the comparative body plan has been appreciated for hundreds if not thousands of years, in the highest plant group there has been no ready key to the comparative unity of structure.

In Professor Eames's book, we have an important contribution to the general understanding of the comparative anatomy and phylogeny of vascular plants. It sums up the findings and conclusions of anatomical and paleobotanical research, a considerable part of which has been contributed during the past thirty-odd years. Several basic conclusions are presented which, if finally validated, will displace general concepts of long standing. These may be noted as follows:

(1) Vascular plants are all grouped together in one phylum, the Tracheophyta. The current division into two phyla, Pteridophyta and Spermatophyta, goes the way of the earlier separation into Cryptogamia and Phanerogamia. The seed habit is recognized as having arisen independently in more than one line of vascular type.

(2) The phylum of tracheophytes is divided into four main groups, largely on the basis of stelar and foliar differences. E. C. Jeffrey was the first to propose a division on this basis, in 1901. He divided vascular plants into two main groups, the Lycopsida and the Pteropsida. The Pteropsida comprised all true ferns and the higher seed plants, all those with large leaves which leave a gap in the vascular cylinder at the point of origin.

In the Lycopsida, he grouped the remaining vascular plants, based on a simpler stelar structure and the absence of foliar gaps. Subsequent workers have split Jeffrey's Lycopsida into three groups; the Lycopsida proper, taking in Lycopodium, Selaginella and similar fossil types; the Sphenopsida, including modern Equisetum and the Paleozoic sphenophyls; and the Psilopsida, with living Psilotum and Tmesipteris and similar Paleozoic forms.

(3) The archetypal vascular plant body is not to be considered as consisting of the three parts, root, stem and leaf. Instead, based on some rather recent paleobotanical work which has reported the structure of Silurian fossils, it is concluded that the primitive, terrestrial, vascular plant had a dichotomously branching axis, partly hypogean, partly epigean, bearing sporangia, but without leaf or root differentiation. Psilotum and Tmesipteris are the modern representatives of this plant form. Psilophyton, Rhynia were among the earliest pre-Carboniferous types.

(4) The long-standing controversy regarding the homologous or antithetic origin of alternation of generations is considered settled in favor of the former principle. The vascular sporophyte has not been derived by the progressive sterilization of a diploid sporangium, but rather by the gradual modification of a thalloid branch system.

(5) Finally, as a corollary of the preceding point, leaves of tracheophytes are recognized as having had two different origins. Those of the lycopsid type are regarded as enations; those of the larger sort, which leave gaps in the stele, are considered to have come from branch systems, become lateral and secondary by sympodial development. The dichotomy of fern venation would represent the persistence of a primitive branch condition.

All these several conclusions sum up into one broader concept, *viz.*, that vascular plants were originally derived directly from some thallophyte ancestor, and not by way of an intermediate bryophyte stage. The latter would constitute a separate line of terrestrial development from the algae.

Not all botanists will be ready to accept these conclusions. Not only will there be delay, due to natural conservatism, and to the difficulty of effecting so radical a change in thought from what has come to be familiar and traditional. Some botanists will prefer the antithetic theory of alternation and possible liverwort ancestry for vascular plants, a view so long and ably upheld by Campbell and Bower. Thus, Brown, in a recent and excellent elementary text in botany (Ginn, 1936), reaches the conclusion that "the structure of the Psilophytales fits in very well with the long-accepted idea that the Pteridophyta are derived from the Bryophyta."

On the other hand, the newer point of view has found expression in the general texts of Torrey (1930) and Sinnott (1935). In Germany, Zimmerman's "Die Phylogenie der Pflanzen" is even more comprehensive than the Eames.

R. C. BENEDICT

BROOKLYN COLLEGE AND
BROOKLYN BOTANIC GARDEN

THE NATIONAL ACADEMY OF SCIENCES. II

ABSTRACTS OF PAPERS PRESENTED AT THE CHICAGO MEETING

A comparison of differential heats of dilution with the predictions of the theory of Debye and Hückel: T. F. YOUNG (introduced by W. D. Harkins). Differential heats of dilution to be used in combination with cryoscopic measurements for the evaluation of activity coefficients of sodium chloride, in aqueous solution, have recently been determined. Significant discrepancies were encountered when the new measurements were compared with published differential heat of dilution data derived from experiments with extremely dilute solutions. Those data were also in conflict with the Debye-Hückel theory which permits a theoretical calculation of

the limit, as the molality approaches zero, of the derivative of the apparent molal heat content with respect to the square root of the molality. Both discrepancies proved to be due to calculations based upon an unjustified assumption, and both disappeared when adequate mathematical methods were applied to the calculation of the derivative. The same methods have now been applied to existing measurements of the heats of dilution of solutions of the halides, halates, nitrates and sulfates of the alkali metals. The new estimates of the limits of the derivative are in good agreement with theory. In nearly as good agreement are the values of the limiting derivatives calculated for the halides and nitrates of the alkaline earth metals. The very satisfactory agreement with theory of the behavior of a large number of electrolytes is in striking contrast with the behavior of a few, whose derivatives rise with decreasing molality, to values much larger than theory predicts. These include sulfuric acid, and the sulfates of calcium, magnesium, copper, zinc and cadmium. The sulfuric acid data can be explained by an increasing dissociation of the bisulfate ion with decreasing concentration. To be consistent with this explanation, the derivative curve should possess a maximum, the position of which is dependent upon the dissociation constant of the bisulfate ion. There is, at present, some evidence that such a maximum actually exists in the derivative curve of calcium sulfate.

Configuration changes in the reactions of complex inorganic compounds: JOHN C. BAILAR, JR., E. H. HUFFMAN and A. R. WREATH (introduced by William A. Noyes). Compounds of the octahedral configuration $[Men_2A_2]$ and $[Men_2AB]$ ("M" represents a metal, "en," ethylenediamine and "A" and "B," singly coordinated groups) can exist in *trans* forms and in optically active *cis* forms. In the replacement of A and B by other groups, there can be configuration changes in the cis-trans sense, as well as changes from one cis configuration to the other. This type of reaction is being studied in the author's laboratory in the hope of throwing some light upon the mechanism of the Walden inversion. The current theories of the Walden Inversion are based upon the behavior of organic substances and can not explain the cases under discussion. The reaction *levo* $[Coen_2Cl_2]Cl \rightarrow$ *levo* or *dextro* $[Coen_2(NH_3)_2]Cl_3$ goes through the intermediate $[Coen_2Cl(NH_3)]Cl_2$. It has been shown that the inversion does not take place in the second step. The first step is now under investigation. The coordinated chlorine groups of $[Coen_2Cl_2]Cl$ have been replaced by several other groups under a variety of conditions. In only two cases has it been demonstrated that optical inversion takes place, but it may have taken place in others. Some reactions of the chromium compound $[Cren_2Cl_2]Cl$ have also been investigated. The coordinated chlorine groups are not readily replaced, and no inversion could be demonstrated.

Catalytic effect of ammonium salts on the ammonolysis of diethylmalonate in liquid ammonia: L. F. AUDRIETH and C. SLOBUTSKY (introduced by William A. Noyes). Solutions of ammonium salts in liquid ammonia have been shown to possess the characteristic chemical properties of acids. Just as acids exert a catalytic effect upon hydrolytic reactions, so it was to have been expected that ammonium salts would influence ammonolytic reactions, that is, reactions involving the action of ammonia as solvent upon dissolved solutes. The authors have shown that the ammonolysis of diethylmalonate is markedly catalyzed by the presence of ammonium salts. This effect is a function of the concentration of the catalyst. Equivalent concentrations of various ammonium salts exert the same catalytic effect.

Distribution of chromosomal prime types in Datura stramonium: A. F. BLAKESLEE, A. D. BERGNER and A. G. AVERY.

The effect of dehydration on the exchange of salt and water between muscle and blood: LILLIAN EICHELBERGER (introduced by H. G. Wells). Experiments on normal dogs are described in which the extra- and intracellular phases of muscle were studied following (1) intravenous injection of hypertonic sodium chloride or sucrose and (2) intraperitoneal injection of (a) isotonic glucose or (b) sucrose or (c) hypertonic sodium chloride. From these data the following conclusions have been drawn: (1) Following the injection of hypertonic solutions, either intravenously or intraperitoneally, the original kilogram of muscle decreased in volume with an increase in the extracellular phase and a marked shrinking of the muscle cells. The maximum shrinkage occurred immediately following the intravenous injections. (2) For four hours following the intraperitoneal injection of isotonic glucose or sucrose the original kilogram of muscle decreased in volume. Both the extra- and intracellular phases lost water during this period of time.

