THE NATIONAL ACADEMY OF SCIENCES

THE scientific program of the annual meeting of the National Academy of Sciences, held in its new building in Washington, from April 28 to 30, together with abstracts of part of the papers, was as follows:

Radio fog signals for the protection of navigation: G. R. PUTNAM (introduced by HERBERT HOOVER). An important new application of radio in safeguarding navigation has come into practical use within the last three years. Radio signals are sent automatically from lightships and lighthouses, and bearings are taken with the radio compass on shipboard. The first successful radio fog signals were those established in the United States in 1921. The paper gives a summary of the present state of these applications of radio, and also describes recent tests made of tube transmitters for radio fog signals, and of the so-called night effect as affecting the use of radio bearings under this system.

A suggestion for a portable gravity meter: E. E. WRIGHT. Repeated efforts have been made to replace the slow and costly dynamic pendulum methods for the measurement of gravity by static methods in which the earth's pull is determined in terms of the elastic deformation either of a solid by torsion and bending or of a gas by compression. These methods have thus far not proved satisfactory because they have failed to give the required degree of accuracy, namely, one part in a million. The conditions to be met by a static gravity meter intended for use in the field are portability and simplicity of operation coupled with high sensitivity and precision of measurement; in addition certain other factors, such as lack of perfect elasticity of available materials, change in their rigidity modulus with change in temperature, and vibrations due to earth tremors are disturbing and have to be considered in the design of a suitable apparatus. Preliminary tests on a new gravity meter which consists essentially of a spring of silica glass or of tungsten wire tapering from each end toward the center at which point a short lever arm is attached at right angles to the spring. Each end of the spring is attached to the axis of rotation of a framework on whose rotation the cross lever arm is gradually raised to a horizontal position; the angle of rotation necessary to raise the cross arm from the one horizontal position to the second is read off directly on a graduated circle; the position of horizontality in each case is observed with the aid of an autocolimating telescope system sighted upon a small plane parallel mirror attached to the cross arm. The tapering springs and cross arm together constitute an aperiodic vibrating system in which all oscillatory movements are quickly damped out. The influence of temperature is either maintained constant by means of an ice packing or an empirical correction is made for it. With this instrument, which is free from friction, any degree of sensitivity can be attained by proper selection of tapering springs and lever arm.

An explanation of the gaps in the distribution of the asteroids: ERNEST W. BROWN.

Allegheny results on the shift of the solar lines predicted by the theory of relativity: HEBER D. CURTIS. A program of more precise determination of solar spectrum wave-lengths has been inaugurated at the Allegheny Observatory, in cooperation with the Bureau of Standards. The work is being carried on by Dr. Burns and Director Curtis, of the Allegheny Observatory, and by Dr. W. F. Meggers, of the Bureau of Standards. In its essentials, it is a continuation of Rowland's work with more modern methods; by a curious coincidence assistance has been received for this work from the same fund of the National Academy, the Bache Fund, from which assistance was given to Rowland's work over thirty years ago.

The method used is a combination of an interferometer with a powerful grating spectrograph; while this method has been used to some extent in studying the spectra of individual elements, this is the first time it has been applied in a systematic and extended program of precision work on the solar spectrum. The method is capable of very high accuracy, the resulting wave-lengths being true within one part in five to one part in eight million.

While the primary purpose of this work at the Allegheny Observatory is a more accurate knowledge of the solar spectrum, a number of very interesting by-products are already in evidence. Perhaps the most interesting of these secondary products of the research is that which has to do with the minute shifts of the spectrum lines of the sun to the red, as compared with the positions of the same lines in luminous sources on the earth.

It will be remembered that one of Einstein's predictions as a result of his theory of relativity was that any light originating in a powerful gravitational field should have its spectrum lines shifted very slightly to the red. In the case of the sun, light emanating from its surface should by Einstein's theory be shifted a very minute amount toward the red end of the spectrum; the shift is only about eight thousandths of an Ångrostöm unit, which amounts roughly to two one-millionths of the wave-length.

