National Academy of Sciences

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Nuclear and Atomic Properties of High-Energy Lithium Beams

Although the technique of preparation and acceleration of lithium ions has been known for several decades, a group at Chicago first observed nuclear reactions initiated by such high-energy ions in 1956. Fast protons observed in the bombardment of Li^7 targets by 1.7-Mev Li^7 projectiles showed the formation of the previously undetected nucleus B^{13}. At kinetic energies of a few million electron volts, two characteristics of lithium-induced transformations, compared with those caused by the conventional projectiles H, D, and He^4, are the relatively high nuclear energy releases and the relatively large number of reactions possible for a given combination of projectile and target. Thus with only 2-Mev kinetic energy available, lithium bombardments have made possible the study of the ground states of B^{13}, C^{15}, and N^{17} and many of the excited states of these little-known nuclei. Since the masses of the two lithium isotopes and of the light nuclei in the targets are well known, measurements of the kinetic energies of the reaction products makes possible the determination of new nuclear masses.

Two of the reactions possible between Li^7 and Be^9 are

$$Be^9(Li^7, Li^8)Be^8;\ Q = 0.363\ \text{Mev}$$

and

$$Be^9(Li^7, p)C^{15};\ Q = 9.05\ \text{Mev}$$

They probably proceed by quite different mechanisms, the former through simple neutron transfer between moving nuclei, the latter by complete barrier penetration and rearrangement of the nucleons in the original projectile and target. The relative yields and angular distributions support this interpretation. Electric excitation of target nuclei, caused by lithium projectiles passing outside the range of nuclear forces, has been observed.

Higher kinetic energies could be attained if, instead of Li^+, Li^{++} or Li^{+++} were accelerated. Furthermore, if Li^- could be prepared, it could be accelerated up a positive gradient, stripped to Li^{+++}, and again accelerated down the same gradient. These possibilities, in addition to the purely scientific interest of such studies, have led to the measurement of the effective ionic charge of lithium beams between 10- and 450-kev kinetic energy as they pass through target gases. Li^- has been observed as a constituent of a lithium beam brought to charge equilibrium in various gases, and, for instance, at 40-kev kinetic energy in propane gas the fraction 3×10^{-4} is in the negative form. Li^{+++} begins to be detectable as an equilibrium charge constituent in helium at around 200 kev.

SAMUEL K. ALLISON
University of Chicago

Structure and Behavior of Blood Cells of Three Species of Tunicates

Phase-microscope studies have been made of the cells of the blood of three species of Bermuda tunicates, *Ascidia nigra*, *Clavelina picta*, and *Ecteinascidia turbinata*. The behavior, including the type of locomotion, the degree of change in shape, and the presence or absence of Brownian motion of crystals or other particles within the cell, has been observed. Each of these three species of tunicates has both colored and colorless types of blood cells. *Ascidia nigra* presents a bluish cell type, an orange cell type, and a green cell type, together with seven colorless cell types. *Ecteinascidia turbinata* has an orange cell type and a green cell type but no blue cell type. The colorless cells are almost entirely similar to those of *Ascidia nigra*. *Clavelina picta* presents green cells, orange cells, and occasional brown cells, the colorless types again resembling those of the other two species. Phase-microscope observation reveals some hitherto unsuspected details of structure in certain of the colorless cell types. On the vacuolated cells of *Ascidia nigra*, a peculiar type of appendage has been seen. Each cell generally shows two to four long, beaded, motile appendages which undergo a sinuous motion. Such appendages maintain their motion for many hours after removal of the blood from the body. They may break off from the parent cell and continue to show independent motion. Attention is called also to the rather constant presence of a small, solid inclusion within the vacuole of these cells. An important feature of the blood and tissue cells in tunicates is the presence in the tissues of counterparts of many of the types of blood cells, fixed cells which appear to be homologous with the cells of the blood. It is suggested that the large "bladder cells" in the tunic of *Ascidia nigra* may correspond actually to the vacuolate cells. The presence in these bladder cells of one or more solid inclusion bodies is described.

WARREN ANDREW
Indiana University

Biochemical Studies of Virus-Induced Neoplastic Growth

Biochemical changes in virus-induced neoplastic growth have been studied in chorioallantoic membranes of embryonated eggs infected with Rous sarcoma virus. Infected and noninfected cells have been incubated in Ringer-HCO_3 medium with C^{14}-glucose present in varying concentrations. Under these conditions the incorporation of C^{14} into tissue glycogen, lactic acid, fatty acids, and CO_2 has been determined. The utilization of glucose by these cells over a 3-hour experimental period was linear. This has allowed utilization of standard enzyme kinetics to evaluate glucose utilization by infected and uninfected cells. Lineweaver-Bruk plots of these data show a remarkable degree of reproducibility for an unresolved enzyme system. Uninfected cells have a $V_{max.}$ of glucose utilization of 3.0 to 7.0 μmole of glucose per hour per gram of wet tissue. The apparent K_s for uninfected cells ranges from 0.8 to 0.9 $\times$ $10^{-3}M$. Rous sarcoma cells (infected tissue) show a $V_{max.}$ of 23 to 25 μmole of glucose per hour per gram. The apparent K_s for these cells ranges from 4.0 to 5.1 $\times$ $10^{-3}M$.

JAMES ASHMORE, RICHARD UHL, ALVIN S. LEVINE
Indiana University Medical School

Erythrocyte Automosaicism in Polycythemics Treated with Phosphorus-32

Erythrocyte automosaicism is a blood-group heterogeneity originating within a single individual. It may be caused by somatic mutation or phenocopy production in the erythropoietic tissue. By means of an isotope dilution method involving serial agglutination of Cr^{51}-labeled cells with unlabeled carrier cells, the minor A_2 and O cell populations in A_1 persons can be measured. They are normally rather stable, although some spontaneous fluctuations in A_2 have been seen.

In two polycythemic patients treated with P^{32}, these minor fractions were followed for evidence of radiation-induced somatic mutation. Both cases showed marked increases in A_2 and O cells within 2 weeks of P^{32} injection (4 mc). At 1 month the A_2 cells had increased tenfold and the O had about doubled. Within 2 months the A_2 populations had returned to below their original levels (about 2×10^{-3}) and in one patient the O population was also beginning to decline. The initial rise seems excessive for specific locus mutation, and the trend reverses within the life span of normal erythrocytes, suggesting that postirradiation loss of A_1 is in part coincidental to the formation of defective cells with subnormal life span. This might be explained on the basis of gross chromosomal losses in the nucleated erythrocyte progenitors, except that the A_2 increase is much greater than the O. Deletions of the locus should not have produced A_2 cells except in the unlikely eventuality that both cases are genotypically A_1A_2. We cannot yet explain this

unforeseen radiation effect which has, very likely, obscured any contribution via the anticipated mutational mechanism.

K. C. ATWOOD, DONALD MEGILL
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Effects of High and Low pH and of Gelating and Liquefying Agents on Antigenic Transformations in Paramecium aurelia

A new antigenic type (51U) appeared during the past year in a culture of the paramecin-sensitive stock 51 of *Paramecium aurelia* that was being grown in 0.75 percent Cerophyl medium inoculated with *Aerobacter aerogenes*, a medium which for 3 years had kept serotype 51N stable. In an effort to learn what environmental change might have brought this new type to expression, we have run a number of experiments to test the effect of *p*H on antigenic transformation. To minimize the action of the bacteria on the *p*H of the medium, the culture fluid has been diluted with a buffer solution in proportions varying from 9 parts of buffer and 1 part of culture fluid to 6 parts of buffer and 4 parts of culture fluid. When used in the 6:4 ratio, Sorensen's Na_2HPO_4-KH_2PO_4 buffer has held the *p*H of the inoculated medium fairly close to the initial *p*H's of 5.8 and 7.8 during 3 days of bacterial growth.

The averaged results of three experiments with this combination of buffer and medium show a transformation of two-thirds of the 51U animals after 4 days of growth in the medium of low *p*H to 51B, a serotype which characteristically appears at low temperatures, while in the medium of high *p*H they show 79 percent of the animals remaining 51U. The total average numbers of divisions that occurred in the two groups during the 4 days of the experiments were closely similar: 5.2 fissions in the medium of low *p*H, 4.8 in that of high *p*H. In more dilute medium the 51U animals transformed 100 percent in both groups of tests, but in every case there was more of the low-temperature serotype 51B in the mixtures of low *p*H and more of the higher temperature types 51A, 51D, and 51E in the mixtures of high *p*H. In agreement with these results is the fact that cultures of 51B have been kept 100 percent stable for 6 weeks of growth in the undiluted rich Cerophyl medium with *p*H adjusted with $Ca(OH)_2$ to 6.2, while 51U was kept 100 percent stable by feeding the same medium after the *p*H was raised to 7.5 to 8.0.

Now in progress is a group of experiments in which the anticoagulant-liquefying substance heparin is being tested. This leaves serotype 51B 100 percent stable, while it induces 51D and 51E to transform almost 100 percent to 51B. In the dilutions used, 51A has transformed in only very small percentages (2 to 6) to 51B, but it is possible that stronger concentrations will increase these. Alcohol, on the other hand, has been found to be similar to heat in its effects on the serotypes. It leaves 51A 100 percent stable, but causes 51B to transform largely, and 51D in smaller numbers, to 51A. It is planned to check these results with tests of other liquefying and gelating agents.

MARY L. AUSTIN
Wellesley College

Effects of Varying the Extent and Intensity of the Daily Exposure to Light on the Cycle of Mating Type Reversals in Paramecium multimicronucleatum

With daily cycles of light and darkness, each individual *Paramecium multimicronucleatum*, syngen 2, is known to be of mating type III during one part, and of mating type IV during another part, of each 24-hour period. With a constant light-dark cycle, the temporal relations between the light-dark changes and the mating-type changes differ in different natural stocks [T. M. Sonneborn, A. Barnett, *J. Protozool.* **5**, suppl., 18 (1958)]. Effects of varying the light-dark cycle were examined in certain clones of stock 19. When exposed daily to 4 hours of continuous illumination, the animals are mating type III except from about the 12th to about the 20th hour after the light goes on; during this period they are mating type IV. As the daily light phase is extended to 8, 12, 16, and 20 hours, the change from type III to type IV is progressively delayed about 2.4 hours for each 4-hour increment of the light phase (decrement of the dark phase), but the duration of the mating type IV phase, though variable (6 to 9.5 hours), is not regularly related to the duration of the light-dark periods. Transfer from any of these light regimes to continuous illumination results in progressive damping of the mating type cycle, the culture expressing type III at all hours after the 4th day. Similar damping occurs after transfer to continuous darkness, but continuous expression of one type did not occur in the period observed (8 days). With an 8-hour daily exposure to light, little if any effect of variations in light intensity within the range 25 to 1000 ft-ca was observed, except perhaps for slight increase in duration of the mating type IV phase with increasing light intensity. The relation of these results to other biological clock systems will be discussed.

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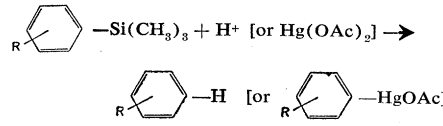
AUDREY BARNETT
Indiana University

Electrical Effects of Alkyl Substituents on an Aromatic Ring as Determined by Detrimethylsilylation

"Detrimethylsilylation" is a substitution reaction in which a trimethylsilyl group, $-Si(CH_3)_3$, is cleaved from an aromatic ring. These cleavages can be accomplished by reagents such as strong acids [protodesilylation; *see* R. A. Benkeser and H. R. Krysiak, *J. Am. Chem. Soc.* **76**, 6353 (1954); C. Eaborn, *J. Chem. Soc.* **1956**, 4858 (1956); R. A. Benkeser, R. A. Hickner, D. I. Hoke, *J. Am. Chem. Soc.* **80**, 2279 (1958)] or mercuric acetate [mercuridesilylation; *see* R. A. Benkeser, D. I. Hoke, R. A. Hickner, *J. Am. Chem. Soc.* **80**, 5294 (1958)].



Both of these reactions are clean-cut and proceed at a rate which can be measured conveniently. Since synthetic methods are generally available which permit the attachment of a trimethylsilyl group to almost any position in an aromatic ring, detrimethylsilylation provides a valuable tool for determining the reactivity of a *particular* ring position toward electrophilic attack.

Recently, considerable interest has been generated in the electrical effects of alkyl groups substituted on a benzene ring [*see* series of papers on this topic in *Tetrahedron* **5**, 166 (1958); R. S. Milliken, *Tetrahedron* **6**, 68 (1959)]. While it is generally conceded that these groups possess a +I inductive effect which is in the order: *t*-butyl> *i*-propyl> ethyl> methyl, they also exhibit frequently a reverse order of influence which, in the past, was explained in terms of hyperconjugation (Baker-Nathan effect). It is the latter influence which has recently come under scrutiny [*see* series of papers in *Tetrahedron* **5**, 166 (1958)]. Detrimethylsilylation affords an excellent method of studying the electrical effects of alkyl groups, since the alkylated phenyltrimethylsilanes can be prepared and purified readily. In addition, they can be made to undergo facile cleavage by both acid [R. A. Benkeser, R. A. Hickner, D. I. Hoke, *J. Am. Chem. Soc.* **80**, 2279 (1958)] and mercuric acetate.

When the *m*-alkyltrimethylsilanes were submitted to both proto- and mercuride-

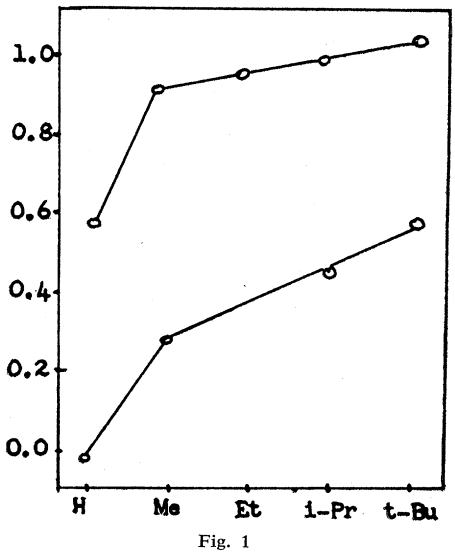


Fig. 1

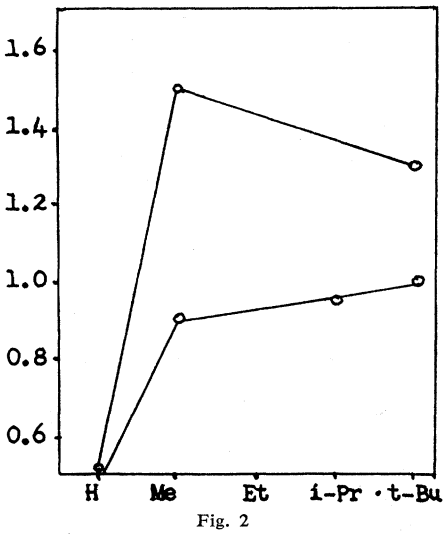


Fig. 2

silylation, a gradual increase in rate was noted as the *m*-alkyl substituent was varied systematically from methyl to *t*-butyl (Fig. 1). Obviously these rate trends can be explained quite satisfactorily in terms of the +I inductive effects of the *m*-alkyl groups. On the other hand, an unexpected conflict of trends was noted when the *p*-alkyltrimethylsilanes were cleaved with acid and mercuric acetate (Fig. 2). Thus, protodesilylation follows the Baker-Nathan sequence, while mercuridesilylation does not.

