ties. The possibilities for service can not be fully realized until the free income of the academy and council is greatly increased.

I shall not dwell upon the activities of the National Research Council, in the attempts to raise the standards of the scientific personnel of the country through post-doctrate fellowships and in numerous other ways; nor on the rapidly developing relations with industrial and medical research; nor yet on the several continuing projects of stimulation of research or of aids to learning in special fields supported by various foundations; nor even on the several research organizations fostered and in some cases set up by aid of the National Research Council. I shall leave these reviews and others to the chairman of the National Research Council at the appropriate time.

But I would like to say something about the government relations of the academy and council. Here I wish to draw a distinction. On the one hand there are day-by-day relations, formal and informal, which are sustained by the chairman of the council, by the executive secretaries of the academy and the council, and as opportunity offers, by members of both, either in official or unofficial capacities. On the other hand, there are formal reports prepared at the request of government agencies by committees appointed by the president of the academy. Somewhere in between comes our relationship with the National Resources Committee of the government through its science committee, on which we have three representatives.

I do not exaggerate when I say that our success in carrying out the obligations of the charter of the academy depends upon what I have called day-by-day relations with government agencies. For it is necessary that we should know them, and that they should know us. In no other way can our relations succeed. They should know that we are here as friendly fellow-citizens with some scientific information, and that if there is occasional criticism on our part it is that of friends with a double stake in the problems with which they deal. They should also know that we are in a position to aid them in utilizing the scientific resources of the country. In this process of growth of mutual understanding we rely especially on those members of the academy and of the council who are also in the direct service of the government.

The rendering of formal reports is occasional. Into these reports should always go the best opinion of the academy. They should be judicial and authoritative. It is such reports that the Congress and the founders of the academy had in mind when framing the act of incorporation. The academy must therefore decline to attempt reports in fields in which it is not fully competent.

In the organization of the academy and council, the Government Relations and Science Advisory Committee, of which the president of the academy is chairman *ex officio,* has special oversight of such reports, which are prepared by subcommittees appointed by the chairman. Such subcommittees are appointed on formal request by the appropriate officers of the government, and the agency concerned provides by contract for payment of out-of-pocket expenses of members of the subcommittees and for any necessary expenses of investigation; but the members of the subcommittees receive no compensation whatever for their services.

At the present time six such subcommittees are in operation, two of these being retained as advisory committees to the agencies in question. Three other advisory committees, not concerned in the preparation of formal reports, have also been appointed as subcommittees of the Government Relations and Science Advisory Committee. It is perhaps needless to say that the proceedings of such committees are held confidential, by the academy, but may be released by the government.

The National Resources Committee, engaged in the preparation of plans for the long-time utilization of national resources, reports its findings to the President and the Congress with recommendations. Such planning involves land, water, public works, industry, energy sources and population. In each of these divisions scientific considerations are of primary importance. A little more than four years ago, the chairman of this committee, the Honorable Harold L. Ickes, requested the president of the academy to appoint three of its members to a science committee of the National Resources Committee, which includes also three members representing the social sciences and three representing education. This was accordingly done, and the academy has been so represented ever since. The work of this committee has been of growing importance, and our own relations to the government have profited increasingly through it. The academy and the council highly value this new avenue of relations with government agencies.

FRANK R. LILLIE

ABSTRACTS OF PAPERS

Ultra-violet solar intensities and ozone distribution in the upper atmosphere: W. W. COBLENTZ and R. STAIR. In a preliminary report (SCIENCE, 87: 426, 1938) a summary was given of the progress made in measuring the ultra-violet solar intensity and thereby determining the vertical distribution of atmospheric ozone at various heights above the earth's surface, by means of a photoelectric ultra-violet intensity meter and auxiliary radio-transmitting apparatus, transported aloft by means of unmanned balloons. As a matter of record the following report is given of the results obtained, during the summer of 1938, with the aid of a grant from the Joseph Henry Fund, in cooperation with the National Bureau of Standards. Two kinds

of measurements were obtained: (a) the spectral quality and total intensity of ultra-violet solar radiation, at a fixed ground station, at Flagstaff, Arizona (elevation 2.2 km), and (b) similar measurements at various elevations above the earth's surface, at Washington, D. C. In the ultra-violet measurements at Flagstaff, a close parallelism was observed in the variation in the percentage transmission of the filters with variation in barometric pressure; in agreement with the well-known variation in the amount of atmospheric ozone that accompanies a change in air pressure. On one occasion the wave of low barometric pressure preceded, by 5 to 6 hours, an appreciable increase in atmospheric ozone; indicating a method of studying the circulation of ozone in the stratosphere. In four balloon ascensions, made in Washington, D. C., in June, 1938, the photoelectric ultra-violet intensity meter attained heights ranging from 25 to 27 km; penetrating 60 to 70 per cent. of the atmospheric ozone, the most of which was localized in a layer extending from an elevation of 18 to 27 km, with a wide maximum of concentration at a height of about 25 km above sea level. At the highest elevation attained by the instruments the intensity of the ultra-violet of short-wave lengths was about ten times that of direct sunlight at sea level.

