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Placental Morphology and Fetal Respiration

Donald H. Barron, *Yale University*

To evaluate the role of the tissues that separate the fetal and maternal capillaries in the mammalian placenta in the movement of diffusible materials from the mother to the fetus, a study has been made of the conditions associated with the transfer of oxygen from the maternal to the fetal blood in the sheep, in which five tissue layers separate the two bloods, and in the rabbit, where but a single layer of cells separates the two bloods at the end of gestation. Oxygen dissociation curves of the fetal and maternal bloods have been compared, and the oxygen pressure gradients determined. The results indicate that in the sheep, with the thick placenta, the dissociation curve of the fetal blood is farther to the left relative to the maternal than that of the rabbit; further, that the oxygen pressure gradient between the maternal and fetal bloods is steeper across the thick placenta than across the thin, and finally that the coefficient of oxygen utilization is smaller in the sheep uterus than in the rabbit; i.e., of each 100 ml of oxygen brought to the placental capillaries by the blood of the sheep only about 25% is transferred to the fetus, whereas about 75% is transferred to the fetuses in rabbits at the end of pregnancy.

Haliclonasterol and Palysterol, Two New Natural Sterols

Werner Bergmann, *Yale University*

From marine invertebrates two new sterols have been isolated which possess structural features not previously encountered among natural sterols. They are the sponge product, *haliclonasterol*, $C_{28}H_{48}O$, which is isomeric with campesterol and 22,23-dihydrobrassicasterol, and the coelenterate product, *palysterol*, $C_{29}H_{50}O$, which is an isomer of β- and γ-sitosterol (clionasterol). Both new sterols are monounsaturated with the double bond in the 5,6-position, as indicated by optical evidence. Assuming the carbon skeletons of the new sterols to be the same as those of their isomers, one can deduce from a comparison of molecular rotations that haliclonasterol is like 22,23-dihydrobrassicasterol a C-24-α-methylsterol, and palysterol like γ-sitosterol a C-24-α-ethylsterol. Further consideration of optical data suggests that in both the new sterols the configuration at C-20 is the opposite of that of cholesterol and other previously known sterols. It appears, therefore, that haliclonasterol and palysterol represent a new type of epimerism among natural sterols.

Microwave Spectra of Paramagnetic Gases in a Magnetic Field

Robert Beringer, *Yale University*

Rotational energy states of paramagnetic molecules are split into their Zeeman components by a magnetic field. For fields of a few thousand gauss the Zeeman level separations correspond to microwave frequencies, and transitions from one level to another can be brought about by microwave fields. Such transitions have been studied for certain rotational states of the gases nitric oxide, nitrogen dioxide, and oxygen. The gases are contained in a resonant cavity; the transitions are observed by the absorption of energy from the microwave fields in the cavity. The method is much like that of nuclear induction experiments at radio frequencies. At low gas pressures the absorption process is highly resonant, so that good precision can be obtained in measuring the level separations and the fine details of the level structure. The measurements are of interest in the theory of the molecular Zeeman effect, hyperfine structure in molecules, and the pressure broadening of spectral lines. Good agreement with Zeeman theory is obtained for the case (*b*) molecule oxygen and the case (*a*) molecule nitric oxide. The latter also shows magnetic and electric quadrupole hyperfine structure due to the nitrogen nucleus. The experimental methods and new results are described.

Appearance and Development of Cholinesterase in the Amphibian Midbrain

E. J. Boell and S. C. Shen, *Yale University*

Unilateral extirpation of the eye from the early amphibian embryo (*Amblystoma punctatum* or *Rana pipiens*), before the formation of the optic nerve and differentiation of the midbrain, results subsequently in decreased production of cholinesterase in the optic portion of the midbrain on the side opposite that of eye removal. This is indicated not only by a reduction in the total cholinesterase content of the affected lobe, which is a consequence of its smaller size, but also in reduced enzyme activity per unit of tissue nitrogen. Under normal circumstances centripetally growing optic fibers induce the differentiation of certain neurons in the midbrain. It seems likely, therefore, that the development of cholinesterase is correlated with this process. In the operated embryo, central differentiation is incomplete in the absence of optic fibers, and cholinesterase activity is accordingly decreased. The difference in cholinesterase activity between the normal and affected optic lobes gives an indication of the relative proportion of nerve cells in a given volume of tissue whose differentiation depends upon optic fibers.

As development proceeds, the difference in cholinesterase activity between normal and affected midbrain lobes becomes progressively lessened. This probably results from the invasion of the midbrain by nonoptic fibers, especially from more posterior levels of the central nervous system, and the consequent physiological and biochemical maturation correlated therewith. That cholinesterase development appears to be a fairly specific indicator of neuron differentiation is shown by the finding that succinoxidase activity of the midbrain is unaffected by eye extirpation.

A Classical Dynamics View of Gauge Invariance

G. Breit and R. L. Gluckstern, *Yale University*

By employing a generalization of the Hamilton principal function W to a functional of field variables one can connect conservation of charge and the validity of Poisson's equation with gauge invariance (GI) in a systematic manner. The infinitesimal gauge transformation defines an infinitesimal contact transformation in the sense of classical dynamics. It is shown that the associated classical integral of motion has, as a consequence, for GI of the first kind conservation of total charge, whereas GI of the second kind with a time-independent gauge implies Poisson's equation with an arbitrary additive time constant charge density. The discussion has the same form, independent of the number and kinds of particles. The reasoning shows that if Poisson's equation holds as above then the associated nonquantized field Hamiltonian is gauge-invariant. One sees that the point character of field matter interaction is essential for the theorem and its inverse. The proof applies to relativistic and nonrelativistic Hamiltonians, including radiation. The current four vector can therefore be defined within an additive constant charge density, and the question of exchange currents derivable from GI considerations does not arise, as is natural in any formulation pretending to specify all interactions.

The Isoenergetic Point of Dyes

L. G. S. Brooker, *Eastman Kodak Company*

"Isoenergetic" implies that situation where the two extreme resonance structures of a dye have the same energy. Applied to dyes in solution, it is of particular significance for nonionized dyes such as the *merocyanines*, which resonate according to the scheme

$$>N-\overset{|}{C}(=\overset{|}{C}-\overset{|}{C})_n=O \longleftrightarrow >\overset{\oplus}{N}=\overset{|}{C}(-\overset{|}{C}=\overset{|}{C})_n-\overset{\ominus}{O},$$

for here the relative energy of the extreme structures is strongly dependent upon the choice of solvent. In the merocyanines the dipolar resonance structure is frequently of unusually high stability, and if such a dye is dissolved in a strongly polar solvent the dipolar structure may become so highly stabilized that it will have by far the lower energy of the two. The consequent energetic asymmetry of the extreme structures causes such dyes to absorb at much shorter wavelengths in polar than in nonpolar solvents, formerly an infrequent phenomenon. For certain of the merocyanines successive additions of small amounts of water to a solution in anhydrous pyridine cause a sharp rise in ε_{max}, though λ_{max} is also slightly affected. At a given point ε_{max} and λ_{max} reach maximum values; further increase in the water content of the solvent causes an abrupt inversion in behavior, ε_{max} now falling sharply and λ_{max} moving to shorter wavelengths. The ε_{max} vs. λ_{max} curve gradually levels off until in the neighborhood of pure water, λ_{max} is much more sensitive to a change in solvent composition than ε_{max}. It is assumed that the apex of the ε_{max} vs. λ_{max} curve, the point of inversion, corresponds to the isoenergetic point; either increasing or decreasing the polarity of the solvent mixture at this point brings about energetic asymmetry of the extreme structures, the immediate result of which is a sharp drop in ε_{max} with, later, a reduction in λ_{max}. With solvent-sensitive dyes such as merocyanines a continuous change in the energy difference between the extreme structures is thus brought about by a continuous change in the environment (solvent) rather than by a series of structural changes such as has been studied in ionized dye series.

A New Discussion of the Changes in the Earth's Rate of Rotation

Dirk Brouwer, *Yale University*

Observations of the moon since early in the seventeenth century show that during the past three centuries the earth has at times been behind and at times ahead of uniform rotation by amounts up to about 30 sec. The cause of these fluctuations is still unknown.

An analysis of the more accurately known part of the fluctuation curve, since 1820, shows that if the derivative of the curve is plotted against time, a set of straight-line sections is obtained, changes in direction taking place with intervals between 4 and 15 years.

Theory shows that random changes of this character produce an amplitude of the fluctuation curve that increases with the power $\frac{3}{2}$ of the time before or after the present epoch. A comparison of the tables of the moon's motion with eclipse observations going back to 700 B.C. confirms this conclusion.

This result has an important effect on the evaluation of the rate of retardation of the earth's rotation. In previous discussions older observations were given too much weight, proportional to the fourth power of the time interval, which must now be changed to the first power of the time.

A provisional discussion indicates that the new solution will lead to a lesser rate of retardation than had been considered established. However, there is need for a complete revision in which, in addition to the modern material, all reliable older observations should be included, from the oldest known records to the invention of the telescope.

