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# Pharmaceutical Sciences—1963. Part I

## A Literature Review

By WAYNE McKEEHAN and LEWIS C. LAPPAS

CONTENTS



[Contents for Part II will accompany the concluding part of this Review Article next month.]

THIS SURVEY of the literature pertaining to pharmaceutical sciences is the first sequel to the 1962 review published in THIS JOURNAL (1, 2). In maintaining continuity, more than 100 periodicals and *Chemical Abstracts'* Pharmaceuticals and Pharmacodynamics sections published during 1963 were searched for appropriate material. Those areas which are reviewed annually in other publications were omitted from this review. Although not all-inclusive, this comprehensive report is directed toward presenting a compilation of the current developments in several areas of pharmaceutical science.

For future reference, two publications are reported which should aid the pharmaceutical scientist in surveying the literature. The initiation of a pharmaceutical abstracting journal was announced (3), and a list of the world's pharmacy periodicals was compiled (4).

## GENERAL PHARMACY

This broad category encompasses those parts of the literature which are difficult to classify specifically. During 1963 considerable attention was focused on regulations for investigational drugs imposed by the Food and Drug Administration. As evidence, many publications were concerned with clarification of these regulations in light of the pharmaceutical industry's role (5–9). Kern emphasized that many requirements are in a continual state of change, thus making it impossible to be in full compliance with all of the regulations at all times (10). The adequacy of proposed clinical trials was discussed in two articles (11, 12). Palmer described the types of studies which may be used in testing the effectiveness of new drugs (13). Schreiner presented the liabilities of the clinical investigator in new drug testing (14), and the need for certain additional safeguards in the testing and handling of investigational drugs was discussed by Archambault (15). Detailed methods of drug evaluation in hospital pharmacy were reported (16). In a discourse on the hazards of new drugs, the scientific approach was advocated as being the safest and most effective (17).

Various aspects of ethical drug market research were presented by Hull (18), and the economics of pharmaceutical research in the United States was reviewed by Arnow (19). The complex and intricate steps essential to a good quality control system for the manufacture of drugs were described (20). A statistical approach to the design and analysis of experiments was disclosed (21). Shindell examined statistical probability (22) and the validity of conclusions (23). Possible errors in application of the Student *t* test in simple comparison studies were pointed out (24). King constructed a multiple-stage design for drug screening (25). Numerous references were presented in a survey of various types of designs which are useful in drug screening (26). Another investigator explored the use of the digital computer and its programming for the handling of complex data (27).

**Preservatives.**—A detailed review of preservatives in pharmacy, with 103 references, was presented by Nogueira (28). Parafinska and Zwolinska also presented an article, with many references, concerning the use of bacteriostatic and bactericidal agents in pharmacy (29). An extensive discussion of the properties and uses of a variety of antimicrobial agents in cosmetic preparations was also reported (30). In another publication, various preservatives in hydrogels, hydrosols, emulsions, and suspensions were studied (31). The adsorption of sorbic acid by plastic cellulose acetates was investigated (32).

Sixteen different 8-hydroxyquinoline salts were prepared and found to have strong fungistatic activity (33). The germ-inhibiting action of some 8-hydroxyquinoline salts was also examined (34). Hexachlorophene and its isomers were evaluated against a broad spectrum of bacteria, molds, and yeasts by Gump and Walter (35), who observed that maximum results occurred in products with bisphenols at pH 5.4 (36). Pyrocarbonic acid diethyl ester was investigated as a potential food preservative (37). Some other preservatives, effective *in vitro* against various bacteria and fungi, were studied by Gaind, *et al.* (38), and Judis conducted research on the mechanism of action of phenolic disinfectants (39). Myers and Sheahan demonstrated an adverse effect of calcium alginate on the antimicrobial activity of benzalkonium chloride (40). Another worker evaluated various antibacterial substances for enhancement of the bactericidal effect of steam (41).

The disappearance of preservative activity due to degradation in solution and absorption by rubber stoppers in multiple-dose vials was investigated (42, 43). Benzethonium chloride showed some antifungal activity but little antibacterial activity when tested as a preservative for poliomyelitis (Salk) vaccine (44). Kohn, *et al.*, developed methods of testing antibacterial effectiveness and evaluated 51 chemical substances for use in ophthalmic solutions against 13 different strains of *Pseudomonas aeruginosa* (45, 46).

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Data support the view that small amounts of certain perfume oils might be used effectively in the control of some dermatophytes (47). Fletcher and Norton studied the antioxidant effect of sodium metabisulfite in sulfacetamide eye drops (48). Schroeter found that many aqueous, oxygen-labile, pharmaceutical systems may be protected by the antioxidant action of sulfurous acid salts (49). Oxidative deterioration of cosmetics and its control have been discussed (50). Hydroquinone served as an effective antioxidant in the preservation of lard (51).

**Flavor, Aroma, and Color.**—Wesley surveyed recent trends in pharmaceutical flavors (52), and Moncrieff discussed the influence of taste and odor on flavor (53). A paper on the materials and factors which affect flavors was published (54). Production applications and stability tests were described for solid citrus flavors (55). Runti classified various synthetic sweetening compounds which have actual or potential application (56), and Brookes compared the sweetening effect of sodium cyclamate with that of sucrose and saccharin sodium in various preparations (57). Development of a stable, flavored, glyceryl guaiacolate cough syrup was reported (58).

The economic potential and future of the fragrance industry were analyzed by Vautin (59). In a discussion of odor mechanism theories, Moncrieff stated that evidence favoring the adsorption process is overwhelming (60). The scents of the fragrant flowers and leaves of the milkweed (61), the camellia (62), and the magnolia (63) families were reported in three manuscripts.

In a review on the psychophysical concept of color, several standard techniques for evaluating small color differences were presented (64). The importance of color and its psychological effect on the human appetite were studied by Birren (65). A current guide to color restrictions was presented (66); 47 references were cited in a review of natural dyes (67).

**Adjuvants.**—The chemical and physical characteristics and applications of several montmorillonite hydrocolloids were summarized by Barr (68). In a comparative study, two highly dispersed colloidal silicic acids were evaluated as adjuvants for pharmaceutical preparations (69). Molecular properties of Ghatti gum, a naturally occurring polyelectrolyte from *Anogeissus latifolia*, were investigated by Elworthy and George (70), and Faust discussed the properties and uses of modified starches in topical preparations (71).

Prescott, *et al.*, considered the chemical and pharmaceutical properties of poly(vinylpyrrolidone) from a cosmetic viewpoint (72, 73). Independent reports appeared on the cosmetic application of acetoglycerides (74) and various cellulose ethers (75). Five anionic certified dyes were adsorbed on various starches in accord with the Langmuir equation (76). Mandak used various condensation products of ethylene oxide to enhance the formulations of galenic preparations (77), and Ullmann demonstrated increased activity of several antibiotics with the aid of nonionic poly(oxyethylene) adducts (78).

The properties and applications of certain specialty polyols have been discussed (79). Hexadecyl alcohol, a new material for cosmetic formulations, was found to be essentially nontoxic and nonirritating (80). Allen reviewed the applications of some fatty alcohols and saturated fatty acids in pharmacy and cosmetics (81, 82). The alcoholic constituents of some modified wool fats were investigated (83).

Brown, *et al.*, suggested dimethyl sulfoxide as a useful solvent for chemical compounds under toxicological evaluation (84). Many references were cited by Spiegel and Noseworthy in a review of toxicity, chemical and physical properties, and applications of some nonaqueous solvents for parenteral products (85). The distribution of phenol in mixtures of water and organic solutions was explored in the presence of polysorbate 20 (86).

**Stability.**—Garrett reviewed the physicochemical and statistical procedures used to study the stability of drugs in solution (87). Statistical analysis was applied to short-term stability data for prediction of shelf life of pharmaceutical suspensions (88). In another paper, several factors to be considered in an accelerated stability-testing program were suggested (89). Awe and Kienert evaluated the effect of various oxidizing agents on phenylbutazones (90). A review of the literature concerning oil and fat oxidation and antioxidation was made by Froelich (91).

Nogami and associates, in a series of papers on drug stability in solution, studied the stabilization of methantheline bromide and choline derivatives (92) and investigated the hydrolysis of several sodium alkyl sulfates (93, 94). Other workers examined the influence of the state of aggregation on the specific acid-catalyzed hydrolysis of sodium dodecyl sulfate (95). Equilibrium moisture contents for a number of representative pharmaceutical materials were determined by Scott, *et al.*, who suggested that

such data are useful in predicting the effects of storage humidity on moisture sorption (96). Experiments for testing the stability of aspirin mixtures were described (97). In another paper, stability studies of aspirin-dried aluminum hydroxide gel tablets were reviewed (98). Guven observed an incompatibility of quinine sulfate or hydrochloride with acetylsalicylic or salicylic acids in tablets and powders (99).

An investigation was conducted on the effects of various granulating processes in decomposition of primary digitalis glycosides (100). Schou examined reactivity in various solid pharmaceuticals and showed that copper contamination from equipment and materials may be important in the catalysis of auto-oxidation (101). The effect of ball-milling on the stability of vateritic calcium carbonate was investigated (102). Everhard and Goodhart demonstrated that fading of FD&C Red No. 3 in tablets follows first-order rate kinetics (103). *In vitro* data have been presented which might explain clinically inactive prednisone tablets U.S.P. XVI (104). A brown discoloration occurring in some pharmaceutical granules was attributed to the reaction between glucose and sodium dihydroxyaluminum carbonate (105). Burkman ascribed the loss of biological activity of apomorphine to auto-oxidation (106). Changes in alkaloid content of ergot (107) and volatile oil content of nine drugs (108) during storage were studied.

From stability data on basic ethers of the diphenhydramine type in acid medium, it was predicted that no noticeable decomposition would occur in the stomach after oral administration (109). The hydrolysis of succinic and tetramethyl succinic anhydrides in water, dilute acids, and aqueous electrolytes was disclosed by Bunton, *et al.* (110). Heparin solutions were stabilized by the addition of 0.1% of sodium metabisulfite and adjustment of the pH to 4–5 (111). Optimum pH values for stability of aqueous physostigmine (112) and fructose solutions (113) were 2 to 4.5 and 4.0, respectively.

The interaction of papaverine hydrochloride with numerous alkaline substances in aqueous solution was investigated by Ryabukhina (114). Stainier, *et al.*, concluded that stability of barbiturates in the presence of sodium hydroxide is inversely related to the number of methyl groups (115). In another monograph, stability of acetazolamide and methazolamide in alkaline solution was evaluated (116). Other researchers found that aminoethylnitrate and some related compounds decompose *via* an imine mechanism down to pH 4.0 (117) and that radioactive 3-acetoxymercuri-2-methoxy-propylurea was stable for 60 days in dilute basic solution (118).

Preliminary data indicated that discoloration of 30% sodium sulfacetamide solutions was eliminated by addition of 0.01% sodium edetate or 0.1% sodium thiosulfate (119). A note was presented on the stability of pilocarpine hydrochloride ophthalmic solutions in two types of containers (120). Brownley and Lachman examined the influence of lactose on the stability of certified dyes in aqueous solution (121). Removal of iodine from aqueous solutions of hydriodic acid was described by Davidson and Jameson (122). Procedure modification enhanced the stability of sweet spirit of nitre (123). In aqueous solution, the rate of decomposition of calcium acetylsalicylate was claimed to be temperature dependent (124). Mitchell studied the hydrolysis of propyl benzoate in aqueous solutions of a nonionic surfactant (125). Blazek presented a review, with 30 references, of the chromatography and stability of some phenothiazine derivatives (126).

The controlled hydrolysis of some antibiotics and their decomposition products in the presence of cation-exchange resins was effected without complete degradation (127). In mixtures, dibazol was found to decompose in the presence of oxygen and moisture after long-term storage (128). Nakatani examined the stability of orotic acid and its amine salts in aqueous solution (129), and Sano, *et al.*, studied the stability of *d*-glucuronamide in the presence of various compounds (130). It has been suggested that polysorbate 80, a nonionic surfactant, might have considerable influence on the stability and availability of ionic drugs in pharmaceutical formulations (131). Forty-nine references were cited in a review of the stability and stabilization of streptomycin (132).

Photodecomposition of acid-aqueous thioproperazine 5-oxide occurred by irradiation with fluorescent light under anaerobic conditions (133). Kitahara and Tanaka studied the behavior of unsaturated fatty acids and liquid organic compounds in the gamma-ray field (134). Experimental work by Luduena, *et al.*, suggested the formation of adrenaline in aqueous solutions of phenylephrine after ultraviolet irradiation (135). The effects of ionizing radiation on two gelatin fractions were reported (136). Fenn and Belcastro examined the effect of ultrasonic waves on the stability of selected surface-active agents, sulfonamides, and *p*-aminobenzoic acid (137).

**Stability Kinetics.**—Conine demonstrated the application of stability data to the prediction

of the shelf life of pharmaceutical products (138). Applications and precautions in using the Arrhenius plot and statistical procedures for accelerated stability testing of pharmaceutical products were considered (139). Guttman discussed the use of kinetic principles and reaction mechanisms in studying drug stability (140). Reaction kinetics were stressed in a survey of the stability of drug solutions (141). A general method for determining the order of a reaction was reported (142). Rogers disclosed an accelerated storage test with programmed temperature rise (143), and Barker applied the Arrhenius equation to calculate the shelf life of atropine eye drops (144). The decomposition of chloral hydrate in the presence of phenobarbital sodium was reported to follow the kinetics of bimolecular reactions (145).

DeLuca discussed the photobinding and photoreactivity of riboflavin in the presence of macromolecules (146). The stabilization of vitamin $B_{12}$ in liquid multiple-vitamin products was demonstrated by Conine and Zuck by the addition of alphahydroxynitriles or their esters (147). These investigators also found potassium ferrocyanide to be superior to iron salts for stabilization of vitamin $B_{12}$ in multiple-vitamin preparations (148). Several compounds were evaluated for their effect on the rate of thiamine hydrolysis (149), and kinetic data were used in predicting the shelf life of vitamins $B_1$ and C in oral liquid formulations (150). A pH-rate profile of the anaerobic degradation of ascorbic acid in aqueous solution was published (151). The stability of ascorbic acid was also studied in a liquid multivitamin emulsion containing sodium fluoride (152).

Research on the solid-state decarboxylation of *p*-aminosalicylic acid was conducted under various conditions (153). Schroeter presented experimental data to corroborate the Abel theoretical equations and radical mechanism for sulfite oxidation (154). Tanaka, *et al.*, reported on kinetics of color changes of fradiomycin sulfate (155). Kinetic investigations were published on the hydrolysis of thioacetazone and its related compounds (156), trimethadione (157), some tropine esters (158), and some carbamate and carbonate esters (159). The inactivation of phenoxymethylpenicillin V and benzylpenicillin G in aqueous solutions above pH 7.0 was explored by Rozenberg (160). Inactivation rates of aqueous, buffered sodium penicillin G were investigated by Ullmann, *et al.*, in the presence of ionic surfactants, organic gel formers, and preservatives (161).