Plasmapheresis, plasma exudation and traumatic shock: HENRY N. HARKINS (introduced by W. D. Harkins). Aside from nervous and toxic factors, a loss of actual fluid from the circulating blood stream has been found in certain types of shock. In some instances this fluid loss consists in whole blood, but in others it more nearly resembles blood plasma. Discussion is made of the quantitative relationship between the amount of blood lost during fatal hemorrhage, the amount of plasma lost during plasmapheresis and the amount of plasma-like fluid that exudes from the blood vessels in certain types of shock.

Respiratory phenomena in a case of dementia praecox: S. SLIGHT (introduced by H. G. Wells).

The nature of disease resistance in plants: F. C. WALKER (introduced by L. R. Jones).

The mechanism of immunity to Nippostrongylus muris, the intestinal nematode of the rat: W. H. TALIAFERRO and M. P. SARLES (introduced by F. R. Lillie). Although acquired immunity has been shown to develop following infection with *Nippostrongylus muris* by many investigators, evidence as to the mechanism of this immunity has been meager. We have found that acquired immunity to this parasite has to a large extent an antibody basis, since

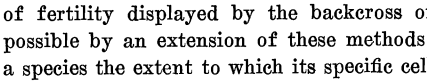
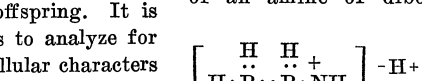
it is passively transferable. Moreover, in the actively immune rat, there is a more rapid and intense inflammatory response than in the normal animal. Thus, the infective larvae attempt their usual migration from the skin to the intestines via the lung in the immune animal, but become coiled up and immobilized, probably because of the presence of antibody, within the first few hours after they reach the skin and the lungs, and become the center of an inflammatory reaction which consists mainly of eosinophils and hypertrophying agranulocytes of hematogenous origin. Such worm-nodules increase steadily in size by the addition of cells at their periphery, within which the parasites eventually disintegrate and are phagocytosed. At later stages, the worm-nodules become tubercle-like masses of cells with a precipitate around the anterior end of the worm. Some of the worms are able to escape from the nodules of the skin and lungs before this occurs, but although they migrate to the intestine of the rat, are mostly passed from the intestine without developing to maturity or laying eggs. So far the only difference we have found in the intestine between normal and immune animals is a great increase of connective-tissue basophils and eosinophils in the *lamina propria* in immune animals, the significance of which is not evident. In the skin and lungs of immune animals, there is, therefore, evidence of antibody action (immobilization of worms and formation of precipitate in and at ends of larvae) and a mobilization of host-cells which eventually remove the disintegrated worms. In the intestine, there is also evidence of antibody action (stunted growth) and mobilization of host-cells, but the exact function of the latter is obscure.

Immunogenetic studies on species relationships: M. R. IRWIN and L. J. COLE (introduced by Ludvig Hektoen). Studies from this laboratory have shown (a) that there are hereditary biochemical characters in the red blood cells of a species which distinguish its cells from those of any other species, and (b) that such characters are separable in the cells of backcross offspring from hybrids between the two species. This shows that these genetic differences between species are of the same order as those within a species. There appears to be a correlation between the presence of these species-specific characters and the amount of fertility displayed by the backcross offspring. It is possible by an extension of these methods to analyze for a species the extent to which its specific cellular characters are shared with other species. Eventually this should provide an assay of the phylogenetic relationships between species.

The relative susceptibility of the mammalian fetus to infectious agents: ORAM C. WOOLPERT and N. PAUL HUDSON. A study of the immunologic state of the adult animal is complicated particularly by two circumstances: (1) the immunologic make-up of the adult has been conditioned by countless past contacts with antigenic substances; (2) the adult is exposed during experimentation to a variety of potentially infectious and immunizing agents. The mammalian fetus, on the other hand, has had little contact with infection and occupies a sterile environment. Therefore, if responsive to infectious agents, it should offer conditions highly suitable for the investigation of certain immunologic problems. In pursuing this concept, a group of us has been studying the susceptibility of guinea pig and rabbit fetuses to parasites directly inoculated, particularly *Mycobacterium tuberculosis, Actinomyces bovis* and the viruses of vaccinia, herpes, poliomyelitis and the submaxillary gland disease of guinea pigs. The observations made in these studies were: (1) Whenever the adult of the host species was at all responsive to the particular agent, the fetus was usually much more susceptible. (2) Younger fetuses appeared to be more susceptible than older fetuses. (3) Fetal reactions to a particular parasite resembled those of the adult with respect to incubation period, organs affected, appearance of cellular inclusions, etc. However, the reaction in the fetus was often more acute and the pathologic changes more widely spread. (4) The infective agents, with certain exceptions, were not altered in their biologic properties by fetal passage. The basis for the low resistance of the fetus as compared with the adult may be due in part to (a) absence of humoral antibodies because of lack of previous exposure, (b) deficient cellular reactivity early in fetal life, (c) the possible presence of enzymatic or other substances associated with rapidly growing embryonic tissue, which may favor parasitization.

Transformation of organic designs: paleontologic aspects of organic evolution: WILLIAM KING GREGORY.

Problems in the chemistry of boron hydrides as illustrated by the newly discovered compounds B_2H_7N and BH_3CO: H. I. SCHLESINGER and A. B. BURG (introduced by W. D. Harkins). The aim of the investigations of the hydrides of boron, of which the present paper is a part, is twofold: (1) to aid in establishing structural formulae which will clarify the abnormal valence relations exhibited by boranes, and (2) to determine whether normal boron hydrides (*e. g.*, BH_3 or B_2H_4) are capable of existence. The work herein reported illustrates the type of approach employed in each problem. The new compound B_2H_7N is prepared and characterized. Its properties, particularly the fact that it takes up only one mole of ammonia instead of two to form a stable compound, are not those of an amine of diborane, $B_2H_5NH_2$. Two formulae

 $^{-}H^{+}$ or  are suggested, and their bearing on the valence problem of diborane is discussed. By the reversible action of carbon monoxide on diborane, the new compound $BH_3 \cdot CO$ is obtained. It is shown to react with trimethylamine to form carbon monoxide and another new compound $BH_3 \cdot N(CH_3)_3$. These reactions and other properties of the compounds suggest that they are complexes containing hitherto unknown monoborine. On the other hand, the compound $BH_3 \cdot CO$ reacts with ammonia, not to liberate carbon monoxide and form $BH_3 \cdot NH_3$, but to add two moles of ammonia without loss of carbon monoxide. It is expected that further study of these substances will lead to an understanding of the relations between monoborine (BH_3) and diborane (B_2H_6).

A new method of determining the ring structures of glycosides: C. S. HUDSON and ERNEST L. JACKSON. The oxidation of several methyl glycosides has been found to yield crystalline salts of several derivatives of di-glycolic acid, the structures of which have been determined. These structures show in turn the ring structures of the parent glycosides. By this method the ring structures of the alpha form of methyl glucoside, methyl mannoside, methyl galactoside, methyl guloside and the alpha and beta forms of methyl arabinoside and methyl xyloside are shown to be of the pyranose type. A new crystalline methyl arabinoside has similarly been shown to be of the furanose type and of the alpha configuration.

A new and problematical cat-like fossil from the Eocene: W. B. SCOTT.

Contribution to the knowledge of Pleistocene vegetation in Minnesota: C. O. ROSENDAHL (introduced by A. J. Carlson). The occurrence of plant remains of Pleistocene age have been reported from 35 counties in Minnesota. A majority of the 65 recorded stations are located in the southern and western parts of the state and are distributed from near the eastern edge of the drift to the Canadian border in the Red River valley. A good deal of the plant material discovered prior to 1920 came from wells, being found at depths ranging from 10 to 195 feet, and only tentatively identified as oak, elm, cedar, tamarack or sticks, leaves and peat. Nearly all the material obtained recently, with one notable exception, has been found in road cuts or other deep excavations incident to industrial activities. Most of it is wood, in a fair to excellent state of preservation, occurring in the Nebraskan till and therefore either of preglacial or Aftonian interglacial age. There is a great preponderance of white and black spruce in the wood from the Nebraskan till, but several species of Dicotyledons are also represented. The richest deposit of Pleistocene plants in Minnesota has come from a deep well in Kittson County in the bed of Glacial Lake Agassiz. At a depth of 88 feet, and at the bottom of the Late Wisconsin till, a layer of ancient vegetation was struck that has yielded pieces of lignite, charcoal, innumerable pieces of wood, mosses, cones and nearly 600 fruits and seeds of Angiosperms. From this material there have been identified 6 genera of mosses, 4 conifers and 38 species of Monocotyledons and Dicotyledons. Many of the pieces of wood show a striking coincidence in the greatly reduced width of the annual rings towards the periphery of the stems. Very short growing seasons are indicated for the last 20 years of the life of the trees.

