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Does Solar Variation Control Weather?

Charles G. Abbot, ***Smithsonian Institution***

The author claims the discovery of a family of periodicities in solar variation comprising more than 20 members, all aliquot parts of 22¾ yr. These, he claims, control weather as concerns monthly and seasonal march. Meteorologists doubt the adequacy of the author's proof and say that, even if real, these solar variations are too small in percentage to produce important weather effects. The author shows that the family of periodicities *exists in weather*. It makes no difference how discovered, or whether solar variation is accredited or not. Forecasts of weather thereby, up to 50 yr in advance, give high coefficients of correlation.

Amino Acids in Fossils

Philip H. Abelson
Carnegie Institution of Washington

Amino acids have been discovered in association with a variety of invertebrate and vertebrate fossils. An Ordovician trilobite Calymene (approximately 360 million yr old) contained amino acids, three of which have been isolated and identified as alanine, glutamic acid, and valine. These three compounds were also found in a fossil vertebra of the Jurassic dinosaur Stegosaurus. Eight other invertebrate and four vertebrate fossils also contained identifiable amino acids.

Particular attention was devoted to $CaCO_3$ fossils. Recent shells of clams, oysters, and tropical snails had 0.1 to 0.2 percent protein made up of most of the common amino acids. Older shells had an amino acid content of 0.1 percent and less. The less stable amino acids, such as tyrosine, were notably diminished or absent in the more ancient remains.

The fossil observations have been correlated with laboratory studies of the temperature stability of amino acids. Experiments conducted at 200°–260° C on aqueous solutions and on amino acids contained in the proteins of clam shells have led to additional knowledge of the thermal stability of amino acids. Half of the alanine present in a dilute solution disappeared in 4 hr at 250° C in a process involving a first-order reaction. From this type of observation, it was estimated that, in storage at room temperature, half of any original alanine could remain after 2 billion yr.

These findings have significance for paleontology and geology.

Effects of Electroconvulsive Shock on Mating Behavior in Male Rats

Frank A. Beach, Allen Goldstein, and George Jacoby
Yale University

Male rats were observed in a series of seven standardized mating tests, during which their responses to receptive females were recorded quantitatively. Each male then received 12 daily shock treatments, which induced pronounced convulsions. Mating tests were conducted after the fourth, eighth, and twelfth shocks, and testing continued for 28 days after the final shock. Some of the measures of sexual activity changed during the period of treatment and then returned to preshock levels following recovery. A number of other behavioral indices revealed lasting increase in the capacity for mating performance.

Self-Focusing Solar Ion Stream Theory of the Aurora

W. H. Bennett and E. O. Hulburt
Naval Research Laboratory

It is assumed that the sun emits a jet of an electrically neutral mixture of fast electrons and positive ions, and that the space between the sun and earth is filled with an ionized, electrically neutral gas whose density may be as small as 1 charged particle per 10^5 cm^3 everywhere except near the sun and near planetary bodies. As the jet rises through the sun's atmosphere, the fast electrons are scattered out of the jet more rapidly than the fast positive ions are, owing to collisions with the slow particles in the sun's atmosphere. The increasing excess of fast ions over fast electrons in the jet is electrically neutralized by slow electrons that remain in the space occupied by the jet, and the excess of fast ions electrically repels slow positive ions from this space. The excess of fast positive ions over fast electrons produces an electric current with which is associated a magnetic field that magnetically repels the remaining fast electrons from the jet while magnetically attracting the fast ions toward the axis of the jet. This produces a magnetically self-focused stream [W. H. Bennett, *Phys. Rev.* 45, 890 (1934)], which consists of fast ions and slow electrons and which continually purges itself of fast electrons and slow ions. Such a stream remains focused, and if correctly aimed, enters the earth's magnetic field and is diverted to auroral latitudes on the earth according to the calculations of Störmer. Meinel's observations [*Astrophys. J.* **113**, 50 (1951)] indicate that the primary solar particles in the stream are protons with speed greater than 3.10^8 cm sec^{-1} and these protons have to have a speed of the order of 10^{10} cm sec^{-1} in order to reach auroral latitudes according to Störmer's calculations. It is suggested that the auroral rays are not the solar proton stream but are formed when the protons are stopped in the upper atmosphere.

Basic Physico-Chemical Changes in Yolk and Embryo During the Course of Embryonic Development

Joseph Hall Bodine, ***State University of Iowa***

A quantitative study has been made of the basic chemical composition and changes taking place in the yolk and embryo during the course of embryonic development. The cleidoic egg of the grasshopper has been employed as experimental material, since no organic connections between yolk and embryo seem to exist. Changes in sul-

fydryl, phosphates, and various enzyme systems have been investigated. It now appears that the yolk may be looked upon almost solely as a catabolic system and the developing embryo as an anabolic one. Basic differences in the two systems are found in most phases of their psysicochemical changes throughout development.

The Morphology of Ionospheric Storms

H. G. Booker, *Cornell University*

An ionospheric storm is primarily a disturbance of the F region of the ionosphere, although near the auroral zones there is also disturbance in the E and/or D regions, resulting in attenuation of HF radio waves. Except in low latitudes, an ionospheric storm involves a marked decrease in the maximum electron-density of the F_2 region and a marked increase in the virtual height of the F_2 region. Whether there is any decrease in the total number of electrons in the entire F_2 region is, however, uncertain. There is one day during an ionospheric storm (the "zero day") on which, particularly in the forenoon, the maximum electron-density in the F_2 region is decreased most markedly (perhaps to half of the normal value). After the zero day, there is a slow recovery extending over several days. As one moves from high to temperate latitudes, phenomena become less complex, and one often finds that the storm has affected the maximum electron-density of the F_2 region for 1 or 2 days prior to zero day. This effect consists of a moderate increase in the maximum electron-density of the layer. In temperate latitudes, therefore, there is often a "positive phase" to the storm in which the maximum electron-density of the F_2 region is increased somewhat followed by the main "negative phase," in which the maximum electron-density of the F_2 region is reduced. As the equator is approached, the negative phase decreases in importance and the positive phase increases. At the magnetic equator, there is only a positive phase, which, however, occurs on roughly the days of negative phase at high latitudes.

In high latitudes, there is a close relationship between the occurrence of ionospheric storms and the occurrence of magnetic and auroral disturbances. Ionospheric storms are most frequent and more intense at sunspot maximum than they are at sunspot minimum. Ionospheric storms are more frequent and more intense at the equinoxes than they are at the solstices; in winter, ionospheric storms are comparatively rare.

Diurnal variation is apparent in the manifestations of ionospheric storms. In particular, F-region echoes obtained on an ionospheric sounder at night during ionospheric storms are quite blurred and have a high fading rate, whereas during the daytime they are more like those from a quiet ionosphere. Oblique incidence transmission at night during an ionospheric storm also shows a high fading with distortion of modulation owing to multipath transmission, but the amplitude of the fading as a fraction of the main signal is considerably reduced. These phenomena indicate a reduction in the scale of irregularities of ionization in the F region at night during ionospheric storms.

There is evidence that ionospheric storms, like auroras, spread equatorward from the auroral zones. The frequency and intensity of ionospheric storms decrease from the auroral zones to the magnetic equator. On a few occasions, the blurred echoes on an ionospheric recorder have been observed to behave in such a way as to suggest that the portion of the F region containing storm-type irregularities of ionization was spreading equatorward over the observing stations. Appleton and Piggott [E. V. Appleton and W. R. Piggott, *J. Terrestrial Magnetism and Atm. Elec.* 2, 236 (1952)] think that many ionospheric storms are unipolar in that they spread equatorward from the auroral zone in one hemisphere without simultaneously doing so in the other hemisphere. Comparatively little is known about the behavior of ionospheric storms on the poleward sides of the auroral zones.

No comprehensive theory of magnetic storms has yet been formulated, although certain relevant suggestions have been made by D. F. Martyn [D. F. Martyn, *Nature* 167, 92 (1951)].

The Ratio of the Diameters of Hydrogen and Oxygen Molecules, Using Negative Pressure as an Indicator

Lyman J. Briggs, *National Bureau of Standards*

Measurement of the diameters of oxygen and hydrogen molecules by various investigators and methods [Dushman, *Scientific Foundations of Vacuum Technique* (1949), p. 43] lead to the following oxygen/hydrogen ratios: viscosity, 1.32 and 1.19; van der Waals constant, 1.06; density, 0.90; electron collision, 1.54. The method employed in the present work is based on the measurement of the minimum electric charge that, when suddenly applied to an electrode in a column of electrolyte under negative pressure, will cause the column to drop [L. J. Briggs, *J. Chem. Phys.* 21, 779 (1953)].