Microbiological Studies on the Intrinsic Factor of Castle

Paul R. Burkholder, *Yale University*

Methods for the preparation and assay of the activity of concentrates of intrinsic factor which binds vitamin B_{12} have been developed. Bacteria isolated from jejunal juice of Addisonian anemia patients were found to have a strong tendency to absorb vitamin B_{12} from solution. The so-called intrinsic factor prevented quantitatively the consumption of vitamin B_{12} by these bacteria. A mutant of *E. coli* was employed to determine the unabsorbed amount of vitamin B_{12} released by heat from its binding to intrinsic factor. Thus the amount of vitamin B_{12} protected by intrinsic factor could be assayed. Numerous bacteria present in the upper gastrointestinal tract of anemic patients were shown capable of absorbing large amounts of vitamin B_{12} in the absence of intrinsic factor.

Various procedures for extraction and concentration of intrinsic factor were carried out, and it was found that considerable concentration of the material could be achieved by enzymic digestion of an aqueous extract of fresh hog gastric mucosa, followed by precipitation of the factor with zinc-ethanol reagent or with ammonium sulphate.

Some evidence was obtained showing that saliva of the Addisonian patient may contain intrinsic factor activity which may be destroyed by the patient's gastric juice.

This action may be prevented by the addition of acid to the gastric juice before incubation with saliva.

These studies add further evidence to support the theory that typical Addisonian anemia may be caused by removal of vitamin B_{12} from the patient's digestive tract by the microbial flora under conditions of achlorhydria.

Electron Exchange-Resins

Harold G. Cassidy, *Yale University*

We have set up the hypothesis that high polymeric materials may be synthesized which are able to undergo electron exchange in a suitable medium in a manner analogous to the exchange of protons by cation exchange-resins. Such substances have been prepared. Their properties are discussed, and it is suggested that we have in these substances the possibility of constructing models of enzyme systems.

Biochemistry and Biomechanics of Blood Collection, Processing, and Analyzing

Edwin J. Cohn, James L. Tullis, Douglas M. Surgenor, William H. Batchelor, and Maurice D'hont

University Laboratory of Physical Chemistry Related to Medicine and Public Health, Harvard University

Further developments render possible reduction in the size of equipment and the time of processing to stable states of blood cells and plasma proteins. The Mobile Blood Processing Laboratory, on a 32-ft refrigerated trailer truck a year since, is now portable and can be completely mechanized.

Replacement of formed element sedimentation and cup centrifugation by newly devised, light, low-speed, continuous centrifugation in a closed system of nonwettable surfaces, and of over-all refrigeration by heat exchange, yields cell-free plasma at the desired low temperature at the time and at the same rate as blood leaves the vein of the donor.

The subzero ethanol-water system has been largely replaced by an aqueous system, and classical electrochemical interactions by specific interactions of metals and sugars with cells and proteins, believed to be more closely related to those of nature.

Red and white blood cells, platelets, prothrombin, isoagglutinins, γ-globulins, α- and β-lipoproteins, fibrinogen, metal-combining protein, and albumins may be separated from each other in a continuous operation in a closed sterile system and preserved under the best known conditions for transfusion. Modifications of the process render it useful in reclaiming for transfusion the stable proteins in outdated blood, and for analyzing fresh blood for any of the above, as well as for other protein, protein enzyme, steroid, or polysaccharide components.

On Finite Groups with Two Independent Generators

Jesse Douglas, *Columbia University*

Although the theory of finite groups is a well-worked branch of mathematics, the study of the topic designated by the title, in its full generality, seems not to have been hitherto undertaken. The key idea is to introduce a certain pair of conjugate substitutions θ, φ of a special nature; these determine the group structure completely, and their investigation furnishes all the properties of the group. Specifically, the substitutions $x \to \theta(x)$, $y \to \varphi(y)$ are defined by the formulas: $BA^x = A^{\theta(x)}B^{\Psi(x)}$, $B^yA = A^{\omega(y)}B^{\varphi(y)}$, where A, B are the independent generators.

If the group is abelian, θ, φ reduce to the identity, and conversely; but practically all the interest resides in the noncommutative case: $BA \neq AB$. Dihedral groups, $A^m = 1$, $B^2 = 1$, $BA = A^{-1}B$, are a very special example.

Multiple Congenital Abnormalities Resulting from Acute Folic Acid Deficiency during Gestation

Herbert M. Evans, Marjorie M. Nelson, and C. Willet Asling

University of California

Previous studies (by Nelson and Evans) have shown that an acute folic acid deficiency may be instituted in normal rats (by using a specific vitamin antagonist, x-methylpteroylglutamic acid, with a purified diet containing succinylthiazole) on the day of breeding or as late as 9 days after breeding, with the invariable occurrence of fetal death and resorption. In contrast, delaying the deficiency to the 11th day resulted in virtually 100% litters, although all young were dead at birth and showed multiple congenital abnormalities. When these young were removed by Caesarian section one day before parturition, they were living as judged by heartbeat and reflex movements, although the lungs would not expand and were markedly translucent in appearance. The kidneys were minute, pale structures, markedly subnormal in development. Cleft palate and syndactylism were obvious macroscopically. Cleared alizarin-stained specimens revealed general retardation in skeletal growth and maturation, together with deformed, misshapen bones and the absence of certain ossification centers.

A transitory folic acid deficiency for 3 days (day 11–14 or 10–13) resulted in young with syndactylism, cleft palate, and facial deformities, more marked in the latter group. A 2-day deficiency period (day 10–12) added harelip and polydactylism to the previously mentioned abnormalities. An earlier period of deficiency (day 9–11) resulted in facial, cranial, and eye abnormalities and umbilical hernias, but no digital deformities. A less acute vitamin deficiency from day 7–9 showed the most marked cranial abnormalities yet encountered, including hydrocephalus, exencephalus, and anencephalus, together with eye abnormalities and abdominal herniations.

These congenital abnormalities strikingly resemble the skeletal and eye abnormalities reported for maternal riboflavin and vitamin A deficiencies (Warkany *et al.*), respectively, and the cranial abnormalities from B_{12} deficiency (Hogan and Richards) and pantothenic acid deficiency (Boissilot). It thus appears that developmental normality is dependent on manifold biochemical mechanisms, and that strikingly similar malformations flow from interference with any one of the underlying mechanisms during the "critical" developmental periods.

Suppressor Genes and Heterosis

Herbert L. Everett

The Connecticut Agricultural Experiment Station

Heterosis is the increased vigor often exhibited by hy-

brid individuals. Previous studies utilizing *Zea mays* as the experimental organism have indicated that this increased vigor may be brought about through the accumulation of favorable dominant alleles of hybrid gene-pairs. Vigor may also be achieved through the combined actions of these heterozygous alleles where the homozygous action of each allelic pair is reduced in comparison with the action of the hybrid or heterozygotic pair. Data have been obtained which suggest a third possible basis for heterosis. Suppressor genes nullify the effects of mutated major genes and in corn have been shown to represent a range of reactions from partial to practically full duplication of a major gene for chloroplast pigment production. In this case a mutation to albinism may be returned to pale green by one suppressor gene, or to normal green by a second suppressor gene. Isolation of the diverse genic combinations has been accomplished, and their isolated and combined effects on plant productivity as well as on plant pigments have been observed. On a biochemical basis, it may be suggested that suppressor genes in combination with nonmutated major genes permit alternate enzymatic pathways. When hybrid gene combinations result in complete chains of these alternate pathways from substrate to end product, a maximum response of the organism to its environment is allowed, and this maximum response results in heterosis.

Evidence of Climatic Fluctuation Common to North America and Europe

Richard Foster Flint, *Yale University*

The Two Creeks peat layer, exposed in southeastern Wisconsin, records through its fossil-plant content a cold-temperate climate. It lies between two sheets of glacial drift. The Alleröd peat layer, exposed in many parts of Europe, records a temperate climate preceded and followed by colder climates. It, too, overlies a glacial deposit.

Dating of several samples of both peat layers by Libby and Arnold, using the radiocarbon method, has established with high probability the age equivalence of the two peats. If contemporaneous, the peats are a product of a single warm climatic fluctuation that occurred between two glacial times and that was common to both North America and Europe.

The alternating sequence of glacial and nonglacial layers within the fourth, or latest, glacial stage in Europe is strikingly similar to the sequence in North America. Furthermore, the Two Creeks–Alleröd peat occupies the same relative position in both sequences. It is therefore probable that a single series of climatic fluctuations has affected both continents simultaneously.

The Effect of Ionizing Radiation on the Transforming Factor of Pneumococci

Donald J. Fluke, Ruth M. Drew, and Ernest Pollard
Yale University and *Brookhaven National Laboratory*

Dry preparations of the transforming factor of pneumococci have been found to be sufficiently stable to permit deuteron and electron bombardment. The measurement of activity is in terms of the ability to convert rough type to Type III pneumococci. Deuteron bombardment gives a semilogarithmic inactivation which yields a cross section related to the area of the molecule. Electron inactivation is similar and yields a volume which may be presumed to be the volume of the molecule.