Paleobotanical research at the University of Chicago: A. C. NOÉ (introduced by F. R. Lillie). Paleobotanical research at the University of Chicago was established in the year 1921. It has developed along two distinct lines: a morphologic study of fossil plant structure and an investigation of fossil plant deposits with reference to problems of floral evolution, paleoclimatology and paleogeography. In recent years the field of our fossil plant exploration has been extended to distant regions in the United States and Mexico and much new structural material has been discovered.

Pre-glacial plant relics in the driftless area: NORMAN C. FASSETT (introduced by L. R. Jones). The Driftless Area, not invaded at any time by the Pleistocene glaciation, is entirely surrounded by glaciated territory. The flora of the glaciated regions is of course entirely postglacial, derived for the most part from survivors south of the glacial margin. But there is evidence that in spite of proximity of the ice some species continued to exist in the Driftless Area throughout the Wisconsin glaciations if not during all the Pleistocene. Thus we find *Montia Chamissoi* ranging from Alaska to New Mexico, with two isolated stations a thousand miles to the east in the Driftless Area. We see *Sullivantia Sullivantii* existing to-day just south of the glacial territory from Missouri to Ohio, and also in the Driftless Area, having obviously been exterminated between these two regions by glacial action. *Dodecatheon amethystinum* is confined to the Driftless Area, except for isolated stations in parts of Missouri and Pennsylvania which escaped the glaciers. In *Hypericum Kalmianum* is an example of a plant which survived glaciation in the Driftless Area, then followed a line of glacial lakes northeastward through the Fox River valley to Lake Michigan, and migrated around the Great Lakes shores.

Objectives of chlorophyll research: C. F. KETTERING.

The absorption spectra of solutions of pure chlorophyll and of chloroplasts in living cells: V. M. ALBERS and H. V. KNORR. This investigation was undertaken to determine whether the absorption spectra of chlorophylls separated by the Willstätter methanol procedure were identical with the spectra of the chlorophylls separated by selective adsorption on sugar. All the chlorophyll was taken from a single original sample and showed a positive Molisch reaction, satisfied the cleavage and basicity tests and had a magnesium content of 2.7 per cent. Absorption spectra of the original chlorophyll *a* and *b* mixture and the two mixtures, made by mixing the two components separated by the above procedures in the proportion of three parts of *a* to one part of *b*, were determined by the method previously described.[1] These spectra indicate that, while the positions of the absorption bands in the visible region fall in very nearly the same positions in all three cases, the magnitudes of the absorption coefficients are quite different. The chlorophyll which had been treated by the method of selective adsorption on sugar showed a much greater difference from the original than that treated by the Willstätter methanol procedure. These results indicate quite definitely that the chlorophylls are changed in some way during the process of separation and that the changes produced vary with the method of separation. They also indicate that the use of the known chemical tests and the positions of the visible absorption bands are not sufficient criteria for comparison of two samples of chlorophyll. In order to eliminate the complicated scattering encountered in the living leaf, the absorption spectra of single chloroplasts were photographed, using a Hilger E_3

[1] V. M. Albers and H. V. Knorr, *Jour. Chem. Phys.*, 4: 422–425, 1936.

spectrograph. The chloroplasts used were those in cells of Protococcus, Spyrogyra and Zygnema. They were mounted on the stage of the microscope and critically illuminated by means of a ribbon filament lamp. The image of the chloroplast was projected on the slit of the spectrograph, using a 4 mm objective with no ocular on the microscope. The plates were calibrated and absorption curves determined for the region from 704 mμ to 665 mμ. The region of absorption is found to be the same as that reported for the entire leaf. However, instead of a single band, four maxima, located at 668 mμ, 673 mμ, 678 mμ and 683 mμ, were observed. The relative intensities of these maxima are different in different chloroplasts, even in the same species.

Recent advances in the chemistry of chlorophyll: PAUL ROTHEMUND (introduced by C. F. Kettering). During the past few years the chemical research in the field of chlorophyll has led to a very intimate knowledge of the chlorophyll structure. It was demonstrated by Fischer that the isocyclic ring system attached to the hydrogenated porphin ring is responsible for a number of typical reactions of the pigment. One methylene group in chlorophyll and in its derivatives was found to be extremely reactive, as long as the magnesium atom was complexly linked to the molecule. Stoll observed the optical activity of chlorophyll solutions in monochromatic polarized light. It was possible for Fischer to prove that the "phorbin" system in chlorophyll contains two hydrogen atoms more than the porphin system. The same author identified a vinyl group in the molecule of chlorophyll *a* and *b*, and he also performed the partial syntheses of the following chlorophyll derivatives: chlorophyllide *a*, methyl chlorophyllide *a*, ethyl chlorophyllide *a* and pheophytin *a*. Our own synthetic work to obtain "porphin", the fundamental ring system of chlorophyll and of hemin, was successful: porphin and a large number of its derivatives and homologues were prepared synthetically by condensing pyrrole with suitable aldehydes. An interesting case of isomerism of porphyrins was found in connection with this synthesis. The syntheses of hydrogenated porphin and of the hydrogenated porphin ring in form of "phorbin" have not been accomplished so far. Our studies on the precursor of chlorophyll in plants led to the isolation of a green pigment, which is closely related to chlorophyll in elementary composition and in spectroscopic properties. The formula (Fig. 1) given herewith is the best expression of our present knowledge of the structure of chlorophyll *a;* in chlorophyll *b* the $-CH_3$ group attached to ring II is replaced by the formyl group $-C\overset{=O}{-H}$.

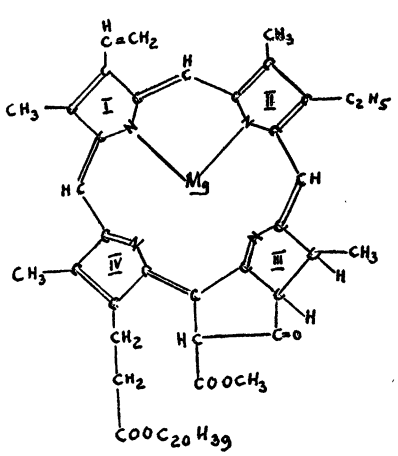


FIG. 1

The ratios of chlorophyll a and b and the mechanism of photosynthesis: ONDESS L. INMAN (introduced by C. F. Kettering). Sorby in 1872 investigated the proportions of chlorophyll *a* (blue chlorophyll) to chlorophyll *b* (yellow chlorophyll). He reported 100 parts of *a* to 0 of *b* in the olive and red algae. Leaves grown nearly in the dark showed a ratio of 100 parts of *a* to 5 or 6 parts of *b*. Healthy green leaves gave 100 parts of *a* to 13 to 17 parts of *b*. Willstatter studied many green plants and found on the average about three parts of chlorophyll *a* to one part of chlorophyll *b*. The brown algae ratio was found to be 19 parts of *a* to one part of *b*. It has been found that when the etiolated leaf of *Zea Mays* is irradiated for two and one half hours and the first evolution of oxygen detected by use of luminous bacteria, the ratio of chlorophyll *a* to chlorophyll *b* is 21.7 parts of *a* to one part of *b*. When the time of irradiation was four hours the ratio was 17.4 parts of *a* to one part of *b*. This indicates that the normal ratio of three parts of *a* to one part of *b* is not essential for photosynthesis, if one assumes that the process of photosynthesis is under way when the evolution of oxygen can be detected. Furthermore, it is reasonable to conclude that any theory of photosynthesis which supposes an equilibrium reaction between chlorophyll *a* and *b* should not require a constant value for the components *a* and *b*. If chlorophyll combines chemically with carbon dioxide, as has been postulated, such data would tend to point toward an assured combination with chlorophyll *a*. If, however, chlorophyll *b* does play the same part as *a*, then it seems most logical to assume that the part of the chlorophyll molecule which combines with carbon dioxide is a portion common to both chlorophyll *a* and chlorophyll *b*, such as, for example, magnesium or the additional five ring component or the phytyl group or some additional part of the natural occurring molecule which is not found in the purified product.