The Allegheny measures can detect wave-length variations ten or more times smaller than this predicted shift, and the results of the measures made by Dr. Burns and Dr. Meggers show shift features very different from the simple and uniform amount predicted by the relativity theory. Instead of all the solar lines being shifted by an equal amount to the red, and that amount the quantity predicted by Einstein's theory, a very marked line-intensity factor is found. That is, for the very faint solar lines there is little, if any, shift, and the amount of this shift increases as the wider and stronger lines are used. The following short table illustrates the main features of the Allegheny results:

INTENSITY OF SOLAR LINE	SHIFT TO RED
0 (very weak)	A .002
1	.002
2	.003
3	.005

4	.006
5	.008
Einstein's prediction	.008
6	.009
8	.012
10 (strong)	.015
15 (very strong)	.015

There is thus seen to be an unmistakable progression in this shift, which must be due to some factor or factors other than relativity, and it does not seem possible to reconcile these results with that theory. For the theory requires that all solar lines be shifted to the red by a certain amount, while our results show that the very weak solar lines are shifted only one quarter or less of that amount. That is, if the relativity prediction is true, we must postulate some cause to shift the very weak lines back toward the violet. Now, while various causes may shift spectrum lines to the red, there is no known case of anything shifting them to the violet, except velocity, which seems untenable in this case. Accordingly the authors regard these results as a negation of one of the so-called proofs of the theory of relativity.

Gravitational influence of spectral lines: CHARLES E. ST. JOHN (introduced by J. C. Merriam).

The spectrohelioscope: GEORGE E. HALE (by title).

Joining the infra-red and electric wave spectra: E. F. NICHOLS and J. D. TEAR. A brief account of the work of previous investigators in this field is given. A new type of electric wave receiver and echelon analyzer for short electric waves is described, together with an improved form of short wave generator. Improvement in apparatus and method of observation has enabled the writers to generate and measure electric waves shorter than the longest heat waves emitted from hot bodies. Two varying types of the new radiometric electric wave receivers have been used to remeasure long heat waves giving results identical with those obtained by earlier investigators with the usual infra-red equipment. The paper offers a further experimental proof of Maxwell's electromagnetic theory of light and provides instrumental equipment for the intensive study of a large and hitherto unexplored region of the spectrum. Finally, the electromagnetic spectrum considered as a whole extending from radio waves down to the shortest gamma rays of radium is briefly discussed.

The spectra of helium in the extreme ultra-violet: THEODORE LYMAN. The chief points to be presented are: First, the confirmation of the discovery of the first ultra-violet enhanced series of helium $4N\left[\frac{1-1}{2^2\ m^2}\right]$. second, the discovery of the first two members of the extreme enhanced series $4N\left[\frac{1-1}{1^2\ M^2}\right]$; third, the extension of the oS — mP arc series to a total of seven terms; fourth, the discovery of a line at the X 591.5 of the type oS — 1p, interesting because it is the first experimental evidence for radiation from helium involving a so-called intersystem combination, that is to say, a jump from a doublet energy level to the fundamental singlet level; fifth, the discovery of a continuous spectrum extending beyond the limit of the oS — mP series.

The paper also contains results on the study of the behavior of diffraction gratings in the extreme ultra-violet, and a brief discussion of a new type of vacuum spectroscope.

New stars in the light of their spectral behavior: W. H. WRIGHT.

Star radiation temperatures and diameters: C. G. ABBOT.

Secondary and tertiary radiations: WILLIAM DUANE.

Stellar statistics: C. V. L. CHARLIER (introduced by A. O. LEUSCHNER).

A statistical discussion of sets of precise astronomical measurements: proper motions: EDWIN B. WILSON and WILLIAM J. LUYTEN.

Relativity and the rotary motion of a spiral nebula: OSWALD VEBLEN.

The application of radio engineering principles to submarine telegraph cables: GEORGE O. SQUIER.

Proper motions in selected areas: PHILIP FOX and FRANK SCHLESINGER. This paper deals with photographs secured by Professor Fox, at Dearborn Observatory, and measured and reduced at Yale University Observatory. They were originally intended for the determination of parallaxes and proper motions in certain of the selected areas. The results indicate that while such observations do not yield sufficiently accurate values of the parallaxes they give good proper motions. To determine many parallaxes on the same plate with sufficient accuracy it will probably be necessary to introduce some device for equalizing the apparent intensities of the star images.

Biographical memoir of George F. Becker: G. P. MERRILL.

Biographical memoir of W. G. Farlow: WILLIAM A. SETCHELL.

Biographical memoir of Alfred G. Mayor: C. B. DAVENPORT.

Biographical memoir of Edward W. Morley: F. W. CLARKE.

Biographical memoir of Wallace C. W. Sabine: EDWIN H. HALL.

Biographical memoir of Edward Emerson Barnard: E. B. FROST.