The apparatus consists of a vertical glass tube (approximately 1 cm bore and 100 cm long) carrying at its closed upper end two opposed spherical platinum electrodes, approximately 1 and 2 mm in diameter. The lower end of the tube is bent upward in the form of a J, to which is attached a cylindrical reservoir. After introduction of sufficient electrolyte ($1N$ H_2SO_4) to more than fill the long tube, the system is evacuated and sealed off.

On rotation of the long tube to a vertical position, the column of liquid remains hanging from the top of the tube, under a negative pressure (at the top) equal to the length of the column down to the level of the meniscus, less the vapor pressure in the reservoir. The minimum charge required to drop the column may now be measured with a mica capacitor (adjustable in steps of 0.001 μf), which is first charged to a known potential and then connected to the electrodes. Hydrogen is deposited as an incomplete monomolecular film [L. J. Briggs, *loc. cit.*] when the smaller test electrode is the cathode; oxygen, when it is the anode.

After the critical anodic charge was divided by 2, since oxygen is bivalent, six series of measurements gave 0.985 ± 0.015 as the ratio of the number of O_2 to H_2 molecules required to drop the column. The reciprocal gives the relative areas covered, and its square root gives the relative diameters, $O_2/H_2 = 1.008 \pm 0.004$.

An Accessory Chromosomal Element Associated with Variegated Pericarp in Maize

R. A. Brink and P. C. Barclay
University of Wisconsin

The unstable *P*VV allele, conditioning medium variegated pericarp in maize, is explainable in terms of a compound mendelizing unit that consists of the stable *P*RR gene (red pericarp and cob) and an accessory element called Modulator which suppresses the pigment-producing action of *P*RR. Medium variegated mutates frequently to

two complementary phenotypes, red and light variegated, which often appear as easily recognizable twin spots on the ear. The reds are stable. The light variegated mutants segregate lights and mediums, as is expected if they carry an unchanged P^{VV} allele and also are hemizygous for Modulator transposed to some locus other than *P*. Twins were postulated to arise in a differential mitosis in which (*a*) one daughter chromatid at the *P* locus becomes P^{RR} and the other remains P^{VV} and (*b*) the transposed Modulator gained by the light variegated is the Modulator lost in the red co-twin in the change from P^{VV} to P^{RR}. Tests show that plants grown from the red kernels of a twin spot lack Modulator, in accordance with this hypothesis. A third variegated phenotype, termed very light, which arose as a mutation from light variegated, was found to carry two transposed Modulators in different positions. Increasing dosages of Modulator reduce the frequency of mutations of variegated to red exponentially. Modulator is similar to McClintock's Activator (*Ac*) in that both "activate" Dissociation (*Ds*), an element which she has described as extragenic and promoting chromosome breakage and instability when present at other loci.

Extracellular Metabolic Products of *Escherichia coli* during Rapid Growth

Roy Britten, ***Carnegie Institution of Washington***

The metabolic products released into the culture fluid by rapidly growing cells of *Escherichia coli* have been studied. Using a synthetic medium containing C^{14}-labeled glucose as a principal carbon source, it has been possible to distinguish between the C^{14}-labeled compounds synthesized by the cells and the C^{12} compounds added as supplements.

In the absence of supplements, a complex pattern of metabolic products, including amino acids, was found. No individual compounds (with the exception of carbon dioxide and acetate) predominated, showing a close balance between the rates of synthesis and the requirements of the cell for growth.

When C^{12}-glutamate was added to the medium, it was used by the cells for protein synthesis. The cell, however, continued to form glutamate from glucose, and large quantities of C^{14}-labeled glutamate then appeared in the culture fluid. A similar situation was found using aspartate, glycine, alanine, and valine as supplements.

However, when C^{12}-proline was added to the medium, it was also used for protein synthesis; but its presence suppressed the synthesis of proline, and no C^{14}-proline could be found in the medium. Arginine, serine, methionine, and threonine gave similar results.

In some cases, more complicated effects occur, including the release of related metabolic products which are also C^{14}-labeled. These immediate responses of the cell to the presence of supplements give definite evidence for the biosynthesis of certain suspected intermediates and indicate striking differences in the physical chemistry of different reactions carried on by the cell. These observations supply some new clues to the factors that control the synthetic rates in the intact cell.

Transition Phenomena in Cosmic Radiation

Robert B. Brode, ***University of California, Berkeley***

The transition effects due to gamma rays, electrons, and mu mesons have been studied for the sea-level cosmic radiation as it passes through various thicknesses of carbon, aluminum, copper, cadmium, and lead. A sharp maximum in the number of narrow pairs due to gamma rays is observed at about one radiation length of the absorbing material. Showers due to gamma rays indicate a maximum in their frequency at about three radiation lengths of the absorber. The transition effect for incident charged particles is due to either electrons or mu mesons. The phenomena for these two types of incident particles have been separated. The electron contribution appears to be appreciably less important than the photon component but gives maxima for pairs and showers similar to the photon-produced curves. The knock-on electrons due to mu mesons are responsible for apparent pairs of particles. The low atomic number materials are more effective sources of knock-on electrons because of their higher critical energy and longer radiation lengths. No evidence was found for the second maximum in the Rossi transition curve reported by Bothe.

This work was assisted by the joint program of the U.S. Office of Naval Research and the U.S. Atomic Energy Commission.

On Planetary Cores

K. E. Bullen, ***California Institute of Technology***

Evidence for the solidity (in an appropriate sense) of the earth's inner core will be reviewed. The evidence includes consideration of compressibilities at pressures of the order of 10^6 atm as indicated by seismological data and interpolation between theoretical results for Thomas-Fermi-Dirac gases and Bridgman's experimental data at 10^5 atm. The prospects of proving the solidity by direct observation of seismic S waves in the inner core will be discussed. It will be concluded that there are good reasons to believe that the rigidity of the inner core lies between 1.5×10^{12} and 3.6×10^{12} dyne/cm^2.

The question of the composition of the whole central core of the earth will be discussed, especially the hypothesis that the outer part of the core may consist of modified silicate rock rather than nickel-iron. Relevant observational data on the masses and diameters of Mars, Venus, and Mercury and on the oblateness of Mars will be discussed. A firm conclusion will be drawn to the effect that each of these planets contains a proportion by mass of uncombined nickel-iron at least equal to the proportion by mass of the earth's inner core to the whole earth.

The Parenteral Utilization of Peptides in Tissue Protein Synthesis

Paul R. Cannon, Laurence E. Frazier, and Randolph H. Hughes

University of Chicago

Protein synthesis is commonly assumed to result from the intracellular utilization of amino acids. It is also believed by some that the process is rapid and that, so far as the essential amino acids are concerned, all are utilized practically simultaneously at the anabolic site. Whether peptides can be similarly utilized is uncertain. Aside from its theoretical interest there is a practical aspect in relation to the use of protein hydrolyzates in parenteral nutrition. These preparations vary considerably in peptide content, and there is evidence that peptides introduced into the blood stream may be largely excreted through the kidneys. It is not known, however, whether all peptides are nonutilizable under such circumstances.

We have studied this problem in the following way. Protein-depleted adult male rats were subjected to pro-

tein repletion by daily subcutaneous injections of a mixture of 16 amino acids in solution while they were being fed a "nonprotein" ration adequate in roughage, calories, vitamins, and salts. On such a regime the animals synthesized tissue protein and regained weight. However, when a single essential amino acid was omitted from the solution, weight loss quickly ensued. It was possible to substitute a synthetic peptide quantitatively for the appropriate essential amino acid in the solution without loss of nutritive potentiality. Six synthetic peptides were used: glycyl-L-Tryptophan, glycyl-L-Leucine, glycyl-DL-Phenylalanine, DL-Alanyl-DL-Phenylalanine, DL-Alanyl-DL-Methionine, and Leucyl-glycylglycine.

We conclude, therefore, that at least some simple peptides can be utilized parenterally in tissue protein synthesis.

A Miocene Swamp-Cypress Forest

Ralph W. Chaney, ***University of California, Berkeley***
and Daniel I. Axelrod,
University of California, Los Angeles

At many localities on the Columbia Plateau, forests of later Tertiary age have left a record of their leaves, fruits, pollens, and stems in volcanic ash interbedded with basaltic flows. The Mascall flora from the John Day Basin of Oregon has long been studied, but a sound interpretation of its relationships and environment has been delayed by the mistaken identification of its dominant conifers. Earlier referred to as *Sequoia* and considered to represent the ancestor of the living Coast redwood of California, these foliage and cone impressions have recently been found to represent two trees now growing on the *eastern* sides of the northern continents, *Taxodium*, of the southeastern United States, and *Metasequoia*, of central China. Living members of both these genera have a deciduous habit, in contrast to the evergreen *Sequoia*.