**Vitamin Stability.**—Vitamin degradation in liquid multivitamin preparations was accelerated by the routine of daily dosage-removal (162). Various antioxidants were evaluated for their stabilizing action of vitamin A in ethyl oleate solutions (163). Nordfeldt and Olsson determined the stability of vitamin A and tocopherol in a mixture of fish liver-wheat germ oils (164), and Christensen, *et al.*, discussed the influence of pH on the stability of vitamin B parenterals (165). The influence of sterilizing temperature on the decomposition rate of vitamin $B_1$ injectable solutions was also reported (166).

Microbiological analysis revealed two new compounds from the photochemical degradation of riboflavin; the major product was identified (167). A comparative study of gamma-ray decomposition and photodecomposition of aqueous solutions of riboflavin was conducted by Takahashi and Yamamoto (168). Results of a spectrophotometric analysis showed that vitamin $B_{12}$ decomposition varied from 2.9% in presence of maltose to 23.5% in the presence of glucose (169). Thermostability and the moisture content of vitamin $B_{12}$ preparations were examined by Bayer and Liptay (170). Degradation of vitamin $B_{12}$ solutions by ionizing radiation was also reported (171).

Color changes of aqueous solutions of L-ascorbic acid during decomposition were investigated (172), and rubeanic acid was proposed as an effective stabilizer for aqueous solutions of L-ascorbic acid (173). In another study of vitamin C stability, ethylenediaminetetraacetic acid significantly stabilized an ascorbic acid syrup (174). Nogueira, *et al.*, reported that ampuls of sodium ascorbate of the Portuguese Pharmacopeia did not decompose on exposure to visible or ultraviolet light (175). Zwolinska reported that cysteine, propylene glycol, or disodium ethylenediaminetetraacetic acid improved the stability of vitamin C solution at pH 4.85 to 4.95 (176). The stability of ascorbic acid in various fruit juice vehicles was evaluated at elevated temperatures (177). Different decomposition products of rutin trisulfate were found at pH values of 3.2 and 8.0 (178). A variety of products was obtained by the oxidation of vitamin E with alkaline ferricyanide (179).

## PHARMACEUTICAL TECHNOLOGY

Chalabala, *et al.*, surveyed 919 references in reporting progress (1959–1961) in the field of galenical preparations (180). The importance of galenic research and its implications in modern pharmaceutical techniques were discussed in another paper (181). Macek reviewed some of

the important physical and chemical factors in new product development and emphasized the magnitude of studies involved in new dosage forms (182). Five hundred and twenty-one references were cited in a comprehensive review of the use of sorbitol in medicine (183). Some aspects of controlled gelling and the use of thickening products were also reviewed (184). Magid summarized the pharmaceutical aspects of dextromethorphan hydrobromide (185).

A comparative evaluation was made of the preparation of tinctures by different methods (186). Ryabukhina studied the solubility of several alkaloids for the formulation of medicinal mixtures (187). Knowledge of dissociation and solubility constants was found useful to predict the salting-out incompatibility of certain pharmaceutical agents (188). Mirigian, *et al.*, formulated a potassium-ion replacement elixir (189); Letassy and Huyck modified the phenobarbital elixir U.S.P. XVI formula to produce a clear product without the time-consuming filtration procedure (190). Current knowledge of 23 commonly used Russian vitamin preparations was summarized (191).

Lach presented a theoretical dissertation on buffers, stressing the importance of these agents in pharmacy (192). A simple apparatus for rapid, aseptic filtration of eye drops was described in another publication (193). Wiegrebe discussed methods for calculating isotonic collyria and isohydric solutions—a table for a borate-acetate buffer system was included (194). The formulation and production of ophthalmic preparations have been reviewed (195).

A general review of the various types of sunscreens was published (196). Walker described the effects of organic sulfur hair tonic formulations (197); Barr discussed antacid properties and possible contaminants of various magnesium-containing substances (198). In a lengthy review of modern cough mixtures, composition and economic impact were examined (199). The effectiveness of keratinase as a depilatory was reported to be dependent upon its purity and the pH of the finished product (200).

The technique, theory, and applications of fluidization to pharmaceutical manufacturing were summarized (201). Hess and Lang described the preparation of granulations by spray-congealing (202). Other publications were found on factors affecting the uniformity of mixing (203) and theoretical and practical concepts of mixing solids (204). Particle size and tablet composition were shown to influence the antimicrobial effect of 5,7-dibromo-8-quinolinol *in vitro* (205). A comparative study of various U.S.S.R. diatomites as filtration material in the production of insulin was presented (206).

**Parenterals.**—Horsch reviewed the technology of injectables and eye drops in the German Democratic Republic (207). A survey of the literature concerning the use of demineralized water as a solvent for injectables was published (208). Gubitz considered the substitution of demineralized water for distilled water in pharmaceutical formulations (209). Methods for calculating isotonic drug concentrations were treated in two publications (210, 211); the latter contained a table of sodium chloride equivalents. Advantages of the hematocrit method over the hemolytic method in testing isotonicity of injectable solutions were presented (212).

Riffkin commented on potential incompatibilities due to mixing parenteral products (213). A procedure was recommended for the preparation of invert sugar solutions for intravenous use (214). Special precautions were necessary in the preparations of glyphylline injections to prevent extraction of silicon and borate from glass (215). Ilver and Jochumsen advocated more rigid testing for commercial nicotinamide used in injectable solutions (216). These investigators also proposed a formulation for decreasing the turbidity of nicotinic acid injections (217).

Macek illustrated some of the problems encountered in the manufacture and stability of parenteral dispersions (218). Aqueous suspensions of deoxycorticosterone trimethylacetate were prepared for injection (219). Revol commented on the pharmacology, accidents, contraindications, and precautions concerned with parenteral administration of lipid emulsions in one paper (220) and reported their preparation, composition, and stability in another (221). Sodium *p*-aminosalicylate solutions could be stabilized at pH 8 with disodium Versenate for sterilization and storage (222). Friebel and Patel attributed loss of action of local anesthetic drugs in glucose solution to the formation of glucosides (223). Studies were made on precipitation in injectable oily solutions due to temperature and impurities (224). Moldovan observed that carbonate and bicarbonate ions form precipitates of calcium carbonate due to the presence of calcium ion in glass containers (225). Several other publications dealt with preservation, stability, and preparation of parenteral products of adrenaline (226), helveticoside (227), morphine (228), procaine (229), and some sulfonamides (230).

Piersma discussed various aspects of numerous

biological products in the drug industry (231), and Gershenfeld reviewed the progress of recent developments in biological products and the importance of maintaining immunity against disease (232–234). The relative merits and disadvantages were compared for living and killed vaccines (235). Another publication was concerned with the principles of chemical preparation of formaldehyde-treated virus vaccines (236). The effect of pH on thermal stabilization of oral polio virus vaccine by magnesium chloride was investigated by Melnick and Wallis (237).

**Sterility.**—A general review of sterilization, disinfection, preservation, and terminology was published (238). Additional reviews on sterilization techniques (239) and pyrogens (240) were noted. Mathews reviewed the principles, sampling, and methodology of sterility testing of biologicals for the period 1957–1962 (241).

Various methods to obtain positive clarification and sterile filtration for pharmaceutical production were given by Stapowick (242). An apparatus for sterilizing heat-labile solutions (243) and a method for aseptic dialysis (244) were also presented. Using an evacuated bottle as the driving force, Minsley developed a simple "closed system" filtration process (245). Buffered glutaraldehyde, a new chemical sterilizing solution, did not have the undesirable properties of formaldehyde (246). The properties and applications of ethylene oxide in sterilization processes have been investigated (247, 248).

A filtration method was developed by Meinhard for the sterilization of urea solutions for intravenous use (249). Glucose degradation during sterilization in acid and alkaline media was discussed (250). Physical characteristics, method of preparation, and procedure for control were described for sterile mannitol solutions (251). Colchicine for injection was prepared by Smith, *et al.*, using sterilization by heat or filtration (252). Peroxides are decomposed by antimicrobial treatment by the Swiss Pharmacopeia VI method for oils used in parenteral injections (253).

**Tablets.**—Tablet manufacturing, including formulations and varieties of compressed tablets, was studied by Heinemann (254) and Burlinson (255). Two investigations were published concerning the instrumentation of tablet equipment for studying various forces operating during the compression cycle (256, 257). Windheuser, *et al.*, explored this problem with respect to pressure transmitted to the die wall during compression (258). Another paper was found which considered pressure distribution in tableting (259). In a preliminary report, Marshall described the application of electrical resistance measurements for investigating tablet compression (260). The advantages of direct compression of tablets (261) and a critical review of existing test methods, with description and proposal of improved test methods (262), were presented.

Engelbrecht presented a series of articles on the problems involved in the compression of granular aggregates and discussed the dynamics and "binding energy" of the compressed aggregates (263–265). Surveillance of the scientific advances and other areas in pharmaceutical research was made by Cooper (266). Successful application of dry granulations was reported for tablet manufacturing (267). Fluidized bed drying of tablet granulations was found to be 15 times faster than tray-drying procedures (268). Gunsel and Lachman presented a comparative evaluation of tablet formulations prepared from conventionally processed and spray-dried lactose (269). Severe powder-sticking to tablet punch surfaces during the production of an effervescent tablet was eliminated by punches tipped with poly(tetrafluoroethylene) (270).

A review of various lubricating agents in tableting was published (271), and methods for evaluating lubricants and tablet friability were established (272). Tawashi investigated the use of colloidal silica for enhancement of the flow properties of powder mixtures (273). The applications of microcrystalline cellulose as a filler, binder, disintegrating agent, and lubricant in tableting were discussed (274). Poly(vinylpyrrolidone) (275) and sodium carboxymethylcellulose gels (276) were evaluated as binding agents in tablets. Chewable vitamins (277) and the use of mannitol in such formulations (278) were discussed in separate papers.

The Pfizer hardness tester was evaluated with eight tablet formulations and found satisfactory (279). New equipment for testing tablet disintegration time has been developed (280, 281). Levy, *et al.*, studied the effect of granule size, starch concentration, and compression pressure on the dissolution rate of tablets (282). The influence of tablet lubricants and the mechanisms by which they modify the dissolution rates of pharmaceuticals in tablets were also examined (283). Nogami, *et al.*, conducted research on the physical properties of tablets; Washburn's equation was applicable for studying penetrating rate in tablet disintegration (284). Powdered corncobs, cellulose, and several starches and gums were evaluated as potential tablet disintegrating agents (285, 286). The disintegrating properties of kaolin in tablet formulations have been at-

tributed to their negative charge in the presence of moisture (287).

Muenzel cited 69 references in a review of the recent contributions to pharmaceutical coatings (288). New tablet shapes and sustained-release developments were also surveyed by this author (289). By combining spray techniques and drying into one operation, Rieckmann developed a new method for the automation of tablet coating (290). Rapid methods for the manufacture of various nonsugar, "film type," tablet coatings have been announced (291).

A procedure to detect core dislocation in compressed coated tablets was offered to determine the optimal granule-size distribution for optimal core concentration (292). Other investigators described the development of enteric coatings from methyl phthaloyl cellulose (293) and salol-shellac mixtures (294). Good color stability from water-soluble carotenoids was demonstrated in tablet coating (295). A simple procedure was developed by Bennett and Hess for the rapid detection of excess glucose in the coloring syrups used for tablet production (296).

In a study of complex tablets, it was found that compressibility and strength were dependent on the proportions of the individual components (297). The sublimation of iodochlorohydroxyquinoline was observed during the manufacture of tablets (298). Hadgraft and Smith examined the formulation and stability of effervescent potassium tablets (299). Sodium lauryl sulfate was found to be an effective foaming agent in the preparation of a new contraceptive tablet (300). Dosage variation was studied by Brochmann-Hanssen and Medina in various production-run tablets (301). Automated instrumentation was also used to study intertablet dosage variation (302).

**Suspensions.**—Finholt conducted a survey of pharmaceutical suspensions (303). Fundamentals, production, and testing were discussed in a paper on parenteral suspensions (304). Utilization of suspensions in hospital pharmacy has also been considered (305). The influence of various ingredients on the physical behavior of calamine suspensions was observed (306), and some of the properties of white lotion were examined (307).

During 1963, many references were found on various theoretical treatments of numerous suspension problems. Hiestand cited several important physicochemical factors in suspension formulation (308). The theoretical treatment of the properties of colloidal dispersions flocculated by polyelectrolytes was reviewed (309), and Higuchi, *et al.*, studied in detail the kinetics of rapid aggregation in suspensions (310). Caking and flocculation were investigated under various conditions for sulfamerazine suspensions (311). Theoretical calculation of sedimentation volume was considered for nonattracting spherical particles (312); the method was applied to data from the literature. Zacek described a sensitive torsion viscometer and its application to determine the viscosity of pharmaceutical suspensions (313). Rheological behavior, sedimentation rate, redispersibility, and microscopic appearance were evaluated for zinc oxide suspensions at varying concentrations (314).

Smith demonstrated some practical methods for converting powders from a nondispersible to a dispersible state after grinding (315); methods were also presented for stabilizing suspensions after dispersion. The dispersibility and adhesiveness of several powdered drugs were investigated in 1% aqueous polysorbate 80 solution (316). Zacek recommended the Grindometer for the quality control of pharmaceutical suspensions (317). Two methods were compared for measuring particle-size distribution of aqueous barium sulfate suspensions (318).

The applications and properties of clay suspending agents for cosmetic formulations were reviewed by Sperandio (319). Montmorillonite and kaolin gels were studied in relation to the "card-house" picture of flocculated suspensions (320). Granquist and McAtee considered the role of the dispersant in gelation of hydrocarbons by montmorillonite-organic complexes (321). Another researcher investigated the effects of dilution and addition of salts on the viscosity of a sodium-ion–containing montmorillonite suspension (322). Electrophoretic mobility of kaolinite gels was determined as a function of electrolyte concentration (323). The preparation and evaluation of a hexamethyltetracosane-organo-magnesium montmorillonite gel was described by Franke and Riley (324).

**Emulsions.**—Schneider discussed oil-in-water emulsions in a review of formulations (325). Two publications appeared concerning the application of ultrasonics in the preparation of emulsions (326, 327). Zettlemoyer, *et al.*, described a simple method of manufacturing reproducible water-in-oil emulsions and a shear method for rating stabilities (328). In another paper, the mechanical properties of emulsions were interpreted rheologically (329). A nonaqueous, immiscible system was used to evaluate the emulsifying effects of several ionic surfactants (330). Emulsions were formulated with a wool wax iso-

late and its ethoxylated derivative (331). Bogs and Naumann evaluated emulsifying agents employed in pharmaceuticals in terms of their emulsifying capacity (332). In a series of statistically designed experiments, the chemical and physical nature of four oils and 13 surfactants were evaluated (333).

Neumann discussed the mechanism of coalescence and compared the coalescence time of oil drops and water drops in various immiscible liquid systems (334). The parameters of emulsion stability were explored with respect to shelf life, creaming, or clearing—interacting forces involved in coalescence were also mentioned (335). In the presence of small amounts of surface-active agents, glycerol tristearate crystals stabilized water-in-oil emulsions (336). Research was conducted on the changes in rheological properties of emulsions on aging (337). Moore and Lemberger devised a procedure for the rapid counting and sizing of droplets as a function of time to study the sedimentation behavior of dispersions (338).