Spectroscopic analysis of hemochromogens: the ferriheme hydroxide-cyanide equilibrium: T. R. HOGNESS, F. P. ZSCHEILE, JR., A. E. SIDWELL, JR., and E. S. G. BARRON (introduced by W. D. Harkins). A precise spectrophotometric method makes possible the analysis of mixtures of hemoglobin derivatives, and consequently the study of equilibria involving these compounds. One of the equilibria studied is that between ferriheme hydroxide and cyanide ion. This study shows definitely that the ferriheme hydroxide is an associated compound and reacts to form ferriheme cyanide, according to the equation,

$$Hm_2(OH)_2 + 4\,CN^- = 2\,Hm(CN)_2^- + 2\,OH^-.$$

This is the first experimental evidence for the association of the ferriheme radical. On the basis of the accepted structure of ferrihemochromogens, there is no apparent explanation for the linkage which accounts for this association.

X-ray studies of the structures of biological materials: GEORGE L. CLARK (introduced by W. A. Noyes). Briefly outlined are the improvements in x-ray diffraction technique which have permitted studies of substances produced in living processes. Primary among these improvements is the resolution of interferences corresponding to very large periodicities—for example, 440 A. U. in collagen. Latest results are summarized on cellulose, chitin, rubber, keratin (human hair, feathers, pig bristle), living nerve, tendon collagen, intestinal wall collagen, muscle, albumin, hemoglobins, cereal proteins, etc. As an example of the usefulness of the diffraction pattern in biological research is cited the 48 A. U. equatorial spacing in intestinal wall collagen which led to the isolation, purification and analysis of a wax-like substance whose molecules are oriented radially on the fibrils and serve both to "lubricate" the fascial tissue and to protect the protein from enzyme digestion.

Slow ionic oxidation-reduction reactions: their mechanism and catalysis: PHILIP A. SHAFFER. Although many ionic reactions are immeasurably rapid there are numerous cases where thermodynamically possible reactions between demonstrably "active" ions are surprisingly slow or even fail to take place without catalysts. In some cases ionic reactions proceed much faster when *separated* in the form of a battery (electro-chemical cell) than when in a single solution. Survey of a number of cases among oxidation-reduction reactions indicates that a simple but hitherto unconsidered quality of the individual ions is frequently an important rate-controlling factor, and appears to explain this strange behavior: namely, the equality or inequality of permissible valence-change. Rapid reactions probably result always from *bi*molecular collisions or a sequence of these. In oxidation-reduction reactions the transfer of electrons from reductant to oxidant requires (in a bimolecular process) "common consent" as to the number to be lost and accepted. Disagreement, because of inability to assume the resulting "impossible" valence state, makes the reaction depend upon third or higher order collisions which are much less frequent events. Like or unlike charge of ions is another factor of less importance. A survey of the periodic table with respect to reactions of elements known in plural valence states indicates many instances which appear to support this simple hypothesis. Greater consideration of characteristic properties of the individual ions, in addition to the present concept of energy levels and "activation energy," is advocated as necessary for progress in the still obscure subjects of chemical kinetics and catalysis.

The rôle of the macrophage in the mechanism of recovery from experimental lobar pneumonia in the dog: O. H. ROBERTSON (introduced by F. R. Lillie). Recent observations on the histological pathology of experimental pneumococcus lobar pneumonia in the dog have shown that the onset of recovery is accompanied by a change in the character of the intra-alveolar cellular exudate from a predominantly polymorphonuclear to a large mononuclear type of cell. These latter cells are for the most part typical macrophages and appear to be derived to a considerable extent from the fixed tissue cells of the lung parenchyma. Associated with this cellular change is a diminution or complete disappearance of pneumococci, due apparently to their phagocytosis by the macrophages. That the mobilization of the macrophages in the lung plays a significant rôle in the termination of the disease is attested by the following experimental findings: (1) The disappearance of pneumococci from lesions in which resolution is occurring during the active phase of the disease when spread of the inflammatory process to other parts of the lung is taking place. (2) The demonstration that the resolving lung constitutes a lethal environment for actively growing, freshly introduced virulent pneumococci. The lung loses this property to a considerable extent upon its return to a normal histological appearance. (3) Studies of macrophage exudates both *in vivo* and *in vitro* have shown that these cells are capable of destroying large numbers of ingested pneumococci within a few hours and that they carry on this process much more effectively than do the polymorphonuclear leucocytes in the presence of relatively weak opsonic fluids.

Some chemical properties of an essential growth factor for pathogenic bacteria: FELIX SAUNDERS and STEWART A. KOSER (introduced by H. G. Wells). Many bacteria, especially the pathogens, develop quite readily in a meat infusion culture but are unable to grow in a simple synthetic medium. If a meat infusion is shaken with charcoal the growth-promoting substance(s) is absorbed and the infusion will no longer support the growth of pathogens. If the charcoal is extracted with boiling alcohol the growth-promoting factor can be eluted and if it is added to a synthetic medium containing inorganic salts, dextrose and amino acids the pathogens will grow. Control tests show that growth is due to a true growth factor and not to the addition of some nutrient to the medium. The growth factor is widely distributed, since it can be isolated from many different kinds of tissue of both plant and animal origin. It is active biologically in extremely small amounts. Only a few gamma are necessary to activate a liter of synthetic medium. Chemical studies show that the growth factor is a substance of low molecular weight. Its most striking property is a remarkable stability. It is heat-stable, resistant to strong oxidants, acids and alkalis. Growth-promoting activity is not destroyed by bromine, ammoniacal silver, acetic anhydride or nitrous acid. The substance is soluble in acetone, methanol, ethanol and phenol but is insoluble in ether, benzene, chloroform and higher alcohols. It does not contain sulfur and is probably inorganic since it is destroyed by ashing.

Experimental meningococcal infection: C. PHILLIP MILLER (introduced by Ludvig Hektoen). Experimental meningococcal infection has been produced quite regularly in the mouse by intraperitoneal inoculation of meningococci suspended in mucin. Of virulent strains approxi-

mately 10 organisms suffice to initiate a lethal infection with invasion of the blood stream. The action of mucin is not clearly understood, but seems to involve interference with the defense mechanism of the host rather than enhancement of the virulence of the micro-organisms themselves. Mice can be protected against infection by preliminary injection of immune serum, which is type specific if monovalent, and they can be spared a fatal outcome if serum is administered in sufficient quantity, even though the infection is quite far advanced.

A study of genital mycosis: H. CLOSE HESSELTINE (introduced by A. J. Carlson). Certain significances of the yeast-like fungi in the female reproductive tract have been demonstrated only recently. The incidence appears to be related partly to the hygienic state. The discussion will give incidences in the pregnant, gynecologic and diabetic patient, include identification problems of the monilia and cryptococci, suggest the influence of available glucose, offer additional evidence that the sporadic oral thrush of the newly born is contracted from the mother, designate avenues now open for therapeutic improvements, and indicate some difficulties in accomplishing cures.

Blood volume changes in eclampsia: WILLIAM J. DIECKMANN (introduced by F. R. Lillie). Changes in blood and plasma volume in eclampsia have been determined by making serial examinations of hemoglobin, hematocrit and serum protein concentration. Determinations of plasma and blood volume have been made with the Congo red method and indicate that in eclampsia there is a very marked concentration of the blood.

A study of the action of some oxytocics, especially ergonovine, on the postpartum uterus: FRED L. ADAIR, M. EDWARD DAVIS and SARAH A. PEARL (introduced by A. J. Carlson). The chemistry, pharmacology and clinical application of a new alkaloid isolated from ergot, ergonovine, which contains most of the desirable oxytocic activity in ergot, was discussed. The various experimental procedures resulting in the isolation of this alkaloid were briefly sketched. A comparison was made of this new oxytocic drug with other oxytocic drugs. A method of studying contractions of the post partum uterus was described and some of the results were presented.