With our attention turned toward these regions characterized by summer-wet and winter-cold climate, we have found that a majority of the Mascall species are closely related to trees now living in and near the swamp-cypress forests of the Mississippi Basin; oaks, hickory, maple, and sweet-gum show marked resemblance to living species that are associates of *Taxodium distichum* in swampy lowlands. There is probably no other Tertiary flora in North America that has survived with so little change. The only major difference has been the disappearance from this continent of several members of this Miocene flora, of which *Metasequoia* is typical, which are now confined to Asia.

Utilization of Internal Sulfur Reservoirs by *Escherichia coli*

Dean B. Cowie, Richard B. Roberts, and Ellis T. Bolton
Carnegie Institution of Washington

The sulfur of *Escherichia coli* is distributed among three chemically distinct fractions of the cell: 25 to 30 percent of this sulfur is found in glutathione and can be extracted with cold trichloracetic acid; 10 to 15 percent is found in a protein fraction that is soluble in acidified alcohol; the remainder of the sulfur is bound in acid alcohol-insoluble proteins. When the cells grow with adequate sulfur present, there is a direct correlation between total sulfur uptake and protein synthesis; the protein-bound sulfur is stable, and no loss or exchange is observed.

When the cells are placed in a sulfur-free medium, growth continues at the optimal rate for a short period, during which the sulfur of glutathione is converted to protein. When the glutathione is depleted, the exponential growth rate abruptly drops by a factor of 10. During this period of slow growth, the alcohol-soluble protein is depleted of sulfur and carbon. Similar results are obtained even though methionine is present in the medium. When adequate sulfur is supplied to the depleted cells, growth resumes immediately at the optimal rate, the reservoirs are rapidly replenished, and the content and distribution of sulfur become normal.

It is concluded that these cells can respond to sulfur deficiency by transferring sulfur and carbon from glutathione and the alcohol-soluble protein fractions to the alcohol-insoluble proteins.

The Infra-red Rotation Spectrum of Methyl Alcohol

David M. Dennison, ***University of Michigan***

A theory of hindered rotation as it occurs in methyl alcohol was developed by Koehler and Dennison [*Phys. Rev.* 57, 1006 (1940)] using a simplified model. The energy levels were given as functions of the molecular dimensions and of the height of the hindering potential. The predicted rotation spectrum was so complex that no progress could be made in identifying the lines of the equally complex observed spectrum. A break in the stalemate occurred when Hershberger and Turkevich discovered a series of related lines in the microwave spectrum of methanol. These lines were subsequently measured with great accuracy by Coles and others, and the transitions involved could be identified uniquely [for references see R. H. Hughes, *et al., Phys. Rev.* 84, 418 (1951)]. An improved theory served to explain most of the features of the microwave spectrum, to fix the low-lying energy levels, and to evaluate the molecular constants.

Knowing the molecular constants, it is now possible to calculate the higher rotation levels. Account has been taken of the effects of centrifugal distortion, which, while small, become significant for the states of rapid rotation. A comparison between the predicted and observed spectra has been made. The agreement is very satisfactory in the region from 16 to 30 μ, where the lines are relatively well separated. At wavelengths exceeding 30 μ, the lines fall so close together and the absorption is so intense that the correlation is less unambiguous.

Improvements in the Technique of Low-Angle X-ray Diffraction for the Study of Biological Materials

J. W. M. DuMond and Dwight Berreman
California Institute of Technology
and Burton Henke, ***Pomona College***

In the study of such biological objects as collagen, keratin, and hemoglobin virus, where the interesting structures may range in size from a few tens to a few thousands of angstroms so that the optical microscope has insufficient resolving power, the electron microscope is the tool that one naturally resorts to. Unfortunately, the electron microscope requires placing the sample in vacuum and, therefore, may profoundly modify it by desiccation. The use of x-rays to replace electrons circumvents this difficulty. To date, however, no very satisfactory technique of x-ray microscopy with results comparable to electron

microscopy has been developed, although work on this is being actively pursued. Another solution, however, is to study these biological objects by means of low-angle x-ray diffraction, a technique which admittedly has the disadvantage that it does not reveal the structures of individual particles or units but gives information regarding statistical average properties of a less direct nature. This information may, nevertheless, be of the greatest value and quite inaccessible in any other way.

At the California Institute of Technology, a program of work toward the improvement of the technique of low-angle x-ray diffraction supported by the Office of Naval Research has been under way for some years and has led to the development of several forms of a new instrument, the point-focusing x-ray monochromator, each of which is briefly described in this paper. The work has concentrated upon two x-ray wavelength domains: 1.4 angstrom units $CuK\alpha_1$ radiation and the much softer domain 13.3 (Cu-L radiation) to 31.6 angstroms (N-K radiation). Some diffraction patterns are shown, and proposed further improvements are discussed.

The Efficiency of Photosynthesis during Transient and Steady-Rate Conditions

Robert Emerson and Ruth V. Chalmers

University of Illinois

Efficiencies of photosynthesis approaching 100 percent have been reported by Warburg, Burk, and coworkers. They measured photosynthesis by observing gas exchange during periods of frequent changes in illumination. This implies certain assumptions regarding the equality of behavior of duplicate samples of cells. We have made experiments to test these assumptions and find that the technique they describe does not assure the required equality of behavior. Rates of photosynthesis measured by their technique are, therefore, of doubtful significance.

We have also tested a modification of their technique and can show that this provides for fulfillment of the required assumptions. Our measurements with this modified technique lead to somewhat lower efficiencies than the highest reported by Warburg and coworkers.

Our measurements also show that the selection of different time intervals for calculation of photosynthesis can lead to a wide range of efficiencies. Highest efficiencies can be calculated from certain periods of transient changes in rate, and periods of steady rate lead to much lower efficiencies. Moreover, during transient rates, the fluctuations in oxygen and carbon dioxide exchange suggest that at least part of the gas exchange may represent changes in metabolic intermediates rather than the production of carbohydrate and oxygen from carbon dioxide and water. Since the energy changes accompanying the formation and disappearance of intermediates are unknown, the calculation of energy efficiency from transient rates of gas exchange seems to be of but little significance.

Physics and Physiology of Neutron Capture Therapy

Lee E. Farr, James S. Robertson, and E. E. Stickley

Brookhaven National Laboratory

Neutron capture therapy is a procedure designed to achieve a strongly localized radiation treatment by inducing energetic heavy particles within the disease site. The technical feasibility of the procedure was shown in experimental trial on 10 patients with the malignant brain tumor, glioblastoma multiforme. Borax, with boron of mass number 10, injected intravenously was used as the capture element vehicle. Tumor dose was calculated from measurement of thermal neutron flux density, published nuclear data, and evaluation of selective kinetics of borax in the tumor. Physically, the radiation is limited by the range of the energized particles (alpha, lithium, or fission). Direct effects of slow neutrons are not significant in comparison with radiation mediated by the capture reaction. Dosimetry of thermal neutrons in tissue was based on studies of radioactivity induced in gold foils distributed in patients treated and throughout tissue equivalent phantoms exposed to the treatment neutron flux. Physiologically, the concept of selective kinetics has been developed at Brookhaven in contrast to previously suggested approaches utilizing preferential uptake as exemplified by dyes. The kinetics of distribution of elements through body water are characteristic of the tissue involved. When sufficient differences in rates of distribution occur, advantage can be taken of precise knowledge of the time of maximum concentration in the tissue to be destroyed. Thus a larger amount of target element is available for the neutron capture reaction than can be achieved at final equilibrium with any presently known substance.

This research was supported by the Atomic Energy Commission.

Geographic Basis for Antarctic Scientific Observation

L. M. Gould, ***Carleton College***

An examination of the list of titles on this symposium automatically emphasizes the urgency of including Antarctic observations during the International Geophysical Year. All deal with phenomena that are world-wide in their manifestations. There is not a field of study that will not receive definitive results from Antarctic observations and some, such as the Aurora Australis, are uniquely dependent upon observations not otherwise obtainable.

Antarctica has unique geographic aspects which emphasize the preceding statements. It is the only polar continent; furthermore its mass is roughly circumpolar in its distribution. It is the only "insular" continent. All other continental landmasses are actually connected with land bridges or separated at most by shallow seas. Antarctica is completely surrounded by oceanic waters of wide extent. Antarctica has an average altitude of a mile above sea level—higher than that of any other continent. It is the only continent completely covered by an icecap or continental glacier.

Electrification of Mist and Drizzle

Ross Gunn, ***United States Weather Bureau***

A theoretical and experimental investigation of the electric charging of moving drops by ionic diffusion has been completed. In an environment containing both positive and negative ions, but neglecting space charge, expressions have been obtained for the rate of diffusion of ions onto a moving sphere and for the equilibrium free charge thereby established. This free charge is proportional to the logarithm of the ratio of the positive- and negative-ion conductivities and to a factor depending on the size and velocity of the sphere relative to its ionized environment. The derived relationships have been verified by laboratory measurements.

