

# Clinical Chemistry

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THIS REVIEW of publications of the significant developments in Clinical Chemistry from December 1, 1960 to December 1, 1962, is a continuation of the author's last, which was published in this journal (12A).

## REVIEWS, NEW BOOKS, AND JOURNALS

The continued interest in and emphasis on the development and application of microtechniques in clinical chemistry was shown by clinical chemists, pathologists and other scientists from several parts of the United States and foreign countries who attended a symposium on field application of microtechniques sponsored by the U. S. Army Medical Research and Development Command conducted at Walter Reed Army Institute of Research on October 8-12, 1962 in which critical evaluations of microtechniques were made by the participants for their application in the field where bulky or sophisticated equipment requiring supplementation and maintenance could not be used.

Critical evaluations of the ultramicro Beckman-Spino system for routine clinical chemistry procedures were made by O'Brien, Ibbott, and Pinfield (20A) and Campbell, Comfort, and Bell (24) in which modifications or substitutions of methods would improve accuracy. Van Haga (24A) reviewed ultramicro clinical chemistry methods in which the difficulty of obtaining large enough samples in pediatrics, the need of determining several constituents in one sample, and the avoidance of venipuncture was emphasized. Reviews were made by Liebhafsky (15A) on the growth of instrumental analysis in modern analytical chemistry, by Levy (14A) on determination of elements in biological systems, and by Ma and Gutterson (16A) on organic microchemistry. Hamilton (8A) reviewed fundamental developments in biochemical analysis covering volumetric methods, centrifugation, dialysis, countercurrent separation, electrophoresis, electron probe, x-ray microanalysis, electron spin resonance, x-ray spectrophotometry and diffraction, etc. A short, interesting review of analytical chemistry in Great Britain was made by Chirnside (6A). Mason (17A) re-

viewed some of the analytical problems in biology and medicine. Recent developments in light absorption spectrometry were reviewed by Mellon (18A) which included nonmetals, organic constituents, photometer, filter photometers, spectrophotometers, and automatic photometric analyzers etc. Hirt (10A) reviewed ultraviolet spectrophotometry, covering vacuum ultraviolet spectroscopy, spectrophotometric titrations, elemental analyses, organic analysis, etc. Fluorometric analysis covering apparatus, inorganic elements, calcium, copper manganese, zinc, and nonmetals together with organic and biological compounds was reviewed by White (26A). Heftmann (9A) reviewed the fundamental developments in analytical chromatography as applied to inorganic ions, hydrocarbons, alcohols, organic acids, lipides, amino acids, proteins, carbohydrates, porphyrins etc. One of the most rapidly growing areas in analytical chemistry, gas chromatography, was reviewed by Dal Nogare (7A) who covered packed columns, capillary columns, detection, and specialized operations. Juvet (11A) gave a report on the Fourth International Gas Chromatography Symposium. Kunin and McGarvey (13A) reviewed the use of ion exchange techniques and principles in inorganic analyses, microanalyses, etc. Wunderly (28A) reported on the progress of immunoelectrophoresis, its methods, interpretation, and results. Strain (23A) discussed the selectivity of separations by chromatography, electrochromatography, and continuous electrochromatography.

Most of the procedures presented in the third volume of Standard Methods of Clinical Chemistry (22A) were more specialized than those of the two previous volumes. Six toxicological methods were presented for poisons and drugs such as arsenic, mercury, ethanol, barbiturates, salicylates, and sulfonamides. Four enzyme methods were described for aldolases, cholinesterase, phosphohexose isomerase, and transaminase. Methods were also described for ascorbic acid, catechol amines, chloride, cortisol, creatine and creatinine, fibrinogen, and gastric acidity. A new teaching manual, "Clinical Chemistry" was presented by Boutwell

(1A) in which principles of clinical biochemistry are discussed such as acid-base equilibrium, blood coagulation, kidney and liver function, etc., principles of quantitative analyses, collection and preservation of specimens, and specific analytical methods. The clinical chemist needs good references for interpretation of his analytical results. Cantarow and Trumper (4A) have furnished such material in their complete revision of "Clinical Biochemistry" (6th edition). Some rewritten sections are: diagnostic significance of plasma proteins, endocrine physiology and abnormalities, and abnormalities of electrolyte metabolism. Some new material has been added, such as diagnostic significance of blood enzymes and hemoglobins. Another good supplement for fundamental reference material for interpretation of clinical data is Cantarow and Schepartz's (3A) "Biochemistry" (3rd edition) in which several significant changes have been made and new material has been presented such as: structure and biosynthesis of proteins, structure and metabolism of nucleic acids, classification and mechanism of action of enzymes and metabolism of steroid and adrenal medullary hormones, etc. Caraway (5A) presented 28 simple standard routine clinical chemistry methods especially adapted to the Coleman Jr. Spectrophotometer in "Microchemical Methods for Blood Analysis." A complete revision of "Laboratory Manual of Pediatric Micro and Ultramicro Biochemical Techniques" was made by O'Brien and Ibbott (19A). Clinical and technical commentaries were presented with each procedure. A detailed description of the construction and handling of micromanometric chamber and needle tipped pipets, a microform of the Van Slyke-Neill gas extraction chamber was presented by Van Slyke and Plazin (25A) in "Micromanometric Analysis" in which methods for the determination of CO<sub>2</sub>, O<sub>2</sub>, CO, Hb, N<sub>2</sub>, N<sub>2</sub>O, cyclopropane, ethylene, urea, and free amino acids were given. A reference manual "Comprehensive Analytical Chemistry, Classical Analysis" was edited by Wilson and Wilson (27A) which covered a wide area, such as theory and principles, apparatus, acidimetry and alkalimetry, metallic ele-

ments, organic groups, and titrations in nonaqueous solvents. Announcement of a new journal "Journal of Gas Chromatography" for publication in January 1963 was made by Editor Preston (21A).

#### APPARATUS AND EQUIPMENT

A review of instrumentation was made by Mueller (28B) covering recent developments in photoelectric spectrophotometers, polarizing filters, photo-multipliers, photo-tubes, recording balances, photoelectric refractometers, etc. A survey of new equipment for use in ultramicro chemistry was made by Knights, Ploompuu, and Whitehouse (20B). Marsh (24B) modified the Klett-Summerson colorimeter to obtain increased accuracy and save time. An improved spectrofluorimeter was described by Moss (27B) which monitors the output of its light source to derive corrected fluorescence excitation spectra. Anderson (1B) gave instructions for the construction of quartz flow-cells for continuous spectrophotometric analysis of column effluents, and Breda and Kotkas (7B) designed a simple glass variable thickness cell for visible, ultraviolet, and near-infrared spectrophotometry. An apparatus for the continuous polarographic determination of alpha-amino acids in flowing solutions as applied to ion exchange column effluents was proposed by Blaedel and Todd (6B). Dahnke *et al.* (12B) described the construction of a vacuum tube oxygen polarograph for the rapid, accurate determination of partial pressure of O<sub>2</sub> in blood, and Barber and Scanlon (5B) designed a simple, inexpensive, and easily constructed apparatus for rapid, simultaneous equilibration of 30 serums with 5% CO<sub>2</sub>. A rapidly responding narrow-band infrared gaseous CO<sub>2</sub> analyzer for physiological studies was introduced by Baker (4B). Dixit and Lazarow (14B) described an apparatus for determining the O<sub>2</sub> capacity of blood using a 20-μl. sample previously equilibrated with O<sub>2</sub>. Ryce and Bryce (32B) described a new design for gas chromatography columns and Muysers Siehoff, and Worth (29B) designed a gas chromatography apparatus for the analysis of O<sub>2</sub> and CO<sub>2</sub> in blood and respiratory gas.

Snell (33B) described an electrode system and associated sample chambers for the electrometric measurement of CO<sub>2</sub>, HCO<sub>3</sub>, NH<sub>3</sub>, HCN, and SO<sub>2</sub>. Cater, Silver, and Wilson (8B) modified an apparatus and technique for the measurement of O<sub>2</sub> tension in tissue by using flush-ended gold and platinum electrodes in conjunction with a transistor amplifier. Lowe (22B) used a macrocondenser-type Cambridge glass

electrode converted into a pH-sensing tonometer to measure CO<sub>2</sub> tension in blood and gas. Kurella and Popov (21B) designed an antimony micro-electrode for the determination of pH, and Holden (16B) described a simple and inexpensive apparatus for the pH determination in 0.2 ml. of blood. Polgar and Forster (31B) modified the membrane covered Clark Pt-Ag electrode, and Charlton (10B) and Awad and Winzler (3B) prepared a similar electrode for the measurement of O<sub>2</sub> tension in blood and tissue.

Mattenheimer (26B) described the construction, calibration, and accuracy of polyethylene constriction pipets for volumes ranging from 0.3 to 300 μl. A semiautomatic pipet described by Mather (25B) was used for the specific purpose of sampling serums (0.25 to 0.50 ml.) and delivering with 5 ml. of reactant reagent. Dixit and Lazarow (13B) calibrated micropipets by filling with nicotinamide, diluting, and measuring absorbance at 262 μμ. A simple accurate microburet suitable for titration of fluid in small Conway units was developed by Holm-Jensen (17B). Hospelhorn (18B) outlined a technique for dialysis which permits almost complete recovery of a dialyzable substance in a minimum volume of solution. A density gradient electrophoresis apparatus which permits the separation of electrophoretic components without the use of a solid supporting medium was developed by Choules and Ballantine (11B). Fischl (15B) constructed a simple, economical micro electrophoresis apparatus using cellulose acetate paper as the supporting medium. Porous glass electrophoresis was described by MacDonell (23B) and agar gel electrophoresis by Osborn (30B). A complete review of thin layer chromatography was made by Cerri and Maffi (9B). Avizonis, Fritz, and Wriston (2B) described a device for measuring the resistance of solutions linearly and continuously. Wells, Denton, and Merrill (34B) made use of a cone plate viscometer for measurement of viscosity of biologic fluids. Jeffrey and Sax (19B) reviewed x-ray diffraction, crystal structure analysis, and the high-speed computer.

#### AUTOMATION

Complete automation of analysis is foreseen in the decades ahead by Müller (40C). Savitzky (49C) believes that the "Computer revolution" will lead to development of new instruments which will yield only partially processed data which will rely on computers to make final computations. Mulay (41C) reviewed instrumentation and some analytical applications of magnetic susceptibility. Natelson (43C) developed an automatic chemical analyzer in which drops of sample are placed

within hydrophobic rings on a tape and printed on a second tape impregnated with color-developing reagent which is dried and the color density of the spots determined. An apparatus for the automatic quantitative determination of individual adrenocortical hormones in mixtures was described by Anderson *et al.* (1C) which is based on the separation of the mixture on a partition column by gradient elution. Epstein and Zak (21C) analyzed 17-ketosteroids by means of automated flow spectrophotometry. Khalameizer (31C) designed a paper chromatography densitometer with complete automatization of measuring, recording, and integration. Edel and Reimann (19C) applied a new automatic scanner for direct photometry of paper electrophoresis strips to the separation and estimation of serum proteins, lipoproteins and phospholipids. Dearnaley and Acheson (16C) described a simple technique for the automatic application of solutions to chromatography paper. Malmstadt and Hadjioannou developed a new method for the determination of glucose (34C) and alcohol (35C) by a rapid automatic spectrophotometric rate procedure. A stable continuously recording electrode system for the determination of oxygen dissolved in protein solutions was described by Cope (12C). Cassels, Brame, and Day (9C) described an automatic sample changer for routine infrared analyses. A graphic prothrombin time recorder with air bath was described by Hamilton (27C). Ehrmantraut and Marshall (20C) developed a simple low-cost instrument to measure clotting time on plasma or blood with a standard deviation of 0.3 second. Cawley and Eberhardt (10C) used the Spinco analytrol as a recorder to measure and record turbidity developing during coagulation of plasma in the 1-stage method for prothrombin time. Dorfman *et al.* (17C) developed an automatic micronitrogen analyzer with which analyses were completed in 6 to 15 minutes. The automatic quantitative amino acid method of Spackman was described by Braunitzer (5C) and simplified by Piez and Morris (47C). Automatic analyses of amino acids were also described by Corfield and Robon (18C) by polarographic estimation of their copper complexes and by Bonnafé (4C) who used a continuous system using ninhydrin for colorimetry. Automatic methods for the determination of CO<sub>2</sub> were described by Gøksøy (26C) using a Warburg apparatus with automatic recording of respiratory CO<sub>2</sub><sup>14</sup>, by Karler and Woodbury (29C) by modifying a Beckman Spinco model LB-1 gas analyzer and by Bunker, Bendixen, and Murphy (7C) by a new automatic CO<sub>2</sub> analyzer based upon changes in pressure of a sample of

known volume after removal of CO<sub>2</sub> by adsorption on soda lime. Cotlove and Nishi (14C) developed a direct read-out for the automatic coulometric-amperometric titrator of Cotlove.

The AutoAnalyzer has had wide acceptance especially in clinical chemistry, and many new and improved methods have been adapted for use with this automated device. Getchell, Kingsley, and Schaffert (25C), Hill and Kessler (28C) and Wincey and Marks (57C) have automated the glucose oxidase-peroxidase system with the AutoAnalyzer. Other glucose methods were adapted to this instrument by Butler (8C), Ferrari *et al.* (23C), Ohmori and Yamamoto (45C), and Tkachuc (54C). Crowley (15C) applied the AutoAnalyzer to the determination of D-xylose in urine. Adrenaline and noradrenaline were assayed in blood and tissue extracts after initial purification by adsorption on alumina and elution with HOAc by Merrills (39C) using an AutoAnalyzer. Skeggs (52C) adapted the AutoAnalyzer for CO<sub>2</sub> determination in blood which was evaluated further by Marsters (38C). Calcium and phosphorous in serum and urine were determined with the AutoAnalyzer by Kessler and Wolfman (30C) and Levy *et al.* (32C). Several miscellaneous blood chemistry methods were adapted to the AutoAnalyzer such as copper by Summers (53C), lactic acid and alcohol dehydrogenase and transaminase by Schwartz, Kessler, and Bodansky (51C), transaminase by Schaffert, Kingsley, and Getchell (50C), alcohol by Nadeau, Fortin, and Dugal (42C), hemoglobin by Nelson and Lamont (44C), creatinine by Chasson, Grady, and Stanley (11C), urea by Pastor and Pauli (46C), ammonia by Logsdon (33C) and Dropsy and Boy (18C). Marsh (37C) reviewed automatic analytical systems utilized in protein analysis, Zak and Cohen (60C) determined tissue culture proteins with stable Folin reagents and Reinhardt and Hardwick (48C) determined proteins colorimetrically with the AutoAnalyzer. Whitehead (56C) reported on a complete automated Kjeldahl nitrogen procedure using the AutoAnalyzer. Protein eluates from chromatographic columns were estimated with an AutoAnalyzer by Mandl (36C). The determination of iodine and organically bound iodine was made by Benotti and Benotti (8C), and Zak and Baginski (58C, 59C) using the AutoAnalyzer. Britt (6C) made precise automated analyses of chloride, nitrate, nitrite, ferrous, ferric, and ammonium ions in water with the AutoAnalyzer.

Frank and Gori (24C) invented an automatic recording turbidimeter for testing biological processes. Baron, Burch, and Uhendorf (2C) developed an automatic diluting machine which can

rapidly perform up to 12 simultaneous sterile dilutions. Feichtmeir, Jenkins, and Baer (22C) devised a semiautomatic pipetting and diluting device. Walter and Gerarde (55C) described a disposable, self-filling, self-measuring, dilution micropipet.

#### CONTROL AND PRECISION OF CLINICAL CHEMISTRY METHODS

The Advisory Board of ANALYTICAL CHEMISTRY (1D) has endorsed a guide for measures of precision and accuracy by defining series, mean, precision data, variance, standard deviation, range, accuracy data, mean error, and relative error. Nelson (9D) gave a short report on statistical methods in chemistry. Youden (17D) in an article, "The Sample, the Procedure, and the Laboratory" discussed statistical techniques, systemic errors, separation of systematic, and random errors. Rice and Grogan (11D) surveyed the clinical chemistry procedures used by members of the American Association of Clinical Chemists and found that as many as 35 procedures were used for the determination of a single blood constituent and that older methods were often favored over newer, improved techniques. Caraway (2D) surveyed and discussed the variables and potential sources of error in the individual specimen that affect the chemical specificity of clinical laboratory tests. Suchet (14D) discussed the difficulties encountered in routine examinations and sources of error in analysis of blood and urine. Methods and techniques to obtain quality control to assure daily accuracy were outlined by Turpin (15D), Schneider (12D), and de Traverse (3D). Control standards were recommended; such as freeze drying serum by Smetana (13D), "ion-free serum" by Levy (7D), lyophilized serum by Klein and Weissman (5D), and use of commercial control serums by Klugerman and Boutwell (6D). Wickers (16D) described the preparation of "pure substances" to serve as chemical standards and their evaluation. Meehan and Beattie (8D) described an absolute method of turbidimetric analysis which eliminates empirical comparison of known and unknown suspensions. Pryce (10D) outlined a simple colorimetric procedure for calibrating micropipets. Fawcett and Wynn (4D) described the effects of posture on plasma volume, blood hematocrit, hemoglobin, and plasma protein.

#### AMINO ACIDS

Hanes and Wood (12E) described a stabilized chromatographic system of high resolving power for amino acids based on buffered miscible solvents

used with buffer impregnated papers. Rothman and Higa (31E) separated all of the amino acids generally encountered in protein hydrolysates by electrophoresis at pH 1.8 with a new two-dimensional system. Mizell and Simpson (24E) suggested a solvent system, BuOH-MeCOEt-H<sub>2</sub>O(2:2:1) with an atmosphere saturated with cyclohexylamine to replace phenol. A rapid and sensitive method was described by Mans and Novelli (22E) for the measurement of the incorporation of radioactive amino acids into protein by a filter-paper disk method. Peraino and Harper (27E) modified the dinitrophenylation procedure of Levy for the quantitative paper chromatography of plasma amino acids. Lundquist and Galatius-Jensen (19E) described an arrangement for the quantitative determination of amino acids by ion-exchange carrier-displacement chromatography. Matheson, Tigane, and Hanes (23E) reported an improved ninhydrin-hydridantin reagent for the quantitative determination of amino acids and peptides separated on filter paper chromatograms.

Harris, Tigane, and Hanes (13E) devised a method based on the use of miniature ion-exchange columns for isolating small amounts of amino acids from biological fluids and tissue extracts. The use of elution chromatography on ion exchangers for the measurement of amino acids in blood serum was reported by Gerok (11E). Rollins, Jensen, and Schwartz (30E) described a rapid one-step method of desalting amino acid solutions by an ion-retardation resin. Dunn and Murphy (7E) employed paper chromatographic methods to detect 0.1 to 0.2% of any one of 26 amino acids present as an impurity. Johnson, Scott, and Meister (15E) carried out gas liquid chromatography of a number of N-acetylamino acid n-amylesters on 2 to 8-ft. columns packed with chromosorb W coated with 0.5 to 5% polyethylene glycol. Cohen (3E) determined arginine released in plasma after plasminogen activation by separating directly on Na-cycled cation-exchange resin (Dowex 50 - X8). Uno, Yasuda, and Kondo (36E) measured cycloserine colorimetrically by addition of phosphotungstic-phosphomolybdic acid reagent to an aqueous solution of I, and alkalization of this solution with Na<sub>2</sub>CO<sub>3</sub>. Fischl, Sason, and Segal (9E) described a simple spot test for the determination of cystinuria and aminoaciduria based on the color reaction between nitroprusside and thiol groups. Dubouloz, Fondarai, and Pavone-Marville (6E) used thio-fluorescein for the colorimetric micro-determination of cysteine and cystine. Saint-Blancard and Storck (32E) characterized and determined glycine by paper electrophoresis. The red color

produced by glycine, ethyl chloroformate, and pyridine was found by Sublett and Jewell (35E) to be a specific colorimetric qualitative test for glycine and some of its simple derivatives. Noah and Brand (25E) used *o*-phthalaldehyde for the fluorimetric determination of histamine in plasma. A specific and highly sensitive fluorometric assay of histamine in urinary extracts was described by Oates, Marsh, and Sjöerdsma (26E). Prockop, Udenfriend, and Lindstedt (29E) and Prockop and Udenfriend (28E) developed a simple technique for the determination of C<sup>14</sup> and chloramine-T labeled hydroxyproline by oxidization to pyrrole and extraction into toluene. Leucine, valine, and isoleucine were determined microbiologically in urine dried on filter paper by Berry *et al.* (2E). Sanahuja and Rios (33E) estimated lysine with a new colorimetric method by diazotization with *p*-nitroaniline to give a stable red-violet color. Dickerman and Carter (5E) devised a spectrophotometric method for the determination of lysine using bacterial lysine decarboxylase. Kurzawa (17E) determined methionine in the presence of cystine with sodium azide and iodine. Garvin (10E) estimated taurine in tissues by the passage of the zwitterion of taurine through both an anion- and cation-exchange resin. A fluorimetric method for the assay of phenylalanine in serum based on the enhancement of a phenylalanine-ninhydrin reaction by leucylalanine was developed by McCaman and Robins (20E). Culley *et al.* (4E) applied a paper chromatographic method to the determination of phenylalanine and tyrosine in finger tip blood. A similar method was also described by Berry (1E). Duval and Delga (8E) modified the Folin and Udenfriend tyrosine methods for the determination of tyrosine in urine and found both satisfactory. Scott (34E) estimated 1-tryptophan in biological material by converting to indole with tryptophanase and colorimetric measurement with *p*-dimethylaminobenzaldehyde or *p*-dimethylaminocinnamic aldehyde reagents. Harrison and Hoffmann (14E) determined tryptophan in proteins by hydrolysis and digestion at pH 9.2 and 37° C. and colorimetric determination with *p*-dimethylaminobenzaldehyde-H<sub>2</sub>SO<sub>4</sub> reagents of Spies and Chambers. Techniques for running two-dimensional paper partition chromatograms of urinary amino acids were described by McEvoy-Bowe (21E). A simple one-dimensional paper electrophoresis screening method for the detection of aminoaciduria was outlined by Kaplan and Hruby (16E). Lipovac (18E) combined chromatographic and electrophoretic techniques for the separation and determination of amino acids in urine.

#### BLOOD PRESERVATION, CLOTTING FACTORS, AND GASOMETRIC ANALYSIS

Potassium metabisulfite and formic acid were investigated by Nehring and Schröder (16F) for their possible use as preserving agents for long time storage of defibrinated blood and found K<sub>2</sub>S<sub>2</sub>O<sub>8</sub> satisfactory for 2 months. The addition of 0.001 to 2% sodium chlorophyllin in isotonic NaCl was reported to prolong the shelf life of blood 2 to 3 times (18F). Sequestrene was not found satisfactory for the preservation of blood by Fiala, Vlokova, and Vopatova (6F).

A method for establishing quality control for prothrombin concentration tests was described by Ross and Zwerneeman (23F) and by Ellerbrook *et al.* (4F) using frozen pooled citrated normal plasma as daily control of plasma prothrombin time. A photoelectric method for the determination of prothrombin has been devised by Lew and Quinn (13F). Phillips *et al.* (19F) described a micromethod using a solution of fibrinogen containing an optimal amount of anticoagulant.

Schoen, Praphai, and Veiss (24F) demonstrated the effectiveness of vacuum Vacutainer collection tubes for the stable storage of blood specimens for quality control of prothrombin time by the Quick method. Ermakova (5F) described a simplified method for the determination of prothrombin by means of heparin. Rapport *et al.* (22F) assayed plasma thromboplastin antecedent activity by the ability of a test plasma to shorten the long partial thromboplastin time of antecedent deficient substrate plasma in the presence of an optimal activating surface. A simple whole blood screening test for disorders of thromboplastin generation based on the use of hemolyzed blood as a source of all clotting factors was described by Sirridge, Bowman, and Allwin (25F). Proctor and Rapport (20F) described a technique for determining a modified partial thromboplastin time in which optimal contact activation of the test plasma was provided by adding kaolin powder to the partial thromboplastin reagent. A procedure for the quantitative determination of heparin in blood was developed by Cesnik and Kronberger (2F). One stage method for the assay of platelet factor 3 was described by Husom (10F) based on the recalcification time of activated platelet-free human plasma enriched with factor V and VII through the addition of adsorbed platelet-free bovine plasma. Kravtsova (12F) reported a method for the determination of the content of factor V in human blood plasma and Quick (21F) assayed and described the properties of factor V. A critical evaluation of the assessment and properties of anti-

thrombin V was made by Vermijlen and Verstraete (30F).

Van Bruggen and Scott (29F) developed a micromethod for determination of CO<sub>2</sub> and a rapid manometric method for its assay in serum was presented by Turpin and Roberts (27F). Maas and van Heijst (15F) measured the accuracy of the microdetermination of the pCO<sub>2</sub> in blood from the ear-lobe. Gambino (9F) demonstrated that blood pCO<sub>2</sub> could be most accurately and precisely determined with the Severinghaus modification of the pCO<sub>2</sub> electrode. Gambino (8F) compared the Lilienthal and Riley virtual anaerobic method of collecting capillary blood for simultaneous determinations of arterial pH, CO<sub>2</sub> content, pCO<sub>2</sub>, and oxygen saturation determinations with paired samples of arterialized capillary blood and brachial artery blood and found no significant differences. Adverse effects of mineral oil on the accuracy of determinations of blood pH, CO<sub>2</sub> content, and chloride concentration was reported by Gambino (7F). Still and Rodman (26F) found excellent correlation between the results obtained on vacuum tube-collected blood for measurement of CO<sub>2</sub> content of plasma and the more cumbersome classical method. Chen and Lyons (3F) reported no significant differences in alveolar CO<sub>2</sub> tension between two techniques: nasal catheter microcell and low resistance breath-through tube chamber. Underwood and Howe (28F) overcame kinetic problems in the alkalimetric titration of CO<sub>2</sub> solutions by use of carbonic anhydrase. Wilson *et al.* (32F) described methods for the determination of blood gases with the Beckman GC-2 gas chromatograph. Janitzki (11F) described the identification of volatile substances in blood after respiratory absorption by gas chromatography. Lukas and Ayres (14F) adapted the method of Ramsey to the determination of oxygen by gas chromatography to permit the application of the method to whole blood. Nilsson (17F) reviewed the history, principles, types, problems, and applications of photoelectric devices for direct measurement of oxygen saturation of blood. Spectrophotometric microestimation of blood oxygen was described by Weale (31F) and Andersen, Jorgensen, and Naeraa (1F).

#### CARBOHYDRATES

Bishop (5G) reviewed the separation of carbohydrate derivatives by gas liquid partition chromatography. Montreuil (29G) described a paper chromatographic method for the separation of galactose from glucose and their quantitative estimation. A gel filtration method was devised by Östling (30G) for a semiautomatic method for the separation of dextran or inulin from

glucose in which the plasma is applied to a column composed of particles of Sephadex. Several diagnostic compositions containing glucose-oxidase for the quantitative determination of glucose were patented by Harvill (17G), Miles Laboratories (25G, 26G), Adams (1G), Bauer and Mast (4G), Gibson (14G), and Dobrick (12G). Gold (15G) patented a reagent for blood sugar test in which the indigosulfonate-glucose reaction was used. Brown (8G) used 2,9-di-methyl-1,10-phenanthroline HCl and Hoh (18G) used Hg I<sub>2</sub> in NaI solution for microdetermination of blood sugar. Ataullakhhanov (3G) extracted the I<sub>2</sub> with toluene for colorimetric determination of sugar instead of titrating in a modified Hagedorn-Jensen method. Blecher (6G) determined 2-deoxy-D-glucose fluorometrically with 3,5-diaminobenzoic acid. Shibata and Mishima (34G) reported an improved technique for the determination of serum glucose with *o*-aminobiphenyl. The 3,5-dinitro-salicylic acid method of Sumner was improved by Mohun and Cook (28G) for C.S. F. sugar determination. Hyvarinen and Nikkila (19G) modified the *o*-toluidine blood glucose method of Hultman by stabilizing the color reagent by addition of thiourea. The thymol-sulfuric acid reagent for blood sugar was assayed by Gröger (16G) and improved by Kraus and Simane (23G). Other colorimetric methods for blood glucose determination were reported by Dubowski (18G) using *o*-toluidine and Aghdashli (2G) by use of phenylhydrazine. Jusic and Fiser-Herman (21G) described a technique for the identification of sugars in urine by paper electrophoresis. A new reagent for the decoloration and deproteinization of urine for the polarimetric determination of glucose was described by Lehmann (24G). Watson (37G) evaluated the interference of nonglucose reducing substances in nine different methods for estimation of blood glucose.

