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Utilization of Carbon Dioxide in the Synthesis of Protein and Nucleic Acid by *Escherichia coli*

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Cells of *E. coli* take up carbon dioxide from the bicarbonate of a synthetic medium which contains glucose as an energy source. The carbon of the $NaHCO_3$ molecule is utilized in the synthesis of proteins and nucleic acids. When $NaHC^{14}O_3$ is used the isotope is found largely in aspartic and glutamic acids, arginine, lysine, proline, and threonine, but not in the remaining amino acids of the proteins. The location of the tracer isotope within the amino acid molecule is characteristic of the amino acid and does not change for a variety of altered culture conditions. Both the purines and pyrimidines of the nucleic acids become labeled with C^{14} after growth of cells in $NaHC^{14}O_3$ media.

When the culture media are supplemented with nonradioactive metabolites such as amino acids or purine bases, the labeling of certain amino acids or nucleic acid constituents, which would occur in the absence of supplementation, is specifically suppressed. It is ordinarily observed that a supplemental compound—e.g., an amino acid—is utilized by the cell for the construction of protein in preference to synthesis *de novo* of the same compound from the simpler constituents of the medium. Metabolic intermediates are also preferentially utilized. For example, citrulline will completely eliminate the utilization of CO_2 for arginine synthesis. These observations have provided a basis for the determination of some biosynthetic interrelationships among a number of the amino acids of the proteins, and among the purines and pyrimidines of the nucleic acids of *E. coli*.

These studies have shown that there are at least five distinct processes by which carbon dioxide is assimilated by *E. coli*: those giving rise to (1) the purines, (2) the pyrimidines, (3) aspartic acid, (4) glutamic acid, and (5) the amidine carbon of arginine. It is significant that these pathways for carbon dioxide utilization are essentially identical with those that have been individually discovered in a number of different living systems.

The Role of Glutathione in Protein Synthesis by *Escherichia coli*

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One fourth of the total sulfur of *E. coli* cells can be extracted with cold trichloracetic acid. This soluble fraction contains one major sulfur component identified as glutathione (GSH). The biosynthesis of S^{35}-labeled GSH from $S^{35}O_4^=$ is blocked by the presence of unlabeled cystine or GSH in the medium but not by the presence of unlabeled methionine or homocystine. Kinetic studies show that GSH has a high rate of turnover.

When cells containing S^{35}-labeled GSH grow in the presence of $S^{32}O_4^=$, roughly one half the S^{35} of the GSH is incorporated into the proteins and one half is released into the medium. With methionine added to the medium the transfer of GSH sulfur to protein-methionine is blocked; with cystine the transfer to both the protein-cystine and the protein-methionine is blocked. The sulfur released into the medium can be separated into several fractions by ion exchange resins or by paper chromatography. These fractions contain GSH and several other organic S-compounds including peptides.

C^{14}-labeled GSH is synthesized by cells growing in a medium containing $C^{14}O_2$, mineral salts, and glucose, but this synthesis is blocked by the presence of unlabeled glutamic acid or GSH in the medium. GSH also suppresses the incorporation of $C^{14}O_2$ into several amino acids of the proteins.

These findings demonstrate the important role of glutathione as an intermediate in the synthesis of proteins by *E. coli*. Some progress has also been made in determining the mechanism of utilization of glutathione.

Amino Acid Sequence in Proteins

Philip H. Abelson, *Carnegie Institution of Washington*

The number of individual proteins to be found in the living world is enormous. This diversity arises largely from combinations of approximately 20 amino acids used as building blocks. The demonstration of recurring patterns in the order of amino acids in the proteins would greatly simplify our understanding of protein synthesis and structure. Examination of the products of partial hydrolysis of the total proteins of *E. coli* has uncovered one such pattern.

Attention was focused on the combinations of amino acids with cysteine. For these studies the cysteine of *E. coli* was specifically labeled with S^{35} by growth of cells in a synthetic medium containing $S^{35}O_4^=$ and nonradioactive methionine. The cells were harvested, freed of nonprotein constituents, treated with performic acid, and partially hydrolyzed to obtain a mixture consisting principally of dipeptides, tripeptides, and tetrapeptides. A combination of electrophoresis, resin chromatography, two-dimensional paper chromatography, and radio-autography facilitated purification and isolation of peptides containing cysteic acid.

More than 75% of the cysteic acid was found in amino acid combinations which included glycine. A peptide containing only cysteic acid and glycine in that order accounted for more than 10% of the original cysteine of the proteins of the bacterial cells. On the basis of a purely random order of amino acids in proteins a maximum of 4% of the cysteine could have been present as cysteicyl-glycine.

The presence of the cysteinyl-glycine combination in glutathione and the wide occurrence of the latter throughout nature are suggestive of a possible widespread occurrence of the cysteinyl-glycine combination in proteins. Indeed, Sanger and Tuppy have recovered cysteicyl-glycine from beef insulin following performic acid treatment and partial hydrolysis. Their fraction "B" of insulin was shown to possess two cysteine molecules, both followed by glycine.

Other possible regularities in patterns of amino acid sequences are under investigation.

Effects of Testosterone Propionate on Social Status in Six Breeds of Common Domestic Hens

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This study in comparative sociology has focused on results of daily injections of male hormone into hens of low social rank in small flocks of the following breeds: Light Brahma (Asiatic); Barred Plymouth Rock, Rhode Island Red, New Hampshire (American); Ancona, White Leghorn (Mediterranean); and the selected single-comb progeny of a cross between White Leghorn and White Wyandotte (American), frequently called the "English" strain of White Leghorn.

Androgen-injected hens became more aggressive in all flocks except in "English" Leghorns. Sixty-four per cent of treated individuals gained higher social status; one of them reached highest social rank among Anconas, uncrossed Leghorns, Plymouth Rocks, and Brahmas. Considering all injected birds in each breed, Anconas were clearly most responsive; Leghorns also showed good reactivity, indicating high effectiveness of the androgen on these light-weight, excitable Mediterranean breeds. Despite the small numbers tested, refractory individuals were found in all breeds tested, except Ancona.

The American breeds, as a group, gave less response to androgen treatment than the Mediterraneans and, Plymouth Rock excepted, were no more responsive than the heavy phlegmatic Brahma. Not counting "English" White Leghorn as a breed, the difference in response between the two White Leghorn strains was greater than that between any two breeds tested.

The characteristic differences in peck-order relations in these breeds are, to some extent, androgen-induced. The interbreed variations may be in part, though not wholly, a matter of dosage in relation to weight. We do not know the mediation processes whereby male hormone influences the fundamental breed differences in behavior.

Poliomyelitis and the Weather

Charles Armstrong, *National Institutes of Health*

A new concept is suggested for explaining the peculiar seasonal incidence of poliomyelitis, which views the upper respiratory tract of man as either the portal of entry or of exit for that portion of virus largely effective in its transmission.

When atmospheric air is inhaled it is warmed in the nose and throat to 90° F and its relative humidity raised to 90%. The increased secretions, and possibly other alterations, necessary to prevent the mucous membranes from becoming parched in cold weather are believed to hinder the transmission of poliomyelitis, whereas a quiescent membrane with a minimum of secretion and evaporation, such as prevails in warm moist weather, favors it. It is felt that the condition of the mucous membranes of the nose and throat is of more significance for the spread of poliomyelitis than is the mere opportunity for the virus to spread from person to person.

