dividual on another, yet differ from those in which the individual differentials play the chief role. He has chapters or sections on serological reactions, on immunity reactions, on blood groups, on cancer, on fertilization, on hormones, on hybridization and on other topics. Most or all of these receive illumination from experimental results presented, or from comparisons. The work thus becomes a veritable encyclopedia of the main factors and processes in development.

The book furnishes material that will be of interest to geneticists as well as to students of ontogenetic and phylogenetic development; in particular to special students of immunity, of inbreeding, of regeneration, of ageing, of cancer, of animal toxins, of tissue culture, of blood groups, of adaptations, of the relationships of groups of organisms to other groups.

The last part, on "Psychical-social Individuality," presents in three chapters the general and philosophical views of the author on what the significance of it all is for the world of man. Chapter headings are "The Physiological Basis of the Psychical-social Individuality"; "Individuality and the World," and "The Evolution of Individuality." There is an extensive bibliography and a good index.

H. S. JENNINGS

REPORTS

WAR RESEARCH AT MELLON INSTITUTE, 1944–5

THE investigational personnel, experience and facilities of Mellon Institute have been utilized fully in wartime essential research programs during its fiscal year ended February 28, 1945, as brought out in the thirty-second annual report of the director, E. R. Weidlein. Some of the vital projects and accomplishments in the pure research department and on industrial fellowships of the institute will be referred to in this summary, which supplements previous wartime records.[1] All the activities of the organization are non-profit.

RESEARCH IN PURE CHEMISTRY

The work of the institute's department of research in pure chemistry has been largely devoted to chemotherapeutic studies, with particular emphasis on the synthesis of new drugs of possible antimalarial activity, for professional, military and public benefit.

Synthesis of New Antimalarial Drugs. The novel hydroxyethylating agents developed for use with apocupreine have been applied to a variety of new compounds, some of which are possibly useful as therapeutic agents. Substituted lepidyl-pyridinium and quinolinium bromides and lepidyl mercaptans have been made for testing as antimalarials. Basically substituted diphenyl ethanolamines and substituted mandelic thioamides have also been prepared as antimalarials.

Of the two synthetic antimalarials that have achieved clinical usage, namely, quinacrine and pamaquine, the latter is representative of the most active chemotherapeutic agents so far discovered for the treatment of malaria. But the adoption of pamaquine to any extent in actual medical practice is precluded, since last year the U. S. Army advised against its routine use because the margin of safety between therapeutic and toxic doses is too small. This experience has led to the departmental search for modified compounds which will retain high antimalarial activity but will be much less toxic to the host. The possibility of obtaining a much less toxic drug of this type is an additional attraction in that pamaquine has been found to have true prophylactic action at the toxic-dose level.

This research on the detoxification of pamaquine has been patterned after the work previously done in this department in detoxifying the antipneumococcic agent "Optochin," work which resulted in the discovery of hydroxyethylapocupreine. A comprehensive plan has in fact been undertaken to synthesize and study hydroxyethyl analogs of the pamaquine series. Several compounds in this class have been made and one substance has considerable promise.

Sulfur derivatives of quinoline, including some thioethers, have been prepared. The selection of the compounds investigated was influenced by the possibility that, where toxicity is low, certain representative derivatives might advantageously be submitted for testing in relation to other fields of tropical medicine. Certain substituted 2-styrylquinolinium quaternary salts are known to have pronounced chemotherapeutic properties, but the corresponding bases have not been studied. Consequently ten new bases of this type have been synthesized.

Four new 4-(*p*-dialkylaminostyryl)-quinolines have been prepared. As it has been the experience here that the introduction of a hydroxyethyl group into the molecule greatly diminishes toxicity, 6-hydroxyethoxylepidine has been synthesized and some of its derivatives are being prepared. The corresponding 6-hydroxy derivatives have also been made. Likewise in progress is a study of the preparation of various lepidyl and quinaldyl carbinols and their derivatives in order to learn the effect of a carbinol bridge in compounds of this type. A somewhat similar carbinol

[1] SCIENCE, 97: 445–7; 99: 389–91, 409–11.

bridge is, of course, present in quinine. As certain quinoline azomethines possess some structural resemblances to quinine, quinacrine and pamaquine, and because the quaternary salts of some show both bactericidal and trypanocidal action, an investigation in this field has been undertaken.