Steinitz (36G) developed a technique for the detection and identification of fructose 1-phosphate by paper chromatography. Smith and Thomas (35G) modified the orcinol procedure of Brückner to permit rapid analysis of galactose in blood. Cipera (11G) determined 2-amino-2-deoxy-galactose spectrophotometrically at 325 m $\mu$  by heating with strong H<sub>2</sub>SO<sub>4</sub>. Improved and simplified methods were reported for xylose in urine by Kerstell (22G), for hexosamines in serum by Canturi (10G), and for glucosamine, galactosamine, and hydroxyproline by Partridge and Elsden (31G). Miller (27G) analyzed oligosaccharides with micro columns packed with stearic acid treated mixtures of charcoal and celite.

The use of the glucose oxidase-peroxidase-*o*-dianisidine system for de-

termination of blood glucose has been reported by Raabo and Terkildsen (32G), Jakobsen (20G) and Blecher and Glassman (7G). Campbell and Kronfeld (9G) used 3,7-dimethoxybenzidine instead of *o*-dianisidine in this system. Schmidt (33G) estimated enzymatically glucose and fructose by conversion to their 6-phosphate derivatives by incubation with hexokinase and adenosine triphosphate. Welch and Danielson (38G) reported on the effect of different methods of precipitation of protein on the enzymatic determination of blood glucose. The sodium hydroxide-zinc sulfate method of Somogyi was found to be the most acceptable.

#### CATIONS AND ANIONS

An expert review of flame photometry was made by Gilbert (28H) which covered terminology, instrumentation, analytical characteristics, elements determined, materials analyzed, and some medical applications. MacIntyre (41H) also reviewed flame photometry to provide a critical account of modern flame photometry to help the clinical chemist decide whether flame photometry is applicable to a particular problem. Margoshes (42H) reviewed emission flame photometry with reference to books, reviews, equipment, individual elements, indirect methods, interference phenomena, and biological materials. West (65H) reviewed inorganic microchemistry. Hall (29H) described practical biological applications of x-ray fluorescence analysis for determination of Fe, Ca, K, S, P, and Br. Beyermann and Cretius (12H) described micro-methods for the determination of Cl, K, Na, Ca, Mg, Fe, and Cu in biological material. Andersen *et al.* (3H) developed a method suitable for capillary blood for the determination of pH, CO<sub>2</sub> tension, base excess, and standard bicarbonate. Astrup (4H) gave a detailed description of a glass capillary electrode for determination of acid-base values of blood based on the equilibration principle. Andersen (2H) devised a new acid-base nomogram for an improved method for the calculation of the relevant blood acid-base data.

New and improved micro methods for the spectrophotometric determination of calcium were described by Williams and Wilson (67H) using glyoxol bis-(2-hydroxyanil), by Webster (64H) using a modification of the Ferro and Ham method, by Radin and Gramza (52H) using Eriochrome Blue SE, and Kingsley and Robnett (35H) used nuclear fast red. Delaville, Delaville, and Noel (19H) and Brush (16H) modified the method of Kingsley and Robnett in which the dye Erio SE (Plasco Corinth B) is used. Ettori and Scoggan (22H) described a two wavelength

spectrophotometric method for the determination of ionized calcium in serum using murexide as the metal indicator. Hofman (32H) used the fluorescent indicator fluorexon as an indicator for the titration of calcium with the disodium salt of ethylene diamine tetra-acetic acid. Plasco Corinth B was used as a calcium titrator indicator by Kitamura and Arimatsu (36H). Lindstrom and Stephens (39H) suggested magnesium iodate tetrahydrate as a superior primary standard for the preparation of standard EDTA solutions for calcium plus magnesium titrations. Toribara and Koval (62H) have experimentally verified theoretical calculations showing the effect of pH on the precipitation of calcium by oxalate in the presence of EDTA. Titration of calcium in biological material was made by Toribara and Koval (63H) using calcein as indicator in EDTA titration, and by Pappenhaben and Jackson (47H) using Cal-Red indicator for titration of calcium in presence of magnesium. Methods for the flame photometric determination of calcium in biological materials were described by Diller (20H) for urine, by Dreisbach (21H) to assay interferences, by Fawcett and Wynn (28H) in plasma, urine, and feces, by Geyer and Bowie (27H) in tissues and by Thiers and Hviid (61H) to obtain "Automatic background-subtraction." Willis (66H) described a method for determination of calcium and magnesium in urine by atomic absorption spectroscopy. Techniques were presented by Breen and Freeman (15H) and Loken *et al.* (40H) to determine protein-bound and free calcium in serum by ultra-centrifugal analysis. Stevenson and Wilson (59H) employed cation-exchange resin to separate calcium and magnesium for their determination in biological fluids.

Improved or modified methods for the determination of chloride in serum were described by Hamilton (30H) who employed mercuric thiocyanate and perchloric acid, by Baar (5H) using colorimetric measurement of the acid chloranilate liberated from the reaction of chloride with dichlorodihydroxybenzoquinone mercuric salt, and by Baumann and Hatmaker (8H) who made an ultramicro modification of the method of Franco and Klein in which argentimetric titration of chloride with dichlorofluorescein was made. Cotlove (17H) developed a Cl<sup>35</sup> isotope-dilution method for measurement of the true chloride content of biological samples.

Spare (58H) made a detailed study of the titan yellow dye lake methods for the estimation of serum magnesium, Kawashima and Ueda (34H) modified the method by the addition of methylene blue to the final reaction mixture, and Lewis (38H) stabilized the color

with polyvinyl alcohol. Flame spectrophotometric methods for the determination of magnesium in biological specimens were described by Alcock, MacIntyre, and Radde (1*H*), Montgomery (43*H*), Nifontova (45*H*), Schmidt (55*H*), Suzuki (60*H*), and Dawson and Heaton (18*H*). Schachter (54*H*) used the reaction of magnesium with 8-hydroxy-5-quinolinesulfonate for its measurement by the characteristic fluorescence produced. Baum (7*H*) used the property of Mg ions to activate isocitric dehydrogenase for the determination of ionized Mg in plasma. A simple and accurate micro procedure for the determination of phosphate and phospholipids was described by Baginski and Zak (6*H*). Oliver and Funnell (46*H*) determined phosphorous in biological material by evolution of P from boiling tartaric acid in a non-oxidizing atmosphere and absorbing the P on HgBr, then eluting with I<sub>2</sub> solution to convert to phosphoric acid for colorimetric measurement. Bernhart, Chess, and Roy (11*H*) determined phosphorous in the presence of Na and K by flame photometry by its interference on flame emission of strontium at 660 m $\mu$ .

Potassium was determined by precipitation as the tetraphenylborate and by flame photometry by Reed and Scott (53*H*) and by Bladh and Gedda (13*H*) by titration of the tetraphenylborate with cetyltrimethylammonium bromide. Complexometric methods for the determination of potassium were described by Holasek and Pecar (33*H*) who precipitated potassium from dilute urine as the hexanitritocobalt salt and the cobalt determined by titration with EDTA using copper-PAN as indicator, and by Herbinger and Hubmayer (31*H*) by titrating cobalt by the addition of an excess of disodium EDTA and back titrating with ZnSO<sub>4</sub> and Eriochrome Black T as indicator. Lazarov (37*H*) determined potassium by a method based on the formation of the insoluble K<sub>2</sub>Pb(Cu(NO<sub>2</sub>)<sub>6</sub>) and the NO<sub>2</sub> of the precipitate oxidized with rivanol and determined colorimetrically. Selleri and Caldini (56*H*) determined sodium and potassium gravimetrically with N<sub>1</sub>V-di-alkyl-ethanolammonium orotates. Sodium and potassium in biological material was determined by Pijek and Hoste (50*H*) by neutron activation analysis and by Bowen and Gawsse (14*H*) by radioactivation. Paton and Steinfeld (48*H*) described techniques for the simultaneous measurement of exchangeable sodium and potassium in man. Newell and Duke (44*H*) adapted the Coleman Model 21 flame photometer for routine micro assays of Na and K in serum. Improved techniques and electrodes for the measurement of sodium and potassium were described by Friedman (25*H*) (glass electrodes) by

Friedman and Nakashima (26*H*) (sodium electrodes), and by Portnoy, Thorman, and Gurdjian (51*H*) (Na and K glass electrodes). Flear and Florence (24*H*) outlined a system for obtaining small amounts of muscle from patients for analysis for water, Na, K, Cl, and fat. The many factors which influence the determination of Na and K in plasma were enumerated by Bergstrom and Hultman (10*H*). An indirect flame photometric determination of total sulfur in biological materials was described by Shaw (57*H*) by the oxidation of the sample in HNO<sub>3</sub>-HClO<sub>4</sub> and determination of the S by the luminescence of the residual Ba after precipitation as BaSO<sub>4</sub>. Berglund and Soerbo (9*H*) presented a simple turbidimetric method for analysis of inorganic sulfate using barium chloride-gelatin reagent. Petersen, Mitchell, and Langham (49*H*) estimated fast-neutron doses in man by S<sup>32</sup> (*n,p*), P<sup>32</sup> reaction in body hair.

## DRUGS

Papariello, Slack, and Mader (17*J*) reviewed analytical procedures of interest to pharmaceutical analysts. Thin layer chromatographic procedures were applied to the separation and identification of barbiturates, "phenothiazines," "antihistamines" and other drugs by Sunshine and Rose (28*J*) and Cochin and Daly (4*J*). Techniques were described by Bonnichsen, Maehly, and Norlander (1*J*) for the separation and identification of caffeine, antipyrine, and phenacetin in human tissue. Colorimetric methods for drugs in biological specimens were described by Nambara and Urakawa (16*J*) for 4-acetamidoantipyrine, by Kaul (11*J*) for tetrahydroaminoacridine, by Quadrat (23*J*) for *p*-dimethylaminobenzaldehyde, by Hanok (8*J*) for salicylates and by Dutkiewicz (6*J*) for *p*-aminophenol. Stevenson (26*J*) determined salicylate in blood by a rapid ultraviolet spectrophotometric method. Chemical methods for the determination of penicillin in urine were developed by Klimov and Zhukova (12*J*) and Grafnetterova (7*J*). Mellett and Woods (14*J*) estimated mechlorethamine (mustargen) in urine by a fluorometric method. Heller *et al.* (9*J*) measured 1-iso-nicotinyl-2-acethylhydrazine in biological fluids by an ion exchange method. A fluorometric method based on the production of a fluorescent derivative of isoniazid by reaction with CNBr was used by Peters (20*J*) to measure isoniazid in plasma. A spot test of isoniazid in urine was proposed by Cattaneo, Fantoli, and Belasio (3*J*) using paper impregnated with borate buffer at pH 10, at 0.3% solution of 1,2-naphthoquinone-4-sulfonate, and 0.5% ether solution of mercuric chloride.

Hetzler (10*J*) estimated phenothiazine derivatives in urine and blood by a method based on the colorimetric determination of the yellow nitration products of these compounds formed after alkaline ether extraction. Street (27*J*) estimated phenothiazine derivatives by photometric measurement at 270, 278, and 219 m $\mu$  after H<sub>2</sub>SO<sub>4</sub> treatment. Sheppard, Mowles, and Plummer (25*J*) determined hydrochlorothiazide in urine by extracting with ethyl acetate and reacting directly with chromotropic acid or hydrolyzing first with alkali followed by diazotization and condensation with *N*-(1-naphthyl)-ethylene diamine HCl. Pisano *et al.* (21*J*) identified *p*-hydroxy-*a*(methylaminomethyl)benzyl alcohol (synephrine) in urine by several different techniques. A comparative study of methods for the determination of tolbutamide and its oxidized catabolite, *p*-carboxybenzenesulfonylbutylurea were made by Mesnard and Crockett (15*J*). Schwartz and Rieder (24*J*) estimated benzoquinolizines in biological fluids by their fluorescence after dehydrogenation with mercuric acetate. Pavlu and Sula (19*J*) estimated trace amounts of 3,4-benzopyrene in biological material by fluorescence spectrophotometry. Parker, Fontan, and Kirk (18*J*) described the preparation of 50 commonly known tranquilizers in organic solvent for injection into the argon gas chromatograph for separation and identification. Bradshaw and Douglas (2*J*) used the fluorescent peak at 580 m $\mu$  for determination of 3-*o*-tolyloxy-1,2-propanediol (mephenesin) at which contaminants interfered less than at 315 m $\mu$ . Madsen (13*J*) determined meprobamate by a method based on the colored compound which it forms with *p*-dimethylaminobenzaldehyde and antimony trichloride-acetic anhydride. Spectrophotometric determination of sodium thiosulfate in body fluids was made by Dixon (5*J*) by use of an iodine-amylose complex. Porcaro and Johnston (22*J*) determined menthols by gas chromatography.

## LIPIDS

Rouser *et al.* (42*K*) reviewed methods, applications, and interpretations of paper chromatography of lipids. Lis, Tinoco, and Okey (34*K*) presented a micro method for separating by silicic acid chromatography 1 to 10 mg. of a complex mixture of lipid of biological origin into four fractions. Doizaki and Zieve (10*K*) separated phospholipids and neutral lipids of serum by rapid thin layer chromatography. Biezenski (5*K*) removed nonlipid contaminants from lipid extracts by applying the extracts in a line to paper lightly impregnated with silicic acid and eluting in a descending manner with 20%

$\text{CH}_3\text{OH}$  in  $\text{CHCl}_3$ . Anderson and Langham (1K) and Forbes and Hursh (15K) reviewed the development of methods for the determination of total body K by whole-body scintillation counting and studies to establish the utility of body K as a measure of the gross body composition.

Simplified methods were proposed for the determination of total lipids in serum by Brandstein and Castellano (7K) who modified the Schain butterfat method, by Azarnoff (2K) by Connerty, Briggs, and Eaton (8K) and by Jacobs and Henry (25K) who reported on an investigation of gravimetric methods.

James (26K) reviewed the qualitative and quantitative determination of fatty acids by gas liquid chromatography. Tinoco *et al.* (47K) compared two absolute methods in the analysis of fatty acid mixtures. Hlynaczak *et al.* (23K) determined higher fatty acids colorimetrically by chromatography, treatment of the separated fatty acids with copper acetate, and elution and measurement of the copper with  $\text{H}_2\text{SO}_4$  and dithizone. Dole and Meinertz (11K) reported that a single extraction of blood plasma with a 2-phase heptane-isopropyl alcohol-water system is sufficiently specific for the determination of long-chain nonesterified fatty acids. Gerstl *et al.* (17K) developed a technique for the efficient removal of polyunsaturated fatty acids of red blood cells by prolonged Soxhlet extraction with ethyl alcohol and ether (3:1). Techniques for the separation of free fatty acids in biological specimens from other lipids were described by McCarthy and Duthie (35K), by Noerby (40K) and by Hallgren and Svanborg (20K). Drysdale and Billimoria (12K) developed a new micro method for the estimation of serum total fatty acids in which extracts made with ether-alcohol (1:8) are hydrolyzed with alkali, extracted with heptane, and titrated in a two-phase system with thymol blue. Barreto and Mano (3K) reported a colorimetric method for the assay of higher fatty acids in blood in which the solubility of the copper salts of the fatty acids in chloroform and their reaction with sodium diethyl-dithiocarbamate was used as a colorimetric method. Metcalfe and Schmitz (39K) rapidly prepared fatty acid esters for gas chromatographic analysis by converting the fatty acids to their methyl esters in 2 minutes with boron trifluoride-methanol. Landowne and Lipsky (32K) distinguished between unsaturated and branch-chain fatty acid isomers by use of high-efficiency polyester capillary columns operated at two different temperatures. A mercury derivative-chromatographic method for the separation of unsaturated fatty acid esters was used by Kuemmel (31K) based on the forma-

tion of the mercuric acetate addition of compounds of unsaturated methyl esters, followed by a chromatographic separation.

The determination of fatty acid esters in serum by the hydroxamate method were described by Verheyden and Nys (49K), Kasuga (27K), Haskins (21K), and Galletti (16K). Prestaining of serum lipoproteins for electrophoresis was described by Zilberman and Moibenko (51K) using acetylated Sudan IV in diacetin, by Ushakov and Polozhentsev (48K) using Sudan Black in 96%  $\text{C}_2\text{H}_5\text{OH}$ , by Searey *et al.* (46K) using protoporphyrin IX, and by McDonald and Kissane (37K) and Bogoyavlenskii and Rozenshtein (6K) by using Sudan Black B. McDonald and Banaszak (36K) studied the rate of fading of Sudan Black B bound to high and low density lipoproteins. A new lipoprotein staining method was described by Kohn (30K) in zone electrophoresis by treatment by either ozone or KI followed with Schiff's stain. Another new color reaction for rapid determination of lipoproteins was used by Di Leo (9K). Groulade and Ollivier (18K) employed Cerol black B instead of Amidoschwarz 10 B for staining lipoproteins in paper chromatograms. A new technique using diphenylcarbazone was reported by Rudd (43K) for the detection of phospholipids in electrophoretically separated serum lipoproteins. Searey *et al.* (44K) described a simplified technique for estimation of serum lipoprotein cholesterol. Ressler, Springgate, and Kaufman (41K) used a semifluid medium for the migration of lipoproteins to minimize their absorption by the medium. Fidanza and Cioffi (13K) outlined a method for the separation and determination of serum lipoproteins by electrophoresis on a starch block. Quantitative serum beta lipoprotein methods were described by Kellen and Pisarcikova (28K) using turbidity measurement in K-agar, by Heiskell *et al.* (22K), Bergquist, Carroll, and Searey (4K) and Searey *et al.* (45K) by means of the immunocrit using a specific antiserum, and by Florsheim and Gonzales (14K) by ultracentrifuge and polyanion precipitation methods.

Hagen (19K) developed an enzymic method for the estimation of plasma glycerol and Mendelsohn and Antonis (38K) modified the Skraup reaction for the determination of glycerol by a fluorimetric micro method. Horrocks and Cornwell (24K) determined glycerol and fatty acids in glycerides by gas liquid chromatography by hydrolyzing glycerol esters with  $\text{LiAlH}_4$  and acetylation with  $\text{Ac}_2\text{O}$  to convert to fatty alcohol and glyceryl acetates. The use of silicic acid paper chromatography was described in detail for the measurement of serum lecithin, lyssolecithin, and sphingomyelin by Vogel, Zieve, and

Carleton (50K). Lauter and Trams (33K) determined sphingosine by complex formation with methyl orange. Khomutov and Garkusha (29K) used 2-thiobarbituric acid as a color forming agent for detection of oxidized fats.

## ENZYMES

King and Campbell (33L) reported at the International Congress on Clinical Chemistry in Edinburgh, August 1960, that the International Sub-Commission on Clinical Enzyme Units recommends that all enzyme activities should be calculated in terms of micromoles of substrate transformed per minute (International Units) and concentrations expressed in liters or milliliters. Examples of calculations necessary for these alterations were given and the conventional units for the most widely used methods were related to micromoles per minute per liter (International Units). Bodansky (5L) reviewed the present and future role of enzymology in clinical pathology.

Sax and Trimble (55L) used a modified saccharogenic method with high concentration of soluble starch and buffering and copper reduction by a modified Nelson-Somogyi technique by which up to 2000 Somogyi units can be measured without repetition. Reif and Nabseth (50L) modified Somogyi's amyloclastic amylase assay by substitution of a spectrophotometric end point for visual observation, and Dahlquist (12L) described a method for the determination of amylase activity in intestinal content using 3,5-dinitrosalicylate reagent for the assay of the reducing groups liberated from starch. Dahlquist (11L) developed a method for the determination of intestinal maltase and isomaltase based on a tris-glucose oxidase reagent. Fomina and Titova (19L) determined hexokinase activity by measurement of the accumulation of 2-deoxy-D-glucose 6-phosphate. Forsell and Palva (20L) devised a sensitive method for the determination of arginase activity in normal serum. Thorup, Strole, and Leavell (62L) localized catalase on starch gel after electrophoresis. Grassmann and Nordwig (22L) employed carbobenzoxyglycylprolylglycyl-glycylprolylalanine as a substrate for colorimetric test for collagenase. Saev and Schchtereva (53L) proposed a new colorimetric hydroxamic method for the determination of serum cholinesterase in 0.1 ml. of serum. Linuchev (38L) described a method for the differential assay of acetylcholinesterase and pseudocholinesterase based on the use of di-choline ester of suberic acid, a substrate hydrolyzable only by pseudo-cholinesterase. Breuer and Schönfelder (7L) also described a method for differentiating the enzymes in serum which split acetylcholine. The determination of

ceruloplasmin in serum using *p*-phenylenediamine as substrate was reported by Ravin (49L), by Scheiffarth, Goetz, and Czagany (56L), by Rice (52L) who standardized ceruloplasmin activity in terms of internationale enzyme units, and by Henry *et al.* (26L) who studied the effects of pH and temperature on the reaction. Abreu (1L) used *N,N*-dimethyl-*p*-phenylenediamine for determination of serum ceruloplasmin oxidative activity. Spectrophotometric methods for the determination of elastase were reported by Chao, Sciarra, and Vosburgh (8L) and Schneider *et al.* (57L). Hughes (29L) described a method for the estimation of serum creatine kinase.

Methods for the electrophoresis of serum lactic dehydrogenase were described by Laursen (37L) using agar plate and fluorimetric measurement, by Yakulis, Gibson, and Heller (66L) using agar gel and histochemical stain, by Dewey and Conklin (18L) and van der Helm (63L), using nitro blue tetrazolium and phenazine methosulfate, by Ressler and Joseph (51L) using a similar method, by Hill (28L) and by Bowers and Bartlett (6L) using cellulose acetate papers. Nachlas *et al.* (43L) compared a colorimetric method using phenazine methosulfate as an intermediate agent for electron transfer from DPNH to a tetrazolium salt to other methods. Ells (15L) used 2,6-dichloro-indophenol in this procedure instead of tetrazolium salt. Hess and Walter (27L) described a method for differentiating two types of lactic dehydrogenase activity from heart and skeletal muscle. Wacker and Dorfman (64L) developed an adequate method for measurement of LDH activity in urine by removing inhibitors by dialysis. Elliott and Wilkinson (14L) determined alpha-hydroxy butyric dehydrogenase activity in serum by a method similar to the LDH method of Wroblewski. Nanikawa and Tawa (44L) preferred neotetrazolium to methylene blue and 2,3,5-triphenyltetrazolium chloride for the determination of succinic dehydrogenase in tissues. King (34L) described a routine colorimetric method for the estimation of serum malate dehydrogenase activity.

Rässler and Schön (48L) modified the Bratton-Marshall reaction for determination of 2-naphthylamine resulting from the splitting of L-leucyl-2-naphthylamide by leucine aminopeptidase activity. Miller and Worsley (41L) described a similar method. Serum lipase methods were described by Wolff, Brignon, and Schemberg (65L) and Suehiro and Nakanishi (61L) for the determination of lipoprotein lipase. Saifer and Perle (54L) modified the method of Raderecht and Moskau in which the substrate phenyllaurate is used to determine small amounts of lipase in normal serum. Zieve and Vogel (67L) determined lecithinase A in serum by meas-

uring free fatty acids released after incubation of a lecithin substrate with the enzyme source. Stern, Wilke, and Hollifield (59L) used *p*-hydroxyphenylacetaldehyde semicarbazone as an internal standard in monoamine oxidase assays. Green and Haughton (23L) used 2,4-dinitrophenylhydrazine in a colorimetric method for the estimation of monoamine oxidase. Jacobsson (31L) determined tartrate-inhibited phosphatase in serum with the chromogenic substrate *p*-nitrophenylphosphate. A specific substrate containing a metal salt of  $\alpha$ -naphthyl phosphate for prostatic acid phosphatase was patented by Babson (2L). Estborn (16L) completely separated serum acid and alkaline phosphatase by zone electrophoresis in starch gel. Methods for a variety of enzyme activities were reported by Humlcek and Hruska (30L), for the determination of procain esterase in serum by chromatography, by Pappenhaben, Koppel, and Olwin (47L) using fluorescein-labeled fibrin for the determination of fibrinolytic activity, by Schonbaum, Zerner, and Bender (58L) for the spectrophotometric determination of  $\alpha$ -chymotrypsin normality, by Klimek and Pietrzycza (35L) for the estimation of oxytocinase, and by Ezerskii (17L) who reported a new clinical test for serum phosphohexose isomerase.

Methods for estimating the activity of various protein splitting and related enzymes were reported by Chikalo (9L) for proteinase action using radioactive protein ( $S^{35}$ ) as substrate, by Nelson, Ciaccio, and Hess (45L) for assay of proteolytic enzymes using insoluble dye-protein complexes as substrates, by Orlowski and Szewczuk (46L) for measurement of  $\gamma$  glutamyl transpeptidase activity based on the colorimetric determination of  $\alpha$ -naphthylamine liberated from  $\gamma$ -L-glutamyl- $\alpha$ -naphthylamide, by Blackwood and Mandl (4L) for trypsin based on the determination of naphthylamine released from trypsin substrate, benzoylarginine- $\beta$ -naphthylamide, by Matsuzawa (40L) for tyrosinase based on the conversion of 3,4-dihydroxy-phenalanine to phenalanine 3,4-quinone at pH 6 and 20° C., by Goldborg *et al.* (21L) for  $\gamma$ -glutamyl-transpeptidase using a synthetic chromogenic substrate *N*-(DL- $\gamma$ -glutamyl)-aniline in which the aniline is liberated, by Floch *et al.* (18L) for uropepsin by means of albumin  $I^{131}$ , and by Chou and Sung (10L) for a colorimetric uropepsin method.

Kurnick (36L) reviewed the assay methods for deoxyribonuclease activity. Miller, Segal, and Harrington (42L) described a method for measurement of urinary deoxyribonuclease based on the reaction of indole with deoxyribonucleotides. A method was employed by Grossman and Greenlees (24L) to distinguish between deoxyribonucleosides,

the monophosphate and the triphosphate esters, based on a colorimetric procedure requiring the free aldehyde form of 2-deoxyribose. Josefsson and Lagerstedt (32L) reviewed the quantitative assay methods for the depolymerizing activity of ribonuclease and methods assaying the cyclic phosphatase activity of RNase by spectrophotometer, turbidimetric, paper chromatographic, and electrophoretic analyses. Stockx, Vandendriessche, and von Parijs (60L) described a new method for the direct spectrophotometric determination of ribonuclease activity with 2',3'-cyclic cytidylic acid. Gupta, Ghosh, and Mal (25L) made a comparative evaluation of three colorimetric techniques (Sall *et al.*, Reitman and Frankel, and Cabaud *et al.*) for the estimation of serum glutamic-oxalacetic transaminase. Bason *et al.* (3L) developed a new colorimetric assay method for serum glutamic-oxalacetic transaminase based on the coupling of oxalacetic acid with a stabilized diazonium salt. Marks (39L) described a simple spectrophotometric method for measuring oxoglutarate and pyruvate specifically in the same blood or urine using glutamic dehydrogenase and lactic dehydrogenase.

#### FUNCTION TESTS

**Gastric.** Methods for the tubeless determination of gastric acidity were described by Grabener (18M) who administered orally caffeine followed by azopyridine, by Balassa (5M) and Babando and Pasquale (4M) who administered orally 3-phenyl-2,6-diaminopyridine combined with protein, and by Lubran (27M) who determined the urinary excretion of Azure A which forms a complex with picric acid soluble in CHCl<sub>3</sub>. Ishimori and Glass (24M) presented a method for the concentration of native gastric juice by dialysis against a 30% solution of Carbowax 6000 in distilled water prior to paper electrophoresis. Welsh, Russell, and Wolf (41M) using resin column chromatography found six distinct and fairly symmetrical protein-containing peaks in normal gastric juice.