Since protodesilylation is carried out in a very polar medium (for example, mineral acids in aqueous acetic acid) and mercuridesilylation is not (mercuric acetate in glacial acetic acid), it can be concluded that, very likely, the Baker-Nathan sequence is associated, at least in part, with solvation effects [W. A. Sweeney and W. M. Schubert, *J. Am. Chem. Soc.* **76**, 4625 (1954); subsequent papers by Schubert; R. A. Clement and J. N. Naghizadeh, *J. Am. Chem. Soc.* **81**, 3154 (1959)].

ROBERT A. BENKESER
THOMAS V. LISTON
Purdue University

Hot Carrier Investigations in Semiconductors

Much of the current extensive information about semiconductors stems from the temperature-dependent studies of the electrical, magnetic, and optical properties. A promising new tool of investigation consists of the increase in the average energy of the charge carriers *alone*, while leaving the lattice temperature constant. Such "hot" carriers are produced by applying short (microsecond) pulses of high electric fields, during which the carriers initially gain energy from the field much faster than they can lose it to the lattice in collisions. After a few collisions, a steady state is attained, with the carriers having an increased "effective temperature." When the carrier mobility is high (10^4 to 10 cm^2/volt sec), carrier heating is already noticeable at a few volts per centimeter. While it has not yet been possible to measure directly the effective temperature of the hot carriers, the latter has been estimated from measurements of energy-dependent properties such as the carrier mobility. Hot carriers have been applied primarily for studying (i) scattering and energy loss mechanisms of carriers from mobility measurements, and (ii) ionization mechanisms of neutral impurities. With regard to the former, the increase in lattice scattering and the decrease in impurity scattering with increasing carrier energy have been demonstrated in germanium. Also the disappearance of magneto-resistance has been observed as the lattice mobility of the hot carriers is decreased. Ionization studies of zinc and copper impurities in germanium have shown that carrier heating is much less effective than lattice heating in ionization processes, leading to the conclusion that impurity ionization and recombination kinetics are dominated by carrier-phonon interactions.

RALPH BRAY
Purdue University

Balance between Coherence and Variation in Evolution

Why do living things exist as recognizable species instead of as confluent masses of variation? Recent experiments have disclosed that even ecological races within the same wild species are held together by moderate genetic coherences, and the segregations of their hybrids favor the parental combinations.

In ecological races each morphological and physiological character is regulated by a system of several genes distributed on several chromosomes. In their segregating hybrids, combinations of paired parental characters are usually correlated, indicating that at least two pairs of the regulating genes are located on a common pair of chromosomes, whereas other genes governing them may recombine freely. The racial characters are thus held together by direct and indirect bonds of various strength.

This kind of genetic structure provides both coherence and flexibility. It favors the retention of the existing races even at their points of contact as long as the differentiating environments remain essentially unchanged. Major changes in the environment, combined with interracial crossings, may favor certain crossover combinations if they are better adapted, and the existing linkage mechanism will accelerate the constancy of the favored recombinants. New variability is simultaneously released, because complementary and oppositional genes carried by separate races become activated through crossing, producing transgressive segregation.

Shifts in the environment tend to alter the balance between coherence and variation, promoting migration, natural crossings, release of potential variability and shifts in selective pressure. Such shifts change the biotype content of the races and of the species itself.

JENS CLAUSEN, WILLIAM M. HIESEY
Carnegie Institution of Washington

Metabolic Fate of Macronuclear DNA after Autogamy in Paramecium aurelia—an Autoradiographic Study

During the nuclear reorganization process of autogamy the macronucleus disintegrates into approximately 40 to 60 fragments. The ultimate fate of these fragments is assumed to be resorption into the cytoplasm. An attempt has been made to answer the question whether the nucleic acid of the macronuclear fragments is reutilized in the formation of the new macronucleus.

Paramecia were grown in a complex axenic medium containing 50 c of tritiated thymidine per milliliter. After 5 days of growth the cells were collected and washed free of excess thymidine with sterile isotonic salt solution. The labeled cells were then either (i) inoculated into fresh medium containing no tracer; (ii) inoculated into sterile exhausted medium containing no tracer; (iii) inoculated into sterile isotonic salt solution. After various time intervals cells were removed for autoradiographic analysis. The results show that there is no preferential incorporation of label into the newly developing macronucleus from the labeled fragments in either fresh or exhausted medium. Reutilization of labeled material under starvation conditions (salt medium) could not be definitely established. The new macronucleus formed in very "hot" autogamous cells was slightly labeled, indicating that small amounts of old macronuclear material are reutilized. The cytoplasm of cells grown in high concentrations of tritiated thymidine is also labeled. Experiments are in progress to determine whether this cytoplasmic labeling is associated with RNA.

JOHN BERECH, JR.
W. J. VAN WAGTENDONK
Indiana University

Hyperventilation and Shivering

Two methods were utilized for inducing increased ventilation in male human subjects clad only in shorts and exposed to ambient temperatures of 5° to 10°C (dry bulb) and 50 percent relative humidity. The first method consisted of having the subject breathe an air mixture containing 6 percent carbon dioxide for 10 to 30 minutes at selected times during the exposure to cold. In the second method the subjects hyperventilated voluntarily at rates simulating that induced by carbon dioxide (40 to 50 l/min). Carbon dioxide suppressed shivering for varying time periods, usually from 20 to 30 minutes. Voluntary hyperventilation increased shivering with an approximate twofold increase in oxygen consumption. Therefore, it can be concluded that the carbon dioxide suppression is a direct effect of shivering mechanisms and is not due to the increased muscular effort of extra ventilation. The time of onset of enhanced shivering with voluntary hyperventilation was not related to the establishment of the arterial pCO_2 at a new lowered level but was related to a certain quantity and rate

of extra heat loss from the respiratory tract. The quantity of heat loss was calculated from data on the changes in temperature and water vapor content in the respired air. Voluntary hyperventilation appears to be a useful tool in experiments on temperature regulation because a controlled rate of imposing a measurable body heat deficit can be established.

R. W. BULLARD, G. D. ANDERSON
Indiana University Medical School

Interconversion of Boranes

Study of the kinetics of reaction and isotope effects and isolation of intermediates in the decomposition of diborane and higher boranes leads to the mechanism

$$B_2H_6 \rightleftarrows 2BH_3 \quad (1)$$

$$B_2H_6 + BH_3 \rightleftarrows B_3H_9 \quad (2)$$

$$B_3H_9 \rightleftarrows B_3H_7 + H_2 \quad (3)$$

$$B_3H_7 + B_2H_6 \rightleftarrows B_4H_{10} + BH_3 \quad (4)$$

$$B_4H_{10} \rightleftarrows B_4H_8 + H_2 \quad (5)$$

$$B_4H_8 + B_2H_6 \rightleftarrows B_5H_{11} + BH_3 \quad (6)$$

where reactions 3 and 5 are relatively slow. The structural implications of the mechanism are considered.

GERALD BRENNAN, RICHARD ENRIONE, RILEY SCHAEFFER
Indiana University
JOHN DUPONT
Redstone Arsenal

Radial Velocities of 11th Magnitude A and K Stars

Spectra of more than 1200 11th magnitude A and K stars have been taken with the Cassegrain spectrograph on the 82-inch reflector at the McDonald Observatory. The observing program was completed in January 1959.

The A stars measured to date seem to be consistent with the standard solar motion of 20 km/sec and a galactic rotation effect rA = 15 km/sec. K stars of luminosity classes I and II are not sufficiently numerous in this material to yield any reliable general conclusions. A preliminary analysis of the K III stars yields a standard solar motion and rA = 17.5 km/sec. The K IV stars also give a solar motion only slightly larger than the standard value.

Space motions have been computed for the dwarfs (K V). The solar motion is about 5 km/sec less than the standard value. The velocity ellipsoid of the K dwarfs has axes ± 18, ± 21, and ± 30 km/sec. These are smaller than the values obtained from other material (for example, see Table 11, page 227, *Handbuch der Physik*, vol. 51). It should be emphasized that the stars in the present study have not been selected according to the size of the proper motion and hence are free from the statistical bias due to such selection.

FRANK K. EDMONDSON
Indiana University

Pharmacological Study of Digitalis-like Steroids

During the last 30 years we have studied pharmacologically almost 400 compounds for their possible digitalis-like action. A large number of them are cardenolides and their glycosides; a smaller number, bufadienolides and their glycosides; and others, simple synthetic lactones. Our work started with the isolation of active substances from the poison of 12 different species of toads. This was followed by the separation of thevetin from the nuts of *Thevetia neriifolia*. In recent years our active materials have been supplied by several steroid chemists, particularly T. Reichstein. The cat is the animal most susceptible to cardiotonic substances. Often sufficient qualitative and quantitative data can be obtained from samples of 3 to 5 mg prior to clinical testing, provided the substance is potent. Among the aglycones of corresponding structures, the bufadienolides are stronger than the cardenolides. The lactone ring is indispensable for the activity in both instances. The glycosides of the cardenolide series are invariably more potent than their aglycones. The activity of bufadienolides, on the other hand, is not increased when conjugation of sugar molecules takes place with the secondary hydroxy group at C_3. Acetylation of the hydroxy group at either C_{16} or C_3 enhances the cardiotonic potency. A change of the asymmetrical center at C_3, C_5, or C_{17} from the natural configuration usually results in a loss of activity. With the cooperation of Harry Gold, 37 glycosides or esters of aglycones were investigated in patients with auricular fibrillation. It is interesting that none of them is as completely absorbed through the gastrointestinal tract as digitoxin. Solubility in water cannot account for the differences.

K. K. CHEN
Lilly Research Laboratories

Incorporation of Adenine Nucleotide into Ribonucleic Acid

An enzyme system, isolated from the soluble, cytoplasmic fraction of embryonic tissue homogenates, appears to be concerned in the synthesis of ribonucleic acid (RNA), as shown by the following properties: it catalyzes the incorporation of labeled pyrophosphate into ribonucleoside triphosphates (reaction 1) and of the adenylate portion of labeled adenosinetriphosphate into RNA (reaction 2). Both reactions require the addition of exogenous RNA and of Mg^{++}, and in both the corresponding ribonucleoside diphosphates are inert, as is phosphate in reaction 1. Reaction 2 is stimulated two- to fivefold by the addition of cytidine triphosphate, uridine triphosphate, and guanosine triphosphate singly or in combination. Up to 85 percent of the incorporated adenylate is found in nonterminal positions under optimal conditions. These include: a pH between 9.0 and 9.5, the presence of Mn^{++} ($8.25 \times 10^{-4}M$) in addition to Mg^{++} ($1.25 \times 10^{-2}M$) and the addition of cadaverine or spermidine (approximately $4 \times 10^{-3}M$). The enzyme system is inhibited by a wide variety of anionic polymers, including DNA at relatively high concentrations (> 20 μg/ml of reaction mixture). At lower concentrations (between 3 and 10 μg/ml) DNA appears to stimulate the reaction. The significance of these findings and the possible role of this system in RNA synthesis will be discussed.

C. W. CHUNG, H. R. MAHLER
Indiana University

Genetic Load as a Means of Analysis of Hidden Variability in Drosophila Populations

When chromosomes from wild populations are made homozygous there is a substantial reduction in viability due to recessive or partially recessive deleterious factors normally carried in the population. Although chromosomes with mild effects grade imperceptibly into the normal class, their over-all effect can be assessed by measuring the homozygous "load"—the average proportional reduction in viability of homozygous chromosomes compared with randomly combined chromosomes from the same population. The average load was about 47 percent for second chromosomes from natural and caged populations of *Drosophila melanogaster*. Of this, a little more than half was due to lethal factors; the rest was due to the cumulative effect of individually milder factors, called here detrimentals. Since these populations should be near equilibrium, the results imply either (i) that detrimentals occur no more frequently than lethals, or (ii) that detrimentals have more dominance than lethals and hence are eliminated more rapidly as heterozygotes. A higher contribution from detrimentals might have been found in more crowded cultures.

Comparison of the ratio of the lethal load to the detrimental load with the same ratio for newly occurring mutants can give information on the comparative rate of elimination of lethals and detrimentals. The data are insufficient to distinguish between a faster elimination rate, and hence greater dominance for detrimentals, and the same average dominance for lethals and detrimentals. However, they offer no support for the idea that mildly detrimental genes are less dominant or that overdominant loci make a major contribution to the decline in fitness with inbreeding.

JAMES F. CROW
University of Wisconsin

Environmental Control of Gastrointestinal Activity

To study the effect of external conditions upon human gastrointestinal activity, a method of recording the activity from external electrodes has been used so as to avoid any possibly stimulating insertion into the tract. The variables of time after eating, rest, body position,

auditory and visual stimulation, problem solving, and avoiding a noxious stimulus have been studied. Recorded under resting conditions, gastrointestinal activity declines during the first 3 to 4 hours after a meal and remains at a low level until at least 15 hours after eating. The effect of rest itself is to produce a decline in gastrointestinal activity lasting ordinarily about 20 minutes. Activity when the person is standing is increased over that found when he is lying down. A strong auditory or visual stimulus produces a high-voltage slow wave in many people. This seems to be of gastric origin, but apparently does not represent a muscular contraction. With or without this wave an increase in activity is produced by such stimuli. This is not highly dependent on digestive state. Solution of arithmetic problems is accompanied by an increase in the motility of the empty stomach. An especially large increase in the activity of the empty stomach is produced by the task of pressing a key every 30 seconds (subject estimating the time) in order to avoid a noxious stimulus.

