National Academy of Sciences

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Amino Acids Formed in "Primitive Atmospheres"

Simulating atmospheric conditions that might have been present early in the history of the earth, amino acids such as alanine, β-alanine, glycine, and sarcosine have been synthesized employing a variety of compositions. Combinations of gases, including CO_2—N_2—H_2—H_2O, CO—N_2—H_2—H_2O, CO_2—NH_3—H_2—H_2O, were subjected to electric discharges, and in each case amino acids were formed. The earlier work of S. Miller [*J. Am. Chem. Soc.* **77**, 2351 (1955)] employing CH_4—NH_3—H_2O has been confirmed.

PHILIP H. ABELSON
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Progress in Solving the Problem of Acute Respiratory Disease

From time immemorial, the human race has been plagued with a great mass of acute respiratory illnesses. Scientific progress toward alleviation of these illnesses began with recognition and classification of the various respiratory diseases according to their clinical signs and symptoms, their pathology, and the nature of their epidemiological occurrence. At this stage of progress, epidemiological observations occasionally indicated methods of control which were generally limited to environmental changes such as isolation and quarantine.

Gradually over the years, specific fungi, bacteria, and viruses were found to be the cause of some of the respiratory illnesses. Whenever such an etiologic agent was discovered, laboratory methods of diagnosis permitted a more precise definition of the clinical, pathological, and epidemiological characteristics of the illness and enabled its reclassification as an etiologic disease entity. As methods are discovered which permit ready laboratory cultivation of such agents, the door is opened for development of specific measures for preventing or treating the disease.

This discussion summarizes the progress of science in studies of acute respiratory illness with particular emphasis on recent developments. It briefs the discovery of a new group of respiratory-tract viruses, the nature of disease produced by these viruses, and the development of vaccines for preventing these diseases.

JOSEPH A. BELL
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High-Pressure Silicates

Recent advances in high-pressure instrumentation at this laboratory and other laboratories have made it possible for geologists to extend their phase equilibrium studies to a pressure of 70,000 atm at high temperature. Hitherto, our information about the nature of materials existing in the earth at great depths has come primarily from seismology. We now, however, have techniques with which to investigate in the laboratory the stability of common minerals up to a pressure corresponding to a depth of more than 100 miles.

Experiments have shown that silicates with open, network structures, such as quartz, the feldspars, and the feldspathoids, are unstable at conditions of temperature and pressure believed to be present below the earth's crust. Under such conditions these minerals, which form the major part of the rocks of the earth's crust, invert or break down to high-pressure phases. New high-pressure phases have been discovered in these investigations.

Transitions to high-pressure phases may be sharp, as is the case with the simple transition quartz $\leftrightarrows$ coesite. In chemically more complex systems, transitions can take place over a range in temperature and pressure; this is the case with the breakdown of the feldspathoid nepheline. Seismic discontinuities at the base of the earth's crust and in the upper part of the earth's mantle may possibly be explained as due to similar phase transitions.

F. R. BOYD
Carnegie Institution of Washington

Effect of the Osmotic Strength of the Growth Medium on the Amino Acid Pool of Escherichia coli

When *Escherichia coli* cells are supplied with an amino acid, it is first taken up into a "pool" and then incorporated into the protein macromolecules. The mechanisms of pool formation and maintenance are being studied in order to understand their relationship to the process of protein synthesis.

Escherichia coli cells grown in a standard salts-glucose medium, supplemented with proline, form a pool proportional to the external amino acid concentration. The internal or pool concentration is 500 times the external proline concentration until the latter reaches 5 μg/ml. Above this concentration the pool maintains a constant saturation level. This saturation level is roughly proportional to the osmotic strength of the medium.

When cells that have formed a proline pool in the standard medium are rapidly washed with the standard medium or with solutions of glucose, sucrose, glycine, or NaCl of the same osmotic strength, the pool is unaffected. Washing with solutions of lower osmotic strength removes part of the pool proline, and a water wash completely removes the pool proline. Recovery from such an osmotic shock is very rapid. Rapidly water-washed cells reform a pool within 1 to 2 minutes when they are resuspended in standard medium supplemented with proline.

These osmotic effects cannot be interpreted in terms of any of the simple models that have yet been considered, and it appears that an investigation of the internal structures of the cell will be necessary for their interpretation.

ROY J. BRITTEN
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Survival of Enucleate Cytoplasm of Human Cells in Tissue Culture

Instrumentation necessary to permit micromanipulation and cinemicrography of human cells in tissue culture has been developed and is described. Essentially, the system is characterized by internal temperature regulation and recording in a chamber mounted on the stage of an inverted microscope and sealed with an oil "coverslip" through which a microtool can be passed for micromanipulation. The problems characteristic for cultivation of human cells in this system have been met successfully. These include control of injury by light, reduced dependence on bicarbonate buffers in the nutrient medium, and provisions for control of temperature without interference with micromanipulative techniques. The latter have been refined to deal with the size and character of human cells in culture.

Human carcinoma cells, strain HeLa, have been observed for several days in this system without apparent deviation from the state of parallel cultures maintained under more standard conditions. Division of cells has been performed for isolation of enucleate cytoplasm. Continuing dynamic activity of enucleate cytoplasm has been observed for periods up to 40 hours at varying temperature levels. Vital manifestations in the independent cytoplasm indicate that selected cells are capable of sealing after micrurgy, that cell boundaries remain actively amoeboid, that enucleate cytoplasm can migrate, and that cytoplasmic organelles retain normal morphologic and dynamic features. These signs of "survival" terminate abruptly when the enucleate cytoplasm undergoes shrinkage and becomes immobile. The time-temperature relationships of "survival" of enucleate cytoplasm suggest that resources for some normal activities of cytoplasm are intrinsic to the cytoplasm and independent of the nucleus for appreciable periods. The state of the culture at the time of micrurgy is evidently important and is discussed. Time-lapse motion picture records are available.