Electronic orbits in stripped atoms (illustrated): R. A. MILLIKAN.

Optically excited mercury atoms: An experimental proof of the Bohr theory: R. W. WOOD.

The derivation of electro-magnetic fields from a basic wave function: H. BATEMAN and B. EHRENFEST (introduced by R. A. MILLIKAN).

The basic wave-function W being represented in Minkowski's world by the inverse square of the distance between two points S and P, a logarithmic wave-function V may be obtained by integrating W along a weighted world-curve Q, which is the locus of S, between two

points A and B which may be joined to P by broken light-lines AGP, BHP with turning points G and H, respectively, on curves C and T close to Q.

When V is used as one component of a Hertzian vector a field is obtained in which radiated electric dipoles are gradually extinguished. If C and T are varied by using infinitesimal rotations in the Minkowski world, six wave-functions are obtained which can be used as components of the field-vectors in a fundamental type of electromagnetic field. Superposition leads to a field in which the charge associated with a moving point fluctuates on account of the emission of simple charges and from this field one may derive a field in which dipoles oriented perpendicular to the rays travel without change of movement and the terms of order (1/r) are finite everywhere.

Atomic collisions: W. D. HARKINS and R. W. RYAN.

Researches in the terephthalic acid group: MARSTON TAYLOR BOGERT. Terephthalic esters, prepared from the waste "spruce terpentine condensate" of the paper mills, are being investigated as possible sources of new and useful drugs and dyes. Compounds structurally related to certain hypnotics and local anesthetics have been prepared, as well as dyes of malachite green type.

Newly discovered properties of permalloy and their theoretical bearing: H. D. ARNOLD (introduced by F. B. JEWETT). It has been found that permalloy, under certain conditions, has its permeability greatly increased by tension, and attains practically complete magnetic saturation in a field of as little as 0.1 gauss. At the same time hysteresis almost vanishes. These and related results have led to a modification of the theory of ferromagnetism in which internal mechanical strain becomes of prime importance.

New invariant forms in a cyclic three-to-three relation: H. S. WHITE. Cyclic binary correspondences (3.3) of period 7 are known since 1915 (our Proceedings, vol. 1.) Seven points or values of x determine the relation, and from them are fixed definitely seven values of y. But the correspondence is neither through circular nor through elliptic functions, and the algebraic details have not been worked out hitherto. I show how the equation is completely determined by the seven values of x in assigned order; I deduce 28 new invariants of the one set equal to 28 corresponding but not similar invariants of the other set; I show how five of these invariants determine by linear equations the cycle of seven values of y from those of x. This determination leaves still free, of course, three parameters of a linear transformation.

Prime power substitution groups whose conjugated cycles are commutative: G. A. MILLER. Main theorem: The subgroup composed of all the substitutions which omit one letter of such a transitive group must be cyclic.

Analytical solutions in Leuschner's method of deriving preliminary orbits of disturbed bodies (illustrated): RAYMOND HENRI SCIEBERETI (introduced by A. O. LEUSCHNER).

The orbits and general perturbations of the Watson planets (168) Sibylla, (94) Aurora, (79) Eurynome and (150) Nuwa: A. O. LEUSCHNER and H. THIELE.

Carnotite and tyuyamunite and their ores in Colorado and Utah: W. F. HILLEBRAND. The paper embodies the results of occasional research during a period of over twenty years since the author's first publication on carnotite and associated minerals in collaboration with F. L. Ransome. The ores contain principally two distinct hydrous uranium-vanadium minerals—namely, carnotite and tyuyamunite. In the first, potassium is the main if not only monoxide-base metal; in the second, calcium. The ratios of the constituents are the same except as to the water. Carnotite fully hydrated has probably not more than two molecules of water, tyuyamunite probably more than eight. In both the water content is much dependent upon the humidity of the surrounding air. Carnotite does not melt at a red heat, tyuyamunite melts readily. Other associates are malachite, azurite, vanadates of barium and copper, a hydrous potassium-aluminum-vanadium silicate, some undetermined molybdenum compound, etc. A statement by Dr. Merwin summarizes what little is known of the optical properties. Owing to the physical character of carnotite and tyuyamunite, optical examination helps little to differentiate them. Analyses of very nearly pure material of both carnotite and tyuyamunite from Colorado and Utah, respectively, and of tyuyamunite from Fergana in Asia were made. Notwithstanding great similarity, the minerals are probably not isomorphous. Tyuyamunite may belong to the uranite or autunite group, but the low water content of carnotite seems to forbid similar placing of that mineral. The potassium of carnotite can be replaced by calcium and the calcium of tyuyamunite by potassium. In undergoing these transformations the water content changes also to or toward that of the other mineral. It is suggested that in nature tyuyamunite is now being formed from carnotite. The transforming salts appear to exercise a selective action, and, if so, a way is indicated by which it may be possible in some cases to determine whether a given material is a homogenous mineral or a mixture of minerals, when optical tests and quantitative analysis fail to do so.