This concept relates the summer incidence to a recognized alteration in the upper respiratory passages, rationalizes the long-recognized correlation of poliomyelitis incidence with warm weather, and presupposes a similar and possibly more significant correlation with humidity, not heretofore apparent. However, when inspired air warmed in the nose and throat to 90° F is considered, a direct correlation between atmospheric relative humidity at this temperature and the incidence of poliomyelitis becomes apparent. The curves where so far studied are so similar in general and in detail as to indicate a significant relationship.

Genic Control of Gene Expression in *Paramecium aurelia*

Geoffrey Beale, *University of Edinburgh*

The hereditary properties of an organism depend, as is well known, on its genes, but these latter can only function satisfactorily in certain environments. Further, the cytoplasm is known, from work with *P. aurelia*, to control which of a series of genes will be fully expressed and which inhibited. Consequently, the direction in which a given cell will develop depends on the state of the cytoplasm. Evidence will be presented showing that this cytoplasmic state is partly controlled by the external environment and partly by the genes themselves.

In variety 1 of *P. aurelia* there is a series of genes—*d, g, s*—controlling the formation of antigenic substances on the cilia. The *d* alleles are expressed in a cytoplasmic state normally formed at a high temperature (29°–33°), the *g* and *s* alleles at medium (25°) and low (18°) temperatures, respectively.

The readiness with which the cytoplasm changes from one state to another under the influence of changing temperature, is markedly different in different races of the organism. The genetic factors controlling these diversities have been investigated by a series of matings, including repeated backcrosses by which the antigen-determining genes of one race were combined with a background of other genes of another race. It was found that the stability of cytoplasmic states depended partly on the antigen-determining genes themselves and partly on other genes.

Hence there is a mutual interaction between genes and cytoplasm whereby the cytoplasm determines whether a given gene shall be expressed, yet is itself partly controlled by the same gene.

The Limiting Negative Pressure of Mercury in Pyrex Glass

Lyman J. Briggs, *National Bureau of Standards*

It is generally considered that mercury does not "wet" glass, as evidenced by the convex surface of the mercury meniscus in a barometer. If this were true under all conditions, the development of a negative pressure in a mercury column would be impossible. But *pure* mercury in a clean evacuated *degassed* tube shows a *flat* meniscus. In other words, when the tube is degassed, mercury does adhere to the glass wall.

A U-tube manometer of 5-mm bore with one leg sealed off was evacuated and degassed at 500° C with a mercury-vapor pump, and then filled with pure mercury by distillation. The vertical height of the mercury column from the top of the closed leg to the meniscus in the open tube was 52 cm. When again evacuated, the mercury column remained suspended from the top of the tube. In other words, the column showed a negative pressure of two thirds of an atmosphere. But when once released by vertical jarring, the column would not hang up again.

In endeavoring to extend these measurements, short mercurial thermometers were first used. Each thermometer was cemented to the spinner of a variable-speed motor, with the spin axis bisecting the distance from the end of the bulb to the meniscus. The maximum stress on the free capillary column was consequently at the spin axis. The results for nine thermometers were erratic, giving negative pressures ranging from 2 to 17 bars.

Finally, freshly-drawn capillary tubes with fine bores were evacuated, degassed at about 550° C, and filled by breaking one end under pure mercury. This procedure gave limiting negative pressures of mercury in Pyrex glass of 46, 47, and 58 bars at room temperature, as compared with about 10 bars in a similar ungassed capillary. Degassing thus appears to result in a fourfold increase in the adhesion of mercury to glass.

The Cytogenetics of Introgression

Roy E. Clausen, *University of California, Berkeley*

The cytogenetical problem of introgression, as exemplified in transfer of genes from wild species of Nicotiana to cultivated tobacco, *Nicotiana tabacum*, involves special features owing to the high sterility of the F_1 hybrids and to the low degree of association of chromosomes of the two species in the hybrids. Thus in the transfer of necrotic mosaic resistance from *glutinosa* to *tabacum*, the normal hybrid is almost completely sterile and the chromosomes of the two species exhibit only a low degree of association. The sterility may, however, be overcome by crossing tetraploid instead of diploid *tabacum* with diploid *glutinosa*, producing in the first instance a relatively fertile triploid hybrid having two sets of *tabacum* and a single set of *glutinosa* chromosomes. Such a hybrid, either when selfed or when backcrossed to *tabacum*, quickly eliminates the alien *glutinosa* chromosomes; but if selection is practiced for a specific feature, such as necrotic mosaic resistance, a $24_{II}+1_I$ segregant is first obtained, which, in addition to the complete diploid set of *tabacum* chromosomes, retains the single alien chromosome carrying the selected factor. Introgression of the alien gene into the *tabacum* complex next ensues as a consequence of association of this extra alien chromosome occasionally with a specific *tabacum* chromosome, where, by following simple segmental interchange, a whole alien chromosome may be substituted for a specific *tabacum* chromosome (alien substitution) or the segmental interchange chromosome may be substituted for it (segmental substitution). The shift of the gene from the extra chromosomal condition either to alien substitution or to segmental substitution is signalized by appropriate alterations in the transmission ratio of the selected character.

Nuclear Cytology of the Fungus *Eremascus albus*

Edward DeLamater, Sidney Yaverbaum, and Lucille Schwartz, *University of Pennsylvania*

Current evidence is conflicting concerning the nature and position of the nucleus in the cells of the lower fungi, including the yeasts, the number of chromosomes, and their characteristics. The mechanism of their division is likewise not clear. Since the advancement of the genetics of the lower fungi depends largely upon a definition of the nucleus, pertinent evidence is important.

The vegetative nuclear divisions in *E. albus*, Eidam, proceed by mitosis. The nucleus is distinct from other cell inclusions, including central vacuoles and basophilic granules.

Sexuality occurs as a fusion between two like gametangia to form a single sexual cell in which the gamete nuclei fuse. In the sexual cell the differentiation of the large central vacuole and the nucleus is most distinct.

In the fusion nucleus the chromosomes occur as long, tangled threads in a characteristic leptotene stage. In the zygotene the chromosomes pair, at first at one or two points along their lengths. Subsequently they pair along their entire lengths, and enter pachytene. The chromosomes contract in the classic manner through typical diakinesis. At metaphase, six pairs of chromosomes are visualized. The centrioles and spindle appear to have an extra nuclear origin. As anaphase and telophase proceed, no new nuclear membranes are formed about the daughter nuclei. Meiosis II follows directly. Only following the third division are nuclear membranes redelineated and spore walls laid down.

The observations presented constitute: (1) the first clear demonstration of the nucleus and its *modus operandi* in this group of organisms; (2) a characterization of its chromosomes; and (3) a demonstration of a remarkably classic pattern of nuclear structure and activity for these organisms.