A new method of determining individual line-of-sight velocities of star groups: R. W. WOOD. Two prisms of 6° angle are mounted one above the other with refracting edges pointed in opposite directions. Each is covered with a replica grating of 4,800 lines to the inch, giving 85 per cent. of the light in the first order spectrum, the combination giving direct vision for the violet region. One grating is inverted with respect to the other, the combination giving two parallel spectra of each star, in coincidence in the violet and ultra-violet regions, the red ends lying in opposite directions. Line of sight velocity causes the spectra to shift in the direction of their length and in opposite directions. Excellent spectra have been obtained of bright stars with a lens of 3 inches aperture and 16 inches focus at the observatory of Mr. Joseph Woods, of Baltimore.

Cosmic ray intensity and the thermal expansion of the atmosphere: A. H. COMPTON, M. SCHEIN and P. S. GILL. The temperature coefficient of the intensity of cosmic rays found by one of us in the data obtained in the northern and southern hemispheres of the Pacific Ocean has recently found a suggested explanation by Blackett. This is based upon Yukawa's hypothesis that the mesotrons which constitute these cosmic rays are produced in the upper atmosphere by less penetrating radiation and that they show spontaneous disintegration similar to radioactivity. When the atmosphere expands at the higher temperature, the elevation at which the mesotron is produced is greater and there is a higher probability of spontaneous disintegration resulting in a lower intensity at sea level. Using for the mean life of the mesotron when at rest $\tau_0 = 2.7 \times 10^{-6}$ sec., Blackett thus calculated a temperature coefficient agreeing closely with that observed by us. He predicted, likewise, that near the equator, where the average energy of the mesotron is greater, the temperature coefficient should be smaller. Using extensive additional data from the Pacific Ocean, we have experimentally confirmed Blackett's predictions of a smaller temperature coefficient in equatorial regions. We have calculated from our data the altitude at which the mesotrons are created in the earth's atmosphere and find that this is a maximum of about 25 kilometers at a latitude of about 38°. This corresponds to the knee in the latitude effect curve. The variation in the altitude at which the mesotrons are produced gives a significant indication regarding their method of production.

Seasonal effects in cosmic ray intensities from sea level up to the top of the atmosphere: ROBERT A. MILLIKAN and H. VICTOR NEHER. By sending our self-recording electroscopes on successive trips from Los Angeles to Vancouver and back, and then around South America and back to Los Angeles, we have checked in these areas the result first recorded by Steinke and very carefully studied later by Messerschmidt, Hess, and Compton and Turner that there is a definite seasonal sea-level variation in cosmic-ray intensities. Like the last observers, we find no seasonal effect in the equatorial belt, but in the higher temperate zones the sea-level intensities are definitely higher by from two to four per cent. in winter than in summer. Furthermore, recent flights which we have made at Omaha up to close to the top of the atmosphere reveal similar but considerably larger intensity differences between winter and summer, the winter readings being consistently higher. These Omaha results seem to be scarcely explicable in terms of the theory advanced by Blackett.

Further confirmation of the Coster-Kronig theory of the production of doubly-ionized atoms: F. K. RICHTMYER and ROSS E. SHRADER. At the Rochester (1937) meeting of the academy we reported measurements on the satellites of the x-ray line $L\alpha$ in the atomic number range $73 < Z < 92$, which qualitatively confirmed the theory proposed by Coster and Kronig (*Physica*, 2: 13, 1935) that the initial state for the production of these lines is a doubly ionized state, $L_{III} + M_{IV, V}$, arising from an internal absorption of energy known as the Auger effect. The energy required to expel an M_{IV} electron from an atom is sufficiently higher than that required to expel an M_V electron so that, while satellites due to $(L_{III} + M_V)$ ionization should appear above Ta 73, satellites due to $(L_{III} + M_{IV})$ ionization should not appear until Ir 77 is reached. We now report more accurate data for the intensities of $L\alpha$ satellites in the range $73 < Z < 92$ obtained by a high-resolving-power two-crystal spectrometer. The curve of intensity vs. Z shows two branches, one beginning at Ta 73 and the other at Ir 77, in excellent agreement with the Coster-Kronig theory.

The number of lines in a series as a function of electron pressure: FRED L. MOHLER (introduced by W. W. Coblentz). In an intense discharge the higher series lines merge into a continuous spectrum at an effective quantum number which depends on the electron pressure. Studies of the cesium discharge covering a wide range of vapor pressure and current density give a basis for determining this relation. The maximum quantum number in a series is found by plotting the relative intensity of line to background versus quantum number

and extrapolating to a ratio of unity. The relation between electron pressure and the maximum quantum number for both the red component of the D series and the F series is P_e (atmospheres) $= 4.5Tn^{-7}$. Computations by Pannekoek for the Balmer series indicate that this relation is equally applicable to hydrogen. The number of absorption lines in the Balmer and Paschen series of some stars has been determined by the same criterion used for cesium. For main sequence Ao stars the electron pressure at the photosphere is about 0.4×10^{-4} Atm. at the Balmer limit, 0.8×10^{-4} at the Paschen limit and 2×10^{-4} Atm. at 4340A. Alpha Cygni has an electron pressure of about 2×10^{-6} Atm. at the Balmer limit, while for white dwarfs the pressure is roughly 10^{-2} Atm.