Actual shifts of mass on or in the earth's crust, and their geological effects as deduced from the doctrine of isostasy: A. C. LAWSON (introduced by J. C. MERRIAM).

An uptilted, beveled-off atoll: W. M. DAVIS. If an atoll were uptilted by deformational forces and beveled off by degradational forces, its understructure would be well revealed. If the atoll had been formed by reef upgrowth and lagoon aggradation over a slowly subsiding foundation, according to Darwin's theory, its revealed understructure would give clear indication of such formation. An island will be described in which various rock structures—volcanic below, limestones with reef-building corals and other shallow-water fossils above—are inclined at an angle of about 15° and beveled off in moderate or low relief. In so far as the structures are revealed, they correspond closely with the structures expectable under Darwin's theory. The total thickness of the exposed section is about five times the depth of the boring made in the reef of the Funafuti atoll in the Pacific.

Some recent studies of rock forming algae: MARSHALL A. HOWE.

A theory of emulsions produced by oleate soaps: WILLIAM D. HARKINS and E. B. KEITH.

Scientific background for the forest policy of the United States: W. B. GREELEY (introduced by J. C. MERRIAM).

Historical tradition and Oriental research: J. H. BREASTED.

Present status of investigations concerning antiquity of man in California (illustrated): JOHN C. MERRIAM.

A recent discovery of ancient human remains in Los Angeles, Calif. (illustrated): CHESTER STOCK (introduced by J. C. MERRIAM).

Fossil men and fossil apes of Europe (illustrated): ALES HRDLICKA.

Paleontologic discoveries in Mongolia by the Third Asiatic Expedition of the American Museum of Natural History: HENRY FAIRFIELD OSBORN.

The influence of alcohol on duration of life: RAYMOND PEARL. In this paper are presented for the first time complete life tables, calculated in precisely the same manner that all insurance life tables based upon the actual experience of the insured are calculated, which give critical evidence on the influence of the use of alcohol as a beverage upon the duration of human life. The data include exact records as to the drinking habits of thousands of persons throughout their lives. The experience includes over 150,000 person-years exposure to risk. Comparison with the official United States life tables shows that the experience dealt with in this study is actuarially entirely normal. That is the persons included in it are not significantly super-standard or sub-standard life insurance risks. They are just normal, average people. The results demonstrate that moderate, steady drinkers have a better expectation of life at all ages from age 30 on to the end of the life span than do total abstainers. The differences are not very great, but there is a distinct and well-marked advantage in favor of the moderate steady drinkers. Heavy drinkers have the poorest expectation of life at all ages after 30 in the case of females, and at all ages after 30 and up to about 65 in the case of males. From about 65 on the heavy drinking males and the total abstaining males have about the same expectation. These conclusions are drawn from what is demonstrably the most critically adequate material, considering both quality and quantity, which has ever been available for the study of the problem of the influence of alcohol upon the duration of human life.

Further report on experiments in epidemiology: SIMON FLEXNER and LESLIE T. WEBSTER. On two previous occasions reports to the academy were made on an experimental study of epidemics among mice induced by microorganisms of the mouse typhoid group. The disease consists of an intestinal infection which later, and before death ensues, becomes general throughout the body as the bacillus is present in the blood and organs at autopsy.

The purpose of the study was the determination of the manner of spread of the diseases among a mouse population previously unexposed and unaffected. An experimental mouse village having been arranged, the infection was started purposely and the precise mode of spread observed and recorded.