An important fraction of gastrointestinal activity seems to be under the control of environmental stimuli and conditions.

R. C. DAVIS

Indiana University

Distribution of DNA in Kappa Particles of Paramecium in Relation to the Problem of Their Bacterial Affinities

In the light microscope, kappa particles appear to possess diffusely and uniformly distributed DNA (Preer, 1950). The same is true for mu and pi particles. This feature has been stressed, as one of two which distinguish these particles from bacteria (Sonneborn, 1959). The difference is not due merely to the small size of the particles because (i) some bacteria of the same size show a distinct chromatinic body, and (ii) a much larger (4 by 1 μ) particle (lambda in killer stock 299) also shows uniformly diffuse DNA. Electron microscope examination of a wide range of particle types in diverse stocks (51, 138, 214, and 299) of *Paramecium aurelia* shows differences in structure among them, but all agree in possessing two main regions: areas of high electron density containing matrix and Palade-type granules; areas of very low electron density and irregular shape, sometimes containing filaments and dense granules. It is well known that bacteria show comparable regions, the areas of high density being cytoplasm, those of low density, chromatinic bodies. If the same were true for kappa particles, the apparently uniform distribution of DNA in light microscopy would follow from the irregular distribution of the low-density areas throughout the particles. The distribution of delimited DNA areas throughout the kappa particle appears to be comparable to dispersion of bacterial DNA under certain conditions (Chapman and Kroll, 1957; Whitfield and Murray, 1956). If this is a result of cytoplasmic conditions in the paramecia, a major difficulty in identifying these particles with bacteria would be removed.

This work was supported by grants to T. M. Sonneborn, Indiana University, from the American Cancer Society and the Atomic Energy Commission.

RUTH V. DIPPELL

Indiana University

Isolation and Properties of Nerve-Growth Promoting Protein from Mouse Salivary Gland and Its Neuro-Cytotoxic Antiserum

A protein which stimulates the growth of sensory and sympathetic nerve cells, both in tissue culture and in the living chick embryo, has recently been isolated from snake venom. This finding has led to an examination of the salivary glands of other species for biologically similar factors.

The submaxillary gland of the mouse has been found to be a very potent source of the growth factor. The biological activity is associated with a protein, which has been purified approximately 100-fold by standard procedures of protein fractionation. When examined in an analytical ultracentrifuge, only a single peak was detectable with an s_{20} of 4.3 Svedberg units. The evidence supporting the view that the salivary gland factor is a protein includes the following data: (i) the biological activity is destroyed upon incubation with proteolytic enzymes, and (ii) the factor is antigenic and the antiserum thus obtained inhibits its biological activity.

The injection of the growth factor into newborn mice results in a marked net increase in the protein, RNA, and DNA content of the superior cervical ganglion. Conversely, the injection of the antiserum into a variety of mammals results in atrophy and destruction of the sympathetic nerve cells.

STANLEY COHEN

Washington University

Preferential Pairing in Trisomic, Triploid and Tetraploid Inversion Heterozygotes of Zea mays

Genetic and cytological studies with trisomic, triploid and tetraploid maize plants which are heterozygous for a paracentric inversion including slightly more than half of the long arm of chromosome 3 (3L.4-.95) indicate that pairing is not at random among homologues which differ by this structural change. There is a great tendency for structurally identical chromosomes to pair preferentially with each other.

Preferential pairing was determined by the backcross ratios for the *a* locus which is included within the inversion. Preferential pairing has a marked effect on the *A*:*a* ratio in the progeny. If only bivalents are formed and pairing is preferential in tetraploids of *In A/ In A/ N a/ N a* constitution, all gametes will be *Aa* and there will be no homozygous recessive *a* individuals in the progeny. Quadrivalent formation accompanied by preferential orientation will give more *Aa* gametes than expected in control plants with identical homologues, if the frequency of genetic nondisjunction is less than 1/3. Data from several types of inversion 3 heterozygotes and the corresponding control plants indicate that pairing is not at random in polyploid heterozygotes.

Cytological evidence of preferential pairing comes from the comparison of chromatid bridge frequencies in tetraploids having a single inverted chromosome (simplex condition) with those possessing two inverted and two normal chromosomes 3 (duplex condition). Since a chromatid bridge is formed after crossing-over between a paired normal and inverted segment, it follows that the frequency of chromatid bridges is a function of the frequency of this type of association. The amount of preferential pairing can be derived from these data. If pairing were at random, the expected frequency of association between two structurally different chromosomes would be 66.6 percent. The data from cytological studies indicate that pairing of this type occurs only 24 percent of the time, whereas structurally identical homologues are associated 76 percent of the time.

Thus a relatively simple morphological change strongly affects the progress of synapsis in a tetraploid. This study is relevant to an understanding of the loss of homology and consequently pairing affinity in evolutionary divergence.

G. G. DOYLE

Indiana University

π^* Bonding in Metal Carbonyls and Derivatives

A qualitative molecular orbital model of the bonding in mononuclear metal carbonyls and derivatives has proved useful in understanding their vibrational spectra. The "lone-pair" σ, the π, and π^* orbitals of CO and the appropriate metal *d*, *s*, and *p* orbitals were used. The results for $M(CO)_4$, for example, show 12 "lower" energy or B orbitals; 9 are bonding between M and CO and 3 are nonbonding, π orbitals. When the relative energies of the π^* orbitals are so high that they make no contribution to the 5 remaining occupied or "A orbitals," the latter are antibonding between M and CO. The occurrence of π^* character in these orbitals results in a stabilization of this subshell, a reduction in M–CO antibonding character, and the appearance of C–O antibonding character. Thus, π^* stabilization of the A orbitals is a primary factor in the bonding description.

The model predicts a substantial increase in π^* stabilization with charge in a series such as $Ni(CO)_4$, $Co(CO)_4^-$, and $Fe(CO)_4^{--}$; a substantial drop was found in the C–O stretching frequencies in these and other ions. A C–O force constant drop of greater than 2.5 md/A occurs from $Ni(CO)_4$ to $Co(CO)_4^-$ and from $Fe(CO)_5$ to $Mn(CO)_5^-$ and of more than 4 md/A from $Ni(CO)_4$ to $Fe(CO)_4^{--}$.

A measure of the π^* stabilization in

$Ni(CO)_4$ relative to that in $Fe(CO)_4^{--}$ may be defined through

$$[k_{CO} - k_{Ni(CO)_4}]/[k_{CO} - k_{Fe(CO)_4^{--}}]$$

(where k is a C–O bond stretching force constant) whose preliminary value is 0.3. This indicates that the π^* stabilization in $Ni(CO)_4$ is only a modest fraction of the total possible. A similar description applies to the CO groups in metal carbonyl hydrides and nitrosyls, while the NO π^* character is definitely greater.

WALTER F. EDGELL
Purdue University

Mechanism of Excitation Transfer in Scintillator Solutions

The decay times of luminescence in scintillator solutions are known to be of the order of millimicroseconds. A repetitive time-selection technique for measurement of such decay times is described; the method derives from that of the older Becquerel (1861). The accuracy of the method now makes possible the resolution of decay times belonging to the solvent and to the scintillator processes respectively. Together with previous work on luminescence intensity, recent data on the decay times of scintillator solutions in benzene and other solvents are interpreted to indicate that the transfer of excitation from a primarily excited solvent molecule to a scintillator molecule occurs through the intermediary of intervening benzene molecules. A typical rate constant of the pertinent excitation-transfer when *p*-terphenyl is the solute is 9.3×10^{10} liter $mole^{-1}$ sec^{-1} within an accuracy of about 5 percent. An excitation transfer in which the intervening solvent molecules are not involved is inadequate to explain the totality of the effects.

MILTON BURTON
University of Notre Dame

Viability of Drosophila Heterozygous for Irradiated Chromosomes

It has been suggested in recent years, mainly as a consequence of studies made with artificial and natural populations, that heterozygosity might be different in principle from homozygosity and that it is usually associated with superior viability. A corollary of such a hypothesis would be that irradiation given to highly isogenic populations would be beneficial on the average rather than detrimental. Experiments made by Wallace seemed to confirm such conclusions.

A great number of lines was prepared from stocks made by H. J. Muller for these purposes so that they were originally homozygous and coisogenic for their second and their *ve*-marked third chromosomes, except for heterozygosity for the recessive marker *st* on their third chromosome. Half the lines had their *ve* st^+ chromosome irradiated with a dose of 24,000 r, given to the spermatogonia. By backcrossing these lines to a coisogenic stock, homozygous for *ve st*, for a number of generations, viability could be measured. Viability of control homozygous lines was compared with that of the lines having one irradiated chromosome superposed on the same otherwise homozygous background. Viability of heterozygotes having one irradiated chromosome on a largely heterozygous but uniform background was also measured.

Although many recessive lethal as well as detrimental mutations were induced, no increase in the average viability of the isogenic flies could be demonstrated as a result of the heterozygosity caused by the radiation-induced mutations.

This work was done while I was on a postdoctoral fellowship of U.S. Public Health Service, administered at Indiana University, and supported by U.S. Public Health Service grant RG5286(C1) to H. J. Muller and associates.

RAPHAEL FALK
Indiana University

Immunological Evidence for Variation of Mitochondria Isolated from Paramecium

Mitochondria and other particulates—cilia, trichocysts, and small granules—have been isolated from cells descended from a single *Paramecium aurelia*. The soluble antigens have been extracted and studied by gel diffusion techniques. As has been found with other organisms, some of the particles probably have several antigens in common as well as specific antigens only associated with certain fractions. There is some evidence for the presence of related but distinguishable antigens from morphologically and functionally different organelles.

Antisera prepared against whole cells and against particles, when diffused against mitochondria of a single clone, have disclosed differences (cross reactions) between antibodies, indicating differences between the antigens injected and those tested. Gel analyses and absorption experiments have lent support to the suggestion that variations exist in the antigenic composition of mitochondria in proliferating cells analogous to the antigenic transformation previously observed with immobilization antigens located in the cilia and pellicle. At least two such labile mitochondrial groups exist, each behaving as though they are separate molecules. These antigens show no immunological relationship to the immobilization antigens.

IRVING FINGER, PHILIP KITTNER, CAROL C. HELLER
Haverford College

Photosynthetic Conversion of Light Energy into Chemical Energy

This theory is based mainly upon the same physical observations which have been decisive for the successful interpretation of ordinary nonbiological photochemical reactions. The behavior of chlorophyll fluorescence in living plants has shown that the energy transfer from one light-excited pigment molecule to another by sensitized fluorescence is an exceedingly efficient process. This mechanism explains the migration of excitation energy from the bulk of the chlorophyll molecules to the few among them that are in permanent contact with water, the OH-accepting enzyme, and dissolved substances. On this basis, not only the role of the photosynthetic unit but also the afterglow of living chlorophyll as well as Emerson's important finding of a cooperation between two light-absorption acts become easily understandable.

Intensity measurements of the fluorescence in plant cells indicate that the final photosynthetic oxidants are not reduced indirectly via electrons or enzymes but in direct contact with the chlorophyll. During this process the first excited singlet and the metastable lowest triplet states contribute their energy equally often to the photochemical steps. We are forced to assume that the metastable state provides its energy for a preparatory step which consists in the transformation of both the chlorophyll and the oxidant from the keto into the enol form. This leads to a storage of about 20 kcal in a new complex. The second step, the simultaneous transfer of H to the oxidant and of OH to the enzyme makes use of the sum of the previously stored 20 kcal plus that of the 41 kcal delivered from a singlet excitation.

JAMES FRANCK
University of Chicago

Evolution of the Structure and Behavior of Termites with a Reexamination of the Concepts of Vestiges, Recapitulation, and Caenogenesis

Comparative study of the structure and behavior of the castes of different genera of termites indicates evolutionary advances and regressions of adaptive functions. Vestigial structures may be found in one caste that are homologous with functional structures in other castes with essentially identical genetics. In addition, nonfunctional vestigial structures are found that are homologous with functional characters in more primitive termites. In some instances, young stages of development (nymphs) exhibit vestigial structures that are nonfunctional in the early stage, are completely absent in the adult, but are functional only in the adult stage in more primitive genera.

The 19th century concepts of the evolution of vestiges, of recapitulation, of caenogenesis, of deuterogenesis, and of the social supraorganism are reexamined, and the attempt is made to bring the facts into harmony with modern principles of genetics, development, ecology, and systematics. The data substantiate many aspects of the theory of recapitulation and also provide circumstantial evidence for the long persistence of genetic elements (genes and gene parts) over many tens of millions of years alongside mutating genes that are naturally selected in the

phenotype by means of their changing effects upon genetic, developmental, and adult functions. There is likewise such detailed parallel evidence in both behavior and structure that we must assume the same basic biological and evolutionary principles underlying manifestations of behavior that we know to be foundational to the genetics, physiology, development, and function of structure.

ALFRED E. EMERSON
University of Chicago

Occurrence of Cladocera Remains in Lake Sediments

Many, possibly all, species of freshwater Cladocera leave recognizable skeletal remains in lake sediments. The family Chydoridae, with the greatest number and diversity of species, is best represented by a variety of skeletal parts. Present evidence indicates that the exuviae of these species accumulate in the sediments to form large populations, which can be studied by suitable statistical means for detecting changes in absolute and relative abundance during geological time.

To determine how accurately the population of fragments in the sediments reflects the living population that produced them, surface samples of the offshore sediments of the five lakes at Madison, Wis., in which E. A. Birge had studied the living Cladocera for more than two decades, were examined. Of the 23 species of chydorids found by Birge in these lakes, all except one (which he collected only on one occasion in one of the lakes) were recovered. In addition six other species were found that Birge had not encountered in his examination of living material.

Hence, any list of species of Cladocera based only on living material, even though collections were made at all seasons of the year and over a number of years, must be suspected of being incomplete. Obviously microhabitat requirements and seasonal and long-term vagaries of occurrence of the various species make it virtually impossible to collect all the species present. A list of species—at least of chydorids—occurring in a given body of water can be obtained with least expenditure of time and greatest assurance of completeness from an examination of the sediments.