On Finite Groups with Two Independent Generators, II

Jesse Douglas, *Columbia University*

This paper continues with the developments begun in a previous paper of the same title, presented to the Academy in November 1951. Necessary and sufficient conditions governing the defining substitutions θ, φ of a two-generator group $\Gamma = \{A^{\alpha}B^{\beta}\}$ (conjugate special substitutions) are given. Included is the simple condition: $\theta(0) = 0$, $\varphi(0) = 0$. *Each* substitution θ (or φ) of such a conjugate pair has *by itself* some very special properties. Characteristic is the following: every 0-*fixing translation of θ must be a power of θ*. "Translation" means a transformation $x = x' + a, y = y' + b$, converting the substitution $x \longrightarrow y$ into $x' \longrightarrow y'$. An equivalent condition is: the *1-translation of any power θ^{ν} of θ must be again a power of θ*: $\theta^{\theta}1^{(\nu)}$. This leads to the idea of *derivative* θ_1 of any special substitution θ. If $\theta, \theta_1, \theta_2, \ldots, \theta_k, \ldots$ denote the series of successive derivatives, the *type* of θ is defined as the least index k such that $\theta_k = (0)$—the identity on the range consisting of the single element 0. Examples of substitutions of various types, up to 6, are given.

Plaques Produced on a Monolayer Tissue Culture by Single Particles of an Animal Virus

R. Dulbecco, *California Institute of Technology*

Plaque formation by single virus particles is the basis for the analytical techniques used in the study of bacterial viruses. This has now been obtained with an animal virus, the virus of Western equine encephalomyelitis growing on chicken fibroblasts. This phenomenon may serve for the development of an animal virus assay much superior to any other assay now in use, and for the isolation of the progeny of single virus particles.

Virus plaques are produced on a continuous fibroblastic layer grown on the bottom of a glass flask of the size of a Petri dish. A continuous cell layer is first grown in two days, following a technique devised by W. R. Earle, and then the virus is applied on it; easily detectable round necrotic areas are produced within two or three days of subsequent incubation.

The number of plaques produced by two different dilutions of the same virus sample is proportional to the concentration of the virus; hence a plaque is produced by a single virus particle. The comparison between the number of plaques produced and the fraction of chicken embryos infected by the same virus sample indicates that all or nearly all virus particles able to infect the embryo produce a plaque. There is therefore a 1: 1 relation between infecting particles and plaques.

Plaque production is technically simple and reproducible.

Experiments are under way in which this phenomenon is applied to a detailed analysis of this virus-host system.

On the Dynamics of the Cochlea and the Middle Ear

Harvey Fletcher, ***Columbia University***

The fundamental differential equations of force and continuity for the liquid in the cochlea are derived. Coupled to the motion of this liquid is the reaction of the basilar membrane separating the two canals of the inner ear, the oval window membrane, the round window membrane, and the helicotrerna. These reactions are taken into account and an equation derived which gives the velocity and displacement of the basilar membrane at any position in terms of the pressure level and frequency of a tone impressed upon the eardrum. Calculations using this equation show that the position of maximum stimulation of the nerve endings along the basilar membrane is near the stapes end for the high frequencies, and near the helicotrena for the low frequencies.

By making the rational assumption that the number of nerve discharges originating from any small part of the basilar membrane is proportional to the square of the velocity of the membrane at that position, it is shown how to calculate the sound pressure levels corresponding to the threshold of hearing at various frequencies. These calculated values agree with those observed. This calculation shows that the poor acuity of the normal ear for perceiving low-frequency sounds is due primarily to the poor transformer actions of the middle ear.

Uterine Influences upon Intrarenal Blood Distribution

Kenneth J. Franklin, ***University of London***

The following résumé is based upon the literature, public statements, and experimental results obtained alone or with colleagues.

In specific cases of renal trouble (oliguria, anuria, acute tubular nephrosis, bilateral cortical necrosis) in pregnant and puerperal women there has been evidence of excessive uterine distension by products of conception / concealed accidental haemorrhage / cortical ischaemia with medullary flow continuing / excessive uterine contraction *post partum.*

Diversion of the renal cortical blood flow can occur physiologically in nonanesthetized animals, and spontaneously in anesthetized animals of various species.

In rabbits it has been found that:

1) Distension of either horn of the virgin, parous, or pregnant uterus with Ringer's solution, the animal's blood, or blood from a donor animal can cause diversion of blood flow from the cortices of both kidneys (*a*) by direct reflex action upon the renal vasomotor apparatus, (*b*) by a reflex *cum* humoral action dependent upon the integrity of the adrenal glands.

2) During spontaneous parturition there is a humoral (probably posterior pituitary) reduction of the renal cortical blood volume.

3) For a while after such parturition there is reduction of the same blood volume through uterorenal reflex action.

4) Appropriate stimulation of the renal nerves has caused acute tubular nephrosis and renal cortical necrosis.

Chain Polymerization of Bi-Bolaform Electrolytes

Raymond Fuoss and Paul Goldberg, ***Yale University***

Ordinary 1-1 electrolytes show a moderate degree of association in methanol, where the electrostatic potential energy of a pair of ions at contact is of the order of several kT. Bolaform electrolytes are multivalent electrolytes in which one ion has the structure (+) . . . (+) or (−) . . . (−). If we consider a bi-bolaform electrolyte such as $Me_3N^+ (CH_2)_3{}^+NMe_3 \cdot {}'O_2C(CH_2)_4CO_2'$ in a solvent where electrostatic forces are sufficiently strong, we might expect chain formation of the sort schematically represented by (− . . . −) [(+ . . . +) (− . . . −)]$_n$ (+ . . . +). Experimentally such association should be detectable as an abnormally large viscosity. Our results demonstrate the expected effect: the reduced viscosity of the above salt in anhydrous methanol is 0.045 (i.e., several times the Einstein limit for spheres). The shape of the curve is similar to that for neutral polymers and in no way resembles the square root curve of the Debye-Falkenhagen theory for strong electrolytes. The following variables have been studied: dielectric constant of solvent, spacing of charges in the bolaform electrolyte, and concentration of added simple electrolytes. These compounds represent a new type of synthetic chain molecule which shows both characteristic similarities and contrasts to polyelectrolytes and polymers.

Homoeotic Mutants and Evolution

Richard B. Goldschmidt, ***University of California***

I have claimed repeatedly that homoeotic mutants, as found in *Drosophila,* are good models of macroevolution by large steps (saltations). A new type of tetraltera is apt to illustrate how a single mutant affecting early embryonic processes can have effects of a macroevolutionary order. The main feature is that the localized action upon a specific developmental process may lead to a set of embryonic regulations and integrations that result in a widely divergent architecture of a part of the body. In the example, a mutant of the podoptera group, the embryonic separation of the anterior wing field from the rest leads to (1) reconstitution of this part into a leg or haltere-like structure (depending upon the size of the wing segment involved) by production of a mirror image half, (2) redetermination of the rest of the winganlage into thorax, which is developed in the lower grade of the effect as a winglike appendage carrying the thoracic bristles; in the higher grades, corresponding to earlier action, the extra half-thorax is completely integrated with the normal part of the thorax into a new type of aberrant thorax, which, nevertheless, is perfect as such. The existence of all transitions proves the interpretation. The problem of the establishment of such a macromutant in nature will be touched upon.