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Reaction of Cell Fractions of the Thymus Gland to Enzymatic Digestion and Changes in Osmotic Pressure

Tissue homogenates of the calf thymus gland prepared in 0.25*M* sucrose plus 0.0018*M* $CaCl_2$ have been shown to contain a certain contamination of intact thymocytes, the extent of which seems to vary from preparation to preparation. Separation of these thymocytes (which appear almost identical to isolated nuclei) from the nuclear fraction of the homogenate by means of differential centrifugation has so far been entirely unsatisfactory. A source of error of unknown magnitude therefore exists in determinations of nuclear enzymatic activity from such preparations.

During a search for a quick and accurate method to determine the degree of such contamination, preparations of thymus homogenate were subjected to enzymatic digestion by trypsin, chymotrypsin, and desoxyribonuclease. Photomicrographs of samples taken during digestion show partial digestion of the nuclei, but some of the formed objects are resistant to such digestion and are presumed to be intact thymocytes.

These resistant thymocytes were subsequently treated with hypotonic (0.001*M*) $CaCl_2$ and showed the previously described swelling and rupture with extrusion of the nucleus. Work on adapting this test to quantitative determinations is continuing.

Joshua R. C. Brown
University of Maryland

Discriminatory Temperature Indication in the Electron Transport System

In investigations of the effect of temperature on the phosphorylative activities of mitochondria prepared from rat liver, it is found that temperature changes from 25° to 45° cause slight decreases in phosphorylation efficiency and an increase in the "respiratory control"—the ratio of the respiratory rates in the active state (with added phosphate acceptor) and the quiescent state (without added phosphate acceptor)—to a maximum at 39°C and a decrease above this value. The steady-state oxidation-reduction levels of the respiratory enzymes have been studied by sensitive spectrophotometric methods and are found to change in a characteristic manner upon the transition from the quiescent to the active state. The nature of these changes is now found to be temperature sensitive in a particularly interesting fashion.

In the case of the flavoprotein component of the respiratory chain, oxidized flavoprotein is formed in this transition at 25°C. The amount oxidized falls as the temperature increases from 25°C, becomes zero in the region of 37°C, and at temperatures above this region reduced flavoprotein is formed in the transition (up to 45°C). Thus in the respiratory chain we find DPNH to be oxidized, flavoprotein to be reduced, and cytochrome *b* to be oxidized in the quiescent-active transition at the higher temperatures. On the basis of our current views of the mechanism of oxidative phosphorylation, flavoprotein would be eliminated as a possible site of phosphorylation, and the remaining three sites identified by these methods are DPNH, cytochrome *b*, and cytochrome *c*.

This extraordinary behavior of flavoprotein in this transition as a function of temperature simulates a discriminatory temperature indicator; it gives not only the magnitude but also the sign of the temperature deviation from 37°.

Britton Chance,
Herrick Baltscheffsky
Eldridge Reeves Johnson Foundation

Crystal Structure of Meyerhofferite

Meyerhofferite ($2CaO.3B_2O_3.7H_2O$) is triclinic $P\bar{1}$, $a = 6.63$, $b = 8.35$, $c = 6.46$ A (all ± 0.015 A), $\alpha = 90°46'$, $\beta = 101°59'$, $\gamma = 86°55'$ (all ± 05'); Z = 1 [$2CaO.3B_2O_3.7H_2O$], density (calc.) = 2.125, density (obs.) = 2.120. The structure was determined from electron-density projections normal to the three crystallographic axes, calculated using phases determined by the direct statistical method of Hauptman and Karle.

The crystal contains polyions consisting of two $BO_2(OH)_2$ tetrahedra and a $BO_2(OH)$ triangle, linked to form a ring of composition $[B_3O_3(OH)_5]^{-2}$. The average B - O distance in the tetrahedra is 1.49 A and in the triangle, 1.38 A. Each Ca^{++} is coordinated by six oxygens and one H_2O at an average distance of 2.40 A. The structural formula for meyerhofferite is $CaB_3O_3(OH)_5.H_2O$. The isolated groups in meyerhofferite are the same elements that condense to form the infinite chains of colemanite:

$$n[B_3O_3(OH)_5]^{-2} = [B_3O_4(OH)_3]_n^{-2n} + nH_2O$$

Reliability factors for the initial structure are: h01, 0.19; hk0, 0.19; 0k1, 0.21. At the present stage of refinement the atomic parameters are as follows.

Atom	*x*	*y*	*z*
Ca	0.010	0.377	0.243
O_1	0.407	0.734	0.327
O_2	0.422	0.889	0.651
O_3	0.115	0.776	0.502
O_4	0.339	0.461	0.211
O_5	0.058	0.642	0.145
O_6	0.165	0.374	0.615
O_7 (H_2O)	0.132	0.104	0.211
O_8	0.145	0.126	0.797
O_9	0.334	0.673	0.955
B_1	0.318	0.792	0.497
B_2	0.308	0.642	0.183
B_3	0.030	0.278	0.633

C. L. Christ, Joan R. Clark
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Some Experiments with Fractionation by Partial Dialysis

Dialysis through cellophane has long been used as a convenient method for separating dialyzable solutes from nondialyzable ones. Recent studies on the rates of passage of various solutes through this material have now shown that simple dialysis can have a much wider application in biochemistry than has been heretofore realized.

For a given membrane, the rate of escape of an ideal solute in solution on one side of the membrane to a solution of essentially zero concentration on the other is analogous to first-order reaction kinetics. A plot of the logarithm of the decrease in concentration against time should give, and with a pure solute has been found to give, a straight line. With an unknown preparation the degree of adherence to a straight line can be of value in studying homogeneity with respect to size and shape (and perhaps charge).