Several factors are now recognized as affecting the spread of the disease. First, by keeping the dosage and host susceptibility factors constant, it has been shown that the mouse typhoid bacilli differ among themselves in virulence, some being potentially able to incite an epidemic while others are relatively harmless, but that the virulence of any given strain is relatively constant, unaffected by animal passage and environmental conditions before, during or after an epidemic. Furthermore, by keeping the bacterial virulence and host susceptibility factors constant it is found that the severity of an epidemic, as judged by the per cent. of mortality, is a direct function of dosage, or quantity of bacilli available to each individual. And finally, by keeping both microbic virulence and dosage constant, it has been shown that, given a massive dose of virulent bacilli, universally distributed throughout any population, the number of individuals infected and the duration of life of those which die depend upon the resistance of the individuals in the community. The degree of this resistance is expressed by the reaction of the animal to the bacilli; the most resistant become healthy carriers, those more susceptible develop infection and recover, and those most susceptible succumb to the infection after varying intervals of time. This resistance has been shown to consist of a non-specific general immunity, markedly influenced by heredity and environment, plus or minus a certain degree of acquired specific immunity. Evidence of specific immunity may be found throughout many laboratory mouse populations by a demonstration of mouse typhoid carriers as well as individuals with specific serum agglutinins. Different degrees of non-specific general immunity are found in various races of mice, and it has been ascertained that selective breeding increases this general resistance of a mouse population more than 200 per cent. Also, certain diets increase the general resistance to infection or intoxication more than 200 per cent. So much for this epidemic disease of mice resembling typhoid fever, etc., in man.

The preceding study was preliminary to an investigation of the manner of spread of respiratory infections among animals. It is now recognized that the epidemic intestinal infections can be prevented in large measure by general sanitary regulations (affecting water, milk, etc.) and by preventive inoculation (typhoid-para-typhoid vaccination). No such measures of control have become generally applicable to the group of respiratory infections. Attention has therefore been given to a common respiratory disease of rabbits, popularly termed "snuffles," pleuro-pneumonia, and septicemia, which may be compared with pneumonia in man. The bacillary source of the infection is *Bacterium lepisepticum.*

This bacterium is of unstable activity and rapidly passes from high to low virulence. To secure suitable animal material for experiment is difficult, since domestic rabbits come usually from infected stocks. Having obtained suitable individuals by selective breeding, they react as follows to a highly virulent culture merely in-

stilled into the nares: the least susceptible remain well but carry the bacteria for variable periods; those somewhat less resistant develop the local condition of infection termed "snuffles" which pursues, as in nature, an irregular course. In the minority the infection subsides and the bacteria disappear. In another fraction it passes into a chronic disease attended by infection of the accessory sinuses, etc.; in still another fraction pneumonia develops leading to death in a few days. These various groups are also present in rabbit communities, where *Bacterium lepisepticum* is prevalent.

This factor of host susceptibility in the rabbit as in the mouse is composed of two parts or elements: one specific (immunity) and the other of more general or non-specific nature, the relation of which to each other comes to play a leading part in determining occurrence and the grade of infection. Finally, it has been found that *Bacterium lepisepticum* undergoes a change in the nasal passages of resistant individuals passing from the state of high to the state of low virulence. The reverse has never been observed.

The rôle of adrenal secretion in the chemical control of body temperature: W. B. CANNON. Earlier work from these laboratories by Aub, Bright and Forman,[1] and by McIver and Bright,[2] has shown that secretion from the adrenal medulla is capable of influencing the rate of metabolism in the body, and that increased secretion accelerates the oxidative processes. The erection of hairs, the ruffling of feathers, the constriction of peripheral vessels, the increase of blood sugar are well-known phenomena occurring when warm-blooded animals are exposed to cold. They are signs that the sympathetic division of the autonomic system is in action. Is secretion from the adrenal medulla, which is admitted to be under sympathetic control, augmented when cold causes a discharge of sympathetic impulses?

In 1923 Hartman and his co-workers,[3] using the denervated iris as an indicator, observed dilation of the pupil when the animals (cats) were wet with cold water, or when wet with warm water and later cooled by a fan. The dilation did not occur after adrenal secretion was suppressed by removal of the glands or by removal of one gland and denervation of the other. The method has been severely criticized by Stewart and Rogoff.[4] Moreover, wetting the animals had emotional effects which might have simulated a reaction to cold. We have investigated the reaction, therefore, by another method.

We have employed as an indicator of adrenal secretion the denervated heart, in animals surviving and living normally. The heart is then influenced only by temperature changes and by agents brought to it in the blood stream. It is highly sensitive to circulating adrenin — 0.00068 mg. of adrenalin per kilo per minute, injected intravenously, has increased the pulse 34 beats per minute. Cooling would decrease the rate. If cold makes the heart beat faster, therefore, the result would be in opposition to the influence of cold. The heart rate was determined by auscultation, by palpation and by electrical registration.