**Ointments.**—Higuchi has reviewed the theory of diffusion as applied to the transport of materials in ointment bases (339). Classification of various ointment bases was the subject of another review—new preservatives and antioxidants were also mentioned (340). In a series of publications, Allen reviewed various absorption bases, including hydrophilic petrolatums (341–343). Walker and Kennedy discussed the rational basis of dermatological formulations (344). The Grindometer was used to determine fineness of powdered drugs in various ointment bases (345); a statistical evaluation of the data was presented in a second paper (346). Hermetically sealed containers were advocated for water-in-oil ointments to prevent evaporation from their surfaces (347). Procedures and apparatus were described for the preparation of a new dosage form for ophthalmic ointments (348).

**Suppositories.**—Jernas derived a formula to calculate the amount of suppository base to use in formulation (349); Tuma discussed various hydrophobic, hydrophilic, and water-soluble bases for suppository preparation (350). The melt-process was applied in preparing suppositories with Lasupol G as the base (351). A simple four-step procedure was described for the preparation of a single shell which serves as mold and package for suppositories (352). Another paper dealt with the technology of various suppository bases for use in tropical climates (353). Benzalkonium chloride was formulated into a water-soluble, vaginal suppository (354). The liberation of water-soluble drugs from 24 different suppository bases was investigated by Krowczynski (355). The absorption rate of sulfonamides from suppository bases was related to the hydrophile-lipophile balance value of the surfactant employed (356). Simon and Slavin compared the stability of imitation cocoa butter and theobroma oil in terms of physical and chemical properties and storage requirements of the finished product (357). In an evaluation of physical properties of suppositories, maximum environmental temperatures were determined for 44 bases (358).

**Packaging.**—Discussions were noted concerning the need for standard specifications for eye drop bottles (359) and prescription containers (360). Consideration was also given to the applications and contraindications for various types of packaging materials and dispensing containers (361). Boerger, *et al.*, enumerated some problems on the new forms in drug packaging (362). An electronic control system was described for increased efficiency in pharmaceutical packaging (363).

Methods of evaluation were presented in a review of the effects of elastomer components on the composition, aging, and efficacy of drug products (364). Various opinions were stated concerning the testing of synthetic materials used in pharmaceutical packaging (365). In two separate publications, Beiersdorf discussed the testing of rubber stoppers used as closures for parenterals (366) and the selection of specific rubber stoppers for certain drug containers (367).

**Aerosols.**—Many comprehensive reviews were published in the field of aerosols in medicine. These covered a wide variety of subjects—from formulations, stability, particle-size measurement, and method of administration to propellants, containers, and packaging techniques (368–375). Methods of testing dip tubes were investigated in relation to stability in certain chemical environments (376).

Lin and deNavarre discussed the properties, viscosity, density of foam, and surface tension as they affect the wetting property of the aerosol foam (377). Over 400 surfactants were evaluated for use in aerosol foams with respect to their emulsion stability, viscosity, discharge characteristics, foam stiffness, stability, and density (378). The coagulation of a homogeneous, slightly charged aerosol of dioctyl phthalate was studied (379). Blaug, *et al.*, formulated a medicated aerosol foam for otic application (380). Electron diffraction was used to measure the particle size of a zinc oxide aerosol (381).

## EQUIPMENT

An all-glass rotary evaporator for vacuum distillation was described by Naff and Spector (382). A new fractionating molecular still has also been designed (383). A laboratory pressure-filter apparatus was described for use in the pharmacy (384). Schroeter and Hamlin developed an automated apparatus for the determination of dissolution rates of capsules and tablets (385), and the design and operation of a programmed automated film-coating technique was illustrated by Lachman and Cooper (386).

For small-scale mixing, a modified 10-ml. syringe with exchangeable cylinders was proposed (387). The design and technical performance of a small, very simple, fast laboratory mixer was given by Smith (388); Albus discussed the principles of the jet mill and various types of nozzles (389). Equations have been derived to express roll-speed ratio, throughput, and efficiency of the three-roll mill (390). A laboratory colloid mill was developed for the emulsification of flavoring oils in the preparation of locked-in fruit flavor (391). Gelperin, *et al.*, used a continuous dryer for the rapid drying of suspended tetracycline (392). A small air-pressure pump for use in the pharmacy has also been described (393).

Application of a portable hand refractometer to normal control procedures was discussed in relation to bulk compounding and manufacturing (394). With the aid of a digital computer, ultracentrifuge data can be used to determine apparent molecular weight (395). The Severs rheometer was applied to rheological problems of lotions and semisolids by Wood, *et al.* (396), who also converted a Brookfield viscometer to an absolute rheometer for use in pharmaceutical rheology (397). For measurement of water diffusion through skin, Isherwood constructed a modified diffusion cell (398). A dielectric moisture meter was described for the determination of moisture in solid dosage forms (399).

Lukoyanov, *et al.*, developed a film evaporator for use in concentrating antibiotic solutions without the aid of mechanical agitation (400). A simple evaporator requiring no rotating joint was designed for flasks under reduced pressure (401). West also demonstrated a simple rotary film evaporator for operation under reduced pressure (402).

A small-scale apparatus was disclosed for the preparation of deionized water (403). Bonnet commented on industrial preparation of water for injection and advocated the use of the distillation technique (404). Water distillation and demineralization equipment were described in two publications: potential application for preparation of water for injection was considered in the first (405); an evaluation of the quality of water produced was presented in the second (406). Fifty-eight references were cited in a review of the preparation of demineralized water for pharmaceutical use (407).

The principles of operation and applications of the Coulter Counter were discussed by Cartmel and Gerrard (408). Size analysis of insoluble drugs has been facilitated by programming an electronic computer to handle Coulter Counter data (409). An automatic apparatus for measuring the specific surface of powders in production operations was reported by Papadakis (410).

The equipment and procedure were described for filling liquid smallpox vaccine into plastic ampuls (411). Two papers were concerned with the application of ultrasound equipment to the washing of ampuls (412) and glass tubing (413). Frost discussed a semiautomatic measuring device and its application to liquid filling operations (414).

## PHYSICAL PHARMACY

Physical pharmacy continues to occupy a position of prominence in pharmaceutical science. This field is concerned with solutions to pharmaceutical problems on a physicochemical basis. Numerous papers on this subject appeared in the literature during 1963.

The freezing points of several pharmaceutical preparations not readily found in the literature were tabulated by Schmidt (415). Freezing-point observations were also reported for the micellar solutions of *p*-methylphenylglucose and *p*-butylphenylglucose solutions (416). McKay and Miles verified the thermodynamic law for solute partition by the independent determinations of the activities in the two phases (417). It was stated in a paper by Veis that entropy factors provide the driving force for the phase separation in gelatin coacervation systems (418). Equilibrium phase relationships for the ternary system sucrose-water-isobutanol were examined (419). Some observations were published on the physical and pharmacological properties of picrotoxin solutions (420).

Size analysis of insoluble drugs has been discussed (421). Heywood published a detailed treatment of the characteristics of size, shape, density, and surface of fine particles (422). A critical survey of the methods and their relative merits was presented by Connor for automatic counting and sizing of particles (423). The adhesion properties of particles less than 50 $\mu$ in

diameter were used for particle-size classification (424). In a brief note, a simple method was revealed for particle-size determination by turbidity measurements (425). Experiments have been carried out to study the influence of particle size on the mixing of powders—mixing time varied directly with particle-size distribution (426). Using the method of Derjagin, Okada and Abe measured the coefficient of friction and adhesion power of various drug powders (427).

**Ionization.**—A viscometric method was illustrated for the determination of the isoelectric point of a protein (428). With electromotive force measurements, Shedlovsky, *et al.*, examined the behavior of aqueous solutions of mixed colloidal electrolytes (429). A study of charged carboxylate bases in dilute acid solutions was published (430). Another presentation was concerned with the theoretical interpretation of the "weakly acid" properties of boric acid (431). Conductance measurements were employed in determining the dissociation constants for acetic, propionic, *n*-butyric, and benzoic acids in water between 25 and 225° (432). The ionization constants of some penicillins and their alkaline hydrolysis and penicillinase hydrolysis products were also determined (433). Bates, *et al.*, developed a suitable scale of pH for alcohol-water solvents (434). Experimental work on the effect of molecular complexing of riboflavin showed that pKa values may be modified if molecular complexation takes place (435). Random and systematic errors in the determination of association constants were considered by Pasternak and Brady (436). A simple method was developed for the determination of ionization constants by paper chromatography (437). Hepler evaluated the effects of various substituents on the acidities of organic acids in water with respect to the thermodynamic theory of the Hammet equation (438).

**Diffusion.**—Knuth announced a unified kinetic theory for description of transport phenomena (439). Schumaker proposed a theory for measuring weight-average diffusion coefficients in single-component and multiple-component systems from ultracentrifuge experiments (440). *In vitro* methods were used to measure the continuous availability of sodium salicylate from tablet bases (441). In another report the effect of polyethylene glycol lauryl ether on the permeation of chlorobutanol was studied kinetically by the partial-dialysis method (442). The permeability of organic amines through collodion membrane was measured by the membrane-electrode method (443). Saunders used a capillary cell and a conductivity method in studying the rates of diffusion of various salts through an interface between sols of lipid and protein (444).

**Solubility.**—Extensive research is being conducted to elucidate the numerous physical phenomena which enter into solubility and solubilization. The thermodynamic relationships involving polymorphism and solubility were investigated in a study of the physicochemical aspects of solid-solution behavior (445). Three papers on dissolution rates were published: in two papers, Niebergal and associates developed a continuous-recording technique for studying dissolution rates (446) and investigated the dissolution of particles under conditions of rapid agitation (447); the third paper, by Smith, described a new spectrophotometric method for determining dissolution rates (448). Higuchi and Hiestand explored the effect of particle-size distribution in a diffusion-controlled process and derived an equation for the dissolution rate (449). In a study of the dissolution rate of micronized methylprednisolone, diffusion of the drug in the aqueous phase was the rate-limiting step (450). The rate of release of benzphetamine pamoate from a self-coating pellet surface was expressed mathematically (451). Schematic models were used in discussing hydrogen-bonding systems as media for chemical mass transport (452).

Wahlgren tested solubility of 38 drugs in polyethylene glycol at 20 and 60° (453), and Kuttel noted the solubilizing effect of polyethylene glycols and their esters with 22 hydrophobic pharmaceuticals (454). The solubility and stability of oleovitamin A were determined in a polyoxyethylene sorbitan ester-polyol-water system (455). Several articles were also published on the solubility and solubilization of acetylsalicylic acid (456), cinchocaine (457), orotic acid and its derivatives (458), various sulfonamides (459), and some *N*-7 theophylline derivatives (460).

Shefter and Higuchi investigated the dissolution behavior of crystalline solvated and nonsolvated forms of some pharmaceuticals (461). The influence of hydrates and solvate formation on the rate of solution and the solubility of crystalline drugs was also discussed (462). The thermodynamic relationships involving polymorphism and solubility were examined and applied by Higuchi, *et al.*, to experimental results from a methylprednisolone system (463). A series of publications dealt with the theoretical and experimental techniques in the study of hygroscopicity of water-soluble, crystalline drugs (464–470).

A new type of ion-pairing was discussed in an

investigation of the aqueous solution behavior of large univalent ions (471). The significance of new ionic-radii values to solvation phenomena in aqueous solution was disclosed by Blandamer and Symons (472). In a study of ion-solvation, the energy transfer of halogen acids and alkali chlorides from water to methanol-water mixtures was explored (473). Frank proposed a return to the ascription of physical significance to single-ion activities in electrolyte solutions (474). True partition coefficients and acidity constants for chlorpromazine and promethazine were determined by Angadji and Colleter using a graphic method (475). It has been demonstrated that osmotic coefficients obtained by the thermoelectric differential vapor-pressure method were valid for a wide variety of electrolytes in moderate concentrations (476). Dielectric constants of water-ethanol-glycerin and water-ethanol-propylene glycol systems were experimentally determined (477).

The solubilization of various drugs with different concentrations of polysorbates (478) and the development of a method and formula for determining the type and amount of polysorbate to solubilize some hydrophobic drugs were presented (479). Solubility titration was used by Hall to evaluate the solubilization of salicylic acid with polysorbate 80 (480). Swarbrick and Carless examined phase equilibria in some betaine-benzaldehyde-water systems (481). Several amines and amides were examined as potential solubilizing agents of orotic acid (482).

Johnson, *et al.*, discussed equilibrium constants for water-alcohol mixtures (483). Methods were developed for estimating oil-water distribution coefficients of glyceryl trinitrate and two similar nitrate esters (484). Higuchi and Hom conducted a phase-solubility study of solid species formed by magnesium aluminate from aqueous solutions containing sulfate ions (485). Tables of specific gravity and refractive index were offered by Reuter and Biegel for the physical testing of stock solution concentrations (486). A simplified method was presented for determining densities of aqueous solutions of some organic compounds (487).

**Complexation.**—Solubility studies were used to follow the interaction of urea and thiourea with benzoic and salicylic acids (488). Graham and Baker discovered that antihistamines form insoluble complexes with carrageenan and other sulfated colloids (489). In another publication, these studies were expanded to include complex formations with various tranquilizers and hypotensive agents (490). A definite interaction has been demonstrated between hydroxybenzoic acids and *p*-hydroxybenzoates with Schardinger dextrins (491); also investigated was the effect of cyclodextrin on water solubility of selected drugs (492). Two papers were concerned with the interactions of dyes and surfactants (493, 494). Phase solubility studies enabled Pisano to determine the extent of complexation between some aromatic carboxylic acids and certain pharmaceuticals in aqueous solutions (495). It was reported that L-ascorbic acid in aqueous solution was stabilized through complexation with dehydroacetic acid (496).

Through a study of physical properties, a correlation was established between the extent of association and the molecular structure of various alcohols (497). Matsushima extended Schubert's method for the determination of complex stability constants by an ion-exchange method to a lower pH region (498). Ion-exchange methods were also used without radio-tracers to study magnesium citrate complexation (499). The properties of biguanide and the formation of its metallic complexes were investigated (500).

In another paper a soluble buffer antacid, sodium gluconatodihydroxoaluminate complex, was compared with some existing preparations by *in vitro* tests (501). George investigated the nature of chelates formed by boric acid in aqueous solution (502); an experiment by Halmekoski indicated that a corbadrine-molybdate chelate is more stable than molybdate chelates of adrenaline and noradrenaline (503). Complex formation between iodine and surfactants was suggested as a possible mechanism of iodine solubilization (504). Complexation was also used to prepare a slightly soluble product of copper and barbital (505). Thirty-nine liquid chelating agents were tested by Nielson for their ability to form dental root-filling cements with metal oxides (506).

The hydrolytic tendencies of several ferric chelates (507) and the stability constants of iron sulfate and chloride complexes (508) have been determined. Sakai prepared crystalline ferric complexes with some higher fatty hydroxamic acids and investigated their properties—molar ratios of 2:1 and 3:1 were found (509). A stable sodium ferric gluconate complex was synthesized by Tanabe and Okada (510). These investigators also examined the properties of some ferric gluconate complexes by means of paper electrophoresis (511).