It is found that the factor is highly sensitive to ionizing radiation, and from the combined results of deuteron and electron bombardment our data fit reasonably well with a molecule of weight 18,000,000 and an axial ratio which is around 40 : 1.

At liquid air temperatures the cross section for deuteron bombardment is considerably less. This shows that a nucleic acid cannot be characterized by lack of thermal sensitivity in its radiation effects.

Polarization of Bremsstrahlung Radiation

R. L. Gluckstern, M. H. Hull, Jr., and G. Breit
Yale University

The polarization of the γ-rays produced in Bremsstrahlung has been investigated in order to see whether this process may be useful in producing high-energy polarized radiation. The calculation was performed by evaluating the matrix element of the radiation field between the initial and final states. Electron states were computed by the first Born approximation. However, the arrangement of the calculation lends itself to the use of exact electron wave functions. The differential cross section for the production of γ-rays with polarization vector $\mathbf{1}_s$ is

$$d\sigma = 2\left(\frac{Ze^2}{2\pi mc^2}\right)^2 \frac{p_f dg d\Omega_f d\Omega_g}{137\, p_i g q^4}\left\{\frac{p_{fs}^2[ii]}{\varepsilon_f^2}+\frac{p_{is}^2[ff]}{\varepsilon_i^2}-\frac{2\,p_{fs}p_{is}[fi]}{\varepsilon_f\varepsilon_i}+\frac{g^2}{\varepsilon_f\varepsilon_i}\,[q^2-(\varepsilon_f-\varepsilon_i)^2]\right\},$$

where

$$\mathbf{q}=\mathbf{p}_f-\mathbf{p}_i+\mathbf{g}$$

and f, i refer to final and initial states, respectively. The notation is

$$\varepsilon_a = E_a-(\mathbf{p}_a\cdot\mathbf{g})/g,\ (a=i,f);$$
$$[ab]=4\,E_aE_b-q^2;$$
$$p_{as}=(\mathbf{p}_a\cdot\mathbf{1}_s).$$

Energies E are in mc^2, momenta p, g in mc, p and E referring to electron, g to photon.

Averaging over polarizations, one obtains the Bethe-Heitler formula.

Nuclear Isomers and Shell Theory

M. Goldhaber, *Brookhaven National Laboratory*

When a nucleus remains in an excited state for a considerable time it is called an isomer. Isomers occur in "islands," close to the "magic numbers," which shell theory can explain. They correspond to the closing of shells and therefore to particularly tight binding of nuclei. Near the end of a shell, states of very different angular momentum are adjacent. The γ-transitions between such states are highly forbidden; hence isomers exist there.

The Production of Extensive Artificial Clouds for the Study of Precipitation Mechanics

Ross Gunn, *U. S. Weather Bureau*

With the object of bringing clouds into the laboratory for study and quantitative evaluation, a shaft $200 \times 2.5 \times 2.5$ m has been prepared that permits the cooling of its air by sudden expansion. Clouds more than 200 m deep may be produced under controllable conditions, and their

behavior determined. The shaft and its auxiliaries are described, and the problems of cloud production, control, and stability in the laboratory are discussed.

Basic methods for measuring evaporation and growth of water droplets falling freely down the shaft are described and actual records shown.

Effect of Bilateral Destruction of Frontal and Posterior Association Areas on Learning by Monkeys

Harry F. Harlow, ***Department of the Army***

The behavior of four normal rhesus monkeys and four rhesus monkeys with extensive bilateral lesions in both the frontal and the posterior association areas was compared on a series of standardized learning tests carried out over a period of a year. The eight monkeys had previously been continuously tested for a 5-year period, and their training history had been maintained for the same period. During the five years the operated monkeys had undergone two brain operations; a third operation produced the above-described preparation.

The test battery included patterned string tests, discrimination tests, discrimination-reversal tests, delayed reaction tests, and oddity tests. In spite of the magnitude of the lesions there were no significant differences in the performances of the two groups on either the discrimination or the discrimination-reversal tests. Significant differences could be demonstrated between the two groups on complex delayed reaction tests but not on simple, 5-sec delayed reactions. Significant differences between normal and operated monkeys on selected string tests could be demonstrated. Consistent, highly significant differences were found between the normal and operated monkeys on the oddity problems. Only on the oddity test was there no overlapping of performances between individual subjects of the operated and control groups.

The data of these experiments show that highly trained animals with very extensive brain damage may perform on discrimination tests at a level of efficiency which would be attainable by normal monkeys only after many hundreds of trials. The solution of such complex problems as oddity and complex delay appears to be adversely affected by very extensive cortical lesions, but even in the case of these problems the degree to which exprience may compensate for cortical destruction is striking.

Species Differences in the Stimulus Value of Equivalent Habitat Temperatures

L. P. Herrington
Yale University* and *the John B. Pierce Foundation

Concentration on the temperature of minimum metabolism under basal conditions for different species has been of great importance in demonstrating common principles of heat regulation in homoiothermic animals. In the laboratory habitat and under strict basal conditions, many domestic animals and common laboratory reagents have points of thermal neutrality that lie within a very narrow temperature range. In their natural habitats, however, animals differing in mass, in degree of peripheral insulation, and in plane of nutrition experience notably different degrees of thermal stimulation from seasonal and diurnal temperature cycles of a physically standard character.

In the temperature habitat, the slow insulative and nutritional adjustments to such temperature cycles represent a compromise between the adjustments most efficient for continued heat stress and those most efficient for a continued cold stress. By utilization of the principles of partitional calorimetry, measurements of peripheral insulation in combination with metabolic data and coefficients of external heat loss may be used to calculate the environmental temperature which requires minimal temperature regulation under natural conditions. The species-specific neutral temperatures found by such studies are distributed over a very much wider range than the comparable temperatures of thermal neutrality as determined under strictly basal conditions.

Application of this technique to data for three species is illustrated, and the biological meaning of the resulting temperature levels discussed. From the standpoint of general biology, such data are of interest as a step toward the construction of a biological scale of temperature which would emphasize biophysically conditioned species differences in the stress imposed by a cyclic habitat temperature. Such a scale, through the incorporation of factors for heat production, optimal insulation, and body mass or thermal inertia, would provide a basis for determining the different physical temperature cycles required to provide equivalent thermal stimulation for different species. In the absence of such a scale, no inter-species comparisons of endocrine or metabolic reactions can be said to be fully controlled with respect to the important stimuli associated with cyclic temperature changes.

Proton Groups from the Deuteron Bombardment of Vanadium

D. C. Hoesterey, ***Yale University***

The energy distribution of protons from the reaction V^{51} (dp) V^{52} has been studied using 3.80-mev deuterons from the Yale University cyclotron. Observations were made at 90°, using aluminum absorber and a peaked proportional counter. Three groups are in evidence with Q values of 6.25, 5.73, and 5.40 mev, corresponding to the ground, first excited, and second excited states, respectively. This gives two levels at 0.52 and 0.85 mev above-ground. From the ground state Q value the mass of V^{52} is 51.9568 mu.

Factors Influencing the Rate of Forgetting of Communicated Material

Carl I. Hovland, ***Yale University***

In their book *Experiments on Mass Communication*, Hovland, Lumsdaine, and Sheffield reported changes in opinion following communications which do not conform to the classical curve of forgetting. Opinion changes were in some cases actually larger after a time interval than immediately after the communication. One hypothesis suggested was that the subjects may have been suspicious of the communicator and therefore initially refused to accept the position advocated; after an interval they may have forgotten where they learned the material but remembered the content. This might then have produced a greater shift in opinion after a lapse of time. This hypothesis was tested as part of a systematic program of research on motivational and emotional factors affecting the acquisition and retention of information, opinion, and attitude. In the first study, by Hovland and Weiss, identi-

cal communications were used but attributed to sources of varying credibility. Opinion changes derived from "trustworthy" sources showed typical "forgetting." Opinions were less affected initially when presented by "untrustworthy" sources, but the extent of change *increased* with time. These results, together with data from related experiments of Weiss and Kelman, appear to indicate that typical forgetting does occur for opinions derived from communications, but that there is superimposed on the forgetting pattern a "discounting" factor for material presented by untrustworthy sources. This "discounting" diminishes with the passage of time, producing a net increase over time in the extent of agreement with an untrustworthy communicator. Theoretical implications of the results are discussed.