**Kidney.** Cooper and Biggs (15M) evaluated the urinary creatinine methods of Folin, Hare, Van Pilsium, and Sullivan and Irreverre and found satisfactory precision with the exception of the latter procedure. Biggs and Cooper (8M), after studying the effects of variation of NaOH and picric acid concentration, volume of solution, and heating time, modified the Folin method for urinary creatine and creatinine to obtain a more convenient method. Adams, Davis, and Hansen (2M) devised a specific method for creatinine determination based on adsorption of creatinine on ion exchange resin [Dowex 2-X-8 (Cl-form) 200 to 400 mesh] from urine diluted with alkaline NH<sub>4</sub>Cl and subse-

quent measurement at 234.5 m $\mu$  and pH 10.4. A simple endogenous creatinine clearance technique was described by Tobias, McLaughlin, and Hopper (38M) for evaluation of glomerular filtration. Clarke (14M) described conditions for the determination of "apparent" creatinine and "total" creatinine in urine within 2% accuracy with the Jaffe method. Grant and Wigh (19M) presented a new renal function test based on excretory urine radiography of organic iodide in urine after intravenous injection of roentgenographic contrast medium. Blanka (9M) detailed procedures for qualitative analysis of renal stones by test tube and droplet reactions and microcrystalloscopic identification.

**Liver.** A joint committee from the American Academy of Pediatrics, College of American Pathologists, American Association of Clinical Chemists and the National Institutes of Health recommended that a bilirubin standard to be acceptable must give a 1 cm. molar absorptivity of 60,700(800 SD) at 453 m $\mu$  in chloroform at 25° C. (3M). Henry, Jacobs, and Chiamori (21M) examined a number of commercial bilirubin preparations and described a technique for purification of bilirubin. Schellong and Wende (34M) outlined a technique for the standardization of bilirubin methods and recommended a standard solution containing 40 mg. of bilirubin in 2 ml. of 0.1M Na<sub>2</sub>CO<sub>3</sub>, added to 13.9 ml. of serum, and neutralized with 0.1N HOAc. Watson (39M) recommended methods for the preservation of specimens to prevent oxidation and procedures to give maximal specificity for the type of bilirubin pigment assayed. Free and total serum bilirubin were determined by Stevenson, Jacobs, and Henry (36M) by measuring the absorbance of serum diluted with acid containing ethylene glycol at 450 m $\mu$  for assay of total bilirubin and free bilirubin was extracted with chloroform for its assay. Michaelsson (30M) in an 80-page monograph compared the commonly used bilirubin methods with each other, studied the effects of adding hemolyzed blood, and proposed a new modified procedure using a copper azo reagent. Rand and DiPasqua (33M) studied several diazo couplers for determining bilirubin and found 2,4-dichloroaniline stable for one month when diazotized and dissolved in methanol. This reagent gave maximum color in 10 minutes. Boutwell (11M) reported optimum conditions for use of the acetamide bilirubin method. A simplified diazo method for total bilirubin using 0.02 ml. of plasma was described by Polesky, Seligson, and Brahen (32M). A modification of Bruckner's total serum bilirubin method was described by Bethoux (6M, 7M) and also a modification of Rivoire's method for free bilirubin. Brodersen (12M) made a detailed study of the kinetics of the Van

den Bergh reaction. Chiamori, Henry, and Golub (13M) concluded from a study of the spectrophotometric determination of bilirubin that direct and indirect bilirubin have essentially equal absorptivities at the wavelengths employed. Fog and Jellum (17M) studied three different reactions between bilirubin and other tetrapyrroles and 3-methyl-2-benzothiazolone hydrazone-HCl. Gregory and Watson (20M) compared the conventional fractional determination with chromatographic and solvent partition methods for free and conjugated bilirubin and concluded that fractionation of the individual bilirubin pigments was neither of diagnostic nor prognostic value. Witmans, Schalm, and Schulte (42M) could not detect conjugated bilirubin in normal serums by chromatography. Watson (40M) found that plasma from infants with hepatitis may contain appreciable amounts of nondiazo-coupling yellow pigments of unknown composition. Thomas and Plaa (37M) described a simple rapid extraction method for the simultaneous determination of sulfobromophthalein sodium and its major metabolite in blood.

MacIntyre and Wootton (28M) reviewed methods of estimation of bile acids in blood. Methods for the determination of serum bile acids were described by Levin and Johnston (26M) using a fluorometric method, and by Hoffman (22M, 23M) using thin layer adsorption chromatography with silicic acid. Boettcher, Pries, and van Gent (10M) described a rapid and sensitive colorimetric micro method for free and bound choline using *cis*-aconitic anhydride. Ackerman and Chou (1M) determined choline in tissue by precipitating as reineckate and dissolving in 50% NH<sub>4</sub>OH and making a spectrophotometric measurement at 303 m $\mu$ . Ellman, Burkhalter, and LaDou (16M) used the fluorescence of hippuric acid in 70% H<sub>2</sub>SO<sub>4</sub> for its qualitative assay in urine (2  $\mu$ l.). Hepatic blood flow was measured by Ketterer, Weigand, and Rapaport (25M) by hepatic uptake and biliary excretion of indocyanine green. Liver function was measured by a new procedure by Wu (43M) by administering compound S-(11-deoxy-17-hydroxycorticosterone) and assaying urinary excretion of 17-keto steroids. Mills (31M) described procedures using anion exchange resin for preliminary purification of porphyrins in highly colored urine specimens. Zenker (44M) presented a screening method for urinary porphyrins utilizing the soot band. A sensitive screening test for coproporphyrin in urine was proposed by Mentz and Grotewall (29M) in which 15 ml. of urine was extracted with 3 ml. of a 1:1:1 mixture of glacial acetic acid, ether and amyl alcohol and examined for fluorescence in ultraviolet light after standing in the dark for 24 hours.

A simple plasma porphyrin method using HCl-treated Floresil chromatograph columns was described by Schlenker, Davis, and Kitchell (35M).

#### HEMOGLOBIN

Remmer (14N) made a critical survey of the procedures used for the determination of hemoglobin in clinical laboratories and concluded that the cyanmethemoglobin method was both accurate and convenient. Kumlien, Paul, and Ljungberg (10N) compared three methods, cyanmethemoglobin, oxyhemoglobin, and pyridine hemochromogen for the assay of hemoglobin in blood and found that all gave correct values. Schoen and Solomon (15N) used thawed frozen mixed oxalated blood from the blood bank as a hemoglobin precision control standard and found it to be accurate and reliable for one to two years after preparation. Van Kampen and Zijlstra (17N) determined hemoglobin as hemoglobincyanide to shorten the procedure to 4 minutes. Collins, Haukohl, and Balmer (2N) evaluated the Crosby and Furth and Fielding and Langley methods for serum hemoglobin and found that the latter method gave lower results. Rapid and precise determinations of blood hemoglobin were made by Street (16N) using a color reaction of EDTA. Dumazert, Ghiglione, and Artaud (4N) determined total iron in blood by a method based on the formation of yellow complexes of ferric iron and antipyrine. Natelson and Sheid (11N) applied x-ray spectroscopy to the determination of the iron content of whole blood. Engle *et al.* (5N) described the separation of normal and abnormal hemoglobins by starch-gel electrophoresis. Methods for the quantitative paper electrophoresis of hemoglobin A<sub>2</sub> have been described by Johnson and Barrett (9N) using glycerol hemolysates, by Jim (8N) using tris(hydroxymethyl) aminomethane buffer, by Ibbotson and Crompton (7N) and by Friedman (6N) using multi-channel cellulose acetate strips. 3,3'-dimethoxybenzidine and peroxide were used by O'Brien (12N) and Amido Black by Puchtler and Sweat (13N) as stains for hemoglobin. Dobryszycka (3N) described a new method for the determination of Hb-binding capacity of serum. Ben-Gershon (1N) described a technique using CO for detecting denaturation in hemoproteins.

#### METALS

Anderson and Weinbren (3P) increased the accuracy of the flame photometric method for the determination of chromium by use of its sesquioxide as an inert reference substance. Anand, Deshmukh, and Pandey (2P) measured cobalt by the absorbance at 358 m $\mu$  of the red color produced by the reaction of cobalt with thioglycolic acid. Frier-

son *et al.* (15P) studied the reactivity of 1,2,3-cyclohexanetrione with cobalt as a method for its spectrophotometric determination. Burke and Yoe (7P) determined both cobalt and nickel by spectrophotometric measurement of their colored complexes with 2,3-quinoxalinedithiol by measuring their combined absorbances at 510 and 656 m $\mu$ . Kupaks (18P) separated cobalt, copper, manganese, and iron by paper chromatography, and found 1-nitroso-2-naphthol the more sensitive reagent for cobalt.

Ropp and Shearer (28P) determined copper in solution by adsorption on silver-activated zinc sulfide, followed by heating to induce copper activation of the phosphor. Newman and Ryan (25P) determined copper in biological materials by oxidizing in an aqueous phase the copper dithizonate with KMnO<sub>4</sub>, reducing with H<sub>2</sub>O<sub>2</sub>, and then subjecting to flame spectrophotometry. Alexander (1P) determined zinc, copper, and iron in biological tissue ash by an x-ray fluorescence method. Connerty and Briggs (10P) found that sodium hypochlorite achieves a smoother, faster, cleaner digestion of hemoglobin of whole blood and release of iron than the use of concentrated H<sub>2</sub>SO<sub>4</sub> and per-sulfate. Spectrophotometric iron methods were described by Duswalt and Mellon (18P) who employed the colored chelate of 6-hydroxy-1,7-phenanthroline dissolved in 40% 1-propanol, by Dinsel and Sweet (11P) using a new method in which ferric iron is added to an excess of N,N - bis(carboxymethyl) anthranilic acid at pH 1.5 and measuring at 370 m $\mu$ , and by Ceriotti and Spandrio (9P) who described a method based on the oxidation of dimethyl *p*-phenylenediamine by Fe<sup>+3</sup> to give a pink color. Block and Morgan (5P), described an iron method based on the reaction between iron and the fluorescent aluminum-Pontachrome Blue Black R complex, which was extremely sensitive. Total blood iron was determined in dried specimens on filter paper by x-ray spectroscopy by Lund and Mathies (21P) and Natelson and Sheid (24P). Dubbs and Davis (12P) applied the simple anion exchange (Dowex 2-X8) procedure of Moore and Kraus for the separation of iron in serum from interfering substances. Simplified and improved iron binding capacity methods were described by Fischl and Cohen (14P), by Beale, Bostrom, and Taylor (4P) which required no heating or precipitation of the serum, by Levy and Vitacca (20P) who eliminated protein digestion and extraction of iron complex, and by Caraway (8P) who presented macro and micro methods. Simple and rapid serum iron-binding capacity methods utilizing Fe<sup>59</sup> were used by Lee and Chiamori (19P) and Tauxe and Yamaguchi (31P).

Spectrophotometric methods for the determination of manganese were reported by Miller and Yoe (22P) who incinerated plasma or red cells at 400° to 475° C. dissolving in HCl and developing color with benzohydroxamic acid. Hill, Hill, and Hill (17P) measured manganese in biological material by the rate of production of a yellow pigment resulting from the reaction between potassium periodate and diethyl analine, the rate of which depends upon the concentration of manganese present. Sastry, Raman, and Sarma (29P) determined manganese in biological samples by oxidizing with potassium periodate in orthophosphoric acid and selectively estimating the presence of excess oxidant with benzidine in formic acid. Ultramicro methods for the determination of manganese in biological materials by neutron activation analysis were described by Papavasiliou and Cotzias (26P), by Smith (30P), and by Borg *et al.* (6P). X-ray spectrometric determination of strontium in human serum and bone was reported by Natelson and Sheid (23P). Grant (16P) developed a spectrochemical method for the determination of yttrium in biological materials which combines ion exchange enrichment with spectrochemical analysis. Methods for the spectrophotometric determination of zinc were reported by Rogers (27P) using Eriochrome blue black R, by Tvaroha and Mala (32P) in blood using Rhodamine B and by Williams, Cohen, and Zak (33P) in serum by differential demasking.

#### NITROGEN COMPOUNDS

Dennemann (9Q) estimated adenosine triphosphate in whole blood by photometrically measuring the oxidation of reduced diphosphopyridine nucleotide in the phosphokinase reaction. Asatoor and Kerr (1Q) described methods for the estimation of amines in blood and urine and Ratcliffe and Smith (29Q) used column chromatography for their detection in urine. Methods for the determination of ammonia in biological specimens by the Berthelot reaction were described by Weller (35Q), by Ternberg and Hershey (33Q), and by Bolleter, Bushman, and Tidewell *et al.* (2Q). Zitomer and Lambert (37Q) described a sensitive spectrophotometric method for ammonia in water in which ammonia was chlorinated with hypochlorite to form trichloramine at pH 5.2. Excess hypochlorite was destroyed with nitrite and trichloramine reacted with cadmium iodide-linear starch reagent to produce a blue complex for spectrophotometric measurement at 615 m $\mu$ . Delorme (8Q) used a mixed indicator of bromoresol green (0.003%) and methyl red (0.066%) for titrating ammonia separated by Conway diffusion from blood. Ion exchange techniques for the deter-

mination of plasma ammonia were described by Dienst (10Q), by Fenton (12Q), by Forman (13Q) and by Hutchinson and Labby (19Q). A simple sensitive procedure for ammonia was proposed by Mathies, Lund, and Eide (27Q) who trapped the ammonia released from a Conway cell on filter paper impregnated with Nessler's reagent and determined Hg after washing by x-ray spectroscopy. Reinhold and Chung (30Q) demonstrated that the formation of ammonia during the analysis of blood samples results from the decomposition of protein by the action of alkali.

Kurohara (21Q) and Gerber, Gerber, and Altman (15Q) estimated urinary creatine by its color reaction with diacetyl and  $\alpha$ -naphthol. Conn (6Q) determined creatine in biological fluids by coupling with ninhydrin in alkaline solution to produce highly fluorescent products. Ramachandran (28Q) measured 2,4-dinitrophenylamino groups in acid solution by reduction with sodium borohydride to form an intense red color. Lee and Montgomery (24Q) presented a simple colorimetric method (490 m $\mu$ ) for hexosamine determination by phenol-sulfuric acid treatment after deamination with nitrous acid. Carr and Schloerb (4Q) described spectrophotometric methods for analysis of guanidine and methylguanidine in plasma. Turner (34Q) proposed a new reagent, *p*-dimethylaminocinnamaldehyde for assay of indole in the tryptophanase reaction. Guillaume, Tacquet, and Berthelot (16Q) described a new method for estimating isonicotinic acid hydrazide which was quantitatively extracted after coupling with salicylaldehyde and a specific reaction carried out with the pyridine nucleus.

Hashmi, Ali, and Umar (17Q) made Kjeldahl nitrogen determinations without distillation by eliminating interference from catalysts and improving the stability of sodium hypobromite and Frie (14Q) eliminated the distillation step by oxidation of nitrogen with 0.05N solution of chloramine T from which the amount of N was calculated. Spectrophotometric methods for the determination of nitrite and nitrate in serum were described by Diven *et al.* (11Q) based on the color complex formed when sulfanilamide and *N*-(1-naphthyl) ethylenediamine-2-HCl reacts with nitrite in weak acid solution and nitrate after zinc reduction. Lambert and Zitomer (22Q) determined nitrate and nitrite by the formation of a red dye by a diazotization with (4-aminophenyl) trimethylammonium and coupling with *N,N*-dimethyl-1-naphthylamine. Hozumi and Kirsten (18Q) made simple fast ultramicro-determinations of nitrogen by combustion in a sealed dry tube and weighing the mercury replacing the gaseous nitrogen. Kogler, Scheifarth, and Frenger (20Q) determined

properdin by separation as a properdin-inulin complex. Crampton *et al.* (7Q) used a 0.9- $\times$  60-cm. column of sulfonated polystyrene resin (Dowex 50) at pH 4 for the estimation of common purine and pyrimidine bases and Sorbo (32Q) applied deproteinized urine to a Dowex 50 W-X8(H form) column for the determination of taurine. Procedures employing the Berthelot reaction for the measurement of urea N in serum, were described by Wilcox and Sterling (36Q) who automated the procedure, by Searcy *et al.* (31Q), by Makarenko (26Q), by Chaney and Marbach (5Q) and by Camponovo (3Q). Other methods for the determination of blood urea N were described by Levine, Leon, and Steigmann (25Q) who formed a colored complex with *p*-dimethylaminobenzaldehyde and urea and by Lawrie (23Q) who used a xanthydroxyl reagent and 50% acetic acid and measured the turbidity produced in 15 minutes.

#### HORMONES

Jacobs, Sobel, and Henry (14R) showed that the wavelength of 365 m $\mu$  for excitation of fluorescence in the trihydroxyindole method for urinary catecholamines was less specific than 405 m $\mu$ . Hagopian, Dorfman, and Gut (12R) found certain advantages were gained by acetylating the catecholamines directly in the aqueous phase before extraction for their isolation and separation. Kraupp, Bernheimer, and Papistas (18R) described a method for the isolation and quantitative determination of total 3-*o*-methyladrenaline and 3-*o*-methylnoradrenaline in urine. Weiss and Rossi (38R) separated catecholamines by paper chromatography. Rosano and Fiore (30R) reported an enzymatic method for the determination of vanillylmandelic acid (VMA) in which L-mandelic acid dehydrogenase, isolated from *Pseudomonas fluorescens* A-312, was used to convert VMA to its alpha-keto derivative which produced an increase in absorbance at 350 m $\mu$ . Weise, McDonald, and Labrosse (37R) determined VMA by radioactive tracer and ion exchange fractionation. Methods for the quantitative determination of 3-methoxy-4-hydroxymandelic acid in urine by oxidation to vanillin for spectrophotometric determination at 350 m $\mu$  were described by Pisano, Crout, and Abraham (26R), by Goldenberg and White (11R) and by Brunjes *et al.* (4R) all of whom oxidized with periodate. Sunderman *et al.* (34R) oxidized with ferricyanide and determined vanillin in presence of indole and phosphoric acid. Woiwod and Knight (40R) coupled 3-methoxy-4-hydroxy mandelic acid in urine with diazotized *p*-nitroaniline to produce an azo dye for colorimetry. Mahler and Humoller (22R) evaluated bioassay, fluorometric, and spectro-

photometric methods for determining catecholamines and 3-methoxy-4-hydroxy mandelic acid in urine. Dauchy and Schwartz (7R) determined VMA in urine by oxidizing to vanillin with K<sub>3</sub>Fe(CN)<sub>6</sub> for colorimetry. Klein and Chernaiak (17R) separated VMA in urine by paper electrophoresis at low voltage.

Crawford and Rudd (5R) and Crosti and Lucchelli (6R) presented methods for the fluorimetric determination of serotonin in platelets or plasma. Serotonin in serum was separated as a compact bluish-purple band by paper electrophoresis by Sturm (32R) and Robertson and Andrews (29R). Sweeley and Williams (33R) reported a method for the quantitative estimation of aromatic amines such as dopamine, epinephrine, and serotonin.

Jutisz *et al.* (15R) described a new method of extraction of gonadotropin of human urine. Unger *et al.* (35R) developed a highly sensitive and specific radio-immunoassay for identification of circulating endogenous glucagon in plasma. Vallance-Owen and Wright (36R) reviewed methods for the bioassay of blood for insulin, with discussion of interpretation of findings. A new method for the determination of insulin in urine was described by Lieberman (20R) by absorption on ion-exchange resins which was sensitive enough to detect 10<sup>-4</sup> to 10<sup>-5</sup> I.U./per milliliter. A method was proposed by Boucher, Biron, and Genest (3R) for the isolation and measurement of blood angiotensin.

A rapid method for the estimation of protein-bound iodine was described by Farrell and Richmond (9R) in which iodide was separated in an Amberlite IRA 400 (Cl) anion exchange resin column. Rapid colorimetric measurements were made by use of a brucine inhibitor. Faulkner, Levy, and Leonards (10R) made several simplifications in the protein-bound iodine method. Robbins (28R) developed micromethods for detecting iodine, applicable to filter paper and column chromatography of iodoproteins and iodoamino acids. A method of preventing contamination of PBI samples during incineration was suggested by Lloyd and Parrelli (21R) by capping the tubes with aluminum foil to reduce the danger of cross-contamination and help prevent abnormal loss of iodine from samples. Elzinga, Carr, and Beierwaltes (8R) adopted the standard Durrum-type cell for reverse flow paper electrophoresis for making satisfactory determinations of thyroxine-binding protein in serum. A 5-minute open alkaline combustion was recommended by Baginski and Zak (2R) as an effective screening test for PBI. Posner (27R) outlined a simplified procedure for the determination of butanol extractable iodine in serum by strong alkali washing of butanol extracts, to remove free iodide, and treatment with aqueous ceric

sulfate in acid medium to split off the thyroxine iodine by oxidation.

Imarisio, Kotlowski, and Imperato (13R) found that dialysis was an efficient technique for removing free radioiodine from plasma. Methods using ion exchange resin uptake for measuring the degree of saturation of thyroxine-binding in red cell and serum protein employing I<sup>131</sup>-labeled triiodothyronine were reported by Lee, Pileggi, and Segalove (19R), by Nava and De Groot (23R), by Parrow (24R), by Sterling and Tabachnick (31R) and by Adams, Specht, and Woodward (1R). Pileggi *et al.* (25R) employed an anion-exchange resin Dowex-1 column for the determination of thyroxine in serum and obtained values similar to those for BuOH-extractable I. Winkler, Zubrzycki, and Mentzel (39R) compared the efficiency of three methods for the extraction of protein-bound iodine from plasma and separation of inorganic I from organic bound I<sup>131</sup> and found that the separation of I by the resin method was 100% complete. Two methods for measuring I content of blood by activation analysis, one a chemical separation before, and the other after irradiation were described by Kellershon, Comar, and LePoec (16R).

#### ORGANIC ACIDS

Nordmann and Nordmann (23T) reviewed the techniques of studying organic acids present in blood and urine which contained only C, H, and O atoms, with the exception of fatty acids, but including conjugated aromatic acids. Williams and Sweeley (36T) described a new method for determining urinary aromatic acids by gas chromatography in which an EtOAC extract of urinary aromatic acids was dried and methylated and dissolved in Et<sub>2</sub>O for gas chromatography on an adipate polyester column at 206° C. Hynie, Vecerek, and Wagner (12T) determined organic acids in urine by their oxidation to acetone, thus producing a quenching effect on 2-naphthol fluorescence. Procos (26T) studied the effects of varying concentrations of dichromate and sulfuric acid on recoveries of acetoacetic and  $\beta$ -hydroxybutyric acids by a spectrophotometric method. Slepecky and Law (33T) developed a rapid spectrophotometric assay of  $\alpha,\beta$ -unsaturated and  $\beta$ -hydroxy acids by measuring the strong bathochromic shift in the ultraviolet absorption maximum when concentrated H<sub>2</sub>SO<sub>4</sub> is employed as a solvent for these acids. Jirgl and Sochman (13T) measured colorimetrically  $\beta$ -aminoisobutyric acid in human urine as the methanolic eluate of the copper complex. Zelnicek (38T) estimated  $\alpha$ -keto acids in blood and urine by paper chromatography. Lane and Chen (17T) reported a rapid modified pentabromoacetone method for citric acid. Herbert, Fisher, and Koontz (10T) modified serum folic acid

assay with *Lactobacillus casei* by addition of phosphate-ascorbic acid buffer to standards as well as to unknowns. The interference of glucose and other agents upon the naphthoresorcinol reaction for the colorimetric determination of glucuronic acid in serum was studied and minimized by Mosher (22T) and Green, Anstiss, and Fishman (7T). Other studies for determination of glucuronic acid were reported by Marogg (21T) and Cornillot (5T) in urine. Katsuki *et al.* (16T) reported a new method for the determination of  $\alpha$ -ketoglutaric acid based on the salting-out and extraction of 2,4-dinitrophenylhydrazone. McFadden and Howes (19T) determined glyoxylic acid in biological systems by reacting with  $\text{Na}_2\text{SO}_3$  to liberate a stoichiometric amount of NaOH. Greiling (8T) developed a new colorimetric method for the enzymic determination of hyaluronic acid based on the production of an unsaturated disaccharide with hyaluronidase and the formation of a chromagen from the disaccharide-Morgan-Elson reaction estimated at 585 m $\mu$ . Vagelos, Vanden Heuvel, and Horning (35T) identified hydroxamic acids by gas chromatography of isocyanate derivatives. An enzymatic spectrophotometric method based on the enzymatic conversion of homogentisic acid to maleylacetone with homogenetic acid oxidase was described by Seegmiller *et al.* (31T) for the determination of the acid in plasma and urine. Ruthven and Sandler (28T) estimated homovanillic acid in urine by its demethylation to dihydroxyphenylacetic acid for colorimetric measurement.

Methods for the enzymatic determination of lactic acid with lactic dehydrogenase were described by Olson (24T), by Loomis (18T) who fixed the pyruvate with semicarbazide, and by Friedland and Dietrich (6T) who used 3-(nitrophenyl)-2-(*p*-iodophenyl) tetrazolium chloride as H acceptor and read the color produced by formazan at 500 m $\mu$ . Scholander and Bradstreet (30T) determined lactic acid in blood and tissues by a micromethod based on the  $\text{Ce}(\text{SO}_4)_2$ , oxidation of lactic acid to acetaldehyde, diffusion into semicarbazide, and measurement of optical extinction at 223 m $\mu$ . Nucleic acids were determined by Tsanov and Markov (34T) without preliminary separation of ribonucleic and deoxyribonucleic acids by the absorbance differences at two wavelengths, by Singh (32T) by paper chromatographic detection with basic dyes (toluidine blue and Azure C), and by Kahan (14T) in microgram amounts of proteins from animal cells in tissue culture by measuring radioactivity incorporated during growth. Hodgkinson and Zarembski (11T) determined oxalic acid in urine by precipitating it as calcium salt, ether washing, reducing to glycolic acid with Zn and  $\text{H}_2\text{SO}_4$ , and measuring colori-

metrically at 570 m $\mu$  with chromotropic acid. Blanka (1T) measured oxalic acid in urine by reducing with  $\text{Ce}(\text{SO}_4)_2$  and photometrically estimating the remaining  $\text{Ce}^{4+}$  salt with brucine.

Marks (20T) reported a combined enzymic method for measuring  $\alpha$ -oxoglutarate and pyruvate in blood and urine. Katsuki *et al.* (15T) devised a modified method for pyruvic acid by extraction of 2,4-dinitrophenylhydrazone of pyruvic acid with 0.1N  $\text{Na}_2\text{CO}_3$  from a mixture of petroleum ether and ethylacetate solvents and measurement at 355 m $\mu$ . Christensen (4T) determined phenyl pyruvic acid by the difference between total urinary dinitrophenylhydrazone and the dinitrophenylhydrazone of the alkali-stable ketones.

Saifer and Gerstenfeld (29T) modified the specific and sensitive thiobarbituric acid method of Warren for sialic acid in serum and cerebrospinal fluid by elimination of the extraction step. Sialic acids were estimated spectrophotometrically in spinal fluid by Papadopoulos and Hess (25T) by the color produced with Bial's reagent. Cerbulis and Zittle (3T) used *p*-anisidine phosphoric acid as a color reagent for sialic acid compounds on paper chromatograms. Remp and Schelling (27T) made a study of and compared the cyanide carbonate, and uricase uric acid methods. Grossmann *et al.* (9T) described a new improved analytical method for the determination of uric acid in serum. Carr and Pressman (2T) determined uric acid in serum by separation on Dowex 2- $\times$ -8, elution with 0.5M NaCl in 0.02M HCl, neutralization and buffering at pH 9.35 and absorption at 293 m $\mu$ . A method to avoid destruction of uronic acids during acid hydrolysis of mucopolysaccharides by reducing the uronic acids to aldoses and alditols before hydrolysis was described by Yosizawa (37T).