**Surface Phenomena.**—Mattoon reviewed film formation, structure, and properties as applied to the pharmaceutical industry (512). The linear expansion of gelatin films by moisture

sorption (513) and a comparative study of liquid and vapor permeation through various polymer films (514) have been reported. James, *et al.*, commented on the enhancement of evaporation by protein films as compared with solutions of certain surfactants (515). A new interface balance for studying films at the oil-water interface was described (516). Equations were presented in a discussion of the computation of surface tension and contact angle by the sessile-drop method (517).

A general discussion of the potential theory of adsorption was published (518). Three papers dealt with methodology applicable to the study of adsorption: one discussed the measurement of contact angles and surfactant adsorption in three-phase systems (519); another was concerned with the use of a rapid-flow method for determining adsorption isotherms (520); the third reported a spectral reflectance method for solid-solid interaction studies (521). Fujiwara, *et al.*, employed a colorimetric method for investigation of barium sulfate adsorption of sodium carboxymethylcellulose in aqueous suspension (522). Adsorption by two forms of carbon has been studied (523, 524). MacRitchie and Alexander published extensively on the kinetics of adsorption of proteins at interfaces (525–527). A new experimental approach was presented for evaluating the protein-binding properties of penicillins (528).

Anderson and Plein continued an investigation of certain bentonites by determining cation-exchange properties (529). It was suggested that considerable energy change is involved in selective adsorption of organic ions by ion-exchange resins (530). Experimental results were published concerning the influence of pH on adsorption of amines by synthetic aluminum silicate gel (531). Vermiculite has also been used for the adsorption of alkylamine ions (532). Slabaugh and Kennedy measured adsorption isotherms in a study of amine complexes of montmorillonite (533), and phenol adsorption by quaternary ammonium derivatives of montmorillonite was investigated by Street and White (534). Another worker reported on the adsorption of polyvinyl alcohols by montmorillonite (535).

The Ferguson principle was suggested as a means of correlating thermodynamic activity with critical micelle concentration for a series of quaternary ammonium salts (536). Independent studies of the thermodynamics of micelle formation in nonionic detergents were made by Schick (537) and Elworthy and Florence (538). A simple dilatometric method was used to determine partial molal volumes of surface-active agents in micellar, singly dispersed, and hydrated solid states (539). Mysels, *et al.*, developed a rocking dialysis cell to demonstrate the activity of association colloids above the critical micelle concentration (540).

Experimental work was published on micelle formation by surfactants and its importance in the solubilization of drugs (541, 542). Several investigators reported on micelle formation and critical micelle concentration (CMC) of some betaine derivatives under a variety of conditions (543–546). Kato revealed the formation of micelles by glycols of the 1,4-hexanediol type (547). A conductivity method was applied in a study of the CMC of some primary and quaternary ammonium dodecyl sulfates (548). Becher commented on the effect of different sucrose concentrations on the CMC of aqueous surfactant solutions (549). Dissolved urea was proposed as a probe for studying micelle formation and hydrophobic bonding in aqueous solutions (550).

Gorman and Hall suggested the dielectric system as a method of classifying surfactants (551). Another publication was concerned with physical chemistry of detergents—including strong electrolytes, simple solutes, and soluble macromolecular colloids (552). Other investigators have pointed out that surfactant structure is not necessarily related to reactivity toward acids and bases (553). A procedure for determining the wetting rate of surface-active substances was presented (554), and Becher determined the interfacial tensions of solutions of nonionic surfactants (555). Surface tension measurements demonstrated pronounced surface-active properties of aqueous sols of lysophosphatidylethanolamine (556). Electric resistance–temperature curves and hydrophile-lipophile balance were reported for some nonionic surfactants (557). Sebba showed that ionic surfactant foams can be destroyed by addition of a surfactant of opposite charge (558).

**Crystallization.**—The physical techniques and measurements required in the application of vapor pressure phenomena to the study of crystallization were discussed at length by Powers (559). Other publications by this investigator dealt with the phenomena associated with initial crystal formation and early growth of the nucleus (560) and the macroscopic growth of crystals (561). Various standard, ionic-crystal structures have been illustrated and described (562). Crystallization of silver bromide was described in terms of the ideal size distribution and growth rate for microcrystalline precipitates (563). With the

aid of X-ray diffraction and infrared spectra, Biles identified four crystal modifications of tertiary butylacetates of prednisolone and hydrocortisone (564). Another study revealed the crystallization conditions in the hydrothermal synthesis of crystalline aluminosilicates (565).

In a review of X-ray and crystallographic applications to pharmaceutical research, Shell described quantitative X-ray diffraction with illustrations (566). A method was also presented for quantitating the crystal habit of given compounds and its use as a control procedure for tableting (567). The crystal structure of a calciferol derivative was solved by the heavy atom method (568). Other researchers established new types of melting-point diagrams for a large number of barbituric acid derivatives (569) and compared isomorphs of these derivatives (570).

**Rheology.**—In a review covering nomenclature and instrumentation, shear rate–viscosity curves of various systems were employed for microrheological classification (571). The logarithmic rheogram was proposed for treating non-Newtonian data (572). McVean developed a rising cylinder rheometer for low shear viscometry (573), and Rutgers presented an extensive review of equations describing the relationship between relative viscosity and concentration of dispersions (574). A viscometer was proposed for determining the intrinsic viscosity of macromolecular solutions at zero rate of shear (575). An evaluation of viscosity constants was also published (576).

Christoff used a rotational viscometer to measure the hysteresis loop of an emulsion ointment base (577). In a series of papers, Schulte and Kassem presented a comparative rheological study of some ointment gels (578) and reported the rheological investigation of a polyethylene–liquid petrolatum gel system (579) and of hydrocarbon mixtures (580). Thixotropic properties were determined for eight types of petrolatum (581). Gstirner and Bodenbach, in a series on the rheology of ointment bases, explored the change in viscosity and thixotropy of 12 lipogels with time (582) and used the electron microscope to study a thixotropic mixture of peanut oil and colloidal silica (583). Also investigated were the viscosity and crystal formations of lipogels (584) and the rheological properties of lipogels after heat treatment (585). The rheological properties of a few suppository bases have also been reported (586).

In a rheological study of aging, aqueous Veegum suspensions were found to be pseudoplastic for all temperatures of preparation and storage (587). Other rheological experiments with Veegum dispersions indicated that sedimentation can be reduced by addition of an electrolyte (588). The viscoelastic properties of bentonite pastes in various media were examined with a cone-disk rheometer (589). Hunter and Alexander considered the influence of physical and chemical conditions on the flow of kaolinite sols through silica columns (590). Rheograms and sedimentation volumes were obtained in an investigation of the rheological effects of some high polymers on barium sulfate particles (591).

Viscosity changes produced by thermal aging of gelatin sols were measured with a concentric cylinder viscometer (592). Gelatin was also found suitable for the demonstration of viscoelastic solution behavior (Weissenberg effect) (593). Nakagaki and Nishino determined the structural viscosity of aluminum distearate in benzene with the capillary viscometer under a variety of conditions (594–596). Changes in specific volume were used to follow the kinetics of solid-liquid phase transformations of methyl stearate (597). In another paper, by Hermans, the viscosity and sedimentation of cellulosic macromolecules in dilute solutions were reported (598).

## REFERENCES[1]


(1) McKeehan, W., This Journal, **52,** 613(1963).
(2) *Ibid.*, **52,** 717(1963).
(3) *International Pharmaceutical Abstracts*, Am. Soc. Hosp. Pharmacists, Washington, D. C. 20037.
(4) Andrews, T., *Am. J. Hosp. Pharm.*, **20,** 43(1963).
(5) Anon., J. Am. Pharm. Assoc., **NS3,** 128(1963).
(6) Kelsey, F. O., *Am. J. Hosp. Pharm.*, **20,** 515(1963).
(7) Meyers, E. L., *Am. J. Pharm.*, **135,** 219(1963).
(8) Duggan, R. E., *Drug Cosmetic Ind.*, **93,** 623(1963).
(9) Crisalli, J. P., *Military Med.*, **128,** 972(1963).
(10) Kern, S. F., *Bio-medical Purview*, 3 (Summer), 45 (1963).
(11) Kelsey, F. O., *Am. J. Pharm.*, **135,** 93(1963).
(12) Silson, J. E., *Drug Cosmetic Ind.*, **92,** 152(1963).
(13) Palmer, H. W., *Proc. Roy. Soc. Med.*, **56,** 547(1963).
(14) Schreiner, G. E., *J. Am. Med. Assoc.*, **185,** 259(1963).
(15) Archambault, G. F., J. Am. Pharm. Assoc., **NS3,** 124(1963).
(16) Autian, J., Berman, A., and Guess, W. L., *Am. J. Hosp. Pharm.*, **20,** 467(1963).
(17) Modell, W., *Science*, **139,** 1180(1963).
(18) Hull, R. L., *Drug Cosmetic Ind.*, **93,** 615(1963).
(19) Arnow, L. E., *Bio-medical Purview*, 3 (Summer), 71(1963).
(20) Cowles, R. S., *ibid.*, 3 (Summer), 51(1963).
(21) Scott, J. F., *Chem. Ind. London*, **1963,** 1182.
(22) Shindell, S., *J. Am. Med. Assoc.*, **186,** 637(1963).
(23) *Ibid.*, **186,** 849(1963).
(24) Mapes, R. E. A., *J. New Drugs*, **3,** 153(1963).
(25) King, E. P., *Biometrics*, **19,** 429(1963).
(26) Federer, W. T., *ibid.*, **19,** 553(1963).
(27) Gregory, R. T., *New Basic Concepts Pharm. Sci., Ann. Visiting Lecture Ser.*, **5,** 231(1961–1962); through *Chem. Abstr.*, **59,** 13234(1963).
(28) Nogueira, A. L., *Rev. Port. Farm.*, **12,** 168(1962), through *Chem. Abstr.*, **58,** 12367(1963).
(29) Parafinska, Z., and Zwolinska, Z., *Farm. Polska*, **18,** 587(1962); through *Chem. Abstr.*, **58,** 13709(1963).
(30) Gershenfeld, L., *Am. Perfumer Cosmet.*, **78** (10), 55 (1963).
(31) Czetsch-Lindenwald, H. v., *Dragoco Rept.*, **10,** 3 (1963); through *Chem. Abstr.*, **58,** 13727(1963).
(32) Saski, W., This Journal, **52,** 264(1963).
(33) Tartler, G., Weuffen, W., and Traenckner, M., *Pharmazie*, **18,** 625(1963).
(34) Weuffen, W., and Tartler, G., *ibid.*, **18,** 630(1963).
(35) Gump, W. S., and Walter, G. R., *J. Soc. Cosmetic*


[1] *Index Medicus* abbreviations were used for journals not listed in *Chemical Abstracts*. In a few instances where the writers were unable to obtain late 1963 issues, references were obtained from *Current Contents*.