Evaporation from Liquid Surfaces in Vacuum

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The accommodation coefficients of liquids at the interface with vapor or foreign gas have been the subject of wide study in many laboratories under the tacit assumption that the coefficient with the pure saturated vapor will be characteristic for each type of liquid and generally less than unity. Experiments to be reported suggest that the coefficient varies over a tremendous range for any liquid according to the momentary and local circumstances at the surface, and is not dependent on chemical composition except under rigidly defined circumstances of purity and surface demand. It is found that the accommodation coefficient decreases when equilibrium with the vapor is disturbed and certain kinds of foreign molecules are present, and it is thus lowest when an impure fluid is evaporating freely into a high vacuum. Relative ratio of emission of vapor is now referred to as the *evaporation coefficient*; and it can be shown that there are definite rules governing the emission, the coefficient decreasing when the surface is pushed, increasing when it is stretched, and the values are repeatable and thus predictable with an accuracy of a few per cent. The low coefficients appear to be due to a traffic jam at the surface caused by molecules of impurity becoming stranded in the surface mosaic, where they limit egress of the solvent molecules. The surface skin has high mechanical strength, but it vanishes as soon as the causative conditions are removed.

The apparatus that led to these conclusions consists of a pot still and a sensitive probe which records the emission of vapor from a chosen point on the surface from moment to moment. The still contains means for stretching, pressing, or agitating the surface in known degree, and it is attached to a purification train which can, at will, continuously distill and overflow the contents. Only when the surface is purer than (it is believed) has ever been obtained before does the coefficient rise to unity, and then the value is not altered by pushing, pulling, or stirring.

A Coordinate System for the Treatment of the Motion of a Shell

R. H. Kent, ***Aberdeen Proving Ground***

In dealing with angular motion of a shell about its center of gravity, it is convenient to use a spinning non-Galilean coordinate system. Two of the most widely applied treatments, using such systems, are those by Fowler, Gallop, Lock, and Richmond and by Nielsen and Synge, especially as extended by Kelley and McShane. The former group uses a coordinate system which turns with the particle trajectory. In this they consider two vectors, Λ, a unit vector representing the direction to the axis of the shell and, X, a unit vector having the direction of the actual trajectory. Nielsen and Synge use a coordinate system associated with the shell. They have three unit vectors, i_1, i_2, i_3. Of these, i_1 has the direction of the axis of the projectile, and the other two are perpendicular to i_1. The author proposes a system which differs slightly but significantly from that of Fowler, Gallop, Lock, and Richmond. In his treatment, the unit vector Λ is defined not with respect to a coordinate system turning not with the particle trajectory but with the actual trajectory. In this way the treatment of the vector X is avoided.

The method of deriving the equation for the complex yaw is briefly explained. The results are compared with those of Fowler, Gallop, Lock, and Richmond, and of Kelley and McShane.

Sign and Symbol in Bee Communications

A. L. Kroeber, ***Columbia University***

Von Frisch's searching experiments on the so-called language or communication of bees prove that these social insects transmit to one another, by dancelike motions, information as to the abundance, distance, and direction of supply of food. Surprisingly, all three of these kinds of information are quantitative. The communication of the first two sets of facts, on abundance and distance, could be explained as quantitative reflex responses to stimuli, which would expectably be genetic and congenital. However, the expression of direction, when a simple pointing repetition is not feasible, is by a movement the axis of which departs from an antigravitational vertical by an angle corresponding to the angle by which the direction of food supply from the hive departs from the direction of the sun from the hive. The relation of this means of expression to the fact denoted seems indirect, physiologically arbitrary, and abstract. In short, the expression resembles a linguistic expression, a true symbol, and not a direct sign or signal, although it is generally accepted that the faculty of symbolization and abstraction is restricted to human beings and is perhaps their most significant differentiating characteristic. The possibility or probability of interpretations contrary to the above is examined; but what analysis makes clearest is the importance of further directed observations and experiments on the problem.

Pure Quadrupole Spectra of Solid Chlorine Compounds

Ralph Livingston, ***Oak Ridge National Laboratory***

The pure quadrupole spectra of a number of covalently bonded chlorine compounds have been observed as solids at low temperatures. A precise measure of the nuclear quadrupole moment ratio of the two stable chlorine isotopes is obtained from the determined quadrupole couplings. A comparison of quadrupole couplings gives a measure of the variation from one molecule to another of the electric field gradient experienced by the chlorine nuclei. The electric field gradient has its origin primarily in properties of the chemical bond that holds the chlorine in the molecule. It is found that the magnitude of the quadrupole couplings increases smoothly in the sequence CH_3Cl, CH_2Cl_2, $CHCl_3$, and CCl_4, as well as in the sequence tert-butyl chloride, isopropyl chloride, and ethyl chloride. In these cases the changes in coupling may be explained by changes in ionic character in the carbon chlorine bond. A large number of other molecules, including many "Freons," correlate well.

The Electron Affinity of Iodide in Liquid Ammonia and the Heat Content of the Electron in Ammonia and Water

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The thermodynamic data are available for the calculation of the ΔH of the reaction in liquid ammonia.

$$I^-_{(am)} = I_{(am)} + e^-_{(am)} \qquad \Delta H = 109.3 \text{ kcal}$$

The absorption curve for iodide in liquid ammonia has

been measured, and the maximum lies at 2540 A. This corresponds to an energy of 112.4 kcal. If the photoabsorption results in complete ionization, the difference between the two energies should represent the relaxation energy of the solvent molecules about the iodide ion after the emission of the electron.

It has been generally assumed that the relaxation energy should be of the order of magnitude of the solvation energy. For iodide in ammonia this should be about 80 kcal. We are unable to give a completely satisfactory explanation for the small value, 3.1 kcal, calculated from the above data.

A comparison of the energies for the photodissociations of I^-, Br^-, and OH^- in water with the thermodynamic data indicates that the relaxation energies in water also are small. If it is assumed to be 4% of the hydration energy, as found for I^- in ammonia, one then calculates for these cases a consistent value of 89 kcal for the heat content of the electron in water.

Aurora Borealis

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

Focused by magnetic fields, protons and electrons in nearly equal numbers reach the earth and, as Gartlein and Meinel have shown, produce broadened and shifted lines of the Balmer series in the aurora borealis. An astrophysical analysis of the emission of hydrogen gas in the neighborhood of the earth indicates that the number of protons and electrons per cm^3 of the gas responsible for this emission is of the order of 10^6.

An analysis of the effect that gas clouds would have on the earth's magnetic field indicates that the latter can exert a focusing action. The corpuscular solar radiation responsible for the aurora borealis tunnels its way through the magnetic barrier of the earth's field.

The total energy carried by the ions stream may approach that of solar radiation itself. Thus, we can relate corpuscular radiation to the heating and dynamics of various portions of the earth's atmosphere.

Technetium in the Stars

Paul W. Merrill
Mount Wilson* and *Palomar Observatories

Technetium, the first "artificial" element, was identified in 1937 by Perrier and Segrè in a piece of molybdenum that had been bombarded with neutrons in the cyclotron at Berkeley. Technetium has also been detected among the products of fission of heavy atoms. No completely stable isotope is known; the most nearly stable has a half-life less than a million years.

The spectrum of technetium was thoroughly investigated in 1950 by Meggers and Scribner at the National Bureau of Standards. Their work has made astronomical investigations possible. In 1951 Charlotte E. Moore announced the possible presence of weak lines of ionized technetium in the solar spectrum.