The Hall effect and change of resistance in a magnetic field: W. V. HOUSTON and L. DAVIS (introduced by R. A. Millikan). The normal Hall effect can be directly interpreted in terms of almost free electrons, although the positive Hall effect requires for its explanation electrons whose binding to the nuclear lattice is of considerable importance. On the other hand, the change of resistance in a magnetic field can be interpreted only on the assumption that the nuclear binding causes essential departures from the behavior of free electrons. These facts can be easily illustrated in a qualitative way. Since a change of resistance is observed in the alkalis, it is of interest to see if this can be understood quantitatively as a small departure from a free electron situation. The electron energy as a function of wave number, as well as the relaxation time, can be expanded in a series of spherical harmonics that have the symmetry of a cubic crystal. This permits the necessary integrals to be carried out to any desired degree of approximation. When only the first two harmonics are retained, the computed change of resistance and Hall effect are close to the observed values. However, the ratio of the transverse to the longitudinal change of resistance can not have a value less than four. This is not in agreement with the available observations. It seems improbable that this result could be changed in any major way by the inclusion of higher series members, so that if the experimental results are to be taken as reliable, doubt is thrown upon the basic method of interpretation of the effects.

The cause of intense color in the carotenoid pigments: ROBERT S. MULLIKEN. As is well known, the carotenoid pigments, which are responsible for the color of various vegetable and animal substances (*e.g.*, carrots) have a conjugated polyene structure. That is, each molecule contains a long chain of alternately single and double carbon-carbon bonds. A theoretical explanation of the existence of visible absorption, hence of color, for such molecules is implicit in quantum-mechanical calculations of Hückel, although Hückel did not himself discuss the spectra. In the present work, quantum-mechanical calculations of the intensities of various spectral absorption regions are made, and it is shown thereby theoretically that the longest wave-length absorption region should be by far the strongest, with very high intensity indeed. This is in agreement with experimental observations. Thus the exceedingly strong visible absorption of the carotenoids, giving intense color, is explained. According to the theory, the shape of the molecule should strongly affect the distribution of intensity in its spectrum. The more elongated the molecule, the more the intensity should be confined to the long wave-length end of the spectrum, and the more intense should be the color. Available experimental evidence on substituted polyenes supports the theoretical predictions if it is supposed that polyene chains normally assume the most elongated possible form. When part of the polyene chain is bent into a ring, the intensity is reduced. According to the present calculations, the intense long wave-length absorption regions in elongated carotenoid molecules correspond to light polarized approximately along the long axis of the molecule. This should give rise to a high polarizability of such molecules along that direction, and this may help to explain their reactivity.

The "liquid structure" of water; with special reference to ionic solutions: G. W. STEWART. The recognition of the manner in which water as a solvent may alter its density is recent. Experimental evidence from an x-ray study of the aqueous solution of fifteen electrolytes is now adduced to show that the ions in solution have a more significant effect than is explicable on an electrostatic basis. This is the alteration in liquid structure of the water through the increase in coordination number. This change in number occurs similarly with increase in temperature of pure water. The variation with concentration of the structure, as indicated by x-rays, has a striking correspondence with the variation of the apparent molal ionic volume. The ions were both simple and complex with six of the electrolytes of a 1–1 type, six of them 2–1, two of 3–1 and one of a 1–2. The effect of the increase in coordination number of the water is to give closer packing and greater density.

The automatic synthesis of speech: HOMER DUDLEY (introduced by O. E. Buckley). Synthetic speech has been formed with an electrical circuit by the modulation of a buzzer-like tone for the voiced sounds and a hiss for the unvoiced sounds. The tone consists of a fundamental vibration and its harmonics; the hiss, of purely random vibrations. The modulation processes are of two types: one, a pitch variation for inflection in the synthetic voiced sounds and the other, amplitude variations of the component vibrations in both the voiced and unvoiced sounds. In the automatic synthesis of speech the two basic sounds are modulated by speech-defining electrical currents, varying at syllabic rates, which are obtained by a substantially instantaneous analysis of a talker's speech. The artificial speech is not only intelligible but reproduces in good measure the inflection and timbre of the original. The simplicity of these speech-defining currents points to such future possibilities as aural speech studies by their controlled modification and reduction in frequency band required for telephonic transmission. The procedure and results will be illustrated from phonograph records.