#### ORGANIC COMPOUNDS

Lundquist, Fugmann, and Rasmussen (9U) described a specific enzymatic method for the determination of free acetate in blood and tissues which involves Conway microdiffusion and reaction with sulfanilamide by means of pigeon-liver enzyme. Wiechowski (16U) determined acetoacetic acid or acetone by adding  $(\text{NH}_4)_2\text{SO}_4$ ,  $\text{Na}_2\text{Fe}(\text{CN})_6 \text{NO}_2 \cdot 2\text{H}_2\text{O}$  and  $\text{Et}_2\text{NH}$  to the sample and reading at 530 m $\mu$ . Tsao and Schwartz (15U) estimated dihydroxyacetone in biological samples by reaction of the triose with diphenylpyridine in alkaline solution. Christensen (4U) studied the identification of simple alcohols by their color reactions with reagents such as salicylaldehyde, catechol, 1-naphthol, *N*-halosuccinimides, and resorcinol. Ruch, Johnson, and Critchfield (12U) revised the hydroxylammonium formate

method for the determination of aldehydes and ketones to eliminate the interference of organic acids, acetals, ketals, and vinyl ethers. A method for the microdetermination of acetals of acetaldehyde, vinyl ethers etc. was developed by Bowman, Beroza, and Acree (3U). Williams, Anderson, and Jasik (17U) described a spectrophotometric procedure for plasmalogens and other enol ethers by their specific reaction with I<sub>2</sub>. In the determination of glycocyamine in urine, Gerber, Gerber, and Altman (6U) removed most of the interfering substances with Norit A and a buffered ion exchange resin prior to colorimetry with 1-naphtholdiacetyl. Barbieri and Brauckmann (2U) estimated glutathione in tissue by electrolytically reducing and determining colorimetrically with sodium nitroprussiate. Curzon and Walsh (5U) determined urinary indican in urine by treatment with *p*-dimethylaminobenzaldehyde-HCl and extraction of the red Gössner compound formed by alkali treatment with petroleum ether for colorimetric measurement. Shivararam and Mueting (18U) reported an improved technique for indican in urine in which indican is oxidized in the presence of  $\text{CCl}_3\text{COOH}$ , reacted with thymol to give a violet condensation product which is dissolved in EtOH and estimated spectrophotometrically. Rorem (11U) used dried paper chromatograms dipped in 1% sulfosalicylic acid in acetone for the fluorimetric detection of ketoses and aldoses with ultraviolet light. Reid (10U) determined ketone bodies in blood by conversion to acetone, distillation and determination at 530 m $\mu$  by reaction with ethanolic salicylaldehyde to form salicylidene acetone in alkaline solution. Glaubitt (7U) made a survey and gave a detailed discussion of the most important assay methods for ketone bodies. Tompsett (14U) used a cation-exchange resin for the determination of some basic substances; tyrosine, tyramine, kynurenine, 3-hydroxypyridine and cystine in urine. Kotake, Tsuji, and Hasegawa (8U) established a new method for determining kynurenine in urine by fluorometrically determining with the cyanogen bromide reaction, the compound in the eluate from a column. Conjugated diolefins, were determined by Altshuller and Cohen (1U) in a new colorimetric method by coupling with *p*-nitrobenzenediazonium fluoborate in a 2-methoxyethanolphosphoric acid solvent medium.

#### PROTEINS

Zuber (59V) reviewed the use of enzyme reactions for testing purity and structural determination of peptides and proteins. Chemical methods for the determination of acid mucopolysaccharides were reviewed by Grabowska (21V). A

method for separating serum proteins on a diethylaminoethylcellulose column into six distinct fractions by stepwise increase in buffer molarity was described by Robinson, Blumberg, and Pierce (41V). Afonso (1V) used glycol and glycerol to depress evaporation to a minimum when applying higher voltages to cellulose acetate membranes. Friedman (18V) made a statistical standardization of the procedure for serum protein electrophoresis on cellulose acetate strips with Amido Black 10 B and also compared the Lissamine Green and Ponceau S staining technique. Electrophoresis of serum proteins in acrylamide gel was reported by Ferris Easterling, and Budd (17V) and Raymond, Nakamichi, and Aurell (36V). Matson (29V) described a microprocedure for agar gel electrophoresis of proteins (1 to 2 ml. cerebrospinal fluid) in which the fluid was concentrated by dialysis against 9% poly(vinylpyrrolidone) and electrophoresis carried out in agar with 0.04M tris(hydroxymethyl)aminomethane buffer. Cawley and Eberhardt (8V) used strips of 35-mm. photographic film base coated with agar and placed across the plastic mid-divider of a Durrum-type electrophoresis cell for the electrophoretic separation of serum protein in 20 to 40 minutes. The visualization of the serum protein electrophoretic pattern in starch by interferometry was described by Bockemüller and Oerter (4V). Gordon (20V) described a technique for the separation of plasma proteins after electrophoresis in starch gel. Altaner and Gregusova (2V) developed a technique for the preparative separation of 0.5 to 1.0 gram of protein on a 35-mm. thick vertical starch gel layer. Patrick and Thiers (93V) described a useful technique for quantitative separation of proteins in spinal fluid by gel filtration by passing the specimen through a dextran gel (Sephadex).

Osborn (32V) made some interesting and informative observations in a study under various conditions of binding of acid dyes, light green, lissamine green and bromocresol green by proteins as applied to quantitative paper electrophoresis. Wilkinson and Wilkinson (57V) described a staining procedure, using bromophenol blue that was virtually free from factors requiring critical control and gave a stable linear dye-protein relationship over a wide range of protein densities. Techniques using cellulose acetate for electrophoresis of serum protein were described by Korotzer, Bergquist, and Searcy (25V), who stained with Ponceau S, and by Clark (9V), who dyed with bromocresol green. A new technique for fluorescent labeling of proteins was developed by Rinderknecht (40V) by adsorption of the dye onto dried diatomaceous earth from  $\text{CHCl}_3$  solution, evaporation, and addi-

tion of serum followed by shaking, dialysis and electrophoresis; 5-Dimethylaminonaphthalenesulfonyl chloride, Lissamine Rhodamine B 200 (sulfonyl chloride) and fluorescein isothiocyanate were tested. Sokol, Hana, and Albrecht (51V) described a fluorescent antibody method for the determination of protein in labeled gamma globulin and 1-dimethylamino-5-naphthalenesulfonic acid in conjugates of fluorescent antibodies at 315  $\mu\text{m}$ . Vanderzant and Tennison (55V) used the disulfonic acid dye, Buffalo Black, to estimate the protein content of milk. Soothill (52V) determined eight serum proteins by a gel diffusion precipitin technique in 2 drops of serum or other biological fluid. Lawrence and Benjamin (27V) made chromatographic separation of plasma proteins with cellulose anion exchange and further characterized the fractions by paper starch gel, immunoelectrophoresis, and enzyme stains. Ressler (38V) described a technique for two-dimensional electrophoresis of protein antigens with an antibody containing buffer. Patterson (34V) by use of  $\text{I}^{131}$ -labeled antigen or antiserum in a gel double diffusion precipitin reaction with autoradiography could increase the sensitivity a hundredfold. Broomfield and Scheraga (6V) enhanced the electromotive force of an electrode drawn along a paper electrophoresis strip by binding various metal ions to the protein. Reisfeld, Lewis, and Williams (37V) accomplished the electrophoresis of 50  $\mu\text{gram}$  of protein in 20 minutes by using disk electrophoresis on polyacrylamide gels. McDonald and Liberti (30V) described an improved apparatus for centrifugally accelerated electrochromatography in the continuous separation of serum proteins. Biemann and Vetter (3V) separated peptide derivatives by gas chromatography and assayed the amino acid sequence by mass spectrometric determination. Fasold, Linhart, and Turba (15V) described a thin layer dialysis with a rotating dialyzer tubing for determination of a partial sequence of amino acid residues of the insulin chain.

Cohen and Raducha (10V) detected Bence-Jones protein by adding 1 ml. of 12% *p*-toluenesulfonic acid in concentrated AcOH to 2 ml. of urine, mixing, and incubating 5 minutes at 20° C. Precipitate within 5 minutes was positive. Shatalova, Meerov, and Savinskii (46V) described a radiometric method using  $\text{C}^{14}\text{O}$  for the quantitative determination of chromoproteins, hemoglobin, myoglobin, cytochrome oxidase, etc. Goodwin (19V) used 13% sodium sulfite to precipitate plasma fibrinogen for determination by the biuret reaction. Leach (28V) described a method for the determination of gelatin in blood and urine dependent on the presence of hydroxyproline in gelatin. Burstein (7V)

employed a turbidimetric method for determining low levels of  $\gamma$ -globulins in blood in which differential precipitation of various fractions of proteins in serum were obtained with heparin and  $\text{CoCl}_2$ . Saifer, Gerstenfeld, and Vecsler (43V) combined the Tauber perchloric acid method and the Fischl colorimetric procedure (a quantitative tryptophan method) for the microdetermination of total serum globulins without hydrolysis. Microimmuno-electrophoretic analysis was used by West, Hinrichs, and Hinkle (56V) for the determination of  $\text{B}_2\text{A}$  and  $\text{B}_2\text{M}$  serum globulins. Uriel and Grabar (54V) described a new technique for the direct detection of glycoproteins and polysaccharides after electrophoresis by periodic acid oxidation, treatment with phenylhydrazine, and then reacting with diazotized *o*-dianisidine and copper acetate to form colored formazan derivatives. Sobral (49V) dyed glycoproteins after electrophoresis by using (in order) 5% periodic acid, formalin, fuchsin and potassium metabisulfite to produce violet bands. A similar method was described by Kosyukovskaya and Zhukov (26V). A method for zone-electrophoretic separation of serum glucoproteins on a poly(vinylchloride) medium was described by Bottiger and Carlson (5V). Smith and Owen (48V) examined the peroxidase activities of methemoglobin and methemoglobin-haptoglobin in the reaction between guaiacol and  $\text{H}_2\text{O}_2$  and devised a method for the determination of haptoglobins in serum. Sochman and Malaskova (50V) described a simple screening test for serum paraproteins by staining the myelomatous paraprotein yellow with saturated alcoholic solution of picric acid.

Scheurlen (44V) performed protein determinations in the range of 30 to 400  $\mu\text{gram}$  per ml. by the use of the protein error of a buffered solution of bromophenol blue in Sorensen's citrate-HCl acid buffer, pH 3.5. Saifer and Gerstenfeld (42V) modified the colorimetric tryptophan procedure for serum proteins for the determination of spinal fluid proteins. Ressler and Goodwin (39V) proposed a rapid and simple procedure for determining total spinal fluid proteins at 210  $\mu\text{m}$  although Murphy and Kies (31V) confirmed Waddell's recommendation of measurement of the difference in absorbance at 215 and 225  $\mu\text{m}$ . Keyser (23V) rapidly estimated albumin and total protein in small amounts of serum by a combination of the methyl orange method for albumin with the biuret method. Techniques for the concentration of protein solutions were described by Farr and Chaney (14V), who designed a modified ring-oven apparatus to permit 100-fold concentration on filter paper, by Colover (11V), and by Faulkner, Gardner, and Lewis (16V), who compared five meth-

ods—acetone precipitation, water absorption by Sephadex, dialyses against PVP, ultrafiltration, and pervaporation in cellophane bags.

Plekhan (35V) reviewed the spectrophotometry of biuret complexes, Cu, Co, Ni, etc., as a method of study of polypeptides and proteins. A critical evaluation of the biuret reaction and its use in the determination of serum proteins was made by Kingsley (24V). Strickland, Freeman, and Gurule (53V) elucidated the stoichiometry of the alkaline copper tartrate biuret reaction with several natural proteins, and found that, with the exception of globulin, six peptide nitrogens are bound by chelation to each copper; they also described methods for determination of peptide nitrogen by means of copper binding and for estimation of protein by a new titrimetric method. Siltanen and Kekki (47V) presented a modification of the biuret method in which a suspension of stable cupric hydroxide in KOH solution was used as the reagent. A micromethod for protein determination was reported by Kekki and Siltanen (22V) in which protein-bound copper in the biuret color solution was estimated colorimetrically with oxalyldihydrazide instead of the biuret color itself. Ellman (13V) reported that the absorption of the biuret color at 263 m $\mu$  is 10 to 15 times as sensitive as the visible biuret.

Refractometric methods for the simple and rapid determination of serum proteins were described by Wolf *et al.* (58V), by Schmidt (45V) and by Drickman and McKeon (12V).

#### STEROLS

A chemical method for aldosterone using blue tetrazolium was compared with the double isotope derivative assay method by Starnes *et al.* (45W) who obtained 25 to 30% higher levels with the latter method. Kliman and Peterson (29W) described a double isotope derivative method for selective measurement of aldosterone in plasma and urine. Staub, Dingman, and Fesler (46W) used rapid chromatography on glass fiber paper for the determination of aldosterone in urine. Aldosterone was detected by gas liquid chromatography by Miras and Contaxis (34W).

Beale and Croft (2W) introduced a new sensitive color reagent for serum cholesterol by persulfuric acid oxidation. Watson (53W) modified Pearson's cholesterol method by substitution of 2,5-dimethylbenzenesulfonic acid or hazardous *p*-toluenesulfonic acid. Yonger and Delorme (54W) made microdeterminations of serum cholesterol and ester with a modified Tschugaeff reaction ( $ZnCl_2$  reaction with cholesterol in  $CHCl_3$  solution). Sheff, Gretz, and McMarlin (43W) used this reaction for spinal fluid cholesterol determination.

Kabara, McLaughlin, and Riegel (24W) described a quantitative method for isolating and assaying radioactive and nonradioactive cholesterol by use of glycosidine tomatine as a precipitating agent. Bowman and Wolf (3W) substituted ethanol for glacial acetic acid in the Zak cholesterol method. Creech and Sewell (10W) determined free and esterified serum cholesterol with a small glass column containing specially prepared activated silicic acid. Turbidimetric determinations of serum cholesterol with sodium alcoholate were made by Velu and Velu (52W) and Kingsley and Robnett (27W). A new reagent for serum cholesterol determination was described by Huang *et al.* (18W) consisting of 30% glacial HOAC, 60%  $Ac_2O$ , and 10% concentrated  $H_2SO_4$  and anhydrous  $Na_2SO_4$  added in an amount equivalent to 2% in these solvents. Crepy, Lachese, and Judas (11W) detected steroid glucuronides on paper chromatograms by treatment with 1-(2-pyridylazo)-2-naphthol in 95% EtOH and a solution of  $Co(NO_3)_2$  in EtOH-dichloromethane. Carstensen (5W) reviewed the analysis of adrenal steroids in blood by countercurrent distribution and also the Porter and Silber, blue tetrazolium, vanillin-phosphoric acid, ethanol-sulfuric acid and ultraviolet absorption methods for adrenal steroids. Exley *et al.* (14W) developed a method for the group determination of 17-deoxycorticosteroids by their conversion into 21-norpregnan-20-als and the measurement of the latter by means of a modified Angeli-Rimini reaction. Lewbart and Mattox (30W) extended the Porter-Silber reaction to a quantitative microdetermination of 17-deoxy- $\alpha$ -ketolic steroids by a preliminary cupric acetate oxidation to corresponding glyoxals and treatment with Porter-Silber reagent. Van der Vies and Organon (51W) determined cortisol and corticosterone in a small sample of peripheral blood by the different partition coefficients of these steroids between water and  $CCl_4$ . Adamec, Matis, and Galvanek (1W) described a simple chromatic technique for separation of corticoids on a thin layer of silica gel. Fluorimetric methods for the determination of cortisone and related compounds in serum and other biological fluids were described by Rudd, Cowper, and Crawford (40W), by Stewart, Albert-Recht, and Osman (48W), by Braunsberg and James (4W) and by de Moor *et al.* (12W). Kirschner and Fales (28W) showed that the bis-methylenedioxy derivative of cortisone confers thermostability to the 20, 21 side chain and renders it suitable for gas liquid chromatographic analysis. Methods for the colorimetric determination of ketogenic steroids with the 17 $\alpha$ -ketol side chain were reported by Monder and White (35W) who used Nessler's reagent and Kingsley and Getchell

(26W) who used blue tetrazolium. Henke, Doe and Jacobson (16W) described a new method for extraction of serum 11-desoxycorticosteroids.

The best organic solvent for the red Kober color in the fluorimetric determination (546 m $\mu$ ) of estrogens in urine was found by Ittrich (20W) to be a solution of 2% of *p*-nitrophenol and 1% of EtOH in ethylene tetrabromide. Ittrich's extraction method was evaluated by Salokangas and Bulbrook (41W) and Strickler, Wilson, and Grauer (49W). Chromatographic methods for the determination of estrogens in serum and urine were described by Oertel (37W), by Kakushkina and Orlova (25W), and by Preedy and Aitken (39W). McGregor *et al.* (32W) estimated diethylstilbestrol and related synthetic estrogens by gas chromatography. Svendson (50W) determined estrone and 17 $\beta$ -estradiol in plasma by double isotope derivative principle using  $S^{35}$  and  $I^{131}$ . Schubert and Wehrberger (42W) isolated testosterone from normal urine by  $\beta$ -glucuronidase hydrolysis, EtOAc extraction, Girard fractionation and column and paper chromatography.

Ober and Kaiser (36W) reviewed the limitations and applications of methods for the determination of pregnanediol and placed the greatest emphasis on chromatographic methods. A simple method for determining urinary pregnanediol and pregnanetriol was described by Staub *et al.* (47W), in which chloroform extracts of urine after enzymatic hydrolysis were chromatographed by an ascending technique on potassium silicate impregnated glass fiber strips in cyclohexane-acetone. Marti and Schindler (33W) described a method for the determination of progesterone in plasma by evaporation of a methylene chloride-ether extract of 15 ml. of alkalinized plasma, elution from an  $Al_2O_3$  column with hexane-benzene- $CHCl_3$  and spectrophotometric measurement at 240 m $\mu$ . Cooper *et al.* (8W) demonstrated and identified pregnanediol in pregnancy urine by means of gas chromatography.

Sparagana, Mason, and Keutmann (44W) chromatographed urine extracts purified by Girard T fractionation on silanized packing at 221° C. for preliminary isolation of 17-ketosteroids for analysis by gas chromatography. Hudson and Oertel (19W) described a method for separate estimation of dehydroepiandrosterone and total 17-ketosteroids in plasma. Epstein (18W) used an aqueous Zimmerman reagent for the determination of 17-ketosteroids which functioned to solubilize steroids and *m*-dinitrobenzene in a stable aqueous phase. Green (15W) outlined a rapid routine technique for determination of urinary 17-ketosteroids. Cohn, Bondy, and Castiglione (6W) described techniques for separation and measure-

ment of unconjugated dehydroepiandrosterone, etiocholanolone and androsterone in plasma. Jacobsohn and Lieberman (21W) hydrolyzed the glucuronides of 17-ketosteroids with 0.1N perchloric acid containing not more than 0.7% water. Joubert (23W) used non-specific cation exchange hydrolysis of steroid glucuronides by incubating the urine with Amberlite IR-120 in the hydrogen phase for 16 hours at 56° C. Chromatographic methods for the determination of 17-ketosteroids in plasma were described by Herrmann (17W), by Lotti and Marcenaro (31W), by Conrad, Mahesh, and Herrmann (7W) and by Oertel and Kaiser (38W). Johnson, Heftmann, and Francois (22W) determined individual 17-ketosteroids by gradient elution chromatography. Cooper and Creech (9W) described the preparation and purification of urine extracts for application of gas liquid chromatographic analysis of 17-ketosteroids.

#### TOXICOLOGY

Kaye (35X) reviewed rapid, presumptive techniques for the identification of barbiturate derivatives, carbon monoxide and methyl alcohol in blood, arsenic, mercury, antimony, bismuth, salicylates and sulfanilamide compounds in emergency toxicology. Hill (29X) reviewed the possible applications of gas chromatography to forensic science. Curry (14X) reviewed in detail the applications of paper chromatography to the detection of volatile and nonvolatile inorganic and organic poisons. Westlake (83X) reviewed selected references to methods of pesticide analysis, published from November 1958 to October 1960.

Methods for the quantitative determination of ethanol and other volatile substances in blood and body fluids by gas chromatography were described by Chundela and Janak (12X), by Machata (45X), and by Parker *et al.* (59X). Matsumoto (50X) determined alcohol in 5 ml. of urine by adding 10 ml. of H<sub>2</sub>O, 5 ml. of 1.5N Ba(OH)<sub>2</sub>, and then filtering and treating the filtrate with 3 grams Amberlite IR-120. The light absorbance of the resulting solution at 450 m $\mu$  indicated the concentration of EtOH (0.02 to 0.1%). Williams, Linn, and Zak (86X) described a rapid micro-screening test for methanol in serum and spinal fluid in which chromotropic-sulfuric acid reagent was used. Ginther and Finch (24X) determined isopropyl alcohol by a colorimetric semimicrodetermination.

Chromatographic methods using cation exchange resin and ion exchange paper were described by Niyogi, Tompsett, and Stewart (57X) for separation of codeine and strychnine, by Street (75X) for detection of a mixture of quinine,

strychnine, and nicotine in blood, and by Berkes and Matvejeva (3X) for determination of morphine. Williams, Brusock, and Zak (84X) described a method for the rapid separation of alkaloids from interfering chromogens by agar gel electrophoresis. Genest and Farmilo (23X) determined morphine, codeine, and porphyrine in opium by infrared spectrometry in carbon tetrachloride after quantitative instantaneous acetylation. Butler and Hill (9X) described techniques for the estimation of volatile anesthetics in tissues by gas chromatography. Lubran (44X) suggested a new color reaction for the detection of barbiturate in biological fluids by treatment of barbiturate separated on paper or in chloroform solution with a mercury salt followed by diphenylcarbazone. Stevenson (72X) described a butyl ether-aqueous partition procedure combined with two methods of permanganate oxidation and two of alkaline hydrolysis for systematic identification of barbiturates in blood. Bush (8X) measured partition coefficients in dilute solutions with ultraviolet spectrophotometry as an aid in identification of a dozen common barbiturates. Methods for separation and identification of barbiturates in blood were described by Parker and Kirk (60X) using gas chromatography, and by Frey, Eberhardt, and Rustemeyer (21X) and Fischl and Segal (20X) using paper chromatography. Stevenson, Sobel, and Kenney (73X) modified Stevenson's quantitative procedure to increase its specificity for detection of phenobarbital in blood and urine. Machly (47X) described a simple all-glass apparatus in which as little as 10 to 20  $\mu$ grams of barbiturate was sublimed in vacuo onto KBr disks. Street (74X) described an extraction technique for determination of bromide in blood using ether, cyclohexane, and dichloroethane as extracting solvents. Mathies and Lund (49X) described an x-ray spectroscopic technique to estimate total bromide in serum, urine, and tissues.

Williams, Linn, and Zak (85X) described a procedure for the determination of carbon monoxide hemoglobin based on the ultraviolet spectrophotometric determination of Pd ions from reaction of excess PdCl<sub>2</sub> with diffused CO. Mokranjac and Jovanovic (53X) determined small quantities of CO in blood by reducing Au from AuCl<sub>3</sub> solution with CO obtained from blood by microdiffusion, followed by polarographic determination of the un-reduced AuCl<sub>3</sub>. Martin, Munn, and Biskup (48X) developed a sensitive method for blood methemoglobin based on a measurement at 360 m $\mu$  corrected for any nonspecific cyanide-porphyrin compounds. Brewer Tarlov, and Alving (7X) described a methemoglobin reduction test based on the increase in reduction rate of methemoglobin by triphosphopyridine nucleo-

tide-methemoglobin reductase in the presence of an electron acceptor and glucose-6-phosphate dehydrogenase. A new method for the polarographic determination of cyanide which depends on a pure reduction wave was described by Hetman (28X) who employed a base electrolyte composed of pyridine and potassium nitrate with a mercuric salt. Buyske and Downing (10X) used the absorption spectra of the red complex of the pentacyanoammine-ferrate with a solution of calcium cyanamide for the determination of cyanamide. Hall (25X) determined 1  $\mu$ gram of fluorine in biological samples by collection of fluorine by diffusion in a polyethylene bottle, absorption by alkali-treated filter paper, and titration with thorium nitrate in the presence of alizarin sulfonate. Kudahl, Fremlin, and Hardwick (39X) made microestimations of fluorine in organic material by isotope dilution.

Page and Verhulst (58X) reviewed laboratory tests and diagnostic data in relation to human poisoning by organic phosphorous insecticides. Gage (22X) reviewed the current analytical techniques for the detection of organic phosphorous pesticides. Sampling techniques for the infrared analysis of volatile organic materials in animal tissues were outlined by Robertson and Erley (64X). A chromatographic technique for determination of DDT and DDE in human fat was described by Read and McKinley (63X). A microspot test for DDT in biological materials was used by Irudayasamy and Natarajan (31X). Nazyrov and Vengerskaya (56X) employed the red color formed by the reaction of 2-furaldehyde with aniline and AcOH for the determination of small quantities of this aldehyde in blood and urine. Merville, Dequidt, and Cortee (51X) determined sulphydryl groups in biological materials by oxidation of SH to SS by means of o-iodobenzoic acid. Linn and Roberts (42X) presented a microassay method for tris(hydroxymethyl)aminomethane in blood and urine based on an adaptation of a serine assay. A technique for determination of phenylalanine mustard and related alkylating agents in blood based on their reaction with nitrobenzylpyridine was described by Klatt, Griffin, and Stehlin (37X). Kingston and Kirk (36X) separated the components of marijuana by gas liquid chromatography using a silicone rubber (SE-30) liquid phase. Tewari (79X) presented a technique for paper chromatographic identification of nitrates in legal medicine.

Perry *et al.* (61X) reported that the concentrations of nonessential metals—strontium, barium, aluminum, titanium, vanadium, chromium, nickel, silver, cadmium, tin and lead—in human organs were more variable than the essential metals. West and Llacer (81X) determined antimony by a technique

which utilized solvent extraction of  $\text{SbI}_4$  complex on the ring oven and development of color with phosphomolybdate acid. Methods for the determination of arsenic in biological materials were described by Mackintosh and Jervis (46X) by neutron activation analysis, by Tewari (78X) by ascending paper chromatography, by Roddy and Wallace (65X) and Cortivo, Cefola, and Umberger (13X) by colorimetric determination with Ag diethyl-dithiocarbamate, and by Hanke (26X) by benzene extraction and colorimetry with molybdate. Dean *et al.* (15X) studied the emission characteristics of the barium ionic doublet at 455.4 and 493.4  $\text{m}\mu$ , the atomic resonance line at 553.6  $\text{m}\mu$ , and the  $\text{BaOH}$  and  $\text{BaO}$  bands at 488 and 513  $\text{m}\mu$  for the flame spectrophotometric determination of barium. West and Mohilner (82X) determined beryllium with Eriochrome Cyanine R and the ring oven technique. Sill, Willis, and Flygare (70X) made further improvements in their microfluorometric determination of beryllium using morin. Misumi and Nagano (52X) described a spectrophotometric method for the determination of microamounts of cerium with 2-methyl-8-quinol. Rosenfeld (67X) determined germanium in biological materials by  $\text{H}_2\text{SO}_4$ - $\text{HNO}_3$  digestion, distillation as  $\text{GeCl}_4$ , hydrolysis to  $\text{GeO}_2$ , treatment with  $\text{NH}_4$  molybdate to form  $\text{H}_2\text{GeO}_3 \cdot 3\text{H}_2\text{O}$ , reduction with ferrous ammonium sulfate, and spectrophotometric measurement of blue complex at 880  $\text{m}\mu$ . Murphy and Affsprung (54X) determined gold by precipitation with tetraphenylarsonium chloride, extraction in chloroform, and absorbance measurement at 323  $\text{m}\mu$ . Methods for the determination of lead in blood and urine were described by Berman (4X) by a rapid dithizone method, by Willis (87X) by flame atomic absorption spectroscopy, and by Hill, Hengstenberg, and Sharpe (30X) by an ion exchange (IRC 50 resin) method. Methods for the determination of mercury in urine and blood were described by Cafruny (11X) by complexing with KBr to form  $\text{K}_2\text{HgBr}_4$  followed by extraction with a chloroform solution of dithizone, by Jacobs and Singerman (34X) by colorimetric estimation of  $\text{Hg-I}$  complex at 490  $\text{m}\mu$ , and by Jacobs, Goldwater, and Gilbert (33X) by microestimation in blood by ultraviolet photometry of mercury vapor. Nickel was implicated by Sunderman and Sunderman (76X) as a pulmonary carcinogen in tobacco smoke. Taussky (77X) made a survey of methods for the determination of selenium in biological fluids and discussed the application of titration, colorimetry, fluorometry, and neutron activation in these methods. Faulkner, Knoblock, and Purdy (19X) described a polarographic method for the determination of selenium in urine.

