyrogen in normal polymorphonuclear leucocytes. Since the incubation of leucocytes with endotoxin in vitro not only inactivates the endotoxin but also causes the release of leucocytic pyrogen into the surrounding medium, and since the endotoxin, when injected in the usual pyrogenic dose, acts indirectly, rather than directly, upon the thermoregulatory centers, it is assumed that endotoxin fever is produced by the following mechanism:



An endogenous pyrogen, similar to if not identical with leucocytic pyrogen, has also been demonstrated in blood of rabbits with fever produced by: (i) tuberculin hypersensitivity; (ii) intravenous injection of influenzal virus, and (iii) active bacterial infection.

Because of the central role which leucocytic pyrogen appears to play in each of these forms of experimental fever, attention has been turned to the isolation and chemical characterization of the leucocytic factor. Its pyrogenicity has been shown to depend upon an essential protein moiety.

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