Influence of Bilateral Adrenalectomy, Adrenocorticotrophin, and Cortisone Acetate on Certain Human Tumors

C. Huggins and Delbert M. Bergenstal
University of Chicago

Bilateral adrenalectomy in man can now be done with comparative safety (14 consecutive cases without fatality) as a result of refinements in surgical technique and the development of adequate hormonal substitution to prevent adrenal insufficiency. The procedure was carried out in patients with metastatic cancer as follows: prostatic cancer, 7 cases; mammary cancer in women, 4 cases; miscellaneous neoplasms, 3 cases. In 5 cases of cancer of the prostate which became reactivated after previous antiandrogenic control, adrenalectomy gave relief of bone pain, increased appetite with weight gain, reduction of acid phosphatase levels in blood serum, shrinkage of the tumor, and resumption of normal activity. The longest postoperative period of observation was 9 months. Two cases of this type of cancer did not improve after adrenalectomy. Pulmonary metastasis in one man with mammary cancer regressed rapidly after adrenalectomy. Two women with mammary cancer were not improved. Pituitary adrenocorticotrophin and cortisone acetate administered to patients with extensive prostatic cancer (with intact adrenals) provided partial relief of bone pain, a sense of well-being, and increased appetite. The relief does not seem to be sustained at maintenance hormonal substitution levels.

Although the mechanism by which the absence of certain adrenal steroids modifies malignant growth processes is not as yet known, there can be little doubt that their removal profoundly alters the activity of certain types of malignant cells.

The Possible Role of Sexual Selection in the Etiology of Endemic Goiter

G. E. Hutchinson and Eva M. Low
Osborn Zoological Laboratory, Yale University, and *Academy of Natural Sciences of Philadelphia*

In the course of a survey of the biogeochemistry of iodine and bromine, the authors have been struck by the irregularity of correlation between the occurrence of endemic goiter and the available iodine of the environment. In company with many former investigators, they have felt other factors must be operating. Evidence exists of genetically determined thresholds in the action of antithyroid compounds on lower mammals, and there is some indication of a genetic basis for susceptibility to goiter. A study of literary and iconographic sources (presented in detail) indicates that at least from the sixteenth century the presence of a goiter was considered a highly attractive attribute of woman in some parts of Europe. Sexual selection acting on a population containing a small proportion of genes conferring susceptibility at a given iodine level might lead to a widespread diffusion of these genes in certain localized areas in which goiter would become particularly prevalent. The importance of the use of ideal types, easily found in provincial religious iconography, in the study of sexual selection is emphasized.

The Cytoplasm in Speciation

Donald F. Jones
The Connecticut Agricultural Experiment Station

The chromosomal mechanism brings about germinal mixture and recombination. All characters are the expression of an interaction between genes in the chromosomes and the cytoplasm or other extranuclear elements contained in it. Within the species nearly all visible variations are brought about by differences among the genes, which indicates that the cytoplasm and its component particles are alike. Many exceptions to this usual condition have been noted. These affect vital processes of chlorophyll formation and reproduction in plants. Many species crosses are partially sterile, and this sterility increases in backcrosses that bring an entire gene set into an unfamiliar cytoplasm. Reciprocal backcrossing that replaces the same gene set in its normal cytoplasm restores full fertility. Many plants are completely pollen-sterile in all progeny of certain matings in successive generations, but may be restored to full fertility when the proper genes are brought in by suitable matings. These genes are adapted to produce normal pollen when acting in some cytoplasms but not in others. This shows clearly that the harmonious interaction of genes and cytoplasm is necessary for normal growth and reproduction, and any deviation from this normal condition leads to a separation into groups that are unable to reproduce when intercrossed.

Biochemical Studies of Ascorbic and Glucuronic Acids

C. G. King, H. B. Burch, H. Horowitz, and J. Douglas
Columbia University

Biological synthesis of ascorbic and glucuronic acids from uniformly labeled (photosynthetic) D-glucose by the rat and guinea pig, respectively, does not change the distribution of C^{14} atoms in the carbon chain. When 1-C^{14}-D-glucose is used as a precursor, however, there is evidence of redistribution of C^{14} from its original position, ruling out the concept that C-1 in ascorbic acid is derived solely from either C-6 or C-1 in D-glucose.

Borneol-fed guinea pigs, supplied with 6-C^{14}-D-glucuronic acid by injection, show a rapid and major respiratory loss of C^{14}, similar to the pattern observed with glucose and ascorbic acid. In addition, some C^{14} appears in the conjugated end product, showing partial utilization of the preformed acid. However, the C^{14} is not confined to the C-6 position. Degradation studies are under way to define more completely the nature and extent of intermediate changes.

The Metabolism of Tocopherol in Laennec's Cirrhosis

Gerald Klatskin and David W. Molander
Yale University School of Medicine

In the experimental animal the structural integrity of the liver depends in part on an adequate supply of tocopherol; and diversion of the normal bile flow from the intestinal tract leads to overt signs of vitamin E deficiency. Such observations have stimulated interest in the metabolism of tocopherol in liver disease in man.

Low plasma tocopherol levels have been reported in cirrhosis and, on the basis of flat oral tolerance curves, have been interpreted as evidence of faulty intestinal absorption. In a previous investigation, however, it was found that there was no relationship between the concentration of tocopherol in the plasma and the height of the tolerance curve or the state of hepatic function, suggesting that other factors were operative.

The present investigation was undertaken to elucidate the significance of alterations in plasma tocopherol and tolerance tests in Laennec's cirrhosis. Balance studies, based on chemical analyses of the excreta, and studies of the plasma level and tolerance tests before and after saturation of the tissues with tocopherol were carried out.

It was found that cirrhotics in contrast to normals (*a*) excreted a smaller fraction of ingested tocopherol, and (*b*) had a sustained rise in plasma tocopherol concentration and exhibited a normal tolerance curve following tissue saturation.

It was concluded that in cirrhosis (*a*) there is no impairment of tocopherol absorption, (*b*) low plasma levels reflect low tissue stores and are probably the result of an inadequate dietary intake of tocopherol, and (*c*) flat tolerance curves are the result of rapid diversion of absorbed tocopherol to relatively unsaturated tissues.

The Abundances of the Elements

Gerard P. Kuiper
Yerkes Observatory, University of Chicago

During the past decade a considerable amount of reliable information has been accumulated concerning the relative abundances in the solar atmosphere, in O and B stars, and in planetary nebula. The solar data used here are those of Strömgren (1940), Menzel and Goldberg (1943), Wildt (1947), Unsöld (1948), and Minnaert (1950), supplemented by Bowen's determination of the solar O content (1948) and by corrected f values for iron (Kopferman and Wessel, 1951). Solar data do not cover all abundant elements, but they are beautifully supplemented by the early-type stars and planetary nebula. The O and B star studies are those of Unsöld (1941) and Aller (1946, 1949, 1950); the planetary nebulae by Menzel (1950).

The weighted mean astronomical values were combined with two groups of meteorite data, taken from Brown's compilation (1949). The first group, consisting of Na, Mg, Al, Si, K, Ca, Ti, Cr, and Mn, occurs evidently in approximately cosmic proportions in the silicate phase, and Fe, Co, and Ni occur similarly in the metal phase. Partly because of the poorly known numerical relation between these two groups, they were separately reduced to the astronomical abundance system (by use of an additive constant to logarithmic values). This results in abundances of Fe, Co, and Ni which are 3½ times smaller than according to the previous compilation. The logarithmic differences between the astronomical and meteorite abundances are ± 0.12 and ± 0.04 (mean errors) for the two groups of elements, which is quite satisfactory. All elements at least as abundant as 10^{-7} of hydrogen are included in the new compilation. Elements more abundant than 10^{-5} of H (by number) are: H, He, C, N, O, Ne, Mg, Si, S, Cl, A, and Fe, with log abund = 10.00, 9.14, 6.04, 6.38, 6.60, 6.67, 5.49, 5.46, 5.09, 5.0, 5.8, and 5.19.

The composition of the earth has been estimated from current geophysical data with the following results (fractional weights): Fe + Ni = 0.365, O = 0.307, Si = 0.154, Mg = 0.118, other elements 0.056. On this basis and from the cosmic abundance table, the minimum mass of proto-earth may be determined. It is found to be 620 times the present mass, quite consistent with the value derived dynamically ($1–2.10^3$). It also follows that the earth collected metallic iron more completely than the silicates, in a ratio of 2 or 2½ to 1. This result is not unexpected.

Cryogenic Research at Yale

C. T. Lane, *Yale University*

The periodic dependence of the diamagnetic susceptibility of metals on magnetic field is being studied for bismuth, zinc, tin, aluminum, and other substances. The work in progress at Yale at this time is mainly directed toward a test of the presence of an influence of the isotopic mass on the characteristics of the variation of the susceptibility with temperature. Separated isotopes are being used. Extensions to lower temperatures are in progress.

Electron mobilities in argon and helium show unexpected differences from electron-atom interaction constants which have been believed on the basis of measurements in gases.

The behavior of second sound in dilute solutions of He^3 in He^4 is being studied at ultra-low temperatures.

The change in the resistance of metals in magnetic fields in the He range of temperatures shows effects much larger than those at room temperatures. Results obtained for Hg are discussed.