In the lower atmosphere, the positive-ion conductivity nearly always exceeds the negative conductivity; hence, droplets falling through such an atmosphere should acquire a free positive charge. F. J. Scrase [*Electricity on Rain*, Met. Office Geophysical Mem. **75** (1938)] has measured the free electric charge transported to the earth throughout a 2-yr interval and found that 93 percent of the precipitated mist and drizzle carried positive charges. By employing droplet diameters characteristic of mist and drizzle, it is found that the derived relationships closely predict Scrase's measured free charge per gram of water, namely, 0.46 esu/g.

It is concluded that ionic diffusion to droplets falling through the free atmosphere plays an important role in precipitation electricity. By assuming that such processes systematically clear out from the atmosphere ions of a selected sign and, thereby, leave excessive numbers of oppositely charged ions to be swept onto droplets that fall later, one may quantitatively describe the observed charges brought down by all types of rain.

In Vitro Analysis of a Diffusible Agent of Mouse Sarcomas that Promotes Nerve Growth in Chick Embryos

Viktor Hamburger, ***Washington University***

Previous experiments have shown that mouse sarcomas 37 and 180 produce a diffusible agent that promotes selectively the growth and nerve fiber production of sympathetic and spinal ganglia of chick embryos, whereas somatic motor, preganglionic, and parasympathetic neurons are refractory. These results were obtained *in vivo* by transplantation of tumor pieces intra-embryonically or onto the extra-embryonic membranes of 3-day chick embryos. The supernumerary nerve fibers emerging from the hyperplastic ganglia flooded the adjacent viscera, which normally have a very sparse innervation or none at all, in corresponding stages.

Tissue culture experiments made in this laboratory by R. Levi-Montalcini have shown that part of these phenomena can be reproduced *in vitro*. When isolated spinal or sympathetic ganglia of 8- to 12-day chick embryos are grown adjacent to fragments of mouse sarcoma, an extraordinary number of radially oriented nerve fibers emerge from the ganglia. The maximal effect is reached at 24 hr, at which time control cultures show little or no growth. The target-specificity is the same as *in vivo*; motor neurons are refractory.

Fractionation experiments of the tumor (in collaboration with Stanley Cohen), using sucrose, indicate that the active principle is concentrated in the microsome fraction. The active agent can then be precipitated completely by the streptomycin procedure for the isolation of nucleo-proteins. The agent is heat-labile and nondialyzable. Its absorption spectrum is typical of nucleo-proteins.

This research was supported by a grant from the Rockefeller Foundation and by a Research Grant (C-1801) from the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

Analysis of the Luminescent Response of the Ctenophore, Mnemiopsis, to Stimulation

E. Newton Harvey and Joseph J. Chang
Princeton University

The luminous tissue of Mnemiopsis within the radial canals responds to electrical or mechanical stimulation directly or through nerves by a flash of greenish light. Records have been taken with photomultiplier-cathode-ray oscillograph-camera recorder of the response to electrical stimulation of small bits of luminous tissue. The relationship of light emission to strength and duration of stimulus, repetitive stimuli, and fatigue at different temperatures has been particularly studied.

The response is remarkably like that of muscle. At 21° to 23° C with single square-wave stimulation and a small piece of tissue, a single flash appears having a latent period that varies considerably, a half-rise time of 35, a maximum-peak time of 60, a half-decay time of 48, and a 0.9-decay time of 114 milliseconds. Lowering the temperature prolongs the time course of single flashes, especially the decay phase. Raising the temperature has the opposite effect. Light intensity increases as strength of stimulus increases, and repetitive stimuli elicit responses similar to summation of twitches, treppe, incomplete and complete tetanus of muscle. Fatigue appears soon and is a marked characteristic of the luminescent response. Repetitive flashes after a single stimulus have been observed in large pieces of tissue. The conduction rate of a luminous excitation along the canals averages 14 cm/sec. Bursts of action potentials, simultaneous with the luminescent responses, appear.

The Joinability of Chromosome Breakage Points Produced by X-rays in *Drosophila* Oocytes

Irwin H. Herskowitz
Indiana University

Following x-irradiation of spermatozoa, gross chromosomal rearrangements resulting from unions between breakage points produced either far apart in a chromosome or in different chromosomes are abundant, but they are reported to be rare when oocytes are treated. One possible interpretation lies in experiments by Rapoport, indicating that in irradiated oocytes points of breakage can become unjoinable and stabilized (''healed'') as distal ends (''telomeres''). Because, after irradiation of spermatozoa, this happens less frequently, if ever.

In the present experiments, oocytes, containing an attached-X but no Y chromosome, were x-rayed with 1000 and 4000 r to obtain the detachments of the arms of the attached-X, which in Rapoport's view represent ''healed'' breakages. These detachments were at least 4 percent when the most mature oocytes received 4000 r, decreasing for oocytes that were younger when treated. The frequency of detachments increased approximately as the 3/2 power of the dosage, demonstrating that most, if not all, of these cases required more than a single event (break) for their production. By genetic tests, a considerable proportion was proved to consist of translocations and gross deletions. The data indicate a less random distribution of the breakage points among the autosomes partaking in translocations in the case of oocytes than is known for spermatozoa.

These observations make untenable the view that new telomeres are formed following x-ray breakage of oocyte chromosomes. They suggest that the orientation of the chromosomes during and after irradiation is a major factor influencing the numbers and kinds of joinings by points of chromosome breakage.

Intermolecular Forces between Chemically Active Molecules, for example, Nitric Oxide

Joseph O. Hirschfelder

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In collisions of free atoms, free radicals, electronically excited molecules, or conjugate double-bond molecules, there are long-range or directional forces that are interesting to contemplate. For example, when two nitric oxide molecules collide, owing to quantum mechanical resonance, there should be a strong interaction at a separation of the order of 15 A, provided that one of the molecules is in the $^2\Pi_{1/2}$ ground state and the other is in the low-lying $^2\Pi_{3/2}$ excited state. Since nitric oxide molecules have quadrupole moments, their energy of interaction must be expressed in terms of four, rather than one, potential energy curves. The probability of a particular collision following any one of these potential curves can be estimated *a priori* from statistical considerations. Because of these anomalous effects, we expect that nitric oxide should have an anomalously large cross section for thermal diffusion, which should assist in the separation of oxygen and nitrogen isotopes. Neither quantum mechanical resonance nor quadrupole-quadrupole forces should have an appreciable effect on the equation of state of the gas, but they should have a large effect on the transport properties.

Another type of force comes into play when two conjugate double-bond molecules collide. Such molecules have pi electrons that can move freely over the conjugate double-bond system. Thus, conjugate double-bond molecules behave like extended oscillators with a variety of nodes and antinodes in the electric fields surrounding them.

Further knowledge of intermolecular forces will come from quantum mechanical predictions on qualitative behavior, together with empirical studies of physical properties of materials.

Fungitoxicity of Sulfur-Bridged Compounds

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The mechanism of antifungal action of sulfur was studied further by offering sulfur-bridged compounds to germinating spores of *Monilinia fructicola*, a known sulfur-sensitive fungus. Diphenyl sulfide and β-nonylmercaptopropionic acid were active, but their sulfone analogs were not, thus suggesting that the activity depends on unfilled valencies of the sulfur atom. Among the most active compounds were N-(trichloromethylthio)-1,2,3,6-tetrahydrophthalimide, 2,4-dinitrophenylthiocyanate, benzothiazolyl-2-thioglycolic acid, and diphenyl sulfide. The striking characteristic of these compounds is that the sulfur bridge is between two electronegative groups: C=O, $-CCl_3$, $-C\equiv N$, —COOH, or benzene ring. It may be assumed that the electronegative groups tend to withdraw electrons from the sulfur, making it even more reactive. Also, bis(2-hydroxy-5-chlorophenyl) sulfide was more toxic than bis(2-aminophenyl) sulfide, which in turn was more toxic than diphenyl sulfide. It may be assumed that the *o*-hydroxyl and *o*-amino groups can act with the nearby sulfur to form metal chelates that rob the organism of needed metals.

DL-methionine is a sulfur-bridged natural compound, which, of course is not toxic. It contains, however, only a single electronegative carboxyl group, and even this is balanced by an electropositive $-NH_2$ group between the carboxyl group and the sulfur bridge.

Sometimes, poor permeation confuses the activity picture. Benzothiazolyl-2-thioglycolic acid is more toxic than the K-salt, presumably because, not being as strongly ionized, it penetrates better.