Some relationships between structure and function of organic arsenicals in experimental chemotherapy: ARTHUR L. TATUM (introduced by A. J. Carlson). A large number of organic arsenicals were used to treat laboratory animals, mostly rats, infected with various species of trypanosomes. A result of such a survey revealed the possibility of grouping the drugs into categories according to their effectiveness. The members of one group of arsenicals were effective in curing infections caused by any of several species which are distinctly pathogenic to the host (*T. equiperdum, brucei, rhodesiense*). The members of the other group of arsenicals were effective in curing rats infected with a relatively non-pathogenic species (*T. lewisi*). Those drugs effective on *T. lewisi* were mostly quite ineffective on the pathogenic species, and conversely those drugs effective on the pathogens are ineffective on the non-pathogen. Similar relationships hold true in *in vitro* susceptibility of the organisms toward the drugs. The arsenicals effective on *T. lewisi* possess a carboxyl group, *i.e.*, an acidic group, whereas those drugs effective on the pathogens have alcoholic or amine groups, *i.e.*, basic groups. The differences in ease of cure of the animals infected by different members of the pathogenic series appear to reside in differences in parasite-host relationships. It can scarcely be due to drug-to-parasite relationship, since *in vitro* drug-to-parasite relationship is relatively the same, whereas actual curability of the infected host differs very markedly with different pathogenic species.

The acid-base and energy metabolism of the stomach and pancreas: MARTIN E. HANKE. The metabolism of the stomach and pancreas was studied in dogs by comparative analysis of the venous blood from these organs and arterial blood simultaneously taken. The experimental determinations on the blood were pH, CO_2, O_2 content, O_2 capacity and per cent. water. Comparison of the available base differences in the blood with the acid and alkali in the gastric and pancreatic secretions has shown that in the case of the stomach the two values are equal within experimental error, while in two experiments in the pancreas the latter is about twice the former, and the relation is more variable. The rate of blood flow through the stomach and pancreas was calculated from the difference in the water content of the arterial and venous bloods and the volume rates of secretion of the two juices, on the assumption that the secretion of water in the juices is quantitatively reflected in a decrease in the water content of the corresponding venous blood. Thus a 20-kg dog, with a mucosa weight of 80 gm, a water difference of arterial and gastric venous blood of 0.5 per cent., and a secretion rate of 1.1 cc of gastric juice per minute, has a blood-volume flow of about 60 cc per minute through the stomach. Calculation of the energy metabolism of the actively secreting stomach from the difference in the O_2 content of arterial and gastric venous blood (about 2.4 millimols O_2 per liter of blood) shows a production of 0.14 gm-calorie per minute per gram of mucosa, or 13.5 gram-calories per cc of gastric juice. Calculation of the free energy of formation of the constituents of gastric juice from blood or lymph from the equation $\Delta F = NRT \ln \frac{C \text{ gastric juice}}{C \text{ blood}}$ shows for hydrogen-ion -1.22 gram-calories, for other ions, Na, K, NH_4 and Cl and water, about $+0.10$ gram-calorie, a net total of -1.1 gram-calories per cc of gastric juice. Assuming that there are no other significant sources of energy in gastric-tissue metabolism besides the conventional oxidation of carbohydrates, fats and proteins, it follows that the minimum osmotic work involved in gastric-juice formation is about 9 per cent. of total energy metabolism of the stomach. Similar conclusions have been reached by Teorell (*Skand. Arch. Physiol.*, 66: 279, 1933), using other methods and another species. Similar calculations of data from experiments on the pancreas show a total metabolism of 8.6 g-cal. (an increase over resting metabolism of 5.0 g-cal) for 1 cc of pancreatic juice. The sum of the free energies of formation of the constituents of pancreatic

juice from blood is about 0.5 cal per cc of pancreatic juice. The ratio of these two values is about 6 per cent. (10 per cent. for the increase over the resting metabolism). These "efficiencies" $\frac{\text{free energy}}{\text{total tissue energy}}$ per unit volume of secretion, are much greater in the case of the stomach and pancreas than they are for the kidney, where the quotient is about 1 per cent. (Borsook and Winegarden, *Proc. Nat. Acad. Sci.*, 17: 13, 1931).

Active and blocked embryonic cells—some phases of their physiology: J. H. BODINE (introduced by Carl E. Seashore). Quantitative physiological studies have been made on actively developing and blocked embryonic cells in an attempt to learn further concerning the "block mechanism" normally occurring in certain cells. Rates of oxygen consumption, the effects of carbon monoxide, oxygen lack, cyanide, methylene blue, etc., on the resting and active stages of the embryonic cell have been investigated and an analysis made of the respiratory mechanisms involved.

The formation and fermentation of hexosemonophosphate in muscle: CARL CORI and G. T. CORI (introduced by Joseph Erlanger).

The scientific analysis of piano performance: C. E. SEASHORE. A camera has been devised to measure in adequate detail and graph photographically the characteristics of the player's performance on the piano. The pianist has at his disposal only two variables; namely, time and intensity. Pitch is determined by the instrument; so also is the timbre, except in so far as it can be modified by overholding with key or pedal. The graph of the performance is made on a standard 4″ film in the time that it takes to play the selection. Time is measured in .01 sec., and intensity in decibels is measured in terms of the rate of impact of the hammer. This photographic chart is condensed into a musical pattern score.

Stroboscopic studies of the human vocal cords: DR. JOSEPH TIFFIN (introduced by Carl E. Seashore). Stroboscopic moving pictures of the vocal cords in action will be shown. These slow-motion pictures indicate the form of vibration of the vocal cords. Analysis of the cordal movement tends to substantiate the Helmholtz theory of vowel production.

Histological studies of the respiratory portion of mammalian lungs: CLAYTON G. LOOSLI (introduced by C. J. Herrick). A detailed study by various histological methods of the lungs of the monkey, dog, cat, rabbit, rat, guinea-pig, opossum and mouse, killed at various stages of postnatal development, has been made. In these animals a continuous epithelial membrane lining the respiratory portion of the lungs is not found. The alveolar wall is made up essentially of a central stroma of reticular and elastic fibers and connective tissue cells. The meshes of the fibers support a network of blood capillaries which form loops which bulge into the adjacent alveolar spaces. An amorphous ground substance or membrane covers the fibers, cells and capillaries. Isolated nucleated cells are scattered over the alveolar walls. Some of the intercapillary spaces in the alveolar walls possess openings or pores which connect adjacent alveoli.

Transmission of successive impulses across synapses: HELEN TREDWAY GRAHAM and RAFAEL LORENTE DE NÓ (introduced by Joseph Erlanger). Normal functioning of the nervous system involves transmission of impulses along a succession of neurones at frequencies ranging from about 5 to 100 per second (intervals of 10 to 200 milliseconds between impulses). Passage of an impulse along the peripherally-placed axons of certain of these neurones—the peripheral nerve fibers—produces long-lasting changes of excitability to electrical stimulation; under certain conditions the fiber after 5 to 10 milliseconds may be more excitable than normally, while after 20 to 100 milliseconds it may be less excitable. It will be observed that these intervals come within the range frequently observed in normal functioning of the nervous system, and it is therefore conceivable that similar changes of excitability, if they occurred under physiological conditions, might play a rôle in the explanation of certain aspects of central nervous activity (facilitation, inhibition, etc). In the physiologically functioning nervous system, however, each neurone is stimulated not by electrical shocks applied to its axon but by the arrival of impulses at the end knobs of the axons of neurones preceding it in the path of transmission. Such stimulation across neurone junctions or synapses may be called synaptic stimulation. The recovery of excitability to this normal synaptic stimulation has been tested by stimulating electrically the neurones ending in synapses with the motoneurones of the trochlear nerve or internal rectus muscle (rabbit eye) from which the impulses were recorded. It has been found that there is no period of increased excitability to such synaptic stimulation, but instead a protracted period of depressed excitability. This depression, which lasts 30 to 50 milliseconds after one impulse, becomes longer and more intense after a succession of impulses (2 to 9 impulses at frequencies of 45 to 200 per second have been found to increase the depression significantly). It appears therefore that certain forms of inhibition in the central nervous system may be explained by changes of excitability to synaptic stimulation and, in particular, that the gradual decrease in excitability with the passage of a train of impulses may account for such phenomena as the dying out of rhythmic activity.

Potentials in the frog's nervous system: R. W. GERARD (introduced by A. J. Carlson).

Some effects of histologic procedure on cells: G. W. BARTELMEZ (introduced by C. J. Herrick).

The secretion of hydrochloric acid in the stomach as revealed by the freezing-drying method: N. D. HOERR (introduced by C. J. Herrick).