Ivanov and Rozenberg (32X) determined silicon in urine colorimetrically by reduction of yellow Si-Mo complex to a blue complex after precipitation of interfering phosphorus. Aumonier and Quilichini (2X) selectively determined total silicon in blood serum by conversion of the  $\text{SiO}_2$  in ash to  $\text{SiF}_4$  with HF, formation of silicomolybdate, and reduction with ascorbic acid to a blue complex for colorimetry. Engel and Holzapfel (18X) developed a new method for the detection and separation of silicic acid from protein compounds in biological fluids. Kudo (40X) improved the recovery of silver from biological specimens by coprecipitation with tellurium. Dux and Fearheller (17X) determined trace amounts of silver by absorption of light at 416  $\text{m}\mu$  by a dispersion of a silver-dithiol complex in an aqueous acid solvent. Leidt and Sanders (41X) determined plutonium in urine by anion exchange separation, electrodeposition on a stainless steel disk and autoradiographic measurement. Rains, Zittel, and Ferguson (62X) determined strontium in calcareous material by flame spectrophotometry at 460.7  $\text{m}\mu$  by means of a high-resolution flame using calcium as a radiation buffer. Strontium in serum and bone was determined by x-ray spectrophotometry by Natelson and Sheid (55X). Stavinoha and Nash (71X) determined thallium in urine by flame spectrophotometry by an organic solvent extraction with 2-octanone. A simple, sensitive test for thallium in organic material was described by Hauck (27X). Sill and Willis (69X) developed a fluorometric method using morin in an alkaline solution of diethylenetriamine-pentaacetic acid for detection of thorium within a limit of 0.01  $\mu\text{gram}$ . Lott, Cheng, and Kwan (43X) used a new highly selective spectrophotometric method for determination of thorium by complexing it with Eriochrome Black T to form a color for absorption measurement at 700  $\text{m}\mu$ . Korkisch and Janauer (38X) reacted thorium with the azo dye Solochromate Fast Red in  $\text{HCl}-\text{CH}_3\text{OH}$  solutions to form an orange complex for absorption measurement at 490  $\text{m}\mu$  for the sensitive and accurate measurement of thorium. Pyrocatechol Violet was used by Ross and White (68X) as a sensitive reagent for the colorimetric determination of tin, which forms a red complex at pH 2.5 and has a maximum absorbance at 555  $\text{m}\mu$ . Sensitive methods for the determination of tungsten in blood and urine were described by Vengerskaya (80X) using methyl violet and tannin, and by Bowen (6X) by activation analysis. Methods for the determination of uranium in urine were reported by Akaishi (1X) by irradiation (ultraviolet) of urine residue fused with  $\text{NaF}$  and  $\text{NaKCO}_3$  and measuring the fluorescence, by Ronteix

and Hugot (66X) using a similar technique, by Dietrich, Taylor, and Johnson (16X) by separation of uranium with a tri-n-octylphosphine oxide column, and by Boni (5X) by electroplating and measurement by radioautography.

## VITAMINS

Jakovljevic (10Y) described a new spectrophotometric method for the determination of vitamin A in serum by KOH saponification, benzene extraction, and final color development in chloroform-ethyl acetate solution and acetic anhydride and phosphotungstic acid for color development at 620  $\text{m}\mu$ . Craig, Bergquist, and Searcy (6Y) determined vitamin A by a new color reaction carried out in 0.5 ml. of chloroform, 6.0 ml. of glacial acetic acid saturated with ferrous sulfate, and 2.0 ml. of sulfuric acid to produce a color for absorption measurement at 520  $\text{m}\mu$ . A new, rapid procedure was used by Ikeda *et al.* (9Y) to determine vitamin  $\text{B}_1$  by colorimetric determination of excess Reinecke salt (which does not combine with vitamin  $\text{B}_1$ ) added in excess at pH 4.5. A new chromatographic method for the determination of thiamine and its mono-, di-, and triphosphates in tissues was described by Rindi and Giuseppe (17Y). Baker *et al.* (1Y) used a new microbiological assay method for biotin, in blood, serum, urine, and tissues using the protozoan *Ochromonas dancia*. Nicotinic acid was determined by Hever (8Y) by a color reaction using the sodium salt of benzenesulfonic acid chloramide, and by Baker *et al.* (2Y) by the ciliate *Tetrahymena pyriformis*. Pelletier and Campbell (15Y) presented a simple method for the determination of *N'*-methylnicotinamide in urine based on its reaction with methyl ethyl ketone. Toepfer, Polansky, and Hewston (20Y) described a pyridoxamine assay based on the fluorescence of a pyridoxal cyanide compound which was obtained by transamination of pyridoxamine to pyridoxal reacted with KCN. Yoshida, Hosokawa, and Yoshida (24Y) compared the sulfonic acid-type resin, lumiflavin fluorescence, and bioassay (*Lactobacillus casei*) methods for assay of riboflavin in blood and found the lumiflavin method highest in specificity. Beck (4Y) presented an excellent and comprehensive review of the metabolic functions of vitamin  $\text{B}_{12}$ . Baker *et al.* (3Y) compared microbiologic assays for vitamin  $\text{B}_{12}$  in blood and serum using *Escherichia coli* 113-3, *Lactobacillus leichmannii* ATCC No. 7839, *Euglena gracilis* Z, and *Ochromonas malhamensis*. Knox and Goswami (11Y) reviewed ascorbic acid in man and animals and discussed enzymatic assay by ascorbic acid oxidase, chromatographic identification and assay, reduction of 2,6-dichlorophenolindophenol, 2,4-dinitro-

phenylhydrazine methods, and differentiation of ascorbic, dehydroascorbic and diketoglutaric acids. Roe (18Y) made an appraisal of methods for the determination of l-ascorbic acid and described a procedure (19Y) for determining specificity with the 2,4-dinitrophenylhydrazine method. Methods for the determination of ascorbic acid were described by Burch (5Y); by Yamaoka (23Y) using BrCN-NaOH or N-bromosuccinimide-NaOH reagents; by Wawrzyczek (22Y) by OsO<sub>4</sub> oxidation to dehydroascorbic acid and OsO<sub>2</sub> to produce a blue colloid; by Crossland (7Y) by cellulose column chromatography and colorimetric measurement in eluate with diazotized nitroanisidine; and by Polk, Flanagan, and Van Loon (16Y) and Lench and Lewis (14Y) by using 2,6-dichlorindophenol instead of activated carbon as the oxidant. Kubin and Fink (12Y) described techniques for the analysis of vitamin E and separate tocopherols in vegetable and animal matter containing protein. Tsen (21Y) described an improved method for the determination of tocopherols using 4,7-diphenyl-1,10-phenanthroline. Leeman and Stich (13Y) used descending paper chromatography to determine vitamins D<sub>2</sub> or D<sub>3</sub>. Petroleum ether saturated with water was used as the mobile phase and detection made by photography at 254 m $\mu$ , ultraviolet illumination, or by phosphotungstic color reaction.

#### MISCELLANEOUS

Forbes (4Z) determined traces of water by conversion to acetylene with calcium carbide, its transference with dry carrier gas to an infrared cell, and measurement in CCl<sub>4</sub>. Water or other forms of active hydrogen were measured by Mungall and Mitchen (10Z) by their destruction of the intense red color of diethylaluminum hydride-2-isoquinoline complex. Critchfield and Bishop (3Z) determined water by its quantitative reaction with 2,2-dimethoxypropane in presence of methanesulfonic acid catalyst to form acetone and 2 moles of methanol. Methods for the determination of deuterium in biological fluids were described by Crespi and Katz (2Z), and by Gaebler and Choitz (5Z) by directly measuring 19 to 18 ratios in vapor from plasma or urine with a mass spectrophotometer of suitable design. Vaughan and Boling (18Z) described two methods for the accurate radioassay of tritiated water in body water determinations. Grisler and Nava (6Z) made a complete review of the various techniques of determination of extracellular, intracellular, intravascular, and plasma water. Remington and Baker (11Z) evaluated blood volume measurement techniques. Mendelsohn and Levin (9Z) used the colori-

metric estimation of 4-aminoantipyrine for the measurement of total body water in infants and children. Hendry (7Z) reported studies of osmotic pressure and chemical composition of human body fluids and found that the mean total osmolarity of normal human serum (8Z) was 289 mOsM (S.D.  $\pm$  4). Bower, Paabo, and Bates (1Z) announced a new National Bureau of Standards pH standard [composed of KH<sub>2</sub>PO<sub>4</sub> (0.008695 molal) and Na<sub>2</sub>HPO<sub>4</sub> (0.03043 molal)] to facilitate measurements of the pH of blood and other physiologic media in the 7 to 8 pH range. Rodkey (12Z) described a rapid, precise, spectrophotometric method for the determination of plasma, serum or whole blood pH at 37° C. in which the effect of protein-indicator binding was essentially eliminated by an indicator-diluent solution containing 0.01M sodium naphthalene- $\beta$ -sulfonate.

#### LITERATURE CITED

##### Reviews, New Books, and Journals

- (1A) Boutwell, J. H., Jr., "Clinical Chemistry," Lea & Febiger, Philadelphia, Pa., 1961.
- (2A) Campbell, D. J., Comfort, D., Bell, R. E., *Am. J. Clin. Pathol.* **38**, 323 (1962).
- (3A) Cantarow, A., Schepartz, B., "Biochemistry," 3rd ed., W. B. Saunders Co., Philadelphia, 1962.
- (4A) Cantarow, A., Trumper, M., "Clinical Biochemistry," 6th ed., W. B. Saunders Co., Philadelphia, 1962.
- (5A) Caraway, W. T., "Microchemical Methods for Blood Analysis," C. C. Thomas, Springfield, Ill., 1960.
- (6A) Chirnside, R. C., *ANAL. CHEM.* **33**, No. 12, 25A (1961).
- (7A) Dal Nogare, S. D., Juvet, R. S., Jr., *Ibid.*, p. 35R.
- (8A) Hamilton, P. B., *Ibid.*, **34**, 3R (1962).
- (9A) Heftmann, E., *Ibid.*, p. 13R.
- (10A) Hirt, R. C., *Ibid.*, p. 276R.
- (11A) Juvet, R. S., Jr., *Ibid.*, No. 10, p. 77A.
- (12A) Kingsley, G. R., *Ibid.*, **33**, 13R (1961).
- (13A) Kunin, R., McGarvey, F. X., *Ibid.*, **34**, 101R (1962).
- (14A) Levy, A. L., *Microchem. J.* **4**, 343 (1960).
- (15A) Liebhafsky, H. A., *ANAL. CHEM.* **34**, No. 7, 23A (1962).
- (16A) Ma, T. S., Gutterson, M., *Ibid.*, p. 111R.
- (17A) Mason, W. B., *Ibid.*, No. 3, p. 23A.
- (18A) Mellon, M. G., Boltz, D. F., *Ibid.*, p. 232R.
- (19A) O'Brien, D., Ibbott, F. A., "Laboratory Manual of Pediatric Micro- and Ultramicro-Biochemical Techniques," Harper & Row, New York, N. Y., 1960.
- (20A) O'Brien, D., Ibbott, F., Pinfield, A., *Clin. Chem.* **7**, 521 (1961).
- (21A) Preston, S. T., Jr., ed., "Journal of Gas Chromatography," Preston Technical Abstracts Co., Evanston, Ill., 1963.
- (22A) Seligson, D., "Standard Methods of Clinical Chemistry," 3, Academic Press, New York, 1961.
- (23A) Strain, H. H., *ANAL. CHEM.* **33**, 1733 (1961).
- (24A) Van Haga, P. R., *Advan. Clin. Chem.* **4**, 321 (1961).
- (25A) Van Slyke, D. D., Plazin, J., "Micromanometric Analyses," The Williams & Wilkins Co., Baltimore, Md., 1961.
- (26A) White, C. E., Weissler, A., *ANAL. CHEM.* **34**, 81R (1962).
- (27A) Wilson, C. L., Wilson, D. W., eds., "Comprehensive Analytical Chemistry," "Classical Analysis," Vols. 1B, 1960, and 1C, 1962, Elsevier Pub. Co., New York.
- (28A) Wunderly, C., *Advan. Clin. Chem.* **4**, 208 (1961).

#### Apparatus and Equipment

- (1B) Anderson, N. G., *ANAL. CHEM.* **33**, 970 (1961).
- (2B) Avizonis, P. V., Fritz, F., Wriston, J. C., Jr., *Ibid.*, **34**, 58 (1962).
- (3B) Awad, O., Winzler, R. J., *J. Lab. Clin. Med.* **58**, 489 (1961).
- (4B) Baker, L. E., *IRE (Inst. Radio Engrs.) Trans. Bio.-Med. Electron.* **8**, 16 (1961).
- (5B) Barber, D., Scanlon, L. J., Jr., *Am. J. Clin. Pathol.* **36**, 333 (1961).
- (6B) Blaedel, W. J., Todd, J. W., *ANAL. CHEM.* **33**, 205 (1961).
- (7B) Breda, E. J., Kotkas, E. V., *Ibid.*, p. 816.
- (8B) Cater, D. B., Silver, I. A., Wilson, G. M., *Proc. Roy. Soc. (London)* **B151**, 256 (1960).
- (9B) Cerri, O., Maffi, G., *Boll. Chim. Farm.* **100**, 940 (1961).
- (10B) Charlton, G., *J. Appl. Physiol.* **16**, 729 (1961).
- (11B) Choules, G. L., Ballantine, R., *Anal. Biochem.* **2**, 59 (1961).
- (12B) Dahnke, J., Johnston, G. I., O'Reilly, M. E., Starr, A., *J. Appl. Physiol.* **16**, 393 (1961).
- (13B) Dixit, P. K., Lazarow, A., *J. Lab. Clin. Med.* **58**, 499 (1961).
- (14B) Dixit, P. K., Lazarow, A., *Lab. Invest.* **11**, 98 (1962).
- (15B) Fischl, J., *Clin. Chim. Acta* **7**, 537 (1962).
- (16B) Holden, H. F., *Australian J. Exp. Biol. Med. Sci.* **38**, 419 (1960).
- (17B) Holm-Jensen, I., *Scand. J. Clin. & Lab. Invest.* **12**, 247 (1960).
- (18B) Hospelhorn, V. D., *Anal. Biochem.* **2**, 180 (1961).
- (19B) Jeffrey, G. A., Sax, M., *ANAL. CHEM.* **34**, 339R (1962).
- (20B) Knights, E. M., Jr., Ploompoo, J., Whitehouse, J. L., *Am. J. Clin. Pathol.* **36**, 203 (1961).
- (21B) Kurella, G. A., Popov, G. A., *Biophysics* **5**, 430 (1960).
- (22B) Lowe, H. J., *J. Appl. Physiol.* **16**, 919 (1961).
- (23B) MacDonell, H. L., *ANAL. CHEM.* **33**, 1554 (1961).
- (24B) Marsh, H. H., *Am. J. Clin. Pathol.* **37**, 115 (1962).
- (25B) Mather, A., *Ibid.*, **30**, 186 (1960).
- (26B) Mattenheimer, H., *J. Lab. Clin. Med.* **58**, 783 (1961).
- (27B) Moss, D. W., *Clin. Chim. Acta* **5**, 283 (1960).
- (28B) Mueller, R. H., *ANAL. CHEM.* **34**, 98R (1962).
- (29B) Muysers, K., Siehoff, F., Worth, G., *Klin. Wochenschr.* **39**, 83 (1961).
- (30B) Osborn, E. C., *Clin. Chim. Acta* **6**, 743 (1961).
- (31B) Polgar, G., Forster, R. E., *J. Appl. Physiol.* **15**, 706 (1960).
- (32B) Ryce, S. A., Bryce, W. A., *ANAL. CHEM.* **33**, 654 (1961).
- (33B) Snell, F. M., *J. Appl. Physiol.* **15**, 729 (1960).
- (34B) Wells, R. E., Jr., Denton, R., Merrill, E. W., *J. Lab. Clin. Med.* **57**, 646 (1961).

#### Automation

- (1C) Anderson, F. O., Crisp, L. R., Riggle, G. C., Vurek, G. G., Heftmann, E., Johnson, D. F., Francois, D., Perrine,

- T. D., ANAL. CHEM. 33, 1606 (1961).  
 (2C) Baron, S., Burch, B. L., Uhlendorf, B. W., Am. J. Clin. Pathol. 36, 555 (1961).  
 (3C) Benotti, J., Benotti, N., Clin. Chem. 8, 431 (1962).  
 (4C) Bonnaffé, M., Protides Biol. Fluids, Proc. 9th Colloq., 86 (1961), Bruges, Belg.  
 (5C) Braunitzer, G., Angew Chem. 72, 485 (1960).  
 (6C) Britt, R. D., Jr., ANAL. CHEM. 34, 1728 (1962).  
 (7C) Bunker, J. P., Bendixen, H. H., Murphy, A. J., J. Lab. Clin. Med. 58, 129 (1961).  
 (8C) Butler, T. J., Am. J. Med. Technol. 27, 205 (1961).  
 (9C) Cassels, J. W., Brame, E. G., Day, C. E., ANAL. CHEM. 33, 813 (1961).  
 (10C) Cawley, L. P., Eberhardt, L., Am. J. Clin. Pathol. 37, 219 (1962).  
 (11C) Chasson, A. L., Grady, H. J., Stanley, M. A., Ibid., 35, 83 (1961).  
 (12C) Cope, F. W., U. S. Dept. Com., Office Tech. Serv., PB Rept. 143 431, 10 pp. (1959).  
 (13C) Corfield, M. C., Robon, A., Biochem. J. 84, 146 (1962).  
 (14C) Cotlove, E., Nishi, H. H., Clin. Chem. 7, 285 (1961).  
 (15C) Crowley, L. V., Am. J. Clin. Pathol. 35, 89 (1961).  
 (16C) Dearnaley, D. P., Acheson, R. M., J. Chromatog. 5, 452 (1961).  
 (17C) Dorfman, L., Oeckinghaus, R., Anderson, F., Robertson, G. I., ANAL. CHEM. 34, 678 (1962).  
 (18C) Dropsy, G., Boy, J., Ann. Biol. Clin. (Paris) 19, 313 (1961).  
 (19C) Edel, H., Reimann, H. F., Z. Ges. Inn. Med. Ihre Grenzgebiete 16, 821 (1961).  
 (20C) Ehrmantraut, H. C., Marshall, B. D., IRE, Trans. Bio-Med. Electron. BME-8, 111 (1961).  
 (21C) Epstein, E., Zak, B., Clin. Chem. 8, 428 (1962).  
 (22C) Feichtmeir, T. V., Jenkins, K. D., Baer, D. M., Am. J. Clin. Pathol. 35, 378 (1961).  
 (23C) Ferrari, A., Kessler, G., Russo-Alesi, F. M., Kelly, J. M., Ann. N. Y. Acad. Sci. 87, 729 (1960).  
 (24C) Frank, M., Gori, G. B., U. S. Patent 2,990,339, June 27, 1961.  
 (25C) Getchell, G., Kingsley, G. R., Schaffert, R. R., Clin. Chem. 8, 430 (1962).  
 (26C) Gøksøyr, J., Anal. Biochem. 3, 439 (1962).  
 (27C) Hamilton, R. H., Clin. Chem. 8, 80 (1962).  
 (28C) Hill, J. B., Kessler, G., J. Lab. Clin. Med. 57, 970 (1961).  
 (29C) Karler, R., Woodbury, D. M., J. Appl. Physiol. 17, 365 (1962).  
 (30C) Kessler, G., Wolfman, M., Clin. Chem. 8, 429 (1962).  
 (31C) Khalameizer, M. B., Fiziol. Rast. 9, 120 (1962).  
 (32C) Levy, A. L., Rajan, R. M., Bianco, A., Dalmasso, C., Clin. Chem. 8, 430 (1962).  
 (33C) Logsdon, E. E., Ann. N. Y. Acad. Sci. 87, 801 (1960).  
 (34C) Malmstadt, H. V., Hadjioannou, S. I., ANAL. CHEM. 34, 452 (1962).  
 (35C) Malmstadt, H. V., Hadjioannou, T. P., Ibid., p. 455.  
 (36C) Mandl, R. H., Protides Biol. Fluids, Proc. 9th Colloq. 81 (1961), Bruges, Belg.  
 (37C) Marsh, W. H., Ibid., p. 11.  
 (38C) Marsters, R. W., Clin. Chem. 8, 91 (1962).  
 (39C) Merrills, R. J., Nature 193, 988 (1962).  
 (40C) Müller, R. H., ANAL. CHEM. 33, 123A (1961).  
 (41C) Mulay, L. N., ANAL. CHEM. 34, 343 R (1962).  
 (42C) Nadeau, G., Fortin, B., Dugal, P., Clin. Chem. 8, 72 (1962).  
 (43C) Natelson, S., U. S. Patent 3,036,893, May 29, 1962.  
 (44C) Nelson, M. G., Lamont, A., J. Clin. Pathol. 14, 448 (1961).  
 (45C) Ohmori, K., Yamamoto, T., Nippon Rinsho 19, 1424 (1961).  
 (46C) Pastor, J., Pauli, A. M., Bull. Soc. Pharm. Marseille 10, 303 (1961).  
 (47C) Piez, K. A., Morris, L., Anal. Biochem. 1, 187 (1960).  
 (48C) Reinhardt, G., Hardwick, W., Ann. N. Y. Acad. Sci. 87, 883 (1960).  
 (49C) Savitzky, A., ANAL. CHEM. 33, 25A (1961).  
 (50C) Schaffert, R. R., Kingsley, G. R., Getchell, G., Clin. Chem. 8, 429 (1962).  
 (51C) Schwartz, M. K., Kessler, G., Bodansky, O., J. Biol. Chem. 236, 1207 (1961).  
 (52C) Skeggs, L. T., Jr., U. S. Patent 2,967,764, Jan. 10, 1961.  
 (53C) Summers, R. M., ANAL. CHEM. 32, 1903 (1960).  
 (54C) Tkachuk, M., Can. J. Med. Technol. 22, 71 (1960).  
 (55C) Walter, A. R., Gerarde, H. W., Clin. Chem. 8, 451 (1962).  
 (56C) Whitehead, E. C., Protides Biol. Fluids, Proc. 9th Colloq. 70 (1961), Bruges, Belg.  
 (57C) Winzey, C., Marks, V., J. Clin. Pathol. 14, 558 (1961).  
 (58C) Zak, B., Baginski, E. S., ANAL. CHEM. 34, 257 (1962).  
 (59C) Zak, B., Baginski, E. S., Chemist-Analyst 51, 39 (1962).  
 (60C) Zak, B., Cohen, J., Clin. Chim. Acta 6, 665 (1961).  
  

### Control and Precision of Clinical Chemistry Methods

(1D) Advisory Board, ANAL. CHEM. 34, 364R (1962).  
 (2D) Caraway, W. T., Am. J. Clin. Pathol. 37, 445 (1962).  
 (3D) De Traverse, P. M., Biotypologie 21, 131 (1960).  
 (4D) Fawcett, J. K., Wynn, V., J. Clin. Pathol. 13, 304 (1960).  
 (5D) Klein, B., Weissman, M., Clin. Chem. 7, 149 (1961).  
 (6D) Klugerman, M. R., Boutwell, J. H., Jr., U. S. Army Chem. 7, 185 (1961).  
 (7D) Levy, A. L., Clin. Chem. 8, 174 (1962).  
 (8D) Meehan, E. J., Beattie, W. H., ANAL. CHEM. 33, 632 (1961).  
 (9D) Nelson, B. N., Ibid., 34, 294R (1962).  
 (10D) Pryce, J. D., Am. J. Clin. Pathol. 36, 189 (1961).  
 (11D) Rice, E. W., Grogan, B. S., Clin. Chem. 8, 181 (1962).  
 (12D) Schneider, D., Can. J. Med. Technol. 24, 80 (1962).  
 (13D) Smetana, J., Casopis Lekaru Cesky 99, 1410 (1960).  
 (14D) Suchet, A., Pathol. Biol., Semaine Hop. 6, 974 (1958).  
 (15D) Turpin, B. C., Am. J. Med. Technol. 26, 286 (1960).  
 (16D) Wicher, E., ANAL. CHEM. 33, No. 4, 23A (1961).  
 (17D) Youden, W. J., Ibid., 32, No. 13, 23A (1960).  
  

### Amino Acids

(1E) Berry, H. K., Clin. Chem. 8, 172 (1962).  
 (2E) Berry, H. K., Scheel, C., Marks J., Ibid., p. 242.  
 (3E) Cohen, S. I., Arch. Biochem. Biophys. 86, 166 (1960).  
 (4E) Culley, W. J., Mertz, E. T., Luce, M. W., Calandro, J. M., Jolly, D. H., Clin. Chem. 8, 266 (1962).  
 (5E) Dickerman, H. W., Carter, M. L., Anal. Biochem. 3, 195 (1962).  
 (6E) Dubouloz, P., Fondarai, J., Pavone-Marville, R., Anal. Chim. Acta 26, 249 (1962).  
 (7E) Dunn, M. S., Murphy, E. A., Anal. Chem. 33, 997 (1961).  
 (8E) Duval, M., Delga, J., Ann. Pharm. Franc. 19, 94 (1961).  
 (9E) Fischl, J., Sason, I., Segal, S., Clin. Chem. 7, 674 (1961).  
 (10E) Garvin, J. E., Arch. Biochem. Biophys. 91, 219 (1960).  
 (11E) Gerok, W., Klin. Wochschr. 38, 1212 (1960).  
 (12E) Hanes, C. S., Wood, D. D., Can. J. Biochem. Physiol. 39, 163 (1961).  
 (13E) Harris, C. K., Tigane, E., Hanes, C. S., Ibid., p. 439.  
 (14E) Harrison, P. M., Hofmann, T., Biochem. J. 80, 38 (1961).  
 (15E) Johnson, D. E., Scott, S. J., Meister, A., ANAL. CHEM. 33, 669 (1961).  
 (16E) Kaplan, A., Hruby, S., Clin. Chem. 8, 449 (1962).  
 (17E) Kurzawa, Z., Chem. Anal. (Warsaw) 5, 331 (1960).  
 (18E) Lipovec, K., Farm. Glasnik 18, 2 (1962).  
 (19E) Lundquist, F., Galatius-Jensen, H., Scand. J. Clin. Lab. Invest. 12, 342 (1960).  
 (20E) McCaman, M. W., Robins, E., J. Clin. Med. 59, 885 (1962).  
 (21E) McEvoy-Bowe, E., Biochem. J. 80, 616 (1961).  
 (22E) Mans, R. J., Novelli, G. D., Arch. Biochem. Biophys. 94, 48 (1961).  
 (23E) Matheson, A. T., Tigane, E., Hanes, C. S., Can. J. Biochem. Physiol. 39, 417 (1961).  
 (24E) Mizell, M., Simpson, S. B., Jr., J. Chromatog. 5, 157 (1961).  
 (25E) Noah, J. W., Brand, A., J. Allergy 31, 236 (1961).  
 (26E) Oates, J. A., Marsh, E., Sjoerdsema, A., Clin. Chim. Acta 7, 488 (1962).  
 (27E) Peraino, C., Harper, A. E., ANAL. CHEM. 33, 1863 (1961).  
 (28E) Prockop, D. J., Udenfriend, S., Anal. Biochem. 1, 228 (1960).  
 (29E) Prockop, D. J., Udenfriend, S., Lindstedt, S., J. Biol. Chem. 236, 1395 (1961).  
 (30E) Rollins, C., Jensen, L., Schwarts, A. N., ANAL. CHEM. 34, 711 (1962).  
 (31E) Rothman, F., Higa, A., Anal. Biochem. 3, 173 (1962).  
 (32E) Saint-Blancard, J., Storck, J., Ann. Pharm. Franc. 18, 711 (1960).  
 (33E) Sanahuja, J. C., Rios, D. S., Rev. Farm. (Buenos Aires) 102, 239 (1960).  
 (34E) Scott, T. A., Biochem. J. 80, 462 (1961).  
 (35E) Sublett, R. L., Jewell, J. P., ANAL. CHEM. 32, 1841 (1960).  
 (36E) Uno, T., Yasuda, H., Kondo, T., Yakugaku Zasshi 81, 499 (1961).  
  

### Blood Preservation, Clotting Factors, and Gasometric Analysis

(1F) Andersen, O. S., Jorgensen, K., Naeraa, N., Scand. J. Clin. Lab. Invest. 14, 298 (1962).  
 (2F) Cesnik, H., Kronberger, L., Med. Welt 1961, 490.  
 (3F) Chen, H. C., Lyons, H. A., J. Lab. Clin. Med. 59, 509 (1962).  
 (4F) Ellerbrook, L. D., Ramsden, D. L., Rhees, M. C., Brown, D. V., Am. J. Clin. Pathol. 32, 218 (1959).  
 (5F) Ermakova, N. M., Lab. Delo 7, 8 (1961).  
 (6F) Fiala, J., Vlokova, M., Vopatova, M., Vnitri Lekar. 6, 167 (1960).