DAVID G. FREY
Indiana University

Sputtering of Silver by Hydrogen Ions in the Energy Range 2 to 12 Kilovolts

Ion beams from a radio-frequency source were analyzed magnetically and allowed to strike a silver target incorporating radioactive Ag^{110} as a tracer. The sensitivity of the detection of sputtered silver was 10^{-8}g, so that the sputtering coefficient S (atoms of metal sputtered per incident ion) could be measured with minimal alteration of the surface of the target. Examination by electron diffraction revealed no contamination of bombarded targets by surface films. The ions H^+, H_2^+, H_3^+, D^+, D_2^+, and D_3^+ were studied at normal incidence from 2 to 12 kv. At 10 kv the values of S were 0.028, 0.070, 0.110, 0.075, 0.165, and 0.28, respectively. The variations of S with ionic energy displayed broad maxima in the region studied, which were displaced to higher energies with increasing mass of the ions. With hydrogen ions in this energy range, inelastic collisions due to electron excitation may account for an increasing proportion of the energy loss in the target and thus contribute to the decline in S at higher energies. Collision theory permits a rough calculation of S in this range, agreeing in order of magnitude with the observations. Although the present values of S are much lower than those reported by previous workers, who did not use analyzed beams, they are still so high as to suggest that sputtering from the walls of containers may cause serious difficulties in the achievement of nuclear fusion in deuterium plasmas.

FINN GRØNLUND, WALTER J. MOORE
Indiana University

Nuclear Syntheses and Induction of Mutation

About half way through the interdivision interval, there is a major discontinuity (D) in the frequency of recessive lethal and slow growth mutations induced by x-rays in the micronucleus of *Paramecium aurelia*. This is not true for mutation induction by 2537-A ultraviolet light. X-irradiation before D produces about 10 times as much mutation as x-irradiation after it. Moreover, certain postirradiation treatments decrease the amount of mutation if started before, but not after, D. The change in apparent sensitivity at D is very rapid, probably requiring only a few minutes for any individual paramecium. It has not yet been possible to follow the major macromolecular syntheses in the micronucleus, but its cross-sectional area starts to increase at or near D and continues to increase throughout the second half of the interdivision interval. Optical measurements of macronuclear DNA (Feulgen), RNA (2650-A absorption), and dry weight (interference microscopy), carried out in collaboration with T. O. Caspersson and his associates in Stockholm, have shown that all three start to increase at or near D and continue to increase throughout most of the second half of the interval. Quantitative autoradiographic determinations of the uptake of tritiated thymidine into the macronucleus follow the same pattern. Since irradiation at any time during the second half of the interval induces very little mutation, the general state of the replicating nucleus rather than the replicated or nonreplicated condition of individual chromosomes or DNA molecules must be responsible for preventing a large part of the radiation damage from being converted into mutation. The ineffectiveness of postirradiation treatment begun after D could mean that the mutational process comes to an end at this time; but it could also mean that the treatments are unable to modify the course of synthesis once it is under way. Thus it is possible to reconcile the idea that the end point in mutation induction is DNA synthesis with the association of D with the onset, instead of with the whole period, of DNA synthesis.

R. F. KIMBALL
Oak Ridge National Laboratory

Nucleon Structure from Electroproduction of Pions

By use of the methods of the dispersion relations, Fubini, Nambu and Wataghin [*Phys. Rev.* **111**, 329 (1958)] showed that experiments on the production of pions in electron-proton collisions may be used to study the electromagnetic structure of nucleons. A new attempt at the evaluation of these dispersion relations has been made by assuming only that the (3, 3) state of the final pion-nucleon system is dominant and that the one-meson approximation is applicable. Both assumptions are expected to be valid at pion-nucleon center-of-mass-energies in the neighborhood of the resonance, regardless (within reasonable bounds) of the magnitude of the momentum transferred by the electron. With this approximation, the dispersion relations may be interpreted as integral equations and solved by conventional methods. The reliability of these results with regard to measurements of nucleon structure may be partially ascertained by comparing a certain limiting form of these formulas with experiments on photomeson production. Work on this comparison is in progress.

SOLOMON GARTENHAUS
Purdue University

Problems in Genetic Control of Protein Synthesis

Recent advances permit the following formulation of the problems of the genetic control of protein synthesis. Each statement is suggested by existing evidence, but full validation lies in the future. (i) The outstanding biological property of proteins is specificity (enzymatic and immunological). Genetic alteration of purely physical properties (thermostability, electrophoretic mobility, and so forth) occurs, but constitutes a less critical problem. (ii) The important variables of the protein molecule are those of primary structure (amino acid sequence) and tertiary structure (folding, polymerization, and so forth). While the primary structure specifies an array of potential tertiary structures, the particular tertiary structure assumed in any case depends on other factors. (iii) The groupings responsible for specificity are large enough to extend over a segment of the polypeptide chain consisting of several adjacent amino acids or over two or more nonadjacent segments brought into juxtaposition by folding of

the chain. Alterations of either primary or tertiary structure could therefore affect specificity. (iv) Primary structure is a product of events occurring in the ribosome and is probably a reflection of the structure of ribosomal RNA. The sequence of nucleotides is probably the structural feature of greatest importance in this regard, but such features as folding of the polynucleotide chain cannot be dismissed. (v) Full specification of tertiary structure occurs subsequently. While nonspecific factors might play a role, it is difficult to avoid the participation of templates at this point; this may be an additional function of RNA. (vi) The problems of information transfer from genetic material to RNA templates are most profitably discussed in terms of nucleotide sequences in DNA, but the participation of either RNA or protein in the genetic code cannot be excluded. (vii) Information specifying both the primary and tertiary structures of proteins is coded in that part of the genetic material called euchromatin. The integrated units of this code need not be coextensive with the units of genetic recombination, and interactions between such units may occur either in the formation of RNA templates or at the level of template activity. (viii) Heterochromatin contains information restricted to the determination of aspects of tertiary structure not specified by amino acid sequence. Alterations in heterochromatin, therefore, are less likely to result in changes in the specificity of proteins and more likely to result in changes in purely physical properties.

ALLEN S. FOX
Michigan State University

Frequency-Modulated Ultrasonic Interferometer; Adiabatic Compressibility of Aqueous Solutions of Some Alkali Halides at 25°C

The determination of adiabatic compressibilities of aqueous solutions is part of our comprehensive study of the thermodynamic properties of strong electrolytes. The adiabatic compressibility β_S of a solution may be determined from measurements of its density d and the velocity u with which it transmits sound, using the equation of Newton and Laplace:

$$\beta_S = 1/u^2 d$$

Here $\beta_S = (\partial \ln V/\partial P)_S$, where V is the volume, P the pressure, and S the entropy.

The liquid is contained in a cylindrical cell, closed at the bottom by a transmission plate covering an x-cut quartz transducer and fitted with a movable reflector. The cell is connected in an RF bridge, the output of which changes with the reactance of the system as the reflector moves through a standing-wave position. Instead of using a fixed-frequency oscillator and presenting this change on a microammeter, we modulate the oscillator by about 5 kcy/sec and present the amplified bridge output on the upper channel of a two-channel oscilloscope as a horizontal trace with a sharp maximum at the standing-wave frequency. The reflector is then moved to bring this maximum to exactly 4 Mcy/sec, as indicated by a pip introduced on the lower (frequency) trace by a quartz crystal marker. This allows rapid and easy adjustment of the reflector position to 1 μ. The accuracy of the instrument now is limited by the uncertainty of ± 2 μ (standard deviation) in the micrometer reading.

Results for some alkali halide solutions will be presented.

FRANK T. GUCKER, CEDRIC L. CHERNICK, PHANIBHUSAN ROY-CHOWDHURY
Indiana University

Origin of Helianthus multiflorus

The cultivated ornamental sunflower, *Helianthus multiflorus* L., has been known since 1591 when it was described from Europe by Tabernaemontanus. The plants are sterile and are propagated by division of the rhizomes. Both Gray and Bailey have concluded that this taxon is a variety of *H. decapetalus*. Dod was the first to suggest a possibility of a hybrid origin with *H. annuus* and *H. decapetalus* as the parents. *Helianthus multiflorus* has been found to be triploid ($2n=51$). Morphologically, the plant is similar to *H. decapetalus* ($n=34$), but it differs from the latter in that it has a slightly more hispid stem, broader and more conspicuously serrated leaves, larger heads, and a more attenuated middle cusp of the chaff, all of which could have been derived from *H. annuus* ($n=17$). The artificial hybrid between these two species, while not readily obtained, has been secured, and the hybrid is similar in appearance to *H. multiflorus*. It is concluded, therefore, that *H. multiflorus* originated in Europe by spontaneous hybridization between *H. annuus* and *H. decapetalus*, after the introduction of these species from North America. *Helianthus annuus* was well known in Europe by 1591, but there is no mention of *H. decapetalus* before 1753, although it is quite probable that it was introduced at a much earlier date.

CHARLES B. HEISER, JR.
Indiana University
DALE M. SMITH
University of Kentucky

Some Consequences of Introducing a Genetically Defined Population of a European Syngen of Paramecium aurelia into an American Pond

Syngen 9 of *Paramecium aurelia* occurs in Europe but has never been found elsewhere. Approximately 4.6 million animals were introduced on 10 July 1959 into a small pond near Bloomington, Ind. They consisted of equal numbers of the three genotypes for two serotypic alleles and were approximately isogenic for other loci. Each genotype was equally represented by the two mating types. The pond also contains *P. caudatum* and *P. multimicronucleatum*, but no other *P. aurelia*. The introduced animals were regularly recovered in replicate 5-ml samples taken from 12 stations in the pond during the subsequent 3 months. The numbers of paramecia recovered have varied markedly, but no conspicuous difference among the three species in this respect has yet appeared. All marker genes and all genotypes put into the pond have regularly been recovered. The introduced proportions were markedly different from expectations on random mating. During the first month, the proportions recovered, though they fluctuated, did not differ significantly from the proportions introduced (except at one station). Later, significant deviations from the introduced proportions were found. The frequency of one allele has increased, the other has decreased. The proportions of the three genotypes deviate not only from the input ratios but also from the ratios expected to result from random mating. Fewer heterozygotes and more of both homozygous genotypes occur than is expected from random mating. Further samples are to be obtained periodically.

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HOWARD E. HOLZMAN
Indiana University

Host Range and Host Reactions as Diagnostic Criteria in Synchytrium

Synchytrium is a genus of obligate fungus parasites of plants which induce cell enlargement, division, and sometimes cell differentiation in their hosts. These reactions result in the formation of galls of varying complexity around the parasites. Inasmuch as the developmental and morphological characteristics are not sharply defined in most species of *Synchytrium*, systematists have used the type and structure of the induced galls as supplementary criteria in the identification and diagnosis of species. To determine the validity of such criteria, several species were tested as to host range, and the reaction of the hosts was studied. *Synchytrium macrosporum*, under greenhouse conditions, has infected 630 species of 460 genera in 138 families of temperate and tropical annuals, shrubs, and trees, ranging from the Taxaceae to the Compositae. On some hosts the induced galls are simple and unicellular and less than 200 μ in diameter, while on others they are composite, large, up to 800 μ or more in diameter, and consist of several hundreds of cells. Furthermore, on some organs of the same host they may be simple and unicellular, and on other organs large, composite and multicellular. Accordingly, host range and host reaction, in *S. macrosporum*, at least, are not specific and valid criteria for identification and diagnosis. Host reaction is specific for one host and then only for specific organs of that host.

JOHN S. KARLING
Purdue University

Hereditary Galactose Sensitivity

Galactose transported into the mammalian cells as well as into many microorganisms (yeast, *Escherichia coli*) is metabolically inert unless it is phosphorylated and incorporated into a nucleotide, uridinediphosphogalactose. These two steps are catalyzed by the enzymes "galactokinase" and "transferase," respectively. The enzyme that catalyzes the "racemization" of uridinediphosphogalactose to uridinediphosphoglucose is called "epimerase." Hereditary blocks of "galactopermease" or galactokinase render cells "galactose negative" (that is, unable to use galactose as a carbon source). Galactose-negative cells which arise from hereditary blocks in transferase or epimerase develop abnormalities in growth or in function after the addition of galactose as an accessory substrate. These types of abnormalities will be called "hereditary galactose sensitivity."

Hereditary galactosemia in man arises from a defect in "transferase." This defect has been demonstrated in several types of cells. Liver and lens epithelium of galactosemic infants degenerate if the subjects receive galactose in the diet. In galactose-negative strains of *E. coli*, two types have been identified as galactose sensitives. One type, defective solely in transferase, can be induced by galactose to become static. Another type is defective solely in epimerase. In this case, as found by Fukasawa and Nikaido, addition of galactose prompts the development of rapid lysis (in hypertonic medium the formation of protoplasts or spheroplasts ensues). Galactose-1-phosphate accumulates during bacteriostasis or bacteriolysis. The continued generation of this ester is probably responsible for the unbalanced growth. The biochemistry of these two types of unbalanced growth is under study.

H. M. KALCKAR, M. B. YARMOLINSKY, H. WIESMEYER
Johns Hopkins University

Anophthalmia (or Microphthalmia) in the Mexican Axolotl Apparently of Genetic Origin but Conditioned by Low Temperature

Several instances of partial or complete anophthalmia were recently discovered in otherwise normal larvae of two groups, one a natural spawning, the other consisting of a few offspring obtained by artificial insemination. The affected larvae of the first group numbered 12 of 39, those of the second group 3 out of 19. Two features of significance were common to both groups: (i) the parents were closely related and (ii) the eggs had been kept at a low temperature (14.5° to 16.5°C) until about the time of hatching.

The parents of group 1 were re-mated, and the eggs of the small spawning thus obtained were divided into two groups, one of which was left at room temperature (about 22°C), while the second was kept at a temperature of 14° to 15°C. All of the 13 survivors of the first group had normal eyes; in 4 of the 10 in the low-temperature group the eyes showed abnormalities.

Early development of the affected individuals proceeds in normal fashion. Optic vesicles are formed and the head attains a size equal to that in the normal siblings. Subsequently, the formation, growth, and differentiation of eye structures fail in varying degree. Animals lacking vision exhibit a marked general hyperpigmentation.