Lipocaic, a new pancreas hormone: LESTER R. DRAGSTEDT, JOHN VAN PROHASKA and PAUL B. DONOVAN (introduced by A. J. Carlson). The observations of Fisher (1924) and of Allen, Bowie, Macleod and Robinson (1924) and others that completely depancreatized dogs adequately treated with insulin usually die within two months with

extensive fatty infiltration of the liver was confirmed. The absence of pancreatic juices from the intestine is apparently not the cause of this liver damage, since it was absent in animals with complete pancreatic fistulae and in dogs whose pancreatic ducts had been ligated and the pancrease extensively degenerated. The administration of fresh activated dog pancreatic juice in amounts of from 1,000 to 1,100 cc per day did not prolong the lives of depancreatized dogs nor prevent the development of the typical liver changes. The oral administration of as little as 25 gm of fresh beef pancreas per day was found sufficient to either prevent or to cure the fatty infiltration and to permit survival. Choline is apparently not the substance in pancreas which accounts for this effect, since as much as 700 gm of choline per day were found to be entirely ineffective. An extract was prepared from fresh beef pancreas and found to be effective in curing and preventing the development of fatty infiltration in the liver of depancreatized dogs adequately treated with insulin. This extract is believed to contain a new hormone, for which we have suggested the name "Lipocaic," which plays a rôle in the metabolism of fat. Some properties of this new hormone are described.

The mechanism of the lytic action of bacteriophage: J. BRONFENBRENNER (introduced by Joseph Erlanger).

The antirachitic effect of tartrate and citrate: BENGT HAMILTON and M. DEWAR (introduced by H. G. Wells). On the basis of certain theoretical considerations it was thought possible that the oral administration of tartrate or citrate would prevent the development of rickets in rats on a rachitogenic diet. This prediction proved to be true, the salts proving to have a preventive effect as marked as that of cod liver oil. It was also shown that fully developed rickets could be effectively healed by the addition of these salts to the rachitic diet, although the healing effect was not, perhaps, as marked as that of vitamin D. The cause of this antirachitic action of tartrate and citrate is not quite clear.

Termite nests—a study of the phylogeny of behavior: A. E. EMERSON (introduced by C. M. Child). Termite nests may be used as examples of behavior evolution because they are morphological indications of behavior patterns, they express the behavior of a population, the patterns are hereditary, there is a natural control over any Lamarckian influence, evolutionary sequences are available, adaptive modifications may be demonstrated, and coordination mechanisms may be partially analyzed. Wood-eating roaches, similar to the hypothetical ancestor of the termites, excavate galleries in wood but make no constructions. The Kalotermitidae excavate wood and construct partitions indicating responses to humidity and mechanical or chemical factors. The Mastotermitidae exhibit a quantitative advance in nest construction compared to the Kalotermitidae. The Hodotermitidae show a further advance with subterranean nests, elaborate carton construction and food storage. The Rhinotermitidae have separately evolved subterranean adjustment and in some species show building activities in response to social factors as well as physical factors. Excavated subterranean nests of the Termitidae exhibit the influence of mechanical and spatial factors. Materials may be dirt, wood or excrement, cemented by saliva or excretions. Structures consist of covered tunnels, roads, rain-shedding projections and ridges, nests of characteristic size and differentiation, ventilation pores in the walls, stored food and fungus gardens. Sterile workers and nymphs of sterile soldiers and workers construct the nests in the Rhinotermitidae and Termitidae. The ecological functions of the nest are the control of temperature, the control of humidity, the protection from predators and harmful fungi—all enabling the termites to live in otherwise uninhabitable niches. The nesting site may be selected partly or wholly by the colonizing pair, but often is selected by the workers followed by a colony migration. Height of the nest from the ground may be fairly characteristic of the species. Different species within a genus may show great divergence in nesting behavior. Species of the genus *Amitermes* have subterranean nests, mound nests, arboreal nests, nests oriented with reference to the sun and rain-shedding constructions. Convergent evolution of rain-shedding constructions has occurred in the Amitermitinae, Termitinae and Nasutitermitinae. "Intelligence" of termites reported in the literature is usually strongly anthropomorphic. Behavior evolution should be correlated with morphological evidences of evolution. Degenerative evolution of behavior patterns may be explained by modern genetic theory.

An evolutionary analysis of insular and continental species: ALFRED C. KINSEY (introduced by C. M. Child). Insular and continental forms so differ in their constitution and behavior that evolutionary theories adequate to the one type of species are not all applicable to the other. In an attempt to evaluate the evolutionary data from the laboratory genetics, the gall wasp family Cynipidae is being used as the basis of an intensive study of species as they actually occur in nature. Among the more than 300 species so far studied, most of the forms which match the current concepts of continental species are located in the eastern half of the United States. There the uniform topography offers few geographic factors to isolate species, and even distance may fail as a factor because of the recent interchanges of faunas and floras consequent on the Pleistocene glaciations. These species all have large ranges, and they show considerable intra-specific variation, local subdivisions of each population, and extensive intergradation from one species to the next. In the western half of the United States, and throughout Mexico and Guatemala, the highly varied topography and multiplicity of the oak hosts of these insects provide isolating factors as effective as the waters surrounding oceanic islands. The essentially insular species occurring there have relatively small ranges, often show a minimum of individual variation (although in some cases the variation is great), rarely develop local variations within the populations, and almost never develop intergrades between species. The Darwinian concept of accumulative variation seems inapplicable, while the laboratory data on mutation seem sufficient explanation of the origin of most of these species. There seems to have been such an early isolation of the new types on the peripheries of

the ranges of the parental species that gene frequencies were soon reduced to equilibrium. While the interspecific gradation between continental species is usually taken to substantiate Darwinian concepts of the multiplication of species through gradual transitions, the intermediate groups seem more exactly analyzed as hybrids between what were originally isolated stocks. Thus the evolutionary pattern laid down by insular species may be taken as basic to the interpretation of continental species. In continental species, however, the chance that interspecific hybridization may give rise to a new species is much greater than among insular species.

Meteorological environment and organic differentiation: W. F. PETERSEN (introduced by F. R. Lillie). In the material presented, confirmation of the Hippocratic suggestion of the rôle of the meteorological environment during the early development of the embryo (paratypic differentiation) is sought. It is assumed that with periods of greater meteorological turbulence the more profound autonomic disturbances of the maternal organism (uterine vascularization and tonus) will disturb the uniformity of environmental conditions for the rapidly developing embryo, with the possibility of optimal stimulation on the one hand as well as injury on the other. An examination of the seasonal conception distribution, of still births, of birth rhythm and premature delivery is first presented. There follows evidence for mental differentiation, including unusual intelligence, feeble-mindedness, the criminal type, the criminal insane and the insane. A study is made of adult habitus with relation to the period of conception, as well as a study of the conception periods of groups who have died from various diseases, including tuberculosis, endocrine disturbances, leukemia, diabetes, etc. A discussion of the possible mechanisms involved and of the significance for racial differentiation.

The laws governing the distribution of bone marrow in the extremities in mammals: CHARLES HUGGINS (introduced by F. R. Lillie). In newborn mammals all bone marrow is red. Soon a peripheral regression of red marrow takes place, and the adult state consists of a central accumulation of red marrow with a peripheral yellow marrow. A thermal decrement has been found in the peripheral bone marrow as compared with the central areas. Elevation of temperature of the outlying regions causes a retention of red marrow or a regression of yellow marrow with replacement by blood-forming tissue.

Establishment of diurnal temperature curve in the child: N. KLEITMAN and S. TITELBAUM (introduced by A. J. Carlson).

A study of certain fatigue symptoms in mental work: A. G. BILLS (introduced by C. J. Herrick). The proposed report brings together the main results of a program of research designed to get at the basic principles of mental fatigue, by analyzing the behavior changes resulting from continuous mental work. The discovery of a hitherto unrecognized fatigue symptom, the "block" or enforced pause, occurring more or less periodically at frequent intervals during work, led to studies of the following special problems: (1) The progressive increase in length and frequency of blocks with prolonged work; (2) the decrease resulting from practice in the task; (3) the effect of kind of task and rate of work; (4) the relation of blocks to error causation; (5) a comparison of blocking in manual and in vocal performances; (6) the exaggeration of the phenomenon in the manual (as well as vocal) performance of stutterers; (7) the relation of the block rhythm to various rhythmic physiological activities, such as breathing; and (8) an investigation of the relation of blocking to nervous metabolism, by noting the effect of systematically varying the oxygen supply of persons engaged in mental work, and the effect of breathing pure oxygen on the performance of persons already fatigued from an hour of mental work. The results indicate that the block is the most sensitive objective fatigue symptom; that it probably serves a function similar to refractory phase, in giving frequent short rests to the reacting mechanisms which prevent excessive exhaustion; and that it is independent of any specific organic rhythm. It occurs in manual responses as well as vocal; is exaggerated in stutterers, and in hesitant speakers; and is a major factor in error causation. It is exaggerated in proportion to the homogeneity and complexity of the task. It is exaggerated under conditions of anoxemia, in inverse proportion to the percentages of oxygen used and the duration of the work period. The excessive blocking present in fatigued workers is apparently reduced by breathing pure oxygen. These last findings suggest a close relation of blocking to the oxygen metabolism of either the nervous or sensory motor mechanisms.