Breakdown in impregnated paper insulation: J. B. WHITEHEAD. In accordance with current theories of the nature of breakdown in solids, it has been assumed that an increase in the density of the impregnated paper used

for cable insulation results in a higher dielectric strength. Following this assumption, manufacturers have used high density papers for a redistribution of normal stresses within the insulation and also for the purpose of increasing dielectric strength. In the present tests four grades of paper of different values of density, but all from the same wood pulp stock and all the same thickness, have been studied in accelerated life tests. In these the voltage was raised with a gradual logarithmic increase, with measurements of various electrical quantities at intervals up to final breakdown. The average duration of the test was about four days. The results show that with increasing specific gravity of the paper, the dielectric strength of the impregnated sample, instead of increasing with increasing density, shows, in fact, a noticeable decrease. Within the range of specific gravity of the paper 0.74 to 1.18, the decrease in breakdown voltage is 30.5 per cent. and the decrease in life is 47 per cent. An explanation of the above result has been found in the use of a device for limiting the current and consequent burning of the breakdown process, and for locating the point at which breakdown begins. The device consists of a thyratron tube controlled by the current from the specimen, and which in turn operates a rapid circuit breaker. Careful examination and dissection of the specimens reveals that breakdown almost invariably begins in the narrow channels between two successive spirals of the paper tapes, these channels being filled with oil. Corresponding measurements of dielectric constant of the oil, of the paper and of the impregnated paper permit computation of the stresses in these oil channels. It was found that these stresses had approximately the same value for all four grades of paper. Thus the decreasing dielectric strength with increasing paper density is caused by the increased dielectric constant of the impregnated paper, as this increase shifts a greater proportion of the total stress to the oil in the oil channels. The values of the stress in the oil channels immediately preceding failure were in the range 1,300 to 1,500 volts per mil. Apparently in this neighborhood ionic motion in the oil becomes so rapid as to cause secondary ionization, increased conductivity, gas liberation and ultimate gaseous ionization, with resulting chemical or thermal attack of the paper structure causing rapid penetration of the latter and leading to complete breakdown.

The neurohumoral activation of vertebrate chromatophores: G. H. PARKER. Two decades ago all vertebrate color-cells would have been said to be under the control of the nervous system. Since that time intermedin, the neurohumor of the intermediate lobe of the pituitary complex, has been shown to be the chief agent in causing darkening in these animals. Only a few teleost fishes appear to be exceptions to this rule, which holds in general for most fishes, and all amphibians and reptiles thus far tested. Darkening is also accomplished in certain teleosts by dispersing nerves. The blanching of chromatic vertebrates is due chiefly either to a loss of intermedin, to the action of such a concentrating neurohumor as adrenalin or to concentrating nerves. From the modern standpoint the blood-soluble hormones intermedin, adrenalin and other like substances far outrun nerves in their control of chromatophores. They appear to be the exclusive agents in the cyclostomes, most elasmobranchs, all amphibians and such lizards as Anolis. Obvious nerve control appears only in a very few elasmobranchs, a number of teleosts and such lizards as the chameleon and the horned toad. Where nervous control has been studied, chiefly among fishes, it is believed both in its concentrating and its dispersing phases to depend upon oil-soluble neurohumors, the lipohumors, from the nerve terminals. Thus the activation of vertebrate chromatophores appears to result in the main from blood-soluble hydrohumors, chiefly intermedin and adrenalin, supplemented by several lipohumors from direct nervous sources. It is remarkable that in these responses acetylcholin appears to play little or no part.

Changes of viscosity and cell activity: WARREN H. LEWIS. Changes of viscosity of protoplasm, sol to gel, gel to sol and intermediate states, play important roles in cell activity. Gelated colloids *in vitro* automatically exert contractile tension and presumably gelated protoplasm acts likewise. The assumption that active cells possess a superficial layer of gelated cytoplasm, the plasmagel layer, which exerts contractile tension offers a key for an explanation of various cell activities. A uniform tension would tend to make cells spherical, local variations of it would produce distortions and thrust out cell processes and pseudopodia. It plays the leading role in locomotion of cells. An early indication that a cell is about to divide is the retraction or partial retraction of its processes and pseudopodia. This is probably due to an increase in the viscosity of the superficial plasmagel layer of the processes which automatically increases their contractile tension. The cell then tends to become spherical, due to the development of a more uniform viscosity of the superficial plasmagel layer over the body of the cell. The cleavage of cells in mitosis is to be explained by the development during anaphase of a thickened or denser equatorial band of the plasmagel layer which automatically flattens and then constricts the cell because of the increased contractile tension developed. Deeper within the cell changes of viscosity play equally important roles. When the chromosomes are in the equatorial metaphase plate motion pictures reveal that individual chromosomes oscillate independently of one another in paths between the poles of the spindle. This suggests (1) that in the living cell there are, after all, invisible spindle fibers which extend from each chromosome to the poles of the spindle; (2) that the fibers are gels and hence exert contractile tension on the chromosomes; (3) that the two fibers of each chromosome undergo somewhat irregular alternate changes in viscosity with corresponding changes in contractile tension; and (4) that the oscillation of each chromosome is thus due to this alternation of pull on it, first toward one and then toward the other pole of the spindle. When the chromosomes are pulled or split apart oscillation ceases and each half moves or is pulled steadily toward its respective pole by the contraction of its spindle fiber.