- (7F) Gambino, S. R., *Am. J. Clin. Pathol.* **35**, 268 (1961).  
 (8F) *Ibid.* p. 175.  
 (9F) Gambino, S. R., *Clin. Chem.* **7**, 236 (1961).  
 (10F) Husom, O., *Scand. J. Clin. Lab. Invest.* **13**, 609 (1961).  
 (11F) Janitzki, U., *Deut. Z. Ges. Gerichtl. Med.* **52**, 22 (1961).  
 (12F) Kravtsova, E. F., *Lab. Delo* **6**, 26 (1960).  
 (13F) Lew, H., Qyinn, M. J., *Am. J. Med. Technol.* **27**, 238 (1961).  
 (14F) Lukas, D. S., Ayres, S. M., *J. Appl. Physiol.* **16**, 371 (1961).  
 (15F) Maas, A. H. J., van Heijst, A. N. P., *Clin. Chim. Acta* **6**, 34 (1961).  
 (16F) Nehring, K., Schröder, I., *Monatsh. Veterinärmed.* **15**, 324 (1960).  
 (17F) Nilsson, N. J., *Physiol. Revs.* **40**, 1 (1960).  
 (18F) Penicillin-Gesellschaft Danlsberg & Co., Ger. Patent **1,068,862**, Nov. 12, 1959 (Cl. 30h).  
 (19F) Phillips, G. E., Luddecke, H. F., Breuchaud, J. S., Lenahan, J. G., *J. Lab. Clin. Med.* **56**, 659 (1960).  
 (20F) Proctor, R. R., Rapport, S. I., *Am. J. Clin. Pathol.* **36**, 212 (1961).  
 (21F) Quick, A. J., *J. Clin. Pathol.* **13**, 457 (1960).  
 (22F) Rapport, S. I., Schiffman, S., Patch, M. J., Ware, A. G., *J. Lab. Clin. Med.* **57**, 771 (1961).  
 (23F) Ross, D., Zwerneman, J., *Am. J. Clin. Pathol.* **35**, 190 (1961).  
 (24F) Schoen, I., Praphai, M., Weiss, A., *Ibid.* **37**, 374 (1962).  
 (25F) Sirridge, M. S., Bowman, K. S., Allwin, J. F., *Ibid.* p. 551.  
 (26F) Still, G., Rodman, T., *Ibid.* **38**, 435 (1962).  
 (27F) Turpin, F. H., Roberts, B. L., *Am. J. Med. Technol.* **28**, 217 (1962).  
 (28F) Underwood, A. L., Howe, L. H. III, *ANAL. CHEM.* **34**, 692 (1962).  
 (29F) Van Bruggen, J. T., Scott, J. C., *Anal. Biochem.* **3**, 464 (1962).  
 (30F) Vermijlen, C., Verstraete, M., *Thromb. Diath. Haemorrhag.* **5**, 267 (1960).  
 (31F) Weale, F. E., *Brit. Heart J.* **22**, 201 (1960).  
 (32F) Wilson, R. H., Jay, B., Doty, V., Pingree, H., Higgins, E., *J. Appl. Physiol.* **16**, 374 (1961).
- Cations and Anions**
- (1H) Adams, E. C., Jr., U. S. Patent **2,982,700**, May 2, 1961.  
 (2G) Aghdashli, M., *Arch. Inst. Hessarek* **12**, 119 (1960).  
 (3G) Ataullakhanov, I. A., *Nauchn. Tr. Samarkandsk. Med. Inst.* **19**, 382 (1960).  
 (4G) Bauer, R., Mast, R. L., U. S. Patent **3,016,292**, May 15, 1959.  
 (5G) Bishop, C. T., *Methods Biochem. Analys.* **10**, 1 (1962).  
 (6G) Blecher, M., *Anal. Biochem.* **2**, 30 (1961).  
 (7G) Blecher, M., Glassman, A. B., *Ibid.* **3**, 343 (1962).  
 (8G) Brown, M. E., *Diabetes* **10**, 60 (1961).  
 (9G) Campbell, L. A., Kronfeld, D. S., *Vet. Research* **22**, 587 (1961).  
 (10G) Canturri, E. J. G., *Med. Seguridad Trabajo* **9**, 13 (1961).  
 (11G) Cipera, J. D., *Analyst* **85**, 517 (1960).  
 (12G) Dobrick, L. A., U. S. Patent **3,009,862**, Oct. 6, 1958.  
 (13G) Dubowski, K. M., *Clin. Chem.* **8**, 215 (1962).  
 (14G) Gibson, J. J., U. S. Patent **2,990,338**, June 27, 1961.  
 (15G) Gold, H., U. S. Patent **2,963,350**, Dec. 6, 1960.  
 (16G) Gröger, W. K. L., *Clin. Chim. Acta* **6**, 866 (1961).  
 (17G) Harvill, E. K., U. S. Patent **3,008,879**, March 18, 1960.  
 (18G) Hob, R., *Repert. Med. Prat.* **3**, 25 (1962).  
 (19G) Hyvarinen, A., Nikkila, E. A., *Clin. Chim. Acta* **7**, 140 (1962).  
 (20G) Jakobsen, L. K., *Scand. J. Clin. Lab. Invest.* **12**, 76 (1960).  
 (21G) Jusic, D., Fiser-Herman, M., *Clin. Chim. Acta* **6**, 472 (1961).  
 (22G) Kerstell, J., *Scand. J. Clin. Lab. Invest.* **13**, 637 (1961).  
 (23G) Kraus, P., Simane, Z., *Klin. Wochschr.* **39**, 309 (1961).  
 (24G) Lehmann, J., *Scand. J. Clin. Lab. Invest.* **14**, 212 (1962).  
 (25G) Miles Laboratories, Inc., Brit. Patent **839,644**, June 29, 1960. Addn. to Brit. Patent **808,742**.  
 (26G) Miles Laboratories, Inc., Brit. Patent **886,778**, Jan. 10, 1962; U. S. Appl. Mar. 27, 1959.  
 (27G) Miller, G. L., *Anal. Biochem.* **1**, 133 (1960).  
 (28G) Mohun, A. F., Cook, I. J. Y., *J. Clin. Pathol.* **15**, 169 (1962).  
 (29G) Montreuil, J., *Pathol. Biol. Semaine Hop.* **10**, 891 (1962).  
 (30G) Östling, G., *Acta Soc. Med. Upsaliens.* **65**, 222 (1960).  
 (31G) Partridge, S. M., Elsden, D. F., *Biochem. J.* **80**, 34 (1961).  
 (32G) Raabo, E., Terkildsen, T. C., *Scand. J. Clin. Lab. Invest.* **12**, 402 (1960).  
 (33G) Schmidt, F. H., *Klin. Wochschr.* **39**, 1244 (1961).  
 (34G) Shibata, S., Mishima, S., *Bull. Yamaguchi Med. School* **9**, 13 (1962).  
 (35G) Smith, M., Thomas, L. E., *Clin. Chem.* **8**, 289 (1962).  
 (36G) Steinitz, K., *Anal. Biochem.* **2**, 497 (1961).  
 (37G) Watson, D., *Clin. Chim. Acta* **7**, 145 (1962).  
 (38G) Welch, N. L., Danielson, W. H., *Am. J. Clin. Pathol.* **38**, 251 (1962).  
 (39H) Lindstrom, F., Stephens, B. G., *ANAL. CHEM.* **34**, 993 (1962).  
 (40H) Loken, H. F., Havel, R. J., Gordian, G. S., Whittington, S. L., *J. Biol. Chem.* **235**, 3654 (1960).  
 (41H) MacIntyre, I., *Advan. in Clin. Chem.* **4**, 1 (1961).  
 (42H) Margoshes, M., *ANAL. CHEM.* **34**, 221R (1962).  
 (43H) Montgomery, R. D., *J. Clin. Pathol.* **14**, 400 (1961).  
 (44H) Newell, J. E., Duke, E., *Am. J. Clin. Pathol.* **38**, 140 (1962).  
 (45H) Nifontova, M. V., *Lab. Delo* **8**, 27 (1962).  
 (46H) Oliver, W. T., Funnell, H. S., *ANAL. CHEM.* **33**, 434 (1961).  
 (47H) Pappenhagen, A. R., Jackson, H. D., *Clin. Chem.* **6**, 584 (1960).  
 (48H) Paton, R. R., Steinfeld, J. L., *J. Lab. Clin. Med.* **57**, 306 (1961).  
 (49H) Petersen, D. F., Mitchell, V. E., Langham, H. W., *Health Phys.* **6**, 1 (1961).  
 (50H) Pijck, J., Hoste, J., *Clin. Chim. Acta* **7**, 5 (1962).  
 (51H) Portnoy, H. D., Thoman, L. M., Gurdjian, E. S., *Talanta* **9**, 119 (1962).  
 (52H) Radin, N., Gramza, A. L., *Clin. Chem.* **8**, 445 (1962).  
 (53H) Reed, M. G., Scott, A. D., *ANAL. CHEM.* **33**, 773 (1961).  
 (54H) Schachter, D., *J. Lab. Clin. Med.* **58**, 495 (1961).  
 (55H) Schmidt, W., *Aerztl. Lab.* **6**, 206 (1960).  
 (56H) Selleri, R., Caldini, O., *ANAL. CHEM.* **33**, 1944 (1961).  
 (57H) Shaw, W. M., *J. Agr. Food Chem.* **9**, 18 (1961).  
 (58H) Spare, P. D., *Am. J. Clin. Pathol.* **37**, 232 (1962).  
 (59H) Stevenson, D. E., Wilson, A. A., *Clin. Chim. Acta* **6**, 298 (1961).  
 (60H) Suzuki, M., *Bunko Kenkyu* **8**, 134 (1960).  
 (61H) Thiers, R. E., Hviid, K., *Clin. Chem.* **8**, 35 (1962).  
 (62H) Toribara, T. Y., Koval, L., *J. Lab. Clin. Med.* **57**, 630 (1961).  
 (63H) Toribara, T. Y., Koval, L., *Talanta* **7**, 248 (1961).  
 (64H) Webster, W. W., Jr., *Am. J. Clin. Pathol.* **37**, 330 (1962).

- (65H) West, P. W., ANAL. CHEM. 34, 104R (1962).  
 (66H) Willis, J. B., *Ibid.*, 33, 556 (1961).  
 (67H) Williams, K. T., Wilson, J. R., *Ibid.*, p. 244.

#### Drugs

- (1J) Bonnichsen, R., Maehly, A. C., Norlander, S., *J. Chromatog.* 3, 190 (1960).  
 (2J) Bradshaw, W. H., Douglas, J. F., ANAL. CHEM. 34, 1172 (1962).  
 (3J) Cattaneo, C., Fantoli, U., Belasio, L., *Ann. Ist. "Carlo Forlanini"* 20, 59 (1960).  
 (4J) Cochin, J., Daly, J. W., *Experientia* 18, 294 (1962).  
 (5J) Dixon, K., *Clin. Chim. Acta* 7, 453 (1962).  
 (6J) Dutkiewicz, T., *Med. Pracy* 11, 167 (1960).  
 (7J) Grafnetterova, J., *Casopis Lekaru Ceskych* 99, 182 (1960).  
 (8J) Hanok, A., *Clin. Chem.* 8, 400 (1962).  
 (9J) Heller, A., Kasik, J. E., Clark, L., Roth, L. J., ANAL. CHEM. 33, 1755 (1961).  
 (10J) Hetzel, C. A., *Clin. Chem.* 7, 130 (1961).  
 (11J) Kaul, P. N., *J. Pharm. Pharmacol.* 14, 237 (1962).  
 (12J) Klimov, A. N., Zhukova, E. N., *Lab. Delo* 6, 25 (1960).  
 (13J) Madsen, O. D., *Clin. Chim. Acta* 7, 481 (1962).  
 (14J) Mellett, L. B., Woods, L. A., *Cancer Res.* 20, 518 (1960).  
 (15J) Mesnard, P., Crockett, R., *Rev. Espan. Fisiol.* 16, Suppl. 3, 163 (1960).  
 (16J) Nambara, T., Urakawa, T., *Yakugaku Zasshi* 80, 1663 (1960).  
 (17J) Papariello, G. J., Slack, S. C., Mader, W. J., ANAL. CHEM. 33, 113R (1961).  
 (18J) Parker, K. D., Fontan, C. R., Kirk, P. L., ANAL. CHEM. 34, 757 (1962).  
 (19J) Pavlu, J., Sula, J., *Collection Czech. Chem. Commun.* 25, 2461 (1960).  
 (20J) Peters, J. H., *Am. Rev. Respirat. Diseases* 81, 485 (1960).  
 (21J) Pisano, J. J., Oates, J. A., Jr., Karmen, A., Sjoerdsma, A., Udenfriend, S., *J. Biol. Chem.* 236, 898 (1961).  
 (22J) Porcaro, P. J., Johnston, V. D., ANAL. CHEM. 33, 1748 (1961).  
 (23J) Quadrat, O., *Casopis Lekaru Ceskych* 99, 745 (1960).  
 (24J) Schwartz, D. E., Rieder, J., *Clin. Chim. Acta* 6, 453 (1961).  
 (25J) Sheppard, H., Mowles, T. F., Plummer, A. J., *J. Am. Pharm. Assoc.*, 49, 722 (1960).  
 (26J) Stevenson, G. W., ANAL. CHEM. 32, 1522 (1960).  
 (27J) Street, H. V., *Chem. Ind. (London)*, 1962, 1501.  
 (28J) Sunshine, I., Rose, E., *Clin. Chem.* 8, 421 (1962).

#### Lipids

- (1K) Anderson, E. C., Langham, W. H., *Science* 133, 1917 (1961).  
 (2K) Azarnoff, D. L., Esker, M. M., Brock, F. E., *J. Lab. Clin. Med.* 60, 331 (1962).  
 (3K) Barreto, R. C. R., Mano, D. B., *Clin. Chim. Acta* 6, 887 (1961).  
 (4K) Bergquist, L. M., Carroll, V. P., Jr., Searcy, R. L., *Lancet* 1, 537 (1961).  
 (5K) Biezenski, J. J., *J. Lipid Res.* 3, 120 (1962).  
 (6K) Bogoyavlenskii, V. F., Rozenshtein, D. N., *Lab. Delo* 7, 24 (1961).  
 (7K) Brandstein, M., Castellano, A., *J. Lab. Clin. Med.* 57, 300 (1961).  
 (8K) Connerty, H. V., Briggs, A. R., Eaton, E. H., Jr., *Clin. Chem.* 7, 37 (1961).

- (9K) Di Leo, F. P., *Ann. Fac. Med. Chir. Univ. Studi Perugia* 51, 521 (1960).  
 (10K) Doizaki, W. M., Zieve, L., *J. Lipid Res.* 3, 138 (1962).  
 (11K) Dole, V. P., Meinertz, H., *J. Biol. Chem.* 235, 2595 (1960).  
 (12K) Drysdale, J., Billimoria, J. D., *Clin. Chim. Acta* 5, 828 (1960).  
 (13K) Fidanza, F., Cioffi, L. A., *Boll. Soc. Ital. Biol. Sper.* 35, 1901 (1959).  
 (14K) Florsheim, W. H., Gonzales, C., *Proc. Soc. Exptl. Biol. Med.* 104, 618 (1960).  
 (15K) Forbes, G. B., Hursh, J. B., *Science* 133, 1918 (1961).  
 (16K) Galletti, F., *Clin. Chim. Acta* 6, 749 (1961).  
 (17K) Gerstl, B., Athineos, E., Kahnke, M. J., Davis, W. E., Jr., Smith, J. K., *Lab. Invest.* 10, 76 (1961).  
 (18K) Groulade, J., Olivier, C., *Ann. Biol. Clin. (Paris)* 18, 577 (1960).  
 (19K) Hagen, J. H., *Biochem. J.* 82, 23P (1962).  
 (20K) Hallgren, B., Svanborg, A., *Scand. J. Clin. Lab. Invest.* 14, 179 (1962).  
 (21K) Haskins, W. T., ANAL. CHEM. 33, 1445 (1961).  
 (22K) Heiskell, C. L., Fisk, R. T., Florsheim, W. H., Tachi, A., Goodman, J. R., Carpenter, C. M., *Am. J. Clin. Pathol.* 35, 222 (1961).  
 (23K) Hlynaczak, A. J., Sysa, J., Tocyzski, T., Horbaciewicz, A., *Biochem. Z.* 334, 357 (1961).  
 (24K) Horrocks, L. A., Cornwell, D. G., *J. Lipid Res.* 3, 165 (1962).  
 (25K) Jacobs, S. L., Henry, R. J., *Clin. Chim. Acta* 7, 270 (1962).  
 (26K) James, A. T., *Methods Biochem. Anal.* 8, 1 (1960).  
 (27K) Kasuga, S., *Clin. Chim. Acta* 5, 772 (1960).  
 (28K) Kellen, J., Pisarcikova, E., *Klin. Wochschr.* 39, 1028 (1961).  
 (29K) Khomutov, B. I., Garkusha, G. A., *Vopr. Med. Khim.* 6, 431 (1960).  
 (30K) Kohn, J., *Nature* 189, 312 (1961).  
 (31K) Kuemmel, D. F., ANAL. CHEM. 34, 1003 (1962).  
 (32K) Landowne, R. A., Lipsky, S. R., *Biochim. Biophys. Acta* 47, 589 (1961).  
 (33K) Lauter, C. J., Trams, E. G., *J. Lipid Res.* 3, 136 (1962).  
 (34K) Lis, E. W., Tinoco, J., Okey, R., *Anal. Biochem.* 2, 100 (1961).  
 (35K) McCarthy, R. D., Duthie, A. H., *J. Lipid Res.* 3, 117 (1962).  
 (36K) McDonald, H. J., Banaszak, L. J., *Clin. Chim. Acta* 6, 25 (1961).  
 (37K) McDonald, H. J., Kissane, J. Q., *Anal. Biochem.* 1, 178 (1960).  
 (38K) Mendelsohn, D., Antonis, A., *J. Lipid Res.* 2, 45 (1961).  
 (39K) Metcalfe, L. D., Schmitz, A. A., ANAL. CHEM. 33, 363 (1961).  
 (40K) Noerby, J. G., *Acta Chem. Scand.* 15, 525 (1961).  
 (41K) Ressler, N., Springgate, R., Kaufman, J., *J. Chromatog.* 6, 409 (1961).  
 (42K) Rouser, G., Bauman, A. J., Nicolaides, N., Heller, D., *J. Am. Oil Chemists' Soc.* 38, 565 (1961).  
 (43K) Rudd, B. T., *Anal. Biochem.* 3, 81 (1962).  
 (44K) Searcy, R. L., Bergquist, L. M., Jung, R. C., Craig, R., Korotzer, J., *Clin. Chem.* 6, 585 (1960).  
 (45K) Searcy, R. L., Carroll, V. P., Jr., Carlucci, J. S., Bergquist, L. M., *Ibid.*, 8, 166 (1962).  
 (46K) Searcy, R. L., Korotzer, J. L., Craig, R. G., Bergquist, L. M., *Anal. Biochem.* 2, 385 (1961).  
 (47K) Tinoco, J., Shannon, A., Miljanich, P., Lyman, R. L., Okey, R., *Ibid.*, 3, 514 (1962).  
 (48K) Ushakov, B. N., Polozhentsev, S. D., *Lab. Delo* 7, 12 (1961).

- (49K) Verheyden, J., Nys, J., *Clin. Chim. Acta* 7, 262 (1962).  
 (50K) Vogel, W. C., Zieve, L., Carleton, R. O., *J. Lab. Clin. Med.* 59, 335 (1962).  
 (51K) Zilberman, D. B., Moibenko, A. A., *Lab. Delo* 7, 16 (1961).

#### Enzymes

- (1L) Abreu, L. A., *Rev. Brasil. Biol.* 21, 97 (1961).  
 (2L) Babson, A. L., U. S. Patent 3,002,893. Appl. Nov. 13, 1958.  
 (3L) Babson, A. L., Shapiro, P. O., Williams, P. A. R., Phillips, G. E., *Clin. Chim. Acta* 7, 199 (1962).  
 (4L) Blackwood, C., Mandl, I., *Anal. Biochem.* 2, 370 (1961).  
 (5L) Bodansky, O., *Am. J. Clin. Pathol.* 38, 343 (1962).  
 (6L) Bowers, G. N., Jr., Bartlett, R. C., *Clin. Chem.* 8, 440 (1962).  
 (7L) Breuer, H., Schönfelder, M., *Clin. Chim. Acta* 6, 515 (1961).  
 (8L) Chao, S., Sciarra, J. J., Vosburgh, G. J., *Proc. Soc. Exptl. Biol. Med.* 109, 342 (1962).  
 (9L) Chikalo, I. I., *Lab. Delo* 6, 52 (1960).  
 (10L) Chou, C.-J., Sung, C.-L., *Tai-wan I Hsueh Hui Tsa Chih* 60, 702 (1961).  
 (11L) Dahlquist, A., *Biochem. J.* 80, 547 (1961).  
 (12L) Dalquist, A., *Scand. J. Clin. Lab. Invest.* 14, 145 (1962).  
 (13L) Dewey, M. M., Conklin, J. L., *Proc. Soc. Exptl. Biol. Med.* 105, 492, (1960).  
 (14L) Elliott, B. A., Wilkinson, J. H., *Lancet* 698 (1961).  
 (15L) Ells, H. A., *Clin. Chem.* 7, 265 (1961).  
 (16L) Estborn, B., *Clin. Chim. Acta* 6, 22 (1961).  
 (17L) Ezerskii, R. F., *Lab. Delo* 6, 15 (1960).  
 (18L) Floch, M. H., Montalvo, G., Crosby, P., LaTorre, R., *Am. J. Clin. Pathol.* 37, 350 (1962).  
 (19L) Fomina, M. P., Titova, G. V., *Biokhimiya* 26, 662 (1961).  
 (20L) Forsell, O. M., Palva, I. P., *Scand. J. Clin. Lab. Invest.* 13, 131 (1961).  
 (21L) Goldbarg, J. A., Friedman, O. M., Pineda, E. P., Smith, E. E., Chatterji, R., Stein, E. H., Rutenburg, A. M., *Arch. Biochem. Biophys.* 91, 61 (1960).  
 (22L) Grassmann, W., Nordwig, A., *Z. Physiol. Chem.* 322, 267 (1960).  
 (23L) Green, A. L., Haughton, T. M., *Biochem. J.* 78, 172 (1961).  
 (24L) Grossman, L., Greenlees, J., *Anal. Biochem.* 2, 1961 (1961).  
 (25L) Gupta, J. C., Ghosh, B. P., Mal, S. N., *Med. Exptl.* 3, 199 (1960).  
 (26L) Henry, R. J., Chiromori, N., Jacobs, S. L., Segalove, M., *Proc. Soc. Exptl. Biol. Med.* 104, 620 (1960).  
 (27L) Hess, B., Walter, S. J., *Klin. Wochschr.* 39, 213 (1961).  
 (28L) Hill, B. R., *Cancer Res.* 21, 271 (1961).  
 (29L) Hughes, B. P., *Clin. Chim. Acta* 7, 597 (1962).  
 (30L) Humlcek, O., Hruska, K., *Sb. Vysoke Skoly Zemedel. Brne Rada B* 8, 16 (1960).  
 (31L) Jacobsson, K., *Scand. J. Clin. Lab. Invest.* 12, 367 (1960).  
 (32L) Josefsson, L., Lagerstedt, S., *Methods Biochem. Anal.* 9, 39 (1962).  
 (33L) King, E. J., Campbell, D. M., *Clin. Chim. Acta* 6, 301 (1961).  
 (34L) King, J., *J. Med. Lab. Technol.* 18, 168 (1961).  
 (35L) Klimek, R., Pietrzycka, M., *Clin. Chim. Acta* 6, 326 (1961).  
 (36L) Kurnick, N. B., *Methods of Biochem. Anal.* 9, 1 (1962).