*Chemists*, **14**, 269(1963); through *Chem. Abstr.*, **59**, 9211 (1963).
(36) Walter, G., and Gump, W., *Soap Chem. Specialties*, **39** (7), 55(1963).
(37) Molin, N., Satmark, L., and Thorell, M., *Food Technol.*, **17** (6), 119(1963).
(38) Gaind, K. N., Mital, H. C., and Singh, J., *Indian J. Pharm.*, **25**, 264(1963); through *Chem. Abstr.*, **59**, 15124 (1963).
(39) Judis, J., This Journal, **52**, 126(1963).
(40) Myers, C. E., and Sheahan, M., *Can. Pharm. J.*, **96**, 329(1963).
(41) Anderson, R. A., *Australasian J. Pharm.*, **44**, S32 (1963).
(42) Lachman, L., *et al.*, This Journal, **52**, 241(1963).
(43) Lachman, L., Urbanyi, T., and Weinstein, S., *ibid.*, **52**, 244(1963).
(44) Pivnick, H., Tracy, J. M., and Glass, D. G., *ibid.*, **52**, 883(1963).
(45) Kohn, S. R., Gershenfeld, L., and Barr, M., *ibid.*, **52**, 1126(1963).
(46) *Ibid.*, **52**, 967(1963).
(47) Maruzzella, J. C., *ibid.*, **52**, 601(1963).
(48) Fletcher, G., and Norton, D. A., *Pharm. J.*, **137**, 145 (1963).
(49) Schroeter, L. C., This Journal, **52**, 888(1963).
(50) Rosenwald, R. H., *Am. Perfumer Cosmet.*, **78** (10), 41(1963).
(51) Sarsunova, M., and Selecky, I., *Gyogyszereszet*, **3**, 181(1959); through *Chem. Abstr.*, **58**, 4382(1963).
(52) Wesley, F., J. Am. Pharm. Assoc., **NS3**, 208(1963).
(53) Moncrieff, R. W., *Drug Cosmetic Ind.*, **93**, 34(1963).
(54) Lea, C. H., *Chem. Ind. London*, **1963**, 1406.
(55) Swisher, H. E., *Food Technol.*, **17** (7), 103(1963).
(56) Runti, C., *Bull. Soc. Pharm. Bordeaux*, **101** (3), 197 (1962); through *Chem. Abstr.*, **58**, 14624(1963).
(57) Brookes, L. C., *Am. Perfumer Cosmet.*, **78** (5), 47 (1963).
(58) Ashbaugh, R. R., and Wolfthal, A., *Am. J. Hosp. Pharm.*, **20**, 363(1963).
(59) Vautin, P., *Drug Cosmetic Ind.*, **92**, 700(1963).
(60) Moncrieff, R. W., *Am. Perfumer Cosmet.*, **78** (12), 37(1963).
(61) Maurer, E. S., *ibid.*, **78** (8), 37(1963).
(62) Maurer, E. S., *Mfg. Chemist*, **34**, 528(1963).
(63) *Ibid.*, **34**, 254(1963).
(64) Raff, A. M., This Journal, **52**, 291(1963).
(65) Birren, F., *Food Technol.*, **17** (5), 45(1963).
(66) Goulden, H. D., *Drug Cosmetic Ind.*, **93**, 31(1963).
(67) Vul'fson, N. S., *Usp. Khim.*, **32** (6), 653(1963); through *Chem. Abstr.*, **59**, 5287(1963).
(68) Barr, M., *Am. Perfumer Cosmet.*, **78** (2), 37(1963).
(69) Horsch, W., and Rossner, F., *Pharm. Praxis, Beilage Pharmazie*, **1963** (1), 5.
(70) Elworthy, P. H., and George, T. M., *J. Pharm. Pharmacol.*, **15**, 781(1963).
(71) Faust, R. E., *Am. Perfumer Cosmet.*, **78** (10), 51 (1963).
(72) Prescott, F. J., Hahnel, E., and Day, D., *Drug Cosmetic Ind.*, **93**, 443(1963).
(73) *Ibid.*, **93**, 629(1963).
(74) Benton, C. H., *Am. Perfumer Cosmet.*, **78** (10), 37 (1963).
(75) Knectel, A. H., *ibid.*, **78** (10), 95(1963).
(76) Zografi, G., and Mattocks, A. M., This Journal, **52**, 1103(1963).
(77) Mandak, M., *Congr. Sci. Farm., Conf. Comun., 21°, Pisa*, **1961**, 681; through *Chem. Abstr.*, **59**, 6204(1963).
(78) Ullmann, E., *ibid.*, **1961**, 902; through *Chem. Abstr.*, **59**, 1442(1963).
(79) Lehne, R. K., *Am. Perfumer Cosmet.*, **78** (10), 103 (1963).
(80) Edman, W. W., and Lowden, W. H., *Drug Cosmetic Ind.*, **93**, 631(1963).
(81) Allen, B. F., *Maryland Pharmacist*, **38**, 368(1963).
(82) *Ibid.*, **38**, 432(1963).
(83) Haedicke, M., *Pharm. Praxis, Beilage Pharmazie*, **1963** (6), 109.
(84) Brown, V. K., Robinson, J., and Stevenson, D. E., *J. Pharm. Pharmacol.*, **15**, 688(1963).
(85) Spiegel, A. J., and Noseworthy, M. M., This Journal, **52**, 917(1963).
(86) Moser, B., Ullmann, E., and Dhamija, O. P., *Arch. Pharm.*, **296**, 730(1963).
(87) Garrett, E. R., *Indian J. Pharm.*, **25**, 285(1963); through *Chem. Abstr.*, **59**, 15125(1963).
(88) Zacek, H., *Pharmazie*, **18**, 766(1963).
(89) Jones, W., *Pharm. J.*, **137**, 459(1963).
(90) Awe, W., and Kienert, H. J., *Pharm. Acta Helv.*, **38**, 805(1963).
(91) Froelich, R., *Pharmazie*, **18**, 20(1963).
(92) Nogami, H., Awazu, S., and Iwatsuru, M., *Chem. Pharm. Bull. Tokyo*, **11**, 1251(1963).
(93) Nogami, H., Awazu, S., and Kanakubo, Y., *ibid.*, **11**, 13(1963).
(94) Nogami, H., and Kanakubo, Y., *ibid.*, **11**, 943(1963).
(95) Motsavage, V. A., and Kostenbauder, H. B., *J. Colloid Sci.*, **18**, 603(1963).
(96) Scott, M. W., Lieberman, H. A., and Chow, F. S., This Journal, **52**, 994(1963).
(97) Jue, J., and Huyck, C. L., J. Am. Pharm. Assoc., **NS3**, 470(1963).
(98) Patel, H. M., and Huyck, C. L., *Mfg. Chemist*, **34**, 100(1963).
(99) Guven, K. C., and Tarçan, S., *Eczacilik Bulteni*, **4**, 162(1962); through *Chem. Abstr.*, **58**, 5456(1963).
(100) Krogerus, V. E., and Latomaki, A., *Farm. Aikakauslehti*, **72**, 85(1963); through *Chem. Abstr.*, **58**, 13711(1963).
(101) Schou, S. A., *Pharm. Acta Helv.*, **38**, 741(1963).
(102) Gammage, R. B., and Glasson, D. R., *Chem. Ind. London*, **1963**, 1466.
(103) Everhard, M. E., and Goodhart, F. W., This Journal, **52**, 281(1963).
(104) Campagna, F. A., *et al.*, *ibid.*, **52**, 605(1963).
(105) Yalcindag, O. N., *Bull. Soc. Pharm. Bordeaux*, **102** (1), 55(1963); through *Chem. Abstr.*, **59**, 4980(1963).
(106) Burkman, A. M., *J. Pharm. Pharmacol.*, **15**, 461 (1963).
(107) Speichert, H., *Biul. Inst. Roslin Leczniczych*, **8** (4), 151(1962); through *Chem. Abstr.*, **59**, 7322(1963).
(108) Balcar, E., and Kozlowski, J., *Biul. Inst. Przem. Zielar-skiego*, **8** (1–2), 44(1962); through *Chem. Abstr.*, **58**, 7791(1963).
(109) de Roos, A. M., Rekker, R. F., and Nauta, W. T., *Pharm. Acta Helv.*, **38**, 569(1963).
(110) Bunton, C. A., *et al.*, *J. Chem. Soc.*, **1963**, 5361.
(111) Isenburg, R., and Sager, H., *Congr. Sci. Farm., Conf. Comun., 21°, Pisa*, **1961**, 589; through *Chem. Abstr.*, **59**, 2596(1963).
(112) Paraak, V., *Acta Chim. Acad. Sci. Hung.*, **33**, 121 (1962); through *Chem. Abstr.*, **58**, 4382(1963).
(113) Longhi, I., *Farmaco, Pavia, Ed. Prat.*, **17**, 504(1962); through *Chem. Abstr.*, **58**, 2325(1963).
(114) Ryabukhina, O. O., *Farmatsevt. Zh. Kiev*, **17** (6), 48(1962); through *Chem. Abstr.*, **59**, 9738(1963).
(115) Stainier, C., *et al.*, *Pharm. Acta Helv.*, **38**, 587(1963).
(116) Yamana, T., *et al.*, *Yakuzaigaku*, **23**, 72(1963); through *Chem. Abstr.*, **59**, 11194(1963).
(117) Spross, B., *Congr. Sci. Pharm.*, **1959**, 425; through *Chem. Abstr.*, **58**, 12372(1963).
(118) Anghileri, L. J., *J. Nucl. Med.*, **4** (5), 410(1963); through *Chem. Abstr.*, **59**, 13771(1963).
(119) Anderson, R. A., and Maudson, J. W., *Australasian J. Pharm.*, **44**, S24(1963).
(120) Fagerstrom, R., *J. Pharm. Pharmacol.*, **15**, 479 (1963).
(121) Brownley, C. A., Jr., and Lachman, L., This Journal, **52**, 86(1963).
(122) Davidson, C. M., and Jameson, R. F., *Chem. Ind. London*, **1963**, 1686.
(123) Ganguli, K. K., *et al.*, *Indian J. Technol.*, **1** (3), 129(1963); through *Chem. Abstr.*, **58**, 13728(1963).
(124) Katona, K., *Gyogyszereszet*, **3**, 143(1959); through *Chem. Abstr.*, **58**, 3274(1963).
(125) Mitchell, A. G., *J. Pharm. Pharmacol.*, **15**, 761 (1963).
(126) Blazek, J., *Farmatsevt. Zh. Kiev*, **17** (6), 9(1962); through *Chem. Abstr.*, **59**, 9740(1963).
(127) Brazhnikova, M. G., and Kudinova, M. K., *Nature*, **200**, 167(1963).
(128) Voskoboinik, S. L., and Popova, V. I., *Farmatsevt. Zh. Kiev*, **17** (6), 54(1962); through *Chem. Abstr.*, **59**, 9740 (1963).
(129) Nakatani, H., *Yakuzaigaku*, **23**, 75(1963); through *Chem. Abstr.*, **59**, 12596(1963).
(130) Sano, H., *et al.*, *ibid.*, **22**, 127(1962); through *Chem. Abstr.*, **58**, 2324(1963).
(131) Hurwitz, A. R., DeLuca, P. P., and Kostenbauder, H. B., This Journal, **52**, 893(1963).
(132) Barker, H. E. R., *Australasian J. Pharm.*, **43**, 790 (1962).
(133) Fujisawa, S., *Yakugaku Zasshi*, **83**, 492(1963).
(134) Kitahara, K., and Tanaka, Y., *ibid.*, **83**, 203(1963).
(135) Luduena, F. P., Snyder, A. L., and Lands, A. M., *J. Pharm. Pharmacol.*, **15**, 538(1963).
(136) Prusak, L. P., and Sciarrone, B. J., This Journal, **52**, 546(1963).
(137) Fenn, G. D., and Belcastro, P. F., *ibid.*, **52**, 340 (1963).
(138) Conine, J. W., *Proc. Am. Assoc. Coll. Pharm. Teachers' Seminar*, **13**, 77(1961).
(139) Grimshaw, J. J., *Pharm. J.*, **137**, 462(1963).
(140) Guttman, D. E., *Proc. Am. Assoc. Coll. Pharm. Teachers' Seminar*, **13**, 63(1961).
(141) Konecny, J., Pohorsky, J., and Vachek, J., *Cesk. Farm.*, **12**, 204(1963); through *Chem. Abstr.*, **59**, 1442(1963).
(142) Zimmerman, H. K., *J. Chem. Educ.*, **40**, 356(1963).
(143) Rogers, A. R., *J. Pharm. Pharmacol.*, **15** (Suppl.), 101T(1963).
(144) Barker, H. E. R., *Australasian J. Pharm.*, **43**, 1267 (1962).
(145) Tuchel, N., Antonescu, V., and Moisescu, S., *Farmacia Bucharest*, **10**, 213(1962); through *Chem. Abstr.*, **58**, 4380(1963).
(146) DeLuca, P. P., *Dissertation Abstr.*, **24**, 1407(1963).
(147) Conine, J. W., and Zuck, D. A., This Journal, **52**, 63(1963).
(148) Zuck, D. A., and Conine, J. W., *ibid.*, **52**, 59(1963).
(149) Windheuser, J. J., and Higuchi, T., *ibid.*, **52**, 557 (1963).
(150) Agrawal, D. K., *et al.*, *Indian J. Technol.*, **1** (2), 90(1963); through *Chem. Abstr.*, **58**, 12373(1963).
(151) Finholt, P., Paulssen, R. B., and Higuchi, T., This Journal, **52**, 948(1963).
(152) Tingstad, J. E., MacDonald, L. H., and Meister, P. D., *ibid.*, **52**, 343(1963).
(153) Kornblum, S. S., *Dissertation Abstr.*, **24**, 1410(1963).
(154) Schroeter, L. C., This Journal, **52**, 559(1963).