Spectrograms, dispersion 10 A/mm, taken by P. W. Merrill with the 100-inch telescope and others taken recently by I. S. Bowen with the 200-inch, show several lines of neutral technetium in the spectra of S-type stars, especially of long-period variables. The strongest of these lines are in the a^6S–$z^6P°$ multiplet, analogous to the well-known triplet at λ4030 in the spectrum of manganese. Stellar spectra of type S are characterized by bands of zirconium oxide and by relatively strong lines of heavy metals such as zirconium and barium.

It is surprising to find an unstable element in the stars. Either (1) a stable isotope actually exists although not yet found on earth; or (2) S-type stars somehow produce technetium as they go along; or (3) S-type stars represent a comparatively transient phase of stellar existence.

Methods of Using Binoculars

Walter R. Miles, ***Yale University***

There are two basic methods of using binoculars: (1) keeping them continuously at the eyes and (2) locating the field by naked eye and then using the binoculars. The relative advantages of the two methods were examined on a group of U. S. Navy personnel and a control group matched for age and visual qualifications. Five target areas, ⅓–2 miles distant, seen against the sky, were used. Observation was from a rooftop station. Standard 7×50 binoculars were employed. The targets, varying in size and contrast, were each made of two black or gray bars that could be oriented vertically or horizontally and were presented in a randomized series determined for each subject individually. Subjects were tested individually after pretraining, and each man made 115 response judgments. The continuous method (1) was found to give more prompt judgments in both groups by 0.2–0.3 sec. In terms of threshold resolution the discontinuous method (2) proved superior by about one log step for target size and target contrast. The choice of method, therefore, in particular military situations should be in terms of the anticipated hazards.

In designing the targets it was assumed that the 7×50 binoculars with coated lenses might yield 4.5 efficiency over naked eye performance. The results indicate that the assumption was more than reached and that the probable efficiency of such glasses over the naked eye is 5: 5.5 in such critical tests and distances as were used in these daytime experiments.

Recent Determinations of Atomic Masses and Nuclear Binding Energies

Alfred O. C. Nier, ***University of Minnesota***

A double-focusing mass spectrometer has been developed which, because of its sensitivity and versatility, makes possible the measurement of atomic masses of virtually every isotope of any element. A systematic study of two regions of the atomic table has been completed, from S^{32} to Zn^{70}, where 42 of the 45 naturally occurring nuclides have been measured, and from Pd^{102} to Xe^{136}, where measurements on 42 of the 48 stable nuclides were made. Measurements are made by the familiar doublet method, hydrocarbon fragments serving as comparisons.

The mass-spectroscopically determined masses, when supplemented by nuclear reaction data, furnish a large block of data making possible extensive comparisons with semiempirical formulas for nuclear binding energies. A comparison with the formula of Wigner indicates discontinuities in the binding energy surface at 20 and 28 protons and neutrons and at 50 protons. The data are sufficiently accurate to reveal other less pronounced details of fine structure.

Low Temperature Properties of Helium 3

Darrell W. Osborne, Bernard M. Abraham, and Bernard Weinstock, ***Argonne National Laboratory***

Sufficient quantities of pure He^3 have been obtained by nuclear transformations to permit investigations of

some properties of the liquid. These investigations are of interest because they may aid in the interpretation of the extraordinary properties of liquid He^4. By studying the flow of the liquids through a small channel it was found that He^3, in contrast to He^4, does not exhibit the phenomenon of superfluidity. This result is consistent with the theory that superfluidity is connected with the fact that He^4 follows Böse-Einstein statistics, whereas He^3 follows Fermi-Dirac statistics. It has also been shown that the addition of He^3 to He^4 depresses the temperature below which the liquid behaves as a superfluid, and that the transition to the superfluid state remains of the second order type as He^3 is added. Further, the viscosity of liquid He^3, like that of all other liquids except He^4, was found to increase as the temperature is lowered. Measurements of the melting pressure of He^3 between 1.5 and 0.16° K have shown that He^3, like He^4, has the remarkable property of remaining liquid when cooled to absolute zero, unless a high pressure is applied. Above 0.5° K the data are represented by the equation $P = 26.8 + 13.1\ T^2$ atmospheres, but below 0.5° K the experimentally determined melting pressures rapidly approach a constant value of 29.3 atmospheres. The results below 0.5° K may be spurious because of possible poor thermal contact between the capillary containing the He^3 and the paramagnetic salt used for cooling below 1° K, but if they are correct they imply a transition in the liquid near 0.5° K. Further experiments are in progress to clarify this point.

Common Metabolites and Stimulation or Inhibition of Growth by Plant Tissue Cultures

A. J. Riker and A. C. Hildebrandt
University of Wisconsin

Various plant tissues have been studied *in vitro* to clarify factors that stimulate or inhibit growth. They came from crown gall on marigold, Paris daisy, periwinkle, and sunflower, and from normal hybrid tobacco stems. They grew during 10 years through many transfers on synthetic media. The amount of growth after six weeks was determined by weighing the tissue pieces. The results reported came from over 60,000 pieces of tissue.

Common metabolites, depending on their concentrations, respectively, often encouraged or discouraged growth of the various tissues.

With various sources of nitrogen at pH 6.0, growth was excellent with nitrate (.008 *M*) and urea (.032 *M*). Except on arginine, growth of sunflower tissue was sharply inhibited by all the amino acids tried at .001 *M*. However, satisfactory growth developed with relatively strong (0.064 *M*) concentrations of alanine, aspartic acid, and glutamic acid, possibly because of transamination.

One tissue or another, respectively, used a wide range of sugars and polysaccharides. Some showed best growth with certain substances at particular concentrations.

The common alcohols at pH 6.0 were poor as sole sources of carbon. With 2% sucrose, some common alcohols inhibited specific tissues at particular concentrations. For example, all five kinds of tissue were inhibited by butanol at .125%, and by propanol at .06%.

The common organic acids at pH 6.0 were poor sources of carbon. With sucrose, many of them inhibited growth. For example, marigold tissue was inhibited by 0.03% of propionic, glutaric, and acetic acids.

Nondilation of Arteries with Pulsating Blood Flow

S. R. M. Reynolds, *Carnegie Institution of Washington*

In the course of collaborative studies of the fetal circulation with G. M. Ardran and M. M. L. Prichard, of the Nuffield Institute for Medical Research, Oxford, observations were made which show that there is no lateral or radial deformation of arteries associated with physiologically pulsating blood flow. In umbilical arteries, direct cineangiographic pictures of blood flow were recorded at 25 frames/sec. Thorotrast was injected into the aorta by way of an iliac artery. Blood pressure was recorded from a branch of the umbilical artery. The following facts were established: (1) blood flow in the artery is laminar; (2) flow is pulsatile; (3) there is no detectable lateral deformation of the artery observed (*a*) in projected moving pictures or (*b*) in tracings of arteries in successive frames in a series; (4) there is lateral pulsatile displacement of the entire artery in certain regions, especially in the vicinity of curves where there is deflection of the pulsating streamline flow.