The time factor in x-ray irradiation: KARL SAX (introduced by I. W. Bailey and E. D. Merrill). Most of the

experiments on the effect of x-ray intensity show that concentrated doses are more effective in killing cells than the same dose given slowly. Similar results have been obtained for chromosome aberrations in Tradescantia. Both intermittent raying and continuous raying at various intensities show the effect of the time factor. In one experiment with a total dosage of 320 r, given at various intensities from 20 to 320 r/m, the relation between the percentage of chromosome breaks and radiation intensity is expressed by the equation, $\log B = 0.314 \log I + 0.764$. Previous experiments on the nature of x-ray-induced chromosome aberrations provide an explanation of the effect of the time factor. Most of the aberrations induced in the resting nucleus are dependent upon two independent x-ray hits. If the radiation is given slowly a break in one chromosome may heal before another break occurs in an adjacent chromosome. The second break also heals and no visible aberrations appear at metaphase. When the radiation is intense two adjacent breaks may occur within the critical time period, so that fusions can take place between broken ends of different chromosomes and produce dicentric chromosomes. In cells irradiated at prophase both 1-hit and 2-hit breaks occur with a rather high frequency, but only the 2-hit breaks are affected by the time factor. Broken ends of chromosomes may remain in an unstable condition and retain their capacity of fusion for about one hour. The duration of the nuclear cycle in the Tradescantia microspores is about one week. This interpretation of the time factor in irradiation may have some application to x-ray treatment of cancer. Intermittent radiation of low intensity should produce sufficient breaks in prophase nuclei to prevent normal cell division, but with little injury to the less active cells of normal tissue.

A new dominant lethal, E, in Neurospora tetrasperma: B. O. DODGE. Ascospores from a culture of *N. tetrasperma,* race substriata from Texas, which had been kept dry for five years germinated fairly well following heat treatment. Their mycelia gave rise to normal ascocarps with 4-spored asci except in one case, where a large percentage of the asci aborted without spore formation, but with no induration of the ascus wall. In some ascocarps no asci with spores were present. As a rule when asci did mature spores there were usually eight and not four spores as should have been expected. All ascospores from an 8-spored ascus that germinated and developed mycelia were normal, since ascocarps formed when two of opposite sex were mated gave 4-spored asci, never 8-spored asci. Occasionally, an ascus delimits seven spores, one being larger and bisexual and one of its nuclei being normal, while the other nucleus, which is usually of opposite sex, carries a new dominant lethal factor, E. A mycelium from such a spore bears ascocarps, the asci of which, with few exceptions, all abort. Such a lethal factor must be dominant because every ascus, of which there are over a hundred in each fruiting body, is heterozygous for the lethal. This new dominant lethal, E, differs from the lethal, I, previously described, in that no induration follows ascus abortion, and asci that do develop spores are usually 8-spored and not 4-spored. In both cases these lethal factors can only be carried along in a cell having another nucleus which is normal or non-lethal.

The nature of x-ray-induced lethal changes in the Notch region of the X-chromosome of Drosophila melanogaster: M. DEMEREC (introduced by A. F. Blakeslee). Cytogenetic study is completed for 36 lethal changes induced by x-rays in the white-Notch region of the X-chromosome. Numerous types of the same region showing mottling, as well as numerous viable changes will not be considered here. X-rays of about 0.72A° and dosage of 2,500 to 3,000 r-units were used in these experiments. Of 36 changes, 7 are connected with either inversions or translocations, 26 are deficiencies showing in salivary gland chromosomes a section of from 1 to 46 bands missing, while three cases had no such cytologically detectable deficiency. A deficiency may be induced either by the occurrence of two breaks, the piece between the breaks being lost or by the elimination of a piece through a chemical change. A study of 1,038 induced breaks made by Bauer, Demerec and Kaufmann shows that they are distributed at random and that they occur independently. Thus, if two independent breaks are responsible for a deficiency, it is to be expected that deficiencies of various lengths will occur with an approximately equal frequency. That holds true for deficiencies involving 5 to 46 bands, but small, 1–4 band deficiencies are much more frequent than expected (12 from 27 cases). This indicates that large deficiencies and part of the small ones are probably induced by two independent events, while the majority of small deficiencies are induced by one event, either an extensive chemical change or two interdependent breaks. The majority of changes involving inversions or translocations showed no cytologically detectable deficiency (6 from 7), indicating the effect of the position on the action of a gene. Salivary chromosome bands, as shown on Bridges' 1938 map, were correlated with genetic loci through overlapping deficiencies as follows: white 3C1, roughest 3C4, facet 3C7 and diminutive 3D1.2 doublet.

Rhythmical impulses in the heart and in a plant cell (Nitella): W. J. V. OSTERHOUT and S. E. HILL. In the heart rhythmical electrical impulses originate in a pacemaker and pass from the auricle to the ventricle. Under certain conditions the rhythm in the auricle becomes too rapid for the ventricle to follow, so that only every second or third impulse passes over. This is known as partial block: complete block also occurs and the ventricle then takes up a rhythm of its own. Various irregular rhythms are encountered, including electrical alternans (every other impulse stronger) and premature beats followed by an extra long pause (as in extra systole). Experiments have been made by creating a pacemaker at one end of a *Nitella* cell by applying a drop of potassium chloride. When the electrical rhythm is made rapid by previously treating the cell with sodium chloride we observe many of the irregularities found in the heart. The irregularities found in the heart have sometimes been regarded as arising in the bundle of His by which the impulses pass from the auricle to the ventricle. Such an explanation can not apply to *Nitella,* in which the conducting medium is undifferen-

tiated protoplasm. Apparently, all conducting systems have certain fundamental factors in common, which make such irregularities possible.