R. R. HUMPHREY
Indiana University

Demonstration of a Normal Serum Macroglobulin Coprecipitating with the Bovine Serum Albumin (BSA)-Chicken Anti-BSA Aggregate

One of the most interesting, yet most perplexing, properties of the chicken precipitin system is the phenomenon of high salt dependency. Wolfe and his associates established that the precipitation can take place best in a salt concentration about 10 times that of the mammalian antiserum (that is, 1.5*M* NaCl). The evidence presented suggests furthermore that the increase in precipitation can be accounted for by a salting-out phenomenon of the soluble antigen-antibody complexes. Since chickens are commonly used in immunoembryologic and tolerance studies and since the data obtained are often subjected to broad generalizations, we thought that an investigation should be carried out to test the hypothesis that there may also be a non-antibody serum protein coprecipitating with the antigen-antibody complexes. Pooled chicken anti-BSA sera were analyzed immunochemically by first solubilizing the thoroughly washed antigen-antibody aggregate with a known amount of BSA. Studies with an ultracentrifuge revealed that a $S_{20,w}$ 20-22 component always appeared in the aggregate when the precipitin reaction was carried out under optimum conditions. Its appearance can be prevented by removing the $S_{20,w}$ 15 or greater components before reacting the antisera with the antigen. This component can be identified by the double serum-agar-diffusion method as the second slowest diffusing serum antigen. It is present in nonimmunized adult chickens. Immunoelectrophoretic studies showed that it does not react with specific rabbit anti-chicken γ-globulin reagent. Finally, a combined paper electrophoresis-double serum-agar-diffusion method revealed that it behaves like a β-globulin. The significance of these findings will be discussed.

T. MAKINODAN, N. GENGOZIAN, R. E. CANNING
Oak Ridge National Laboratory

Selective Radiation Coatings

A thin coating of a suitable black semiconductor can be prepared on a bright metallic plate to give a surface which will absorb most of the sun's radiation between 0.3 to 2.5 μ but which will not emit over 20 percent of the radiation of a perfect radiator in the infrared region between 7 and 10 μ. These coatings, described by H. Tabor, are important for the heating of boilers and thermoelectric generators in solar devices and space vehicles. They give a greater efficiency in the conversion of solar radiation into heat and they help to produce higher temperatures.

The chemical stability at high temperatures in air and in vacuum is important.

Experiments are described with several different metals and selective coatings. The coatings may be prepared by chemical reactions, but the best results have been obtained by electroplating a thin coating of copper or cobalt (5×10^{-5} cm thick) on bright nickel, silver, or platinum (depending on the temperature needed) and then oxidizing the plated metal in air at around 400°C.

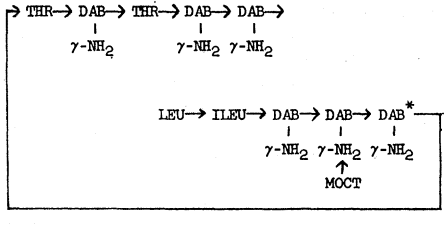
Experimental details will be given for methods of preparation and stability tests.

Hypotheses for the selective behavior will be discussed. The selectivity depends on the thinness of the coating, on its semiconducting nature, and on the character of the metallic oxide surface.

PANOS KOKOROPOULOS
FARRINGTON DANIELS
University of Wisconsin

Chemistry, Site of Action, and Biosynthesis of the Circulins

Bacillus circulans, strain Q19, synthesizes several lipopeptide antibiotics, the circulins; circulins A and B are the main products. Both are remarkably active against many Gram-negative bacteria and contain L-α, γ-diaminobutyric acid (DAB), L-threonine, D-leucine, L-isoleucine, and (+)-6-methyloctanoic acid (MOCT) in the molar relationship 6:2:1:1:1 [*Abstr. of Papers*, 133rd meeting, Am. Chem. Soc., 25C (1958); *Federation Proc.* **17**, 233 (1958)]. The structure of circulin A is as follows [*Abstr. Communs. 4th Intern. Congr. Biochem.* 9 (1958)]



Circulin B is identical to circulin A, with the exception that MOCT is attached through the γ-amino group of the DAB marked by an asterisk.

Because of the fact that the circulins possess a hydrophilic moeity (the cyclopeptide) and a hydrophobic portion (MOCT), we thought that these antibiotics might be cellular components having interfacial functions. However, recent work in collaboration with P. Knolle and H. R. Garner does not support this hypothesis.

On the other hand, they seem to act on bacterial surfaces, as is shown by the location of C^{14}-circulins within or near

the outer layers of the cell when these antibiotics exert their lethal action [*Bacteriol. Proc.* **1956**, 72 (1956)]. For maximum antibiotic activity the complete molecule is needed. The cyclopeptide, though only 2 to 2.5 percent as active as the parent compound, still possesses fairly impressive antibacterial activity. None of the constituent molecules, alone or in various combinations, is active.

T. Kobayashi and I recently succeeded in demonstrating the synthesis of circulins by sonically disintegrated cells of *B. circulans;* the activity resides mainly in the fraction that precipitates when the sonicate is centrifuged between 2000 and 15,000 grav for 30 minutes. The incubation mixture included L-DAB, L-Thr, L-Leu, L-ILeu, and MOCT (6:2:1:1:1), adenosinetriphosphate, and Mg^{++}, Mn^{++}, and K^{+} ions. Dialysis resulted in a decrease of the activity; addition of the dialyzate again increased the synthesizing capacity. D-Leu, the form of Leu found in the circulins, could not be substituted for the L-form. Further studies on the biosynthesis of these interesting compounds are underway.

HENRY KOFFLER
Purdue University

Energy Levels in Neon-22

The 21.8-Mev alpha particle beam from the Indiana University cyclotron has been used to excite the $F^{19}(\alpha,p)$ Ne^{22} reaction. The outgoing proton energies have been measured in double-focusing a magnetic spectrometer [Rasmussen, Miller, Sampson, *Phys. Rev.* **100**, 181 (1955)]. A large number of proton groups were seen and could be identified with the fluorine reaction. Groups were found corresponding to the ground state of Ne^{22} and known states at 1.28- and 3.37-Mev excitation energy. A state found at 4.52-Mev excitation energy was located at 4.9 Mev in earlier work [Ajzenberg-Selove and Lauritsen, *Nuclear Phys.* **11**, 1 (1959)]. Additional proton groups indicated previously unknown states in Ne^{22} at excitation energies of 5.18, 5.67, 6.41, 6.88, and 7.48 Mev. All of the energy measurements are $\pm$0.040 Mev.

H. J. MARTIN, M. B. SAMPSON
D. W. MILLER
Indiana University

Mutagenicity in Aspergillus terreus of Sublethal X-ray Doses and Its Modification by Chemical Protection

Saline suspensions of *Aspergillus terreus* spores show nonlogarithmic inactivation with 250-kv(peak) x-rays. The curves relating the logarithm of the surviving fraction to dose are S-shaped. Addition of cysteamine at concentrations above 0.1*M* extends the shoulder and reduces the slope of the inactivation curve (DRF = 1.8). It has previously been observed in many microorganisms that the percentage of mutations is inversely proportional to the percentage of spores that survive. Careful tests have shown that mutations are induced at low doses, when there is no killing, and that the number is proportional to the amount of energy absorbed. It is also shown that it is possible to reduce the number of mutations by irradiating in the presence of cysteamine without killing any cells. The linear relation between mutations induced and radiation dose is maintained whether or not any spores are killed. This finding indicates that the protection given by cysteamine against mutation induction is real and is not an artifact of slective survival or some other phenomenon that depends on killing of spores.

ALEXANDER HOLLAENDER
A. MARIE MCCARTHY
Oak Ridge National Laboratory

Disintegration of Lanthanum-131

The decay of La^{131} has been studied with the help of a magnetic lens spectrometer, scintillation spectrometers, and scintillation coincidence spectrometers. The half-life is 61 $\pm$ 2 min. Three positron groups have been found having end-point energies and relative abundances as follows: 1.939 $\pm$ 0.045 Mev (27 percent), 1.424 $\pm$ 0.036 Mev (56 percent), 0.704 $\pm$ 0.045 Mev (17 percent). Gamma rays are found at 115, 169, 214, 254, 285, 364, 417, 445, 511 (annihilation radiation), 597, and 878 kev. The line at 115 kev is strongly internally converted. A disintegration scheme is proposed.

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

ALLAN C. G. MITCHELL
CHARLES B. CREAGER, C. W. KOCHER
Indiana University

Far-Infrared Photoconductivity in Germanium

Elements of group III and group V, when introduced into germanium as impurities, have small ionization energies, of the order of 10^{-2} ev. At sufficiently low temperatures, the atoms of the impurities remain electrically neutral. Photoionization of the impurities adds conduction electrons or holes to the germanium crystal, giving photoconductivity which is expected to extend to the region of 100 μ. Photoconductivity in single germanium crystals containing arsenic or phosphorus has been investigated at liquid-helium temperatures, in the range 40 to 130 μ. The response showed a long wavelength, sloping edge in the region 80 to 100 μ for arsenic and 86 to 108 μ for phosphorus. These results are consistent with the absorption spectra measured in this laboratory, placing the ionization threshold near 88 μ for arsenic and 97 μ for phosphorus. At short wavelengths, the response per absorbed photon was nearly constant. The lifetime of the ionized charge carriers was estimated from the photoconductive response. Values of the order of 10^{-9} sec were obtained for both the arsenic and phosphorus-doped samples.

G. T. MCCONVILLE, H. Y. FAN
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(d,p) Reactions in Bismuth and Uranium

A double-focusing magnetic spectrometer has been employed to observe the energy and angular distributions of proton groups from Bi^{209} targets bombarded by 11-Mev deuterons. The Q value of the most energetic proton group, previously unobserved, is found to be 2.34 $\pm$ 0.03 Mev. Since the ground-state Q value calculated from known binding and disintegration energies is 2.38 Mev, this group may represent either the ground-state or a low excited-state transition, or both. Broad but distinct proton groups were also observed corresponding to groups of states in Bi^{210} with mean excitation energies of 0.41, 0.88, 1.5, 2.02, 2.56, 2.81, 3.15, and 4.03 Mev. The observed properties of these groups yield interesting information on the neutron-proton interaction outside a closed-shell core of the atomic nucleus.

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

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Influence of Perfluoroalkyl Groups Adjacent to Reaction Centers

The purpose of this paper is to demonstrate the anomalous chemistry encountered with compounds carrying one or more perfluoroalkyl groups adjacent to a reaction center. The unique reactivities can be attributed to two most conspicuous features. One is the *inductive effect* exerted by the fluorine atoms, generally leading to a decrease in electron density at an adjacent reaction center of a given compound, thus influencing the chemical reactivity. The other factor to be aware of is *steric hindrance.* To illustrate the latter point, the effective diameter of the trifluoromethyl group lies approximately half way between the diameters of the trichloromethyl and the methyl groups.

In many instances both inductive and steric effects must be considered significant factors, and it is often difficult to decide the preponderance of one over the other.

Several results, evidencing this influence by perfluoroalkyl groups, are described in the field of aliphatic chemistry. Reactions have been carried out with halides, alcohols, ketones, aldehydes, acids, esters, and olefins, all carrying perfluoroalkyl groups adjacent to the reaction center.

E. T. MCBEE
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Nuclear Differentiation in Serotype Determination in Tetrahymena

A genetic analysis of serotype differences in two strains of *Tetrahymena pyriformis,* variety 1, reveals two types of segregation: a segregation of potentialities at meiosis, consistent with conventional

behavior of alleles at a single locus, and segregation of expressed serotypes during vegetative reproduction in all heterozygotes. The vegetative segregation can be interpreted as due to the fixation of the activity of one allele and the suppression of the alternate allele in each diploid subnucleus of the macronuclei, followed by a random assortment of differentiated subnuclei at each subsequent cell division. This system of mutual exclusion is superimposed upon a second, presumably of nonallelic specificities. Unlike the second system (Inoki and Matsushiro, 1958; Margolin *et al.*, 1959), the interallelic differentiations appear irreversible and incorporate no cytoplasmic component in their system of perpetuation.

D. L. NANNEY
University of Illinois

Threshold Discontinuities: Application to X-ray Scattering

It is shown that, in contrast to elastic and partial reaction cross-sections, the total cross-section averaged over the Coulomb resonances is continuous at the threshold of a channel of two outgoing oppositely charged particles. An instance in which the effects discussed should be experimentally observable is the elastic scattering of x-rays near a photoelectric threshold. It is shown that the discontinuity in that case should equal the size of the photo effect cross section.

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Use of Chromosomes Showing Meiotic Drive in Study of Population Structure

An individual heterozygous for alleles *A* and *A'* ordinarily produces progeny half of which carry one allele and half the other. Any deviation from this equality will have the immediate effect of altering the allele frequencies in a population. When such a deviation has its origin in an anomaly of the meiotic divisions, the phenomenon is referred to as meiotic drive. Chromosomes or alleles characterized by meiotic drive have, in principle, the capability not only of increasing their own frequencies but also of forcing into the genome of a species neutral or even somewhat deleterious genes inseparably associated with those chromosomes or alleles. Mutation, natural selection, or some other agent must counteract the disadvantage thus imposed on the species; otherwise its genetic make-up will be permanently altered. In this way, meiotic drive experimentally introduced into a population can be used as a tool to assess the relative efficacies of the agents of evolution, to define more accurately the structure of the population itself, or even to modify experimentally the genetic composition of a species. However, it is first necessary to derive artificially induced chromosomes or alleles showing meiotic drive before such an experiment can be considered seriously. This has been attempted in *Drosophila melanogaster*; two cases which appear to show drive, one involving the X-chromosome and the other the second chromosome, have been recovered from irradiated populations of *Drosophila*, suggesting that the phenomenon of meiotic drive may become a potent tool in the study of evolution.

E. NOVITSKI, G. D. HANKS
University of Oregon

Remarkable Irregular Galaxy

The galaxies of irregular shape are not among the most frequently encountered in space, but they have especial interest because of the nature of their stellar population. The light of the majority of these systems is due principally to very large numbers of hot, blue stars; and the color of the light of the irregular galaxies is usually considerably bluer than sunlight.

Among the brighter members of the irregular class of galaxies there is one exceptional object, Messier 82, which is in marked contrast to the others. While the spectroscopic evidence indicates that most of its light comes from stars bluer (hotter) than the sun, the observed color suggests that the temperature of the radiation from Messier 82 is considerably lower than the solar temperature.

New observations carried out at the McDonald Observatory of the University of Texas in the spring of 1959 give the explanation of the discordance between stellar population and color. The behavior of the emission lines of hydrogen and oxygen indicates that Messier 82 is immersed in a great complex of dust; this dust reddens and dims the light from the stars comprising the galaxy.

The presence of the heavy dust absorption in Messier 82 sets off this irregular galaxy from most of the others of the same class; in general, the space between the stars in irregular galaxies seems to be transparent, and reddening and absorption effects are generally minor.