(155) Tanaka, I., *et al.*, *Yakuzaigaku*, **22**, 147(1962); through *Chem. Abstr.*, **59**, 12596(1963).
(156) Asahi, Y., *Chem. Pharm. Bull. Tokyo*, **11**, 1241 (1963).
(157) Gallelli, J. F., and Kostenbauder, H. B., THIS JOURNAL, **52**, 649(1963).
(158) Patel, J. M., and Lemberger, A. P., *ibid.*, **52**, 1129 (1963).
(159) Dittert, L. W., and Higuchi, T., *ibid.*, **52**, 852(1963).
(160) Rozenberg, A. I., *Med. Prom. SSSR*, **17** (7), 43 (1963); through *Chem. Abstr.*, **59**, 11193(1963).
(161) Ullmann, E., Thoma, K., and Zelfel, G., *Pharm. Acta Helv.*, **38**, 577(1963).
(162) Murray, T. K., Pelletier, O., and Campbell, J. A., *J. Pharm. Pharmacol.*, **15**, 192(1963).
(163) del Pozo, A., and Alemany, P., *Pharm. Acta Helv.*, **38**, 508(1963).
(164) Nordfeldt, S., and Olsson, N., *Kgl. Lantbruks-Hogskol. Ann.*, **28**, 189(1962); through *Chem. Abstr.*, **58**, 13729(1963).
(165) Christensen, H. B., Ulrich, K., and Weis-Fogh, O., *Arch. Pharm. Chemi*, **70**, 345(1963); through *Chem. Abstr.*, **59**, 7322(1963).
(166) Guven, K. C., and Tarcan, S., *Bull. Fac. Med. Istanbul*, **24**, 314(1961); through *Chem. Abstr.*, **58**, 1307 (1963).
(167) Smith, E. C., and Metzler, D. E., *J. Am. Chem. Soc.*, **85**, 3285(1963).
(168) Takahashi, T., and Yamamoto, E., *Yakugaku Zasshi*, **83**, 487(1963).
(169) Aithal, H. N., and Sirsi, M., *Indian J. Pharm.*, **25**, 100(1963); through *Chem. Abstr.*, **58**, 13729(1963).
(170) Bayer, J., and Liptay, G., *Z. Anal. Chem.*, **191**, 335 (1963); through *Chem. Abstr.*, **58**, 5457(1963).
(171) Herzmann, H., and Hennig, A., *Z. Naturforsch.*, **17b**, 646(1962); through *Chem. Abstr.*, **58**, 1307(1963).
(172) Tanaka, I., and Otani, S., *Yakuzaigaku*, **22**, 150 (1962); through *Chem. Abstr.*, **59**, 12596(1963).
(173) Grochmalicka, J., *Arch. Farm. Belgrade*, **12**, 157 (1962); through *Chem. Abstr.*, **58**, 11171(1963).
(174) Ch'en, C.-H., *J. Taiwan Pharm. Assoc.*, **13**, 2(1961); through *Chem. Abstr.*, **58**, 3274(1963).
(175) Nogueira, A. L., Faria, M. J., and Ruivo, M. L. S., *Rev. Port. Farm.*, **13**, 16(1963); through *Chem. Abstr.*, **59**, 11193(1963).
(176) Zwolinska, Z., *Farm. Polska*, **18**, 548(1962); through *Chem. Abstr.*, **58**, 13729(1963).
(177) Uprety, C., Revis, B., and Jafar, S. M., THIS JOURNAL, **52**, 1001(1963).
(178) Hoeller, H. J. A., and Janisch, H., *Sci. Pharm.*, **30**, 183(1962); through *Chem. Abstr.*, **58**, 4382(1963).
(179) Skinner, W. A., and Alaupovic, P., *Science*, **140**, 803(1963).
(180) Chalabala, M., Maly, J., and Zacek, H., *Pharmazie*, **18**, 177(1963).
(181) Steiger-Trippi, K., *Galenica Acta Madrid*, **15**, 263 (1962); through *Chem. Abstr.*, **59**, 381(1963).
(182) Macek, T. J., *Bio-medical Purview*, 3 (Summer), 35(1963).
(183) Schramm, G., *Wiss. Ber. E. Merck*, **1963** (3), 155; through *Chem. Abstr.*, **58**, 13710(1963).
(184) Smith, E. A., *Mfg. Chemist*, **34**, 102(1963).
(185) Magid, L., *Drug Cosmetic Ind.*, **93**, 620(1963).
(186) Haensel, W., and Syre, K., *Mitt. Deut. Pharm. Ges.*, **33**, 37; published in *Arch. Pharm.*, **296** (3), (1963).
(187) Ryabukhina, O. O., *Farmatsevt. Zh. Kiev*, **16** (4), 24(1961); through *Chem. Abstr.*, **58**, 12371(1963).
(188) Jaspersen, H. P., and Buechi, J., *Congr. Sci. Pharm. Conf. Comun., 21°, Pisa*, **1961**, 601; through *Chem. Abstr.*, **59**, 6202(1963).
(189) Mirigian, R. A., Christensen, G. W., and Dean, S. J., *Am. J. Hosp. Pharm.*, **20**, 476(1963).
(190) Letassy, B. R., and Huyck, C. L., *ibid.*, **20**, 292 (1963).
(191) Chaplins'ka, M. G., and Revyats'ka, A. P., *Farmatsevt. Zh. Kiev*, **17** (2), 7(1962); through *Chem. Abstr.*, **58**, 7783 (1963).
(192) Lach, J. L., *Proc. Am. Assoc. Coll. Pharm. Teachers' Seminar*, **13**, 100(1961).
(193) Wolff, G., *Pharm. Praxis, Beilage Pharmazie*, **1963** (3), 46.
(194) Wiegrebe, W., *Mitt. Deut. Pharm. Ges.*, **33**, 53; published in *Arch. Pharm.*, **296** (4), (1963).
(195) Apfelroth, S., *Proc. Sci. Sect. Toilet Goods Assoc.*, **39**, 29(1963); through *Chem. Abstr.*, **59**, 6194(1963).
(196) Anon., *Drug Cosmetic Ind.*, **92**, 417(1963).
(197) Walker, G. T., *ibid.*, **92**, 298(1963).
(198) Barr, M., *Central Pharm. J.*, **16** (12), 24(1962).
(199) Kalish, J., *Drug Cosmetic Ind.*, **92**, 696(1963).
(200) Walker, G. T., *ibid.*, **92**, 563(1963).
(201) Jones, J. F. H., *Chemist Druggist*, **179**, 729(1963).
(202) Hess, H., and Lang, E., *Pharm. Acta Helv.*, **38**, 604 (1963).
(203) Scott, M. W., *Am. Perfumer Cosmet.*, **78** (12), 25 (1963).
(204) Roseman, B., *Ind. Chemist*, **39**, 84(1963).
(205) Bergman, J., *Farm. Revy*, **62**, 234(1963); through *Chem. Abstr.*, **59**, 3721(1963).
(206) Mdivnishvili, O. M., *et al.*, *Tr. Kavkazsk. Inst. Mineral'n. Syr'ya*, **1961** (3), 231; through *Chem. Abstr.*, **59**, 3720 (1963).
(207) Horsch, W., *Pharm. Praxis, Beilage Pharmazie*, **1963** (2), 21.
(208) Beng, L. G., *Suara Pharm. Madjalah*, **7** (1), 16 (1962); through *Chem. Abstr.*, **58**, 12367(1963).
(209) Gubitz, K., *Deut. Apotheker-Ztg.*, **103**, 871(1963); through *Chem. Abstr.*, **59**, 7322(1963).
(210) Goyan, F. M., *Proc. Am. Assoc. Coll. Pharm. Teachers' Seminar*, **13**, 92(1961).
(211) Kudakova, N. A., *Tr. 1-go Mosk. Med. Inst.*, **18**, 29 (1962); through *Chem. Abstr.*, **59**, 3721(1963).
(212) Setnikar, I., and Temelcou, O., THIS JOURNAL, **52**, 1086(1963).
(213) Riffkin, C., *Am. J. Hosp. Pharm.*, **20**, 19(1963).
(214) Kuy, A. van der, and Huizinga, T., *Pharm. Weekblad*, **98**, 397(1963); through *Chem. Abstr.*, **59**, 8547(1963).
(215) Ilver, K., and Jochumsen, B., *Dansk Tidsskr. Farm.*, **37**, 118(1963); through *Chem. Abstr.*, **59**, 4981(1963).
(216) *Ibid.*, **37**, 113(1963); through *Chem. Abstr.*, **59**, 4981 (1963).
(217) *Ibid.*, **37**, 100(1963); through *Chem. Abstr.*, **59**, 3721 (1963).
(218) Macek, T. J., THIS JOURNAL, **52**, 694(1963).
(219) Volkovinskaya, L. P., and Pozharskaya, A. M., *Med. Prom. SSSR*, **17** (7), 42(1963); through *Chem. Abstr.*, **59**, 11192(1963).
(220) Revol, L., *Ann. Pharm. Franc.*, **21**, 331(1963).
(221) *Ibid.*, **21**, 245(1963).
(222) Vos, T., and Huizinga, T., *Pharm. Weekblad*, **97**, 573 (1962); through *Chem. Abstr.*, **58**, 6650(1963).
(223) Friebel, H., and Patel, N., *Anaesthesist*, **11**, 356 (1962); through *Chem. Abstr.*, **58**, 6651(1963).
(224) Ciocanelea, V., *et al.*, *Farmacia Bucharest*, **10**, 267 (1962); through *Chem. Abstr.*, **58**, 4382(1963).
(225) Moldovan, A., *ibid.*, **10**, 641(1962); through *Chem. Abstr.*, **58**, 13729(1963).
(226) Hossein, A. M., Kassim, A., and Hamad, H. A. A., *Egypt. Pharm. Bull.*, **42** (4), 395(1960); through *Chem. Abstr.*, **58**, 4380(1963).
(227) Zathurecky, L., *et al.*, *Cesk. Farm.*, **12**, 171(1963); through *Chem. Abstr.*, **59**, 2596(1963).
(228) Coombe, R. G., and Roxon, J. J., *Australasian J. Pharm.*, **44**, S34(1963).
(229) Russu, C., Pelloni, V., and Sterescu, M., *Rev. Chim. Bucharest*, **14**, 48(1963); through *Chem. Abstr.*, **59**, 2595 (1963).
(230) Korkuczanski, A., *Dissertationes Pharm.*, **11**, 149 (1959); through *Chem. Abstr.*, **58**, 6651(1963).
(231) Piersma, H. D., *Bio-medical Purview*, 3 (Summer), 59(1963).
(232) Gershenfeld, L., *Am. J. Pharm.*, **135**, 278(1963).
(233) *Ibid.*, **135**, 360(1963).
(234) *Ibid.*, **135**, 403(1963).
(235) Beale, A. J., *Mfg. Chemist*, **34**, 146(1963).
(236) Fel'dman, M. Y., *Vopr. Med. Khim.*, **9** (3), 232 (1963); through *Chem. Abstr.*, **59**, 13770(1963).
(237) Melnick, J. L., and Wallis, C., *Proc. Soc. Exptl. Biol. Med.*, **112**, 894(1963).
(238) Gay, M., and Fust, B., *Pharm. Acta Helv.*, **38**, 641 (1963).
(239) Gimborn, H. v., *Pharm. Praxis, Beilage Pharmazie*, **1963** (9), 197.
(240) *Ibid.*, **1963** (9), 203.
(241) Mathews, A. G., *Australasian J. Pharm.*, **44**, S62 (1963).
(242) Stapowick, H. E., *Texas J. Pharm.*, **4** (3), 308(1963); through *Chem. Abstr.*, **59**, 12596(1963).
(243) Godfrey, G., *Nature*, **198**, 1020(1963).
(244) Chelton, E. T. J., and James, C. G., *Chem. Ind. London*, **1963**, 1077.
(245) Minsley, N. M., *Military Med.*, **128**, 1220(1963).
(246) Stonehill, A. A., Krop, S., and Borick, P. M., *Am. J. Hosp. Pharm.*, **20**, 458(1963).
(247) May, J. J., *Kosmetik-Parfum-Drogen-Rundschau*, **10**, 112(1963); through *Chem. Abstr.*, **59**, 15125(1963).
(248) Lhoest, W., *Rev. Questions Sci.*, **24**, 367(1963); through *Chem. Abstr.*, **59**, 11191(1963).
(249) Meinhard, J., *Pharm. Praxis, Beilage Pharmazie*, **1963** (7), 147.
(250) Wollmann, H., and Wollmann, C., *Pharmazie*, **18**, 483(1963).
(251) Jeffrey, L. P., and Fish, K. H., Jr., *Am. J. Hosp. Pharm.*, **20**, 255(1963).
(252) Smith, G., Bullivant, J. M., and Cox, P. H., *J. Pharm. Pharmacol.*, **15** (Suppl.), 92T(1963).
(253) Freudweiler, R., *Pharm. Acta Helv.*, **38**, 596(1963).
(254) Heinemann, A., *Pharm. Ind.*, **25**, 573(1963).
(255) Burlinson, H., *Indian J. Pharm.*, **25**, 85(1963); through *Chem. Abstr.*, **58**, 12371(1963).
(256) Bogs, U., and Moldenhauer, H., *Pharmazie*, **18**, 704 (1963).
(257) Shotton, E., Deer, J. J., and Ganderton, D., *J. Pharm. Pharmacol.*, **15** (Suppl.), 106T(1963).
(258) Windheuser, J. J., *et al.*, THIS JOURNAL, **52**, 767 (1963).
(259) Fuehrer, C., *Pharm. Ind.*, **25**, 674(1963).
(260) Marshall, K., *J. Pharm. Pharmacol.*, **15**, 413(1963).
(261) Milosovich, G., *Drug Cosmetic Ind.*, **92**, 557(1963).
(262) Haruni, M., *Egypt. Pharm. Bull.*, **42** (4), 385(1960); through *Chem. Abstr.*, **58**, 415(1963).
(263) Engelbrecht, E., *Pharm. Ind.*, **25**, 120(1963).
(264) *Ibid.*, **25**, 181(1963).
(265) *Ibid.*, **25**, 262(1963).
(266) Cooper, J., *New Basic Concepts Pharm. Sci., Ann. Visiting Lecture Ser.*, **5**, 177(1961–1962); through *Chem. Abstr.*, **59**, 13234(1963).