Comparison of the rates of escape of different-sized solutes in different membranes has shown that a much higher selectivity in separating them can be achieved than if the process was based on simple diffusion alone. This leads to a useful separation tool based mainly on molecular size. An easy way of deriving approximate molecular sizes with unknowns by comparison of rates with those of similar known solutes is also indicated.

Lyman C. Craig, Te Piao King
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Evidence of Evolutionary Forces Leading to the Spread of Lethal Genes in Wild Populations of Mice

Mutant alleles at one locus, most of them lethal to embryos, are widespread in populations of wild house mice (*Mus musculus*) in the United States. The distribution and inheritance of 16 such alleles is described. In all cases males carrying such alleles transmit them to 90 to 99 percent of their offspring. It is mainly this altered transmission ratio which accounts for the high frequency of such alleles, even when their spread is opposed by complete selection against homozygotes. In addition, animals heterozygous for either of the two alleles of which special studies have been made are favored by natural selection. The effects of the transmission ratio and selection on equilibrium in wild populations are discussed.

L. C. Dunn
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Studies on Polysaccharide Formation by a Rumen Bacterium

The rumen bacterial population is unique and diverse, and despite "species" differences it is adjusted to the production of similar or identical end-products useful to the host animal or its flora.

A sheep rumen bacterium has been shown to produce an internal polysaccharide (ISS) of the amylopectin type from numerous carbon compounds. Conditions governing the formation and utilization have been studied. ISS is a polymer composed solely of glucose and is hydrolyzed by amylase preparations. The bacterium utilizes ISS only when it is within the living cell but cannot do so when it is external to the cell. ISS is identical to that produced by the mixed rumen flora. The significance of such reactions to the evolution of the ruminant flora is considered.

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Low-Temperature Studies of Reduced Hemoproteins

The visual spectroscopic observations of Keilin and Hartree [*Nature* **164**, 254 (1949)] on the influence of low temperatures on the spectral characteristics of reduced hemoproteins has prompted the development of a technique whereby spectrophotometric recordings can be obtained of samples of hemoproteins cooled to the temperature of liquid air. The method has been applied to the study of both soluble and particle-bound cytochromes.

The main advantages of the technique are the the sharpening and intensification of the α and β absorption bands of the reduced pigments. The resulting spectra have shown that there is a threefold increase in the number of α and β absorption bands of reduced heart-muscle cytochrome *c* at low temperatures. Previously unrecognized differences in the location and number of absorption bands of reduced purified cytochrome *c* from yeast, photosynthetic bacteria, and heart muscle have been determined.

Of principal importance is the application of the technique to the resolution of the absorption bands of reduced cytochromes b, c_1, and c in heart-muscle particles, liver mitochondria, fly sarcosomes, and yeast. At liquid-air temperatures the main α absorption bands of reduced cytochromes b, c_1, and c are located at 560, 554, and 549 mμ, respectively. Since the low-temperature technique is the only method of determining the relative concentrations of cytochromes c and c_1, it has served as a foundation for experimentation designed to determine the role of cytochrome c_1 in biological oxidations.

One of the more interesting facets of the low-temperature studies is the application of the technique to an investigation of the formation of cytochromes b, c_1, and c during adaptation of anaerobically grown baker's yeast to aerobiosis. The transition from a double α band structure of cytochrome b_1 to the three-banded structure of cytochromes b, c_1, and c has been clearly shown to be correlated to the ability of the adapting yeast to utilize oxygen.

Ronald W. Estabrook
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Ion Transport in Plants

The absorption of ions by plant cells is the most widespread instance of active ion transport in the biological realm. In land plants, the roots are the tissue directly exposed to a medium containing inorganic nutrient—and other—ions, and the absorption of ions by the roots of higher plants has long been intensively studied. Since higher plants furnish most of the food of beast and man, they are also our own main source of needed minerals.

Active ion transport in roots is by carriers. The carriers operate across membranes not permeable to free ions. At the outer surface of the membrane, the ions are attached at specific sites of the carriers, the complex so formed traverses the membrane, and the ions are then released in a rate-limiting, largely irreversible step to "inner" spaces. Once transported into the "inner" spaces of the cells, the ions are no longer subject to ready loss by diffusion or exchange.

Since active transport seems to result in a largely irreversible trapping of the absorbed ions in the "inner" spaces of the cells of the root, the question arises how the ions can pass through the tissue and on to the shoot. Recent evidence strongly suggests that passage through the tissue is not, in fact, by way of the metabolic carrier mechanism but bypasses it. About 23 percent of the volume of barley roots and similar percentages of the roots of other species are freely and reversibly accessible to inorganic ions by diffusion and ion exchange. This volume—the "outer" space of the tissue—appears to be the pathway of the ions through the root tissue to the shoot.

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Effect of Oxygen on the Stability of Geologically Important Iron Silicates

The stability fields of silicate are usually defined in terms of temperature T and hydrostatic pressure p. A large number of geologically important silicates contain iron as a major constituent, either as Fe^{+2} replacing Mg^{+2}, or as Fe^{+3} replacing Al^{+3}. For the stability of such minerals, the partial pressure of oxygen (p_{O_2}) must be considered as an additional variable. The size of its effect has now been determined for an important test case. A newly designed technique employing platinum as a semipermeable membrane makes it possible to regulate the exceedingly small (10^{-14} to 10^{-24} atm) p_{O_2} involved in hydrous systems at temperatures up to 1000°C and pressures up to several thousand bars.

The stability of ferrous biotite, an important member of the mica family, was determined in isobaric sections by varying T and p_{O_2}. It was demonstrated that different breakdown products are obtained in different p_{O_2}-T regions. At low p_{O_2} the products of decomposition are fayalite + leucite + kalsilite + vapor, at intermediate p_{O_2} they are sanidine + magnetite + vapor; and at high p_{O_2} they are sanidine + hematite + vapor. It was also clearly shown that for one and the same reaction the equilibrium temperature T depends very strongly on the magnitude of the p_{O_2}, if a transfer of oxygen is involved in the reaction. At 2000 bars total pressure, the upper stability limit of the synthetic biotite varies from 620° to 805°C for a p_{O_2} varying from 10^{-16} to 10^{-20} atm.