Carbohydrate Metabolism in Mammalian Placenta

A. St. G. Huggett, *St. Mary's Hospital Medical School of the University of London*

The placenta passes glucose from the maternal blood to the fetus (*1*), and in the Ungulata it also converts glucose into fructose (*1*), which in this group of mammals forms the larger part of the fetal blood sugar.

This formation of fructose occurs not only with hyperglycemic levels but also at normal blood sugar levels, as shown by the use of C^{14}-glucose (*2*). It is formed by the placenta, but not by the fetus, and at a constant rate of approximately 12 mg/min. The removal by the placental and fetal tissues of fructose is dependent on the level of circulating glucose. Increase in glucose concentration depresses the fructose utilization (*3*).

The fetal blood glucose production by the placenta depends on the level of glucose in the maternal and fetal bloods. Glucose differs from fructose in that it goes back freely to the mother. Further, the placental cells actively transport glucose in both directions; diffusion is inadequate to explain its passage, which is best explained on the carrier hypothesis of Widdas (*4*).

The carbohydrate metabolism of the placenta groups them into two main groups: those with little or no fructose in the fetal blood (*5*) and considerable glycogen in the placenta (rodents) (*6*); those with considerable fructose in the fetal blood and little glycogen in the placenta (Ungulata). The primates appear to be a special class partaking of both states, although to a small degree.

This work was supported by grants from the Medical and Agricultural Research Councils of Great Britain.

References: (1) Huggett, *et al.*, *J. Physiol.* **113**, 258 (1951); (2) Alexander, *et al.*, *J. Physiol.* **115**, 36P (1951); (3) Alexander, *et al. J. Physiol.* **118**, 58P (1952); (4) Widdas, *J. Physiol.* **118**, 23 (1952); (5) Goodwin, *Nature* **170**, 750 (1952); (6) Huggett, *J. Physiol.* **67**, 360 (1929).

Induction of Growth with Monofunctional Steroids

Charles Huggins and Elwood V. Jensen

University of Chicago

Functional groups at the C_3 or C_{17} positions of steroids are essential for the promotion of growth by these compounds. An evaluation was made of the effect of position and of the state of oxidation of side groups of both monofunctional and difunctional steroids upon biological indicators that are highly sensitive in reflecting growth. The test objects were the uterus and vagina of the hypophysectomized rat protected from contact with extraneous steroids by feeding a synthetic ration.

Although monofunctional steroids are less active than those with two side groups, a single 17β-hydroxyl group endows steroids in the androstane series with considerable growth-promoting activity. Similar C_{19} steroids with a 3β-hydroxyl group as the sole function have merely a trace of, or no, activity in a dosage as high as 3 mg daily. Monofunctional steroids with a ketone group at C_3

or C_{17} do not induce growth. Thus, in monofunctional steroids, the cyclopentanol structure of ring D has far greater activity than the cyclohexanol of ring A in promoting growth of secondary-sex structures of the rat.

Monofunctional steroids containing a phenolic group at C_3 cause marked stimulation of the uterus and vagina.

The Scientific Program of the International Geophysical Year

J. Kaplan, ***University of California, Los Angeles***

The principal subjects now included in the scientific program of the International Geophysical Year are aurora and airglow, cosmic rays, geomagnetism, glaciology, ionospheric physics, longtitude and latitude, meteorology, solar activity, oceanography, and the rocket exploration of the upper atmosphere. The close relationships among these subjects, the guiding principles of the planning for this program, and some of the most important goals of the program will be presented.

The Study of the Nonlinear Alternating Gradient Synchrotron Using a Digital Computer

D. W. Kerst and J. N. Snyder, ***University of Illinois***
and J. L. Powell, ***University of Wisconsin***

The linear theory of the alternating gradient synchrotron [Courant, Livingston, and Snyder, *Phys. Rev.* **88**, 1190 (1952)] is well developed, but an accelerator built with linear restoring forces has many dangerous orbit resonances that must be avoided by conservative design and by close tolerances. To learn whether nonlinear restoring forces can be used to avoid these resonances, the University of Illinois Digital Computer (Illiac) is being used by the Midwestern Accelerator Group. The differential equations treated are

$$x'' = nx - \frac{e}{3}x^3 + e\,x\,y^2,$$

$$y'' = -ny - \frac{e}{3}y^3 + e\,y\,x^2,$$

where n is constant but changes sign abruptly many times during one revolution of the particle about the machine; e may or may not change sign. The Illiac displays, accurately and numerically, the coupled solutions of these equations.

Photographs of the oscillographic display that was built by the computer laboratory can be taken at the rate of 15 betatron oscillations per minute. Usually, 20 Runge-Kutta points are plotted in a sector. In addition, phase diagrams and x vs. y diagrams can be plotted in a few minutes.

Of several hundred cases examined, typical examples will be shown. One of these examples, a class of motion of special interest that was pointed out by H. R. Crane, is motion locked into the machine by lens forces or by inhomogeneities. Such mathematical experimentation on a wide range of cases aids in understanding the general features of nonlinear motion, and it has proved useful in formulating analytic approaches.

Periodic Structure in the Flagella and Cell Walls of a Bacterium as Shown by Electron Microscopy

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National Institutes of Health

The peritrichous flagella of a noncapsulated motile nonspore-forming gram-negative bacterium are shown by electron microscopy to have a helical structure. Each flagellum has a diameter of about 150 A and appears to be a tightly wound counterclockwise helix of a 130-A diameter fiber. The pitch of the helix varies between 25 and 35 deg.

The cell wall of this bacterium is composed wholly or in part of a membrane that shows no regular structure on its outside surface but has a rectangular array with a periodicity in each direction of about 115 A on its inside surface. The thickness of this membrane appears to be about 75 A.

Absolute Free Energies and Entropies of Aqueous Ions

Wendell M. Latimer, ***University of California, Berkeley***

The absolute free energies are now known with considerable accuracy for combinations of all the common positive and negative ions in aqueous solutions, as for example, $Na^+ + Cl^-$, $Ca^{++} - Mg^{++}$ or $I^- - Br^-$. The assignment of absolute values to the individual ions is still highly questionable. The theoretical Born equation for the reaction, ion (gas) = ion (aqueous), $\Delta F = -Z^2/2r\,(1 - 1/K)$ has the limitation that the effective dielectric constant K and the ion radius (or ion cavity) r are not known. Latimer, Pitzer, and Slansky [*J. Chem. Phys.* **7**, 108 (1939)] proposed values for the effective "Born radii" that would make the free energies of both the positive and the negative ions fall on the theoretical curve ΔF vs. $1/r$, but there has been no substantiation of this assignment. However, it may now be shown that an assignment of absolute entropies, based upon the value $\overline{S}_{H^+} = -2.1$ eu, as determined by Eastman and students [Goodrich, *et al. J. Am. Chem. Soc.* **72**, 4411 (1950)] leads to values for the entropy of hydration ΔS that are simply related to the ΔF values given by Latimer, Pitzer, and Slansky. Since ΔS is the temperature coefficient of ΔF, such a relationship should exist if the correct absolute values have been assigned to both quantities. The relationship between ΔS and ΔF is highly sensitive to the value of $\overline{S}_{H^+}$ and limits the absolute value of the entropy of H^+ to -2.1 ± 1 entropy units.

The entropies of hydration, using the "Born radii," are a function of Z/r and not Z^2/r. This may imply that the change of the radius of the ion cavity with temperature contributes more than the change of the dielectric constant.

The Morphology of the Aurora

A. B. Meinel, ***Yerkes Observatory, University of Chicago***

As scientists throughout the world turn their attention to the oncoming International Geophysical Year activities, one of the fields of special interest is the polar aurora. The aurora is a polar phenomenon and does not yield itself to easy study. Since the aurora presents one of the most baffling of natural phenomena and is of great synoptic complexity, further progress will require combined effort.

The aurora is not a phenomenon to be associated exclusively with an unusual set of events, although large auroral storms frequently may follow violent outbursts of solar activity. Auroras may be seen as often as one out of two clear nights in the auroral belt.

Observational evidence now leads us to believe that there are two separate phases to a typical aurora. The aurora generally begins as a homogeneous arc stretching

from horizon to horizon. The second phase can set in abruptly at any time with the arc breaking up into beautiful rayed structures. The spectrograph reveals that a subtle but profound change has occurred. The bombarding solar material, easily evident during the arc stage is no longer observed.

While the main problem is to explain these and many other interesting observations, more tangible benefits result, since the aurora constitutes an inexpensive probe of the upper atmosphere. With the spectrograph, radar transmitter, and other tools, we find intimate facts about our upper atmosphere. In an age when man must seriously consider his atmosphere some 50–100 mi above the surface of the earth, this knowledge takes on practical importance.