W. W. MORGAN
Yerkes Observatory
N. U. MAYALL
Lick Observatory

Effects of a Protein Isolated from Mouse Salivary Gland, and Its Antiserum, on Mammalian Sympathetic Ganglia

Mouse sarcoma, snake venom, and mouse salivary gland contain closely related nerve-growth promoting agents which elicit exuberant nerve fiber outgrowth specifically from sensory and sympathetic ganglia of the chick embryo, both in vitro and in vivo. We have found that the mouse salivary gland agent has the same effect on sensory and sympathetic ganglia of mouse and human embryos in vitro. Fractions of the mouse salivary gland prepared by Stanley Cohen were injected daily into newborn, young, and adult mice, for periods ranging from 1 day to 1 month. In all instances, the sympathetic ganglia of the injected animals showed a remarkable increase in size. Maximal effects of a sixfold increase in volume were observed in newborn mice after 19 injections; the enlargement is due, in part, to an increase in cell number and, to a major extent, to cellular hypertrophy. The enlargement of the ganglia resulted in an overproduction of nerve fibers and hyperneurotization of the viscera. These results parallel previous findings in the chick embryo.

Stanley Cohen has found that an antiserum prepared against the purified mouse salivary gland agent, when injected into newborn mice, results in a near-total destruction of the sympathetic ganglia. We have found that this antiserum has the same destructive effects on the sympathetic ganglia of newborn rats, rabbits, and kittens. A similar but less severe effect was obtained in adult mice. The injected animals were otherwise as healthy and vigorous as controls.

RITA LEVI-MONTALCINI
Washington University

Separation of Growth-Promoting Activity of Serum for Tissue Culture Cells by Dialysis

The dialyzate from horse serum dialyzed against a relatively small volume of synthetic medium or salt solution has been found to be capable of substituting for whole serum in tissue-culture growth medium. The dialyzate in combination with synthetic medium 1066 supports the growth of six cell strains thus far tested (HEP 2, Giardi human heart, J-96, LLMC 1, Hela, Mox and numerous clone cultures derived from Mox). The active factor (or factors) is released from the serum as a function of time and temperature. When serum is dialyzed at 37°C, growth-promoting activity was initially observed at about 72 hours with maximum activity appearing at about 120 hours. In the cold (4°C), 14 days were required before activity was detected. If serum was allowed to stand at 37°C for 7 days or more preceding dialysis, the activity was detected within 24 hours after dialysis commenced. With this method a preparation has been obtained which does not react with protein precipitants such as sulfosalicylic acid or trichloroacetic acid and which can support the growth of cells to the same extent as when whole serum is used in the medium. Prolonged dialysis results in the accumulation of substances which are precipitated by sulfosalicylic acid but which do not appear to be associated with growth-promoting activity. Indeed, the appearance of this material in the dialyzate coincides with a decrease in the ability of the dialyzate to support growth. A preliminary chromatographic separation of the dialyzate yielded six fractions of which four manifested growth-promoting activity. Studies on the chemical nature of the active fractions are being initiated.

DON P. METZGAR, JR.
MERWIN MOSKOWITZ
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Shape of the Beta Spectrum of Europium-152

Previous measurements of the shape of the highest energy beta group in the decay of 13-year Eu^{152} have suggested that the spectrum has a "unique" shape [Bhattacherjee, Nainan, Raman, Sahai, *Nuovo Cimento* **7**, 501 (1958); Cork, Brice, Helmer, Sarason, *Phys. Rev.* **107**, 1621 (1957)] or an "allowed" shape [Alburger, Ofer, Goldhaber, *Phys. Rev.* **112**, 1998 (1958)]. Measurements made with a strong, relatively thin source in a high-resolution spectrometer permit a definitive interpretation of the spectrum shape in spite of the presence of interfering internal conversion lines. The shape is found to be neither "allowed" nor "unique." For energies above $W = 3.2\ m_oc^2$, the distribution is best fitted by a shape factor

$$(W_o-W)^2 + .79(W^2-1) + 5 \pm 2$$

with $W_o = 3.902\ m_oc^2$, corresponding to an end point of 1.483 ± .007 Mev. The shape is consistent with what one might expect for a once forbidden 3− to 2+ transition with an abnormally high comparative half life.

This work was supported by the Office of Naval Research.

L. M. Langer, D. R. Smith, M. P. Klein
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Further Evidence of the Relatively High Rate of Origination of "Invisible" Detrimental Mutations

To develop a criterion of relative fitness including both survival and reproductive effectiveness, *Drosophila* X-chromosomes, to serve as "experimental" and "control," respectively, were first made coisogenic except for a small terminal region differentiated as regards yellow. After experimentals (nonyellows) were subjected to the chosen influence, each experimental chromosome and its (randomly picked) control were multiplied rapidly. Of each such experimental and control pair about 12 parallel sublines were then established in capacious culture jars, by putting into each jar 600 males, equally divided among experimentals and controls, and 600 females having attached X-chromosomes. In every generation parents were discarded, and offspring, after abundant accumulation, were transferred en masse. Thus the males' X-chromosomes competed severely without interchanging parts. Yellow was meanwhile "covered" by Y-chromosomes containing nonyellow. Anomalous interchange, via triploidy or chromosome detachments, was prevented by sterility genes. After 12 to 24 generations of competition a subline's resultant ratio was ascertained by crossing its males en masse to recessive females having separate X-chromosomes, and then scoring "regular" daughters for yellow.

Disregarding fitness changes of <10 percent as insufficiently conclusive, 10 pairs of chromosomes having neither member experimental showed one yellow inferior, also one nonyellow; 14 pairs whose nonyellows had before competitive breeding accumulated spontaneous mutations (evidenced by 10 percent lethals) heterozygously in females for 53 generations showed four fitness decreases, all nonyellows; 43 pairs whose nonyellows had averaged 16,000 r exposure in oogonia (lethal yield, 8 percent) showed 12 inferior, all nonyellows. These results confirm earlier conclusions that "invisible detrimentals" arise at least 3 to 4 times as frequently as lethals.

This work was supported by U.S. Public Health Service grant RG5286(C1).

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Incorporation of C^{14}-Leucine into Protein by a Cell-free Preparation from Maize Endosperm

A cell-free system that incorporates C^{14}-leucine into protein has been prepared from developing maize endosperm. A particulate preparation is obtained by grinding corn kernels with sand in the cold and extracting with 1 volume of 0.45*M* sucrose. The homogenate is centrifuged at 1000*g* and 10,000*g*, and finally the particles are collected at 100,000*g*. These particles, when suspended in distilled water and incubated at 37°C in phosphate buffer at *p*H 7.0 with C^{14}-leucine, catalyze the incorporation of the amino acid into particle protein. The incorporation system requires ATP, GTP, Mg^{++}, and an ATP-generating system. The incorporation is markedly inhibited by 200 μg of chloramphenicol and by treatment of the particles with ribonuclease. When the particles are washed with distilled water they lose 90 to 100 percent of their ability to catalyze the incorporation. Full activity is restored by supplementation with a *p*H 5.2 preparation from the 100,000*g* supernatant or by a similar fraction prepared from rat liver supernatant. The incorporation efficiency of this system is comparable to that reported for the rat liver microsomal system—that is, 1 to 2 percent of the added radioactivity appears in the protein.

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Mutational Load Due to Detrimental Genes in Man

Morton, Crow, and Muller [*Proc. Natl. Acad. Sci. U.S.* **42**, 855 (1956)] estimated from studies of increased mortality in children of consanguineous marriages that the average person carries heterozygously the equivalent of 3 to 5 recessive lethals acting between late fetal and early adult stages, due to a mutation rate to such genes of 0.03 to 0.05 per gamete per generation. This theory of lethal equivalents has now been extended to detrimental traits, not measured as mortality, for which consanguinity may be ascertained either prospectively, before studying morbidity, or retrospectively, as a family study of ascertained cases (probands). In the latter case, if the incidence of the trait I and the mean inbreeding coefficient of probands $\bar{F}$ are known, the relation between the frequency of the trait P and the inbreeding coefficient $\bar{F}$ can be estimated as $P = 1 - e^{-(A+B\bar{F})}$, where $A = I - B\alpha$ and $B = I(F-\alpha)/\sigma^2$, and α and σ^2 are the mean and variance of F in the general population.

This theory is applied to data on malformations, deaf mutism, limb-girdle muscular dystrophy, and mental defect, in which it is possible by appropriate methods to isolate the components due to simple recessive genes. Under this condition the theory simplifies greatly and leads to a distinction between mutational damage (the mutational load) and segregation from superior heterozygotes (the segregation load). The evidence indicates that most of the genetic load revealed by inbreeding is due to mutational damage. The mutation rate per gamete is $s[A + (A+B)\alpha']$, where s is the selection against the trait in question and α' is the long-term inbreeding coefficient. The number of loci or complementary alleles undergoing mutation is at least $(A+B)^2/A$, and the mutation rate is approximately 10^{-5} per locus per generation.

N. E. Morton
University of Wisconsin

Genetic Basis of Somatic Damage Produced by Radiation

The loss of individual chromosomes, caused by their breakage, forms the chief basis of the mortality induced by irradiating *Drosophila* larvae was indicated by results (Oster, 1959) showing that males are more often killed than females, and males with a ring X-chromosome, which restitutes with difficulty, more often than ordinary males. Moreover, Oster's finding that one ring X-chromosome hardly impairs the survival of females indicated chromosome loss, not chromosome bridge formation per se, as the usual cause of mortality. Tests both by Oster (1959) and by us showed further that, as expected for chromosome loss involving breakage, females having attached X-chromosomes considerably exceed ordinary females in mortality (though complications prevent their distinctly exceeding males).

We now find that females heterozygous for either of two known deficiencies in the X-chromosome have as high mortalities as males. Even the loss of a major autosome seldom kills unless its homologue is deficient. These results also bespeak chromosome loss, not bridge formation per se, or mere deletion of a chromosome section.

However, chromosomes which are pulled poleward with high effectiveness (for example, Novitski's "X.Y" and chromosomes of early zygotes) do kill by bridge formation. For mortality caused by irradiating such chromosomes is not conditional on their loss occasioning a deficiency.

Mortality caused by irradiating larvae

continues throughout life, thus resembling aging although probably different qualitatively from spontaneous aging. Although these mortality-dosage curves are sigmoid (multi-hit), chromosome losses are induced linearly at low dose-rates; hence "aging" accruing therefrom should depend on total dose accumulated.

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Chemically Induced Mating without Mating Type Difference in Paramecium caudatum

Since the discovery of mating types in *Paramecium aurelia* by Sonneborn (1937), it has become evident that mating type differentiation occurs also in other species of *Paramecium*, including *P. caudatum*; and that such conjugation between animals of different mating type is initiated by a typical agglutinative mating reaction (involving ciliary adhesion) and is followed by more intimate holdfast union. Unexpectedly, it has been found that chemical agents can regularly induce the occurrence of conjugation between animals that do not differ in mating type, and that this reaction involves direct holdfast union without a prior agglutinative mating reaction. Although irregularities in the relative positions of the conjugants may sometimes occur, processes characteristic of normal conjugation—degeneration of cilia on the oral side of the animals, micronuclear divisions, breakdown of the macronucleus, transfer of gamete nuclei from mate to mate, and the development of viable clones from exconjugants—have all been observed. Important for chemical induction of conjugation is a low concentration of Ca. Highly effective agents are K, Mg, and heparin; less effective are Rb, Cs, and acriflavine; Na and Li are slightly effective. Some organic agents—for example, acetamide, biuret, and urea—promote the conjugation-inducing effect of the inorganic agents. These chemical agents can also induce conjugation between animals of different syngens in such a manner that both mating types of one syngen conjugate with one mating type of another syngen.

AKIO MIYAKE
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Theory of Repetitive Discharge of Specific Afferents Underlying Fast Spike Waves of Evoked Cortical Responses

The spikelike discharges seen at the onset and during evoked cortical responses produced by single shocks to a sensory input have been ascribed by Chang to discharges in groups of afferent fibers terminating in the sensory cortex, each group with a different conduction velocity, by Bishop to successive groups of interneurones in the cortex synaptically activated after a first afferent fiber group discharge, and by Bremer to a series of discharges in specific afferents as a result of different conduction velocities in their finer intracortical branches.

The first spikelike wave it is agreed by all workers on the basis of latency, is the sign of activity in terminating specific afferents and the correspondence in the origin of the first sensorily evoked spike with the first spikelike fast wave in the similarly appearing pattern produced by direct cortical excitation was shown previously by their occlusiveness (Ochs). Evidence is presented that the second fast wave is similar in origin to the first, and also that the successive fast waves may originate in the same neural element. When recording from animals directly stimulated at the cortex by means of chronic implanted electrodes, ten or more such spikelike discharges may sometimes be seen instead of the usual two or three. This would indicate that some labile mechanism determines the number of spikelike fast waves and leads to the theory that they are a repetitive or oscillatory discharge of the specific afferents at their termination in the cortex.

S. OCHS
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What Is the Infective Agent in Breis of Killer Paramecia?

Breis of killer paramecia of stock 51 have two activities: they kill sensitive paramecia (Sonneborn, Jacobson, Dippell, 1946); they can, under certain conditions, infect sensitives of appropriate genotype, converting them into hereditary killers (Sonneborn, 1948; Tallan, 1959). Killing activity and a distinctive enlarged form of kappa (the B particle containing a characteristic body, the refractile or R body) can be completely sedimented at 3000*g* (Preer, Siegel, Stark, 1953). The supernatant (containing virtually no killing activity) is rich in infective activity, indicating that B particles are not essential for infectivity. Most of this infective activity can be sedimented by centrifuging the supernatant at 5000*g*. This sediment contains a smaller form of kappa (N particles) which lack R bodies. N particles are also present in the sediment obtained at 3000*g* (Preer, Siegel, Stark, 1953). This sediment (containing N and B particles) kills sensitives so that its infectivity cannot be tested. However, it is possible to destroy its killing activity without destroying its infective activity. This is done by centrifuging brei at 25,000*g*, exposing the sediment to the detergent Duponal for 30 minutes, washing, and recentrifuging the suspension at 3000*g*. The sediment so obtained lacks 95 percent of the killing activity of comparable sediment from untreated brei but is highly infective; it contains free R bodies, apparently liberated by the disruption of B particles. Conclusions: (i) infective activity is correlated with the presence of N particles; (ii) neither B particles nor R bodies are essential for infection; (iii) the possibility that B or R, or both, can also infect has not yet been excluded.