Contrasts in the genetic effects of ultra-violet radiation and x-rays: L. J. STADLER and G. F. SPRAGUE (introduced by Sewall Wright). Ultra-violet radiation applied to mature pollen of maize induces mutation and deficiency, but unlike x-ray treatment it has little or no effect on the frequency of translocation. The endosperm deficiencies induced by UV include a larger proportion of fractionals, and the relative frequency of loss of specific marker genes differs distinctly from that found under x-ray treatment.[1] Since the frequency of deficiency was lower under the UV doses used than under the x-ray doses commonly applied, it is possible that the difference in effect on translocation is incidental to dosage. If translocations result from chromosome breakage followed by reattachment of broken ends in new combinations, translocation can occur only in cells with two or more breaks. The rarity of translocation following UV treatment may then be due to the smaller number of breaks produced by the UV dose applied. A further trial was made, comparing a maximal dose of UV with a rather low dose of x-rays. These doses were approximately equal in total frequency of induced deficiencies for the endosperm genes *A* and *Pr*, the UV treatment producing about one third as many deficiencies affecting the entire endosperm and two and one half times as many fractionals as the x-ray treatment. The frequency of translocation was determined for each treatment by direct cytological examination of about 100 unselected

[1] *Proc. Nat. Acad. Sciences*, in press.

plants of the F_1 progeny. Only one translocation was found in the UV progeny, while 44 per cent. of the plants of the x-ray progeny showed translocations, several of them two or more independent translocations. The frequencies of plants with segregating defective pollen were 14 per cent. and 77 per cent., respectively.

The reality of neurofibrils in the living ganglion cell and nerve fiber: PAUL WEISS (introduced by C. J. Herrick). Photographs were presented demonstrating the existence of neurofibrils as discrete filaments, both in the cell body and the axone of living ganglionic cells of chick embryos grown in tissue culture but otherwise untreated. The experiments (done with the assistance of Mr. H. Wang) consisted of explanting embryonic spinal ganglia into blood plasma under provisions permitting direct microscopic observation. The gradual appearance in the healthily growing and differentiating cells of neurofibrils was observed in the course of prolonged cultivation up to two weeks. These observations seem to end the old argument of the reality versus artifact nature of neurofibrils in the living undisturbed cell, specifically in regard to warm-blooded vertebrates.

The physiological basis of heterosis: R. A. BRINK (introduced by Sewall Wright). Cross-fertilization in *Medicago sativa*, using an unrelated strain as the pollen parent, increases the proportion of functional seeds formed several fold, as compared with self-fertilization under the same conditions. The disparity results from a much lower incidence of abortion during development in the case of the hybrid embryos. The superior ability of the latter to continue growth to maturity may be considered a manifestation of heterosis. It is a well-recognized fact that growth in certain regions of the plant tends to suppress it in many other potential centers of similar activity. Immature embryos are subject to the conditions imposed by this growth-regulating mechanism and continue development or abort according to the reciprocal relation established between them and their environment in the host plant. The increased capacity of hybrid as compared with inbred embryos in Medicago to complete development may be accounted for on the assumption that the primary effect of outcrossing on the physiology of the resulting zygote is to shift the balance in the growth-regulating mechanism in favor of the forward processes and against the retarding influences. The nature of the growth-regulating mechanism is obscure, but some facts concerning it are available which enable one to visualize how such a shift might be effected. There is much evidence suggesting that heterosis in general may rest upon a physiological basis of this sort.

The oxidation-reduction potentials of hemin and some hemochromogens: E. S. G. BARRON (introduced by H. G. Wells). The importance of hemin and of the nitrogenous derivatives of hemin, the hemochromogens, has increased considerably during the last years. Because they are electromotively active oxidation-reduction systems, they act as catalysts of most of the biological oxidations. Since the catalytic power is conditioned by the relation between the free energy of the catalyst and the free energy of the oxidizable substance, a knowledge of these free energies is essential for the understanding of the mechanism of biological oxidations. The free energy (as determined by measuring the oxidation-reduction potential) of hemin and of a number of hemochromogens (cyanide, nicotine, pyridine, α-picoline, pilocarpine, histidine) has been studied. It has been found that the oxidation reduction potential of hemin becomes more positive on its conversion to hemochromogen, the potential varying with the nature of the nitrogenous compound attached to hemin. Thus at pH 9.50, the E'_0 of hemin is −0.235 volt; that of cyanide-hemochromogen is −0.182 volt; of pilocarpine-hemochromogen, −0.156 volt; of histidine-hemochromogen, −0.138 volt; of α-picoline-hemochromogen, −0.022 volt; of pyridine-hemochromogen, +0.017 volt; of nicotine-hemochromogen, +0.053 volt. The ratio $\frac{\triangle E'_0}{\triangle pH}$ of hemin changes with a slope of −0.06 volt per pH unit from pH 7 to 9.2, and with a slope of 0.09 from pH 9.2 to 12. The E'_0 of cyanide-hemochromogen remains constant. The E'_0 of the other hemochromogens changes with a slope of about 0.06 volt per pH unit. Pyridine and nicotine-hemochromogens, at pH 11, give titration curves similar to that of systems with 2-electron transfer, due possibly to polymerization. Hemin and the other hemochromogens pass from the oxidized to the reduced state with a transfer of one electron. The fact that the potential of hemin can be changed to varied levels of energy by the addition of nitrogenous compounds explains why catalysts containing hemin as the active nucleus, to which are attached a variety of nitrogenous compounds, oxidize selectively a considerable number of oxidizable substances of different free energies.

Variation in Ustilago zeae: E. C. STAKMAN. *Ustilago zeae*, the fungus that causes corn smut, comprises an indefinite number of strains or lines. This fungus is especially suitable for studies of heritable variations, because single unicellular, unisexual individuals can be isolated and propagated vegetatively on nutrient media in the laboratory, thus giving rise to unisexual lines. Barring mutation, all individuals in any one of these lines are then alike in their heritable properties, as has been shown by extensive studies. But innumerable new lines can be produced by hybridization between lines and by mutation within lines. Even from the progeny of two unicellular individuals of opposite sex that were crossed about three years ago by the writer and his associates, hundreds of lines have arisen as the result of segregation and mutation in laboratory and greenhouse cultures. These lines differ from each other in one or more of the following characters: type of growth; color, size and topography of colonies on artificial media; sex and parasitism; and tendency to mutate. Several hundred mutant lines have been isolated and studied; some are conspicuously different from each other, and others differ in almost imperceptible but distinctive characters. Factors for the new mutant characters are inherited when mutant lines are crossed with lines of opposite sex. The tendency to mutate is itself due to heritable factors and differs greatly in different lines. When crosses were made between mutable and con-

stant lines, some of the resulting segregates were very mutable, others moderately so, and still others were constant; but by crossing the most mutable lines with each other for several generations material has been obtained in which all segregates are extremely mutable.

Seed-cone development in Sequoia gigantea: J. T. BUCHHOLZ (introduced by William Trelease). For *Sequoia gigantea,* the information concerning seed-cone production has been very fragmentary. This information is essential as a first step in a study of the embryology of this species. The cones are evergreen and persistent for many years after the morphological development of the embryo is completed within the seed. Some measurements have been made on the diameters of the leaders, the seed-cone-bearing branches, vegetative branches and pollen-cone branches. New methods have been worked out by which the dates of origin, pollination and development of the cones may be determined even after many years so that most of the cones and their seeds may be dated with a fair degree of accuracy. Seed cones require three years in their formation. They are formed at the tips of branches during the summer of a given season, pass the first winter within a bud and are pollinated during April of the following spring. During the summer of the same season, the cones enlarge very greatly, becoming full grown, hard and woody in August. Fertilization takes place during the last week in August. The embryos begin to develop, but pass the winter in a very immature condition and require still another season for their growth, so that they are morphologically developed only by the end of the second year following pollination or at the end of the third year after the formation of the cone primordium at the tip of the stem. The embryo is very small during the first month after fertilization and undergoes cleavage polyembryony. The smallest stage of the embryo observed thus far, a 2-celled stage after cleavage of the zygote, was 20,000 cubic microns. Thus, in the big tree which may eventually reach a volume of 1,640 cubic meters (estimated for the General Grant tree), the organism enlarges 82×10^{15}-fold. The mature specimen of *Sequoia gigantea* is as much larger than its embryo as the earth is larger than a building similar in size to the dome of the Adler Planetarium.