The demonstration of the pronounced effect of oxygen on iron-bearing hydrous systems is important to the geologist, because a large number of rock-forming processes involve redox reactions. It is now possible to study such reactions quantitatively at high pressures and temperatures. The data for the test mineral biotite are significant in particular, because they fix the p-T range for the mineral assemblages of rocks belonging to the pyroxen-hornfels facies, the granulite facies, and the charnockites.

H. P. Eugster
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Distribution of "Motor" Functions in the Cerebral Cortex in the Conscious Intact Monkey

Classically the "motor" functions of the cerebral cortex are placed in and restricted to the "precentral motor cortex," anterior to the central sulcus. This view has persisted despite some evidence in the literature that "motor" functions are more widely distributed in the cortex (Schäfer, Walker and Weaver, and von Bechterev).

By means of stimulations of unanesthetized monkeys' cortices through implanted electrodes, it can be shown that most (if not all) of the cerebral cortex can produce motor effects at approximately the same threshold value of stimulating electric current. By means of arrays of electrodes packed at intervals from 1 to 2 mm apart and in total numbers from 25 to 610 in a given animal, it is shown that there are no "silent" areas in the cortex; every area produces a movement.

In any classical "sensory" region, the elicited movements are such as to direct the sense organ for that region in a specific direction—that is, in the acoustic area detailed ear movements are evoked; in the visual areas, conjugate eyes and head movements; in the tactile regions, somatic movements. In all areas but two the activity elicited was restricted to contralateral movements; in the face and the spinal column areas, bilateral asymmetrical movements are elicited; the latter region is the only cortical one from which general excitement of the whole animal can be evoked. It is suggested that the cerebral cortex in each and every small area is "sensorimotor" rather than either "sensory" alone or "motor" alone; the precentral region up to the frontal pole is a predominantly efferent system, whereas the postcentral regions belong to a predominantly afferent system.

John C. Lilly
National Institute of Mental Health

Quantum Theory of Nuclear Collective Oscillations

One of the principal goals of nuclear physics is to understand the nature of the states of internal agitation into which nuclei can be brought by experiments in the laboratory. The most striking feature, that the states occur only for certain discrete energies of excitation, can be derived from the most basic principles of quantum mechanics. Quantitative application of quantum mechanics to the stationary states of the nuclei has, however, been less direct and much less satisfactory. A general difficulty is that working from first principles, one predicts fewer low-lying excited states than are experimentally observed.

We have recently reexamined this question and have found [with W. M. Visscher, *Phys. Rev.* **102**, 450 (1956)] that, although most of the states are high-lying, there are also a few low-lying ones which are probably sufficiently abundant to account for the observed energy level spectra. These states are of a special collective nature. The simplest is the so-called "breathing mode" of oscillation, which may correspond to the first excited state of O^{16}.

Our previous estimate of the energy required for this type of excitation was necessarily very rough, since it involved subtracting two large numbers. A related method used [P. S. Zyrianov and V. M. Eleonskii, *J. Exptl. Theoret. Phys. U.S.S.R.* **30**, 592 (1956)] to treat quantum mechanically the collective oscillations of an electron plasma can also be applied to the present problem and yields greatly improved accuracy.

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Deuterium-Hydrogen Fractionation during Freezing of Water

Laboratory experiments show that during the freezing of water, deuterium and oxygen-18 concentrate in the ice phase. Deuterium enrichment was determined on samples of sea water and sea ice collected while ice was forming. An enrichment of deuterium of 1.3 percent in the ice relative to the water from which it was forming was found, compared with 1.4 percent found by freezing water in the laboratory.

Sea ice will have a salinity close to zero but a hydrogen isotopic composition that differs only slightly from that of sea water. The significance of this effect in determining the salinity-deuterium relationship of Arctic and Antarctic sea water is discussed. The isotopic composition of frozen sea water will differ greatly from that of glacial ice, and this offers a means of differentiating sea ice from ice of glacial origin.

The relatively small deuterium fractionation that occurs during the reaction ice ⟷ water rules out this reaction as an important factor in explaining the deuterium depletion of snow and glacial ice. The reaction water ⟷ vapor seems to be the important fractionating agent in this case.

The work was supported by the Woods Hole Oceanographic Institution and the U.S. Geological Survey on behalf of the U.S. Atomic Energy Commission, Division of Research.

IRVING FRIEDMAN
U.S. Geological Survey
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Control of Anthocyanin Formation in Plants

The action spectra have been determined for anthocyanin synthesis (cyanidin derivatives) in turnip and red cabbage seedlings.

The action spectrum of turnip seedlings, grown in the presence of chloronphenical to inhibit chlorophyll formation, has a strong peak in the region of 7200 to 7400 A, with the principal action extending over the region of 7000 to 8000 A and no evidence of action below 6000 A. Anthocyanin synthesis has a 2-hour lag phase at 25°C after which it is proportional to light intensity. This and other findings indicate that synthesis depends on two photoreactions, those two having the same action spectrum, which are separated by one or more dark reactions. High radiant energies are required in the reaction, and the effective pigment possibly contains copper. The two photo-receptive pigments of the turnip exchange excitation energy in the region of 6200 to 6900 A.

In red cabbage seedlings anthocyanin formation is prominent in darkness but is enhanced by low-energy radiation. A strong peak of anthocyanin formation occurs in the region of 6600 A. Far-red radiation reverses the promotional effect of red radiation. Conditions affecting photocontrol in red cabbage are similar to those for the photoperiodic pigment system. In addition, irradiation at high energies (10 joule/cm^2) produces anthocyanin by the first of the two light reactions of the turnip.