This work was supported by grants to T. M. Sonneborn from the Rockefeller Foundation, the American Cancer Society, and the Atomic Energy Commission.

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Evidence of the Lower Mutagenicity of Chronic than Intense Radiation in Drosophila Gonia

To ascertain whether the principle, discovered by the Russells (1958) in mouse oögonia, of the lower mutagenic effectiveness of chronic than acute gamma radiation holds also in *Drosophila;* adult inseminated female *Drosophila* were exposed to 4000 r radiation from a cobalt-60 source, one group being irradiated evenly over 2 weeks at 11 r/hr while actively reproducing and another group getting the same dose within 31 seconds. Both groups were shielded similarly. We are grateful to H. J. Curtis and Dale M. Steffensen for arranging these irradiations for us at the Brookhaven National Laboratory. After both groups had been allowed to reproduce for 10 days subsequent to irradiation, the females were placed, singly, in fresh cultures. Daughters (F_1) that developed in these cultures were tested individually for recessive lethals in their maternal X-chromosome. Omitting tests of flies whose mothers proved to have preexisting lethals, the tests of the chronic series gave 7 lethals, all from separate treated mothers, among 537 F_1 females tested, and the tests of the acute series gave 32 lethals, including 6 that arose in three clusters of two sister F_1 females each, among 932 F_1 females tested. The respective percentages with their errors (in which clustering is allowed for) are 1.3 ± 0.5 and 3.4 ± 0.65. The difference is statistically significant and in the direction expected if flies resemble mice in the respect in question. Less conclusive evidence indicates that the same principle holds in *Drosophila* spermatogonia, both for the production of ordinary lethals and of minute deficiencies.

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Cytogenetic Studies on Human Somatic Cells in vitro

Techniques have been developed for culture of somatic cells from any individual; growth of such cells for indefinite periods without karyotype distortion; accurate chromosome identification; and quantitative plating whereby every cell produces an isolated colony so that effects of various agents on growth can be accurately titrated and mutant clones can be isolated. Their application in human genetic diseases may elucidate the pathogenesis, identify chromosomes on which

specific genes are carried, and provide cells with genetic markers for in vitro studies. Thus ovarian dysgenesis in the human female was previously shown to result from a missing sex chromosome, producing an XO constitution. A similar, though not identical condition, familial primary amenorrhea, has now been found with a male chromosome constitution (XY). Pedigree data indicate a recessive gene defect, presumably on the X-chromosome, which prevents normal male character expression.

X-ray survival curves for normal, diploid human cells reveal the mean lethal dose for reproduction to be 50 r. Quantitative analysis of the chromosomal dynamics in such irradiated cells confirms the chromosomal nature of the primary damage. If irradiated cells are fixed shortly after irradiation, only chromatid and chromosome breaks and deletions are observed. With continued incubation, broken ends recombine, leaving recognizably aberrant recombinations as the only visible evidence of radiation injury. The mean dose required to introduce one chromosome break per cell under these conditions is about 25 r. Thus on the average, two such breaks can produce reproductive death of the cell.

THEODORE T. PUCK
University of Colorado Medical Center

Scattering Length and Effective Range Theory for Coupled Two-Body Channels

The threshold properties of a two-body channel which is coupled to other channels are investigated. In particular, we examine the "new" channel when it is coupled to only one or two other open, two-body channels. We describe the system by specifying generalized potential: a diagonal interaction for each channel and coupling interactions between the channels. A number of relations are derived among the following quantities: the complex scattering length and effective range describing the new channel, the phase shifts in the old channels, some matrix elements of the interactions, and some integrals over wave functions. We then illustrate the usefulness of some of these relations by solving, exactly, the problem in which a two-channel system is described by two coupled Schroedinger equations with square well potentials. The scattering length and effective range are also examined by means of a complex potential for the situation in which there are many coupled channels.

MARC H. ROSS, GORDON L. SHAW
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New Theoretical Foundation for the Concept of Ionic Character

This paper is concerned with the nature of the two-electron chemical bond. It is shown that it is possible to define mutually orthogonal "atomic" and "ionic" wave functions such that they have optimum properties associated with the intuitive concepts implied by their names. Then in an extremely good approximation which is well defined and independent of a particular choice of basis functions, the bond may be described as a linear combination of these two orthogonal functions. The binding arises almost completely from the ionic-atomic cross-term in the square of the wave function for the bond. Application to the heteropolar two-electron bond leads logically to the definition of a theoretical parameter which has many of the characteristics of electronegativity difference. The Wang, Weinbaum, and Rosen approximate wave functions for the H_2 molecule are analyzed by this method. They are strikingly similar, demonstrating the invariant characteristics of the new functions defined here.

HARRISON SHULL
Indiana University

Synthesis of Isomaltose

A method for directly coupling two glucose units in the α-D linkage is needed and to this end the insertion of the nonparticipating nitrate group into the second position of the known 3,4,6-tri-*O*-acetyl-β-D-glucopyranosyl chloride appeared attractive. The nitration was effected at $-20°$C with acetyl nitrate and the crystalline product, tri-*O*-acetyl-2-*O*-nitryl-β-D-glucopyranosyl chloride (I), underwent solvolysis with methanol in the presence of silver carbonate, and methyl tetra-*O*-acetyl-α-D-glucopyranoside was isolated after reductive removal of the nitrate ester with hydrogen and Raney nickel and subsequent acetylation. (I) reacted with 1,2,3,4-tetra-*O*-acetyl-β-D-glucopyranose in alcohol-free chloroform and in the presence of silver carbonate to yield, after reductive cleavage of the nitrate group, acetylation and chromatographic separation by Magnesol-Celite extrusive chromatography, β-isomaltose octaacetate (9 percent) and β-gentiobiose octaacetate (5 percent). The reaction is under further study.

M. L. WOLFROM
IAN C. GILLAM
Ohio State University

Mathematical Analysis of the Mating Type Determining System in Paramecium aurelia, Syngen 7

In *Paramecium aurelia*, syngen 7, mating type XIII may be genotype mt^{XIII}/mt^{XIII}; $mt^{XIII,\ XIV}/mt^{XIII}$; or $mt^{XIII,\ XIV}/mt^{XIII,\ XIV}$, and type XIV may be either $mt^{XIII,\ XIV}/mt^{XIII}$, or $mt^{XIII,\ XIV}/mt^{XIII,\ XIV}$. Because sexually produced progeny of animals carrying mt^{XIII} usually become type XIV, if genetically competent, while animals homozygous for $mt^{XIII,\ XIV}$ usually do not change mating type in the next sexual generation, Taub (1959) postulated that most matings in populations containing both alleles would be between heterozygous XIV's and XIII's homozygous for mt^{XIII}, when the following parameters are low: (i) the fraction, A, of autogamy among all sexual processes, and (ii) C_3, the frequency with which XIII's of genotype $mt^{XIII,\ XIV}/mt^{XIII,\ XIV}$ give rise to XIV's in the next generation, and C_1, C_2, C_4, and C_5, the frequencies with which the remaining four genotype-phenotype combinations give rise to XIII's in the next generation.

In order to test this postulate, equations were derived which describe, on the basis of random mating, the frequencies of the five genotype-phenotype combinations in any generation in terms of their frequencies in the preceding generation and of the six parameters. The equations were fed into a computer, using various test values for the eleven variables. The data obtained reveal: (i) A stable equilibrium is approached at rates depending upon the initial eleven values, even (under certain conditions) when either allele is initially at very low frequency. (ii) In all equilibria examined the mating type ratio is 1:1. (iii) The prevalence of the homozygote by heterozygote mating (as in genotypic sex determination of higher organisms), as postulated, was confirmed for cases of low C values (the empirically verified situation) and A values less than about 0.7. (iv) With higher A values, most matings are between homozygotes for $mt^{XIII,\ XIV}$, the kind of system prevalent in *Paramecium aurelia*.

This work was supported by PHS genetics training grant 2G-82(C1), and partially by a grant to T. M. Sonneborn from the Rockefeller Foundation.

STEPHEN R. TAUB
Indiana University

Biological Contamination of the Moon

The probability of survival of a terrestrial microorganism, accidentally deposited on the moon by an impacting lunar probe, is computed. A population of the least radiosensitive dormant anaerobic microorganisms, if exposed to solar ultraviolet radiation, would be totally destroyed in hours. The resulting organic dissociation products would remain intact for much longer periods of time; 0.1 to 10 years if the lunar surface magnetic field strength is much less than 10^{-2} gauss, and 10^4 to 10^5 years if it exceeds 10^{-2} gauss. Organisms shielded from solar illumination, perhaps in congealed dust matrix interstices, would survive for 10^9 years or more.

The possible existence of indigenous lunar organic matter, with which the remnants of deposited microorganisms might be confused, is then discussed. The rate of synthesis of organic molecules by solar ultraviolet radiation in the primitive lunar atmosphere is estimated. The consequent lunar surface density of organic molecules is probably greater than 10 gm/cm^{-2}. As the lunar atmosphere was dissipated, heat and radiation produced organic molecules of great complexity from the deposited material. Such organic matter would now be situated beneath overlying layers of meteoritic and other surface debris. If Whipple's picture of a congealed semiporous dust matrix is a correct description of these upper layers, the likelihood of contamination of indigenous or-

ganic matter by terrestrial organic matter would appear to be fairly small. But such contamination, if it did occur, would destroy possibly unique sources of information on such problems as the origin of life and the early history of the solar system. It is recommended that all hard-landing lunar probes be decontaminated.

CARL SAGAN
Yerkes Observatory

Genetic Basis of Mating Type Determination in Paramecium bursaria

The discovery of a breeding system comprising four interfertile (but self-sterile) complementary mating types in *Paramecium bursaria* by Jennings in 1938 led him to carry out an extensive genetic analysis aimed at establishing the mechanism of mating type inheritance and determination. Jennings' data led him to suggest that the four mating types are controlled by genotypic differences, but he was unable to assign genic formulae to each of the types. The present research confirms the suggestion proposed by Jennings; the mating types are now known to be directly controlled by genes at two unlinked loci. A similar two-gene hypothesis was considered by Jennings in 1942 but discarded because it failed to account for all of his data. Crosses among the present strains and their sexual progeny reveal that cells of mating type A carry dominant alleles at both loci, A^-/B^-; homozygous recessives, *aa/bb,* are type C; mating types B and D are respectively aa/B^- and A^-/bb. The cytological events of conjugation and nuclear reorganization confirm the genetic interpretation and the two-locus hypothesis satisfactorily accounts for most of Jennings' results. Jennings' rare instances of mating type instability within a clone may indicate changes in the expression of macronuclear genes ("mutation") but probably do not involve alterations of micronuclear genes. A similar interpretation is proposed for the qualitatively unexpected types which appear rarely in certain of Jennings' crosses. Several observations of Jennings, confirmed here, suggest that alleles at the B-locus regularly come to expression before those at the A-locus; the temporal sequence is independent of dominance and recessivity and has not, so far, been altered by changes in background genes.

R. W. SIEGEL, L. LARISON
University of California, Los Angeles

Biochemical Studies on the Action of a Gene Controlling Meiosis in Maize

The recessive gene ameiotic (*am*), when homozygous, completely suppresses meiosis in maize in both the male and the female sporocytes. Meiosis is replaced by a type of mitotic division.

Studies of free amino acids and sugars by paper chromatography have revealed no differences between normal and ameiotic plants. However, paper chromatogram of water or alcohol extracts of various organs of ameiotic plants show the presence of a compound giving a yellow fluorescence in ultraviolet light, which is almost absent in the normal plants.

Analyses of root tips and of young ears at different stages of development with regard to nucleic acids, their precursors and histones, have given the following results: (i) In the ameiotic plants there is an accumulation of certain acid-soluble precursors which are probably not incorporated into nucleic acids as rapidly as in normal plants. No acid-soluble material accumulates in vegetative meristematic regions such as root tips, nor in the very early stages of ear development prior to megasporogenesis. (ii) Ameiotic plants and normal sibs do not differ in the quantity of DNA or total nucleic acids, but the amount of RNA relative to DNA is greater in the ameiotic plants than in the normal ones. Differences were also found in the (iii) apurinic DNA fraction obtained after hydrolysis with dilute hydrochloric acid and (iv) in the relative amount of histones compared with DNA.

It seems probable that a critical balance between the two nucleic acids and between DNA and histones is essential for the onset of meiosis and for its normal progress.

S. K. SINHA
Indiana University

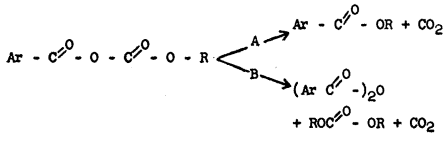
Hypoelastic Waves

Hypoelasticity is a smooth rate theory of large deformation. Although the differential equations of the theory are nonlinear, certain accelerationless disturbances may be propagated along surfaces of discontinuity. Such waves are determined and described in the present investigation.

C. A. TRUESDELL
Indiana University

Decomposition of Mixed Carboxylic-Carbonic Anhydrides

It was shown recently [Tarbell and Longosz, *J. Org. Chem.* **24**, 774 (1959); compare Windholz, *ibid.* **23**, 2044 (1958)] that the mixed carboxylic-carbonic anhydrides decompose by two paths, A and B.



The structural factors which determine the proportion of paths A and B were investigated, and it was found that with R an optically active group, there was complete retention of configuration of R during reactions A and B. A kinetic study of the reaction in solution by following the rate of carbon dioxide evolution now shows that the decomposition is powerfully catalyzed by amine hydrochlorides, dry HCl, sodium benzoate, lithium bromide, lithium chloride, and tetramethylammonium chloride, salts which are only slightly soluble in the reaction mixture. Lithium perchlorate is not a catalyst, although it is soluble. The reaction is much more rapid in dimethylformamide than in hydrocarbon or ether solvents, and the proportions of paths A and B are not affected by the presence of catalysts. A consideration of the rate evidence and of some additional stereochemical observations indicates that paths A and B have a common rate-determining stage and that the reactions occur by a set of ionic chain reactions.

D. STANLEY TARBELL, EDWARD J. LONGOSZ
University of Rochester

Rock-Stratigraphic Classification in the Pleistocene

The system of stratigraphic classification used in North America for all sedimentary rock units except nonmarine deposits of Pleistocene age establishes groups, formations, and smaller units on characteristics of the rocks and not on geologic time or geomorphic features. Students of the nonmarine Pleistocene have not kept these kinds of units distinct.