The Problem of Crustal Deformation

Chester R. Longwell, *Yale University*

Students of tectonics continue the search for clues to solution of a major baffling problem—the mechanism of deformation in mountain belts. Systems of folds and thrusts, like those of the Appalachians and the Alps, record the operation of compressive stresses on a vast scale. According to the classic contraction hypothesis, these stresses are distributed throughout the crust and are transmitted through great distances to zones of failure. Apparent defects of this proposed mechanism, as tested by the sum of structural evidence, led to development of the convection hypothesis, which assumes drag of the crust above great convection cells, with resulting deformation through both compressional and tensional stresses. Serious objections to this concept also have been urged. There is growing interest in a third concept, according to which folding and thrusting result from gravitational sliding of vast crustal plates on the flanks of great welts, which in the older mountain belts have subsided. Some structural features in the Alps are now widely accepted as effects of gravitational sliding. Many competent Alpine students, however, regard these effects as secondary, and look for another cause of the major

deformation. Structural features of the Appalachians and of our cordilleran region are being re-examined in the light of the sliding concept.

Aboriginal American Metallurgy

S. K. Lothrop, *Peabody Museum, Harvard University*

A changed picture of New World metallurgy has recently arisen as the result of spectroscopic and quantitative analyses, as well as microphotography combined with dendrochronology and radiocarbon dating. As a result, much more is known about native ores, various alloys, and the characteristics that made them of use in industry.

Evidence now available places the earliest metalwork on the coast of Peru between 300 and 700 B.C. Annealing, soldering, and welding of gold and silver were employed. Casting of copper soon appeared in the southern mountains, where the discovery of tin led to the production of bronze. The early styles and techniques of the Peruvian coast disappeared, and, after several centuries, there was a renaissance or reinvention of metallurgy, the continuous growth of which can be followed until the Spanish Conquest.

In North America a copper industry based on "float" copper is of very early date, in some areas even preceding the use of pottery. Few technical changes have occurred, and no definite interrelationship with the south has been detected.

Isthmian and Colombian metalwork has as yet not been traced to its beginnings. The outstanding contribution of this area is *tumbaga*, a gold-copper-silver alloy as hard as bronze or soft steel.

No metals much before A.D. 1000 are known in Mexico, where most techniques seem to have been imported rather than invented, but skilled local craftsmen soon rivaled those of Peru.

Independent inventions and local processes were widely spread by Inca and Aztec commerce in the sixteenth century.

Simple Estimate of Atomic Diameters

H. Margenau and Maurice Karnaugh, *Yale University*

Atomic diameters are measures of the distance of approach between atoms at which strong repulsive forces set in. The correct way of calculating these forces leads to great mathematical difficulties, which arise chiefly from the mutual attractions between the electrons.

An attempt is here made to simplify these calculations by replacing electron-electron interactions, which involve the positions of two electrons, with suitable single attractions to the nuclei involving only the position of a single one. This process is not unique and is incapable of rigorous justification, but it can be made plausible on the grounds that it reproduces correctly the energy of each individual atom in the screening-constant approximation. It is similar to a procedure used successfully and made reasonable by Hylleraas in dealing with the term system of the H_2 molecule. The diameter of the helium atom computed in this way is surprisingly accurate. The method is being applied to other rare gas atoms.

Electron Microscope Studies of Viruses and Cells

Joseph L. Melnick, *Yale University School of Medicine*

The nature of the interaction of viruses and the cells they invade is being elucidated by the use of the electron microscope in different laboratories. Two approaches are discussed: (*a*) replication of the surfaces of erythrocytes treated with viruses, and (*b*) direct visualization of viruses within ultra-thin sections of infected cells.

Following treatment of intact human erythrocytes with influenza virus, three changes in the surface of the cells were observed: (1) presence of individual virus particles on the surface, (2) localized eroded or pitted areas which may contain single or clumped virus particles, and (3) a general roughening of the cellular surface.

The development of virus particles in the skin lesions of *Molluscum contagiosum* of man has been followed in ultra-thin sections of infected tissue. In a mature inclusion, the entire cytoplasm may be filled with virus particles. Inclusion bodies are often divided into locules by septa, with mature virus particles being present within the locules. Virus particles appear to arise from the material composing the matrix of the septa by a process of segmentation into a provirus phase, followed by condensation to form the mature virus. The virus particles themselves have been sectioned and have a formed cortex with a less dense interior.

Behavioral Effects of Food via Stomach Fistula Compared with those of Food via Mouth

Neal E. Miller, *Yale University*

Drives and rewards are important determinants of behavior. The present study starts to localize some of the mechanisms involved by comparing the hunger-reducing and the rewarding effects of food injected directly into the stomach with those of food taken normally by mouth.

The first experiment used the volume of milk consumed to measure hunger. Hungry male albino rats with small plastic-tube fistulas to their stomachs learned to drink enriched milk from a tube leading to a graduated cylinder. The effects of three procedures were compared: 14 ml of milk drunk by mouth; 14 ml of milk injected directly into the stomach; and 14 ml of normal saline injected directly into the stomach. The amounts of milk drunk immediately after these procedures were, respectively: 5.9, 8.7, and 18.0 ml. All differences are statistically reliable beyond 5%. Milk injected directly into the stomach had more effect than normal saline, but milk by mouth had the most effect.

The second experiment used the rate of learning to measure reward. When rats chose the correct arm of a T-maze, they got milk; on the incorrect arm they got normal saline. One group found the milk or saline in dishes, another had these substances injected directly into the stomach. As would be expected from the drive-reduction theory of reinforcement, both groups learned, and the first one learned faster than the second ($p = .01$). Milk injected directly into the stomach was a reward, but milk by mouth was a stronger reward.

The Molecular Structure of Societies

George P. Murdock, *Yale University*

It appears to be true of all science that the aspects which first attain rigorous precision are those concerned with the aggregation of standardized unitary elements into standardized larger systems. Astronomy, nuclear physics, chemistry, and genetics provide outstanding examples. Similarly, in the field of the social sciences, by

all odds the most precise knowledge achieved to date concerns the ways in which human individuals, as atoms, so to speak, are combined into very specific types of social molecules on the basis of kinship and locality. There are only two basic types of human atoms—male and female—but each has several ontogenetic phases, i.e., infancy, childhood, maturity, senescence. In the mature phase, the two atoms have a special affinity for each other, producing marriage and a localized family organization in every known society. They can unite in only three combinations—monogamy, polygyny, and polyandry—and can become localized in only four ways—by modes of residence called patrilocal, matrilocal, neolocal, and avunculocal. The children they produce can be affiliated with their relatives in only three ways, by rules of descent called patrilineal, matrilineal, and bilateral. The local group may be migratory or sedentary, and may or may not be linked to others by political bonds. The permutations and combinations of these variables produce a limited number of fundamental structural or molecular systems, according to which all the three or four thousand known human societies are organized.

Developmental Effects after Inversion of Neural Plate Materials

J. S. Nicholas
Osborn Zoological Laboratory, Yale University

The potentiality of embryonal floor plate material of the spotted salamander to form nervous tissues was tested by inverting a strip either with normal polarity or with other axes reversed. Such implants healed readily and did not complicate the immediately succeeding closure of the undisturbed neural folds, which behaved in apparently regular fashion in early-stage operations. When a slightly older stage was used, the neural folds did not quite approximate, and a double dorsal nervous system was formed when the implant was oriented with normal axiation. In some cases, triplicate nervous systems developed in the region of operation.

Microscopic examination shows that the inverted plate material forms nervous system and that its development is specific for the level of the neural plate chosen for operation. The cord or medulla is inverted and develops within the body cavity of the embryo and larva.

In those animals in which the axis of the implant was reversed, the nervous system developing within the body cavity was morphologically complete, and anomalous nervous structures developed from the normal neural folds. Abnormality was caused by diversion, reduction, reduplication, and inhibition of elements which ordinarily would have completed nervous system.

The experiments show that the material of the floor plate is fully competent to form nervous system characteristic of its embryonic level when the anteroposterior axis is not reversed. Disharmony produced by axial reversal is responsible for maldistribution of nervous elements.

The Interaction of α-Chymotrypsin with Enantiomorphic Molecules

Carl Niemann, *California Institute of Technology*

In the course of an investigation on the mode of action of the proteolytic enzyme α-chymotrypsin it has been observed that this enzyme can interact with the D- and L-forms of a number of enantiomorphic compounds which individually may serve as specific substrates or competitive inhibitors of the above enzyme. Although it has been suggested that the mode of combination of the enzyme with an L-specific substrate is substantially different from that of the enzyme with the enantiomorphic D-competitive inhibitor, it is suggested that there are no compelling reasons why this should be so. On the contrary, it can be shown that under certain circumstances both the D- and L-forms of an enantiomorphic pair can achieve a reasonable fit to a common complementary surface, and it is proposed that in principle the mode of combination of the enzyme with D- and L-enantiomorphs is qualitatively the same.