Animals thus prepared showed accelerations of heart rate varying from 12 to 43 per cent. when taken to a cold room, accelerations from 34 to 43 per cent. when placed in an ice box, an acceleration of 43 per cent. when held in the lap and exposed to the cold draught of an open window, and accelerations between 27 and 64 per cent. when cold water was introduced into the stomach. If the adrenal glands were rendered inactive the effects did not occur.

The use of cold water to produce what we have called a "heat liability" has several advantages: it can be used anywhere, it is easily available at any time, and it is satisfactorily quantitative. The weight, the temperature and the specific heat of the water are known in relation to the weight, the temperature and the specific heat of the body, and thus the heat liability can be nicely adjusted to the purposes of the experiment.

If the heat liability is more than 1,000 calories per kilo acceleration of the denervated heart (indicating increased adrenal secretion) is almost uniformly attended by shivering. Thus two calorigenic factors, adrenin and muscular movements, are at work to protect the body against a fall of body temperature. If a heat liability of 900 calories is to be met, shivering rarely occurs, and if it occurs, it is ofshort duration (3 minutes). The heart rate is faster, however, showing that the adrenal factor is operating. If now the adrenal glands are rendered inactive, and a heat liability of 900 calories is established, shivering almost uniformly occurs and may last for as long as 17 minutes. Thus when the heat-producing service of the adrenal medulla is lacking, the shivering mechanism is resorted to.

Establishing a heat liability of 574 calories per kilo in man, by giving 750 cc. of water at 1° C., has caused the metabolism to increase as much as 25 per cent. The peak of the increase occurred in five different experiments from 12 to 25 minutes after the cold water was given. In no case did shivering appear. When 750 cc. of water at 34.5° was given the maximal increase was 4 per cent.

The foregoing experiments have an important bearing on the long-waged controversy over the question of true chemical augmentation of metabolism, apart from muscular activity. They support the contentions of Voit and of Rubner that such a mechanism exists and they account for the mode of action of that mechanism.

Influence of experimental changes in blood sugar level on gastric hunger contractions: A. J. CARLSON. (1) Experimental hyperglycemia produced by intravenous injection of glucose inhibits normal gastric hunger contractions. This effect is not due to hypertonicity, since similar injection of lactose or sodium chloride does not have this effect. (2) In insulin hyperglycemia (normal dogs) increase in gastric tonus and hunger contractions (tetany) appears at a blood sugar concentration of 0.08 and 0.07 per cent. As the blood sugar falls towards the convulsion level, the stomach motor mechanism

[1] Aub, Bright and Forman: Am. Jour. Physiol., 1922, lxi, 349.

[2] McIver and Bright: *Ibid.*, 1924, lxviii.

[3] Hartman, McCordock and Lodie: *Ibid.*, 1923, lxiv, 19; and Hartman and Hartman: *Ibid.*, 1923, lxv, 612.

[4] Stewart and Rogoff: *Ibid.*, 1923, lxvi, 260.

usually shows alternate periods of atony and tetany, the inhibition predominating. Prior to the hyperglycemia gastric tetany, the gastric hunger contractions are more frequent and usually slightly stronger. (3) Glucose inhibits the gastric tetany of hyperglycemia. Lactose does not produce this effect. (4) In diabetic dogs insulin produces a primary depression of gastric tonus and contractions, followed by increased gastric tonus and contractions when the initial stage of hyperglycemia is reached. (5) Intravenous injections of glucose does not inhibit gastric tonus and hunger contractions in diabetic dogs except when hyperglycemia and gastric tetany are induced with insulin.