Solar Activity and Terrestrial Disturbances

Donald H. Menzel, ***Harvard College Observatory***

Although scientists have long recognized that magnetic storms, auroras, and various types of ionospheric disturbances arise from solar activity, we cannot identify the exact regions on the sun responsible for these terrestrial effects. In some cases the "M region"—that is, the area responsible for magnetic activity—appears to be merely an active spot group. But the fact that strong magnetic disturbances may occur when the sun is completely without spots indicates that the problem is not simple.

The majority of workers agree that clouds of ions, drifting toward the earth cause the disturbances, so the problem is one of locating the solar source of these clouds. Motion-picture records show that sunspots may eject intense surges or geysers of hot, luminous gas.

Theoretical studies indicate that the ejected matter may carry intense electric currents, up to 10^{10} amp or more. The expansive forces associated with a current loop elevate the prominence material against gravity.

Some recent studies of the solar "spicules," the bubbling activity near the solar poles discovered by W. O. Roberts, indicate that these geysers, too, may be current loops. If they are, then we may expect interplanetary space to be filled with innumerable gaseous current loops, like smoke rings. Some come from active spots and others from the solar regions near the pole. The "pinch effect" caused by the current will tend to hold the loop together and keep it from dispersing into space. These rings of gas would act, in a terrestrial encounter, very much like the ion stream discussed by Chapman.

Electronic Reproduction of Wide-Range Signals

Harry F. Olson, ***Radio Corporation of America***

The storage of information in the form of reproducible electronic signals plays an important part in the fields of communication, education, business, industry, and manufacturing. For example, the electronic recording of audio signals for electronic reproduction at any convenient and subsequent time, as exemplified by the phonograph and sound motion picture, plays an important role in the dissemination of information, art, and culture. There are many different means for the storage and reproduction of information in the form of electronic signals. For example, the possibility of the magnetic storage of information has been known for more than a half-century. However, only within the last few years have theories, techniques, and materials been developed that make it possible to store relatively large amounts of information by means of the magnetic system.

In the latest magnetic tape systems, the entire audio-frequency range can be reproduced with a realizable signal-to-noise ratio of more than 70 decibels. A signal of more than 3 megacycles can be reproduced with a realizable signal-to-noise of more than 20 decibels. In the latter system, more than 15,000 cycles per linear inch of the tape have been recorded.

A storage system capable of holding a large quantity of information that can be easily reproduced at any time has applications in many fields. A few of these are recording and reproducing audio signals; recording and reproducing television signals; the coding of signals in both audio and video reproduction; the grading of examinations and storage of grades in schools; a readily accessible storage system for computers; the recording of inventories, payments, receipts, and services in business; the controlling of machines in factories.

The Radioactivity of the Ocean

Hans Pettersson, ***Scripps Institution of Oceanography***

The much debated origin of deep-sea radium was explained through teamwork by Scandinavian and Austrian research workers. Ionium produced from uranium in sea water becomes coprecipitated with iron onto the bottom, there giving rise to radium. From a near-surface maximum, where radioactive equilibrium has been attained between radium and ionium after about 10,000 yr both elements decrease downward, according to the disintegration rate of ionium. Hopes for an exact geochronology of deep-sea deposits extending over several hundred thousand years have been based on radium measurements on sediment cores by Piggot and Urry but are not supported by recent measurements made in Göteborg, which prove the vertical distribution of radium in deep-sea cores to be much less regular than would follow from theory. Approximate values for the sedimentation rate of Pacific Red clay, derived from these measurements, give values between 1 and 3 mm in 1000 yr. Alternative explanations for the irregularities in the radium curves are being put forward by V. Kröll in the "Reports of the Swedish Deep-Sea Expedition." Recently developed methods for measuring uranium and ionium in the deposits support the ionium-precipitation hypothesis, proving the high radium content in the the surface layers to be ionium-supported, whereas the much lower values farther down in the sediment are due to uranium-supported radium. Tentative conclusions from the radium distribution are drawn regarding past variations in the uranium and ionium content of ocean waters and also regarding past submarine volcanic activity in great depths.

Diurnal and Seasonal Variation of the Airglow

F. E. Roach
U.S. Naval Ordnance Test Station, Inyokern

For several decades, it has been known that there exists a faint background glow in the night sky. That the glow is of terrestrial (atmospheric) origin is established by the nature of its variation in intensity over the sky. The principal known contributors to the glow are atomic oxygen and sodium, molecular oxygen, and the radical OH. The atomic radiations have been systematically observed at Cactus Peak, California, for 5 years and some generalizations are now possible.

During the night, the intensities vary but not according to the same pattern for each color. The forbidden oxygen radiation in the green at 5577 A (transition $^1S_0 \rightarrow {}^1D_2$) usually exhibits a maximum of intensity near

the middle of the night. On the other hand, another forbidden oxygen radiation in the red at 6300 A ($^1D_2 \rightarrow {}^3P_2$) usually exhibits a maximum of intensity at the very beginning of the night, steadily decreasing in intensity until about midnight followed by a slight rise toward morning. Sodium D is rather sporadic in its nocturnal changes with a general tendency to increase in intensity during the night. Simultaneous observations at two stations separated in longitude have given evidence that the gross diurnal variations are dependent on the local time of the observer and, hence, on the interval of time since the sun has energized the upper atmosphere.

The seasonal variation of 5893 is characterized by a maximum of intensity in the winter about 5 times the minimum in the summer. The two oxygen radiations have very slight winter maxima, which are largely obscured by the sporadic changes from night to night.

During the International Geophysical Year, it is planned to set up a number of observing stations for the study of the night airglow. Among the problems of general interest are (i) the relationship, if any, between the airglow and the polar aurora, (ii) the nature of the latitude variation of the airglow intensity and its diurnal changes, (iii) the systematic study of the seasonal changes of intensity with special reference to a comparison of the Northern and Southern Hemispheres.

Control of Tree Growth by Phloem Blocks

Karl Sax, *Harvard University*

It has long been known that tree growth can be checked, and earlier fruiting induced, by girdling or killing the bark, thus preventing the flow of organic nutrients down the phloem into the root system. More recently, it has been shown that the killing of a section of the stem prevents the downward movement of organic carbohydrates and nitrogen, vitamins, auxin, and exogenous growth regulators.

A phloem block can be induced without killing a section of the stem by inverting a ring of bark or by irradiating a stem segment with x-rays. In both cases, the phloem block is induced by the suppression of cell division, which prevents the renewal of phloem elements. In the case of the irradiation block, nuclear division is suppressed without killing the tissue. The reversed polarity of the phloem cells in the inverted bark prevents the renewal of sieve tubes by checking the flow of nutrients and auxins necessary for all division.

The bark inversion technique can be modified to produce varying degrees of dwarfing of fruit and ornamental trees.

The Glass Electrode in Water-Methanol Solutions

Theodore Shedlovsky, *Rockefeller Institute for Medical Research*

The familiar electrochemical cell (A),

Hg, HgCl | KCl(H_2O) || solution X | glass | HCl | AgCl, Ag,
saturated

is used for determining the *p*H of aqueous solutions X. The emf of this cell depends on the potential difference between the glass and the solution X and also on the corresponding change in the liquid junction potential as X is altered, both of these factors being included in the measured *p*H and in its scale.

To establish the *p*H scale for solutions in solvents consisting of water and methyl alcohol mixtures, measurements are made in cell (B), which is similar to cell (A) except for the fact that the saturated KCl is in the same solvent mixture as in the solution X. Moreover, the *p*K (ionization constant) values are determined from conductance measurements on the buffer acids in these solvents. Also, the behavior of the glass membranes as hydrogen-ion electrodes in these solutions is established by direct comparison with platinum-hydrogen electrodes.

The magnitude of the errors introduced in the determination of "*p*H" with cell (A) for solutions containing methyl alcohol can be estimated by comparing the emf values with corresponding ones in cell (B).

Problems of Gene Structure: III. Relationship of Unequal Crossing-Over to the Interdependence of R^r Elements (S) and (P)

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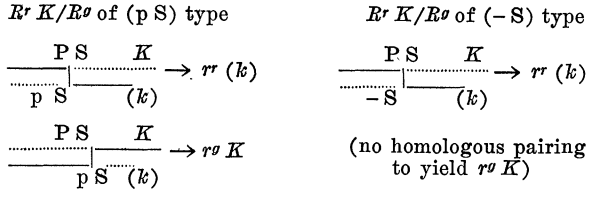
University of Missouri

The apparent lowering of the mutation rate of (S) by the mutation of (P), observed in certain R^r/R^g cultures (see paper I, this series) may be explainable by unequal crossing-over within the R complex (paper II), if the following assumptions are valid.

1) That mutant R^g's showing this effect are of constitution (−S) rather than (p S).