The High-Field Conductance of some Symmetrical Divalent Electrolytes

Andrew Patterson, *Yale University*

High-field conductance measurements have been made on magnesium and zinc sulfates by a new experimental measurement technique using a differential pulse transformer bridge circuit. The bridge circuit is described briefly. The high-field conductance results deviate from the theoretical values calculated from the Onsager-Wilson theory for symmetrical valence type strong electrolytes. This deviation may be accounted for by a combination of the Onsager-Wilson theory and the Onsager theory for weak electrolytes if a value of an ionization constant is assumed for the electrolytes under study. The nature of the deviation is examined.

Antibodies and Geography

John R. Paul, *Yale University School of Medicine*

In remote or tropical areas of the world where mortality and morbidity statistics either do not exist or are limited, one may learn something of the local prevalence of disease from serological surveys. These can be made by collecting sera from sample groups of the local population representing 200 or more people and covering a wide age distribution. At least a third of the serum samples obtained should be from children. By measuring antibody levels in these sera to a variety of antigens one can determine the numbers in each age group which contain antibodies, and such determinations can not only give some idea of the degree of recent or past exposure or infection but the age at which it has been acquired.

Studies are reported in which such antibody levels are measured for poliomyelitis, mumps, Coxsackie virus, hemolytic streptococci, and others. Samples of sera have been obtained from various parts of the United States and from arctic or semiarctic areas such as north coast of Alaska, and Iceland; from tropical and semitropical areas such as Cuba, Egypt, and South Sea islands. Interpretation of the findings is briefly discussed.

Physical Inactivation of Invertase

Ernest Pollard, W. F. Powell, and S. H. Reaume
Yale University

The effect of dry and wet thermal inactivation, of deuteron and electron bombardment, and of combined deuteron and thermal action on invertase has been studied. Thermal action in the dry state is in accord with the relation

$$k_1 = \frac{kT}{h} e^{\frac{\Delta S^\ddagger}{R}} e^{-\frac{\Delta H^\ddagger}{RT}}$$

where k_1 is the reaction constant for a monomolecular reaction, k is Boltzmann's constant, T is absolute temperature, h is Planck's constant, $\Delta S^\ddagger$ is the entropy of activation, R is the gas constant, and $\Delta H^\ddagger$ is the heat of activation. The value of $\Delta S^\ddagger$ is zero and of $\Delta H^\ddagger$ 30,000 cal/mole. In the wet state the enzyme is partially reversibly inactivated, in agreement with unpublished findings of L. G. Herriott. For the forward reaction $\Delta S^\ddagger$ is 95 cal/mole/degree centigrade, and $\Delta H^\ddagger$ is 53,000 cal/mole at pH 7. Both values depend on pH. The reverse reaction cannot be analyzed in this way, as the reaction constant rises and falls again with temperature.

Deuteron bombardment inactivates dry invertase with an efficiency which increases with increased ion density until a flat maximum is reached. The cross section at this maximum value corresponds to a spherical molecule of mol wt 120,000. Electron bombardment also readily causes inactivation, which permits the calculation of a target volume for a primary ionization. This agrees with a spherical molecule of the same molecular weight. The electron bombardment was carried out by M. Slater.

The effect of deuteron bombardment at various temperatures from 90° K to 400° K shows considerable variation. The cross section for inactivation is lower at 90° K, rises to a fairly constant value between 200° K and 320° K, and thereafter rises sharply. The constant value corresponds to the area of the whole molecule, and the increased cross section to a highly sensitive condition of the enzyme.

The Copper Metabolism of *Drosophila*

D. F. Poulson and V. T. Bowen

Yale University* and *Brookhaven National Laboratory

Uptake, distribution, and excretion of copper by larvae of 4 species of *Drosophila*, *D. ananassae*, *D. melanogaster*, *D. repleta*, and *D. virilis*, have been followed by determining activities of whole and dissected larvae at intervals after the feeding of Cu^{64} on various media at a series of copper concentrations. Uptake by larvae is proportional to concentrations between 0.25 μg Cu/g of food and 25.0 μg Cu/g. Within this range the data indicate that from 10 to 20% of the copper is located in the middle midgut cells. At higher concentrations, 25.0–50.0 μg Cu/g of food, disproportionately larger quantities of copper are present in these cells. The quantities of copper taken up from media in the presence or absence of yeasts are essentially the same. Copper previously incorporated in yeasts of the genera *Candida*, *Debaryomyces*, and *Hansenula* is also readily taken up by larvae. When yeasts grown on Cu^{64} are suspended in saline containing varying concentrations of stable copper, the uptake by larvae of Cu^{64} from these yeasts is not influenced by the stable copper concentrations. There are thus two definite paths of uptake, one for free copper, one for yeast copper. Excretion is slower than uptake and is performed chiefly by cells of the middle midgut. Autoradiographs show the greatest relative concentrations of Cu^{64} in the middle midgut cells, with the decreasing concentrations in other regions of the midgut and in the Malpighian tubules. The data are discussed in relation to histochemical and fluorescence studies.

The Effects of Domestication on the Steroids of Animals and Man

Curt P. Richter, *The Johns Hopkins Hospital*

The Norway rat is the first animal that has been domesticated for scientific purposes. It offers an excellent opportunity for the study of the effects of domestication since (1) more is known about its anatomy, physiology, and behavior than those of any other animal, and (2) its wild ancestor is still available in large numbers literally at our doorsteps.

Comparisons between the two forms have revealed great anatomical, physiological, and behavioral differences. Of most interest at the present time is that the adrenal glands have undergone a marked atrophy during the process of domestication. These glands are much smaller in size, less active and efficient, less able to help the animal protect itself from the effects of stress and fatigue. The operation of a selection process in a controlled environment may account for most of the changes that domestication has produced in this animal.

Man may have undergone parallel changes during his transition from a wild to a controlled, protected environment. As he has become more civilized, his adrenals may have become less efficient, thus accounting for the present-day high incidence of diseases that respond so remarkably to treatment with cortisone and ACTH.

The Extrusion of Desoxyribose Nucleic Acid from the Nucleus in the Formation of Nutritive Materials in the Egg

Franz Schrader, *Columbia University*

In many insects, the end chambers of the ovary contribute to the nutritive materials in the growing egg. In an analysis of this process—made with C. Leuchtenberger—it has been found that a breakdown of cell walls, as well as an irregular fusion of nuclei, is involved. A significant feature lies in the fact that, in a certain region of the ovarial end chamber, droplets of desoxyribose nucleic acid are extruded through the nuclear membrane. Such droplets join the stream of cytoplasmic materials that enters the egg. In the course of this transfer the desoxyribose nucleic acid undergoes certain changes and becomes Feulgen-negative. A preliminary analysis indicates that in such alterations a depolymerization, as well as a formation of polyaldehydes, takes place.

The Yale Linear Electron Accelerator

H. L. Schultz and W. G. Wadey

Yale University

The Yale linear accelerator has been designed to produce large currents of 15-mev electrons. It consists of a series of eight mutually uncoupled cavity resonators operating in the TM_{010} mode at 590 mc/sec. Synchronization problems have been solved by the use of 500-kw triode pulse power amplifiers to energize each cavity, the amplifiers being driven from a frequency-stable master source. Electrons are injected at 5 kev, and the strong bunching action in the first resonator is used to form the beam.

Special problems in design are emphasized, and the results of preliminary experiments with the accelerator are described.

Temperature-dependence of the Effect of Ionizing Radiation on Catalase

R. B. Setlow, *Yale University*

Bombardment of dried samples of catalase by deuterons causes a loss in the ability to catalyze the decomposition of hydrogen peroxide. The radiation sensitivity of the enzyme is expressed by its cross section, which is the reciprocal of the number of deuterons/cm^2 to give 37% relative activity. At room temperature the cross section corresponds to half a molecule of mol wt 250,000. Thus the passage of a deuteron through a catalase molecule does not destroy all its catalytic activity. Bombardments have been performed at temperatures ranging from 90° to 383° K with 4-mev deuterons. At this energy a deuteron produces an average of one primary ionization in passing through a catalase molecule. As the temperature is increased, the cross section remains constant up to 316° K, then increases within a 2-degree range, and remains constant until 377°, where it again increases within the same range. The cross section corresponding to the highest temperature agrees well with the size of the catalase molecule. At low temperatures the energy released by a primary ionization cannot spread throughout the entire molecule. Above the threshold temperature of 377° K the range can spread over the entire molecule.

Explorations in Three Galaxies

Harlow Shapley, *Harvard College Observatory*

In the continuing search for clues bearing on the origin and development of galaxies, we find it as profitable to explore the inner structure of the brightest and nearest systems as to investigate the population, structure, and dynamics of the metagalaxy. The present communication reports progress in the investigation of the inner structure of our own spiral and of the two middle-sized irregular galaxies—the Magellanic Clouds.