Hydroxyethylmorphine. With the assistance of the new alkylating agents mentioned, the hydroxyethyl ether derivative of morphine has been prepared and some of its pharmacological properties have been determined. Introduction of the hydroxyethyl group was again shown to cause a marked lowering of systemic toxicity. In mice, hydroxyethylmorphine was 1/5 as toxic and 1/5 as convulsant as morphine, 1/11 as toxic and 1/17 as convulsant as the methyl ether of morphine (codeine), and 1/20 as toxic and 1/22 as convulsant as the ethyl ether (dionine). The analgesic power of hydroxyethylmorphine in mice, subjected to a pain stimulus induced by heat, was substantially equivalent to that of codeine and dionine. Derivatives of morphine are known that are 5 to 10 times as analgesic as and 10 to 20 times more toxic than the parent alkaloid. When these materials become available, they will be subjected to the hydroxyethylation procedure.

Drug Standardization. The 13th revision of the "Pharmacopoeia of the United States" is now under way. Of the 93 new admissions 21 have been assigned to the subcommittee on organic chemicals, which is conducting pertinent investigations in the institute. Because war conditions in the Pacific have detached our normal source of natural l-menthol, the physical and chemical properties of synthetic racemic menthol have been studied. A method has been developed for the determination of iodine in organic compounds and a procedure for determining iodine in thyroid has received favorable industrial comment. There is a steady increase in parenteral medication, calling for a vast supply of ampuled solutions or of dry compounds in ampules for the preparation of injections, such as penicillin and the organic arsenicals. It is imperative that containers made of highly insoluble glass shall be used for such purposes, and accordingly the ASTM and the USP have speeded up their cooperative study on the chemical methods of analysis. Mellon Institute is one of the six organizations participating in this investigation.

Investigations in Applied Science

New Physical Methods and Devices. Research has demonstrated the potential speed of a process for separating gas mixtures by diffusion into a fast-streaming vapor. A procedure has been evolved for determining hydrogen in gases with a thermal conductivity apparatus. The spectrometric analysis of gases has had much attention. The physical and thermodynamical properties of sulfur vapor are being tracked down, commencing in a study of density. Methods proposed for measuring surface areas of porous adsorbents have been studied critically. A procedure has been worked out for determining thermal conductivities at low temperatures. An automatic torque machine has been developed to record rapidly and accurately frictional resistance to rotary motion. Engineering benefit has come from the completion of a program on frictional losses in vaned elbows of asbestos ducts that has resulted in these losses being reduced to an absolute minimum.

Useful Ceramic Progress. Research has been devoted to the treatment of dry air-set mortars so as to prolong the period during which they may be stored, and this investigation has led to a product with decidedly improved keeping properties. By comparison, the new mortar may be stored approximately four times as long as the present-day material. Through searching study efficiency has been imparted to the manufacture of "Garcrete," "Garspar" and "Gartex," with improvements in the quality of these products. The applications of "Garspar" in ceramics have been increased, especially in the making of china and sanitary wares; the uses of "Gartex" have been extended in rubber and plastics technology. A new process has been devised for the manufacture of "Garsand," a promising glass batch ingredient. Under contract with the Office of Production Research and Development of the War Production Board, there have been developed wire-wound resistors qualified for employment by the Armed Services.

Solving War Problems in Metallurgy. An investigation has been begun on the reactions occurring during the sintering of iron powder compacts. Refinements have been made in metallographic procedures for examining such compacts and also iron powder particles. Research on compacts has eventuated in the installation of an industrial physical testing laboratory, and certain of their properties, *e.g.*, tensile strength, have been correlated with the variables occurring in the manufacturing processes. Manganese powder (99.9 per cent.) and also steel powders have been developed from work in the institute. The properties and uses of copper powders are being investigated minutely.