The fact that pulsating arteries do not dilate but are displaced locally was confirmed throughout the descending aorta of the cat by direct cineangiography. Only the ascending aorta and the arch of the aorta expanded and contracted with periodic ejection of blood from the heart.

Contrary to common belief, pulsatile arterial blood flow is not associated with significant radial deformation of the vessel wall in the propagation of a pulse wave. It therefore appears that the pulse wave is transmitted as a wave of pressure within the moving blood stream.

Nature of Inherited Resistance to Viruses Affecting the Nervous System

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The Children's Hospital Research Foundation, University of Cincinnati

The accidental discovery that an inbred line of mice (PRI) is 100% resistant to the 17 D strain of yellow fever virus made it possible for the first time to work out the mechanism by which animals inherit resistance to certain viruses. The results indicate that resistance to the 17 D virus is inherited as a dominant in accord with the Mendelian laws for a single pair of autosomal genes. The dominant gene does something to the cells of the resistant host to make them a poorer medium for the propagation of yellow fever virus—multiplication being 10,000–100,000 greater in the brains of susceptible than in those of resistant mice. The lower level of viral multiplication permits the development of immunity without disease.

The possession of the dominant gene does not, however, protect the mice during the first few days of life. The virus does not multiply to a higher level in the newborn, but its cells are more vulnerable. The mouse-adapted French neurotropic strain of yellow fever virus kills 24% of adult PRI mice, even though it multiplies only to the same low level as the 17 D virus. The special cellular vulnerability to the French neurotropic strain of yellow fever was also found to be genetically determined, but independently of the factor controlling viral multiplication.

The genetic factor which depresses multiplication of

the yellow fever virus has a similar effect on the viruses of dengue, West Nile fever, Japanese B, St. Louis, and Russian tick-borne encephalitis, but is without effect on the viruses of western equine, eastern equine, and Venezuelan encephalitis, poliomyelitis, rabies, and a number of others tested. It was also found that some viruses possess or can develop variants which can overcome the genetic resistance of the host.

Cloud Chamber Observations of the New Unstable Particles in Cosmic Rays

Bruno Rossi, ***Massachusetts Institute of Technology***

The MIT group has operated for several years a multiple-plate cloud chamber at the Inter-University High Altitude Laboratory at Echo Lake, Colo. (alt., 10,600′). Most of the time the chamber was triggered by a penetrating shower selector placed above it. This triggering arrangement afforded the possibility of an unbiased investigation into the properties of the secondary particles from nuclear interactions occurring above the chamber. Among these secondary particles we found many examples of the new unstable particles. Some of these decay in flight and exhibit the characteristic appearance of the so-called V-particles (both charged and neutral); the large amount of material present in the chamber made it possible to investigate, in some detail, the nuclear interactions of the secondary particles arising from their decay. Other particles disintegrate after coming to rest in matter. Their secondary products are heavier than electrons, for they traverse several lead plates without multiplication. These particles, for which our observations provided the first experimental evidences, are possibly identical to the so-called κ-particles that shortly afterward were detected in photographic emulsions by the Bristol group. Our results, together with those of the Bristol group, make it appear unlikely that κ-particles may be identical to charged V-particles.

Imperfections in Crystals: A Synthesis

Frederick Seitz, ***University of Illinois***

The primary imperfections responsible for many of the most interesting properties of crystals have been studied in detail for about 25 years. During this period separate imperfections have been introduced into the field to explain individual properties, such as plasticity, diffusion, electrical resistivity, and many other characteristic properties. At the present time six primary types of crystal imperfection are recognized: phonons, electrons and holes, excitons, vacant lattice sites and interstitial atoms, foreign atoms in either interstitial or substitutional position, and dislocations.

It is regarded as unlikely that there are more primary imperfections characteristic of the principal types of solid, although special imperfections may exist in materials with specialized properties, such as ferromagnetic materials. In addition to the primary imperfections there are three transient imperfections: light quanta, charged radiations, and uncharged radiations. The transient imperfections may have a brief life within the crystal. The individual imperfections are discussed with a brief account of the historical introduction of each type. It is pointed out that two or more imperfections of the same type or of different types may interact to generate other imperfections, so that the group forms a closely interlocking family. This feature of the imperfections is regarded as an essential part of their pattern of behavior, intimately related to the normal properties of the imperfections.

Seismic Results Relative to Crustal Structure in the Wisconsin Area

Louis B. Slichter, ***University of California***

Seismic results from six large underground blasts in the Wisconsin area are reported. The observations were made with a group of a dozen three-component seismographs, located on selected bedrock sites. Time signals at 1-sec intervals were transmitted by radio. On the scale of the present work, which involved an area about 600 km × 150 km, the major structure was a relatively homogeneous layer about 40 km thick. The observed time-distance relations corresponding to this layer are nearly linear and would imply constant compressional wave velocities of 6.16, 6.26, 6.22, and 6.16 km/sec, respectively, at the four regions investigated. However, a somewhat improved fit to the observational data is obtained if the wave velocity is not constant, but increases slightly from 6.0 km/sec at the top to 7.0 km/sec at the bottom of the layer. Under the latter assumption, the mean absolute value of the time residuals is reduced to about one half its value for the assumption of a homogeneous layer. Above the main layer is a thin superficial layer 0.6–2.8 km thick, with wave velocity 4.2–4.6 km/sec. The coarse scale of the field observations permits only spotty sampling of this thin upper layer. Beneath the thick, nearly homogeneous layer, at depth 40–44 km below the ground's surface, a major crustal discontinuity is indicated, where the wave velocity increases suddenly from 7.0 km/sec above the transition to 8.2 km/sec below.

The Action of Isotopic Insulin Bound to Tissues

William C. Stadie, Niels Haugaard, and Martha Vaughan
University of Pennsylvania

We previously reported that muscle, liver, adipose tissue, and lactating mammary glands of rats bind insulin. The bound insulin exerts its customary effect on metabolism.

In further work we prepared isotopic insulin labeled with S^{35} and I^{131} to relate biological effect to mass of insulin. These preparations have greatly extended the precision and significance of our experiments. Some types of experiments which will be reported are: (1) Insulin bound is a function of concentration and time of exposure. (2) There is a saturation level of bound insulin at higher concentrations of insulin. (3) Insulin binds readily at pH 2. (4) The binding is increased with rising temperature. (5) There is a close correlation between insulin bound and its biological activity. This was measured both *in vivo* and *in vitro* with concordant results. These measurements for the first time measure the biological activity per unit mass of a hormone. (6) Measurements of distribution of insulin following intravenous and subcutaneous injection show contrasting results.

These experiments lead to the concept that a prerequisite for insulin action is a chemical binding on intact cellular elements. Contra-insulin effects of pituitary or adrenal hormones may either: (*a*) inhibit the *action* of the bound insulin, or (*b*) inhibit the *binding* of insulin. In either case the metabolic activity of insulin would be decreased but by quite different mechanisms.

The distinction between these two possibilities is of fundamental importance in the problem of hormonal interaction.