- (37L) Laursen, T., *Scand. J. Clin. Lab. Invest.* **14**, 152 (1962).
- (38L) Linuchev, M. N., *Prob. Med. Chem. (Moscow)* **6**, 426 (1960).
- (39L) Marks, V., *Clin. Chim. Acta* **6**, 724 (1961).
- (40L) Matsuzawa, T., *Tokushima J. Exptl. Med.* **7**, 143 (1960).
- (41L) Miller, A. L., Worsley, L., *British Med. J.* **1960**, 1419.
- (42L) Miller, L. L., Segal, H. L., Harrington, P. A., *Proc. Soc. Exptl. Biol. Med.* **106**, 270 (1961).
- (43L) Nachlas, M. M., Margulies, S. I., Goldberg, J. D., Seligman, A. M., *Anal. Biochem.* **1**, 317 (1960).
- (44L) Nanikawa, R., Tawa, N., *Nagoya Med. J.* **6**, 13 (1960).
- (45L) Nelson, W. L., Ciaccio, E. I., Hess, G. P., *Anal. Biochem.* **2**, 39 (1961).
- (46L) Orlowski, M., Szewczuk, A., *Acta Biochim. Polonica* **8**, 189 (1961).
- (47L) Pappenhaben, A. R., Koppel, J. L., Olwin, J. H., *J. Lab. Clin. Med.* **59**, 1039 (1962).
- (48L) Rässler, B., Schön, H., *Clin. Chim. Acta* **6**, 583 (1961).
- (49L) Ravin, H. A., *J. Lab. Clin. Med.* **58**, 161 (1961).
- (50L) Reif, A. E., Nabseth, D. C., McVety, L. M., *Clin. Chem.* **8**, 113 (1962).
- (51L) Ressler, N., Joseph, R., Schulz, J., *J. Lab. Clin. Med.* **60**, 349 (1962).
- (52L) Rice, E. W., *Anal. Biochem.* **3**, 452 (1962).
- (53L) Saev, G., Schchtereva, T., *Suvremenna Med.* **11**, 81 (1960).
- (54L) Saifer, A., Perle, G., *Clin. Chem.* **7**, 178 (1961).
- (55L) Sax, S. M., Trimble, G. E., *Ibid.* **8**, 439 (1962).
- (56L) Scheiffarth, F., Goetz, H., Czagany, F., *Med. Welt* **1961**, 1449.
- (57L) Schneider, I. J., Tindel, S., Shapira, D., State, D., Weisz, E., *J. Lab. Clin. Med.* **60**, 514 (1962).
- (58L) Schonbaum, G. R., Zerner, B., Bender, M. L., *J. Biol. Chem.* **236**, 2930 (1961).
- (59L) Stern, I. J., Wilk, S., Hollifield, R. D., *Anal. Biochem.* **2**, 396 (1961).
- (60L) Stockx, J., Vandendriessche, L., van Parijs, R., *Arch. Intern. Physiol. Bio-Chim.* **68**, 417 (1960).
- (61L) Suehiro, M., Nakanishi, K., *J. Biochem. (Tokyo)* **47**, 777 (1960).
- (62L) Thorup, O. A., Jr., Strole, W. B., Leavell, B. S., *J. Lab. Clin. Med.* **58**, 122 (1961).
- (63L) Van der Helm, H. J., *Clin. Chim. Acta* **7**, 124 (1962).
- (64L) Wacker, W. E. C., Dorfman, L. E., *J. Am. Med. Assoc.* **181**, 148 (1962).
- (65L) Wolff, R., Brignon, J. J., Schemberg, M., *Compt. Rend. Soc. Biol.* **155**, 575 (1961).
- (66L) Yakulis, V. J., Gibson, C. W., Heller, P., *Am. J. Clin. Pathol.* **38**, 378 (1962).
- (67L) Zieve, L., Vogel, W. C., *J. Lab. Clin. Med.* **57**, 586 (1961).
- Function Tests**
- (1M) Ackerman, C. J., Chou, M., *Anal. Biochem.* **1**, 337 (1960).
- (2M) Adams, W. S., Davis, F. W., Hansen, L. E., *ANAL. CHEM.* **34**, 854 (1962).
- (3M) American Academy of Pediatrics *et al.*, *Clin. Chem.* **8**, 405 (1952).
- (4M) Babando, G., Pasquale, A., *Policlinico (Rome), Sez. Prat.* **67**, 126 (1960).
- (5M) Balassa, M., *Orv. Hetilap* **101**, 259 (1960).
- (6M) Bethoux, R., *Repert. Med. Prat.* **11**, 11 (1961).
- (7M) Bethoux, R., *Ibid.*, p. 13.
- (8M) Biggs, H. G., Cooper, J. M., *Clin. Chem.* **7**, 656 (1961).
- (9M) Blanka, B., *Vnitrni Lekar.* **6**, 817 (1960).
- (10M) Boettcher, C. J. F., Pries, C., van Gent, C. M., *Rec. Trav. Chim.* **80**, 1169 (1961).
- (11M) Boutwell, J. H., Jr., *Clin. Chem.* **7**, 557 (1961).
- (12M) Brodersen, R., *Scand. J. Clin. Lab. Invest.* **12**, 25 (1960).
- (13M) Chiamori, N., Henry, R. J., Golub, O. J., *Clin. Chim. Acta* **6**, 1 (1961).
- (14M) Clarke, J. T., *Clin. Chem.* **7**, 271 (1961).
- (15M) Cooper, J. M., Biggs, H. G., *Ibid.*, p. 665.
- (16M) Ellman, G. L., Burkhalter, A., LaDou, J., *J. Lab. Clin. Med.* **57**, 813 (1961).
- (17M) Fog, J., Jellum, E., *Nature* **195**, 490 (1962).
- (18M) Grabener, E., *Internist* **1**, 179 (1960).
- (19M) Grant, B. P., Wigh, R., *J. Am. Med. Assoc.* **174**, 1304 (1960).
- (20M) Gregory, C. H., Watson, C. J., *J. Lab. Clin. Med.* **60**, 1 (1962).
- (21M) Henry, R. J., Jacobs, S. L., Chiamori, N., *Clin. Chem.* **6**, 536 (1960).
- (22M) Hofmann, A. F., *Anal. Biochem.* **3**, 145 (1962).
- (23M) Hofmann, A. F., *J. Lipid Res.* **3**, 127 (1962).
- (24M) Ishimori, A., Glass, G. B. J., *Clin. Chem.* **7**, 457 (1961).
- (25M) Ketterer, S. G., Weigand, B. D., Rapaport, E., *Am. J. Physiol.* **199**, 481 (1960).
- (26M) Levin, S. J., Johnston, C. G., *J. Lab. Clin. Med.* **59**, 681 (1962).
- (27M) Lubran, M., *Clin. Chim. Acta* **6**, 582 (1961).
- (28M) MacIntyre, I., Woottton, I. D. P., *Ann. Rev. Biochem.* **29**, 635 (1960).
- (29M) Mentz, H. E. A., Grotewass, W., *S. African J. Lab. Clin. Med.* **6**, 43 (1960).
- (30M) Michaelsson, M., *Scand. J. Clin. Lab. Invest.* **13**, 1 (1961), Suppl. 56, 80 page monograph.
- (31M) Mills, G. C., *Clin. Chem.* **7**, 165 (1961).
- (32M) Polesky, H., Seligson, D., Brahen, L., *Ibid.*, **8**, 433 (1962).
- (33M) Rand, R. N., DiPasqua, A., *Ibid.*, **7**, 557 (1961).
- (34M) Schellong, G., Wende, U., *Klin. Wochschr.* **38**, 703 (1960).
- (35M) Schlenker, F. S., Davis, C. L., Kitchell, C. L., *Am. J. Clin. Pathol.* **36**, 31 (1961).
- (36M) Stevenson, G. W., Jacobs, S. L., Henry, R. J., *Clin. Chem.* **8**, 433 (1962).
- (37M) Thomas, M. C., Plaa, G. L., *Am. J. Clin. Pathol.* **34**, 488 (1960).
- (38M) Tobias, G. J., McLaughlin, R. F., Jr., Hopper, J. Jr., *New Engl. J. Med.* **266**, 317 (1962).
- (39M) Watson, D., *Clin. Chem.* **7**, 603 (1961).
- (40M) Watson, D., *Clin. Chim. Acta* **6**, 737 (1961).
- (41M) Welsh, J. D., Russell, L., Wolf, S., *J. Clin. Invest.* **41**, 660 (1962).
- (42M) Witmans, J., Schalm, L., Schulte, M. J., *Clin. Chim. Acta* **6**, 7 (1961).
- (43M) Wu, T.-L., *Tai-wan I Hsueh Hui Tsa Chih* **59**, 727 (1960).
- (44M) Zenker, N., *Anal. Biochem.* **2**, 89 (1961).
- Hemoglobin**
- (1N) Ben-Gershon, E., *Biochem. J.* **78**, 218 (1961).
- (2N) Collins, R. A., Haukohl, R. S., Balmer, E., *Am. J. Clin. Pathol.* **36**, 285 (1961).
- (3N) Dobryszycka, W. M., *Clin. Chim. Acta* **6**, 565 (1961).
- (4N) Dumazert, C., Ghiglione, C., Artaud, M., *Bull. Soc. Pharm. Marseille* **9**, 307 (1960).
- (5N) Engle, R. L., Jr., Markey, A., Pert, J. H., Woods, K. R., *Clin. Chim. Acta* **6**, 136 (1961).
- (6N) Friedman, H. S., *Clin. Chim. Acta* **7**, 100 (1962).
- (7N) Ibbotson, R. N., Crompton, B. A., *J. Clin. Pathol.* **14**, 164 (1961).
- (8N) Jim, R. T. S., *Ibid.*, p. 441.
- (9N) Johnson, T., Barrett, O'N., Jr., *J. Lab. Clin. Med.* **57**, 961 (1961).
- (10N) Kumlien, A., Paul, K. G., Ljungberg, S., *Scand. J. Clin. Lab. Invest.* **12**, 381 (1960).
- (11N) Natelson, S., Sheid, B., *Clin. Chem.* **7**, 115 (1961).
- (12N) O'Brien, B. R. A., *Stain Technol.* **36**, 57 (1961).
- (13N) Puchtler, H., Sweat, F., *Arch. Pathol.* **73**, 247 (1962).
- (14N) Remmer, H., *Internist* **1**, 232 (1960).
- (15N) Schoen, I., Solomon, M., *J. Clin. Pathol.* **15**, 44 (1962).
- (16N) Street, H. V., *J. Forensic Med.* **8**, 47 (1961).
- (17N) Van Kampen, E. J., Zijlstra, W. G., *Clin. Chim. Acta* **6**, 538 (1961).

### Metals

- (1P) Alexander, G. V., *ANAL. CHEM.* **34**, 951 (1962).
- (2P) Anand, V. D., Deshmukh, G. S., Pandey, C. M., *Ibid.*, **33**, 1933 (1961).
- (3P) Anderson, J., Weinbren, I., *Clin. Chim. Acta* **6**, 648 (1961).
- (4P) Beale, R. N., Bostrom, J. O., Taylor, R. F., *J. Clin. Pathol.* **15**, 156 (1962).
- (5P) Block, J., Morgan, E., *ANAL. CHEM.* **34**, 1647 (1962).
- (6P) Borg, D. C., Segel, R. E., Kienle, P., Campbell, L., *Intern. J. Appl. Radiation Isotopes* **11**, 10 (1961).
- (7P) Burke, R. W., Yoe, J. H., *ANAL. CHEM.* **34**, 1378 (1962).
- (8P) Caraway, W. T., *Clin. Chem.* **7**, 572 (1961).
- (9P) Ceriotti, G., Spandrio, L., *Clin. Chim. Acta* **6**, 233 (1961).
- (10P) Connerty, H. V., Briggs, A. R., *Clin. Chem.* **8**, 151 (1962).
- (11P) Dinsel, D. L., Sweet, T. R., *ANAL. CHEM.* **33**, 1078 (1961).
- (12P) Dubbs, C. A., Davis, F. W., *Clin. Chem.* **8**, 444 (1962).
- (13P) Duswalt, J. M., Mellon, M. G., *ANAL. CHEM.* **33**, 1782 (1961).
- (14P) Fischl, J., Cohen, S., *Clin. Chim. Acta* **7**, 121 (1962).
- (15P) Frierson, W. J., Patterson, N., Harrill, H., Marable, N., *ANAL. CHEM.* **33**, 1096 (1961).
- (16P) Grant, C. L., *Ibid.*, p. 401.
- (17P) Hill, R. M., Hill, J. R., Hill, M. M., *Clin. Chem.* **7**, 571 (1961).
- (18P) Kupaks, E., *Tru. Inst. Ekspерим. Med., Akad. Nauk Latv. SSR* **22**, 115 (1960).
- (19P) Lee, N. D., Chiamori, N., *Clin. Chim. Acta* **6**, 624 (1961).
- (20P) Levy, A. L., Vitacca, P., *Clin. Chem.* **7**, 241 (1961).
- (21P) Lund, P. K., Mathies, J. C., *Norelco Repr.* **7**, 127 (1960).
- (22P) Miller, D. O., Yoe, J. H., *Anal. Chim. Acta* **26**, 224 (1962).
- (23P) Natelson, S., Sheid, B., *ANAL. CHEM.* **33**, 396 (1961).
- (24P) Natelson, S., Sheid, B., *Clin. Chem.* **7**, 115 (1961).
- (25P) Newman, G. E., Ryan, M., *J. Clin. Pathol.* **15**, 181 (1962).
- (26P) Papavasiliou, P. S., Cotzias, G. C., *J. Biol. Chem.* **236**, 2365 (1961).

- (27P) Rogers, D. W., ANAL. CHEM. **34**, 1657 (1962).
- (28P) Ropp, R. C., Shearer, N. W., *Ibid.* **33**, 1240 (1961).
- (29P) Sastry, K. S., Raman, N., Sarma, P. S., *Ibid.* **34**, 1302 (1962).
- (30P) Smith, H., *Ibid.*, p. 190.
- (31P) Tauxe, W. N., Yamaguchi, M. Y., *Am. J. Clin. Pathol.* **35**, 403 (1961).
- (32P) Tvaroha, B., Mala, O., *Mikrochim. Acta* **1962** 634.
- (33P) Williams, L. A., Cohen, J. S., Zak, B., *Clin. Chem.* **7**, 572 (1961).
- Nitrogen Compounds**
- (1Q) Asatoor, A. M., Kerr, D. N. S., *Clin. Chim. Acta* **6**, 149 (1961).
- (2Q) Bolleter, W. T., Bushman, C. J., Tidewell, P. W., ANAL. CHEM. **33**, 592 (1961).
- (3Q) Camponovo, P. B., *Rev. Asoc. Bioquim. Arg.* **26**, 67 (1961).
- (4Q) Carr, M. H., Schloerb, P. R., ANAL. CHEM. **1**, 221 (1960).
- (5Q) Chaney, A. L., Marbach, E. P., *Clin. Chem.* **8**, 130 (1962).
- (6Q) Conn, R. B., Jr., *Ibid.* **6**, 547 (1960).
- (7Q) Crampton, C. F., Franel, F. R., Benson, A. M., Wade, A., ANAL. BIOCHEM. **1**, 249 (1960).
- (8Q) Delorme, M. L., *Repert. Med. Prat.* **11**, 13 (1961).
- (9Q) Dennemann, H., *Z. Ges. Exptl. Med.* **134**, 335 (1961).
- (10Q) Dienst, S. G., *J. Lab. Clin. Med.* **58**, 149 (1961).
- (11Q) Diven, R. H., Pistor, W. J., Reed, R. E., Trautman, R. J., Watts, R. E., *Am. J. Vet. Res.* **23**, 497 (1962).
- (12Q) Fenton, J. C. B., *Clin. Chim. Acta* **7**, 163 (1962).
- (13Q) Forman, D. T., *Clin. Chem.* **8**, 432 (1962).
- (14Q) Fric, F., *Biologie (Bratislava)* **16**, 918 (1961).
- (15Q) Gerber, G. B., Gerber, G., Altman, K. I., ANAL. CHEM. **33**, 852 (1961).
- (16Q) Guillaume, J., Tacquet, A., Berthelot, J. Y., *Rev. Franc. Etudes Clin. Biol.* **5**, 729 (1960).
- (17Q) Hashmi, M. H., Ali, E., Umar, M., ANAL. CHEM. **34**, 988 (1962).
- (18Q) Hozumi, K., Kirsten, W. J., *Ibid.*, p. 434.
- (19Q) Hutchinson, J. H., Labby, D. H., *J. Lab. Clin. Med.* **60**, 170 (1962).
- (20Q) Kogler, W., Scheiffarth, F., Frenger, W., *Acta Haematol.* **25**, 49 (1961).
- (21Q) Kurohara, S. S., *Clin. Chem.* **7**, 384 (1961).
- (22Q) Lambert, J. L., Zitomer, F., ANAL. CHEM. **32**, 1684 (1960).
- (23Q) Lawrie, H., *Central African Assoc. Med. Lab. Technol., Quarterly Rev.* **3**, 193 (1960).
- (24Q) Lee, Y. C., Montgomery, R., *Arch. Biochem. Biophys.* **93**, 292 (1961).
- (25Q) Levine, J. M., Leon, R., Steigmann, F., *Clin. Chem.* **7**, 488 (1961).
- (26Q) Makarenko, V. S., *Lab. Delo* **7**, 6 (1961).
- (27Q) Mathies, J. C., Lund, P. K., Eide, W., ANAL. BIOCHEM. **3**, 408 (1962).
- (28Q) Ramachandran, L. K., ANAL. CHEM. **33**, 1074 (1961).
- (29Q) Ratcliffe, J., Smith, P., *Chem. Ind. (London)* **1960**, 1159.
- (30Q) Reinhold, J. G., Chung, C. C., *Clin. Chem.* **7**, 54 (1961).
- (31Q) Searcy, R. L., Gough, G. S., Korotzer, J. L., Bergquist, L. M., *Am. J. Med. Technol.* **27**, 255 (1961).
- (32Q) Sorbo, B. H., *Clin. Chim. Acta* **6**, 87 (1961).
- (33Q) Ternberg, J. L., Hershey, F. B., *J. Lab. Clin. Med.* **56**, 766 (1960).
- (34Q) Turner, J. M., *Biochem. J.* **78**, 790 (1961).
- (35Q) Weller, H., *Roentgen-Lab. praxis* **15**, L77 (1962).
- (36Q) Wilcox, A. A., Sterling, R. E., *Clin. Chem.* **8**, 427 (1962).
- (37Q) Zitomer, F., Lambert, J. L., ANAL. CHEM. **34**, 1738 (1962).
- Hormones**
- (1R) Adams, R., Specht, N., Woodward, I., *Clin. Chem.* **7**, 595 (1961).
- (2R) Baginski, E., Zak, B., *Ibid.*, p. 571.
- (3R) Boucher, R., Biron, P., Genest, J., *Can. J. Biochem. and Physiol.* **39**, 581 (1961).
- (4R) Brunjes, S., Wybenga, D., Sproed, J., Chaney, A. L., *Clin. Chem.* **8**, 452 (1962).
- (5R) Crawford, N., Rudd, B. T., *Clin. Chim. Acta* **7**, 114 (1962).
- (6R) Crosti, P. F., Lucchelli, P. E., *J. Clin. Pathol.* **15**, 191 (1962).
- (7R) Dauchy, F., Schwartz, J. C., *Pathol. Biol.*, *Semaine Hop.* **10**, 527 (1962).
- (8R) Elzinga, K. E., Carr, E. A., Jr., Beierwaltes, W. H., *Am. J. Clin. Pathol.* **36**, 125 (1961).
- (9R) Farrell, L. P., Richmond, M. H., *Clin. Chim. Acta* **6**, 620 (1961).
- (10R) Faulkner, L. W., Levy, R. P., Leonards, J. R., *Clin. Chem.* **7**, 637 (1961).
- (11R) Goldenberg, H., White, D. L., *Ibid.* **8**, 453 (1962).
- (12R) Hagopian, M., Dorfman, R. I., Gut, M., ANAL. BIOCHEM. **2**, 387 (1961).
- (13R) Imarisio, J. J., Kotlowski, B. B., Imperato, A. A., *J. Lab. Clin. Med.* **60**, 526 (1962).
- (14R) Jacobs, S. L., Sobel, C., Henry, R. J., *J. Clin. Endocrinol. Metab.* **21**, 305 (1961).
- (15R) Jutisz, M., Theoleyre, M., Cologne, A., Courrier, R., *Bull. Soc. Chim. Biol.* **44**, 83 (1962).
- (16R) Kellersohn, C., Comar, D., Le Poec, C., *Intern. J. Appl. Radiation Isotopes* **12**, 87 (1961).
- (17R) Klein, D., Chernaik, J. M., *Clin. Chem.* **7**, 257 (1961).
- (18R) Kraupp, O., Bernheimer, H., Papistas, D., *Clin. Chim. Acta* **6**, 851 (1961).
- (19R) Lee, N. D., Pileggi, V. J., Segalove, M., *Clin. Chem.* **8**, 446 (1962).
- (20R) Lieberman, L. L., *Clin. Chim. Acta* **7**, 159 (1962).
- (21R) Lloyd, H. E. D., Parrelli, A. M., *Am. J. Clin. Pathol.* **38**, 339 (1962).
- (22R) Mahler, D. J., Humoller, F. L., *Clin. Chem.* **8**, 47 (1962).
- (23R) Nava, M., De Groot, L. J., *New Engl. J. Med.* **266**, 1307 (1962).
- (24R) Parrow, A., *Scand. J. Clin. Lab. Invest.* **14**, 192 (1962).
- (25R) Pileggi, V. J., Lee, N. D., Golub, O. J., Henry, R. J., *J. Clin. Endocrinol. Metab.* **21**, 1272 (1961).
- (26R) Pisano, J. J., Crout, J. R., Abraham, D., *Clin. Chim. Acta* **7**, 285 (1962).
- (27R) Posner, I., *J. Lab. Clin. Med.* **57**, 314 (1961).
- (28R) Robbins, J., *Compt. Rend. Trav. Lab. Carlsberg* **32**, 233 (1961).
- (29R) Robertson, J. I. S., Andrews, T. M., *Lancet* **1**, 578 (1961).
- (30R) Rosano, C. L., Fiore, J. M., *Clin. Chem.* **8**, 452 (1962).
- (31R) Sterling, K., Tabachnick, M., *J. Clin. Endocrinol.* **21**, 456 (1961).
- (32R) Sturm, A., *Klin. Wochschr.* **39**, 365 (1961).
- (33R) Sweeley, C. C., Williams, C. M., ANAL. BIOCHEM. **2**, 83 (1961).
- (34R) Sunderman, F. W., Jr., Cleveland, P. D., Law, N. C., Sunderman, F. W., *Am. J. Clin. Pathol.* **34**, 293 (1960).
- (35R) Unger, R. H., Eisentraut, A. M., McCall, M. S., Madison, L. L., Sims, K. R., Patman, L., *J. Clin. Invest.* **41**, 682 (1962).
- (36R) Vallance-Owen, J., Wright, P. H., *Physiol. Revs.* **40**, 219 (1960).
- (37R) Weise, V. K., McDonald, R. K., Labrosse, E. H., *Clin. Chim. Acta* **6**, 79 (1961).
- (38R) Weiss, B., Rossi, G. V., *Nature* **195**, 178 (1962).
- (39R) Winkler, C., Zubrzycki, Z., Mentzel, G., *Klin. Wochschr.* **38**, 965 (1960).
- (40R) Woiwod, A. J., Knight, R., *J. Clin. Pathol.* **14**, 502 (1961).
- Organic Acids**
- (1T) Blanka, G., *Vnitni Lekar.* **6**, 1301 (1960).
- (2T) Carr, M. H., Pressman, B. C., *Anal. Biochem.* **4**, 24 (1962).
- (3T) Cerbulis, J., Zittle, C. A., ANAL. CHEM. **33**, 1131 (1961).
- (4T) Christensen, P. J., *Scand. J. Clin. Lab. Invest.* **13**, 84 (1961).
- (5T) Cornillot, P., *Clin. Chim. Acta* **7**, 42 (1962).
- (6T) Friedland, I. M., Dietrich, L. S., ANAL. BIOCHEM. **2**, 390 (1961).
- (7T) Green, S., Anstiss, C., Fishman, W. H., *Biochim. Biophys. Acta* **62**, 574 (1962).
- (8T) Greiling, H., *Z. Rheumaforsh.* **20**, 298 (1961).
- (9T) Grossmann, G. F., Grossmann, A., Kravitz, E., Pollack, R. L., *Am. J. Pharm.* **133**, 213 (1961).
- (10T) Herbert, V., Fisher, R., Koontz, B. J., *J. Clin. Invest.* **40**, 81 (1961).
- (11T) Hodgkinson, A., Zarembski, P. M., *Analyst* **86**, 16 (1961).
- (12T) Hynie, I., Vecerek, B., Wagner, J., *Casopis Lekaru Ceskych* **99**, 88 (1960).
- (13T) Jirgl, V., Sochman, J., *Clin. Chim. Acta* **7**, 388 (1962).
- (14T) Kahan, F. M., ANAL. BIOCHEM. **1**, 107 (1960).
- (15T) Katsuki, H., Kawano, C., Yoshida, T., Kanayuki, H., Tanaka, S., ANAL. BIOCHEM. **2**, 433 (1961).
- (16T) *Ibid.*, 421 (1961).
- (17T) Lane, K., Chen, P. S., Jr., *U. S. At. Energy Comm. UR-579*, 1 (1960).
- (18T) Loomis, M. E., *J. Lab. Clin. Med.* **57**, 966 (1961).
- (19T) McFadden, B. A., Howes, W. V., ANAL. BIOCHEM. **1**, 240 (1960).
- (20T) Marks, V., *Clin. Chim. Acta* **6**, 724 (1961).
- (21T) Marogg, J., *Arzneimittel-Forsch.* **10**, 987 (1960).
- (22T) Mosher, R. E., *Clin. Chem.* **8**, 378 (1962).
- (23T) Nordmann, J., Nordmann, R., in "Advances in Clinical Chemistry," H. Sobotka, C. P. Stewart, eds., Vol. 4, p. 53, Academic Press, New York, 1961.
- (24T) Olson, G. F., *Clin. Chem.* **8**, 1 (1962).
- (25T) Papadopoulos, N. M., Hess, W. C., *Arch. Biochem. Biophys.* **88**, 167 (1960).
- (26T) Procos, J., *Clin. Chem.* **7**, 97 (1961).
- (27T) Remp, D. G., Schelling, V., *Ibid.* **8**, 432 (1962).
- (28T) Ruthven, C. R. J., Sandler, M., *Biochem. J.* **83**, 30P (1962).
- (29T) Saifer, A., Gerstenfeld, S., *Clin. Chim. Acta* **7**, 467 (1962).
- (30T) Scholander, P. F., Bradstreet, E., *J. Lab. Clin. Med.* **60**, 164 (1962).
- (31T) Seegmiller, J. E., Zannoni, V. G., Laster, L., La Du, B. N., *J. Biol. Chem.* **236**, 774 (1961).
- (32T) Singh, C., *J. Sci. Ind. Res. (India)* **19C**, 78 (1960).
- (33T) Slepecky, R. A., Law, J. H., ANAL. CHEM. **32**, 1697 (1960).
- (34T) Tsaney, R., Markov, G. G., *Bulgar. Akad. Nauk* **10**, 111 (1960).

- (35T) Vagelos, P. R., Vanden Heuvel, W. J. A., Horning, M. G., *Anal. Biochem.* **2**, 50 (1961).  
 (36T) Williams, C. M., Sweeny, C. C., *J. Clin. Endocrinol. Metab.* **21**, 1500 (1961).  
 (37T) Yosizawa, Z., *Tohoku J. Exptl. Med.* **72**, 140 (1960).  
 (38T) Zelnicek, E., *Casopis Lekaru Ceskych* **99**, 927 (1960).

#### Organic Compounds

- (1U) Altshuller, A. P., Cohen, I. R., *ANAL. CHEM.* **32**, 1843 (1960).  
 (2U) Barbieri, F. D., Brauckmann, E. S., *Arch. Bioquim., Quim. Farm., Tucuman* **9**, 85 (1961).  
 (3U) Bowman, M. C., Boroza, M., Acree, F., Jr., *ANAL. CHEM.* **33**, 1053 (1961).  
 (4U) Christensen, G. M., *Ibid.* **34**, 1030 (1962).  
 (5U) Curzon, G., Walsh, J., *Clin. Chim. Acta* **7**, 657 (1962).  
 (6U) Gerber, G. B., Gerber, G., Altman, K. I., *ANAL. CHEM.* **33**, 852 (1961).  
 (7U) Glaubitt, D., *Arzneimittel-Forsch.* **10**, 837 (1960).  
 (8U) Kotake, Y., Tsuji, M., Hasegawa, N., *Proc. Japan Acad.* **37**, 48 (1961).  
 (9U) Lundquist, F., Fugmann, U., Rasmussen, H., *Biochem. J.* **80**, 393 (1961).  
 (10U) Reid, R. L., *Analyst* **85**, 265 (1960).  
 (11U) Rorem, E. S., *Anal. Biochem.* **1**, 218 (1960).  
 (12U) Ruch, J. E., Johnson, J. B., Critchfield, F. E., *ANAL. CHEM.* **33**, 1566 (1961).  
 (13U) Shivaram, K. N., Mueting, D., *Aerzl. Forsch.* **15**, I/337 (1961).  
 (14U) Tompsett, S. L., *Clin. Chim. Acta* **7**, 50 (1962).  
 (15U) Tsao, M. U., Schwartz, E. L., *Anal. Biochem.* **3**, 448 (1962).  
 (16U) Wiechowski, W., *Deut. Gesundheitsw.* **16**, 80 (1961).  
 (17U) Williams, J. N., Jr., Anderson, C. E., Jasik, A. D., *J. Lipid Res.* **3**, 378 (1962).
- (1V) Afonso, E., *Clin. Chim. Acta* **6**, 883 (1961).  
 (2V) Altaner, C., Gregusova, V., *Collection Czech. Chem. Commun.* **26**, 1727 (1961).  
 (3V) Biemann, K., Vetter, W., *Biochem. Biophys. Research Commun.* **3**, 578 (1960).  
 (4V) Bockemüller, W., Oerter, A., *Klin. Wochschr.* **39**, 371 (1961).  
 (5V) Bottiger, L. E., Carlson, L. A., *Clin. Chim. Acta* **5**, 812 (1960).  
 (6V) Broomfield, C. A., Scheraga, H. A., *J. Biol. Chem.* **236**, 1960 (1961).  
 (7V) Burstein, M., *Ann. Biol. Clin. (Paris)* **18**, 655 (1960).  
 (8V) Cawley, L. P., Eberhardt, L., *Am. J. Clin. Pathol.* **38**, 539 (1962).  
 (9V) Clark, A., *Clin. Chim. Acta* **7**, 299 (1962).  
 (10V) Cohen, E., Raducha, J. J., *Tech. Bull. Registry Med. Technologists* **32**, 82 (1962).  
 (11V) Colover, J., *J. Clin. Pathol.* **14**, 559 (1961).  
 (12V) Drickman, A., McKeon, F. A., Jr., *Am. J. Clin. Pathol.* **38**, 392 (1962).  
 (13V) Ellman, G. L., *Anal. Bicchem.* **3**, 40 (1962).  
 (14V) Farr, A. F., Chaney, A. L., *ANAL. CHEM.* **33**, 1790 (1961).  
 (15V) Fasold, H., Linhart, P., Turba, F., *Biochem. Z.* **336**, 191 (1962).  
 (16V) Faulkner, W. R., Gardner, M., Lewis, L. A., *Clin. Chem.* **8**, 424 (1962).  
 (17V) Ferris, T. G., Easterling, R. E., Budd, R. E., *Am. J. Clin. Pathol.* **38**, 383 (1962).
- (18V) Friedman, H. S., *Clin. Chim. Acta* **6**, 775 (1961).  
 (19V) Goodwin, J. F., *Am. J. Clin. Pathol.* **35**, 227 (1961).  
 (20V) Gordon, A. H., *Biochim. Biophys. Acta* **42**, 23 (1960).  
 (21V) Grabowska, M., *Postepy Hig. Med. Doswiadczanej* **14**, 145 (1960).  
 (22V) Kekki, M., Siltanen, P., *Scand. J. Clin. Lab. Invest.* **12**, 235 (1960).  
 (23V) Keyser, J. W., *Clin. Chim. Acta* **6**, 445 (1961).  
 (24V) Kingsley, G. R., *Clin. Chem.* **8**, 431 (1962).  
 (25V) Korotzer, J. L., Bergquist, L. M., Searcy, R. L., *Am. J. Med. Technol.* **27**, 197 (1961).  
 (26V) Kostyukovskaya, O. M., Zhukov, A. V., *Vopr. Med. Khim.* **7**, 642 (1961).  
 (27V) Lawrence, S. H., Benjamin, D. C., *Clin. Chim. Acta* **6**, 398 (1961).  
 (28V) Leach, A. A., *Anal. Biochem.* **2**, 529 (1961).  
 (29V) Matson, C. F., *Am. J. Clin. Pathol.* **37**, 143 (1962).  
 (30V) McDonald, H. J., Liberti, P. A., *Anal. Biochem.* **4**, 28 (1962).  
 (31V) Murphy, J. B., Kies, M. W., *Biochim. Biophys. Acta* **45**, 382 (1960).  
 (32V) Osborn, D. A., *Clin. Chim. Acta* **5**, 777 (1960).  
 (33V) Patrick, R. L., Thiers, R. E., *Clin. Chem.* **7**, 555 (1961).  
 (34V) Patterson, R., *J. Lab. Clin. Med.* **57**, 657 (1961).  
 (35V) Plekhan, M. I., *Khim. Belka, Moskov. Gosudarst. Univ., Khim. Fak., Sbornik Statei* **1961**, No. 1, 191.  
 (36V) Raymond, S., Nakamichi, M., Aurell, B., *Nature* **195**, 697 (1962).  
 (37V) Reisfeld, R. A., Lewis, U. J., Williams, D. E., *Ibid.* **281** (1962).  
 (38V) Ressler, N., *Clin. Chim. Acta* **5**, 795 (1960).  
 (39V) Ressler, N., Goodwin, J. F., *Am. J. Clin. Pathol.* **38**, 131 (1962).  
 (40V) Rinderknecht, H., *Experientia* **16**, 430 (1960).  
 (41V) Robinson, J. C., Blumberg, B. S., Pierce, J. E., *J. Lab. Clin. Med.* **60**, 468 (1962).  
 (42V) Saifer, A., Gerstenfeld, S., *Clin. Chem.* **8**, 236 (1962).  
 (43V) Saifer, A., Gerstenfeld, S., Vecsler, F., *Ibid.* **7**, 626 (1961).  
 (44V) Scheurlen, P. G., *Clin. Chim. Acta* **4**, 760 (1959).  
 (45V) Schmidt, V., Roentgen, *Lab. praxis* **13**, L57 (1960).  
 (46V) Shatalova, A. A., Meerov, G. I., Savinskii, Y. R., *Biokhimiya* **25**, 577 (1960).  
 (47V) Siltanen, P., Kekki, M., *Scand. J. Clin. Lab. Invest.* **12**, 228 (1960).  
 (48V) Smith, H., Owen, J. A., *Biochem. J.* **78**, 723 (1961).  
 (49V) Sobral, C., *Anais Fac. Med. Univ. Recife* **20**, 285 (1960).  
 (50V) Sochman, J., Malaskova, V., *Clin. Chim. Acta* **7**, 383 (1962).  
 (51V) Sokol, F., Hana, L., Albrecht, P., *Folia Microbiol. (Prague)* **6**, 145 (1961).  
 (52V) Soothill, J. F., *J. Lab. Clin. Med.* **59**, 859 (1962).  
 (53V) Strickland, R. D., Freeman, M. L., Gurule, F. T., *ANAL. CHEM.* **33**, 545 (1961).  
 (54V) Uriel, J., Grabar, P., *Anal. Biochem.* **2**, 80 (1961).  
 (55V) Vanderzant, C., Tennison, W. R., *Food Technol.* **15**, 63 (1961).  
 (56V) West, C. D., Hinrichs, V., Hinkle, N. H., *J. Lab. Clin. Med.* **58**, 137 (1961).  
 (57V) Wilkinson, G. K., Wilkinson, G. N., *Australian J. Exptl. Biol. Med. Sci.* **38**, 487 (1960).  
 (58V) Wolf, A. V., Fuller, J. B., Goldman, E. J., Mahony, T. D., *Clin. Chem.* **8**, 158 (1962).
- (59V) Zuber, H., *Chimia (Aarau)* **14**, 405 (1960).