2) That, while two types of crossover mutants should be expected in progenies from compounds of R^r with R^g mutants of (p S) constitution, one of these should be rare or absent in progenies from similar compounds with R^g mutants of (−S) constitution, because of the pairing relationships indicated below:



3) That the r^r mutants in R^r/R^g (−S) progenies are due in large proportion to unequal crossing-over rather than to gene mutation.

Preliminary data on the compound $R^r K/R^g$–14 support this possibility. In a test of about 30,000 ♀ gametes, it yielded 12 r^r mutants (6 noncrossovers, $r^r K$) and 6 crossovers ($r^r k$), and 1 r^g mutant, a noncrossover ($r^g k$). The ♀ transmission ratio for chromosomes with and without K was approximately 75 : 25.

The proportion of crossovers among the r^r mutants, adjusted for the transmission advantage of chromosomes bearing K, is 75 percent. There were no $r^g K$ crossovers, although with equal frequency of occurrence of the two crossover types, 75 percent of the crossovers detected should be of this type.

Since the crossover type missing in the R^r/R^g–14 progenies occurs as expected in R^r/R^r progenies, the results indicate that R^g–14 is deficient for element (P).

Transfer of Antibody-Forming Capacity in Splenic Materials

William H. Taliaferro and Lucy Graves Taliaferro
University of Chicago

Donor rabbits have been immunized by the intravenous

route at 1- to 3-day intervals for 42 days with boiled sheep red cell stromata and spleens removed at various stages during the process of immunization, minced and injected intravenously into (*a*) normal and (*b*) x-irradiated recipient rabbits. So far, appreciable degrees of lysogenesis, as indicated by a rise in antibody (measured photometrically in 50-percent hemolytic units) in the recipients, have been found only when antibody was rising to peak titer in the donor animal (4th to 8th day). Little, if any, antibody-forming capacity was present in the donors during the induction period (0 to 3rd day) or after peak titer (9th to 42nd day). The rise in the recipients was not due to antigen, because it occurred equally well in x-rayed recipients. The antibody rise was not due to passive transfer of serum antibody, because (i) the rise did not occur immediately and (ii) there was insufficient antibody in the spleen mince to account for it. No intracellular antibody could be demonstrated by distilled water lysis of the splenic cells. It was probably due to the transfer of cells that had acquired the capacity to form antibodies. The repeatedly injected donor rabbits after peak titer have been found to be in a refractory phase, during which continued antigenic stimulation incites no increased antibody formation. It is noteworthy that, during this stage, the splenic cells did not possess the lysogenic capacity. So far, lysogenic capacity has been found only in the spleen.

The Transformation of Cortisone into Corticosterone

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Recently, Mattox (*1*) observed that derivatives of both pregnane-17α,21-diol-20-one and of Δ^{16}-pregnene-21-ol-20-one are transformed by methanolic hydrogen chloride into systems bearing a glyoxal 21,21-dimethyl acetal side chain; thus, cortisone acetate was found to give Δ^{4}-pregnene-3,11,20-trione-21-al dimethyl acetal.

In the present investigation, application of the Mattox conditions to hydrocortisone acetate was found to bring about the same rearrangement of the side chain without involving the 11β-hydroxyl group. The retention of the latter group is in contrast with earlier observations (*2*) that 11β-hydroxysteroids are readily dehydrated to the corresponding $\Delta^{9,11}$-anhydro compounds. Like hydrocortisone acetate, the anhydro derivative, $\Delta^{4,9(11)}$-pregnadiene-17α,21-diol-3,20-dione 21 acetate, also undergoes the side-chain rearrangement without involving other functional groups.

Reduction of either Δ^{4}-pregnene-11β-ol-3,20-dione-21-al dimethyl acetal or Δ^{4}-pregnene-3,11,20-trione-21-al dimethyl acetal with lithium aluminum hydride gave a mixture of epimeric triols in which the predominant configurations of the pertinent hydroxyl groups are probably 3β, 11β, and 20β. The triol mixture was converted by manganese dioxide in benzene into Δ^{4}-pregnene-11β,20β-diol-3-one-21-al dimethyl acetal. Hydrolysis of the latter under carefully controlled conditions gave a poorly defined product in which the aldehyde carbonyl group was largely masked (infrared study), suggesting polymeric forms (*3*). On treatment of the hydrolysis product with pyridine, rearrangement of the glyoxal side chain occurred with the formation of corticosterone, Δ^{4}-pregnene-11β,21-diol-3,20-dione. A better yield of corticosterone was obtained by treatment of the hydrolysis product with sodium bisulfite followed by reaction of the isolated sodium bisulfite addition product with sodium methoxide in methanol.

References: (*1*) V. R. Mattox, *J. Am. Chem. Soc.* 74, 4340 (1952); (*2*) C. W. Shoppee and T. Reichstein, *Helv. Chim. Acta* 26, 1316 (1943); R. P. Graber, A. C. Haven, Jr., and N. L. Wendler, *J. Am. Chem Soc.* 75, 4722 (1953); (*3*) W. Schindler, H. Frey, and T. Reichstein, *Helv. Chim. Acta* 24, 360 (1941).

Fractionation of Silicates and Metal in the Planets and Meteorites

Harold C. Urey, ***University of Chicago***

The variation in densities of the terrestrial planets and the existence of two groups of meteorites having different ratios of silicate to metal and different total iron contents indicate that chemical fractionation of the iron from the other "nonvolatile" constituents occurred during the formation of the solar system. Previously it was suggested that this occurred by evaporation of silicates. An alternative process of loss of silicates by splashing of silicates during collisions will be presented. This process is suggested by the structures of chondritic meteorites and the processes that occurred on the moon during the formation of its surface.

A brief presentation of possible sources of the high temperatures will be given. These processes include a temporary high luminosity of the sun, heating of asteroidal-type objects in protoplanets due to adiabatic compression of gases, and possible processes during the formation of the solar nebulae. Of these, the second appears most probable. In such processes, little separation of the more volatile from the less volatile elements of the "nonvolatile" fraction of cosmic matter has occurred.

An Application of High-Speed Computing to Fermat's Last Theorem

H. S. Vandiver, ***University of Texas***
and D. H. Lehmer and Emma Lehmer
University of California, Berkeley

The statement of Fermat (known as Fermat's Last Theorem), which dates from 1672, that

$$x^n + y^n = z^n, \; n > 2, \qquad (1)$$

has no nonzero solutions in integers still awaits a proof or disproof. It is known that for a proof it is sufficient to consider the case of $n = l$, an odd prime.

By means of criteria devised by E. E. Kummer (1850 and 1857) and by H. S. Vandiver (1929 and 1934), it was possible to examine Eq. (1) for each exponent $n = l$, and the necessary tests were carried out by Kummer, Vandiver, and some collaborators of the latter for all $l < 619$. At this point, the calculations became prohibitively long and laborious for desk calculator work.

It is the object of this paper to show how the program has been carried out for all primes < 2000 in a few hours using the high-speed calculating machine of the National Bureau of Standards known as the SWAC at the Institute for Numerical Analysis in Los Angeles, as coded by D. H. and Emma Lehmer. As a result of this work, we are able to state that Fermat's Last Theorem is true for all exponents < 2000, or in effect, Eq. (1) is impossible in nonzero integers for all exponents $n < 2001$.

The results obtained also have many applications to the theory of algebraic fields defined by roots of unity.

Vitamin A and Skin Keratinization *in Vitro*: Experimental Dissociation of Induction and Realization Phases in Cytodifferentiation

Paul Weiss and Ruth James
University of Chicago

Experiments were undertaken to disengage the dual functions of cellular environment in cytodifferentiation: (i) activation ("induction") of a given course and (ii) continuous support for its realization. Fell and Mellanby (1953) noted that embryonic chick skin explanted to normal plasma keratinizes but, in the presence of excess vitamin A, produces mucoid cells instead. In our experiments, the vitamin treatment was made to precede actual culturing. Earlier, we had found that cells of 6- to 8-day embryo skin dissociated by trypsin, reaggregated, and cultured in normal plasma produce typical squamous keratinizing epidermis. In the present series, the dissociated cells were suspended for 30 to 60 min in a solution of vitamin A in alcohol; controls were in alcohol alone. Both lots were then treated alike: washed repeatedly and cultured in normal plasma, with transfers every second day.

The control (alcohol-treated) cultures developed typical squamous layering, followed by keratinization and desquamation at 12 to 13 days total age. Contrastingly, cells passed through vitamin A formed cuboid to columnar epithelia, with no (or abortive) keratin formation during the same period. Full mucoid metaplasia has not yet been obtained, presumably because of insufficient survival times. However, the mere fact that transient exposure to vitamin A for half an hour alters morphological and physiological cell behavior for at least 5 days of subsequent growth in normal medium points to the "inducing" rather than "supporting" role of that agent in this instance. This seems to furnish a pertinent model for mechanisms involved in cell transformation (differentiation and metaplasia).