"Ferrocarbo," a research creation, minimizes segregation and breaks up inclusions in cast iron and also serves as an effectual deoxidizer in steel. The corrosion of metals by sulfur is a recently started inquiry. Pickling inhibitors are under comprehensive investigation. A galvanizing flux has been invented that retards materially the formation of dross during the hot-dipping process. A combination limestone-lime process, which can provide substantial savings in many localities, has been developed for treating waste

pickle liquor. A process yielding chemically pure gypsum, a hydrated iron oxide suitable for sintering, and a relatively pure magnesia from waste pickle liquor and dolomitic lime has been completed on a laboratory scale. Current investigation indicates that magnetic iron oxide of pigment quality can be produced from waste pickle liquor by a simple procedure with low operating costs.

Harnessed tightly to war are research and development on special type mortar shells, rockets and pressure vessels. Captured enemy pressure vessels have been investigated in cooperation with the War Metallurgy Committee and the Armed Forces. A program on the production of chromium has been resumed after an intermission caused by emergency work. New alloying possibilities of magnesium with other metals and particularly the improvement of the cast and wrought properties of magnesium alloys are getting fundamental attention. The precision casting of metal alloys for numerous critical applications has benefited from studies of the use of ethyl silicate in sand molding. Research on electrode coating practice has moved on. Packaging tests have been conducted on a wide variety of products in substitutes for tin collapsible tubes, such as aluminum, tin-coated lead and lead. Internal protective coatings for tubes have also been studied. Improved methods are now at hand for the application of internal coatings of waxes in collapsible tubes. Investigational work on closures has resulted in a satisfactory adhesive for cementing liners into canteen caps.

Contributions to Coal Chemistry. A practical investigation is under way on aspects of the combustion of anthracite that are of consequence in domestic heating. Research is quite active on problems concerning bituminous coal derivatives, including the recovery of compounds from coke-oven gas, the elimination of wastes, the improvement of quality of products and the industrial uses of these chemicals. A study of the impurities in "nitration benzene," the most important commercial grade, has been completed, revealing that the principal contaminants are naphthenes. A speedy and accurate method has been composed for determining hydrocyanic acid and certain of its derivatives in gaseous, liquid or solid state. A project pertains to the recovery of thiocyanates from solutions. A new process for making guanidine nitrate has been announced.

Research on the rheological properties of various tar products has been continued. An outcome of utility has been the introduction of a pitch compound of modified flow characteristics, suitable for the protection of metal products, such as corrugated roofing and siding, flat and V-crimp sheets, and associated constructional accessories. The desulfurization of naphthalene is in the pilot-plant stage. A method has been contrived for determining small amounts of sulfur in naphthalene. Studies have been begun on the oxidation of ethylnaphthalene. A new procedure has been found for making vinylnaphthalene, which has promise in plastics technology. Cyclopentadiene, one of the recently investigated coal chemicals, is now recovered by a number of coke plants for use in the production of synthetic resins. A novel approach has been found to the separation of the constituents of anthracene cake. Improvements have been made in the preparation of vinylcarbazole. Progress has been accomplished in the synthesis of picolines and vinyl derivatives of pyridine and in research on the oxidation of lutidines and picolines.

Pathfinding in Petroleum Projects. A new type of still has been designed that gives very striking effects in fractionation; the separation is much better than any so far obtained under vacuum. Research has been conducted on the betterment of methods for separating individual paraffin hydrocarbons of higher molecular weight. The physical properties of waxes are being investigated fundamentally. A mathematical study has been completed on the influence of high rates of shear on the viscosity of lubricating oils. Good progress has been made on the characterization of crude oils as related to their geological environment. An investigation on the physical chemistry of olefin reactions has been advanced. Research has defined the synthesis and properties of 1,1,3-trimethylcyclopentane, a new hydrocarbon. Some fifty alkylated phenols have been identified by finding the properties and x-ray diffraction spectra of their phenylisocyanate derivatives.

The synthesis of liquid hydrocarbons from gases is being investigated by another group. Physical methods have been elaborated for the instantaneous analysis of gaseous mixtures of as many as five components. The extraction of hydrocarbons has been studied with unusual solvents manifesting high degrees of selectivity. The reaction of sulfur with solvent extracts from petroleum stocks has been found to lead to an asphalt-like solid of promise in filling joints and in caulking. The program on nickel compounds and catalysts has been expanded, especially with reference to their applications in the petroleum industry. Research and development have been carried forward on filters, electric refrigeration units and vacuum stills used in controlling the proper condition of machine tool coolants. Equipment has been devised for the collection by froth flotation of grinding waste dispersed in soluble oil emulsions. Studies have been completed on aircraft crankcase oil filters and on appliances for handling and conserving carbon-removing and washing solutions in aircraft engine-repair depots.