#### Sterols

- (1W) Adamec, O., Matis, J., Galvanek, M., *Lancet* **1**, 81 (1962).  
 (2W) Beale, R. N., Croft, D., *J. Clin. Pathol.* **15**, 221 (1962).  
 (3W) Bowman, R. E., Wolf, R. C., *Clin. Chem.* **8**, 302 (1962).  
 (4W) Braunsberg, H., James, V. H. T., *Anal. Biochem.* **1**, 452 (1960).  
 (5W) Carstensen, H., *Methods of Biochem. Anal.* **9**, 127 (1962).  
 (6W) Cohn, G. L., Bondy, P. K., Castiglione, C., *J. Clin. Invest.* **40**, 400 (1961).  
 (7W) Conrad, S., Mahesh, V., Herrmann, W., *Ibid.*, 947 (1961).  
 (8W) Cooper, J. A., Abbott, J. P., Rosengreen, B. K., Claggett, W. R., *Am. J. Clin. Pathol.* **38**, 388 (1962).  
 (9W) Cooper, J. A., Creech, B. G., *Anal. Biochem.* **2**, 502 (1961).  
 (10W) Creech, B. G., Sewell, B. W., *Ibid.* **3**, 119 (1962).  
 (11W) Crepy, O., Lachese, B., Judas, O., *Rev. Franc. Etudes Clin. Biol.* **6**, 601 (1961).  
 (12W) De Moor, P., Osinski, P., Deckx, R., Steeno, O., *Clin. Chim. Acta* **7**, 475 (1962).  
 (13W) Epstein, E., *Ibid.*, 735 (1962).  
 (14W) Exley, D., Ingall, S. C., Norymberski, J. K., Woods, G. F., *Biochem. J.* **81**, 428 (1961).  
 (15W) Green, A. G., *Clin. Chim. Acta* **7**, 674 (1962).  
 (16W) Henke, W. J., *J. Clin. Endocrinol. Metab.* **20**, 1527 (1960).  
 (17W) Herrmann, W. L., *Gynaecologia* **151**, 156 (1961).  
 (18W) Huang, T. C., Chen, C. P., Wefer, V., Raferty, A., *ANAL. CHEM.* **33**, 1405-7 (1961).  
 (19W) Hudson, B., Oertel, G. W., *Anal. Biochem.* **2**, 248 (1961).  
 (20W) Ittrich, G., *Acta Endocrinol.* **35**, 34 (1960).  
 (21W) Jacobsohn, G. M., Lieberman, S., *J. Biol. Chem.* **237**, 1469 (1962).  
 (22W) Johnson, D. F., Heftmann, E., Francois, D., *J. Chromatog.* **4**, 446 (1960).  
 (23W) Joubert, S. M., *Clin. Chem.* **7**, 596 (1961).  
 (24W) Kabara, J. J., McLaughlin, J. T., Riegel, C. A., *ANAL. CHEM.* **33**, 305 (1961).  
 (25W) Kakushkina, E. A., Orlova, V. G., *Gormonal'n. Issledovan. v Ginekol. (Moscow): Gosudarst. Izdatel. Med. Lit.) Sbornik* **1960**, 35.  
 (26W) Kingsley, G. R., Getchell, G., *Anal. Biochem.* **2**, 1 (1961).  
 (27W) Kingsley, G. R., Robnett, O., *ANAL. CHEM.* **33**, 561 (1961).  
 (28W) Kirschner, M. A., Fales, H. M., *Ibid.* **34**, 1548 (1962).  
 (29W) Kliman, B., Peterson, R. E., *J. Biol. Chem.* **235**, 1639 (1960).  
 (30W) Lewbart, M. L., Mattox, V. R., *ANAL. CHEM.* **33**, 559 (1961).  
 (31W) Lotti, G., Marceano, A., *Arch. "E. Maragliano" pathol. clin.* **16**, 605 (1960).  
 (32W) McGregor, R. F., Ward, D. N., Cooper, J. A., Creech, B. G., *Anal. Biochem.* **2**, 441 (1961).  
 (33W) Marti, M., Schindler, O., *Gynaecologia* **151**, 67 (1961).  
 (34W) Miras, C. J., Contaxis, C. C., *Chim. Chronika (Athens, Greece)* **27**, 43 (1962).  
 (35W) Monder, C., White, A., *Endocrinology* **68**, 159 (1961).  
 (36W) Ober, W. B., Kaiser, G. A., *Am. J. Clin. Pathol.* **35**, 297 (1961).

- (37W) Oertel, G. W., *Clin. Chim. Acta* **6**, 242 (1961).  
 (38W) Oertel, G. W., Kaiser, E., *Ibid.*, **7**, 463 (1962).  
 (39W) Preedy, J. R. K., Aitken, E. H., *J. Biol. Chem.* **236**, 1297 (1961).  
 (40W) Rudd, B. T., Cowper, J. M., Crawford, N., *Clin. Chim. Acta* **6**, 686 (1961).  
 (41W) Salokangas, R.A.A., Bulbrook, R. D., *J. Endocrinol.* **22**, 47 (1961).  
 (42W) Schubert, K., Wehrberger, K., *Naturwissenschaften* **47**, 281 (1960).  
 (43W) Sheff, M. F., Gretz, M. D., McMarlin, J. B., *Clin. Chem.* **7**, 504 (1961).  
 (44W) Sparagana, M., Mason, W. B., Keutmann, E. H., *ANAL. CHEM.* **34**, 1157 (1962).  
 (45W) Starnes, W. R., Williams, B. H., Partlow, T. F., Myer, G. B., Pittman, J. A., Hill, S. R., *J. Lab. Clin. Med.* **59**, 1026 (1962).  
 (46W) Staub, M. C., Dingman, J. F., Fesler, K. W., *J. Clin. Endocrinol. Metab.* **21**, 148 (1961).  
 (47W) Staub, M. C., Gaitan, E., Dingman, J. F., Fesler, K. W., *Ibid.*, **22**, 87 (1962).  
 (48W) Stewart, C. P., Albert-Recht, F., Osman, L. M., *Clin. Chim. Acta* **6**, 696 (1961).  
 (49W) Strickler, H. S., Wilson, G. A., Grauer, R. C., *Anal. Biochem.* **2**, 486 (1961).  
 (50W) Svendson, R., *Acta Endocrinol.* **35**, 161 (1960).  
 (51W) Van der Vies, J., Organon, N. V., *Ibid.*, **38**, 399 (1961).  
 (52W) Velu, P., Velu, M., *Rev. Pathol. Gen. Physiol. Clin.* **60**, 1321 (1960).  
 (53W) Watson, D., *Clin. Chim. Acta* **5**, 637 (1960).  
 (54W) Yonger, J., Delorme, G., *Ann. Biol. Clin. (Paris)* **19**, 151 (1961).

### Toxicology

- (1X) Akaishi, J., *Nippon Genshiryoku Gakkaishi* **2**, 379 (1960).  
 (2X) Aumonier, P., Quilichini, R., *Bull. Soc. Pharm. Bordeaux* **101**, 41 (1962).  
 (3X) Berkes, P., Matvejeva, L., *Godisen Zbornik Med. Fab. Skopje* **5**, 25 (1959).  
 (4X) Berman, E., *Am. J. Clin. Pathol.* **36**, 549 (1961).  
 (5X) Boni, A. L., *Health Phys.* **2**, 288 (1960).  
 (6X) Bowen, H. J. M., *Biochem. J.* **77**, 79 (1960).  
 (7X) Brewer, G., Tarlov, A., Alving, A. S., *Bull. World Health Organ.* **22**, 633 (1960).  
 (8X) Bush, M. T., *Microchem. J.* **5**, 73 (1961).  
 (9X) Butler, R. A., Hill, D. W., *Nature* **189**, 488 (1961).  
 (10X) Buyske, D. A., Downing, V., *ANAL. CHEM.* **32**, 1798 (1960).  
 (11X) Cafruny, E. J., *J. Lab. Clin. Med.* **57**, 468 (1961).  
 (12X) Chundela, B., Janak, J., *J. Forensic Med.* **7**, 153 (1960).  
 (13X) Cortivo, L. A. D., Cefola, M., Umberger, C. J., *Anal. Biochem.* **1**, 491 (1960).  
 (14X) Curry, A. S., *J. Forensic Sci.* **6**, 373 (1961).  
 (15X) Dean, J. A., Burger, J. C., Rains, T. C., Zittel, H. E., *ANAL. CHEM.* **33**, 1722 (1961).  
 (16X) Dietrich, W. C., Caylor, J. D., Johnson, E. E., *U. S. At. Energy Comm.* **Y-1322**, 1 (1960).  
 (17X) Dux, J. P., Feairheller, W. R., *ANAL. CHEM.* **33**, 445 (1961).  
 (18X) Engel, W., Holzapfel, L., *Beitr. Silikose-Forsch., Sonderband* **4**, 67 (1960).  
 (19X) Faulkner, A. G., Knoblock, E. C., Purdy, W. C., *Clin. Chem.* **7**, 22 (1961).

- (20X) Fischl, J., Segal, S., *Clin. Chem.* **7**, 252 (1961).  
 (21X) Frey, H. H., Eberhardt, G., Rustemeyer, J., *Arch. Toxikol.* **18**, 189 (1960).  
 (22X) Gage, J. C., *Med. Sci. Law* **1**, 137 (1961).  
 (23X) Genest, K., Farmilo, C. G., *ANAL. CHEM.* **34**, 1464 (1962).  
 (24X) Ginther, G. B., Finch, R. C., *Ibid.*, **32**, 1894 (1960).  
 (25X) Hall, R. J., *Analyst* **85**, 560 (1960).  
 (26X) Hanke, M. E., *Clin. Chem.* **8**, 421 (1962).  
 (27X) Hauck, G., *Deut. Z. Ges. Gerichtl. Med.* **51**, 570 (1961).  
 (28X) Hetman, J., *Lab. Pract.* **10**, 155 (1961).  
 (29X) Hill, D. W., *Forensic Sci. Soc. J.* **2**, 32 (1961).  
 (30X) Hill, W. H., Hengstenberg, F. H., Sharpe, C. E., *Am. Ind. Hyg. Assoc. J.* **22**, 430 (1961).  
 (31X) Irudayamamy, A., Natarajan, A. R., *ANAL. CHEM.* **33**, 630 (1961).  
 (32X) Ivanov, V. I., Rozenberg, P. A., *Gigiena Truda i Prof. Zabolevaniya* **4**, 39 (1960).  
 (33X) Jacobs, M. B., Goldwater, L. J., Gilbert, H., *Am. Ind. Hyg. Assoc. J.* **22**, 276 (1961).  
 (34X) Jacobs, M. B., Singerman, A., *J. Lab. Clin. Med.* **59**, 871 (1962).  
 (35X) Kaye, S., *The Laboratory Digest* **24**, 4 (1960).  
 (36X) Kingston, C. R., Kirk, P. L., *ANAL. CHEM.* **33**, 1794 (1961).  
 (37X) Klatt, O., Griffin, A. C., Stehlin, J. S., Jr., *Proc. Soc. Exptl. Biol. Med.* **104**, 629 (1960).  
 (38X) Korkisch, J., Janauer, G. E., *ANAL. CHEM.* **33**, 1930 (1961).  
 (39X) Kudahl, J. K., Fremlin, J. H., Hardwick, J. L., *Radioisotopes Phys. Sci. Ind., Proc. Conf. Use Copenhagen* **2**, 317 (1960).  
 (40X) Kudo, K., *Nippon Kagaku Zasshi* **81**, 570 (1960).  
 (41X) Leidt, S. C., Sanders, S. M., Jr., *U. S. At. Energy Comm. TID-7591*, 64 (1960).  
 (42X) Linn, S., Roberts, M., *Ann. N. Y. Acad. Sci.* **92**, 419 (1961).  
 (43X) Lott, P. F., Cheng, K. L., Kwan, B. C. H., *ANAL. CHEM.* **32**, 1702 (1960).  
 (44X) Lubran, M., *Clin. Chim. Acta* **6**, 594 (1961).  
 (45X) Machata, G., *Mikrochim. Acta* **4**, 691 (1962).  
 (46X) Mackintosh, W. D., Jervis, R. E., *At. Energy Can. Ltd.* **1083**, 11 pages (1960).  
 (47X) Maehly, A. C., *Analyst* **87**, 116 (1962).  
 (48X) Martin, G. E., Munn, J. I., Biskup, L., *J. Assoc. Offic. Agr. Chemists* **43**, 743 (1960).  
 (49X) Mathies, J., Lund, P. K., *Norelco Repr.* **7**, 134-9 (1960).  
 (50X) Matsumoto, H., *Kagaku Keisatsu Kenkyusho Hokoku* **13**, 79 (1960).  
 (51X) Merville, R., Dequidt, J., Corteel, M. L., *Ann. Pharm. Franc.* **18**, 625 (1960).  
 (52X) Misumi, S., Nagano, N., *ANAL. CHEM.* **34**, 1723 (1962).  
 (53X) Mokranjac, M. S., Jovanovic, D., *Acta Pharm. Jugoslav.* **11**, 65 (1961).  
 (54X) Murphy, J. W., Affsprung, H. E., *ANAL. CHEM.* **33**, 1658 (1961).  
 (55X) Natelson, S., Sheid, B., *Ibid.*, 396 (1961).  
 (56X) Nazyrov, G. N., Vengerskaya, Kh. Y., *Lab. Delo* **6**, 35 (1960).  
 (57X) Niyogi, S. K., Tompsett, S. L., Stewart, C. P., *Clin. Chim. Acta* **6**, 739 (1961).  
 (58X) Page, L. A., Verhulst, H. L., *Am. J. Diseases of Children* **103**, 107 (1962).  
 (59X) Parker, K. D., Fontan, C. R., Yee, J. L., Kirk, P. L., *ANAL. CHEM.* **34**, 1234 (1962).  
 (60X) Parker, K. D., Kirk, P. L., *Ibid.*, **33**, 1378 (1961).  
 (61X) Perry, H. M., Jr., Tipton, I. H., Schroeder, H. A., Cook, M. J., *J. Lab. Clin. Med.* **60**, 245 (1962).  
 (62X) Rains, T. C., Zittel, H. E., Ferguson, M., *ANAL. CHEM.* **34**, 778 (1962).  
 (63X) Read, S. T., McKinley, W. P., *Arch. Environ. Health* **3**, 209 (1961).  
 (64X) Robertson, D. N., Erley, D. S., *Anal. Biochem.* **2**, 45 (1961).  
 (65X) Roddy, T. C., Jr., Wallace, S. M., *Am. J. Clin. Pathol.* **36**, 373 (1961).  
 (66X) Ronteix, C., Hugot, G., *Comm. Energie At. (France), Rappt. CEA* **1706**, 9 pages (1960).  
 (67X) Rosenfeld, G., *Anal. Biochem.* **1**, 469 (1960).  
 (68X) Ross, W. J., White, J. C., *ANAL. CHEM.* **33**, 421 (1961).  
 (69X) Sill, C. W., Willis, C. P., *Ibid.*, **34**, 954 (1962).  
 (70X) Sill, C. W., Willis, C. P., Flygare, J. K., Jr., *Ibid.*, **33**, 1671 (1961).  
 (71X) Stavinotha, W. B., Nash, J. B., *Ibid.*, **32**, 1695 (1960).  
 (72X) Stevenson, G. W., *Ibid.*, **33**, 1903 (1961).  
 (73X) Stevenson, G. W., Sobel, C., Kenney, P., *Clin. Chem.* **8**, 422 (1962).  
 (74X) Street, H. V., *Clin. Chim. Acta* **5**, 938 (1960).  
 (75X) *Ibid.*, **7**, 226 (1962).  
 (76X) Sunderman, F. W., Sunderman, F. W., Jr., *Am. J. Clin. Pathol.* **35**, 203 (1961).  
 (77X) Taussky, H. H., *Clin. Chem.* **8**, 423 (1962).  
 (78X) Tewari, S. N., *Arch. Kriminol.* **128**, 30 (1961).  
 (79X) *Ibid.*, **33** (1961).  
 (80X) Vengerskaya, Kh. Y., *Lab. Delo* **7**, 19 (1961).  
 (81X) West, P. W., Llacer, A. J., *ANAL. CHEM.* **34**, 555 (1962).  
 (82X) West, P. W., Mohilner, P. R., *Ibid.*, 558 (1962).  
 (83X) Westlake, W. E., *Ibid.*, **33**, 88R (1961).  
 (84X) Williams, L. A., Brusock, Y. M., Zak, B., *Ibid.*, **32**, 1883 (1960).  
 (85X) Williams, L. A., Linn, R. A., Zak, B., *Am. J. Clin. Pathol.* **34**, 334 (1960).  
 (86X) Williams, L. A., Linn, R. A., Zak, B., *J. Forensic Sci.* **6**, 119 (1961).  
 (87X) Willis, J. B., *ANAL. CHEM.* **34**, 614 (1962).

### Vitamins

- (1Y) Baker, H., Frank, O., Matovich, V. B., Pasher, I., Aaronson, S., Hutner, S. H., Sobotka, H., *Anal. Biochem.* **3**, 31 (1962).  
 (2Y) Baker, H., Frank, O., Pasher, I., Hutner, S. H., Sobotka, H., *Clin. Chem.* **6**, 576 (1960).  
 (3Y) Baker, H., Frank, O., Pasher, I., Sobotka, H., *Ibid.*, 581 (1960).  
 (4Y) Beck, W. S., *New Engl. J. Med.* **266**, 708, 765 (1962).  
 (5Y) Burch, H. B., *Ann. N. Y. Acad. Sci.* **92**, 268 (1961).  
 (6Y) Craig, R. G., Bergquist, L. M., Searcy, R. L., *Anal. Biochem.* **1**, 433 (1960).  
 (7Y) Crossland, I., *Acta Chem. Scand.* **14**, 805 (1960).  
 (8Y) Hever, O., *Z. Physiol. Chem.* **325**, 275 (1961).  
 (9Y) Ikeda, D., Yaku, F., Yu, H., Sakota, N., *Yakugaku Kenkyu* **33**, 26 (1961).  
 (10Y) Jakovljevic, I. M., *Pharm. Weekblad* **95**, 549 (1960).  
 (11Y) Knox, W. E., Goswami, M. N. D., *Advan. Clin. Chem.* **4**, 121 (1961).

- (12Y) Kubin, H., Fink, H., *Fette, Seifen, Anstrichmittel* **63**, 280 (1961).  
 (13Y) Leeman, H. G., Stich, K., *Helv. Chim. Acta* **45**, 1275 (1962).  
 (14Y) Lench, E. R. H., Lewis, G. T., *Chemist-Analyst* **50**, 18 (1961).  
 (15Y) Pelletier, O., Campbell, J. A., *Anal. Biochem.* **3**, 60 (1962).  
 (16Y) Polk, A., Flanagan, T. L., Van Loon, E. J., *Clin. Chem.* **6**, 558 (1960).  
 (17Y) Rindi, G., De Giuseppe, L., *Bio-Chem. J.* **78**, 602 (1961).  
 (18Y) Roe, J. H., *Ann. N. Y. Acad. Sci.* **92**, 277 (1961).  
 (19Y) Roe, J. H., *J. Biol. Chem.* **236**, 1611 (1961).  
 (20Y) Toepfer, E. W., Polansky, M. MacA., Hewston, E. M., *Anal. Biochem.* **2**, 463 (1961).  
 (21Y) Tsen, C. C., *ANAL. CHEM.* **33**, 849 (1961).  
 (22Y) Wawrzyczek, W., *Z. Anal. Chem.* **184**, 191 (1961).  
 (23Y) Yamaoka, T., *Bitamin* **21**, 304 (1960).  
 (24Y) Yoshida, K., Hosokawa, A., Yoshida, S., *Mie Med. J.* **11**, 13 (1961).  
 (4Z) Forbes, J. W., *Ibid.*, **34**, 1125 (1962).  
 (5Z) Gaebler, O. H., Choitz, H. C., *Clin. Chem.* **6**, 549 (1960).  
 (6Z) Grisler, R., Nava, C., *Recenti Progr. Med.* **30**, 438 (1961).  
 (7Z) Hendry, E. B., *Clin. Chem.* **8**, 246 (1962).  
 (8Z) *Ibid.*, **7**, 156 (1961).  
 (9Z) Mendelsohn, D., Levin, N. W., *S. African J. Med. Sci.* **25**, 13 (1960).  
 (10Z) Mungall, T. G., Mitchen, J. H., *ANAL. CHEM.* **33**, 1330 (1961).  
 (11Z) Remington, J. W., Baker, C. H., *Circulation Res.* **9**, 60 (1961).  
 (12Z) Rodkey, F. L., *J. Biol. Chem.* **236**, 1589 (1961).  
 (13Z) Vaughan, B. E., Boling, E. A., *J. Lab. Clin. Med.* **57**, 159 (1961).

## Miscellaneous

- (1Z) Bower, V. E., Paabo, M., Bates, R. G., *Clin. Chem.* **7**, 292 (1961).  
 (2Z) Crespi, H. L., Katz, J. J., *Anal. Biochem.* **2**, 274 (1961).  
 (3Z) Critchfield, F. E., Bishop, E. T., *ANAL. CHEM.* **33**, 1034 (1961).

# Coatings

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**T**HIS biennial review contains the authors' choice of the important contributions to the analysis of coating materials from November 1960 to November 1962 since the previous summary (110). It is hoped that, in an attempt to be selective, valuable publications have not been omitted. Other similar reviews were made within this period (88, 90), in addition to some on special subjects. In the annual reviews of analytical methods for the examination of oils and fatty acids (51, 108), numerous references are made to instrumental techniques. Newer techniques for analyzing lipides were presented in the collected lectures of the 1961 short course sponsored by the American Oil Chemists' Society (58). A comprehensive, alphabetical list of analytical and other test methods that appear in U. S. and Canadian specifications on coating materials (84) was published in 1960. Some of the papers presented in a symposium (1) on the analysis of high polymers were collectively reprinted and include such subjects as resinography, chemical structure, pyrolysis techniques, tagged standards, polymer fractionation by column methods, molecular orientation in polymer films, and chemical analysis. The application of infrared spectroscopy and gas chromatography to coating analysis was reviewed by Brenner (12); a similar review including pigment analysis was made by Lamprecht (64). Woolridge (120) reviewed the application of paper chromatography, ion exchange resins, and complexones to the analysis of such paint components as dicarboxylic

acids, polyhydric alcohols, and pigments and included some original procedures. A summary (60) was made of the qualitative and quantitative methods for the determination of the fatty and rosin acids present in tall oil.

The 12th edition of the Gardner Laboratory manual on paint, varnish, and lacquer testing (34) was released in recent months. Parts II and III of "Analytical Chemistry of Polymers" (61, 62) dealing with techniques for the determination of chemical and physical structure have been published.

### GENERAL ANALYTICAL SCHEMES

Gas chromatographic examination of the products of thermal degradation and description of devices for obtaining or introducing pyrolyzates continue to be the principal topic of discussion in coating analysis. Porter, Hoffman, and Johnson (96) describe a unit for pyrolyzing weighed samples at ambient to over 500° C. temperatures and state that their unit is adaptable to most commercial instruments. Barlow, Lehrle, and Robb (5) employed two degradation techniques, characterizing polymers by chromatograms of their degradation products at a number of temperatures and observed quantitative yields. Hewitt and Whitham (47) described their glass pyrolysis unit, which is suitable for both liquid and solid samples, and reviewed the literature on gas chromatographic identification of materials by this method. In still another paper on direct analysis of polymers (30) by thermal degradation, the pyrolyzates of nitrocellulose, poly(*n*-butyl methacry-

late), and poly(vinyl alcohol) were obtained and measured at 650° C. Jones and Moyles (57) explain the use of a simple unit for obtaining chromatograms of the pyrolyzates of acrylic and styrene polymers.

The use of controlled pyrolytic conditions followed by fractional distillation and sometimes sublimation is reported by Cleverley and Herrmann (19) for identifying elastomers and their additives from the infrared spectra of the isolated products. The application of the paper chromatographic technique to the identification of the pyrolysis products of elastomers was reported (31). In this procedure, mercuric acetate adducts of the 700° pyrolyzates were formed and the chromatographic patterns compared to those from known materials. Diphenylcarbazone spray was used for detection and the study applied mostly to natural and synthetic rubbers. Paper chromatography was also used by Noda and Hirayama (83) for the detection of fatty acids and glycerides.

Vargas (115) tabulated a variety of tests for the identification of polymers of styrene, isobutylene, chloroprene, vinyl acetate, and natural rubber. Extensive treatment of the subject of qualitative and "spot" tests for polymers and resins was presented by Lucchesi and Tessari (70). Color reactions for the detection of poly(vinyl alcohol), poly(vinyl acetate), poly(vinyl chloride), epoxy resins, urea-, thiourea-, and melamine-formaldehyde, methylated nitrogen resins, and dicyandiamide on fabrics have been described (23).