This work was aided by the Abbott Fund (University of Chicago) and the American Cancer Society (Committee on Growth NRC).

Transport Problems in the Atmosphere

H. Wexler, *U.S. Weather Bureau*

Three-dimensional transport of various meteorological properties, such as mass, momentum, heat, and water vapor, is examined. Atmospheric flow patterns associated with the major modes of transport are discussed. Deficiencies in knowledge, both of the distribution of the meteorological properties and the intensity and mechanism of their transport, are pointed out.

Evidence for Winds in the Outer Atmosphere

Fred L. Whipple, *Harvard College Observatory*

Clear evidence for horizontal winds generally exceeding those near the earth's surface is now available continuously to an altitude through the E-region. Much stronger winds have been detected in the F-regions of the ionosphere. The 12-hr solar tide clearly appears in the averaged E-region winds. Some progress is being made in establishing the general circulation patterns in the high atmosphere as a function of season and latitude.

The older observational techniques involving balloons and visual observations of persistent meteor trains, noctilucent clouds, and night-sky radiations have been augmented by a number of complex and precise techniques involving rockets, radio, radar, photoelectricity, and photography. The applications of these new techniques during the Geophysical Year should go far in establishing the world-wide circulation patterns in the high atmosphere. We may expect to increase vastly our understanding of the relationships among the motor sources for atmospheric motions, the ozone layer, the ionospheric layers, solar phenomena, terrestrial magnetism, and other of the many interrelated phenomena in the high atmosphere. Perhaps these observations will give us some clue to a dynamic coupling between the upper and the lower atmosphere, involving meteorology.

Particularly needed are techniques for measuring vertical motions at high levels in the atmosphere, to explain the thorough mixing now recognized to heights above the E-region.

Action of Alkali on *D*-Fructose

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In an attempt to interpret in part the nature of the alkaline defecation process in cane sugar-house work, an aqueous solution 0.2*M* in *D*-fructose and 0.2*M* in aconitic acid was adjusted to *p*H 7.8 with potassium hydroxide and heated for 24 hr at 100° C; final *p*H 6.15. Excess *D*-fructose was removed by yeast fermentation from the deionized solution, and the sirup obtained on solvent removal was chromatagraphed on clay with 90 percent ethanol as developer. A crystalline mixture of *D,L*-sorbose + *D*-sorbose was isolated from the effluent, identification being made primarily by conversion to the alditols *D,L*-glucitol, *L*-glucitol, *D,L*-iditol, and *D*-iditol, identified as their crystalline hexa-acetates separated by fractional crystallization. The main zone from the clay column was further chromatographed on paper sheets (1-butanol, ethanol and water as developer) and a crystalline mixture was isolated which was separated and identified as *D,L*-allose + *D*-(or *L*) allose. Reduction of the crude zone material yielded galactitol (dulcitol) and allitol, identified as their crystalline hexa-acetates. These data are interpretable on the basis of interconversion through enediol intermediates accompanied by reverse aldolization followed by triose fragmentation recombination.

A Biochemical and Pharmacological Suggestion about Certain Mental Disorders

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Recent findings in animals made in this laboratory and elsewhere have revealed that certain mental processes probably are mediated through the action of the hormone serotonin. This tentative conclusion is based on studies of a variety of antiserotonins. Thus, the ergot alkaloids, the harmala alkaloids, and yohimbine function in smooth-muscle preparations as antimetabolites of serotonin. These natural drugs are structurally related, each in a different way, to serotonin. Similarly, several synthetic analogs of the hormone have been prepared and likewise shown to act as antimetabolites of it. Among each of these classes of compounds are substances that cause mental aberrations. Thus, the ergot alkaloid derivative lysergic acid diethylamide, harmaline, yohimbine, and the synthetic antimetabolite called medmain are such representatives. The demonstrated ability of such agents to antagonize the action of serotonin in smooth muscle and the finding of

serotonin in the brain suggest that the mental changes caused by the drugs are the result of a serotonin-deficiency which they induce in the brain. If this be true, then the naturally occurring mental disorders—for example, schizophrenia—which are mimicked by these drugs, may be pictured as being the result of a cerebral serotonin deficiency arising from a metabolic failure rather than from drug action. Possibly, therefore, these natural mental disorders could be treated with serotonin.

Those professionally qualified for clinical experimentation are urged to apply these biochemical and pharmacological findings. Experiments in animals revealed that serotonin injected peripherally fails to penetrate the blood-brain barrier. Consequently, it is suggested that a serotonin-like compound which will penetrate to the desired site may be required.

News and Notes

Radio Astronomy Conference

A 3-day conference on radio astronomy, jointly sponsored by the National Science Foundation, the Carnegie Institution of Washington, and the California Institute of Technology, was held in Washington, January 4–6, 1954. The organizing committee of the conference consisted of Jesse L. Greenstein, chairman, Bart J. Bok, J. B. Wiesner, Merle A. Tuve, and John P. Hagen, secretary. A special fund was provided by the National Science Foundation for the conference. The conference was called to bring together some 75 astronomers, physicists, and electronic engineers to discuss the current status of research in this country and abroad, the nature of the problems in radio astronomy, and profitable directions for future work in this relatively new field, which has become a promising new method of attacking astronomical problems.

The group was welcomed by Lee DuBridge, of the California Institute of Technology, Paul A. Scherer, of the Carnegie Institution of Washington, and Raymond J. Seegar, of the National Science Foundation. Dr. Seegar, noting the international character of the gathering, called attention to the presence of distinguished visitors from other countries: H. Alfven, from Sweden; L. Owren, from Norway; B. Y. Mills and E. G. Bowen, from Australia; R. Hanbury-Brown, C. G. Little, F. Graham Smith, and F. Hoyle, from England; A. E. Covington, from Canada; H. C. van de Hulst, from the Netherlands; A. P. Mitra, from India. United States participants included representatives of leading universities, industrial and government laboratories.

Discrete sources of radio radiation of both galactic and extragalactic origin

B. Y. Mills presented the work of the Radio Physics Laboratory on the spectra, shapes and sizes of the stronger radio point sources. The intensity was shown to follow a law, $I = \lambda^n$, where $n = 1.7$ for three sources Cygnus A, Virgo A, and Centaurus, and $n = 0.7$ for Taurus. When the work at the longest wavelength, 16 m, was included, n was scattered with a grouping around $n = 1$ and $n = 2$. Interferometric measurement of the size and shape were made using two instruments with base lines at right angles to each other. The shapes were roughly oval with an angular size of 5′ to 10′. *R. Hanbury-Brown* continued the discussion with a description of the work at Manchester. Observation of those sources within the field of view of the 218-ft parabola (focal length 126 ft, $\lambda = 1.9$ m, which is a band on the celestial sphere bounded by the two latitude circles $+40°$ and $+70°$), shows that the intense sources seem to lie near the galactic plane. Among the sources seen in this strip are Cygnus X and one at the position of Tycho Brahe's supernova. A new type interferometer capable of operating at extremely long base lines and depending for its operation upon the correlation between the low-frequency components in the envelope of the signal was described. This instrument was used to measure the angular diameter of Cassiopeia and Cygnus A. Cassiopeia had a diameter of about 5′ of arc. Cygnus A, however, appeared asymmetrical. The simplest model fitting the observations consists of two objects 50″ × 30″ separated by 1′28″. Five of the discrete sources seen have been associated with extragalactic nebulae. In each case, the radio flux agrees with the light flux. Variations in the background radiation have been associated with aggregates of nebulae and with irregularities in their distribution.

C. G. Little, of Jodrell Bank, described the work on the measurement of ionospheric winds through the motion of meteor trails. He also pointed out that measurement of the winds through scintillation of radio stars has revealed that the ionospheric irregularities are about 4 km in size and have a predominantly westerly motion in the evening and easterly in the morning. *F. G. Smith* then discussed some of the work now in progress at Cambridge and described the new interferometer system consisting of four aerial systems, each 18,000 ft² in area, placed at the corners of a rectangle 1800 by 180 ft. With this system, a new source IC443 has been identified. Observation of the occultation of the Taurus source by the solar corona reveals that the radio waves are scattered by inhomogeneities in the corona out to 15 solar radii, indicating that the outer corona is more extensive and dense than thought previously. *F. T. Haddock,* of the Naval Research Laboratory, reported on the new measurements with the 50-ft radiotelescope at wavelength 9.4 cm. Radiation from several of the radio sources has now been measured at this short wavelength, thus extending the short-wave limit of the radio spectrum of the sources. Radiation from the Orion Nebula and other emission nebulae was measured for the first time.