The influence of thermal environment upon basal metabolism: FRANCIS G. BENEDICT and CORNELIA GOLAY BENEDICT. Ten years ago the measurement of the heat production of a human being was a physiological curiosity, but to-day, since the heat production is found to be an excellent index of general tone or well-being and an important aid in diagnosis of goiter, a proceeding that ten years ago was a physiological curiosity has now become a pathological necessity. In the physician's diagnosis it is of the greatest importance to be able to compare the heat production of different individuals. Muscular activity of any kind and digestive processes have long been known to increase heat production, and scientists and physicians have accordingly insisted upon the greatest degree of repose when measuring the heat production and have waited until 12 hours after the last meal before making such tests. It is not merely to satisfy scientific curiosity, therefore, that so much labor is spent to find out under what conditions the least heat is produced. It has been believed that heat is produced to keep the body warm. A French scientist has proposed recently that, as heat is in part produced to keep the body warm and as people, even when clothed and lying covered with a steamer rug, are producing heat to combat the cooling effect of the surrounding air, all measurements of the minimum heat production must be made not in the air under ordinary conditions but with the body immersed in bath water at 98° F. This scientist argues that the heat production under this latter condition may be one third lower than under ordinary conditions. Experiments made at the Nutrition Laboratory to test this point show that if the metabolism is measured, first, with the subject lying, clothed and covered with one thin blanket, in a laboratory room at 60° F., and then with the body immediately thereafter immersed in a bath at 98° F., the heat production not only is not lowered in the bath, but usually is slightly increased. The extra heat is stored to warm up the large amount of peripheral body tissue that even with a normally clothed man is considerably below so-called body temperature, 98.6° F. When this warming is accomplished, then the temperature of the whole body will increase until again the heat loss just balances the heat production.

A comparison of the amoeba of the human bowel and that of the gums with special reference to the relationships of the amoeba in bone marrow in arthritis deformans: CHARLES A. KOFOID. Infections by the amoeba which produce so-called tropical amoebic dysentery are in some instances followed by the invasion of other organs of the body such as the liver, lung and brain, where they produce abscesses, or the skin where they are found in ulcers, or the lymph glands where they are found in Hodgkin's disease. They have also been reported from the genital and renal organs. Recently we have found them in the bone marrow adjacent to enlarged joints in chronic arthritis deformans of Ely's second type. Infections by amoeba in this region have been distinguished from normal and abnormal human cells, especially from the amoeba-like leucocytes, or white blood cells, by finding both human cells and amoebas in the division stages and determining the number of chromosomes in each. Amoeba has six and the human cells forty-eight. Clinical experience affords abundant evidence of a relationship between diseased teeth and some forms of arthritis. The gums around some diseased teeth and some supposedly normal teeth are also infected by an amoeba. These amoebas have a striking resemblance to those of the bowel, so much so as to raise the question as to whether or not the amoeba found by us in the bone marrow in arthritis might not be that of the mouth and diseased gums. A reinvestigation of the amoeba of the gums and of that of the bowel in motile stages both in the bowel and in infected organs elsewhere establishes the fact that these two amoebas are very distinct in the structure of their nuclei, and in their feeding habits. The amoeba of the gums feeds predominantly on white blood cells, that of the bowel on the red blood cells. The amoeba of the gums has no critical resemblance to the amoeba of the bone marrow which has the nuclear structure and feeding habits of that of the bowel. The amoeba of the gums is therefore not associated with this form of arthritis deformans. The portal of entry of the amoeba of bone marrow is the ulcerated bowel, not the abscesses of the gums.

The growth of marine animals on metallic surfaces: G. H. PARKER. These studies were made in connection with an investigation of the fouling of ship bottoms. The metals tested were aluminum, zinc, iron, tin, lead and copper. It was concluded that marine animals would grow upon any heavy metal provided that metal does not liberate ions or soluble compounds. The ions and soluble compounds of the heavy metals are usually extremely poisonous and where they are liberated freely from a metallic surface that surface is protected against organic growth. Such seems to be the case with zinc and copper. With aluminum, iron, tin and lead the products of marine corrosion are essentially insoluble and hence organisms grow upon these metals in the sea. By coupling copper with members higher in the electromotive series, this metal can be rendered chemically inactive in sea water and under such circumstances animals will grow freely upon it. Zinc in this respect is much less easily controlled, for it lies high in the electromotive series and consequently it is not open to the electrochemical protection that copper is. Its compounds moreover are relatively freely soluble and thus become very effective in checking the growth of animals.