1. The central nucleus of our wheel-shaped system—the Hub—is under study in collaboration with Bart Bok, who has recently reported new results on the distribution of the clouds of absorbing material in the direction of the galactic center. He has spent much of the past two years at the South African Harvard station, where the new Baker-Schmidt telescope has gone into operation. Altogether some thousands of photographs have been made for the study of the variable stars, stellar spectra, colors, luminosities, and distribution in the nuclear region. We estimate that on photographs now available 10,000 new variable stars can be discovered, supplementing the thousands already found in the dense central star clouds. So many of the variables are of the type occurring in globular clusters that the early surmise (by Lundmark, Shapley, Baade, and others) that the nuclear populations of spiral galaxies resemble, or are exactly identical with, that of globular star clusters appears fully verified. The population at the centers of the Magellanic Clouds is quite different, and cluster-type variables are absent.

2. Using the photographic material accumulated during the past 10 years for the anti-center region of the Milky Way, we have now found several hundred new variable stars; those of lowest latitude were discovered chiefly by Hoffmeister and his colleagues at Sonneberg. The mapping of the galaxies brighter than magnitude 17.5, over an area of 4,400 square degrees, has yielded 22,500 galactic systems in the anti-center region. This survey will serve, in connection with the newly discovered Cepheid variables, to test the conclusion that our galaxy extends some 9 kiloparsecs (about 30,000 light years) in the anti-center direction, again demonstrating that it is a giant among the local galaxies.

3. Explorations in the Magellanic Clouds have produced evidence (*a*) on the tilt of the "bar" of the Large Cloud, (*b*) on the essential transparency of the Small Cloud (except possibly at the center), and (*c*) on the high opacity of the Large Cloud.

4. The analysis of several scores of variable stars in both Clouds by Mrs. Nail and assistants proves the existence of many superluminous stars ten thousand times the brightness of the sun, and the existence of gigantic Cepheids and irregular variable stars that are reddish like Betelgeuse and have a mean density like that of the highest vacuum attainable in the terrestrial laboratory. It is possible that what we call a supervoluminous star in the Magellanic Clouds is only a reddish gaseous shell that is maintained by radiation pressure and gravitation in a detached manner at a distance of half a billion miles from a central star of normal stellar proportions.

Transistor Electronics

W. Shockley, *Bell Telephone Laboratories*

The supremacy of the vacuum tube as an amplifier of electrical signals and a component of electronic computing machines has now been challenged by the transistor, a device usually made of germanium, a semiconductor, having no vacuum and no hot cathode. For some applications in which low power, small size, or extreme ruggedness are important, transistors are already superior to vacuum tubes. The functioning of transistors can be explained using the theory of semiconductors developed about 1931. This theory predicts that electrons in a semiconductor behave normally like negatively charged electrons and also cooperate so as to mimic the behavior of positively charged electrons, or "holes." Techniques developed during transistor research have permitted the investigation for the first time of many aspects of the behavior of normal electrons and holes and thus have contributed to the science of electrical conductivity. Conversely, transistor electronics, the engineering science based on this theory, has been applied in the design of devices and has led to the "junction transistor," a nearly ideal amplifier for very low power applications. Physical principles over a wide range are included in transistor electronics and are expected to produce a variety of devices comparable to that of conventional vacuum and gaseous electronics.

The Morphogenetic Significance of Reaction Wood

Edmund W. Sinnott, *Yale University*

The reaction wood (compression wood, redwood) of conifers differs in color and certain other characters from normal wood. It develops considerable lengthwise pressure, and, if present on one side of an axis, this tends to bend the axis away from this side. The distribution of reaction wood was studied in a series of terminal shoots and lateral branches of white pine which had been tied in various abnormal positions and held there during one or two seasons of growth. Reaction wood was found to be produced only where it would tend to restore the axis to its normal position. It therefore seems not to be a direct response to compression or other external factors

but to be regulatory in character. Since reaction wood is readily distinguishable, it provides a very useful means of studying experimentally the regulatory growth reactions involved in the development of tree form and thus offers favorable material for morphogenetic research.

An Algebra of Population Growth

L. B. Slobodkin
Yale University
and *Fish and Wildlife Survey,*
Sarasota, Florida

An algebraic notation capable of describing the population history of a genetically homogeneous asexual group of organisms is presented. Population oscillations and equilibria can be described in terms of the physiological state of the organisms. If it can be shown that a unique solution or a finite number of solutions exists to describe any population growth curve, then this notation predicts the physiological reactions of any organism in the population. The advantages of this notation over the existing population growth notations are (1) the occurrence of a lag period in population phenomena can be expressed, and (2) the differences in ecological effect between different individuals in the population can be expressed.

Some Cytological and Morphological Changes Induced in Plants by Ionizing Radiation

Arnold H. Sparrow
Brookhaven National Laboratory

Several species of plants have been exposed to chronic γ irradiation from Co^{60} for periods up to 4 months. There was considerable variation in the radiosensitivity of different species, but in one instance no significant effect was detectable after 2,000 r/day for 6 weeks. Generally, however, much lower dosages were sufficient to produce one or more characteristic morphological responses. These included, in addition to growth inhibition, some fasciation and various unusual shapes and sizes of leaves and of reproductive structures. Hypertrophic growth in certain structures was frequently produced in some species. In others tumorlike growths, as well as somatic mutations, were observed. In *Tradescantia paludosa* a dramatic increase in the number of both vegetative and flower buds was noted after chronic irradiation of about 30 r/day.

Cytological observations were made on both meiotic and somatic cells of irradiated *T. paludosa*. The expected types of chromosomal aberrations were found, and their frequency in both tissues was determined. Meiotic chromosomes were shown to be much more radiosensitive than chromosomes of somatic cells. This agrees with the observation that pollen sterility and morphological abnormalities in the anthers occur at dosages that have relatively little gross effect on somatic tissue.

Dosages which caused marked morphological changes also produced a considerable amount of chromosomal aberration. However, since recovery to a normal growth pattern occurred in many plants which had previously shown severe radiation damage, it would seem that most of the morphological aberrations were not of a genetic nature. It is considered that they were probably the result of radiation-induced physiological changes, although the possibility that they are somehow related to chromosomal aberrations cannot yet be excluded.

Problems of Gene Structure. I, The Interdependence of the Elements (S) and (P) in the Gene R^r of Maize

L. J. Stadler
U. S. Department of Agriculture and *University of Missouri*

Previous studies have shown that spontaneous mutation of R^r affects seed color action and plant color action independently, producing the alleles r^r and R^g, respectively. Mutant loss of seed color action has no detectable effect on the level of plant color action, and vice versa. Thus the action of R^r includes two apparently independent components. This suggests that the structure designated R^r may include two independent genes or genic elements, (S) and (P), which are very closely or completely linked. An alternative hypothesis is that R^r is a single unit (or complex functioning as a unit) with effects on two processes; a unit that may change in certain ways that modify its effect on one process and in other ways that modify its effect on the other.

Under the first hypothesis we may expect that mutation for plant color (P) will have no effect on the subsequent mutation rate for seed color (S), since (S) is the same gene before and after the mutation of (P). Under the second hypothesis, the mutation rate for seed color subsequent to mutation for plant color is unpredictable, as it depends on the stability of the gene R^g.

The mutation rates may be compared with precision in plants heterozygous for R^r and its mutant R^g. Comparisons of this type, made with several R^g mutants of separate origin, show that the frequency of mutation for seed color effect is reduced about tenfold in the R^g mutants. This indicates that (S) and (P) are not independent genes. There may be structurally distinct genic elements determining seed color and plant color action, but if so they are apparently parts of a functional complex.

Thermodynamics of Hydrolysis of Peptide Bonds

Julian M. Sturtevant, Alan Dobry, and Joseph S. Fruton, *Yale University*

The thermodynamics of peptide bonds is of fundamental importance in the study of the synthesis and breakdown of proteins in biological systems. We have undertaken a program of direct measurements of the heats and free energies of enzymatic hydrolysis of peptide bonds in compounds of known structure, since the data of this type at present available in the literature are of doubtful accuracy.

Results obtained for the hydrolysis of benzoyl-L-tyrosylglycinamide catalyzed by chymotrypsin are reported and discussed. The heat of hydrolysis was determined by a calorimetric method recently developed by one of the authors, and the free energy by a method employing N^{15} as tracer.

Chromatography and Exchange-Adsorption on Clay Minerals

Henry C. Thomas, *Yale University*

For a variety of reasons, of interest to the geochemist, the agricultural chemist, the physical chemist engaged with the theory of solutions, and those concerned with the possible effects on public health of the products of atomic fission, it is important that there become available a more comprehensive knowledge of the exchange adsorp-

tion of the cations on clay minerals. It is possible to apply the theory of the chromatographic process to the determination of these exchange isotherms. For a fairly general type of process it is shown that the approximate equation

$$f=\frac{1}{x}\left\{\mathrm{F}+yc+\Delta\left(y\frac{\delta c}{\delta y}-c\right)\right\}$$

serves to determine an isotherm, $f(c)$, in terms of the behavior of the column of interest and of others run for isotopic exchange only. The details of the method, its advantages, and the possible sources of error are discussed.