Novel Synthetic Lubricants. Through collaboration

with the Bureau of Aeronautics, Navy Department, there have been evolved new and improved instrument lubricants of real value. Processes have been devised and demonstrated for making one of these novel lubricants on a manufacturing scale. There has been gained a background of information and experience that points to the development of still better aircraft instrument lubricants as the program proceeds.

At the start of this research it was ascertained that synthetic organic chemicals were the most promising sources for such new lubricants with strict properties. Accordingly several hundred compounds were synthesized and studied extensively, and from the most promising of them 185 blends were prepared. The best compositions determined by laboratory examination were then tested under operating conditions by Naval Air Stations and instrument manufacturers. It was next decided to transfer the procedure for making one of these oils from the laboratory to a unit plant and to introduce such alterations in the processing as became necessary. From this work has come a very satisfactory method that yields a high quality product.

Another program has enabled the production of chemicals for the improvement of hydraulic fluids and low-temperature lubricants of value to the Armed Forces. Experience earned in this research has been followed in the revision of specifications for Army Ordnance hydraulic fluids. The cooperative testing of extreme pressure additives has been carried out for a government agency to provide superior products.

A Harvest of Food Developments. Research has been concluded on the proteolytic enzyme activity in chicken eggs. An economic industrial process for drying yeast is at the production stage. Studies on improving the quality of dry active yeast have been going forward constantly. Another investigation is on the value of yeast as a source of antibiotic agents. New synthetic vitamin-D agents are receiving research. Investigational work is in progress on conditions influencing molds and infections in bread. A new dried cereal for infant feeding is in production. A novel pre-cooked baby cereal has been investigated clinically and found satisfactory. In another study strained green soybeans have evinced good nutritive value and other favorable characteristics for inclusion in infant foods. Advancement has been made in research on carbohydrate preparations for modifying milk for infant feeding.

Observations indicate that the phospholipids from cottonseed resemble soybean lipositol more closely than they do other phospholipids previously reported as plant constituents. Soybean protein hydrolyzates have been investigated as flavoring agents for prepared food products. Work is being pursued on processing soybean flakes for the production of proteins especially suited for various industrial applications. Novel granular adsorbents for sugar refining have entered pilot-plant development.

Research-Woven Textile Events. The buoyancy and other distinctive qualities of fibrous materials have been studied for military purposes. Fundamental advances have been made in a program on cotton properties. Sizes for the knitting of hosiery have been investigated very near to mill operations. Resin coatings for fibers have been under research from all standpoints. Pleasing results have been attained in increasing permanently the strength of thread by plastics, without imparting stiffness, and in making molded spools. New treatments of woolen felts against heat, water, certain chemicals and abrasion have supplied materials of usefulness. Research on the felting properties of fur and on the standardization of relevant tests and grades has been quite beneficial. Accomplishments have been effected in improving pearl-button machinery and in attacking chemical problems in pearl-button technology. Studies are being conducted on factors influencing detersive action and on the synthesis of detergents with special properties indicated thereby.

For the benefit of the domestic front, commodity standards specialists of the institute have worked with the government in helping to conserve and to standardize home-essential materials. Advisory service has been rendered to the Research and Development Branch, Office of the Quartermaster General. Large experience in the appraisal of consumer goods has made this aid useful in the correlation of laboratory data and field and service test results on new products developed for the Quartermaster. Cooperation has also been extended to the Office of Civilian Requirements, War Production Board, in its program for supplying more adequate quantity and quality in "cost-of-living" textile products.