Further Studies on the Localization of X-Ray Injury to the Initial Phases of Antibody Response

W. H. Taliaferro, Lucy Graves Taliaferro, and E. F. Janssen, ***University of Chicago***

Rabbits have been injected intravenously once with 1.25 ml of 1% sheep red cells at intervals from 4 days before to 38 days after a single total body x-irradiation with 600 or 700 r. Hemolysin was determined photometrically in 50% units at frequent intervals. Maximum inhibition of antibody production occurred in rabbits receiving antigen 1–7 days after irradiation, and consisted of doubling the induction period and reducing peak titer to one seventh that in nonirradiated controls. Ability to form normal amounts of antibody was recovered in most animals receiving antigen 28 days after irradiation. The most striking finding was that animals receiving antigen from 2 days before to 3 min before starting irradiation formed normal amounts of antibody, although many exhibited a lengthened induction period. X-ray injury is probably largely limited to an early phase of antibody formation, because in the last group (1) the most pronounced injury was a prolongation of the induction period, and (2) normal amounts of antibody were formed in the week following x-irradiation when x-ray injury is most apparent. This critical phase may be a stage in antigen localization or metabolism. It is related to the amount of antigen injected since, in another series of experiments, increased antigenic stimulation given as a series of injections also stimulated the formation of normal amounts of antibody after a lengthened induction period, even though given during the week following irradiation.

Systematic Errors in Elemental Abundances in Meteorites

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

It has previously been suggested that the chondritic meteorites are an average sample of nonvolatile planetary material. These objects, judging from their structure, have been heated to about the melting point of iron for brief periods only. The question arises as to whether certain elements have been markedly volatilized from them, thus leading to systematic errors in elemental abundances. The volatility of compounds of the halogens, sulfur, phosphorus, the alkalis and alkaline earth metals, and silicon leads to the conclusion that none have been markedly fractionated, but that halogens would be lost rapidly from cosmic mixtures heated to these temperatures, and that iron oxides and sulfide would be rapidly reduced in hydrogen gas. Since bromide and iodine have been retained, no great losses of any of the halogens have occurred. It is concluded that these objects were made rapidly in times of the order of one day or less. A collision between two asteroids with relative velocities of some two km/sec, such as has often been suggested, would supply adequate temperatures and would last perhaps some 10 min. Objects resulting from such a collision would cool rapidly to low temperatures.

From a reconsideration of volatilities of sodium, magnesium, calcium, and silicon oxides in the presence of cosmic gases, it is concluded that the first mechanism proposed by the writer for the fractionation of the iron and silicate phases as the earth and other terrestrial planets were formed—i.e., by differences in volatility—cannot by itself explain this effect and that the second method proposed—namely, by iron sinking below a molten silicate layer and thus not being volatilized while the silicate layer was rapidly evaporated—is a required process.

Studies of Populations Exposed to Radiation

Bruce Wallace

Biological Laboratory, Cold Spring Harbor

Experimental populations of *Drosophila melanogaster* exposed to continuous γ-radiation or to a single, massive dose of x-radiation are being studied. The analyses are primarily of two types: determination of the frequencies of second chromosomes carrying lethal and semilethal gene mutations in the several populations, and estimation by various techniques of the adaptive values or well-being of the populations. Two populations (the control and the one exposed to x-rays) have been maintained for over 120 weeks (approximately 60 generations), and three others (those exposed to γ-rays) for about 80 weeks.

Gene content, as revealed by the second-chromosome analyses, varies greatly among the five populations. Lethal-chromosome frequencies range from about 15% to about 70%; semilethal-chromosome frequencies from about 5% to about 20%. The average viability of flies homozygous for nonlethal, nonsemilethal second chromosomes is relatively constant within any one population (even those receiving continuous radiation), but each population has its characteristic frequency.

The estimates of adaptive value vary, depending on the technique used for estimation, but nevertheless present a consistent pattern, which indicates a lower value in those populations that have received the most chronic irradiation.

The results indicate that the genetic structures of populations are under constant review by natural selection, and that well-adapted structures are maintained in spite of mutagenic forces operating counter to natural selection.

Self-Regulation of Organ Growth by its Own Products

Paul Weiss, ***University of Chicago***

In 1945, the author proposed a concept of organ-specific growth control as follows. Protoplasm synthesis of a given organ yields (*a*) "templates" for further reproduction, and (*b*) accessory diffusible compounds capable of inactivating the former. As the latter, accumulating in the common humoral pool, reach critical concentration, growth ceases. Partial removal of an organ, by reducing the concentration of (*b*) will automatically entail "compensatory" growth in the rest of the organ. Growth and differentiation, being somewhat antagonistic, may react in opposite directions.

The organ-specific aspects of this concept have now been subjected to three new experimental tests. In one (with I. Fischer), embryonic chick organs were reared in tissue culture media prepared with extracts of whole embryos and of embryos from which the homologous organ had been removed. Of 333 heart fragments with healthy growth in full extract (2-day transfers), only two pulsated after the fourth day, whereas of 349 fragments similarly reared except for omission of heart extract from the medium, 129 pulsated, indicating progressive muscular differentiation. Likewise, of 1007 embryonic kidney fragments (metanephros) in full extract,

only 74 differentiated new tubules in the growth zone, as against 176 of 1006 cultures grown without kidney extract. Presence of a given organ extract thus markedly reduces differentiation capacity in the homologous organ.

In another test (with G. Andres), embryonic kidney brei was injected intravenously into younger embryos. Mitotic counts after 24 hr showed a 50% increase above normal in the host kidneys, with electivity of the effect indicated, though not yet crucially proved. In a third test (S. Ferris), the destruction of one embryonic metanephros in a prefunctional stage entailed "compensatory hyperplasia" of the remaining kidney (12 cases) marked by a more than 100% increase of mitotic activity within 48 hr. Functional overload being excluded, this result corroborates the operation of an automatic growth control principle such as outlined above.

Winds in the Upper Atmosphere by Meteor-Train Photography

Fred L. Whipple, ***Harvard College Observatory***

A new technique for the study of persistent meteor trains and the measurement of wind velocity in the upper atmosphere has been made possible by the development of the Baker Super-Schmidt meteor camera. This instrument, operating at f/0.65 optically, with an aperture of 12 in. and a field of 54°, can obtain multiple photographs of the persistent luminous trains left behind very bright meteors. The objective shutter is opened on the appearance of the meteor, and a programming device is used to shift the telescope slightly at intervals of 2 sec. The first Super-Schmidt meteor camera, belonging to the U. S. Naval Bureau of Ordnance, located at one of two meteor-observing stations near Las Cruces, N. M., has been operated by the Harvard Observatory for some months under a contract with the U. S. Office of Naval Research. After considerable experimentation with photographic emulsions and processing, Robert C. Wells obtained the first successful multiple photograph of a persistent train with the new equipment on the night of December 22, 1951. The meteor itself was photographed by small cameras at both stations. A persistent train extended from an altitude of 94 km to 81 km above sea level. The northwest-southeast component of the wind vector normal to the meteor trail remained usually less than ± 50 km/hr except for a 150-km/hr current of 2-km depth centered at an altitude of 88 km. The wind component changed by about 150 km/hr from southeast to northeast in an altitude range of only 1700 feet. The precision of wind measurement is about 5 mph over an altitude range of 0.1 km. The highly turbulent character of upper atmospheric circulation is indicated clearly in these results. The decay rate of the train increased markedly with decreasing altitude.