Reaction gradients and pigmentation thresholds in the feather germ: RICHARD M. FRAPS (introduced by C. M. Child). Lillie and Juhn published in 1932 a detailed account of the order of localization, extension and reversion of patterns induced in breast and saddle feathers of the Brown Leghorn capon by injection of hormones (female hormone and thyroxin). On the basis of these and other data they concluded that the feather germ is subject to growth-rate distributions which determine orders of reaction to the hormones employed. The "high" end of this gradient in rates is at the ventral limit of pigmentation (apex of the individual barb), from which point rates decrease gradually to minimal values at the dorsal limit of the germ (base of the individual barb). An extension of similar experimental procedures to induction of pattern modifications in other tracts has produced orders of pigmentation which are completely or partially the reverse of those described by Lillie and Juhn (unpublished data of Mary Juhn). On the assumption that the forces tending to effect alternative pigmentation reactions are *differential functions* of the primary rate gradient, these orders of pigmentation are completely accounted for without change in direction of the ventro-dorsal (or apico-basal) gradient postulated by Lillie and Juhn. Alternative pigmentation thresholds become, on this view, functions of the relation between the assumed differential gradient functions. The hypothesis accounts satisfactorily for experimental results specifically in the Brown Leghorn, and may possibly be of value in interpretation of phenotypic pigmentation combinations found in the plumage of this breed.

Spectrographic analysis of pure samples of cytoplasm and nuclei from liver cells: GORDON H. SCOTT (introduced by Joseph Erlanger).

The conjugated form of male sex-hormone in human urine: DUREY H. PETERSON, T. F. GALLIGHER and F. C. KOCH (introduced by J. Stieglitz). Heretofore the yield of male-hormone activity as extracted from acidified urine without boiling and with boiling for two hours or longer was practically the same. We now find that when the acidified urine is boiled for fifteen minutes, the yield of male hormone is increased by approximately 70 per cent. over the no-boiling or the two or more hours boiling process. This is true for men's and women's urine. The results suggest that a conjugated form of male hormone is liberated by acid hydrolysis and that this is subsequently destroyed by boiling with acid.

Some effects of numbers present on the rate of first cleavage in Arbacia: W. C. ALLEE and GERTRUDE EVANS (introduced by C. M. Child). Other things being equal, under the conditions tested, *Arbacia* eggs cleave sooner if in moderately dense groups than if isolated or with few present in the same volume. Cleavage is delayed if too many eggs are piled upon each other. With temperature, evaporation and other pertinent variables controlled, these relations held when tested in volumes that varied from drops of 10 cu mm to vials with two cc of sea water. In the latter case, positive acceleration from crowding was obtained with as many as approximately 10,000 eggs present, when contrasted with accompanying lots of a few tens of eggs. Two techniques were employed: In one, the time to 50 per cent. cleavage was found for living eggs at the first and second cleavages. In approximately 90 paired experiments of different kinds, the mean time to first cleavage was 0.88 minutes faster in the denser populations and to second cleavage, this increased to 2.24 minutes. The respective statistical significances are: $P = 0.053$ and $P = 0.0016$ when $P = 0.05$ is equivalent to three times the probable error. The smaller the value of P, the greater the statistical significance. With the second technique, the eggs were allowed to develop to some selected critical stage and then were killed serially, with one dense and several sparse populations killed approximately simultaneously. A total of 47 paired experiments of different kinds showed that

near mid-cleavage the denser lots, on the average, were 14 per cent. ahead at first cleavage, 14–20 per cent. ahead at second cleavage and 10 per cent. ahead at third cleavage, as compared with accompanying sparse lots. The respective statistical probabilities are: $P = < 0.0001$, $P = 0.015$ to 0.0008 and $P = 0.0002$. We know that somewhat similar results can be produced by the presence of certain toxic substances, as in other and better analyzed cases of mass protection; great care was taken to avoid such contamination in this work. Analysis of the causal factors involved has given only negative results to date. These tests included increasing artificially the carbon dioxide content of sea water to various slight degrees, and the use of egg-conditioned sea water which had been prepared by several different methods. Hence while the effect itself is real, the underlying processes are still unknown.

Some derivatives of the neural folds in amphibian embryos: pigment cells, spinal ganglia and Rohon-Beard cells: GRAHAM P. DUSHANE (introduced by C. M. Child). Experiments involving bilateral excision and transplantation of the trunk neural folds indicate that the following diverse elements are derived from the folds: (1) pigment cells (xanthophores, guanophores and melanophores) of the dermis and the deeper structures (pericardium, mesenteries); (2) spinal ganglion cells; (3) Rohon-Beard or giant ganglion cells. Such embryos later show motor responses to tactile stimuli applied to head or tail, but no response to trunk stimulation. Rohon-Beard cells are absent from the insensitive region and present in the sensitive areas (head and tail). Despite the fact that the Rohon-Beard cells, which normally form the sensory tract in the spinal cord, are absent from the trunk, sensory impulses pass from the tail headward through this region. It is probable, as Coghill has suggested in a personal communication, that the Rohon-Beard cell axons extend from the tail to the anterior part of the spinal cord, thus forming the ascending tract. Coghill's preparations show axons of hitherto unsuspected length. One such process could be followed through six segments of the spinal cord. The fact that the Rohon-Beard cells and spinal ganglion cells have a common primordium lends some support to the idea that they are homologous. It is of further interest that there is no regeneration of pigment, Rohon-Beard and spinal ganglion cells following the removal of the neural folds.

Comparisons of the relative growth velocities of the various mineral constituents with body growth in the human fetus and the young rat throughout the nursing period: W. W. SWANSON and VIVIAN IOB (introduced by A. J. Carlson). Graphical presentations are used to show the relative velocities of growth in per cent. per lunar month for the various mineral constituents of the human fetus, and the relative velocity of growth of the same minerals during the nursing period of the infant and the suckling period of the young rat.

Studies of correlations between measured mental and physical differences in identical twins reared apart and rated differences in the environment: H. H. NEWMAN (introduced by F. R. Lillie). This represents one aspect of a study of hereditary and environmental factors responsible for twin differences and, by inference, for human beings in general. The work has been done in collaboration with two colleagues, F. N. Freeman and Karl Holzinger. A monograph on the whole study is now in press. In this particular study twenty pairs of identical twins separated in infancy and reared apart under differing environments were used. Many physical, intellectual and temperamental differences were determined by direct measurements and by tests. Full data on the life histories of the twin pairs were then rated by five judges independently, differences being rated on a scale from 1 to 10 points, for education, social and physical-health separately. The agreement was over 90 per cent. in all three categories and was considered as highly satisfactory. Then coefficients of correlation were determined for each of the measured differences and the various rated differences in environment. The majority of the coefficients were statistically non-significant, but a few were high and statistically valid. The most striking correlation was between amount of educational experience and amount of difference in scores of several intelligence tests. The least correlation existed between differences in social environment and differences in scores on several temperament-emotion tests. Differences in physical-health environment were strongly correlated with differences in weight, but not at all with height, head form and other physical differences. By determining the degree of correlation between measured differences in twins and the various environmental differences, it was possible to state approximately the shares of the different environmental factors in determining the observed differences in the whole set of twins.

The utilization of organic and inorganic iron in early infancy: HELEN OLDHAM and F. W. SCHLUTZ (introduced by A. J. Carlson). The iron retention of a normal infant was studied at three different levels of total iron intake. Each level was fed with varying proportions of inorganic iron. The organic iron of the diet appeared to be utilized as well as the inorganic iron.

Histology of the bone marrow in cobalt polycythemia: KATSUJI KATO (introduced by C. J. Herrick). In young rats first made anemic on an exclusive goat's milk diet, polycythemia was produced by administration of iron and cobalt. Sections made from the mid-femur shows a marked hyperplasia of all the hemopoietic elements, especially of the myeloid series. The hyperplasia of the erythron consists mostly of normoblasts, although scattered throughout the marrow are also found many clusters of more primitive erythroblasts. The megakaryocytes also showed definite quantitative increase. The fat cells are reduced in number.

The influence of tension and relaxation on blood pressure: E. JACOBSON (introduced by A. J. Carlson).

Studies on the renal excretion ratio and reabsorption of urea in the dog: A. ALVING and W. GORDON (introduced by H. G. Wells).