Advances in Wood Products and Paper. Research on lignin has been concerned with the preparation of utilizable derivatives. Wood glues are getting expansive investigation; the gluing of treated (such as creosoted) woods is likewise under study. Sawdust moldings are being investigated in a far-reaching project. Waxes, new resins and intrinsically grease-resistant materials in eleven groups have been employed experimentally for integrally greaseproofing carton and boxboard stocks. Progress has indicated that such stocks are definite possibilities within permissible cost limits. The improvement of GR-S rubber for use in paper saturation has moved forward, particularly as to heat resistance and non-staining. The three primary grades of such paper are being applied as leather replacements and in shoe-material and garment manufacturing. The technology of a new direct line paper is being defined in a pilot plant.

Investigational Acquisitions for Plastics Technology. A miniature plant for making bentonite plastics has been constructed as an adjunct to the laboratory work. Service tests have demonstrated the utility of new coriaceous plastics in several essential industries. Preformed plastic, developed in a 5-year program, is produced from a mixture of 99 per cent. water and 1 per cent. wood fibers and a phenolic resin, beaten together and then strained by vacuum through a screen to preform to the desired shape, as an airplane wing tip. The wet preform is next oven-dried and molded under heat and pressure. An investigation has been completed on the reaction of sulfur with olefins. Research is continuing on other organic plastics containing sulfur. Allyl alcohol has been studied as an intermediate in synthetic resin production.

Much work has to do with processing and utilizing plastics. Precision casting, molding-laminating techniques and drying are being investigated. Fibrous reinforcing fillers for molding mixtures are receiving study. Other projects relate to new plasticizers. Plastics for lock-nut manufacture have been examined from all aspects. The relative temperature stability of stressed plastics is a concluded research. Another program pertains to the improvement of plastic piston rings and to the development of bearings and bushings fabricated of synthetic resins. The properties of various types of electrical tapes constitute a new investigation, and research is being continued on the aging characteristics of industrial tapes. Synthetic waterproof adhesives are being studied for specific purposes.

A research has covered the characterization and utilization of byproduct oils resulting from butadiene manufacture from alcohol. The infrared analysis of butadiene has been dealt with comprehensively. New uses are being sought for styrene. Amines are under trial in compounding synthetic rubber. Surface-treated pigments prepared by the "Micronizer" process are proving of interest as fillers in synthetic rubber and as carriers for insecticides.

Better Protective Coatings. An investigation of "Vinylite" resin solution coatings has been accelerated to cope with critical problems arising from allocation trends. Suspensions of these resins in organic media have been developed and adapted to the manufacture of battery separators, to metal foil, wire, paper and cloth coatings, and to the molding of soft rubberlike plastics of many kinds. Improvements have been made in vinyl resin coatings for "Nylon" and in the use of plastic film in packaging.

Protective coatings secured by research are now being widely employed, in army and naval services, to line concrete aviation gasoline storage tanks and airplane wing tanks. New synthetic resins and resin combinations have been formulated into protective coatings with special properties for steel shell casings, gun barrels, airplane propellers, bomb shackles, food containers and other war materials. More economical methods of coating formulation have been investigated. Evaluative tests have been started on synthetic resin coatings for use in hot-water tanks and pipe lines. Fundamental studies have been continued on marine coatings, with particular attention to the prevention of fouling by marine organisms.

Research on Organosilicon Derivatives. A fellowship was founded by the Macbeth-Evans Glass Company in 1931 for the development of certain types of glass composition. Upon the merger of this donor with the Corning Glass Works the problem of coating glass blocks with a cement-adherent material, assigned to the fellowship, was successfully solved. The fellowship was then asked to carry on cooperative research with the Corning laboratories on the synthesis of organosilicon compounds intended as impregnants for electrical glass tape. This investigation brought useful findings. A series of organosilicon oxide fluids was synthesized that proved to be the basis for other diversified preparations. Resinous compounds of utility in impregnating and molding were also discovered. As this collaborative research went forward it was realized that efficient production would require the assistance of experience in technochemical procedure. The Dow Chemical Company undertook to evolve production methods and the outcome was the formation of the Dow Corning Corporation, which is manufacturing these materials in a large new plant at Midland, Mich.