The Pleistocene sediments of Indiana and the surrounding states are of continental rather than marine origin, and thus they show far less lithologic homogeneity than sediments can and should be grouped into logical and usable formational units by lithologic characteristics. In such an approach, units that are wholly geomorphic such as terraces are omitted, but many time-lithic units now shown on most surficial geologic maps are not changed; rather, they are named as groups, formations, or members, or are regarded as facies. Four of the six formations proposed for Pleistocene sediments in Indiana have upper and lower contacts that correspond closely to time boundaries and are marked by key beds such as paleosols. The other two formations consist of several related lithofacies through which time boundaries may be drawn only with great difficulty, if at all.

Where this approach is used, local names can be designated for useful lithostratigraphic units in the Pleistocene series. Existing stage terminology is retained as time-stratigraphic nomenclature. This change in philosophy should be of particular value where problems of correlation with a standard time sequence frequently arise.

WILLIAM J. WAYNE
Indiana Geological Survey

Dynamics of Cell Ultrastructure in Development and Growth

In an actively growing root apex, cells may be followed through the stages of division, development, and growth directly along a short linear axis. An electron microscope study of the fine structure of cells in successive stages of development in the maize root has revealed an extensive general vesicular reticulum of which the nuclear envelope of the interphase cell is

a component. The system is such as to provide a relatively great lipoprotein surface area contact between the nucleus and the cytoplasm, between the nucleus and the surface of the cell, and, through intercellular connections, between the reticula of neighboring cells. This reticulum fragments during the prophase of mitosis, but the fragments remain in position around the dividing nucleus. If the cell is to divide again, the nuclear envelope is reconstituted as part of the general system. It is suggested that the Golgi apparatus, which appears to be very active at the time of cell division, may play a part in the formation of this extensive reticulum. Changes in the character of the system accompanying cell division and cell growth and the involvement of the reticulum in formation of the cell plate are discussed. Attention is directed to the implications of the findings for nuclear-cytoplasm-cell surface and cell-to-cell transport and to their possible importance in relation to cellular differentiation.

W. G. WHALEY

University of Texas

Beta-Gamma Directional Correlation Measurements in First Forbidden Transitions

The energy dependence of the anisotropy coefficient for the first forbidden beta decay and the subsequent gamma ray has been studied in the cases of Rb^{86} and La^{140}. The measurements were made with a small-shaped-field 180° beta-ray spectrometer which defined the electron energy and a movable scintillation gamma-ray detector. In the case of Rb^{86}, the anisotropy ranges from + 0.06 at 160 kev to + 0.19 at 630 kev. The values obtained at seven energies in this range are accurate to about 5 percent. It is hoped that with these more reliable data a theoretical analysis of the results may lead to a knowledge of the matrix elements involved in the decay. In the case of La^{140} the measured positive anisotropy of $+ 0.12 \pm 0.03$ at 1.67 Mev is to be compared with the theoretical value of + 0.133 which prevails for a spin sequence $4^- - 2^+ - 0$. This datum together with the results of Langer's shape determination of the high-energy beta group makes the spin assignment of 4^- to the ground state of La^{140} unambiguous.

R. G. WILKINSON
H. J. FISCHBECK

Indiana University

Theory of High-Energy Peaks in Pion-Nucleon Cross Sections

We wish to report an investigation of whether the spectrum of high-energy peaks observed at 650 Mev, 950 Mev, and 1.3 Bev in pion-proton scattering (and photoproduction) can be explained in terms of the conventional low-energy pseudoscalar pion-nucleon interaction. Previous investigation of this problem has yielded negative results, stimulating speculation on the role of pion-pion interactions. We suggest that the previous investigations of the pion-nucleon interaction have been inadequate. A Chew-Low formalism is outlined below which predicts two isobars, or metastable states, of the nucleon. We consider the two-p-wave pion, one static nucleon system, and explicitly examine the effects of the low-energy p 3/2 T = 3/2 pion-nucleon scattering resonance on this system. Loosely speaking, we consider one meson and then the next meson, and so forth, scattering in the 3/2 3/2 state, with respect to the nucleon. The propagation of the two-pion-one-nucleon system is being examined just as a mechanism for the existence of isobars. If the diagonal T matrix element in the two-pion-one-nucleon state is sharply peaked, the various observable cross sections, which we have not attempted to calculate, will also be peaked.

After making several approximations, we obtain an integral equation in which the basic parameter is the amplitude for finding one pion in the 3/2 3/2 state if the other pion is in that state. This amplitude depends on the total angular momentum and isotopic spin. A numerical solution of this equation leads to the definite indication of two isobars: the (even parity) states J,T = 5/2, 1/2 and J,T = 3/2, 3/2, which may correspond to the 950-Mev and 1.3-Bev peaks.

WEN NONG WONG, MARC ROSS

Indiana University

Regional Melanism in Aquatic Beetles

A significant number of the aquatic beetles (Coleoptera: Dytiscidae, Haliplidae, and Hydrophilidae) found in the flatwoods of Florida are much darker than their relatives in the adjacent coastal plain or in the Antilles. The Florida race of the *Tropisternus mexicanus* complex is a striking example. Most members of this rassenkreise are light-colored with narrow dark stripes on the elytra, but in peninsular Florida a very dark form (*viridis*) replaces the usual light race of the eastern United States (*striolatus*). Nonconcordance with environmental conditions, the steplike nature of the intermediates, and the absence of similar variants in other members of the genus indicate genetic rather than purely environmental control of the patterns. The occurrence of light-colored, *striolatus*-like, specimens in extreme southern Florida suggests that *viridis* may be a relatively recent mutant the genes of which have not yet spread through the entire Florida population. Dark forms such as *viridis* may be favored because they are less visible to predators in dark-bottomed habitats such as are common in Florida. If so, the regional melanism of the water beetles may be due directly to differential elimination of light and dark forms as in the "industrial melanism" of the moths of the English midlands.

FRANK N. YOUNG

Indiana University

Modification of Abnormal Genetic Ratios

Inequalities in recovery between members of each of two nonhomologous pairs of chromosomes and among the expected gametic types were reported by Novitski and I. Sandler (1957) from *Drosophila* males of "Stone's Bar" mutant type, possessing as one pair of homologues a fourth chromosome attached to a large distal piece of the X-chromosome and a normal fourth chromosome, and as another pair the proximal piece of the X-chromosome and the longer Y-chromosome. Despite the inequalities, simple cross-products of the recovered frequencies of the individual homologues gave expected gametic frequencies in excellent agreement with those observed. The authors suggested the possibility that not all the products of spermatogenesis are functional and that certain chromosomes, the longer ones, segregate preferentially into the nonfunctional meiotic products.

My experiments show that both pairs of homologues always vary in the same direction in any one experiment—that is, either members of both or of neither show inequalities in recovery rate. Moreover, otherwise indistinguishable Y-chromosomes and autosomes derived from different laboratory stocks appear to be responsible for the variation, for in the presence of NE ("no-effect") Y-autosome combinations, the inequalities tend to disappear while in the presence of E ("effect") Y-autosome combinations, inequalities are observed. The results suggest also that the greatest effect in the direction of either inequality or equality is observed when the Y-chromosome and all major autosomes are of the E or NE type, respectively, intermediate effects being observed in the presence of mixtures of E and NE chromosomes.

This work was supported by NSF grant G-5929.

S. ZIMMERING

Indiana University

Line Blending in Stellar Spectra

The absorption lines in stellar spectra provide the principal data for the determination of the abundance of the elements and the structure of stellar atmospheres. In some regions of the spectra of cool stars these absorption lines are crowded together and become blended. No satisfactory general method for disentangling the information present in a blend has thus far been devised and, consequently, blends are usually ignored in the quantitative analysis of stellar spectra. The availability of high-speed digital computers now makes it possible to study a great many theoretical models of line blending in detail. A program of this kind has been undertaken at the Indiana University astronomy department, making use of the IBM type 650 computer at our Research Computing Center. This paper is a report of the results of numerical studies of the simplest models.

MARSHAL H. WRUBEL

Indiana University

Growth of a Fireball

The potential commercial utilization of the heat of underground nuclear explosions has attracted a renewed interest in the detailed mechanics of the expansion of a nuclear fireball. The many phenomena which occur simultaneously in an actual nuclear explosion render difficult an over-all general picture of the explosion. The purpose of the present study was to obtain such an over-all picture by the method of introducing simplifying assumptions as to the medium in which the explosion takes place. The assumption that the explosion takes place in a hydrogen plasma enables us to obtain a complete analytical solution for the expansion of the fireball during that stage which precedes hydromechanical expansion. The most interesting feature of this analysis is the vertical drop of temperature at the boundary of the fireball.

C. ZENER
Westinghouse Research Laboratories

Symposium on Antibody Formation

William H. Taliaferro, *Chairman*

Effect of the Interval between Two Stimuli on the Height of the Secondary Antibody Response

Antibody formation takes place at a greatly accelerated rate in lymph nodes in cells of lymphoid tissue which have had a previous exposure to the antigenic stimulus. The increase in the rate of synthesis is dependent on a greatly increased number of cells which make a response in such an experienced cell population. For many years it has been known in an empirical way that good secondary responses were dependent on a delay between the application of the two stimuli. In order to answer the question whether there was transmittal of any kind of information by such experienced cells to their descendants, an experiment was carried out in mice testing the dependence of the peak secondary response on the duration of the interval between the first and secondary antigenic stimuli. It was found that the response increased in extent during the first 3 weeks after the first injection but that there was no further change, the subsequent response staying approximately equal throughout the whole of the interval examined (160 days). It is concluded that either there is no multiplication of the cells after the 3-week period or else that only one of a pair of daughters receives the information.

A. H. COONS, A. FECSIK
Harvard University

Cellular Phenotypes and Genotypes in Antibody Formation

An attempt has been made to devise a genetic approach to the immune response. To analyze the process in genetic terms, one must be able to study the phenotypes and genotypes of individual antibody-forming cells.

In a study of the phenotypes of antibody-forming cells, we have incubated cells from immunized lymph nodes singly in microdroplets. The antibody titration method used depended on the specific immobilization of motile *Salmonella* by small amounts of antiflagellar antibody. It has been shown that all antibody-producing cells belong to the plasma cell series and that far more cells form antibody in a secondary than in a primary response. Moreover, in a secondary response, individual plasma cells seem to form more antibody in a given time. When animals were immunized by a variety of schedules with two or three unrelated antigens, single cells formed detectable amounts of one antibody only. Nearly 2000 plasma cells from such animals have been examined, and in no case did one form detectable amounts of two or three antibodies.

The study of the genotypes of antibody-forming cells has been more indirect. Populations of immunologically competent cells have been transferred serially through immunologically neutral newborn rat hosts. While these experiments are at an early stage, the evidence is consistent with the view that cells are genotypically as well as phenotypically restricted in their antibody-forming capacity.

G. J. V. NOSSAL
Stanford University

Role of Antigen in Antibody Production

Three distinct cellular phenomena are involved in the process of antibody production. (i) In a small fraction of lymphoid cells there is a quickly reversible and visible change which lasts several days after an injection of antigen. During this time these cells synthesize large amounts of antibody—more than 100 molecules per cell per second. (ii) A specialization in the responsiveness of antibody-producing cells limits the response of a given cell to a few antigens. The degree of specialization of these cells is not known, but the number of cells responding to a given antigen increases after immunization with that antigen. The persistence of an animal's ability to make an anamnestic response indicates that specific responsiveness of a cell, once achieved, is lasting. (iii) Replication of antibody-producing cells is shown by a marked increase in mitotic figures in spleen and lymph node after an antigenic stimulus.

Two major questions concerning the mechanism of antibody production relate to the role of antigen and cell replication in the first two phenomena listed above. In the first case the question is whether antigen becomes an intrinsic part of the synthetic mechanism or acts only as a trigger. In the second case the question is whether the large numbers of specifically responsive cells in the immunized animal arise through an antigen-induced change or by selected replication of preexisting spontaneously differentiated cells.

DAVID W. TALMAGE
University of Colorado

Antibody Formation in the Primary and Secondary Response

Producing a primary response to ovalbumin (OA) and a simultaneous secondary response to bovine serum albumin (BSA) in rabbits injected with S^{35}-amino acids, we find almost identical specific activities in both precipitating antibodies. Evidently their bulk is formed from the same amino acid pool. In rabbits injected with S^{35}-amino acids before and with C^{14}-amino acids 3 days after the secondary dose of BSA or bovine γ-globulin in the ratio "S^{35} in antibody/S^{35} in γ-globulins" and the analogous C^{14}-ratio indicate the presence of some preformed antibody. Using the agglutination of antigen-coated erythrocytes as a test method, we find nonprecipitating antibodies over periods of at least 6 to 8 months after the primary injection of OA or BSA. We attribute the intensity of the secondary response to the combination of this circulating antibody with the reinjected antigen, rapid phagocytosis of the antigen-antibody complexes by reticuloendothelial cells, and subsequent formation of antibody in a large number of these cells; the antigen portion of the complexes may act as a template. In the primary reaction, where circulating antibody is absent and cannot act as carrier, only a few antigen molecules may reach the sites of antibody formation. Therefore the primary response is less vigorous than the anamnestic reaction. We see no need to invoke adaptation, selection or mutation as responsible for the intensity of the anamnestic reaction.

F. HAUROWITZ,
M. RICHTER, B. PATRAS
Indiana University

Antibody Formation by Single Cells

Antibody formation by single cells from the lymph nodes of hyperimmunized rabbits can be detected by distributing such cells in drops of very small volume (10^{-6} to 10^{-7} ml) containing culture medium. Using as immunizing antigens three serologically distinct bacteriophages, antibody specific for them can be assayed by inactivation in the drops of their plaque forming ability. Background controls are drops of culture fluid in which the cells are suspended during distribution in microdrops. A fourth bacteriophage is included in the drops as a volume control.

From such cells in mass suspensions and in microdrops the following facts have been ascertained: (i) As high as 20 percent of randomly chosen cells make γ-globulin specific for the immunizing bacteriophages. (ii) Cells do not make such γ-globulin in the absence of a course of immunization. (iii) A single cell can, and frequently does, make antibody to more than one bacteriophage. (iv) The ability to form antibody is not restricted to a single cell type, though cells of the plasmacytic series are the more frequent antibody formers.

EDWIN S. LENNOX
University of Illinois
MELVIN COHN
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