STERLING B. HENDRICKS,
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Experimental Approach to the Virotherapy of Cancer

The general aims and methods of virotherapeutic efforts are not dissimilar from chemotherapeutic attempts at treatment of cancer. In collaborative studies of cancer virotherapy by investigators of the National Cancer Institute and the National Institute of Allergy and Infectious Diseases, emphasis has been on the utilization of the newly recognized common viruses of man, such as the adenoviruses (APC-R1), and certain of the enteric viruses, such as the Coxsackie group, in experimental therapy of human epidermoid carcinoma.

In the laboratory, emphasis has been placed on the development of highly reproducible *in vivo* and *in vitro* tools, and advantage has been taken of the specific effects of certain of the viruses on epidermoid carcinoma grown in tissue culture (*in vitro*) and in the peritoneal cavity of x-irradiated and cortisonized rats (*in vivo*), the latter being a modification of Toolan's methods.

In the clinical studies, adenoviruses grown to high titer in HeLa cell tissue cultures (epidermoid carcinoma of the cervix) have been given to 40 patients with definite, sometimes extensive local destruction of cancer tissue, minimal side effects, and no ascertainable destruction of normal tissues. The effects were not complete, and in no case curative; however, they were sufficiently promising to encourage further efforts in both laboratory and clinical areas.

Laboratory studies designed to further this end—that is, to adapt certain relatively benign viruses to produce more rapid and complete oncolysis of human carcinoma *in vivo*, namely, in rats with solid HeLa tumor—have been successful. Similar efforts to achieve comparable oncolytic effects *in vivo* by utilizing successive passage material of the same virus strains in the same cells grown on glass *in vitro* have, on the contrary, not succeeded. Indeed, present evidence suggests that such *in vitro* passages reduce, rather than increase, the desired *in vivo* effects. The methods used for adapting and testing viruses with *in vivo* oncolytic properties are suitable for large-scale testing and are described in some detail.

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Internuclear Potential Functions for Bonds of Polyatomic Molecules

A simple form of a general relationship between energy and internuclear distance is applied to the bonds of a large number of polyatomic molecules. This relation has the form

$$V = De[1 - \exp(-n\Delta r^2/2r)]$$

where the parameter n is defined by the equation $n = k_e r_e / D_e$. Using known values of bond-stretching force constants determined from valence force models with known bond lengths, dissociation energies of bonds in polyatomic molecules have been calculated more accurately than was hitherto possible. The proposed internuclear potential function may be derived from a simplified quantum mechanical model with the result that application to polyatomic molecules may be made independent of any empirically evaluated parameters.

The relationship between bond dissociation energy and average bond energy as related to the proposed function is discussed. A number of other applications of this function are suggested. Limitations of the proposed function are that it does not appear to describe accurately the bond properties of some polar molecules or of bonds where the valence force model is a poor approximation to the molecular force field. With due consideration to its limitations, this function should be useful as a tool for elucidating problems of bond formation and structure.

ELLIS R. LIPPINCOTT
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Present Status of Research on the Physical Constants at the National Bureau of Standards

At the present time at the National Bureau of Standards, measurements at optimum magnitudes may be made in terms of our primary standards with probable errors of about 3 in 10^9 (1 kg mass), 3 in 10^8 (1 m length), 1 in 10^8 (1 sec time or more), and 3 in 10^7 (triple point temperature). Since all of these, except temperature, are presently defined in terms of prototype standards (even time in a certain sense), selected for their ready measurability and assumed stability, they may be subject to long-time changes. It is desirable, therefore, when the state of measurability permits, to define the primary standards in terms of physical constants.

Length and time can now be expressed in terms of certain physical constants with greater precision than either can be referred to the primary standards. This is accomplished through the measurement of the wavelength or light and microwave spectra of atomic and molecular systems. Great degradation in precision arises in measuring many of the other physical constants, particularly important elemental ones as h, e, and m. This comes about largely because electric standards with probable errors of 6 in 10^6 (ampere), 5 in 10^6 (ohm), 6 in 10^6 (volt), and the transfer constant g (2 in 10^6) are involved in the measurement chain.

The National Bureau of Standards has in recent years remeasured a number of important constants, including the speed of light (c), the Faraday (F), the gyromagnetic ratio of the proton (γ), the ratio of charge to mass for elemental particles $(e/m)\rho$. Precise determinations of the electric standards, the acceleration of gravity (g), and extensive intercomparisons of optical wavelengths have also been completed recently.

Future plans call for remeasurement of several of these, particularly c, γ'_ρ, F, and the transfer constant g. In these measurements, it is hoped to achieve a probable error in the accuracy approaching 1 in 10^7 in both c and g with appreciable improvement in the accuracy of γ and F. The recent and proposed determinations are discussed.

R. D. Huntoon, A. G. McNish
National Bureau of Standards

Radiocarbon-Based Pleistocene Correlations and World-Wide Climatic Change

Radiocarbon data permit reassessment of the concept of world-wide, contemporaneous climatic history. South-central Alaska and midwest glacial chronologies are correlated with a European sequence as follows (an asterisk indicates approximate B.C. date): Eklutna-Illinoian-Saale (between 130,000 and 85,000*); Knik-"X." Warthe (to 45,000*); Naptowne-Wisconsin-Fourth Glaciation (to 3500*), with substages pro-Moosehorn-Farmdale, Iowan-Brandenberg, Frankfurt Posen (to 17,000*), Moosehorn-Tazewell-Pomeranian (to 13,500*), Killey-Cary-Scanian (to 10,500*), Skilak-Mankato-Fennoscandian (to 7000*), Tanya-Cochrane-Ragunda Pause (to 3500*); and Alaskan-"little ice age"-(?) (after 3500*). These dated boundaries, marking culminations of interglacials and interstadials at intervals of 40,000 to 45,000 and 3000 to 4000 years, are derived from radiocarbon, varve (Degeer), depth of leaching (Kay), and astronomic ("Obliquity Cycle") calculations.