(267) Andersen, S. I., *Arch. Pharm. Chemi*, **69**, 557(1962); through *Chem. Abstr.*, **58**, 6651(1963).
(268) Scott, M. W., *et al.*, THIS JOURNAL, **52**, 284(1963).
(269) Gunsel, W. C., and Lachman, L., *ibid.*, **52**, 178 (1963).
(270) Siegel, S., Hanus, E. J., and Carr, J. W., *ibid.*, **52**, 604(1963).
(271) Maor, Z., *Harokeach Haivri*, **9**, 401(1963); through *Chem. Abstr.*, **59**, 6193(1963).
(272) Maly, J., *Pharm. Ind.*, **25**, 257(1963).
(273) Tawashi, R., *ibid.*, **25**, 64(1963).
(274) Fox, C. D., *et al.*, *Drug Cosmetic Ind.*, **92**, 161(1963).
(275) de Vries, H., *Suara Pharm. Madjalah*, **4** (4), 116 (1959); through *Chem. Abstr.*, **58**, 13727(1963).
(276) Nosovitskaya, S. A., Borzunov, E. E., and Safiulin, R. M., *Farmatsevt. Zh. Kiev*, **17** (4), 6(1962); through *Chem. Abstr.*, **58**, 13726(1963).
(277) Hanus, E. J., and Stoyle, L. E., Jr., *Drug Cosmetic Ind.*, **92**, 552(1963).
(278) Daoust, R. G., and Lynch, M. J., *ibid.*, **93**, 26 (1963).
(279) Freudweiler, R., *Schweiz. Apotheker-Ztg.*, **100**, 585 (1962); through *Chem. Abstr.*, **58**, 3273(1963).
(280) Rahman, A. A., and Fouli, A. M., *Egypt. Pharm. Bull.*, **42** (4), 369(1960); through *Chem. Abstr.*, **58**, 414(1963).
(281) Ludwicki, H., *Acta Polon. Pharm.*, **19**, 209(1962); through *Chem. Abstr.*, **59**, 384(1963).
(282) Levy, G., *et al.*, THIS JOURNAL, **52**, 1047(1963).
(283) Levy, G., and Gumtow, R. H., *ibid.*, **52**, 1139(1963).
(284) Nogami, H., Fukuzawa, H., and Nakai, Y., *Chem. Pharm. Bull. Tokyo*, **11**, 138°(1963).
(285) Fakouhi, T. A., Billups, N. F., and Sager, R. W., THIS JOURNAL, **52**, 700(1963).
(286) Patel, R. P., and Chikhlia, D. T., *Indian J. Pharm.*, **25**, 220(1963); through *Chem. Abstr.*, **59**, 6203(1963).
(287) Safiulin, R. M., Nosovitskaya, S. A., and Borzunov, E. E., *Farmatsevt. Zh. Kiev*, **17** (3), 17(1962); through *Chem. Abstr.*, **58**, 13727(1963).
(288) Muenzel, K., *Pharm. Acta Helv.*, **38**, 129(1963).
(289) *Ibid.*, **38**, 65(1963).
(290) Rieckmann, P., *Pharm. Ind.*, **25**, 172(1963).
(291) Barahona, A. G., *Anales Fac. Quim. Farm., Univ. Chile*, **13**, 165(1961); through *Chem. Abstr.*, **58**, 3273(1963).
(292) Lachman, L., Speiser, P. P., and Sylwestrowicz, H. D., THIS JOURNAL, **52**, 379(1963).
(293) Gluzman, M. K., *et al.*, *Med. Prom. SSSR*, **17** (7), 34(1963); through *Chem. Abstr.*, **59**, 11192(1963).
(294) Smith, G., and Cox, P. H., *Pharm. J.*, **136**, 245 (1963).
(295) Klaeui, H., Capeder, A., and Muenzel, K., *Pharm. Ind.*, **25**, 173(1963).
(296) Bennett, H. W., and Hess, F. T., THIS JOURNAL, **52**, 607(1963).
(297) Nosovitskaya, S. A., and Borzunov, E. E., *Med. Prom. SSSR*, **16** (8), 30(1962); through *Chem. Abstr.*, **58**, 4381(1963).
(298) Gan, K. H., *Pharm. Weekblad*, **98**, 717(1963); through *Chem. Abstr.*, **59**, 15124(1963).
(299) Hadgraft, J. W., and Smith, G., *Pharm. J.*, **137**, 167 (1963).
(300) Czetsch-Lindenwald, H. v., and Khalek, M. M. A., *Egypt. Pharm. Bull.*, **42** (4), 359(1960); through *Chem. Abstr.*, **58**, 1306(1963).
(301) Brochmann-Hanssen, E., and Medina, J. C., THIS JOURNAL, **52**, 630(1963).
(302) Smith, C. D., *et al.*, *ibid.*, **52**, 1183(1963).
(303) Finholt, P., *Norg. Apotekerforen. Tidsskr.*, **70**, 225 (1962); through *Chem. Abstr.*, **58**, 7783(1963).
(304) Kuntscher, H., and Lorenz, F., *Pharm. Ind.*, **25**, 503 (1963).
(305) Miyazaki, J., *Yakuzaigaku*, **23**, 19(1963); through *Chem. Abstr.*, **59**, 13770(1963).
(306) Anderson, R. A., and Hill, K., *Pharm. J.*, **136**, 399 (1963).
(307) Coffman, H. L., and Huyck, C. L., *Am. J. Hosp. Pharm.*, **20**, 132(1963).
(308) Hiestand, E. N., *Proc. Am. Assoc. Coll. Pharm. Teachers' Seminar*, **13**, 125(1961).
(309) LaMer, V. K., and Smellie, R. H., Jr., *Clays Clay Minerals, Proc. Natl. Conf. Clays Clay Minerals*, **9**, 295(1962); through *Chem. Abstr.*, **58**, 8433(1963).
(310) Higuchi, W. I., *et al.*, THIS JOURNAL, **52**, 49(1963).
(311) Wilson, R. G., and Ecanow, B., *ibid.*, **52**, 757(1963).
(312) Nakagaki, M., and Sunada, H., *Yakugaku Zasshi*, **83**, 73(1963).
(313) Zacek, H., *Pharmazie*, **18**, 134(1963).
(314) Briner, F., and Steiger-Trippi, K., *Congr. Sci. Farm. Conf. Comun., 21°, Pisa*, 1961, 232; through *Chem. Abstr.*, **59**, 12597(1963).
(315) Smith, E. A., *Mfg. Chemist*, **34**, 16(1963).
(316) Zacek, H., *Pharmazie*, **18**, 308(1963).
(317) *Ibid.*, **18**, 619(1963).
(318) Fujiwara, H., *et al.*, *Takeda Kenkyusho Nempo*, **21**, 54(1962).
(319) Sperandio, G. J., *Am. Perfumer Cosmet.*, **78** (10), 99 (1963).
(320) Weiss, A., *Rheol. Acta*, **2**, 292(1962); through *Chem. Abstr.*, **59**, 2199(1963).
(321) Granquist, W. T., and McAtee, J. L., Jr., *J. Colloid Sci.*, **18**, 409(1963).
(322) Bergseth, H., *Kolloid-Z.*, **189**, 63(1963).
(323) Hunter, R. J., and Alexander, A. E., *J. Colloid Sci.*, **18**, 820(1963).
(324) Franke, N. H., and Riley, T. N., *Am. J. Pharm.*, **135**, 328(1963).
(325) Schneider, W., *Deut. Med. Wochschr.*, **87**, 1449 (1962); through *Chem. Abstr.*, **58**, 1307(1963).
(326) Marshall, K., *Mfg. Chemist*, **34**, 562(1963).
(327) Tamas, G., *Acta Pharm. Hung.*, **32**, 225(1962); through *Chem. Abstr.*, **58**, 2325(1963).
(328) Zettlemoyer, A. C., Buckingham, J. S., and Schaeffer, W. D., *J. Colloid Sci.*, **18**, 104(1963).
(329) Bosworth, R. C. L., *Australasian J. Pharm.*, **44**, S79(1963).
(330) McMahon, J. D., Hamill, R. D., and Petersen, R. V., THIS JOURNAL, **52**, 1163(1963).
(331) Silverman, H. I., *ibid.*, **52**, 593(1963).
(332) Bogs, U., and Naumann, H., *Pharmazie*, **18**, 750 (1963).
(333) Benson, F. R., Griffin, W. C., and Truax, H. M., *J. Soc. Cosmetic Chemists*, **13**, 437(1962); through *Chem. Abstr.*, **58**, 8847(1963).
(334) Neumann, H. J., *Naturwissenschaften*, **50**, 544(1963).
(335) Vold, R. D., and Groot, R. C., *J. Soc. Cosmetic Chemists*, **14**, 233(1963); through *Chem. Abstr.*, **59**, 5807 (1963).
(336) Lucassen-Reynders, E. H., and Temple, M. van den, *J. Phys. Chem.*, **67**, 731(1963).
(337) Sherman, P., *ibid.*, **67**, 2531(1963).
(338) Moore, A., and Lemberger, A. P., THIS JOURNAL, **52**, 223(1963).
(339) Higuchi, W. I., *Proc. Am. Assoc. Coll. Pharm. Teachers' Seminar*, **13**, 162(1961).
(340) Petricic, V., *Farm. Glasnik*, **19**, 177(1963); through *Chem. Abstr.*, **59**, 11189(1963).
(341) Allen, B. F., *Maryland Pharmacist*, **37**, 888(1962).
(342) *Ibid.*, **38**, 316(1962).
(343) *Ibid.*, **38**, 278(1962).
(344) Walker, G. C., and Kennedy, D. R., *Bull. Ontario Coll. Pharm.*, **12**, 43(1963).
(345) Melichar, M., *Pharmazie*, **18**, 358(1963).
(346) *Ibid.*, **18**, 362(1962).
(347) Muenzel, K., and Zwicky, R., *Oesterr. Apotheker-Ztg.*, **16**, 539(1962); through *Chem. Abstr.*, **58**, 1307(1963).
(348) Dolder, R., *Pharm. Acta Helv.*, **38**, 418(1963).
(349) Jernas, A., *Poznan. Towarz. Przyjaciol Nauk, Wydzial Lekar., Prace Komisji Farm.*, **1** (3), 59(1962); through *Chem. Abstr.*, **58**, 7790(1963).
(350) Tuma, R., *Mitt. Deut. Pharm. Ges.*, **33**, 137; published in *Arch. Pharm.*, **296** (3), (1963).
(351) Wollmann, C., and Papke, K., *Pharm. Praxis, Beilage Pharmazie*, **1963** (7), 132.
(352) Anon., *Drug Cosmetic Ind.*, **92**, 562(1963).
(353) Kedvessy, G., and Regdon, G., *Pharm. Ind.*, **25**, 445 (1963).
(354) Toomey, J. R., and Wolfthal, A., *Am. J. Hosp. Pharm.*, **20**, 321(1963).
(355) Krowczynski, L., *Acta Polon. Pharm.*, **19**, 127(1962); through *Chem. Abstr.*, **58**, 13727(1963).
(356) Kakemi, K., Arita, T., and Muranishi, S., *Yakuzaigaku*, **23**, 39(1963); through *Chem. Abstr.*, **59**, 13771 (1963).
(357) Simon, G. I., and Slavin, R. K., *Am. J. Hosp. Pharm.*, **20**, 259(1963).
(358) Setnikar, I., and Fantelli, S., THIS JOURNAL, **52**, 38(1963).
(359) Richards, R. M. E., Fletcher, G., and Norton, D. A., *Pharm. J.*, **137**, 605(1963).
(360) Archambault, G. F., *Am. J. Hosp. Pharm.*, **20**, 358 (1963).
(361) Gerrard, H. N., and Parker, M. S., *Pharm. J.*, **137**, 407(1963).
(362) Boerger, H., Kayer, K.-H., and Biebl, R., *Pharm. Ind.*, **25**, 634(1963).
(363) Denk, J., *ibid.*, **25**, 662(1963).
(364) de Roeck-Holtzhauer, Y., *Rev. Gen. Caoutchouc*, **38**, 1643(1961); through *Chem. Abstr.*, **59**, 5346(1963).
(365) Pechtold, F., *Pharm. Ind.*, **25**, 638(1963).
(366) Beiersdorf, R., *ibid.*, **25**, 388(1963).
(367) *Ibid.*, **25**, 649(1963).
(368) King, L., *New Jersey J. Pharm.*, **35** (9), 26(1962).
(369) *Ibid.*, **35** (10), 22(1962).
(370) Herzka, A., *Pharm. J.*, **136**, 87(1963).
(371) Marsden, R., *Mfg. Chemist*, **34**, 400(1963).
(372) Kanig, J. L., THIS JOURNAL, **52**, 513(1963).
(373) Haertel, A., *Kosmetik-Parfum-Drogen Rundschau*, **10**, 8(1963); through *Chem. Abstr.*, **59**, 2588(1963).
(374) Cavanna, D., *Minerva Farm.*, **11**, 161(1962); through *Chem. Abstr.*, **58**, 5453(1963).
(375) Marsden, R., *Mfg. Chemist*, **34**, 472(1963).
(376) Seckel, P. H., *Soap Chem. Specialties*, **39** (3), 58 (1963).
(377) Lin, T. J., and deNavarre, M. G., *Am. Perfumer Cosmet.*, **78** (4), 36(1963).
(378) Sanders, P. A., *Soap Chem. Specialties*, **39** (9), 63 (1963).
(379) Devir, S. E., *J. Colloid Sci.*, **18**, 744(1963).
(380) Blaug, S. M., Slattery, T. W., and Henderson, W. M., *Am. J. Hosp. Pharm.*, **20**, 326(1963).
(381) Yamaguchi, S., *J. Colloid Sci.*, **18**, 596(1963).
(382) Naff, M. B., and Spector, W., *J. Chem. Educ.*, **40**, 327 (1963).
(383) Pan, H.-P., *Chem. Ind. London*, **1963**, 1029.
(384) Howorka, K., *Pharm. Praxis, Beilage Pharmazie*, **1963** (4), 66.
(385) Schroeter, L. C., and Hamlin, W. E., THIS JOURNAL **52**, 811(1963).

(386) Lachman, L., and Cooper, J., *ibid.*, **52**, 490(1963).
(387) Hackl, H., *Z. Med. Laborlech.*, **3**, 233(1962); through *Chem. Abstr.*, **59**, 9739(1963).
(388) Smith, E. A., *Mfg. Chemist*, **34**, 412(1963).
(389) Albus, F. E., *Drug Cosmetic Ind.*, **93**, 452(1963).
(390) Crowell, W. J., *Am. J. Hosp. Pharm.*, **20**, 289(1963).
(391) Schultz, T. H., and Rockwell, W. C., *Food Technol.*, **17** (9), 100(1963).
(392) Gelperin, N. I., *et al.*, *Med. Prom. SSSR*, **16** (9), 37(1962); through *Chem. Abstr.*, **58**, 4380(1963).
(393) Michel, K. J., *Pharm. Praxis, Beilage Pharmazie*, **1963** (11), 237.
(394) Jeffrey, L. P., *Am. J. Hosp. Pharm.*, **20**, 9(1963).
(395) Spragg, S. P., *Nature*, **200**, 1200(1963).
(396) Wood, J. H., Catacalos, G., and Lieberman, S. V., This Journal, **52**, 375(1963).
(397) *Ibid.*, **52**, 296(1963).
(398) Isherwood, P. A., *J. Invest. Dermatol.*, **40**, 143(1963).
(399) Frauch, P., and Lang, E., *Pharm. Acta Helv.*, **38**, 676(1963).
(400) Lukoyanov, V. I., Shvedov, D. I., and Litvinov, N. V., *Med. Prom. SSSR*, **16** (9), 32(1962); through *Chem. Abstr.*, **58**, 4182(1963).
(401) Momose, T., *Yakugaku Zasshi*, **83**, 653(1963).
(402) West, D. W., *Chem. Ind. London*, **1963**, 1118.
(403) Jaspersen, H. P., and Mueller, T., *Schweiz. Apotheker-Ztg.*, **101**, 280(1963); through *Chem. Abstr.*, **59**, 2587 (1963).
(404) Bonnet, R., *Ind. Farm. Bioquim. Montevideo*, **2** (3), 1(1961); through *Chem. Abstr.*, **58**, 4380(1963).
(405) Hopkins, S. J., *Mfg. Chemist*, **34**, 458(1963).
(406) Hanke, H., *Pharm. Zentralhalle*, **102**, 699(1963).
(407) Du Ban, G., *Boll. Chim. Farm.*, **102**(4), 247(1963); through *Chem. Abstr.*, **59**, 8547(1963).
(408) Cartmel, R., and Gerrard, H. N., *Pharm. J.*, **137**, 383(1963).
(409) Thornton, M. J., *J. Pharm. Pharmacol.*, **15**, 742 (1963).
(410) Papadakis, M., *Rev. Mater. Construct. Trav., Publ.* **No. 570**, 79(1963); through *Chem. Abstr.*, **59**, 2189(1963).
(411) Espmark, A., and Lindner, S., *Biotechnol. Bioeng.*, **4**, 323(1962); through *Chem. Abstr.*, **58**, 7789(1963).
(412) Konev, F. A., *Med. Prom. SSSR*, **16** (8), 26(1962); through *Chem. Abstr.*, **58**, 5455(1963).
(413) Sosnovskii, L. E., Mardashev, P. F., and Gavrilov, B. M., *ibid.*, **16** (9), 41(1962); through *Chem. Abstr.*, **58**, 4381 (1963).
(414) Frost, E., *Pharm. Praxis, Beilage Pharmazie*, **1963** (7), 130.
(415) Schmidt, F., *ibid.*, **1963** (6), 113.
(416) Hutchinson, E., and Tokiwa, F., *J. Chem. Educ.*, **40**, 472(1963).
(417) McKay, H. A. C., and Miles, J. H., *Nature*, **199**, 65(1963).
(418) Veis, A., *J. Phys. Chem.*, **67**, 1960(1963).
(419) Kelly, F. H. C., and Rolls, J. M., *J. Appl. Chem. London*, **13**, 496(1963).
(420) Ramwell, P. W., and Shaw, J. E., *J. Pharm. Pharmacol.*, **15**, 611(1963).
(421) Thornton, M. J., *Mfg. Chemist*, **34**, 207(1963).
(422) Heywood, H., *J. Pharm. Pharmacol.*, **15** (Suppl.), 56T(1963).
(423) Connor, P., *Ind. Chemist*, **39**, 69(1963).
(424) Burson, J. H., Iinoya, K., and Orr, C., Jr., *Nature*, **200**, 360(1963).
(425) Dezelic, G., Dezelic, N., and Tezak, B., *J. Colloid Sci.*, **18**, 888(1963).
(426) Tawashi, R., and Speiser, P., *Pharm. Acta Helv.*, **38**, 310(1963).
(427) Okada, J., and Abe, T., *Yakugaku Zasshi*, **83**, 39 (1963).
(428) Benson, J. E., *J. Chem. Educ.*, **40**, 468(1963).
(429) Shedlovsky, L., Jakob, C. W., and Epstein, M. B., *J. Phys. Chem.*, **67**, 2075(1963).
(430) Dwyer, J. S., and Rosenthal, D., *ibid.*, **67**, 779(1963).
(431) Ploquin, J., *Bull. Soc. Pharm. Bordeaux*, **102** (1), 12(1963); through *Chem. Abstr.*, **59**, 4980(1963).
(432) Ellis, A. J., *J. Chem. Soc.*, **1963**, 2299.
(433) Rapson, H. D. C., and Bird, A. E., *J. Pharm. Pharmacol.*, **15** (Suppl.), 222T(1963).
(434) Bates, R. G., Paabo, M., and Robinson, R. A., *J. Phys. Chem.*, **67**, 1833(1963).
(435) Cilento, G., and Berenholc, M., *ibid.*, **67**, 1159 (1963).
(436) Pasternak, R. A., and Brady, A. P., *J. Chem. Educ.*, **40**, 254(1963).
(437) Rouffiac, R., Lattes, A., and Valdiguie, P., *Ann. Pharm. Franc.*, **21**, 413(1963).
(438) Hepler, L. G., *J. Am. Chem. Soc.*, **85**, 3089(1963).
(439) Knuth, E., *J. Chem. Educ.*, **40**, 486(1963).
(440) Schumaker, V. N., *Arch. Biochem. Biophys.*, **103**, 139 (1963).
(441) Marlow, E., *Dissertation Abstr.*, **24**, 257(1963).
(442) Nishida, M., and Iguchi, S., *Yakuzaigaku*, **22**, 257 (1962); through *Chem. Abstr.*, **59**, 7320(1963).
(443) Nakagaki, M., Koga, N., and Nishiuchi, M., *Yakugaku Zasshi*, **83**, 885(1963).
(444) Saunders, L., *J. Pharm. Pharmacol.*, **15**, 348(1963).
(445) Lau, P.-K., *Dissertation Abstr.*, **24**, 1411(1963).
(446) Niebergall, P. J., and Goyan, J. E., This Journal, **52**, 29(1963).
(447) Niebergall, P. J., and Milosovich, G., *ibid.*, **52**, 236 (1963).
(448) Smith, W. E., *Dissertation Abstr.*, **24**, 1411(1963).
(449) Higuchi, W. I., and Hiestand, E. N., This Journal, **52**, 67(1963).
(450) Higuchi, W. I., Rowe, E. L., and Hiestand, E. N., *ibid.*, **52**, 162(1963).
(451) Higuchi, W. I., and Hamlin, W. E., *ibid.*, **52**, 575 (1963).
(452) Eigen, M., *Naturwissenschaften*, **50**, 426(1963).
(453) Wahlgren, S., *Svensk. Farm. Tidskr.*, **66**, 585(1962); through *Chem. Abstr.*, **58**, 6651(1963).
(454) Kuttel, D., *Gyogyszereszet*, **7**, 131(1963); through *Chem. Abstr.*, **59**, 6203(1963).
(455) Huettenrauch, R., and Klotz, L., *Arch. Pharm.*, **296**, 145(1963).
(456) Bayly, P. J., McInnes, J., and Reynolds, B. L., *Australasian J. Pharm.*, **43**, 1138(1962).
(457) Perlia, X., *Pharm. Acta Helv.*, **38**, 306(1963).
(458) Nakatani, H., *Yakugaku Zasshi*, **83**, 6(1963).
(459) Likholet, N. M., and Gusyakov, V. P., *Med. Prom. SSSR*, **17** (5), 28(1963); through *Chem. Abstr.*, **59**, 9739 (1963).
(460) Hannig, E., and Wolff, K., *Pharmazie*, **18**, 113(1963).
(461) Shefter, E., and Higuchi, T., This Journal, **52**, 781 (1963).
(462) Higuchi, T., *Proc. Am. Assoc. Coll. Pharm. Teachers' Seminar*, **13**, 119(1961).
(463) Higuchi, W. I., *et al.*, This Journal, **52**, 150(1963).
(464) Kuroda, K., *Yakugaku Zasshi*, **83**, 250(1963).
(465) Kuroda, K., and Nakagaki, M., *ibid.*, **83**, 256(1963).
(466) Kuroda, K., *ibid.*, **83**, 333(1963).
(467) *Ibid.*, **83**, 337(1963).
(468) *Ibid.*, **83**, 445(1963).
(469) *Ibid.*, **83**, 455(1963).
(470) *Ibid.*, **83**, 463(1963).
(471) Diamond, R. M., *J. Phys. Chem.*, **67**, 2513(1963).
(472) Blandamer, M. J., and Symons, M. C. R., *ibid.*, **67**, 1304(1963).
(473) Feakins, D., and Watson, P., *J. Chem. Soc.*, **1963**, 4734.
(474) Frank, H. S., *J. Phys. Chem.*, **67**, 1554(1963).
(475) Angadji, E., and Colleter, J. C., *Bull. Soc. Pharm. Bordeaux*, **101** (3), 147(1962); through *Chem. Abstr.*, **58**, 8851 (1963).
(476) Burge, D. E., *J. Phys. Chem.*, **67**, 2590(1963).
(477) Sorby, D. L., Bitter, R. G., and Webb, J. G., This Journal, **52**, 1149(1963).
(478) Regdon-Kiss, E., *Pharmazie*, **18**, 755(1963).
(479) Kuettel, D., *Pharm. Zentralhalle*, **102**, 115(1963).
(480) Hall, N. A., This Journal, **52**, 189(1963).
(481) Swarbrick, J., and Carless, J. E., *J. Pharm. Pharmacol.*, **15**, 507(1963).
(482) Nakatani, H., *Yakugaku Zasshi*, **83**, 1(1963).
(483) Johnson, A., Nilawar, B. B., and Peters, R. H., *Nature*, **199**, 692(1963).
(484) Bell, F. K., O'Neill, J. J., and Burgison, R. M., This Journal, **52**, 637(1963).
(485) Higuchi, T., and Hom, F. S., *ibid.*, **52**, 426(1963).
(486) Reuter, W., and Biegel, M., *Pharm. Praxis, Beilage Pharmazie*, **1963** (8), 166.
(487) Davis, D. S., *Ind. Chemist*, **39**, 75(1963).
(488) Bolton, S., This Journal, **52**, 1071(1963).
(489) Graham, H. D., and Baker, Y. M., *ibid.*, **52**, 964 (1963).
(490) Graham, H. D., Baker, Y. M., and Njoku-Obi, A. N., *ibid.*, **52**, 192(1963).
(491) Cohen, J., and Lach, J. L., *ibid.*, **52**, 132(1963).
(492) Lach, J. L., and Cohen, J., *ibid.*, **52**, 137(1963).
(493) Haque, R., and Malik, W. U., *J. Phys. Chem.*, **67**, 2082(1963).
(494) Tori, K., and Nakagawa, T., *Kolloid-Z.*, **191**, 42 (1963).
(495) Pisano, F. D., *Dissertation Abstr.*, **23**, 4326(1963).
(496) Goto, S., Matsumura, H., and Iguchi, S., *Yakuzaigaku*, **22**, 171(1962); through *Chem. Abstr.*, **59**, 7321 (1963).
(497) Thomas, L. H., and Meatyard, R., *J. Chem. Soc.*, **1963**, 1986.
(498) Matsushima, Y., *Chem. Pharm. Bull. Tokyo*, **11**, 566(1963).
(499) Tobia, S. K., and Milad, N. E., *J. Chem. Soc.*, **1963**, 734.
(500) Schwarzenbach, G., and Anderegg, G., *Pharm. Acta Helv.*, **38**, 547(1963).
(501) Grossmith, F., *J. Pharm. Pharmacol.*, **15**, 114(1963).
(502) George, R. S., *Dissertation Abstr.*, **24**, 1814(1963).
(503) Halmekoski, J., *Suomen Kemistilehti*, **B35**, 238 (1962); through *Chem. Abstr.*, **58**, 13726(1963).
(504) Hugo, W. B., and Newton, J. M., *J. Pharm. Pharmacol.*, **15**, 731(1963).
(505) Ciogolea, G., *et al.*, *Ann. Pharm. Franc.*, **21**, 681 (1963).
(506) Nielsen, T. H., *Acta Odontol. Scand.*, **21**, 159(1963); through *Chem. Abstr.*, **59**, 8547(1963).
(507) Gustafson, R. L., and Martell, A. E., *J. Phys. Chem.*, **67**, 576(1963).
(508) Kanroji, Y., *Yakugaku Zasshi*, **83**, 424(1963).
(509) Sakai, T., *ibid.*, **83**, 44(1963).
(510) Tanabe, H., and Okada, K., *Takeda Kenkyusho Nempo*, **21**, 1(1962).
(511) *Ibid.*, **21**, 11(1962).
(512) Mattoon, R. W., *Proc. Am. Assoc. Coll. Pharm. Teachers' Seminar*, **13**, 112(1961).
(513) Nakamura, K., *Kolloid-Z.*, **189**, 130(1963).
(514) Stannett, V., and Yasuda, H., *J. Polymer Sci.*, **1B**, 289(1963).