The products resulting from this teamwork vary widely in physical characteristics. Fluids are being made that have high heat stability and low freezing points, with exceedingly small slope to the temperature-viscosity curve. Greases have been developed that have found uses as lubricants or electrical sealing compounds where corrosive and high-temperature conditions prevail. Water-repellent compounds are available for application to ceramic insulators and the like. Resins are in production that have given rise to a new class of electrical insulation, unique for its heat-resistance and moisture-proofness. The laminating type of resin employed in conjunction with glass cloth affords sturdy panels that are electrically non-tracking and are not flammable. Relaxation of secrecy orders permits the statement that temperature-resistant elastic types of silicones have been under development here for several years and that some of them are now on the market. Practically all the materials produced were originally completely allocated to war purposes and have helped in the solution of problems presented by the Armed Forces.

Fellowship Research for Public Health. The petro-

latum gauze announced a year ago is now implanted in production. Intermediates for sulfa drugs and antimalarials have been synthesized and put at the disposal of medicinal research organizations. Pentanedione is available to the pharmaceutical industry. Special amines have been made in a pilot plant for use in the synthesis of a new anesthetic. A novel process for preparing ethyl-phenyl malonic ester has been worked out. The synthesis of intermediates for theophylline production has been improved and the synthesis of papaverine is undergoing research along new lines.

The range-finding test is offered as a discerning solution to the problem of probing the toxic hazards of new chemical compounds before their uses justify large expenditures upon detailed studies. Coal-tar derivatives of promise as disinfectants have been appraised and ways of using them are under study. A new insecticide mentioned last year is in small-scale production. The synthesis of insect repellents has been supplemented and progress has been accomplished in the search for satisfactory means of utilizing existing repellents by combat forces. The repelling property of "Hubbellite" for specific insects is another project.

What Is Being Done in the Maintenance of Manpower. Industrial Hygiene Foundation, which has its headquarters at Mellon Institute, has added to the forward health movement through its numerous services and activities for the maintenance of manpower among its member companies and the industrial fields in general. Most important have been plant hygiene investigations to appraise working conditions for their possible effects upon health, and to provide preventive engineering measures to control noxious and obnoxious exposures in workplaces. Sixty of these surveys were conducted during the year, mainly in the East and Middle West, and the projects ranged from several days to over a month in duration.

Numerous studies have been made of soldering operations. Several chemical dermatitis problems have been overcome through the coordination of field investigations with experimental studies by ten dermatologists. In other research electron photomicrographs of air-borne asbestos dust have disclosed that the particles are preponderantly fibrous and that the ultimate fiber is about 0.01 micron in diameter. In addition to its plant hygiene surveys and research, the foundation, with the collaboration of the U. S. Public Health Service, has carried on a program, started in 1940, to help reduce sick absences in the industries. Systematic course of action in industrial hygiene demands concrete knowledge not only of the amount of sick absenteeism, but also of when, where and why it occurs.

W. A. HAMOR

SPECIAL ARTICLES

CRYSTALLIZATION OF SOUTHERN BEAN MOSAIC VIRUS

SINCE the first chemical isolation of tobacco mosaic virus in 1935,[1] a fairly large number of plant[2,3] and animal[4,5,6] viruses and certain bacteriophages[7] have been obtained in more or less pure form. In spite, however, of widespread success of the purification procedures, only three viruses, tobacco mosaic,[1] tomato bushy stunt[8] and tobacco necrosis[9] viruses, have been crystallized. Considerable interest is therefore attached to the isolation of a fourth virus, southern bean mosaic virus, in crystalline form. This virus, which was first described and studied by Zaumeyer and Harter,[10] is sufficiently stable that it may be purified and concentrated by the methods commonly employed for the purification of proteins. Perhaps it is of significance that some of the crystalline forms, the shape of the particles and the thermostability of southern bean mosaic, tomato bushy stunt and tobacco necrosis viruses are similar. On the other hand, their host ranges and cross protection tests indicate that they are not closely related.

Purified preparations of southern bean mosaic virus were obtained by fractionating the juice from infected Bountiful bean plants. The fractionation was carried out either by alternating cycles of high- and low-speed centrifugation or by chemical treatment. The chemi-

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[10] W. J. Zaumeyer and L. L. Harter, *Phytopath.*, 32: 438, 1942; *Jour. Agr. Res.*, 67: 305, 1943.