Induction of periclinal chimeras in Datura stramonium by colchicine treatment: A. F. BLAKESLEE, A. D. BERGNER, S. SATINA and E. W. SINNOTT. It has been earlier reported that colchicine by its action on dividing nuclei may induce a doubling of the number of chromosomes in the individual cells affected. When $2n$ seeds of *Datura stramonium* are treated, a mixture of $2n$ and $4n$ tissue results from which pure $2n$ and $4n$ branches as well as branches which lack one or more chromosomes may arise. It is now possible to report from seed treatment of Daturas the occurrence of periclinal chimeras in which the cells of the inner portions of the branch have the normal number of chromosomes, while the cells of the outer tissue contain the doubled number. The occurrence of these periclinal chimeras has been established by several lines of evidence. In many cases the appearance of a given branch disagreed with the chromosome number of the generative layer estimated by size of pollen grains or determined by actual chromosome counts in pollen-mother cells. Guard cells of the epidermis and their nuclei in some cases were of the $4n$ size, while the pollen mother cells were $2n$. Cross sections of flower stalks in such cases showed the epidermis cells enlarged like those in $4n$ plants but the inner cells of the size characteristic of such $2n$ tissue. The size relations of cells have been checked by chromosome counts. In periclinal chimeras in which the epidermis is $4n$ and the inner tissue $2n$, it is possible to identify cells of epidermal origin by their chromosome number. It is thus possible to show that part of the internal tissue of calyx, corolla, stamens and pistil are derived from the epidermal layer and that the chromosomal constitution of the epidermis is of major importance in determining the shape of the mature capsule.

The chemical induction of genetic changes in fungi: CHARLES THOM and ROBERT A. STEINBERG. The monographer of molds finds groups of strains differing in colony aspect to a degree commonly accepted as specific but producing spores with essential characters in common. Discrimination between variation, mutation and specific identity is difficult. The possibility of increasing the numbers of variants among fungi upon definite lines, by stimulating substances seemed worth considering. The molds selected were strains of *Aspergillus niger*, *A. amstelodami* and *Penicillium caseicolum* which had grown in the laboratory more than 20 years without noteworthy variation. Neither colchicine nor acenaphthene produced inheritable variations. A large number (154) of dyes, phenanthrene derivatives and miscellaneous organic compounds led only to sporadic variants with the *Aspergilli*, none with *Penicillium*. Growth in a nutrient salts solution containing carbon as 5 per cent. mannitol, nitrogen as 0.2 per cent. sodium nitrite and adjusted to pH 4.0, gave almost invariable response with the *Aspergilli*. Changes in dilutions were occasionally required. *Aspergillus niger* has formed thus far about a dozen variants which persist in culture and tend to reappear in successive trials. *Aspergillus amstelodami* produced a variant differing greatly in colony character, with ascospore production greatly delayed and almost suppressed. The variants show suppression of characters, production of sterile mycelia, reduction of accessory spore-producing mechanisms such as stalk, and vesicle of Aspergillus to vestigial, and spore production reduced to small clusters of spore-producing cells with short chains of conidia. Spores when produced retain the sizes and markings characteristic of the species. Similar variants are already known among the black Aspergilli. A similar series in *A. sydowi* have been collected in nature. Hypothetically the process involved may be due to the effects of nitrous acid on amino nitrogen, suggesting the possibility that other natural aberrant forms may also be associated in some instances with excess nitrite.

Cellular relationships during growth and differentiation in plant growing-points: EDMUND W. SINNOTT. By means of a technique previously described it is possible to study the multiplication, enlargement and differentiation of living cells in the apical meristems of certain roots. Changes in a given cell are found to be closely related to those in the cells which surround it. In rapidly growing roots, when a cell divides, the new transverse wall tends to be laid down in a position as far as possible from contact with the transverse walls of neighboring cells. In most slowly growing roots, where the longitudinal walls have become firmer, this relationship is less pronounced. A study of expanding cells indicates that the cells do not slide along one another, but that the wall of one cell is firmly attached to those of its neighbors. Different portions of a cell wall, however, may expand at different rates during the process of development, so that the relative sizes of cells become altered; but the growth of any portion of a cell wall is the same as that of the adjacent wall of its neighboring cell. This process of differential wall growth is an important aspect of cellular differentiation.