(515) James, L. K., Jr., and Berry, D. J. O., *Science*, **140**, 312(1963).
(516) Jones, T. G., Pethica, B. A., and Walker, D. A., *J. Colloid Sci.*, **18**, 485(1963).
(517) Staicopolus, D. N., *ibid.*, **18**, 793(1963).
(518) Polyani, M., *Science*, **141**, 1010(1963).
(519) Lucassen-Reynders, E. H., *J. Phys. Chem.*, **67**, 969 (1963).
(520) Lange, K. R., *J. Colloid Sci.*, **18**, 65(1963).
(521) Zeitlin, H., Anthony, P., and Jordan, W., *Science*, **141**, 423(1963).
(522) Fujiwara, H., Yashiki, T., and Kanzawa, T., *Chem. Pharm. Bull. Tokyo*, **11**, 201(1963).
(523) Muehlemann, H., and Hofstetter, R., *Pharm. Acta Helv.*, **38**, 474(1963).
(524) Gott, V. L., Whiffen, J. D., and Dutton, R. C., *Science*, **142**, 1297(1963).
(525) MacRitchie, F., and Alexander, A. E., *J. Colloid Sci.*, **18**, 453(1963).
(526) *Ibid.*, **18**, 458(1963).
(527) *Ibid.*, **18**, 464(1963).
(528) Acred, P., *et al.*, *Nature*, **199**, 758(1963).
(529) Anderson, A. J., and Plein, E. M., THIS JOURNAL, **52**, 814(1963).
(530) Samsonov, G. V., *et al.*, *Kolloidn. Zh.*, **25** (2), 222 (1963); through *Chem. Abstr.*, **59**, 4578(1963).
(531) Otsuka, A., and Chikushi, Y., *Yakugaku Zasshi*, **83**, 244(1963).
(532) Schneider, H., and Ziesmer, H., *Naturwissenschaften*, **50**, 592(1963).
(533) Slabaugh, W. H., and Kennedy, G. H., *J. Colloid Sci.*, **18**, 337(1963).
(534) Street, G. B., and White, D., *J. Appl. Chem. London*, **13**, 203(1963).
(535) Greenland, D. J., *J. Colloid Sci.*, **18**, 647(1963).
(536) Ecanow, B., and Siegel, F. P., THIS JOURNAL, **52**, 812(1963).
(537) Schick, M. J., *J. Phys. Chem.*, **67**, 1796(1963).
(538) Elworthy, P. H., and Florence, A. T., *J. Pharm. Pharmacol.*, **15**, 851(1963).
(539) Shinoda, K., and Soda, T., *J. Phys. Chem.*, **67**, 2072 (1963).
(540) Mysels, K. J., Mukerjee, P., and Abu-Hamdiyyah, M., *ibid.*, **67**, 1943(1963).
(541) Kedvessy, G., and Regdon-Kiss, E., *Pharmazie*, **18**, 131(1963).
(542) Regdon-Kiss, E., and Kedvessy, G., *ibid.*, **18**, 541 (1963).
(543) Beckett, A. H., and Woodward, R. J., *J. Pharm. Pharmacol.*, **15**, 422(1963).
(544) Tori, K., and Nakagawa, T., *Kolloid-Z.*, **188**, 47 (1963).
(545) Tori, K., Kuriyama, K., and Nakagawa, T., *ibid.*, **191**, 48(1963).
(546) Tori, K., and Nakagawa, T., *ibid.*, **189**, 50(1963).
(547) Kato, Y., *Chem. Pharm. Bull. Tokyo*, **11**, 1202 (1963).
(548) Packter, A., and Donbrow, M., *J. Pharm. Pharmacol.*, **15**, 317(1963).
(549) Becher, P., *J. Colloid Sci.*, **18**, 196(1963).
(550) Mukerjee, P., and Ray, A., *J. Phys. Chem.*, **67**, 190 (1963).
(551) Gorman, W. G., and Hall, G. D., THIS JOURNAL, **52**, 442(1963).
(552) Garrett, H. E., *Chem. Ind. London*, **1963**, 1606.
(553) Moore, C. D., and Hardwick, R. B., *ibid.*, **1963**, 1268.
(554) Kretzschmar, G., *Kolloid-Z.*, **189**, 66(1963).
(555) Becher, P., *J. Colloid Sci.*, **18**, 665(1963).
(556) Robins, D. C., and Thomas, I. L., *J. Pharm. Pharmacol.*, **15**, 522(1963).
(557) Aoki, M., Kamada, A., and Matsuzaki, T., *Yakugaku Zasshi*, **83**, 1132(1963).
(558) Sebba, F., *Nature*, **197**, 1195(1963).
(559) Powers, H. E. C., *Ind. Chemist*, **39**, 485(1963).
(560) *Ibid.*, **39**, 351(1963).
(561) *Ibid.*, **39**, 421(1963).
(562) Gehman, W. G., *J. Chem. Educ.*, **40**, 54(1963).
(563) Berry, C. R., and Skillman, D. C., *J. Phys. Chem.*, **67**, 1827(1963).
(564) Biles, J. A., THIS JOURNAL, **52**, 1066(1963).
(565) Nakagaki, M., *et al.*, *Yakugaku Zasshi*, **83**, 945 (1963).
(566) Shell, J. W., THIS JOURNAL, **52**, 24(1963).
(567) *Ibid.*, **52**, 100(1963).
(568) Hodgkin, D. C., *et al.*, *J. Chem. Soc.*, **1963**, 4945.
(569) Brandstaetter-Kuhnert, M., and Aepkers, M., *Mikrochim. Ichoanal. Acta*, **1962**, 1041; through *Chem. Abstr.*, **59**, 6204(1963).
(570) *Ibid.*, **1963**, 360; through *Chem. Abstr.*, **59**, 7319 (1963).
(571) Dintenfass, L., *Australasian J. Pharm.*, **44**, S38 (1963).
(572) Hagger, O., *Pharm. Acta Helv.*, **38**, 887(1963).
(573) McVean, D. E., *Dissertation Abstr.*, **24**, 985(1963).
(574) Rutgers, I. R., *Rheol. Acta*, **2**, 305(1962); through *Chem. Abstr.*, **59**, 2199(1963).
(575) Fujishige, S., Kuwana, J., and Shibayama, M., *J. Polymer Sci.*, **1B**, 355(1963).
(576) Kobayashi, H., *ibid.*, **1B**, 299(1963).
(577) Christoff, K., *Pharmazie*, **18**, 223(1963).
(578) Schulte, K. E., and Kassem, M. A., *Pharm. Acta Helv.*, **38**, 34(1963).
(579) *Ibid.*, **38**, 162(1963).
(580) *Ibid.*, **38**, 358(1963).
(581) Elsner, Z., and Pawlak, Z., *Pharmazie*, **18**, 762 (1963).
(582) Gstirner, F., and Bodenbach, H. J., *Arch. Pharm.*, **296**, 184(1963).
(583) Gstirner, F., and Bodenbach, H. J., *Pharm. Acta Helv.*, **38**, 235(1963).
(584) Gstirner, F., and Bodenbach, H. J., *Arch. Pharm.*, **296**, 487(1963).
(585) *Ibid.*, **296**, 606(1963).
(586) Kedvessy, G., *et al.*, *ibid.*, **296**, 837(1963).
(587) Wood, J. H., Catacalos, G., and Lieberman, S. V., THIS JOURNAL, **52**, 354(1963).
(588) Vogt, H., *Pharm. Ind.*, **25**, 12(1963).
(589) Aida, H., Hanai, T., and Gotoh, R., *Nippon Kagaku Zasshi*, **83**, 536(1962); through *Chem. Abstr.*, **59**, 2182(1963).
(590) Hunter, R. J., and Alexander, A. E., *J. Colloid Sci.*, **18**, 846(1963).
(591) Fujiwara, H., Yashiki, T., and Kanzawa, T., *Chem. Pharm. Bull. Tokyo*, **11**, 198(1963).
(592) Castello, R. A., *Dissertation Abstr.*, **24**, 1407(1963).
(593) Wiegand, J. H., *J. Chem. Educ.*, **40**, 475(1963).
(594) Nakagaki, M., and Nishino, M., *Yakugaku Zasshi*, **83**, 185(1963).
(595) *Ibid.*, **83**, 1137(1963).
(596) *Ibid.*, **83**, 1141(1963).
(597) Wray, P. E., *Dissertation Abstr.*, **24**, 258(1963).
(598) Hermans, J. J., *J. Polymer Sci.*, **1963C** (2), 117.