These correlations satisfy parallel sequence and indicate apparent contemporaneity of climatic trends throughout the Northern Hemisphere. However, local factors determined major differences in glacial intensity and age of maximum extent. Greatest extent of Naptowne, Fourth Glaciation, and Wisconsin glaciers was, respectively, 40,800 and 1500 miles from icecap centers and was reached at 16,500* in Illinois (Tazewell) and in Alaska (Moosehorn); 20,000* in Iowa (Iowan); and probably before 22,000* in Germany (Brandenberg). The suggested 41,000-year "Obliquity Cycle" climatic control for glacial stages involves a theoretical lag between hemispheres of about 5000 years for Wisconsin age maxima. This is less than the indicated Northern Hemisphere regional lags and underscores the fact that more critical geoclimatic data is necessary before the postulated climatic lag between Northern and Southern Hemispheres can be discounted.

Thor N. V. Karlstrom
U.S. Geological Survey

Possible Mechanism of the Accumulation of Electrolytes by Living Cells

The simultaneous accumulation of anions and cations against concentration gradients can be achieved by certain composite membranes consisting of highly cation-selective and highly anion-selective parts [K. Sollner, *Arch. Biochem. and Biophys.* 54, 129 (1955)]. Two Donnan equilibria arise between an "outside" solution of constant composition ana an "inside" solution in which the concentration of some electrolyte is kept constant, in excess of its "outside" concentration. The two membrane equilibria must be independent of each other while the solution in the two inside compartments is mixed, and while the flow of a discharging current is prevented by having, between the membranes, in the "inside" or "outside" solution an infinitely high electric resistance.

The theoretical requirements of accumulation are fulfilled also if the biologically more realistic assumption is made that the membranes represent the high resistance part of the system. The membranes may be nonconducting phases across which ions exchange by non-ionic processes, or stirred liquid phases (of suitable geometry and extremely high resistance) across which the exchange is ionic. Stirring accelerates manyfold the exchange and accumulation of ions but does not increase the conductance of the membranes or the strength of the discharging current; thus accumulation occurs.

Karl Sollner
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Some Biological Applications of the X-ray Microscope

The projection x-ray microscope of the type developed by Cosslett and Nixon has now been developed to the point where it is necessary to determine how useful this new instrument will be in the study of biological materials. A comparison is made between the results to be expected from it and from conventional contact radiography. Problems of specimen preparation are discussed and current studies of large objects at low magnifications (developing teeth and bone) and of thin sections of soft tissues are illustrated.

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Biological Action of Polymyxin B

The selective toxicity of polymyxin B, a natural polypeptide of *Bacillus polymyxa,* has been demonstrated in a study of its action on certain algae, bacteria, and fungi. The antibiotic is less toxic to the green algae *Scenedesmus* and *Chlorella* than to common bacteria and fungi growing with them as contaminants in nonsterile culture. The cause for this selectivity has been investigated by examining growth, respiration, and photosynthesis in the presence of various metabolic intermediates.

The inhibition of growth and respiration in the sensitive bacteria can be overcome by using lactose or galactose as the energy source. This reduction of toxicity in the presence of galactose suggests that the usual pathway of galactose assimilation through glucose-1-phosphate does not opperate in these organisms unless the site of inhibition is only at the initial phosphorylation of glucose. This can be shown not to be the case, and the evidence indicates an alternative pathway not common to both glucose and galactose. Studies with polymyxin-susceptible and polymyxin-resistant strains of *Chlorella* provide further information concerning this phenomenon.

Robert W. Krauss,
Raymond A. Galloway
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Synoptic Study of the Airglow

In earlier studies two hypotheses have been advanced concerning the form and structure of the night airglow (5577A). The first asserts that there is an intensity pattern which retains its gross features on the night side of the earth with respect to the sun-earth axes. An observer at a particular location transverses this pattern as the earth rotates during the night. The second hypothesis considers that airglow emission layer has folds which make the integrated intensity depend on the aspect of the folds with respect to the observer. In the current study four nights of simultaneous observations at Cactus Peak, Calif., and Sacramento Peak, N.M., are examined in the light of these hypotheses.

Franklin E. Roach
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Some Properties of Crystallized Coxsackie Virus

Coxsackie A-10 virus, grown in suckling mouse muscle, was purified by methods previously described. Several interesting characteristics of the virus were noted, among which were variation in isoelectric precipitability, dependence of stability on saline concentration, and variation in relative infectivity with route of infection, not seen with unpurified virus.

Highly infective dodecahedral or platelike crystals formed in ultracentrifugal pellets, depending on the type of salt present. Electron microscopy of pseudo replicas has revealed both rectangular and hexagonal arraying of 28-mμ particles, with angles equal to those presented by the crystal faces. Crystals are nonbirefringent, which is characteristic of crystals belonging to the cubic system. Both forms of crystal exhibit the instability seen in most virus crystals when, on drying, they disintegrate into amorphous hygroscopic residue.

Chemical analysis indicates that the virus consists of 10 percent nitrogen by weight. Preliminary, but inconclusive, pentose analysis suggests that the nucleic acid contains ribose. Quantitative, as well as qualitative, studies of pentose and purine and pyrimidine composition are in progress.

Carl F. T. Mattern, Herman G. duBuy
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Infrared Emission Spectrum of Silicon Carbide Heating Elements

The extreme temperatures encountered by modern high-speed aircraft and missiles and the importance of radiation in heat transfer at high temperatures have resulted in demands by aircraft engineers for infrared emissivity data on construction and coating materials. Some information on total emissivity is available, but this is not useful in heat-transfer calculations unless the spectral distribution of emissivity is known for both emitter and absorber. The determination of spectral emissivities involves measurements of radiation in a cavity observed through an aperture which must be very narrow if the source is to approximate a black body. The consequent narrowness of the spectrometer slit requires high amplifier gain and slow scanning of the spectrum. Hence, it is desirable to use an ordinary spectrometer source as a secondary standard for routine measurements.