The method has now been applied to a caesium-sodium exchange on a montmorillonite and to the same exchange on a synthetic exchanger. The results for these two cases are presented.

The Biological Effects of the Streptococcal Enzymes, Streptokinase and Streptodornase, on Local Areas of Disease in Patients

William S. Tillett
New York University College of Medicine

Hemolytic streptococci as they grow elaborate into their surrounding medium a diverse number of independently acting extracellular substances. One of these reagents was initially described under the heading the fibrinolytic activity of hemolytic streptococci (now called streptokinase). This substance when added to a sample of human blood, *in vitro*, which is subsequently clotted, mediates the rapid and complete liquefaction of the fibrin clot in a few minutes.

Subsequently a second enzyme was found in the same streptococcal concentrates, which proved to be desoxyribonuclease (now called streptodornase); it rapidly depolymerizes desoxyribose nucleoprotein.

Since both fibrin and desoxyribose nucleoprotein are defined in technical chemical terms as fibrous insoluble proteins, and, since in diseases characterized by extravascular hemorrhagic deposits or purulent exudations, they often constitute unmanageable components of the areas of disease and are deterrents to recovery, local topical instillations of SK-SD have been employed for therapeutic effects in a variety of diseases. In many instances, striking and rapid favorable effects leading to cure have been observed.

The principles involved in the action of the enzymes on local diseased tissues have been a subject of considerable study. As biological reagents, their actions fall into three main categories: (1) eradication by liquefaction and aspiration of exudative substances that persist as mechanical deterrents to restoration of organic functions; (2) promotion of the eradication of obstinate chronic refractory infections (the enzymes are not, in themselves, bactericidal); and (3) promotion of regrowth and regeneration of tissues leading to effective healing.

Detailed clinical cases are given which illustrate the application of the above principles and the actual therapeutic effects.

Cosmic Abundances of the Elements

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

Goldschmidt made a survey of the abundances of the elements in his classical work. He assumed that the meteorites were the best source of observational data for the preparation of such tables, and for the nonvolatile materials he weighted the stones, irons, and the troilite phase in the ratio 10: 2: 1. Brown revised these tables, added estimates for the lighter elements from stellar data, and weighted the stones and irons in the ratio of 3: 2, and neglected the troilite phase, adding sulfur from stellar abundances.

Early in my study of the origin of the solar system I concluded that the moon represented more nearly the average sample of material from which the planets were made than does the earth or the other terrestrial planets. There is a variation in the composition of the terrestrial planets, and, since a chemical process for fractionation is available which could remove silicate rather than iron, the lowest density material should be correct. The mean density of the moon at zero pressure and ordinary temperatures is estimated to be 3.5.

The chondrites from their structure indicate that they were produced in some sort of a silicate hailstorm, and it appears just possible that they in themselves represent a rather average sample. Prior's composition for the chondrites is 44% olivine, 30% augite, 10% feldspar, 9% iron phase, 6% troilite, and 1% minor constituents. If the iron is oxidized to magnetite, the density of this material should be approximately 3.5, thus agreeing with the estimate for the moon. Because of this agreement a table of abundances has been calculated. The siderophile elements are of course less abundant than those given by Goldschmidt and very considerably less abundant than those given by Brown. On the basis of silicon as 10,000 the atomic abundance of iron is 7,250 instead of 8,900 (Goldschmidt) and 18,300 (Brown). The ratio of iron to nickel is 30 instead of 13.6 (Brown) or 19.3 (Goldschmidt). Curves are shown illustrating the differences between the three sets of values.

The Optical Theory of Willard Gibbs

Lynde P. Wheeler
Pickard and Burns, Inc., Needham, Massachusetts

In this paper is presented an outline of Gibbs' development of optical theory as presented in his published papers and in his manuscript notes. The principal difference between his development and the classical one of Maxwell lies in the definition of the quantity "displacement;" and to the unorthodox Gibbsian definition may be ascribed the neglect to which his views in the field of optics have been subjected.

The consequences of the two definitions are here worked out by computations based on the experimentally determined optical constants of metallic silver. Curves giving the density of the conduction electrons as a function of the frequency as determined from each of the definitions are shown, and compared with the normal incidence reflection curve of Hagen and Rubens. It is suggested that, since this comparison shows the Gibbsian hypothesis to be in closer accord with the experimental facts than the Maxwellian, a case has been made for a re-examination of Gibbs' theory and a further comparison of its consequences with those of the classical development.

Effect of Limited and Distributed Distensibility on the Pressure Pulses in the Arterial System

Carl J. Wiggers
Medical School, Western Reserve University

The pressure wave created in the aorta by ventricular

ejection is altered in its transmission to peripheral branches partly by the superposition of a standing wave created, according to common belief, by reflection from peripheral branching arteries. The period of this wave depends on the volume of blood in the aortic system and the volume elasticity characteristics of the aortic compression chamber. Normally such superposition is responsible for augmentation of the primary wave in the femoral artery and the occurrence of a marked dicrotic wave.

Previous work has shown that when distensibility is increased over the entire length of aorta (distributed distensibility) the natural period of the system becomes longer and the transmission rate of pressure waves is reduced. As a result the dicrotic wave in the femoral artery is flattened or abolished.

Experiments recently carried out in our laboratory by Robert E. Whittlesey revealed that when the volume elasticity of the aorta was apparently doubled by insertion of a large compression chamber (limited distensibility) the aortic and femoral pressure pulses showed just the opposite of the anticipated effects. The following conclusions were reached:

1. The insertion of a compression chamber into the aorta does not produce a common system but two systems with independent natural frequencies.

2. Such a chamber affects pressures in the arterial system by abstraction of blood during the latter portion of systole and early diastole. This initiates a negative pressure wave and, through reverberation, a positive pressure wave in the arterial system proper. The natural frequency of the arterial system remains virtually unchanged. These negative and positive standing waves are superimposed on the aortic and femoral pulses and respectively account for the marked lowering of pressure at the beginning of diastole and an intensification of the dicrotic wave.

3. The reduction in pulse amplitude is not due to damping but to an effect of increasing the capacity of the whole arterial system.

Rice in Asia

Robert R. Williams, *Research Corporation, New York*

Throughout southern Asia, except northwest India and western Pakistan, rice is prevailingly the staple food of the masses, supplying about 80% of the daily calories. The life of the people centers largely in the production of rice, which requires an incredible amount of hand labor.

With progressive industrialization of the East, rice is increasingly milled to whiteness to render it more palatable and better adapted to storage during long transport from distant farm to city kitchen. Thus the tendency to beriberi is aggravated.

Large-scale experimental fortification of rice has been practiced in Bataan, Philippines, for the past 3 years. Whereas formerly there were 150–300 deaths from beriberi each year in this 93,000 population, no single death from this disease has been reported for the past 18 months.

The question of applicability of such a measure in other parts of Asia occasioned a recent tour of all principal rice-eating lands, where observations were made of the various factors involved. A major obscurity is the extent of beriberi in Asia, where few countries have trustworthy mortality figures. Accordingly, it is hoped that further trial introduction of the fortified product will give a better measure of the present extent of this need as compared with needs based on numerous other dietary shortcomings. Also food, politics, and peace are not unrelated, and interesting observations were made on these aspects of Asian life.

Technical Papers

Induction of Mutations with β-Propiolactone[1]

Harold H. Smith and Adrian M. Srb

Department of Plant Breeding, Cornell University, Ithaca, New York

In a search for new chemical mutagens, compounds are being screened on the basis of tests using *Vicia faba* and *Neurospora crassa*. Results are reported here with the compound β-propiolactone, which was found to be effective in (1) inducing chromosomal aberrations in mitotic divisions of root tip cells in *V. faba*; and (2) causing reversions to growth-factor-independence in biochemical mutant strains of *N. crassa* and inducing gene mutations which confer resistance to the antibiotic effects of canavanine on *Neurospora*.

β-propiolactone[2] is the simplest lactone, and consists of a 4-membered ring containing 1 oxygen and 3 carbon atoms. The structural formula is $CH_2 - CH_2 - C = O$, with the O bridging the first CH_2 and the C:
|___O___|

Compounds with 4-membered rings are usually characterized by great chemical activity because of the tendency of the ring to open. The highly strained ring of β-propiolactone is known to open under the influence of many types of reagents to form a large variety of compounds. β-propiolactone is a liquid (bp, 155° C at 760 mm) and is soluble in water (37% by vol, at 25° C). The compound is available in quantity owing to its use in the field of industrial synthetic organic chemistry.

Preliminary trials with *V. faba* root tips, at different concentration-time levels, showed that immersion in a 0.05% aqueous solution of β-propiolactone for 20

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[2] Appreciation is expressed to the B. F. Goodrich Chemical Company, Cleveland, Ohio, for supplying β-propiolactone in lots for experimental purposes.