Routine systematic photography of persistent meteor trains by the new technique is planned to begin in the fall of 1952, when two Super-Schmidt meteor cameras will be put into operation in New Mexico for the U. S. Air Force.

The Giant Mitochondria of Insects

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Harvard University* and *U. S. Army Quartermaster Research and Development Laboratories

The striated muscles that propel the wings of the higher insects (Diptera and Hymenoptera) are clearly divisible into two mechanisms: a contractile mechanism localized in the actomyosin of the fibrils, and an energy-trapping mechanism centering in the sarcosomes. The latter are spherical, intracellular bodies, 1 μ–6 μ in diameter, aligned in individual longitudinal rows between the fibrils. They make up one third of the muscle mass and are readily isolated by centrifugation or filtration.

Cytological, histochemical, spectroscopic, and biochemical studies demonstrate that the sarcosomes are the "giant mitochondria" of this extraordinary muscular tissue. Within the muscle fibers the sarcosomes appear to be the principal sites of oxygen consumption, electron transmission, and ATP formation. The succinoxidase system is localized exclusively in these bodies.

Each sarcosome consists of a gelatinous matrix surrounded by a discrete membrane. The latter is disrupted by freezing and thawing, by temperatures above 40° C, by the vapors of fat solvents, or by the addition of digitonin; the contents are released as minute granules. The sarcosomal membrane is permeable to water, electrolytes, ATP, intermediates of the Krebs cycle, pentoses, and phosphorylated hexoses. But it is essentially impermeable to protein, AMP, and nonphosphorylated hexoses. Substances that penetrate the sarcosome exert only transient osmotic effects on the membrane. The osmotic entry of water then results in a pronounced swelling of the sarcosome. Its contents are frequently extruded, leaving the empty membrane as a discrete, spherical "ghost."

The Abnormal Bimolecular Displacement Reaction in Allylic Systems

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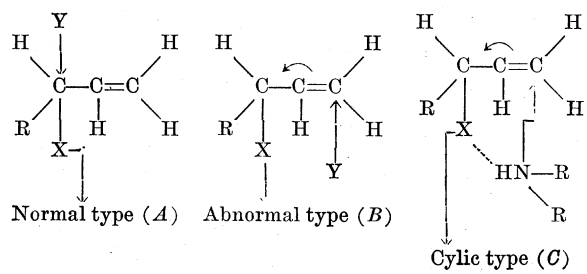
Two types of second-order nucleophilic displacement upon allylic halides are recognized:



The most common type (*A*) is a normal nucleophilic displacement (S_N2) upon the saturated α carbon atom bearing the leaving group, producing an allylic system identical with the original, except group *Y* has replaced group *X*. The second type (*B*) is an abnormal nucleophilic (S_N2') displacement upon the unsaturated carbon atom γ in the original system, accompanied by rearrangement of the double bond and expulsion of the halide, and producing a new allylic system in which the entering nucleophile *Y* has become bonded to the carbon atom γ in the original system. All unambiguous cases of S_N2' displacement upon allylic halides involving amines as the entering nucleophile have been demonstrated with dialkyl amines. In these cases the possibility exists that the success of S_N2' displacement over S_N2 displacement is due to the attraction between the amine hydrogen atom and the halide atom (hydrogen bonding), followed by a cyclic reaction type (*C*). It has now been shown that hydrogen

bonding is not essential to the success of the S_N2' displacement by amines on allylic halides by employing the reaction of trimethyl amine (which has no hydrogen atom to engage in hydrogen bonding) with α-methylallyl chloride in acetone. Both normal and abnormal products are formed by S_N2 and S_N2' displacements, respectively. No rearrangement of starting material or products occurs. The kinetics are second order. Heats and entropies of activation have been calculated for both the S_N2 and the S_N2' displacements.

Intellectual Ability of Students Entering Different Fields of Science

Dael Wolfle

Commission on Human Resources and Advanced Training National Research Council

High school grades. Of 1050 students who earned Ph.D.'s in science, 21% were high school valedictorians and 62% were in the top 10% of their classes. The fields ranged from physics and mathematics, with 77%, to agriculture, with 48%, from the top 10%.

Scholastic aptitude tests. Among college graduates, average scores for engineering, language, physical science, and psychology majors are above college averages. Biological science, social science, and arts majors about equal college averages. Agriculture, business, and education students are below average.

Twelve per cent of science Ph.D.'s were in the top 1% and 52% in the top 10% of college freshmen. Percentages from the top 10% are: physical sciences, 60; earth sciences, 52; biological sciences, 40; and agriculture, 26.

These differences disappear among the most eminent research scientists. Roe found that eminent physicists, biologists, and psychologists and anthropologists all averaged far above the typical Ph.D., but tapered off to an ability level only moderately above the undergraduate average. Interest and persistence can produce research eminence from a wide range of intellectual ability, but typically the most eminent come from among those who make very high test scores. The distribution of such men among the sciences is uneven.

The Anomalous Transparency of Thick Crystals to X-Rays

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The anomalous transparency of some thick crystal specimens to a beam of x-rays producing "Laue case" diffraction was first observed by Borrmann. Quantitative experimental studies of the effect, using calcite crystals, have recently been made by Borrmann and by H. N. Campbell.

The complete solution for Laue case diffraction in absorbing perfect crystals is capable of explaining the observed phenomenon. In order to make a quantitative comparison between theory and experiment it has been necessary to modify the solution so as to fit the specific experimental procedures used by Borrmann and by Campbell. This modification has been made, and the result is presented in the form of an expression for the effective absorption coefficient.

The usual absorption coefficient of calcite for x-rays of wavelength 1.54A is 193 cm^{-1}. The experimentally measured and the theoretically calculated values for the effective absorption coefficient in the region of anomalous transparency are given in the table below.

Crystal thickness (cm)	Calculated (cm^{-1})	Measured (cm^{-1})	Experimenter
0.040	79	86	Campbell
.212	30.5	30.2	Borrmann
0.271	28.6	27.7	"

William de Berniere MacNider: 1881–1951

W. C. George

Department of Anatomy, School of Medicine, University of North Carolina, Chapel Hill

WILLIAM DE BERNIERE MACNIDER, son of Virginius St. Clair and Sophia Beatty (Mallett) MacNider, was born in Chapel Hill, North Carolina, June 25, 1881, and died in Chapel Hill, May 31, 1951. He received his elementary education in the schools of his home town, and his college and professional training at the University of North Carolina. After three years of study in college and the preclinical Medical School at Chapel Hill he transferred to the clinical school of the university that had just been established at Raleigh. He graduated there with the first class of young men to receive the degree of Doctor of Medicine from that institution. His professional education was extended during subsequent summers at the University of Chicago and Western Reserve University.

Throughout most of his life Dr. MacNider was a member of the faculty of the University of North Carolina, being successively assistant in biology (1899–1900), assistant in anatomy (1900–1902), assistant in clinical diagnosis (1902–1905), professor, Kenan professor, and Kenan research professor of pharmacology (1905–1950). He retired as professor emeritus in 1950. From 1937 to 1940 he was dean of the Medical School.

Dr. MacNider's achievements and the force and charm of his personality were recognized by honorary degrees from Davidson College and the Medical Col-