A method for determining the spectral emissivity of a silicon carbide heating element (Globar) was devised, using as a primary standard an electrically heated black body consisting of a hollow carbon cylinder with a narrow slot. Data were obtained over the wavelength range from 1.25 to 15.25 μ for temperatures 900°, 1200°, 1500°, and 1800°F. The emission spectrum at all four temperatures approximates that of a gray body having an emissivity of about 0.75 between 4 and 15.25 μ, except for two shallow minima at about 9 μ and 12.5 μ. The first of these is ascribed to minor amounts of silica present on the surface of the heating element, while the second corresponds to a strong Raman line of silicon carbide. At wavelengths shorter than 4 μ the emissivity slowly falls to about 0.6 at 1.25 μ.

Using the silicon carbide secondary standard, spectral emissivities have been determined for electropolished and sandblasted specimens of stainless steel and Inconel, with oxidized and unoxidized surfaces, and for specimens of stainless steel and Inconel with certain coatings used on aircraft components.

James E. Stewart,
Joseph C. Richmond
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On the Estimation of Physical Quantities

This paper presents an account of recent research on partial differential equations carried out at the University of Maryland. It is concerned in particular with the estimation of important physical quantities arising in the study of electrostatic fields, incompressible fluid flow, elastic deformation, and other problems of physical interest.

Many of these problems can be reduced to the determination of a harmonic function satisfying certain boundary conditions. Consequently, for definiteness, attention is focused in this paper on methods for obtaining bounds in harmonic problems. Let u be harmonic in a region D whose boundary C is star-shaped with respect to some point, and let u or its normal derivative be prescribed on C. For such a region upper and lower bounds are obtained for the Dirichlet integral of u and for the value of u and its derivatives at a point inside D. These bounds are an improvement over those obtained previously by H. F. Weinberger and me [*J. Math. Phys.* 33, 291 (1955)].

L. E. Payne
University of Maryland

Precise Coulometric Titrations

A number of electrode reactions proceed quantitatively in that the amount of the reaction can be calculated using Faraday's laws of electrolysis. Coulometric titrations based on such reactions are capable of high precision and have the advantage that they employ a universal and pure reagent, the electric current. By using a constant current, which is measured precisely, integration is eliminated and the determination of the duration of the reaction is the only other measurement required.

This paper is concerned with coulometric methods of high precision and accuracy for absolute chemical determinations and for the standardization of chemical reagents. The apparatus, consisting of current source, instrumentation for measurement of current and time, and electrolysis cells designed to separate the anode and cathode to prevent interaction of the respective electrode reactions, is described in detail. The factors that affect the precision and accuracy of the method are considered. The technique is illustrated by a discussion of acidimetric and redox titrations with precision of about 0.01 percent investigated in this laboratory.

John K. Taylor, Stanley W. Smith
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Biochemical Basis for the Toxicity of Pentachlorophenol

Pentachlorophenol is extremely toxic to a wide variety of organisms, including microorganisms, fungi, molluscs, and mammals. Experiments, aimed principally at uncovering an enzymatic basis for its molluscicidal activity, led to the demonstration that pentachlorophenol can interfere drastically with the biochemical energetics of the cell. Specifically, the coupling of phosphorylation to oxidation is completely inhibited by minute concentrations of pentachlorophenol in both rat and snail mitochondrial preparations. Anaerobic (glycolytic) phosphorylations are not interrupted by concentrations of pentachlorophenol that uncouple aerobic phosphorylation. The same low concentrations of pentachlorophenol that dissociate oxidative phosphorylation *in vitro* increase respiration and glycolysis in living snails.

These findings in their qualitative and quantitative aspects lend cogent support to the hypothesis that pentachlorophenol not only stimulates a compensatory mechanism of increased glycolytic activity but, in effect, fatally interferes with the organism's principal energy source. Although pentachlorophenol's uncoupling action resembles the well-known effect of 2,4-dinitrophenol, it is considerably more effective in this respect. Furthermore, pentachlorophenol possesses certain biochemical properties not shared by the nitrophenol. In contrast to the latter compound, pentachlorophenol, under certain conditions, inhibits mitochondrial adenosine-triphosphatase. Although the physiological significance of the latter enzyme remains obscure, its inhibition by pentachlorophenol may provide indirect evidence of additional profound disturbance of phosphate metabolism by the halophenol. Moreover, this toxic compound under *in vitro* conditions can effect gross change of the mitochondrial structure itself.

Eugene C. Weinbach
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Emission Spectra of Actinium

Small samples of actinium, produced by transmuting radium, have been investigated by photographing the spectra of light emitted by the samples when they were excited in a hollow cathode or in arcs and sparks between copper or silver electrodes. The wavelengths were measured, and intensities were estimated, for some 500 Ac lines in the spectral range 2062.00 to 7886.82 A. A comparison of line characteristics in different sources permitted sorting into five categories; about 140 lines belong to Ac I, more than 300 were ascribed to Ac II, eight were definitely assigned to Ac III, four may belong to Ac IV, and about 80 represent band heads produced by Ac 0 molecules.