Reactions in the female reproductive system following

irradiation in the thyroids: H. J. BAGG and G. N. PAPANICOLAOU. The thyroids of guinea-pigs have been exposed in this experiment to direct irradiation of radium emanation. The purpose has been to study the effects upon these glands and the secondary reactions induced in the genital organs. The thyroids were treated either by exposing the surface to a relatively large amount of emanation or by interstitial implantation of small tubes containing the radioactice substance. Following the treatments vaginal smears were taken in all cases and the animals were finally killed at various intervals. The thyroids have shown varying degrees of atrophy associated with degenerative changes depending upon the method and intensity of treatment. There was mainly a granular degeneration of the epithelial cells with reduction in the colloidal secretion and with interstitial fibrosis. A detailed examination was made of the ovary, uterus and vagina in different instances at varying periods after treatment. The genital organs have shown an increased functional activity associated with marked hyperemia which often was considerably in excess of the normal. These reactions vary in degrees depending upon the severity of the treatment. One of us (Papanicolaou) has noted that in certain ovaries the most interesting result was seen in the activation of the germinal epithelium as exhibited by a marked stimulation of the ovogenetic processes. These instances have demonstrated the progress of ova differentiation much more clearly than can be seen in normal cases, thus contributing materially to the solution of the much disputed problem of post-pubertal ovogenesis. These experiments apparently demonstrate that there is a definite, well-marked reaction in the female genital organs following irradiation of the thyroids and a possible unbalanced reaction of the endocrine system.

Is pneumonia increasing? EWALD TOMANEK and EDWIN B. WILSON.

The measurement of the respiratory function of the blood: L. J. HENDERSON.

Experiments on the development of the internal ear: ROSS G. HARRISON. The plate of skin, or placode, out of which the internal ear develops by invagination, was transplanted in salamander embryos (*Amblystoma punctatum*) in the following four ways: 1, normally oriented; 2, upside down; 3, the left placode on the right side, with the dorso-ventral axis normally placed; 4, the left placode on the right side with the dorso-ventral axis inverted. When the operation is done at the time of closure of the medullary folds, or immediately thereafter, the results are as follows: in 1 and 4 normal right ear vesicles develop on the right side; in 2 and 3 normal, or only slightly distorted, left ear vesicles develop on the right side, except that in some cases the ear is partially reduplicated. These results are quite comparable to the results of similar experiments with the fore limb, *i.e.*, the inversion of the graft changes the resulting ear from a left to a right. The reduplications of the ear are, however, relatively less frequent. There is evidence that the auditory placode in this early stage is equipotential, since a whole ear may be formed out of a part, a normal single ear may develop out of two placodes fused together, and a normal right ear develops out of an inverted left placode. It is concluded that at this stage only the antero-posterior axis of the placode and of its elements is polarized. The definitive asymmetry of the organ is determined then by two factors: 1, the polarization of its antero-posterior axis, and, 2, its orientation with respect to the surrounding parts of the embryo. When the transplantation is made in slightly later stages, the results are different. Only those in which the dorso-ventral axis was not inverted develop normally, the right rudiment becoming a right ear and the left a left, on whichever side it is placed. When the dorso-ventral axis of the placode is inverted the ear becomes an enlarged vesicle, without showing the usual division into saccule, utricle and semicircular canals. As far as can be determined from the position of the maculae, such vesicles are, however, not inverted.

A photographic method of recording primitive music: C. E. SEASHORE. The author presented a method of photographing music, either direct from the singer or player or from photographic records, and illustrated with scientific terminology for musical description based upon such objective record, and a new type of musical notation making possible the representation of many details in the musical score in measures of precision. Illustrations were given from an Indian song and from an artist's singing of "Annie Laurie."

Hereditary abnormalities of viscera: HALSEY J. BAGG. Descendants of mice that were exposed to X-ray irradiation have shown characteristic deformities of the eyes and legs. The defects are definitely inherited. Blindness may be present in one or both eyes, associated with club feet, polydactylism or syndactylism of the limbs. A complete study of many defective animals has shown that the above abnormalities may be but comparatively slight external manifestations of more profound changes occurring within the body. Many animals have been found with a complete absence of one kidney, in two instances hydronephroma were noted, and in one situs inversus viscerum. Breeding tests have shown that the unilateral kidney condition is definitely inherited and recessive to normal, but it remains to be determined as to whether it is Mendelian or not. Inbreeding for this condition has resulted, in several instances, in young with congenital absence of both kidneys. Such animals die soon after parturition.

An investigation into the nature of disease resistance in plants: J. C. WALKER. There exists in all colored types of the onion a high degree of resistance to two common diseases of the bulb, smudge (*Colletotrichum circinans*) and neck-rot (Botrytis spp.). The white varieties, on the other hand, are uniformly susceptible. An inquiry into the nature of this phenomenon has shown that there exists in the outer scales of the colored bulbs a water-soluble substance which is highly toxic to the causal fungi concerned. This substance is absent from or negligible in quantity in the white bulbs. All evidence so far obtained points to the fact that the resistant principle is identified with one or more of the pigment compounds, and these are probably certain of the water-soluble glucosidal derivatives of quercetin.