The active uptake of ions by organisms: AUGUST KROGH. It is well known that the ionic composition of the protoplasm in animal cells differs significantly from that of the surrounding fluid, and in the case of a few eggs there is evidence to show that ions are absorbed from very dilute solutions. In the large plant cells, studied by Osterhout, Collander and others, active absorption of ions into the cell sap has been observed and mechanisms for such absorption suggested. In plant roots Lundegårdh has demonstrated an active transport of anions from very dilute external solutions into the much more concentrated sap rising in the stem. In a number of fresh-water animals we have observed more or less specialized mechanisms which take up certain ions from the outside solution and concentrate them say from millimolar or less to 100 millimoles in the blood. We find separate mechanisms for kations and anions, respectively. In certain Crustacea the kation mechanism will take up Na and K indiscriminately, leaving out Ca, but in most animals studied the mechanism is strictly specific for Na only. The anion mechanism has been found in a single case not to discriminate between Cl, Br, CNS and CNO, but in all other cases it is specific for Cl and Br, which can not be distinguished, either, by

the kidney mechanism of man. It is suggested that all these mechanisms are nearly related, but that the more specialized are more likely to furnish clues as to the modus operandi.

The ontogeny, nature and mode of activation of the intracellular enzyme, tyrosinase: JOSEPH HALL BODINE (introduced by Carl E. Seashore). By means of manometric methods the growth of the enzyme tyrosinase has been followed throughout the entire development of the embryo of the grasshopper. Evidence has been obtained indicating the auto-catalytic nature of this growth. The enzyme as produced is in an inactive state and can be activated by a normally occurring intracellular activator as well as by various chemical and physical reagents such as sodium oleate, acetone, ether, chloroform, heat, etc. The kinetics of the activator have been studied in some detail. The parts played by the denaturation and active center formation in protein are discussed; a probable correlation between these and the activation of the enzyme is pointed out.

Evidence for the existence of an electro-dynamic field in living organisms: H. S. BURR (introduced by Walter R. Miles). The existence of electrical activity in living things is attested by electrocardiographs and electroencephalographs. Recently, it has been possible to add to these graphs of steady state voltage differences which possess definitive patterns characteristic of the species to which the animal belongs and, in all probability, of the individual itself. This pattern has been shown to change with alterations in the fundamental activity of the organism. In the growing embryo the electrical pattern develops hand in hand with the development of the whole organism. A definite cycle of electrical phenomena correlates with the menstrual cycle in women. Under proper conditions it has been possible to record electrically the exact instant of ovulation in rabbits, cats and women. The progress of healing in wounds shows electrical concomitants which parallel very closely the reparative process. In mice it has been possible to detect adenocarcinoma of the mammary gland by characteristic changes in the overall electrical pattern of the organism a week or more before it can be detected by palpation. The results of many hundreds of thousands of determinations indicate that relatively steady state voltage differences are an expression in quantitative terms of one form of the relationships which exist between the units of the organism. This suggests that the simplest assumption with which to explain all the evidence so far gathered is that of the existence in the living organism of an electro-dynamic field.

The steady potential of the human eye in subjects with unilateral enucleation: WALTER R. MILES. The electrical potential derived from the human eyeball may be measured with a sensitive galvanometer connected with small metal foil electrodes on the skin near the eye. Measurements may be made with subjects reclining in a chair or sitting upright at a headrest. The method of making such examinations, and their reliability, has recently been described. The present study deals with an analysis of data secured on a group of subjects who have suffered unilateral enucleation, and in consequence have to wear one artificial eye. The steady potentials found in 9 such cases are compared with the steady potentials found for normal subjects who each have two living eyes. The relationships previously described, Ld. 1 plus Ld. 2 = Ld. 3 plus Ld. 4 can not hold in cases of unilateral enucleation. In the normal eye it is found that the potential is larger after abductive movements than after adductive movements. The difference is usually about 8 per cent. The same relationship is found to hold for the enucleation group. The bitemporal lead in the normal group gives a potential value that is one third larger than the mean of the two eyes measured separately. In the enucleation group this is essentially reversed, the single active eye providing a potential that is one third larger than that found for the bitemporal lead. The enucleation group provides a special opportunity to analyze the potential-field relationships associated with and surrounding a single active eye. Lantern slides will be used.

The span of visual discrimination as a function of duration and intensity of stimulation: W. S. HUNTER. A study of the span of visual discrimination as dependent upon the duration and intensity of stimulation affords an opportunity to relate what has been known as the span of "attention" to known facts of light stimulation. The Bunsen-Roscoe Law, $I \cdot t$ equals a Constant, has been shown to hold within limits for a variety of biological processes ranging from the heliotropic curvatures of seedlings to visual acuity in man. In the present experiments, which are the first systematic study of the effects of time and intensity on the span of discrimination, the law has again been found to hold within certain limits. In the present work light of controlled intensity and duration was transmitted through stimulus plates containing various numbers of black dots on translucent white paper, the entire stimulus falling within the fovea of the subject. The absolute intensities ranged from 0.016–13.3 millilamberts; the durations of stimulation, from 0.004–1.0 sec. The subject's response indicated the number of dots seen at each presentation. For each time and intensity, limens were determined showing the number of dots seen correctly 50 per cent. of the time. When these limens are plotted against log I, there results a family of curves for the different durations showing decreases in the required intensities with increases in time. The maximal limen for durations of 0.004, 0.008, 0.016, 0.032 and 0.075 secs. was 8 dots, although the intensities at which the limen was reached varied with the different durations. For 0.150 secs., the maximal limen was 9 dots; for 0.30 secs., 10 dots; for 0.60 secs., 12 dots; and for 1.0 secs., 14 dots. A graph of log $I \cdot t$ against log T for the discrimination of 1, 2 or 3, and up to 6 dots indicates that $I \cdot t$ is constant for durations from 4 to 32 ms., after which the intensity required does not decrease proportionately as time increases.