Analyses of the first three spectra of actinium have revealed their most important features, including atomic energy levels, spectral terms, and electron configurations. The ground state of Ac I is found to be ($6d\ 7s^2$) $^2D_{1\frac{1}{2}}$, that of Ac II is ($7s^2$) $^1S_0$, and that of Ac III is ($7s$) $^2S_{0\frac{1}{2}}$. Comparisons of the analogous spectra of the chemical homologs (scandium, yttrium, lanthanum, and actinium) show that actinium closely resembles yttrium, except that additional terms of odd parity, first found in lanthanum spectra and attributed to the 4 f electron, are also found in actinium spectra where they provide evidence of the presence of the 5 f electron. In Ac II practically all the spectral terms arising from $7s^2$, $6d$, $7s$, $6d^2$, $7s\ 7p$, $6d\ 7p$, $5f\ 7s$, $5f\ 6d$, $7s\ 8s$, and $5f\ 7p$ have been found. From a two-member series in this spectrum an ionization potential of 12.0 ev has been derived for Ac^+ ions.

William F. Meggers
National Bureau of Standards
Mark Fred, Frank S. Tomkins
Argonne National Laboratory

Glycogen Turnover and Metabolic Inhomogeneity

The distribution of isotopic label in glycogen of liver and of muscle has been studied after administration of glucose-C^{14} to intact animals. Labeling of glycogen has been found to be inhomogeneous in two respects. Intramolecularly, glucosyl residues are initially introduced into glycogen at the peripheral (nonreducing) termini, and only subsequently does isotope appear in the inner tiers of glycogen. The latter process is slower in muscle than in liver. Within the polydisperse population of glycogen molecules, glucosyl residues are added at differing rates to molecules of differing sizes. In muscle the larger molecules are favored over the smaller, whereas in liver the reverse is the case.

The turnover of glycogen cannot be described in terms of replacement of a preexisting molecule by a newly formed one. Rather it appears that glucose residues are continuously being added to and removed from the nonreducing ends of the treelike glycogen structure, and by secondary processes of branching and debranching residues are transformed from tier to tier. The rates of these processes are influenced by the enzyme architecture of the tissue and by the sizes of the individual macromolecules. In contrast to current speculation in regard to protein biosynthesis, no "template" mechanism is postulated in polysaccharide biosynthesis. There is no "finished" glycogen molecule, as there may be a "finished" protein molecule. The polydispersity of glycogen, in contrast to the monodispersity of many known proteins, reflects the interruption, by the experimenter, of a process of continuous growth and degradation.

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Structure of the Earth's Crust from Gravity Measurements

Explosion seismic measurements of typical continental structures [H. E. Tatel and M. A. Tuve, *Spec. Paper 62 Geol. Soc. Amer.* (1955), pp. 35–60] have shown surprising complexities. The simple ideas of Airy and Pratt which relate topographic heights to crustal thicknesses are not universal. The question now arises whether or not these seismic measurements are in disagreement with the results of gravity measurements. These latter have been considered to be the basis of our picture of a continental crust constructed like a large floating plate with thickness proportional to the topographic height. The answer is that the two analyses, seismic and gravity, differ not in principle, only in interpretation.

The gravity measurement can be used to demonstrate that the crust is floating. However, the isostatic reductions leave an unexplained residual, of ± 30 milligals for median height (200–1200 m) continental stations. This spread masks the difference of about 5 milligals expected for compensation computed at 30- and 60-km depths, respectively.

In mountainous regions, where there is contrasting topography, the gravity analyses are far more sensitive to the crustal depth. Even in these regions there are large unexplained anomalies. For the vast, almost level, continental regions, the values of gravity are quite insensitive to the crustal depths. Therefore, we are at present unable to determine gravimetrically, with any precision, how the depth of the crust varies over most of a continent.

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Some Relations of Later Tertiary Volcanology and Structure in Eastern Oregon

Along the southern edge of the Columbia Plateau and the northern edge of the Basin and Range province variations in Miocene volanic rocks seem closely related to patterns of deformation.

The dominant structural feature of the region is the east-west Aldrich-Strawberry Mountain range, which is partly an asymmetric anticline with the north limb vertical, and partly a south-dipping fault block. To the north, the uniform basalt flows of the Columbia Plateau were fed from fissures and deformed by east-west folds accompanied by subordinate faulting. To the south, the Miocene volcanic rocks range from olivine basalt to rhyolite, were erupted from volcanoes, and were broken by northwest-trending faults. At a few places in the volcanic border zone, plateau basalts are intercalated with basaltic andesite and rhyolite; elsewhere detailed correlation of the two lava facies is uncertain. In the zone of structural transition, 40 to 50 miles wide, the northwest-trending faults merge with the westerly trending folds in ways indicating contemporaneity, and there are indications that the plateau lavas differ significantly in composition from the average for the plateau as a whole. The correlations between different types of volcanism and deformation are believed to indicate a common control by variations in the crust and subcrustal layers.

T. P. Thayer
U.S. Geological Survey

Recent Theoretical Results in the Propagation of VLF Radio Waves

The recent availability of extensive experimental data on the propagation characteristics of very-low-frequency waves has prompted a renewed look at the theory. Some aspects that have been considered are the extension of geometric optics to include diffraction effects, the wave-guide mode theory, the effect of the earth's magnetic field, the propagation of ground waves across a coastline, and related transient phenomena. The essential features and conclusions of these investigations are described.

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Stereochemical Studies of Building Stones of Collagen

With our increasing understanding of the architecture of the collagen molecule, the exact configurations of the two typical building stones, the open hydroxyamino acid δ-hydroxylysine (I) and the cyclic 4-hydroxyproline (II) become a matter of importance. Four approaches are presently available to this end. (i) Cyclization of I to normal (and allo) 5-hydroxypipecolic acid (III), which is a new naturally occurring amino acid and is the configurational ana- and homolog of II. (ii) Cyclization of the dibenzoyl derivative of I to a lactone and application of Hudson's lactone rule to the rotations of the lactone and open acid. (iii) Complete x-ray analysis of the two diastereoisomeric *cis*- and *trans*-*p*-iodobenzoyl lactones of I. (iv) Stereoinductive reduction of the optically active keto-analogs of I, II, and III with metal hydrides to give preferentially one reduction product. The available evidence favors the L-*erythro* configuration for I.

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