The function of the mute on the violin: CARL E. SEASHORE, ARNOLD SMALL and E. P. HORNE. What is the effect of the mute on the total intensity and the harmonic

structure of the tone? This paper is a unit in a series of experimental studies on the acoustic characteristics of the violin. Tones were recorded from good violins, played mechanically in a dead room and submitted to harmonic analysis. The effect of shape, weight, material and seating of the mute was studied on each of the four open strings. It was found that the chief variable in a mute is its weight. The effect of size, material and seating were relatively insignificant; although different for the different strings. The mute tends to reduce the total intensity of the tone, not in the fundamental but in the other partials at various levels. The change of harmonic structure varies with the string, the pitch level, the character of the violin, the character of the mute and other factors. Results are shown in graphs.

History in the archives of the Royal Society: SIR WILLIAM BRAGG. The large store of papers in the possession of the Royal Society provides material for history from many different points of view. In particular, it shows how the simple experimental science of its founders, with their common interest in all that came under their notice, has gradually become the highly developed science of to-day, each section of which is intelligible only to its specialist. At the same time, the study of natural knowledge has become of great importance in all branches of human activity. The effects of these changes upon the relations between science and the human society are obvious and very important. They are in consequence receiving serious consideration. For this purpose it is of interest to compare the position of experimental science at different times since the Royal Society was founded: and the society's archives furnish convenient illustrations.

Higher element transformations: EDWARD KASNER. The concept of differential element is important in differential equations and physics. The simplest type in the plane is a point with a direction represented by (x, y, y'). The next type, here studied, is curvature element (x, y, y', y''). A set of ∞^1 elements is called a *series,* ∞^2 elements a *field,* ∞^3 elements an *opulence,* and the totality of ∞^4 elements a *plenum.* The transformation problem of unions is known, the new problem relates to integrable fields (see *Proceedings* of the National Academy, February, 1939). The corresponding problem of surface elements in space (x, y, z, p, q) relates to integrable fields and is more difficult (see *Duke Journal,* March, 1939). A new problem in space relates to sets of ∞^1 surface elements. When will surface strips go into strips? Finally, we study lineal elements in space (x, y, z, y', z'). If we consider merely ∞^1 elements, we obtain the classic theorem of Lie. However, when ∞^2 elements are considered, a new theory is obtained.

(To be concluded)

OBITUARY

HERBERT HENRY WOOLLARD

THE sudden death, on January 18, of Herbert Henry Woollard, professor of anatomy in University College, University of London, is a great blow to British anatomy and to his many friends throughout the world.

Woollard was born in Australia on August 4, 1889. He attended the University of Melbourne, graduating in medicine in 1910. With the coming of the Great War he joined the Australian Army Medical Corps, serving in both Gallipoli and Flanders and attaining the rank of lieutenant-colonel, with three decorations for gallantry. Following the war, he went to University College, London, to work for the fellowship of the Royal College of Surgeons. Here, largely through his contact with Professor Grafton Elliot Smith, Woollard's interests soon shifted to the field of anatomy and he became a member of the anatomy staff of University College, serving as assistant professor from 1923 to 1927. During this period he spent a year in the United States as a Rockefeller fellow, an experience that exerted a profound influence upon his later work. The friendships formed in America forged a strong link between British and American anatomy. In 1927, he was appointed to the chair of anatomy and histology at the University of Adelaide, returning to London in 1929 as professor of anatomy at St. Bartholomew's Hospital Medical School. Finally, in 1936, he succeeded Sir Grafton Elliot Smith in the chair of anatomy at University College, a post of utmost distinction. He was elected fellow of the Royal Society in 1938.

Woollard's interests covered an extremely broad scope. In his earlier years he chiefly devoted his attention to morphological problems, publishing, for example, a monograph on *Tarsius*—an outstanding contribution to primate anatomy—and a number of papers dealing with the visual pathways of primates. Much of his later work was of an experimental nature. It produced among others a series of publications on the innervation of the heart, blood-vessels and skin, which constitute his major contributions to anatomical science. At the time of his death he was concerned with other problems of cutaneous innervation and with the nervous system of coelenterates.

He was a man capable of inspiring deep devotion. Those who were privileged to work with him are particularly able to appreciate his sterling character—his uncompromising and outspoken honesty; his willingness to give unstintingly without thought of return, especially to younger workers; and his intense loyalty and devotion to his friends.

The death of Woollard at the early age of 49 years is an inestimable blow to British anatomy, for he was equally at home in microscopic and gross anatomy and, what is less common among morphologists, he knew how to utilize experimental methods for determining